



DOCUMENT
VERSION

1.9



FUEL LEVEL SENSOR

TKLS

USER MANUAL



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Unauthorized distribution of the AutoGRAPH Hardware Interface Protocol is strictly prohibited.

Safe Operation and Installation

This section contains important information for effective and safe operation of TKLS fuel level sensors. Please read the information below before using the sensor.

- Sensors with damaged insulation of conductive parts, testing probe and body must not be used.
- Operational conditions of the TKLS such as electrical and environmental characteristics and condition of measured liquid should fit the requirements contained in this User Manual. Otherwise, the manufacturer will not be responsible for sensor safety and functional efficiency.
- All connections should be made when the sensor and external devices to be connected to the sensor are disconnected from the power supply.

Introduction

This User Manual applies to the TKLS fuel level sensor (hereafter – TKLS, sensor) produced by TechnoKom Ltd. It contains installation and connection procedures of the TKLS, as well as its function and control.

This Manual is intended for specialists who are aware of the maintenance and installation principles typical for motor vehicles and are proficient in using the electronic and electrical equipment of various vehicles.

To ensure the best performance of the TKLS, it should be installed and set up only by qualified specialists.

The TKLS sensor can operate both as a part of a fuel monitoring system and as a part of a fleet management system. For proper operation of the TKLS sensor, the customer should be aware of the operating principles of these systems as a whole, as well as understanding the functions of its individual components



All information on functions, functional capabilities and other specifications related to TKLS fuel level sensors, as well as all information contained in this User Manual is based on current data (at time of writing) and is deemed to be valid as of the date of publication.

TechnoKom reserves the right to modify the information or specifications without prior notice or commitment.

VERSION HISTORY

This table provides a summary of the document revision.

Version	Description	Date
1.8	Added instruction on auto calibration	07/2015
1.8.1	Corrected auto calibration station diagram	07/2015
1.8.2	Added information about the empty/full tanks calibration	08/2015
1.9	Added the section "Sensor empty/full tank calibration" Corrected the frequency output connection diagram	12/2015

Product Overview

The TKLS fuel level sensor is designed to measure fuel level in a vehicle fuel tank and transfer this information to external devices via one of the supported interfaces. The TKLS can be used as a replacement of the factory-fitted standard fuel level sensor or as an additional sensor for fuel level monitoring.

The TKLS supports data transfer via RS-485 bus, in LLS and Modbus protocols, and via frequency output as pulses proportional to measured fuel level, PWM signal or periodic sequence.

In addition to fuel level, the sensor measures ambient temperature and sends the readings to an external device.

Any device equipped with RS-485 which supports data exchange in LLS or Modbus protocols can operate as an external device (for example, a level indicator or an onboard vehicle tracking device).

Technical Specification

Description	Value
Output Interface	RS-485 (TIA/EIA-485-A), Frequency output
Protocols for RS-485	AGHIP ¹ / LLS / ModBus
Bluetooth (BLE)	Yes
Built-in Accelerometer / Inclinator	Yes
Automatic calibration	Yes
Self-diagnostic	Yes
Error Report	Yes
Remote Configuration via Bluetooth	Yes
Remote Configuration via RS-485	Yes
Remote Firmware Update	Yes
Logging	Yes
Temperature Measuring ²	Yes
Digital Input, numbers	1
Frequency Output	
Output Frequency Range, Hz	100...3000
Output Type	Open collector
Maximum Load Current, mA	200
Measuring Features	
Operational Liquids	Gasoline, fuel oil
Level Measuring Accuracy, %	≤1
Resolution, bit	12
Temperature Measuring Range, °C	-40...+85
Temperature Measuring Accuracy, °C	±1
Operational Conditions	
Operational Voltage, V	+7...+60
Power Consumption at 12 VDC, mA	< 30
Operational Temperature, °C	-40...+85
Protection Class	IP69K

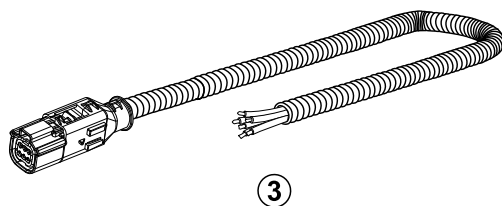
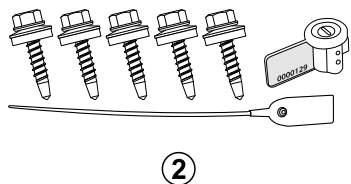
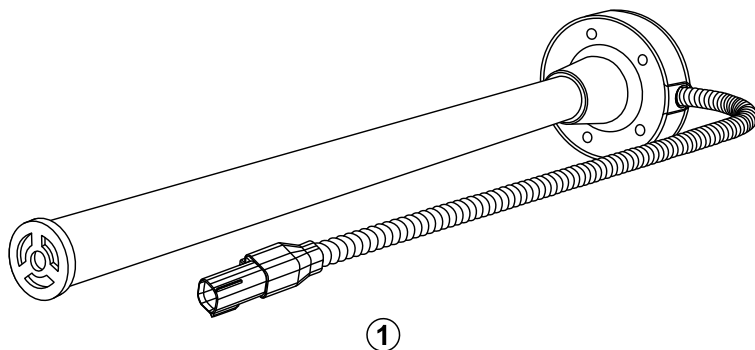
Probe Length, mm	750 / 1000 / 1500 / 2000
Mounting	SAE 5-bolt pattern
Average Life Time, years	10

¹ The AGHIP protocol is the AutoGRAPH Hardware Interface Protocol used by AutoGRAPH onboard controllers to communicate with TKLS sensors and providing exchange of additional information, e.g. inclinometer readings, error reports and etc. In order to establish the communication between the AutoGRAPH controller and the TKLS sensor in AGHIP protocol, it is sufficient to enable the protocol in the controller as it is enabled in the TKLS by default and does not require any sensor re-configuration. It means that if the device, which the TKLS is connected to, initiates the communication in the AGHIP protocol, the sensor will automatically recognize it even if other protocol is enabled in the sensor.

² The function is available only for AGHIP and LLS protocols. When the TKLS is connected to the AutoGRAPH on-board controller, the “Wide record” option should be enabled in the controller’s settings in order the controller to be able to read temperature readings.

Scope of Supply

№	Description	Qty
1	"TKLS" Fuel Level Sensor with Plastic Cover	1 pc.
2	Mounting Kit*	1 set
3	Signal Cable in Corrugated Pipe	7,5 m.
3	Registration Certificate	1 pc.
4	Warranty Certificate	1 pc.

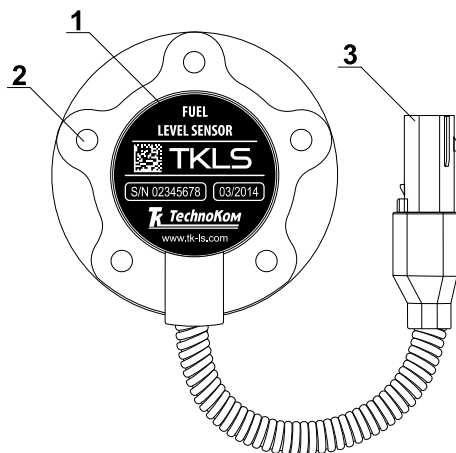


*The mounting kit includes following tools:

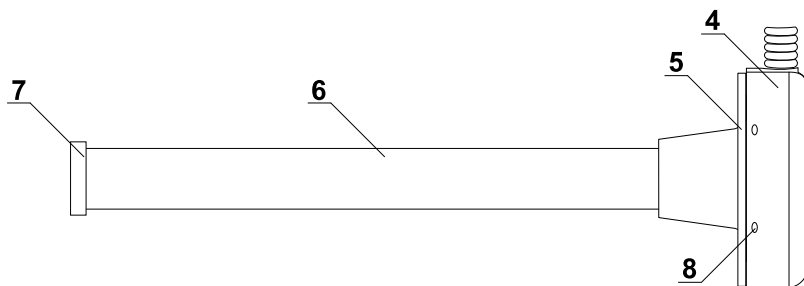
Seal gasket	– 1 pc.
Self-tapping screws with mounted washer and sealing, M5 size	– 5 pc.
Rivet nut, knurled, M5 size	– 5 pc.
Machine screw, M5 size	– 5 pc.
Plastic seal	– 1 pc.
Meter seal (for connector)	– 1 pc.
End cap (spare)	– 1 pc.
Fuse with holder	– 1 pc.

The figure given above shows just an example of the scope of supply which can differ from the real set delivered with the TKLS sensor.

Components of Sensor



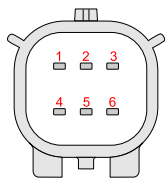
1. Product identification*.
2. Mounting hole (x5).
3. Interface Connector 1 (male).
4. Sensor cover.
5. Seal gasket.
6. Measuring probe.
7. End cap**.
8. Sealing hole (x4).



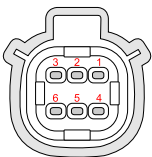
*Device designation contains trademark and contact details of the manufacturer, device description, serial number and release date of the device.

**The sensor is supplied with a transport plug, which should be removed before sensor installation.

Interface Connectors



Interface Connector 1 (male)
View from side of pins



Connector 2 (female)
View from side of sockets

No	Wire Colour	Assignment
1	Red	+Vin
2	Orange	RS-485 (A)
3	Gray	Frequency output (OK)
4	Black	-Vin
5	Brown	RS-485 (B)
6	White	Digital input (active low)

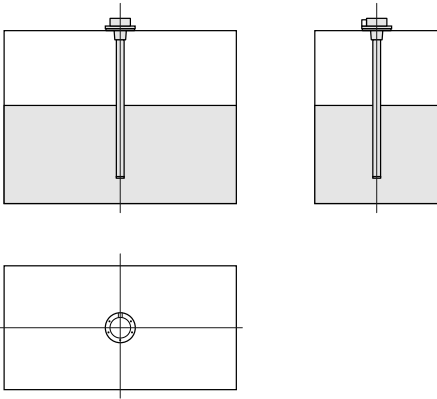
Both connectors are keyed to prevent wrong orientation.

Getting started

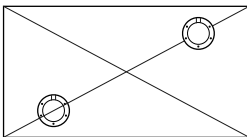
Before installation it is highly recommended to check the sensor for any mechanical damage.

Sensor location

- The sensor location depends on the geometric form of the tank and should be chosen in such a way as to provide accurate readings regardless of fuel movement in the tank during vehicle motion.
- Normally, the sensor should be located at the centre of the top of the tank. See figures below:



- If it is impossible to install the sensor as shown above, it should be located as close as possible to the recommended area.
- If, due to the geometric features of the tank, one fuel level sensor does not provide the required accuracy of readings, it is recommended that several sensors are installed into the tank. A set of two sensors is commonly used in this way. In this case, the fuel level in the tank amounts to the average readings of the two sensors.



Preparation of the fuel tank

All preparation work must be performed in accordance with the safety requirements specified for the tank:

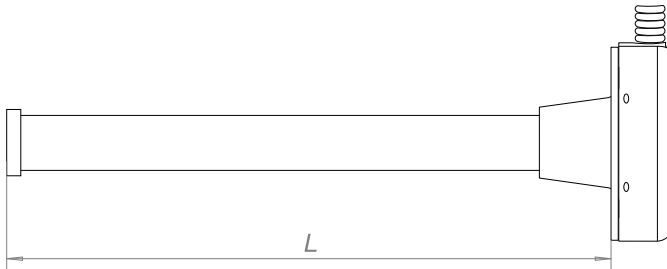
- Before installation on a petrol tank, it must be completely emptied of petrol and filled with water.
- Before drilling, ensure that there aren't any baffle plates inside in the tank in the proposed

sensor installation area within a radius of 20 mm. This can be checked by drilling a small hole (about 3 mm) in the installation area.

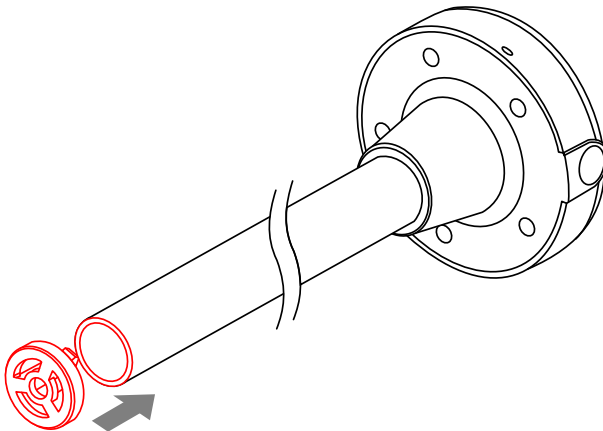
- Drill a central hole 35...37 mm diameter using a bimetal boring bit.
- Drill five holes for SAE-5 bolts.
- Install the seal gasket on the sensor, then mount the sensor into the tank.

Sensor cutting

- The sensor length can be cut to match the specific fuel tank. To do this, you should follow these steps:
 - Measure the tank depth by inserting a ruler in the tank through the central hole that has been prepared for installing the sensor.
 - Measure the tank depth on the effective length of the sensor L . It is recommended that the sensor is shorter than the tank depth by 10-30 mm to prevent false reading due to impurities (including water) in the bottom of the tank. The effective length of the sensor should be adjusted depending on the amount of the impurities.
 - When cutting the sensor, be sure that the cut is straight and perpendicular to the roll axis of the sensor.



- After cutting, install the supplied end cap on the measuring probe (see figure below). Do not forget to remove the transport plug before the sensor installation.



**NOTE**

The effective length of the sensor must be at least 150 mm after cutting.

- After the end cap installation, it is highly recommended to set up the empty and full tanks calibration readings. The calibration can be performed using the TKLS configuration tool.

Sensor empty/full tank calibration

The empty/full tank calibration is required to set a measuring range of the sensor.

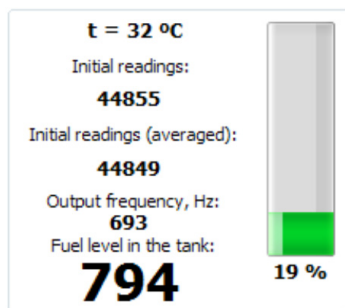
It is highly recommended to start with an empty tank calibration and perform it before the sensor first use while the measuring probes have not been inserted in fuel yet. If the sensor is used earlier, it must be removed from fuel tank and the measuring tubes must be cleaned from fuel residues (e.g. let the fuel drain off the tubes for about 15-20 minutes after the sensor removing from fuel tank).


**NOTE**

It is not recommended to disconnect the TKLS sensor from the configuration tool during the calibration in order to prevent calibration data loss. If you need to save the calibration data, press the Save settings on the configuration tool button before disconnecting the sensor from PC.

To set an empty tank readings:

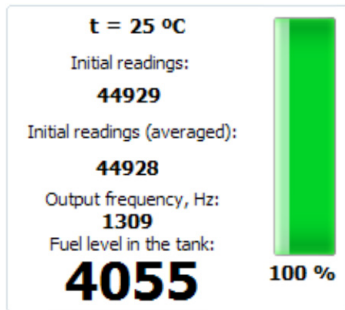
- connect the TKLS sensor to the configuration tool following the instruction given in the help file for this software. The sensor readings of empty tank will be displayed on the Settings tab of the configuration tool;



- wait for about 1-2 minutes and apply empty tank readings pressing the button  in the "Empty tank" field. The sensor initial readings will be entered in the "Empty tank" field;
- after setting the empty tank readings, you need to perform the full tank calibration.

To set a full tank readings:

- connect the TKLS sensor to the configuration tool following the instruction given in the help file for this application.
- if the sensor is calibrated by inserting into a fuel storage, first turn the sensor upside down and pour about 10-20 ml of fuel into the measuring probes through the drain hole, e.g. by means of a syringe, or pour it into the measuring probes from above. Then install the sensor in the storage filled up with fuel;
- if the sensor is calibrated by pouring fuel into the measuring probes, first you need to turn the sensor upside down, block the drain hole, then fill up the measuring probes with fuel;
- the sensor readings will be displayed on the configuration tool:

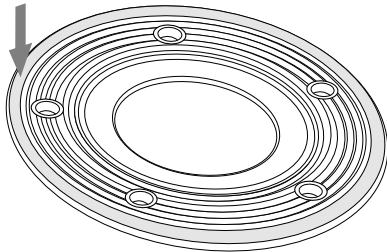


- apply full tank readings pressing the button  in the “Full tank” field. The sensor initial readings will be entered in the “Full tank” field;

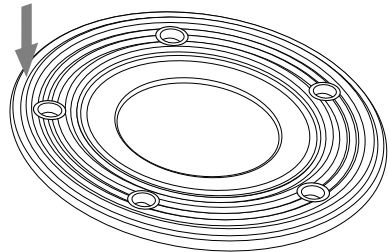
Sensor installation

- Install the seal gasket on the sensor with the wide side of the seal's outer ring facing the sensor (see figure below). When installing the seal, also be sure that the mounting holes of the sensor matches the mounting holes of the seal.

TO SENSOR



TO FUEL TANK



- Install the sensor into the tank and tighten five fastening screws supplied with the sensor.

Connection of the Sensor

This section covers connection procedures of the TKLS fuel level sensor:

- Power supply connection
- RS-485 bus connection
- Frequency output connection

The sensor is supplied with a 7.5m signal cable in a corrugated pipe. The cable is equipped with a female connector (Connector 2) for connecting to the sensor (to Connector 1). Both connectors are keyed, which prevents incorrect orientation.

When making connections, pay careful attention to the safety rules stipulated by the regulations for motor vehicle repair procedures. All connections should be properly isolated and securely connected. If the wire is too short, it can be spliced with a wire of at least 0.5 mm² cross section (20 AWG or thicker).

The TKLS sensor can be connected to any external unit that supports ModBus or LLS protocols to transfer fuel level readings.

The TKLS sensor is equipped with a frequency output that provides transfer of fuel level values in the form of pulses at a variable frequency. The sensor is also capable of measuring ambient temperature.



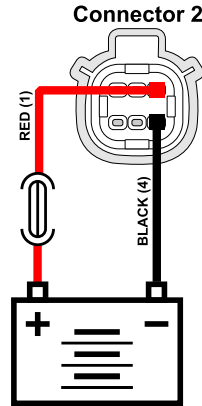
All connections should be performed when the sensor and all external devices be connected to the sensor are disconnected from the power supply.

Power Supply Connection

When making the power connection, pay careful attention to the safety rules stipulated by the regulations for motor vehicle repair procedures.

The sensor is supplied with a fuse intended to provide short circuit protection of the power supply. The fuse holder is installed on a wire ring, which should be cut before operation.

The power supply input of the sensor is rated for a voltage of 7-60 V.



To connect the power to the sensor you should follow these steps:

- Connect “+Vin” wire of the signal cable to “+Vin” line of vehicle power system and connect “-Vin” wire to “-Vin” line of the vehicle power system.
- Connect the fuse supplied with the sensor to the “+Vin” line. The fuse should be placed as close as possible to the point where the TKLS is connected to vehicle power system.
- Connect Connector 2 of the signal cable to the male Connector 1.

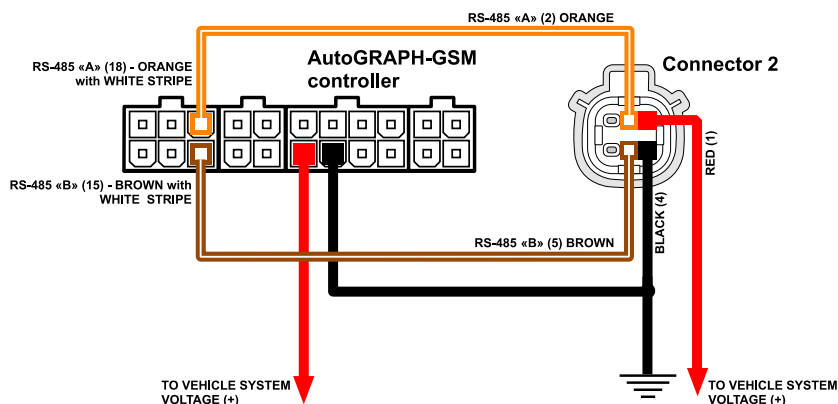
RS-485 (TIA/EIA-485-A) Bus Connection

The TKLS sensor is equipped with an RS-485 (TIA/EIA-485-A) bus, which allows the sensor to transfer collected data to an external unit equipped with RS-485. The TKLS supports the following commonly used data transmission protocols: LLS and ModBus. The data transfer protocol can be selected using the configuration program. The configuration program ("TKLSConf") can be downloaded for free from the manufacturer's official web site (www.tk-chel.ru).

General diagram of connection of external devices to RS-485 bus:

The connection diagram of the TKLS to the AutoGRAPH-GSM on-board vehicle tracking controller is depicted in the figure below. This diagram is also true for another AutoGRAPH Series on-board vehicle tracking controllers and other devices which are connected to the sensor via the RS-485 bus.

The TKLS sensor is able to transfer fuel level readings in liters, ADC stages or percent of full tank to external device via RS-485 in AGHIP or LLS protocol. To send fuel level readings in liters, the volume calibration table must be recorded in the TKLS. This option, as well as the protocol, can be configured in the configuration tool.



Be careful not to cross the "A" and "B" wires, otherwise the sensor may operate incorrectly.



All connections should be performed when the sensor and all external devices to be connected to the RS-485 bus are disconnected from the power supply.

Frequency Output Connection

TKLS sensor is equipped with one frequency output, which is open-collector. The frequency of the output signal is proportional to the fuel level in the tank.

The output frequency range varies from 100Hz to 3000Hz.

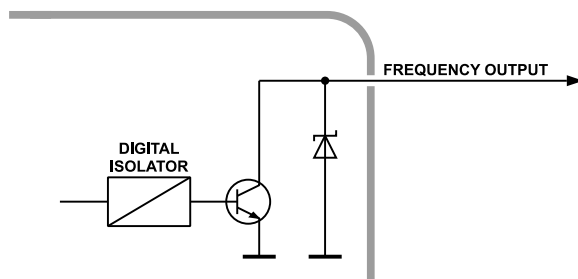
Maximum load current should not exceed 200 mA.

The frequency output is intended to be connected to the digital input of the AutoGRAPH on-board vehicle tracking device, which can acquire the reading in frequency form. Before connecting to the TKLS, the input of the AutoGRAPH must be switched to Frequency Mode.



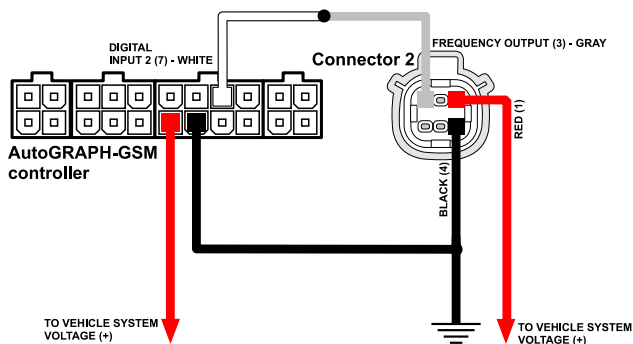
When connection to the AutoGRAPH controller, the sensor must be connected to one of the active low digital inputs of the controller (inputs 1-4).

Internal diagram of frequency output:



General Connection Diagram for Frequency Output:

The connection diagram of the sensor's frequency output to digital input 2 of the AutoGRAPH-GSM on-board vehicle tracking controller of a hardware version 3.0 is depicted in the figure below. This diagram is also true for another AutoGRAPH Series on-board vehicle tracking controllers.



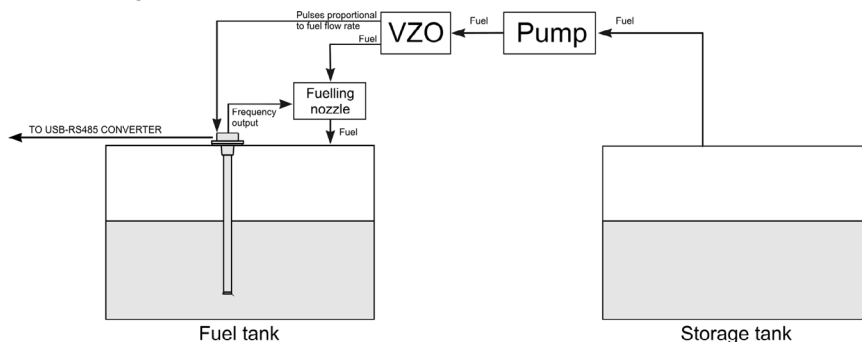
Auto calibration

TKLS sensors with firmware of version TKLS-1.37 and higher support automatic calibration.

During the automatic calibration fuel is transferred from storage tank to fuel tank with the calibrated sensor. The transferred fuel volume is measured by a flowmeter which output is connected to digital input of the TKLS sensor. At each calibration step, when the required fuel volume has been transferred in the tank, the sensor waits until the fuel fluctuations in the tanks stop and takes measurements with the specified timeout. If difference between adjacent readings does not exceed the acceptable deviation, the last reading is added in the calibration table – in the form of ADC stages and frequency, along with actual fuel level in the tank, calculated using the flowmeter readings.

The TKLS sensor is connected to a PC via USB-RS485 Converter produced by TechnoKom. For more detailed information see section “Sensor configuration” of this User Manual.

Structural diagram of auto calibration station:



Described below is the instruction on the TKLS sensor auto calibration procedure:

- Connect the sensor which is being calibrated to the TKLS configuration tool;
- Go to the “Settings” tab and set the sensor frequency output to the Auto calibration mode (Fig.1);

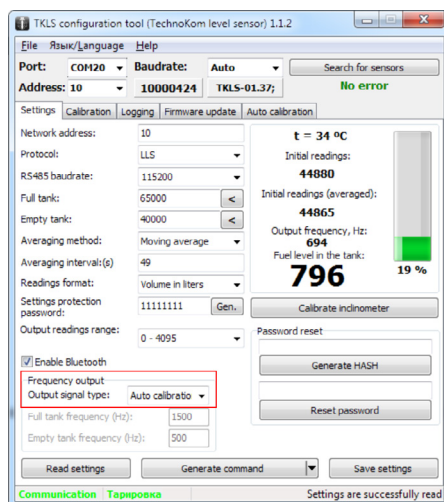


Fig.1. Frequency output configuration for auto calibration mode.

- Then select Menu File – Settings... in the configuration tool;

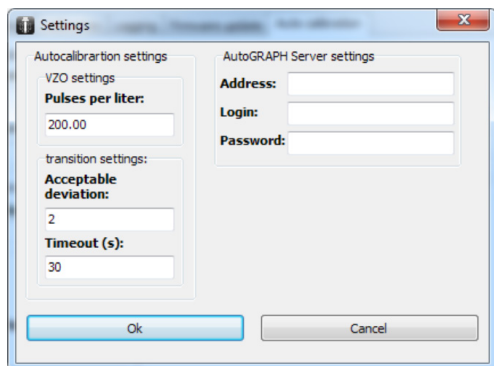


Fig.2. Calibration settings.

- In the Settings menu (Fig.2), set up the flowmeter parameters – a number of pulses accounted for 1 litre of fuel. This characteristic is given in technical documentation on the flowmeter;
- Also set up acceptable deviation and timeout between sensor adjacent readings;
- Then apply settings by pressing OK button and go to the Auto calibration tab;
- Before starting the calibration, specify the fuel tank volume in the “Tank volume (l)” field (Fig.3). Also specify a number of calibration points in the “Number of points” field. Maximum value is 50;
- Then specify the storage tank volume in litres (Fig.3);

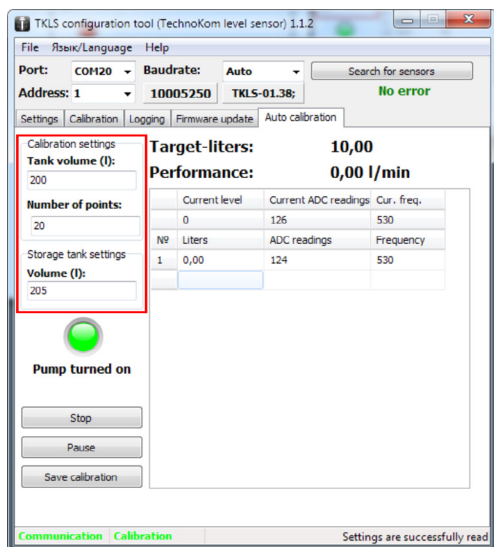


Fig.3. Auto calibration tab.

- To start auto calibration, press the Start calibration tab. The pump will start fuel transition from the storage tank into the fuel tank. The current state of the pump is displayed on the Auto calibration tab – Pump is turned off, Pump is turned on. If the calibration has not started, check the frequency output mode and ensure that the Auto calibration mode is selected on the Settings tab (see Fig.1);
 - While calibration, calculated calibration points are added in the calibration table on the Auto calibration tab. Current readings of the TKLS sensor are displayed at the top of the table – current fuel level in liters, appropriate sensor readings in the form of ADC stages and frequency;
 - The target-liters display fuel level achieving which starts next step of calibration;
 - The performance displays fuel volume transferred by the pump per a minute;
 - When the calibration is on, the status “Calibration” is displayed on the status bar (at the bottom of the window);
- To pause the calibration, press the Pause button. To cancel the calibration, press the Stop button (displayed instead of the Calibration button when the calibration is on);
 - As all calibration points have been calculated, the calibration finishes (Fig.4). After that the calibration table can be saved in an external file by pressing the Save calibration button. The calibration table is saved in text file in the \Tare folder located in root directory of the configuration tool.

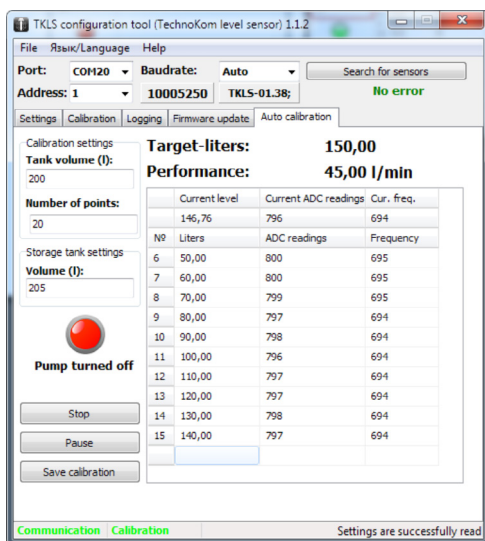


Fig.4.Calibration finished.



Calculated calibration table is stored in the sensor memory till the sensor power restart. That's way it is not recommended to restart the sensor after finishing the calibration till the calibration data will be read from the sensor.



The calibration is totally managed by the TKLS sensor. It means that after starting the calibration the configuration tool can be closed and opened to read complete calibration data after finishing the calibration.

Error Codes

The TKLS sensor has an embedded self-diagnostic procedure that provides detection of errors during sensor operation.

When connected to the “AutoGRAPH-GSM” controller via RS-485 bus the TKLS sends error codes (if any) to the controller. The code will be recorded in the controller as a temperature record.

Error Code Description

Error Code	Error / failure description
-127	short circuit
-126	capacitance probe break
-125	frequency out of calibration range
-124	built-in accelerometer fault



The TKLS sensor transfers the error code via RS-485 only when it is connected to the “AutoGRAPH” Series onboard vehicle tracking controllers. When connecting to other external device, the error code won't be transferred.

Diagnostic operation can be performed using the “TKLS configuration tool”. If an error is occurred, this will be shown in the program window.

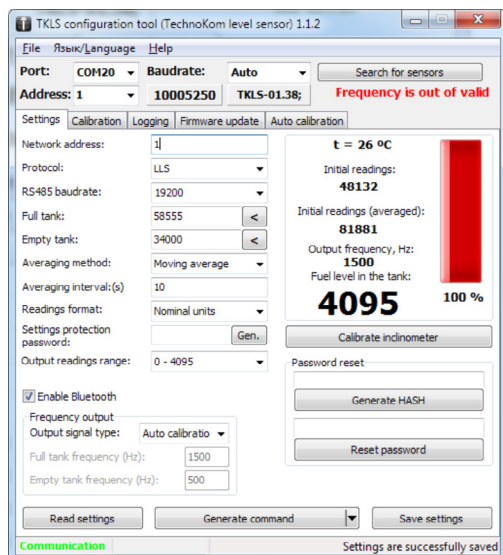


Fig.5.Sensor diagnostics.

Sensor Configuration

The TKLS can be set up in the following ways:

- using the «TKLSConf» Configuration Software;
- remotely via Bluetooth;
- remotely via RS-485;

To set up the sensor using the “TKLSConf” program it is necessary to connect the device to a PC or a laptop. For correct operation, the sensor drivers should be installed before connection. If the device drivers have not been installed, follow the steps in the “Installing the Drivers” section.

To connect the sensor to a PC, use the special adaptor and USB data cable supplied with the sensor (see fig.5).

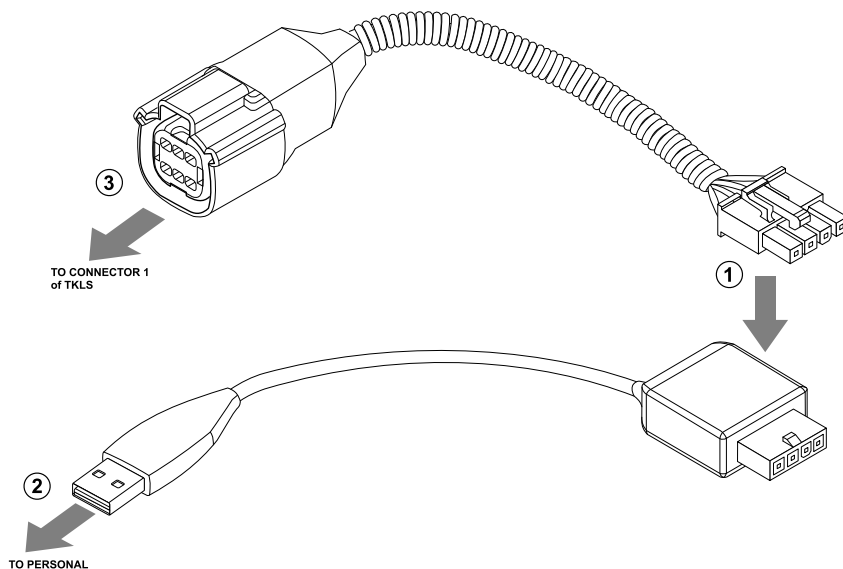


Fig.6. – Connection to a PC.

To connect the sensor to a PC follow these steps:

- turn off the sensor power supply;
- connect the 4-pin connector of the USB cable to the 4-pin connector of the adaptor (see fig.5, step 1);
- connect the USB cable to the PC (fig.5, step 2);
- connect the free end of the adaptor (Molex connector) to Connector 1 of the sensor (fig.5, step 3);
- if the sensor drivers were previously installed, the PC will automatically detect the connected device.



For more information on the “TKLSConf” Software see “TKLS Configuration Software” help file.

The “TKLSConf” Software provides configuration of the sensor via the RS-485 bus. The customer can specify the settings in the “TKLSConf” program and send them to the data server. These settings will be transferred to the “AutoGRAPH” onboard controller which is connected to the sensor and after that will be transferred to the sensor via the RS-485 bus.

The sensor supports remote configuration via Bluetooth using a mobile device. To do this, the Bluetooth option must be enabled in the sensor’s settings and an access password must be known by the customer.

Driver Installation

This section covers an installation procedure of the TKLS driver. For proper operation the AGUSB Driver must be installed before the sensor connection to a PC. This driver can be downloaded for free from the official website of TechnoKom. The AGUSB Driver is compatible with MS Windows 7, 8, Server 2003, Server 2008 (x86 и x64).

To install the driver:

Connect the sensor to a PC.

The system will automatically search for a new equipment.

If the Internet connection is available, the TKLS driver will be automatically downloaded from Windows Update server and installed. If the Internet connection is not available, continue with the procedure outlined below.

Download the archived drivers folder from the official website of TechnoKom and extract files to a temporary directory on a hard driver.

Launch the driver update wizard and select “Browse my computer for driver software” to search for the drivers manually.

Install the driver. When the drivers is installed the system will automatically identify connected device. The sensor is ready to operate with configuration and troubleshooting applications.

Modbus Register Mapping

The TKLS is capable of communication via the RS-485 serial bus in the Modbus/RTU protocol. The TKLS supports the Modbus function 03 – Read Holding Registers.

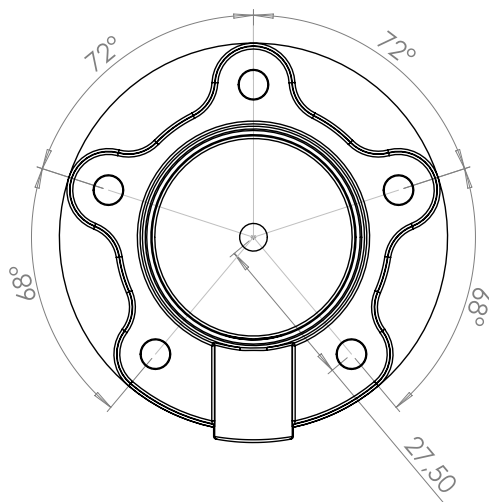
Address (HEX)	Description
0x00	TKLS address
0x01	RS-485 baud rate (high bit)
0x02	RS-485 baud rate (low bit)
0x03	Full calibration (high bit)
0x04	Full calibration (low bit)
0x05	Zero calibration (high bit)
0x06	Zero calibration (low bit)
0x07	Averaging time / weighting coefficient (%)
0x08	Temperature
0x09	Raw fuel level data (high bit)
0x0A	Raw fuel level data (low bit)
0x0B	Fuel level
0x0C	Serial number (high bit)
0x0D	Serial number (low bit)
0x0E	Averaging method
0x0F	Output frequency when tank is full
0x10	Output frequency when tank is empty
0x11	Raw fuel level data before temperature-compensation (high bit)
0x12	Raw fuel level data before temperature-compensation (low bit)
0x13	Averaged raw fuel level data (high bit)
0x14	Averaged raw fuel level data (low bit)
0x15	Error code (high bit)
0x16	Error code (low bit)
0x17	Number of input pulses (high bit)
0x18	Number of input pulses (low bit)
0x19	Roll angle
0x1A	Pitch angle



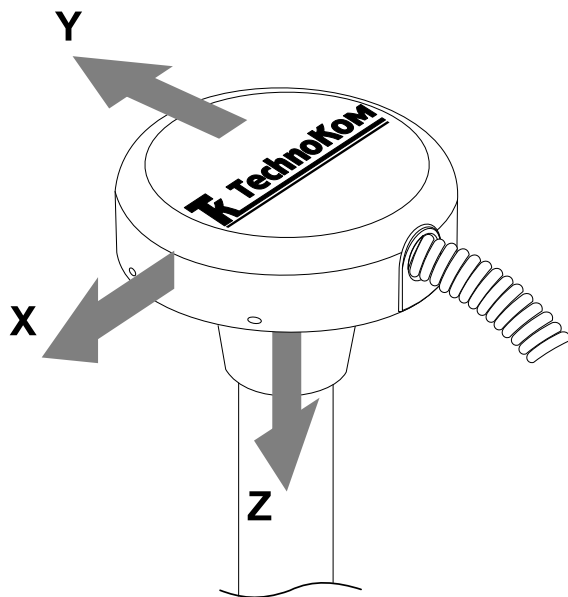
Reading of Modbus Holding Registers is supported by the firmware of revision TKLS-1.32.

Appendix

APPENDIX 1: SAE-5 MOUNTING.



APPENDIX 2: BUILD-IN ACCELEROMETER AXES ORIENTATION.





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