

Winch 150P Operator's Guide

Wave Glider SV3 v100, v200, v300

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Revision 1

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Introduction

The Winch 150P is a Wave Glider accessory that enables operators to deploy sensors at variable depths **from a single vehicle on a single mission.**



Components

The Winch 150P includes the following components:

- a sub-mounted, level-wind, gravity-fed winch with 150m of line
- sinker
- motion-isolating tow cable (Souriau)
- firmware that runs on the Winch Power Domain Controller (WPDC)
- firmware that runs on the motor controller
- a software plugin that runs on the Wave Glider CCU and implements user-level commands for shore-side operation and interacts with the WPDC



The winch is essentially an extension cord between the thruster and a payload. The winch can put a payload at depths between 7 m and 150 m.

What Winch 150P Adds to Your Toolset

Adding the Winch 150P to a Wave Glider provides mission planners and operators with the following advantages:

- **Increases the range and detection potential of acoustic sensors**

Previously, deployment of hydrophone arrays and similar sensors was limited to a static length that could feasibly be deployed as part of a standard Wave Glider launch. Adding the Winch 150P to a Wave Glider increases that potential depth by up to a factor of 18.

- **Capture surface and sub-surface metocean data from a single unmanned vehicle**

That allows for continuous CTD casting at varying depths over many months.

Specifications in Brief

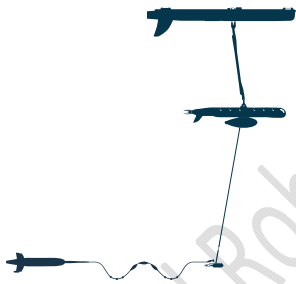
Available Line Length	Up to 150m
Payload Mass (Max)	30lbs
Payload Negative Buoyancy	0-5lbs
Payload Power	Up to 10W, 12V DC
Sinker Overhead Power	Up to 3W

Payload Communications	Ethernet at 10 MB/s, RS-232
Speed	20 min for complete 150m cast*
Energy Usage	8.5 Wh for complete 150m cast*
Hotel Load	Up to 3W
Wave Glider Speed Impact	10% with payload retracted, 35% with payload at 100m*
Winch Mass (includes line)	29lbs
Winch Negative Buoyancy (includes line)	17lbs
Sinker Mass	20lbs
Sinker Negative Buoyancy	15lbs
Line Minimum Bend Radius	30mm
Magnetic Coupling Break Over Line Load	100 (<150) lbf for magnetic coupling of motor
Operable Sea State	1 - 5
Depot Service Interval	Min of 6 months at sea or 1500 casts
Software Version Support	Regulus 3.x or higher, WGMS Legacy only

Technical Diagram

If No Tow Cable Is Used

In most applications, the payload will be attached to the sinker with a tow cable.



The tow cable provides directional stability for the sinker (i.e. it prevents the sinker from spinning around).

If the payload is instead mounted directly to the sinker and no tow cable is present, the sinker must have a rigid tail and a drogue attached to provide directional stability.



The rigid tail should be attached to the "rail" on the sinker and protrude rearward approximately 2.5-3 feet. The drogue, consisting of approximately 20 feet of 1" diameter rope with neutral buoyancy, should be tied to the end of the rigid tail. The following figure shows the rigid tail and drogue. Contact Liquid Robotics for further details regarding design and construction of the rigid tail and drogue.



Important Guidance

- **Safety:** The winch generates up to 400 volts. There is a blinking, blue, power indicator light on the winch electronics housing that will blink if power is applied to the winch. Before working on the winch or sinker, ensure that the winch is unplugged from Wave Glider and that it has no other power supply. When the winch is shut off, all parameters are saved, and the brake is applied.
- Turn off the winch when not in use to reduce the risk of voltage-induced corrosion.
- Be careful handling the winch line. For example, a cart running over the line can render it unstable/unreliable, and **the minimum bend radius needs to be respected**.
- Avoid kinking, cutting or abrading the thin line. Check for breaks or cuts in the thin line jacket before every deployment.
- Both Legacy Stands and Rapid Stands are supported.
- Approximate vertical speed: 20 minutes for complete 150m cast, based on a neutrally-buoyant payload attached to the sinker, pausing every 10m to allow the tow cable to stabilize. This process is handled automatically by the software.
- Watch circle diameters should be at least 100m to prevent twisting.
- Assume that the payload will be within 3.5% of the requested depth.

Installing the Winch

Safety

During the installation, be careful not to allow the winch line to be crushed, kinked, pinched or otherwise damaged.

Procedure

1. Retract the winch line as far as it will go, leaving only the last two meters of line with the protective tubing exposed.
2. Place the sub in the stand.
3. Put a piece of thick foam or other padding under the sub.
4. Ensure that the 2-meter expansion port cable that connects the winch to the thrudder is routed through the sub properly, with one end plugged into the thrudder and the other end protruding from the bottom of the sub below the umbilical.
5. With the help of another person, lift the winch into place under the sub.
 - The winch mounting plates fit around the spine of the sub, with the holes in the mounting plates lining up with the holes in the sub spine below the umbilical.
 - As you lift the winch into place, make sure the free end of the expansion port cable is routed through the groove in the rear plastic bearing piece in the mounting bracket.
 - The plastic electronics enclosure on the winch should face rearward.
6. Install the 2 M6 hex-head cap screws and 2 locknuts. Torque to X in-lb and secure the screw heads with safety wire as shown.
7. Connect the expansion port cable to the bulkhead connector on the rear face of the winch.
8. Make sure that the transformer cable is also plugged into its connector on the rear face of the winch.
9. Coil excess cable into a neat loop and use zip ties as shown to secure the cables.
 - Make sure there is enough slack in the expansion port cable for the winch to swing left and right.
 - Also make sure that there is slack in the transformer cable so that it isn't tugging on the transformer.
10. Check that the correct plugin and Regulus versions are installed. Contact Liquid Robotics

Technical Support for help.

General

- Installing the winch on the sub takes about 30 minutes.
- Put a piece of foam under the winch to protect the cable.
- Tighten 4 screws in turn, don't over tighten or cable damage will result.

Including a Tow Cable

A tow cable is recommended for attaching the payload to the sinker.

1. Attach the Tow Cabl.
2. Remove the Tow Cable Attach Brackets from the Sinker and from each other.
3. Insert the Tow Cable pivot in the Tow Cable Attach Brackets as shown.
4. Route the Tow Cable pigtail as shown through the plastic pieces on the Tow Cable Attach Brackets.
5. Screw the Tow Cable Attach Brackets to each other.
6. Wrap any excess Cable around the Tow Cable Attach Brackets.
7. Connect the Tow Cable connector to the connector on the aft end of the Sinker and install the Locking Collar.
8. Fasten the Tow Cable Attach Brackets to the aft end of the Sinker.

v100/v200/v300

Note that the v100 Wave Glider differs from the v200 and v300 models in the following ways:

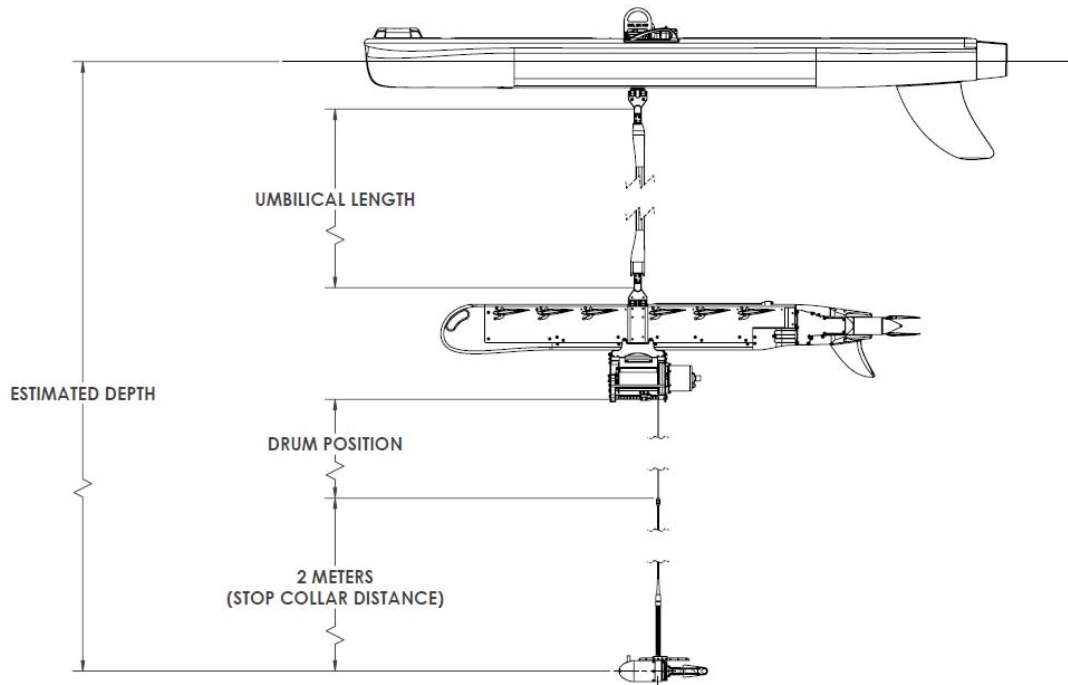
- Different cabling
- Different sub width

These differences do not affect the process of installing the winch.

Terminology

The sinker/payload estimated depth is the sum of:

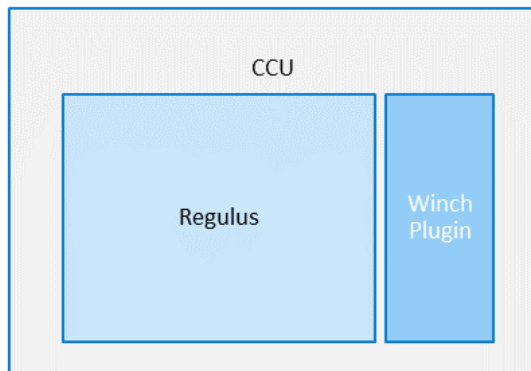
- Umbilical length plus a little more for the height of the sub
- “Drum position” (how much line is payed out)
- 2 meters between stop collar and sinker



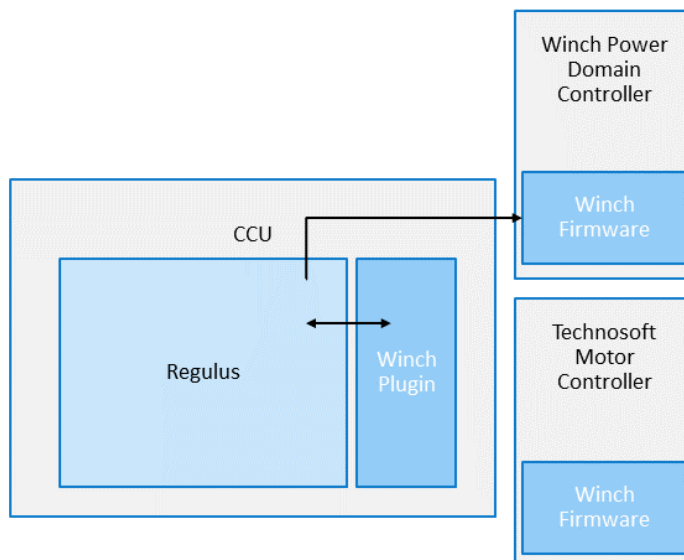
Therefore, going to an estimated depth of 15m would pay out just 5m of line, because the payload is already at 10m to start.

Software and Firmware Components

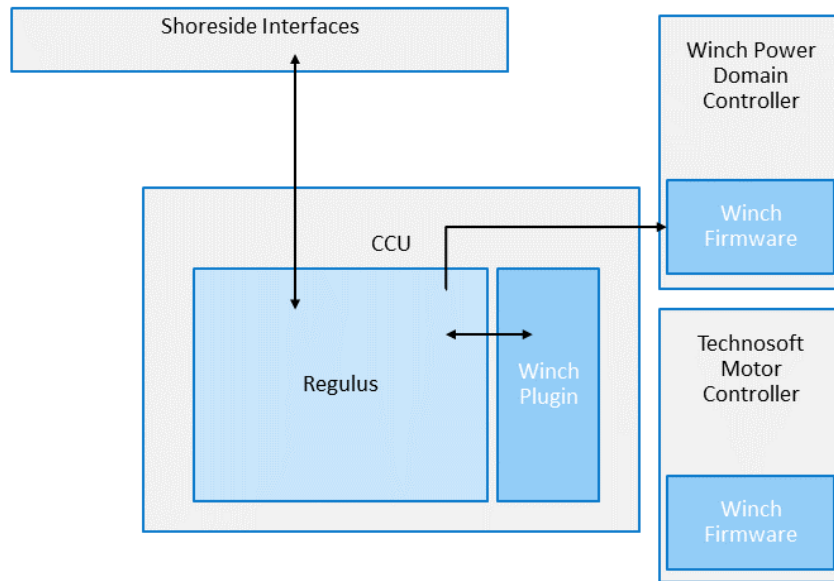
The Winch Plugin runs on the CCU along with Regulus.



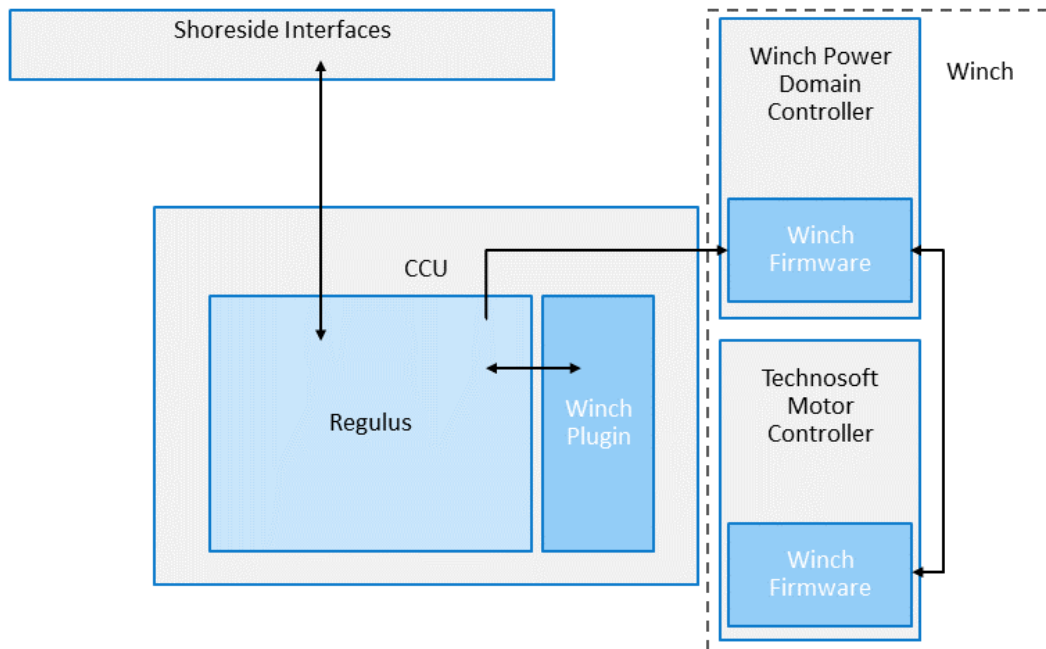
The Winch Plugin interfaces with Winch Firmware on the Winch Power Domain Controller via Regulus.



The Winch Plugin implements user-level commands issued from shoreside interfaces.



The WPDC will engage the brake if the maximum working length of the cable is reached. The WPDC will then have the TSMC engage the brake and the WPDC will power off the TSMC. This is for safety reasons so the Winch doesn't over pay out the cable and damage the cable.



The WPDC and the TSMC are inside the Winch. The Winch is connected to "T1" expansion port on the Thrudder.

Use Cases

Estimated Depth (From Surface)

Estimated Depth (From Surface) is a measurement made based on several configurable factors and the amount of cable payed out.

- Umbilical Length, e.g. 8m
- Sub Height and Winch Height, e.g. 1m
- Length of line after the stopper on the cable, e.g. 1m
- Amount of cable payed out, e.g. 100m

The above examples amount to an estimated depth from surface of 110m. The "Home" position (aka zero position) would be 10m from the surface.

Limitations on Estimated Depth (Lack of Pressure Sensor)

The external pressure sensor on the sinker is not currently implemented. Therefore, there is no pressure reading which might be converted to an estimated depth from the surface.

Go To Estimated Depth (From Surface)

Going to Estimated Depth means paying out enough cable to cause the payload to reach the specified depth from the surface. The "Home" position (aka zero position) would be 10m from the surface.

Example of Success

In a successful case, the user issues the Go To Estimated Depth (From Surface) SV3 command. Success results in a message similar to the following for a value of 135m:

```
"winchStatus=0xc3d0000 unpowered brake-hold errors=[ControlField-commandBusy] command=30  
EXECUTE_TSMC_FUNCTION (busy) wmcResponsePending=6 length=124.9979m depth=134.9979m  
tsmc=0x7000F840"
```

Where:

- "length=124.9979" is the amount of cable payed out as measured from the winch
- "depth=134.9979m" is the amount of cable payed out as measured from the surface of the ocean

Note: Of note, Go To Estimated Depth (From Surface) will go to the nearest estimated depth the winch can control to, above the estimated depth requested by the user.

If the Command Fails to Execute

If the command fails to execute, the user might see a message similar to the following for a value of 125m:

```
"com.liquidr.winch.services.WinchException: Failed to achieve target drum position 124.9979m (5730)  
moving from 10m (0): end position 0 out of expected range, -32...32"
```

Workaround: Try again. The motor controller sometimes fails to disengage the brake and initiates pay in or pay out of the cable.

If the Winch Refuses to Go to Depth

If the user instructs the winch to go to a depth that is not in the specified working range, the user will see a message similar to the following for a value of 142m:

"java.lang.IllegalArgumentException: target value 142.0 does not fall within the expected range (10.99...139.9835)"

Note: The intended maximum working depth of 140m is not precisely 140m, but the next closest value above 140m that the winch can control to.

Pay In To Home

- Pay In To Home will always try to go to the "zero" position. The zero position is intended to be defined by where the stopper on the winch cable is. This is different from Pay In To Stop, which asks the winch to pay in the cable until it over torques, presumably where the stopper is.
- Pay In To Home does not obey minimum working length.
- Pay In To Home may move very close to the true zero position, e.g. it may pay in to 0.25m of cables payed out. In this case, this is an example of how close the winch could control to the true zero position.

Note: Use Go To Estimated Depth (From Surface) to obey the minimum working estimated depth from the surface and avoid bring the sinker and/or tow body to close to the Wave Glider's sub.

Auto Cast Cycle

Auto Cast Cycle uses Go To Estimated Depth (From Surface), and so has all the benefits and limitations of that command.

Example of Success

Given an Auto Cast Cycle with the following values:

- Pay Out To Estimated Depth (meters) (From Surface) of 125m
- Sleep at Depth (for example, \"5m\" for 5 minutes or \"1h\" for one hour) of \"1h\"
- Pay In To Estimated Depth (meters) (From Surface) of 10m
- Repeat Delay (for example, \"1h\" for 1 hour, 0=no repeat) of \"1h\"

the user will see the following updates:

- autoCast cast #1 arrived at bottom (depth=124.9979m) with an estimated payed out cable length from the surface of 124.9979m
- autoCast cast #1 complete (depth=10m) with an estimated payed out cable length from the surface of 10.0

After one hour at depth, it will return to the surface and report this event. It has completed auto cast cycle #1.

Auto cast #2 starts and produces a message similar to the following:

- autoCast starting cast #2 with an estimated payed out cable length from the surface of 10.0

After one hour at the requested pay in depth, it will report its starting auto cast cycle #2:

- autoCast cast #2 arrived at bottom (depth=124.9979m) with an estimated payed out cable length from the surface of 124.9979m

Auto Cast will repeat until the user runs Stop and Brake or a new Auto Cast Cycle.

If Auto Cast Cycle Fails

- Sometimes the Go To Estimated Depth (From Surface) command fails to execute, where the brake stays engaged, and the sinker stays at the same surface.
- If the Go To Estimated Depth (From Surface) command fails during an Auto Cast Cycle, the Auto Cast Cycle will exit and leave the sinker at whatever depth it is currently at. The user will see a message similar to the following:
 - "Winch command "AutoCastNow[PayingG " faulted at 1h02m26.491s:
WinchException: Failed to set new command (assumed aborted) with an estimated payed out cable length from the surface of 10.0"

This means the Auto Cast Cycle will make no more attempts, the brake is engaged, and the sinker will stay at the depth (10 meters in this example).

Auto Cast Cycle with Frequent Depth Changes

An Auto Cast Cycle that includes frequent depth changes might produces fewer than expected messages because the Winch plugin is set to prevent overly-frequent messages to shore. If Repeat Delay and/or Sleep at Depth are set to 5 minutes or less for the Auto Cast Cycle, then the user might see the following at the end of any Auto Cast Cycle event:

- "(4 messages dropped)"
indicating the Auto Cast Cycle had 4 messages not sent to WGMS because the frequency of the cycle is too high.

Note: It may not always report an Auto Cast failure to WGMS, however this use case has not been fully tested.

Pre-Launch

Note: Use Google Chrome to operate the Regulus Winch page. Some features don't function properly with Firefox.

Winch Plugin Configuration

Before launching a Wave Glider equipped with the Winch 150P, you must set important parameters on the Wave Glider web page. These settings are stored with the Winch Plugin in Regulus and are specific to that Wave Glider. **Do not launch without setting these parameters.**

1. On the vehicle's webpage, go to **Config > Miscellaneous**.
2. Go to **Winch_winch**.
3. Adjust the following settings as needed:

Item	Description	Default
Polling Interval	The time delay between status readings (10s..10m). If the Wave Glider has many devices, payloads, and APUs, a short polling interval for the Winch 150P can result in decreased responsiveness for the other devices. In this case, consider adjusting the polling interval to between 30 s and 60 s.	10 s
Umbilical Length	The length of the installed umbilical (meters). Used to calculate minimum winch depth (4m..100m).	8 m
Expansion Port	The name of the device that controls power to the winch.	T1

Power On

1. Go to **Operate > Winch**.

At this point, the Status LEDs at the top of the page should show Power is OFF and plugin state is Unhappy.

2. Click on **Winch ON**.

You will see Winch Not Found and Winch Unhappy until the plugin and firmware communicate successfully.

3. Go to **Status – AMPS**.
4. Locate the “Unknown” domain with one slot, “Slot 0”.
5. Confirm that Mfg. S/N=Winch.
6. Confirm that the status is now Winch Happy and Winch Found.

Winch PDC Configuration

1. On the vehicle's webpage, go to **Operate > Winch**.

<i>Inter-Segment Wait Time (s)</i>	15
<i>Maximum Working Length (m)</i>	140.0024
<i>Minimum Working Length (m)</i>	0
<i>Pay-Out Speed (m/minute))</i>	10.2148
<i>Reel-In Torque (mA)</i>	8000
<i>Reserve Length (m)</i>	0
<i>Segment Length (m)</i>	3.448
<i>TechnoSoft ID</i>	127
<i>Usable Line Length (m)</i>	148.9983

2. Adjust the following settings as needed:

Item	Description
Inter-Segment Wait Time (s)	The amount of time that the winch will pause when paying out cable. This wait time is applied under any of the following conditions: • Sufficient length of cable is being payed out to trigger automatic pay out in segments. • A Go To Estimated Depth command has completed. • A Pay In or Pay Out by cable length command is completed. Segments are triggered when the length of cable being paid out is sufficient to justify waiting for the sinker to reach the requested depth by pull of gravity. Segments and pausing help prevent tangling. When paying out over long enough cable length, the pay out will occur in segments, e.g. pay out to 100m and then pay out to 125m when a user requests a go to estimated depth command. The Segment Length will determine how much cable is payed out from the bottom of the Winch. This is the time the plugin will wait between issuing the next go to depth command, e.g. after the 100m pay out is complete, it will pause for this amount of time, and then the final 15m of cable are payed out to reach 125m estimated depth from surface. Additionally, every Go To Estimated Depth or Pay In Or Out By Cable Length From Winch will wait this amount of time before allowing a new command to execute. The vehicle's

	Winch page will display the "Command" status as "Wait 20s or depth 100m" before allowing a new command to execute.
Maximum Working Length (m)	The maximum amount of cable that is allowed to be payed out during a Go To Estimated Depth command. This is in terms of cable length from the winch. Should be set before the mission based on the ocean depths at the mission location or the payload depth rating and should only be changed with careful consideration. Enforced to be less than or equal to Usable Line Length.
Minimum Working Length (m)	The minimum amount of cable that must be payed out during a Go To Estimated Depth command. This is in terms of cable length from the winch. Typically, this parameter would be set at the beginning of a mission based on factors such as whether the sinker's payload might get entangled in the glider or whether it's beneficial for payload dynamics to keep the payload at a minimum depth, and then only changed with careful consideration. Note: Pay In To Home does not obey the minimum working length and always returns to the zero position.
Pay-Out Speed (m/m)	Not used.
Reel-In Torque (mA)	The motor controller will reel in up to this torque value. Default is 800
Reserve Length (m)	Do not change this setting. Line length that remains on the drum when reeled out at full useable line length position.
Segment Length (m)	When using Go To Estimated Depth (From Surface) or Pay In Or Out By Cable Length From Winch or Auto Cast Cycle, the plugin will ask the Winch PDC to pay out cable in segments of this length, as appropriate. For example, if the segment length is 50m and the request is to go to 100m estimated depth from surface, it will pay out 50m of cable, pause, and then the final 40m. This is a rough estimate to help allow the sinker reach the requested depth. This could also be used in conjunction with the Inter-Segment Wait Time to have the Winch profile during a Go To Estimated Depth command. If the Inter-Segment Wait Time is 60 seconds, then a large change in depth will pause at each of the Segment Lengths for 60 seconds and then continue.
Technosoft ID	Do not change this setting.
Usable Line Length (m)	The total length of line minus the amount of line below the stop collar minus the desired amount of reserve line on the drum (which is typically ten turns or about 3 meters). This parameter may be used by the winch to set the maximum amount of line that you can pay out.

Equipment Prep

1. Pressurize the sinker to 3-8 psi prior to launching. Do not exceed 8 psi.

Why not > 8 psi: The pressure inside the sinker should always be lower than the pressure outside. When the sinker is fully retracted, the water pressure outside the sinker will reach about 10 psi. As the sinker goes deeper, the water pressure will increase. If you had the pressure inside the sinker at a higher value (like 20 psi), then moving the sinker up and down would repeatedly reverse the direction of the pressure on the seals. The pressure acting on the seals should always be in the same direction. Reversing once upon launch is acceptable.

2. Access pressure valve by unscrewing nylon screws 02524-06-016 and removing valve cap 01478. Pressurize the winch to 3-8 psi prior to launching.
3. Access pressure valve by removing screws 02517-05-012 and removing pressure port cover 07853. It is preferable to operate the sinker with a negative pressure of 2-3 psi. If pulling a partial vacuum is not possible, pressurize to positive 2-3 psi but no more than 4 psi. Check pressure after 24 hours to ensure there are no leaks.

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Launching

General

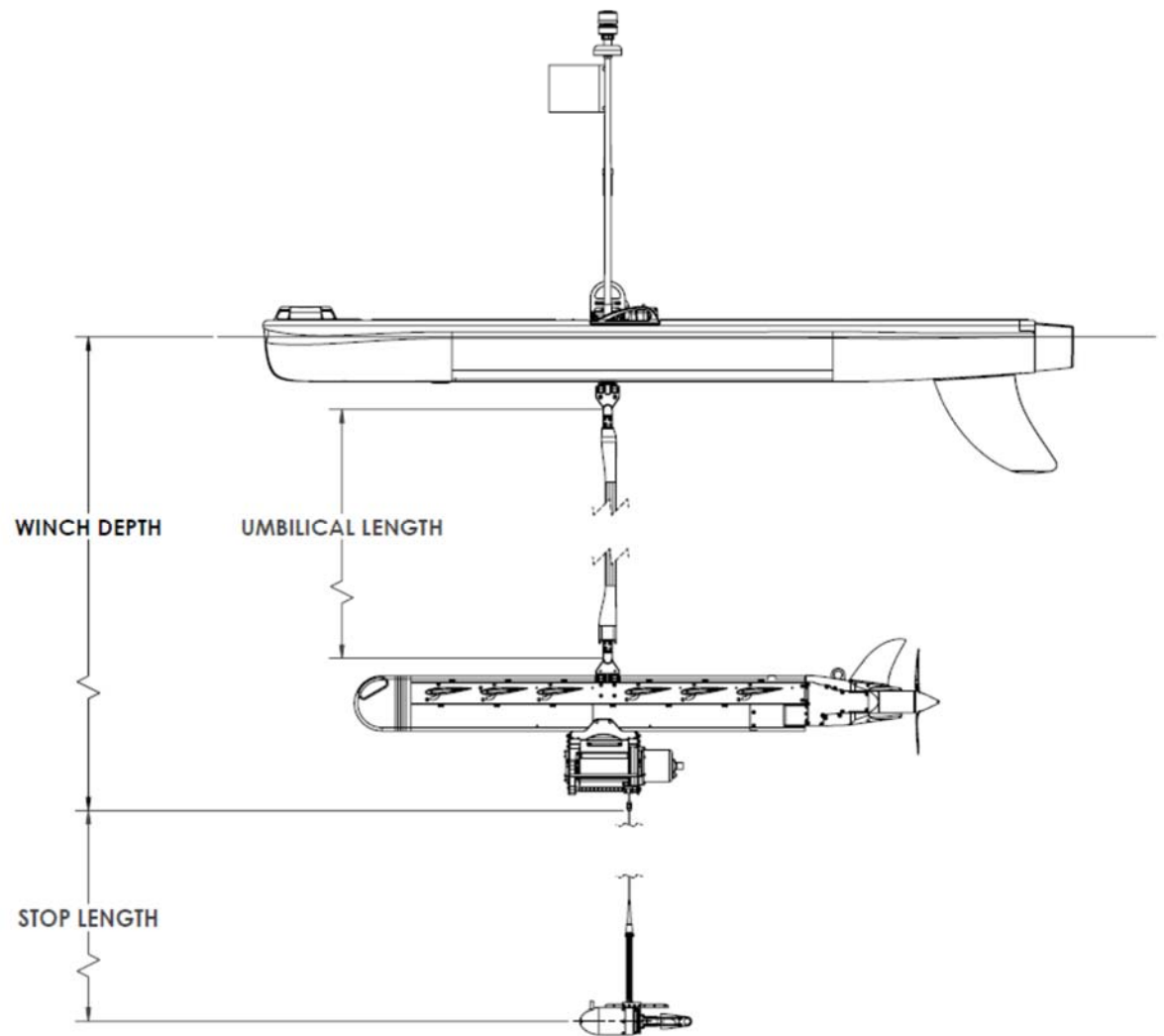
- When the winch is installed on the sub and the sub is in the stand, make sure the winch is pivoted up to one side and secured with something reliable like a ratchet strap.
- Which side you pivot the winch to while it's in the stand DOES matter. Technically, either side will work, but one side will provide better protection for the cable.

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Piloting

Usage Notes

- The WPDC will cause the motor controller to engage the brake and will turn off the motor controller if the maximum working length of the cable is reached. This ensures that the winch doesn't damage the cable.
- Expectation for Thin Line spooling onto Drum: The Level Wind will ensure that the Thin Line wraps neatly around the Drum for the first several layers. It is common, however, for the last few layers to wrap on less neatly, as shown in the picture. This is normal and will not affect the function of the winch.
- For very large towed payloads (ASW array for example) we try not to turn 180 degrees on ourselves to reduce chances of tangling. This creates issues for pilots because at this time we are unable to use the auto-avoidance feature and other autonomous nav modes because Regulus at times will force the vehicle to turn 180 automatically (may need a Regulus change for max turn steering parameters within avoidance code as I'm unsure adjusting the turn radius goes into effect for avoidance; adding Devin in case I'm not understanding properly). For this reason, we make manual turns for avoidance of no more than 90 degrees at a time, and set up waypoint courses to not make turns sharper than 90 degrees. I would think we take the same approach with the winch and guide customers to do the same until we better understand the behavior and know that Regulus turn parameters in the avoidance code is safe for use with winch/towed arrays.



- Recommended depth for reducing wear on Thin Line (the line will be flexing a lot less if it's paid out, say, ten meters)
- Boat Ops
- Pivot winch up to the side to get it off the ground
- Rinse and soak Winch after pulling from water: After recovering vehicle with Winch and turning off power to Winch, rinse Winch thoroughly with fresh water. Try to squirt water between Rotary Transformer halves (using your fingers to separate halves). If possible, submerge Winch in fresh water for at least one hour. This is especially important if Winch is to be operated dry, as salt crystals will form in the bearings and other moving interfaces.

Maintenance

- **Safety:** The winch generates up to 400 volts. There is a blinking blue power indicator light on the winch electronics housing that will blink if power is applied to the winch. Before working on the winch or sinker, ensure that winch is unplugged from Wave Glider and that it has no other power supply.
- If you have to remove the line from the winch, just pull it off into a large cardboard box. It'll be sorta messy looking but it will be fairly easy to wrap it back onto the winch (or a separate spool) later. In other words, it doesn't tangle very easily.
- If you ever spool a significant amount of line (more than 10 meters) onto the winch while it's not in the water, try to apply tension while it's spooling on. If there's little or no tension, it won't spool on cleanly and you could end up with the line getting a wedgie and not coming unspooled.
- Soak the winch in fresh water for an hour after removing it from salt water. This is to prevent salt crystals from forming in the moving parts and causing scratches on moving surfaces. If you can't soak it in fresh water, then try not to pay in or pay out line until it's back in the water (and even then, you'd ideally give it an hour or so for the water to penetrate and dissolve salt crystals).
- Accessing Winch Electronics: Remove six screws 02518-05-025 around perimeter of electronics bottle 07453. Carefully lift off electronics bottle, detaching electrical connectors as necessary. To prevent marring of the O ring sealing surface, do not place electronics bottle with the O ring sealing surface down on the table. After reassembly, pressurize to 2-3 psi and check pressure after 24 hours to ensure there is no leakage.

Removing Thin Line

1. Unspool all the thin line cable from the winch. This can be done by commanding "brake off" from the winch plug-in and pulling the cable out, preferably spooling it neatly onto an external spool. As the last wrap of cable is being spooled off, release tension on the line to prevent putting a kink in the cable where it exits the fiberglass cable clamp 07508.
2. When all the cable is spooled off, remove the two end plate spacers 07469 by removing screws 02518-06-015 on each end of the end plate spacers. Un-hook one end of each of the two extension springs 07471 using needle-nose pliers. Then remove the two paws 07470 along with the end plate spacers. Be sure not to lose the paw spacers 07505.
3. Remove the 6mm shoulder screw 07511 and locknut 02661-05 from the level wind body 07436, being careful not to lose the nylon spacer 09283.
4. Remove the two M4 screws 02518-04-006 from the cable terminus 07911. Remove the four flat-head screws 02540-05-008 from the fiberglass cable clamp 07508. Then lift off the fiberglass cable clamp and the cable at the same time and remove from the winch. Try not to allow the cable to slip out of the serpentine groove on the backside of the fiberglass cable clamp. If it slips out, simply re-insert it.

Reinstalling Thin Line

To re-install, perform the above steps in reverse, making sure that the cable is routed properly through the level wind body. Also make sure the O ring 02544-013 in the thin line terminus is clean and lubed, and that the mating sealing surface is clean. Apply loctite to the M4 screws on the thin line terminus before screwing them in. Loctite is not necessary on the M5 flat head screws.

Adjusting the level wind position

Note: it should only be necessary to adjust the level wind position if the thin line cable has been replaced or the level wind position was changed for some reason.

Remove two screws 02518-05-010 from the level wind screw retainer 07788 and pull the level wind screw retainer and level wind screw 07426 towards the rear of the winch until you can see the gear 07957 on the front of the level wind screw. Now rotate the level wind screw as needed to move the level wind body forward or backward. Put the level wind screw and level wind screw retainer back in place. Check that the level wind body is in the right place and that it will be going the right direction. Then tighten the two screws on the level wind screw retainer.

A less-preferred way to adjust the position and direction of the level wind body is to remove the four M3 flat-head screws 02540-03-010 from the level wind body, remove the cover plate 07487, and remove the level wind follower 07439. The level wind body can then be slid back and forth on the level wind screw. The direction that the level wind will go is determined by the orientation of the tangs on the level wind follower. After re-installing the level wind follower and cover plate, CAREFULLY tighten the M3 screws to avoid stripping out the threads.

Check that the level wind goes in the proper direction by paying out some cable and noting the movement of the level wind.

Detaching the Sinker from the Thin Line

Remove the four screws 02518-05-010 from the lower end of the sinker snubber. Gently lift the sinker snubber assembly off of the sinker rail 08153. The coiled cable 09143 will still be attached to the sinker, so be careful not to yank on it.

Remove the two screws 02517-05-018 from the sinker rail and gently lift the rail off the sinker. The penetrator 08154 will come with the rail.

Remove the two M4 set screws 08158 that hold the penetrator into the rail and remove the penetrator from the rail. Protect the O rings on the penetrator with a plastic bag to keep them clean.

Troubleshooting

For debugging purposes, e.g. the Winch doesn't enumerate on T1, would be a good step to plug a Winch into an expansion port, e.g. G3.

To have the winch plugin look for the winch on another expansion port:

Winch Off: Power off the winch

Swap the Winch to the expansion port you want

Change this value to G3

Winch On: Power on the winch

AMPS

Winch is a fairly busy AMPS device. On a vehicle with many AMPS devices, e.g. APUs and integrator payloads, there may be some cases that AMPS appears to be very slow, trying the patience of even the best Wave Glider users.

AMPS Domains Very Slow Or Not Coming Up (any AMPS domains) or Increase the Winch PDC Polling Interval

- Assumption: Winch is On and Found. Winch is responding to Status and Commands
- If some device is having issues enumerating through AMPS, we can alleviate traffic on the can bus by increasing the Winch PDC polling interval
- Power off the device that's having trouble
- On the vehicle page, go to Config -> Miscellaneous
- Find the "Winch_winch: pollingInterval: the time delay between status readings (10s..10m, default: 10s)"
- May change to "30s" or "60s"
- Press OK in the bottom right of the page
 - When operating from WGMS, a user won't notice the increase.
 - This mainly affects if you're working with the Operate -> Winch vehicle page.
- Power on the device that's having trouble with its AMPS domain

Winch PDC AMPS domain fails to appear during Winch power on or if the Winch PDC AMPS domain disappears after a successful power on

- Is the Thrudder responding?
 - If not, need to power cycle the thrudder.
 - Can unplug U1, or power cycle through the vehicle AMPS page
- If the Thrudder is responding
- Power cycle the Winch and see if it comes online (Winch Off -> Winch On)
 - Wait to see if "Winch Found" (green light) appears on the vehicle Winch page

- If the Winch isn't showing up "Winch not found" (red light) and no AMPS domain appears on the vehicle's AMPS page.

▶ AMPS System Summary

▶ Thrudder-1 Domain

▶ PyIdInt-0x3034511331313737003d0050 Domain

▶ Host Domain

▼ Unknown-0x3236470433343636001b002e Domain

Domain is Located at CAN Node 11 (Domain Index for Power Reports = 5)
S/N=0x3236470433343636001b002e, Uptime: 0 days, 00:02:49 (Expected S/N=)

Number of Input Bridges = 0, Number of Output Bridges = 0

No reboot information available for this domain

Reset PDC Only
Reset PDC & modules

- **Slot 0:** Unknown Module: type=0x00000029
Firmware Version: 0x00004de5, Boot Loader Version: 0x00004dc2
Mfg. S/N=Winch
HW ID=0x3334363632364704001b002e
Reported Arena Part Number = 7722?
Module Type = 41

Figure 1: Successful Winch AMPS domain

- Note that the "Unknown" domain with only "Slot 0" is the Winch domain.
- If the Winch AMPS domain isn't there, then there is some communication issue
- Winch OFF
 - Power cycle the Thrudder or the Umbilical
 - Can unplug U1 or power cycle the Umbilical through the AMPS vehicle page
- After the Thrudder AMPS domain is available, Winch ON
- Wait to see if "Winch Found" (green light)
- If Winch is never found, then there may be another problem... See next section

Winch AMPS domain isn't found after umbilical power cycle

- See previous section first. If that doesn't work, there may be an electrical problem
- May try to plug the Winch directly into another expansion port, e.g. G3
- Winch OFF
- Go to Config -> Miscellaneous
- Find " Winch_winch: name of the device that controls power to the winch (default: T1)"
- Change to "G3" (or whichever expansion port is appropriate)
- Press OK in the bottom right of the page
- Winch ON
- Is the "Winch Found" (green light) on G3?
- If not, must contact engineering. There may be an issue with the Winch PDC and/or wiring

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Command Reference

Auto Cast Cycle

- Begin executing pay out/pay in cycle with time delay and repeat interval. Stops any other auto cast functions. Will report events to shore indicating status or an error if it fails. If it fails, the auto cast cycle will stop, the brake will engage, and the cable will stay payed out wherever it is. User may abort auto cast at any time with Stop.
- Parameter List:
 - Pay Out To Estimated Depth (meters) (From Surface)
 - Sleep at Depth (for example, \"5m\" for 5 minutes)
 - Pay In To Estimated Depth (meters) (From Surface)
 - Repeat Delay (for example, \"1h\" for 1 hour, 0=no repeat)

Go To Estimated Depth (From Surface)

- Pay out cable to the given meters as measured from the float of the Wave Glider (or ocean surface). As the cable is payed out, the sinker will fall at its own pace. Obeys minimum and maximum working depths. The estimated depth is based on the amount of cable payed out, umbilical length, and other factors.
- Parameter List
 - Estimated Depth (meters) (From Surface)

Pay In Or Out By Cable Length From Winch

- Pay in or out to specified winch cable length. NOTE: This length is directly from the bottom of the Winch and doesn't include the Wave Glider's umbilical length or other factors.
- Parameter List:
 - Cable Length (m) (From Winch)

Pay In To Home

- Pay in to home will nominally pay in the entire cable until it reaches the zero position, which may be above the minimum working depth. Note, this may not get exactly to the zero position, however this is expected within a configurable tolerance of undershooting.
- Parameter List:
 - Cable Length (m) (From Winch)"

Pay In to Stop

- NOTE: Better to use Go Home while in water. Pay in to the stop means pay in until the motor controller over torques. There is a stopper on the Winch cable and presumably this is where the over torque occurs. Over torque may occur before the stopper due to environmental conditions, e.g. sinker or towbody is caught on a fishing line. May optionally zero the drum position counter

(the only indicator of how much cable is payed out) in the Winch, however while in water, it is strongly recommended to never do this. While in water, use Pay In To Home instead.

- Parameter List
 - o Zero the Drum Position: true=Zero the drum position counter after over torque, false=Do not zero the drum position counter after over torque

Winch On

- Pilot requests power on and wait for the Winch AMPS domain to enumerate.

Winch Off

- Pilot requests power off. Brake automatically engages when power is off.

Stop and Brake

- Stop motion, abort command or autocast, power off the motor controller, and apply brakes.

Release Brake (WARNING: Do not use in water) (Expert)

- WARNING: DO NOT USE IN WATER. Release the brake to allow the winch to move freely. If issued in water, will drop to the end cable stopper in an uncontrolled manner and damage the cable.

Get Latest Winch Status

- Returns the last status read from the winch.

Uninstalling the Winch

During removal, be careful not to allow the winch line to be crushed, kinked, pinched, or otherwise damaged. Retract the winch line as far as it will go, leaving only the last two meters of line with the protective tubing exposed.

Place the sub in the stand and put a piece of thick foam or other padding under the sub.

Detach the cable that connects the thrudder to the winch at the rear of the winch, cutting the zip ties as necessary. Remove the four screws 06263 and locknuts 02661-06 that attach the winch to the Wave Glider and carefully remove the winch.

v100/v200/v300

Note that the v100 Wave Glider differs from the v200 and v300 models in the following ways:

- Different cabling
- Different sub width

These differences do not affect the process of uninstalling the winch.

Misc

- Winch Electrical Cable routing: route the cable as shown, with the cable connected to the Thrudder port on one end, passing through the sub weight bar, exiting just above the winch, and passing rearward through the slot in the plastic part of the Winch Mounting Bracket. Secure the Cable to the Electronics Enclosure using a zip tie.
- Transformer Cable routing: the Transformer Cable should have a service loop as shown and should be tied to the Winch Electrical Cable with a zip tie. Ensure that the Transformer Cable does not pull on the Rotary Transformer. There is a spring that pushes the rear half of the Rotary Transformer onto the front half of the Rotary Transformer. If the Transformer Cable is pulling on the rear half of the Rotary Transformer, a gap will open up between the Rotary Transformer halves.
- Sinker mechanical interface to towcable/payload: If a Towcable is used to attach the Payload to the Sinker, attach the Towcable as shown. Remove the Towcable Attach Brackets from the Sinker and from each other. Insert the Towcable pivot in the Towcable Attach Brackets as shown. Route the Towcable pigtail as shown through the plastic pieces on the Towcable Attach Brackets. Screw the Towcable Attach Brackets to each other. Wrap any excess cable around the Towcable Attach Brackets. Connect the Towcable connector to the connector on the aft end of the Sinker and install the Locking Collar. Fasten the Towcable Attach Brackets to the aft end of the Sinker
- Required Sinker Wet Weight: the wet weight of the sinker plus any objects affixed to it must be between 15 lb and 25 lb. The Winch relies on gravity to pay out line, therefore if the wet weight of the sinker plus any objects affixed to it is less than 15 lb, the Winch may not be able to pay out line. If the wet weight is greater than 25 lb, the Winch motor may not be able to pay in line.
- Magnetic Coupling function: the Magnetic Coupling transfers torque from the Winch Motor to the Drum via a watertight barrier. It also provides a degree of mechanical shock protection, as it will break over at about 150 lb line tension. If the Magnetic Coupling breaks over during operation, the Winch software will detect the break over and warn the user.
- Purpose of towcable on sinker: For many applications, the Thin Line itself will not provide adequate motion isolation between the surging motion of the Sub and the Payload. This is especially true at shallower payload depths (when the Thin Line is paid in all the way or close to all the way). Therefore a towcable is usually needed to provide the motion isolation.
- Pressurization of Winch Electronics Enclosure: The Electronics Enclosure should be pressurized to 2-5 psi. Since internal pressure is monitored, any pressure drop will give warning of a leak.
- Pressurization of Sinker: The Sinker should have a partial vacuum of -2 - -5 psi applied or a positive pressure of 2-5 psi applied, but should not have a positive pressure of more than 5 psi applied. This is to prevent the O ring seals in the Sinker from experiencing reversing pressure as the Sinker is raised and lowered (outside water pressure will range from approx. 8 psi to 230 psi)
- Energy usage per cast: Typical energy usages per cast are shown in the table below. A cast is defined as a complete cycle of raising and lowering the Sinker/Payload by a certain number of

meters:

Sinker/payload wet weight	Energy usage per meter of cast (Joules)
15	X
25	Y

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