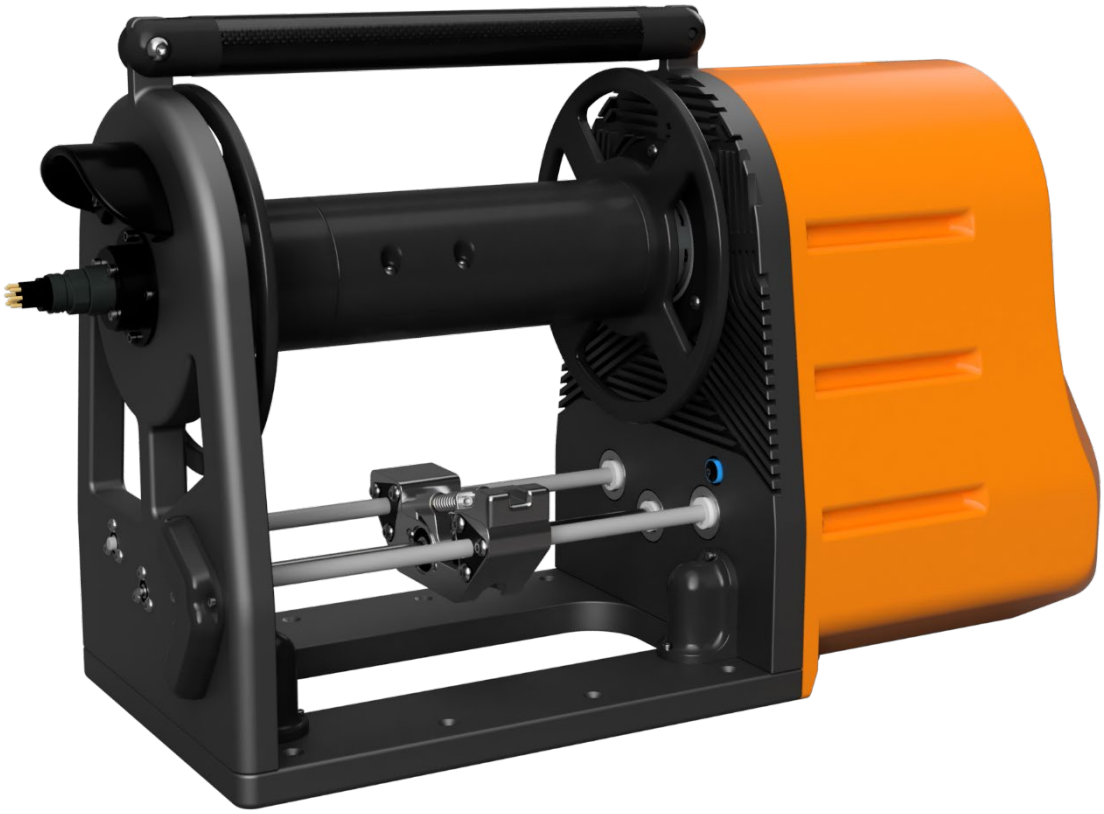
NAUTILUS TMS

Operations Manual



Hybrid Robotics

REV1.3

Created by: Aaron Bottke

Month: 1/2026

Contents

Introduction: 4
Anatomy of a TMS 4
Connecting to the TMS 5
Tether In/Out Button Operation: 7
Alternative Keyboard Shortcuts for Tether Control: 7
Default Network Configuration 7
Calibrate Definition 7
Change Tether 8
Step 1 – Ensure that Your Tether is Unloaded to its Minimum Extent: 8
Step 2 – Disengage the Drum Brake: 9
Step 3 – Manually Turn the Drum Back to the Zero Position: 10
Step 4 – Engage the Drum Brake: 11
Step 5 – Get TMS Back Into the Stopped State (Bug Workaround – Fix Coming): 12
Step 5 - Alternative Method: 13
Step 6 – Home TMS: 14
Step 7 – Remove Screws from the drum cover: 15
Step 8 – Remove Screws from the *Levelwind Tensioner Assembly*: 16
Step 9 – Remove the Levelwind Tensioner Assembly: 17
Step 10 – Remove the *Spool Drum Cover* and *Tether*: 18
Step 11 – Feed *Tether* up through through *Levelwind Carriage*: 19
Step 12 – Install the Levelwind Tensioner Assembly: 20
Step 13 – Install flathead screws into the *Levelwind Tensioner Assembly*: 21
Step 14 – Wrap Tether Around Drum: 22
Step 15 – Install Drum Cover 23
Step 16 – Install Screws Into Drum Cover & Pull Loose Cable Through *Levelwind*: 24
Step 17 – Change Tether Diameter and Length in the User Interface: 25
Step 18 – Establish a Fresh Connection with the TMS (Bug Workaround – Fix Coming): 26
Step 19 – Home TMS: 27
Step 20 – Pay in the First Few Wraps of Tether: 28
Step 21– Manually Organize the Wraps so That the Tether Does Not Cross Over Itself: 29
TMS API Reference 30
1. Command Interface 30

- Read Commands 31
- Update Commands 31

2. Core Safety & Motion Commands 32

stop → bool 32

drum_speed → int (ERPM) 32

3. Spooling by Length 32

spool_length → list [distance_m, speed_erpm] 32

spool_to_setpoint → list [setpoint_m, speed_erpm] 32

4. Tether Configuration Commands 33

set_tether_diameter → float (mm) 33

set_tether_length → float (m) 33

5. Motor Limits & Safety Commands 33

set_primarymotor_maxcurrent → float (A) 33

limit_primarymotor_maxspeed → int (ERPM) 33

6. Levelwind & Homing Commands 34

calibrate_levelwind_position → bool 34

find_home_position → bool 34

7. Brake Control 34

disengage_brake → bool 34

8. System / Service Commands (Advanced) 35

pi_oninit → bool 35

pi_restart → bool 35

pi_restart_servodriver → bool 35

pi_restart_apiserver → bool 35

9. Telemetry & Information Endpoints 36

/system_info/ 36

/general_info/ 36

/derived_telemetry/ *(Experimental)* 37

/tetherparams/ 37

/motorparams/ 38

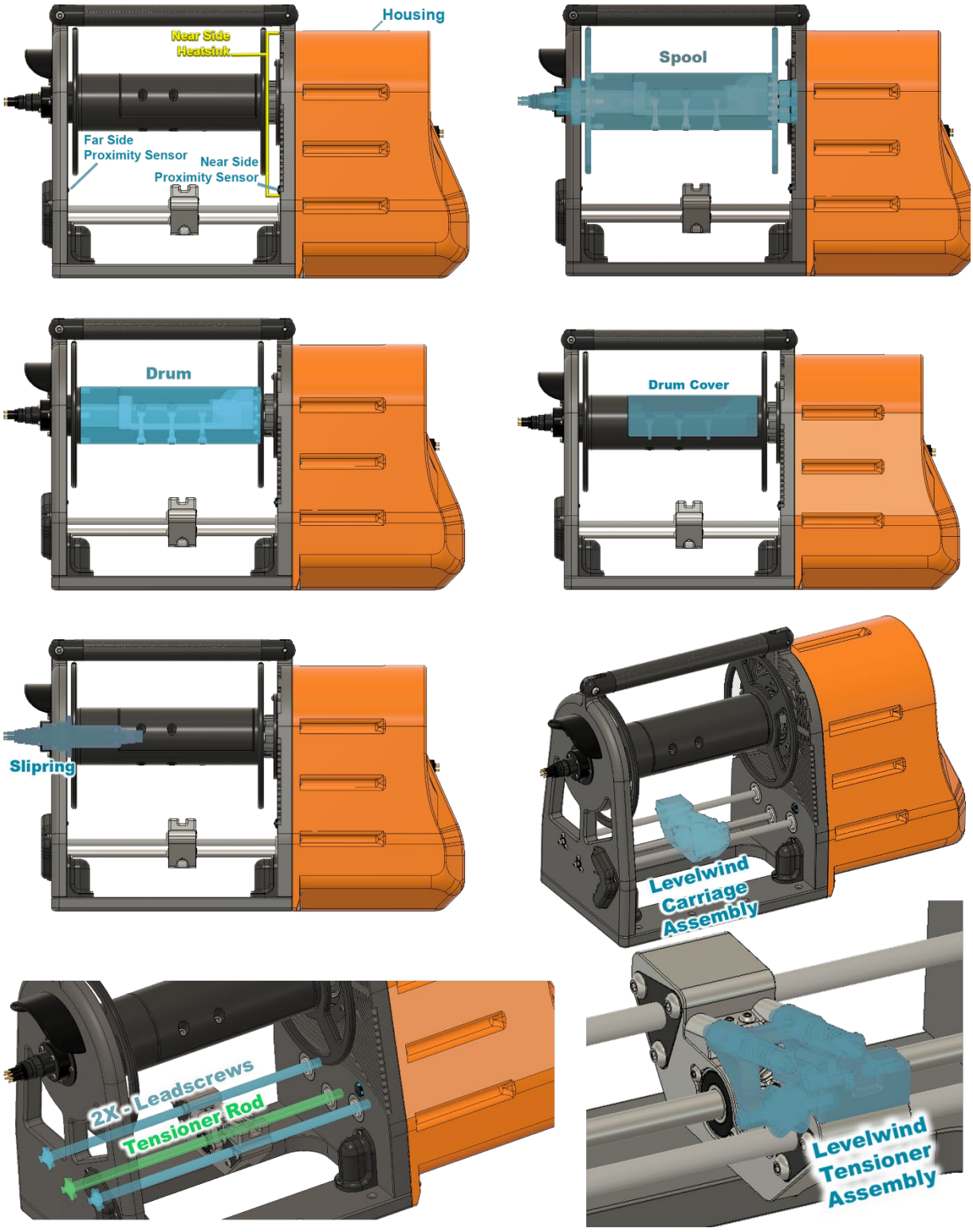
10. Design Notes 38

Glossary 39

Pinouts..... 39
Standard Pinouts 39
External Proximity Endstop (If included) 39
Specifications:..... 40

Introduction:

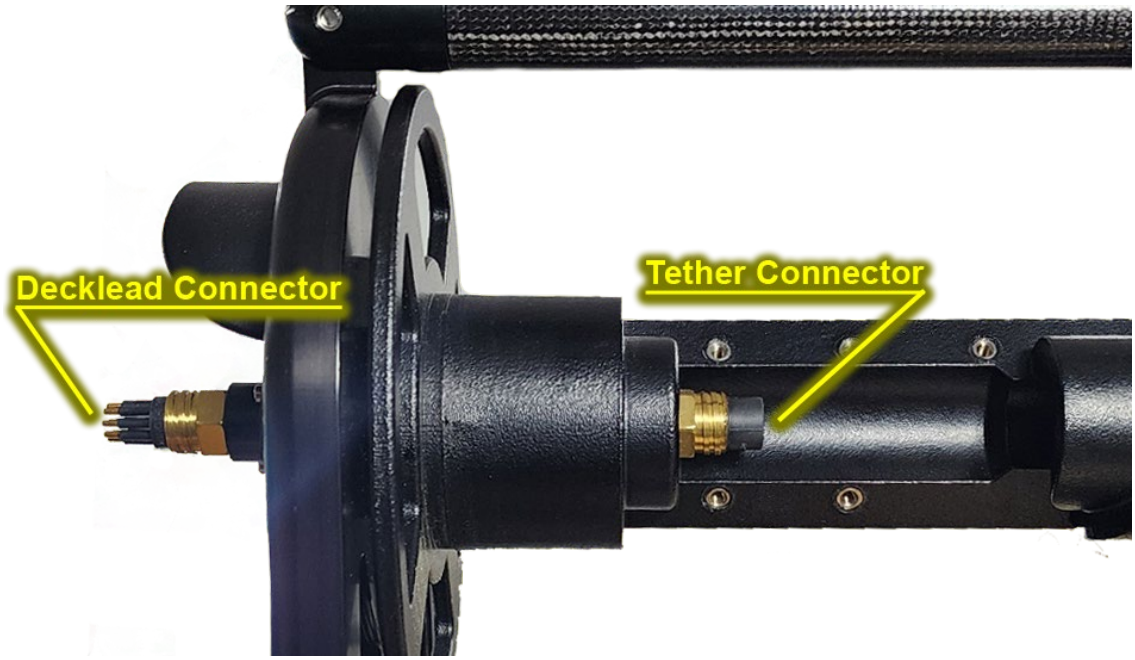
Anatomy of a TMS



Connecting to the TMS

The standard TMS has two connectors on the housing: Power (20-30Vdc) and communications (Ethernet), as shown in the image below.

There are two connectors on the slipring for connecting the tether and decklead; see the image below.



To access the control interface, navigate to *tmscontrol.local* in a web browser.

Tether In/Out Button Operation:

You can use a click-and-drag technique to continuously operate the Tether In or Tether Out function without holding down the button. Simply left-click and hold down on either the Tether In or Tether Out button, drag your mouse cursor away from the button, and then release. This action will 'lock' the command, allowing continuous operation without needing to press the button. You can left-click either button again or use the disarm function to stop the drum's motion. The drum will also automatically stop at the minimum or maximum extent of the drum load, provided it accurately knows its position.

Alternative Keyboard Shortcuts for Tether Control:

When the *tmscontrol.local* interface is the active window on your computer; you can utilize keyboard shortcuts for quick tether commands. Press the 'i' key to initiate a 'Tether In' command at the speed set on the slider bar, and press the 'o' key for a 'Tether Out' command at the preset speed. These shortcuts offer an efficient alternative to mouse clicks, streamlining the operation process.

Default Network Configuration

TMS Network Config:

- IP – 192.168.2.37
- Subnet Mask: 255.255.255.0

Example Control Computer Network Config:

- IP – 192.168.2.1
- Subnet Mask: 255.255.255.0
- Default Gateway: 192.168.2.37

To change the TMS network settings, you can access the control computer's desktop using VNC Viewer at either the TMS IP address or tmscontrol.local.

Calibrate Definition

The calibrate button only homes the Levelwind Carriage position. If the Levelwind Carriage is not in the correct position or fails to switch directions, you should run a Calibration. It will follow the below steps to complete this:

1. Feed some cable up through the top of the Levelwind Carriage, giving some slack.
2. Travel to the Nearside Proximity Sensor.
3. Find Leadscrew 0 position.
4. Travel back to the correct position.
5. Then, feed the loose cable back through the bottom of the Levelwind Carriage.

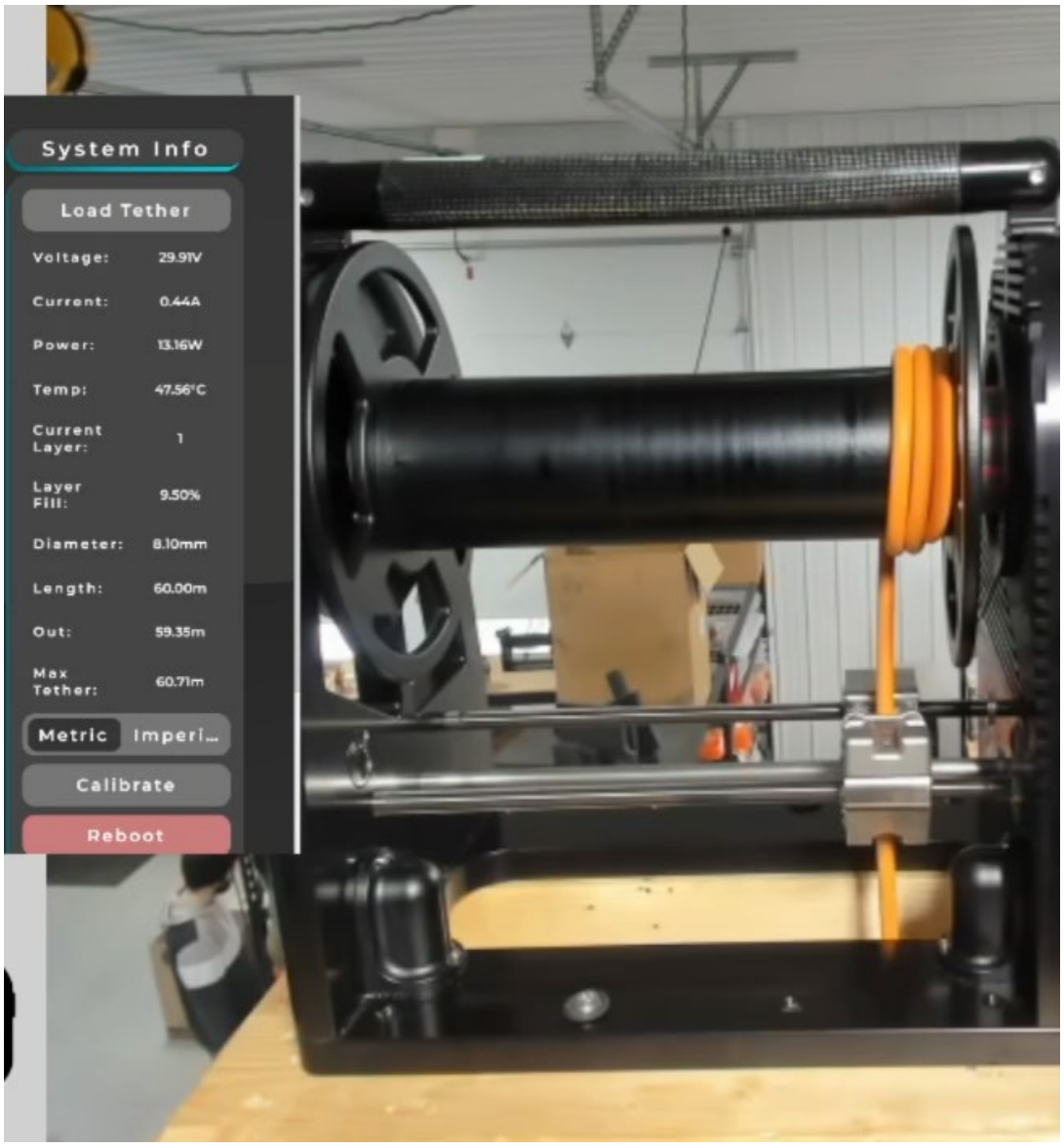
You should pay out a few meters of cable after running a calibration to ensure a clean fill.

Change Tether

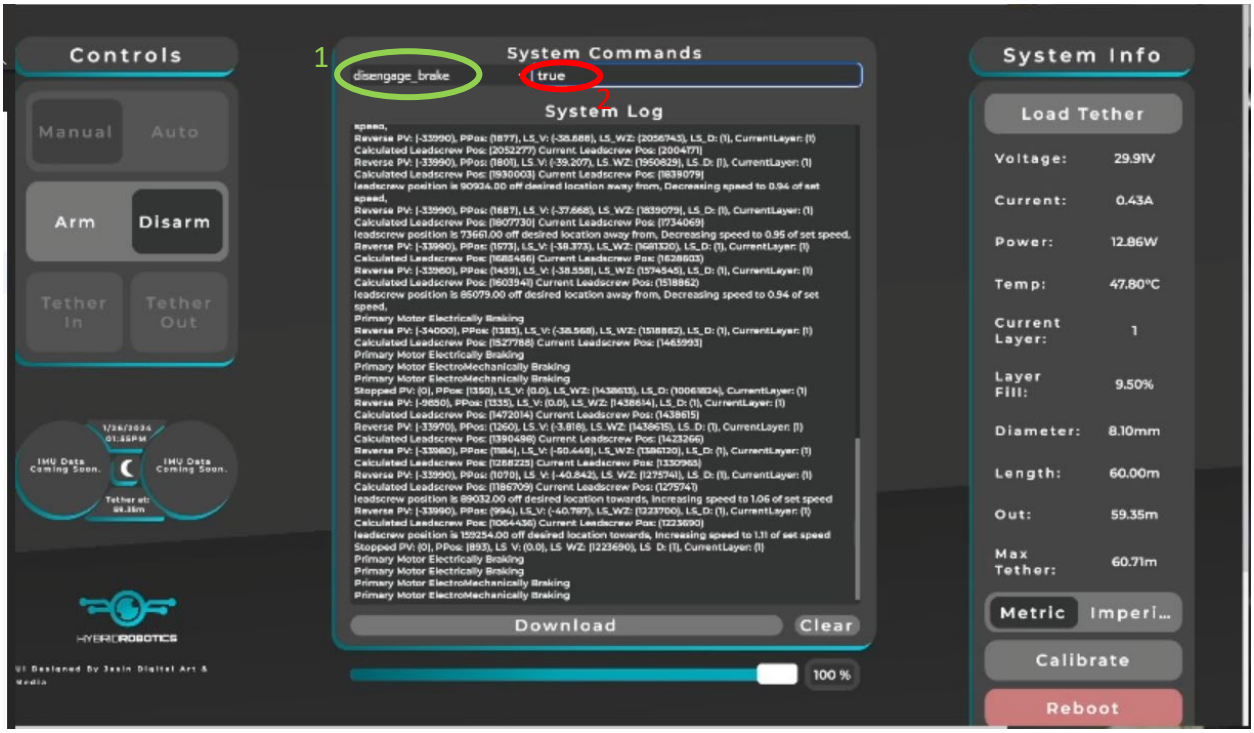
The following steps are instructions that will allow you to unload the last few degrees of the tether, home the *levelwind carriage,* and then change the tether to a different diameter. If you do not have tether loaded on the TMS, skip to **Step 7**.

Step 1 – Ensure that Your Tether is Unloaded to its Minimum Extent:

- It should look similar to the image below, with only a few wraps of tether towards the drum's near side extent.

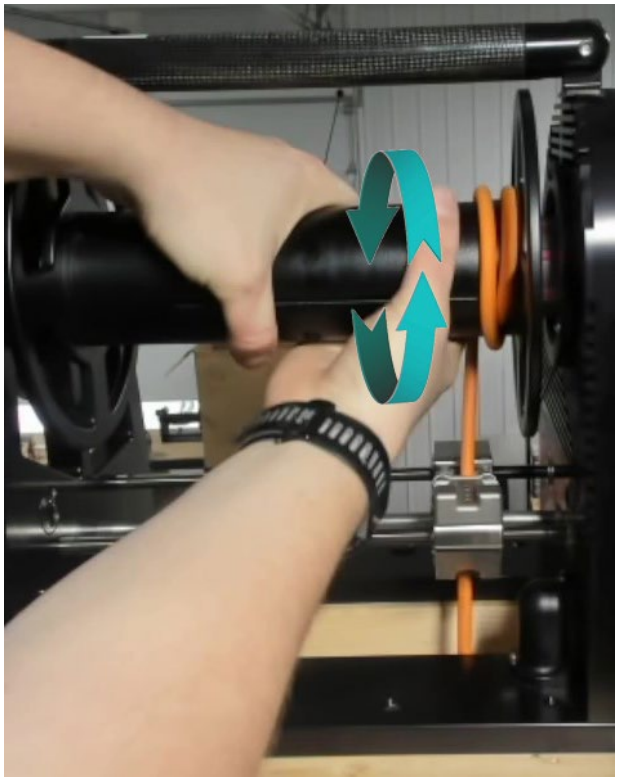


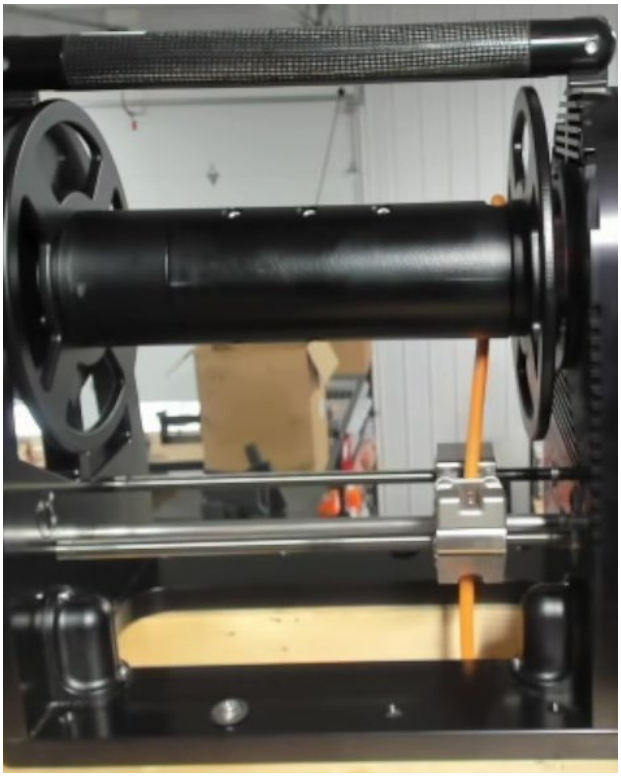
Step 2 – Disengage the Drum Brake:



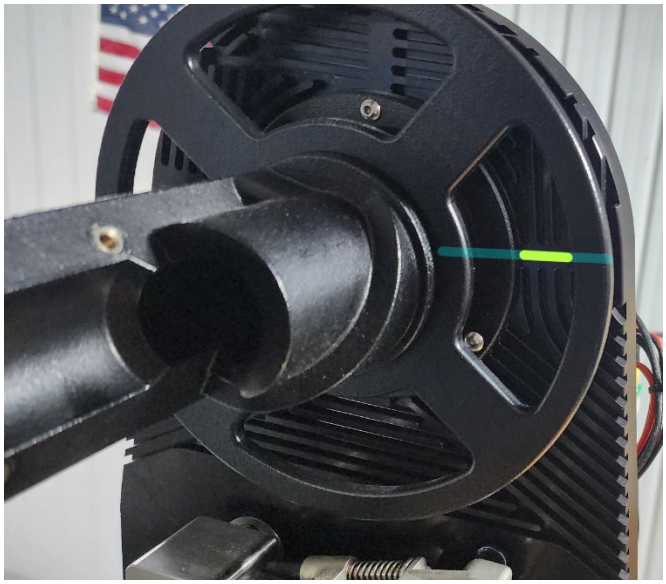
1. Dropdown Menu Selection (Green Oval):
    - Locate and select *disengage_brake* from the dropdown menu.
2. Input in Text Box (Red Oval):
    - Type *true* in the provided text box.
3. Execute Command:
    - Press Enter to send the command.
4. Auditory Confirmation:
    - Listen for a click sound, indicating the brake has disengaged.

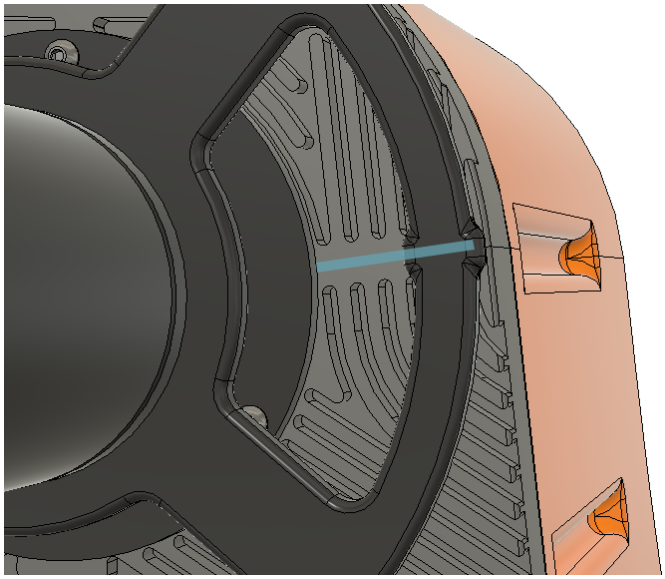
Step 3 – Manually Turn the Drum Back to the Zero Position:



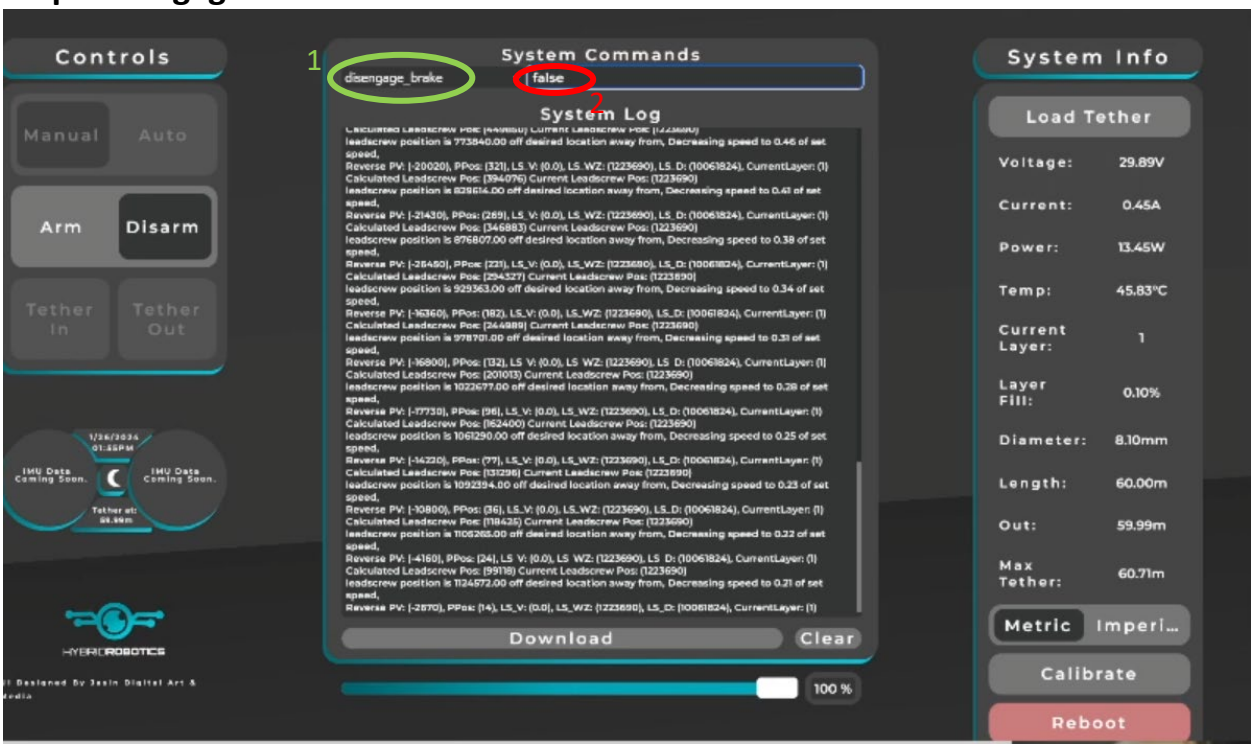


- Manually turn the drum until there are no more full wraps of tether around the drum.
- Ensure the drum cover is facing the proximity sensors.
- Use the heatsink pattern as a guide to align the center of the cover side wheel with the thicker portion of the heatsink pattern, as shown in the images below.





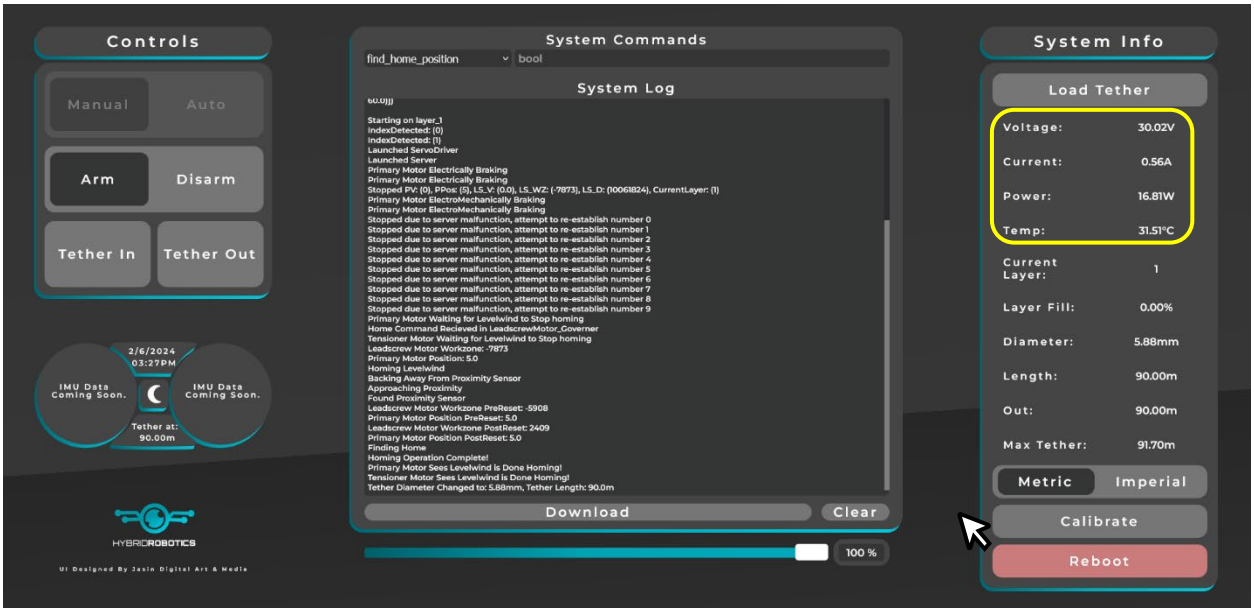
Step 4 – Engage the Drum Brake:



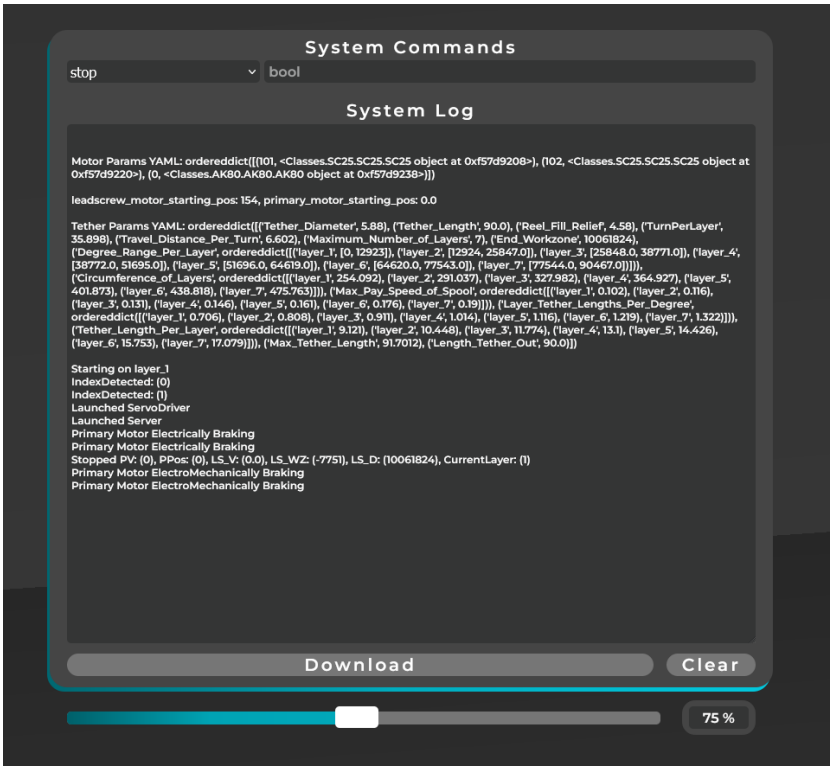
1. Dropdown Menu Selection (Green Oval):
    - Locate and select *disengage_brake* from the dropdown menu.
2. Input in Text Box (Red Oval):
    - Type *false* in the provided text box.
3. Execute Command:
    - Press Enter to send the command.
4. Auditory Confirmation:
    - Listen for a click sound, indicating the brake has engaged.

Step 5 – Get TMS Back Into the Stopped State (Bug Workaround – Fix Coming):

1. Power cycle the TMS
2. Wait for the TMS to finish booting. You will know it has finished if the telemetry values under System Information start updating.

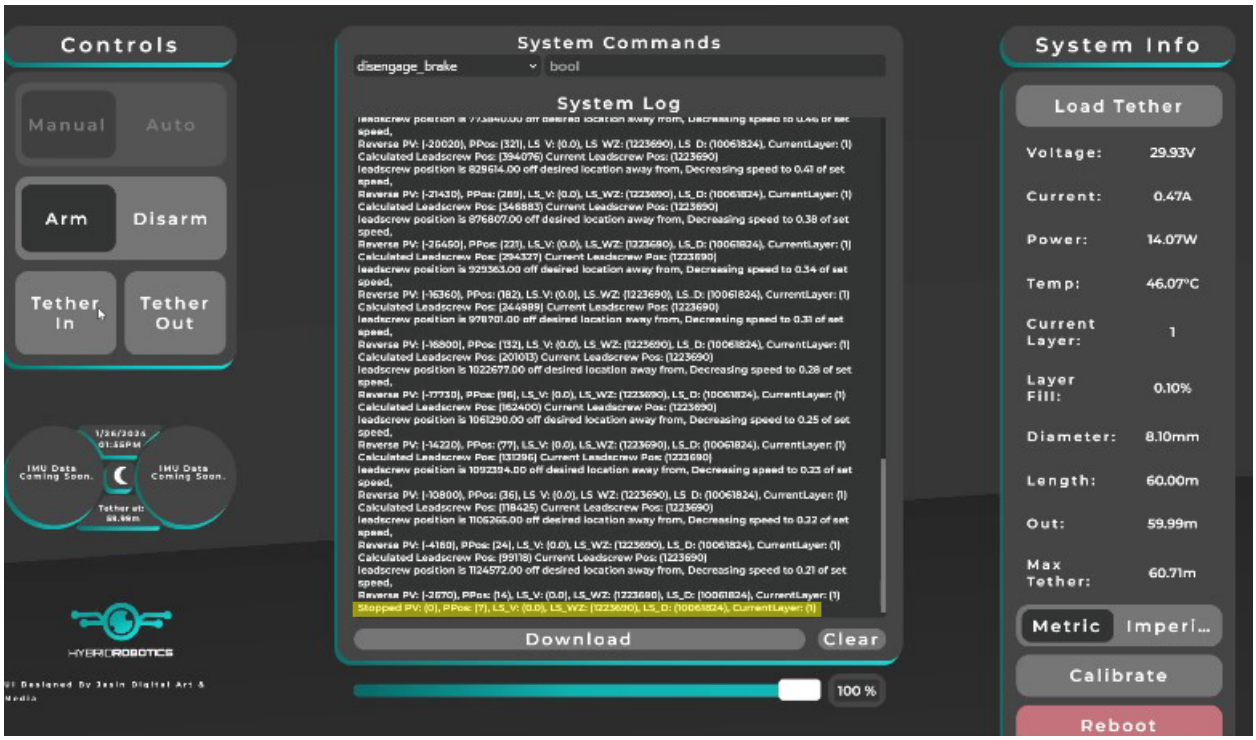


Once the connection is established, left-click the *Clear* button under *System Log* and refresh the page. After refreshing, the *System Log* should look similar to the image below.

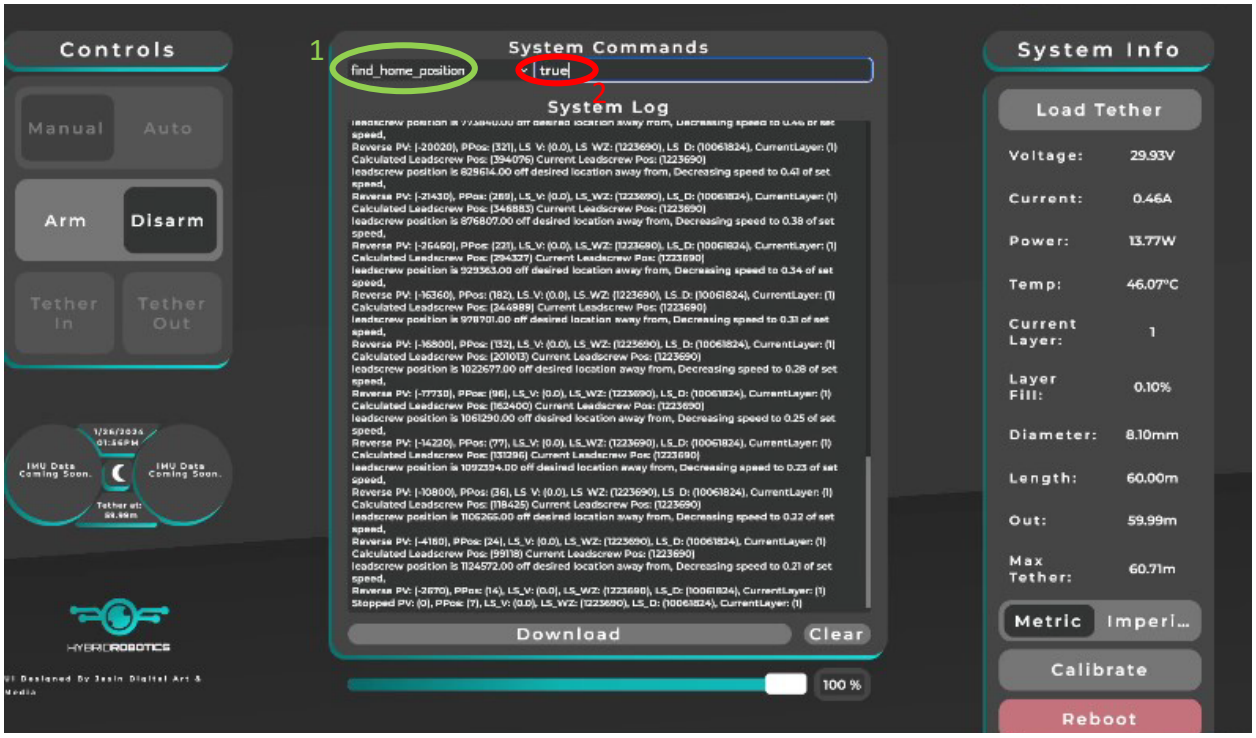


Step 5 - Alternative Method:

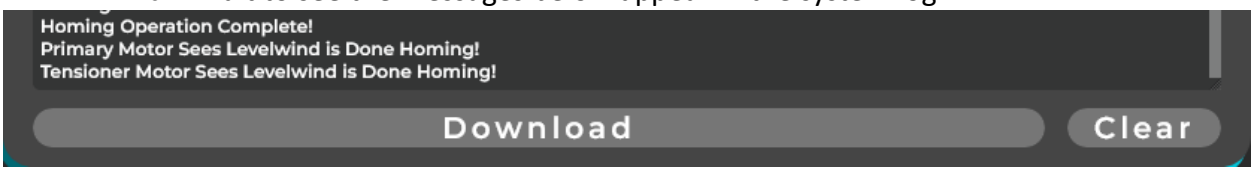
1. **Manually Turn the Drum**: When we rotate the drum to the zero position, it temporarily disrupts the unit's 'officially stopped' state.
2. Re-engage System to Stopped State:
    - Use the' tether in' button to reset the system without further drum adjustment.
    - Press ' tether in' briefly, for about 1-2 seconds, then release.
    - Repeat this process and monitor the system log.
    - Once the 'stopped' message appears in the system log, the system is back in its stopped state. It is highlighted in the image below.
    - This procedure is a workaround for a software bug, pending resolution in future updates.



Step 6 – Home TMS:

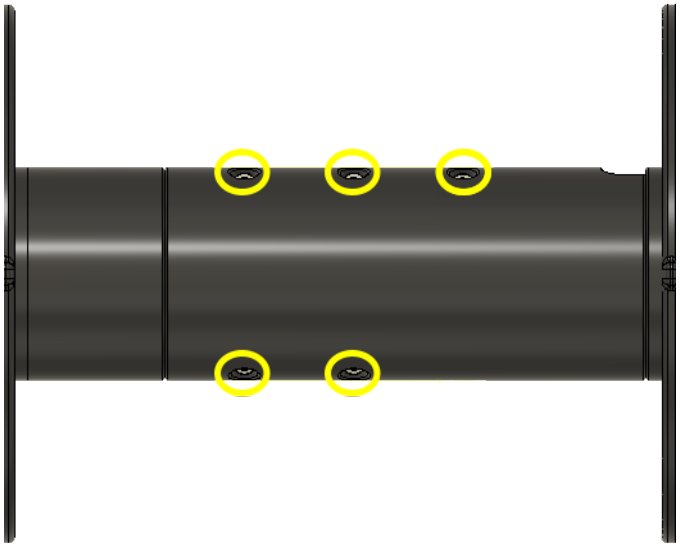


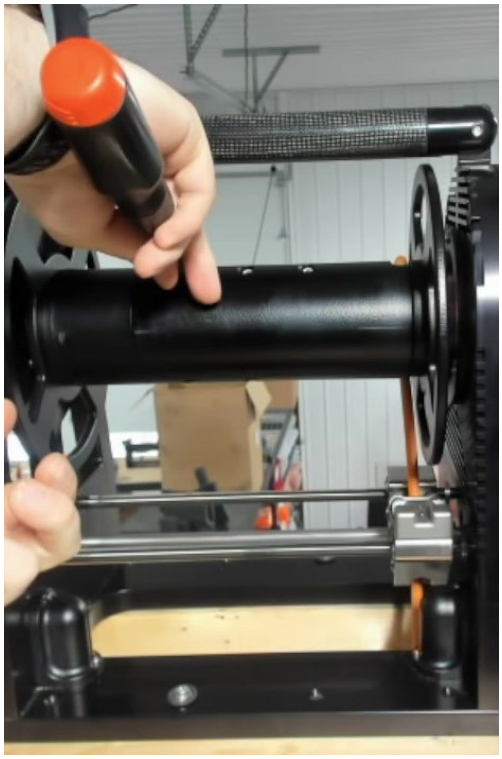
1. Dropdown Menu Selection (Green Oval):
    - Locate and select *find_home_position* from the dropdown menu.
2. Input in Text Box (Red Oval):
    - Type *true* in the provided text box.
3. Execute Command:
    - Press Enter to send the command.
4. Levelwind will travel to the nearside proximity sensor:
    - Wait to see the messages below appear in the system log



Step 7 – Remove Screws from the drum cover:

Use a 4mm hex drive.
Remove the five M5x20 socket head cap screws from the drum cover.

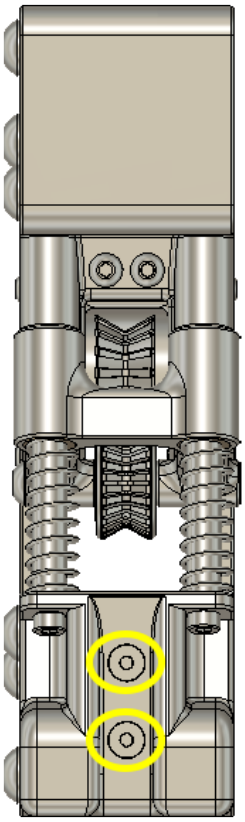


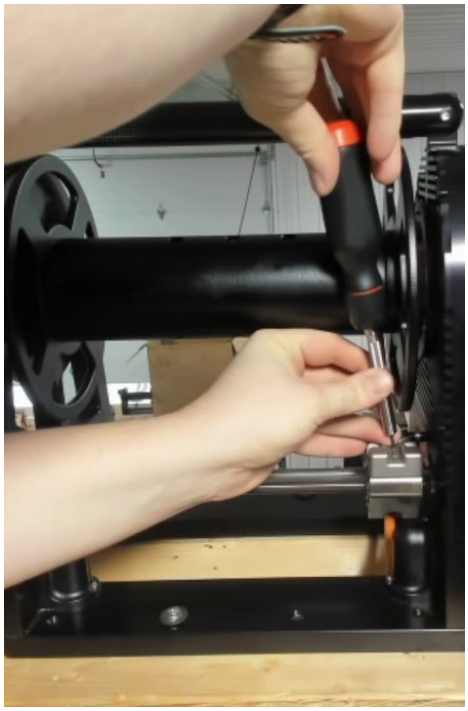


Step 8 – Remove Screws from the *Levelwind Tensioner Assembly*:

Use a 2mm hex drive.

Remove the two M3x12 flat head screws from the levelwind mount.

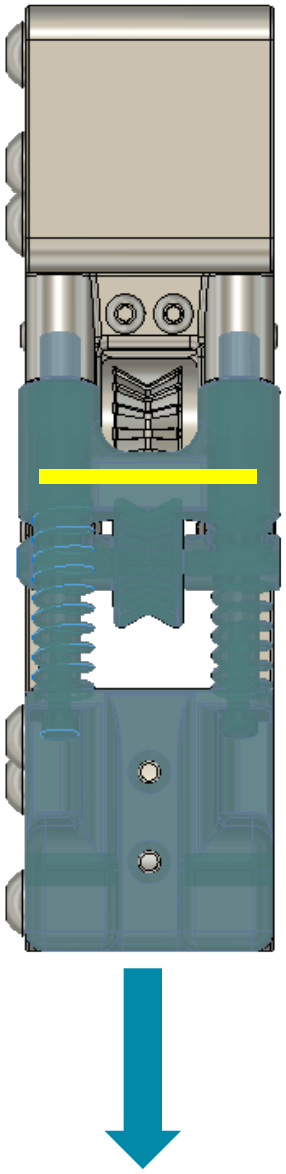


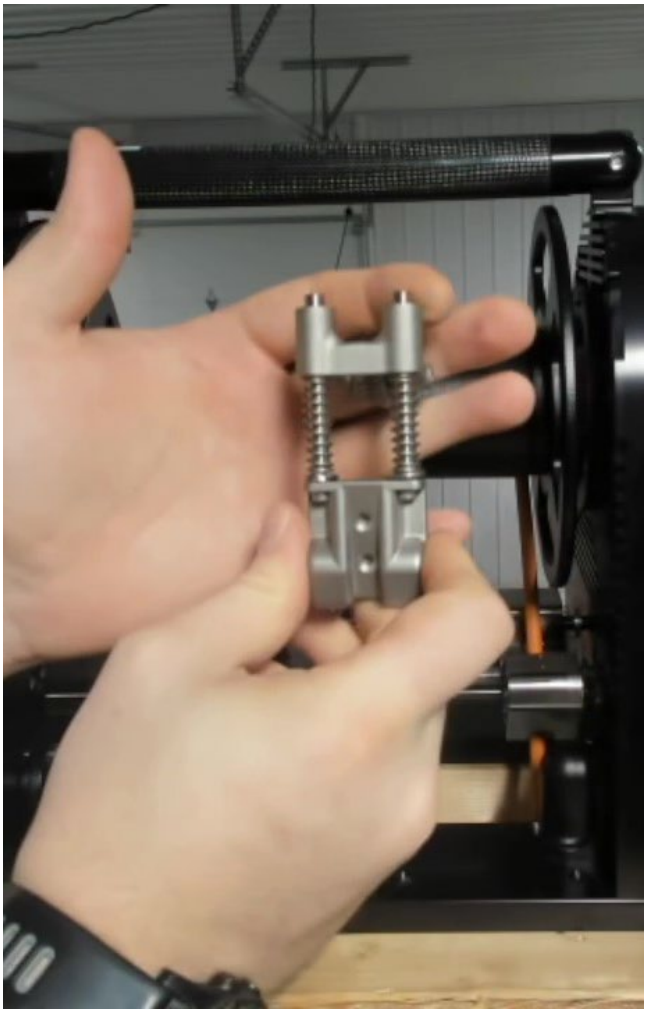


Step 9 – Remove the Levelwind Tensioner Assembly:

Pull Out: Carefully pull the Levelwind Tensioner Assembly out of the Levelwind Tensioner Backstop. It would help if you held onto the yellow area while you remove it to ensure that the assembly doesn't force itself apart due to the spring torsion.

Wiggle Gently: It might require a bit of maneuvering, so gently wiggle the Levelwind Tensioner Assembly to loosen it.

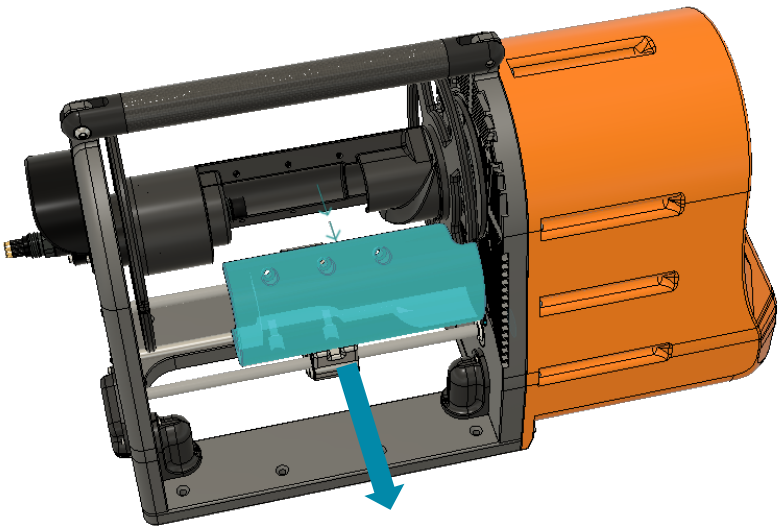


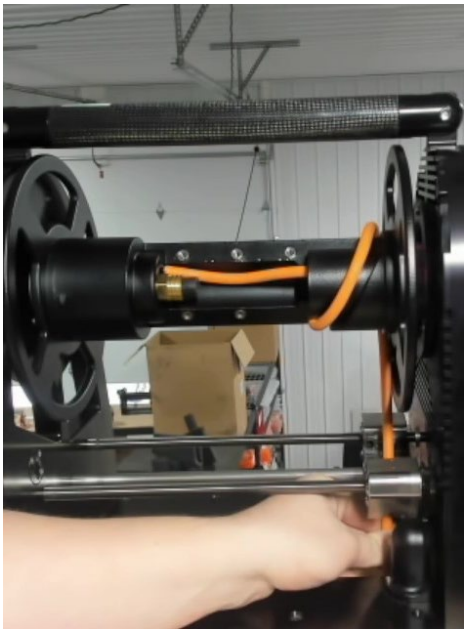


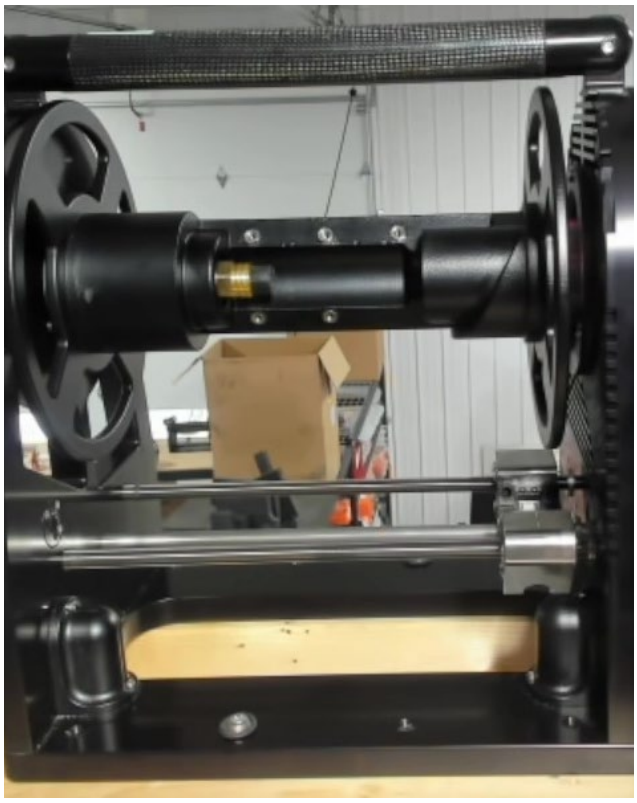
Step 10 – Remove the *Spool Drum Cover* and *Tether*:

Pull Off: Carefully pull the cover off of the Drum.

Remove Tether: Pull the tether out of the drum and through the bottom of the levelwind to remove the tether from the system.

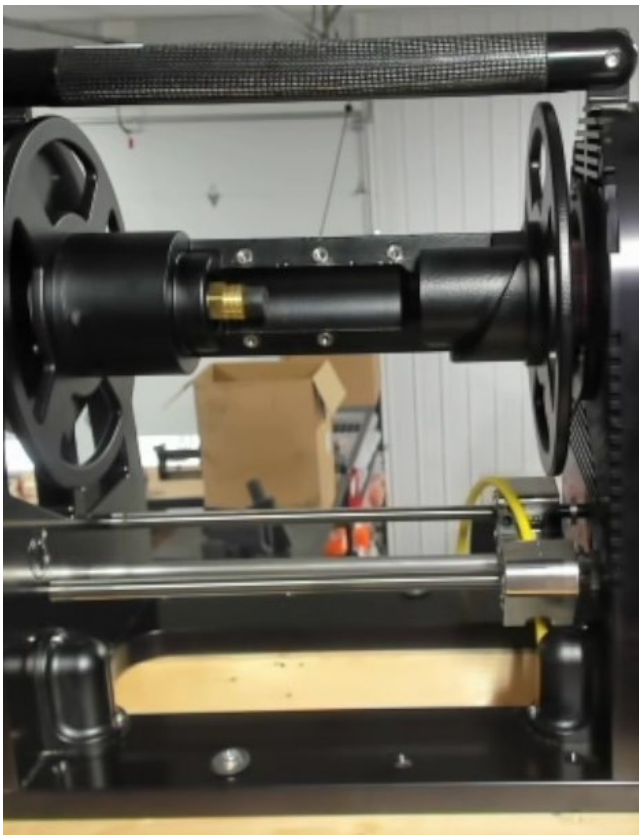






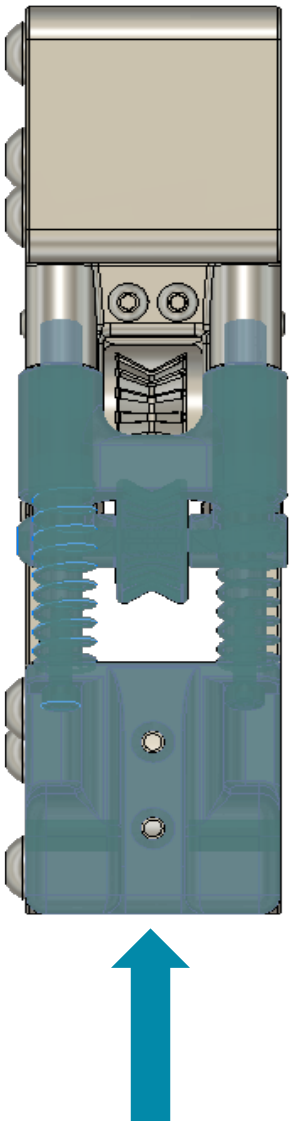
Step 11 – Feed *Tether* up through through *Levelwind Carriage*:

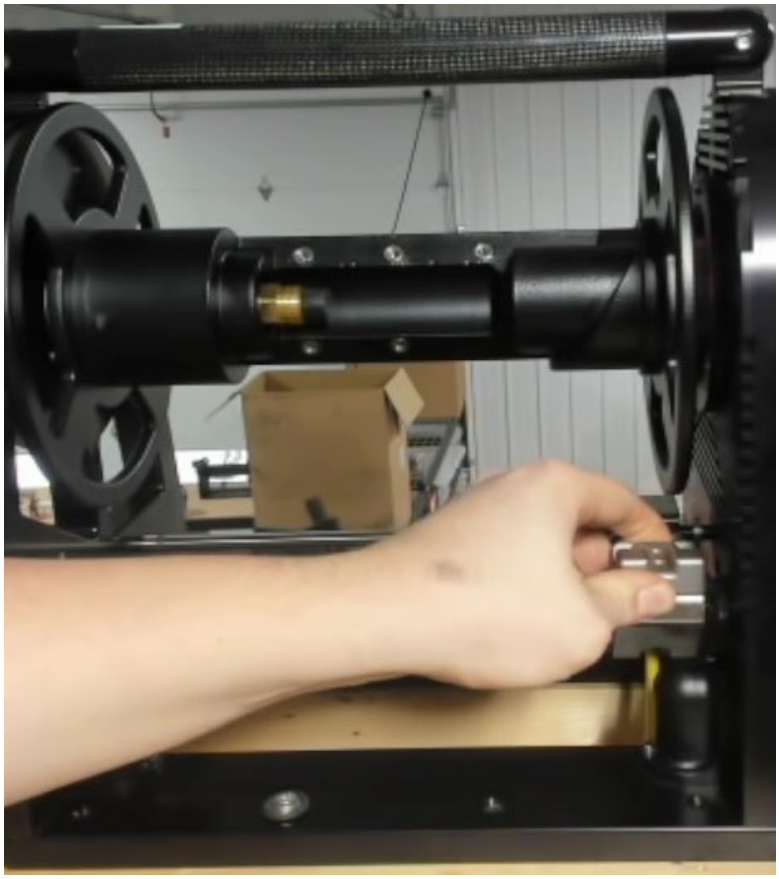
Feed Tether: Feed the tether up through the bottom of the levelwind carriage.



Step 12 – Install the Levelwind Tensioner Assembly:

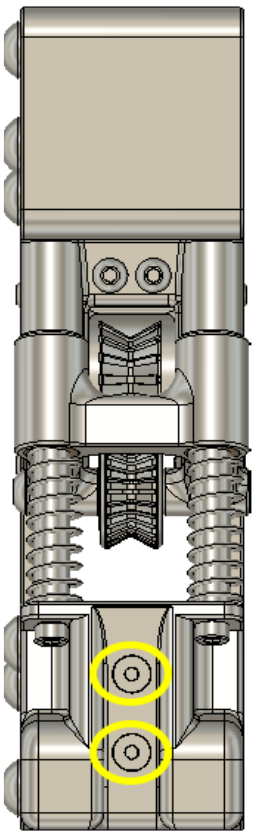
Insert the Levelwind Tensioner Assembly into the Levelwind Tensioner Backstop with the tether between the two wheels.

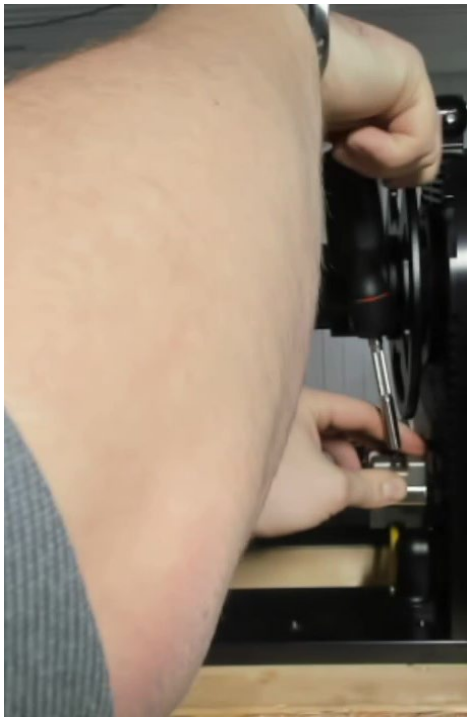


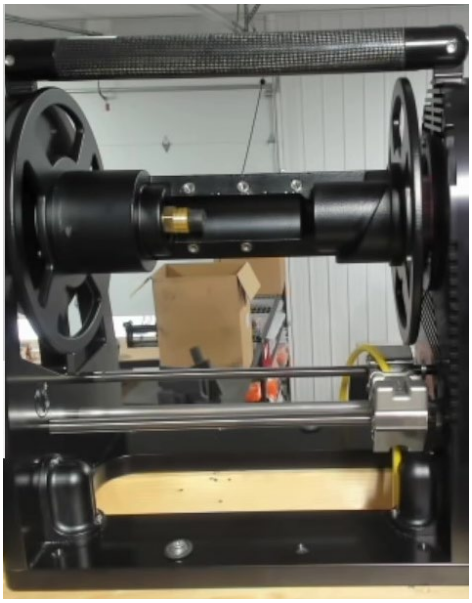


Step 13 – Install flathead screws into the *Levelwind Tensioner Assembly*:

1. Use a 2mm hex drive.
2. Install the two M3x12 flat head screws from the levelwind mount. These do not need to be very tight; 10in-lb of torque is plenty tight.



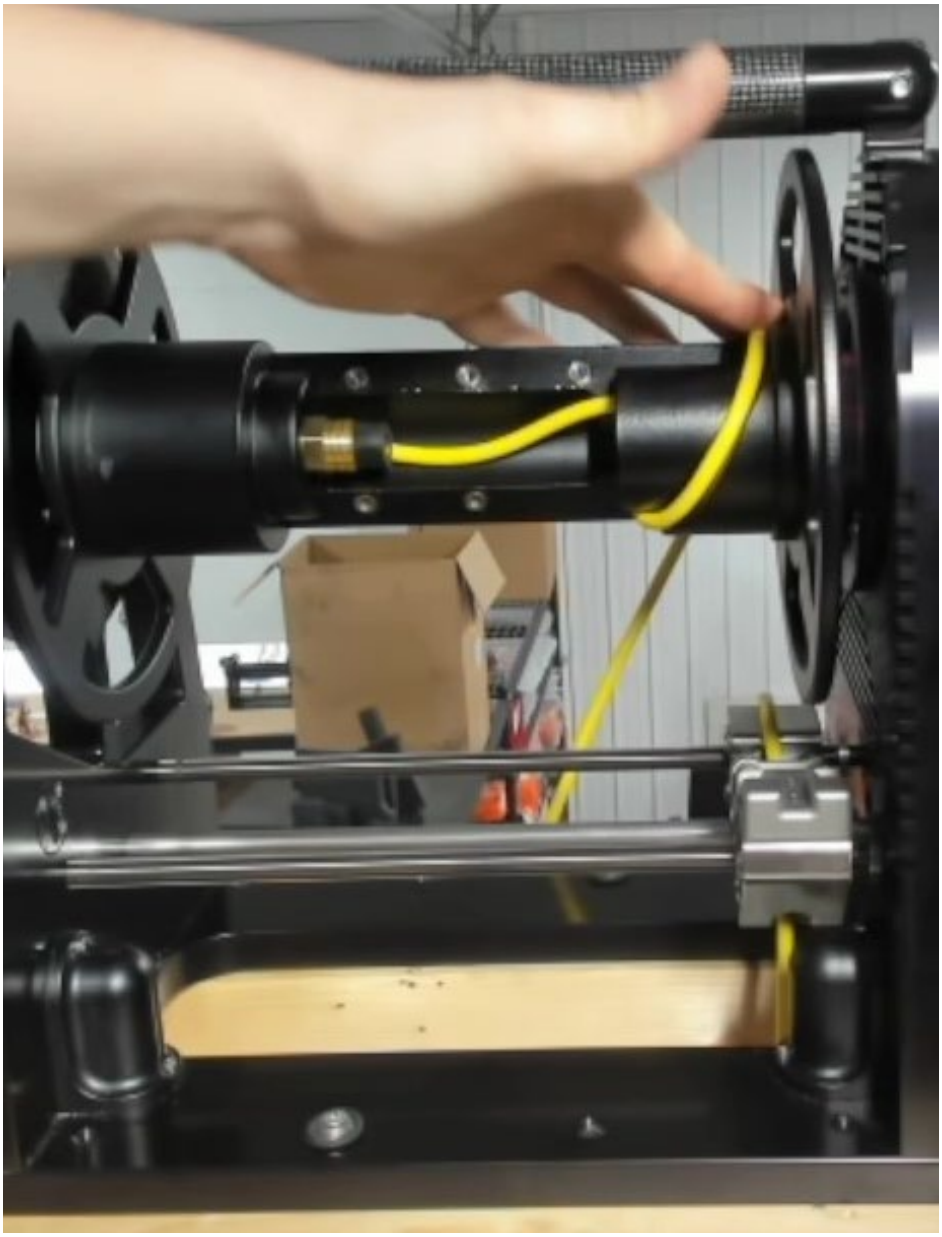




Step 14 – Wrap Tether Around Drum:

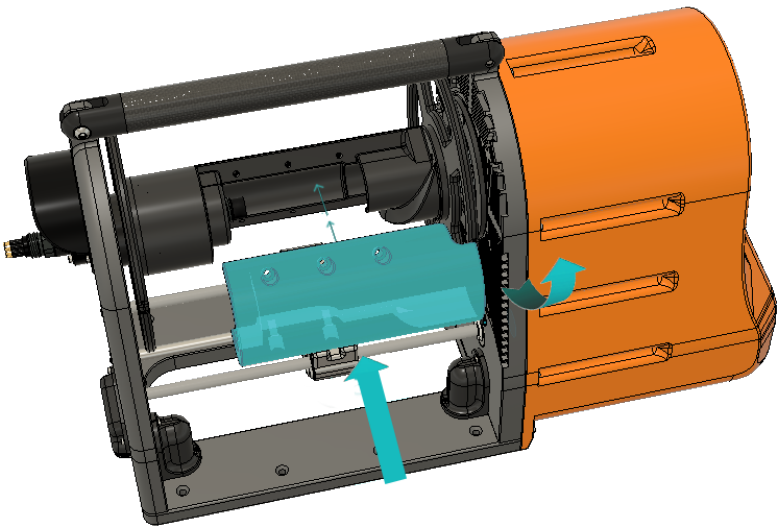
1. Plug the tether into the slipring **(note: not visible here)**
2. Secure the locking collar to the slipring **(note: not visible here)**
3. Wrap the tether around the drum, as shown below.

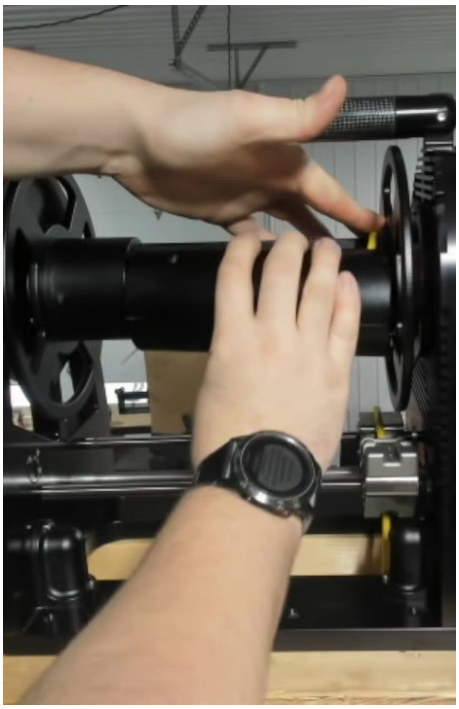
Note: The tether will likely need to be looped into the hole towards the nearside to make it safely around the bend.



Step 15 – Install Drum Cover

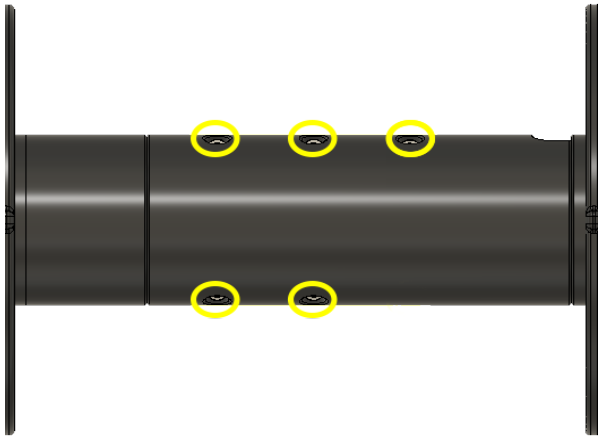
Install the Spool Drum Cover onto the Drum while holding the tether where it is. Putting the cover on can require a slight roll motion toward the tether output, as is shown in the image below.

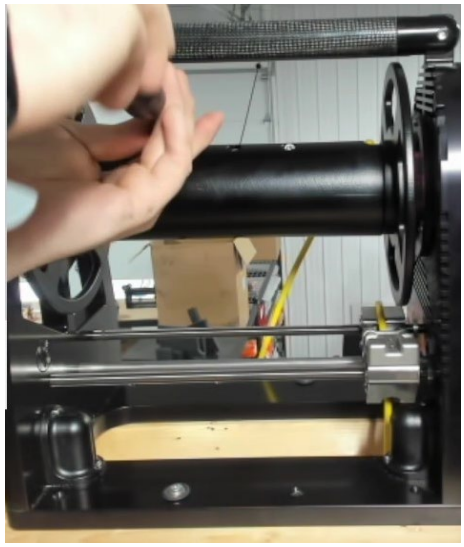




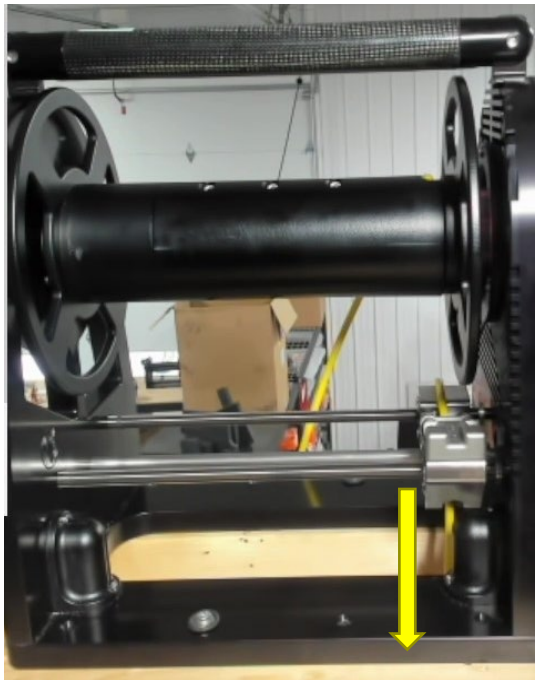
Step 16 – Install Screws Into Drum Cover & Pull Loose Cable Through *Levelwind*:

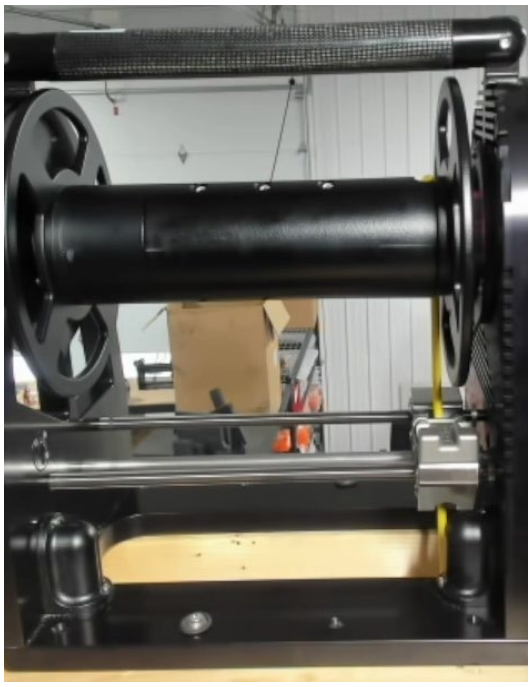
1. Use a 4mm hex drive.
2. Install the five M5x20 socket head cap screws into the drum cover. These do not need to be very tight; 15in-lb of torque is plenty tight.





3. Pull any loose cable through the bottom of the *Levelwind Carriage* so there isn't any slack between the drum and the carriage.

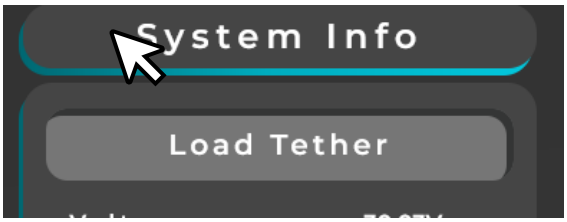




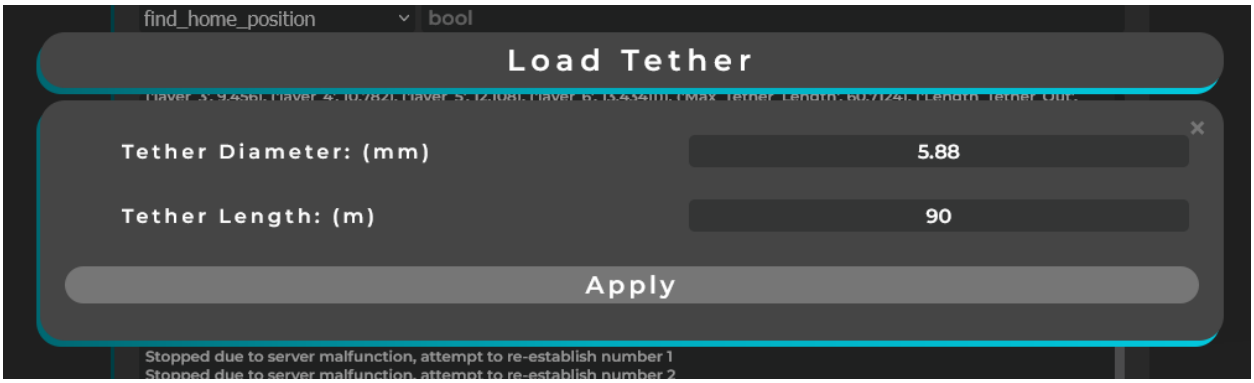
Step 17 – Change Tether Diameter and Length in the User Interface:

1. Left-click on the Load Tether Button in your display's upper right-hand corner.

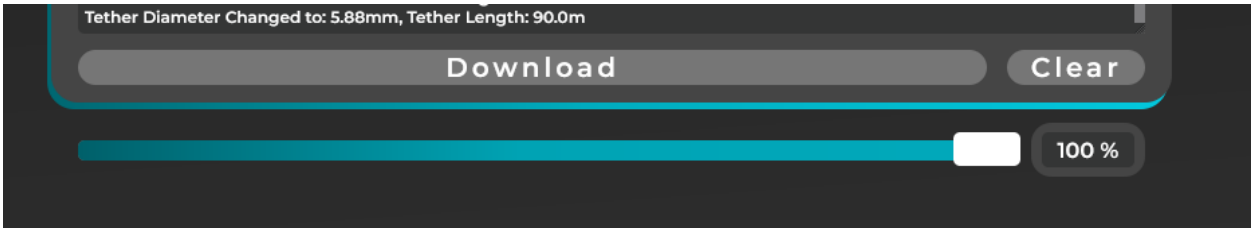
Note: You will only be able to change tether diamter or length if the TMS is at its zero position. Thus, after a *find_home_position* has been completed.



2. In the popup window, input your new tether specifications. In this case, we are using a tether diameter of 5.88mm and a tether length of 90m. Then click Apply.



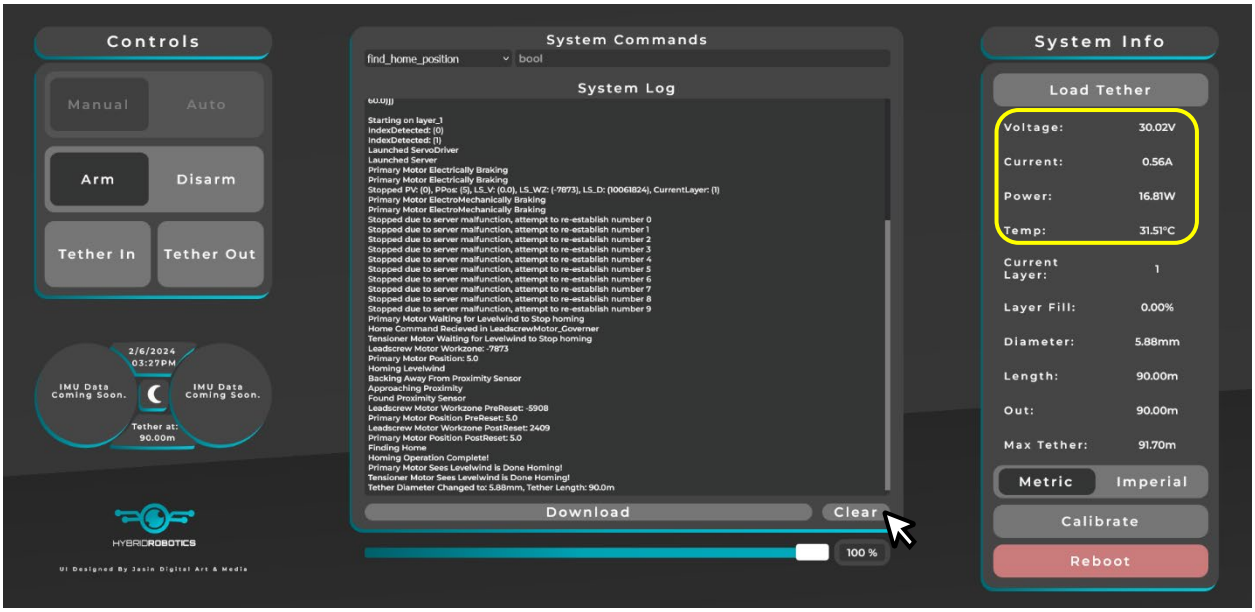
3. This message appears in the *System Log* if it is set correctly.



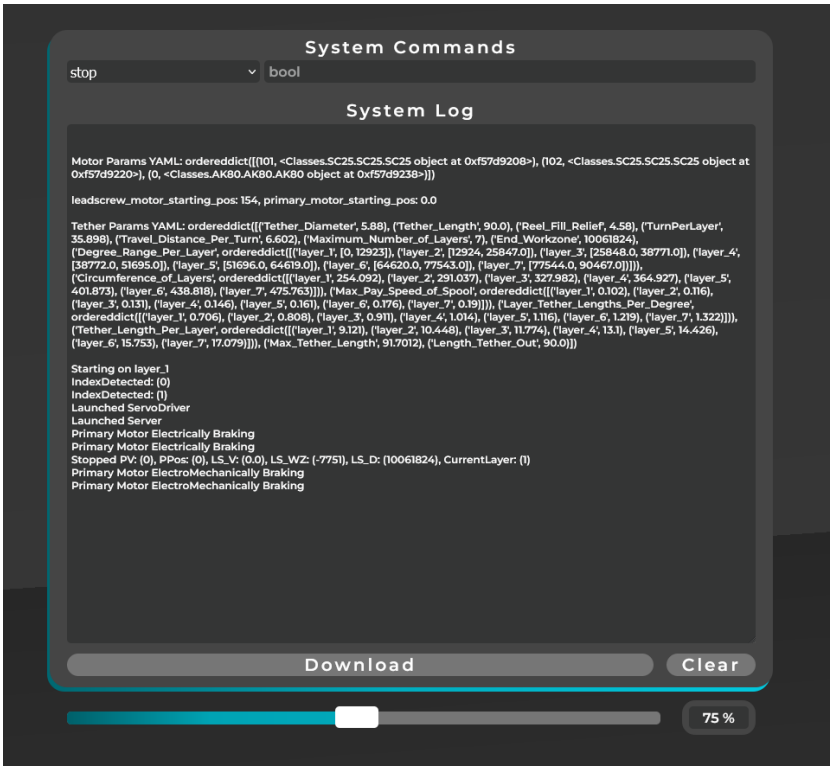
4. Power Cycle the TMS **(Bug Workaround – Fix Coming)**

Step 18 – Establish a Fresh Connection with the TMS (Bug Workaround – Fix Coming):

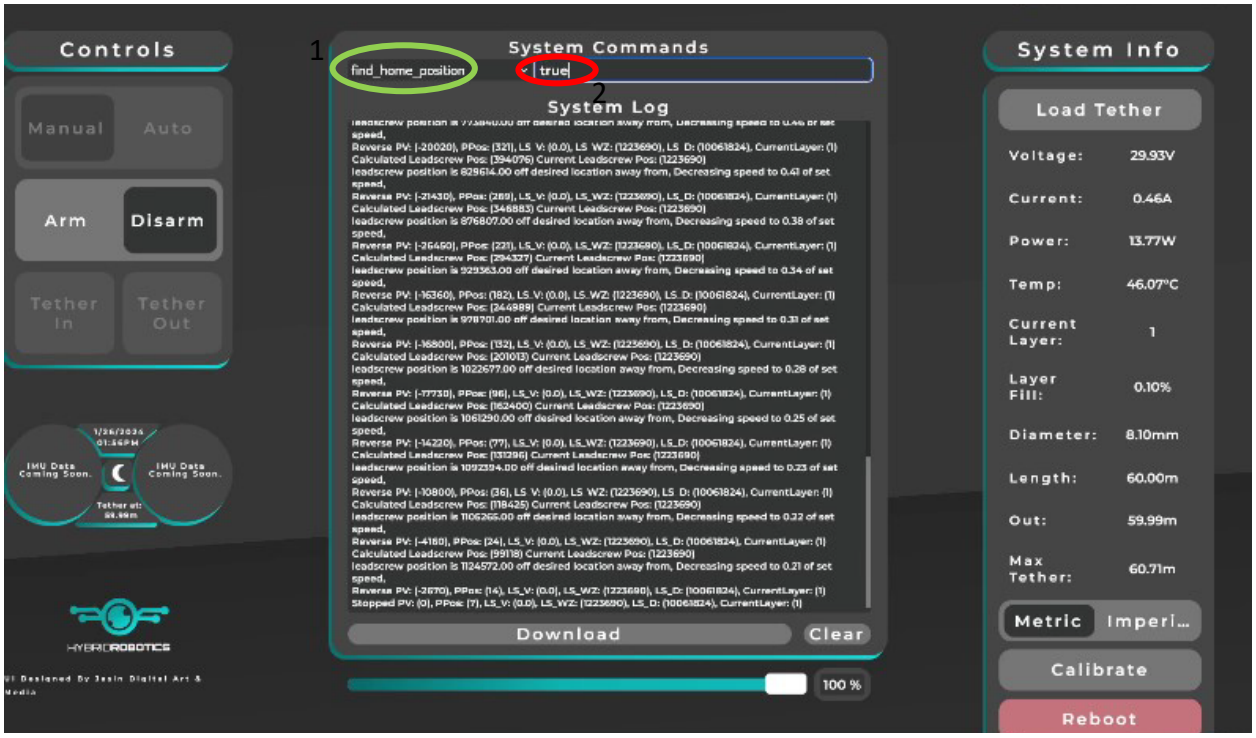
1. Wait for the TMS to finish booting. You will know it has finished if the telemetry values under System Information start updating.



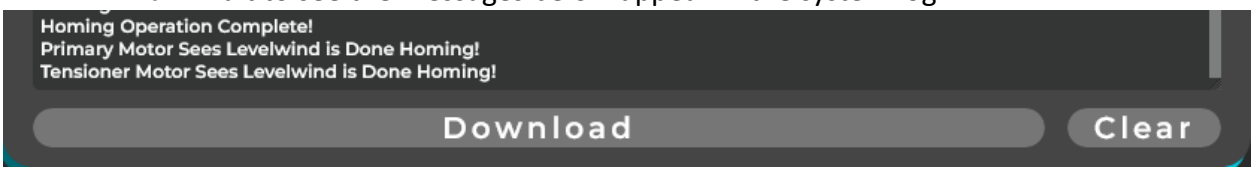
2. Once the connection is established, left-click the *Clear* button under *System Log* and refresh the page. After refreshing, the *System Log* should look like the image below.



Step 19 – Home TMS:

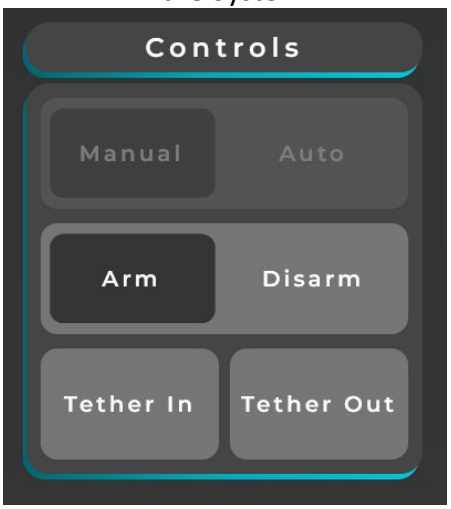


1. Dropdown Menu Selection (Green Oval):
    - Locate and select *find_home_position* from the dropdown menu.
2. Input in Text Box (Red Oval):
    - Type *true* in the provided text box.
3. Execute Command:
    - Press Enter to send the command.
4. Levelwind will travel to the nearside proximity sensor:
    - Wait to see the messages below appear in the system log

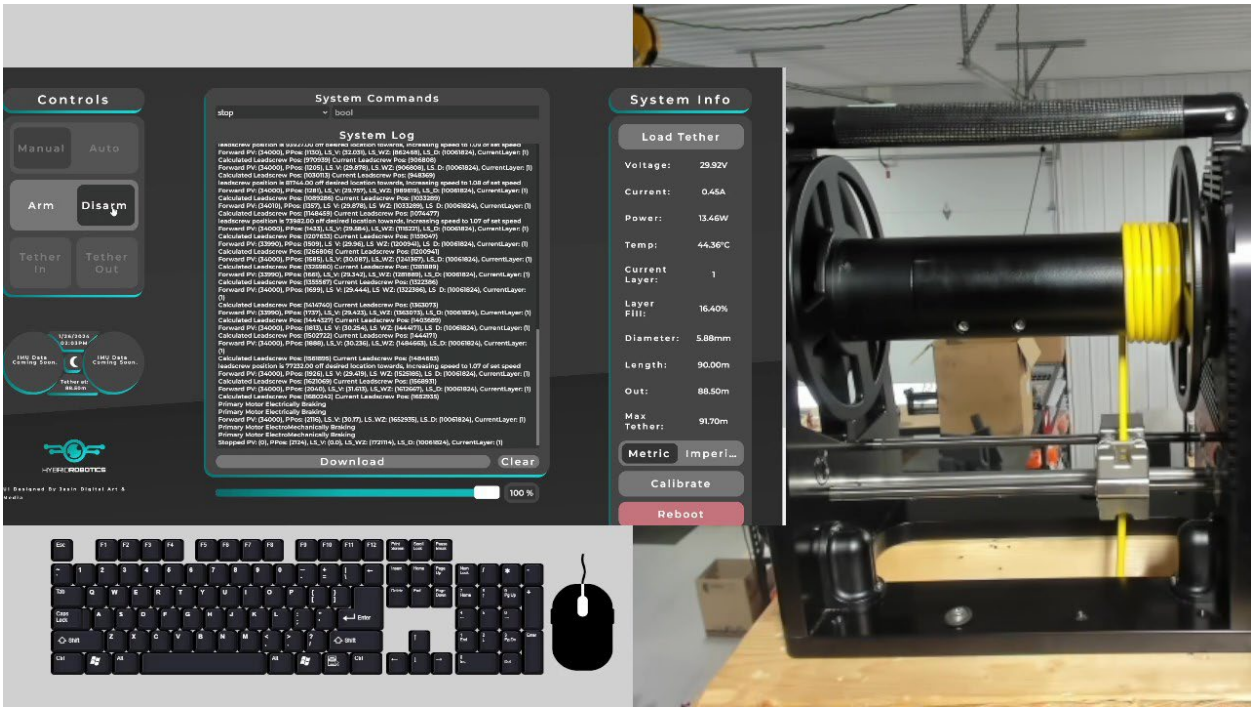


Step 20 – Pay in the First Few Wraps of Tether:

1. *Arm* the System

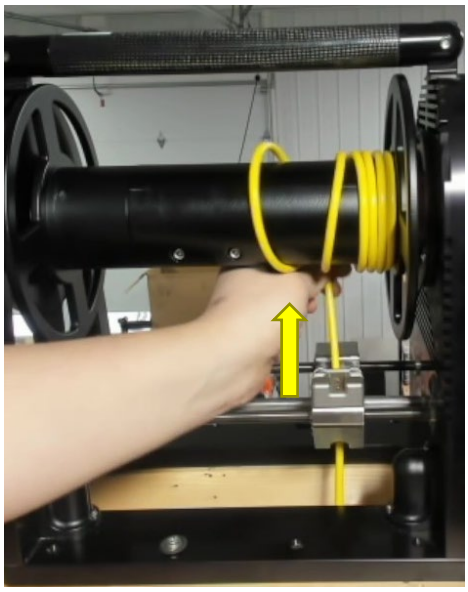


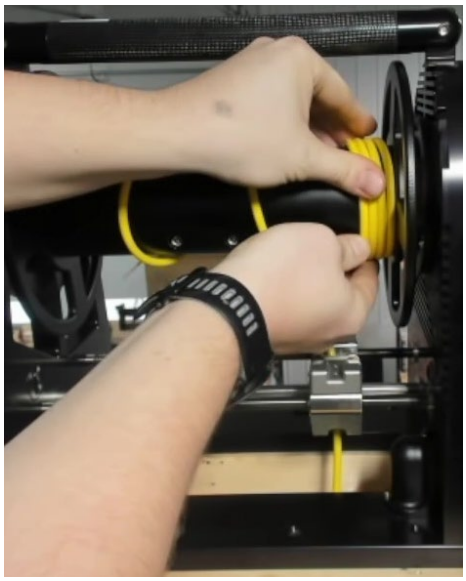
2. Left-click and hold the *tether In* button until the *Layer Fill* is around 15%. Then *Disarm*



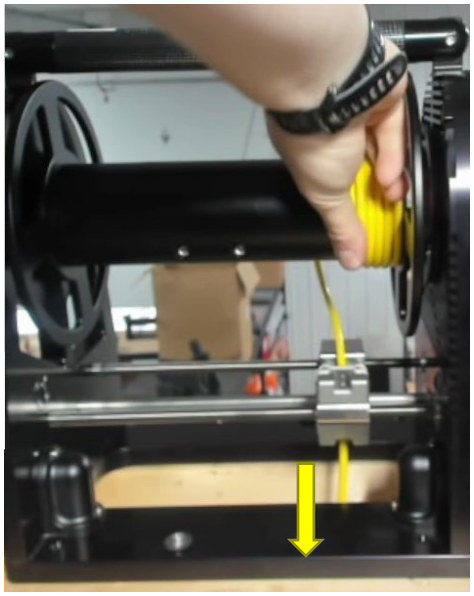
Step 21– Manually Organize the Wraps so That the Tether Does Not Cross Over Itself:

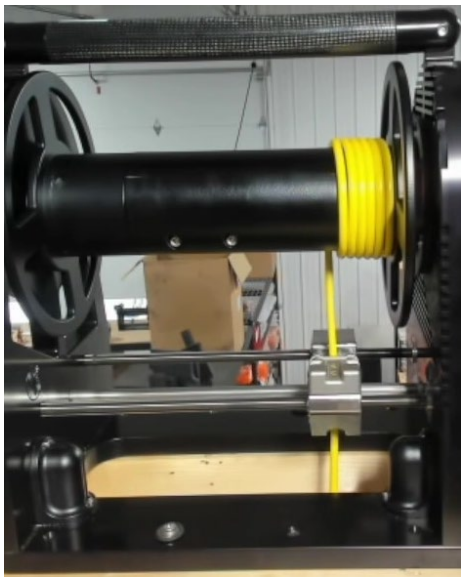
1. Pull a few inches of slack through the top of the levelwind to loosen the current wraps of cable.
2. Start wrapping the tether Around the Drum Manually so that the tether does not cross over itself.





3. While holding your organized cable, pull the *tether* slack back through the *Levelwind Carriage* so there is no slack between the *Levelwind Carriage* and the *Drum*.





4. You are loaded and ready to *tether In* the rest of your cable!

TMS API Reference

User-Accessible Commands & Telemetry

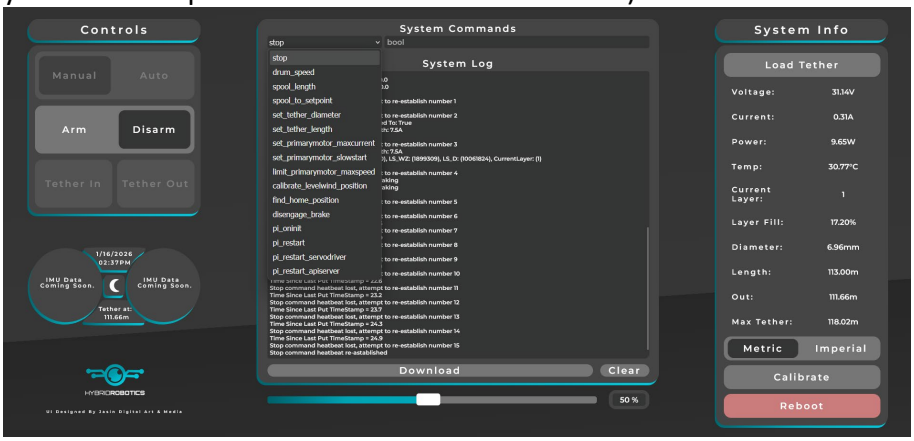
This section documents all user-accessible API endpoints exposed by the Tether Management System (TMS). The API is designed around a small number of read-only telemetry endpoints and a centralized command dictionary used for motion control and configuration.

All endpoints use standard HTTP semantics and JSON payloads.

---

1. Command Interface

Commands are exposed as key–value entries in a centralized command dictionary. The system continuously acts on the **most recent value** of each command, subject to internal safety logic. Commands are accesible on the standard GUI in the dropdown shown below: (Type the value you want and press enter to send the command)



There is also a API documents page hosted on board and accessible at <ip_address>:5000/docs or <tmscontrol.local>:5000/docs. You can read the values accessible at each endpoint as well as send data for testing purposes.

- **Read Commands**
  - **GET /commands/**
    Returns all commands with their current value and expected data type.
  - **GET /commands/{command}**
    Returns a single command entry.

    Command entry format

    {
     "value": <current_value>,
     "data_type": "<expected_type>"
}
  - **Update Commands**

    - **PUT /commands/{command}**

    Payload format:

    {
     "value": <new_value>,
     "data_type": "<type>"
    }

    Important notes

    - data_type is required in the payload but **cannot be changed**.
    - The system enforces the correct type internally.
    - Only the value field is acted upon.
    - Invalid values are rejected or clamped internally.

2. Core Safety & Motion Commands

stop → bool

Heartbeat / safety signal.

- **Must be updated every 0.5–1.0 seconds**, regardless of value.
- True → hard stop request.
- False → motion allowed.
- If heartbeat updates stop arriving, the system **automatically halts motion**.

---

drum_speed → int (ERPM)

Direct speed command to the primary drum motor.

- Positive → pay out tether
- Negative → reel in tether
- Speed is clamped by:
  - Physical motor limits
  - limit_primarymotor_maxspeed
  - Internal safety limits

---

3. Spooling by Length

spool_length → list [distance_m, speed_erpm]

Spools a **relative length** of tether from the current position.

Examples:

- [5.3, 42000] → spool out 5.3 m
- [-5.3, 42000] → spool in 5.3 m

Stops automatically when distance is reached or a safety condition trips.

---

spool_to_setpoint → list [setpoint_m, speed_erpm]

Moves to an **absolute tether length setpoint**.

Example: (Direction is chosen automatically. Stops within internal tolerance or on fault.)

- [55.2, 42000] → move until ~55.2 m is deployed

4. Tether Configuration Commands

set_tether_diameter → float (mm)

Sets the tether diameter used for spooling math.

- **Requires the TMS to be homed**
- Affects all length, speed, and layer calculations

---

set_tether_length → float (m)

Sets the total available tether length on the drum.

- Updates internal maximum length model
- Can be changed at any time

---

5. Motor Limits & Safety Commands

set_primarymotor_maxcurrent → float (A)

Sets maximum allowed primary motor current.

- Acts as a torque limiter
- Internally clamped to safe bounds
- Used to tune pulling aggressiveness

---

limit_primarymotor_maxspeed → int (ERPM)

Applies a soft cap to the maximum motor speed.

- Reduces maximum commanded ERPM
- Does not increase physical motor limits

6. Levelwind & Homing Commands

calibrate_levelwind_position → bool

Re-homes the levelwind carriage only.

- Does not reset tether length tracking
- Used to correct minor alignment drift

---

find_home_position → bool

Full system home cycle.

- Homes levelwind
- Zeros primary motor and leadscrew positions
- Resets length model to 0 m
- Required before loading a new tether

---

7. Brake Control

disengage_brake → bool

Controls the primary mechanical brake.

- True → brake released (manual drum rotation allowed)
- False → brake engaged
- Internal logic may include debounce and trim switch checks

8. System / Service Commands (Advanced)

These commands are intended primarily for service or debugging.

pi_oninit → bool

Internal initialization flag used during system startup.

---

pi_restart → bool

Requests a restart of the TMS control stack.

---

pi_restart_servodriver → bool

Restarts the motor/servo driver interface without rebooting the Pi.

---

pi_restart_apiserver → bool

Restarts the HTTP API server process only.

9. Telemetry & Information Endpoints

/system_info/

Static system identification.

Fields

- SOFTWARE_VERSION *(string)* — software version
- HARDWARE_VERSION *(string)* — controller/hardware revision

/general_info/

Live operating telemetry.

Fields

- voltage *(V)* — DC bus voltage
- current *(A)* — total system current
- power *(W)* — instantaneous power draw
- temp *(°C)* — average system temperature
- current_layer *(int)* — active tether layer
- layer_fill *(0–1)* — fraction through current layer
- tether_diameter *(mm)* — configured tether diameter
- tether_length *(m)* — configured tether length
- tether_length_out *(m)* — estimated deployed length
- tether_lenth_max *(m)* — maximum deployable length *(note: spelling preserved)*
- current_time *(epoch seconds)*
- leadscrew_motor_faultbits *(int)*
- tensioner_motor_faultbits *(int)*
- leadscrew_motor_faults *(dict)* — parsed faults
- tensioner_motor_faults *(dict)* — parsed faults
- primary_motor_max_Erpm *(ERPM)*

/derived_telemetry/ *(Experimental)*
Calculated advisory values derived from motor characteristics.

- primary_max_shaft_erpm
- primary_max_rpm
- primary_efficiency
- primary_torque

These values are informational and not guaranteed limits.

/tetherparams/
Tether configuration and derived spool geometry.

Primary configuration (User Input)

- Tether_Diameter *(mm)*
- Tether_Length *(m)*

Derived geometry

- Reel_Fill_Relief
- TurnPerLayer
- Travel_Distance_Per_Turn
- Maximum_Number_of_Layers
- End_Workzone

Per-layer maps

- Degree_Range_Per_Layer *(degree position of the primary drum layer)*
- Circumference_of_Layers *(mm)*
- Max_Pay_Speed_of_Spool *(m/s)*
- Layer_Tether_Lengths_Per_Degree
- Tether_Length_Per_Layer *(m)*

Derived limits

- Max_Tether_Length *(m)*
- Length_Tether_Out *(m)*

/motorparams/
Low-level motor telemetry grouped by motor ID.

Each motor entry may include:

- `id`
- `Position`
- `Velocity`
- `Current`
- `FaultBits`
- `Faults`
- `Voltage_DCbus_Udc`
- `Speed_ElectricalFreq`
- `Operation_Mode`
- `Commutation_Mode`
- `WorkZoneCount`
- `Current_PhaseA_Ia`
- `Current_PhaseB_Ib`
- `Direction`
- `LastDestination`

Available fields may vary by motor and hardware configuration.

---

10. Design Notes

- All motion commands are subject to internal safety interlocks.
- Heartbeat (`stop`) enforcement is mandatory for motion.
- Clients should tolerate additional fields in telemetry responses.
- Read-only endpoints never modify system state.

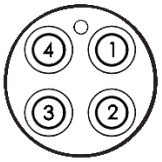
Glossary

Pinouts

Standard Pinouts

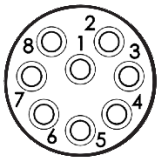
Below, you can find the standard connector pinouts on the TMS. They include the Tether/Decklead, Comms(Ethernet), and Power.

4-pin Male Subconn (MC-Series) Power Input



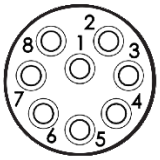
1: GND
2: GND
3: +24Vdc
4: +24Vdc

8-pin Male Subconn (MC-series) Comms Input



1: Blue
2: Blue/White
3: Orange
4: Orange/White
5: Green
6: Green/White
7: Brown
8: Brown/White

8-pin Male Subconn (MC-series) Tether Input



1:PWR(+)
2: Comms 1 (+)White (Red Pair)
3: Comms 1 (-) Red (Red Pair)
4: N/C
5: GND (-)
6: Comms 2 (+)White (Green Pair)
7: Comms 2 (-) Green (Green Pair)
8: Shield (Earth)

External Proximity Endstop (If included)

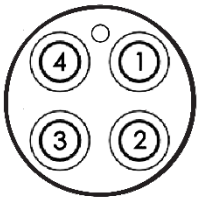
This is only included on TMS systems that have specifically requested this addon.

Note: Testing and certification of this addon is still underway.

Compatible Proximity Sensor Specs:

- 1. Type: NPN-NO (Normally Open)
  2. Operating Voltage: 10-30V

4-pin Male Subconn (MC-Series) Proximity Input



1: 24Vdc
2: GND
3: Signal
4: NC

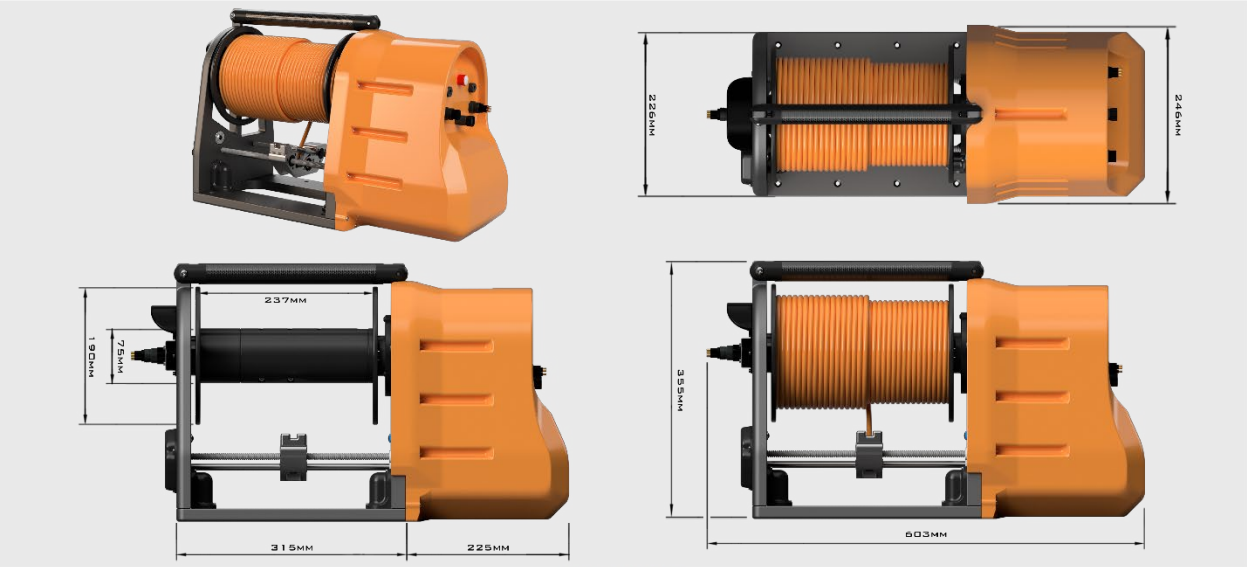
Specifications:

The Nautilus

Tether Management System

HYBRIDROBOTICS

Housing REV 1.4
Dimensions are in Millimeters



Software

Communication	Web Interface & API

Physical

Weight (No Tether)	24kg
Continuous Motor Torque/Max Torque	48Nm /120Nm
Continuous Pull Force (Varies based on tether diameter and Amount of Tether on Spool)	40kgf
Brake Holding Torque	100Nm
Max Pull Force (Drum Stationary With Brake Applied)	140kg
Max Spool Speed @ Rated Torque	24rpm
Input Voltage	24-48Vdc
Typical Current/Peak Current	0.5-10A/20A
Compatible Tether Diameter Range	4-11mm
Slip-Ring Specs	6 @ 24 Vdc, 2 A / 2 @400 Vdc,10 A
Housing REV1.3 Depth Rating (Max Tested)	50m
Housing REV1.4 Depth Rating (Design Target - UnTested)	100m