SICK
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LSI/PLS

Definition of telegrams between the user interface and LSI or PLS system via RS 422/RS 232

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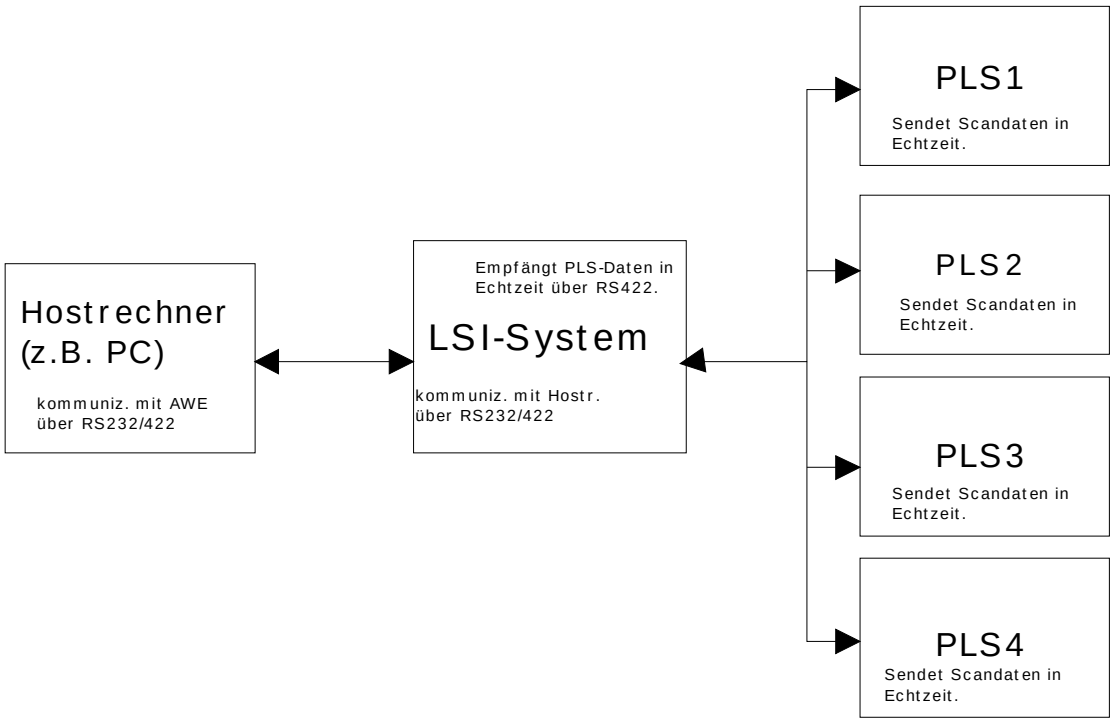
1 LSI system description

The LSI is the evaluation component for the measured distance values created by the PLS.
The LSI receives the PLS data via an asynchronous serial interface in real time so that each scan by the LSI can be processed.
A maximum of 4 PLS can be connected to one LSI.
Up to 8 protective fields and 8 warning fields are managed in the LSI; these can be allocated to any PLS.

For diagnosis, parametering and configuration, the LSI has a second asynchronous serial interface, via which data can be transmitted to a superior host computer.
The following telegram descriptions relate to this LSI / host interface.

The maximum configuration of an LSI system is shown in the following diagram:



Information regarding the connected PLS can be received by targeted addressing via the LSI.
The most important telegrams which can be transferred to the PLS via LSI are:

- STATUS REQUEST
- READ OUT ERROR MEMORY
- INITIALIZATION (SW RESET)
- REQUEST MEASUREMENTS
- TEST REQUEST
- READ OUT MEMORY

A significant difference to operation with the PLS as a stand-alone unit is that the outputs of the entire system switch to red with every communication with the PLS.
The LSI must therefore first be switched to the setup or diagnosis mode before data can be requested and received from the PLS.
This is because the LSI processes the measured values in real-time. If the host requests communication the LSI can no longer process in real-time.

The PLS-specific telegrams are referred to in the detailed telegram description.
Protective and warning fields are labeled in an index and can therefore be received / transmitted clearly from / to the LSI.

2 Definition of the LSI interface to the host

2.1 Electrical interface:

The electrical interface can be implemented either in accordance with EIA RS-422-A or EIA RS-232-C.

2.2 Transfer and data format:

The baud rate of the LSI is variable and can be set to the following:

- 38400 baud
- 19200 baud
- 9600 baud

In the delivery state the LSI is configured with a baud rate of 9600 baud.
The baud rate can be reconfigured via the interface. The corresponding telegram is described in more detail in the telegram description chapter entitled "Changing the operating mode".
The baud rate after PowerON is 9600 baud as standard.
However, the LSI can be configured in such a way that the baud rate defined by the user remains set after PowerON. For further information, please refer to the telegram description "Defining a permanent baud rate".
A data byte comprises 1 start bit, 8 data bits, 1 parity bit with even parity or without parity bit (depending on variant) and 1 stop bit.

Table: LSI variants and parity used:

	No parity	Even parity
Variant **LSI** safe		X

Predefined telegrams are available for communication via the serial interface of the LSI to the host.
The data is transferred in binary format.
The transfer procedure is initiated by STX (02h).
The data is transferred in INTEL data format, i.e. the word transfer takes place with the lower address and the least significant byte first followed by the high byte on the high address.

The evaluation unit of the LSI data is referred to below as HOST.

2.3 Telegram structure:

STX	ADR	Len		CMD	Data ...		Status	CRC

Designation	Data width [bits]	
STX	8	Start byte (02h)
ADR	8	Address of subscriber The exact address division can be found in the table below. The LSI adds the value 80h to the address when it responds to the HOST. With the PLS connected, the address used by the host is encoded with 0x80. The behavior with the channel addresses 0x7e and 0x7f is the same.
Len	16	Number of following bytes excluding CRC.
CMD	8	Command byte from the HOST to LSI. When the LSI responds to the HOST, it adds the value 80h to the original command.
Data	n x 8	Optional, depends on previous command.
Status	8	Optional, the LSI transmits its status message only when it transfers the data to the HOST. The HOST does not transmit a status message to the LSI.
CRC	16	CRC checksum for the entire data package. Algorithm is described below.

Table for address administration of LSI and connected PLS

Unit addressed	***ADDRESS***
Broadcast LSI, always values from channel 1	**0**
PLS 1	**1**
PLS 2	**2**
PLS 3	**3**
PLS 4	**4**
Individual addresses of LSI	**5**
...	**...**
Individual addresses of LSI	**0x7E**
Broadcast LSI channel 2	**0x7F**

Transfer reliability:

- Byte reliability via parity bit, even parity (depends on variant).
- Block reliability via block check at the end of the telegram with a CRC checksum over the entire data package with CRC 16 generator polynomial.

Time conditions:

- A time interval of max. 6 msec. must not be exceeded between 2 bytes within a telegram, otherwise a time-out is detected. The telegram which has started is then ignored.
- The response to a command sent from the HOST must take place within a certain reply time which depends on the requested telegram.
- The maximum response time for a request for the current measured values of a scan is 60 ms. The response to an operating mode change can take up to 3 seconds.
- The host is the communication master.
- A request from the host always interrupts data transfer from the sensor.
- A software handshake is initiated by the sensor when a correct request is received with ACK(06H). The sensor responds with NAK(15H) if an error is detected.
- The PLS sensor remains silent if the address is incorrect.
  The sensor responds with NACK if the address is correct but the checksum incorrect.
  The sensor responds with ACK if both the address and checksum are correct.
- The LSI system always responds with NACK if the checksum is incorrect.
  The LSI responds with ACK if the checksum is correct.
  The LSI responds with NACK if the address is incorrect.
- The maximum response time of the sensor for NACK or ACK is 60 msec.

Example:

For the sake of simplicity, only a concrete request from the HOST and the response from the **LSI** are described here:

Request from HOST to LSI*:*
Transfer the current measured values of the active PLS

STX	0x00	0x002	0x30	0x01	CRC

STX Start character for start of transmission
0x00 LSI address, here BROADCAST address
0x02 Two data bytes follow
0x30 Command for measured value request
0x01 Mode for all 361 measured values from the current scan
CRC CRC 16 checksum

LSI response: if received correctly within 60 msec.

ACK

LSI response: if not received correctly within 60 msec.

NAK

LSI response: *All measured values from a scan* within 60 msec.

STX	0x85	0x2d6	0xb0	0x0169	0x01	...	0x169	0x00	CRC

STX Start character for start of transmission
0x85 Host address; comprises the **LSI** address + 0x80.
In this case the individual address of the **LSI** is 0x05.
0x2d6 Telegram length: 726 bytes follow
0xb0 Command for transferring the measured values
0x169 Number of measured values transferred: 361 measured values from the current scan
0x01 1st measured value as unsigned integer.
.
0x169 361st measured value as unsigned integer.
0x00 **LSI** status, information on various internal system states
CRC CRC 16 checksum

2.3.1 Structure of LSI status byte

The status byte comprises 8 bits.

Bit 0 A combination of bits 0, 1 and 2 produces the values 0 o 4 and must
Bit 1 be evaluated as follows:
Bit 2

value	Meaning
0	No error
1	Information
2	Warning
3	Error
4	Fatal Error

Bit 3 The LSI always transfers 1 as the data source. 0 is the data source for the PLS . The host therefore has feedback on the origin of the Data.
Bit 4 TBD
Bit 5 TBD
Bit 6 Measured values not plausible
Bit 7 Contamination

2.3.2 Structure of PLS status byte

The status byte comprises 8 bits.

Bit 0 A combination of bits 0, 1 and 2 produces the values 0 o 4 and must
Bit 1 be evaluated as follows:
Bit 2

value	Meaning
0	No error
1	Information
2	Warning
3	Error
4	Fatal Error

Bit 3 The LSI always transfers 1 as the data source. 0 is the data source for the PLS . The host therefore has feedback on the origin of the data.
Bit 4 TBD
Bit 5 TBD
Bit 6 Measured values not plausible
Bit 7 Contamination

2.4 Formation of the CRC16 checksum

```
/************************************************************
FUNCTION
Signature formation via CRC16 generator polynomial
unsigned int build_crc16 (unsigned char *data_ptr, unsigned int len)

DESCRIPTION
   Forms the checksum with CRC16_GEN_POL
   The following algorithm is used for a 16 bit checksum via the byte-oriented
   buffer:
   CRC_sum[High-BYTE] = CRC_sum[Low-BYTE]
   CRC_sum[Low-BYTE] = new data-BYTE
   Formation of 16 bit CRC via CRC_sum

The following generator polynomial is used: x^16 + x^15 + x^2 + 1
CRC16_GEN_POL          EQU 8005H      ;
This constant corresponds to x^15 + x^2 + 1,  x^16 is in the CARRY flag
************************************************************/
unsigned int build_crc16 (unsigned char *CommData, unsigned int uLen)
{
unsigned int uCrc16 = 0; /* Signature register */
unsigned int crc_data = 0; /* Current date */
static register unsigned int reg_len = uLen;
unsigned char *reg_data_ptr; /* Pointer to transferred data */

  reg_data_ptr = CommData; /* Load transfer values from stack to register RAM */

/* CRC16 Calculate checksum */
CONT_CRC16:
    asm SHL   crc_data, #8; /* Shift low byte to high byte */
    asm LDB   crc_data, [reg_data_ptr]+; /* Load next byte and auto-increment */
    asm SHL   uCrc16, #1; /* Shift signature register one place to the left */
    asm BNC   NO_CARRY_SET; /* Request for set CARRY flag */
    asm XOR   uCrc16, #CRC16_GEN_POL; /* If CARRY set, XOR with gen. polynomial*/
NO_CARRY_SET:
    asm XOR   uCrc16, crc_data; /* XOR of current item of data with signature reg. */
    asm DEC   reg_len; /* Continue loop until all data processed */
    asm BNE   CONT_CRC16;
END_CRC16:
    return (uCrc16); /* Return value is CRC16 checksum of data flow */
}
```

Depending on the implementation, in ANSI C this function is as follows:

```
#define CRC16_GEN_POL  0x8005
#define MKSHORT(a,b)   ((unsigned short) (a) | ((unsigned short)(b) << 8))
/* ::---------------------------------------------------------------------
:: FN: CreateCRC; CRC in  ANSI - C
:: Synopsis: static void CreateCRC(BYTE *CommData,UINT uLen)
:: Function: Formation of CRC16 checksum.
---------------------------------------------------------------------*/
static UINT  CreateCRC(unsigned char *CommData, unsigned int uLen )
{
unsigned short uCrc16:
unsigned char abData[2];

   uCrc16 = 0;
   abData[0] =  0;
   while (uLen-- )
   {
      abData[1] = abData[0];
      abData[0] = *CommData++;
      if(uCrc16 & 0x8000)
      {
         uCrc16  = (uCrc16 & 0x7fff) << 1;
         uCrc16 ^= CRC16_GEN_POL;
      }
      else
      {
         uCrc16 <<= 1;
      }
      uCrc16 ^=  MKSHORT (abData[0] , abData[1]);
   }
   return(uCrc16);
}
```

3 Description of the telegrams implemented

3.1 Data direction host -> sensor

The telegram numbers 0x00 to 0x0F are reserved for internal LSI telegrams.

3.1.1 Start sequence for download in the flasheprom (LSI only) (0BH)

Telegram number: 0BH (STARTDOWNL_TGM)	
Transfer parameters:	
Start sequence Data type: BYTE[4]	33H, 44H, 55H, 66H
Description: Signals to the LSI that the flasheprom data is loading **The LSI response is only ACK.** **ONLY POSSIBLE AFTER RESET TELEGRAM OR LSI BOOTING**	

3.1.2 Download data for the flasheprom (LSI only) (0CH)

Telegram number: 0CH (DOWNL_TGM)	
Transfer parameters:	
CMD Data type: BYTE	00: Sequence block 01: End block
ADR Data type: LONG	32 bit address: 1. ADR LOW WORD LOW BYTE 2. ADR LOW WORD HIGH BYTE 3. ADR HIGH WORD LOW BYTE 4. ADR HIGH WORD HIGH BYTE
DATA Data type: Byte	Maximum 80H data bytes
Description: Data for the LSI to load the flasheprom. **The LSI response is only ACK.** **ONLY POSSIBLE AFTER RESET TELEGRAM OR LSI BOOTING**	

3.1.3 Initiating and reset (PERMITTED for PLS and LSI)

Telegram number: 10H (INIT_TGM)
Transfer parameters: None
Description: Initialization of sensor has same effect as a hardware reset. The configured warning and protective fields still remain active. The error memory is cleared. There is no history memory for the errors which have occurred. The direct LSI response to this telegram is 091H (INIT_ACK_TGM). After 2 - 3 seconds the response 090H (PWON_TGM) is transmitted with the PowerOn string if the LSI has been booted.

3.1.4 Selecting and changing the operating mode

Telegram number: 20H (BM_TGM)
Transfer parameters: Mode; Password string

Mode DATA TYPE: BYTE	Mode: 00H -- > Setup mode for configuring the protective field and sensor parameters. 01H -- > Balancing mode of LSI. It is only necessary to select this mode for the three balancing routines. 02H -- > Reset to default password in order to set up and maintain the PF. The default password is "SICK_LSI". NOT POSSIBLE IN MONITORING MODE. The diagnosis mode should be selected first. 10H -- > Diagnosis mode: Mode for executing individual tests. 20H -- >Monitoring mode: min. measured values per segment are output continuously. 21H -- > Monitoring mode: min. measured values per segment are only output on request. If an object is detected in the WF or PF the measured values are output for each scan. 22H -- >Monitoring mode: minimum vertical distance from sensor is output continuously**. Only possible with rectangular PF.** 23H -- > Monitoring mode: minimum vertical distance from sensor is only output on request. With INTERVENTION the minimum distance is output for every scan. **Only possible with rectangular PF.** 24H -- > Monitoring mode: all of the measured values of a scan are output continuously. 25H -- > Monitoring mode: measured values are only output on request, no data with protective field violation. 30H -- > Setup password test. The protective field monitoring function remains active. 31H -- > Superuser password test. The protective field monitoring function remains active. 32H -- > Maintenance password test. The protective field monitoring function remains active. 40H -- > Configuration for 38400 baud. 41H -- > Configuration for 19200 baud. 42H -- > Configuration for 9600 baud. 43H -- > Configuration for 58000 baud. 44H -- > Configuration for 111111 baud. 45H -- > Configuration for 200000 baud. 46H -- > Configuration for 250000 baud. 47H -- > Configuration for 333333 baud. 48H -- > Configuration for 500000 baud.

Password string	Mode 00H: Password string 1 (setup password): String with length 8 comprising '0'-'9', 'a'-'z', 'A'-'Z' and '_'. This password must be defined by the user and can be changed as often as required. Mode 01H: Password string 3 (Superuser password): String with length 8 comprising '0'-'9', 'a'-'z', 'A'-'Z' and '_'. This password is only known by Sick, the system may only be balanced by Sick. Mode 02H: Password string 2 (Init-Password): String with length 8. This password is derived from the serial number and is stored in the EEPROM. The serial number is an 8-digit number. The algorithm for converting the code is only known by SICK. Mode 10H: PW string not required Mode 20H: PW string not required Mode 21H: PW string not required Mode 22H: PW string not required Mode 23H: PW string not required Mode 24H: PW string not required Mode 25H: PW string not required Mode 30H: Password string 1 (setup password): String with length 8 comprising '0'-'9', 'a'-'z', 'A'-'Z' and '_'. This password must be defined by the user and can be changed as often as required. Mode 31H: Password string 3 (Superuser password): String with length 8 comprising '0'-'9', 'a'-'z', 'A'-'Z' and '_'. This password is only known by SICK, the system can only be balanced by SICK under defined conditions. Mode 32H: Password string 4 (maintenance password): String with length 8 comprising '0'-'9', 'a'-'z', 'A'-'Z' and '_'. This password must be defined by the user and can be changed as often as required. Mode 40H, 41H, 42H, 43H, 44H, 45H, 46H, 47H and 48H PW string not required.
Description:	After a reset, monitoring mode 21H is active as standard. The LSI only enables its outputs in modes 20H, 21H, 22H, 23H, 24H and 25H. The diagnosis mode should be selected before the password is reset. The baud rate can only be changed in mode 00H or 01H, i.e. first transmit BM_TGM with mode 00H or 01H and then BM_TGM with parameters 40H to 48H.

3.1.5 Measured value request

Telegram number: 30H (MWANF_TGM) **(PERMITTED FOR PLS AND LSI)**	
Transfer parameters: PLS No., Mode, (Modes 00, 02 and 05H only) SegmNo. or field number	
PLS No. DATA TYPE: BYTE **LSI ONLY**	00H > Measured values of PLS currently active 01H > Measured values of PLS1 02H > Measured values of PLS2 03H > Measured values of PLS3 04H > Measured values of PLS4 11H > Measured values of PLS1 raw value 12H > Measured values of PLS2 raw value 13H > Measured values of PLS3 raw value 14H > Measured values of PLS4 raw value
Mode DATA TYPE: BYTE	00H > Only send minimum measured value per segment. Possible number of measured values: 9, 10, 15, 18, 30, 45, 90 and 180. 01H > Send all 361 measured values of a scan. 02H > Send minimum vertical distance from sensor. 1 measured value is sent. Only possible with rectangular PF. 03H > Send taught-in data, 361 measured values 04H > Send verification data, 361 measured values 05H > Send minimum measured value for defined number of segments.
No. of segments with mode 5 Field No. with mode 0, 2, 3 and 4 **LSI ONLY** Field number DATA TYPE: BYTE	Mode 5: Possible number of measured values: 9, 10, 15, 18, 30, 45, 90 and 180. MODE 0, 2, 3 and 4: Field number **LSI ONLY**

Description: The form in which the LSI supplies the measured values to the user is defined here.
If the minimum measured value per segment is requested from the sensor, the number of measured values which are to be transferred are specified by the following algorithm:
1.) If both protective fields are stored in segmented form, the number of measured values corresponds to the highest number of segments in the protective or warning field.
2.) If the protective field is radial or rectangular, the number of measured values corresponds to the number of segments in the warning field.
PLS and **LSI** are differentiated by means of addressing.
I.e. If the **LSI** is addressed, the measured values of the PLS which is currently active are transferred or the values of the PLS which is identified by the PLS No..
If the measured values are requested from one of the connected PLS, they are obtained via the specific PLS address 1 - 4 (only possible in setup or diagnosis mode).

3.1.6 Sensor status request (PERMITTED for PLS and LSI)

Telegram number: 31H (SSANF_TGM)
Transfer parameters: None
Description: See sensor status. PLS and **LSI** are differentiated by means of addressing.

3.1.7 Error telegram request (PERMITTED for PLS and LSI)

Telegram number: 32H (ERRANF_TGM)
Transfer parameters: None
Description: See Error / test telegram. PLS and LSI are differentiated by means of addressing.

3.1.8 Test in diagnosis mode request (PERMITTED for PLS and LSI)

Telegram number: 33H (TSTANF_TGM)
Transfer parameters: Test number DATA TYPE: BYTE
Description: See Error / test telegram. PLS and LSI are differentiated by means of addressing.

3.1.9 Memory dump request (PERMITTED for PLS and LSI)

Telegram number: 34H (MEMANF_TGM)	
Transfer parameters: Start address DATA TYPE: LONG with LSI, UNIT with PLS Length of data byte to be read DATA TYPE: BYTE	
Start address DATA TYPE: LONG with LSI UNIT with PLS	Start address of memory dump
Number n of data bytes 1 DATA TYPE: BYTE	Number n of transferred data bytes; n is limited to 0xFF bytes.
Description: See memory dump telegram. PLS and LSI are differentiated by means of addressing.	

3.1.10 LSI configuration request

Telegram number: 38H (LSIKFGANF_TGM)
Transfer parameters: None
Description: The saved **LSI** hardware configuration is requested.

3.1.11 MF definitions request

Telegram number: 39H (UWFANF_TGM)
Transfer parameters: MF number
Description: An MF definition is requested for a specific MF number.

3.1.12 Configure the safe protective field (permitted only in setup or balancing mode)

Telegram number: 40H (BSFKFG_TGM)	
Transfer parameters: Mode; PF No., PF name, **LSI ONLY** Minute, Hour, Day, Month, Year RADIUS; EXP or LI, RE, HO, EXP or segment data, EXP.	
PF Number DATA TYPE: BYTE **LSI ONLY**	Number of protective field varies between 1 and 8.
PF Name DATA TYPE: CHAR[8] **LSI ONLY**	Name for the protective field consists of 8 ASCIII characters.
Mode DATA TYPE: BYTE	00H Rectangular PF 01H Radial PF (semicircle with radius R) 02H Segmented PF (as configuration WF)
Minute DATA TYPE: BYTE	Range from 0 to 59
Hour DATA TYPE: BYTE	Range from 0 to 23
Day DATA TYPE: BYTE	Range from 1 to 31
Month DATA TYPE: BYTE	Range from 0 to 11, January is 0.
Year DATA TYPE: UNIT	Range from 95 to max. of UNIT Corresponds to current year minus 1900.
RADIUS DATA TYPE: UNIT	Radius of PF semicircle
or LI DATA TYPE: UNIT	Distance (left) from sensor in cm.
RE DATA TYPE: UNIT	Distance (right) from sensor in cm.

HO DATA TYPE: UNIT	Height of rectangle, viewed from sensor, in cm.
or segment data	AS, EP[1] to EP[AS+1]
AS DATA TYPE: BYTE	Number of segments - variable between 9 and max. 360. The number must be an integral divisor of 180 and for a sensor aperture angle of 180 °. 0xfe is transferred with 360 segments.
EP[1] DATA TYPE: UNIT	Radius for the corner point [1] in units of 1 cm.
:	:
EP[AS+1] DATA TYPE: UNIT	Radius for the corner point [AS+1] in units of 1 cm.
EXP DATA TYPE: UNIT	XOR checksum of the expanded values for the 361 measuring points.
Description: Configuration of the safe protective field via three corner points of a rectangle with distance left and right and height viewed from the sensor. The expanded checksum ensures reliable transfer as the LSI calculates and returns the checksum in accordance with the same algorithm. The second configuration option is the radius specification for a semicircle as PF. The third option is similar to the configuration of a warning protective field. Between 9 and max. 180 segments or 10 to max. 181 segment points can be specified. These are connected by means of approximated straight lines. The default PF is a semicircle with a radius of 4 meters (in versions 04.xx of 50 meters.)	

The following table and calculations must be used for the expansion algorithm:

```
/*********************************************************************/
#define TAN_OF          0xFFFF    /* Overflow value for the tangent; unsigned int */
#define TAN_NORM          512     /* Scaling factor for the tangent table */
#define COS_NORM          4096    /* Scaling factor for the cosine table */
#define MESS_PRO_SCAN   361       /* 361 measurements per scan */

/* Table for COSINE (Alpha)*COS_NORM from 0° to 90°, with 0.5° Delta */
static const unsigned int cos_tab[181] =
                        {4096, 4096, 4095, 4095, 4094, 4092, 4090, 4088, 4086, 4083,
                         4080, 4077, 4074, 4070, 4065, 4061, 4056, 4051, 4046, 4040,
                         4034, 4027, 4021, 4014, 4006, 3999, 3991, 3983, 3974, 3966,
                         3956, 3947, 3937, 3927, 3917, 3906, 3896, 3884, 3873, 3861,
                         3849, 3837, 3824, 3811, 3798, 3784, 3770, 3756, 3742, 3727,
                         3712, 3697, 3681, 3666, 3650, 3633, 3617, 3600, 3582, 3565,
                         3547, 3529, 3511, 3492, 3474, 3455, 3435, 3416, 3396, 3376,
                         3355, 3335, 3314, 3293, 3271, 3250, 3228, 3206, 3183, 3161,
                         3138, 3115, 3091, 3068, 3044, 3020, 2996, 2971, 2946, 2921,
                         2896, 2871, 2845, 2820, 2793, 2767, 2741, 2714, 2687, 2660,
                         2633, 2605, 2578, 2550, 2522, 2493, 2465, 2436, 2408, 2379,
                         2349, 2320, 2290, 2261, 2231, 2201, 2171, 2140, 2110, 2079,
```

```
                                2048, 2017, 1986, 1954, 1923, 1891, 1860, 1828, 1796, 1763,
                                1731, 1699, 1666, 1633, 1600, 1567, 1534, 1501, 1468, 1434,
                                1401, 1367, 1334, 1300, 1266, 1232, 1198, 1163, 1129, 1095,
                                1060, 1026,  991,  956,  921,  887,  852,  817,  782,  746,
                                 711,  676,  641,  605,  570,  535,  499,  464,  428,  393,
                                 357,  321,  286,  250,  214,  179,  143,  107,   71,   36,
                                 1 };
/*****************************************************************/
/* Table for TANGENT (Alpha)*TAN_NORM from 0° to 89.5° with 0.5° Delta;
   The scaled values for the tangent are too large from 89.5° onwards.
   The values are therefore rounded off with 0xFFFF = 65535 */
static const unsigned int tan_tab[181] =
                               {  0,   4,   9,  13,  18,  22,  27,  31,  36,  40,
                                 45,  49,  54,  58,  63,  67,  72,  77,  81,  86,
                                 90,  95, 100, 104, 109, 114, 118, 123, 128, 132,
                                137, 142, 147, 152, 157, 161, 166, 171, 176, 181,
                                186, 191, 197, 202, 207, 212, 217, 223, 228, 233,
                                239, 244, 250, 255, 261, 267, 272, 278, 284, 290,
                                296, 302, 308, 314, 320, 326, 332, 339, 345, 352,
                                359, 365, 372, 379, 386, 393, 400, 407, 415, 422,
                                430, 437, 445, 453, 461, 469, 477, 486, 494, 503,
                                512, 521, 530, 540, 549, 559, 569, 579, 589, 599,
                                610, 621, 632, 644, 655, 667, 679, 692, 705, 718,
                                731, 745, 759, 774, 788, 804, 819, 836, 852, 869,
                                887, 905, 924, 943, 963, 984, 1005, 1027, 1050, 1073,
                               1098, 1123, 1150, 1178, 1206, 1236, 1267, 1300, 1334, 1369,
                               1407, 1446, 1487, 1530, 1576, 1624, 1675, 1728, 1786, 1846,
                               1911, 1980, 2054, 2133, 2218, 2309, 2409, 2517, 2634, 2763,
                               2904, 3060, 3233, 3426, 3643, 3889, 4170, 4494, 4871, 5317,
                               5852, 6506, 7322, 8371, 9770,11727,14662,19552,29332,58669,
                               TAN_OF };
/*****************************************************************/
/*******************************************************
:: Function: Formation of the expanded checksum for the protective field.
*******************************************************/
static void  CreateExpandChecksum(UINT uSchutzfeldTyp)
{
    UINT uRadius /* Radius supplied by the user */
    UINT uHoehe /* Rectangle height supplied by the user */
    UINT uRechtsabstand /* Right-hand distance of rectangle from sensor supplied by the user */
    UINT uLinksabstand /* Left-hand distance of rectangle from sensor supplied by the user */
    UINT cbAnzahlSegmente /* Number of segments supplied by the user */
    UINT auEckpunkt[cbAnzahlSegmente+1] /* Array of configured corner points
                                           supplied by the user */
        DWORD tan_alpha = 0; tan_beta = 0;
        UINT  alpha = 0; beta = 0;
        UINT Messwertzaehler = 0; Messungen_pro_Segment = 0;
        UINT seg_point_1 = 0; seg_point_2 = 0;
        UINT segment_cnt = 0;
        UINT index = 0; delta = 0;
        UINT SF_distanz = 0; SF_distanz2 = 0;

  switch(uSchutzfeldTyp)
  {
    /* In the case of a semicircle, the expanded checksum is equal to the supplied radius */
    case SCHUTZFELD_HALBKREIS:
```

```
    uExpandChecksum =   uRadius;
   break;

 case SCHUTZFELD_RECHTECK:
      /* !!! Important !!!; Sensor turning anti-clockwise => scan begin right */
      /* Determine the two limit angles alpha and beta; As in table, TAN_NORM is also */
      /* used here for scaling. Intercept tangent overflow */
   tan_alpha =((unsigned long)( uHoehe) * TAN_NORM) / (unsigned long)   uRechtsabstand ;
   if ( tan_alpha >= TAN_OF )          tan_alpha = TAN_OF;
   alpha = 0;
   while ( (tan_alpha > tan_tab[alpha]))          alpha ++;

   tan_beta =  ((unsigned long) uHoehe * TAN_NORM) / ((unsigned long)   uLinksabstand ) ;
   if ( tan_beta >= TAN_OF )          tan_beta = TAN_OF;
   beta = 0;
   while ( (tan_beta > tan_tab[beta]))          beta ++;

   /* Expansion algorithm for rectangle */
   uExpandChecksum = 0;
   for (Messwertzaehler = 0; Messwertzaehler < MESS_PRO_SCAN; Messwertzaehler++)
   {
     if (Messwertzaehler < alpha)
       {
       SF_distanz = (unsigned int) (((unsigned long) uRechtsabstand * COS_NORM) /
                   (unsigned long)(cos_tab[Messwertzaehler]) );
       }
     else if  ( (Messwertzaehler == alpha) )
       {
       SF_distanz = (unsigned int) ( ((unsigned long) uRechtsabstand * COS_NORM) /
                  (unsigned long)(cos_tab[Messwertzaehler]) );
       SF_distanz2 =  (unsigned int)( ((unsigned long)   uHoehe * COS_NORM) /
                   (unsigned long)(cos_tab[180 - Messwertzaehler]) );
       if(SF_distanz > SF_distanz2)  SF_distanz = SF_distanz2;
       }
     else if  ( (Messwertzaehler > alpha) && (Messwertzaehler <= 180) )
       {
       SF_distanz =  (unsigned int)( ((unsigned long)   uHoehe * COS_NORM) /
                   (unsigned long)(cos_tab[180 - Messwertzaehler]) );
       }
     else if  ( (Messwertzaehler > 180) && (Messwertzaehler < (360 - beta)) )
       {
       SF_distanz =  (unsigned int)( ((unsigned long)   uHoehe * COS_NORM) /
                   (unsigned long)(cos_tab[Messwertzaehler - 180]) );
       }
     else if  (  (Messwertzaehler == (360 - beta)) )
       {
       SF_distanz =  (unsigned int)( ((unsigned long)   uHoehe * COS_NORM) /
                   (unsigned long)(cos_tab[Messwertzaehler - 180]) );
       SF_distanz2 =  (unsigned int)( ((unsigned long)   uLinksabstand * COS_NORM) /
                   (unsigned long)(cos_tab[360 - Messwertzaehler]) );
       if(SF_distanz > SF_distanz2)  SF_distanz = SF_distanz2;
       }
     else if  ( (Messwertzaehler > (360 - beta)) && (Messwertzaehler <= 360) )
       {
       SF_distanz =  (unsigned int)( ((unsigned long)   uLinksabstand * COS_NORM) /
                   (unsigned long)(cos_tab[360 - Messwertzaehler]) );
```

```
            }
            uExpandChecksum ^= SF_distanz;
          }
          break;

        case SCHUTZFELD_SEGMENTE:
          Messungen_pro_Segment = (MESS_PRO_SCAN - 1) / cbAnzahlSegmente;
          /* Initialization of the expansion algorithm for the segmented bumper protective field */
          Messwertzaehler = 0;

          /* Determine first segment corner point */
          /* Mask 0x1fff corresponds to the internal counter mask */
          seg_point_2 =   auEckpunkt[0] & 0x1fff;
          /* Expansion algorithm */
          uExpandChecksum = 0;
          for (segment_cnt = 0; segment_cnt < cbAnzahlSegmente; segment_cnt++)
          {
            seg_point_1 = seg_point_2;
            seg_point_2 =   auEckpunkt[segment_cnt+1]& 0x1fff;
            uExpandChecksum ^=   auEckpunkt[segment_cnt];
            Messwertzaehler++;
            /* Distinction between positive and negative delta since unsigned int */
            if (seg_point_2 >= seg_point_1)
            {
              delta = ((seg_point_2 - seg_point_1) << 5) / Messungen_pro_Segment;
              for (index = 1; index < Messungen_pro_Segment; index++)
              {
                 uExpandChecksum ^= seg_point_1 +  ((delta * index) >> 5);
                Messwertzaehler ++;
              }
            }
            else
            {
              delta = ((seg_point_1 - seg_point_2) << 5) / Messungen_pro_segment;
              for (index = 1; index < Messungen_pro_segment; index++)
              {
                uExpandChecksum  ^= seg_point_1 - ((delta * index) >> 5);
                Messwertzaehler ++;
              }
            }
          }
          /* Last measured value */
          uExpandChecksum ^=   auEckpunkt[segment_cnt];
           break;
      }
    }
```

3.1.13 Confirmation of the configured safe protective field (permitted only in setup or balancing mode)

Telegram number: 41H (BSFCONF_TGM)	
Transfer parameters: Field number, status, PLS number	
Status DATA TYPE: BYTE	00H > NOT OK 01H > OK; Verification can begin 02H > End of verification
Field number DATA TYPE: BYTE **LSI ONLY**	Range 1 to 8
PLS number DATA TYPE: BYTE **LSI ONLY**	Range from 1 to 4; This parameter shows which PLS is used for verification.
Description: If confirmed with OK, the new PF is transferred after verification. Otherwise the current PF remains active.	

3.1.14 Change the password for setting up the protective field (permitted only in setup or balancing mode)

Telegram number: 42H (PWCHG_TGM)	
Transfer parameters: Status, PW type, password string 1	
Status DATA TYPE: BYTE	00H > New password 01H > Confirmation of new password
PW type DATA TYPE: BYTE	00H > Password for SICK service and authorized customers. 01H > Password for maintenance.
Password string 1	String with length 8 comprising '0'-'9', 'a'-'z', 'A'-'Z' and '_'.
Description: When the password is changed, this telegram must be sent twice, whereby the status must change from 00H to 01H.	

3.1.15 Configure the warning field

Telegram number: 43H (KSFKFG_TGM)	
Transfer parameters: WF No., AS, EP[1], ..., EP[AS+1]	
WF number DATA TYPE: BYTE **LSI ONLY**	The number of warning fields varies between 1 and 8. The warning field name consists of 8 ASCII characters. This is identical to the associated PF name and is saved in the same place.
AS DATA TYPE: BYTE	Number of segments - variable between 9, 10, 15, 30, 45, 90 and max. 180. The number must be an integral divisor of 90 or the maximum number must be 180.
EP[1] DATA TYPE: UNIT	Radius for the corner point [1] in units of 1 cm.
:	:
EP[AS+1] DATA TYPE: UNIT	Radius for the corner point [AS+1] in units of 1 cm.
Description: Configuration of the warning field via the corner points of the segments. The corner points are connected via approximated straight lines and are expanded for the individual measured values. The warning field can be configured on-line as a function of the defined parameters (provided that it is stored in the volatile memory), i.e. the LSI remains in monitoring mode while the newly configured warning field is transferred and the outputs remain in the 'green state' if the protective field is free. However, it should be noted that the sensor system assigns highest priority to monitoring the protective fields and the cyclical self-tests. WARNING: Attempts to reconfigure the warning field in the monitoring mode could cause data transfer errors as the interface interrupts must be disabled temporarily. This state can be bypassed easily by transferring the configuration data again. A repetition rate of 3 is recommended.	

3.1.16 Define the restart behavior (permitted only in setup or balancing mode, PLS only)

Telegram number: 44H (WANL_TGM)	
Transfer parameters: Mode, Time in seconds	
Mode DATA TYPE: BYTE	00H > Restart after actuation of restart button (default setting) 01H > Restart after n seconds 02H > Without restart inhibit
Time DATA TYPE: BYTE	In the case of mode 01H, the time in seconds, after which the sensor enables the outputs when the protective field is free, is transferred here. This parameter is not used for the other two modes.
Description: This parameter determines the sensor behavior when the protective field is free after it has signaled INTERVENTION. The selected setting must be confirmed again with WANLCFRM_TGM.	

3.1.17 Configured protective fields request

Telegram number: 45H (SFANF_TGM)	
Transfer parameters: Field number, field type	
Field number DATA TYPE: BYTE	Range 1 to 8
Protective field type DATA TYPE: BYTE	00H > Safe protective field (PF) 01H > Warning field (WF)
Description: The configuration of the protective fields programmed in the sensor is requested.	

3.1.18 Teach-in mode for PF configuration (permitted only in setup or balancing mode)

Telegram number: 46H (LMOD_TGM)	
Transfer parameters: Field number, action, etc....	
Field number DATA TYPE: BYTE **LSI ONLY**	Range 1 to 8
PF Name DATA TYPE: CHAR[8] **LSI ONLY**	The name for the protective field consists of 8 ASCIII characters.
PLS number DATA TYPE: BYTE **LSI ONLY**	Range from 1 to 4; This parameter shows which PLS is used for teaching-in.
Action: DATA TYPE: BYTE	00H Start teach-in mode 01H Regular end of teach-in mode 02H Abort teach-in mode
Minute DATA TYPE: BYTE	Range from 0 to 59
Hour DATA TYPE: BYTE	Range from 0 to 23
Day DATA TYPE: BYTE	Range from 1 to 31
Month DATA TYPE: BYTE	Range from 0 to 11, January is 0.
Year DATA TYPE: UNIT	Range from 95 to max. of UNIT Corresponds to current year minus 1900.
Description: The sensor receives a signal at the start and end of the teach-in mode. If the teach-in mode is aborted, the LSI does not expect verification. The taught-in data can be used by the host as the editing basis for a manually processed PF. The date and time are also transferred when the teach-in mode is started. (not possible with PLS316)	

3.1.19 Confirm restart definition (permitted only in startup or balancing mode, PLS only)

Telegram number: 47H (WANLCFRM_TGM)	
Transfer parameters: Mode, Time in seconds	
Mode DATA TYPE: BYTE	00H > Restart after actuation of restart button (default setting) 01H > Restart after n seconds 02H > Without restart inhibit
Time DATA TYPE: BYTE	In the case of mode 01H, the time in seconds, after which the sensor enables the outputs when the protective field is free, is transferred here. This parameter is not used for the other two modes.
Description: This parameter confirms the sensor behavior after it has signaled INTERVENTION when the protective field is free. The restart definition is activated in the sensor if it has been defined correctly.	

3.1.20 Perform balancing (permitted only in balancing mode) (PERMITTED for PLS and LSI)

Telegram number: 50H (AGL_TGM)	
Transfer parameters: Mode; Serial number;	
Mode DATA TYPE: BYTE	00H Reference measurement balancing 01H Contamination evaluation balancing 02H Enter serial number PLS 03H Enter serial number **LSI** 04H ... reserved for **LSI** final test. 0AH
Serial number	In mode 02H and mode 03H an 8-digit serial number is expected.
Description: The system is notified of which type of balancing is to be performed. **Mode 0**: The amplitude of the test target is taught-in. **Mode 1**: The amplitudes of the light grid for the contamination monitoring function are taught-in. **Mode 2**: The standard settings for the sensor are activated. The EEPROM is initialized. For this reason, the two other balancing modes must also be performed. **The baud rate is set to 9600 baud.** **Mode 3**: The standard settings for the **LSI** are activated. The EEPROM is initialized. **Mode 4 to 0AH** reserved for final check. **The baud rate is set to 9600 baud.** **PLS and LSI are selected by means of addressing.**	

3.1.21 Define startup test (permitted in only startup or balancing mode, PLS only)

Telegram number: 60H (ANLDEF_TGM)	
Transfer parameters: Mode;	
Mode DATA TYPE: BYTE	00H Without startup testing 01H With startup testing
Description: The sensor is notified of whether the system should function with or without startup testing. The selected setting must be confirmed again with ANLCFRM.	

3.1.22 Confirm startup test (permitted only in startup or balancing mode, PLS only)

Telegram number: 61H (ANLCFRM_TGM)	
Transfer parameters: Mode;	
Mode DATA TYPE: BYTE	00H Without startup testing 01H With startup testing
Description: The startup test definition is confirmed to the sensor. This telegram ensures that the most recent definition is valid.	

3.1.23 Define switching output WF or contamination (permitted only in startup or balancing mode, PLS only)

Telegram number: 62H (OUTPUTDEF_TGM)	
Transfer parameters: Mode;	
Mode DATA TYPE: BYTE	00H Output switches both with WF violation and contamination warming or error (default setting). 01H Output switches only with WF violation. 02H Output switches only with contamination warning or error.
Description: The sensor is notified of how high the sensor system is to logically connect the switching output.	

3.1.24 Define scan rate (permitted only in setup or balancing mode, PLS only)

Telegram number: 63H (RSPTIMEDEF_TGM)	
Transfer parameters: Scan rate	
Scan rate DATA TYPE: BYTE	Minimum setting 2 (default for balancing) Maximum setting 16.
Description: This parameter defines the scan rate (between 2 and 16) for protective field violation.	

3.1.25 Confirm definition of scan rate (permitted only in setup or balancing mode, PLS only)

Telegram number: 64H (RSPTIMECFRM_TGM)	
Transfer parameters: Scan rate	
Scan rate DATA TYPE: BYTE	Minimum setting 2 (default for balancing) Maximum setting 16.
Description: This parameter confirms the scan rate (between 2 and 16) for protective field violation.	

3.1.26 Define WF type (permitted only in setup and balancing mode, only to PLS SW version 03.09)

Telegram number: 65H (WSFTYPDEF_TGM)	
Transfer parameters: WF type;	
Type DATA TYPE: BYTE	00H WF is present in **volatile** memory range. 01H WF is present in **nonvolatile** memory range. Default setting for balancing is **nonvolatile** .
Description: Definition of WF type, volatile or nonvolatile.	

3.1.27 Define a permanent baud rate (permitted only in setup or balancing mode)

Telegram number: 66H (BRPERMDEF_TGM)	
Transfer parameters: Mode for PowerON;	
Type DATA TYPE: BYTE	00H The baud rate is set to 9600 baud with PowerON. 01H The configured baud rate remains set even after PowerON. Default setting with balancing is baud rate 9600 baud with PowerON.
Description: Definition of the sensor behavior with PowerOn for the current baud rate.	

3.1.28 Define LSI address (permitted only in setup or balancing mode)

Telegram number: 67H (ADRDEF_TGM)	
Transfer parameters: Address;	
Address DATA TYPE: BYTE	Current **LSI** address to be set.
Description: Definition of current **LSI** address.	

3.1.29 Switch laser on/off (PERMITTED for PLS only)

Telegram number: 68H (LASER_TGM)	
Transfer parameters: Desired state of laser sender.	
Status DATA TYPE: BYTE	Desired state of laser sender: 00H laser sender is deactivated, OSSDs are in red state. 01H laser sender is activated, the **LSI** state is similar to a change from red to green state.
Description: The laser sender can be switched on and off in each operating mode. The **LSI** behavior when the sender is switched off is similar to after a protective field violation. If the sender is reactivated, the **LSI** first changes to the green state after checking the valid restart parameters.	

3.1.30 Define application variant (PERMITTED for PLS only)

DEFINE APPLICATION VARIANT (PERMITTED ONLY IN SETUP AND BALANCING MODE)	
Telegram number: 69H (APPVARDEF_TGM)	
Transfer parameters: Desired application variant.	
State DATA TYPE: BYTE	Desired application variant: 00H Area protection variant. 01H AGV variant
Description: In the AGV variant, a glare message is ignored if the protective fields have a radius of less than 110 cm. In addition, the anti-manipulation protection test only comes into effect for a period of two hours. In the variant for area protection, a glare is always regarded as a violation of the protective field. The test period of the anti-manipulation protection is 3 seconds.	

CONFIRMATION FOR DEFINITION OF APPLICATION VARIANTS (PERMITTED ONLY IN SETUP AND BALANCING MODE)	
Telegram number: 6AH (APPVARCFRM_TGM)	
Transfer parameters: Desired application variant.	
State DATA TYPE: BYTE	Desired application variant: 00H Variant for area protection. 01H AGV variant
Description: see above	

3.1.31 Define LSI configuration (permitted only in setup or balancing mode)

Telegram number: 70H (LSIKFGDEF_TGM)	
Transfer parameters: Various configuration parameters.	
PLS variant DATA TYPE: BYTE	04 4 Meters Vers. 07 7 Meters Vers. 50 50 Meters Vers.
Number of sensors DATA TYPE: BYTE	Number of PLS connected p (max. 4)
Name of sensor 4 times DATA TYPE: Char[8] 4 times	Name of sensors 1 to 4. Name consists of fixed length CHAR[8]. Unused characters are filled with SPACE.
4 dummy bytes DATA TYPE: BYTE	Reserved
Application variant DATA TYPE: BYTE	Bit 0 = desired application variant: 00H Variant for area protection 01H AGV variant. Comment: In the AGV variant a glare message is ignored if the protective fields have a radius of less than 110 cm . In addition, the test of the anti-manipulation protection only comes into effect for a period of 2 hours. In the variant for area protection, a glare message is always regarded as a protective field violation. The test period of the anti-manipulation protection is 3 seconds. Bit 2 = desired evaluation algorithm: 00H Standard evaluation 01H Pixel evaluation Bit 3 = reserved to Bit 7 = reserved
Inputs DATA TYPE: BYTE	Bit 0: port A used if 1 Bit 1: port B used if 1 Bit 2: port C used if 1 Bit 3: port D used if 1 Bit 4: Restart A used if 1 Bit 5: Restart B used if 1 Bit 6: Incremental encoder used if 1 Bit 7: RESERVED
Outputs DATA TYPE: BYTE	Bit 0: OSSD A available if 1 Bit 1: OSSD B available if 1 Bit 2: free Bit 3: free Bit 4: free Bit 5: free Bit 6: free Bit 7: free

Protection check DATA TYPE: BYTE	Bit 0: Contactor monitoring OSSD A is carried out if 1 Bit 1: Contactor monitoring OSSD B is carried out if 1
Dummy DATA TYPE: BYTE	Reserved
Number of fields DATA TYPE: BYTE	Number of protective / warning pairs / triplets: s Valid between MIN 1 and MAX 8
Field name 8 times DATA TYPE: Char[8] 8 times	Name of fields 1 to 8 with pairs. Name consists of fixed length CHAR[8]. Unused characters are filled with SPACE.
Dummy DATA TYPE: BYTE	Reserved
Number of monitoring cases DATA TYPE: BYTE	Possible definitions of monitoring cases Valid between MIN 1 and MAX 10 The names of the MF are determined with the MF definition.
INC Count 1 DATA TYPE: UNIT	Number of pulses from the INC encoder 1 per cm
INC Count 2 DATA TYPE: UNIT	Number of pulses from the INC encoder 2 per cm
INC tolerance DATA TYPE: UNIT	Difference between the two INC encoders in %
DUMMY DATA TYPE: UNIT	Dummy byte
Address DATA TYPE: BYTE	Current **LSI** address to be set.
Restart OSSD A DATA TYPE: BYTE	00H > Restart after actuation of restart button A 01H > Restart after n seconds 02H > Without restart inhibit (default setting) Comment: This parameter determines the LSI behavior after it has signaled INTERVENTION when the protective field is free.
Restart time OSSD A DATA TYPE: BYTE	In the case of the 01H mode, the time in seconds, after which the LSI enables the output A when the protective field is free, is transferred here . This parameter is not relevant for the other two modes.

Restart OSSD B DATA TYPE: BYTE	00H > Restart after actuation of restart button B 01H > Restart after n seconds 02H > Without restart inhibit (default setting) Comment: This parameter determines the LSI behavior after it has signaled INTERVENTION when the protective field is free.
Restart time OSSD B DATA TYPE: BYTE	In the case of the 01H mode, the time in seconds, after which the LSI enables the output B when the protective field is free, is transferred here. This parameter is not relevant for the other two modes.
Startup testing DATA TYPE: BYTE	00H Without startup testing 01HWith startup testing
Baud rate DATA TYPE: UNIT	Baud rate: 40H -- > Configuration for 38400 baud. 41H -- > Configuration for 19200 baud. 42H -- > Configuration for 9600 baud. 48H -- > Configuration for 500000 baud.
Description:	

3.1.32 Confirmation for LSI configuration definition (permitted only in setup or balancing mode)

Telegram number: 71H (LSIKFGCFRM_TGM)	
Transfer parameters: Configuration parameters.	
PLS variant DATA TYPE: BYTE	04 4 Meters 07 7 Meters 50 50 Meters
Number of sensors DATA TYPE: BYTE	Number of PLS connected p (max. 4)
Name of sensor 4 times DATA TYPE: Char[8] 4 times	Name of sensors 1 to 4. Name consists of fixed length CHAR[8]. Unused characters are filled with SPACE.
4 dummy bytes DATA TYPE: BYTE	Reserved
Application variant DATA TYPE: BYTE	Bit 0 = desired application variant: 00H Variant for area protection 01H AGV variant. Comment: In the AGV variant a glare message is ignored if the protective fields have a radius of less than 110 cm . In addition, the anti-manipulation protection test only comes into effect for a period of 2 hours. In the variant for area protection, a glare message is always regarded as a protective field violation. The test period of the anti-manipulation protection is 3 seconds. Bit 2 = desired evaluation algorithm: 00H Standard evaluation 01H Pixel evaluation Bit 3 = reserved to Bit 7 = reserved
Inputs DATA TYPE: BYTE	Bit 0: port A used if 1 Bit 1: port B used if 1 Bit 2: port C used if 1 Bit 3: port D used if 1 Bit 4: Restart A used if 1 Bit 5: Restart B used if 1 Bit 6: Incremental encoder used if 1 Bit 7: RESERVED
Outputs DATA TYPE: BYTE	Bit 0: OSSD A available if 1 Bit 1: OSSD B available if 1 Bit 2: free Bit 3: free Bit 4: free Bit 5: free Bit 6: free Bit 7: free

Protection check DATA TYPE: BYTE	Bit 0: Contactor monitoring OSSD A is carried out if 1 Bit 1: Contactor monitoring OSSD B is carried out if 1
Dummy DATA TYPE: BYTE	Reserved
Number of fields DATA TYPE: BYTE	Number of protective / warning pairs / triplets: s Valid between MIN 1 and MAX 8
Field name 8 times DATA TYPE: Char[8] 8 times	Name of fields 1 to 8 with pairs. Name consists of fixed length CHAR[8]. Unused characters are filled with SPACE.
Dummy DATA TYPE: BYTE	Reserved
Number of monitoring cases DATA TYPE: BYTE	Possible definitions of monitoring case Valid between MIN 1 and MAX 10
INC Count 1 DATA TYPE: UNIT	Number of pulses from the INC encoder 1 per cm
INC Count 2 DATA TYPE: UNIT	Number of pulses from the INC encoder 2 per cm
INC tolerance DATA TYPE: UNIT	Difference between the two INC encoders in %
DUMMY DATA TYPE: UNIT	DUMMY BYTE
Address DATA TYPE: BYTE	Current LSI address to be set.
Restart OSSD A DATA TYPE: BYTE	00H > Restart after actuation of restart button A 01H > Restart after n seconds 02H > Without restart inhibit (default setting) Comment: This parameter determines the LSI behavior after it has signaled INTERVENTION when the protective field is free.
Restart time OSSD A DATA TYPE: BYTE	In the case of the 01H mode, the time in seconds, after which the LSI enables the output A when the protective field is free, is transferred here. This parameter is not relevant for the other two modes.
Restart OSSD B DATA TYPE: BYTE	00H > Restart after actuation of restart button B 01H > Restart after n seconds 02H > Without restart inhibit (default setting) Comment: This parameter determines the LSI behavior after it has signaled INTERVENTION when the protective field is free.

Restart time OSSD B DATA TYPE: BYTE	In the case of the 01H mode, the time in seconds, after which the LSI enables the output B when the protective field is free, is transferred here. This parameter is not relevant for the other two modes.
Startup testing DATA TYPE: BYTE	00H Without startup testing 01HWith startup testing
Baud rate DATA TYPE: UNIT	Baud rate: 40H -- > Configuration for 38400 baud. 41H -- > Configuration for 19200 baud. 42H -- > Configuration for 9600 baud. 48H -- > Configuration for 500000 baud.
Description:	

3.1.33 Definition of a monitoring case (permitted only in setup or balancing mode) LSI ONLY

Telegram number: 72H (UWFDEF_TGM)	
Transfer parameters: MF parameters	
MF No. DATA TYPE: BYTE	MF No.: 1 MF number or index.
MF name DATA TYPE: Char[8]	Name of MF 1 Name consists of fixed length CHAR[8]. Unused characters are filled with SPACE.
Input diagram DATA TYPE: UNIT	The mask for the input status or INC values which activate these MF is defined as follows. BIT 0 and 1 for input A: A_LOW = 0x0002 A_HIGH = 0x0001 A_UNDEF = 0x0003 BIT 2 and 3 for input B: B_LOW = 0x0008 B_HIGH = 0x0004 B_UNDEF = 0x000C BIT 4 and 5 for input D: C_LOW = 0x0020 C_HIGH = 0x0010 C_UNDEF = 0x0030 BIT 6 and 7 for input C: D_LOW = 0x0080 D_HIGH = 0x0040 D_UNDEF = 0x00C0 BIT 8 and 9 free BIT 10 and 11 for INC values: I_INACTIVE = 0x0000 I_ACTIVE = 0x0C00
Active PLS DATA TYPE: BYTE	Determines the sensor active for this MF. Valid between 1 and 4.
Active field pair DATA TYPE: BYTE	Determines the protective and warning fields active for this MF. Valid between 1 and 8.
DUMMY DATA TYPE: BYTE	RESERVED
Output diagram DATA TYPE: BYTE	Bit 0: OSSD A is addressed if 1 Bit 1: OSSD B is addressed if 1 Bit 2: to BIT 7: free Only one OSSD must be assigned to one MF.
Dummy DATA TYPE: UNIT	Reserved
DUMMY reference DATA TYPE: BYTE	RESERVED
Scan rate DATA TYPE: BYTE	Minimum setting: 2 (default with balancing) Maximum setting: 16.
NextCase1 Byte	Next monitoring case no. 1 - 15, 0xFF means any sequence
NextCase2 Byte	Next monitoring case no. 1 - 15, 0xFF means any sequence

MaxSpeed DATA TYPE: INT	Maximum speed for this monitoring case with in cm/sec
MinSpeed DATA TYPE: INT	Minimum speed for this monitoring case in cm/sec
Description: The definition described for a MF repeats itself n times for the total number of defined monitoring fields.	

3.1.34 Confirm definition of a monitoring case (permitted only in setup or balancing mode) LSI ONLY

Telegram number: 73H (UWFCFRM_TGM)	
Transfer parameters: MF parameters	
MF No. DATA TYPE: BYTE	MF No.: 1 MF number or index.
MF name DATA TYPE: Char[8]	Name of MF 1 Name consists of fixed length CHAR[8]. Unused characters are filled with SPACE.
Input diagram DATA TYPE: UNIT	The mask for the input status or INC values which activate these MF is defined as follows. BIT 0 and 1 for input A: A_LOW = 0x0002 A_HIGH = 0x0001 A_UNDEF = 0x0003 BIT 2 and 3 for input B: B_LOW = 0x0008 B_HIGH = 0x0004 B_UNDEF = 0x000C BIT 4 and 5 for input D: C_LOW = 0x0020 C_HIGH = 0x0010 C_UNDEF = 0x0030 BIT 6 and 7 for input C: D_LOW = 0x0080 D_HIGH = 0x0040 D_UNDEF = 0x00C0 BIT 8 and 9 free BIT 10 and 11 for INC values: I_INACTIVE = 0x0000 I_ACTIVE = 0x0C00
Active PLS DATA TYPE: BYTE	Determines the sensor active for this MF. Valid between 1 and 4.
Active field pair DATA TYPE: BYTE	Determines the protective and warning fields active for this MF. Valid between 1 and 8.
DUMMY DATA TYPE: BYTE	RESERVED
Output diagram DATA TYPE: BYTE	Bit 0: OSSD A is addressed if 1 Bit 1: OSSD B is addressed if 1 Bit 2: to BIT 7: free Only one OSSD must be assigned to one MF.
Dummy DATA TYPE: UNIT	Reserved
DUMMY DATA TYPE: BYTE	RESERVED
Scan rate DATA TYPE: BYTE	Minimum setting: 2 (default with balancing) Maximum setting: 16.
NextCase1 Byte	Next monitoring case no. 1 - 15, 0xFF means any sequence
NextCase2 Byte	Next monitoring case no. 1 - 15, 0xFF means any sequence

MaxSpeed DATA TYPE: INT	Maximum speed for this monitoring case with in cm/sec
MinSpeed DATA TYPE: INT	Minimum speed for this monitoring case in cm/sec
Description: The definition described for a MF repeats itself n times for the total number of defined monitoring fields.	

3.1.35 Saving the configuration values in E2Prom (permitted only in setup or balancing mode) LSI ONLY

Telegram number: 74H (CFGSAVE_TGM)	
Parameters: Status selection of telegrams to be saved	
Acceptance data DATA TYPE: UNIT	Bit 0: Configuration in EEPROM **if 1** Bit 1: MF 1 into EEPROM **if 1** Bit 2: MF 2 into EEPROM **if 1** Bit 3: MF 3 into EEPROM **if 1** Bit 4: MF 4 into EEPROM **if 1** Bit 5: MF 5 into EEPROM **if 1** Bit 6: MF 6 into EEPROM **if 1** Bit 7: MF 7 into EEPROM **if 1** Bit 8: MF 8 into EEPROM **if 1** Bit 9: MF 9 into EEPROM **if 1** Bit 10: MF 10 into EEPROM **if 1** Bit 11: MF 11 into EEPROM **if 1** Bit 12: MF 12 into EEPROM **if 1** Bit 13: MF 13 into EEPROM **if 1** Bit 14: MF 14 into EEPROM **if 1** Bit 15: MF 15 into EEPROM **if 1**

3.1.36 Shifting PLS into LSI mode (permitted only in setup or balancing mode)

Telegram number: 77H (LSIMODE_TGM)	
Transfer parameters:	
Mode state DATA TYPE: BYTE	00H LSIMODE OFF 01H LSIMODE ON
Description: The flag for operation with LSI is not saved in volatile memory in EEPROM. This flag is read after RESET. If it is active, the PLS changes to the operating mode "all measured values continuously". Baud rate 500 Kbaud, permanent. LED state can be controlled via LEDSET_TGM OSSDs are red as standard, and the LED. The transfer report has no parity bit.	

3.1.37 Controlling the red/green LED of PLS (in LSI mode only)

Telegram number: 78H (LEDSET_TGM)	
Transfer parameters:	
LED state DATA TYPE: BYTE	Bits 0 and 1: 00H LED Red 01H LED Green 02H LED red and LED yellow for RESTART Information REQUIRED Bits 2 to 7: Number of scans up to PLS without received LEDSET_TGM remains in the previous LED state.
Description: The LED and OSSDs can only be controlled via this telegram in the imLSI mode. The PLS does not respond to the telegram since the PLS must continuously send its measured values. The status block in the measured value telegram 0B0H shows the state of the LED.	

3.2 Data direction LSI -> host

The telegram numbers 0x80 to 0x8F are reserved for internal LSI telegrams.

3.2.1 Message after Power On (response possible from PLS and LSI)

Telegram number: 90H (PWON_TGM)	
Transfer parameters: String with name and SW version	
String	E.g.: "LSI , 01.00" or "PLS, 03.07a".
Description: After Power On, the LSI uses this message to notify the host that it is ready. The LSI sends this telegram both after hardware reset and requested software reset.	

3.2.2 Confirmation of the SW reset telegram (response possible from PLS and LSI)

Telegram number: 91H (INIT_ACK_TGM)
Transfer parameters: None
Description: After INIT_TGM for a SW reset is received, the LSI sends this ACK and performs a SW reset after approx. 10 milliseconds.

3.2.3 Not Acknowledge (e.g. with forbidden operating mode change) (response possible from PLS and LSI)

Telegram number: 92H (NACK_TGM)
Transfer parameters: None
Description: If a telegram was received correctly but the requested function cannot be executed, the LSI sends this NACK telegram to the host, e.g. with an invalid operating mode change or an invalid number of segments in a measured value request.

3.2.4 Response to change of operating mode

Telegram number: A0H (BMACK_TGM)	
Transfer parameters: Status	
Status DATA TYPE: BYTE	00H Mode change performed successfully. 01H Mode change not possible - password incorrect 02H Mode change not possible - **LSI FAULT**

3.2.5 Response to measure value request (response possible from PLS and LSI)

Telegram number: B0H (MW_TGM)	
Transfer parameters:	
Status block: OSSD status DATA TYPE: BYTE 10 individual test addresses in monitoring mode DATA TYPE UNIT Last 2 test numbers DATA TYPE BYTE **LSI ONLY**	Status block only transferred in LSI mode of PLS!!! OSSD status: Bit 0: OSSD1 0-> RED, 1-> GREEN Bit 1: OSSD2 0-> RED, 1-> GREEN Bit 2: LED RED/GREEN 0-> RED, 1-> GREEN Bit 3: LED YELLOW 0-> OFF, 1-> CONSTANTLY ON contamination error Bit 4: LED YELLOW 1-> FLASHING 1 Hz contamination warning Bit 5: LED YELLOW 1-> FLASHING 4 Hz Fatal Error Bit 6: LED YELLOW 1-> FLASHING 1 Hz RESTART REQU. 1st test address: RTC_START -> 0xffff 2nd test address: RTC_2 -> 0x0001 3rd test address: RTC_3 -> 0xfffd 4th test address: RTC_4 -> 0x0003 5th test address: RTC_51 -> 0x0005 6th test address: RTC_513 -> 0xfff5 7th test address: RTC_511 -> 0xfff7 8th test address: RTC_5121 -> 0x0009 9th test address: RTC_5122 -> 0x000d 10th test address: RTC_END -> 0x000f Last current test carried out: n [0 ... MAX_TEST_NR] Penultimate test carried out: n-1 or 0 if n == MAX_TEST_NR MAX_TEST_NR = 76 for PLS SW Version 03.08.
PLS No. DATA TYPE: BYTE **LSI ONLY**	00H > Measured values of PLS currently active 01H > Measured values of PLS1 02H > Measured values of PLS2 03H > Measured values of PLS3 04H > Measured values of PLS4
AMW DATA TYPE: UNIT	Number of measured values transmitted (2 bytes)
MW[1] DATA TYPE: UNIT	MW[1] violated, measured distance
:	:
MW[AMW] DATA TYPE: UNIT	MW[AMW] violated, measured distance

Description: Transfers the measured values from a scan to the host.

Structure of a transmitted measured value:

Bit [0..12]: Measured distance from the measuring point in units of 1cm. Range from 0...(2^{13}-1) (0cm ... approx. 81 m)

Bit [13]: Glare flag. Flag is set if glare was detected in this segment.

Bit [14]: WF-V-Flag. Flag is set if WF was violated in this measuring point

Bit [15]: PF-V-Flag. Flag is set if PF was violated in this measuring point.

If the LSI sends the minimum measured value per segment, the number of measured values to be transmitted is determined by the following algorithm:

1.) If both protective fields are stored in segmented form, the number of measured values corresponds to the highest number of segments in the protective or warning field.

2.) If the protective field is stored in radial or rectangular form, the number of measured values corresponds to the number of measured values in the warning field.

3.2.6 PLS sensor status

Telegram number: B1H (SS_TGM)	
Transfer parameters: SW version, operating mode, status, ...etc.	
SW version	Version of software 7 ASCII character, e.g." 01.00 ".
Operating mode DATA TYPE: BYTE	Mode: 00H -- > Setup mode for configuring the protective field 01H -- > Balancing mode 10H -- > Diagnosis mode 20H -- >Monitoring mode: min. measured values per segment are output continuously. 21H -- > Monitoring mode: min. measured values per segment are only output on request. With INTERVENTION the measured values are output for every scan. 22H -- >Monitoring mode: minimum vertical distance to sensor is output continuously. 23H -- > Monitoring mode: minimum vertical distance to sensor is only output on request . With INTERVENTION the minimum distance is output with each scan. 24H -- > Monitoring mode: all measured values of a scan are output continuously without request. 25H -- > Monitoring mode: Measured values on request only, also no data for protective field violation.
Status DATA TYPE: BYTE	if > 0 , sensor faulty (error or fatal error)
Serial number DATA TYPE: CHAR[9]	8-digit number, 8 ASCII characters.
Variant byte DATA TYPE: BYTE	00H: WF in **VOLATILE** memory range 01H: WF in **NONVOLATILE** memory range
Contamination values DATA TYPE: UNIT	8 integer values with the current amplitude values measured through the front screen
Reference contamination values DATA TYPE: UNIT	4 integer values with the current amplitude values of the reference diodes.
Balancing values of the contamination channels	8 integer values with the amplitude values measured through the front screen during balancing

Balancing values of the reference contamination channels DATA TYPE: UNIT	4 integer values with the amplitude values of the reference channels measured through the front screen during balancing.
Motor speed DATA TYPE: UNIT	Integer value in microseconds for 1/90 rotation time.
PLL of TICs DATA TYPE: UNIT	Integer value in microseconds for 1048576 periods of the TICs.
DA-AD Test values DATA TYPE: UNIT	6 integer values for the DAC and ADCs.
DAC Offset DATA TYPE: UNIT	Integer in DAC-INCs.
TIC Offset DATA TYPE: UNIT	Integer in TIC-INCs.
Amplitude Reference target DATA TYPE: UNIT	Integer value for the amplitude of the reference target in mV.
Balance value TIC Offset DATA TYPE: UNIT	Integer value in TIC INCs during reference measurement balancing.
Balance value Amplitude Reference target DATA TYPE: UNIT	Integer value in mV of the amplitude received during reference measurement balancing.
Glare current (DC) DATA TYPE: UNIT	Integer value in mV for the amplitude of the direct current during the glare test.
Glare current (differ.) DATA TYPE: UNIT	Integer value in mV for the amplitude of the differential current during the glare test.
Stop comparator thresholds DATA TYPE: UNIT	2 integer values in DAC-INCs for the two stop comparator thresholds.

Correction comparator thresholds DATA TYPE: UNIT	5 integer values in DAC-INCs for the five correction comparator thresholds.
Restart mode DATA TYPE: BYTE	00H > Restart after actuation of restart button (default setting) 01H > Restart after n seconds 02H > Without restart inhibit
Restart time DATA TYPE: UNIT	Time for automatic restart in units of 5 ms.
Startup test DATA TYPE: BYTE	00H Without startup testing 01H With startup testing
Definition of 3rd switching output DATA TYPE: BYTE	00H Output switches both with WF violation and contamination warning or error. 01H Output switches only with WF violation. 02H Output switches only with contamination warning or error.
Baud rate DATA TYPE: UNIT	Integer value for active baud rate in sensor 500000 baud: 0x8001 334000 baud: 0x8002 250000 baud: 0x8003 200000 baud: 0x8004 111000 baud: 0x8008 58800 baud: 0x8010 38400 baud: 0x8019 19200 baud: 0x8033 9600 baud: 0x8067
No. of evaluations DATA TYPE: BYTE	Byte value for the number of evaluations with protective field violation. Must be between 1 and 15.
Permanent baud rate DATA TYPE: BYTE	00H: The baud rate is set to 9600 baud with PowerON. 01H: The configured baud rate remains set with PowerON .
Sensor address DATA TYPE: BYTE	Range from 0 to 127.
Application variant DATA TYPE: BYTE	00H Area protection variant 01H AGV variant.
Glare evaluation DATA TYPE: BYTE	00H: Glare evaluation is inactive; only in the case of protective fields with a radius smaller than or equal to 110 cm. 01H: Glare evaluation is active.
Laser ON/OFF switching DATA TYPE: BYTE	00H: Laser is switched off. 01H: Laser is switched on.
Description: Supplies the sensor status to the host	

3.2.7 LSI status

Telegram number: B1H (LSISS_TGM)	
Transfer parameters: SW version, operating mode, status, ...etc/	
SW version	Version of software 7 ASCII character, e.g." 01.00a".
Operating mode DATA TYPE: BYTE	Mode: 00H -- > Setup mode for configuring the protective field 01H -- > Balancing mode 10H -- > Diagnosis mode 20H -- >Monitoring mode: min. measured values per segment are output continuously. 21H -- > Monitoring mode: min. measured values per segment are only output on request. With INTERVENTION the measured values are output for every scan. 22H -- >Monitoring mode: minimum vertical distance to sensor is output continuously. 23H -- > Monitoring mode: minimum vertical distance to sensor is only output on request . With INTERVENTION the minimum distance is output with each scan. 24H -- > Monitoring mode: all measured values of a scan are output continuously without request. 25H -- > Monitoring mode: Measured values on request only, also no data for protective field violation.
Status DATA TYPE: BYTE	if > 0, LSI faulty (error or fatal error)
Serial number DATA TYPE: CHAR[8]	8-digit number, 8 ASCII characters.
PLS variant DATA TYPE: BYTE	04 4 Meters 07 7 Meters 50 50 Meters
Baud rate DATA TYPE: UNIT	Integer value for active baud rate in the LSI 38400 baud: 0x40 19200 baud: 0x41 9600 baud: 0x42
Permanent baud rate DATA TYPE: BYTE	00H: Baud rate is set to 9600 BAUD with PowerON. 01H: The configured baud rate remains set with PowerON .
LSI address DATA TYPE: BYTE	Range from 0 to 127.
Glare evaluation DATA TYPE: BYTE	00H: Glare evaluation is inactive; only in the case of protective fields with a radius smaller than or equal to 110 cm. 01H: Glare evaluation is active.

Active MF DATA TYPE: BYTE	Active MF in the LSI range from 1 to 10. LOW NIPPEL > active monitoring case HIGH NIPPEL > active monitoring case Both MF active with simultaneous evaluation -> Toggle measured value request between the active MFs
Status of outputs DATA TYPE: BYTE	Bit 0 > OSSD A 1 = green 0 = red Bit 1 > OSSD B 1 = green 0 = red Bit 2 > Warning field A 1 = free 0 = violated Bit 3 > Warning field B 1 = free 0 = violated
Status of inputs A, B, C, D, and Restart DATA TYPE: BYTE	The logical level of the inputs, as processed by the processor, is given in the status. Bit 0: Port A Bit 1: Port B Bit 2: Port C Bit 3: Port D Bit 4: Restart A Bit 5: Restart B Bit 6: free Bit 7: free
Speed in cm/sec DATA TYPE: UNIT	Speed of INC 1 currently measured
Speed in cm/sec DATA TYPE: UNIT	Speed of INC 2 currently measured
Function variant DATA TYPE: BYTE	The active function variant in the LSI gives the number of PLS modules connected value Meaning 0 No module connected 1 1 PLS 2 2 PLS 3 3 PLS 4 4 PLS
Description: Supplies the LSI status to the host	

3.2.8 Error message / test message (response possible from PLS and LSI)

Telegram number: B2H (ERR_TGM)	
Transfer parameters: Error type 1, error number 1 or test number 1,..., error type n, error number n.	
Error type 1 DATA TYPE: BYTE	Provides information about the type of error 0 -> no error, test OK 1 -> Information 2 -> Warning 3 -> Error 4 -> Fatal error 17 -> LSI channel 1 Information 18 -> LSI channel 1 Warning 19 -> LSI channel 1 Error 20 -> LSI channel 1 Fatal error 33 -> LSI channel 2 Information 34 -> LSI channel 2 Warning 35 -> LSI channel 2 Error 36 -> LSI channel 2 Fatal error
Error number 1 DATA TYPE: BYTE	Describes the error.
...	...
Error type n DATA TYPE: BYTE	Provides information about the type of error 0 -> no error, test OK 1 -> Information 2 -> Warning 3 -> Error 4 -> Fatal error 17 -> LSI channel 1 Information 18 -> LSI channel 1 Warning 19 -> LSI channel 1 Error 20 -> LSI channel 1 Fatal error 33 -> LSI channel 2 Information 34 -> LSI channel 2 Warning 35 -> LSI channel 2 Error 36 -> LSI channel 2 Fatal error
Error number n DATA TYPE: BYTE	Describes the error.
Description: Describes the errors which occur with a test or error message request. If a test request is made, only the result of the relevant test is output. In the case of an error request, however, the entire contents of the error memory are output. An overview of the possible errors is provided at the end of this document.	

3.2.9 Memory dump on request only in diagnosis mode (response possible from PLS and LSI)

Telegram number: B4H (MEMRD_TGM)	
Transfer parameters: Start address of the memory dump, number n of data bytes transmitted, data bytes 1 to n	
Start address DATA TYPE: LONG with LSI UNIT with PLS	Start address of memory dump
Number n of data bytes 1 DATA TYPE: BYTE	Number n of transferred data bytes; n is limited to 0xFF bytes.
Data bytes 1 DATA TYPE: BYTE	
Description: Provides a memory dump from the specified memory address in the address range 0x0 to 0xFFF. The number of data bytes transferred is limited to 0xFF bytes.	

3.2.10 LSI configuration data

Telegram number: B8H (LSIKFG_TGM)	
Transfer parameters: LSI configuration data	
PLS variant DATA TYPE: BYTE	04 4 Meters 07 7 Meters 50 50 Meters
Number of sensors DATA TYPE: BYTE	Number of PLS connected p (max. 4)
Sensor name 4 times DATA TYPE: Char[8] 4 times	Name of sensors 1 to 4. Name consists of fixed length CHAR[8]. Unused characters are filled with SPACE.
4 dummy bytes DATA TYPE: BYTE 4 times	Reserved

Application variant DATA TYPE: BYTE	Bit 0 - Bit 1 = Desired application variant: 00H Variant for area protection 01H AGV variant. Comment: In the AGV variant, a glare message is ignored if the protective fields have a radius of less than 110 cm. In addition, the anti-manipulation protection only comes into effect for a period of two hours. In the variant for area protection, a glare is always regarded as a violation of the protective field. The test period of the anti-manipulation protection is 3 seconds. Bit 4 - Bit 7 = Desired evaluation algorithm: Bit 2 = desired evaluation algorithm: 00H Standard evaluation 01H Pixel evaluation Bit 3 = reserved to Bit 7 = reserved
Inputs DATA TYPE: BYTE	Bit 0: port A used if 1 Bit 1: port B used if 1 Bit 2: port C used if 1 Bit 3: port D used if 1 Bit 4: Restart A used if 1 Bit 5: Restart B used if 1 Bit 6: Incremental encoder used if 1 Bit 7: RESERVED
Outputs DATA TYPE: BYTE	Bit 0: OSSD A available if 1 Bit 1: OSSD B available if 1 Bit 2: free Bit 3: free Bit 4: free Bit 5: free Bit 6: free Bit 7: free
Protection check DATA TYPE: BYTE	Bit 0: Contactor monitoring OSSD A is carried out if 1 Bit 1: Contactor monitoring OSSD B is carried out if 1
Dummy DATA TYPE: BYTE	Reserved
Number of fields DATA TYPE: BYTE	Number of protective / warning pairs / triplets: s Valid between MIN 1 and MAX 8
Field name 8 times DATA TYPE: Char[8] 8 times	Name of fields 1 to 8 Name consists of fixed length CHAR[8]. Unused characters are filled with SPACE.
Dummy DATA TYPE: BYTE	Reserved

Number of monitoring cases DATA TYPE: BYTE	Possible definitions of monitoring cases n Valid between MIN 1 and MAX 10
INC Count 1 DATA TYPE: UNIT	Number of pulses from the INC encoder 1 per cm
INC Count 2 DATA TYPE: UNIT	Number of pulses from the INC encoder 2 per cm
INC tolerance DATA TYPE: UNIT	Differential of both INC encoders in % [0 - 50%]
DUMMY DATA TYPE: UNIT	RESERVED
Address DATA TYPE: BYTE	Current LSI address to be set.
Restart OSSD A DATA TYPE: BYTE	00H > Restart after actuation of restart button A 01H > Restart after n seconds 02H > Without restart inhibit (default setting) Comment: This parameter determines the LSI behavior after it has signaled INTERVENTION when the protective field is free.
Restart time OSSD A DATA TYPE: BYTE	In the case of the 01H mode, the time in seconds, after which the LSI enables the output A when the protective field is free, is transferred here. This parameter is not relevant for the other two modes.
Restart OSSD B DATA TYPE: BYTE	00H > Restart after actuation of restart button B 01H > Restart after n seconds 02H > Without restart inhibit (default setting) Comment: This parameter determines the LSI behavior after it has signaled INTERVENTION when the protective field is free.
Restart time OSSD B DATA TYPE: BYTE	In the case of the 01H mode, the time in seconds, after which the LSI enables the output B when the protective field is free, is transferred here. This parameter is not relevant for the other two modes.
Startup testing DATA TYPE: BYTE	00H Without startup testing 01HWith startup testing
Baud rate DATA TYPE: UNIT	Baud rate: 40H -- > Configuration for 38400 baud. 41H -- > Configuration for 19200 baud. 42H -- > Configuration for 9600 baud. 48H -- > Configuration for 500000 baud.
Description: The LSI hardware configurations are transferred to the host.	

3.2.11 MF definition data

Telegram number: B9H (UWF_TGM)	
Transfer parameters: MF parameters	
MF No. DATA TYPE: BYTE	MF No.: 1 MF number or index.
MF name DATA TYPE: Char[8]	Name of MF 1 Name consists of fixed length CHAR[8]. Unused characters are filled with SPACE.
Input diagram DATA TYPE: UNIT	The mask for the input status or INC values which activate these MF is defined as follows. BIT 0 and 1 for input A: A_LOW = 0x0002 A_HIGH = 0x0001 A_UNDEF = 0x0003 BIT 2 and 3 for input B: B_LOW = 0x0008 B_HIGH = 0x0004 B_UNDEF = 0x000C BIT 4 and 5 for input D: C_LOW = 0x0020 C_HIGH = 0x0010 C_UNDEF = 0x0030 BIT 6 and 7 for input C: D_LOW = 0x0080 D_HIGH = 0x0040 D_UNDEF = 0x00C0 BIT 8 and 9 free BIT 10 and 11 for INC values: I_INACTIVE = 0x0000 I_ACTIVE = 0x0C00
Active PLS DATA TYPE: BYTE	Determines the sensor active for this MF. Valid between 1 and 4.
Active field pair DATA TYPE: BYTE	Determines the protective and warning fields active for this MF. Valid between 1 and 8.
DUMMY DATA TYPE: BYTE	RESERVED
Output diagram DATA TYPE: BYTE	Bit 0: OSSD A is addressed if 1 Bit 1: OSSD B is addressed if 1 Bit 2: to BIT 7: free Only one OSSD must be assigned to one MF.
Dummy DATA TYPE: UNIT	Reserved
DUMMY DATA TYPE: BYTE	RESERVED
Scan rate DATA TYPE: BYTE	Minimum setting: 2 (default with balancing) Maximum setting: 16.
NextCase1 Byte	Next monitoring case no. 1 - 15, 0xFF means any sequence
NextCase2 Byte	Next monitoring case no. 1 - 15, 0xFF means any sequence

MaxSpeed DATA TYPE: UNIT	Maximum speed for this monitoring case with in cm/sec
MinSpeed DATA TYPE: UNIT	Minimum speed for this monitoring case in cm/sec
Description: An MF definition is transferred to the host.	

Response to WF configuration

Telegram number: C0H (BSFACK_TGM)	
Transfer parameters: Status, PF no., PF name, mode, time, date, PF values (LI, RE, HO or RADIUS or segment data), EXP	
Status DATA TYPE: BYTE	Provides information about the success of the configuration 00H -> configuration aborted. Current PF remains active. 01H -> configuration transferred.
PF Number DATA TYPE: BYTE **LSI ONLY**	Number of protective field varies between 1 and 8
PF Name DATA TYPE: CHAR[8] **LSI ONLY**	The name for the protective field consists of 8 ASCIII characters.
Mode DATA TYPE: BYTE	00H -> Rectangular PF 01H -> Radial PF (semicircle with radius R) 02H -> Segmented PF
Minute DATA TYPE: BYTE	Range from 0 to 59
Hour DATA TYPE: BYTE	Range from 0 to 23
Day DATA TYPE: BYTE	Range from 1 to 31
Month DATA TYPE: BYTE	Range from 0 to 11, January is 0.
Year DATA TYPE: UNIT	Range from 95 to max. of UNIT Corresponds to current year minus 1900.
RADIUS DATA TYPE: UNIT	Radius of PF semicircle
LI DATA TYPE: UNIT	Distance (left) from sensor.
RE DATA TYPE: UNIT	Distance (right) from sensor.
HO DATA TYPE: UNIT	Height of rectangle viewed from sensor.
Segment data with	Segment data
AS DATA TYPE: BYTE	Number of segments - variable between 9 and max. 360. The number must be an integral divisor of 90 or max. 180 0xfe is transferred with 360 segments.
EP[1] DATA TYPE: UNIT	Radius for the corner point [1] in units of 1 cm.
:	:

EP[AS+1] DATA TYPE: UNIT	Radius for the corner point [AS+1] in units of 1 cm.
EXP DATA TYPE: UNIT	XOR checksum of the expanded values for the 361 measuring points.
Description: Returns the data received for the configuration.	

3.2.12 Response to PF configuration

Telegram number: C1H (BSFCFRM_TGM)	
Transfer parameters: PF number, status, PLS number	
Status DATA TYPE: BYTE	00H -> Configuration aborted. Current PF remains active. 01H -> Configuration transferred, verification was successful. 02H -> Internal error. Default error for PF is active. 03H -> Verification is active. 04H -> Date and time of protective field not acceptable.
PF Number DATA TYPE: BYTE **LSI ONLY**	Number of protective field varies between 1 and 8
PLS number DATA TYPE: BYTE **LSI ONLY**	Range from 1 to 4; This parameter shows which PLS is used for verification.
Description: Describes the reception of the PF confirmation. Status 02H sets the warning flag to error status . With status 04, the LSI has received a protective field with a date which is older than the date already stored in the sensor.	

3.2.13 Confirm new password

Telegram number: C2H (PWACK_TGM)	
Transfer parameters: Password change status	
Status DATA TYPE: BYTE	00H -> New password was not transferred. 01H -> New password was transferred. 02H -> New password must be confirmed by user.
PW type DATA TYPE: BYTE	00H > Password for SICK service and authorized customers. 01H > Password for maintenance.
Description: Describes the password change or that confirmation of the new password is expected.	

3.2.14 Response to WF configuration

Telegram number: C3H (KSFACK_TGM)	
Transfer parameters: PF number, configuration status	
Status DATA TYPE: BYTE	00H -> Configuration not OK 01H -> Configuration OK
PF Number DATA TYPE: BYTE **LSI ONLY**	Number of protective field varies between 1 and 8
Description: Provides information about the success of the configuration	

3.2.15 Response to restart definition (PLS only)

Telegram number: C4H (WANLACK_TGM)	
Transfer parameters: Restart definition status, mode, time in seconds	
Status DATA TYPE: BYTE	00H -> Definition not transferred. 01H -> Definition transferred. 02H -> Definition received, please confirm.
Mode DATA TYPE: BYTE	00H > Restart after actuation of restart button (default setting) 01H > Restart after n seconds 02H > Without restart inhibit
Time DATA TYPE: BYTE	In the case of mode 01H, the time in seconds, after which the sensor enables the outputs when the protective field is free, is transferred here. This parameter is not used for the other two modes.
Description: Describes the success of the restart definition	

3.2.16 Configuration data of programmed protective fields

Telegram number: C5H (SFDAT_TGM)	
Transfer parameters: Number, name, protective field type, protective field data	
verification flag for PF BYTE **LSI ONLY**	0: PF not verified. 1: PF not verified. **PARAMETERS ONLY FOR LSI**
PF Number DATA TYPE: BYTE **LSI ONLY**	Field number varies between 1 and 8.
PF Name DATA TYPE: CHAR[8] **LSI ONLY**	Field name consists of 8 ASCIII characters.
Protective field type DATA TYPE: BYTE	00H -> PF; Rectangular configuration. 01H -> PF; Radial configuration. 02H -> PF; Configuration with n segments. 03H -> WF; Configuration with n segments. 04H -> PF; Taught-in protective field. 07H -> PF; Dynamic protective field
Minute DATA TYPE: BYTE	Range from 0 to 59 Not with warning fields.
Hour DATA TYPE: BYTE	Range from 0 to 23 Not with warning fields.
Day DATA TYPE: BYTE	Range from 1 to 31 Not with warning fields.
Month DATA TYPE: BYTE	Range from 0 to 11, January is 0. Not with warning fields.
Year DATA TYPE: UNIT	Range from 95 to max. of UNIT Corresponds to current year minus 1900. Not with warning fields.

Protective field data	Protective field type 00H : LI, RE, HO as corner values of rectangle in cm. DATA TYPE: UNIT Protective field type 01H : RADIUS of PF in cm. DATA TYPE: UNIT Protective field type 02H : n segments, DATA TYPE: BYTE n+1 radii of equidistant segments of PF in cm. DATA TYPE: UNIT Protective field type 03H : n segments, DATA TYPE: BYTE n+1 radii of equidistant segments of WF in cm. DATA TYPE: UNIT Protective field type 04H : 361 radii of taught-in measuring points in cm DATA TYPE: UINT. Protective field type 07H : Data of dynam. protective field see Dynam. PF configuration.
Description: Supplies the data of the field programmed in the sensor.	

3.2.17 Response in teach-in mode

Telegram number: C6H (LMODACK_TGM)	
Transfer parameters: Status	
Status DATA TYPE: BYTE	00H -> Teach-in mode not terminated correctly. 01H -> Teach-in mode terminated, verification can begin. 03H -> Teach-in mode is active.
PLS number DATA TYPE: BYTE **LSI ONLY**	Range from 1 to 8 This parameter shows which PLS is used for teaching-in.
Description: Describes success of PF configuration in teach-in mode.	

3.2.18 Response to balancing (response possible from PLS and LSI)

Telegram number: D0H (AGLACK_TGM)	
Transfer parameters: Status	
Status DATA TYPE: BYTE	00H -> Balancing not OK. 01H -> Balancing OK.
Description: Describes the success of the balancing.	

3.2.19 Response to start test definition (PLS only)

Telegram number: E0H (ANLACK_TGM)	
Transfer parameters: Status, mode;	
Status DATA TYPE: BYTE	00H -> Startup test definition not accepted. 01H -> Startup test confirmation received, the desired definition is active in sensor. 02H -> Startup test definition received, please confirm.
Mode DATA TYPE: BYTE	00H Without startup testing 01H With startup testing
Description: Describes the success of the startup test definition.	

3.2.20 Response to output definition (PLS only)

Telegram number: E2H (OUTPUTACK_TGM)	
Transfer parameters: Status, mode	
Status DATA TYPE: BYTE	00H -> Initial definition not accepted. 01H -> Initial definition transferred.
Mode DATA TYPE: BYTE	00H Output switches both with WF violation and contamination warning or error. 01H Output switches only with WF violation. 02H Output switches only with contamination warning or error.
Description: Describes the success of the initial definition.	

3.2.21 Response to scan rate definition (PLS only)

Telegram number: E4H (RSPTIMEACK_TGM)	
Transfer parameters: Status, mode;	
Status DATA TYPE: BYTE	00H -> Scan rate definition not accepted. 01H -> Scan rate confirmation received, the desired definition is active in sensor. 02H -> Scan rate definition received, please confirm.
Scan rate DATA TYPE: BYTE	Between 2 and 16. Default value for balancing is 2.
Description: Describes the success of the scan rate definition.	

3.2.22 Response to WF type definition (PLS only)

Telegram number: E5H (WSFTYPACK_TGM)	
Transfer parameters: Status, type	
Status DATA TYPE: BYTE	00H -> WF type definition not accepted. 01H -> WF type definition is transferred.
Type DATA TYPE: BYTE	00H WF is stored in **volatile** memory. 01H WF is stored in **nonvolatile** memory.
Description: Describes the success of the WF type definition.	

3.2.23 Response to permanent baud rate definition

Telegram number: E6H (BRPERMACK_TGM)	
Transfer parameters: Status, type	
Status DATA TYPE: BYTE	00H -> Perm. baud rate definition not accepted. 01H -> Perm. baud rate definition transferred.
Type DATA TYPE: BYTE	00H Baud rate is set to **9600** baud after POWER ON. 01H Baud rate is **not changed after POWER ON**.
Description: Describes the success of the permanent baud rate definition.	

3.2.24 Response to LSI / PLS address definition

Telegram number: E7H (ADRACK_TGM)	
Transfer parameters: Status, address	
Status DATA TYPE: BYTE	00H -> Address definition not accepted. 01H -> Address definition transferred.
Address DATA TYPE: BYTE	Current sensor address
Description: Describes success of address definition.	

3.2.25 Response to laser on / off switching (response possible from PLS)

Telegram number: E8H (LASERACK_TGM)	
Transfer parameters: Status, state	
Status DATA TYPE: BYTE	00H -> Laser state change not accepted. 01H -> Last state change not transferred.
State DATA TYPE: BYTE	00H Laser switched off 01H Laser switched on
Description: Describes success of switching laser sender on / off.	

3.2.26 Define response to application variant

DEFINE RESPONSE TO APPLICATION VARIANT	
Telegram number: E9H (MNPTESTACK_TGM)	
Transfer parameters: Status, state;	
Status DATA TYPE: BYTE	00H -> Anti-manipulation protection definition not accepted. 01H -> Anti-manipulation protection confirmation received, the desired definition is active in sensor. 02H -> Anti-manipulation protection definition received, please confirm.
Anti-manipulation protection state DATA TYPE: BYTE	00H -> Anti-manipulation protection is deactivated. 01H -> Anti-manipulation protection is active. Default value for balancing is active anti-manipulation protection.
Description: Describes success of activating/deactivating anti-manipulation protection.	

3.2.27 Response to LSI configuration (permitted only in setup or balancing mode)

Telegram number: F0H (LSIKFGACK_TGM)	
Transfer parameters: Status, various parameters;	
Status DATA TYPE: BYTE	00H -> LSI configuration definition not accepted. 01H -> LSI configuration confirmation received, the desired definition is active in the LSI. 02H -> LSI configuration definition received, please confirm.
PLS variant DATA TYPE: BYTE	04 4 Meters 07 7 Meters 50 50 Meters
Number of sensors DATA TYPE: BYTE	Number of PLS p connected (max. 4)
Sensor name 4 times DATA TYPE: Char[8] 4 times	Name of sensors 1 to 4. Name consists of fixed length CHAR[8]. Unused characters are filled with SPACE.
4 dummy bytes DATA TYPE: BYTE	Reserved
Application variant DATA TYPE: BYTE	Bit 0 - Bit 1 = Desired application variant: 00H Variant for area protection 01H AGV variant. Comment: In the AGV variant, a glare message is ignored if the protective fields have a radius of less than 110 cm. In addition, the anti-manipulation protection test only comes into effect for a period of two hours. In the variant for area protection, a glare is always regarded as a violation of the protective field. The test period of the anti-manipulation protection is 3 seconds. Bit 4 - Bit 7 = Desired evaluation algorithm: Bit 2 = desired evaluation algorithm: 00H Standard evaluation 01H Pixel evaluation Bit 3 = reserved to Bit 7 = reserved
Inputs DATA TYPE: BYTE	Bit 0: port A used if 1 Bit 1: port B used if 1 Bit 2: port C used if 1 Bit 3: port D used if 1 Bit 4: Restart A used if 1 Bit 5: Restart B used if 1 Bit 6: Incremental encoder used if 1BIT 4: free Bit 7: RESERVED

Outputs DATA TYPE: BYTE	Bit 0: OSSD A available if 1 Bit 1: OSSD B available if 1 Bit 2: free Bit 3: free Bit 4: free Bit 5: free Bit 6: free Bit 7: free
Protection check DATA TYPE: BYTE	Bit 0: Contactor monitoring OSSD A is carried out if 1 Bit 1: Contactor monitoring OSSD B is carried out if 1
Dummy DATA TYPE: BYTE	Reserved
Number of fields DATA TYPE: BYTE	Number of protective / warning pairs / triplets: s Valid between MIN 1 and MAX 8
Field name 8 times DATA TYPE: Char[8] 8 times	Name of fields 1 to 8 with pairs. Name consists of fixed length CHAR[8]. Unused characters are filled with SPACE.
Dummy DATA TYPE: BYTE	Reserved
Number of monitoring cases DATA TYPE: BYTE	Possible definitions of monitoring case Valid between MIN 1 and MAX 10
INC Count 1 DATA TYPE: UNIT	Number of pulses from the INC encoder 1 per cm
INC Count 2 DATA TYPE: UNIT	Number of pulses from the INC encoder 2 per cm
INC tolerance DATA TYPE: UNIT	Difference between the two INC encoders in %
DUMMY DATA TYPE: UNIT	DUMMY BYTE .
Address DATA TYPE: BYTE	Current LSI address to be set.
Restart OSSD A DATA TYPE: BYTE	00H > Restart after actuation of restart button A 01H > Restart after n seconds 02H > Without restart inhibit (default setting) Comment: This parameter determines the LSI behavior after it has signaled INTERVENTION when the protective field is free.

Restart time OSSD A DATA TYPE: BYTE	In the case of the 01H mode, the time in seconds, after which the LSI enables the output A when the protective field is free, is transferred here. This parameter is not relevant for the other two modes.
Restart OSSD B DATA TYPE: BYTE	00H > Restart after actuation of restart button B 01H > Restart after n seconds 02H > Without restart inhibit (default setting) Comment: This parameter determines the LSI behavior after it has signaled INTERVENTION when the protective field is free.
Restart time OSSD B DATA TYPE: BYTE	In the case of the 01H mode, the time in seconds, after which the LSI enables the output B when the protective field is free, is transferred here. This parameter is not relevant for the other two modes.
Startup testing DATA TYPE: BYTE	00H Without startup testing 01HWith startup testing
Baud rate DATA TYPE: UNIT	Baud rate: 40H -- > Configuration for 38400 baud. 41H -- > Configuration for 19200 baud. 42H -- > Configuration for 9600 baud. 48H -- > Configuration for 500000 baud.
Description: Describes the success of the scan rate definition.	

3.2.28 Response to monitoring case definition (permitted only in setup or balancing mode)

Telegram number: F2H (UWFACK_TGM)	
Transfer parameters: Status, MF parameters	
Status DATA TYPE: BYTE	00H -> MF definition not accepted. 01H -> MF confirmation received, the desired definition is active in the LSI. 02H -> MF definition received, please confirm.
MF No. DATA TYPE: BYTE	MF No.: 1 MF number or index.
MF name DATA TYPE: Char[8]	Name of MF 1 Name consists of fixed length CHAR[8]. Unused characters are filled with SPACE.
Input diagram DATA TYPE: UNIT	The mask for the input status or INC values which activate these MF is defined as follows. BIT 0 and 1 for input A: A_LOW = 0x0002 A_HIGH = 0x0001 A_UNDEF = 0x0003 BIT 2 and 3 for input B: B_LOW = 0x0008 B_HIGH = 0x0004 B_UNDEF = 0x000C BIT 4 and 5 for input D: C_LOW = 0x0020 C_HIGH = 0x0010 C_UNDEF = 0x0030 BIT 6 and 7 for input C: D_LOW = 0x0080 D_HIGH = 0x0040 D_UNDEF = 0x00C0 BIT 8 and 9 free BIT 10 and 11 for INC values: I_INACTIVE = 0x0000 I_ACTIVE = 0x0C00
Active PLS DATA TYPE: BYTE	Determines the sensor active for this MF. Valid between 1 and 4.
Active field pair DATA TYPE: BYTE	Determines the protective and warning fields active for this MF. Valid between 1 and 8.
DUMMY DATA TYPE: BYTE	RESERVED
Output diagram DATA TYPE: BYTE	Bit 0: OSSD A is addressed if 1 Bit 1: OSSD B is addressed if 1 Bit 2: to BIT 7: free Only one OSSD must be assigned to one MF.
Dummy DATA TYPE: UNIT	Reserved
DUMMY DATA TYPE: BYTE	RESERVED

Scan rate DATA TYPE: BYTE	Minimum setting: 2 (default with balancing) Maximum setting: 16.
NextCase1 Byte	Next monitoring case no. 1 - 15, 0xFF means any sequence
NextCase2 Byte	Next monitoring case no. 1 - 15, 0xFF means any sequence
MaxSpeed DATA TYPE: INT	Maximum speed for this monitoring case with in cm/sec
MinSpeed DATA TYPE: INT	Minimum speed for this monitoring case in cm/sec
Description: The definition described for a MF repeats itself n times for the total number of defined monitoring fields.	

3.2.29 Saving the configuration data (F4H)

Telegram number: F4H (CFGACK_TGM)	
Parameters: Status selection of telegrams to be saved	
Transfer mode DATA TYPE: BYTE	Error-free transmission **if 1** (transfer configuration into EEPROM) Error-free transmission **if 0** (ignore configuration)
Acceptance data DATA TYPE: UNIT	Bit 0: Basic configuration in EEPROM **if 1** Bit 1: MF 1 into EEPROM **if 1** Bit 2: MF 2 into EEPROM **if 1** Bit 3: MF 3 into EEPROM **if 1** Bit 4: MF 4 into EEPROM **if 1** Bit 5: MF 5 into EEPROM **if 1** Bit 6: MF 6 into EEPROM **if 1** Bit 7: MF 7 into EEPROM **if 1** Bit 8: MF 8 into EEPROM **if 1** Bit 9: MF 9 into EEPROM **if 1** Bit 10: MF 10 into EEPROM **if 1** Bit 11: MF 11 into EEPROM **if 1** Bit 12: MF 12 into EEPROM **if 1** Bit 13: MF 13 into EEPROM **if 1** Bit 14: MF 14 into EEPROM **if 1** Bit 15: MF 15 into EEPROM **if 1**

3.2.30 Response to shifting PLS into LSI mode

Telegram number: F7H (LSIMODEACK_TGM)	
Transfer parameters:	
Status DATA TYPE: BYTE	00H -> LSI mode change not successful. 01H -> LSI mode change successful.
Mode state DATA TYPE: BYTE	00H LSIMODE OFF 01H LSIMODE ON
Description: PLS changes to "All measured values continuously" operating mode Baud rate 500 Kbaud, not permanent LED state can be controlled via LEDSET_TGM OSSDs red as standard, LED also.	

4 Overview of telegrams implemented

4.1 Data direction host -> sensor / LSI

INITIALIZATION AND RESET	HEADER	10H (INIT_TGM)	BCC				
SELECTING AND CHANGING THE OPERATING MODE	HEADER	20H (BM_TGM)	Mode	Password string	BCC		
MEASURED VALUE REQUEST	HEADER	30H (MWANF_TGM)	Mode	NO. OF SEGMENTS	BCC		
SENSOR STATUS REQUEST	HEADER	31H (SSANF_TGM)	BCC				
ERROR TELEGRAM REQUEST	HEADER	32H (ERRANF_TGM)	BCC				
TESTING DIAGNOSIS MODE REQUEST	HEADER	33H (TSTANF_TGM)	TEST NUMBER	BCC			
MEMORY DUMP IN DIAGNOSIS MODE REQUEST	HEADER	34H (MEMANF_TGM)	START ADDRESS	NUMBER N OF DATA	DATA1...N	BCC	
LSI CONFIGURATION REQUEST	HEADER	38H (LSIKFGANF_TGM)	BCC				
MF DEFINITIONS REQUEST	HEADER	39H (UWFANF_TGM)	NUMBER OF MF	BCC			
CONFIGURE THE BUMPER PROTECTIVE FIELD	HEADER	40H (BSFKFG_TGM)	Mode, Date, Time	LI, RE, HO, EXP OR RADIUS OR SEGMENT DATA	BCC		
CONFIRMATION OF THE CONFIGURATION BUMPER PROTECTIVE FIELD	HEADER	41H (BSFCONF_TGM)	Status	BCC			
CHANGE THE PASSWORD	HEADER	42H (PWCHG_TGM)	Status	PW type	Password string 1	BCC	
CONFIGURE THE COLLISION PROTECTION FIELD	HEADER	43H (KSFKFG_TGM)	AS	EP[1]	...	EP[AS+1]	BCC
DEFINE THE RESTART BEHAVIOR (PERMITTED ONLY IN SETUP OR BALANCING MODE, PLS ONLY)	HEADER	44H (WANL_TGM)	Mode	BCC			
CONFIGURED PROTECTIVE FIELDS REQUEST	HEADER	45H (SFANF_TGM)	Protective field type	BCC			
TEACH-IN MODE	HEADER	46H (LMOD_TGM)	Action	Date, Time	BCC		
CONFIRM RESTART DEFINITION (PERMITTED ONLY IN STARTUP OR BALANCING MODE, PLS ONLY)	HEADER	47H (WANLCFRM_TGM)	Mode	BCC			
CONFIGURE DYNAMIC PROTECTIVE FIELD	HEADER	48H (DYNSFKFG_TGM)	Dyn. PF parameters	BCC			
CONFIGURATION OF DYNAMIC PROTECTIVE FIELD CONFIRMATION	HEADER	49H (DYNSFCONF_TGM)	Status	BCC			
PERFORM BALANCING	HEADER	50H (AGL_TGM)	Mode	Serial number	BCC		

DEFINE STARTUP TEST (PERMITTED IN ONLY STARTUP OR BALANCING MODE, PLS ONLY)	HEADER	60H (ANLDEF_TGM)	Mode	BCC
CONFIRM STARTUP TEST (PERMITTED ONLY IN STARTUP OR BALANCING MODE, PLS ONLY)	HEADER	61H (ANLCFRM_TGM)	Mode	BCC
DEFINE SWITCHING OUTPUT WF OR CONTAMINATION (PERMITTED ONLY IN STARTUP OR BALANCING MODE, PLS ONLY)	HEADER	62H (OUTPUTDEF_TGM)	Mode	BCC
DEFINE SCAN RATE (PERMITTED ONLY IN SETUP OR BALANCING MODE, PLS ONLY)	HEADER	63H (RSPTIMEDEF_TGM)	Number	BCC
CONFIRM DEFINITION OF SCAN RATE (PERMITTED ONLY IN SETUP OR BALANCING MODE, PLS ONLY)	HEADER	64H (RSPTIMECFRM_TGM)	Number	BCC
DEFINE THE WF TYPE (PERMITTED ONLY IN SETUP OR BALANCING MODE, PLS ONLY)	HEADER	65H (WSFTYPDEF_TGM)	Type	BCC
DEFINITION OF PERMANENT BAUD RATE WITH POWERON	HEADER	66H (BRPERMDEF_TGM)	Mode	BCC
DEFINITION OF LSI ADDRESS	HEADER	67H (ADRDEF_TGM)	Address	BCC
SWITCH LASER SENDER ON/OFF	HEADER	68H (LASER_TGM)	State	BCC
DEFINE LSI CONFIGURATION	HEADER	70H (LSIKFGDEF_TGM)	KFG parameters	BCC
CONFIRMATION FOR LSI CONFIGURATION DEFINITION	HEADER	71H (LSIKFGCFRM_TGM)	KFG parameters	BCC
DEFINITION OF MONITORING CASE	HEADER	72H (UWFDEF_TGM)	MF parameters	BCC
CONFIRM DEFINITION OF A MONITORING CASE	HEADER	73H (UWFCFRM_TGM)	MF parameters	BCC
Save the configuration values in E2Prom	HEADER	74H (CFGSAVE_TGM)	PARAMETERS	
Switch PLS to LSI mode	HEADER	77H (LSIMODE_TGM)	BCC	
Control red/green LED of PLS in LSI	HEADER	78H (LEDSET_TGM)	Parameters	BCC

4.2 Data direction sensor / LSI -> host

MESSAGE AFTER POWER ON	HEADER	90H (PON_TGM)	Name	SW version	BCC			
MESSAGE AFTER POWER ON	HEADER	91H (INIT_ACK_TGM)	BCC					
MESSAGE AFTER POWER ON	HEADER	92H (NACK_TGM)	BCC					
OPERATING MODE CHANGE	HEADER	A0H (BMACK_TGM)	Status	BCC				
MEASUREMENT	HEADER	B0H (MW_TGM)	AMW	MW[1]	...	MW [AMW]	BCC	
SENSOR STATUS	HEADER	B1H (SS_TGM)	SW Version	Oper. mode	Status	Ser-ial number	...	BCC
ERROR MESSAGE TEST MESSAGE	HEADER	B2H (ERR_TGM)	Error type	Error number / test number	... other errors	BCC		
MEMORY DUMP	HEADER	B4H (MEMRD_TGM)	Start address	Number n of Data bytes 1	Data	BCC		
LSI CONFIGURATION DATA	HEADER	B8H (LSIKFG_TGM)	LSI config. parameters	BCC				
MF DEFINITION DATA	HEADER	B9H (UWF_TGM)	MF parameters	BCC				
RESPONSE TO PF CONFIGURATION	HEADER	C0H (BSFACK_TGM)	Status, Mode, Date, Time	LI, RE, HO, EXP OR RADIUS OR SEGMENT DATA	EXP	BCC		
RESPONSE TO PF CONFIRMATION	HEADER	C1H (BSFCFRM_TGM)	Status	BCC				
CONFIRM NEW PASSWORD	HEADER	C2H (PWACK_TGM)	Status, PW type	BCC				
RESPONSE TO WF CONFIGURATION	HEADER	C3H (KSFACK_TGM)	Status	BCC				
RESPONSE TO RESTART DEFINITION (PLS ONLY)	HEADER	C4H (WANLACK_TGM)	Status	Mode	BCC			
CONFIGURATION DATA OF PROTECTIVE FIELD	HEADER	C5H (SFDAT_TGM)	Protective field type, Date, Time	Protective field data 1	...	Protective field data n	BCC	
RESPONSE IN TEACH-IN MODE	HEADER	C6H (LMODACK_TGM)	Status	BCC				
RESPONSE TO DYNAM. PF CONFIGURATION	HEADER	C8H (DYNSFACK_TGM)	Status, Dyn. PF data	BCC				
RESPONSE TO DYNAM. PF CONFIRMATION	HEADER	C9H (DYNSFCFRM_TGM)	Status	BCC				
RESPONSE TO PERFORM BALANCING	HEADER	D0H (AGLACK_TGM)	Status	BCC				

RESPONSE TO START TEST DEFINITION (PLS ONLY)	HEADER	E0H (ANLACK_TGM)	Status	MODE	BCC
RESPONSE TO OUTPUT DEFINITION (PLS ONLY)	HEADER	E2H (OUTPUTACK_TGM)	Status	MODE	BCC
RESPONSE TO SCAN RATE DEFINITION (PLS ONLY)	HEADER	E4H (RSPTIMEACK_TGM)	Status	NUMBER	BCC
RESPONSE TO WF TYPE DEFINITION (PLS ONLY)	HEADER	E5H (WSFTYPACK_TGM)	Status	Type	BCC
RESPONSE TO PERM. BAUD RATES DEFINITION	HEADER	E6H (BRPERMACK_TGM)	Status	Type	BCC
RESPONSE TO DEFINE LSI ADDRESS	HEADER	E7H (ADRACK_TGM)	Status	Address	BCC
RESPONSE TO SWITCHING LASER SENDER ON/OFF	HEADER	E8H (LASERACK_TGM)	Status	State	BCC
RESPONSE TO LSI CONFIGURATION	HEADER	F0H (LSIKFGACK_TGM)	Status	LSI config. parameters	BCC
RESPONSE TO MONITORING CASE DEFINITION	HEADER	F2H (UWFACK_TGM)	Status	MF parameters	BCC
Response to Configure values in E2Prom	HEADER	F4H (CFGACK_TGM)	Status	PARAMETERS	
Response to shifting PLS into LSI mode	HEADER	F7H (LSIMODEACK_TGM)	Status	BCC	

The names in brackets next to the telegram numbers are the constant definitions which are also used in the system software of the sensor.

5 Overview of the mode restrictions with regard to the various telegram requests from the user

X indicates that the telegram request is permitted in the corresponding operating mode.

	Monitoring mode	Diagnosis mode	Balancing mode	Setup mode
INIT_TGM	X	X	X	X
BM_TGM	X	X	X	X
MWANF_TGM	X	X	X	X
SSANF_TGM	X	X	X	X
ERRANF_TGM	X	X	X	X
KSFKFG_TGM	(X)	(X)	X	X
SFANF_TGM	X	X	X	X
MEMANF_TGM	X	X	X	X
LSIKFGANF_TGM	X	X	X	X
UWFANF_TGM	X	X	X	X
TSTANF_TGM	(with fatal error)	X		
AGL_TGM			X	(Contamination measurement permitted)
WANL_TGM			X	X
WANLCFRM_TGM			X	X
ANLDEF_TGM			X	X
ANLCFRM_TGM			X	X
OUTPUTDEF_TGM			X	X
RSPTIMEDEF_TGM			X	X
RSPTIMECFRM_TGM			X	X
WFTYPDEF_TGM			X	X
BSFKFG_TGM			X	X
BSFCONF_TGM			X	X
DYNSFKFG_TGM			X	X
DYNSFCONF_TGM			X	X
PWCHG_TGM			X	X
LMOD_TGM			X	X
BRPERMDEF_TGM			X	X
ADRDEF_TGM			X	X
LASER_TGM	X	X	X	X
LSIKFGDEF_TGM			X	X
LSIKFGCFRM_TGM			X	X
UWFDEF_TGM			X	X
UWFCFRM_TGM			X	X
LSIMODE_TGM			X	X
LEDSET_TGM	X			

6 Abbreviations and notes

The data type BYTE corresponds to the range 0 to 255, length 1 byte.
The data type UINT corresponds to the range 0 to 2^{16}-1, length 2 bytes.

Hexadecimal values are used in the following representations:

- 0xAA
- 0AAH
- 0AAh

The designations for the protective field can vary between:

- SPF for safe protective field
- BSP for bumper protective field
- PF for protective field

The designations for the warning field can vary between:

- WPF for warning protective field
- KSK for collision protective field
- WF for warning field

The designation for a monitoring case or the monitoring case definition is MF or MFD.

The control characters used in the transfer protocol are defined as follows:

- STX 002H
- ACK 006H
- DLE 010H
- NAK 015H