Specification

1. Customer : _____

2. Product : **Lithium-Ion 3S3P Battery Pack (7,200mAh)**

3. Model : **Li 204SX-72**

4.Reviewed By :

Emerging Power, Inc.
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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, Smart Module (SMBus 1.0v/1.1v), safety units, and a Protection Circuit Module.

2. Description and Model

2.1. Description	Lithium-Ion rechargeable battery pack
2.2. Battery Cell Configuration	3S – 3P
2.3. Model name	Li 204SX-72

3. Ratings

3.1. Nominal Capacity	7,200mAh
3.2. Minimum Capacity	7,000mAh
3.3. Charging Voltage	12.6V ± 100mV
3.4. Nominal Voltage	11.1V (3.7V / 1Cell)
3.5. Charging Method	CC-CV (Constant-Voltage with Limited current)
3.6. Charging Current	
Standard charge	2,000mA / 200mA Cut-off
3.7. Max. Pulse charge current	6,000mA
3.8. Max. Charge current	4,000~5,000mAh
3.9. Max. Discharge current	4,000~5,000mAh
3.10. Discharge cutoff voltage	9.0V
3.11 Internal Resistance	≤350mΩ
3.12. Weight	≤480g
3.13. Operating Temperature	
Standard Charge	0 to 45℃
Standard Discharge	-20 to 60℃
3.14. Storage Temperature	
-20 ~ 20℃	≤ 1 Year
-20 ~ 45℃	≤ 3 Months
-20 ~ 60℃	≤ 1 Month
3.15. Storage Humidity	20 ~ 85 % RH (not condensed)

4. Outline Dimension

H × W × L = 214.5±0.5 × 58.5±0.5 × 22.5±0.5 (mm)
Refer to attached drawings.

5. Gas Gauge Indicator

5.1 LED Display

RSOC	LED1	LED2	LED3	LED4	LED5
Voltage < EDVF	Off	Off	Off	Off	Off
RC < RemainingCapacityAlarm	Blink	Off	Off	Off	Off
1 ~ 19%	On	Off	Off	Off	Off
21 ~ 40%	On	On	Off	Off	Off
41 ~ 60%	On	On	On	Off	Off
61 ~ 80%	On	On	On	On	Off
81 ~ 100%	On	On	On	On	On

6. Protection Circuit Module

6.1. PCM Ratings

6.1.1 Maximum Input Voltage 18V
6.1.2 Maximum Charging Current 6.0A
6.1.3 Maximum Discharging Current 6.0A

6.2. PCM Electrical Characteristics at 25℃

6.2.1 Overcharge Prohibition Voltage 4.35±0.05V / Cell
6.2.2 Overcharge Prohibition Release Voltage 4.10±0.05V / Cell
6.2.3 Overcharge Prohibition Delay Time 0.5~1.0s
6.2.4 Over-discharge Prohibition Voltage 2.30±0.15V / Cell
6.2.5 Over-discharge Prohibition Release Voltage 2.90±0.15V / Cell
6.2.6 Over-discharge Prohibition Delay Time 50~150ms
6.2.7 Over-current Protection 6.0~10A
6.2.8 Over-current Protection Delay Time 5~15ms
6.2.9 Operating Current less than 350㎂

6.3. Power dissipation

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

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" is defined as charging the pack with a Charge Current of **2000mA at a constant voltage of 12.6V until the Charge Current reaches 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 1,440mA with 9V cutoff at 25℃ within 1 hour after Standard Charge is applied.

The Initial Discharge time shall be greater than 285min.

8.3. Cycle Life

Cycle life is defined by the discharge time after 299 Cycles measured after and plus 1 day, measured under the same condition in 8.2

Each cycle includes the following periods:

Charging period with 2,000mA / 12.6V and 200mA cut-off

Rest period of 10minutes

Discharging period at 1,440mA with 9.0V cutoff

Rest period of 30 minutes

Discharge time after 299cycles ≥ 240min.

8.4. Initial internal impedance

This is the AC impedance of the pack measured at 1kHz after Standard Charge

Initial internal impedance ≤ 350mΩ

8.5. Discharge capacity with temperature

This is defined as the relative value of Discharge Time at various temperatures compared with the Discharge Time at 25℃ (100%)

Conditions required are :

Standard charge at 25℃

Discharge current at 1,440mA with 9.0V cutoff

Relative capacity	70%	100%	100%	90%
At	-10℃	25℃	45℃	60℃

8.6. Storage characteristics

Remaining capacity of the pack which has been stored at 25℃ for 30 days should be measured by the Discharge Capacity.

Conditions required are:

Standard charge before storage

Discharge current at 1,440mA with 9.0V cutoff

Remaining Capacity (after the storage) ≥ 240Min.

9. Function of Protection Circuit Module (hereinafter PCM)

9.1. Overcharge protection

4.35 ± 0.05 V/cell with reset at 4.10 ± 0.05 V/cell

9.2. Over-discharge protection

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

9.3. Over-current protection

6A to 10A depending upon pack voltage, with reset when load is removed or pack is recharged.

10. Safety test

10.1. Overcharge test

Test method: Apply charge voltage 13.2V to the pack.

Criteria: PCM should be working properly and should stop over charging.
No damage such as leakage, flame, or fire is allowed.

10.2. External short circuit test

Test method: Short-circuit the fully charged battery pack with 12.6V, by connecting positive and negative terminals of the pack with 50mΩ wire for 1 hour.

Criteria: PCM should be working properly and should stop discharging.
No damage such as leakage, flame, or fire is allowed.

10.3. Over-discharge test

Test method: Discharge the battery pack to a voltage less than 6.75V

Criteria: PCM should operate and stop 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 height in any directions consecutively over 3 times.

Criteria : No leakage , OCV ≥ 11.1V, and Internal impedance ≤ 350mΩ.

11.2. Vibration Test

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

Criteria: No leakage , OCV ≥11.1V, and Internal impedance ≤ 350mΩ.

12. Shipment

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

13. Caution

Before using and handling the pack, the attached instruction sheets must be carefully read in detail:

a) "Handling Instruction For Lithium Ion Rechargeable Battery"

b) "Proper Use and Handling of Lithium Ion Cells "

For the purpose of safety, battery packs are shipped out to the customers in a 'low capacity' state. The battery packs have to be fully charged and discharged up to 3 times to utilize Li-Ion smart packs before use.

14. Other

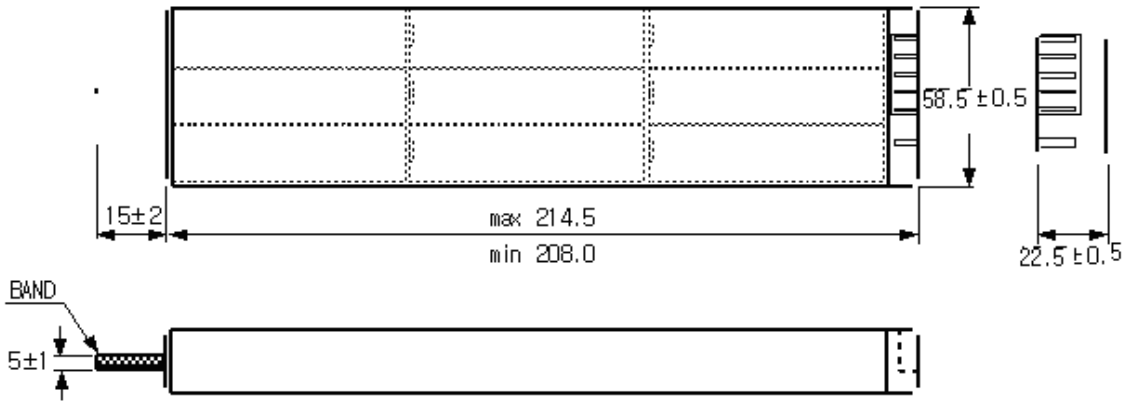
14.1. Storage for a long term

If the pack is to be stored for a long period (3 months or more), it is strongly recommended that the pack be preserved under dry and low temperature conditions. Battery pack should be recharged before use.

14.2. Warranty

Emerging Power, Inc., USA 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 covered under this Warranty.

Revision : 0	Li-204 SX-60 PROPOSAL (OUT VIEW DRAWING, PARTS LIST)	5 6



No.	PART NAME	SPECIFICATION	QTY	REMARK
16	Label	214*130*0.1t	1	Material : P.P
15	Glue	Super-X	1cc	maker : Cemedine
14	Double Adhesive Tape	8*20*0.13	1	maker : 3M, #9070
13	Removal Band	W4xL60x0.2t	1	Material : Nylon
12	C.R Sponge	W10xL40x2.5t	1	
11	Lower Cap	Li-202RL	1	
10	Upper Cap	Li-202RU	1	
9	TUBE	Li-202RT	1	
8	Insulator (#3)	W10xL12x0.15t	4	Material : Nomex
7	Insulating Tape	W8xL15x0.15t	18cm	
6	Ni-tap	6Kinds	10	Nickel
5	PTC	SRP420	1	maker : Raychem
4	FPCB	W20xL20x0.2t	1	maker : Saehan EnerTech
3	Connector	146800-1	1	maker : AMP
2	Module	Li-204SX	1	maker : Saehan (mi-com : bq_2060)
1	Li-ion Cell	18650	9	maker : TBD

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

Read before charging or using the 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 given in the Product Specification.

2.2. Charging voltage

Charging voltage should be less than maximum charging voltage given 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 safety considerations, which shuts off further charging at the specific time given in the Product Specification.

2.4. Charging temperature

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

2.5. Inverse charging

Inverse charging is 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 given in the Product Specification.

3.2. Discharging temperature

The Cell should be discharged within a range of specified temperatures specified in the Product Specification, 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 beyond 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 voltage and to determine recharging procedures.

4. Storage

4.1. Storage conditions
4.1.1. The Cell should be stored within the temperature range 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 the number of times specified in the Product Specification with capacity as 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. The Cell should be welded with leads on its terminal and then be soldered with wire or leads to soldered leads.
6.1.2. Otherwise, it may cause damage of components such as separator and insulator, due to the heat generated.
6.2. Positioning the battery in the system
6.2.1. The battery should be positioned as far as possible 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 it from being short-circuited during transportation, battery assembly and /or system operation.

6.4.2. If the sleeve of the Cell is damaged due to an impact from the outside, it may cause a short-circuit with the 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. Prohibitions on 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 damage.

8. Other

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. If the electrolyte comes in contact with the skin or eyes by accident, 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. 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, as it may cause Cell rupture.

8.4. Immersion

8.4.1. Soaking the Cell in water is strictly prohibited, because it may cause components to get melted and damage cell functions.

8.5. Use with mixed cell types

8.5.1. Use of different types of cells, or same cell types but from different manufacturers in combination may lead to cell rupture or damage to system due to different cell characteristics.

8.6. Battery Disposal

8.6.1. Although the Cell does not contain environmentally hazardous components, such as Lead or Cadmium, the battery should be disposed according to the local regulations.

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 specification describes the requirements for Smart Battery Management Module for Smart Battery Pack "Li204SX-72".

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 documents given below:

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) Reports Battery Voltage, Charging and Discharging Current, Remaining Capacity, Remaining time, Cycles, Temperature, Manufacturing Data, and so on.
(2) Communicates 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.

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 interruption.

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 is shown in Appendix B

[Appendix C. SBD and SMBus Parameters]

1. SMBus Logic Levels and Transfer Rate

SMBUS-CLOCK and SMBUS-DATA Logic Thresholds

$V_{\_LOW}$: 0.6V or lower

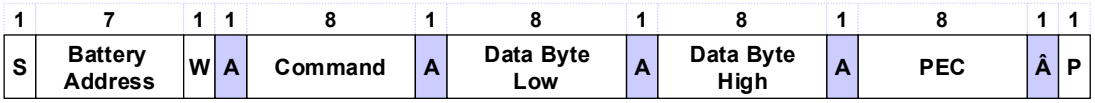
$V_{\_HIGH}$: 1.4V or higher

Transfer Rate

10 ~ 100 kHz

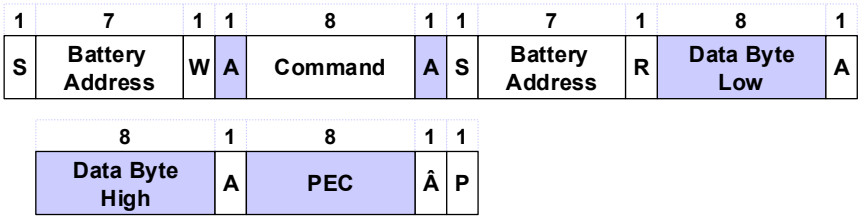
2. SMBus Communication Protocols

Write Word: (Host to Battery)



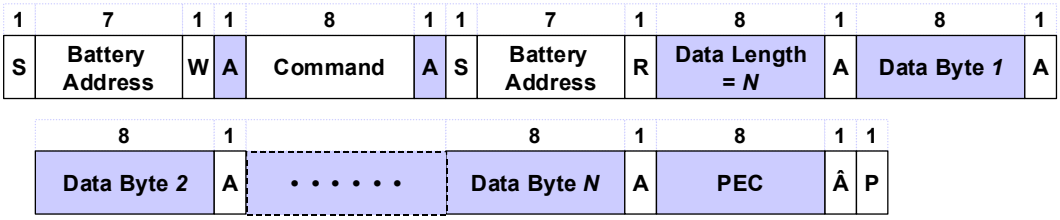
** SMB Data Command 00h ~ 04h supports*

Read Word: (Host to Battery)



** SMB Data Command 00h ~ 1Fh supports*

Read Block: (Host to Battery)



** SMB Data Command 20h ~ 23h supports*

< Legend >

	From Smart Battery	S	Start Condition
	From Host	P	Stop Condition
W	Write Mode Bit (Low)	A	Acknowledge
R	Write Mode Bit (High)	Â	No Acknowledge
PEC	Packet Error Correct Data based on CRC-8		

[Appendix D. Smart Battery Data Specification]

LI204SX-72 (bq2060, ICR18650 2,400mAh)

Function	Code	Access	Defaults	Unit	Remarks
ManufacturerAccess	0x00	R/W	0x0018	hex	
RemainingCapacityAlarm	0x01	R/W	720	mAh	
RemainingTimeAlarm	0x02	R/W	10	min	
BatteryMode	0x03	R/W	0x0000	hex	
AtRate	0x04	R/W	0	mA	
AtRateTimeToFull	0x05	R	0xffff	min	
AtRateTimeToEmpty	0x06	R	0xffff	min	
AtRateOK	0x07	R	1	bool	
Temperature	0x08	R	-	K	Variable
Voltage	0x09	R	-	mV	Variable
Current	0x0a	R	-	mA	Variable
AverageCurrent	0x0b	R	-	mA	Variable
MaxError	0x0c	R	100	%	
RelativeStateOfCharge	0x0d	R	-	%	Variable
AbsoluteStateOfCharge	0x0e	R	-	%	Variable
RemainingCapacity	0x0f	R	-	mAh	Variable
FullChargeCapacity	0x10	R	7200	mAh	Variable
RunTimeToEmpty	0x11	R	0xffff	min	
AverageTimeToEmpty	0x12	R	0xffff	min	
AverageTimeToFull	0x13	R	0xffff	min	
ChargingCurrent	0x14	R	2000	mA	
ChargingVoltage	0x15	R	12600	mV	
BatteryStatus	0x16	R	0x0080	-	
CycleCount	0x17	R	0	int	
DesignCapacity	0x18	R	7200	mAh	
DesignVoltage	0x19	R	12600	mV	
SpecificationInfo	0x1a	R	0x0030	hex	
ManufacturerDate	0x1b	R	03/10/2004	-	
SerialNumber	0x1c	R	1	int	
ManufacturerName	0x20	R	SHEnerTech	string	
DeviceName	0x21	R	LI204SX	string	
DeviceChemistry	0x22	R	LION	string	
ManufacturerData	0x23	R	7 Bytes	hex	Control Mode Digital Filter Self-discahrge rate Battery Low % Near Full Calculated EDV