OPERATION MANUAL

MODBUS RTU

Modbus Protocol for ZIRKOR200

Operation

SICK
Sensor Intelligence.

Beschriebenes Produkt

Modbus RTU for ZIRKOR200

Version2 for Software Version 4.xx

Manufacturer

SICK AG
Erwin-Sick-Str. 1
79183 Waldkirch
Germany

Legal information

Original document

This document is an original document of SICK AG.

Notes about this Manual

This manual contains important information about the design, installation, commissioning, operation, maintenance and trouble-shooting. Safe work with this system requires becoming familiar with all warnings, safety instructions and maintenance tasks of this manual.

Symbols used in this Manual

Below listed symbols are important information as well as safety instructions for installation, operation and maintenance, to protect the personnel and the equipment.

	**Warning** Follow all instructions of that manual
	**Warning hot Surface** Warns of danger of burns which could occur from hot system parts
	**Attention** Warns of risks by destroying the system or its components or its functionality

	**Consider Information** Points out important information which must be noted before execution
	**Note** Contain further detailed information
	Ground earth electrical protection

Safety Instruction

The system is operated with line voltage. After removal of terminal covers some parts of that system may be accessible which could be already under high line voltage.

Only well trained and authorised personnel are allowed to work on this system. Personnel must know and understand all pre-cautions, safety instructions, installation and maintenance instructions of this manual. The trouble free and safe operation of the system requires safe transportation, professional storage, installation, operation and maintenance.

Furthermore all local safety requirements at that point of installation and operation must become considered.

This system cannot be used to measure oxygen in combustible gases neither in an environment with combustible gases. Parts of this system may cause an explosion risk.

Table of Contents

1 General Description

The MODBUS protocol is an open "industrial standard" which based on a Master/Slave architecture. Thus, a master (e.g. a PC) can be connected to multiple slaves.

MODBUS provides the possibility of data transfer via MODBUS ASCII, MODBUS RTU or MODBUS ETHERNET protocol over serial RS232 or RS485 interfaces as well as ETHERNET.

Note

The option module MODUS RTU described in this manual supports the MODBUS RTU data transfer via RS232- or RS485 serial interface.

The exchange of device-specific data is carried out via

- read access to binary flags, termed as Discrete Inputs by the MODBUS specification
- read/write access to binary flags, termed as Coils by the MODBUS specification
- read access to 16bit registers, termed as Input Registers by the MODBUS specification
- read/write access to 16bit registers, termed as Holding Registers by the MODBUS specification
- Read access to data structures with constant size, termed as File Records by the MODBUS specification

over address ranges defined by the slave. 32bit values are interpreted by 2x16bit registers.

1.1 Discrete Inputs

As defined as Discrete Inputs are:

- active (i.e. applied) error status conditions
- active (i.e. applied) alarm status conditions
- active (i.e. applied) maintenance status conditions
- active (i.e. applied) signal status conditions
- actual relay- and digital input status conditions

1.2 Coils

As defined as Coils are:

- applied and saved error status conditions
- applied and saved alarm status conditions
- control flags (virtual digital inputs)
- switches (O2 limit alarm function on/off, measured values held on calibration on/off, …)

1.3 Input Registers

As defined as Input Registers are:

- all actual measured values

1.4 Holding Registers

As defined as Holding Registers are:

- all system settings

1.5 File Records

As defined as File Records are:

- Calibration results of the at least 10 last sensor calibrations

2 Value Ranges and Constants

2.1 INT8

Value, Value Range	Label	Description
-128 … +127		Range of valid values

2.2 UINT8

Value, Value Range	Label	Description
0 … 255		Range of valid values

2.3 INT16

Value, Value Range	Label	Description
-32766 … +32766		Range of valid values
-32768	INT16_INVALID	Value is invalid, either it is not available or due to an error
32767	INT16_OVER	Value overruns the valid designated range
-32767	INT16_UNDER	Value underruns the valid designated range

2.4 UINT16

Value, Value Range	Label	Description
0 … 65535		Range of valid values

2.5 INT32

Value, Value Range	Label	Description
-2147483646 … +2147483646		Range of valid values
-2147483648	INT32_INVALID	Value is invalid, either it is not available or due to an error
2147483647	INT32_OVER	Value overruns the valid designated range
-2147483647	INT32_UNDER	Value underruns the valid designated range

2.6 UINT32

Value, Value Range	Label	Description
0 … 4294967295		Range of valid values

3 Memory Map

3.1 Discrete Inputs

3.1.1 Category Error

Address	Byte	Description
0000h	0	1= hardware error 1 (ADC24)
0001h		1= hardware error 2 (ADC12)
0002h		1= hardware error 3 (temperature sensor)
0003h		1= hardware error 4 (FRAM)
0004h		1= hardware error 5 (DataFlash)
0005h		1= hardware error 6 (Real Time Clock)
0006h		1= hardware error 7 (supply voltages +5V, +12V, -12V)
0007h		1= device type does not match
0008h	1	1= hardware calibration data corrupted
0009h		1= sensor data corrupted
000Ah		1= device type and options data corrupted
000Bh		1= customer related data currupted
000Ch		1= open circuit thermocouple
000Dh		1= probe temperature setpoint not reached
000Eh		1= probe temperature too low
000Fh		1= probe temperature too high
0010h	2	1= open circuit O2 sensor signal
0011h		1= error pressure input
0012h … 0017h		reserved
0017h … 001Fh	3	reserved
0020h	4	1= O2 sensor calibration failed
0021h		reserved
0022h		1= test gas flow too low
0023h		1= test gas flow too high
0024h		1= O2 sensor offset too low
0025h		1= O2 sensor offset too high
0026h		1= O2 sensor slope too low
0027h		1= O2 sensor slope too high
0028h	5	1= O2 sensor signal instable during calibration
0029h … 002Fh		reserved

3.1.2 Category Alarm

Address	Byte	Description
0030h	6	1= reference air flow rate too low
0031h		1= reference air flow rate too high
0032h		1= O2 limit alarm 1
0033h		1= O2 limit alarm 2
0034h		1= electronic temperature lower than specified
0035h		1= electronic temperature above specification
0036h		1= power on-reset proceeded
0037h		1= RTC battery empty
0038h	7	1= hardware calibration data restored
0039h		1= sensor data restored
003Ah		1= device type and options data restored
003Bh		1= customer related data restored
003Ch		1= factory settings H (hardware calibration data) corrupted
003Dh		1= factory settings S (sensor data) corrupted
003Eh		1= factory settings D (device type and options data) corrupted
003Fh		1= factory settings C (customer related data) corrupted

3.1.3 Category Maintenance

Address	Byte	Description
0060h	12	1= maintenance (global)
0061h		1= measured values held
0062h		1= 1-point calibration is running
0063h		1= 2-point calibration is running
0064h		1= test gas 1 is being applied
0065h		1= test gas 2 is being applied
0066h … 0067h		reserved
0068h	13	1= system code level active
0069h		1= service code level active
006Ah		1= factory code level active
006Bh … 006Fh		reserved

3.1.4 Category Signal

Address	Byte	Description
0090h	18	1= O_2 measuring range 2 active
0091h		1= O_2 probe heater switched on
0092h		1= O_2 measurement failure
0093h … 0097h		reserved
0098h … 009Fh	19	reserved
00A0h	20	1= digital input set for: O_2 measuring range 2
00A1h		1= digital input set for: sensor calibration permission
00A2h		1= digital input set for: test gas 1 is applied
00A3h		1= digital input set for: test gas 2 is applied
00A4h … 00A7h		reserved

3.1.5 Category Inputs/Outputs

Address	Byte	Description
00C0h	24	1= probe heater relay energised
00C1h		1= relay 18A/B energised
00C2h		1= relay 19A/B energised
00C3h		1= relay 20A/B energised
00C4h		1= test gas 1 relay energised
00C5h		1= test gas 2 relay energised
00C6h		1= relay 21A/B energised
00C7h		1= relay 22A/B energised
00C8h	25	reserved
00C9h		1= digital input 1 HIGH input status detected
00CAh		reserved
00CBh		1= digital input 2 HIGH input status detected
00CCh		reserved
00CDh		1= digital input 3 HIGH input status detected
00CEh … 00CFh		reserved

3.2 Coils

3.2.1 Category Error

Address	Byte	Description
0000h	0	1= hardware error 1 (ADC24)
0001h		1= hardware error 2 (ADC12)
0002h		1= hardware error 3 (temperature sensor)
0003h		1= hardware error 4 (FRAM)
0004h		1= hardware error 5 (DataFlash)
0005h		1= hardware error 6 (Real Time Clock)
0006h		1= hardware error 7 (supply voltages +5V, +12V, -12V)
0007h		1= device type does not match
0008h	1	1= hardware calibration data corrupted
0009h		1= sensor data corrupted
000Ah		1= device type and options data corrupted
000Bh		1= customer related data currupted
000Ch		1= open circuit thermocouple
000Dh		1= probe temperature setpoint not reached
000Eh		1= probe temperature too low
000Fh		1= probe temperature too high
0010h	2	1= open circuit O2 sensor signal
0011h		1= error pressure input
0012h … 0017h		reserved
0017h … 001Fh	3	reserved
0020h	4	1= O2 sensor calibration failed
0021h		reserved
0022h		1= test gas flow too low
0023h		1= test gas flow too high
0024h		1= O2 sensor offset too low
0025h		1= O2 sensor offset too high
0026h		1= O2 sensor slope too low
0027h		1= O2 sensor slope too high
0028h	5	1= O2 sensor signal instable during calibration
0029h … 002Fh		reserved

3.2.2 Category Alarm

Address	Byte	Description
0030h	6	1= reference air flow rate too low
0031h		1= reference air flow rate too high
0032h		1= O2 limit alarm 1
0033h		1= O2 limit alarm 2
0034h		1= electronic temperature lower than specified
0035h		1= electronic temperature above specification
0036h		1= power on-reset proceeded
0037h		1= RTC battery empty
0038h	7	1= hardware calibration data restored
0039h		1= sensor data restored
003Ah		1= device type and options data restored
003Bh		1= customer related data restored
003Ch		1= factory settings H (hardware calibration data) corrupted
003Dh		1= factory settings S (sensor data) corrupted
003Eh		1= factory settings D (device type and options data) corrupted
003Fh		1= factory settings C (customer related data) corrupted

3.2.3 Category Control Flags (Virtual Digital Inputs)

Address	Byte	Description
0060h	12	0➔1 start of O2 1 point calibration 1 O2 1 point calibration started 1➔0 cancel of O2 1 point calibration
0061h		0➔1 start of O2 2 point calibration 1 O2 2 point calibration started 1➔0 cancel of O2 2 point calibration
0062h … 0067h		reserved
0068h	13	1= active O2 measuring range 2
0069h		1= apply test gas 1
006Ah		1= apply test gas 2
006Bh … 006Fh		reserved

3.2.4 Category Switches

Address	Byte	Description
0070h	14	1= O2 limit alarm 1 switched on (0= off)
0071h		1= O2 limit alarm 2 switched on (0= off)
0072h		1= O2 limit alarm 1: max (0= min)
0073h		1= O2 limit alarm 2: max (0= min)
0074h		1= measured value held on calibration (0= off)
0075h		1= automatic calibration on (0= off)
0076h		1= mA output 17A/B 0…20 mA (0= 4…20 mA)
0077h		1= O2 measuring range switching via digital input (0= via keypad)

3.3 Input Registers

Address	Format	Factor / Unit	Description
0000h	INT16	10^{-3} mA	1st mA output
0001h	INT16	10^{-3} mA	2nd mA output
0002h … 0003h	INT32	10^{-5} % O2	O2 measured value from main display
0004h … 0005h	INT32	10^{-5} % O2	O2 measured value (raw value)
0006h … 0007h	reserved		
0008h … 0009h	INT32	10^{-2} °C	probe temperature
000Ah	INT16	10^{-2} °C	internal temperature electronics
000Bh	INT16	10^{-2} °C	terminal temperature
000Ch	INT16	10^{-2} °C	cold junction temperature
000Dh	INT16	10^{-1} %	O2 heater power
000Eh	INT16	10^{0} l/h	reference air flow rate
000Fh	INT16	10^{0} l/h	test gas flow rate
0010h … 0011h	INT32	10^{-3} mV	O2 sensor voltage
0012h … 0013h	INT32	10^{-3} mV	thermocouple voltage
0014h	INT16	10-2 %	calibration progress
0015h	INT16	10^{-3} mA	mA input 28A/B
0016h	INT16	10^{-3} mA	mA input 29A/B
0017h	INT16	10^{-3} mA	mA input 30A/B
0018h	INT16	10^{-3} mA	O2 sensor protection current
0019h	INT16	10^{4} major index 10^{2} minor index 10^{0} build	software version
001Ah … 001Bh	INT32	10^{-5} % O2	actual O2 limit value 1
001Ch … 001Dh	INT32	10^{-5} % O2	actual O2 limit value 2
001Eh	INT16	10^{0} %	O2 sensor life
001Fh … 0031h	reserved		
0032h	INT16	10^{0} mbar	Process pressure[1]
0033h	INT16	10^{0} mbar	Absolute pressure at altitude[1]

[1] for option pressure compensation only

3.4 Holding Registers

Address	Format	Factor / Unit	Description
0000h … 0001h	INT32	10^{-3} mV	O2 sensor offset
0002h … 0003h	INT32	10^{-3} mV/dec	O2 sensor slope
0004h … 0005h	INT32	10^{-5} % O2	O2 measuring range 1 from
0006h … 0007h	INT32	10^{-5} % O2	O2 measuring range 1 to
0008h … 0009h	INT32	10^{-5} % O2	O2 measuring range 2 from
000Ah … 000Bh	INT32	10^{-5} % O2	O2 measuring range 2 to
000Ch … 000Dh	INT32	10^{-5} % O2	O2 limit alarm value 1
000Eh … 000Fh	INT32	10^{-5} % O2	O2 limit alarm value hysteresis 1
0010h … 0011h	INT32	10^{-5} % O2	O2 limit alarm value 2
0012h … 0013h	INT32	10^{-5} % O2	O2 limit alarm value hysteresis 2
0014h … 0017h	reserved		
0018h	INT16	10^{0} s	mA output 17A/B averaging
0019h	INT16	10^{0} s	mA output 34A/B averaging
001Ah	INT16	10^{-3} mA	mA output 17A/B error value
001Bh	INT16	10^{-3} mA	mA output 34A/B error value
001Ch … 001Dh	INT32	10^{-5} % O2	O2 concentration test gas 1
001Eh … 001Fh	INT32	10^{-5} % O2	O2 concentration test gas 2
0020h	INT16	10^{0} min	Time per test gas apply on calibration
0021h	INT16	10^{0} min	Delay time to process after test gas apply
0022h	INT16	10^{0}	ACAL mode 0= O2 1 point calibration 1= O2 2 point calibration
0023h	INT16	10^{0}	ACAL start permission 0= time 1= time + digital input 2= digital input only
0024h	INT16	10^{0} days	ACAL interval
0025h	INT16		not currently used
0026h … 0027h	INT32	calendar time	ACAL next execution at
0028h … 0029h	INT32	calendar time	system time
002Ah … 0052h	reserved		
0053h	INT16	10^{-2} % H2O	O2 conversion wet ➔ dry
0054h … 0057h	reserved		
0058h	INT16		language 0: english | 1: german
0059h	INT16		unit: temperature 0: °C | 1: °F
005Ah	INT16		uint pressure: 0: mbar | 1: psi
005Bh … 0061h	reserved		
0062h	INT16	10^{0} mbar	pressure compensation from[2]
0063h	INT16	10^{0} mbar	pressure compensation to[2]
0064h … 006Ch	reserved		
006Dh	INT16	10^{0} m	Altitude[2]

[2] for option pressure compensation only

4 Supported Functions

4.1 01 - Read Coils

On read access beyond the address range as defined under 3.2 - Coils always return the value 0.

← Master Request

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**01h**	
2, 3	MSB, LSB	start address	UINT16	0000h … FFFFh	0000h … FFFFh
4, 5	MSB, LSB	coils to be read (bits)	UINT16	0001h … 07D0h	
6, 7	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ Slave Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**01h**	
2		counts of following data bytes	UINT8	**N**[3]	
3+**n**[4]		status flags of coils	UINT8[**n**]	00h … FFh	
4+(**N**-1), 5+(**N**-1)	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ Slave Error Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**81h**	
2		exception code	UINT8	01h … 04h	
3, 4	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

4.2 02 - Read Discrete Inputs

On read access beyond the address range as defined under 3.1 - Discrete Inputs always return the value 0.

← Master Request

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**02h**	
2, 3	MSB, LSB	start address	UINT16	0000h … FFFFh	0000h … FFFFh
4, 5	MSB, LSB	Disc. Inputs to be read	UINT16	0001h … 07D0h	
6, 7	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

[3] N= (counts of returned Coils+7)/8, rounded down

[4] n= 0 … (N-1)

➔ **Slave Response**

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**02h**	
2		counts of following data bytes	UINT8	**N**[5]	
3+**n**[6]		status flags of Discrete Inputs	UINT8[**n**]	00h … FFh	
4+(**N**-1), 5+(**N**-1)	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ **Slave Error Response**

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**82h**	
2		exception code	UINT8	01h … 04h	
3, 4	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

4.3 03 - Read Holding Registers

On read access beyond the address range as defined under 3.4 - Holding Registers always return value 0.

➔ **Master Request**

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**03h**	
2, 3	MSB, LSB	start address	UINT16	0000h … FFFFh	
4, 5	MSB, LSB	register to be read	UINT16	0001h … 007Dh	
6, 7	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ **Slave Response**

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**03h**	
2		counts of following data bytes	UINT8	2x**N**[7]	
3+2x**n**[8], 4+2x**n**	MSB, LSB	register values	UINT16[**n**]	0000h … FFFFh	
5+2x(**N**-1), 6+2x(**N**-1)	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

[5] N= (counts of returned Discrete Inputs+7)/8, rounded down

[6] n= 0 … (N-1)

[7] N= counts of returned Holding Registers

[8] n= 0… (N-1)

➔ Slave Error Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**83h**	
2		exception code	UINT8	01h … 04h	
3, 4	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

4.4 04 - Read Input Registers

On read access beyond the address range as defined under 3.3 - Input Registers always return value 0.

➔ Master Request

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**04h**	
2, 3	MSB, LSB	start address	UINT16	0000h … FFFFh	
4, 5	MSB, LSB	registers to be read	UINT16	0001h … FFFFh	
6, 7	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ Slave Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**04h**	
2		counts of following data bytes	UINT8	2x**N**[9]	
3+2x**n**[10], 4+2x**n**	MSB, LSB	register values	UINT16[**n**]	0000h … FFFFh	
5+2x(**N**-1), 6+2x(**N**-1)	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ Slave Error Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**84h**	
2		exception code	UINT8	01h … 04h	
3, 4	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

[9] N= counts of returned Input Registers

[10] n= 0 … (N-1)

4.5 05 - Write Single Coil

Write access beyond the address range as defined under 3.2 - Coils may not have any effect, value 0 is always returned

← Master Request

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**05h**	
2, 3	MSB, LSB	coil address	UINT16	0000h … FFFFh	
4, 5	MSB, LSB	value to be set	UINT16	0000h: OFF FF00h: ON	
6, 7	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ Slave Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**05h**	
2, 3	MSB, LSB	coil address	UINT16	0000h … FFFFh	
4, 5	MSB, LSB	value set	UINT16	0000h: OFF FF00h: ON	
6, 7	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ Slave Error Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**85h**	
2		exception code	UINT8	01h … 04h	
3, 4	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

4.6 06 - Write Single Register[11]

Write access beyond the address range as defined under 3.4 - Holding Registers may not have any effect, value 0 is always returned.

Note

The values which have been written into the Holding Registers are automatically checked and - if neccessary - corrected to their limits. The function returns then the written and if neccessary corrected values.

← Master Request

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**06h**	
2, 3	MSB, LSB	register address	UINT16	0000h … FFFFh	
4, 5	MSB, LSB	value to be written	UINT16	0000h … FFFFh	
6, 7	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

[11] This function can not be used for writing 32bit values, because they consists of 2 continguous 16bit holding registers.

➔ Slave Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**06h**	
2, 3	MSB, LSB	register address	UINT16	0000h … FFFFh	
4, 5	MSB, LSB	register value	UINT16	0000h … FFFFh	
6, 7	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ Slave Error Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**86h**	
2		exception code	UINT8	01h … 04h	
3, 4	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

4.7 07 - Read Exception Status

➔ Master Request

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**07h**	
2, 3	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ Slave Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**07h**	
2		exception status	UINT8	00h … FFh	
3, 4	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

The returned exception status represents the status of the relay outputs.

Bit	Assignment	Description
0	probe heater relay	1= O2 probe heater relay is on
1	relay contact terminals 18A/B	1= maintenance
2	relay contact terminals 19A/B	1= O2 measuring valid
3	relay contact terminals 20A/B	1= O2 measuring range 2 active
4	relay contact test gas 1/test gas pump	1= test gas 1/test air is applied
5	relay contact test gas 2/test gas	1= test gas 2/test gas is applied
6	relay contact terminals 21A/B	1= O2 limit alarm 1 active
7	relay contact terminals 22A/B	1= O2 limit alarm 2 active

➔ Slave Error Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**87h**	
2		exception code	UINT8	01h … 04h	
3, 4	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

4.8 08 - Diagnostics

4.8.1 0000 - Return Query Data

Returns the data which has been transmitted (echo). The data length is variable, but the buffer size of up to 255 characters can not be exceeded. This means that no more than 249 useful bytes may be sent.

4.8.2 0001 - Restart Communication Option

This function does not execute a restart of the complete system automatically, but it restarts the serial interface to its initial settings after returning the acknowledge.

4.8.3 0002 - Return Diagnostics Register

This function returns wether one of the error-, alarm- or maintenance flags are set (see also 1.1 - Discrete Inputs).

4.8.4 0003 - Change ASCII Input Delimiter

This function returns an echo only, but it does not have any influence, because only the MODBUS RTU data transfer is supported.

4.8.5 0004 - Force Listen Only Mode

Puts the MODBUS slave in the Listen Only Mode, no acknowledge is returned.

4.8.6 000A - Clear Counters and Diagnostic Register

Returns the request (echo). All diagnostic counters will be reset.

4.8.7 000B - Return Bus Message Count

Returns the counts of all bus messages

4.8.8 000C - Return Bus Communication Error Count

Returns the counts of all bus communication errors, i.e. the accumulation of all parity-, frame- , overrun- and CRC16 errors including frames with less than 3 characters.

4.8.9 000D - Return Bus Exception Error Count

Returns the counts of exception responses returned by the device.

4.8.10 000E - Return Slave Message Count

Returns the counts of requests proceeded by the device (slave).

4.8.11 000F - Return Slave No Response Count

Returns the counts of requests which have had not been responded by the device. The device does not response requests which have not been addressed to it as well as requests which have been proceeded in the listen only mode.

4.8.12 0010 - Return Slave NAK Count

Returns the counts of NAK excpetions which have been responded by the device.

4.8.13 0011 - Return Slave Busy Count

Returns always 0, because the device does not use the busy mode.

4.8.14 0012 - Return Bus Character Overrun Count

Returns the counts of recognised character overruns.

4.8.15 0013 - Clear Overrun Counter and Flag

This function clears the counts of recognised character overruns. Flags must not be reset.

4.9 11 - Get Comm Event Counter

← Master Request

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**0Bh**	
2, 3	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ Slave Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**0Bh**	
2, 3	MSB, LSB	status	UINT16	0000h[12]	
4, 5	MSB, LSB	event count	UINT16	0000h … FFFFh	
6, 7	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

As an event count all fully completed transactions are counted, which have led to any exception error message.

➔ Slave Error Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**8Bh**	
2		exception code	UINT8	01h … 04h	
3, 4	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

4.10 12 - Get Comm Event Log

← Master Request

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**0Ch**	
2, 3	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ Slave Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**0Ch**	
2		counts of following data bytes	UINT8	**N**[13]	
3, 4	MSB, LSB	status	UINT16	0000h[14]	
5, 6	MSB, LSB	event count	UINT16	0000h … FFFFh	
7, 8	MSB, LSB	message count	UINT16	0000h … FFFFh	
9+**n**[15]		events	UINT8[**n**]	00h … FFh	
10+(**N**-1), 11+(**N**-1)	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

As an event count all fully completed transactions are counted, which have led to any exception error message.

[12] Returns always 0 because the system does not use the busy mode

[13] N= counts of event entries

[14] Returns always 0 because the system does not use the busy mode

[15] n= 0 … (counts of event entries-1)

Message Count counts all recognized as valid frames on the MODBUS, the event log is returned in accordance with the MODBUS specification.

➔ Slave Error Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**8Ch**	
2		exception code	UINT8	01h … 04h	
3, 4	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

4.11 15 - Write Multiple Coils

Write access beyond the address range as defined under 3.2 - Coils does not have any effect, the returned value is always 0.

➔ Master Request

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**0Fh**	
2, 3	MSB, LSB	start address of first coil	UINT16	0000h … FFFFh	0000h … FFFFh
4, 5	MSB, LSB	coils to be written	UINT16	0001h … 07B0h	
6		counts of following data bytes	UINT8	**N**[16]	
7+**n**[17]		output values	UINT8[**n**]	00h … FFh	
8+(**N**-1), 9+(**N**-1)	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ Slave Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**0Fh**	
2, 3	MSB, LSB	start address of first coil	UINT16	0000h … FFFFh	0000h … FFFFh
4, 5	MSB, LSB	counts of coils	UINT16	0001h … 07B0h	
6, 7	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ Slave Error Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**8Fh**	
2		exception code	UINT8	01h … 04h	
3, 4	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

[16] N= (coils to be written+7)/8, rounded down

[17] n= 0 … ((coils to be written+7)/8-1), rounded down

4.12 16 - Write Multiple Registers

Write access beyond the address range as defined under 3.4 - Holding Registers does not have any effect, the returned value is always 0.

Note

The values which have been written into the Holding Registers are automatically checked and - if neccessary - corrected to their limits. The function returns then the written and if neccessary corrected values.

← Master Request

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**10h**	
2, 3	MSB, LSB	start address of first register	UINT16	0000h … FFFFh	0000h … FFFFh
4, 5	MSB, LSB	registers to be written	UINT16	0001h … 007Bh	
6		counts of following data bytes	UINT8	2x**N**[18]	
7+2x**n**[19], 8+2x**n**	MSB, LSB	register values	UINT16[**n**]	0000h … FFFFh	
9+2x(N-1), 10+2x(N-1)	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ Slave Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**10h**	
2, 3	MSB, LSB	start address of first register	UINT16	0000h … FFFFh	0000h … FFFFh
4, 5	MSB, LSB	registers which have been written	UINT16	0001h … 007Bh	
6, 7	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ Slave Error Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**90h**	
2		exception code	UINT8	01h … 04h	
3, 4	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

4.13 20 - Read File Record

Notwithstanding the MODBUS specification this function allows the request of a single file record only. For compatibility reasons, at the request of several file records the function returns the exception error 02h (Illegal Data Address).

[18] N= registers to be written

[19] n= 0 … (registers to be written -1)

← Master Request

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**14h**	
2		counts of following bytes	UINT8	07h	
3		subrequest 0, reference type	UINT8	06h	
4, 5	MSB, LSB	file number	UINT16	0001h … FFFFh	
6, 7	MSB, LSB	record number	UINT16	0000h … FFFFh	
8, 9	MSB, LSB	record length	UINT16	0000h … FFFFh	
10, 11	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ Slave Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**14h**	
2		counts of data bytes (total)	UINT8	**L**[20]	04h … F5h
3		counts of data bytes of record	UINT8	2x**M**[21]+1	03h … F5h
4		subrequest 0, reference type	UINT8	06h	
5+2x**m**[22], 6+2x**m**	MSB, LSB	subrequest, record data	UINT16[**m**]	0000h … FFFFh	
7+2x(**M**-1), 8+2x(**M**-1)	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ Slave Error Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**94h**	
2		exception code	UINT8	01h … 04h	
3, 4	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

[20] L= bytesum over all record blocks +1

[21] M= record size in registers

[22] m= 0 … (M-1)

4.13.1 File 01 - Calibration Results

Record No.	Register No.	Format	Meaning
0000h … 0009h	0000h … 0001h	INT32	calendartime, seconds since 01.01.2000 00:00:00 0x80000001: last record (EOF)
	0002h	UINT16	calibration method: 0: O2 1-point calibration 1: O2 2-point calibration
	0003h … 0004h	INT32	O2 sensor offset
	0005h … 0006h	INT32	O2 sensor slope
	0007h … 0008h	INT32	O2 value at test gas 1
	0009h … 000Ah	INT32	O2 value at test gas 2
	000Bh … 000Ch	INT32	O2 sensor voltage at test gas 1
	000Dh … 000Eh	INT32	O2 sensor voltage at test gas 2
	000Fh	INT16	O2 sensor response at test gas
	0010h	INT16	O2 sensor response at process gas
	0011h	INT16	O2 sensor life 0..11 0= 0% 1= >0%...<10% 2= >=10%...<20% 3= >= 20%...<30% 4= >= 30%...<40% 5= >= 40%...<50% 6= >= 50%...<60% 7= >= 60%...<70% 8= >= 70%...<80% 9= >= 80%...<90% 10= >=90%...<100% 11= 100%
	0012h … 0024h	reserved	
	0025h … 0026h	INT32	O2 concentration test gas 1
	0027h … 0028h	INT32	O2 concentration test gas 2
	0029h … 002Dh	reserved	
	002Eh	INT16	Process pressure at testgas 1[23]
	002Fh	INT16	Process pressure at testgas 2[23]

4.14 21 - Write File Record

Only for factory internal use.

4.15 23 - Read/Write Multiple Register

Write access beyond the address range as defined under 3.4 - Holding Registers does not have any effect, the returned value is always 0.

Note

The values which have been written into the Holding Registers are automatically checked and - if neccessary - corrected to their limits. The function returns then the written and if neccessary corrected values.

[23] for option pressure compensation only

← Master Request

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**17h**	
2, 3	MSB, LSB	start address of first register (read)	UINT16	0000h … FFFFh	
4, 5	MSB, LSB	registers to be read	UINT16	0000h … 007Dh	
6, 7	MSB, LSB	start addr. of first register (write)	UINT16	0000h … FFFFh	
8, 9	MSB, LSB	registers to be written	UINT16	0000h … 0079	
10		counts of following data bytes	UINT8	2x**N**[24]	
11+2x**n**[25], 12+2x**n**	MSB, LSB	registers to be written	UINT16[**n**]	0000h … FFFFh	
13+2x(N-1), 14+2x(N-1)	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ Slave Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	17h	
2		counts of following data bytes	UINT8	2xN	
3+2xn, 4+2xn	MSB, LSB	register values	UINT16[n]	0000h … FFFFh	
5+2x(N-1), 6+2x(N-1)	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

➔ Slave Error Response

Byte	Order	Description	Format	Range	Total Range
0		device address	UINT8	00h … F7h	
1		function code	UINT8	**94h**	
2		exception code	UINT8	01h … 04h	
3, 4	LSB, MSB	CRC16	UINT16	0000h … FFFFh	

[24] N= registers to be written

[25] n= 0 … (registers to be written -1)

5 Not Supported Functions

5.1 17 - Report Slave ID

Is not supported, because the software does not have a unique device identification number.

5.2 22 - Mask Write Register

No meaningful application for this function available

5.3 24 - Read FIFO Queue

No meaningful application for this function available

5.4 43 - Encapsulate Interface Transport

This MODBUS implementation is not intended for tunneling through other interface types

A Technical Data

A.1 Applied MODBUS Specifications

The following MODBUS specifications are considered for the implementation of the MODBUS protocol:

- MODBUS over serial line specification and implementation guide V1.02
- MODBUS application protocol specification V1.1b

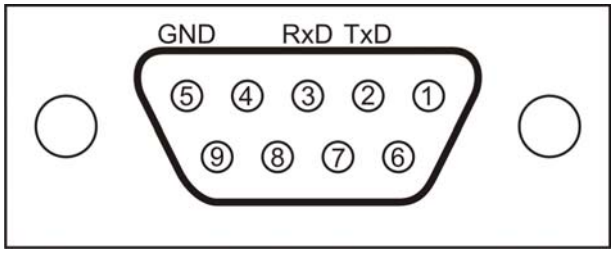
A.2 Configuration of the Serial Interface

The following configurations for the serual interface (RS232 and RS485) are possible and can be altered by the software of the device (default values are **bold**):

device address	**1** … 247
baudrate	1200, 2400, 4800, 9600, **19200**, 38400, 57600
sarity	one, **even**, odd
stopbits	**1**, 2

A.3 RS232 - Interface

Sub-D Female connector assignment of the RS232-interface

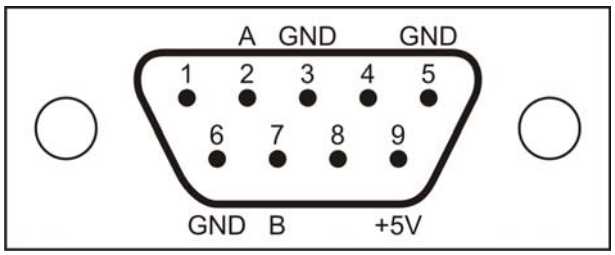


Pin	Assignment	Direction
1		
2	transmission line TxD	output
3	receive line RxD	input
4		
5	ground (GND)	
6		
7		
8		
9		

Voltage Level	follows V.24
Transmission Mode	full duplex
Hardware Handshake	not available

A.4 RS485 - Interface

Sub-D Male connector assignment of the RS485-interface:



Pin	Assignment	Direction
1		
2	bus line A (not inverted)	input/output
3	gound (GND)	
4		
5	ground (GND)	
6	ground (GND)	
7	bus line B (inverted)	input/output
8		
9	+5V auxiliary voltage (10 mA max.)	output

Termination	120 Ohm, fixed
Transmission Mode	half duplex

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Australia
Phone +61 3 9457 0600
1800 334 802 – tollfree
E-Mail sales@sick.com.au

Austria
Phone +43 22 36 62 28 8-0
E-Mail office@sick.at

Belgium/Luxembourg
Phone +32 2 466 55 66
E-Mail info@sick.be

Brazil
Phone +55 11 3215-4900
E-Mail marketing@sick.com.br

Canada
Phone +1 905 771 14 44
E-Mail information@sick.com

Czech Republic
Phone +420 2 57 91 18 50
E-Mail sick@sick.cz

Chile
Phone +56 2 2274 7430
E-Mail info@schadler.com

China
Phone +86 20 2882 3600
E-Mail info.china@sick.net.cn

Denmark
Phone +45 45 82 64 00
E-Mail sick@sick.dk

Finland
Phone +358-9-2515 800
E-Mail sick@sick.fi

France
Phone +33 1 64 62 35 00
E-Mail info@sick.fr

Germany
Phone +49 211 5301-301
E-Mail info@sick.de

Hong Kong
Phone +852 2153 6300
E-Mail ghk@sick.com.hk

Hungary
Phone +36 1 371 2680
E-Mail office@sick.hu

India
Phone +91 22 6119 8900
E-Mail info@sick-india.com

Israel
Phone +972 4 6881000
E-Mail info@sick-sensors.com

Italy
Phone +39 02 274341
E-Mail info@sick.it

Japan
Phone +81 3 5309 2112
E-Mail support@sick.jp

Malaysia
Phone +6 03 8080 7425
E-Mail enquiry.my@sick.com

Mexico
Phone +52 (472) 748 9451
E-Mail mario.garcia@sick.com

Netherlands
Phone +31 30 2044 000
E-Mail info@sick.nl

New Zealand
Phone +64 9 415 0459
0800 222 278 – tollfree
E-Mail sales@sick.co.nz

Norway
Phone +47 67 81 50 00
E-Mail sick@sick.no

Poland
Phone +48 22 539 41 00
E-Mail info@sick.pl

Romania
Phone +40 356 171 120
E-Mail office@sick.ro

Russia
Phone +7 495 775 05 30
E-Mail info@sick.ru

Singapore
Phone +65 6744 3732
E-Mail sales.gsg@sick.com

Slovakia
Phone +421 482 901201
E-Mail mail@sick-sk.sk

Slovenia
Phone +386 591 788 49
E-Mail office@sick.si

South Africa
Phone +27 11 472 3733
E-Mail info@sickautomation.co.za

South Korea
Phone +82 2 786 6321
E-Mail info@sickkorea.net

Spain
Phone +34 93 480 31 00
E-Mail info@sick.es

Sweden
Phone +46 10 110 10 00
E-Mail info@sick.se

Switzerland
Phone +41 41 619 29 39
E-Mail contact@sick.ch

Taiwan
Phone +886 2 2375-6288
E-Mail sales@sick.com.tw

Thailand
Phone +66 2645 0009
E-Mail Ronnie.Lim@sick.com

Turkey
Phone +90 216 528 50 00
E-Mail info@sick.com.tr

United Arab Emirates
Phone +971 4 88 65 878
E-Mail info@sick.ae

United Kingdom
Phone +44 1727 831121
E-Mail info@sick.co.uk

USA
Phone +1 800 325 7425
E-Mail info@sick.com

Vietnam
Phone +84 945452999
E-Mail Ngo.Duy.Linh@sick.com

Further locations at **www.sick.com**

SICK AG | Waldkirch | Germany | www.sick.com

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