



RIFTEK
Sensors & Instruments



LASER SPEED AND LENGTH SENSORS

ISD-5-M+ 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.
- Do not use sensors in locations close to powerful light sources.
- To obtain stable results, wait about 20 minutes after sensor activation to achieve uniform sensor warm-up.

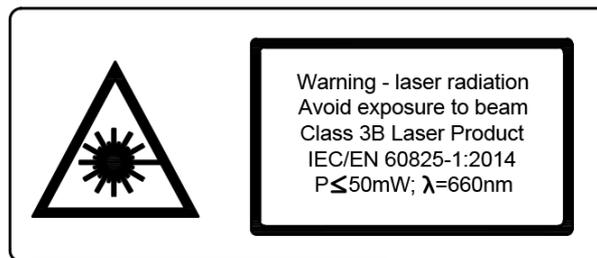
2. CE compliance

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.

3. Laser safety

The sensors make use of a c.w. 635 nm (or 808 nm) wavelength semiconductor laser. The output power is 5...20 mW, or up to 120 mW (IR lasers, for longest working distance). The sensors belong to the 3B laser safety class. The following warning label is placed on the housing (as an example):



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.
- Use the protective screen mounted on the sensor for the blocking of the outgoing beam.
- Use the laser deactivation function in emergency.

4. General Information

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 applications:

- 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 (>10m).
- Reliable measurements on virtually all types of surfaces, including glass.
- Original monolithic beam splitter forms stable interferometric pattern, and provides the bigger distance tolerance among such sensors – up to $\pm 25\%$ of nominal distance.
- Thermo compensated design provides temperature independent measurements, no thermo stabilization needed in broad temperature range.
Note: No temperature drift in +5...+40°C range. At lower temperatures thermo stabilization of housing can be used.
- Monoblock design (build-in controller, no need for controller housing and high environmental noise immunity).
- Low power consumption: 1 Wt typically.
- Low weight: 250 g only.

Currently, the ISD-5-M+ series includes 2 models with nominal working range 15 and 30 cm with $\pm 20\%$ tolerance. Custom-ordered configurations are possible with parameters different from those shown below.

5. Basic technical data

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Parameter		Value	Notes
Speed range, m/min		From 0,04...40 to 0,4...400	User selectable (see User Manual).
Speed accuracy, % RMS		$\pm 0,07$ $\pm 0,02$	No signal averaging. With averaging 0,2...0,3 s at $V > 1$ m/s. Precalibration is needed to reject the geometric errors of sensor mounting.
Length accuracy, % RMS		$< \pm 0,05$	Precalibration is needed to reject the geometric errors of sensor mounting.
Measuring frequency, Hz		54	
Nominal distance to the object, \pm tolerance, cm		15 ± 3 ; 30 ± 6	Others on request.
Emitter type		IR c.v. laser, 20 mW	Class 3R.
Power supply, Vs		8 – 24 V	
Power consumption		1 Wt	
Temperature working range, °C		+5...+45	
Sensor weight, g		250	
Sensor size, mm		114x64x26	Without connector.
Sensor environmental protection		IP65	
Sensor output	Frequency out	Length, 100...10000 pulses/m meander 0 – Vs, HTL	User adjustable (see User Manual).
	Digital out	COM – USB (Prolific PL2303HX)	Freq resolution: 32 bit. Communication with computer, display and save all data, sensor setup.
	Physical data latency at measurement freq, ms 54 Hz	9	Stable, $\approx 1/2$ of measuring time, without averaging.
	Base Software	Program to read data via COM-USB, visualization and saving data, sensor diagnostic and setup.	Custom software by request is possible.

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

6. Example of item designation when ordering

ISD-5M+-30cm-COM-PL-3m-H-P

Symbol	Description
St	St – Standard. Lt – Mini.
30cm	Nominal distance to the object.
COM	Digital interfaces: COM-USB converter. Others (old style RS232...) on request.
PL	Pulse out – base. Analog out, voltage (U) or current (I) – on request.
3m	Cable length from sensor to custom system.
H	Sensor with in-built heater (option).
P	Sensor with protect air cooling housing (option).

7. System parts and connections

System parts and connections are shown in Figure 1.



Figure 1. Sensor parts and connectors.

8. Overall demands for sensor mounting

Mounting holes sizes and sensor axes relative to moving object are shown in Fig. 2.

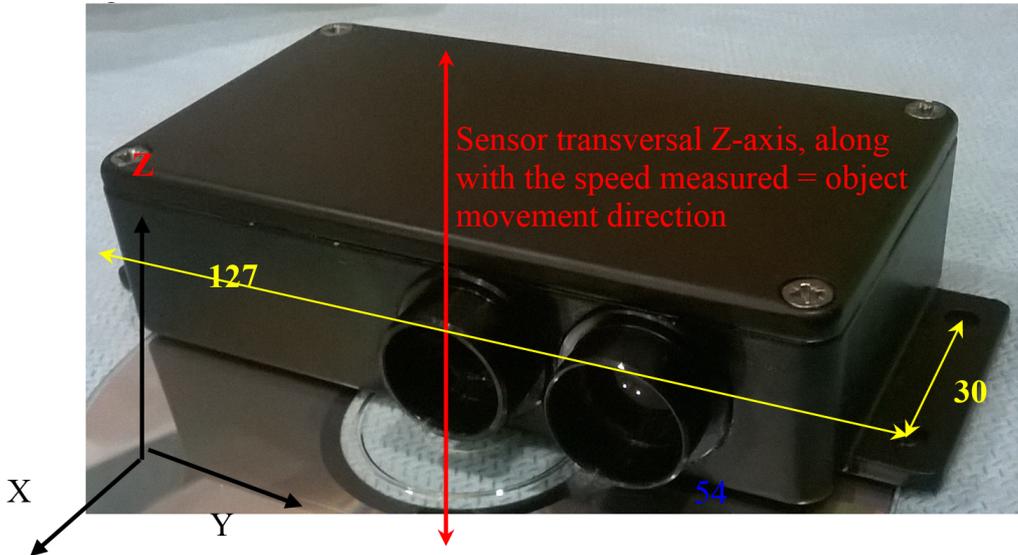


Figure 2. Sensor position relative to moving object along Z-axis. Mounting holes: 127x30mm.

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

Sensor X-axis must be perpendicular and Z-axis – parallel to object moving direction. In ZY plane (perpendicular to drawing plane) sensor Y-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 Z axis relative to object moving direction will lead to decreasing the measurements as $\sin(\alpha)$. For instance, at $\alpha=4^\circ$ measured speed will be less than actual in 0,24%. That is why, the pre-calibration needed to reject the alignment errors to achieve the maximum accuracy.

9. Connection

Designation of connector contacts.

Connector	Type	Assignment, Comments
Power and UART	PY04-4Z plug	1 – Power supply $V_s=8-24V$ 2 – GND ¹ 3 – Tx (connected to Rx of PL2303HX) 4 – Rx (connected to Tx of PL2303HX)
Pulse output	BNC	0 – V_s (HTL), 20 mA max

1 – Ground connected to sensor housing.

10. Software

10.1. Installation

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

PC operational systems: from Win XP to Win 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 Win <7 install visa320runtime, for >=7 - visa540_runtime. Note: only one must be installed! If you install wrong version – uninstall it before other version installation.
- COM-USB Driver for Prolific PL2303HX. For Win 8/10 old v.1.5.0 (10.21.2011) works well.

10.2. Program ISD_COM read description

Open program ISD_COM read.exe.

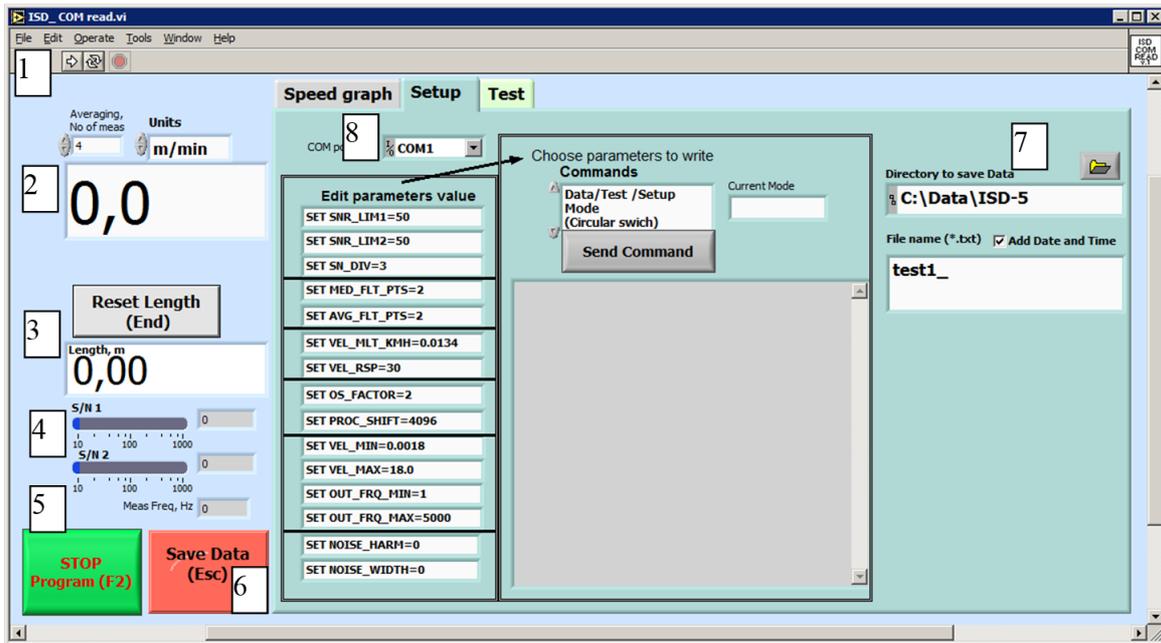


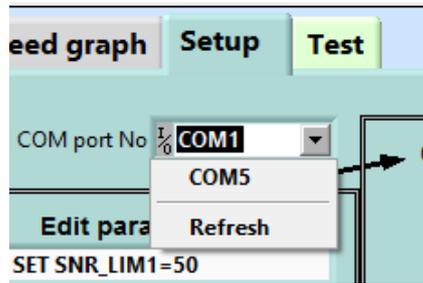
Figure 3. Program window.

Here:

- 1 – Run program button . When it runs the indicator  (abort button) becomes red.
- 2 – Current speed indicator in selectable units and averaging. Graph is on "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 button "set Length to 0" before start measurement (or restart sensor by power OFF-ON).
- 4 – Signal quality indicator (Signal to NoiseRatio). It is visible on the graph in Test tab too. 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, date and time added to the name. Known issues here: if PC data format is like 02/10/2018 – file not saved. Change date-time format in PC or uncheck date-time adding.
- 8 – Setup tab. To manage sensor parameters and operating modes (see below in details).

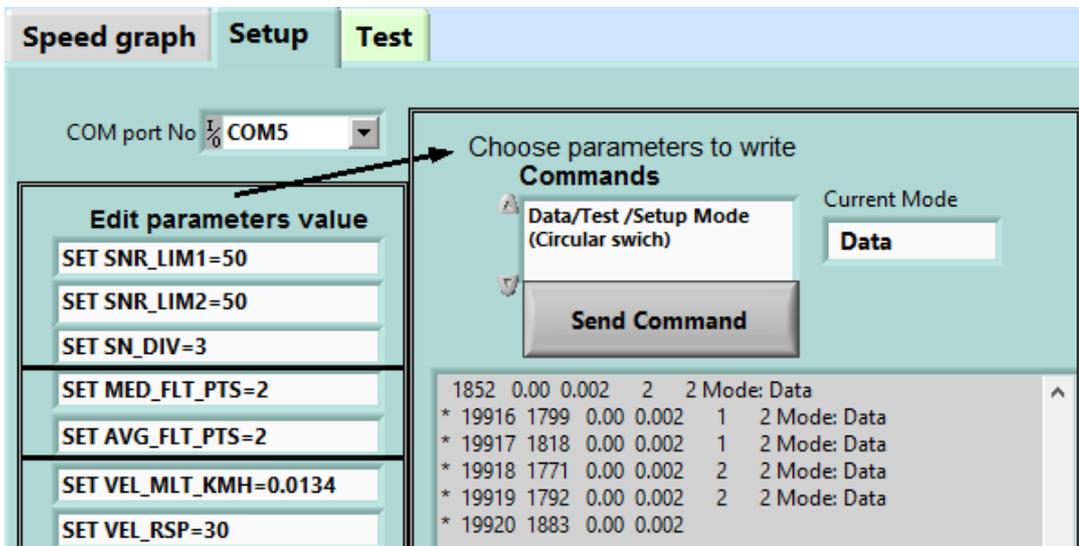
10.3. Sensor parameters configuration

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

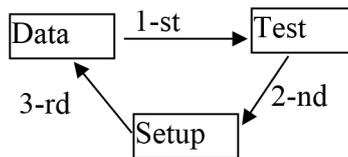


By default it is COM1. To see actual No of your Prolific COM-USB unfold the window and press Refresh. Then unfold again and choose the right port. Refer to Device manager if you do not sure which is your Prolific.

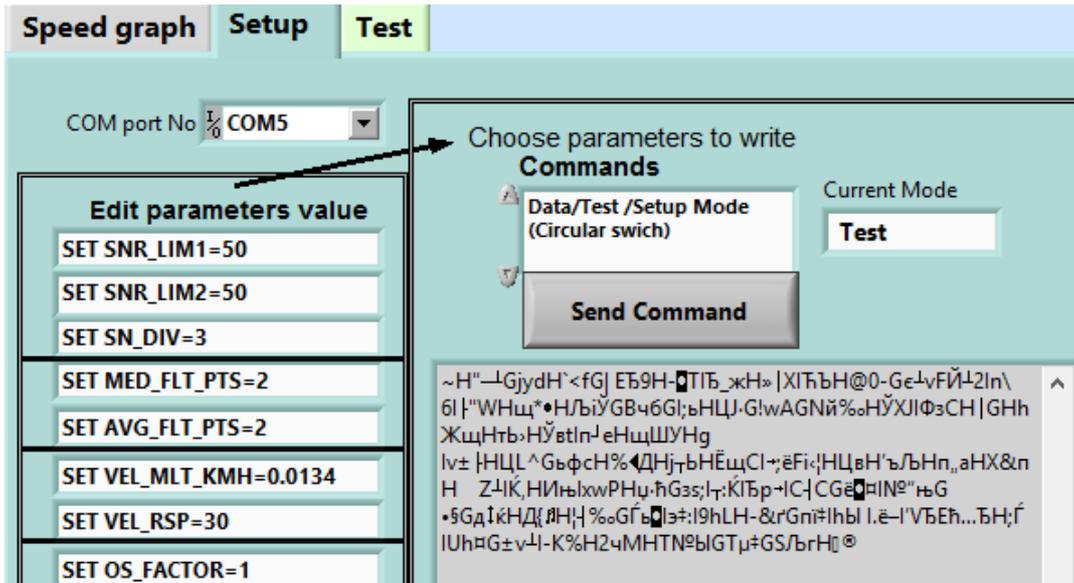
- Run the program. At sensor power ON it is in Data mode, it is visible on screen:



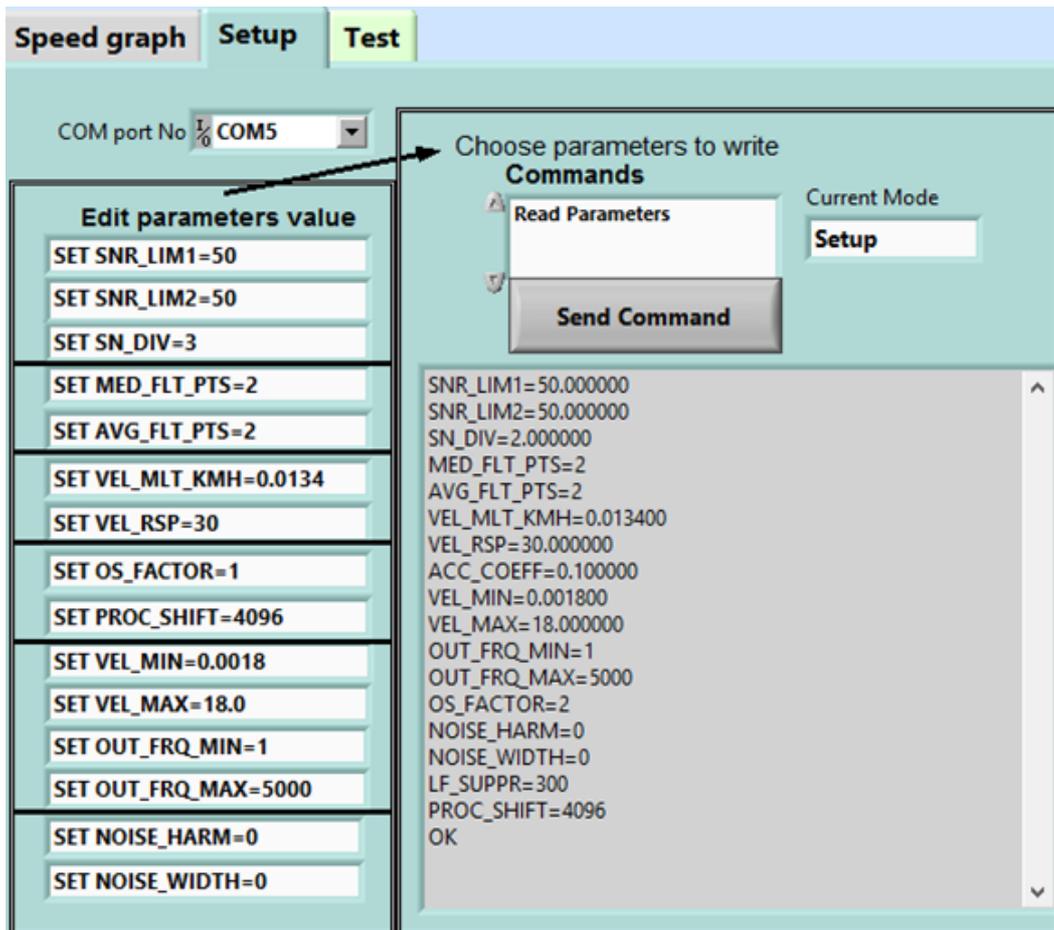
It is main working mode for measurement. There are two other modes:



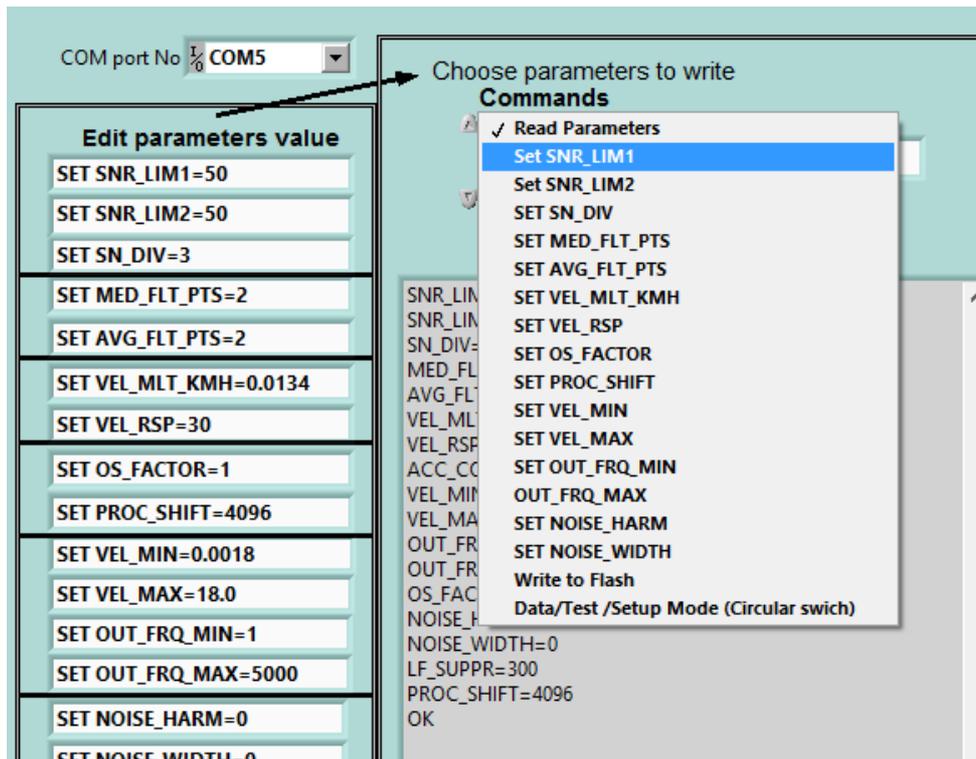
It changed circularly by sending command as on picture above. Actual mode displayed on the indicator on the right.



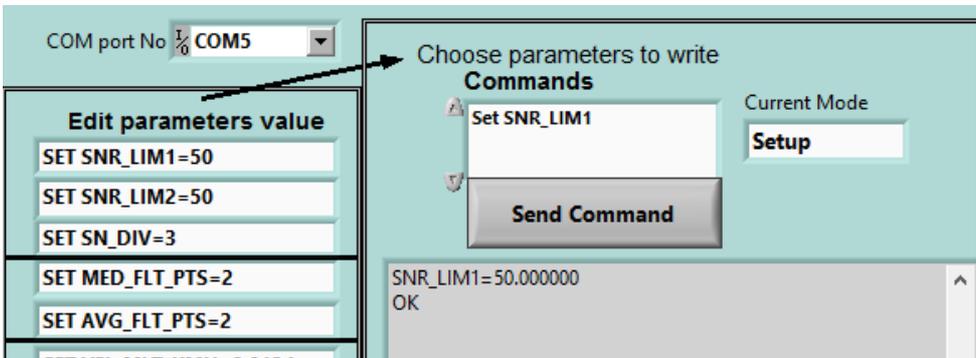
1-st Send : sensor in Data mode. Along with measurement data sensor sends array of signal spectrum, it appears on tab Test. Use it to adjust sensor position relative to object to get a maximum signal quality (see below for details).



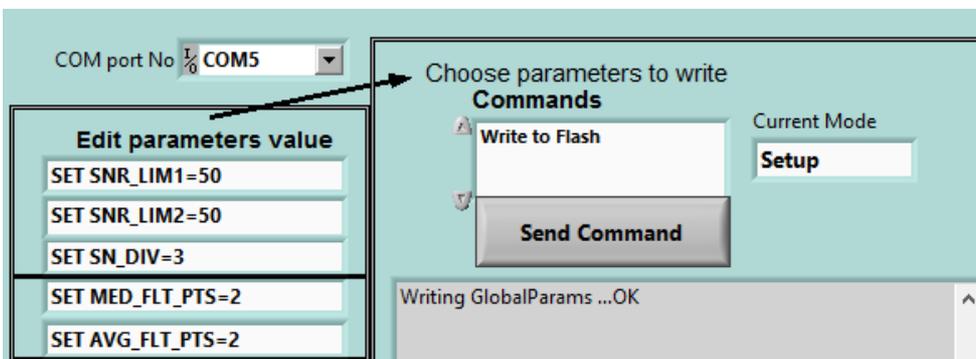
2-nd Send: sensor in Setup mode. On the picture: result of sending command “Read Parameters”. You see actual parameters in sensor controller Flash memory (at first read it is factory default, save it as text or picture in the PC to have a copy of factory defaults). Full list of command unfolded by pointing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



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



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



All parameters has written to Flash. You can check it by command Read Parameters. 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

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

Parameters details:

- 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 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. 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. Min. 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 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 object appear/disappear in sensor point of view.

- OS_FACTOR – Act on ADC sampling time. Respectively, it defined max 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 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 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 range of 1000 better to set MAX to 1000 (1 pulse/0.5 mm) or even more.

- NOISE_HARM and NOISE_WIDTH – Allows programmatically suppress narrow-band electromagnetic noise. For instance, in Test mode you see some peak of by-said noise much higher then 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.

10.4. Sensor position adjustment in Test Mode



In Test Mode signal spectrum visible. You can see real useful signal from fringe pattern of laser beam and LF parasitic signal and background noises. Adjust sensor position to get max useful signal (especially it needed for objects like a thin wire to aim the beam center to wire) and min background noises. For instance, if mirrored light (from glossy metal sheet or wire) comes to sensor receiving optic window - background noises increases dramatically and you will see it.

11. 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!

12. Warranty

Warranty period is 18 months after selling.

13. Troubleshooting

13.1. 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 pulse power consumers (like DAQ system) fed from the same source. Use separate power source if possible. Use Setup mode to see the noise and to suppress it.

13.2. No speed measurement when the object is moving

- Cable or electronic damage or wrong parameters in the sensor setup. Use the diagnostic program to see the signals.

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

14. Revisions

Date	Revision	Description
14.06.2018	1.0.0	Starting document.

15. Distributors

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