RIFTEK

Sensors & Instruments

LASER TRIANGULATION SENSORS

RF603 Series

User's manual

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Contents

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.

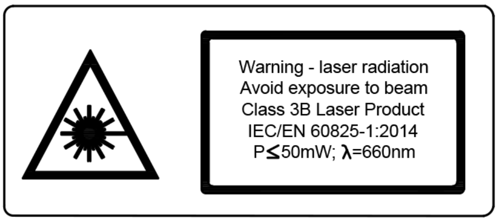
3. Laser safety

The sensors correspond to the following laser safety classes according to IEC/EN 60825-1:2014.

Model of the sensor	RF603R	RF603L	RF603	RF603P
Wavelength	660 nm			
Output power	≤0,2 mW	≤1 mW	≤4,8 mW	≤50 mW
Laser safety class	1	2	3R	3B

3.1. Class 3B sensors

The sensors make use of a c.w. 660 nm (or 405 nm or 450 nm) wavelength semiconductor laser. Maximum output power is 50 mW. The sensors belong to the 3B laser safety class. The following warning label is placed on the laser body:



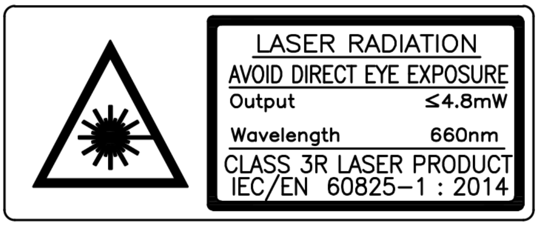
The following safety measures should be taken while operating the sensor:

- 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.

Note. These sensors are supplied only as an OEM product. The consumer is solely responsible for compliance with the laser safety requirements.

3.2. Class 3R sensors

The sensors make use of a c.w. 660 nm (or 405 nm or 450 nm) wavelength semiconductor laser. Maximum output power is 4.8 mW. The sensors belong to the 3R laser safety class. The following warning label is placed on the laser body:

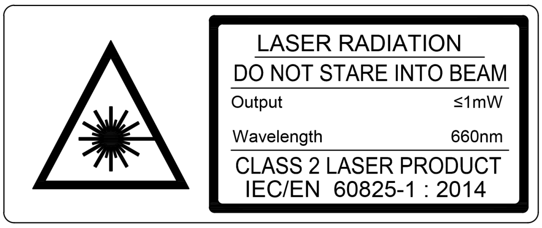


The following safety measures should be taken while operating the sensor:

- 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.
- Use protective goggles when operating the sensor.
- Avoid staring into the laser beam.
- Do not disassemble the sensor.

3.3. Class 2 sensors

The sensors make use of a c.w. 660 nm (or 405 nm or 450 nm) wavelength semiconductor laser. Maximum output power is 1 mW. The sensors belong to the 2 laser safety class. The following warning label is placed on the laser body:



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

- Do not target laser beam to humans.
- Do not disassemble the sensor.
- Avoid staring into the laser beam.

3.4. Class 1 sensors

The sensors make use of a c.w. 660 nm (or 405 nm or 450 nm) wavelength semiconductor laser. Maximum output power is 0.2 mW. The sensors belong to the 1 laser safety class. The following warning label is placed on the laser body.

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

- Avoid staring into the laser beam during a prolonged time period.
- Do not disassemble the sensor.

4. General information

The sensors are intended for non-contact measuring and checking of position, displacement, dimensions, surface profile, deformation, vibrations, sorting and sensing of technological objects as well as for measuring levels of liquid and bulk materials.

The series includes 26 sensors with the measurement range from 2 to 1250 mm and the base distance from 10 to 260 mm.

There are two options of laser mounted in the sensor: RED (660 nm) or BLUE laser (405 or 450 nm, BLUE version). The use of blue lasers instead of conventional red lasers greatly enhances capabilities of the sensors, in particular, for such uses as control of high-temperature objects and organic materials. Custom-ordered configurations are possible with parameters different from those shown below.

5. Basic technical data

RF603-	R-X/4	X/2	X/5	X/10	X/15	X/25	X/30	X/50	X/100	X/250	X/500	X/750	X/1000	X/1250
Base distance X, mm	39	15	15	15, 25, 60	15, 30, 65	25, 45, 80	35, 55, 95	45, 65, 105	60, 90, 140	80	125	145	245	260
Measurement range, mm	4	2	5	10	15	25	30	50	100	250	500	750	1000	1250
Linearity, %	±0.05 of the range												±0.1	
Resolution, %	0.01 of the range (for the digital output only)												0.02	
Temperature drift	0.02% of the range/°C													
Max. measurement frequency	9.4 kHz													
Light source	red semiconductor laser (660 nm wavelength), blue or UV semiconductor laser (450 or 405 nm wavelength, BLUE version)													
Model	RF603													
Output power	≤0,2	≤5 mW												
Laser safety class	1	3R (IEC60825-1)												
Model		RF603L												
Output power		≤0,95 mW												
Laser safety class		2 (IEC60825-1)												
Model											RF603P			
Output power											≤20 mW			
Laser safety class											3B (IEC60825-1)			
Output interface:														
Digital № 1	RS232 or RS485 (max. 921600 baud)													
Digital № 2 (optional)	Ethernet (max. 100 Mbit) or CAN V2.0B (max. 1 Mbit)													
Analog	4…20 mA (load ≤ 500 Ohm) or 0…10 V													
Synchronization input	2,4 – 24 V													
Logic output	programmed functions, NPN: 100 mA max; 40 V max for output													
Power supply	9...36 V													
Power consumption	1,5...2 W													
Environmental resistance:														
Enclosure rating	IP67 (only for sensors with a connector on the housing)													
Vibration	20 g /10…1000 Hz, 6 hours for each of XYZ axes													
Shock	30 g / 6 ms													
Operating ambient temperature	-10…+60°C, (-30…+60°C for the sensors with in-built heater), (-30…+120°C for the sensors with in-built heater and air cooling housing)													
Permissible ambient light, lx	10000 – RF603L, 30000 – RF603, >30000 – RF603P													
Relative humidity	5-95% (no condensation)													
Storage temperature	-20…+70°C													
Housing material	aluminum													
Weight (without cable)	100 gram													

Note: RF603-R-39/4 sensor is designed to use with mirror surfaces and glass.

6. Example of item designation when ordering

RF603(BLUE)(L/P).F-X/D(R)-SERIAL-ANALOG-IN-AL-CC(90X)(R)-M-H-P-B

Symbol	Description
(BLUE)	Blue (405/450 nm) laser option
L/P	Laser safety class: L - Class 2, P - Class 3B
F	Max. measurement frequency, kHz (2 or 10)
X	Base distance (beginning of the range), mm
D	Measurement range, mm
(R)	Round shape laser spot (see p. 18.3)
SERIAL	The type of serial interface: 232 (RS232) or 485 (RS485); CAN or ET (Ethernet)
ANALOG	Attribute showing the presence of 4…20 mA (I) or 0…10 V (U)
IN	Trigger input (input of synchronization) presence
AL	User programmed input/output signal
CC(90X)(R)	Cable gland - CG, or cable connector - CC (Binder 712, IP67) **Note 1:** sensors with CAN or Ethernet interfaces have 2 connectors or two cable glands. **Note 2:** 90(X) option – angle cable connector (see. p. 18.4.) **Note 3:** R option – robot cable
M	Cable length, m
H	Sensor with in-built heater
P	Sensor with protective air cooling housing (see p. 18.1.)
B	Sensor with spray guard (see p. 18.2)

Example: RF603L.140/100R-232-I-IN-AL-24-CCR90A-3 – Class 2 laser, base distance – 140 mm, range – 100mm, round shape laser spot, RS232 serial port, 4…20 mA analog output, trigger input and AL input are available, cable connector, angle type, position "A", robot cable, 3 m cable length.

7. Structure and operating principle

Operation of the sensors is based on the principle of optical triangulation (Figure 1).

Radiation of a semiconductor laser (1) is focused by a lens (2) onto an object (6). Radiation reflected by the object is collected by a lens (3) onto a linear CMOS array (4). Moving the object (6 - 6') causes the corresponding shift of the image. A signal processor (5) calculates the distance to the object from the position of the light spot on the array (4).

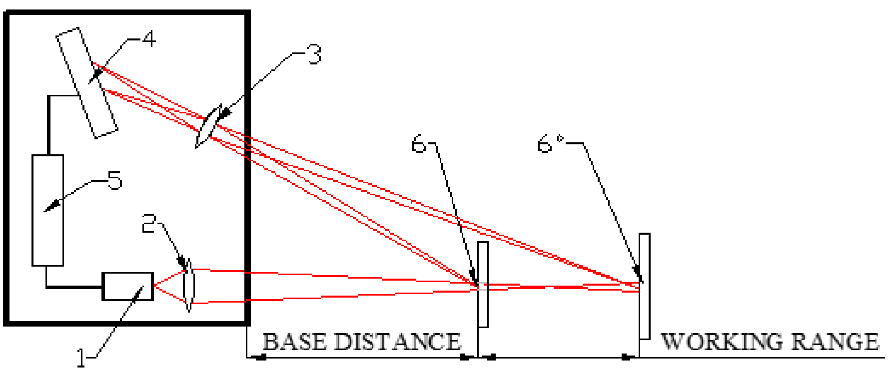


Figure 1

8. Dimensions and mounting

8.1. Overall and mounting dimensions

Overall and mounting dimensions of the sensors are shown in Figure 2 and Figure 2.1. Sensor package is made of anodized aluminum. The front panel of the package has two glass windows: one is output, the other for receiving radiation reflected from the object under control. The package also contains mounting holes.

Sensors are equipped with cable gland or connector. Sensors with CAN or Ethernet interface are equipped with two connectors, Figure 3 and Figure 3.1.

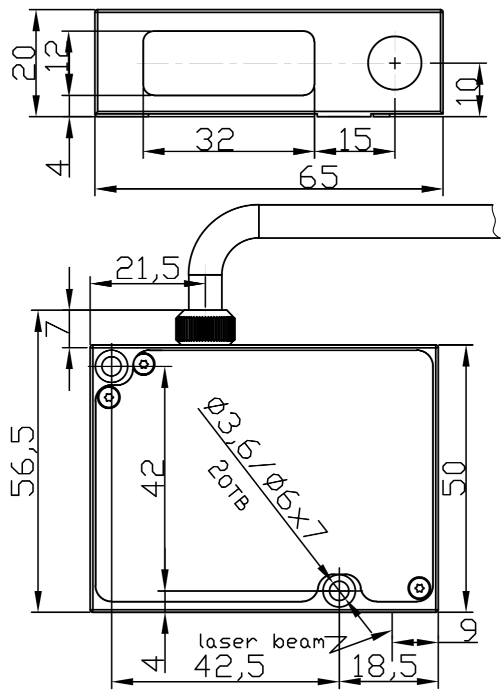


Figure 2. Sensor with cable gland (CG)

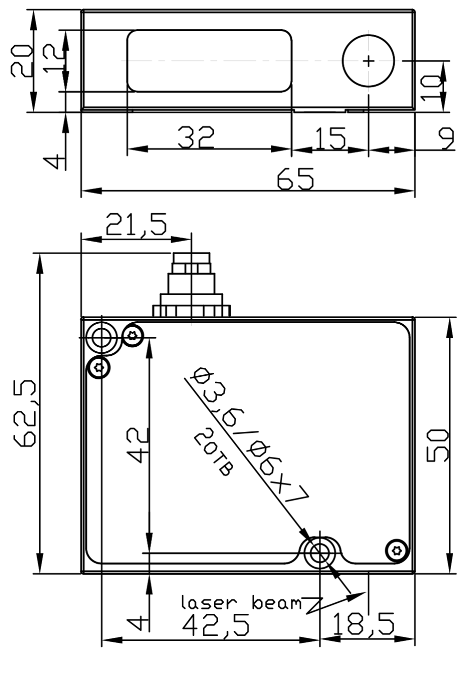


Figure 2.1. Sensor with connector (CC)

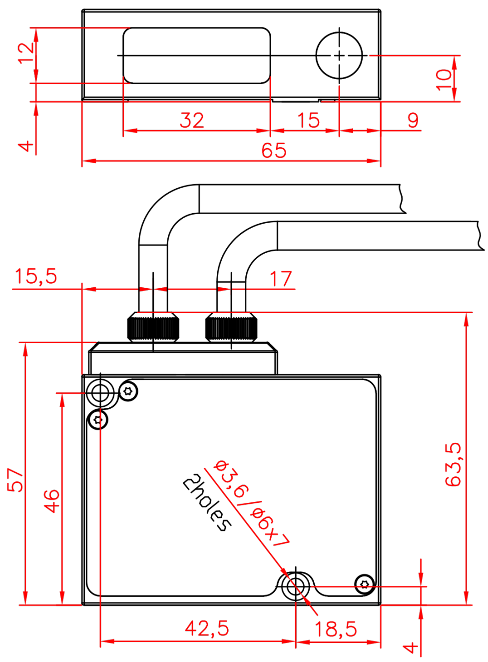


Figure 3. Sensor with two cable glands (CG)

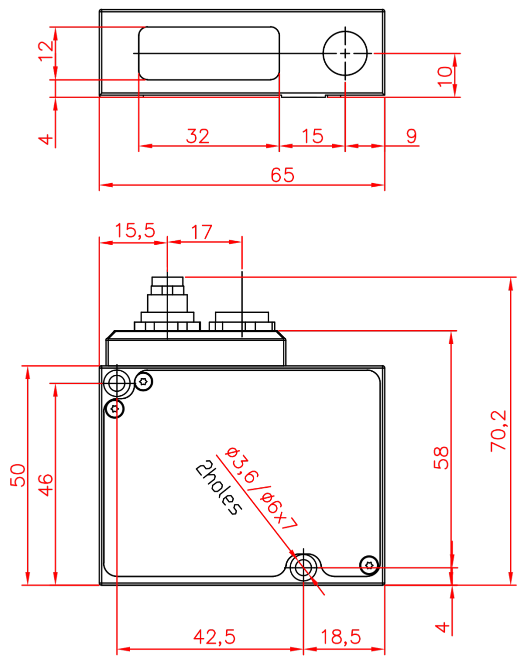


Figure 3.1. Sensor with two connectors (CC)

8.2. Mounting of the sensors for mirror surface control

Figure 4 shows the requirements for the mounting of the **RF603-R-39/4** sensor for control of mirror objects and glass. The special mounting device is included into the shipping, Figure 5.

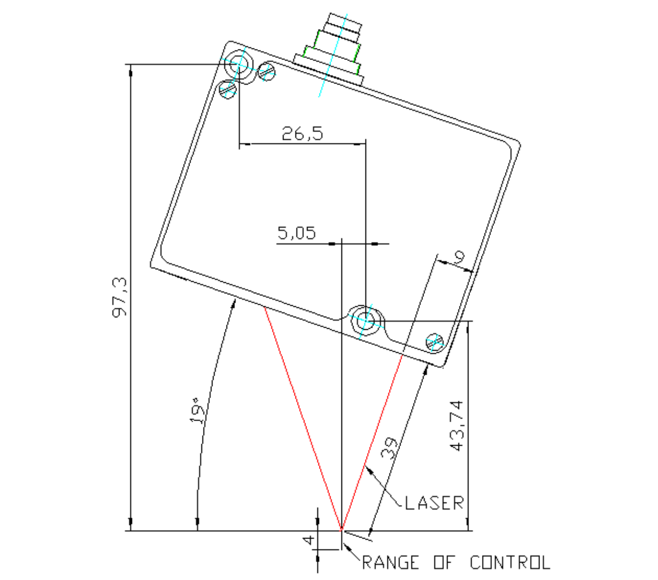


Figure 4

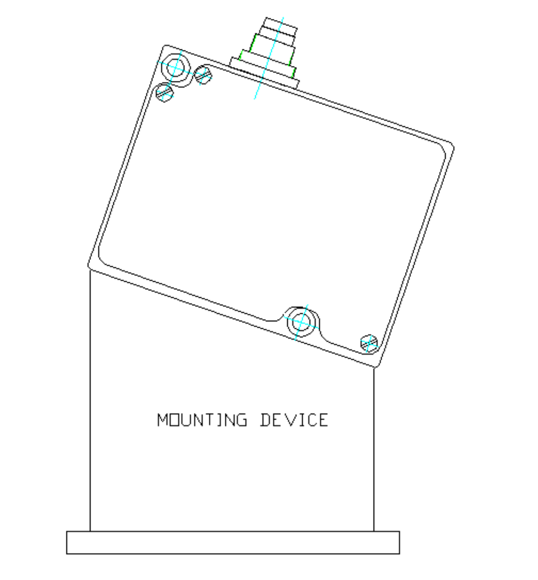


Figure 5

8.3. Overall demands for mounting

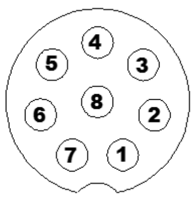
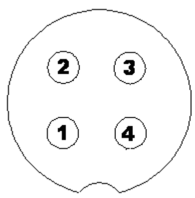
The sensor must be positioned so that the object under control has to be placed within the working range of the sensor. In addition, no foreign objects should be allowed to stay on the path of the incident and reflected laser radiation. Necessary free space for the sensor mounting is shown in par. 18.3.

Where objects to be controlled have intricate shapes and textures, the incidence of mirror component of the reflected radiation to the receiving window should be minimized.

9. Connection

9.1. Designation of connector contacts

View from the side of connector contacts used in the sensor is shown in the following figures. One connector sensors have connector #1.

Connector #1 (Binder 712 Series, #09-0427-80-08)	Connector #2 (Binder 712 Series, #09-0412-80-04)
	

Designation of contacts is given in the following tables:

Connector #1

Model of the sensor	Pin number	Assignment
232-U/I-IN-AL	1	IN
	2	Gnd (power supply)
	3	TXD
	4	RXD
	5	Gnd (common for signals)
	6	AL
	7	U/I
	8	Power U+
485-U/I-IN-AL	1	IN
	2	Gnd (power supply)
	3	DATA+
	4	DATA-
	5	Gnd (common for signals)
	6	AL
	7	U/I
	8	Power U+

Connector №2

Model of the sensor	Pin number	Assignment
-ET-	1	TX+
	2	TX-
	3	RX+
	4	RX-
-CAN-	1	CAN_H
	2	CAN_L
	3	
	4	GND

9.2. Cables

Designation of cable wires is given in the table below:
Cable #1

Model of the sensor	Pin number		Assignment	Wire color
232-U/I-IN-AL	free lead	-	Power U+	Red
	free lead	-	Gnd (power supply)	Brown
	DB9	2	TXD	Green
	DB9	3	RXD	Yellow
	free lead	-	U/I	Blue
	free lead	-	IN	White
	free lead	-	AL	Pink
	DB9	5	Gnd (common for signals)	Gray
485-U/I-IN-AL	free leads		Power U+	Red
			Gnd (power supply)	Brown
			DATA+	Green
			DATA-	Yellow
			U/I	Blue
			IN	White
			AL	Pink
			Gnd (common for signals)	Gray

Cable #2

Model of the sensor	Pin number		Assignment	Wire color
-ET-	RJ-45	1	TX+	White-orange
		2	TX-	Orange
		3	RX+	White-green
		4		
		5		
		6	RX-	Green
		7		
		8		
-CAN-	free leads		CAN_H CAN_L Gnd	White-orange Orange Green

10. Configuration parameters

The nature of operation of the sensor depends on its configuration parameters (operation modes), which can be changed only by transmission of commands through serial port RS232 or RS485. The basic parameters are as follows:

10.1. Time limit for integration

Intensity of the reflected radiation depends on the surface characteristic of objects under control. Therefore, output power of the laser and the time of integration of radiation incident onto the CMOS-array are automatically adjusted to achieve maximum measurement accuracy.

Parameter "time limit for integration" specifies maximum allowable time of integration. If the radiation intensity received by the sensor is so small that no reasonable result is obtained within the time of integration equal to the limiting value, the sensor transmits a zero value.

Note 1. The measurement frequency depends on the integration time of the receiving array. Maximum frequency (9,4 kHz) is achieved for the integration time ≤106 µs (minimum possible integration time is 3 µs). As the integration time increases above 106 µs, the result updating time decreases proportionally.

Note 2. Increasing of this parameter expands the possibility of control of low-reflecting (diffuse component) surfaces; at the same time this leads to reduction of measurement frequency and increases the effects of exterior light (background) on the measurement accuracy. Factory setting of the limiting time of integration is 3200 µs.

Note 3. Decreasing of this parameter lets to increase measurement frequency, but can decrease measurement accuracy.

10.2. Sampling mode

This parameter specifies one of the two result sampling options in the case where the sensor works in the data stream mode:

- Time Sampling
- Trigger Sampling

When the *Time Sampling* is selected, the sensor automatically transmits the measurement result via serial interface in accordance with selected time interval (sampling period).

When the *Trigger Sampling* is selected, the sensor transmits the measurement result when external synchronization input (IN input of the sensor) is switched and taking the division factor set into account.

10.3. Sampling period

If the Time Sampling mode is selected, the 'sampling period' parameter determines the time interval in which the sensor will automatically transmit the measurement result. The time interval value is set in increments of 1 μs.

If the Trigger Sampling mode is selected, the 'sampling period' parameter determines the division factor for the external synchronization input. ***For example***, for the parameter value equal to 100, data are transmitted through bit-serial interface when each 100th synchronizing pulse arrives at IN input of the sensor.

Note 1. It should be noted that the 'sampling mode' and 'sampling period' parameters control only the transmission of data. The sensor operation algorithm is so built that measurements are taken at a maximum possible rate determined by the integration time period, the measurement results are sent to buffer and stored therein until a new result arrives. The above-mentioned parameters determine the method of the readout of the result form the buffer.

Note 2. If the bit-serial interface is used to receive the result, the time required for data transmission at selected data transmission rate should be taken into account in the case where small sampling period intervals are used. If the transmission time exceeds the sampling period, it is this time that will determine the data transmission rate. The calculation of time required to transmit the result is given in par. 11.7.4.

Note 3. It should be taken into account that the sensors differ in some variation in the parameters of the internal generator, which affects the accuracy of the Time Sampling period.

10.4. The point of zero

This parameter sets a zero point of absolute system of coordinates in any point within the limits of a working range. You can set this point by corresponding command or by connecting AL input to the ground line (this input must beforehand be set to mode 4). When the sensor is fabricated, the base distance is set with a certain uncertainty, and, if necessary, it is possible to define the point zero more accurately.

10.5. Line AL operation mode

This line can work in one of the eight modes defined by the configuration parameter value:

- mode 1: indication of run-out beyond the range;
- mode 2: mutual synchronization of two or more sensors ("Slave");
- mode 3: mutual synchronization of two or more sensors ("Master");
- mode 4: hardware zero-set line;
- mode 5: hardware laser switch OFF/ONN;
- mode 6: encoder;
- mode 7: input;
- mode 8: reset of the Ethernet packets counter.

In the *"Indication of run-out beyond the range"* mode, logical "1" occurs on the AL line if an object under control is located within the working range of the sensor (within the selected window in the range), and logical "0" occurs if the object is absent in the working range (within the selected window). For example, in such mode this line can be used for controlling an actuator (a relay) which is activated when the object is present (absent) within the selected range (Fig. 6.1).

The *"Mutual synchronization"* mode makes it possible to synchronize measurement times of two and more sensors. It is convenient to use this mode to control one object with several sensors, e.g., in the measurement of thickness. On the hardware level, synchronization of the sensor is effected by combining AL lines (Fig. 6.2.). Using the parametrization program, one of the sensors should be set to the "Master" mode, and the rest - to the "Slave" mode.

In the *"Hardware zero-set"* mode, connection AL input to the ground potential sets the beginning of coordinates into the current point (Fig. 6.3.)*.

In the *"Hardware laser switch OFF/ON"* mode, connection AL input to the ground potential switches the laser ON/OFF (Fig. 6.3.)*.

In the *"Encoder"* mode, the AL and IN lines work as inputs of quadrature signals. In this mode, the encoder can be connected to these lines, and the measurements will be synchronized with the encoder.

In the *"Input"* mode, the AL line state is transmitted in the status word in the Ethernet packet.

In the *"Reset of the Ethernet packets counter"* mode, connection AL input to the ground potential resets the counter (Fig. 6.3.)*.

***Note.** A low level of the AL line is holding for 100 µs or more, and a high level of the AL line is holding for 100 µs.

Out of the range indication

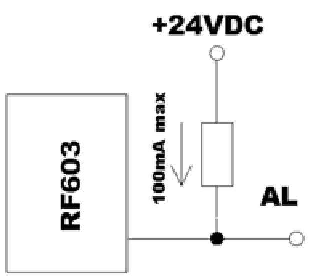


Figure 6.1.

Mutual synchronization

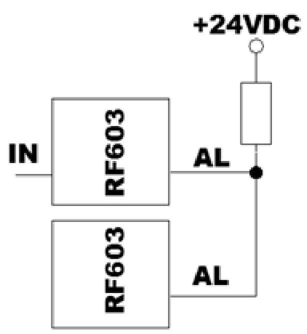


Figure 6.2.

Hardware zero-set/ Hardware laser ON/OFF

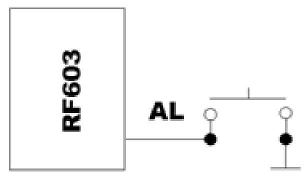


Figure 6.3.

10.6. Time lock of the result

If the sensor does not find the object or if the authentic result cannot be received, a zero value is transferred. The given parameter sets time during which the last authentic result is transferred. The time is set in increments of 5 ms.

10.7. Method of results averaging

This parameter defines one of the two methods of averaging of measurement results implemented directly in the sensor:

- Averaging over a number of results
- Time averaging

When *averaging over a number of results* is selected, sliding average is calculated.

When *time averaging* is selected, the results obtained are averaged over the time interval chosen.

10.8. Number of averaged values/time of averaging

This parameter specifies the number of source results to be averaged for deriving the output value or time of the averaging .

The use of averaging makes it possible to reduce the output noise and increase the sensor resolution.

Averaging over a number of results does not affect the data update in the sensor output buffer.

In case of time averaging, data in the output buffer are updated at a rate equal to the averaging period.

Note. The maximum value is 127.

10.9. Factory parameters table

The sensors are supplied with the parameters shown in the table below:

Parameter	Value
Time limit for integration	3200 (3,2 ms)
Sampling mode	time
Sampling period	5000 (5 ms)
Point of zero	Beginning of the range
Line AL operation mode	1
Time lock of the result	2 (10 ms)
Method of results averaging	Over a number of results
Number of averaged values	1

The parameters are stored in nonvolatile memory of the sensor. Correct changing of the parameters is carried out by using the parameterization program supplied with the sensor or a user program.

11. Description of RS232 and RS485 interfaces

Data exchange with the sensor is carried out over the RIFTEK or Modbus RTU protocols in binary format or in the ASCII format. The protocol and the data format are selected using the parametrization program.

11.1. RS232 port

The RS232 port ensures a “point-to-point” connection and allows the sensor to be connected directly to RS232 port of a computer or controller.

11.2. RS485 port

In accordance with the protocol accepted and hardware capability, the RS485 port makes it possible to connect up to 127 sensors to one data collection unit by a common bus circuit.

11.3. Serial data transmission format

Data message has the following format:

1 start-bit	8 data bits	1 even bit	1 stop-bit

11.4. Modes of data transfer

Through these serial interfaces the measurement data can be obtained by two methods:

- by single requests (inquiries);
- by automatic data streaming (stream).

11.5. Communication sessions types

The communications protocol is formed by communication sessions, which are only initiated by the 'master' (PC, controller). There are two kinds of sessions with such structures:

1) "request", ["message"] — ["answer"], _square brackets include optional elements._
2) "request" — "data stream" — ["request"].

11.6. Configuration parameters

11.6.1. Rate of data transfer through serial port

This parameter defines the rate of data transmission via the bit-serial interface in increments of 2400 bit/s. ***For example***, the parameter value equal to 4 gives the transmission rate of 2400*4 = 9600 bit/s.

Note. The maximum transmission rate for RS232 and RS485 interfaces is 921,6 kbit/s.

11.6.2. Net address

This parameter defines the network address of the sensor equipped with RS485 interface.

Note. The network data communication protocol assumes the presence of a 'master' in the net, which can be a computer or other information-gathering device, and from 1 to 127 'slaves' (RF603 Series sensors) which support the protocol.

Each 'slave' is assigned a unique network identification code – a device address. The address is used to form requests or inquiries all over the net. Each slave receives inquiries containing its unique address as well as '0' address which is broadcast-oriented and can be used for formation of generic commands, for example, for simultaneous latching of values of all sensors and for working with only one sensor (with both RS232 port and RS485 port).

11.6.3. Factory parameters table

Parameter	Value
Baud rate (RS232 or RS485)	9600 bit/s
Net address	1
Mode of data transfer	request

11.7. RIFTEK protocol (binary format)

11.7.1. Request

'Request' is _a two-byte_ message, which fully controls a communication session and can be transmitted by the 'master'. The 'request' message is the only one of all messages in a session where _the most significant bit is set at 0_, therefore, it serves to synchronize the beginning of the session. In addition, it contains the device address (ADR), code of request (COD) and, optionally, the message [MSG].

Request format ('master'):

Byte	Bits								Description
	7	6	5	4	3	2	1	0	
0	**0**	ADR							network address
1	**1**	0	0	0	COD				code of request
2	**1**	0	0	0	MSG[0] lo				lower tetrad of the 0th byte
3	**1**	0	0	0	MSG[0] hi				higher tetrad of the 0th byte
4	**1**	0	0	0	MSG[1] lo				lower tetrad of the 1st byte
5	**1**	0	0	0	MSG[1] hi				higher tetrad of the 1st byte
...	...	...	...	...	...				

11.7.2. Answer

'Answer' is the data burst that can be transmitted by 'slave' in the course of the session.

All messages with a message burst contain 1 in the most significant digit. *Data in a message are transferred in tetrads*. When byte is transmitted, lower tetrad goes first, and then follows higher tetrad. When multi-byte values are transferred, the transmission begins with lower byte.

When 'answer' is transmitted, the message contains:

- SB-bit, characterizes the updating of the result. If SB is equal to "1", this means that the sensor has updated the measurement result in the buffer, if SB is equal to "0" - then non-updated result has been transmitted (see Note 1, p. 10.3.). SB=0 when parameters transmit;
- two additional bits of cyclic binary batch counter (CNT). Bit values in the batch counter are identical for all sendings of one batch. The value of batch counter is incremented by the sending of each burst and is used for formation (assembly) of batches or bursts as well as for control of batch losses in receiving data streams.

The following is the format of the 'answer' data burst for the message transmission (MSG):

Byte	Bits								Description
	7	6	5	4	3	2	1	0	
0	**1**	SB	CNT		MSG[0] lo				lower tetrad of the 0th byte
1	**1**	SB	CNT		MSG[0] hi				higher tetrad of the 0th byte
2	**1**	SB	CNT		MSG[1] lo				lower tetrad of the 1st byte
3	**1**	SB	CNT		MSG[1] hi				higher tetrad of the 1st byte
...	...	...	...		...				...

11.7.3. Data stream

'Data stream' is an infinite sequence of data bursts or batches transmitted from 'slave' to 'master', which can be interrupted by a new request. In transmission of 'data stream' one of the 'slaves' fully holds a data transfer channel, therefore, when 'master' produces any new request sent to any address, data streaming process is stopped. Also, there is a special request to stop data streaming.

11.7.4. Output rate

Output rate ("OR") depends on Baud rate of serial interface ("BR"), and is calculated by such a manner:

OR = 1 / (44/BR+1*10-5) Hz

For example, for BR=460800 bit/s, Output rate = 9,4 kHz.

11.7.5. Request codes table

Request code	Description	Message (size in bytes)	Answer (size in bytes)
01h	Device identification	—	- device type (1) - firmware version (1) - serial number (2) - base distance (2) - range (2)
02h	Read a parameter	- code of parameter (1)	- value of parameter (1)
03h	Write a parameter	- code of parameter (1) - value of parameter (1)	—
04h	Store current parameters to FLASH-memory	- constant AAh (1)	- constant AAh (1)
04h	Recover default values of parameters in FLASH-memory	- constant 69h (1)	- constant 69h (1)
05h	Latch a current result	—	—
06h	Request a result	—	- result (2)
07h	Request a stream of results	—	- stream of result (2)
08h	Stop data streaming	—	—

11.7.6. List of parameters

Code of parameter	Name	Values
00h	Sensor ON	1 — laser is ON, measurements are taken (default); 0 — laser is OFF, sensor in power save mode.
01h	Analog output ON	1 — analog output is ON; 0 — analog output is OFF.
02h	Control of averaging, sampling, AL and analog output	x,M2,A,C,M1,M0,R,S – control byte which determines the operation mode. **M2:M1:M0** bits (AL mode): 000 - out of the range indication (by default); 001 - 'slave' mode (mutual synchronization); 010 - hardware zero set mode; 011 - laser switch OFF/ON; 100 - encoder mode; 101 - input mode; 110 - reset of the Ethernet packets counter; 111 - 'master' mode (mutual synchronization). **A** bit (averaging mode): 0 - averaging over a number of results (by default); 1 - time averaging (5 ms). **C** bit is not used **R** bit (analog output mode): 0 - window mode (by default); 1 - full range. **S** bit (sampling mode): 0 - time sampling (by default); 1 - trigger sampling. **x** bit is not used
03h	Network address	1…127 (default — 1)
04h	Rate of data transfer through a serial port	1…192 (default — 4), specifies data transfer rate in increments of 2400 baud; e.g., 4 means the rate of

		4*2400=9600 baud.
05h	***Reserved***	
06h	Number of averaged values	1…128 (default — 1)
07h	***Reserved***	
08h	Low byte of the sampling period	1) 10…65535 (default — 5000) The time interval in increments of 1 µs with which sensor automatically communicates the results on streaming request (priority of sampling = 0). 2) 1…65535 (default — 5000) Divider ratio of trigger input (priority of sampling = 1).
09h	High byte of the sampling period	
0Ah	Low byte of maximum integration time	2…3200 (default – 3200) The limiting time of integration by CMOS-array in increments of 1 µs.
0Bh	High byte of maximum integration time	
0Ch	Low byte for the beginning of analog output range	0…16383 (default – 0)
0Dh	High byte for the beginning of analog output range	
0Eh	Low byte for the end of analog output range	0…16383 (default – 16383)
0Fh	High byte for the end of analog output range	
10h	Time lock of result	0…255, specifies the time interval in increments of 5 ms.
11…16h	***Reserved***	
17h	Low byte of a zero point	0…16383 (default — 0), specifies the beginning of absolute coordinate system.
18h	High byte of a zero point	
19…1Ch	***Reserved***	
20h	Data transfer rate via CAN interface	10…200, (by default — 25), specifies data transmission rate in increments of 5 000 baud, for example, the value of 50 gives the rate of 50*5 000= 250 000 baud.
22h	Low byte of standard identifier	0…7FFh, (by default — 7FFh) specifies standard CAN identifier.
23h	High byte of standard identifier	
24h	0th byte of extended identifier	0…1FFFFFFFh, (by default — 1FFFFFFFh) specifies extended CAN identifier.
25h	1st byte of extended identifier	
26h	2nd byte of extended identifier	
27h	3rd byte of extended identifier	
28h	CAN interface identifier	1 — extended identifier; 0 — standard identifier .
29h	CAN interface ON/OFF	1 — CAN interface ON; 0 — CAN interface OFF.
6Ch	0th byte of Destination IP Address	by default — FFFFFFFFh = 255.255.255.255
6Dh	1st byte of Destination IP Address	
6Eh	2nd byte of Destination IP Address	
6Fh	3rd byte of Destination IP Address	
70h	0th byte of Gateway IP Address	by default — C0A80001h = 192.168.0.1
71h	1st byte of Gateway IP Address	
72h	2nd byte of Gateway IP Address	
73h	3rd byte of Gateway IP Address	
74h	0th byte of Subnet Mask	by default — FFFFFF00h = 255.255.255.0

75h	1st byte of Subnet Mask	
76h	2nd byte of Subnet Mask	
77h	3rd byte of Subnet Mask	
78h	0th byte of Source IP Address	by default — C0A80003h = 192.168.0.3
79h	1st byte of Source IP Address	
7Ah	2nd byte of Source IP Address	
7Bh	3rd byte of Source IP Address	
7Ch	Low byte of the number of measurements in the packet	1…168 (by default – 168), specifies the number of measurements in one Ethernet packet.
7Dh	High byte of the number of measurements in the packet	
88h	ETHERNET interface ON/OFF	0 — ETHERNET interface OFF; 1 — ETHERNET interface ON (UDP).
89h	Autostart of the stream when the sensor is turned on (after 20 seconds)	1 — Autostart is ON; 0 — Autostart is OFF (default).
8Ah	Protocols for RS232/RS485 interfaces	0 — RIFTEK protocol (default); 1 — ASCII protocol; 2 — MODBUS RTU protocol.

11.7.7. Notes

- All values are given in binary form.
- Base distance and range are given in millimeters.
- The value of the result transmitted by a sensor (D) is so normalized that 4000h (16384) corresponds to a full range of the sensor (S in mm), therefore, the result in millimeters is obtained by the following formula:

  X=D*S/4000h (mm) (1)
- On special request (05h), the current result can be latched in the output buffer where it will be stored unchanged up to the moment of arrival of request for data transfer. This request can be sent simultaneously to all sensors in the net in the broadcast mode in order to synchronize data pickup from all sensors.
- When working with the parameters, it should be borne in mind that when power is OFF the parameter values are stored in nonvolatile FLASH-memory of the sensor. When power is ON, the parameter values are read out to RAM of the sensor. In order to retain these changes for the next power-up state, a special command for saving current parameter values in the FLASH-memory (04h) must be run.
- Parameters with the size of more than one byte should be saved starting from the high-order byte and finishing with the low-order byte.
- **ATTENTION!** It is not recommended to configure the network addresses of the sensors connected to the network using the "common bus" scheme (RS485).

11.7.8. Examples of communication sessions

1) Request: "Device identification".

Conditions: device address - 1, request code - 01h, device type - 63 (3Fh), firmware version - 144 (90h), serial number - 17185 (4321h), base distance - 80 mm (0050h), measurement range - 50 mm (0032h), packet number (CNT) - 1, result update flag (SB) - 0.

Request ('master'):

Byte	Bits								Value	Description
	7	6	5	4	3	2	1	0		
0	**0**	0	0	0	0	0	0	1	01h	Network address
1	**1**	0	0	0	0	0	0	1	81h	Request code

Answer ('slave'):

Byte	Bits								Value	Description
	7	6	5	4	3	2	1	0		
0	**1**	0	0	1	1	1	1	1	9Fh	Lower tetrad of the device type
1	**1**	0	0	1	0	0	1	1	93h	Higher tetrad of the device type
2	**1**	0	0	1	0	0	0	0	90h	Lower tetrad of the firmware version
3	**1**	0	0	1	1	0	0	1	99h	Higher tetrad of the firmware version
4	**1**	0	0	1	0	0	0	1	91h	Lower tetrad of the 0th byte of a serial number
5	**1**	0	0	1	0	0	1	0	92h	Higher tetrad of the 0th byte of a serial number
6	**1**	0	0	1	0	0	1	1	93h	Lower tetrad of the 1st byte of a serial number
7	**1**	0	0	1	0	1	0	0	94h	Higher tetrad of the 1st byte of a serial number
8	**1**	0	0	1	0	0	0	0	90h	Lower tetrad of the 0th byte of a base distance
9	**1**	0	0	1	0	1	0	1	95h	Higher tetrad of the 0th byte of a base distance
10	**1**	0	0	1	0	0	0	0	90h	Lower tetrad of the 1st byte of a base distance
11	**1**	0	0	1	0	0	0	0	90h	Higher tetrad of the 1st byte of a base distance
12	**1**	0	0	1	0	0	1	0	92h	Lower tetrad of the 0th byte of the range
13	**1**	0	0	1	0	0	1	1	93h	Higher tetrad of the 0th byte of the range
14	**1**	0	0	1	0	0	0	0	90h	Lower tetrad of the 1st byte of the range
15	**1**	0	0	1	0	0	0	0	90h	Higher tetrad of the 1st byte of the range

2) Request: "Reading of parameter".

Conditions: device address - 1, request code - 02h, parameter code - 05h, parameter value - 04h, packet number (CNT) - 2, result update flag (SB) - 0.

Request ('master'):

Byte	Value	Description
0	01h	Network address
1	82h	Request code
2	82h	Lower tetrad of the parameter code
3	80h	Higher tetrad of the parameter code

Answer ('slave'):

Byte	Value	Description
0	A4h	Lower tetrad of the parameter value
1	A0h	Higher tetrad of the parameter value

3) Request: "Inquiring of result".

Conditions: device address - 1, result value - 677 (02A5h), packet number (CNT) - 3, result update flag (SB) - 1.

Request ('master'):

Byte	Value	Description
0	01h	Network address
1	86h	Request code

Answer ('slave'):

Byte	Value	Description
0	F5h	Lower tetrad of the 0th byte of the result value
1	FAh	Higher tetrad of the 0th byte of the result value
2	F2h	Lower tetrad of the 1st byte of the result value
3	F0h	Higher tetrad of the 1st byte of the result value

Measured distance (mm) (for example, range of the sensor = 50 mm): X=677(02A5h)*50/16384 = 2.066 mm

4) Request: "Writing sampling regime (trigger sampling)".

Conditions: device address - 1, request code - 03h, parameter code - 02h, parameter value - 01h.

Request ('master'):

Byte	Value	Description
0	01h	Network address
1	83h	Request code
0	82h	Lower tetrad of the parameter code
1	80h	Higher tetrad of the parameter code
2	81h	Lower tetrad of the parameter value
3	80h	Higher tetrad of the parameter value

5) Request: "Writing the divider ration".

Condition: divider ration - 1234 (3039h), device address - 1, request code - 03h, parameter code - 09h (first or higher byte), parameter value - 30h.

Request ('master'):

Byte	Value	Description
0	01h	Network address
1	83h	Request code
0	89h	Lower tetrad of the parameter code
1	80h	Higher tetrad of the parameter code
2	80h	Lower tetrad of the parameter value
3	83h	Higher tetrad of the parameter value

and for lower byte, parameter code - 08h, parameter value - 39h.

Request ('master'):

Byte	Value	Description
0	01h	Network address
1	83h	Request code
0	88h	Lower tetrad of the parameter code
1	80h	Higher tetrad of the parameter code
2	89h	Lower tetrad of the parameter value
3	83h	Higher tetrad of the parameter value

11.8. Modbus RTU protocol (binary format)

11.8.1. Input Registers (Read only)

Register / Address	Description	Example
1	Device type	63
2	Firmware version	40
3	Serial number	19999
4	Base distance	125
5	Measurement range	500
6	Measured value	15894

11.8.2. Holding Registers (Read / Write)

Register / address	Name	Values
10	Sensor ON	1 — laser is ON, measurements are taken (default state); 0 — laser is OFF, sensor in power save mode.
11	Analog output ON	1 — analog output is ON; 0 — analog output is OFF.
12	Control of averaging, sampling, AL-output modes	x,x,x,x,x,x,x,x,x,M2,A,C,M1,M0,R,S - control register, which determines the operation mode: averaging - M bit, CAN interface - C bit, logic output - M0:M2 bits, analog output - R bit, sampling mode - S bit; x bits are not used. **M2:M0** bits: 000 - out of the range indication (default); 001 - 'slave' mode (mutual synchronization); 010 - hardware zero set mode; 011 - laser switch OFF/ON; 100 - encoder mode; 101 - input mode; 110 - reset of the Ethernet packets counter; 111 - 'master' mode (mutual synchronization). **A** bit: 0 - averaging over a number of results (default); 1 - time averaging (5 ms). **C** bit: 0 - CAN interface mode by request (default); 1 - CAN interface mode with synchronization by time or trigger. **R** bit: 0 - window mode (default); 1 - full range. **S** bit: 0 - time sampling (default); 1 - trigger sampling.
13	Network address	1…128 (default — 1)
14	Rate of data transfer through a serial port	1…192 (default — 4) Specifies data transfer rate in increments of 2400 baud; e.g., 4 means the rate of 4*2400=9600 baud.
15	Number of averaged values	1…128 (default — 1)
16	Sampling period	1) 100…65535 (default — 5000)

		The time interval in increments of 1 μs with which sensor automatically communicates the results on streaming request (sampling mode = 0). 2) 1…65535 (default — 5000) Divider ratio of trigger input (sampling mode = 1).
17	Maximum integration time	3…3200 (default – 3200 μs)
18	Beginning of analog output range	0…16383 (default — 0)
19	End of analog output range	0…16383 (default — 16383)
20	Time lock of result	0…255 Specifies the time interval in increments of 5 ms.
21	Zero point	0…16383 (default — 0)
22	Data transfer rate via CAN interface	10…200, (by default — 25), specifies data transmission rate in increments of 5 000 baud, for example, the value of 50 gives the rate of 50*5 000= 250 000 baud.
23	Standard identifier	0…7FFh, (by default — 7FFh)
24	Extended identifier (higher part)	0…1FFFFFFFh, (by default — 1FFFFFFFh)
25	Extended identifier (lower part)	
26	Identifier of CAN interface	0 — Standard identifier; 1 — Extended identifier.
27	CAN interface ON/OFF	0 — CAN interface OFF; 1 — CAN RIFTEK protocol; 2 — CANOpen.
28	Destination IP Address (higher part)	By default — 255.255.255.255
29	Destination IP Address (lower part)	
30	Gateway IP Address (higher part)	By default — 192.168.0.1
31	Gateway IP Address (lower part)	
32	Subnet Mask (higher part)	By default — 255.255.255.0
33	Subnet Mask (lower part)	
34	Source IP Address (higher part)	By default — 192.168.0.3
35	Source IP Address (lower part)	
36	Number of measurements in one packet	0…168, (by default — 168)
37	ETHERNET interface ON/OFF	0 — ETHERNET interface OFF; 1 — ETHERNET interface ON (UDP).
38	***Reserved***	
39	Change the protocol (RS interface)	0 — RIFTEK protocol; 1 — ASCII protocol; 2 — MODBUS RTU protocol.
40	Save/recover the settings	0x00AA — Save current parameters to FLASH-memory 0x0069 — Restore the default parameters
41	Latch a current result	0 — nothing will happen; 1 — a result will be latched.

11.9. ASCII format

Data exchange with the sensor in ASCII format is carried out via the RS232 or RS485 interfaces. The command always consists of the request code (see the table below), followed by the symbols CR and LF. The description of commands and the structure of answers are given below.

Request code + <CR><LF>	Name	Description	Answer
PRT	Changing the data format	After entering a command and receiving an answer, the sensor will change the ASCII format to the RIFTEK binary protocol.	"OK" line (OK<CR><LF>)
V	Device identification	Information about the device type, firmware version, serial number, base distance and measurement range.	- device type (603<LF>) - firmware version (40<LF>) - serial number (19999<LF>) - base distance (125<LF>) - measurement range (500<CR><LF>)

Request code + <CR><LF>	Name	x values	Answer (line + <CR><LF>)
Wx	Working with FLASH-memory	0 - save current parameters to FLASH-memory; 1 - recover default values of parameters in FLASH-memory	0 – "OK" line 1 – "OK" line
Rx	Request of a result	0 - in increments (0 .. 16384); 1 - in millimeters; 2 - in inches.	"1124.4200" line "0223.0870" line "0099.8204" line
Ox	Sensor ON	1 - laser is ON, measurements are taken (default state); 0 - laser is OFF, sensor in power save mode.	0 – "OK" line 1 – "OK" line
Ax	Analog output ON	1 - analog output is ON; 0 - analog output is OFF.	0 – "OK" line 1 – "OK" line
TMx	Control of averaging mode	0 - averaging over a number of results (default); 1 - time averaging (5 ms).	0 – "OK" line 1 – "OK" line
TCx	Modes of CAN interface	0 - Request mode (by default); 1 - Time or Trigger sync.	0 – "OK" line 1 – "OK" line
TLx	Control of logic output mode	0 - out of the range indication (default); 1 - mutual synchronization mode; 2 - hardware zero set mode; 3 - laser switch OFF/ON.	0 – "OK" line 1 – "OK" line 2 – "OK" line 3 – "OK" line
TAx	Control of analog output mode	0 - window mode (default); 1 - full range.	0 – "OK" line 1 – "OK" line
TSx	Control of sampling mode	0 - time sampling (default); 1 - trigger sampling.	0 – "OK" line 1 – "OK" line
Bxxx	Rate of data transfer (RS232 / RS485)	1…192 (default - 4) Specifies data transfer rate in increments of 2400 baud; e.g., 4 means the rate of 4*2400=9600 baud.	"OK" line
Gxxx	Number of averaged values	1…128 (default - 1)	"OK" line
Sxxxxx	Sampling period	1) 10…65535 (default - 5000)	"OK" line

		The time interval in increments of 1 µs with which sensor automatically communicates the results on streaming request (priority of sampling = 0). 2) 1…65535 Divider ratio of trigger input (priority of sampling = 1).	
Exxxx	Maximum integration time	2…3200 (default - 3200) The limiting time of integration by CMOS-array in increments of 1 µs.	"OK" line
Dxxx	Time lock of result	0…255 Specifies the time interval in increments of 5 ms.	"OK" line
Zxxxxx	Zero point	0…16384 (default - 0) Specifies the beginning of absolute coordinate system. Z* - reset to 0.	"OK" line
CBxxx	Data transfer rate via CAN interface	10…200, (by default — 25), specifies data transmission rate in increments of 5 000 baud, for example, the value of 50 gives the rate of 50*5 000= 250 000 baud.	"OK" line
CSxxx	Standard identifier	0…7FFh, (by default - 7FFh) specifies the standard CAN identifier	"OK" line
CExxxxxxxx	Extended identifier	0…1FFFFFFFh, (by default - 1FFFFFFFh) specifies the extended CAN identifier	"OK" line
CIx	Identifier of CAN interface	1 - extended CAN identifier; 0 - standard CAN identifier.	0 – "OK" line 1 – "OK" line
COx	CAN interface ON/OFF	1 - CAN interface ON; 0 - CAN interface OFF.	0 – "OK" line 1 – "OK" line
IPDxxx.xxx.xxx.xxx	Destination IP Address	By default - 255.255.255.255	"OK" line
IPGxxx.xxx.xxx.xxx	Gateway IP Address	By default - 192.168.0.1	"OK" line
IPMxxx.xxx.xxx.xxx	Subnet mask	By default - 255.255.255.0	"OK" line
IPSxxx.xxx.xxx.xxx	Source IP Address	By default - 192.168.0.3	"OK" line
IPOx	ETHERNET interface ON/OFF	0 - ETHERNET interface OFF; 1 - ETHERNET interface ON (UDP).	0 – "OK" line 1 – "OK" line

12. Description of CAN interface

CAN interface is used only to receive data from the sensor. Parametrization of sensors is carried out via RS232 interface.

12.1. Modes of data transfer

The sensor can operate in the following modes:

- No transmission.
- *The request mode*. In this mode, each sensor receives a frame of remote data request (Remote Frame) containing frame identifier, and responds by sending a data frame (Data Frame) with the same identifier.
- *Automatic data streaming mode*. When operating in this mode, each sensor automatically transmits a data frame (Data frame) together with its identifier in accordance with a sampling mode of Time or Trigger (see p. 10.2) and corresponding sampling period (see p. 10.3).

12.2. Configuration parameters

12.2.1. Data transmission rate via CAN interface

This parameter defines data transmission rate through CAN interface in increments of 5000 bit/s. ***For example***, the parameter value of 50 gives the transmission rate of 5000*50 = 250000 bit/s.

Note. Maximum transmission rate via CAN interface is 1 Mbit/s.

12.2.2. Identifiers

The sensor equipped with CAN 2.0B port supports data exchange using standard frames (with 11-bit identifiers) and extended frames (with 29-bit identifiers). Each sensor is set with standard or extended identifier which is unique for a network given. The number of sensors in the network is up to 112.

12.3. Factory parameters table

Parameter	Value
Data transmission rate	125 kb/s
Standard identifier	7FFh
Extended identifier	1FFFFFFFh
Interface condition	ON
Mode of data transfer	request

12.4. Format of transmitted data

The sensor transmits 8 byte long frame:

Byte	Description
0	type of device
1	= 0 - reserved
2	low byte of serial number
3	high byte of serial number
4	low byte of operating range
5	high byte of operating range
6	low byte of the result
7	high byte of the result

Calculation of the result is made according to Formula 1 (see par. 11.7.7).

13. Description of CANopen interface

13.1. Communication profile

Index	Sub index	Name	Type*	Attribute**	Default value	Description
1000h	00h	Device type	UI32	ro	00080196h	Device type: device profile 406, absolute linear position encoder
1001h	00h	Error register	UI8	ro	0	0: no errors
1005h	00h	COB-ID SYNC message	UI32	ro	80h	Synchronization object identifier

1008h	00h	Manufacturer device name	VS	const	RF603	Manufacturer device name
100Ch	00h	Guard time	UI16	rw	0h	Time of requesting the sensor for operability (Node Guard) in ms
100Dh	00h	Life time factor	UI8	rw	0h	Multiplier for calculating the response time in ms
1010h		*Store parameters*				-
	00h	Number of elements	UI8	ro	1	Number of elements
	01h	Save all parameters	UI32	rw	2	Save all parameters to FLASH memory when writing the 'save' (65766173h) value. If the parameters are successfully saved, the value will be 1.
1011h		*Restore parameters*				-
	00h	Number of elements	UI8	ro	1	Number of elements
	01h	Restore parameters	UI32	rw	2	Restore all parameters in FLASH memory when writing the 'load' (64616F6Ch) value. If the parameters are successfully restored, the value will be 1.
1016h	00h	Consumer heartbeat time	UI32	rw	0	Bits 0..15 - control time in ms Bits 16..23 - node number Bits 24..32 - not used
1017h	00h	Producer heartbeat time	UI16	rw	0	Producer heartbeat time in ms
1018h		*Identity Object*				-
	00h	Number of elements	UI8	ro	4	Number of elements
	01h	Vendor-ID	UI32	ro	00080196h	Device type set by CiA
	02h	Product code	UI32	ro	0h	Manufacturer identifier
	03h	Revision number	UI32	ro	0h	Firmware version
	04h	Serial number	UI32	ro	0h	Serial number
1200h		*Server SDO parameter*				-
	00h	Number of elements	UI8	ro	2	Number of elements
	01h	COB-ID Client->Server (rx)	UI32	ro	600h + Node-ID	COB-ID request to the server
	02h	COB-ID Server->Client (tx)	UI32	ro	580h + Node-ID	COB-ID answer to the client
1800h		*Transmit PDO parameter*				-
	00h	Number of elements	UI8	ro	2	Number of elements
	01h	COB-ID	UI32	ro	180h + Node-ID	COB-ID used PDO
	02h	Transmission Type	UI8	rw	254	Asynchronous mode. Synchronous mode is enabled by writing the values from 1 to 253.
	03h	Inhibit time	UI16	rw	0	Transmission period in ms.
1A00h		*Transmit PDO Mapping*				-

	00h	Number of objects	UI8	ro	1	Number of elements
	01h	1st object PDO	UI32	const	60040020h	Measurement

13.2. DS406 profile

Index	Subindex	Name	Type*	Attribute**	Default value	Description
6004h	00h	Position Value	UI32	ro	No	Bits 0..15 - measurement Bits 16..23 - status word for measurement Bits 24..31 - not used

13.3. Manufacturer profile

Index	Subindex	Name	Type*	Attribute**	Default value	Description
2000h	00h	Device type	UI8	ro	No	Device type
2001h	00h	Firmware	UI8	ro	No	Firmware version
2002h	00h	Serial Number	UI16	ro	No	Serial number
2003h	00h	Base Distance	UI16	ro	No	Base distance, mm
2004h	00h	Range	UI16	ro	No	Measurement range, mm
2005h	00h	Sensor ON	UI8	rw	1	1 - laser is ON, measurements are taken; 0 - laser is OFF, sensor in power save mode.
2006h	00h	Node-ID	UI8	rw	9	Identifier of the CANOpen node (1..127)
2007h	00h	CAN Baudrate	UI8	rw	25	10…200, specifies data transmission rate in increments of 5000 baud, for example, the value of 50 gives the rate of 50*5000= 250000 baud.
2008h	00h	Analog output ON	UI8	rw	0	1 - analog output is ON; 0 - analog output is OFF.
2009h	00h	Window control	UI8	rw	0	0 - window mode; 1 - full range.
200Ah	00h	Window beginning	UI16	rw	0	Beginning of analog output range
200Bh	00h	Window end	UI16	rw	16384	End of analog output range
200Ch	00h	Network address	UI8	rw	1	Network address (1..127)
200Dh	00h	Rate of data transfer through serial port	UI16	rw	4	1…192, specifies data transfer rate in increments of 2400 baud; e.g., 4 means the rate of 4*2400=9600 baud.
200Eh	00h	Sampling mode	UI8	rw	0	1 - time sampling; 0 - trigger sampling.
200Fh	00h	Sampling period	UI16	rw	5000	1) 100…65535, specifies the time interval in increments of 1 μs with which sensor automatically communicates the results on streaming request. 2) 1…65535, divider ratio of trigger input.
2010h	00h	Line AL operation mode	UI8	rw	0	0 - out of the range indication; 1 - mutual synchronization; 2 - hardware zero set mode;

						3 - laser switch OFF/ON.
2011h	00h	Time limit for integration time	UI16	rw	3200	2…3200, specifies the limiting time of integration by CMOS-array in increments of 1 µs.
2012h	00h	Method of results averaging	UI8	rw	0	0 - averaging over a number of results; 1 - time averaging (5 ms).
2013h	00h	Number of averaged values	UI8	rw	1	Number of averaged values (1..128)
2014h	00h	Time lock of the results	UI8	rw	2	0…255, specifies the time interval in increments of 5 ms.
2015h	00h	Point of zero	UI8	rw	0	0…16384, specifies the beginning of absolute coordinate system.

* UI8 = Unsigned8, UI16 = Unsigned16, UI32 = Unsigned32, VS = VisibleString.
** ro = read only, rw = read / write, const = constant.

14. Description of Ethernet interface

The Ethernet interface is used only for the data transmission. Parametrization of sensors is carried out via RS232 or RS485 interface.

14.1. Modes of data transfer

The sensor can be operated in the following modes:

- No transmission.
- *Automatic data streaming mode*. At the beginning, the internal data transmission buffer of the sensor is filled with measurement data in accordance with a selected sampling mode of Time or Trigger (see p. 10.2) and corresponding sampling period (see p. 10.3). After the internal buffer has been filled (buffer size is 168 measurements), the sensor transmits the UDP data packet accumulated in the transmission buffer to the network.

14.2. Factory parameters table

Parameter name	Value
Destination IP Address	255.255.255.255
Gateway IP address	192.168.0.1
Subnet Mask	255.255.255.255
Source IP address	192.168.0.3
Interface condition	ON
Mode of data transfer	stream
Number of measurements in one packet	168

14.3. Data packet format

The sensor sends 512 byte data packet to IP port 603:

Byte	Value
0	low byte of the result of the 1st measurement
1	high byte of the result of the 1st measurement
2	status word for the 1st measurement

3	low byte of the result of the 2nd measurement
4	high byte of the result of the 2nd measurement
5	status word for the 2nd measurement
...	...
501	low byte of the result of the 168th measurement
502	high byte of the result of the 168th measurement
503	status word for the 168th measurement
504	low byte of a serial number
505	high byte of a serial number
506	low byte of the base distance
507	high byte of the base distance
508	low byte of the measurement range
509	high byte of the measurement range
510	cyclic counter of packet number
511	device type

The result is calculated according to Formula 1 (see par. 15.3).

14.4. Data structure

- The result of measurement is transmitted as a 16-bit word and calculation of the result is performed according to formula (1), see par. 15.3.
- The status word size is 1 byte.

The status of the SB bit determines the update of the result:

- If the bit is equal to "1", this means that the sensor has updated the measurement result by the time of arrival of the external synchronization pulse (beginning of a new sampling period).

- If the bit is equal to "0", then a non-updated result has been transmitted.

The status of the ALB bit determines the state of the AL line.

The status of the INB bit determines the state of the IN input (only for the time sampling mode).

Bits 7…3 of the status word are reserved and equal to "0"

The status word format:

Bits							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	0	0	0	0	INB	ALB	SB

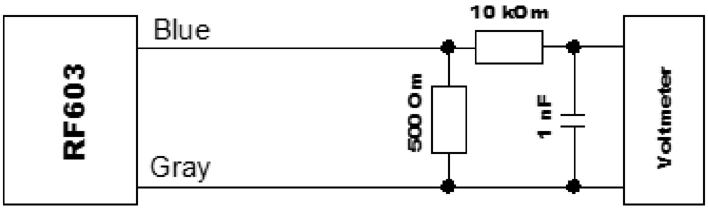
- The base distance of the sensor is transmitted as a 16-bit word with discreteness of 1 mm
- The sensor measurement range is transmitted as a 16-bit word with discreteness of 1 mm;
- Cyclic counter of packet number has a one-byte size. The counter value is incremented with transmission of each packet and is used to control packet loss in the course of data reception;
- The packet checksum has an one-byte size and is calculated as OR of all the bytes of the packet.

15. Analog outputs

Changing of the signal at analog output occurs in synchronism with changing of the result transferred through a bit-serial interface.

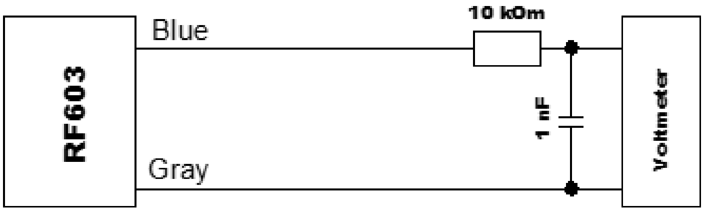
15.1. Current output 4…20 mA

The connection scheme is shown in the figure. The value of load resistor should not be higher than 500 Ohm. To reduce noise, it is recommended to install RC filter before the measuring instrument. The filter capacitor value is indicated for maximum sampling frequency of the sensor (9,4 kHz) and this value increases in proportion to the frequency reduction.



15.2. Voltage output 0…10 V

The connection scheme is shown in the figure. To reduce noise, it is recommended to install RC filter before the measuring instrument. The filter capacitor value is indicated for maximum sampling frequency of the sensor (9,4 kHz) and this value increases in proportion to the frequency reduction.



15.3. Configuration parameters

15.3.1. Range of the analog output

While working with the analog output, resolution can be increased by using the ‘Window in the operating range’ function which makes it possible to select a window of required size and position in the operating range of the sensor within which the whole range of analog output signal will be scaled.

Note. If the beginning of the range of the analog signal is set at a higher value than the end value of the range, this will change the direction of rise of the analog signal.

15.3.2. Analog output operation mode

When using ‘window in the operating range’ function, this mode defines the analog output operation mode.

Analog output can be:

- in the window mode or
- in the full mode.

'Windowmode'. The entire range of the analog output is scaled within the selected window. Outside the window, the analog output is "0".

'Full mode'. The entire range of the analog output is scaled within the selected window (operating range). Outside the selected window, the whole range of the analog output is automatically scaled onto the whole operating range of the sensor (sensitivity range).

15.4. Factory parameters table

Parameter	Value
Range of the analog output	Measuring range of sensor
Analog output operation mode	Window

16. Parameterization program

16.1. Function

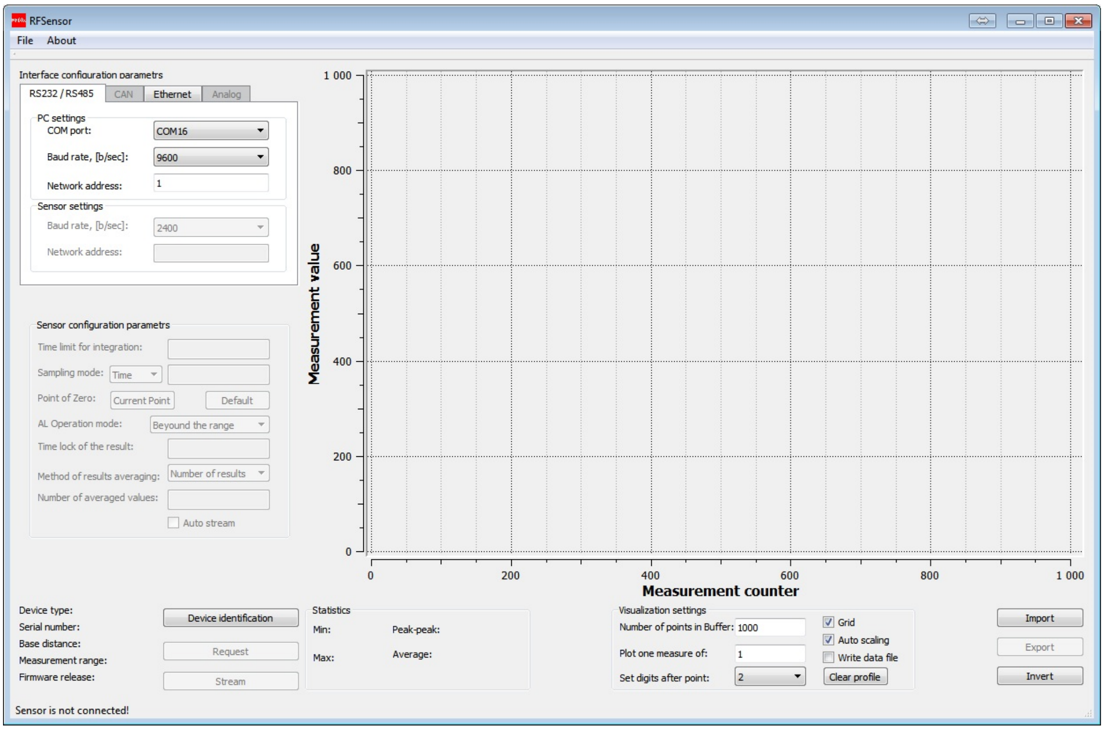
The RF60X-SP software is intended for:
1) Testing and demonstration of work of RF603 series sensors.
2) Setting of the sensor parameters.
3) Reception and gathering of the sensor data signals.
Download link:
https://www.riftek.com/media/documents/rf60x/rf60x-sp.zip

16.2. Program setup

Run **setup.exe** and follow the instructions of the installation wizard.

16.3. Obtaining connection to sensor (RS232/RS485)

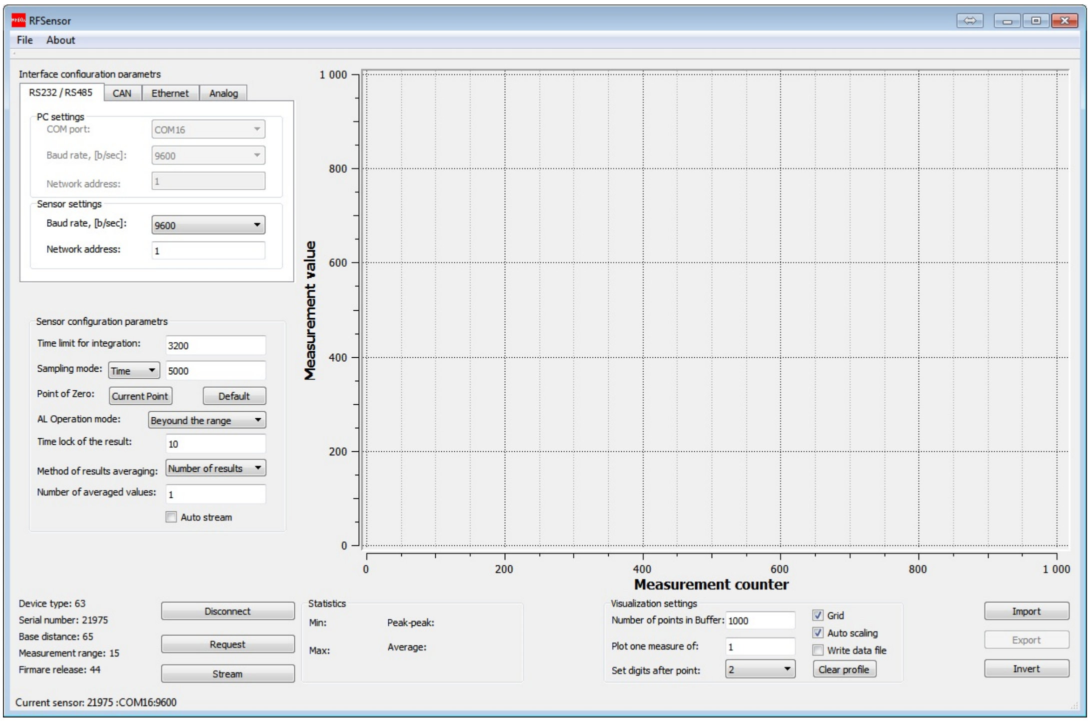
Once the program is started, the main window appears:



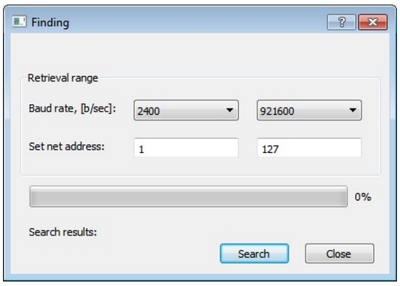
To obtain connection via RS232/RS485 interfaces, go to **RS232/RS485 PC settings** in the **Interface configuration parameters** panel:

- Select the COM-port whereto the sensor is connected (logical port if the sensor is connected via USB-adapter).
- Select the transmission rate (**Baud rate**) at which the sensor works.
- Select the sensor network address, if necessary.
- Press the **Device identification** button.

If the selected parameters correspond to the parameters of the sensor interface, the program will identify the sensor, read and display its configuration parameters:



If connection is not established, a prompt window will appear asking to make the automatic search for the sensor:



- Set the range of transmission rate search in the **Baud rate** line.
- Set the range of network address search in the **Net address** line.
- Press the **Search** button.

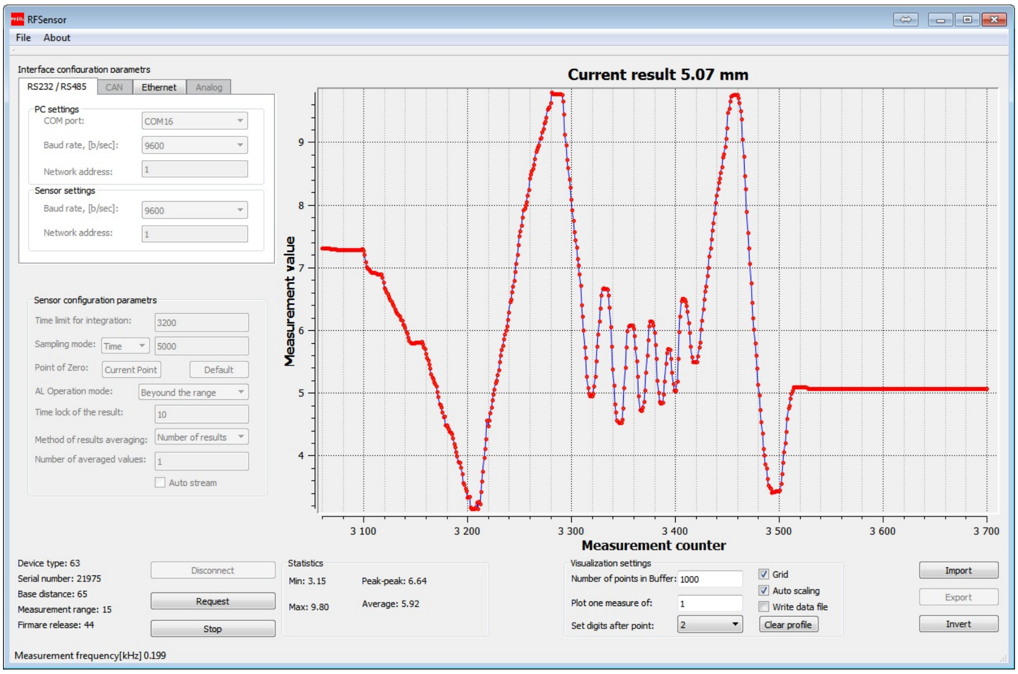
The program will perform the automatic search for the sensor by searching over possible rates, network addresses and COM-ports of PC.

16.4. Checking of the sensor operability

Once the sensor is successfully identified, check its operability as follows:

- place an object inside the sensor working range;
- by pressing the **Request** button, obtain the result of one measurement on the (**Current result**) indicator. The 06h request type is realized (see par. 11.7.5);
- pressing the **Stream** button will switch the sensor to the data stream transmission mode. The 07h request type is realized (see par. 11.7.5);
- by moving the object, observe changes in the readings;
- the status line in the lower part of the window will show the current data transmission and refreshing rates.

To stop the data transmission, press the **Stop stream** button.



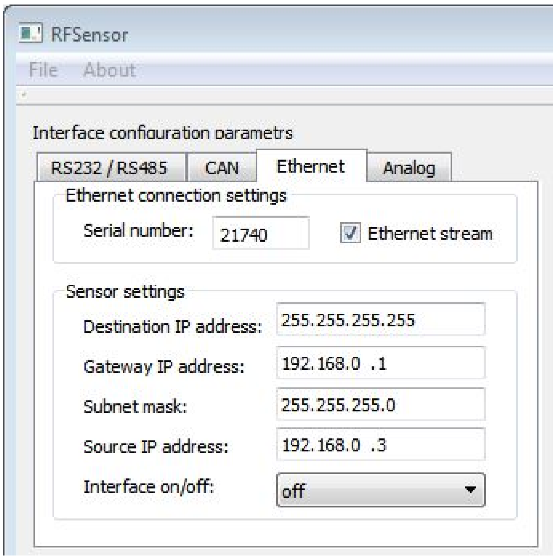
16.5. Connection via the Ethernet interface

To receive data via the Ethernet interface:

- Tick the **Ethernet stream** checkbox in the **Ethernet** tab.
- If there are multiple sensors on the network, type a serial number of the sensor, from which you want to receive data, in the **Serial number** field.
- Click the **Stream** button.

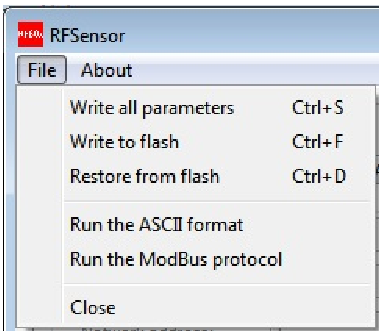
Note 1. If the **Serial number** field is empty, the software will work with the sensor, the data from which were received first.

Note 2. If the **Ethernet stream** checkbox is not ticked and the sensor is connected via RS232/RS485, then the data will be received via this interface.

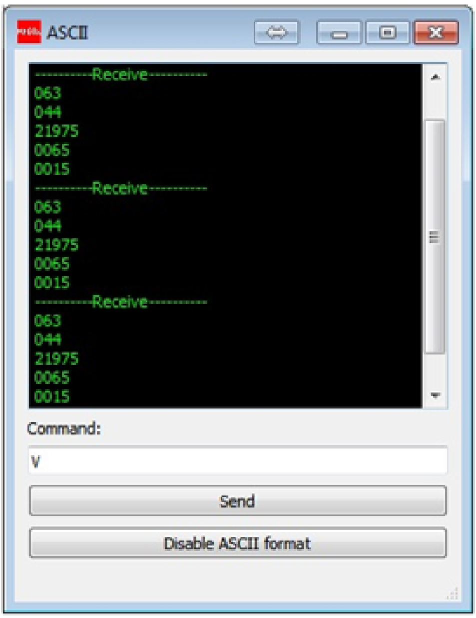


16.6. Connection via the ASCII interface

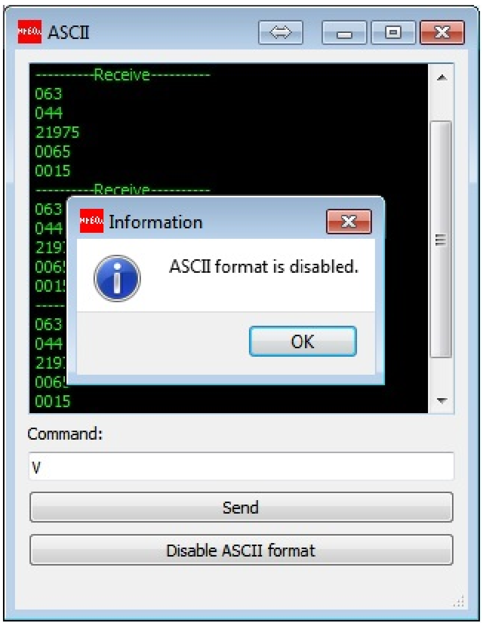
Select **File > Run the ASCII format**:



Use the emerged window to send commands:



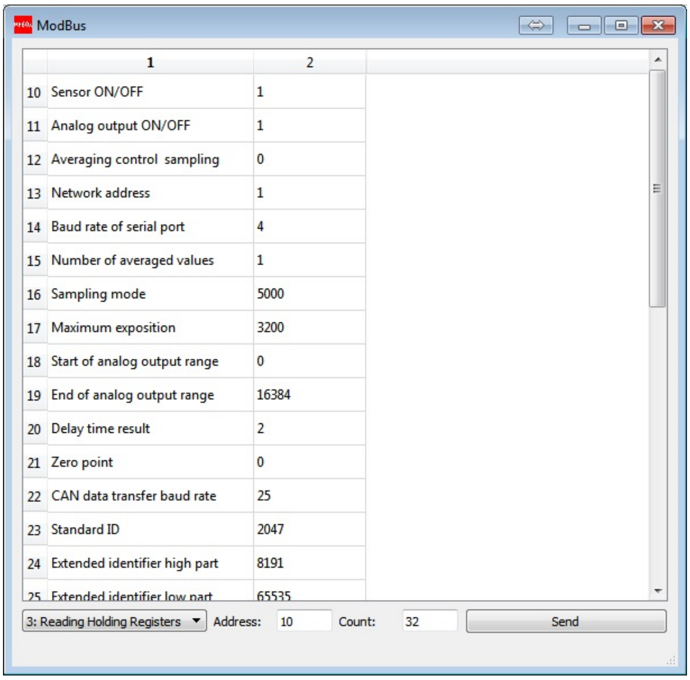
After closing the window, the sensor continues to work in the ASCII data format. To switch to the binary data format, click the **Disable ASCII format** button:



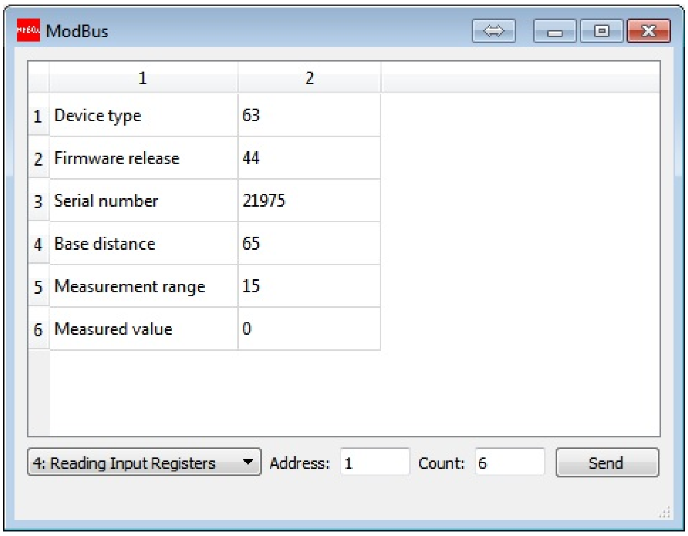
16.7. Connection via the Modbus RTU protocol

Select **File > Run Modbus protocol**.

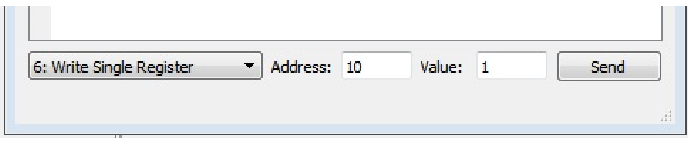
To read the **Holding Registers**, select the corresponding option from the drop-down list in the lower left part of the window. Write the address of the initial register (**Address**) and their number (**Count**), then click **Send**.



To read the **Reading Registers**, select the corresponding option:



To write to the register, select **Write Single Register**, specify the address and required value, then click **Send**.



To change the protocol, write the value to register 39 (0 - RIFTEK protocol, 1 - ASCII format, 2 - MODBUS protocol).

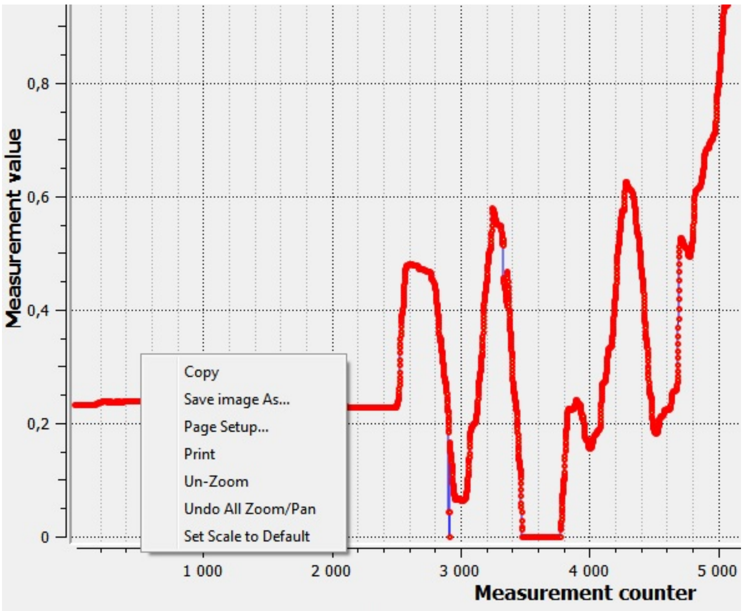
16.8. Display, gathering and scanning of data

Measurement result is displayed in digital form and in the form of oscillogram and is stored in the PC memory.

- The number of points displayed along the X coordinate can be set in the **Number of points in buffer** window.
- Scaling method along the Y coordinate can be set by the **Auto scaling** function.
- Turn-on/turn-off of the scaling grid is effected by using the **Grid** function.
- The number of displayed digits after decimal point can be set in the **Set digits after point** window.
- To save received data to a file, select (tick) **Write data file**.

Note: the number of points displayed on the graph depends on PC speed and becomes smaller in proportion to the data transmission rate. After the stream is stopped by using the **Stop Stream** button, the graph will display all data received.

- To work with the image, press the right mouse key on the graph to call the corresponding menu:

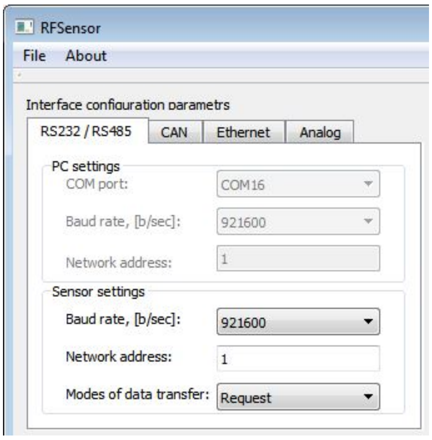


- To move the image, just press the mouse wheel.
- To zoom, rotate the mouse wheel.
- To save data to a file, press the **Export** button. The program will offer saving of data in two possible formats: internal and Excel.
- To scan or look at previously saved data, press the **Import** button and select the required file.

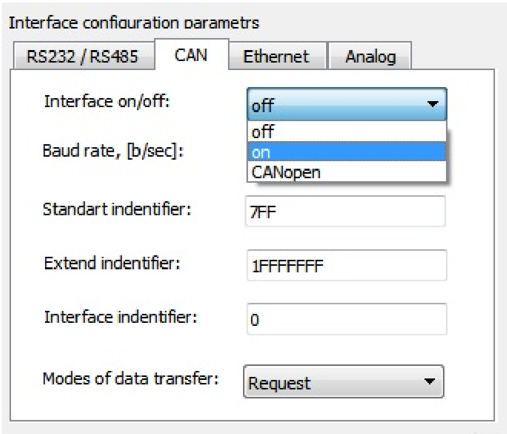
16.9. Setting and saving parameters of the sensor

16.9.1. Setting parameters

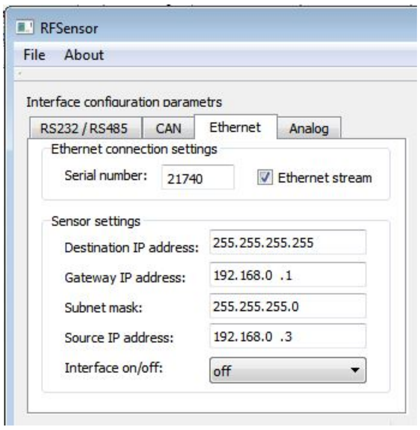
The sensor parameters can be configured only via the RS232/RS485 interfaces. Setting of parameters for all interfaces can be done using the respective tabs on the **Interfaces configuration parameters** panel:



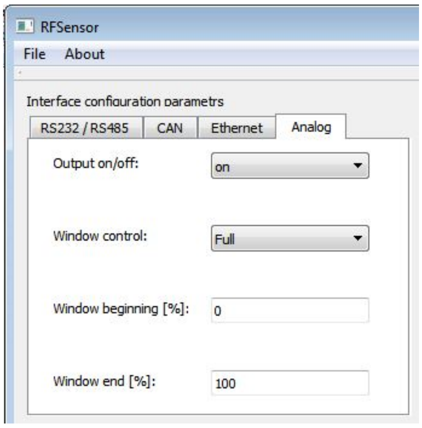
RS232/RS485



CAN

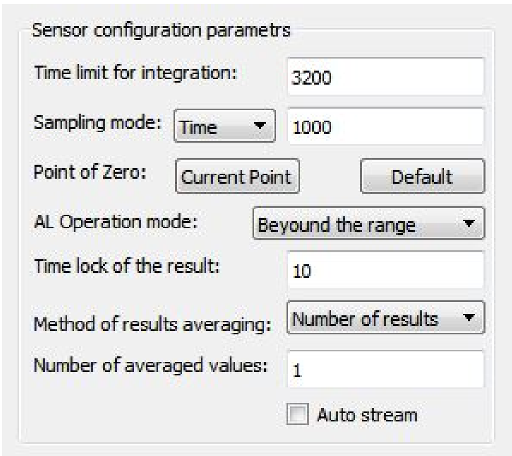


Ethernet



Analog outputs

Setting of all configuration parameters of the sensor is possible with the help of the respective panel (**Sensor configuration parameters**):

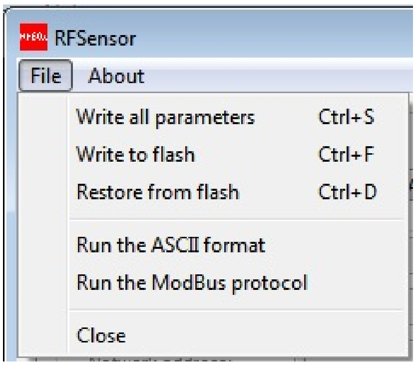


16.9.2. Automatic data stream mode after power switch on

By default, after the power supply is switched on, the sensor is waiting for the request result command. To get a continuous data stream after switching on the power supply, tick the **Auto stream** box. Save parameters (see below). Now with any subsequent activation of the sensor it will work in the data stream mode.

16.9.3. Saving parameters

- All parameters are applied immediately after setting.
- Perform testing of the sensor operation with new parameters.
- To store new parameters in nonvolatile memory, execute **File > Write to flash**. Now, with any subsequent activation of the sensor it will work in the configuration you have selected.



16.9.4. Saving and writing a set of parameters

Parameters of the sensor can be saved to a file. Select **File > Write parameters set** and save the file in the window offered.

To call a group of parameters from a file, select **File > Sensor parameters sets…**, and select the file required. **Note**: these functions are convenient to use if it is necessary to write identical parameters to several sensors.

16.9.5. Recovery of default parameters

To restore the sensor parameters set by default, use **File > Restore from flash**.

17. RFSDK library

To work with the laser sensors, we offer a RFSDK library which is available for free download on the RIFTEK company website.

RFSDK contains API to work with all products of our company, documentation on classes and methods, examples and wrappers for various program languages.

RFSDK allows users to develop their own software products without going into details of data communication protocol for the sensor.

Software	Description	Link
Service program (parametrization program)	User software for work with laser sensors, parameter setting, and data acquisition.	http://www.riftek.com/media/documents/rf60x/rf60x-sp.zip
RF Device Software Development Kit	Designed for work with all RIFTEK's devices. Includes: • Support of MSVC and BorlandC for Windows, Linux, Wrapper C#, Wrapper Dephi. • Examples for C#, Delphi, LabView, Mathlab.	http://www.riftek.com/media/documents/software/RFDevice_SDK.zip
Firmware	Firmware for RF603 sensors.	http://www.riftek.com/media/documents/rf603/Firmware.zip

18. Appendix

18.1. Protective housing

Air-cooled protective housing can be used when operating sensor under conditions of elevated temperatures and high pollution levels. Overall and mounting dimensions of the housing are shown in Fig. 7. Basic requirements:

- Temperature of pressed air at the sensor input <25°C.
- Air must be clear of oil and moisture.
- Maximum allowable ambient temperature 120°C for air pressure of 6 atm.
- The sensor is calibrated directly in the housing, therefore if the device is used without housing linearity of characteristics is lost.

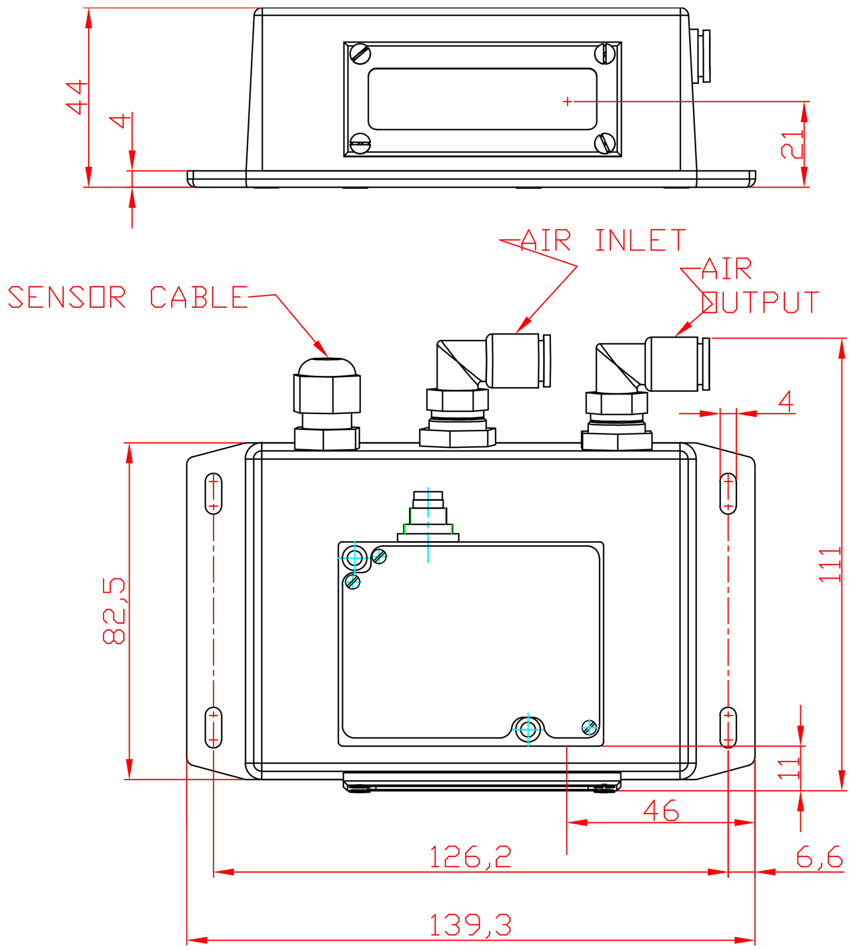


Figure 7

18.2. Spray guard

The spray guard is intended to reduce dirtying of the sensor windows. Overall dimensions are shown in Fig. 8

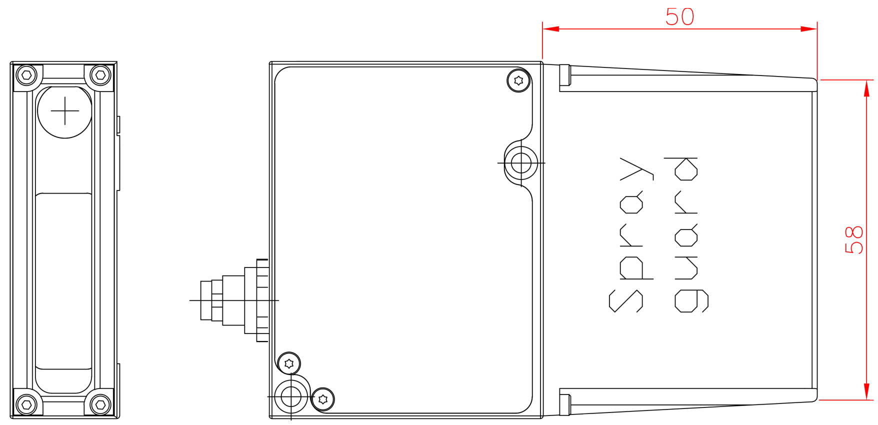


Figure 8

18.3. Size of the laser spot and mounting space

The laser spot dimensions for two device modifications (elliptical spot and round spot) as well as parameters characterizing required space for the passing of laser beams are given in the table and explained in Figure 9 (names: SMR – start of measuring (working) range, MMR – midpoint of measuring (working) range, EMR – end of measuring (working) range, MR – measuring (working) range).

RF603-	D, µm			D1, µm			D2, µm			α, deg	β, deg	A, mm	B, mm
	SMR	MMR	EMR	SMR	MMR	EMR	SMR	MMR	EMR				
10/2	30	20	30	40	30	40	60	40	60				
39/4	110	140	110	90	110	80	190	470	80	38	42	27	37
15/5	100	40	100	200	60	200	300	80	300	45	53	15	25
15/10	250	50	250	350	80	350	700	90	700	49	50	17	30
25/10	200	50	200	300	80	300	650	90	650	38	40	19	29
60/10	200	60	200	250	80	250	700	90	700	27	30	30	39
15/15	400	60	400	450	100	450	1000	110	1000	50	46	18	32
30/15	300	70	300	350	80	350	900	120	900	35	35	20	32
65/15	220	80	220	250	90	250	850	130	850	25	25	39	39
25/25	400	60	400	500	70	500	1400	100	1400	42	35	23	36
45/25	400	70	400	450	80	450	1100	120	1100	31	28	27	39
80/25	250	80	250	350	90	350	800	130	800	21	21	31	40
35/30	500	70	500	550	80	550	1200	120	1200	38	31	26	37
55/30	350	60	350	450	90	450	800	130	1300	29	26	29	40
95/30	300	90	300	350	120	350	900	150	900	18	18	31	40
45/50	600	80	600	700	100	700	1600	130	2000	32	29	27	39
65/50	500	80	500	600	90	600	1100	140	1700	24	18	28	39
105/50	400	90	400	450	100	450	800	140	1300	17	14	31	39
60/100	700	70	700	900	80	900	2000	130	2500	28	15	31	43
90/100	700	100	700	900	120	900	1300	140	2300	17	9	28	39
140/100	600	120	600	650	140	650	1100	150	1700	12	10	31	43
80/250	1300	130	1300	1700	150	2400	2500	180	4000	21	7	32	43

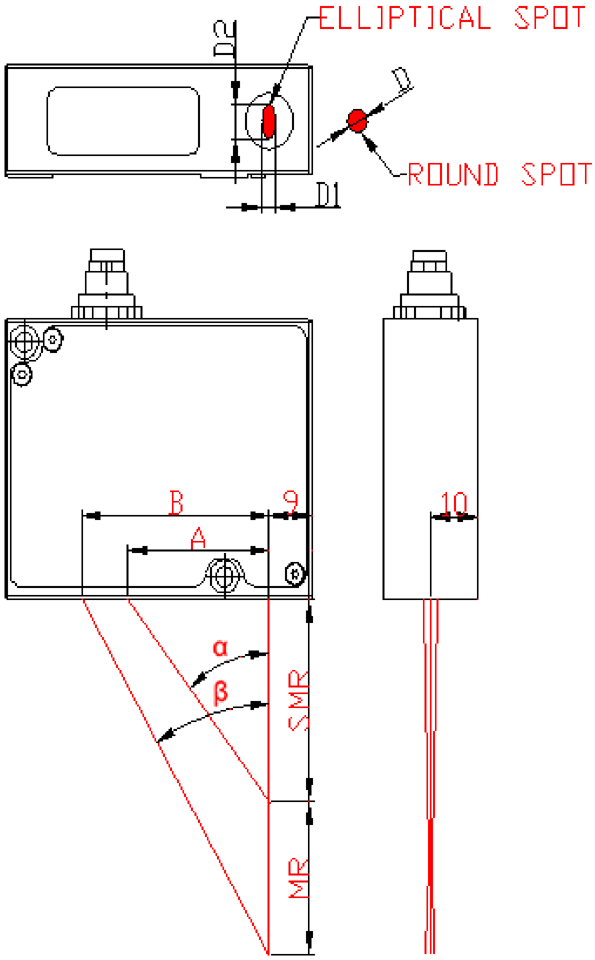


Figure 9

18.4. Connector mounting options

Overall dimensions of a cable connector sensor are shown in Fig. 10 and Fig. 12, and mounting options for 90 degree connector are shown in Fig. 11 and Fig. 13.

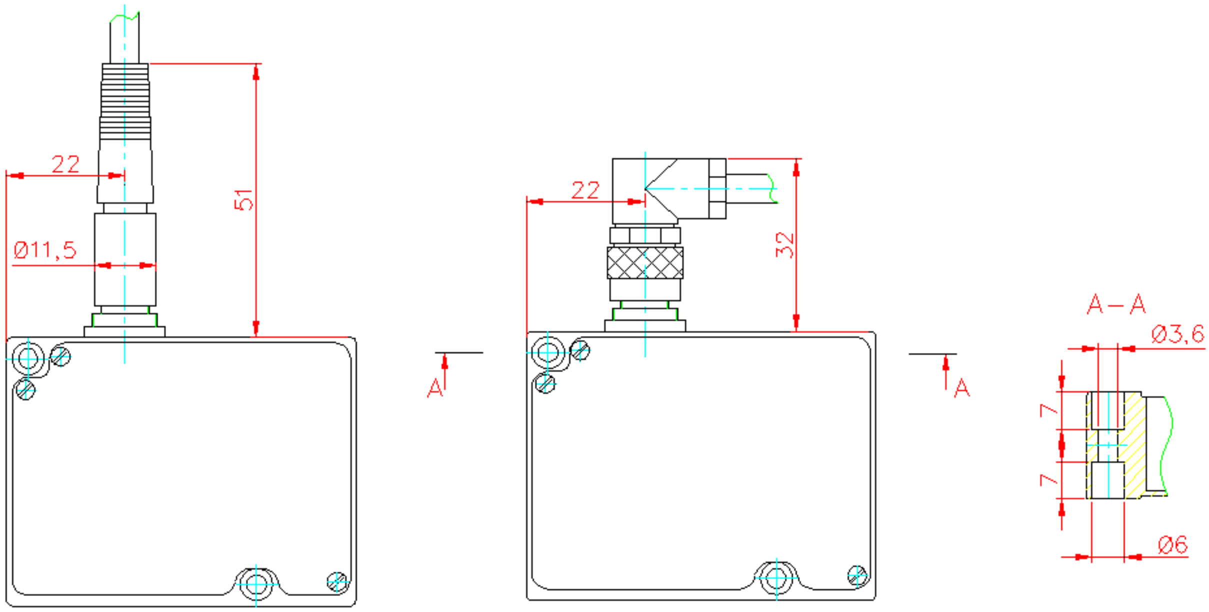


Figure 10

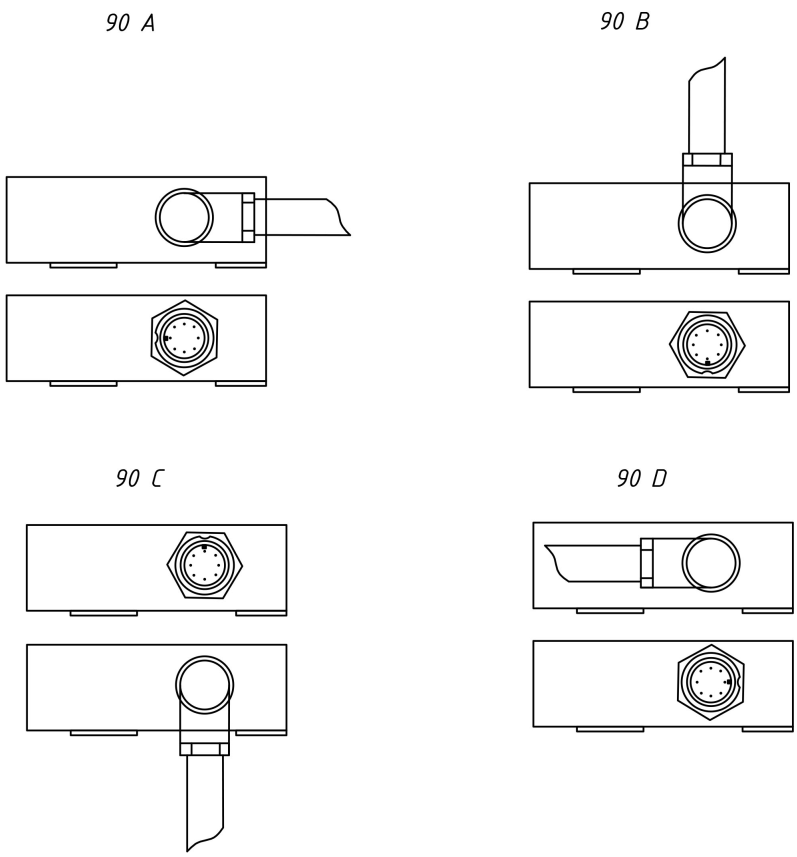


Figure 11

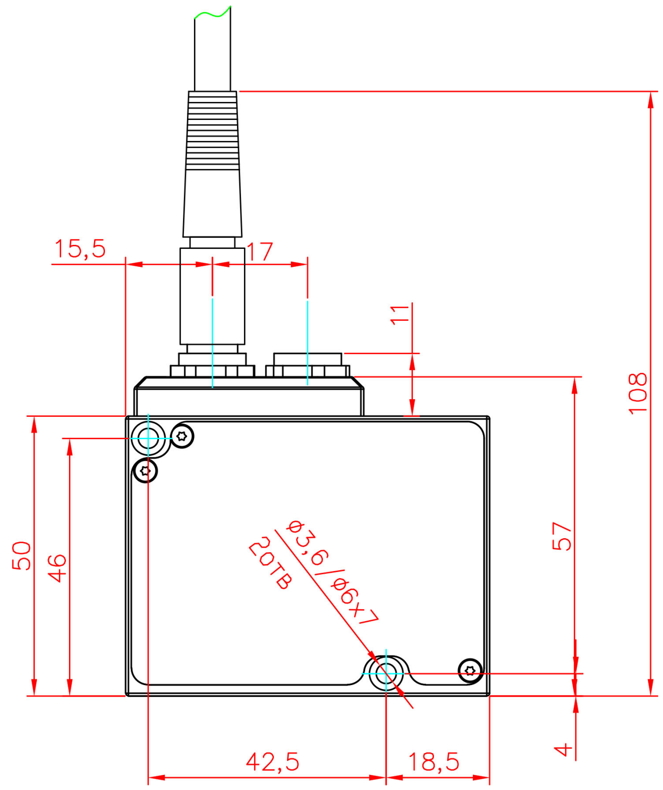


Figure 12

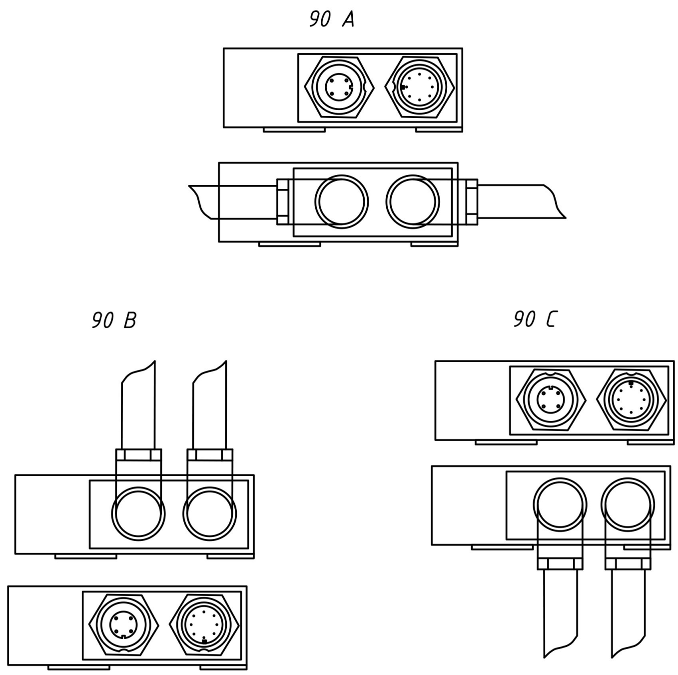


Figure 13

19. Warranty policy

Warranty assurance for Laser Triangulation Sensors RF603 Series – 24 months from the date of putting in operation; warranty shelf-life – 12 months.

20. Revisions

Date	Revision	Description
20.04.2013	3.0.0	Starting document.
20.11.2013	3.1.0	RF603-10/2 sensor is excluded. RF603-15/2 sensor is added. Automatic stream mode after sensor activation is added. Distributors list is updated.
18.12.2013	3.2.0	Figure 12, two connectors placement is added.
14.08.2014	4.0.0	Description of SDK functions is deleted. A link for download of updated SDK and functions description is added. Support of MSVC and Borland C for Windows, Linux, Wrapper C#, Wrapper Delphi. Examples for C#, Delphi, LabView, Mathlab.
18.06.2015	4.1.0	Linearity of sensors became twice as good (0,05% of the range). The group of sensors with Class 2 laser safety is increased.
23.11.2017	5.0.0	Added: description of CANopen and Modbus RTU interfaces, ASCII data format, sync modes.
29.01.2019	5.1.0	Par. 18.3: the table is updated.

21. Distributors

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