Installation, Operation and Maintenance Manual
FCIM-20107-EN Rev. 0
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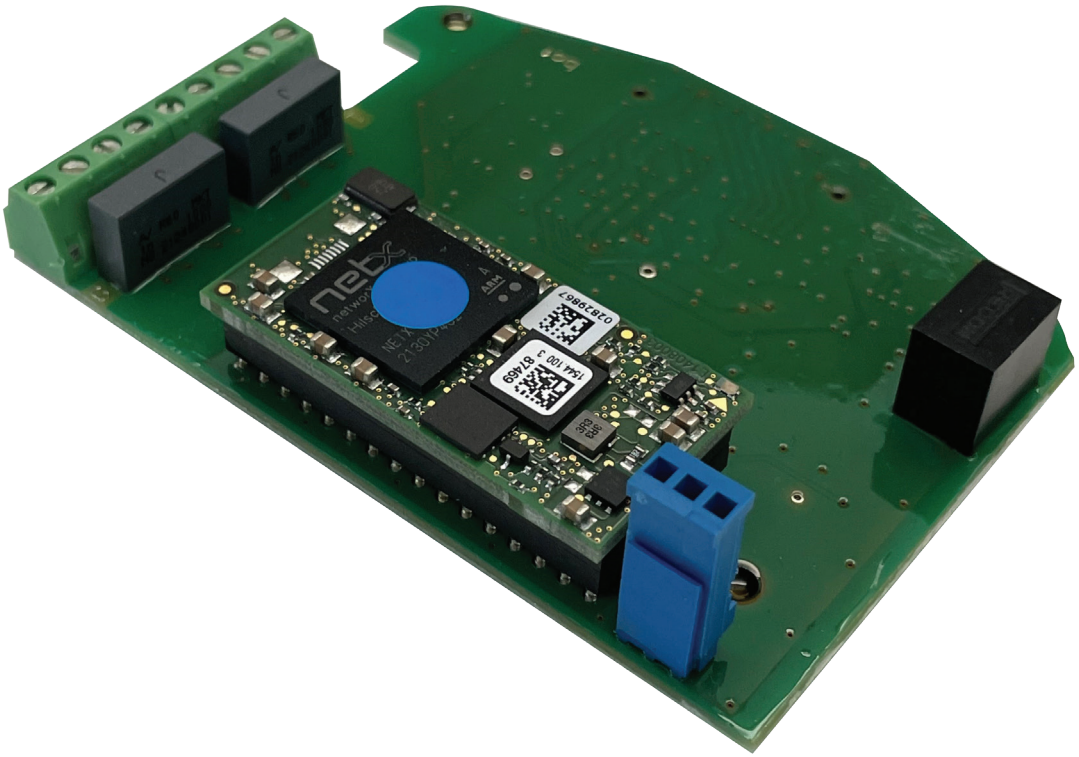
Bettis RTS

Connectivity with Ethernet IP



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Hazard warnings in this manual indicate potential harm to the user or the product. For the person interacting with the product, the level of risk includes consequences ranging from slight, up to lethal injuries. As for the product, disobeying the warnings may cause damage to the equipment and/or void the warranty. Therefore, said warnings are made apparent to instruct and warn the user, which precautions have to be made prior to performing any actions described in this manual. The user must read and be familiar with the manual, before performing any tasks as described in this manual.

Hazard warnings in this manual are presented in these three forms:

⚠ WARNING

These warning notices refer to personal safety. Failure to obey these notices could result in personal injury or death.

⚠ CAUTION

General precautions must be made. Failure to obey these notices could result in personal injury and/or equipment damage.

NOTE:

Directs the user's attention to essential information.

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Section 1: General

A fieldbus interface for the EtherNet/IP bus system is available for Bettis RTS electric actuators.

EtherNet/IP is an Ethernet-based fieldbus system.

This interface is a hardware option and should already be known when ordering the actuator.

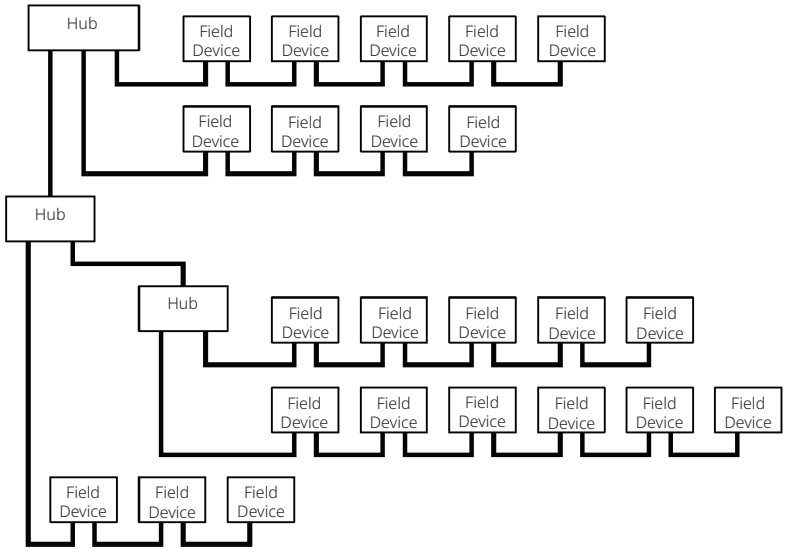
Section 2: Topology

Since two ports are executed on the additional board for the EtherNet/IP, 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



Section 3: Connection

Depending on the order, these are the following connections possible:

- Standard design: M12 connectors
- Explosion proof design: terminals

3.1 Standard Design

The connection of the RTS control unit 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).

Two equivalent M12 connectors, which are internally wired to a hub, are located on the RTS control with EtherNet/IP. With this, a line structure can be implemented. To function, it is irrelevant which connection is used.

Figure 2. Pin Assignment on Device Side (Female Side)

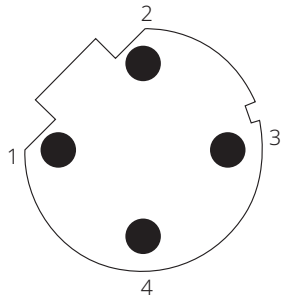


Table 1. Pin Assignment on Device Side (Female Side)

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-

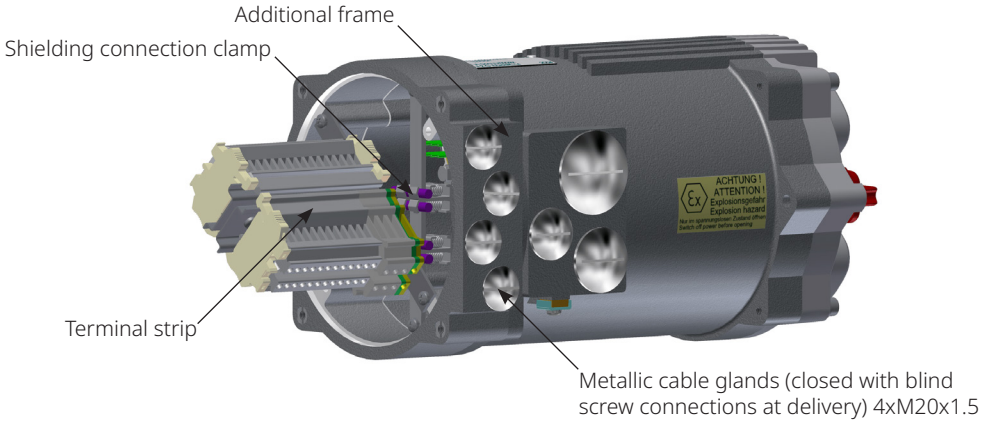
The cable types recommended are standard patch cables (twisted pair, S/UTP, AWG26, Cat5e). The cable shield has to be connected to the actuator housing over the connector housing. It is important to ensure that there are no potential differences between the individual devices in the EtherNet/IP network 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 3, 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 Figures 3 and 4.

Figure 3. Connection to the Fieldbus

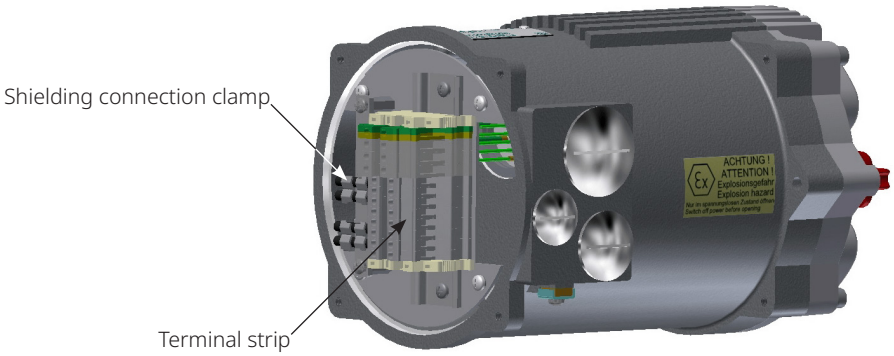


The devices are connected via crossover cables, i.e.:

- 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 EtherNet/IP network so that no transient currents flow over the cable shield.

Figure 4. Shielding Connection Clamp



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

Section 4: Settings

The following additional parameters become visible in the control unit for the Bettis RTS electric actuator with the EtherNet-IP option enabled.

Table 2.

	Menu Item	Sub Menu Item	Possition Setting	Notes/Comments
P15.1	EtherNet/IP	Bus	0: not actived	EtherNet-IP 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	EtherNet/IP	IP Adress	0 to 255	Valid IP address (only relevant if P15.1 is set to 1 (fixed IP)).
P15.3	EtherNet/IP	Net Mask	0 to 255	Valid net mask (only relevant if P15.1 is set to 1 (fixed IP)).
P15.4	EtherNet/IP	Gateway	0 to 255	Valid gateway (only relevant if P15.1 is set to 1 (fixed IP)).
P15.5	EtherNet/IP	Swap Bytes	0, 1	Swap the low and high bytes in the registers.
P15.6	EtherNet/IP	Watchdog Time	0.0 to 10.0 s (0.0 s)	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	EtherNet/IP	Speed	0: Auto	The communication speed is automatically detected.
			1: 10M HDX	10MBits/sec half duplex.
			2: 10M FDX	10MBits/sec full duplex.
			3: 100M HDX	100MBits/sec half duplex.
			4: 100M FDX	100MBits/sec full duplex.
P15.8	EtherNet/IP	Setpoint Source	{0}: Standard	The set point is specified via the EtherNet/IP (only relevant when the positioner is enabled).
			1: Analog	The set point is specified by the analogue signal (only relevant when the positioner is enabled).
			2: Bus/analog	With an error-free bus, the set point is specified via the EtnerNet/IP. With a bus error, the analogue value is switched to (only relevant when the positioner is enabled).
P15.9	EtherNet/IP	Status 2	(0)	Standard assignment for Status 2.
			1 to 2	Reserved for future use.
P15.10	EtherNet/IP	Status 3	(0)	Standard assignment for Status 3 (current event).
			1 to 2	Reserved for future use.
P15.11	EtherNet/IP	Status 4	(0)	Standard assignment for Status 4 (current event).
			1 to 2	Reserved for future use.
P15.12	EtherNet/IP	Bus Monitor	0: Ignore	-
			1: Stop	-
			2: Open	-
			3: Close	-
			4: Emerg.pos.	-
			5: Emerg.open	-
			6: Emerg.close	-
			7: Last valid value	-
			8: Fail-safe	-

NOTES:
- After changing parameters P15.1 to P15.3, the protocol stack for the EtherNet/IP is restarted to apply the change.
- To allow the actuator to be unambiguously identified in the network, the MAC address is displayed in the bottom most line of Status Area S5.

Section 5: Description of Input and Output Data

General information: Depending on the master, it is possible that the low byte (bits 0 to 7) and the high byte (bits 8 to 15) have to be swapped in the registry values. This swapping can be done by the control unit with parameter P15.5.

The transmission mode (big endian/little endian) always has to be adjusted such that the analog 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 (10_{Hex}: 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}.

5.1.1 Set point

Register number: 0_{Hex}

Data format: 16-bit, the lower 10 bits (0 to 1023) are used.

NOTE:

The other bits are reserved for future use and have to be set to zero.

Table 3. Structure

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

5.1.2 Command

Register number: 1_{Hex}

Data format: 16-bit (bit field)

Table 4. 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	EMERGENCY OPEN	-	EMERGENCY OPEN command in LOCAL and REMOTE modes.
4	EMERGENCY CLOSE	-	EMERGENCY CLOSE command in LOCAL and REMOTE modes.
5	BLOCK	-	BLOCK drive in LOCAL and REMOTE modes. The drive is not operable either via the selector switch locally nor via commands by REMOTE nor EtherNet/IP.
6	POSITIONER OFF	-	Deactivate the positioner in REMOTE mode.
7	WATCHDOG	Toggle bit for bus watchdog. Bit has to toggle before the specified time-out or a bus watchdog error will be detected.	
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	FAIL-SAFE	-	Trigger the fail-safe unit (if available).
15	OVERRIDE	-	Binary inputs are not processed.

5.1.3 Command 2

Register number: 2_{Hex}

Data format: 16-bit (bit field)

Table 5. Structure

Bit no.	Function	Description	
		Bit= 0	Bit=1
0	Bus Bit 1	-	The binary outputs can be assigned to the bus bits. The assignment can be done arbitrarily, including the assignment of a single bit to multiple outputs.
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	-	Move to intermediate position (bits 9, 10, 11 and 13). See Table 6 for bit pattern.
9	Intermediate Position Bit 9	-	
10	Intermediate Position Bit 10	-	
11	Intermediate Position Bit 11	-	
12	PVST Start	-	Start PVST.
13	Intermediate Position Bit 13	-	See Table 6 for bit pattern.
14	Reserved	-	-
15	Reserved	-	-

The table below shows the bit pattern for the intermediate positions:

Table 6. Bit Pattern

Bit 13	Bit 11	Bit 10	Bit 9	Command
0	0	0	0	Position 1
0	0	0	1	Position 2
0	0	1	0	Position 3
0	0	1	1	Position 4
0	1	0	0	Position 5
0	1	0	1	Position 6
0	1	1	0	Position 7
0	1	1	1	Position 8
1	0	0	1	Position 9
1	0	1	0	Position 10
1	0	1	1	Position 11
1	1	0	0	Position 12
1	1	0	1	Position 13
1	1	1	0	Position 14
1	1	1	1	Position 15

5.1.4 Set Point – Revolution Speed

Register number: 3_{Hex}

Data format: 16-bit, the lower 8 bits are used.

NOTE:
The other bits are reserved for future use and have to be set to zero.

Table 7. Structure

Bit	Value	Description
0 to 6	0 to 100	Value corresponds to 0 to 100%
7	0, 1	Sets the direction to OPEN

5.2 Extended Control

Register number: 8_{Hex}

Data format: 16-bit

By means of the extended registers, it is possible to execute further commands or to read out various information. For this purpose, the desired register number is entered in position number 9_{Hex} (see Section 5.2.1), and if applicalbe, in position number 10_{Hex} (see Section 5.2.2) the value is entered.

NOTE:
The other bits are reserved for future use and have to be set to zero.

Table 8. Structure

Bit	Value	Description
0	0, 1	Exec Execute Bit to execute data transfer; Operation has to be set (see Sections 5.2.1 and 5.2.2) + Exec bit.
14	0, 1	Write operation bit
15	0, 1	Read operation bit

5.2.1 Extended Register Address

Register number: 9_{Hex}

Data format: 16-bit

The register to be read or written is written in this position number upon execution of an extended control command.

Table 9. Structure

Bit	Value	Description
0 to 15	0 to 65535	Corresponds to requested register address

5.2.2 Extended Register Value

Register number: 10_{Hex}

Data format: 16-bit

If applicable, the value to be written to the given register number in position number 9_{Hex} is written in this position number.

Table 10. Structure

Bit	Value	Description
0 to 15	0 to 65535	Corresponds to requested value for the requested extended register address (see Section 5.2.1).

5.3 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}.

5.3.1 Actual Position

Register number: 0_{Hex}

Data format: 16-bit, the lower 10 bits (0 to 1023) are used

NOTE:
The other bits are reserved for future use and have to be hidden.

Table 11. Structure

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

5.3.2 Status

Register number: 1_{Hex}

Data format: 16-bit (bit field)

Table 12. 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 TEMPERATURE	-	Motor temperature sensor has responded (overtemperature).
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	Livebit 1 toggles every second.	
15	LIVEBIT 2	Livebit 2 is the copy from the watchdog toggle bit (see command bit 7).	

5.3.3 Actual Torque

Register number: 2_{Hex}

Data format: 16-bit, only the lower 8 bits are used

NOTE:
The other bits are reserved for future use and have to be hidden.

Table 13. Structure

Bit	Value	Description
0 to 6	0 to 100	Corresponds to 0 to 100%
7	0, 1	Is set, if the direction is OPEN

5.3.4 Actual Speed

Register number: 3_{Hex}

Data format: 16-bit, only the lower 8 bits are used

NOTE:
The other bits are reserved for future use and have to be hidden.

Table 14. Structure

Bit	Value	Description
0 to 6	0 to 100	Corresponds to 0 to 100%
7	0, 1	Is set, if the direction is OPEN

5.3.5 External Actual Value

(Only with PID-controller option)

Registry number: 4_{Hex}

Data format: 16-bit, the lower 10 bits (0 to 1023) are used

NOTE:
The other bits are reserved for future use and have to be hidden.

5.3.6 Status 2

Register number: 5_{Hex}

Data format: 16-bit (bit field)

Table 15. Structure

Bit no.	Function	Description	
		Bit= 0	Bit=1
0	Digital output 1	-	Corresponding binary output is set.
1	Digital output 2	-	
2	Digital output 3	-	
3	Digital output 4	-	
4	Digital output 5	-	
5	Digital output 6	-	
6	Digital output 7	-	
7	Digital output 8	-	
8	Digital input 1	-	Corresponding binary input is set.
9	Digital input 2	-	
10	Digital input 3	-	
11	Digital input 4	-	
12	Digital input 5	-	
13	PHASE SEQUENCE	-	Phase sequence error: Error in supply voltage (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	FAIL-SAFE ERROR	-	Fail-safe unit not ready (if there is one).

Parameter P15.9 can be used to set alternative output functions for Status 2.

5.3.7 Status 3

Register number: 6_{Hex}

Data format: 16-bit, error number

Table 16. Error Number

Error number	Meaning
3	Motor temperature warning
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 fail-safe unit (provided there is one)
17	Fault position sensor
22	Fault torque sensor (provided there is one)

Parameter P15.10 can be used to set alternative output functions for Status 3.

5.3.8 Status 4

Register number: 7_{Hex}

Data format: 16-bit

NOTE:
The other bits are reserved for future use and have to be hidden.

Table 17. Structure

Bit 1	Bit 0	Description
0	0	Bus channel A active.
0	1	Bus channel B active.
1	0	Bus channel A and B active. Main channel for input is A.
1	1	Bus channel A and B active. Main channel for input is B.

NOTE:
Bits 0 to 1 show the channel activity.

Table 18. Structure

Bit 9	Bit 8	Description
0	0	PVST functionality not activated or not available.
0	1	PVST Active: A PVST is currently active.
1	0	PVST OK: The last PVST was successful.
1	1	PVST Error: The last PVST was not successful.

NOTES:
- Bits 2 to 7 are reserved for future use.
- Bits 8 to 9 show the PVST Status.
- Bits 10 to 15 are reserved for future use.

Parameter P15.11 can be used to set alternative output functions for Status 4.

5.4 Extended Message Status

Register number: 8_{Hex}

Data format: 16-bit

In this position number, the status of a read or write command as described in Section 5.2 is shown according to the table below.

Table 19. Structure

Bit	Message	Description
0	Idle	New extended transaction can start.
1	Pending	Extended transaction is executing.
2	Done	Extended transaction is done, result is ready.
3	-	-
4	-	-
5	-	-
6	-	-
7	-	-
8	-	-
9	-	-
10	-	-
11	-	-
12	-	-
13	-	-
14	Error	Transaction Error, reset = clear EXEC control bit.
15	Busy	Transaction Busy, wait till Done or Error bit is set.

5.4.1 External Register

Register number: 9_{Hex}

Data format: 16-bit

This position number shows the current extended register number, which is currently being accessed according to Section 5.2.

Table 20. Structure

Bit	Value	Description
0 to 15	0 to 65535	Processing register

5.4.2 External Value

Register number: 10_{Hex}

Data format: 16-bit

Ths position number shows the current value of the currently accessed extended register (see Section 5.2.1).

Table 21. Structure

Bit	Value	Description
0 to 15	0 to 65535	Corresponds to the external register (see Section 5.4.1) In case of "Status bit Done" = 1 (see Section 5.4)

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