

Owner's Manual



*Falco*  
ELEVATE THE RIDE.



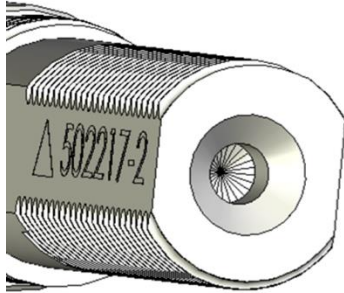
Rakesh Dhawan  
President

To let dreams come true also means hard work. We have always dreamt of building the best eBike components in the world, and of creating a unique eBike experience. Achieving that with the Falco name means innovation and technological leadership. My team and I share the passion of striving for technical excellence.

Falco designs develops and manufactures eBike Systems for trikes, tandems, and bicycles. The Falco brand name has quickly become synonymous with speed, extraordinary experience, utterly seamless mobility, technology leadership, highest product quality and reliable customer service in the market for premium eBike Systems. It is our goal to improve the natural and urban environment by designing interfaces between human and machine, utilizing smart systems and green technology. We believe that our products are a crucial enabler to promote healthy living, reduce carbon emissions and – besides – change the mode of transportation, in particular in urban areas. While eBike systems not only reduce emissions, they also provide solutions to road congestion in urban centers, a growing challenge around the world. We remain committed to working aggressively on solutions for alternative mobility.



## Quick Installation 1-2-3

<p><b>Step 1:</b> Install the Wheel. The marking or red mark on the flat part of axle on the drive side should point to the back of the wheel.</p>	
<p><b>Step 2:</b> Secure the axle with a torque bar, two washers and a nut on each side. A torque arm can be used for additional security. M12 large nuts should be secured with a torque of about 40Nm or more.</p> <p>Many possibilities exist of installing the torque arms. They can be installed on either side of the frame.</p> 	 <p>Torque Arm Installation - Example 1</p> <p>Torque Arm Installation Example 2</p>
<p><b>Step 3:</b> Hook up the wireless module to the 6-pin of the motor. (Note: Throttle if available hooks to the 4-pin connector of the motor)</p>	
<p><b>Step 4:</b> Connect the Battery (2-pin Connector). Motor connector has male pins and battery connector is smaller with female pins.</p>	



## Quick Installation 1-2-3

<p><b>Step 5:</b> Start riding</p>	<p>Turn the battery ON and start riding</p>
<p><b>Step 6 (Optional):</b> Pair with the Console. If you have the console, please pair the console by holding the MODE button for 10 seconds (or until MOT flashes). Turn the battery ON, wait for 10 seconds and hold the MODE button for 10 seconds.</p>	<p style="text-align: center;">Industry's 1st eBike Wireless Console</p>
<p><b>Step 7 (Optional):</b> Control with your smart phone</p>	<p>GO to Google Play store or Apple app store to download Falco Flash. Download the BLE (Bluetooth low energy) apps and start controlling the motor through your app. If your Android phone is ANT+ enabled, you can also use ANT+ version of the Falco flash app.</p>
<p><b>Step 8 (Optional):</b> Install wired plus minus controls</p>	<p>For those seeking simplicity, order and install wired plus minus controls. Falco version of wired plus minus behaves as follows: Single, double, and triple click of the plus will enable assist levels 1, 3 and 5 respectively. Similarly, Single, double, and triple click of the minus will enable regen levels -1, -3 and -5 respectively. Holding the plus will enable throttle functionality. Holding the minus will enable the regen functionality.</p>

# Falco eBike Wheel Technology



# Falco eBike Wheel Technology



Wherever this symbol appears, there is a chance of injury, death, or damage to property. Follow the directions precisely whenever this symbol appears.

## 1.0 Review of all Components

In this section, we learn about various components of the Falco eBike wheel technology as per the list below.

- A. Wheel Technology
  - a. Hx Motor;
  - b. Motor Hardware;
  - c. Torque Arms;
  - d. Rims;
  - e. Spokes;
  - f. Wireless Module;

## 1.1 Wheel Technology

### 1.1.1 Hx Motor

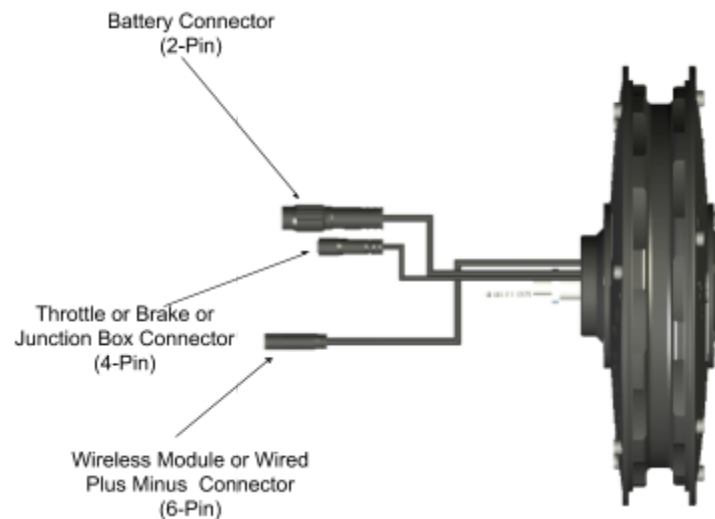
Falco has streamlined the product line in the recent years to manufacture a single motor platform rated at 750W power. All other models of lower and higher power levels were obsoleted in 2017. The motor has been upgraded with new manufacturing technology, new electronics, firmware, new torque sensor and new free hub attachment. Let us have a quick look at the Hx Motor (2017 and 2018 Models).

# Falco eBike Wheel Technology



**Figure 1: View of the Hx Motor from the drive side**

Figure 1 above shows the Hx motor from the drive side or the free hub side. Figure 2 below shows the motor's connectors which come out of the disc brake side.




**Figure 2: Hx Motor Connectors**

Hx motor has three cables coming out of the disc brake side. 2-pin cable is connected to the battery, 4-pin is meant to connect to a throttle or a regenerative brake sensor or a junction box and the 6-pin

# Falco eBike Wheel Technology

cable is meant for the wireless module or a wired plus minus interface. Wired plus minus interface can also be connected through the wireless module as well. Connecting a wired plus minus through the wireless module allows use of wireless devices with the motor.



It is easy to confuse between the 6-pin and 4-pin connectors. Also, the connectors are polarized and require careful attention when connecting and disconnecting. Because the connectors are water-proof, their connection and disconnection require more force than usual.

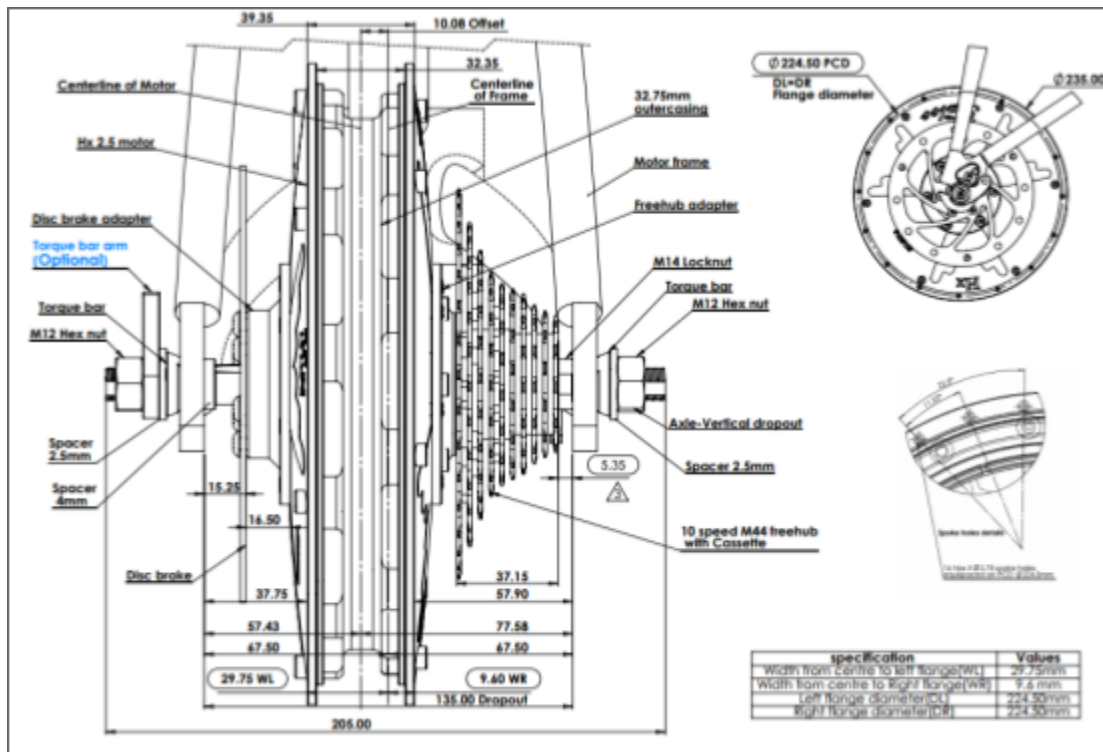


Figure 3: Standard Hx Motor has 32 spoke holes and a 135mm O.L.D (over the locknut Dimension)

Figure 3 above can be used to build a wheel. [Falco spoke length calculator](#) can be used to calculate spoke lengths. The calculator is meant to be used



# Falco eBike Wheel Technology

as a guide. At times, it may require a few attempts at wheel building to determine more accurate spoke lengths for your rim.

## 1.1.1.1 Spoke Holes

Hx Motor is available in different number of spoke holes. Spoke holes are CNC machined and hence can be machined for any number of holes. Standard configuration in stock has 32 spoke holes. Falco can provide any number of spoke holes. The non-standard spoke holes require extra lead time for delivery.

## 1.1.1.2 O.L.D (Over the Locknut Dimension)

Standard in stock motor has 135mm as O.L.D. However, additional non-standard O.L.D configurations are also available. For example, 160mm O.L.D for Santana Tandems is available. Other custom O.L.Ds can also be made available. Any O.L.D other than 135mm requires extra time for delivery.

## 1.1.1.3 Frame Dropouts

Hx Motors are available for vertical as well as horizontal dropouts. However, motors suitable for vertical dropouts are stocked. Horizontal drop-out motors require additional lead time for delivery. Dropout angle is critical for the functioning of the torque sensor or the pedal assist functionality. Adjustments for dropout variations can be done through the use of Falco Flash or eBike lab software available for mobile as well as Windows and Mac platforms.

## 1.1.1.4 What are Dropouts?

If your wheel can be removed from the bottom of the frame then you have a vertical drop-out. If your wheel can be removed from the back of the frame, then you have a horizontal dropout. Drop-outs at various angles are also available in the market.

# Falco eBike Wheel Technology

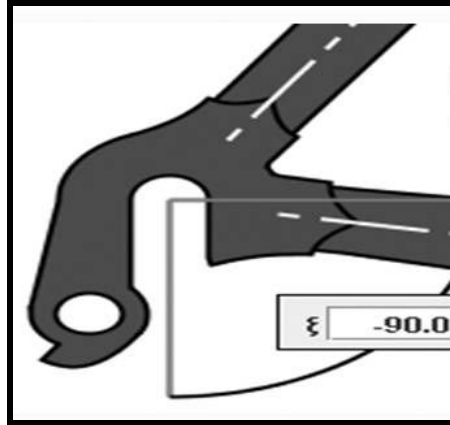


Figure 4: Vertical Dropout in a bicycle frame. The wheel is removed vertically from the frame.

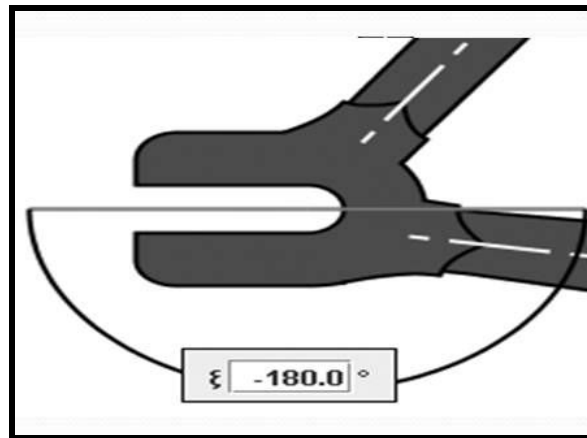


Figure 5: Horizontal Dropout in a bicycle frame. The wheel is removed horizontally from the frame.

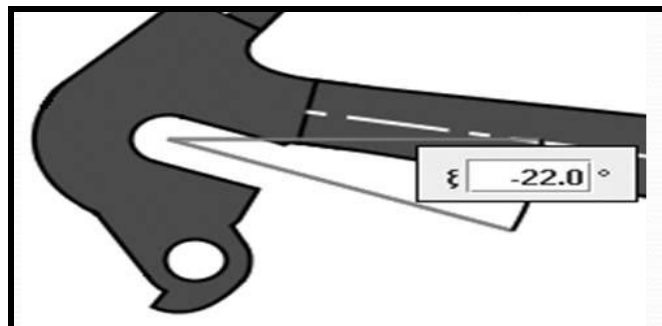


Figure 6: An example of a Non-Standard ( $-22^\circ$ ) Dropout in a bicycle frame. This dropout will require a Hx motor with horizontal dropouts and use of Falco Flash or eBike lab software for torque sensor adjustments.

# Falco eBike Wheel Technology

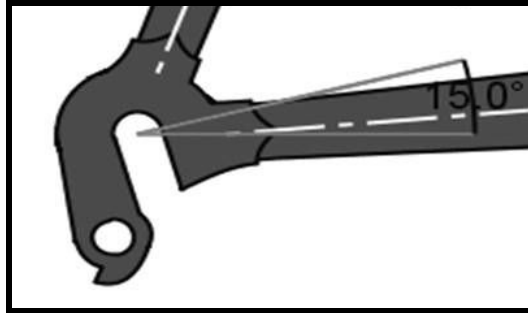


Figure 7: Another example of a Non-Standard (+15°) Dropout in a bicycle frame. This dropout will require a Hx motor with vertical dropouts and use of Falco Flash or eBike lab software for torque sensor adjustments.

Additional information on dropouts is provided below.

Reference: [Sheldonbrown.com](http://Sheldonbrown.com)

*Rear dropouts come in two styles:*

**Horizontal dropouts** have a longish slot for the rear axle to fit into, which runs more-or-less horizontally along the dropout. They permit the wheel to be placed in various positions front to rear. Horizontal dropouts are necessary for bicycles which don't have derailleurs, because the axle must be moveable to adjust the chain tension. With horizontal dropouts, it is possible to misalign the wheel in the frame if it is installed carelessly. The axle nuts or quick-release must be tightened quite securely, or the chain tension may pull the axle askew.

**Vertical dropouts** have a vertical notch for the axle to go up into, and the axle's position is not adjustable. With vertical dropouts, the axle cannot be pulled out of position, even if it is not properly secured. Vertical dropouts are generally intended for use with derailleur gearing, and do not permit any adjustment of the position of the rear wheel, so there's no way to regulate chain tension if you don't have a derailer or pulley type chain tensioner.

## 1.1.1.5 Motor Hardware

The following hardware is installed on the shaft of the motor when shipped from the factory.

# Falco eBike Wheel Technology

1. Torque Bars (2 Quantities - One on each side of the axle);
2. Axle Nuts M12X1 (2 Quantities - One on each side of the axle);
3. Axle Washers (4 Quantities - Two on each side of the axle).

Hardware picture is shown below:

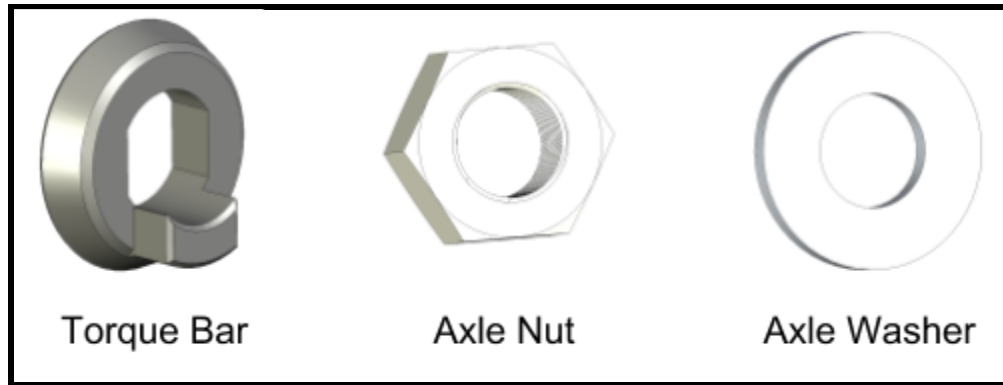


Figure 8: Each motor is shipped with two torque bars and nuts and four washers.

## 1.1.1.6 Torque Arms

One set of torque arms is included with every motor shipment. Torque arms are not necessary for every installation. However, many bike and trike frames can have shallow drop-outs. With shallow drop-outs, the motor axle can spin out causing damage or injury. Use of torque arms prevents such an event. A careful evaluation should be done for non-use of torque arms. Falco highly recommends the use of torque arms to prevent any damage or injury. See the installation section of the manual for how to use them.



Torque arm though optional is highly recommended for all installations. Non-use of torque arms should be carefully evaluated.

# Falco eBike Wheel Technology

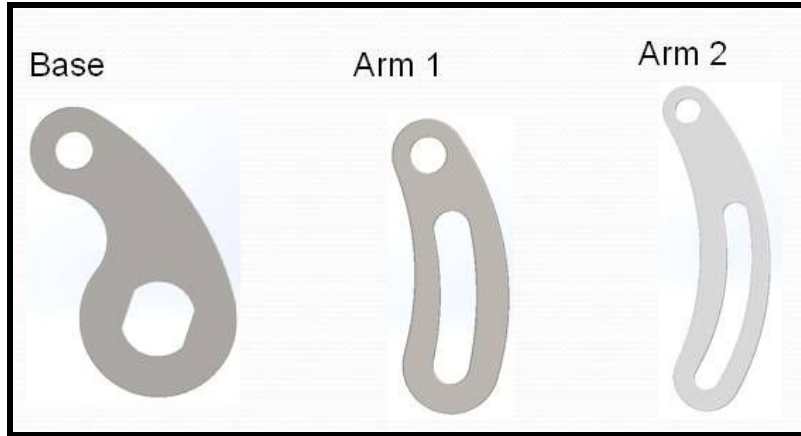


Figure 9: A set of torque arms consists of three components - a base, Arm 1 and Arm 2.

## 1.1.2 Rims

Falco uses two types of rims in building the wheels in the US. Velocity and Rhynolite rims from Sun Ringle. All rims are disc brake as well as rim brake compatible. Rim pictures are shown below:



Figure 10: Velocity Dyad is one of the rims used for building the wheels in the US

# Falco eBike Wheel Technology

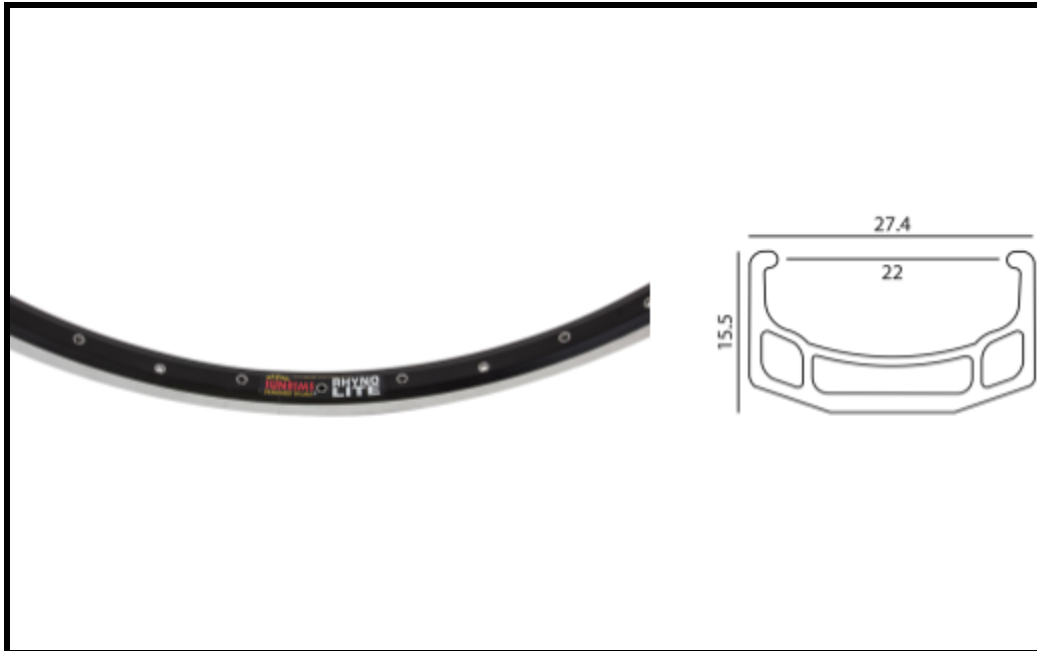


Figure 11: Sunringle's Rhyno Lite rim is one of the rims used for building the wheels in the US

## 1.1.3 Spokes

All wheels are built using [SAPIM strong spokes](#).

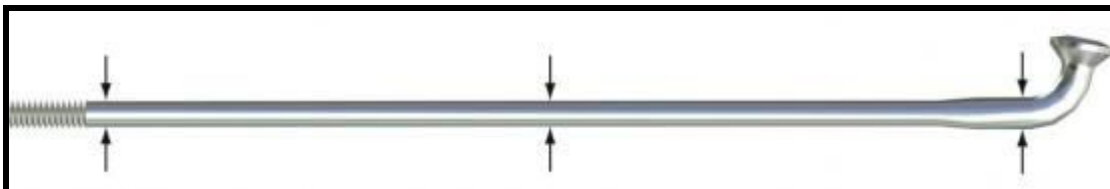


Figure 12: SAPIM strong spokes are used for all wheel builds in the US

This is the strongest spoke in Sapim's product range, the Strong has been developed for specific and heavy usage such as tandem, e-bikes or heavy load use. Spokes have a diameter of 2.3mm at the neck and 2.0mm near the threads.

## 1.1.4 Wireless Module

A wireless module is included with every motor shipment. This wireless module has built in ANT+ and BLE technology allowing the motor to communicate wirelessly with PCs, Macs, iPhones and Android devices.

# Falco eBike Wheel Technology



**Figure 13: ANT+/BLE Wireless Module**

The module is shown in fig. 13. It comes with two connectors on each of its side and it has a green LED on the top. The green LED serves two purposes. It indicates that the motor is receiving power from the battery and when the LED is flashing, it indicates that the motor is ready for a ride and can be controlled wirelessly.

The two connectors on each side of the wireless module serve to connect one side to the motor and the other side to a Wired plus minus controls. The wired plus minus controls allow control of assist and regeneration levels, throttle, and brake on a compact module.



The Hxd wireless/wired console is simple to install and operate with your Falco eBike System. It allows you to adjust the assist level of your motor on the fly. With the easy to read LCD, you'll always know your speed and assist level. Five levels of assist and regeneration are available. To reach any level of assist, press the + or - buttons to increment or decrement the levels.

**Installation:**

Mount The console and the wireless plus-minus on a handle-bar of your trike or bike. No wire is required to go from the console to the motor in a wireless configuration.



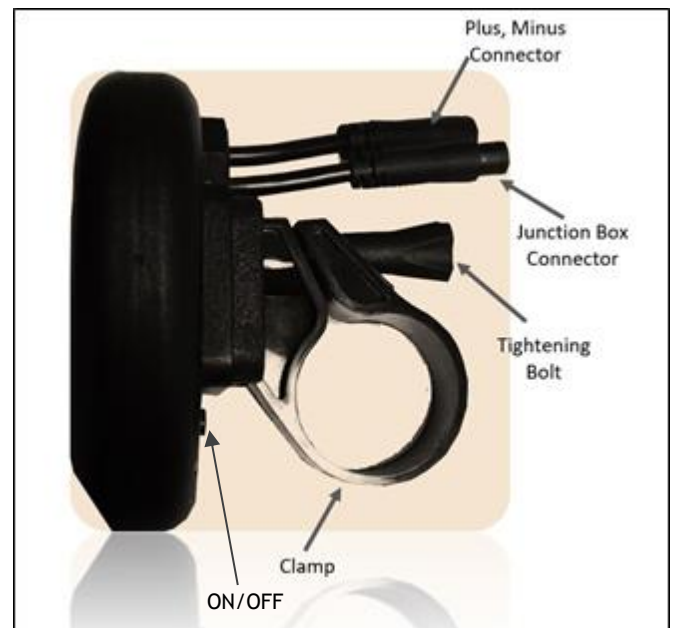
**Hxd Wireless/Wired Console**

v 0.1

May 29, 2018

**Guide for use with Falco eBike Systems**

Change Levels of Assist/Regen, ODO Meter, and Speed Read Out, Set CRM, Know Battery Level



*Figure 1: Side View of the Console*

Figure 1 shows different parts of the console from a side view. The **ON/OFF** button is used to turn the console ON (in wireless configuration). This button can be used to turn OFF the console during winter to save built-in rechargeable battery. The **Clamp** is used to mount the console on a handlebar. The **tightening bolt** is used to tighten the clamp on the handlebar. The **plus-minus connector** is used to connect to the wireless plus minus buttons. The **junction box connector** (not used in wireless configuration) is used to power the console from the motor directly.





*Figure 2: Detachable parts of the console*

Figure 2 shows that the clamp and the tightening bolts can be detached from the main console body.



*Figure 3: Mounting the clamp*

The clamp can be mounted on a handlebar with a diameter of less than 32mm.



*Figure 4: Console body mounted on the clamp and the tightening bolt*

Figure 4 shows how the console body can be mounted on the clamp using the tightening bolt.



*Figure 5: Mount the Wireless Plus Minus button in the same way as the console body*



*Figure 6: Connection between the console and the wireless plus minus buttons*

Figure 6 shows the connection between the console body and the wireless plus minus buttons. Please note that the same connector is used to charge the console. Therefore, the wireless buttons should be disconnected to be able to charge the console.



*Figure 7: Junction box connector is not used in the wireless configuration. Please cover it with a cap or piece of tape to avoid dust or water penetration.*

Figure 7 shows the junction box connector. This connector is not used in the wireless configuration and should be covered with a cap or a piece of tape.

### Functionality:

Below we summarize some of the functionality you can enable using the console. However, before any of the functionality can be activated, it is important to pair the console. Both consoles, wired and wireless versions require pairing.

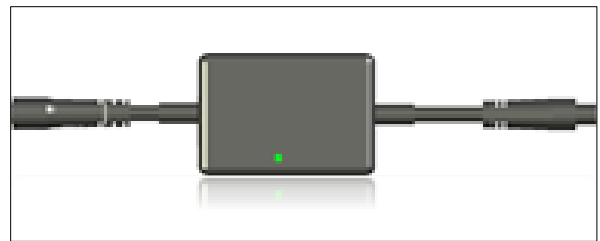
### Turning ON the Console:

The console has an ON/OFF button on the back which must be pushed to turn on the console. However, the button is contrary to US norms. When the button is raised up, it turns on the console. When the button is depressed, it turns off the console. To turn on the console, the button should be raised up. Also, to charge the internal battery of the console, the console must be on before hooking it up to the charger.

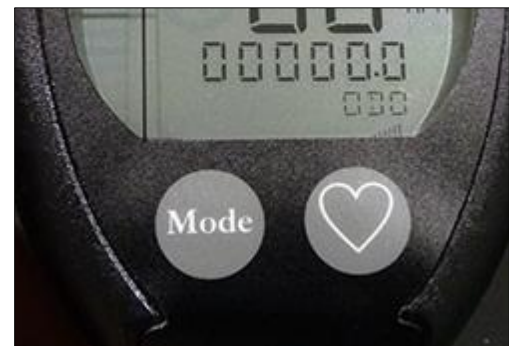


*Figure 8: To use the console, one must turn on the console by pushing the ON/OFF button on the back.*

**Pairing:** Pairing is a process by which we can establish communication between the motor and the console. To achieve pairing, one must have a wireless module connected to the motor's 6-pin connector. Also, the battery should be ON and the green LED in the wireless module should be blinking.



*Figure 9: Wireless Module has two connectors one on each side and has a green LED*



*Figure 10: There are two buttons on the console - Mode, and Heart. Hold the Mode button for 10 seconds to start the pairing process*

To start the pairing process, we must hold the Mode button of the console for approximately 10 seconds. We can let go of the Mode button once we see the word MOT flashing below the very top line of numbers on the console LCD. MOT flashing indicates that the console has started to search for the motor and as soon as it finds it, it should

connect with it. Pairing is complete when the word BAT displays below the very top line of numbers, and the numbers change to show the battery voltage. One may see numbers ranging from 32 to 55V depending on the voltage of the battery.

**Read-Outs:** There are several read-outs and graphic elements which we should get familiar with before the use of the console. Let us go through them one by one.

**Console Battery State of Charge:**



Figure 11: These bars on the top left-hand side of the console indicate the state of charge of the console when the motor is at stand-still. Six horizontal lines indicate the full state of charge.

**Speed:**

The speed read-out is in MPH or KPH. Switch the read-out between MPH and KPH by holding the + and - buttons at the same time for a quick second.

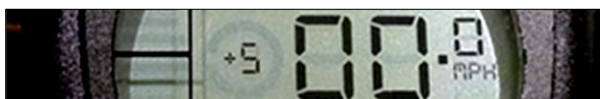


Figure 12: Two big digits and one small digit show the speed. To the left of the speed, +5 shows the level of assist.

**Battery Voltage:**

The word BAT when displayed indicates two things: State of charge of the main battery and establishment of communication between the motor and the console.



Figure 13: Once paired, the top line shows the battery voltage. Bottom left of this line shows the word, and to the bottom right shows the word BAT

Table 1: Approximate Battery Capacity for 36V batteries based on battery voltage

Battery Voltage (V)	Battery Capacity
42	100%
39	80%
37	60%
36	40%
35	20%
29	0%

Table 2: Approximate Battery Capacity for 48V batteries based on battery voltage

Battery Voltage(V)	Battery Capacity
55	100%
51	80%
48	60%
47	40%
46	20%
38	0%

Table 1 and 2 above can be used to interpret the battery voltage regarding the battery capacity.

**Changing the Assist or Regen Levels:**

The console has five assists, and five regen levels in addition to “0” or no-assist level. Clicking the + button increments the level and clicking the - button decrements the level. The numbers increase linearly from -5 to +5 as shown below:

Number	Level
+5	Assist level 5
+4	Assist level 4
+3	Assist level 3
+3	Assist level 2
+1	Assist level 1
0	No Assist or Regen
-1	Regen Level 1
-2	Regen Level 2
-3	Regen Level 3
-4	Regen Level 4
-5	Regen Level 5

### Activate CRUISE:

For motor models with the adjustable speed limit, CRUISE function can be used to adjust the speed limit between 20mph and 28 mph. To activate CRUISE, click the Mode button for less than a second.

### Activate Turbo:

Turbo mode can be used to climb hills. It is an extremely fast mode, and motor delivers tremendous power to the wheel in turbo mode. Use this mode sparingly. Press the HEART button for slightly more than a second to activate this mode. Deactivate the same way. Activation of the Turbo mode deactivates the Cruise mode. Turbo mode can over-heat the motor and completely disables the motor when used for a long time.

### Backlight:

Press the HEART button for slightly more than 2 seconds. Deactivate the same way. Backlight remains ON as long as speed is NON-ZERO.

### Input Wheel Size:

Hold the MINUS button (about 12 seconds) until the screen shows CRM. Use MODE button to move the cursor position and + to input the wheel size. (Approximate wheel sizes are: 20" = 1596, 24" = 1915, 26" = 2075, 27" = 2156 etc.). Continue to press MODE to exit.

### Reset ODO:

Hold PLUS until the ODO goes to 0.

**Internal Battery Charging:** Internal battery must be charged every 7 days at a minimum. Make sure that the console is ON before you hook up the charger. LCD can be ON if the charger is hooked and the console is OFF. Under these circumstances, the console does not get charged. Store the console by turning it OFF. Otherwise, the battery may not recover the next time.

### Charging the Console:

Charging the console requires a USB charger. Any USB charger can be used with the charging chord provided with your console. Use any regular smart phone charger or a laptop or a desktop computer with USB port to charge the console. Charge the console by disconnecting the plus minus buttons and hooking up the charging chord. Hook the other end of the charging chord to a USB port.



Figure 14: Charging chord for the Console

### Converting the Wireless to Wired Console:

The console has an extra connector on its back. This connector is provided to connect the console directly to the motor and motor power can be used to charge the console. A junction box is required to connect the motor to the console.



Figure 15: Junction Box

---

## Falco eMotors Inc.

100 Executive Dr.  
Ste C  
Dulles, VA 20166  
+1 877 278 6323  
Revision Feb 10, 2019

# Elevating Your Ride Experience Customizing Your Falco Torque Sensor

Feb 2019

## OVERVIEW

The below article is meant for riders who want to customize their ride experience further using the Falco torque sensor Falco flash apps or eBike lab software. Default Falco wheels manufactured in 2018 or beyond require no calibration for vertical dropouts.

This article discusses how to calibrate and fine tune the torque sensor once a falco wheel is installed in the frame of a bicycle or a trike for an enhanced riding experience.

1. Download Falco's eBike Lab Software for PC (Requires ANT+ USB);
2. Download Falco's eBike Lab Software for Mac (Requires ANT+ USB);
3. Download Android App to Your Phone (ANT+ or BLE App - ANT+ App may require ANT+ USB);
4. Download iPhone App (BLE App).

There are 5 parameters which are important to understanding in the eBike Lab Software. Those parameters are:

1. **Torque Sensor Raw Value** (Found under Motor Parameters Tab);
2. **Torque Sensor Final Value** (Found under Motor Parameters Tab);
3. **Flip Torque Sensor Command** (Renamed as Flip Axle);
4. Max TS Value (Renamed as **Torque Multiplier** for newer versions);
5. TS Offset Value (Renamed as **Dropout Offset**).

How do you get the most out of your torque sensor? The first step is to calibrate your torque sensor by using Falco eBike Lab for Falco Flash (Mobile Version).

First, we want to focus on the following parameters:

1. **Torque Sensor Raw Value**
2. **Torque Sensor Final Value**

## Stand-Still Calibration:

Torque Sensor Raw Value allows us to make sure that when you're not pedaling and when the bike is at a standstill, the torque sensor is correctly calibrated. First, look at the Torque Sensor Raw Value. The TS Raw Value will have an initial value between 300 to 600 at a standstill. Afterward, sit on the bike or trike with feet on the ground and see the variation in the Torque Sensor Raw Value. If there's no variation, that's great, and it means that the motor is very close to a calibrated value in the frame. This value should go down when pressure is applied to the pedals for correct installation of the wheel.

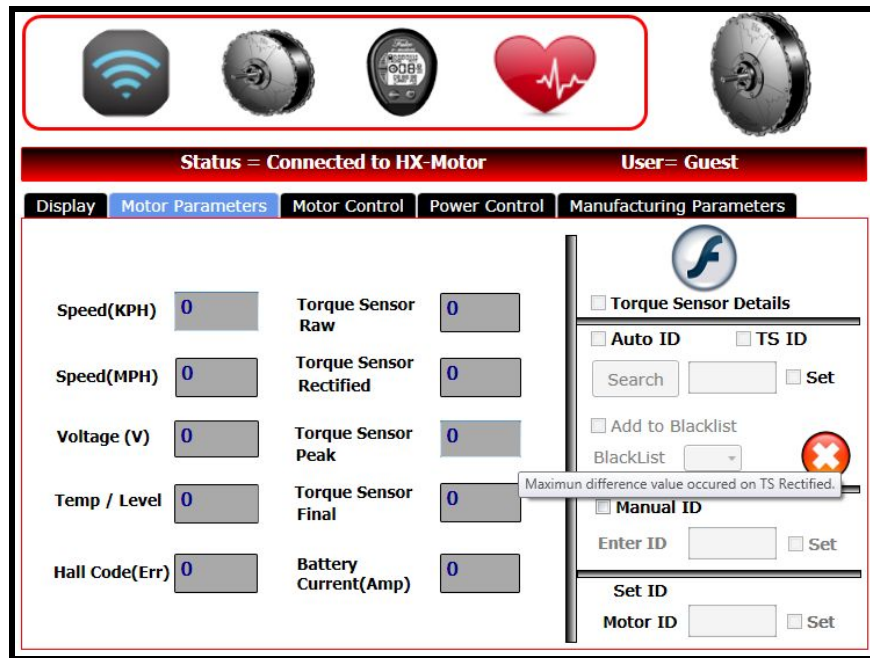


Figure 1: eBike Lab (Windows version) *Motor Parameters* tab showing *Torque Sensor Raw value*

### Other Points to Note:

1. If the value goes down, note down the value;
2. If the values go up, make sure the wheel is installed correctly and note down the value;
3. Note the change in value. Let us say the initial value was 492 and it changed to 482 or 502. This change of 10 counts is your drop-out offset or the drop-out angle of your frame. This is the value which is needed for the Drop-out offset parameter. Let us say this change is A;
4. If the value goes up, and the wheel is installed correctly, we will need to set the dropout selection to Horizontal dropout under the *Motor Control* tab.

## Throttle Calibration:

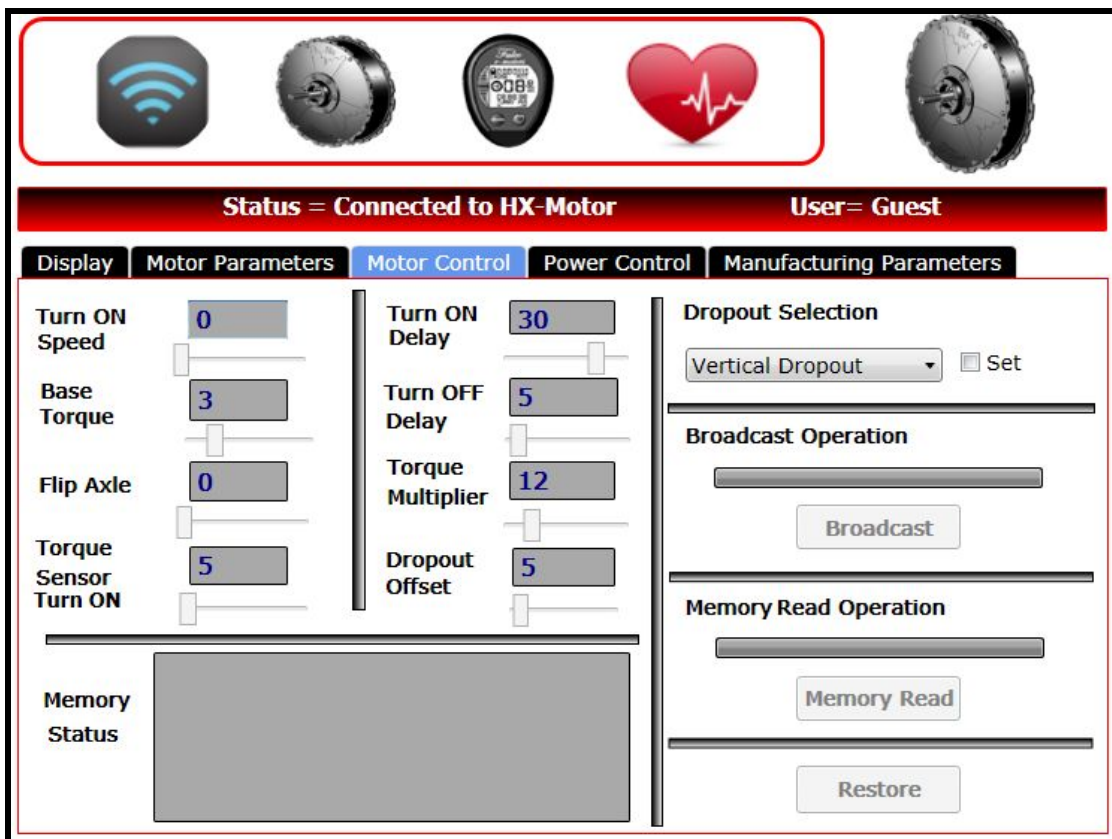
This calibration is pre-set at the factory in 2017 models and beyond. The second step is that you want to take the wheel off the ground and twist your throttle, and look at the Final Torque Sensor Value. If this remains zero, that's great. If not, let us note this change in value as well. Let us say this change in value is two counts. Let us say this change is B.

You essentially take these two offset values then add them together as  $A+B = 10+2 = 12$ . The 12 count is the value plus 20% goes into the parameter called dropout offset under the Motor Control Tab. 20% of 12 is 2.4. We round to 3. So the value for the Dropout Offset is  $12+3 = 15$ .

Now, the last important parameter, the Torque Sensor multiplier. This value is the amount of amplification; the drive system will produce of your effort. If you produce 2 Nm of torque, with an amplification of 5, the motor will produce 10 Nm of torque. So higher the number, more amplification is provided by the drive system.

That essentially completes the calibration of the Torque Sensor.

## Torque Sensor Fine Tuning



The screenshot displays the HX-Motor control interface. At the top, there are five icons: a Wi-Fi symbol, a motor, a speedometer, a heart with a pulse line, and another motor. Below the icons, a red bar shows "Status = Connected to HX-Motor" and "User = Guest". The interface is divided into five tabs: Display, Motor Parameters, Motor Control (selected), Power Control, and Manufacturing Parameters. The Motor Control tab contains several adjustable parameters:

- Turn ON Speed: 0
- Base Torque: 3
- Flip Axle: 0
- Torque Sensor Turn ON: 5
- Turn ON Delay: 30
- Turn OFF Delay: 5
- Torque Multiplier: 12
- Dropout Offset: 5

On the right side, there are three sections:

- Dropout Selection:** A dropdown menu set to "Vertical Dropout" with a "Set" checkbox.
- Broadcast Operation:** A horizontal slider and a "Broadcast" button.
- Memory Read Operation:** A horizontal slider, a "Memory Read" button, and a "Restore" button.

At the bottom left, there is a "Memory Status" section with a large grey rectangular area.

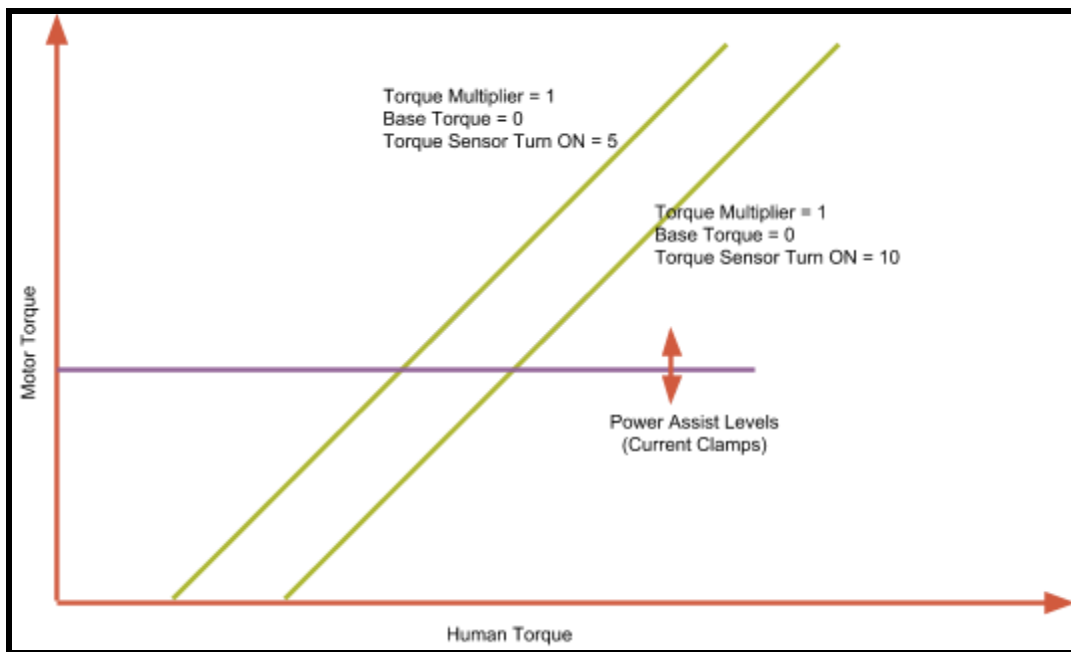
**Figure 2: eBike Lab (Windows version) *Motor Control* tab showing torque sensor parameters**

We have the following parameters to do the fine tuning of the Torque Sensor.

1. Turn On Speed (RPM)
2. Turn On Delay
3. Base Active Current (Base Torque)
4. Turn Off Delay
5. Flip Torque Sensor Command
6. Max TS Value (Torque Multiplier)
7. TS Turn On Value (Torque Sensor Turn ON)
8. TS Offset Value (Dropout Offset)

Now let's understand the operation of the Torque Sensor. Torque Sensor gives you infinite combinations to match human power to motor power.

Figure 1 below shows the relationship between motor torque and human torque. The linear relationship can be modified by changing the torque multiplier and the base torque. Figure 2 and 3 give an example of the effect of the modification.



**Figure 3: Falco torque sensor activates motor power as a function of human torque**



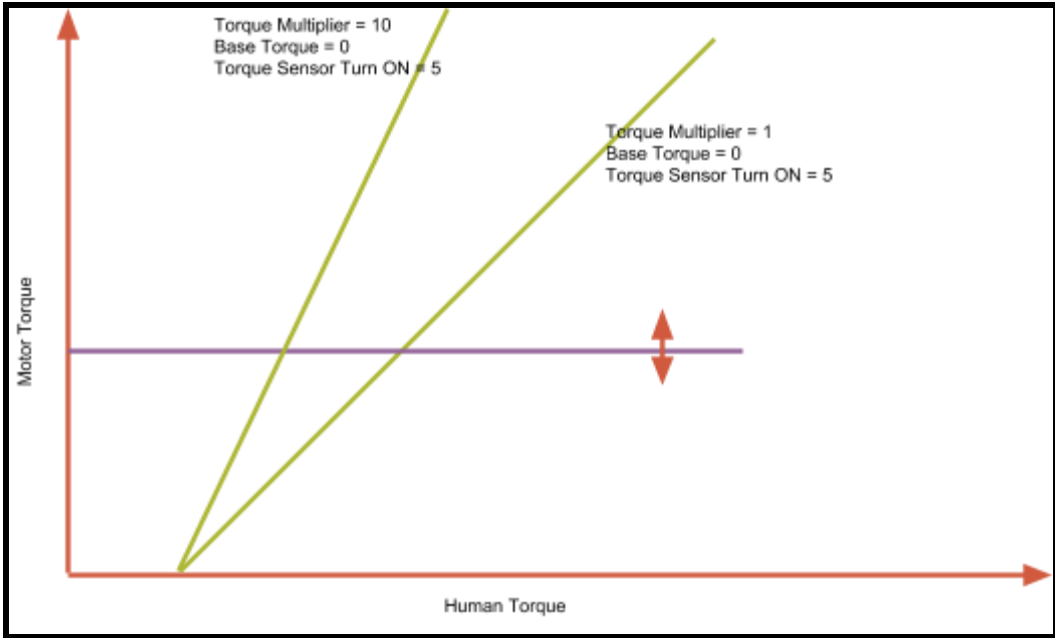


Figure 4: Falco torque sensor behavior modification as the *Torque Multiplier* is changed

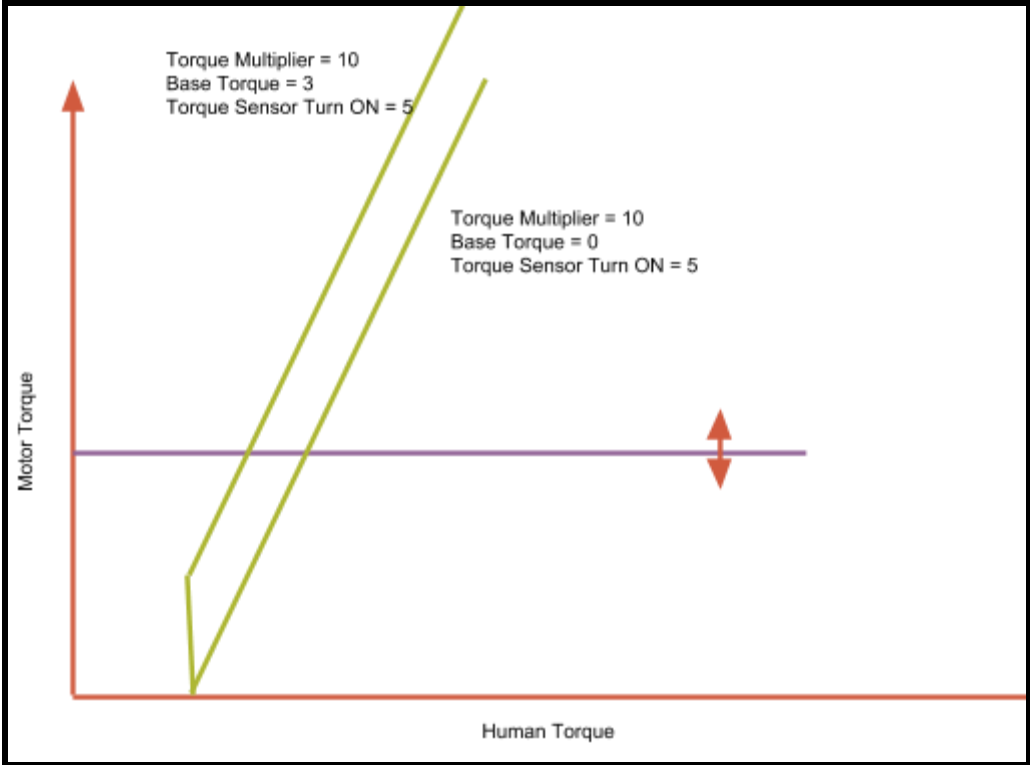


Figure 5: Falco torque sensor behavior modification as the *Base Torque* is changed

If you are a fit athlete and let's say that you can produce a lot of torque on your own, and you want to have more of human power being used rather than the motor power. How do you set that? Start by setting the torque multiplier to 5.

You want to use more of the motor power and less of human power to avoid a sweaty situation. How do you set that? Start by setting the torque multiplier to 12.

## Assist Levels

Let us talk about the different assist levels. There are six assist levels. Level 1 thru 5 and Turbo mode. Level 1 thru 5 control torque. Turbo controls torque and also the slope of the torque sensor behavior. Turbo mode should not be used unless you are completely familiar with its use. Turbo mode draws a substantial amount of current from the battery and can accelerate the bike dangerously.

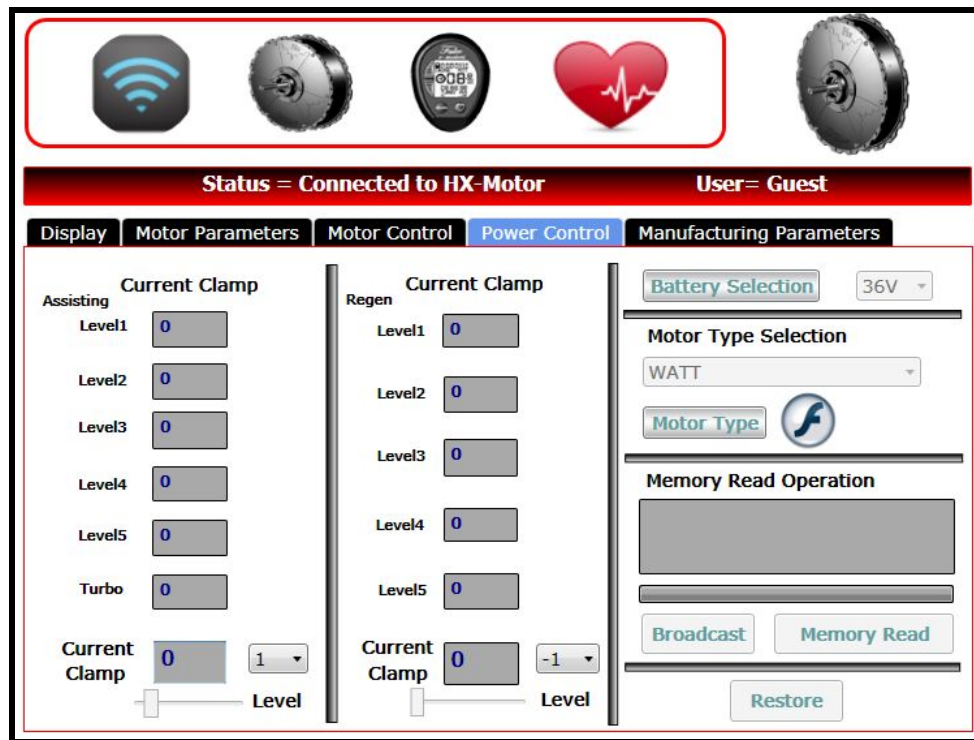


Figure 6: eBike Lab (Windows version) *Power Control* tab showing *assist levels* (left-hand side) and *regen levels*

## Other Torque Sensor Parameters

Other parameters to consider are the Turn On Speed, the Turn On Delay, Base Active Current, Turn Off Delay, Flip TS Command, and TS Turn On Value.

**Turn On Speed** is the speed at which the torque sensor comes on. The motor computes the speed very fast, If you set it high, let's say, 150 rpm, then the torque sensor is going to turn on when the motor thinks that it's rotating at 150 rpm.

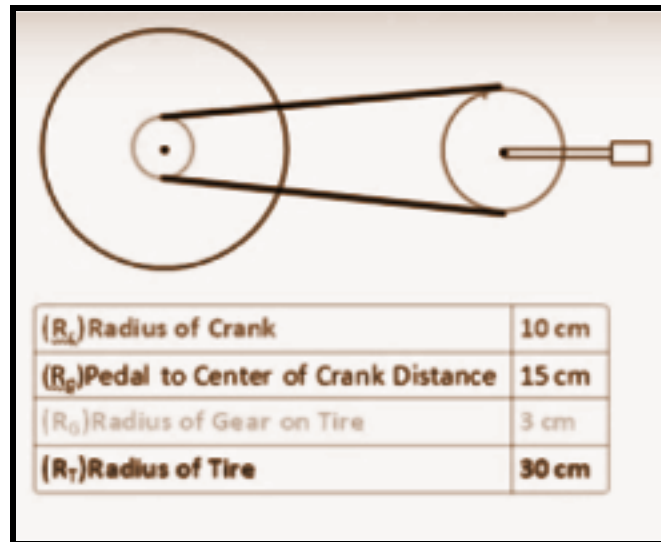
**Turn On Delay** - This is a non-linear delay. This delay is speed dependent and multiplies automatically with an increase in speed. If you set it too low, the torque sensor can feel choppy or unsmooth. If you set it too high, there could be more delay before the torque sensor turns on after you start pedaling.

**Base Active Current/Base Torque** - This provides a boost at startup or zero speed. Higher this value, higher the boost.

**Turn Off Delay** - This is a non-linear delay. This delay is speed dependent and multiplies automatically with an increase in speed. If you set it too low, the torque sensor can feel choppy or unsmooth. If you set it too high, there could be more delay before the torque sensor turns off after you stop pedaling.

**Flip TS Command/Flip Axle** - This allows virtual rotation of the axle by 180 degrees and helps calibrate the torque sensor in the opposite direction (used for cable routing at times where the regular wheel installation does not leave comfortable cable routing).

**TS Turn ON Value (Torque Sensor Turn ON)** - This is the value at which the torque sensor becomes active. Each count of the torque sensor is roughly equal to 2kgf (20N or 4.4lbf). If you set the turn ON value to 5, that means you need to produce 10kgf (100N or 22 lbf) before the motor can activate. This kind of force is easy to produce in a bicycle because of the gears. Using bicycle gears correctly, one can precisely control the activation of the motor at will.



**Figure 6: Falco torque sensor is designed to exploit the bicycle gears and bicycle science. The riding experience is enhanced with the correct use of bicycle gears.**

---

## Falco eMotors Inc.

100 Executive Dr.  
Ste C  
Dulles, VA 20166  
+1 877 278 6323  
Revision Feb 10, 2019

# Falco eBike Smart Phone Technology

Feb 2019

## OVERVIEW

Falco eBike Smart Phone apps can be used in lieu of the Hxd wireless LCD console. They are available free of cost from Apple's app store or Google play store. As of Feb 2019, in the Apple app store, the app is listed as Falco Flash BLE 2.0 and Falco Flash BLE 1.1 in the Google play store. The app can connect to Falco Hx Motor (2018 or higher versions). The app can read the data from the motor as well as allow a user to change its settings. The data which can be read are speed, eDrive parameters (voltage, battery, temperature, range, hall sensor error etc.), torque sensor parameters, assist and regenerative levels. The data which can be transmitted to the motor are: assist or regenerative levels, wheel size, torque sensor settings, wheel diameter, sensor selection, torque, and motor sensor channel IDs. No data is collected or stored or transmitted to Falco eMotors in this app.

## GOALS OF THE APP

Allow the end user

- a. **Control:** to have an easy way to control the motor;
- b. **Evaluate:** to evaluate the drive performance during riding;
- c. **Modify:** to modify settings to enhance the ride experience;
- d. **Diagnose:** to diagnose any potential issues easily and conveniently.

## SPECIFICATIONS

The app is compatible with any phone which has BLE (Bluetooth Low Energy) capability. The wireless module (connected to the 6-pin of the Hx Motor) is a best-in-class, very-long-range,

dual-mode Bluetooth Smart (BLE) / ANT module that combines communication with smartphones via BLE with a practical mesh network via ANT, up to +16 dBm Tx power, and chip antenna. The wireless module is certified with the Bluetooth SIG and regulatory agencies has an integrated 2.4GHz radio subsystem and include a mature dual-protocol software stack supporting BT4.1, GATT-based profiles, and ANT mesh networking. The module also contains an ARM® Cortex® M0 microcontroller with 256KB flash memory and 32KB RAM. The module has a very long range of greater than 400m (direct line of sight). There is no range issue for long base tandems.

## DOWNLOADING THE APP

The apps can be downloaded on your iPhone or Android phone by going to the respective Apple app or Google play stores. Desktop screenshots of both the apps are shown below:

iPhone and Android app sizes are 34MB and 15MB respectively.

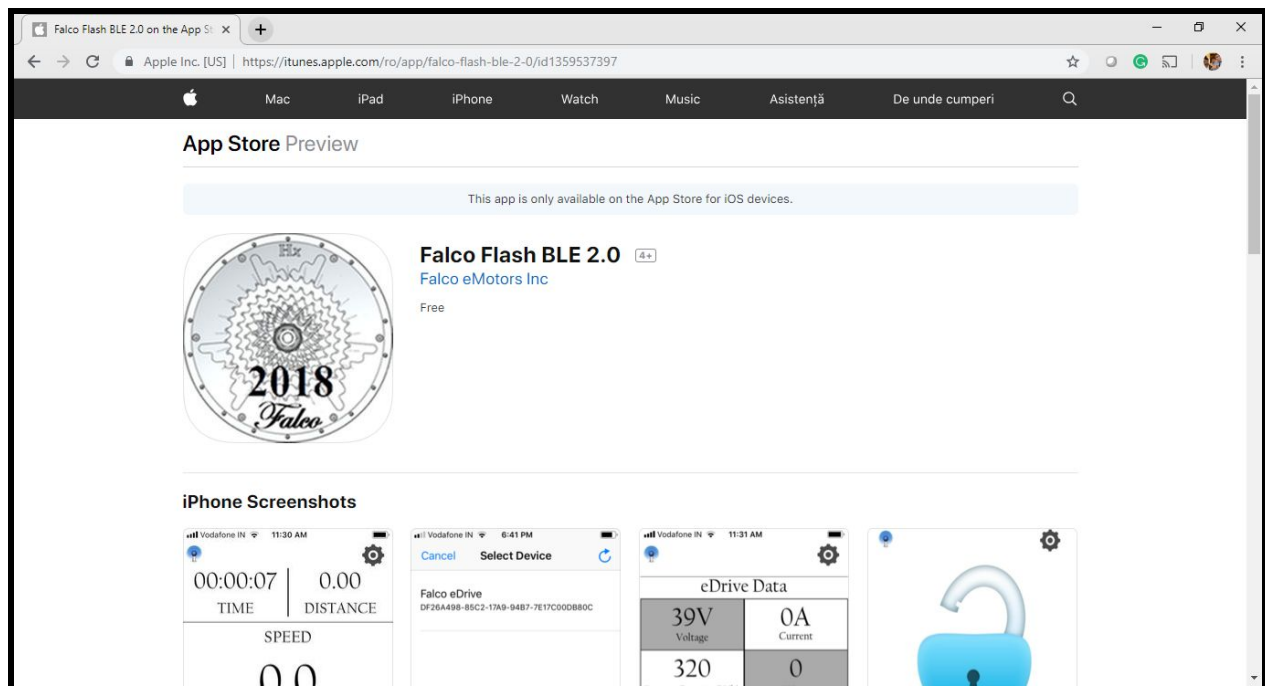


Figure 1: Falco Flash BLE 2.0 in the Apple App Store

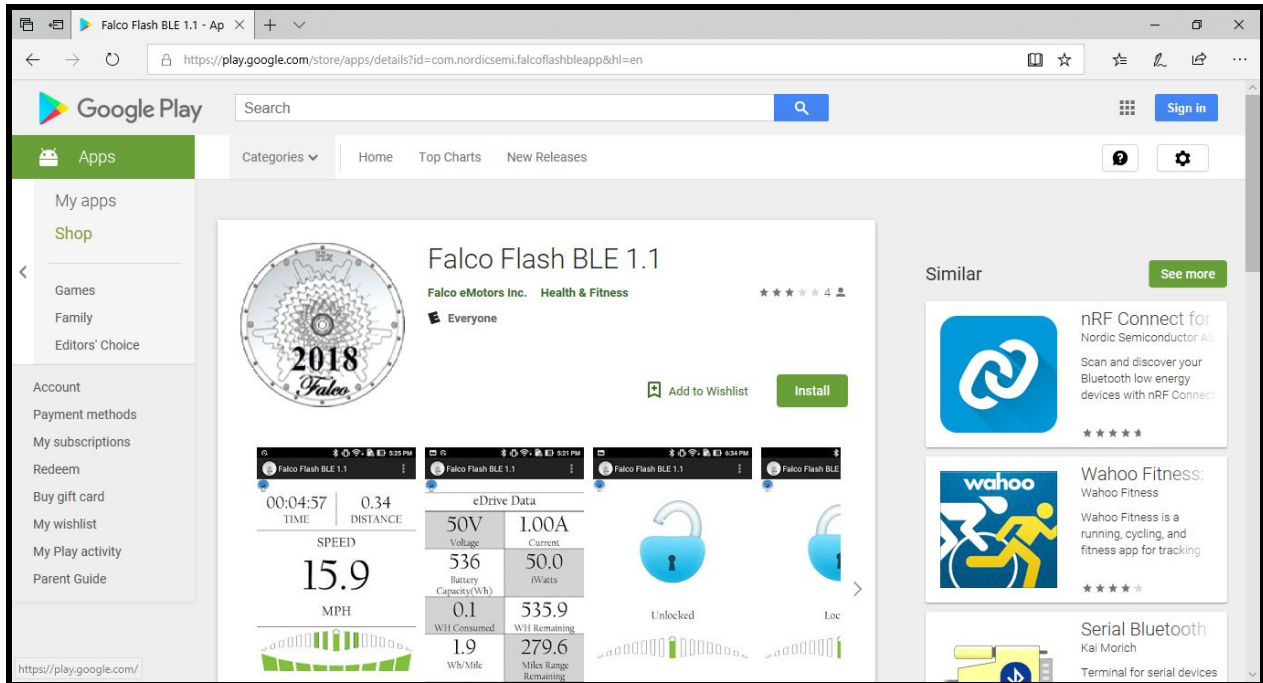


Figure 2: Falco Flash BLE 1.1 in the Google Play Store

## Connecting to the Hx Motor

Once the app is downloaded, launch the app. You will see the following screen:



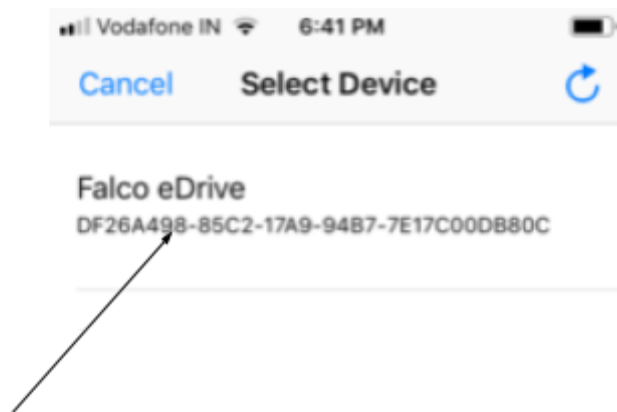
Figure 3: Falco Flash Launch Screen

---

Make sure Bluetooth is turned ON in your smartphone. Hit on the circle with the blue center on the bottom left-hand side to start the connection.



Figure 4: How to connect your Smart Phone with the Hx Motor



Once circle with blue center is tapped, you will see a list of bluetooth devices pop up on your phone. Select Falco eDrive to continue the connection process.

Figure 5: How to connect your Smart Phone with the Hx Motor

Continue the connection process by clicking on the Falco eDrive as shown in Figure 5.

## Understanding Various Screens

The following screens are available in the app

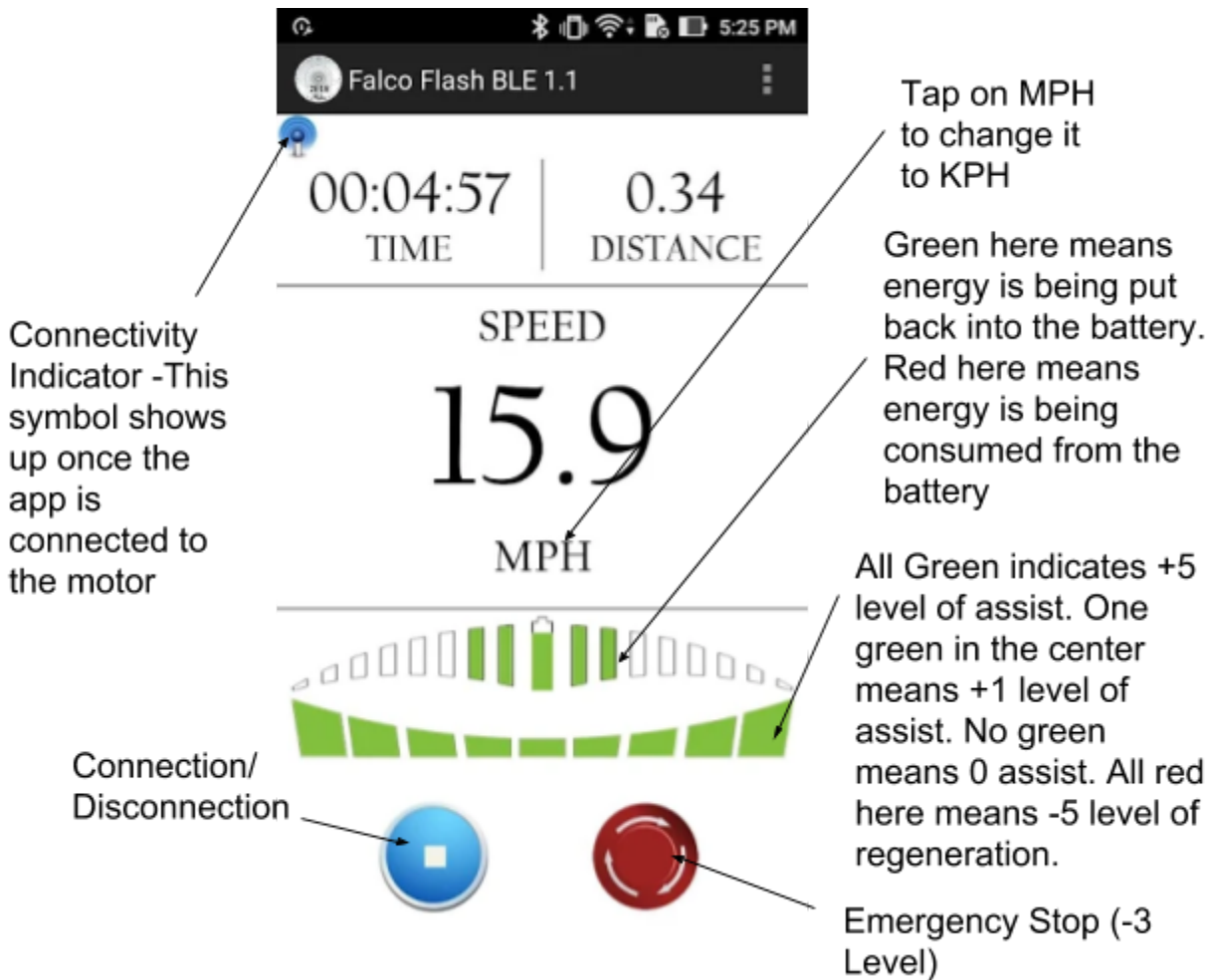


Figure 6: Launch Screen Details



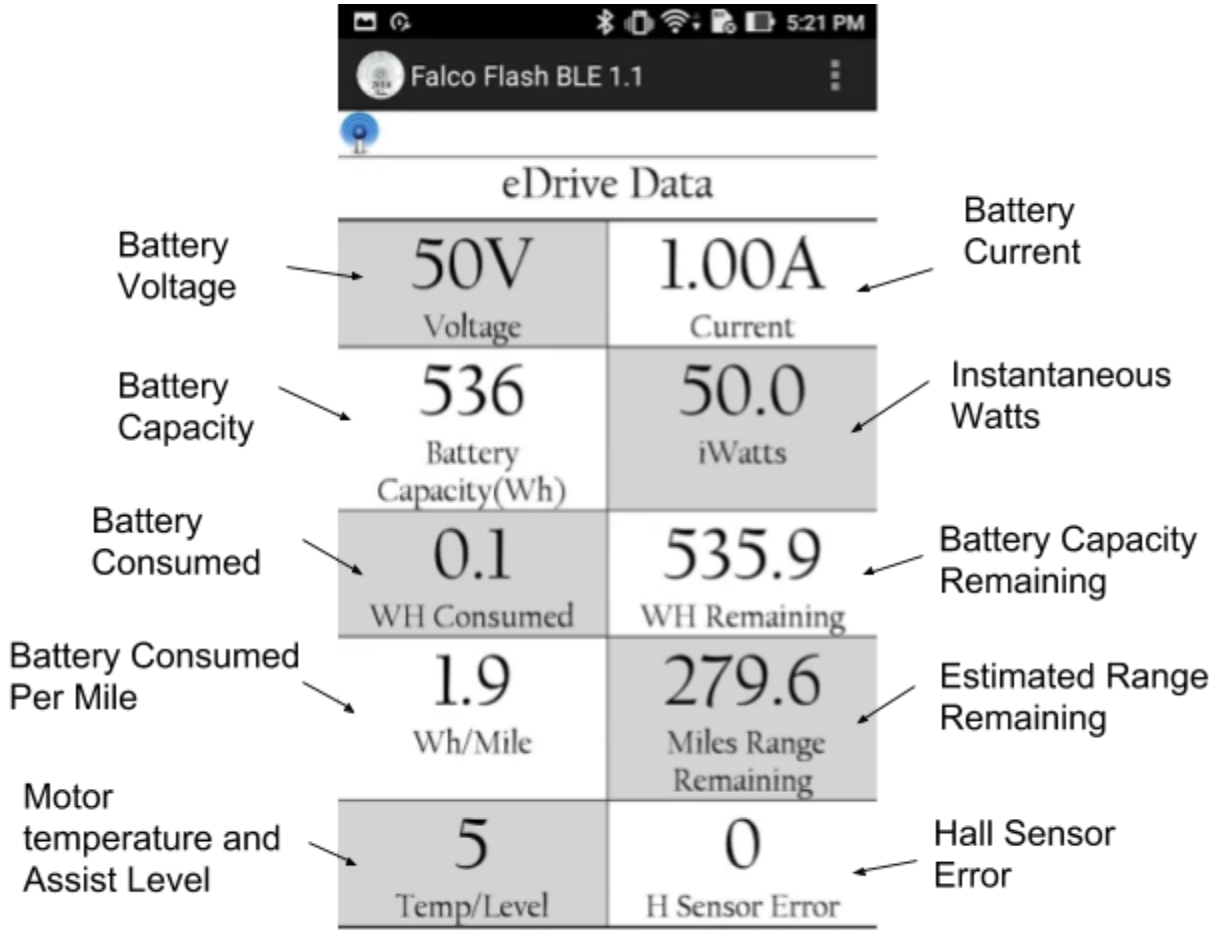


Figure 7: eDrive Data Screen Details

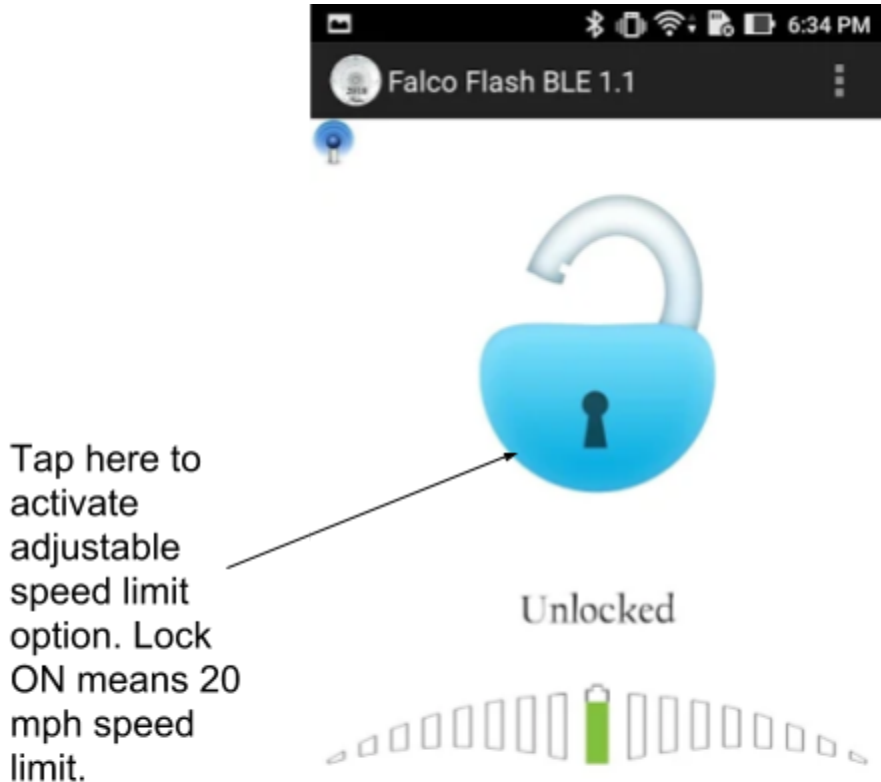


Figure 7: Adjustable Speed Limit Screen Details

The screenshot shows the 'Torque Sensor Settings' screen on a mobile device. The screen title is 'Falco Flash BLE 1.1'. The settings are organized into a grid:

- Dropout Selection:** A dropdown menu with a 'Send' button next to it.
- Turn ON Speed:** A numeric field set to '10'.
- Turn ON Delay:** A numeric field set to '30'.
- Base Torque:** A numeric field set to '00'.
- Turn OFF Delay:** A numeric field set to '30'.
- Flip Axle:** A numeric field set to '00'.
- Torque Multiplier:** A numeric field set to '05'.
- Torque Sensor Turn ON:** A numeric field set to '05'.
- Dropout Offset:** A numeric field set to '05'.

At the bottom, there are three buttons: 'Broadcast', 'Memory Read', and 'Restore'.

Annotations on the left side:

- 'Select horizontal to subtract dropout offset from human effort' (points to Dropout Selection)
- 'Torque Sensor turns on at this wheel speed' (points to Turn ON Speed)
- 'A number between 1 and 10 will add additional boost when starting' (points to Turn ON Delay)
- 'If axle is installed backwards, make this number 1' (points to Flip Axle)
- 'This is the minimum effort needed before motor will turn on' (points to Torque Sensor Turn ON)
- 'Tap here to broadcast new settings to the motor' (points to Broadcast button)

Annotations on the right side:

- 'Use this number to smooth out the torque sensor turn ON' (points to Turn ON Delay)
- 'Use this number to smooth out the torque sensor turn OFF' (points to Turn OFF Delay)
- 'Torque Multiplier multiplies human effort by this factor' (points to Torque Multiplier)
- 'Frame Calibration Factor to account for non-vertical dropouts' (points to Torque Multiplier)
- 'Tap here to see what is stored inside the motor' (points to Memory Read button)
- 'Tap here to restore factory defaults' (points to Restore button)

Figure 8: Torque Sensor Settings Screen Details

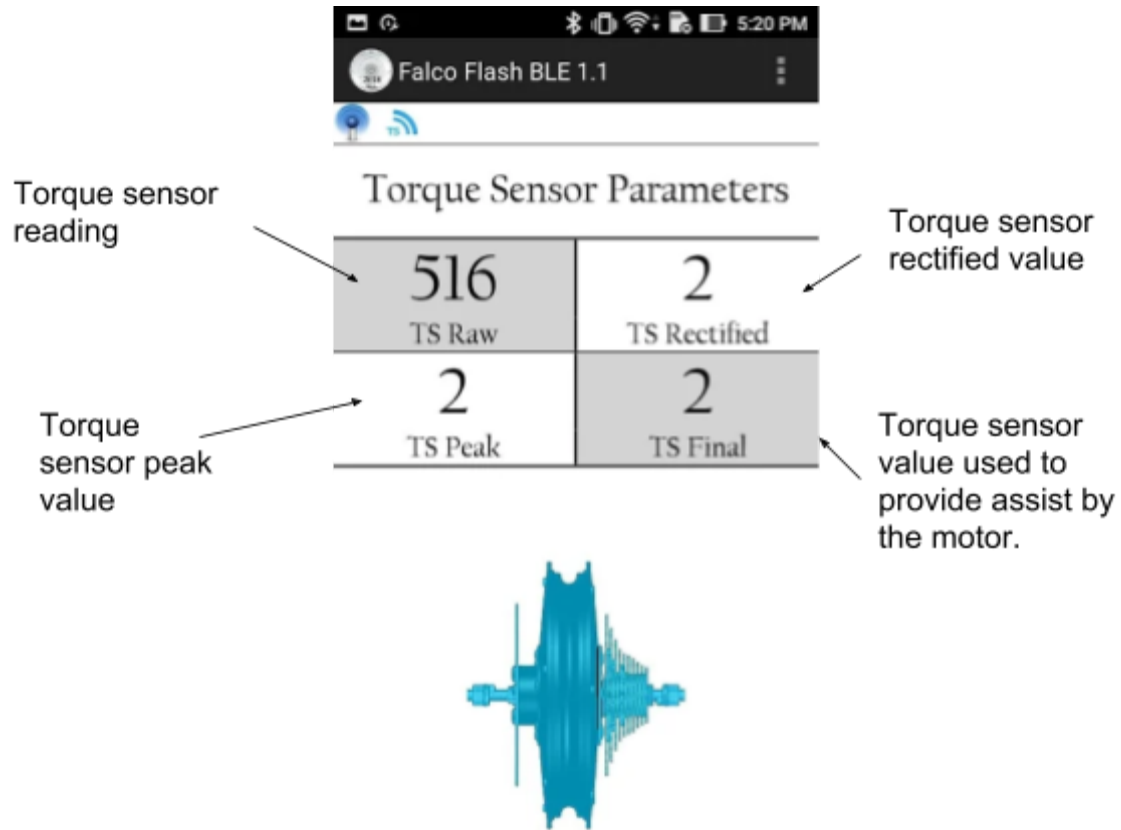


Figure 9: Torque Sensor Parameters Screen Details

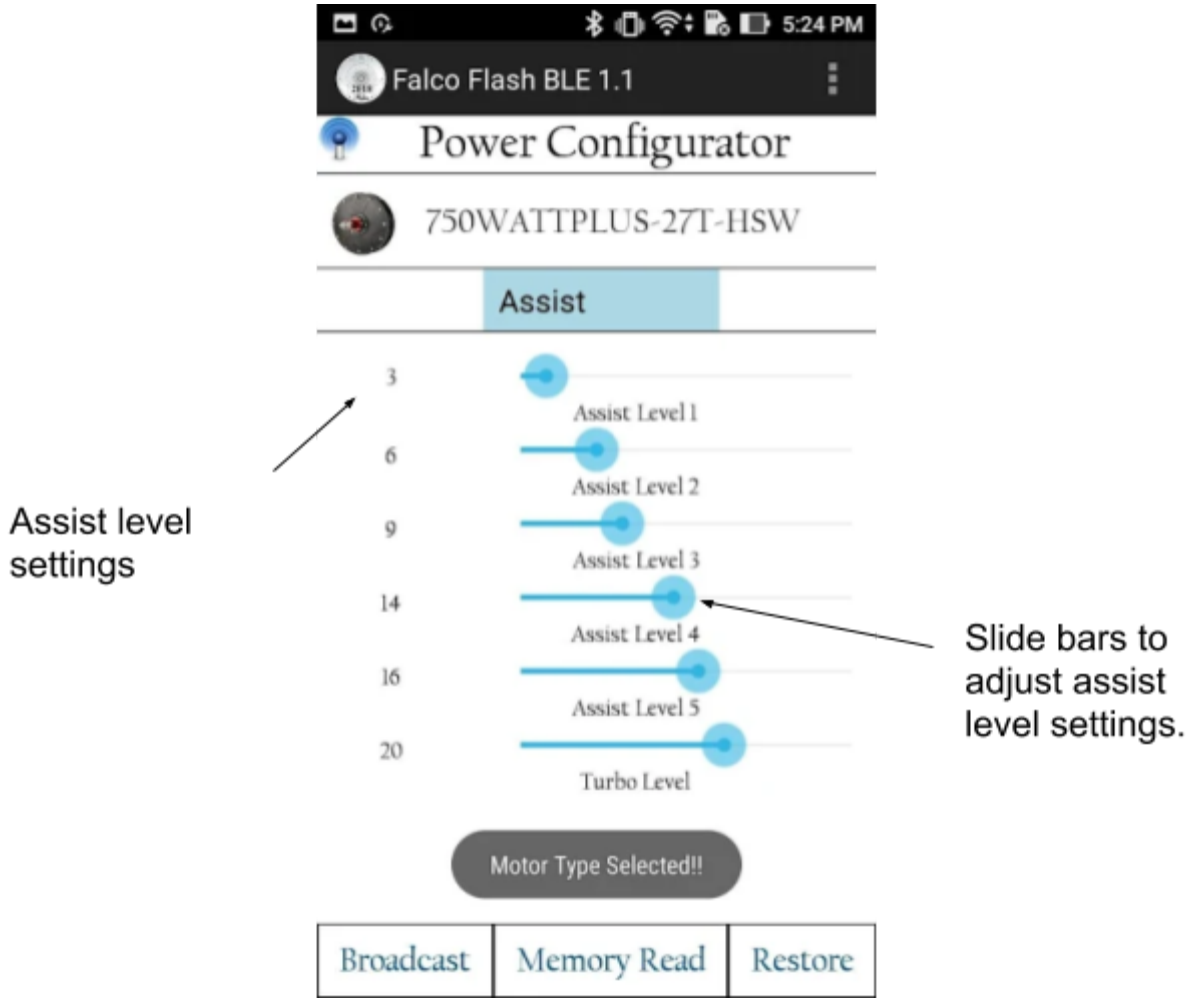


Figure 9: Power Configurator Screen Details (Assist Levels)

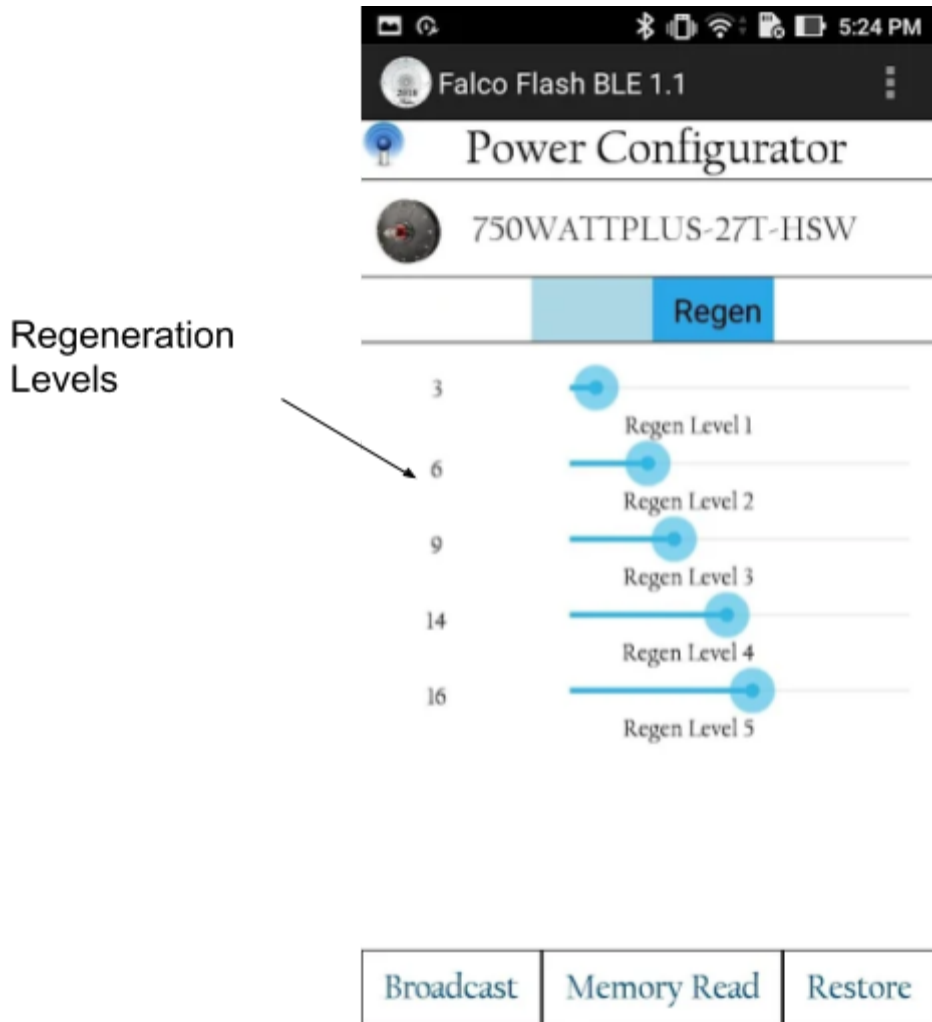


Figure 10: Power Configurator Screen Details (Regeneration Levels)

## OPERATING THE APP



Figure 11: How to increase or decrease assist levels



Figure 12: How to move to the next screen

## SETTINGS

Additional settings can be accessed using the gear icon in the iPhone app or the three vertical dots in the Android app in the top right-hand corner. The following settings can be accessed:

1. Read Firmware Number;
2. Set Turn ON Voltage (Mainly for 24V operation);
3. Search and Set Motor ID;
4. Set Torque Sensor ID;
5. Set Wheel diameter;
6. Set Battery Selection;
7. Set Sensor Selection.





Figure 13: Accessing additional settings

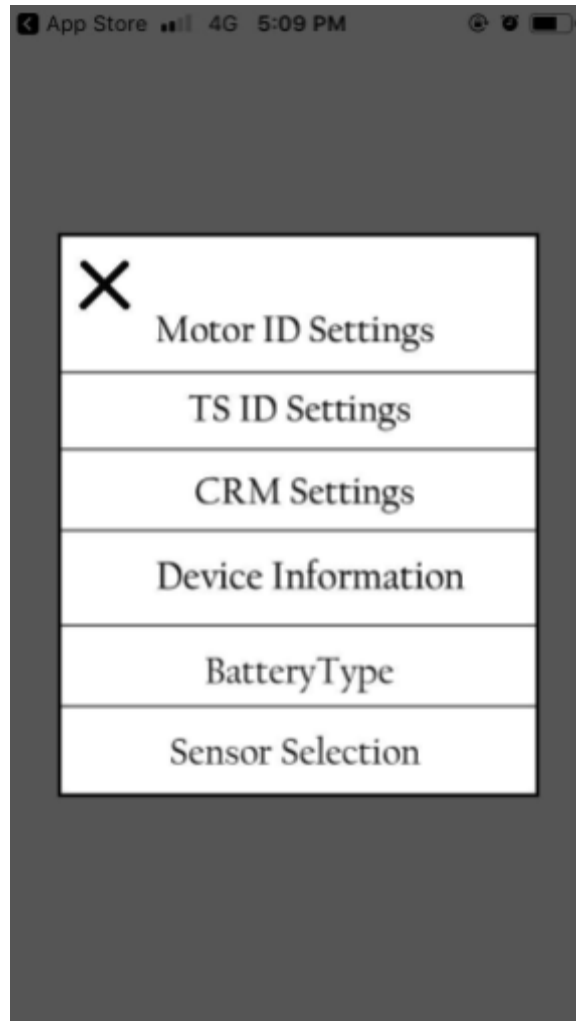


Figure 14: Accessing additional settings

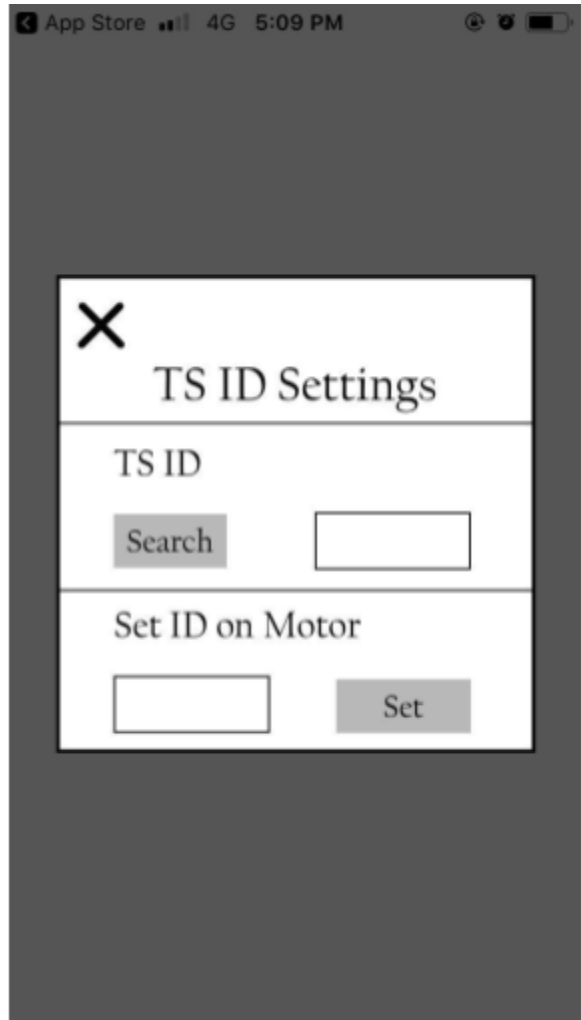
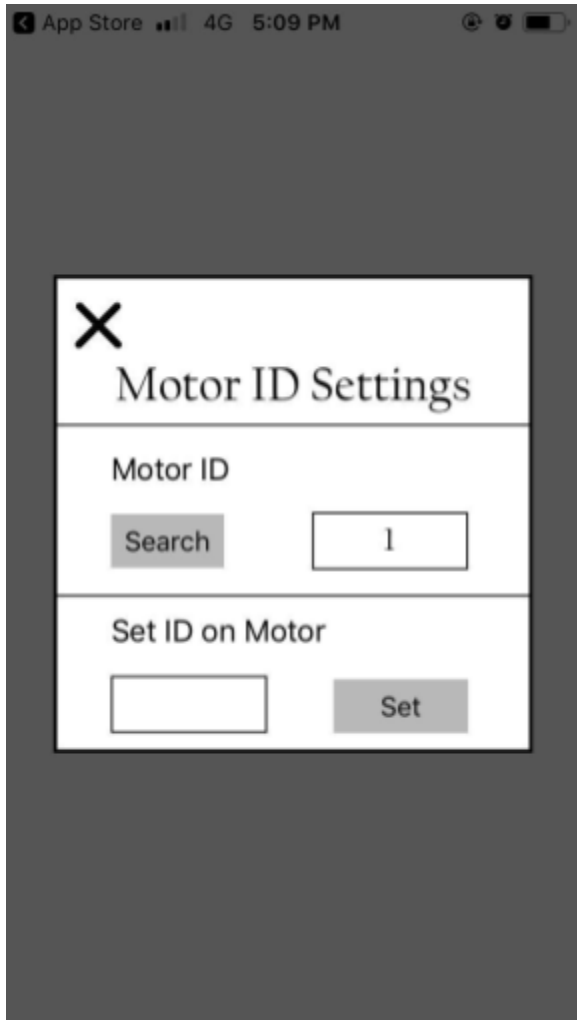


Figure 15: Accessing TS and Motor ID Settings (Don't Change this without Consultation with Falco)

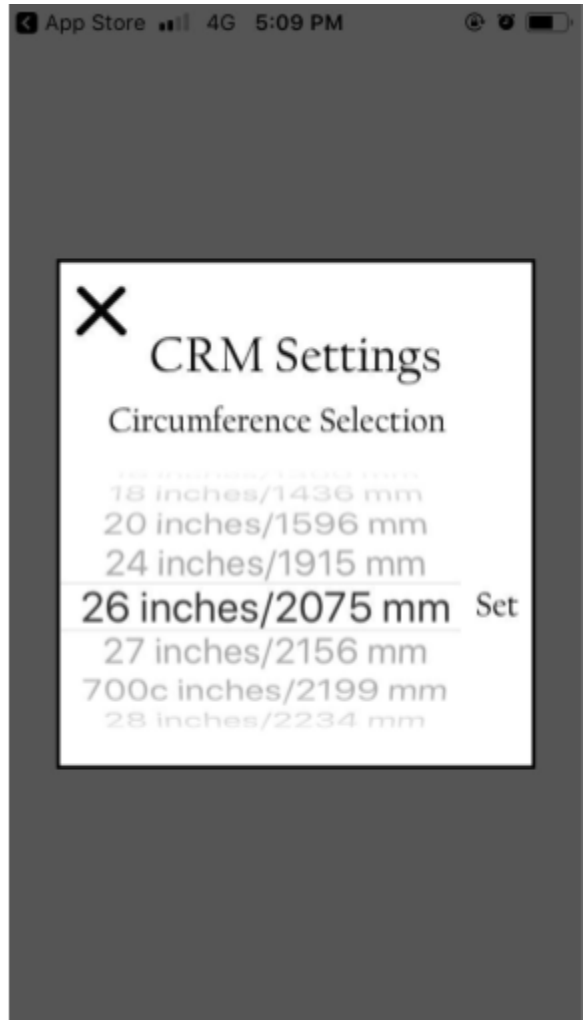


Figure 16: Accessing Battery and CRM Settings

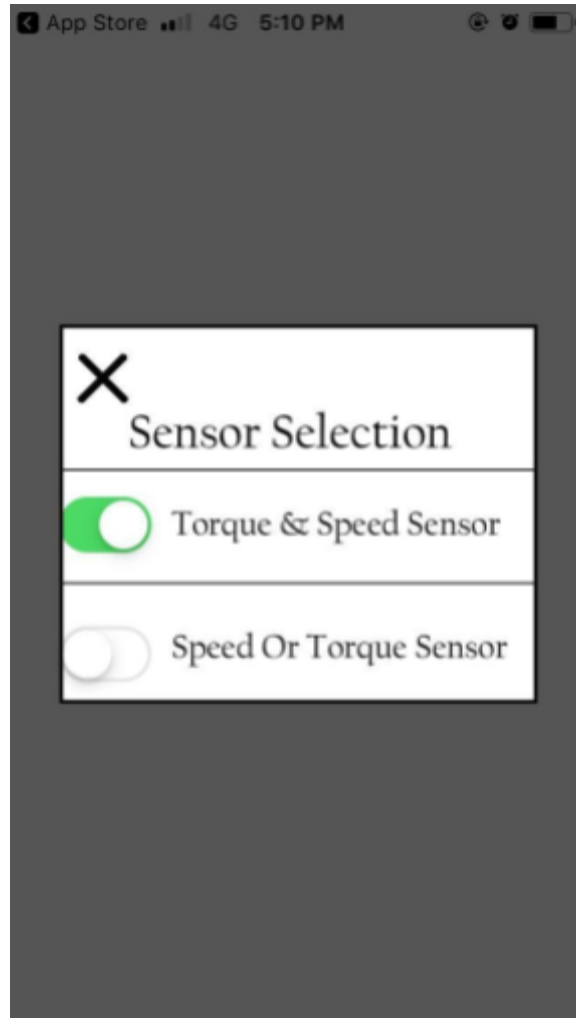


Figure 17: Accessing Sensor Selection

### **Firmware Number**

This is the operating system in the motor. This essentially controls how the motor behaves and interacts. By changing the firmware, we can change the behavior of the motor.

### **Turn ON Voltage**

This setting does not require any change while operating with 36 or 48V batteries. It does, however, require a change if you were to use the motor with a 24V battery.

### **Motor and Torque Sensor ID**

---

There are two wireless channels of communication. One channel is dedicated to the motor and another one for the torque sensor. Both the IDs need to be different for proper communication with the app. Do not change these IDs without consultation with Falco first.

## **Wheel Diameter**

Set the correct wheel diameter to display proper speed. Setting a smaller diameter will show less than real speed and vice versa.

## **Battery Selection**

Set the proper battery from the choice of Li1, Li3, Li7, Li9, and Li11 batteries. This allows for the correct range to be estimated by the app.

## **Sensor Selection**

The Hx motor has built in torque and speed sensors. Selection for torque and speed sensor is recommended for the best ride experience. However, torque or speed sensor choice is also available to experience different sensors or have the app be compatible with older models with no speed sensor. To transmit the sensor selection, perform Memory Read in the torque sensor settings screen (this will populate the screen with existing torque sensor settings stored inside the motor) and then hit broadcast to transmit the new sensor selection without disturbing the existing torque sensor settings.

## **Reading the eDrive Data Screen**

This screen is automatically populated by the app once a connection has been established. All the parameters are explained below.

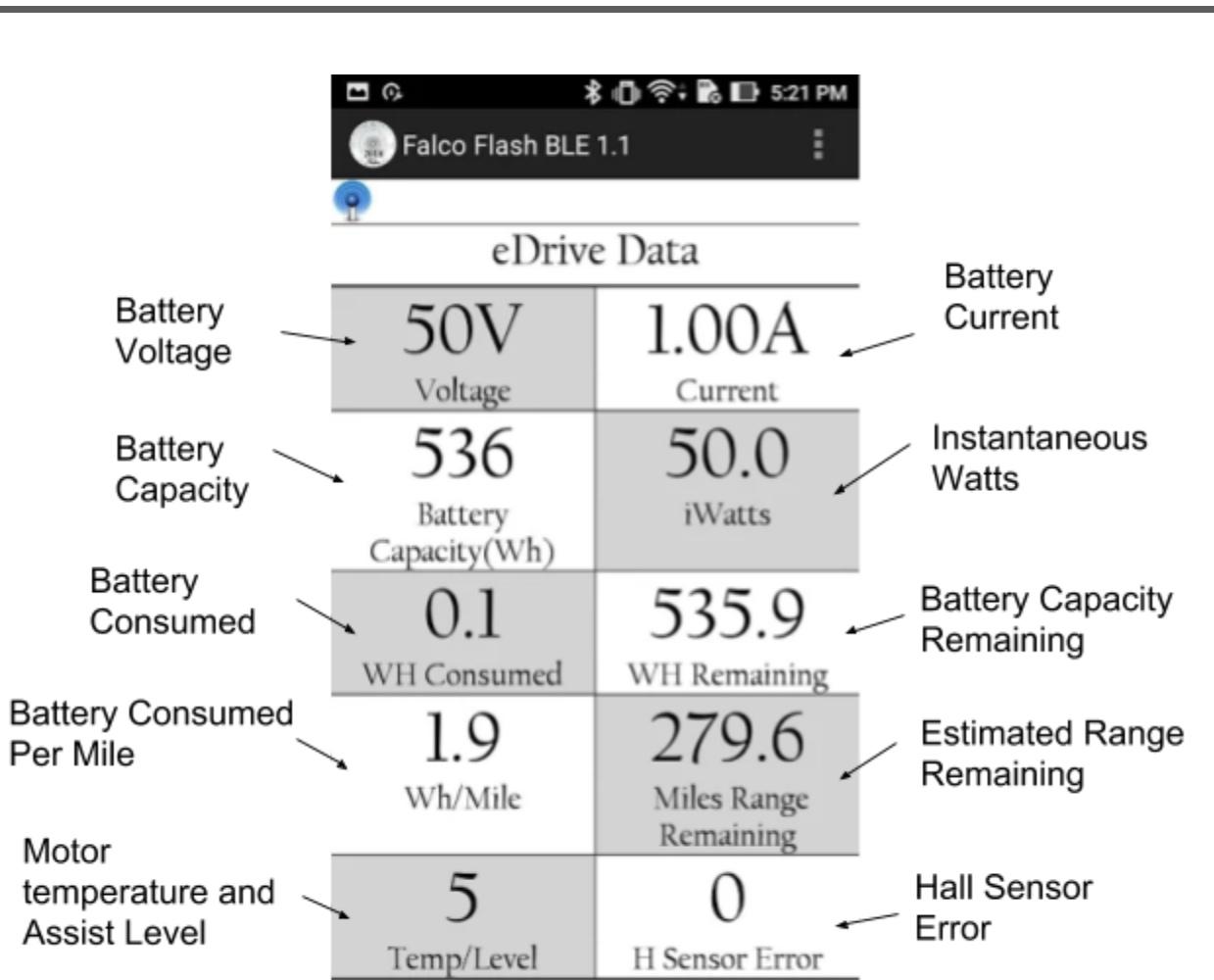


Figure 18: Reading the eDrive Data Screen

### Battery Voltage

When the app connects, it displays the battery voltage in volts as seen by the motor. The 36V battery will have a range from 29 to 42V. The 48V battery will have a range from 39 to 55V.

### Battery Current

This is the current drawn from the battery. This number is displayed in Amps. This number should be 0 at a standstill. This number will increase as the motor delivers more power.

### Battery Capacity

This is the capacity in watt-hours (Wh) of the battery as read by the app. This number is accurate only for Falco batteries. Using other batteries will produce inaccurate results. Li1 and Li3 have 400Wh capacity whereas Li7 and Li9 have a 672Wh capacity and Li11 has a 500Wh capacity.

---

## Instantaneous Watts

This is the instantaneous power being delivered by the battery. This number is in Watts (W). This number can go as high as 1000W.

## Battery Consumed

This number is displayed in watt-hours (Wh). This number shows how much battery has been consumed during the ride.

## Battery Capacity Remaining

This number shows how much battery capacity is remaining. This number is in Watt-hours (Wh).

## Battery Consumed per Mile

This number is akin to vehicle efficiency. In cars, we may look at gallons per mile or miles per gallon. Here we are interested in knowing Wh per mile to how much battery capacity is being consumed per mile of travel. Higher the number means lower the electrical vehicle efficiency.

## Estimated Range Remaining

This is an estimated range based on the speed of the vehicle, remaining battery capacity and battery consumed per mile. This number can vary greatly based on road, vehicle and rider conditions. Use this number along with your best range judgment.

## Motor Temperature Level

This number along with the motor assist level is shown in the same block. These numbers are shown in 30-second intervals. Motor temperature is normally a two digit number in degree Celsius. Assist levels range from -5 to +5. There is a built-in algorithm to reduce motor power when the temperature increases to certain limits. The first reduction of power occurs at 60 degrees Celsius. The second reduction occurs at 90-degree Celsius. The motor will reduce power to zero when the internal temperature reaches 115-degree Celsius.

## Motor Assist Level

Motor assist level as read by the motor is displayed in the same block as the motor temperature in the 30-seconds interval. Sometimes, what assist level is shown in the LCD console or the launch screen can be different than what is understood by the motor. This is the place to confirm at what assist level is the motor operating.



---

## Hall Sensor Error

The Hx motor has five hall sensors. Those hall sensors are critical sensors to operate the motor. This number should always remain zero. If this number becomes 1, the wheel needs to be returned to Falco for repair as it indicates that one of the hall sensors inside the hub has malfunctioned.

## Understanding Torque Sensor Settings

To understand torque sensor settings, please refer to this article:

[Elevating Your Ride Experience Customizing Your Falco Torque Sensor](#)

Any of the 8 parameters on this screen can be changed by the rider. Parameters should be changed when the vehicle is not in motion. There is an acceptable range of values for each of the parameters.

**Turn On Speed** is the speed at which the torque sensor comes on. The motor computes the speed very fast, If you set it high, let's say, 150 rpm, then the torque sensor is going to turn on when the motor thinks that it's rotating at 150 rpm.

**Turn On Delay** - This is a non-linear delay. This delay is speed dependent and multiplies automatically with an increase in speed. If you set it too low, the torque sensor can feel choppy or unsmooth. If you set it too high, there could be more delay before the torque sensor turns on after you start pedaling.

**Base Active Current/Base Torque** - This provides a boost at startup or zero speed. Higher this value, higher is the boost.

**Turn Off Delay** - This is a non-linear delay. This delay is speed dependent and multiplies automatically with an increase in speed. If you set it too low, the torque sensor can feel choppy or unsmooth. If you set it too high, there could be more delay before the torque sensor turns off after you stop pedaling.

**Flip TS Command/Flip Axle** - This allows virtual rotation of the axle by 180 degrees and helps calibrate the torque sensor in the opposite direction (used for cable routing at times where the regular wheel installation does not leave comfortable cable routing).

**TS Turn ON Value (Torque Sensor Turn ON)** - This is the value at which the torque sensor becomes active. Each count of the torque sensor is roughly equal to 2kgf (20N or 4.4lbf). If you set the turn ON value to 5, that means you need to produce 10kgf (100N or 22 lbf) before the motor can activate. This kind of force is easy to produce in a bicycle because of the gears. Using bicycle gears correctly, one can precisely control the activation of the motor at will.

To change settings, enter the number in the specific block, press enter. Once all the numbers have been entered, hit broadcast to transmit the numbers to the motor.

## Understanding Torque Sensor Parameter Screen

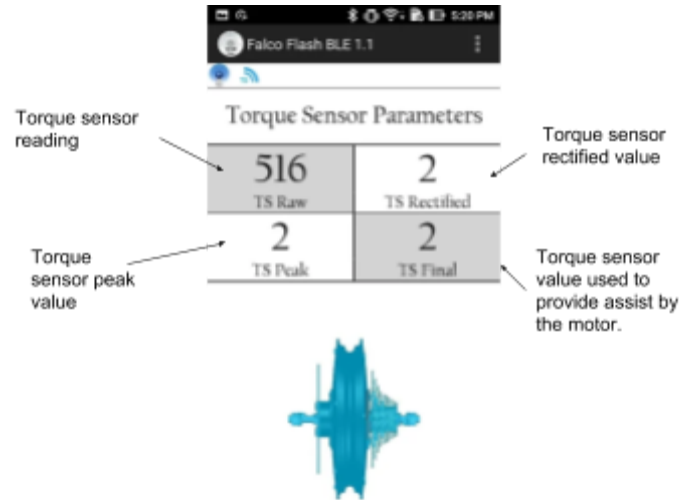


Figure 19: Reading the Torque Sensor Parameters Screen

This screen is automatically populated by the app upon connection. This screen is shown above.

**TS Raw** is the value of the torque sensor as read by the motor. It should be a number between 300 and 600. If this number is less than 50 or more than 900, the torque sensor is most likely defective. This value should also go down when pressure is applied to the pedals. The torque sensor is more sensitive if this value changes by 30 to 50 counts upon applying pressure to the pedals. If this value varies by less than 10 counts, the torque sensor is not very sensitive and rider can have a problem getting enough assistance from the motor.

**TS Rectified** is a rectified torque sensor value obtained by subtracting the TS value at power on or startup.

**TS Peak** is the maximum rectified torque sensor value captured by the motor during the ride.

**TS Final** is the rectified and processed torque sensor value used by the motor to generate final assistance to the rider.

When pedal assist does not work, this is the screen to verify the correct install of the axle. For correct install, torque sensor raw value (TS Raw) should go down when pressure is applied onto the pedals. If this value does not go down, one will need to either physically rotate the axle in the frame so that the cables are exiting towards the bottom of the frame and the flat face of the axle

with a triangle is towards the rear. If that is not possible (because of cable routing issues) then flip axle command (in the previous screen) should be set to 1.

## Understanding Power Configurator Screen

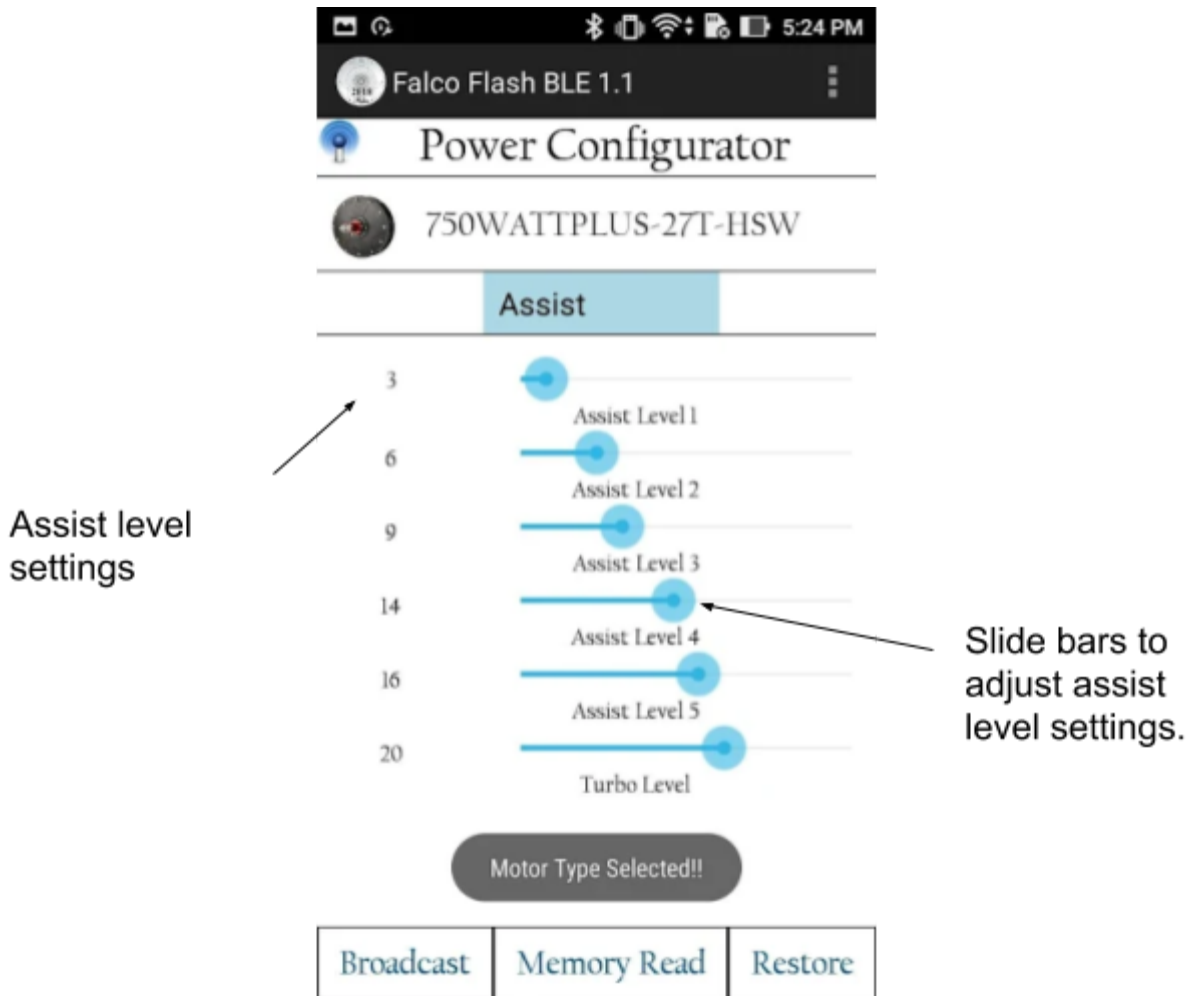


Figure 20: Reading the Power Configurator Screen

This screen is not populated automatically. To populate this screen, click on the motor icon. This will read the motor type and the corresponding assist and regenerative levels.

To change the assist levels, slide the bars to appropriate levels. +5 level assist needs to be higher than +4 level of assist and +4 should be higher than +3 levels of assist and so on and so forth. Turbo assist level can also be set through the app. However, the turbo assist level is only accessible the Hxd LCD wireless console. Once levels are set, hit broadcast. Once broadcast is complete, hit Memory Read to read the assist levels stored in the motor.

Regenerative levels can be accessed by clicking next to the word Assist. Same steps as above can be repeated to set the regenerative levels.

---

## **When do you want to set the levels?**

Assist levels allow greater control over the motor performance. Riders with a disability can use this function to limit motor power and speed quite effectively. Riders requiring more power and speed can also increase these levels to higher numbers. Excessively higher numbers can lead to motor overheating and reduction of power as well.

Questions or comments, write to us at [info@falcoemotors.com](mailto:info@falcoemotors.com) or call us the toll-free from the US or Canada +1 877 278 6323.

Our products enable healthy living, reduce carbon emissions and, change the mode of transportation, in particular in urban areas. Our eBike systems provide solutions to road congestion, a growing challenge around the world. We remain committed to working aggressively on solutions for alternative mobility and carbon-neutral lifestyle.

# ELEVATE THE RIDE.

Falco eMotors Inc.  
100 Executive Dr., Ste. C Dulles, VA 20166 USA  
Phone: +1 877 278 6323, Web: [www.ElectricBicycleWorld.com](http://www.ElectricBicycleWorld.com)  
Email: [info@falcoemotors.com](mailto:info@falcoemotors.com)