1. GENERAL INFORMATION

The sensor is made on the basis of Hall elements or magneto-induction transducers and can be used in any control systems where determination of rotation angles, number of revolution, speed of rotation, etc.

2. STRUCTURE AND OPERATING PRINCIPLE

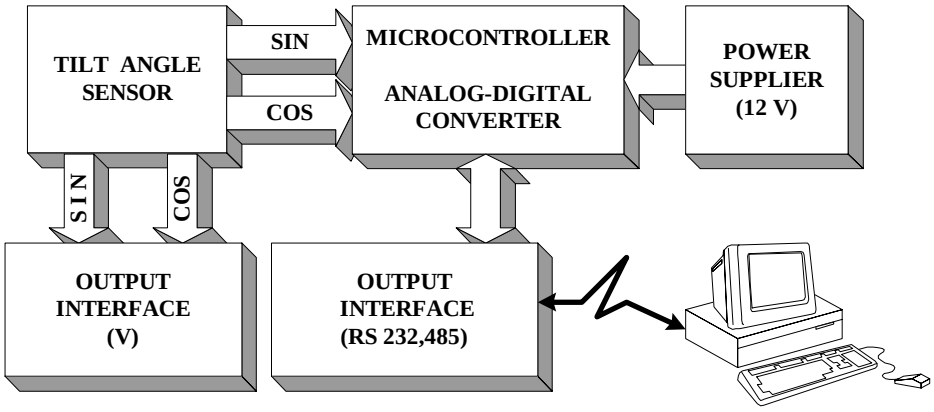

Figure 1

As the shaft of the constant-magnet-equipped sensing device rotates, the transducer forms two sinusoidal signals which are 90° out of phase relative to each other. The microcontroller built in the sensing device serves for determination of the rotation angle and organization of the output interface.

3. PERFOMANCE SPECIFICATION

Model	RF701
max speed of rotation, rev/s	40
measurement error, angular minutes	20
output signal	RS232, 485, 0..5V
supply voltage, V	12
enclosure rating	IP67
operating temperature, ^{0}C	-60..+70
Resistance to: -vibrations of 10-60 Hz frequency with maximum acceleration of 1 g. -1000 impacts with maximum acceleration of 15 g.	

4. EXAMPLE OF ITEM DESIGNATION WHEN ORDERING

RF701-TTT

Symbol	Name	Values	Description
-TTT	Output signal	V	Sinusoidal, voltage
		232	RS232.
		485	RS485.

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5. TYPE OF OUTPUT INTERFACE

5.1. Type "V" – sinusoidal, voltage.

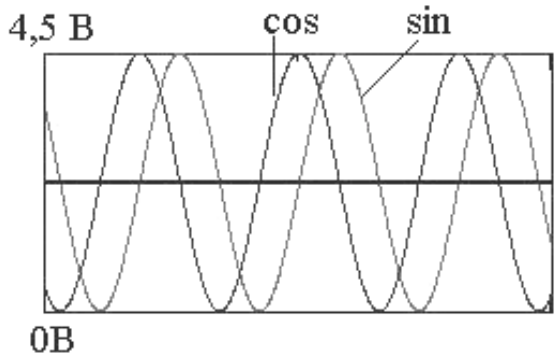

Figure 2

As the shaft is rotated, two orhtogonally shifted sinusoidal signals are generated at the sensing device output (one period per one revolution). These signals carry information about the amount and direction of displacement. By appropriate processing of the signals (interpolation) it is possible to measure the rotation angle with discreteness much smaller than the period of the signals.

5.2. RS232, RS485
Operation modes and configuration parameters

Measurement data from encoders can be obtained through serial interface and/or on the analog current output. Through the serial interface measurement data can be obtained by both single requests (inquiries) and by automatic data streaming

The nature of operation of the encoder governs its configuration parameters, which can be changed by transmission of commands through serial port.

5.2.1. Sampling period

Sampling period — specifies the time interval for automatically refreshment of measurement results by the encoder. The value of the time interval is set in increments of 0.1 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.

5.2.2. Number of averaged samples

The encoder controller performs sampling of displacement counter readings every 50 μs. 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.

5.3. Description of serial interface

The hardware port RS232 allows encoder to be connected directly to a computer.

In accordance with network capabilities of the RS485 standard, the implemented serial data communications protocol permits connection of several encoders to one information collection unit through a ‘common bus’ circuit

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5.3.1. Data communications protocol

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’ (RF701 Series encoders) 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 encoders and for working with only one encoder (with both RS232 port and RS485 port).

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.

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 consisting of two messages one-byte message INCA and INCB. First from that, INCA contains 7-bit device address ADR(6:0), and it 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. Second message INCB contains 7-bit inquiry code MSG(6:0). The ‘inquiry’ format:

INCA(7:0) = 0,ADR(6:0)
INCB(7:0) = 1,MSG(6:0).

‘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 a 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.
All messages with a data 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).

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).

5.3.2. Types of inquires

Inquire code	Description	Message (size)	Answer (size)
01_h	Device identification	—	-device type = 701h (3)

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			-modification =0h (1) -serial number (4)
02_h	Reading of parameter	-code of parameter (2)	-value of parameter (*)
03_h	Writing of parameter	-code of parameter (2) -value of parameter (*)	—
04_h	Storing current parameters to FLASH-memory	-constant AAh (2)	-constant AAh (2)
04_h	Recovery of parameter default values in FLASH-memory	-constant 69h (2)	-constant 69h (2)
05_h	Latching of current result	—	—
06_h	Inquiring of result	—	-result (4)
07_h	Inquiring of a stream of results	—	-stream of resalts (4)
08_h	Stop data streaming	—	—

(*)the size is determined by the parameter dimension see. p.5.2.3

5.3.3. List of parameters

Code of parame-ter	Size (tetrad)	Name	Values
00_h	2	Transducer status word	Contains encoder status and error flags
01_h	2	Network address	1…127 (default — 1)
02_h	2	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.
03_h	4	Sampling period	10…65535, (default — 1000) specifies the time interval in increments of 100 μs with which sensor automatically communicates the results on streaming inquiry
04_h	2	Number of averaged values	1…128, (default — 1)
05_h	1	Discreteness, D	1…10 (default — 10) specifies the number of increments per 1 degrees

NOTE:

All values are given in binary form.

The result value (G) transmitted by the encoder is set in increments in accordance with the disreteness parameter (D), therefore the result expressed in degrees obtained by the following formula:

$$X=G / D \text{ (degrees)}.$$

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 encoders 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 encoder. When power is ON, the parameter values are read out to RAM of the encoder. 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.

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5.3.4. Examples of communication sessions

1) Condition: request for device identification, device address—1, device type —701h, modification —0h, serial number —0402 (0192h), burst number —1.
   Inquiry (“master”) — 01h, 81h;
   Answer (“slave”) — 91h, 90h, 97h, 90h, 92h, 99h, 91h, 90h
2) Condition: Request for reading of parameter, device address —1, parameter code —05h, parameter value —04h, burst number —2.
   Inquiry (“master”) — 01h, 82h;
   Message (“master”) — 85h, 80h;
   Answer (“slave”) — A4h, A0h
3) Condition: Request for result, device address —1, result value — 0002A5h, dimension of the result — 3, burst number —3.
   Inquiry (“master”) — 01h, 86h;
   Answer (“slave”) — B5h, BAh, B2h

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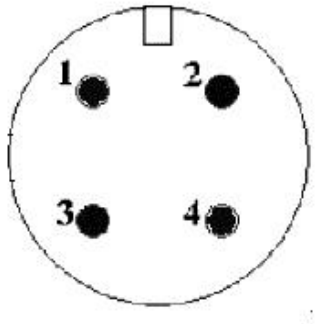
6. POWER SUPPLY AND INTERFACE CONNECTION

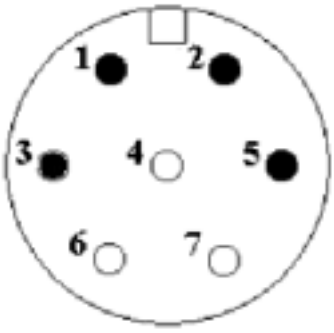
6.1. "V"-Type interface



Number	Description
1	**U+** - supply voltage, 12V;
2	output (COS)
3	**0V** - "0" power supply;
4	output (SIN)

Figure 3

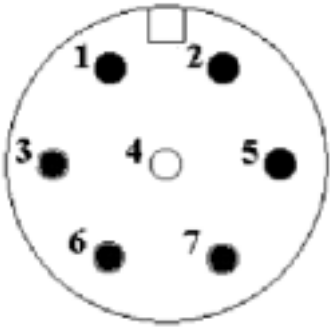
6.2 RS232 interface



Number	DEscription
1	**Rxd**- input RS232;
2	**Txd** - output RS232;
3	**U+** - supply voltage, 5…12V;
5	**0V** - "0" power supply;

Figure 4

6.3. RS485 interface



Number	Description
1	**DI** – input RS485;
2	**DI+** - input RS485;
3	**U+** - supply voltage, +12V;
5	**0V** - "0" power supply;
6	**DO+** - output RS485;
7	**DO** - output RS485;

Figure 5

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7. DIMENSIONS

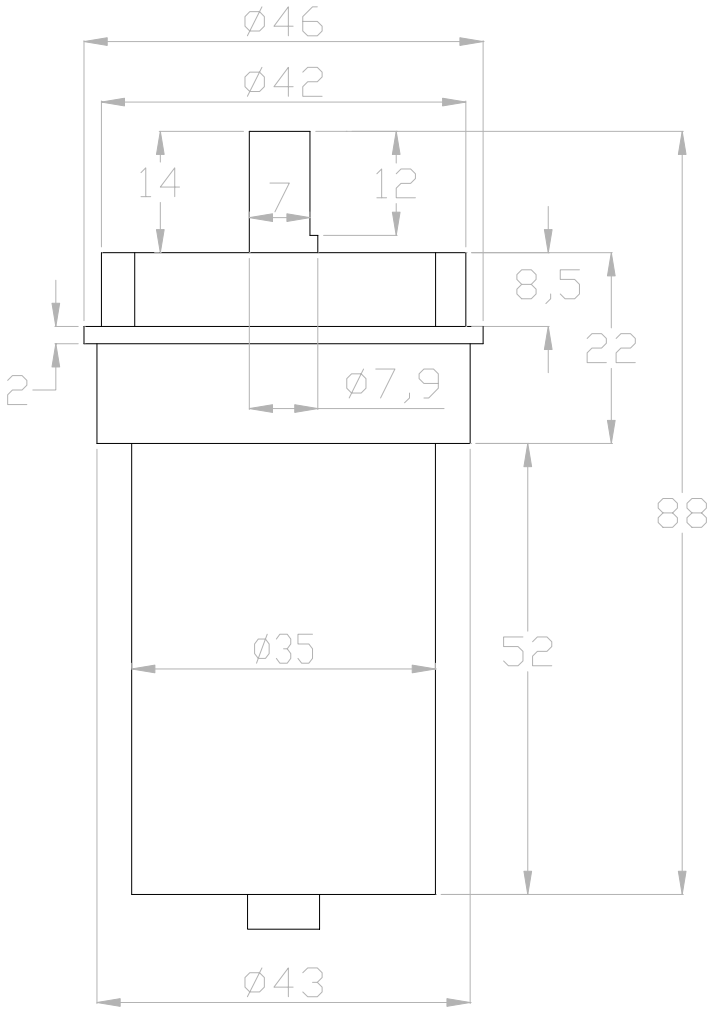

Figure 6

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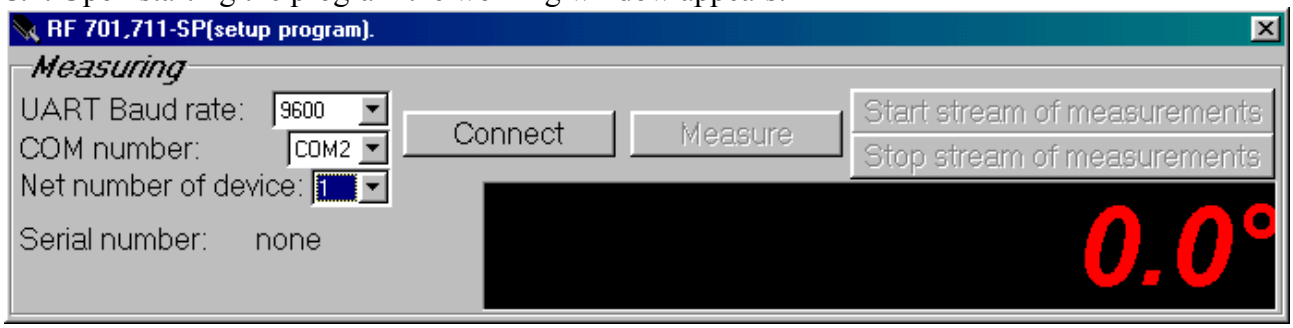
8. INSTALLATION PROGRAM

8.1. The "RF701,711-SP" software is intended for:

1) testing and demonstration of operation of incremental encoders of RF20X Series;
2) setting parameters of encoders;

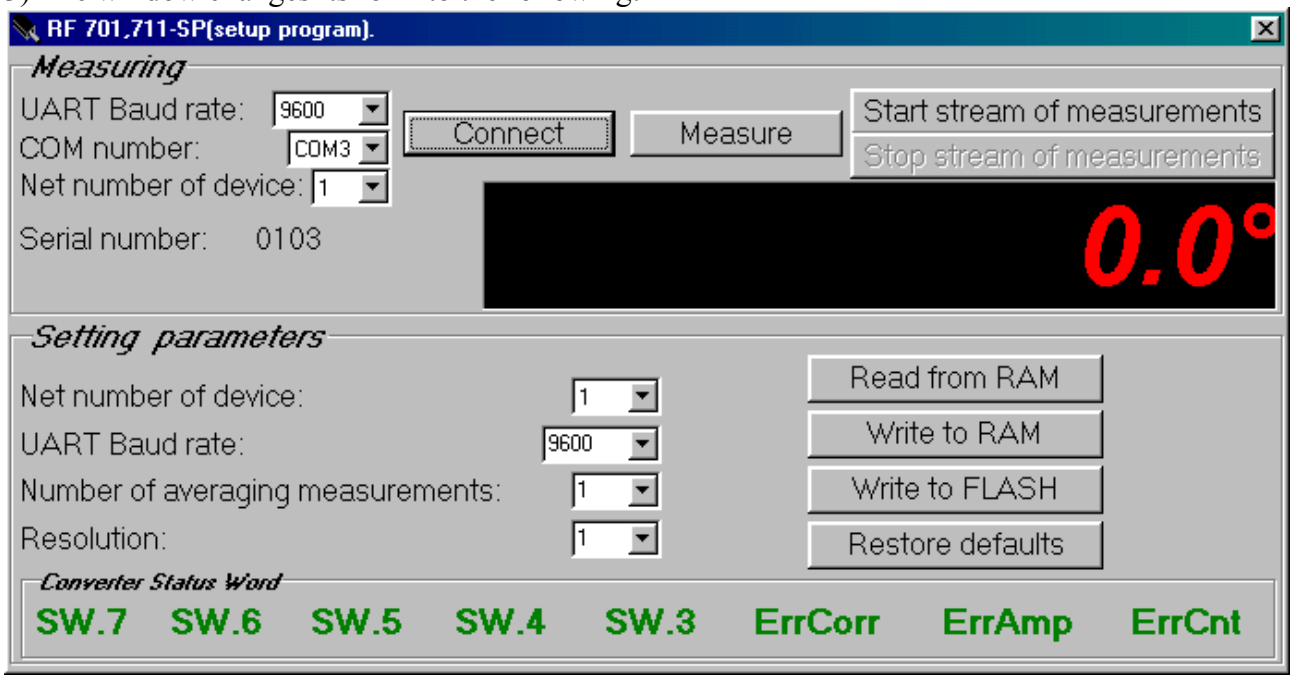
8.2. Upon starting the program the working window appears:



1. In the line "UART Baud rate" select encoder operation speed (factory setting – 9600 bit/s),
2. In the line "COM number" select PC RS232 port number where encoder is connected.
3. The line "Net number of device" defines sensor network address (factory setting for all sensors – "1")
4. Upon clicking the "Connect" button, RF701,711-SP will attempt to establish communication with encoder with parameters selected as above. If it fails, a 'communication error' message is displayed.
5. If communication is successfully established:

1) In the line "Serial number" , a serial number of the encoder is displayed

3) The window changes its form to the following:



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8.3. After communication has been successfully established, it is possible to check encoder performance. To do so:
1. Press the "Measure" button. As a result, the button name changes to "Stop", and measurement-on-inquiry mode is started. Measured value is sent to the display field. To cancel this mode, "Stop" should be pressed.
2. Clicking the "Start stream of measurement" button activates continuous measurement mode (data streaming mode).
3. Clicking of the "Stop stream of measurement" button deactivates the data streaming mode.

8.4. Setting parameters of the sensor

The "Setting parameters" window makes it possible to edit and enter the relevant encoder parameters to RAM and FLASH-memory.
1. 1. In the line “UART Baud rate”, select preferred data exchange rate for the encoder.
2. In the line "Number of averaging measurements", select the number of measurements to be averaged directly by the encoder. Factory setting – "1".
3. In the field " Resolution (Increment) ", set counting discreteness of the encoder.
4. In the field " Condition word of Gauge", status of the encoder flags is shown.
5. Having finished setting of required parameters, click the "Write to RAM" button.
6. Test encoder performance with a new set of parameters according to 8.3.
10. To store the new parameters in the encoder memory, click the "Write to FLASH" button. The encoder will operate with these parameter settings in subsequent activations.

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