LUNA M600 Ludicrous V2 USER MANUAL

Date: 2025-04-24
Revision: E

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Abstract

The purpose of this document is to provide general user guidance for the installation and operation of the enhanced Luna M600 Ludicrous V2 controller.

Controller Operating Specs

Parameter	Value	Unit
Max Input Voltage	84	Vdc
Max Phase Current (5 sec burst)	100	Apk
Max Battery Current	60	A
Standby Current	<100	uA
SW Frequency	20	kHz
Max Speed	30000	eRPM
Motor temp cutoff	120	°C

Don’t operate the controller beyond the listed values. Listed values are subject to change.

These are ***controller*** specs; when installed on an M600 drive unit, other limits will likely apply, like motor thermal overload or battery sag and available battery current.

A stock M600 motor can flow about 30 phase Amps peak (30Apk) continuously and will get very hot (120°C) under continuous high power. Pushing more Amps (the V2 controller can do 100Apk) will increase motor temperature quickly and hit thermal cutoffs, so be mindful about the motor thermal capacity. Check the app temperature gauge to learn how your system behaves.

Similarly, a 48V battery could limit the power delivery by sagging too low at high power.

Safety Notice

This motor controller is powerful enough to melt a motor, wires, destroy a battery and break bones. With great power comes great responsibility! ***Don’t try to break stuff, because you will!***

The controller comes with a default configuration that should work for any user. As you can tell from the extreme power density achieved, these motors, wires and power electronics are already being pushed to the limit.

We are offering it for people who know what they are doing and will be responsible with this kind of power (know what gear to ride in, understand battery limits, etc).

We prefer to sell this controller pre-installed in our bikes to avoid mishandling and installation problems like misconnections and pinched wires.

Luna is supporting a fully Open Source platform named VESC®, which means users could potentially change any parameter of this motor drive, and have full access to the source code to change or improve fundamental features. Luna builds come with a custom UI that hides advanced parameters to deter people from changing safety-critical parameters, but we know it's only a mild entry barrier.

Modifying the default motor configuration is NOT advised as it greatly increases the likelihood of property damage and severe injury -and source code changes are far more dangerous-.

It is NOT legal to ride this at full power on public streets or trails. We sell this bike for use on private property and/or for race/track riders.

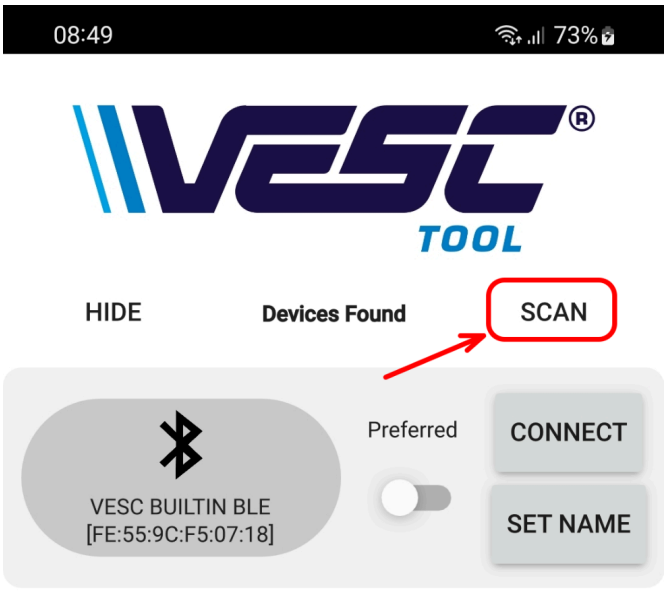
Connecting to VESC Tool

VESC Tool is available for free, for Android, Linux and Windows PCs here: VESC Tool Downloads
Free and paid versions are the same, only the logo color changes.

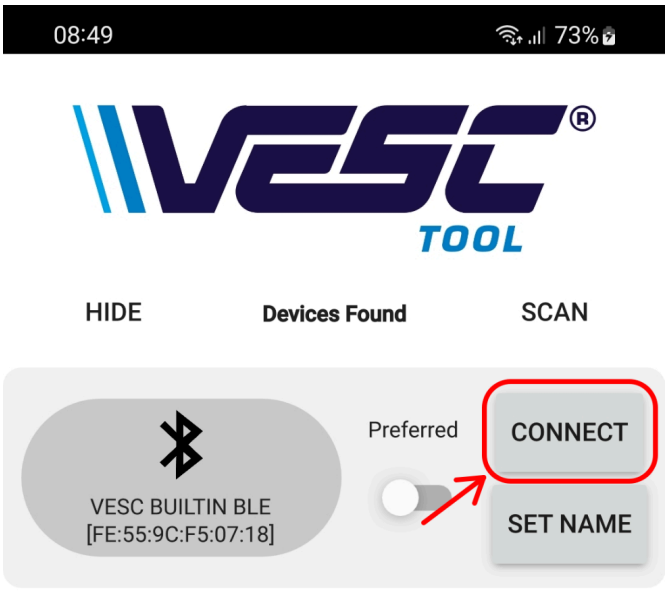
You can also find the VESC Tool app in the iOS App Store and Google play if you would like to contribute to the open source VESC® project.

Learn more about the VESC® in the official homepage: www.vesc-project.com

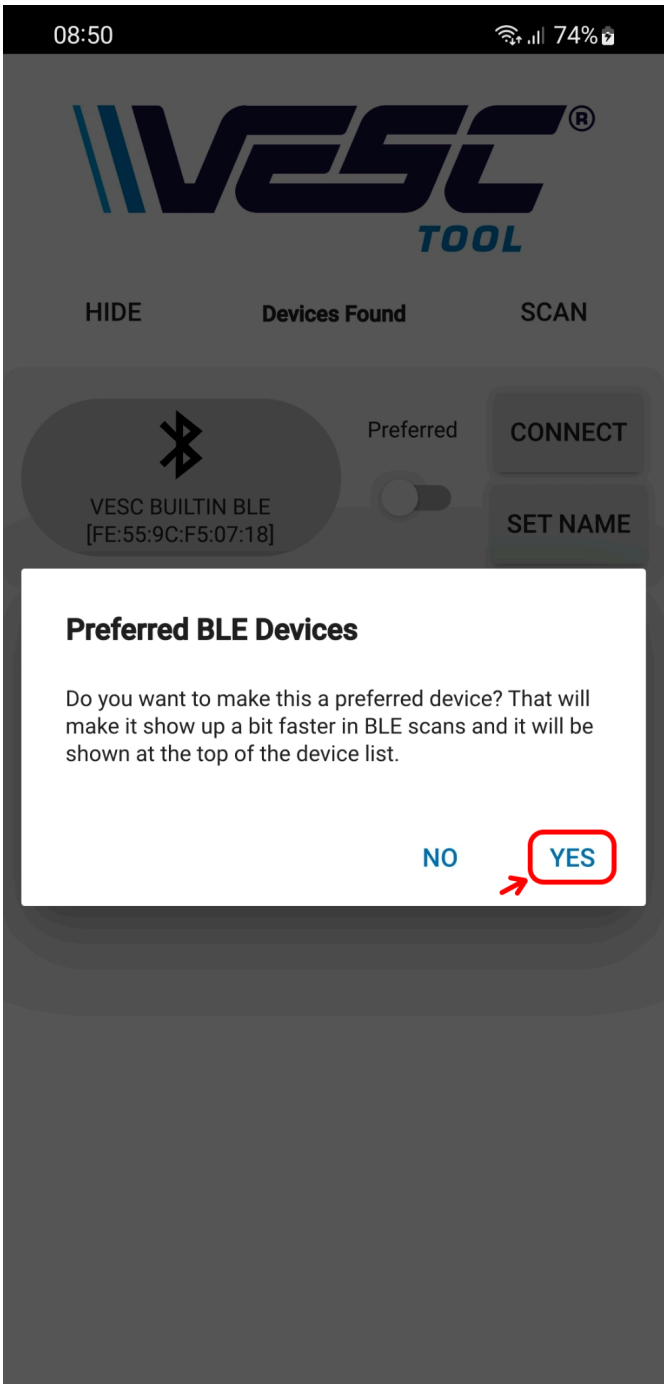
Here is a video tutorial to cover the basics of the connection:
WIRELESS CONNECTION - VESC-Tool Mobile Tutorial



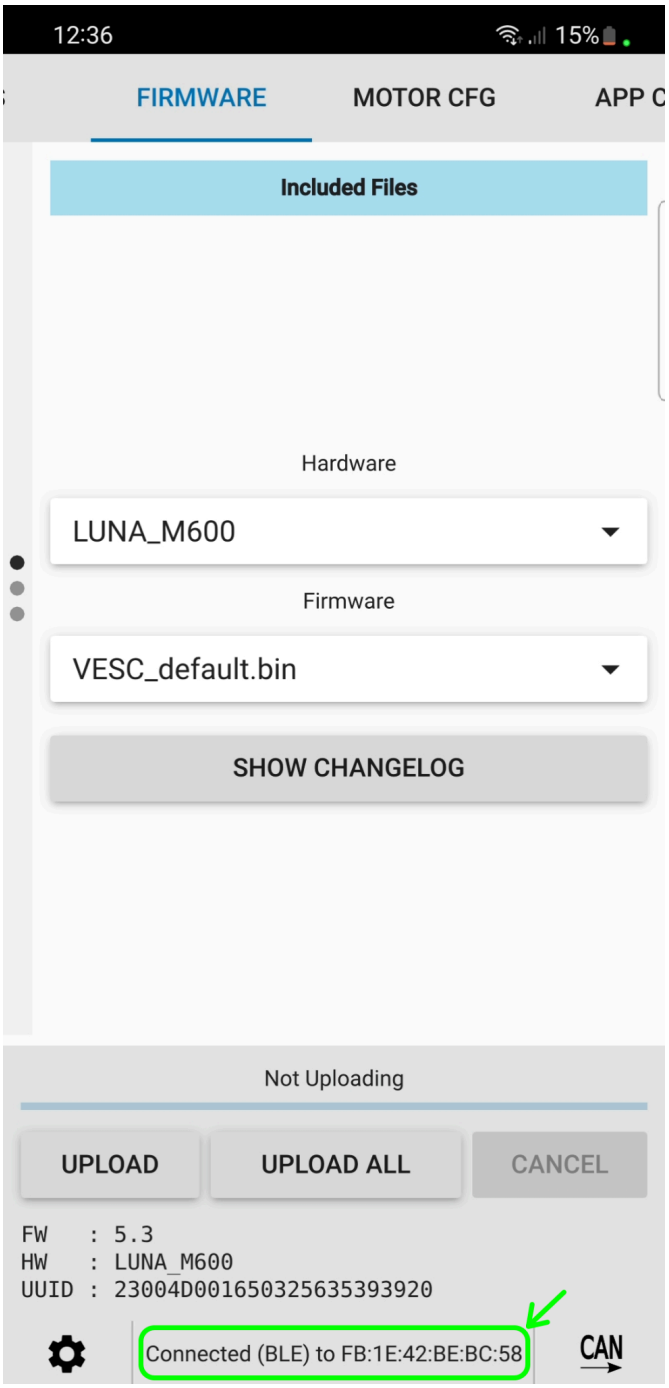
1. Turn ON the M600 from its display, open the VESC Tool App and start Scanning



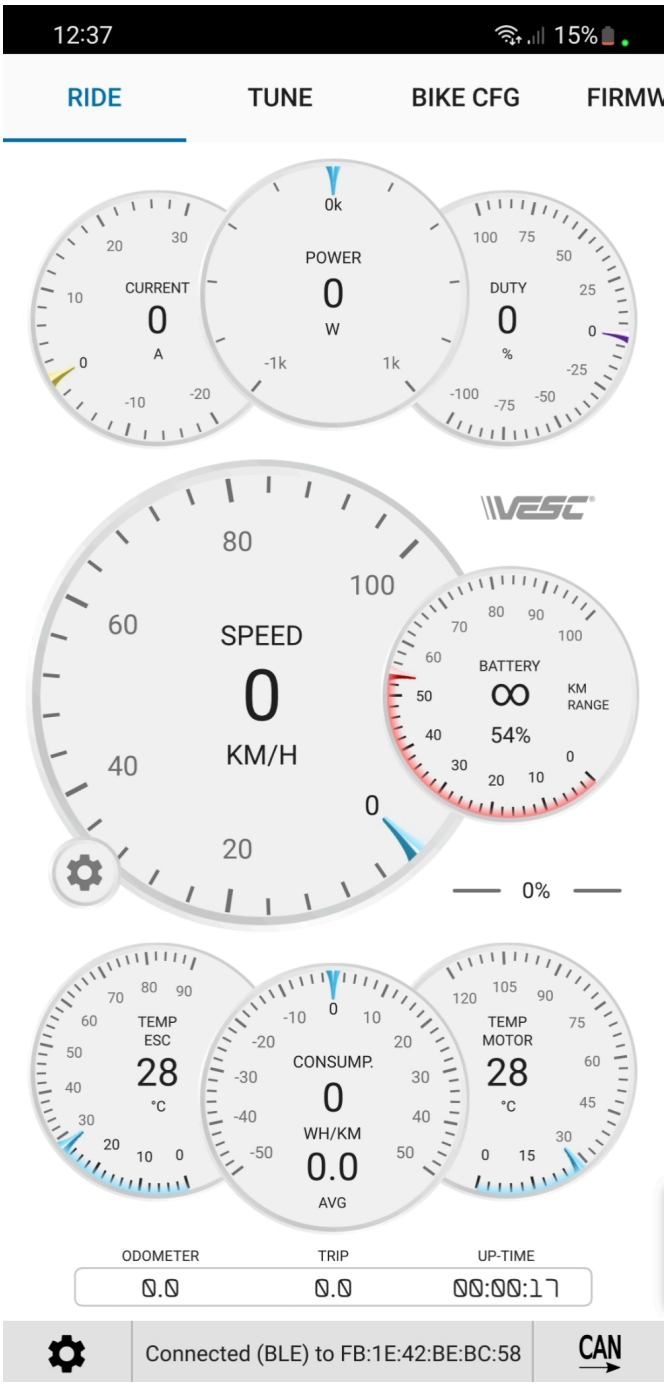
2. When your M600 shows up, click CONNECT. Note there may be more than one Bluetooth Low Energy (BLE) device in the air.



3. Making your Ludi v2 a preferred device will make your following connections quicker.



4. Your M600 is now connected! After a couple of seconds the controller will transfer the custom Luna UI to the phone.
Note: If the controller firmware is old the Luna UI won't load as a firmware update is required, use the included firmware..

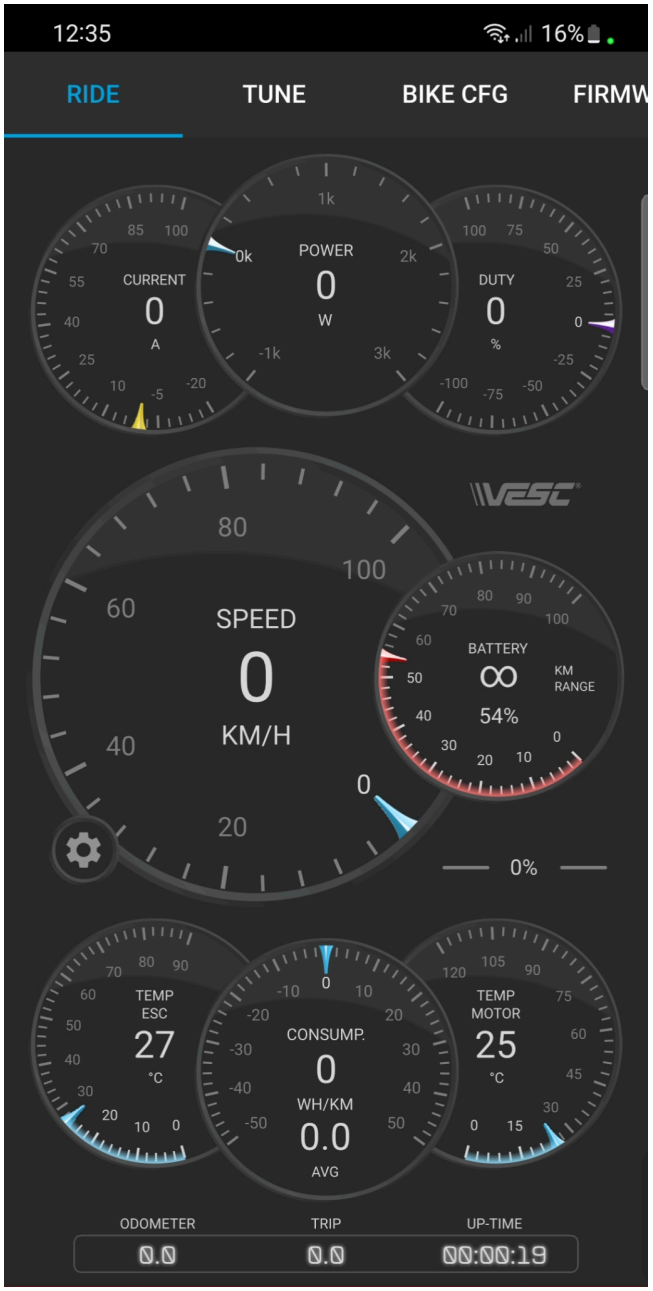


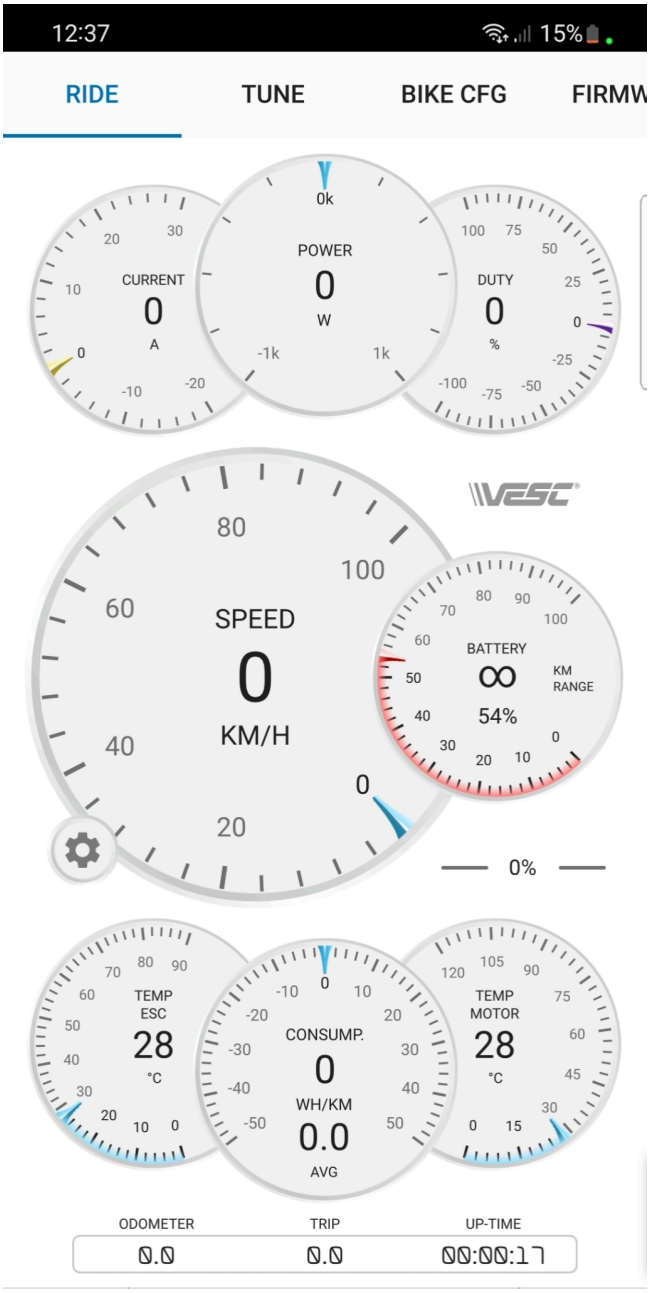
5. In the RIDE tab you can see live data coming from the controller. If you are pushing the bike hard, the motor temperature gauge is useful to avoid thermal throttling..

App settings

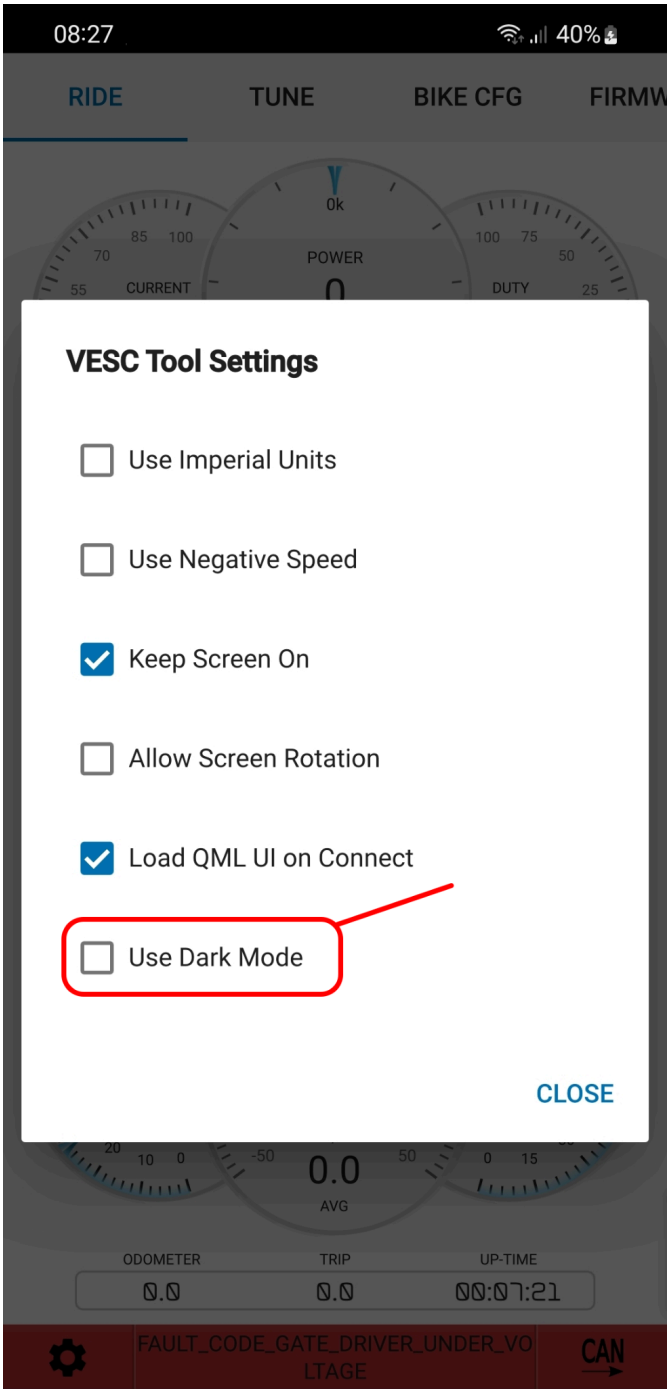
Light and Dark themes

Dark mode is less distracting, but for better daytime visibility, the light mode is recommended.



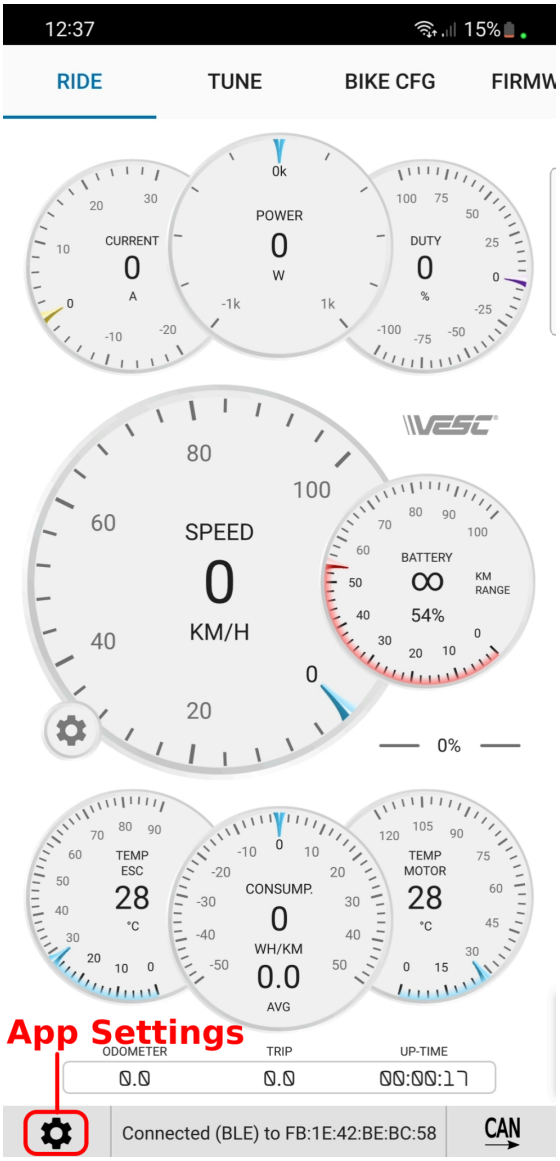


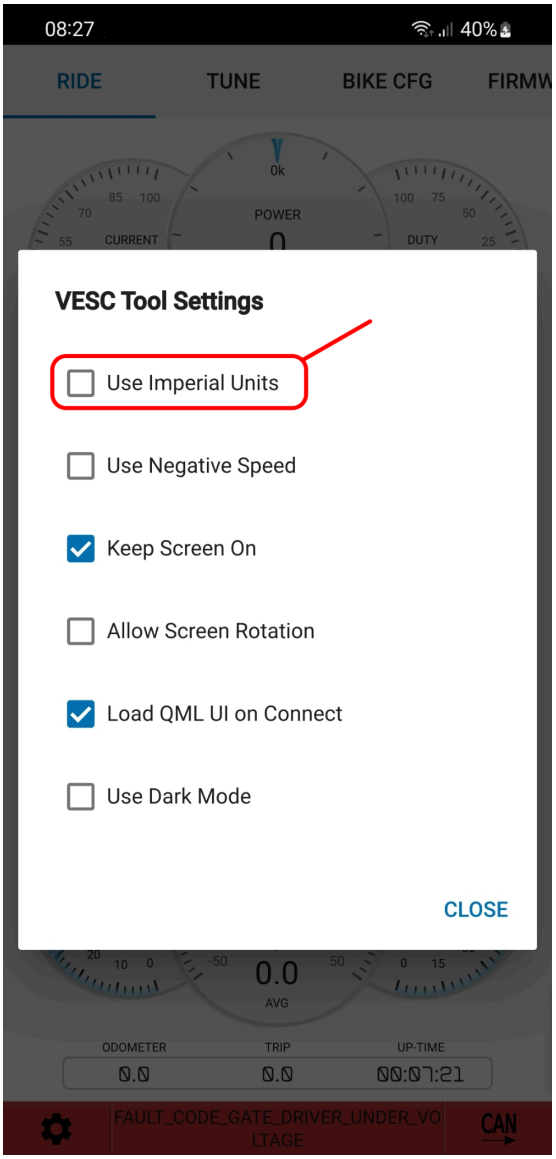
To change it to the app settings menu and disable Dark mode:



Set units to Imperial or Metric

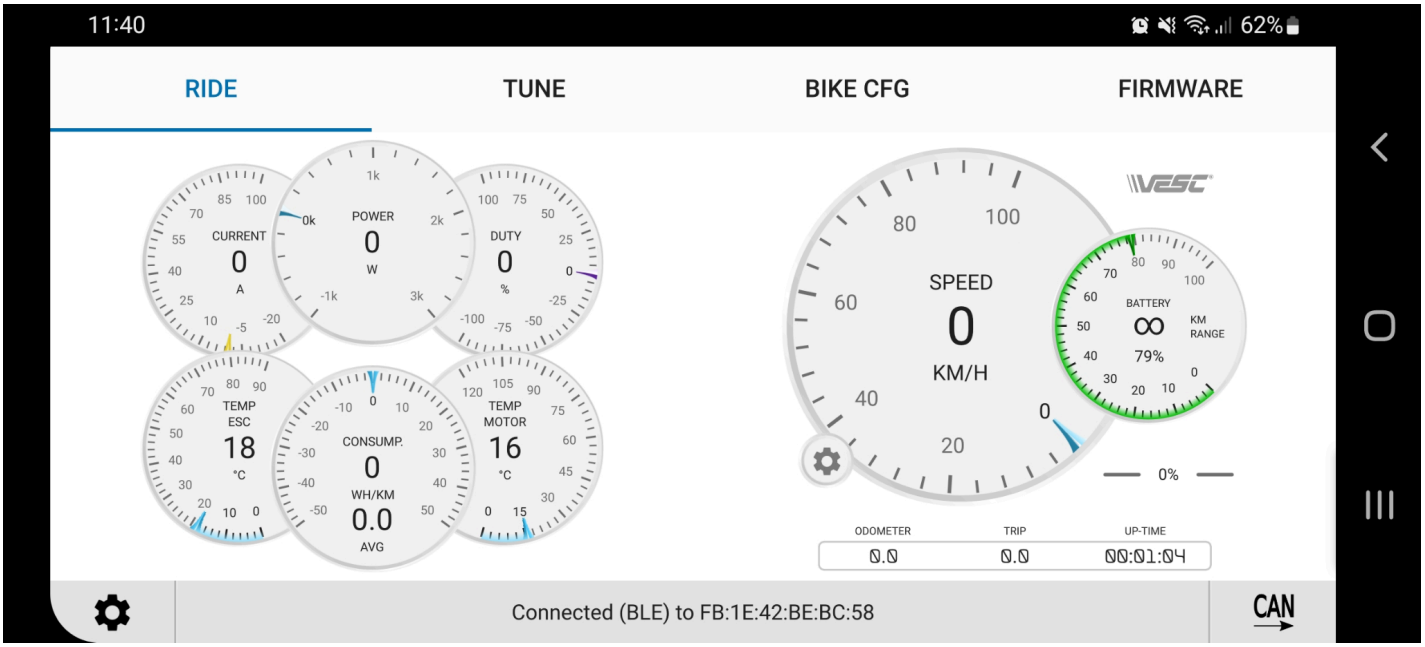
To change the units to imperial, go to Settings, and tick the Use Imperial Units box

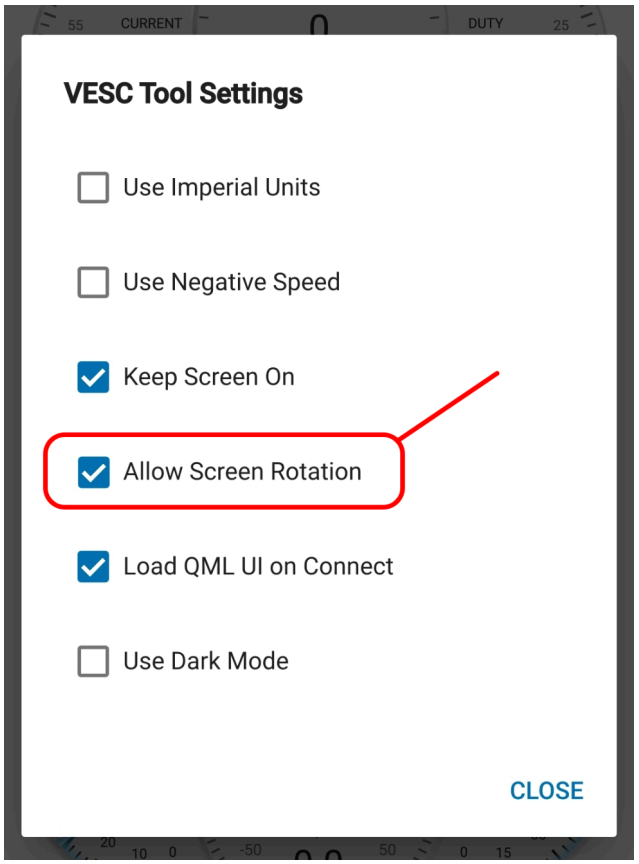




Horizontal gauge cluster

If screen rotation is allowed in both phone settings and app settings, the gauges can be displayed horizontally.





Customizing Power Delivery Preferences

Power Levels

The M600 platform allows the user to set assist levels, by default divided in 5 levels.

When set to 9 levels, it modifies the torque (or phase current) produced by the M600 in the following way:

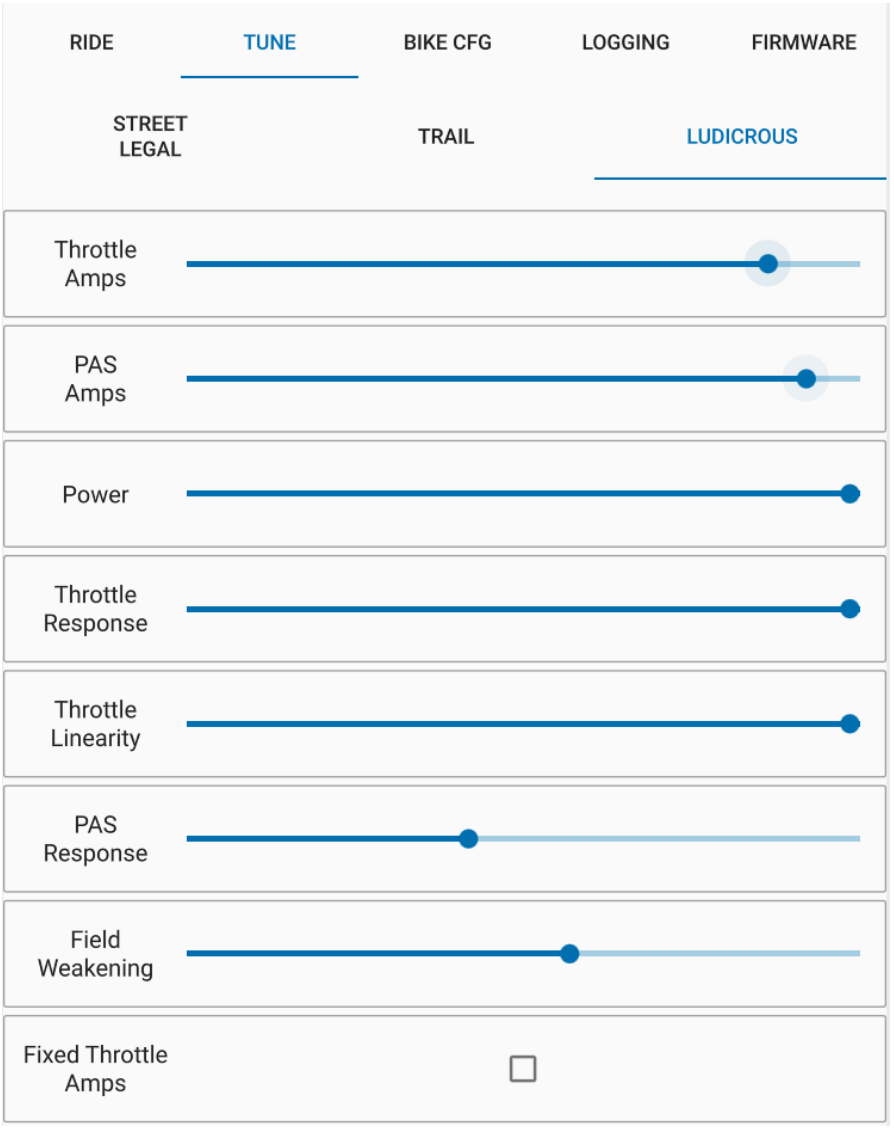
PAS LEVEL	Available torque
LEVEL 9	100%
LEVEL 8	88.8%
LEVEL 7	77.7%
LEVEL 6	66.6%
LEVEL 5	55.5%
LEVEL 4	44.4%
LEVEL 3	33;3%
LEVEL 2	22.2%
LEVEL 1	11.1%
LEVEL 0	Throttle and PAS disabled

These torque reductions are applied to the pedal assist algorithm. The throttle always has 100% of the torque available at all times.

In the **TUNE** page you can store 3 different tuning profiles:

- **STREET LEGAL**
- **TRAIL**
- **LUDICROUS**

The profile names are fixed, but the actual tuning is fully configurable.



First tap READ SETTINGS to sync with the controller. By tapping the WRITE button, the selected profile will be stored in the controller.

Each profile has these parameters to tune:

- **Throttle Amps**
  The throttle controls the phase Amps, and this slider sets the max available phase current at the throttle. Torque output is directly proportional to phase current, so the slider is ultimately setting the amount of torque your motor produces.

- **PAS Amps**
  The Torque-based Pedal Assist algorithm provides motor torque based on crank torque. This slider sets the max phase Amps produced by PAS.

- **Power**
  Maximum power limit. Decreasing power will mostly affect mid-high speed performance.

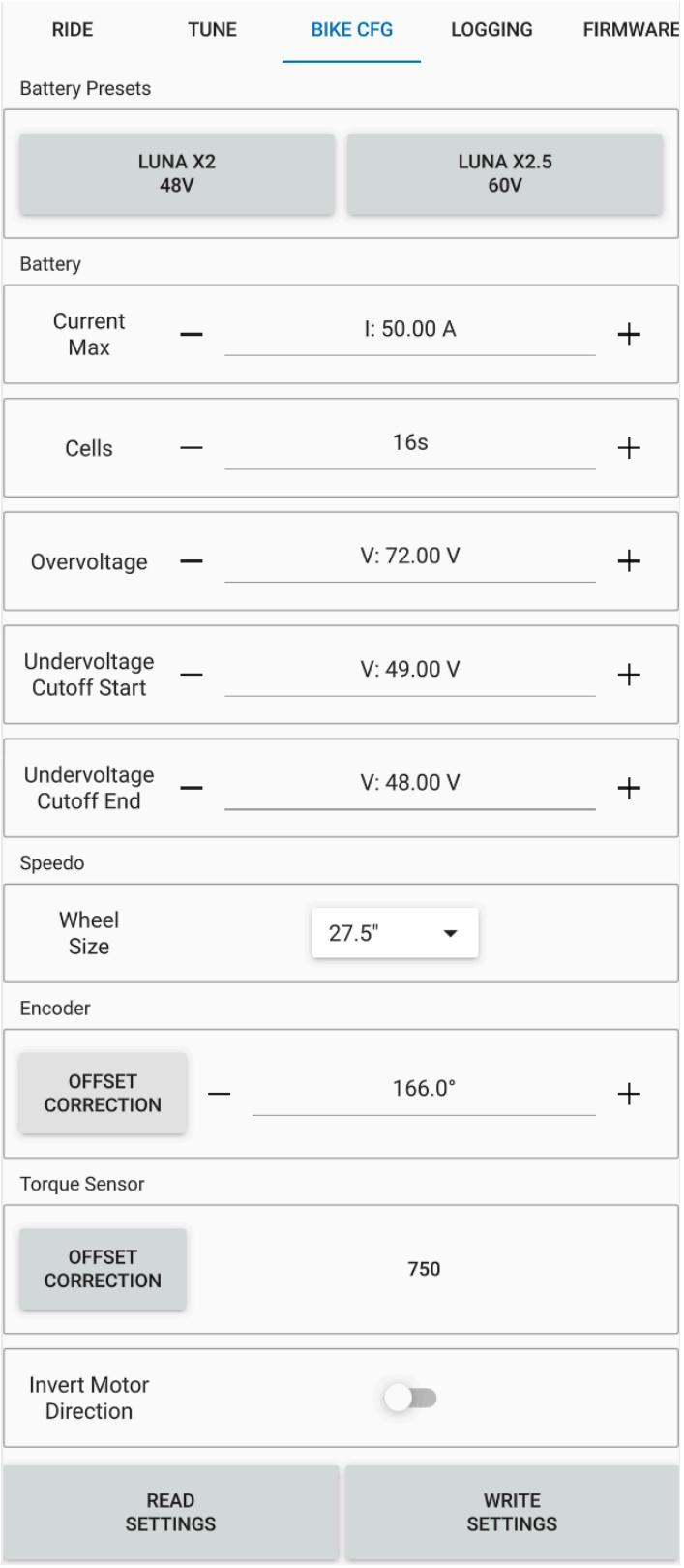
- **Throttle Response**
  The sharpest throttle response is achieved by reducing the ramp-up time to only 0.3 seconds. For a more smoother response, the slider can increase the ramp-up time to up to 3 seconds.

- **Torque Linearity**
  With the slider maxed out, the Throttle angle vs Torque will be fully linear. Reducing linearity will reduce the Torque in the initial part of the throttle, making it smoother on the low end.

- **Field Weakening Amps**
  This current extends the maximum speed of a motor for a given battery voltage. Set as 0.0A it behaves like a stock M600. Increasing FW Amps provides more end speed, some compensation for battery sag, but also increases the motor temperature due to I^2R losses in the windings with the corresponding efficiency penalty.

- **Fixed Throttle Amps**
  When checked, the throttle will always provide maximum torque, equivalent to level 9. When not checked, throttle torque follows the display levels (1 to 9). Setting level 0 disables both throttle and PAS.
  .

In the **BIKE CFG** tab you can set your battery, wheel size and datalogging parameters.



- **Battery current max**
  Limits your battery current to avoid exceeding its cell ratings. For example, each Q30 cell can supply 25A in short bursts.

- **Overvoltage**
  When the battery exceeds this voltage, a fault will be asserted.

- **Undervoltage Cutoff Start**
  At this voltage the torque available is 100%.

- **Undervoltage Cutoff End**
  At this voltage the torque available is 0%. Torque is linearly decreased between UV cutoff start and end to prevent the battery from sagging too low.

- **Wheel diameter**
  Used to calculate the speed from the wheel sensor. Wheel speed is shown in the display, in the apps, and in the logs. Go to Vesc Tool settings if you prefer imperial or metric units.

- **Encoder offset**
  Perform an encoder offset detection routine.

- **Invert motor direction**
  Some bafang motors are wired backwards. If the throttle spins the motor in the wrong direction, toggle this switch to reverse it.

- **Logging Directory**
  In order to store datalogs, this path needs to be defined.

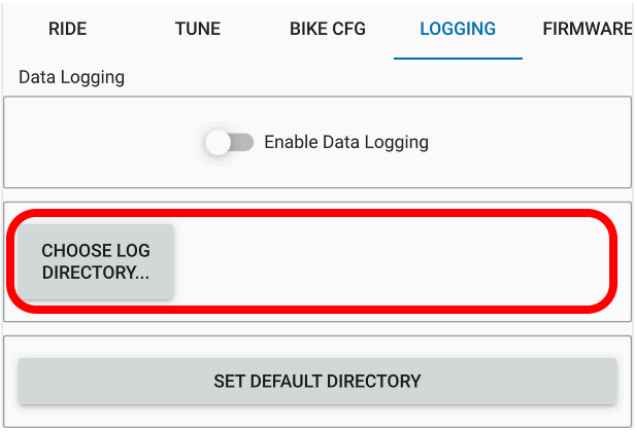
Default settings

Slider settings are stored in the phone app, so reinstalling the app will set the sliders to the default position.

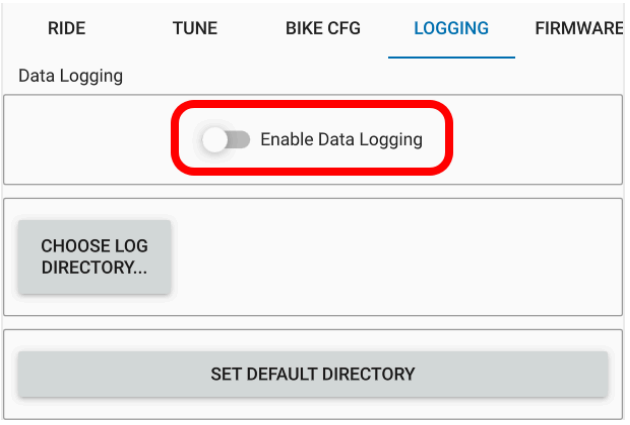
Log Analysis

With a M600 v2 controller you can save realtime data logs on your Android phone, and study the logs on your computer.

First, configure the logging directory in the app (the default directory won't work), the setting is found in the BIKE CONFIG tab:

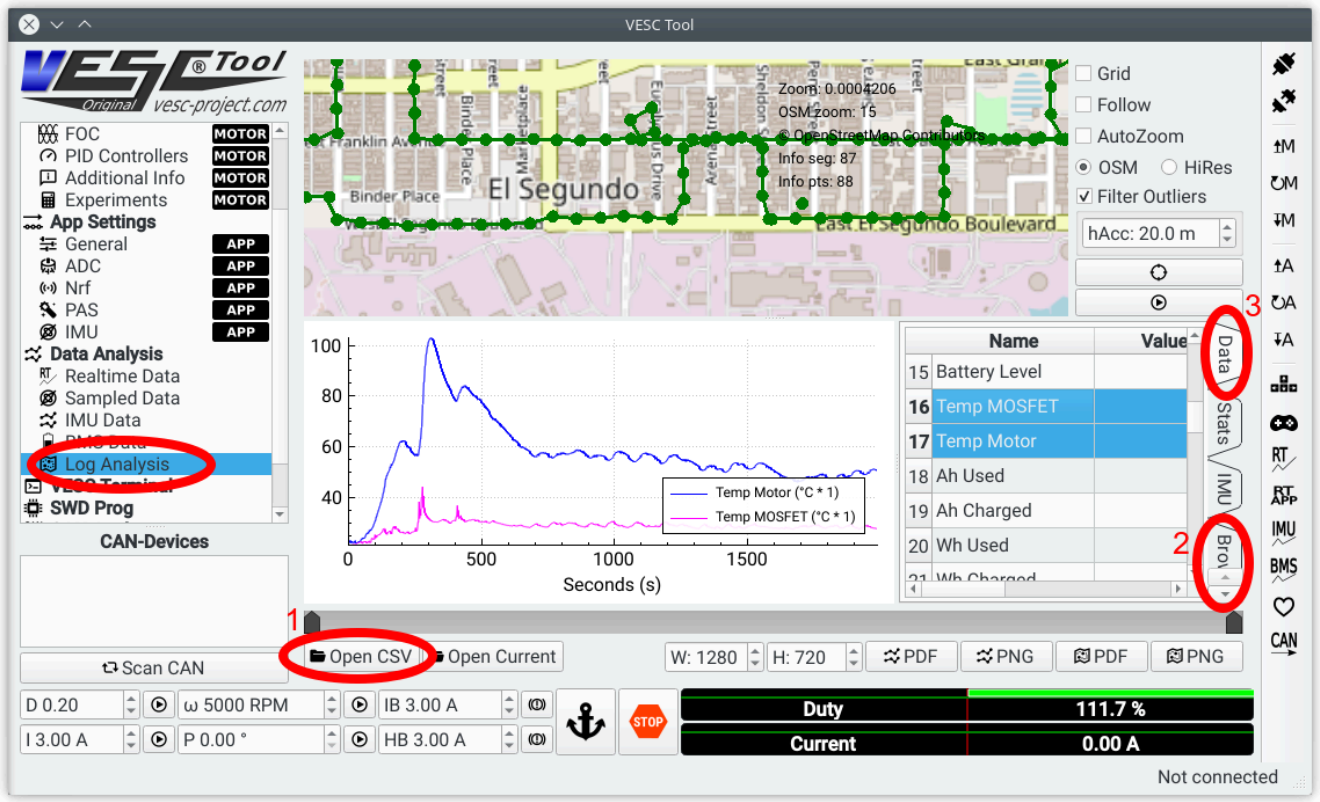


Once configured, you can enable data logging at any time.



When datalogging is enabled, a .csv file will be created in the directory you configured. Each time logging is enabled, a new .csv will be created.

After logging, send the CSV files to your PC.

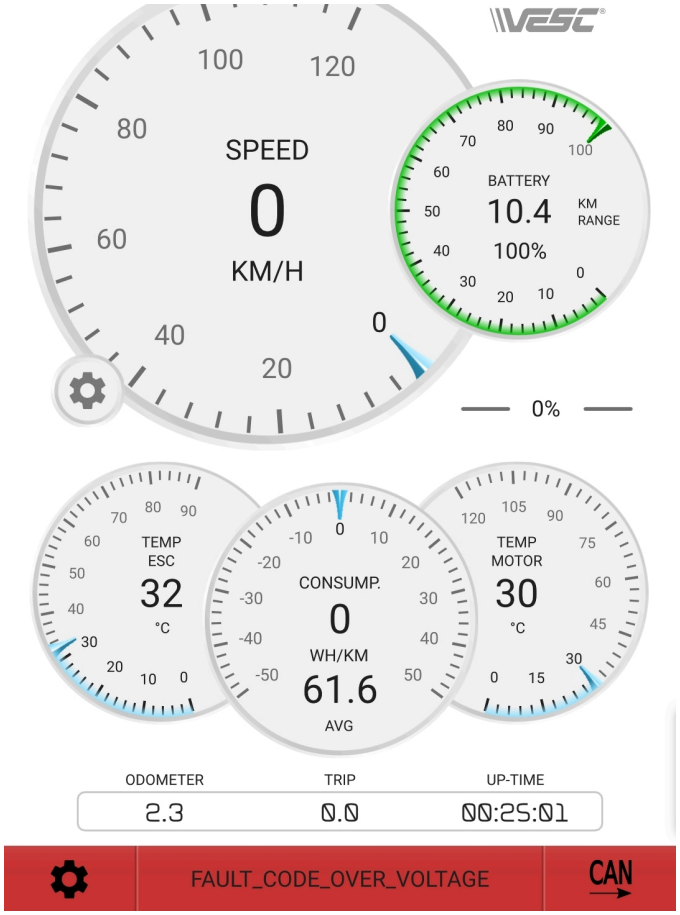


3. From VESC Tool, Go to Data Analysis -> Log Analysis.
4. Open CSV
5. Browse the csv
6. Configure your variables to display.

Here you can find a video with a walk through this Log Analysis feature:
https://www.youtube.com/watch?v=1dm12zB78Ic

Fault Codes

When the controller detects a problem, the fault source will be shown on the bottom of the dashboard (RIDE tab):



Fault codes are also stored in the csv when logging is enabled, which is useful when fault is cleared before you can read it.

Here are some of the faults the controller could report:

VESC Tool Code	Display code	Description
	Error 30	Display can't reach the motor controller in the CANbus network
FAULT_CODE_ENCODER_NO_MAGNET	Error 08	Encoder magnet not detected
FAULT_CODE_ENCODER_SPI	Error 08	Magnetic encoder error. Most

		likely the offset angle got reset
FAULT_CODE_OVER_VOLTAGE	Error 07	Battery overvoltage. Check if your battery limits are ok
FAULT_CODE_UNDER_VOLTAGE		Battery undervoltage. Check if your battery limits are ok
FAULT_CODE_DRV		Powerstage failure
FAULT_CODE_ABS_OVER_CURRENT	Error 12	Phase current exceeded 230A for an instant
FAULT_CODE_OVER_TEMP_FET	Error 10	Mosfets reached 95°C
FAULT_CODE_OVER_TEMP_MOTOR	Error 10	Motor reached 120°C
FAULT_CODE_GATE_DRIVER_OVER_VOLTAGE		Internal 12V supply failure
FAULT_CODE_GATE_DRIVER_UNDER_VOLTAGE		Internal 12V supply failure
FAULT_CODE_MCU_UNDER_VOLTAGE		3.3V regulation failure
FAULT_CODE_FLASH_CORRUPTION		Background memory integrity check failed
FAULT_CODE_HIGH_OFFSET_CURRENT_SENSOR_1	Error 12	Phase A current sense off-spec
FAULT_CODE_HIGH_OFFSET_CURRENT_SENSOR_2	Error 12	Phase B current sense off-spec
FAULT_CODE_HIGH_OFFSET_CURRENT_SENSOR_3	Error 12	Phase C current sense off-spec
FAULT_CODE_UNBALANCED_CURRENTS	Error 12	Phase current sensor damaged
FAULT_CODE_BRK	Error 12	Hardware overcurrent protection tripped
-	Error 25	Display can’t reach the torque sensor in the CANbus network
FAULT_CODE_FLASH_CORRUPTION_APP_CFG		Application config integrity check failed
FAULT_CODE_FLASH_CORRUPTION_MC_CFG		Motor config integrity check failed

More fault sources could be added over time.

Firmware update

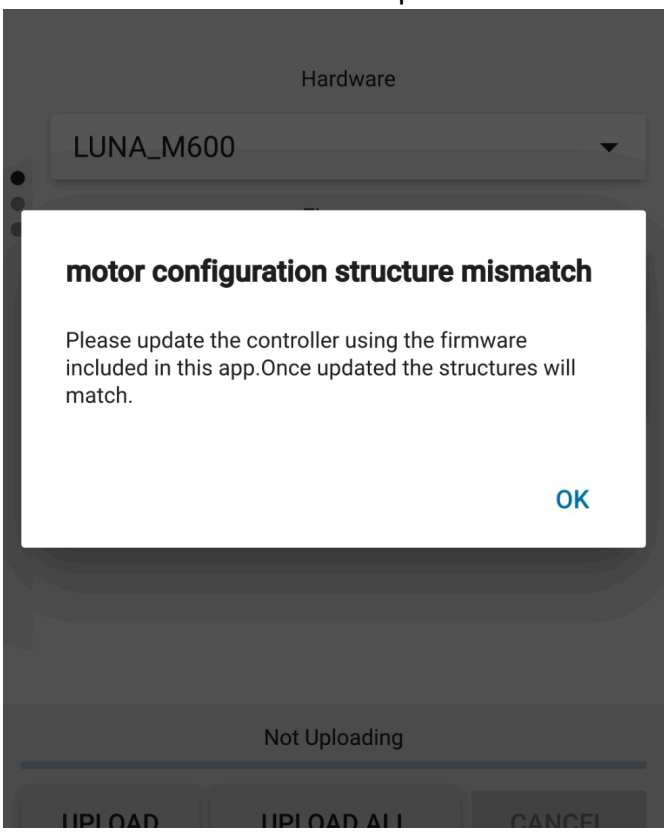
See instructions and screenshots below

1. Don't remove the battery during the update process. The controller can get bricked if that happens.

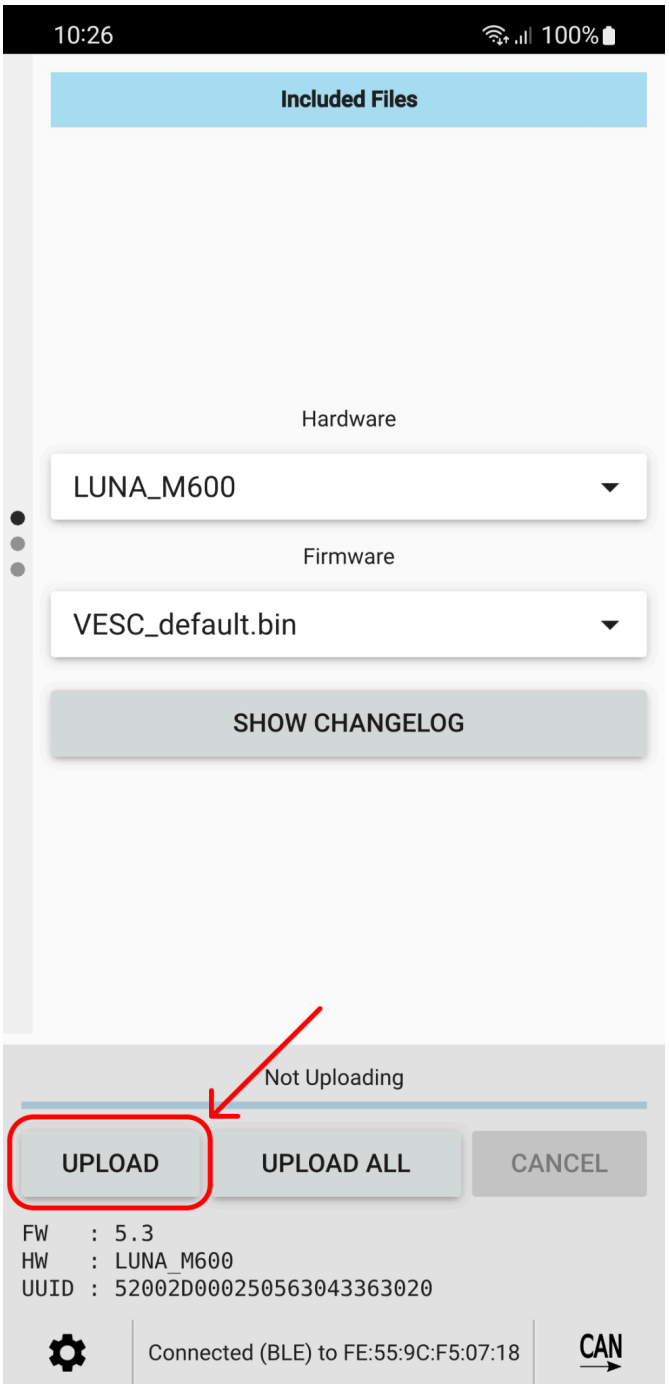
2. If your Ludi V2 had special settings, write them down as the firmware update will reset all settings to default

3. Get the latest VESC Tool app

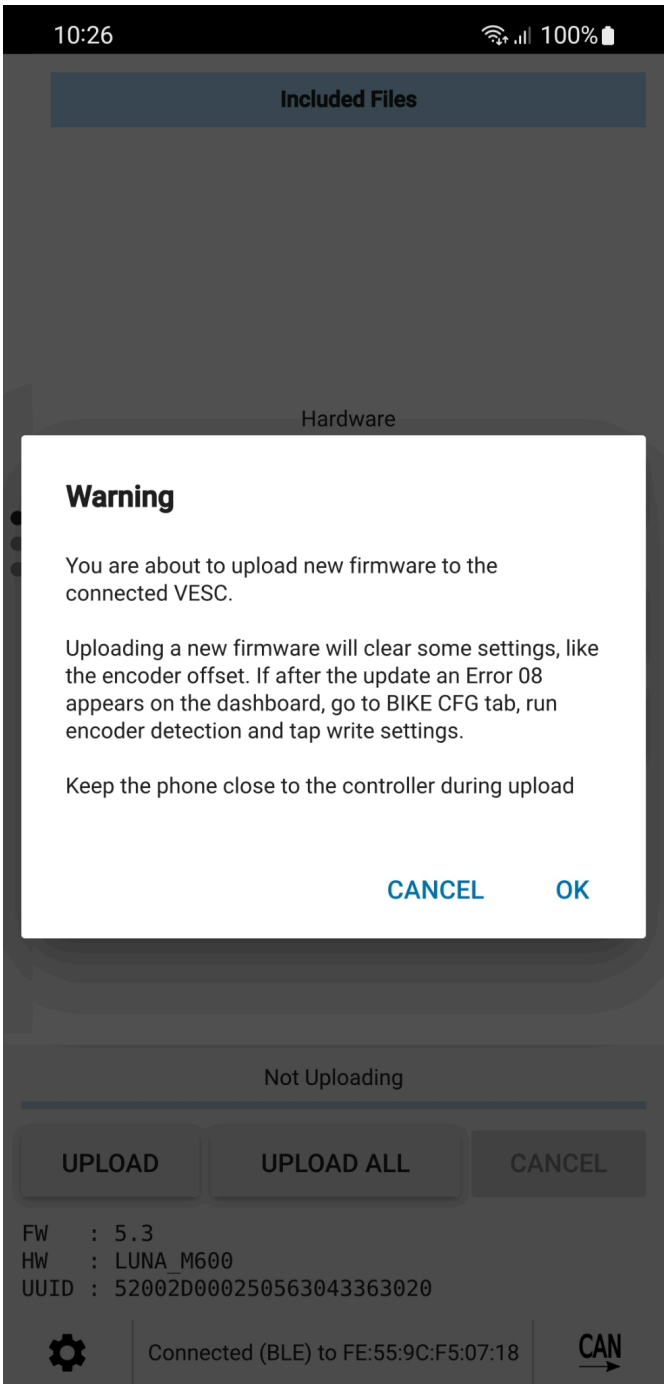
If you have an old firmware and are greeted with this structure mismatch message, continue with the firmware update.



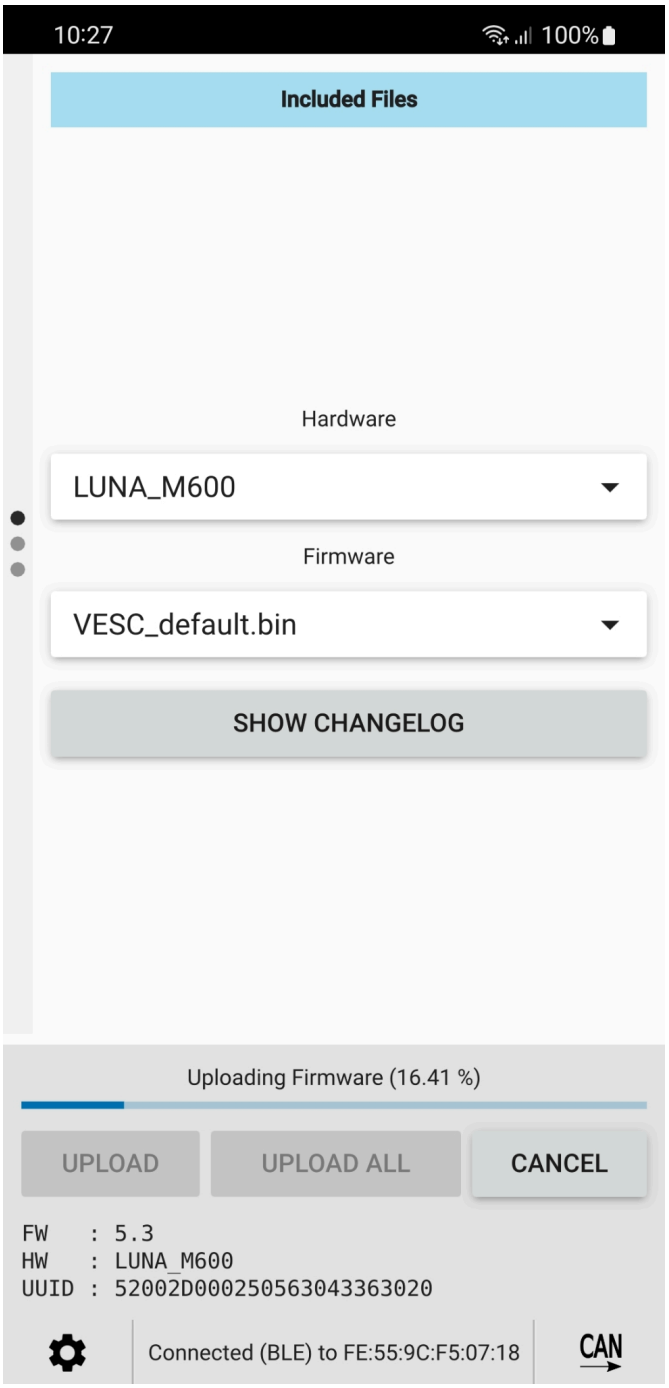
Luna will let you know when new firmwares are available



4. From the app, go to **FIRMWARE** tab and select the firmware according to your battery



5. Read and accept the warning



6. Wait some minutes until upload finishes. You can press the display buttons to avoid auto-shutdown during the upload.

Make sure the phone is close to the controller and don't shut down the M600 while firmware is being updated.
The bike display might show a brief error code right after upload finishes, it will clear itself.

If the controller had an old (2021) firmware, the bike will show an Error 08, meaning that the encoder offset needs to be configured. See Encoder Offset Detection (ERROR 08).

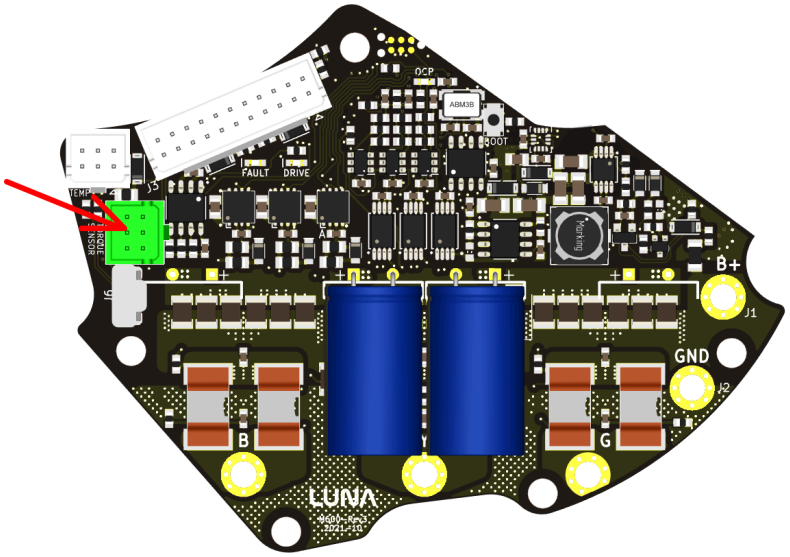
Some reasons for updating the firmware may include:

- Bug fixes
- New features
- Tuning optimization
- Power increases

Firmware update over USB

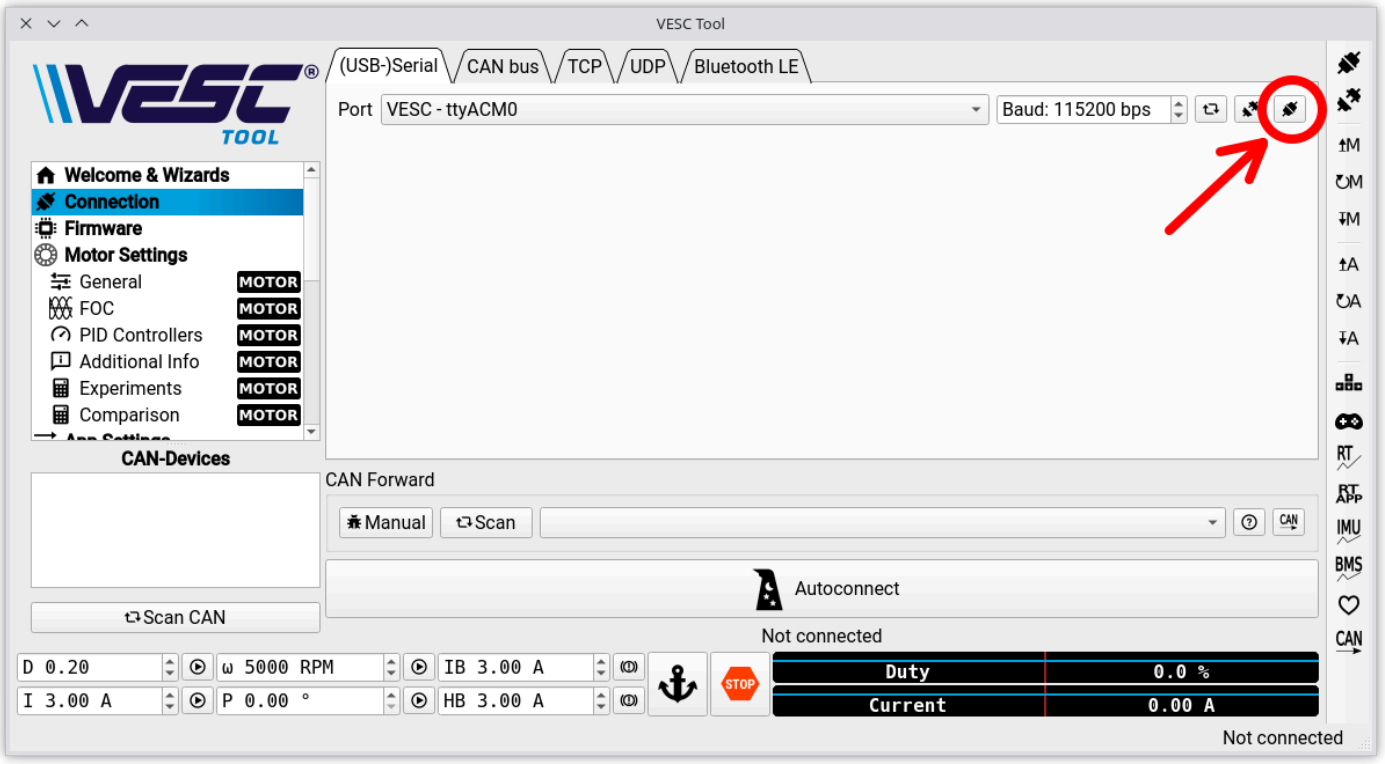
In case reflashing the firmware over USB is needed, for instance when the controller gets bricked with a wrong firmware, you can reflash the firmware using VESC Tool for windows. There is a Mac version that probably does the job but we haven't tested it.

1. Download and install VESC Tool for windows
2. Remove the battery.
3. Remove the controller from the drive unit, it's held by 4 screws.
4. Locate the micro-USB connector and disconnect the white cable next to it (it mechanically interferes with some usb cables)



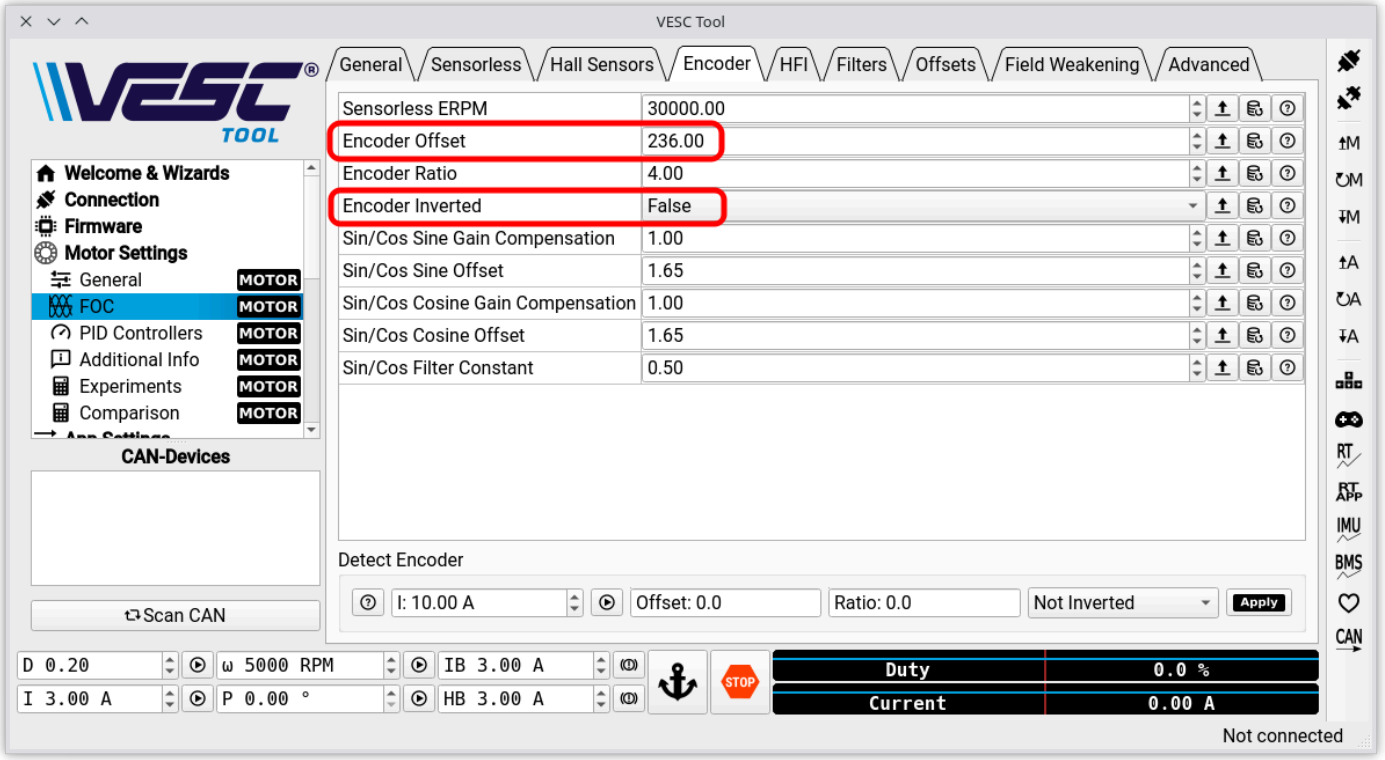
Disconnect the white torque sensor cable

5. Connect the micro USB cable to a PC. A red LED will start flashing in the board
6. Run the VESC Tool software and connect to the M600 control board over usb



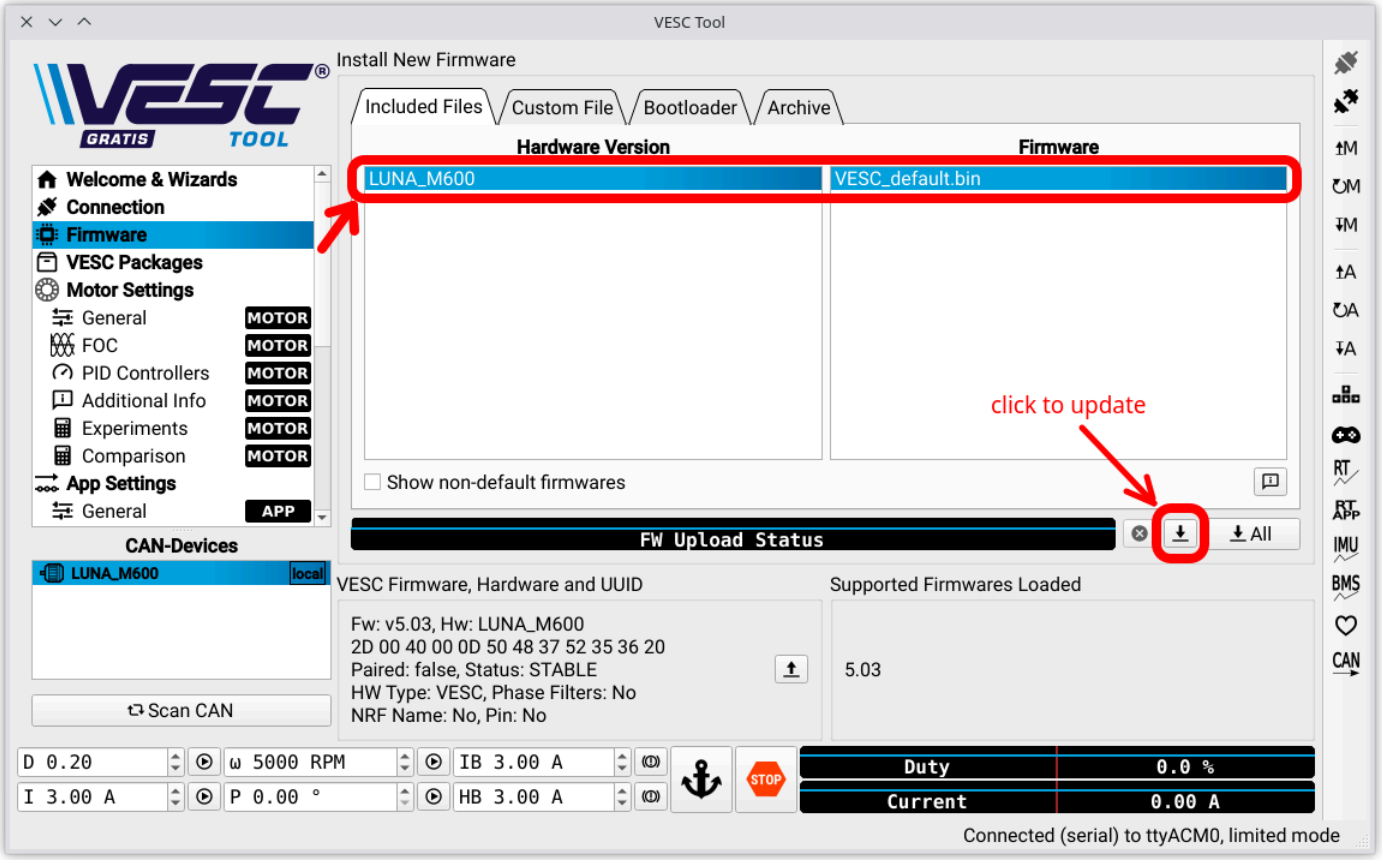
Connection tab

7. Go to FOC->Encoder and **write down the Offset value and inversion**. You will need this number later.

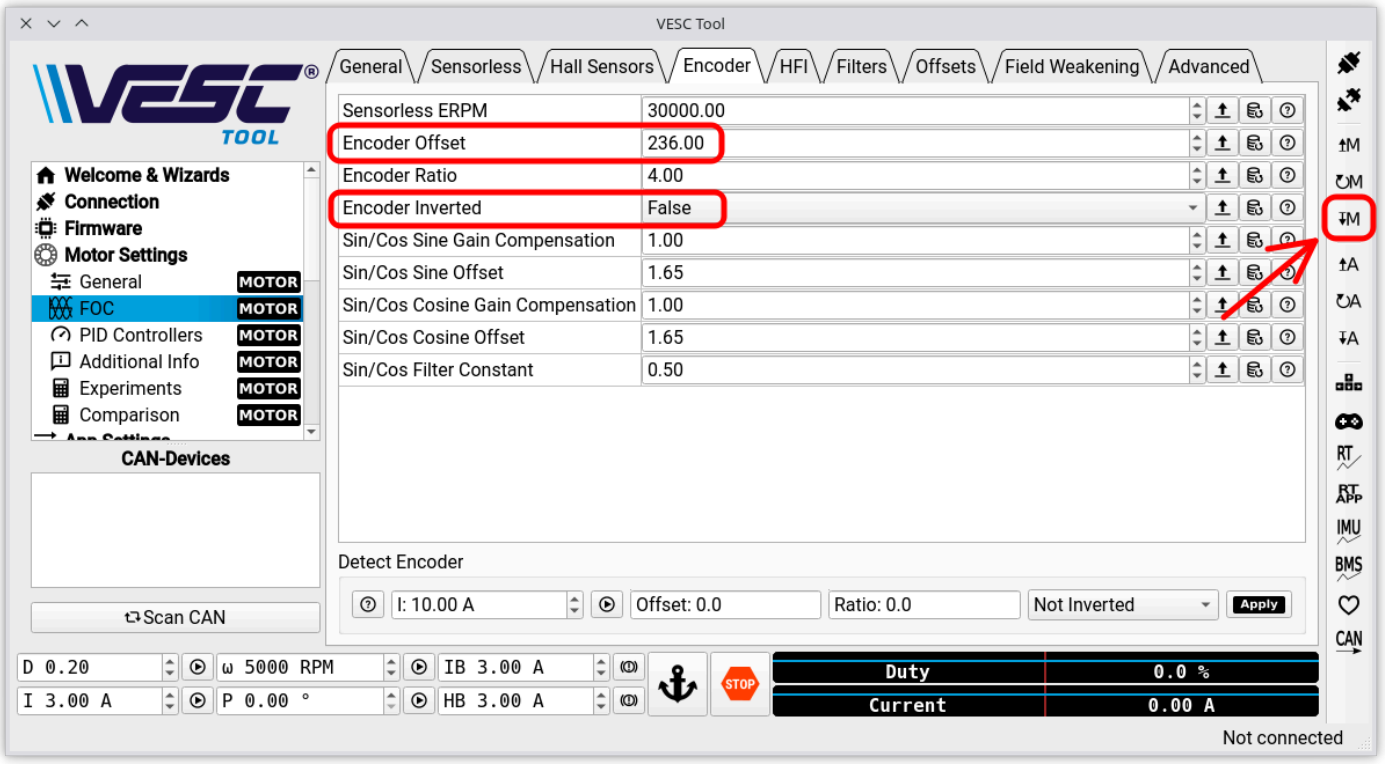


WARNING: IF YOU DON'T HAVE AN ANDROID PHONE, YOUR BIKE WON'T WORK IF YOU LOSE THIS NUMBER

8. Use the ***included*** firmware to perform the firmware upload



9. Wait until the upload is finished, wait another 10 seconds and reconnect
10. Go to FOC panel, Encoder tab. In the Offset field use the value from step 6. And click on *Write motor config* button on the right panel.



11. Disconnect USB, connect the white cable and install the controller
12. Install battery and power on the bike, it should be ready to run

Recovering a bricked controller

If the controller does not respond to a USB connection, a full firmware upload shall take place. In case of bricking scenarios, the controller, as a last resort, has a standard DFU bootloader stored in ROM, and can't get bricked.

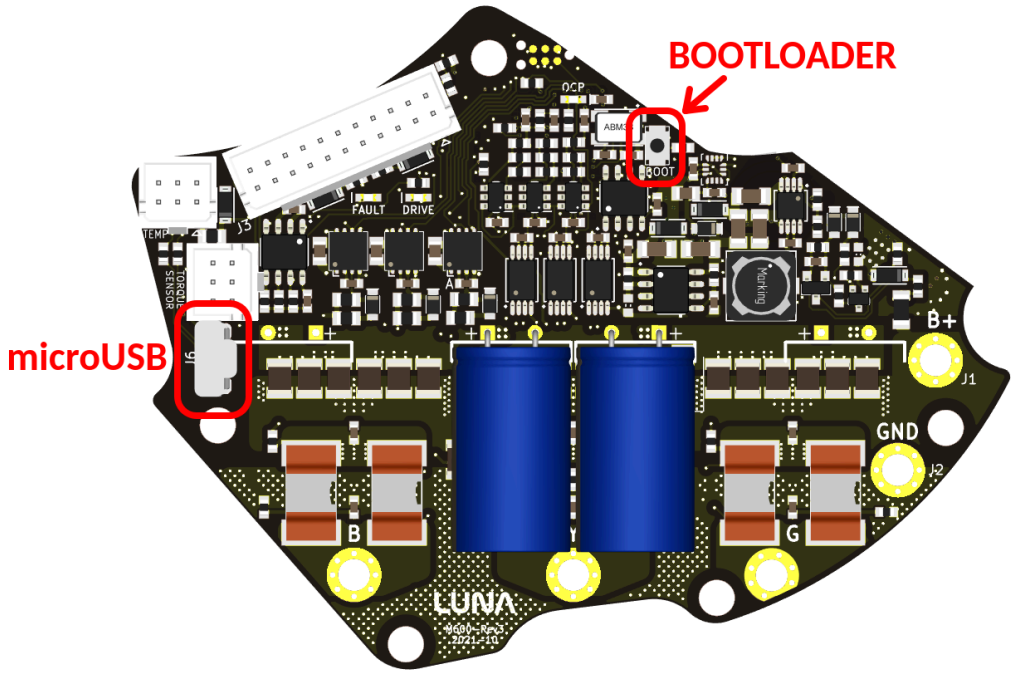
On linux machines, all you need is to install one package:

```
sudo apt install dfu-utils
```

There are DFU tools for Windows but we haven't used them in many years.

The process is like this

- Press the BOOTLOADER button, and don't release it. Some recent batches don't have the button populated, you can short the pads with a tweezer or just short them by soldering a small wire.
- Connect the control board over USB. 3.3V (green) and "OC" (red) LEDs should light up.
- Release bootloader button.



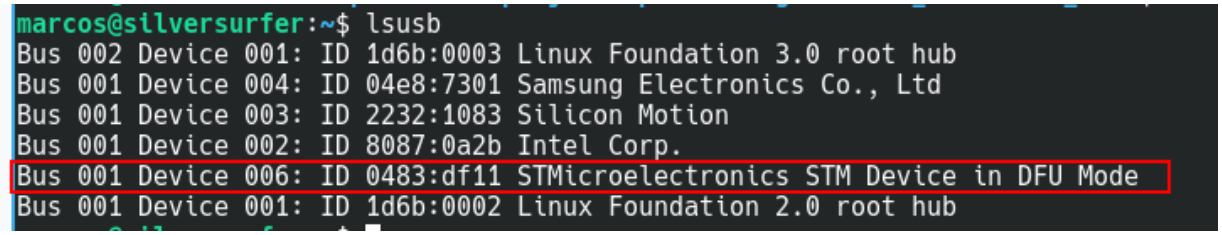
Locations for Rev1 boards. Rev1 through the current Rev7 don't change much these locations

- The board should have started in DFU bootloader mode. With the following command the firmware will be flashed:

```
cd <path_to_M600_fw.bin>
sudo dfu-util -a 0 -s 0x08000000:leave -D VESC_M600_V5.03_48v_full_image_for_DFU.bin
```

This very special .bin that includes the application+bootloader is available here. Note that the firmware is a bit old, you'll want to update it to the latest firmware included in vesc tool.
This single step takes a couple of minutes, and flashes at once the VESC bootloader, VESC

firmware, M600 motor configuration and M600 throttle configuration. The encoder offset will be wrong and need re-calibration once it is installed again in the drive unit.
A successful download looks like this:



lsusb listing a DFU bootloader

```
marcos@silversurfer:~$ time sudo dfu-util -a 0 -s 0x08000000:leave -D ~/BBSHD_fw_dev_5_02.bin
dfu-util 0.9

Copyright 2005-2009 Weston Schmidt, Harald Welte and OpenMoko Inc.
Copyright 2010-2016 Tormod Volden and Stefan Schmidt
This program is Free Software and has ABSOLUTELY NO WARRANTY
Please report bugs to http://sourceforge.net/p/dfu-util/tickets/

dfu-util: Invalid DFU suffix signature
dfu-util: A valid DFU suffix will be required in a future dfu-util release!!!
Opening DFU capable USB device...
ID 0483:df11
Run-time device DFU version 011a
Claiming USB DFU Interface...
Setting Alternate Setting #0 ...
Determining device status: state = dfuIDLE, status = 0
dfuIDLE, continuing
DFU mode device DFU version 011a
Device returned transfer size 2048
DfuSe interface name: "Internal Flash  "
Downloading to address = 0x08000000, size = 1024000
Download        [=========================] 100%      1024000 bytes
Download done.
File downloaded successfully
Transitioning to dfuMANIFEST state

real    2m4.664s
user    0m0.127s
sys     0m0.281s
marcos@silversurfer:~$
```

Programming sequence complete

This process can be faster with specialized programming tools (STLink programmer and a Tag-connect cable).

It’s worth noting that once VESC firmware is programmed and running, for following firmware updates it’s quicker to use VESC Tool GUI to upload a new firmware.

FAQ

Why doesn't the bike turn on?
The battery has a toggle switch, it could be in the OFF position.

Why does my bike feel underpowered?
Check with the app if the controller is in a low power Street Legal mode. If you have doubts you can send us a data log and we'll take a look.

Why the display odometer and app odometer don't match?
Bafang and VESC use different ways of tracking mileage, so there will be some drift over time.

If I install the phone on the handlebar the connection drops?
Bluetooth range is short, but it should reach the handlebar. Contact Luna for support. As a side note, users recommended this holder to attach the phone to the frame

What does Error 30 mean?
It means that the display can't reach the controller. It's usually a wiring issue, refer to the troubleshooting section

When are the new VESC Apps (iOS, google play) released?
When the VESC developers and community decide so, it's not up to us.

Do I have to run the encoder detection on every update?
No,if the controller has a new firmware (2022 release) it will remember your encoder offset through the update process

The gauge cluster is too busy, can I customize it?
Not yet but we are working on it!

What is the micro USB port for inside the controller?
That is for a PC connection in case the controller gets bricked.

Installing a new controller

Required tools and hardware

In order to install the controller into an existing M600 drive unit, the following tools are necessary:

- M600 drive unit
- M600 Ludicrous V2 controller
- Torx screwdriver
- Android smartphone
- VESC Tool app

Installation

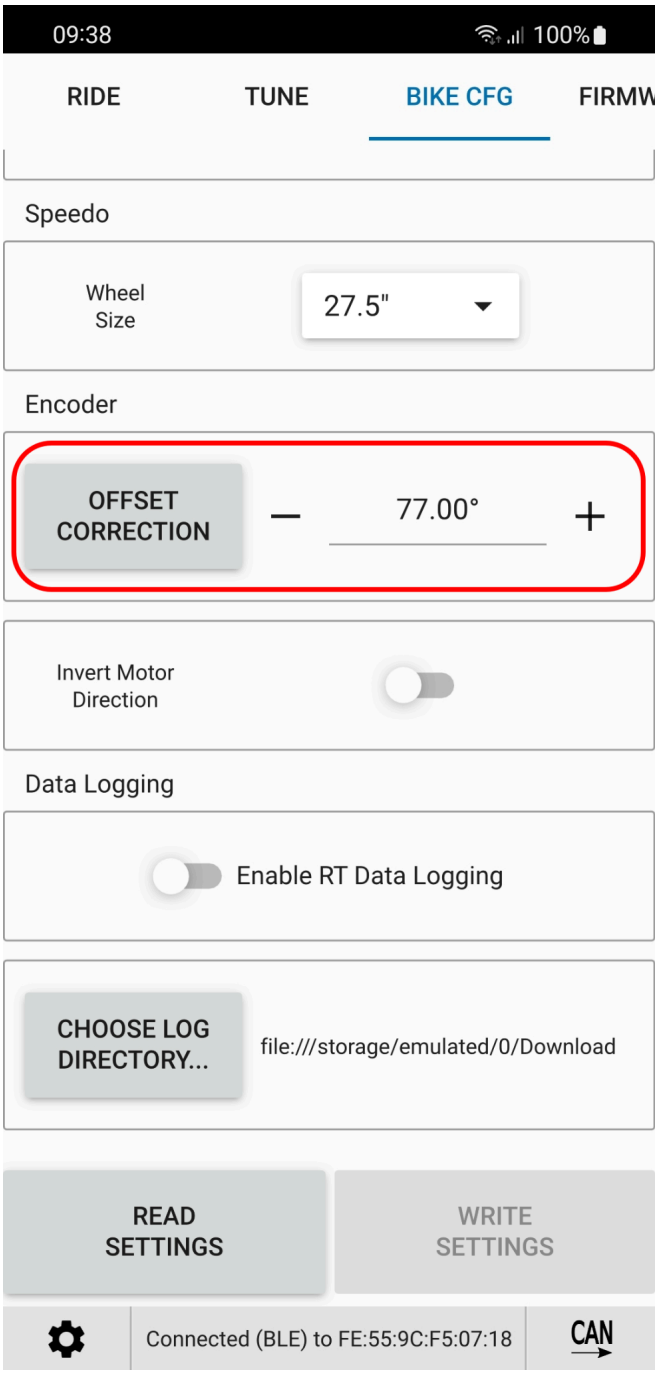
- Remove the stock controller by removing the 4 torx screws and unplugging the 5 signal and power cables. This is a bit easier if the chainring is removed first.
- Install the gasket on the new controller heatsink noting there is a locating pin which helps keep the gasket in place.
- Take the new controller and connect the black 2 wire cable (temp sensor), then the wide 20-wire signal connector, then the 6-wire PAS connector and finally XT60 battery and MR60 connectors. This is just a guideline to make the connections with a bit less effort.
- Insert the controller assembly in place. It's a very tight fit and there are lots of wires that can block the installation, try to move them out of the way, otherwise the board can get damaged. The bluetooth antenna is particularly delicate and prone to damage if it gets pinched during installation.
- Install and tighten the x4 Torx screws
- Connect the battery and power ON the system from the display button. The display should show ERROR 08 which means that the encoder offset must be programmed.

Encoder Offset Detection (ERROR 08)

The M600 drive unit takes the rotor position feedback from a magnet glued at the end of the rotor shaft. This cylindrical magnet is not keyed, so it ends up glued in a random position which needs to be detected in order to have a functioning drive unit.

This detection process is done with the VESC Tool app:

- Download the app from the link in the previous section for the Android/iOS App.
- Open the app
- Power up your bike with the M600 drive unit and Ludi controller (the app will NOT work for standard controllers!)
- Connect to the controller over Bluetooth
- Go to the BIKE CFG tab in the mobile app
- Lift the rear wheel or remove the chain from the chainring so that the motor can spin freely.
- Tap Offset Detection. The motor will spin slowly forward and backwards and the angle offset will be acquired. You may want to write this number down temporarily.



- After the Offset Detection completes, tap **WRITE SETTINGS** to write this into the controller memory. Verify that the write succeeds.
- Once you get confirmation the write succeeded, power cycle the bike/motor/controller by turning it off, then back on. Error 08 on the display should be cleared. You should not need to do this again unless the controller is removed or work is performed on the motor.)

The controller is now ready to run!

Troubleshooting

Problem	Possible cause	Solution
Error 30 shown in display	Loose connection, wiring damage	Wiring issue, tighten all connectors
	Non-luna firmware flashed	Flash the Luna M600 firmware
	Damaged internal supply (BLE wouldn't work)	Contact Luna
Error 25 shown in display	Display can't communicate with torque sensor	Wiring issue, tighten all connectors
		Temp sensor and torque sensor connectors swapped during installation. Un-swap them.
Poor motor performance	Wrong encoder offset	Repeat the encoder offset correction.
Motor not working	Wrong battery settings (FAULT_CODE_UNDER_VOLTAGE or FAULT_CODE_OVER_VOLTAGE)	Use your battery parameters
	Wrong motor/throttle/PAS config	Re-flash the firmware to go back to default values
	Motor overheat (FAULT_CODE_OVER_TEMP_MOTOR)	Let the motor cool down
	Gate driver supply damage (FAULT_CODE_GATE_DRIVER_UNDER_VOLTAGE)	Contact Luna. Please attach a log file.
Non smooth torque	Load too high	Use lower gearing
Display does not turn on	Battery power switch is off	Toggle battery switch
	If battery power switch is on	Try the M600 troubleshooting guide
No BLE on the air	Bluetooth module not programmed	Request instructions from Luna to flash the module over USB
Poor BLE range	Bluetooth antenna damaged or disconnected	Contact Luna

“This VESC is not paired to your Local version of VESC Tool”	Controller was paired to a lost/unavailable instance of VESC Tool	Unpairing can only be done with the phone that has been paired. If that phone and app is not available, re-flash the Luna M600 firmware using the the Desktop version of Luna VESC Tool over USB.
USB does not show up	Windows CDC driver not installed in windows older than win10	Install the driver from here: https://www.st.com/en/development-tools/stsw-stm32102.html

In any case, if something stops working its useful to check in the app if there is any FAULT_CODE

Downloads and Resources

- ☐ This device contains open source software ©Benjamin Vedder and contributors
- ☐ The source code is licensed under the GPLV3 license. You can find a copy of the license here: https://www.gnu.org/licenses/gpl-3.0.en.html
- ☐ VESC Tool on iOS App Store and Google play
- ☐ VESC Tool source code: https://github.com/vedderb/vesc_tool
- ☐ VESC Firmware source code: https://github.com/vedderb/bldc/