

Document No.	EP03HPS-NM15SX002	Date	Dec. 30, 2003	Ver.	1.1
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Specification

1. Customer : _____

2. Product : NiMH 9S1P Battery Pack(2,150mAh)

3. Model : NM15SX-21



Emerging Power, Inc.

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1. Scope

This Product Specification ('Specification' here in after) covers the requirements for the rechargeable Nickel Metal Hydride('NiMH' here in after) battery hard pack ('Pack' hereinafter) manufactured and supplied by Emerging Power, Inc.

The pack contains NiMH cells, safety and protection devices, and a fuel gauge module compatible with Smart Battery Specification R1.0/1.1.

2. Description and Model of the pack

2.1. Description	Nickel Metal Hydride rechargeable battery pack
2.2. Model name	NM15SX-21
2.3. Pack Revision	R1.1
2.3. Cell Configuration	9S1P

3. Pack Ratings

3.1. Nominal Capacity	2,150mAh(0.1C charge/0.2C discharge)
3.2. Operation Voltage	Nominal 10.8V(1.2V per cell)
	Shut-down 7.8 ± 0.2V (via Terminal with 2C Discharge))
3. Charging	Voltage 18.0V
	Current 215mAh for standard charging
	1,100mAh for fast charging
	Method CC (Constant current)
	Cut-off -Peak dV > 0.90V for the fast charge
	dT/dt > 1 deg.C/min. for the nominal charge
3.4. Discharging Current	430mAh for standard discharge
	4,300mAh for the max. discharge
3.5. Discharge cut-off voltage	9.0V
3.6. Internal Resistance	≤ 250mΩ
3.7. Weight	≤ 350g
3.8. Operating Temperature	
	Standard Charge 0 ~ 45 °C
	Standard Discharge -10 ~ 60 °C
	Fast Discharge (2C) -10 ~ 30 °C



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3.9. Storage Temperature

-20 ~ 25 °C	≤ 1 Year
-20 ~ 45 °C	≤ 3 Months
-20 ~ 60 °C	≤ 1 Month

3.10. Storage Humidity 20 ~ 85 %RH (not condensed)

3.11. Dimension(W x L x H) 52.5±0.5 x 145.0±1.0 x 18.5±0.5 (mm)

(Refer to attached drawings.)

4. Smart Battery System Support

4.1. Introduction

NM15SX has a Smart Function Module with SMBus Interface and supports the Smart Battery Data(SBData revision 1.0 fully compatible) commands, SBData charge control function, the Battery state of charge, remaining capacity, remaining time, chemistry, and manufacturer information, which are accessible over the serial link.

4.2. Major Features

NM15SX provides accurate measurement of the electrical properties in the pack such as voltage, current, temperature, full capacity, and remaining capacity and time. Four segment LEDs display for remaining capacity. Battery charge state can be directly indicated using a four segment LED display to graphically depict battery full-to-empty in 25% increments.

- *System Management Bus Specification v1.0*
- *Smart Battery Data Specification v1.0*
- *Smart Battery Charger Specification v1.0*

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*



4.4. Smart Module Maximum Rate and Functions

4.4.1. Communication	Type	SMBus
	Revision	v1.0
	Speed	10~100kHz
	Timeout	25~35ms
	Ready Timeout	25ms
4.4.2. Charger Control	Type	Smart Charger Level 1/2/3
	Broadcast Interval	10s
4.4.3. Compatibility	With	SBS(Smart Battery System)
	Revision	v1.0
4.4.4. Accuracy	Voltage	< 2% (via Cell Voltage)
	Current	< 4% (AverageCurrent)
	Temperature	< 2%
	Capacity	< 3% (Standard Cycle)
4.4.5. Operation Mode	Run	Pack voltage higher than 9.0V
	Shut-down	Pack voltage lower than 9.0V

4.4.6. Major Function or Information

- *Cycle Count Learning*
- *Self Capacity Calibration and MaxError Adjust*
- *Smart charger control function support*
- *Cell Information such as Voltage, Current, Temperature and Capacity*
- *Charging information such as ChargingCurrent and Voltage*
- *Pack Informaiotn such as Model, Device Name and Chemistry*
- *Manufacture Information such as Manufacture Name, Date and Serial Number*
- *Optimized for the specific device (contact us to get the detaile information)*
- *Gas gauging indicator*

4.4.7. Smart Battery Data

See Appendix B.

4.5. Self Capacity Calibration

FullChargeCapacity(FCC) is the last measured discharge capacity of the battery. On initialization(application of Vcc or Reset) FCC is set to the default value such as the DesignCapacity.



The FCC is susceptible to error on initialization or if no updates occur. On initialization, the FCC value includes the error between the design capacity and the actual capacity. This error is present until a qualified discharge occurs and FCC is updated. The other cause of FCC error is battery wear-out. As the battery ages, the measured capacity must be adjusted to account for changes in actual battery capacity. Periodic qualified discharges from full to empty will minimize errors in FCC.

4.6. Calibration Method

Step 1 : Full Charge

For Li-Ion charge control, the ChargingVoltage must be set to the desired pack voltage during the constant voltage charge phase. The NM15SX detects a dT/dt when it measures the pack temperature deviation to be higher than 1 deg.C/min and non-zero for at least 100s. Valid charge is not have any errors such as

- *Over current fault exists when the AverageCurrent is less than 2.500A.*
- *Over-temperature fault exists when the Temperature is higher than 61 deg.C.*
- *Low-temperature faults exists when the Temperature is lower than 12 deg.C*

Step 2 : Full DisCharge

Discharged to 9.00V without error. Discharging current should be lower than 1.0A.

- *No valid charge(charges greater than 10mAh) initiations during the discharge process*
- *The self-discharge is not more than 256mAh.*
- *No Low or High temperature state*
- *Battery voltage is not more than 256mV below the EDV1 threshold when EDV1 is set*

4.7. LED Display

Pressing LED button will activate the LED display for 4 seconds. Each LED output represents the RelativeStateOfCharge.(RSOC)

RSOC	LED1	LED2	LED3	LED4
Voltage < 9.40V	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



5. Protection Circuit Module

5.1. PCM Ratings

5.1.1. Maximum Input Voltage	24V
5.1.2. Maximum Charging Current	6.0A
5.1.3. Maximum Discharging Current	6.0A

5.2. PCM Electrical Characteristics at 25°C

5.2.1. Over-discharge Prohibition Voltage	7.8±0.20V
5.2.2. Over-discharge Prohibition Release Voltage	12.00±0.20V
5.2.3. Over-discharge Prohibition Delay Time	5~15 ms
5.2.4. Over-current Protection	7.0~12 A
5.2.5. Over-current Protection Delay Time	5~15 ms

5.3. Power dissipation

5.3.1. Run	< 250μA
5.3.2. Shut down :	< 30μA

5.4. Other protections in the pack

5.4.1. Over Current Protection with PTC	> 12A at 25 deg.C > 8A at 60 deg.C
5.4.2. Thermal Protector Operation	> 70±5 deg.C
5.4.3. Thermal Protector Release	< 45±5 deg.C
5.4.4. Thermal Fuse Operation	> 93±5 deg.C

6. Standard test condition

6.1. Test sample condition

The battery used for the test shall be manufactured and delivered no later than one month.

6.2. Environmental condition

Unless otherwise specified, all tests stated in the specification are conducted at temperature 25± 5°C and humidity 65± 20%RH and charged state.



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6.3. Test equipment condition

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

7. Characteristics

7.1. Standard Charge

“Standard Charge” means charging the pack with the constant current 0.1C rate until a full charge condition detected.

The full charge condition is detected as below

- Pack temperature is higher than 55°C while charging (Maximum T Control).
- Pack temperature is increased by 1°C/min or higher (dT/dt Control).
- Pack voltage is decreased by 90mV while charging (-dV Control).
- Full Charge Detected by the smart module in the battery pack.
- Time Limited by 15 hours.

7.2. Initial Capacity

“Initial Capacity” is defined as the initial discharge capacity of the pack, which is measured in discharge current of 430mA with 8.0V cut-off at 25°C within **1~2 hour after the standard charge. The initial Discharge time shall be longer than 540 Min.**

7.3. Cycle Life

Cycle life is defined by the discharge time right after 299 Cycles.

It is measured under the same condition in 7.2.

The discharge time of the 300th is more than 450 Min.

7.4. Initial internal impedance

Internal impedance shall be checked at 1000Hz with standard charge state.

The initial internal impedance of the pack is lower than 300mΩ.

7.5. Discharge capacity with temperature

This means relative value of discharge time at various temperature compared with the discharge time at 25°C (100%).



* Discharge current 430mA with 9.0V cutoff

<i>Temperature</i>	-10 °C	25 °C	45 °C	60 °C
<i>Relative Capacity</i>	50%	100%	90%	80%

7.6. Storage characteristics

In case of fully charged pack stored at 25°C for 30 days,
Remaining Capacity (after storage) will be more than 1600mAh.

8. Safety test

8.1 Over-charge Test

Method : Apply charge to continuous until the thermal protection is operated.

Criteria : No leakage, flame, or fire is allowed.

Nominal : Protected by Thermal Protector or Fuse

8.2 Over Discharge Test

Method: Discharge the pack to voltage less than 6.0V

Criteria: No damage such as leakage, flame, or fire is allowed.

Nominal: Protected by PCM operation.

9. Mechanical Characteristics

9.1 Drop Test

Method : Pack-drop onto the concrete floor from 0.76m heights at any directions for 3 times.

Criteria : No leakage, OCV higher than 10.8V, and impedance lower than 300mΩ

9.2 Vibration Test

Method : This means the endurance of the pack against vibration.

Frequency and amplitude : 10Hz → 55Hz → 10Hz/0.8mm.

Sweep speed : 1±0.055Hz/min.

Criteria : No leakage, OCV higher than 10.8V, and internal impedance lower than 500mΩ



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10. Shipment

The battery shall be shipped in about 40~80% charged state.

11. Caution and prohibition

Before using and handling the pack, see carefully attached “Handling Instruction Guide for NiMH Battery Pack”

For safety reasons, rechargeable batteries are shipped in a low remaining capacity state. Please charge before use. The battery pack needs to be fully charged and discharged up to 3 times for the max. performance at full capacity. The battery pack is initialized before shipment but if kept being used without fully charged and discharged state for long time, the accuracy for the capacity loss will be occurred. In order to recover to original performance can be made through a few times cycles of full charging and discharging.

13. Storage for a long term

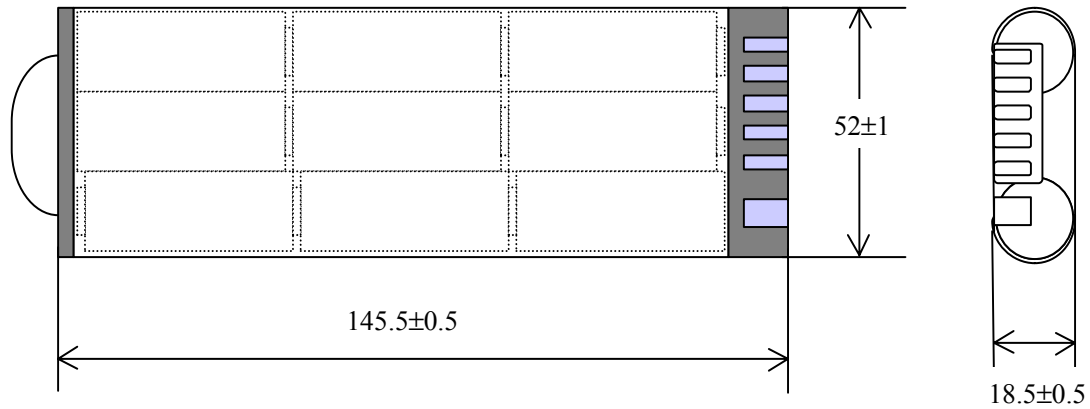
If the pack is stored for a long term (3 months or longer), it is strongly recommended that the pack be preserved at dry and low temperature atmosphere.

14. Warranty

EP will be responsible for replacing the pack against defects or poor workmanship for 12 months from the date of shipping. Any other problem caused by malfunction of the equipment or misuse of the battery is not under this warranty.



[Appendix A : Out-side drawing and parts list]



No.	Part Name	Specification	Qty.	Remark
1	NiMH Cell	2150mAh or 2100mAh	9 ea	Sanyo, Japan (BYD)
2	Smart Module	NM15SX (bq2040, Seiko 8231)	1 ea	Saehan, Korea
3	Connector	146800-1	1 ea	AMP, Japan
4	FPCB	W20xL20x0.2t	1 ea	Woosu, Korea
5	Thermal Fuse	G4A50, 93 deg.C	1 ea	Microtemp
6	Thermal Protector	4MM70A, 70 deg.C	1 ea	TI
7	PTC	LR4-600	1 ea	LayChem
8	Nickel Tap	3 kinds	14 ea	
9	Wire	AWG22, 3 kinds	80 mm	
10	Insulation Tape	W15xL150x0.15t	1 ea	
11	Rubber Sponge	W14xL50x1.0t	1 ea	
12	Spacer-I	W5xL20x1.0t	1 ea	Material : PC
13	Spacer-II	W5xL5x1.5t	2 ea	Material : Poron
14	Cell&Case Support	-	2 ea	Material : PC
15	Case	-	1 set	Material : PC
16	Removal Band	W4xL60x0.2t	1 ea	Material : Nylon
17	Label	NM15SX	1 ea	Hanvit, Korea



[Appendix B : Smart Battery Data Set for “**NM15SX-S21**”]

Function	Code	Access	Defaults	Unit	Remarks
ManufacturerAccess	0x00	R/W	0x0018	hex	
RemainingCapacityAlarm	0x01	R/W	215	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	2150	mAh	Variable
RunTimeToEmpty	0x11	R	0xffff	min	
AverageTimeToEmpty	0x12	R	0xffff	min	
AverageTimeToFull	0x13	R	0xffff	min	
ChargingCurrent	0x14	R	2150	mA	
ChargingVoltage	0x15	R	18000	mV	
BatteryStatus	0x16	R	0x0080	-	
CycleCount	0x17	R	0	int	
DesignCapacity	0x18	R	2150	mAh	
DesignVoltage	0x19	R	10800	mV	
SpecificationInfo	0x1a	R	0x0010	hex	
ManufacturerDate	0x1b	R	07/10/2001	-	
SerialNumber	0x1c	R	1	int	
ManufacturerName	0x20	R	SH EnerTech	string	
DeviceName	0x21	R	NM15XS2	string	
DeviceChemistry	0x22	R	NIMH	string	
ManufacturerData	0x23	R	EP	string	



< Legend >



From Smart Battery



From Host



W Write Mode Bit (Low)



R Write Mode Bit (High)



PEC Packet Error Correct Data based on CRC-8



S Start Condition



P Stop Condition



A Acknowledge



Â No Acknowledge



[Appendix D : Handling Instruction Guide for NiMH Battery Pack]

1. General

Battery packs supplied by Preferred Power Technologies, Inc have to be handle carefully according to the specification. Here are some more to be followed.

2. Storage of pack

The packs are requested to be stored under the following conditions:

- a. Indoor storage in a cool circumstances without direct sun light on the packs or cartons.
- b. Store batteries in a dry location with low humidity, and a temperature range of -20°C to $+30^{\circ}\text{C}$.

In case of the long term storage

- a. As long-term storage can accelerate battery self-discharge and lead to the deactivation of the batteries. To minimize the deactivation effect, store battery packs in a temperature range of $+10^{\circ}\text{C}$ to $+30^{\circ}\text{C}$.
- b. When charging for the first time after long-term storage, deactivation of the packs may have led to decreased capacity. Recover such packs to original performance through repeating several cycles of full charging and discharging.
- c. When store packs for more than 6 month, charge at least once charing require per 6 months to prevent leakage and deterioration in performance due to self-discharging.

3. Charging pack

- a. Use suitable charger with the specified voltage and current. We strongly recommend EP smart battery charger. **If you want to get more detail information, please contact us.**
- b. **Never attempt reverse charging.** Charging with polarity reversed can cause a reversal in battery polarity, causing gas pressure inside of the battery to rise, which can be lead to leakage of the batteries in the pack.
- c. Avoid overcharing. Repeated overcharging can be lead to deterioration in pack performance. and Over-heat occured.
- d. Charging efficiency drops at temperatures above 40°C .



4. Protection from unexpected damaged to pack

- a. (+) and/or (-) terminals must not be connected in metal wire, necklace, chaings.
- b. Do not drop packs from height to prevent them from possible malfunction or damage.
- c. Do not twist or bend packs to prevent possible damage.

5. For Safety

- a. Do not disassemble packs.
- b. Do not use pack when something abnormal found such as smells, deformation, discoloration, and so on.
- c. Do not re-use NiMH cells or other parts after removing from the packs.
- d. When the electrolyte leakage occurs, do not touch the liquid.
- e. Once watered, packs may have potential malfunctions. Do not use those packs.
- f. Do not have packs in the hot-temperature (60°C or more).
- g. Do not put packs into fire.
- h. Do not crush/nail packs.
- i. Do not apply solder directly to packs.

