USER GUIDE

HYDROBALL®

Models: HB01L - LoRaWAN / HB01N - NB IoT

DENODL®

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Technical Specifications - Name and model - Generation

Product: HYDROBALL®

Generation: 1

Available Models: Our HYDROBALL® probe is available in two alternative models, depending on the type of connectivity used for wireless data transmission.

• **NB-IoT Model (HB01N)**: Ideal for urban or agricultural environments with NB-IoT network coverage.

• **LoRaWAN Model (HB01L):** Designed for environments without NB-IoT network coverage.

Technical Specifications – Device description

HYDROBALL® is a fully autonomous soil probe designed to accurately measure the key parameters that define soil water conditions. Its use enables data-driven decision-making, optimizing resource use, improving irrigation efficiency, and contributing to higher crop quality and productivity.

Its spherical design eliminates edges, ensuring uniform contact with the soil and optimal integration within the soil profile.

HYDROBALL® continuously measures the following parameters:

- Volumetric Water Content (VWC)
- Water Tension (Matric Potential)
- Apparent Electrical Conductivity (ECa)
- Soil Temperature

Technical Specifications – Device description

Depending on the model (HB01N or HB01L), the device transmits data to the cloud using different communication technologies. The **HB01N** model uses **NB-IoT**, connecting directly to the cellular network through an integrated SIM card provided by the manufacturer, enabling autonomous communication without the need for additional infrastructure such as external antennas or repeaters. Check with your distributor for network coverage availability in your area.

On the other hand, the **HB01L** model uses **LoRaWAN®** technology, which requires the presence of a **gateway** device to collect the data and transmit it to the cloud. Both options ensure efficient, low-power connectivity, adapting to different operational environments and coverage levels.

The choice between one communication model or the other depends on the **NB-IoT** coverage available in the installation area. To support this decision, coverage verification can be easily performed using the **DENODL® Connect** app, which allows real-time network availability checks and ensures proper device operation before deployment.

Technical Specifications – Device description

HYDROBALL® is a robust, durable, and fully autonomous device designed to operate without the need for data loggers, external power sources, or additional infrastructure. It integrates all necessary components for measurement, power supply, and data communication into a single unit, simplifying installation and startup in any environment while also minimizing maintenance requirements.

The probe must be installed at the depth corresponding to the crop's root system. It operates on standard AA batteries, with a minimum estimated battery life of 3 years for the NB-IoT model and 4 years for the LoRaWAN model, depending on the configured measurement and data transmission frequency. These minimum lifespans are calculated based on one measurement every 15 minutes with the energy-saving mode (adaptive mode) activated. Battery life can be extended by reducing the transmission frequency.

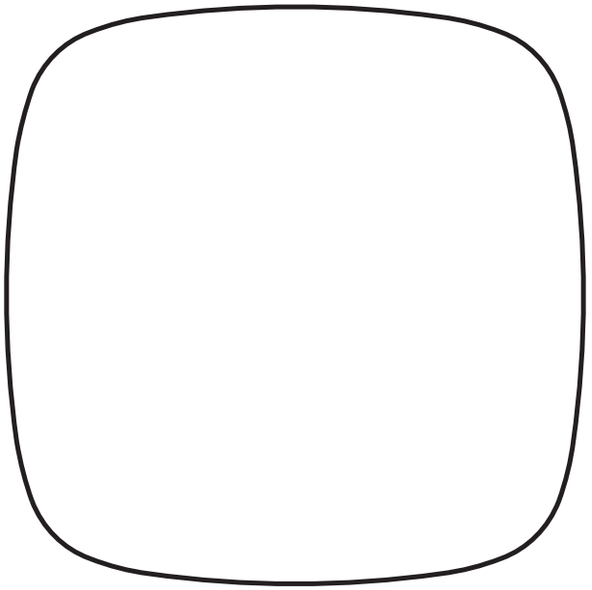
Technical Specifications – Device description

The data recorded by HYDROBALL® is automatically sent to the cloud, where it is processed and made available to the user through the DENODL® App, a digital platform for agronomic data management. Available in both web and mobile versions, the DENODL® App allows users to view real-time information, access historical data, configure alerts, and compare metrics across different sensors or monitored zones. Its interface makes technical decision-making based on objective data simple and user-friendly.

Technical Specifications – Parts and components / Interface

1. Threaded cap
2. Flat gasket
3. O-ring
4. Body
5. Ceramic
6. Bottom transducer
7. Battery cover
8. Battery compartment
9. Button
10. LED light
11. USB-C port

(Exclusivamente para uso de mantenimiento técnico y diagnóstico por parte del fabricante).



Technical Specifications – Application / Uses

The main applications of the probe are found in the following sectors:

- **Agricultural applications:** field crops (cereals, legumes, oilseeds), horticultural crops (open field and greenhouse), deciduous fruit trees, woody crops (vineyards, olive trees, almond trees), tropical trees (avocado, mango, papaya), low-growing or bushy crops (tomato, strawberry, pepper).
- **Green spaces in urban environments:** municipal parks and gardens, street-aligned trees, landscaped green areas, seasonal flowers, planters, grass surfaces in public areas.
- **Private gardens:** gardens in hotel complexes, hospitals, educational centers, residential developments, home gardens, university or other campuses.
- **Sports areas:** golf courses, football fields, tennis courts, natural grass surfaces in sports facilities.
- **Composting:** compost piles and tunnels, organic waste treatment plants, sludge processing, moisture and temperature control in maturation processes.

Technical Specifications – Main features

• **Autonomous device: does not require a data logger or external power source.**

• Models based on communication protocol

o **HYDROBALL® HB01L – LoRaWAN®:** transmits data via a LoRaWAN network using an external, easy-to-install gateway

o **HYDROBALL® HB01N – NB IoT:** transmits data directly to the cellular network using an integrated SIM card provided by the manufacturer.

• Installation: must be buried at the depth of the crop's root system. Refer to the "Installation" section for details on burial technique and device orientation.

• Power supply and autonomy: four standard AA batteries. Minimum estimated battery life of 3 years for the NB-IoT model and 4 years for the LoRaWAN model, depending on the configured measurement and data transmission frequency.

Technical Specifications – Main features

• **Power supply and autonomy:** These minimum lifespans are calculated based on one measurement every 15 minutes with the energy-saving mode (adaptive mode) activated. Battery life will be longer if the transmission frequency is reduced. It is recommended to use high-quality alkaline or lithium batteries for maximum durability. Rechargeable batteries may be used; however, their autonomy is considerably lower.

• **Parameters measured by a single device**

o Volumetric Water Content (VWC, %): quantifies the fraction of water present in the soil relative to the total soil volume—a key metric for adjusting irrigation depth

o Water Tension (kPa): indicates the effort the plant must exert to extract water from the soil; used to define specific irrigation thresholds based on soil texture

o Apparent Electrical Conductivity (ECa, dS/m): provides an estimate of soil salinity and helps prevent salt stress and nutrient lockou.

Technical Specifications – Main features

- **Soil Temperature (°C):** monitors root activity and the kinetics of water and nutrient absorption, providing valuable information for the proper application of certain treatments

Derived indicators in DENODL® App

- **Soil suction curve and texture estimation:** based on the real-time relationship between volumetric water content and water tension, the platform generates the soil suction curve and uses its parameters to estimate soil texture. This information helps to approximately determine field capacity and permanent wilting point, and to define specific irrigation thresholds for each soil type

- **Growing degree days (GDD):** thermal accumulation used to model phenological development, anticipate water needs, and schedule field operations

• **Compatibility and integration:** data access via REST API for integration with external or third-party platforms.

Technical Specifications – Main features

• **Durability and resistance:** sealed housing (IP68), no moving parts, resistant to immersion, dust, and high temperatures.

• **Minimal maintenance:** plug-and-play installation. The only maintenance required is battery replacement at the end of their life and the potential replacement of the ceramic component acting as a tensiometer, which is easily replaceable by the user with a spare part.

Technical Specifications – Technical datasheet

Dimensions	Spherical shape, 85 mm diameter.
Weight without batteries	450 g.
Weight with batteries	526 g.
Finish	Matte black.
Materials	PBT/PET + fibra POM TPE PC Polyurethane resin Ceramic material
Tolerances and quality standards	Designed and manufactured in the EU Water- and dust-resistant (IP68) Resistant to temperatures up to 85ºC when using batteries specifically designed for high temperatures (the batteries included with the device are not suitable for such conditions) CE marked

Technical Specifications – Technical datasheet

Communication Protocol

HYDROBALL® is available in two versions, distinguished by the technology used for data transmission:

- **HYDROBALL® HB01N (NB-IoT)**
- **HYDROBALL® HB01L (LoRaWAN®)**

Both models collect the same parameters and share the same physical and operational functionality, but differ in how they transmit data from the probe to the cloud. The choice between models depends on the available network coverage at the installation site.

NB-IoT (Narrowband Internet of Things)

The **HB01N** model uses the **NB-IoT** communication protocol, a cellular network technology specifically designed for IoT devices. This protocol enables data transmission through the mobile network infrastructure without the need for gateways or other intermediary devices.

Technical Specifications – Technical datasheet

The probe includes an **integrated SIM card** provided by the manufacturer, allowing direct connection to the available NB-IoT operator network in the area. This type of communication is especially suitable for urban, agricultural, or sports environments with good NB-IoT coverage.

During **initial startup,** the device may take **up to 5 minutes** to register with the operator's network for the first time. It is recommended to leave the probe idle during this time. A continuous double LED flash indicates that the probe is searching for the network operator.

LoRaWAN® (Long Range Wide Area Network)

The **HB01L** model uses **LoRaWAN®** technology, a long-range, low-power wireless communication protocol. Unlike the NB-IoT model, this system requires a nearby **LoRaWAN® gateway** to act as a bridge between the probe and the cloud server. The effective range of the base station with the gateway and antenna can reach up to 1 km, depending on the terrain and the line of sight between the antenna and the probe.

Technical Specifications – Technical datasheet

The probe periodically transmits data to the gateway, which in turn forwards it to the central management system (DENODL servers) via the Internet. This model is suitable for rural areas or installations where NB-IoT coverage is unavailable but a LoRaWAN infrastructure can be deployed.

Coverage Verification

Before selecting the probe model, it is necessary to check the availability of **NB-IoT** coverage in the intended area. It is advisable to consult with your distributor. Additionally, you can use the **DENODL®** Connect app (see corresponding section below), which allows for easy verification of the presence and signal quality of this protocol using a mobile device.

Coverage Verification Process with DENODL® Connect

To determine the viability of installing a HYDROBALL® NB-IoT probe, follow these steps using the **DENODL® Connect** app:

Technical Specifications – Technical datasheet

1. Power on the HYDROBALL® probe

Insert the AA batteries, close the cover, and ensure that the LED begins to flash. Make sure the battery polarity is correct (+ and -), as indicated inside the battery compartment.

2. Pair the probe with DENODL® Connect

Enable Bluetooth on your mobile device. Open the DENODL® Connect app and pair the probe by following the on-screen instructions.

3. Walk around the field

With the probe in hand (burying it is not necessary), move through representative points of the field where you intend to install the probe.

4. Check coverage at each point

At each desired location, press the corresponding button on the app screen to record a coverage check. The probe will automatically detect whether NB-IoT signal is available and indicate its strength.

Technical Specifications – Technical datasheet

5. Generate the coverage map

As the different points are recorded, the app will generate an estimated coverage map and indicate the maximum installation depth for the NB-IoT model.

6. Export the coverage map to the DENODL web app

In DENODL App (app.denodl.com), log in and create the coverage node. Then, from the DENODL Connect app, simply scan the QR code displayed on screen to automatically export the coverage data.

This procedure helps assess the technical feasibility of the installation in advance and choose the most suitable communication model according to field conditions.

Technical Specifications – Operating conditions

The operating temperature range is between -15°C and 60°C. With suitable batteries, the probe can operate at temperatures up to 85°C (e.g., in composting applications).
Store in a dry environment at a temperature between -15°C and 50°C.

The probe is designed to function in contact with soil and dust, as well as in humid environments and saturated soils.

Technical Specifications – Power supply and consumption

The probe is powered by 4 AA 1.5V batteries.

Standby power consumption: 5 µA.

Battery life: minimum of 3 years for the NB-IoT version and 4 years for the LoRaWAN version, depending on the measurement interval configuration, data transmission frequency, and the type of batteries used.

Technical Specifications – Measurements

Measurement range and maximum error for volumetric water conten.	0% a 70%, +/- 3%
Measurement range and maximum error for water tension.	0kPa a 150 kPa, +/- 2kPa
Measurement range and maximum error for apparent electrical conductivity.	0dS/m a 6 dS/m, +/- 0,2dS/m
Measurement range and maximum error for soil temperature.	-40°C a +100°C, +/- 1°C

Technical Specifications – Safety information

Do not disassemble or modify the device; unauthorized intervention voids the warranty. All repairs must be carried out by authorized technical personnel.

The USB-C port is reserved for advanced configurations performed by authorized DENODL® personnel. Do not use it without explicit instruction.

Transport the device in its original packaging. Avoid impacts, drops, and severe vibrations.

Handle the device with care. Do not insert objects into its openings or apply pressure to the probe body using tools.

Keep the device away from excessive heat sources and flammable materials. Use only the recommended accessories and power sources. Do not connect cables to avoid overloads and device misconfiguration.

Technical Specifications – Safety information

Use the probe within the temperature range specified in the technical datasheet.

Dispose of the device and used batteries in accordance with local regulations on electronic and battery waste. Take both to an authorized recycling center.

For inquiries or support, contact your distributor or the DENODL® Technical Support Service.

Warranty – Warranty coverage

Thank you for purchasing your HYDROBALL® probe. It has been designed to operate under demanding conditions. However, to ensure proper functionality, it is essential to adhere to the recommended operating and storage conditions. In addition to these conditions, certain guidelines should be followed to prevent damage or device failure. You can consult these and other recommendations in the user guide or at: https://welcome.denodl.com/hydroball/ (QR code available on the back cover).

Warranty Coverage:

HYDROBALL® is covered by a two (2) year warranty from the date of purchase, which covers internal malfunctions due to manufacturing defects or device-related failures

Warranty– Warranty exclusions

The warranty does NOT cover the following cases:
- Damage caused by misuse, impacts, or external physical shocks.
- Breaks or cracks in the ceramic component.
- Damage resulting from incorrect handling of the seals.

Any damage not directly caused by a manufacturing defect is excluded from this warranty.

Warranty – What to do in case of malfunction within the warranty period?

Contact your authorized distributor or the manufacturer's Technical Support Service directly through: https://welcome.denodl.com/hydroball/

You will need to send in your damaged probe for evaluation. If repair is possible, it will be returned to you as soon as possible. If not, a replacement unit will be sent. This replacement may or may not be identical to the original model; however, it will have equivalent or improved features.

Warranty – What to do in case of malfunction outside the warranty period?

If the damage occurs outside the warranty period or is not covered by it, you can still contact your authorized distributor or the manufacturer's Technical Support Service directly through: https://welcome.denodl.com/hydroball/

You will need to send your damaged probe for evaluation. After inspection, you will receive a repair quote. If the repair is not feasible, a replacement unit will be offered with a corresponding quote. Upon acceptance, the repair or replacement will be carried out as soon as possible. The replacement unit may or may not be identical to the original model; however, it will have equivalent or improved features.

Warranty – Contact and Technical Support Service

For any inquiries or support requests, please contact your authorized distributor or the manufacturer’s Technical Support Service directly.

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Before Use – Handling the probe

Before using your HYDROBALL®, carefully read this guide. Remove the probe from the box and take out all packaging materials. Verify that all parts and components are present and in good condition.

If you notice any visible damage, contact the Technical Support Service.

Before Use – Bottom ceramic piece

Located at the bottom of the probe, this component enables the measurement of soil water tension. As it is made of ceramic material, it may break if struck or dropped. Handle with care. Small superficial cracks may appear due to the manufacturing and drying process; these do not affect its integrity or performance. In case of visible damage, contact Technical Support.

Warranty – Sealing gasket

HYDROBALL® is a fully sealed device. The only potential entry point for water is the joint between the threaded cap and the body of the device. To ensure watertightness, the probe includes a flat gasket and an O-ring, the latter positioned in the lower seating around the thread perimeter. After configuring the device or replacing the batteries, make sure both seals are properly positioned and clean.

Recommendations for Opening and Closing

- **Before opening the probe:**

o Clean the exterior to remove any soil or moisture residues.

- **After opening the probe:**

o Wipe the gasket area with a damp cloth.

o If there are soil particles, remove and clean both the gaskets and their seating areas.

Warranty – Sealing gasket

o Ensure that the thread and both gaskets are completely clean.

• **While closing the probe:**

o Verify that the gaskets are properly seated in their original positions.

o Screw the cap on firmly.

Before Use – Machinery passage and soil aeration operations

HYDROBALL® can remain buried during machinery operation as long as it is installed at a depth that prevents contact with wheels, tools, or other components. If the probe is shallow or not deeply buried, take extra precautions. During mechanical soil aeration tasks, it is recommended to temporarily remove the probe or clearly mark its location to prevent damage, avoiding driving over it. Do not allow soil aeration machinery to pass over the probe installation area.

Installation and Use of the Probe

Before installing your HYDROBALL®, you must download the DENODL® App from the App Store or Google Play and follow these initial steps:

Create an account or log in using the credentials provided to you.

Create the Digital Twin of the area to be monitored. If this is your first installation, consult the full user guide for the DENODL® App at: https://welcome.denodl.com/es/ You will need to create the corresponding elements that will allow you to locate the probe.

Once these steps are completed, proceed with the physical installation of the probe:

1. Selecting the Control Point

Choose the location based on the monitoring objectives. The probe must be installed at the depth where the crop's root volume is most concentrated. If in doubt, refer to the specific installation guide at: https://welcome.denodl.com/es/

Installation and Use of the Probe

2. Powering On

Unscrew the top cap.

Open the battery compartment and insert four 1.5V AA batteries, properly oriented.

Close the compartment. Once contact is made, the LED will begin to flash. If no light is observed, check the battery placement.

Warning: On first startup of the probe (NB-IoT model), the initial connection to the operator’s network may take several minutes. It is recommended to power on the probe and leave it idle for a few minutes before installation.

The network registration process may take up to 10 minutes before the first data transmission. During the operator search process, the probe will emit a continuous double LED flash. A successful connection is confirmed with a long flash. [In a gray box]

Installation and Use of the Probe

3. Pairing

To pair the device, the probe must be in idle mode (no LED activity).

Enable Bluetooth and location services on your mobile device.

Open the DENODL® App and, from the screen of the corresponding sector, tap “Add,” then “HYDROBALL.”

Follow the app instructions to pair and configure the probe via Bluetooth. Note that Bluetooth mode on the probe can only be activated when the probe is idle (no LED activity).

Installation and Use of the Probe

4. Configuration

Set the measurement interval.

Define the energy-saving mode. This prevents unnecessary power consumption when environmental conditions remain unchanged over several measurements.

Activate field test mode, which temporarily increases the transmission frequency to verify the probe’s operation immediately after installation and during its initial hours of operation.

Assign a custom name to your device.

Do not modify the device identifier (Alt ID). This links your probe to the application. If altered, the HYDROBALL will be unable to transmit data to the platform.

Using your mobile device’s geolocation, select the exact location of the control point and tap “Save” to complete the pairing.

Installation and Use of the Probe

5. Connection Test

Make a hole at the chosen location to the appropriate depth. A 10 cm diameter cylindrical auger is recommended. These tools are commonly supplied for tasks like creating holes on golf courses. Keep the extracted soil in a bucket for later refilling.

Insert the probe into the provided test bag, without the cap, so you can view the LED while preventing soil from contacting the interface. Insert the probe into the hole at the desired depth.

While the probe is idle, press the button once. You will see a sequence of flashes, indicating the measurement process.

Transmission will be confirmed with a long flash.

Check in the DENODL App that the data has been recorded, confirming the measurement time matches the current time.

Once the connection test is complete, you may proceed.

Installation and Use of the Probe

6. Referencing

Take references using nearby objects, such as with a measuring tape, to accurately position the probe.

Use the notes and photo log tools in the DENODL App to record these references. It is recommended to take installation images using the Gallery tool within the app.

Once properly referenced to ensure it can be easily found again, proceed with the installation.

7. Soil Installation

Ensure the flat and O-ring seals are properly seated and firmly close the top cap by hand. It is very important that both seals are clean (free from soil or other contaminants) and properly fitted in their slots.

These seals prevent moisture from entering the device.

Installation and Use of the Probe

Insert the probe at an approximate 10° angle from vertical, with the ceramic part facing downward. This angle supports the hydraulic dynamics of the ceramic and prevents air or water accumulation.

With field test mode activated (see configuration section), wait for the next reading and verify again that data is being received in the app. Remember that in test mode, during the first hour after activation, the probe transmits every 2 minutes.

Refill the hole with the previously extracted soil, preserving its structure and original compaction. It is essential that no voids remain around the device, as the absence of soil may affect readings.

To ensure this, use water to fill all gaps. Recommended process: Apply soil → Add water → Press the soil gently with your hands (avoid excessive pressure) to ensure it is properly packed around the probe. Repeat this cycle until the device is completely buried.

Level the surface to prevent runoff or water pooling.

Installation and Use of the Probe

Mark the installation point approximately 20 cm from the probe location, if possible, using a Hydrotee (red marker) or a flagged stake.

You may take additional fixed visual references to facilitate future location. Record this information in the notes and photo log section of the mobile app.

As mentioned, this can be done before or after installation.

Check the data in the DENODL App and confirm that the probe is transmitting correctly.

You should see data indicating soil saturation levels, as significant water should have been added during the installation.

Allow at least 48 hours of device operation for the altered soil's moisture conditions to equilibrate with the surrounding soil.

Soil texture analysis information will appear in the app one week after the installation date.

Installation and Use of the Probe

To access the full user guides for the DENODL® App and HYDROBALL® probe installation, scan the QR code included in the box and in this guide below. For any questions or technical support, contact your distributor or the manufacturer’s Technical Support Service, whose contact details are found in this guide and the QR code below.

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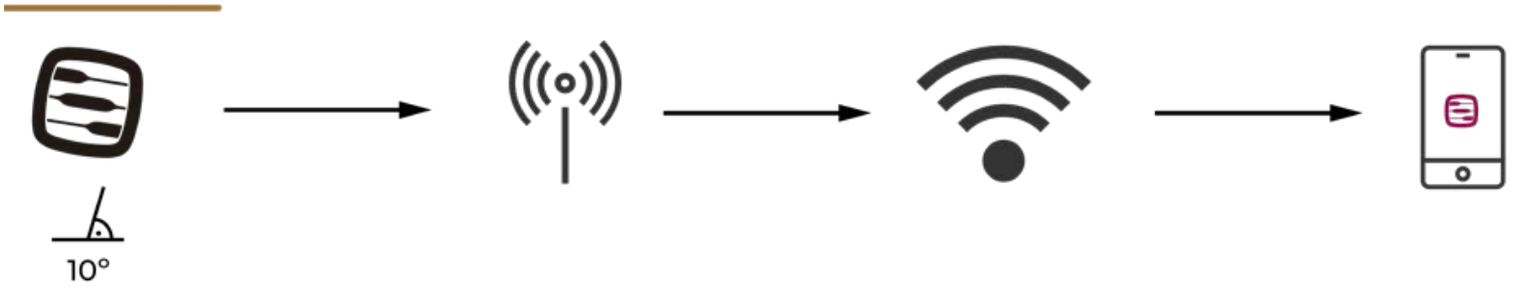
HYDROBALL NB IoT

HYDROBALL LoRaWAN



Manufacturer Information:

Company name.

Fernando Sarría Agrotechnologies S.L.

Trade name.

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