Fuel level sensor
«Zond»
DUT-3404-03

Setup and Operation Manual

Firmware version 2.1.0
Configuration program version 2.1.0
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1. Description

The fuel level sensor (FLS) Zond MIELTA is designed to measure the level of light oil hydrocarbons (diesel fuel, gasoline, kerosene, etc.) in various purposes containers. Sensor can be installed both on stationary objects, and on automobile and railway transport.

Sensor uses the linear capacitor capacitance measuring method. The capacitance value depends on sensor immersion level in the dielectric liquid.

Sensor is made in a rugged metal case with IP68 protection class, equipped with a flexible heat-resistant cable in a synthetic protective sheath and a sealed connector. Sensor mounted in the hole in the tank and has a flange for fastening with screws.

2. Specifications

Table 1.

Supply voltage	8 – 55 V
Average power consumption	0,5 W
Measurement period	1 c
Averaging interval	1-60 sec
Relative error of level measurement in the whole range	1%
Frequency output: maximum frequency range	30-2048 Hz
Frequency output resolution	1 Hz
Frequency output pull-up	2 kOhm
Frequency output current limit	0,1 A
RS485 baud	9600, 19200, 38400, 57600, 115200, 8n1

Galvanic isolation:
    Power supply, frequency output - RS485
    Power supply, frequency output – measuring part
    Measuring part – RS485
	
	1000 V
	1000 V
	1000 V

Measuring part length	700-2000 mm
Minimum recommended measuring part length	200 mm
Cable Length	0,7 m
Mounting kit cable length	5 m
Working temperature	-40..+80 °C
Protection class	IP68

2.1 Power Supply

FSL Zond is designed to operate over a wide range of supply voltages, has a reverse polarity protection, overvoltage protection and a self-resetting fuse. A wide range of operating voltage allows the sensor to work stably even in abnormal situations - with a voltage drop of up to 8 V or an increase to 55 V.

If the supply voltage exceeds 55 V, a protective diode and a self-resetting fuse in the sensor are triggered, the sensor power off. After returning the supply voltage level to the operating range, the sensor restores its operability.

⚠️ **To avoid deep discharge and damage the battery, it is recommended to use the MIELTA BEETLE power supply controller (KPA-4601-02).**

Integrated sensor power supply module is galvanically isolated from the housing, measuring part and RS485 digital interface. Breakdown voltage of insulation - 1000 V. This feature allows you to connect the sensor to a data reading system (to a satellite terminal) at remote distances without combining the ground potentials with a drain wire and supply it from different sources.

2.2 Frequency output

Sensor frequency output is intended for data transmission in discrete signal form of variable frequency and a 50% duty cycle. The positive signal potential is provided by a pull-up to the sensor supply via a 2 kΩ resistor. The negative potential is formed by a transistor, operating in a common-emitter circuit. The maximum current of the frequency output is limited to 100 mA. When the maximum current threshold is exceeded in either direction, a high-speed protection is triggered and the output circuit is disconnected. When the current decreases to the permissible value, the frequency output continues to function.

The lower value of the output frequency is 30 Hz. The upper value is programmable in the range of 500-2048 Hz.

If an error occurs, the sensor sets the frequency corresponding to the error code (see Table 2). The error is also duplicated via the RS485 digital interface.

Table 2.

Freq., Hz	Error code	Error description
20	20	Level is less than the minimum at calibration
Max +50	5000	The level is higher than the maximum at calibration
Max +100	6000	Exceeding the measurement limits, closing in the measuring system

If it is necessary to match the frequency output to a voltage level lower than the sensor supply voltage, it is necessary to disable the built-in pull-up and use an external pull-up resistor. The resistor rating is chosen so that when it is grounded it provides a current in the range of 5-10 mA (for example, for 12 V a resistor from 1200 to 2400 ohms is needed).

The frequency output is galvanically integrated with the power module and isolated, respectively, from the measuring system and the digital interface. When connecting a sensor to a data reading system (terminal), it is necessary to combine potentials (connecting negative power wires).

2.3 RS485 interface

The digital interface RS485 is made according to the international standard ANSI EIA / TIA-485-A. The data is transmitted using a protocol developed by MIELTA, which is compatible with the Omnicomm protocol for obtaining fuel level data.

The digital interface is for receiving telemetric data from a sensor, setting parameters and updating firmware. Used to connect to a monitoring system or a personal computer (PC) using a USB-RS485 adapter. To work with a PC, a configuration program is used, which implements all possible functions of the sensor.

The RS485 interface allows you to connect several sensors to one terminal port (Fig. 1, 2). All MIELTA satellite terminals support the connection of up to 8 any sensors or peripherals on the RS485 bus.
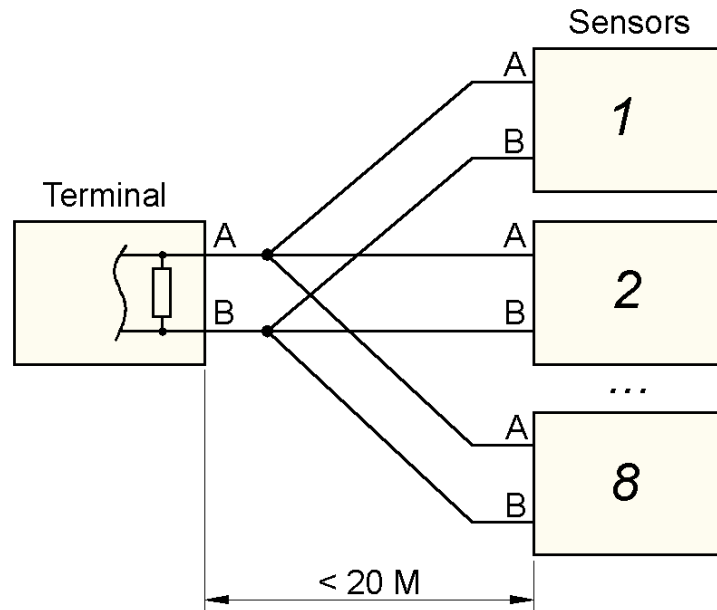
Fig 1. Type "star" connection scheme.

When connecting several sensors at a distance less than 20 m from a terminal, the "star" topology scheme is recommended. This topology does not require additional terminal resistors.
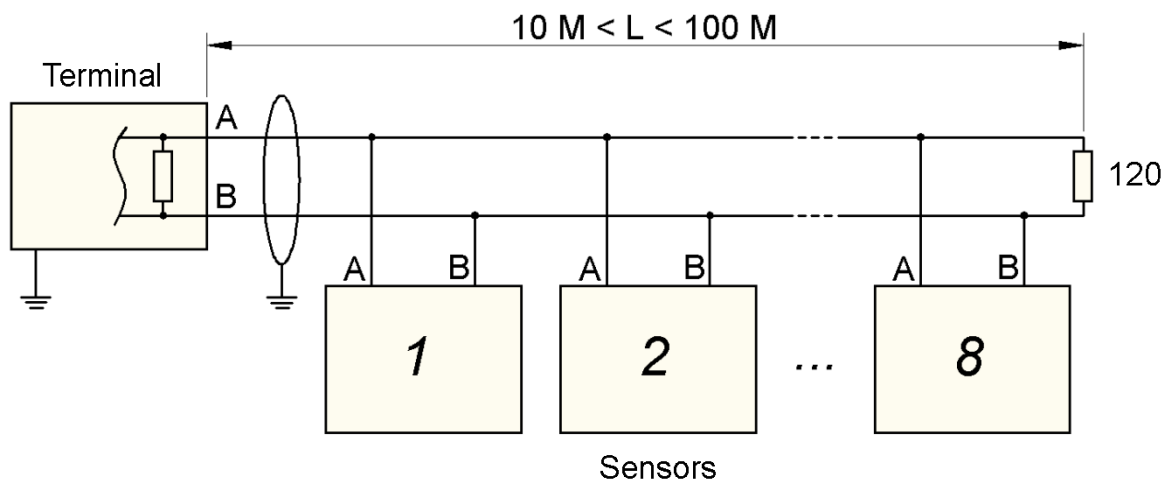

Fig 2. Type "bus" connection scheme.

The "bus" topology is used to connect several sensors at distances up to 100 m. In this case, an external termination resistor of 120 ohms 0.25 W is required, which is connected at the location of the most remote sensor from the terminal.

If the length of the bus is more than 20 meters, the use of a shielded twisted pair is recommended. The cable shield is connected only from one side to the "-" terminal's contact ("-" supply). The connection of the cable shield to the sensor's "-" is not required. Due to galvanic isolation in the sensors, each sensor can be powered from various sources.

Before connecting several sensors to the common bus, it is necessary to configure each of them individually. All devices on the bus are assigned unique addresses. Then for

each sensor set the address, the transmission rate and the type of data requested (level, output frequency or temperature) in satellite terminal.

The digital value "level" is in the range 30 - 4095. Values of 20, 5000 and 6000 are error codes in the sensor operation (Table 2). The digital value "frequency" is the frequency formed at the sensor frequency output, the upper value of which is programmed (see "Frequency output" section). The value "temperature" reflects the actual temperature in the sensor housing.

3   Installation and Connection

The sensor is mounted at the top of the fuel tank and opposite to the lowest point of the bottom of the tank. The surface for mounting the sensor must be horizontal and selected with regard to the availability and ease of installation.
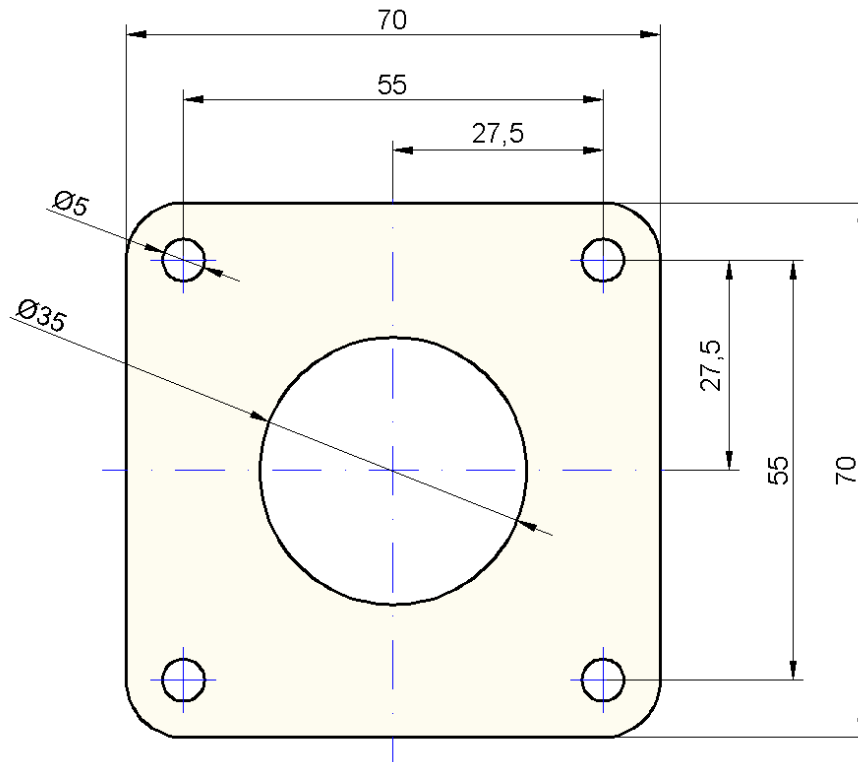
Fig 3. Sensor connecting dimensions.

The central hole has a Ø35 mm diameter (Figure 3). The mounting holes diameter is chosen based on the material of the fuel tank and the attachment method. Self-tapping screws are used to fix the sensor. When mounted on a metal tank, 4 holes with a diameter of 4-4.5 mm are drilled or screws with a drill are used. When mounted in a plastic tank, 4 holes with a diameter of 3 mm are drilled and self-tapping screws without a drill are used.
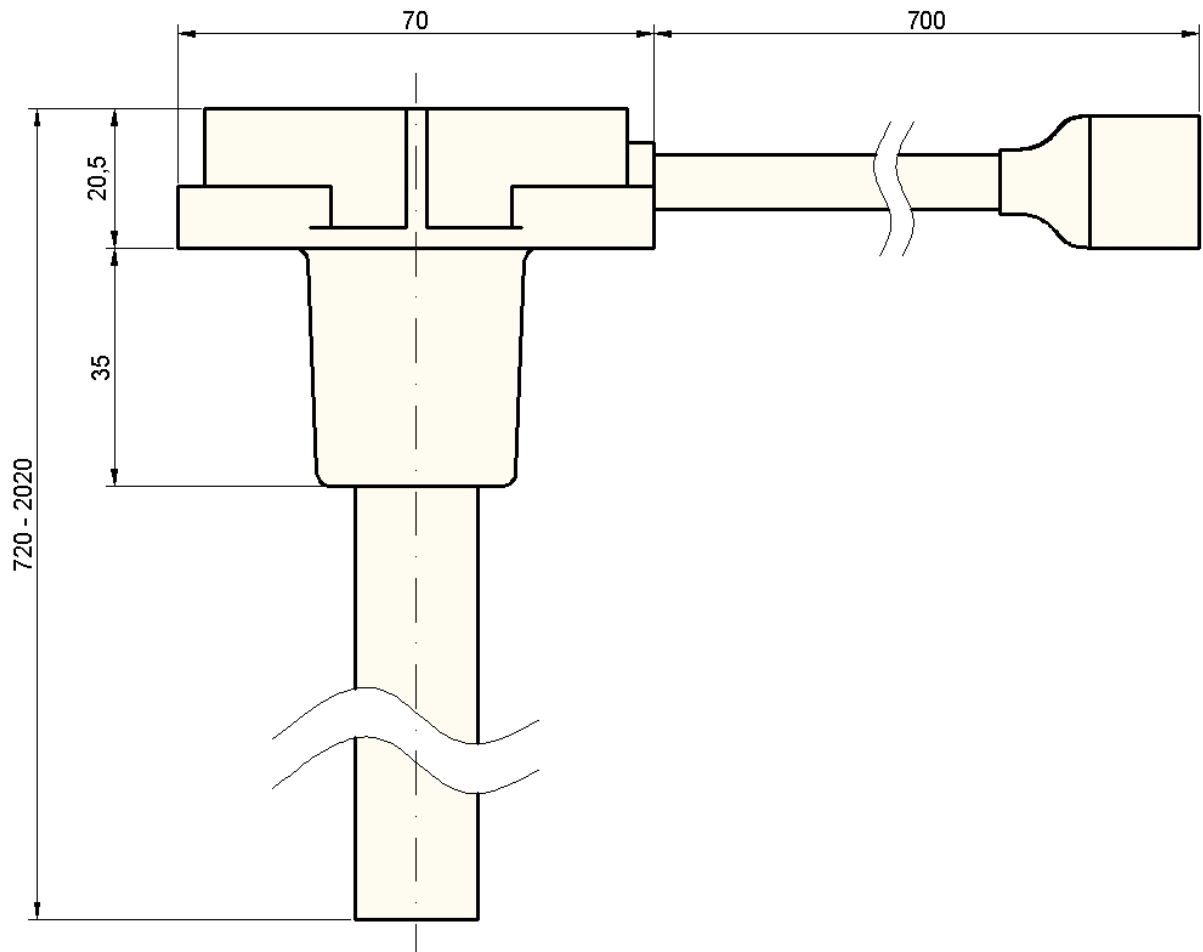
Fig 4. Sensor overall dimensions.

Mounting procedure:
1. Select a location for installation, clean it of contamination.
2. Mark the holes according to the template, drill and remove the sawdust.
3. Measure the depth of the fuel tank from the bottom to the mounting surface.
4. Measure the sensor length from the mounting flange 20 mm shorter than the measured depth of the fuel tank.
5. Saw off the tube and the central electrode, deburr, insert the insulator into the end of the measuring tube.
6. Calibrate the sensor (section 4.2).
7. Clean and degrease the mounting surface of the fuel tank. Apply a sealant to the surface, glue the rubber seal. Apply the sealant to the gasket and install the sensor.
8. Secure the sensor with screws.
9. Connect the cable connector.
10. Seal the sensor mount and connector.

If necessary, to bypass obstacles in fuel tanks of complex shape, the measuring tube of the sensor can be bent. Bending is performed using specialized pipe benders with a bend radius of at least 250 mm. The bend angle should not exceed 15 degrees (Figure 5).
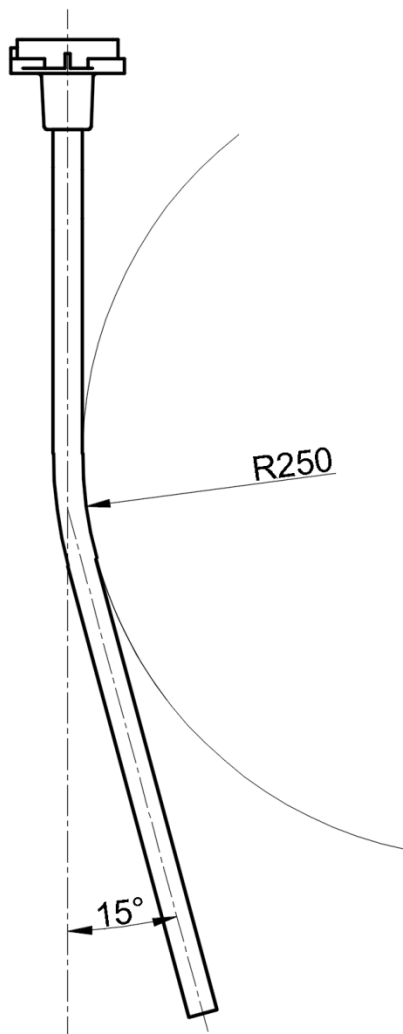
Fig 5. Sensor tube bending.

Bending sensor tube procedure:

1. Disconnect sensor power supply.
2. Calculate the location of the fold, mark it on the sensor tube.
3. Place the sensor tube in the pipe bender with the label in the middle.
4. Connect the measuring device (multimeter) in the continuity mode with probes to the tube and the central electrode, respectively.
5. Bend the tube until the required angle is reached, preventing the closure of the central electrode and tube.
6. If there is an electrical shortage of the central electrode and tube, it is necessary to reduce the angle of the bend by applying force to the folding position on the reverse side, until the central electrode from the tube insulation guaranteed.
7. Saw the measuring tube to the required length.
8. Calibrate, install and taring the sensor.

If necessary, the sensor tube can be bent in two or more places to give it a complex shape.

Keep in mind that the bent measuring tube loses its symmetry and linearity, which directly affects the values of the sensor. A bent sensor without taring can have non-linear distortions in the readings at different levels. During taring of the sensor, it is recommended to do more number of measuring points (30-50 points per meter) to compensate nonlinearity.

Table 3.

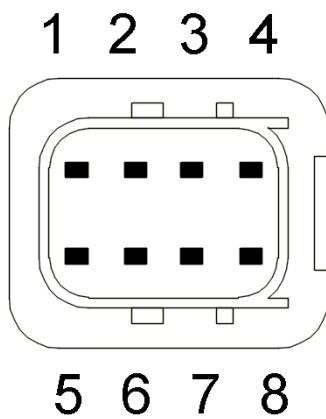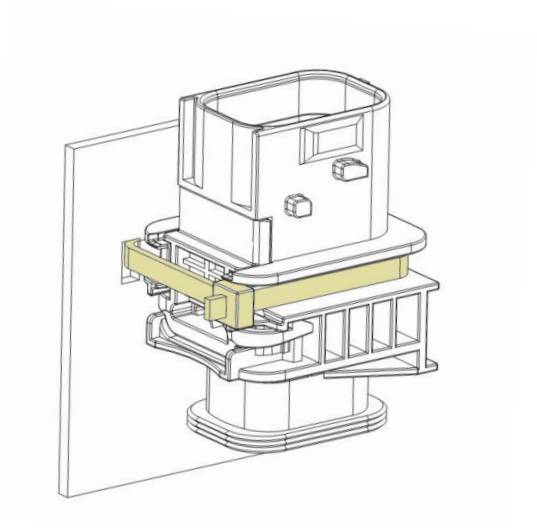| Pin	Wire color	Appointment
1	Red	Plus power ("+")
3	White	Frequency output
4	Yellow	RS485-A
5	Black	Minus supply ("-")
8	Blue	RS485-B

Fig 6. Sensor pinouts.

Fig 7. Mounting the connector.

Below are several options for connecting the sensor in the monitoring system (Figures 8 - 10).

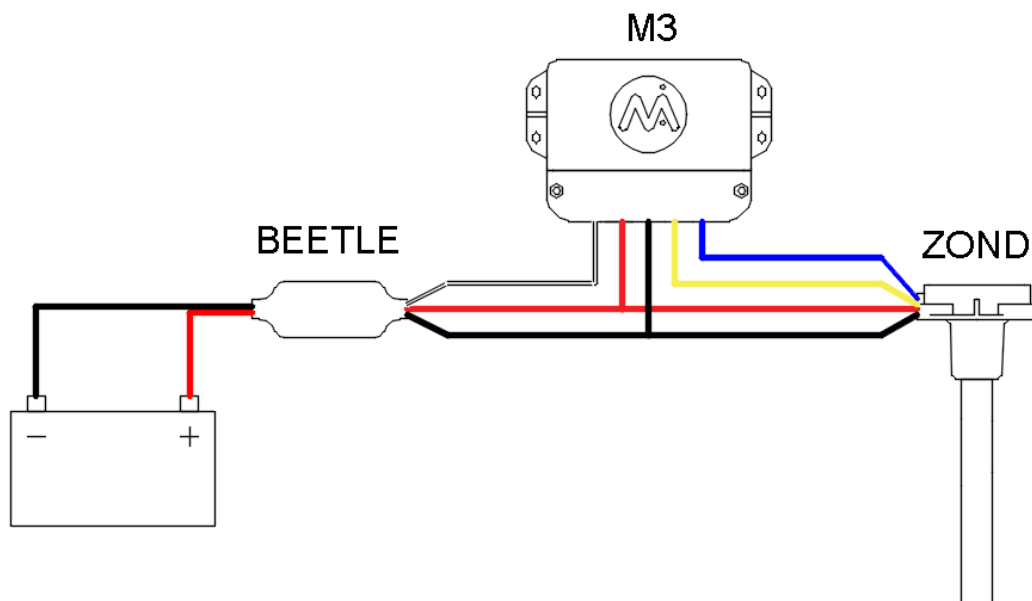⚠ **All electrical connections must be soldered or crimped. Seal the joints using a heat-shrinkable adhesive tube.**

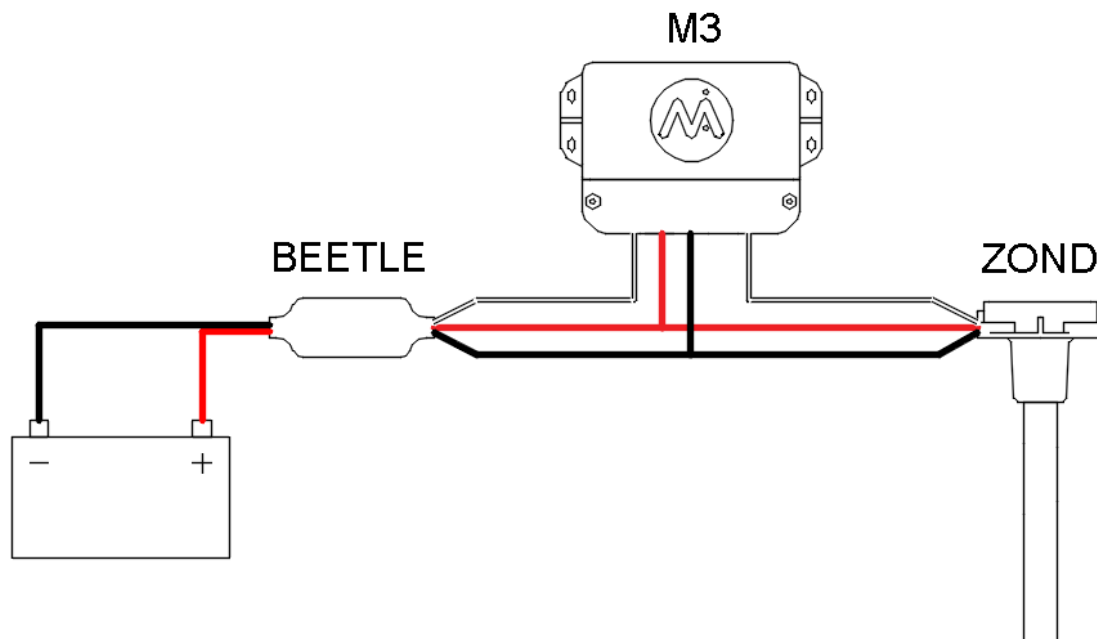Fig 8. Connection diagram for RS485 interface with common power supply.

M3

Fig 9. Connection scheme using a frequency signal and a common power source.
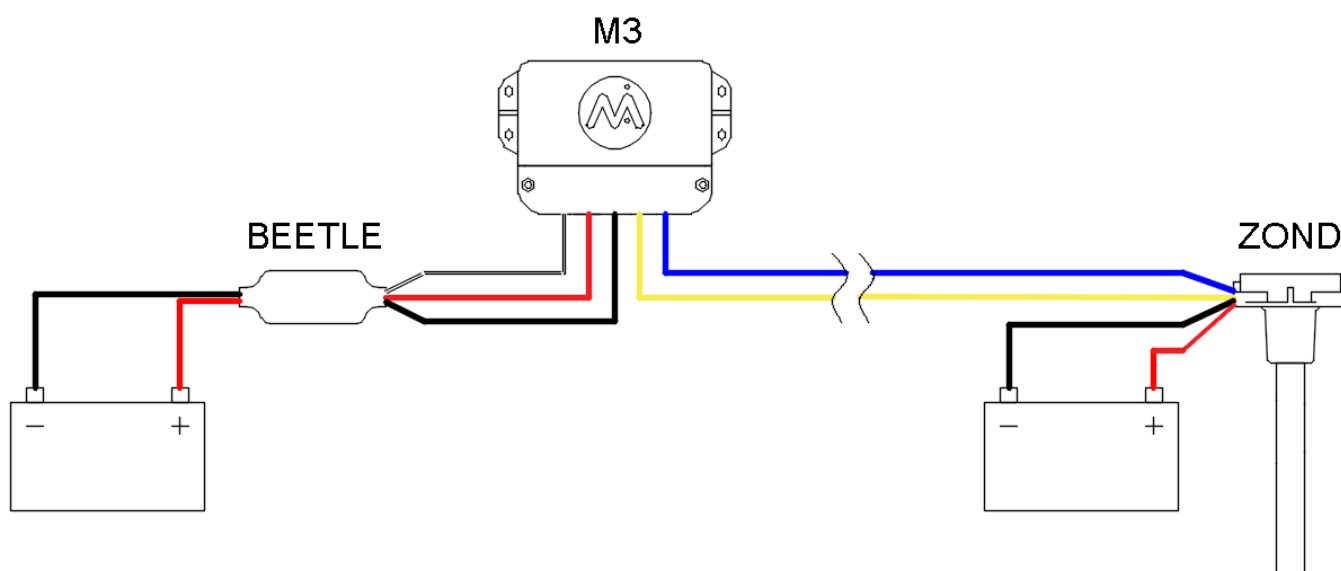
M3

Fig 10. Connection scheme for RS485 interface and separate power sources.

4   Configuring the Sensor

Configuration program is used to configure the Sensor. Viewing the Sensor's information is available without restrictions, and a password is required to change the settings. By default, the manufacturer sets the password to "0000".
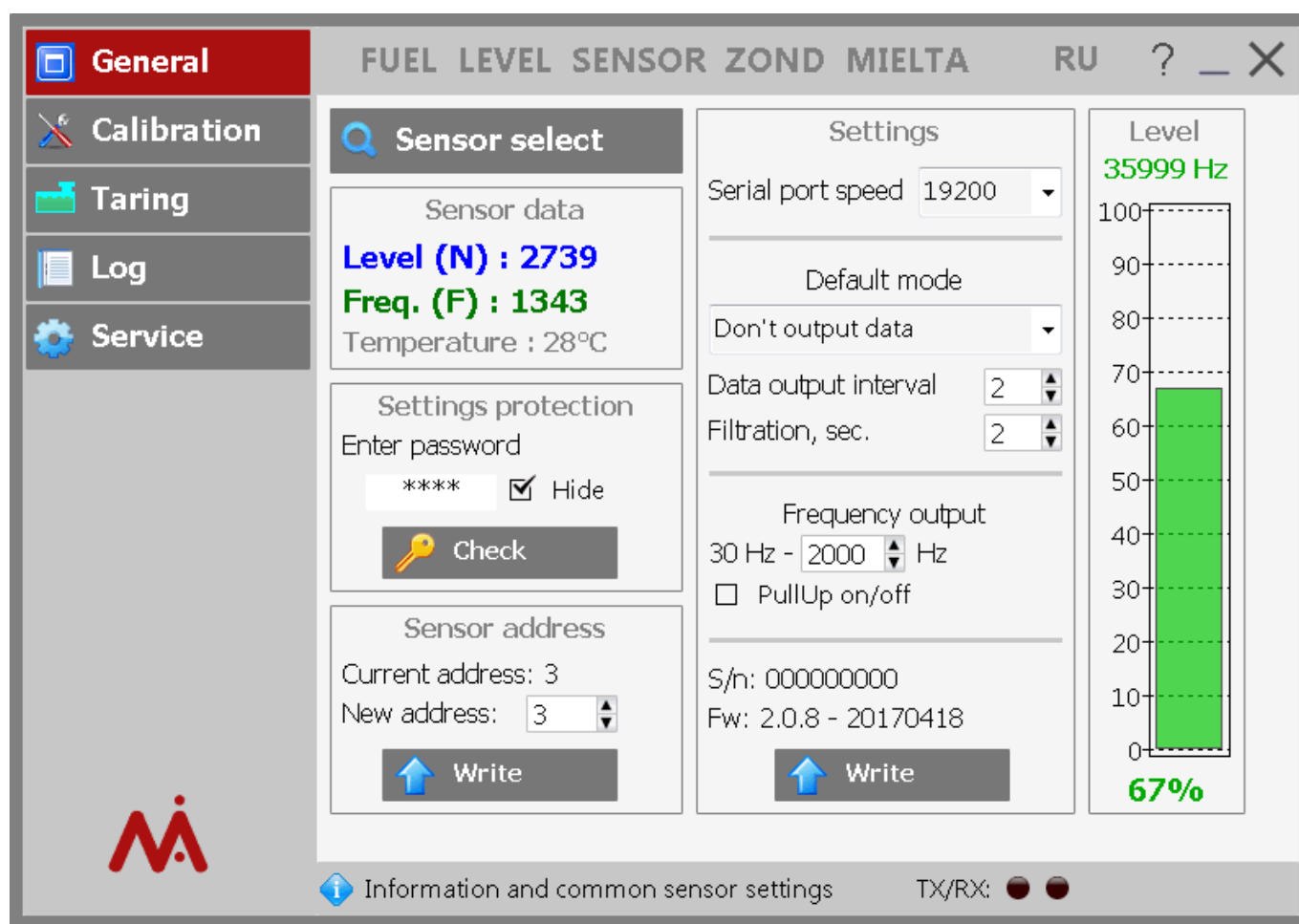
Fig 11. Main window of the configuration program

4.1 Connecting to a Sensor

Connection to the sensor is possible via the RS-485 interface using a special adapter. Before you start working with the sensor, you need to search for devices on the RS485 bus. To do this, click the "Sensor Select" button, which is located in the "General" menu of the configuration program (Figure 11).

In the window that opens, specify the serial port to which the RS-485 adapter is connected, select the search mode (broadcast or by address range) and click the "Search" button (Figure 12). The search results will be displayed in the right part of the window in the "Discovered sensors" block in the following format:

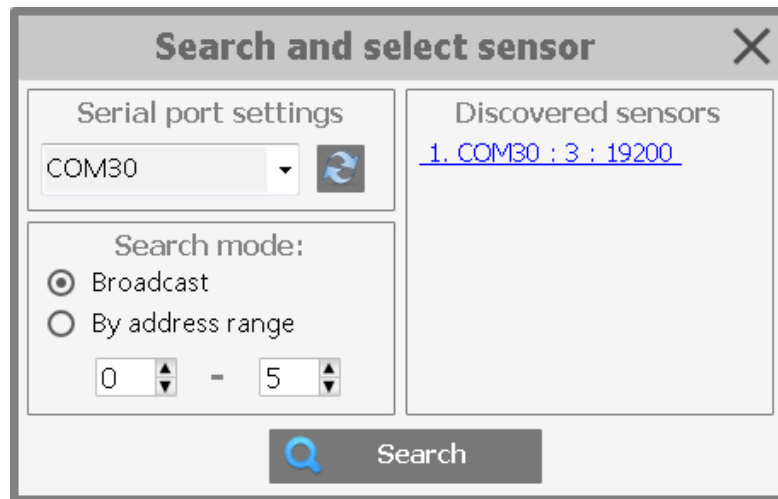**COM-port : RS-485 address : port speed**

Fig 12. " Search and select sensor" window

For example, in Figure 12, the program detected one sensor with address 3, configured for a speed of 19200. To start working with the desired sensor, click on the corresponding line with the left mouse button. The program will connect to the sensor and display its parameters in the main window.

4.2 Calibration

Before using the Sensor, it is necessary to calibrate it using the "empty fuel tank" and "full fuel tank" values. These values will correspond to the sensor readings of 0% and 100% respectively.

Sensor calibrating procedure:
1. Saw the sensor measuring tube at a distance from the mounting flange 20 mm shorter than the depth of the fuel tank.
2. Connect the Sensor to the configuration program (section 4.1).
3. Securely seal the drain hole in the sensor housing.
4. Completely fill the sensor measurement tube through the open end of the tube with fuel from the fuel tank.
5. After stabilizing the readings in the program, perform calibration on a "full tank" (Figure 13).
6. Drain fuel from the sensor tube, allow the fuel to drain for 5 minutes.
7. After stabilizing the indications in the program, perform the calibration on "empty tank" (Figure 13).

⚠️ **Calibrate in the order shown. Calibration on the "empty tank" value of a dry sensor (without filling the tube with fuel) causes incorrect level readings. The fuel vapor in the tube significantly affects the sensor reading.**
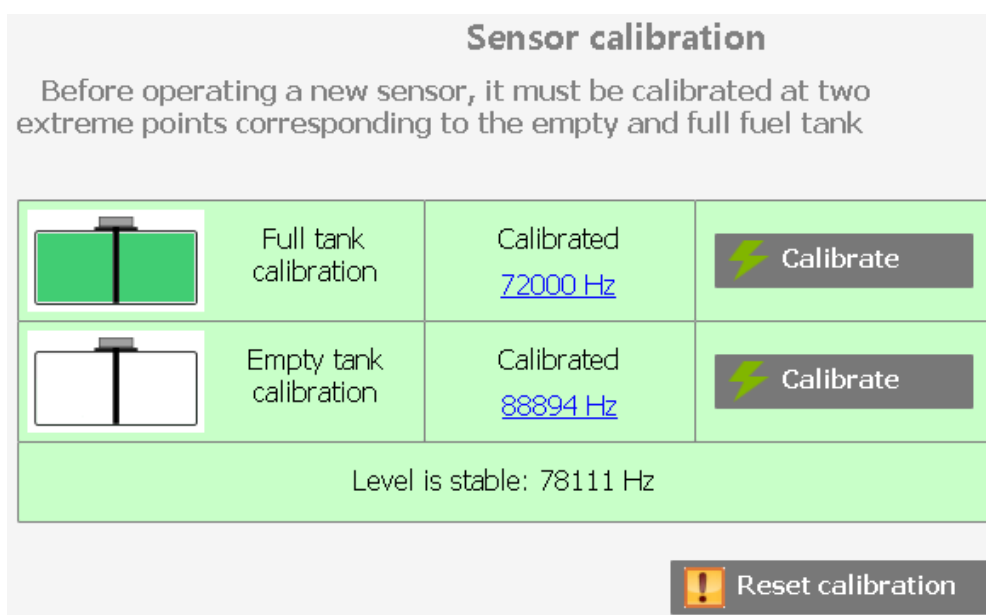
Fig 13. Sensor calibration.

Red means no calibration at the appropriate point. In order to calibrate the Sensor at the desired point, click the appropriate "Calibrate" button. After the calibration, the line will change its color to green. To calibrate the sensor again, press the Calibrate button again. To completely reset the Sensor calibration (in two points), press the "Reset calibration" button.

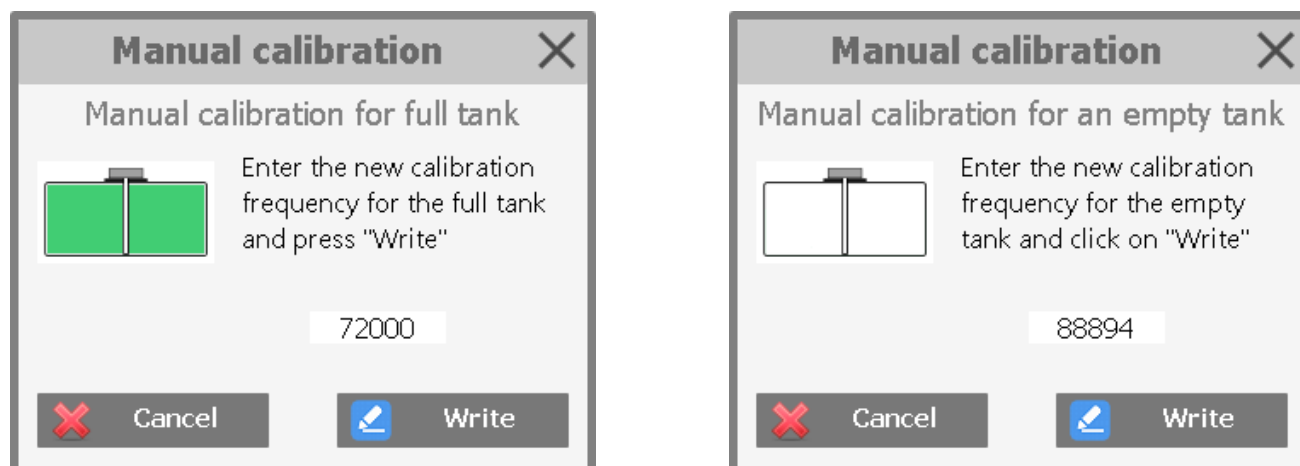Calibration frequency values can be changed manually by left mouse button click on the corresponding value.

Fig 14. Manual Calibration.

4.3 Taring

Sensor taring is a create a table proces to link the sensor level readings to the actual volume of fuel in the tank. Taring is carried out for each fuel tank individually and is necessary for obtaining readings in liters with a given accuracy and linearity. The more complex the form of capacity, the more taring points need to be done. Most often in practice, enough 20-40 taring points.

The configuration program allows you to simplify the sensor taring process, using the "Taring" program menu (Figure 14).

Before starting the taring process, select the required sensor parameter (level N or frequency F) and specify the taring step in liters. Fill the fuel tank with the required amount of fuel, wait for the level to stabilize and press the "Add row" button - the program will automatically fill the next line of the taring table in accordance with the selected parameters. The ready table can be written in the Sensor's memory (maximum 128 lines), exported to an Excel file or printed. In addition, you can import a table from an Excel file. If a taring table has already been recorded in the sensor, you can download it from the Sensor to the configuration program using the "Read table" button (Figure 14).
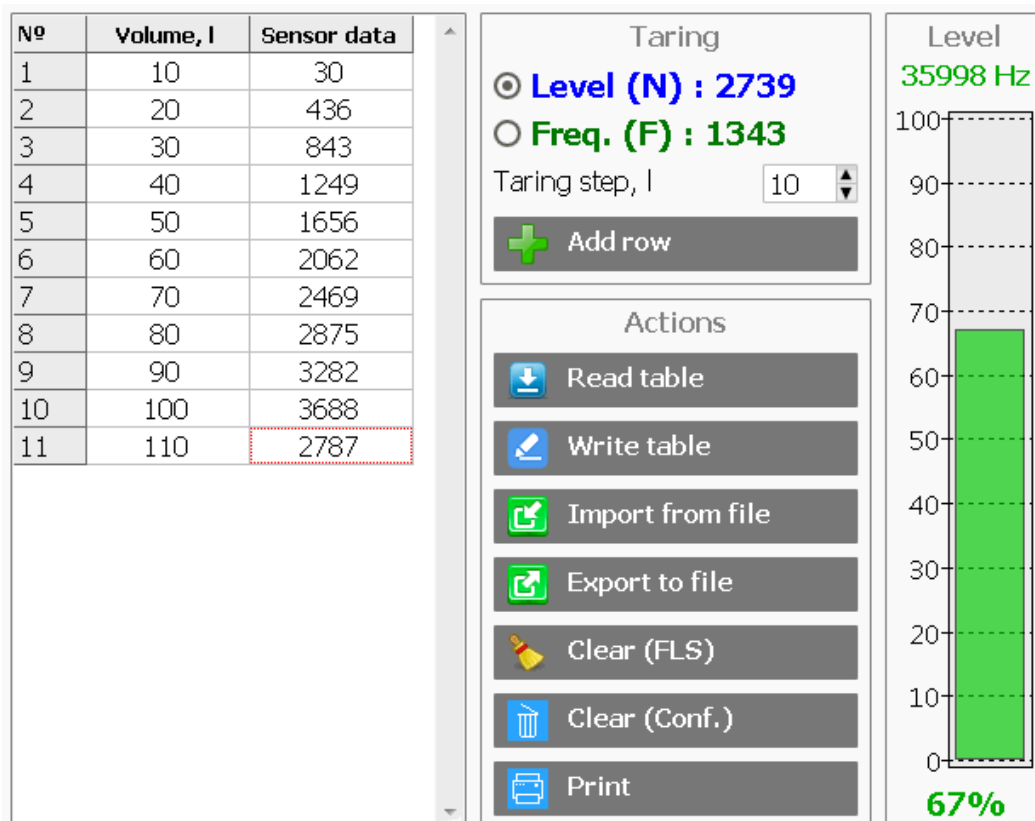
Fig 15. Taring.

4.4 Other settings

Configuration program allows you to change the following Sensor settings.
- Sensor address on the RS-485 bus (valid values are 0..254);
- RS-485 bus speed (9600, 19200, 38400, 57600, 115200);
- Data output mode:
  - ⇨ without automatic data output;
  - ⇨ automatic data output in binary form;
  - ⇨ automatic data output in symbolic form;
- Automatic data output interval (1..60 sec);
- Sensor data filtering interval (1..60 sec);
- The upper limit of the frequency output (500..2047 Hz);
- Enabling or disabling the frequency output pullup;

- User password for changing Sensor settings.

After changing the settings, click the "Write" button to save the new settings to the sensor.

All changes made to the sensor settings are recorded in the configuration change log, which is stored in the internal memory of the sensor. In addition, the sensor stores the total operating time and the number of starts in the internal memory. To view the log of changing settings, use the "Log" program menu (Fig. 15).

Fig 16. Sensor settings change log.

To download a log from the Sensor, click the "Get log data" button. To save the log to a text file, click the "Export to File" button.

The "Service" program menu contains the following functions:
- change the user password;
- reset the user password using the master password;
- reset sensor settings to factory defaults
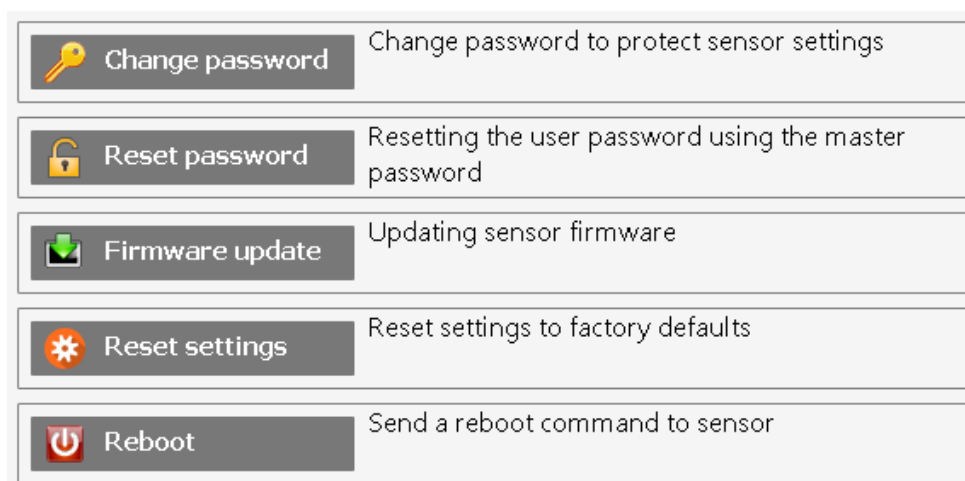- sensor firmware update;
- sensor reset.

Fig 17. "Service" program menu.

To change the user's password, click the "Change password" button, in the opened window enter the current and new passwords and click "Change" (Fig. 17).
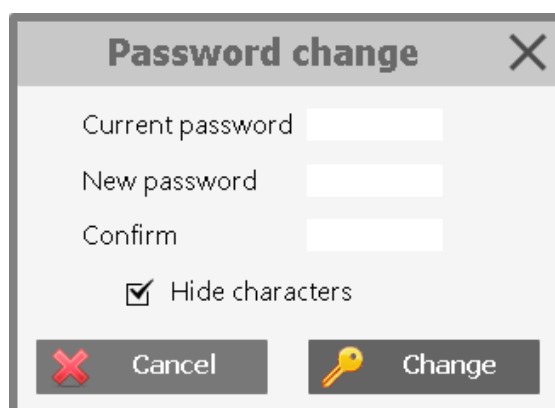

Fig 18. Change user's password.

⚠ If the user's password is lost, it is possible to reset the user's password. To obtain a master password, contact your hardware vendor.
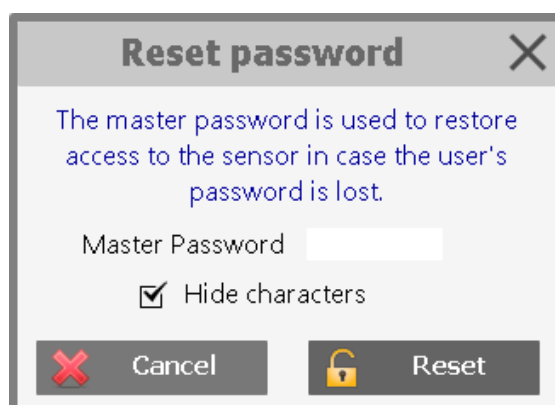

Fig 19. User password reset.

To update the Sensor firmware, click the "Firmware update" button in the "Service" menu, specify the firmware file and click the "Update" button (Fig. 19). During the upgrade, do not interrupt communication with the Sensor and do not turn off the Sensor power.
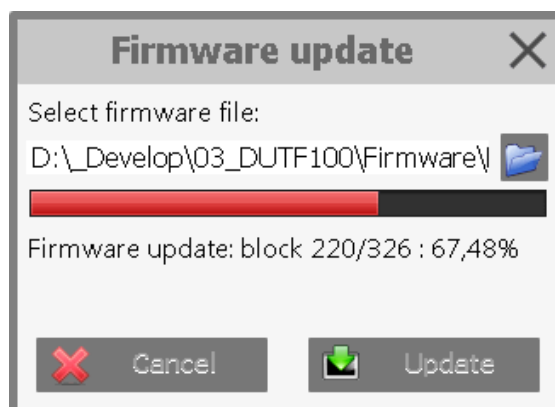
Fig 20. Sensor firmware update.

To reset the sensor settings to factory defaults, click the "Reset Settings" button.

To reboot the Sensor, click the "Reboott" button in the "Service" menu.

5. Transportation and storage

The fuel level sensor should be stored in warehouse conditions at a temperature of - 20 ° C to + 50 ° C and a relative humidity of not more than 85 ° C. Water and technical liquids are excluded.

Sensor is transported in the original packing, by any kind of transport.

6. Warranty

The manufacturer guarantees the operation of the fuel level sensor within 5 years from the date of sale, subject to the consumer's compliance with the conditions and rules of transportation, storage, installation and operation. The average service life is 10 years.

Warranty does not apply:

- for the sensors with mechanical damages and defects (cracks, chips, dents, traces of impacts, thermal, electrical and chemical effects) caused by the fault of the consumer or third parties due to violation of operating, storage or transportation conditions;

- for the sensors with traces of repair outside the manufacturer's service center;

- for the sensors with traces of electrical and / or other damages caused by unacceptable changes in the parameters of the external electrical network or signals;

- for the sensors which failed due to incorrect software update.

7. Package Contents

Name	Amount
FLS Mielta ZOND (DUT-3404-03)	1
Mounting harness	1
Mounting kit:	
- Gasket	1
- self-tapping screw	2
- self-tapping screw for sealing	2

- seal	1
- wire for sealing	1
Short guide	1
Packaging	1

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