Protocol DUT-E COM

Version 3.7

1. Purpose

This protocol is used for data exchange with digital fuel level sensors DUT-E 232 and DUT-E 485 (further "sensors") developed by Technoton company. The protocol is valid for the sensors with firmware version 1.13 and later versions.

2. General info

On physical and channel layers, data exchange is carried out in accordance with standards ANSI/TIA-485-A and TIA/EIA 232-F.

In RS-485 bus-line the addressing is carried out over the sensor address. The factory setting of the address is the last 2 digits of the sensor serial number.

Only one device can be active on the bus-line, i.e. the idea "master-slave" is supported.

Inter-byte data interval of data exchange should not exceed 100 msec.

3. Session

There are two modes of data exchange (depending on the setting "mode of the periodic parameter delivery"):

1) Automatic data delivery. Delivery interval can be adjusted. At the factory sensors are set to this mode. Delivery interval is 60 seconds;
2) "Request-response" data exchange mode. The sensor works as a "slave". Time intervals shall be followed during the data exchange.

Table 1. Time intervals

Time intervals	**Min, ms**	**Max, ms**
Time between Request and Response	1	300
Time between Response and beginning of the next Request	3	500

4. Request

Table 2. Request structure

0x31	Adr	Fmt	Data	CS
1 byte	1 byte	1 byte	from 0 to 128 byte	1 byte

Adr field specifies the address of the sensor that has been requested.
The byte value of the address 255 means sending the request to all possible addresses.
Fmt field specifies the type of Request. Possible values are described in Table 4.
Possible field values **Data** are described in Table 4.
For calculation of checksum **CS,** please see chapter 6.

5. Response

Table 3. Response structure

0x3e	Adr	Fmt	Data	CS
1 byte	1 byte	1 byte	from 1 to 128 byte	1 byte

Adr field specifies the address of the sensor which sends the Response.
Fmt field specifies the type of Request for which the Response was given.
Possible field values **Data** are described in Table 4.
For calculation of checksum **CS,** please see chapter 6.

Table 4. Requests and Responses

№	Request					Response – field Data		
	Fmt		Data					
	Meaning	Description	Type	Description	Discreteness	Type	Description	Discreteness
1.	0x02	Reading of serial number	-	-	-	U32	Serial number	
2.	0x06	Reading of the filtered parameters[5)]	-	-	-	S8 S16 U16	Temperature [4)] The transmitted parameter • fuel level (0 .. 1000) • fuel level • fuel volume in the tank • fuel volume in the tank Current frequency of oscillator	1 °C 1 unit 0.1 mm 0.1 l 0.4 % 1 Hz
3.	0x1F[2)]	Reading of the non-filtered parameters	-	-	-	S8 S16 U16	Temperature [4)] The transmitted parameter • fuel level (0 .. 1000) • fuel level • fuel volume in the tank • fuel volume in the tank Current frequency of oscillator	1 °C 1 unit 0.1 mm 0.1 l 0.4 % 1 Hz
4.	0x05	Reading of the complete configuration	-	-	-	U32 U16 U16 S16 S8 U16 U16 U8 U8 U8	serial number (T_IDVU) max. calibration frequency min. calibration frequency Temperature correction coefficient k1 additional coefficient of temperature correction k2 not used not used sensor address in the network (T_NET_ADRES) not used not used	 1 Hz 1 Hz
5.	0x14[2)]	Reading of the filtration interval	-	-	-	U8	0..25	5 s
6.	0x26[2)]	Reading of the table of the tank calibration	-	-	-	S8 S8 S8 S8 struct{ U16 x; U16 y; }dim[30]	max. number of lines in the table (30) actual number of lines in the table (2..30) service field service field number of lines (x, y)	 0.1 mm 0.1 l
7.	0x1B[2)]	Reading of the time of firmware compilation	-	-	-	U8 dim[16]	Line	

№	Request					Response – field Data		
	Fmt		Data					
	Meaning	Description	Type	Description	Discreteness	Type	Description	Discreteness
8.	0x1A[2)]	Reading the date of firmware compilation	-	-	-	U8 dim[16]	Line	
9.	0x1C[2)]	Reading the firmware version	-	-	-	U8 dim[3]		
10.	0x23[1) 2)]	Reading the working parameters	-	-	-	S16 S16 U16 U32 U32 S16 S16 S16 S16 S16 S16 S16 S16 S16 S16 S16 U16 U8 U8 S16	fuel temperature electronic board temperature frequency of reference oscillator frequency of the measuring oscillator, initial frequency of the measuring generator, compensated not used height of fuel in conditional units not used not used not used fuel volume in the tank not used not used height of fuel in the sensor, initial height of fuel in the sensor, adjusted height of fuel in the sensor, filtered not used not used fuel volume in the tank in % of its volume not used	0.1 °C 0.1 °C 1 Hz 0.01 Hz 0.01 Hz 1 c.u. 0.1 l 0.1 mm 0.1 mm 0.1 mm 0.4 %
11.	0x1E[2)]	Reading the structure for the additional settings	-	-	-	U16 U8 U8 U8 U8	not used interval of parameter filtration (0..25) interval of automatic parameter delivery (0..255) periodic parameter delivery mode (0..3) parameter filtration mode (1-OFF/0-ON)	 5 s 1 s
12.	0x24[2)]	Reading the setting structure of output signal ranges	-	-	-	S16 S16 S16 S16 S16 S16 S16 U8 U8	max value for frequency output (1500) min value for frequency output (500) Max value of the fuel height Min value of the fuel height in the sensor max value of the fuel level in cond. units (1000) min value of the fuel level (0) not used parameter selection at frequency output (0 – cond. unit, 1 - l, 2 - mm, 3 -%) parameter selection on the digital interface	1 Hz 1 Hz 0.1 mm 0.1 mm 1 1

№	Request					Response – field Data		
	Fmt		Data					
	Meaning	Description	Type	Description	Discreteness	Type	Description	Discreteness
13.	0x15	Read the installer password	-	-	-	U8 dim[8]	Array of values with coded password	
14.	0x03[3]	Record the sensor address in the network	U8	0…254		U8	0x00 - without errors/0x01 - with error	
15.	0x0A[2] [3]	Record parameters of temperature correction	U16 S8	Coefficient k1 Additional coefficient k2		U8	0x00 - without errors/0x01 - with error	
16.	0x11[3]	Record filtration interval	U8	0…25	5 sec	U8	0x00 - without errors/0x01 - with error	
17.	0x13[3]	Record interval of automatic parameter delivery	U8	0..255	1 sec	U8	0x00 - without errors/0x01 - with error	
18.	0x17[3] [6]	Record the periodic parameter delivery mode after restart (power supply)	U8	• 0 – off • 1 – HEX • 2 – ASCII • 3 – ASCII EXT		U8	0x00 - without errors/0x01 - with error	

19.	0x34[6]	Read ASCII-EXT prefix and postfix	-	-	-	struct{
						U8 pre[30];
						U8 post[30];
						}
							Two lines of symbols, that end with "zero"	

20.	0x35[6]	Record ASCII-EXT prefix and postfix	struct{
			U8 pre[30];
			U8 post[30];
			}
				Two lines of symbols, that end with "zero"	-	U8	0x00 - without errors/0x01 - with error	

21.	0x27[2] [3]	Record the calibration table	S8 S8 S8 S8 struct{ U16 x; U16 y; }dim[30]	max. number of lines in the table (30) actual number of lines in the table (2 .. 30) 0x07 service field 0x00 service field number of lines (x, y).	 0.1 mm 0.1 l	U8	0x00 - without errors/0x01 - with error	

№	Request					Response – field Data		
	Fmt		Data					
	Meaning	Description	Type	Description	Discreteness	Type	Description	Discreteness
22.	0x0B[3)]	Record the minimum calibration frequency	U16	value of the minimal calibration frequency	1 Hz	U8	0x00 - without errors/0x01 - with error	
23.	0x0C[3)]	Record the maximum frequency of calibration	U16	value of the maximal calibration frequency	1 Hz	U8	0x00 - without errors/0x01 - with error	
24.	0x25[2) 3)]	Record the setting structure of output signal ranges	S16 S16 S16 S16 S16 S16 U8 U8	max value for frequency output (1500) min value for frequency output (500) Max value of the fuel height Min value of the fuel height in the sensor max value of the fuel level in cond. units (1000) min value of the normalized fuel level (0) not used parameter selection at frequency output (0 – cond. unit, 1 - l, 2 - mm, 3 - %) parameter selection on the digital interface	1 Hz 1 Hz 0.1 mm 0.1 mm 1 1	U8	0x00 - without errors/0x01 - with error	
25.	0x16[3)]	Record the installer password	U8 dim[8]	Array of values with coded password	-	U8	0x00 - without errors/0x01 - with error	
26.	0x12[3)]	Set the access level of the installer (valid for 3 seconds if there are no requests)	U8 dim[8]	Array of values with coded password	-	U8	0x00 - without errors/0x01 - with error	
27.	0x07[3)]	Switch on the periodic parameter delivery. Delivery stops when the device receives any other valid request or if power is switched off.	-	-	-	U8	0x00 - without errors/0x01 - with error	

№	Request					Response – field Data		
	Fmt		Data					
	Meaning	Description	Type	Description	Discreteness	Type	Description	Discreteness
28.	0x08[3)]	Calibrate to minimum	-	-	-	U8	0x00 - without errors/0x01 - with error	
29.	0x09[3)]	Calibrate to max	-	-	-	U8	0x00 - without errors/0x01 - with error	
30.	0x1D[2) 3)]	Start firmware download	-	-	-	U8	0x00 - without errors/0x01 - with error	

1) For DUT-E built on IoT Burger Technology (firmware version 1.14 and higher) only those requests are applicable.

2) Only for the sensors DUT-E with firmware version 1.5 and later versions.

3) Required the access level of the installer. Algorithm for access is transferred under the "Confidential information Agreement".

4) If an error is detected in the sensor operation, the malfunction code is transmitted in the temperature field (see Table 5 and 5a).

5) Filtered parameters are the parameter values processed by filtration function within the adjustable interval.

6) Mode – ASCII EXT is available only for DUT-E with firmware version 2.8 and later versions.

Types:

U8	- unsigned	8 bit value
S8	- signed	8 bit value
U16	- unsigned	16 bit value
S16	- signed	16 bit value
U32	- unsigned	32 bit value
S32	- signed	32 bit value

Table 5. Malfunction codes for the sensor microprogram version lower than v2.9.

Malfunction code	Malfunction description
255	Sensor is not calibrated to the minimum or maximum (difference between the calibration frequencies of the measurement oscillator at minimum and maximum levels of fuel less than 100 Hz).
254	Sensor is not calibrated to maximum of fuel level.
253	The measurement oscillator is out of order in the sensor, possible the short circuit of the sensor measuring tubes.
252	Calibration values for minimum and maximum fuel levels in the sensor differ by less than 5 Hz.
251	Error EEPROM. Hardware failure of the sensor.
250	The current frequency of the measurement oscillator is more than the set frequency by calibration for minimum (difference of more than 100 Hz).

Table 5a. Malfunction codes for the sensor microprogram version v 2.9 and more updated versions.

Malfunction code	Malfunction description
128 (-128)	Sensor is not calibrated to the minimum or maximum (difference between the calibration frequencies of the measurement oscillator at minimum and maximum levels of fuel less than 100 Hz).
129 (-127)	Sensor is not calibrated to maximum of fuel level.
130 (-126)	The measurement oscillator is out of order in the sensor, possible the short circuit of the sensor measuring tubes.
131 (-125)	Calibration values for minimum and maximum fuel levels in the sensor differ by less than 5 Hz.
132 (-124)	Error EEPROM. Hardware failure of the sensor.
133 (-123)	The current frequency of the measurement oscillator is more than the set frequency by calibration for minimum (difference of more than 100 Hz).
134 (-122)	The current frequency of the measurement oscillator is less than the set frequency by calibration for minimum (difference of more than -50.00 Hz).

6. Checksum

The checksum is calculated for all byte of the message (excluding the checksum) over a polynomial a^8+a^5+a^4+1.

For calculation of CRC you can use the following algorithms (language C):

1)

```
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;
}
```

2)

```
U8 CRC8 (U8 b, U8 crc)
{
  U8 i = 8;
  do {
    if ( (b ^ crc) & 0x01) {
      crc = ( (crc ^ 0x18) >> 1 ) | 0x80;
    } else {
      crc >>= 1;
    }
    b >>= 1;
  } while (--i);
  return crc;
}
```

3) Table method described in Dallas APPLICATION NOTE 27: Understanding and Using Cyclic Redundancy Checks with Dallas Semiconductor iButton Products.