



FDRF603HS SERIES



valid for sensors with serial numbers 17559 and higher

Certified according to ISO 9001:2008

■ Contents

1.	Safety precautions	4
2.	Electromagnetic compatibility.....	4
3.	Laser safety.....	4
3.1.	Class 3B sensors.....	4
3.2.	Class 3R sensors	5
3.3.	Class 2 sensors	5
4.	General information.....	5
5.	Basic technical data	6
6.	Example of item designation when ordering	6
7.	Structure and operating principle	7
8.	Dimensions and mounting.....	7
8.1.	Overall and mounting dimensions	7
8.2.	Overall demands for mounting	8
9.	Connection	8
9.1.	Designation of connector contacts	8
9.2.	Cables.....	9
10.	Configuration parameters.....	10
10.1.	The "Time limit for integration" parameter.....	10
10.2.	"Sampling mode" parameter (synchronization).....	10
10.3.	"Sampling period" parameter.....	11
10.4.	The point of zero.....	11
10.5.	Line AL operation mode	11
10.6.	Time lock of the result	12
10.7.	Method of results averaging	12
10.8.	Number of averaged values/time of averaging	13
10.9.	Factory parameters table.....	13
11.	Description of RS232 and RS485 interfaces	13
11.1.	RS232 port	13
11.2.	RS485 port	13
11.3.	Modes of data transfer.....	13
11.4.	Configuration parameters	14
11.4.1.	Rate of data transfer through serial port.....	14
11.4.2.	Net address.....	14
11.4.3.	Factory parameters table	14
11.5.	Interfacing protocol	14
11.5.1.	Serial data transmission format	14
11.5.2.	Communication sessions types	14
11.5.3.	Request.....	14
11.5.4.	Message	15
11.5.5.	Answer	15
11.5.6.	Data stream	15
11.5.7.	Output Rate.....	15
11.5.8.	Request codes and list of parameters	16
12.	Description of Ethernet interface.....	16
12.1.	Modes of data transfer.....	16
12.2.	Factory parameters table.....	16
12.3.	Data packet format	16
12.4.	Data structure	16
13.	Voltage output.....	17
14.	Sensor connection	17
15.	Request codes and list of parameters	18
15.1.	Request codes table.....	18
15.2.	List of parameters.....	18
15.3.	Notes	19
15.4.	Examples of communication sessions	20
16.	Parameterization program.....	21
16.1.	Function.....	21
16.2.	Program setup	22

16.3.	Obtaining connection to sensor (RS232/RS485)	22
16.4.	Checking of the sensor operability	23
16.5.	Connection through Ethernet interface.....	24
16.6.	Display, gathering and scanning of data	25
16.7.	Setting and saving parameters of the sensor.....	25
16.7.1.	Setting parameters	25
16.7.2.	Saving parameters.....	27
16.7.3.	Saving and writing a group of parameters	27
16.7.4.	Recovery of default parameters.....	27
17.	RFSDK Library	27
18.	Appendix	28
18.1.	Protective housing.....	28
18.2.	Spray guard	28
18.3.	Size of the laser spot and mounting space	29
18.4.	Connector mounting options	30
19.	Warranty policy.....	31
20.	Revisions.....	31

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. Electromagnetic compatibility

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

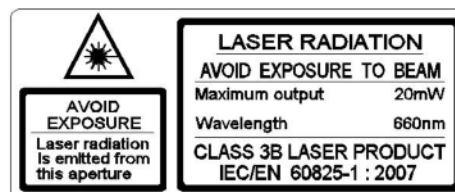
- EN 55022:2006 Information Technology Equipment. Radio disturbance characteristics. Limits and methods of measurement.
- EN 61000-6-2:2005 Electromagnetic compatibility (EMC). Generic standards. Immunity for industrial environments.
- EN 61326-1:2006 Electrical Equipment for Measurement, Control, and Laboratory Use. EMC Requirements. General requirements.

3. Laser safety

The sensors correspond to the following laser safety classes according to IEC 60825-1:2007

3.1. Class 3B sensors

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

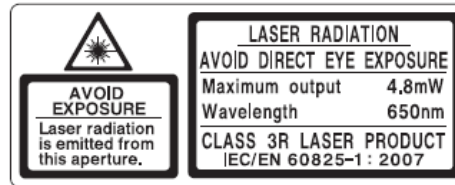


The following safety measures should be taken while operating the sensor:

- Do not target laser beam to humans;
- Avoid staring into the laser beam through optical instruments;
- Mount the sensor so that the laser beam is positioned above or below the eyes level;
- Mount the sensor so that the laser beam does not fall onto a mirror surface;
- Use protective goggles while operating the sensor;
- Avoid staring at the laser beam going out of the sensor and the beam reflected from a mirror surface;
- Do not disassemble the sensor;
- Use the protective screen mounted on the sensor for the blocking of the outgoing beam;
- Use the laser deactivation function in emergency.

3.2. Class 3R sensors

The sensors make use of an c.w. 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 laser body:

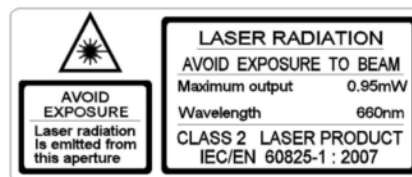


The following safety measures should be taken while operating the sensor:

- Do not target laser beam to humans;
- Avoid staring into the laser beam through optical instruments;
- Mount the sensor so that the laser beam is positioned above or below the eyes level;
- Use protective goggles when operating the sensor;
- Avoid staring into the laser beam;
- Do not disassemble the sensor.

3.3. Class 2 sensors

The sensors make use of an c.w. 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 laser body:



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

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

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.

Three versions of laser sensor with 60, 120 and 180 kHz rates are available.

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

FDRF603HS-	X/2	X/5	X/10	X/15	X/25	X/30	X/50	X/100	X/250	X/500	X/750	X/1000	X/1250
Base distance X, MM	15	15	15, 25 60	15, 30 65	25, 45 80	35, 55 95	45, 65 105	60, 90 140	80	125	145	245	260
Measurement range, mm	2	5	10	15	25	30	50	100	250	500	750	1000	1250
Max. measurement frequency, kHz	60, 120, 180												
Linearity, %	$\pm 0.1 \cdot (60 \text{ kHz})$, $\pm 0.2 \cdot (120 \text{ kHz})$, $\pm 0.3 \cdot (180 \text{ kHz})$ of the range												
Resolution, %	0.01 (60 kHz), 0.02 (120 kHz), 0.04 (180 kHz) of the range												
Temperature drift	0,02% of the range/°C												
Light source	red semiconductor laser, 660 nm wavelength or UV semiconductor laser 405 nm wavelength (BLUE version)												
Output power	$\leq 0,95 \text{ mW}$			$\leq 4,8 \text{ mW}$				$\leq 70 \text{ mW}$					
Laser safety Class	2 (IEC608251)			3R (IEC608251)				3B (IEC608251)					
Output interface	parameter-ization data transfer analog						RS232 or RS485 Ethernet (UDP) 0...10·V						
Synchronization input	2,4 – 5 B (CMOS, TTL)												
Logic output	programmed functions, NPN: 100 mA max; 40 V max for output												
Power supply, V	9 ...36												
Power consumption, W	4,8												
Environment resistance	Enclosure rating							IP67					
	Vibration							20g/10...1000Hz, ·6·hours, ·for·each·of·XYZ·axes					
	Shock							30 g / 6 ms					
	Operation temperature, °							-10...+60, ·(-30...+60·for·the·sensors·with·in-built heater), (-30...+120·for·the·sensors·with·in-built heater and air cooling housing)					
	Permissible ambient light, lx							30000					
	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

FDRF603HS(BLUE).FX/D(R)SERIAL ANALOG IN AL CC(R)(90)MHPB

Symbol	Description
(BLUE)	Blue (405 nm) laser option
F	Maximal sampling frequency, 60 or 120 or 180 kHz
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...10V·(·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 in-built heater
P	Sensor with protect air cooling housing (see p.18.1)
B	Sensor with spray guard (see p.18.2.)

Example: FDRF603HS.60140/100R232ETUINAL24CR90A3 – 60kHz sampling frequency, base distance – 140 mm, range – 100mm, round shape laser spot, RS232 and Ethernet serial port, 0...10V 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.

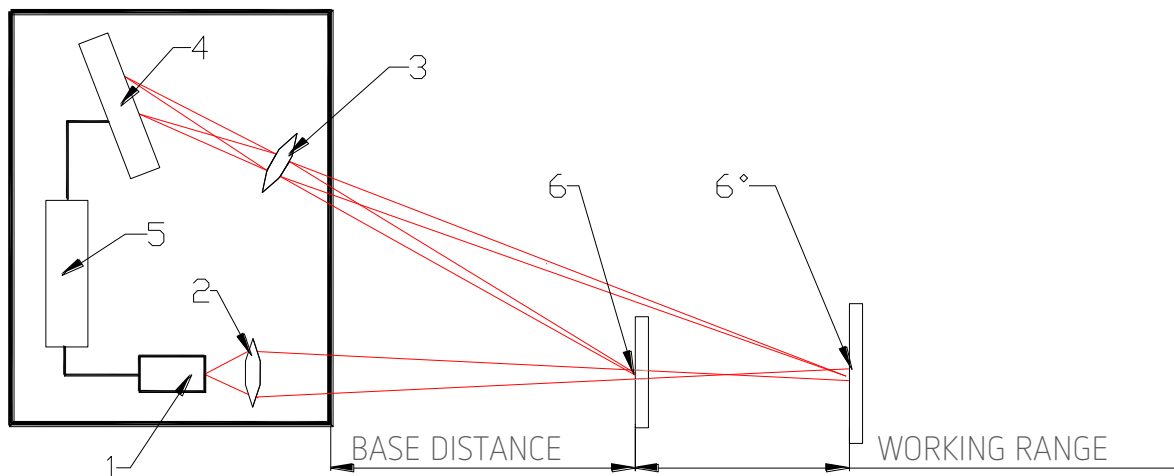


Figure 1

8. Dimensions and mounting

8.1. Overall and mounting dimensions

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

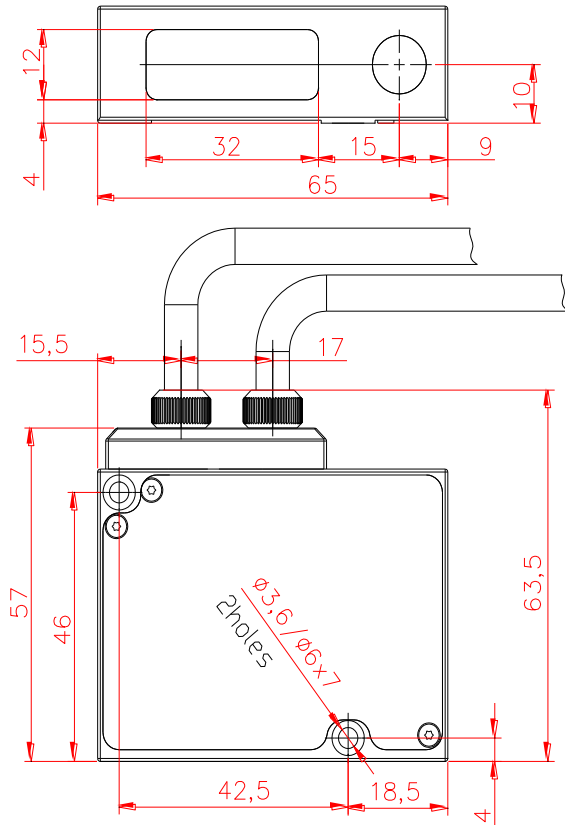


Figure 2. Sensor with cable glands (CG)

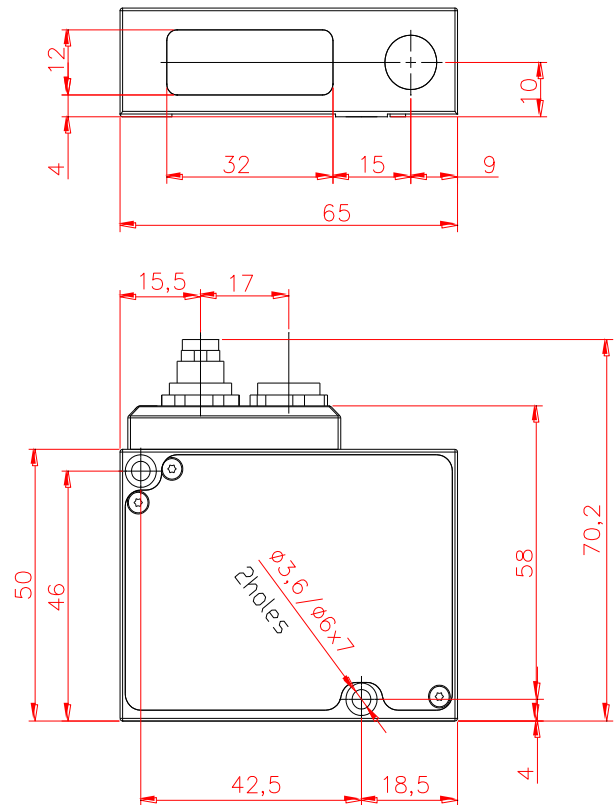


Figure 2.1. Sensor with connectors (CC)

8.2. Overall demands for mounting

The sensor is positioned so that of object under control should place in this working range. 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 cm² and using thermal paste.

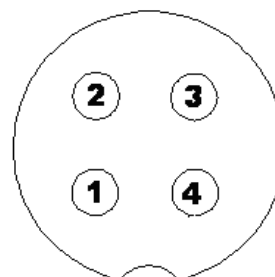
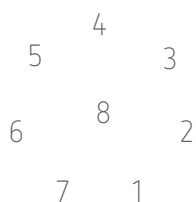
9. Connection

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

Connector #2

Model of the sensor	Pin number	Assignment
ET	1	TX+
	2	TX-
	3	RX+
	4	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	-	Power U+	Red
	free lead	-	Gnd (power)	Brown
	DB9	2	TXD	Green
	DB9 free	3	RXD	Yellow
	lead free	-	U	Blue
	lead free	-	IN	White
	lead	-	AL	Pink
	DB9	5	Gnd (Common for signals)	Gray
485-U-IN-AL	free leads	-	Power U+	Red
		-	Gnd (power)	Brown
		-	DATA+	Green
		-	DATA-	Yellow
		-	U	Blue
	-	IN	White	

	AL	Pink
	Gnd (Common for signals)	Gray

Cable #2

Model of the sensor	Pin number	Assignment	Wire color
ET	RJ-45	1	TX+
		2	TX-
		3	RX+
		4	
		5	
		6	RX-
		7	
		8	
			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 as follows:

10.1. The "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 (60 kHz or 120 kHz or 180 kHz) is achieved for the integration time $\leq 16 \mu\text{s}$ for 60 kHz, $\leq 8 \mu\text{s}$ for 120 kHz and $\leq 5 \mu\text{s}$ for 180 kHz sensors. As the integration time increases above specified values, 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 so built that measurements are taken at a maximum possible rate determined by the integration time period, the measurement results is sent to buffer of measurements and stored therein until a new result arrives.

"Sampling mode" parameter determines the method of the readout of the result form the buffer of measurements to buffer of transmitting (a concept of "buffer of transmitting", see point 12.1.) Tree sampling modes are possible:

- Time Sampling;
- Trigger Sampling.
- Encoder Sampling

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

With Trigger sampling is selected, the sensor fills a buffer of transmitting (automatically transmits measurement results from buffer of measurement into buffer of transmitting) when external synchronization input (IN input of the sensor) is switched and taking the division factor set into account (see point 10.3).

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

Note 1. When AL input is set as "Encoder_B" input, the line IN is set as "Encoder_A" input automatically. At other settings of AL line the input IN is used as a trigger Input.

Note 2. Electrical parameters of IN-input: logical "0" - [0V..1,6V], logical "1" - [2,4V.. 5V].

Note 3. Electrical parameters of 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 in which the sensor fills a buffer of transmitting. The time interval Value is set in increments of 1 us. For example, for the parameter value equal to 100, data from buffer of measurement are transmitted into buffer of transmitting with a period of $1 \cdot 100 = 1 \text{ us}$.

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

10.4. The point of zero

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

10.5. Line AL operation mode

This line can work in one of the 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/ONN
- mode 5: Encoder_B input
- mode 6: status line input
- mode 6: 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/ONN" mode connection AL input to the ground potential switch laser ON/OFF (Fig.3.4.).

In the "Encoder_B" input AL line is used as B_input of encoder signal (fig. 3.3.).

In the "Status line input" 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" AL line is used for internal buffers and counters of Ethernet interface (fig. 3.4.).

Note. For modes 3, 4, and 6 operations occurs 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

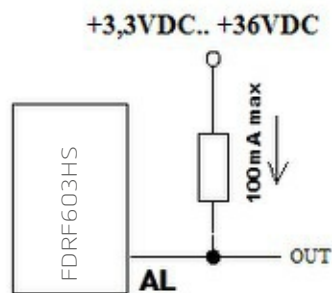


Figure 6.1
Encoder inputs mode

Mutual synchronization

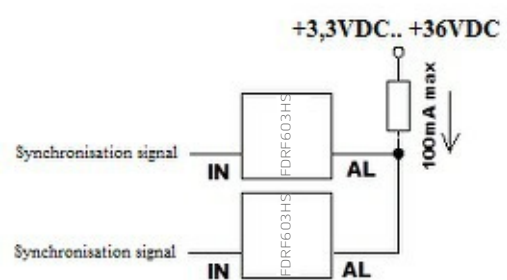


Figure 6.2
Hardware zero-set/
Hardware laser ON/OFF
Ethernet restart

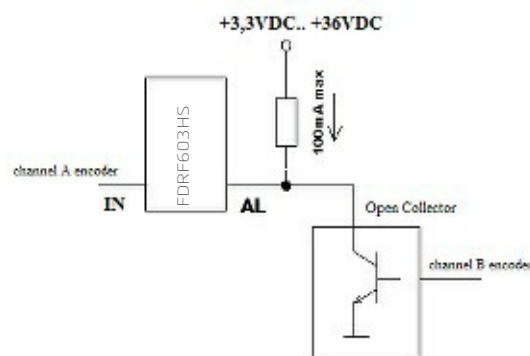


Figure 6.3

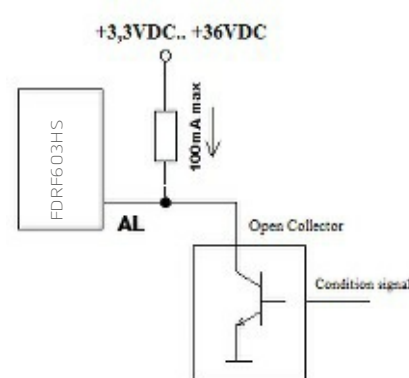


Figure 6.4

10.6. Time lock of the result

If the sensor does not find out object or if the authentic result cannot be received, zero value is transferred. The given parameter sets time during which is transferred the last authentic result instead of 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 of measurement results implemented directly in the sensor:

- Averaging over a number of results
- Time averaging

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

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

10.8. Number of averaged values/time of averaging

This parameter specifies the number of source results to be averaged for deriving the output value or time of the averaging (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. Maximum parameters 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	5us (180 kHz), 8us (120 kHz), 16 us(60 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 & 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

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

- 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 $2400 \times 4 = 9600$ 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 broadcast request it fulfills command but doesn't send 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

Data message has the following format:

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

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				[Bytes 2...N]
INCO(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:

Byte 0				DAT(7:0)				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:

Byte 0				DAT(7:0)				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

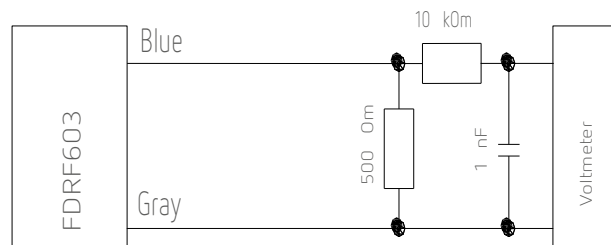
- The value of the result transmitted by a sensor (D) is so normalized that 4000h (16384) corresponds to a full range of the sensor (S in mm), therefore, the result in millimeters is obtained by the following formula:

$$X=D*S/4000h \text{ (mm)} \quad (1).$$

- 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;
- The packet checksum has a one-byte size and is calculated as XOR of all the bytes of packet

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 Ethernet interface and 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 1: connection of RS232 (RS485) is necessary if parameterization (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..+36V) to the Power U+ 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

Code of parameter	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: 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 42400=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)

09h	Higher byte of the sampling period	the time interval in increments of 1 us with which sensor automatically communicates of results on streaming request (priority of sampling = 0); 2) 1..65535, (default — 500) divider ratio of trigger input with which sensor automatically communicates of result on streaming request (priority of sampling = 1)
0Ah	Lower byte of maximum integration time	2..65535, (default — 200) specifies the limiting time of integration by CMOS-array in increments of 1mks
0Bh	Higher byte of maximum integration time	
0Ch	Lower byte for the beginning of analog output range	0...4000h, (default — 0) specifies a point within the absolute range of transducer where the analog output has a 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 a point within the absolute range of transducer where the analog output has a maximum value
0Fh	Higher byte for the end of analog output range	
10h	Time lock of result	0...255, specifies of time interval in increments of 5 m
11...16h	Reserved	
17h	Lower zero point	0...4000h, (default — 0) specifies beginning of 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	1 st byte of Destination IP Address	
6Eh	2 nd byte of Destination IP Address	
6Fh	3 rd byte of Destination IP Address	
70h	0th byte of Gateway IP Address	by default — C0A80001h = 192.168.0.1
71h	1 st byte of Gateway IP Address	
72h	2 nd byte of Gateway IP Address	
73h	3 rd byte of Gateway IP Address	
74h	0th byte of Subnet Mask	by default — FFFFFFF0h = 255.255.255.0
75h	1 st byte of Subnet Mask	
76h	2 nd byte of Subnet Mask	
77h	3 rd byte of Subnet Mask	
78h	0th byte of Source IP Address	by default — C0A80003h = 192.168.0.3
79h	1 st byte of Source IP Address	
7Ah	2 nd byte of Source IP Address	
7Bh	3 rd 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:

$$X=D*S/4000h \text{ (mm)} \quad (1).$$

- 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.

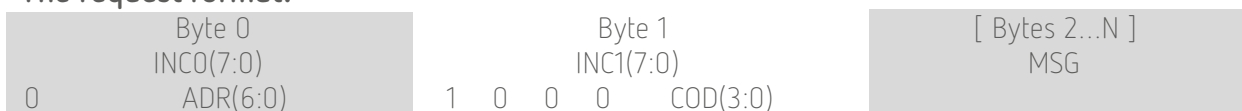
- When working with the parameters, it should be borne in mind that when power is OFF the parameter values are stored in nonvolatile FLASH-memory of the sensor. When power is ON, the parameter values are read out to RAM of the sensor. In order to retain these changes for the next power-up state, a special 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.

15.4. Examples of communication sessions

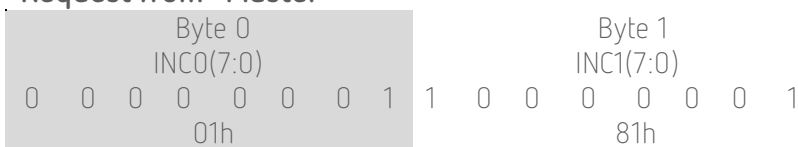
1) Request "Device identification".

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 — 50 (0032h), packet number — 1.

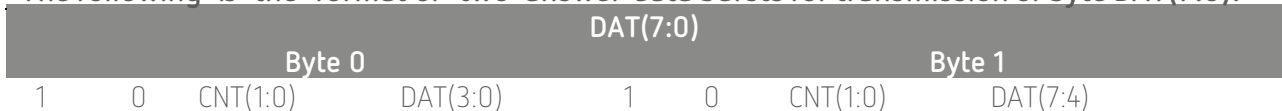
The request format:



Request from "Master"

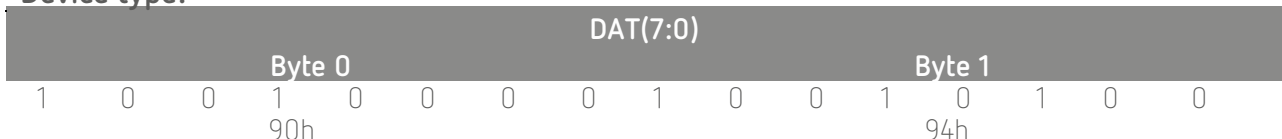


The following is the format of two 'answer' data bursts for transmission of byte DAT(7:0):

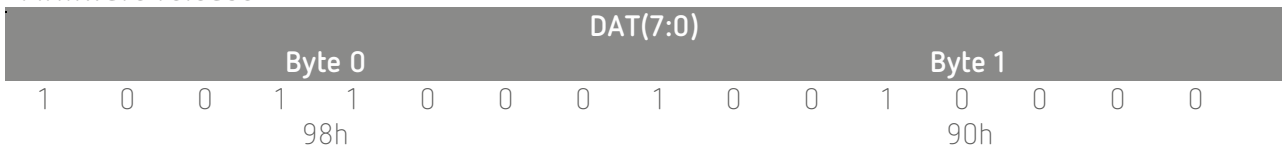


Answer of "Slave":

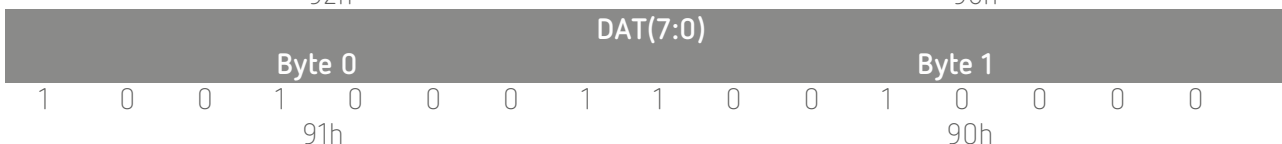
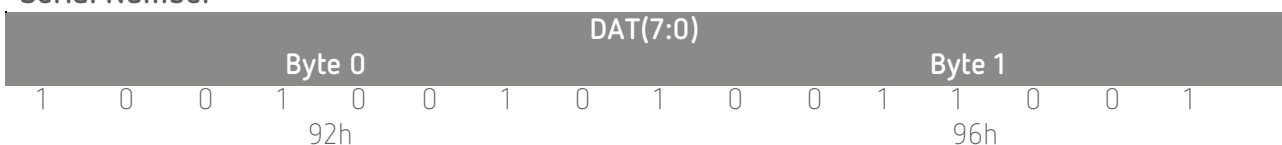
Device type:



Firmware release



Serial Number



Base distance

DAT(7:0)															
Byte 0								Byte 1							
1	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0
90h								95h							
DAT(7:0)															
Byte 0								Byte 1							
1	0	0	1	0	0	0	0	1	0	0	0	1	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	0	1	0	1	1
92h								93h							
DAT(7:0)															
Byte 0								Byte 1							
1	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0
90h								90h							

Note: as bust number =1, then CNT=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):

$$X=677(02A5h)*50/16384 = 2.066 \text{ mm}$$

4) Request "writing sampling regime (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

and for lower byte, code of parameter — 08h, value of parameter — 39h

Request ("Master") — 01h, 83h

Message ("Master") — 88h, 80h, 89h, 83h

16. Parameterization program

16.1. Function

The program is intended for:

- 1) Testing and demonstration of work of the sensors;

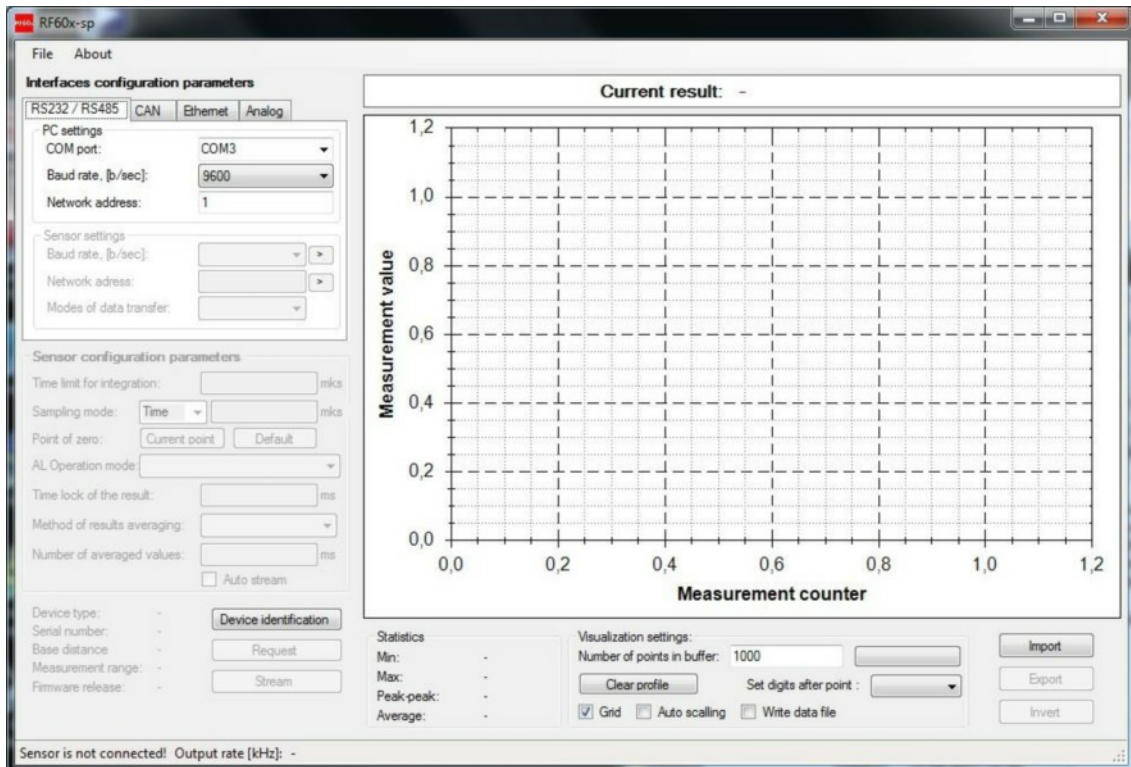
- 2) Setting of the sensor parameters;
- 3) Reception and gathering of the sensor data signals

16.2. Program setup

Start file RF603setup.exe and follow instructions of the installation wizard

16.3. Obtaining connection to sensor (RS232/RS485)

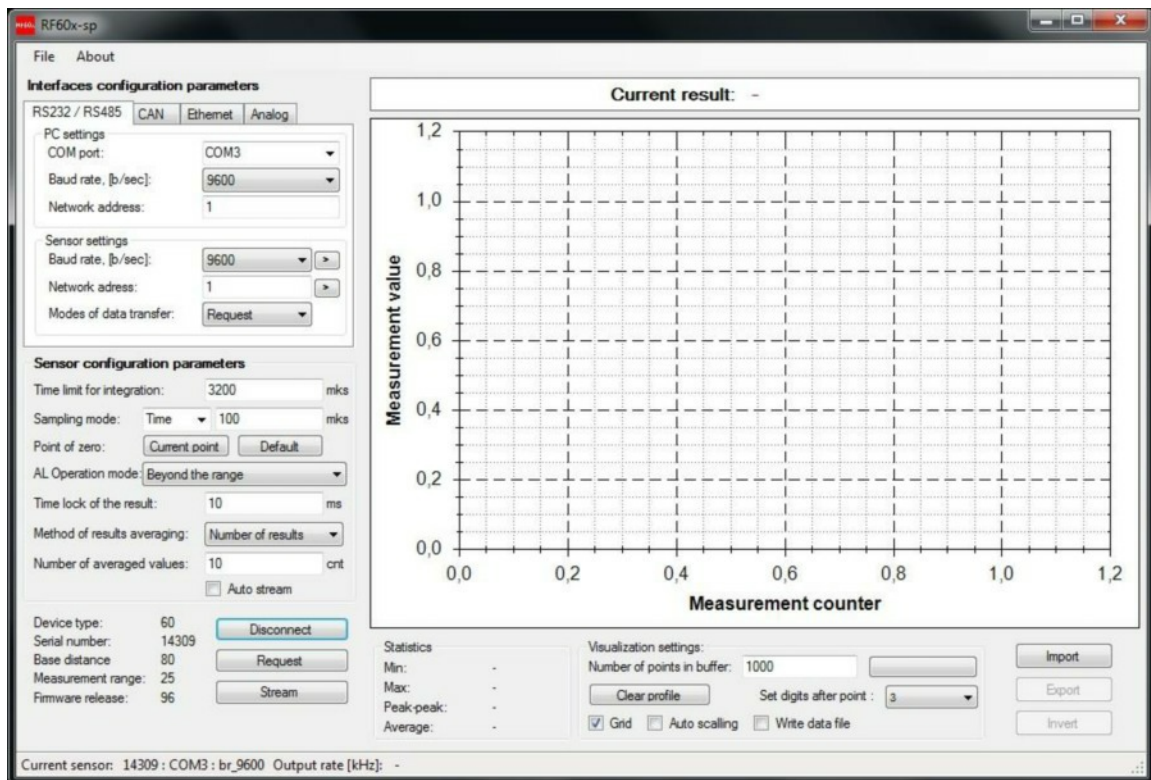
Once the program is started, the pop-up window emerges:



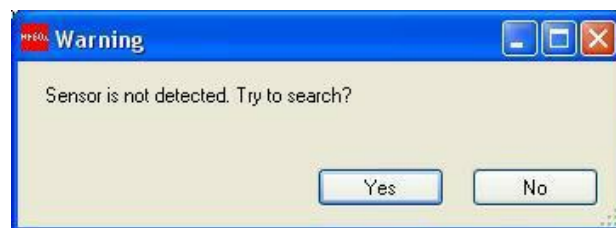
To obtain connection via RS232/RS485 interfaces, go to RS232/RS485 PC settings in the Interface configuration parameters panel:

- select COM port where to 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
- press the Device identification button.

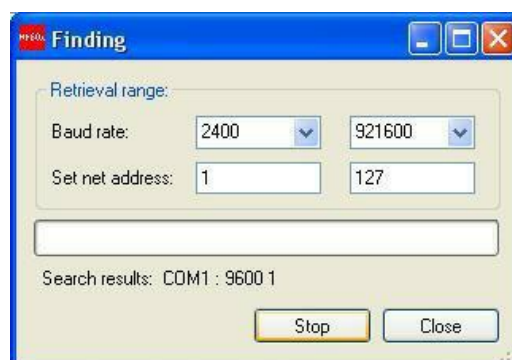
If the selected parameters correspond to the parameters of the sensor interface, the program will identify the sensor, read and display its configuration parameters:



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



To start search, press the **Yes** button



- set the range of transmission rate search in the Baud rate line
- set the range of network address search in the Net address line
- press the Search button

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

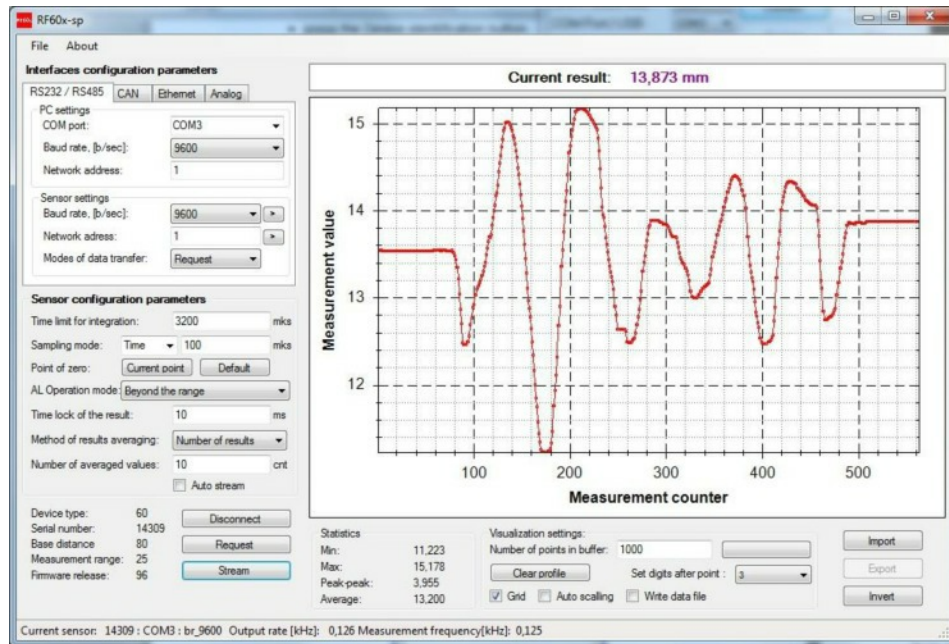
16.4. Checking of the sensor operability

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

- place an object inside the sensor working range

- by pressing the Request button, obtain the result of one measurement on the (Current result) indicator. The 06h request type is realized (see par. 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 current data transmission and refreshing rates.

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



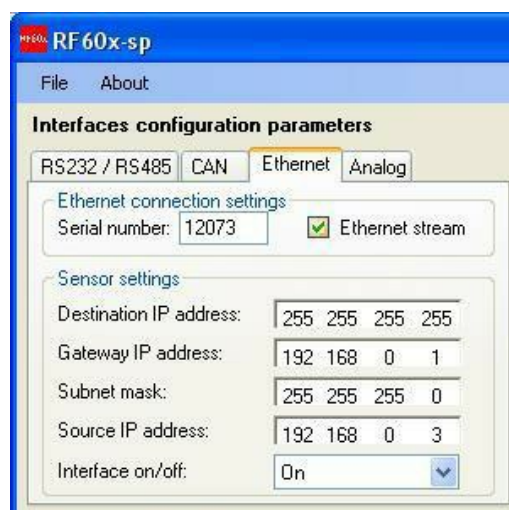
16.5. Connection through Ethernet interface

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 a serial number of the sensor from which data have to be received
- press 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.



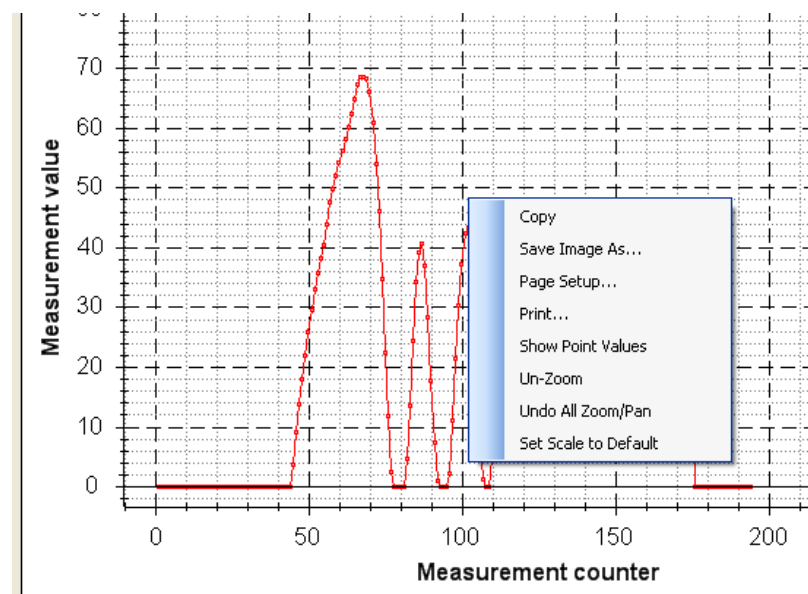
16.6. Display, gathering and scanning of data

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 co-ordinate can be set in the Number of points in buffer window;
- scaling method along the Y co-ordinate 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 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:

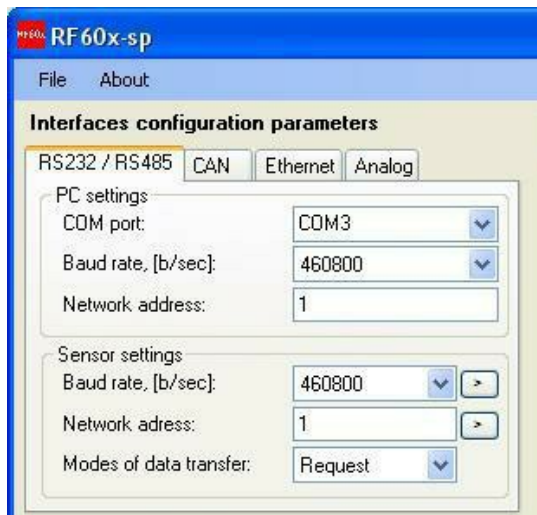


- to move the image, just press the mouse wheel
- to zoom, rotate the mouse wheel
- to save data to a file, press the Export button. The program will offer saving of data in two possible formats: internal and Exel.
- to scan or look at previously saved data, press the Import button and select the required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

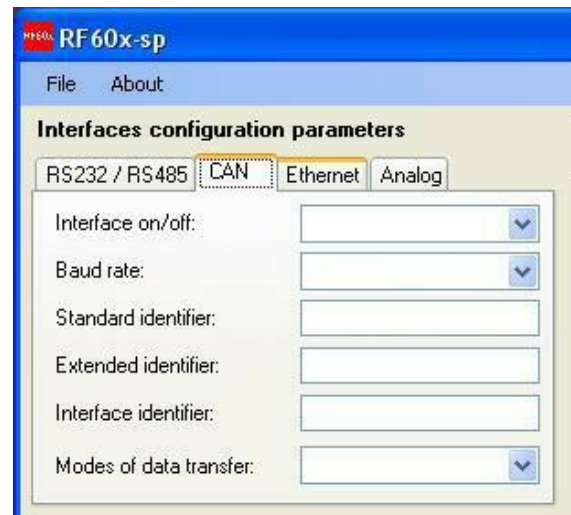
16.7. Setting and saving parameters of the sensor

16.7.1. Setting parameters

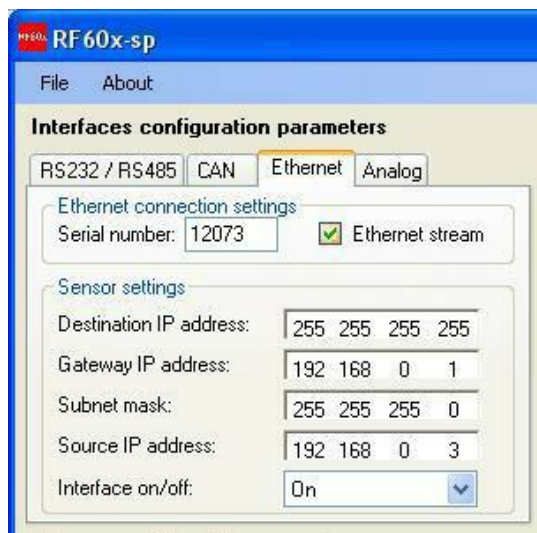
Parameterization of the sensor is only effected through RS232 or RS485 interfaces. Setting of parameters for all interfaces can be done using the respective tabs on the Interfaces configuration parameters panel:



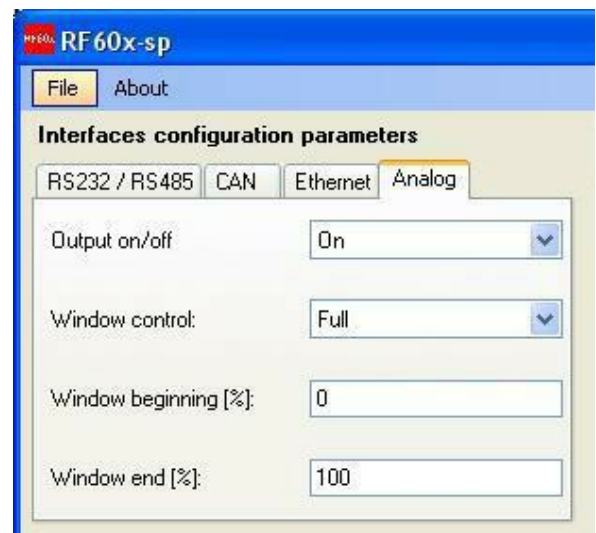
RS232/RS485 setting



CAN setting, besides FDRF603HS

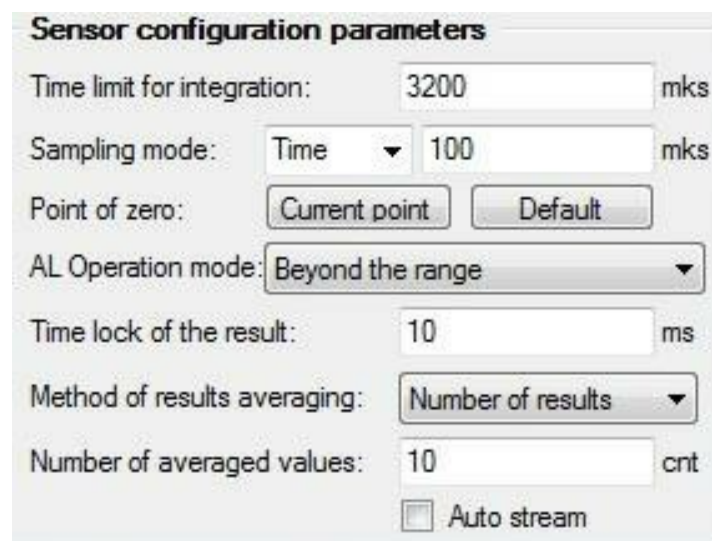


Ethernet setting



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 key  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 set and saving the file in the window offered.

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

16.7.4. Recovery of default parameters

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

17. RFSDK Library

To work with the laser sensors, we offer a RFSDK library which is available for free on request.

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

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

Software	Description	
Service program (parameterization program)	User software for work with laser sensors, parameter setting, and data acquisition	Please inquire

RF Device Software Development Kit	Designed for work with all related devices. Includes: <ul style="list-style-type: none"> • Support of MSVC and BorlandC for Windows, Linux, Wrapper C#, Wrapper Dephi. • Examples for C#, Delphi, LabView, Mathlab 	Please inquire
Firmware	Includes: <ul style="list-style-type: none"> • Firmware for FDRF603HS sensors 	Please inquire

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 <math><25^{\circ}\text{C}</math>
- 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.

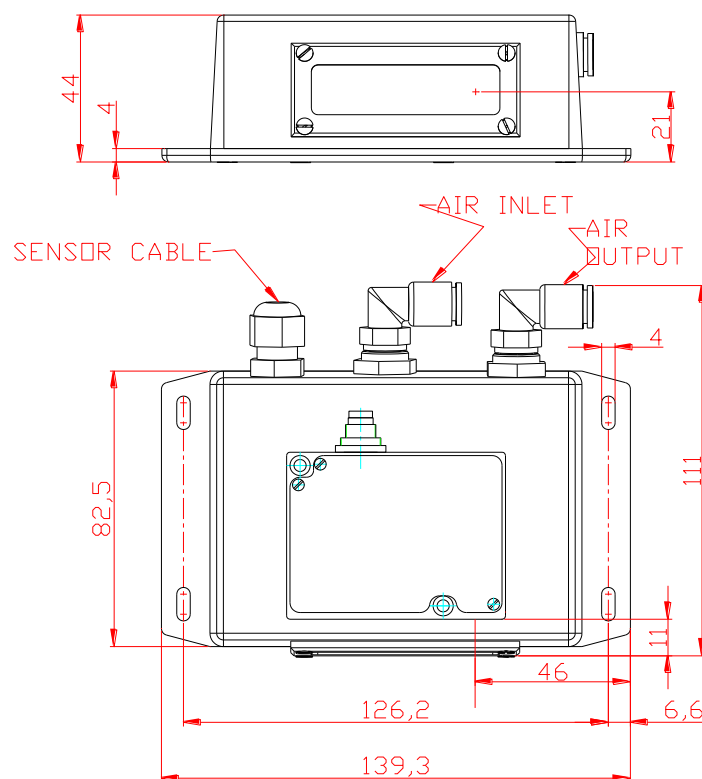


Figure 4

18.2. Spray guard

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

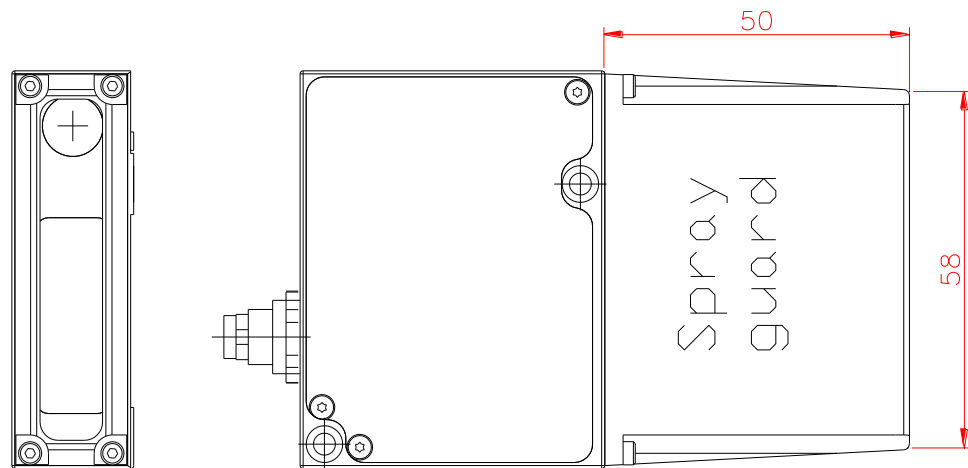


Figure 5

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).

FDRF603	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
125/500	1100	140	2000	1700	160	3000	3000	190	5000	14	4	31	44
145/750	1150	300	1150	1500	400	1500	3000	500	3000	12	3	32	42
245/1000	1200	500	1200	1600	500	1600	2500	800	3500	8	2	34	46

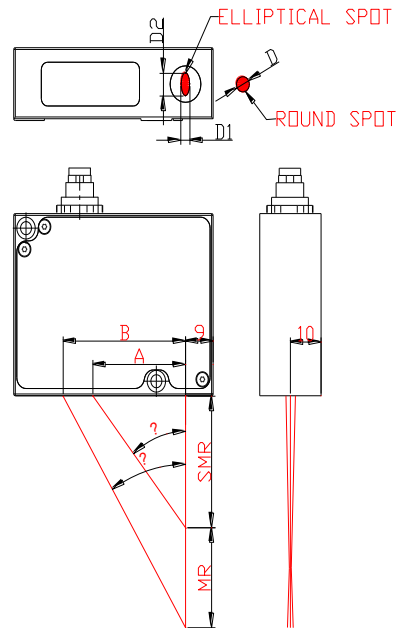


Figure 6

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.

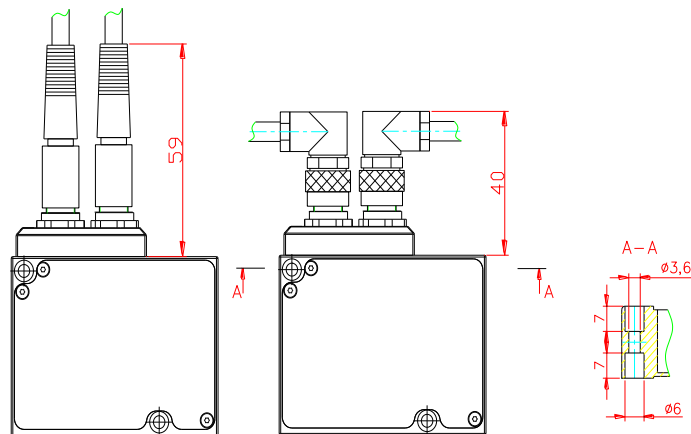


Figure 7

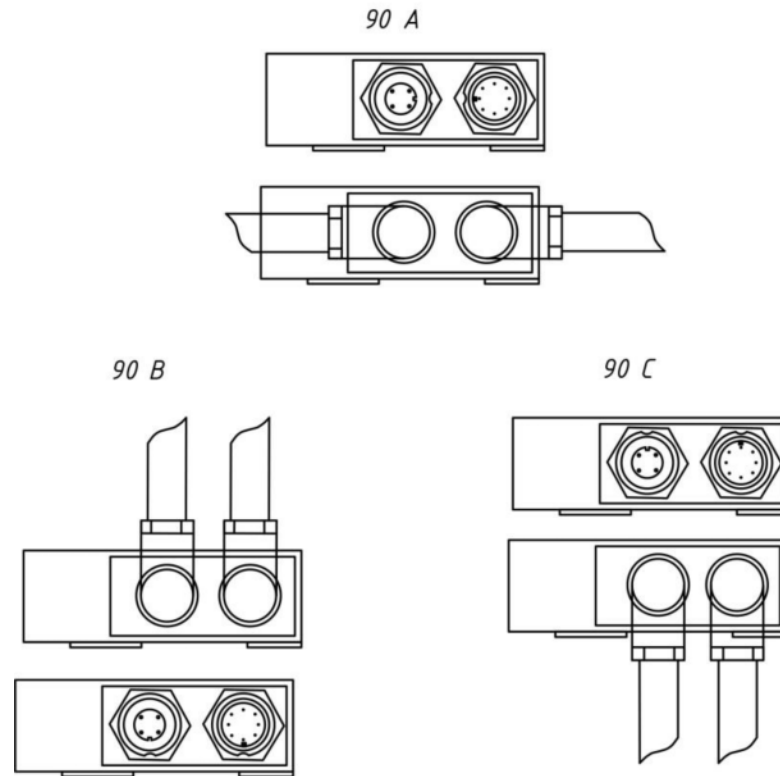


Figure 8

19. Warranty policy

Warranty assurance for the Laser triangulation sensors FDRF603HS - 24 months from the date of putting in operation; warranty shelf-life - 12 months.

20. Revisions.

Date	Release	Description
27.01.2013	1.1	Starting document
10.11.2013	2.0	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.	Synchronization input is changed from optocoupled to 2,4 – 5 V (CMOS, TTL)
14.12.2014	3.0.	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·&·RS485 interfaces is added Parameterization by Terminal is eliminated Description of parameterization software added SDK description added Note for RFSDK added
14.08.2014	3.1.	SDK is updated. Support of MSVC and BorkandC for Windows, Linux, Wrapper C#, Wrapper Dephi. Examples for C#, Delphi, LabView, Mathlab