



Modbus communication

Reference guide v1 - EN

ORIGINAL INSTRUCTIONS

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	ΤΖ

1. Scope

This document defines the data exchanged using the Modbus protocol with SBV System Series and LBK System Series.

2. Applicability

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

- ISC-B01
- ISC-02

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

3. System Overview

The ISC-B01 and ISC-02 devices communicate by means of the RJ45 connector on the top (Refer to Figure 1).



Figure 1 ISC-B01 device

4. MODBUS data exchange

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

To use the feature, the user has to enable MODBUS data exchange on the controller via Configuration software (available at https://tools.inxpect.com/industrial/tools).

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).

ISC-B01 and ISC-02 use the following Modbus address:

• 41000 for controller and sensors data (length: 76 double byte)

4.1 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 O

41000	NA	Controller status
41001		NA
41002	NA	Fieldset ID currently in use
41003	CRC32 of the	e fieldset ID currently in use (32 bit) MSB
41004	CRC32 of the	e fieldset 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	Ser	sor 1 detection field 1 distance
41015	NA	Sensor 1 detection field 1 angle
41016	Ser	sor 1 detection field 2 distance
41017	NA	Sensor 1 detection field 2 angle
41018	Ser	sor 1 detection field 3 distance
41019	NA	Sensor 1 detection field 3 angle
41020	Ser	sor 1 detection field 4 distance
41021	NA	Sensor 1 detection field 4 angle
41022	Ser	sor 2 detection field 1 distance
41023	NA	Sensor 2 detection field 1 angle
41024	Ser	sor 2 detection field 2 distance
41025	NA	Sensor 2 detection field 2 angle
41026	Ser	sor 2 detection field 3 distance
41027	NA	Sensor 2 detection field 3 angle
41028	Ser	sor 2 detection field 4 distance
41029	NA	Sensor 2 detection field 4 angle
41030	Ser	sor 3 detection field 1 distance
41031	NA	Sensor 3 detection field 1 angle
41032	Ser	sor 3 detection field 2 distance
41033	NA	Sensor 3 detection field 2 angle
41034	Ser	sor 3 detection field 3 distance
41035	NA	Sensor 3 detection field 3 angle
41036	Ser	sor 3 detection field 4 distance
41037	NA	Sensor 4 detection field 4 angle
41038	Ser	sor 4 detection field 1 distance
41039	NA	Sensor 4 detection field 1 angle
41040	Ser	sor 4 detection field 2 distance
41041	NA	Sensor 4 detection field 2 angle
41042	Ser	sor 4 detection field 3 distance
41043	NA	Sensor 4 detection field 3 angle
41044	Ser	sor 4 detection field 4 distance
41045	NA	Sensor 4 detection field 4 angle
41046	Ser	sor 5 detection field 1 distance
41047	NA	Sensor 5 detection field 1 angle

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
41048		Sensor 5 detection	field 2 distance
41049	N	4	Sensor 5 detection field 2 angle
41050		Sensor 5 detection	field 3 distance
41051	N	4	Sensor 5 detection field 3 angle
41052		Sensor 5 detection	field 4 distance
41053	N	4	Sensor 5 detection field 4 angle
41054		Sensor 6 detection	field 1 distance
41055	N	4	Sensor 6 detection field 1 angle
41056		Sensor 6 detection	field 2 distance
41057	N	4	Sensor 6 detection field 2 angle
41058		Sensor 6 detection	field 3 distance
41059	N	4	Sensor 6 detection field 3 angle
41060		Sensor 6 detection	field 4 distance
41061	N	4	Sensor 6 detection field 4 angle
41062	N	4	Controller error status
41063		Controller detail	s error status
41064	N	4	Sensor 1 error status
41065		Sensor 1 details	s error status
41066	N	4	Sensor 2 error status
41067		Sensor 2 details	s error status
41068	N	4	Sensor 3 error status
41069		Sensor 3 details	s error status
41070	N	4	Sensor 4 error status
41071		Sensor 4 details	s error status
41072	N	4	Sensor 5 error status
41073		Sensor 5 details	s error status
41074	N	A	Sensor 6 error status
41075		Sensor 6 details	s error status

4.1.1 Controller status

The byte containing the status of the controller (address 41000) is encoded as a bit mask as described in 4. :

Bit 0	DETECTION FIELD 1	(Values: 0 is DETECTION, 1 is FREE)
Bit 1	DETECTION FIELD 2	(Values: 0 is DETECTION, 1 is FREE)
Bit 2	DETECTION FIELD 3	(Values: 0 is DETECTION, 1 is FREE)
	(available only in SBV System Series)	
Bit 3	DETECTION FIELD 4	(Values: 0 is DETECTION, 1 is FREE)
	(available only in SBV System Series)	
Bit 4	RESTART FEEDBACK SIGNAL	(Values: 0 is "The system is waiting for a manual restart", 1 otherwise)
Bit 5	STOP FEEDBACK SIGNAL	(Values: 0 is "Emergency required", 1 otherwise)
Bit 6	SYSTEM DIAGNOSTIC SIGNAL	(Values: 0 is "The system is in error", 1 otherwise)
Bit 7	CONFIGURATION FEEDBACK	(Values: 0 is "The system is in configuration", 1 otherwise)

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

4.1.2 Current fieldset ID and its CRC32

The byte at address 41001 contains the ID of the current fieldset 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).

4.1.3 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)

4.1.4 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 ON, 0 is OFF)
Bit 1:	Output 2 status	(Values: 1 is ON, 0 is OFF)
Bit 2:	Output 3 status	(Values: 1 is ON, 0 is OFF)
Bit 3:	Output 4 status	(Values: 1 is ON, 0 is OFF)
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)

4.1.5 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

4.1.6 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 FREE)
Bit 1:	DETECTION FIELD 2	(Values: 0 is DETECTION, 1 is FREE)
Bit 2:	DETECTION FIELD 3	(Values: 0 is DETECTION, 1 is FREE)
	(available only in SBV System Series	
Bit 3:	DETECTION FIELD 4	(Values: 0 is DETECTION, 1 is FREE)
	(available only in SBV System Series	
Bit 4:	DIAGNOSTIC FEEDBACK	(Values: 0 is in FAULT, 1 is OK)
Bit 5:	MUTING FEEDBACK	(Values: 0 is in MUTED, 1 otherwise)
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 FREE)
Bit 9:	PRESENCE FIELD 2	(Values: 0 is PRESENT, 1 is FREE)
Bit 10:	PRESENCE FIELD 3	(Values: 0 is PRESENT, 1 is FREE)
	(available only in SBV System Series	
Bit 11:	PRESENCE FIELD 4	(Values: 0 is PRESENT, 1 is FREE)
	(available only in SBV System Series	
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	(Values: 0 is RESTART MODE, 1 is ACCESS MODE)
	(available only in SBV System Series	
Bit 15:	WORKING MODE FIELD 4	(Values: 0 is RESTART MODE, 1 is ACCESS MODE)
	(available only in SBV System Series	

4.1.7 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 SBV System Series.

4.1.8 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 $(0^{\circ}, +180^{\circ})$ and centered in 90° .

Note: this section is available only in SBV System Series.

4.1.9 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.

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. Detailed error is a bit mask composed of the following faults: • 0x0001 Vin Undervoltage • 0x0002 Vin Overvoltage • 0x0004 1.2V Undervoltage • 0x0008 1.2V Overvoltage • 0x0010 1.2V Sensor Undervoltage • 0x0020 1.2V Sensor Overvoltage • 0x0040 VUSB Undervoltage • 0x0040 VUSB Overvoltage • 0x0100 VRef Undervoltage • 0x0200 VRef Overvoltage • 0x0400 ADC conversion error
0x02	Internal temperature error	 Controller temperature value is wrong. Detailed error is a bit mask composed of the following faults: 0x0001 Low Temperature 0x0002 High Temperature
0x03	OSSD error	At least one digital output (OSSD) is in error. Detailed error is a bit mask composed of the following faults: • 0x0001 OSSD 1 SHORT CIRCUIT • 0x0002 OSSD 2 SHORT CIRCUIT • 0x0004 OSSD 3 SHORT CIRCUIT • 0x0008 OSSD 4 SHORT CIRCUIT • 0x0010 OSSD 1 NO LOAD • 0x0020 OSSD 2 NO LOAD • 0x0040 OSSD 3 NO LOAD • 0x0080 OSSD 4 NO LOAD • 0x0100 OSSD 1-2 CROSS CHECK • 0x0100 OSSD 1-3 CROSS CHECK • 0x0400 OSSD 1-4 CROSS CHECK • 0x0800 OSSD 2-3 CROSS CHECK • 0x1000 OSSD 2-4 CROSS CHECK • 0x2000 OSSD 3-4 CROSS CHECK
0x04	Input error	At least one digital input is in error. Detailed error is a bit mask composed of the following faults: • 0x0001 input 1 error • 0x0002 input 2 error

Error Code	Error	Description
0x05	Internal peripheral error	At least one of the controller peripherals is in error
		Detailed error not relevant.
0x06	Sensor communication error	Communication error with at least one sensor.
		Detailed error is a bit mask composed of the following faults:
		0x0010 Communication lost0x0100 Polling timeout
0x07	Internal EEPROM error	Configuration saving error, configuration not performed or memory error.
		Detailed error not relevant.
0x08	Internal flash error	Flash memory error.
		Detailed error not relevant.
0x09	Internal RAM error	Invalid checksum of the internal RAM.
		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.
		Detailed error not relevant.
0x0B	Fieldset error	An invalid dynamic configuration has been selected.
		Detailed error not relevant.
0x0C	Internal communication error	An internal communication issue occurred between microprocessors.
		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.
		The list of the not-configured sensors is reported as the detail of this error.

5.2 LBK-S01 sensor error codes

The error codes of the LBK-S01 sensor are reported in the table below.

Error Code	Error	Description
0x81	Power supply error	At least one voltage value of the sensor is wrong .
		Detailed error is a bit mask composed of the following faults:
		 0x0001 Vin Undervoltage 0x0002 Vin Overvoltage 0x0004 3.3V Undervoltage 0x0008 3.3V Overvoltage 0x0010 1.2V Undervoltage 0x0020 1.2V Overvoltage 0x0040 V+ Undervoltage 0x0080 V+ Overvoltage 0x0100 V DC/DC Undervoltage 0x0200 V DC/DC Overvoltage 0x0400 VOp.Amp. Undervoltage 0x0800 VOp.Amp. Overvoltage 0x1000 VADC Ref. Undervoltage 0x2000 VADC Ref. Overvoltage 0x2000 VADC Ref. Overvoltage
0x82	Internal temperature error	Sensor temperature value is wrong.
		 Detailed error is a bit mask composed of the following faults: 0x0001 Low Temperature 0x0002 High Temperature 0x0004 Chip - Low Temperature 0x0008 Chip - High Temperature 0x0010 Generic Temperature Error
0x84	Internal peripheral error	At least one of the sensor peripherals is in error. Detailed error not relevant
0x85	Controller communication error	Communication error with the controller. Detailed error is a bit mask composed of the following faults: • 0x0001 Communication timeout • 0x0002 Cross-check error • 0x0004 Sequence number error • 0x0008 Wrong CRC • 0x0010 Communication lost • 0x0020 Protocol error • 0x0020 Protocol error • 0x0040 Message ID error • 0x0080 Data format error • 0x0100 Polling timeout • 0x0200 Generic CANbus error

Error Code	Error	Description
0x8F	Signal error	Signal errors of the sensor. Detailed error is a bit mask composed of the following faults: • 0x0001 Not used • 0x0002 Head fault • 0x0004 Head power off • 0x0008 Signal dynamic • 0x0010 Signal Min • 0x0020 Signal Min Max • 0x0040 Signal Max • 0x0040 Signal Avg • 0x0100 Dynamic Low • 0x0200 Min Dynamic High • 0x0400 Min Dynamic Low • 0x0800 Max Dynamic Low • 0x1000 Avg Dynamic Low • 0x2000 Generic Signal Error
0x90	Accelerometer error	 Placement error of the sensor. Detailed error is a bit mask composed of the following faults: 0x0001 Pitch angle error 0x0002 Roll angle error 0x0004 Reading error
0xFD	Masking error	Masking/Occlusion error

5.3 SBV-01 sensor error codes

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

Error Code	Error	Description
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. Detailed error not relevant.
0x82	Status error	The status error occurs when the sensor is in an internal invalid status. Detailed error not relevant.
0x83	Protocol error	The protocol error occurs when the sensor receives commands with an unknown format. Detailed error not relevant.
0x84	Fault error	The fault error occurs when the sensor has reached an internal fault condition. Detailed error not relevant.
0x85	Controller communication error	Communication error with the controller. Detailed error is a bit mask composed of the following faults: • 0x0001 Communication timeout • 0x0002 Cross-check error • 0x0004 Sequence number error • 0x0008 Wrong CRC

Error Code	Error	Description
0x86	Power error	At least one voltage value of the sensor is wrong .
		Detailed error is a bit mask composed of the following faults: • 0x0001 Vin Undervoltage • 0x0002 Vin Overvoltage • 0x0004 3.3V Undervoltage • 0x0008 3.3V Overvoltage • 0x0010 182V Undervoltage • 0x0020 1.8V Overvoltage • 0x0040 1.2V Undervoltage • 0x0080 1.2V Overvoltage • 0x0100 1V Undervoltage
		0x0200 1V Overvoltage
0x87	MSS error	Error detected by diagnostics relative to the internal micro- controller (MSS), its internal peripherals or memories. Detailed error not relevant.
0x88	Signal error	The signal error occurs when the sensor detected an error in the RF signals part. Detailed error not relevant.
0x89	Internal temperature error	Sensor temperature value is wrong.
		 Detailed error is a bit mask composed of the following faults: 0x0001 Low Temperature 0x0002 High Temperature 0x0004 Chip - Low Temperature 0x0008 Chip - High Temperature 0x0010 IMU - Low Temperature 0x0020 IMU - High Temperature
0x8A	Tamper error	Placement error of the sensor. Detailed error is:
		 first 4 bits, a bit mask composed of the following faults: 0x0001 Yaw angle error 0x0002 Roll angle error 0x0004 Pitch Reading error bit 4 to bit 7: pitch angle deviation (in degrees) bit 8 to bit 11: roll angle deviation (in degrees) bit 12 to bit 15: yaw angle deviation (in degrees) Max deviation in degrees: 15.
0x8B	DSS error	Error detected by diagnostics relative to the internal micro-
		controller (DSS), its internal peripherals or memories. 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.





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