ENERGY
BACKUP

48TL200

Installation & Operating Instructions
Technical manual

FZSoNick

SODIUM NICKEL TECHNOLOGY

Index:

1 GENERAL INFORMATION

1.1 Introduction

The 48TL200 is a 48 Volt – 200Ah complete battery system designed for stationary applications. This battery, assembled with five strings of Sodium-Nickel cells in a 20 cell series configuration, is provided with internal electric heaters to achieve and maintain the internal working temperature of 265°C. The thermal insulation of the battery is such that, with an internal temperature of 265°C, the surface temperature of the enclosure is just 10 to 15°C above the environment.
The battery is provided with an electronic controller (BMS) which manages all the battery functions and ensures a reliable and safe operation.

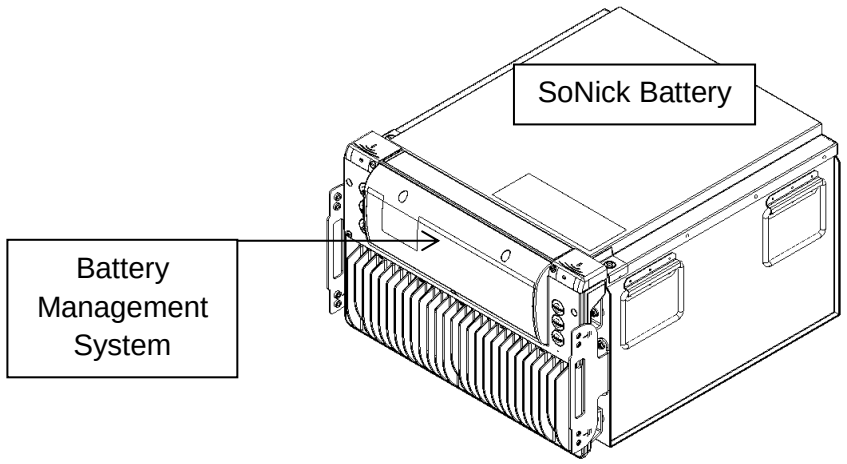


Figure 1

1.2 Purpose

This manual provides information required to install and operate the FZSoNick 48TL200 battery. Anyone involved in handling, installing or using the FZSoNick 48TL200 battery must read and understand this manual.

1.3 Related Publications

Publication Name	Publication Number
Battery safety data sheet	SDS FZSoNick Battery 04-2017 IT SDS FZSoNick Battery 04-2017 EN SDS FZSoNick Battery 04-2017 DE SDS FZSoNick Battery 04-2017 ES SDS FZSoNick Battery 04-2017 FR SDS FZSoNick Battery 04-2017 PT
Monitoring Software Manual	SMCMonitor200 User Manual_rev.3
Battery ModBus Protocol	TB_48TL200_ModBus-protocol_rev7

Table A

2 SAFETY

2.1 Battery Safety

This manual contains important instructions that should be followed during installation and operation of the Sonick Battery.
The 48TL200 battery is designed to operate safely and to protect personnel from danger. Because it is an industrial product, however, the battery may cause risk to personnel, equipment or facilities if not handled properly.
The hazardous materials found in the battery are sealed inside the battery's case. Under normal operating conditions, this design is intended to help protect the user from the risk of injury.

If multiple layers of the battery are breached or the battery ruptures, extra care must be taken. Refer to the Battery Safety Data Sheet (SDS) for instructions on how to manage these extreme conditions.

The following guidelines should be followed when handling and operating the battery under normal circumstances.

This battery should only be installed and operated by qualified personnel.
If you have any questions regarding safety for this product, please refer to section 5.11 of this manual

Unlike traditional batteries, this Sodium Nickel battery can be charged or discharged only when the internal temperature reaches the operative value. Whenever the internal temperature is below, the battery acts as a passive device.
Before use, be sure to fully understand the battery functionality described in this manual

2.2 Warnings

A battery can present a risk of electrical shock. The following precautions should be observed when working on batteries and energy storage systems:

- Remove watches, jewelry, rings and other metal objects.
- Use tools with insulated handles

High voltages may be present within this unit even when it does not appear to be operational. Observe all cautions and warnings in this document.

The 48TL200 Sodium Nickel Battery is a Class-A digital device. These Class limits' provide reasonable protection against harmful interference in commercial, industrial or business environment

In a domestic environment this product may cause radio interference

2.3 Site conditions caution

Install and operate the battery in an indoor or enclosed environment only in an ambient temperature range of -20°C to +60°C. Install it in a clean environment, free from conductive contaminates, flammable liquids or gases.
The installation site must have a properly rated and tested grounding system.

Ventilation for outgassing or cooling is not required. Each Sonick Battery module will dissipate average of 115 Watts of heat under normal operation, which may affect room or cabinet ventilation design.

The installation site should be clear of obstructions. The installation team should understand the route that personnel and equipment will take when moving the batteries into position.

DO NOT open or damage sealed batteries. For additional information, refer to the battery Safety Data Sheet (SDS).

2.4 Safety Precautions

To prevent damages to the batteries and personal injuries, following safety instructions need to be followed all the times:

- Do not install the battery if you notice physical damage
- Do not place the battery on its power terminals, with the front plastic cover facing down or upside down
- Do not pack the battery when it is hot
- Do not expose the battery to temperatures above 90°C (194°F) or below -40°C (40°F)
- Max relative humidity for a battery in operation is 95%
- Do not allow metal objects to rest on the battery or to fall across the terminals
- Remove rings or metal wristbands when working with the battery
- Use insulated tools to install the battery
- Use all the handles when handling the battery

2.5 Required Safety Equipment

The following safety equipment should be available on site . Check local safety codes and standards to determine if additional equipment is required.

- Safety rated eye protection
- Hearing protection
- Electrically insulated gloves
- Flame-retardant clothing (8 cal/cm2)
- Electrically insulated/impact resistant footwear
- Electrically insulated tools

Verify the requirement with the AHJ (Authority Having Jurisdiction) to determine if additional equipment is required.

3 HANDLING PROCEDURES

3.1 Unpacking and Inspections

FZSoNick carefully tests and inspects the battery before shipment.
Upon receiving a shipment of batteries, open the wooden crate box and check the battery and hardware against the packing list.
Report any damage immediately to the carrier if the shipment shows signs of damage in transit. Also notify your FZSoNick customer service representative.

3.2 Handling

The use of certified non-conductive tools is highly recommended.
High energy batteries should always be handled carefully to avoid the possibility of creating a short circuit. In some circumstances, when in operation, the battery surface may be hot.
Battery handles are for hand carrying only, do not sling from the handles. Use an appropriate battery lifting harness for hoisting the battery. The battery handles are to be used to remove the battery from its original packaging and to securely place the battery in its operating location.
Always use all handles when handling the battery.
Never push or pull the battery by applying force to the Battery Management System.
Personnel should inspect the nearby environment where batteries will be handled to identify and eliminate all potential sources of electrical and physical damage to the batteries. Avoid conditions that could result in short-circuits, overheating, puncture or crush.

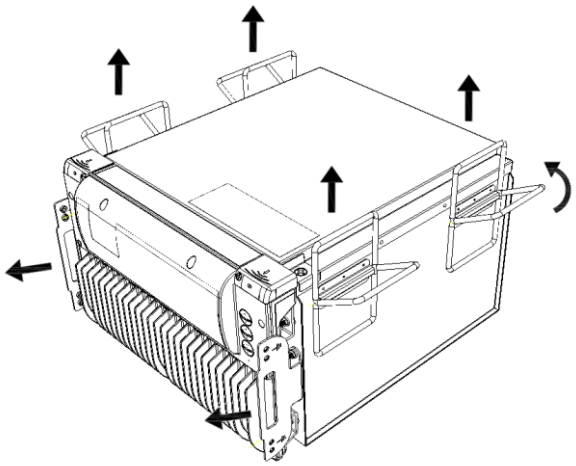


Figure 2

3.3 Storage

The best environment to store the SoNick battery system is a cool, dry, and well-ventilated location, in a properly identified warehouse area.
The battery can be stored for any length of time in the cold state without changing its characteristics or state of charge.
The battery has an extremely high resistance in the cold state and even a very low current can damage the battery when cold. Do not try to disassemble the battery management system (BMS) and apply any load or perform any measurement using the internal terminals of the battery, especially when it is in cold state.
The storage temperature should be between –40°C and +60°C.

3.4 Battery Return and Disposal

A Sodium Nickel battery must be transported cold and, if possible, discharged.
Do not burn or dispose of the battery. End of life or defective batteries are to be returned to FZSoNick, where recycling and/or disposal of the different parts will be performed.
Notify FZSoNick customer service prior to returning the battery.

3.5 Packaging

The 48TL200 battery is shipped cold and completely discharged in a wooden crate fixed with straps to avoid any risk of uncontrolled movement or drops and surrounded by a protective foam cushion (fig.3, dimensions in mm).

In case of battery return, battery should be packed in the original wooden box, only when turned off and cold. Battery with a heavily damaged external case should be wrapped with polyethylene sheets before of the packing, to avoid the risk of release of material or odors.
The package should include the relevant safety information for the transport: please contact FZSoNick for the details.

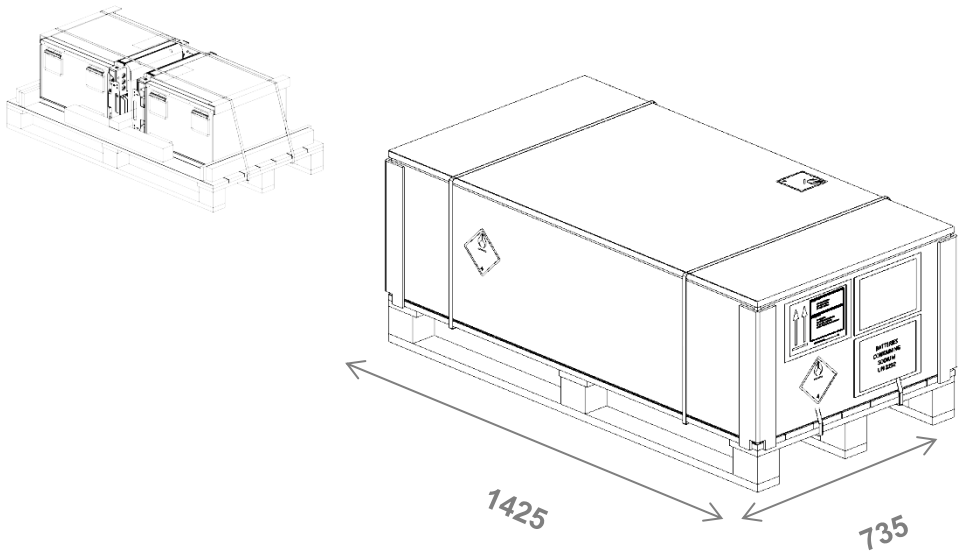


Figure 3

3.6 Transportation

Anyone who is engaged in shipping Sodium Nickel batteries must comply with all the rules and regulations listed below.

UN number:	3292 “Batteries or cells containing sodium”
Class:	4.3 “Water reactive substances” In contact with water produces flammable gas
Packing group:	II Materials of medium danger
Packing instructions:	433 For air shipment P408 For road shipment IMDG For sea shipment
Kemler nr:	Not Identified
ERG:	4W
Particular caution:	Protect from humidity and water Handle with care

Table B

Transport classification conforming to the following specific regulations:

For road or rail transport	ADR/RID (SDR)
For air transport	lATA
For sea transport	IMDG

Table C

Use ADR vehicles only if the gross weight for each transport unit is > 333 kg.
During air transport: use only cargo flight

Conforming to the regulations, the batteries are transported:

- At ambient temperature with the sodium at the solid state
- labeled and packed conforming to international rules (ADR, IATA, IMDG)
- Not charged (state of charge 0%).

4 BATTERY INSTALLATION

4.1 Tools and Hardware Required

- Insulated 13mm socket and a torque wrench 5-10Nm (3 -7Ft-Lbs. or 10 - 88 in-Lbs.);
- Insulated wrench set;
- Insulated screwdrivers;
- Multi-meter.

4.2 Battery Layout and Mounting Orientation

The FZSoNick 48TL200 battery, when active, contains some materials in a liquid form. Even though the battery is fully sealed, the maximum permanent inclination, when installed, is 30 degrees.
During handling when the battery is cold (all internal materials are in a solid state) a temporary placement, with angles greater than 30° are allowed.
In any case, never place the battery on its power terminals or upside down or with the front plastic cover facing down.
Provide adequate shelf loading capacity, ensure that there is sufficient aisle space and avoid short-circuits between the battery terminals and the shelf's metal parts.

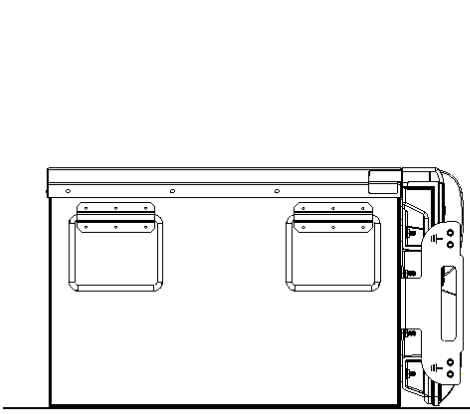


Figure 4A

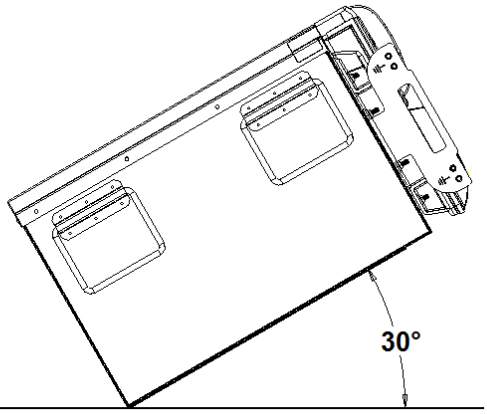


Figure 4B

The battery must be properly locked to the shelf, ensuring complete mechanical stability.
Fixing points are indicated in the following picture:

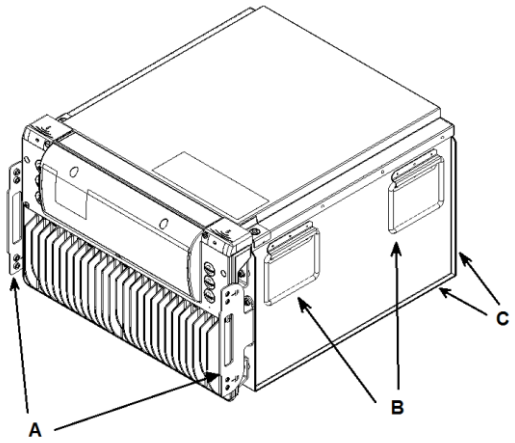


Figure 5

Point	Item	Suggested operation
A	Front handles	Fasten to the structure by means of M6 Hardware
B	Lateral handles	Fasten to the structure by means of ties
C	Lateral panels board	Lock to the structure by means of clamps

Table D

Never drill, weld or modify battery surface to lock it to structure

4.3 Battery Front Panel

The battery power terminals and interface ports are located in the front panel of the battery as indicated in the fig.6. Some connections (n° 2, 3, 4, 6, 7, 8 of the fig.6) are protected by six plastic screw plugs. All the connections of the 48TL200 battery are described in the Table E.

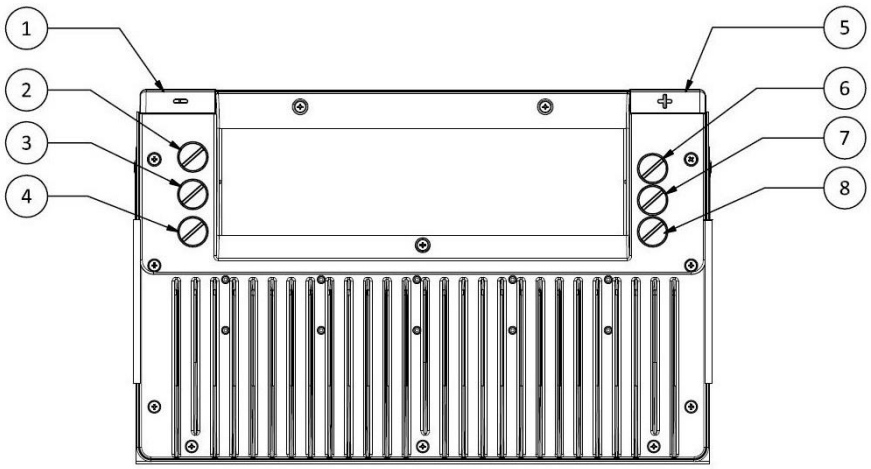


Figure 6

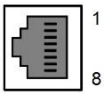
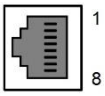
Item	Description	Type
1	Negative battery terminal	M8,female
2	Power switch	-
3	USB port	USB type B 
4	Not used	-
5	Positive battery terminal	M8, female
6	Com port output (RS485)	RJ-45 
7	Com port input (RS485)	RJ-45 
8	Alarm configuration jumper	See Section 4.5.3

Table E

The IP rating of the battery is guarantee only if all the plastic plugs in the front panel are properly screwed in. If the higher IP rating is required while one or more cables are permanently connected to the battery, the appropriate PG11 cable glands must be used.

4.4 Power Cable Connection

Do not connect batteries in series. Parallel connection is allowed.
Each SMC battery is a 48 VDC battery and is to be considered as a 48 VDC battery system.

If there is a **switch in series with the battery, please turn it off before connecting the power cables to the battery**. Otherwise please note that sparks may occur.
In any case the battery and the BMS will not be damaged.

4.4.1 Individual Connection

1) Remove the terminal insulation covers by pulling them as in the figure n°7 below

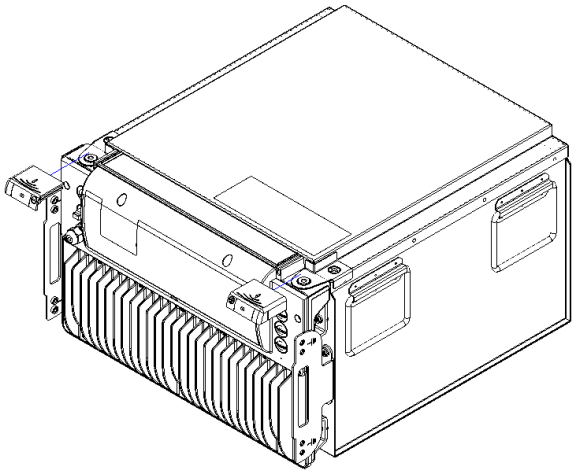


Figure 7

2) Ensure that the battery switch is in the OFF position (Fig.8)

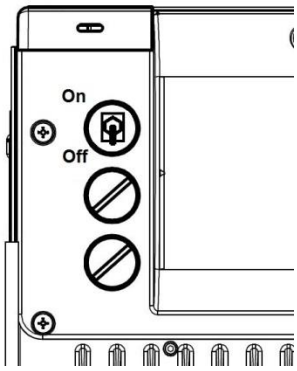


Figure 8

3) Connect the negative DC power supply terminal to the negative terminal of the battery (1, fig.6).
4) Connect the positive DC power supply terminal to the positive terminal of the battery (5, fig.6).
5) Power terminal bolts should be torqued to 7-8 Nm (5-6 Ft-Lbs., 60-70 in-Lbs.).
Install the terminal insulator cover on the terminal bolts to protect the battery terminals from accidental contact/short circuit.
6) If a Ground connection is necessary, multiple grounding locations are provided; figure 9a shows two of the four two-hole lug grounding locations. The connection accepts 1/4" x 5/8" spacing two-hole lugs.
7) If no data connection is being used, secure all the protective dust caps provided with the battery on each data port.

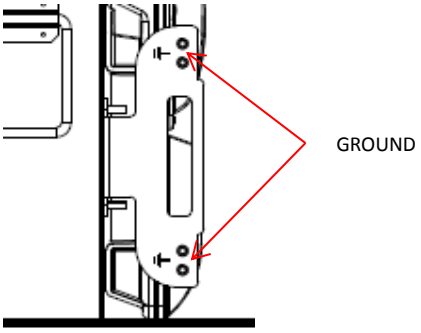


Figure 9a

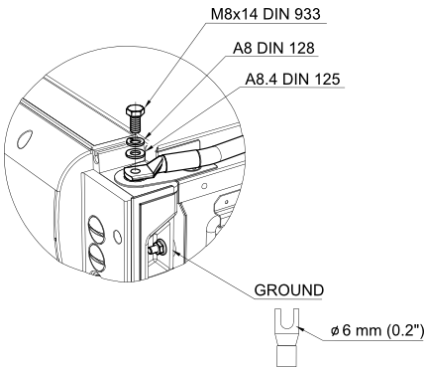


Figure 9b

4.4.2 Parallel Connection

48TL200 batteries can be connected in parallel to the same rectifier. There is no limit in the number of the batteries that can be paralleled

1) Before connecting any cables, match proper polarity (only connect positive to positive and negative to negative).
2) Connect the positive terminal of each battery together or to the same DC bus bar
3) Connect the negative terminal of each battery together or to the same DC bus bar
4) Power terminal bolts should be torqued to 7-8 Nm (5-6 Ft-Lbs., 60-70 in-Lbs.).
5) Install the terminal insulator cover on the terminal bolts to protect the battery terminals from accidental contact/short circuit.
6) For more than one paralleled string of batteries, repeat steps 1 to 4.
7) If a Ground connection is necessary, a bolt on the side of the batteries can be used, as indicated in figure 9 above.
8) If no data connection is being used, secure all the protective dust caps provided with the battery on each data port.

4.5 Data Cable Connection

4.5.1 Com Port Pin-Out

The following Table shows the pin-out of the output com port (ref. 6, fig.6)

PIN	RS485-Modbus	CANbus (Optional)
1	ALARM dry contact, NO	
2	ALARM dry contact, C	
3	ALARM dry contact, NC	
4	Remote ON/OFF	
5	Remote ON/OFF	
6	GND_485	GND_CAN
7	RS485 D+	CAN_L
8	RS485 D-	CAN_H

Table F

4.5.2 Remote Power On/Off (RPO)

Battery can be turned on and off applying or not a DC voltage (12-60V) between the pins n° 4 and 5 of the com port.

Remote battery powering is enabled only when the battery switch is in the OFF position. When the battery switch is in the ON position the battery is forced on.

Battery switch	DC Voltage between pins 4&5	Battery status
OFF	yes	Powered
	no	Not Powered
ON	yes	Powered
	no	Powered

Table G

4.5.3 Alarm Dry Contact Configuration

The battery has a Form C alarm relay; it has Open to Alarm (OTA) and Closed to Alarm (CTA) contact with a common connection between them (fig.10a). When the battery issues an alarm, the dry contact is de-activated. Dry contact terminals are located in the (output) com port as indicated in the Table F. A configuration jumper is located behind the plastic screw plug (ref. 8 fig.6) as indicated in the fig 10b

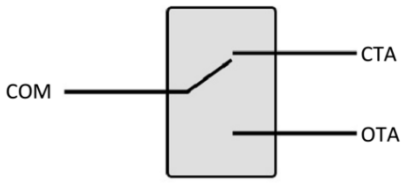


Figure 10a

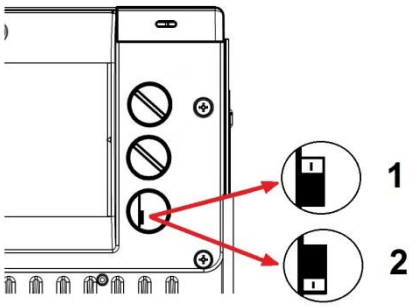


Figure 10b

4.5.4 Single Battery Installation

In case of a single battery installation a data cable could be permanently connected to the output port in order to access the communication bus, the alarm dry contact and the remote powering pins.

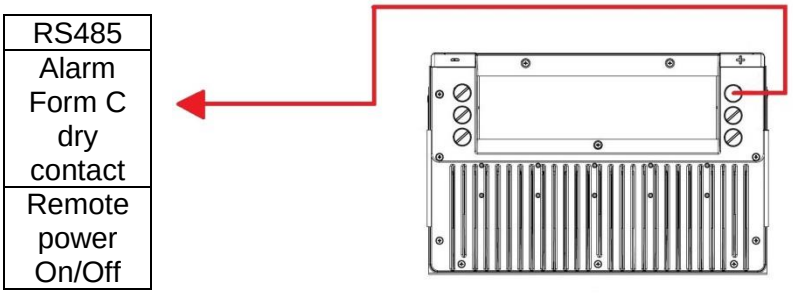


Figure 11

With this configuration the Alarm both dry contacts are available. The jumper configuration will need to be set as indicated in the Table H (ref. fig.10b and fig.12)

Option	Configuration	Output pins on battery 1	Jumper setting
1	Alarm contacts Form C (OTA or CTA)	Output port, pins 1 and 2 = Open to Alarm pins 2 and 3 = Closed to Alarm	Battery : 2

Table H

4.5.5 Multiple Batteries Installation

In case of multiple battery installation, a daisy chain configuration of the data cable is possible. Output port of one battery should be connected with the input port of the following battery, as showed in the figure 12. With this configuration all the battery of the chain is connected to the same communication bus (RS485) and each battery have to be given a unique address with the software configuration tool available for the battery.

The battery default Modbus (RS485) address is 0x02h. It is recommended that this address is not used when designing an addressing scheme for the application. Reserve this address for placing new modules on the bus so they can be accessed with the configuration tool and correctly readdressed.

Maximum number of batteries that can be connected in the same data chain is 64 with the RS485.

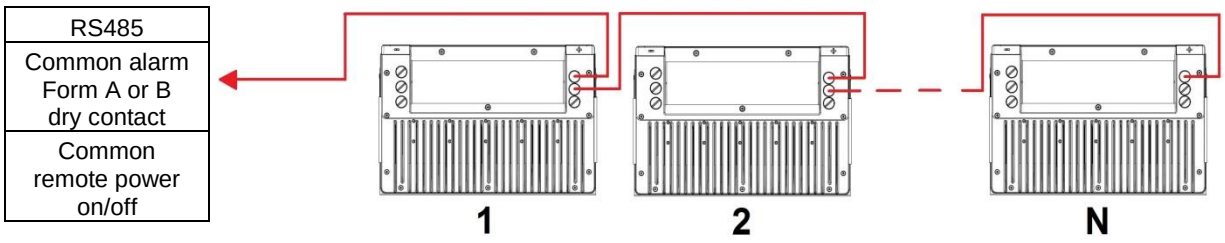


Figure 12

With this configuration the Alarm dry contacts are connected together in order to have a common signal. Two options are available depending on the jumper configuration, as indicated in the Table I (ref. fig.10b and fig.12)

Option	Configuration	Output pins on battery 1	Jumper setting
1	Series of normally closed contacts Form A (OTA)	Output port, Open to Alarm Pins 1 and 2	Batteries 1..N-1 : 1 Battery N : 2
2	Parallel of normally opened contacts Form B (CTA)	Output port – Close to Alarm Pins 2 and 3	Batteries 1..N : 2

Table I

4.6 Battery Activation

1) Set the DC power supply at a voltage between 54Vdc and 60Vdc. No current limitation is needed, however, with the factory setting, a minimum current supply of 40 Amps per module from the rectifier is necessary to ensure the shortest charging time. Contact customer service if a different setting is required.
2) Turn on the DC power supply
3) Turn the battery switch (Fig.8) to the ON position. The display should indicate “INIT” and the green led (1, Fig.13) on the front panel should start blinking, indicating that the BMS is powered and the battery is not yet connected to the DC Bus (the internal power switch is still open).

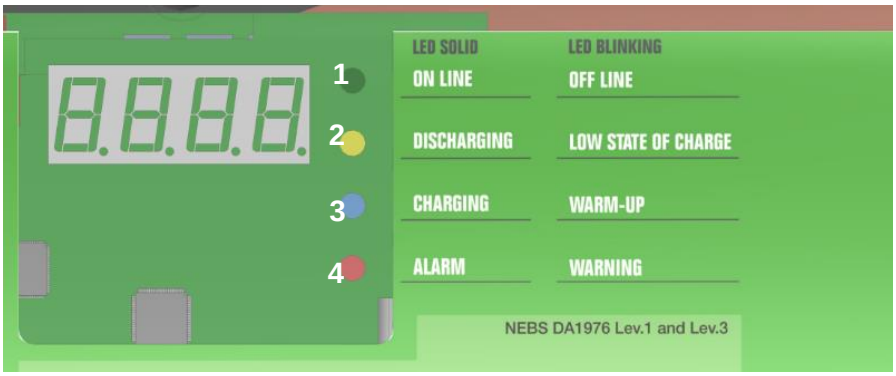


Figure 13

4) If the battery internal temperature is below 265°C (518°F) the warm up phase is started, (see section 5.1 of this manual) till the target temperature is achieved. At this point the main contactor is closed, connecting the battery to the DC power supply. The green and blue led (1-3, Fig.13) on the front panel stops blinking and remains solid.
5) Now the battery is electrochemically operative, and if it is not in the full state of charge, the built-in battery charger turns on and the charging phase starts. (See section 5.2 of this manual).
6) A discharge is always possible, even if the battery is in charge mode (see section 5.2 of this manual).

When an SMC battery is turned off, it’s always necessary to connect it to a powered DC bus to turn it on again, for any battery SOC and internal temperature condition.

5 BATTERY IN OPERATION

5.1 Battery Warm-Up

The FZSoNick 48TL200 battery needs to be warm before it starts to deliver energy since it operates between 265° and 350°C (509-662°F).
The BMS performs the warm-up process automatically as soon as it is turned ON (by means of the BMS power switch or by the external 48V RPO Remote Power Off circuit). When the battery is in this state the LED indication are both green and blue LEDs blinking while the 7 Segment display of the battery continuously indicates the internal temperature.
Starting from room temperature, this process takes 14 hours. A graph of the process is included in the appendix I section. Power consumption during this process is indicated in the Table J.

Elapsed Time (h)	Temperature (°C)	Power consumption (W)
0	25	380
7	160	380
14	260	380
>14	265	115

Table J

Power consumption values in the first three lines in Table I are during the warm-up phase of operation. Whenever the battery SOC is lower than 100%, the battery will automatically Start the charge cycle after the warm-up condition. After the charge cycle the Power consumption of the battery remains constant. The exact value is affected by ambient temperature. See Appendix for details.

After the battery is warmed up for the first time or has been stored cold for a long period of time, few water drops may be visible in the BMS cover. Some residual humidity inside the battery is released during the warm up and condense inside the clear plastic cover of the BMS. This is a normal operating condition and the water will disappear in few days of operation thanks to the evacuation valve of the BMS. To accelerate this process is also possible to leave open 2 or 3 plastic plugs of the BMS for 24h.

5.2 Battery Charging

The BMS of the 48TL200 battery is equipped with an integrated charge regulator, basically a DCDC step-down (Buck) converter. The battery accepts any voltage between 54 and 59V, and regulates the charging current and the charging voltage to the optimal levels. Recharge current is limited by the BMS to 40A therefore there is no need to limit the current at the rectifier level. To charge the battery, a simple DC power supply can be used. In any case the BMS is fully compatible with any typical rectifier used in the telecommunication market.

If the BMS detects that the SOC of the battery is below 100%, the charge phase is automatically started. This is indicated by the blue LED which will turn solid on while the display of the battery alternatively shows all the charging parameters (voltages, current).

Battery recharge time depends on the current availability and the initial SOC. If the full current is available, a complete charge takes approximately 12hrs. More charging information is included in the appendix II section.

If the available current is below 40A, during the first part of the charge process, the DC Bus voltage could decrease below the minimum value. A warning could be issued by the BMS. Besides the factory setting of 40A, lower current settings are available on request.

5.3 Floating

When a fully charged battery is connected to the DC bus (with only green led solid on) the internal charge regulators are switched off. In this condition the Battery “float” current has 2 main “components”.
The first one is due to the power consumption of the electronics controller and the second is due to the power consumption used to compensate for the heat losses.
The first component of the float current is constant over the battery status while the second depends on battery working conditions. (i.e. ambient temperature).
The average float power consumption at 20°C is 115W; more detailed information is available in the appendix III section of this manual.

5.4 Discharging and Rated Capacity

A discharge is always possible in case the battery is in float or charge state, when the green LED is on solid. When the battery is performing a warm-up or is an alarm condition a discharge is not possible (green LED blinking).
In case the battery goes into discharge, the yellow LED turns on solid and, when the state of charge of the battery is under 20% of its nominal capacity value this LED turns to a blinking indication. For some specific firmware the BLU led , indicating a charge phase, is solid on in the discharge to indicate the direct charge mode is active. In this mode charging current can be quickly accepted by the battery (during a discharge when SOC<100%) without the activation time needed by internal charge regulator.
The rated capacity of The FZSoNick 48TL200 battery is 200 Ah. At higher rates the capacity is lower because of the higher internal resistance losses; at lower rates the useful capacity is lower due to the fact that some power is needed to maintain the battery at the internally working temperature and this power is drawn from the battery itself. The 48TL200 discharge performance is not significantly affected by temperature variations, especially compared with other battery

technologies. Even if the outside ambient temperature varies greatly, its internal temperature will remain within the operative range and then the capacity and life are not affected.
Detailed information is available in the appendix IV section of this manual.

The discharge performances of a new battery could result slightly lower (5-6% less) compared to the nominal battery performances described in the appendix IV of this manual.
FZSoNick technology requires some run-in cycles (10 maximum) in order to reach the maximum battery performances.

5.5 Battery Cool Down

The 48TL200 battery is kept at its operating temperature with three internal heaters, controlled by the BMS and it is insulated with special insulation material to limit both the thermal losses and the temperature gradients inside the battery. If the battery is operative (ON-LINE), the thermal management of the BMS keeps the internal temperature at a minimum of 265°C.
As soon as the battery is turned off (by the power switch) the BMS is powered off and so the heating elements: the internal temperature starts to decrease with a typical behavior (see appendix V section for details).
If the battery is removed from the DC bus with its power switch in the on position, the battery starts to use its own energy to keep the internal temperature. After a number of hours, depending on the SOC, the battery turns off (when it's SOC=0%) and the temperature starts to decrease.

5.6 Battery Internal Resistance

The internal battery resistance varies depending on the different states of charge;
Average value is 35mOhm, see appendix VI section for details.

5.7 Maintenance Free

The FZSoNick Sodium Nickel Metal Chloride battery does not require any maintenance.
The battery is designed and manufactured without user serviceable parts.
User interface provides battery statuses and operation data.

6 TECHNICAL INFORMATION

6.1 FZSoNick Battery Description

The battery's primary function is to store electrical energy and to supply it to an external load when needed. The battery management system also provides secondary functions that are essential to achieve the required service life duration.

6.1.1 BMS Functions

Main functions of the integrated Battery Management System (BMS) are:

- Battery Thermal Management: battery needs to be warm before it starts receive or deliver energy. The thermal management of the BMS performs the warm-up process automatically as soon as it is powered.
- Battery Charge Process: the BMS is equipped with a charge controller which is able to regulate the charging parameters (voltage and current) in order to obtain the best charging performance.
- Battery Power/Energy Output Checks: the BMS calculates the battery SOC to provide a reliable and safe operation and to avoid overcharge or over discharge.
- Battery Operating Conditions Checks: the BMS continuously measures all the battery parameters such as voltages, currents, temperatures, insulation levels providing a continuous monitoring of the operating conditions.
- Redundant Control: the controller is equipped with a safety redundant microprocessor (Watchdog) for safe operations.
- Battery communication: the BMS has various communication capability using different communication ports: USB, RS485, optional CAN Bus or Ethernet.

6.2 Battery Specification

Characteristics	Values
Nominal Voltage	48 Vdc
Operating Voltage Range	42 to 59 Vdc
Nominal Capacity	200 Ah at C4 to 42V
Nominal Energy	9300 Wh at C4 to 42V
Continuous Discharge Current	150A
DC Bus Voltage Range	53 – 59 Vdc
Internal Low Voltage Disconnect	40 Vdc
Power Fuse Rating	200A
Communication Port	USB / RS 485 / (Options CanBus or Ethernet)
Alarm Dry Contact Rating	200mA (60V ac/dc)
Length	496 mm [19.5 in]
Width	558 mm [21.9 in]
Height	320 mm [12.6 in]
Weight	105 kg / 231 lb.
Continuous Operating Ambient Temperature	-20 to +60°C (-4 to 140°F)
Terminal Bolt Torque	7-8 Nm, 5-6 Ft-Lbs, 60-70 In-Lbs
Terminal Bolt Size	M8

Table K

6.3 Battery Labels

The FZSoNick 48TL200 battery has three visible labels located as in the picture 14 below:

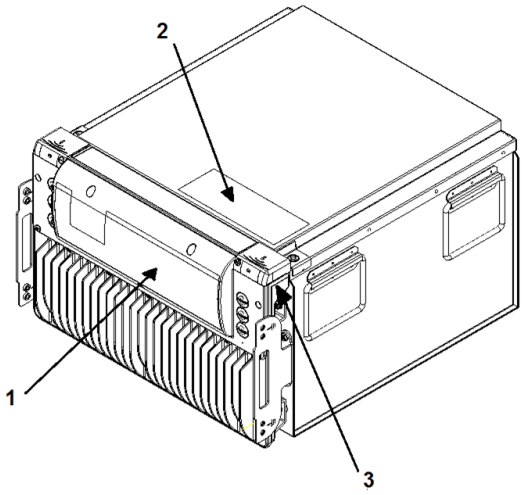


Figure 14

6.3.1 Front Label

The label in Fig.15 contains battery technical information, the LED explanation legend and the interface ports indications.

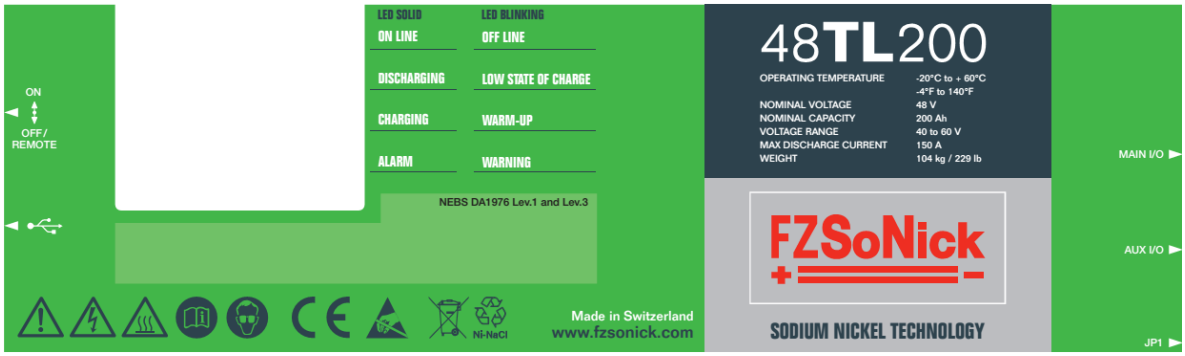


Figure 15

6.3.2 Side BMS Label

The label in Fig.16 contains the BMS serial number

Figure 16

6.3.3 Top Label

The label in Fig.17 contains battery technical information, the production date and the battery serial number.

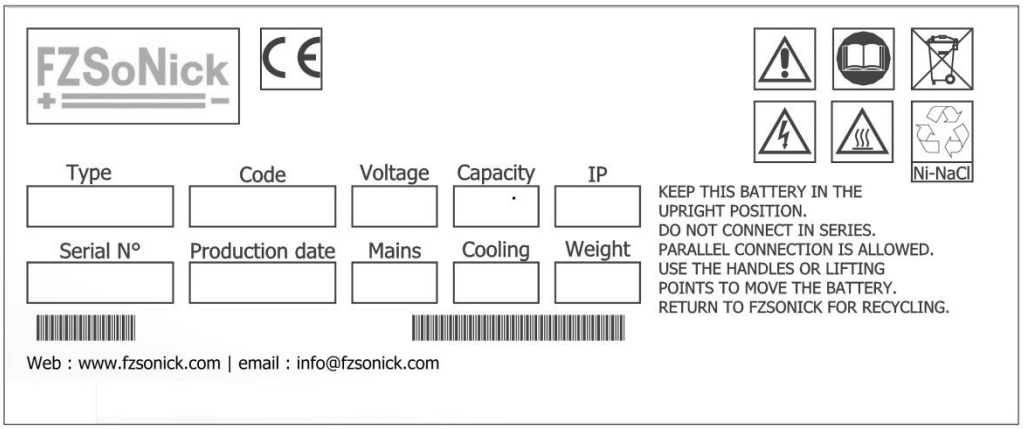


Figure 17

Symbol	Description
	Keep the battery in the upright position. Do not connect in series two or more batteries. Parallel connection is allowed.
	Hazardous voltage risk of electric shock. Authorized personnel only.
	The battery surface may be hot.
	Observe operating instructions and display it visibly in the vicinity of the battery. Work on batteries only after instruction by qualified staff.
	Wear eyes protection and protective clothing when working with batteries. Observe accident prevention regulations.
	The battery is an electrostatic-sensitive device, pay attention during its manipulation.

Table L

6.4 Battery Alarms

Battery management system issues warnings or alarms depending on the battery working conditions or to the presence of internal faults. Depending on the criticality of the situation, the front red LED begins to blink (warning) or become solid (Alarm). In case of alarm situation the display shows the alarm code, as indicated in the Table M below, the main contactor is open (Green LED blinking) and the alarm dry contact is closed.

6.4.1 Warnings/Alarms List (fw vers.:, mcu_app 0xxx, mcu_app Axxx, mcu_app Cxxx)

Alarm no.	Descr String	Function	Alarm Family	Severity	Delay	Alarm condition
0	Tam	Tamb_Min	TEMP	RALR	NULL	if BMS Temperature is < -40°C
1	TaM1	Tamb_Max_1	TEMP	WARN	NULL	if BMS Temperature is > 70°C
2	TaM2	Tamb_Max_2	TEMP	RALR	LONG	if BMS Temperature is > 85°C
3	Tbm	Tbatt_Min	TEMP	RALR	SHORT	If low battery internal temperature is detected
4	TbM1	Tbatt_Max_1	TEMP	WARN	LONG	if max(Battery temperatures) > 340°C
5	TbM2	Tbatt_Max_2	TEMP	RALR	SHORT	if max(Battery temperatures) > 350°C
6	VBm1	Vbus_Min_1	V_BUS	WARN	NULL	if Vbus < 40V (hyst. 0.2V)
7	VBm2	Vbus_Min_2	V_BUS	RALR	LONG	if Vbus < 39V (hyst. 0.2V)
8	VBM1	Vbus_Max_1	V_BUS	WARN	NULL	if Vbus > 60V (hyst. 0.2V)
9	VBM2	Vbus_Max_2	V_BUS	RALR	LONG	if Vbus > 65V (hyst. 0.2V)
10	IDM1	Ibatt_Dch_Max_1	DISCH	WARN	NULL	if Ibatt_Discharge > 151A
11	IDM2	Ibatt_Dch_Max_2	DISCH	RALR	NULL	if Ibatt_Discharge > 160A
12	ISOB	Isobatt	HW	UALR	LONG	alarm thresholds have been set according to insulation detection circuit
13	MSWE	Main_Sw_Error	HW	UALR	SHORT	if Main switch AUX contact feedback mismatches the command issued
14	FUSE	Fuse_Blown	HW	UALR	SHORT	if Main Fuse is blown
15	HTRE	Heaters_Error	HW	RALR	LONG	if the battery is in WARM-UP and the 3 temperature sensors measure each a non-increasing temperature

Alarm no.	Descr String	Function	Alarm Family	Severity	Delay	Alarm condition
16	TCPE	Thermocouple_Error	HW	UALR	LONG	1st issue: if temp. difference between sensor max and min > 80°C 2nd issue: no response from sensor for 5 sec
18	CME	String_Current_Measure_Error	HW	RALR	LONG	if Current measurement circuit fails
19	HWFL	Hw_Failure	HW	UALR	NULL	If BMS hardware fails
20	HWEM	HW_Emergency	HW	RALR	NULL	If Hardware protection system is activated
21	ThM	Ths_Max	TEMP	RALR	LONG	if heatsink temperature > 85°C
22	vsm1	Vstr_min_1	DISCH	RALR	SHORT	if Vstring < 39V
23	vsm2	Vstr_min_2	DISCH	UALR	NULL	if Vstring < 34V
24	vsM1	Vstr_MAX_1	V_STR	WARN	SHORT	if Vstring > 53.5V
25	vsM2	Vstr_MAX_2	V_STR	RALR	SHORT	if Vstring > 53.6V
26	iCM1	Istr_Ch_Max_1	CHRG	WARN	LONG	If string charge current > 9A
27	iCM2	Istr_Ch_Max_2	CHRG	UALR	LONG	if string charge current > 10A
28	iDM1	Istr_Dch_Max_1	DISCH	WARN	NULL	if string discharge current > 33A
29	iDM2	Istr_Dch_Max_2	DISCH	UALR	NULL	if string discharge current > 34A
30	MID1	MidString_Error_1	V_STR	WARN	LONG	String voltages unbalance warning
31	MID2	MidString_Error_2	V_STR	RALR	LONG	String voltages unbalance alarm
32	BLPW	Bus_Power_Too_Low	CHRG	WARN	SHORT	if not enough charging power is available on Vbus
33	CCBF	CCB_HW_Error	HW	UALR	LONG	if an HW failure is detected on battery internal charger
35	Ah_W	Ah_String_Empty_1	DISCH	WARN	SHORT	if string_SOC < 5Ah
38	MPMM	MidPointMismatch	CHRG	WARN	NULL	Error on Midpoint wiring
40	TCdi	ThermoCoupleDiff	TEMP	WARN	LONG	if difference between side and center sensors is > 5°C
42	HTFS	Heaters_Fuse_Blown	INIT	UALR	SHORT	If Heaters Fuse Blown
43	DATA	Parameter_Out_Of_Range	HW	UALR	SHORT	checks if all parameters are within the range (MIN …MAX)

Table M1

6.4.2 Descriptions

Alarm Severity:

Abbreviation	Extended	Description
WARN	WARNING	Pre-alarm status, check system conditions to clear it out.
RALR	RECOVERABLE	Alarm status, check system conditions to clear it out.
UALR	UNRECOVERABLE	Major alarm status, battery will disconnects itself. Check system conditions and contact FZSoNick if alarm belongs to the battery.

Table M2

Alarm Family:

Type	Description
CHRG	Charge
DISCH	Discharge
HW	Hardware
INIT	Initialization
TEMP	Temperature measurement
V_BUS	External Battery Bus Voltage
V_STR	String Voltage

Table M3

Delays:

Type	Description
SHORT	Default value is 10 s
LONG	Default value is 120 s
NULL	No delay

Table M4

6.5 Service Life Definition

The service life of the FZSoNick 48TL200 battery is the period of useful service under the conditions defined in the battery specification expressed as the period elapsed between the start of life and the time where the ampere-hour maximum capacity has fallen to 80% of the rated capacity. Even if the battery goes below 80%, its rated capacity will not drop abruptly and suddenly like other battery technologies.

6.6 Extended Outages

Extended outages don't have any consequences on the battery health. In case of a prolonged discharge, the battery disconnects itself from the load when its energy is expended and, if the main DC supply doesn't come back, the internal temperature will start to decrease. When cold the battery is completely inactive and can stand in such condition for a period of time which is virtually infinite. As soon as the mains return the battery starts the warm up procedure (if needed).

6.7 Light Emitting Diodes (LED's) Explanation

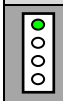
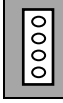
LED COLOUR		INDICATION	NOTE / ACTION
	SOLID *GREEN*	Battery ready to operate, connected to the DC bus	The battery is fully charged State of Charge (SOC) =100%
	BLINKING *GREEN* BLINKING *BLUE*	Battery is warming up, not connected to the DC bus	Temperature is below operational. Charging or discharging is not allowed
	SOLID *GREEN* SOLID *BLUE*	Battery under charge, connected to the DC bus	Battery SOC is < 100% Discharging is allowed
	SOLID *GREEN* SOLID *YELLOW*	Battery is discharging	Battery SOC is > 12.5% Only valid for certain firmware (mcu_app 0xxx, Cxxx)
	SOLID *GREEN* BLINKING *YELLOW*	Battery is discharging	Battery SOC is < 12.5% Only valid for certain firmware (mcu_app 0xxx, Cxxx)
	SOLID *GREEN* SOLID *YELLOW* SOLID *BLUE*	Battery is discharging. Direct charge is allowed	Battery SOC is > 12.5% Only valid for certain firmware (mcu_app Axxx)
	SOLID *GREEN* BLINKING *YELLOW* SOLID *BLUE*	Battery is discharging. Direct charge is allowed	Battery SOC is < 12.5% Only valid for certain firmware (mcu_app Axxx)
	SOLID *GREEN* BLINKING *RED*	A warning occurred during the float (idle) condition	Check float (idle) conditions/parameters
	SOLID *GREEN* SOLID *BLUE* BLINKING *RED*	A warning occurred while the battery was charging	Check charge conditions/parameters
	SOLID *GREEN* SOLID *YELLOW* BLINKING *RED*	A warning occurred while the battery was discharging	Check discharge conditions/parameters
	BLINKING *GREEN* SOLID *RED*	Alarm status – the battery is not connected to the DC bus	The battery was disconnected because of a major issue. Charging or discharging is not allowed
	NO LED ON	the BMS is not powered-up	Check if battery switch is OFF If not, check if DC bus is up otherwise, the BMS has to be serviced/repaired

Table N

6.8 Display

The FZSoNick 48TL200 battery is equipped with a 4 digits, 7 segments display. During battery operation the display cyclically shows the main battery parameters, as in the Table O below

		Displayed parameters				
		Battery Temperature [°C]	Bus Voltage [V]	Battery Current [A]	SOC %	Alarm Codes
	Display indication	tEMP	u bUS	I bAtt	SOC	ALArM COdES
Battery Operating Status	Warm-up	X				
	Charge	X	X	X	X	
	On-line	X	X	X	X	
	Discharge	X	X	X	X	
	Alarm					X

Table O

6.9 Safe Technology

Each 48TL200 is made of 100 sodium nickel cells. A single cell is composed by a fully sealed prismatic steel case which contains the active materials and the cell separator. The cells are electrically connected by brazed/welded rigid inter-cell connectors and the resulting cell pack is contained into a stainless steel (inner) box together with 3 heating elements and the temperature probes.
The inner box is surrounded by the thermal insulation complex which is composed by a number of micro-porous silica panels with the appropriate thickness to provide the right level of insulation, minimizing the thermal losses.
The outer stainless steel battery box contains the inner box and the thermal insulation barrier and provides the adequate mechanical strength and a sealed construction.
All of the active materials are safely and permanently contained within the battery, which has zero spillage and cannot leak or outgas in normal operation.

6.10 Battery Protection

Each battery has its own electrical, thermal and mechanical protection built-in.

6.10.1 Electrical Protection

Electrical protections are considered as primary security.

FZSoNick 48TL200 battery is protected against short circuit or prolonged current overload (current above 200A will open the positive leg) by the Battery Management System's (BMS) ability to disconnect the battery terminals. Battery is also provided with internal fusible link protection, (150A) that will open the negative leg if an over current situation, in the remote case of non-intervention by the BMS, occurs.

6.10.2 Battery Thermal Protection

Thermal protection devices are used to prevent battery overheating situations. The following is a list of the thermal protections built in each battery:

- To maintain the battery internal temperature between 265 and 350 °C (509-662°F), heaters activated by a closed-loop temperature control system, are managed by the BMS.
- The BMS will temporarily disconnect the battery path should its internal temperature exceed 350°C (662°F).
- The BMS will cut power to the battery heaters should the battery temperature be above 350°C (662°F).

6.10.3 BMS Thermal Protection

The BMS itself is equipped with a ventilation system, able to cool down the electronic components during standard battery operations or when overheating condition occurs. This component is a “no life critical” device: no specific alarms are issued by the battery because, in case of its failure, the BMS is globally protected against overheating.

6.10.4 Mechanical Protection

Batteries are packed with a double stainless steel case and cells are hermetically sealed with metal cases which fully enclose the active materials and which are so constructed and closed to prevent the release of the active materials under normal conditions.

6.10.5 Reliability

A battery failure in a multi-battery installation will not cause the battery backup system to fail nor will it cause the other batteries to malfunction. The defective battery will take itself off-line from the other batteries. Power to the load will not be compromised with the only effect being a reduction in the backup time.

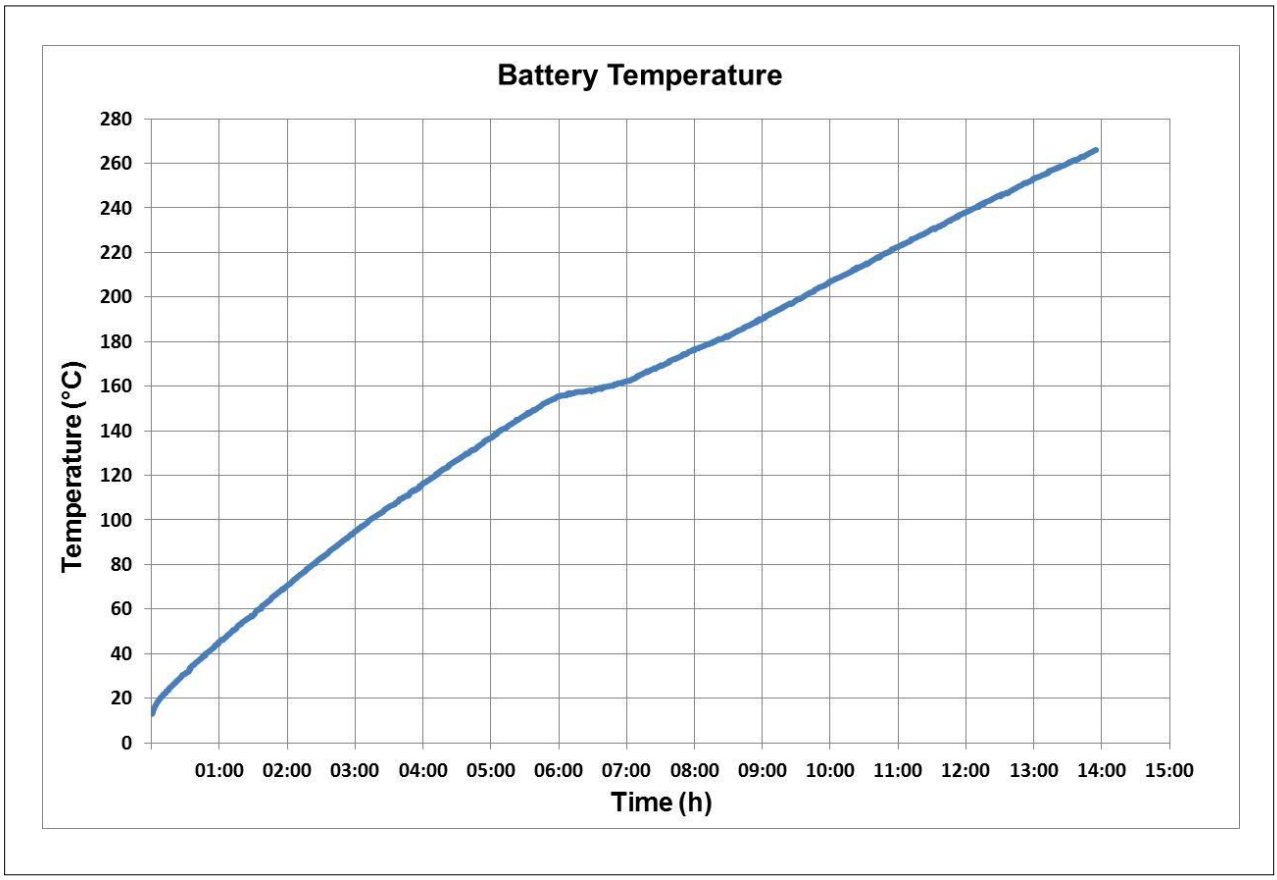
6.11 Technical Assistance

For technical assistance or any questions concerning FZSoNick or any of its products, contact FZSoNick customer support.

Appendix

I - Warm Up Process

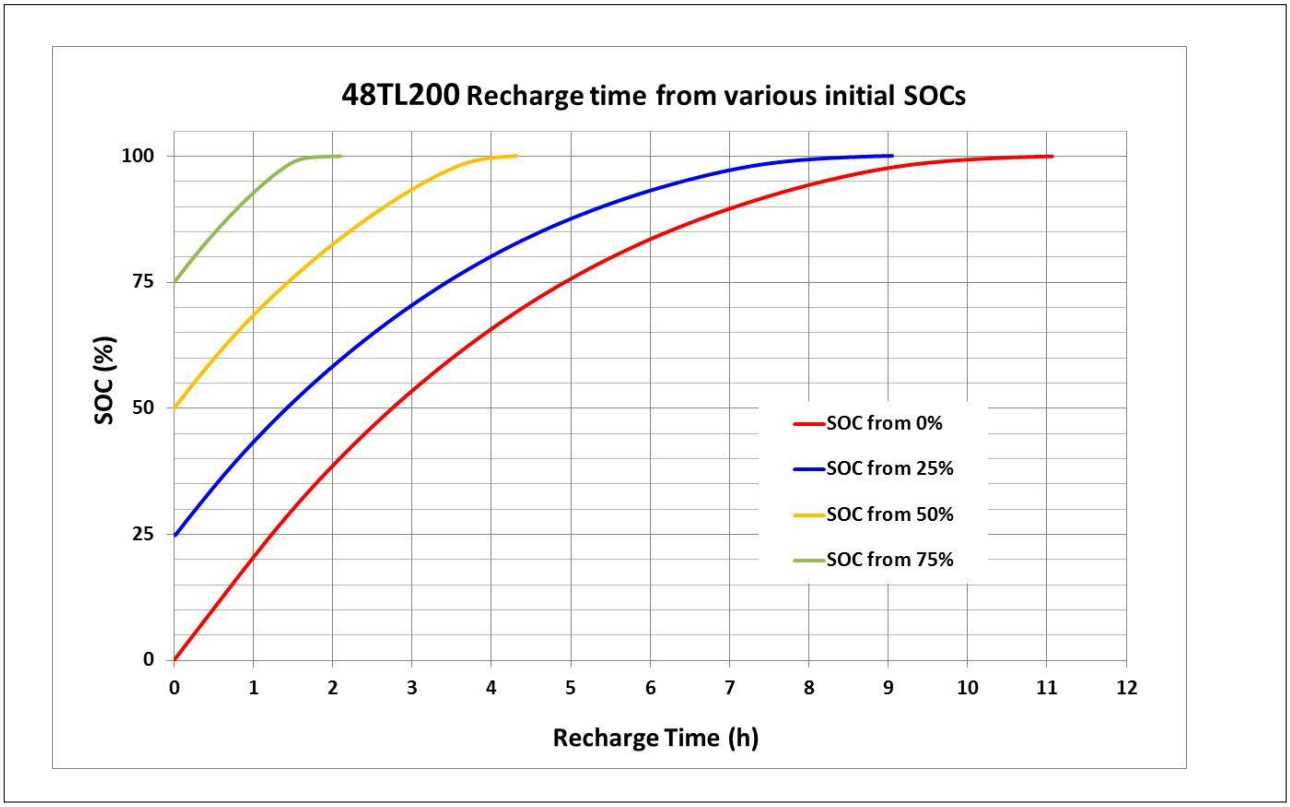
The graph below shows the internal temperature evolution of a 48TL200 battery during the warm-up process



II - Battery Recharge

The 48TL200 battery can be recharged using a constant voltage DC power supply. Excess of charging capacity is not a concern because internal battery circuitry automatically limits the charging current to ensure the safe and optimum operation of the battery.

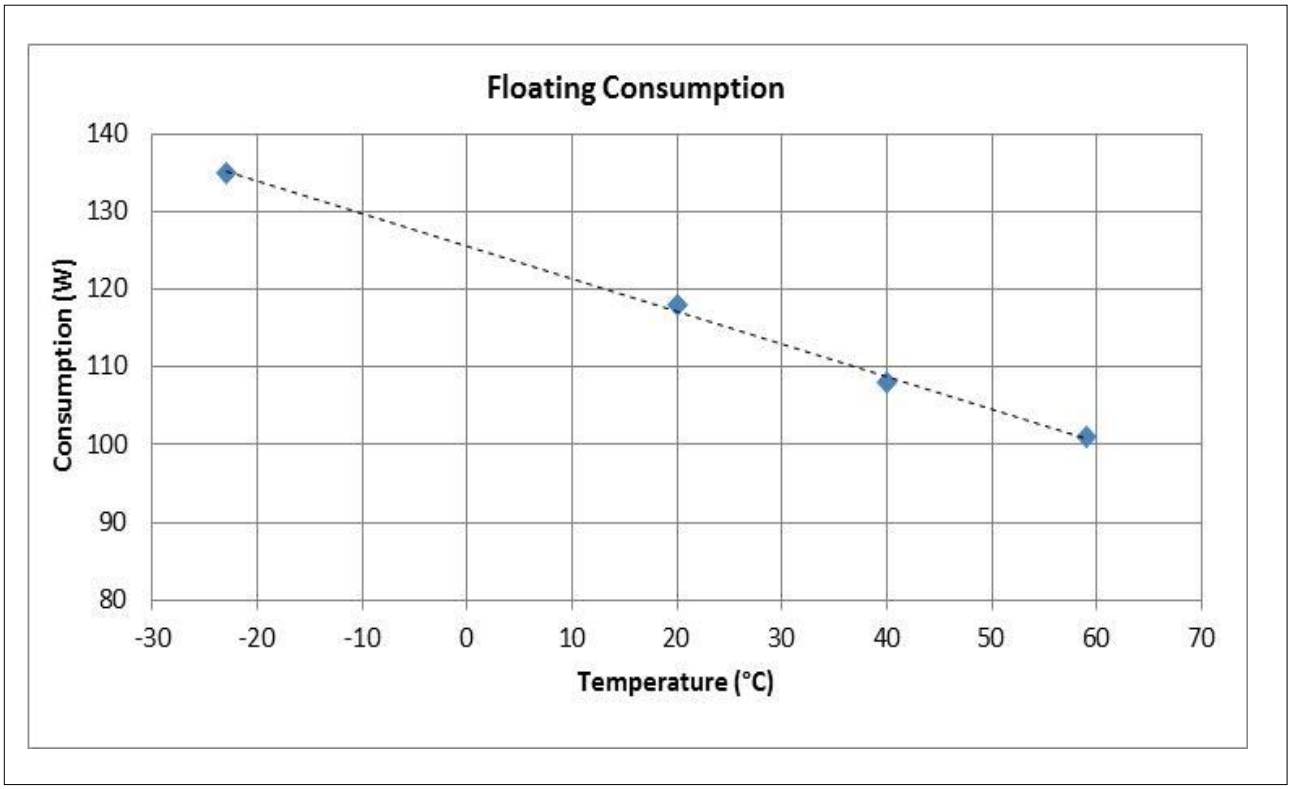
The graph below shows the recharge time for various initial states of charge. These results can be obtained when the recharge power required by the battery (standard setting, 40A) is fully available from the rectifier.



48TL200 Recharge time [h] [-20 + 60°C; -4 ÷ +140°F]				
Final SOC (%) / Initial SOC (%)	**25**	**50**	**75**	**100**
0	1.2	2.7	5	11
25		1.4	3.4	9
50			1.4	4.2
75				2
100				

III - Battery Floating

The float power consumption of the 48TL200 battery depends on the temperature of the ambient where the battery is installed. This behavior is mainly due to the variations of the heat power requirements with the temperature. The graph below shows the power consumption at different ambient temperatures



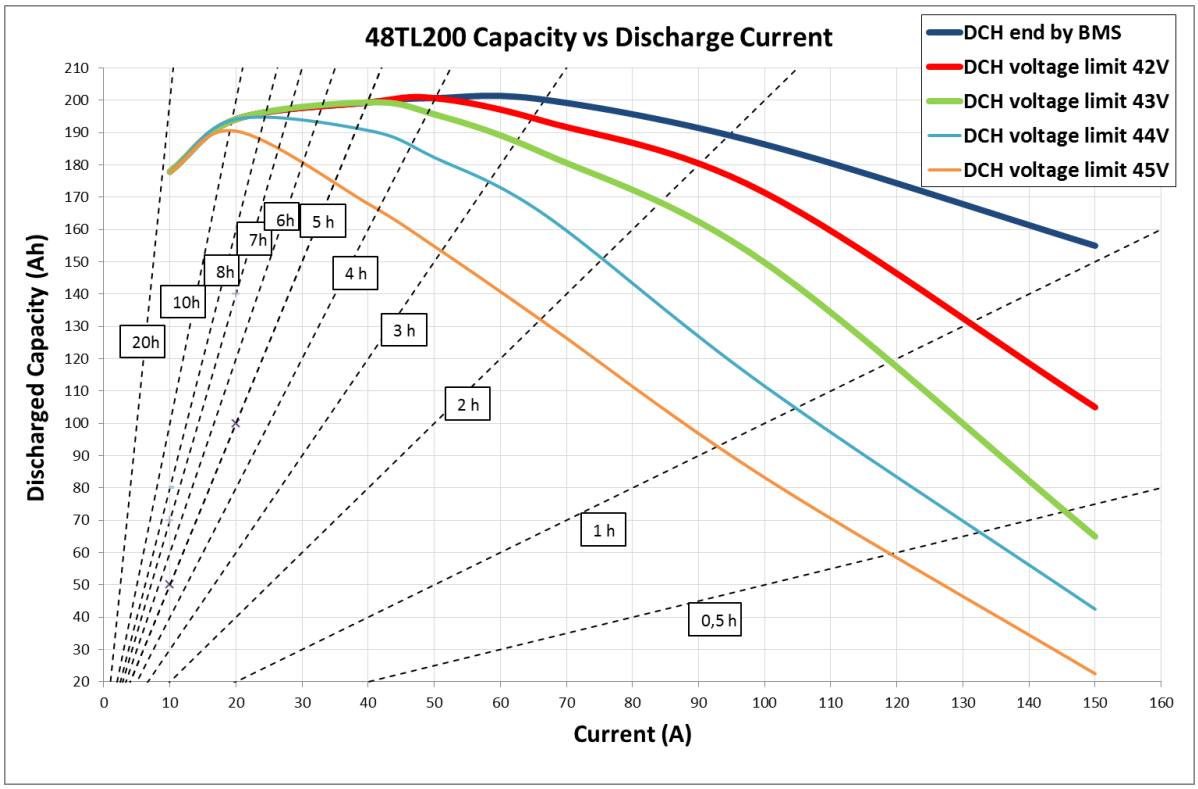
IV - Battery Performance

Following tables show the 48TL200 capacity and energy at different final voltage levels when the battery is discharged with a constant current or constant power load.
During a discharge at low temperatures, the internal heaters will consume more energy than at higher ambient temperatures, but the capacity or energy reduction is minimal. During operation at high temperatures, capacity or energy is not affected.

- **Capacity / Current**

48TL200 Capacity [Ah] ***[-20 + 60°C; -4 ÷ +140°F]***						
End voltage [V] / Discharge time [h]	**45**	**44**	**43**	**42**	**Termination By BMS**	
					Ah	**Vfin**
1	93.5	105.0	120.0	132.0	154.5	40.0
2	132.4	151.2	170.5	183.5	191.8	40.6
3	150.6	173.7	190.5	198.5	200.0	41.8
4	165.0	187.0	198.5	200.0	200.0	42.0
5	175.0	193.0	200.0	200.0	200.0	43.4
6	180.0	195.6	198.5	198.5	198.5	44.1
7	185.0	196.0	196.5	196.5	196.5	44.5
8	188.0	193.5	193.5	193.5	193.5	44.8
10	190.0	190.0	190.2	190.2	190.2	45.0
20	170.3	170.3	170.3	170.3	170.3	45.6

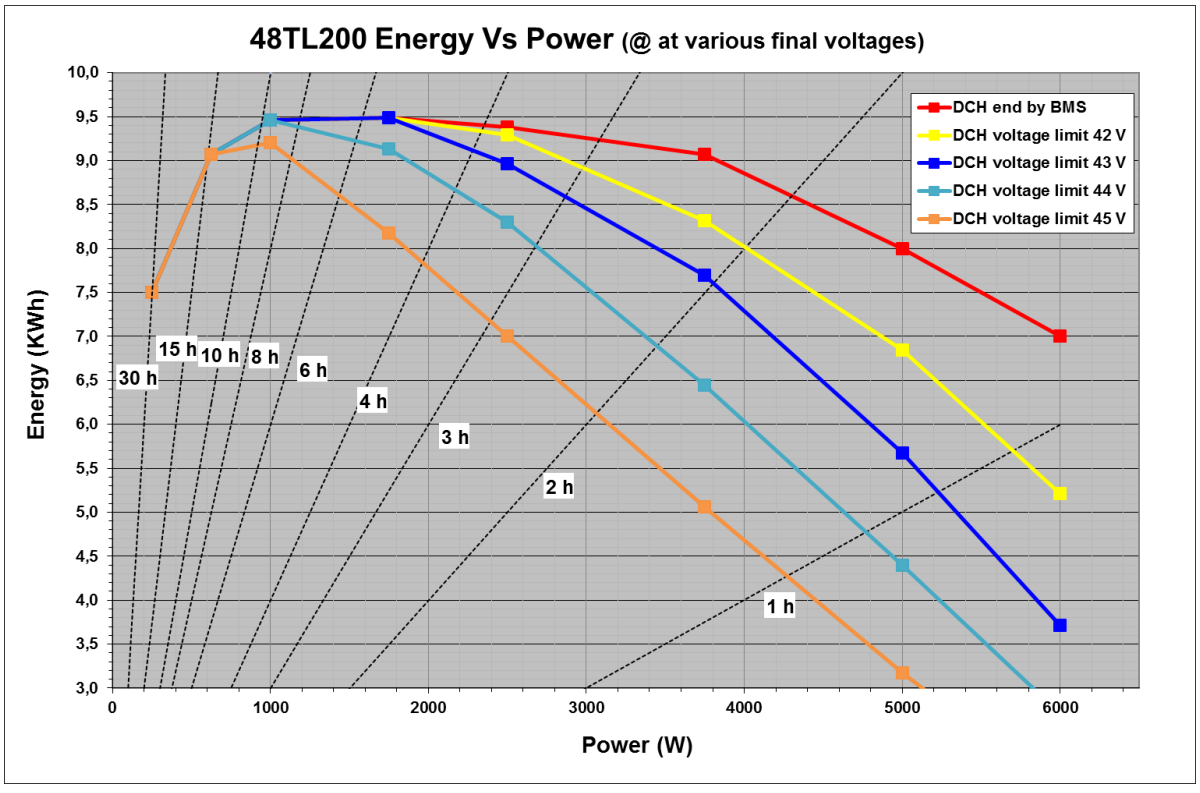
48TL200 Discharge Current [A] ***[-20 + 60°C; -4 ÷ +140°F]***						
End voltage[V] / Discharge time [h]	**45**	**44**	**43**	**42**	**Termination By BMS**	
					A	**Vfin**
1	93.5	105.0	120.0	132.0	154.5	40.0
2	66.2	75.6	85.2	91.7	95.9	40.6
3	50.2	57.9	63.5	66.1	66.6	41.8
4	41.3	46.8	49.6	50.0	50.0	42.0
5	35.0	38.6	40.0	40.0	40.0	43.4
6	30.0	32.6	33.1	33.1	33.1	44.1
7	26.4	28.0	28.1	28.1	28.1	44.5
8	23.0	24.2	24.2	24.2	24.2	44.8
10	19.0	19.0	19.0	19.0	19.0	45.0
20	8.5	8.5	8.5	8.5	8.5	45.6



- **Energy / Power**

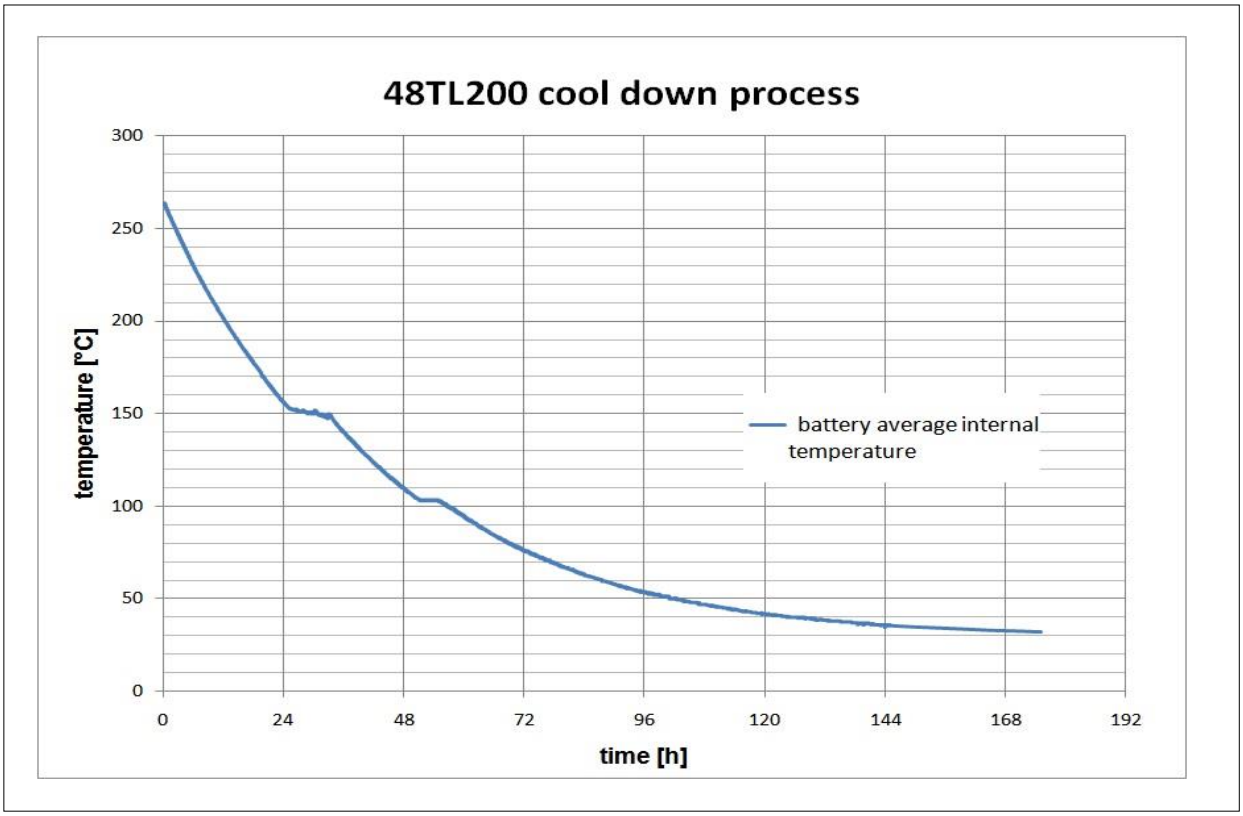
48TL200 Discharge Energy (kWh) *[-20 + 60°C; -4 ÷ +140°F]*						
End Voltage [V] / Discharge Time [h]	Termination By BMS		42	43	44	45
	kWh	Vfin				
1 h	6.0	40.0	5.7	5.2	4.8	4.3
2 h	8.6	40.0	8.0	7.6	6.9	6.1
3 h	9.2	41.8	8.9	8.6	8.0	7.2
4 h	9.4	41.9	9.3	9.1	8.7	7.8
6 h	9.5	43.8	9.5	9.5	9.2	8.6
8 h	9.5	44.8	9.5	9.5	9.4	9.0
10 h	9.4	45.0	9.4	9.4	9.4	9.2
15 h	9.1	45.3	9.1	9.1	9.1	9.1
30 h	7.5	45.9	7.5	7.5	7.5	7.5

48TL200 Discharge Power (kW) [-20 + 60°C; -4 ÷ +140°F]						
End Voltage [V] / Discharge Time [h]	Termination By BMS		42	43	44	45
	kW	Vfin				
1 h	6.00	40.0	5.70	5.20	4.80	4.30
2 h	4.30	40.0	4.00	3.80	3.45	3.05
3 h	3.05	41.8	2.95	2.85	2.65	2.40
4 h	2.35	41.9	2.33	2.27	2.18	1.95
6 h	1.58	43.8	1.58	1.58	1.53	1.12
8 h	1.19	44.8	1.19	1.19	1.18	1.12
10 h	0.94	45.0	0.94	0.94	0.94	0.92
15 h	0.60	45.3	0.60	0.60	0.60	0.60
30 h	0.25	45.9	0.25	0.25	0.25	0.25



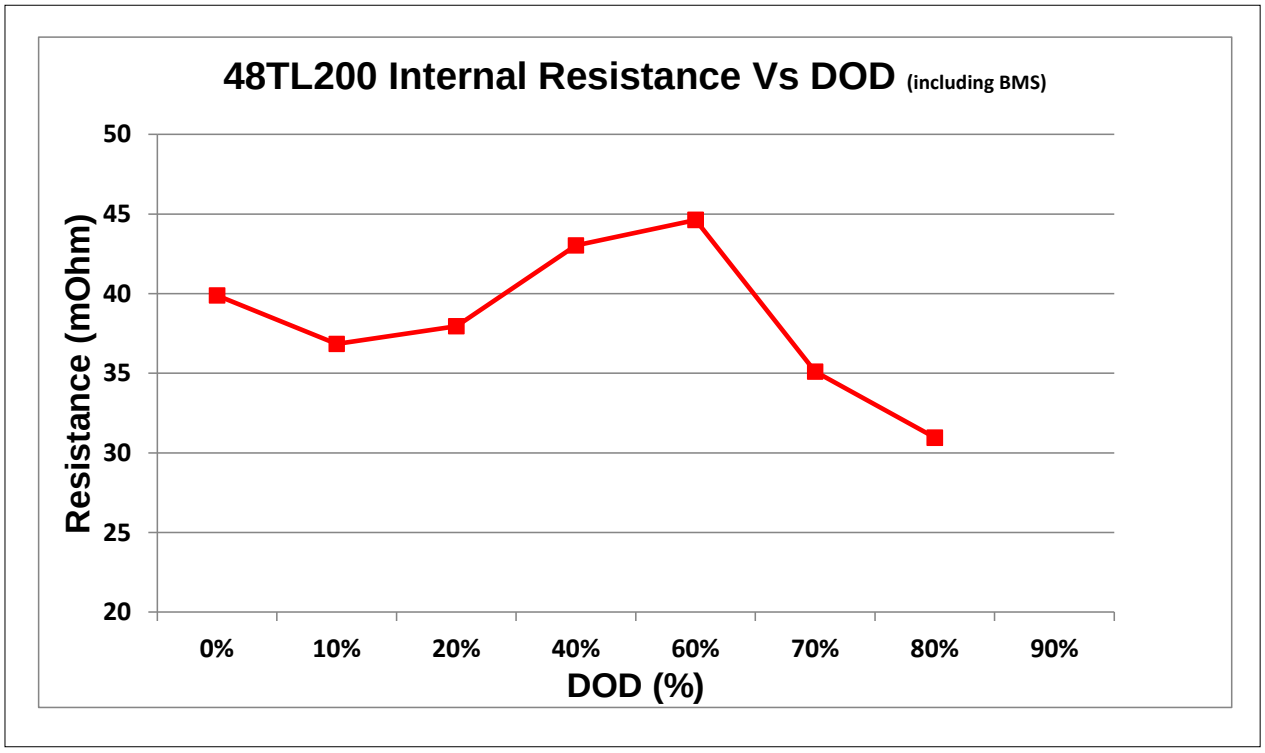
V - Battery Cool Down

The graph below shows the internal temperature evolution of a 48TL200 battery during the cool down process.



VI – Battery Internal Resistance

The graph below shows the resistance trend:
The measured values includes the battery electronic controller internal resistance (Battery Management System).



Title	Issue Date	Revision
I&O 48TL200 Manual	2017-07-04	July2017

FZSoNick

SODIUM NICKEL TECHNOLOGY

FZSONICK SA
Via Laveggio, 15
6855 Stabio (Switzerland)
Tel. +41 (0)91 6415511
Fax +41 (0)91 6415596

FZSONICK S.p.A.
Viale Europa, 75
36075 Montecchio Maggiore - VI (Italy)
Tel. +39 0444 709311
Fax +39 0444 709340

FZSONICK Inc.
1730 Todd Farm Drive, Elgin
IL 60123 (USA)
Tel. +1 (630) 635-6737
Fax +1 (630) 635-6742

info@fzsonick.com
www.fzsonick.com