Leuze

Original Operating Instructions

# Controller LBK ISC

## MODBUS TCP Specification


The Sensor People

We reserve the right to make technical changes
EN•2023-08-15•50149166

Leuze electronic GmbH + Co. KG
In der Braike 1
73277 Owen / Germany
Phone: +49 7021 573-0
Fax: +49 7021 573-199
www.leuze.com
info@leuze.com

# 1 Scope

This document defines the data exchanged using the MODBUS protocol with LBK S-01 System and LBK SBV System.

# 2 Applicability

The protocol can be enabled only on the following controller models, thanks to their Ethernet capability:

- LBK ISC BUS PS
- LBK ISC100E-F
- LBK ISC-02
- LBK ISC110E-P
- LBK ISC110E-F
- LBK ISC110E

All the information exchanged using the protocol is to be considered not safe and consequently must be used only for not safe purposes.

## 2.1 Protocol version

| Protocol version | Controller firmware version |
|---|---|
| V1 | Before 2.0.0 |
| V2 | From 2.0.0 onwards |

# 3 System Overview

The devices communicate by means of the RJ45 connector **[A]** on the top (Refer to Figure 2, Figure 3, Figure 5 and Figure 6).

## 3.1 LBK ISC BUS PS, LBK ISC100E-F and LBK ISC-02 devices

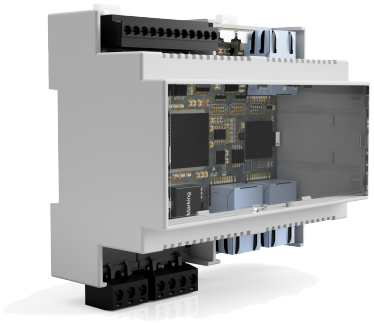

***Figure 1*** *Device*

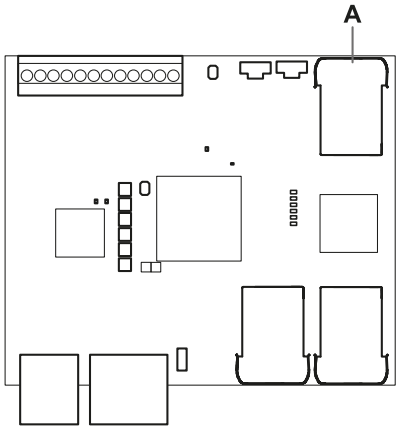


***Figure 2*** *LBK ISC BUS PS, LBK ISC100E-F structure*

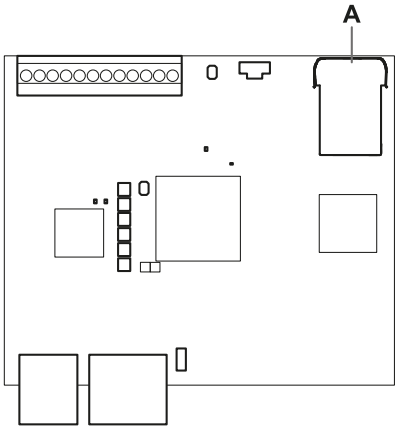


***Figure 3*** *LBK ISC-02 structure*

## 3.2 LBK ISC110E-P, LBK ISC110E-F and LBK ISC110E devices

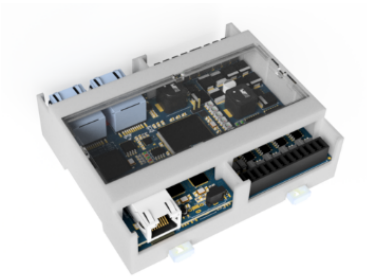

***Figure 4*** *Device*

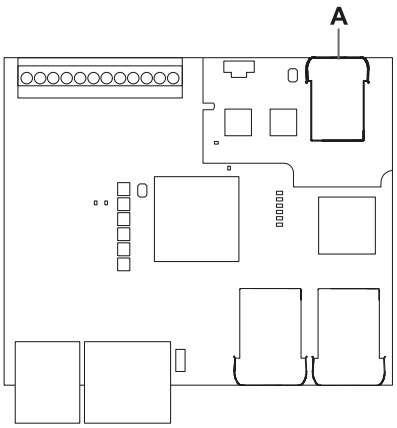


***Figure 5*** *LBK ISC110E-P, LBK ISC110E-F structure*

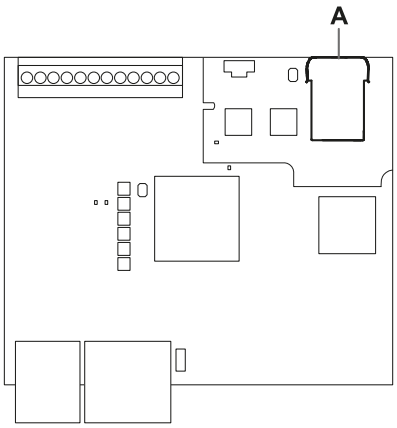


***Figure 6*** *LBK ISC110E structure*

# 4 MODBUS data exchange

Within the Ethernet network, the controller acts like a server (MODBUS TCP protocol).

To use the feature, the user has to enable MODBUS data exchange on the controller via LBK Designer application (available at www.leuze.com).

The MODBUS client has to send requests at the IP address set in the Network parameters and at the specific MODBUS port (default is 502).

The controllers use the following MODBUS address:

- 40000 for controller and sensors information* (length: 62 double byte)
- 41000 for controller and sensors data (length: 76 double byte)

**Note***: available from MODBUS protocol V2, that is firmware version 2.0.0 of the controller.

## 4.1 MODBUS controller and sensor information

**Note**: available from MODBUS protocol V2, that is firmware version 2.0.0 of the controller.

### MODBUS protocol information

| Word | Bit 15 | Bit 14 | Bit 13 | Bit 12 | Bit 11 | Bit 10 | Bit 9 | Bit 8 | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40000 | MODBUS interface version | | | | | | | | | | | | | | | |

### Controller information

| Word | Bit 15 | Bit 14 | Bit 13 | Bit 12 | Bit 11 | Bit 10 | Bit 9 | Bit 8 | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40001 | HW revision (32 bit) | | | | | | | | | | | | | | | |
| 40002 | | | | | | | | | | | | | | | | |
| 40003 | FW version (32 bit) | | | | | | | | | | | | | | | |
| 40004 | | | | | | | | | | | | | | | | |
| 40005 | ETH version (32 bit) | | | | | | | | | | | | | | | |
| 40006 | | | | | | | | | | | | | | | | |
| 40007 | Reserved (*Params revision*) | | | | | | | | | | | | | | | |
| 40008 | Reserved (*ISP revision*) | | | | | | | | | | | | | | | |
| 40009 | Model | | | | | | | | | | | | | | | |
| 40010 | V1: Fieldbus FW version (32 bit) | | | | | | | | | | | | | | | |
| 40011 | from V2: NID (32 bit) | | | | | | | | | | | | | | | |
| 40012 | Fieldbus stack revision (32 bit) | | | | | | | | | | | | | | | |
| 40013 | | | | | | | | | | | | | | | | |

### Sensor information

*n* starts from 40014 and data are replicated six times, one for each sensor.

| Word | Bit 15 | Bit 14 | Bit 13 | Bit 12 | Bit 11 | Bit 10 | Bit 9 | Bit 8 | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| n | HW identifier (32 bit) | | | | | | | | | | | | | | | |
| n + 1 | | | | | | | | | | | | | | | | |
| n + 2 | FW version (32 bit) | | | | | | | | | | | | | | | |
| n + 3 | | | | | | | | | | | | | | | | |
| n + 4 | Sensor protocol | | | | | | | | | | | | | | | |
| n + 5 | SID (Serial Number) | | | | | | | | | | | | | | | |
| n + 6 | | | | | | | | | | | | | | | | |
| n + 7 | Sensor model/type | | | | | | | | | | | | | | | |

### Information coding

The following table reports how the information is encoded in the MODBUS registers.

| Name | Format | Description |
|---|---|---|
| **MODBUS information** | | |
| MODBUS interface version | uint16_t | V1 = 1<br>V2 = 2 |
| **Controller information** | | |
| HW revision | uint32_t | x.y where<br>x = bit 16..bit 31<br>y = bit 0..bit 15 |
| FW version | uint32_t | x.y.z<br>where<br>x = bit 24..bit 31<br>y = bit 16..bit 23<br>z = bit 0..bit 15 |
| ETH version | uint32_t | x.y.z<br>where<br>x = bit 24..bit 31<br>y = bit 16..bit 23<br>z = bit 0..bit 15 |
| Fieldbus FW version | uint32_t | x.y.z<br>where<br>x = bit 24..bit 31<br>y = bit 16..bit 23<br>z = bit 0..bit 15 |
| Controller model | uint16_t | 0 = invalid<br>1 = LBK ISC BUS PS<br>2 = reserved<br>3 = LBK ISC100E-F<br>4 = LBK ISC-02<br>5 = LBK ISC-03<br>6 = LBK ISC110E-P<br>7 = reserved<br>8 = LBK ISC110E-F<br>9 = LBK ISC110E<br>10 = LBK ISC110 |
| NID | uint32_t | Network ID, that is the 5-figure number reported on the product label (see NID/SID decoding function on the next page) |
| Fieldbus stack revision | uint32_t | x.y.z<br>where<br>x = bit 24..bit 31<br>y = bit 16..bit 23<br>z = bit 0..bit 15 |

| Name | Format | Description |
|---|---|---|
| **Sensor information** | | |
| HW identifier | uint32_t | The value encodes HW information like PCB revision, BOM rev, model, type, etc. To be shown as HEX number. |
| FW version | uint32_t | x.y<br>where<br>x = bit 16..bit 23<br>y = bit 0..bit 15<br>**Note**: bit 24..bit 31 are reserved. |
| Sensor protocol | uint16_t | 0 = not valid<br>1 = obsolete value<br>2 = LBK SBV sensor protocol<br>3 = LBK S-01 sensor protocol |
| SID | uint32_t | Sensor ID, that is the 5-figure number reported on the product label (see NID/SID decoding function below) |
| Sensor model/type | uint16_t | 0 = not valid<br>1 = LBK S-01<br>2 = LBK SBV-01<br>3 = reserved<br>4 = LBK SBV201<br>5 = reserved<br>6 = LBK SBV205<br>7 = reserved |

### NID/SID decoding function

NID (Network ID) and SID (Sensor ID) are five-char numeric strings (E.g. 01234).

The conversion from the encoded value to the string can be achieved using the following pseudo code:

```
if ((value & 0xFF000000) >> 24U) != 0
        serialNumberId = (serialNumber & 0x0001FFFFU);
        sprintf(stringa, "%05u", serialNumberId);
else
        string[0] = (char)((value & 0x00FE0000) >> 17);
        string[1] = (char)((value & 0x0001FC00) >> 10);
        string[2] = (char)(value / 100) + '0';
        string[3] = value/ 10 % 10 + '0';
        string[4] = value % 10 + '0';
        string[5] = 0;
```

## 4.2 MODBUS controller and sensors data

| Word | Bit 15 | Bit 14 | Bit 13 | Bit 12 | Bit 11 | Bit 10 | Bit 9 | Bit 8 | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41000 | NA | | | | Restart Signal feedback | | | | Controller status | | | | | | | |
| 41001 | NA | | | | Status of single channel inputs | | | | NA | | | | Static Object Detection Status | | | |
| 41002 | NA | | | | | | | | Configuration ID currently in use | | | | | | | |
| 41003 | CRC32 of the configuration ID currently in use (32 bit) MSB | | | | | | | | | | | | | | | |
| 41004 | CRC32 of the configuration ID currently in use (32 bit) LSB | | | | | | | | | | | | | | | |
| 41005 | NA | | | | | | | | Digital inputs | | | | | | | |
| 41006 | NA | | | | | | | | Digital outputs | | | | | | | |
| 41007 | NA | | | | | | | | Muting status | | | | | | | |
| 41008 | Sensor 1 status | | | | | | | | | | | | | | | |
| 41009 | Sensor 2 status | | | | | | | | | | | | | | | |
| 41010 | Sensor 3 status | | | | | | | | | | | | | | | |
| 41011 | Sensor 4 status | | | | | | | | | | | | | | | |
| 41012 | Sensor 5 status | | | | | | | | | | | | | | | |
| 41013 | Sensor 6 status | | | | | | | | | | | | | | | |
| 41014* | Sensor 1 detection field 1 distance | | | | | | | | | | | | | | | |
| 41015** | NA | | | | | | | | Sensor 1 detection field 1 angle | | | | | | | |
| 41016* | Sensor 1 detection field 2 distance | | | | | | | | | | | | | | | |
| 41017** | NA | | | | | | | | Sensor 1 detection field2 angle | | | | | | | |
| 41018** | Sensor 1 detection field 3 distance | | | | | | | | | | | | | | | |
| 41019** | NA | | | | | | | | Sensor 1detection field 3 angle | | | | | | | |
| 41020** | Sensor 1 detection field 4 distance | | | | | | | | | | | | | | | |
| 41021** | NA | | | | | | | | Sensor 1 detection field4 angle | | | | | | | |
| 41022* | Sensor 2 detection field 1 distance | | | | | | | | | | | | | | | |
| 41023** | NA | | | | | | | | Sensor 2 detection field1 angle | | | | | | | |
| 41024* | Sensor 2 detection field 2 distance | | | | | | | | | | | | | | | |
| 41025** | NA | | | | | | | | Sensor 2 detection field 2 angle | | | | | | | |
| 41026** | Sensor 2 detection field 3 distance | | | | | | | | | | | | | | | |
| 41027** | NA | | | | | | | | Sensor 2 detection field 3 angle | | | | | | | |
| 41028** | Sensor 2 detection field 4 distance | | | | | | | | | | | | | | | |
| 41029** | NA | | | | | | | | Sensor 2 detection field 4 angle | | | | | | | |
| 41030* | Sensor 3 detection field 1 distance | | | | | | | | | | | | | | | |
| 41031** | NA | | | | | | | | Sensor 3 detection field 1 angle | | | | | | | |
| 41032* | Sensor 3 detection field 2 distance | | | | | | | | | | | | | | | |
| 41033** | NA | | | | | | | | Sensor 3 detection field 2 angle | | | | | | | |
| 41034** | Sensor 3 detection field 3 distance | | | | | | | | | | | | | | | |
| 41035** | NA | | | | | | | | Sensor 3 detection field 3 angle | | | | | | | |
| 41036** | Sensor 3 detection field 4 distance | | | | | | | | | | | | | | | |
| 41037** | NA | | | | | | | | Sensor 4 detection field 4 angle | | | | | | | |
| 41038* | Sensor 4 detection field 1 distance | | | | | | | | | | | | | | | |

| Word | Bit 15 | Bit 14 | Bit 13 | Bit 12 | Bit 11 | Bit 10 | Bit 9 | Bit 8 | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41039** | NA | | | | | | | | Sensor 4 detection field 1 angle | | | | | | | |
| 41040* | Sensor 4 detection field 2 distance | | | | | | | | | | | | | | | |
| 41041** | NA | | | | | | | | Sensor 4 detection field 2 angle | | | | | | | |
| 41042** | Sensor 4 detection field 3 distance | | | | | | | | | | | | | | | |
| 41043** | NA | | | | | | | | Sensor 4 detection field 3 angle | | | | | | | |
| 41044** | Sensor 4 detection field 4 distance | | | | | | | | | | | | | | | |
| 41045** | NA | | | | | | | | Sensor 4 detection field 4 angle | | | | | | | |
| 41046* | Sensor 5 detection field 1 distance | | | | | | | | | | | | | | | |
| 41047** | NA | | | | | | | | Sensor 5 detection field 1 angle | | | | | | | |
| 41048* | Sensor 5 detection field 2 distance | | | | | | | | | | | | | | | |
| 41049** | NA | | | | | | | | Sensor 5 detection field 2 angle | | | | | | | |
| 41050** | Sensor 5 detection field 3 distance | | | | | | | | | | | | | | | |
| 41051** | NA | | | | | | | | Sensor 5 detection field 3 angle | | | | | | | |
| 41052** | Sensor 5 detection field 4 distance | | | | | | | | | | | | | | | |
| 41053** | NA | | | | | | | | Sensor 5 detection field 4 angle | | | | | | | |
| 41054* | Sensor 6 detection field 1 distance | | | | | | | | | | | | | | | |
| 41055** | NA | | | | | | | | Sensor 6 detection field 1 angle | | | | | | | |
| 41056* | Sensor 6 detection field 2 distance | | | | | | | | | | | | | | | |
| 41057** | NA | | | | | | | | Sensor 6 detection field 2 angle | | | | | | | |
| 41058** | Sensor 6 detection field 3 distance | | | | | | | | | | | | | | | |
| 41059** | NA | | | | | | | | Sensor 6 detection field 3 angle | | | | | | | |
| 41060** | Sensor 6 detection field 4 distance | | | | | | | | | | | | | | | |
| 41061** | NA | | | | | | | | Sensor 6 detection field 4 angle | | | | | | | |
| 41062 | NA | | | | | | | | Controller error status | | | | | | | |
| 41063 | Controller details error status | | | | | | | | | | | | | | | |
| 41064 | NA | | | | | | | | Sensor 1 error status | | | | | | | |
| 41065 | Sensor 1 details error status | | | | | | | | | | | | | | | |
| 41066 | NA | | | | | | | | Sensor 2 error status | | | | | | | |
| 41067 | Sensor 2 details error status | | | | | | | | | | | | | | | |
| 41068 | NA | | | | | | | | Sensor 3 error status | | | | | | | |
| 41069 | Sensor 3 details error status | | | | | | | | | | | | | | | |
| 41070 | NA | | | | | | | | Sensor 4 error status | | | | | | | |
| 41071 | Sensor 4 details error status | | | | | | | | | | | | | | | |
| 41072 | NA | | | | | | | | Sensor 5 error status | | | | | | | |
| 41073 | Sensor 5 details error status | | | | | | | | | | | | | | | |
| 41074 | NA | | | | | | | | Sensor 6 error status | | | | | | | |
| 41075 | Sensor 6 details error status | | | | | | | | | | | | | | | |
| 41076*** | Sensor 1 configuration bitmask | | | | | | | | | | | | | | | |
| 41077*** | | | | | | | | | | | | | | | | |
| 41078*** | Sensor 2 configuration bitmask | | | | | | | | | | | | | | | |
| 41079*** | | | | | | | | | | | | | | | | |

| Word | Bit 15 | Bit 14 | Bit 13 | Bit 12 | Bit 11 | Bit 10 | Bit 9 | Bit 8 | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41080*** | Sensor 3 configuration bitmask | | | | | | | | | | | | | | | |
| 41081*** | | | | | | | | | | | | | | | | |
| 41082*** | Sensor 4 configuration bitmask | | | | | | | | | | | | | | | |
| 41083*** | | | | | | | | | | | | | | | | |
| 41084*** | Sensor 5 configuration bitmask | | | | | | | | | | | | | | | |
| 41085*** | | | | | | | | | | | | | | | | |
| 41086*** | Sensor 6 configuration bitmask | | | | | | | | | | | | | | | |
| 41087*** | | | | | | | | | | | | | | | | |

**Note ***: for LBK S-01 System, it represents the distance of the nearest target. This distance is reported equal in both DF 1 and DF 2 distance fields.

**Note ****: available only for LBK SBV System.

**Note *****: available from MODBUS protocol V2, that is firmware version 2.0.0 of the controller.

### Controller status

The byte containing the status of the controller (address 41000) is encoded as a bit mask as follows:

| | | |
|---|---|---|
| **Bit 0** | DETECTION FIELD 1 | (Values: 0 is DETECTION, 1 is NO DETECTION) |
| **Bit 1** | DETECTION FIELD 2 | (Values: 0 is DETECTION, 1 is NO DETECTION) |
| **Bit 2** | DETECTION FIELD 3<br>(available only for LBK SBV System) | (Values: 0 is DETECTION, 1 is NO DETECTION) |
| **Bit 3** | DETECTION FIELD 4<br>(available only for LBK SBV System) | (Values: 0 is DETECTION, 1 is NO DETECTION) |
| **Bit 4** | RESTART FEEDBACK SIGNAL | (Values: 0 is “The system is waiting for a manual restart”, 1 is "System is running") |
| **Bit 5** | STOP FEEDBACK SIGNAL | (Values: 0 is “Emergency required”, 1 is "System is running") |
| **Bit 6** | SYSTEM DIAGNOSTIC SIGNAL | (Values: 0 is “The system is in error”, 1 is "System is running") |
| **Bit 7** | CONFIGURATION FEEDBACK | (Values: 0 is “The system is in configuration”, 1 is "System is running") |

**Note:** detection in one field means that at least one connected sensor is in detection in that field.

### Restart Signal Feedback

The byte containing the status of the restart signal feedback (word 41000) is encoded as a bit mask as follows:

| | | |
|---|---|---|
| **Bit 8** | DETECTION FIELD 1 | (Values: 0 is "Waiting for manual restart", 1 is "System is running") |
| **Bit 9** | DETECTION FIELD 2 | (Values: 0 is "Waiting for manual restart" 1 is "System is running") |
| **Bit 10** | DETECTION FIELD 3 (available only for LBK SBV System) | (Values: 0 is "Waiting for manual restart", 1 is "System is running") |
| **Bit 11** | DETECTION FIELD 4 (available only for LBK SBV System) | (Values: 0 is "Waiting for manual restart", 1 is"System is running") |
| **Bit 12** | *NA* | |
| **Bit 13** | *NA* | |
| **Bit 14** | *NA* | |
| **Bit 15** | *NA* | |

#### Static Object Detection status

The byte containing the status of the Static Object Detection option (word 41001) is encoded as a bit mask as follows:

| | | |
|---|---|---|
| **Bit 0** | STATIC OBJECT DETECTION FIELD 1 (available only for LBK SBV System*) | (Values: 0 is DETECTION, 1 is FREE) |
| **Bit 1** | STATIC OBJECT DETECTION FIELD 2 (available only for LBK SBV System*) | (Values: 0 is DETECTION, 1 is FREE) |
| **Bit 2** | STATIC OBJECT DETECTION FIELD 3 (available only for LBK SBV System*) | (Values: 0 is DETECTION, 1 is FREE) |
| **Bit 3** | STATIC OBJECT DETECTION FIELD 4 (available only for LBK SBV System*) | (Values: 0 is DETECTION, 1 is FREE) |
| **Bit 4** | *NA* | |
| **Bit 5** | *NA* | |
| **Bit 6** | *NA* | |
| **Bit 7** | *NA* | |

**Note *:** only if controller has firmware version 1.5.0 or later.

#### Status of single channel inputs

The byte containing the status of the single channel inputs (address 41001) is encoded as follows:

| | | |
|---|---|---|
| **Bit 8** | Input 1 Channel 1 logical status | (Values: 1 is HIGH, 0 is LOW) |
| **Bit 9** | Input 1 Channel 2 logical status | (Values: 1 is HIGH, 0 is LOW) |
| **Bit 10** | Input 2 Channel 1 logical status | (Values: 1 is HIGH, 0 is LOW) |
| **Bit 11** | Input 2 Channel 2 logical status | (Values: 1 is HIGH, 0 is LOW) |
| **Bit 12** | *NA* | |
| **Bit 13** | *NA* | |
| **Bit 14** | *NA* | |
| **Bit 15** | *NA* | |

#### Current configuration ID and its CRC32

The byte at address 41002 contains the number of the current dynamic configuration in use. Valid range is from 0 to 31, depending on the configuration of the system.

The double bytes at addresses 41003 (MSB) and 41004 (LSB) contain its relevant signature (32-bit checksum).

#### Status of the digital inputs

The byte containing the status of the digital inputs (address 41005) is encoded as follows:

| | | |
|---|---|---|
| **Bit 0** | Input 1 logical status | (Values: 1 is HIGH, 0 is LOW) |
| **Bit 1** | Input 1 diagnostic error | (Values: 1 is in ERROR, 0 is OK) |
| **Bit 2** | *NA* | |
| **Bit 3** | Input 1 configuration | (Values: 1 is NOT CONFIGURED, 0 is in USE) |
| **Bit 4** | Input 2 logical status | (Values: 1 is HIGH, 0 is LOW) |
| **Bit 5** | Input 2 diagnostic error | (Values: 1 is in ERROR, 0 is OK) |
| **Bit 6** | *NA* | |
| **Bit 7** | Input 2 configuration | (Values: 1 is NOT CONFIGURED, 0 is in USE) |

### Status of digital outputs

The byte containing the status of the digital outputs (address 41006) is encoded as follows:

| | | |
|---|---|---|
| **Bit 0** | Output 1 status | (Values: 1 is HIGH, 0 is LOW) |
| **Bit 1** | Output 2 status | (Values: 1 is HIGH, 0 is LOW) |
| **Bit 2** | Output 3 status | (Values: 1 is HIGH, 0 is LOW) |
| **Bit 3** | Output 4 status | (Values: 1 is HIGH, 0 is LOW) |
| **Bit 4** | Output 1 diagnostic error | (Values: 1 is in ERROR, 0 is OK) |
| **Bit 5** | Output 2 diagnostic error | (Values: 1 is in ERROR, 0 is OK) |
| **Bit 6** | Output 3 diagnostic error | (Values: 1 is in ERROR, 0 is OK) |
| **Bit 7** | Output 4 diagnostic error | (Values: 1 is in ERROR, 0 is OK) |

### Muting status

The byte containing the status of the system muting (address 41007) is encoded as follows:

| | | |
|---|---|---|
| **Bit 0** | Muting status of sensor 1 | (Values: 0 is MUTED, 1 is NOT MUTED) |
| **Bit 1** | Muting status of sensor 2 | (Values: 0 is MUTED, 1 is NOT MUTED) |
| **Bit 2** | Muting status of sensor 3 | (Values: 0 is MUTED, 1 is NOT MUTED) |
| **Bit 3** | Muting status of sensor 4 | (Values: 0 is MUTED, 1 is NOT MUTED) |
| **Bit 4** | Muting status of sensor 5 | (Values: 0 is MUTED, 1 is NOT MUTED) |
| **Bit 5** | Muting status of sensor 6 | (Values: 0 is MUTED, 1 is NOT MUTED) |
| **Bit 6** | *NA* | |
| **Bit 7** | *NA* | |

### Sensor status

Each double byte at addresses from 41008 to 41013 contains the status of the relevant sensor encoded as follows:

| | | |
|---|---|---|
| **Bit 0** | DETECTION FIELD 1 | (Values: 0 is DETECTION, 1 is NO DETECTION) |
| **Bit 1** | DETECTION FIELD 2 | (Values: 0 is DETECTION, 1 is NO DETECTION) |
| **Bit 2** | DETECTION FIELD 3<br>(available only for LBK SBV System) | (Values: 0 is DETECTION, 1 is NO DETECTION) |
| **Bit 3** | DETECTION FIELD 4<br>(available only for LBK SBV System) | (Values: 0 is DETECTION, 1 is NO DETECTION) |
| **Bit 4** | DIAGNOSTIC FEEDBACK | (Values: 0 is in FAULT, 1 is OK) |
| **Bit 5** | MUTING FEEDBACK | (Values: 0 is in MUTED, 1 NOT MUTED) |
| **Bit 6** | *NA* | |
| **Bit 7** | INSTALLATION STATUS | (Values: 0 is INSTALLED, 1 is not INSTALLED) |
| **Bit 8** | PRESENCE FIELD 1* | (Values: 0 is PRESENT, 1 is NOT PRESENT) |
| **Bit 9** | PRESENCE FIELD 2* | (Values: 0 is PRESENT, 1 is NOT PRESENT) |
| **Bit 10** | PRESENCE FIELD 3*<br>(available only for LBK SBV System) | (Values: 0 is PRESENT, 1 is NOT PRESENT) |
| **Bit 11** | PRESENCE FIELD 4*<br>(available only for LBK SBV System) | (Values: 0 is PRESENT, 1 is NOT PRESENT) |
| **Bit 12** | WORKING MODE FIELD 1 | (Values: 0 is RESTART MODE, 1 is ACCESS MODE) |
| **Bit 13** | WORKING MODE FIELD 2 | (Values: 0 is RESTART MODE, 1 is ACCESS MODE) |
| **Bit 14** | WORKING MODE FIELD 3<br>(available only for LBK SBV System) | (Values: 0 is RESTART MODE, 1 is ACCESS MODE) |
| **Bit 15** | WORKING MODE FIELD 4<br>(available only for LBK SBV System) | (Values: 0 is RESTART MODE, 1 is ACCESS MODE) |

**Note ***: "presence" means that the sensor is detecting a target in the detection field. Unlike "detection", presence does not consider the Restart timeout value.

#### Detection Field distance

For each sensor, *Detection field x Distance* represents the minimum distance of the target detected in the field *x*.

A whole word is used for this purpose.

The distance is reported in mm. Value 0 is used in case of no detection.

**Note:** detection fields 3 and 4 distances are available only in LBK SBV System.

#### Detection Field angle

For each sensor, *Detection Field x Angle* represents the azimuth angle of the minimum distance of the target detected in the field *x*.

A byte is used for this purpose.

The angle is reported in degrees (°) in the range (0°, +180°) and centered in 90°.

**Note:** this section is available only in LBK SBV System.

#### Extended info

Some additional system information is described from address 41062.

In particular, the error status of controller and sensors are reported with their details.

### Sensor configuration bitmask

**Note**: available from MODBUS protocol V2, that is firmware version 2.0.0 of the controller..

The four bytes containing the status of the sensor configuration are encoded as a bitmask as follows:

| | | |
|---|---|---|
| **Bit 0** | DETECTION FIELD 1 USAGE | (Values: 0 is NOT USED, 1 is IN USE) |
| **Bit 1** | DETECTION FIELD 2 USAGE | (Values: 0 is NOT USED, 1 is IN USE) |
| **Bit 2** | DETECTION FIELD 3 USAGE | (Values: 0 is NOT USED, 1 is IN USE) |
| **Bit 3** | DETECTION FIELD 4 USAGE | (Values: 0 is NOT USED, 1 is IN USE) |
| **Bit 4** | STATIC OBJECT DETECTION DF1 USAGE | (Values: 0 is DISABLED, 1 is ENABLED) |
| **Bit 5** | STATIC OBJECT DETECTION DF2 USAGE | (Values: 0 is DISABLED, 1 is ENABLED) |
| **Bit 6** | STATIC OBJECT DETECTION DF3 USAGE | (Values: 0 is DISABLED, 1 is ENABLED) |
| **Bit 7** | STATIC OBJECT DETECTION DF4 USAGE | (Values: 0 is DISABLED, 1 is ENABLED) |
| **Bit 8** | CUSTOM TARGET DETECTION DF1 USAGE | (Values: 0 is DISABLED (Human detection, default), 1 is ENABLED) |
| **Bit 9** | CUSTOM TARGET DETECTION DF2 USAGE | (Values: 0 is DISABLED (Human detection, default), 1 is ENABLED) |
| **Bit 10** | CUSTOM TARGET DETECTION DF3 USAGE | (Values: 0 is DISABLED (Human detection, default), 1 is ENABLED) |
| **Bit 11** | CUSTOM TARGET DETECTION DF4 USAGE | (Values: 0 is DISABLED (Human detection, default), 1 is ENABLED) |
| **Bit 12** | *NA* | - |
| **Bit 13** | *NA* | - |
| **Bit 14** | *NA* | - |
| **Bit 15** | *NA* | - |
| **Bit 16** | *NA* | - |
| **Bit 17** | *NA* | - |
| **Bit 18** | *NA* | - |
| **Bit 19** | *NA* | - |
| **Bit 20** | *NA* | - |
| **Bit 21** | *NA* | - |
| **Bit 22** | *NA* | - |
| **Bit 23** | *NA* | - |
| **Bit 24** | *NA* | - |
| **Bit 25** | *NA* | - |
| **Bit 26** | *NA* | - |
| **Bit 27** | *NA* | - |
| **Bit 28** | *NA* | - |
| **Bit 29** | *NA* | - |
| **Bit 30** | *NA* | - |
| **Bit 31** | *NA* | - |

# 5 Controller and sensors error status

Erroneous conditions related to the controller and/or the sensors are sent via MODBUS filling up the relevant error code and detailed error mask fields.

The error code indicates the type of the error occurred. The detailed error mask represents the details related to the type of the error occurred and it is reported in this document where relevant and useful to understand in detail the fault.

In the following paragraphs, all the controller and sensor error codes are listed and described.

## 5.1 Controller error codes

The error codes of the controller are reported in the table below.

| Error Code | Error | Description |
|---|---|---|
| 0x01 | Power supply error | At least one voltage value on the controller is wrong.<br><br>Detailed error is a bit mask composed of the following faults:<br>• 0x0001 Vin Undervoltage<br>• 0x0002 Vin Overvoltage<br>• 0x0004 1.2V Undervoltage<br>• 0x0008 1.2V Overvoltage<br>• 0x0010 1.2V Sensor Undervoltage<br>• 0x0020 1.2V Sensor Overvoltage<br>• 0x0040 VUSB Undervoltage<br>• 0x0080 VUSB Overvoltage<br>• 0x0100 VRef Undervoltage<br>• 0x0200 VRef Overvoltage<br>• 0x0400 ADC conversion error |
| 0x02 | Internal temperature error | Controller temperature value is wrong.<br><br>Detailed error is a bit mask composed of the following faults:<br>• 0x0001 Low Temperature<br>• 0x0002 High Temperature |

| Error Code | Error | Description |
|---|---|---|
| 0x03 | OSSD error | At least one digital output (OSSD) is in error.<br><br>Detailed error is a bit mask composed of the following faults:<br>• 0x0001 OSSD 1 SHORT-CIRCUIT<br>• 0x0002 OSSD 2 SHORT-CIRCUIT<br>• 0x0004 OSSD 3 SHORT-CIRCUIT<br>• 0x0008 OSSD 4 SHORT-CIRCUIT<br>• 0x0010 OSSD 1 NO LOAD<br>• 0x0020 OSSD 2 NO LOAD<br>• 0x0040 OSSD 3 NO LOAD<br>• 0x0080 OSSD 4 NO LOAD<br>• 0x0100 OSSD 1 SHORT-CIRCUIT (VDD)<br>• 0x0200 OSSD 2 SHORT-CIRCUIT (VDD)<br>• 0x0400 OSSD 3 SHORT-CIRCUIT (VDD)<br>• 0x0800 OSSD 4 SHORT-CIRCUIT (VDD) |
| 0x04 | Input error | At least one digital input is in error.<br><br>Detailed error is a bit mask composed of the following faults:<br>• 0x0001 input 1 error<br>• 0x0002 input 2 error<br>• 0x0003 encoding error<br>• 0x0004 0-1-0 plausibility transition error |
| 0x05 | Internal peripheral error | At least one of the controller peripherals is in error<br><br>Detailed error not relevant. |
| 0x06 | Sensor communication error | Communication error with at least one sensor.<br><br>Detailed error is a bit mask composed of the following faults:<br>• 0x0010 Communication lost<br>• 0x0100 Polling timeout |
| 0x07 | Internal EEPROM error | Configuration saving error, configuration not performed or memory error.<br><br>Detailed error not relevant. |
| 0x08 | Internal flash error | Flash memory error.<br><br>Detailed error not relevant. |
| 0x09 | Internal RAM error | Invalid checksum of the internal RAM.<br><br>Detailed error not relevant. |
| 0x0A | Fieldbus error | At least one of the inputs and outputs has been configured as “fieldbus controlled”, but the fieldbus communication is not established, in error or passivated by the host.<br><br>Detailed error not relevant. |

| Error Code | Error | Description |
|---|---|---|
| 0x0B | Dynamic configuration error | An invalid dynamic configuration has been selected.<br><br>Detailed error not relevant. |
| 0x0C | Internal communication error | An internal communication issue occurred between microprocessors.<br><br>Detailed error not relevant. |
| 0x0D | Configuration error | Error occurred on the sensors during the configuration process or at system power up. At least one of the connected sensors did not get the correct configuration.<br><br>The list of the not-configured sensors is reported as the detail of this error. |
| 0x0E | Backup or Restore error | Error occurred during the backup or restore via SD card |

## 5.2 LBK S-01 sensor error codes

The error codes of the LBK S-01 sensor are reported in the table below.

| Error Code | Error | Description |
|---|---|---|
| 0x06 | Controller communication error | Communication error with the controller.<br><br>Detailed error is a bit mask composed of the following faults:<br>• 0x0010 Communication lost |
| 0x81 | Power supply error | At least one voltage value of the sensor is wrong.<br><br>Detailed error is a bit mask composed of the following faults:<br>• 0x0001 Vin Undervoltage<br>• 0x0002 Vin Overvoltage<br>• 0x0004 3.3V Undervoltage<br>• 0x0008 3.3V Overvoltage<br>• 0x0010 1.2V Undervoltage<br>• 0x0020 1.2V Overvoltage<br>• 0x0040 V+ Undervoltage<br>• 0x0080 V+ Overvoltage<br>• 0x0100 V DC/DC Undervoltage<br>• 0x0200 V DC/DC Overvoltage<br>• 0x0400 VOp.Amp. Undervoltage<br>• 0x0800 VOp.Amp. Overvoltage<br>• 0x1000 VADC Ref. Undervoltage<br>• 0x2000 VADC Ref. Overvoltage<br>• 0x4000 ADC conversion error |

| Error Code | Error | Description |
|---|---|---|
| 0x82 | Internal temperature error | Sensor temperature value is wrong.<br><br>Detailed error is a bit mask composed of the following faults:<br>• 0x0001 Low Temperature<br>• 0x0002 High Temperature<br>• 0x0004 Chip - Low Temperature<br>• 0x0008 Chip - High Temperature<br>• 0x0010 Generic Temperature Error |
| 0x84 | Internal peripheral error | At least one of the sensor peripherals is in error.<br><br>Detailed error not relevant. |
| 0x85 | Controller communication error | Communication error with the controller.<br><br>Detailed error is a bit mask composed of the following faults:<br>• 0x0001 Communication timeout<br>• 0x0002 Cross-check error<br>• 0x0004 Sequence number error<br>• 0x0008 Wrong CRC<br>• 0x0020 Protocol error<br>• 0x0040 Message ID error<br>• 0x0080 Data format error<br>• 0x0100 Polling timeout<br>• 0x0200 Generic CANbus error |
| 0x8F | Signal error | Signal errors of the sensor.<br><br>Detailed error is a bit mask composed of the following faults:<br>• 0x0001 Not used<br>• 0x0002 Head fault<br>• 0x0004 Head power off<br>• 0x0008 Signal dynamic<br>• 0x0010 Signal Min<br>• 0x0020 Signal Min Max<br>• 0x0040 Signal Max<br>• 0x0080 Signal Avg<br>• 0x0100 Dynamic Low<br>• 0x0200 Min Dynamic High<br>• 0x0400 Min Dynamic Low<br>• 0x0800 Max Dynamic Low<br>• 0x1000 Avg Dynamic Low<br>• 0x2000 Generic Signal Error |
| 0x90 | Accelerometer error | Placement error of the sensor.<br><br>Detailed error is a bit mask composed of the following faults:<br>• 0x0001 Pitch angle error<br>• 0x0002 Roll angle error<br>• 0x0004 Reading error |
| 0xFD | Masking error | Masking/Occlusion error |

## 5.3 LBK SBV sensor error codes

The error codes of the LBK SBV sensor are reported in the table below.

| Error Code | Error | Description |
|---|---|---|
| 0x06 | Controller communication error | Communication error with the controller.<br><br>Detailed error is a bit mask composed of the following faults:<br>• 0x0010 Communication lost |
| 0x81 | Misconfiguration error | The misconfiguration error occurs when the sensor does not have a valid configuration or it has received an invalid configuration from the controller.<br><br>Detailed error not relevant. |
| 0x82 | Status error | The status error occurs when the sensor is in an internal invalid status.<br><br>Detailed error not relevant. |
| 0x83 | Protocol error | The protocol error occurs when the sensor receives commands with an unknown format.<br><br>Detailed error not relevant. |
| 0x84 | Fault error | The fault error occurs when the sensor has reached an internal fault condition.<br><br>Detailed error not relevant. |
| 0x85 | Controller communication error | Communication error with the controller.<br><br>Detailed error is a bit mask composed of the following faults:<br>• 0x0001 Communication timeout<br>• 0x0002 Cross-check error<br>• 0x0004 Sequence number error<br>• 0x0008 Wrong CRC |
| 0x86 | Power error | At least one voltage value of the sensor is wrong .<br><br>Detailed error is a bit mask composed of the following faults:<br>• 0x0001 Vin Undervoltage<br>• 0x0002 Vin Overvoltage<br>• 0x0004 3.3V Undervoltage<br>• 0x0008 3.3V Overvoltage<br>• 0x0010 182V Undervoltage<br>• 0x0020 1.8V Overvoltage<br>• 0x0040 1.2V Undervoltage<br>• 0x0080 1.2V Overvoltage<br>• 0x0100 1V Undervoltage<br>• 0x0200 1V Overvoltage |

| Error Code | Error | Description |
|---|---|---|
| 0x87 | MSS error | Error detected by diagnostics relative to the internal micro-controller (MSS), its internal peripherals or memories.<br><br>Detailed error not relevant. |
| 0x88 | Signal error | The signal error occurs when the sensor detects an error in the RF signals part.<br><br>Detailed error not relevant. |
| 0x89 | Internal temperature error | Sensor temperature value is wrong.<br><br>Detailed error is a bit mask composed of the following faults:<br>• 0x0001 Low Temperature<br>• 0x0002 High Temperature<br>• 0x0004 Chip - Low Temperature<br>• 0x0008 Chip - High Temperature<br>• 0x0010 IMU - Low Temperature<br>• 0x0020 IMU - High Temperature |
| 0x8A | Tamper error | Placement error of the sensor. Detailed error is:<br><br>first 4 bits, a bit mask composed of the following faults:<br>• 0x0001 Pan angle error<br>• 0x0002 Roll angle error<br>• 0x0004 Tilt reading error<br><br>bit 4 to bit 7: tilt angle deviation (in degrees) bit 8 to bit 11: roll angle deviation (in degrees) bit 12 to bit 15: pan angle deviation (in degrees)<br><br>Max deviation in degrees: 15. |
| 0x8B | DSS error | Error detected by diagnostics relative to the internal micro-controller (DSS ), its internal peripherals or memories.<br><br>Detailed error not relevant. |
| 0xFD | Masking error | Masking/Occlusion error |
| 0xFE | Masking reference error | The sensor is not able to acquire the reference for masking functionality. |