Sankt Florian Straße 6
D-64521 Groß-Gerau
Fon: +49 6152 39035

Manual

Lithium-Iron-Phosphate Battery

Typ: 24V – 480 Ah - 2

Rev. 7.x

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Fon: +49 6152 39035

1. Introduction

Dear Customer,

We are pleased that you decided to buy our battery

Safety first !

Before using this battery the first time, please read these instuctions carefully and keep them in a save place nearby. Basis for liability is to hand out this manual to next user.

2. Safety guidelines und safety measures

2.1 General Rules

Operations at **L**ithium **I**ron **P**hosphate Batteries (LIP) should be executed only by experts

During operations at Lithium Iron Phosphate Batteries you have to wear protective clothes and protective eyewear.

If you have contact to skin or eyes with material like electrolyte or powder from a not covered battery you have immediately to wash it thoroughly with normal water. Please contact a doctor. Clothes can also be cleaned by water.

Danger of Explosion and Fire. The pole terminals of this LIP Batterie are energized if the batterie is switched on, so donot place tools or other objects on the battery ! Avoid short-circuits, deep discharge or a to high load-current !

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Use isolated tools. Donot wear metallic objects like watch, bracelets etc. Use only fire extinguishers Class D, Foam or CO2.

Never try to open or disassemble the LIP Battery. Electrolyte is highly caustic. Under normal conditions a contact to electrolyte is excluded. In cases where this cell case is damaged donot touch electrolyte or powder, both are strongly causted.

LIP Batteries are heavy-weighted. In case of an accident a battery can become a „bullet“. Take care of good fastening and professional transporting. LIP Batteries are sensitive to shock.

If a LIP Battery was charged or discharged over permissable limits and/or a case is damaged, a toxic gas like phosphat can escape.

Failure to observe the instructions on use, repair with non-original spareparts, unauthorised intervention, or use of additives expire Warranty.

2.2 Transportation Notes

LIP Batteries must be transported in original packages and in a upright position. For fixing use soft binders to prevent damages. Never stay below the load. Donot lift the batteries at their electric connectors.

LIP Batteries are tested according the UN Manual, Gazette Part III, Subsection 38.3 (ST/SG/AC. 10/11/Version 5).

For Shipment of LIP Batteries they belong to Category UN3480, Class 9, Packing Group II and must be observed. This means transport via land and sea (ADR, RID & IMDG).

According packing instructions P903 und airfreight (IATA) packing instructions P965, the original packing fulfills these savety specifications.

2.3 Waste Disposal of LIP Batteries

Batteries marked with the Recycling Symbol must be given back to Recycling Stations. Batteries can not be disposed with domestic or industrial waste.

Leakproofed

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3. General Informations about Lithium- Iron Phosphate-Batteries

A Lithium-Iron-Phosphate-Battery (LIP)-Battery is one of the most save regular battery types. The single cell voltage is 3.2V and a 25,6V-Battery consists of 8 cells or blocks in serial connection.

3.1 Compared to Lead-Batteries

Sulphation is in following cases mostly the reason for premature malfunctions:

- If Lead Batteries are used long time while not sufficient charged (such as those batteries which are rare or not fully charged).
- If Lead Batteries are left back in a particular or fully discharged state.

In contrast to Lead Batteries a LIP Battery must not be fully charged, which is a great advantage. Another advantages are a huge temperature range and a very low internal resistance, as well as a high efficiency up to 97%.

3.2 Efficiency

For many applications, especially solar energy systems, high efficiency is significant. Lead Batteries own only about 50% efficiency for one charge and discharge cycle, in contrast to LIP Batteries >96%, even in the state of low charge.

3.3 Weight and Size

Savings in weight and space are about 70%, important for motor homes, boats and so on.

3.4 Handling

LIP Batteries are easier chargeable then lead batteries. The optimal charging voltage should be 28.0V - 28.4V (constant voltage). At 3.6V per cell the charging current will descend to nearly zero. The max cell voltage is 3,65V. Opposite to lead batteries, cells must not be fully charged, for this reason batteries can be connected in parallel without any damages.

4. Installation

4.1 Short Circuit Protection

To avoid short circuits during installing the batteries they have to be **switched** completely **off**, by the LED-Push-Button or softkey (WLAN).

4.2 Batterie Connection

Before connecting the batterie it must be switched off – press push button for about 2 seconds-
LED is no longer flashing !

When electric installation is finished, switch on the batterie in the same way for about 2 seconds
LED is flashing again.

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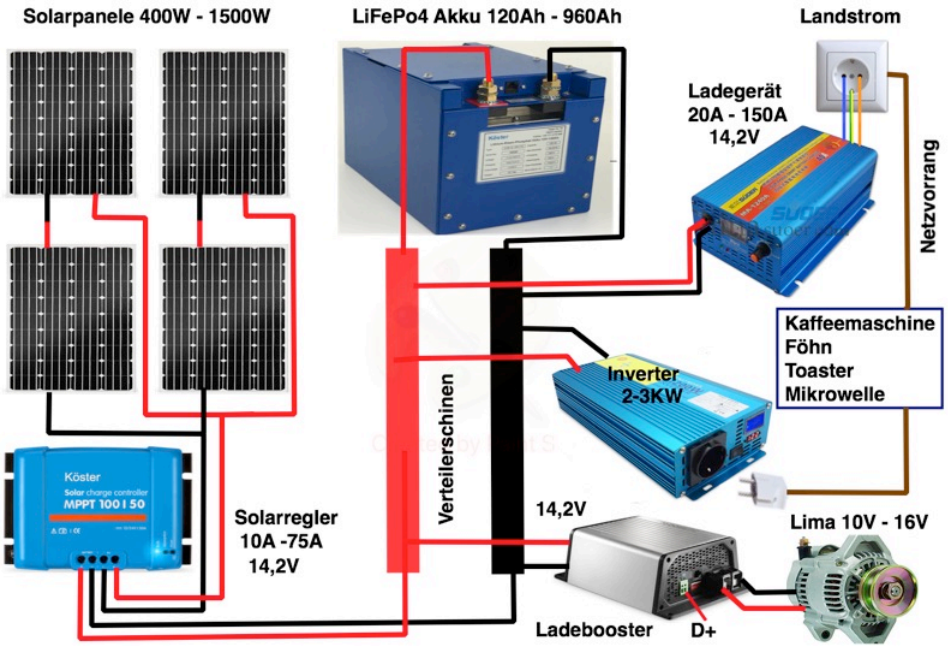
The electric connection of this battery is very easy, the same as lead batteries. The Positve Pole is red marked (M10 brass) and the negative pole (GND) is black marked (M10 brass). The connecting sequence is free. Charger and solar controller as well as all power consumers are to connect in parallel. Battery control for under- and overvoltage is integrated in the BMS.

For continous operation, please read Chapture 10.



Connection Overview (24V plants, double voltage)

4.3 Battery Charging

Supplied to the customer, the battery is minimal charged to 80% and can be used directly. For optimal charging a constant voltage charger with 28.4V is needed. The first charging cycle should take several hours to balance the cells completely. Afterwards the trickle charge voltage (float) should be 27.6V. These batteries can not be charged (only discharged), when the cell temperature is below -10°C. A BMS (**B**attery **M**anagement **S**ystem) inside takes control and avoids damages.

4.4 Battery Discharging

As supplied to the customer the battery is minimal charged to 80% it can be used directly. Depending from capacity the battery can be stressed up to 300A means 3kW. By BMS the battery is protected against total discharge.

4.5 Normal Operation

This Battery looks like a lead battery, connected by only 2 pole terminals and can be charged or discharged by them. The integrated BMS avoids passing the electric limits. In rare cases of a shut down, the system restarts automatically as soon as the values are within their limits again.

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5. Battery Description

5.1 The Cells

Cells 120Ah – 240Ah

This LIP Battery contains (HighTech) cells which own proved efficiency for over many years. Depending from capacity and size four different types of cells could be installed. They have a temperature range from: charging -10°C - +60°C and discharging -20°C - +60°C. All values are controlled by the BMS.

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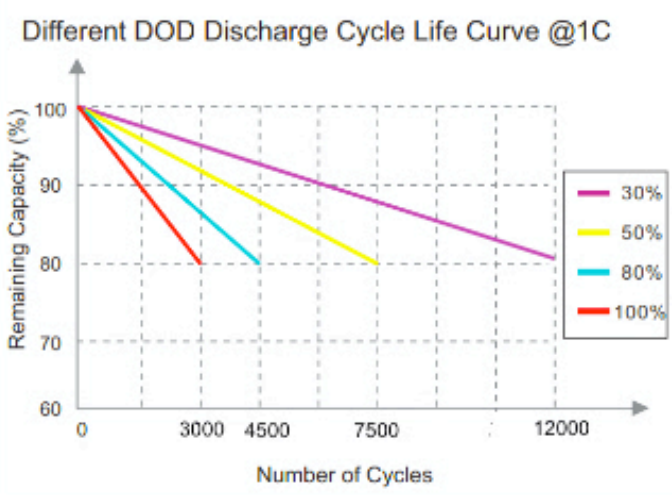
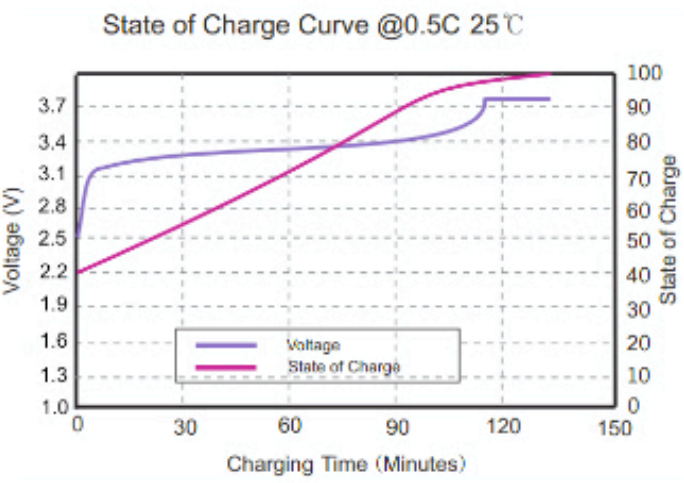
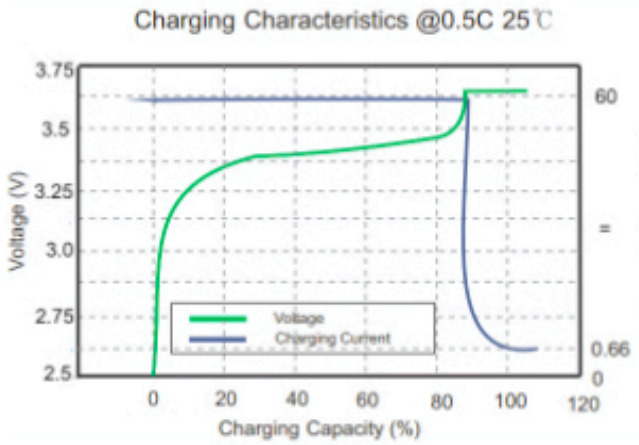
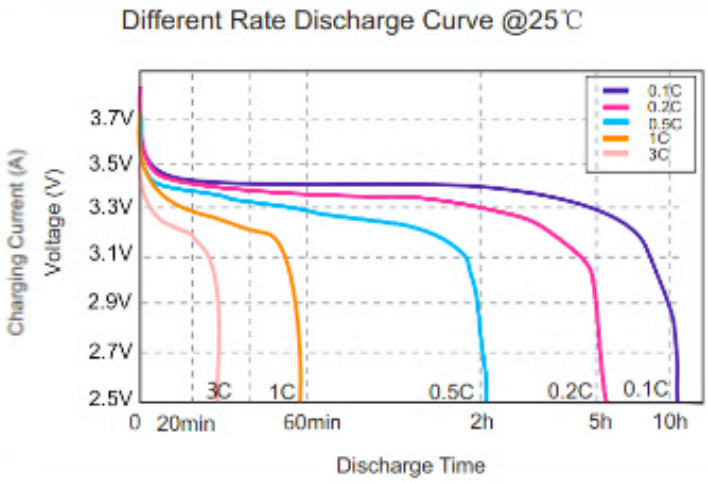
5.2 Curves of Charging and Discharging of a Cell









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5.3 The Case

3-Housing Chambers

The four parted steel cases are exclusively industrial manufactured with a tolerance of < +/- 1 mm.They provide an impact resistance powder coating and contain all assemblies.

Significant is the 3 housing chamber system:

- The Main Chamber is located central and contains all LIP cells. It is pressure resistant and prevents an expansion of cells and prevents an leakage of liquid too, according UN 38.3.
- The left chamber contains the contactors for currents up to 300A, and the connection poles.
- The right chamber contains the controller board and is insulating it against electromagnetic and thermal influences, according UN ECE R10.

Another important function is the fire protection. For better handling there are 2 recessed grips, they care for ventilation of shunt and balancer too.

5.4 The Power Switches

The power system is respectively depending from size, capacity or current. Each module consists of 2 or 4 bistable impulse controlled contactors, one for Undervoltage and one for Overvoltage.

Only by means of this technology it can be ensured that the battery can be charged after switching off by undervoltage. Total switch off means both contactors are open.

In case of total- or partial switch off the Positve Pole (+) will be switched according car technology.

This technology will become important when the vehicle is for example in winter storage and the battery is switched off by undervoltage. In this case further continous current would destroy the cells.

An integrated Diode-Matrix-System ensures that the battery can be used by „half-current“ procedure despite switching off.

By an undervoltage switch off the battery can be charged without interrupt. The charging current must be between 6A up to 65A, max. 100A. Charging is possible without changing connectors or separate cables then usual for many other products.

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By an overvoltage switch off the battery can be discharged without interrupt also with currents up to 65A max. 100A, without changing connectors or separate cables. By reaching the threshold voltage the contactor switches automatically back.

The battery can be **completely switched on or off** by pushing the LED-Button or WLAN softkey for >2 sec. Charging or discharging is then no longer possible.
The limiting current up to 300A is set by factory default value, depending battery specifications. In case of a total failure a 500A Fuse is implemented.

5.4.1. State of the Power Switches

Pole Voltage Temperature	Switch for Overvoltage	Switch for Undervoltage	Effect
14.4 – 15.0V	**open**	**closed**	Charging not possible. Automatic restart at a discharging current > 10A or when the batterie voltage degrades by 200mV.
10.6 – 14.4V	**closed**	**closed**	The **Battery** can be completely charged or discharged
8.6 -10.6V	**closed**	**open**	Discharging impossible. Automatic restart at a charging current > 10A or when the battery voltage rises up by 200mV
below 8.6V	**open**	**open**	Total-Switch Off – Confirm the error message by LED- Push Button > 2s or Battery On. At the same time a charging current > 10A , otherwise Switch Off again (4min)
Cell-Under-Temperature	**open**	**closed**	Discharging only by max 75A, Charging not possible. Otherwise switch off. Automatic switch on when cell temperature > -10°C .
Cell-Over-Temperature	**closed**	**closed**	Total-Switch Off – Charging or discharging are not possible. Automatic restart when the cell temperature is below limit, <50°C.

5.5 The Controller (BMS)

The development of this Battery Management System (BMS) will never stop. The latest version is Rev. 7.x and has some additional functions, which make it nearly perfect now. Development and production are completely done in our german research centre.

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5.5.1 The Balancer (2 x 12V)

As LIP cells have differrent electrical patterns, they drift apart while charging and discharging. For a series connection, this also means some cells may have under- or overvoltage. Both is extremely dangerous for these cells.

A 24V-LIP Battery contains 8 cells or blocks in serial connection, what means all cells have the same current. The balancers task is to keep all cells on the same voltage level by a differencial current splitting. This balancer is semi-activ.

For cells of 100Ah or more sometimes currents **> 5A** are needed. Most of customary deviations are only able to balance with some mA. So a special PWM-System was developed to provide currents > 5A now.

Caused by such currents the balancer generates excessive heat. It is necessary to limit the temperature on 65°C by controlling the PWM signal. The balancer is only active while charging or a cell voltage > 3,5V per cell. For equality balancing is stopped without quiescent current !!

5.5.2 The Voltage Control

LIP Batteries are very expensive and for this reason they should work for long time. To achieve this goal, an elaborated voltage management for all cells as well as for the whole battery is essential.
To protect the cells, the undervoltage limit is 2.6V and overvoltage limit is 3.65V, means the voltage range for a battery is between 21.0V and 28.8V.
In case, one of these limits is exceeded, the responsible contactor switches off and then the battery works in the „Protected Mode“. Here the resposible diode is patched on without interrupt. That means if the charging voltage is > 14.4V the overvoltage contactor prevents further charging but discharging is possible.
If the voltage is < 21.0V the undervoltage contactor prevents further discharging but charging is possible.
When the battery returns to its operating range the contactors will be resetted automatically to the normal Mode. Digital filters prevent against voltage peaks or other technical faults, except short circuit.

5.5.3 The Current Monitoring

To protect cells, contactors and cables, the max charging- or dicharging current is limited, depending from specification to 150 – 300A by software. If a higher current stays on > 5sec it is swiched off. Digital filters take care that current peaks by support legs or other electricity consumers donot switch off.

Is a current over its limit for some measuring cycles, it will be interpreted as short circuit or overload switched off. An automatic restart follows after 30sec. If the system recognizes the same fault, it is switched off permanetly. For restart, a Reset must be done by the LED-Push-Button or softkey.

5.5.4 The Temperature Monitoring

To protect cells and balancer the temperature must be controlled by sensors of high quality. Here the inner cell temperature is important, relating to the limits. These threshold values are preset by factory default values. Exceeding the limits switches the battery off.

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5.4.5 The Function Monitoring

Error	Protection		
	Overvoltage Switch open	Undervoltage Switch open	
Switch Off	X	X	
Reset	X	X	
Error: Undervoltage		X	
Error: Overvoltage	X		
Error: Overcurrent, Charging	X		
Error: Overcurrent, Discharging		X	
Error: Short Circuit		X	
Limit: Low Temperature	X		
Error: To low cell Temperature (-10°C)		X	
Error: To low cell Temperature (-20°C)	X	X	
Error: To high cell Temperature	X	X	

To protect against faults and unintended shutdows the BMS is doing automatic self-tests for hard- and software. Error messages are reported.

5.5.6 The Error Memory

Errors or faults are reported and saved to the storage of the BMS, which enables the technican to reproduce them by reading out the error storage and understand what kind of fault and at what time the incident was.

5.5.7 The Maintenance Interface

is placed at the mainboard (BMS) for software updates and configuring all individual parameters:

1. max charging- and discharging current (current limit) depending from load, cells, wire size and connector current.
2. limits for over- and undervoltage
3. depending on cell type min charging temperature (-10°C) as well as the max cell temperature for working.
4. The capacity of the battery
5. some more specifications.

Modifications can made only by factory setting to ensure proper working.

5.5.8 The Token Ring

For batteries or blocks with higher voltage from 24V...96V in series connection one BMS per 12V each is necessary and for higher currents with batteries in parallel connection, too. The Token Ring is a communication bus system with galvanic separation coordinating all BMS.

Is there a disturbance or fault in one of all blocks a message is directly send to the Master BMS and will be evaluated. All blocks together are working like only one battery. In this way up to 64 systems can be managed together at once.

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5.5.9 The LED Push- and Reset Button (Also in Level Display)

This Button has several funftions. It shows the different operating modes or faults to the technician. In case of switch off, it remains in stand-by to save energy.

Sequence of Flashes within 4sec															Message / Status
LED off															Battery Switched OFF
X															Battery Switched ON and Discharging
	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Battery Switched ON and Charging
X	X			X	X										Protection-Mode - Undervoltage
X	X			X	X			X	X						Protection-Mode - Overvoltage
X	X			X	X			X	X			X	X		Overcurrent or Short Circuit, Battery OFF
X	X	X		X											Message: Undertemperature of cells, Charging Limit active
X	X	X		X		X									Switch OFF: Undertemperature of Battery, Batterie OFF
X	X	X		X		X		X							Abschaltung: Overtemperature of Battery, Batterie OFF
X		X		X		X									Message: Internal Error, Normal-Mode
X		X		X		X		X		X		X			Switch OFF: Internal Error, Battery OFF

To Reset the BMS, the button must be pushed for > 5sec, the LED is flashing quickly. If the button is pushed > 2sec and the LED is permanent on, the Battery will be switched off completely while stop pushing, for maintenance and winter storage, an important function to save energy.

6. The Data Interface (UART)

Due to the different functions and permanent storage of all relevant data, as:

- Capacity in Ah
- State of Charge in Ah
- Charging Current in A
- Dicharging Current in A
- Voltage of 4 Cells/Blocks in V
- Total Voltage of Battery in V
- Temperature of Balancer in °C
- Temperature of Cells inside in °C
- State of Contactors incl. ON/OFF
- Errors s. Capture 5.4.5

Level Display with push button for Reset and Switch Off can be connected without problems.

The newly developed **WiFi-Module** can be connected by the UART Interface, too.
These modules are connected by RJ45 patch cables (> Cat 5). This interface is galvanic separated by optical couplers.
The Baud rate is especially defined at 1kHz for reliable working of external modules. A cable length over 10m is no problem, external influences are nearly completely eliminated.

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Level Display	WLAN-Module

7. CE-Certificate according UN ECE R10

Test Report No.:	P19-Z-00315-002
Test type:	Compliance Test
Date:	26 April 2021
Device(s) Under Test:	LiFePo4 Accumulator (24 V, 480 Ah) incl. Battery Management System

Test Report No.: P19-Z-00315-002

Performing the test:	EMC Test NRW GmbH Electromagnetic Compatibility Emil-Figge-Straße 76 D – 44227 Dortmund
Test site:	EMC Test NRW GmbH Electromagnetic Compatibility Emil-Figge-Straße 76 D – 44227 Dortmund
Applicant:	Steitz GmbH Sankt-Florian-Str. 6 64521 Groß-Gerau
Manufacturer:	See applicant
Project No.:	P19-Z-00315 [A21-Z-00265]
Type of project:	Compliance Test
Test specification(s):	**On customers request the tests are performed acc. to:** ***UN ECE R10, Revision 6, 2019-10*** *(Uniform provisions concerning the approval of vehicles with regard to electromagnetic compatibility)* ***Performed tests:*** - *Electromagnetic Interference generated by ESAs* - *Emission of transient conducted disturbances by ESAs* - *Immunity of ESAs to conducted transient disturbances*
Device(s) under test:	LiFePo4 Accumulator (24 V, 480 Ah) incl. Battery Management System
Identification:	See chapter 3.1
Documents:	User manual: “HB 24V-480Ah-1.pdf”
Date of receipt:	2021-04-12
Period of tests:	2021-04-12 … 2021-04-15
Result:	The device under test **complies** with the requirements of the test specification(s). Results of performed tests are given on the following pages.

Sign for contents of this test report

i.V. (Mr.) Marc Maarleveld
(Head of Project Management)

Sign for realization of test procedures

i.A. (Mr.) Marcel Olbrich
(Project Responsibility)

7 Annex

List of battery types covered with the test of the 24V-480Ah variant:

- 12V-120Ah-1
- 12V-240Ah-1
- 12V-240Ah-2
- 12V-350Ah-2
- 12V-400Ah-3
- 12V-480Ah-1
- 12V-525Ah-1
- 12V-600Ah-1
- 12V-700Ah-2
- 12V-800Ah-2
- 12V-960Ah-2
- 24V-120Ah-1
- 24V-175Ah-2
- 24V-200Ah-2
- 24V-240Ah-1
- 24V-350Ah-2
- 24V-400Ah-2
- 24V-480Ah-1

including the tested WLAN-module.

The information in the list is based on the information provided by the customer.

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8. Transport-Certificate UN 38.3

NCT Technology

Lithium Battery UN38.3 Test Report

UN38.3 检测报告

UN38.3 Test Report

Client 委托方	Shenzhen RJ Energy Co.,Ltd 龙马科技有限公司
Add. of Client 委托方地址	913 Room, Cai Yue Building, No.24 liuxian Avenue, Longhua District, Shenzhen City. 深圳市龙华新区民治留仙大道 24 号彩悦大厦 913-914
Samples Description 样品名称	LIFEPO4 Cell 磷酸铁锂电芯
Model/Type 型号规格	**RJ-LFP48173166-120**
Testing Laboratory 测试机构	Shenzhen NCT Testing Technology Co., Ltd. 深圳诺测检测技术有限公司 1 / F, No. B Building, Mianshang Younger Pioneer Park, Hangcheng Road, Gushu Xixiang Street, Baoan District, Shenzhen, Guangdong, China 中国广东省深圳市宝安区西乡街道固戍航城大道绵商青年创业园 B 栋第 1 层
Report No. 报告编号	NCT16028260B1-1
Issued Date 发行日期	Mar.24, 2018
Test Conclusion 测试结论: **Shown in the Conclusion of test report. 见检测报告结论页.**	

Tested by 主检人: Klaus Peng

Inspected by 审核人: Holy Wang

Approved by 批准人

Seal of NCT 报告单位

Date of Issue 签发日期: 2018. 03. 24

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9. Technical Data

9.1 Technical Data of a single cell

Specifications:	**Cell 3.2V – 240Ah**
Casing material for single cell	Aluminum shell
Nominal Voltage	3.2V
Capacity	240Ah
Core size	D71*W173*200MM
Cell Weight	5.0kg
Charging Current	Standard Charging:0.2C
	Max Charging:1C
Max Discharging Rate	Max Discharging:2C
Cut-off Voltage	Charging:3.65V
	Discharging:2.5V
Internal Resistance	≤ 0.3mΩ (At 0.2C rate, 2.0V cut-off)
Working Temperature	Charging: -10℃~75℃
	Discharging: -20℃~75℃
Storage Temperature	≤1month: -10–45℃
	≤3month: 0–30℃
	≤6month: 20±5℃
Life Cycle	>6000 times

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9.2 Technical Data of the battery

Special Construction for Motor Homes, Electric Mobility and Solar Plants

- 16 cells 240Ah, 3,2V
- Lithium-Iron-Phosphate Battery (LIP) free of maintenance
- Nominal Voltage: 25.6 Volt
- Nominal Capacity at 25°C: 480 AH (Discharging ≤1C)
- Nominal Energy at 25°C: : 12.288 Wh
- Operating Range: 20V – 28.8 DC (cell voltage 2.5V - 3,65V)
- Discharging Current: 0-480A (limited by internal protection)
- Charging Current: max 1-480 (limited by internal protection)
- Internal Current Limit/Triggering 300A
- Charging Voltage: 28.0V – 28.8V (28.4V, constant voltage is optimal)
- Trickle Charging: 27.2V – 27.6V (27.6V is optimal)
- Charging Cycles: > 6.000 at 80% depth of discharge
- Undervoltage Switch OFF: <21.0V DC (cell voltage <2.5V) ±0.1V
- Shift Back from Undervoltage Switch OFF: >23.0V (cell voltage >2.85V) ±0.1V
- Overvoltage Switch OFF: >28.8V (cell voltage >3.60V) ±0.1V
- Shift Back from Overvoltage Switch OFF: <28.4V (cell voltage <3.55V) ±0.1V
- low self-dicharge, BMS stand by current < 8mA
- free UART Interface for Level Diplay and WLAN-Module (remot switch)
- Storage time without recharging at 25°C: 6 months after full charge.
- Over- and Undertemperature Switch Off: -10 to >60°C ± 2°C
- Discharging Temperature Range: -20°C to +60°C
- Charging Temperature Range: -10°C to +45°C
- Storage Temperature: -10°C to +30°C
- Humidity: max 95% non-condensing
- Protection Class: IP54
- Pole Connector brass bolt M10 for ring terminal connection
- Case Material: steel, powder coated
- Weight96.0 kg (without packing material)
- Dimensions (L x W x H): 670 x 350 x 240mm

Applications:

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10. Hints for Proper Operating

To ensure a proper operating of this Battery please take care for:

10.1 Mounting

Basically this **Battery** can be installed in all campers, it must be protected from slipping by belts. A fixing in driving direction is important to avoid movement of the battery in case of emergency braking or a crash.

10.2 Charging

Most charging units like normal Chargers, combi-chargers, solar-chargers or generators have their own charging characteristic, not always suitable for LIP Batteries.

Optimal is a **Constant Charging Voltage** of **28.4V**. In this case the Battery will take the max possible current, limited by the charging unit or internal switch off (as labelled). The current will reduce by the cell character automatically. Now the charging unit should reduce to **27.6V Float (trickle voltage).**

All temperature compensations must be deactivated as the BMS contains it already.

Most customary **Charging Units and Solar Chargers** must be **set** by hard- or software before use.

The new generators may cause problems, as the charging characteristic can not be changed. For 27.6V – 28.4V voltage it is ok. If the charging voltage exceeds this range a booster is recommended. Various voltages between 20V and 32V are changed to a constant voltage like 28.4V. The Booster will be switched on and off by the D+ Signal (engine).

The absolute voltage limit is 28.8V, small increases already cause a switch off, whereas 28.0V is no problem. With an endvoltage of 27.6V the batterie is alredy >99% charged.

All charging units, single use or combined, should be checked for a max voltage of 28.4V, the best with a switched off Battery, no load - open-circuit voltage !

10.3 Discharging

A LIP Battery should be used at charging state between 50% and 100% for higher loads. Below, the voltage drop increases and this may cause a switch off of Battery or inverter. The Battery itself is BMS protected.

10.4 Damages

For consequencial damages caused by partial- or total **switch-offs** there is no responsibility **taken** by the manufacturer.