Wireless echosounder calibration winch manual

Aqualyd Limited

Version 1.3

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The latest vesion of this manual is available on github.

User Manual

This is the User Manual for the Aqualyd wireless echosounder calibration winch system and provides information on setting up and using the system.

1. First-use setup

1.1. Batteries

The controller batteries (Nokia BL-5C or equivalent) need to be installed. The steps to do this are:

1. Remove the silicone case from the controllers.
2. Remove the loose half of the case to expose the controller electronics.
3. Remove one of the screws that holds the strap that sits across the battery holder and rotate it out of the way.
4. Insert the battery, taking care to line up the battery terminals.
5. Rotate the strap into place and insert and tighten the screw.
6. Find the plastic bag containing four small black screws, reinstall the controller case halves and screw them together.
7. Put the silicone cover back on and attach a lanyard strap.
8. Turn the controller on and check that an LED is flashing on the end of the controller case.

The winch batteries (Hikoki/Metabo HPT MultiVolt) slide vertically down onto the black clip on each winch. Press the gray buttons on the side of the batteries and pull up to remove a battery.

1.2. Installation of line on the reels

Line should be added to the reels so that the free end leaves from underneath the drum (and away from you) when viewing the unit with the yellow tube to your right. If the direction of the winches does not match the arrows on the controller, it is most likely that the line has been wound on the wrong way.

2. Operating the system

2.1. Installing the winches and poles

Assemble each winch/pole as per this list:

1. Insert a telescopic pole into the yellow tube on each winch unit (orient the pole so that the brand names is uppermost),
2. Extend the telescopic pole to the desired length,
3. Align the holes in the yellow tube and pole and inserting the locking pin (the pole will extend about 200 mm inboard from the yellow tube),
4. Insert the supplied eye-bolt into the hole in the onboard end of the pole,
5. Attach a tie-down cord to each eye-bolt using the attached carabiner,
6. Insert a battery into the winch unit
7. Pay out line and lead it through the eye-bolt on the outboard end of the pole,
8. Secure the assembled unit to the vessel,

The winch units are designed to be attached to a pipe or plate railing on a vessel (Figure 1). A pipe attachment uses the supplied hose clamps to secure the aluminium section of the winch unit to the railing. A plate attachment uses clamps (user supplied) to secure the winch units' plastic base or the aluminium section to the flat plate.

The leverage from the extended poles is countered by the cord attachment from the inboard end of the pole to suitable point(s) on the vessel (e.g., a lower railing or gusset).

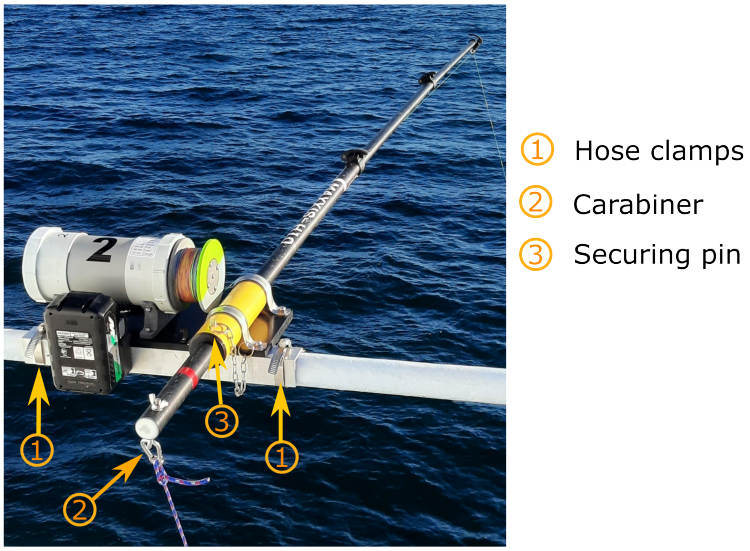

Figure 1. Winch unit installed on a ship's railing showing hose clamps, securing pin, and attachment carabiner.

Each winch is numbered - place the winches in a location that fits with the layout of the numbered switches on the controller (Figure 2). For example, if one pole is at the bow of the vessel and the other two poles on port and starboard side, place winch 1 at the bow, winch 2 to port and winch 3 to starboard. Winch 1 holds the long pole.

To make it easy to relate the three winch switches to the winch locations, rotate the controller so that the switches approximately match the locations of the winches on the vessel when facing the echosounders' split-beam display. This will often mean holding the winch controller in a landscape orientation.

The controller and winches automatically form a wireless mesh network that relays commands from the controller to the winches even if all winches are not reachable directly from the controller.

The controller can function as a range extender - to activate this, move the mode switch on the end of the controller to `Extender`. The LED on the end of the unit will then flash red instead of green. Multiple range extenders can be used if necessary. When in extender mode, none of the winch controls on that controller are operational.

1 On/off
2 Speed
3 Direction

Figure 2. Controller functions.

NOTE	When extending the telescopic poles do not extend each section beyond the red or blue band and ensure that each pole clip is closed after extending.
WARNING	Avoid rotating the winches by hand - instead, insert a battery and use the controller.
WARNING	The winch units are watertight, but the batteries are not. If using the winches in wet weather, secure a plastic bag over the battery/battery clip part of the winch (a thick rubber band works well to hold it in place).

2.2. Controlling the winches

Individual winches can be controlled using the three in/out switches on the controller. The speed of the winches is set with the dial. The slowest speed is 20 mm/s and the fastest 1 m/s. Multiple winches can be operated at the same time.

The in/out switches are configured to pay out line when the inner side of the switch is pressed - the arrows on the switches point in the direction that the sphere will move when viewed in a split-beam sphere position plot.

WARNING	Only use speeds in the red section of the dial when the weight on the winch is less than about 1.5 kg.
NOTE	It is easy to operate the winches without observing the winch and this can quickly cause unintentional damage to the winches or the poles (e.g., pulling a line too hard when the line is caught on the hull, paying out line when there is no tension on the line leading to tangles). Experience suggests that until the sphere is visible on the echosounder split-beam display, operation of the winches should be done while observing the winch/pole unit.
NOTE	If both controllers are turned on and set to `controller` mode, then both controllers

will be sending potentially contradictory commands to the winches. A typical symptom of this is a winch moving in a struttering manner (i.e., one controler is telling the winch to rotate while the other is telling it to not rotate).

2.3. Android app

An app is available on the Google Play Store under the name `Aqualyd Winch Status`, via this URL, or the QR code below.

The app requires an Android device running version 9 of Android or later that also supports Bluetooth. The app does not provide a way to control the winches.

The app shows line out, line speed, battery voltage, and internal winch temperature for each winch (Figure 3). Controller battery charge, mode, and serial number are also shown. The winch battery voltage number turns red when a battery need charging.

The displayed line out values can be zeroed (using the `Zero` button) and restored with the `Unzero` button. The winches will reset their line out counters when the `Reset` button in pressed. This cannot be undone. The winches remember the current line out value even when the batteries are removed, so a `Reset` is the only way to force the winches' line counters to be zero. The `Save` button is not yet implemented, but will eventually allow for saving (and restoring) of line out values along with with a timestamp and label.

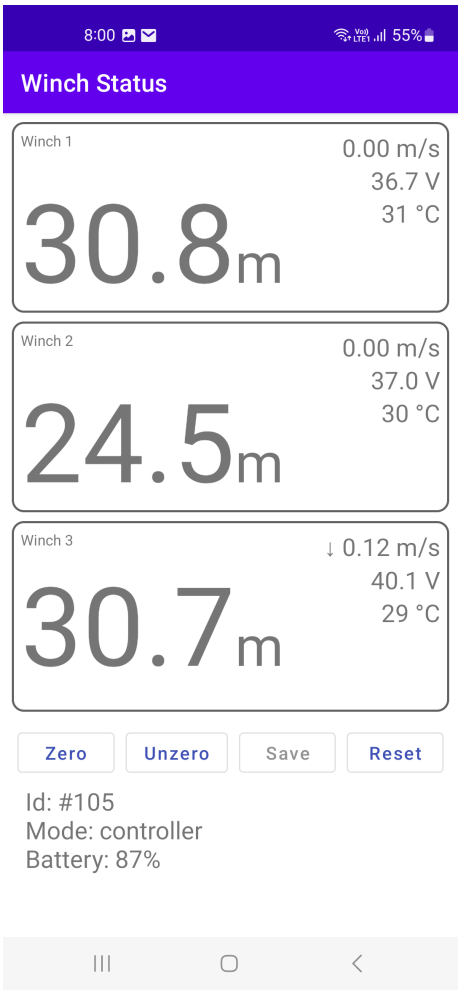

Figure 3. Screenshot from the Android app.

2.4. Charging the batteries

The controller contains a rechargable battery. To charge this, connect a micro USB cable to the unit and to a USB power supply (the USB port on a computer is fine - there is also a USB port on the Hikoki/Metabo HPT charger) and **turn the controller on**. Charging a completely flat battery will take about 4 hours and a fully charged battery will work for about 20 hours.

Note that the controller will be operating and transmitting whenever USB power is suppled, but will not charge the battery until the power switch is turned on (the on/off switch connects or disconnects the battery from the system - it does not affect supply of USB power to the controller's electronics). This means that a controller with a flat, faulty, or absent battery can be used normally by connecting USB power - it will operate as per normal and charge the battery if present.

The winch batteries are charged with the supplied Hikoki/Metabo HPT charger. It takes about 30

minutes to fully charge an empty winch battery.

Technical Manual

This is the Technical Manual for the Aqualyd wireless echosounder calibration winch system. This section provides details on how the system works, the main components, and information to assist with repair and modifications of the system.

3. System description

The overall system consists of two controllers and three winches. Communication between these units occurs via a 2.4 GHz mesh network, provided by Digi XBee3 radio modules. The controller broadcasts a message at 10 Hz that contains the state of all three in/out switches (up, down, stationary) and the potentiometer (0-255). Each winch unit listens to these messages, picks out the relevant in/out switch state and sends speed and direction commands to the motor controller, which operates the stepper model to rotate the winch drum. The relationship between the speed setting on the controller and the actual motor speed is determined by calculations done by the code running in the winch unit. At every 5th broadcast, each winch replies with winch status information which the controller sends via bluetooth to the Android app.

The system is provided in three parts: 1) a transit/storage case that contains the controllers and three winch units,, 2) a transit/storage case with the winch batteries and chargers, and 3) a tube that contains the three poles (Figure 4).

Figure 4. Supplied winch system showing (left) the transit case with included winches and controllers, (centre) the tube containing the poles, and (right) the battery and charger case.

3.1. Winches

The motors are of NEMA 23 size with an integrated 4.25:1 planetary gearbox, supplied by StepperOnline (model 23HS30-2804S-PG4). The motor is driven from a Pololu Tic T246 motor controller which is controlled via serial (I2C in later models) communication with a microPython programm running on the XBee3 radio module in each winch unit.

The acceleration and decceleration applied when the motor speed is changed is determined by a programmable setting in the Tic T246, as well as the maximum motor speed, and command timeout

when no controller messages are received. Each unit stores the current line out value in non-volatile RAM and recalls that on power up so that battery swaps preserve the line out value.

The winches were designed to hold a 6 kg load and are able to lift and lower 6 kg at slow speeds. Operation at higher speeds is only possible with smaller loads. The winch units operate with a 10-40 V DC input, but at least 36 V is needed to achieve sufficient motor torque to hold a 6 kg line load.

3.2. Controller

The controller contains a Digi XBee3 radio module, switches, a potentiometer, a rechargable battery, and a PCB that contains a MAX17048 battery status chip, LED's, and a mode switch. The XBee3 is integrated in a SparkFun Thing Plus XBee3 board (P/N WRL-15454) which provides power to the XBee3 via USB or a Lithium-Polymer battery. Battery management circuitry is also included that will charge the battery when USB power is provided.

The mode switch on the controller sets whether the controller operates as a controller or as a range extender. In range extender mode the winch controls are disabled.

3.3. Software

The controller runs a microPython program on the XBee3 module to translate buttons presses and speed setting into the message that is broadcast to the winches. The XBee3 in each winch also runs a microPython program that receives these messages, decodes them and sends motor speed and direction commands to the motor controller. The code that runs on these XBee3 modules is available on github.

Uploading the microPython code to the XBee3 module in the controller is done via the USB connector on the controller. Uploading to the XBee3 module in the winches requires a separate board that provides serial communication access to the Xbee3 (e.g. an XBee Grove Development Board). Modifying the parameters in the Pololu motor controller can be done via the USB connector on the Pololu unit.

3.4. Changing winch identification

Changing the winch identification may be necessary when replacing a faulty winch.

Each winch has an identification number (1, 2, 3). This is used by each winch to select the appropriate part of the message sent by the controller. This number is stored in the NI parameter in the XBee3 unit and is read when powering up. Changing this number can be done using the Digi XCTU software (via USB) or the Digi XBee mobile app (via Bluetooth). The Bluetooth password is **aqualyd**.

Note that the controller only sends out messages to winches with identification codes of 1, 2, or 3. If the winch NI parameter is set to any other value that winch will not act on any commands from the controller.

3.5. Poles

The poles are telescopic and made either of a 50/50 mix of carbon fibre and fibreglass or 100% carbon fibre (depends on the model). They are originally made for window washing and replacements are readily available from cleaning suppliers.

4. Communication

4.1. Controller-produced messages

The controller broadcasts a message to the winches, consisting of a single string containing six ASCII characters. Optionally, the message can contain two extra characters that are used to configure a winch. The meaning of the characters are:

- Characters one to three specify the required winch motion for each winch (first character for winch 1, second for winch 2 and the third for winch 3). The value of each character is `0`, `1`, or `2`. `0` means to stop the winch, `1` to pay out line, and `2` to take in line.
- Characters four to six are interpreted as an integer number between 0 and 255 that gives the position of the speed dial.
- Character 7 is a command code. The only value accepted to date is `z`, used to tell a winch to reset to zero the line out counter. If `z` is sent, character 8 specifies which winch the reset applies to (i.e., `1`, `2`, or `3`). When the line out is reset, that winch will stop rotating, the line out value will be set to zero, a status message will be sent to the Android app, and then any speed/direction commands in the message for that winch will be acted upon.

Some examples:

- `000105` will ensure that all winches are stopped. The speed potentiometer is set to a little under half speed.
- `011000` will cause winches 2 and 3 to pay line out at the minimum speed.
- `20125500` will cause winch 1 to take line in and winch 3 to pay line out, both at the maximum speed. Winch 2 will not rotate. As the 7th character is not `z`, the last two characters will have no effect.
- `201128z2` will cause the line counter for winch 2 to be zeroed, winch 1 to take line in, and winch 3 to pay line out, both at half speed.

The controller also sends a message to the Android app using the same message style as the message sent by the winches (see below) and contains information about the controller. The message is a comma separated ASCII string in the form:

`0,id,mode,v.v,s.s,r.r`

where the fields are:

Field	Content	Decimal places	Units
id	Serial number of the controller	string	
mode	Mode of the controller	string	
v.v	Controller battery voltage	2	V
s.s	Controller battery charge	1	%
r.r	Controller battery rate of (dis)charge	1	%/hour

The `0` in the first location is used by the app to separate controller messages from winch messages (which always start with the winch identification number: 1, 2, or 3).

4.2. Winch-produced messages

A winch status message is sent by each winch unit back to the controller, which forwards it out over the Bluetooth Low Energy communication link (using the Xbee3 User Data Frame mechanism). An Android app is available that uses these messages to show winch status information. This message is a comma separated ASCII string in the form:

`w,v.v,t,pp.pp,ss.ss,V`

where the fields are:

Field	Content	Decimal places	Units
w	Winch identification (1, 2, or 3)		
v.v	Battery voltage	1	V
t	Winch internal temperature	0	°C
pp.pp	Line paid out (can include leading negative sign)	2	m
ss.ss	Line speed (can include leading negative sign)	2	$m\ s^{-1}$
V	Winch version idenfication (optional)	string	

A negative line paid out value indicates the line has been taken in more than paid out. A negative line speed indicates the line is being taken in. The winch version idenfication is used by the Andoid app to modify its' user interface to match the capabilities of the winch. It is optional and it and the preceeding comma are not produced by earlier versions of the winch code. Currently used values are:

Value	Comms with motor controller	Remembers line out
1	UART	No
2	UART	Yes
3	i2c	Yes

4.3. App-produced messages

The Android app can send two-byte ASCII strings to the controller, which appends them to the messages sent to the winches (these are the 7th and 8th characters in the controller-produced message). This is currently used to tell the winches to reset their line counters.

4.4. Status display without the Android app

The winch and controller status messages that are sent to the Android app over Bluetooth are also copied out on the controller's USB connector via a virtual serial port. This can be useful if an Android device is not available, or the winch status app cannot be installed.

Simple status displays written in Python are provided here and here. The former provides a graphical display and the latter a terminal-based text display. You can write your own, or you can use some dashboard software that can parse data from a serial port (e.g., Serial-Studio).

The virtual serial port should be set to 9600/8/N/1 and is provided by a Silicon Labs CP210x USB to UART bridge device.

Appendix A: Specifications

Parameter	Value	Units
Maximum line speed	1	m/s
Minimum line speed	0.02	m/s
Maximum stationary load	6	kg
Maximum load at 1 m/s line speed	~1.5	kg
Maximum load at 0.5 m/s line speed	~3	kg
Winch supply voltage	10-40	V DC
Winch supply voltage for design performance	36	V DC
Current usage at 6 kg load, 0.02 m/s	<0.1	A
Peak current usage at 3 kg load, 0.5 m/s	0.07	A
Recommended minimum current rating of power supply	1.5	A
Maximum current usage based on motor specs	3.4	A
Wireless communication protocol	XBee DigiMesh	
DigiMesh network identification	0xA1A1	
DigiMesh network channel	0x1A	
DigiMesh wireless channel	26 (2480 MHz)	
Controller battery	Nokia BL-5C	
Battery chemistry	Lithium Ion	
Battery voltage	3.7	V
Battery rating	1.05	Ah
Battery rating	3.8	Wh
Winch battery	Hikoki/Metabo HPT MultiVolt BSL36A18X	
Battery chemistry	Lithium Ion	
Battery voltage	36	V
Battery rating	2.5	Ah
Battery rating	90	Wh

Appendix B: Supplied Parts

A wireless system consists of the following components:

Component	Quantity
Transit/storage case (Nanuk 960) for winches and controllers with fitted foam	1
Transit/storage case (Nanuk 945) for batteries and charger with fitted foam	1
Transit/storage tube for poles	1
Winch unit (for short pole)	2
Winch unit (for long pole)	1
Short pole	2
Long pole	1
Pole attachment cord with carabiner	4
Pole attachment eyebolt	3
Winch batteries	4
Winch battery charger	1
Controller	2
Controller charging cord (USB)	1
User & Technical manual (online)	1
Hose clamps (46-70 mm diameter)	6