RIFTEK
Sensors & Instruments

LASER PROBES

RF609, RF609Rt Series

User's manual

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Contents

1. Safety precautions

- Use supply voltage and interfaces indicated in the probe specifications.
- In connection/disconnection of cables, the probe power must be switched off.
- Do not use the probe in locations close to powerful light sources.
- To obtain stable results, wait about 20 minutes after powering on to achieve uniform probe warm-up.

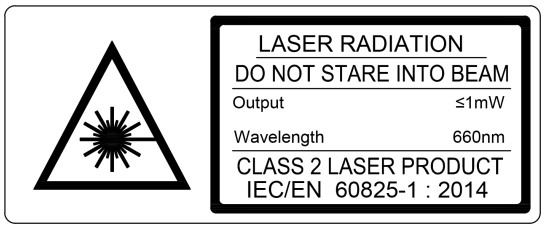
2. CE compliance

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



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

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

4. General information

Laser probes are designed for non-contact measurement and control of the geometric parameters of the holes.

It is also possible to order configurations other than those listed below.

5. Structure and operating principle

The main component of the probe is a laser sensor. Operation of the laser sensor is based on the principle of optical triangulation (Figure 1). The sensor contains a semiconductor laser (1) with the forming optics (2), the receiving lens (3), the CMOS array (4), and the controller (5).

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

The laser sensor is characterized by a base distance (the distance from the probe body to the beginning of the working range) and the working range (distance measurement range).

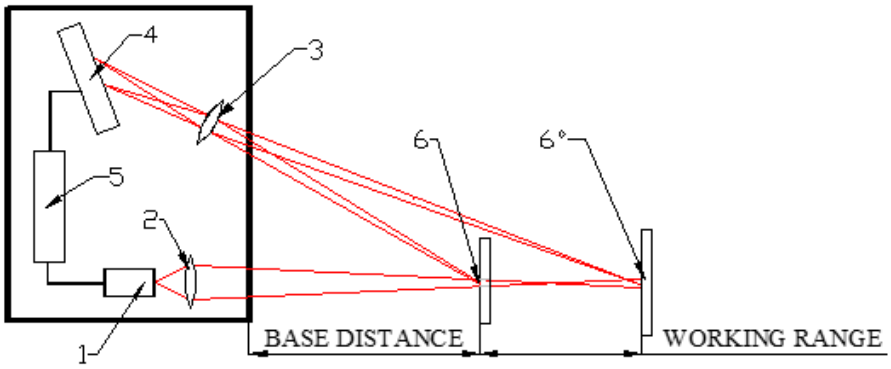


Figure 1

5

5.1. Measuring principle

The measuring principle is illustrated in Figure 2. The laser probe is inserted into the controlled hole. The probe or the part is driven in rotation. A triangulation laser sensor, which is built into the probe, measures the distance to the hole surface synchronously with the angle of rotation. The resulting set of polar coordinates is used to calculate the geometric parameters of the hole. Moving the probe along the hole allows you to get the geometric parameters of the hole in different sections and build a 3D model of the inner surface.

Examples of measuring systems:

https://riftek.com/eng/products/~show/instruments/laser_systems_for_inner_diameter_measurement

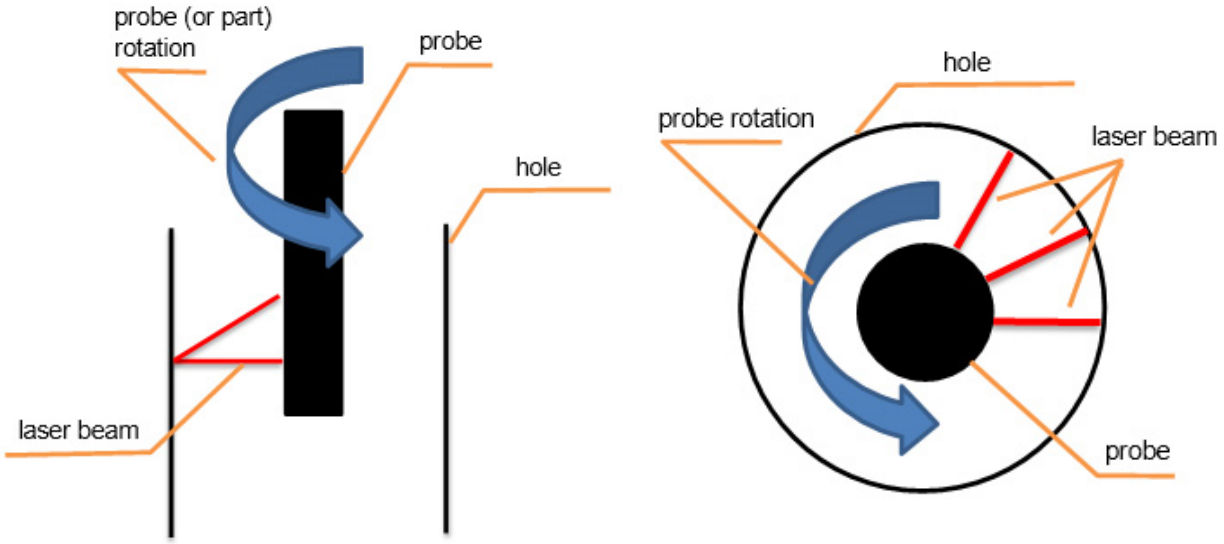


Figure 2

5.2. Configurations and overall dimensions

Two configurations are available: RF609 and RF609Rt.

Laser probes RF609Rt Series differ from RF609 ones by the presence of a built-in slip ring, which makes it possible to connect to a rotating laser sensor.

The probe series includes two RF609 models and two RF609Rt models with different measuring ranges.

Overall and mounting dimensions of the probes are shown in Fig. 3.1.-3.4.

6. Basic technical data

RF609 (RF609Rt) -	9/19	16/48
Diameter of the laser sensor body, mm	9	15
Range of controlled diameters, mm	9.2...19	16...48
Depth of controlled holes, mm	on request	
Base distance of the laser sensor, mm	0.1	0.5
Working range of the laser sensor, mm	5	16
Laser sensor linearity, %	±0.05 of the range	
Max. measurement frequency, Hz	9400	
Light source	red semiconductor laser, 660 nm wavelength for both models; blue or UV semiconductor laser, 450 or 405 nm wavelength (BLUE version) only for 16/48 model	
Output power, mW	≤1	
Laser safety class	2 (IEC60825-1)	
Output interface:		
Digital (RF609)	RS485 (max. 921600 baud)	
Digital (RF609Rt)	RS232 (max. 460.8 kbit/s) or RS485 (max. 921.6 kbit/s)	
Analog (only for RF609Rt)	4…20 mA (load ≤ 500 Ohm) or 0…10 V	
Sync inputs (RF609), V	2.4 – 24, trigger (IN input)	
Sync inputs (RF609Rt), V	trigger (IN input), A-B encoder (IN and AL inputs)	
Power supply, V	9...36	
Power consumption, W	1...1.5	
Environmental resistance:		
Enclosure rating	IP67	
Vibration	20 g / 10…1000 Hz, 6 hours for each of XYZ axes	
Shock	30 g / 6 ms	
Operating ambient temperature, °C	-10…+60	
Permissible ambient light, lx	10000	
Relative humidity, %	5-95 (no condensation)	
Storage temperature, °C	-20…+70	
Housing material	aluminum	
Weight (without cable), RF609, gram	40	85
Weight (without cable), RF609Rt, gram	from 900	

7. Example of item designation when ordering

RF609(Rt)(BLUE)-X/D-L-SERIAL-ANALOG--M

Symbol	Description
Rt	Probe with a built-in slip ring.
(BLUE)	Blue laser option (405 nm or 450 nm). Only for 16/48 probes.
X	Minimum controlled diameter, mm.
D	Maximum controlled diameter (when the probe is located along the hole axis), mm.
L	Probe length (prior consultation with the manufacturer is required).
SERIAL	Type of serial interface for RF609Rt: 232 (RS232) or 485 (RS485).
ANALOG	Attribute showing the presence of analog output for RF609Rt: 4…20 mA (I) or 0…10 V (U).
M	Cable length, m.

Example. RF609Rt-9/19-100-232-I-3 – Probe with a built-in slip ring, red semiconductor laser, range of controlled diameters - 9...19 mm, probe length - 100 mm, RS232 serial port, analog output 4…20 mA, cable length - 3 m.

8. Dimensions and mounting

8.1. Overall and mounting dimensions

Overall and mounting dimensions of the probes are shown in Fig. 3.1.-3.4.

The probe housing is made of anodized aluminum. The cable is mounted on the probe without connector.

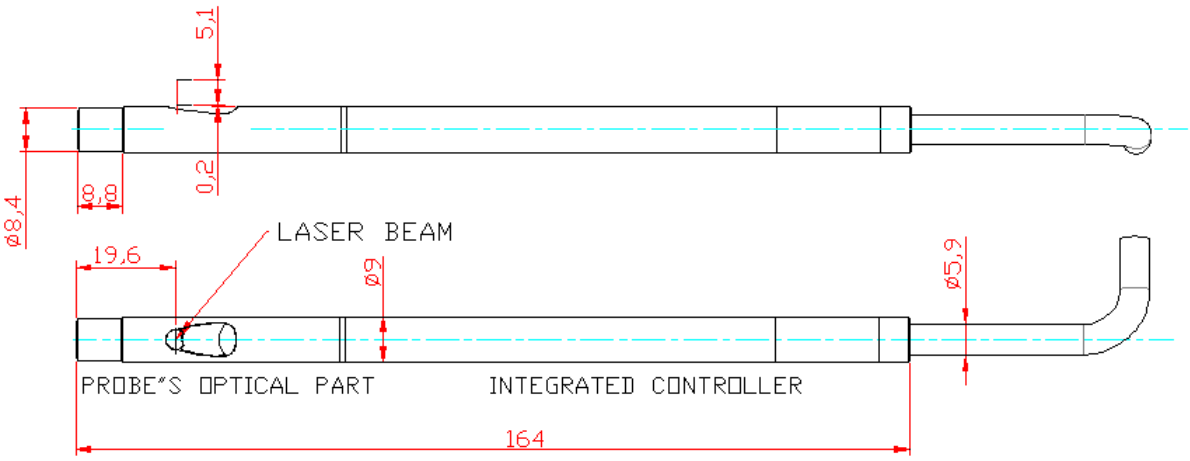


Figure 3.1. RF609-9/19.
The minimum possible length of the probe (without cable) is 164 mm.
The greater length is possible on request.

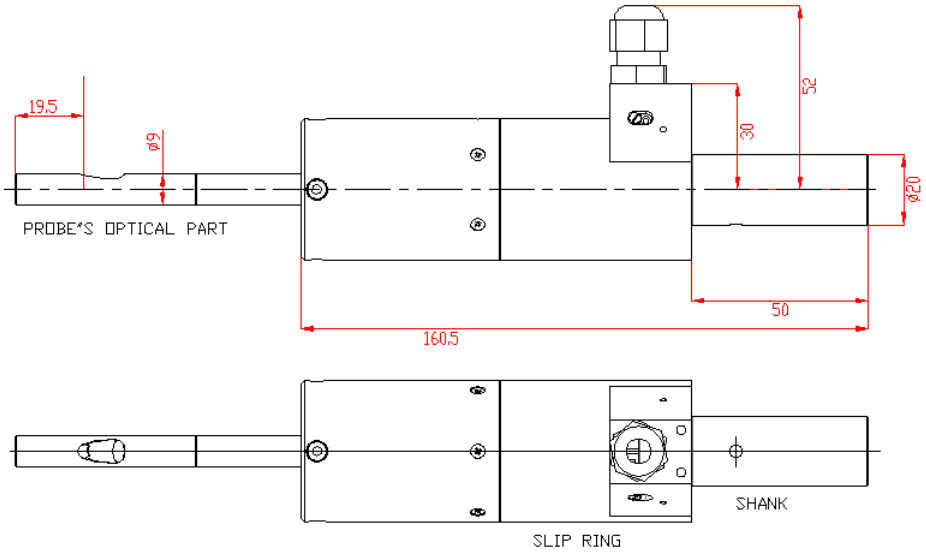


Figure 3.2. RF609-9/19Rt.
The length of the optical part of the probe - on request.

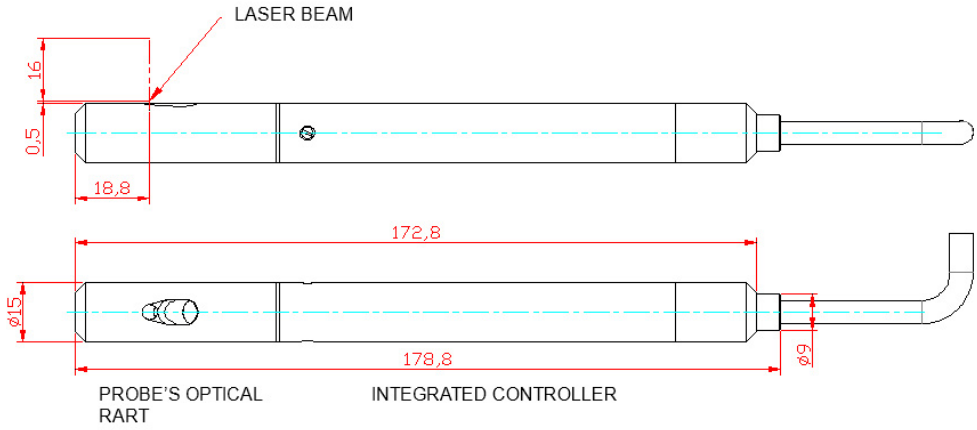


Figure 3.3. RF609-16/48.
The minimum possible length of the probe (without cable) is 180 mm.
The greater length is possible on request.

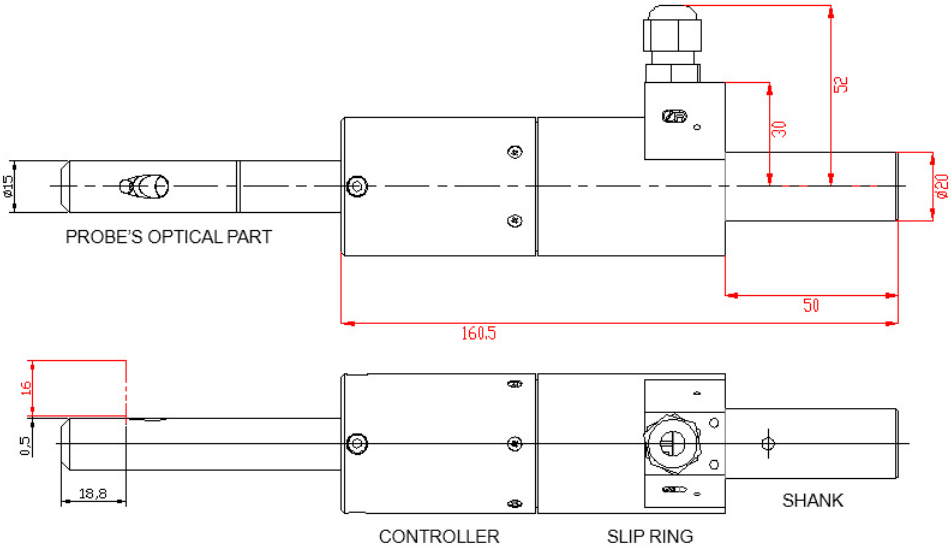


Figure 3.4. RF609-16/48Rt.
The length of the optical part of the probe - on request.

8.2. Overall demands for mounting

The sensor should be positioned so that the object under control is within the working range of the sensor.

9. Connection

Assignment of the cable wires for the RF609 sensor is given in the table below:

RF609	Pin number	Assignment	Wire color
485-IN	free leads	Power U+ Gnd (power) DATA+ DATA- IN Gnd (common for signals)	Red Brown Green Yellow White Gray

Assignment of the cable wires for the RF609Rt sensor is given in the table below:

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

10. Configuration parameters

The nature of operation of the probe depends on its configuration parameters, 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, entering the probe sensor, depends on the surface characteristics of the object under control. Therefore, the output power of the laser and the time of integration of radiation incident onto the CMOS array are automatically adjusted to achieve the maximum measurement accuracy.

Parameter "time limit for integration" specifies the 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. The 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 reduces proportionally.

NOTE 2. Increasing 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 this parameter makes it possible to increase the measurement frequency, but can decrease the measurement accuracy.

10.2. Sampling mode

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

- Time Sampling;
- Trigger Sampling.

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

When *Trigger Sampling* is selected, the sensor transmits the measurement result when the external synchronization input (IN input of RF609 or RF609Rt sensor) is switched or switching of A-B inputs of RF609Rt and taking *the division factor* set into account.

NOTE. The Trigger Sampling mode is the main mode when using probes to control the hole diameter.

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 п. 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. 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.

10.5. 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.

10.6. 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 averaging (discreteness - 5 ms).

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.

10.7. 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)
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

The data message has the following format:

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

The even parity bit pads 8-bit data to even parity.

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’ (RF602 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:

$$OR = 1 / (44/BR+1*10^{-5}) \text{ Hz}$$

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

Parameter code	Description	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	Lower 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	Higher byte of the sampling period	
0Ah	Lower byte of maximum integration time	2…3200 (default - 3200) The limiting time of integration by the CMOS array in increments of 1 µs.
0Bh	Higher byte of maximum integration time	
0Ch	Lower byte for the beginning of analog output range	0…16383 (default - 0)
0Dh	Higher byte for the beginning of analog output range	
0Eh	Lower byte for the end of analog output range	0…16383 (default - 16383)
0Fh	Higher 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	Lower byte of a zero point	0…16383 (default - 0), specifies the beginning of the absolute coordinate system.
18h	Higher byte of a zero point	
19…88h	***Reserved***	
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:

$$X=D*S/4000h\ (mm) \quad (1)$$

- 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	85h	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	Description	Value
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)
22-38	***Reserved***	
39	Change the protocol (RS interface)	0 - RIFTEK protocol; 1 - ASCII protocol; 2 - MODBUS RTU protocol.
40	Save/recover settings	170 - save current parameters to FLASH memory; 105 - restore default parameters.
41	Latch a current result	0 - nothing will happen; 1 - the 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>)

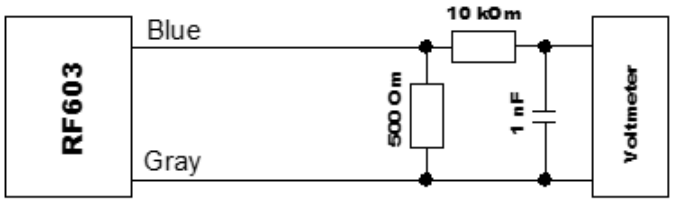
Request code + <CR><LF>	Name	X values	Answer (line + <CR><LF>)
Wx	Working with FLASH-memory	0 - save current parameters to FLASH-memory; 1 - recover default values of parameters in FLASH-memory	0 – “OK” line 1 – “OK” line
Rx	Request of a result	0 - in increments (0 .. 16384); 1 - in millimeters; 2 - 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
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) 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).	“OK” line
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

12. Analog outputs

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

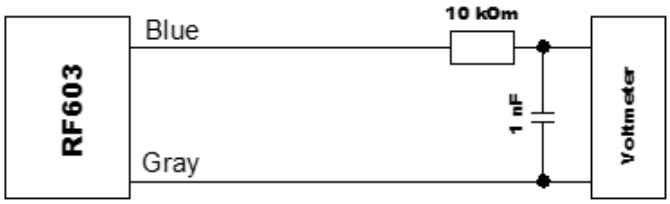
12.1. Current output 4…20 mA

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.



12.2. 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.



12.3. Configuration parameters

12.3.1. 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.

12.3.2. Analog output operation mode

When using the '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.

"Window mode". 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).

12.4. Factory parameters table

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

13. Parameterization program

13.1. Function

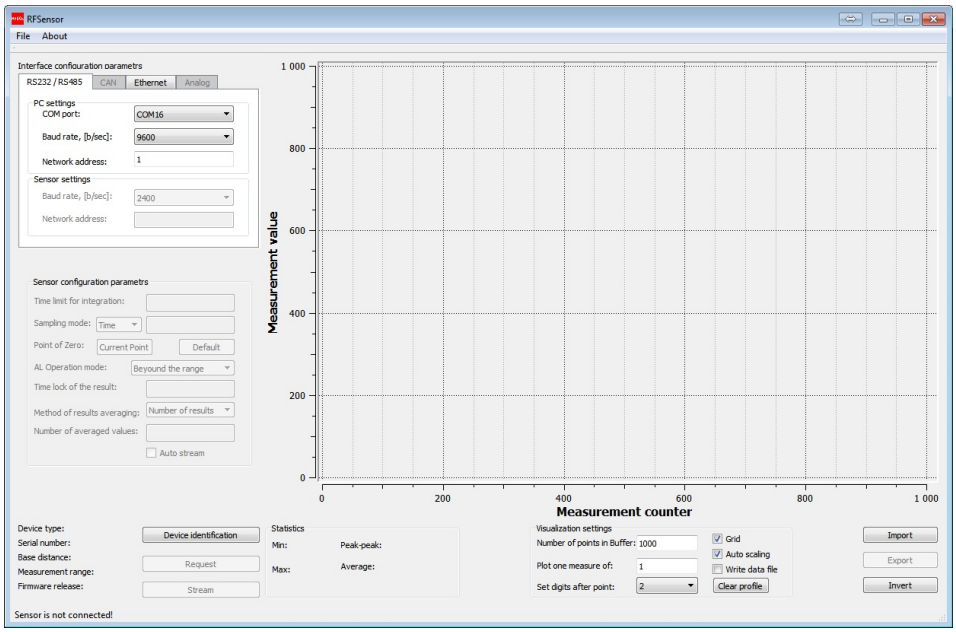
The **RF60X-SP** software is intended for:
1) Testing and demonstration of the sensor operation.
2) Setting of the sensor parameters.
3) Reception and gathering of the sensor data signals.
Download link:
https://riftek.com/upload/iblock/cb3/rf60x_sp.ZIP

13.2. Program setup

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

13.3. Obtaining connection to sensor (RS232/RS485)

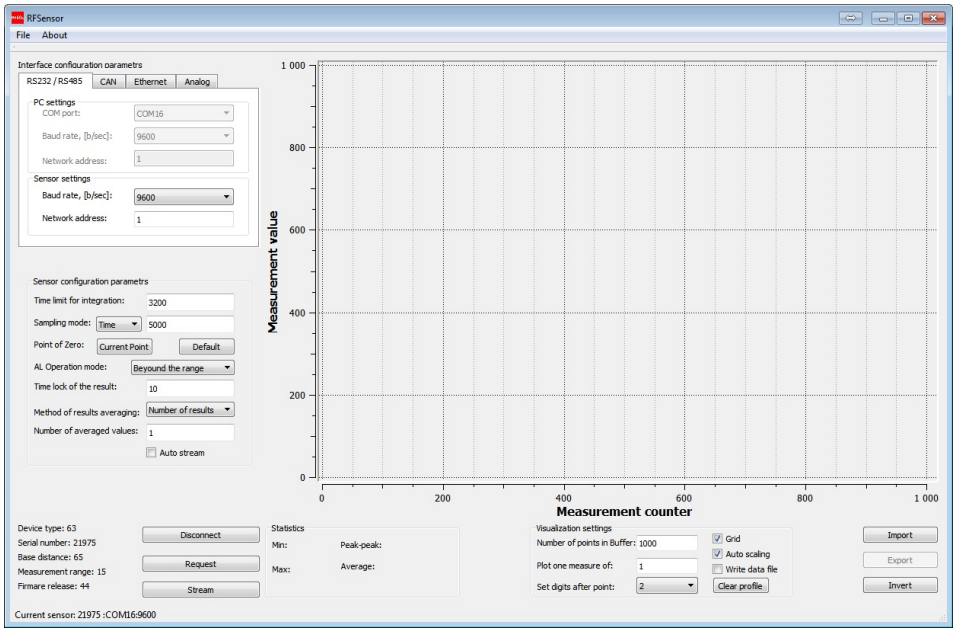
Once the program is started, the main window appears:



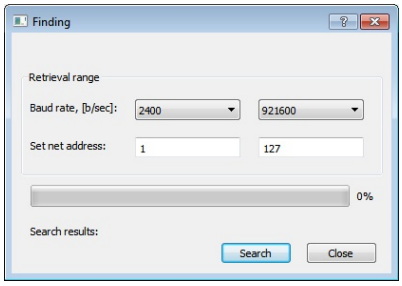
To obtain connection via RS232/RS485 interfaces, go to **RS232/RS485 PC settings** in the **Interface configuration parameters** panel:

- 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.
- Click 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.
- Click the **Search** button.

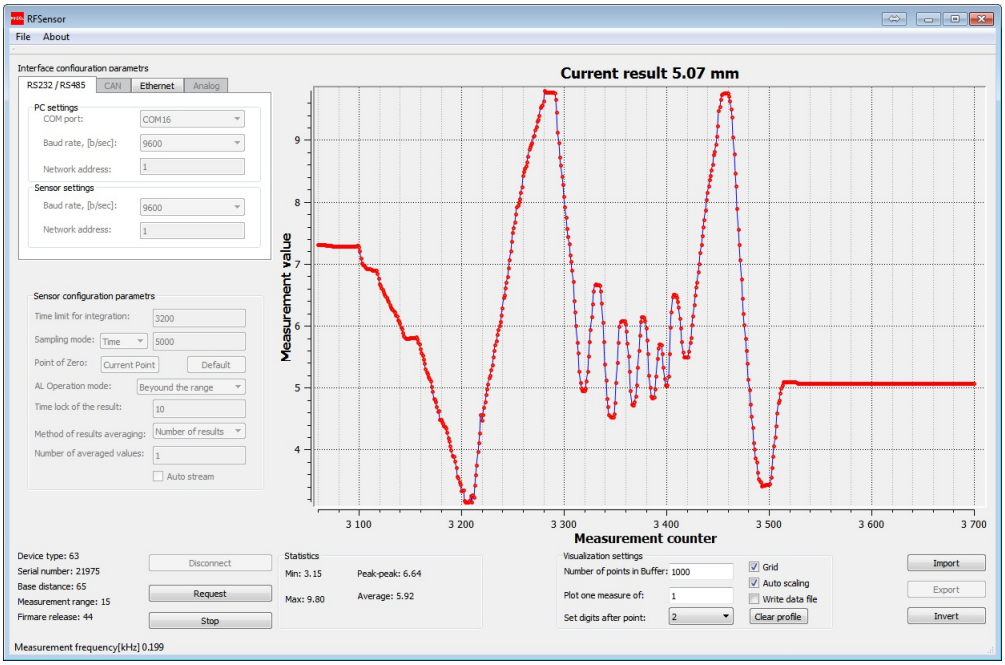
The program will perform the automatic search for the sensor by searching over possible rates, network addresses and COM ports of PC.

13.4. Checking of the sensor operability

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

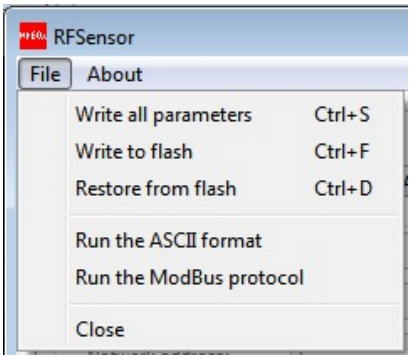
- Place an object within the sensor working range.
- By clicking the **Request** button, obtain the result of one measurement on the (**Current result**) indicator. The 06h request type is realized (see par. 11.7.5).
- Clicking the **Stream** button will switch the sensor to the data stream transmission 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, click the **Stop stream** button.

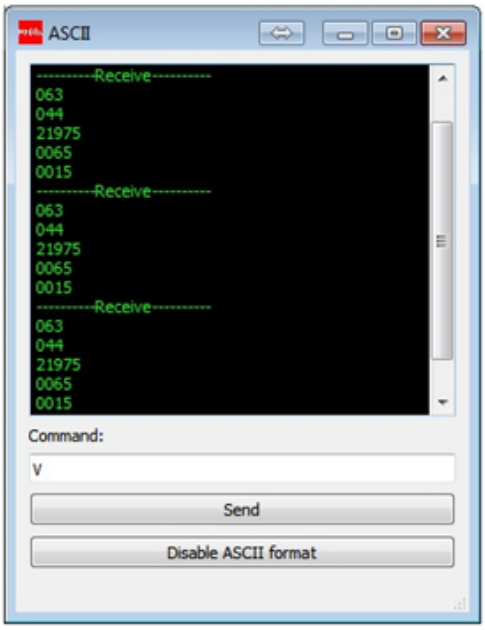


13.5. Connection via the ASCII interface

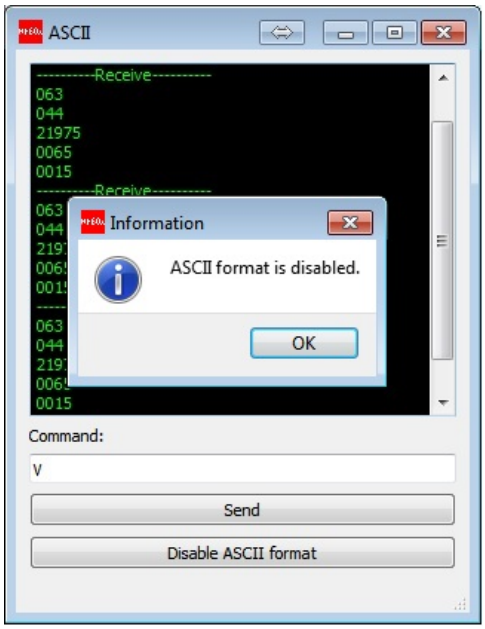
Select **File > Run the ASCII format**:



Use the emerged window to send commands:



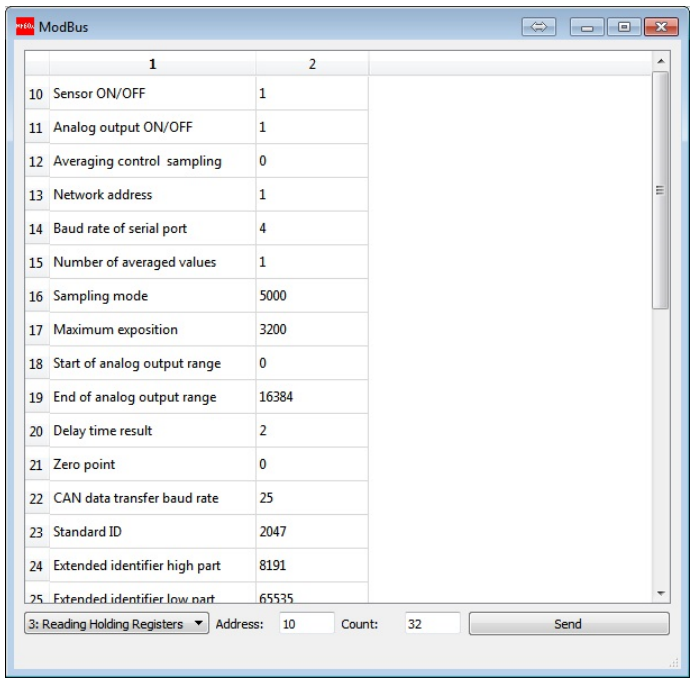
After closing the window, the sensor continues to work in the ASCII data format. To switch to the binary data format, click the **Disable ASCII format** button:



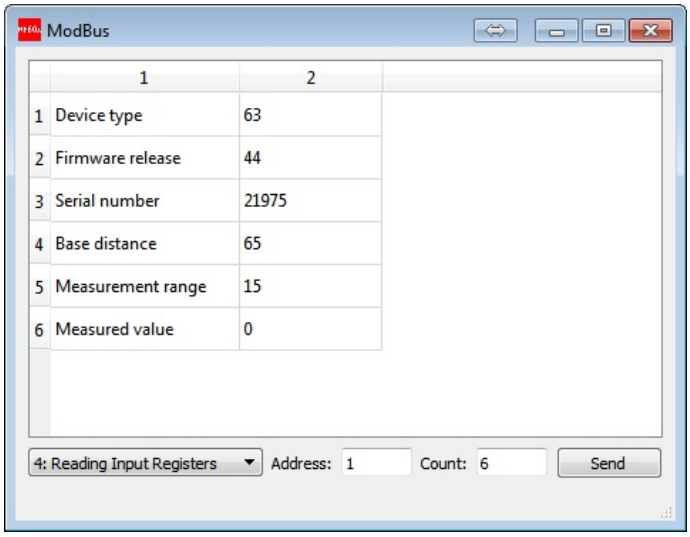
13.6. Connection via the Modbus RTU protocol

Select **File > Run Modbus protocol**.

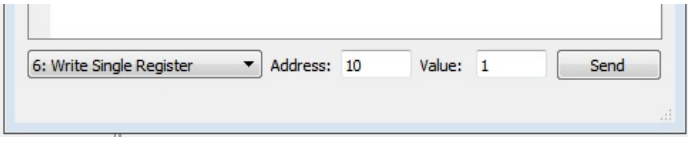
To read the **Holding Registers**, select the corresponding option from the drop-down list in the lower left part of the window. Write the address of the initial register (**Address**) and their number (**Count**), then click **Send**.



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 required value to register 39 (0 - RIFTEK protocol, 1 - ASCII format, 2 - MODBUS protocol).

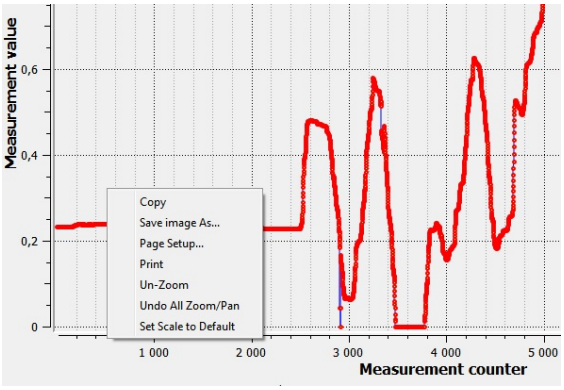
13.7. Display, gathering and scanning of data

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, right-click on the graph to call the corresponding menu:

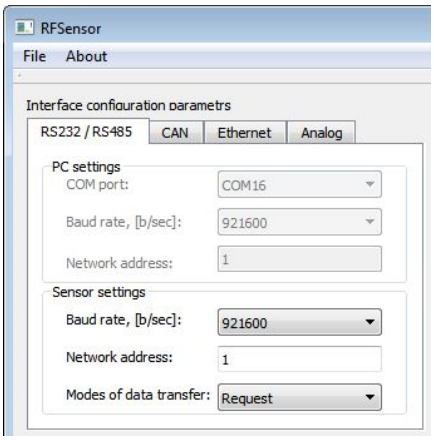


- To move the image, use the right mouse button.
- To zoom in/out the image, rotate the mouse wheel. The area to be zoomed in/out is selected by pressing the left mouse button.
- To save the data to a file, click the **Export** button. The program will offer to save the data in two possible formats: internal and Excel.
- To view previously saved data, click the **Import** button and select the file.

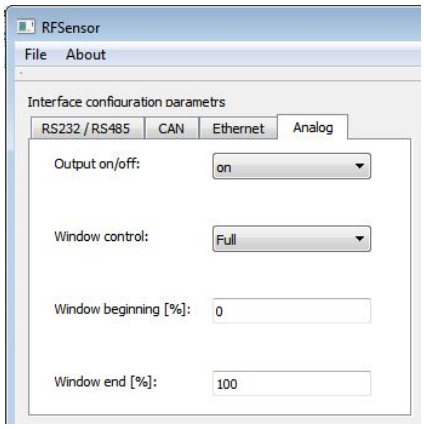
13.8. Setting and saving parameters of the sensor

13.8.1. Setting parameters

Setting of parameters for all interfaces can be done using the respective tabs on the **Interfaces configuration parameters** panel:

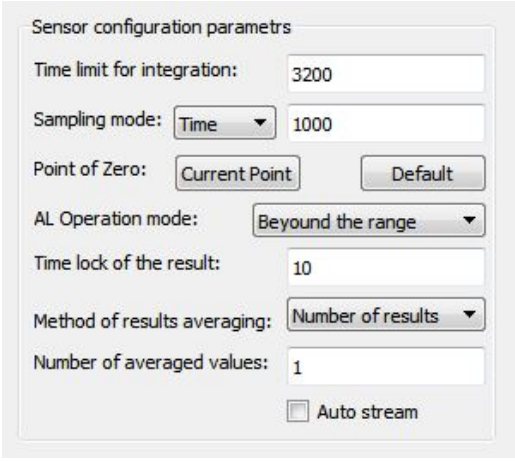


RS232/RS485



Analog outputs

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



13.8.2. Setting the data stream mode

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.

13.8.3. Saving parameters

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

13.8.4. 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.

13.8.5. Recovery of default parameters

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

14. RFDevice SDK

To work with laser sensors, we offer the RFDevice SDK library. This library allows users to develop their own software products without going into the details of the sensor communication protocol.

The RFDevice SDK library contains an API for working with all the company's products and includes:

- Documentation on classes and methods.
- Support for MSVC and BorlandC for Windows, Linux, Wrapper C#, Wrapper Delphi.
- Examples for C#, Delphi, LabView, MATLAB.

Download link:
https://riftek.com/upload/iblock/a1a/RFDevice_SDK.ZIP

15. Warranty policy

Warranty assurance for Laser Probes RF609, RF609Rt Series – 24 months from the date of putting in operation; warranty shelf-life – 12 months.

16. Revisions

Date	Revision	Description
10.06.2019	1.0.0	Starting document.
30.04.2021	1.1.0	Updated links in par. 13.1 and par. 14.

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