Laser Level Transmitter

TL400-I

USER GUIDE – V3.0x B

NOVUS
We Measure, We Control, We Record

ANATEL
13883-22-07089

1 SAFETY ALERTS

The symbols below are used in the device and throughout this manual to draw the user's attention to valuable information related to device safety and use.

CAUTION	CAUTION OR HAZARD	ATTENTION
Read the manual fully before installing and operating the device.	Risk of electric shock.	Material sensitive to static charge. Check precautions before handling.

All safety recommendations appearing in this manual must be followed to ensure personal safety and prevent damage to the instrument or system. If the instrument is used in a manner other than that specified in this manual, the device safety protections may not be effective.

CLASS 1 LASER PRODUCT

according to DIN EN 60825-1:2015-07

This product emits radiation in the infrared range and uses LASER technology. It has been developed to meet the class 1 requirements of IEC 60825-1:2014 (Third Edition). Provided that the user follows **NOVUS** recommendations described in this manual, the radiation emission will remain within the limits of class 1. Lenses or any form of optical device should not be used to alter the product performance.

2   PRESENTATION

TL400-I is a non-intrusive level transmitter with no moving parts, using an infrared laser technology (~920 nm) that is completely safe to the human eye (LASER CLASS-1). Its measurement principle is based on ToF (Time of Flight), providing an accurate and reliable distance measurement, regardless of the color or transparency of the surface[1] . It can be used to measure from grains and solids to transparent liquids such as water and diesel.

It has a robust housing, withstanding pressures up to 8 bar, and excellent resistance to flammable materials such as diesel, gasoline, or alcohol.

With a measurement capacity up to 4 meters and 1 Hz sampling, **TL400-I** is an excellent alternative to level sensors based on ultrasonic, capacitive, or floating technology since it does not need to be in contact with the surface to be measured.

The transmitter has a dedicated filter for non-static tank applications based on machine learning algorithms that have been validated in real-life situations and have configurable parameters for specific applications.

The sensor allows you to configurate the opening angle, ranging from 12° degrees for irregular tank or reservoir applications to 27° degrees for tanks where the base diameter is half the height to be measured.

TL400-I has a BLE (Bluetooth Low Energy) interface. With it you can:

- Configure the **analog output** (4-20 mA), according to the specific application
- Configure the **opening angle** of the sensor (from 12° to 27° opening degrees)
- Customize the tank with up to 20 points in level percentage
- Perform sensor **diagnostics** in real time
- Configure the dynamic **filter** based on the application
- Update the **firmware** to the most current version, which will always be available on **NOVUS** website

These functions can be adjusted through the **SigNow** app, available for Android and iOS.

The sensor can retransmit the analog output in **Level**, **Volume**, or **Distance**. Level and distance are set in your preferred unit (mm, cm, m, inches, or feet) and volume is always displayed in percent.

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[1] In sunlit environments or in small to medium sized tanks that have reflective walls, the sensor may have difficulty to make an accurate measurement. See recommendations for use and application.

3   IDENTIFICATION

3.1   OVERVIEW

The housing of the equipment is made of polycarbonate, an extremely resistant material, and was built to meet the IP68 protection index. It has a gasket in NBR material.

Figure 1 –   Overview

3.2   IDENTIFICATION

The identification label, located on the top of the housing, shows the model, serial number, and product code. To make it easier to see the serial number, you can also scan the QR Code.
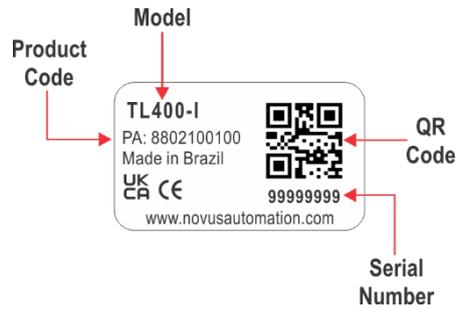

Figure 2 –   Equipment identification

3.3   TL400-I

TL400-I is suitable for industrial installation. It can be installed on a tank lid and has a cable with an M12 connector.

Figure 3 –   TL400-I

4 INSTALLATION

4.1 ELECTRICAL INSTALLATION

4.1.1 INSTALLATION RECOMMENDATIONS

- Electronic and analog signal drivers must run the plant separately from the output and power leads. If possible, in grounded conduits.
- The power supply for the electronic instruments must come from a proper power grid for instrumentation.
- It is recommended to use RC FILTERS (noise suppressors) in contactor coils, solenoids, etc.
- In control applications, it is essential to consider what can happen when any part of the system fails. The device internal security features do not guarantee full protection.

4.1.2 ELECTRICAL CONNECTIONS

The output connector is a M12 type with the following wiring connections:

1 – Vcc (9 – 33Vdc)

2 – Analog Out +

3 – GND

4 – Analog Out -

Figure 4 – Electrical connections

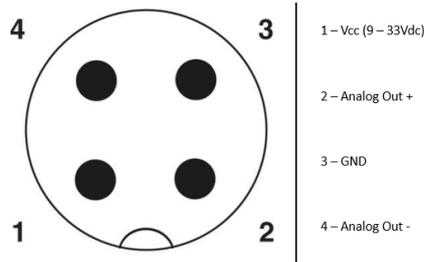**TL400-I** has two accessory cables, which can be purchased separately:

- 1 m PVC sensor cable 4-pin | M12 female connector (Order code: *8806065000*)
- 3 m PVC sensor cable 4-pin | M12 female connector (Order code: *8806065100*)

4.1.3 DIMENSIONS

4.1.3.1 TL400-I

The figures below show the dimensions of the **TL400-I** and an overview of the equipment:
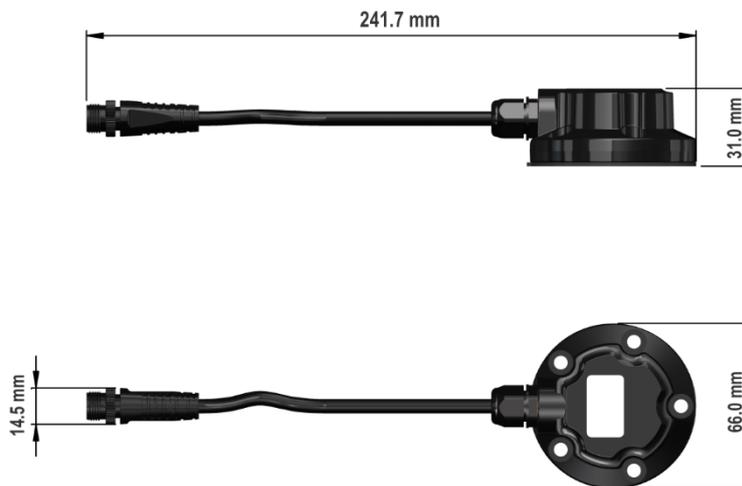

Figure 5 – Dimensions

4.1.3.2 5-HOLE TO 4-HOLE ADAPTER

The 5-hole to 4-hole adapter is an accessory for tanks that already have standard 4-hole drilling. The figure below shows the dimensions and drilling of the adapter for attaching the equipment:
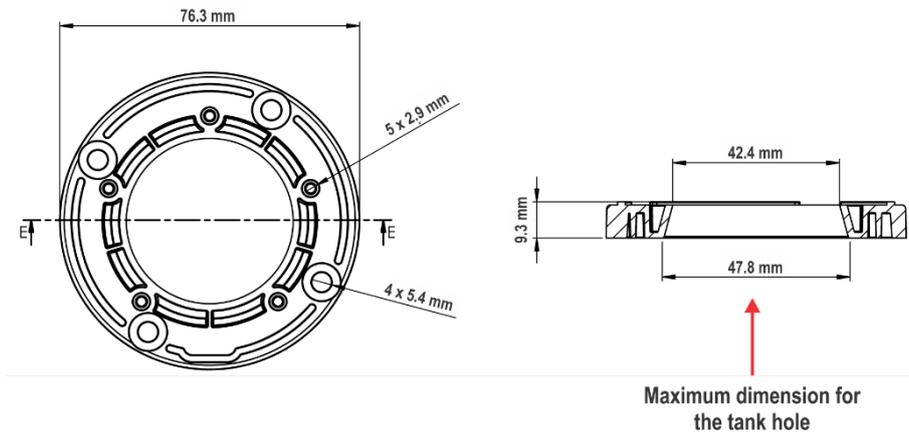

Figure 6 –   Adapter

4.2   MECHANICAL INSTALLATION

To install the level sensor, the following tools are required:

- 4.0 to 4.2 mm drill for the screws
- 20 to 40 mm hole saw for the sensor
- Pencil for marking the hole points

After that, you must follow the steps below:

1. **Perform the marking:** While the tank is empty, use the gasket to mark the hole points of the 5 screws and the sensor in the center of the ring. When using an adapter, mark the hole points of the 4 screws and the sensor in the center of the ring.
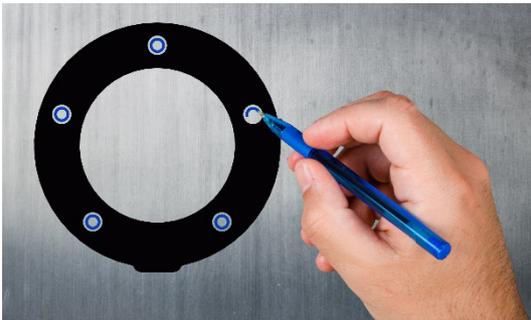
Figure 7 –   Marking the gasket
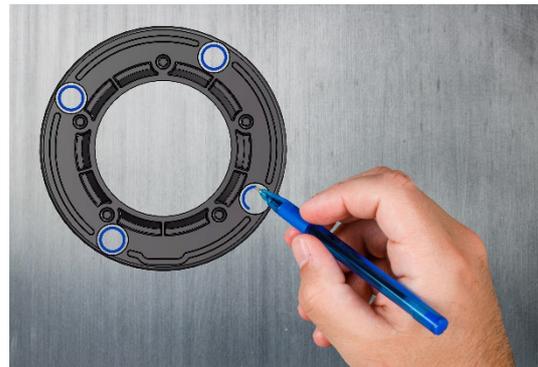
Figure 8 –   Marking the adapter (accessory)

2. **Install:** Use a drill with the hole saw to drill the tank in the center, where the sensor will be installed. Then drill 4 mm holes at the marked positions. The gasket has a small cutout between the longer distance holes where the sensor output cable will be positioned.

3. **Make the connections:** After placing the equipment in the desired location, tighten the screws and then make the electrical connections (see ELECTRICAL CONNECTIONS section).

4. **Configure:** Use the **SigNow** app to configure the equipment (see SIGNOW APP chapter).

4.2.1 TL400-I WITH AND WITHOUT ADAPTER

The figures below show versions of the equipment with and without the adapter (optional accessory):

Figure 9 – TL400-I

Figure 10 – TL400-I with adapter

To install the adapter and the gasket, the correct position must be observed:
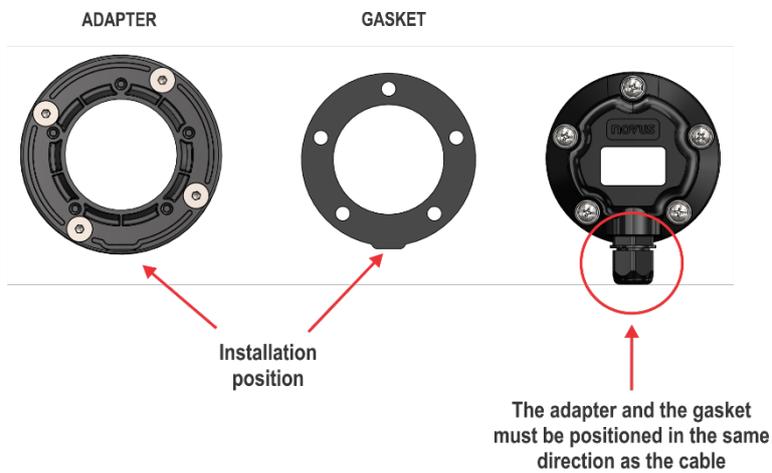
Figure 11 – Installation position

4.2.2 INSTALLATION EXAMPLES

The figures below show examples of how to position the equipment, according to the environment where it will be installed and considering the application:
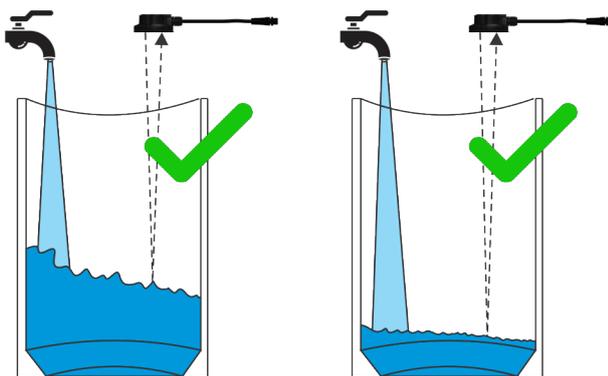
Figure 12 – Installation examples

- Install the equipment so that the laser is perpendicular to the surface of the substance to be monitored.
- Ensure that the equipment is positioned away from the area where the liquid or solid will be poured into the tank or reservoir.

The figures below show examples of situations to be avoided during the installation process:

- **Do not** install the equipment sideways or with the laser pointing into the area where the liquid or solid will be poured into the reservoir.

- **Do not** install the equipment over a faucet, which will completely block the laser.

Improper application will block the equipment from measuring the area to be monitored as intended. **For this reason, you must always ensure that it is positioned perfectly perpendicular to the surface**.

Figure 13 – Examples of improper installations

TL400-I is not recommended for applications in environments with direct sunlight. In such cases, measurement may be affected.

5   DEFINITIONS

This chapter presents definitions of terms to be considered throughout the manual.

5.1   TECHNICAL TERMINOLOGY

TL400-I uses a few specific terms, such as ullage, level, distance, and height, which can be analyzed below:

- **Ullage:** Term used to describe the difference between the height of the tank and the surface of the liquid or solid.
- **Level:** Term used to describe the height of the liquid or solid when compared to the bottom of the tank.
- **Distance:** Term used to describe to the height between the surface of the liquid or solid and **TL400-I** (Offset = 0).
- **Tank Heigh:** Term used to describe the total tank height.
- **Filter Type:** The equipment allows using a static filter or a dynamic filter. The static filter is a moving average with a configurable response time of at least 1 second. The dynamic filter, on the other hand, constitutes a stable measurement algorithm for applications where the tank may be in motion with a fixed response time of 1 minute and 40 seconds. If you need to use the dynamic filter with another response time, please contact Technical Support.
- **Angle of View:** Also known as Field of View (FoV), this parameter allows you to define the field of view for the sensor. To achieve the best sensor performance, it is recommended that it always be as large as possible. When using a sensor based on optical principles, it is important that the installation ensures that the bottom of the sensor is directed at the liquid surface in a fixed and perpendicular way, as shown in the figure below.
- **Installation Offset:** Term used to describe the difference between the height where **TL400-I** was installed and the maximum tank height. The value must be inserted in the configured unit of measure. You must define an installation Offset when the maximum tank height and the height at which **TL400-I** is installed are not the same.
- **Full Tank (URV):** Term that corresponds to the height of the tank at which the analog output will show a maximum value.
- **Empty Tank (LRV):** Term that corresponds to the height of the tank at which the analog output will show a minimum value.
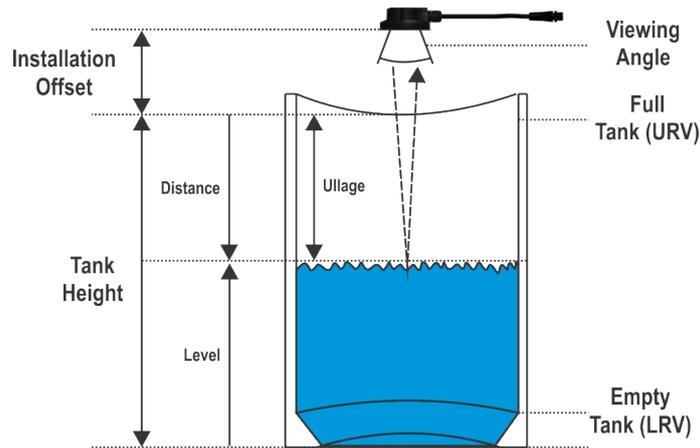
Figure 14 –   Example

5.2   SOME TYPES OF TANKS

TL400-I can be used with several types of tanks, as shown in the examples below:
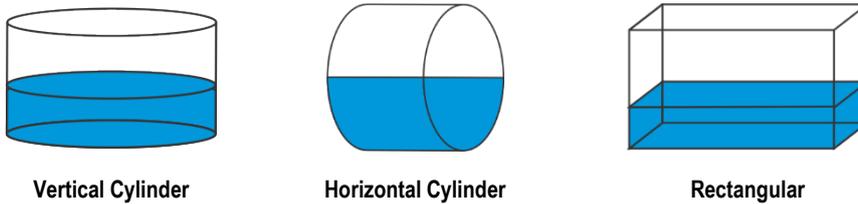
Vertical Cylinder   **Horizontal Cylinder**   **Rectangular**

Figure 15 –   Types of tanks

If the options do not fit the type of tank being used, **TL400-I** also allows you to create custom tanks. This feature is useful for tanks that are shaped with curves, rises, and other irregularities.

When you select this option, you will need to perform a linearization at specific points on the tank. Up to 20 linearization points are allowed. The data configured in these parameters will always be in centimeters.
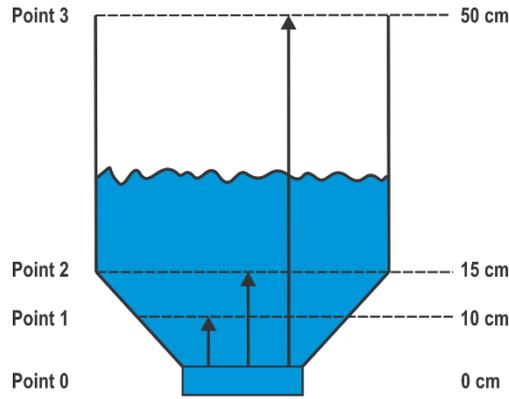

Figure 16 – Example of a customized tank

The custom curve can also be used to correct a possible non-linearity of the level sensor's measurement. To use the function for this purpose, you must go to the Diagnosis tab.

In the example below, the measurement inferred in the Diagnosis tab with an empty tank was 80 cm; with the tank at 50 %, it was 40 cm. Regardless of the actual distance measured by other means, simply insert the points as follows to obtain a custom curve:

When using the Diagnostics tab, you must take the measurements of the desired curve and write down the distance values versus the desired percentage. Once you have all the values from 0 to 100 % with the desired number of points (with a maximum of 20 points), follow the path **Configuration > Advanced > Input > Tank Calibration** and insert the points as shown in the figure to the side. To delete a calibration point, simply drag it to the right.

After inserting all the points, follow the path **Menu > Send**.

> ⚠️ **Before sending the configuration, it is suggested that you check the configured parameters. The parameters will be overwritten in the equipment.**

To check if the curve is in accordance with the set value, you can follow the path **Diagnostics > Advanced > Forcing** and force a distance, which will allow you to analyze if the analog output response is adequate.

Figure 17 – Filter

6   SIGNOW APP

SigNow app is the ideal tool to use your **TL400-I** on a daily basis. Available for Android and iOS smartphones, it allows you to configure or perform diagnostics on the equipment. Connection to the equipment can be made via the Bluetooth interface.

SigNow can be downloaded for free from *Google Play Store* or *App Store*.

If your smartphone does not support BLE technology, has an Android version lower than 9 or an iOS version lower than 12, the application will not be available for download.

This manual provides basic information about configuring your **TL400-I**. For more information about **SigNow** features, see the specific manual.

6.1   BLUETOOTH INTERFACE

TL400-I has a Bluetooth Low Energy (BLE) interface, compatible with smartphones that have Bluetooth modules with version 4.0 or higher.

The Bluetooth interface allows you to configure the equipment through the **SigNow**.

6.2   PAIRING TL400-I WITH YOUR SMARTPHONE

Once the **SigNow** app has been installed, you must enable the Bluetooth interface of your smartphone to connect to the **TL400-I**. After that, simply open the app and follow the steps below:
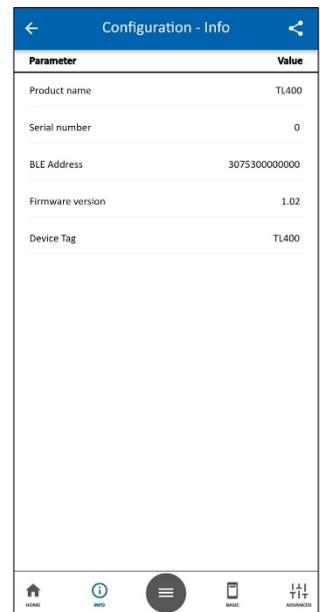
1. Click on the **Configuration** button.

2. Click on the **TL400-I** icon.

3. Wait for the connection process to finish.

4. Okay, that is it. **SigNow** will display the equipment configuration screens.

6.3 CONFIGURING YOUR TL400-I

6.3.1 INFORMATION

Upon successfully completing the pairing process between smartphone and device, **SigNow** will display the configuration screens. The **Information** screen is the first one:
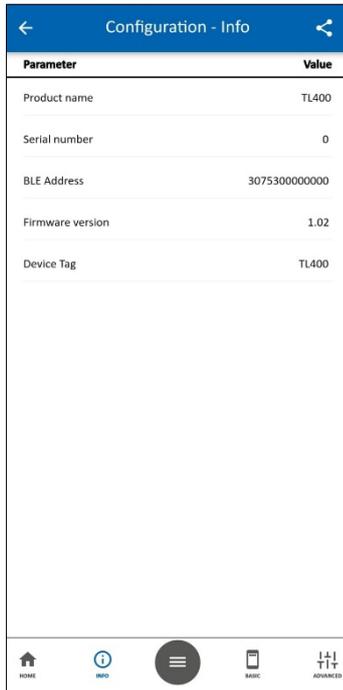

Figure 18 – Configuration: Info

The **Info** section of the **Configuration** screen presents information such as serial number, firmware version, BLE address and device tag, which can be set in the **Device Tag** parameter of the **Basic** section.

None of this information is editable.

By clicking the **Home** button, you will be redirected to the **SigNow** home page.

By clicking the ⬤ button, **SigNow** will display a set of buttons, as shown in the figure below.
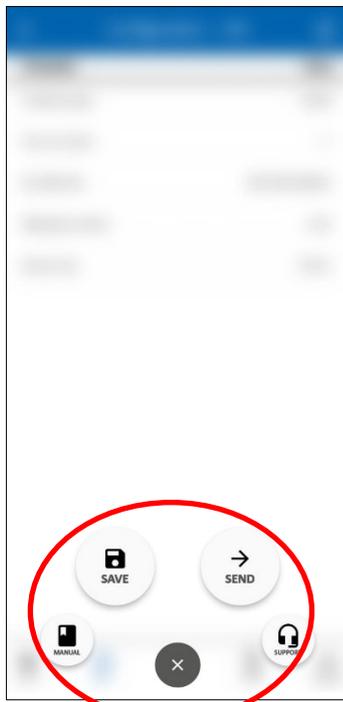
Figure 19 – Button functions

By clicking the **Manual** button, you will be redirected to the online manual for the equipment.

By clicking the **Support** button, you will be redirected to **NOVUS** Technical Support page.

The **Send** button allows you to send the settings to the equipment.

The **Save** button allows you to save these configurations in a file with a .sigc extension, which can be used later by clicking the **Open Configuration** button on **SigNow**.

6.3.2 BASIC CONFIGURATION

By clicking the **Basic** button, **SigNow** will display parameters regarding the basic configuration of the equipment:

By default, the equipment is already configured with the magnitude **Level** (the magnitude can be changed in the **Input** subsection of the **Advanced** section, as will be shown later), which allows you to configure the following parameters:

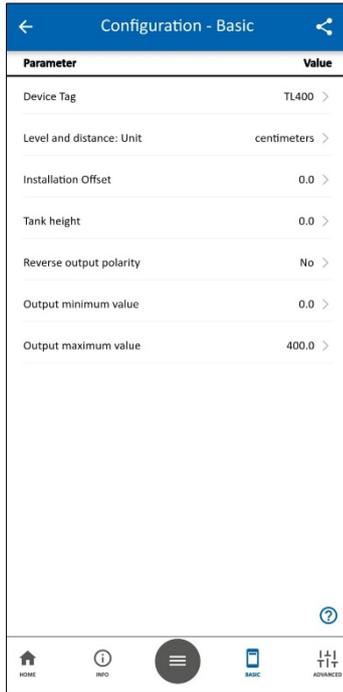- **Device Tag:** Allows you to define a tag with up to 20 characters for the equipment.
- **Level and distance: Unit:** Allows you to define the unit of measurement to be used (meters, centimeters, millimeters, inches, feet).
- **Installation Offset:** Allows you to define the installation Offset.
- **Tank heigh:** Allows you to define the height of the tank to be used.
- **Reverse output polarity:** Allows you to invert the output polarity.
- **Output minimum value:** Allows you to define a minimum level value.
- **Output maximum value:** Allows you to define a maximum level value.

Figure 20 – Basic configuration

6.3.3 ADVANCED CONFIGURATION

By clicking the **Advanced** button, **SigNow** will display sections regarding the advanced configuration of the equipment:
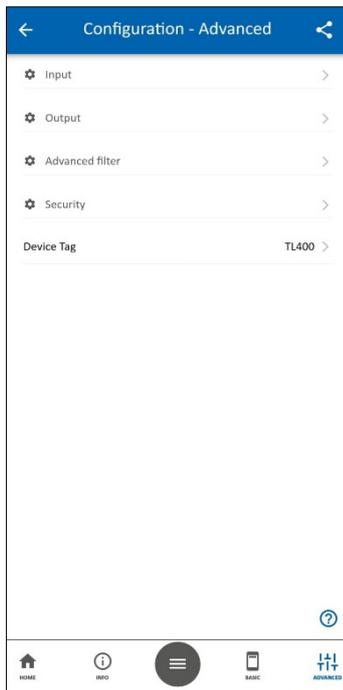

Here you can select the parameter group to be configured: **Input**, **Output**, **Advanced Filter**, or **Security**. You can also change the equipment tag.

Figure 21 – Advanced configuration

6.3.3.1 INPUT

By clicking the **Input** button, **SigNow** will display sections regarding the input settings of the equipment:
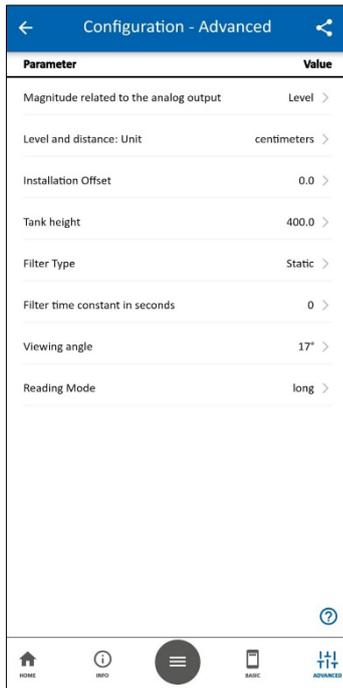

Figure 22 – Input advanced configurations

By default, the parameter **Magnitude related to the analog output** is set as **Level**, which allows you to configure the following parameters:

- **Level and distance: Unit:** Allows you to define the unit of measurement to be used (meters, centimeters, millimeters, inches, feet).

- **Installation Offset:** Allows you to define the installation Offset.

- **Tank heigh:** Allows you to define the height of the tank to be used.

- **Filter type:** Allows you to define the type of filter to be used. If you select the **Static** option, you will need to set a filter time constant in seconds.

- **Filter time constant in seconds:** Allows you to configure a moving average filter with a response time configurable in seconds. From 1 to 65000 seconds (or 1000 hours).

- **Viewing angle:** Allows you to define the viewing angle of the equipment: 15°, 17°, 19°, 21°, 24°, or 27°.

- **Reading mode:** Allows you to set the measurement mode: 1 − Short (for distances shorter than 1 meter), 2 − Medium (for distances up to 3 meters), or 3 − Long (for distances up to 4 meters). Long mode is the most recommended mode for most applications.

If the parameter **Magnitude related to the analog output** is set to **Distance**, these same parameters will be displayed.
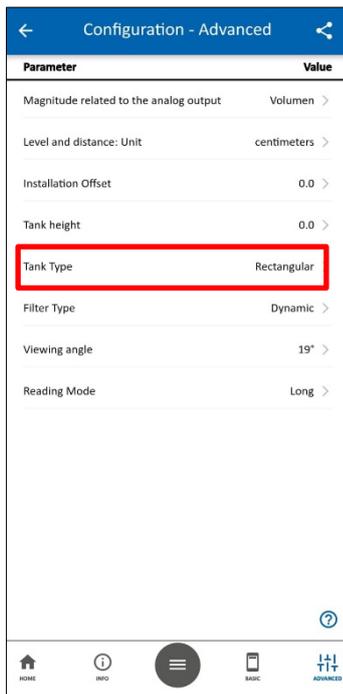

Figure 23 – Volume advanced configurations

When configuring the parameter **Magnitude related to the analog output** with the **Volume** option, in addition to the parameters shown in the previous figure, you can also change the parameter **Tank Type** (Vertical cylinder, Horizontal cylinder, Rectangular, or Custom).

According to the tank type selected, **SigNow** will present configurable parameters to determine the size and measurement of the tank to be used.

If none of the standard tank types suits your needs, you can select the **Custom** option.

Here, you can add calibration points for the tank. You can set up to 20 linearization points by adding the desired values.

The custom tank type can be useful for tanks that are shaped with curves, rises, or other irregularities.

When configured to **Custom**, the calibrated points should go from the greatest distance to the smallest distance (smallest volume to greatest volume), as shown in the example below:

POINT	DISTANCE	VOLUME (%)
1	200	0
2	75	50
3	20	100

Table 1 – Calibration points

Figure 24 – Example of calibration points in an irregular tank
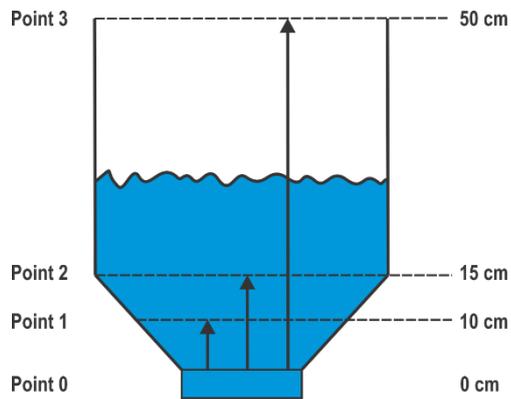
The figure at the side exemplifies the calibration points in a tank with an irregular form.

6.3.3.2 OUTPUT

By clicking the **Output** button, **SigNow** will display sections regarding the output settings of the equipment:
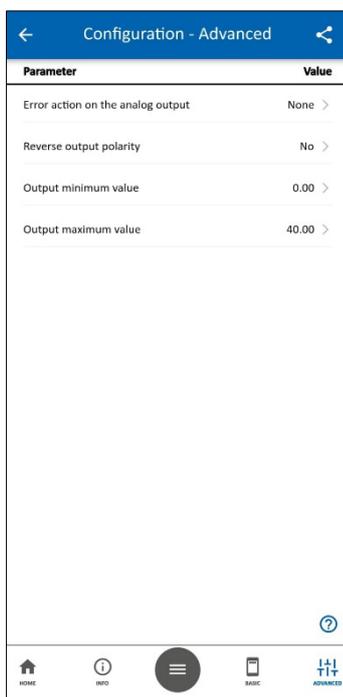
The parameter **Error action on analog output** allows you to configure the error action of an equipment with 4-20 mA output. This parameter has the following options:

- Low (4 mA)
- High (20 mA)
- None
- Low/High (4 mA / 20 mA)

In addition, you can set a minimum value and a maximum value for the output.

Figure 25 – Output advanced configurations

6.3.3.3 ADVANCED FILTER

By clicking the **Advanced Filter** button, **SigNow** will display parameters for configuring the advanced filter:

Figure 26 – Advanced filter configuration

- **Size of the main vector:** Allows you to define the number of samples to be collected by the filter. If the user sets this parameter to 100, for example, **TL400** will only consider the first 100 values collected.
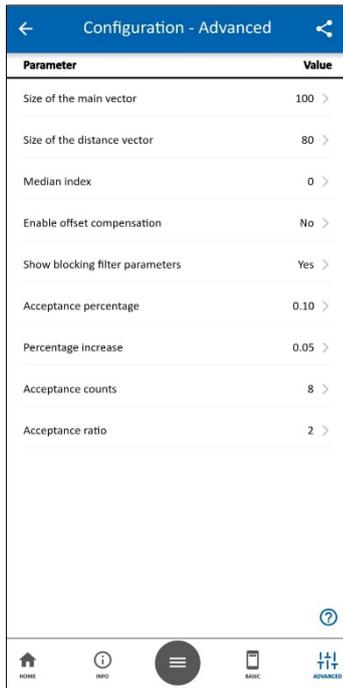- **Size of the distance vector:** Allows you to select the best quality samples from among those collected by the filter (i.e., those with the least variation in values).
- **Median index:** Allows you to reorder the ideal samples, i.e., those already filtered by the **Size of the distance vector** parameter, now according to distance.
- **Show Blocking Filter parameters:** Allows you to display the parameters relating to the Blocking Filter, which prevents values that are too discrepant from the previous value from being displayed in the output. By default, the Blocking Filter remains disabled.
- **Acceptance percentage:** Allows you to define the maximum percentage of variation between the previous value and the value to be accepted by Blocking Filter.
- **Percentage increase:** Allows you to set the percentage of values to be incremented, according to the criterion and each time a new value outside this percentage occurs.
- **Acceptance counts:** Allows you to set the maximum number of times that the Blocking Filter can reject data outside the standard defined in the **Acceptance ratio** parameter.
- **Acceptance ratio:** Allows you to reduce the oscillation or data peaks of the analog output.

The ADVANCED FILTER chapter provides more complex information on how the parameters of this filter work, as well as examples and graphs.

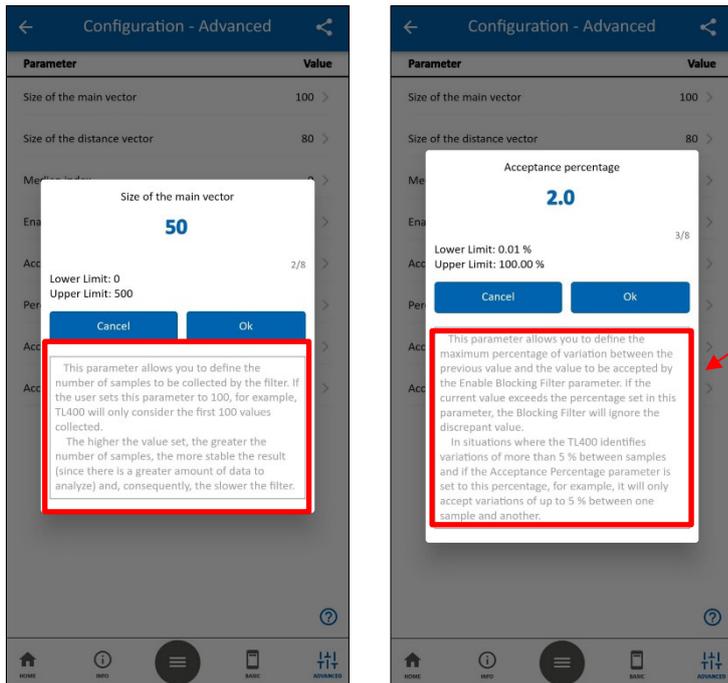By clicking on a specific parameter to configure it, as shown in the examples opposite, you can see explanations of how to use it.

These explanations are also shown in detail in the ADVANCED FILTER chapter.

Figure 27 – Definitions

6.3.3.4 SECURITY

TL400 allows you to protect the device's connection with a password. By default, the password is disabled. However, it is possible to create a numeric password of between 4 and 10 digits. Once the device has received a password, the connection can only be made by entering it. This feature prevents access by unauthorized users.

If the configured password is lost, the master password can be used, consisting of the number 9 + the last 3 digits of the serial number.

Master password = 9 + last three digits of the device's serial number.

By clicking the **Advanced Filter** button, **SigNow** will display parameters referring to the security settings of the equipment:
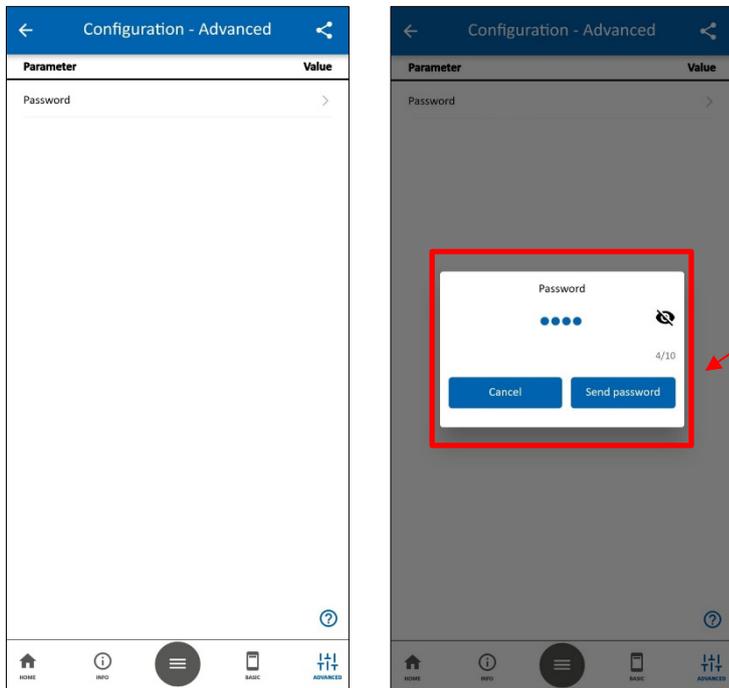
By clicking on the **Password** parameter, you can enter a password that will prevent changes to the device's settings.

You must define a numeric password with at least 4 characters.

To remove the added password, simply keep the **Password** parameter field empty and click **Send password**.

Figure 28 – Creating a password

6.4 DIAGNOSTIC

By clicking the **Diagnostics** button on the **SigNow** home screen, the app displays information about the connected equipment:
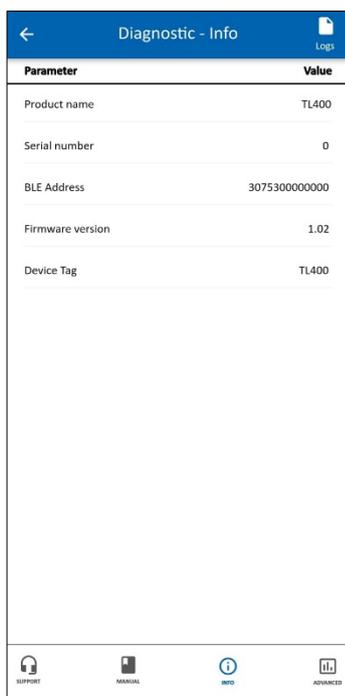
The **Info** section of the **Diagnostics** screen presents information such as serial number, firmware version, BLE address and device tag, which can be set in the **Configuration** section.

None of this information is editable.

By clicking the **Manual** button, you will be redirected to the online manual for the equipment.

By clicking the **Support** button, you will be redirected to **NOVUS** Technical Support page.

Figure 29 – Diagnostic – Info

The **Advanced** button is in the lower right corner of the **Info** screen. By clicking on this button, you can access the advanced diagnostic settings, which allow you to force values to check the correct operation of the equipment and evaluate the settings applied to it.

Figure 30 – Diagnostic – Advanced

The **Advanced** section of the **Diagnostics** screen allows you to:

1) In the first part of the screen, you can see the current values of the equipment, according to the configuration.

2) In the second part of the screen, in the **Forcing** subsection, you can force specific values by selecting any of the four available options:

- **Distance:** This parameter allows you to force a distance value for the equipment.
- **Level:** This parameter allows you to force a level value for the equipment.
- **Volume:** This parameter allows you to force a volume value for the equipment.
- **Analog Output:** This parameter allows you to force the analog voltage output.

In either case, the output **must be enabled** to force test values.

By selecting one of the forcing options in the section above, you will be redirected to the appropriate screen, where you can set specific values for each parameter:
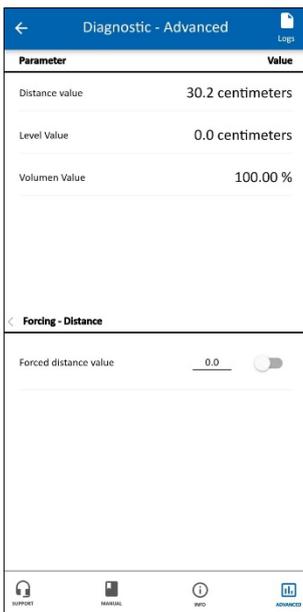
Figure 31 – Forcing: Distance

Figure 32 – Forcing: Level

Figure 33 – Forcing: Volumen
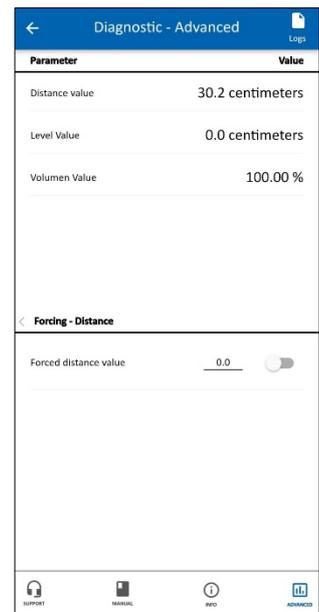
Figure 34 – Forcing: Analog Output

6.5 FIRMWARE UPDATE

Figure 35 – Firmware update

Figure 36 – Pairing the equipment

To update the firmware, you must click on the **Firmware** button, located at the bottom of **SigNow** home screen.

After that, you must select the equipment to be used and perform the pairing process.
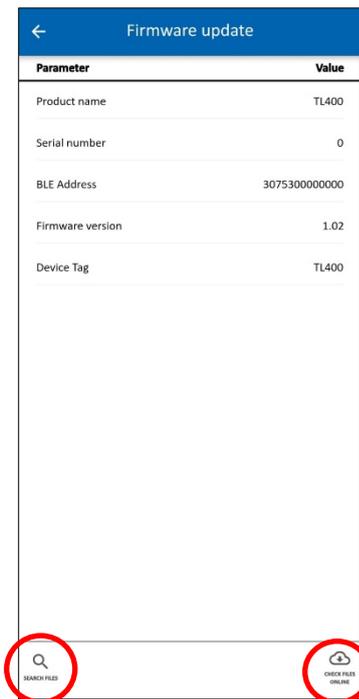
Figure 37 – Selecting a file

By clicking on the **Search Files** button, located in the left corner of the screen, you can search for previously downloaded files on your smartphone.

By clicking on the **Check Files Online** button, located in the right corner of the screen, you can check online for firmware files.

After that, simply select the file to be used by **SigNow** and perform the update process.

7 ADVANCED FILTER

7.1 WHEN USE THE ADVANCED FILTER

There are applications in which the sensor may show instabilities in level measurement. In general, these instabilities are related to the optical properties of the application, such as reflective walls and the incidence of sunlight. In these cases, to improve the result, **TL400** has a filtering algorithm that is based on the quality of the measurements of a group of samples.

The advanced filter can be configured within the **Advanced Configuration** section of **SigNow** app (see ADVANCED FILTER section of SIGNOW APP chapter). By configuring certain parameters, this algorithm can significantly reduce measurement instabilities.

To better exemplify the need to use the advanced filter in certain situations, below is a real example of a measurement that doesn't need the filtering algorithm (left) and one in which it was necessary to use it (right). The raw measurement is in blue; the filtered measurement is in orange.
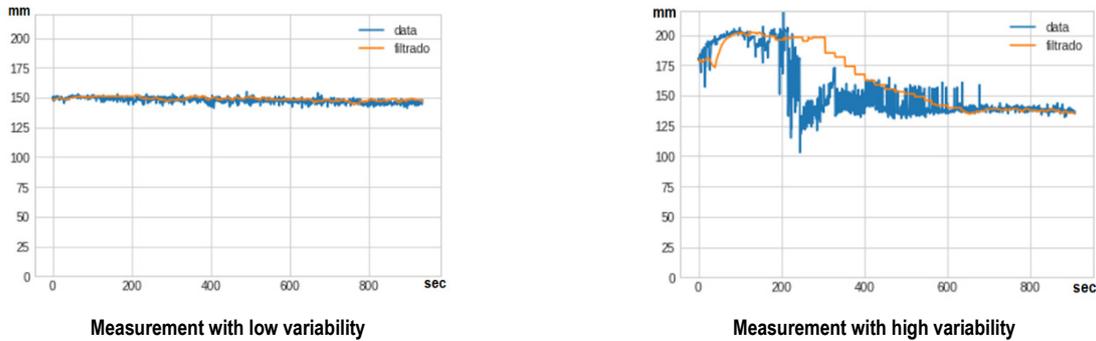

Measurement with low variability   **Measurement with high variability**

Figure 38 –   Measurements with low and high variability

Internally, the algorithm is based on a sample sorting logic that acts according to the quality measure of the measurement itself and based on sorting according to the distance to collect the most stable measure of the group (median). Below is a description of the parameters and their influence on the measurement result.

7.2 A MORE DETAILED EXPLANATION OF THE ADVANCED FILTER PARAMETERS

The **Advanced Filter** of **SigNow** app is composed of 8 parameters. Below, it is possible to see a more complex explanation about their functioning.

7.2.1 "SIZE OF THE MAIN VECTOR" PARAMETER

This parameter allows you to define the number of samples to be collected by the filter. If the user sets this parameter to 100, for example, **TL400** will only consider the first 100 values collected.

The higher the value set, the greater the number of samples, the more stable the result (since there is a greater amount of data to analyze) and, consequently, the slower the filter.

7.2.2 "SIZE OF THE DISTANCE VECTOR" PARAMETER

This parameter allows you to select the best quality samples from among those collected by the filter (i.e., those with the least variation in values).

More precisely, the vector will order the samples from the lowest standard deviation to the highest standard deviation (always considering the value 1 as the ideal standard deviation), creating an internal ordering, not visible to the user. Thus, the first measurement on this list will always have the smallest deviation and is theoretically the most accurate within this margin.

When performing an analysis from 1 up to the size configured in the **Size of the main vector** parameter, the measurements in this set will be those that survive after the other values have been discarded. If you put 100 in the **Size of the main vector** parameter and 20 in **Size of the distance vector**, for example, the parameter will select the 20 best of these 100 samples, rejecting the others.

This parameter must be smaller than the one configured in the **Size of the main vector** parameter. The lower the value, the more selective the filter will be, and the fewer samples will be considered. The more unstable the behavior of the sensor, the "worse" samples should be discarded and therefore the smaller the **Size of the distance vector** should be.

When looking for greater stability and in conditions where response time is relevant, it is possible to increase the **Size of the main vector** and the **Size of the distance vector**. By setting the **Size of the main vector** parameter to 400 and the **Size of the distance vector** parameter to 350, for example, an 80 cm measurement application will have an accuracy of 3 millimeters.

7.2.3 "MEDIAN INDEX" PARAMETER

This parameter allows you to reorder the ideal samples, i.e., those already filtered by the **Size of the distance vector** parameter, now according to distance. In this case, the **Median index** parameter will ignore the standard deviation, opting instead to analyze the median, which would be the central number of these values (the number of times that a value is repeated among the number of samples), either increasing or decreasing.

The **Median index** displays the position of the value in relation to the median containing the output value to be considered by the filter. The values that are most repeated among the samples collected are given the position 0 as an index. Samples with lower values receive negative indexers, while higher values receive positive indexers.

If the sensor is "missing too much" when collecting data, it is possible to reduce this difference by selecting a smaller position, using a **Median index** value that is less than 0.

The figure below exemplifies the position of the median, according to symmetrical situations (ideal situation not in line with reality), distortion to the right (negative indexers) and to the left (positive indexers):
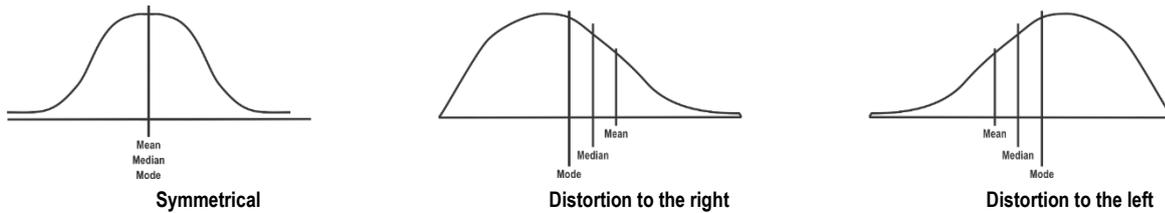

Symmetrical **Distortion to the right** **Distortion to the left**

Figure 39 –   Median examples

7.2.4   "ACCEPTANCE PERCENTAGE" PARAMETER

This parameter allows you to define the maximum percentage of variation between the previous value and the value to be accepted by the Blocking Filter. If the current value exceeds the percentage set in this parameter, the Blocking Filter will ignore the discrepant value.

In situations where the **TL400** identifies variations of more than 5 % between samples and if the **Acceptance percentage** parameter is set to this percentage, for example, it will only accept variations of up to 5 % between one sample and another.

This parameter will only be displayed if the Show Blocking Filter Parameters parameter has been set to "yes".

Use of the Blocking Filter functions is recommended for advanced users only.

7.2.5   "PERCENTAGE INCREASE" PARAMETER

This parameter allows you to set the percentage of values to be incremented, according to the criterion and each time a new value outside this percentage occurs. If values fluctuate outside the percentage defined in **Percentage increase**, for example, certain measures will no longer be accepted, and the acceptance rate will be increased by the increment.

Whenever a new measure fails to enter, the acceptance criterion is increased, increasing the chance that the next sample will be accepted.

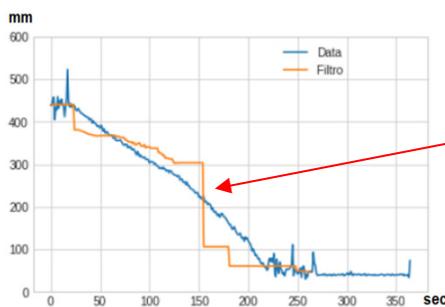**This parameter will only be displayed if the Show Blocking Filter Parameters parameter has been set to "yes".**

Use of the Blocking Filter functions is recommended for advanced users only.

7.2.6   "ACCEPTANCE COUNTS" PARAMETER

This parameter allows you to set the maximum number of times that the Blocking Filter can reject data outside the standard defined in the **Acceptance ratio** parameter. That is, it will register the number of occurrences of new measures being blocked and, when it reaches the maximum value configured, it will accept these new values at a percentage defined in the **Acceptance ratio**.

The **Acceptance counts** parameter is complementary to the **Percentage increase** parameter. If the value set in **Acceptance counts** is reached, the blocking filter will accept the next values, even if they exceed the value set in the **Percentage increase** parameter. This allows data to be collected even during sudden changes in level.

When filling the tank quickly, for example, this parameter prevents the **TL400** from taking too long to identify changes in the tank level, since it will start accepting new samples after a sudden variation has occurred repeatedly and has reached the value set in this parameter:

The moment when the **TL400** identified the change and, because of the excessive variation, began to accept the new samples.

Figure 40 –   Acceptance counts

This parameter will only be displayed if the Show Blocking Filter Parameters parameter has been set to "yes".

Use of the Blocking Filter functions is recommended for advanced users only.

7.2.7   "ACCEPTANCE RATIO" PARAMETER

This parameter allows you to reduce the oscillation or data peaks of the analog output. When it collects a new value, it analyzes the acceptance rate, which is why this new value will be accepted. If it is 1, the new value accepted will be the new value itself. If it is 2, it will be half the new value.

This parameter will only be displayed if the Show Blocking Filter Parameters parameter has been set to "yes".

Use of the Blocking Filter functions is recommended for advanced users only.

8 USAGE EXAMPLES

8.1 EXAMPLE 1: 3-METER HIGH AND 2-METER WIDE WATER TANK

In one application, the user intends to apply the sensor to measure a tank in a water tank with a tank height of 3 meters, the maximum level being 2.8 meters and with the bottom of the tank as the minimum level. It is also expected to get the current measurement proportional to the level, i.e. 20 mA at the maximum level (minimum distance) and 4 mA at the minimum level (maximum distance).

Here is an example of parameter configuration for this application:

- **Magnitude related to the analog output:** Level
- **Unit:** cm
- **Tank height:** 300 cm
- **Offset:** 0 cm
- **Filter type:** Static
- **Filter time constant in seconds:** 20
- **Angle of view:** 27°
- **Reading mode:** Long
- **Error action on analog output:** None
- **Invert output polarity:** No
- **Value for minimum output:** 0
- **Value for maximum output:** 280

Figure 41 – Tank

8.2 EXAMPLE 2: 80 CM OIL TANK

When performing the diagnosis of the measurements that fill the tank of an oil tank with 80 cm high and 10 cm wide, it was verified that, although proportional to the level, the informed measurement did not match the real value. In this case, as shown in the information below, the user intends to correct the sensor reading with a 5-point curve:

PERCENTAGE OF VOLUME FILLED (PERCENT)	DISTANCE MEASURED ON DIAGNOSTIC TAB (CM)	REAL DISTANCE (CM)
0 % - Empty tank	100	80
25 %	85	60
50 %	50	40
75 %	25	20
100 %	10	0

Table 2 – Values

In this case, you must insert the points through the following path: **Configuration > Advanced > Input > Tank Calibration**, as shown in the figures below. Then, in **Diagnostic > Advanced**, you can check the volume according to the distance, depending on the configured calibration. When using the custom curve, the tank height value will be ignored for the volume calculation.
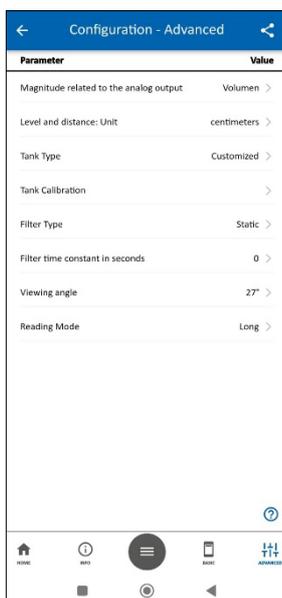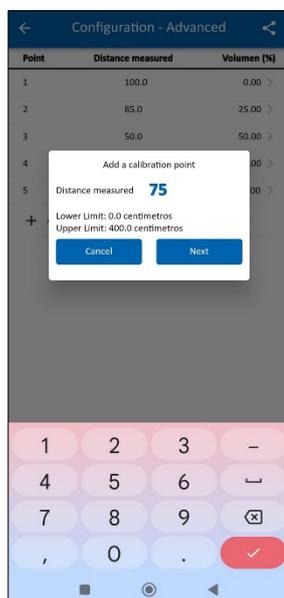

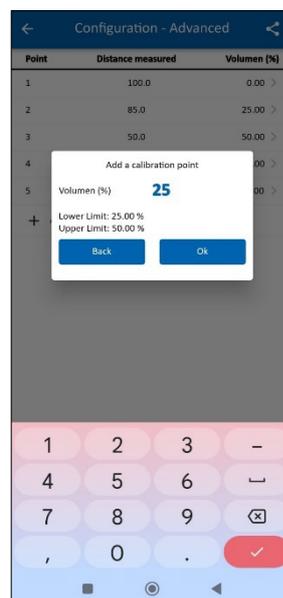**Figure 42 –** Configuration (1)

Figure 43 – Configuration (2)

Figure 44 – Configuration (3)
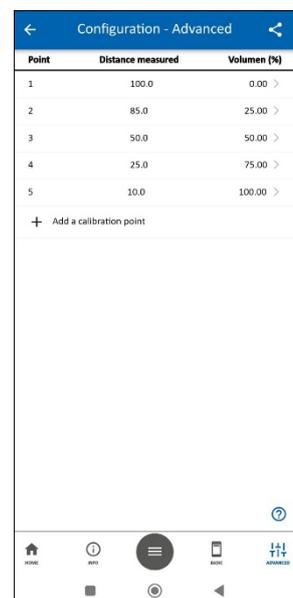
Figure 45 – Configuration (4)

Diagnostic result.

Figure 46 – Diagnostic

9   TECHNICAL SPECIFICATIONS

FEATURES	TL400-I
Dimensions	241.7 x 66 x 31 mm
Distance Measurement	Configurable from 0 to 4000 mm.
Accuracy	Minimum of 30 mm but can reach 2 mm if in good measuring conditions.[2]
Resolution	1 millimeter
Blind spot	20 millimeters
Sampling	1 Hz
Connector	M12 with 4 pins.
Output	4-20 mA with 0.01 mA resolution.
Assembly	Standard SAE 5 holes or adapter for standard 4 holes.
Consumption	<70 mA @ 12 V or <40 mA @ 24 V
Power Supply	8 – 33 Vdc
Storage Temperature	-20 to 80 °C
Operation Temperature	-20 to 80 °C
Protection Index	IP68
Housing	Polycarbonate
Configuration Application	SigNow (for smartphones)
Certifications	CE, Anatel (13883-22-07089), UKCA, LASER CLASS 1, ISO 16750-2

Table 3 – Technical specifications

9.1   CERTIFICATIONS

CE MARK / UKCA

This is a Class A product. In a domestic environment, this product may cause radio interference in which case the user may be required to take adequate measures.

LASER CLASS 1

The radiation used by the sensor is classified by IEC 60825-1:2014 as CLASS 1 LASER PRODUCT and does not present a risk to the human eye as long as you do not make any changes not described in the manual.

ANATEL

This device is homologated by ANATEL, according to the regulated procedures for conformity assessment of telecommunications products, and meets the technical requirements applied.

This equipment is not subject to the protection from harmful interference and may not cause interference with duly authorized systems.

For more information, see the ANATEL website: www.gov.br/anatel.

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[2] A good measuring environment consists of a tank where the sensor can work at a maximum opening angle of 27°, without the incidence of sunlight. Factors that worsen the measurement conditions involve the reflectivity of the walls and bottom of the tank and the incidence of sunlight

10 WARRANTY

Warranty conditions are available on our website www.novusautomation.com/warranty.