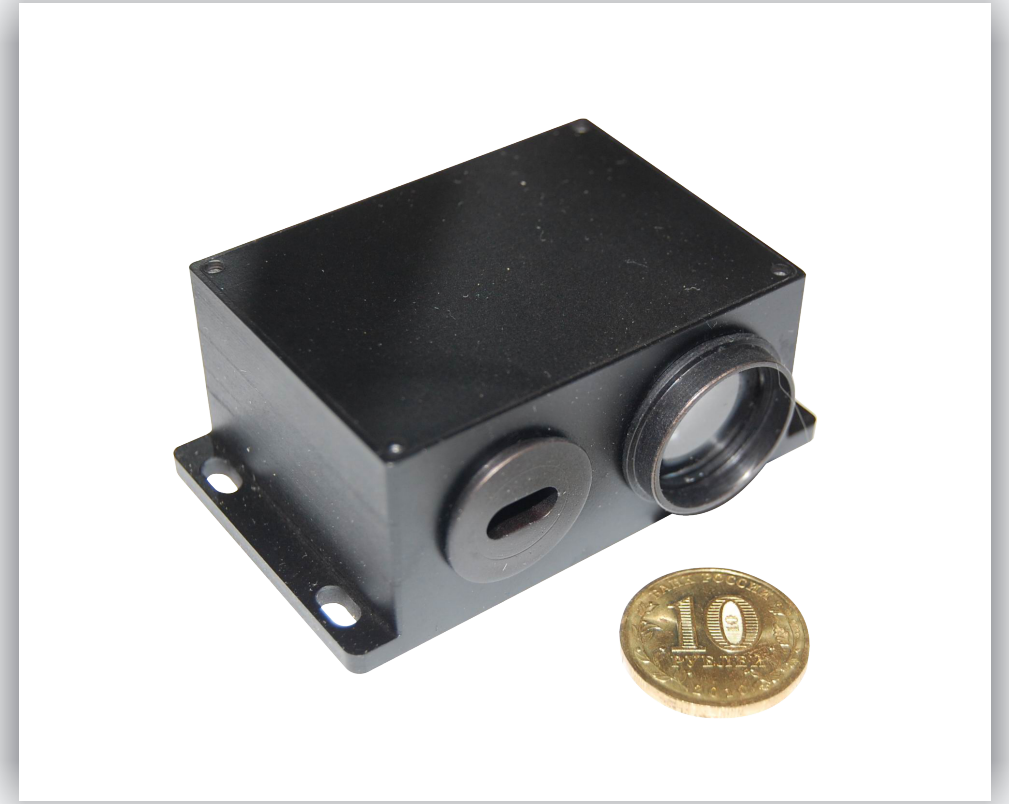
RIFTEK
Sensors & Instruments



LASER SPEED AND LENGTH SENSORS

ISD-5 Series

User's manual

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Certified according to ISO 9001:2008

2

Contents

1. Overview

Laser speed and length sensors are intended for industrial application in metallurgy, cable production, textile fabrics etc.

Measuring principle – Laser Doppler interferometry (reflected type) for direct speed measurement and length calculation based on speed integration.

Industrial applicanions:

- Precision speed and length measurements of finite or infinite moving objects relative to fixed sensor.
- The sensor can be fixed on moving object (crane, electric loader etc.) to measure its speed and displacement relative to ground

Main features:

- Precision measurements: up to 0,02 – 0,1 % RMS of speed and <0,05% absolute length (>1m).
- Reliable measurements on virtually all types of surfaces, including glass.
- Broad range of nominal distances: 10 – 100 cm and more.
- Original monolithic beam splitter forms stable interferometric pattern, and provides the bigger distance tolerance among such sensors – up to ±25% of nominal distance.
- Thermo compensated design provides temperature independent measurements, no thermo stabilization needed in broad temperature range*.
- Low power consumption of sensor head (0,5 – 2 Wt depends of laser power needed) and controller module (1 Wt).

*****_No temperature drift in +15…+50˚C range. At lower temperatures thermo stabilization of housing can be used._

2. Safety precautions

- Use supply voltage and interfaces indicated in the sensor specifications.
- In connection/disconnection of cables, the sensor power must be switched off..

3. Electromagnetic compatibility

The sensors have been developed for use in industry and meet the requirements of the following standards:

- EN 55022:2006 Information Technology Equipment. Radio disturbance characteristics. Limits and methods of measurement.
- EN 61000-6-2:2005 Electromagnetic compatibility (EMC). Generic standards. Immunity for industrial environments.
- EN 61326-1:2006 Electrical Equipment for Measurement, Control, and Laboratory Use. EMC Requirements. General requirements.

4. Laser safety

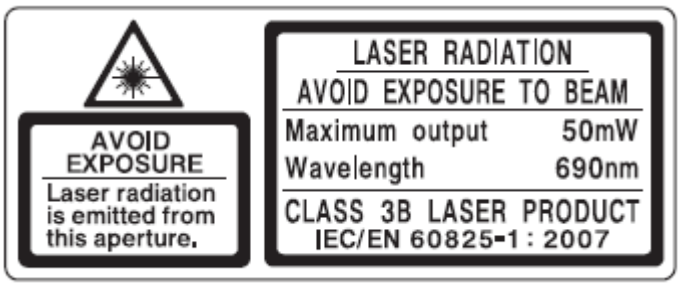
The sensors correspond to the following laser safety classes according to IEC 60825-1:2007

Model of the sensor	ISD-5 Standard	ISD-5 Mini
Wavelength, nm	635, 660, 808	635, 660
Output power. mW	5 - 120	3 – 4,8
Laser safety class	3B	3R

4

4.1 Class 3B sensors.

In ISD-5 Standard c.w. semiconductor visible range lasers 5 – 20 mW or IR up to 120 mW (for longest working distance) are used. They belong to 3B laser safety class. The following warning label is placed on the laser body (as an e[ample):



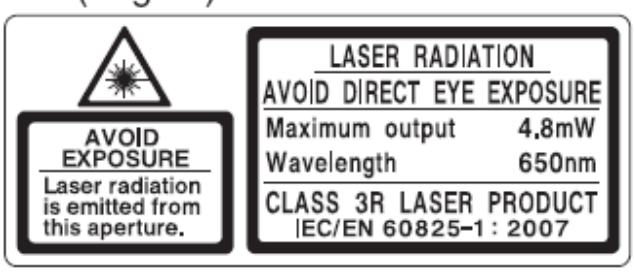
The following safety measures should be taken while operating the sensor:

- Do not target laser beam to humans;
- Avoid staring into the laser beam through optical instruments;
- Mount the sensor so that the laser beam is positioned above or below the eyes level
- Mount the sensor so that the laser beam does not fall onto a mirror surface;
- It is recommended to use protective goggles while operating the sensor;
- Avoid staring at the laser beam going out of the sensor and the beam reflected from a mirror
- surface;
- Do not disassemble the sensor;
- Use the protective screen mounted on the sensor for the bocking of the outgoing beam:

4.2. Датчики класса 3R

In ISD-5 Standard c.w. semiconductor visible range lasers <5 mW are used. They belong to 3B laser safety class. The following warning label is placed on the laser body (as an e[ample):

IEC (English)



The following safety measures should be taken while operating the sensor:

- Do not target laser beam to humans;
- Avoid staring into the laser beam through optical instruments;
- Mount the sensor so that the laser beam is positioned above or below the eyes level;
- Mount the sensor so that the laser beam does not fall onto a mirror surface;
- Use protective goggles while operating the sensor;
- Avoid staring at the laser beam going out of the sensor and the beam reflected from a mirror surface;
- Do not disassemble the sensor;

5. General Information

Currently ISD-5 family included 2 models with different versions with working range from 10 cm up to 100 cm and more. Custom-ordered configurations are possible with parameters different from those shown below.

Coming soon are 2-Dimentional sensors to measure, for instance, longitudinal speed of rotating tubes in tube-rolling mill, or transversal displacement of moving objects.

Although a special version of sensor for road application in automotive testing industry will be available soon.

6. Main Technical Data

Parameter	ISD-5 Standard	ISD-5 Mini	Notes
Speed range, m/s	0,02 – 20	0,005 - 5	Typical values. The less nominal working distance the less min and max speed range.
Speed accuracy*, % RMS	±0,07 ±0,02	±0,15 ±0,05	No signal averaging With averaging 0,2 - 0,3 s, at V > 1 m/s
Length accuracy*, % RMS	<±0,05	<±0,1	При предварительной калибровке на длинах пути >2 м.
Measuring frequency, Hz	16 - 54		
Nominal distance to the object (tolerance), cm	10, 20, 30, 50, 75, 100)	10,15, 20	Could be noted at ordering
Distance tolerance	±20-25% of nominal		Depends on the surface (on the edge of the range signal decreased)
Emitter type	Visible or IR c.v. laser, 5 – 120 mW	Visible c.v. laser, <5 mW	class 3B – 3R
Power supply, V	12 (8 - 14)		Internal linear voltage regulators +5V in sensor and controller unit.
Power consumption, Wt: Sensor Controller unit	0,5 - 2 1	0,5	
Temperature working range, ˚C	+15...+50		-10…+50 – with active thermostabilization (option): -50..+80˚C with protect air cooling housing (option).
Sensor weight, g	320	70	
Sensor size, mm	85x79x46	58x43x30	Without connector , blend and fixing holes (see picture below)
Cable length from sensor to	1,8 or 3		Standard cable RS-232 or VGA with

controller unit, v		DB9 connectors are used. To extend a length it is possible to connect cables sequential.
Sensor environmental protection	IP67	
Controller unit:		
Weight, g Size, mm Analog out	350 120x100x35 Speed, 150 mV/(m/s) 3V max.	
Freuency out	Length, 2000 pulces/m (=speed 2000 Hz/(m/s), meander 0 – 3 V, TTL compatible, up to 200 KHz.	Typical values, user adjustable (see software description below). ADC and frequency resolution – 12 bit
Digital out Physical data latency at measurement freq, ms 54 Hz 16 Hz	Ethernet (UDP protocol) 9 31	Others on request Stable, =½ of measuring time, without averaging.
Base Software	- Program to read data via Ethernet, visualization and saving data; - Program for sensor diagnostics - Read data example (LabView 8.2.1 and higher); - Dynamic library (DLL) to read data via Ethernet - Sensor parameters configuranion via any Internet browther	See below for details. Custom software by request are possible.

*Precalibration needed to reject the geometric errors of sensor mounting.

Due to our continuous efforts to improve sensors, Riftec reserves the right to change specification without prior notice.

7. Example of item designation when ordering

ISD – 5 – St – 30cm – ET+232+CAN – AN(U) – PL – 3m – H – P

Symbol	Description
St	St – Standard Lt – Mini
30cm	Nominal distance to the object
ET+232+CAN	Digital interfaces: ET - Ethernet – base, other - options: 232 or 485– RS232 (485), CAN – to avoid any discrepancies the data format of client DAQ needed
AN(U)	Analog out, voltage (U) – base - or current (I)
PL	Pulce out – base
3m	Cable length from sensor to controller unit
H	Sensor with in-built heater (option)
P	Sensor with protect air cooling housing (option)

8. System Parts and Connections

System parts and connections are shown on fig.1 below.

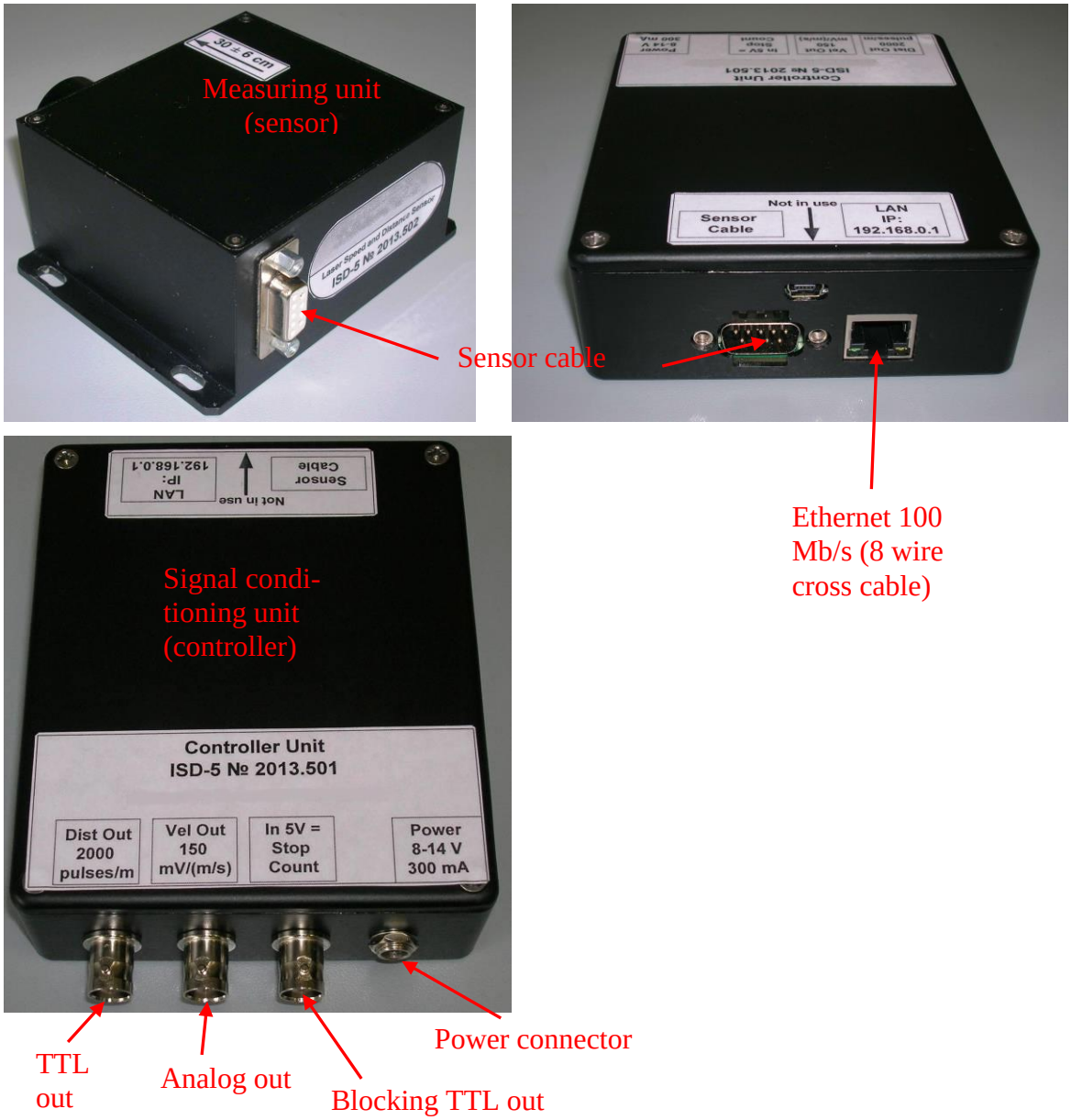


Fig. 1. Sensor parts and connectors.

At +5V on “Stop Count” on no pulces on TTL out. It is used when there are long stops in object (cable, for instance) mowing to avoid false reading in length.

9. Dimensions and mounting

9.1. Overall demands for sensor mounting

Mounting holes sizes and sensor axes relative to moving object are shown on fig.2.

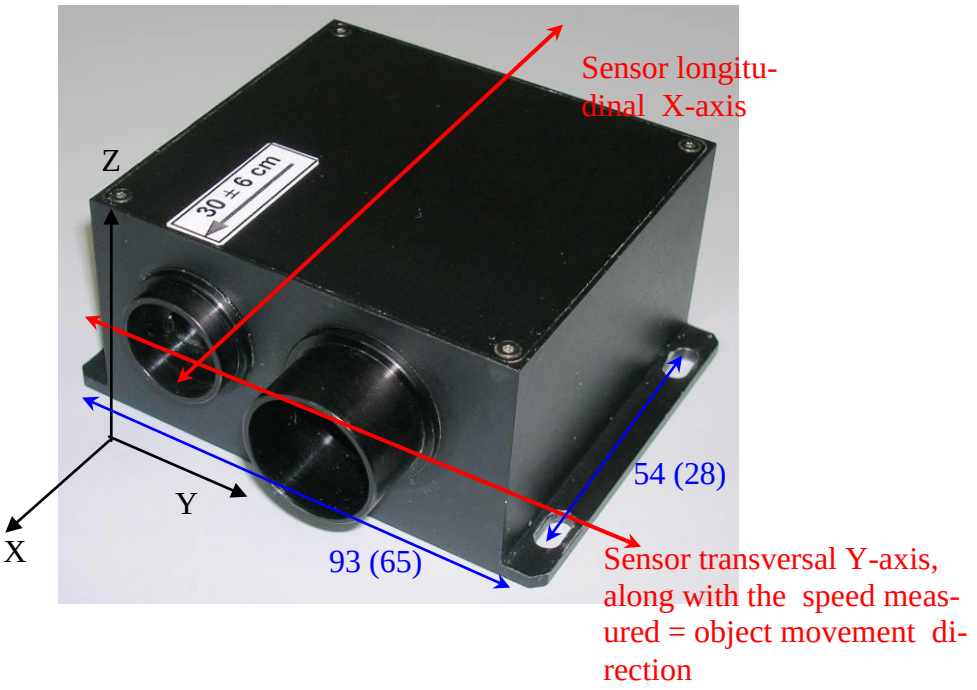


Fig. 2. Sensor position relative to moving object along Y-axis.

Nominal distance to the object could be measured from front plane of the sensor, as indicated. Mountig holes positions in brackets – for Mini version.

Sensor X-axis must be perpendicular and Y-axis – parallel to object moving direction. In ZY plane (perpendicular to drawing plane) sensor Z-axis can be tilted from vertical position (for instance, to avoid the light direct reflection to sensor receiver area from glossy surface). Note: inaccuracy (non-perpendicular/parallel with angle α) in sensor X and Y axis relative to object mowing direction will lead to decreasing the measurements as sin(α). For instance, at α=4˚ measured speed will less then actual in 0,24%. That is why, the pre-calibration needed to reject the align errors to achieve the maximum accuracy.

9

9.2. Overall and mounting sensor dimensions

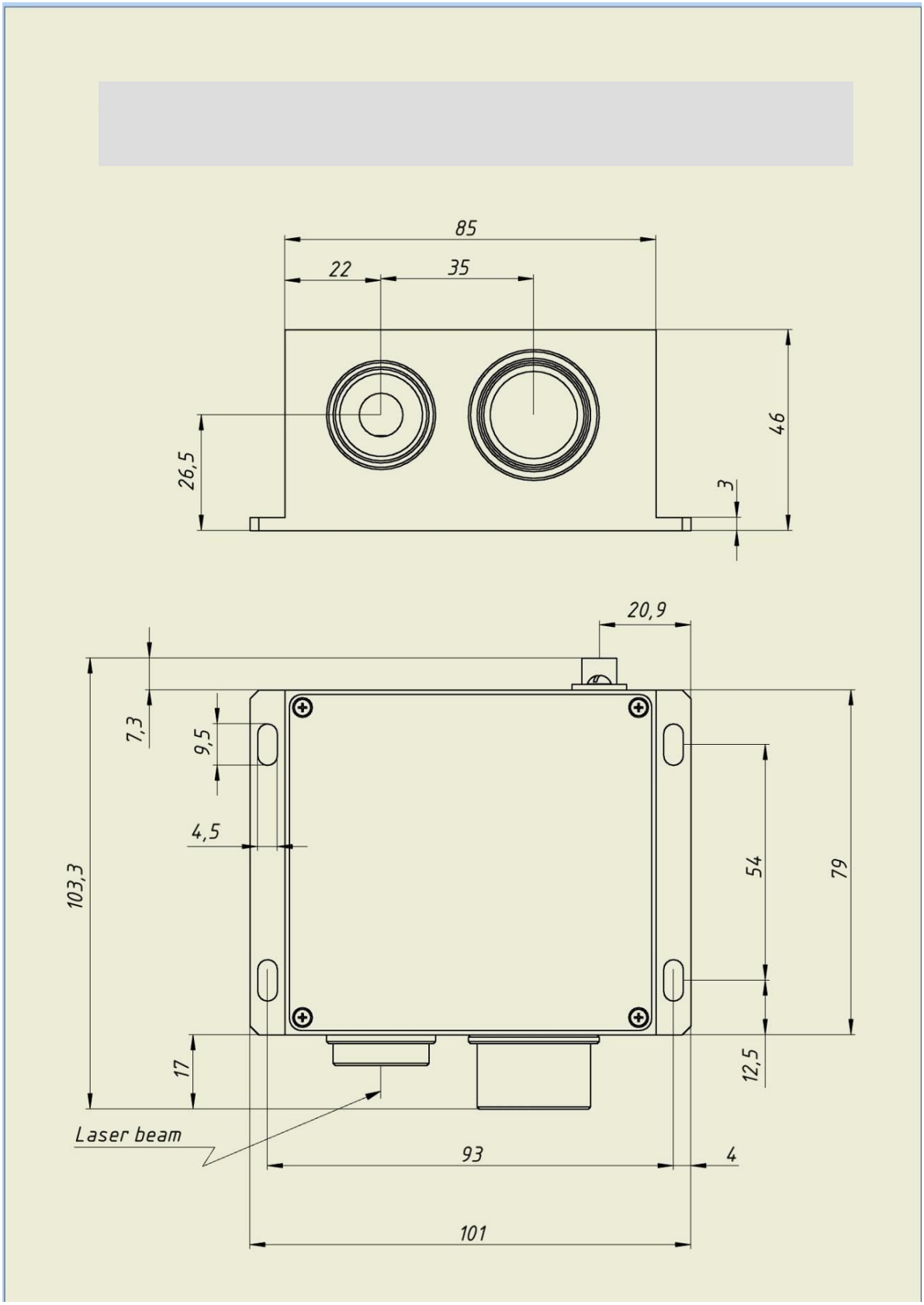


Fig.3. Overall and mounting dimentions of ISD-5 Standard.

10. Connection

10.1. Designation of connector contacts.

Connector	Type	Assignment, Comments
Sensor:		
Cable	DB9F	1 – GND of power supply [1] 2 – GND of signals [1] 3 – Signal «+» [2] 4 – Signal«-» [2] 5 – «+» of power supply
Controller unit:		
Cable	DB9M	
Ethernet	RJ-45	To connect controller unit with other PC wia Ethernet 100 Mb (8 wires cross cable)
Pulce output	BNC	0 – 3V, 8 mA max [3]
Analog output	BNC	0,015 – 2,8 V, Rout = 15 KOm [4]
Stop pulce output	BNC	Input, 5V stops pulses (output stay in «1»)
Питания	DS-016N socket	«+» on central
	Вариант: PY04-4Z plug	4-pins 1,2 – «+» power, 3,4 – GND.

1 – Grounds joined in controller unit. Signal ground connected to the controller unit housing.
2 – Differential pair, joined to single-ended in controller unit.
3 – Direct digital output. Max. Freq is 200 KHz.
4 – Direct not buffered DAC output. Load resistance must be > 1,5 MOm.

10.2. Cables

All cables used are standard (on the shell).

Cable between sensor and controller unit: RS232 or VGA 9 pin 9 wires: 1-1; 2-2; … 9-9. VGA cable has shield connected to the connectors houses (recommended at high EMI environment). Cables can be connected in series up to 10 – 15 m.

Ethernet cable – 8 wires 4 twisted pair cross cable, up to 30 m.

Signals outputs (BNC) – coaxial up to 15 m.

11. Working with system and its software

11.1. Working with external (custom) DAQ

- Fix sensor properly relative to the object.

- Connect sensor and controller unit by cable, switch the power ON. Warming time (without thermostabilization) is 1 -2 min.

- Connect pulce output with the counter input. At 2000 pulcas/m 1 count = 0,5 mm.

- At first mounting, to reject a geometric errors, sensor calibration needed. Move the object from stand still to stand stil on the known distance (>2 m or more) for 3 – 5

times. If needed correct the calibration multiplier in DAQ or controller software (see below).

Pulce output can be used for speed measurement too. Frequency 2000 Hz corresponds 1 m/s. But to measure frequency correctly measurement frequency could be at least no less then sensor update frequency.

To measure the speed analog output is more convenient. Calibration multiplier that was found by length measurement could be applied here too. Warning: DAC output is not buffered to keep the metrological characteristic, so load resistance must be high, at least >1,5 MOm. Additinaly, there is a DC offset – ab. 15 mV that could be taken into account.

11

11.2. Working with sensor software

The sensor can be connected to the PC via network. Sensor IP address is 192.168.0.1 by default. To establish the direct cable (use cross cable configuration) connection, PC must have static address 192.168.0.XXX with 255.255.255.0 mask.

11.3. Configuration parameters

Open any Internet browser (Internet Explorer, Opera …), enter controller IP as an address. Page with sensor configuration parameters appears:

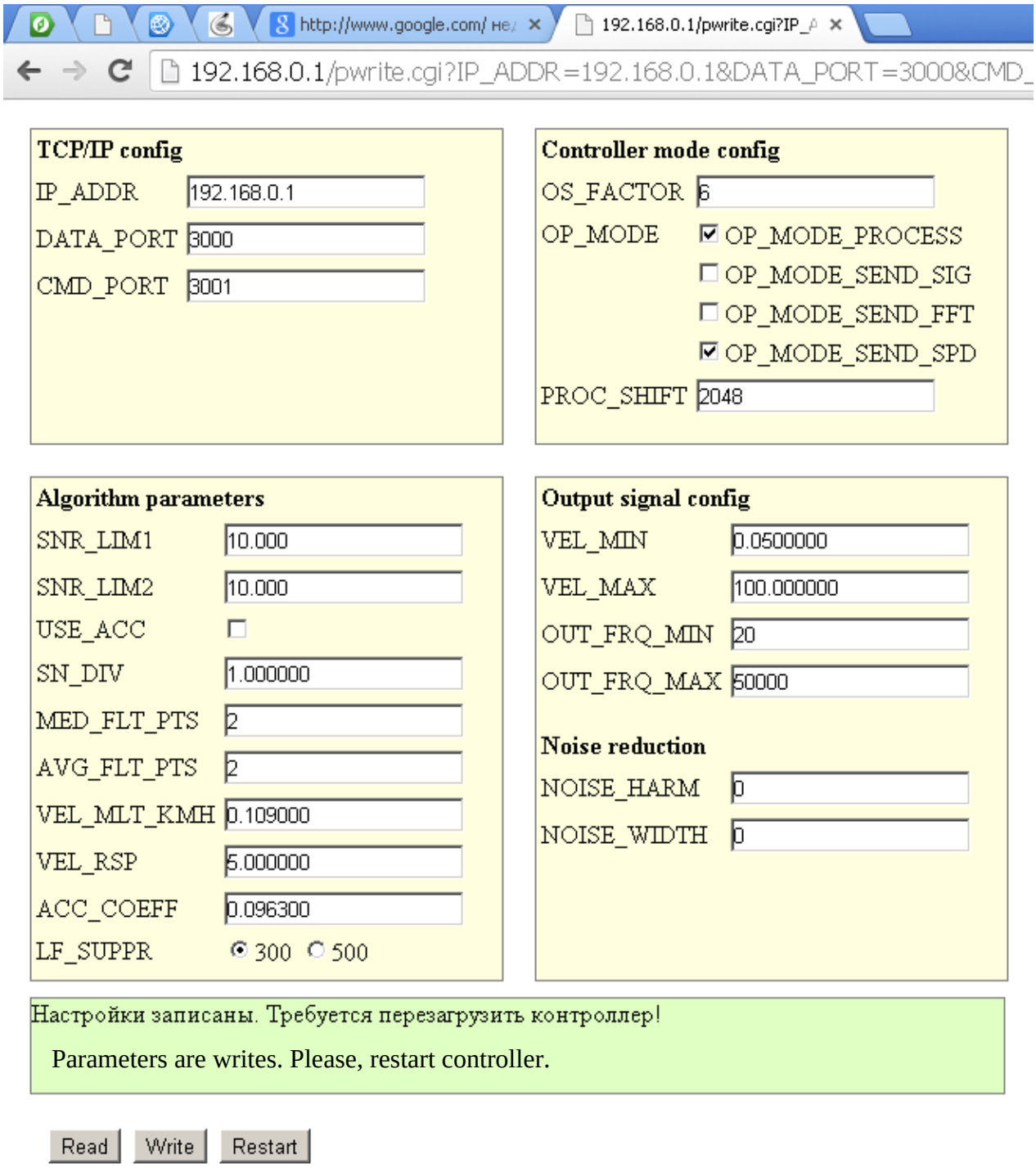


Fig. 4. Page with sensor configuration parameters.

What is opened is a content of flash memory of the controller. It is factory (not recommended to change) and user's parameters. It is recommended to save factory configuration, at least as a picture (ALT+PrtSc).

Parameters details:

"TCP/IP Config":

- IP_ADDR – Contriller's address. Non recommended to change without necessity. If changed – do not foget to enter new address in browther after controller restart.

- DATA_PORT – Port on PC where data sended. The same must be used as a parameter to read data by DLL (see below).

- CMD_PORT – Controller port where writes the parameters. Do not change!

"Algorithm parameters":

- SNR_LIM1 и SNR_LIM2 – Signal to Noise Ratio Limit – to distinguish between standstill and mowing object. If real less – speed regarded as = 0. Typical values at stand still are 4 – 6. At moving object S/N 1 (and S/N 2 at velocities > 20% of Vmax) > 100 typically. See real S/N at stand still in the software (see below) and set it 1,5 – 2,5 times more to guarantee V=0 at stand still. But in some cases (vibrating object or by-side mowing objects in the sensor beam pass, including possible reflections) – some velocity measurement at standstill can occur. In some range it can be overcome by S/N increasing. Current S/N can be observed in the program supplied (see below). At very high noises at standstill or at long stops– use function "Stop Count" (when frequency output used) and unblock it just before the start moving.

- USE_ACC – Not used in industrial version, do not change!

- S/N_DIV – For future use, do not change.

- MED_FLT_PTS – Median filter order (points of measurements taking into account. Min. value = 0 (no filter).

- AVG_FLT_PTS – Order of data averaging filter. Min. value = 1 (no filter)

- VEL_MLT_KMH – Velocity calibration multiplier. Act to length calculation too.

- VEL_RSP – Define the maximum velocity changing at abrupt real velocity changing. The more the value, the faster sensor can react. For automotive application value 10 corresponded ab. 1 g acceleration at 34 Hz measurement.

- AC_COEFF – Calibration multiplier for internal accelerometer (when USE_ACC selected). Do not change!

- LF_SUPPR – for factory use only, do not change!

«**Controller mode config** »:

- OS_FACTOR – Act on ADC sampling time, Do not change!

- OP_MODE – Set the controller mode. Selected modes activates ones:

OP_MODE_PROCESS – process the data and send the result to frequency and analog output. OP_MODE_SEND_SIG, OP_MODE_SEND_FFT, OP_MODE_SEND_SPD – Send the data via Ethernet. **Only one or no one must be selected** (No one – data not sent to Net, just to Freq and An – max measuring freq possible (up to 100 Hz)).

Use OP_MODE_SEND_SPD to work with a visualization program supplied (see below). Use OP_MODE_SEND_FFT to work with a diagnostic program supplied (see below)

- PROC_SHIFT – Allow to change measurement frequency (sliding average mode) with step of 512 points. But maximum result frequency must not exceed 80 Hz with sending data via Net and 100 Hz without Net.

«**Output signal config**»:

- VEL_MIN и VEL_MAX – Limits max and min velocities measured in Km/h in terms of analog and frequency outputs (at VEL_MIN analog output is 0,015 V, at VEL_MAX analog output is 3 V). Example: to set 40 mV/m/s : 3V/0,04V/m/s = 75 m/s = 270 Km/h = VEL_MAX

- OUT_ERQ_MIN и OUT_FRQ_MAX – Define min and max frequency output at VEL_MIN and VEL_MAX. To set 400 pulces/m (=400Hz/m/s) : 400Hz/m/s*75m/s = 30000 Hz = OUT_FRQ_MAX.

«**Noise reduction**»:

- NOISE_HARM и NOISE_WIDTH – Allows programmatically suppress narrow-band electromagnetic noise. See 10.4. below for details.

After changing and writing parameters, controller must be restarted. Press button “Restart” (it takes 1 sec only), then you have to reload the page, because during reset the connection with controller was lost.

11.1. Controller reset to factory settings

In case of controller firmware damage (loosing power during writing new data, writing wrong parametes etc.) it can work incorrect or loose Ethernet connections.In this case initial factory settings can be restored as following:

- Swich OFF Controller Power.

- Unplug the sensor cable from controller and insert DB9 with pins 7 and 8 connected or just connect pins 7 and 8 by wire.

- Swich ON Controller Power for 3 – 5 s. Factory settings is restored.

- Remowe DB9 or wire, plug the sensor cable.

- Do not forget to write user parameters if they were differ from factory ones.

11.2. Working with sensor software

For viewing and saving the sensor data a special program supplied (LabView based). To run LV execution files an environment like Run Time Engine must be installed first. Just run setup in ISD_Installer directory. After installation, any LV .exe files can be run on this PC.

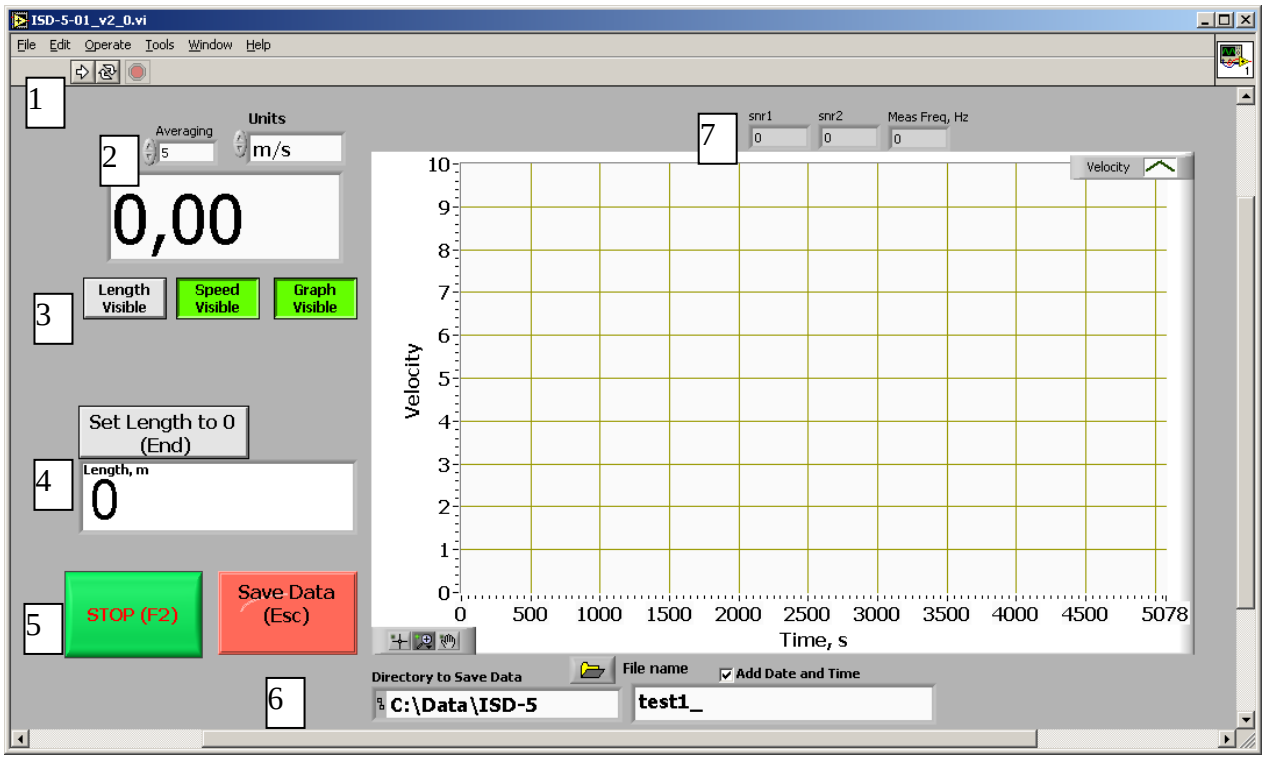


Fig.5. ISD-3_En_v2_0.exe – Program to work with sensor data sended from controller to PC via Ethernet connection.

Here:

1 – Run program button  . When it runs the indicator  (abort button) becomes red.

2 – Current speed indicator in selectable units and averaging (acts to indicator and Speed Chart only, not to saving data).

3 – Visibility ON/OFF of indicators. All ON load PC significantly, especially at high measurement frequency

4 – Length indicator with button to set it to 0. Act on saving length data too. Note: controller send cumulative length from its power ON, so use the button “set Length to 0” before start measurement (brake test for instance).

5 – Program Stop button. Use it to stop program to correct closing the PC ports and data file (see 6 below).

6 – Save Data button. When it pressed, the data writes to file – its directory and name are editable. Note, that the directory must exist (created in advance), file with the name will be created automatically. After test is over, use Stop program button to correct closing the file. Data saves as text file (ASCII) in 3 columns: No of measurement; Speed [Km/h]; Length [m] starting from 0 if Set to 0 was pressed before test starts.

7 – Current S/N and measuring frequency indicators. Normally, at standstill S/N is ab. 4 – 7. If it much more – there are some extra noises or mowing objects in the sensor view area (see 10.3 above). Try to increase S/N in “Algorithm Parameters” or use diagnostic program (see fig.6. below).

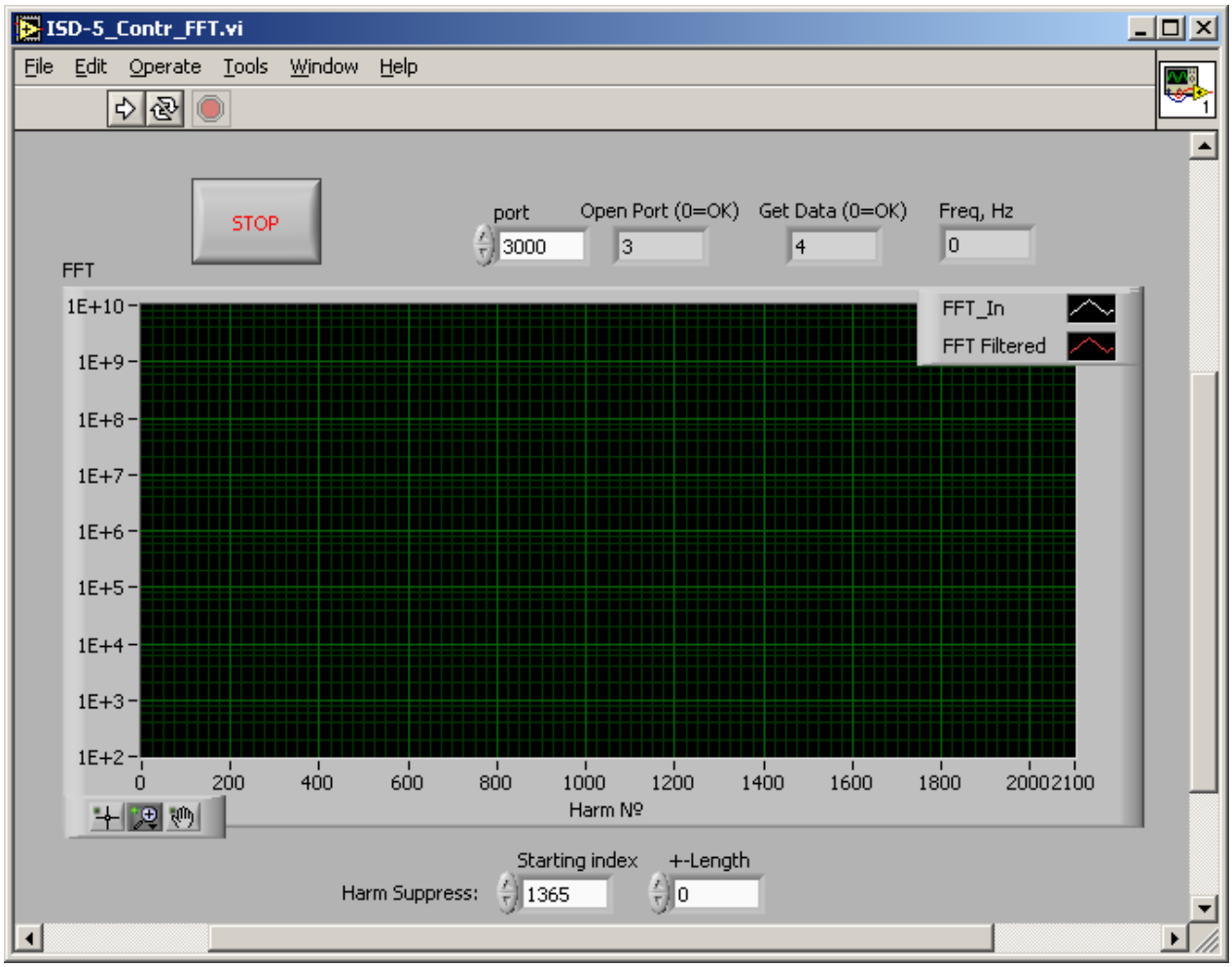


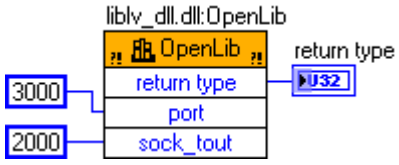
Fig.6. ISD-5_Contr_FFT.exe – Sensor diagnostic program.

This program mostly designated for industrial sensor application. To work with it, select OP_MODE_SEND_FFT in “Controller mode config”. Here the FFT spectrum of sensor signal presented. You can see the presence of signal from mowing object, adjust the sensor position to get a maximum signal (measuring of cable length, for instance). Additionally, the possible electromagnetic or optical noises (in hard industrial environment) can be seen. If it present, try to change the sensor position, grounding etc. If it unremovable, it is possible to suppress it with “Noise reduction” function.

11.3. Dynamic Link Library description

User can read the sensor data in third party software environment like C++, LabView and others. For this, liblv_dll.dll module can be used. Data format is in lv_dll.h file. To read the data via Ethernet only 3 function needed. Below are examples for LabView environment.

OpenLib :



Opens and configure PC ports to work with net UDP protocol.

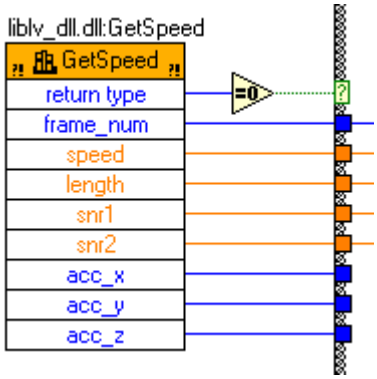
Input parameters:

- **port** - No of port to receive the data – must be the same as in controller DATA_PORT (see. 10.3).

- **sock_tout** – Timeout for data waiting in ms.

Output: **return type**, 0 = OK, or see lv_dll.h for list of errors.

GetSpeed :



Reads the data continuosly.

- **return type**, 0 = OK;

- **frame_num** – No of measurement;

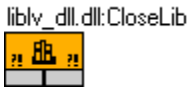
- **speed** – current speed [Km/h];

- **length** – length [m] from controller power ON;

- **snr1, snr2** – Current S/N;

- **acc_x, acc_y, acc_z** – Current accelerations [m/c^2]

CloseLib :



Close the port and releases the PC resources. It must be executed before program stops.

12. System maintenance

The sensor head and processor unit has no service points. Maintenance limited to keeping clean the sensor windows. Note: Do not use solvents for cleaning!

13. Warranty

Warranty period is 18 months after selling.

14. Troubleshooting

14.1. Some constant speed measured and standstill

There is strong electromagnetic noise on the controller ADC input. As a rule, it induced on cable signal wires from power wires, especially if pulse DC-DC converter used or some pulce power consumers (like DAQ system) feeded from the same source. Use separate power source if possible. Use diagnostic program to see the noise and to suppress it.

14.2. No speed measurement at object mowing

- Cable or electronic damage or wrong parameters in the sensor setup. Use the diagnostic program to see the signals.
- No Ethernet connection (programs does not running). Reset the controller to factory settings (see 9.3. abowe).

Sensor repairing must curried out by manufacturer only.

15. Distributors

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