# HyQuant L / L+V / Q - Water Level Radar Sensor

## User Manual – Version 1.0

**KISTERS AG**

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*Disclaimer*

*The information provided in this manual was deemed accurate as of the publication date. However, updates to this information may have occurred*
*This manual does not include all of the details of design, production, or variation of the equipment nor does it cover every possible situation which may arise during installation, operation or maintenance. KISTERS shall not be liable for any incidental, indirect, special or consequential damages whatsoever arising out of or related to this documentation and the information contained in it, even if KISTERS has been advised of the possibility of such damages.*
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# Glossary & Abbreviations

| Term | Explanation |
|---|---|
| CE | Short for French "***C***onformité ***E***uropéenne"; CE Marking on a product indicates that the manufacturer verifies that their products meet the European Union's (EU) health, safety, and environmental protection standards. It is a legal obligation that confirms compliance with the Product Directives. |
| dB | Short for decibel; The decibel is a relative unit of measurement that equals one-tenth of a bel (B). It measures the intensity of an electrical signal by comparing it with a specific level on a logarithmic scale. |
| ESD | Short for Electrostatic Discharge; the release of stored static electricity. Most commonly, the potentially damaging discharge of high voltages that occurs when an electronic device is touched by a charged body. |
| Doppler | Short for Doppler Radar; a radar that is specifically designed to use the Doppler effect to generate information on the velocity of objects that are located at a distance. This is achieved by reflecting a microwave signal off an intended target and analyzing how the motion of the object has affected the frequency of the returned signal. |
| FCC | Short for ***F***ederal ***C***ommunication ***C***ommission; The FCC logo or mark is a symbol used on electronic products produced or marketed in the United States. It shows that the device's electromagnetic radiation is under the limits defined by the Federal Communications Commission, and the manufacturer has complied with the Supplier's Declaration of Conformity authorization procedures. |
| FMCW | Short for Frequency-Modulated Continuous Wave; an FMCW radar has the ability to alter its operating frequency while measuring. This means that the transmission signal is modulated in either frequency or phase. Changes in frequency or phase are technically necessary to perform radar measurements through runtime measurements. |
| GHz | Short for gigahertz, a frequency unit equal to a billion hertz or cycles per second |
| GND | Short for ground; in electronics, the ground serves as the reference point for all signals or a common path in an electrical circuit from which all of the voltages can be measured. |
| Gyroscope | A tool employed to measure or uphold orientation. |
| HDPE | Short for high-density polyethylene, a thermoplastic polymer |
| IP | Short for Ingress Protection; IP ratings indicate the degree of protection provided by an enclosure against solids and liquids. |
| L | Short for Level or Water Level |
| Modbus RTU | Modbus is a communication protocol for transmitting data, which follows a request-response model. The protocol uses a Client-Server architecture where the Client sends a request to the Server device, which responds accordingly. The language of the protocol is clear, concise and designed to enable interoperability among different devices. Modbus RTU is the prevailing option for serial connections. With Modbus RTU, data is transmitted in binary format. |
| Output rate | The output rate pertains to how frequently the output data is refreshed. It remains constant and is independent of filter settings, since the data is updated discretely during each output cycle. The unit for the sample rate is Hertz (Hz). It is equivalent to the reciprocal second, as 1 Hz = 1 [$s^{-1}$]. |
| Q | International short notation of the hydrological discharge determined for a stream cross-section. |
| Radar | Short for ***Ra***dio ***D***etection ***a***nd ***R***anging; a system or device that employs short radio waves to determine the position or velocity of objects by measuring the direction, frequency and timing of reflected signals. |

| | |
|---|---|
| Radome | a blend word made from ***ra***dar and ***dome*** – the radome is the shelter that protects the radar antennas |
| RS-485 | RS-485 is an industrial standard that establishes the electrical interface and physical layer for point-to-point communication between electrical devices. It effectively enables long cabling distances in environments with strong electrical interference and permits multiple devices to communicate on the same bus. Electrical signalling is balanced. |
| Sample rate | HyQuant utilizes radar technology to convert analog water level changes into a digital data stream. By sampling water height amplitude at specific time intervals, HyQuant produces discrete data. The sampling rate is the frequency of sample collection per second, measured in samples per second (sps). The unit for the sample rate is Hertz (Hz). It is equivalent to the reciprocal second, as 1 Hz = 1 [$s^{-1}$]. |
| SDI-12 | Serial Digital Interface at 1200 baud, an asynchronous serial communications protocol for smart sensors, SDI-12 sensors reply to commands send by the data logger, the standard also specifies supply voltage and current and including modes for low-power operation |
| SLA | Short for Sealed Lead-Acid; A sealed lead-acid battery, also known as a gel cell, is a type of lead-acid battery where the electrolyte, which is sulfuric acid, is thickened so that it does not spill out. |
| SNR | Short for Signal-to-Noise Ratio; Signal-to-Noise Ratio (SNR) is a measure of the relative strength of the desired signal to the noise signal at a specific point in time. A higher number indicates better performance. It is typically expressed in decibels (dB). |
| USB | Universal Serial Bus, an asynchronous serial communication protocol for peripheral devices |
| V | Short for Velocity or Surface Water Velocity |
| VDC | Short for ***V***olt ***D***irect ***C***urrent |
| Wi-Fi | certification mark of the interoperability of wireless computer networking devices using wireless network protocols based on the IEEE 802.11 family |

# 1 Scope of Delivery

- 1x HyQuant Sensor Unit
- 1x two-part mounting bracket (tilt & swivel)
- 1x 10 m cable w/ 8-pin female angled connector and open-ended wires
- 1x Torx key
- 1x Magnet
- 1x Test Certificate
- 1x Quick Installation Guide

# 2 Accessories

- HyQuant user manual in English
- Configuration software "KISTERS HyComm"
- "KISTERS HyComm User Manual"; in English language
- Tube Mounting Bracket
- 20 m connection cable with 8-pin angled plug connector (socket) and open wire ends
- 30 m connection cable with 8-pin angled plug connector (socket) and open wire ends
- 40 m connection cable with 8-pin angled plug connector (socket) and open wire ends
- SDI-12/USB interface adapter
- RS-485/USB interface adapter
- KISTERS iRIS data logger or KISTERS IoTa Sensor Node

# 3 Safety Instructions

The warnings used in this user manual classify the type and severity of a given hazard. The resulting hazard levels are marked in the user manual with the sig-nal words WARNING | CAUTION in combination with a colour coding in orange | yellow:

**⚠ WARNING**

Warning of a hazardous situation with a medium level of risk

The warning indicates the type and source of the hazard. If you do not follow the instructions given here, the hazardous situation could result in death or serious injury.

- Specific instructions for avoiding the hazardous situation!

**⚠ CAUTION**

- Warning of a hazardous situation with a low level of risk

The warning indicates the type and source of the hazard. If you do not follow the handling instructions listed here, the hazardous situation can lead to minor to moderate injuries.

- Specific instructions for avoiding the hazardous situation!

**Note**

Information to prevent malfunctions or damage to the HyQuant.

Information to ensure the safety of the appliance.

## 3.1 General Safety Instructions

- Read the user manual including all operating instructions prior to installing, connecting and powering up the HyQuest Solutions HyQuant. The manual provides information on how to operate the product. The manual is intended to be used by qualified personnel, i.e. personnel that have been adequately trained, are sufficiently familiar with installation, mounting, wiring, powering up and operation of the product.
- Keep the user manual on hand for future reference!
- Please contact the manufacturer or its authorised distributor for support if you have any problems understanding the information in this manual (or any part of it).
- KISTERS' HyQuant is intended to be used in hydrometeorological or environmental monitoring applications.
- Before starting to work, you have to check the functioning and integrity of the system.
- Check for visible defects on the HyQuant, this may or may not include any or all of the following mounting facilities, connectors and connections, mechanical parts, internal or external communication devices, power supplies or power supply lines, etc.
- If defects are found that jeopardize the operational safety, work must be stopped. This is true for defects found before starting to work as well as for defects found while working.
- The present user manual specifies environmental/climatic operating conditions as well as mechanical and electrical conditions. Installation, wiring, powering up and operating the KISTERS HyQuant must strictly comply with these specifications.
- Perform maintenance only when tools or machinery are not in operation.
- If guards are removed to perform maintenance, replace them immediately after servicing.
- Never make any electrical or mechanical diagnostics, inspections or repairs under any circumstances. Return the sensor to the manufacturer's named repair centre. You can find information on how to return items for repair in the relevant section of the KISTERS web site.

- Disposal instructions: After taking the KISTERS HyQuant out of service, it must be disposed of in compliance with local waste and environmental regulations. The KISTERS HyQuant is never to be disposed in household waste!

- Inputs and outputs of the device are protected against electric discharges and surges (so-called ESD). Please do not touch any part of the electronic components! If you need to touch any part, please discharge yourself, i.e. by touching grounded metal parts.

## 3.2 Specific Safety Instructions

| **Bestimmungsgemäße Verwendung** |
| --- |
| HyQuant is a hydrographic sensor that uses radar technology for contactless measurement of either water stage or water surface velocity or both. Do not use the sensor for other applications. At all times respect the specifications for use, deployment, maintenance, repair and disposal described in the present manual. HyQuant must not be used in areas where there is a risk of explosion! |

**WARNING**

Risk of explosion due to sparking and electrostatic charging – not intrinsically safe!

Operation of the HyQuant in such an atmosphere may result in ignition of the atmosphere, which could cause serious damage to property and injury to personnel.

- HyQuant not be operated in an explosive atmosphere. Furthermore, the HyQuant does not have ATEX approval (explosion protection)!

- Whether you are installing or deploying the sensor, please note and follow the detailed safety information provided for each work step.
- Working on electrical systems requires special knowledge and training. For this reason, the electrical installation of the HyQuant may only be carried out by a suitably trained specialist.
- Electrical, technical and climatic specifications must be respected at all times.
- Modifications or retrofitting to the HyQuant will void the warranty and the RF approval required for safe operation of the device.
- Comply with electrical safety standards.
- Comply with Health, Safety & Environment regulations and directives.

**WARNING**

Risk of drowning!

Be particularly careful when working over or near to water.

- Wear a Life Jacket/Buoyancy Aid: Ensure that workers at risk of falling into the water are provided with and wear a life jacket or buoyancy aid. The life jacket should be thoroughly checked by the user prior to use.!
- Never Work Alone: Always be accompanied when working near or over water.!

# 4 Introduction

HyQuant is a hydrographic sensor that uses radar technology for contactless measurement of water stage (model HyQuant L) and water surface velocity (model HyQuant V) or both (model HyQuant L+V, which can be expanded to HyQuant Q for discharge measurement). Radar sensors are characterized by long-term stability and low maintenance. HyQuant has been designed to ensure stable system behaviour and stable signals in all weather conditions and for all types of natural or polluted water.

### 4.1.1 KISTERS HyQuant Sensors

All HyQuant models have been awarded the CE mark, and have received FCC and UL approval. Consequently, they are suitable for deployment in the respective target markets.

**Figure 1 - HyQuant Sensor with standard mounting bracket and sensor cable**

HyQant models are equipped with:

- A 61 GHz radar module
- HyQuant L: One antenna pair for level measurement
- HyQuant V: One antenna pair for surface velocity measurement
- HyQuant L+V and Q: Two antenna pairs, one for level and one for velocity measurement
- Wi-Fi interface for local configuration
- Digital data output via either SDI-12 or Modbus (RS-485)
- Aluminium die-cast housing with HDPE lid/radome
- M12 8-Pin male sensor/actuator connector
- A gyroscope to determine the angular position during installation

#### 4.1.1.1 HyQuant L – Level or Stage Sensor

- The distance between the sensor's antenna edge and the medium's surface is the measurand for this system, with the antenna edge serving as the measurement reference plane. With proper configuration, the sensor will output the absolute water level calculated with respect to a user-defined reference datum.
- HyQuant L is available for 2 measuring ranges:
  - HyQuant L20: up to 20 m, and
  - HyQuant L50: up to 50 m.

- Radar levels are used for contactless level measurement in surface waters. Based on the travel time of electromagnetic waves (microwaves) from the sensor to the water surface and back a distance measurement is carried out. As the Radar Sensor measures distance between the sensor and water level, different modes are available to reference the water level e.g. to a staff gauge.

#### 4.1.1.2 HyQuant V – Surface Velocity Sensor

- The measurand is the flow velocity of the water at the surface of the stream/river/brook.
- HyQuant V is available for installation height of up to 20 m with respect to the lowest expected water level.
- For surface velocity measurement, the sensor relies on the principle of the Doppler frequency shift. The sensor emits a microwave radar signal at a given frequency. This signal is reflected when it impinges on the water surface. The reflected electromagnetic wave oscillates with a shifted frequency. The observed frequency shift is proportional to the surface flow velocity. The sensors samples at a high speed and assesses all collected reflected signals to determine the surface flow velocity.

#### 4.1.1.3 HyQuant L+V – Combined Water Level/Stage and Surface velocity Sensor

- HyQuant L+V is available for an installation height of up to 20 m at the lowest expected water level. This model combines the features of the two models L and V in a single device of the same size.

#### 4.1.1.4 HyQuant Q – Radar sensor for discharge monitoring

- HyQuant Q is available for an installation height of up to 20 m at the lowest expected water level. HyQuant Q is an L+V with additional, fully integrated discharge calculation capabilities.

### 4.1.2 Why RADAR technology?

Stable, dependable, and exceedingly precise non-contact quantification of water levels in diverse ecological and natural contexts. The scanning frequency enables appropriate recognition of dynamic constituents, including ripples on the water surface.

Rader water level provide a major advantage over other measurement systems as radar technology is largely independent of the properties of the measurement medium, such as

- temperature,
- viscosity,
- density, or
- conductivity.

Moreover, radar sensors are not affected by daylight conditions, mist and light rain.

Heavy rainfall is known to affect radar measurement due to the difficulty in distinguishing reflections from thick drops from those at the water surface. Furthermore, the kinetic energy causes concentric waves to form at the water surface, further complicating the measurement process. To alleviate these effects, HyQuant V, L+ V and Q are equipped with tailor-made filters.

HyQuant is a microwave-based sensor. Radar beams follow wave theory. The beam angle specifies the width the beam opens up from the antenna. The angular aperture widens with distance. Ensure that the HyQuant radar sensors have an unobstructed vertical view of the water surface: No obstacles should obstruct the beam path from the antenna to the water surface. For further information on beam spread measurement, consult section 7.1

The sensor comes with a mounting bracket and has a small profile. Installing HyQuant sensors is hassle-free, and minimal maintenance is necessary.

### 4.1.3 HyQuant Components

The basic components of the actual HyQuant device are illustrated in this chapter. The pictures show the exact position of each of the device components.
HyQuant is a small-footprint self-contained unit that shares measurement data with external devices (data loggers, RTU, etc.) via a cable connection and either SDI-12 or Modbus protocol.

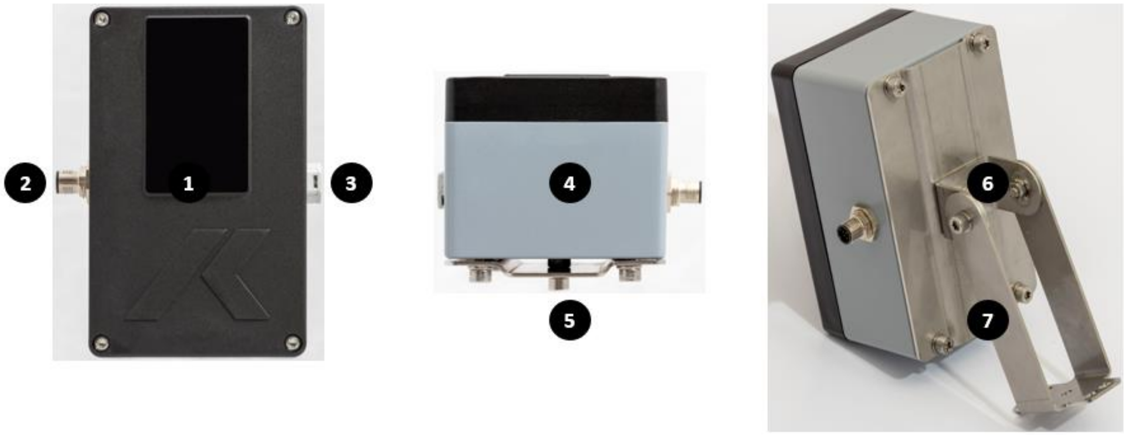



**Figure 2 – HyQuant front and side view**

**Table 1 – List of HyQuant Components**

| | |
|---|---|
| 1 | Lid with integrated radome |
| 2 | M12 8-Pin Connector for signal cable (incl. in the delivery) |
| 3 | Pressure compensation gland |
| 4 | Aluminium die cast housing |
| 5 | Rear mounting sheet |
| 6 | U-bracket |
| 7 | Mounting bracket |

# 5 Installation

HyQuant is always delivered with a mounting bracket and a sensor/actuator cable with one side terminated with an M12 8-pin female connector (HyQuant side) and one side with open-ended wires. It should be noted that optional items such as longer cables and a pole mount bracket are available and can be ordered separately.

## 5.1 Site Selection Criteria for L and V

To ensure accurate measurements, careful consideration must be given to selecting suitable installation locations for water level (L) and/or flow velocity (V) sensors. HyQuant sensors are designed for use in hydrological applications. HyQuant sensors can be deployed on waterways, rivers, streams, brooks, lakes, reservoirs, and similar bodies of water.

**WARNING**

Risk of explosion due to sparking and electrostatic charging – not intrinsically safe!
Operation of the HyQuant in such an atmosphere may result in ignition of the atmosphere, which could cause serious damage to property and injury to personnel.

- HyQuant not be operated in an explosive atmosphere. Furthermore, the HyQuant does not have ATEX approval (explosion protection)!

- **Alignment**: Ensure precise alignment of the sensor in the Y and Z directions (< ±2° deviation) using the integrated inclination sensor.
- **Suitable Locations**: Consider potential installation locations such as bridge structures, pontoons, or auxiliary constructions directly above the section of the waterway to be measured.
- **Exception for Steel Bridges**: It is advisable to avoid mounting sensors on steel bridges at the centre between two supporting poles/structures. Solar radiation can cause steel bridges to become warmer, expand and sag, which will have an impact on the measured distance and subsequently the hydrological water level. Steel may also be more reflective than other construction materials, so it is important to exercise caution.
- **Stability and Vibration**: Choose stable installation points free of vibration to avoid disturbances caused by traffic or wind influence.
- **Avoidance of Bridge Piers**: Prevent flow velocity influence, backwater zones, and turbulence by avoiding installation directly on or near bridge piers.
- **Height Placement**: Mount sensors above typical high-water marks to prevent antenna immersion, ensuring accurate readings. Maintain a minimum distance of 0.15 meters (5.9 inches) between the sensor and water surface.
- **Water Surface Conditions**:
  - For L measurements: Optimal water surface characteristics include a smooth surface within the circular measurement area.
  - For V measurements: Ensure a minimum water surface roughness of 2 mm around the sensor radar footprint.
  - For all parameters: Avoid areas with turbulent water surfaces, foam accumulation, obstructions causing changes in water level or flow velocity, ice or snow-covered surfaces, and protruding obstructions.
- **Wind Influence on V Measurements**: Minimize wind effects on the water surface (such as inverse flows or side-flows resulting from cross-winds) to maintain measurement accuracy.
- **Clearance**: Ensure the sensor radar footprint is clear of obstructions, with no inflows, outlets, weirs, or other obstacles in front of the measuring point. Optimum minimum clearance distance: 10 times the waterway width.

- **Bottom Stability**: Choose stable waterway bottoms and cross-sections free of large stones and vegetation to prevent measurement inaccuracies.

By carefully adhering to these criteria, suitable installation locations can be identified to ensure accurate and reliable water level and flow velocity measurements.

## 5.2 Orientation of the HyQuant

The enclosure is made of a grey aluminium die-cast housing with a black HDPE lid. The radome is located on the smooth elevated surface of the lid. HDPE has a dielectric constant that makes it virtually transparent for electromagnetic microwaves. The lid with the integrated radome protects the radar antennas from weather and mechanical shock. The KISTERS "K" is found right beneath the radome.

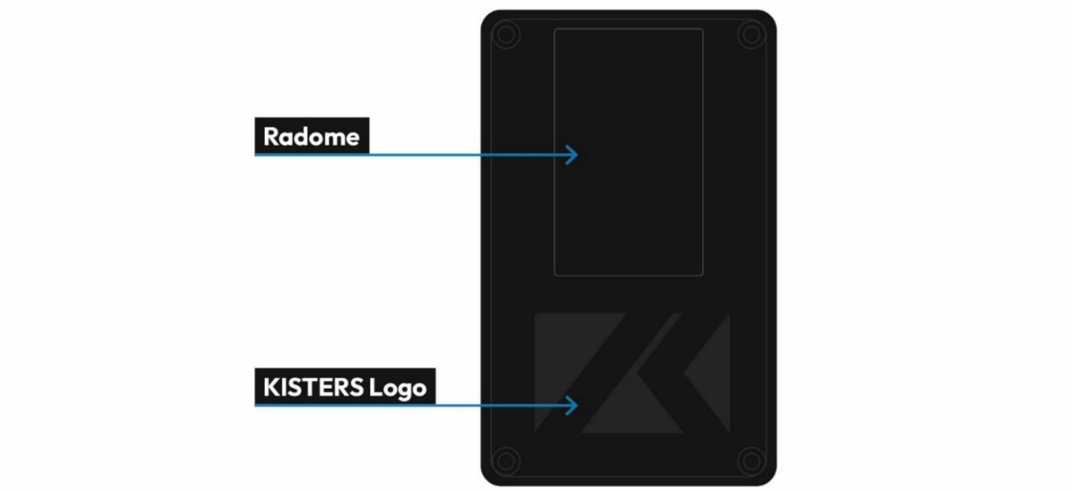



**Figure 3 – Position of both the radome and the KISTERS K on the lid**

HyQuant assumes it is positioned parallel to the water surface. During installation, the gyro data helps the installer to find the best position relative to the water surface. HyComm, the KISTERS Sensor Configuration Software, shows the mounting angle on a mobile device linked to the sensor through Wi-Fi.
HyQuant sensors must be installed parallel to the water surface (acceptable tolerance: +/- 2°) to ensure

- proper orientation of the level beam, which points straight downwards at 0°;
- proper orientation of the velocity beam, which points sideways at a 45° inclination.

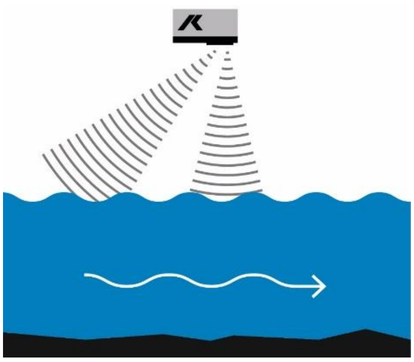


**Figure 4 – Orientation of the HyQuant sensor relative to flow direction (arrow)**

## 5.3 Standard Installation Bracket

**WARNING**

Risk of Pinch Points!!

Fingers are exposed to pinch points when installing a HyQuant device with bolts.

- Take precautions and wear protective gloves!

The installation bracket is included in the standard delivery box's foam insert base. It comprises two pieces:

- a small U-bracket to install against the base plate of the HyQuant sensor, and
- a U-shaped long arm with mounting lugs.

**Figure 5 – Rear side view of HyQant with mounting bracket installed**

The mounting lugs and corresponding holes are designed to accommodate M6 screws.
The standard mounting bracket is compatible with any supports that provide a flat surface, including

- rectangular metal tubes with a minimum width of 30 mm.
- concrete surfaces: walls, bridge support structure, …

## 5.4 Optional Bracket for Round Tubes

The sensor's optional mounting bracket for cylindrical poles is obtainable as a peripheral and must be acquired separately.
It will facilitate the sensor's installation and alignment on a pole or tube, running parallel to the water surface, with an external diameter of up to 60.3 mm (2").
The accessory provides a plane mounting sheet for the standard mounting bracket. A clamp bracket is used to mount the sensor on a round poles with diameters ranging from 1.5” to 2” (60 cm external diameter).

## 5.5 Power Supply

**CAUTION**

- Device Operating on Low DC Power

No life or health risk except for vulnerable or highly sensitive individuals who should refrain from working with electrical devices.

- **Precaution:** Electrical devices should always be installed by qualified personnel!!

The HyQuant operates within a voltage range of 9 to 30 VDC, with a nominal operating voltage of 12 VDC, which is typical for SLA batteries – a rechargeable battery suitable for solar-powered applications. It can also be connected to a mains DC power supply.
Once an appropriate power supply unit is connected, the HyQuant is ready for use.

## 5.6 Cable and Connector Pinout

HyQuant sensors come with a suitable 10 m sensor/actuator cable that has a female M12 8-pin connector on one end and open leads on the other end. The HyQuant enclosure is equipped with a male M12 8-pin connector. The cable connector should be inserted into the housing socket. Note that the coding only allows the connector to fit in one direction.

**⚠ WARNING**

Incorrect connection of the supply power may result in damage to the HyQuant!
The HyQuant employs a reverse-protected interface and power circuitry to safeguard against such occurrences. However, it is crucial to note that an improper or false connection between the power lines and the interface lines could still lead to damage to the instrument.

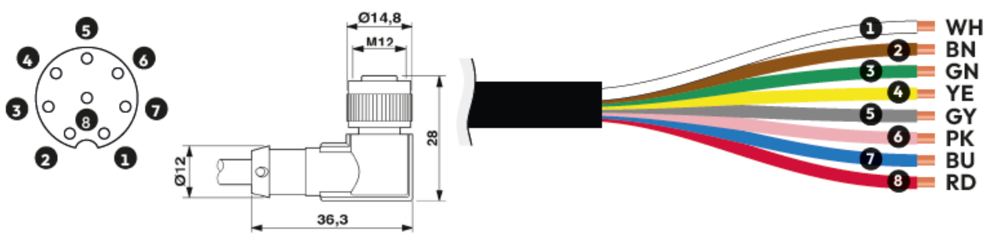
- Verify the pinout configuration and ensure that no power is applied to the connection cables other than those explicitly designated as "Power VCC +" and "Power GND -".

**Table 2 – Connector Pinout**

**Cable and connector pinout**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| Power VCC + | Power GND - | SDI-12 GND | SDI-12 Data | RS485A | RS485B | NC | NC |

Pin assignment (female view) Connection diagram




⚠ Caution: Incorrect or faulty connection can damage the device. All interface and power cables are protected against reverse polarity, but incorrect connection of power cables to interface cables can damage the device.

# 6 Configuration

HyQuant is equipped with an integrated Wi-Fi hotspot and can be locally configured/operated wirelessly from a PC/Notebook with activated Wi-Fi via KISTERS' HyComm software. The Wi-Fi hotspot is protected against unwanted access from the outside. This makes it impossible to read measured values or status values or to change device settings via this interface without authentication. The Wi-Fi hotspot must be activated by the user as described below.

## 6.1 Configuration Software

HyComm is KISTERS software utilized for local communication between a Windows computer and the HyQuant radar sensor. Communication occurs through a Wi-Fi connection, where the HyQuant operates as a Wi-Fi Hot-Spot. HyComm allows for parameter configuration of the sensor. Users can find more information about HyComm in a separate manual that can be downloaded here: HyComm User Manual.
To safeguard the parameterization, the user can secure the unit with a self-chosen keyword.

### 6.1.1 System requirements

Make sure that your PC/Notebook meets the following system requirements:

- Operating system: Windows 10 or newer
- Wireless connection: Wi-Fi / WLAN Adapter: activated
- Wired connection: SDI-12 to USB interface OR RS-485 to USB interface (for Modbus interface). Note: Interfaces can be ordered from KISTERS as optional items.

## 6.2 Enabling of the local Wi-Fi hot-spot for configuration

There are different ways to enable the local Wi-Fi hotspot: Magnet + reed switch, Modbus, SDI-12 or power-cycle.
After the hotspot has been enabled, regardless of which method was used, a beep will sound indicating the hotspot is starting up. After a beep it takes up to 60 seconds until the Wi-Fi hot-spot is available. The SSID of the hot-spot is the same as the serial-number of the sensor and the default password is 'Kisters123!'. It is strongly recommended to change the password using HyComm in order to prevent others from changing the sensor configuration.

### 6.2.1 Enable with Reed Switch / Magnet

The HyQuant contains a reed switch, which is actuated by moving a magnet in the immediate vicinity of the reed switch. Refer to Figure 6 for position of the reed switch integrated into the HyQuant housing. It is necessary to place the magnet directly onto the housing.

**⚠ WARNING**

Risk of falling when activating the WLAN hotspot
If the HyQuant is installed at a great height above the water and/or the sensor is difficult to access, there is a risk of falling when activating the Wi-Fi hotspot.

- Use personal protective equipment (PPE) to prevent falls!
- If possible, use a swivelling bracket for installation! This allows you to swivel the sensor into a safe working area for configuration.

**Figure 6 – HyQuant lid with indication of the reed-switch position**

### 6.2.2 Enable through Modbus

Write '1' to holding register (FC06) 401
See Modbus Register Mapping 7.3.2 .

### 6.2.3 Enable through SDI-12

Use extended command aXWI-FI!
SDI-12 Extended Command set: see 7.2.2

### 6.2.4 Enable with Power Cycle

HyQuant automatically turns on its Wi-Fi hotspot when it is switched on. This allows the user to simply disconnect and reconnect the power supply to activate the Wi-Fi hotspot.

**Note**

If the sensor is connected to SDI-12 and the data logger is configured to switch off the HyQuant between measurements this feature should be disabled using HyComm. Otherwise, the Wi-Fi hotspot will be activated every time the logger reads a value which can increase the power consumption. HyComm Navigation path: "Connection" | "Wi-Fi"; deactivate "Start Wi-Fi when sensor is powered on".

### 6.2.5 Automatic disabling

When HyQuant is running the Wi-Fi hotspot, power consumption is significantly higher than normal.
To keep power consumption low, the hotspot is automatically disabled after 5 minutes of inactivity. The hotspot is considered inactive as long as HyComm is not connected.
As long as HyComm is connected, the Wi-Fi hotspot will not be turned off.

## 6.3 Filters

### 6.3.1 Removing unwanted reflections / outliers

Objects in close proximity to the sensor, particularly sharp metal or concrete edges, can cause unwanted reflections. Normally, the radar will detect the water surface as the most prominent reflection. However, occasionally a false reflection can be stronger.
By comparing new readings with the average of recent values, the radar sensor can identify false signals and reject them using a configurable threshold. This setting is automatically adjusted when one of the user adjustable filters (see 6.3.1) is selected.

### 6.3.2 User adjustable filters

In the KISTERS HyComm software, the user can choose from a total of three different moving average filters. Each filter is pre-configured to reflect digital filter settings for a typical water flow situation as encountered in real open channel flows.

- The filter settings are designed to remove false signals (see 5.3.1). The more turbulent the water surface, the longer the filter. Therefore, (recent) historical data will have a greater influence on the evaluation of current readings. The effect is that correct values are correctly identified, the overall trend is not altered by the filter and no significant and real changes are missed.
- The purpose of the moving average filter, with a user-adjustable length of 1-200 seconds, is to remove the "noise" caused by a turbulent surface in order to obtain a smooth measurement curve. HyComm allows the user to change the filter length and see the effect on the distance value in real time.
- A major advantage of the HyQuant filter settings in HyComm is that the user is protected from entering complicated digital filter parameters.

**Table 3 - HyQuant L: Filters**

| Site | Comment | Example | Filter length preset |
|---|---|---|---|
| Calm | A calm body of water refers to a contained water body of fresh water with no or very low flow velocity but subject to some surface turbulence depending on wind conditions. | Lake, reservoir, pond, rain retention basin, … | 10 sec |
| Stream | Refers to an uninterrupted expanse of water that flows along a channel (or open canal) confined by its bed and banks. | River, waterway, brook, creek, tributary, open canal, open channel, etc. | 30 sec |
| Turbulent | A turbulent, continuously or intermittently flowing stream, with run-off varying significantly over short periods due to thunderstorms or snow melting. | Torrent, natural mountain streams/brooks/creeks, whitewater, … | 60 sec |

## 6.4 Reference level

The primary measurand of a radar level sensor is the distance between the antenna and the water surface. This distance needs to be converted into a level reading for hydrological purposes. To obtain a level reading, the sensor must be referenced to a site-specific reference level.
Referencing can be:

- Relative to a staff gauge
- Relative to a geodetic datum

Use the KISTERS HyComm software to enter the site-specific level reference.
HyComm guides the user through the process with convenient input masks.

## 6.5 Operational range

The operational range definition allows the user to restrict or limit the measurement range.

- Limit the maximum depth: This feature is particularly interesting to avoid wrong readings for instance in a drought when a stream runs dry. In such a situation, the radar beams will be reflected by any object (e.g. rocks, man-made structures, …) that happens to be inside the sensing area.

- Limit the min depth: helps to ignore obstacles in the radar beam near the installation position.

In both cases the Operational Range settings helps to avoid false readings.
All readings outside the Operational Range are ignored. HyQuant L returns the user-defined upper or lower limit.

## 6.6 Configuration for Q Calculation

Only HyQuant Q models can be configured to calculate the discharge Q from the measured surface velocity V, the measured water level L and a corrective constant *k* that relates the surface velocity to the average velocity for a given wet cross-section of the stream. The KISTERS HyComm software enables the user to make the settings. Choose between three available Q calculation methods:

- **Cross-section profile**: To calculate the discharge (Q) of a stream accurately, a cross-section profile of the stream is essential. This profile helps transform the measured surface velocity into the average velocity across the entire stream width.
- **Constant k-factor**: k-factors are chosen to reflect characteristics of the chosen monitoring site. In hydrology, k-factors are essential for understanding the impact of stream conditions on flow. Various studies suggest k-factors based on empirical data. For example, one approach for natural streams is to use a factor of 0.87, while for engineered channels, it might be around 0.95. It's essential to refer to specific hydrological studies or guidelines relevant to the geographical area and stream type for precise values.
- **Dynamic *k*-factor**: relies on applying imported $k$-factors for improved accuracy. The $k$-factors have been calculated using a power law. The method is more accurate but requires more effort in providing solid input data for the power law model.
- **V Index**: relies on k-factors calculated using statistical methods modelling the relationship between measured surface velocities and the mean velocity of a cross-section. The method is moderate complex and achieves good accuracy.

Format of a suitable k table:

- The best way to create a table is in Microsoft EXCEL®. Note that for all tables, only the first two columns are used.
- The table and data values are typically exported from a cross section or rating curve editor or the corresponding module of your hydrological data management software. KISTERS software solutions WISKI, HYDSTRA and SKED all provide the required functionality.
- Save the data in a CSV UTF-8 file (Comma Separated Values) file:

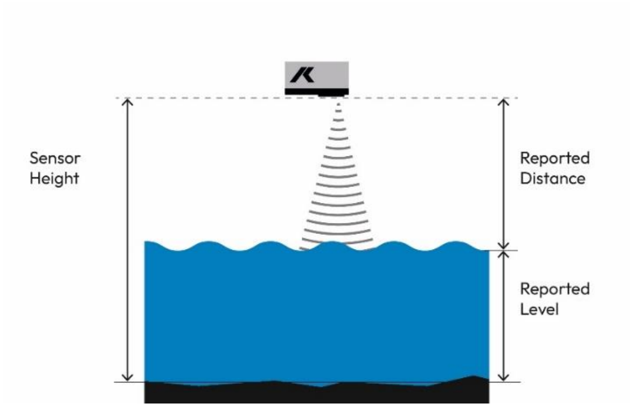
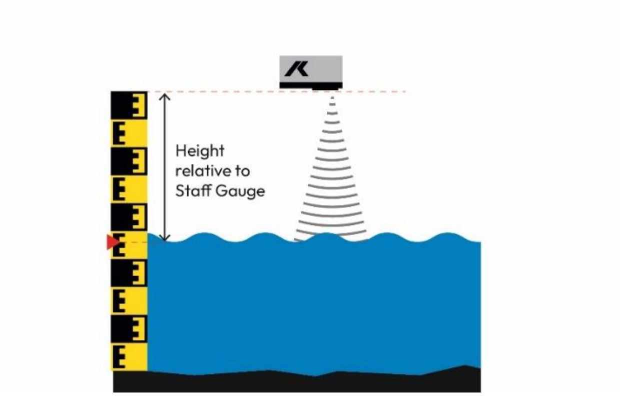
For details refer to the following PDF document that can be downloaded from the KISTERS web site: “White Paper - Discharge Calculation with HyQuant Q”.

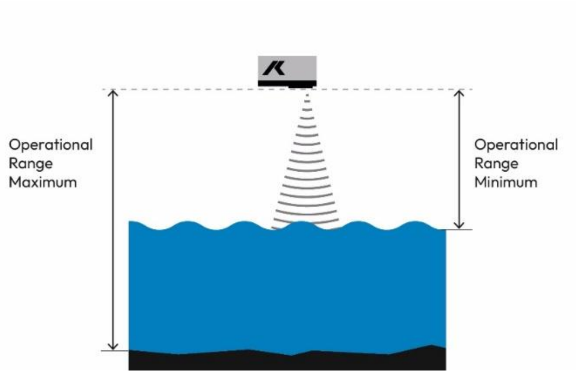
## 6.7 Settings

### 6.7.1 Parameters

**Table 4 - Parameters**

| Item | Description | Default |
|---|---|---|
| Units and decimals | Units can be adapted to local / user preferences: see 6.7.2. | Metrical units |
| Filter type (For Level and Velocity) | Select installation environment (see Table 3)<br>Define filter length (1 - 200 seconds) | Calm: 10 seconds |
| Interface selection | Available interfaces:<br>• SDI-12<br>• Modbus<br>Both can be enabled or disabled, but at least one of them needs to be activated. | SDI-12 enabled<br>Modbus enabled |
| SDI-12 Configuration | Set device address using KISTERS HyComm configuration software or SDI-12 commands | Address: 0 |
| Modbus Configuration | The following settings can be edited by the user:<br>• Address range: 1 – 255<br>• Parity: Even, Odd, None<br>• Stop-bits: 1 or 2<br>• Baudrate: 9600, 19200, 38400, 57600, 115200<br>⚠ Databits are always set to 8 and not configurable | Address; 1<br>Baudrate: 9600<br>Parity: None<br>Stopbits: 1 |

| | | |
|---|---|---|
| gauge zero reference height | HyQuant L provides a water level reading.<br>The water level is the height of a surface water body above a fixed reference height, known as the gauge zero reference height. The reference height is levelled and may not correspond to the level of the river bed. It must remain stable during the operating time of the water level gauge.<br>By definition, a radar sensor measures the distance between the sensor antenna and the water surface. The absolute water level is then calculated using the following formula:<br>Absolute water level = gauge zero reference height – distance<br><br>Choose from the following 2 options to enter the required gauge zero reference height:<br><br>(1) Sensor Height above reference point: The user can enter the distance between sensor and reference level.<br><br>(2) Staff Gauge: The user can enter staff gauge measurement.<br> | Sensor height above reference level defaults to 0, level will be 0 as long as this is not set.<br><br>Reading staff-gauge will always return 0 |

| | | |
|---|---|---|
| Operational range (level) | The operational denotes the range within which the readings recorded by the sensor hold true. A maximum and a minimum level can be configured to set the operational range. The operational range is then by definition smaller or equal to the measurement range.<br>Values exceeding the fixed maximum will be automatically set to maximum level; while those lower than the minimum will be set to the specified minimum level.<br>The quality flag indicates whether values fall within the prescribed operational range or not.<br><br> | Min: 100 for L20, 150 for L50 [mm]<br>Max: upper range [mm] |
| Flow direction | HyQuant detects the direction of flow.<br>For a sensor installed and oriented as described in 5.2 with the K on the cover pointing in the direction of flow, the flow velocity is measured as a positive value.<br>If for some reason HyQuant is installed with the K facing downstream, a correction is required and the user must change the flow direction setting to negative.<br>Options: positive, negative | positive |
| Wi-Fi auto enable on power up | See Enable with Power Cycle | Enable on power up |
| Wi-Fi password | Configurable. For IT security reasons, it is advisable to alter the initial password upon first sign-in. *It's worth noting that if you forget the password, you won't be able to change it without returning the device to KISTERS*. | Kisters123! |

### 6.7.2 Units

**Table 5 - Units**

| Parameter | Description | Units |
|---|---|---|
| Filtered Water Level | = Sensor height above reference point – *Filtered Distance*<br>• Lower cut-off is the user-defined minimum level of the operational range if enabled | [mm, cm, m ft, in] |
| Current Level | = Sensor height above reference point – *Current Distance*<br>• Lower cut-off is the user-defined minimum level of the operational range if enabled | |
| Current Distance | Distance readings taken from the HyQuant after removal of outliers and similar spikes.<br>Reference is the lid of the HyQuant. | |
| Filtered Distance | Current distance filtered with moving average filter. The moving average filter of duration N computes the mean value of each consecutive set of N sensor readings. Each reading is equally weighted. | |
| Level Quality Flag | bitfield<br>0x01 level below active zone min<br>0x02 level above active zone max | ./. |
| Velocity | Surface flow velocity | [mm/s, m/s, mph, km/h, fps, fpm, cm/s] |
| Supply voltage | | [V] |
| Internal temperature | | [°C, °F] |
| Internal relative humidity | | [%] |
| Angle | Separately for X- and Y-axis | [°] |
| Radar SNR | Signal to noise of the *Current Distance* measurement. | [dB] |

# 7 Operation

**Note**

The HyQuant begins measuring immediately upon the application of the supply voltage!
However, it should be noted that a radar sensor always requires a proper setup of its operating parameters, especially to reference a defined zero point in order to transform distance measurements into hydrological water level. It is recommended that HyComm be downloaded from the KISTERS website and that HyQuant be configured without delay.

Depending on the model of HyQuant you are deploying, the sensor continuously determines the current water level, the current surface velocity and the current discharge. New data is made available once per second.

A HyQuant sensor determines additional measured values in parallel to the actual water measurements:

- internal device temperature
- Internal humidity
- Inclination angle of the sensor X-axis
- Inclination angle of the sensor Y-axis
- SNR value of the water level measurement
- Status indicator of the water level measurement

This "metadata" can be employed to assess the quality of a measurement and identify potential sources of error at an early stage. All measured values can be accessed via the SDI-12 or the Modbus RTU (RS-485) interface. A detailed description of the provision of measured values via the two interfaces can be found in chapters 7.2 (SDI-12) and 7.3 (RS-485).

It is also possible to perform temporary in-situ measurements as a special application. In this case, the HyQuant must be connected directly to a PC/laptop via Wi-Fi, and a data logger is not required. The measured values are then displayed directly in the "HyComm" configuration software. It is also necessary to observe the criteria for a suitable installation location (see chapter Selecting a suitable installation location 5.1). It is also of paramount importance to ensure that the sensor is aligned parallel to the water surface.

## 7.1 Radar Beams

**⚠ CAUTION**

- Radar electromagnetic wave emissions

The device operates with very low emitting power radar beams.

- **Precaution:** While the risk is minimal, it is advisable to avoid prolonged direct exposure. Vulnerable or highly sensitive individuals should exercise caution.
- Always follow standard safety guidelines when handling or installing radar devices!

A radar emits electromagnetic waves. The beam is the focused electromagnetic emission from the radar antenna. The beam is defined by the main lobe. It is accompanied by one or several side lobes.

The main lobe is the area delimited by the beam angle, i.e. the lateral positions where the attenuation reaches roughly -3 dBm.

- HyQuant L: the beam angle is defined as 8° (4° both sides of the 0° perpendicular)
- HyQuant V: the beam angle is defined as 8° azimuth by 12° elevation (again split in two by the perpendicular)

Sidelobes are clearly identifiable accumulations of electromagnetic waves besides the main lobe. Ideally the sidelobes are completely attenuated, which is usually never the case. Depending on the material and the orientation of an obstacle sidelobes can interfere with the measurement in the main lobe. HyQuant is equipped with specific algorithms to filter out these interferences.

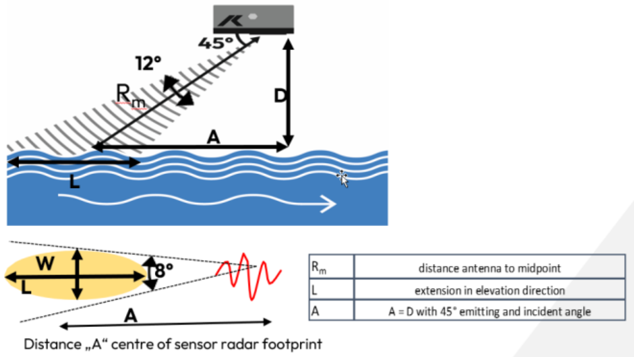
The beam angle $\alpha$ is defined in degrees. The angle $\alpha$ is the total geometrical beam opening. The concept is illustrated in Figure 8.

Based on the beam angle $\alpha$ one can calculate the width of the beam at certain distance of the water surface from the sensor antenna.

**HyQuant radar antenna – caution: 2 different cases:**
•**Velocity:** beam angle azimuth = 8°, and elevation 12°
•**Level:** beam angle azimuth = elevation = 8°.

W=2 x D x tan (8°/2) $R_m = \dfrac{D}{\sin(45°)}$

$L \approx 2R_m\, tan(12°/2)$




| Metric | | | | Imperial | | | |
|---|---|---|---|---|---|---|---|
| D [m] | W [m] | Rm [m] | L [m] | D [ft] | W [ft] | Rm [ft] | L [ft] |
| --- | --- | --- | --- | --- | --- | --- | --- |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 20,0 | 2,80 | 28,28 | 5,95 | 65,62 | 19,51 | 92,80 | 19,51 |
| 15,0 | 2,10 | 21,21 | 4,46 | 49,21 | 14,63 | 69,60 | 14,63 |
| 10,0 | 1,40 | 14,14 | 2,97 | 32,81 | 9,75 | 46,40 | 9,75 |
| 7,0 | 0,98 | 9,90 | 2,08 | 22,97 | 6,83 | 32,48 | 6,83 |
| 5,0 | 0,70 | 7,07 | 1,49 | 16,40 | 4,88 | 23,20 | 4,88 |
| 3,0 | 0,42 | 4,24 | 0,89 | 9,84 | 2,93 | 13,92 | 2,93 |
| 2,0 | 0,28 | 2,83 | 0,59 | 6,56 | 1,95 | 9,28 | 1,95 |
| 1,0 | 0,14 | 1,41 | 0,30 | 3,28 | 0,98 | 4,64 | 0,98 |
| 0,5 | 0,07 | 0,71 | 0,15 | 1,64 | 0,49 | 2,32 | 0,49 |

**Figure 7 - Beam Angle α and calculation of equivalent diameter on water surface for distance D**

## 7.2 SDI-12

**Note**

To be able to use the SDI-12 interface, it must be activated via the "HyComm" configuration software! Navigation path: "Configuration" | "Interfaces" | "SDI-12".
The SDI-12 sensor address can also be changed via the configuration software if required (navigation path: "Configuration" | "Interfaces" | "SDI-12"). Factory default setting: "0".

**Note**

If the sensor is not continuously supplied with power when using the SDI-12 interface (sensor is only switched on at the time of the actual measurement), it is strongly recommended for IT security reasons to deactivate the automatic activation of the Wi-Fi hotspot! Otherwise, the sensor will start the Wi-Fi hotspot every time the supply voltage is switched on.

### 7.2.1 Standard Commands

| Name | Com-mand | Response | Details |
|---|---|---|---|
| Address Query | ?! | a<CR><LF> | a - the sensor address<br>Sensor responds with its address. This will only work when only one sensor is connected. |
| Acknowledge Active | a! | a<CR><LF> | a - the sensor address<br>The sensor responds with its address in order to show that it is available |

| | | | |
|---|---|---|---|
| Send Identification | aI! | a13KISTERS_HYQUANfff-mmmxxxxxxxxxx<CR><LF> | a - the sensor address<br>13 - SDI-12 Version 1.3<br>KISTERS_ - company name (8 character)<br>HYQUAN - sensor Name HyQuant (6 character)<br>fff - firmware version (3 characters i.e. 1.01 = '101')<br>Add-on information[1]:<br>• mmm - model (3 characters, L20, L50, VEL, L+V)<br>• xxxxxxxxxx - device serial number (10 characters, i.e. HYR-230001) |
| Change Address | aAb! | b<CR><LF> | a - the original sensor address<br>b - the new sensor address |

#### 7.2.1.1 HyQuant L20, L50

| Name | Command | Response | Details |
|---|---|---|---|
| Start Measurement (and request CRC) | aM!<br>aMC! | atttn<CR><LF><br>When measurement is ready (Service Request): a<CR><LF> | a - the sensor address<br>ttt - The time taken by the sensor to generate the measurement output is shown in seconds. The datalogger must wait until this time has elapsed before requesting data. After power up, the sensor will take as long as the configured filter length to calculate the first valid value. As soon as a reading is available, this time will be zero.<br>n = 5 - number of measurement values that will be returned<br>When the sensor has measured the required data, it will generate a service request. This cannot take longer than ttt. Note that a service request will not be generated if ttt is equal to zero.<br>When a CRC is requested, subsequent Send Data commands will respond with the appropriate CRC code (refer to details below).<br>It is important to note that the SDI-12 standard limits the number of values that can be returned from a measurement started with the aM! command to 9.<br>To obtain further values, aM1! and so on must be used.. |
| Start additional Measurement 1 (and request CRC) | aM1!<br>aMC1! | atttn<CR><LF><br>When measurement is ready (Service Request): a<CR><LF> | See above<br>n = 4 |

[1] According to the SDI-12 specification, it is permissible to utilise the last 13 characters as add-on information, not just for the serial number.

<table>
<tr><td>Start additional Measurement x (and request CRC)</td><td>aMx!<br>aMCx!<br>x >= 2</td><td>atttn<CR><LF><br>When measurement is ready (Service Request):<br>a<CR><LF></td><td>see above<br>n = 0</td></tr>
<tr><td>Start Concurrent Measurement (and request CRC)</td><td>aC!<br><br>aCC!</td><td>atttnn<CR><LF></td><td>a - the sensor address<br>ttt - time in seconds until the sensor will have the measurement ready. The data recorder must wait for this time until it can request the data. See above for detailed description.<br>nn = 09 - number of measurements that will be returned<br><br>When a CRC is requested the subsequent Send Data commands will respond with CRC (see below)</td></tr>
<tr><td>Send Data</td><td>aD0!</td><td>a+d+d+d+d+d<CR><LF><br>a+d+d+d+d+d<CRC><CR><LF></td><td>a - sensor address<br>+d - filtered level [user-defined unit]<br>+d - current level [user-defined unit]<br>+d - current distance [user-defined unit]<br>+d – SNR [dB]<br>+d - quality flag<br><br><CRC> - 3-character CRC code is only appended if aMC! or aCC! commands were issued before</td></tr>
<tr><td>Send Data additional aM1!</td><td>aD0!</td><td rowspan="2">a+d+d+d+d<CR><LF><br>a+d+d+d+d<CRC><CR><LF></td><td rowspan="2">a - sensor address<br>+d - sensor temperature [user-defined unit]<br>+d - sensor tilt angle x direction [°]<br>+d - sensor tilt angle y direction [°]<br>+d - sensor height above reference level [user-defined unit]<br><CRC> - 3-character CRC code is only appended if aMC! or aCC! commands were issued before</td></tr>
<tr><td>Send Data after aC! / aCC!</td><td>aD1!</td></tr>
<tr><td>Send additional data after aMn! command</td><td>aDx!</td><td>a<CR><LF><br>a<CRC><CR><LF></td><td>Only cases return data, other additional data is not available.<br>x = 1 … 9 (after M / MC)<br>x = 2 … 9 (after C / CC)</td></tr>
</table>

#### 7.2.1.2 HyQuant L+V

| Name | Command | Response | Details |
|---|---|---|---|
| Start Measurement (and request CRC) | aM!<br>aMC! | attn<CR><LF><br>When measurement is ready (Service Request):<br>a<CR><LF> | a - the sensor address<br>ttt - The time taken by the sensor to generate the measurement output is shown in seconds. The datalogger must wait until this time has elapsed before requesting data. After power up, the sensor will take as long as the configured filter length to calculate the first valid value. As soon as a reading is available, this time will be zero.<br>n = 6 - number of measurement values that will be returned<br>When the sensor has measured the required data, it will generate a service request. This cannot take longer than ttt. Note that a service request will not be generated if ttt is equal to zero.<br>When a CRC is requested, subsequent Send Data commands will respond with the appropriate CRC code (refer to details below).<br>It is important to note that the SDI-12 standard limits the number of values that can be returned from a measurement started with the aM! command to 9.<br>To obtain further values, aM1! and so on must be used.. |
| Start additional Measurement 1 (and request CRC) | aM1!<br>aMC1! | attn<CR><LF><br>When measurement is ready (Service Request):<br>a<CR><LF> | See above<br>n = 3 |
| Start additional Measurement 1 (and request CRC) | aM2!<br>aMC2! | attn<CR><LF><br>When measurement is ready (Service Request):<br>a<CR><LF> | See above<br>n = 4 |
| Start additional Measurement x (and request CRC) | aMx!<br>aMCx!<br>x >= 3 | attn<CR><LF><br>When measurement is ready (Service Request):<br>a<CR><LF> | see above<br>n = 0 |
| Start Concurrent Measurement (and request CRC) | aC!<br><br>aCC! | atttnn<CR><LF> | a - the sensor address<br>ttt - time in seconds until the sensor will have the measurement ready. The data recorder must wait for this time until it can request the data. See above for detailed description.<br>nn = 12 - number of measurements that will be returned<br><br>When a CRC is requested the subsequent Send Data commands will respond with CRC (see below) |

<table>
<tr><td>Send Data</td><td>aD0!</td><td>a+d+d+d+d+d+d<CR><LF><br>a+d+d+d+d+d+d<CRC><CR><LF></td><td>a - sensor address<br>+d - filtered level [user unit]<br>+d - filtered velocity [user unit]<br>+d - SNR level [dB]<br>+d - SNR velocity [dB]<br>+d - quality flag level<br>+d - quality flag velocity<br><br><CRC> - 3-character CRC code is only appended if aMC! or aCC! commands were issued before</td></tr>
<tr><td>Send Data additional aM1!</td><td>aD0!</td><td rowspan="2">a+d+d+d<CR><LF><br>a+d+d+d<CRC><CR><LF></td><td rowspan="2">a - sensor address<br>+d - current level [user unit]<br>+d - current distance [user unit]<br>+d - current velocity [user unit]<br><CRC> - 3-character CRC code is only appended if aMC! or aCC! commands were issued before</td></tr>
<tr><td>Send Data after aC! / aCC!</td><td>aD1!</td></tr>
<tr><td>Send Data additional aM2!</td><td>aD0!</td><td rowspan="2">a+d+d+d+d<CR><LF><br>a+d+d+d+d<CRC><CR><LF></td><td rowspan="2">a - sensor address<br>+d - sensor temperature [user-defined unit]<br>+d - sensor tilt angle x direction [°]<br>+d - sensor tilt angle y direction [°]<br>+d - sensor height above reference level [user-defined unit]<br><CRC> - 3-character CRC code is only appended if aMC! or aCC! commands were issued before</td></tr>
<tr><td>Send Data after aC! / aCC!</td><td>aD2!</td></tr>
<tr><td>Send additional data after aMn! command</td><td>aDx!</td><td>a<CR><LF><br>a<CRC><CR><LF></td><td>Only cases return data, other additional data is not available.<br>x = 1 … 9 (after M / MC)<br>x = 3 … 9 (after C / CC)</td></tr>
</table>

#### 7.2.1.3 HyQuant Q

| Name | Command | Response | Details |
|---|---|---|---|
| Start Measurement (and request CRC) | aM!<br>aMC! | attn<CR><LF><br>When measurement is ready (Service Request): a<CR><LF> | a - the sensor address<br>ttt - The time taken by the sensor to generate the measurement output is shown in seconds. The datalogger must wait until this time has elapsed before requesting data. After power up, the sensor will take as long as the configured filter length to calculate the first valid value. As soon as a reading is available, this time will be zero.<br>n = 5 - number of measurement values that will be returned<br>When the sensor has measured the required data, it will generate a service request. This cannot take longer than ttt. Note that a service request will not be generated if ttt is equal to zero.<br>When a CRC is requested, subsequent Send Data commands will respond with the appropriate CRC code (refer to details below).<br>It is important to note that the SDI-12 standard limits the number of values that can be returned from a measurement started with the aM! command to 9.<br>To obtain further values, aM1! and so on must be used.. |
| Start additional Measurement 1 (and request CRC) | aM1!<br>aMC1! | attn<CR><LF><br>When measurement is ready (Service Request): a<CR><LF> | See above<br>n = 6 |
| Start additional Measurement 1 (and request CRC) | aM2!<br>aMC2! | attn<CR><LF><br>When measurement is ready (Service Request): a<CR><LF> | See above<br>n = 4 |
| Start additional Measurement x (and request CRC) | aMx!<br>aMCx!<br>x >= 3 | attn<CR><LF><br>When measurement is ready (Service Request): a<CR><LF> | see above<br>n = 0 |
| Start Concurrent Measurement (and request CRC) | aC!<br><br>aCC! | atttnn<CR><LF> | a - the sensor address<br>ttt - time in seconds until the sensor will have the measurement ready. The data recorder must wait for this time until it can request the data. See above for detailed description.<br>nn = 15 - number of measurements that will be returned<br><br>When a CRC is requested the subsequent Send Data commands will respond with CRC (see below) |

<table>
<tr><td>Send Data</td><td>aD0!</td><td>a+d+d+d+d+d<CR><LF><br>a+d+d+d+d+d<CRC><CR><LF></td><td>a - sensor address<br>+d - filtered level [user unit]<br>+d - filtered velocity [user unit]<br>+d - SNR level [dB]<br>+d - SNR velocity [dB]<br>+d - discharge [user unit]<br><br><CRC> - 3-character CRC code is only appended if aMC! or aCC! commands were issued before</td></tr>
<tr><td>Send Data additional aM1!</td><td>aD0!</td><td rowspan="2">a+d+d+d<CR><LF><br>a+d+d+d<CRC><CR><LF></td><td rowspan="2">a - sensor address<br>+d - current level [user unit]<br>+d - current distance [user unit]<br>+d - current velocity [user unit]<br>+d - quality flag level<br>+d - quality flag velocity<br>+d - quality flag discharge<br><CRC> - 3-character CRC code is only appended if aMC! or aCC! commands were issued before</td></tr>
<tr><td>Send Data after aC! / aCC!</td><td>aD1!</td></tr>
<tr><td>Send Data additional aM2!</td><td>aD0!</td><td rowspan="2">a+d+d+d+d<CR><LF><br>a+d+d+d+d<CRC><CR><LF></td><td rowspan="2">a - sensor address<br>+d - sensor temperature [user-defined unit]<br>+d - sensor tilt angle x direction [°]<br>+d - sensor tilt angle y direction [°]<br>+d - sensor height above reference level [user-defined unit]<br><CRC> - 3-character CRC code is only appended if aMC! or aCC! commands were issued before</td></tr>
<tr><td>Send Data after aC! / aCC!</td><td>aD2!</td></tr>
<tr><td>Send additional data after aMn! command</td><td>aDx!</td><td>a<CR><LF><br>a<CRC><CR><LF></td><td>Only cases return data, other additional data is not available.<br>x = 1 … 9 (after M / MC)<br>x = 3 … 9 (after C / CC)</td></tr>
</table>

#### 7.2.1.4 HyQuant Velocity

| Name | Com-mand | Response | Details |
|---|---|---|---|
| Start Meas-urement (and request CRC) | aM!<br>aMC! | atttn<CR><LF><br>When measurement is ready (Service Request): a<CR><LF> | a - the sensor address<br>ttt - The time taken by the sensor to generate the measurement output is shown in seconds. The datalogger must wait until this time has elapsed before requesting data. After power up, the sensor will take as long as the configured filter length to calculate the first valid value. As soon as a reading is available, this time will be zero.<br>n = 4 - number of measurement values that will be returned<br>When the sensor has measured the required data, it will gener-ate a service request. This cannot take longer than ttt. Note that a service request will not be generated if ttt is equal to zero.<br>When a CRC is requested, subsequent Send Data commands will respond with the appropriate CRC code (refer to details be-low).<br>It is important to note that the SDI-12 standard limits the number of values that can be returned from a measurement started with the aM! command to 9.<br>To obtain further values, aM1! and so on must be used. |
| Start addi-tional Meas-urement 1 (and request CRC) | aM1!<br>aMC1! | atttn<CR><LF><br>When measurement is ready (Service Request): a<CR><LF> | See above<br>n = 4 |
| Start addi-tional Meas-urement x (and request CRC) | aMx!<br>aMCx!<br>x >= 2 | atttn<CR><LF><br>When measurement is ready (Service Request): a<CR><LF> | see above<br>n = 0 |
| Start Concur-rent Meas-urement (and request CRC) | aC!<br><br>aCC! | atttnn<CR><LF> | a - the sensor address<br>ttt - time in seconds until the sensor will have the measurement ready. The data recorder must wait for this time until it can re-quest the data. See above for detailed description.<br>nn = 08 - number of measurements that will be returned<br><br>When a CRC is requested the subsequent Send Data commands will respond with CRC (see below) |

| | | | |
|---|---|---|---|
| Send Data | aD0! | a+d+d+d+d<CR><LF><br>a+d+d+d+d<CRC><CR><LF> | a - sensor address<br>+d - filtered velocity [user unit]<br>+d - current velocity [user unit]<br>+d - SNR [dB]<br>+d - quality flag<br><br><CRC> - 3-character CRC code is only appended if aMC! or aCC! commands were issued before |
| Send Data additional aM1! | aD0! | a+d+d+d+d<CR><LF><br>a+d+d+d+d<CRC><CR><LF> | a - sensor address<br>+d - sensor temperature [user-defined unit]<br>+d - sensor tilt angle x direction [°]<br>+d - sensor tilt angle y direction [°]<br>+d - sensor height above reference level [user-defined unit]<br><CRC> - 3-character CRC code is only appended if aMC! or aCC! commands were issued before |
| Send Data after aC! / aCC! | aD1! | | |
| Send additional data after aMn! command | aDx! | a<CR><LF><br>a<CRC><CR><LF> | Only cases return data, other additional data is not available.<br>x = 1 … 9 (after M / MC)<br>x = 2 … 9 (after C / CC) |

### 7.2.2 Extended commands

| Name | Command | Response | Details |
|---|---|---|---|
| Enable Wi-Fi | aXWI-FI! | a0<CR><LF> | a - sensor address<br>Enable HyQuant Wi-Fi in order to do configuration through HyComm |
| Set Staff Gauge | aXSG+s! | a+d<CR><LF> | a - sensor address<br>+s - the current staff gauge value<br>+d - the new value of sensor height above reference level stored in the sensor |
| Set Sensor Height above reference level | aXSHAR+s! | a+d<CR><LF> | a - sensor address<br>+s - the measured sensor height above reference level<br>+d - the new value of sensor height above reference level stored in the sensor |

## 7.3 Modbus

**Note**

To be able to use the Modbus (RTU) protocol on the RS-485 interface, "Modbus" must be activated via the "HyComm" configuration software! Navigation path: "Configuration" | "Interfaces" | "Modbus".

### 7.3.1 Default settings

The communication parameters of the RS-485 interface can also be set via the configuration software (navigation path: "Configuration" | "Interfaces" | "Modbus"). Before commissioning, please check whether the Modbus server and client parameters match.

| Parameter | Default |
|---|---|
| Baudrate | 9600 |
| Parity | None |
| Data bits | 8 |
| Stop bits | 1 |
| Modbus byte order | Big endian |
| Modbus float / uint32 word order | Big endian |
| Modbus default Server address | 1 |

### 7.3.2 Modbus Register Mapping

| R | W | Modbus Register | Internal Address | Length/ bytes | type | Description | Data range |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| x | | 1 | 0 | 4 | float 32 | Filtered level measurement | depending on configured unit |
| x | | 3 | 2 | 4 | float 32 | Current level measurement | depending on configured unit |
| x | | 5 | 4 | 2 | uint 16 | SNR Level | 0 … 100 dB |
| x | | 6 | 5 | 2 | uint 16 | Quality flag level | bitfield<br>0x01 level below active zone min<br>0x02 level above active zone max |
| | | | | | | Spare | |
| x | | 11 | 10 | 4 | float 32 | Filtered velocity measure-ment | depending on configured unit |
| x | | 13 | 12 | 4 | float 32 | Current velocity measure-ment | depending on configured unit |
| x | | 15 | 14 | 2 | uint 16 | SNR Velocity | 0 … 100 dB |
| x | | 16 | 15 | 2 | uint 16 | Quality flag velocity | bitfield<br>TBD |
| | | | | | | Spare | |
| | | 21 | 20 | 4 | float 32 | Discharge | depending on configured unit |
| | | 23 | 22 | 2 | uint 16 | Quality flag discharge | bitfield<br>TBD |
| | | | | | | spare | |
| x | | 31 | 30 | 4 | float 32 | Filtered distance | depending on configured unit, |
| x | | 33 | 32 | 4 | float 32 | Current distance | depending on configured unit |
| | | | | | | Spare | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| x | | 41 | 40 | 4 | float 32 | x-axis tilt angle | Range +-90°, Resolution: 0.1° [°] |
| x | | 43 | 42 | 4 | float 32 | y-axis tilt angle | Range +-90°, Resolution: 0.1° [°] |
| x | | 45 | 44 | 4 | float 32 | Internal temperature | |
| x | | 47 | 46 | 2 | uint 16 | Internal humidity | |
| | | | | | | Spare | |
| x | | 61 | 60 | 2 | uint 16 | Model | 0: L20<br>1: L50<br>2: VEL<br>3: L+V<br>4:Q |
| x | | 62 | 61 | 2 | uint 16 | FW version major | |
| x | | 63 | 62 | 2 | uint 16 | FW version minor | |
| x | | 64 | 63 | 2 | uint 16 | FW version subminor | |
| x | | 65 | 64 | 2 | uint 16 | Serial number [0 - 1] | |
| x | | 66 | 65 | 2 | uint 16 | Serial number [2 - 3] | |
| x | | 67 | 66 | 2 | uint 16 | Serial number [4 - 5] | |
| x | | 68 | 67 | 2 | uint 16 | Serial number [6 - 7] | |
| x | | 69 | 68 | 2 | uint 16 | Serial number [8 - 9] | |
| | | | | | | | |
| x | x | 81 | 80 | 4 | float 32 | Staff gauge value | [unit as configured] |
| x | x | 83 | 82 | 4 | float 32 | Sensor height above refer-ence point | [unit as configured] |
| | | | | | | | |
| x | x | 401 | 400 | 2 | uint 16 | Enable Wi-Fi | Write of 1 triggers start of Wi-Fi<br>Read<br>0: Wi-Fi not enabled<br>1: Wi-Fi enabled |

# 8 Maintenance

**CAUTION**

- Radar electromagnetic wave emissions

The device operates with very low emitting power radar beams.

- **Precaution:** While the risk is minimal, it is advisable to avoid prolonged direct exposure. Vulnerable or highly sensitive individuals should exercise caution.
- Always follow standard safety guidelines when handling or installing radar devices!

**WARNING**

Risk of falling when activating the WLAN hotspot

If the HyQuant is installed at a great height above the water and/or the sensor is difficult to access, there is a risk of falling when activating the Wi-Fi hotspot.

- Use personal protective equipment (PPE) to prevent falls!
- If possible, use a swivelling bracket for installation! This allows you to swivel the sensor into a safe working area for configuration.

**WARNING**

Risk of drowning!

Be particularly careful when working over or near to water.

- Wear a Life Jacket/Buoyancy Aid: Ensure that workers at risk of falling into the water are provided with and wear a life jacket or buoyancy aid. The life jacket should be thoroughly checked by the user prior to use.!
- Never Work Alone: Always be accompanied when working near or over water.!

The HyQuant radar sensor is low-maintenance by design. No special maintenance work is required, nor is it necessary to replace components at regular intervals. Nevertheless, the entire measuring point should be inspected and checked regularly. We recommend carrying out the following maintenance work at least once a year - for example as part of a measuring point inspection. Unscheduled maintenance work is recommended after the occurrence of exceptional (flood) events or if the measured values are implausible.

**Maintenance work to be carried out annually (recommended):**

- Check that the measuring section between the radar sensor and the water surface is free of obstacles. If necessary, remove flotsam, vegetation or other objects in the measuring section.
- Check the underside of the device with the radar antenna for soiling (insect nests, bird droppings, spider webs, other dirt deposits). If necessary, clean the underside of the device with a damp cloth
- and a little household detergent. Do not use aggressive cleaning agents!
- Check the sensor position and correct if necessary: the underside of the device must be aligned as parallel as possible to the water surface.
- Check the mounting point of the radar sensor for position and stability. Correct if necessary or if not possible, select a new fixing point.

- Check the angled plug connector and connecting cable for mechanical damage. If necessary, replace complete connecting cable with angled plug connector.
- Check all screw connections for sufficient tightening strength. Retighten screws if necessary.
- Check all metal fastening components for corrosion. If there is a risk of the radar sensor falling down due to material failure, replace corroded parts.
- Check sensor alignment: Verify that the sensor is properly aligned relative to the water surface (+/- 2 °). For velocity sensors, ensure that the HyQuant is correctly positioned and aligned with the flow direction: the KISTERS “K” must be pointing upstream (water flows from K to the radome area of the lid).
- Finally, carry out a control measurement and compare with the reference value (e.g. level staff value). If this results in an unexpectedly large deviation, the radar sensor must be re-referenced. The cause of the deviation is often a change in the position of the mounting point.

**Note**

In accordance with the prevailing local conditions, it may be necessary to implement maintenance procedures at more frequent intervals. This is particularly the case in instances where there is a substantial accumulation of debris at the measuring point, or where the likelihood of increased soiling is high due to unfavourable environmental conditions.

# 9 Troubleshooting

**CAUTION**

- Radar electromagnetic wave emissions

The device operates with very low emitting power radar beams.

- **Precaution:** While the risk is minimal, it is advisable to avoid prolonged direct exposure. Vulnerable or highly sensitive individuals should exercise caution.
- Always follow standard safety guidelines when handling or installing radar devices!

**WARNING**

Risk of falling when activating the WLAN hotspot

If the HyQuant is installed at a great height above the water and/or the sensor is difficult to access, there is a risk of falling when activating the Wi-Fi hotspot.

- Use personal protective equipment (PPE) to prevent falls!
- If possible, use a swivelling bracket for installation! This allows you to swivel the sensor into a safe working area for configuration.

**WARNING**

Risk of drowning!

Be particularly careful when working over or near to water.

- Wear a Life Jacket/Buoyancy Aid: Ensure that workers at risk of falling into the water are provided with and wear a life jacket or buoyancy aid. The life jacket should be thoroughly checked by the user prior to use.!
- Never Work Alone: Always be accompanied when working near or over water.!

**WARNING**

Incorrect connection of the supply power may result in damage to the HyQuant!

The HyQuant employs a reverse-protected interface and power circuitry to safeguard against such occurrences. However, it is crucial to note that an improper or false connection between the power lines and the interface lines could still lead to damage to the instrument.

- Verify the pinout configuration and ensure that no power is applied to the connection cables other than those explicitly designated as "Power VCC +" and "Power GND -".

The unit ensures high functional reliability, but malfunctions can occur during operation.
Such malfunctions may result from the following causes:

- **Sensor is not ready for operation; no communication with the sensor possible**
  - Check power supply to the unit. Within range? Polarity reversed? Direct Current?
  - Check the cable connector: Mechanical damage? Not connected?
  - Check the cable: Mechanical damage?
  - Assess error messages if any

- Assess changes in the installation site: for instance, new obstacles obstructing direct view to the water surface?

- **No SDI-12 or Modbus data**
  - SDI-12 or Modbus connection to the connected data logger: Is the wiring suitable for the interface used? Is the RS-485 interface mismatched? Is the sensor address configured correctly? Are there addressing conflicts with other SDI-12 sensors on the same bus?
  - Is the required communication interface activated in the HyQuant L?
  - Do the communication parameters of the Modbus (RTU) interface of the sensor and controller match?

- **Unstable or no Readings**
  - Sensor position: parallel to the water surface? K pointing upstream?
  - Unstable water level?
  - Check the lid: deposition of dirt or scratches on the radome?
  - Obstruction in the measurement beam?
  - False reflections on large object in close vicinity to the sensor?

- **Erroneous Sensor Configuration**
  - The sensor settings require verification to ensure they are both plausible and complete.
  - Refer to section 6 for a detailed description of configuration/settings.

# 10 Repair

KISTERS precision instruments and data loggers are produced in quality-controlled processes. All KISTERS production and assembly sites in Australia, New Zealand and Europe are ISO 90001 certified. All equipment is factory tested and/or factory calibrated before it is shipped to the client. This ensures that KISTERS products perform to their fullest capacity when delivered.

Despite KISTERS most rigorous quality assurance (QA), malfunction may occur within or outside of the warranty period. In rare cases, a product may not be delivered in accordance with your order.

In such cases KISTERS' return and repair policy applies. For you as a customer, this means the following:

(1) Contact KISTERS using the Repair Request Form made available online: [Download Link]
In response you will receive a reference number that must be referenced on all further correspondence and on the freight-documents accompanying your return shipment.

(2) Please provide as much information and/or clear instructions within the return paperwork. This will assist our test engineers with their diagnosis.

(3) Please do not ship the goods prior to obtaining the reference number. KISTERS will not reject any equipment that arrives without reference number; however, it may take us longer to process.

Custom requirements for items sent to KISTERS for warranty or non-warranty repairs: Check with your national customs/tax authorities for details, processes and paperwork regarding tax exempt return of products. Typically, special custom tariff codes are available (such as HS Code = 9802.00) that verify the item is being returned for repair and has no commercial value.

Please note that the customs invoice / dispatch documents should also clearly state: "Goods being returned to manufacturer for repair – No Commercial value". It is mandatory to have any returned goods accompanied by a commercial invoice on headed paper. KISTERS reserves the right to charge the customer for time spent rectifying incorrect customs documents.

Note: Please ensure that your goods are packed carefully and securely. Damage that occurs during transit is not covered by our warranty and may be chargeable.

# 11 Technical Data

| Technical specifications | HyQuant – L20 / L50 | HyQuant V | HyQuant L + V |
|---|---|---|---|
| Radar Type / Frequency Band | FMCW 60 GHz V-Band Radar level sensor | FMCW Doppler 60 GHz V-Band Radar Velocity sensor. | Integrated FMCW 60 GHz V-band Radar Level (L) and Doppler Velocity (V) sensor |
| Measurement Range | L20: 0.10 … 20 m<br>L50: 0.15 … 50 m | L: 0.10 … 20 m<br>V: 0.05 … 15 m/s | |
| Sampling rate | 1 Hz (1 measurement / second) | | |
| Accuracy | <= 2 mm | L: <= 2 mm<br>V:<br>0.02…4.5 m/s: 1% of measured value<br>4.5 … 15 m/s: 2% of measured value | |
| Resolution | ±1 mm | L: ±1 mm<br>V: 1 mm/s | |
| Blind zone/blanking distance | L20: 0.1 m<br>L50: 0.15 m | 0.1 m | |
| Minimum ripple - velocity | n.a. | 2-3 mm | |
| Supply Voltage (Range) | 9 … 30 VDC | | |
| Power consumption @ 12V DC | Typical < 20 mA, peak operation < 80 mA | | |
| Beam Angle (azimuth by elevation) | 8° by 8° | L: 8° by 8°<br>V: 8° by 12° | |
| Ingress Protection | IP68[2] | | |
| Communication & Interfaces | SDI-12, Modbus, Wi-Fi | | |
| Operating Temperature Range | -40 … +80 °C | | |
| Humidity range | Relative Humidity 0...100 % non-condensing | | |
| Dimensions and weight | HyQuant sensor with backplate: LxWxH 160 mm x 97mm x 91mm, 1.15 kg<br>Packaged Dimensions: LxWxH 300 x 300 x 187 mm, 2.5 kg | | |
| Signal Connector | M12 8-Pin | | |
| Materials | Housing: Powder coated aluminium and Radome / Front panel HDPE | | |
| Compliance | CE, FCC Class B, UL, RoHS, further information available on our Homepage | | |

[2] The IP68 states that the device is both dustproof and protected against continuous immersion in water up to a maximum depth of 1.5 metres for a maximum of 3 hours. However, it does not provide protection from other liquids such as salt water, soapy water, alcohol, or heated liquids. Note: In order to attain IP68, ensure that the M12 8-pin connector is correctly inserted and securely fastened.

# 12 Obligations of the Operator and Disposal

When disposing of the units and their accessories, the applicable local regulations regarding environment, disposal and occupational safety must be observed.

Before dismantling:

- Electrical Devices:
- Switch off the units.
- Disconnect electrical appliances from the power supply, regardless of whether the appliances are connected to the mains or to another power source.
- Mechanical devices:
  - Fix all loose components. Prevent the device from moving independently or unintentionally.
  - Loosen mechanical fastenings: Please note that appliances can be heavy and that loosening the fastenings may cause them to become mechanically unstable.

*Disposal:*

Operators of old appliances must recycle them separately from unsorted municipal waste. This applies in particular to electrical waste and old electronic equipment.
Electrical waste and electronic equipment must not be disposed of as household waste!
Instead, these old appliances must be collected separately and disposed of via the local collection and return systems.
Integrated or provided batteries and accumulators must be separated from the appliances and disposed of at the designated collection point. At the end of its service life, the lithium-ion battery must be disposed of according to legal provisions

*EU WEEE Directive*

- As players in the environmental market, KISTERS AG and KISTERS are committed to supporting efforts to avoid and recycle waste. Please consider:
  - Avoidance before recycling!
  - Recycling before disposal!

- This symbol indicates that the scrapping of the unit must be carried out in accordance with Directive 2012/19/EU.

Please observe the local implementation of the directive and any accompanying or supplementary laws and regulations.

# 13 Contact Data

| | | |
|---|---|---|
| **Europe** | KISTERS Europe | +49 2408 9385 0<br>hydromet.sales@kisters.eu<br>www.kisters.eu |
| **Australia** | KISTERS Australia | +612 9601 2022<br>sales@kisters.com.au<br>www.kisters.com.au |
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