1. GENERAL INFORMATION

The micrometers are intended for non-contact measuring and checking of position, displacement, dimensions of technological objects.

2. BASIC TECHNICAL DATA AND PERFORMANCE CHARACTERISTICS

Model	RF651-25	RF651-25TWIN	RF651-5
Measuring range, mm	25	59[1]	5
Distance between transmitter and receiver, L, mm	0…1000		
Linearity[2], um	±10 (L ≤ 50 mm), ±15 (50 mm< L ≤ 200 mm), ±20 (200 mm< L ≤ 250 mm), ±30 (250 mm < L)		±5 (L ≤ 50 mm), ±10 (50 mm< L ≤ 200 mm), ±15 (200 mm< L ≤ 250 mm), ±25 (250 mm < L)
Maximum sampling rate, Hz	1000		5000
Laser type	1 mW, wavelength 660 nm or LED		
Output signal: digital	RS232 or RS485 (max 460800 bit/s)		
Output signal: analog	4…20 mA (<500 Ω load) or 0…10 V		
External synchronization input	2,4 – 5 V (CMOS, TTL)		
Logical outputs	3 outputs, NPN: 100 mA max; 40 B max		
Power Supply, V	5 (4,5…9) or 12 (9…18) or 24 (18…36)		
Power consumption, W	1,5		
Enclosure rating	IP67		
Operating temperature, °C	-10…+50		
Size	figure 3	figure 4	figure 5
Weight (without cable), g	200 (transmitter); 150 (receiver)	400 (transmitter); 300 (receiver)	30 (transmitter); 70 (receiver)

[1] With central dead zone of 9 mm (figure 4)
[2] Typical data obtained when a knife edge was used to interrupt the laser beam

CE compliance.

The micrometers are designed for use in industry and are in compliance with the following standards:

- EN55022:2006 Information technology equipment. Radio disturbance characteristics. Limits and methods of measurement:
- EN61000-6-2:2005 Electromagnetic compatibility (EMC). Generic standards. Immunity for industrial environments
- EN61326-1:2006 Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements

The micrometers fulfil the specification of the EMC requirements, if the instructions in the manual are followed.

3. EXAMPLE OF ITEM DESIGNATION WHEN ORDERING

RF651-25-L-UART-AN-TTL-OUT-VV-CC

Symbol	Description
L	distance between transmitter and receiver (mm)
UART	type of the serial interface (232 or 485 or CAN)
AN	attribute showing the presence of Current Loop (I) or U output
TTL	trigger input (input of synchronization)

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OUT	attribute showing the presence of 3 logical outputs
VV	supply voltage
CC	Cable gland – CG or socket + cable - CC (Binder 702, IP67)

For example: RF651-100-232-I-12-CC – distance between transmitter and receiver – 100 mm, serial port - RS232, 4…20 mA output available, supply voltage 12V (9…18V), socket + cable. Cable lengths are agreed with the ordering customer separately.

4. STRUCTURE AND OPERATING PRICIPLE

4.1. The micrometer operation is based on the so-called 'shadow' principle, Fig.1. The micrometer consists of two blocks – transmitter and receiver. Radiation of a semiconductor laser 1 is collimated by a lens 2. With an object placed in the collimated beam region, shadow image formed is scanned with a CCD photo-detector array 3. A processor 4 calculates the position (size) of the object from the position of shadow border (borders).

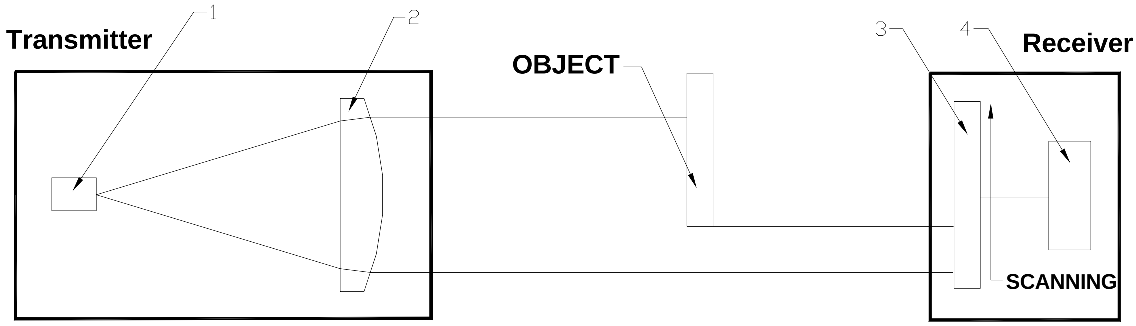

Figure 1.

4.2. Ways of using the micrometer for gauging of technological objects are shown in Fig. 2. Fig.2.1 – measuring of the edge position; Fig.2.2. – measuring of size or position; Fig.2.3. – measuring of the gap value or position; Fig.2.4. – measuring of internal or external dimension; Fig.2.5. – measuring of the size or position of large-size objects.

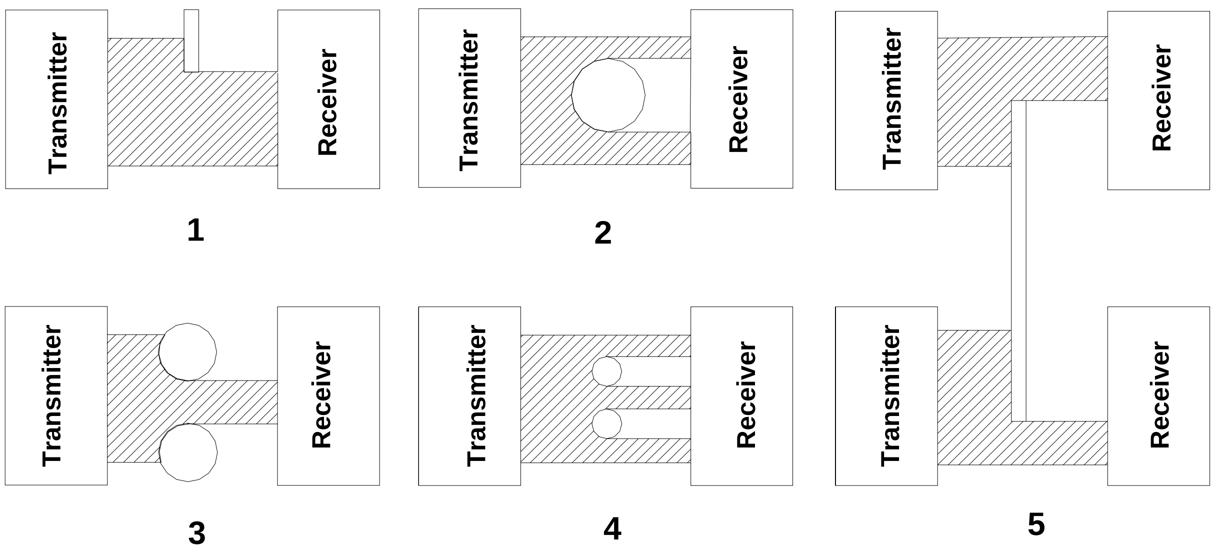

Figure 2.

5. OVERALL AND MOUNTING DIMENSIONS

5.1. Overall and setup dimensions of the RF651-25 micrometer are shown in Fig.3, RF651-5 – in Fig. 4. Bodies of the receiver and transmitter are made of anodized aluminum. On the front panel of the body there is a window, on the opposite face there are power supply and interface connectors. Transmitter and receiver are mounted on the rail. The rail have fastening holes allowing setup of the device on equipment.

5.2. The micrometer is set up in such a way that the light beam leaving the transmitter falls onto the receiver window. No foreign objects should be located on the radiation propagation path.

5.3. To obtain reliable results, the micrometer must be warmed up for 20 minutes after power is switched on.

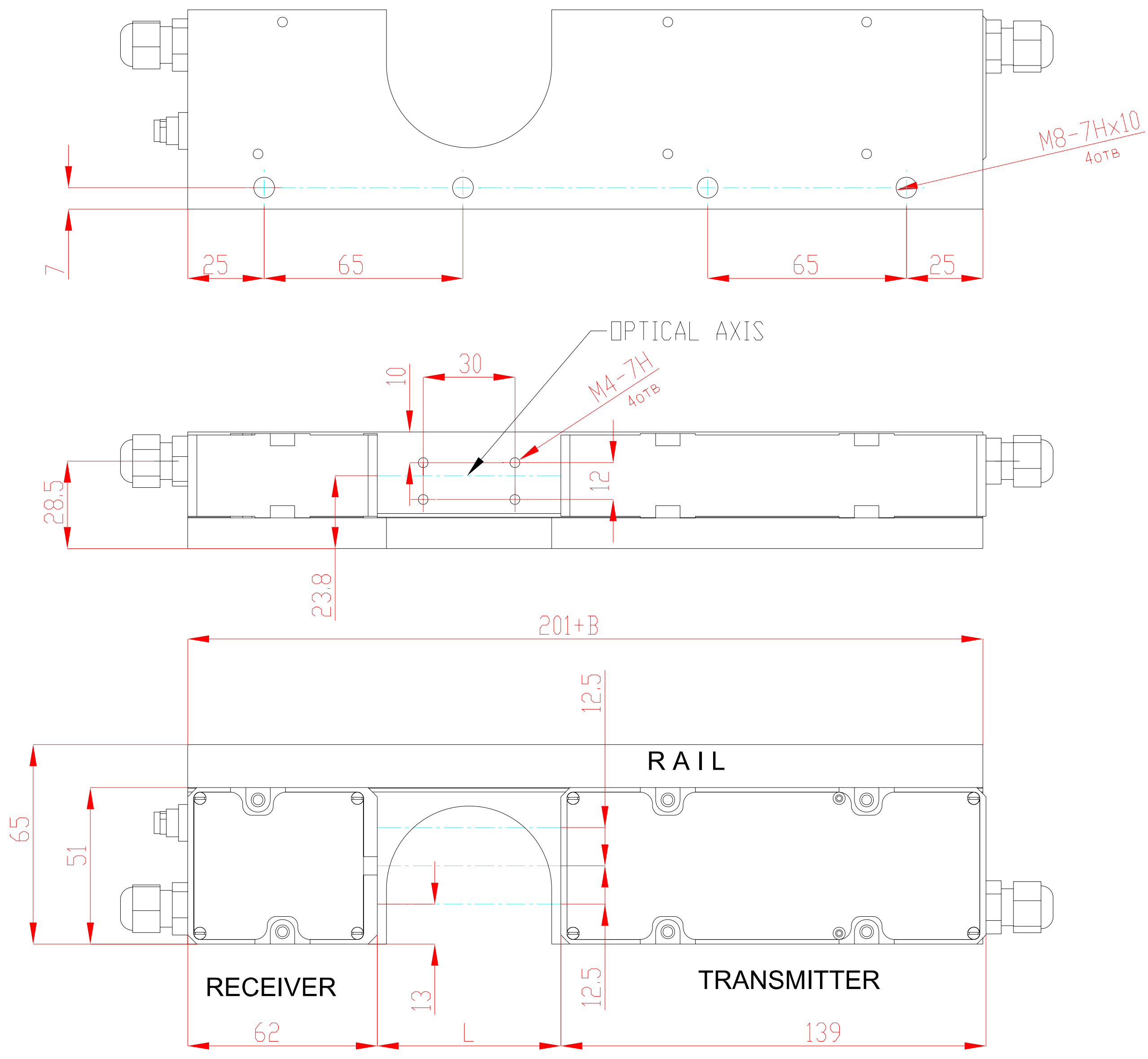

Figure 3.

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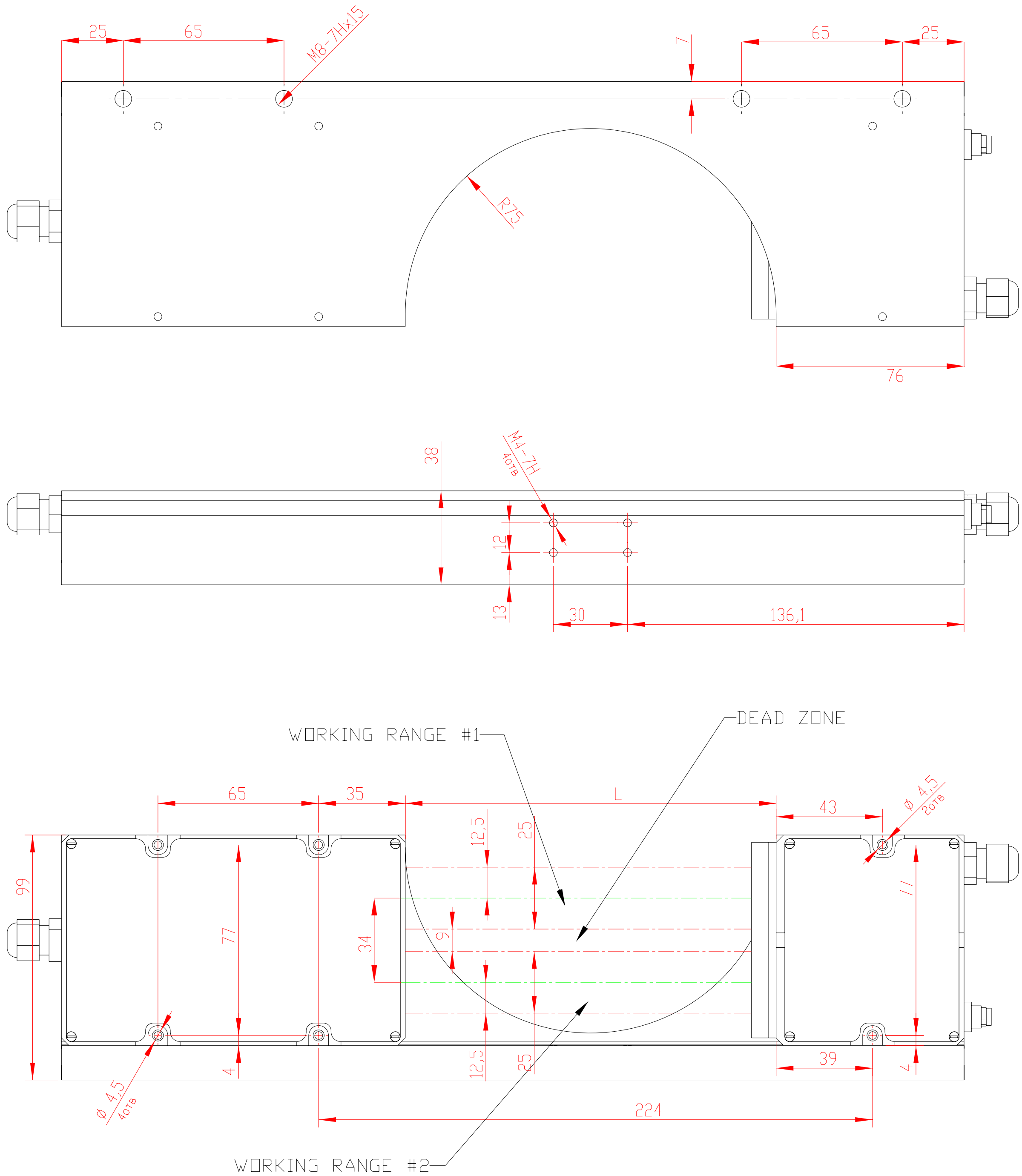
25
65
M8-7Hx15
7
65
25
R75
76
38
M4-7H
4отв
12
13
30
136,1
WORKING RANGE #1
DEAD ZONE
65
35
L
43
ø 4,5
2отв
12,5
25
99
77
34
9
77
4
12,5
25
39
4
224
ø 4,5
4отв
WORKING RANGE #2

Figure 4.

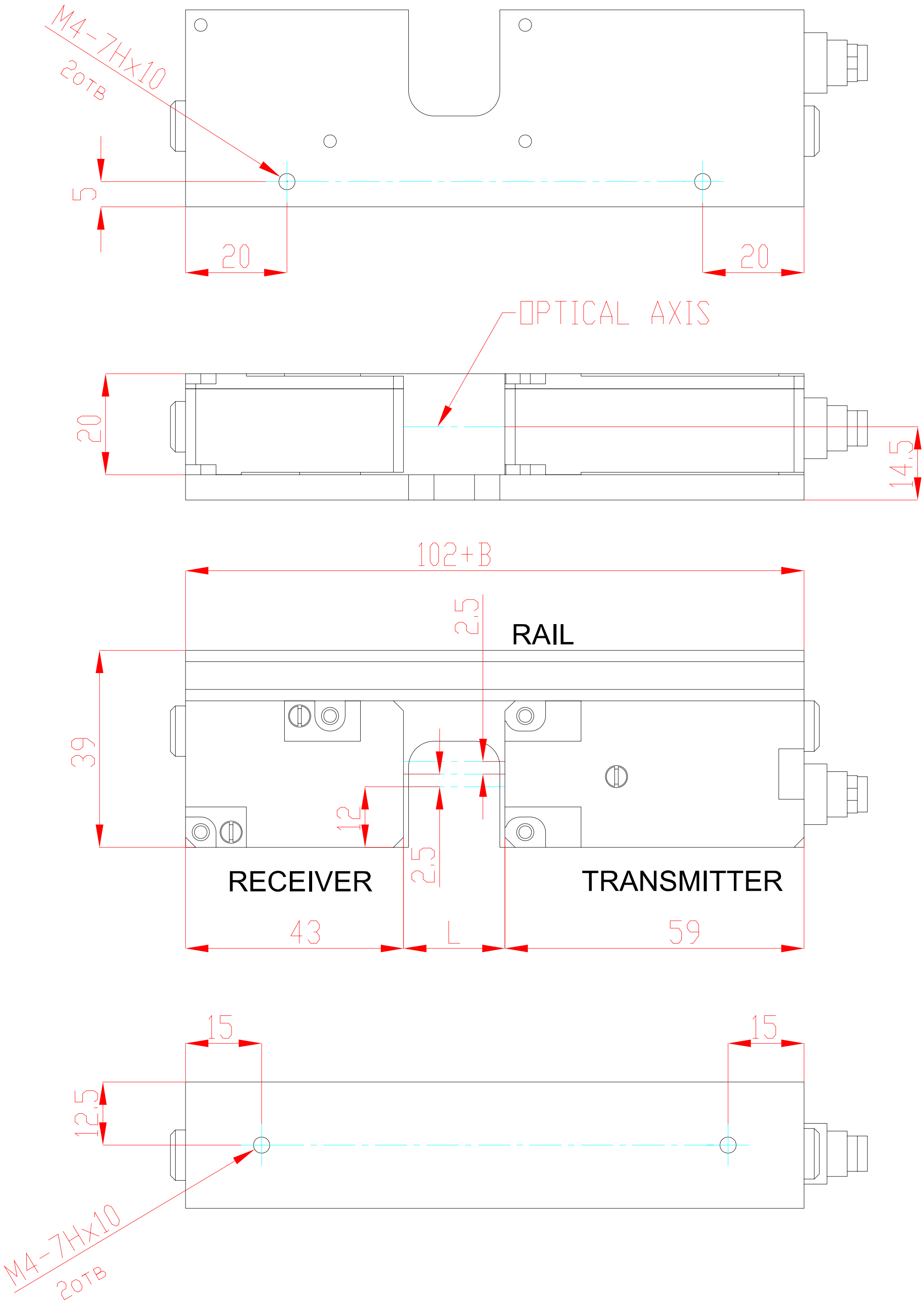
M4-7Hx10
2отв
5
20
20
OPTICAL AXIS
20
14.5
102+B
2.5
RAIL
39
12
2.5
RECEIVER
TRANSMITTER
43
L
59
15
15
12.5
M4-7Hx10
2отв

Figure 5.

6. CONNECTION

Model	Symbols	D-sub 9-pin (fem)	Wire color
232-U/I-IN-AL-LO	Power U+	-	Red
	Power U-	-	Brown
	TXD	2	Green
	RXD	3	Yellow
	U/I	-	Blue
	IN	-	Violet
	AL	-	Orange
	UpLimit	-	Light-blue
	Normal	-	Grey
	LowLimit	-	Light-green
	Gnd (Common for signals)	5	Black
485-U/I-IN-AL-LO	Power U+	-	Red
	Power U-	-	Brown
	DATA+	-	Green
	DATA-	-	Yellow
	U/I	-	Blue
	IN	-	Violet
	AL	-	Orange
	UpLimit	-	Light-blue
	Normal	-	Grey
	LowLimit	-	Light-green
	Gnd (Common for signals)	-	Black

7. OPERATION MODES AND CONFIGURATION PARAMETERS.

7.1. Measurement data from micrometer can be obtained through serial interface and/or on the analog output. Through the serial interface measurement data can be obtained by both single requests (inquiries) and by automatic data streaming (see Section 7, 'Description of serial interface'). When RS485 interface is used, several micrometers can be connected to the data collection device through 'common bus' circuit (network operation mode).

7.2. The nature of operation of the micrometer governs its configuration parameters, which can be changed by transmission of commands through serial port. The basic parameters are as follows:

Sampling period — specifies the time interval or divider ratio of the synchronization input for automatically refreshment of measurement results by the micrometer. The value of the time interval is set in increments of 0.01 ms. If serial interface is used to receive the result and the time intervals set are small, the time required for data transmission at the selected data transfer rate should be taken into account. If the transfer time exceeds the sampling period, it wills this parameter, which will determine the data transfer rate.

Synchronization parameter — specifies

- time priority or
- synchronization input priority and
- mutual synchronization mode.

When *time priority* is chosen, the micrometer automatically transmits the measurement result via serial interface in accordance with the specified time interval (sampling period). When *synchronization priority* is chosen, the micrometer transmits the measurement results when external synchronization input is switched and with the selected division factor taken into account. When chosen, the mutual synchronization mode allows synchronization of the points of measurement of two

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or more micrometers operated simultaneously, for example, in gauging large-size objects (Fig.2.5.), or in gauging several cross-sections of an object.

Number of averaged values specifies the number of source results to be averaged for deriving the output value. Source data are stored in a circular buffer, and new mean value is calculated each time the new result arrives; therefore, the output may regarded as a moving average.

The refreshment of the result through the analog output is also controlled by the two parameters described above.

Type of the result. The micrometer can provide the following types of results:
- object size, or
- position, or
- deviation of size (position) from the target (nominal) value.

Nominal value and tolerances. The nominal value (size or position) can be transmitted as *a parameter* or preset *by teaching*. In the course of measurement, the micrometer controls sizes going beyond the permissible limits. Value of tolerances can be transmitted as parameters.

Logical outputs operation modes. Logical outputs of the micrometer are used to signal that the size under control is within or outside the tolerances selected. Logics of operation of the outputs can be changed, i.e. activate either low or high logical level.

The analog output scaling. 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 micrometer 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.

For 'deviation'-type result, the window boundaries must be defined so that the value corresponding to zero deviation is located in the middle of the window. In this case, the middle part of the analog output range (12mA or 5V) will correspond to zero deviation.

Number of borders. A border means "light-shadow' transition or "shadow-light" transition which forms a shadow image of the object. Measurement is only conducted in the case where the number of borders detected by micrometer corresponds to a given parameter.

Numbers of borders under control. The measurement domain can include up to 8 borders, however, measurement can be made in relation to any two borders (hereinafter – borders A and B), whose numbers are specified by this parameter. Border numbers are counted in the direction of scanning. Direction of scanning is indicated on the body of receiver.

The reserved parameters are used for the micrometers setting. Change of these parameters can lead to infringement of micrometer calibration. Correct change of parameters is made with the help **of the installation program** supplied with the micrometer**.**

8. DESCRIPTION OF SERIAL INTERFACE

8.1. The micrometer can be equipped with hardware port RS232 or RS485. The RS232 port ensures "point-to-point" connection and allows connection of the micrometer directly to RS232 port of the computer.

8.2. In accordance with networking capabilities of RS485 standard, serial exchange protocol allows connection of up to 127 micrometers to one data acquisition unit via "common bus' scheme.

8.3. 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 micrometers and for working with only one micrometer (with both RS232 port and RS485 port).

8.4. Serial data transmission format:

1-start bit,8-data bits,1-odd bit,1-stop bit.

Odd bit is complementary to 8-data bits for oddness.

8.5. The communications protocol is formed by communication sessions, which are only initiated by the 'master'. There are two kinds of sessions:

1) 'inquiry',['message'] — ['answer'], square brackets include optional elements
2) 'inquiry' — 'data stream' — ['inquiry'].

'Inquiry' (INC) is a two-byte message, which fully controls communication session. The 'inquiry' 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 inquiry (COD) and, optional, the message (MSG).

The 'inquiry' format: INC0(7:0),INC1(7:0) = 0,ADR(6:0),1,0,0,0,COD(3:0), [MSG].

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

8.6. Message transfer.

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):

Dt0(7:0);Dt1(7:0) = 1,0,0,0,DAT(3:0);1,0,0,0,DAT(7:4).

8.7. Answer transfer (for the 01h…04h enquiry codes).

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 three 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):

Dt0(7:0);Dt1(7:0) = 1,CNT(2:0),DAT(3:0);1,CNT(2:0),DAT(7:4).

8.8. Types of inquiries.

Inquiry code	Description	Message (size in bytes)	Answer (size in bytes)
01h	Device identification	—	–device type (1) –modification (1) –serial number (2) –max 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)
0Ch	Teaching		- constant 0Ch (1)

8.9. List of parameters

Code of parame-ter	Name	Values
00h	Micrometer ON	1 — laser is ON, measurements are taken (default state); 0 — laser is OFF, sensor in power save mode
01h		**Reserved**
02h	Synchronization control byte	x,x,x,x,x,C,x,S – control byte which determines priority of sampling, bit S; and bit of mutual synchronization, C bites x – do not use; bit S: 0 – priority of time sampling (default) 1 – priority of trigger sampling bit C: 0 — mutual synchronization ON (on default); 1 — mutual synchronization OFF;
03h	Network address	1…127 (default — 1)
04h	Rate of data transfer through serial port	1…192, (default — 4) specifies data transfer rate in increments of 2400 baud; e.g., 4 means the rate of 4×2400=9600baud. (**NOTE**: max baud rate = 460800)
05h		**Reserved**
06h	Number of averaged values	1…128, (default — 1)
07h		**Reserved**
08h	Lower byte of the sampling period	1) 10…65535, (default — 500) the time interval in increments of 0.01 ms with which micrometer automatically communicates of results on streaming inquiry (priority of sampling = 0); 2) 1…65535, (default — 500) divider ratio of trigger input with which micrometer automatically communicates of result on streaming inquiry (priority of sampling = 1)
09h	Higher byte of the sampling period	
0Ah..1Bh		**Reserved**
0Ch	Lower byte for the beginning of analog output range	0…4000h, (default — 0) specifies a point within the absolute range of micrometer 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 micrometer where the analog output has a maximum value
0Fh	Higher byte for the end of analog output range	
10h..1Dh		**Reserved**
17h	Low byte of the nominal value	0…65535, (by default — 0) specifies magnitude of the nominal value in relation to which deviation is calculated
18h	High byte of the nominal value	

1Eh	Type of results and number of borders	0XYh, (by default — 00h) High tetrad X – number of borders under control minus 1. For example, when diameter is measured two borders must be checked. Parameter X = 2 -1=1; Low tetrad Y – measurement mode: 0 – measurement of position of one border (knife); 1 – measurement of the distance between borders A and B (measurement of object size). Result = B – A. (Numbers of borders A are B set by parameter 1Fh) 2 – measurement of object position. Result = (B + A)/2; 3 – measurement of position of border A; 4 – measurement of position of border B;
1Fh	Numbers of borders under control	0XYh (by default — 00h) High tetrad X – serial number of border A minus 1; Low tetrad Y – serial number of border B minus 1;
20h,21h	Low byte of nominal value	**Reserved**
22h	Low byte of the minimal tolerance (LowLimit)	0…65535, (by default —0) Specifies minimum permissible value of deviation value from the nominal value
23h	High byte of the minimal tolerance (LowLimit)	
24h	Low byte of the maximum tolerance (UpLimit)	0…65535, (by default —0) Specifies maximum permissible value of deviation value from the nominal value
25h	High byte of the maximum minimal tolerance (UpLimit)	
26h	Output signal logics control byte UpLimit, LowLimit	x,x,x,x,x,N,U,L L –bit - signal logics control bit, LowLimit: 0 – LowLimit - low level active, 1 – LowLimit – high level active; U –bit – signal logics - control bit, UpLimit: 0 – UpLimit -low level active, 1 – UpLimit – high level active; N-bit - PASS signal logics control bit: 0 – Normal - low level active, 1 – Normal – high level active;

Examples:

1 Measuring the position of a knife – 1 border, A = 1, B = 1; Parameters 1Eh = 00h, 1Fh = 00h;
2 Measuring the diameter – 2 borders , A = 1, B = 2; Parameters 1Eh = 11h, 1Fh = 01h;
3 Measuring the slit size – 2 borders, A = 1, B = 2; Parameters 1Eh = 11h, 1Fh = 01h;
4 Measuring the rod center – 2 borders, A = 1, B = 2; Parameters 1Eh = 12h, 1Fh = 01h;
5 Measuring the inner diameter of a ring – 4 borders, A = 2, B = 3; Parameters 1Eh = 31h, 1Fh = 12h

NOTE:

1) All values are given in binary form.

2) Max distance and range are given in millimeters.

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

X=D*S/4000h (mm).

The beginning of analog output range, the end of analog output range, nominal value, maximum tolerance (Upimit) and minimum tolerance (LowLimit) have the same format.

4) On special inquiry (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 inquiry can be sent simultaneously to all sensors in the net in the broadcast mode in order to synchronize data pickup from all micrometers.

5) 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 micrometer. When power is ON, the parameter values are read out to RAM of the micrometer. 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.

6) **Parameters, which have dimension more than one byte, should be kept, since the high byte and finishing lower.**

8.10. Examples of communication sessions:

1) Condition: request for device identification. Device address —1, inquiry code – 01h, device type —65h, modification —00h, serial number —0402 (0192h), max distance —300 mm (012Ch), range —20 mm (0014h), burst number —1.

The ‘inquiry’ format:
INC0(7:0),INC1(7:0) = 0,ADR(6:0),1,0,0,0,COD(3:0), [MSG].
Inquiry (‘master’) — 01h;81h (INC0(7:0)=0,ADR=0000001,INC1(7:0)=1,0,0,0,COD=0001)
The following is the format of two ‘answer’ data bursts for transmission of byte DAT(7:0):
Dt0(7:0);Dt1(7:0) = 1,CNT(2:0),DAT(3:0);1,CNT(2:0),DAT(7:4)
Answer (‘slave’) — 91h, 94h (device type), 90h, 90h (modification), 92h, 99h, 91h, 90h (serial number), 9Ch, 92h, 91h, 90h (max distance), 94h, 91h, 90h, 90h (range)
(note: as bust number =1, then CNT=1)

2) Condition: request for reading of parameter. Device address —1, inquiry code – 02h; parameter code —04h, parameter value —04h, burst number —2.
Inquiry (‘master’) — 01h, 82h;
Message (‘master’) — 84h, 80h;
Answer (‘slave’) — A4h, A0h

3) Condition: request for result, device address —1, inquiry code – 06h, result value —02A5h, burst number —3.
Inquiry (‘master’) — 01h, 86h;
Answer (‘slave’) — B5h, BAh, B2h, B0h

The displacement (mm) is equal (for example, range of the sensor = 50 mm):

X=677(02A5h)*20/16384 = 0.826 mm

6) Condition: writing priority of sampling (priority of the external synchronization). Device address – 1, inquiry code – 03h, parameter code – 02h, parameter value – 01h.
Inquiry (‘master’) — 01h, 83h;
Message (‘master’) — 82h, 80h; 81h; 80h

7) Condition: writing the divider ratio, for example, 12345=3039h. Device address – 1, inquiry code – 03h, parameter code – 09h (first of all, higher byte), parameter value – 30h
Inquiry (‘master’) — 01h, 83h;
Message (‘master’) — 89h, 80h; 80h; 83h
and, for lower byte, parameter code – 08h, parameter value – 39h:
Inquiry (‘master’) — 01h, 83h;
Message (‘master’) — 88h, 80h; 89h; 83h

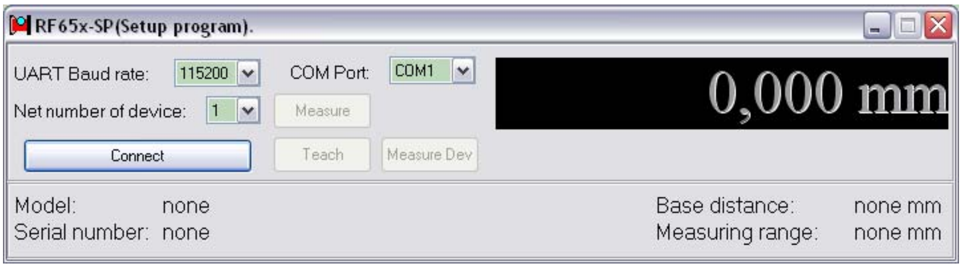
9. INSTALLATION PROGRAM

9.1. The "RF65X-SP" software is intended for:

1) testing and demonstration of operation of micrometers of RF651 Series;
2) setting parameters of micrometer.

3) real working with the micrometer.

9.2. Upon starting the program the working window appears:



1. In the line "UART Baud rate" select micrometer operation speed (factory setting – 115200 bit/s),
2. In the line "COM Port" select PC RS232 port number where micrometer is connected.
3. The line "Net number of device" defines micrometer network address (factory setting for all micrometers – "1")
4. Upon clicking the "Connect" button, RF65X-SP will attempt to establish communication with micrometer with parameters selected as above. If it fails, a 'communication error' message is displayed.
5. If communication is successfully established the window changes its form to the following:

1) In the line "Model" the micrometer model is displayed
2) In the line "Serial number", a serial number of the micrometer is displayed
3) In the line "Base distance", max distance of the micrometer is displayed
4) In the line "Measuring range", the micrometer working range is displayed

9.3. Setting parameters of the micrometer

The opening part of the "RF65X-SP" application ("Parameter – Value Table ") allows one to edit and enter the required parameters into both RAM and FLASH memory of the micrometer.

- to switch ON/OFF the micrometer, click the left mouse key twice in the 'Value' field of the 'Sensor On/Off' parameter;
- to set Synchronization Control Byte, press the key in the 'Value' field, thus calling out "Synchronization Control Byte" edit menu;

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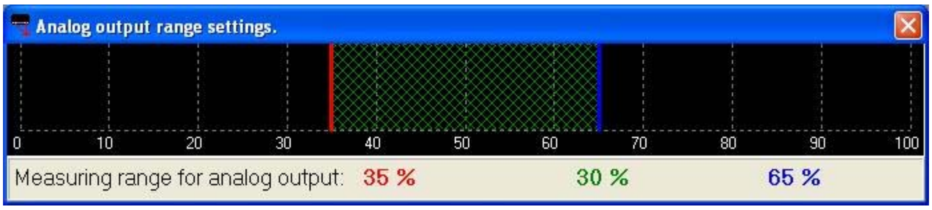
- to set the exchange speed, click the left mouse key in the 'Value" field of the 'UART Baud rate' line, thus calling out the list of permissible speeds;
- in the 'Averaged values counter' line, select the number of measurements to be averaged directly in the micrometer. Factory setting is "0";
- in the lines 'Analog output range (BEG)' and '(END)', it is possible to set the analog output window boundaries in increments of 0.1% of the working range. It is also possible to call out the control toolbar by clicking twice in the 'Value' field:



- Pressing the left mouse key activates red cursor which indicates the beginning of the scaling range, while pressing the right mouse key activates blue cursor indicating the end of the scaling range. To set up working window boundaries, press the respective button and, holding it in the pressed position, move the cursor within the sensor measurement region. Then, boundaries of the selected window will be displayed in the lower line in % (percentage) of the range.

  For 'deviation'-type result, the window boundaries must be defined so that the value corresponding to zero deviation is located in the middle of the window. In this case, the middle part of the analog output range (12mA or 5V) will correspond to zero deviation.
- in the line "Number of Borders", select the number of borders;
- in the line "Measure type", select the type of result;
- in the fields "Border A" and "Border B", specify numbers of borders under control;
- the field "Etalon" is used to specify nominal value. Two choices are possible:

1) place a standard (reference) object within the measurement zone and press "Teach" button. In the field "Etalon" the reference measurement value will appear.
2) type the value of the size (position) of the standard object in the field.

- in the fields "LowLimit" and "UpLimit" write tolerances;
- in the field "OutLogic"tune output logic.

By clicking the right key of the mouse on the left panel "Parameters save" menu is activated. Select 'Load' (to store one parameter) or 'Load All' (to store all parameters).

Perform testing of the micrometer operation with new parameters.

To store the new parameters in the micrometer memory, click the "Write to FLASH" of "Parameters save" menu. The micrometer will operate with these parameter settings in subsequent switched on.

9.4. After communication has been successfully established, it is possible to check micrometer performance. To do so

1. Place an object within the micrometer operating range.
2. Clicking the "Measure" button leads to indication of the result of a continuous measurement of the object position (dimension) on the display.
3. Pressing "Measure Dev" button gives the results of deviations from the standard (reference) objects.
4. By moving the object within the operating range, observe changes of readings on the display and oscilloscope.
5. Data coming from the micrometer are accumulated and stored in a circular buffer with 10000 measurements storage capacity. The "Oscilloscope" window shows graphic representation of the accumulated data. (X-axis – number of the result, Y-axis – coordinates). By clicking left key of the

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mouse scale of the image can be changed, the right key is used to drag the graphic image within viewing region. By clicking the right key "Save to the file" menu is activated.

10. RF65X-SDK. FUNCTIONS DESCRIPTION

Optical micrometer is supplied together with SDK (software development kit) consisting of:
- dynamic library RF65x.dll,
- file for static linking of DLL to project RF65x.lib,
- definition file RF65x.h.

The SDK allows user to develop his own software products without going into details of the sensor communications protocol.

10.1. Connection to COM-port (RF65x_OpenPort)

The function **RF65x_OpenPort** opens COM-port with specified symbolic name, fills in the pointer to the device descriptor and returns the operation result:

```
BOOL RF65x_OpenPort(
          LPCSTR    lpPort_Name,
          DWORD         dwSpeed,
          HANDLE *  lpHandle
);
```

Parameters:
lpPort_Name – name of COM-port (e.g., “COM1:”), full syntax for COM-port name specification see in MSDN, function CreateFile;
dwSpeed - operation speed through COM-port. The parameter is identical to field BaudRate in DCB structure described in MSDN;
lpHandle - pointer to the device descriptor;
Returned value:
If COM-port fails to be opened and adjusted, the function will return FALSE, otherwise if COM-port was opened and adjusted successfully the function will return TRUE. More detailed information about returned errors can be obtained using API function GetLastError described in MSDN.

10.2. Disconnection from COM-port (RF65x_ClosePort).

The function **RF65x_ClosePort** closes COM-port and returns the operation result:

```
BOOL RF65x_ClosePort(
          HANDLE        hHandle
);
```

Parameters:
hHandle – descriptor of the device obtained from function RF65x_OpenPort or CreateFile;
Returned value:
If COM-port fails to be closed, the function will return FALSE, otherwise if COM-port was closed successfully, the function will return TRUE.

10.3. Device identification (RF65x_HelloCmd).

The function **RF65x_HelloCmd** makes identification of RF65x according to net address and fills ***RF65xHELLOANSWER*** structure:

```
typedef struct _RF65x_HELLO_ANSWER_ {
    BYTE      bDeviceType;
    BYTE      bcDeviceModificaton;
    WORD      wDeviceSerial;
    WORD      wDeviceMaxDistance;
        WORD      wDeviceRange;
```

There:

`bDeviceType` – one byte value, which shows type of the device (for RF65x this value is equal 65) (type **BYTE**);

`bDeviceModificaton` – one byte value, which shows device modification (type **BYTE**);

`wDeviceSerial` – two byte value, which contains serial number of the device (type **WORD**);

`wDeviceMaxDistance` – two byte value, which contains the working distance of RF65X sensor (type **WORD**);

`wDeviceRange` – two byte value, which contains the measurement range of RF65X sensor (tpe **WORD**).

```
BOOL RF65x_HelloCmd (
          HANDLE              hCOM,
          BYTE                bAddress,
          LPRF65xHELLOANSWER  lprfHelloAnswer
);
```

Parameters:

hCOM – descriptor of the device obtained from function RF65x_OpenPort or CreateFile;

bAddress - device address;

lprfHelloAnswer - pointer to the **RF65xHELLOANSWER** structure.

Returned value:

If the device does not respond to identification request, the function returns FALSE, otherwise the function returns TRUE and fills variable **RF65xHELLOANSWER** structure.

10.4. Reading of parameters (RF65x_ReadParameter)

The function **RF65x_ReadParameter** reads internal parameters of the micrometer and returns the current value to the parameters address:

```
BOOL RF65x_ReadParameter (
          HANDLE              hCOM,
          BYTE                bAddress,
          WORD                wParameter,
          DWORD *             lpdwValue
);
```

Parameters:

hCOM – descriptor of the device obtained from function RF65x_OpenPort, or CreateFile;

bAddress - address of the device;

wParameter - number of parameter, see Table 1,

Table 1

Parameter	Description
RF65x_PARAMETER_POWER_STATE	Power status of sensor
RF65x_PARAMETER_PRIORITY_AND_SYNC	Priority and mutual sinchronization
RF65x_PARAMETER_NETWORK_ADDRESS	Network address
RF65x_PARAMETER_BAUDRATE	Data transmission rate through serial port
RF65x_PARAMETER_AVERAGE_COUNT	Number of averaged values
RF65x_PARAMETER_SAMPLING_PERIOD	Sampling period
RF65x_PARAMETER_BEGIN_ANALOG_RANGE	Beginning of analog output range
RF65x_PARAMETER_END_ANALOG_RANGE	End of analog output range
RF65x_PARAMETER_NOMINAL_VALUE	Nominal value
RF65x_PARAMETER_RESULT_AND_BORDER_TYPES	Type of result and numbers of boundaries
RF65x_PARAMETER_NUM_CONTROLLED_BORDERS	Number of the borders
RF65x_PARAMETER_MINIMAL_TOLERANCE	Minimal tolerance
RF65x_PARAMETER_MAXIMAL_TOLERANCE	Maximal tolerance
RF65x_PARAMETER_OUTPUT_PINS_SETTINGS	Output signals logic

lpdwValue - pointer to WORD-type variable where current parameter value will be saved.

Returned value:

If the device does not respond to parameter reading request, the function returns FALSE, otherwise the function returns TRUE and fills variable *lpdwValue*.

10.5. Saving current parameters in FLASH-memory (RF65x_FlushToFlash).

Function **RF65x_FlushToFlash** saves all parameters in the FLASH-memory of the micrometer:

```
BOOL RF65x_FlushToFlash(
          HANDLE    hCOM,
          BYTE      bAddress
);
```

Parameters:

hCOM – descriptor of the device obtained from function RF65x_OpenPort or CreateFile;

bAddress - address of the device.

Returned value:

If the device does not respond to request to save all parameters in the FLASH-memory, the function returns FALSE, otherwise, if record confirm is obtained from the sensor, the function returns TRUE.

10.6. Restoration of default parameters from FLASH-memory (RF65x_RestoreFromFlash).

The function **RF65x_RestoreFromFlash** restores all parameter values in the FLASH by default:

```
BOOL RF65x_RestoreFromFlash(
              HANDLE        hCOM,
              BYTE          bAddress
);
```


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Parameters:

hCOM – descriptor of the device obtained from function RF65x_OpenPort or CreateFile;

bAddress - address of the device.

Returned value:

If the device does not respond to request to restore all parameters in the FLASH-memory, the function returns FALSE, otherwise, if restore confirm is obtained from the sensor, the function returns TRUE.

10.7. Latching of the current result (RF65x_LockResult)

```
BOOL RF65x_LockResult(
         HANDLE        hCOM,
         BYTE          bAddress
);
```

The function **RF65x_LockResult** restores all parameter values in the FLASH by default:

Parameters:

hCOM – descriptor of the device obtained from function RF65x_OpenPort or CreateFile;

bAddress - address of the device.

Returned value:

If the device does not respond to result-latching request, the function returns FALSE, otherwise the function returns TRUE.

10.8. Getting measurement result (RF65x_Measure)

The function **RF65x_Measure** reads current measurement value from the micrometer sensor. The result value (D) transmitted by the sensor is normalized in such a way as the value of 4000h (16384) corresponds to full range of the sensor (S в мм), the result in mm is obtained by the following formula: X=D*S/4000h (mm) :

```
BOOL RF65x_Measure(
         HANDLE        hCOM,
         BYTE          bAddress,
         USHORT *      lpusValue
);
```

Parameters:

hCOM – descriptor of the device obtained from function RF65x_OpenPort or CreateFile;

bAddress - address of the device.

lpusValue - pointer to USHORT/WORD-type variable containing the result D.

Returned value:

If the device does not respond to result request, the function returns FALSE, otherwise, if the restore confirm is obtained from the sensor, the function returns TRUE.

10.9. Starting measurement stream (RF65X_StartStream)

The function **RF65x_StartStream** switches micrometer to the mode where continuous transmission of measurement results takes place:

```
BOOL RF65x_StartStream(
          HANDLE         hCOM,
          BYTE           bAddress
);
```

Parameters:

hCOM – descriptor of the device obtained from function RF65x_OpenPort or CreateFile;

bAddress - address of the device.

Returned value:

If the device fails to be switched to continuous measurement transmission mode, the function returns FALSE, otherwise the function returns TRUE.

10.10. Stopping measurement stream (RF65x_StopStream)

The function **RF65x_StopStream** switches the sensor from continuous measurement transmission mode to the "request-response" mode:

```
BOOL RF65x_StartStream(
          HANDLE         hCOM,
          BYTE           bAddress
);
```

Parameters:

hCOM – descriptor of the device obtained from function RF65x_OpenPort or CreateFile;

bAddress - address of the device.

Returned value:

If the device fails to be stopped in the continuous data transmission mode, the function returns FALSE, otherwise the function returns TRUE.

10.11. Getting measurement results from the stream (RF65X_GetStreamMeasure)

The function **RF65x_GetStreamMeasure** reads data from the COM-port input buffer which are received from micrometer after successful execution of the RF65X_StartStream function. The data arrive in the buffer at a rate specified in the micrometer parameters. Since depth of the input buffer is limited to 1024 bytes, it is preferable to read data with periodicity equal to that specified in the micrometer parameters. The parameter *lpusValue* is identical to the parameter *lpusValue* in the RF65x_Measure function.

```
BOOL RF65x_GetStreamMeasure(
          HANDLE              hCOM,
          USHORT *            lpusValue
);
```

Parameters:

hCOM – descriptor of the device obtained from function RF65x_OpenPort or CreateFile;

lpusValue - pointer to USHORT/WORD-type variable containing the result D.

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Returned value:
If there are no data in the buffer, the function returns FALSE, otherwise the function returns TRUE and fills the value *lpusValue.*

10.12. Transmission of user data (RF65x_CustomCmd)

The function **RF65x_CustomCmd** is used for transmission and/or reception of data from in micrometer.

```
BOOL RF65x_CustomCmd(
          HANDLE        hCOM,
          char *        pcInData,
          DWORD              dwInSize,
          char *        pcOutData,
          DWORD *       pdwOutSize
);
```

Parameters:

hCOM – descriptor of the device obtained from function RF65x_OpenPort or CreateFile;

pcInData - pointer to data array which will be transmitted to micrometer. If no data need to be transmitted, *pcInData* must be NULL and *dwInSize* must be 0.

dwInSize - size of transmitted data. If no data need to be transmitted, this parameter must be 0.

pcOutData - pointer to data array where data received from micrometer will be saved. If no data need to be received, *pcOutData* must be NULL.

pdwOutSize - pointer to the variable containing size of data to be received. If no data need to be received, this parameter must be NULL. After successful receipt of data, the amount of read bytes will be recorded to the variable where this parameter points to.

Returned value:
If transmission or reception of bytes fails, the function returns FALSE, otherwise the function returns TRUE.

10.13. Functions for operation of sensors connected to FTDI-based USB.

To work with FTDI-based USB devices, this library supports functions operating through D2XX library of FTDI. Performance of the functions is identical to that of the functions used for operation through serial port, the main difference being the presence of **FTDI_** prefix in the function name, for example: "getting result" function for serial port is **RF65x_Measure** while for FTDI USB devices it is **RF65x_FTDI_Measure**.

11. COMPLETE DELIVERY PACKAGE

The delivery package includes:

RF651 Series micrometer	1 pc
CD with RF65X-SP (executable module) and RF65x-sdk	1 pc

12. WARRANTY POLICY

Warranty assurance for the micrometer RF651 - 18 months from the date of putting in operation; warranty shelf-life - 12 months.

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