5. 76.8 V electrical system components

5.1. Problem solving

The battery is not charging

- Schuko to Type 2 Adapter Cable disrupted
- Type 2 cable or connection to charger disrupted (brown cable: 220V, alternating; blue: neutral)
- Defective charger

The lighting does not work

- Check whether it is a particular lighting component (see chapter 6) or the whole assembly: lights, headlights, taillight, brake light, indicators, horn and dashboard
- Check input fuse Convert DC/DC→ 5.9.
- Check 12 V circuit fuse→ 6.15.
- Faulty DC/DC converter

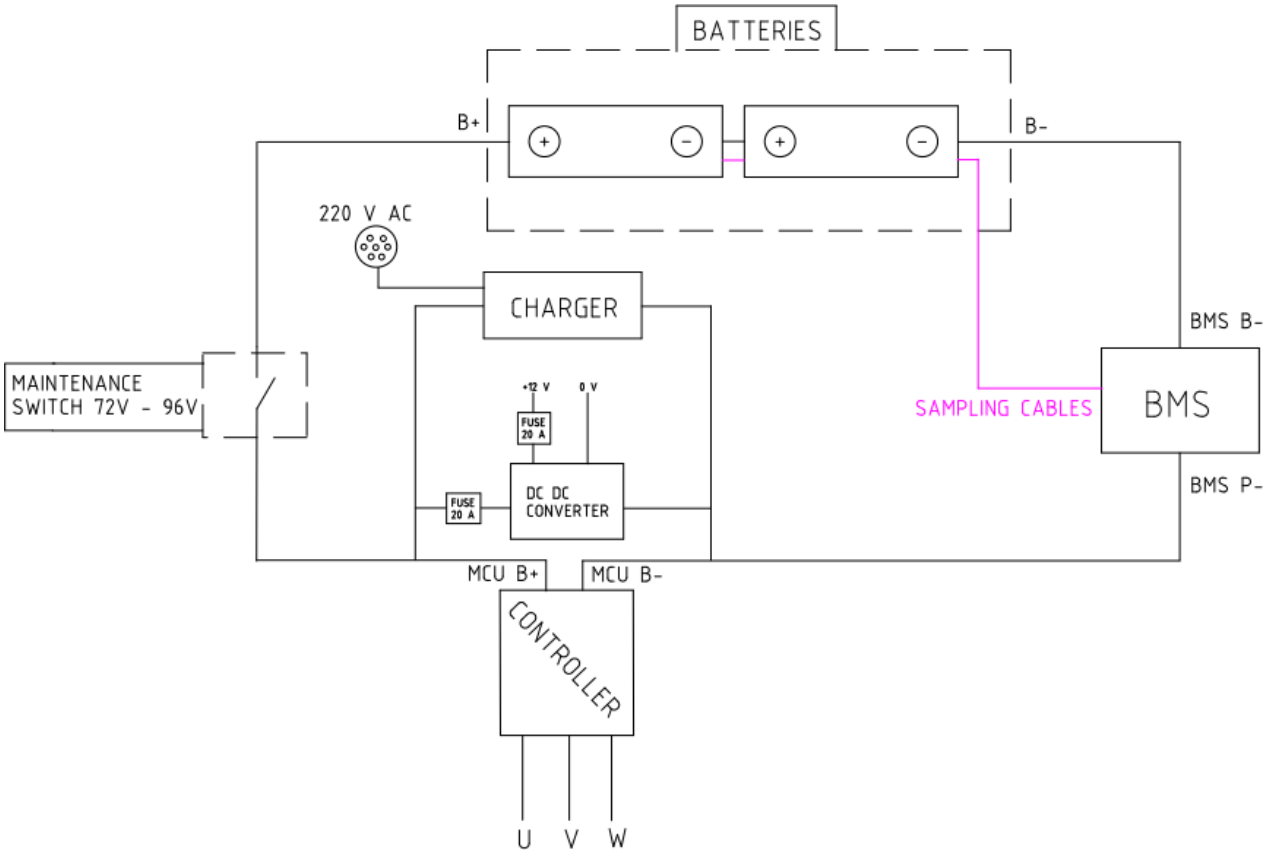
The vehicle will not run and nothing lights up

- Main maintenance switch open
- 76.8 V circuit #1 and/or #2 (200 A) fuses blown
- Loose connection in 76.8 V circuit
- CAN BUS cable disrupted or loose connector
- Defective BMS
- Battery problem
- Faulty DC/DC converter

The engine does not work

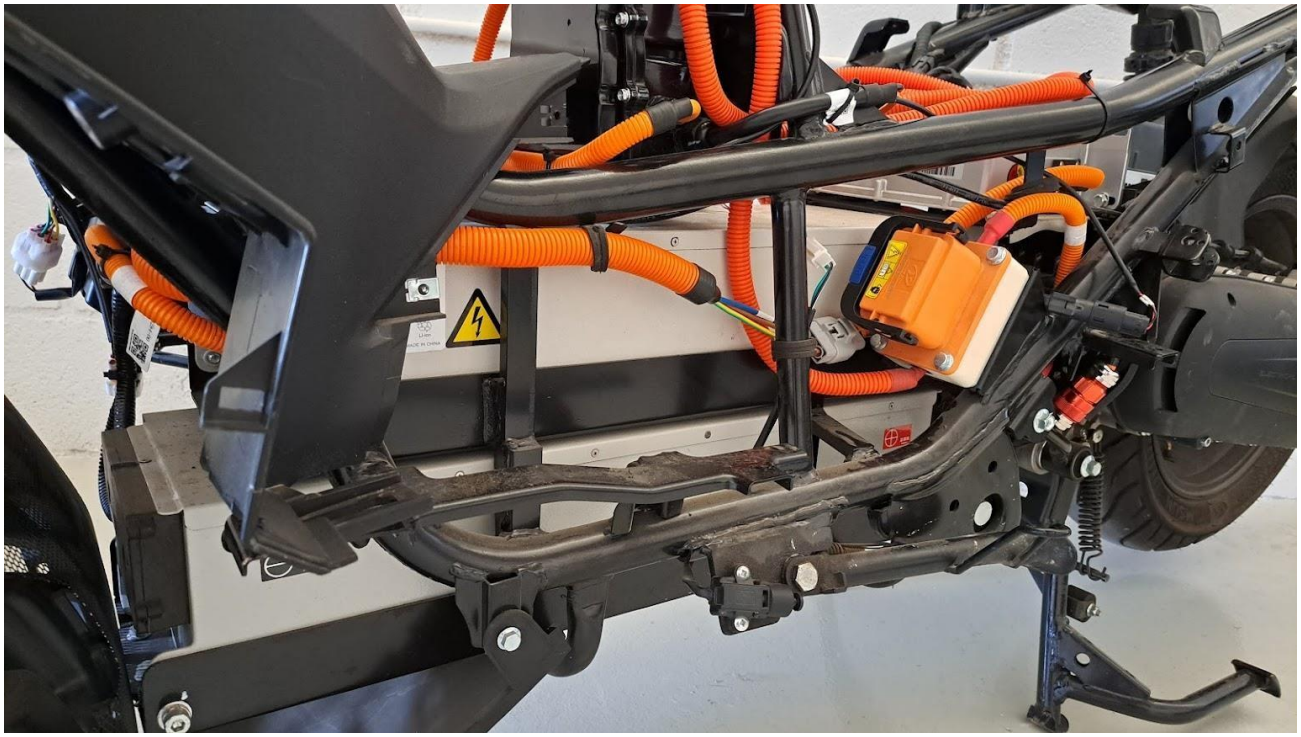
- The “P” button has not been activated
- Loose or disrupted phase cables
- CAN BUS cable disrupted
- Broken transmission belt
- STOP message on TFT screen (this message appears for different reasons; take the vehicle to a Nerva Technical Service)
- Defective engine

5.2. Nerva Exe electrical components diagram



5.3. Introduction to Nerva Exe electrical components

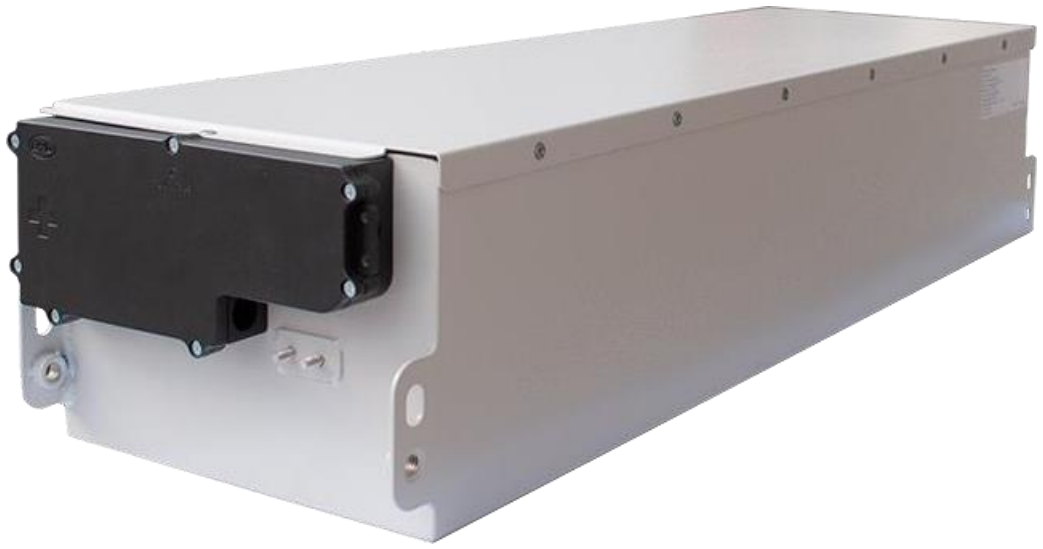
5.3.1. Battery



This is a new lithium battery called LFP (lithium-iron-phosphate, LiFePo4) with much

better performance than that of conventional NMC batteries (lithium with nickel base) manufactured by the oriental giant BYD. Their production process is cleaner than that of NMC batteries, since it does not incorporate any toxic materials such as cobalt, manganese or nickel.

Another advantage of LFP batteries is that they withstand more charge cycles than NMCs. An NMC battery declares 1000 to 2000 cycles, while LFP batteries increase their longevity by three with 4000 to 6000 charge cycles.



The set of batteries is made up of two units arranged in series, the total of which is equal to 76.8 V with a capacity of 75 Ah. The weight of the two batteries is 60 kg and is located in the lower central part of the chassis, thus helping to improve their dynamic qualities with optimal mass distribution and a low centre of gravity.

Another advantage of LFP batteries over NMC is their autonomy over time. Thus, after 5 years, while an NMC battery sees its efficiency decrease to 75%, the LFPs decrease by barely 5%.

NOTE: You are not authorised to handle the batteries unless Nerva gives you consent. Any suspicious activity on the battery will automatically void the warranty.

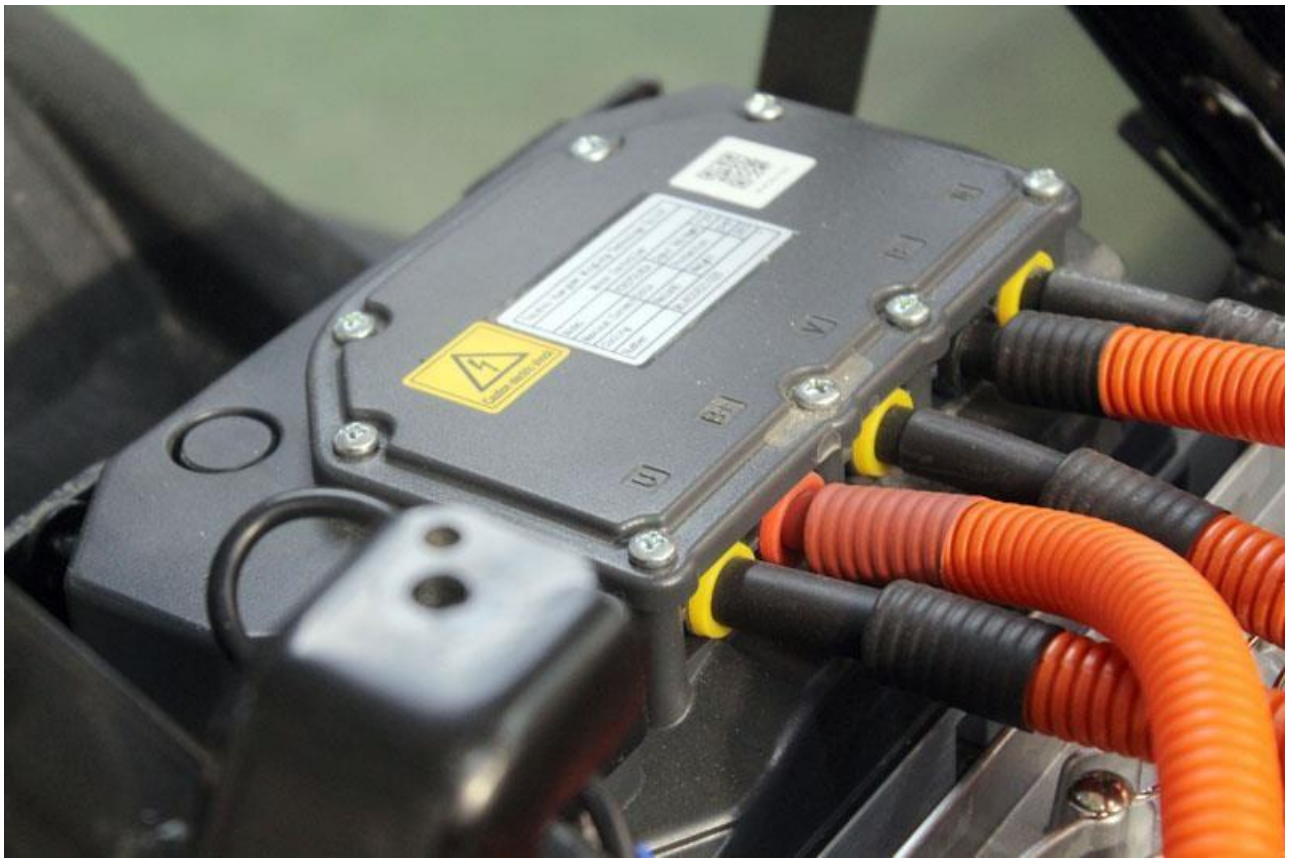
5.3.2. BMS (Battery Management System)

The BMS, or battery management system, takes numerous safety measures to protect the integrity of the batteries, which impacts their longevity. Its mission is to control the charging and discharging currents not only of the entire battery, but also at the internal level of each of the cells that make it up. This control of internal currents results in a lower operating temperature, which also contributes to longevity.

Among the safety measures adopted, we can highlight that if for 60 seconds the consumption is greater than 130 amps, the current will be limited to 120 amps and the power will be available again after 10 seconds.

The second protection provided consists of limiting consumption when the intensity exceeds 170 amps for 20 seconds, decreasing to 145 amps and restoring power after 40 seconds. Obviously, if this second protection is not met, the first, which is more restrictive, comes into play.

5.3.3. Controller

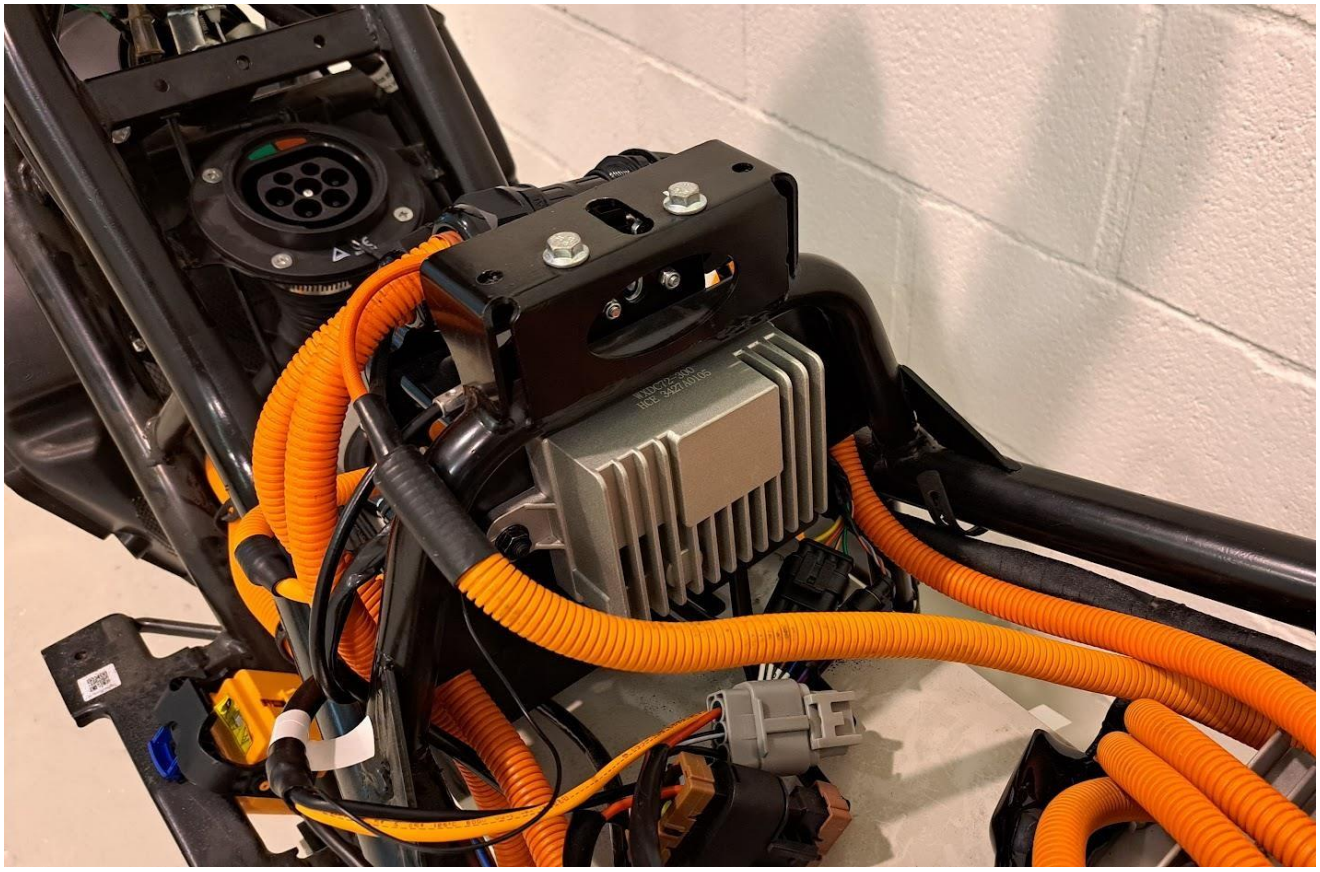


This is the “brains” of the system. Its mission is to power the electric motor from the direct current supply provided by the batteries, according to the user's dosage of the accelerator. Internally, it converts direct current into the three-phase alternating current needed by the engine.

5.3.4. Charger

The charger's mission is to recharge the batteries. Initial input is provided by the 220 V AC voltage arriving via the Type 2 connector or from the home network via the Type 2 Schuko adapter cable supplied with the vehicle. The charger is contained in a box with heat sink complete with a fan to further cool the electronics inside.

5.3.5. DC/DC Converter



Logically, the components of the scooter's electrical system (headlight, taillight, horn, dashboard) are designed to work on any type of motorcycle and therefore require a 12-volt direct current supply. The mission of the converter is, therefore, to adapt the voltage of 76.8 volts direct current, supplied by the two batteries to 12 volts direct current.

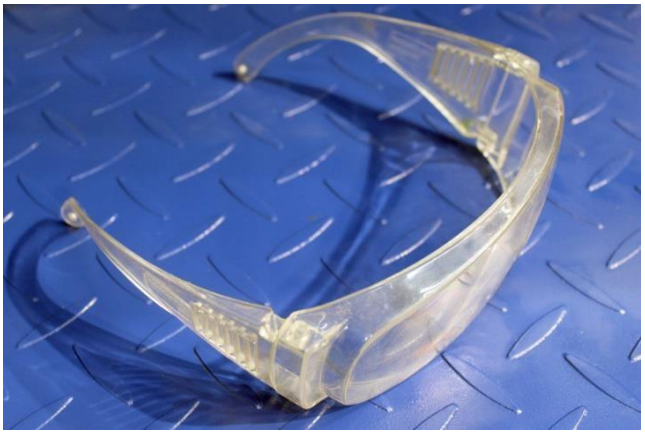
The converter has two protection fuses: one at the converter input and the other at the output.

5.3.6. Main or maintenance switch

This is a high current switch that cuts off the power supply to the batteries as a safety measure when servicing high current electrical components.

At the end of any electrical maintenance operation involving the removal of the maintenance switch, once completed and connected, the motorcycle battery should be 100% charged.

5.4. Personal protective equipment (PPE)



Before undertaking the maintenance and repair tasks of the Nerva Exe scooter, it is important to address the topic of risk prevention when handling the components of the 76.8 volt circuit which, due to the large capacity of its batteries, exposes the mechanic to discharges of up to 200 amps, which is the intensity of the two fuses which protect this circuit.

The mechanic's basic personal protective equipment (PPE) consists of gloves and goggles. The gloves must have category 00 dielectric protection capable of insulating up to 750 volts of direct current, and must, before use, be checked visually for the possible presence of holes or cuts.

For their part, glasses must protect the visual field at least at eye level against impacts produced by short circuits or voltaic arcs.

Other recommended equipment are shoes with dielectric protection and insulating overalls covering the operator's chest.

Another additional prevention measure lies in the use of equipped tools with an insulated handle.

5.5. Disconnecting the main switch

DANGER
• Use dielectric gloves to protect against short circuits and electric shocks • Disconnect the main maintenance switch before handling any electrical system component from the 76.8 volt circuit • Even if the main switch is disconnected, continue to use at least gloves as a precaution when handling the components of the 76.8 volt circuit (someone else may have turned off the switch, or the power capacitors of a component may have been charged).

Preliminary operations:

- Remove the helmet box (→ See 1.4.1. Helmet box). Disassembly of the base is not necessary

The main switch for the 76.8V circuit is on the left side of the centre area.

With one finger, lift the central tab of the blue coloured handle which holds it in place.

Turn the handle 90° forward.

Extract the handle with its cover by pulling it outwards and the 76.8 V circuit will be disrupted.

To restore the 76.8V circuit again, follow the steps in reverse.

Finally, each time the maintenance switch is reconnected, the battery should be 100% charged.

5.6. Extracting the controller

Preliminary operations:

- Remove the helmet box (→ See 1.4.1. Helmet box. Disassembly of the base is not necessary).
- Disconnect the main maintenance switch (→ See 5.5. Disconnecting the main switch)

Necessary tools

Phillips screwdriver no.2

10 mm socket wrench

Remove the 8 screws securing the controller top cover with a no.2 tip Phillips screwdriver.

Remove the top cover of the controller.

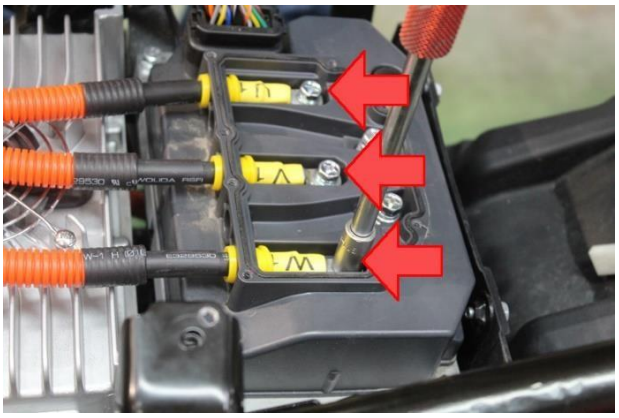
With a Phillips screwdriver or a 10 mm socket wrench remove the screw that secures the B+ cable

Take out the B+ cable.

Insulate the B+ cable with electrical tape or by covering the terminal with a rubber plug.

Disconnect the B- cable with a 10 mm socket wrench or a No. 2 Phillips screwdriver, remove it from its housing and insulate it with an insulating strip or rubber plug.

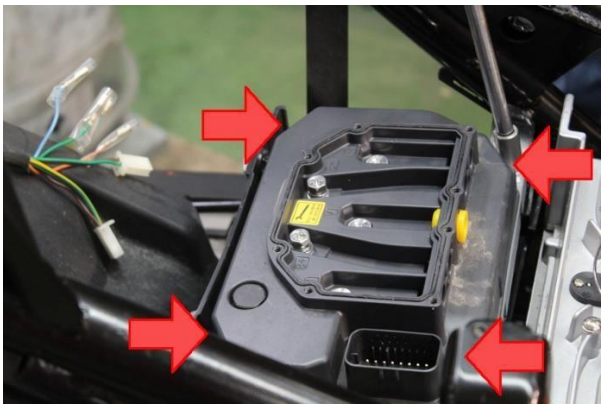
By disconnecting the power from the controller, there are no more electrical risks.
Remove the three screws from the U, V, and W cables with a 10mm socket wrench or #2 Phillips screwdriver. Remove the three phases from the regulator.



Disconnect the red connector from the signal cables on the right side of the controller by depressing the tab under the "U" shaped projection.

Pull the connector upwards to disconnect it.

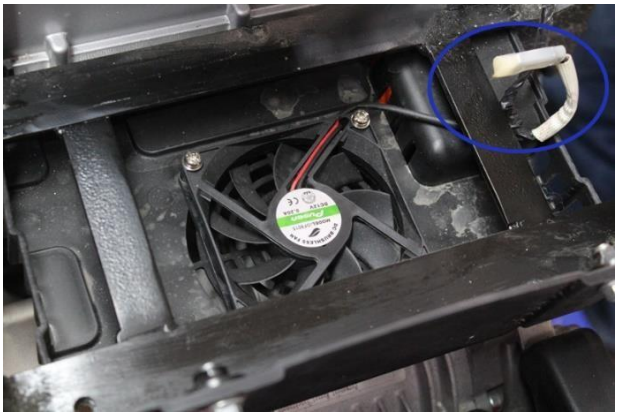
Remove the four screws that secure the controller to the chassis.



Remove the controller. You will observe at its base a space on the cooling fins.

In this space is the temperature sensor (marked in blue circle) of the controller which must be inserted through the edge in the assembly process.

Follow the reverse order of disassembly to reassemble the controller.



After installing the new controller, it must be calibrated.

You must call Nerva technical service for this calibration.

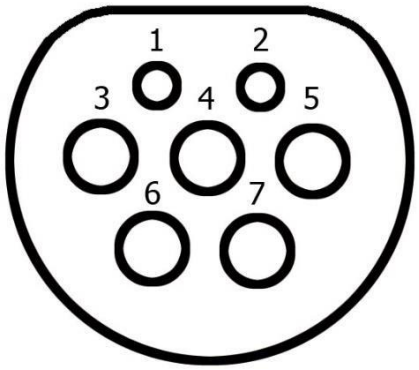
Tightening torques:

Power/phase cable screws 5 Nm,

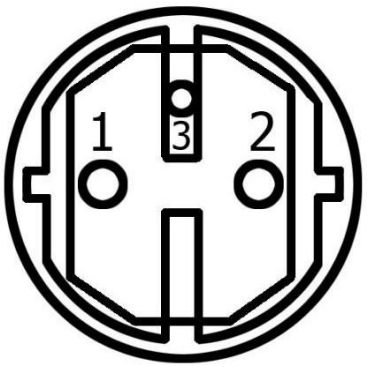
controller fixing screws 10 Nm.

Charge the motorcycle battery to 100%.

5.7. Checking the charging cable



Type 2



Schuko

Identifying the cables on the Type 2 connector terminals
① Without connection
② Without connection
③ Phase
④ Neutral
⑤ Earth
⑥ Without connection
⑦ Without connection

Identifying the cables on the Type 2 connector terminals
① Neutral
② Phase
③ Earth

Before disassembling the charger, check continuity between the charging cable connector terminals:
Type 2 ③ ←→ Schuko ②
Type 2 ④ ←→ Schuko ①
Type 2 ⑤ ←→ Schuko ③

5.8. Checking charger operation

Preliminary operations:

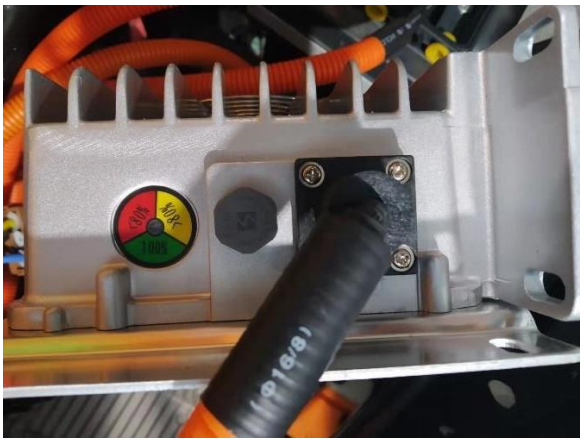
- Remove the helmet box (→ See 1.4.1. Helmet box. Disassembly of the base is not necessary).

Necessary tools

10 mm socket wrench

Identify the charger.

There is a bright LED indicator on the left side.



Check the sequence of the LED indicator to evaluate its operation:

Red LED: one-second cycle Green LED: off or constant background.	Normal charge
Green LED: constant	Charging complete
Yellow LED: three-second cycle	220V abnormal
Red LED: three-second cycle	Battery overheating

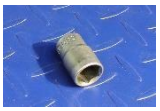
Green LED: three-second cycle	Charger overheating

5.9. Charge current measurement

Preliminary operations:

- Remove the helmet box (→ See 1.4.1. Helmet box. Disassembly of the base is not necessary).

Necessary tools



10 mm socket wrench

Identify the positive pole of the charger.

Wrap the cable with the amperometric pliers. This cable stands out from the others because it is covered with interwoven fibres.

Wrap the cable with the current clamp. Configure the clamp meter to read direct current.

Plug in the charging cable.

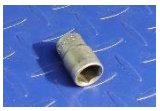
Measurement: between 17 A and 20 A

5.10.Removing the charger

Preliminary operations:

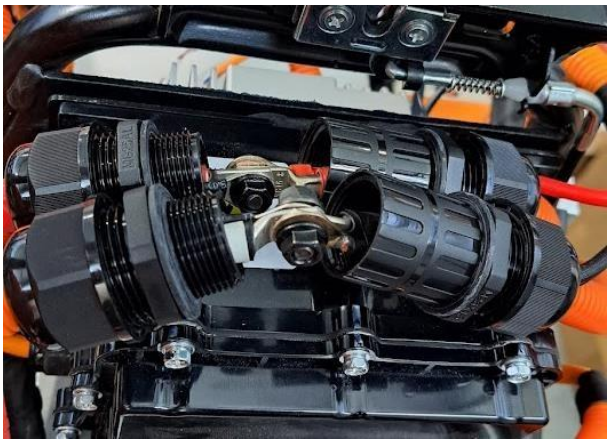
- Remove the helmet box (→ See 1.4.1. Helmet box. Disassembly of the base is not necessary).
- Disconnect the main maintenance switch (→ See 5.5. Disconnecting the main switch)

Necessary tools



10 mm socket wrench

Open the plastic covering that protects the cable joint. To do this, you must unscrew to be able to free one of the sides and access the joint screw.

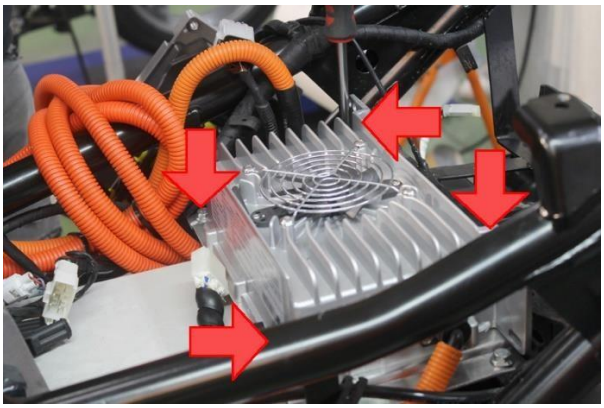


With a 10mm socket wrench remove the nut and screw that secures the positive cable joint. Identify the positive charger cable, release it and insulate it with tape. The charger cables are distinguished by their fibre coating intertwined.

With a 10mm socket wrench remove the nut and screw that secures the negative cable joint. Identify the negative charger cable, release it and insulate it with tape.

Unplug the grey connector located under the main switch.

Remove the four screws holding the charger to the chassis using a 10mm socket wrench.



Remove the charger.

The assembly procedure is the reverse of that of disassembly.

Tightening torques:

Cable-fuse fixing nuts 25 Nm.

Charger fixing screws 10 Nm.

Charge the motorcycle battery to 100%.

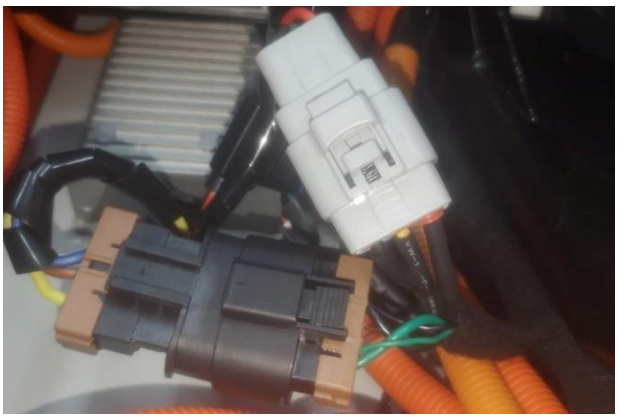
5.11.DC/DC converter operation measurement

Preliminary operations:

- Remove the helmet box (→ See 1.4.1. Helmet box. Disassembly of the base is not necessary).

The converter has two connectors, the input (76.8V) through the grey 3-pin connector and the output (12V) through the brown-black 3-pin connector.

Disconnect the brown-black connector first, then the grey connector.



Insert the multimeter probes as we can see in the photo: positive probe on the blue cable and negative probe on the yellow cable (make sure that the probes are in good contact with the metal of the cable).

Configure the multimeter to read DC voltage and turn on the motorcycle.

5.12.Removing the DC/DC converter

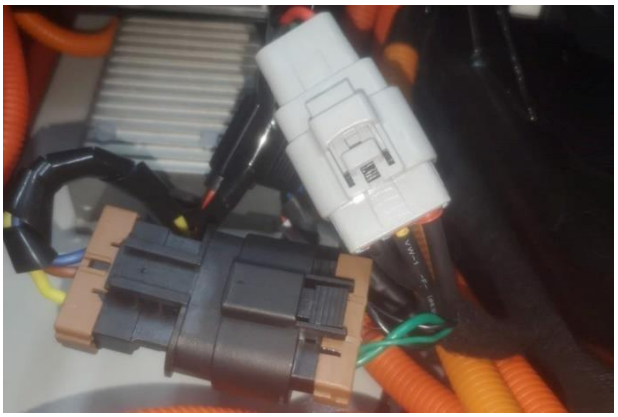
Preliminary operations:

- Remove the helmet box (→ See 1.4.1. Helmet box. Disassembly of the base is not necessary).
- Disconnect the main maintenance switch (→ See 5.5. Disconnecting the main switch)

Necessary tools

The converter has two connectors, the input (76.8V) through the grey 3-pin connector and the output (12V) through the brown-black 3-pin connector.

Disconnect the brown-black connector first, then the grey connector.



By unplugging the connector(s), the converter will be isolated and you will no longer have to protect yourself against electric shock. Remove the two screws that secure the converter to the chassis using a 10mm socket.

You can now remove the converter.

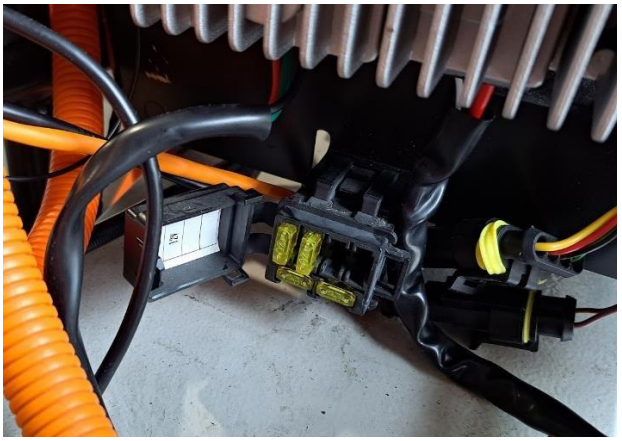
The assembly procedure is the reverse of that of disassembly.

Tightening torques:

Converter fixing screw 10 Nm.

Under the converter are located, in a small fuse box, the two fuses which protect the 12 V and 76.8 V circuit

Both fuses are 20 A overhead type. As indicated in the identification on the internal side of the cover, the left fuse protects the 76.8 V input of the converter while the other protects the output of the 12V converter.

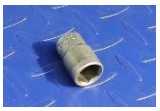


5.13.DC/DC converter voltage bypass measurement

Preliminary operations:

- Remove the helmet box (→ See 1.4.1. Helmet box).

Necessary tools

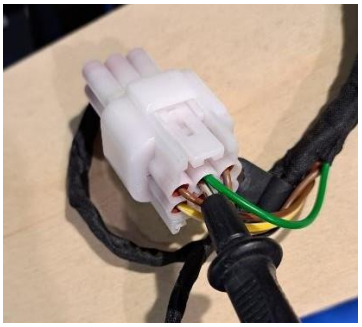


10 mm socket wrench

Configure the multimeter in the DC voltage measurement option.

The DC voltage measurement will be carried out between the DC DC housing and the negative output line of the converter itself.

The most accessible point of the converter output negative line is on the diagnostic connector. The negative line can be identified by its green wiring and its central position of the top row of pins.



The measurement value should be approximately 0.006V.

In addition to measuring the voltage, it is necessary to measure the insulation between the internal electronic plate and the converter wiring.

Configure the multimeter in the resistance measurement option.

Measure the resistance between the DC DC converter shell and the five converter wires.

The resistance must be greater than 50 mega ohms and even close to infinity (0L).

The image on the right shows an example with the red cable.

5.14.Extracting the BMS

Preliminary operations:

- Remove the helmet box (→ See 1.4.1. Helmet box).
- Disassembly of the rear assembly (→ See 1.4.3. Disassembly of the rear assembly)
- Remove the two side parts from the central bodywork (→ See 1.4.5. Central bodywork/ Platforms/Keel)
- Disassembly of the two front sides (→ Refer to point 1.3.2 Disassembly of the two front sides)
- Disconnect the main maintenance switch (→ See 5.5. Disconnecting the main switch)

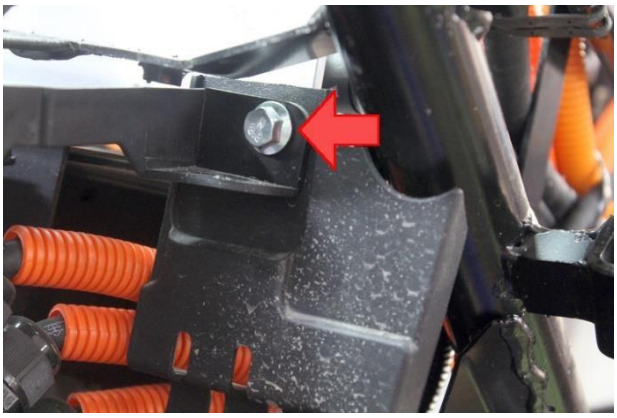
Necessary tools

10 mm socket wrench

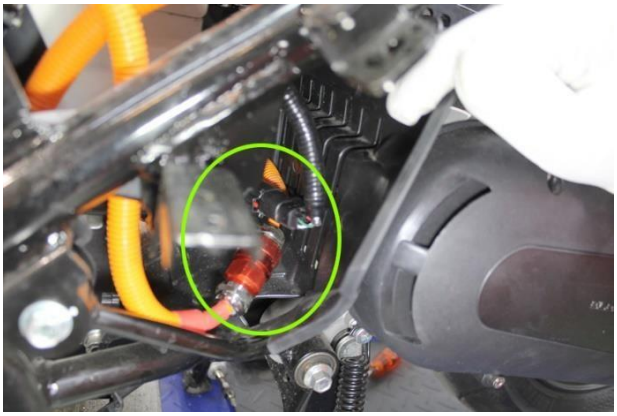
Phillips screwdriver no.2

10 mm flat wrench

Remove the two screws holding the cover separating the motor from the electrical components at the top using a 10mm socket wrench and a 10mm open end wrench. Do not remove the bottom screws.



On the left of the scooter, by moving the cover backwards, you can find the two connectors that must be disconnected.



To unplug them, there is better access from the right side of the scooter.

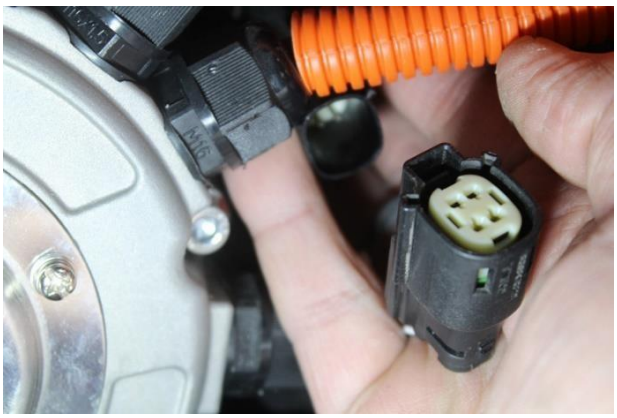
Start with the red anodised connector whose cable has a B- on it.

It has a quarter turn bayonet lock.

The second connector is low voltage and can be handled without insulating gloves.

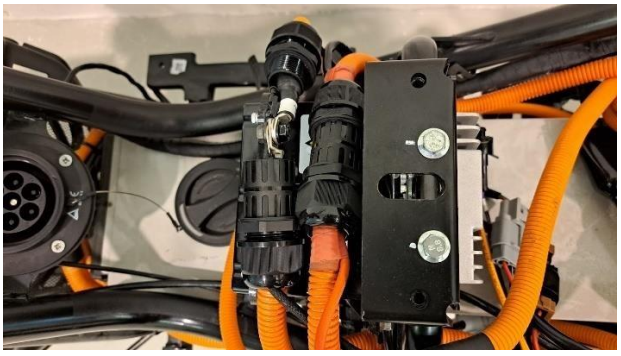
First release the latch marked with an arrow by moving it backwards.

Then, press the small red tab also located on the front to disconnect the connector.

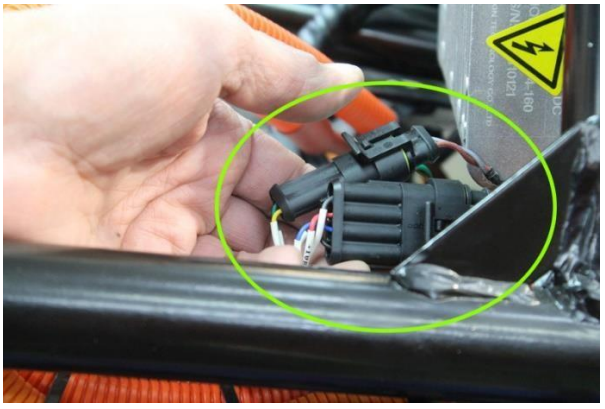


Open the upper fuse box cover. Identify the P - cable and remove it from the joint. Insulate it with electrical tape or tubing immediately after releasing it from the screwdriver.

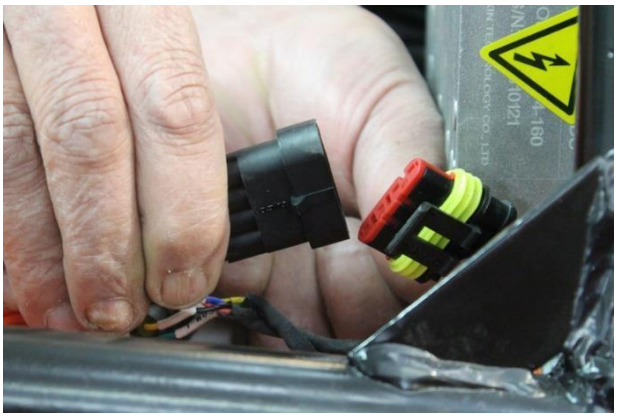
Negative cables are identified by their heat shrink covered terminals in black



Locate, on the right of the scooter, at the converter, the two BMS connectors. These are low voltage signal connectors which do not require the use of insulating gloves.



Start by unplugging the 4-pin connector.



Then, unplug the 2-pin connector.

Unscrew the hex head screws that secure the BMS to the motorcycle frame.

Charge the motorcycle battery to 100%.

5.15.Battery voltage measurement

Preliminary operations:

- Remove the helmet box (→ See 1.4.1. Helmet box. Disassembly of the base is not necessary).
- Disconnect the main maintenance switch (→ See 5.5. Disconnecting the main switch)

Necessary tools

10 mm socket wrench

On the left side, identify the negative battery terminal connector. The connector is located right in front of the electric motor.

The negative is characterised because the cable has a black coating.

Configure the multimeter to measure DC voltage.

Place the positive terminal of the multimeter on the right side of the maintenance switch.

Open the connector and identify the male connector.

The negative terminal of the multimeter will be placed in contact with the wall of the internal shank of the connector.

Charge the motorcycle battery to 100%.

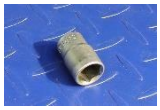
5.16.Removing the battery modules

Prior operations:

- Remove the helmet case (❼ See 1.4.1. Helmet case. The seat does need to be removed).
- Disconnect the main maintenance switch (❼ See 5.5. Disconnecting the main switch)
- Remove the left and right-hand front side (❼ See 1.3.2. Dismantling the front side)
- Remove the front end: wheel and fork legs (❼ See 7.11 Removing the fork legs)

Necessary tools

Dielectric gloves, category00



10 mm socket

Each terminal of the battery modules is identified with stickers. The black sticker identifies the negative terminal, while the red identifies the positive.

On the rear left-hand side, identify the battery's negative terminal connector. The connector is located just in front of the electric motor.

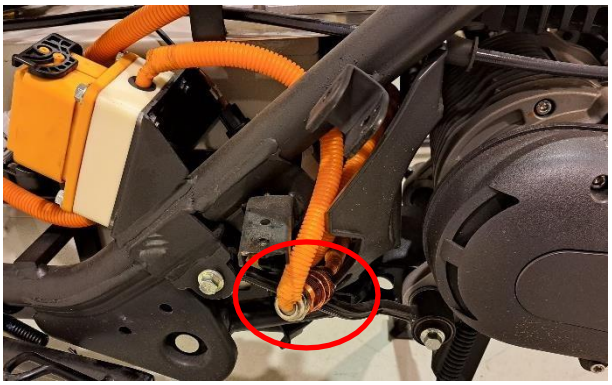
The negative has a black cable sheath. The negative terminal comes from the rear of the top module and is connected to the BMS.

Unscrew it to disconnect.

On the same side, identify the battery's positive terminal.

The positive terminal comes from the rear of the bottom module and is connected to the maintenance switch.

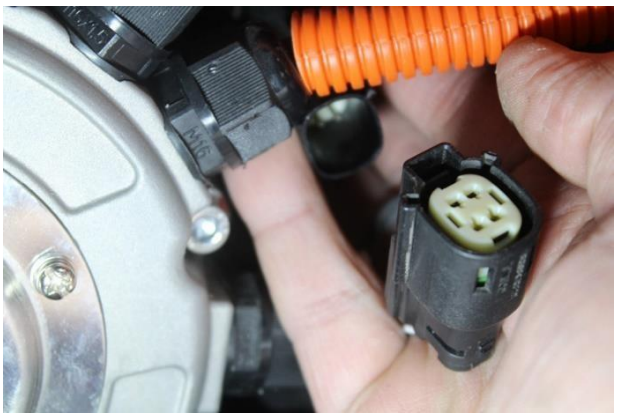
Unscrew it to disconnect.



Disconnect the communication cable that connects the top module to the BMS. This cable comes from the rear of the top module.

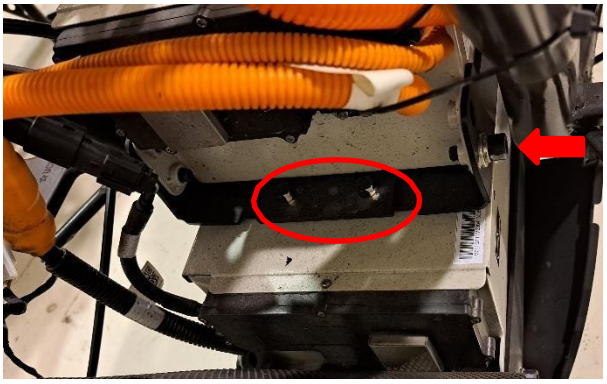
First, release the latch marked with the arrow by moving it backwards.

Then, press the small red tab as well, located in front, to disconnect the connector.



At the front, disconnect the two connectors that connect the two modules in series.

To release the two modules from the chassis, remove the side screws and remove the front stop plate. Each module has a stop plate at the front and four screws around its perimeter.



Side tightening torques: 25±1Nm
Front stop tightening torque: 11±1Nm

Remove the modules from the front. Take care to avoid damaging the connectors during removal.

The assembly of the battery modules is the reverse of the disconnection explained in this point. It is important to identify the correct position for each terminal and fit it in that location. In case of doubt, contact the Nerva after-sales service.

Finally, charge the motorcycle up to 100%.