Modbus TCP Additional Board for SMARTCON Control

1 General

A fieldbus interface for the MODBUS-TCP bus system is available for SCHIEBEL actuators in the ACTUSMART and SMARTCON series.
MODBUS-TCP is an Ethernet-based fieldbus system.
This interface is a hardware option and should already be known when ordering the actuator.

2 Topology

Since two ports are executed on the additional board for the MODBUS-TCP, the following network topologies can be implemented:

- Line structure

- Tree structure

- Star structure

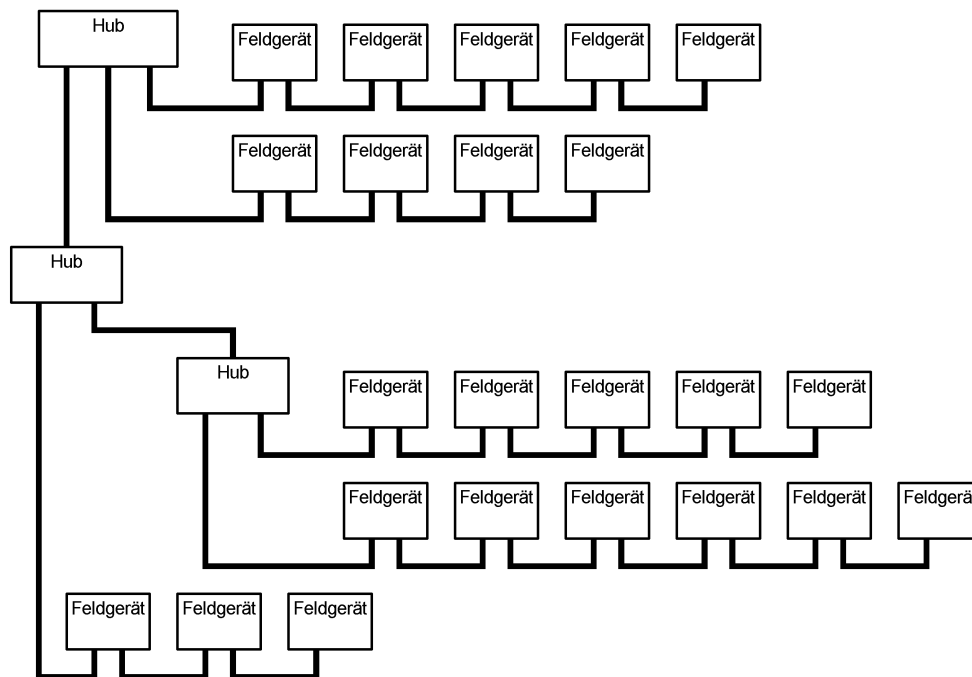- Ring structure (if supported by the master)

- Mixed forms

Example:

Figure 1: *Topology*

3 Connection

Depending on the order there are the following connections possible:

- standard design: M12 connectors

- explosion proof design: terminals

3.1 Standard design

The connection of the SMARTCON control to the EtherNet/IP is done at the field level because of the high degree of protection required via 4-pin, D-coded, M12 connectors (see IEC 61076-2-101).
The female side is on the device, and the male side on the cable side.
Two equivalent M12 connectors, which are internally wired to a hub, are located on the SMARTCON control with EtherNet/IP. With this, a line structure can be implemented. Which connection is used is irrelevant for the function.
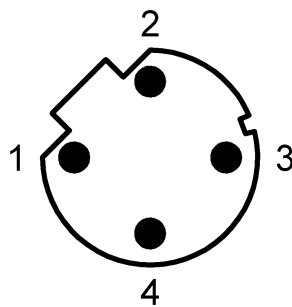

Figure 2: *Pin assignment on device side (female side)*

Pin	Function
1	Tx+
2	Rx+
3	Tx-
4	Rx-

The devices are connected via crossover cables, i.e.:

Tx+	to	Rx+
Tx-	to	Rx-
Rx+	to	Tx+
Rx-	to	Tx-

The cable types recommended are standard patch cables (twisted pair, S/UTP, AWG26, Cat5e).
The cable shield has to be connected to the actuator housing over the connector housing.
It is important to ensure that there are no potential differences between the individual devices in the EtherNet/IP network so that no transient currents flow over the cable shield.

3.2 Explosion proof design

For explosion proof actuators and control units, the connection to the fieldbus is realized through screw terminals. As shown in figure 6, an additional frame is provided to enable proper wiring. There are in total four M20x1,5 threaded holes, which lead directly to shielding connection clamps, to allow proper earthing of the fieldbus cables.
NOTE: The shield must be connected to the shielding connection clamp (windowcut) - see Figure 6 or 7
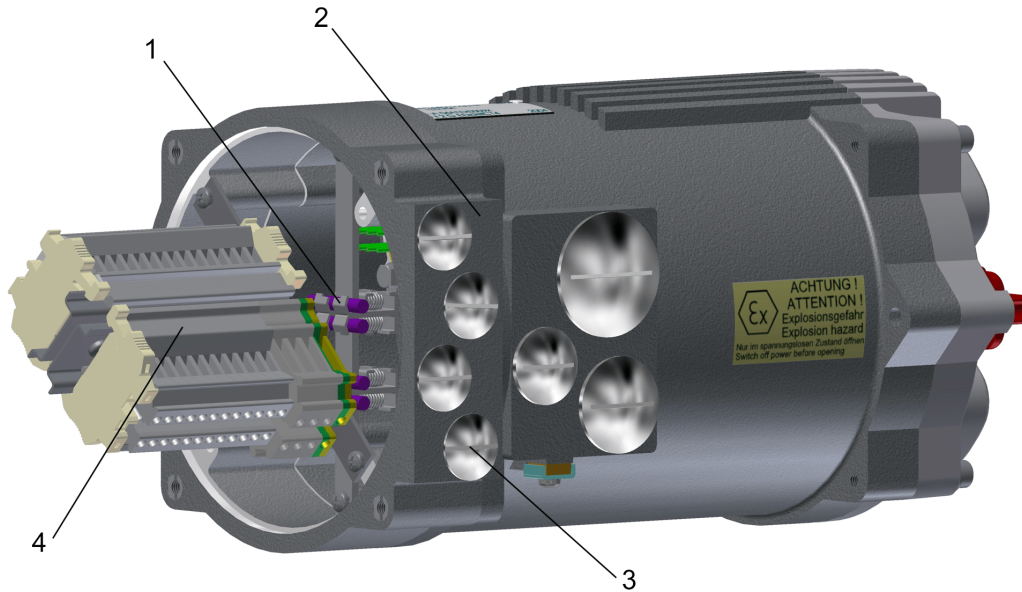
Figure 3: *1. . . shielding connection clamp, 2. . . additional frame, 3. . . metallic cable glands (closed with blind screw connections at delivery) 4 xM20x1,5, 4. . . terminal strip*

The devices are connected via crossover cables, i.e.:

Tx+	to	Rx+
Tx-	to	Rx-
Rx+	to	Tx+
Rx-	to	Tx-

The cable types recommended are standard patch cables (twisted pair, S/UTP, AWG26, Cat5e).
The cable shield has to be connected to the actuator housing over the shielding connection clamp.
It is important to ensure that there are no potential differences between the individual devices in the Ether-Net/IP network so that no transient currents flow over the cable shield.
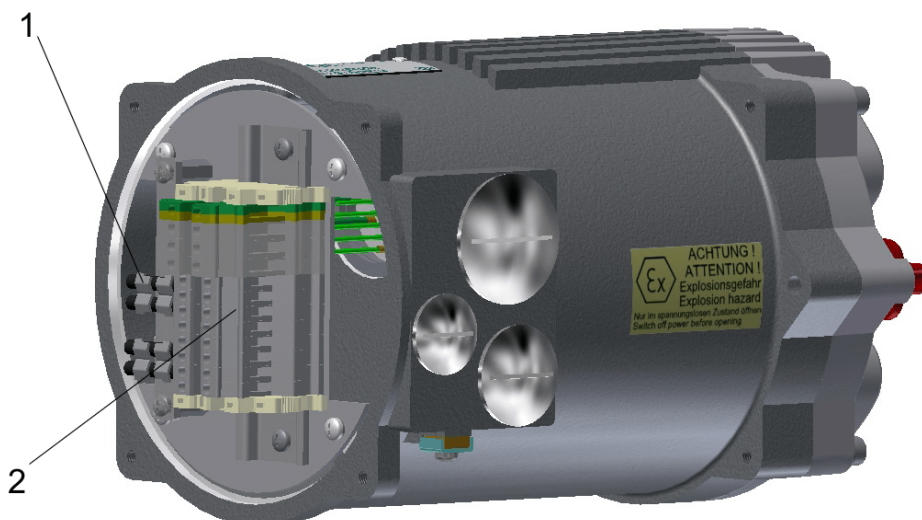

Figure 4: *1. . . shielding connection clamp, 2. . . terminal strip*

An additional frame with 4xM20 holes is possible on special request.

4   Settings

The following additional parameters become visible in the control unit for the ACTUSMART or the SMARTCON actuator with the MODBUS-TCP option enabled.

	menue item	sub menue item	poss. setting	notes / comments
P15.1	MODBUS-TCP	MODBUS-TCP	0: inaktive	MODBUS-TCP disabled
			1: fixed IP	The actuator has a fixed IP address (parameters P15.2 and P15.3 have to be parametrised correctly).
			2: DHCP	The actuator receives its IP address from the DHCP server.
			3: BOOTP	The actuator receives its IP address from the BOOTP server.
P15.2	MODBUS-TCP	IP Adresse	0 to 125	Valid IP address (only relevant if P15.1 is set to 1 (fixed IP))
P15.3	MODBUS-TCP	Net Mask	0 to 125	Valid net mask (only relevant if P15.1 is set to 1 (fixed IP)).
P15.4	MODBUS-TCP	Gateway	IP Address	IP Address to access the internet
P15.5	MODBUS-TCP	Swap Bytes	0, 1	Swap the low and high bytes in registers.
P15.6	MODBUS-TCP	Watchdogtime	0.0 – 10.0s {0.0s}	Monitoring of the toggle bit transmitted from the master (bit 7 in the command). With a bus watchdog time set, this bit has to toggle within that time; otherwise there is a bus watchdog fault. At 0.0 s the watchdog function is disabled, in which case toggling of the toggle bit may be omitted.
P15.7	MODBUS-TCP	Server Connections	1 to 16	Number of server connections open at the same time.
P15.8	MODBUS-TCP	Setpoint Source	{0}: Standard	The set point is specified via the MODBUS-TCP (only relevant when the positioner is enabled).
			1: Analogue	The set point is specified by the analogue signal (only relevant when the positioner is enabled).
			2: Bus/analogue	With an error-free bus, the set point is specified via the MODBUS-TCP. With a bus error, the analogue value is switched to (only relevant when the positioner is enabled).
P15.9	MODBUS-TCP	Status 2	{0}	Standard assignment for Status 2
			1 - 2	Reserved for future use.
P15.10	MODBUS-TCP	Status 3	{0}	Standard assignment for Status 3 (current event)
			1 - 2	Reserved for future use.
P15.11	MODBUS-TCP	Status 4	{0}	Standard assignment for Status 4 (current event)
			1 - 2	Reserved for future use.
			0: Ignore	Bus fault or watchdog timeout is ignored.
			1: Stop	The actuator stops in case of a bus fault or watchdog timeout.

continued from previous page

	Menu item	Sub-menu item	poss. setting	Notes / Comments
P15.12[1]	MODBUS-TCP	Bus Monitor	2: Open	The actuator moves to the open position in case of a bus fault or watchdog timeout.
			3: Close	The actuator moves to the closed position in case of a bus fault or watchdog timeout.
			4: Emergency Position	The actuator moves to the emergency position (see parameter P8.5) in case of a bus fault or watchdog timeout.
			5: Emergency Open	The actuator moves to the open position with a superimposed run command in case of a bus fault or watchdog timeout.
			6: Emergency Close	The actuator moves to the closed position with a superimposed run command in case of a bus fault or watchdog timeout.
			7: Last Valid Value	The actuator moves to the last valid value set by the setpoint register (see chapter **??** on page **??**) in case of a bus fault or watchdog timeout
			8: Failsafe	The actuator moves to the failsafe position in case of a bus fault or watchdog timeout (only for failsafe actuators).

NOTE: After changing parameters P15.1 ... P15.3, the protocol stack for the MODBUS-TCP is restarted to apply the change.

NOTE: To allow the actuator to be unambiguously identified in the network, the MAC address is displayed in the bottommost line of Status Area S5!

5 Description of Input and Output Data

General information: Depending on the master, it is possible that the low byte (bits 0 ... 7) and the high byte (bits 8 ... 15) have to be swapped in the registry values. This swapping can be done by the control unit with parameter P15.4.

The transmission mode (big endian/little endian) always has to be adjusted such that the analogue values are transmitted correctly. Only then can the binary data be swapped.

5.1 Register assignment for the input data (data from master to slave)

The register values can be written with functions 6 (06_{Hex} : Write single register): and 16 (10hex : Write multiple registers).

The register values can be read back with function 3 (03_{Hex} : Read holding register).

NOTE: Depending on the master, the register numbers are assigned with an offset! For example, register 0 in the master has the address 1_{Dec} or 40001_{Dec} !

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[1]FW1515 or higher

5.1.1 Set point

Registry number: 0_{Hex}
Data format: 16-bit, the lower 10 bits (0 . . . 1023) are used.
The other bits are reserved for future use and have to be set to zero!

Structure:

Value	Function:	Description:
0 (0_{Hex})	0 %	
512 (200_{Hex})	50%	
1023 ($3ff_{Hex}$)	100%	

5.1.2 Command

Registry number: 1_{Hex}
Data format: 16-bit (bit field)

Structure:

Bit no.:	Function:	Description:	
		Bit = 0	Bit = 1
0	OPEN	-	OPEN command in REMOTE mode
1	CLOSE	-	CLOSE command in REMOTE mode
2	STOP	-	STOP command in REMOTE mode
3	NOT-AUF	-	EMERGENCY OPEN command in LOCAL & REMOTE modes
4	NOT-ZU	-	EMERGENCY CLOSE command in LOCAL & REMOTE modes
5	BLOCK	-	BLOCK drive in LOCAL & REMOTE modes. The drive is not operable either via the selector switch locally nor via commands by REMOTE nor MODBUS-TCP.
6	CONTROL INHIBIT	-	CONTROL INHIBIT in REMOTE mode Engagement of the positioner is suppressed
7	WATCHDOG	Toggle bit from the master for bus watchdog monitoring With bus watchdog time set, the bit has to toggle within this time; otherwise there is a bus error.	
8	OPEN-SH	-	OPEN command with self-retention in REMOTE mode jettison with STOP
9	CLOSE-SH	-	CLOSE command with self-retention in REMOTE mode jettison with STOP
10	LOCKING- OPEN	-	Trigger locking OPEN (in LOCAL and REMOTE modes) the drive runs OPEN with highest priority, the command continues to queue internally even after reaching the OPEN end position. Jettison only with LOCKING OFF, supply off or OFF mode
11	LOCKING- CLOSE	-	Trigger locking CLOSED (in LOCAL and REMOTE modes) the drive runs CLOSED with highest priority, the command continues to queue internally even after reaching the CLOSED end position. Jettison only with LOCKING OFF, supply off or OFF mode
12	LOCKING OFF	-	Jettison locking
13	BLOCK LOCAL	-	BLOCK drive in LOCAL mode The drive is not operable via the selector switch locally
14	FAILSAFE	-	Trigger the failsafe unit (if there is one)
15	OVERRIDE	-	Binary inputs are not processed

5.1.3   Command 2

Register number: 2_{Hex}
Data format: 16-bit (bit field)

Structure:

Bitno.:	Function:	Description:	
		Bit = 0	Bit = 1
0	Bus Bit 1	-	These binary outputs can be assigned to the bus.
1	Bus Bit 2	-	The assignement can be done arbitrarily,
2	Bus Bit 3	-	including the assignement of a single bit to mulitple outputs.
3	Bus Bit 4	-	(Available with Firmware 1.323)
4	Bus Bit 5	-	
5	Bus Bit 6	-	
6	Bus Bit 7	-	
7	Bus Bit 8	-	
8	Intermediate position	-	Intermediate position, defined by Bit9, Bit10 and Bit11
9	Definition intermediate position	-	Bit-setting for intermediate position see table 2, page 7.
10	Definition intermediate position	-	Bit-setting for intermediate position see table 2, page 7.
11	Definition intermediate position	-	Bit-setting for intermediate position see table 2, page 7.
12	PVST-Start	-	start PVST
13	reserved	-	
14	reserved	-	
15	reserved	-	

Bit11	Bit10	Bit9	Function
0	0	0	move to intermediate position: Position 1
0	0	1	move to intermediate position: Position 2
0	1	0	move to intermediate position: Position 3
0	1	1	move to intermediate position: Position 4
1	0	0	move to intermediate position: Position 5
1	0	1	move to intermediate position: Position 6
1	1	0	move to intermediate position: Position 7
1	1	1	move to intermediate position: Position 8

Table 2: *Bit-setting for intermediate position (Bit8)*

5.2   Modules for the output data (slave to master)

The register values can be read with function 4 (04_{Hex} : Read input register).
NOTE: Depending on the master, the register numbers are assigned with an offset! For example, register 0 in the master has the address 1_{Dec} or 40001_{Dec} !

5.2.1 Actual value

Registry number: 0_{Hex}
Data format: 16-bit, the lower 10 bits (0 . . . 1023) are used.
The other bits are reserved for future use and have to be hidden!

Structure:

Value	Function:	Description:
0 (0_{Hex})	0%	
512 (200_{Hex})	50%	
1023 ($3ff_{Hex}$)	100%	

5.2.2 Status

Registry number: 1Hex
Data format:16-bit (bit field)

Structure:

Bit no.:	Function:	Description:	
		Bit = 0	Bit = 1
0	READY	-	Actuator is ready
1	END POSITION OPEN	-	End position OPEN reached (taking into account the type of de-activation (torque- or travel-dependent))
2	END POSITION CLOSED	-	End position CLOSED reached (taking into account the type of de-activation (torque- or travel-dependent))
3	TRAVEL OPEN	-	Travel end position OPEN reached (no allowance for the type of de-activation (only straightforward travel information))
4	TRAVEL CLOSED	-	Travel end position CLOSED reached (no allowance for the type of de-activation (only straightforward travel information))
5	TORQUE OPEN	-	Cut-out torque in OPEN direction has been exceeded.
6	TORQUE CLOSED	-	Cut-out torque in CLOSE direction has been exceeded.
7	MOTOR TEMP.	-	Motor temperature sensor has responded (overtemp.)
8	OPERATION OPEN	-	The drive is operating by motor OPEN
9	OPERATION CLOSED	-	The drive is operating by motor CLOSED
10	LOCAL	-	Selector switch in position LOCAL
11	REMOTE	-	Selector switch in position REMOTE
12	LOCKING OPEN	-	Locking OPEN is active. OPEN command is queued with the highest priority and will not be jettisoned even in the end position (see command for bits 10 and 12)
13	LOCKING CLOSED	-	Locking CLOSED is active. CLOSE command is queued with the highest priority and will not be jettisoned even in the end position (see command for bits 11 and 12)
14	LIVEBIT 1	Livebit1 toggles every second	
15	LIVEBIT 2	Livebit 2 is the copy from the watchdog toggle bit (see command bit 7)	

5.2.3 Actual torque

Register number: 2_{Hex}
Data format: 16-bit, only the lower 8 bits (Bit 7: in direction OPEN; bit 6 . . . 0: 0 . . . 100 corresponding to 0 . . . 100%) are used.
The other bits are reserved for future use and have to be hidden!

5.2.4 Actual speed

(only for ACTUSMART)
registry number: 3_{Hex}
Data format: 16-bit, only the lower 8 bits (Bit 7: in direction OPEN; bit 6 . . . 0: 0 . . . 100 corresponding to 0 . . . 100%) are used.
The other bits are reserved for future use and have to be hidden!

5.2.5 Ext. actual value

(only with PID controller option!!!)
Registry number: 4_{Hex}
Data format: 16-bit, the lower 10 bits (0 . . . 1023) are used.
The other bits are reserved for future use and have to be hidden!

5.2.6 Status 2

Registration number: 5_{Hex}
Data format: 16-bit (bit field)

Structure:

Bit no.:	Function:	Description:	
		Bit = 0	Bit 0 = 1
0	Dig. output 1	-	Corresponding binary output is set.
1	Dig. output 2	-	
2	Dig. output 3	-	
3	Dig. output 4	-	
4	Dig. output 5	-	
5	Dig. output 6	-	
6	Dig. output 7	-	
7	Dig. output 8	-	
8	Dig. input 1	-	Corresponding Binary input is set
9	Dig. input 2	-	
10	Dig. input 3	-	
11	Dig. input 4	-	
12	Dig. input 5	-	
13	PHASE SEQUENCE	-	Phase sequence error: Error in supply voltage the (incorrect phase sequence, phase loss, total loss, asymmetry)
14	FC ERROR	-	FC error: error in the power supply unit and/or the frequency converter (if there is one)
15	FAILSAFE ERROR	-	Failsafe unit not ready (if there is one)

Parameter P15.8 can be used to set alternative output functions for status 2.

5.2.7   Status 3

Record Number: 6_{Hex}
Data format: 16-bit, error number

Error number:	Meaning:
3	Motor temperature warning (only for ACTUSMART)
4	Motor temperature cut-out
5	Phase sequence error or phase loss
9	Error in the power supply or the frequency converter
11	Error in the failsafe unit (provided there is one)
17	Fault position sensor
22	Fault torque sensor (provided there is one)

Parameter P15.9 can be used to set alternative output functions for status 3.

5.2.8   Status 4

Record Number: 7_{Hex}
Data format: 16-bit (bit field)

Structure:

Bitno.:	Function:	Description		
		Bit1	Bit0	Signal
0 and 1	Channel activity	0	0	Bus: Channel A active.
		0	1	Bus: Channel B active.
		1	0	Bus: Channel A and B active, main channel for inputs is channel A.
		1	1	Bus: Channel A and B active, main channel for inputs is channel B.
2	reserved			
3	reserved			
4	reserved			
5	reserved			
6	reserved			
7	reserved			
8 and 9	PVST Status	Bit9	Bit8	Signal
		0	0	PVST functionality not activated or no PVST realised yet.
		0	1	PVST active: There is a PVST active currently.
		1	0	PVST OK: The last PVST was successful.
		1	1	PVST Error: The last PVST was not successful.
10	reserved			
11	reserved			
12	reserved			
13	reserved			
14	reserved			
15	reserved			

Parameter P15.10 can be used to set alternative output functions for status 4.