



AUTOMATED ENVIRONMENTAL MONITORING NETWORKS

User Manual

TerraTransfer Measuring Buoy

Shallow Water Buoy and Standard Measuring Buoy · Installation and Operating Manual

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I Disclaimer

The information contained in this manual corresponded to the state of the art at the time of publication. Subsequent updates are possible. This manual does not cover all details of the construction, production or variants of the device and does not cover every possible situation that may arise during installation, operation or maintenance.

TerraTransfer GmbH shall not be liable for incidental, indirect, special or consequential damages arising out of or related to this documentation and the information contained herein — even if TerraTransfer has been advised of the possibility of such damages.

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II Safety Instructions

Read this manual completely before installing, commissioning or maintaining the measuring buoy. It is intended for qualified technical personnel who are familiar with working on and around water bodies and with the operation of electrical measurement technology.

Note: Keep this manual for the entire service life of the installation.

Work on Water

Warning: All assembly and maintenance work on water must be carried out with a suitable vessel, under stable weather conditions and by at least two persons. Every person must wear a suitable life jacket.

- No work during thunderstorms, strong winds (wind force > 4 Bft) or restricted visibility.
- Safety equipment (life jackets, throw lines, first aid kit) always on board.
- Observe local regulations for water use and navigation.

Electrical Safety

- Wire data loggers and sensors only when de-energised (batteries removed).
- Check cable connections for secure locking and tightness before commissioning.
- Do not establish BLE connections from the boat during thunderstorms.

Lifting and Transporting Heavy Parts

Warning: The concrete anchor weight can weigh several tens of kilograms. Use suitable lifting equipment and sufficient personnel for lifting and transport. Observe ergonomic lifting practices.

Safety Symbols in this Manual

Warning: Potentially hazardous situation — non-compliance may result in property damage or injury.

Note: Useful information for protecting the device or for optimal operation.

III Specific Safety Instructions

Drifting Risk and Vandalism

Buoys are exposed in public spaces. Mark the buoy clearly as a monitoring installation (sign with operator details, authority logo if applicable). Check at every maintenance visit that the buoy is still in its target position and has not been damaged.

Warning: A detached buoy can become a hazard for other watercraft. The anchoring system is the safety-critical element of the installation — it must be regularly inspected for wear and corrosion.

Anchor Chain and Pressure Forces

During high water, considerable flow forces can act on the buoy and anchor chain. The chain and all connecting elements must be designed for the expected maximum loads. In case of doubt, choose an oversized version.

Batteries

Warning: Lithium batteries of the Aquatos Web LTX must not be short-circuited, thrown into fire or mechanically damaged. Remove and dispose of depleted batteries immediately and properly.

Water Body Protection

All materials used (housing, cables, sensors) must be suitable for contact with the respective water body and must not release pollutants. If in doubt, consult the responsible water authority.

Part 1 Scope of Delivery

Standard Scope of Delivery per Buoy

- Buoy float body (as ordered: shallow water buoy black or standard measuring buoy red-black)
- Central mast with mounting plate for Aquatos Web LTX
- Stainless steel cable entry ring for measurement chains and anchor chain
- Mounting screws and sealing material
- Quick-start guide (printed)

Not Included — to be provided by the operator

- Aquatos Web LTX (data logger with antenna and SIM card)
- Sensors: water quality sensors, temperature measurement chain and/or pressure sensor
- Anchor chain (length and strength according to site conditions, stainless or galvanised steel)
- Concrete anchor weight (size according to site conditions)
- Shackles and connecting elements for the anchoring system

Note: We offer planning support for the design of anchor chain, concrete weight and sensors. Contact TerraTransfer before procurement.

Part 2 Introduction

2.1 Buoy Types Overview



Figure 1: Shallow water buoy (black) — compact design for shallow waters from 20 cm depth.



Figure 2: Standard measuring buoy (red-black) — robust platform for deeper waters.

Shallow water buoy (black): Compact, flat design for use in shallow water bodies from approx. 20 cm depth. Suitable for ponds, wetlands, flood plains, oxbow lakes and calm river sections. The low float body offers little wind surface area and is well-suited to exposed, low-wind shallow water.

Standard measuring buoy (red-black): Larger float body for use in deeper and more current-affected water bodies — rivers, lakes, reservoirs and coastal areas. The higher volume provides more buoyancy and stability. The red-black colour scheme follows nautical marking conventions and increases visibility.

2.2 Area of Application

The TerraTransfer measuring buoys are carrier platforms for the Aquatos Web LTX and various environmental sensors. Typical areas of application include:

- Continuous water quality monitoring (pH, O₂, conductivity, turbidity, nitrate, etc.)
- Vertical temperature profile measurement with temperature measurement chains
- Water level monitoring with pressure sensor on the anchor chain
- Early warning systems for oxygen depletion or algal growth in lakes and reservoirs
- Scientific measurement campaigns and time-limited monitoring projects

2.3 System Components

A complete measuring buoy installation consists of the following components:

Aquatos Web LTX: The data logger is mounted at the top of the buoy mast. It records all sensor data, stores it internally and transmits it automatically to the Sensor Manager via LTE-M mobile network.

Water quality sensors: SDI-12 sensors for pH, dissolved oxygen, conductivity, turbidity or other parameters. They are suspended from the buoy body or a sensor frame at a defined depth.

Temperature measurement chain: Thermistor chain with up to 30 nodes for continuous temperature measurement across various water depths. Connected to the Aquatos Web LTX via the SDI-12 bus.

Pressure sensor on anchor chain: A piezoresistive pressure sensor can be attached to the anchor chain at a defined depth. It measures the water level via hydrostatic pressure — independently of the buoy float and thus robust against buoy rise and fall.

Anchor chain and concrete weight: The anchor chain connects the buoy to the concrete weight on the water body floor. It must be long enough to follow regular water level fluctuations (daily and seasonal cycles, high water) without submerging the buoy or pulling it taut.

Part 3 Planning and Preparation

3.1 Selecting the Buoy Type

Criterion	Shallow water buoy (black) / Standard measuring buoy (red-black)
Minimum depth	from approx. 20 cm / from approx. 1 m
Water body type	Ponds, wetlands, calm shallow waters / Lakes, rivers, reservoirs
Current	low to none / moderate, stable even in moderate current
Sensor load	light sensors / also heavy chains and multiple sensors
Visibility	unobtrusive / nautical marking red-black, widely visible

Note: If in doubt, choose the standard measuring buoy — it offers more reserve buoyancy and is more robust for changing conditions.

3.2 Site Survey and Permits

The following points must be clarified before installation:

- Water depth at the planned buoy position (echo sounder or sounding)
- Maximum and minimum water levels (historical gauge data)
- Flow direction and strength (relevant for chain design and anchoring depth)
- Boat traffic and fairways (no obstruction of navigation)
- Ownership of the water body and regulatory permits (water authority, navigation authority)
- Mobile network coverage at the site (LTE-M — if necessary, conduct a test measurement with the Aquatos Web LTX in advance)

3.3 Anchor Chain Design

The length of the anchor chain is a critical planning parameter. It must have sufficient catenary (sag) at every water level so that the buoy floats freely and the chain is not pulled taut.

Rule of thumb: Chain length = maximum water depth × 2.5 to 3.0. With strongly fluctuating water levels (> 2 m), add the range of fluctuation.

Example: Maximum water depth 4 m, level fluctuation 1.5 m → required chain length: $(4 + 1.5) \times 3.0 \approx 17$ m.

Note: A chain that is too short pulls the buoy underwater during high water or tears the concrete weight off the bottom. A chain that is too long allows too much drift and may become tangled. The calculation should be based on the site-specific extreme water level.

Chain type and strength are determined by the expected buoyancy of the buoy and the flow force. For most applications, an anchor chain of stainless steel (AISI 316) or hot-dip galvanised steel is sufficient. TerraTransfer provides advice on request.

3.4 Concrete Anchor Weight

The concrete anchor weight anchors the buoy on the water body floor. It must be heavy enough to permanently hold the buoyancy of the buoy and the hydrodynamic forces from current and wind.

Guideline: Minimum weight underwater ≥ 3 times the net buoyancy of the fully equipped buoy. Design higher for strong currents.

Concrete weights can be prefabricated or cast on-site. Integrated stainless steel (AISI 316) eyes for the chain connection are recommended. The weight must rest completely on the bottom — a flat, stable substrate is ideal.

Warning: On soft mud floors, the weight may sink and effectively shorten the chain. Use spacer plates or wide-area base plates in such conditions.

Part 4 Installation

4.1 Installing and Preparing the Aquatos Web LTX

The Aquatos Web LTX is mounted on the central mast of the buoy. The mast protects the logger housing from spray water and positions the LTE-M antenna above the water surface.

1. Fully configure the Aquatos Web LTX before installation (measurement interval, sensor addresses, APN, insert SIM card — see user manual TT-ANL-LTX-001).
2. Insert batteries only immediately before deployment to avoid capacity loss during transport.
3. Attach the logger to the mast mounting. Ensure secure fit and cable strain relief.
4. Align the LTE-M antenna at the mast top (vertical, open sky facing upward).
5. Route SDI-12 cables of sensors through the provided cable entry on the buoy body and connect to the logger.

Note: The cable entries are sealed with O-rings. Insert cables without kinking and tighten the lock nut hand-tight. Never connect cables under tension.

4.2 Mounting Sensors

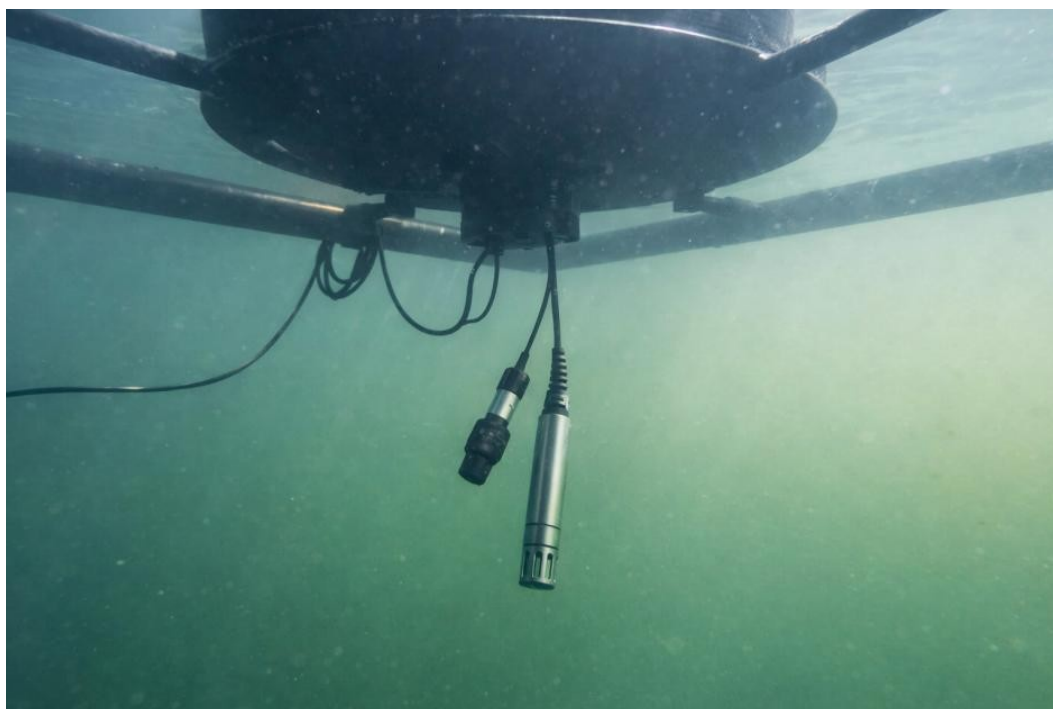


Figure 7: View from below the buoy — water quality sensors suspended from the buoy entry at a defined measurement depth.

4.2.1 Water Quality Sensors



Figure 3: Typical SDI-12 water quality sensor for buoy deployment.

Water quality sensors are mounted at the desired measurement depth on the buoy body or on a sensor frame. All sensors communicate with the Aquatos Web LTX via the SDI-12 bus.

- Assign each sensor a unique SDI-12 address (0–9) before installation (via Bluetooth app or BlueShell).
- Secure sensor cables to the buoy body with cable ties and clamps — no free hanging.
- Minimum distance between different sensors ≥ 10 cm to minimise mutual interference.
- Protect sensors with sensitive membranes (e.g. O₂ optode) with the enclosed protective cage.

Note: Calibrate water quality sensors according to the respective sensor manual before installation.

4.2.2 Temperature Measurement Chain



Figure 4: Temperature measurement chain with multiple thermistor nodes for depth profile measurement.

The temperature measurement chain is attached to the buoy entry and guided vertically downward. The chain end is tensioned with a small weight (approx. 0.5–1 kg) so that the chain hangs straight.

- Node spacing of the measurement chain corresponds to the desired depth profile (e.g. 0.5 m, 1 m, 2 m).
- Secure the measurement chain at the buoy entry with a cable tie or clamp.
- Register the connection cable to the Aquatos Web LTX as an SDI-12 sensor (address as per measurement chain documentation).

Note: Measurement chains longer than 20 m can oscillate autonomously and must be guided at several points on the buoy body or in a guide pipe.

4.2.3 Pressure Sensor on Anchor Chain



Figure 5: Piezoresistive pressure sensor Type 0312 — mounted on the anchor chain at a defined depth.

A piezoresistive pressure sensor can be attached to the anchor chain at a defined depth. This method measures the water level independently of the buoy's floating behaviour and is particularly more precise during strong water level fluctuations than a near-surface measurement.

6. Secure the pressure sensor at the desired reference depth to the anchor chain with a stainless steel cable tie or clamp. The pressure diaphragm must face downward and remain clear of the bottom.
7. Route the SDI-12 cable of the sensor upward along the anchor chain. Secure the cable with cable ties at approx. 50 cm intervals — leave enough loops so that the chain can move freely.
8. Route the cable through the buoy entry upward and connect to the Aquatos Web LTX.

Warning: The cable must not be pulled taut when raising and lowering the anchor chain. Plan sufficient cable length with loops to absorb the maximum water level fluctuation.

4.3 Assembling Anchor Chain and Concrete Weight

9. Position the concrete weight at the deployment point (boat or shore).
10. Attach the anchor chain to the concrete weight (shackle tight and secured with safety wire).
11. Stack the anchor chain on the boat or lay it in a tub so it does not become tangled when lowered.
12. Attach the buoy-side chain to the entry ring of the buoy (also with secured shackle).
13. Check all connections once more for secure fit before launching the buoy.

4.4 Deployment

4.4.1 Deployment by Inflatable Boat (small water bodies)



Figure 6: Deployment of the shallow water buoy from an inflatable boat — life jackets are mandatory.

For ponds, small lakes or shallow water areas, an inflatable boat is sufficient. Procedure:

14. Navigate the inflatable boat with outboard motor or paddles to the planned buoy position.
15. Secure the concrete weight on the boat (safety line, until it is lowered in a controlled manner).
16. Place the buoy in the water. Check the chain for freedom from tangles.
17. Lower the concrete weight slowly and in a controlled manner. Secure the position with a GPS device or bearing if necessary.
18. After setting down the weight, let the buoy float into final position and check for free drifting.
19. Document position with GPS coordinates.

Warning: When lowering the concrete weight, keep body parts away from the path of the chain or weight. Lower in a guided manner, never let it fall.

4.4.2 Deployment by Larger Vessel

At larger water bodies (lakes, reservoirs, wider rivers), a motorised boat with sufficient load capacity for the concrete weight is required. For very heavy weights (> 100 kg), a crane or anchor winch should be used.

- Differing from inflatable boat deployment: position heavy weight with winch or crane over the planned lowering point.
- Check chain and cable for freedom from tangles before the weight enters the water.
- After lowering, document chain length and buoy position in GPS.

Note: In water bodies with shipping traffic or in protected areas, official supervision during deployment may be required. Clarify in advance.

Part 5 Configuration

5.1 Configuring the Aquatos Web LTX

The full configuration of the Aquatos Web LTX is described in the separate user manual TT-ANL-LTX-001. The following points are particularly relevant for buoy deployment:

- Measurement interval: For continuous monitoring we recommend 15 minutes. For early warning systems, 5 minutes if necessary.
- Channel configuration: Enter all connected SDI-12 sensors with their address and measurement parameters.
- Alarm thresholds: Set threshold values for critical parameters (O₂, temperature, water level) in the Sensor Manager.
- LTE-M / SIM: Set APN and connection parameters according to network operator. Check signal strength at the site before deployment.

5.2 Addressing and Testing Sensors

Before deployment, configure all SDI-12 sensors to unique addresses using the Bluetooth app or BlueShell and run a test measurement cycle.

20. Open Bluetooth app (<https://ltxdata.net/ttblx/>) and connect via Bluetooth to the Aquatos Web LTX.
21. In the "Sensors" menu, check all registered sensors and their current measurement values. Verify plausibility of values.
22. Temperature measurement chain: All nodes must respond with measurement values. Missing nodes indicate a cable break or incorrect address.
23. Pressure sensor: Compare measurement value at known immersion depth with reference value (approx. 0.1 bar per metre water depth).

Note: Always run the test measurement at the final installation location and in the submerged state — air value and water value can differ significantly.

Part 6 Operation

6.1 Retrieving Measurement Data Online (Sensor Manager)

After successful commissioning, the Aquatos Web LTX transmits measurement data automatically via LTE-M mobile network to the TerraTransfer Sensor Manager. No manual readout required.

- Access: www.terratransfer.de/sensormanager (access credentials provided by TerraTransfer)
- Time series, maps and status overviews of all measurement parameters in real time
- CSV export and FTP connection for your own analysis
- Status monitor: battery voltage, signal strength, last transmission time and device temperature

6.2 Alarms and Threshold Values

In the Sensor Manager, alarm thresholds (upper and lower limits) can be set for each measurement channel. When exceeded, an e-mail or SMS is automatically sent to registered recipients.

Note: For early warning systems (e.g. oxygen depletion, high water), we recommend configuring multi-level alarms: pre-warning level and alarm level. This allows measures to be triggered in a graduated manner.

6.3 Seasonal Operation and Winterisation

In water bodies with ice drift, the buoy must be retrieved before the onset of winter to prevent damage from ice formation and drift.

- Recommended retrieval date: before the first regular frost, typically October–November (site-dependent).
- Bring the buoy to an accessible location by boat or inflatable boat and lift it out of the water.
- Remove batteries, clean sensors and store dry.
- Anchor chain and concrete weight can generally remain in the water — ensure sufficient depth (ice drift hazard).

Note: In ice-free water bodies (deep lakes, certain reservoirs), year-round operation may be possible. Consultation with the local hydrologist is recommended.

Part 7 Maintenance

7.1 Regular Visual Inspection

Recommended maintenance interval: at least once per season (spring and autumn), monthly for critical applications.

- Compare buoy position with GPS coordinates from initial installation — large deviations indicate chain breakage or weight displacement.
- Check visible condition of the buoy body, mast and entries from the outside.
- Regularly check battery status and transmission status in the Sensor Manager.

7.2 Cleaning the Buoy and Sensors

24. Approach the buoy by boat and, if necessary, briefly anchor or moor to an assisting boat.
25. Remove visible growth (algae, mussels) from the buoy body with a brush.
26. Clean sensor membranes (pressure sensor, O₂ sensor, turbidity probe) according to the sensor manual.
27. Check cable entries for tight seating, tighten lock nuts if necessary.

Warning: Do not clean sensor membranes with sharp objects or aggressive cleaning agents.

7.3 Inspecting Anchor Chain and Weight

Once a year or after extreme events (high water, ice drift), the anchor chain should be fully inspected:

- Check chain links for corrosion, deformation and wear.
- Check shackle bolts for secure seating and safety wire.
- Inspect concrete weight if possible with an underwater camera or diver — is it still lying flat? Is it still complete?

7.4 Replacing Batteries (AquatOS Web LTX)

The battery status of the AquatOS Web LTX can be viewed in the Sensor Manager at any time. Replacement is recommended when the battery voltage falls below the limit value stated in the logger manual. To replace the battery, the logger must be removed from the buoy.

Reference: Battery replacement procedure as per TT-ANL-LTX-001, Part 6.

Part 8 Troubleshooting

Problem	Possible cause and action
No data in Sensor Manager	Check LTE-M connection (signal strength in Sensor Manager). Check SIM card and APN. Replace battery. Read logger locally via Bluetooth app.
Buoy no longer at target position	Chain breakage or weight displacement. Immediately approach by boat and check chain connection.
Measurement value of a sensor missing	SDI-12 address collision or cable break. Check sensor status via Bluetooth app. Inspect cable for damage.
Conspicuously high/low values	Sensor dirty or not calibrated. Clean and calibrate sensor. Perform comparison measurement on-site.
Temperature chain incomplete	Cable break or node out of measurement range. Visually inspect chain. Replace defective section.
Pressure sensor shows no water level	Cable taut or torn. Pull sensor out of chain and check for damage. Recalibrate zero point.
Battery depletes quickly	Short measurement interval or permanently open BLE connection. Increase interval. Check last BLE connection time in Sensor Manager.
Buoy body damaged	Vandalism or ice drift. Retrieve buoy, contact TerraTransfer. Check buoy body for water ingress.

For problems that cannot be resolved using this table, please contact TerraTransfer (contact details at the end of this manual).

Part 9 Repair and Return

Repairs to the buoy, logger and sensors may only be carried out by TerraTransfer or authorised specialist personnel. Unauthorised interventions void the warranty.

RMA Process

28. Report the defect and serial number of the device to TerraTransfer (contact details on last page).
29. Receive RMA number and note it on the shipment.
30. Pack the device securely and send to TerraTransfer GmbH, Ottostraße 19a, 44867 Bochum, Germany.
31. Upon receipt you will receive a diagnosis and cost estimate.

Part 10 Technical Data

Shallow Water Buoy (black)

Property	Value
Operating depth	from approx. 20 cm water depth
Float body material	Stainless steel, protective coating (black)
Mast mount	Central mast for Aquatos Web LTX and antenna
Cable entries	Stainless steel cable entries, O-ring sealed
Chain connection	Stainless steel entry ring at bottom
Operating water body	Fresh water, wetlands, calm shallow water bodies
Protection class	Float body IP68, permanently submersible

Standard Measuring Buoy (red-black)

Property	Value
Operating depth	from approx. 1 m water depth
Float body material	Stainless steel, protective coating (red-black, nautical marking)
Mast mount	Central mast for Aquatos Web LTX and antenna
Cable entries	Stainless steel cable entries, O-ring sealed
Chain connection	Stainless steel entry ring at bottom
Operating water body	Lakes, reservoirs, rivers, also in moderate current
Protection class	Float body IP68, permanently submersible

Anchoring System (operator-supplied)

Component	Recommendation
Anchor chain	Stainless steel AISI 316 or hot-dip galvanised steel, chain gauge ≥ 8 mm
Chain length	Max. water depth $\times 2.5$ – 3.0 (+ level fluctuation reserve)
Shackles	Stainless steel, secured with wire or split pin
Concrete weight	Net buoyancy of buoy $\times 3$ (underwater)
Base plate	On soft substrate: concrete slab ≥ 0.5 m ² bearing area

Part 11 Operator Obligations and Disposal

Operator Obligations

The operator is responsible for the safe operation of the installation, compliance with regulatory permits and regular inspection of the anchoring system. A maintenance log must be kept. Defective or detached buoys must be reported and secured immediately.

Marking

The measuring buoy must be marked as a monitoring installation (name and contact details of the operator, authority logo if applicable). On shipping lanes, additional nautical marking regulations apply — consultation with the navigation authority is mandatory.

Disposal — EU WEEE Directive

In accordance with the EU WEEE Directive (2012/19/EU), old equipment (loggers, sensors, electronics) must be disposed of separately from household waste. TerraTransfer GmbH accepts old equipment for proper disposal.

Battery Disposal

Depleted lithium batteries must not be placed in household waste. Return to collection points at retail outlets or municipal collection points.

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