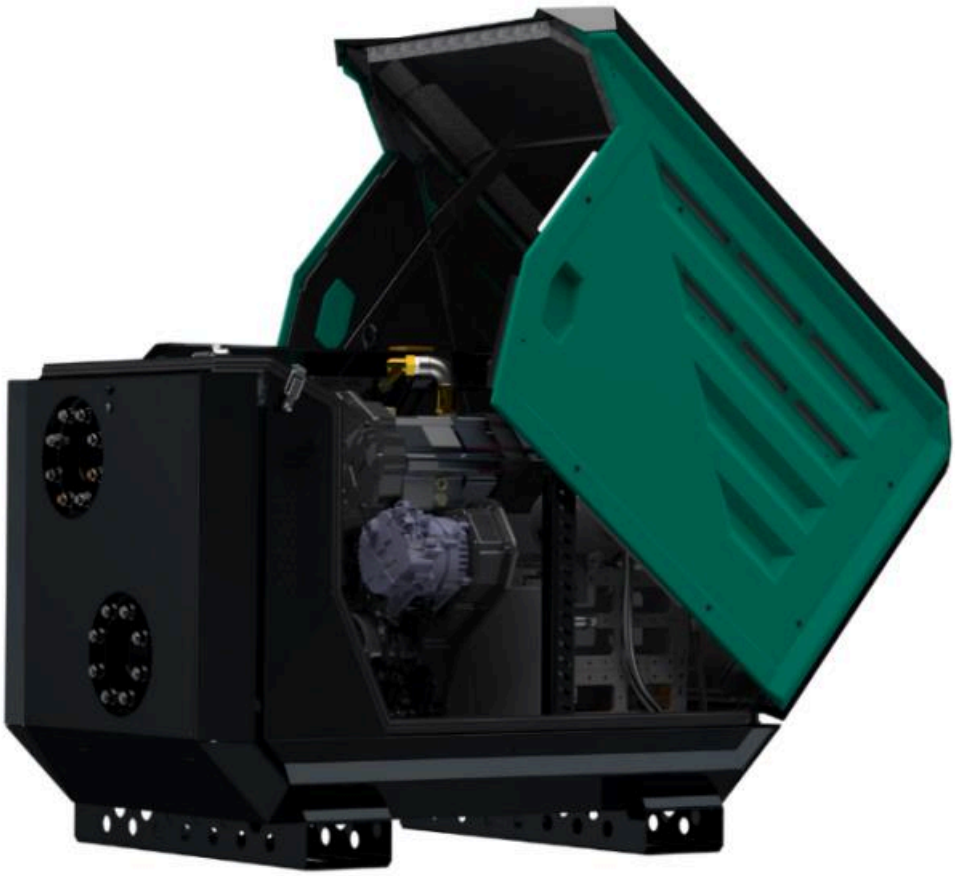
AEONPUMP

RAPTOR battery driven pump

USER MANUAL



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1. Description, General Information

In this manual, the correct use of the Raptor centrifugal pump, which shall be observed during storage, transportation, installation, and operation of the pump unit is described.

Failure to comply with the provisions of this manual may result in damage to the pump unit or premature failures, which may cause damage. Any such actions shall invalidate the guarantee.

All information in this publication is based on the latest product information that was available at the time of print approval.

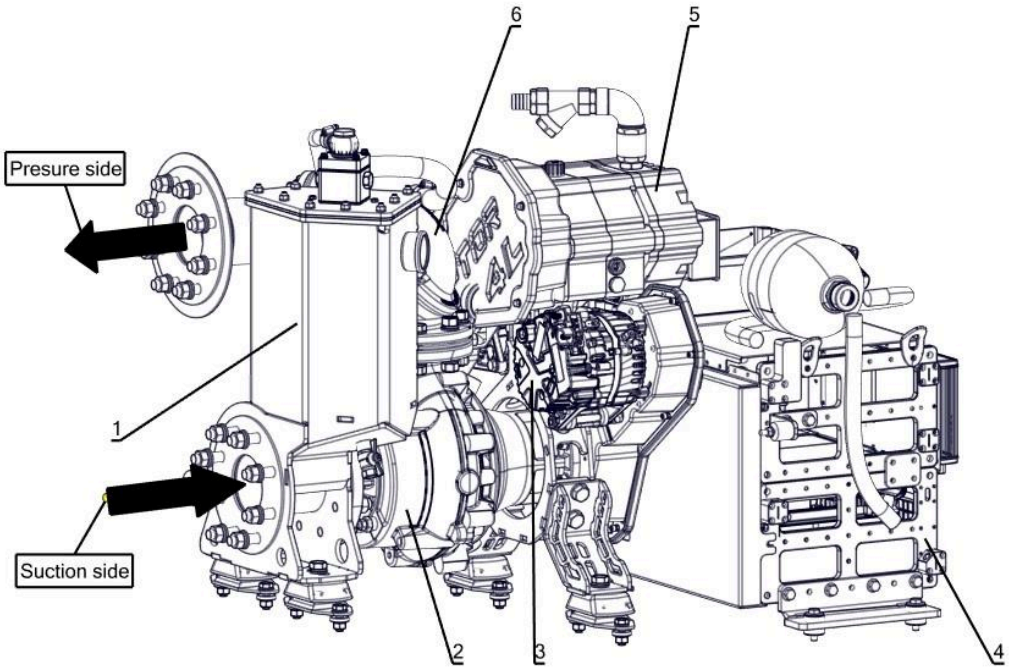
This manual is an integral part of the pump assembly, and, in case of resale, shall be accompanying the pump unit.

Manufacturer reserves the right to make changes at any time without prior notice and without accepting any obligations.

2. Design, Principle of Operation and Application

Raptor battery driven pump is a versatile wastewater pump, which is equipped with a vacuum system and a vacuum pump for automatic and extremely fast priming. Priming beforehand to ensure proper suction is therefore unnecessary. Pumps are supplied in a sound-attenuated version or on the frame. The pumps are suitable for pumping clean and polluted liquids containing large solids. The pump set was designed for a temperature range of 0 °C to +40 °C.

2.1. Construction



Main components:

1. Suction chamber
2. Centrifugal suction pump
3. DC pump motor
4. Battery
5. Vacuum pump
6. Non-return valve

2.2. Working Principle

- For pump and vacuum pump are own separated DC electric motor. At first startup the pump both DC motors will start running, because pump system is not filled with water. The return valve on the discharge of the pump closes the discharge line. As there is no liquid in the vacuum chamber the float valve is open allowing the vacuum pump to draw air from the vacuum chamber.

- The vacuum pump will suck out the air from the vacuum chamber and suction line.
- Because of the vacuum created in the suction line, water is drawn up the suction hose until it reaches the pump.
- As soon as water enters the pump, it will start to discharge and the speed of flow in the suction line will increase.
- The vacuum chamber will start to fill-up with water, causing the float valve to rise until it reaches a level where the float valve is closed, and no further air can be drawn out of the vacuum chamber. When system is primed, approximately after 30 seconds vacuum pump will stop working.
- As soon as the pump is starved of liquid, air enters the suction line and then in turn the vacuum chamber, causing the water level to decrease in the vacuum chamber.
- As the water level in the vacuum chamber decreases the Float valve reopens allowing the Vacuum pump to re-prime the pump.

2.3. Intended Use

The pump is designed to pump:

- Surface water
- Drainage water
- Sewage
- Rainwater

2.4. Unintended Use

The pump is not designed to pump:

- It is not permitted to use the pump for pumping flammable and/or explosive substances.
- It is not permitted to deploy a standard pump or pump unit in an environment in which there is a danger of fire and/or explosion.
- It is not permitted to deploy a standard pump or pump unit in an *ATEX* environment.
- Use the pump only for those applications listed on the pump specification sheet.
- It is not permitted to use the pump for any application and/or field of activity other than that for which the pump was originally specified and installed without written permission from the manufacturer.

WARNING – Manufacturer is not responsible for incorrect use and/or application of the pump.

Note

Pump is not designed for food processing. The materials used in the selected pump version must in all cases be checked in advance for their suitability for the concerned foodstuff.

3. Technical Plate Data

Standard technical specification example

4. Safety Instructions and Label Locations

Pay particular attention to the sentences preceded by any of the following safety symbols and/or words: They are designed for your safety and to prevent damage to the environment and the pump unit.

DANGER – When the danger symbol with the text 'DANGER' is displayed, it is accompanied by the information that is particularly important for the safety of all those involved. Ignoring the information can result in injury (possibly serious) or even death.

WARNING – When the warning symbol with the text 'WARNING' is displayed, it is accompanied by information that is particularly important for everyone involved with the pump unit. Failure to observe this information may result in injury or damage to the pump unit (possibly serious).

DANGER ELECTRICITY – When the warning symbol "DANGER ELECTRICITY" is displayed, it is accompanied by crucial information, in case of non-observance of which the person operating the pumping unit may be compromised by electric shock.

NOTE – Provides useful information

The pump unit conforms to the European Machinery Directive. However, this does not exclude the possibility of accidents if used incorrectly. Use of the pump for an application and/or deployment of the pump in an environment other than defined at the time of purchase is strictly prohibited and can result in a hazardous situation. This is particularly true for corrosive, toxic or other hazardous liquids.
The pump unit may only be installed, operated, and maintained by persons who have received appropriate training and are aware of the associated dangers. The installer, operator and maintenance personnel must comply with the local safety regulations. The company management is responsible for ensuring that all work is performed by qualified personnel in a safe manner.

It is not permitted to make changes to the pump unit without written permission from Aeonpump SIA. If changes are made to the pump without the written permission of Aeonpump SIA, Aeonpump SIA accepts no responsibility or liability whatsoever.

DANGER – Ensure that hot/cold and rotating parts of the pump are shielded adequately to prevent unintentional contact. It is not permitted to start the pump if such guards are missing or damaged.

The company management must ensure that everyone who works with/on the pump unit is aware of the type of liquid that is being pumped. These persons must know what measures are to be taken in the event of leakage. Dispose of any liquids that have leaked, in a responsible manner. Observe local regulations.

DANGER – Never allow the pump unit to run with a blocked discharge line. The heat build-up could lead to an explosion.

4.1. Safety Measures

DANGER – To prevent accidents and damage to the pump unit or the environment, the following safety measures should be taken:

- Use personal protective equipment (PPE) during loading, unloading, transportation and installation of the pump set.
- Loading, Unloading, Transportation and Installation of the pump unit should only be carried out by competent approved persons.
- Provide ample space around the pump unit to allow clear, unrestricted access.
- Always keep the housing doors closed during operation.
- Always stop the pump unit first and ensure all controls are in the Off position on the panel before repair and maintenance.
- Pump units should ONLY be lifted using the Lifting Lug, which is situated in the center of the pump set on top of the soundproof housing or by means of a ForkLift using the Channels situated on the base of the pump set. Before lifting the pump set All suction and discharge hoses MUST be disconnected. The pump unit must NEVER be lifted with the engine running.
- Pump units in storage **stacking on top of each other is not allowed**.

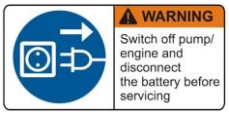
Note

To prevent unauthorized persons from operating or encountering the pump unit, it is advisable to install a barrier or fence.

4.2 Safety Labels explanation

These labels warn you regarding the possible hazards that may cause serious injury.
Read the labels and safety features and warnings described in this manual carefully.
If the label peels off or is difficult to read, contact the pump manufacturer to replace it.

	**DANGER -** Ignoring the information can result in injury (possibly serious) or even death.

	**Close doors** - keep the doors closed when the pump is in use.
	**Ear protection** - Use hearing protection when the engine is running.
	**DANGER ELECTRICITY** - be aware of electricity.
	**Freezing** - be aware of freezing.
	**Hot surface** - be aware of hot surfaces.
	**User manual** - see information in user manual.
	**Contact information** - contact information ***info@aeonpump.com***.
	**Oil** - To identify the engine oil filler cap or fill point.
	**Rotating parts** - rotating parts keep away.
	**Switch OFF** - switch off the engine and disconnect the battery before servicing
	**Water tap** - place for drain the water.

5. Transportation and Storage

5.1. Lifting with a Lifting Eye

DANGER – Before the commencement of the lifting process, first, the lifting capacity of the lifting gear and the weight of the item to be lifted shall be determined.

DANGER – All persons not involved in the lifting operations shall be removed when lifting loads from the lifting area.

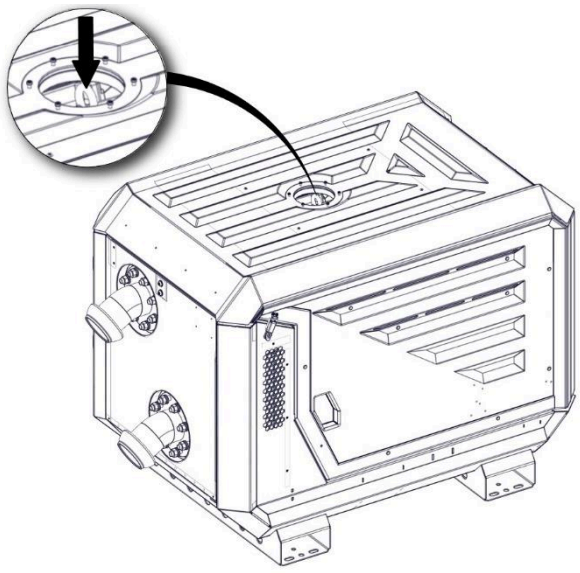
DANGER – Never walk/stand under the lifted load. This can result in a life-threatening situation.

DANGER – If there is a slightest suspicion regarding the unsafe state of the load or others at the time of lifting, the operations shall be stopped.

WARNING – Always disconnect all external connections before moving the pump unit.

WARNING – Lifting forces must be as vertical as possible; the maximum lifting angle is 15°.

There is a lifting eye located on the top of the housing. Only lift the unit from this lifting eye.

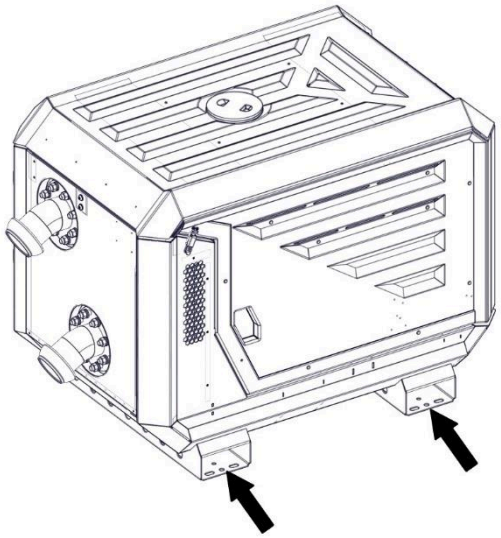


WARNING – If the pumping unit is mounted on a swampy or muddy surface, the equipment may sink into the ground, resulting in a higher lifting force to pull the unit away from the ground.

DANGER – NEVER move or lift the pumping unit by the corner sections of the housing or other places, which are not intended for lifting.

5.2. Lifting with a Forklift

Forklift pockets can be used for moving the pump unit with a forklift. The forks of the forklift must be inserted into these pockets to lift the pump unit.

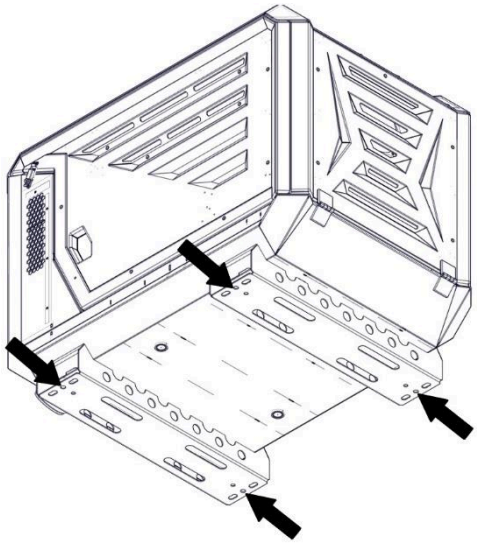


WARNING – Use certified lifting equipment with an adequate lifting capacity and always lift from directly above. Lifting from an angle can lead to dangerous situations. Lifting work may only be performed by appropriately authorized personnel. Because many different versions of the pump unit are available, only general instructions are provided. See the specification sheet for the pump unit for the weight and dimensions.

5.3. Fixing points for RAPTOR trailer version

- Lift the pump unit only with the following lifting points **(see chapter 5.1.)**.

- Place the pump unit in place where it's needed and screw it through fixing points.



5.4. Long-term Storage

Before you place the pump for storage for a longer period, you shall follow these steps:

- Make sure that there is no excess moisture or dust in the storage area, as well as there are no chemicals that may harm the pumping unit.
- Remove the residue from the inside of the pump if the pump has been used in muddy, sandy water, or very dirty water.
- Open the lid of the nonreturn valve, lift out the valve ball, clean it and clean the ball fit from foreign objects, close back the lid.
- Pump clean water with the pump before switching it off, otherwise restarting it may damage the impeller.
- After rinsing process, open the drain valve, drain the water completely, then close the drain valve.
- Pay attention to the wiring for possible damage.
- Check the oil levels in the bearing unit and vacuum pump housing.
- Inspect the pump visually for any mechanical damage.
- Cover the exhaust and intake nozzles or the whole pump with a cover that will protect against dust deposition in or on the pump.
- **Stacking on top of each other is not allowed**.

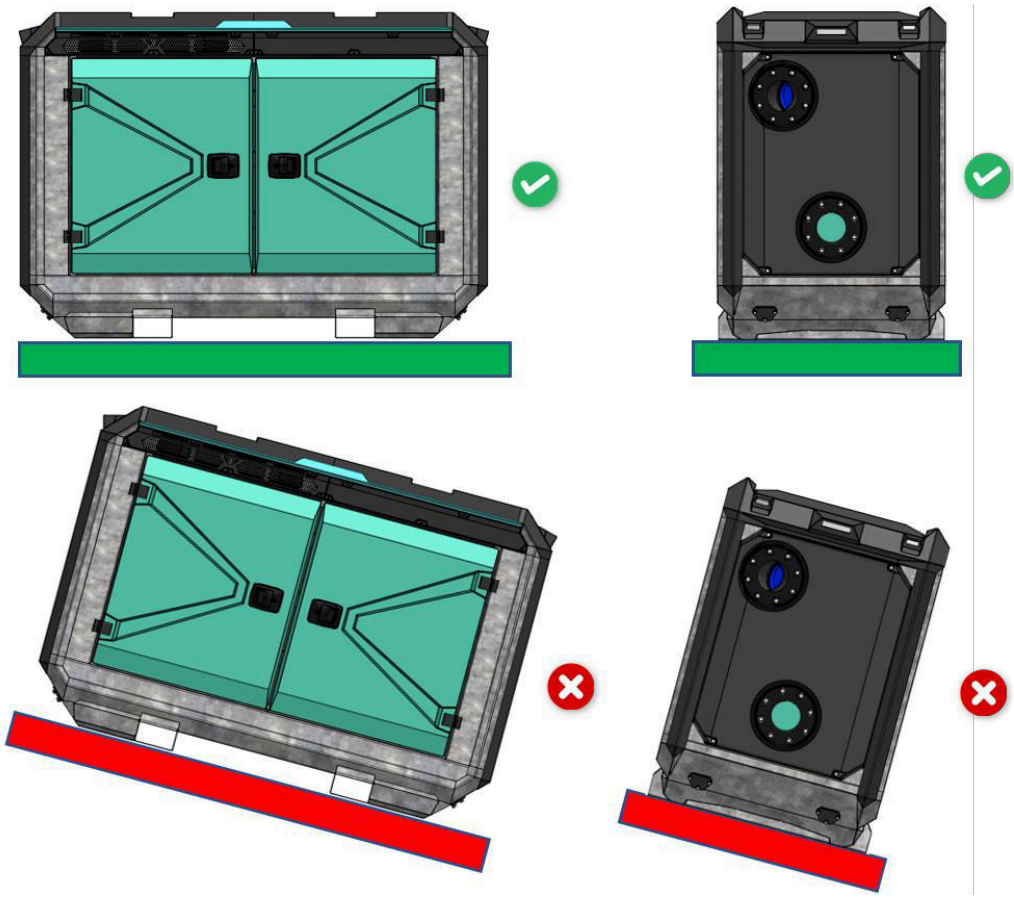
6. Pump Installation

WARNING – Failure to follow the guidelines for the placement and installation of the pump unit can result in danger to the user and/or severe damage to the pump or pump unit.

DANGER – The pump shall be so placed that it does not have the opportunity to slide, tip over, fall, or otherwise endanger the user or other personnel.

***AEONPUMP SIA* is not responsible for accidents and damage that result from failure to follow the guidelines in this manual. Such use results in forfeiture of the right to assert any warranty or damage compensation claims.**

- Place the pump on a horizontal surface capable of supporting the load.



- Make sure the pump unit is placed in such a manner that it is not subjected to any distorting forces.

- Make sure there is sufficient space around the pump unit for operation and maintenance activities. The recommended free access distance is 2 meters.
- Make sure that the sides of the pumping unit are not covered or are not close to the wall. This is important because the pump cools directly from the ventilation spaces specially created on the sides.
- Install shields to prevent contact with hot surfaces > 70 °C (158 °F). Affix warning symbols where necessary.
- When pumping hot liquids, ensure that there is sufficient air circulation to prevent bearings and lubricants from overheating.

7. Use of the Pump Indoors and Outdoors

7.1. Outdoor Use

The pump unit is suitable for outdoor use. In addition to the general instructions, the following additional requirements must be met:

- Ensure that there is sufficient free space around the air intake, so the engine can draw as much air as it needs.
- Avoid dusty conditions and locations where corrosion or erosion can occur.
- Do not place the pumping unit on an unstable surface.
- Ensure that there is sufficient free space around the hot air outlets, and they are not blocked. A free distance of at least 2 meters is recommended.
- Make sure that all electrical installations are safe and professionally installed.

7.2. Indoor Use

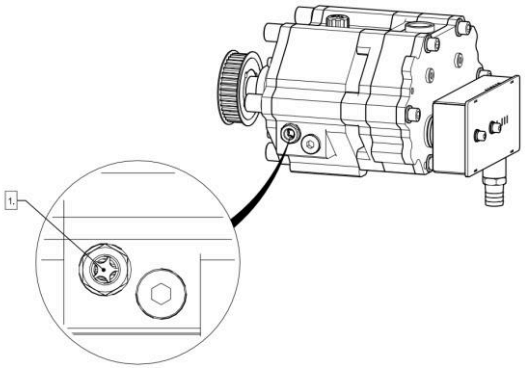
The pump unit is suitable for indoor use. In addition to the general instructions, the following additional requirements must be met:

- Make sure that ventilation is suitable in the pumping area.
- Ensure that there is sufficient free space around the air intake, so the pump cooling system can draw as much air as it needs.
- Prevent high ambient temperature and humidity. Avoid dusty conditions and locations where corrosion or erosion can occur.
- Ensure that there is sufficient free space around the hot air outlets, and they are not blocked. A free distance of at least 2 meters is recommended.
- Do not place the pumping unit on an unstable surface.
- Make sure that all electrical installations are safe and professionally installed.

8. Test before Each Use

Testing the pump before each use is a particularly important procedure when operating the pump, since it is possible to notice or eliminate any deficiencies in a timely manner, thus protecting the user or other personnel from dangerous situations.

- Check the oil level in the vacuum oil reservoir via gauge glass in the sidewall of the vacuum pump, and supply if required. The oil must be clear and full of glass (See chapter “18. Vacuum pump maintenance”).



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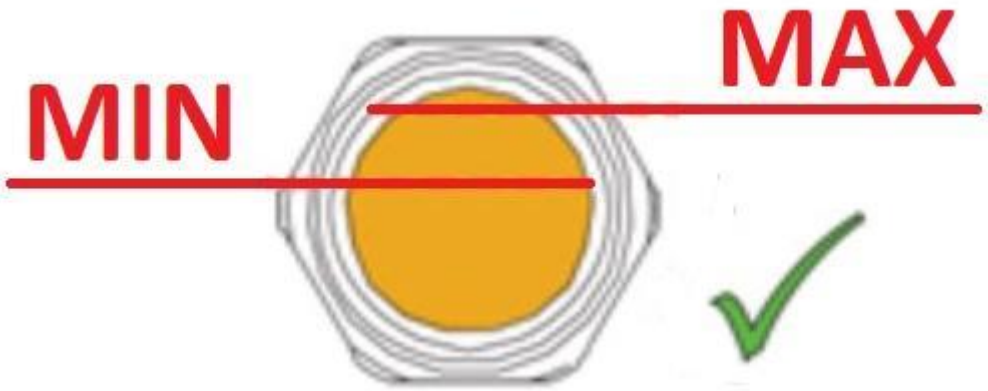
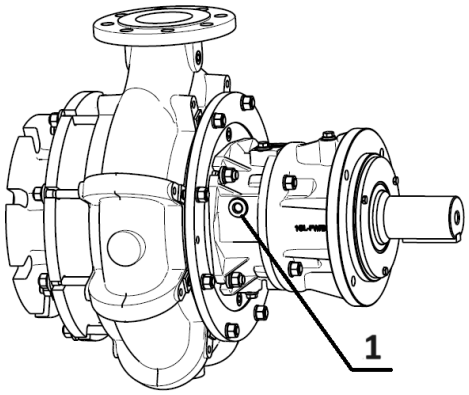


- Check the oil level and clarity in the pump seal chamber (1). If the oil is not clear but white, it means that the oil contains water. Drain this mixture, check the gasket, and fill the gasket chamber with fresh oil. *(See screw centrifugal pump user manual).*



- Check that all guards and panels are installed and not damaged.
- Check that the equipment is securely installed, the equipment is located on a sufficiently load-bearing surface.
- Check whether the drain valve below the pump housing is closed (if equipped).
- Check whether all connections of suction and delivery lines are tightened and connected securely.
- Check that the pump is positioned correctly, in accordance with Chapter "6. Pump Installation"
- Check that electrical installations are not damaged and are safe.
- Check that electrical installations are installed correctly in accordance with all local regulations.
- Check battery visual inspection, cooling liquid leakage, cracks, loose components, etc

DANGER ELECTRICITY – The pump must be disconnected from the mains before the inspection of the wiring.

9. Control Panel

9.1. Control panel

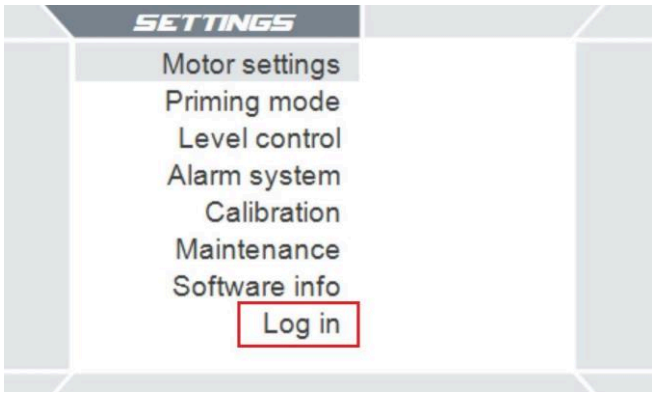
1. Main screen (alterable) with buttons 7 and 8
2. Language selection
3. Manual / automatic control
4. Settings
5. *START* button
6. ESC – return button to the previous window, or cancellation of an action
7. Home screen change button or menu on the left
8. Home screen change button or menu on the right
9. Pump speed acceleration button or menu up
10. Pump speed deceleration button or menu down
11. OK - Confirmation button
12. *STOP* button
13. Current or error history button
14. Light button
15. Information button

10. Log in

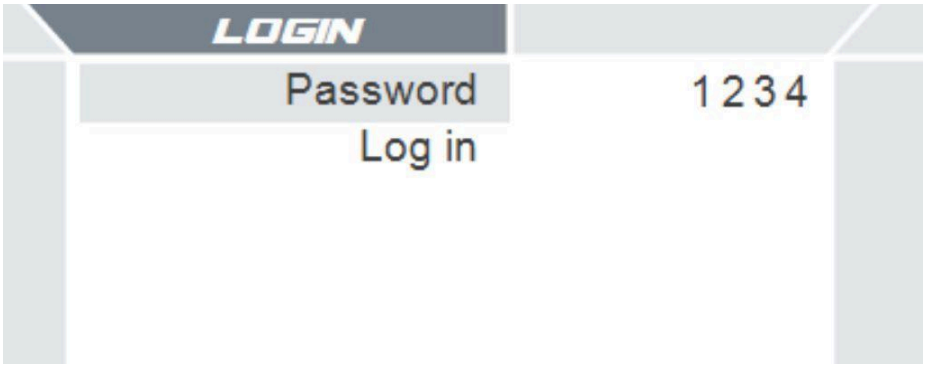
To change pump parameters are possible only after logging in as a user.
To do log in, must do following steps:

- Press the "Settings" button 4.

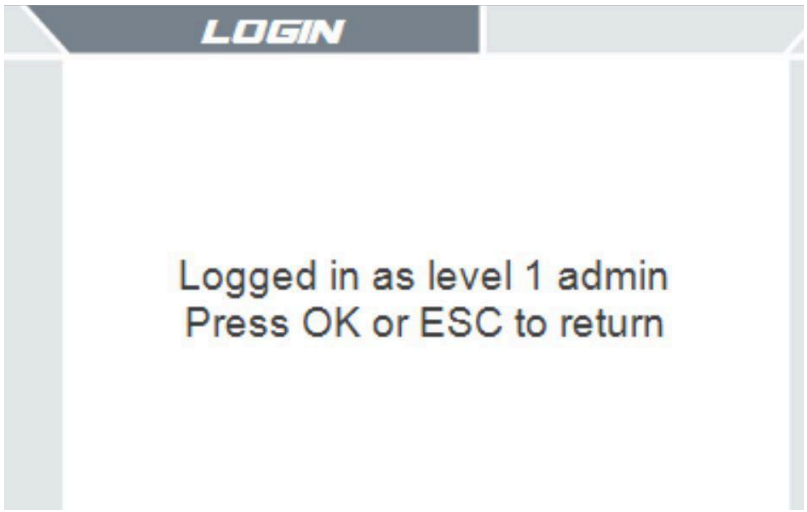
- Choose the Log in field pressing the button 9 and 10 in the Control Panel.



- Accept pressing *OK* button in the Control Panel, input **password 1234** and accept with OK button in the Control Panel.



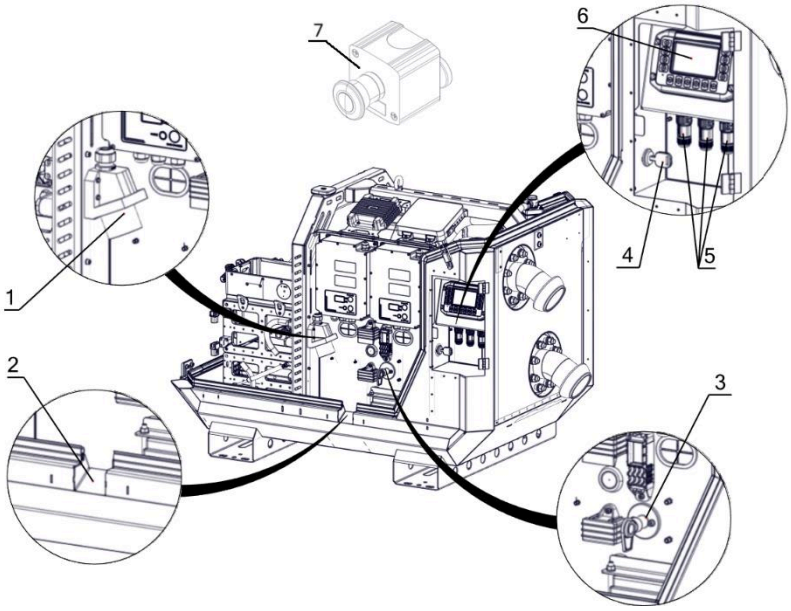
- Using Control Panel buttons 9 and 10 choose the Log in field and accept with OK button in the control Panel, the following window will appear.



- Press the button *OK* or *ESC* to return.

11. Starting Automatic or manual mode

- Follow the requirements of the Chapter "6. Pump Installation".
- Follow the requirements of the Chapter “7. Use of the Pump Indoors and Outdoors”.
- Follow the requirements of the Chapter “8. Test before each use”.
- Connect the supply cable to the pump female plug (1) and get supply cable through a special channel (2).
- Connect level control devices to designated socket (5) (floats or hydrostatic sensor) if necessary. *See Chapter 14.*
- Turn on the Earth switch (3).
- Turn on ignition switch(4).
- Wait for the control panel (6) to start.

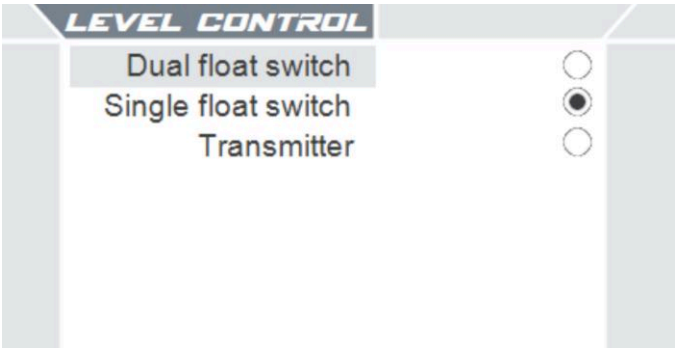


- If the *Emergency STOP* button (7) is pressed, on the screen appears the following window. Release the STOP button.

- If you need to set the level control in automatic mode (floats or hydrostatic sensor), press the "Settings" button 4.

- Select "Level control" by pressing the control panel buttons 9 and 10.

- Choose one of the level controls by pressing the button 9 and 10 in the Control Panel.
- Change these must be logged in like a user. *(See chapter 10 Log in).*

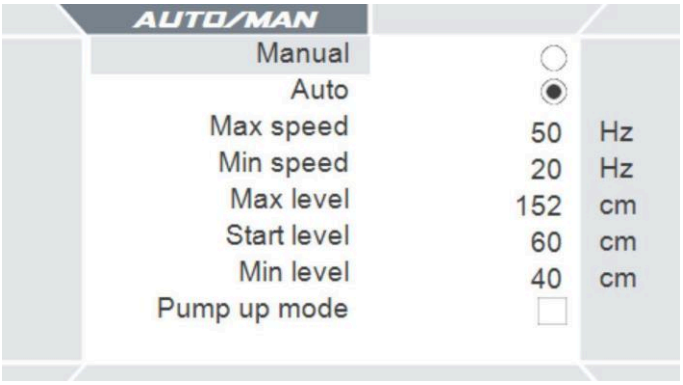


- Confirm the level control device selected *with the OK* button in the control panel.

- Return to the main display by pressing the *ESC* button in the control panel.

- Press button 3 in the control panel, manual/automatic control  .

- Select *Auto* or *Manual* mode with buttons 9 and 10.



- Confirm the level control device selected *with the OK* button in the control panel.

- Return to the main display by pressing the *ESC* button in the control panel.

- Press the *START button* in the Control Panel.

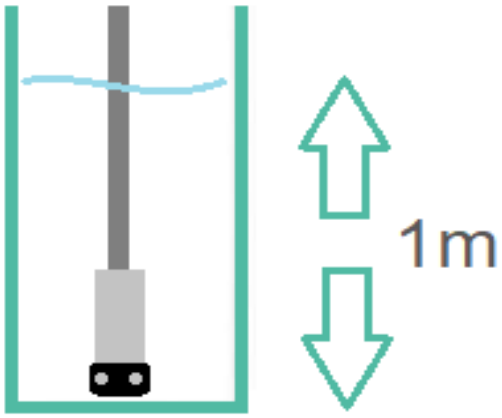
- The electric motor will start operating.

Pump speed for electric motor can only be changed in the manual mode with control panel buttons 9 and 10  .

DANGER – **If there are any problems during the operation of the pump, the pump must be switched off immediately, the cause shall be rectified, however, if it is not possible to rectify the cause, it is imperative to contact the manufacturer.**

11.1. Transmitter – level control (calibration)

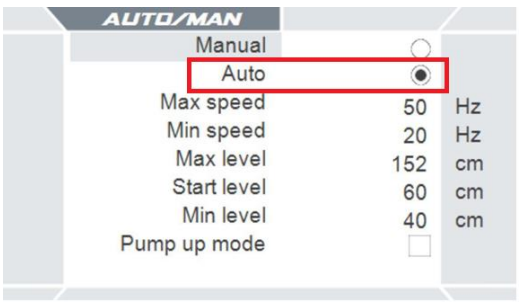
WARNING – Before the use of hydrostatic sensor, it shall be calibrated by immersion in 1 m of pumping liquid and by pressing "Do calibration".



To calibrate transmitter must do following steps:

- Press button 3 in the control panel, manual/automatic control .

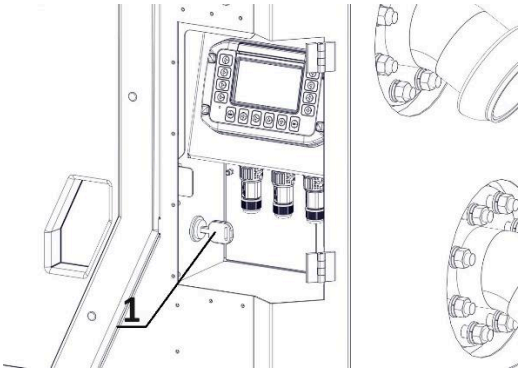
- Select ***Auto*** mode with buttons 9 and 10.



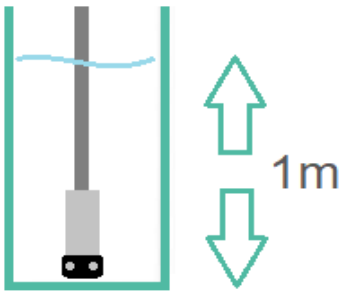
- Confirm the level control device selected *with the OK* button in the control panel.

- Return to the main display by pressing the *ESC* button in the control panel.

- Switch off the ignition, wait 30 seconds and turn on ignition again



- Connect the hydrostatic sensor and submerge in water exactly 1m deep use tape measure these.

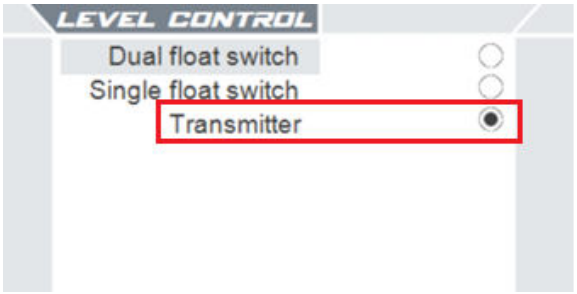


- Press the "Settings" button 4.

- Select "Level control" by pressing the control panel buttons 9 and 10.

- Confirm the level control device selected *with the OK* button in the control panel.

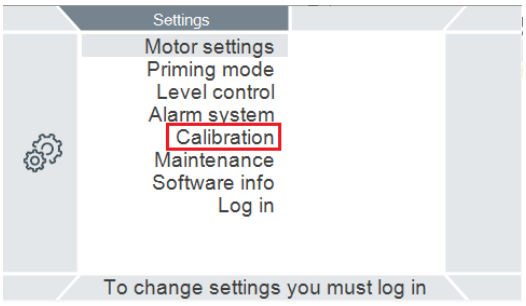
- Choose the Transmitter by pressing the button 9 and 10 in the Control Panel.



- Confirm the level control device selected *with the OK* button in the control panel.

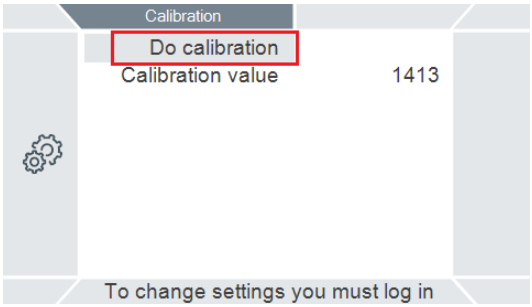
- Return to the Settings display by pressing the *ESC* button in the control panel.

- Choose the Calibration by pressing the button 9 and 10 in the Control Panel.

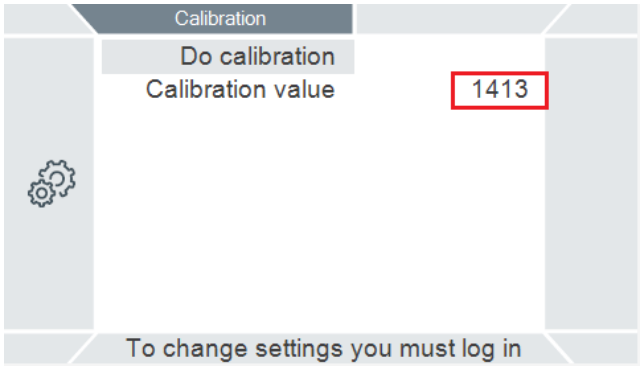


- Confirm the level control device selected *with the OK* button in the control panel.

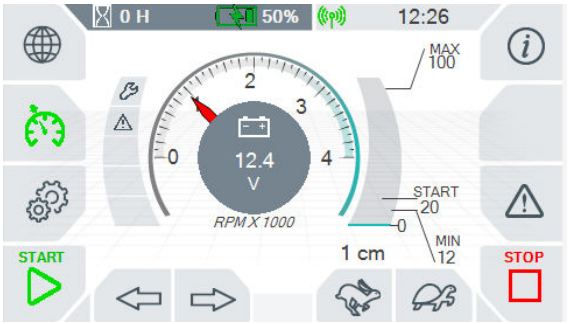
- Confirm the Do calibration selected *with the OK* button in the control panel.



- After calibration is complete there will be some Calibration value.



- Press the ESC button twice to return to main screen



11.2. Priming mode – vacuum enable, vacuum disable or vacuum eco mode

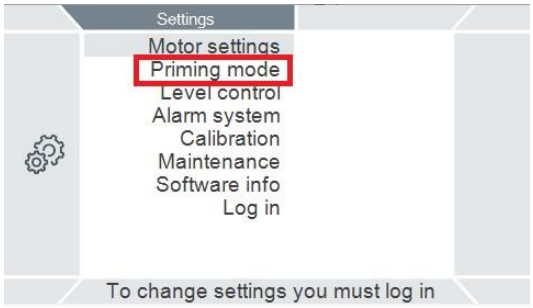
WARNING – to change these modes, user must clear understand for what reason it is will be done.

- **Eco mode - Main reason for eco mode is to save battery working time in action. Vacuum pump switching on or off when it is needed saving the energy.**
- **Enable – Vacuum pump works all time not switching off. Use when is possibility of air mixture in suction line.**
- **Disable - Vacuum pump is disabled, usually use when suction line is full of water and no need for priming.**

- Press the "Settings" button 4.

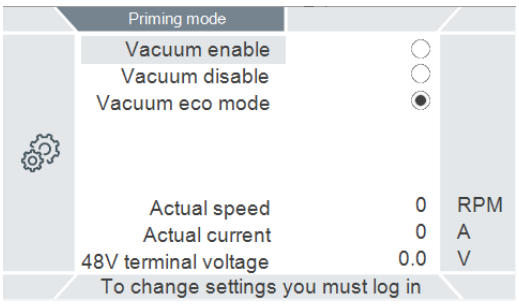
- Confirm the level control device selected *with the OK* button in the control panel.

- Use control panel buttons 9 and 10 to chose Priming mode



- Confirm the Priming mode *with the OK* button in the control panel.

- Chose between options “Vacuum enable”, “Vacuum disable” “Vacuum eco mode” use buttons on control panel 9 and 10



- Confirm the needed option *with the OK* button in the control panel.

DANGER – If there are any problems during the operation of the pump, the pump must be switched off immediately, the cause shall be rectified, however, if it is not possible to rectify the cause, it is imperative to contact the manufacture.

11.2. Alarm system

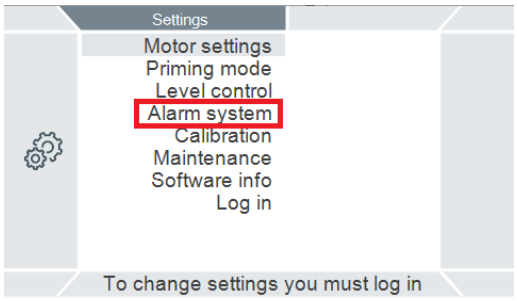
Alarm system is created for the convenience of costumer. In any critical situation when something is wrong with the pump, the pump is possible to transfer information via SMS about fault. It is very helpful when customer wants to leave pump alone, but in the same time is taking full control of pump.

How to create own mobile number for alarm SMS

- Press the "Settings" button 4.

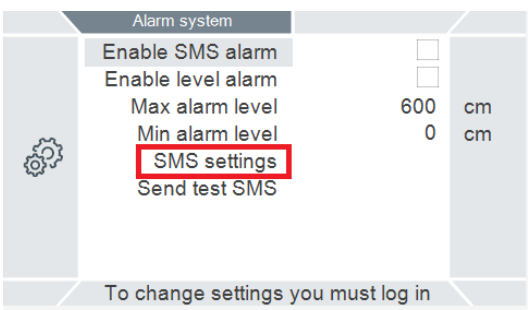
- Confirm the level control device selected *with the OK* button in the control panel.

- Use control panel buttons 9 and 10 to chose Alarm system



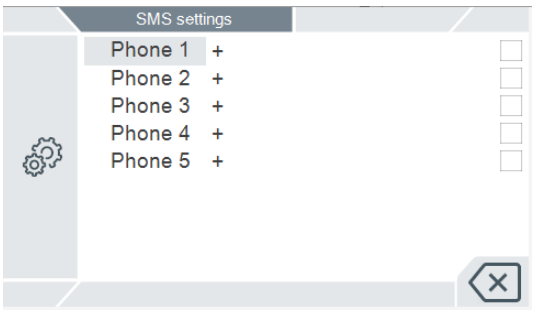
- Confirm the Alarm system *with the OK* button in the control panel.

- Confirm SMS setttings
-

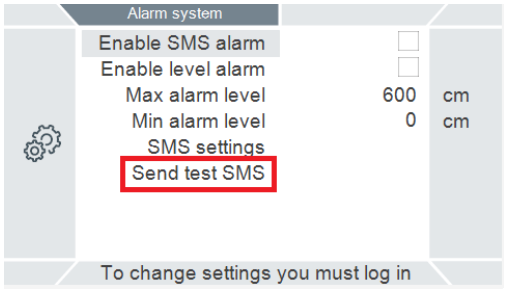


- Confirm the SMS settings *with the OK* button in the control panel.

- Using buttons 7,8,9 and 10 on control panel create full mobile number.



- Check if SMS is working, tray to send SMS test choosing “Send test SMS” on control panel. After approximately in 30 seconds must receive SMS to created mobile number

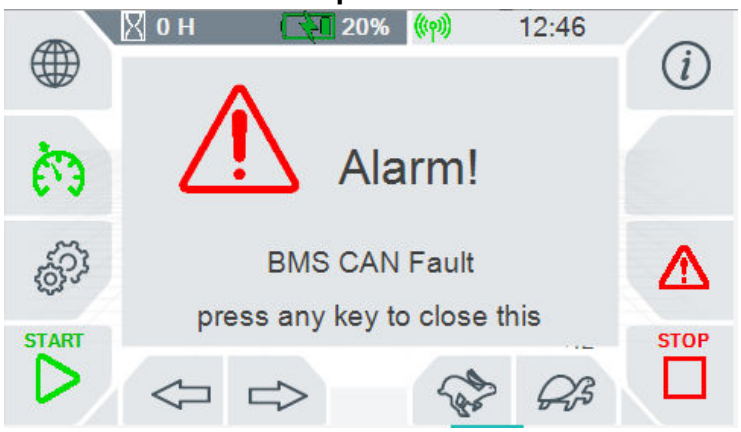


- If test SMS didn’t receive contact pump dealer.

12. Alarms

DANGER - Alarms shows the problem situation with pump. Operation of the pump is prohibited until the fault is eliminated.

Example of fault



To see fault list follow the steps:

- Press the "Alarm" button 12.

- Press the reset buttom fault must be erased.

- Press button 5 to see fault history

Example of fault history

13. Monitoring During Operation

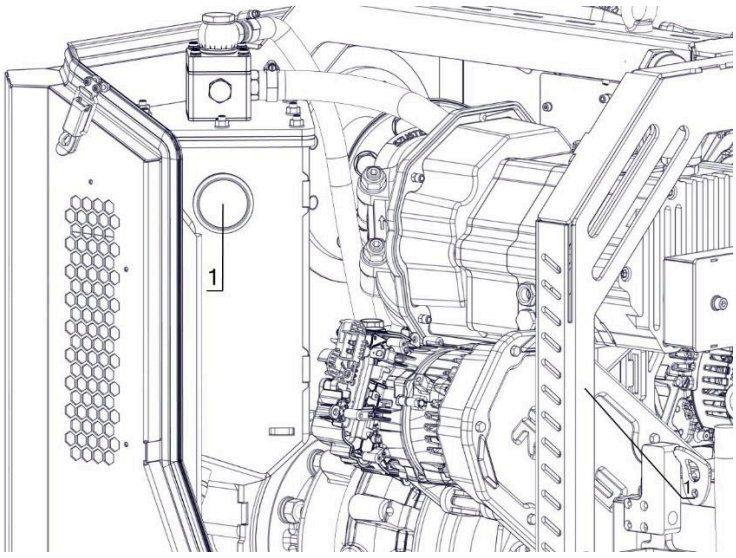
DANGER – During the operation of the pump, no activities related to its maintenance, modifications to the pump or supply, output system, or electronics, and other activities are allowed.

DANGER – The pump shall not be moved during operation.

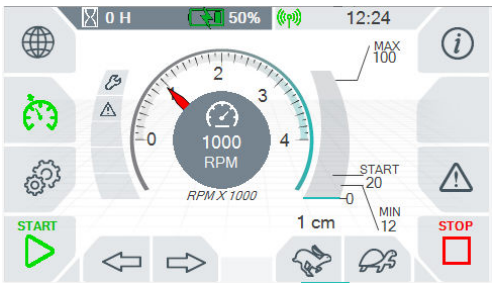
DANGER – The pump must be switched off before carrying out any work on the pump system.

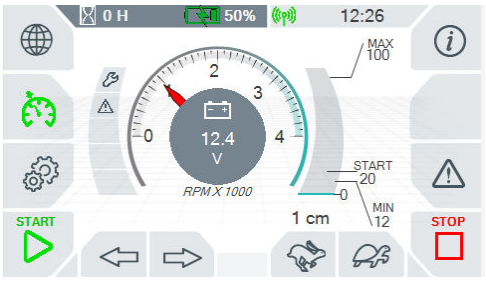
When the pump is in operation, it is imperative to pay attention to the following:

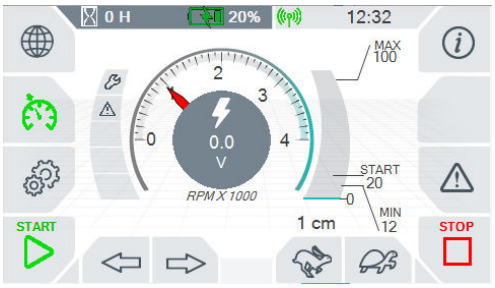
- During operation of the pump, attention shall be paid to the stability of its operation, there shall be no unnecessary sounds, noise, and vibrations.
- Check for oil leakage from the vacuum pump or mechanical seal chamber.
- Check for water leaks.
- Check pump is stable placed.
- Check that it does not rotate without the liquid to be pumped, which may result in damage to the mechanical seal.
- Check the pressure gauge whether the pump develops pressure (if equipped).
- Check the vacuum gauge (1) whether the pump develops vacuum.

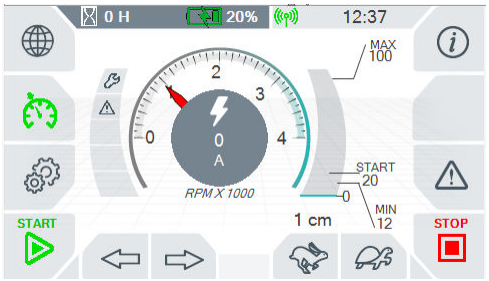


- During operation is possible to check different parameters on screen, switching between parameters use buttons 7 and 8









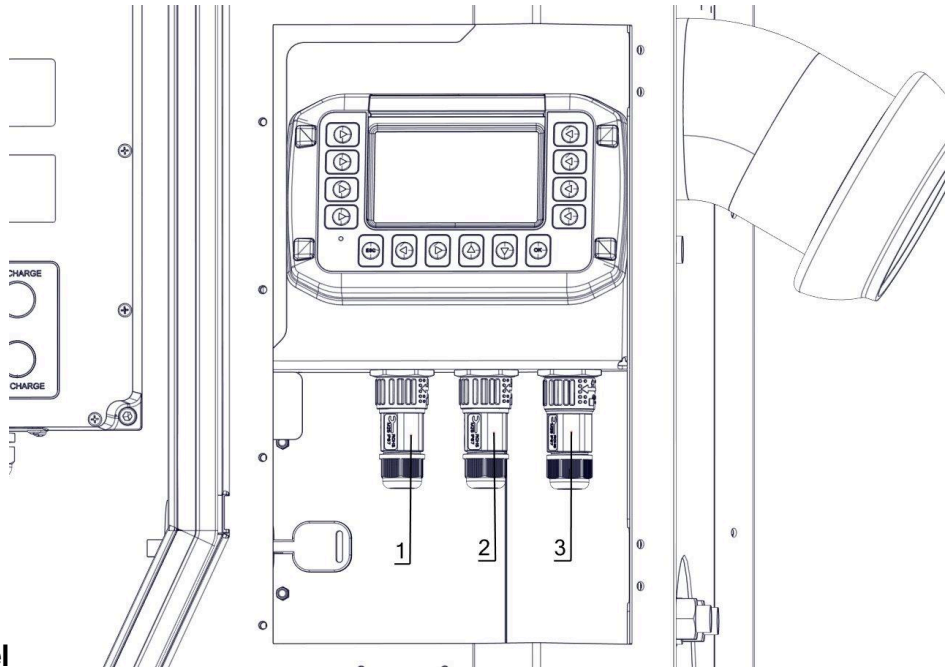
DANGER – If there are any problems during the operation of the pump, the pump must be switched off immediately, the cause shall be rectified, however, if it is not possible to rectify the cause, it is imperative to contact the manufacturer.

14. Level Control Devices

DANGER – When the pump is set to the automatic mode, under no circumstances, maintenance shall be performed, or suction or discharge line nodes reconnected; it is prohibited to relocate the pump or perform any other operations as the pump can switch on independently. Before starting these operations, the pump shall be completely switched off.

When using float switches, place the floats in such a way that the pump does not turn on more than four (4) times in one hour.

Level control sockets are under the control panel.



1 - Minimum level
2 - Maximum level
3 - Hydrostatic sensor (option)

14.1. Level Control Using 1 Float

When a small difference between the minimum and maximum suction limits is required, only one float control can be used.

Level Control Using 1 Float

14.2. Level Control Using 2 Floats

When a large amount of water is needed from the minimum and maximum suction limits, a control of 2 floats can be used.

Level Control Using 2 Floats

14.3. Level Control Using Hydrostatic Sensor (OPTION)

The hydrostatic sensor is only an option, it is easier to operate using this sensor. And it is possible to pump the required amount of fluid to be pumped much more accurately.
The advantage of a hydrostatic sensor is the simple use.

15. Stopping the Pump

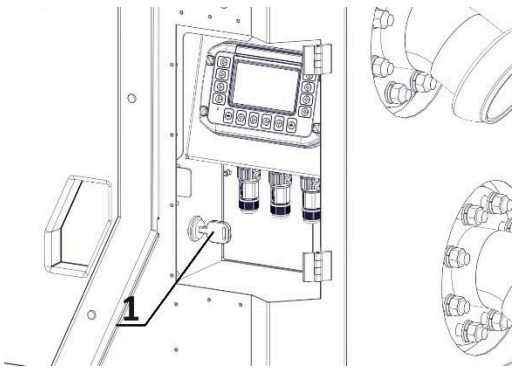
To correct STOP the pump is very important. To correct stopping save pomp lifetime and avoid the unnecessary damages or dangerous situations.

DANGER – FOR NORMAL PUMP STOPPING NEWER USE EMERGENCY STOP BUTTON.

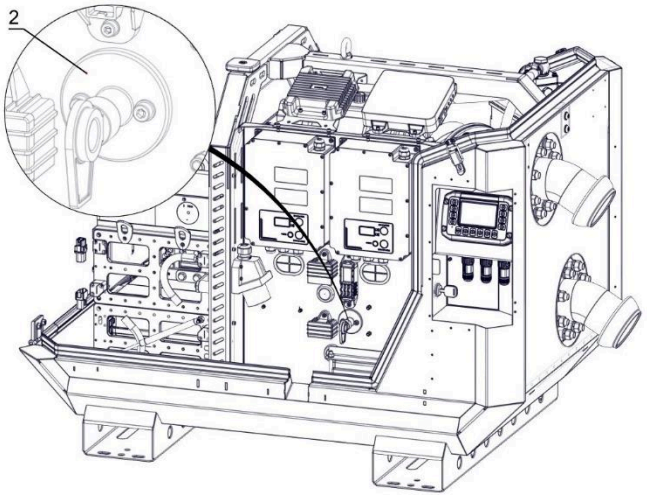
- If the pump is in manual mode, with control panel buttons 9 and 10, gradually reduce the pump speed to a minimum. If the pump is operating in automatic mode, the pump will automatically stop and shut down itself.

- Press the stop button on the control *panel*.

- Turn off the ignition switch (1).



- Turn off the earth switch (2)



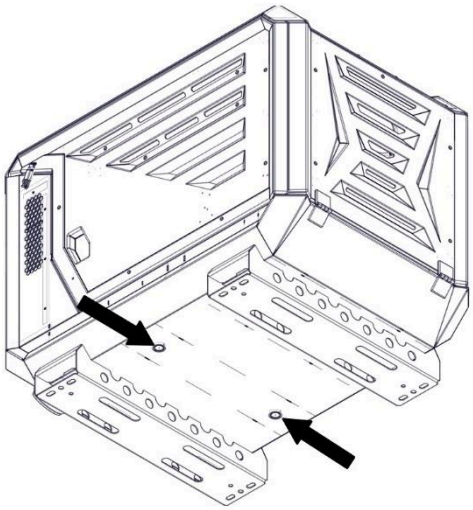
WARNING – If after complete shutdown of the pump, the air temperature starts to drop to or below 2 degrees Celsius, it is mandatory to drain the pumped liquid from the pump housing, see Chapter "16. Draining the Pump at Risk of Freezing".

16. Draining the Pump at Risk of Freezing

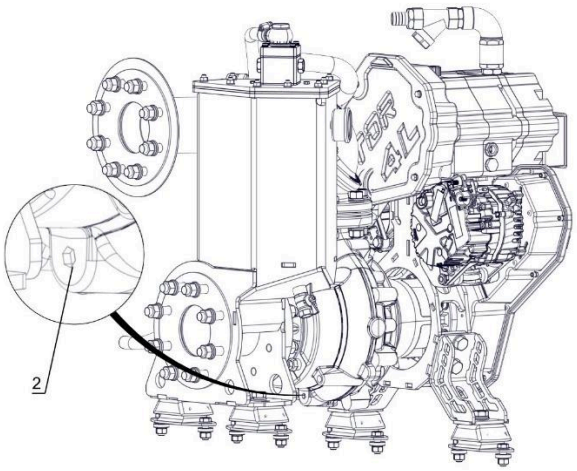
WARNING – If after complete shutdown of the pump, the air temperature starts to drop to or below 2 degrees Celsius, it is mandatory to drain the pumped liquid from the pump housing. Otherwise, the water contained in the pump housing will freeze and cause serious defects and material damage. If the above-mentioned action is not performed, the guarantee considered or declared null and void.

In order to completely drain the water from the pump, it is necessary to perform the following actions:

- Open the drain caps at the bottom of the canopy.



- Open the drain valve (2) (check that the valve is not clogged).



- Unscrew and remove the cap of the nonreturn valve, lift out the ball, clean the ball fit and the ball itself. Pay attention to the sealing rubber of the cap, it shall not be cracked or otherwise mechanically damaged.

- Put a ball in place and screw the cap of the nonreturn valve.
- Close the drain valve when the liquid has drained completely.
- Close the drain covers of the housing.

17. Maintenance

17.1. General

When maintenance is insufficient, incorrect and/or not performed regularly this can lead to malfunctions of the pump or pump unit, danger to the user, high repair costs and lengthy breakdowns. Manufacturer is not responsible for accidents and damage that result from failure to follow the instructions.
Read the supplied manual carefully and follow the procedures and safety instructions.

DANGER - The pump must be stopped before any maintenance work is started. Comply with legal requirements when handling and disposing of old oil, filters and cleaning materials.

WARNING - Keep the ignition starting key out of reach of unauthorized persons.

WARNING - At the end of the maintenance work, check that all tools have been removed from the pump and all safety guards, covers etc. replaced in their correct positions.

WARNING - Before starting the pump, make sure that nobody is in the danger area.

WARNING - Leakage of oil can be extremely harmful to the environment. Do everything necessary to prevent oil leakage.

17.2. Maintenance instructions

WARNING - **Before each maintenance see specific model of pump.**

- Clean the pump before beginning the work. Make sure the work area is clean.
- Use the correct tools and make sure they are in good condition. Use them in the proper manner.
- Replace damaged bolts, nuts and/or parts with damaged threads with new parts of the same fastener class.
- Replace used seals or tape. Only replace the flat and filled seals under the plugs with original seals from the pump manufacturer.

17.3. Daily maintenance of the pump

- Check for leaks from the pump and pipes.
- Check the shaft seal for leaks.
- Check the parts of the electrical system for visible damage.
- Check the attachment of the electrical cables and plug connectors.
- Check the oil clarity and level of vacuum pump.
- Check the oil level and clarity in sealing chamber of the screw centrifugal pump.
- Check the operation of the non-return valve.
- Check the operation of the floats.

17.4. One-time maintenance after 50 hours of operation

- Change the oil in the vacuum pump *(see chapter "18. Vacuum pump maintenance").*
- Check the clarity of oil in mechanical shaft seal *(see user manual for "Screw centrifugal pump").*

17.5. Pump maintenance Every 12 months or 500 hours

- Check the pump bearing *(see manual for "Screw centrifugal pump").*
- Check the oil in the mechanical shaft seal *(see manual for "Screw centrifugal pump").*
- Clean the pump from dust and dirt.
- Change the oil in the vacuum pump *(see chapter "18. Vacuum pump maintenance").*

17.6. Lubricants

The quantities named are maximum quantities after the systems have been completely emptied.

Lubricant point	Lubricant to be used	Quantity
Oil chamber of the screw centrifugal pump	**See user manual of the screw centrifugal pump**	
Vacuum pump	**MOL Ultrans EP150**	**0,5L**
Lubrication point on the bearing bracket	**See user manual of the screw centrifugal pump**	

18. Vacuum pump maintenance

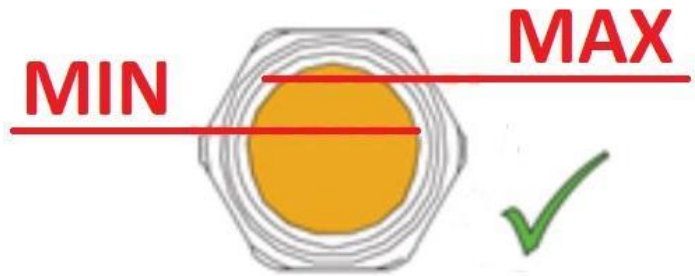
WARNING - Use only **MOL Ultrans EP150** oil for vacuum pump.

DANGER - Hot surface. Risk of burns! Prior to any action requiring touching the machine, let the machine cool down first.

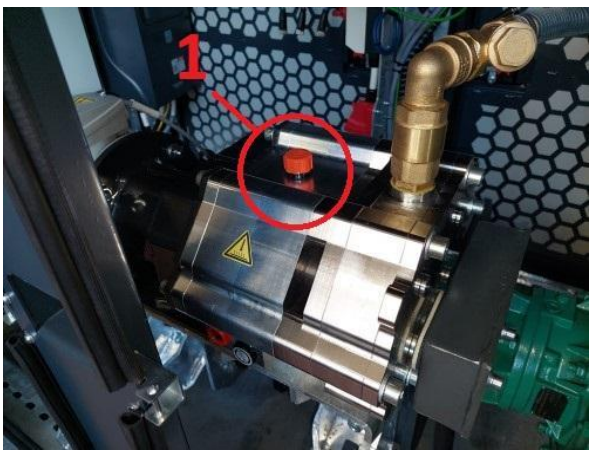
Interval	Maintenance work
After first 50 hours	• Change oil in vacuum pump
Every 12 month or after 500 hours	• Change oil in vacuum pump • Clean the vacuum pump of dirt

18.1. Oil level inspection

- Switch off the pump.
- When the pump is stopped, wait 1 minute before checking the oil level in the vacuum pump.



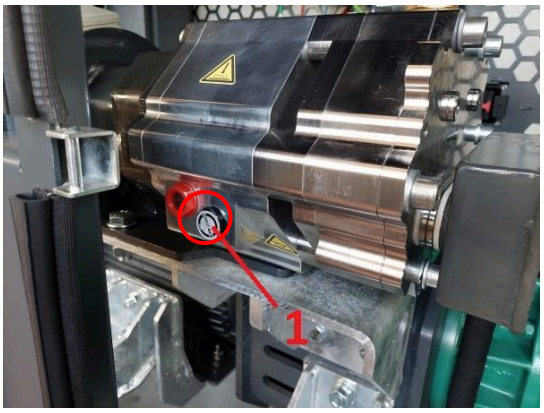
- Fill up if necessary, to do these, open the oil filling cup (1) top of the vacuum pump.



18.2. Oil change

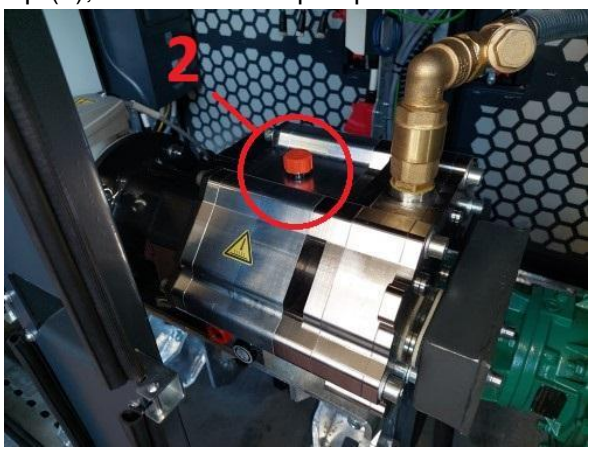
Only use an oil type which has previously been approved and recommended by the manufacturer.
The oil level should stay constant over the lifetime of the oil. If the level does fall, this indicates a leak and the vacuum pump requires repair.

- Open the drain plug (1), let the oil fully drain out of the vacuum pump, it can take about 5 min.

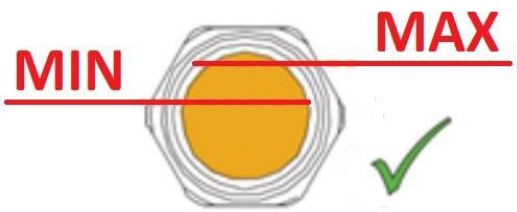


- Clean drain plug magnetic part from obstacles.

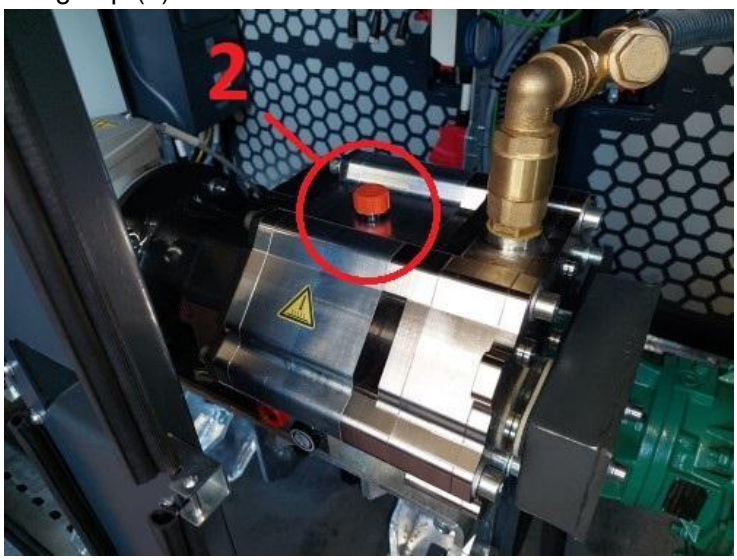
- Close the drain plug (1).
- Open the filling cup (2), fill the vacuum pump with fresh oil.



- Oil level must be full of the glass.



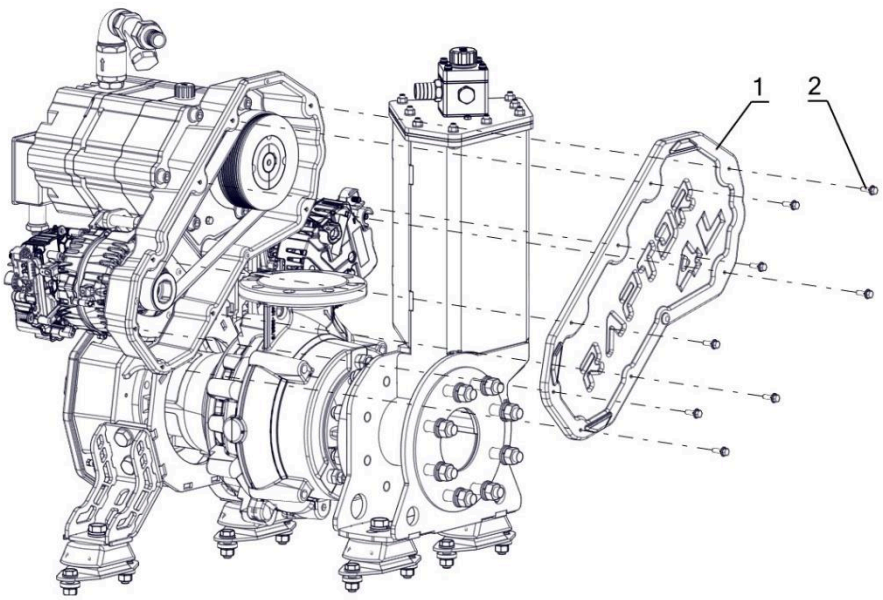
- Close the Filling cup (2).

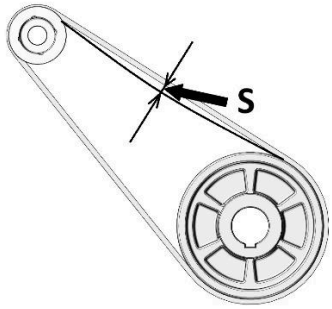


18.3. Vacuum pump belt tension

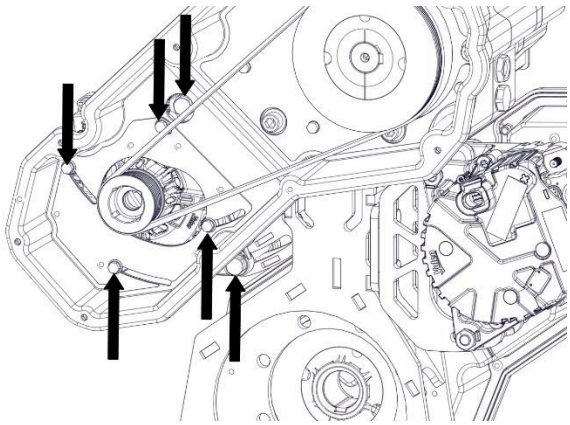
To check and tighten the vacuum pump belt is possible to do in the following steps.

- Take off cover (1) unscrewing all bolts (2). Measure the distance of the belt, must be depressed in the middle of the span. The distance **S** must be approximately 4mm.

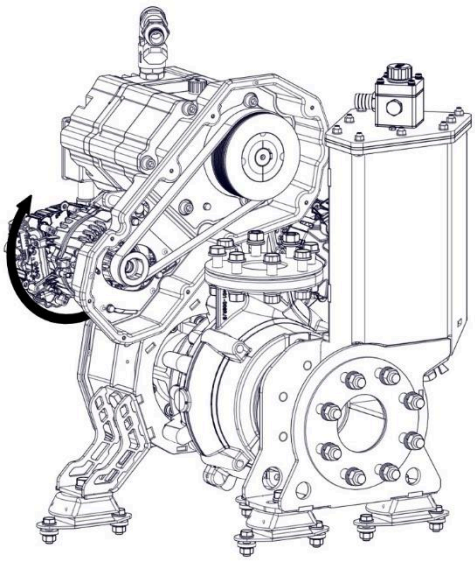


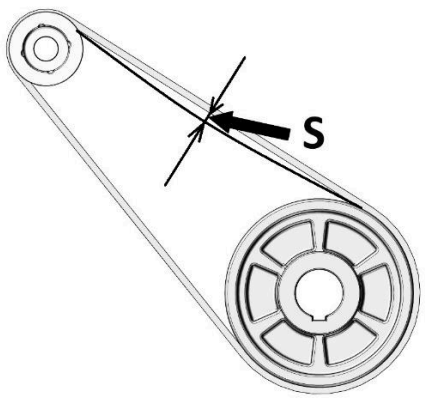


- If distance **S** is less or more than reading 4mm, do the following steps. Unscrew all six counter screws.

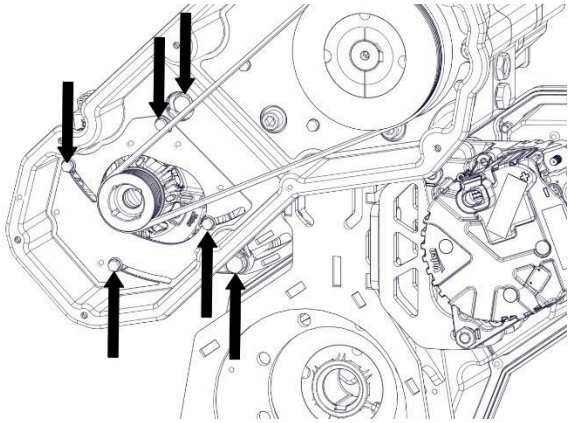


  - Lift up the DC vacuum pump drive motor till the depression in the middle of the span distance **S** is approximately 4mm.

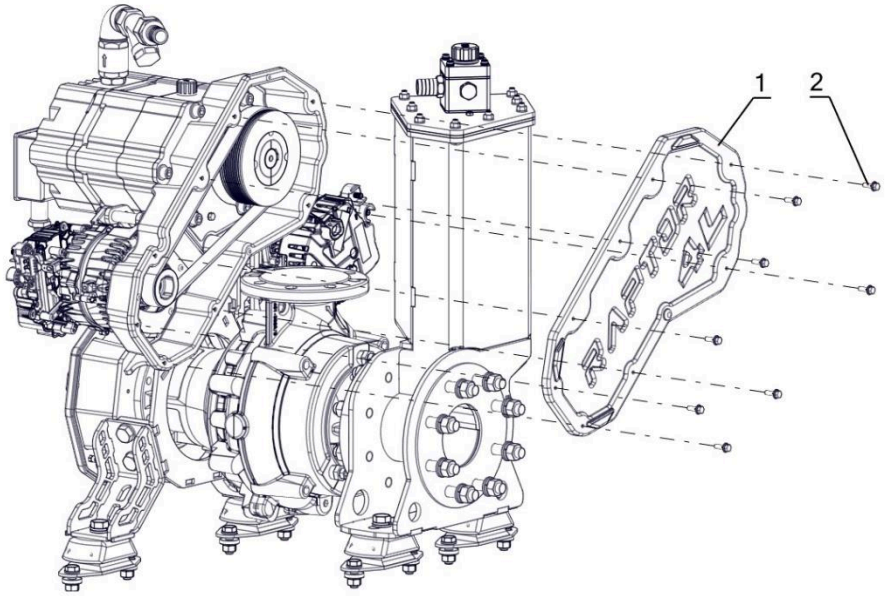




- Tighten all six counter screws



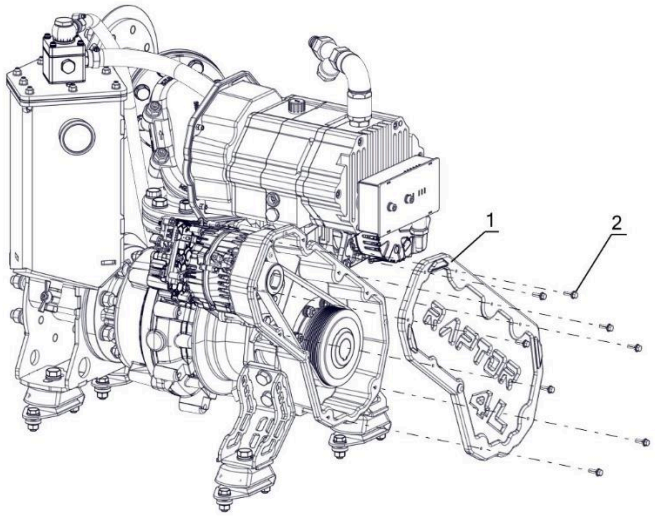
- Put back panel (1) and screw back all cover bolts (2)

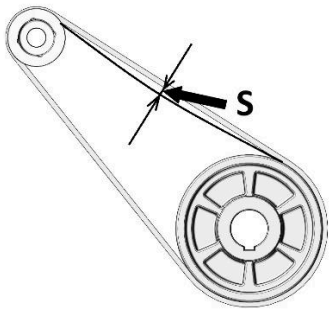


18.4. Pump drive belt tension

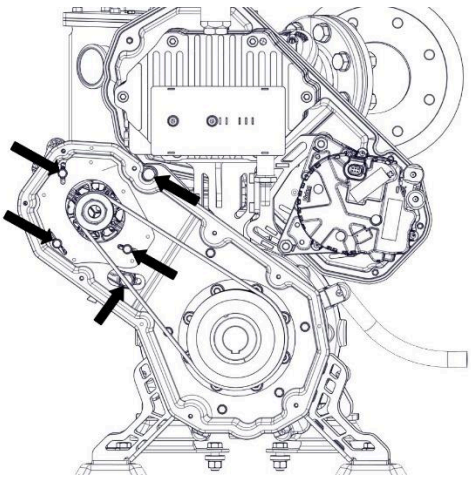
To check and tighten the centrifugal pump belt is possible to do in the following steps.

- Take off cover (1) unscrewing all bolts (2). Measure the distance of the belt, must be depressed in the middle of the span. The distance **S** must be approximately 4mm.

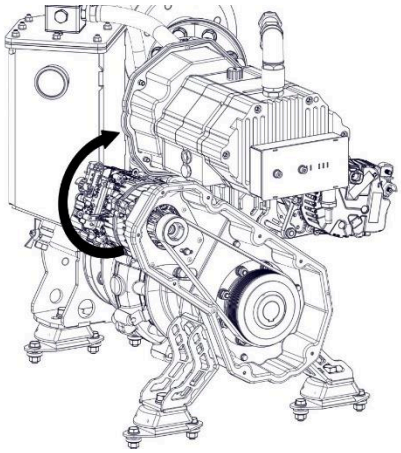


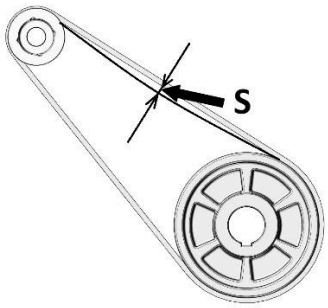


- If distance **S** is less or more than reading 4mm, do the following steps. Unscrew all five counter screws.

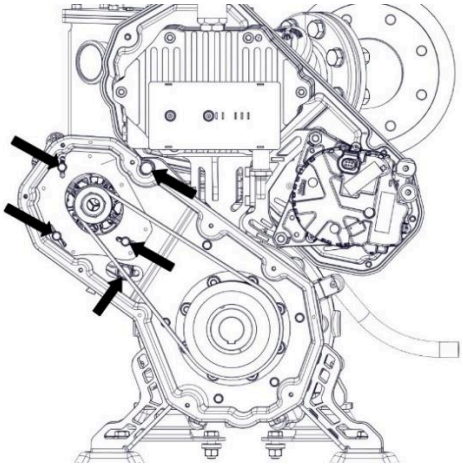


- Lift up the DC pump motor till the depression in the middle of the span distance **S** is approximately 4mm.

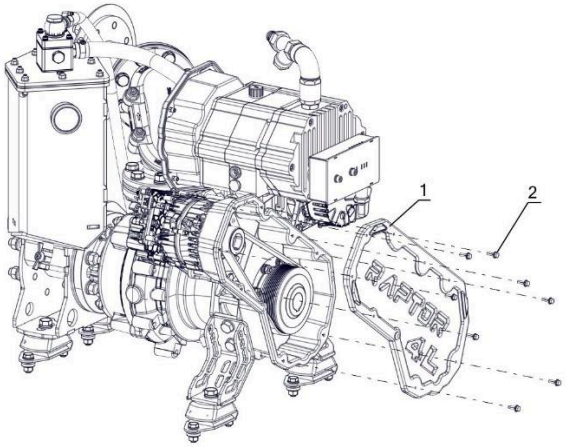




- Tighten all five counter screws



- Put back panel (1) and screw back all cover bolts (2)



19. Problem / Solution

Problem	Solution
Pump does not pump liquid or has low productivity	Increase pump speed
	Check the validity of the pumped liquid
	Immerse fully the suction end of the suction hose
	Clean the suction hose filter
	Check the length of the discharge and suction line
	Change the suction hose
	Check and clean the impeller
	Dilute or mix the liquid to be pumped if possible
	Reduce the lifting height of pump
	Clean the discharge hose
	Check the operation of the vacuum pump
When the pump is switched on, it does not work	Check that the pump is connected to the power supply.
	Check if battery is not empy
	Check fuse
	Check the STOP switch
	Check the wiring
Vacuum pump does not work	Check for obstruction of the vacuum pump
	Check if vacuum pump is not “disabled” mode
	Check fuse

	Check vacuum pump belt tension
Vacuum pump works with noise or heats up quickly	**Check oil level in the vacuum pump**
	Remove dirt from the vacuum pump
	Clean the vacuum pump
	Clean the exhaust pipe of the vacuum pump
The pump vibrates during operation	**Reduce the pumping height of pump**
	Check pump bearings for heating
	Check the oil level and oil quality in the bearing unit.
	Check belt tension
	Clean the impeller
	Straighten and clean the discharge hose
	Straighten and clean the suction hose and filter

DANGER– If appear some pump defect and cannot find fault immediately contact the manufacturer.

20. SMS fault list

Level below min	
Level over max	
Float incorrect signal	
Probe error!	
Probe out of water!	
BMS CAN Fault	
PumpMot CAN Fault	
VacMot CAN Fault	
IO CAN Fault	
E-Stop pressed	
Battery charge low	
Battery charge critical	
Maintenance - days!	
Maintenance - hours!	
BMS Alert temperature	
BMS Alert voltage	
BMS Alert current	
BMS Alert heater	
BMS Warn. temperature	
BMS Warn. voltage	
BMS Warn. current	
BMS Warn. oil	
BMS Warn. pump	
BMS Warn. internal	
BMS Failure internal	
BMS Failure temperature	
BMS Failure voltage	
BMS Failure current	
BMS Failure oil	
BMS Failure EMS	
BMS Failure HVIL	
PumpMot internal fault	
PumpMot CAN fault	
PumpMot 12V high	
PumpMot 12V low	
VacMot 12V high	
VacMot CAN fault	
VacMot internal fault	

VacMot overcurrent	
VacMot loaddump	
VacMot undervoltage	
VacMot overvoltage	
VacMot overheat	
VacMot stalled	
VacMot therm derating	
VacMot unexp torque	
VacMot neg speed	
PumpMot neg speed	
PumpMot unexp torque	
PumpMot therm derating	
PumpMot stalled	
PumpMot overheat	
PumpMot overvoltage	
PumpMot undervoltage	
PumpMot loaddump	
PumpMot overcurrent	

AEONPUMP

Customer	
Project name	Mobile pump station electric scheme
Project Description	Electric scheme for: 48VDC motors
Control voltage	12 VDC
Responsible for project	I. Gorkins

Start	16.12.2022
Edited	21.07.2023

Number of pages 7

			Date	16.12.2022	Mobile pump station electric scheme		AEONPUMP	Title page	=
			Ed.	PC					+
			Appr.					2020.003	Page 0
Modification	Date	Name	Original		Replacement of	Replaced by			Page 1 / 7

SAFETY REGULATIONS

GENERAL SAFETY REGULATIONS

DANGER !

During plant operation certain items are under dangerous voltage!
Non-observance of safety instructions can result in death, serious injuries or material damage.

Only specialist personnel may carry out transport, installation and commissioning work.

The applicable valid standards as well as the national and / or company-specific accident prevention regulations are to observed.

The following safety instructions are to be observed:

The erection, commissioning, troubleshooting as well as repair of the plant may only be carried out by qualified personnel that is familiar with the corresponding operating instructions.

Mounting of the devices has to be effected in accordance with the valid standards, state and local regulations.
Proper grounding and conductor dimensioning as well as proper short-circuit proofing have to be ensured.
These measures serve to ensure the safety of the plant and of the operating personnel.

Before carrying out safety checks, maintenance work and repair measures ensure that all the power supplies are switched off, are secured against being switched on unintentionally and are marked correspondingly.

Only test devices that are in a technically perfect condition and are suitable for the respective measurement may be used to carry out measurements!

The instructions specified in the respective operating instructions are to be followed strictly!
It is mandatory that hazard, warning and safety instructions be observed!

All doors and covers are to be kept closed during the plant operation.
If cooling devices are installed in the plant, ensure that these systems operate trouble-free.
These include the regular cleaning of the filters, in as far as they exist.

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Column X: An automatically generated page was edited

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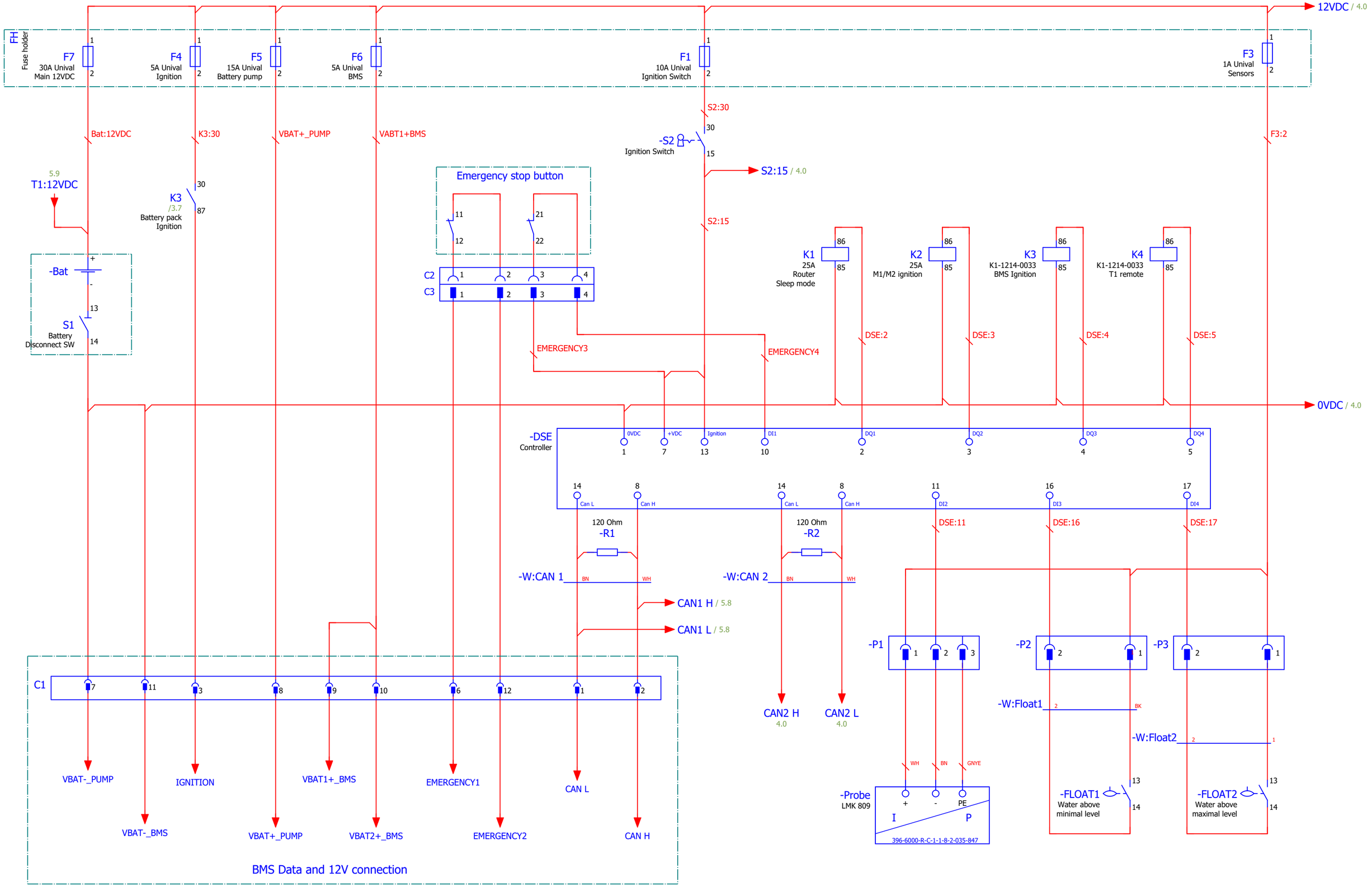
/0	Title page		16.12.2022	PC	X
/1	Safety instructions		16.12.2022	PC	X
/2	Table of contents : /0 - /6		21.07.2023	PC	
/3	Control wiring		21.07.2023	PC	
/4	Control wiring		21.07.2023	PC	
/5	Battery chargers, motors		21.07.2023	PC	
/6	Parts list : ZIVAN SG3 - LAPP.1119403		21.07.2023	PC	



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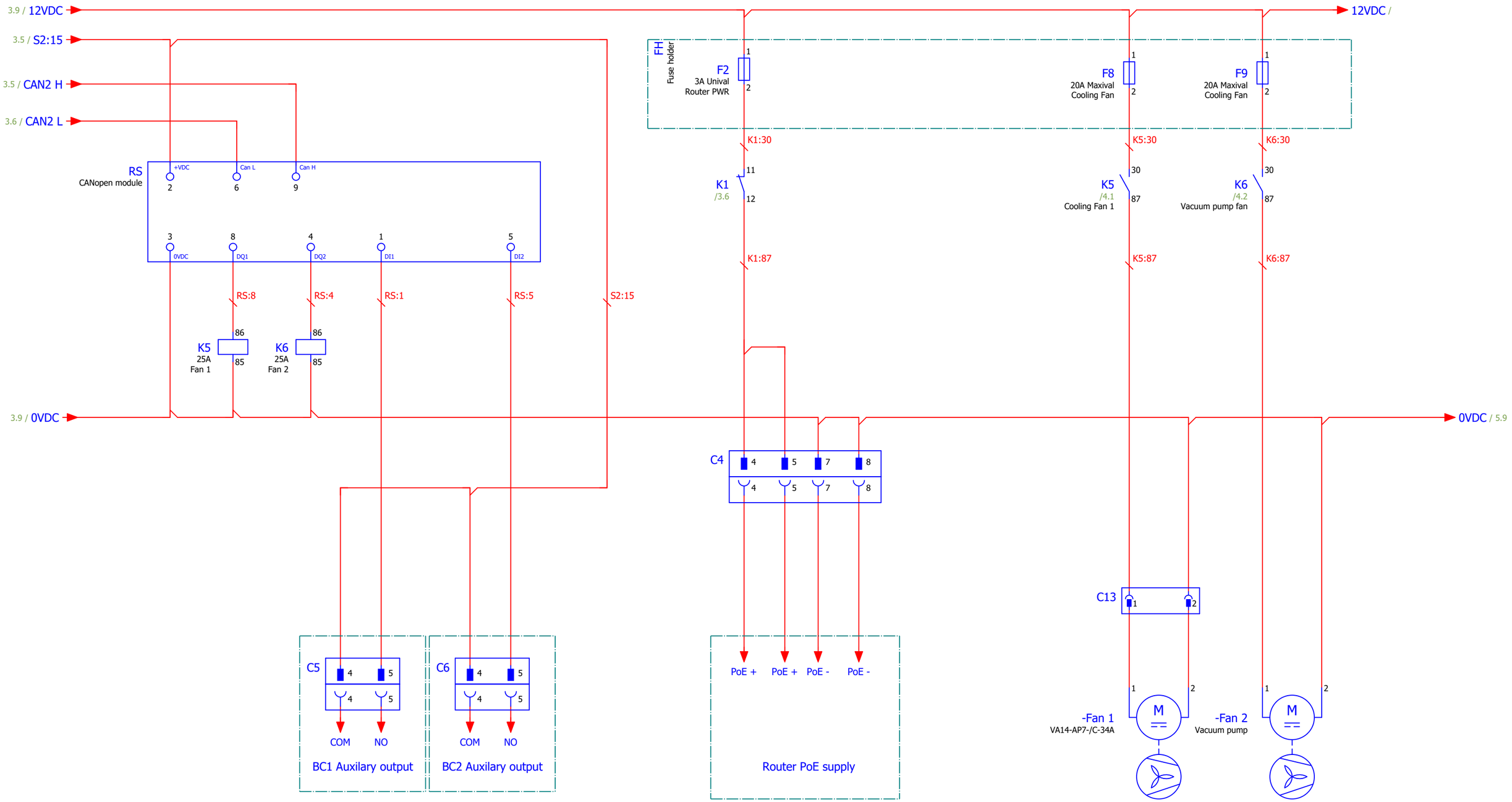

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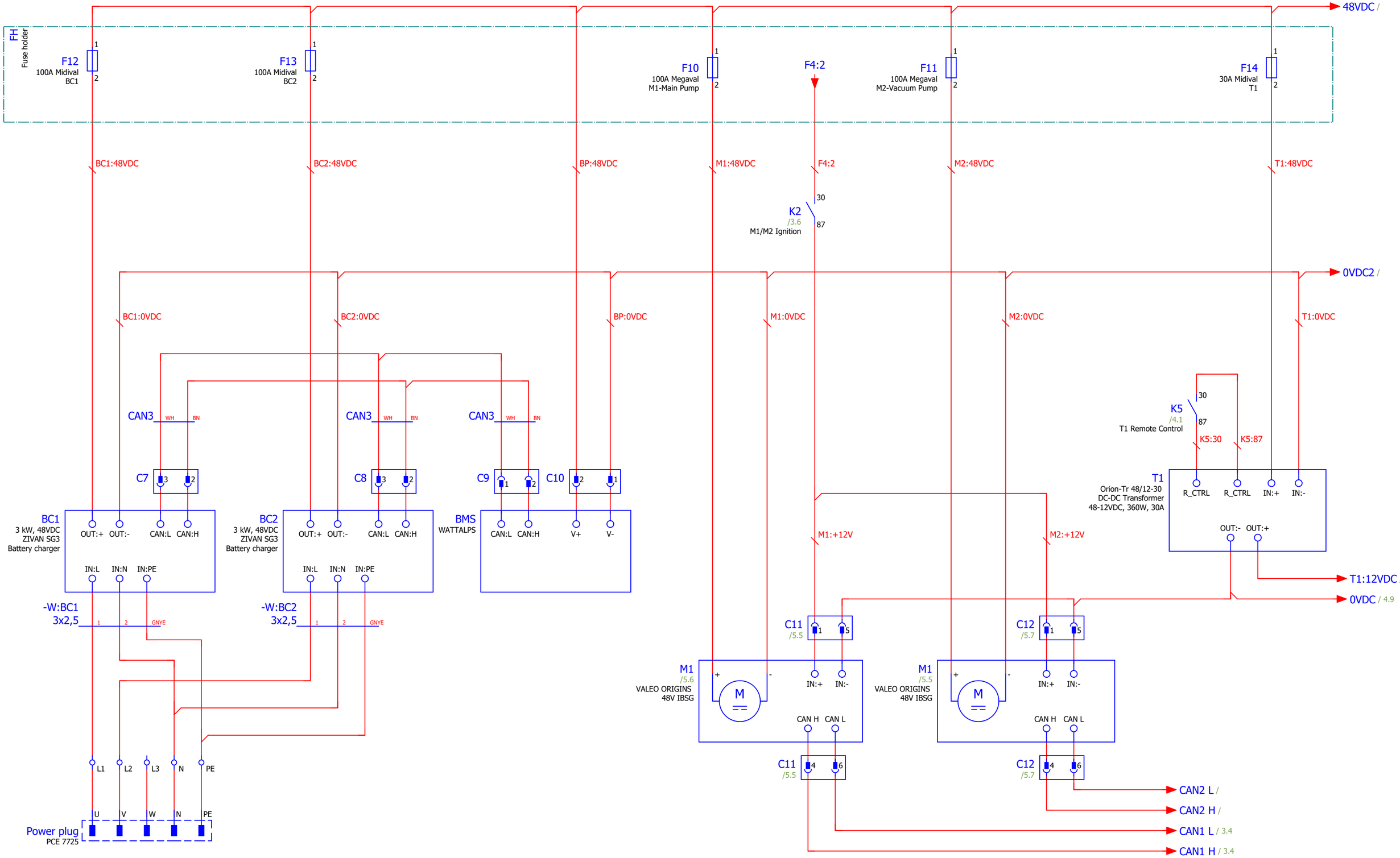
Control wiring



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Parts list

F01_001

Device tag	Quantity	Designation	Type number	Supplier	Part number
-BC1	1				ZIVAN SG3
-C5	1				282108-1
-BC2	1				ZIVAN SG3
-C6	1				282108-1
-C1	1				DT06-12SA
-C2	1				DT06-4S
-C3	1				DT04-4P
-C4	1				1018820000
-C7	1				282107-1
-C8	1				282107-1
-C9	1				DT06-6S
-C10	1				HVSL1000082A150
-C11	1				2005372-2
-C12	1				2005372-2
-C13	1				282080-2
-DSE	1				DSEM840
-FH-F1	1				Muinske 5000236
-FH-F2	1				Miunske 5000211
-FH-F3	1				Miunske 5000210
-FH-F4	1				Muinske 5000235
-FH-F5	1				Muinske F1-1161-5000
-FH-F6	1				Muinske 5000235
-FH-F7	1				Muinske F1-1263-0000
-FH-F8	1				Muinske F1-1262-0000
-FH-F9	1				Muinske F1-1262-0000
-FH-F10	1				Miunske F1-2171-0000
-FH-F11	1				Miunske F1-2171-0000
-FH-F12	1				Miunske F1-2071-0000
-FH-F13	1				Muinske F1-2071-0000
-FH-F14	1				Muinske F1-2063-0000
-FH	1				Muinske F9-2100-4211, F7-0002-0009
-K1	1				Miunske.K1-1214-0033
-K2	1				Miunske.K1-1214-0033
-K3	1				Miunske.K1-1214-0033
-K4	1				Miunske.K1-1214-0033
-K5	1				Miunske.K1-1214-0033
-K6	1				Miunske.K1-1214-0033
-Power plug	1				PCE.7725
-RS	1				Muinske N6-3007-0060
-S2	1				Miunske.36139
-T1	1				Orion-Tr 48/12-30
-W:BC1	1	ÖLFLEX CLASSIC 110 3G2,5	ÖLFLEX® CLASSIC 110		LAPP.1119403
-W:BC2	1	ÖLFLEX CLASSIC 110 3G2,5	ÖLFLEX® CLASSIC 110		LAPP.1119403

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			Date	21.07.2023	Mobile pump station electric scheme		ETR Automation	Parts list : ZIVAN SG3 - LAPP.1119403	
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Specifications

Applicative External CAN Software Interface

DIN-001566-A-04

Visas

	Responsible	Date	Visa
Writer	Sylvain Basset	20/03/2023	SBA
Checker	Sebastien Bossan	22/03/2023	SBO
Approval	Matthieu Desbois-Renaudin	17/04/2023	MDR

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Revisions

Rev	Date	Object
X-01	09/12/2021	First edition for gen 3 BMS
A-01	09/12/2021	First valid release
A-02	28/02/2022	- Adding software name and version reference - Adding information on contactor, heater state, and “end of charge” states - Fixing BMS_VMU_INFO_INSULATION description message - Updating BMS_VMU_STATUS error mode value to 0x3 - Updating Failures/warnings/alerts according to new specifications
A-03	25/05/2022	- Fixing VMU_BMS_STATUS message DLC to 8
A-04	27/02/2023	- Adding statistics message (BMS_VMU_STATS) - Adding Junction-box temperature message (BMS_VMU_INFO_JB_TEMPERATURE) - Adding “IsPumping”, and “IsCooling” flags to Battery status message (BMS_VMU_STATUS) - Set Battery status message (BMS_VMU_STATUS) DLC to 4 - Adding optional detailed set-points messages (BMS_VMU_SP_DETAIL_XX) - Adding note about messages timing adjustments - Updating failures message (BMS_VMU_FAILURE) with new flags - Updating warning message (BMS_VMU_WARNING) with new flags - Split between regular and optional messages

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Terminology

Acronym, term, Abbreviation	Signification
BMS	Battery management System
CAN database	Set of CAN message used to communication with battery BMS
CAN message	Standard frame of CAN bus protocol, specified by a CAN-Id, data length (DLC), and data bytes, which are composed by CAN signals
CAN Signal	Information to transmit/receive from BMS. It specifies a set of parameters, characterizing its position the CAN message data, length, scale, unit, etc…
VMU	Vehicle Management Unit, or by extension any software unit what communicate with BMS, through CAN bus

Object of the document

This document specifies the BMS external CAN Database of BMS **vA-06** applicative software.

1. Introduction

Two types of CAN messages are described:

- CAN messages sent from VMU to BMS: VMU_BMS_xxx
- CAN messages sent from BMS to VMU: BMS_VMU_xxx

For each CAN message, this document specifies the corresponding CAN-id, Data length, and all its signals.

Without any other information, endianness is always considered as “little endian”.

2. VMU to BMS messages

2.1.VMU_BMS_STATUS

CAN-ID	*Msg name*	*DLC*	*Expected Period*	*Description*
0x18011E00	VMU_BMS_STATUS	8	200 ms	**Message from VMU to BMS:** **Battery status setting**

Signal Name	*Bit index*	*Bit length*	*Signed*	*Min*	*Max*	*Offset*	*Scale*	*Unit*	*Description*
AskMode	0	2	no	0	2	0.0	1.0	-	BMS asking mode: - 0x0: Standby - 0x1: Charge - 0x2: Drive
Reseved	2	62	-	-	-	-	-	-	*Reserved: must be set to 0*

3. BMS to VMU regular messages

3.1.BMS_VMU_STATUS

CAN-ID	*Msg name*	*DLC*	*Period*	*Description*
0x18F0011E	BMS_VMU_STATUS	4	200 ms (1)	**Message from BMS to VMU: Battery general status**

Signal Name	*Bit index*	*Bit length*	*Signed*	*Min*	*Max*	*Offset*	*Scale*	*Unit*	*Description*
Mode	0	2	no	0	3	0.0	1.0	-	BMS functioning Mode: - 0x0: Standby - 0x1: Charge - 0x2: Drive - 0x3: Error
Soc	8	8	no	0	100	0.0	1.0	%	Battery State of Charge
IsFailure	16	1	no	0	1	0.0	1.0	-	Failure indication (3rd Level)
IsWarning	17	1	no	0	1	0.0	1.0	-	Warning indication (2nd Level)
IsAlert	18	1	no	0	1	0.0	1.0	-	Alert indication (1st Level)
IsBalancing	19	1	no	0	1	0.0	1.0	-	Balancing processing indication
IsEndOfCharge	20	1	no	0	1	0.0	1.0	-	End of charge indication
IsDcContactorClosed	21	1	no	0	1	0.0	1.0	-	DC-bus contactor closed indication
IsHeating	22	1	no	0	1	0.0	1.0	-	Battery heater activation indication
IsPumping	23	1	no	0	1	0.0	1.0	-	Battery pump activation indication
IsCooling	24	1	no	0	1	0.0	1.0	-	Battery cooler activation indication

3.2.BMS_VMU_SP_CHARGE

CAN-ID	*Msg name*	*DLC*	*Period*	*Description*
0x18F0021E	BMS_VMU_SP_CHARGE	4	200 ms (1)	**Message from BMS to VMU: Charge set-points**

Signal Name	*Bit index*	*Bit length*	*Signed*	*Min*	*Max*	*Offset*	*Scale*	*Unit*	*Description*
ChargeVoltage	0	16	no	0	65535	0.0	0.1	V	Charge voltage set-point
MaxChargeCurrent	16	16	no	0	65535	0.0	0.1	A	Maximum Charge current set-point

3.3.BMS_VMU_SP_DRIVE

CAN-ID	*Msg name*	*DLC*	*Period*	*Description*
0x18F0031E	BMS_VMU_SP_DRIVE	4	200 ms (1)	**Message from BMS to VMU: Drive set-points**

Signal Name	*Bit index*	*Bit length*	*Signed*	*Min*	*Max*	*Offset*	*Scale*	*Unit*	*Description*
MaxDischargeCurrent	0	16	no	0	65535	0.0	0.1	A	Maximum discharge current set-point
MaxRegenCurrent	16	16	no	0	65535	0.0	0.1	A	Maximum regenerative current set-point

3.4.BMS_VMU_FAILURES

CAN-ID	*Msg name*	*DLC*	*Period*	*Description*
0x18F0101E	BMS_VMU_FAILURES	8	200 ms (1)	**Message from BMS to VMU: Battery failures (3rd level) details**

Signal Name	*Bit index*	*Bit length*	*Signed*	*Min*	*Max*	*Offset*	*Scale*	*Unit*	*Description*
Reserved	0	1	-	-	-	-	-	-	-
ExternalCommunication	1	1	no	0	1	0.0	1.0	-	Applicative external communication failure (VMU timeout)
uCCommunication	2	1	no	0	1	0.0	1.0	-	Applicative internal communication failure
AuxShunt	3	1	no	0	1	0.0	1.0		Applicative shunt measurement failure
Config	4	1	no	0	1	0.0	1.0	-	Applicative configuration failure
Contactor	5	1	no	0	1	0.0	1.0	-	Applicative contactor failure
PrechargeContacteur	6	1	no	0	1	0.0	1.0	-	Applicative contactor pre-charge failure
InternalPowerAlimentation	7	1	no	0	1	0.0	1.0	-	Applicative power voltage failure
InternalTemperature	8	1	no	0	1	0.0	1.0	-	Applicative master board temperature failure
Reserved	9	23	-	-	-	-	-	-	-
Safety_TempmaxMod	32	1	no	0	1	0.0	1.0	-	Safety high module temperature failure
Safety_TempImbalance	33	1	no	0	1	0.0	1.0	-	Safety imbalance temperature failure
Safety_Voltmax	34	1	no	0	1	0.0	1.0	-	Safety cell high voltage failure
Safety_Voltmin	35	1	no	0	1	0.0	1.0	-	Safety cell low voltage failure
Safety_VoltImbalance	36	1	no	0	1	0.0	1.0	-	Safety imbalance voltage failure
Safety_Curmax2s	37	1	no	0	1	0.0	1.0	-	Safety maximum 2s average current failure
Safety_Curmax5s	38	1	no	0	1	0.0	1.0	-	Safety maximum 5s average current failure

Safety_Curmax10s	39	1	no	0	1	0.0	1.0	-	Safety maximum 10s average current failure
Safety_Curmax30s	40	1	no	0	1	0.0	1.0	-	Safety maximum 30s average current failure
Safety_Curmax60s	41	1	no	0	1	0.0	1.0	-	Safety maximum 60s average current failure
Safety_Oil	42	1	no	0	1	0.0	1.0	-	Safety low oil level failure
Safety_Contactor	43	1	no	0	1	0.0	1.0	-	Safety contactor failure
Safety_Config	44	1	no	0	1	0.0	1.0	-	Safety configuration failure
Safety_SlaveSpiComm	45	1	no	0	1	0.0	1.0	-	Safety slave board SPI communication failure
Safety_SlaveComm	46	1	no	0	1	0.0	1.0	-	Safety slave board ASCI communication failure
Safety_SlaveNumber	47	1	no	0	1	0.0	1.0	-	Safety number of slave boards failure
Safety_SlaveId	48	1	no	0	1	0.0	1.0	-	Safety slave board identification failure
Safety_SlaveMeasTimeout	49	1	no	0	1	0.0	1.0	-	Safety slave board measures timeout failures
Safety_SlaveMaxim	50	1	no	0	1	0.0	1.0	-	Safety maxims internal error failure
Safety_CommAuxShunt	51	1	no	0	1	0.0	1.0	-	Safety shunt measurement failure
Safety_EmergencyStop	52	1	no	0	1	0.0	1.0	-	Safety emergency stop detection
Safety_Hvil	53	1	no	0	1	0.0	1.0	-	Safety HVIL error failure
Safety_VoltSensor	54	1	no	0	1	0.0	1.0	-	Safety slave board voltage sensor failure
Safety_TempSensor	55	1	no	0	1	0.0	1.0	-	Safety slave board temperature sensor failure
Safety_CurrSensor	56	1	no	0	1	0.0	1.0	-	Safety slave board current sensor failure
Safety_Vpack	57	1	no	0	1	0.0	1.0	-	Safety battery pack maximum voltage failure
Safety_ContextAlim	58	1	no	0	1	0.0	1.0	-	Safety context power supply failure
Safety_JunctionBox Temperature	59	1	no	0	1	0.0	1.0	-	Safety Junction-box maximum temperature failure

Safety_ApplComm	60	1	no	0	1	0.0	1.0	-	Safety internal communication failure
Reseved	61	3	-	-	-	-	-	-	-

3.5.BMS_VMU_WARNINGS

CAN-ID	*Msg name*	*DLC*	*Period*	*Description*
0x18F0111E	BMS_VMU_WARNINGS	8	200 ms (1)	**Message from BMS to VMU: Battery warnings (2nd level) details**

Signal Name	*Bit index*	*Bit length*	*Signed*	*Min*	*Max*	*Offset*	*Scale*	*Unit*	*Description*
Reserved	0	1	-	-	-	-	-	-	-
TempmaxMod	1	1	no	0	1	0.0	1.0	-	Maximum high module temperature warning
TempImbalance	2	1	no	0	1	0.0	1.0	-	Imbalance temperature warning
Voltmax	3	1	no	0	1	0.0	1.0	-	Maximum high cell voltage warning
Voltmin	4	1	no	0	1	0.0	1.0	-	Minimum low cell voltage warning
VoltImbalance	5	1	no	0	1	0.0	1.0	-	Imbalance voltage warning
Curmax2s	6	1	no	0	1	0.0	1.0	-	Maximum 2s average current warning
Curmax5s	7	1	no	0	1	0.0	1.0	-	Maximum 5s average current warning
Curmax10s	8	1	no	0	1	0.0	1.0	-	Maximum 10s average current warning
Curmax30s	9	1	no	0	1	0.0	1.0	-	Maximum 30s average current warning
Curmax60s	10	1	no	0	1	0.0	1.0	-	Maximum 60s average current warning
Oil	11	1	no	0	1	0.0	1.0	-	Oil/pressure level warning
Pump	12	1	no	0	1	0.0	1.0	-	Pump faulty status warning
JunctionBoxTemperature	13	1	no	0	1	0.0	1.0	-	Junction-box maximum temperature warning
Reseved	14	18	-	-	-	-	-	-	-
Safety_Contactor	32	1	no	0	1	0.0	1.0	-	Safety contactor (open under charge) warning

Safety_TempSensor	33	1	no	0	1	0.0	1.0	-	Safety slave board temperature sensor warning
Safety_CurrSensor	34	1	no	0	1	0.0	1.0	-	Safety slave board current sensor warning
Safety_Heater	35	1	no	0	1	0.0	1.0	-	Safety heater oil temperature warning
Safety_HeaterRange	36	1	no	0	1	0.0	1.0	-	Safety heater oil temperature sensor range warning
Safety_PowerBranchCut	37	1	no	0	1	0.0	1.0	-	Safety power branch cutting warning
Reseved	38	26	-	-	-	-	-	-	-

3.6.BMS_VMU_ALERTS

CAN-ID	*Msg name*	*DLC*	*Period*	*Description*
0x18F0121E	BMS_VMU_ALERTS	4	200 ms (1)	**Message from BMS to VMU: Battery alerts (1st level) details**

Signal Name	*Bit index*	*Bit length*	*Signed*	*Min*	*Max*	*Offset*	*Scale*	*Unit*	*Description*
TempmaxMod	0	1	no	0	1	0.0	1.0	-	Maximum high module temperature alert
Voltmax	1	1	no	0	1	0.0	1.0	-	Maximum high cell voltage alert
Voltmin	2	1	no	0	1	0.0	1.0	-	Minimum low cell voltage alert
Curmax2s	3	1	no	0	1	0.0	1.0	-	Maximum 2s average current alert
Curmax5s	4	1	no	0	1	0.0	1.0	-	Maximum 5s average current alert
Curmax10s	5	1	no	0	1	0.0	1.0	-	Maximum 10s average current alert
Curmax30s	6	1	no	0	1	0.0	1.0	-	Maximum 30s average current alert
Curmax60s	7	1	no	0	1	0.0	1.0	-	Maximum 60s average current alert
Heater	8	1	no	0	1	0.0	1.0	-	Heater faulty status alert
Reseved	9	23	-	-	-	-	-	-	-

3.7.BMS_VMU_INFO

CAN-ID	Msg name	DLC	Period	Description
0x18F0201E	BMS_VMU_INFO	7	200 ms (1)	**Message from BMS to VMU: Battery contextual information**

Signal Name	Bit index	Bit length	Signed	Min	Max	Offset	Scale	Unit	Description
Current	0	16	yes	-32768	32767	0.0	0.1	A	Measured current
UpStreamVoltage	16	16	no	0	65535	0.0	0.1	V	Measured upstream voltage (before contactors)
DownStreamVoltage	32	16	no	0	65535	0.0	0.1	V	Measured upstream voltage (after contactors)
SOH	48	8	no	0	100	0.0	1.0	%	Battery state of health

3.8.BMS_VMU_INFO_CELLS

CAN-ID	Msg name	DLC	Period	Description
0x18F0211E	BMS_VMU_INFO_CELLS	6	1000 ms (1)	**Message from BMS to VMU: Battery Cells information**

Signal Name	Bit index	Bit length	Signed	Min	Max	Offset	Scale	Unit	Description
MinimumCellVoltage	0	16	no	0	5000	0.0	1.0	mV	Minimum cell voltage
AverageCellVoltage	16	16	no	0	5000	0.0	1.0	mV	Average cell voltage
MaximumCellVoltage	32	16	no	0	5000	0.0	1.0	mV	Maximum cell voltage

3.9.BMS_VMU_INFO_TEMPERATURE

CAN-ID	*Msg name*	*DLC*	*Period*	*Description*
0x18F0221E	BMS_VMU_INFO_TEMPERATURE	3	1000 ms (1)	**Message from BMS to VMU: Battery Temperature information**

Signal Name	*Bit index*	*Bit length*	*Signed*	*Min*	*Max*	*Offset*	*Scale*	*Unit*	*Description*
MinimumCellTemp	0	8	Yes	-128	127	0.0	1.0	°C	Minimum cell temperature
AverageCellTemp	8	8	Yes	-128	127	0.0	1.0	°C	Average cell temperature
MaximumCellTemp	16	8	Yes	-128	127	0.0	1.0	°C	Maximum cell temperature

3.10. BMS_VMU_STATS

CAN-ID 0x18F0301E reserved for future usage.

3.11. BMS_VMU_IDENTIFICATION

CAN-ID	Msg name	DLC	Period	Description
0x18F0311E	BMS_VMU_IDENTIFICATION	8	1000 ms (1)	**Message from BMS to VMU: Battery identification**

Signal Name	Bit index	Bit length	Signed	Min	Max	Offset	Scale	Unit	Description
ProductIdChar_0	0	8	no	0	255	0.0	1.0	-	Product identification character 0
ProductIdChar_1	8	8	no	0	255	0.0	1.0	-	Product identification character 1
ProductIdChar_2	16	8	no	0	255	0.0	1.0	-	Product identification character 2
ProductIdChar_3	24	8	no	0	255	0.0	1.0	-	Product identification character 3
ProductIdChar_4	32	8	no	0	255	0.0	1.0	-	Product identification character 4
ProductIdChar_5	40	8	no	0	255	0.0	1.0	-	Product identification character 5
ProductIdChar_6	48	8	no	0	255	0.0	1.0	-	Product identification character 6
ProductIdChar_7	56	8	no	0	255	0.0	1.0	-	Product identification character 7

3.12. BMS_VMU_SW_VERSION

CAN-ID	Msg name	DLC	Period	Description
0x18F0321E	BMS_VMU_SW_VERSION	8	1000 ms (1)	**Message from BMS to VMU: Software version**

Signal Name	Bit index	Bit length	Signed	Min	Max	Offset	Scale	Unit	Description
SafetySwVerChar_0	0	8	no	0	255	0.0	1.0	-	Safety Software version character 0
SafetySwVerChar_1	8	8	no	0	255	0.0	1.0	-	Safety Software version character 1
SafetySwVerChar_2	16	8	no	0	255	0.0	1.0	-	Safety Software version character 2
SafetySwVerChar_3	24	8	no	0	255	0.0	1.0	-	Safety Software version character 3
ApplSwVerChar_0	32	8	no	0	255	0.0	1.0	-	Applicative Software version character 0
ApplSwVerChar_1	40	8	no	0	255	0.0	1.0	-	Applicative Software version character 1
ApplSwVerChar_2	48	8	no	0	255	0.0	1.0	-	Applicative Software version character 2
ApplSwVerChar_3	56	8	no	0	255	0.0	1.0	-	Applicative Software version character 3

3.13. BMS_VMU_CONF_VERSION

CAN-ID	Msg name	DLC	Period	Description
0x18F0331E	BMS_VMU_CONF_VERSION	8	1000 ms (1)	**Message from BMS to VMU: Configurations version**

Signal Name	Bit index	Bit length	Signed	Min	Max	Offset	Scale	Unit	Description
SafetyConfVerChar_0	0	8	no	0	255	0.0	1.0	-	Safety configuration version character 0
SafetyConfVerChar_1	8	8	no	0	255	0.0	1.0	-	Safety configuration version character 1
SafetyConfVerChar_2	16	8	no	0	255	0.0	1.0	-	Safety configuration version character 2
SafetyConfVerChar_3	24	8	no	0	255	0.0	1.0	-	Safety configuration version character 3
ApplConfVerChar_0	32	8	no	0	255	0.0	1.0	-	Applicative configuration version character 0
ApplConfVerChar_1	40	8	no	0	255	0.0	1.0	-	Applicative configuration version character 1
ApplConfVerChar_2	48	8	no	0	255	0.0	1.0	-	Applicative configuration version character 2
ApplConfVerChar_3	56	8	no	0	255	0.0	1.0	-	Applicative configuration version character 3

3.14. BMS_VMU_STATS

CAN-ID	Msg name	DLC	Period	Description
0x18F0401E	BMS_VMU_STATS	8	1000 ms (1)	**Message from BMS to VMU: Battery statistics**

Signal Name	Bit index	Bit length	Signed	Min	Max	Offset	Scale	Unit	Description
CounterCharge	0	32	no	0	0xFFFFFFFF	0.0	0.01	Ah	Total charge counter
CounterDischarge	32	32	no	0	0xFFFFFFFF	0.0	0.01	Ah	Total discharge counter

4. BMS to VMU optional messages

The following messages are distributed on CAN bus only if the associated option has been activated for the battery pack.

Please contact your WATTALPS retailer for any further information.

4.1.BMS_VMU_SP_DETAIL_2S optional message

CAN-ID	*Msg name*	*DLC*	*Period*	*Description*
0x18F0041E	BMS_VMU_SP_DETAIL_2S	8	200 ms (1)	**Message from BMS to VMU: Detailed set-points for 2s current averages**

Signal Name	*Bit index*	*Bit length*	*Signed*	*Min*	*Max*	*Offset*	*Scale*	*Unit*	*Description*
ChargeMeasuredCurrent2s	0	16	no	0	65535	0.0	0.1	A	Measured charge current on 2s average
ChargeSafetyThreshold2s	16	16	no	0	65535	0.0	0.1	A	Charge current safety limit for 2s average
DischargeMeasuredCurrent2s	32	16	no	0	65535	0.0	0.1	A	Measured discharge current on 2s average
DischargeSafetyThreshold2s	48	16	no	0	65535	0.0	0.1	A	Discharge current safety limit for 2s average

4.2.BMS_VMU_SP_DETAIL_5S optional message

CAN-ID	*Msg name*	*DLC*	*Period*	*Description*
0x18F0041E	BMS_VMU_SP_DETAIL_5S	8	200 ms (1)	**Message from BMS to VMU: Detailed set-points for 5s current averages**

Signal Name	*Bit index*	*Bit length*	*Signed*	*Min*	*Max*	*Offset*	*Scale*	*Unit*	*Description*
ChargeMeasuredCurrent5s	0	16	no	0	65535	0.0	0.1	A	Measured charge current on 5s average
ChargeSafetyThreshold5s	16	16	no	0	65535	0.0	0.1	A	Charge current safety limit for 5s average
DischargeMeasuredCurrent5s	32	16	no	0	65535	0.0	0.1	A	Measured discharge current on 5s average
DischargeSafetyThreshold5s	48	16	no	0	65535	0.0	0.1	A	Discharge current safety limit for 5s average

4.3.BMS_VMU_SP_DETAIL_10S optional message

CAN-ID	*Msg name*	*DLC*	*Period*	*Description*
0x18F0041E	BMS_VMU_SP_DETAIL_10S	8	200 ms (1)	**Message from BMS to VMU: Detailed set-points for 10s current averages**

Signal Name	*Bit index*	*Bit length*	*Signed*	*Min*	*Max*	*Offset*	*Scale*	*Unit*	*Description*
ChargeMeasuredCurrent10s	0	16	no	0	65535	0.0	0.1	A	Measured charge current on 10s average
ChargeSafetyThreshold10s	16	16	no	0	65535	0.0	0.1	A	Charge current safety limit for 10s average
DischargeMeasuredCurrent10s	32	16	no	0	65535	0.0	0.1	A	Measured discharge current on 10s average
DischargeSafetyThreshold10s	48	16	no	0	65535	0.0	0.1	A	Discharge current safety limit for 10s average

4.4.BMS_VMU_SP_DETAIL_30S optional message

CAN-ID	*Msg name*	*DLC*	*Period*	*Description*
0x18F0041E	BMS_VMU_SP_DETAIL_30S	8	200 ms (1)	**Message from BMS to VMU: Detailed set-points for 30s current averages**

Signal Name	*Bit index*	*Bit length*	*Signed*	*Min*	*Max*	*Offset*	*Scale*	*Unit*	*Description*
ChargeMeasuredCurrent30s	0	16	no	0	65535	0.0	0.1	A	Measured charge current on 30s average
ChargeSafetyThreshold30s	16	16	no	0	65535	0.0	0.1	A	Charge current safety limit for 30s average
DischargeMeasuredCurrent30s	32	16	no	0	65535	0.0	0.1	A	Measured discharge current on 30s average
DischargeSafetyThreshold30s	48	16	no	0	65535	0.0	0.1	A	Discharge current safety limit for 30s average

4.5.BMS_VMU_SP_DETAIL_60S optional message

CAN-ID	*Msg name*	*DLC*	*Period*	*Description*
0x18F0041E	BMS_VMU_SP_DETAIL_60S	8	200 ms (1)	**Message from BMS to VMU: Detailed set-points for 60s current averages**

Signal Name	*Bit index*	*Bit length*	*Signed*	*Min*	*Max*	*Offset*	*Scale*	*Unit*	*Description*
ChargeMeasuredCurrent60s	0	16	no	0	65535	0.0	0.1	A	Measured charge current on 60s average
ChargeSafetyThreshold60s	16	16	no	0	65535	0.0	0.1	A	Charge current safety limit for 60s average
DischargeMeasuredCurrent60s	32	16	no	0	65535	0.0	0.1	A	Measured discharge current on 60s average
DischargeSafetyThreshold60s	48	16	no	0	65535	0.0	0.1	A	Discharge current safety limit for 60s average

4.6.BMS_VMU_INFO_INSULATION optional message

CAN-ID	*Msg name*	*DLC*	*Period*	*Description*
0x18F0231E	BMS_VMU_INFO_INSULATION	3	1000 ms (1)	**Message from BMS to VMU: Battery insulation resistance**

Signal Name	*Bit index*	*Bit length*	*Signed*	*Min*	*Max*	*Offset*	*Scale*	*Unit*	*Description*
InsulationResistance	0	32	No	0	1000000	0.0	1.0	kOhm	Battery insulation resistance measured value

This message is only valid for batteries equipped with insulation resistance monitoring system.

4.7.BMS_VMU_INFO_JB_TEMPERATURE optional message

CAN-ID	*Msg name*	*DLC*	*Period*	*Description*
0x18F0241E	BMS_VMU_INFO_JB_TEMPERATURE	3	1000 ms (1)	**Message from BMS to VMU: Junction-box temperature**

Signal Name	*Bit index*	*Bit length*	*Signed*	*Min*	*Max*	*Offset*	*Scale*	*Unit*	*Description*
JunctionBoxShuntTempMeas	0	16	Yes	-100	300	0.0	1.0	°C	Junction-box shunt measured temperature
JunctionBoxShuntTempMax	16	16	Yes	-100	300	0.0	1.0	°C	Junction-box shunt maximum temperature
JunctionBoxThermTempMeas	0	16	Yes	-100	300	0.0	1.0	°C	Junction-box thermistance measured temperature
JunctionBoxThermTempMax	16	16	Yes	-100	300	0.0	1.0	°C	Junction-box thermistance maximum temperature

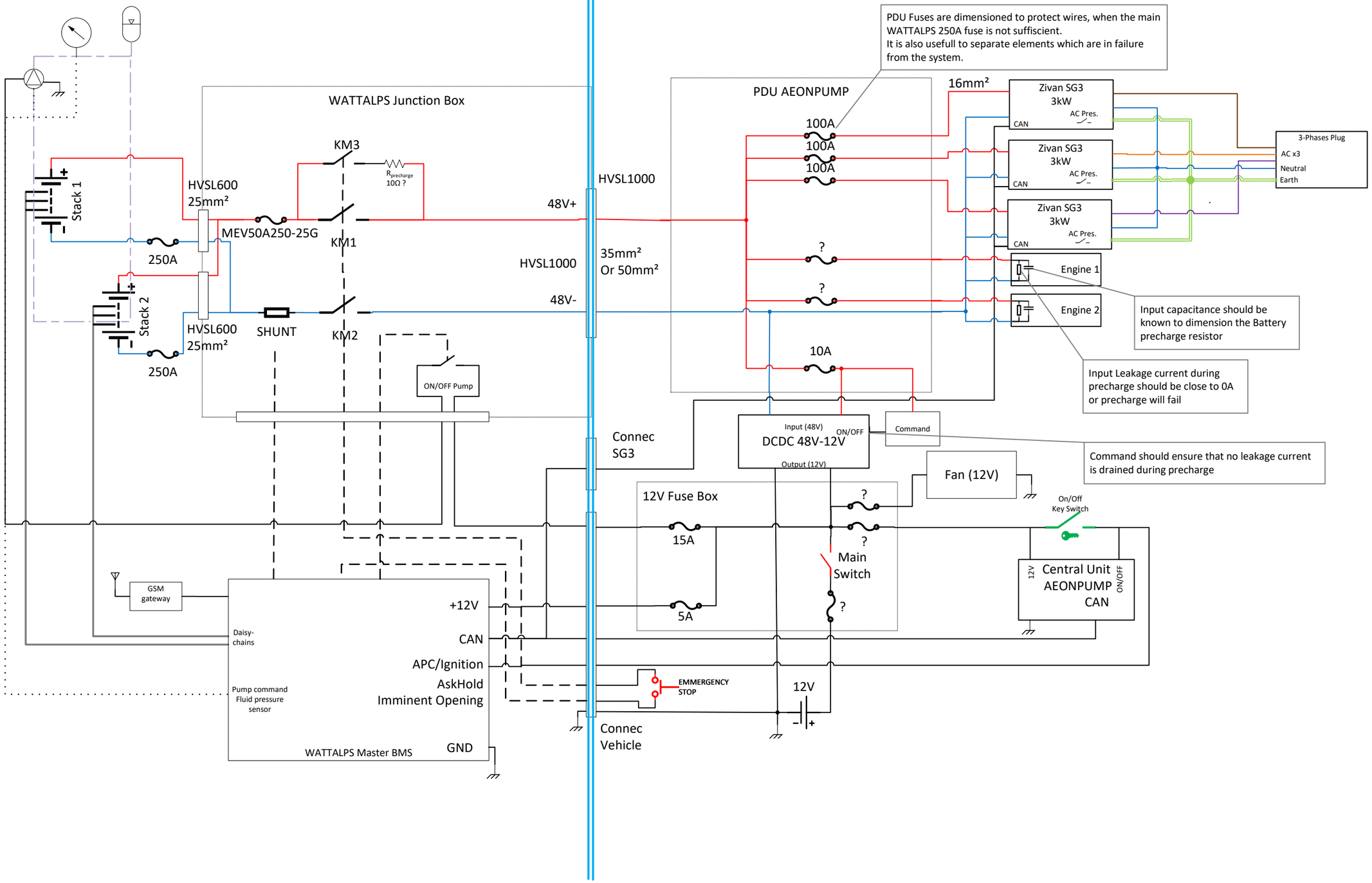
This message is only valid for batteries equipped with Junction-box temperature monitoring system.

5. Additional information

Note (1): Periods given along with messages are default values. Timings can be adjusted for specific needs. Please contact your WATTALPS retailer for any further information.

WATTALPS Battery pack Architecture

Exemple Architecture for AEONPUMP part
(Out of WATTALPS project Scope and Responsability)



Ind	Date	Modification	Visa
A-02	30/11/2022	Add Key switches, improvements	
A-01	29/11/2022	Initial release	

wattalps®

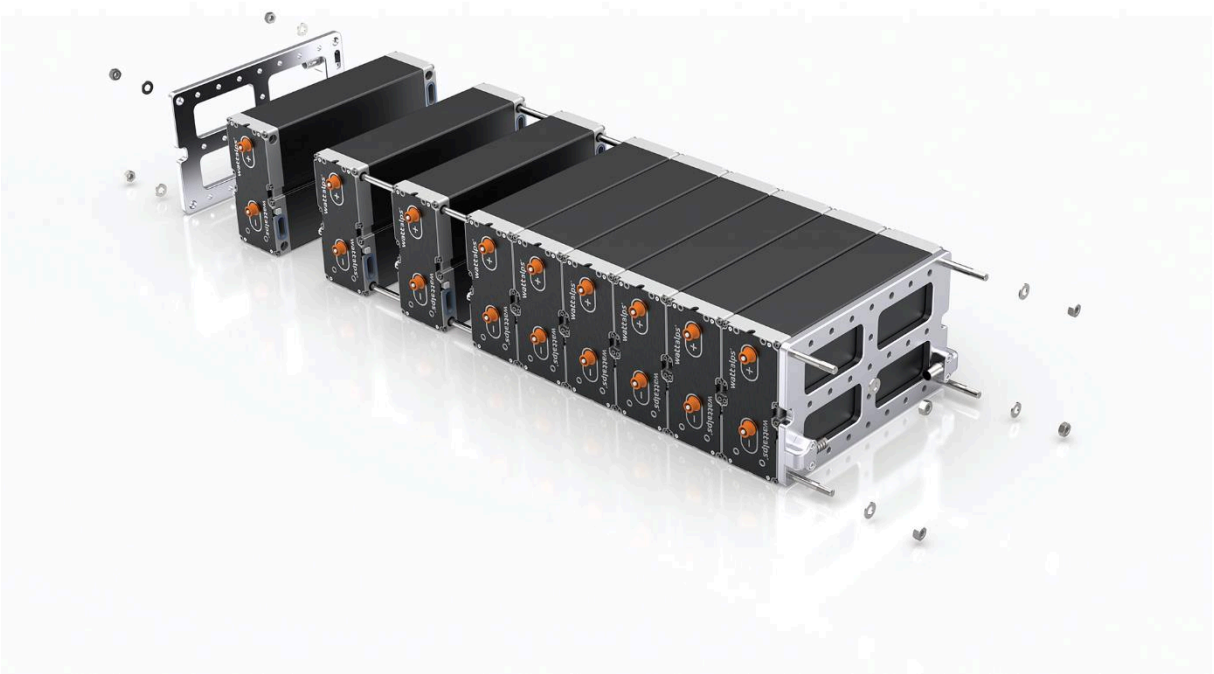
DIN-003341-A-02

Aeonpump Battery Architecture

CONFIDENTIEL

Manufacturer's Manual

WATTALPS Battery System



NOT-000854-A-09 WATTALPS proprietary and confidential information

Advanced Lithium Power Systems

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IBAN FR7630004024750001081115908
BIC/Swift code BNPAFRPPAAE

Table of Contents

Tracking changes:

Version	Modification	Author	Date
A-01	First edition	MDR	02/04/20
A-02	Addition of section on grounding straps	MDR	06/04/20
A-03	Addition of activity check of BMS & 8.2.6.	MDR & BDU	08/04/20
A-04	Clearer description of isolation controller	SBA	15/09/20
A-05	Update vs new version	BHA	08/12/21
A-06	Improvement of exported requirement Update on isolation control and isolation coordination Update on CAN communication document	BHA, SBA, & MDR	21/12/21 08/03/22 31/05/22
A-07	Addition in the maintenance part, in the voltage supply network and installation	MDR, MRO	21/06/22 04/11/22
A-08	Enlarging the overpressure mechanisms variants to safety valve	BHA	31/01/23
A-09	Explanation of process in case of module fuse blown – EMC validation – Pack handling schematics	MDR, MRO	29/03/2023

Glossary

Battery or pack: System comprising battery modules, their mechanical fixing, their electrical and electronic connections, safety elements (Master BMS, fuses, contactors, etc.) and any specific thermal conditioning elements.

Battery junction box: Box comprising all the battery protection elements, in particular the power contactor(s) to secure the battery, the main fuse(s), the current sensor and potentially other elements (insulation monitor for high voltage batteries, auxiliary relays, *etc.*). The junction box is electrically connected to the battery modules on the one hand and to the application (vehicle, device) on the other hand.

BMS: Battery Management System. This is the battery management electronics. It consists of a Master BMS electronic board for each battery system and Slave BMS electronic boards for each module.

Branch: Set of modules electrically connected in series.

Cell: low voltage electrochemical accumulator (between 2.5 and 5V) and small size (cylinder of 18 mm diameter and 65 mm height).

Customer: natural or legal person in direct commercial relationship with WATTALPS for battery supply.

WATTALPS dielectric fluid: Fluid in which the battery cells are submerged. This fluid can circulate in the battery and in heating/cooling components, in order to maintain the battery in an optimum temperature range.

Master BMS: Central electronic battery management board. The Master BMS receives all the information coming from the Slave boards of the modules, summarises it and communicates with the application.

Module: Set of cells fixed together and electrically connected. The voltage of a battery module is less than 60V. The energy can vary depending on the type of integrated cells.

Slave BMS: electronic board for monitoring battery modules. The Slave boards measure the voltages and temperature of each battery module and transfer this information to the Master BMS board.

Stack: Set of modules mechanically fixed and hydraulically connected by four tie rods and 2 closing plates.

User: any natural or legal person in contact with the battery, for example for transport, handling, installation, use, maintenance, servicing, repair, etc.

VMU: Vehicle Management Unit: electronic application management (machine or vehicle) which communicates with the battery BMS to control the battery and consumers connected to the battery output power bus.

1. Foreword

You have just received your WATTALPS battery and we would like to thank you for your trust in us.

WATTALPS batteries are designed to bring you the highest level of satisfaction and we are here to provide you with the best possible service.

Please take a moment to read the explanations contained in this manual which will help familiarise you with your new battery.

This instruction and maintenance manual, also called the Manufacturer's Manual or instruction manual, will provide you with important information, advice and warnings on safety, handling, transport, storage, installation, use, servicing, after-sales service, maintenance as well as end of life/recycling of your WATTALPS battery.

Full and constant compliance with the instructions contained in this technical document guarantees the safety of both the person and the vehicle in which the battery is to be fitted, the best quality of service and savings and a longer operating time as well as protecting the environment. This is why we ask you to read it very carefully before integration of your battery.

The products described in the instructions, illustrations and descriptions which appear in this manual can be improved or modified at any time. WATTALPS therefore declines all responsibility in the event of modifications or printing errors.

This manual has been written by the WATTALPS Company for manufacturers of vehicles or equipment using its batteries. It is the Customer's responsibility to bring to the attention of all potential Battery Users, direct or indirect, the safety elements that may potentially concern them. Failure to communicate these elements may lead to the cancellation of the warranty.

Some information contained in this manual must under no circumstances be divulged or communicated by the Customer. This information is identified in the manual by the words "Client Confidential". It is the Customer's responsibility to specify the level of information necessary for each User.

Heed the warnings and carry out the specified inspections and maintenance on a regular basis on schedule.

The battery pack shall be transported, installed and maintained only by specialised, authorised and duly empowered personnel and, in all cases, operations shall comply with the instructions given in this manual. Strictly observe all standards relating to the prevention of accidents at work.

The user will be responsible for any danger caused by compliance with provisions other than those described in this document and will therefore not be able to assert, if applicable, the factual circumstances attributable to the manufacturer WATTALPS.

No modification of the battery pack is permitted without the written consent of WATTALPS.

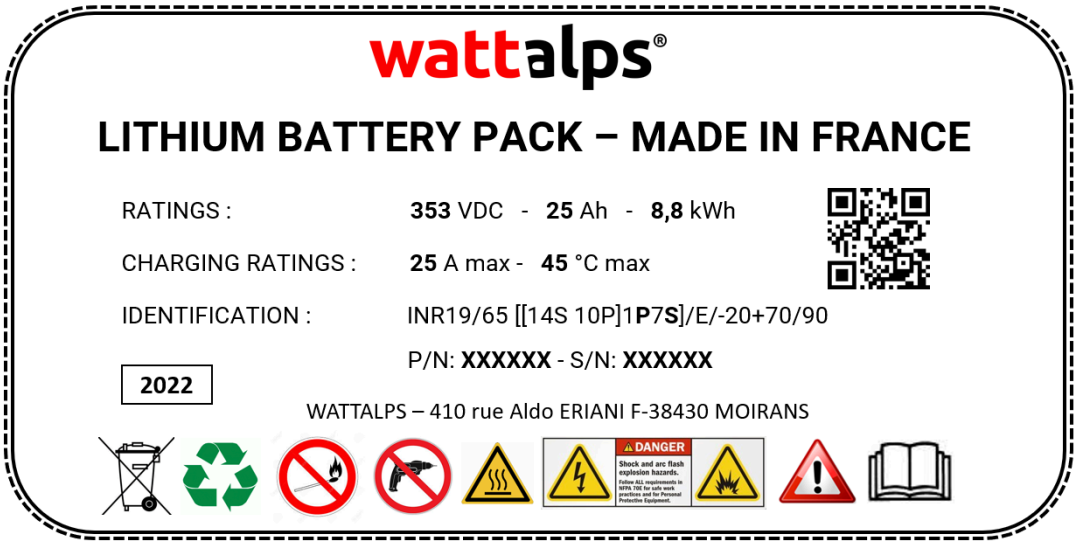
WATTALPS cannot be held responsible for the consequences of any modification to the battery pack made without its written approval.

The WATTALPS company constantly strives to improve its products. We rely on your understanding if we reserve the right to make technical changes to improve the product.

Even if the battery pack you have does not exactly match the illustrations in this document and its appendices, the safety and information on the battery pack is still guaranteed.

We will also update the documentation, but the instructions and technical data indicated will in no way be definitive and cannot be used for complaints or compensation in general.

IDENTIFICATION OF THE BATTERY PACK:

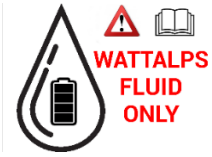


An identification label is affixed to the battery pack. It should not be removed or damaged. If it is lost or damaged it should be replaced immediately.

2. Warning – Safety Information – Prevention

Read all safety instructions before installing and/or using a WATTALPS battery system. Safety information has been included in this manual and in documents specific to your battery. If you believe that the battery will not be used in the manner suggested by these instructions, immediately stop all operations. Contact WATTALPS with any questions or concerns regarding the safety, handling, transport, storage, installation, use, care, maintenance and recycling of your battery.

The following symbols can be found on the battery system, one of these devices, in this manufacturer's manual or in the manual written by the manufacturer for its customers:

	Indication that an important safety instruction will follow.
	Carefully read the manufacturer's manual
	Risk of electric shock. This symbol may be affixed on or inside equipment to alert that dangerous voltage may be present.
	Risk of burning. This symbol may be affixed on or inside equipment to alert that a surface temperature may be dangerous.
	Do not pierce.
	Do not place in a fire or near a strong source of heat.
	Do not throw the battery in the rubbish
	100% of batteries must be recycled according to regulations. Contact WATTALPS.
	WATTALPS dielectric fluid

Failure to follow the safety instructions will void the warranty and may lead to dangerous situations. Misuse of a WATTALPS system can cause material and bodily damage (fire, pollution, serious injuries, death, etc.).

Without the written authorisation of WATTALPS, you should not under any circumstances:

- Remove and/or open a battery module.
- Remove and/or open the battery junction box even for maintenance or repair.
- Disassemble a stack of battery modules.
- Charge and discharge the battery without using the protection provided by the activated BMS and the associated original battery junction box.
- Put modules from another manufacturer in series or parallel with the WATTALPS modules.
- Modify the battery system assembly.
- Modify the implementation of the system in the application.
- Expose the system to a high temperature (> 60°C), nor leave it near a source of high heat.
- Use a battery that shows signs of damage.
- Incinerate a battery.

You should, on the other hand:

- When you receive the battery, check whether the battery or any of its components has been damaged during transport.
- Follow the instructions in this manual and the regulations in force at the place of use.
- Ensure that the installation, upkeep, maintenance and handling of the battery system is carried out by a professional duly authorised and trained in WATTALPS technology and batteries.
- Use collective and individual protective equipment suitable for all situations.
- Do not wear any metallic object (jewellery, belt, watch, buttons, etc.) when working on the battery or its components.

Fire prevention:

Contact the fire safety services in your area to determine what measures to put in place to prevent and deal with a case of fire.

3. In an emergency (fire, battery crash, etc.)

In the event of a fire, chemical reactions may cause self-combustion which could sustain the fire. A lithium-ion battery fire therefore cannot be extinguished. All you can do is stop it from spreading. We recommend taking the following steps:

1. **Quickly evacuate the area**. If possible, without endangering yourself, move the battery outdoors and/or protect the surroundings to prevent the spread of the fire.
2. **Call the emergency services and let them know that there is a lithium battery fire.**
3. **Spray the battery with plenty of water** without endangering yourself and until the battery has cooled down completely. The spraying time can be several hours depending on the size of the battery. Any handling of the battery must be done while protecting people against strong heat, flames and gas fumes. If possible, always without endangering yourself, immerse the battery in a specific container or in a dedicated tank.

- Risk of explosion, projection of parts and particles several tens of metres away.
- Irritating and potentially dangerous fumes for the eyes and respiratory organs. Move in the opposite direction of the fumes. For more information, refer to the safety data sheet for the lithium-ion cell used, available on request from WATTALPS.

4. Handling of the WATTALPS battery pack

CAUTION: Before any operation, read the manufacturer's manual and specific documents adapted to your WATTALPS battery pack.

For each handling operation, follow the recommendations and lifting points recommended by WATTALPS. Deviating from these recommendations may lead to damage to the battery pack and cause a fire.

Use only handling equipment suitable for the total weight of the battery pack. The weight of the battery is indicated on the associated dangerous goods transport documents. **When handling the battery pack in its transport packaging**, the handling equipment must be suitable for the total weight of the battery pack plus that of its transport packaging.

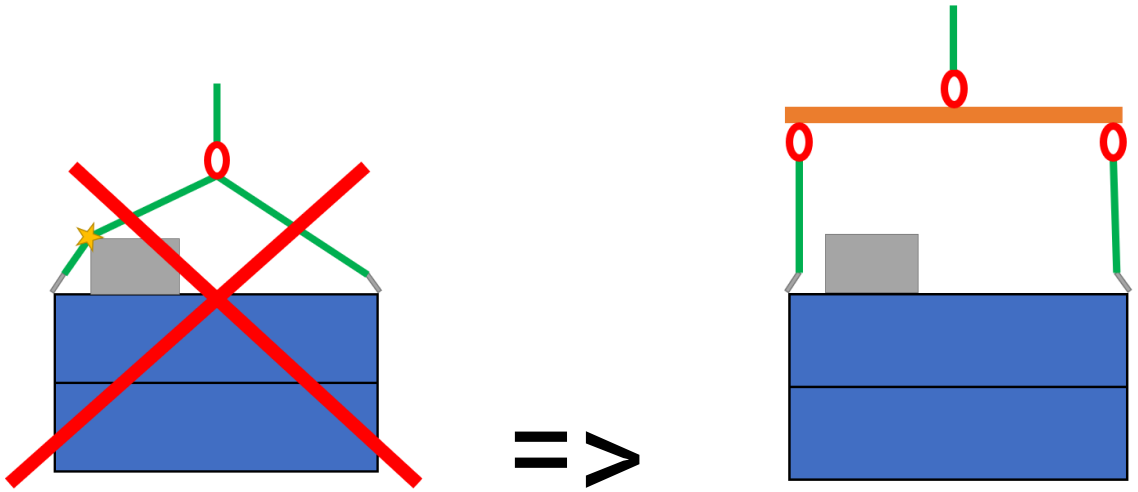
Carry out all handling operations in a clean workshop without any obstacle hindering the emergency exits.

During handling operations, it is very important not to disassemble or modify the battery. The battery pack is equipped with integrated safety features. Removing them may be dangerous and cause an accident.

It is very important to take all measures to prevent any fall or shaking of the battery pack during handling, whether in its transport packaging or when installing the pack. Dropping the battery pack may cause overheating and/or start a fire.

During the unloading step of the battery pack from the transport vehicle (truck, boat, etc.) to the storage location, be careful to preserve the physical integrity of the transport packaging (wooden crate, metal box, etc.). If the packaging is punctured, broken, crushed or has suffered any damage, secure the area, keep staff off the area and contact WATTALPS directly.

When handling the battery pack for moving or during installation in the customer system, it is imperative to ensure the complete integrity of the battery pack throughout these operations (do not damage, puncture, crush, shake, remove the cables or hydraulic hoses or cause any other damage to the shape of the battery pack, etc.). If the packaging is defective or has suffered any damage whatsoever, secure the area and contact WATTALPS directly.



Some handling equipment such as fixing brackets, pads are installed. They usually must stay on the battery pack for potential further maintenance handling. Some may have to be removed in order to complete the battery installation inside the customer system.

When handling the battery pack for travel or during installation in the customer system, it is imperative for operators to wear the appropriate protective equipment.

If the battery pack emits smoke, an odour, a flame or generates abnormal heat, ensure the safety of the area by evacuating the personnel present then:

- If the battery pack is still on the handling tool and if no immediate danger is observed, remove the battery pack from the building, in an area away from all personnel, vehicles, buildings or equipment, then contact the fire department.
- If the battery pack cannot be transported, contact the fire brigade and move all equipment as far as possible from the battery to avoid any propagation in the event of a fire.

If the battery pack is deformed, broken open, or if any abnormal appearance is observed:

- If the battery pack is still on the handling tool and if no immediate danger is observed, remove the battery pack from the building, in an area away from all personnel, vehicles, buildings or equipment, then contact WATTALPS or a representative trained by WATTALPS and authorised by your company.
- If the battery pack cannot be transported, move all equipment as far as possible from the battery to avoid any propagation in the event of a fire, then contact WATTALPS or a representative trained by WATTALPS and authorised by your company.

5. Transport of the WATTALPS battery pack

5.1. Receiving the WATTALPS battery pack

When receiving a WATTALPS battery pack, make sure to check that the battery pack transport box is securely stowed in the transport vehicle and has not suffered any damage during transport.

Refer to section 6 for storage instructions.

5.2.Shipping the WATTALPS battery pack

Transporting a WATTALPS battery pack is considered transport of dangerous goods. It is the shipper's responsibility to follow all regulations associated with this type of transport (ADR regulations for Europe for example). In particular, the transporter must follow the regulations for the transport of dangerous goods. If necessary, contact WATTALPS who can provide you with the necessary elements to develop your dispatch protocol and specific documents.

Sending a battery pack requires specific packaging for the transport of dangerous goods and the size of the battery pack. According to ADR regulations, WATTALPS batteries must be transported in accordance with the following packing instructions:

- P903 (approved packaging Y, or packing group II) for new and undamaged batteries;
- P908, for so-called damaged batteries according to ADR;
- P911, for so-called defective batteries according to ADR.

Damaged batteries according to ADR: conventional or rechargeable lithium ion or lithium metal batteries identified so as to no longer comply with the provisions of MEC 38.3, including when they are contained in equipment. These could be:

- Conventional or rechargeable batteries considered defective for safety reasons;
- Conventional or rechargeable batteries which show signs of fluid or gas leakage;
- Conventional or rechargeable batteries which cannot be examined prior to transport or
- Conventional or rechargeable batteries that have suffered physical or mechanical deterioration.

Defective batteries according to ADR: conventional or rechargeable lithium ion or lithium metal batteries identified so as to no longer comply with the provisions of MEC 38.3, including when they are contained in equipment. Likely to disassemble quickly, to react dangerously, to produce a flame or dangerous change of heat or emission of toxic, corrosive or flammable gas or vapour.

For any reshipment of the battery to WATTALPS, the WATTALPS "Unique Safety Protocol" for shipping must be provided to the carrier when shipping the battery.

Before sending a WATTALPS battery, check the integrity of the battery pack and the stowage to eliminate any danger during transport. Do not disassemble or change the battery. The pack is equipped with integrated safety features, disabling them may put the transporter in danger.

If shipping separate battery elements, you must contact WATTALPS for transport arrangements.

6. Storage

The battery is designed to be integrated into a device, vehicle or system providing it with a minimum of protection. It is delivered to you in a transport box. Unless otherwise notified in writing by WATTALPS, the battery must be stored in this transport case and in a protected area. It should only be taken out of this box for its immediate integration into the final application, according to the installation methods validated by WATTALPS (see "Installation" section).
The battery storage area must have the following characteristics:

- It must be able to support the weight and packaging of the battery;
- It must be far away from any heat source. The temperature of the battery must stay below 45°C and if possible below 30°C.
- Do not allow it to be shaken, for example close to the movement of vehicles, machinery of handling operations.

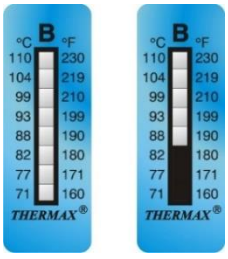
When a battery is disconnected from its application, the monitoring electronics of each module go into standby and significantly reduce its consumption. For prolonged storage, it is important to ensure that the battery is in standby mode (BMS not powered). For storage periods longer than 1 month, the following instructions must be observed:

- The battery should be stored at a charge status of between 30% and 50%;
- The BMS must be put on standby for storage and/or its very low voltage power supply must be deactivated (see section dedicated to BMS);
- The condition of the battery should be checked every 6 months; if the charge status has dropped below 20%, the battery must be recharged to maintain the charge status between 30% and 50%;
- The battery should be stored in a ventilated, clean and dry place;
- The battery temperature must be maintained between -20°C and + 45°C for the long life version and between 0°C and 45°C for the high energy version. For storage of more than 3 months, it is recommended to keep the battery at a temperature below 25°C to maximise its lifespan;
- The battery should be protected from direct sunlight, humidity and precipitation;
- The battery must be protected from the risk of fires or strong sources of heat nearby (no direct source of more than 60°C within 1 m);
- It is forbidden to put loads on the battery or apply some force to it during storage.

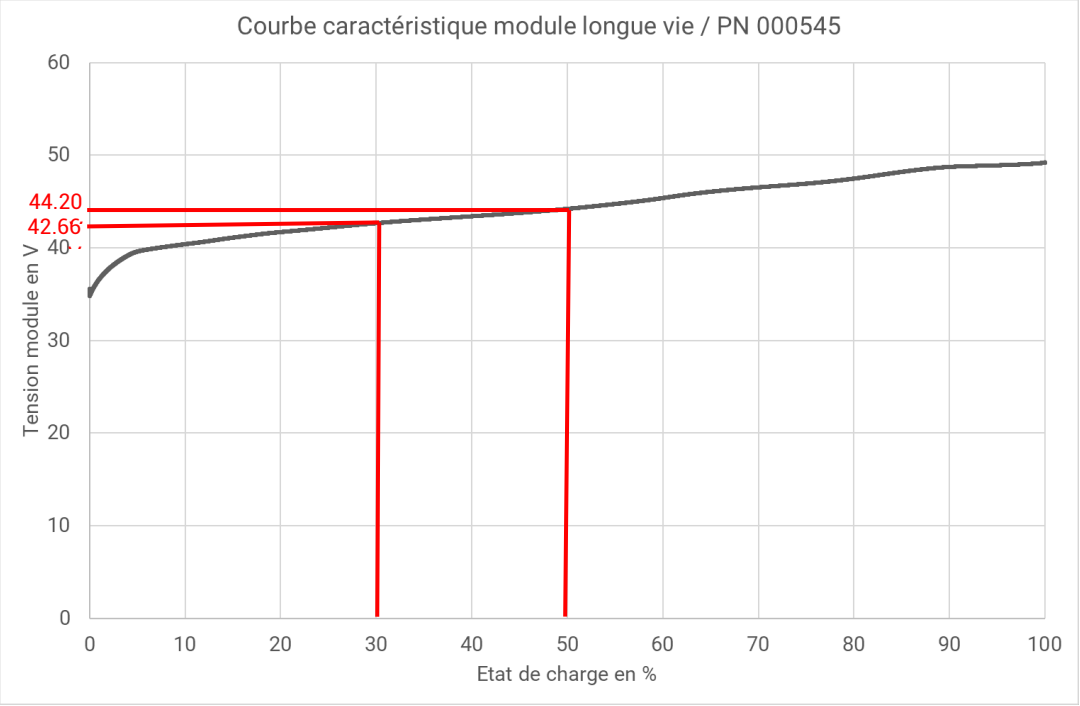
Failure to follow these instructions may result in the total or partial cancellation of the warranty.

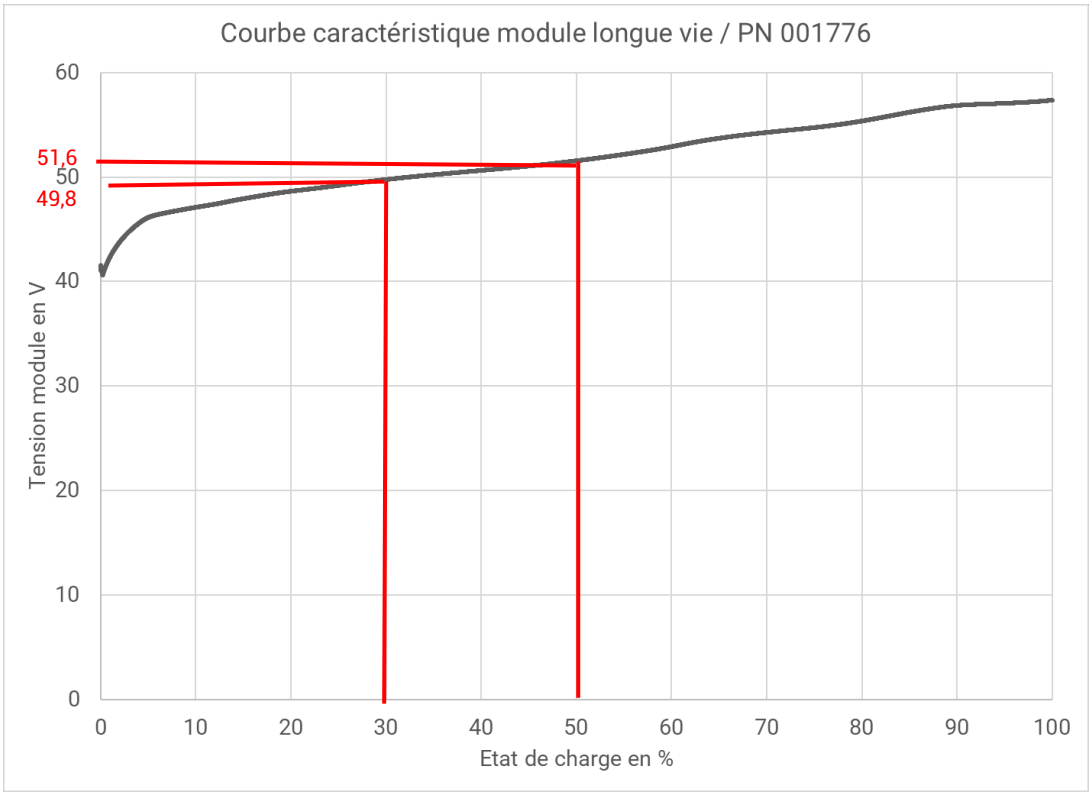
Checking the temperature shown on the battery:

WATTALPS batteries are equipped with labels for measuring the maximum temperature of the battery (see below). Check that the temperature indicated on the label is correct and that the indicated temperature does not exceed the value specified below.

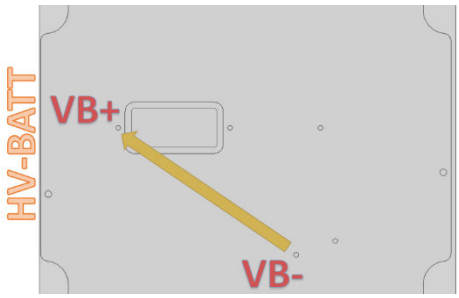
	MAX STORAGE TEMPERATURE = 45°C If the maximum storage temperature is exceeded, the warranty will no longer be valid. Illustration opposite: on the left, the temperature never exceeded 71°C; on the right, the maximum temperature shown by the label is between 82 and 88°C.

Checking the battery charge status in storage and maintenance charging:
Case No.1: the battery consists of a WATTALPS module alone. In this case, measuring the battery voltage makes it possible to estimate the charge status by referring to the graphs below.





Below is an illustration of how to measure the voltage of a battery pack using a multimeter with test probes. This measurement is performed by opening the battery junction box, without removing the transparent protection, using the measurement points associated with the lockout/tagout procedure in order to check voltage absence.



If the battery charge status is less than 20%, the battery must be:

- Positioned in the equipment (machine or vehicle) in which it is supposed to be used;

  or

- Connected to a load bank complying with all the instructions in the section devoted to BMS and having all the necessary safety elements for users (in particular complying with the standards and regulations on electrical safety in force). The BMS must be activated;
-

Reminder: In the second configuration, the BMS must be activated and the battery chassis must be connected to the building earth.

It can then be charged with the charger suitable for the application to increase its charge level to between 30% and 50%.

Case No.2: the battery consists of a set of WATTALPS modules connected in series and possibly in parallel. In this case, the battery must be equipped with its junction box and its BMS. The charge status is indicated by the WATTALPS BMS.
If the battery charge status is less than 20%, the battery must be:

- Positioned in the equipment (machine or vehicle) in which it is supposed to be used;

or

- Connected to a load bank complying with all the instructions in the paragraph devoted to BMS and having all the necessary safety elements for users (in particular complying with the standards and regulations on electrical safety in force).

Reminder: In the second configuration, the BMS must be activated and the battery chassis must be connected to the building earth.

It can then be charged with the charger suitable for the application to increase its charge level to between 30% and 50%.

7. Installation

The information contained in this part (7. and sub-sections) is considered by WATTALPS as Client Confidential.

This section contains the general instructions for installing a WATTALPS battery pack. These instructions are therefore applicable to all WATTALPS battery packs, but are by no means exhaustive. Refer to the Specific Installation Instructions for each battery pack for detailed explanations.

7.1.General information

7.1.1. Safety recommendations

WATTALPS batteries are electrical devices with dangerous short-circuit capacity and potentially dangerous voltages. Any operation on WATTALPS batteries must therefore be carried out in compliance with regulations and standards on electrical safety and safety in general.

To work safely with battery packs, WATTALPS recommends in particular:

- Whenever possible, work in an open area allowing easy evacuation in an emergency.
- Personnel must be trained and authorised for electrical work. The level of authorisation and training must be appropriate for the battery and the work to be performed. The characteristics of the battery are indicated on the type label.
- When installing the battery, the number of workers in the area should be kept to a minimum. Work being carried out nearby must not interfere with the assembly of the battery.
- Use suitable and insulated tools for electrical work.
- Wear personal protective equipment (PPE) and use collective protective equipment (CPE) appropriate to the situation. Follow the recommendations provided in the electrical work training.
- Do not wear jewellery, watches or any other metallic object near the battery pack.
- Do not modify or disassemble the battery without the written consent of WATTALPS.

7.2.Installation recommendations

Before installing any WATTALPS battery pack, ensure that the pack integration study has been validated by the WATTALPS engineering/design office. Even though it is made up of standard components, the battery is still considered a prototype until WATTALPS has given its written consent.

The WATTALPS battery integration validation process is as follows:

1. Battery integration study in the application
2. Validation of the integration study by WATTALPS
3. Installation of the battery prototype in the application
4. Review of the Prototype battery installation in the application by WATTALPS (MOD-002121 start-up checklist to be requested from WATTALPS)
5. Removal of non-conformities identified during the installation review
6. Review of Series installation with removal of all non-conformities (MOD-002121).

Any battery delivered by WATTALPS before the validation of the series design is considered a prototype.

A series of tests and validations are necessary in order to validate the commissioning of this battery under the conditions of use of the vehicle or machine. It is therefore recommended to set up a meeting with the WATTALPS teams to perform the Prototype Battery Installation Review in the application, then the Serial Installation Review when the non-conformities are resolved.

In particular, the purpose of the Prototype and Series Installation Reviews is to check:

- That the mechanical integration, electrical wiring, configuration and initial commissioning of the battery pack are carried out according to the standards set by WATTALPS.
- That the performance of the battery conforms to those specified in agreement with WATTALPS.
- That safety is ensured.
- That the means of communication provided or validated by WATTALPS allow remote monitoring of the battery over a sufficiently long period (duration to be set by WATTALPS and the manufacturer) in order to validate the maximum number of use cases.

7.3.Points to consider after the integration study phase

When preparing for the Prototype and Series Installation Reviews, the following points must be considered during the mechanical installation of the battery pack:

- The battery must be protected from drops, shocks, crushing and other forces. Refer to the section on handling for more detail.
- The battery must be installed in a ventilated part of the vehicle or machine so that its temperature does not exceed 45°C under any circumstances. Bear in mind that the battery heats up during the charging and discharging phases. In case of doubt, field tests are necessary.
- The battery must be protected from thermal radiation. For example: prolonged exposure to the sun or other heat sources.
- The power connectors internal to the battery and upstream of the junction box must not be accessible without tools.
- Make sure that a fluid quick coupler of the hydraulic circuit is positioned in a manner suitable for top-up filling. Warn the User that no top-up filling can be performed by Him. WATTALPS authorised personal only are to perform this operation.
- Make sure degassing of the cells (potential projection of hot and potentially harmful gases) through the vent or safety valve does not put the User at risk.
- Make sure that the equipment positioned around the battery pack (chargers, motors, thermal conditioning equipment, hydraulic equipment or other equipment, etc.) does not damage the battery in storage and in use. Refer to the installation recommendations for this equipment before connecting to the WATTALPS battery.
- Do not place a heat source near the battery; in particular, do not carry out welding or grinding near the battery (heat and projection of material).
- Do not pinch electric cables or hydraulic hoses, make sure there are no cutting edge within the harnesses area.
- Make sure that the battery fixing points are correctly sized and avoid hyperstatic mountings.

- Make sure the maximum charging current allowance communicated by the BMS is not infringed even if more than one charger (*e.g.* internal and external) is connected to the HVDC bus

The following points must also be taken into account during the electrical installation of the battery pack:

- Use only the WATTALPS BMS (as well as its configuration equipment) and the junction box supplied and validated by WATTALPS.
- Provide a means of disconnection to ensure safe, accessible, manual, quick and tool-free disconnection to protect the vehicle or the machine (depending on the installation of the battery, this means can be provided by WATTALPS or by the vehicle manufacturer or machine).
- A very low isolated voltage power supply is required to power the battery electronics. Refer to the electrical diagram for more information (section 8.2 electrical considerations). The characteristics of the power supply is to be considered and the Master BMS shall be located near a surge limiter if the supply network is likely to see >60V surges.
- All battery power and communication cables must be securely attached and protected from damage in all phases of battery life.
- All conductive parts located near high voltage cables or connectors must be earthed (to the chassis). This measure protects the user against electric shock by indirect contact.
- Install the grounding straps specified with WATTALPS during the battery integration study. The grounding straps must have a suitable shape and current flow section (see specific section on this subject in this manual).
- Before connecting electrical auxiliary equipment (chargers, thermal conditioning equipment, hydraulic equipment, etc.), ensure that these have been validated by WATTALPS. Refer to the installation recommendations for this equipment before connecting to the WATTALPS battery.
- All alerts indicated by the battery BMS (via CAN bus) must be taken into account. Refer to the document describing the WATTALPS CAN messages (DIN-001566) for more details.
- The battery has been tested according to automotive regulation 10 revision 5 for electromagnetic compatibility. It should not be subjected to stronger electromagnetic fields. The power connectors at the junction box output have a shielding connection. **CAUTION: the cables connecting with the DC power bus must all be shielded to limit interference.**
- Check that the minimum and maximum battery voltages have been taken into account in the design of the application.
- Check the compatibility of charging systems (AC or DC chargers) with IEC 61851 standard and with a supply voltage not exceeding 260V single phase or 260/400V 3 phase (assigned voltage for surge 2 500 V according to IEC 60664-1) as well as good earth connection according to the same standard.

7.4.Installation instructions

7.4.1. Special precautions

During the battery pack installation, remember to:

- Clear the work area to allow easy and quick evacuation in an emergency.
- Wear personal protective equipment (PPE) and use adapted collective protective equipment (CPE).
- Check the status of the battery before installing it. Do not handle the battery pack if it appears damaged.
- Eliminate any risk of the battery pack falling or shocks with other equipment.
- If necessary use insulated tools.
- WATTALPS battery connectors prevent electrical contact with a human finger (IPXXB), but do not protect against indirect contact with small metal tools (screwdriver, blower nozzle, pliers, *etc.*). These tools should be avoided in the battery working environment.

CAUTION: The use of control and measurement devices must be strictly supervised. Improper use of control and measuring devices when installing the battery pack can be dangerous.

7.4.2. Mechanical installation

IMPORTANT: Ensure that mechanical installation instructions are followed at all times Refer to the previous sections for more details. As before, check the load capacity of the lifting means used for handling the battery pack.

Before mechanically installing the battery pack:

- Check with the BMS the level of dielectric fluid present in the expansion tank: no anomaly shall be raised.
- Check that the battery pack mounting brackets are not damaged.
- Check that the battery pack lifting points are not damaged. NB: lifting rings and other parts specifically intended for the handling operation are not intended to remain on the battery; in case of doubt or difficulty, contact WATTALPS.
- Check that the vent in the safety valve vicinity is not blocked and that the degassing area has been examined.
- Check that any non-IP69K components are protected from high pressure water projections.
- Check that the battery is installed in a ventilated part of the vehicle or machine so that the temperature of the battery does not exceed 55°C during discharge and 45°C under any other circumstances.
- Make sure that the battery is properly mounted on sturdy mounts and equipped with damping and shock absorber devices (silent block type).
- Ensure that the mechanical integration of auxiliary equipment (chargers, thermal conditioning equipment, hydraulic equipment or other equipment, etc.) cannot alter the mechanical integrity of the battery. Refer to the installation recommendations for this equipment before installing them.
- The routing of electric cables and hydraulic hoses must be protected against friction. The fixing elements of these cables and hoses must be removable and reusable in the event of maintenance.

- Make sure that all the points specified for fixing the battery are used and that the recommended tightening torque is respected.

WATTALPS battery packs are designed to be attached to the chassis via screws available on demand on the closing plates, as shown in the figure below.

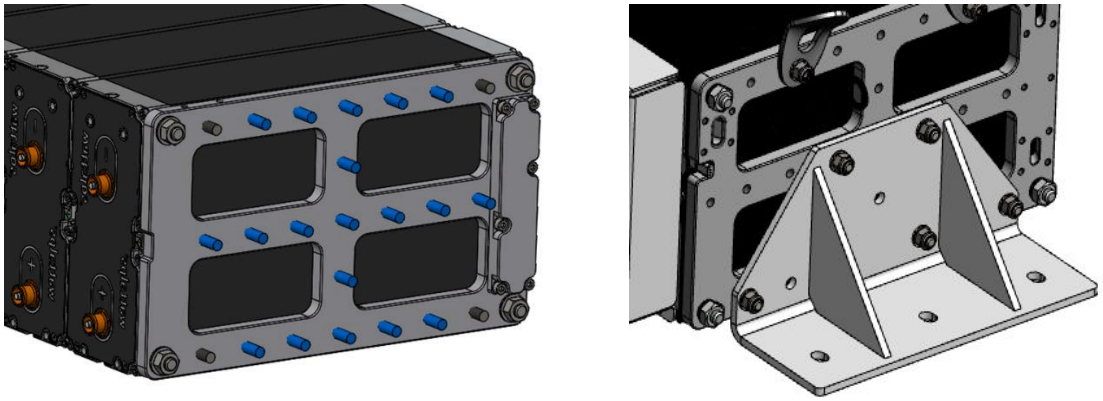


Figure 11: Detailed view of the attachment points

Each attachment point is an M8 screw and of the proposed attachment points, at least 6 must be used to secure the battery to the chassis. The position of the studs must be defined and agreed with the customer during the study, before battery manufacturing. It is the responsibility of the Customer to ensure that the M8 nuts and associated washers are correctly sized, assembled and compatible with WATTALPS M8 screws. In case of doubt, contact a WATTALPS technical representative.

7.4.3. Electrical installation

7.4.3.1. Grounding straps

The grounding of the metallic parts of the battery is important for the safety of persons and for the behaviour of the battery with respect to electromagnetic waves (EMC).

For the safety of people, comply with table 1 - article 5.2 of standard EN 60204, which is shown below as a reminder:

Section "S" of the POWER conductors of the installation (mm²)	**EARTH conductor cross section (mm²)**
S ≤ 16	S
16 < S ≤ 35	16
S > 35	S/2

For electromagnetic compatibility, a ground connection should be as short as possible, and have a maximum contact area. By virtue of its sheet form, the grounding strap is the most suitable conductor for this use. In addition, the strap has a much lower impedance than a wire or cable made of the same material, especially at high frequency. This implies less resistance, and therefore better electrical contact. The strap is therefore the conductor of choice for ground connections. Images of grounding straps are shown below, as an example:

7.4.3.2. Preliminary steps

CAUTION: The use of control and measurement devices must be strictly supervised. Improper use of control and measuring devices when installing the battery pack can be dangerous.

IMPORTANT: During this preliminary step, you must NOT connect the power cables between the battery and the application.

Before connecting the electric power cables, the following points must be checked:

- Caution, in the event of a fault, the entire battery frame and vehicle frame may be brought to a dangerous voltage level. It is mandatory to protect people likely to touch the vehicle chassis.
  For example, connecting the vehicle chassis to the ground before any connection to the electrical network (non-insulated power supply, measuring equipment, charger, etc.) provides protection for people when the network trips in the event of a ground fault.
- Make sure that the grounding straps have been correctly sized and connected (see dedicated section in this manual).
- Make sure the BMS is powered by a voltage between 9V and 60V.
- Ensure good communication between the battery and the vehicle via the CAN bus:
  1. Configure the CAN bus speed to match that set in the document describing the BMS CAN messaging.
  2. For systems equipped with an insulation monitor, wait for the value of the insulation resistance provided by the WATTALPS insulation monitor to stabilise (this may take up to 1 minute).
  3. Check the correct reception of warning messages and the absence of faults on the CAN bus.

7.4.3.3. Electrical installation procedure

Use the connectors recommended by WATTALPS to connect the junction box.

Do not disconnect the connectors already connected to the battery. If you accidentally disconnect them, do not reconnect them without contacting WATTALPS.

Once the preliminary steps have been carried out and validated, the electrical power connection can be made.

8. Usage

8.1.General information

8.1.1. Operating temperature ranges

The battery system is designed to operate at an internal temperature range of [-20°C; + 60°C]. Battery charging is only possible when the battery temperature is within the range [0°C ; +45°C].

WATTALPS offers systems dedicated to maintaining the battery in these temperature ranges, even in extreme weather and use conditions. Contact your sales representative if you have questions.

Note: temperature is an important factor affecting battery performance. A low temperature will reduce performance. A high temperature will accelerate the ageing process.

8.1.2. In the event of smoke, electric arc, suspicious odours or other abnormal signs

In these situations it is important to take special precautions. If the suspicious element comes from the battery or if it is not identifiable without endangering yourself, you should evacuate the area and notify the fire department.

Risk reminder in case of fire:

- Risk of explosion, projection of parts and particles several tens of metres away.
- Risk of electric shock on contact with metal parts surrounding the battery.
- Very irritating fumes for the eyes and respiratory organs. Move in the opposite direction of the fumes.

8.1.3. Cleaning

The design of the battery pack is compatible with high pressure cleaning. However, it is important to use cold water, to stay at a reasonable distance and not to concentrate the spray on a single area. Using detergents directly on the battery is prohibited.

8.1.4. Prolonged shutdown

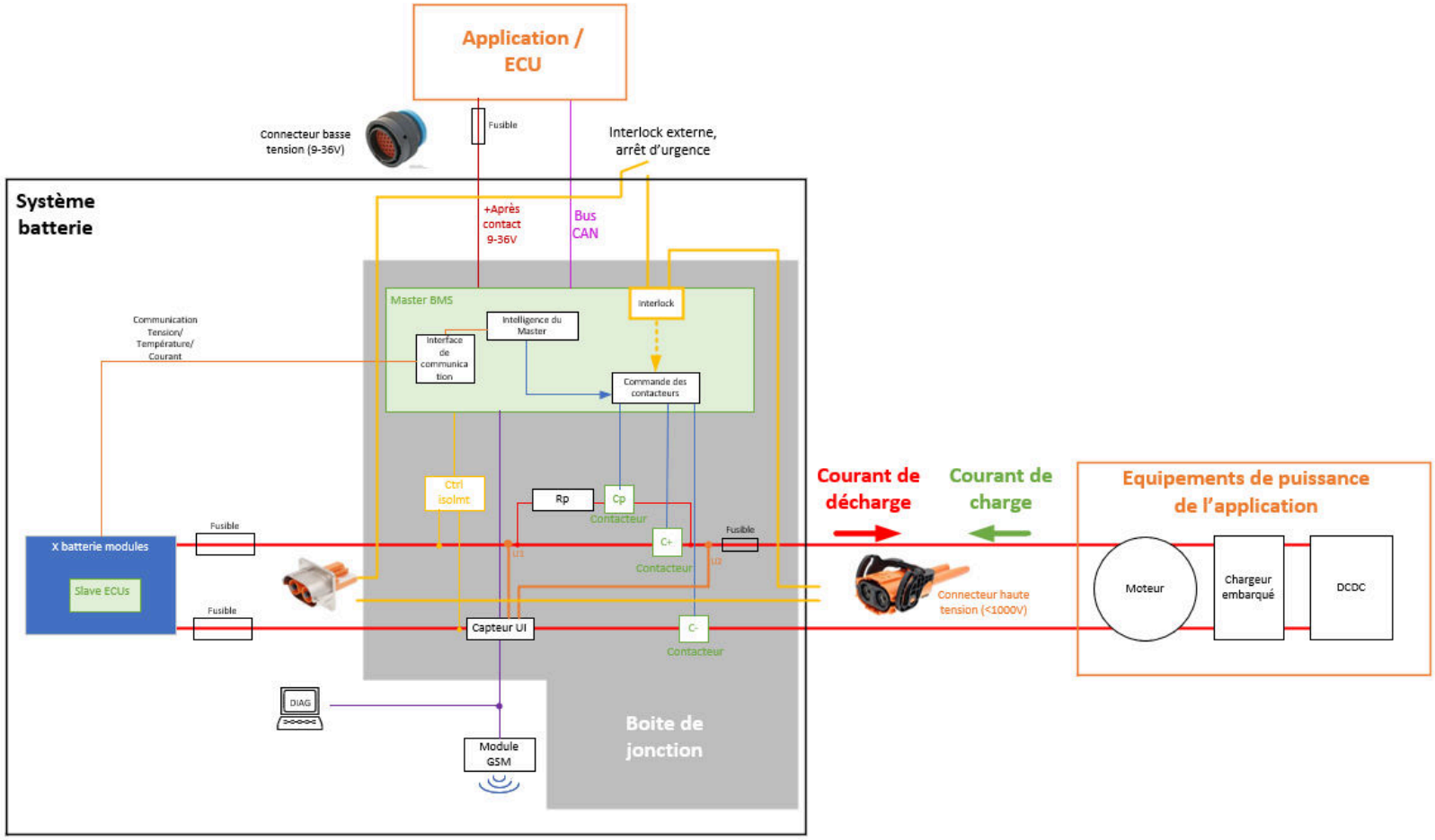
If the vehicle using the battery is not being used for a period of more than 1 month, refer to the recommendations in the “Storage” section of this document. In particular, the battery charge status must then be maintained between 30% and 50%.

8.1.5. Partial charging

WATTALPS batteries tolerate incomplete charging and have no memory effect. It is nevertheless important to fully charge the battery regularly so that the BMS automatically balances the voltages within the battery. This balancing makes it possible to maintain maximum autonomy. A full charge must therefore be carried out every 10 charges or every month, whichever comes first.

8.2.Electrical considerations

The information contained in this part (8.2. and sub-sections) is considered by WATTALPS as Customer Confidential and shall not be transmitted to any third party without a prior written consent from WATTALPS.



The very low voltage supply (9-36V) of the BMS must be protected by a 5A fuse. The connections must be made according to the wiring diagrams provided by WATTALPS.

8.2.1. Connecting or disconnecting the internal battery connections is not permitted

The power or internal communication wiring to the battery must under no circumstances be disconnected/reconnected or modified by a person not expressly authorised by WATTALPS for the operation to be carried out.

All cables and connectors upstream of the battery junction box, as well as the cables connecting the battery modules to the junction box are considered as cables internal to the battery.

8.2.2. Electrical insulation and insulation coordination

WATTALPS batteries are designed for use at a maximum voltage of 800VDC. The electrical architecture principles used are the one described in the standard ISO 6469-3: « Electrically propelled road vehicles — Safety specifications — Part 3: Electrical safety. ». The isolation distance and creepage are designed according to NF EN 60664-1 et NF EN 60664-3. The following table synthetizes the characteristics of the electrical insulation in WATTALPS batteries.

Isolation voltage according to NF EN 60664-1:2008 Specification valid under 2000m from sea level	
Working voltage*	800VDC
Overvoltage category	300V RMS CAT I-II 600V RMS CAT I
Insulation between HVDC power bus and chassis*	
Basic insulation	800 VDC
Clearance distance	> 3.3 mm
Creepage distance / Pollution degree / Material	> 10.0 mm / 2 / Group III > 4.0 mm / 2 / Printed wiring > 3.3 mm / 1 / Printed wiring
Insulation between HVDC power bus and low voltage (<60VDC)*	
Basic insulation	800VDC (Reinforced insulation is optional)
Clearance distance	> 6.6 mm
Creepage distance / Pollution degree / Material	> 16.0 mm / 2 / Group III > 8.0 mm / 2 / Printed wiring > 6.6 mm / 1 / Printed wiring

** VDC means Volt Direct Current. The values listed here are standard for WATTALPS battery modules and BMS. They may vary depending on the junction model and options. Refer to your WATTALPS technical contact for further details. HVDC means hazardous voltage direct current.*

8.2.3. Power connections check - HVIL or interlock loop

The power connectors of the WATTALPS junction boxes are equipped with an auxiliary contact to check their correct connection. All of these contacts are electrically connected in series to form a loop that triggers an action if one of the contacts is opened. This loop may be called an “interlock” or “HVIL loop”.

Depending on vehicle architecture, the HVIL loop can be connected directly to the emergency stop (command line of the power contactors) to cause the battery to open instantly as soon as a connector is open. This configuration is very safe for the battery but can cause application problems and lead to component breakage following the overvoltage induced by the sudden opening of the battery contactors.

The HVIL loop can be linked to a standard alert message (non ISO 26262) sent to the application (VMU and/or other power components), which must take the appropriate measures to deal with this case as soon as possible. By default, the BMS will open the contactors after a default confirmation delay of 2s.

It is the responsibility of the Manufacturer to ensure that the battery power contactors are open before a possible manual disconnection of a connector of the power circuit. Such disconnection under charge can cause burns and/or start a fire.

8.2.4. BMS

The Battery Management System (BMS) is the electronic battery management system. It ensures its safety but also the interface with the application to function optimally.

8.2.4.1. Changes to the BMS software

The BMS software shall not be changed by the user under any circumstances. However, some software components can be changed by WATTALPS with a specific programming tool.

If necessary, contact your WATTALPS sales representative.

Changes or updates to the software requested by WATTALPS must be implemented as soon as possible. WATTALPS will provide the corresponding procedure and the list of equipment required for the operation. If the changes are not implemented, WATTALPS will not be held responsible for any incident related to this lack of update.

8.2.4.2. BMS Configuration

The BMS is configured specifically for a battery pack topology based on cell type, the number of modules in series and in parallel. The following is not permitted: to add or remove modules, to modify the series/parallel configuration of the battery, to replace a module or a slave board with an element with a different reference and to replace the BMS Master by a BMS Master configured differently. The BMS is in fact a safety device and changing the battery configuration can lead to dangers.

A loss of communication on one of the modules will cause an alarm and the battery to be locked, after a delay.

8.2.4.3. CAN Messaging

CAN messaging allows the battery to communicate its status and ensure system security. It is mandatory to take into account all messages sent by the battery, including current limitations and anomalies. These messages shall be taken into account from the first system

operation. WATTALPS declines all responsibility and any warranty in the event that anomalies sent by CAN messaging are not taken into account.

Anomaly messages are broken down into three levels: ALERT (1st level), WARNING (2nd level) and FAILURE (3rd level). The FAILURE anomaly level corresponds to the ultimate level of safety at which the BMS automatically places the battery in safety by opening all contactors.

Refer to the document "Battery CAN interface" (DIN-001566) for further details.

8.2.4.4. Functional interface with the BMS

The BMS communicates with the application (machine or vehicle) via CAN bus. This allows you to read the system statuses sent by the BMS as well as to control its operating mode.

CAN messaging is described in detail in the document DIN-001566. The operating modes are shown in the "Operating modes" section below.

The following information, among others, is available on the CAN bus:

- Operating mode (Standby, Charge, Drive)
- Battery information
    - Status of Charge (SOC)
    - FAILURE status
    - WARNING status
    - ALERT status
    - Balancing status
    - End of charge indicator
    - State of each contactor
    - Status of thermal conditioning subsystem
- Maximum current allowance during charge (including regen. current) and discharge
- Charge voltage to be set on charger
- Anomalies (ALERT, WARNING, FAILURE) detailed status
- Current measurement flowing through battery pack
- Battery voltage (before contactors) and HVDC bus voltage (after contactors)
- Minimum and maximum cell voltages
- Minimum and maximum modules temperatures
- Insulation monitor measurement
- Battery pack and software identifiers

The vehicle control unit (hereinafter referred to as VMU) defines the operating mode of the BMS (STANDBY, CHARGE, DRIVE), regularly sending a status message via the CAN bus.

This message shall be sent at regular intervals (T<200ms) so that the BMS can ascertain the proper functioning of the VMU. Not receiving this CAN message triggers a BMS failure (3rd level anomaly) causing the contactors to open, if this feature is enabled for your system.

Important note: the operating mode requested by the application (VMU to BMS) is different from the current operating mode (transmitted by the BMS). The current operating mode is defined according to several criteria: requested mode of operation, but also the presence of the IGN/APC or BMS anomalies.

8.2.4.5. Operating modes

The state machine of BMS operating modes is illustrated below.

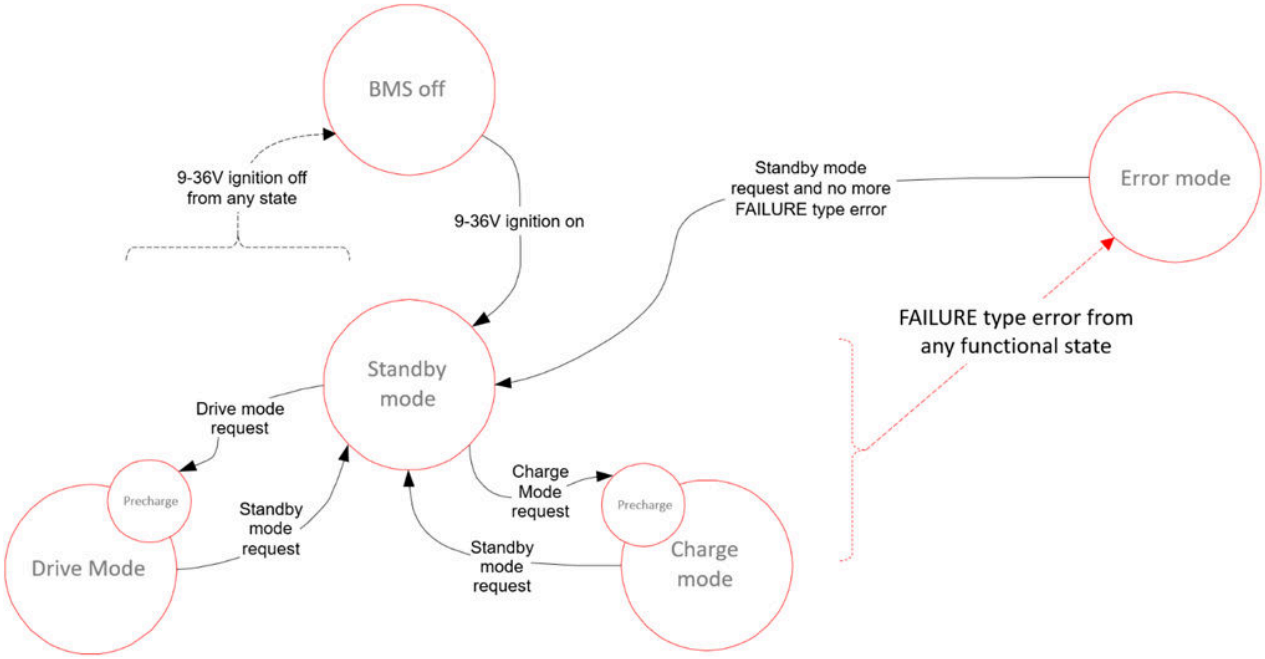


Figure 22 Diagram of operating modes

8.2.4.5.1. STANDBY Mode

The BMS enters STANDBY mode as soon as it is powered on and ignition signal is triggered, or when it receives an explicit request from the VMU. In this mode, all contactors are open, and the BMS awaits instructions from the VMU.

8.2.4.5.2. DRIVE Mode

The DRIVE mode is when the system uses the battery as an energy source. It can be either for discharging the battery or temporarily injecting current (current regeneration).

The switch to DRIVE mode can be requested by the VMU from the BMS when the BMS is in STANDBY mode. In this mode the main contactors are closing. A precharge period is started (if relevant) at the beginning of the DRIVE operation, before the main contactors closure.

The BMS then sends the VMU information on maximum discharge and regeneration current, battery voltage, SOC, etc.

8.2.4.5.3. CHARGE Mode

The CHARGE mode is when the system charges the battery and increases the battery stored energy.

The switch to CHARGE mode can be requested by the VMU from the BMS when the BMS is in STANDBY mode. In this mode the main contactors are closing except (if relevant to your system) for end of charge or cells balancing. When entering this CHARGE mode, the BMS precharges the HVDC bus (if relevant) and closes the main contactors when this is completed.

The BMS then sends the VMU the maximum charge voltage and current instructions, as well as the battery voltage information, SOC, etc.

8.2.4.5.4. ERROR Mode

In the event of a FAILURE anomaly, the BMS switches to ERROR mode with no required action from the VMU. The contactors are then opened. This mode may or may not be exited, depending on the type of anomaly and whether the fault no longer appears; a STANDBY request is necessary to exit the ERROR mode. Some errors require a complete restart to be removed.

Note : the BMS continues to monitor physical parameters of the battery pack (for further details, refer to the CAN interface document DIN-001566).

8.2.4.6. Operating example

8.2.4.6.1. STANDBY, DRIVE and CHARGE mode use examples

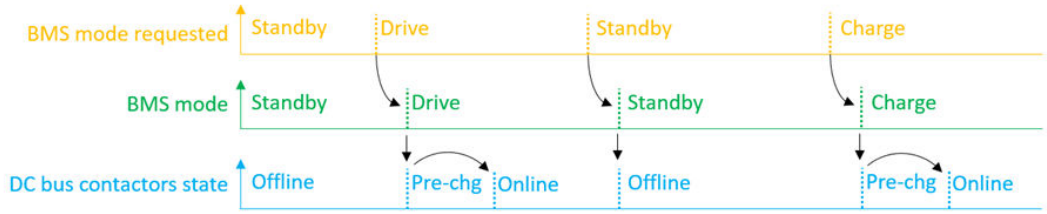


Figure 33 STANDBY / DRIVE / CHARGE / ALTERNATIVE CHARGE Sequence

8.2.4.6.2. Example of error sequence

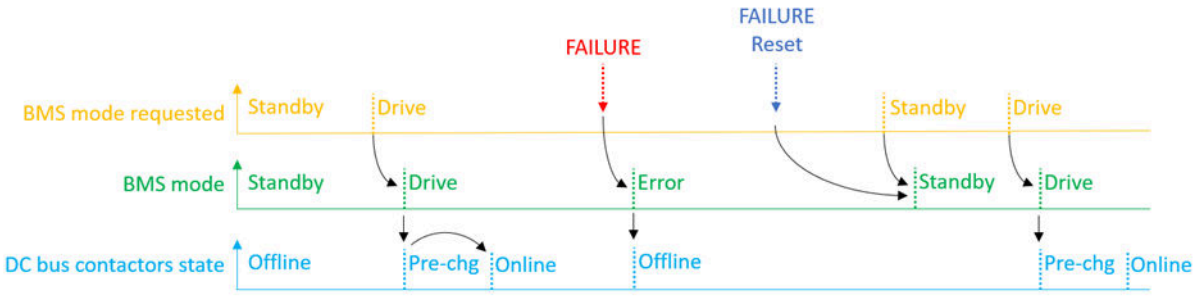


Figure 44 Error sequence

8.2.4.7. HVDC bus precharge

For the proper functioning of the contactors, it is necessary, when closing them, to ensure that the HVDC bus is at a voltage close to the one of the battery pack.

This operation is performed by the precharge contactor. Thus, each request to close the main contactors (switch to "Online") implies for the BMS to carry out the following operations:

1. Negative (-) contactor closure
2. Closing the precharge contactor
3. Waiting that the voltage of the HVDC bus is close enough to the one of the battery pack, and that the preload current (seen by the current sensor) is low enough to allow the positive (+) contactor to close
4. Closing the positive contactor (+)
5. Opening the precharge contactor

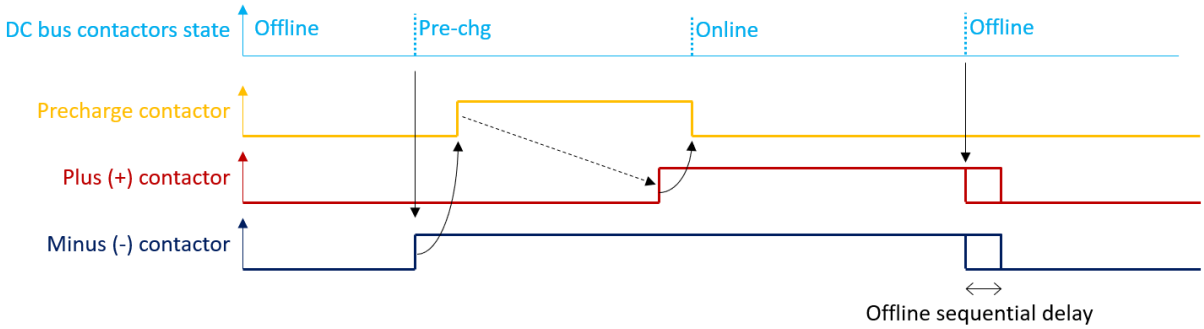


Figure 55 HVDC bus precharge sequence

Note: In step 3, if the BMS fails to obtain the valid conditions after a defined period of time, a 3rd level anomaly (FAILURE) is reported, indicating a failure of the preload. This failure is automatically reset to 0 after a certain period of time, allowing a new precharge operation (after switching to STANDBY mode).

Contact your WATTALPS technical representatives for more information on your system's precharge times.

8.2.4.8. Maximum current allowance and voltage set-point while in CHARGE

The system must ensure that the maximum permissible currents in charge, discharge, and regeneration (set-points in current), as well as the charging voltage (set-point in voltage) instructions are followed.

Compliance with these constraints can be ensured:

- Either by the transmission of these levels (set-points) to the charger, loads or actuator driving units and current consumers of the system;
- Or by design, ensuring that the charger, loads or actuator driving units and current consumers of the system will respect by design the currents allowance and maximum voltage, in all operational conditions.

8.2.4.9. Balancing

Imbalances are naturally created between the different groups of cells that make up the battery. The BMS has a balancing mode to correct these imbalances and use the maximum capacity of the battery. Balancing is activated under the following conditions:

- The BMS must be powered on;

- No 3rd level anomaly (FAILURE) occurred since ignition;
- Under-voltage anomaly is not shown;
- The charge status must be greater than the threshold defined for your application;
- Cell voltages must be stabilised: battery current is very low for a specific period of time, specifically defined for your application.

Contact your WATTALPS technical representatives for more information on your system's parameters.

Note: It is normal to see a slight increase in certain temperatures inside the modules being balanced.

8.2.5. Auxiliary power contactors

The BMS can command a total of 8 contactors to add a charger, a range extender, a fuel cell, a heater, etc. Contact your WATTALPS sales representative for more information.

8.2.6. Error management

8.2.6.1. Types of possible errors

Alerts can be classified into three levels according to their severity:

- **ALERT (level 1)**
  These errors do not require the contactors to be opened immediately. However, the maximum allowable currents can be reduced, these reductions must be taken into account by the VMU to prevent the system from reaching a higher alert level.
- **WARNING (level 2)**
  When an WARNING type anomaly is triggered, a contactor opening request is sent to the VMU. The latter must then ask the BMS to switch to STANDBY mode as soon as possible, which will disconnect the battery from the charge or charger. It is recommended to allow a slight delay between receiving the alarm on the CAN bus and the request to switch to STANDBY mode to allow all application components to shut down properly.
- **FAILURE (level 3)**
  If the VMU does not take the sent alerts into account, the BMS moves to FAILURE anomaly level after a delay proper to your application and will take the necessary measures to secure the system, regardless of the commands sent by the VMU. ERROR mode is then activated to open the contactors immediately. An alert message is then sent on the CAN about the imminent opening of the contactors. The delay can be configured (default is 5s) between the sending of the message and the actual opening of the contactors.

When one of the following errors occurs, a message specifying the error and its severity is sent over the CAN bus:

- Overheating
- Temperature imbalance within battery pack
- Cells undervoltage
- Cells overvoltage
- Voltage imbalance among battery cells
- Overvoltage on the battery pack
- Overcurrent

- Oil leakage

Example or error management in the event of overheating:

NORMAL T° < 50°C	ALERT T > 50°C	WARNING T > 55°C	FAILURE T > 60°C
No error	ALERT sent on the status CAN message ALERT « overtemperature » activated in the CAN message regarding alerts summary	WARNING sent on the status CAN message. Should be decoded by the VMU as an opening request for the main contactors. WARNING « overtemperature » activated in the CAN message regarding warnings summary	FAILURE sent on the status CAN message. Should be decoded by the VMU as an opening request for the main contactors. FAILURE « overtemperature » activated in the CAN message regarding failures summary Opening of contactors after configured delay

Anomalies can take some time to be initialised, *i.e.* its information shall be actually available for the microcontroller: For instance the over-temperature alert will occur only once the communication to all modules has been established.

Non-initialised anomalies are seen as active in the CAN messages.

Therefore, at start-up, all anomalies are active. They then gradually become inactive, as the initialisation of the BMS progresses.

In the nominal case of operation, all anomalies must be initialised (and therefore inactivated) after a time of 3 seconds.

8.2.6.2. Specific error management

Some errors do not follow the logic presented in the previous section, so they are described independently below:

- **Precharge contactors failure**
  When the precharge does not follow proper operation, a "contactor precharge" failure is activated. This failure is automatically disabled after a certain period of time, if the VMU (re)requests the "STANDBY" operating mode.
- **Contactor fault**
  The main contactors of WATTALPS batteries are equipped with an auxiliary position reading contact so as to detect the case of a stuck contactor. The "contactor" fault occurs when there is a discrepancy between the command sent to the contactor and its rereading.
- **Internal failure**
  The BMS monitors internal errors (supply voltages, internal communication, *etc.*) to ensure safe operation. If an internal failure is detected, the corresponding failure is activated.
- **Open interlock**
  The WATTALPS junction box connectors are equipped with an interlock to check that they are correctly connected. The "Interlock open" fault occurs when the interlock loop is open and generates an opening of the contactors. The opening of the interlock loop can be used for the emergency locked open state of the system.
- **Emergency switch**
  The BMS has an emergency switch input enabling opening of the contactors. The emergency switch failure is then activated.
- **Lost module**
  This fault is activated if a communication fault occurs, or communication is lost with one or more modules. Modules with communication errors can no longer be supervised by the BMS, which therefore opens the contactors.
- **Temperature or voltage sensor fault**
  This fault is activated if a voltage or temperature sensor of a module has a fault (short circuit, open circuit). These sensor faults lead to anomalies. For example, an open circuit temperature sensor results in an overheating fault.
  Note: redundancy is taken into account on the temperature sensor's specific case: depending on the application, a thermistor failure can be acceptable, thus a parameter is implemented to activate an alarm only (not a failure); its values is secluded and is not taken into account anymore in the reported minimum and maximum temperature.
- **VMU timeout**
  If the VMU_BMS_INFO CAN message is not sent by the VMU at the frequency defined in the CAN messaging description, an error is sent on the CAN bus, and the contactors are opened after a delay. This anomaly can be resetted if the VMU restores periodic transmission of the VMU_BMS_INFO message.
- **Main current sensor fault**
  If the main current sensor, used for calculating the status of charge (or SOC) and measuring the voltage of the power bus, no longer communicates, an anomaly is generated. The SOC is affected by this anomaly.

- **Incorrect configuration**
  At startup, if the BMS parameters are not valid, this anomaly is raised.
- **Temperature sensors anomaly, module current anomaly**
  This alarm is activated as soon as a temperature or current sensor of a module has a malfunction (short circuit, open circuit).
- **Power branch cut anomaly**
  When the battery consists of several power branches, and one fuse of one of the branches is blown, there is a current imbalance between the branches. The BMS checks this difference in current between the branches. If a deviation is found, it adapts the maximum allowed current (set-points) and activates this alarm.
- **Pump, fan, cooling unit, heater fault**
  If a component used for thermal management is faulty, the VMU is informed. These faults do not cause the contactors to open.

N.b.: only a failure anomaly sees all contactors being opened by the BMS.

8.2.6.3. Insulation monitor

For systems with an operating voltage exceeding 60V, human contact with the 2 poles of the battery creates a risk of death from electrocution. WATTALPS therefore provides the battery pack with an insulation monitoring system. It enables an insulation fault to be detected early not only during vehicle tuning, but also in all phases of battery use. Fault detection enables the triggering of protective measures adapted to the level of the vehicle.

The WATTALPS insulation monitor determines a resistance value between the potential of the chassis and the positive and negative terminals of the power bus. The insulation monitor is active during all operating modes.

The measured resistance value is sent on the CAN bus. The default configuration does not entail the opening of the contactors when a fault is detected. The VMU must request this via the CAN communication bus.

The insulation measurement is not instantaneous and can take up to 30 seconds after the BMS starts. The duration is dependent on the electrical architecture of the system. One of the possible strategies is to start the vehicle without delay if there was no insulation fault when it was last shut down.

For batteries equipped with an isolation controller, the status of the insulation measurement is sent over the CAN bus (see CAN message documentation).

Isolation controllers offered by WATTALPS cannot be used as safety devices and have not been developed according to any standard of operational safety. If your application requires an isolation control device to ensure the safety of people, suitable and certified devices should be added to your system.

8.2.7. Information sent to the VMU (Vehicle Management Unit)

All of the information exchanged with the VMU is described in CAN messaging

8.2.8. Functional safety of batteries fitted with the WATTALPS BMS

The new WATTALPS battery pack management electronics are being developed according to the ISO26262 standard, based on the IEC61508. The safety functions have been developed according to the safety requirements. The applications targeted by WATTALPS must meet the following conditions:

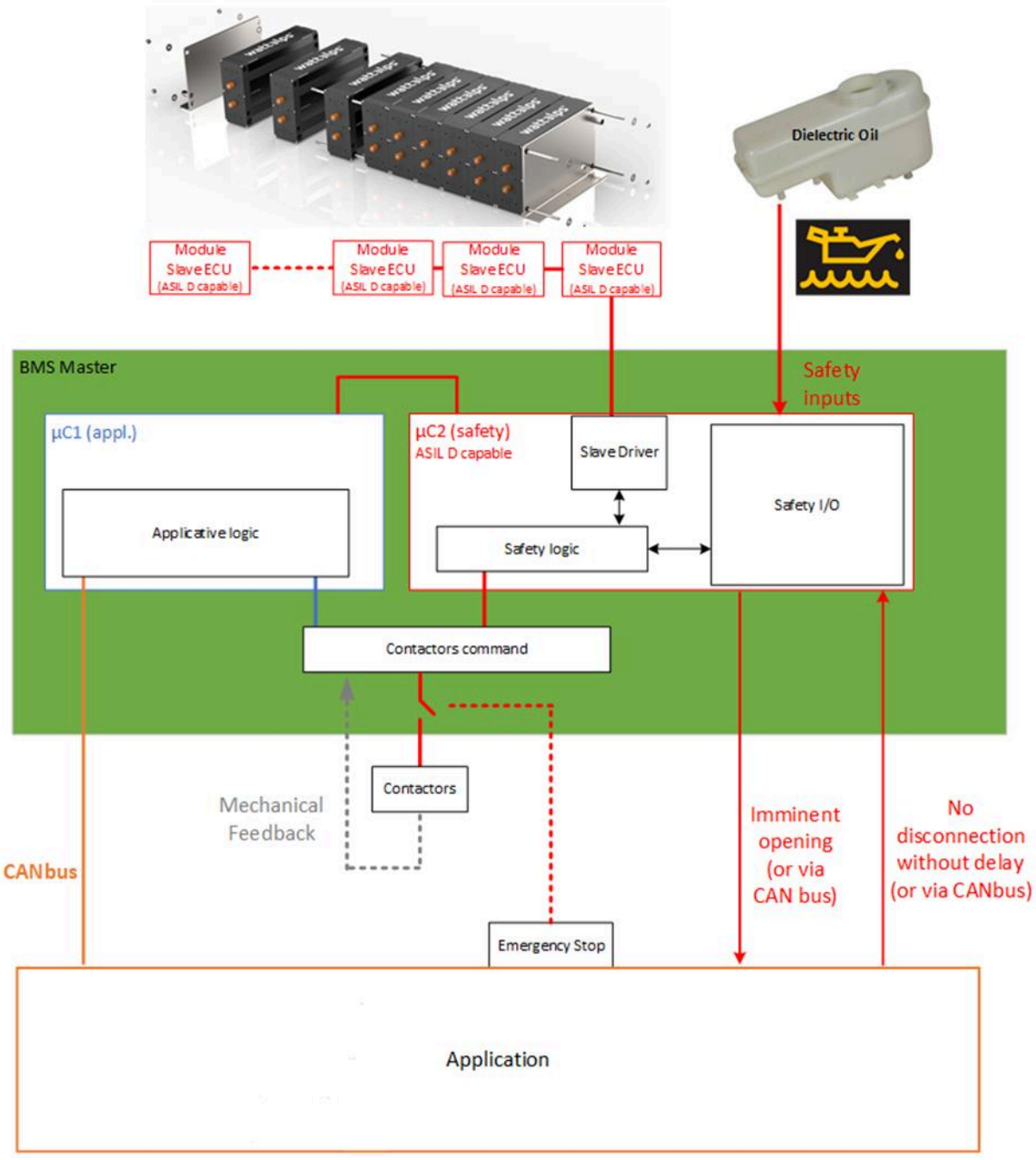
- Allow rapid evacuation of people exposed to the risk of battery fire;
- Unexpected opening of the battery power contactors may occur and therefore suddenly cut off the power supply to the vehicle or machine.

It is the responsibility of the designer of the vehicle or machine to ensure that escaping and that perceiving start of fire warning signs (smoke, heat, fire) is ensured.

The **level of functional safety of the application will form the subject of a specific analysis between WATTALPS and the Manufacturer**.

The WATTALPS BMS consists of two parts each with their own microcontroller. The functions are distributed between these two microcontrollers based on whether they are involved in the safety of the system or not. The first microcontroller manages the application functions such as the calculation of the status of charge, the management of the precharge as well as all the errors which are not related to safety. The second microcontroller is in charge of the safety functions and their interface with the application.

The functional architecture of the WATTALPS BMS is shown in the following figure.



The three safety objectives provided by the different safety functions are:

1) **No violations of the safe operating conditions for the cells in terms of temperature, voltage, current and presence of oil.**

The operating conditions of the cells are monitored in real time by the BMS and can cause contactors to open if the settings measured are outside the safe ranges. If the contactors must be opened for safety, an alarm is sent to the VMU, and the contactors are opened immediately or after an optional delay.

2) **Opening the contactors in case of emergency**

The BMS can provide the means for the application to physically open the contactors in an emergency. This opening can cause irreversible damage to the contactors, inverter, charger if a large current was flowing in the system when opening. A software lock inhibit the contactors closing again later on, until next power-up.

3) **Optionally, no sudden battery disconnection**

To ensure that the contactors do not open suddenly (which would result in a loss of power input for the application) the microcontroller in charge of safety can lock the contactor control. This function is physically activated at the request of the VMU or the application. If a fault requires the contactors to open, a hardware imminent opening signal is sent to the application and the contactors are opened after a delay. The time between the imminent opening signal and the actual opening can be set depending on the severity of the fault.

If the VMU holds the request to close the contactors despite the deactivation of the IGN/+APC signal, the BMS will stay active and the sub-systems will be powered during the chosen delay (after the IGN/+APC signal deactivation). The low voltage power supply being used in the command logic of the contactors, the loss of this latter must be treated with the same functional safety level as the contactor control.

8.3. WATTALPS dielectric fluid

All WATTALPS batteries are filled with dielectric fluid to ensure passive safety in the event of thermal runaway of a cell and to allow the battery to be at the right temperature (heating and/or cooling).

WATTALPS batteries are equipped with a low level sensor to detect a dielectric fluid leak.

No filling, purging or adding dielectric fluid action should be carried out without the approval of WATTALPS and the fluid used should be validated by WATTALPS. Failure to comply with this instruction puts users and the system at risk and also leads to a loss of warranty.

9. Servicing

The WATTALPS battery has been designed to require little or no maintenance throughout its lifetime.

9.1.Filter status check

Some WATTALPS batteries are equipped with filters. The filters help prevent particles from circulating in the dielectric fluid that can damage the cooling system and batteries.

In order to ensure the proper operation of the cooling system, it may be necessary to replace the filters. The filters are equipped with a visual clogging indicator. If clogging is detected, it is time to change the filters. Refer to the specific instructions related to your battery or contact WATTALPS for the appropriate procedure.

On the left is a non-clogged filter indicator; on the right, a clogged filter indicator.

9.2.Cooling or air conditioning unit

Some batteries may have one or more cooling units in their hydraulic circuit making it possible to maintain the temperature of the heat transfer fluid at an acceptable level for the cells during high temperatures or during intensive use at high power. A specific maintenance plan for the cooling unit is provided with the documentation specific to your battery.

Complete replacement of the cooling unit requires partial or complete draining of the dielectric fluid circuit. This operation must be carried out by an approved refrigeration technician who will recover the refrigerant gas if necessary, and will fill it with gas after the maintenance operation on the compressor, expansion valve or condenser.

As for the pumps, the cooling unit is supplied with 12/24/48V and does not require any particular precaution when disconnecting it.

No reprogramming of the BMS is necessary after the cooling unit has been serviced in any way.

9.3.Air heat exchanger

Some batteries may have one or more air heat exchangers in their hydraulic circuit (radiator or fan unit). Batteries equipped with cooling units will also have an exchanger for condensing the coolant.

The cleanliness of the heat exchangers should be checked regularly. A dirty heat exchanger loses its efficiency and can no longer cool the fluid passing through it.

If the exchanger is clogged, it must be cleaned with a water jet (refer to the specific maintenance manual for more details).

9.4.Fluid overpressure

Overpressure handling is for some battery systems performed by a safety valve. For ISO 26262 managed systems, a regular servicing is to be organised by the User (grease), but also by WATTALPS: contact your WATTALPS representative to establish the servicing schedule.

9.5.Suspension strut (or silent block) check

Some batteries are equipped with suspension struts. Their condition should be visually checked every 1000 hours of operation or annually. The suspension struts should not show the following faults:

- Crack(s);
- Mould;
- Tearing or break(s).

If faulty, they should be replaced by following the specific instructions for your battery.

9.6.Checking the ground continuity between battery and chassis

Electrical continuity between all visible metal parts of the battery and the vehicle frame is an element to ensure user safety. It must therefore be checked during periodic vehicle checks.

In the absence of a review plan validated by WATTALPS, the ground link between the chassis and the battery must be visually checked every year or every 1000 hours of operation. A grounding strap should not show the following faults:

- Cut grounding strap;
- Unscrewed grounding strap;
- Frayed grounding strap;
- Missing grounding strap;
- Oxidised grounding strap stopping electrical continuity.

9.7.Electronic diagnostics

The WATTALPS BMS constantly communicates the status of the battery to the VMU. The following information should be collected and sent to WATTALPS annually or every 1000 hours of operation:

- Status of charge;
- Health status;
- Total operating time;
- Charged and discharged Ah counter;
- Current maximum and minimum voltage;
- Current maximum and minimum temperature;
- Active faults.

9.8.Periodic servicing table

Servicing	**Frequency**
Filter check	1/yr or 1000 operating hours
Cooling or air conditioning unit	According to model
Air heat exchanger	According to the dirt level
Fluid overpressure handling mechanism	According to model
Suspension struts	1/yr or 1000 operating hours
Grounding straps	1/yr or 1000 operating hours
Electronic diagnostics	1/yr or 1000 operating hours

10. Breakdown assistance and after-sales service

In the event of a WATTALPS battery failure, the user must contact the vehicle or machine manufacturer. No direct end user request will be processed by WATTALPS.

If necessary, the vehicle or machine manufacturer can contact WATTALPS using the following contact details:

Tel: +33 (0)4 58 00 54 91, ask for after-sales service.

Email: aftersales@wattalps.com.

11. Maintenance and battery operations

Maintenance operations are described in the Repair Manual specific to your battery. The Repair Manual is considered Client Confidential by WATTALPS.

Any work on the battery can endanger your life. Personnel must be trained and authorised. Do not attempt any repairs if you are not trained and duly authorised. Any replacement part must be exactly the same as the original part. In case of doubt, written permission from WATTALPS is absolutely necessary.

11.1. Junction box fuse replacement

The replacement of a fuse is not trivial and it is necessary to find the cause of the failure before supplying an exactly identical fuse (it is forbidden to replace the fuse in place with a different fuse).

When a junction box fuse is blown, the BMS transmits the diagnosed state using CAN messaging: if an error message is present in the following list, it may be necessary to replace a fuse (refer to the Repair Manual for the replacement procedure).

1. FAIL_CONTACTOR
2. FAIL_CONTACTOR_PRECH

In any case the diagnostic operation by *in-situ* measurement shall be carried out after completely disconnecting the battery junction box from the power and signals

11.2. Battery internal fuse replacement

The replacement of a fuse is not trivial and it is necessary to find the cause of the failure before supplying an exactly identical fuse (it is forbidden to replace the fuse in place with a different fuse).

There are several fuses inside WATTALPS batteries so as to ensure a safer behavior in case of crash or catastrophic failure. When a battery internal fuse is blown, the BMS transmits the diagnosed status using the CAN message “Safety_PowerBranchCut" in most cases. For battery systems consisting of only modules connected in series, the “UpStreamVoltage" messages in BMS_VMU_INFO CAN message will show a value near 0V.

When a battery internal fuse is blown, the battery power will be limited to a single string of modules and if your battery system consists of only modules connected in series (no parallel string connection), the battery will not be able to supply any power until the blown fuse has been identified and repaired.

Contact your WATTALPS representative in this case. He will help you identify which fuse is blown and guide you through a fuse replacement process.

12. End of life and recycling

WATTALPS batteries are composed of electrochemical accumulators of lithium-ion technology. These accumulators cannot under any circumstances be left outside or in a conventional rubbish dump. They should be handled by professionals who are knowledgeable about lithium-ion batteries.

If your battery is no longer covered by the warranty, or no longer meets your expectations and you think it is at the end of its life, contact your WATTALPS sales representative to organise its collection.

Do not organise the transport of the used battery outside of its equipment without the advice of WATTALPS. Specific packaging and a carrier must be provided (refer to section 5 dedicated to transport for more information).

Under certain conditions and if a contract has been established with WATTALPS, WATTALPS will be able to take back your battery free of charge, or even help you to value it if it is in sufficiently good condition.

WATTALPS is grateful to you for having read this document and would like to thank you in advance for any comments which could help supplement or improve it.