

Mini-e and Max-e Controllers

Operating Manual

Adapto E-Drives Lab.

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Section 1

Quick Start



Warnings!

- Motor or regenerative braking can not be used as the primary method of braking. Installation of standard brakes that ensure emergency stops is mandatory.
- Controller must not be operated without using a fuse or circuit breaker. A fuse or circuit breaker must trip when peak current exceeds 250A for MINI-E and 400A for MAX-E. Note that this is the peak current ratings. For instance, a C circuit breaker with rated current 63A is triggered when peak current is app 200A.
- Controller is built to environmental protection standard IP54. This means that the controller can tolerate splashing water. Nevertheless bear in mind that when driving in the rain at high speed, water (for example, from the wheels) and drips at high speeds acts like a pressurized water stream, which is like a splash. Therefore, do not operate the controller without proper protection when driving in rain or through puddles.
- Input voltage to the controller above 98V is prohibited. If you want more power (more than 70 amps of phase-current), do not use a battery that is more than 90V. Recommended battery voltage for maximum power is 85V.

1.1 General

1.1.1 Capabilities

Key Capabilities of the Controller

- Three fully customizable power profiles including braking
- Built-in power meter with a variety of information displayed
- Integration with BMS, a second controller, DC-DC converter and digital throttle
- Settings for throttle linearity and progression for smooth power
- Ability to connect virtually any source in DC Charging mode
- Capability to use the controller as a DC power supply
- Security lock controller using a password
- Ability to program the required distance to go. The controller will automatically limit the power and maximum speed as necessary to reach your destination.
- Display the voltage of each battery cell connected to BMS
- Ability to continue to operate with a faulty Hall sensor in motor

1.1.2 Package Contents

Package Content:

| | |
|------------------|-------|
| Controller | 1 pcs |
| Display | 1 pcs |
| Operating manual | 1 pcs |
| Installation kit | 1 pcs |

Installation kit

| | |
|--|-------|
| Contact connector XT150 Female, | 2 pcs |
| Contact Connector XT150 Male, | 3 pcs |
| Insulator connector XT150 Female, black, | 1 pcs |
| Insulator connector XT150 Female, red, | 1 pcs |
| Insulator connector XT150 Male, blue, | 3 pcs |
| Display miniature connector for the throttle cable | 1 pcs |
| Thermocouple | 1 pcs |
| Jack for Hall sensors | 1 pcs |
| Fastening clamps, Display Module | 2 pcs |
| Display long mounting screws | 2 pcs |
| Display short mounting screws | 2 pcs |
| Display mounting nuts | 4 pcs |
| Hex wrench | 1 pcs |

1.1.3 Connections

Display Connection

Connect the long cable with the 4 pin blue connector to the display according to the connection color codes.

Throttle and Brake Connections

To work correctly you need to solder the throttle cable conductors to the corresponding wire mating connector according to the conductor color codes (see table below). To use regenerative braking connect the brake handle. In the case of using a brake handle button instead of a Hall sensor, connect one button contact to the brake sensor output, second to +5 V.

| Conductor color | Function | Contact number |
|-----------------|------------------------------|----------------|
| Brown | +5V | 1 |
| White | Brake sensor (button) output | 2 |
| Black | GND | 3 |
| Blue | Throttle Hall sensor output | 4 |

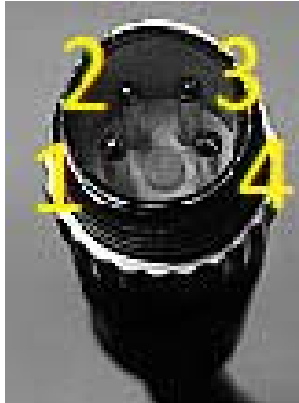


Figure 1.2. Throttle cable connector pinout

Motor Connection

Connecting Motor Hall Sensors

Solder motor Hall sensor wires to the connector pins according to the table. Traditionally motors use standard color-coded wires as shown below. However there are motors with different color markings. Match circuits as shown in the table.

| Wire colors (traditional) | Pin functions | Contact number |
|---------------------------|---------------------------|----------------|
| Yellow | Sensor output 1 | 1 |
| Green | Sensor output 2 | 2 |
| Blue | Sensor output 3 | 3 |
| (any) | Output temperature sensor | 4 |
| Black | GND (negative terminal) | 5 |
| Red | Positive terminal | 6 |

Phase Conductors Connection

Solder three blue XT150 pins to the motor phase conductors. Connect them to the blue XT150 connectors on the controller. Any combination is OK. No matching is required.

Power Connection

Solder the black XT150 connector to negative battery lead, and the red XT150 connector to battery positive. We strongly recommend using a current limiting device (fuse or circuit breaker) in the power supply circuit. For MINI-E it is recommended to install a C 63A circuit breaker. For the MAX-E it is advisable to install two parallel C 63A circuit breakers.



Figure 1.2 Hall sensor connector pinout

Connecting the charger to the controller

Connect a T-connector to any phase cable break as shown below.

Connect the black connector of the charging coil to the controller black connector.

Connect the red connector of the charging coil to a T-connector. Observe the polarity. Connect the charger to the charging coil using the XT90 connector supplied.

Connect the charger to the mains power.

For instructions for configuring the controller when charging see Section 3.3.6.

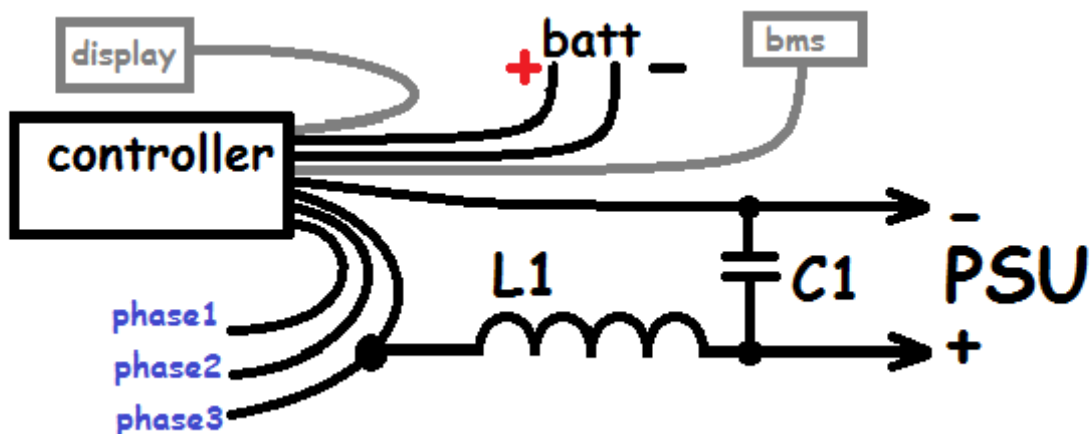


Figure 1.3 Charging

1.1.4 Quick Setup

As soon as the connection is done and power is supplied as appropriate you will see the main screen. In order to get to the main menu you have to press Down button. If you have activated the quick menu press Down again, you will access the main menu (Screen 1.4).

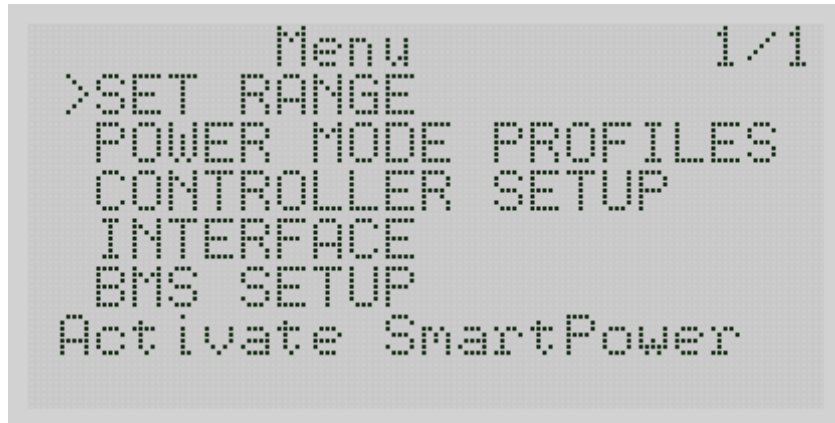



Fig. 1.4 Main menu

 First, make sure that the correct settings for upper cutoff and lower cutoff voltages are shown on the display for your battery. They are in the BMS Setup 3.5. Proceed with BMS Setup using Down button and press Right to enter the menu.


Set the lower (Dischg cutoff) and the upper (HV cutoff) voltage threshold in accordance with the minimum and maximum voltage of your battery. In order for regenerative braking function to work with a fully charged battery, the upper threshold voltage can be set slightly higher. Controller Setup menu 3.3.1 is necessary to configure the following settings:

Set <Speed Ratio> depending on your motor configuration.

This value is given in millimeters per electrical revolution. To calculate the required value must be the circumference of the wheel assembly divided by the number of pole-pairs in your motor.

For most direct-drive motors the number of pole-pairs is equal to 23. If possible, verify the data for your motor. For example, for a 9 Continent motor, 24" rim with a 2.5" tire the value will be $1,965\text{mm}/23 = 85.4\text{ mm}$.

The next step is to perform the Autodetect process. See Clause 3.3.2.

 **Warning!** The wheel must be securely raised off the ground and free to rotate during auto-detection!!!

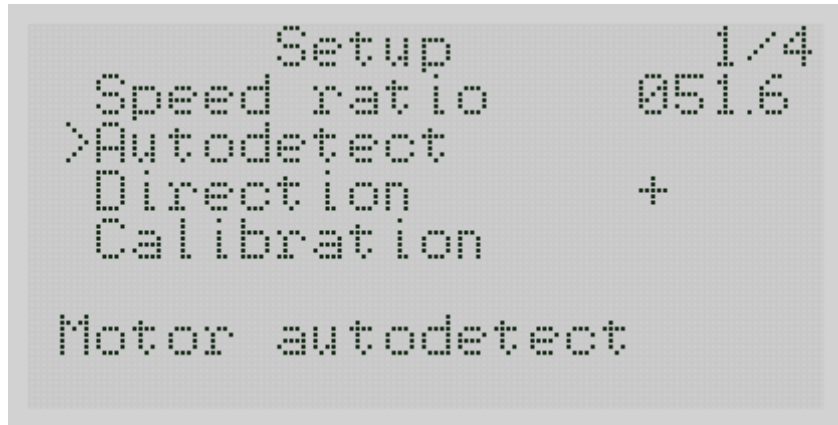


Figure 1.5 Setup menu

Select <Autodetect> menu by pressing Right, then slowly open and hold the throttle control to the maximum position. Be careful, the wheel can rotate in the opposite direction, causing rotation of the pedals. If you noticed that the wheel begins to spin in the wrong direction, immediately release the throttle. Change the direction of rotation (<Direction> option) and repeat the <Autodetect> process. The full auto detection cycle takes 2-3 minutes. The wheel will rotate slowly for app 2/3 of the entire time period required to autodect and then at the full speed for the remainder of the cycle. Please remember: in order to autodetect the correct timing angles, the wheel must spin freely during the entire cycle.

If Autodetection is successful, you will see the message <Successful>. This means that auto detection is completed and you can release the throttle.

If an error message is displayed:

- <Interrupted By thr> indicates the throttle was released before the auto-detection cycle was completed.
- <Halls Error> problem with the Hall sensors
- <Interrupted By key> if you press any button during the cycle
- <Unknown error> other errors

Set the current limit profiles using the menu <POWER MODE PROFILES> [3.2](#) (found in the main menu):

- Ib A - battery current limit in amps
- Ip A - phase current limit in amps
- Ipr A - regenerative braking phase current limit in amps

- Skph - maximum speed limit in kmh or mph. Note: speed units are set in the menu item <INTERFACE> (Clause 3.4).
- Acc - acceleration limiting. This dimension is an abstract value. Increasing the number increases the acceleration.

| | | ECO | NORM | BST |
|------|--|------|-------|-------|
| Ib A | | 11.2 | 19.9 | 35.0 |
| Id A | | 37.0 | 44.6 | 55.8 |
| IdcA | | 111 | 120 | 131 |
| Skph | | 49.0 | 94.0 | 110 |
| Acc | | 15 | ----- | ----- |

Figure 1.6 Profiles

Installing BMS 3.5 (Battery Monitoring System)

If BMS module is not connected (or disabled), you should set the battery capacity and the lower and upper voltage cutoff limits.

You should specify the capacity of the battery in amp-hours and watt-hours for the correct operation of the power meter. These values can be changed automatically during a full discharge cycle.

Setting regenerative braking 3.3.5

When using a brake lever with a Hall sensor it is sufficient to specify the maximum battery voltage and maximum battery inrush current during regenerative braking.

The brake handle signal can be inverted through <Inversion> if required. When using reed switches or a regen button, enabling the <Smooth> option is recommended. This will reduce stress on the dropouts.

Calibration of throttle / brake controls

Calibration of controls is performed in Controller setup-> Calibration> <Thr Limits> 3.3.4.

After setting the throttle limits, configure the linearity of the throttle (<Thr linear>), especially if you are using a Hall sensor type throttle control.

When you select this option, twist the throttle control fully 4 times, one after the other as uniformly as possible for 2-3 seconds each time. After each successful motion you will see the curve of the signal output of your throttle.

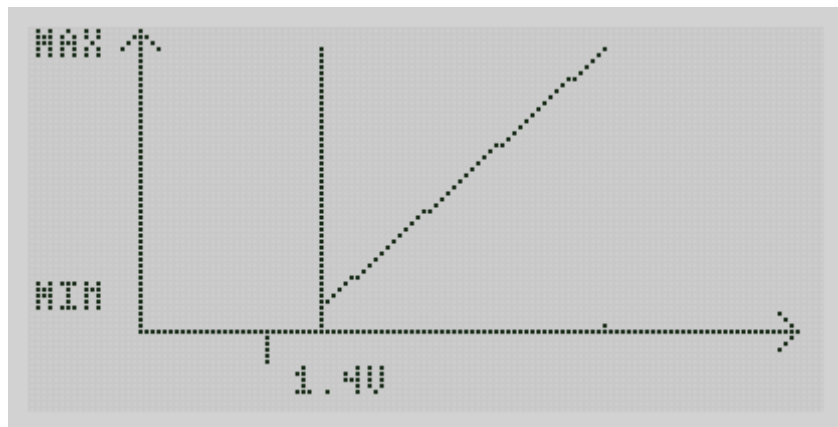


Figure 1.7 Calibration

After the 4th time calibration is complete and the throttle control will work linearly.

If you require a progressive type throttle, change the value in <thr progr.> from 0 to 1-3 to suit your needs.

After calibration of the throttle is completed select <Brk limits>. Calibration of the brake sensor/switch is similar to the throttle limits procedure.

Congratulations, your controller is ready to use!

Section 2

User Guide

2.1 Display

2.1.1 User Interface

The controller is provided with 5 keys. 4 keys are located crosswise in a joystick pattern and the fifth just above and to the left.

Keys are referred to as “**Up**”, “**Down**”, “**Left**”, “**Right**”, or “**Exit**”.

From the main screen using keys Left or Right you can switch between the following views:

Main screen ⇔ Powermeter ⇔ BMS ⇔ Health Monitor.

Use Up key in standby mode to switch power profiles between Eco-Normal-Boost.

Down key allows you to get to the main menu settings of the controller.

To scroll through the menus, press Up or Down.

Press Right to enter a menu. To change a value in the right column press Right again. Press Left to leave menu, or press Exit. When you exit from the main menu, if settings have been changed, and you want to save them, you must confirm. If you want to save the new setting select **Save**

settings. If you want to leave the SETUP unchanged, select **Discard setting**.

2.1.2 Main Screen

The Main screen comprises the following:

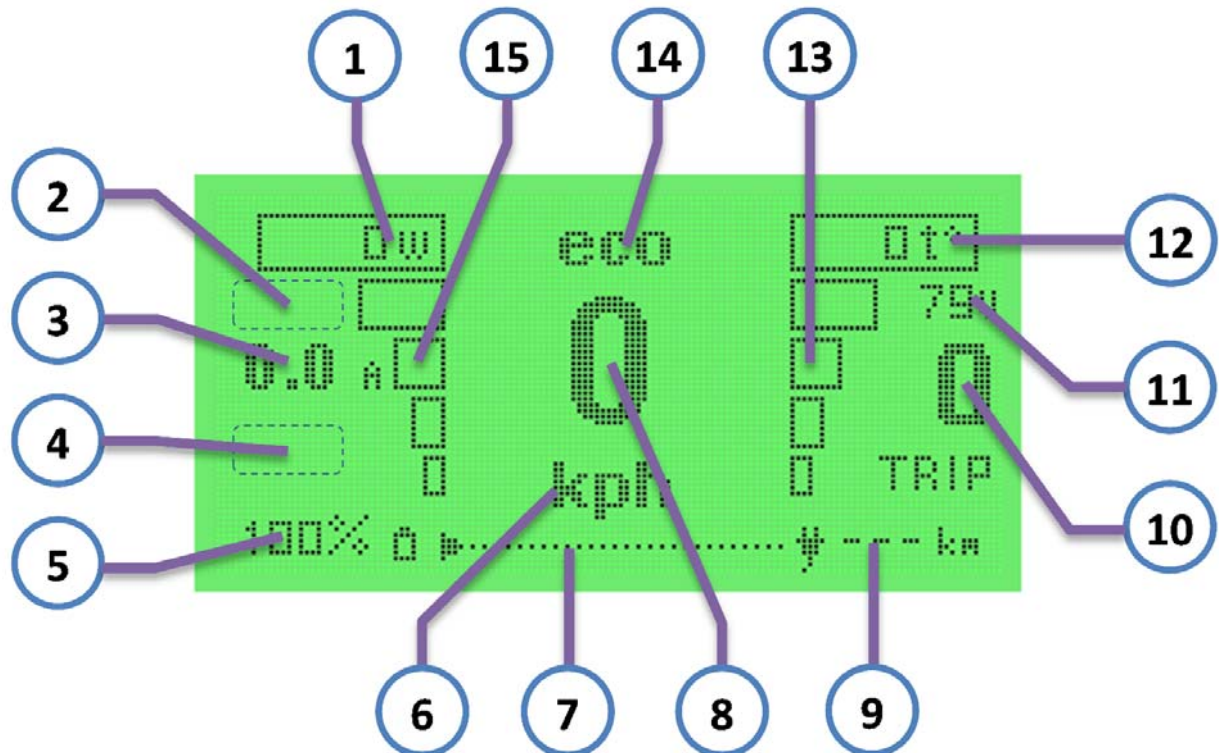


Figure 2.1 Main screen

1. Real time power use in watts
2. TSC (traction control system) is displayed when enabled
3. Battery current in amperes
4. Smart-Range data (when enabled)
5. Battery level SOC (state of charge) in %
6. Speed units (kph, mph)
7. Graphic display battery "fuel gauge"
8. Speedometer
9. Estimated remaining range at current SOC
10. Odometer (since the last reset)
11. Battery voltage
12. Motor Temperature (if thermocouple is connected and configured)
13. Graphic display temperature gauge / Overheat current limit bar

14. Power profile / information messages (eco / normal /boost / cruise / brake / charge etc.)
15. Graphic display power gauge.

2.1.3 Mapping Statistics

Statistics display (parameters shown since the last reset)

| | | |
|-----|--------------------|-------------------------|
| trp | Trip distance | Wh used |
| tme | Driving time | Ah used |
| ren | Remaining range | Remaining Wh |
| avg | Average speed | Average consumption |
| max | Max recorded speed | Max power |
| reg | Regen Ah recovered | Recovered power Wh |
| bat | Average voltage | Battery Int. Resistance |

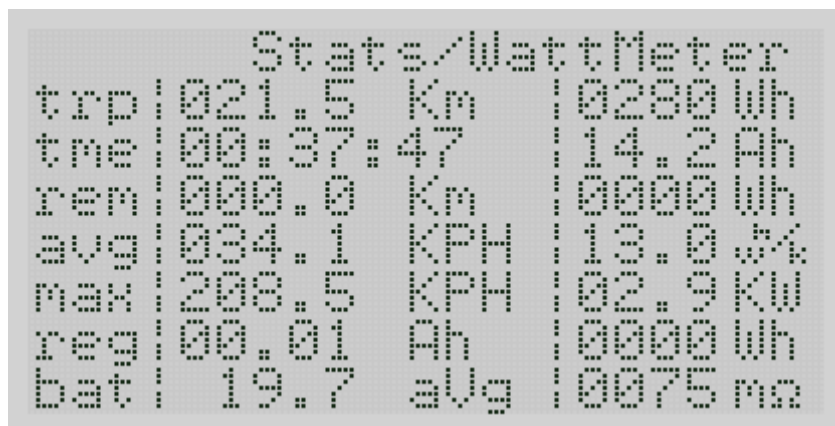


Figure 2.2 Statistics

The statistics screen displays information about the current trip since the last reset. This data is not reset after a controller restart. By pressing Up you will enter the reset statistics menu. There are several options, namely:

No - Exit reset screen with no changes

Yes - Resets the statistics without resetting the current value of the battery charge. Used to reset the odometer, the speedometer and information for the last trip

Set Full Charge - Resets the current battery level (SOC) at 100 percent. Apply this setting after a full charge, if you do not use E-BMS module or if BMS balancing option is disabled.

Reset and Set Full Charge - Resets statistics and also resets battery level (SOC) to 100%.

Pressing Down displays general statistics:

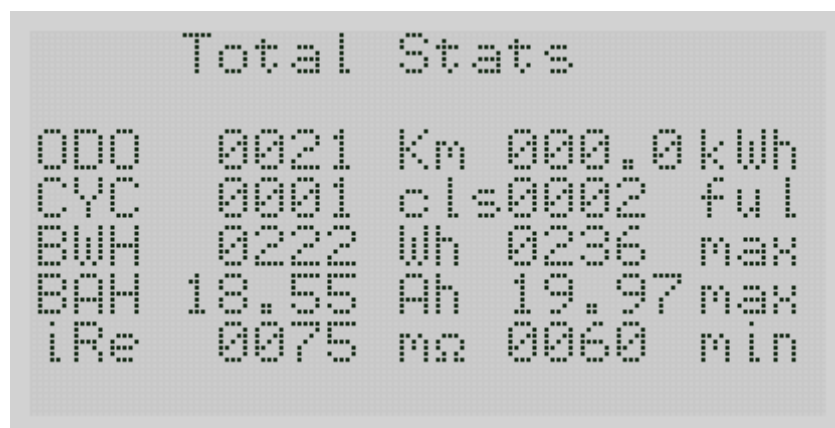


Figure 2.3 General Statistics

| | | | |
|-----|-------------------------|-----|-------------------------|
| ODO | Odometer | Km | Total used kWh |
| CYC | Number of cycles | cls | No. of completed cycles |
| BWH | Remaining capacity Wh | Wh | Max battery capacity Wh |
| BAH | Remaining capacity Ah | Ah | Max battery capacity Ah |
| Ire | Current int. resistance | mΩ | Minimum int. resistance |

The overall statistics are not reset and this screen is used to display data on capacity and mileage for the entire time of operation of the controller.

2.1.4 BMS Status

Only available when BMS module is installed and enabled.

1. Upper limit of the voltage displayed (autodetect)
2. Difference between the maximum and minimum voltage of battery cells
3. Lower limit of the voltage displayed (autodetect)
4. Battery status (BMS fail, Battery empty, Balancing, Charged, Battery OK)

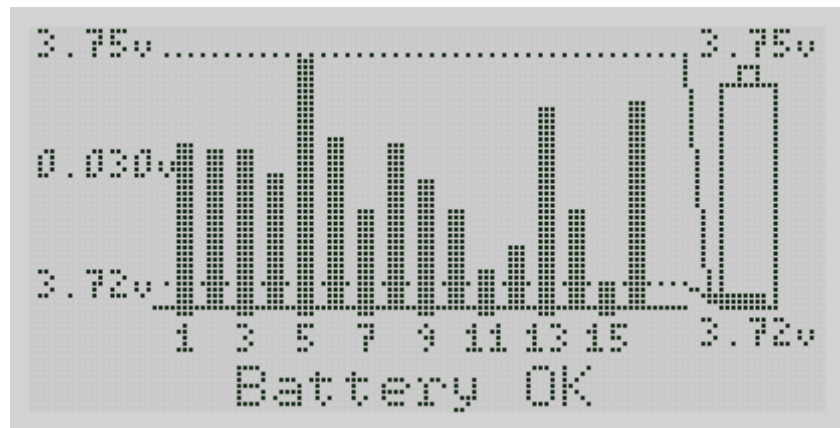


Figure 2.4 BMS

- BMS fail - BMS error (failure or improper configuration)
- Battery empty – low battery
- Balancing - battery balancing mode is active
- Battery OK - battery is serviceable, other modes are disabled

The BMS screen displays the cell voltage dynamics and the difference between the maximum and minimum cell voltages to the left. BMS status is shown on the bottom. If you press Down while in the BMS screen you will enter < BMS Setup > menu. See [Clause 3.5](#) for a detailed description of BMS Setup menu settings.

2.1.5 System Information

```

Health monitor
U: 12.6V/13.4V/3.27V
Uhall: 4.66V/002mA
Motor t°: 000°C 00 00 00
HALLS: 111,H2 OFF
P0000N0828 Protect: N
Mosfet T°: 026°C
-4.0°+9.9°-0.0°-2.3°+3.4°

```

Figure 2.5 Health monitor

Health monitor. This screen appears when you press Left from the main screen. It displays the controller parameters necessary for troubleshooting. Intended for diagnostic purposes by the service center personnel.

```

Device information
Serial #: 10300275
Product ID: #C1002
Firmware Ver.: #001
UNLOCKED: F001
Compiled
F/W Rev.: v1-RC8f

```

Figure 2.6 Device Information

Device information. This screen appears when you press Up from <Health monitor> screen. It displays the firmware version and controller serial number. The controller serial number is set when the controller is manufactured and cannot be changed by the end-user. The firmware version shown may change after a firmware update. If you choose to load the unlocked firmware version, the screen will display <UNLOCKED>. This means lifting the restrictions on the SETUP maximum currents in the profiles and also the maximum current available at voltages exceeding the 90V supply voltage threshold. By loading unlocked firmware, the warranty is voided by the user, and the user assumes all responsibility for exceeding the manufacturers established voltage thresholds and

maximum current limits. Changing the type of firmware from locked to unlocked is only possible in one direction. In other words once you've flashed the <UNLOCKED> version, it is impossible to return to the <LOCKED> version.



Figure 2.7 Debug

Debug. This screen displays the service information and is required only for service personnel.

2.2 Controller Setup

2.2.1 Configuring the interface

Customizing the Interface menu is made from the main menu. Users may select the desired units, miles or kilometers per hour. Note, this setting also changes the display mode of the temperature in Fahrenheit or Celsius, respectively. Display brightness may be adjusted to HI or LOW, refresh rate of the information on the screen can be changed, the quick menu mode can be enabled and also the power save mode can be configured. For a detailed description of how each menu item looks see Interface, Clause [3.4](#).

2.2.2 Motor operation modes

There are several modes in which the controller is able to manage the motor, namely: sine-sine control, block control, and sensorless mode. Mode selection is made in menu Controller setup- > Advanced Settings -> Control MODE. See Clause 3.3.8. Sensorless mode can be used in the event of damage to the wiring, the motor Hall sensors themselves, or if the Hall sensors are on standby. Using sensorless mode is not recommended when Hall sensors are present since it fails to ensure the best performance.

2.2.3 Working with Planetary type motors

The controller supports motors with planetary gearsets and has some additional SETUP options to simplify use with these types of motors. Also possible to connect a reed type speed sensor in place of the brake lever sensor when using a motor with a freewheel for correct speed detection. The sensor calibration parameter can be found in Controller setup menu -> Ext SPD ratio. For A full description of the special settings for working with planetary motors see Advanced Settings, Clause 3.3.8.

2.2.4 Manual motor tuning

Manual adjustment of the motor may be required in the case of the specific configuration of the motor, as well as if the Hall sensors are installed in the motor with significant phase-shift (about 30 degrees). If auto detect does not work the first time because the Hall sensors are phase-shifted by 30 degrees, adding a slight resistance to the motor rotation at the beginning of the auto-detection process by, for example, using the brakes with just enough force to slow down the rotation but not so much as to lock the motor may help. If this method fails, you can customize or adjust the motor parameters manually after attempting auto-detection.

Manual adjustment of the motor is made as follows:

1. Connect the hall sensors and phase wires in an arbitrary manner.
2. Verify that the hall sensors are working. To do this:

- a) Navigate to the health monitor (from the main screen to the left)
- b) Slowly roll the wheel forward and watch the figure in following inscription "Halls: xxx, Hy". Figure "y" should vary according to either scheme 1-2-3-4-5-6-1-2-3-4-5-6 - or 6-5-4-3-2-1-6-5-4-3-2-1 - ... and three figures "x" denote the logic levels of each of the three hall sensors.



If, during the rotation of the motor numbers "y" sometimes takes the value of "0" or other sequence of digits, the hall sensors are not working properly, or motor sensors have an angle of 60 degree angle. (If 60 degrees - then you need to reverse one of the hall sensors in the motor, not all, but a specific sensor).

3. Choose the direction of rotation of the motor.

If you rotate the motor forward, then values in the health monitor after Halls: should increase. If the numbers are falling, then change the setting Hall reverse or Direction.

4. Set the phase combinations.

Setting consists of setting the direction of the control of the signal and the phase shift control signal. Change the direction of the motor rotation by changing the wire reverse setting. To determine the correct direction try applying a little throttle.

If the wheel does not rotate there are two possible reasons:

- a) When the current is supplied the motor is locked in any relevant position or starts to move around trying to remain in the previous position. If you try to swing the motor in order to move it out of its position, a spring effect will be present in both directions. If you try to spin the motor by hand while applying low power, you may feel the motor trying to turn in the reverse direction at pronounced intervals. If the motor behaves this way, then you need to change the wire reverse setting.
- b) During the current supply the motor either rotates or slows down. However, when you try to swing it there is no evident interval present with the rotor trying to return to its position and no spring effect. It means the wire reverse setting is correct and you need to change the hall offset setting.

After the selection of wire reverse choose a Hall offset (total 6 combinations possible), where the motor rotates in the forward direction without using excess power.

At this time the selection of phase and Hall combinations is completed.

The next step is to configure the timing angles.

There are three parameters: angle corr, ind timing and pwr timing.

To start, set the angle corr value close to zero, ind timing in the value between 400-500 and pwr timing to 0.3-0.5, and finally OVS to 0.

First you need to choose the angle corr. (angle correction)

To do this, run the motor slowly (to about 10-15 kmh), and while changing the angle corr setting from negative to positive, observe the operation of the motor. You will notice that when this setting is shifted strongly negative or strongly positive, the motor starts to rotate slower and sound louder. Try to choose a value approximately midway between the two extremes where the motor rotates best.

Next you need to configure ind timing.

To do this, accelerate the motor up to cruising speed. If you don't know what cruising speed is for the motor, then take a look at the debug screen which can be reached from the main screen by pressing the button combination "left-up-up." In the row "OA:xxxx DA = xxxx Axxxx" look at "Axxxx". Look at the first digit after the letter "A" and gradually speed up the motor. It will begin to change in the following order: 8, 9, A, B, C, D, E, F. Accordingly, F corresponds to the maximum speed and 8 to the minimum. Cruising speed corresponds to the letter "D". After reaching motor cruising speed start changing ind timing parameter. Select a value where the cruising speed is achieved with minimal effort (i.e. the minimum throttle).



If the wheel does not spin or vice versa spins very quickly, very high speed is not valuable. Keep current consumption at no more than 5-7 amps. Under strong throttle, settings above certain values will make the motor begin to accelerate and get noisy. This should be avoided, reduce the throttle input. The value generally should be slightly less than the threshold at which the motor begins to accelerate and get noisy.

Next you need to configure the PWR timing and OVS.

PWR timing affects power consumption (and efficiency) of the motor under load. Set PWR timing (usually one of these values: 0.17 for highspeed motors, 0.3-0.5 for average and 0.7-1.2 for slow motors), to achieve maximum acceleration when you mash the throttle at cruising speed.

OVS can raise the maximum speed by reducing the efficiency of the motor. Optimal values are usually 2-4. Select a value by trial and error.



Keep in mind that if you raise OVS and ind timing settings really high and run high currents, no speed limit and high RPM, the motor can quickly overheat and you can even burn up the controller. Therefore, to avoid such situations it is recommended to set the maximum speed limit when configuring profiles somewhere around 20% more than the maximum speed of your vehicle on the road.

2.2.5 Setting distance to travel

(SET RANGE)

This function is used to automatically correct the necessary power for traveling a given distance.

You need to specify the amount of energy that you plan to spend <Power amount> and how far you want to go <Range>, and then enable the automatic power control function (Go).

```

SmartRange setup 1/1
Range           037.7KM
Power amount    15.2Ah
>Power range    00.5Ah
Go

Power range
for adjust torque
  
```

Figure 2.8 Set Range

Additional <Power range> tuning is needed in order to overcome the inclines and compensate for uneven loads. More <power range> should be set if your route has a lot of hills or climbing. In other words, this option sets the reserve capacity that can be used without significantly reducing power.

The controller will automatically limit the power of the motor to travel a given distance.

It should be understood that the power consumption depends primarily on the vehicle speed and optional automatic power correction cannot increase the maximum range on a single charge indefinitely.

When activated, <Set Range> mode is displayed in the lower left hand corner of the main screen. Display reads R and two values corresponding to the percentage of distance traveled relative to the percentage of remaining and reserve capacity.



If you reach the reserve early, the bike will continue to run in economy mode, but the remaining battery capacity may not be enough to reach your destination.

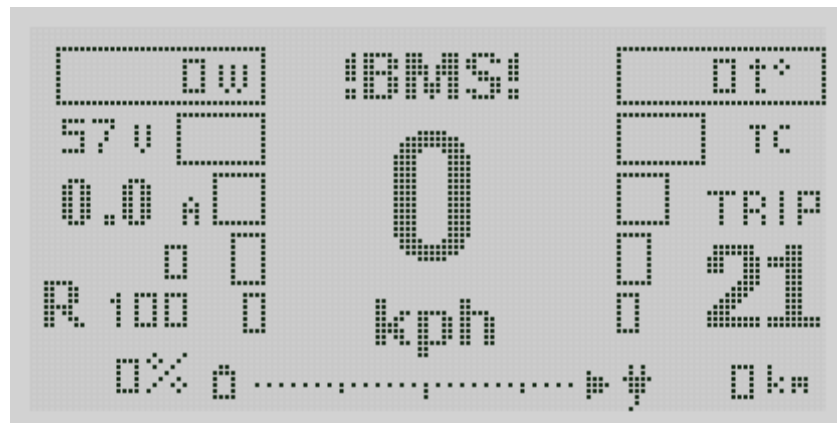


Figure 2.9 Set Range

2.2.6 Regeneration

(regen settings)

In the Settings menu, in order to configure regenerative braking you must set the maximum battery voltage, maximum safe intermittent charging current which the battery can handle, and also enable and configure the active engine braking mode when needed. For a full description of each setting, see [Clause 3.3.5 \(Controller Setup-> Regen Settings\)](#).

2.2.7 Security password

You can set a password to enter the main menu, or to enable the controller. Password is set in the Master password and Menu Password, respectively. Password is entered using the Up Down Left Right buttons in a random sequence. At the end of the password sequence, push the Back button. By default, the password is disabled. When first changing your password, be careful and note the sequence you have entered since it is impossible to reset the password yourself without knowing the original password. See Clause [3.4](#).

2.2.8 Anti-theft Protection

This mode is designed to provide extra security for a password protected bike or moped without a freewheel. This feature makes the wheels very hard to turn, making it difficult for an unauthorized person to ride the bike. If the mode is enabled, the controller will prevent the motor and/or wheel from turning until the correct password is entered. The function is activated by entering Controller Setup -> Traction settings -> Anti Theft menu. For this function to work it is recommended to set the phase current protection regime (Anti th. PHC) in accordance with your motor. See detailed descriptions of the options in Clause [3.3.8](#).

2.2.9 Setting battery parameters

For correct operation of the controller, you need to specify the correct parameters for your battery, namely:

- maximum allowable battery voltage (HV cutoff)
- minimum allowable low voltage cutoff (Dischg cutoff)
- battery capacity ampere-hours (Battery AH)
- battery capacity in watt-hours (Battery WH)

These parameters are defined through BMS setup and setting these values is required before using the controller.

Also when using Adapto BMS, in this menu you can configure BMS for the battery. For more detail see Clause [3.5](#).

2.2.10 DC-DC converter

The DC-DC converter function [3.3.9](#) allows you to use the controller as a power source with a set voltage, which may be lower than the voltage of the connected battery.

To use this option, you must be connected to the capacitor/charge coil output. Enable the function by selecting “ON” in the menu to use the switching DC-DC converter. However, if you enter the menu on the main screen and save the settings when prompted, the feature is automatically turned off for safety reasons. Therefore, it is recommended to set the required parameters DC-DC voltage and DC-DC Current, exit while saving the settings, and then switch the DC-DC Enable mode to ON. When you exit to the main screen, the controller should not prompt you to saving settings if no other parameters were changed.

The main screen will display the battery current and power consumption from the controller.

To deactivate the DC-DC converter, go to the menu and switch mode DC-DC Enable to OFF. If you have changed any parameters and then exit to the main screen by selecting Save Settings the DC-DC converter is switched off automatically.

2.2.11 Charging

Charging mode can be used only with the optional capacitor/charge coil connected as shown in [Figure 1.3](#).

For the charge mode to work correctly, you must configure the maximum charge voltage (Max voltage), plug-in power supply current limit (Supply Current), charging current of the battery (Battery current) as well as the allowable voltage drop of the power supply (Supply Vdrop).

Since the charge current is directly dependent on the power supply current, the current limit will occur at an absolute minimum of the two values. In other words a high battery current setting may not be achieved when using a fixed, low current power supply that can't tolerate a significant voltage drop. For details see [Clause 3.3.6](#).

2.2.12 Throttle and Brake Calibration

Knob calibration (Controller Settings -> Calibration - Throttle | Brake) is a compulsory setting stage. Once ignored it may cause incorrect operation of certain options, including but not limited to, motor AutoDetect. Calibration includes throttle and brake knob voltage limit setting, throttle knob linearity calibration and knob pressing compression adjustment. Please note that upon any material modification of any relevant limit or replacement of a Hall sensor (knob assembly) linearity shall be re-calibrated.

For more detail on the aforesaid items see Calibration menu description (Clause [3.3.4](#) hereof).

2.2.13 Current and Voltage Calibration

Shunt and voltage values shall be set in Calibration Setup -> Calibration ShuntR and Voltage adj menus.

The aforesaid values are set by the manufacturer and are not required to be adjusted by the user. However, if a precision voltmeter and ampere meter are available the user may re-calibrate the same as appropriate.

Using a precision voltmeter measure the input voltage at the controller power terminals to calibrate voltage with the controller switched on and change Voltage adj value until it matches the value displayed by the voltmeter.

A precision ampere or voltmeter connected to the controller open circuit is required to calibrate current. Subject to availability of a constant load and adjusted current limits of 10A-15A compare the values displayed by the precision ampere meter and on the controller main screen. Adjust ShuntR value until the aforesaid parameters are aligned.

Please note that the manufacturer shall not be held liable for any eventual damage caused to the battery or motor by improper calibration made by the user.

For more detail on Calibration menu options see Clause [3.3.4](#) hereof.

2.2.14 Traction

This mode is intended to reduce skidding due to poor traction, for example when riding on an icy road. TRK option is enabled in Controller Setup -> Traction control menu. TRK dV, TRK dA, PWR rise settings are adjusted experimentally by trial and error. For a detailed description of each setting, see Clause [3.3.7](#).

2.2.15 External DC-DC converter

The controller can control an external DC-DC converter on the data bus to control headlights, break and marker lamps, horn etc. Headlight options are set in the Interface menu.

Control of the headlight and horn ports is possible by using the function keys and quick menu options. The DC-DC converter unit itself is not included with the standard controller. For more detail see documentation supplied with DC-DC converter.

2.2.16 All-wheel drive mode

Optional 2WD mode used to connect a second slave controller to operate a second motor. From the menu, you can enable / disable the second motor, and set the maximum vehicle speed at which the second motor will run. For example when using a planetary geared motor with an over running clutch as a slave, you can set it to turn off when it reaches a preset speed, since it only acts as an helper at startup and low speeds or in those situations like climbing where the main direct-drive motor may not be sufficiently effective. The slave controller must have an additional connector. The additional connector is not included as standard and must be ordered separately.

2.3 Common problems

2.3.1 Motor does not run when applying the throttle

Controller disables the motor in the following cases:

- If the supply voltage is higher than the maximum allowed by the firmware. The supply voltage is higher than the HV cutoff setting or lower than the Dischg cutoff setting in the BMS setup menu.
- If the BMS module is connected and enabled and showing incorrect thresholds, the battery is low or damaged, or if communication with the BMS is faulty or has ceased.
- Overcurrent protection tripped (Protect = "Y") To recover, you can try to reset protection to "N" in the Advanced menu settings, or restart the controller.

2.3.2 It is impossible to perform Autodetect process

Autodetection may not work in a few cases, namely:

- Hall sensors are connected incorrectly, defective or damaged
- All phase conductors are not connected, or connections are poor
- Hall sensors are installed with app 30 degrees of offset
- Sensors in the motor were installed to work with a 60 degree controller



In this case, you must make sure that all phase conductor connections are secure and correct and the motor has the correct hall sensor locations designed for use with a 120 degree controller.

2.3.3 Jolt felt when applying or releasing the throttle or brake

Typically, this problem occurs when the values for the active engine braking settings as well as Wire R PHC are not right. To resolve this problem, you must perform a full Autodetect cycle and check that all the settings associated with active braking are displayed correctly.

2.3.4 Motor cuts out intermittently

This problem occurs usually due to the incorrect setting of the upper or lower battery voltage limits. Navigate to the BMS setup and set the correct value LVC and HV cutoff for your battery. Keep in mind that a battery with high internal resistance may require values with a small margin, since the voltage across the battery under load may be very different from the no-load voltage.

Section 3

Menu Description

3.1 Set range

This function is used to automatically adjust the necessary power to reach a preset destination. For more detail see Clause [2.2.5](#).

3.2 Power mode profiles

In this menu you can adjust 3 power profiles to suit your needs.

- Ib A = battery current limit in amps
- Ip A = phase current limit in amps
- Ipr A = phase current limit regenerative braking in amps
- Skph = maximum speed limit in kmh or mph
- Acc = Acceleration limiting

3.3 Controller setup

3.3.1 Speed ratio

Select <Speed Ratio> setting to match your motor/ rim/ tire combination. This value is given in millimeters per electrical revolution. To calculate the required value must be the circumference of the wheel assembly divided by the number of pole-pairs in your motor. For most direct-drive motors the number of pole-pairs is equal to 23. If possible, verify the data for your motor.

3.3.2 Motor Autodetect

Autodetect. The auto-detect option is designed to enter automatic settings of the controller with due regard to the motor specification. When you run this option, make sure that the motor rotates freely, and is located in a convenient position for 2-3 minutes of free rotation. It is strongly recommended not to conduct this procedure with your bike up in the air. Support the vehicle securely so that the motor/wheel is not obstructed in any way, and you can keep the throttle applied. In the event of an emergency, interrupt the process by immediately releasing the throttle.

To start the process you need to press and hold the throttle control fully open. Within a few seconds after starting, the motor should make a few brief movements forward while determining the connection sequence for the Hall sensors. At this time, you must make sure that the rotation actually occurs in the forward direction.



If the motor / wheel rotates in the reverse direction, immediately release the throttle control, exit to the previous menu and change the next <Direction> parameter to the opposite. Then you can return to Autodetect prompt and start over.

After confirming that the motor/wheel rotates in the correct direction, continue holding the throttle until <Successfull> message is displayed. If there is an error, there will be a corresponding message. During the first 1.5-2 minutes when Autodetect is active, the motor will rotate slowly, after which it will spin for about 75 % of the maximum speed.

If Autodetect is complete (motor has stopped turning and the message <Successfull> is displayed), you can release the throttle. You may exit to the main screen. Be sure to save settings when prompted.

If an error message appears:

- <Interrupted By thr> (interrupted throttle) indicates the throttle was released before the auto-detection cycle was completed
- <Halls Error> problem with the Hall sensors
- <Interrupted By key> if you press any button during the cycle
- <Unknown error> other errors

3.3.3 Direction

Direction. Change the direction of rotation of the motor. Change this option to the opposite if when you try to run the Autodetect process, the wheel rotates in the wrong direction. After changing direction restart the Autodetect process.

3.3.4 Calibration

Voltage adj - Calibration of voltmeter. Press left and right buttons to adjust the voltage displayed on the right. Adjustment by the user is normally not necessary.

ShuntR – Resistance of the built-in shunt. Calibrated by the manufacturer. Adjustment by the user is normally not necessary.

Shunt2 – Power profiles compensation. If the maximum current shown on the ammeter while in use differs from the maximum current set in the power mode profiles, change this value. Adjusting this value will change the settings of current profiles (power mode profiles), while the actual current used does not change. This setting is used to fine tune the displayed current while in use to match the actual controller current limits.

Zero Offset - Calibration of zero current. Setting used to adjust "zero" on the display when there is no load. Used to correct zero point of the power meter.

Thr limits - Calibration of the throttle

Thr linear - Throttle linearity calibration

Thr progr. - Set the throttle progression (0 = linear)

Brk limits - Calibration of the brake lever

Brk progr. - Setting the brake lever progression (0 = linear)

Weight - Total weight of the vehicle with a driver

Int TSensor - Type of thermal sensors. Set by the manufacturer, the user does not require adjustment.

In the calibration mode the throttle / brake buttons <left and right> you can adjust the current limit and the <up and down> switch between upper and lower limit.

The current position of the throttle / brake limits is displayed under the coordinate axis.

At the throttle minimum position, it is recommended to set the lower limit just to the right (with the cross-over), as the hall sensors are subject to a temperature shift and changing environmental conditions may result in the threshold adjustment. Thus, incorrect calibration may lead to a sudden movement of the vehicle. The figure below is an example of proper calibration.

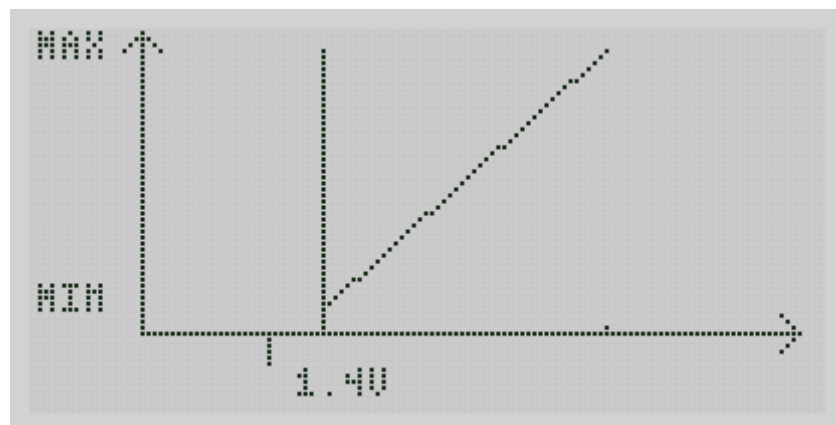


Figure 3.1 Calibration

3.3.5 Regen Settings

Enable. There are three possible settings:

On- Regenerative braking is enabled;

Off- Regenerative braking is disabled, and when the brake lever is pulled the motor does not shut off;

M-off- Regenerative braking is disabled, and when the brake lever is pulled the motor shuts off.

ActiveMode - When braking, the motor thrust is reversed. And regeneration is possible down to zero speed. KV and motor winding resistance settings are required for this mode of operation. These parameters are set during the Autodetect process.

ForcedActive - With this option disabled, regenerative braking is initially performed by classical regeneration (i.e. shorting all phases of the motor and the subsequent current accumulated in the windings is drained to the battery), and when the current starts to decline, the mode automatically switches to reverse motor braking. When switching to reverse you will hear an audible “click”. If this option is On, braking is ensured in the thrust reverse mode. At high speeds reverse motor braking requires the right timing settings and complementary lead angles.

Rated Current - Current limit during regeneration. Set this value not to exceed your battery maximum safe charging current.

Inversion - Inverts brake sensor inputs. When setting brake calibration limits, if you press the brake lever and the signal voltage decreases (i.e. calibration slider moves to the left), change this setting to the opposite.

Smooth – If this option is enabled, the reverse force during regeneration will gradually increase and also decrease smoothly when the brakes or regen button is released. Useful when using a switch instead of a Hall sensor.

PWM limit - Limits minimum PWM cycle when using standard brakes. A higher value will allow you to slow down to a lower speed, however the efficiency will be reduced, and the motor temperature will increase. Recommended to set at about 95 percent.

SPD sensor - Allows you to connect a speed sensor to the brake lever input on the controller. Useful for bikes with a freewheel or motors with an overrunning clutch where regenerative braking cannot be used and an external speed sensor is required.

Torque rise – Optional setting for reverse motor braking. Allows you to configure a smooth response at low speeds. The higher the value, the stronger the braking at low speed. 80-150 is recommended.

Min speed - Minimum speed during motor reverse braking. In tenths of kmh. The default value is 2.

3.3.6 Charge settings

Charge Enable - Enable/disable charging through the controller. When set to YES the charge mode will be active and will begin immediately after connecting the charger with the charging coil to the controller.

Max voltage - The maximum charging voltage of the battery.

Supply Current - Limits power supply current. Set at no more than the permissible rated current for the power supply / charger used.

Charge current - Limit the battery charge current. Set this value no higher than the maximum safe charging current for your battery.

Supply Vdrop - Maximum voltage drop cutoff. Sets the power supply maximum voltage drop under load. When using high-quality switching power supplies, use a value of about 3V.

3.3.7 `Traction settings

Throttle mode - TORQ (default) or SPD. In TORQ mode, power is regulated by the applying throttle. The SPD speed mode commands speed within a small range of power (i.e. setting close to Chinese controllers).

ThrCruise - Enables or disables the ability to use cruise control. Cruise control mode allows you to maintain a constant speed without holding the throttle. If this setting is disabled, then the cruise control mode cannot be used. If this option is enabled, then cruise control can be activated in two ways:

- a) rapid triple click the accelerator;
- b) while holding the throttle in non-zero position, press the display up button, then release the throttle. Turn off cruise control pressing on the brake lever or press the regen button. To activate the cruise control you need to increase speed to at least 8-10 km/h. When active, cruise control speed can be adjusted by pressing the display up and down buttons.

PWM rise lim - regulates the maximum speed of the motor (or the maximum rate of increase in cycle of the PWM) and to some extent the rate of acceleration when cracking the throttle. The larger the number, the faster. The highest setting is 80, for extreme driving and maximum performance.

SPD smooth - Adjusts the smoothness of operation when approaching speed limits. When the speed nears the maximum, the controller starts to limit power. The size of this window near the speed limit is controlled by this setting. The higher the number, the sharper the speed limit is triggered. The smaller the number, the harder it is to maintain a constant speed, but maintaining speed is smoother and softer.

TRK - Enables Traction. When enabled, the controller limits the acceleration of the motor. Usually if the wheel ran over a piece of ice, it starts to sharply accelerate. At this point, Traction works for some time and then resets motor power.

TRK dV - Sets the speed at which Traction control is activated

TRK dA - limits sharpness (term for the acceleration of acceleration) when Traction is enabled. You can gain more control and at the same time achieve high thrust (acceleration) with no downside. When traction is lost, and the wheel starts to spin, sharpness is high, unlike applying throttle smoothly with good traction.

PWR rise – The recovery time after traction loss is detected.

LS enable - Current limitation at low speeds. Helps when using motors BMC / MAC, which can start with a sharp jolt due to the engagement of the freewheel.

LS current - Limits the starting current.

LS start - The speed at which the current is allowed to start increasing.

HS start - Speed above which maximum current is available (that current specified in the profile). That is, the current gradually increases, from the speed LS start and maximizing at speed HS start.

2WD enable – enables/ disables all-wheel drive mode. A second controller can be connected to the peripheral bus of the main controller. The slave controller is controlled by the main controller, if this option is enabled.

Slave SL - When this speed is reached, the second additional controller is disabled. It is recommended to use this setting if in 2WD mode, the second motor has a planetary gear and overrunning clutch and helps only at low speeds and at high speeds spins uselessly.

BMC halls fix - Option to help overcome the start problem in BMC/MAC Motors by shifting the lead angle back when starting. There is a bit of reduced efficiency initially, but starts are better.

ACC off on BRK - with this option enabled, if you hold the throttle on and let go of the brake, the motor will not operate. To run the motor you must release the brake control before applying the throttle.

Backwd SPD - Maximum reverse speed.

Anti thief - If enabled, the wheel will be locked when the controller is locked with a password.

Anti th. PHC - Maximum motor phase current in Anti theft protection mode. Allows you to set the maximum force of the motor.

3.3.8 Advanced settings

Angle corr. - This setting makes up for the inaccuracy of the Hall sensors installed. That is, the difference between the applied magnetic field of the stator and the Hall sensor angle readings. Since three Hall sensors are installed, this setting is the average deviation of the three gauges from zero. Deviation of each sensor separately is determined and automatically compensated for during the rotation of the motor. Determined automatically during the motor auto-detect process.

Ind timing - Sets the delay compensation between the signal hall sensor and the control signal of the controller. When rotating at high speeds, the signal from the sensors has been delayed, so you need to adjust the timing. Accordingly, it is the sum of the controller Hall sensor filter circuit delay and the controller CPU processing time. Determined automatically during the motor auto-detect process.

PWR timing - Sets the lead angle shift in relation to the phase current. The greater the inductance of the windings of the motor, the stronger the control signal phase currents. This setting compensates BEMF.

angle corr2 and PWR timing2 (In the firmware since v1RC8b) - Analog versions of the above settings for reverse thrust mode (i.e. active braking).

OVS timing - Setting responsible for extra motor speed when the battery voltage is not high enough to achieve the maximum vehicle speed. Works like this: When the PWM cycle is nearly 100%, the controller increases the lead angle, which enables additional speed (and reduced efficiency of the motor). Only if the voltage is limiting the maximum motor speed, not the wind resistance, will this work.

HallOffset, HallReverse, WireReverse – Three settings are responsible for setting up the correct orientation of the Hall sensors with respect to the phase conductors, as well as the reversal the motor phase conductors and Hall sensors. These settings are altered when “guessing” to find the correct phase and Hall wiring combinations. Determined automatically during the auto-tuning the motor.

Wire R - Stator resistance at standard temperature (24 C°). Determined automatically during the motor auto-detect process.

Motor KV - KV motor. Measured in arbitrary units. Determined automatically during the motor auto-detect process.

Wire R and Motor KV values are needed for a new algorithm for calculating the phase current (based on the current speed, control voltage and winding resistance, and not from the control voltage and current, as in the standard version). This algorithm is required to reverse the engine braking, and also improves the smoothness and precision of the phase current limits. It is activated by the following parameter.

Wire R PHC - The use of an alternative algorithm for calculating the phase current. Allows you to calculate the current even at zero cycle of the PWM that is required for proper zero crossing at work reverse braking. Important: when this setting is turned off, the motor KV will be sensed automatically if the motor spins up to medium speed and the throttle is released. After you enable this setting, automatic motor KV sensing does not occur.

PWM freq – Controller PWM frequency for motor control and also charge mode and the DC-DC converter function using the optional capacitor-coil. Normal PWM frequency is 18kHz MAX-E controller frequency is preset to 18 kHz only. The MINI-E controller can be set to 33kHz, however this is only recommended with motors or coils that do not work well on 18kHz.

ADDNZ - Compensation for motor hum that occurs at low speeds due to the switching speed of the controller power switches. Recommendations: MINI-E 2-3, MAX-E 5-6. Adjust by trial and error. This setting is safe.

Termosensor – Enables motor temperature sensor function. Possible values: NO (off), YES (connected and enabled), YES/P (enabled with prediction). YES/P mode enables compensation for the reaction time of the temperature sensor.

Motor Tsens - Selection of the temperature sensor in the motor.

T° limit - Peak temperature limit of the motor. Upon reaching the temperature 20 degrees below this limit, the controller will begin limiting power as the temperature increases, reaching zero power at the temperature limit.

Control method - Method of motor control. Sine-Sine (recommended). **SQWAV** – Similar to sine, but disconnects the third phase. Emulates block control. Not recommended. **SLESS** - sensorless mode. Recommended only in the case of emergency due to failure of the hall sensors, because at low speed and at high power it is unstable. This is not an error.

3.3.9 DCDC setup

Current limit - Output current limitation

Voltage out - Setting the output voltage

DC-DC enable - Enabling DC-DC converter function

3.3.10 Master passwd

System password protection/switch for the controller. When you enable this function you will need enter this password each time to activate the controller. The controller will not boot without the password, and motion is impossible.

3.3.11 Menu passwd

Password menu allows you to set a password only to enter the main menu, i.e. when it is activated, you can include a controller, drive, switch profiles, view and reset statistics. However, to change the settings in the main menu you will be required to enter the password that you set.

3.4 Interface

Speed units – Displayed speed and temperature units. When selecting KPH the speed will be displayed in kilometers per hour and the temperature in degrees Celsius. When selecting MPH speed will be displayed in miles per hour and the temperature in degrees Fahrenheit, respectively.

T°Display - Graphic display bar indicator on the right side of the home screen. When you select "T°" the bars will fill as the motor/controller temperature increases. When you select OVH bars will fill out only when the overheat protection temperature limit is reached and current limiting is enabled due to overheating of the motor/controller.

LCD refresh - Change the refresh rate on the main screen. Values specified in tenths of a second.

Brightness – Backlight brightness. Settings: HIGH (bright) and LOW (blackout).

BackLight - Activates the rear taillight / brake light. Function can only be used with an external DC-DC converter connected.

HeadLight - Activates the front headlight/ running lights. Function can only be used with an external DC-DC converter connected.

Quick menu - option enables the quick menu that appears when you press the "Down" button from the main screen instead of the usual multi-step method. Used for quick access to frequently used functions.

QMenu Setup - In this menu you can set the quick menu functions you want when the Quick menu is enabled.

Suspend Mode - Enabling reduced energy consumption when idle. Enable this option if you want the controller to enter the power saver mode when not in use. When Suspend Mode is active the display is blank. To wake up the controller, simply press any button on the display.

Suspend time - Time in seconds after which the controller will go into power save mode when not in use.

3.5 BMS setup

BMS Enable - Enables BMS Adaptto module. If BMS is not used in your configuration, select "No".

BMS Setup - In this menu you can configure the module BMS Adaptto module if it is both connected and enabled. Instructions for configuring the module are included with the Adaptto BMS.

Battery AH – Set the battery capacity in Amp-hrs

Battery WH – Set the battery capacity in Watt-hrs. Calculate by multiplying the nominal pack voltage by the battery capacity in Amp-hrs.

Discharge cutoff - Low battery voltage cutoff (LVC). Setting protects the battery from over-discharge if the Adaptto BMS module is not used. Set value according to the requirements of your battery.

HV cutoff – Setting for the maximum charge voltage. Protects battery from overcharging during prolonged use of regenerative braking, for instance when descending long grades.



Attention! Regenerative braking does not work on a fully charged battery.

```
      BMS setup      1/1
BMS enable      YES
>BMS SETUP
Battery AH      30.0Ah
Battery WH      01444Wh
Dischg cutoff   0370
```

Figure 3.2 E-BMS Setup

E-BMS setup – If using the Adaptto BMS module, you need to set the minimum and maximum voltage thresholds for the particular type of cells used in the battery in BMS configuration menu. Detailed instructions for the settings can be found in the Adaptto BMS module documentation.

Section 4

Maintenance and Service

4.1 Operating conditions

Operating temperature range, ambient -20 40 ° C

Environmental Protection Water Resistant IP54

An overcurrent device must be installed in the positive power supply conductor between the battery and controller. When using a time delay fuse or circuit breaker, a C 63A rating is recommended for the mini-E. For MAX-E parallel connection of two C 65A time delay fuses or circuit breakers is recommended.

4.2 Disclaimer

The manufacturer uses its best efforts to clear all errors and ensure safe operation of the device. However, it is impossible to foresee any and all events or circumstances. The manufacturer shall not be held liable for any damage (including but not limited to, damage to property, physical harm, injuries, death or non-pecuniary damage) resulting from any use or non-use of the controller, lost profit, third party acts, force-majeure circumstances or other acts or events whatsoever which inter alia include battery or electronic device burning, injuries through road traffic accidents occurring when operating the vehicle, uncontrolled motion (in particular, due to a faulty throttle or for any other reason whatsoever); motor braking system failure (a redundant mechanical brake system is a must); driving with no proper skills available; using electronic devices in any mode of operation exceeding maximum allowable power limits (i.e. motor overheating; battery, wire or electronics failure or burning; vehicle failure due to overload etc); installing the controller on any vehicle other than a wheeled or motor vehicle or otherwise as provided by applicable law. Please note that any vehicle driven by a motor is a hazard.

4.3 Warranty

We hereby guarantee that the controller has no visible mechanical damage and has undergone the final quality assurance inspection prior to delivery to any relevant distributor or point of sale. Since the device is subject to compulsory operability control which may be performed for two or more times its connectors may have minor plugging and unplugging traces. This is not a defect. The manufacturer shall assume warranty obligations as provided by applicable law. The warranty shall be valid for 12 months as from the date of sale. If the warranty certificate is lost or completed incorrectly the term of validity of this warranty shall commence on the manufacturing date. The manufacturer shall as well guarantee availability of non-warranty or post-warranty repairs for at least 36 months as from the manufacturing date.

4.4 Warranty Certificate

Dear Customer,

Thank you for purchasing Adapto controller! We believe that it will be equal to all your expectations! Please read and understand the operating manual supplied with the controller and specifying data on the assembly, settings and use thereof to be adhered to in order to keep it in good order prior to operation. This warranty shall cover the controller and display as well and be valid for 12 months as from the date of sale. Subject to compliance with this warranty any defect shall be eliminated free of charge within the aforesaid period. Any respective work aimed at eliminating any relevant defect or repairing the controller shall be performed only by qualified engineers duly authorized by the distributor which represents the manufacturer within the territory of the Russian Federation. For any other information related to Adapto product warranty repairs and services please contact:

Adapto E-drives lab, 8 Vvedenskogo st., Moscow 117246; tel. +7 (495) 228-18-78

Registered address: Office 64, 19 Nauchny proezd, Moscow 117246

Product name: _____

Serial No.: _____

Date of purchase: _____

Seller's official seal:

Full name and signature of the sales
manager: _____

Warranty Terms and Conditions

1. The warranty repairs shall be performed only throughout the warranty term specified herein by qualified engineers duly authorized by the distributor representing the manufacturer within the territory of the Russian Federation.
2. This warranty shall be effective subject to availability of duly completed warranty certificate, including but not limited to, specifying properly and clearly the product name, serial number, date of purchase, full name, seal and signature of any relevant sales manager of the seller.
3. As soon as any defect is identified the purchaser shall immediately cease to operate the controller and take proper measures in order to avoid or mitigate any extra damage resulting therefrom.
4. This warranty shall not cover any of the following:
 - Maintenance
 - Repairs or replacement of controller components due to mechanical damage caused thereto
 - Repairs of the controller which has been operated with no circuit breaker or fuse available as provided by this manual
 - Any defect arising as a result of any failure to comply with the operating manual or improper transportation or penetration of fluids inside the enclosure of the controller
 - Repairs of the controller when any relevant defect is a result of any accident, mechanical damage caused to the wiring system, strain or any act by any third party whatsoever or force-majeure events
 - Repairs of any damage caused by any modification of the controller design or assembly made by the purchaser at the discretion thereof

5. This warranty shall be deemed null and void upon occurrence of any of the following:
- Repairs performed by any person other than duly authorized engineers or disassembly of the controller or any other act other than provided by the operating manual
 - Operation for any purpose whatsoever other than intended, including but not limited to, any misuse, operation under extreme conditions (i.e. overpower, penetration of fluids or foreign matters) or in conflict with applicable operating or storage terms and conditions specified in the operating manual
 - Any failure of the purchaser to adhere to Clause 3 hereof

I hereby certify that I have read, understood and agreed with operating terms and conditions. There are is visual defect or shortage in the contents. The auxiliary components (if any) are available. The device is operable and in good order.

Purchaser _____
Full name

Signature