

Data communications protocol for sensors EUROSENS Delta

Manual addendum

CJSC Mechatronics

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2. PURPOSE AND TECHNICAL SPECIFICATION

2.1 Purpose

The data communications protocol serves to read information in the standardized form from sensors of the Delta and Direct (except Direct P) series, manufactured by CJSC Mechatronics.

2.2 Technical specification

To provide operation of sensors manufactured by CJSC Mechatronics under the data communications protocol the external device has to allow connection by standard lines of serial data communication RS232, RS485, K-Line.

The software has to support serial data communication protocols.

3. DESCRIPTION OF DATA COMMUNICATIONS PROTOCOL FOR SENSORS MANUFACTURED BY CJSC "MECHATRONICS"

3.1 General data

The protocol supports two types of communication: binary (HEX) and symbolical (transfer of symbol sequence ASCII). The best choice is the binary communications protocol.

The process of data communication begins not right away after turning on. Some time is required to run the built-in microprogram of the sensor, pass the tests, enter the set operating mode. Approximately turn-on time doesn't exceed 3000 ms. After the set mode is entered, data exchange between the sensor and the external device begins.

When the sensors work in the slave mode there is a wait for the response from the sensor after sending interrogation command. Response delay time depends on the communication speed and the communication protocol type, but it's not more than 100 ms. In case there is no response after 100 ms interrogation command can be resent.

Data between the sensor and the external device are transferred as standard format messages. The message is transferred by packages of bytes. Transfer of each byte begins with START bit and ends with STOP bit (fig. 1). Data are transferred by least significant byte first.

The interval between the subsequent bytes in a package (T_T) has to be either less than transfer duration 35 bits or less than 1 ms, if

$$\frac{35}{\text{speed (bod)}} < 1 \text{ ms}$$

The termination of bytes package is considered the situation when the subsequent byte doesn't come during the time (T_T) that exceeds the maximum interval (T_T) + 1 ms (fig. 2).

T_{byte} - transfer time of one byte of information;

T_T - timeout between the subsequent bytes in a package.

This order applies for sensor operation and for operation of the external device.

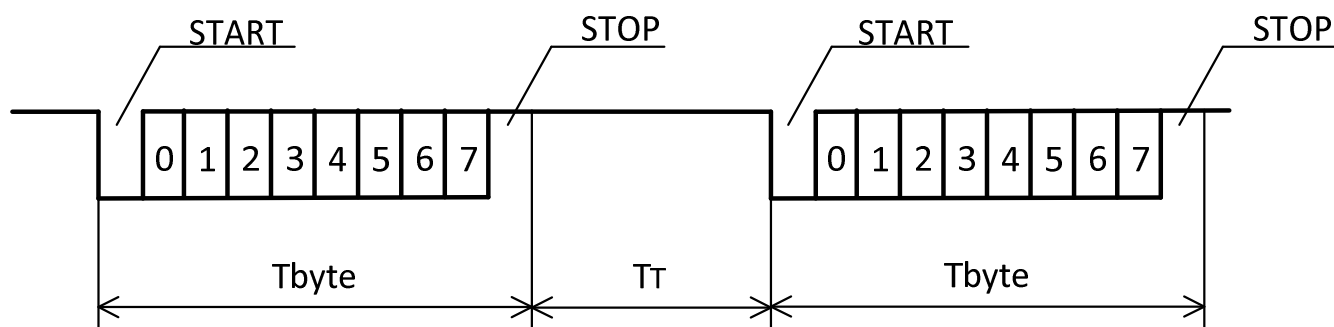


Fig. 1. Communications signal. Signal structure

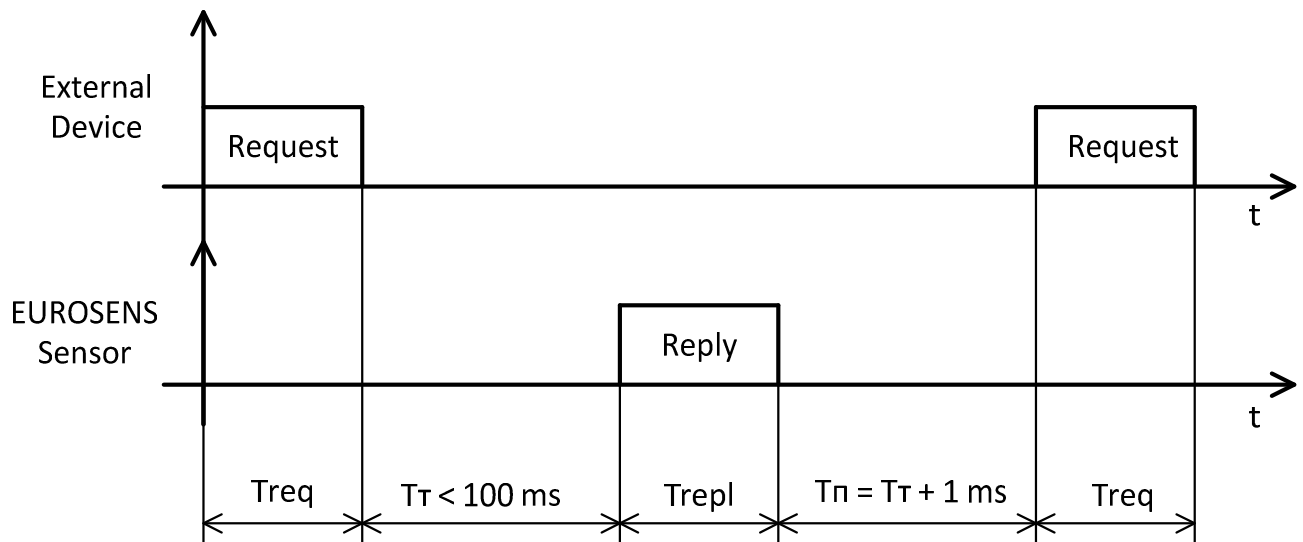


Fig. 2. Communications signal. Process structure of data communication

3.2 Description of commands for binary communications protocol

3.2.1 Message format for binary communications protocol

All commands of the binary communications protocol have the identical standardized view represented in table 1:

Tab. 1. Structure of the binary communications protocol

Index number of the field	Field name	Field size, Byte	Description
1	Prefix	1	The field is the beginning of message mark. The incoming messages have to have prefix 31h, the outgoing messages have to be generated by the program with the prefix 3Eh.
2	Network address	1	The field contains: -for prefix 31h - the network address of the message receiver; -for prefix 3Eh - the network address of the message sender.
3	Operation code	1	The field contains: -for prefix 31h - operation code, that needs to be fulfilled by the program; -for prefix 3Eh - operation code to which the response is sent.
4	Data	Depends on operation code	Data contents and field format depend on the operation code.
5	Check sum	1	The field is used for data continuity control. Calculation algorithm is given in the Appendix A.

3.2.2 Single data reading (command 46h)

The command serves to read the current data: fuel volume from the moment of sensor turning on, the current speed of flow, the status. Data are transferred by least significant byte first.

Command format:

Table.2. Structure of command of the binary data communications protocol

Shift, byte	Field size, byte	Value	Description
0	1	31h	Prefix
+1	1	00h...FFh	Network address of the recipient.
+2	1	46h	Operation code
+3	1	00h...FFh	Check sum

Command response format:

Table.3. Structure of response of the binary data communications protocol

Shift, byte	Field size, byte	Value	Description
0	1	3Eh	Prefix
+1	1	00h...FFh	Network address of the recipient.
+2	1	46h	Operation code.
+3	4	-2147483647... 2147483647	Fuel volume in 0.01 l. (character variable integer 32 bit)
+7	4	-2147483647... 2147483647	Flow speed in 0.1 l/h (character variable integer 32 bit)
+11	1	00h...FFh	Status (non-character variable byte, 8 bit)
+12	1	00h...FFh	Check sum.

The status field reads as follows:

Table.4. Status field structure (0 – non-active, 1 - active)

Bit number	Description
0	Current mode: idle run
1	Current mode: nominal mode.
2	Current mode: overload.
3	Current mode: cheating.
4	Current mode: negative.
5	Intervention.
6 - 7	Not in use.

3.2.3 Periodical data output (command 47h)

The command serves to turn on the periodical data output.

After command processing the sensor will start generate periodical data similar to command 46h with time interval set by command 53h. At zero value of an interval data aren't generated.

The periodical data output is switched off after receiving any reliable command, reset of the processor or shutdown of supply voltage if the mode of data output isn't set by default (art. 3.2.5).

The message format with data is represented in the table (Table 5). Data are transferred by least significant byte first.

Command format:

Tab. 5. Structure of command of the binary data communications protocol

Shift, byte	Field size, byte	Value	Description
0	1	31h	Prefix
+1	1	00h...FFh	Network address of the recipient.
+2	1	47h	Operation code
+3	1	00h...FFh	Check sum

Command response format:

Табл.6. Structure of response of the binary data communications protocol

Shift, byte	Field size, byte	Value	Description
0	1	3Eh	Prefix
+1	1	00h...FFh	Network address of the recipient.
+2	1	47h	Operation code
+3	1	00h	The command is successfully completed.
		01h	The command cannot be completed.
+4	1	00h...FFh	Check sum
+8	1	00h...FFh	Check sum

Format of periodically generated data:

Table.7. Structure of periodically generated data

Shift, byte	Field size, byte	Value	Description
0	1	3Eh	Prefix
+1	1	00h...FFh	Network address of the recipient.
+2	1	47h	Operation code
+3	4	-2147483647... 2147483647	Fuel volume in 0.01 l. (character variable integer 32 bit)
+7	4	-2147483647... 2147483647	Flow speed in 0.1 l/h (character variable integer 32 bit)
+11	1	00h...FFh	Status (similar to command 46h)
+12	1	00h...FFh	Check sum

3.2.4 Adjustment of periodical data output (command 53h)

The command serves for interval setting of periodical data output.

On command the sensor saves new value of an interval of data output in non-volatile storage.

At zero value of an interval data aren't generated.

Command format:

Tab. 8. Structure of command of the binary data communications protocol

Shift, byte	Field size, byte	Value	Description
0	1	31h	Prefix
+1	1	00h...FFh	Network address of the recipient.
+2	1	53h	Operation code.
+3	1	0...255	Period of data output in seconds
+4	1	00h...FFh	Check sum

Command response format:

Table.9. Structure of response of the binary data communications protocol

Shift, byte	Field size, byte	Value	Description
0	1	3Eh	Prefix
+1	1	00h...FFh	Network address of the recipient.
+2	1	53h	Operation code.
+3	1	00h	The command is successfully completed.
		01h	The command cannot be completed.
+4	1	00h...FFh	Check sum

3.2.5 Data output mode by default (command 57h)

The command determines an order of data output after power on or reset of the processor.

On command (Table 10) the program saves parameter in non-volatile storage and sends the response (Table 11) with results of command completion.

After power on or reset the program will periodically send data via the interface with time interval set by command 53h. At zero value of an interval data won't be generated.

Command format:

Tab. 10. Structure of command of the binary data communications protocol

Shift, byte	Field size, byte	Value	Description
0	1	31h	Prefix
+1	1	00h...FFh	Network address of the recipient.
+2	1	57h	Operation code
+3	1	00h	Data are not generated.
		01h	Data are generated binary.
		02h	Data are generated symbolically.
+4	1	00h...FFh	Check sum

Command response format:

Table.11. Structure of response of the binary data communications protocol

Shift, byte	Field size, byte	Value	Description
0	1	3Eh	Prefix
+1	1	00h...FFh	Network address of the recipient.
+2	1	57h	Operation code
+3	1	00h	The command is successfully completed.
		01h	The command cannot be completed.
+4	1	00h...FFh	Check sum

3.2.6 Single reading of extra data (command 58h)

The command serves for reading of extra data (Table 12). Data are sent by the least significant byte first.

Command format:

Table.12. Structure of command of the binary data communication protocol

Shift, byte	Field size, byte	Value	Description
0	1	31h	Prefix
+1	1	00h...FFh	Network address of the recipient.
+2	1	58h	Operation code
+3	1	00h...FFh	Code of interrogation data.
+4	1	00h...FFh	Check sum

Command response format:

Table.13. Structure of response of the binary data communications protocol

Shift, byte	Field size, byte	Value	Description
0	1	3Eh	Prefix
+1	1	00h...FFh	Network address of the recipient.
+2	1	58h	Operation code
+3	1	00h...FFh	Code of interrogation data. (Table 14)
+4	4	-2147483647... 2147483647	Field 1 (Table 14) (character variable integer 32 bit)
+8	4	-2147483647... 2147483647	Field 2 (Table 14) (character variable integer 32 bit)
+12	1	00h...FFh	Field 3 (Table 14) . (character or non-character variable byte, 8 bit)
+13	1	00h...FFh	Check sum

Extra data:

Table.14. Extra data

Code of interrogation data	Field 1 (character variable integer 32 bit)	Field 2 (character variable integer 32 bit)	Field 3 (variable byte, 8 bit)
00h	Fuel volume from the moment of sensor switch on in 0.01l.	Current flow speed in 0.1 l/h	Status (similar to command 46h) (non-character variable byte, 8 bit)
01h	Fuel volume of supply chamber from the moment of sensor switch on in 0.01 l.	Current flow speed of supply chamber in 0.1 l/h	Temperature of supply chamber in °C (character variable byte, 8 bit)
02h*	Fuel volume of return chamber from the moment of sensor switch on in 0.01 l.	Current flow speed of return chamber in 0.1 l/h	Temperature of return chamber in °C (character variable byte, 8 bit)
10h	Stored fuel volume in the idle run mode in 0.01 l.	Stored fuel volume in the nominal mode 0.01 l.	Not in use
11h	Stored fuel volume in the overload mode in 0.01 l.	Stored fuel volume in the cheating mode in 0.01 l.	Not in use
12h	Stored fuel volume in the negative mode in 0.01 l.	Not in use	Not in use
13h	Stored fuel volume of supply chamber in the idle run mode in 0.01 l.	Stored fuel volume of supply chamber in the nominal mode in 0.01 l.	Not in use
14h	Stored fuel volume of supply chamber in the overload mode in 0.01 l.	Stored fuel volume of supply chamber in the cheating mode in 0.01 л.	Not in use
15h*	Stored fuel volume of return chamber in the idle run mode in 0.01 l.	Stored fuel volume of return chamber in the nominal mode in 0.01 l.	Not in use
16h*	Stored fuel volume of return chamber in the overload mode in 0.01 l.	Stored fuel volume of return chamber in the cheating mode in 0.01 l.	Not in use
17h	Time in the idle run mode in sec.	Time in the nominal mode in sec.	Not in use
18h	Time in the overload mode in sec	Time in the cheating mode in sec.	Not in use
19h	Time in the negative mode in sec.	Not in use	Not in use
1Ah	Time of the supply chamber in the idle run mode in sec.	Time of the supply chamber in the nominal mode in sec.	Not in use
1Bh	Time of the supply chamber in the overload mode in sec.	Time of the supply chamber in the cheating mode in sec.	Not in use
1Ch*	Time of the return chamber in the idle run mode in sec.	Time of the return chamber in the nominal	Not in use

		mode in sec.	
1Dh*	Time of the return chamber in the overload mode in sec.	Time of the return chamber in the cheating mode in sec.	Not in use
1Eh	Time in the intervention mode in sec.	Sensor operation time in sec	Not in use
1Fh	Device serial Number	Not in use	Device type

* - These parameters are not used for sensors Direct.

3.3 Command description for symbol communications protocol

The communication under the symbol protocol involves reception and sending of sequence ASCII symbols perceived as interrogation and response commands.

3.3.1 Data reading

The command serves to read the current data: fuel volume from the moment of sensor turning on, the current flow speed and the status.

The command is a sequence of ASCII symbols of "D" and "O". After command "DO" is received the program will answer in the form of sequence of ASCII symbols.

For example, V=007B u=01F5 S=02 <cr> <lf> (at volume 1.23 l, flow speed 50.1 l/h and the nominal mode),

where V - accumulated fuel volume in 0.01 l (character variable integer 32 bits), u - current flow speed 0.1 l/h (character variable integer 32 bits), S – status (similar to command 46h) (non-character variable byte, 8 bits). All values are in hexadecimal form.

3.3.2 Periodical data output

The command serves to switch on the periodical data output. After command processing the sensor periodically delivers symbolical data (ASCII codes) similar to "DO".

Data are generated periodically with the interval set at sensor setup. In case data output interval is set to zero data won't be generated.

Activating the periodical data output is made by sending a line of symbols "DP". After command processing the line of symbols will be received.

For example, V=007B u=01F5 S=02 <CR><LF> (at volume 1.23 l, flow speed 50.1 l/h and the nominal mode),

where V - accumulated fuel volume in 0.01 l (character variable integer 32 bits), u - current flow speed 0.1 l/h (character variable integer 32 bits), S – status (similar to command 46h) (non-character variable byte, 8 bits). All values are in hexadecimal form.

Switching off periodic data output is made after receiving any reliable command, reset of the processor or shutdown of supply voltage.

3.3.3 CRC generation algorithm

To calculate CRC with polynom $a^8 + a^5 + a^4 + 1$ the following algorithm is used (language C):

```
U8 CRC8(U8 data, U8 crc)
{
    U8 i = data ^ crc;
    crc = 0;
    if(i & 0x01) crc ^= 0x5e;
    if(i & 0x02) crc ^= 0xbc;
    if(i & 0x04) crc ^= 0x61;
    if(i & 0x08) crc ^= 0xc2;
    if(i & 0x10) crc ^= 0x9d;
    if(i & 0x20) crc ^= 0x23;
    if(i & 0x40) crc ^= 0x46;
    if(i & 0x80) crc ^= 0x8c;
    return crc;
}
```

4. MANUFACTURING FACTORY AND TECHNICAL SUPPORT

4.1 Manufacturing factory

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