RIFTEK
Sensors & Instruments

LASER TRIANGULATION SENSORS

RF603HS 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.
- Mount sensor on the metal construction in order to avoid overheating of the sensor.

2. CE compliance

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

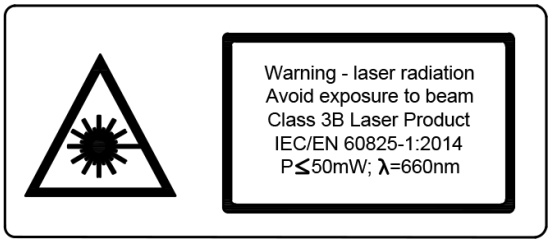
- EU directive 2014/30/EU. Electromagnetic compatibility (EMC).
- EU directive 2011/65/EU, “RoHS“ category 9.

3. Laser safety

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

3.1. Class 3B sensors

The sensors make use of a cw 660 nm wavelength semiconductor laser. Maximum output power is 90 mW. The sensors belong to the 3B laser safety class. The following warning label is placed on the sensor body:

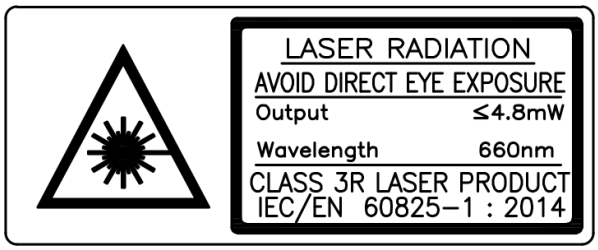


The following safety measures should be taken while operating the sensor:

- Do not target the 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.

3.2. Class 3R sensors

The sensors make use of a cw 660 nm wavelength semiconductor laser. Maximum output power is 5 mW. The sensors belong to the 3R laser safety class. The following warning label is placed on the sensor body:

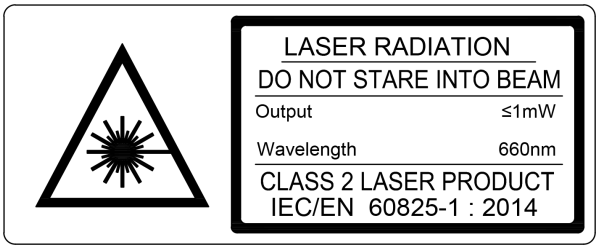


The following safety measures should be taken while operating the sensor:

- Do not target the 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 cw 660 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 sensor body:



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

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

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 25 sensors with the measurement range, from 2 to 1250 mm and the base distance from 15 to 260 mm.

There are two options of laser mounted in the sensor, RED or BLUE laser. 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

Model RF603HS-	X/2	X/5	X/10	X/15	X/25	X/30	X/50	X/100	X/250	X/500	X/750
Base distance X, mm	15	15	15, 25 60	15, 30 65	25, 45 80	35, 55 95	45, 65 105	60, 90 140	80	125	145
Measurement range, mm	2	5	10	15	25	30	50	100	250	500	750
Max. measurement frequency, kHz	70										
Linearity, % (of the range)	±0.1 (70 kHz)										
Resolution, % (of the range)	0.01 (70 kHz)										
Temperature drift	0.02% of the range / °C										
Light source	red semiconductor laser (660 nm wavelength) or UV semiconductor laser (450 nm or 405 nm wavelength, BLUE version)										
Output power	≤4.8 mW						≤20 mW		<80 mW		
Laser safety class	3R (IEC/EN 60825-1:2014)						3B (IEC/EN 60825-1:2014)				
Output interface:											
Parameterization	RS232 or RS485										
Data transfer	Ethernet (UDP)										
Analog	0…10 V										
Synchronization input	2.4 – 5 V (CMOS, TTL)										
Logic output	programmed functions, NPN: 100 mA max; 40 V max										
Power supply	9...36 V										
Power consumption	4.8 W										
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	-10...+60 °C										
Permissible ambient light	30000 lx										
Relative humidity	5-95% (no condensation)										
Storage temperature	-20…+70 °C										
Housing material	aluminum										
Weight (without cable)	110 gram										

6. Example of item designation when ordering

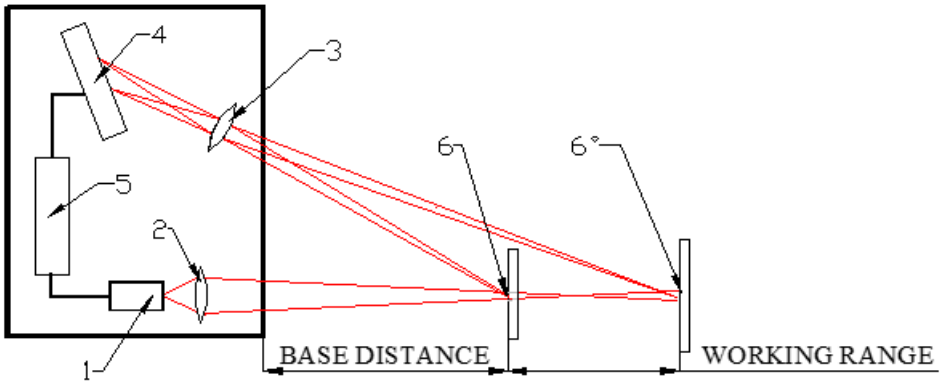
RF603HS(BLUE).F-X/D(R)-SERIAL-ANALOG-IN-AL-CC(R)(90)-M-H-P-B

Symbol	Description
(BLUE)	UV semiconductor laser (450 nm or 405 nm).
F	Maximal sampling frequency.
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: (RS232 and Ethernet) – 232-ET or (RS485 and Ethernet) – 485-ET.
ANALOG	Attribute showing an analog output presence 0…10 V (U).
IN	User programmed signal, which has several purposes: 1) Trigger input (input of synchronization). 2) Encoder_A input.
AL	User programmed signal, which has several purposes. It can be used as: 1) Logical output (indication of run-out beyond the range). 2) Line of mutual synchronization of two and more sensors. 3) Line of hardware zero setting. 4) Hardware laser switch ON/OFF. 5) Encoder_B input. 6) Status line input. 7) Input for Ethernet restart.
CC(90X)(R)	Cable gland - CG, or cable connector - CC (Binder 712, IP67). Note 1: 90(X) option – angle cable connector (see. p. 18.4.). Note 2: R option – robot cable.
M	Cable length, m.
H	Sensor with built-in heater.
P	Sensor with protect air cooling housing (see p. 18.1.).
B	Sensor with spray guard (see p. 18.2.).

Example: RF603HS.70-140/100R-232-ET-U-IN-AL-24-CCR90A-3 – 70 kHz sampling frequency, base distance – 140 mm, range – 100 mm, round shape laser spot, RS232 and Ethernet serial port, 0…10 V 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. A signal processor 5 calculates the distance to the object from the position of the light spot on the array 4.



8. Dimensions and mounting

8.1. Overall and mounting dimensions

Overall and mounting dimensions of the sensors are shown in Figure 2 and 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 glands or connectors.

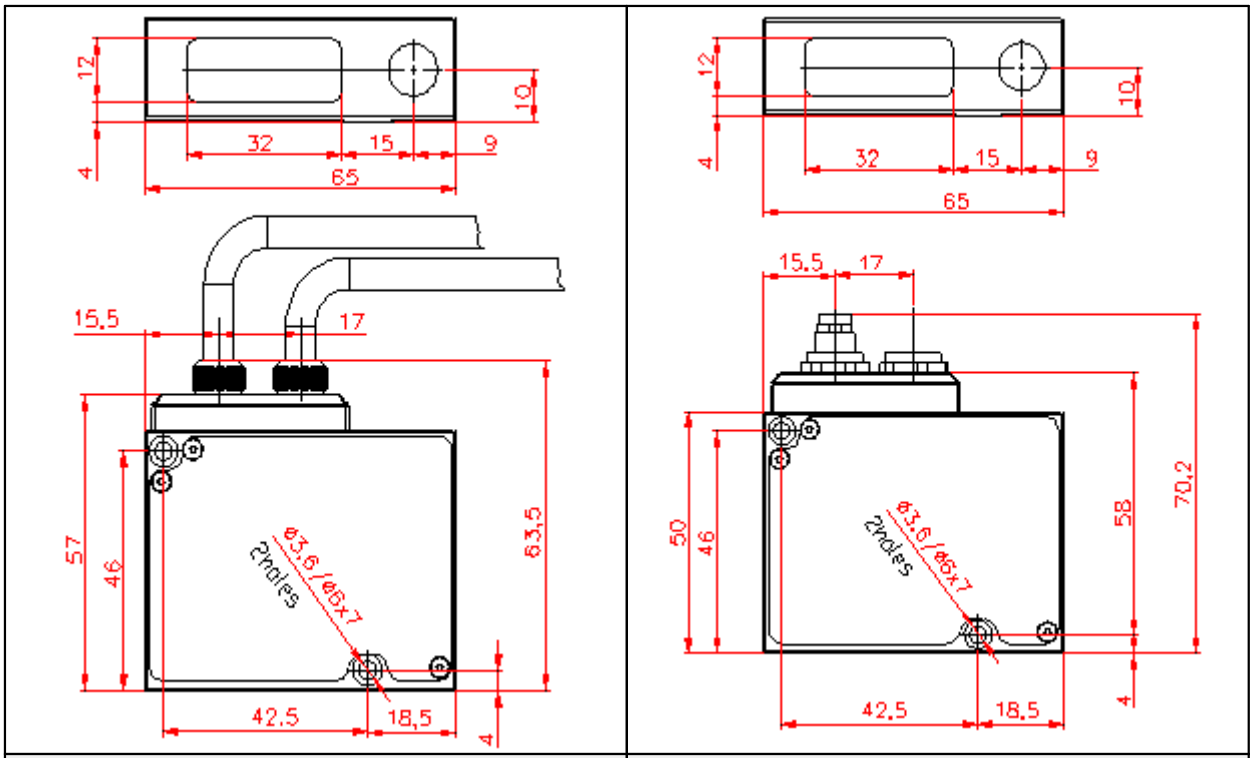


Figure 2. Sensor with cable glands (CG)

Figure 2.1. Sensor with connectors (CC)

8.2. Overall demands for mounting

The sensor must be positioned so that the object under control is 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 p. 18.3.

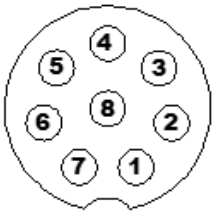
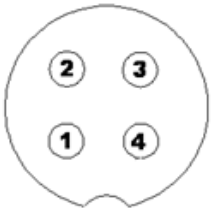
Where objects to be controlled have intricate shapes and textures, the incidence of mirror component of the reflected radiation to the receiving window should be minimized.

CAUTION! To avoid overheating of the sensor, mount the sensor only to a metallic plate with area not less than 50 cm^2 and using thermal paste.

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.

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-ET-U-IN-AL	1 2 3 4 5 6 7 8	IN Gnd (power supply) TXD RXD Gnd (Common for signals) AL U Power U+
485-ET-U-IN-AL	1 2 3 4 5 6 7 8	IN Gnd (power supply) DATA+ DATA- Gnd (Common for signals) AL U Power U+

Connector #2:

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

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-IN-AL	free lead free lead DB9 DB9 free lead free lead free lead DB9	- - 2 3 - - - 5	Power U+ Gnd (power) TXD RXD U IN AL Gnd (Common for signals)	Red Brown Green Yellow Blue White Pink Gray

Model of the sensor	Pin number	Assignment	Wire color
485-U-IN-AL	free leads	Power U+ Gnd (power) DATA+ DATA- U IN AL Gnd (Common for signals)	Red Brown Green Yellow Blue White Pink Gray

Cable #2:

Model of the sensor	Pin number		Assignment	Wire color
ET	RJ-45	1 2 3 4 5 6 7 8	TX+ TX- RX+ RX-	White-orange Orange White-green 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 given below.

10.1. "Time limit for integration" parameter

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 (70 kHz) is achieved for the integration time ≤14 μs. As the integration time increases above the specified value, the result updating time increases 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 2000 μs.

10.2. "Sampling mode" parameter (synchronization)

The sensor operation algorithm is built in such a way that measurements are taken at a maximum possible rate determined by the integration time. The measurement result is sent to the *buffer of measurements* and stored therein until a new result arrives.

The "Sampling mode" parameter determines the method of the readout of the result from the *buffer of measurements* to the *buffer of transmitting*. Three sampling modes are possible:

- Time Sampling
- Trigger Sampling
- Encoder Sampling

When the Time Sampling mode is selected, the sensor fills a buffer of transmitting (automatically transmits measurement results from the buffer of measurements into the buffer of transmitting) in accordance with the selected time interval (sampling period).

When the Trigger Sampling mode is selected, the sensor fills a buffer of transmitting (automatically transmits measurement results from the buffer of measurements into the buffer of transmitting) when an external synchronization input (IN input of the sensor) is switched taking into account the division factor (see p. 10.3).

When the Encoder Sampling mode is selected, the sensor fills the buffer of transmitting when encoders inputs (Encoder_A and Encoder_B) are switched taking into account the division factor.

NOTE 1. When the AL input is set as the "Encoder_B" input, the line IN is set as "Encoder_A" input automatically. With other settings of the AL line, the IN input is used as the trigger input.

NOTE 2. Electrical parameters of the IN input: logical "0" - [0V...1.6V], logical “1” - [2.4V...5V].

NOTE 3. Electrical parameters of the AL input: logical "0" - [0V...1.6V], logical “1” - [3.3V...36V].

10.3. "Sampling period" parameter

If the Time Sampling mode is selected, the 'sampling period' parameter determines the time interval after which the sensor fills the transmission buffer with the measured values. The value of the time interval is set in 1 μs increments. ***For example***, for the parameter value equal to 100, this interval is 1*100 = 100 μs.

If the Trigger or Encoder Sampling mode is selected, the 'sampling period' parameter determines the division factor for the external synchronization input or for encoder inputs. ***For example***, for the parameter value equal to 100, the transmission buffer is filled up when each 100th synchronizing pulse arrives at the IN input of the sensor.

NOTE. 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 mode.

10.4. "Point of zero" parameter

This parameter sets a zero point of the absolute coordinate system at any point within the working range. You can set this point by the corresponding command or by connecting the AL input to the ground line (this input must be preliminarily set to mode 3). When the sensor is fabricated, the base distance is set with some uncertainty, and, if necessary, it is possible to define the zero point more accurately.

10.5. Line AL operation mode

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

- Mode 1: indication of run-out beyond the range ("0" – object is beyond the range (beyond the selected window in the range), "1" – object is within the range (within the selected window in the range).
- Mode 2: mutual synchronization of two or more sensors.
- Mode 3: hardware zero-set line.
- Mode 4: hardware laser switch OFF/ON.
- Mode 5: Encoder_B input.
- Mode 6: status line input.
- Mode 7: Ethernet restart input.

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, and logical "0" occurs if the object is absent in the working range. *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. 3.1).

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. 3.2.).

In the *"Hardware zero-set"* mode, connection AL input to the ground potential sets beginning of coordinates into current point (Fig. 3.3.).

In the *"Hardware laser switch OFF/ON"* mode, connection AL input to the ground potential switches a laser ON/OFF (Fig. 3.4).

In the *"Encoder B" input* mode, AL line is used as B_input of encoder signal (Fig. 3.3.).

In the *"Status line input"* mode, AL line is used for control of the status of any input signal (Fig. 3.4.). The status is transmitted in the UDP packet.

In the *"Ethernet restart"* mode, AL line is used for internal buffers and counters of Ethernet interface (Fig. 3.4.).

NOTE. For modes 3, 4 and 6, operations occur after retention of AL line at low level during 100 ms with subsequent retention at a high level during 100 ms.

Example of AL line using:

Out of the range indication	Mutual synchronization

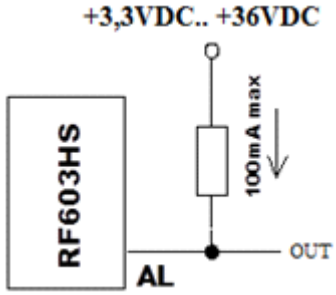
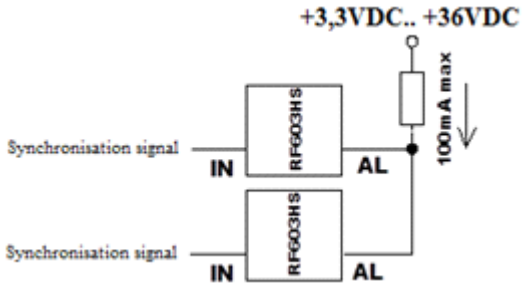

	

Figure 6.1	**Figure 6.2**
Encoder inputs mode	**Hardware zero-set/ Hardware laser ON/OFF Ethernet restart**

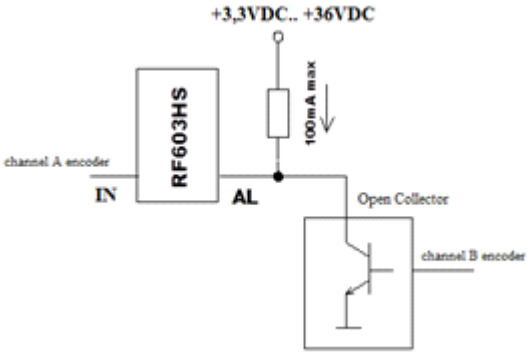
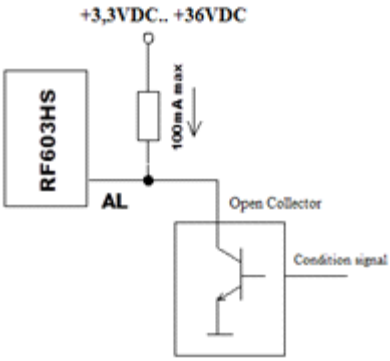

	

Figure 6.3	**Figure 6.4**

10.6. Time lock of the result

If the sensor does not detect an object, or if the authentic result cannot be obtained, a zero value is transferred. This parameter sets the time during which the last authentic result is transferred instead of a zero value. Discreteness of the time setting is 5 ms.

10.7. Method of results averaging

This parameter defines one of the two methods of averaging the 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 (discreteness is 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 parameter 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	6 us (160 kHz), 8 us (120 kHz), 14 us (70 kHz)
Sampling mode	time
Sampling period	500 (5 ms)
Point of zero	Beginning of the range
Line AL operation mode	1
Time lock of the result	5 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

RS232 и RS485 are used for sensor parameterization and data transmit. Please be aware, that maximal speed of data transmit by these interfaces does exceed 19 kHz. For high speed data transmit Ethernet interface is used.

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. Modes of data transfer

There are two methods for obtaining measurement data:

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

11.4. Configuration parameters

11.4.1. 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 interface is 460.8 kbit/s, and for RS485 interface the rate is 921.6 kbit/s.

11.4.2. Net address

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

NOTE. Network data communications protocol assumes the presence of ‘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 receive 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).

NOTE. When the sensor receives a broadcast request, it executes the command but doesn't send a replay.

11.4.3. Factory parameters table

Parameter	Value
Baud rate	9600 bit/s
Net address	1
Mode of data transfer	request

11.5. Interfacing protocol

11.5.1. 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.

11.5.2. 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”].

11.5.3. Request

"Request" (INC) — is a two-byte message, which fully controls communication session. The ‘request’ message is the only one of all messages in a session where 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, optional, the message [MSG].

"Request" format:

Byte 0								Byte 1								[Bites 2…N]
INC0(7:0)								INC1(7:0)								MSG
0	ADR(6:0)							1	0	0	0	COD(3:0)				

11.5.4. Message

"Message’’ is data burst that can be transmitted by ‘master’ 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.

The following is the format of two ‘message’ data bursts for transmission of byte:

DAT(7:0)									
Byte 0					Byte 1				
1	0	0	0	DAT(3:0)	1	0	0	0	DAT(7:4)

11.5.5. Answer

"Answer’’ is 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 two 'answer' data bursts for transmission of byte:

DAT(7:0)							
Byte 0				Byte 1			
1	SB	CNT(1:0)	DAT(3:0)	1	SB	CNT(1:0)	DAT(7:4)

11.5.6. 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 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.

11.5.7. 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 b/s, Output Rate = 9.4 kHz.

11.5.8. Request codes and list of parameters

Request codes and list of parameters are presented in Chapter 15.

12. Description of Ethernet interface

Ethernet interface is used only for the reception of data from the sensor. Parameterization of sensors is carried out via RS232 or RS485 interface.

12.1. Modes of data transfer

The sensor can be operated in the following modes:

- No transmission.
- *Automatic data streaming mode*. At the beginning, the internal buffer of transmission of the sensor is filled with measurement data in accordance with a selected sampling mode of Time or Trigger or Encoder (see p. 10. 2.) and corresponding sampling period (see p. 10.3.). After the buffer has been filled (buffer size is 168 measurements), the sensor transmits data packet accumulated in the buffer of transmission to UDP network.

12.2. Factory parameters table

Parameter name	Value
Destination IP Address	255.255.255.255
Gateway IP address	192.168.0.1
Subnet Mask	255.255.255.0
Source IP address	192.168.0.3
Mode of data transfer	time sampling
Interface condition	ON

12.3. Data packet format

The sensor sends IP/UDP packet to 512 byte data packet to destination port 603. The packet contains field of header (42 byte) and field of data (512 byte).

The data field:

- byte 0, byte 1: 1st measurement
- byte 2, : status word for the 1st measurement
- byte 3, byte 4: 2nd measurement
- byte 5, : status word for the 2nd measurement

. . . . . .

- byte 501, byte 502 : 168th measurement
- byte 503, : status word for the 168th measurement
- byte 504, byte 505 : serial number of the sensor
- byte 506, byte 507 : base distance
- byte 508, byte 509 : measurement range
- byte 510, : cyclic counter of packet number
- byte 511, : packet checksum (=0)

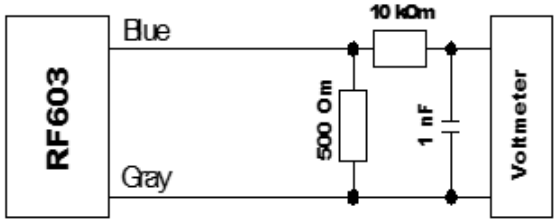
12.4. Data structure

- 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).
- The status word size is 1 byte. The bit 0 of status word characterizes the updating of the result. If the bit 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 non-updated result has been transmitted. The bit 1 of status word characterizes status of AL line (in Encoder input mode this bit shows the direction of count). The bit 2 of status word characterizes status of IN line in the mode of Time Sampling.
- The bits 7…3 of the status word are reserved and equal to "0".
- 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.

13. Voltage output

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 (150 kHz) and this value increases in proportion to the frequency reduction.



NOTE. When the Ethernet interface and the analog output work simultaneously, the sampling frequency of the sensor can't be more than 150 kHz.

14. Sensor connection

Switch off the power supply. Connect cable #1 to the sensor (p. 9.1.) and other cable end - to PC (use interface adapter if necessary).

NOTE. Connection of RS232 (RS485) is necessary if parametrization (or parameters viewing) of the sensor is suggested.

Connect cable #2 to the sensor and other cable end – to Ethernet connector PC or to the switch. Connect the power supply (+9...+36 V) to the Power U+ и Gnd wires. Switch on the power supply.

15. Request codes and list of parameters

15.1. Request codes table

Request code	Description	Message (size in bytes)	Answer (size in bytes)
01h	Device identification	—	– device type (1) – firmware release (1) – serial number (2) – base distance (2) – range (2)
02h	Reading of parameter	– code of parameter (1)	– value of parameter (1)
03h	Writing of parameter	– code of parameter (1) – value of parameter (1)	—
04h	Storing current parameters to FLASH memory	– constant AAh (1)	– constant AAh (1)
04h	Recovery of parameter default values in FLASH memory	– constant 69h (1)	– constant 69h (1)
05h	Latching of current result	—	—
06h	Inquiring of result	—	– result (2)
07h	Inquiring of a stream of results	—	– stream of results (2)
08h	Stop data streaming	—	—

15.2. List of parameters

Parameter code	Name	Values
00h	Sensor ON	1 – laser is ON, measurements are taken (default state); 0 – laser is OFF, sensor in power save mode.
01h	Analog output ON	1/0 – analog output is ON/OFF; if a sensor has no analog output, this bit will remain in 0 despite all attempts of writing 1 into it.
02h	Averaging, sampling and AL output control	x,x,M,C,M1,M0,R,S – control byte which determines averaging mode – bit M, CAN interface mode – bit C, logical output mode – bit M1, analog output mode – bit R, and sampling mode – bit S. Bites x – do not use. Bit M: 0 – quantity sampling mode (by default); 1 – time sampling mode. Bit C:

Parameter code	Name	Values
		0 – request mode of CAN interface (by default); 1 – synchronization mode of CAN interface. Bit M1 and M0: 00 – out of the range indication (by default); 01 – mutual synchronization mode; 10 – hardware zero set mode; 11 – laser turn OFF/ON; 100 – Encoder_B input mode; 101 – status line input mode; 110 – Ethernet reset mode. Bit S: 0 – time sampling (default); 1 – trigger sampling.
03h	Network address	1…127 (default – 1)
04h	Rate of data transfer through serial port	1…192 (default – 4) specifies data transfer rate in increments of 2400 baud; e.g., 4 means the rate of 4□2400=9600baud. (NOTE: max baud rate = 460800).
05h	**Reserved**	
06h	Number of averaged values	1…128 (default – 1)
07h	**Reserved**	
08h	Lower byte of the sampling period	1) 10…65535 (default – 500) Specifies the time interval in increments of 1 us after which the sensor automatically transmits results on the data stream request (sampling priority = 0). 2) 1…65535 (default – 500) Specifies the division ratio of trigger input with which the sensor automatically transmits results on the data stream request (sampling priority = 1).
09h	Higher byte of the sampling period	
0Ah	Lower byte of maximum integration time	2…65535 (default – 200) Specifies 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…4000h (default – 0) Specifies the point within the range of the sensor at which the analog output reaches its minimum value.
0Dh	Higher byte for the beginning of analog output range	
0Eh	Lower byte for the end of analog output range	0…4000h (default – 4000h) Specifies the point within the range of the sensor at which the analog output reaches its maximum value.
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 zero point	0…4000h (default – 0) Specifies the beginning of the absolute coordinate system.
18h	Higher byte zero point	
19…1Ch	**Reserved**	
6Ch	0th byte of Destination IP Address	By default – FFFFFFFFh = 255.255.255.255
6Dh	1st byte of Destination IP Address	

Parameter code	Name	Values
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	
88h	ETHERNET interface ON/OFF	0 – ETHERNET interface OFF; 1 – ETHERNET interface ON (UDP protocol).

15.3. 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.

15.4. Examples of communication sessions

1) Request "Device identification".
Condition: device address – 1, request code – 01h, device type – 64 (40h), firmware release – 08 (08h), serial number – 0402 (0192h), base distance – 80mm (0050h), measurement range – 50мм (0032h), packet number – 1.

The request format:

Byte 0		Byte 1					[Bytes 2…N]
INC0(7:0)		INC1(7:0)					MSG
0	ADR(6:0)	1	0	0	0	COD(3:0)	

Request from “Master":

Byte 0								Byte 1							
INC0(7:0)								INC1(7:0)							
0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1
01h								81h							

The following is the format of two ‘answer’ data bursts for transmission of byte DAT(7:0):

DAT(7:0)							
Byte 0				Byte 1			
1	0	CNT(1:0)	DAT(3:0)	1	0	CNT(1:0)	DAT(7:4)

Answer of “Slave”:

- Device type:

DAT(7:0)															
Byte 0								Byte 1							
1	0	0	1	0	0	0	0	1	0	0	1	0	1	1	0
90h								94h							

- Firmware release:

DAT(7:0)															
Byte 0								Byte 1							
1	0	0	1	1	0	0	0	1	0	0	1	0	0	0	0
98h								90h							

- Serial number:

DAT(7:0)															
Byte 0								Byte 1							
1	0	0	1	0	0	1	0	1	0	0	1	1	0	0	1
92h								96h							
DAT(7:0)															
Byte 0								Byte 1							
1	0	0	1	0	0	0	1	1	0	0	1	0	0	0	0
91h								90h							

- Base distance:

DAT(7:0)															
Byte 0								Byte 1							
1	0	0	1	0	0	0	0	1	0	0	1	0	1	0	1
90h								95h							
DAT(7:0)															
Byte 2								Byte 3							
1	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0
90h								90h							

- Measurement range:

DAT(7:0)															
Byte 0								Byte 1							
1	0	0	1	0	0	1	0	1	0	0	1	0	0	1	1
92h								93h							
DAT(7:0)															
Byte 2								Byte 3							
1	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0
90h								90h							

NOTE. Since packet number is "1", CNT is "1".
2) Request "Reading of parameter".
Condition: device address – 1, request code – 02h, code of parameter – 05h, value of parameter – 04h, packet number – 2.
Request (“Master”) – 01h, 82h.
Message (“Master”) – 85h, 80h.
Answer (“Slave”) – A4h, A0h.
3) Request "Inquiring of result".
Condition: device address – 1, result – 02A5h, packet number – 3.
Request (“Master”) – 01h, 86h.
Answer (“Slave”) – B5h, BAh, B2h, B0h.
Measured distance (mm) (for example, range of the sensor = 50 mm):
X=677(02A5h)*50/16384 = 2.066 mm.
4) Request "writing sampling mode (trigger sampling)".
Condition: device address – 1, request code – 03h, code of parameter – 02h, value of parameter – 01h.
Request ("Master") – 01h, 83h.
Message ("Master") – 82h, 80h, 81h, 80h.
5) Request: "writing the divider ration".
Condition: divider ration – 1234=3039h, device address – 1, request code – 03h, code of parameter – 09h (first or higher byte), value of parameter – 30h.
Request ("Master") – 01h, 83h.
Message ("Master") – 89h, 80h, 80h, 83h.
For the lower byte: parameter code – 08h, parameter value – 39h.
Request ("Master") – 01h, 83h.
Message ("Master") – 88h, 80h, 89h, 83h.

16. Parameterization program

16.1. Function

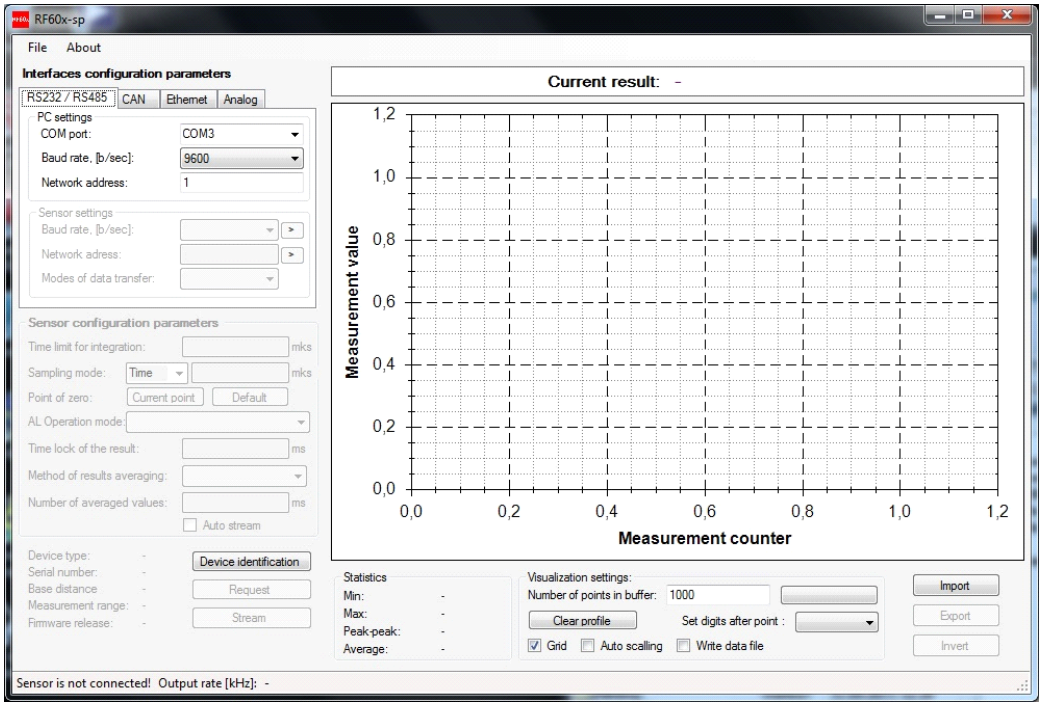
The **RF60X-SP** software is intended for:
1) Testing and demonstration of work of the sensors.
2) Setting of the sensor parameters.
3) Reception and gathering of the sensor data signals.
Download link:
https://riftek.com/upload/iblock/cb3/rf60x_sp.ZIP

16.2. Program setup

Start **RF60Xsetup.exe** and follow the instructions of the installation wizard.

16.3. Obtaining connection to sensor (RS232/RS485)

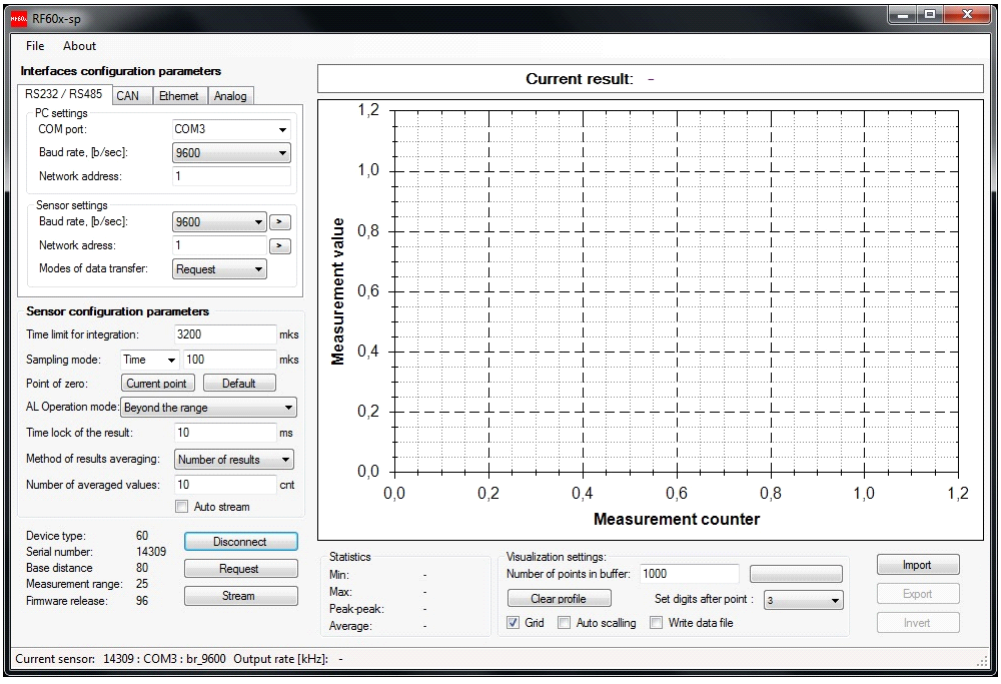
Once the program is started, the pop-up window emerges:



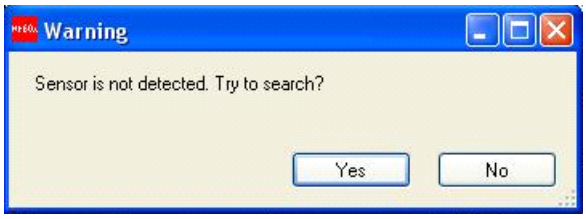
To obtain connection via RS232/RS485 interfaces, go to RS232/RS485 PC settings in the **Interface configuration parameters** panel:

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

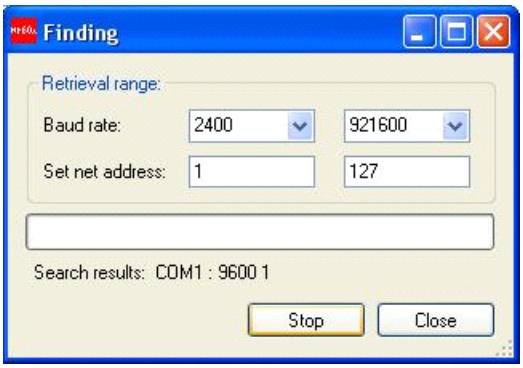
If the selected parameters correspond to the parameters of the sensor interface, the program will identify the sensor, read and display its configuration parameters:



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



To start search, click the **Yes** button:



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

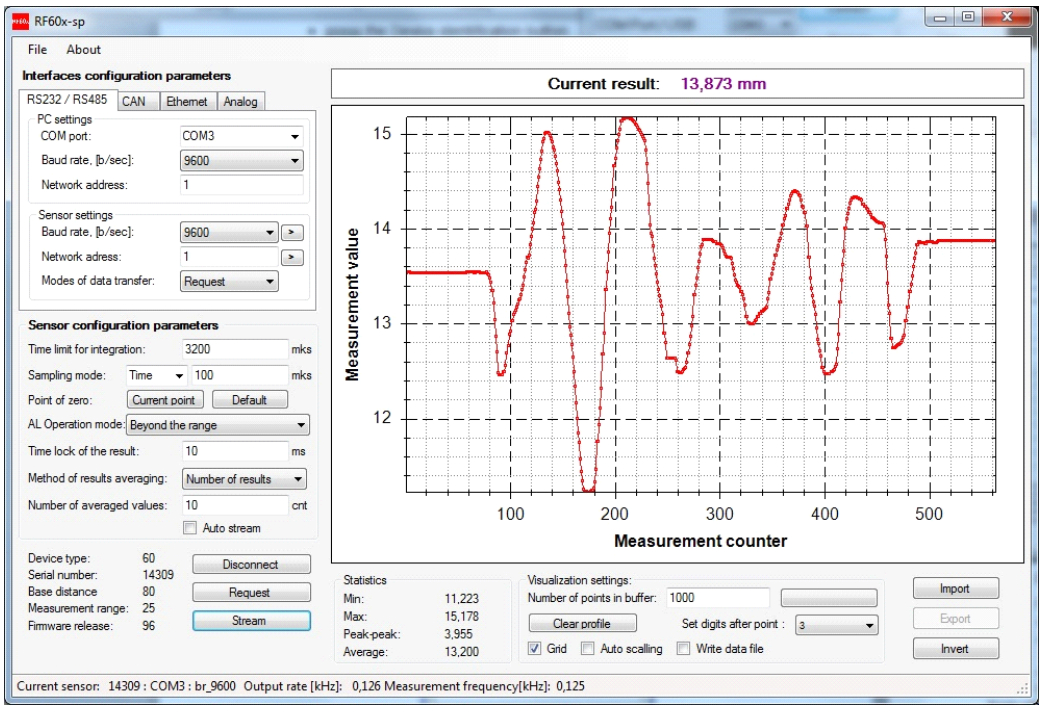
The program will perform automatic search of the sensor by searching over possible rates, network addresses and COM-ports of the PC.

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. 15.1.).
- Pressing the **Stream** button will switch the sensor to the data stream transmission mode. The 07h request type is realized (see par. 15.1.).
- By shifting 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.

Pressing the **Stop stream** button will stop the data transmission.



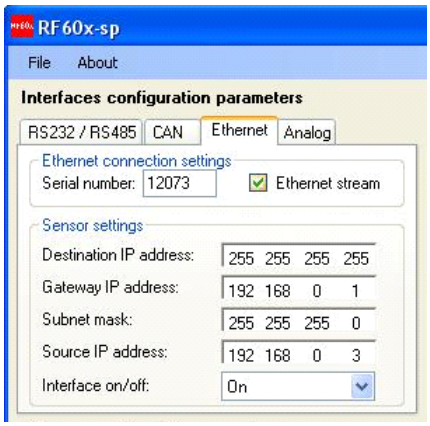
16.5. Connection through Ethernet interface

For data reception via Ethernet interface:

- Tick **Ethernet stream** in the **Ethernet** tab.
- If there are several sensors in the network, write in the **Serial number** field the serial number of the sensor from which data have to be received.
- Click the **Stream** button.

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

Note 2. If **Ethernet stream** is not selected (ticked) while the sensor is connected also via RS232/RS485, then data will be received through the latter interface.



16.6. Display, gathering and scanning of data

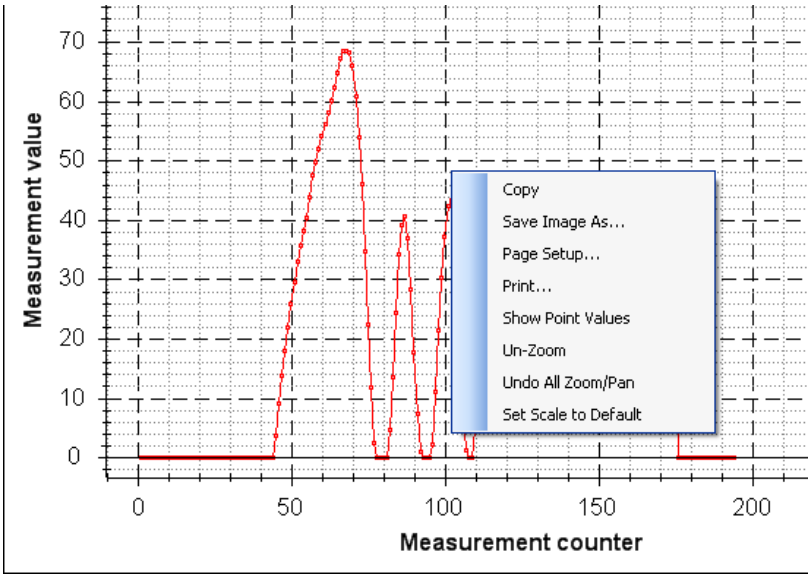
Measurement result is displayed in digital form and in the form of oscillogram and is stored in the PC memory.

- 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.
- Turning on / turning off the scaling grid is effected by using the Grid function.

- The number of displayed digits after decimal point can be set in the Set 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, click the right mouse key on the graph to call the corresponding menu:

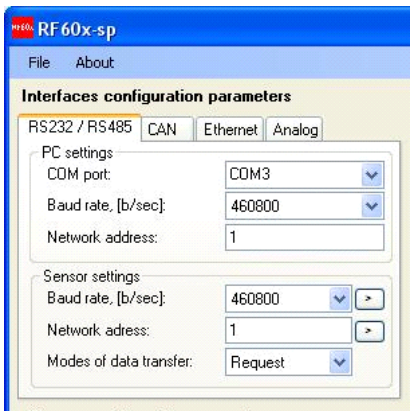


- To move the image, just press the mouse wheel.
- To zoom, rotate the mouse wheel.
- To save data to a file, click the **Export** button. The program will offer to save data in two possible formats: internal and Excel.
- To scan or look at previously saved data, click the **Import** button and select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

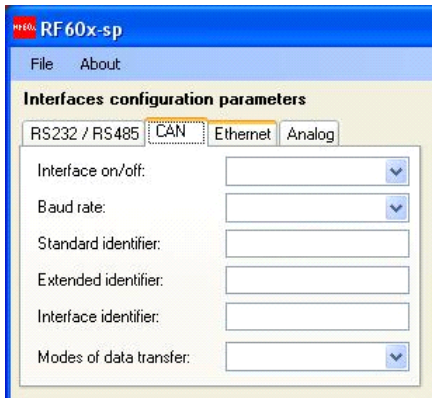
16.7. Setting and saving parameters of the sensor

16.7.1. Setting parameters

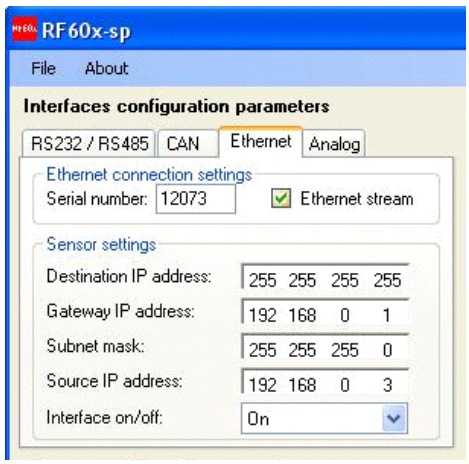
Parameterization of the sensor is only effected through RS232 or RS485 interfaces. Setting of parameters for all interfaces can be done using the respective tabs on the **Interfaces configuration parameters** panel:



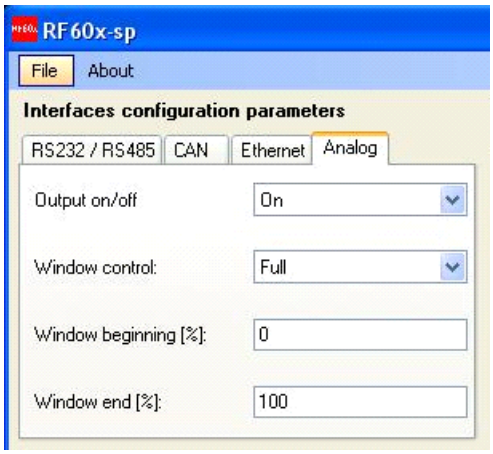
RS232/RS485 setting



CAN setting, besides RF603HS

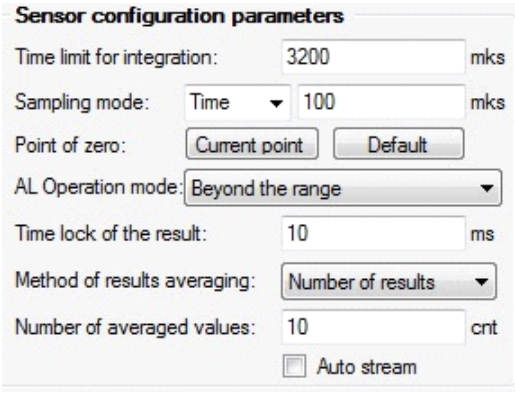


Ethernet setting



Analog outputs setting

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

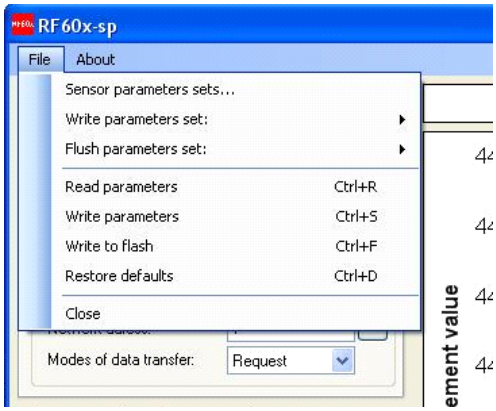


16.7.2. Saving parameters

- After setting one or several parameters as required, it is necessary to write them into the sensor memory, this is done by executing **File>Write parameters**.

NOTE. A special button [>] is offered for fast writing of parameters of the RS232/RS485 interfaces.

- 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.



16.7.3. Saving and writing a group of parameters

Parameters of the sensor can be saved to a file. This is done by selecting **File > Write parameters**.

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.

16.7.4. Recovery of default parameters

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

17. 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

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. 4. 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.

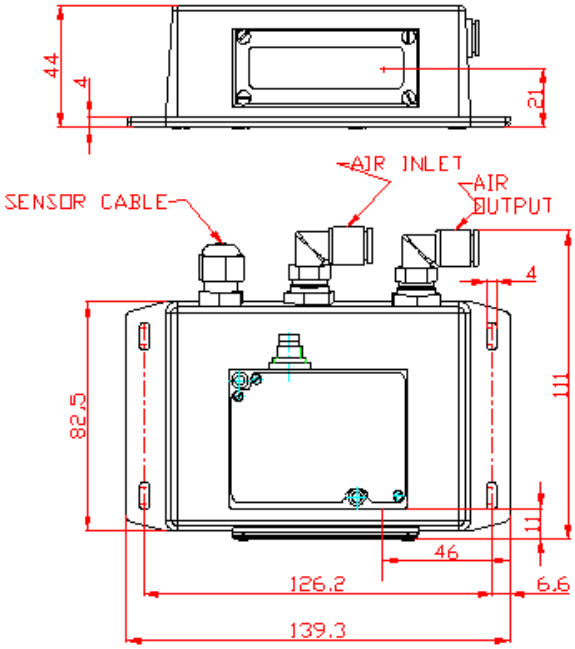


Figure 4

18.2. Spray guard

The spray guard is intended to reduce dirtying of the sensor windows. Overall dimensions are shown in Fig. 5.

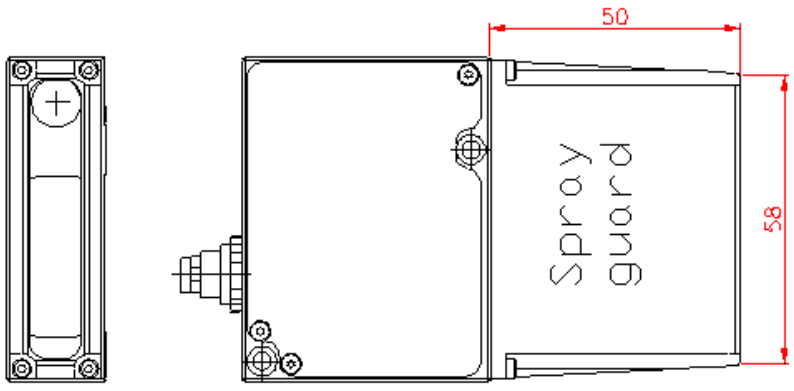


Figure 5

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 the figure 6 (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, um			D1, um			D2, um			α, deg	β, deg	A, mm	B, mm
	SMR	MMR	EMR	SMR	MMR	EMR	SMR	MMR	EMR				
15/2	30	20	30	40	30	40	60	40	60	43	49	19	14
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

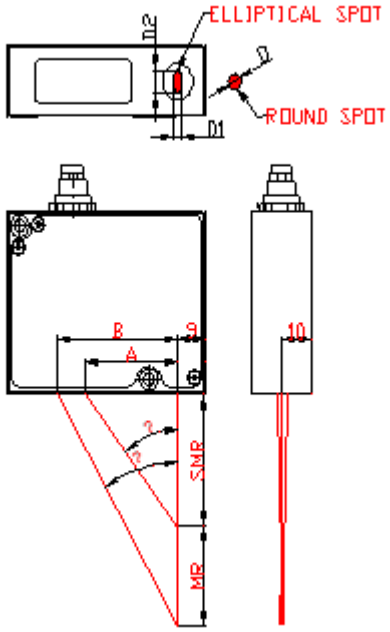


Figure 6

18.4. Connector mounting options

Overall dimensions of a cable connector sensor are shown in Fig. 7 and mounting options for 90 degree connector are shown in Fig. 8.

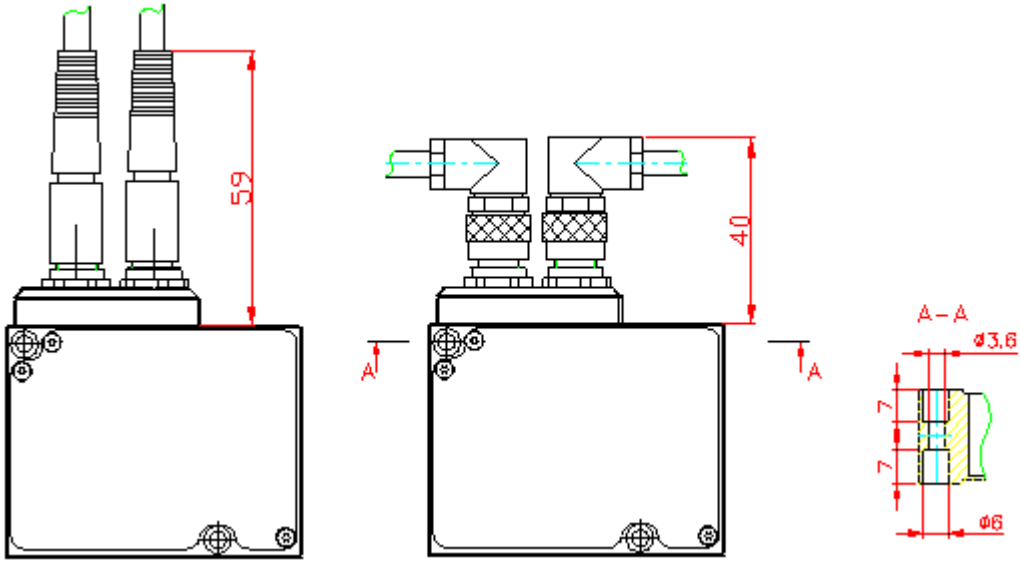


Figure 7

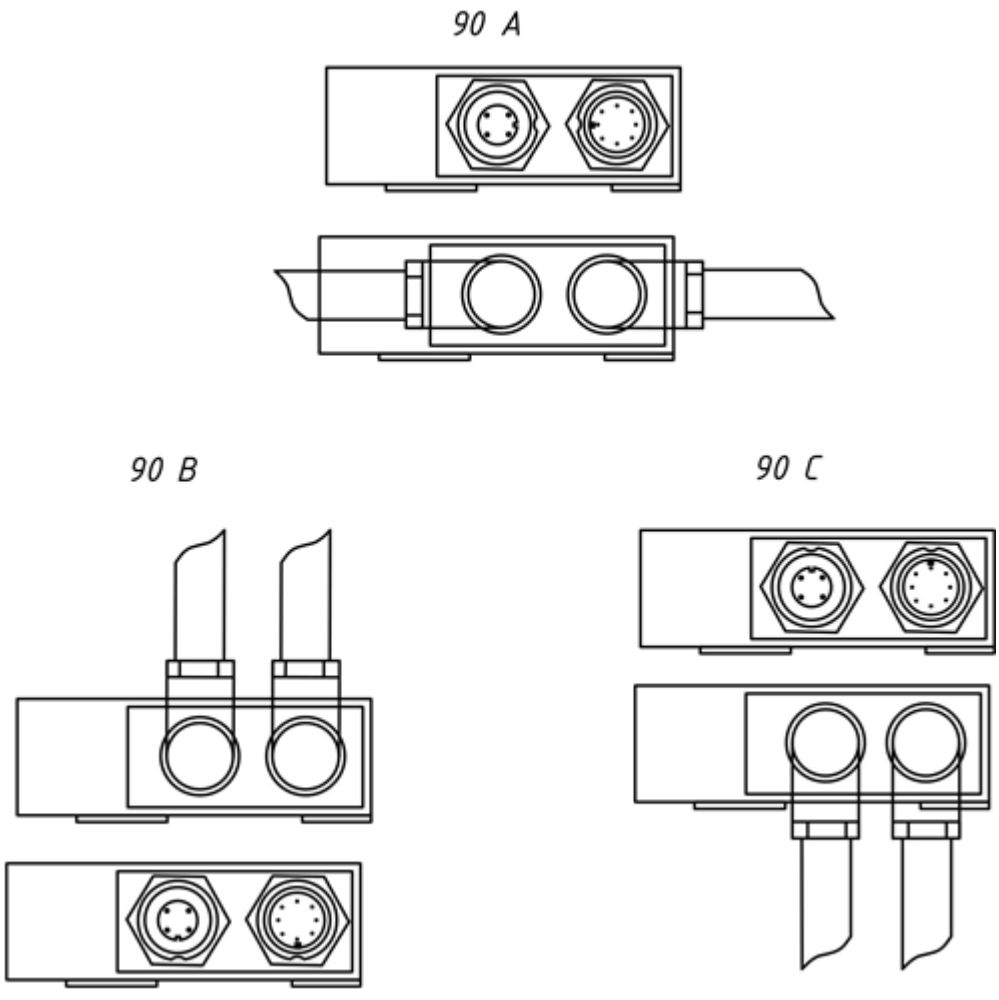


Figure 8

19. Warranty policy

Warranty assurance for the Laser triangulation sensors RF603HS – 24 months from the date of putting in operation; warranty shelf-life – 12 months.

20. Revisions

Date	Revision	Description
27.01.2013	1.1.0	Starting document.
10.11.2013	2.0.0	Housing size is changed. 4 models are added. 0…10V analog output is added. Sample frequencies are changed. Distributors list is updated.
18.12.2013	2.1.0	Synchronization input is changed from optocoupled to 2,4 – 5 V (CMOS, TTL).
14.12.2014	3.0.0	Sampling frequencies are increased to 60 kHz, 120 kHz and 180 kHz. New modes of AL line are added. Encoder synchronization mode is added. Description of RS232 и RS485 interfaces is added. Parameterization by Terminal is eliminated. Description of parameterization software added. SDK description added. Links for RFSDK download added.
14.08.2014	3.1.0	SDK is updated. Support of MSVC and BorlandC for Windows, Linux, Wrapper C#, Wrapper Dephi. Examples for C#, Delphi, LabView, Mathlab.
29.01.2019	3.2.0	Par. 18.3: the table is updated.
09.01.2020	3.3.0	The maximum frequency has been changed from 180 kHz to 160 kHz, the integration time has been changed from 5 µs to 6 µs.
13.07.2020	3.4.0	The maximum frequency has been changed to 70 kHz. The maximum output power has been changed to 80 mW for X/250, X/500 and X/750 models.
30.04.2021	3.5.0	Updated links in par. 17.

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