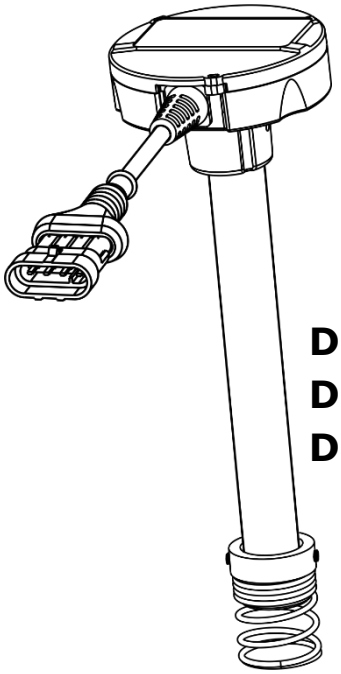
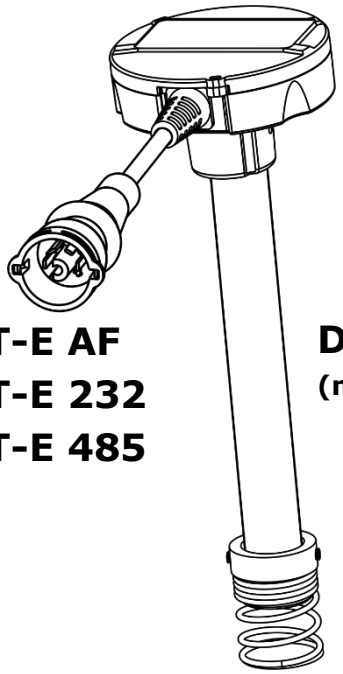
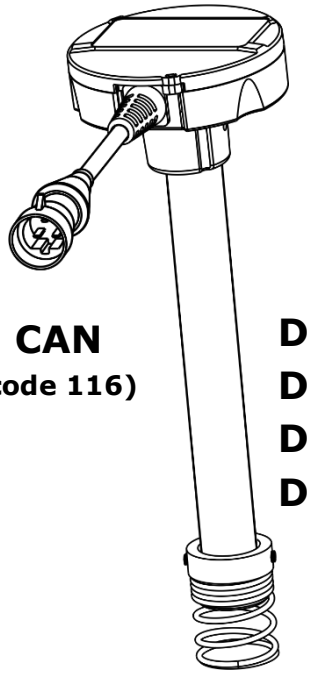
FUEL LEVEL SENSORS



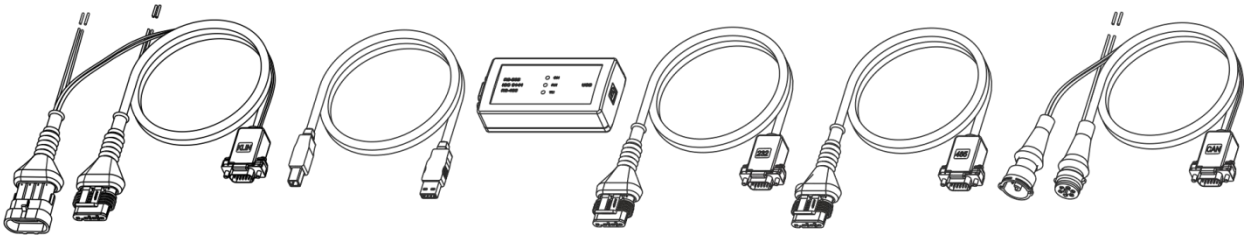
DUT-E AF
DUT-E 232
DUT-E 485



DUT-E CAN
(model code 116)



DUT-E A5
DUT-E A10
DUT-E F
DUT-E I



SK DUT-E service adapter

OPERATION MANUAL

(includes Service DUT-E software manuals)

Version 8.1

TECHNOTON
ADVANCED VEHICLE TELEMATICS

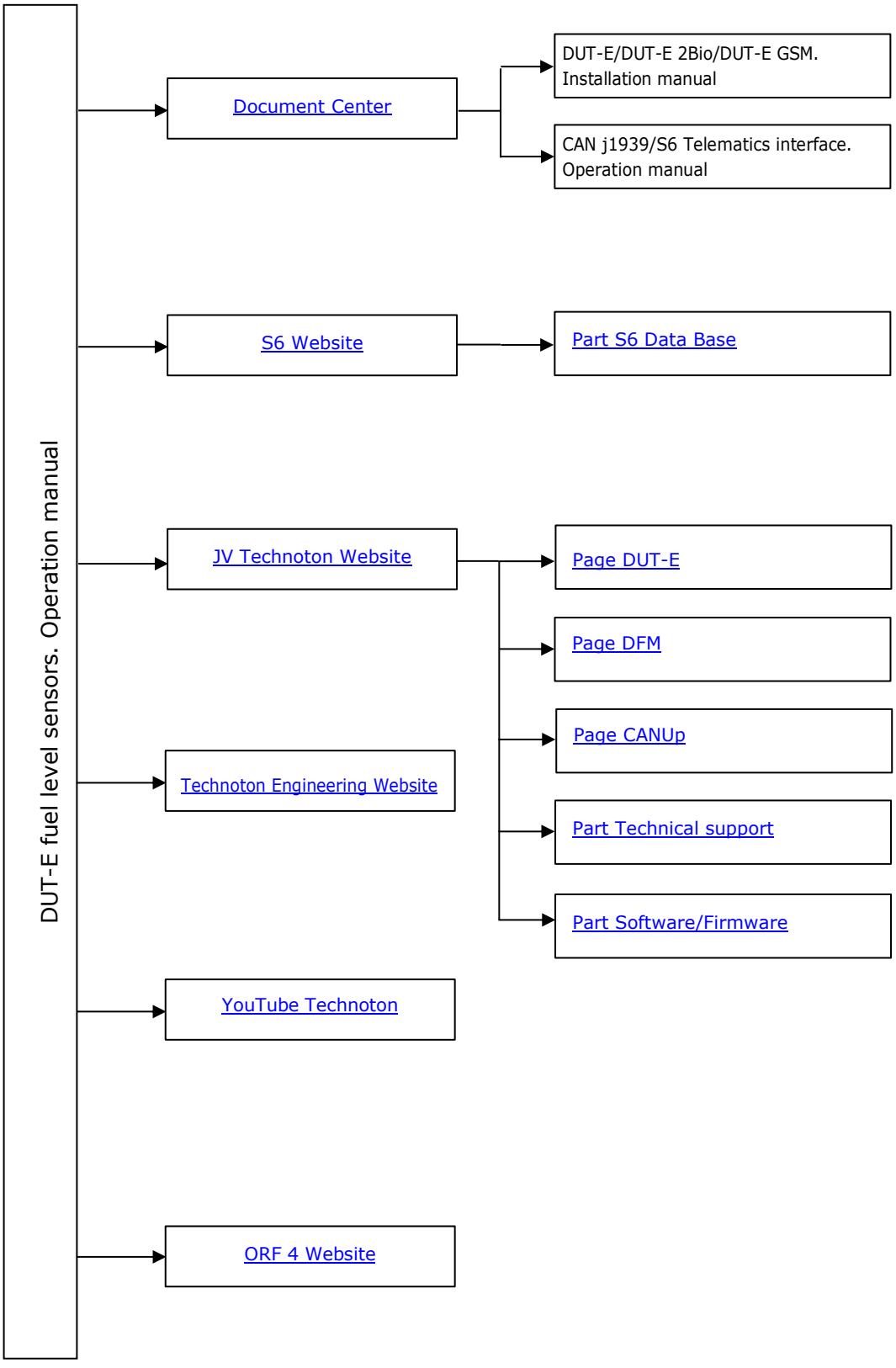
E28 10 R - 04 1549

Contents

Revision history

Version	Date	Editor	Description of changes
1.0	01.2007		Basic version.
7.0	04.2016	OD	• New design of measurement head of DUT-E. • Changes in delivery set of DUT-E, MK DUT-E. • Addition and updates to description of installation of DUT-E. • Changes in description of Service software. • New packaging of DUT-E. • Methodology of thermal correction coefficient calculation added. • International certificates ISO 9001:2015 (DaKKs) and Customs Union added.
8.0	01.2017	OD	• Instructions on S6 SK operation while configuring DUT-E CAN added. • Schemes of connection of DUT-E CAN to PC via S6 SK added (including scheme of sensors for configuration within S6 interface). • Terminology updated. • Operation instructions for software Service DUT-E updated. • New accessories for DUT-E added.
8.1	02.2020	OD	1) Updated: - currently valid certificates; - composition of DUT-E and MK DUT-E delivery sets; - diagrams of sensors connection to the PC with S6 SK service adapter; - minimum requirements for PC for work with Service DUT-E software; - examples of diagrams of DUT-E CAN connection to the Telematics terminal; - document terminology. 2) Information added on: - sensors models codes; - sensors electromagnetic compatibility; - taking into account the dead zone while creating the tank calibration table; - additional sensors accessories. 3) The structure of the document external links is introduced.

Structure of external links



Terms and Definitions

S6 is the Technology of combining smart sensors and other IoT devices within one wire network for monitoring of complex stationary and mobile objects: vehicles, locomotives, smart homes, technological equipment etc. The Technology is based and expands SAE J1939 automotive standards.

Information on cabling system, service adapter and S6 software refer to CAN j1939/S6 Operation manual.

PGN (Parameter Group Number) — is a combined group of S6 parameters, which has common name and number. Functional modules (FM) of the Unit can have input/output PGNs and setup PGNs.

SPN (Suspect Parameter Number) — informational unit of S6. Each SPN has determined name, number, extension, data type and numerical value. The following types of SPN exist: Parameters, Counters, Events. SPN can have a qualifier which allows qualification of parameter's value (e.g. – Onboard power supply limit/Minimum).

ORF 4 — is the by JV Technoton developed for receiving and processing Onboard reports via Internet, displaying Operational Data overlapped on area maps, information storage in database and Analytical reports generation upon user's request.

Analytical report — report generated in ORF 4 on vehicle or group of vehicles operation for chosen time period (usually a day, week or month). Can be composed of numbers, tables, charts, mapped route of vehicle, diagrams.

Onboard equipment (OE) — Telematics system elements, directly installed in Vehicle.

Onboard reports (the Reports) — information about vehicle which is returned to a user of Telematics system in accordance with inputted criteria. The Reports are generated by a terminal unit both periodically (Periodic reports) and on Event occurrence (Event report).

GNSS (Global Navigation Satellite System) — System for area positioning of an object through satellite signal processing. GNSS is composed of space, ground and user segments. Currently, there are several GNSSs: GPS (USA), GLONASS (Russia), Galileo (EU), BeiDou (China).

Parameter — time-varying or space characteristic of the Vehicle (SPN value). For example, speed, fuel volume in the tank, hourly fuel consumption, coordinates. Parameter is usually displayed in the form of graph, or averaged data.

Server (AVL Server) — hardware-software complex of Telematics service ORF 4, used for processing and storage of Operational data, formation and transmission of Analytical reports through Internet by request of ORF 4 users.

Event — a relatively rare and sudden change in SPN. For example, the sharp increase of volume in the tank is the Event «Fuelling». An Event may have one or more characteristics. Thus, the Event «Fuelling» has the following characteristics: «volume of fuel at the beginning of the fuelling», «volume of fuel at the end of the fuelling», «volume of the fuelling» and so on. As soon as an Event is detected, the Terminal registers the time of the Event which is subsequently specified in the Report of the Event. The Event is always linked to the time and the location where it was detected.

Counter — cumulative numerical characteristic of Parameter. Counter is displayed by a single number and over time its value is increasing. Examples of counters: fuel consumption, trip, engine hours counter etc.

Telematics system — complex solution for vehicle monitoring in real time and trip analysis. The main monitored characteristics of the vehicle: Route, Fuel consumption, Working time, technical integrity, Safety. In includes On-board report, Communication channels, Telematics service ORF 4.

Telematics terminal (Tracking device, Telematics unit) is a unit of Telematics system used for reading the signals of Vehicle standard and additional sensors, getting location data and transmitting the data to the Server.

During the use of DUT-E GSM fuel level sensor within the Telematics system the Terminal is not required.

Vehicle is an object controlled by the Vehicle Tracking System. This is generally a truck, a bus or a tractor, sometimes a locomotive, a ship, a utility vehicle. From the point of view of Vehicle Tracking System, static equipment such as diesel generators, heating boilers, burners, and so on are considered vehicles.

Function module (FM) unit-embedded component of hardware and software combination, executing a group of special functions. Uses input/output PGNs and settings PGNs.

Unit is an element of vehicle on-board equipment compatible with S6 bus, which uses S6 Technology.

Introduction

Recommendations and rules set out in this Operation Manual apply to **DUT-E fuel level sensors** (further on — DUT-E), models codes: **116** (for DUT-E CAN), **111** (for DUT-E 232), **115** (for DUT-E 485), **124** (for DUT-E AF), **112** (for DUT-E A5), **113** (for DUT-E A10), **114** (for DUT-E F), **068** (for DUT-E I) and SK DUT-E **service adapter** (further on — SK DUT-E) manufactured by JV Technoton, Minsk, Republic of Belarus.
The model code of DUT-E is identified by the first three digits of its serial number printed at its measuring probe or on its packing label:

The manual contains information on design, operation principle, specifications and instructions on installation, use and maintenance of DUT-E. The manual defines SK DUT-E connection and usage guidelines as well as Service DUT-E software (version 3.26 and higher) installation and use.

DUT-E are additional sensors within Telematics systems. DUT-E sensors are used for accurate level measurement in fuel tanks of vehicles and stationary units.
SK DUT-E serves for data exchange between the sensor and the personal computer.

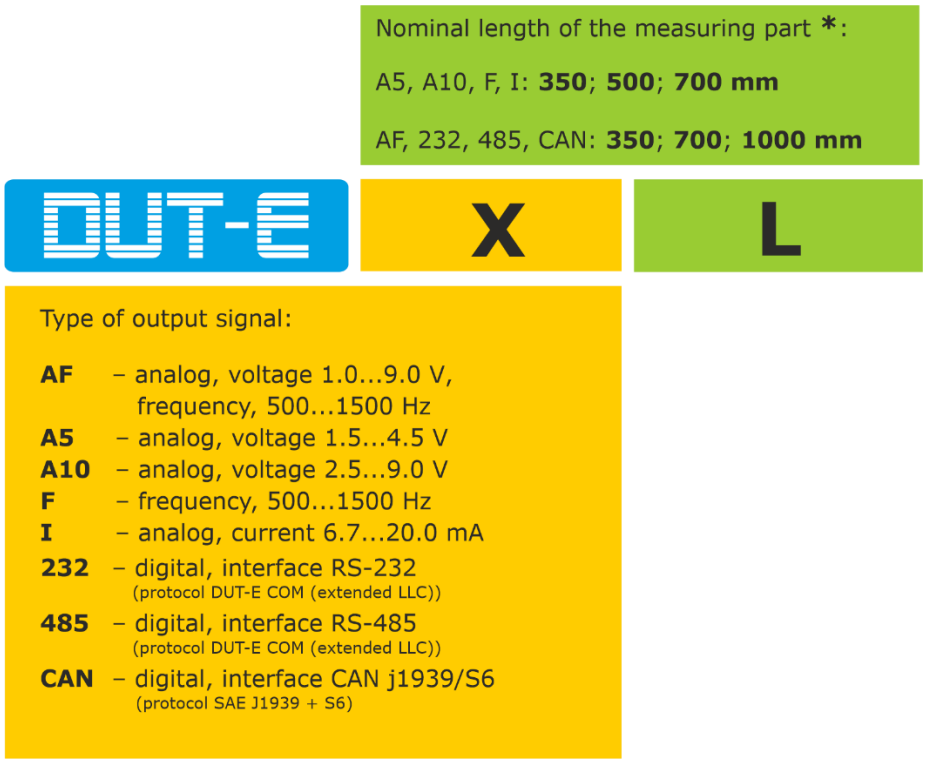
DUT-E features:

DUT-E key features:

- compliance with Units, Database and cabling system S6 Technology*;
- adjustable temperature correction for automatic measurement correction based on ambient temperature**;
- function of digital self-diagnostics for sensor quality control**;
- measuring probe length extension up to 6 m with additional sections**;
- measuring probe length reduction without min/max recalibration***;
- ergonomic bayonet mount allows to save installation time;
- bottom spring for better mounting rigidity;
- screen filter for secure protection from water and mud ****;
- full set of mounting accessories and connection cable included;
- built-in voltage stabilizer – output signal does not depend on vehicle power supply voltage;
- reverse polarity and short circuit protection of any output to vehicle electrical system and chassis;
- sealing possibility to avoid unauthorized intrusion and tampering;
- conformity with European and national automotive standards;
- high-quality technical support and documentation.

* DUT-E CAN.
** DUT-E AF/232/485/CAN.
*** DUT-E A5/A10/F/I.
**** Starting from 01.09.2017 the screen filter is purchased separately.

See figure 1 for identification codes for DUT-E ordering.



* Per special order sensor can be manufactured with any custom measuring probe length up to 1400 mm. For orders less than 200 pieces in calendar quarter, 10 % extra fee is applied.

Figure 1 —DUT-E order identification codes

Examples of DUT-E ordering identification codes:

Fuel level sensor DUT-E A10 L=700 mm,
(output voltage from 2.5 to 9.0 V, nominal measuring probe length 700 mm).

Fuel level sensor DUT-E CAN L=1000 mm,
(CAN j1939/S6 interface, nominal measuring probe length 1000 mm).

For DUT-E AF/232/485/CAN configuration a service adapter (SK DUT-E or S6 SK) is used, which is ordered additionally, and software Service DFM Marine you can download and/or update your Service DUT-E software at https://www.jv-technoton.com/, in Software/Firmware category.

ATTENTION: It is strongly recommended to follow strictly the instructions of the present Manual when using, mounting or maintaining DUT-E.

The Manufacturer guarantees DUT-E compliance with the requirements of technical regulations subject to the conditions of storage, transportation and operation set out in this Manual.

ATTENTION: Manufacturer reserves the right to modify DUT-E specifications that do not lead to a deterioration of the consumer qualities without prior customer notice.

1 General information and technical specifications

1.1 Purpose of use and application area

DUT-E **is designed** to measure level of liquid fuel and other nonconductive liquids in vehicle and stationary tanks (see figure 2).

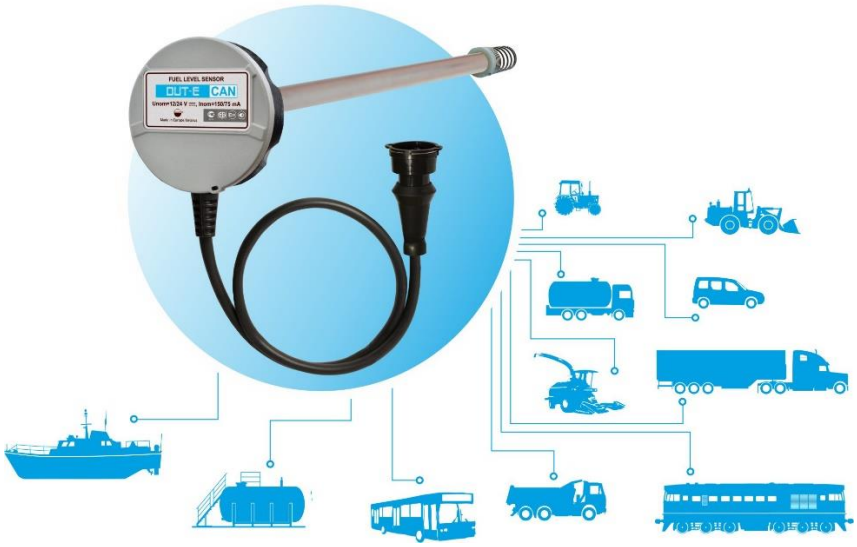


Figure 2 — DUT-E purpose of use

Application area — DUT-E fuel level sensors are used in Vehicle Telematics systems as additional fuel sensors or as a replacement of standard (factory built-in) fuel level sensors (see figure 3).

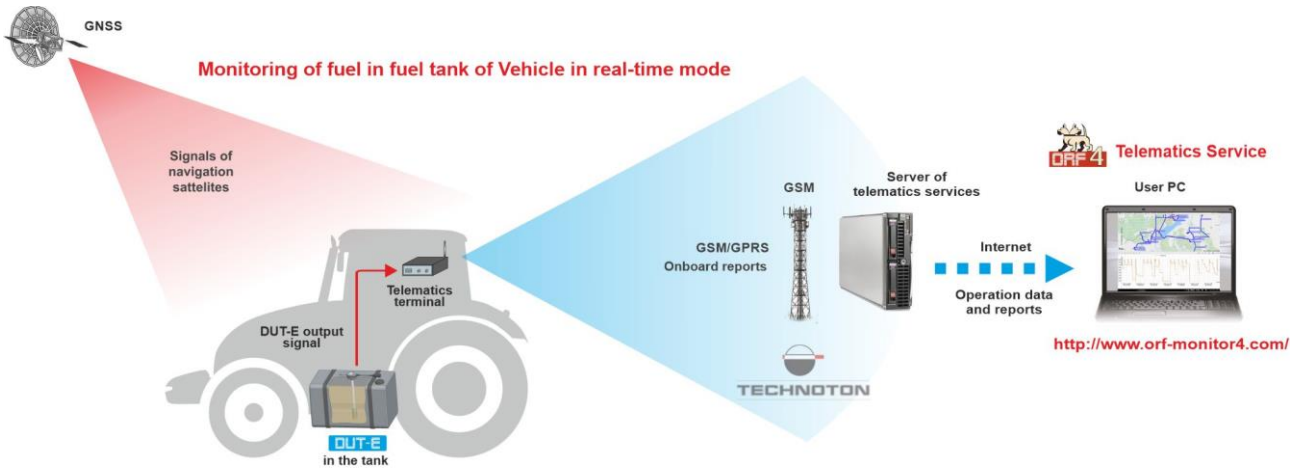


Figure 3 — DUT-E application within Vehicle Telematics system

DUT-E is installed into a fuel tank of a vehicle. The sensor measures fuel level in the tank and generates an output signal to forward it to a Vehicle Tracking device.

Telematics terminal records and processes the sensor data for further transmission to the telematics server. Server software processes and analyzes the received data to generate Analytical reports for a selected period of time.

The availability of CAN j1939/S6 interface enables DUT-E CAN fuel level sensors to operate together with DFM CAN fuel flow meters and other standard and additional equipment by means of S6 Technology (see figure 4).

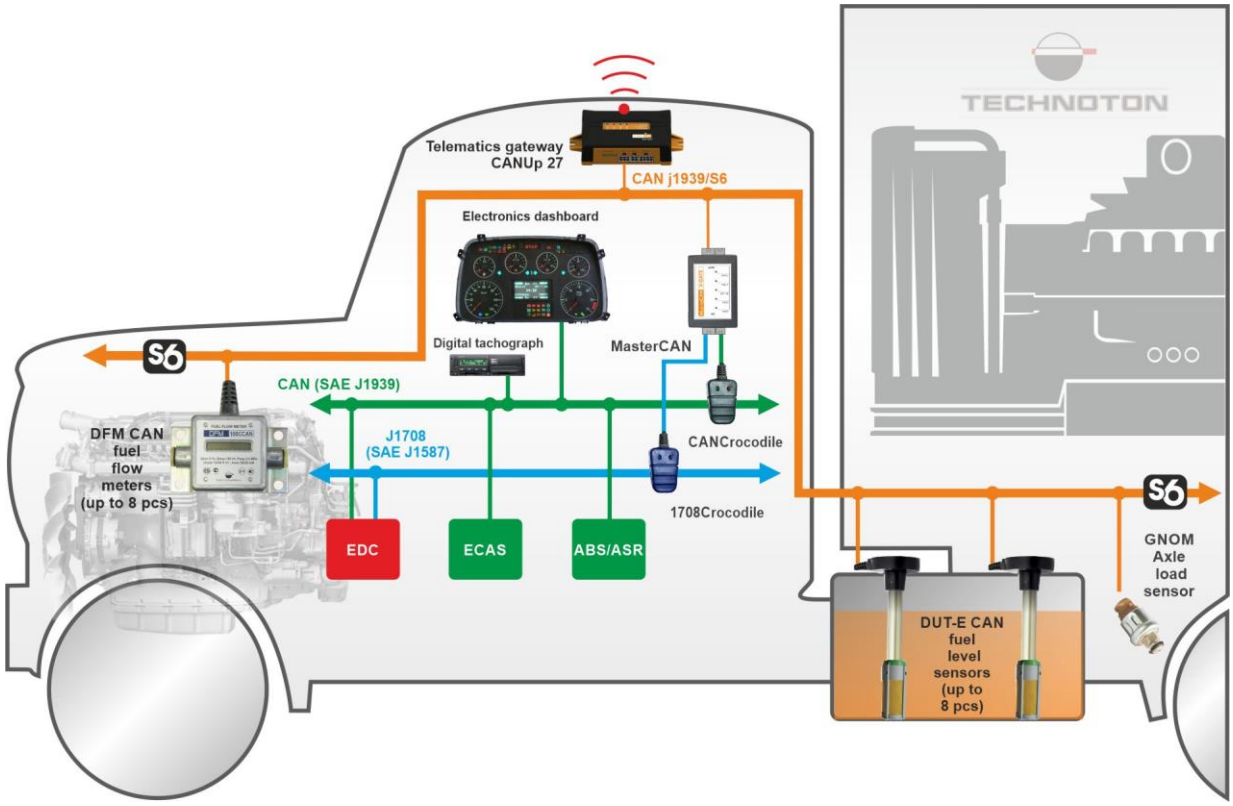


Figure 4 — Employment of DUT-E CAN sensors using S6 Technology

With the help of DUT-E CAN connected by means of S6 Technology, you can monitor in real time:

- fuel tank level and volume;
- total volume of fuel in up to 8 tanks and a separate volume value for each of the tanks;
- fuel temperature;
- sensor specification data (passport);
- presence of water in fuel;
- sensor malfunctions.

Tracking device can receive data from up to 8 DUT-E CAN sensors and up to 8 DFM CAN fuel flow meters via a single CAN interface port. This technical option is of particular importance for complicated mobile or fixed objects.

ORF-4 Telematics service allows convenient analysis of fuel volume inside tank of Vehicle (see figure 5).

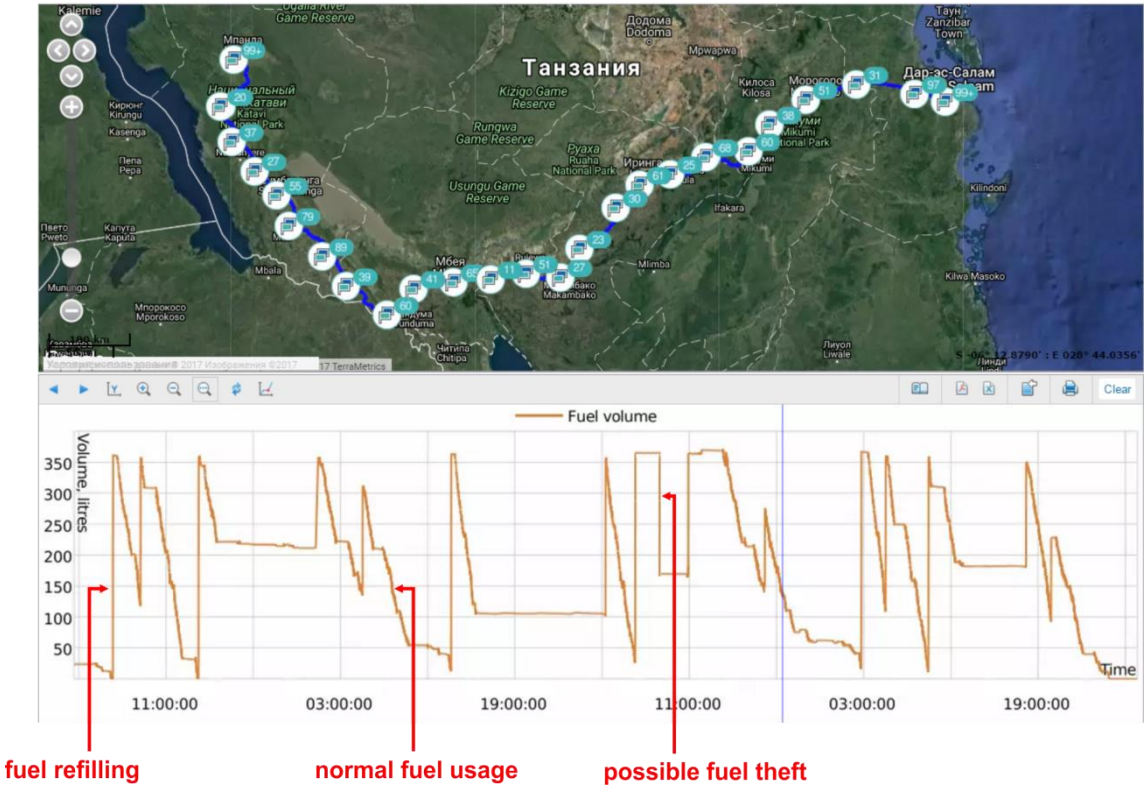
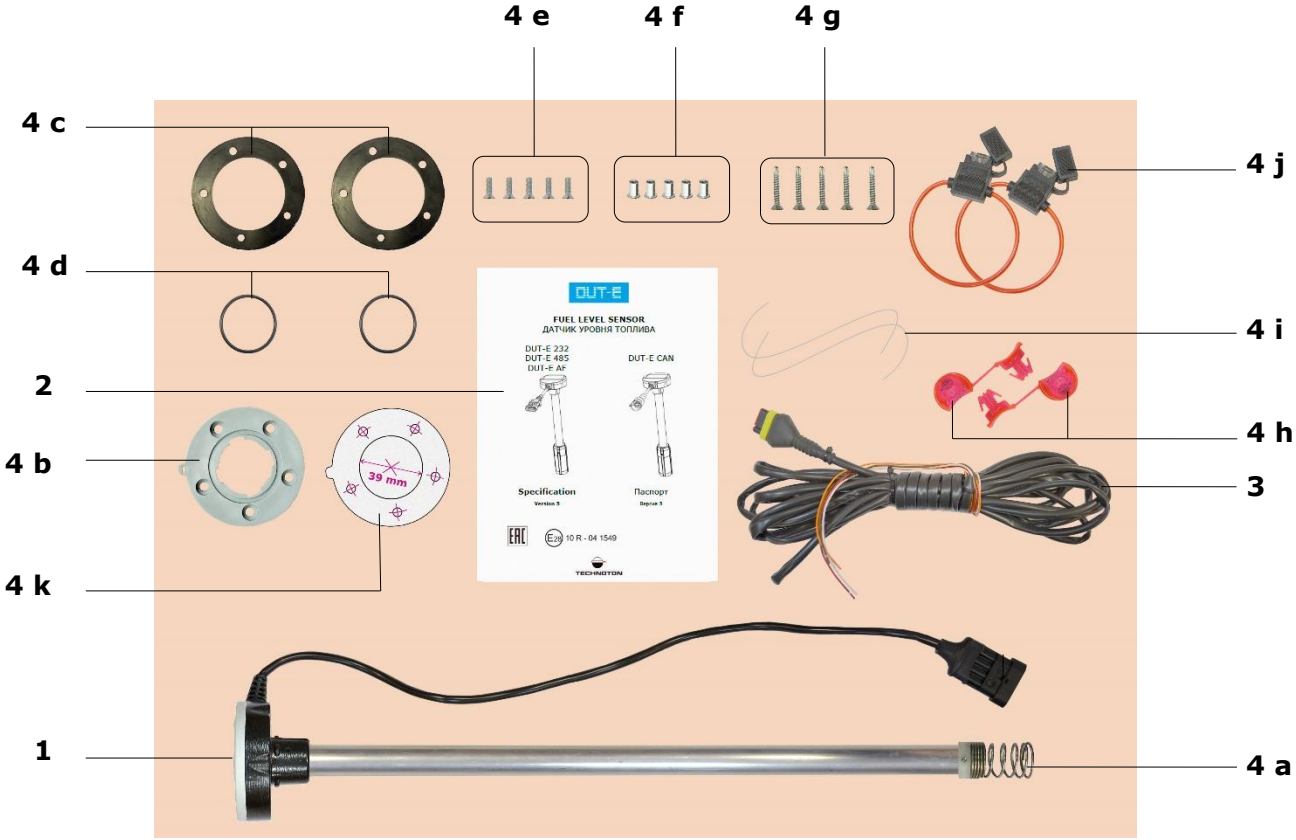


Figure 5 — Example of Analytical report generated in ORF 4 software, based on the DUT-E data

DUT-E application as a part of vehicle Telematics system allows operator to:

- receive accurate information on the current amount of fuel in the tank;
- determine exact refueling amount;
- reveal fuel theft facts;
- monitor fuel consumption rate.

1.2 Exterior view and delivery set



1	- DUT-E fuel level sensor	– 1 pc.;
2	- Specification with factory settings sheet	– 1 pc.;
3	- SC-CW-700-RS signal cable (7.5 m)	– 1 pc.*;
4	- Mounting kit (1 pc.) including:	
	a) bottom stop	– 1 pc.;
	b) plastic mounting plate	– 1 pc.;
	c) rubber gasket	– 2 pcs.**;
	d) sealing rubber ring	– 2 pcs.**;
	e) bolt	– 5 pcs.;
	f) threaded rivet	– 5 pcs.;
	g) self-tapping screw	– 5 pcs.;
	h) plastic seal	– 2 pcs.***;
	i) sealing cord	– 2 pcs.;
	j) fuse with holder (2 A)	– 2 pcs.;
	k) hole placement template	– 1 pc.

Figure 6— DUT-E delivery set

* Ordered separately signal cable (7.0 m) for DUT-E CAN.

** 1 pc. is for initial DUT-E GSM mounting and 1 pc. as a spare part. The delivery set may include just 1 gasket of 4 mm.

*** Exterior of seal can be different.

1.3 Design and operation principle

DUT-E fuel level sensor (see figure 7) consists of a measuring probe **(1)**, fuel level sensor "head" with an electronic module located inside **(2)**, interface cable **(3)** with connector for electrical connection **(4)**.

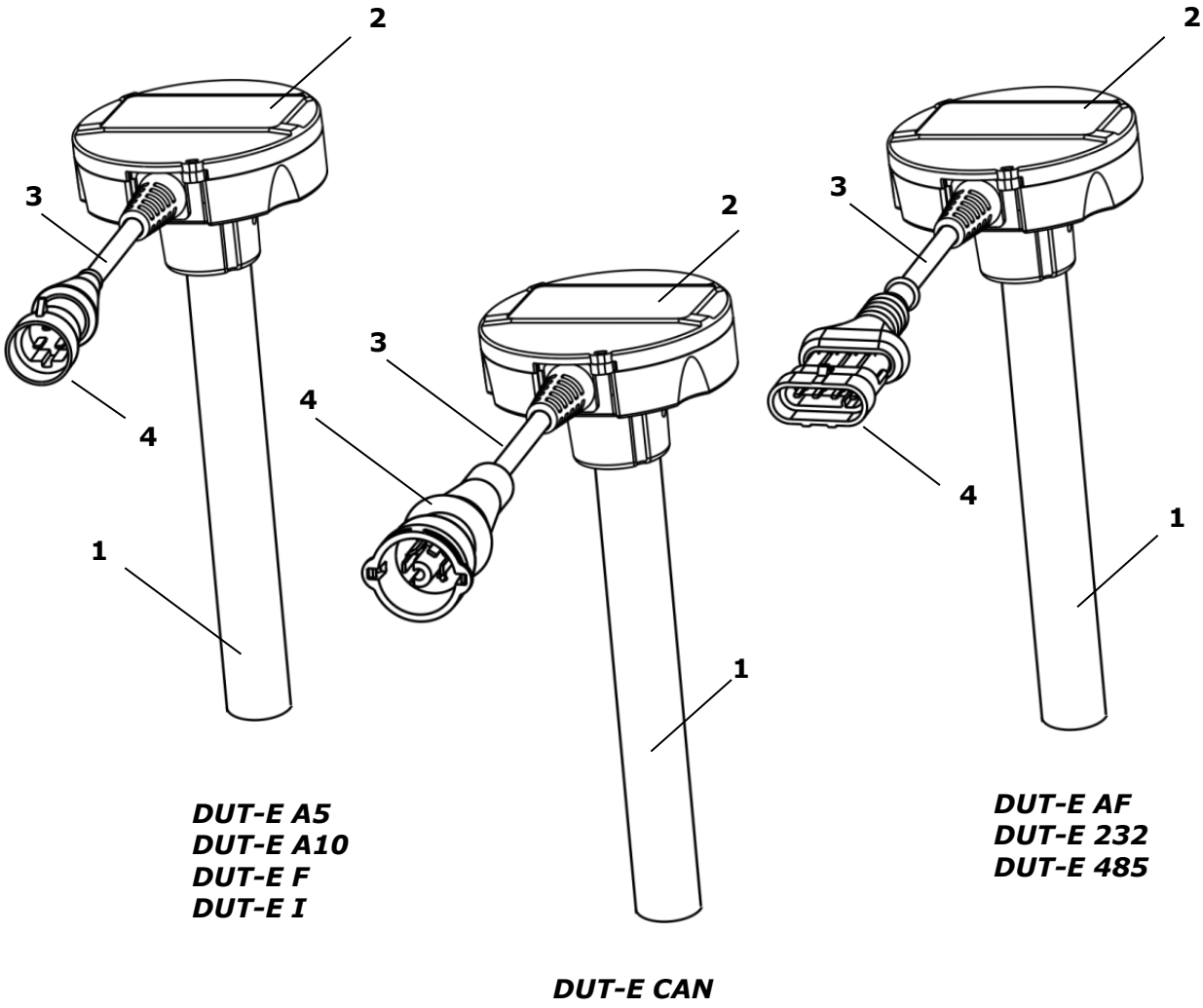


Figure 7 — DUT-E structure

DUT-E operation principle is based on condenser capacitance measurement, where measuring probe pipes are used as capacitor plates. Electric capacitance changes depending on measuring probe immersion depth in the fuel which is dielectric liquid. The sensor analyzes current value of electric capacitance and then generates an appropriate output signal.

WARNING: Capacitive principle ensures highest accuracy of liquid measurement when the liquid has **constant dielectric permeability coefficient**. Otherwise, additional inaccuracy of measurement may appear.

Fuel level translation is carried out in accordance with calibration table. To create the table, it is necessary to calibrate the fuel tank. This procedure is a sequence of fixed refueling portions from empty to full tank. During calibration, the value of DUT-E output signal is established depending on fuel amount in a particular tank (see DUT-E fuel level sensor installation video for details).

DUT-E can be used in combination with recording and display units (including GPS/GLONASS Vehicle Tracking devices), and their input signal specifications have to be compatible with DUT-E output signal specification according to Clauses 1.4.2 — 1.4.5.

When using DUT-E AF/A5/A10/F/I fuel level sensors, calculation of fuel amount is carried out in a registration unit such as a GPS Tracking device or on the server using vehicle monitoring system software.

DUT-E 232/485/CAN fuel level sensors can calculate current fuel amount independently in accordance with calibration table recorded in the sensor internal memory with Service DUT-E software.

1.4 Technical specifications

DUT-E is powered by on-board power supply of the Vehicle where it is installed.

DUT-E can be used in the conditions of temperate and cold climates.

For resistance to mechanical impact DUT-E is shake and shockproof.

1.4.1 Main specifications

Table 1 — DUT-E main specifications

Parameter, measuring unit	Value
Fuel level sensor operating principle	Capacitive
Relative measuring error (to the length of the measuring part), %, not more than	±1.0
Power supply voltage range, V	10…50
Maximal current consumption at supply voltage 12/24 V, mA, not more than	50/25 150*/75*
Availability time after power-up, seconds, not more than	10
Maximum trimming of the measuring probe	see 2.4
Maximum length increase, mm, not more than	see 2.5
Temperature range, °C	-40…+85
Ingress protection rating	IP55/57
Electromagnetic compatibility	see annex G
Weight, kg, not more than	0.6 (at L=1000 mm) 0.5 (at L=700 mm) 0.4 (at L=350 mm)
Overall dimensions, mm, not more than	see figure 8
* For DUT-E CAN.	

1.4.2 Specifications of DUT-E AF output signal

DUT-E AF fuel level sensor has an analog and frequency output which can be configured via K-Line (ISO 14230) interface.

Output signal value does not depend on supply voltage and is linear dependent on the fuel level.

The capacity of analog-digital output signal converter is 12 bit.

DUT-E AF output signal ranges:

1) Voltage output — from 1.0 to 9.0 V. The lower limit of the range can be configured from 1.0 V to 8.0 V and the upper limit from 2.0 V to 9.0 V;

Note — variation of the output voltage of the sensor can be set in both direct and inverse dependence.

2) Frequency output — from 500 to 1500 Hz. Frequency output signal has a meander shape with 50 % duty ratio. High level voltage value equals to (10.0±1.0) V. Low level voltage value is not more than 0.5 V.

Depending on settings DUT-E AF output signal value can stand for:

- fuel level in the tank (mm);
- fuel volume (l);
- total fuel volume (l) of up to eight tanks.

DUT-E AF output signal correspondent to fuel volume is generated according to calibration Table of the fuel tank which is stored in the sensor's memory.

Input resistance of the device DUT-E AF is connected to in frequency output mode should not be less than 10 kOhm;

In voltage output mode output resistance value is not more than 5 kOhm for low level and not more than 50 kOhm for high level.

1.4.3 Specifications of DUT-E A5/A10/F/I output signal

Output signal voltage values (for DUT-E A5 and DUT-E A10), frequency values (for DUT-E F) and current values (for DUT-E I) are linear dependent on fuel level in the tank.

Output signal value does not depend on supply voltage value.

- Input resistance of the device DUT-E A5/A10 is connected to should not be less than 10 kOhm.
- Output stage of DUT-E F – open collector with load resistor of 10 kOhm.
- Input resistance of the device DUT-E I is connected to should not be more than 260 Ohm for 12 V power supply voltage and should not be more than 800 Ohm for 24 V power supply voltage.

For DUT-E I correct performance the difference between minimum on-board power supply voltage and load voltage for the full tank should not be less than 5 V.

Table 2 — DUT-E A5/A10/F/I output signal specifications

DUT-E model	Fuel tank status	Voltage, V		Frequency, Hz		Current, mA	
		for nominal probe length	for 30 % cut probe	for nominal probe length	for 30 % cut probe	for nominal probe length	for 30 % cut probe
DUT-E A5	Empty	1.5	0.9	-	-	-	-
	Full	4.5	3.7	-	-	-	-
DUT-E A10	Empty	2.5	1.0	-	-	-	-
	Full	9.0	5.6	-	-	-	-
DUT-E F	Empty	-	-	500	262	-	-
	Full	-	-	1500	941	-	-
DUT-E I	Empty	-	-	-	-	6.7	4.0
	Full	-	-	-	-	20.0	16.4

1.4.4 Specifications of DUT-E 232/485 output signal

Specifications of DUT-E 232 and DUT-E 485 output signal correspond to the specifications of RS-232 and RS-485 interfaces.
Depending on settings output value of DUT-E 232 and DUT-E 485 can stand for:

- standard (normalized) units, from 0 to 1000 (0 – empty tank, 1000 – full tank);
- fuel level in the tank (mm);
- fuel volume (l);
- percentage of full tank capacity (%).

DUT-E sensor sends data on current temperature as well (value is measured with the temperature sensor located on the PCB).

DUT-E 232 and DUT-E 485 data transfer is carried out according to DUT-E COM Protocol.

1.4.5 Specifications of DUT-E CAN output signal

Parameters of DUT-E CAN output signal correspond to the specification of CAN j1939/S6 Telematics interface. The data transfer protocol is based on SAE J1939 standard and meets its requirements.

DUT-E CAN data is sent in automatic transmission mode and by request.

Output messages list of DUT-E CAN data transmission protocol can be found in table 3.

The configuration of CAN j1939/S6 interface parameters by the user is conducted via K-Line interface (ISO 14230) using Service DUT-E service software.

S6 Technology allows to configure the summarization of parameters of up to 8 DUT-E CAN fuel level sensors. For each sensor a unique network address (SA) from 101 to 108 should be specified.

Table 3 — Messages of DUT-E CAN data transfer protocol

Message format*	Brief message transcript
PGN 62982	Fuel level and fuel volume in the tank
PGN 62995	Unit passport
PGN 63008	Unit state
PGN 65226	Active DTC
PGN 65276	Dash display
PGN 65279	Operator indicators
* See annex C for detailed description.	

1.4.6 DUT-E and Tracking devices compatibility

DUT-E sensors may be used together with Telematics terminals or other tracking devices whose input specifications correspond to parameters of DUT-E output signals, in accordance with 1.4.2 — 1.4.5.

Technoton regularly conducts compatibility and mutual accuracy tests of all manufactured products with Terminals of different models.

A table containing the up-to-date list of Declarations of compatibility of Telematics terminals from different manufacturers with products manufactured by Technoton is provided at: https://www.jv-technoton.com/.

Recommendations on the equipment connection and configuration can be received at the Technoton technical support service.

1.4.7 Overall dimensions

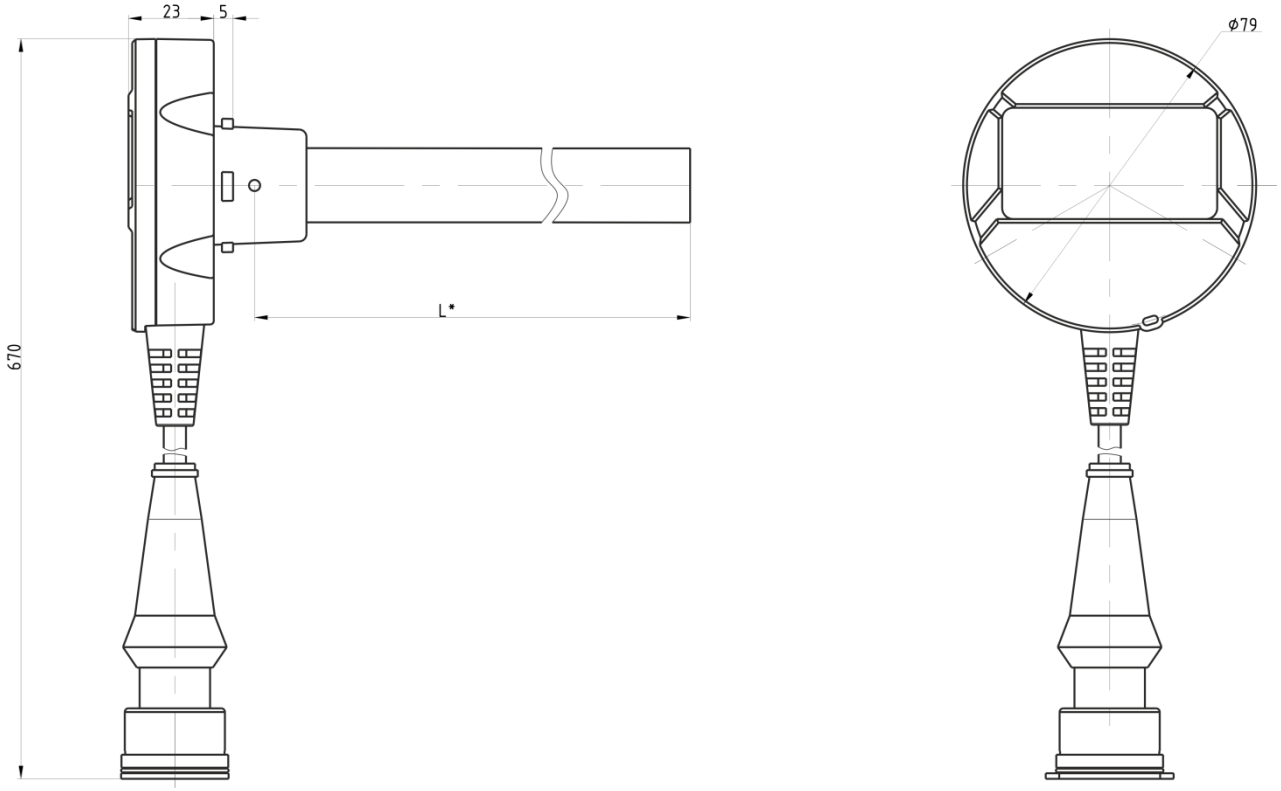


Figure 8 — DUT-E overall dimensions

***** Nominal measuring probe length (350 mm/700 mm/1000 mm, see figure 1).

2 DUT-E installation

For DUT-E correct operation its mounting and configuration should be carried out by certified specialists who have passed corporate technical training.

ATTENTION: Strictly follow safety rules of automobile repair works as well as local safety rules of the customer company when mounting sensor.

DUT-E can be mounted either into the flange of factory mounted float sensor* or into a specially drilled hole of the fuel tank.

This chapter contains basic recommendations on DUT-E installation. Detailed instructions regarding the sensor installation are provided in the DUT-E Installation guide.

In the DUT-E fuel level sensor installation video you can see the general order of sensor installation

2.1 Exterior inspection prior to starting works

It is necessary to conduct DUT-E exterior inspection for the presence of the possible defects arisen during transportation, storage or careless use.

Contact the product supplier if there any defects.

* Study carefully the layout of the mounting bores for a factory mounted fuel sensor and compare it with the drawing of bores for a DUT-E mounting plate.

2.2 Standard fuel sensor replacement

ATTENTION: If the standard fuel sensor is not located in the geometrical center of the tank, it is not recommended to replace it with DUT-E. DUT-E installation far from the geometrical center of the tank will lead to significant fluctuations in fuel level readings.

Dismount the standard sensor and clean the mounting area before DUT-E mounting.

The holes of the mounting plate and rubber gasket must be aligned with the bores in the tank.

M5x16 bolts can be used for installation; they are included into the DUT-E package. Bolt or screw heads must be completely sunk in the mounting plate (see figure 9)**.**

Figure 9 — Mounting plate screwed to the tank

Preorder correspondent mounting plate to replace the standard sensor with **SAE 5 bolt** bores layout.

2.3 Installation into a special hole

IMPORTANT:

1) Before drilling a bore in a fuel tank, the tank must be emptied, dismounted (if necessary) and dried or filled with water.

2) Before drilling, make sure that there are no bulkheads that interfere DUT-E installation.

3) Eliminate contact of DUT-E measuring probe with the bar of the standard float fuel sensor.

DUT-E installation procedure:

1) Determine installation location. **Geometrical center of the fuel tank** is recommended (see figure 10). This will reduce measurement errors caused by fuel level deviation during driving.

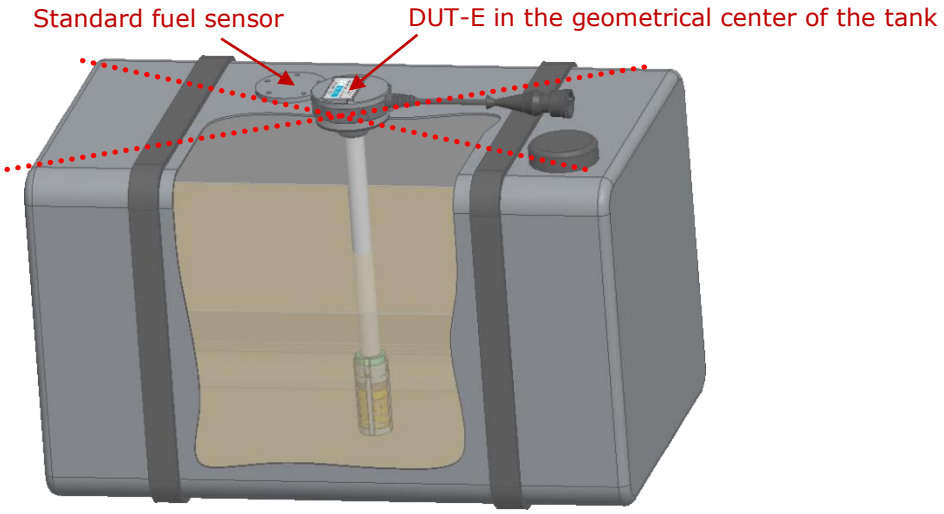
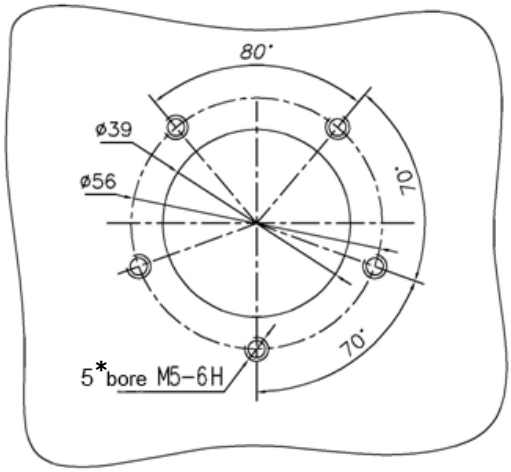


Figure 10 — Recommended location for a DUT-E installation

2) Stick hole placement template from DUT-E delivery set to the top of the tank and drill holes accordingly (see figure 11).

BE CAREFUL: The mounting plate can be installed only in one position on the bores prepared! Before marking and drilling, examine the place where you plan to fix the mounting plate because sealing holes should be accessible.

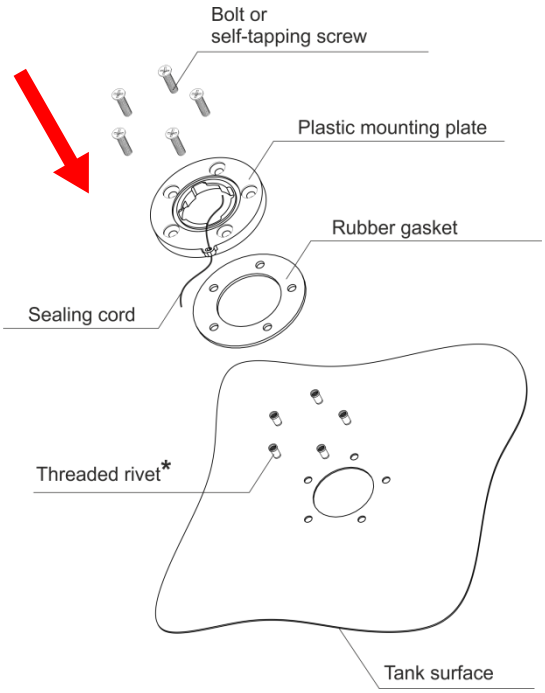


***** While installing fastening plate with threaded rivets, make d=**7 mm** holes for rivets.

Figure 11 — Bores layout for DUT-E mounting plate fastening

3) Put rubber gasket and fastening plate over prepared holes, fix them with screws and threaded rivets of with self-tapping screws from MK DUT-E mounting kit (see figure 12).

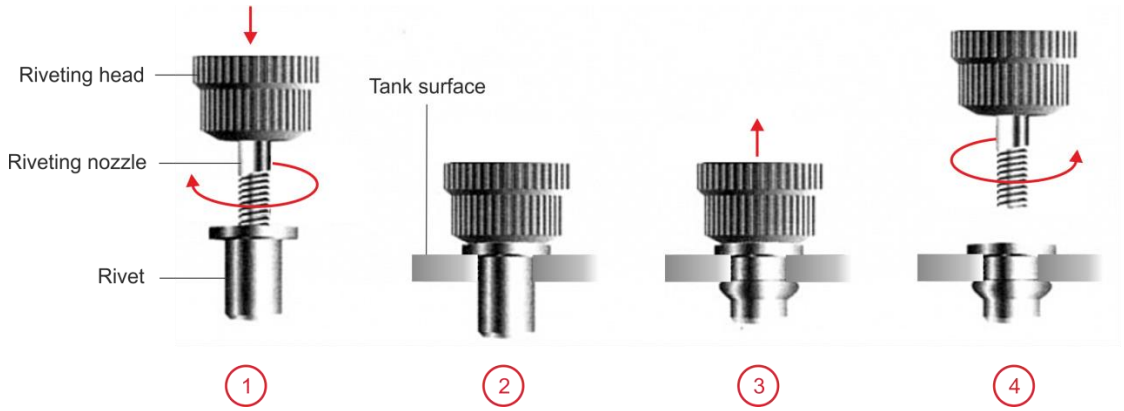
RECOMMENDATION: For a further easier sealing of DUT-E sensor pass the sealing cord through the sealing hole of the plate **prior** to fastening the plate to the tank!



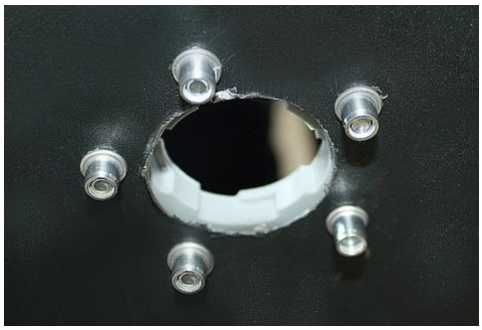
***** Recommend for installation of sensor in fuel tank with thin walls (**less than 2 mm**).

Figure 12 — Mounting plate fastening

When using threaded rivets, they should be mounted using riveter and according to figure 13.



a) threaded rivets procedure of installation



b) installed fastening plate view of from inside of tank

Figure 13 –Threaded rivets usage for sensor installation

ATTENTION: When fixing the mounting plate to the tank, make sure that the bolt or screw heads are not skewed and completely sunk in the plate in order to provide electrical isolation between the tank and DUT-E.

2.4 Probe cutting according to tank depth

ATTENTION: **DUT-E AF/232/485/CAN** allow cut off up **to any required probe length** with mandatory further calibration.
DUT-E A5/A10/F/I allow cut off **up to 30 %** of the initial length of the measuring probe with no further calibration.

DUT-E cutting procedure instructions:

1) Measure the depth of the tank from mounting plate to the bottom.

IMPORTANT: It is **required to leave a 20…30 mm gap** between the edge of the measuring probe and the tank bottom to:
- provide at least 10 mm operation area for bottom spring stopper (if the bottom spring is fixed in full loading position the bayonet mounting plate can get damaged);
- avoid the short circuit of the measuring probe tubes with conductive mud or water at the tank bottom.

2) Cut off DUT-E probe so that the edge of the probe is in 25 mm above the bottom of the tank.

Figure 14 — DUT-E measuring probe cutting

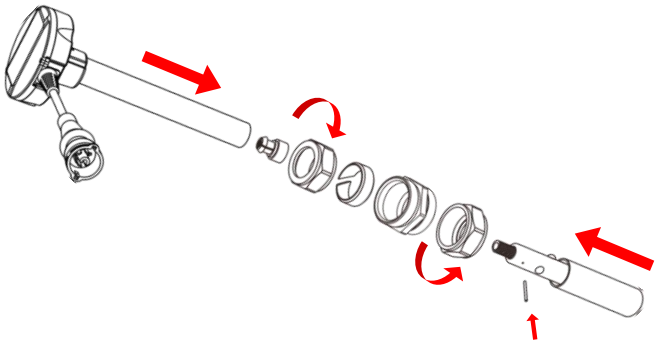
RECOMMENDATION: Cut DUT-E probe with a metal hacksaw. Carefully clean the edge and wash the tubes with clean fuel (see figure 14).

3) After cutting the measuring probe of DUT-E AF/232/485/CAN models, you need to carry out the sensor calibration using Service DUT-E service software (see 3.10.3).

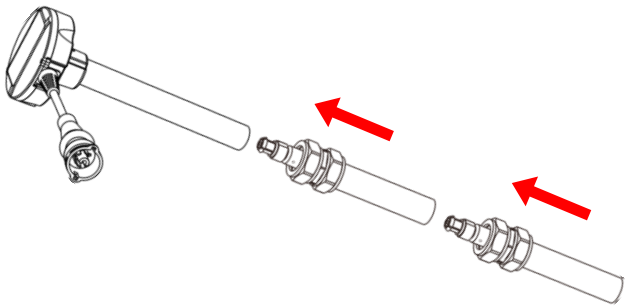
2.5 Length extension

Length extension is performed by fastening KDC additional sections to the measuring probe of DUT-E sensor (see figure 15 and DUT-E Length extension with KDC video).
DUT-E AF/232/485/CAN can be extended up to 6000 mm length.
DUT-E A5/A10/F/I extension is possible only up to the initial size of particular sensor (if been cut).
Length extension option significantly decreases expenses on storage and transportation.

a) exterior view



b) fastening order



c) fastening order of two sections

Figure 15 — DUT-E additional section

DUT-E additional sections can be cut to necessary size. Follow instructions of clause 2.4 when cutting the sections.
Model range of DUT-E additional sections includes: KDC 250, KDC 500 and KDC 1000 with lengths of 250, 500 and 1000 mm respectively.
After length extension the measuring probe of DUT-E AF/232/485/CAN models, you need to carry out the sensor calibration using Service DUT-E service software (see 3.10.3).

2.6 Mounting

To fasten DUT-E it is necessary to place sealing ring gasket in the groove of fastening plate and put measurement part of sensor equipped by screen filter through the central hole. After that, firmly push sensor's head and turn clockwise to lock it (see figure 16).

RECOMMENDATION: It is recommended to put some oil or fuel on the sealing ring of the mounting plate to prevent its deformation during DUT-E mounting.

The mounting should be carried out so that both sensor and mounting plate sealing holes would match one another after locking the DUT-E.

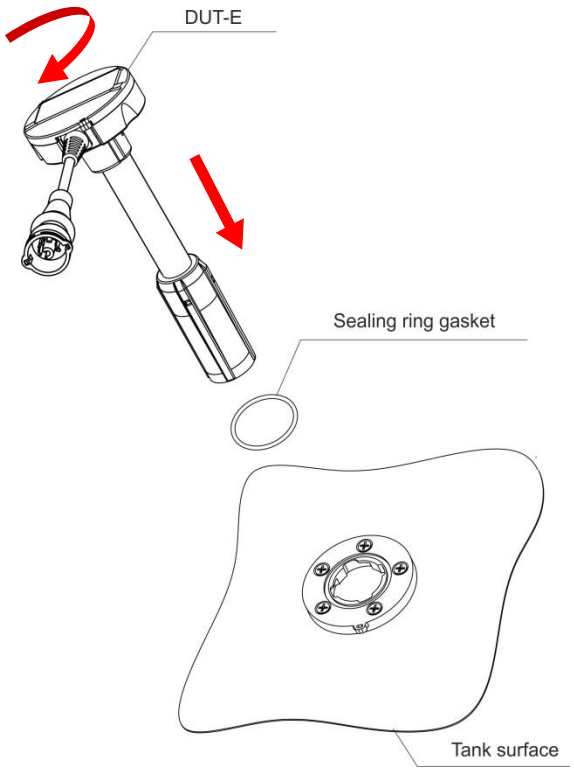


Figure 16 — DUT-E mounting

2.7 Electrical connection

DUT-E is powered from the Vehicle onboard circuit.

IMPORTANT:

1) Before mounting and connecting DUT-E switch off power supply of the vehicle electrical circuits. To do this switch off the battery switch or release the terminals of the wires connected to the battery.

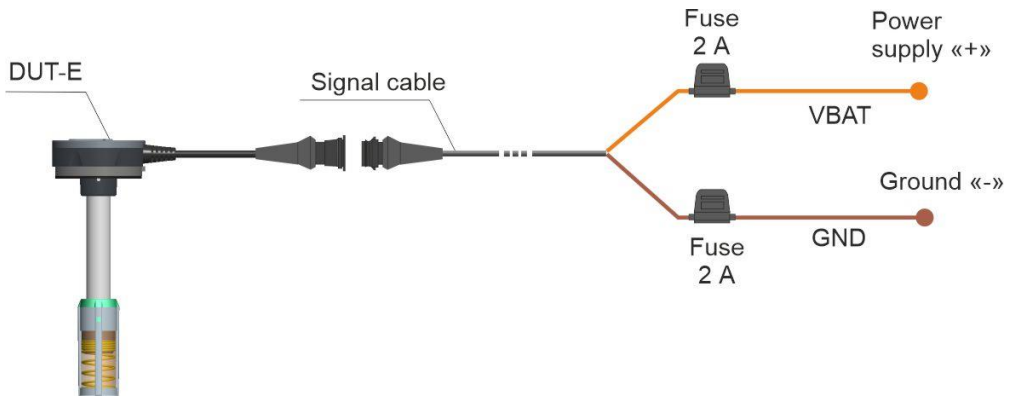
2) Prior to electrical connection of the sensor pay special attention to checking Vehicle chassis ground. Resistance between any point of vehicle chassis and "-" terminal of the battery or between terminals of the chassis ground switch should not exceed 1 Ohm.

3) When connecting DUT-E to onboard electrical network of Vehicle, use **fuses** from delivery set in accordance to scheme of connection (see figure 17 a). Nominal fuse current is not more than 2 A.

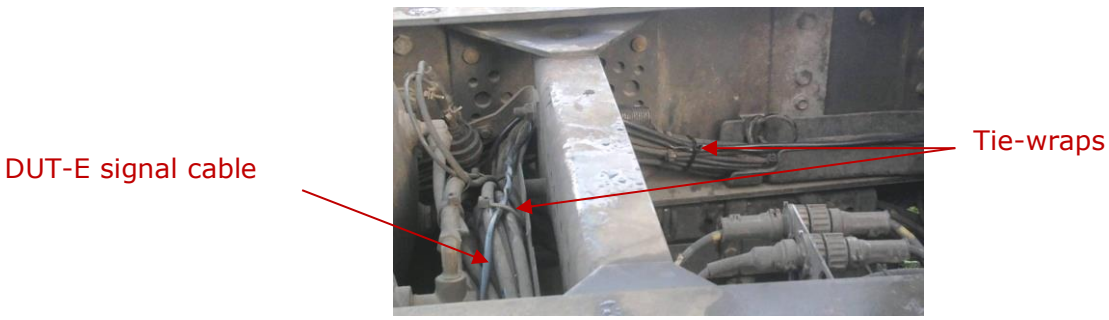
4) DUT-E power supply "+" and Ground "-" wires should be connected to the same points of vehicle electric circuit as correspondent wires of the tracking device.

5)) It is **strongly recommended** to lay signal cable together with standard electrical vehicle wiring with mandatory cable ties fixing of every 50 cm, at a positive ambient temperature (see figure 17 b).

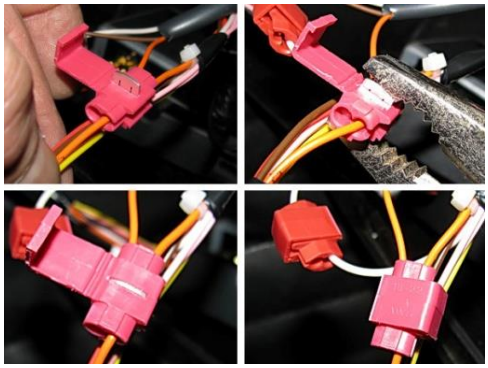
6) Quick splice connectors (ordered separately) are recommended for electrical connection of power supply wires (see figure 17 c).



a) DUT-E to onboard electrical network scheme of connection



b) connection cable laying



c) using connectors to connect wires of signal cable

Figure 17 — Electrical connection of DUT-E

IMPORTANT: DUT-E body is electrically connected to Ground "-" (brown wire of the connection cable). Electrical isolation between the DUT-E body and the fuel tank is provided by the mounting plate made of dielectric plastic material.

2.7.1 Electrical connection of DUT-E AF

DUT-E AF electrical connection is made according to pinout of the connector and interface cable wires description. See figure 18 and table 4 for details.

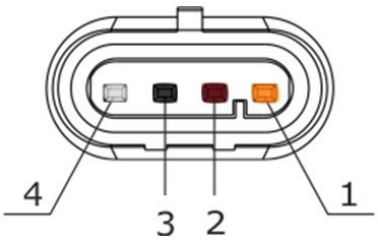


Figure 18 — DUT-E AF interface cable connector pinout

Table 4 — DUT-E AF interface cable wires assignment

Pin number	Wire marking	Wire color*		Assignment
1	VBAT	Orange		Power supply "+"
2	GND	Brown		Ground "-"
3	KLIN	Black		K-Line (ISO 14230)
4	T034	White		Output signal (see 1.4.2)
* Manufacturer reserves the right to modify wire colors				

2.7.2 Electrical connection of DUT-E A5/A10/F/I

DUT-E A5/A10/F/I electrical connection is made according to pinout of the connector and interface cable wires description. See figure 19 and table 5 for details.

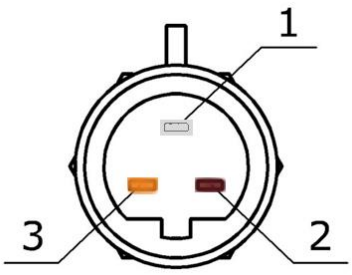


Figure 19 — DUT-E A5/A10/F/I interface cable connector pinout

Table 5 — DUT-E A5/A10/F/I interface cable wires assignment

Pin number	Wire marking	Wire color*		Assignment
1	T701/T034	White		Output signal, see 1.4.3
2	GND/T734	Brown		Ground "-"
3	VBAT	Orange		Power supply "+"
* Manufacturer reserves the right to modify wire colors				

2.7.3 Electrical connection of DUT-E 232/485

DUT-E 232 and **DUT-E 485** electrical connection is made according to pinout of the connector and interface cable wires description. See figure 20 and table 6 for details.

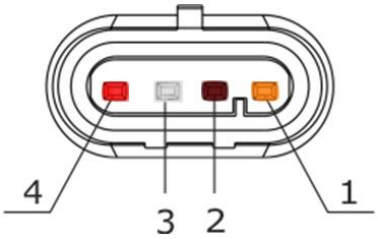


Figure 20 — DUT-E 232/485 interface cable connector pinout

Table 6 — DUT-E 232/485 interface cable wires assignment

Pin number	Wire marking	Wire color*		Assignment
1	VBAT	Orange		Power supply "+"
2	GND	Brown		Ground "-"
3	232R/485A	White		Received data (RS-232) Data exchange (RS-485)
4	232T/485B	Red		Transmitted data (RS-232) Data exchange (RS-485)
* Manufacturer reserves the right to modify wire colors				

2.7.4 Electrical connection of DUT-E CAN

DUT-E CAN electrical connection is made according to pinout of the connector and interface cable wires description. See figure 21 and table 7 for details.

See annex B for DUT-E CAN connection options indicating additional cables to be ordered for particular connection type.

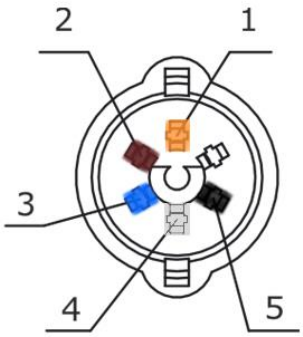


Figure 21 — DUT-E CAN interface cable connector pinout

Table 7 — DUT-E CAN interface cable wires assignment

Pin number	Wire marking	Wire color*		Assignment
1	VBAT	Orange		Power supply "+"
2	GND	Brown		Ground "-"
3	CANH	Blue		CAN-High (SAE J1939)
4	CANL	White		CAN-Low (SAE J1939)
5	KLIN	Black		K-Line (ISO 14230)
* Manufacturer reserves the right to modify wire colors				

RECOMMENDATION: Primarily check wire marking when connecting DUT-E sensors.

2.8 Monitoring of two and more tanks

2.8.1 DUT-E 232 readings totalizing

DUT-E SUM 232 summator designed by Technoton is used together with DUT-E 232 sensors on vehicles with two and more fuel tanks for measuring total amount of fuel (see figure 22).

ATTENTION:
1) DUT-E SUM 232 summator operates only with DUT-E 232 sensors with firmware version 3.0 and higher.
2) Fuel tank calibration table should be recorded into the internal memory of each sensor (see 3.10.7).

Figure 22 — DUT-E SUM 232 summator

DUT-E SUM 232 output message contains total fuel volume (in liters) as a sum of the values measured by sensors connected to its **IN** and **IN/OUT** inputs.

Electrical connection of summators is carried out according to the diagrams provided in figure 23 and in compliance with wire assignment provided in table 8.

Two DUT-E 232 sensors are connected to the single tracking device according to figure 23 a.

If there are three or more fuel tanks to be measured with DUT-E 232 sensors, cascade connection can be used according to figure 23 b.
Quick splice connectors (ordered separately) are recommended for electrical connection of signal wires.

Table 8 —DUT-E SUM 232 wires assignment

Wire number	Wire marking	Wire color*		Assignment
1	VBAT	Orange		Power supply "+"
2	GND	Brown		Ground "-"
3	232R	White		Received data (RS-232)
4	232T	Red		Transmitted data (RS-232)
* The Manufacturer reserves the right to change wire colors.				

To get correct values DUT-E 232 sensors should be configured with Service DUT-E software according to the following instructions (see 3.10.4, 3.10.6)):

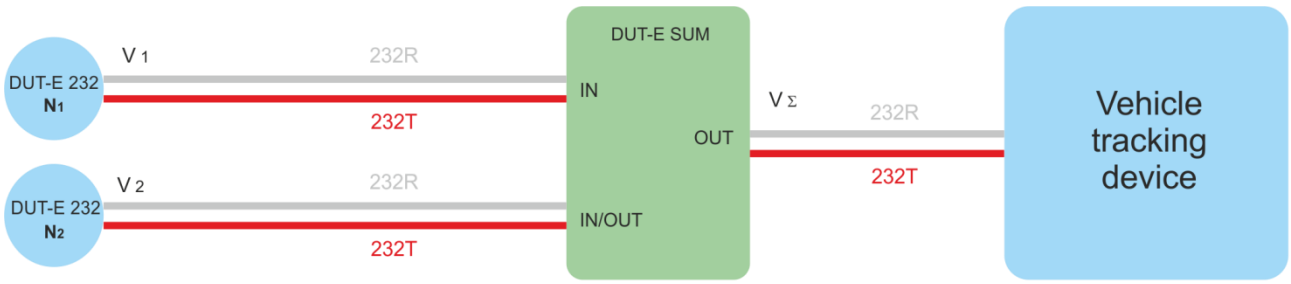
1) For data output in **upon request** mode the following parameters must be applied for **all** the sensors:

- **Automatic transmission mode** switched **Off** (**Operation modes** module);
- **Output message** selected as **Volume (L)** (**Output message** module).

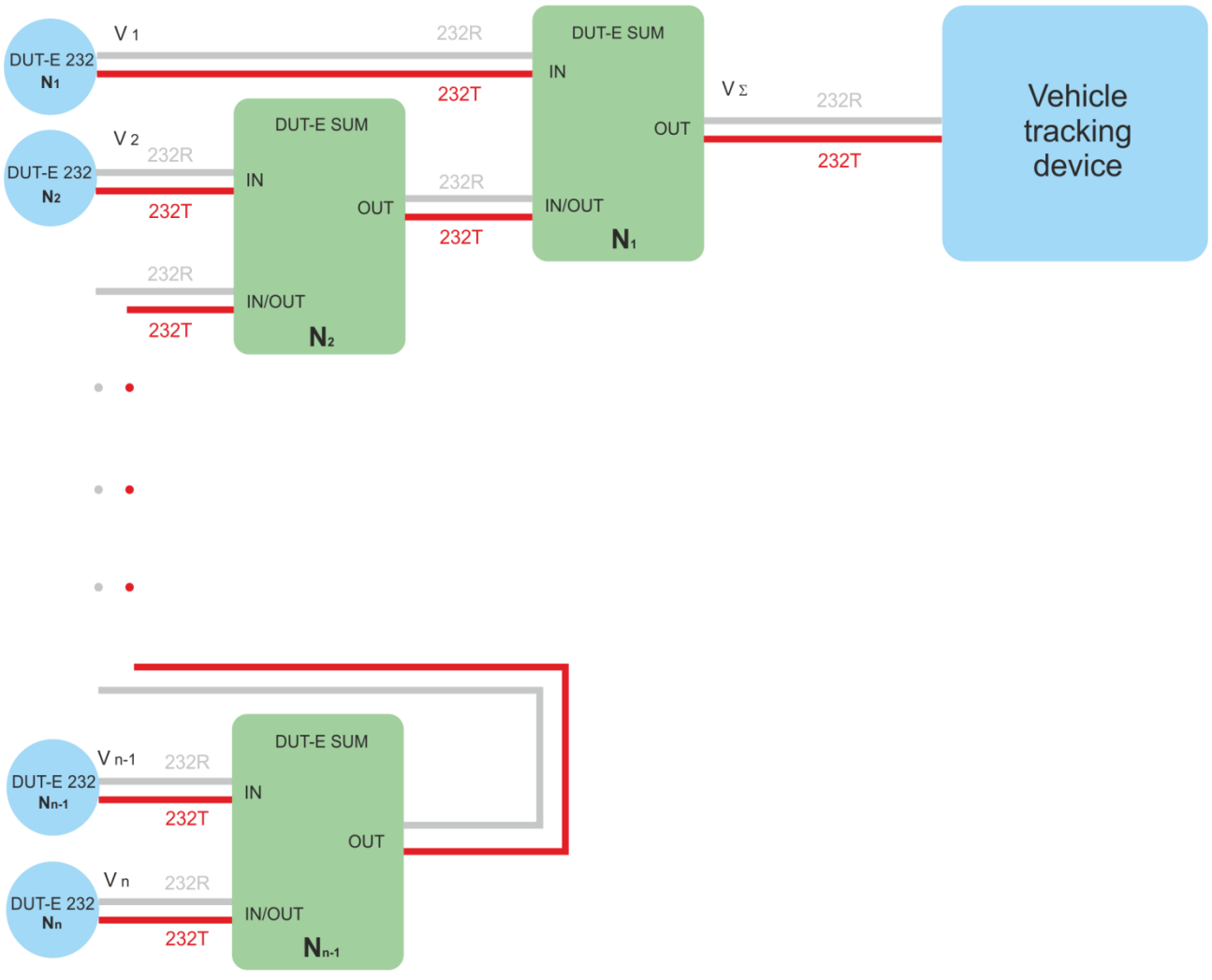
2) For data output in **automatic** mode the following parameters must be applied:

- for **all** the sensors — **Output message** selected as **Volume (L)** (**Output message** module);
- sensor $\mathbf{N_1}$ — **Automatic transmission mode** selected as **HEX**, **Message Interval (s)** value is 1 (**Operation modes** module);
- sensors $\mathbf{N_2}$ … $\mathbf{N_{(n-1)}}$ — **Automatic transmission mode** switched **Off** (**Operation modes** module);
- sensor $\mathbf{N_n}$ (the last one) — **Automatic transmission mode** set to **HEX\ASCII\ ASCII EXT**, **Message Interval (s)** set any required by the tracking device value (**Operation modes** module).

Note — for sensor $\mathbf{N_n}$ (the last one) at least 8 second message interval is recommended.



a) Connection scheme of two DUT-E 232 sensors



b) Connection scheme of three and more DUT-E 232 (summators cascading)

Figure 23 — DUT-E SUM 232 connection schemes

2.8.2 DUT-E AF readings totalizing

DUT-E SUM AF summator designed by Technoton is used together with DUT-E AF sensors on vehicles with two and more fuel tanks for measuring total amount of fuel (see figure 24).

ATTENTION:

1) DUT-E SUM AF summator operates only with DUT-E AF sensors with firmware version 3.5 and higher.

2) Fuel tank calibration table should be recorded into the internal memory of each sensor (see 3.10.7).

3) Readings can be totalized both analog (voltage) and frequency output signal types of DUT-E AF.

Figure 24 — DUT-E SUM AF summator

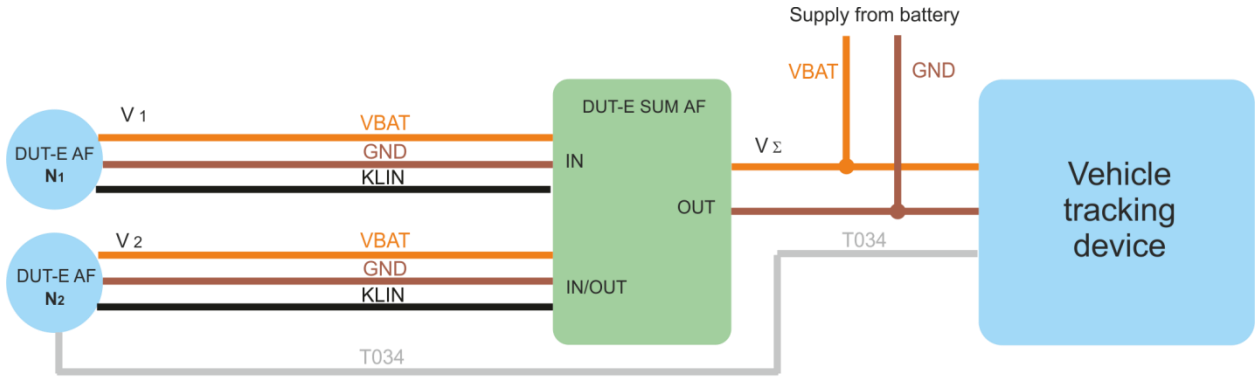
DUT-E SUM AF output message contains total fuel volume (in liters) as a sum of the values measured by sensors connected to its **IN** and **IN/OUT** inputs.

Electrical connection of summators is carried out according to the diagrams provided in figure 25 and in compliance with wire assignment provided in table 9.

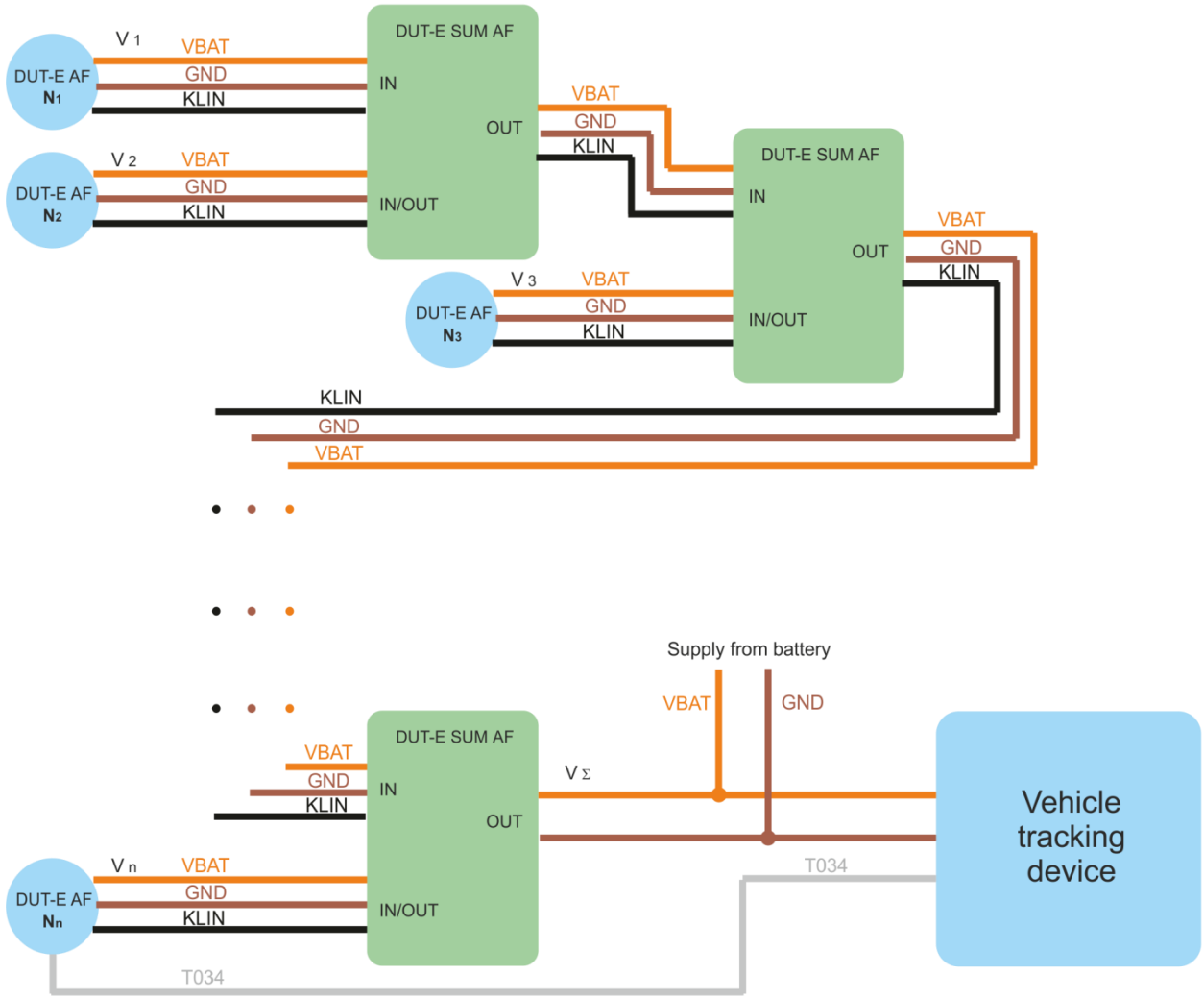
Two DUT-E AF sensors are connected to the single tracking device according to figure 25 a.

If there are three or more fuel tanks to be measured with DUT-E AF sensors, cascade connection can be used according to figure 25 b.

Quick splice connectors (ordered separately) are recommended for electrical connection of signal wires.



a) Connection scheme of two DUT-E AF sensors



b) Connection scheme of three and more DUT-E AF (summators cascading)

Figure 25 — DUT-E SUM AF connection schemes

Table 9 — DUT-E SUM AF wires assignment

Wire number	Wire marking	Wire color*		Assignment
1	VBAT	Orange		Power supply "+"
2	GND	Brown		Ground
3	KLIN	Black		K-Line (ISO 14230)
* The Manufacturer reserves the right to change wire colors.				

To get correct values DUT-E AF **Analog output** should be configured with Service DUT-E software (version 3.22 and higher). Configuration instructions (see 3.10.4):

- when totalizing readings of DUT-E AF in analog output mode select **U** output signal type for **all** sensors. Insert minimum (U_{min}, V) and maximum (U_{max}, V) signal values into correspondent fields.

ATTENTION: When totalizing readings of DUT-E AF in frequency output mode select **F** parameter value for $\mathbf{N_n}$ sensor from the **Output type** drop-down list. Select **U** for $\mathbf{N_1}$…$\mathbf{N_{n-1}}$ sensors.

- select the highest address for $\mathbf{N_n}$ sensor at **Settings-Operation modes** module. Select consecutive network addresses for $\mathbf{N_1}$…$\mathbf{N_{n-1}}$ sensors without missing addresses for the best and fastest totalizing performance (see figure 24).
- select **Sum** parameter value for $\mathbf{N_n}$ sensor from the second drop-down list**.** Any type (Level or Volume) can be set for $\mathbf{N_1}$…$\mathbf{N_{n-1}}$ sensors.
- exit Service DUT-E since sensor is configured because the software is blocking data exchange between DUT-E AF.

2.8.3 DUT-E CAN readings totalizing

ATTENTION: S6 Technology allows to summarize fuel volume indications of up to **8 pcs.** of DUT-E CAN sensors. Each sensor should be assigned a unique network address within the range 101…108. Fuel tank calibration table should be stored in the internal memory of each DUT-E CAN connected to S6 bus (see 3.10.7).

1) To receive data on the measured total volume of fuel of two and more Vehicle tanks via RS-232/RS-485 interface, you may use MasterCAN C 232/485 vehicle data interface together with DUT-E CAN sensors. In order to receive data on the total volume of fuel via RS-232 interface, you may use MasterCAN V-GATE together with DUT-E CAN.

See annex D for connection scheme of MasterCAN and DUT-E CAN and order codes of required cables.

Check out MasterCAN Operation manual for detailed information on vehicle data interfaces MasterCAN C 232/485 and MasterCAN V-GATE.

2) DUT-E CAN sensors with 4.6 and higher can be used for obtaining data on total fuel volume of several tanks under CAN j1939/S6 interface.

See annex B for connection scheme of DUT-E CAN and order codes of required cables.

To get correct values DUT-E CAN should be configured with Service DUT-E software (version 3.25 and higher). Configuration instructions (see 3.10.4):

- select the highest address for $\mathbf{N_n}$ sensor at **Settings-Operation modes** module. For the correct and fast data transfer from sensor to sensor network addresses $\mathbf{N_1}$ to $\mathbf{N_{n-1}}$ should be consequent.
- set **Master** for $\mathbf{N_n}$ sensor in **Summator** drop-down list.
- set **Slave** status for $\mathbf{N_1}$ to $\mathbf{N_{n-1}}$ in **Summator** drop-down list.
- set **Off** in drop-down list if there no need for totalizing
- shut down Service DUT-E since configuration is made because the further operation of the software blocks data exchange between DUT-E CAN.

Summerized data of fuel volume (PGN 62982, see annex C) are provided only by the sensor which is assigned **Master** status.

2.9 Sealing

It is required to seal the sensor and cable connector with sealing cords and disposable plastic seals to prevent fuel thefts or unauthorized interference into DUT-E operation (see figure 26). Seals and cord are included into DUT-E delivery set.

ATTENTION: Security sealing of DUT-E AF, DUT-E 232, DUT-E 485 and DUT-E CAN cable connector should be carried out after the configuration and calibration are finished (see 3)

To seal the sensor put the sealing cord through the special holes of the mounting plate and DUT-E body. Then put the ends of the cord through the holes in the center of the plastic seal body. Latching the seal will lock the cord. Seal removal will be impossible without its damaging.

Figure 26 — Plastic seal and sealing cord*

WARNING: Sealing rope should not touch the fuel tank body!

* Design of the seal supplied within the delivery set can differ from the one displayed in figure 26.

3 Configuration of sensor using service adapter

Minimum/maximum measurement level **calibration** is required for correct operation of DUT-E AF/232/485/CAN as well as **configuration** according to specific operating conditions and requirements of tracking devices/data loggers.

ATTENTION: DUT-E A5/A10/F/I do not require any calibration and configuration.

Calibration and configuration is carried out with SK DUT-E or S6 SK service adapter (ordered separately). You may also use S6 SK service adapter for DUT-E CAN configuration.

S6 SK description can be found in CAN j1939/S6 Telematics interface Operation Manual.

Check out DUT-E installation video for configuration instance.

3.1 SK DUT-E purpose of use

SK DUT-E service adapter is designed for configuration of DUT-E AF/232/485/CAN models and communication between sensor and PC.

Before starting with service adapter, it is necessary to download software from https://www.jv-technoton.com/ (section Software/Firmware) and install it to PC:

- USB driver;
- Service DUT-E software.

Service DUT-E software functions:

- checking and modifying sensor settings;
- sensor calibration;
- fuel tank calibration;
- saving sensor configuration profile to PC;
- upload previously saved configuration profile from PC to sensor;
- monitor sensor output data;
- run sensor diagnostics;
- update sensor firmware.

3.2 Hardware requirements

For work with Service DUT-E software, you need a separate PC (desktop or laptop) on which **only** Technoton service software that meets the following minimal requirements is installed:

- Windows XP/Vista/7/8/8.1/10 operating system of X32/X64 bit depth;
- CPU — Intel Core i3, dual-core, 2.0 GHz;
- RAM — 4 Gb;
- availability of USB 2.0 port;
- display resolution 1366x768.

ATTENTION: Service adapter operation is possible only after preliminary installation of USB driver.

3.3 Service adapter components

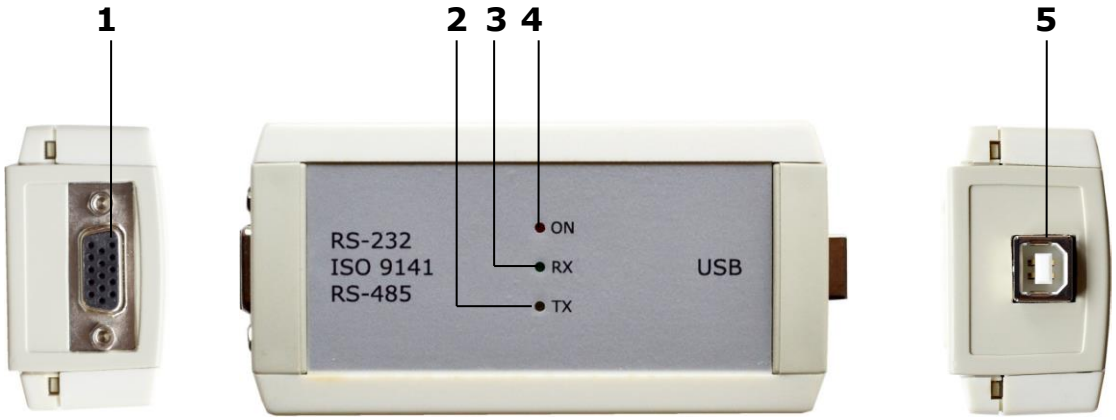
3.3.1 Exterior view and delivery set

1 - universal service adapter;
2 - SK DUT-E specification;
3 - USB A-B cable;
4 - CAN service cable;
5 - RS-485 service cable;
6 - RS-232 service cable;
7 - AF service cable.

Figure 27 — SK DUT-E delivery set

3.3.2 Universal service adapter

Universal service adapter (hereinafter adapter) is designed to transmit data between DUT-E sensors and PC.



1 – RS-232/ISO9141/RS-485 socket for DUT-E connection;
2 – TX yellow LED indicator of data transmitted to DUT-E;
3 – RX green LED indicator of data received from DUT-E;
4 – ON red LED indicator of power supply;
5 – USB B port for PC connection.

Figure 28 — Adapter exterior view

3.3.3 USB A-B Cable

USB A-B cable is used for connection of PC and adapter (see figure 29)

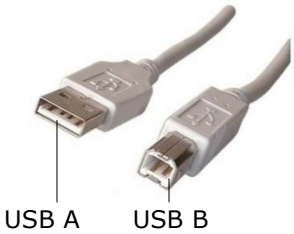
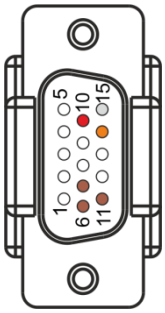
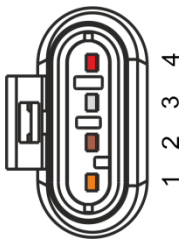


Figure 29 — USB A-B cable connectors

3.3.4 RS-485 service cable

RS-485 service cable used to connect adapter to DUT-E 485.

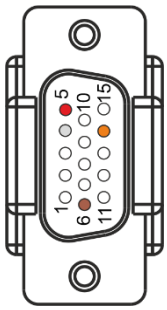
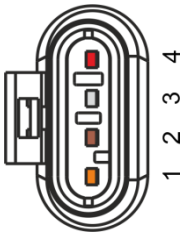
Table 10 — Pinout of RS-485 service cable connectors

View	Pin No	Wire			Signal	
		Marking	Color		Assignment	Type
	6	GND		Brown	Ground	-
	7	GND		Brown	Ground	-
	10	485B		Red	Transmitted data	Serial, RS-485 interface
	11	SEL1		Brown	RS-485 selection	Discrete
	14	VBAT		Orange	Power supply	Analog, voltage 0…50 V
	15	485A		White	Received data	Serial, RS-485 interface
	1	VBAT		Orange	Power supply	Analog, voltage 0…50 V
	2	GND		Brown	Ground	-
	3	485A		White	Received data	Serial, RS-485 interface
	4	485B		Red	Transmitted data	Serial, RS-485 interface

3.3.5 RS-232 service cable

RS-232 service cable used to connect adapter to DUT-E 232.

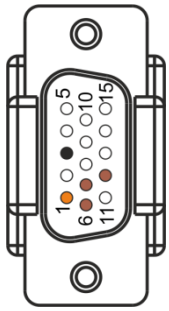
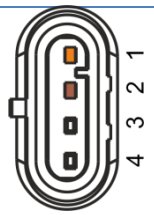
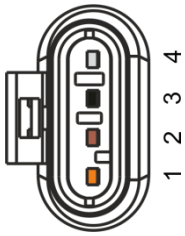
Table 11 — Pinout of RS-232 service cable connectors

View	Pin No	Wire			Signal	
		Marking	Color		Assignment	Type
	5	232T		Red	Transmitted data	Serial, RS-232 interface
	4	232R		White	Received data	Serial, RS-232 interface
	6	GND		Brown	Ground	-
	14	VBAT		Orange	Power supply	Analog, voltage 0…50 V
	1	VBAT		Orange	Power supply	Analog, voltage 0…50 V
	2	GND		Brown	Ground	-
	3	232R		White	Received data	Serial, RS-232 interface
	4	232T		Red	Transmitted data	Serial, RS-232 interface

3.3.6 AF service cable

AF service cable used to connect adapter to DUT-E AF.

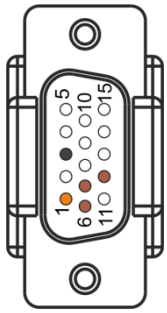
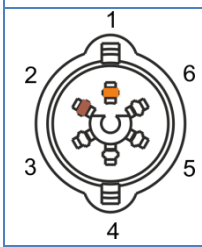
Table 12 — Pinout of AF service cable connectors

View	Pin No	Wire			Signal	
		Marking	Color		Assignment	Type
	1	VBAT		Orange	Power supply	Analog, voltage 0…32 V
	3	KLIN		Black	K-Line	Serial, ISO 14230 standard
	6	GND		Brown	Ground	-
	7	GND		Brown	Ground	-
	12	SEL2		Brown	K-Line selection	Discrete
	1	VBAT		Orange	Power supply	Analog, voltage 0…32 V
	2	GND		Brown	Ground	-
	1	VBAT		Orange	Power supply	Analog, voltage 0…32 V
	2	GND		Brown	Ground	-
	3	KLIN		Black	K-Line	Serial, ISO 14230 standard
	4	T034		White	Fuel level	Analog, voltage 0…9 V

3.3.7 CAN service cable

CAN service cable used to connect adapter to DUT-E CAN.

Table 13 — Pinout of CAN service cable connectors

View	Pin No	Wire			Signal	
		Marking	Color		Assignment	Type
	1	VBAT		Orange	Power supply	Analog, voltage 0…32 V
	3	KLIN		Black	K-Line	Serial, ISO 14230 standard
	6	GND		Brown	Ground	-
	7	GND		Brown	Ground	-
	12	SEL2		Brown	K-Line selection	Discrete
	1	VBAT		Orange	Power supply	Analog, voltage 0…32 V
	2	GND		Brown	Ground	-
	1	VBAT		Orange	Power supply	Analog, voltage 0…32 V
	2	GND		Brown	Ground	-
	5	KLIN		Black	K-Line	Serial, ISO 14230 standard

3.4 Software installation

3.4.1 USB driver installation

ATTENTION: Service adapter operation is possible only after preliminary installation of USB driver.

1) Download and unzip the file containing USB driver. Run CP210xVCPInstaller_x64.exe (for x64 architecture Windows) and or CP210xVCPInstaller_x86.exe (for x32 architecture Windows) from unzipped folder).

2) Press Next > in CP210x USB to UART Bridge Driver Installer window (see figure 30) to continue installation.

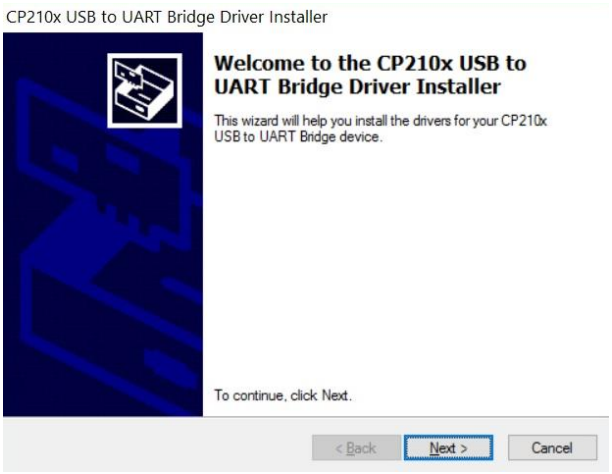


Figure 30 — CP210x USB to UART Bridge Driver Installer window

3) After accepting User License Agreement (see figure 16) the installation process will be continued. During installation, please follow the instructions of Bridge Driver Installer.

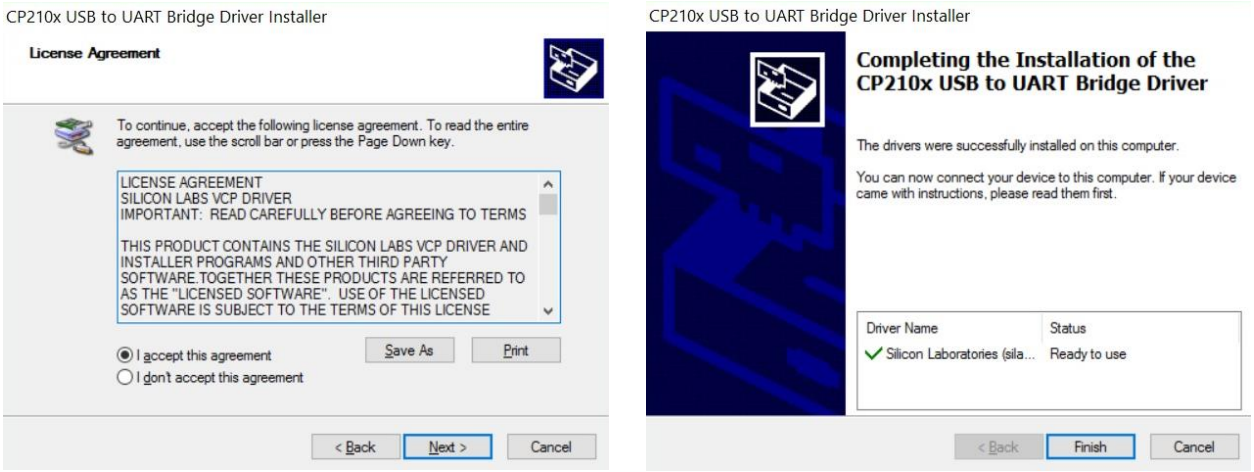


Figure 31 — Acceptance of the License agreement and successful installation notification USB driver window

3.4.2 Service DUT-E software installation

To install the software, download and run necessary installation file Setup Service DUT-E vX.XX.exe

Note — X.XX corresponds to the version of software. The latest version described in the present manual is 3.26.

Select installer language out of the drop-down list (see figure 32).

Figure 32 — Installer language selection

Click Next > button to start installation of the software (see figure 35) and follow the instructions.

Figure 33 — Service DUT-E installation wizard window

The following window will indicate the process of installation of Service DUT-E files. Since the installation of Service DUT-E software is finished PC is ready for service adapter connection and operation (see figure 34).

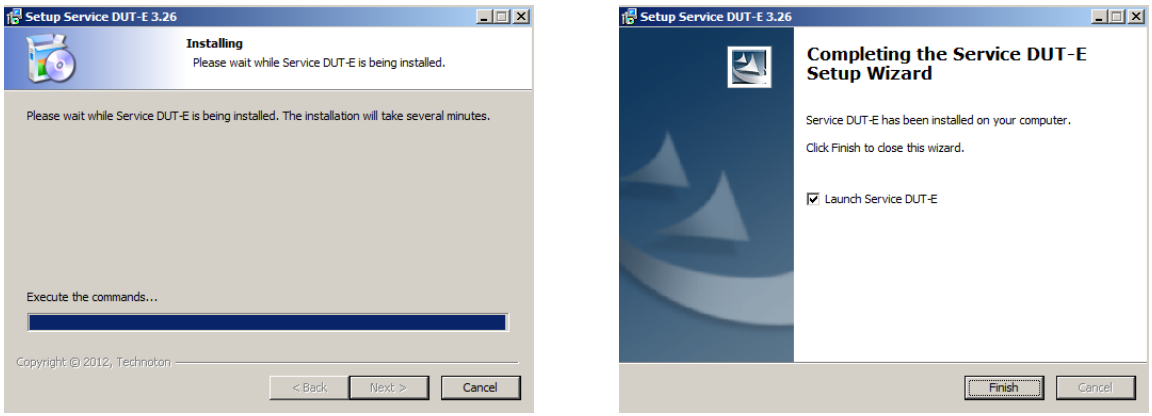


Figure 34 — Service DUT-E installation progress

3.5 Service adapter connection

3.5.1 Exterior inspection prior to connection

It is necessary to conduct service adapter exterior inspection for the presence of the possible defects arisen during transportation, storage or careless use:

- visible damages of the adapter body;
- connector and insulation damages of cables.

Contact the supplier if any defects detected.

3.5.2 Operation restrictions

Avoid the following when connecting service adapter to the sensor mounted into the fuel tank of the Vehicle:

- ingress of fuel and lubricants and moisture to the contact pins of adapter slots or connectors of cables;
- potential damage of the adapter and cables by the rotating and heating elements of the engine.

ATTENTION: To avoid any service adapter faults in communication between PC and sensor make sure there are no sources of electromagnetic interference close to the workplace (running electric motors, welding equipment, high-power transformers, power lines, etc.).

3.5.3 Connecting DUT-E to PC

ATTENTION: Power down the electrical system of the Vehicle prior to DUT-E connecting to the PC*. Use the battery switch or take off the battery contact terminals.

DUT-E sensors are connected to PC through service adapter according to the connection schemes (see figures 35 and 36).

Follow the instructions:

1) Connect adapter to DUT-E

- when using SK DUT-E the connection is carried out via service cable corresponding to model of installed sensors: RS-232/RS-485/AF/CAN (see figure 35 a-e).

Notes

1 While configuring DUT-E 232/485 it is power-supplied through USB A-B cable from USB-port.

2 While configuring DUT-E AF/CAN power supply should be additionally connected from accumulator battery or other power source.

- while configuring DUT-E CAN connected by S6 Technology, the connector of service cable from S6 SK (see figure 36 b) or SK DUT-E (see figure 35 c) should be connected to any free S6 connector. Sensor and adapter are now power supplied through S6 cabling system.

- while using S6 SK for configuration of DUT-E CAN which is not connected by S6 Technology (see figure 36 a), adapter's service cable should be connected to interface cable through connector (from delivery set of S6 SK). Power supply of DUT-E CAN and the adapter is carried out through one of free connectors.

2) Connect the adapter using USB A-B cable (when using SK DUT-E) or USB cable (when using S6 SK) to a free USB-port of your PC.

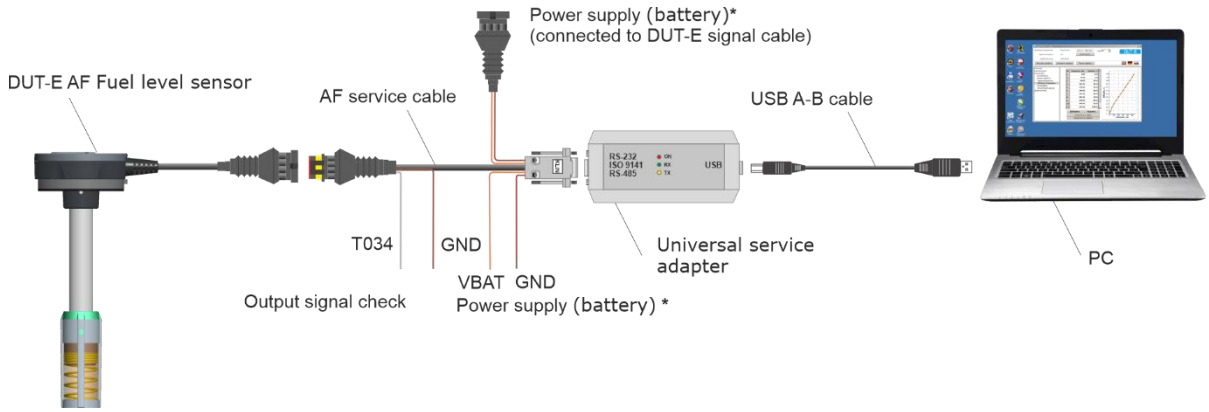
Note – it is allowed to connect adapter to USB-port of your PC after turning on power supply of sensor and running Service DUT-E software.

3) Connect power supply and ground wires to vehicle electrical system or battery.

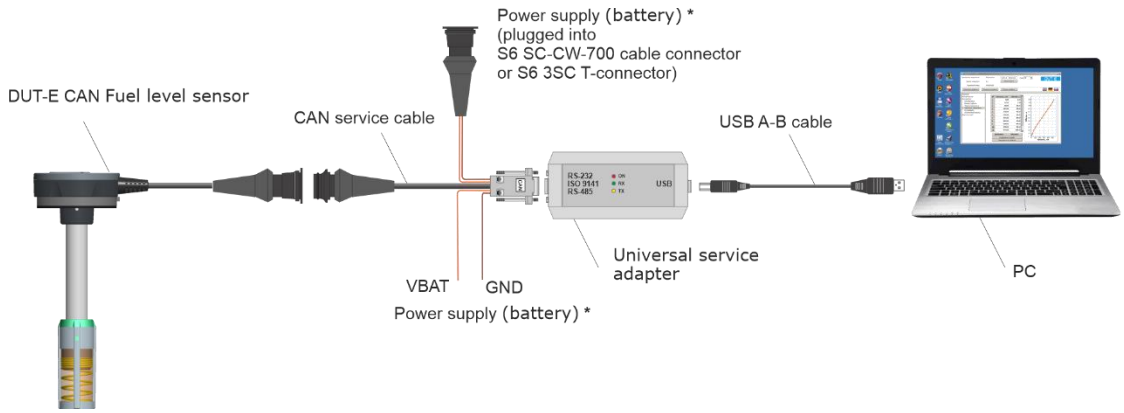
4) Power on the vehicle (battery).

---

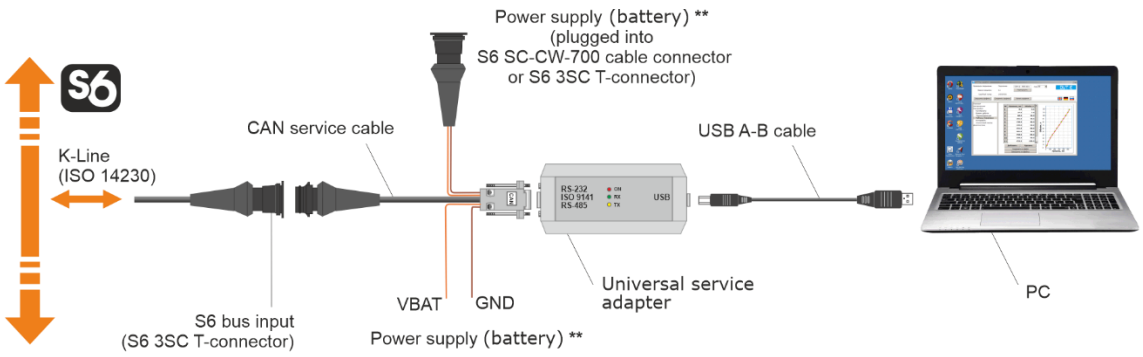
* When configuring DUT-E installed on Vehicle.
When configuring sensors connected by S6 Technology, power supply of onboard network (battery) can be turned on.



a) DUT-E AF connection



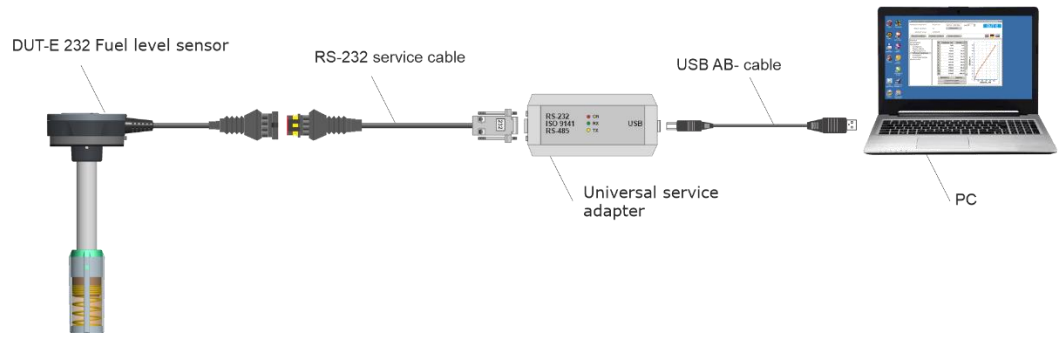
b) DUT-E CAN connection



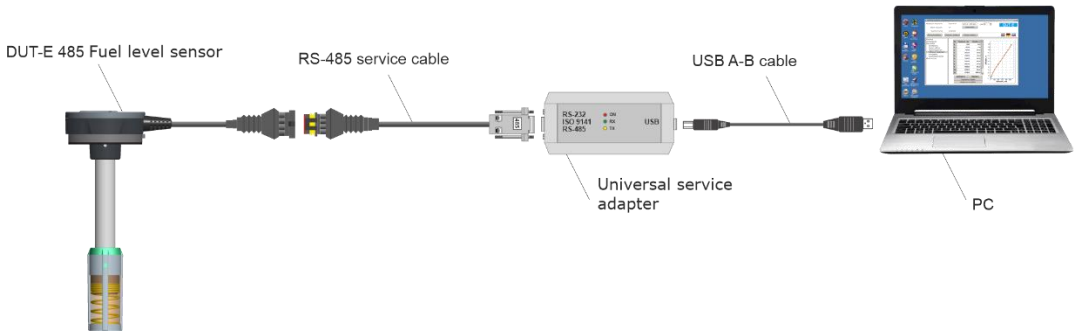
c) DUT-E CAN connection via [S6 Technology]

* For connecting power supply (battery) you can choose any of marked places.

** No need to connect. Power supply (battery) is carried out though S6 cabling system.

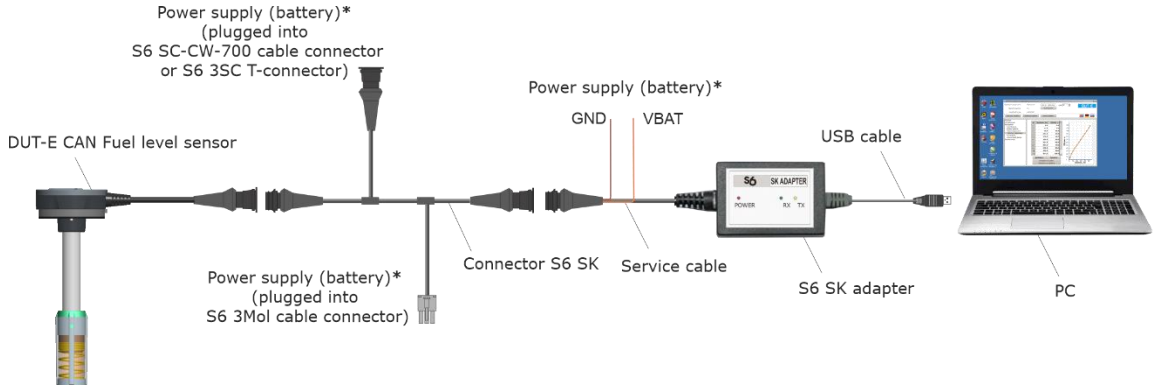


d) DUT-E 232 connection

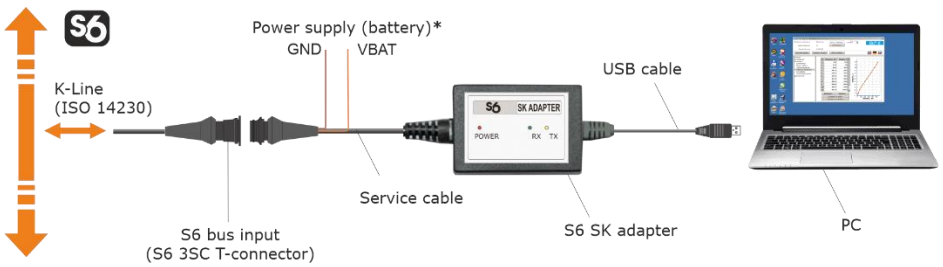


e) DUT-E 485 connection

Figure 35 — DUT-E to PC connection schemes while using SK DFM



a) DUT-E CAN connection



b) DUT-E CAN connection via S6 Telematics Interface

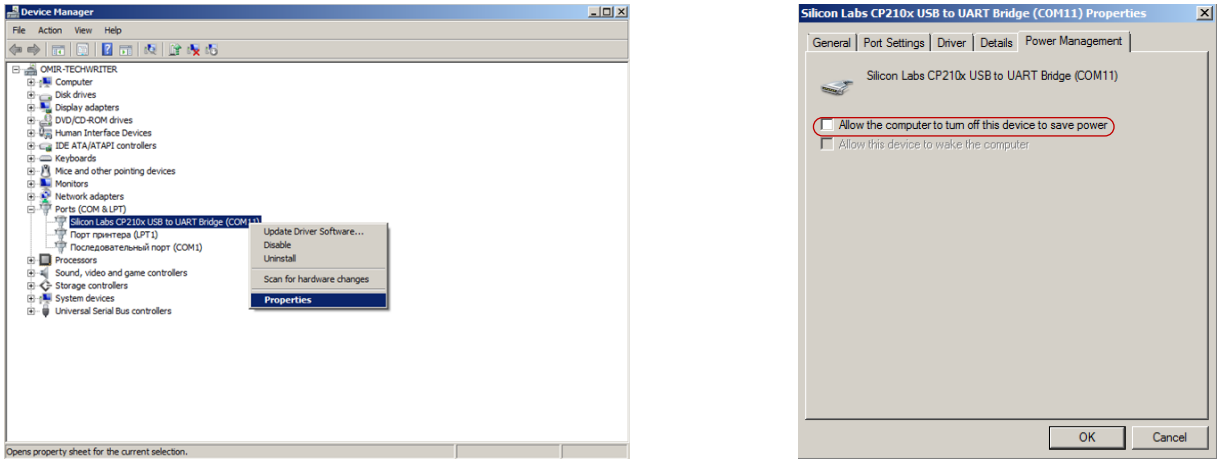
Figure 36 — DUT-E to PC connection schemes while using S6 SK

* For connecting power supply (battery) you can choose any of marked places.
** No need to connect. Power supply (battery) is carried out though S6 cabling system.

3.6 Operation test

Windows automatically detects adapter connected to PC's USB port as USB device and enables virtual COM port driver for it. The virtual COM port will be displayed in the list of ports of Windows Device manager (see figure 37).

ATENTION: It is recommended to untick power save check box for Service DUT-E in the virtual COM-port properties for energy safety purpose (see figure 37 b).



a) selecting port properties *b) disabling power save option*

Figure 37 — Virtual COM-port configuration in Device manager

Service adapter is ready to use since the power is on. See table 14 for signal description of LED indicators located on the adapter.

Table 14 – Adapter LED signals description

LED Indicator				Signal description
Marking		Status	Light color	
for S6 SK adapter	for SK DUT-E adapter			
POWER	**ON**		Red	Power supply is on
		No signal		Power supply is off (or voltage is less than minimum required)
RX			Green	DUT-E data is being received
		No signal		No data from DUT-E
TX			Yellow	Data is being transmitted to DUT-E
		No signal		No data to DUT-E

3.7 Software launch

Service DUT-E software is launched with 

desktop shortcut created during installation.

To enable connection between the sensor and PC connect adapter to USB port of PC and tick connection checkbox in the left from COM-port parameters field.

Note — when connecting DUT-E CAN/AF firstly select network address from the drop-down list ADDR (see figure 38).

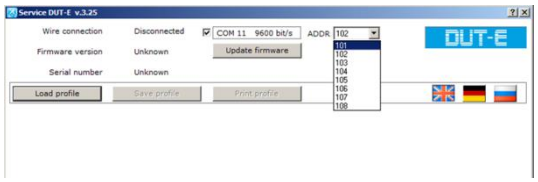


Figure 38 — Network address selection for DUT-E CAN/AF

Software will automatically change the connection status to "Connected". Firmware version, serial number of the DUT-E sensor, virtual COM port number will be displayed as well as baud rate for RS-232, RS-485 or K-line connection (see figure 39). LED indicators of the adapter will display signals according to table 14.

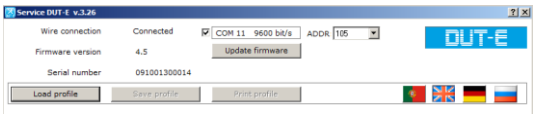


Figure 39 — Service DUT-E main window with sensor connection established

3.8 User interface and initial setup

Service DUT-E user interface consists of **Horizontal menu**, **Vertical menu**, **Connection status area** and **Information and configuration area** (see figure 40)

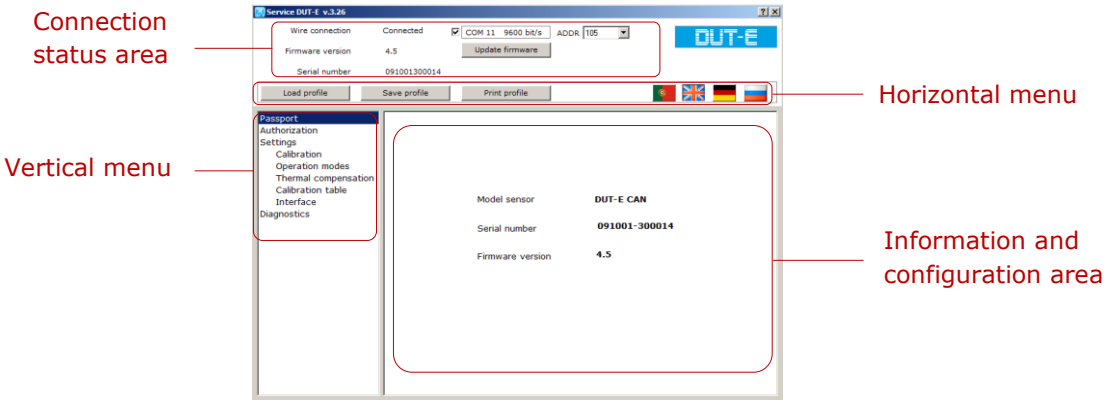


Figure 40 — Service DUT-E user interface

The top left area is **Connection status area** which displays current connection status of the sensor (Connected/Disconnected), firmware version and serial number of the connected DUT-E sensor, network address selection drop-down list (ADDR) and firmware update button.

Note — network address selection drop-down list (ADDR) is not displayed when DUT-E 232/485 connected.

Horizontal menu located under Connection status area provides following options:

- profile options (loading profile, saving profile, printing profile);
- selection of interface language.

Vertical menu is located at the left side of the window and used for selection of sensor profile entries which are displayed in **Information and configuration area** at the right side of the window. Vertical menu also contains Diagnostics and Fuel tank calibration entries.

The only initial setting required is selection of user interface language.

3.9 Operations with DUT-E profile

Service DUT-E software is designed for managing DUT-E sensor profile (hereinafter profile).

Profile is combination of specification data, configurations and settings of DUT-E sensor and vehicle it is mounted on.

Software can operate profiles in both DUT-E connected and autonomous modes. In autonomous mode, previously saved profiles can be loaded and modified.

ATTENTION: The following Service DUT-E operation description is compiled for DUT-E connected mode. While in autonomous mode of Service DUT-E some features and options are not available.

Profile can be saved as a file on PC's hard drive or saved to internal memory of connected DUT-E or printed if this is required.

3.9.1 Load profile

The following options of profile loading are available on Load profile button click (see figure 41):

- from disk;
- default;
- from sensor.

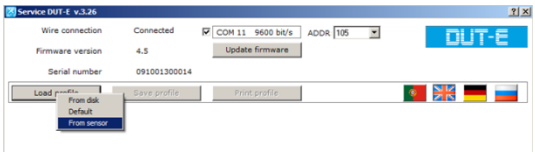


Figure 41 — Profile loading

Previously saved profile can be loaded from hard drive or removable disk when **From disk** option is selected.
Profile with default DUT-E settings is loaded when **Default** option is selected. This profile lets the user to get acquainted with software without establishing sensor connection.
Profile of the connected DUT-E sensor is loaded when **From sensor** option is selected.

ATTENTION: File extension of DUT-E profile is ***.dpf**

3.9.2 Save profile

The following options of profile saving are available on Save profile button click (see figure 42):

- to file;
- to sensor.

a) selection of saving option *b) profile saved*

Figure 42 — Saving profile

Select file location and enter file name when saving profile **To file**. The saved profile can be uploaded to any other DUT-E sensor of the same modification.

All the setting modifications will be saved to sensor's internal memory when saving profile **To sensor.**

The software will prompt authorization dialogue (see 3.10.2) on saving profile to sensor or on calibration if user has not been yet authorized (see figure 43).

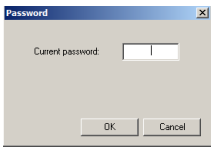
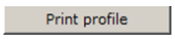


Figure 43 — Password request

Note — default password for DUT-E sensors is **1111**. It is stated in sensor specification in factory settings list.

3.9.3 Print profile

This feature converts loaded profile into HTML document.

After clicking 

button select location for saving of ***.html** file with sensor profile data. Then this file can be viewed or printed.

See annex E for DUT-E profile printed copy example.

RECOMMENDATION: It is recommended to attach profile hard copy to sensors Specification for further tracking of setting modifications made for particular sensor.

3.10 Vertical menu description

3.10.1 Passport

When the profile is loaded from the connected sensor **Passport** entry shows the following information on connected DUT-E (see figure 44):

- sensor model;
- serial number;
- firmware version.

This data cannot be edited by the user. Serial number and firmware version is also displayed at connection status area of the window.

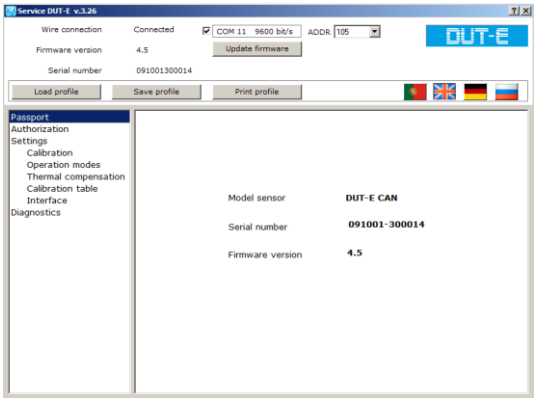


Figure 44 — Passport module

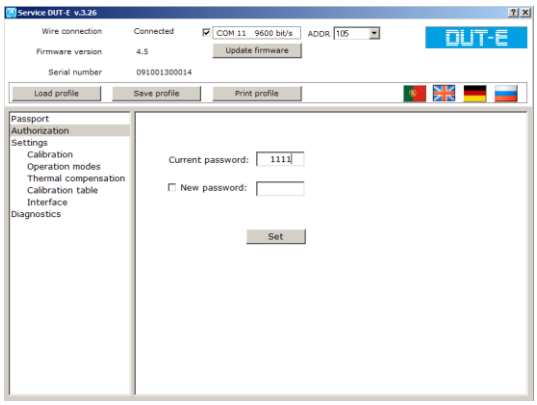
3.10.2 Authorization

Authorization module provides access to DUT-E settings modification.

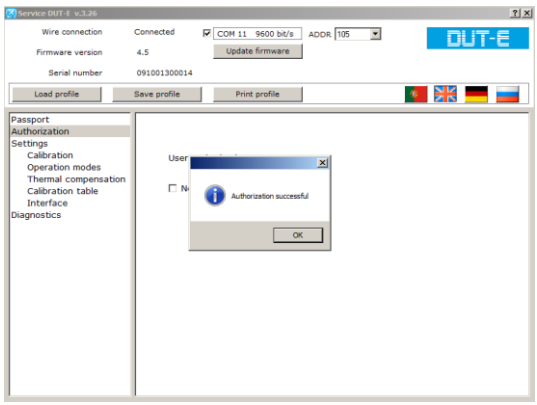
Service DUT-E users can be divided into two groups:

- guest — can view DUT-E settings but cannot modify them;
- specialist — can view and modify DUT-E settings.

Unauthorized user has guest rights. To get specialist rights user should log in with current password and click Set button (see figure 45).



a) authorization with current password

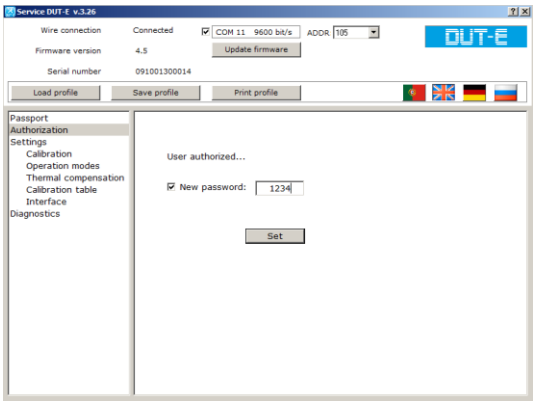


b) successful authorization notification

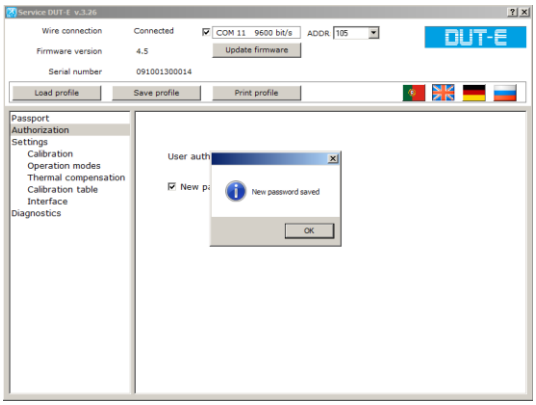
c) invalid password notification

Figure 45 — User authorization

To set new password enter current password, tick new password box, enter new password and click Set button (see figure 46).



a) entering new password



b) confirmation of successful password modification

Figure 46 — Setting new password

ATTENTION:
Contact Technoton technical support at support@technoton.by if the password is lost.
Requirements for password recovery request:
- scan copy of the request signed and sealed by the official representative of the company the sensor been purchased by should be attached;
- request should contain serial number and manufacture date of the sensor;
- email should contain password recovery code in a text form (not a screenshot!);
- email should contain full name and contact e-mail of a person who should receive the recovered password.

To generate password recovery code (see figure 47) use **Ctrl+F10** shortcut in the current password field of authorization dialogue (see figure 45 a).

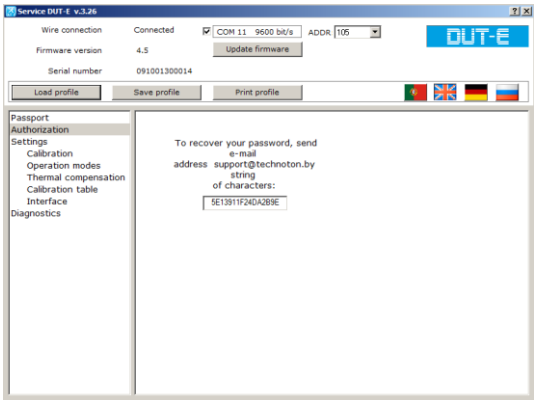


Figure 47 — Generating password recovery code

3.10.3 Settings - Calibration

Calibration is required for correct operation of DUT-E. Calibration is conducted to determine minimum and maximum levels of measurement of fuel in the tank.

ATTENTION: All DUT-E sensors are factory calibrated! Re-calibration is needed **only after the cutting/extension** of the sensor measuring probe.

To calibrate minimum and maximum level follow the procedure:

1) Get the measuring probe (tubes) out of the fuel.

2) Wait for 30…60 seconds so that all the fuel run off the probe.

3) Measure the probe length **L (mm)** from the edge to the drain holes (see figure 48 a).

4) Enter the value into **Actual length of sensor after trimming** field of Settings-Calibration entry (see figure 48 b).

5) Wait for 3…5 seconds for sensor readings stabilization.

6) Click Set empty for minimum level calibration.

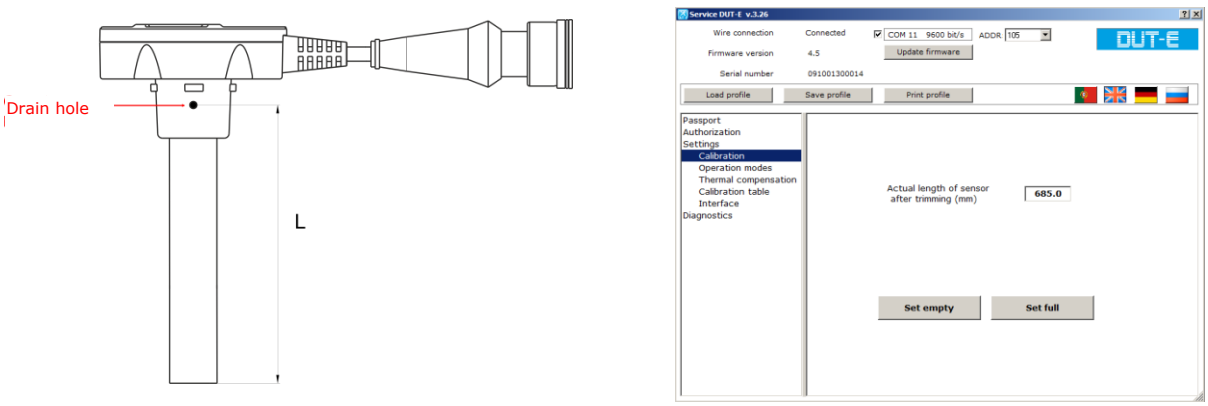
ATTENTION: When calibrating sensor to minimum level, there should not be fuel residues on surface of tubes of probe.

7) Dip the probe's tubes fully into the fuel.

8) Wait for 3…5 seconds for sensor readings stabilization.

9) Click Set full for maximum level calibration.

10) Min/max calibration is finished.

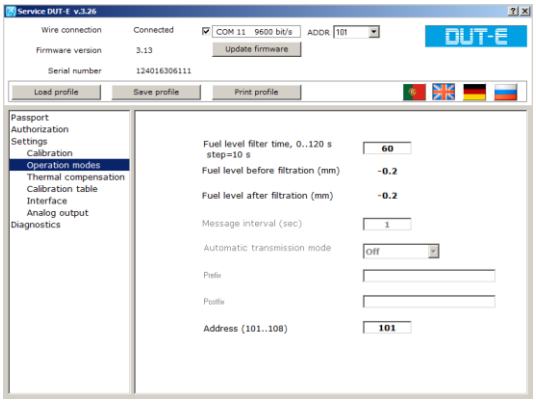


a) measuring probe length *b) Settings-Calibration entry*

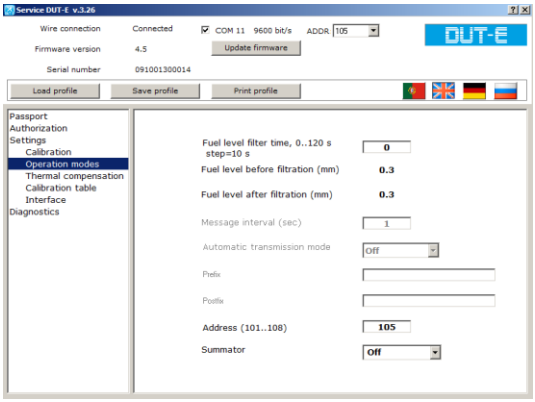
Figure 48 — DUT-E min/max calibration

3.10.4 Settings – Operation modes

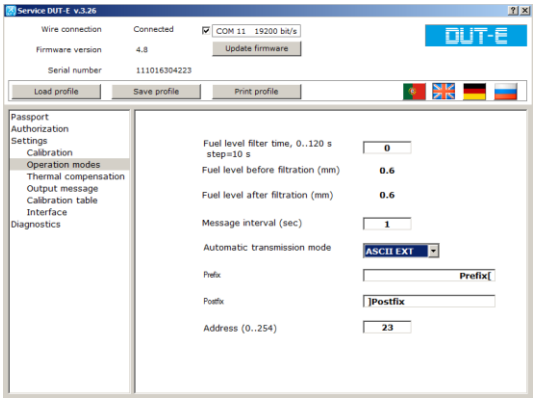
Operation modes entry contains settings to configure sensor for operation in particular conditions with compliance of tracking device requirements (see figure 49).



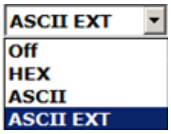
a) DUT-E AF



b) DUT-E CAN



c) DUT-E 232/485



d) Automatic transmission mode drop-down list

e) Summator mode drop-down list

Figure 49 — Operation mode configuration

1) Fuel level filter time — time interval preceding the data transmission. Fuel level value is smoothed during this interval. Thus, fuel level value transmitted by sensor to the tracking device is not instantaneous and is averaged over a certain period of time.

Parameter value range is 0…120 seconds with 10 second step. Default value is 60 seconds.

Setting this parameter is very important for DUT-E mounted on vehicles operated on hilly surfaces.

2) Message interval* — time period the sensor automatically send output message to the tracking device.

Parameter value range is 1…255 seconds with 1 second step. Default value is 1 second.

3) Automatic transmission mode* – defines sensor output message type:

- **Off** - no automatic message transmission, sensor waits for tracking device request;
- **HEX** - automatic message transmission in binary format (used by default);
- **ASCII** - automatic message transmission in text format;
- **ASCII EXT** - automatic message transmission in extended text format. Additional **Prefix** and **Postfix** configurable parameters are available for this mode to insert required header or ending of the message.

4) Address **** - provides DUT-E with network address when several operate via single bus (network). The following addresses are set by the Manufacturer by default:

- DUT-E 485 - two last digits of the sensor serial number;
- DUT-E CAN/AF - 101.

5) Summator*** — sets sensors network status when working in CAN summator mode (see figure 49 e):

- **Off** - no need to summarize sensor values (default value);
- **Master** - should be selected for a sensor which has the highest decimal address in the network;
- **Slave** - should be selected for all the other network sensors.

---

* Only for DUT-E 232/485.
** Only for DUT-E AF/CAN/485.
*** Only for DUT-E CAN.

3.10.5 Settings – Thermal compensation

Temperature extension/shrinking of fuel cause by change of its temperature, leads to change of fuel volume in fuel tank. As result – sensors transmit to tracking/monitoring unit information on rising/lowering fuel level.

DUT-E makes recalculation of fuel level – automatic temperature correction, which recoups temperature extension/shrinking of fuel.

By default, temperature correction function is turned off. To turn it on, tick the box **Thermocorrection**. In the field, which will appear next to the box, pleas enter thermal compensation coefficient (see figure 50).

Thermal compensation coefficient $K_{ther.corr.}$ is determined by formula (1):

$$K_{ther.corr.} = (-1) \cdot \frac{(V_{max} - V_{min}) \cdot 100}{(T_{max} - T_{min}) \cdot V_{min}} \quad (1)$$

where T_{min} and T_{max} — respectively the minimum and the maximum measured values of fuel temperature in the tank during 24 hours;

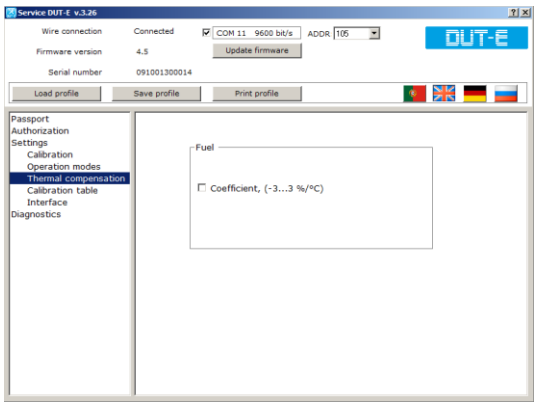
V_{min} and V_{max} — measured values of fuel volume in the tank with minimum and maximum fuel temperature respectively.

IMPORTANT:

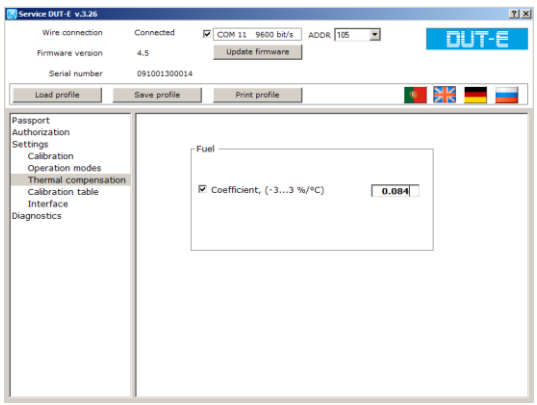
1) It is recommended to determine Values V_{min}, V_{max}, T_{min}, T_{max} by data on Server.

2) When measuring values V_{min}, V_{max}, T_{min}, T_{max} during 24 hours follow the requirements:

- Vehicle is not moving with engine off.
- Ambient temperature should correspond to normal operating conditions of the Vehicle.
- Tank should be filled with fuel not less than 10 % of the total fuel volume.
- There should be the same fuel volume in the tank (refueling or draining is not allowed)



a) disabling the feature



b) inserting coefficient

Figure 50 — Thermal compensation setting

3.10.6 Settings – Output message

One of the following output value types available for DUT-E 232/485 (see figure 51):

- fuel level in standard (normalized) units (0...1000);
- fuel level in millimeters (mm), 0.1 mm step;
- fuel volume in liters (L), 0.1 l step;
- fuel volume in percentage (%), 0.4 % step.

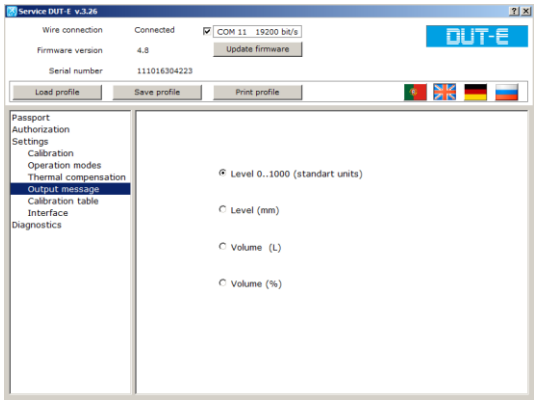


Figure 51 — Selection of output value type for DUT-E 232/485

3.10.7 Settings – Calibration table

This submenu is used for storing calibration table for particular Vehicle into sensor's internal memory. The sensor will recalculate level of fuel into volume of fuel on the basis of this table.

ATTENTION: Without storing calibration table into sensor's memory DUT-E CAN/AF/232/485 will show incorrect data on fuel volume in liters, DUT-E CAN/232/485 show incorrect data in percentage.
When summarizing signals from several DUT-E CAN/AF/232 it is obligatory to store calibration table into each sensor.

Calibration table is based on values, received when performing **tank calibration**. This procedure consists of refilling fuel tank with certain portions of fuel from empty to full state (see video Installing fuel level sensor).

IMPORTANT: to measure volume of fuel portions used to refill fuel tank, use containers with accuracy error not more than 0.25 %.

To make tank calibration properly, please, follow the instructions:

- vehicle being equipped should not be loaded and should be parked on even horizontal surface;
- fuel tank should be empty;
- vehicle's tires should by of standard size and type for this model;
- pressure in tires should be within allowed range for this model;
- vehicle should not move, ignition is turned on, engine not running;
- between to consequent tank refilling operations, please, wait at least 60 seconds.

The data is entered as a table of correspondence between measured fuel level value (**Level (mm)** field) and fuel volume in the tank (**Volume (l)** field). Recommended number of table entries is 15. Max possible is 30 entries (see figure 52).

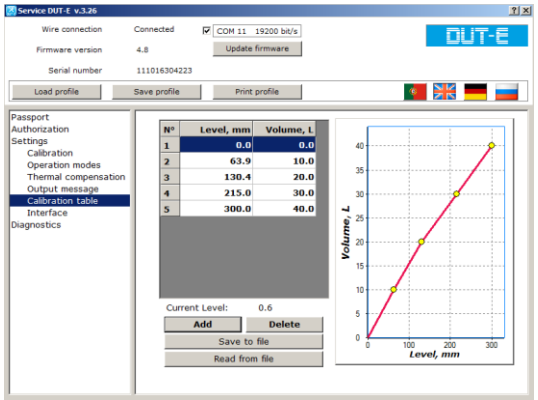


Figure 52 — Calibration table

ATTENTION:
1) The number of calibration points is proportional to the measurement accuracy of fuel volume. The recommended number of calibration pints is not less than 15. You may add altogether **30 points** into the calibration table.
2) The maximum possible fuel volume value that can be added into the calibration table is **6556 l**.
3) For DUT-E CAN, you can enter into the calibration table the point with the maximum fuel level value not more than **3000 mm**.

Click Add button to insert a new entry into the table and fill out the fields. Entries are automatically sorted from low to high fuel level value. To delete an entry highlight it and click Delete button.
Clicking Save to file button will allow saving the table as a ***.ttd** file. To load previously saved table from file click Read from file button.

RECOMMENDATION: After the sensor mounting in the tank, the end of its measuring probe is located at a distance of 20…30 mm from the tank bottom. Some 10…30 l of the remaining fuel which is not consumed is usually left in this dead zone which is not accessible for monitoring. While creating the calibration table, we recommend to enter for its first point (level of 0.0 mm) the value of the fuel volume which is equal to the volume of not consumed fuel remaining in the tank.

3.10.8 Settings - Interface

Interface module (see figure 53) provides selection of baud rate for RS-232 (for DUT-E 232), RS-485 (for DUT-E 485) and K-line (for DUT-E CAN/AF) connections out of drop-down list:

- 4800 bit/s;
- 9600 bit/s;
- 19200 bit/s.

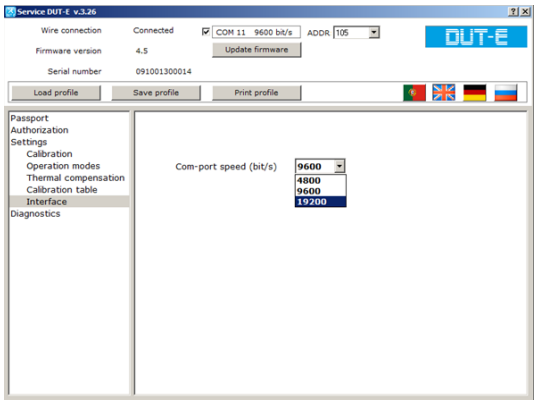
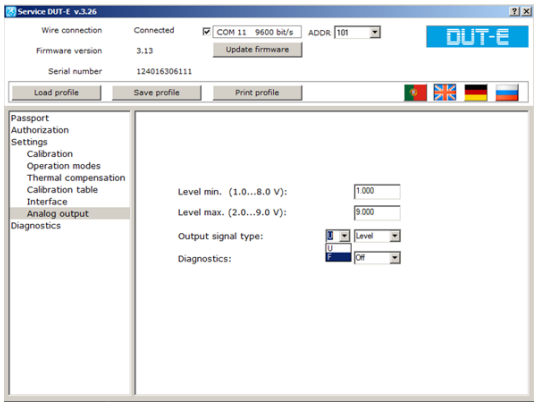


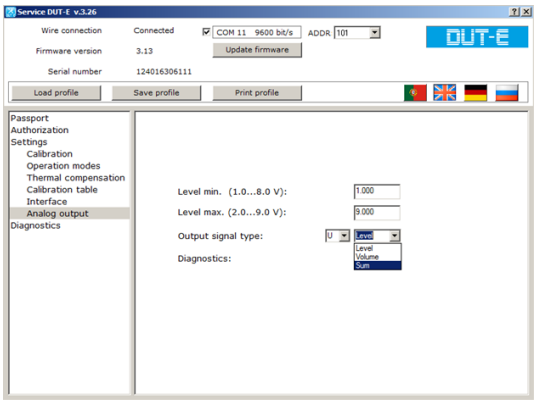
Figure 53 — Interface setting

3.10.9 Settings – Analog output

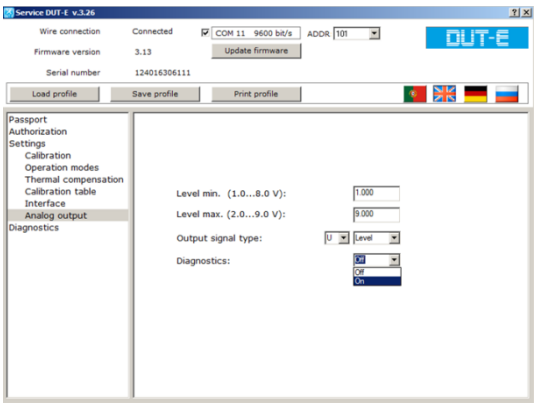
Analog output* module of Service DUT-E used for configuration of DUT-E AF output voltage range according to the voltage range of the tracking device input (see figure 54).



a) selection of signal type



b) value type selection



c) enabling diagnostics values of output signal

Figure 54 — DUT-E AF output configuration

The first drop-down list is for selection of **Output signal** according to 1.4.2:

- **U** (voltage);
- **F** (frequency).

The second drop-down list for configuring value type:

- **Level** (fuel level in the tank);
- **Volume** (fuel volume in the tank);
- **Sum** (totalizing readings of several sensors according to 2.8.2).

***** Only for DUT-E AF.

To configure analog output, follow the instructions:

1) Enter value of the lower range limit into **Minimum level (1.0…8.0 V)** field.

2) Enter value of the higher range limit into **Maximum level (2.0…9.0 V)** field.

Diagnostics drop-down list (see figure 54 c) allows to enable/disable special output signal diagnostics values:

- **On** — for **U** mode 0.5 V and 9.5 V voltage are diagnostics values according to table 20. For **F** mode 400 Hz and 1600 Hz frequency are diagnostics values according to table 21.
- **Off** — special diagnostics output values are disabled. Default setting.

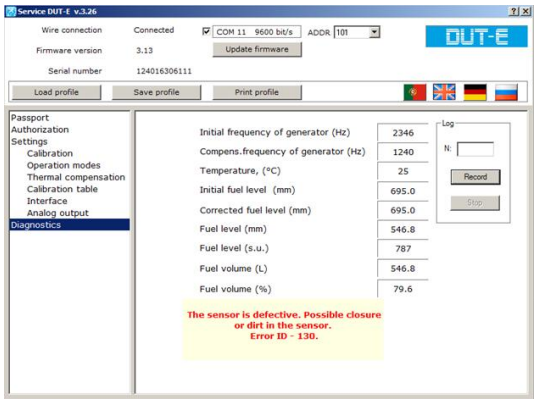
3.10.10 Diagnostics

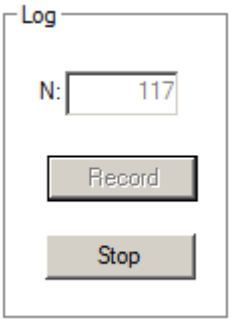
Diagnostics module is used to view the current values and information on possible malfunction of the sensor (see figure 55 a).
Values displayed in **Fuel level (mm)** can be used for fuel tank calibration.

Analyzing the values of the parameters (fuel level in millimeters, standard units and liters) the correctness of the calibration and sensor settings can be verified.
Diagnostics tab will display the following information if there any malfunction:

- malfunction code;
- transcript of the malfunction code;
- possible malfunction reason.

DUT-E COM Protocol includes malfunctions codes according to table 17.





a) displaying current values and malfunction info *b) logging current values*

Figure 55 — Diagnostics module

For analysis of sensor data, it is possible to log the values into the file. Recording interval is about 1 second. To log data, enter quantity of required log entries into **N** field of **Log** area and click Record. Click Stop to stop logging.
Recorded log files **(*.txt)** are automatically stored to **\DUT_LOG** folder of the software installation directory on PC. File name consists of sensor serial number, date and time of log start.
See annex F for a log file example.

Table 17 — Malfunction codes

Malfunction code		Transcript of the malfunction code	Possible solution
Firmware version up to 2.9	**Firmware version 2.9 and higher**		
255	128 (-128)*	Calibration error	Check if the measuring probe actual size value is inserted correctly and (or) recalibrate the sensor**
254	129 (-127)*		
253	130 (-126)*	Short circuit in measuring probe tubes	Wash the measuring probe tubes with clean fuel, clean fuel tank of mud and water
252	131 (-125)*	Calibration error	Check if the measuring probe actual size value is inserted correctly and (or) recalibrate the sensor**
251	132 (-124)*	Hardware failure	Contact your supplier
250	133 (-123)*	Calibration error	Check if the measuring probe actual size value is inserted correctly and (or) recalibrate the sensor**
—	134 (-122)*		

***** Different malfunction code display.

****** Fuel tank calibration table should be recompiled and recorded all over again into sensor internal memory.

3.11 Firmware update

ATTENTION: DUT-E firmware update should be done **only** to apply changes recommended by the Manufacturer.

DUT-E firmware update procedure is started on Update firmware button click. The button is located at Connection status area of Service DUT-E window (see figure 56).

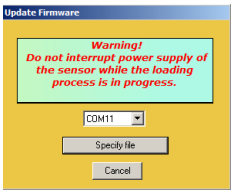


Figure 56 — Firmware update window

To cancel firmware update click Cancel button. To continue with firmware update, click Specify file and select firmware file **(*.cod)** from the PC hard drive (see figure 57).

Figure 57 — Opening firmware file

ATTENTION: Check the details of firmware file to make sure it matches DUT-E modification!

Enter sensor password into the prompted dialogue window (see figure 58).

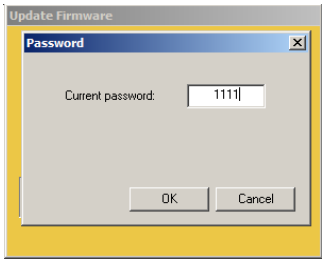


Figure 58 — Password request window

Firmware update process can last for several minutes (see figure 59).

ATTENTION:
Before the end of the update process it is **forbidden** to
1) Disconnect DUT-E from the adapter.
2) Disconnect adapter from the PC.
3) Power down the PC.
4) Run any resource-intensive applications on the PC.

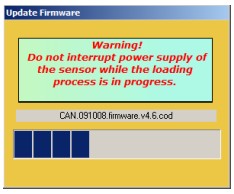


Figure 59 — Firmware file uploading to the sensor memory

Service DUT-E will display the new firmware version at Connection status area in case the update is successful. DUT-E is ready for further operation.

In case of any error occur check all the cable and adapter connections and retry. Contact Technoton technical support at support@technoton.by if another try is also unsuccessful.

3.12 Software shutdown and DUT-E disconnection

When configuration is made follow the instructions to disconnect DUT-E:

1) Save modified profile if necessary (see 3.9.2).
2) Shutdown Service DUT-E software clicking  at the top left corner of the window.
3) Power down vehicle electrical system if the sensor is powered from it or switch off power supply of the sensor*.
4) Disconnect DUT-E service cable from the sensor connector.

Adapter can now be used for the next sensor connection (see 3.5.3).

* This step is only applied for DUT-E CAN/AF.

4 Measurement accuracy check

4.1 Basic principles

DUT-E accuracy check test is conducted to determine the reduced and absolute error of fuel level measurement on the particular Vehicle.

The procedure of DUT-E accuracy check requires filling/draining of the fuel tank and comparing sensor data with the actual amounts of filling/draining.

Fuel drain is carried with manual or mechanical pump.

Calibrated measuring containers must be used to determine the exact amount of drained/refilled fuel.

ATTENTION: The amount of any fuel filling/draining during the accuracy test should not be less than 20 % of total tank capacity.

4.2 Check tests procedure

Check tests should be carried out in the following order:

1) Turn ignition on.

2) Drain a fixed volume of fuel.

3) Determine the exact amount of fuel with the calibrated measuring container.

4) Record the data into the Check test report.

5) Wait for the fuel getting still in the tank (for a stable DUT-E readings).

6) Refuel the tank with the previously drained fuel.

7) Record the data into the Check test report.

8) When analyzing accuracy errors, "Drain" and "Refill" parameters are estimated as a percentage relative to the total tank capacity.

See annex A for check test report template and error calculation formula.

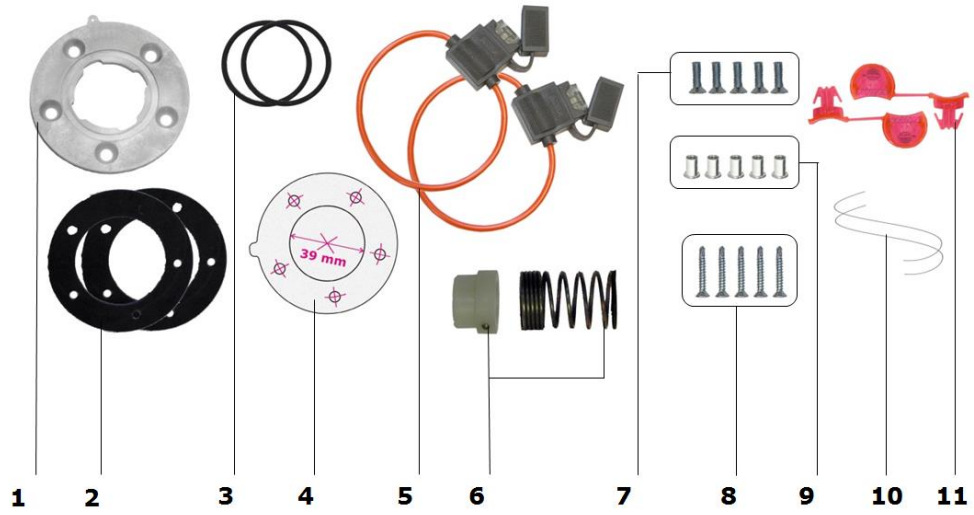
5 Accessories

Technoton offers **high quality accessories** for mounting, connection and operation of DUT-E sensors.

5.1 MK DUT-E mounting kit

DUT-E mounting kit (hereinafter MK DUT-E) is used for sensor mounting into the fuel tank of vehicle or stationary tank. MK DUT-E is included into DUT-E delivery set. Extra mounting kits can be ordered separately if required. DUT-E sensor is mounted quickly and accurately with MK DUT-E. See figure 60 for MK DUT-E components.

Mounting plate with SAE 5 bolt standard bore position can be preordered.



1	- plastic mounting plate	– 1 pc.;
2	- rubber gasket	– 2 pcs.*;
3	- sealing rubber ring	– 2 pcs.*;
4	- hole placement template	– 1 pc.;
5	- fuse with holder (2 A)	– 2 pcs.;
6	- bottom stop	– 1 pc.;
7	- bolt	– 5 pcs.;
8	- self-tapping screw	– 5 pcs.;
9	- threaded rivet	– 5 pcs.;
10	- sealing cord	– 2 pcs.;
11	- plastic seal	– 2 pcs.**

Figure 60 — MK DUT-E mounting kit

* 1 pc. – used for DUT-E installation and 1 pc. is a spare part.
Could be complemented with 4 mm thick gasket.

** Exterior of seal can be different.

5.2 US-1 adapter unit

In case DUT-E is mounted as a replacement of the factory installed float sensor the fuel gauge in the vehicle cabin does not operate any more. To enable the fuel gauge working with DUT-E US-1 adapter unit is used (see figure 61)

ATTENTION: Adapter unit can only operate with DUT-E A5 or DUT-E AF with 1.5…4.5 V configured output signal.

Table 18 — Adapter unit modifications

Order code	Description
US-1-90	Fuel level sensor emulation with low resistance: 0…90 Ohm. When fuel level increases, resistance increases as well
US-1-800	Fuel level sensor emulation with high resistance: 800…185 Ohm. When fuel level increases, resistance decreases

Figure 61 — US-1 adapter

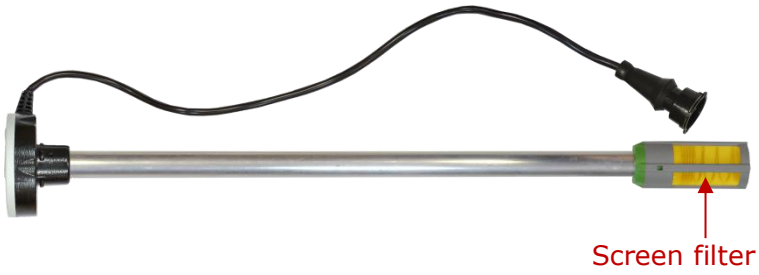
Electrical connection of US-1 is carried out in compliance with wire assignment according to Table 19.

Table 19 — US-1 wires assignment

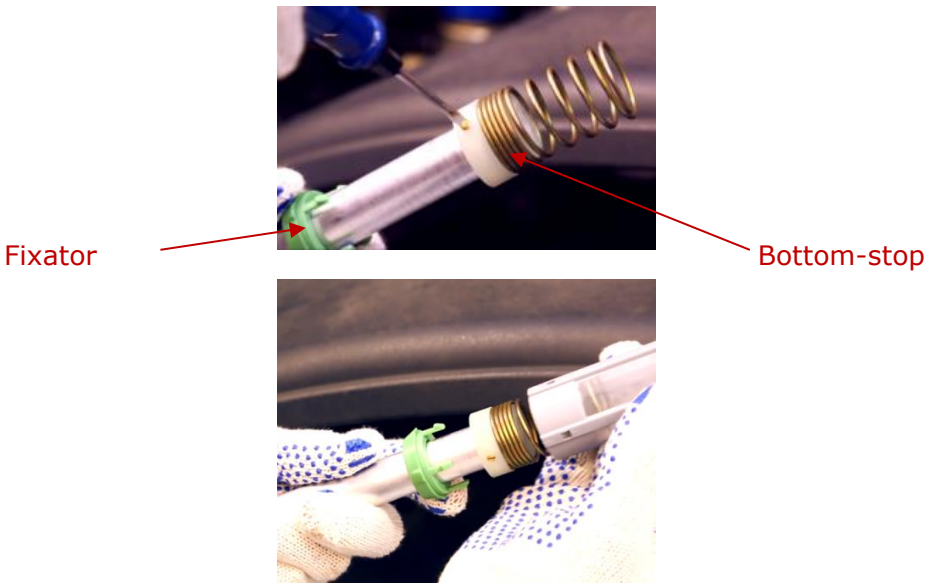
Wire number	Wire marking	Wire color*		Assignment
1	T034	White		Fuel level sensor signal (input)
2	GND	Brown		Ground
3	T734	Pink		Fuel level indicator (output)
4	T733	Pink		Fuel level warning lamp (output)
5	VBAT	Orange		Power supply “+”
* The Manufacturer reserves the right to change wire colors.				

5.3 Screen filter

The screen filter which is mounted at the end of DUT-E measuring probe (see figure 62 a) is designed to protect its electrodes from water and mud. This allows to significantly enhance the sensor service life (see DUT-E screen filter video).
Screen filter mounting order: firstly, put on fixator, then put on bottom stop and fix it with two side screws. Put the screen filter over bottom stop and fasten it with a fixator locks. (see figure 62 b).



a) mounting location



b) mounting order

Figure 62 — Screen filter

ATTENTION: Screen filter cannot be used without installed bottom spring stop.

5.4 Connection cables

The following connection cables are used for DUT-E electrical connection (table 18).

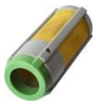
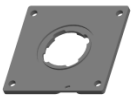
Table 18 — DUT-E connection cables

View	Indication (order code)	Function and description
	Cable 076-01 (sensor cable)	To connect sensors to recording and display units and to external power supply. Length – 7.5 m
	Cable 084 (extension for cable 076-01)	To extend the length of 076-01 cable. Length – 3 m
	Cable DUT-E-232/485 (sensor connection cable)	To connect the sensors to recording and display units and to external power supply. Length – 7 m
	RS 2AMP-300 (232/485 cable extender)	To extend the length of cable DUT-E-232/485. Length – 3 m
	RS 2AMP-1000 (232/485 cable extender)	To extend the length of cable DUT-E-232/485. Length – 10 m
	S6 SC-CW-700 (cable)	To connect DUT-E CAN sensors to recording and display units and to external power supply. Length – 7 m

5.5 Additional accessories

Additional accessories may be required for DUT-E mounting on a Vehicle (see table 19).

Table 19 — DUT-E Additional accessories

View	Name	Description	Application
	Filter DUT-E	Screen filter	For protecting electrodes (tubes) against water and mud in tanks' bottom
	Catch DUT-E	Bottom-stop	To enhance sensor mounting rigidity
	FTP DUT-E	Fuel tank plug	Bayonet plug for temporary sensor replacement
	Plug	Plug for sensor mounting hole	To plug fuel tank opening
	DUT-E WP-11	Adaptor plate with 4 holes	To mount the sensor in the tank in the place for the Omnicomm sensor
	SAE 5 bolt	Mounting plate	Mounting plate with SAE 5 bolt standard bore position
	DUT-E FP CT	Mounting plate for barrel-shaped tanks	Mounting plate for sensors installation on barrel-shaped fuel tanks
	DUT-E TAM-d105	Mounting plate	Special duralumin mounting plate for 6 screws
	DUT-E WP-10	Wedge-shaped fastening plate	Fastening plate for sensors installation on fuel tanks with inclined surface (10-degree angle)

6 Diagnostics and troubleshooting

In case of any malfunction first of all examine condition of Vehicle power supply system and power supply pins condition of the DUT-E connector.

WARNING:
1) Severe contact corrosion of chassis ground connection switch or its malfunction can seriously affect DUT-E output signal.
2) DUT-E readings will be invalid if the measuring tubes are closed by conducting mud or water.

6.1 DUT-E with analog output

Normal operation of analog DUT-E sensors can be verified with a multimeter by measuring their output voltage (for DUT-E AF/A5/A10) or current (for DUT-E I) and comparing the measurement results with the data of table 20.

Table 20 — Analog DUT-E malfunctions

Output signal value	Malfunction reason	Solution
Voltage: from 1 to 9 V (for DUT-E AF) from 0.4 to 5.0 V (for DUT-E A5); from 0.4 to 10.0 V (for DUT-E A10) Current: 2…22 mA (for DUT-E I)	No malfunctions, normal operation	Check tracking device operation
Voltage: from 9.5 to 10 V (for DUT-E AF) over 5 V (for DUT-E A5); over 10 V (for DUT-E A10) Current: Over 22 mA (for DUT-E I)	Short circuit of the measuring probe tubes due to metal shavings and burrs, conductive mud or water at the bottom of the fuel tank	Eliminate short circuit, wash the tubes of the sensor, clean the fuel tank
Voltage: from 0.5 V and less (for DUT-E AF) less than 0.4 V (for DUT-E A5 and DUT-E A10) Current: less than 2 mA (for DUT-E I)	Sensor is not calibrated*	Calibrate the sensor*
	Sensor PCB failure	Contact the closest service center
* Only for DUT-E AF		

Diagnostics of DUT-E AF can be carried out with service adapter the same way as for other DUT-E modifications having digital output (see 6.3).

6.2 DUT-E with frequency output

Normal operation of frequency DUT-E can be verified with frequency meter by measuring output sensor frequency and comparing results of measurements with the data in table 21.

Table 21 — Frequency DUT-E malfunctions

Output frequency, Hz	Malfunction reason	Solution
from 500 to 1500	No malfunctions, normal operation	Check tracking device operation
1600	Short circuit of the measuring probe tubes due to metal shavings and burrs, conductive mud or water at the bottom of the fuel tank	Eliminate short circuit, wash the tubes of the probe, clean the fuel tank
400	Sensor is not calibrated	Calibrate the sensor
	Sensor PCB failure	Contact the closest service center

Diagnostics of DUT-E AF can be carried out with service adapter the same way as for other DUT-E modifications having digital output (see 6.3).

6.3 DUT-E with digital output

Normal operation of digital DUT-E sensors is verified with the help of service adapter connection (see 3.10.10).

7 Maintenance

7.1 General instructions

DUT-E visual inspection and operation check is recommended at least once per year.

IMPORTANT: it is recommended to periodically (once per year) check calibration of sensor for minimum and maximum values of fuel level (given the shape of fuel tank was not changed). In case of incorrect values, make calibration once again according to 3.10.3*. Repeated calibration of fuel tank of Vehicle in this case is not needed.

DUT-E repair works are carried out only by certified Regional Service Centers (hereinafter, RSCs). Full RSCs list can be found at https://www.jv-technoton.com/.

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* DUT-E AF/232/485/CAN models. Repeated calibration of sensor for minimum and maximum values for DUT-E A5/A10/F/I is done only by RSC.

7.2 Demounting

Clean the tank surface nearby the mounting location before DUT-E demounting.

Prepare a clean napkin to clean the fuel from the sensor probe.

Cut the sealing cord carefully, with no damage to connection cable.

Disconnect DUT-E cable connector.

Unfasten DUT-E by turning its body counterclockwise.

Mount the fuel tank plug (be ordered separately) for protection from any possible clogging through mounting opening.

ATTENTION:
1) To avoid any cable/PCB damage do not pull the interface cable when demounting DUT-E.
2) In case of repeated installation of DUT-E – replace the old rubber gasket with a new one.

7.3 Examination

Since DUT-E is demounted conduct a visual examination to detect the following defects:

- visible damages of the sensor head body, measuring probe, interface cable, cable;
- backlash of measuring unit tubes relative to each other and/or the body;
- presence of mud or paraffin between the tubes of the measuring probe;
- damage of the plastic mounting plate and traces of fuel leaks through the rubber gasket of the mounting plate.

Contact RSC (see 7.1) or Manufacturer if the defects detected.

7.4 Cleaning

During DUT-E operation mud or paraffin formation is possible on the surface of the measuring probe pipes. Pollution of the cavity between the pipes of the measuring probe can lead to significant increase of accuracy error.

ATTENTION: Mud coating inside the inner measuring tube does not affect DUT-E normal operation. Examine the space between the tubes for mud and paraffin.

To clean the tubes wash them with the clean fuel.
It is also recommended to wash the screen filter as well.

ATTENTION: Avoid fuel getting on DUT-E head body, interface cable and its connector when washing the tubes.

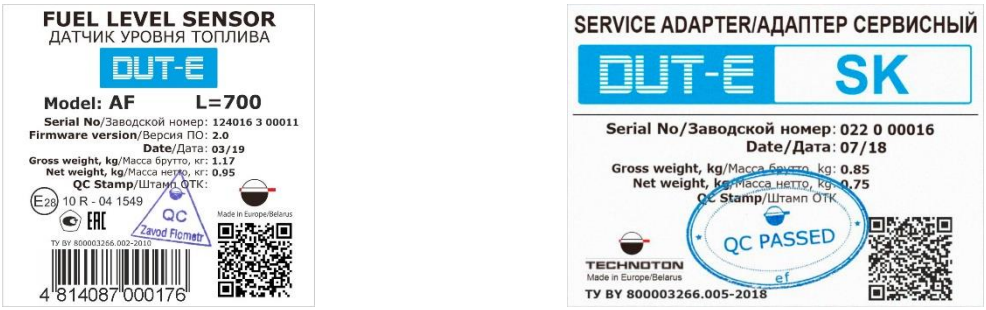
8 Packaging

DUT-E and SK DUT-E delivery sets come in cardboard boxes of the following shape (see figure 63)

a) DUT-E *b) SK DUT-E*

Figure 63 — Packaging

Label sticker with information on the product name, certificates, serial number, firmware version, manufacture date, certificates, weight as well as Quality Control seal and QR code is stuck on two sides of the DUT-E box (see figure 64 a).
Label sticker with information on the product name, serial number, software Service DUT-E version, manufacture date, weight and Quality Control seal and QR code is stuck on two sides of the SK DUT-E box. (see figure 64 b).



a) DUT-E *b) SK DUT-E*

Figure 64 — Packaging label

Note — label design and contents can be modified by the Manufacturer.

9 Storage

DUT-E is recommended to be stored in dry enclosed areas.

DUT-E storage is allowed only in original packaging at temperature range from -50 to +40° C and relative humidity up to 100 % at +25° C.

Do not store DUT-E in the same room with substances that cause metal corrosion and/or contain aggressive impurities.

DUT-E shelf life must not exceed 24 months.

10 Transportation

Transportation of DUT-E is recommended in closed transport that provides protection for DUT-E from mechanical damage and precipitation.

When transporting by air, DUT-E must be stored in heated pressurized compartments.

Air environment in transportation compartments should not contain acid, alkaline and other aggressive impurities.

Shipping containers with packed DUT-E sensors should be sealed.

11 Utilization/re-cycling

DUT-E does not contain harmful substances and ingredients that are dangerous to human health and environment during and after the end of life and recycling.

DUT-E does not contain precious metals in amount that should be recorded.

Contacts

Distribution, technical support and service

Tel/fax: +375 17 240-39-73

marketing@technoton.by

support@technoton.by

Manufacturer

Zavod Flometr

Tel/fax: +375 1771 3-29-21

office@flowmeter.by

Annex A
Template of check test report

Report

Date: _____

DUT-E model and serial number	
Vehicle type, model, registration number	
Tracking/displaying device model and serial number	

Drainage volume	According to calibrated container V_M, liters	
	According to tracking device V_{track}, liters	
Accuracy error	Absolute error $\Delta = V_{track} - V_M$, liters	
	Normalized to total tank volume $\delta = \frac{V_{track} - V_M}{V_{total\_volume}} \cdot 100\%$	

Refueling volume	According to calibrated container V_M, liters	
	According to tracking device V_{track}, liters	
Accuracy error	Absolute error $\Delta = V_{track} - V_M$, liters	
	Normalized to total tank volume $\delta = \frac{V_{track} - V_M}{V_{total\_volume}} \cdot 100\%$	

Resume:

The results of measurement **match**/**do not match** specifications.

The results of refueling measurement **match**/**do not match** specifications.

Comments: _____

representative of the CUSTOMER: _____/_____/

representative of the CONTRACTOR: _____/_____/

Annex B
Examples of DUT-E CAN connection

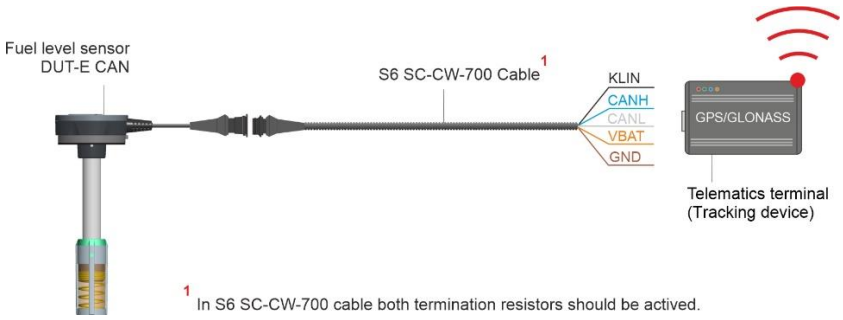


Figure B.1 — Connecting one DUT-E CAN to the Telematics terminal which is incompatible with S6 cable system

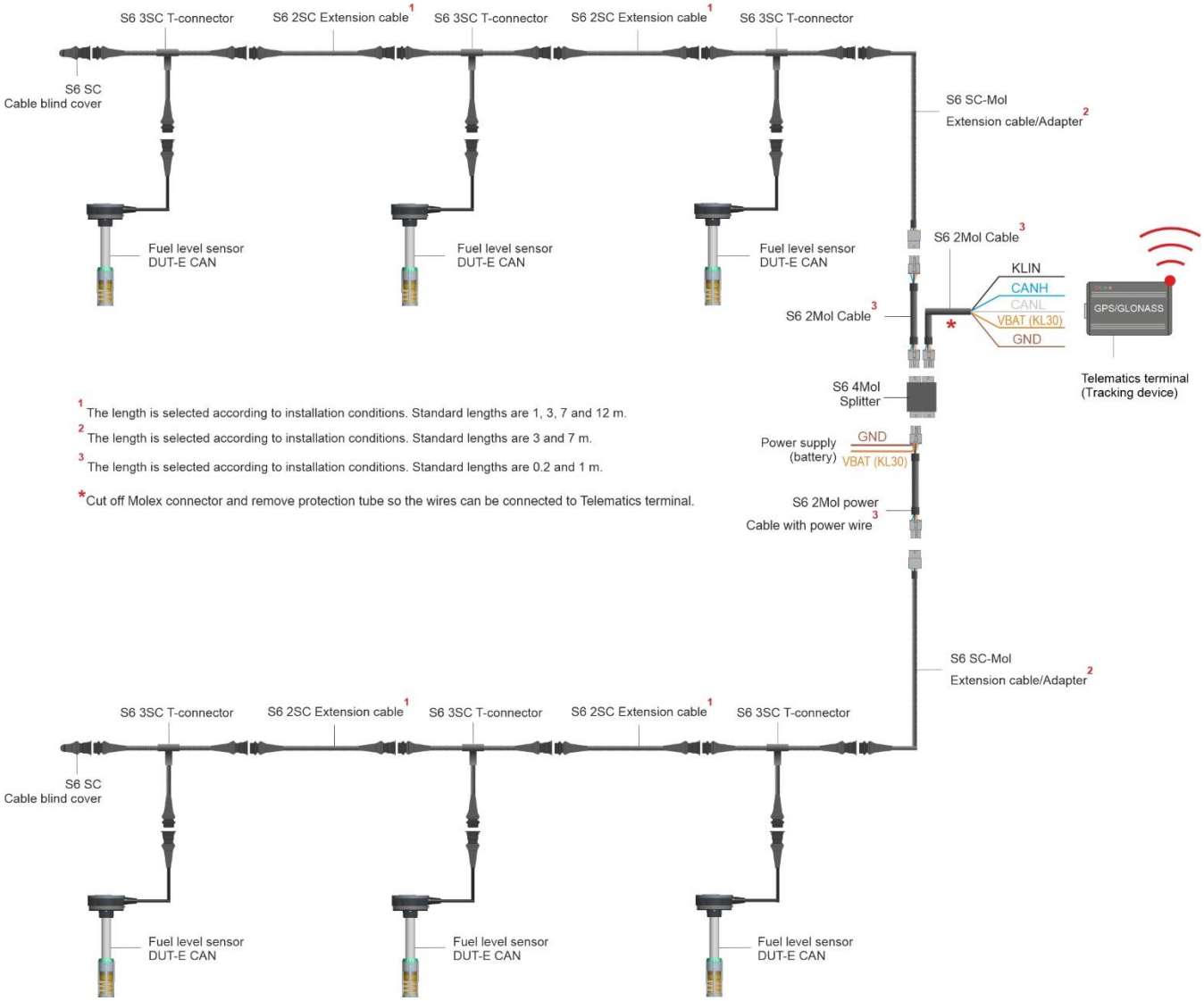


Figure B.2 — Connecting several DUT-E CAN to the Telematics terminal which is incompatible with S6 cable system

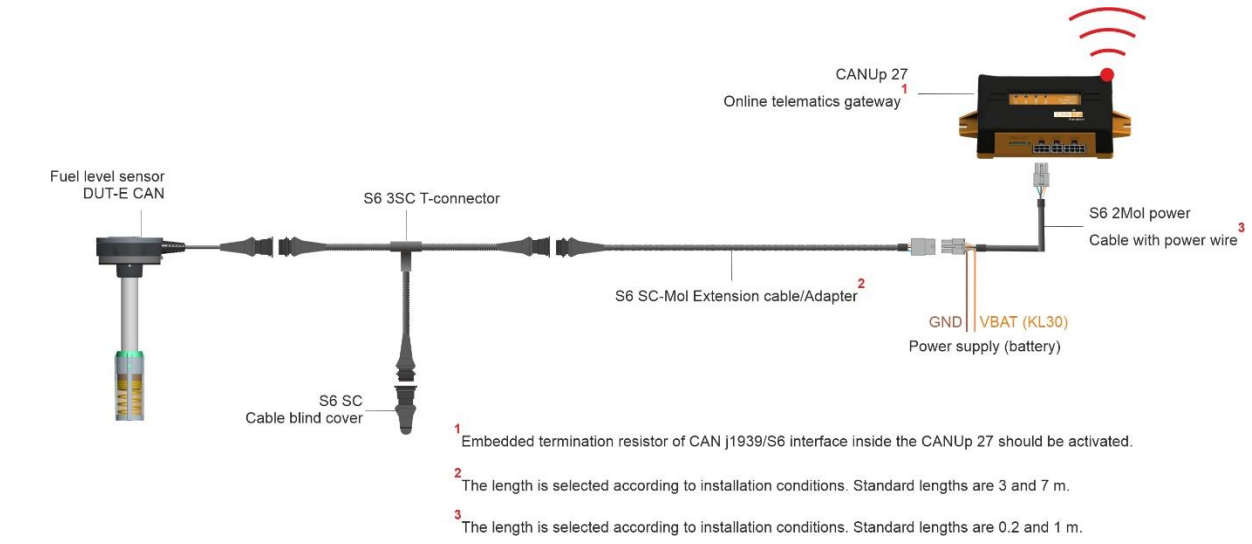


Figure B.3 — Connecting one DUT-E CAN to the Telematics terminal which is compatible with S6 cable system

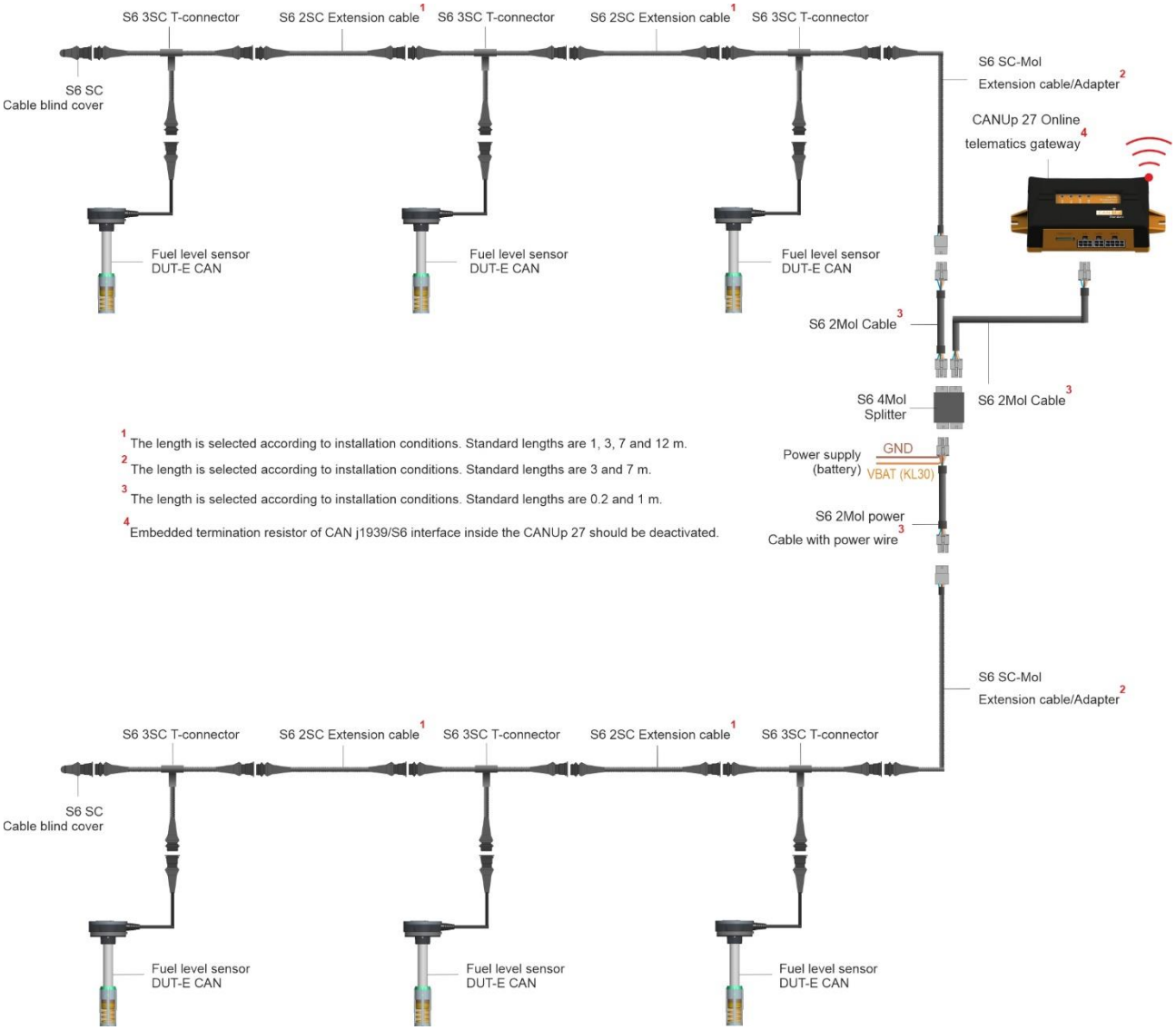


Figure B.4 — Connecting several DUT-E CAN to the Telematics terminal which is compatible with S6 cable system

Annex C
Messages of DUT-E CAN data transfer protocol

Table C.1 — Data composition of DUT-E CAN outgoing messages

#	Message name	Message parameters								Message content			
		Broadcast interval	Data length	Extended data page (EDP)	Data page (DP)	PDU format (PF)	PDU specific (PS)	Default priority (P)	Parameter group number (PGN)	Initial position	Length	Valuable data	Suspect Parameter Number (SPN) SAE J1939
1	PGN 62982 "Fuel level and fuel volume in the tank"	1 s	8	0	0	246	6	6	62982 (0xF606)	1	2 bytes	Fuel level (0.1 mm)	521023
										3	2 bytes	Fuel volume in the tank (0.1 L)	521024
										5	2 bytes	Reserve	521025
										7	1 byte	Fuel temperature (step 1 °C, offset 40 °C) Example: 0 value stands for temperature of -40 °C	174
										8	1 byte	Reserve	524000
2	PGN 62995 "Unit passport"	On request	45	0	0	246	19	6	62995 (0xF613)	1	16 bytes	Serial number DUT-E CAN	521120
										17	8 bytes	Firmware version DUT-E CAN	521121
										25	8 bytes	Hardware version DUT-E CAN	521123
										33	8 bytes	Settings version DUT-E CAN	521124
										41	4 bytes	Production date DUT-E CAN	521125
										44	1 byte	DUT-E CAN address in the CAN bus	521188

— the bytes are not used.

Table C.1 continued

#	Message name	Message parameters							Message content			
		Broadcast interval	Data length	Extended data page (EDP)	Data page (DP)	PDU format (PF)	PDU specific (PS)	Default priority (P)	Parameter group number (PGN)	Initial position	Length	Valuable data	Suspect Parameter Number (SPN) SAE J1939
3	PGN 63008 "Unit state"	1000 ms	8	0	0	246	32	6	63008 (0xF620)	1.1	2 bytes	Ignition Key State	521049
										1.3	2 bytes	Cross-Axle Blocking Status	521054
										1.5	2 bytes	PTO Switch Status	521059
										1.7	2 bytes	Events Status	521136
										2.1	2 bytes	Active Faults Presence Status	521137
										2.3	2 bytes	Passive Faults Presence Status	521138
										2.5	2 bytes	Unit Power Status	521129
										2.7	4 bytes	Engine Mode by Fuel Rate	521181
										3.3	4 bytes	Movement mode based on vehicle speed	521180
										3.7	2 bytes	Vehicle Fuel Saving Mode Status	521139
										4.1	4 bytes	Axle Weight Mode	521182
										4.7	2 bytes	GPS/GLONASS Receiver Status	521134
										5.1	2 bytes	GPS/GLONASS Antenna Status	521135
										5.3	2 bytes	Modem Power Status	521130
										5.5	2 bytes	Modem Registration Status	521131
										8	1 byte	Reserved_8	524000

— the bytes are not used.

Table C.1 continued

#	Message name	Message parameters							Message content			
		Broadcast interval	Data length	Extended data page (EDP)	Data page (DP)	PDU format (PF)	PDU specific (PS)	Default priority (P)	Parameter group number (PGN)	Initial position	Length	Valuable data	Suspect Parameter Number (SPN) SAE J1939
4	PGN 65226 "Active Diagnostic Trouble Codes (DTC)"	1 s	Variable	-	0	254	202	6	65226 (0XFECA)	1	7-8 bits	Reserve	987
											5-6 bits		624
											3-4 bits		623
											1-2 bits		1213
										2	7-8 bits		3041
											5-6 bits		3040
											3-4 bits		3039
											1-2 bits		3038
										3-4	2 bytes	SPN 523000 (see table C.2) 16 high valuable bits	1214
										5	6-8 bits	SPN 523000 (see table C.2) 3 low bits	
											1-5 bits	FMI malfunction codes (see table C.2)	1215
										6	8 bit	Reserve. Value equals 0	1706
											1-7 bits	Counter. Value is 127 if counter is used. Value varies from 0 to 126 if counter is not used	1216
5	PGN 65276 "Dash display"	1 s	8	0	0	254	252	6	65276 (0xFEFC)	1	1 byte	Reserve	80
										2	1 byte	Fuel level	96
										3	1 byte	Reserve	95
										4	1 byte		99
										5-6	2 bytes		169
										7-8	2 bytes		-
6	PGN 65279 "Operator indicators"	10000 ms	2	6	0	254	255	6	65279 (0xFEFF)	1.1	2 bits	Water in Fuel Indicator (1 – yes; 0 – no)	97
										1.3	2 bits	Operator Shift Prompt	5675
										2.1	3 bits	Driver Warning System Indicator Status	5825
										2.4	3 bits	Emission Control System Operator Inducement Severity	5826

— the bytes are not used.

DUT-E CAN data transfer protocol is using malfunctions codes (FMI) according to table C.2.

Table C.2 — DUT-E CAN malfunctions codes (FMI)

Parameter number (SPN)	Malfunction codes (FMI)	Description	Possible solution
523000	13	Sensor is not calibrated (the difference between calibration frequencies of signal generator with minimum and maximum fuel levels is less than 100 Hz)	Check if the measuring probe actual size value is inserted correctly and (or) recalibrate the sensor*
		Sensor is not calibrated for maximum fuel level	
523000	4	Signal generator is not functioning. Possible short circuit in measuring probe tubes	Wash the measuring probe tubes with clean fuel, clean fuel tank of mud and water.
523000	12	Calibration values for minimum and maximum fuel levels in the sensor differ less than 5 Hz	Check if the measuring probe actual size value is inserted correctly and (or) recalibrate the sensor*
523000	0	Current frequency of the signal generator is more than fixed one when calibrating for minimum (the difference is more than 100 Hz)	Check if the measuring probe actual size value is inserted correctly and (or) recalibrate the sensor*
* Fuel tank calibration table should be recompiled and recorded all over again into sensor internal memory.			

Annex D
Example of DUT-E CAN connection via RS-232 interface, to receive data on the total volume of fuel

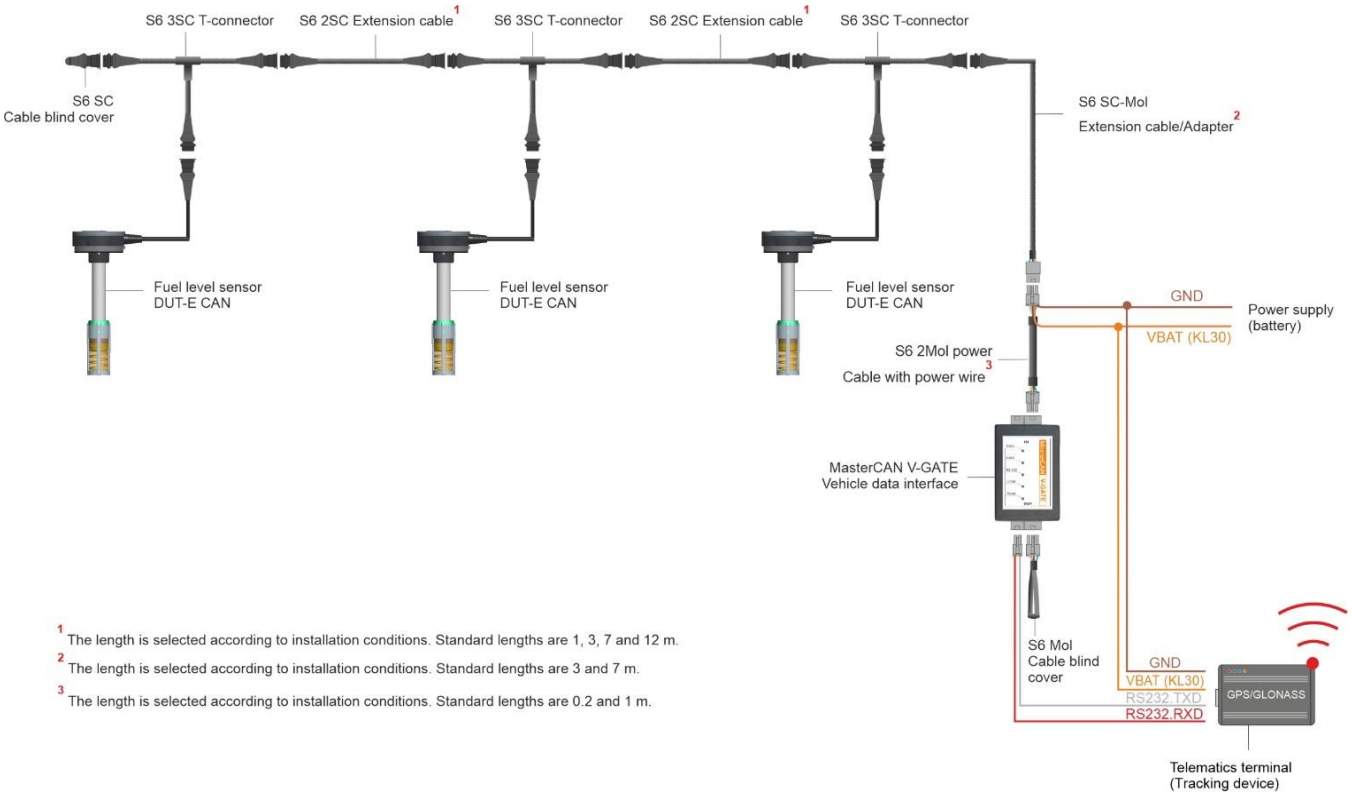


Figure D.1 — Connection of several DUT-E CAN to the Telematics terminal for summarization of readings via RS-232 interface

Annex E
DUT-E profile printed copy

Fuel level sensor

Passport

Model sensor	DUT-E AF
Serial number	092001302783
Firmware version	3.12
Date compil	Jan 09 2016
Time compil	09:15:05

Settings

Calibration

Actual length of sensor after trimming (mm)	685.0

Thermal compensation

Thermal compensation (-3...3 %/°C)	0

Operation mode

Fuel level filter time, 0..120 s step=10 s	0
Address (101..108)	101

Analog output

Level min. (1.0...8.0 V):	1.000
Level max. (2.0...9.0 V):	9.000
Output signal type:	U
Output signal type:	Level
Diagnostics:	off

Calibration table

No	Level, mm	Volume, l
001	0.0	0.0
002	63.9	10.0
003	130.4	20.0
004	215.0	30.0
005	300.0	40.0
006	408.6	50.0
007	510.5	60.0
008	603.7	70.0
009	685.0	80.0

Parameters of sensor calibration

Frequency of calibration "free", Hz	2309.99
Frequency of calibration "free", Hz	1200.94

Annex F
DUT-E log file example

Filename: DUT_SN 092001302783 _D15.04.2015_T145012.txt

File contents:

```
 1 14:50:12 23.0 2306.14 2308.67    1 0.4 0.4 0.4 0.1 0.0
 2 14:50:13 23.0 2305.98 2308.51    1 0.5 0.5 0.5 0.1 0.0
 3 14:50:14 23.0 2306.00 2308.53    1 0.5 0.5 0.5 0.1 0.0
 4 14:50:16 23.0 2305.83 2308.36    1 0.5 0.5 0.5 0.1 0.0
 5 14:50:17 23.0 2306.16 2308.69    1 0.4 0.4 0.4 0.1 0.0
 6 14:50:18 23.0 2305.96 2308.49    1 0.5 0.5 0.5 0.1 0.0
 7 14:50:19 23.0 2305.99 2308.52    1 0.5 0.5 0.5 0.1 0.0
 8 14:50:20 23.0 2306.08 2308.61    1 0.4 0.4 0.4 0.1 0.0
 9 14:50:21 23.0 2305.87 2308.40    1 0.5 0.5 0.5 0.1 0.0
10 14:50:22 23.0 2306.07 2308.60    1 0.4 0.4 0.4 0.1 0.0
11 14:50:24 23.0 2306.11 2308.64    1 0.4 0.4 0.4 0.1 0.0
12 14:50:25 23.0 2306.05 2308.58    1 0.5 0.5 0.5 0.1 0.0
13 14:50:26 23.0 2305.99 2308.52    1 0.5 0.5 0.5 0.1 0.0
14 14:50:27 23.0 2305.90 2308.43    1 0.5 0.5 0.5 0.1 0.0
15 14:50:28 23.0 2305.92 2308.45    1 0.5 0.5 0.5 0.1 0.0
16 14:50:29 23.0 2305.91 2308.44    1 0.5 0.5 0.5 0.1 0.0
17 14:50:30 23.0 2305.97 2308.50    1 0.5 0.5 0.5 0.1 0.0
18 14:50:31 23.0 2306.16 2308.69    1 0.4 0.4 0.4 0.1 0.0
19 14:50:33 23.0 2305.98 2308.51    1 0.5 0.5 0.5 0.1 0.0
20 14:50:34 23.0 2305.84 2308.37    1 0.5 0.5 0.5 0.1 0.0
21 14:50:35 23.0 2306.00 2308.53    1 0.5 0.5 0.5 0.1 0.0
22 14:50:36 23.0 2306.01 2308.54    1 0.5 0.5 0.5 0.1 0.0
23 14:50:37 23.0 2305.89 2308.42    1 0.5 0.5 0.5 0.1 0.0
24 14:50:39 23.0 2306.17 2308.70    1 0.4 0.4 0.4 0.1 0.0
25 14:50:40 23.0 2305.84 2308.37    1 0.5 0.5 0.5 0.1 0.0
26 14:50:41 23.0 2306.24 2308.77    1 0.4 0.4 0.4 0.1 0.0
27 14:50:42 23.0 2306.02 2308.55    1 0.5 0.5 0.5 0.1 0.0
28 14:50:43 23.0 2305.82 2308.35    1 0.5 0.5 0.5 0.1 0.0
29 14:50:44 23.0 2306.05 2308.58    1 0.5 0.5 0.5 0.1 0.0
30 14:50:45 23.0 2305.81 2308.34    1 0.5 0.5 0.5 0.1 0.0
31 14:50:46 23.0 2305.88 2308.41    1 0.5 0.5 0.5 0.1 0.0
32 14:50:48 23.0 2305.95 2308.48    1 0.5 0.5 0.5 0.1 0.0
33 14:50:49 23.0 2305.93 2308.46    1 0.5 0.5 0.5 0.1 0.0
34 14:50:50 23.0 2306.05 2308.58    1 0.5 0.5 0.5 0.1 0.0
35 14:50:51 23.0 2306.01 2308.54    1 0.5 0.5 0.5 0.1 0.0
36 14:50:52 23.0 2306.03 2308.56    1 0.5 0.5 0.5 0.1 0.0
37 14:50:53 23.0 2305.98 2308.51    1 0.5 0.5 0.5 0.1 0.0
38 14:50:55 23.0 2306.04 2308.57    1 0.5 0.5 0.5 0.1 0.0
39 14:50:56 23.0 2306.07 2308.60    1 0.4 0.4 0.4 0.1 0.0
```

1 2 3 4 5 6 7 8 9 10 11 ← Data field numbers

Data fields description:

1 — check point number;
2 — current time;
3 — ambient temperature (C°);
4 — initial measuring generator frequency (Hz);
5 — temperature compensated measuring generator frequency (Hz);
6 — fuel level (s.u.);
7 — initial fuel level (mm);
8 — temperature compensated fuel level (mm);
9 — temperature compensated filtered fuel level (mm);
10 — fuel volume (l);
11 — fuel volume (%).

Annex G
Electromagnetic compatibility specifications of DUT-E

Table G.1 — Protection of power circuits of DUT-E against conductive, capacitive and inductive interference as described in ISO 7637-2:2002

Test pulse	Test level	U_S tested level, V for supply voltage	
		12 V	24 V
1	IV	-100	-600
2a	IV	+50	+50
2b	IV	+10	+20
3a	IV	-150	-200
3b	IV	+100	+200
4	IV	-7	-16
5	III	+65	+123

Table G.2 — Protection of signal circuits of DUT-E against conductive, capacitive and inductive interference as described in ISO 7637-3:2002

Test pulse	Test level	U_S tested level, V for supply voltage	
		12 V	24 V
Pulse “a” of short duration	IV	-60	-80
Pulse “b” of short duration	IV	+40	+80
Positive pulse of long duration (DCC)	IV	+30	+45
Negative pulse of long duration (DCC)	IV	-30	-45
Positive pulse of long duration (ICC)	IV	+6	+10
Negative pulse of long duration (ICC)	IV	-6	-10

Table G.3— DUT-E own radio interference field strength as per UNECE Regulation No.10 (Revision 4)

Tested bandwidth, Mhz	Quasi-peak value of field strength of radio interference, dB μV/m		Average value of field strength of radio interference, dB μV/m	
	Horizontal polarization	Vertical polarization	Horizontal polarization	Vertical polarization
30…34	27	25	20	20
34…45	23	21	16	18
45…60	18	18	13	14
60…75	17	16	10	9
75…100	11	13	7	8
100…130	12	14	7	9
130…170	22	16	18	12
170…225	24	18	18	13
225…300	32	24	27	11
300…400	19	21	13	14
400…525	22	24	16	15
525…700	24	27	23	23
700…850	34	32	25	27
850…1000	35	33	27	26

Annex H
Videography

1) Animation DUT-E 2Bio fuel level sensor.

Check out the link: https://www.youtube.com/watch?v=WR1556gaN7o

2) Animation DUT-E 2Bio fuel level sensor: reaction to impurities in the liquid.

Check out the link: https://www.youtube.com/watch?v=Etp9dD_-_so

3) Video clip DUT-E 2Bio: detection of fuel type change.

Check out the link: https://www.youtube.com/watch?v=2bNqoit78w8

4) Animation DUT-E GSM fuel level sensor.

Check out the link: https://www.youtube.com/watch?v=ixBaKMzKtG8

5) Video clip DUT-E 485 fuel level sensor installation.

Check out the link: https://www.youtube.com/watch?v=X0gUSF3dRWk

6) Video clip length extension of measurement part DUT-E Using measuring sections KDC

Check out the link: https://www.youtube.com/watch?v=dWuY_JJfhFw

7) Video clip Filter Screen of DUT-E fuel level sensor

Check out the link: https://www.youtube.com/watch?v=B5dcYxGfSqQ

8) Other Technoton videos are on the YouTube channel which is regularly updated:

https://www.youtube.com/channel/UCq7EF3DHrgl7fOWB2ynsR-A