mm

FDRF600 Series

Valid for sensors with serial numbers 11000 and higher

Certified according to ISO 9001:2008

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1. Safety precautions

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

2. 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.

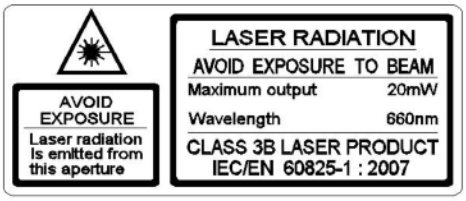
3. Laser safety

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

Wavelength	660 nm	
Output power	≤4,8 mW	≤20 mW
Laser safety class	3R	3B

3.1. Class 3B sensors

The sensors make use of an c.w. 660 nm wavelength semiconductor laser. Maximum output power is 20 mW. The sensors belong to the 3B laser safety class. The following warning label is placed on the laser body:



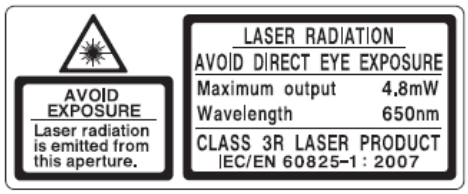
The following safety measures should be taken while operating the sensor:

- Do not target laser beam to humans;
- Avoid staring into the laser beam through optical instruments;
- Mount the sensor so that the laser beam is positioned above or below the eyes level;
- Mount the sensor so that the laser beam does not fall onto a mirror surface;
- Use protective goggles while operating the sensor;

- Avoid staring at the laser beam going out of the sensor and the beam reflected from a mirror surface;
- Do not disassemble the sensor;
- Use the protective screen mounted on the sensor for the blocking of the outgoing beam;
- Use the laser deactivation function in emergency.

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.

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 13 sensors with the measurement range, from10 to 2500 mm and the base distance from 230 to 1 mm. The Series is divided into 3 groups. The first group includes the sensors with large bases and short measurement ranges, second group includes sensors with medium bases and ranges and the third group is the sensors with long ranges.
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

FDRF600-	X/10	X/30	X/40	X/100	X/250	X/500	X/600	X/1000	X/1000	X/1500	X/2000	X/2500
Base distance X, MM	230	300	330	500	230	300, 1000	230	1300	380	390	410	420
Measurement range, mm	10	30	40	100	250	500	600	1000	1000	1500	2000	2500
Linearity, %	±0.05 of the range										±0.1	
Resolution, %	0.01 of the range (for the digital output only)										0.02	
Temperature drift	0,02% of the range/ ^{0}c											
Max. measurement frequency, Hz	9400											
Light source	red semiconductor laser, 660 nm wavelength or UV semiconductor laser 405 nm wavelength (BLUE version)											
output power	≤4,8 mW										≤20 mW	
laser safety Class	3R (IEC60825-1)										3B (IEC60825-1)	
Output interface digital	RS232 (max. 460,8 kbit/s) or RS485 (max. 921,6 kbit/s) or RS232 and CAN V2.0B (max 1Mbit/s) or Ethernet and (RS32 or RS485)											
Output interface analog	4...20 mA (≤500 Ω load) or 0...10 V											
Synchronization input	2,4 – 5 V (CMOS, TTL)											
Logic output	programmed functions, NPN: 100 mA max; 40 V max for output											
Power supply, V	9 ...36											
Power consumption, W	1,5..2											
Environment resistance: Enclosure rating	IP67 (for the sensors with cable connector only)											
Environment resistance: Vibration	20g/10...1000Hz, 6 hours, for each of XYZ axes											
Environment resistance: Shock	30 g / 6 ms											
Environment resistance: Operation temperature, °c	-10...+60, (-30...+60 for the sensors with in-built heater)											
Environment resistance: Permissible ambient light, lx	30000											
Environment resistance: Relative humidity	5-95% (no condensation)											
Environment resistance: Storage temperature	20...+70 , °c											
Housing material	Aluminum											
Weight (without cable),	500 gram											

6. Example of item designation when ordering

PØ600(BLUE)(-X/D(R)-SERIAL-ANALOG-IN-AL-CC (90X)(R)-M-H

Symbol	Description
(BLUE)	Blue (405 nm) laser option
X	Base distance (beginning of the range), mm
D	Measurement range, mm
SERIAL	The type of serial interface: RS232-232 or RS485-485 or (CAN and RS232) - CAN, or (Ethernet and RS232) – ET-232 or (Ethernet and RS485) - ET-485
ANALOG	Attribute showing the presence of 4...20 mA (I) or 0...10V (U) Note: 1) I output – only for sensors with RS232 or RS485 2) U output – only for sensors with RS232 or RS485 or CAN
IN	Trigger input (input of synchronization) presence
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
CC(90X)(R)	Cable gland - CG, or cable connector - CC (Binder 712, IP67) Note 1: sensors with CAN or Ethernet interfaces have 2 connectors and are available with cable connectors only (CC only). Note 2: 90(X) option – angle cable connector Note 3: R option – robot cable
M	Cable length, m
H	Sensor with in-built heater

Example. FDRF600-380/1000-232-I-IN-AL-CC-R90A-3 – sensor with base distance – 380 mm, range – 1000mm, RS232 serial port, 4...20mA 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.

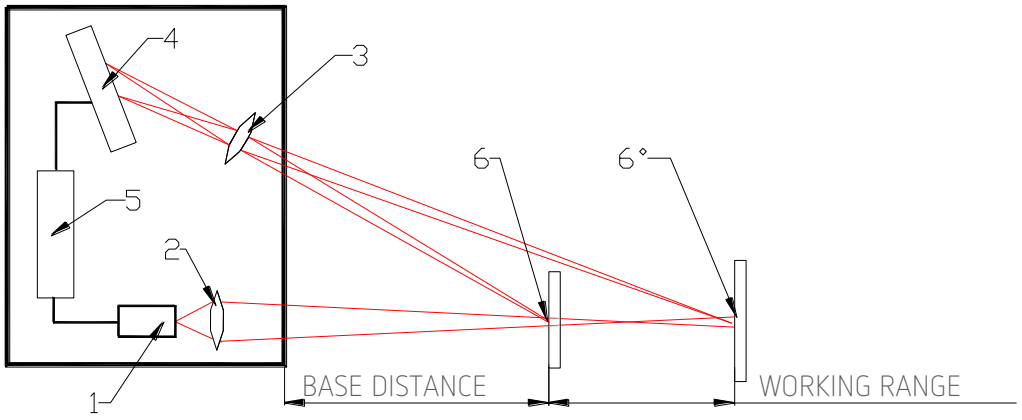


Figure 1

8. Dimensions and mounting

8.1. Overall and mounting dimensions

Overall and mounting dimensions of the FDRF600 sensor are shown in Figure 2. Sensor package is made of anodized aluminum. The front panel of the package has two 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 gland or connector. Sensors with CAN or Ethernet interface are equipped by two connectors.

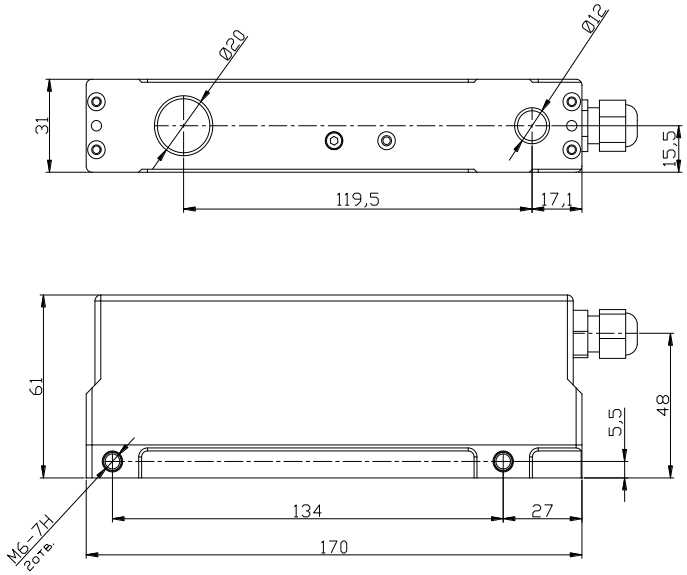


Figure 2. FDRF600 sensor with cable gland (CG)

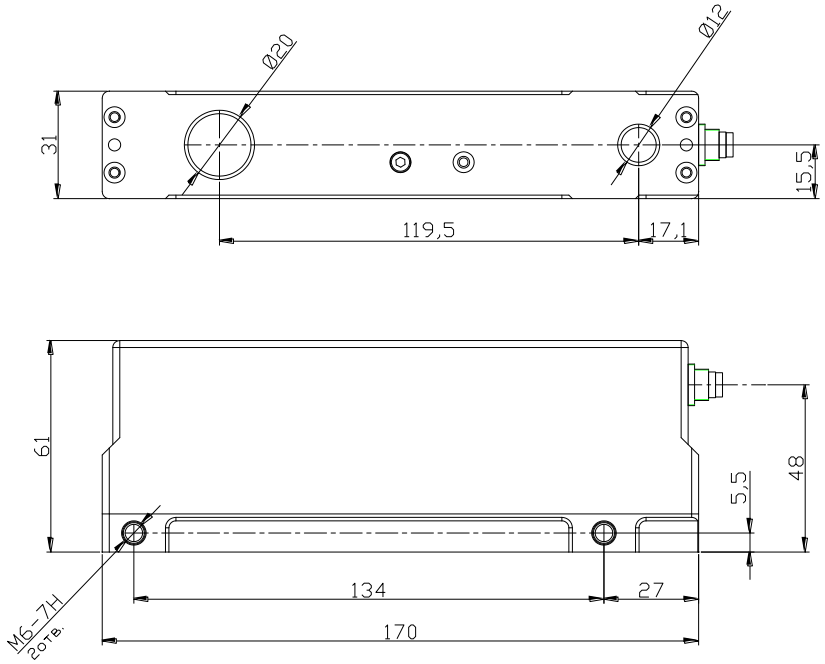


Figure 2.1. FDRF600 sensor with connector (CC)

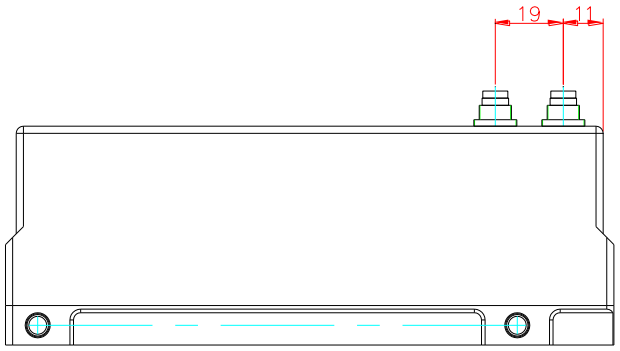


Figure 2.2. FDRF600 sensor with two connector (CC)

8.2. Overall demands for mounting

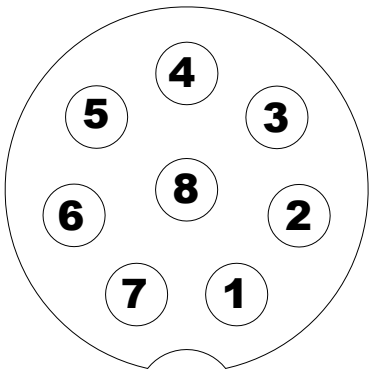
The sensor is positioned so that of object under control should place in this working range. In addition, no foreign objects should be allowed to stay on the path of the incident and reflected laser radiation.
Where objects to be controlled have intricate shapes and textures, the incidence of mirror component of the reflected radiation to the receiving window should be minimized.

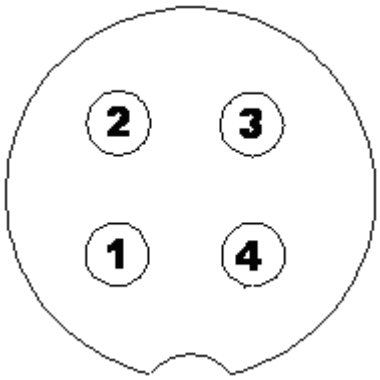
9. Connection

9.1. Designation of connector contacts

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

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





Designation of contacts is given in the following tables:

Connector #1

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

Connector #2

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

9.2. Cables

Designation of cable wires is given in the table below:

Cable #1

Model of the sensor	Pin number		Assignment	Wire color
(CAN/ET)-232-U/I-IN-AL	free lead	-	Power U+	Red
	free lead	-	Gnd (power)	Brown
	DB9	2	TXD	Green
	DB9	3	RXD	Yellow
	free lead	-	U/I	Blue

	free lead	-	IN	White
	free lead	-	AL	Pink
	DB9	5	Gnd (Common for signals)	Gray
(ET)-485-U/I-IN-AL	free leads		Power U+	Red
			Gnd (power)	Brown
			DATA+	Green
			DATA-	Yellow
			U/I	Blue
			IN	White
			AL	Pink
			Gnd (Common for signals)	Gray

Cable #2

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

10. Configuration parameters

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

10.1. Time limit for integration

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

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

Note 1. The measurement frequency depends on the integration time of the receiving array. Maximum frequency (9,4 kHz) is achieved for the integration time ≤106 μs (minimum possible integration time is 0,1 μs). As the integration time increases above 106μs, 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 3200 us.

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

10.2. Sampling mode

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

- Time Sampling;
- Trigger Sampling.

With Time Sampling selected, the sensor automatically transmits the measurement result via serial interface in accordance with selected time interval (sampling period).
With Trigger sampling is selected, the sensor transmits the measurement result when external synchronization input (IN input of the sensor) is switched and taking the division factor set into account.

10.3. Sampling period

If the Time Sampling mode is selected, the 'sampling period' parameter determines the time interval in which the sensor will automatically transmit the measurement result. The time interval value is set in increments of 0.01 ms. For example, for the parameter value equal to 100, data are transmitted through bit-serial interface with a period of 0,01*100 = 1 ms.
If the Trigger Sampling mode is selected, the 'sampling period' parameter determines the division factor for the external synchronization input. For example, for the parameter value equal to 100, data are transmitted through bit-serial interface when each 100th synchronizing pulse arrives at IN input of the sensor.
Note 1. It should be noted that the 'sampling mode' and 'sampling period' parameters control only the transmission of data. The sensor operation algorithm is so built that measurements are taken at a maximum possible rate determined by the integration time period, the measurement results is sent to buffer and stored therein until a new result arrives. The above-mentioned parameters determine the method of the readout of the result form the buffer.
Note 2. If the bit-serial interface is used to receive the result, the time required for data transmission at selected data transmission rate should be taken into account in the case where small sampling period intervals are used. If the transmission time exceeds the sampling period, it is this time that will determine the data transmission rate.

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 four 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

In the "Indication of run-out beyond the range" mode, logical "1" occurs on the AL line if an object under control is located within the working range of the sensor (within the selected window in the range), and logical "0" occurs if the object is absent in the working range (within the selected window). For example, in such mode this line can be

Used for controlling an actuator (a relay) which is activated when the object is present (absent) within the selected range (Fig.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.3.3)

Out of the range indication

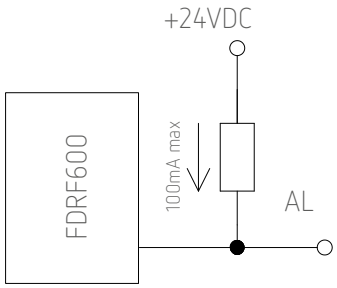


Figure 3.1

Mutual synchronization

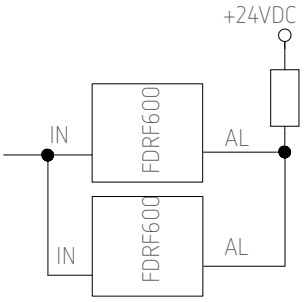


Figure 3.2

Hardware zero-set/
Hardware laser ON/OFF

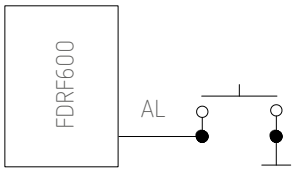


Figure 3.3

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.

10.7. Method of results averaging

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

- Averaging over a number of results
- Time averaging

When averaging over a number of results is selected, sliding average is calculated. When time averaging is selected, the results obtained are averaged over the time interval chosen.

10.8. Number of averaged values/time of averaging

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

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

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

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

Note. 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	3200 (3,2 ms)
Sampling mode	time
Sampling period	5000 (5 ms)
Point of zero	Beginning of the range
Line AL operation mode	1
Time lock of the result	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

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*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' (FDRF600 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).

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								[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:

$OR = 1 / (44/BR+1*10^{-5})$ 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 CAN interface

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

12.1. Modes of data transfer

The sensor can operate in the following modes:

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

12.2. Configuration parameters

12.2.1. Data transmission rate via CAN interface

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

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

12.2.2. Identifiers

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

12.2.3. Factory parameters table

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

12.2.4. Format of transmitted data

The sensor transmits 8 byte long frame:
- byte 0: type of device
- byte 1: = 0 - reserved
- byte 2: low byte of serial number
- byte 3: high byte of serial number
- byte 4: low byte of operating range
- byte 5: high byte of operating range
- byte 6: low byte of the result
- byte 7: high byte of the result

Calculation of the result is made according to formula (1), (see par. 15.3)

13. 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.

13.1. Modes of data transfer

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

13.2. Factory parameters table

Parameter name	Value
Destination IP Address	255.255.255.255
Gateway IP address	192.168.0.1

Subnet Mask	255.255.255.255
Source IP address	192.168.0.3
Interface condition	ON
Mode of data transfer	stream

13.3. Data packet format

The sensor sends 512 byte data packet to IP port 6003:

- 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 507, byte 508: reserved
- byte 509, byte 510: reserved
- byte 511, : packet checksum

13.4. Data structure

- The result of measurement is transmitted as a 16-bit word and calculation of the result is performed according to formula (1), see par. 16.3.
- The status word size is 1 byte. The bit status "0" 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 bits 7...1 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

14. Analog outputs

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

14.1. Current output 4...20 mA

The connection scheme is shown in the figure. The value of load resistor should not be higher than 500 . To reduce noise, it is recommended to install RC filter before the measuring instrument. The filter capacitor value is indicated for maximum sam-

pling frequency of the sensor (9,4 kHz) and this value increases in proportion to the frequency reduction.

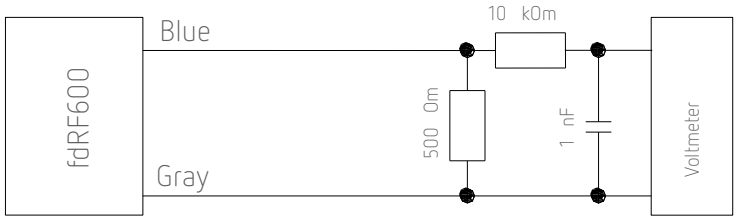


Figure 4

14.2. 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 (9,4 kHz) and this value increases in proportion to the frequency reduction.

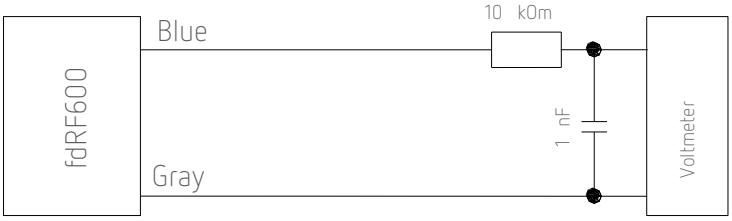


Figure 5

14.3. Configuration parameters

14.3.1. Range of the analog output

While working with the analog output, resolution can be increased by using the 'Window in the operating range' function which makes it possible to select a window of required size and position in the operating range of the sensor within which the whole range of analog output signal will be scaled.
If the beginning of the range of the analog signal is set at a higher value than the end value of the range, this will change the direction of rise of the analog signal.
Note. If the beginning of the range of the analog signal is set at a higher value than the end value of the range, this will change the direction of rise of the analog signal.

14.3.2. Analog output operation mode

When using 'window in the operating range' function, this mode defines the analog output operation mode.
Analog output can be:

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

"Window mode". The entire range of the analog output is scaled within the selected window. Outside the window, the analog output is "0".
"Full mode". The entire range of the analog output is scaled within the selected window (operating range). Outside the selected window, the whole range of the analog

Output is automatically scaled onto the whole operating range of the sensor (sensitivity range).

14.4. Factory parameters table

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

15. Request codes and list of parameters

15.1. Request codes table

Request code	Description	Message (size in bytes)			
01h	Device identification	—		– device type – firmware release – serial number – base distance – range	(1) (1) (2) (2) (2)
02h	Reading of parameter	- code of parameter	(1)	- value of parameter	(1)
03h	Writing of parameter	- code of parameter - value of parameter	(1) (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 bit R: 0 – window mode (default); 1 – full range. 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 09h	Lower byte of the sampling period Higher byte of the sampling period	1) 10...65535, (default — 500) the time interval in increments of 0.01 ms 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 0Bh	Lower byte of maximum integration time Higher byte of maximum integration time	2...65535, (default — 200) specifies the limiting time of integration by CMOS-array in increments of 1mks
0Ch 0Dh	Lower byte for the beginning of analog output range Higher 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
0Eh 0Fh	Lower byte for the end of analog output range Higher 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
10h	Time lock of result	0...255, specifies of time interval in increments of 5 mC
11...16h	Reserved	
17h 18h	Lower zero point Higher byte zero point	0...4000h, (default — 0) specifies beginning of absolute coordinate system.
19...1Ch	Reserved	
20h	Data transfer rate via CAN interface	10...200, (by default — 25) specifies data transmission rate in increments of 5 000 baud, for example, the value of 50 gives the rate of 50*5 000= 250 000 baud.
22h 23h	Low byte of standard identifier High byte of standard identifier	0...7FFh,(by default — 7FFh) specifies standard CAN identifier
24h 25h 26h 27h	0th byte of extended identifier 1st byte of standard identifier 2nd byte of extended identifier 3rd byte of standard identifier	0...1FFFFFFFh, (by default — 1FFFFFFFh) specifies extended CAN identifier CAN
28h	CAN interface identifier	1 — extended identifier; 0 — standard identifier .
29h	CAN interface ON/OFF	1 — CAN interface ON; 0 — CAN interface OFF.
6Ch 6Dh 6Eh 6Fh	0th byte of Destination IP Address 1st byte of Destination IP Address 2nd byte of Destination IP Address 3rd byte of Destination IP Address	by default — FFFFFFFFh = 255.255.255.255
70h 71h 72h 73h	0th byte of Gateway IP Address 1st byte of Gateway IP Address 2nd byte of Gateway IP Address 3rd byte of Gateway IP Address	by default — C0A80001h = 192.168.0.1
74h 75h 76h 77h	0th byte of Subnet Mask 1st byte of Subnet Mask 2nd byte of Subnet Mask 3rd byte of Subnet Mask	by default — FFFFFF00h = 255.255.255.0
78h 79h	0th byte of Source IP Address 1st byte of Source IP Address	by default — C0A80003h = 192.168.0.3

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:

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

- 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 — 61, firmware release — 88 (58h), serial number — 0402 (0192h), base distance — 80mm (0050h), measurement range — 50A (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 1	1 0 0 1 0 1 1 0

91h	96h

Firmware release

DAT(7:0)															
Byte 0								Byte 1							
1	0	0	1	1	0	0	0	1	0	0	1	0	1	0	1
98h								95h							

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 0								Byte 1							
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 0								Byte 1							
1	0	0	1	0	0	0	0	1	0	0	1	0	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 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 RF_Sensor_60x is intended for:

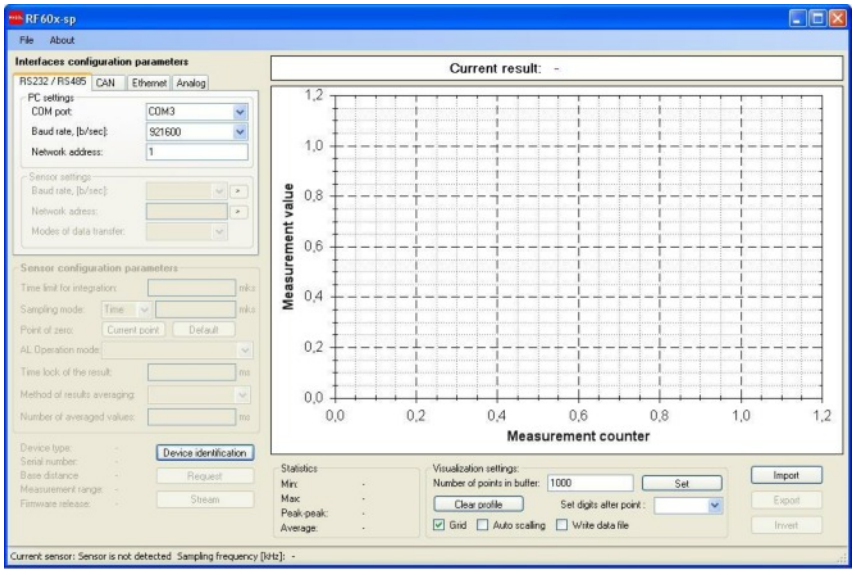
1) Testing and demonstration of work of FDRF600 series sensors;
2) Setting of the sensor parameters;
3) Reception and gathering of the sensor data signals

16.2. Program setup

Start file RF60xsetup.exe and follow instructions of the installation wizard

16.3. Obtaining connection to sensor (RS232/RS485)

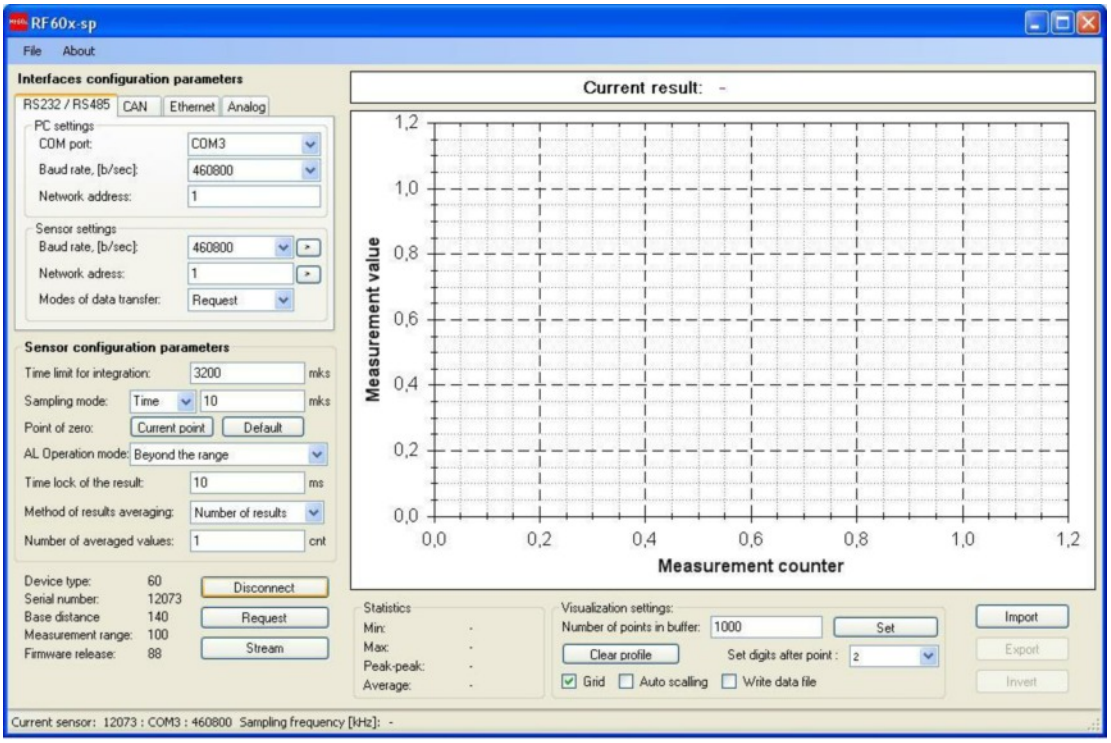
Once the program is started, the pop-up window emerges:



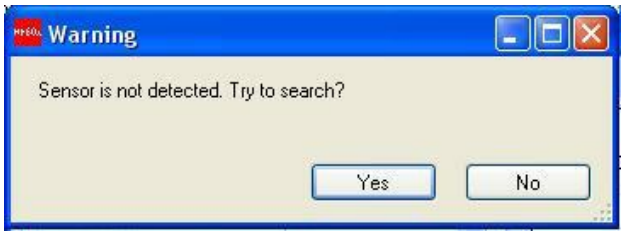
To obtain connection via RS232/RS485 interfaces, go to RS232/RS485 PC settings in the Interface configuration parameters panel:

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

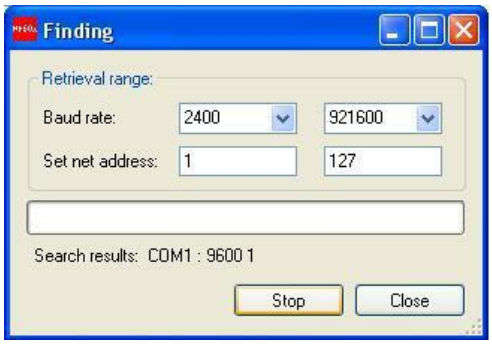
If the selected parameters correspond to the parameters of the sensor interface, the program will identify the sensor, read and display its configuration parameters:



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.

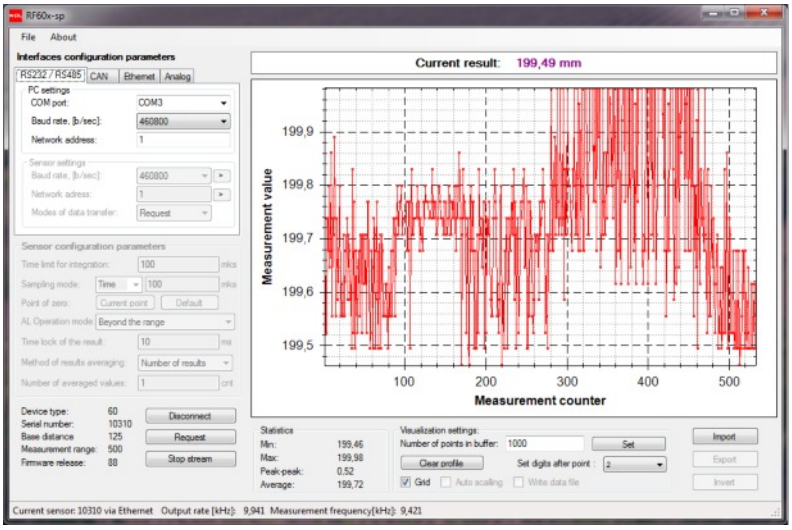
16.4. Checking of the sensor operability

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



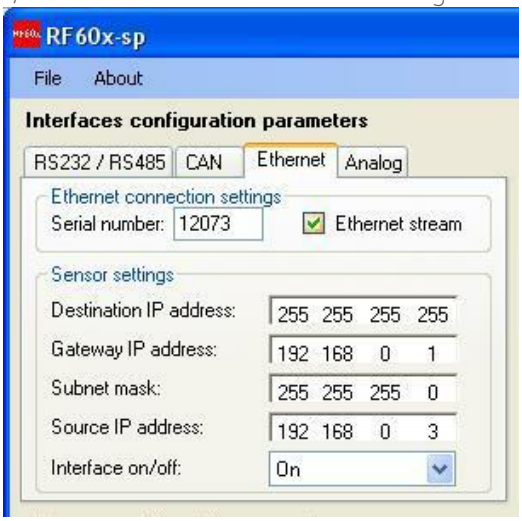
16.5. Connection through Ethernet interface

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.



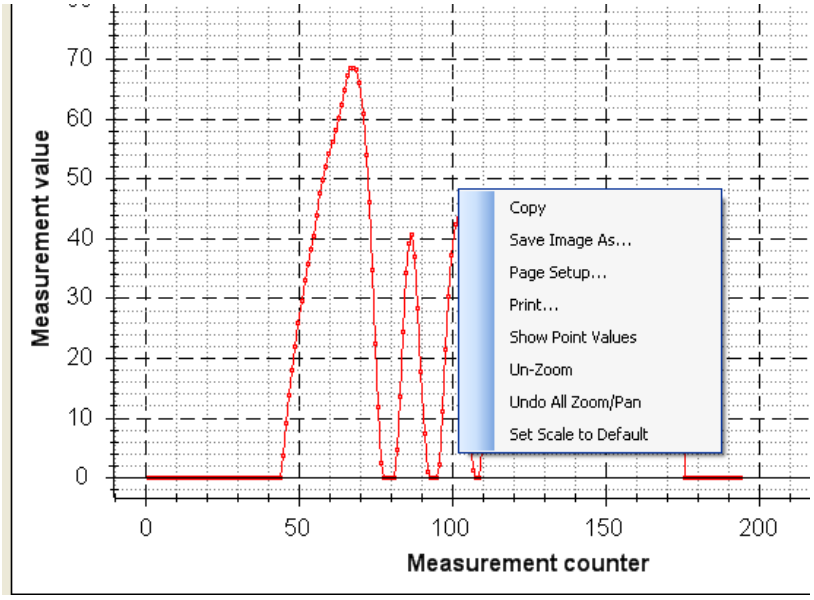
16.6. Display, gathering and scanning of data

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:

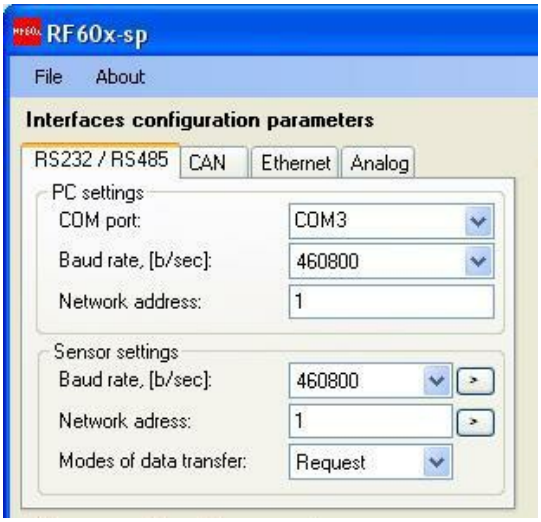


- to move the image, just press the mouse wheel
- to zoom, rotate the mouse wheel
- to save data to a file, press the Export button. The program will offer saving of data in two possible formats: internal and Exel.
- to scan or look at previously saved data, press the Import button and select the required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

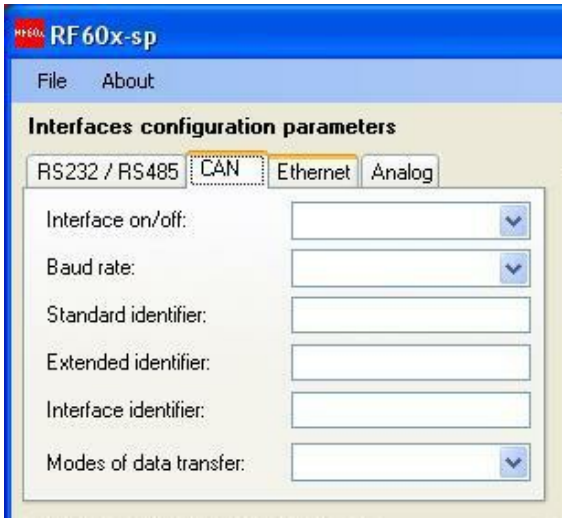
16.7. Setting and saving parameters of the sensor

16.7.1. Setting parameters

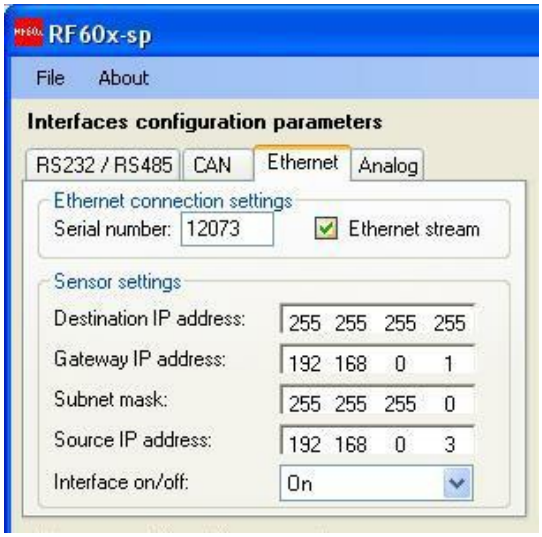
Parameterization of the sensor is only effected through RS232 or RS485 interfaces. Setting of parameters for all interfaces can be done using the respective tabs on the Interfaces configuration parameters panel:



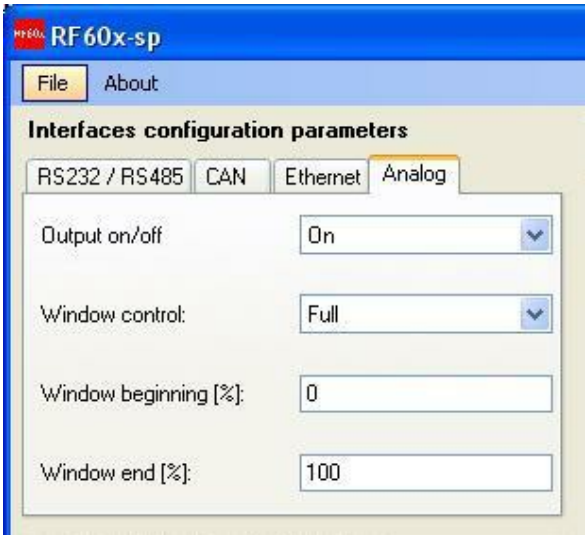
Setting RS232/RS485



Setting CAN

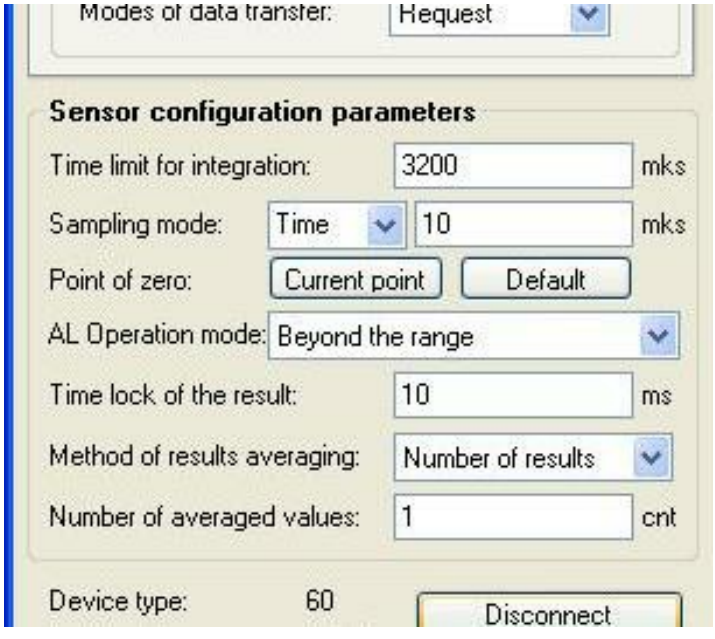


Setting Ethernet



Setting analog outputs

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

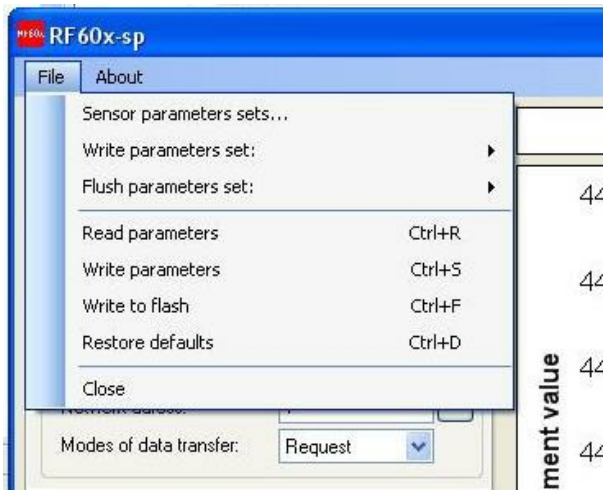


16.7.2. Saving parameters

- 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

18. Appendix

18.1. Connector mounting options

Overall dimensions of a cable conector sensor are shown in Fig 4, 6, the variant with Binder connector is shown in Fig.5
The mounting options for 90 degree connector are shown in Fig.5 and Fig.7.

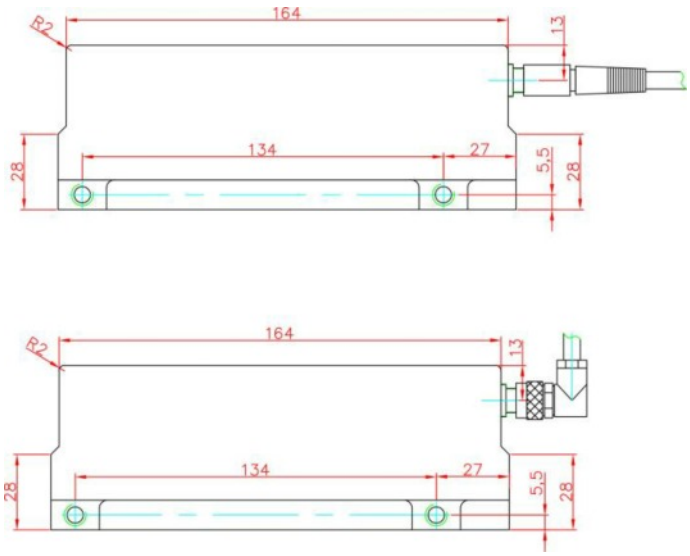


Figure 4

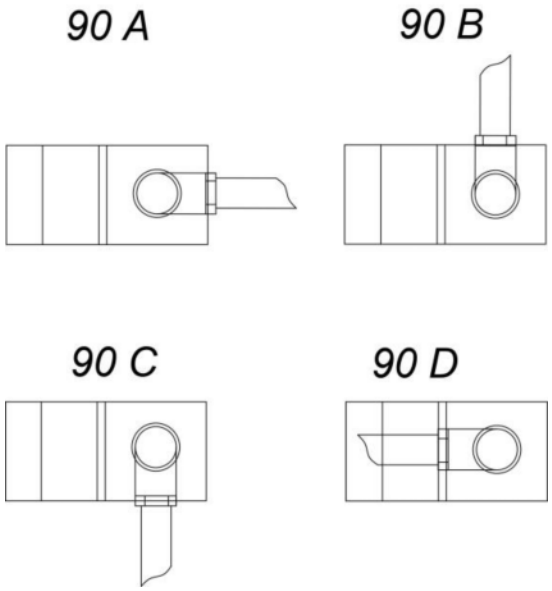


Figure 5

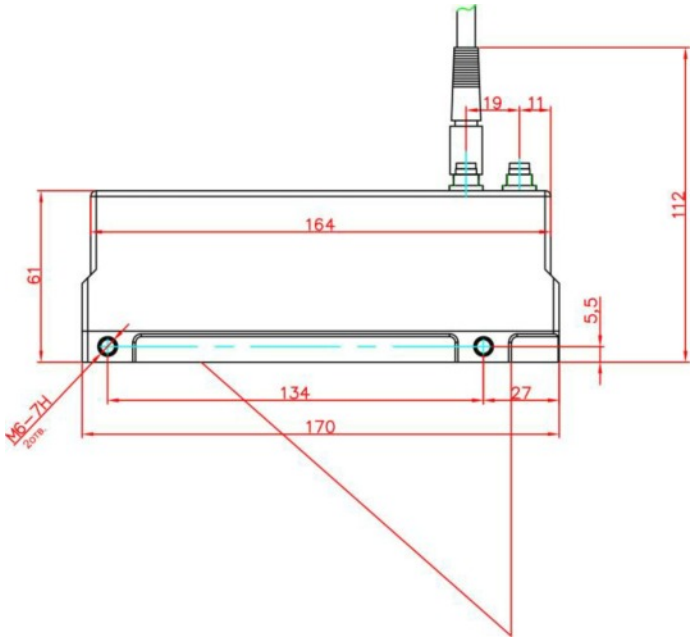


Figure 6

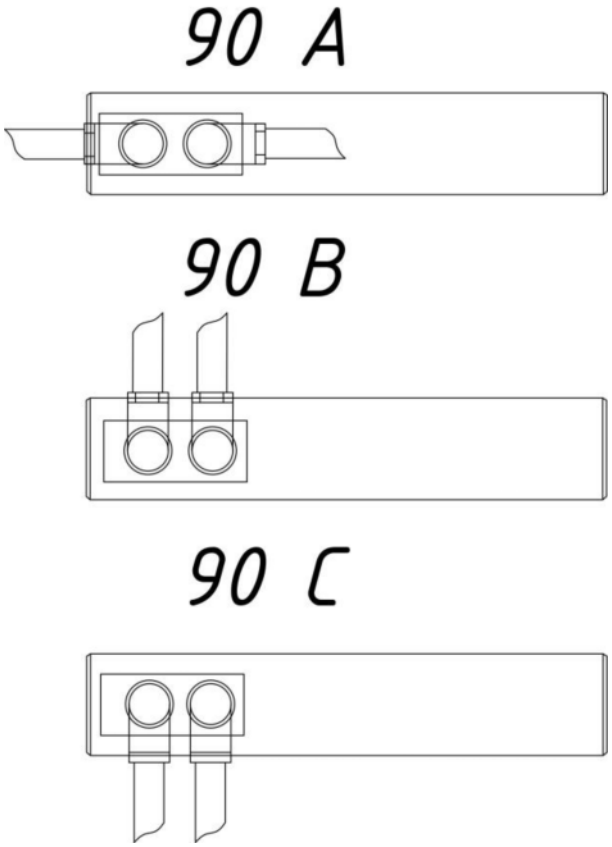


Figure 7

19. Warranty policy

Warranty assurance for the Laser triangulation sensors FDRF600 - 24 months from the date of putting in operation; warranty shelf-life - 12 months

The information provided herein is to the best of our knowledge true and accurate, it is provided for guidance only. All specifications are subject to change without prior notification.

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