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BOGE
COMPRESSED AIR SYSTEMS

Modbus Interface Module

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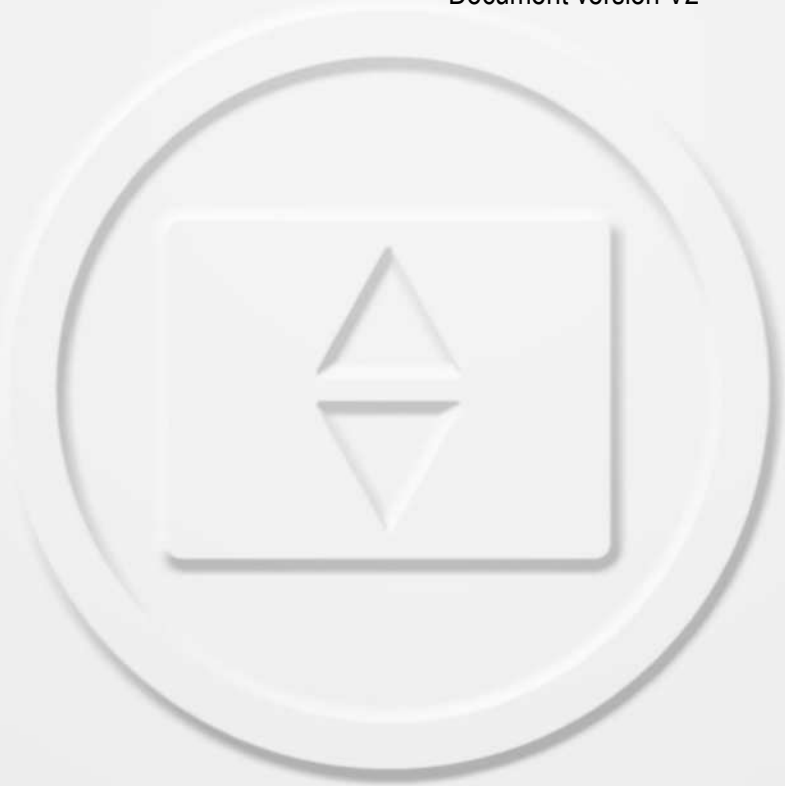

GLC CERTIFIED ISO 9001

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Table of changes

Index	Date	Chapter	Description
1	14.06.2011	all	creation
2	15.06.2011	some	revised

Table of contents

Common

Modbus is a serial communications protocol published by Modicon in 1979 for use with its programmable logic controllers (PLCs). Simple and robust, it has since become one of the de facto standard communications protocols in the industry, and it is now amongst the most commonly available means of connecting industrial electronic devices.

Modbus allows for communication between many (approximately 240) devices connected to the same network, for example a system that measures temperature and humidity and communicates the results to a computer. The Modbus interface module uses the protocol version named Modbus RTU over a serial EIA-485 (former RS485) physical layer (half duplex).

Each device intended to communicate using Modbus is given a unique address. In serial networks only the node assigned as the Master may initiate a command. A Modbus command contains the Modbus address of the device it is intended for. Only the intended device will act on the command, even though other devices might receive it (an exception is specific broadcastable commands sent to node 0 which are acted on but not acknowledged)

The description of specifications and protocols could be found here: http://modbus.org/ .

The Modbus interface module could be used for the following purposes:

1. Connection of a compressor with **air**telligence plus, that is not equipped with a physical Modbus interface
2. As I/O-module with 4 digital and 2 analog (4…20mA) inputs, 2 relay – and 1 analog (4…20mA) outputs.

All values are passed in the Modbus conform format (High-Byte, Low-Byte (Big endian)).

Settings

Communication settings

Communication is done by using the following settings:

Baudrate:	19200
Data bits:	8
Parity:	even
Stoppbits:	1

This values could not be changed.

Device address

The station address is set by way of the rotary switches. The address is set as a decimal number. The right rotary switch stands for the units position and the left one stands for the tens position of the address. To ensure that the rotary switch setting is recognized, the Interface module must be reset (by interrupting the power supply).

example, address 14:

Depending on the address, the Modbus Interface module acts different:

0:	initialisation with default values
1…32:	interfacing of compressors
33	test digital IOs and LEDs
34	test analog IOs
80…99:	I/O module

Diagnostic LEDs

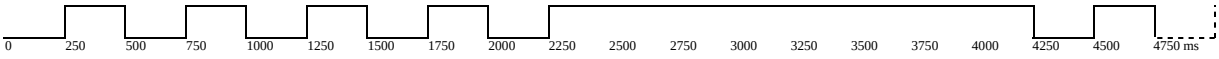
Red

The red LED shows erros. The different errors are coded in the following manner: The LED changes in constant intervals (~250ms) the state and than stays on for approximatly 2 seconds.

The following error could be shown:

Error	**LED is on *n* times**
addresse 0 is active	3
error of flash memory	4
missing calibration data	5
invalid address	7
life bit not recognized (only when used as compresor interface)	9

example: missing calibration data



Yellow

The yellow LED is switched ON during frame reception and sending.

Green

The green LED shows that the application is running.

IO - Test

Digital IOs and LEDs

When setting device address to ‚33', the digital inputs, the relays and the LEDs could be tested. Setting of digital inputs causes switching of relay respectively lightens LEDs. Following combinations are supported:

DIN 1(B)	DIN 2(S)	DIN 3(M)	DIN 4(L)	output
X				R1
	X			R2
		X		LED yellow
			X	LED green
		X	X	LED red

Analog IOs

The device address 34 is used to verify the analog inputs and outputs.
If DIN 1 is not set, analog input 1 is tested, otherwise (DIN 1 is set) analog input 2 is tested.

The measured current is transferred as analog signal on the analog output. Further, the value is shown by the LEDs :

LED yellow	LED green	LED red	current
			I < 3,5mA
X			3,5mA >= I >= 7,2mA
X	X		7,2mA > I >= 10,4mA
	X		10,4mA > I >= 13,6mA
	X	X	13,6mA > I >= 16,8mA
		X	16,8 > I > 20mA
X	X	X	I >= 20mA

Function codes

Depending on the selected device address following Modbus functions are supported:

Code	Function	supported if
01 (0x01)	Read Coils	device address >= 80
02 (0x02)	Read Discrete Inputs	device address >= 80
03 (0x03)	Read Holding Registers	device address >= 80
04 (0x04)	Read Input Registers	0 < device address < 33 and device address >= 80
05 (0x05)	Write Single Coil	device address >= 80
06 (0x06)	Write Single Register	0 < device address < 33 and device address >= 80
16 (0x10)	Write Multiple Registers	0 < device address < 33 and device address >= 80

Compressor Interface

Read Input Register

Modbus Address	Name	Description
1	Identification	Identification 18765 (494D $_{hex}$) = Modbus IO Interface
2	Reserve	
3	VersionMajorNo	Major version No.
4	VersionMinorNo	Minor version No.
5…14	Reserve	
15	CompressorInfo	Bit 0 : compressor with proportional switch Bit 1…4: reservered Bit 5: 0: compressor with fixed speed 1: compressor with frequency converter Bit 6 …15: reserved
16	CompressorEfficiency	compressor – effiviency [%]
17	Reserve	
18	CompressorUtilisation	compressor utilisation[%] 0…100 = utilisation -1 = compressor with fixed speed -2 = proportional switch (closed) -3 = proportional switch (open)
19	SystemtimeHighWord [2]	time [ms] since last power up: Bits 31…16
20	SystemtimeLowWord [3]	time [ms] since last power up: Bits 15…0
21	CompressorState	state of compressor 0: off 1: ready 3: start-up phase 4: load-run 5: idle-run 7: fault
22…24	Reserve	
25	FaultIdentificationCode	fault id 0: no fault 79$_{dez}$: error during saving data 210$_{dez}$: compressor reports malfunction via contact
26	ServiceIdentificationCode	servicing id: 0 : no service message 11$_{dez}$: compressor servicing is due
27	OperatingTimeHighWord [2]	working hours of compressor [s]: Bits 31 … 16
28	OperatingTimeLowWord [3]	working hours of compressor [s]: Bits 15 … 0
29…30	Reserve	
31	ServicingPeriod	time till next service [h]
32	ServicingPeriod	time till next service [h]

[1] 32-bit values must be read in the order high word, low word. This ensures that – after reading the low word – the correct value can be calculated:
value = (High-Word * 65536) + Low-Word

[2] Low – word mus be read after high word. (see [1])

Write Single Register / Write Multiple Registers

Modbus Address	Name	Descripition
1	CommandWord	Bit 0…1 Reserve[1] Bit 2: release Bit 3…5: Reserve[1] Bit 6: life bit Bit 7: restart efficiency calculation Bit 8…15: Reserve[1]
3	ServicingPeriod	time till next servicing [h]
4	OperatingTimeHighWord	working hours of compressor [s]:[2] Bits 31 … 16
5	OperatingTimeLowWord	working hours of compressor [s]: [2] Bits 15 … 0
6	IdlingTimeHighWord	idling time of compressor [s]: [2] Bits 31 … 16
7	IdlingTimeLowWord	idling time of compressor [s]: [2] Bits 15 … 0

Release (pressure control)

This bit controls relay 1 (pressure control). If this bit is "0", the relay is energized. As for driving the compressor, the opener is used, this means that release is disabled. The release will only be considered if the life bit is served.

Life bit

This bit must change at least every 15 seconds the value. If the interface module doesn't register a change, relay 1 would not be activated anymore.

Restart efficiency calculation

Setting this bit causes a reset of internally used counter for efficiency calculation.

Time till next servicing (ServicingPeriod)

For displaying the time until next servicing it is necessary to set this value after every maintenance. Initialisation is done in unit 'hours'.
Based on the feedback from the compressor via the digital inputs, the interface module can now perform an independent calculation.

[1] Must be 0.
[2] High and Low – Word must be transfered by using function code „*Write Multiple Register*".

Working hours

For displaying operating time, it is necessary to set it once. The initialization is done in units of "seconds". Based on the feedback from the compressor via the digital inputs, the interface module can now perform an independent calculation.

IdlingTime

For displaying idling time, it is necessary to set it once. The initialization is done in units of "seconds". Based on the feedback from the compressor via the digital inputs, the interface module can now perform an independent calculation.

IO-Interface Module

Read Coils

Modbus Address	Name	Description
1	Relay1	state of relay 1 (terminal 11, 12 and 14)
2	Relay2	state of relay 2 (terminal 21, 22 and 24)

Read Discrete Inputs

Modbus Address	Name	Description
1	IN1	State of digital input 1 (terminal B)
2	IN2	State of digital input 2 (terminal S)
3	IN3	State of digital input 3 (terminal M)
4	IN4	State of digital input 4 (terminal L)

Read Holding / Input Registers

All registers described in the following could be read either by using function code „03“ (Read Holding Register) as well as function code „04“ (Read Input Register).

Modbus Address	Name	Description
1	Identification	identification 18765 ($494D_{hex}$) = Modbus IO Interface
2	Reserve	
3	SoftwareVersionMajorNo	Major version No.
4	SoftwareVersionMinorNo	Minor version No.
5…18	Reserve	
19	SystemtimeHighWord	time [ms] since last power up: bits 31…16
20	SystemtimeLowWord [3]	time [ms] since last power up: bits 15…0
21	DigitalIn1to4	state of digital inputs 1…4 bit 0 : status of digital input 1 (terminal B) bit 1 : status of digital input 2 (terminal S) bit 2 : status of digital input 3 (terminal M) bit 3 : status of digital input 4 (terminal L) bit 4…15 : Reserve
22	AnalogIn1	analog input 1: -1: Signal < 3mA 0…1000‰: 4…20mA
23	AnalogIn2	analog input 2: -1: Signal < 3mA 0…1000‰: 4…20mA
24	Relay1to2	state of relay outputs bit 0 : state relay 1 bit 1 : state relay 2
25	AnalogOutput	Analog output [‰] 0…1000‰ = 4…20mA
26	Reserve	
27	AnalogIn1Filtered	filtered ADC value of analog input 1
28	AnalogIn2Filtered	filtered ADC value of analog input 2
29	AnalogIn1Raw	raw ADC value of analog input 1

Modbus Address	Name	Description
30	AnalogIn2Raw	raw ADC value of analog input 2

Write Single Coil

Modbus Address	Name	Description
1	SetRelay1	activation of relay 1 (terminal 11, 12 and 14)
2	SetRelay2	activation of relay 2 (terminal 21, 22 and 24)

Write multiple coils is not supported!

Write Single / Multiple Register

Modbus Address	Name	Description
24	SetRelay1to2	activation of relay outputs: bit 0 : relay 1 (terminal 11, 12 and 14) bit 1 : relay 2 (terminal 21, 22 and 24) bit 2…15 : 0
25	SetAnalogOutput	analog output [‰] 0…1000‰ = 4…20mA