



RIFTEK
Sensors & Instruments



OPTICAL SPEED AND LENGTH SENSORS

ISD-3+ Series

User's manual

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1. Safety precautions

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

2. CE compliance

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

- EU directive 2014/30/EU. Electromagnetic compatibility (EMC).
- EU directive 2011/65/EU, “RoHS” category 9.

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3. General information

Currently, the ISD-3 family includes 6 models with different versions with the working range from 10 cm to 80 cm (available on request). Custom-ordered configurations are possible with parameters different from those shown below.

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

In addition, a special version of sensor for sport application (bobsleigh, toboggan) is available on special request.

The main purpose of the Sensor is a high precision measurement of speed and traveling distance of the vehicle relative to ground (automotive and railroad application) and speed and length of objects moved relative to the sensor (industrial application).

Measuring principle – raster spatial filtration of an object image, technology is patent pending.

Main features of the ISD-3 family:

- High precision of measurement: 0.03 – 0.1% RMS in industrial, 0.1 – 0.2% RMS of velocity and <0.1% of distance (>100 m) in automotive application.
- Reliable measurements on virtually all types of surfaces.
- Broad range of nominal working distances – from 10 cm to 80 cm and it can vary up to 2.5 times during measurements.
- Big lens aperture – geometric aperture ratio up to 1:4. As a sequence, 10 W of halogen lamp or even IR diode of 2 W electrical power is enough for object illumination in most cases.
- Low weight and power consumption of controller module (1.5 W) due to last generation of ARM microcontrollers used.

4. Basic technical data

Parameters	Value	Notes
Speed range	from 0.5 to 250 km/h	Others on request (up to 500 km/h).
Speed accuracy*	<±0.1 % RMS	Determined on test bench (treadmill) at 18.38 km/h.
Absolute distance accuracy*	<±0.1 % RMS	After calibration at S > 100 m.
Measuring frequency	34.5 or 54 Hz	Others are user adjustable (max 80 Hz).
Nominal distance to the road and tolerance (range of working distance)	35 ± 15 cm, 50 ± 20 cm, 80 ± 25 cm **	Others on request (up to 180 cm).
System power supply (tolerance)	12 V nominal (11 – 14.5 V)***	
System power consumption	Sensor head: 20 W (5 W with LED as illuminator) Processor unit: 1.5 W	
Sensor head operation temperature range	-20...+50°C	
Weight of the sensor + mounting bracket	200 g + 120 g	Without cable.
Processor unit	Built in the sensor housing	
Sensor dimensions	150 x 67 x 45 mm	Including illuminator, see fig. 2.
Sensor cable length	3 m	Up to 10 m on request.
System power cable length	2 m	Up to 10 m on request.
Environmental sensor head protection	IP67	
Magnetic fixing tool	4 magnets x 16 kg strength	Option, see fig. 2.
Controller unit outputs:		
Analog output	Speed, 40 mV/(m/s) 3 V max.	Typical values, user adjustable (see the software description below). DAC resolution – 12 bit, frequency resolution – 32 bit.
Frequency output	Length, 1000 pulses/m (=speed 1000 Hz/(m/s), meander HTL 0 – 12 V, up to 100 KHz	
Digital output	COM-USB adapter No of meas, Speed, Length, SNR	
Physical data latency at measurement freq, ms 34.5 Hz 54.5 Hz	15 10	Stable, =½ of measuring time, without averaging.
Base Software	Program to read data via COM, visualization and saving data, sensor diagnostics and parameters configuration.	See below for details. Custom software by request are possible.

* After calibration on the object to eliminate mounting axes errors.

** For typical road surface. On even and non-contrast surface the actual upper limit may be less.

*** Restricted by illuminating lamp only, for it powered directly from power supply. Processor unit and sensor electronics have an individual +5V linear regulator with up to 35 V tolerances.

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

5. Example of item designation when ordering

ISD-3-35cm-COM-PL12-3m

Symbol	Description
35cm	Nominal distance to the object
COM	Digital interface, COM-USB converter
PL12	Pulse out: 0-12 V, 0-5 V, or 0-24V
3m	Cable length from sensor to controller unit, up to 15 m

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6. System parts and connections

System parts and connections are shown below.

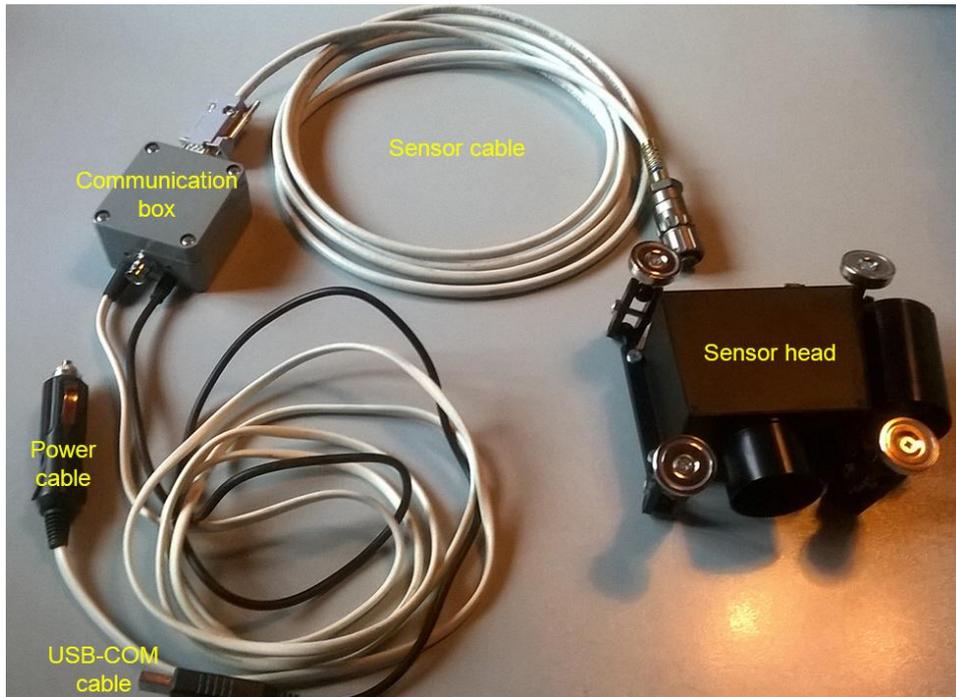


Figure 1. Sensor parts and connectors.

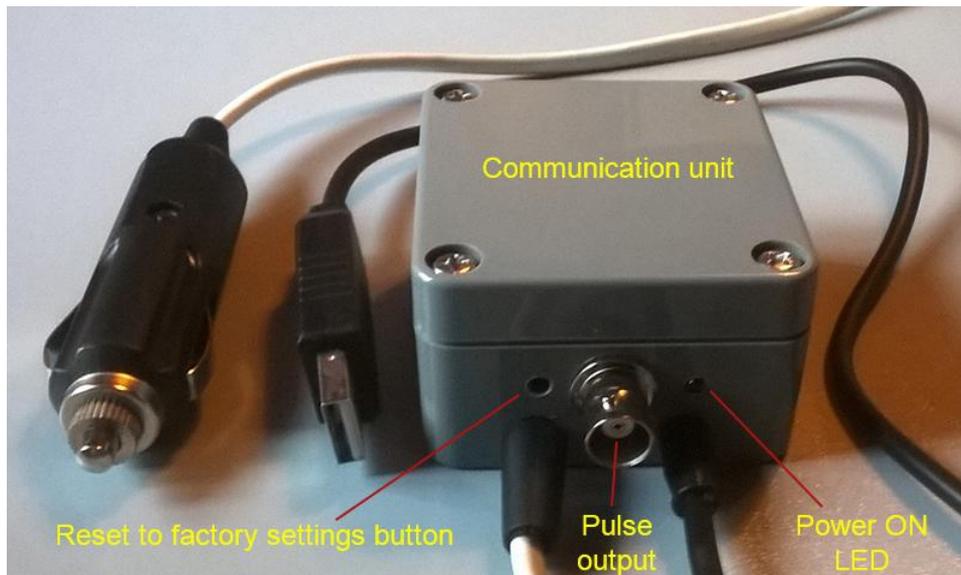


Figure 2. Communication unit. “Reset to factory”, see par. 8.3 for details.

7. Overall demands for sensor mounting

Sensor dimensions and mounting tools are presented in Figure 3.

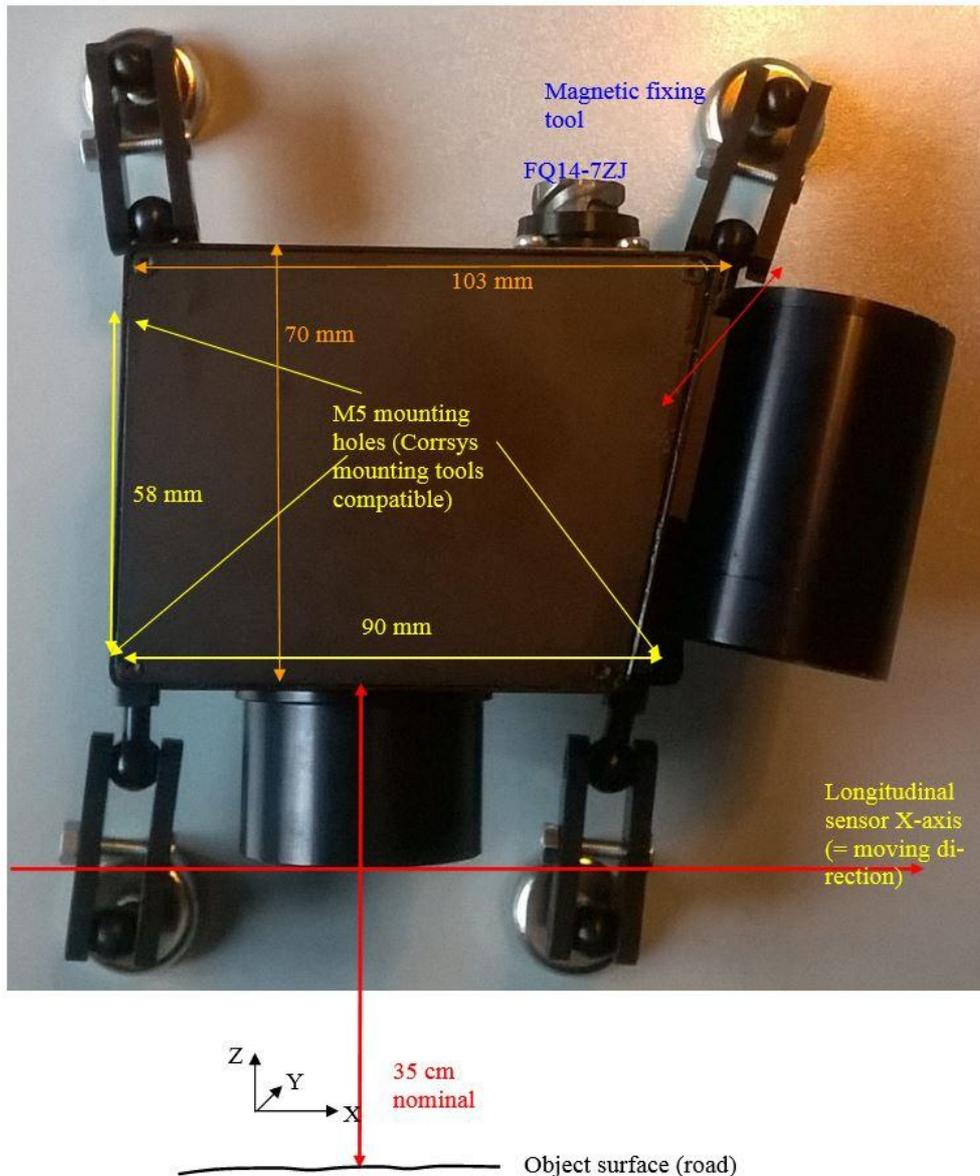


Figure 3. Sensor dimensions and position relative to the road. Moving along X-axis.

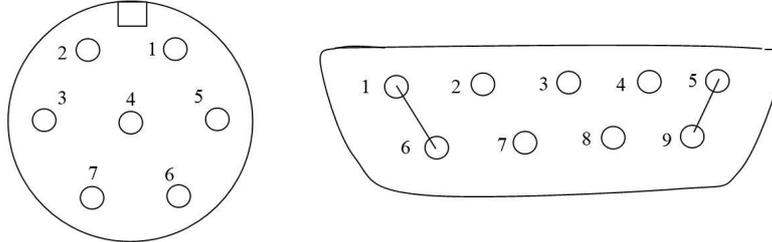
Nominal distance to the object could be measured from front plane of the sensor, as indicated.

Sensor X-axis must be perpendicular and Y-axis must be parallel to the 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 the object moving direction will lead to decreasing the measurements as $\sin(\alpha)$. For instance, at $\alpha=4^\circ$ the measured speed will be less than the actual speed in 0.24%. That is why, the pre-calibration is necessary to reject the align errors to achieve the maximum accuracy.

8. Connection

8.1. Sensor cable: 7 pin FQ14-7T-type to DB9-M

Cable view:



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Signal	FQ14-7T pin	DB-9-M pin	Note
GND	4	5, 9	
Power (+12V)	2	1, 6	
Pulse output	6	4	
Rx	1	2	
Tx	5	3	
	3	7	Reserved
	7	8	Reserved

8.2. Other cables

Destination	Type	Comments
COM-USB converter	PL2303HX	To connect to PC, 115200, 8n1 Black – GND White – Rx Green - Tx
Pulse output	BNC	0 – 12V, Rout=1,5K
Power	Lighter socket	Standard type

8.3. Controller reset to factory settings

In case of any problems, controller can be reset to factory settings. Press the button by some stick, then power ON the system. Factory settings are restored.

9. Working with the sensor

9.1. Working with the external (custom) DAQ

- Fix the sensor properly relative to the object.
- Connect the sensor and controller unit by the cable, switch on the power. Controller is ready in 3 s.
- Connect the pulse output with the counter input to measure the distance.
- If needed, correct the calibration multiplier in DAQ or controller software (see below).

10. Software

10.1. Installation

The COM-USB cable is used for connection to PC to set up sensor parameters, view signals quality for sensor position adjustment, view and save measurement data.

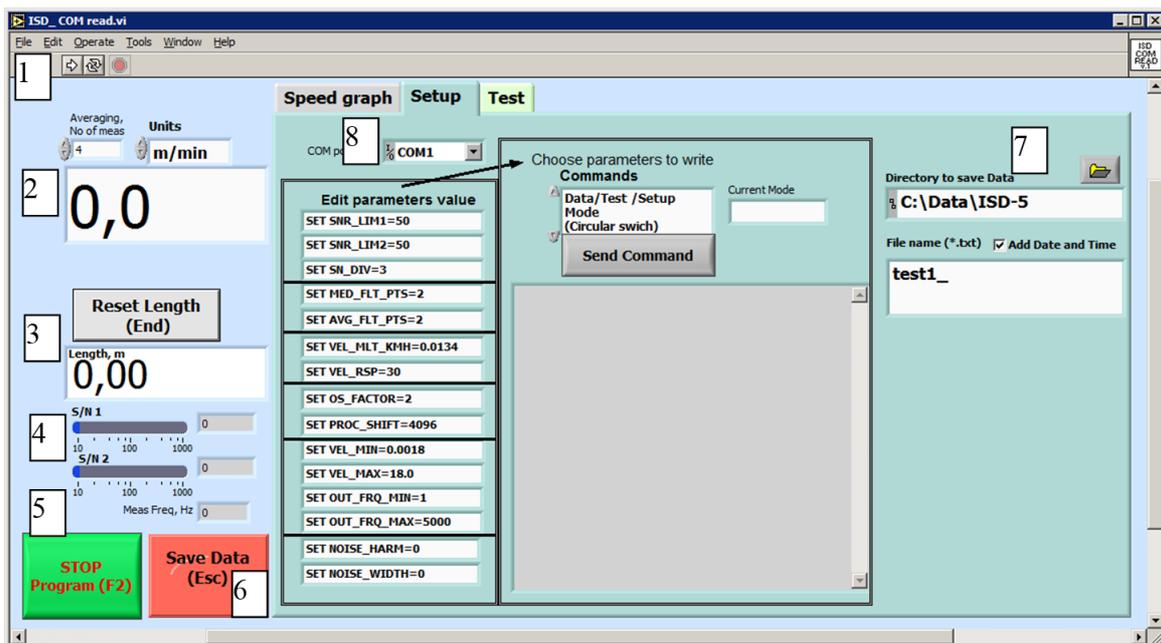
Operating systems: from Windows XP to Windows 10 (different drivers may be needed).

What to be installed for program functionality:

- Run-Time Engine for support LabView *.exe programs. Run Setup in directory "ISD Installer".
- LV Visa to get access to PC ports, including COM. For Windows <7, install *visa320runtime*. For Windows 7 and later, install *visa540_runtime*. **Note:** Only one version must be installed! If you have installed the wrong version, uninstall it before installing the other version.
- COM-USB Driver for Prolific PL2303HX. For Windows 8/10 old v.1.5.0 (10.21.2011) works well.

10.2. Program ISD_COM read description

Open the program **ISD_COM read.exe**.



Here:

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

2 – Current speed indicator in selectable units and averaging. The graph is in the Speed Graph tab.

3 – 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 "Set Length to 0" button before starting the measurement (or restart sensor by power OFF-ON).

4 – Signal quality indicator (Signal to NoiseRatio). It is visible on the graph in the Test tab too. It is used to control and adjust to max signal quality (see below in details)

5 – Stop program.

6 – Save Data button. When pressed – data saves in operating memory (RAM), after Stop Program – it writes all data to the file, specified in 7.

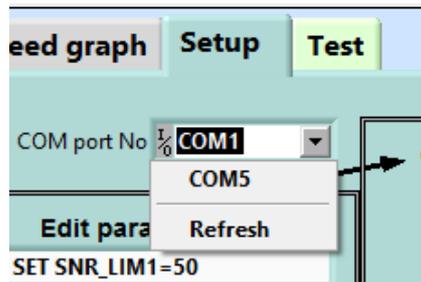
7 – Directory and file name to save data. Directory must be created in advance, file will be created automatically, edit the name before program Start. By default, the date and time are added to the name. **Known issues here: If the PC data format is like 02/10/2018, the file will not be saved. Change the date-time format in PC or uncheck date-time adding.**

8 – Setup tab. To manage sensor parameters and operating modes (see below in details).

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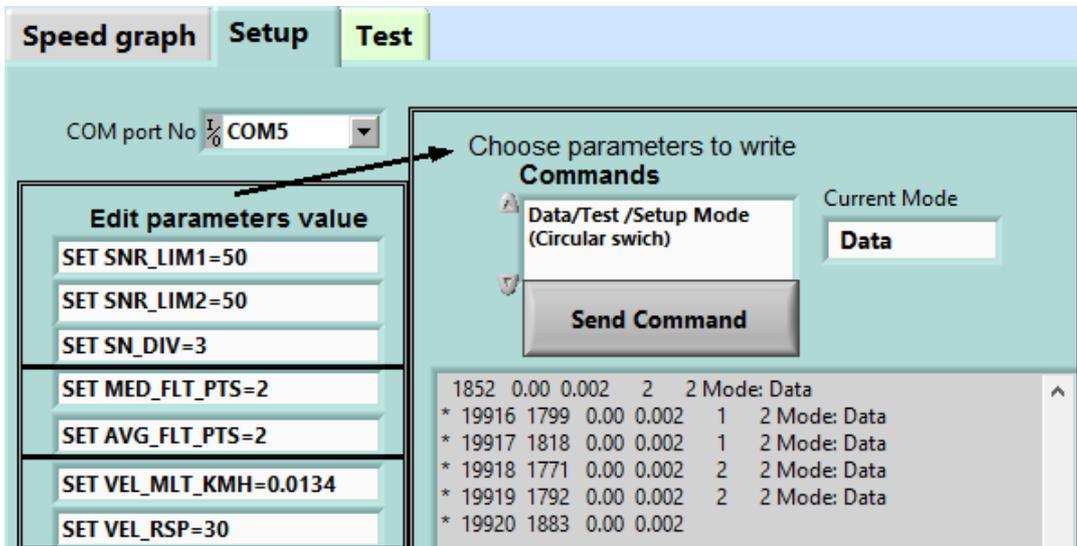
10.3. Sensor parameters configuration

- First, before Start program be sure the right COM port chosen:

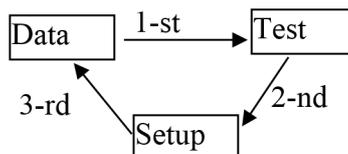


By default it is COM1. To see the actual number of your Prolific COM-USB, unfold the window and press **Refresh**. Then unfold again and choose the right port. Refer to **Device manager** if you do not sure which is your Prolific.

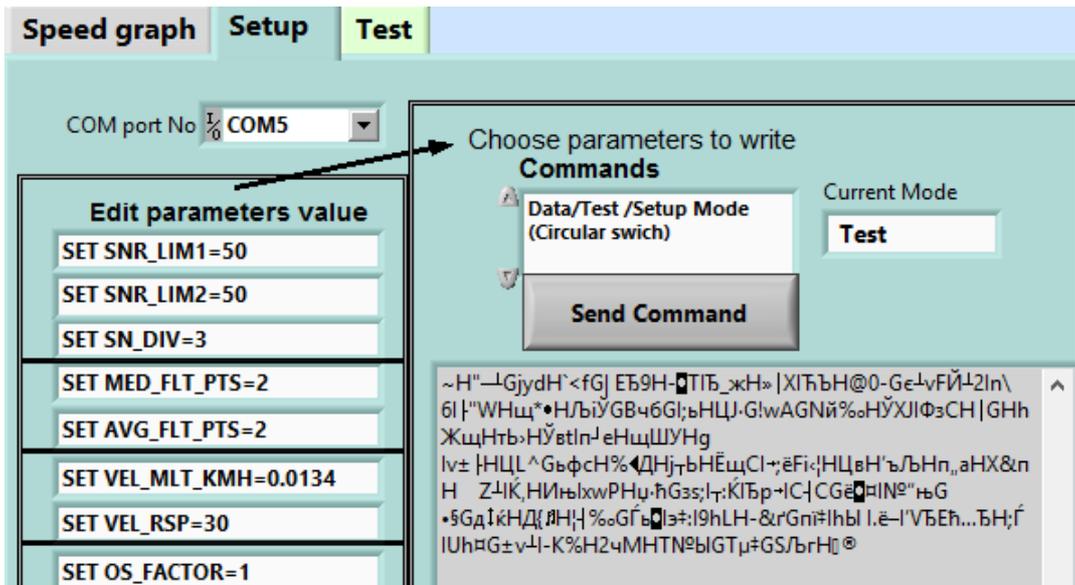
- Run the program. At sensor power ON it is in Data mode, it is visible on screen:



It is main working mode for measurement. There are two other modes:

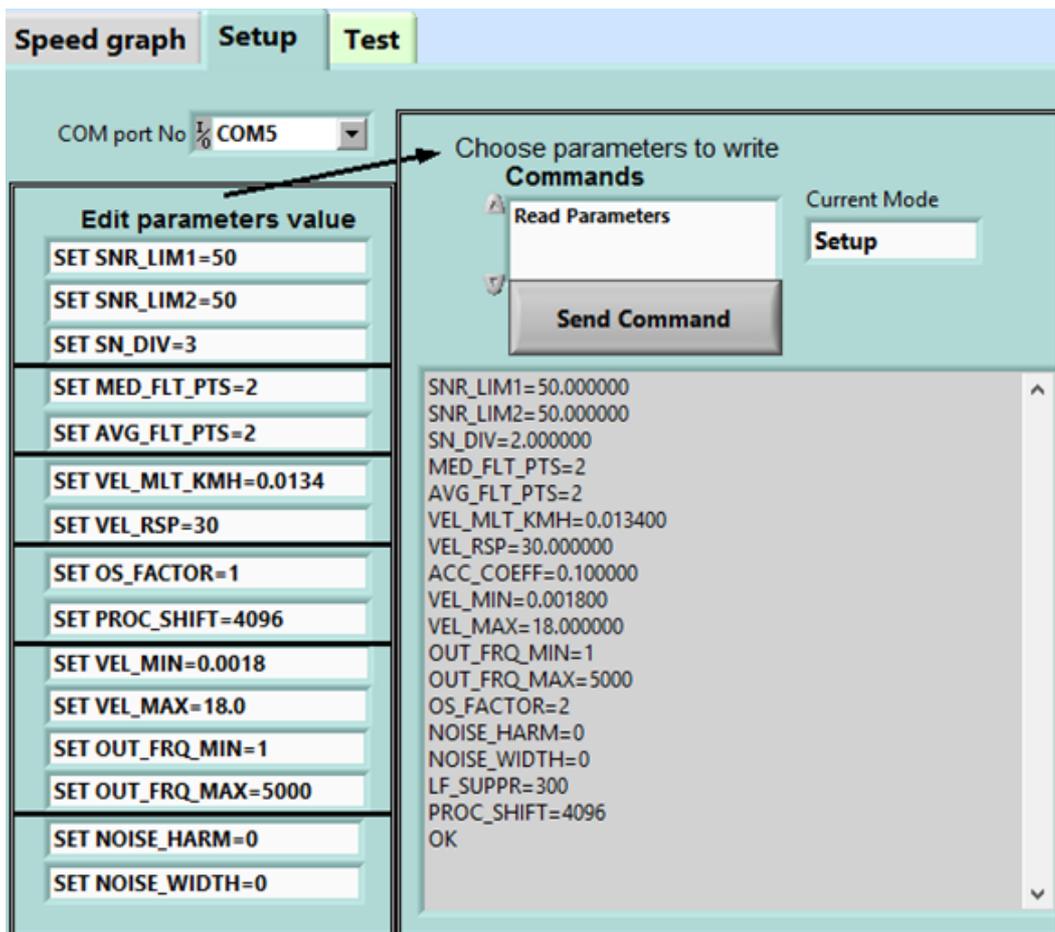


It changed circularly by sending command as shown in the figure above. The actual mode is displayed on the indicator to the right.

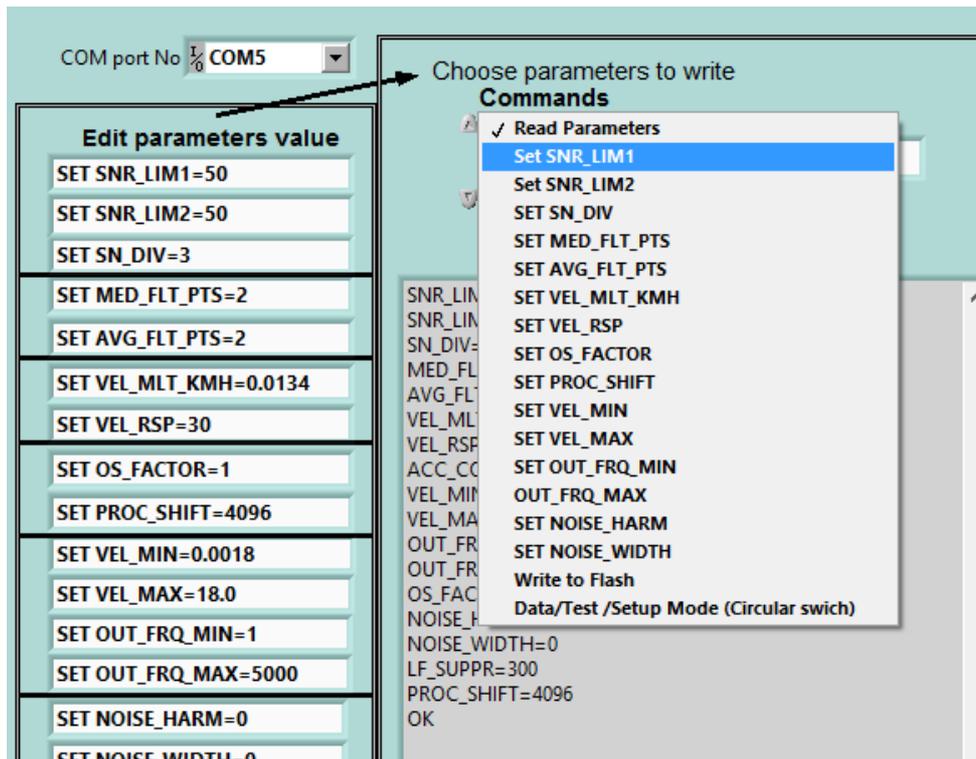


10

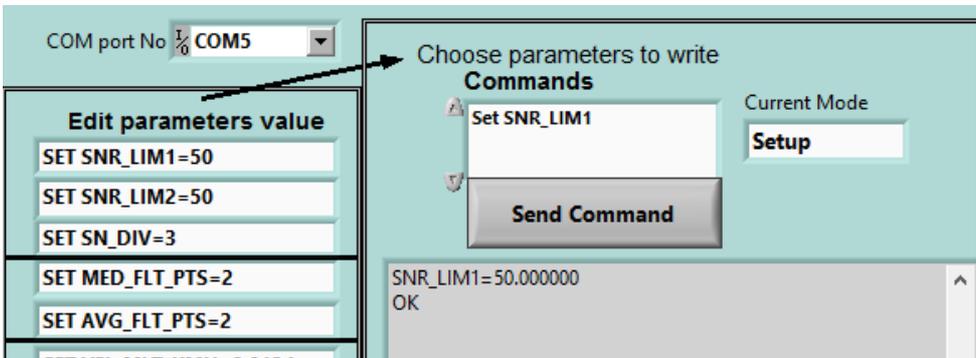
1-st Send: sensor in Data mode. Along with measurement data, the sensor sends an array of signal spectrum, it appears in the Test tab. Use it to adjust the sensor position relative to the object to get the maximum signal quality (see below in details).



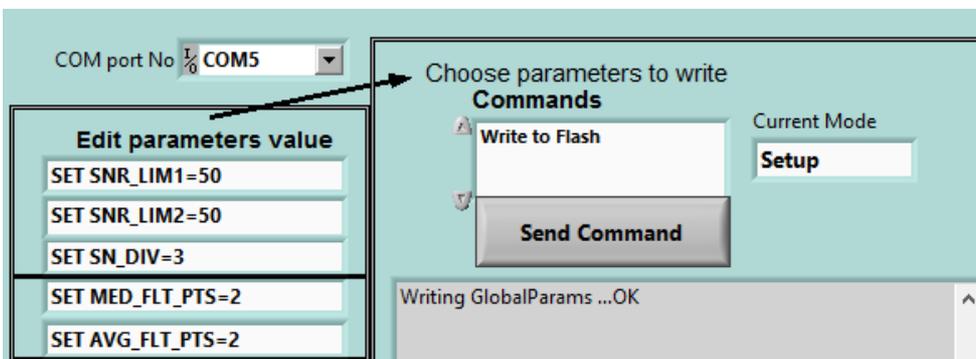
2-nd Send: sensor in Setup mode. In the picture: result of sending command “Read Parameters”. You see actual parameters in sensor controller Flash memory (at first read, it is the factory defaults, save it as text or picture in the PC to have a copy of factory defaults). The full list of commands is unfolded by pointing to the Commands window:



List of Commands. First, edit the parameter value you want to change (in the left column (default values, they appear as default at first program Run), then send it by appropriate Command one by one:



Result of sending the command. Now the parameter value is in the operating memory of the sensor controller. Change other parameters if needed, then write it to the controller Flash memory:



All parameters are written to Flash. You can check it by the Read Parameters command. Then change the Mode to “Data” – sensor is ready for measuring. Note: Actually, Pulse output always works in any mode, but, for instance, in Test mode the

controller is very busy, which leads to reducing the measurement frequency and some data may be distorted.



After Writing, reset controller by RESET command . It will start in Data mode with new parameters.

Parameters details:

Usually there is no need to change parameters in normal working conditions, but it gives the maximum flexibility in sensor adjustment. It is used in industrial application mostly. In road applications, it is hard environmental conditions (rain, snow, clear ice surface, ...).

- SNR_LIM1 и SNR_LIM2 – Signal to Noise Ratio Limit – to distinguish between stand-still and moving object. If real values less – speed regarded as = 0. Typical values at stand still are 2 – 6. At moving object S/N 1 (and S/N 2 at velocities > 20% of Vmax) > 100 - 1000 typically. See real S/N at stand still/ no object and set it 5 – 10 times more to guarantee V=0 at stand still. But in some cases (vibrating object or by-side moving objects in the sensor beam pass, including possible reflections) – some velocity measurement at standstill may occurs. In some range it can be overcome by S/N increasing. The less LIM value – the more measurement sensitivity. Current S/N can be observed on indicators and Chart form (Tab Setup).

- S/N_DIV – decreases SNR_LIM1,2 at high velocities (>30% of Vmax) in N times, to increase sensitivity. Typical value is 2 – 3.

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

- AVG_FLT_PTS – No of measured data averaging. Minimum value = 1 (no averaging).

- VEL_MLT_KMH – Main parameter: Velocity calibration multiplier. Act to length calculation too. Usually, after sensor mounting some precalibration needed to compensate geometric errors (noncollinearity of sensor measurement axis and object moving direction). Measure object with known length (>10m) and compare it with the sensor data. Adjust the multiplier if needed.

- VEL_RSP – Define the maximum measured velocity changing at abrupt real velocity changing. The more the value, the faster sensor can react. Value 20 corresponded ab. 1 g object acceleration at 54 Hz measurement. If finite objects length measured (sheets...) – set it to the max (1000 – 2000) – sensor will measure real velocity instantly, as soon as the object appears/disappears in sensor point of view.

- OS_FACTOR – Act on ADC sampling time. Respectively, it defined the maximum velocity measurement. For instance, OS_FACTOR =2 corresponds up to 5 m/s. Dynamic range of velocity measurement is 1:1000 typically. But the best way to measure (imagine voltmeter, for instance) in the middle of the range. So, if your real velocity in range of <0,5 m/s, it is possible to decrease Vmax to 0,5 m/s by setting OS_FACTOR=20. ADC sampling time increases 10 times, respectively, Vmin decreased 10 times too. Remember that VEL_MLT_KMH must be changed too, namely, decreased 10 times to keep right value. OS_FACTOR can be 1, 2,4...24.

- PROC_SHIFT – Allow to change the measurement frequency (sliding average mode) with step of 512 points. At high OS_FACTOR measurement frequency decreased, with this parameter it is possible to increase it up to 4 times (at PROC_SHIFT=512).

- VEL_MIN и VEL_MAX – Limits max and min velocities measured in km/h in terms of frequency output. At default values, it is up to 18[km/h]/3.6 = 5 m/s with dynamic range 10000. At low velocities measurement (OS_FACTOR=20) set it to 0.00018 and 1.8 to keep frequency range 1:10000.

- OUT_FRQ_MIN и OUT_FRQ_MAX – Define min and max frequency output at VEL_MIN and VEL_MAX. Default value 5000 means 5000 Hz at 5 m/s i.e. 1000 Hz/(m/s) = 1000 pulses/m. To keep the same step of 1 pulse/mm at VEL_MAX=1.8, set OUT_FRQ_MAX = 500. But OUT_FRQ_MIN can not be <1, so, to have the range of 1000, it is better to set MAX to 1000 (1 pulse/0.5 mm) or even more.

- NOISE_HARM and NOISE_WIDTH – Allows programmatically suppress a narrow-band electromagnetic noise. For instance, in Test mode you see some peak of by-said noise much higher than background noise level, which affect to SNR. Set NOISE_HARM = No of central noise harmonic and NOISE_WIDTH = width of noise peak in \pm harmonics. It will be suppressed without measurement distortion even if current velocity in the same range.

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11. System maintenance

The sensor head and processor unit have no service points. Maintenance limited to keeping clean the sensor windows.

Note: Do not use solvents for cleaning!

The only part that may be replaced by user is an illuminating lamp. To change it, unscrew the back cover of the lamp housing, then, unscrew the front lamp splash guard. Use only the same type of lamp 20 W Philips Alu Line 6°. Seal the back cover and the gap between the splash guard and lamp with silicone sealant ($t > 200^{\circ}\text{C}$) to meet the IP67 protection.

12. Warranty

Warranty period is 12 months after selling.

13. Troubleshooting

13.1. Some constant speed measured at standstill

Some strong vibration of sensor head mounting point (on tractor, for instance), or moving objects on the road (water pools at raining, or grass, ...). Use setup mode to see the noise. Increasing S/N1 may help. Anyhow, it disturbs the measurements at standstill only. When a car is moving, the measurement will not be disturbed even at hard raining, till the sensor is completely splashed.

13.2. Program does not run

Be sure the right COM port is chosen and a driver is OK (no yellow mark in Device Manager).

If sensor Setup is damaged, reset the controller to factory settings.

Repairs to the sensor should only be carried out by the manufacturer.

14. Revisions

Date	Revision	Description
17.09.2018	1.0.0	Starting document.

15. Distributors

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