

MICROFREEZE® USER'S GUIDE

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Inline Quality Control Measurements

1 Contact information

Aquantis S.A.

EPFL Innovation Park Bâtiment C

CH-1015 Lausanne

Switzerland

Tel: +41 79 159 97 25

E-mail : info@aquantis.org

Website : www.aquantis.org

Aquantis Belgium B.V.B.A.

Generaal De Wittelaan 17C

B-2800 Mechelen

Belgium

Tel: +32 15 68 24 21

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2 About the user guide

2.1 Introduction

The Microfreeze is intended to determine the level-of-frozenness (LOF) of your food products. This device is developed and manufactured by Aquantis. The product number is indicated on the device and has the format: AQMF-XXX-XX-2019-X. Please provide the product number during every communication with Aquantis.

This user's guide is intended for the personnel in charge of the process and quality control of frozen products and/or freezing or thawing processes. When using the Microfreeze according to the user's guide, no specific qualifications are required to operate the system. Read this user guide carefully since the installation and operation in accordance with these instructions is a prerequisite for proper functioning of the Microfreeze sensor.

The pictures in the user guide are for illustrative purposes only. The illustrations can differ in minor details from your sensor, they are only intended to provide general information. Aquantis pursues a policy of ongoing product development with all sensors. Changes in terms of supply scope are possible at any time with regards to design, features and technology. The information listed in this user guide corresponds to the information available at the time of going to press. Therefore, legal claims cannot be made based on the technical data, illustrations and information contained in the user guide.

The following nomenclature will help when reading this user guide.

2.2 Nomenclature

BMU	bottom measurement unit: emitter of receiver unit placed underneath the conveyor belt
CSV	comma separated values
dB	decibels
EM(W)	electromagnetic (waves)
GHz-waves	electromagnetic waves in the GHz frequency range
HF	high frequency, typically referring to the GHz frequency range
LF	low frequency
LOF	level-of-frozenness
TMU	top measurement unit: emitter of receiver unit placed above the conveyor belt
UINT16	unsigned integer of 16 bits

2.3 Publication

Manual version 1.0 with Document No: MICROFREEZE2019-1 was published on April 1st, 2019.

2.4 Additional Documents

Additional documents for the MICROFREEZE include:

- MICROFREEZE Fabrication Instructions (Document No: MICROFREEZE2019-FAB-1): Protocol for fabrication, adjustments and testing the Microfreeze including its different components. This document is solely meant MICROFREEZE manufacturers.
- MICROFREEZE Bill of Materials (Document No: MICROFREEZE2019-BOM-1): Overview of the components used in the Microfreeze. This document is solely meant MICROFREEZE manufacturers.
- MICROFREEZE Product Label (Document No: MICROFREEZE2019-LABEL-1): The label can be found on the product.

3 Disclaimer

In no respect shall Aquantis incur any liability for any damages, including, but limited to, direct, indirect, special, or consequential damages arising out of, resulting from, or any way connected to the use of the sensor, whether or not based upon warranty, contract, tort, or otherwise; whether or not injury was sustained by persons or property or otherwise; and whether or not loss was sustained from, or arose out of, the results of, the item, or any services that may be provided by Aquantis.

4 Safety information

This sensor has been designed for safe use but must be operated with caution. If used properly according to this user's guide, the Microfreeze poses no health concerns for the personnel.

4.1 General safety instructions

- Check the voltage rating before you connect the equipment to an electrical power source to ensure that the required voltage and frequency match the available power source.
- Do not connect the equipment power cables to the power outlet if the power cable is damaged.
- If you use an extension power cable, ensure that the total ampere rating of the products plugged in to the extension power cable does not exceed the ampere rating of the extension cable.

WARNING: The customer is responsible to connect all metal parts of the Microfreeze to protective earth via a low resistive path (< 1 Ohm).

WARNING: A minimum distance of 1 meter from the emitter unit should be respected to stay within the maximum electromagnetic exposure limit.

CAUTION: If any smoke or unusual odours are detected, disconnect the device from the electrical outlet and contact Aquantis immediately. See page 2 for the appropriate contact information.

4.2 Laser classification (Class II)

The Microfreeze sensor system includes a visible class 2 laser for measuring the product (layer) thickness. The laser-beam is normally pointed downwards to the conveyor belt on which the products pass. Do not stare into the beam or direct the beam to anyone's eyes.

WARNING: Do not directly view or point the laser pointer at an eye. Low power visible lasers do not normally present a hazard but may present potential for hazard if viewed directly for extended periods of time.

Permitted sensor uses:

The Microfreeze system is designed for use in industrial environments

- Measure LOF of products (layers) on a conveyor belt or free-fall.
- Measure product thickness of products (layers) on a conveyor belt or free-fall.

No other uses are permitted.

Prohibited sensor uses:

- Compromising or deactivating safety systems built into the sensor
- Removal of hazard or explanatory labels affixed to the sensor
- Opening the sensors enclosure (during operation or cleaning)
- Modifying or converting the instrument
- Using third party accessories

Notices:

- Avoid shocks and impacts to the sensor.
- Protect the sensor cables against damage.
- Avoid exposure of sensor to aggressive media.
- Mount the sensor only by means of the foreseen mounting spaces according to the installation guidelines.

5 Transport and storage

5.1 Transport

For your own safety and to avoid damage to the sensor due to improper transport, respect the following considerations:

- Transport should be performed by trained specialist staff only.
- The utmost care and attention are required at all times during unloading and transportation on company premises.

Do not remove packaging until immediately before you start mounting

5.2 Transport inspection

Upon receipt, please check the delivery for completeness and for any damage that may have occurred in transit. In the case of transit damage that is visible externally, proceed as follows:

- Do not accept the delivery or only do so conditionally.
- Note the scope of damage on the transport documents or on the transport company's delivery note.
- Contact Aquantis.

Complaints regarding defects should be filed as soon as these are detected. Damage claims are only valid before the applicable complaint deadlines.

5.3 Storage

Store the sensor under the following conditions:

- Do not store outdoors.
- Store in a dry area that is protected from water and dust.
- Do not expose to any aggressive substances.
- Protect from sunlight.
- Avoid mechanical shocks.
- Storage temperature: between -40 and $+50$ °C
- Relative humidity: max. 95%, non-condensing
- For storage periods of longer than 3 months, check the general condition of the individual units and packaging on a regular basis.

6 Sensor installation and integration

6.1 Installation guidelines

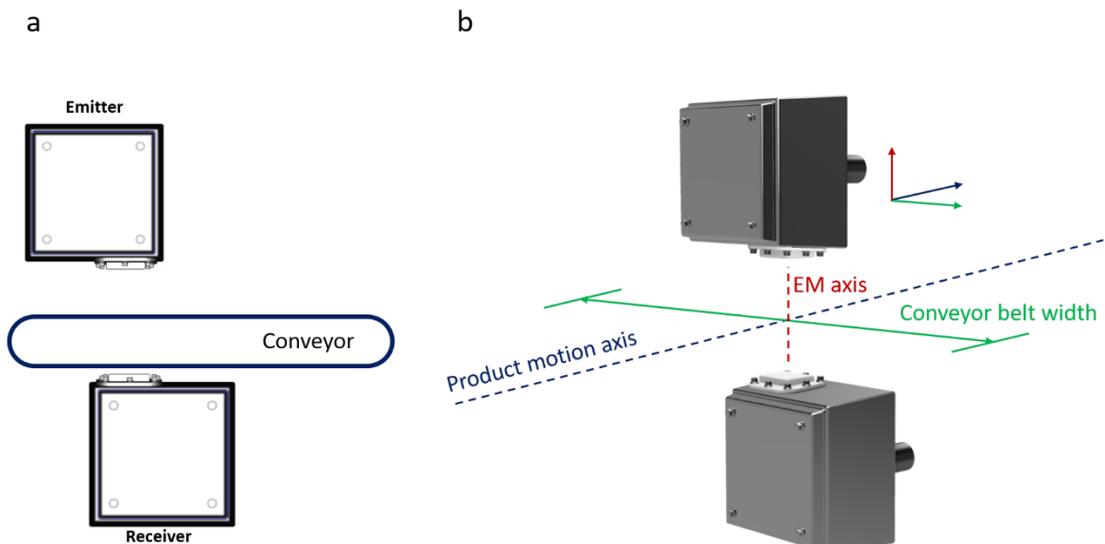
The installation will be conducted by Aquantis engineers or Aquantis-certified engineers. Therefore, no specific tools nor materials will be provided. Calibration of the sensor can be conducted with your own products.



WARNING: The customer is responsible to connect all metal parts of the system to protective earth via a low resistive path (< 1 Ohm). Aquantis is not responsible for any damage or dysregulation of the system and other equipment due to no or a bad connection to earth.

The best sensor performance can be achieved by following these installation guidelines:

- ✓ In case a conveyor belt is used, the conveyor belt material should be rather transparent for microwaves. The insertion loss caused by the belt may not exceed 3 dB. Most plastic conveyor belt materials comply with this requirement, metal conveyor belts don't.
- ✓ The HF emitter is mounted as close as possible above (or underneath) the conveyor belt or products by which sufficient space should be foreseen for the products to pass. The HF receiver is placed underneath (or above) the conveyor belt, well aligned with the emitter as shown in



- ✓ Figure 1. It is strongly recommended to have as few as possible metal parts near the electromagnetic-axis. The distance between the emitter and receiver (from antenna cover – to – antenna cover) should be kept to a minimum. Foresee sufficient margin (> 2 cm) such that under all conditions moving parts are not touching the instrument.

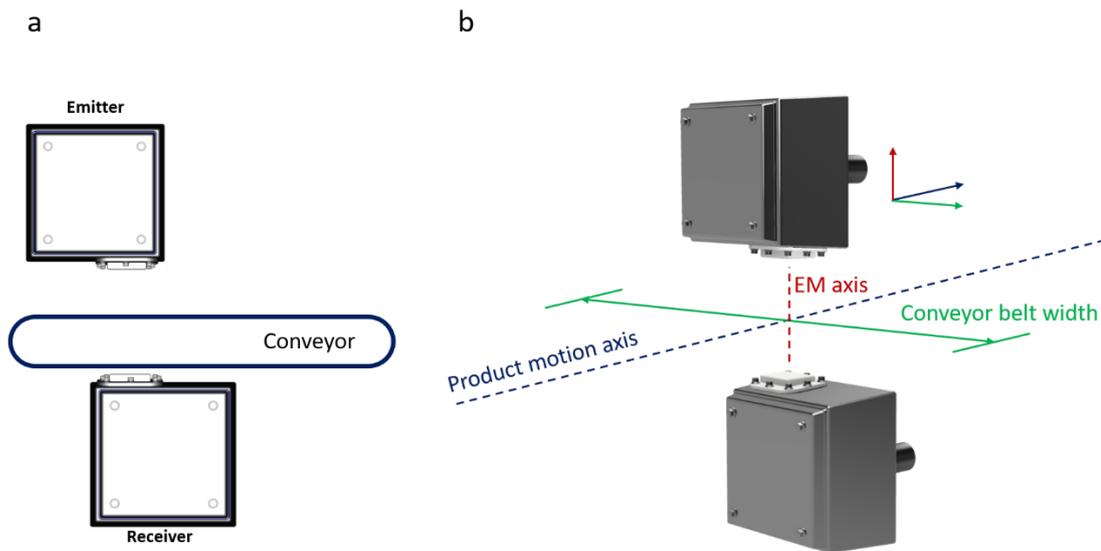


FIGURE 1: ORIENTATION OF THE SENSOR RELATIVE TO THE CONVEYOR BELT AND PRODUCT MOTION AXIS.

- ✓ Please foresee free space (minimum 50 cm) around the top measurement unit (TMU) to facilitate the installation of the product-thickness sensor at the antenna side as indicated in Figure 2. The product thickness sensor is attached to a stainless-steel base plate which is mounted to the two wall-mount spacers of the HF receiver unit. All units need to be mounted on metal frame which needs to be accessible from the back to fix the different units.
- ✓ Mount the computational unit in the vicinity of the TMU and BMU with the cable glands pointed towards the floor. Please foresee a save and easy access to the TMU, BMU and the computational unit to facilitate the maintenance on the MICROFREEZE measurement system.

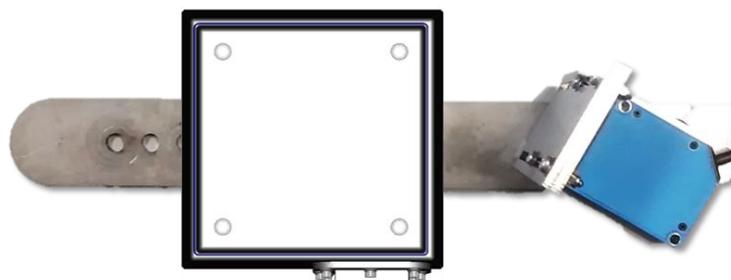


FIGURE 2: STAINLESS STEEL BASE PLATE FOR MOUNTING THE SENSOR MODULE AND THICKNESS SENSOR.

- ✓ The conveyor belt thickness at the electromagnetic-axis should be constant (toothed sections of the conveyor belt should not be placed in the EM field-of-view).
- ✓ The HF units and the computational unit should be mounted rigidly on a frame limiting any vibrations as much as possible.
- ✓ Make sure there is no electromagnetic coupling from other devices operating in the same HF frequency range: 2.4-2.5 GHz and 5.725-5.875 GHz. Respect a distance of 1 m from the MICROFREEZE system.

- ✓ The cable distance between the computer-box and the HF units may not be longer than 3 m. Cables longer than 3 will compromise the data acquisition speed.
- ✓ For typical product thicknesses, the laser-spot of the thickness sensor should preferentially intersect with the EM-axis at the top surface of the product. See Figure 3 for details.

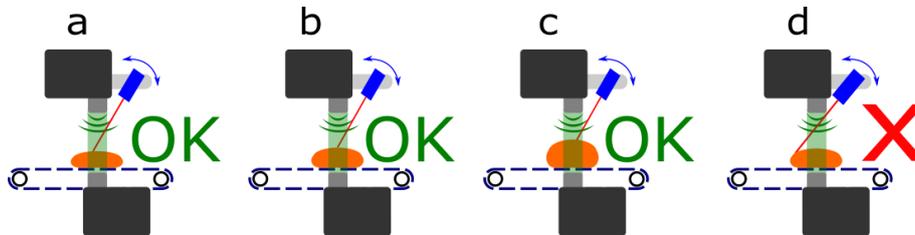


FIGURE 3: POSITIONING OF THE THICKNESS SENSOR: SECTION A,B AND C SHOW CORRECTLY MOUNTED DISTANCE SENSORS. THE LASER POINT OF THE DISTANCE SENSOR IS POINTED AT THE CENTRE REGION OF THE PRODUCT. SECTION D SHOWS THE INAPPROPRIATE POSITIONING OF THE DISTANCE WHICH RESULTS IN WRONG MEASUREMENTS.

6.2 Power supply cables

The Microfreeze is powered via the computer unit which further distributes the power to the distance sensor, emitter and receiver units. Figure 4 shows the incoming power (red) and the distribution links (blue). Please connect the main power to a single 230 VAC – 50 Hz power source with an external switch or remote relay controlled via a PLC. The power distribution to the distance sensor is already foreseen.

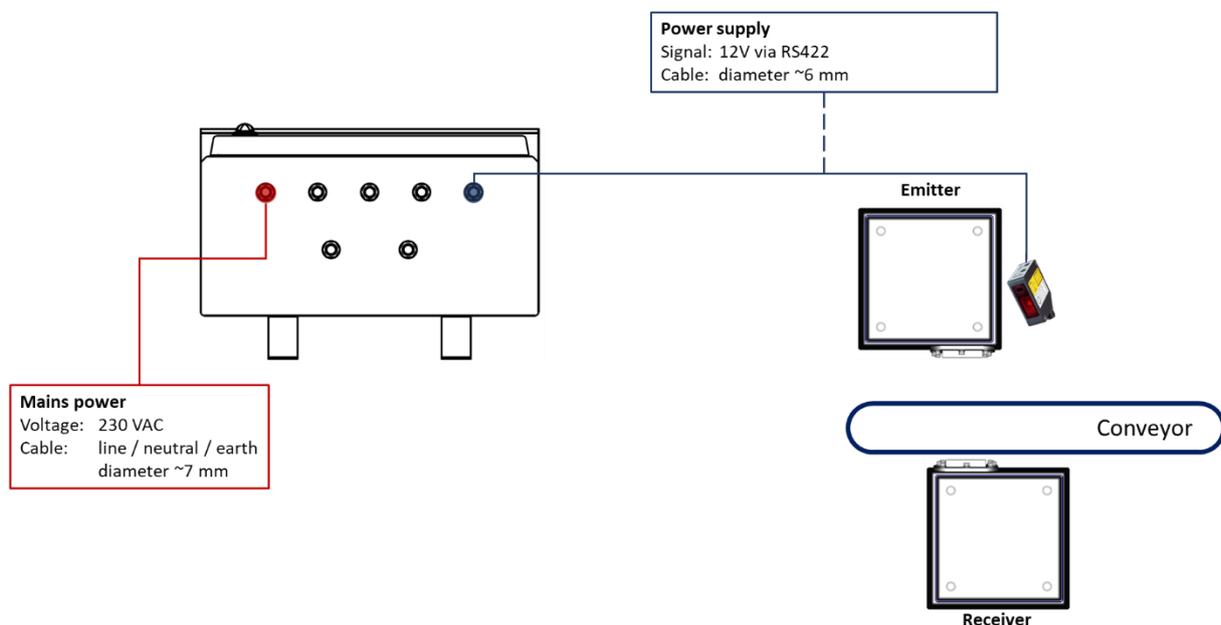


FIGURE 4: POWER SUPPLY INTERCONNECTIONS.

6.3 Data interconnection

The data streams between the computer unit, distance sensor, emitter and receiver units are shown in Figure 5. From the computing unit, an ethernet cable which can be directly connected to a pc or a network. More information can be found in the next section *Connectivity*.

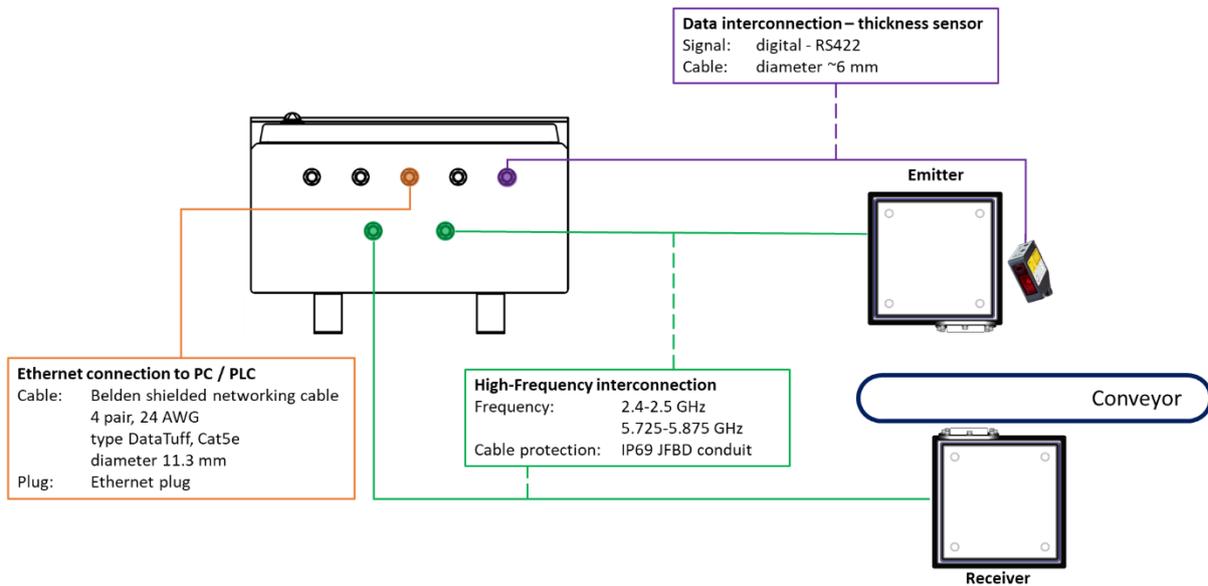


FIGURE 5: DATA SIGNAL INTERCONNECTIONS.

7 Operation

7.1 Sensor power-on and shutdown

7.1.1 Power on

The Microfreeze is switched on by plugging the power cord in a socket or by supplying the power via the PLC system. The sensors operating system boots up automatically upon switching on. This start-up phase takes a few minutes. If the system doesn't respond, proceed to section Unexpected stop and restart 9.1 Unexpected stop and restart.

CAUTION: If any smoke or unusual odours are detected, disconnect the device from the electrical outlet and contact Aquantis immediately. See page 2 for the appropriate contact information.

7.1.2 Shutdown

The Microfreeze sensors software needs to be shutdown properly prior to cut off its mains power. The system is turned off via the webserver's shutdown-button or by writing a "0" to the Modbus holding register 11. Ensure that the sensor mains power is kept on for at least 2 min after the shutdown process is initiated. Incorrect closing may affect the proper functioning of the device. In case the power is switched off too early, check on the next start up if the software boots up and functions normally.



FIGURE 6: WEBSERVERS MENU: SHUTDOWN BUTTON.

7.2 Connectivity

7.2.1 Connecting to the sensor via a PC

The Microfreeze can be directly connected to a PC by means of the Ethernet RJ45 connector. The sensor can then be interfaced via a web browser or dedicated PLC emulation software making use of the MODBUS TCP protocol.

For direct interconnection to a windows PC, a fixed IP address need to be used: 192.168.3.100. To do so, one need to change the Ethernet adaptor settings as follows:

STEP 1: Open the “**Network and sharing centre**”.

STEP 2: Select “**change adaptor settings**”.

STEP 3: Select the Ethernet connection to which the sensor will be connected to the PC. Right-click on the connection and select **properties** from the drop-down menu.

STEP 4: Under the tab “Networking”, select **Internet protocol version 4 (TCP/IPv4)**, then select **properties**.

STEP 5: Set the settings as indicated in Figure 7 and press OK.

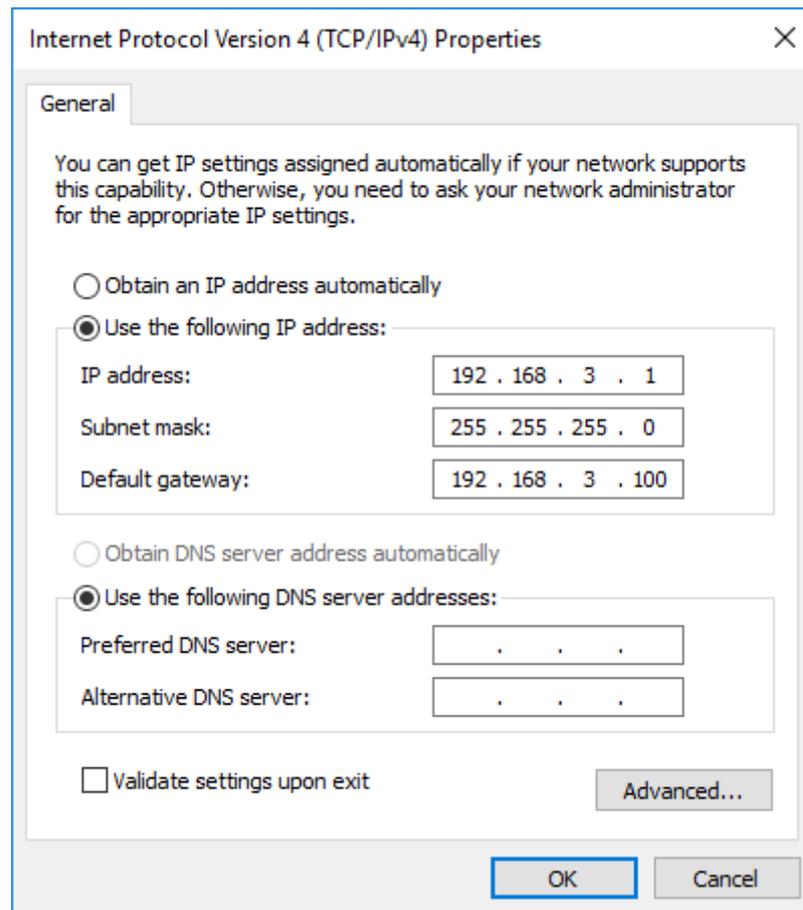


FIGURE 7: IP SETTINGS FOR DIRECT CONNECTION TO THE SENSOR.

STEP 6: Connect the sensor to your PC, open a web browser and navigate to <http://192.168.3.100>.

STEP7: Congratulations, you are now connected to the sensor.

7.2.2 Connecting to the sensor via the network infrastructure

The Aquantis sensor can be connected to the network infrastructure to access it from a distance, e.g. by means of a PLC. The sensor is equipped with a DHCP client to negotiate an IP address within the network domain. Depending on your IT infrastructure it can be useful to assign a fixed IP address to the sensor based on its MAC address [xx:xx:xx:xx:xx:xx]. This can typically be set as a rule at the router side.

STEP 1: connect the sensor the LAN.

STEP 2: connect to the sensor with the IP address which was automatically assigned during the DHCP procedure.

- “Calibration needed” No product (thickness < the range specified in product database)
Low signal (signal too small for no product – < 80% of current calibration level)
solution: run sensor and thickness calibration wizards
- “No Product or product to thin” Measured product thickness < minimum product thickness specified in the product database
causes:
- Wrong product selection or database parameters
- Product is not placed correctly under the sensor
- Thickness sensor needs calibration – execute the thickness calibration wizard
- “Product to thick” Measured product thickness > maximum product thickness specified in the product database
causes:
- Wrong product selection or database parameters
- Multiple products are stacked on top of each other
- Thickness sensor needs calibration – execute the thickness calibration wizard

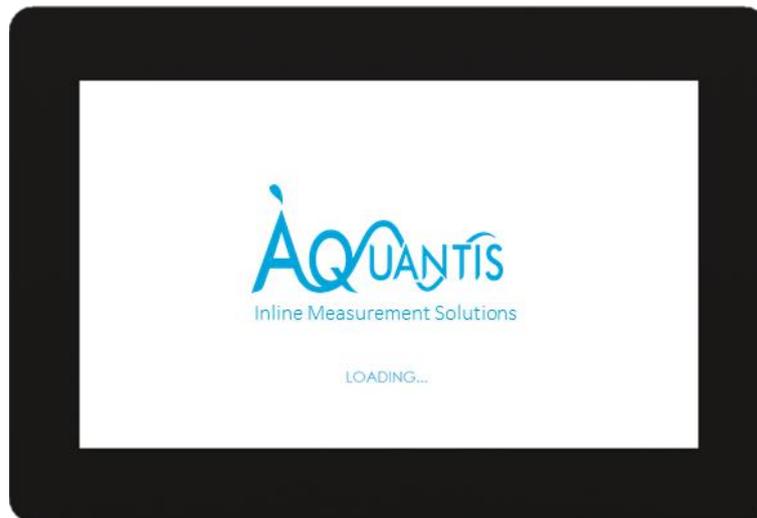
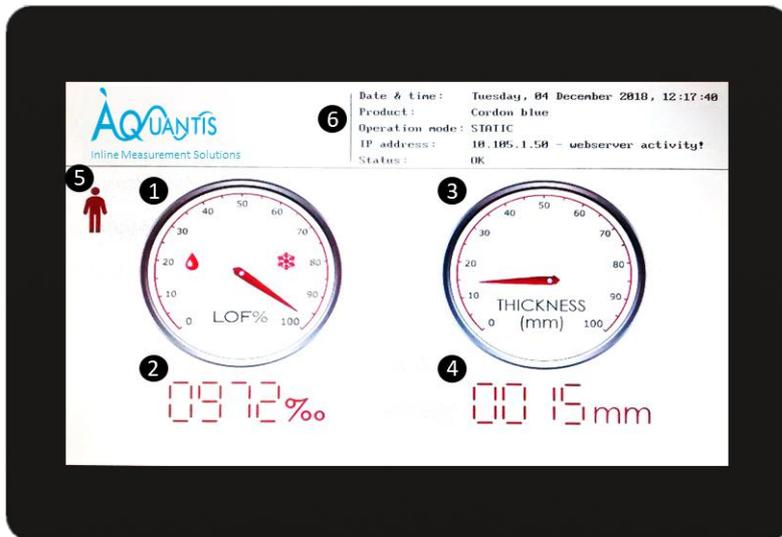


FIGURE 8: LCD-DISPLAY: START UP SCREEN



- ① INDICATOR - LOF gauge: current LOF value (%)
- ② INDICATOR - digital LOF indicator (%)
- ③ INDICATOR - Thickness gauge (mm)
- ④ INDICATOR - digital thickness indicator (mm)
- ⑤ INDICATORS - Operation mode | Warning
 -  STATIC
 -  DYNAMIC
 -  WARNING: status not "OK"
- ⑥ TEXTFIELD showing:
 - Systems Date & time
 - Product label
 - Mode-of-operation STATIC | DYNAMIC
 - IP address + indication of webservice activity
 - Sensor status
 - OK
 - No HF power
 - Calibration needed
 - Product thickness out-of-range
 - Etc.

FIGURE 9: LCD-DISPLAY: DATA SCREEN

7.3.4 Webservice interface

Note: it is advised to make use of Google Chrome version 70.x or later for consulting the sensors webpages.

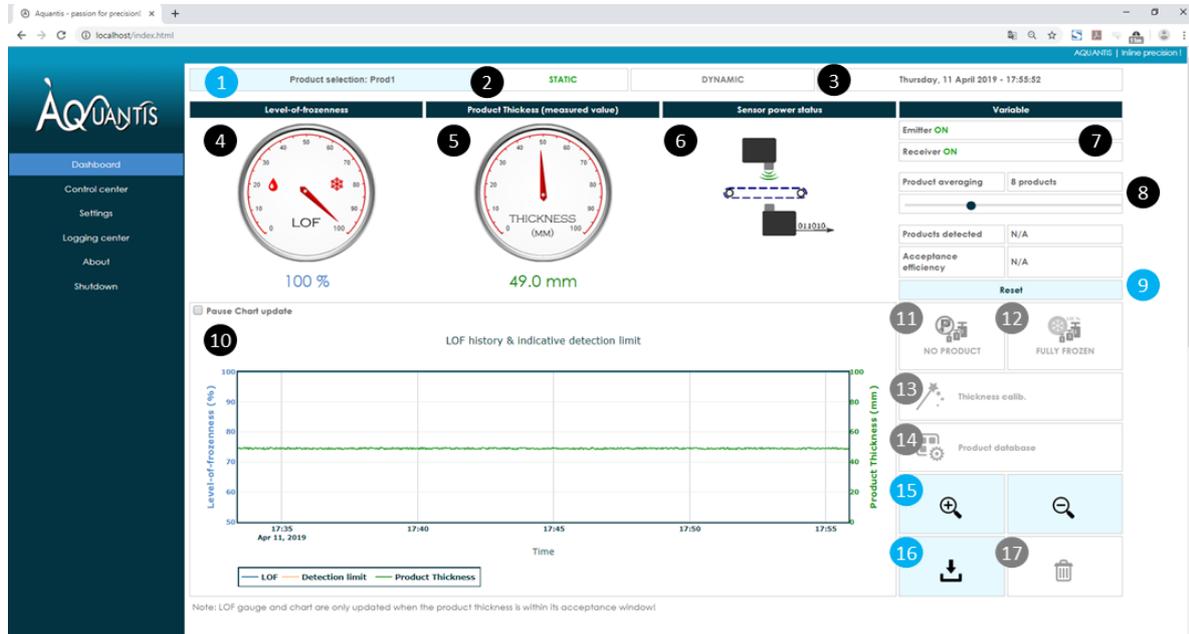
7.3.4.1 The web page structure

- DASHBOARD (home-page) [freely accessible - read only]

- CONTROL CENTER [password protected – read/write]
 - LINK TO: NO PRODUCT and FULLY FROZEN PRODUCT Calibration
 - LINK TO: Thickness sensor calibration wizard
 - LINK TO: Product specifications / signal processing
 - LINK TO: Product signal processing wizard

- SETTINGS [password protected – read/write]
- LOGGING CENTER [password protected – read/write]
- ABOUT [freely accessible - read only]
- SHUTDOWN

7.3.4.2 Dashboard
Protection level: freely accessible.



- | | |
|--|--|
| 1 CONTROL - Product selection: 1 - 12 | 9 CONTROL - Reset dynamic mode variables to 0 |
| 2 INDICATOR - Sensors operation mode: Static / Dynamic | 10 INDICATOR - LOF chart: LOF history (%) |
| 3 INDICATOR - Current date and time | 11 CONTROL (disabled) – Static mode no product calibration |
| 4 INDICATOR - LOF gauge: current LOF value (%) | 12 CONTROL (disabled) - Static mode fully frozen product calibration |
| 5 INDICATOR - Prod. thickness gauge – current prod. thickness (mm) | 13 CONTROL (disabled) - Product thickness sensor calibration wizard |
| 6 INDICATOR - Emitter / receiver power status | 14 CONTROL – Access to Product Database |
| 7 INDICATOR - Emitter / receiver power status | 15 CONTROL - Zoom in/out on LOF chart |
| 8 INDICATORS – Dyn. mode: prod. Averaging prod. Accept. yield | 16 CONTROL (disabled) - Download current LOF chart data |
| | 17 CONTROL (disabled) - Delete current LOF chart data |

FIGURE 10: DASHBOARD WEBPAGE

The home-page of the MICROFREEZE sensor consist of a freely accessible dashboard (Figure 10) on which the following parameters of the sensor are published:

1. **PRODUCT SELECTION:** shows the active product together with its product label as specified in the product database. Pressing this button activates a drop-down menu in which a product from the product database can be selected.
2. **OPERATION MODE:** shows the mode of operation of the sensor. In **static** mode of operation, the sensor is continuously publishing new measurement values. This mode is intended to be used for at-line measurements where the product under test is statically placed underneath the sensor’s aperture. In **dynamic** mode of operation, the sensor is analysing each interaction of passing products. Only when detected products are accepted for measurement (based on criteria specified in the product database), the new measurement is published. In this mode, the product averaging is active, and you can select the averaging number of the accepted products.

3. CURRENT DATE AND TIME: shows the real-time clock of the MICROFREEZE sensor.
4. LEVEL-OF-FROZENNESS GAUGE:
 - **static mode:** real-time LOF value (%).
 - **dynamic mode:** product-averaged LOF value (%) (only products accepted for measurement).
5. PRODUCT THICKNESS GAUGE:
 - **static mode:** real-time product thickness value (mm).
 - **dynamic mode:** product-averaged thickness value (mm) (only products accepted for measurement).
6. SENSOR POWER STATUS: shows the power status of the emitter and receiver unit.
7. SENSOR POWER STATUS: shows the power status of the emitter and receiver unit.
8. DYNAMIC MODE VARIABLE INDICATOR:
 - **product averaging:** shows the number of accepted products to average.
 - **products detected:** shows the number of products detected by the sensor since last reset or sensor settings change.
 - **acceptance efficiency:** shows the relative portion of accepted products with respect to the number of detected products.
9. RESET: reset the number of detected & accepted products to 0.
10. LOF CHART: shows the history of the LOF chart. Data on the outer right side of the chart is the most recent data. By checking the box PAUSE CHART UPDATE, the chart is paused allowing to zoom in. Note the system continues in the background. Unchecking the tick box resumes the chart update.
11. STATIC MODE NO PRODUCT CALIBRATION (Disabled feature on the DASHBOARD page, can be accessed by the CONTROL-CENTER page): This feature can only be used in static mode and is used for immediate calibration in absence of a product to correct for the effects of the conveyor, condensation, etc.
12. STATIC MODE FULLY FROZEN PRODUCT CALIBRATION (Disabled feature on the DASHBOARD page, can be accessed by the CONTROL-CENTER page): This feature can only be used in static mode and is used for immediate calibration of a fully frozen product. The LOF will be set to 100% from which other parameters (e.g. scattering, ...) will be calculated. To obtain reliable results, the system should first be calibrated using the STATIC MODE NO PRODUCT CALIBRATION followed by the STATIC MODE FULLY FROZEN PRODUCT CALIBRATION.
13. PRODUCT THICKNESS CALIBRATION WIZARD (Disabled feature on the DASHBOARD page, can be accessed by the CONTROL-CENTER page): This wizard guides the user through the calibration process of the product thickness sensor.
14. PRODUCT DATABASE (Disabled feature on the DASHBOARD page, can be accessed by the CONTROL-CENTER page): This button gives access to the product database. In this database, products can be specified. Also, products specific signal processing parameters can be calculated by means of an integrated wizard.

15. LOF CHART ZOOM CONTROL: controls that allow to zoom in and out on the LOF chart. In this way one can chose to see the last
 - 45 min
 - 1h 30 min
 - 3h
 - 6h
 - 12h
 - 24hof the LOF data, indicative detection limit and product thickness.

16. DOWNLOAD: control to download to current LOF data shown on the LOF history chart as a CSV-file.

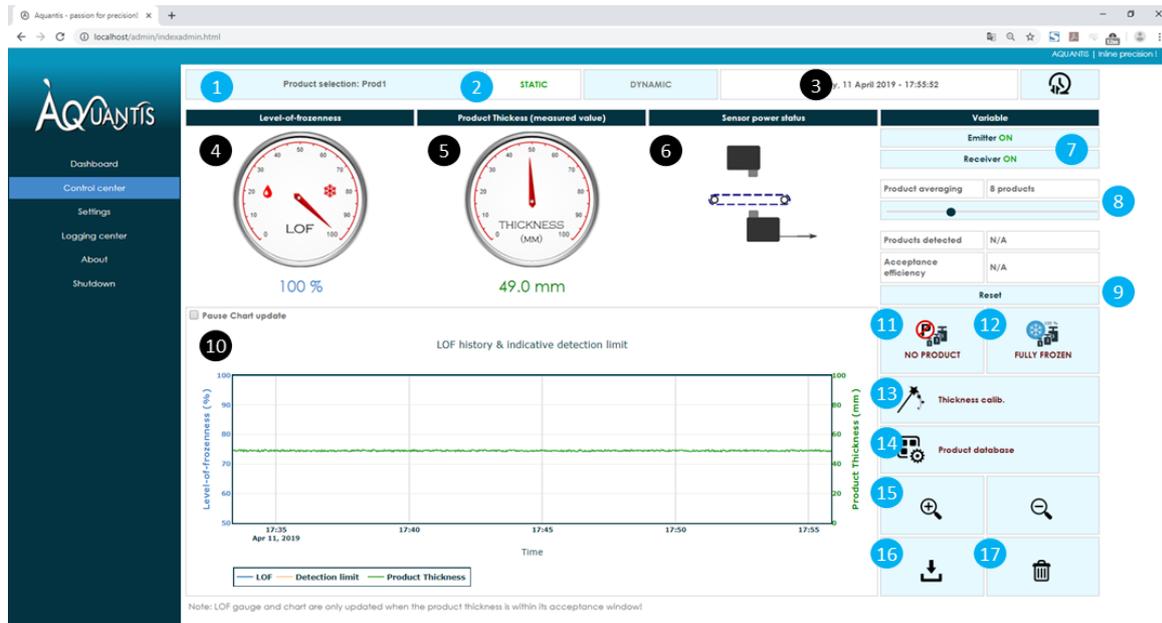
17. DELETE (Disabled feature on the DASHBOARD page, can be accessed by the CONTROL-CENTER page): control to clear to LOF chart data by resetting all data to 0.

7.3.4.3 Control centre

Protection level: password protected.

To get access to the control centre page, the user will be prompted for a username and password. The standard login is:

username: "admin"
password: "aquantis"



- | | |
|--|--|
| 1 CONTROL - Product selection: 1 - 12 | 9 CONTROL - Reset dynamic mode variables to 0 |
| 2 INDICATOR - Sensors operation mode: Static / Dynamic | 10 INDICATOR - LOF chart: LOF history (%) |
| 3 INDICATOR - Current date and time | 11 CONTROL (disabled) – Static mode no product calibration |
| 4 INDICATOR - LOF gauge: current LOF value (%) | 12 CONTROL (disabled) - Static mode fully frozen product calibration |
| 5 INDICATOR - Prod. thickness gauge – current prod. thickness (mm) | 13 CONTROL (disabled) - Product thickness sensor calibration wizard |
| 6 INDICATOR - Emitter / receiver power status | 14 CONTROL – Access to Product Database |
| 7 INDICATOR - Emitter / receiver power status | 15 CONTROL - Zoom in/out on LOF chart |
| 8 INDICATORS – Dyn. mode: prod. Averaging prod. Accept. yield | 16 CONTROL (disabled) - Download current LOF chart data |
| | 17 CONTROL (disabled) - Delete current LOF chart data |

FIGURE 11: CONTROL CENTRE WEBPAGE

The structure of this web-page is similar to the structure of the Dashboard-page. The main difference is that this page allows to control the settings which are displayed, by means of light blue control-fields on the page. It furthermore gives access to the product database and various calibration wizards. The control centre page is illustrated in Figure 11.

7.3.4.4 The thickness sensor calibration wizard Protection level: password protected.

The product thickness sensor calibration wizard starts with an introduction describing the prerequisites that needs to be fulfilled prior to continue with the thickness calibration procedure as illustrated in Figure 12. The product thickness sensor calibration procedure requires one or two non-transparent reference objects with known thicknesses. The first and the second reference object should be, respectively, thicker and thinner than the product thickness on the production line.

The calibration procedure is initiated by selecting the appropriate sensor configuration: products on conveyor or products in free-fall.

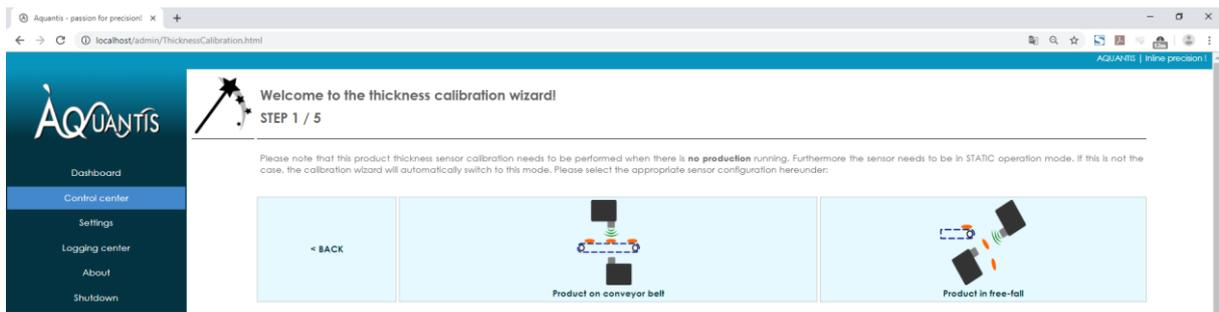


FIGURE 12: THICKNESS SENSOR CALIBRATION WIZARD - SENSOR CONFIGURATION.

Next, one needs to place a first non-transparent reference object (with known thickness) on the conveyor belt in front of the sensor such that the red laser-spot is clearly visible on the top surface of the object. This is illustrated in Figure 13.

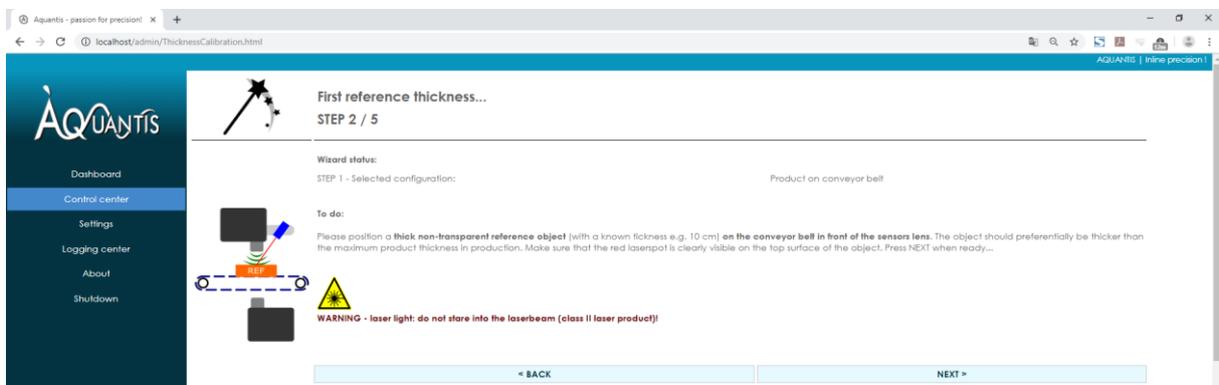


FIGURE 13: THICKNESS SENSOR CALIBRATION WIZARD - REFERENCE 1.

Next, the exact thickness of the reference object needs to be provided in mm with a precision of 1 digit after the comma. The same procedure is repeated for the second reference object (see Figure 14 - Figure 16).

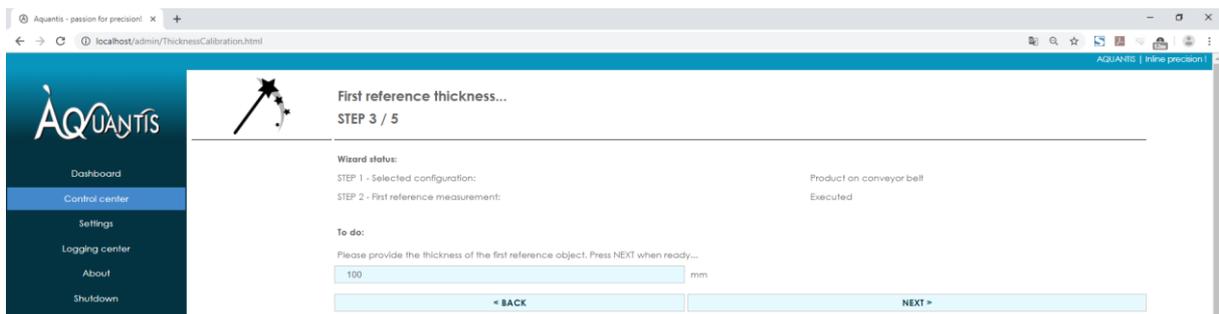


FIGURE 14: THICKNESS SENSOR CALIBRATION WIZARD - THICKNESS INPUT OF REFERENCE 1.

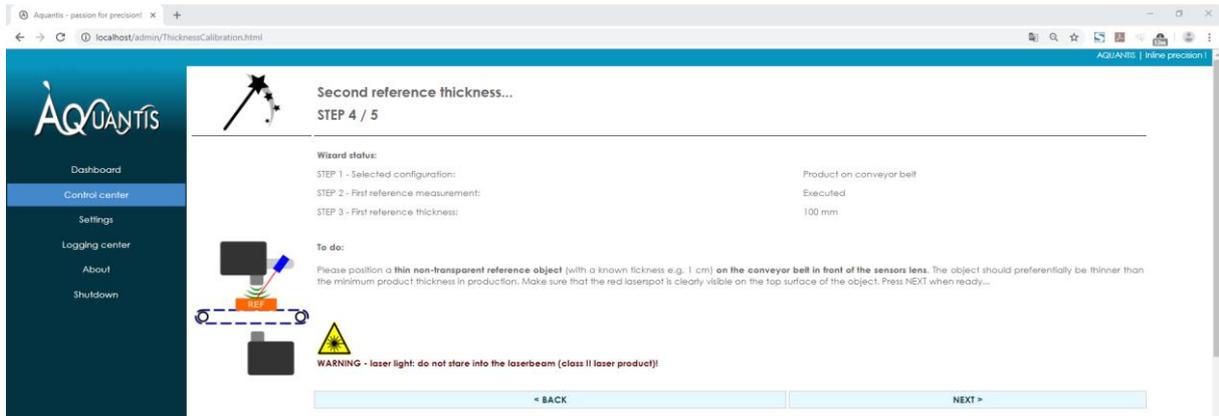


FIGURE 15: THICKNESS SENSOR CALIBRATION WIZARD - REFERENCE 2.

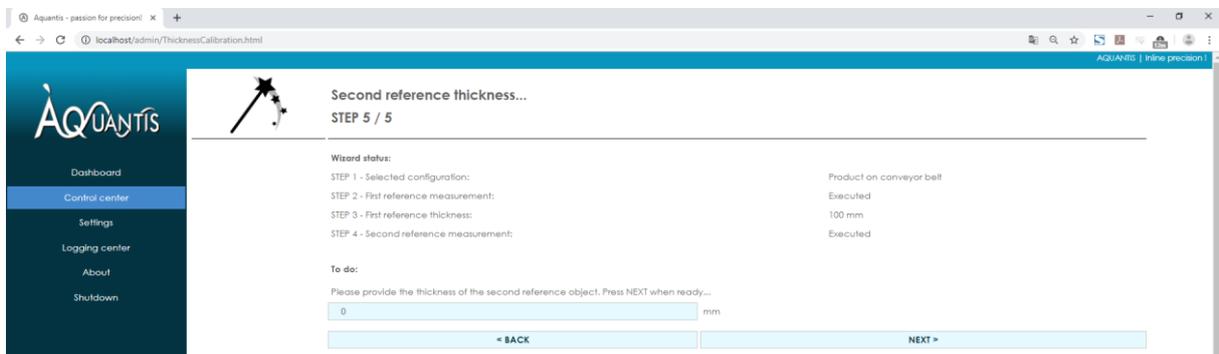
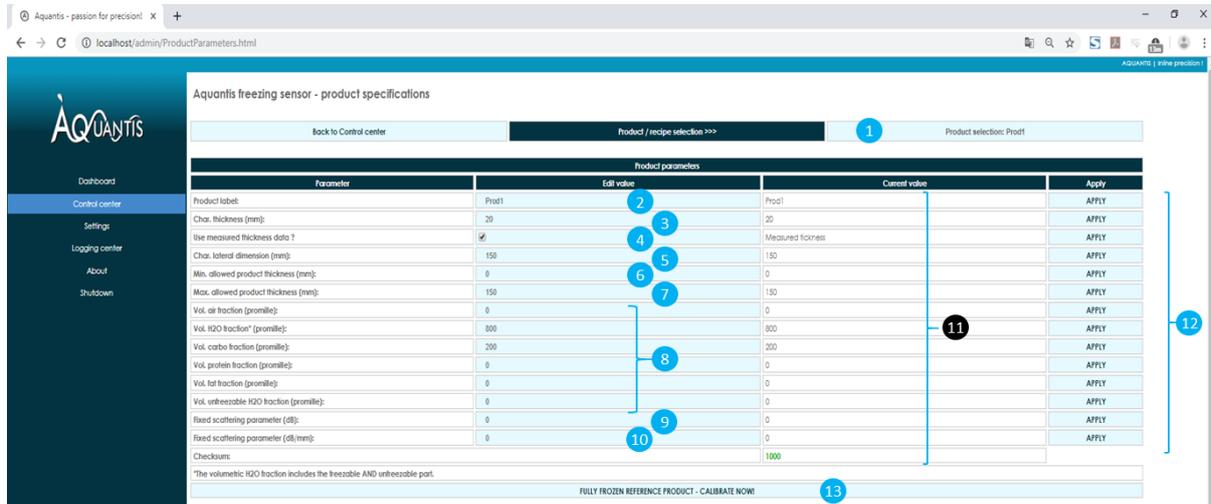


FIGURE 16: THICKNESS SENSOR CALIBRATION WIZARD - THICKNESS OF REFERENCE 2.

7.3.4.5 Product specifications & Signal processing

Protection level: password protected.



- 1 CONTROL – Dropdown menu for product selection: 1 - 12
- 2 CONTROL – Enter product label of selected product
- 3 CONTROL – Enter characteristic thickness of the product (mm)
- 4 CONTROL – Select product thickness source (database or measured)
- 5 CONTROL – Enter characteristic lateral dimension (mm)
- 6 CONTROL – Enter min. allowed product thickness for measurement acceptance in dynamic mode
- 7 CONTROL – Enter max. allowed product thickness for measurement acceptance in dynamic mode
- 8 CONTROL – Enter volumetric fractions of product ingredients (promille)
- 9 CONTROL – Enter a product specific scattering loss parameter (dB)
- 10 CONTROL – Enter a product specific scattering loss parameter (dB/mm)
- 11 INDICATOR – Current value in the database
- 12 CONTROL – Store new value in the database
- 13 CONTROL – Calibration with fully frozen reference product

FIGURE 17: PRODUCT SPECIFICATIONS PAGE - PART 1/2.

This webpage allows to specify the characteristic dimensions and composition of the individual products. Once inserted in the database, the product can be selected at the top of the page. The characteristics to be specified are:

1. **PRODUCT SELECTION:** shows the active product together with its product label as specified in the product database. Pressing this button activates a drop-down menu in which a product from the product database can be selected to be edited below.
2. **PRODUCT LABEL:** This is a user-defined label which is used to refer to the product.
3. **CHARACTERISTIC THICKNESS:** This is a fixed thickness in mm associated to the product. This is especially suited for artificially shaped product with a well-defined geometry.
4. **THICKNESS SOURCE SELECTION:** Here you can choose to use the measured thickness from the distance sensor or the characteristic thickness value from the database to perform the LOF calculation. It is generally advised to use the measured thickness for this calculation unless the product thickness cannot be measured accurately based on laser-technology (e.g. pre-packed ready meals).
5. **CHARACTERISTIC LATERAL DIMENSION:** This parameter, together with the conveyor belt or product velocity, is used to estimate the product interaction time. A tolerance on the expected interaction time is applied to accept or reject products based on the measured interaction time in dynamic mode of operation.

6. MIN ALLOWED PRODUCT THICKNESS: This is a criterion on the product thickness based on which products can be accepted or rejected in dynamic mode of operation.
7. MAX ALLOWED PRODUCT THICKNESS: This is a criterion on the product thickness based on which products can be accepted or rejected in dynamic mode of operation.
8. VOLUMETRIC FRACTION OF PRODUCT INGREDIENTS: The volumetric fractions of the main product ingredients need to be specified to calculate the LOF value for that given product.
9. SCATTERING LOSS PARAMETER 1: The product will introduce scattering losses which need to be compensated. Scattering losses are inserted in dB.
10. SCATTERING LOSS PARAMETER 2: The product will introduce scattering losses which need to be compensated. Scattering losses are inserted in dB/mm.
11. CURRENT VALUES IN THE DATABASE
12. STORE NEW VALUES IN THE DATABASE
13. FULLY FROZEN REFERENCE PRODUCT – CALIBRATE NOW: Static mode calibration of the sensor by taking a fully frozen product as a reference.

Description	Edtl value	Current value	Apply
Product / belt speed (cm/min):	300	300	APPLY
Product averaging:	8 products	8 products	
Dyn. mode prod. accepl. tolerance (%):	20 %	20 %	
Rel. averaging filter strength (%):	0 % → 20.0 %	0 % → 20.0 %	
Product detection relative threshold (%):	10 %	10 %	
Valley filler output type:	Centered 50% averaging	Centered 50% averaging	
Valley filler static max. ref. type:	Static	Static	
Expected sensor/product interaction time:	3000 ms	3000 ms	
Acquisition rate:	FPGA - 4000 Hz	VNA - 20.3 Hz	
Expected number of samples:	FPGA - 12000 samples	VNA - 61 samples	
Averaging intensity:	FPGA - 4 samples 1.0 ms	VNA - 4 samples 197.3 ms	
Product detection module - Detection threshold offset:	FPGA - 6553 digits	VNA - 6554 mW	
Product detection module - minimum S:	200 samples 2400 ms		
Product detection module - maximum S:	1200 samples 3600 ms		

- 14 CONTROL – Autoconfiguration wizard
- 15 CONTROL – Hide signal processing settings
- 16 CONTROL – Enter product or conveyor belt speed (cm/min)
- 17 CONTROL – Slider control for selecting the number of accepted products to average in dynamic mode (#)
- 18 CONTROL – Slider control to set the tolerance based on product interaction time in dynamic mode (% of expected interaction time)
- 19 CONTROL – Slider control to set the relative averaging filter strength (window size) in dynamic mode (% of expected interaction time)
- 20 CONTROL – Slider control to set the relative product detection threshold in dynamic mode (% of expected max. signal)
- 21 CONTROL – Slider control for selecting the product analysis method in dynamic mode
- 22 CONTROL – Set calibration data source: static – use static calibration data | dynamic – continuous auto-calibration
- 23 INDICATOR – Current values in the database
- 24 CONTROL – Store new value in the database

FIGURE 18: PRODUCT SPECIFICATIONS PAGE - PART 2/2.

A second part of the webpage contains the autoconfiguration and visualisation of the settings:

14. AUTOCONFIGURATION WIZARD: See section 7.3.4.6 for more information.

15. SHOW/HIDE SIGNAL PROCESSING SETTINGS: Show or hide the signal processing settings.

A third part of this webpage (illustrated in Figure 17: Product specifications page - part 1/2.) can be visualized by pressing the button “*Show signal processing settings*”. It is advised to make use of the **data processing wizard** to calculate the optimal product specific signal processing settings, but manual fine-tuning can be done by editing the field in this second part of the page. Parameters that can be specified are:

16. PRODUCT / BELT SPEED: This parameter is together with the characteristic lateral dimension is used to estimate the product interaction time. A tolerance on the expected interaction time is applied to accept or reject products based on the measured interaction time in dynamic mode of operation.
17. PRODUCT AVERAGING: This slider allows to select the number of accepted products (in dynamic mode) that needs to be averaged.
18. PRODUCT INTERACTION TIME TOLERANCE: This is the relative tolerance with respect to the expected product interaction time. In dynamic mode, this parameter determines whether a product can be accepted for measurement based on its measured product interaction time. This selection mechanism eliminates low-quality measurements characterized by a lower/higher than expected interaction time (e.g. a measurement on the edge of the product).
19. RELATIVE AVERAGING FILTER STRENGTH: This is the relative fraction of the products lateral characteristic dimension that will be averaged in a moving averaging filter
20. PRODUCT DETECTION RELATIVE THRESHOLD: This threshold determines which signal change is significant enough to be interpreted as a product.
21. VALLEY FILTER OUTPUT TYPE: this parameter sets the amount of points used in the valley filter.
22. VALLEY FILTER STATIC MAX REFERENCE TYPE: This parameter determines whether the static or dynamic reference is used
23. Current settings
24. Apply and save the altered settings.

Changing the above settings can lead to unreliable results. Therefore, the auto-configuration wizard needs to be followed.

7.3.4.6 Signal processing – auto-configuration wizard

Protection level: password protected.

The auto-configuration wizard starts with an introduction describing the prerequisites that needs to be fulfilled prior to continue with the configuration procedure. This is illustrated in Figure 19 to Figure 24. The configuration procedure is initiated by pressing NEXT.

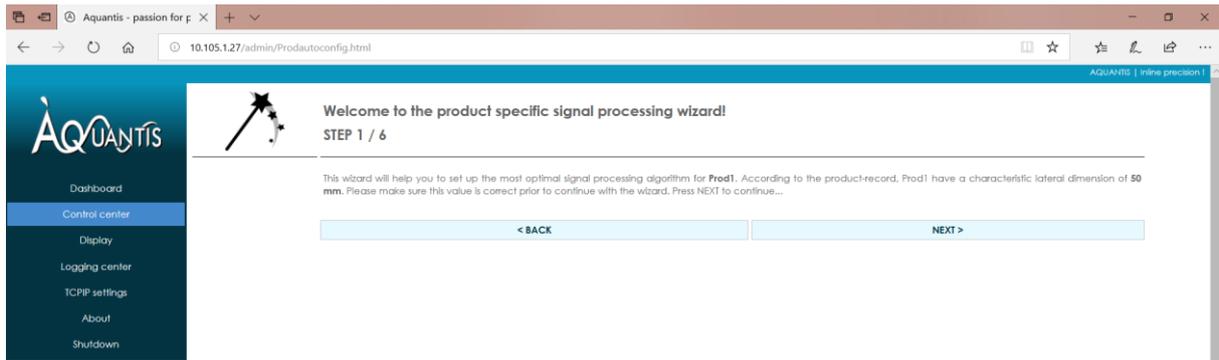


FIGURE 19: AUTO-CONFIGURATION WIZARD - INTRODUCTION - STEP 1/6.

Next, the user needs to provide the product speed.

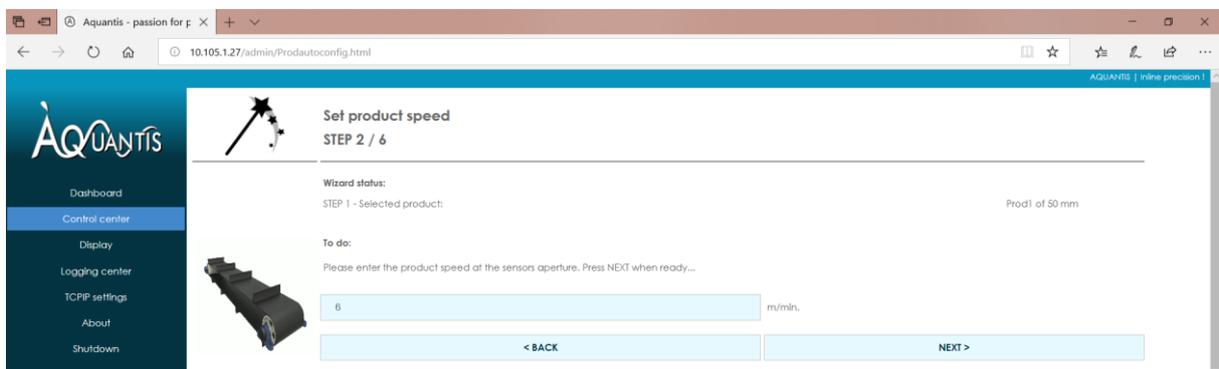


FIGURE 20: AUTO-CONFIGURATION WIZARD - PRODUCT SPEED - STEP 2/6.

Products showing a non-ideal interaction with the sensor (e.g. an interaction time outside the expectation range) should not be accepted for measurement. The acceptance interval needs to be specified in step 3 of the wizard (see Figure 21).

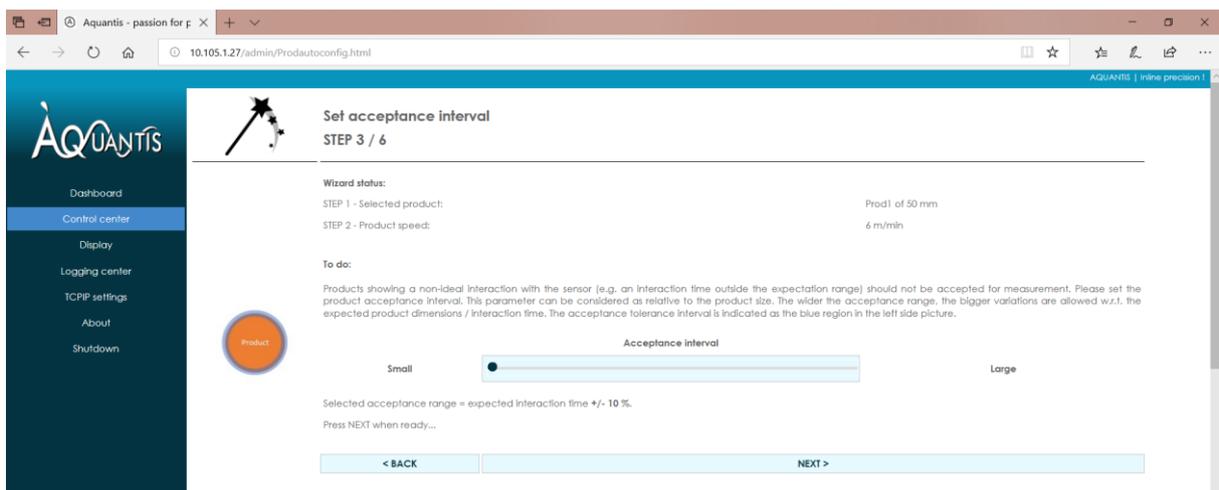


FIGURE 21: AUTO-CONFIGURATION WIZARD - ACCEPTANCE INTERVAL - STEP 3/6.

In step 4, the averaging intensity needs to be specified. This value is relative to the product size / interaction time.

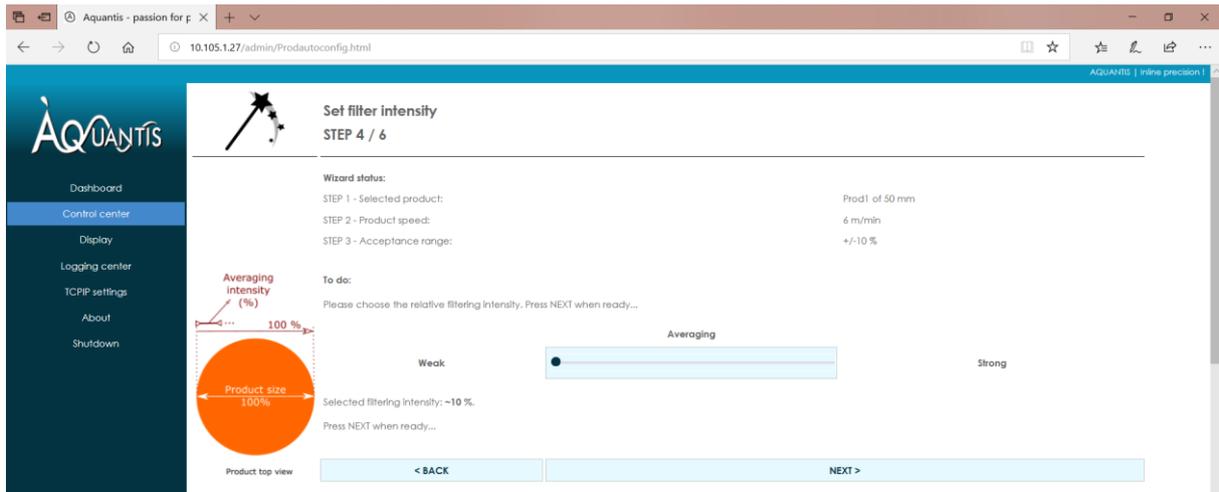


FIGURE 22: AUTO-CONFIGURATION WIZARD - FILTER INTENSITY - STEP 4/6.

In step 5, the number of products to be averaged for the LOF calculation needs to be specified.

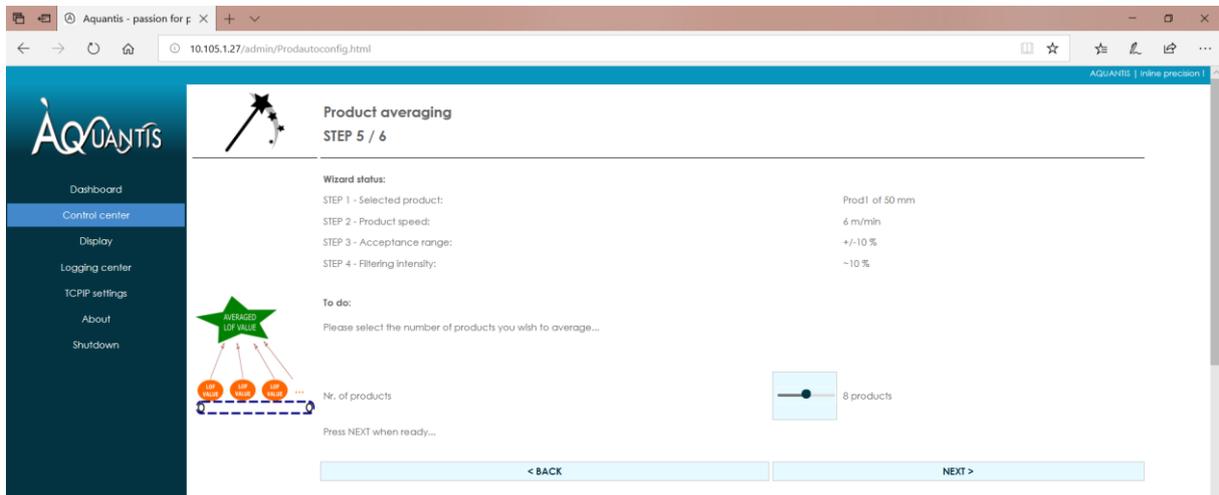


FIGURE 23: AUTO-CONFIGURATION WIZARD - PRODUCT AVERAGING - STEP 5/6.



FIGURE 24: AUTO-CONFIGURATION WIZARD - OVERVIEW - STEP 6/6.

7.3.4.7 TCPIP settings

Protection level: freely accessible.

The TCPIP settings page shows the current IP and MAC address. A static IP address will be active unless DHCP is used to attribute the IP address automatically.

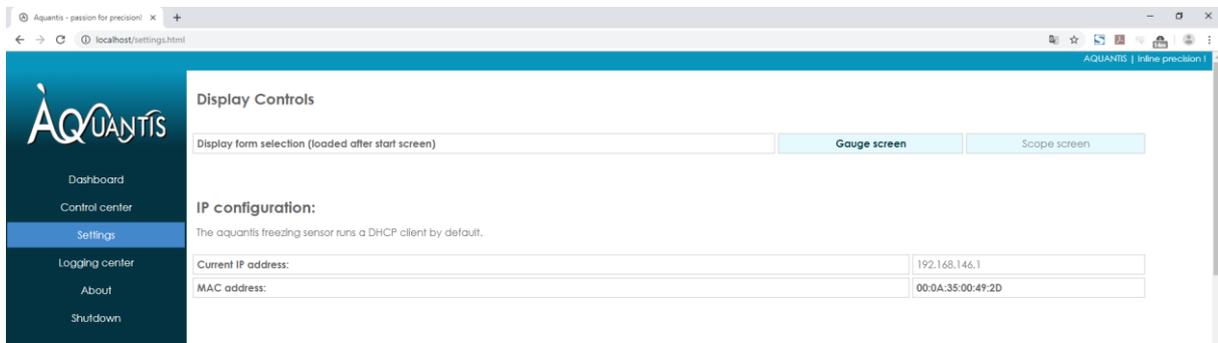
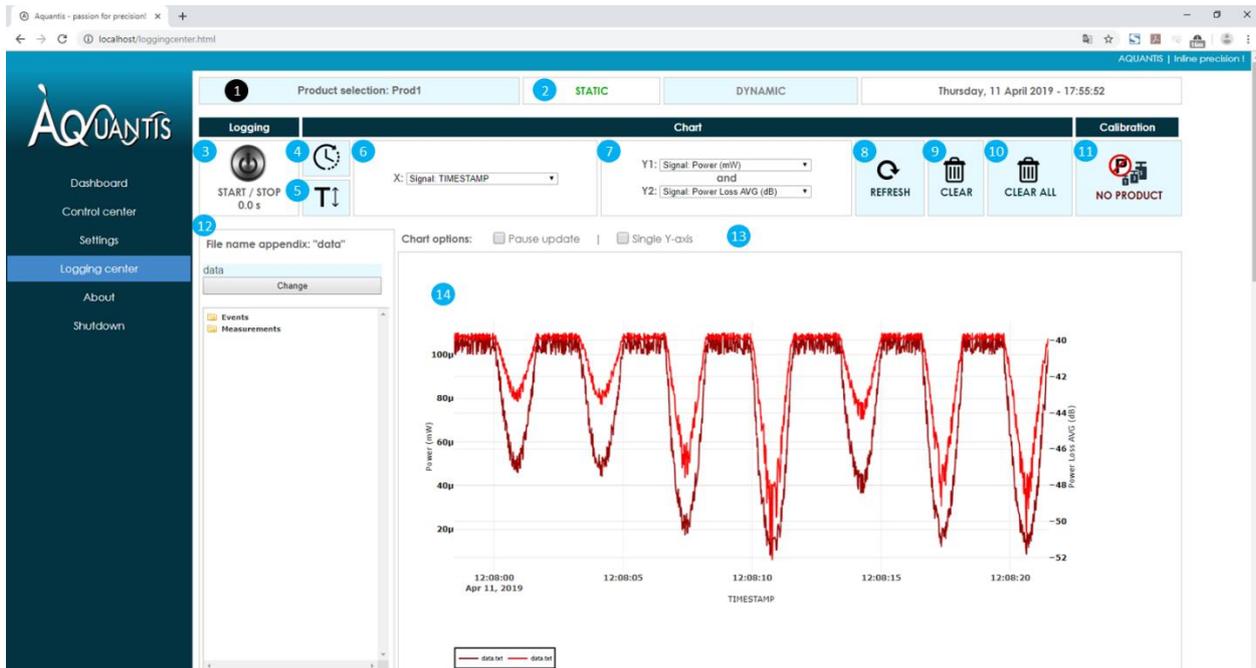


FIGURE 25: TCPIP SETTINGS PAGE.

7.3.4.8 Logging center

Protection level: freely accessible.

The logging center page allows to log measurement data to files stored on the MICROFREEZE sensor. When logging is active, the sensor starts automatically a new logging file every 10 min. The file name of every logging file comprises the timestamp at the time of closing the file. The MICROFREEZE has an event logging feature which is always active.



- | | | |
|--|--|--|
| 1 INDICATOR – Product selection | 6 CONTROL – Selection parameter horizontal axis | 11 CONTROL – Calibration without product |
| 2 CONTROL – Static or Dynamic mode | 7 CONTROL – Selection left (Y1) and right (Y2) vertical axis | 12 CONTROL – File naming and file tree |
| 3 CONTROL – Start / Stop measurement | 8 CONTROL – Refresh graph | 13 CONTROL – Chart options |
| 4 CONTROL – Data acquisition vs. Time | 9 CONTROL – Clear data points except current acquisition | 14 CONTROL – Chart |
| 5 CONTROL – Data acquisition vs. Temperature | 10 CONTROL – Clear all data points (including current acquisition) | |

FIGURE 26: LOGGING CENTRE WEB PAGE.

1. **PRODUCT SELECTION:** shows the selected product.
2. **MODE OF OPERATION:** Static or dynamic mode of operation. The active mode is indicated in green.
3. **START / STOP:** Start and stop of the data acquisition.
4. **DATA ACQUISITION VS. TIME:** setting the data acquisition vs. time in the graph (14).
5. **DATA ACQUISITION VS. TEMPERATURE:** setting the data acquisition vs. temperature in the graph (14).
6. **X-AXIS:** Set the parameter of the horizontal axis.
7. **Y-AXIS:** Set the parameters of the vertical axes with Y1 on the left side and Y2 on the right side on the graph.
8. **REFRESH:** Refreshes the graph.
9. **CLEAR:** Clears the graph without removing the current acquisition data.
10. **CLEAR ALL:** Clears the graph completely including the current acquisition data.

11. CALIBRATION: Calibrates the system without the product to correct for dirt or condensation on the conveyor belt.
12. FILE NAMING AND FILE TREE: Used for naming the files which already contain an initial date and time stamp. The file tree allows to display the data files. Note that new data files might only be visible after refreshing the directory tree by closing and opening the “Measurements” directory.
13. CHART OPTIONS: The chart can be paused temporarily to allow zooming or other actions. The data acquisition continues in the background. Once unticked, all data is displayed. The single axis option allows to have a single axis.
14. CHART: Chart displaying the data points.

7.3.4.9 About

Protection level: freely accessible.

The about-page contains basic information about the sensor as well as a download-link to the user-manual.



FIGURE 27: ABOUT PAGE.

7.3.5 Modbus TCP/IP interface

7.3.5.1 Holding registers (READ only)

Index	Format	Description	Values
2	UINT16	Product index	1 – 12 (selected product)
3	UINT16	Operation mode of the sensor	0: STATIC (at-line) 1: DYNAMIC (in-line)
4	UINT16	Product Averaging Filter Intensity	X = 0 – 8 # products = 2 ^X
5	UINT16	LOF value	min – 1000 (permille)
6	UINT16	Product thickness	thickness (x 10 ⁻¹ mm)
7	UINT16	# Products detected	0 – (2 ¹⁶ – 1)
8	UINT16	# Products accepted	0 – (2 ¹⁶ – 1)
9	UINT16	Static signal output validity	0: not valid 1: valid
10	UINT16	Dynamic signal output validity	0: not valid 1: valid
11	UINT16	Sensor heart beat	

auto-initialized to 1 at start-up
writing 0 to this register results in sensor software shutdown. Keep the sensor power on for at least 2 min after initiating the shutdown process.

8 Maintenance & Disposal

Aquantis sensors are designed to provide many years of service in the field. To assure the system performs at its highest accuracy, the sensor should be kept in good conditions.

8.1 Daily maintenance

On a daily base, the antenna caps and laser distance sensor window should be dry and clean to get the best measurement results. Dust, dirt or drops of liquid can impair the measurement result and in worst case cause wrong measurement results. No specific tools nor material are supplied for daily maintenance. No chemicals can be used which are not compatible with polytetrafluoroethylene (PTFE) or stainless steel (AISI 304) materials.

8.2 Yearly maintenance

A yearly maintenance is mandatory to guarantee proper system performance during the 10-year life expectancy of the Microfreeze. No specific tools nor material are supplied for yearly maintenance. Only Aquantis engineers or Aquantis-certified engineers are allowed to conduct the yearly maintenance and/or repair the Microfreeze sensor. The maintenance certification can be obtained after training given by Aquantis. Contact Aquantis for more information.

8.3 Disposal

The device can be disposed by removing the individual units from their frame and returning them to Aquantis on one of the contact addresses. During removal, the units should not be opened.

9 Troubleshooting

9.1 Unexpected stop and restart

In case the system or a part of the system stopped working, the following steps needs to be followed:

1. Open the web interface.
2. Check if all product and operational parameters are set correctly including the product composition and product speed.
3. Check that the appropriate mode (static or dynamic) is selected. In dynamic mode, the system will only provide information of the products which fall within the detection boundaries. These boundaries are determined by the product speed and product variation (see section 7.3.4.2 above Dashboard). Select static mode to check if the thickness and LOF sensors respond accordingly.
4. Recalibrate the LOF by means of the NO PRODUCT and FULLY FROZEN PRODUCT buttons (see section 7.3.4.3 control center), auto-configuration wizard in dynamic mode (see section 7.3.4.6) and thickness sensors using the calibration wizards (see section 7.3.4.4 The thickness sensor calibration wizard).
5. Check if the clock in the top right of the web page is stopped functioning. If the clock stopped, proceed to step 3. If the clock displays the correct time, proceed to step 4.
6. Perform a hard refresh of the webpage which is on a typical Windows PC done via the key combination CTRL + F5.
7. Try to shut down the system using the webserver's shutdown-button. In case this doesn't work, turn off the power, wait for at least 10 seconds and restart the system. Avoid hard restarts as much as possible since this may affect the proper functioning of the device.
8. Contact Aquantis if the above steps didn't solve the problem.

9.2 Returns

For efficient processing and finding the cause of the fault, include the following information when returning:

- Details of a contact person
- Description of the application
- Description of the fault which occurred.

9.3 Repairs

Repairs of the sensor are only carried out by Aquantis or Aquantis-certified engineers. Contact Aquantis for the repair of the sensor. Any manipulation or modification of the sensor can result in additional costs.

10 Technical data

10.1 General specifications

- Operating temperature: -40 °C to +40 °C

10.2 Electrical specifications

10.2.1 High frequency electronics – GHz Technology

- Power Order of 10 dBm
- Frequency bands 2.4 – 2.5 GHz and 5.725 – 5.875 GHz
- Dynamic range ~60dB
- Output Waveguide-based HF emission
- Sensors spot size @ product About 10 cm

10.2.2 Low frequency electronics

10.2.2.1 Power connectivity

- Input: AC Single Phase 100-240V~ 0.5A 50-60 Hz

10.2.2.2 Data connectivity / interface

- Ethernet RJ45 plug
- Industrial interface MODBUS TCP/IP server
- Web-server based user interface Remote interaction with the sensor via a browser
- DHCP client Automatic negotiation of IP address

10.2.2.3 Data acquisition

- Resolution 16 bits
- Capacity LOF calculations > 10 LOF values per second (1 LOF per product or batch)

10.3 Mechanical specifications

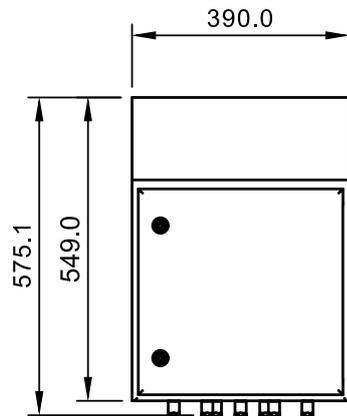
10.3.1 Materials

Sensor body	Hygienic food-grade stainless steel housing (AISI 304), IP66
Cable glands	Hygienic food-grade stainless steel cable glands
EM output cap	Polytetrafluoroethylene (PTFE)
Fixation	Stainless steel spacers M10
Sealing	White EPDM flat seals for HF box covers & EM output cap

10.3.2 Computer-box

Weight: order of magnitude of 30 kg

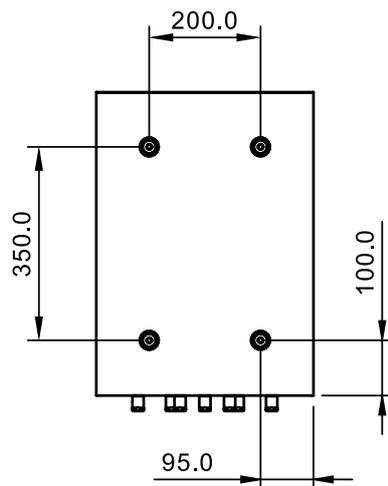
Front



General



Back



Side

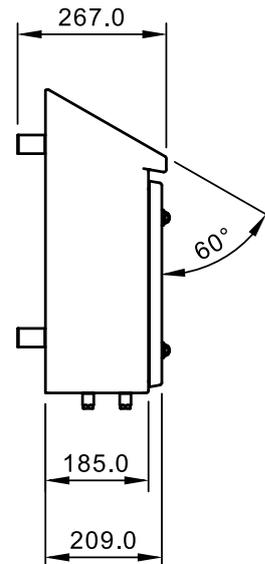


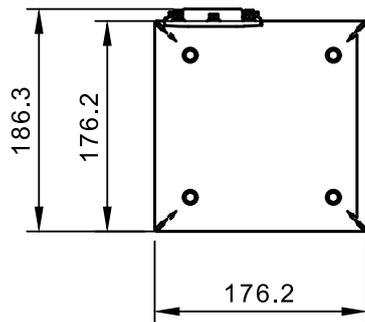
FIGURE 28: COMPUTER UNIT OUTER DIMENSIONS.

10.3.3 HF measurement units

Figure 29 shows the outer dimensions of both the emitter and receiver.

Weight per unit: order of magnitude of 5 kg

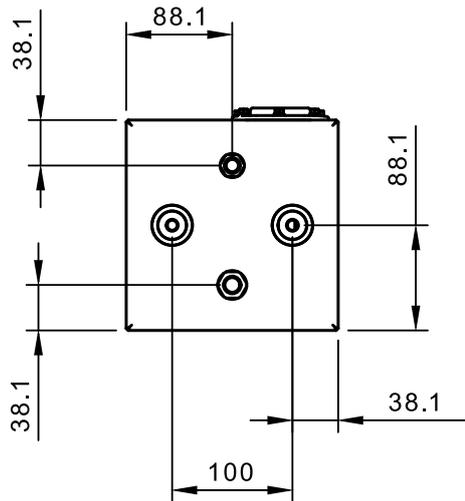
Front



General



Back



Side

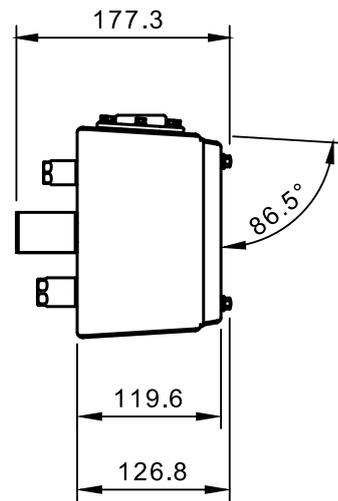


FIGURE 29: RECEIVER UNIT OUTER DIMENSIONS.