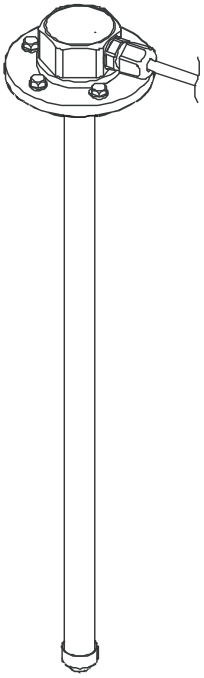
Cellocator Fuel Probe Sensor Overview



Cellocator Division
Pointer Telocation Ltd.

Proprietary and Confidential

Version 1.0

Revised and Updated: July 2, 2014

POINTER

Pointer Telocation Ltd. 14 Hamelacha St., Rosh Ha'ayin 48091, Israel • Tel: 972-3-5723111 • Fax: 972-3-5723100 • www.pointer.com

Legal Notices

IMPORTANT

1. All legal terms and safety and operating instructions should be read thoroughly before the product accompanying this document is installed and operated.
2. This document should be retained for future reference.
3. Attachments, accessories or peripheral devices not supplied or recommended in writing by Pointer Telocation Ltd. May be hazardous and/or may cause damage to the product and should not, in any circumstances, be used or combined with the product.

General

The product accompanying this document is not designated for and should not be used in life support appliances, devices, machines or other systems of any sort where any malfunction of the product can reasonably be expected to result in injury or death. Customers of Pointer Telocation Ltd. using, integrating, and/or selling the product for use in such applications do so at their own risk and agree to fully indemnify Pointer Telocation Ltd. for any resulting loss or damages.

Warranty Exceptions and Disclaimers

Pointer Telocation Ltd. Shall bear no responsibility and shall have no obligation under the foregoing limited warranty for any damages resulting from normal wear and tear, the cost of obtaining substitute products, or any defect that is (i) discovered by purchaser during the warranty period but purchaser does not notify Pointer Telocation Ltd. Until after the end of the warranty period, (ii) caused by any accident, force majeure, misuse, abuse, handling or testing, improper installation or unauthorized repair or modification of the product, (iii) caused by use of any software not supplied by Pointer Telocation Ltd., or by use of the product other than in accordance with its documentation, or (iv) the result of electrostatic discharge, electrical surge, fire, flood or similar causes. Unless otherwise provided in a written agreement between the purchaser and Pointer Telocation Ltd., the purchaser shall be solely responsible for the proper configuration, testing and verification of the product prior to deployment in the field.

POINTER TELOCATION LTD.'S SOLE RESPONSIBILITY AND PURCHASER'S SOLE REMEDY UNDER THIS LIMITED WARRANTY SHALL BE TO REPAIR OR REPLACE THE PRODUCT HARDWARE, SOFTWARE OR SOFTWARE MEDIA (OR IF REPAIR OR REPLACEMENT IS NOT POSSIBLE, OBTAIN A REFUND OF THE PURCHASE PRICE) AS PROVIDED ABOVE. POINTER TELOCATION LTD. EXPRESSLY DISCLAIMS ALL OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, SATISFACTORY PERFORMANCE AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL POINTER TELOCATION LTD. BE LIABLE FOR ANY INDIRECT, SPECIAL, EXEMPLARY, INCIDENTAL OR CONSEQUENTIAL DAMAGES (INCLUDING WITHOUT LIMITATION LOSS OR INTERRUPTION OF USE, DATA, REVENUES OR PROFITS) RESULTING FROM A BREACH OF THIS WARRANTY OR BASED ON ANY OTHER LEGAL THEORY, EVEN IF POINTER TELOCATION LTD. HAS BEEN ADVISED OF THE POSSIBILITY OR LIKELIHOOD OF SUCH DAMAGES.

Intellectual Property

Table of Contents

1 Introduction

1.1 Document Purpose

The purpose of this document is to describe the features and capabilities of the Cellocator Fuel Probe Sensor. It is intended for customers, customer support, and sales personnel.

1.2 Abbreviations

Abbreviation	Description
OTA	Over The Air
IP	Ingress Protection

1.3 References

#	Reference	Description
1		
2		

1.4 Revision History

Version	Date	Description
1.0	02/07/2014	Initial document

2 Cellocator Fuel Probe Sensor Description

The Cellocator Fuel Probe Sensor (from this point on referred to as *the sensor*) is used to accurately measure the fuel level in containers and the fuel tanks of vehicles. The sensor helps the service provider to measure the actual fuel volume in the tank and thus to provide dynamic fuel consumption data including the volume, time and location of refueling and draining (theft).

The sensor includes a probe which should be immersed into the fuel and a measuring head which is mounted on the fuel tank. Several variants with different probe lengths are available for supporting multiple fuel tank dimensions. The sensor is connected via an interface cable to the Cellocator unit pulse counter input.

2.1 Structure and Components of the Sensor

2.1.1 *Structure of the Sensor*

The structure of the sensor is shown in the following image.

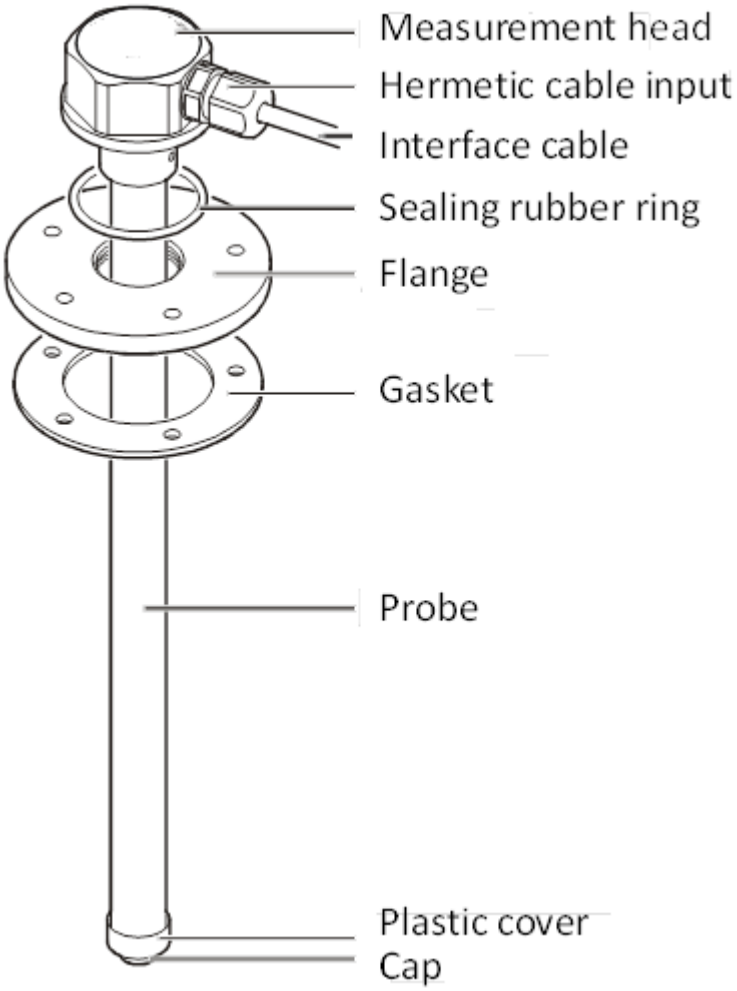


Figure 1: General View of the Sensor

The measuring head of the sensor (as shown in the image) consists of a level converter, a digital circuit for signal processing, the device for communication, power circuit and circuit which provides the necessary protection for input and output.

Connection to external devices is provided via an interface cable.

The probe is a coaxial capacitor, which is made of an aluminum tube (external electrode) and insulated copper string (internal electrode). The required tension of the string is supported by a spring which is in contact with the probe's connector.

Mounting of the sensor is performed with self-drilling screws, which fix the sensor's flange on the fuel tank. The measuring head's impermeability is provided by a sealing ring, located in the front groove.

The interface cable is protected from mechanical damage by a flexible metal sleeve or corrugated pipe.

Safe usage of the sensor is ensured via the following:

- A fuse for protection against overloads and short circuits
- An intrinsically safe measuring circuit with normalized values of voltage, inductance, capacitance and resistance
- The multi-level protection of charging and interface circuits
- A metal sheath which supports IP56
- Compound filling of the measuring head's membrane

2.1.2 *Sensor Operation*

When immersed into fuel, the sensor's probe performs the function of a variable capacitor; its capacity depends on the fuel level in the tank.

The measuring head of the sensor performs a linear transformation of the probe's capacitance to digital format, averaging algorithm, transformation to frequency pulses and sends it via the RS232 Tx to the Cellocator unit.

In order to determine the amount of fuel in vehicle tank, calibration of the fuel tank should be performed. During this procedure the conversion table between the amount of fuel and its level, as measured by the sensor, is defined. The calibration is performed by using the Fuel Sensor Management application, which communicates with the sensor via RS232 interface with a proprietary protocol.

Managing the calibration procedure and the setting of the sensor configuration parameters via the Fuel Sensor Management application are described in the *Fuel Sensor Management* section.

2.1.3 *Compliance with Explosive Atmosphere and Materials*

The sensor is designed to operate in an environment with an explosive atmosphere and materials and comply with Russian Federation and Ukraine standards on the following conditions:

- The Sensor should be powered from an electrical circuit that feeds only from the vehicle battery with a voltage not more than 36V. It should not have any electrical connections with electrical equipment with other sources of supply, including main power network (230V or 110V).
- Connection of sensors to the power supply should be carried out via a fuse rated at no more than 0.1 A. The fuse is provided as part of the Fuel Sensor Harness.

3 Installation and Calibration

3.1 Pre-Installation Disclaimer

During installation of the sensor you should take organizational and technical measures to ensure a safe working environment for the relevant instrumentation, accessories and consumables.

Responsibility for the implementation of security measures is down to the technical personnel that install the sensor and to those responsible for the working environment where the work will be performed.

Note that the installation should be performed according to the safety regulations of your country / state.

3.2 Sensor kit

The Cellocator Fuel Probe Sensor includes the following components:

Item #	Name	Quantity	Notes
1.	Measuring head	1	
2.	Probe	1	
3.	Fuel sensor harness	1	
4.	Level converter	1	
5.	Flange	1	
6.	Cap	1	
7.	Self-drilling screw for sealing	1	With a hole for sealing
8.	Self-drilling screw	4	
9.	Flange Gasket	1	
10.	Certificate of compliance	1	
11.	Seal with wire	2	
12.	String	1	
13.	Cable tie	15	

3.3 Documents and Software components

The following components can be downloaded from the Cellocator website:

- Cellocator Fuel Probe Sensor Overview
- Cellocator Fuel Sensor Manager (FS Manager) Application

3.4 List of Devices and Equipment for Sensor's Installation and Calibration

3.4.1 *Instrumentation*

Name	Quantity
Multimeter	1
Measurement Tape 3 m	1
Measuring cup or flow meter, providing measuring errors of fuel volume not worse than ± 0,1%	1

3.4.2 *Equipment, Tools and Consumables*

Name	Quantity
Metal cutting tool for holes making Ø22 ± 0.5 mm in the sheet material of the tank surface.	1 set
Electric drill with holder for clamping of the tool shank with diameter NLT 10 mm.	1
Power extender cable in polyurethane insulation, 220V, 4A.	1
Pipe cutter used to cut the probe.	1
Spanner with 7 mm gap amount.	1
Spanner with 36 mm gap amount.	1
Special spanner for probe.	1
Auto Sealant Loctite 5900.	0.1 ml
Laptop (PC) with MS Office and a free COM port or USB port.	1
Special Adapter for connecting the sensor to the PC.	1
711-30017 USB to RS232 Adapter for PC without COM (RS232) port.	1

3.5 Preparation of Fuel Tank for Sensor's Installation

The sensor should be installed *in the center* of the fuel tank, as shown in the image below.

This ensures that when the vehicle is inclined, the fuel level at the measuring point is the least volatile for fluctuations during acceleration or deceleration (note that the measuring probe should be set *vertically down*). Improper installation of the probe may result in inaccurate fuel readings.

If the top of the tank is difficult to access, you may need to remove the tank from the vehicle for proper installation of the sensor. Note that the fuel tank where the sensor will be installed should be cleaned.

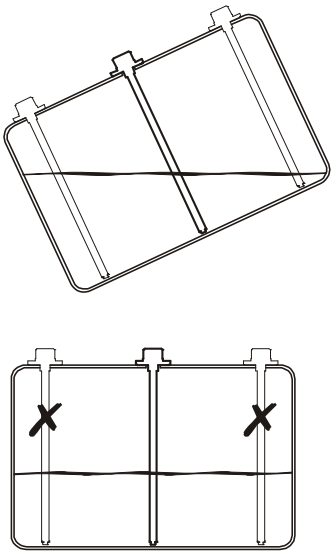


Figure 2: Correct Position of Sensor on Fuel Tank

WARNING: Before installing the sensor in the tank, you should first fill it with water or drain fuel and oil lubricants and clean the tank to ensure the complete removal of flammable liquids and vapors.

To ensure proper positioning of the cable entry of the sensor and correct sealing, perform the following steps:

- Determine the optimal orientation of the sensor. The cable entry of the sensor and the direction of the interface cable should be oriented to the side of stowage and the connecting cable set on the car body.
- Mark on the tank the position of the flange holes and position of the cable entry.
- Set the flange on the sensor.
- Drill or punch a central hole Ø22 and put the sensor with a flange into it.
- Drill 5 holes in the tank body for the flange setting (it is possible to make holes by self-drilling screws). Illustration of hole drilling for self-drilling screws and the flange, as well as the sizes of the flange setting for reference, is shown below.

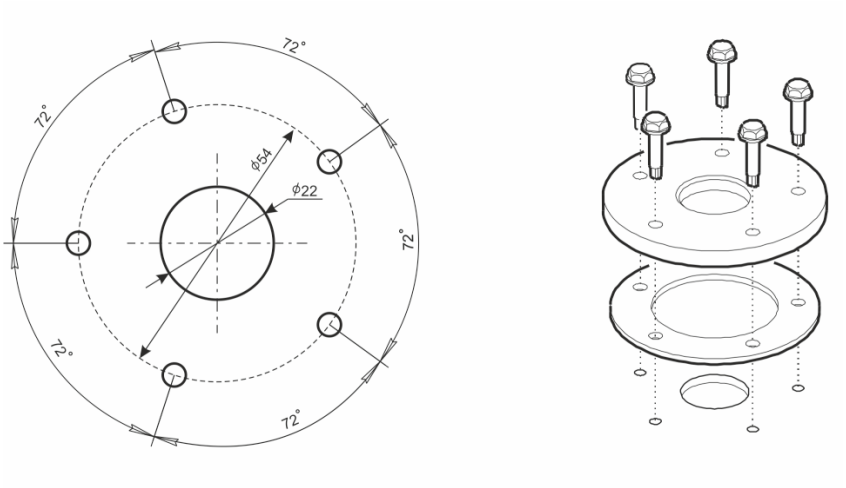


Figure 3: Size and Method of Flange Setting on Fuel Tank

- Remove the sensor with the flange.

WARNING: You must remove the drilling debris from the holes, and also make sure that there are no foreign objects and dirt on the bottom of the tank.

- Lubricate both sides of the gasket and self-drilling screws with sealant. The type of sealant required is detailed in *Equipment, Tools and Consumables*.
- Set the flange and gasket to the prepared surface of the fuel tank with the help of an self-drilling screw (with an extra hole, provided for sealing). The screw should be placed on the right side of the cable input, as shown in the following image.
- Fix the flange with four self-drilling screws.

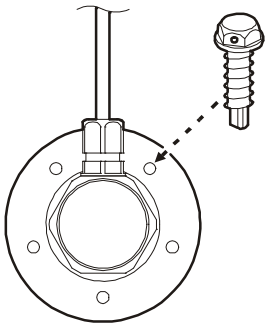


Figure 4: Position of Screw with a Hole for Sealing

3.6 Preparation of Sensor for Installation

3.6.1 *Changing the Probe's Length*

To set the probe's length:

1. Measure the depth of the fuel tank and then measure and mark a probe with length L-15 mm, to ensure the gap of 10 mm between the probe and the bottom of the tank during sensor usage. This step is described in the following image.

WARNING: For tanks with a lack of stiffness (for example - plastic tanks of considerable height) it is recommended to increase the gap between the probe and the bottom of the tank by up to 30 mm. This is due to changes in the sizes of the tank due to the changing of temperature, poured fuel mass, and deformation during motion.

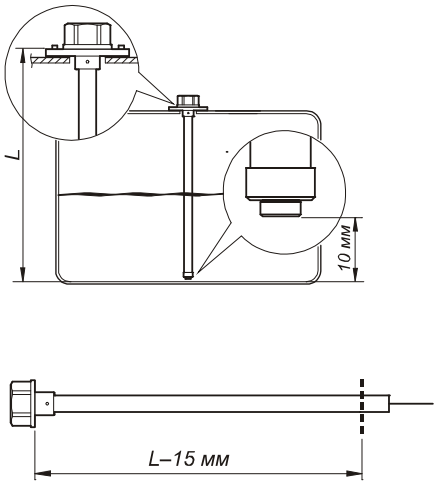


Figure 5: Measuring Probe's Length

2. Cut the relevant metal part of the probe's tube. Be careful not to cut the central conductor string. The cut must be made carefully, any burrs must be removed. The plane of the cut should also be perpendicular to the guide line of the pipe. It is recommended to use a special tool for cutting pipes; refer to the *Equipment, Tools and Consumables* section.
3. Mount the plastic cover at the end of the probe, as shown below, on the left.
4. Fasten the central conductor string of the probe. To do this, pull it up to its limit (about 5 mm), fold the string around and through the groove as shown below and place the end of the string in the groove of the cover, as shown below.

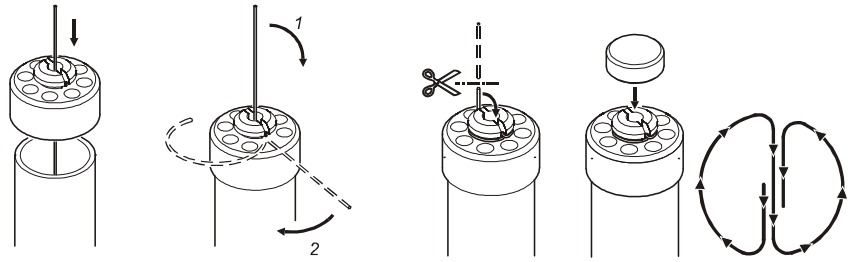


Figure 6: Fastening String on the Plastic Cover

5. Check the quality of the tension. To do this you should gently tap your finger on the probe (the probe should be screwed to the measuring head as tightly as possible); you should feel the vibration of the taut central conductor string; cut the remaining part of the conductor in a way that the cut is roughly located in the center of a stub.
6. Apply a drop of sealant (refer to the *Equipment, Tools and Consumables* section) on the conductor string cut to provide protection to the end of the conductor from water that may accumulate in the tank.
7. Attach the cap on the plastic cover (shown in the Figure 6 above), and push until it clicks.

   Preparation for installing the sensor is complete.

3.7 Installing the Sensor on the Fuel Tank

The sensor should be screwed into the threaded hole of the flange as shown below. Tightness of connection is ensured by a sealing ring located in the front groove of the measuring head. Before installing the sensor it is recommended to apply a thin layer of grease or engine oil to the ring.

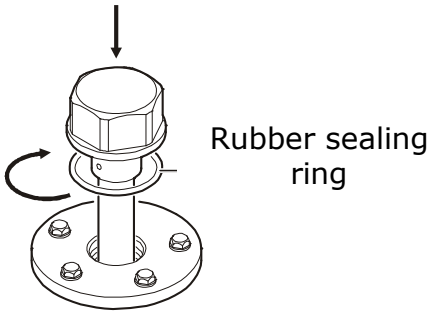


Figure 7: Installation of Assembled Sensor on Fuel Tank

3.8 Connecting the Sensor to a Cellocator Unit

To connect the sensor to a Cellocator unit, the following components should be used:

- Interface Cable (0.45 m)
- Fuel Sensor Harness (7.5 m)
- Level Converter

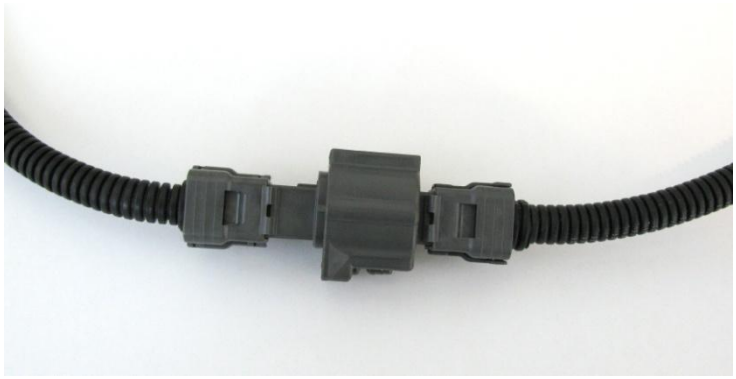
To connect the sensor to the Cellocator unit:

1. Connect the interface cable to the measuring head as shown in the picture below.

WARNING: Do not twist the cable entry on the measuring head; this may violate the integrity of the sealing and electrical connectivity between the measuring head and the interface cable.

---

2. Connect the fuel sensor harness to the interface cable as shown in the picture below:



3. The fuel sensor harness should be installed from the sensor which is installed on the fuel tank, to the Cellocator unit, which is usually located in the driver's cab, through the holes provided within the vehicle structure. The harness should be fixed with cable ties on immovable parts of the structure every 50-60 cm.
4. The fuel sensor harness is terminated with four pressed wires. Connect them according to the connection table below.

Wire Name	Wire Color	Description	Connected to
RXD	Yellow	RS232 Tx and frequency	Level Converter yellow wire
TXD	Green	RS232 Rx	Isolate

Wire Name	Wire Color	Description	Connected to
V+	Red	Power	Vehicle Battery
GND	Black	Ground	Vehicle Ground

5. The level converter adjusts the fuel sensor TXD electrical signal to the required signal of the Cellocator unit frequency counter input.

Connect the Level converter wires according to the following connection table.

Group	Wire Color	Description	Connected to
Input wires	Yellow	Frequency Input	Fuel Sensor Harness Yellow wire
	Black	Ground	Sensor (Vehicle) Ground
Output wires	Blue	Frequency Output	Frequency counter input wire in the Cellocator harness
	Black	Ground	Cellocator unit (Vehicle) Ground

The sensor GND (black wire), the level converter ground wires, the Cellocator unit GND and all other devices in the vehicle must be connected to the same vehicle GND point. This connection should be maintained without regarding to the vehicle battery V- connection to the ground (i.e. even if the battery V- is disconnected from the vehicle ground).

The resistance between the body of the installed sensor and the point of connection of its common wire to the vehicle ground should not exceed 0.5 Ohms. In any case, the total resistance of the sensor ground wires to the Cellocator unit ground should not exceed 0.5 Ohms.

3.9 Sealing the Sensor

To protect the sensor from unauthorized interference you should install two seals. The first seal prevents the measuring head from twisting and the second seal is set on a detachable connection of the interface cable and the fuel sensor harness.

To seal the measuring head (also refer to the image below):

1. Make a wire loop.
2. Tightly wrap the hermetic input connector.
3. Make a twist of wire and thread one of the wires through the hole of the special screw.
4. Place the ends of the wire in the holes of the seal on the side opposite to the marking.
5. Fasten the seal to the screw and snap the seal.

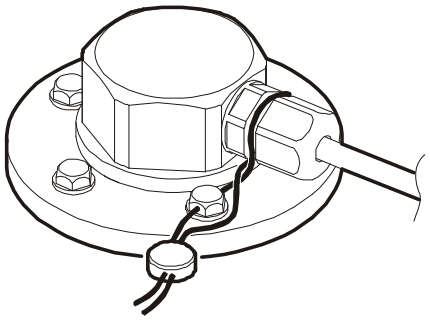


Figure 8: Sealing the Installed Fuel Level Sensor

3.10 Calibration

To ensure the most accurate control of the fuel level, tank calibration should be performed: an empty (full) tank should be filled (merged) gradually with equal portions of fuel on each step. With the help of the Fuel Sensor Manager application the sensor reports on the fuel level are processed and stored on each step.

Portion sizes should be chosen depending on the configuration of a tank: if the horizontal cross-sectional area of the tank in height changes sharply the portion should be smaller. (For example, the recommended portion for a 500 liter tank should be 10 liters). You must also take into account the time for level balancing in tanks in a complex configuration (for example, in 2-tank systems) due to the fuel flow.

Requirements for a measuring cup or a flow meter to measure portions are shown in the *Instrumentation* section.

WARNING: Calibration of the tank must be made using the same type of fuel with which the sensor will be operating (for example, you cannot use petrol for calibration, if you intend to operate with diesel fuel).

To accurately operate the sensor the sensor should undergo some “training”. In other words, it is required to perform the calibration procedure after some time the sensor is in use (for example, when 50 – 70% of tank’s fuel capacity is used) – and not immediately after installation of the sensor. During this time, mechanical clearances will normalize, guaranteed by the rubber gasket flange and a polymer sealant, and on the entire surface of the probe a stable dielectric fuel film is formed.

If the "training" of the sensor cannot be performed before the calibration, the probe should be immersed into the fuel and then removed, and then the fuel should be allowed to drain for 20-30 minutes. If the calibration is performed by the method of draining the tank, this procedure is unnecessary.

Before calibration the sensor should be disconnected from the Cellocator unit and connected to a PC COM (or USB) port. Once calibration is completed, the connection to the Cellocator unit should be restored.

The result of the calibration process in the form of a tank calibration table and process information is stored as a file on the PC. This file should be used by the back office application for the required fuel reports and alerts. Details of how to perform calibration using the Fuel Sensor Manager application is described in the *Fuel Sensor Manager Application* section.

4 The Fuel Sensor Manager Application

The **Fuel Sensor Manager** application is designed to provide the calibration process of a fuel tank and to create a calibration table that details the dependence of the output code of the sensor measurement to the fuel volume.

4.1 Application Installation and launching

The application should be downloaded from Cellocator web site and copied into the required folder on a laptop (PC).

A special adapter connecting the interface cable connector to DB9 connector for PC COM port and to power and GND should be prepared. In case of a USB port the USB to RS232 adapter should be used as well.

Connect the sensor to the PC RS232 port and provide power to the sensor either from the vehicle battery or from an external power supply (power settings are described in the *Technical Specifications* section).

Launch the application by double-clicking on its icon.

4.2 Start Communication with the sensor

After launching, the following window appears:

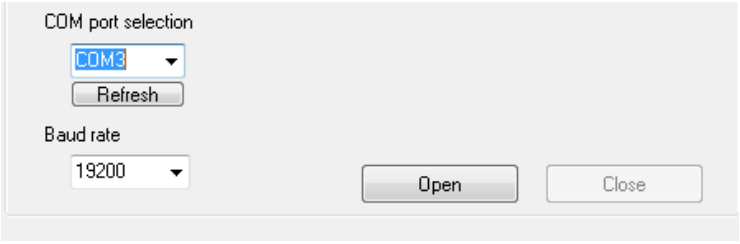


Figure 9: Start communication

At the bottom of the window the status of the port is displayed. The current status should be ***Port is closed.***

1. Select the required COM port
2. Set the communication baud rate. The default baud rate is 19200.
3. Click **Open**. The port status should change to ***COM port N5 is open*** and the **Information** tab is displayed, as shown in the following section.

Note that if the port status is ***Error in port 257 opening***, this indicates the COM port is opening with an error (check and set up the port driver or check the COM port wiring). In addition, if the Search symbol is displayed, this indicates that a device (sensor) is not connected to the specified COM port.

4.3 The Information Tab

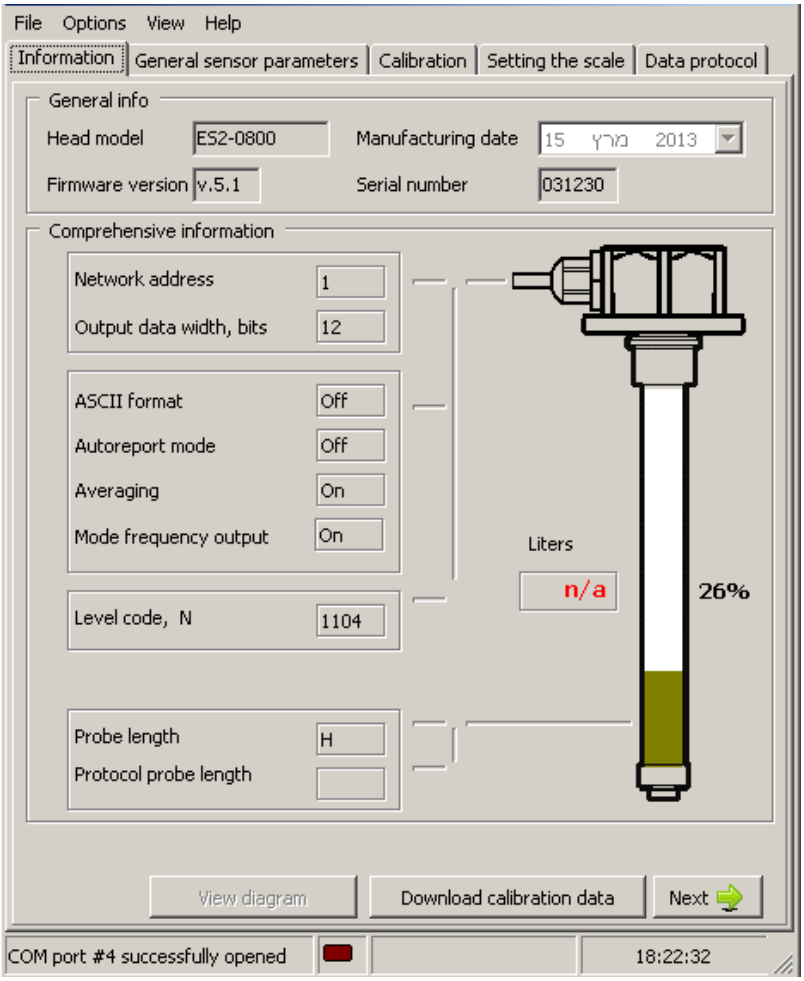


Figure 10: Information Tab

This tab consists of two main sections:

- General Info: displays information about the factory settings and configurations of the product.
- Comprehensive Information: displays the online information received from the measuring head and the known configuration information.

The availability and conformity of the displayed information can be reviewed.

To progress with the calibration process, click **Next**. The **General Sensor Parameters** tab is displayed, which shows parameters of the serial protocol with the Cellocator unit (by default, factory settings are shown).

The **Information** tab also allows the user to view the online status of the fuel volume and the remaining percentage of the fuel in the tank, for the already calibrated fuel sensor.

Click **Download calibration data** and select the appropriate calibration file allowing the application to convert the fuel level code to liters. The fuel volume in liters and the fuel percentage in the tank appear in the window.

Note that a percentage value is calculated from the measured maximum volume of the tank. If the measurement is not available, a maximum possible value is used.

At this stage the user may also view and edit the calibration diagram and table.

Click **View diagram** to view and edit the calibration diagram and table. The *Monitoring of fuel tank calibration* window is displayed. The process for editing is described below in *The Data Protocol Tab* section.

4.4 The General Sensor Parameters Tab

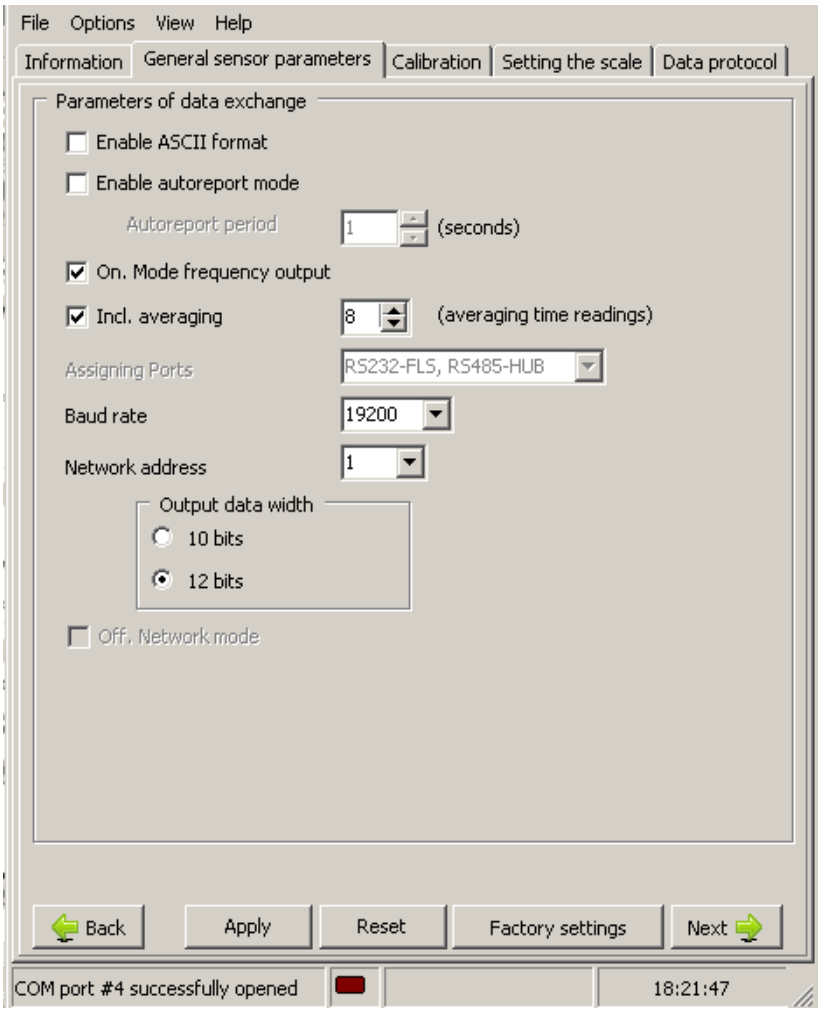


Figure 11: General Sensor Parameters

Sensor parameters:

- **Enable ASCII format** - activates the data output in text format. By default is not activated. It should not be activated.
- **Enable autoreport mode** - activates periodic report of the fuel level. By default is not activated. It should not be activated.
- **Frequency output mode** - activates the frequency output mode. It should be activated.
- **Incl. averaging** - activates averaging of the data. It should be activated.

- **Baud rate** - set the RS232 baud rate.
- **Network address** - this parameter is irrelevant for RS232 communication. By default is 1.
- **Output data width** – number of bits in the fuel level report. Default is 12. It should be set to 12.

Set the parameters as shown in the image above.

Click **Apply** to save your changes.

OR

Click **Reset** to cancel changes.

OR

Click **Factory Settings** to reset the changes you made back to the default factory settings.

Click **Next** to continue. The **Calibration** tab is displayed.

4.5 The Calibration Tab

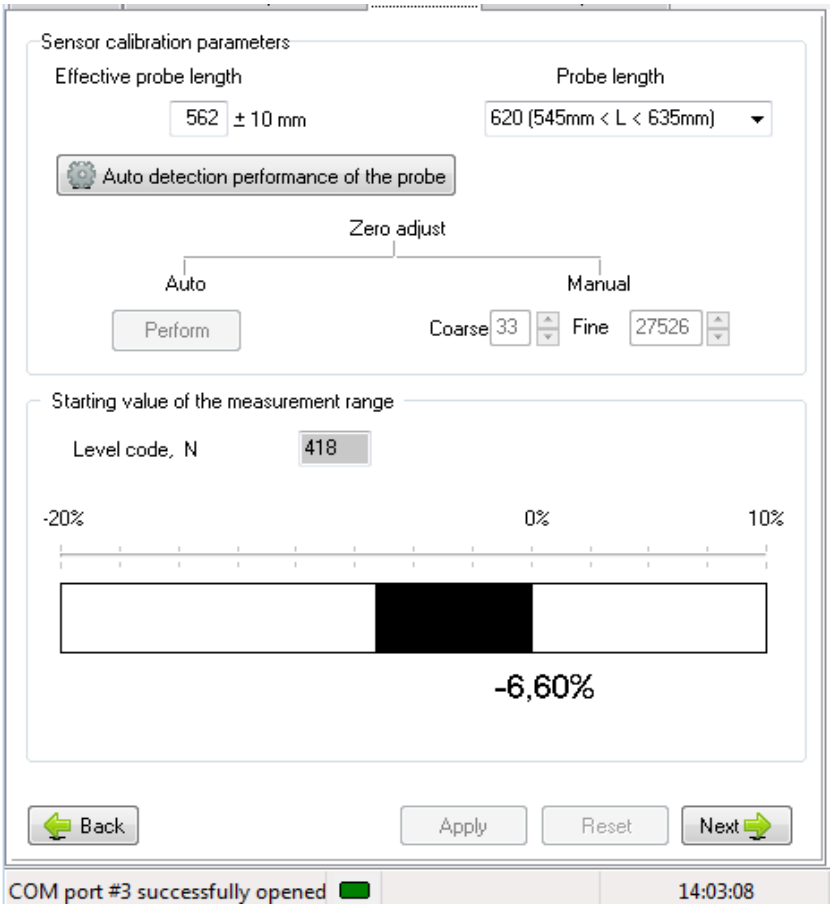


Figure 12: Calibration Tab

4.5.1 *Setting the Probe Length*

The application can detect the actual probe length and the factory length automatically. Click **Auto detection performance of the probe**, which will automatically determine the actual length of the probe and present it in the *Effective probe length* field, and offer the original factory length of probe, which will be presented in the *Probe length* field.

If the probe is shorter than 185 mm or longer than 725 mm, you will be prompted to set the "User's L" or "User's H" factory length type.

Alternatively these two fields can be set manually. Enter the actual length of the probe as defined in the installation process in the *Effective probe length* field. Select the standard factory length in the *Probe length* field.

4.5.2 *Setting the Starting Point of the Measurement Range (Zero Adjustment)*

Zero adjustment defines the reported value of empty tank and should be performed automatically by clicking **Perform**.

If necessary, you can refine the settings manually by increasing or decreasing the values in the manual boxes. The *Starting value of the measurement range* section in the lower part of the window displays the starting level code and the percentage of deviation (from the value of the full range) referring the relative position. Allowable deviation is within the whole window; going beyond its limits will be displayed by a flashing percentage value (in red).

Click **Next** to continue. The *Protocol Selection* window is displayed.

4.6 The Protocol Selection Window

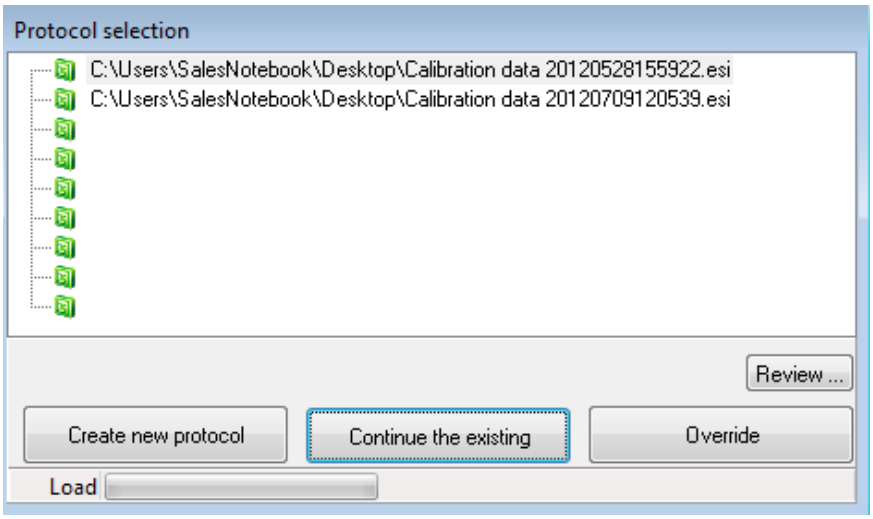


Figure 13: Protocol Selection Window

The Protocol Selection window allows the user to define the calibration file in which the calibration information of the current calibration process will be saved. Available created calibration files are displayed in the window as shown in the picture above.

1. Create a new calibration file by clicking **Create new protocol** or select one previously created (if the calibration, for whatever reason, has not been completed and it is necessary to continue it) by clicking **Continue the existing** and navigating to the relevant calibration file. The calibration data will be saved in this calibration file; in the event of a PC power disconnection, data will not be lost.
2. After selecting the calibration protocol, the **Setting the Scale** tab is displayed, as shown in the following section.

4.7 Setting the Scale tab

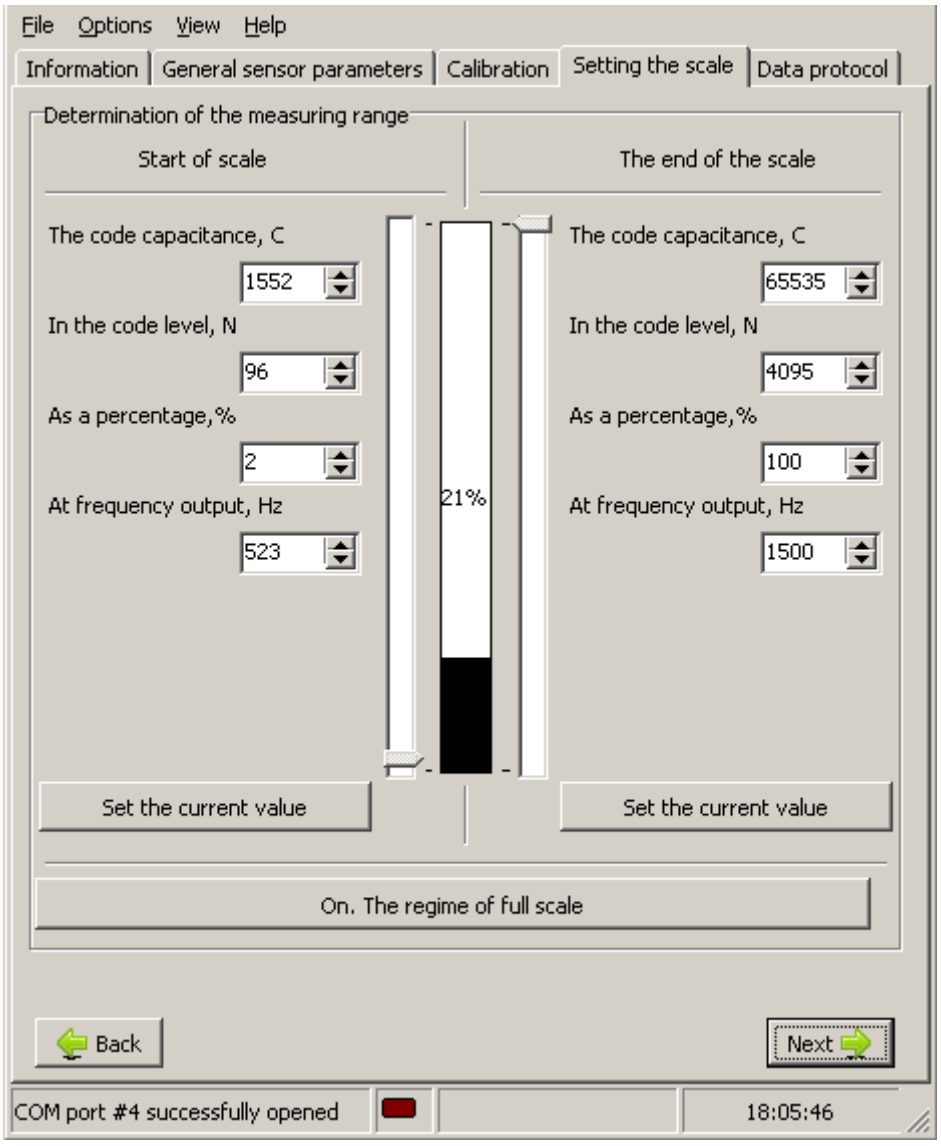


Figure 14: Setting the Scale Tab

For best accuracy click **The regime of full scale** and then click **Next** to continue. The **Data Protocol** tab is displayed.

4.8 The Data Protocol Tab

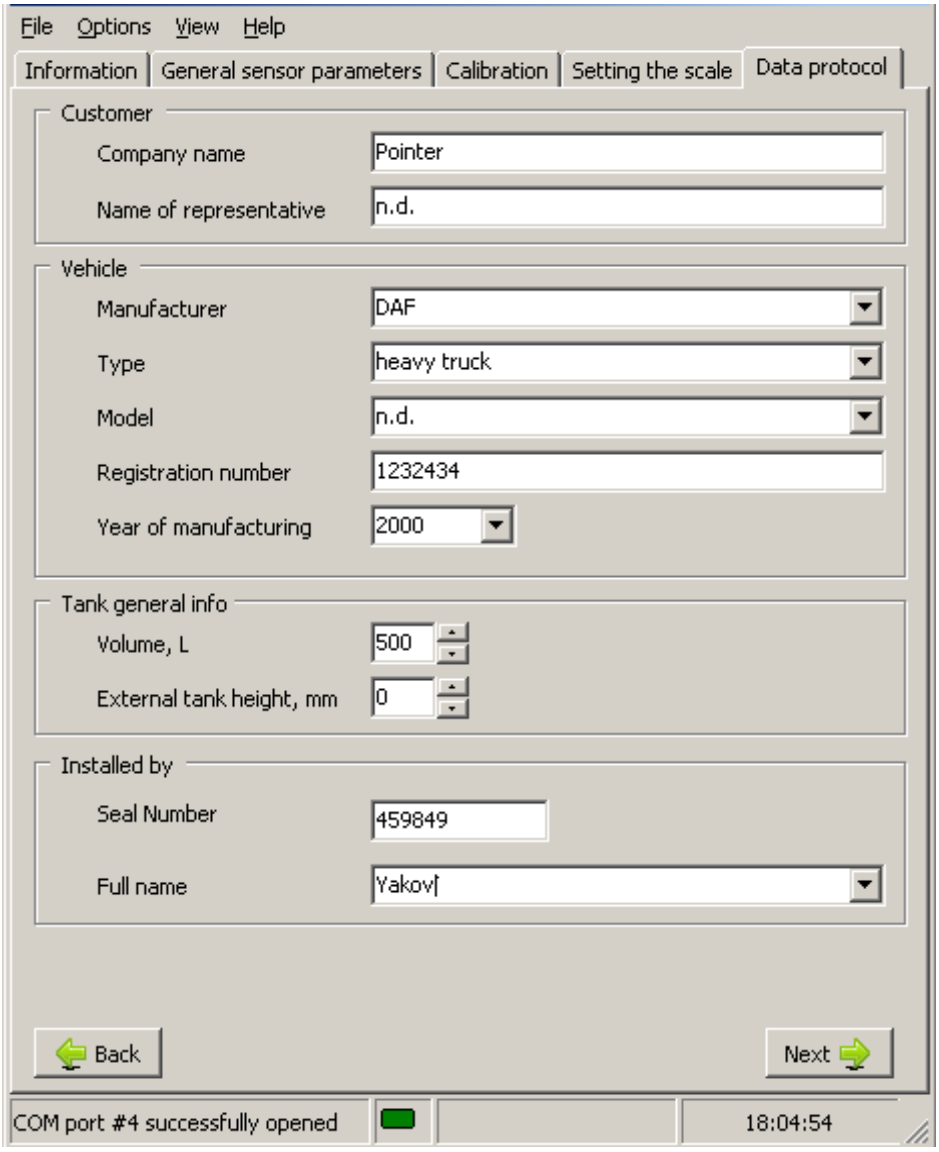


Figure 15: Data Protocol Tab

Fill in the required information which will be used for administration purpose by technical support. The information is not mandatory and does not affect the fuel measurement. Then click **Next**. The *Fuel Tank Calibration Monitoring* window is displayed.

4.9 The Fuel Tank Calibration Monitoring window

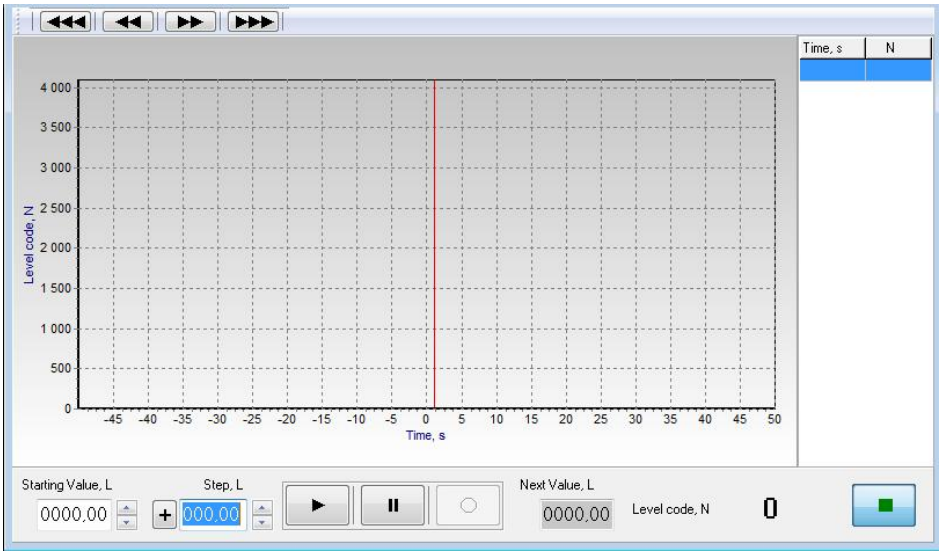


Figure 16: Monitoring Fuel Tank Calibration

4.9.1 *Fuel Tank Calibration Monitoring Fields and Buttons*

In the **Starting Value, L** field, the initial volume of fuel (number of liters) in the tank for that calibration session should be filled.

In the **Step, L** field, the amount of fuel (in liters) which is added to or removed from the tank should be filled.

In the **Next Value, L** field, the expected amount of the fuel in the tank is displayed. If this value exceeds the full tank volume (indicated in the protocol), the field will be highlighted in orange.

The **Level Code, N** field displays the result of measuring the fuel level by the sensor in decimal format.

 Initiates the calibration process.

 Pauses the calibration process.

 Records the point of calibration.

4.9.2 *The 1st Step in Calibration*

1. Fill in the initial volume of fuel (number of liters) in the tank in the **Starting Value, L** field. If the fuel tank is empty, enter "0"; otherwise the exact volume of fuel should be entered.
2. Click  to initiate the monitoring procedure. The fuel level graph begins its progress and the fuel level measurement is presented in the **Level Code, N** field.

3. Wait for the measurement to stabilize and then click  to record the point of calibration. The 1st point of calibration appears on the graph and in the adjunct table as displayed in the image below.

   The Typical values for an empty tank for 12-bit representation are: for probes shorter than 800 including "User's L" type - N = 625, for probes longer than 800 mm ("User's H") - N = 100.

4.9.3 *Procedure for the Following Calibration Steps*

1. Add or remove the measured portion of fuel to / from the fuel tank. The fuel level in the graph and in the **Level Code, N** field changes gradually.
2. Fill in the measured portion in liters in the **Step, L** field. Use the "+" or "-" symbol near the field to indicate addition or subtraction of the fuel portion. The volume of fuel in the tank is presented in the **Next Value, L** field. If you are using the same portion of fuel for each time, you can skip on this step.
3. Wait for the measurement to stabilize and then click  to record the point of calibration. The new point of calibration appears on the graph and in the adjunct table as displayed in the image below.

   If you are continuing a calibration process, you should fill the tank with the same amount of fuel as recorded in the last step and initiate the process from that step.

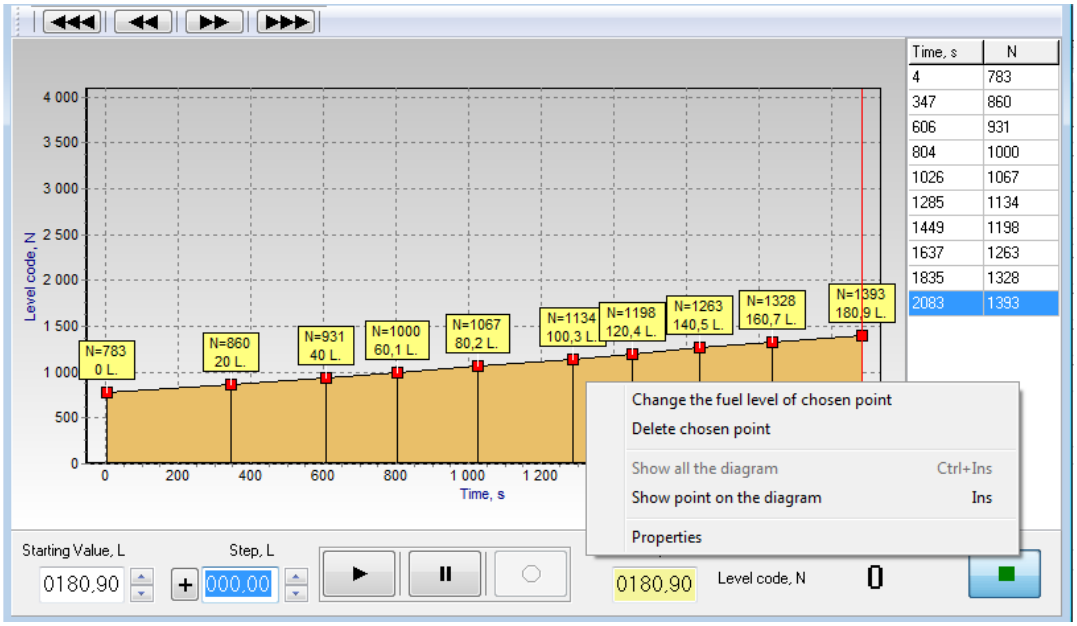


Figure 17: Monitoring Fuel Tank Calibration

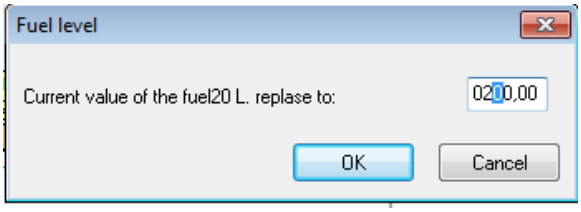
To pause the graph movement (on long pauses), click  .

To restart click  .

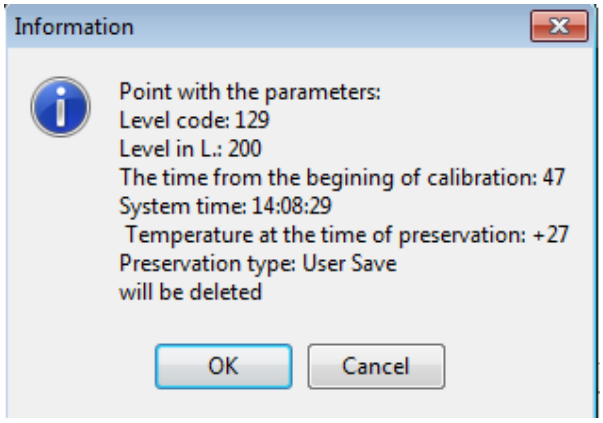
4.9.4 *View, Delete and Edit Calibration Points*

To select a calibration point of interest, click on its position in the table on the right (or on the graph). The red line is moved to the selected point. To view or manipulate the calibration point information, right-click on any place on the graph. A message box (presented in the image above) is displayed via which several manipulations can be performed:

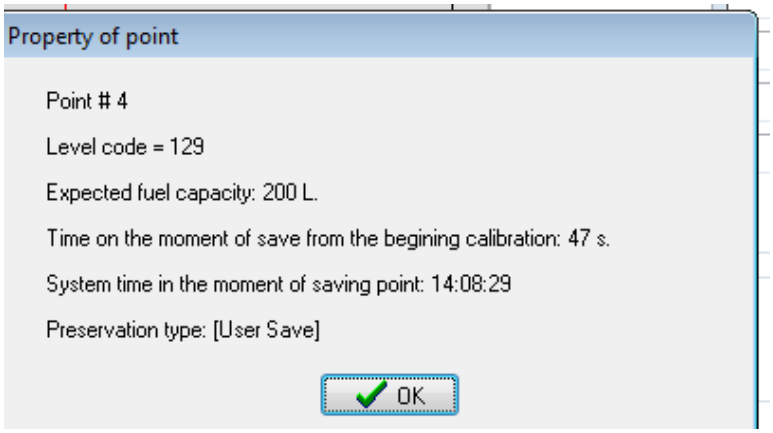
- **Change the fuel level of selected point**: When selected, a Fuel Level dialog is displayed in which you can enter a new value in liters of the tank fuel volume for the selected point. After clicking **OK**, you can also change the values of all subsequent points with the same fuel quantity difference. Click **Yes** to change all values, or **No** to change only the selected point.



- **Delete chosen point**: This displays the Information dialog, which shows the properties of the point you are deleting. Click **OK** to delete the point.



- **Properties**: This displays a dialog box in which all the properties of the point are listed.



4.9.5 *Graph Maneuvers*

You can navigate the graph by using the scroll buttons in the top left corner.

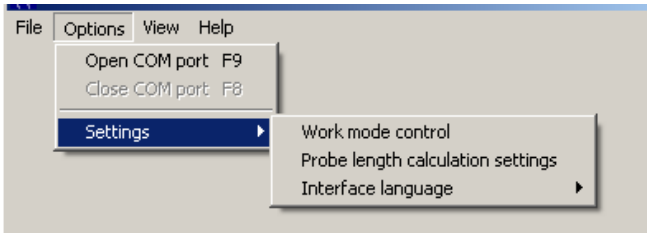
You can resize the graph (by zooming in or out). Click on the required point on the graph and then drag from left to right or from top to bottom *to zoom in*, or drag from right to left or from bottom to top *to zoom out*.

4.9.6 *Terminating the Calibration Process and Saving the Calibration Information in an Excel File*

The configuration information should be saved in an Excel file for usage by the Fleet Management application or any other back office application.

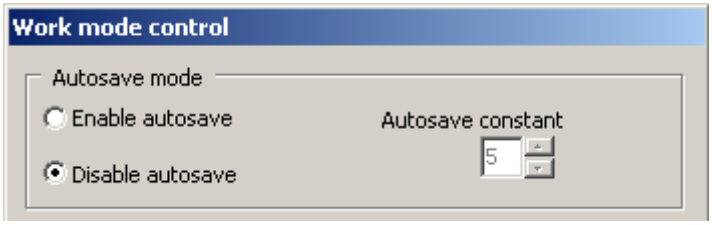
Click  in the lower right corner to complete the calibration; the application prompts you to export the calibration information to an Excel file. Once approved, the Excel file which provides the relevant information regarding calibration points and the administrative information, is opened. Review the information and remove any calibration point marked as 'auto save' and not 'user save'. Assign an appropriate name to the file and save it in the appropriate folder.

4.10 The Option Tab



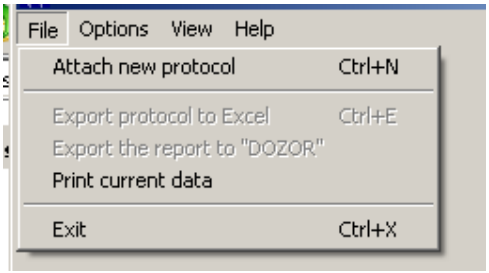
The Option tab enables the following:

- The opening and closing of the COM port.
- Setting of the autosave mode by selecting **Work mode control** from the *Options* > *Settings* menu. The default value is **Disable autosave**. Validate that the autosave mode is disabled, as shown in the picture below.



- Setting the interface language to English or Russian.
- **Note:** The **Probe length calculation settings** should not be used.

4.11 The File Tab



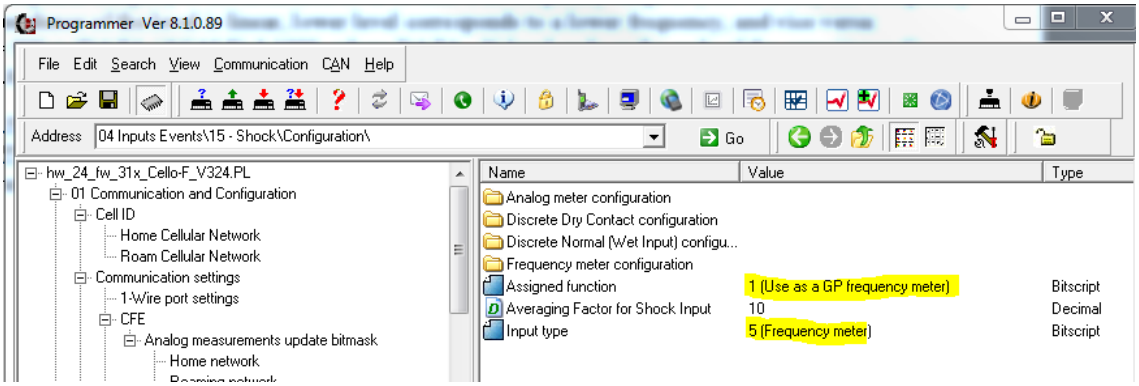
The File tab enables the following:

- The exporting of the protocol to Excel allows the calibration Excel file to be used by back office applications if it was not generated at the end of the calibration process. After exporting a calibration file into Excel, the calibration graph is presented automatically for reviewing the calibration information.
- Printing of current data.
- **Note:** The **Attach new protocol** option should not be used.

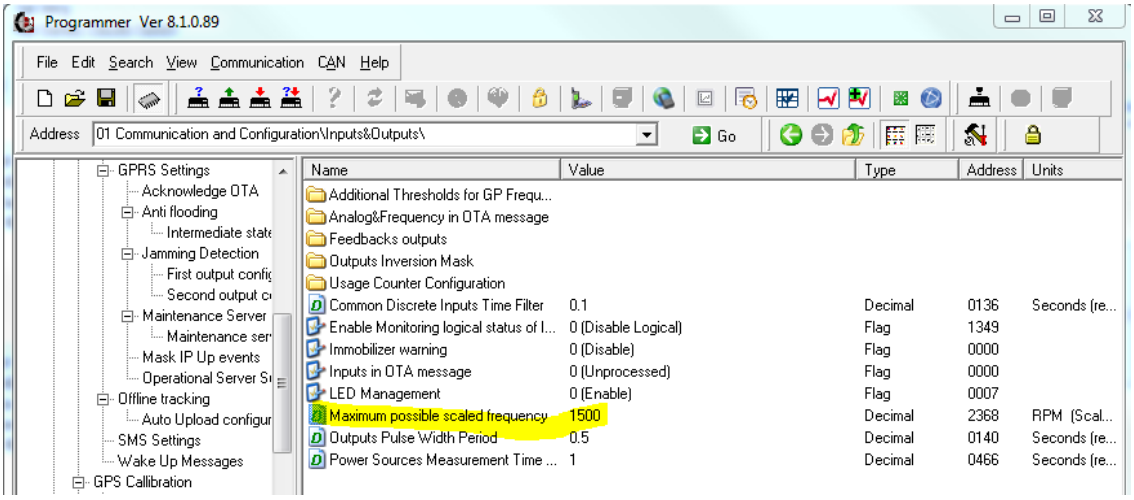
5 Integration with the Cellocator unit

The Cellocator unit allows the usage of shock and door inputs for frequency counter inputs. The CFE also supports frequency counter inputs. The Cellocator unit should be programmed to support the appropriate input (shock or door input is used in the example below) as General Purpose Pulse Frequency Measurement.

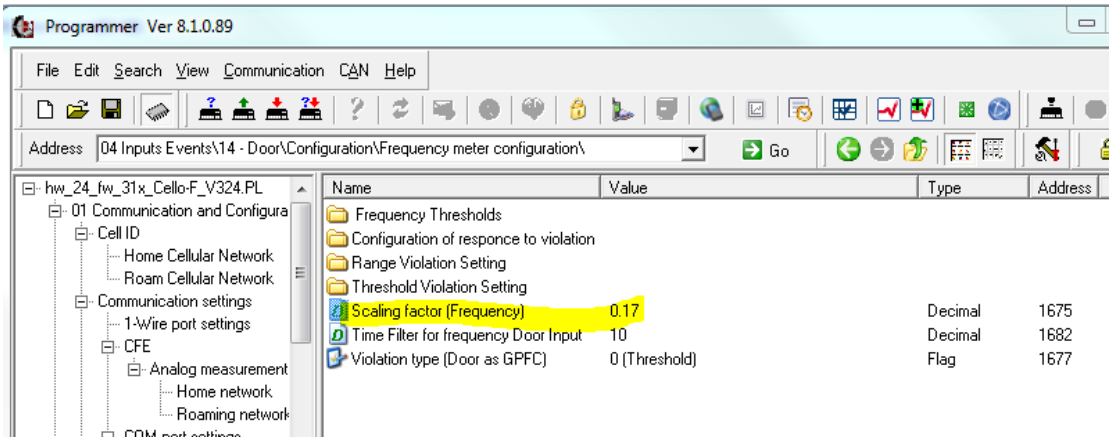
1. Configure the input type of the appropriate input to 5 and the assigned function to 1 as shown in the picture below.



2. Set the **Maximum possible scaled frequency** parameter to 1500 as shown in the picture below.

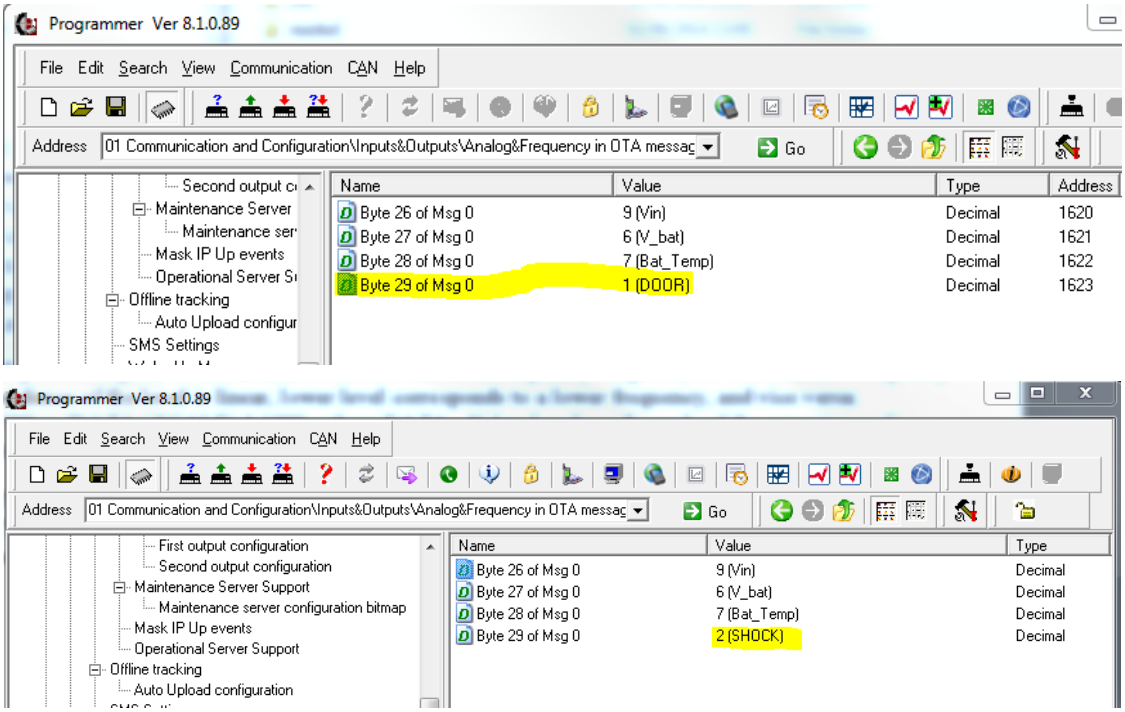


3. For maximum accuracy set the **Scaling factor (Frequency)** parameter to 0.17 as shown in the picture below.



Note that since the maximum frequency value is 1500 Hz and the maximum value represented in a byte is 255, the scaling factor is 255/1500=0.17

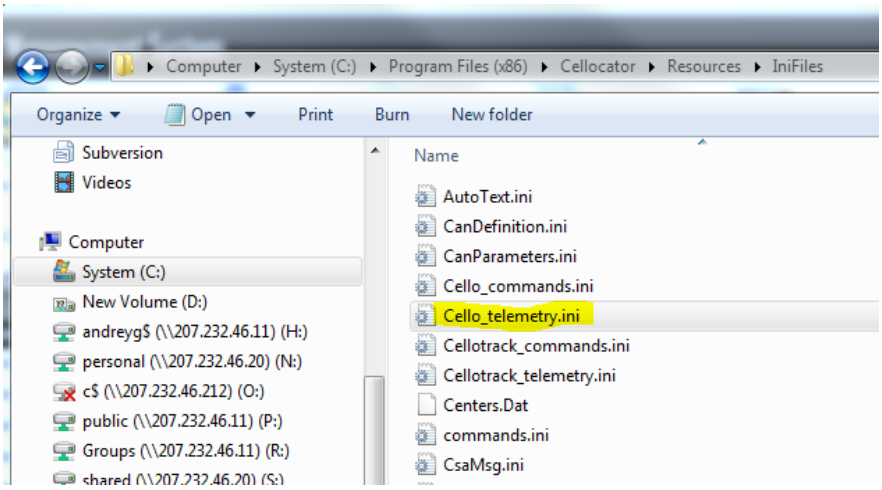
4. Configure the appropriate input value (1 for door in the example below) to be reported on the appropriate byte (29 in the example below) in message 0.

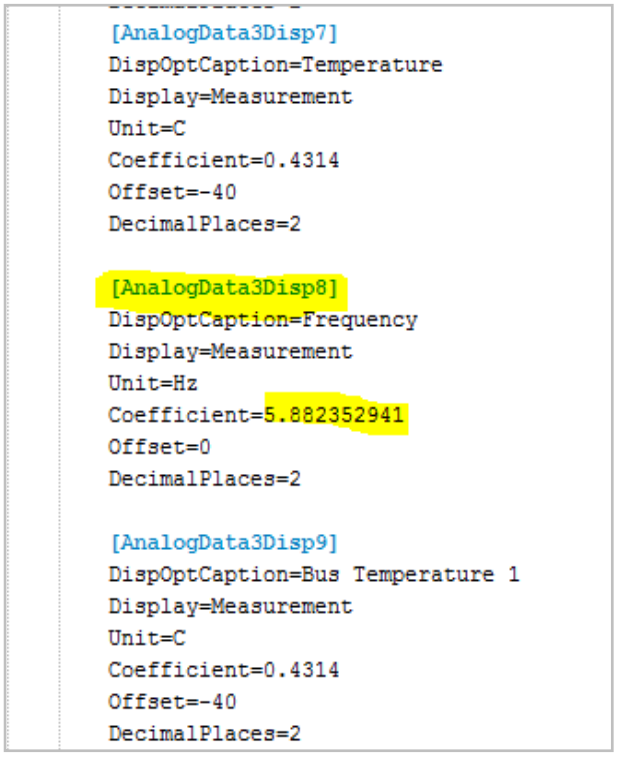


5. If required, program the **Alerts** parameters.

6. Open the **Cello_telemetry.ini** file via the path described in the picture below and in the section of byte 29 set the value to 5.88 as described below.

   Note that the value is set to 1500/255=5.88.





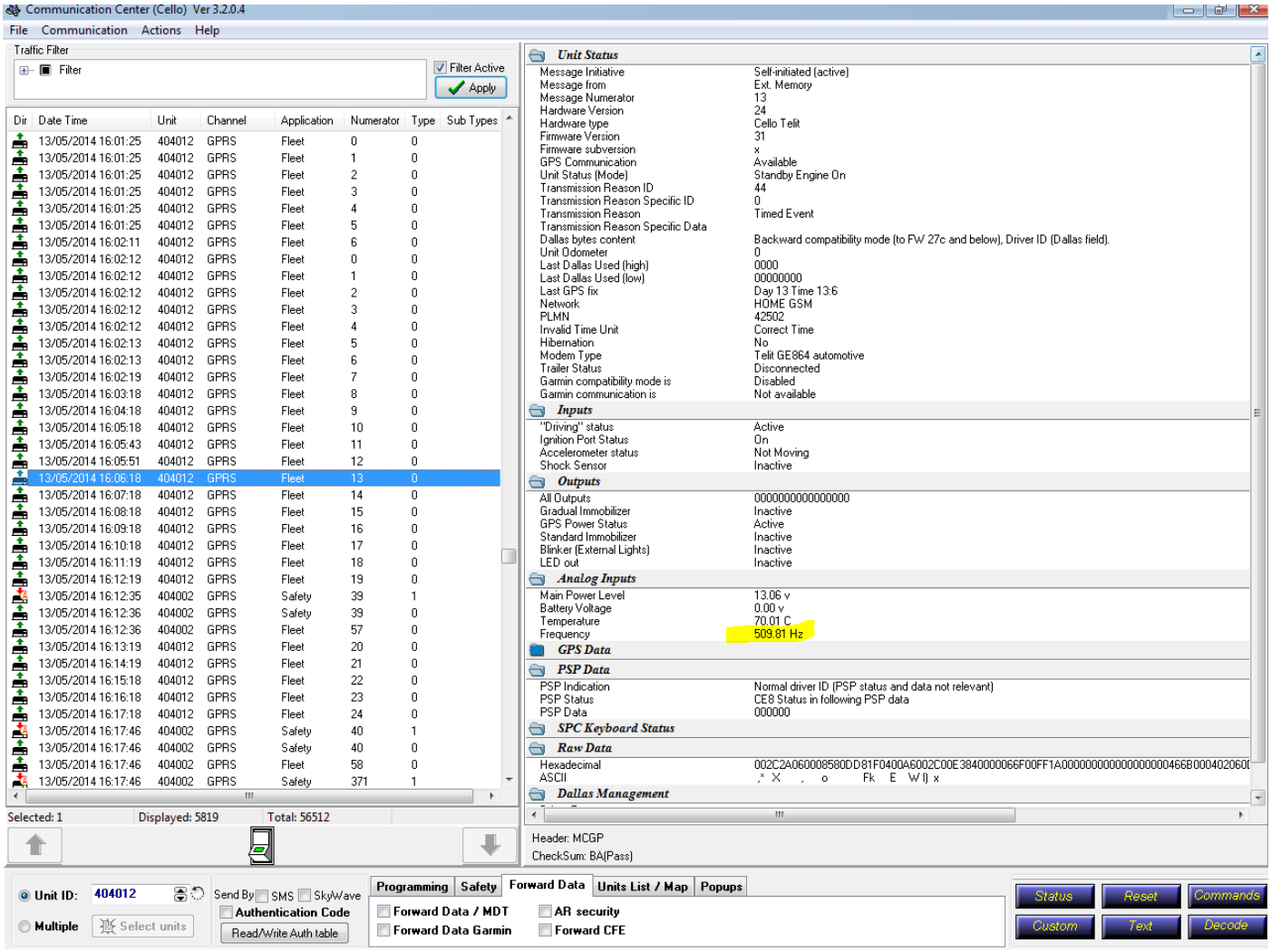
```
[AnalogData3Disp7]
DispOptCaption=Temperature
Display=Measurement
Unit=C
Coefficient=0.4314
Offset=-40
DecimalPlaces=2

[AnalogData3Disp8]
DispOptCaption=Frequency
Display=Measurement
Unit=Hz
Coefficient=5.882352941
Offset=0
DecimalPlaces=2

[AnalogData3Disp9]
DispOptCaption=Bus Temperature 1
Display=Measurement
Unit=C
Coefficient=0.4314
Offset=-40
DecimalPlaces=2
```

For further information regarding the configuration options please refer to the following sections in the Cellocator Cello Programming Manual:

- Analog (& Frequency) inputs in OTA message
- Frequency metering
- Additional Thresholds for GP Frequency meter
- 14 – Door

- 15 – Shock
- CFE

The reports of the fuel sensor can be reviewed in the unit status pane in the Communication Center, as shown in the picture below.



6 SW Integration Guide

The back office application should use the calibration Excel files as a conversion table between the online reported values of the sensor and the fuel volume in the tank. The Excel file provides a conversion table for each calibration point from a decimal number in the range of 0-4095 to the number of liters in the tank.

However, the real online reported value is in the range of 500 to 1500 Hz while the appropriate values in the calibration table, as reported in the calibration process, are decimal numbers from 0 to 4095. The following function converts the online reported value (F Hz) to the table reported value (N Decimal):

N= (F-500)*4095/1000

The SW application converts the reported value F to N and then looks up in the configuration table the calibration points below and above the reported value and calculates the number of liters using a linear interpolation.

7 Maintenance

7.1 Preventive Service

The sensor is an unattended product, but if the regulations of vehicle maintenance requires fuel tank maintenance it is advisable to simultaneously perform preventive service to the sensor.

Maintenance steps include the following:

- Perform a complete removal of the sensor (see the procedure below).
- Wash the internal part of the probe by using the fuel in which the sensor is operating, and then blow with compressed air.
- Verify the parameters of the measuring head (by using the Fuel Sensor Manager application).
- Install and seal the sensor according to the requirements described in the *Installation and Calibration* section.

7.2 Measuring Head Replacement

If the measuring head fails, you must replace it by performing the following:

- If you want to use the vehicle before a new measuring head is installed, you should remove the measuring head (see the procedure below).
- The new measuring head should be configured (using the Fuel Sensor Manager application) exactly as the replaced one and automatic zero adjustment should be performed as well.
- Remove the sensor from the tank and let the fuel drain from the drain holes in the plastic cover of the probe. Then, the zero adjustment fuel level should be changed manually to match the empty tank value reported in the calibration file of the replaced measuring head. Once this is done the calibration file of the replaced measuring head can be used for the new one.
- Complete the installation, sealing, and connection to the Cellocator unit as described in the *Installation and Calibration* section.

7.3 Removing only the Measuring Head

To remove only the measuring head:

1. Disconnect the interface cable and fuel sensor harness.
2. Remove only the measuring head of the sensor.
3. If necessary, partially tighten the sleeve of the sensor's probe into the flange, as shown in the image below.
4. Close the sleeve of the sensor's probe with a maintenance cap.

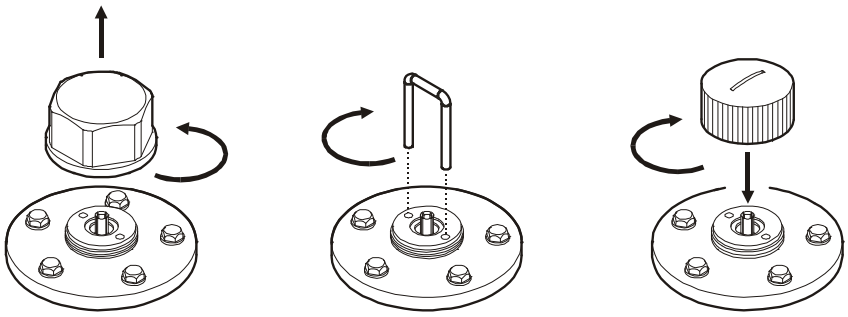


Figure 18: Removal of the Measuring Head

7.4 Removing the Sensor

To completely remove the sensor:

1. Disconnect the interface cable and fuel sensor harness.
2. Remove the measuring head and the sensor's probe from the flange.
3. Close the hole of the flange with the maintenance plug (see the accessory table below), as shown in the following image.

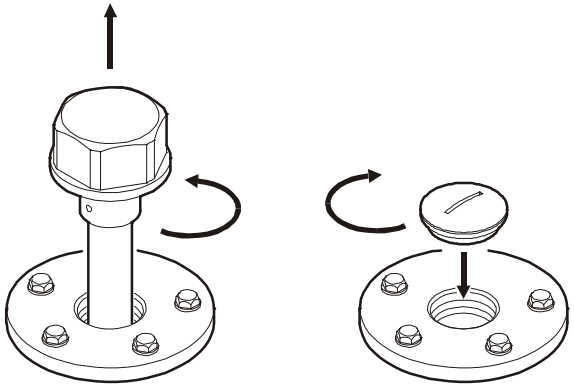


Figure 19: Complete Removal of Fuel Level Sensor

The following optional accessories are required for the fuel sensor maintenance.

Name	Notes
Maintenance Cap	M25x1.5, installed on the tank after removal of the sensor.
Maintenance Plug	Installed on the tank after removal of measuring head.

8 Transportation and Storage

Transportation of the sensor is allowed via all means of land and sea transport (such as railway, cars, containers, closed vehicles, holds, etc.). It is also possible to transport the sensor in sealed heated compartments of aircraft. During transportation and storage, the relevant signs must be printed on the transport package.

9 Technical Specifications

Name of Characteristic or Parameter	Units	Value	Notes
General			
Maximum allowed value of electrical conductivity of measured fuel	Cm/m	10^{-8}	1
Range of operating temperature	^{0}C	– 40 to + 75	
Ingress Protection Marking		IP56	
Measurement			
Range of measured values of the fuel level for 800 mm probe	mm	10 to 800	2
Minimum measured values of the fuel level for probes longer than 800 mm	mm	800	2
Minimum resolution of measurement of diesel fuel level in static mode	mm	0.05	3
Maximum error in level measuring in static mode	mm	0.5	4
Programmable averaging Period of measurement results on dynamic mode	s	0…32	
Number of Bits representation of measurement results	bit	10/12/16 for fuel level	5
		8 for Temperature	
Supply			
Voltage supply, operating range	V	+8 -10% ÷ +36 +20%	
Current consumption	мА	6±0,5	with 12V
		3±0,2	with 24V
Operating mode		Long-term	
Immunity to surge pulses on the power circuit.		+ 160V, 1 sec -1000V, 1 msec	

Interface			
Digital communication interface		RS-232	
frequency	Hz	500 - 1500	
Accession size, weight			
Flange holes characteristics		5 holes. ∅4.5mm	
probe's thread		M25x1.5	
Maximum height of measuring head above surface of tank, including flange	mm	29	6
Maximum weight	g	250	

Notes:

1. Allows measuring different sorts of fuel with high electrical conductivity (which contain anti-electrostatic additives).
2. The position of the upper (maximum) value of the measured level corresponds to the upper edge of the drain holes in the plastic cover of the probe.
3. For 16 bit representations of measurement results.
4. For 800 mm probe in normal climatic conditions.
5. Number of bits representation is configurable via the Fuel Level Manager. It should be set to 12, which is also the default value.
6. Does not include gasket