Extension Board for MODBUS-RTU on SMARTCON Control Unit

1 General Information

For SCHIEBEL ACTUSMART or SMARTCON actuators the standardized fieldbus interface MODBUS-RTU is available.
This interface is a product option represented in hardware on the device, thus making it beneficial to advertise intended use upon ordering.
Although enabling MODBUS-RTU a posterior is possible, such upgrades should only be performed by authorized SCHIEBEL engineers or specially trained personnel.

MODBUS-RTU determines technical and functional characteristics of the serial fieldbus system used to connect distributed autonomous devices. MODBUS-RTU distinguishes Master- and Slave-Devices and has been designed for data-transmission on field-level, hence, the communication of central control units - as SPS or PC - with decentrale field-devices over a fast serial connection.
Communication functionality is standardized by the MODBUS Organization (modbus.org).

The **physical communication layer** is based on a RS-485 interface connected through a shielded twisted two-wire cable.

SCHIEBEL Actuators ACTUSMART or SMARTCON are always slave devices.

Communication settings
The detection of the settings of the Modbus RTU communication is done automatically in the SCHIEBEL MODBUS-RTU slave module during communication start-up.

The supported baud rates are:
4800 bps, 7200 bps, 9600 bps, 14400 bps, 19200 bps, 28800 bps,
38400 bps, 57600 bps, 76800 bps, 115200 bps

The byte frame has following bits:
1 start bit
8 data bits, LSB first
1 parity bit (even, odd or mark)
1 stop bit

If mark parity is not supported by the MODBUS-RTU master, you can use no parity and 2 stop bits instead.

2 Connection

Depedning on the order there are the following connections possible:

- standard design: connection board
- explosion proof design: terminals

2.1 Standard design

Connecting the actuator to the fieldbus system is accomplished through connecting the bus cable to the connection print in the connection compartment of the actuator. Thus for convinience, the MODBUS-RTU connector is pluggable like every other external connector for signal or power on our actuators. Disconnecting a device will have no effect on the communication of other devices in the same strand. Meaning, the network maintains full functionality if a device is disconnected while the network is in operation. But beware: At the end of each strand MODBUS-RTU has to be terminated. This termination can either be performed by a SMARTCON-Actuator or a separate active bus termination device. Note that the power for the termination resistors of SMARTCON-Devices comes from the actuator. Hence, disconnecting the terminating SMARTCON

renders the bus in this strand inoperational. Therefore, it is advised to use active bus termination through a dedicated device.
The single-channel version of SMARTCON is connected to MODBUS-RTU via channel I. The dual-channel version (Option: redundant) is connected via channel I and II.

2.1.1 Connection Board (customer end)

The connection board is situated in the connection compartment under the topmost cover.

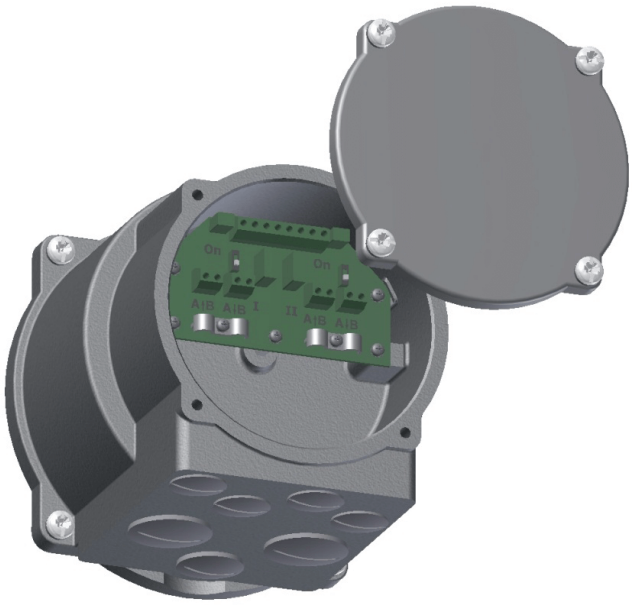
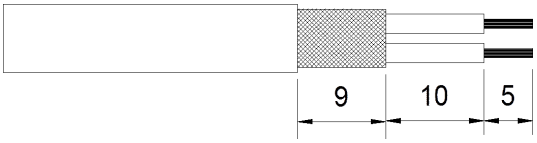


Figure 1: *Connection Board*

2.1.2 Connecting to MODBUS-RTU

Recommended Cable Confectioning

Prior to connection the bus lines are to be confectioned as seen in the figure below:



The clamps on the connection board are designed for a maximum line cross-section of 1.5mm^2. The line diameter has to be in the range of 5 to 8 mm.

Connecting to a Strand between Devices

Other devices are connected to the bus in front and behind of the new Slave-Device.
Line configuration:

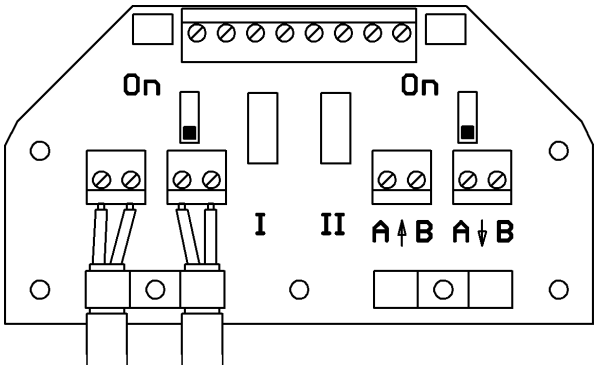


Figure 2: *single channel*

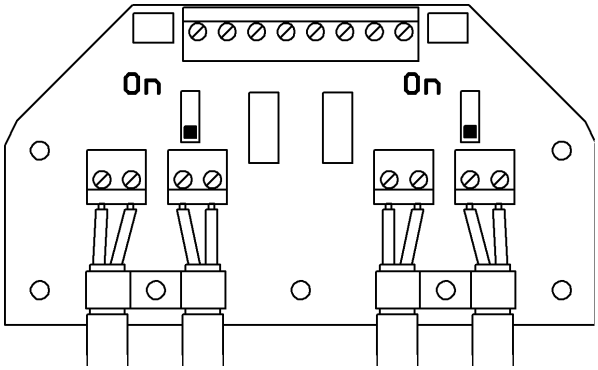


Figure 3: *dual channel*

Connecting at the End of a Strand, Bus Termination

There is either no device connected to the bus in front or behind of the new Slave-Device.
Line configuration:

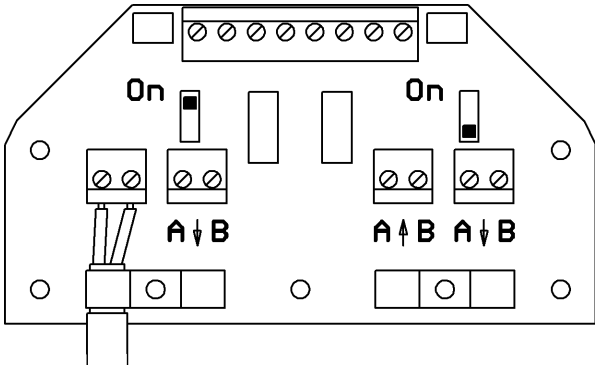


Figure 4: *single channel*

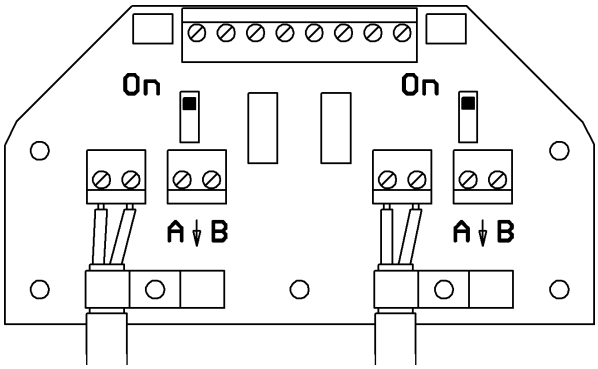


Figure 5: *dual channel*

Bus termination:
MODBUS-RTU has to be terminated on both ends of every strand. Termination can be accomplished through the termination resistor implemented in your SMARTCON-Device. Bus termination is activated when the respective switch on the connection board is switched to ”ON” as seen in figure 4.

2.2 explosion proof design

Normaly in explosion proof deisgn there is no termination available in the control unit. That means that the bus termination must be done seperate outside of the control unit.
Optionaly also a bus termination in the control unit is possible, this must be specified by the order.
In this case you can activate the bus termination by connecting the following terminals:
A with AT and B with BT (single channal version) or
A1 with A1T, B1 with B1T, A2 with A2T and B2 with B2T (dual channel version).

CAUTION: The shield must be connected to the shielding connection clamp (windowcut) - see Figure 6 or Figure 7

2.2.1 Design with bin. In- and Outputs

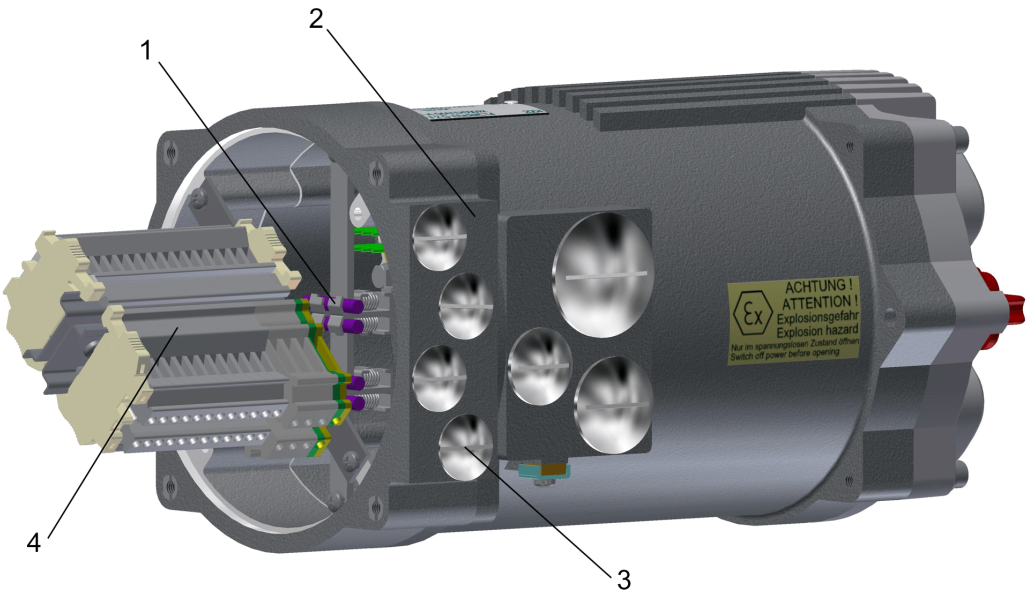


Figure 6: *1. . . shielding connection clamp, 2. . . additional frame, 3. . . metallic cable glands (closed with blind screw connections at delivery) 4 xM20x1,5, 4. . . terminal strip*

2.2.2 Design without bin. In- and Outputs

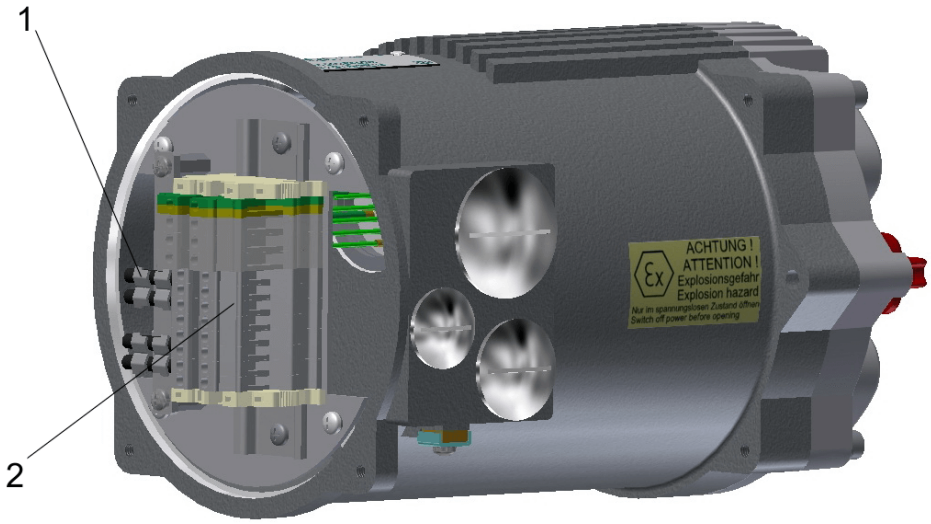


Figure 7: *1. . . shielding connection clamp, 2. . . terminal strip*

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

3 Setup

If MODBUS-RTU is activated, the following additional parameters will be visible in the control menu of your ACTUSMART or SMARTCON-Device.
Each device connected to a MODBUS-RTU-network has to receive a unique address during setup.

	Menu Item	Subitem	Options	Explanation/Comments
P15.1	Modbus	Modbus	0: not active	MODBUS-RTU deactivated.
			1: activated	MODBUS-RTU activated.
P15.2	Modbus	Address Channel A	0 bis 247	Set the bus address of the first/primary channel.
P15.3	Modbus	Address Channel B	0 bis 247	Set the bus address of the second/secondary channel. (only for option ”MODBUS-RTU redundant”)
P15.4	Modbus	Watchdogtime	0.0 – 10.0s {0.0s}	Monitoring period of the togglebit. (Bit 7 in Master’s command). This bit has to toggle in the specified time or a buswatchdog error is detected. If Watchdogtime is set to 0.0s, the watchdog is deactiveted. Toggling the respective bit can now be ommited.
P15.5	Modbus	Setpoint Source	{0}: Standard	Setpoint specified by MODBUS-RTU (effective only if positioner is activated).
			1: Analog.	Setpoint specified by analogue signal. (effective only if positioner is activated)
			2: Bus/Analog.	Setpoint specified by MODBUS-RTU. In case of bus error, setpoint specified by analogue signal. (effective only if positioner is activated)
P15.6	Modbus	Status 2	{0}	Standard value for Status 2
			1 - 2	Reserved for future use.
P15.7	Modbus	Status 3	{0}	Standard value for Status 3 (current event).
			1 - 2	Reserved for future use.
P15.8	Modbus	Status 4	{0}	Standard value for Status 4
			1 - 2	Reserved for future use.
P15.9[1)]	Modbus	Bus Monitor	{0: Ignore}	Bus fault or watchdog timeout is ignored.
			1: Stop	The actuator stops in case of a bus fault or watchdog timeout.
			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.

continued at the next page

[1)] FW1515 or higher

Continuation of the Table

	Menu Item	Subitem	Options	Explanation/Comments
			7: Last Valid Value	The actuator moves to the last valid value set by the setpoint register (see chapter 4.1.1 on page 7) 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: The actuator must be turned off and on again to apply address changes.

4 Specification of Input and Output Data

General requirement: Depending on the Master it is possible that the Lowbyte (Bit 0 . . . 7) and the Highbyte (Bit 8 . . . 15) are to be switched. Generally speaking, the mode of transmission (Big Endian / Little Endian) has to be set in a way that ensures the correct transmission of the analogue information. Only after this has been accomplished, the binary data can be transmitted.

4.1 Input Data Modules (Master to Slave Communication)

Input data can be handled with following Modbus functions:

Function:		
06 (06 hex)	Preset Single Register	Writes data to one single register in the slave.
16 (10 hex)	Preset Multiple Registers	Writes data to multiple consecutively registers in the slave.
03 (03 hex)	Read Holding Register	Reads back one single register from the slave.
04 (04 hex)	Read Input Register	Reads back one single register from the slave.
23 (17 hex)	Read/Write Multiple Registers	Writes data to multiple consecutively registers in the slave and reads multiple consecutively registers from the slave. If the reading and writing addresses the same registers, a read back of the written data is performed. The write operation is performed before the read operation.

4.1.1 Setpoint

Register number: 1, address 0000_{Hex}
Data format: 16bit, only the lowest 10 bits (0 . . . 1023) are in use.
Other bits are reserved for future use and have to be set to zero!

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

4.1.2 Command

Register number: 2, address 0001_{Hex}
Data format: 16 bit (Bitfield)

Bitno.:	Function:	Description:	
		Bit = 0	Bit = 1
0	OPEN	-	OPEN in REMOTE mode.
1	CLOSE	-	CLOSE in REMOTE mode.
2	STOP	-	STOP in REMOTE mode.
3	EMERGENCY-OPEN	-	EMERGENCY-OPEN in REMOTE & LOCAL mode.
4	EMERGENCY-CLOSE	-	EMERGENCY-CLOSE in REMOTE & LOCAL mode.
5	BLOCK	-	Blocking the actuator in REMOTE & LOCAL mode. Actuator can neither be controlled through the switch on the device nor through commands over REMOTE nor MODBUS-RTU.
6	POSITIONER OFF	-	Deactivating the positioner in REMOTE mode.
7	WATCHDOG	Togglebit for buswatchdog. Bit has to toggle before specified time-out or a buswatchdog error will be detected.	
8	OPEN-SH	-	Latched OPEN in REMOTE mode. Release with STOP.
9	CLOSE-SH	-	Latched CLOSE in REMOTE mode. Release with STOP.
10	LOCK-OPEN	-	Locks OPEN (in REMOTE and LOCAL mode) Actuator carries out a latched OPEN command with highest priority which can only be released with LOCK-OFF, power-off or mode OFF.
11	LOCK-CLOSE	-	Locks CLOSE (in REMOTE and LOCAL mode) Actuator carries out a latched CLOSE command with highest priority which can only be released with LOCK-OFF, power-off or mode OFF.
12	LOCK-OFF	-	Releases the lock.
13	BLOCK LOCAL	-	Blocking the actuator in mode LOCAL. Actuator can’t be moved with selection switch.
14	FAILSAFE	-	Trigger FAILSAFE-Unit (if available).
15	OVERRIDE	-	Binary inputs will not be processed.

4.1.3 Command 2

Register number: 3, address 0002_{Hex}
Data format: 16 bit (Bitfield)

Bitno.:	Function:	Description:	
		Bit = 0	Bit = 1
0	Bus Bit 1	-	These binary outputs can be assigned to the bus. The assignement can be done arbitrarily, including the assignement of a single bit to mulitple outputs. (Available with Firmware 1.323)
1	Bus Bit 2	-	
2	Bus Bit 3	-	
3	Bus Bit 4	-	
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 9.
10	Definition intermediate position	-	Bit-setting for intermediate position see table 2, page 9.
11	Definition intermediate position	-	Bit-setting for intermediate position see table 2, page 9.
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)*

4.1.4 Setpoint Revolution Speed

Only with ACTUSMART!

Register number: 4, address 0003_{Hex}
Data format: 16 bit, only the lowest 8 bits (Bit 7: Direction OPEN; Bits 6 . . . 0: 0 . . . 100 corresponding to 0 . . . 100%) are in use.
Other bits are reserved for future use and have to be set to zero!

4.2 Output Data Modules (Slave to Master communication)

Output data can be handled with following Modbus functions:

Function:		
03 (03 hex)	Read Holding Register	Reads one single register from the slave.
04 (04 hex)	Read Input Register	Reads one single register from the slave.
23 (17 hex)	Read/Write Multiple Registers	Writes data to multiple consecutively registers in the slave and reads multiple consecutively registers from the slave. The write operation is performed before the read operation.

4.2.1 Actual position value

Register number: 257, address 0100_{Hex}
Data format: 16bit, only the lowest 10 bits (0 . . . 1023) are in use.
Other bits are reserved for future use and have to be set to zero!

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

4.2.2 Status

Register number: 258, address 0101_{Hex}
Data format: 16 bit (Bitfield)

Bitno.:	Function:	Description:	
		Bit = 0	Bit = 1
0	READY	-	Actuator is ready.
1	END POSITION OPEN	-	End position OPEN reached (under consideration of switch-off mode (torque or travel dependent)).
2	END POSITION CLOSE	-	End position CLOSE reached (under consideration switch-off mode (torque or travel dependent)).
3	TRAVEL OPEN	-	End travel OPEN reached (under consideration of switch-off mode (torque or travel dependent)).
4	TRAVEL CLOSE	-	End travel CLOSE reached (travel dependent).
5	TORQUE OPEN	-	Power-off torque in opening direction exceeded.
6	TORQUE CLOSE	-	Power-off torque in closing direction exceeded.
7	MOTORTEMP.	-	Motor temperature sensor signal (overheat).
8	OPENING	-	Actuator moving in OPEN direction.
9	CLOSING	-	Actuator moving in CLOSE direction.
10	LOCAL	-	Switch in LOCAL mode position.
11	REMOTE	-	Switch in REMOTE mode position.
12	LOCK OPEN	-	Latched OPEN command with highest priority. (Refer to Command bit 10 und 12)
13	LOCK CLOSE	-	Latched CLOSE command with highest priority. (Refer to Command bit 10 und 12)
14	LIVEBIT 1	Livebit1 toggles with 1 Hz.	
15	LIVEBIT 2	Livebit2 is a copy of the watchdog toggle-bit. (Refer to command Bit 7)	

4.2.3 Actual torque value

Register number: 259, address 0102_{Hex}
Data format: 16 bit, only the lowest 8 bit (Bit 7: Direction OPEN; Bit 6 ... 0: 0 ... 100 corresponding to 0 ... 100%) are in use.
Other bits are reserved for future use and have to be set to zero!

4.2.4 Actual speed value

Only with ACTUSMART!

Register number: 260, address 0103_{Hex}
Data format: 16 bit, only the lowest 8 bit (Bit 7: Direction OPEN; Bit 6 ... 0: 0 ... 100 corresponding to 0 ... 100%) are in use.
Other bits are reserved for future use and have to be set to zero!

4.2.5 External actual value

Only with Option PID-Controller!

Register number: 261, address 0104_{Hex}
Data format: 16 bit, only the lowest 10 bits (0 ... 1023) are in use.
Other bits are reserved for future use and have to be set to zero!

4.2.6 Status 2

Register number: 262, address 0105_{Hex}
Datenformat: 16 bit (Bitfield)

Structure:

Bitno.:	Function:	Description	
		Bit = 0	Bit 0 = 1
0	Dig. Output 1	-	Corresponding binary output enabled.
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 enabled.
9	Dig. Input 2	-	
10	Dig. Input 3	-	
11	Dig. Input 4	-	
12	Dig. Input 5	-	
13	PHASE SEQUENCE	-	Phase Sequence Error: wrong phase order, phase failure, total failure, asymmetry.
14	FC ERROR	-	FC Error: Error in power supply or frequency converter (if present).
15	FAILSAFE ERROR	-	Failsafe-Unit not ready (if present).

Using parameter P15.6 it is possible to assign alternative output-functions to ”Status 2”.

4.2.7 Status 3

Register number: 263, address 0106_{Hex}
Data format: 16 bit, error codes

Error Code:	Corresponds:
3	Motor temperature warning (only with ACTUSMART).
4	Motor temperature power-off.
5	Phase order error or phase failure.
9	Power supply error or frequency converter error.
11	Failsafe-Unit error (if available).
17	Travel sensor error.
22	Torque sensor error.

Using parameter P15.7 it is possible to assign alternative output-functions to ”Status 3”.

4.2.8 Status 4

Register number: 264, address 0107_{Hex}
Data format: 16 bit (Bitfield)

Structure:

Bitno.:	Function:	Description		
0 and 1	Channel activity	Bit1	Bit0	Signal
		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			

Using parameter P15.8 it is possible to assign alternative output-functions to ”Status 4”.