1.2 System Technology of the Communication Interface Modules

1.2.1 Modbus Communication Interface Module

1.2.1.1 Overview

The Modbus TCP bus module CI52x-MODTCP is used as decentralized I/O module in Modbus TCP networks. The network connection is performed via 2 RJ45 connectors which are integrated in the terminal unit.

CI521-MODTCP

I/O channels properties:

- 4 analog inputs (1.0...1.3)
- 2 analog outputs (1.5...1.6)
- 8 digital inputs 24 VDC in 1 group (2.0...2.7)
- 8 digital outputs 24 VDC in 1 group (3.0...3.7)

Functionality

Interface	Ethernet
Protocol	Modbus TCP
Power supply	from the process supply voltage UP
Supply of the electronic circuitry of the I/O expansion modules attached	Through the expansion bus interface (I/O bus)
Rotary switches	For setting the last BYTE of the IP (00h to FFh)
Analog inputs	4 (configurable via software)
Analog outputs	2 (configurable via software)
Digital inputs	8 (24 VDC; delay time configurable via software)
Digital outputs	8 (24 VDC, 0.5 A max.)
LED displays	For system displays, signal states, errors and power supply
External supply voltage	Via terminals ZP, UP and UP3 (process supply voltage 24 VDC)

CI522-MODTCP

I/O channels properties:

- 8 digital configurable inputs/outputs in 1 group (1.0...1.7)
- 8 digital inputs 24 VDC in 1 group (2.0...2.7)
- 8 digital outputs 24 VDC in 1 group (3.0...3.7)

Functionality

Interface	Ethernet
Protocol	Modbus TCP
Power supply	from the process supply voltage UP
Supply of the electronic circuitry of the I/O expansion modules attached	Through the expansion bus interface (I/O bus)
Rotary switches	For setting the last BYTE of the IP (00h to FFh)
Configurable digital inputs/outputs	8 (configurable via software)
Digital inputs	8 (24 VDC; delay time configurable via software)
Digital outputs	8 (24 VDC, 0.5 A max.)
LED displays	For system displays, signal states, errors and power supply
External supply voltage	Via terminals ZP, UP and UP3 (process supply voltage 24 VDC)

The inputs/outputs are electrically isolated from the Ethernet network. There is no potential separation between the channels.

The configuration of the inputs/outputs is performed by software.

For usage in enhanced ambient conditions (e.g. wider temperature and humidity range), a special XC version of the device is available.

1.2.1.2 Modbus TCP Registers

1.2.1.2.1 Register Layout for CI52x-MODTCP

The registers can be divided in 4 sections:

- Information data section 0x0000 to 0x0D50 (for acyclic use)
- I/O data and diagnosis section 0x0FFA to 0x2B00 (for cyclic use)
- Parameter data section 0x3000 to 0x3B00 (for acyclic use)
- Special functionality section 0x5A00 to 0x6A00 (for acyclic use)

1.2.1.2.2 Information Data Section (Acyclic Data)

The information data section can be used to read out common and module specific information.

This section is read only.

Register (hex)	Description	Readable by Modbus function code	Writeable by Modbus function code
0	Device and FW information CI	3	x
50	Production data CI	3	x
100	Device and FW information 1. EXP	3	x
125	Device and FW information 1. Hot swap terminal unit	3 *)	x
150	Production data 1. EXP	3	x
175	Production data 1. Hot swap terminal unit	3 *)	x
...	...		x
A00	Device and FW information 10. EXP	3	x
A25	Device and FW information 10. Hot swap terminal unit	3 *)	x
A50	Production data 10. EXP	3	x
A75	Production data 10. Hot swap terminal unit	3 *)	x
D00	Common device information	3	x

*) supported from CI52x firmware version V3.2.0 (device index F0)

This section can be divided again in two sections:

- The module specific section (containing information for each module CI52x-MODTCP and expansion modules and hot swap terminal units)
- The common device information block

The Module Specific Information Registers

For each module (CI52x device, expansion modules and hot swap terminal units) the following data can be read out:

- Device and FW information
  This section consists of 20 WORDs per module and contains information on each module using the following structure:

Data	DATA TYPE	Description
Module ID	WORD	The module ID of the requested module
Module name	ARRAY [1..10] OF BYTE	The module name of the requested module

Data	DATA TYPE	Description
Version 1st processor	ARRAY [1..4] OF BYTE	The version of the 1st processor of the requested module
Version 2nd processor	ARRAY [1..4] OF BYTE	The version of the 2nd processor of the requested module
Version 3rd processor	ARRAY [1..4] OF BYTE	The version of the 3rd processor of the requested module
Version 4th processor	ARRAY [1..4] OF BYTE	The version of the 4th processor of the requested module
Hardware version [1])	ARRAY [1..4] OF BYTE	The hardware version of the 4 processors
Reserved	ARRAY [1..8] OF BYTE ARRAY [1..4] OF BYTE [2])	Reserved
Number input data	WORD	Number of input data of the requested module in BYTES
Number output data	WORD	Number of output data of the requested module in BYTES

[1]) supported from CI52x firmware version V3.2.0 (device index F0)

[2]) from CI52x firmware version V3.2.0 (device index F0) “Reserved” is ARRAY [1..4] OF BYTE

- Production / Traceability data:
  This section consists of 25 WORDs per module and contains the traceability data for each module using following structure:
  - Article number: Byte 01..15
  - Index: Byte 16..17
  - Name: Byte 18..29
  - Production date: Byte 30..33
  - Key number: Byte 34..38
  - Site: Byte 39..40
  - Year: Byte 41..42
  - Serial number: Byte 41..50 (The serial number implies the year)
- Production / Traceability data from CI5x2 firmware version V3.2.0 (device index F0):
  This section consists of 26 WORDs per module and contains the traceability data for each module using following structure:
  - Article number: Byte 01..15
  - Index: Byte 16..17
  - Name: Byte 18..31
  - Production date: Byte 32..35
  - Key number: Byte 36..40
  - Site: Byte 41..42
  - Year: Byte 43..44
  - Serial number: Byte 42..52 (The serial number implies the year)

The Common Device Information Registers

The Common Device Information Block

This section consists of 80 WORDs (90 WORDs from CI52x firmware version V3.2.0 (device index F0)) and contains cluster wide information (CI52x device and connected expansion modules using the following structure:

Data	DATA TYPE	Description
Device state	BYTE	The actual state of the device: 0: STATE_PREOP (device booting) 1: STATE_OPERATION (device in operational, no bus supervision active) 2: STATE_ERROR (device detected a bus error, bus supervision active) 3: STATE_IP_ERROR (the device has a IP address error) 4: STATE_CYCLIC_OPERATION (device in operational, bus supervision active)
Parameter state	BYTE	The actual parameter state of the device: 0: PARA_STATE_NO_PARA (the device has no parameters) 1: PARA_STATE_PARA_ACTIVE (parameterization process running) 2: PARA_STATE_PARA_DONE (the uses valid parameters) 3: PARA_STATE_ERROR (The device has invalid
Module ID CI device	WORD	Module ID of the CI52x device itself
Module ID 1st expansion	WORD	Module ID of the 1st connected expansion module
Module ID 2nd expansion	WORD	Module ID of the 2nd connected expansion module
...		
Module ID 10thexpansion	WORD	Module ID of the 10th connected expansion module
Expansion bus error count	DWORD	Global telegram error count over all expansion modules
Good count onboard I/O	DWORD	Telegram good count onboard I/Os
Good count 1st expansion	DWORD	Telegram good count 1st expansion module
Good count 2nd expansion	DWORD	Telegram good count 2nd expansion module
...		
Good count 10th expansion	DWORD	Telegram good count 10th expansion module
Error count onboard I/O	DWORD	Telegram error count onboard I/Os
Error count 1st expansion	DWORD	Telegram error count 1st expansion module

Data	DATA TYPE	Description
Error count 2nd expansion	DWORD	Telegram error count 2nd expansion module
...		
Error count 10th expansion	DWORD	Telegram error count 10th expansion module
Input address onboard I/O	WORD	Modbus TCP register address for inputs of the onboard I/Os
Input address 1st expansion	WORD	Modbus TCP register address for inputs of the 1st expansion module
Input address 2nd expansion	WORD	Modbus TCP register address for inputs of the 2nd expansion module
...		
Input address 10th expansion	WORD	Modbus TCP register address for inputs of the 10th expansion module
Output address onboard I/O	WORD	Modbus TCP register address for outputs of the onboard I/Os
Output address 1st expansion	WORD	Modbus TCP register address for outputs of the 1st expansion module
Output address 2nd expansion	WORD	Modbus TCP register address for outputs of the 2nd expansion module
...		
Output address 10th expansion	WORD	Modbus TCP register address for outputs of the 10th expansion module
Module ID 1st hot swap terminal unit *)	WORD	Module ID of the 1st connected hot swap terminal unit *)
Module ID 2nd hot swap terminal unit *)	WORD	Module ID of the 2nd connected hot swap terminal unit *)
...		
Module ID 10th hot swap terminal unit *)	WORD	Module ID of the 10th connected hot swap terminal unit *)

*) supported from CI52x firmware version V3.2.0 (device index F0)

1.2.1.2.3 I/O / Process Data and Diagnosis Section (Cyclic Data)

The cyclic data section for CI52x-MODTCP

Register (hex)	Description	Readable by Modbus function code	Writeable by Modbus function code
FCE *)	Module state	3,4, 23	x
FFA	Diagnosis	3,4, 23	x

Register (hex)	Description	Readable by Modbus function code	Writeable by Modbus function code
1000	Inputs CI	3, 4, 23	x
1100	Inputs 1.EXP	3, 4, 23	x
...	...		x
1A00	Inputs 10.EXP	3, 4, 23	x
2000	Outputs CI	3, 23	6, 16, 23
2100	Outputs 1.EXP	3, 23	6, 16, 23
...	...		
2A00	Outputs 10.EXP	3, 23	6, 16, 23
2B00	Dummy output	3, 23	6, 16, 23

*) supported from CI52x firmware version V3.2.0 (device index F0)

This section can be divided again in three sections:

- Module state (containing the state of connected expansion modules and hot swap terminal units)
- Diagnosis data (containing diagnosis data in AC500 specific format)
- Process data (containing I/O data)

Module State

The module state section consists of 44 WORDs and contains the module state of connected expansion modules and hot swap terminal units using the following structure:

Data	DATA TYPE	Description
Module ID	WORD	Module ID of the CI52x
Expected module ID	WORD	Expected (configured) module ID of the CI52x

Data	DATA TYPE	Description
Module state	BYTE	The current module state of the CI52x: 0: NO_MOD (no module detected) 1: MOD_INIT (module detected, module is in initialization phase) 2: MOD_RUN (module detected and running or in failsafe state, input data are valid) 3: WRONG_MOD (wrong module detected, module ID doesn't match expected module ID) 4: MOD_REMOVED (module removed or defective on hot swap terminal unit, no communication to module possible) 5: MOD_ERROR (module defective on hot swap terminal unit, no communication to module possible) 6: MOD_LOST (lost communication to module on not hot swap capable terminal unit) 7: UNKNOWN (module detected but not configured)
Diagnosis flag	BYTE	Diagnosis flag for the CI52x: 0: NO_DIAG (no diagnosis available from CI52x I/O cards) 1: DIAG_AVAILABLE (diagnosis available for CI52x I/O cards)
Terminal unit state	BYTE	Terminal unit state for the CI52x: 0: NO_HOTSWAP_TU (not hot swap terminal unit detected) 1: HOTSWAP_TU_RUNNING (hot swap terminal unit detected and working) 2: HOTSWAP_TU_ERROR (hot swap terminal unit detected, but communication errors for hot swap terminal unit detected)
Parameter state	BYTE	Parameter state of the CI52x: 0: NO_PARA (module is in initialization phase and not ready for parameterization) 1: WAIT_PARA (module awaits parameterization) 2: PARA_RUN (parameterization running) 3: LEN_ERR (length of parameters not correct) 4: ID_ERR (module ID inside parameters not correct) 5: PARA_DONE (parameterization finished without errors)
Module ID	WORD	Module ID of the 1st connected expansion module
Expected module ID	WORD	Expected (configured) module ID of the 1st connected expansion module
Module state	BYTE	The current module state of the 1st connected expansion module

Data	DATA TYPE	Description
Diagnosis flag	BYTE	Diagnosis flag for the 1st connected expansion module 0: NO_DIAG (no diagnosis available for expansion module) 1: DIAG_AVAILABLE (diagnosis available for expansion module)
Terminal unit state	BYTE	Terminal unit state for the 1st connected expansion module
Parameter state	BYTE	Parameter state of the 1st connected expansion module
...		
Module ID	WORD	Module ID of the 10th connected expansion module
Expected module ID	WORD	Expected (configured) module ID of the 10th connected expansion module
Module state	BYTE	The current module state of the 10th connected expansion module
Diagnosis flag	BYTE	Diagnosis flag for the 10th connected expansion module
Terminal unit state	BYTE	Terminal unit state for the 10th connected expansion module
Parameter state	BYTE	Parameter state of the 10th connected expansion module

Diagnosis Data

The diagnosis data section contains one diagnostic message with the following structure (according to AC500 diagnosis):

Byte Number	Description	Possible Values
1	Diagnosis Byte, slot number	31 = CI52x-MODTCP (e. g. error at integrated 8 DI / 8 DO)
		1 = 1st connected S500 I/O Module
		...
		10 = 10th connected S500 I/O Module
2	Diagnosis Byte, module number	According to the I/O bus specification passed on by modules to the fieldbus master
3	Diagnosis Byte, channel	According to the I/O bus specification passed on by modules to the fieldbus master

Byte Number	Description	Possible Values
4	Diagnosis Byte, error code	According to the I/O bus specification Bit 7 and Bit 6, coded error class 0 = E1 1 = E2 2 = E3 3 = E4 Bit 0 to Bit 5, coded error description
5	Diagnosis Byte, flags	According to the I/O bus specification Bit 7: 1 = coming error Bit 6: 1 = leaving error
6	Reserved	0

If a diagnosis message is read out, the next one will be automatically filled in.

If no more diagnosis messages are available the buffer will be reset to zero.

This ensures that each diagnosis message can be delivered to the Modbus TCP client/slave and no diagnosis will be lost.

I/O Data

The I/O data section can use two different formats according to the module parameter “I/O Mapping Structure” (see *hardware description* for details).

- Fixed I/O mapping
  In case of fixed I/O mapping each module has a predefined register range for each Inputs and Outputs.
- Dynamic I/O mapping
  In case of dynamic I/O mapping the mapping is build according to the actual configuration.

The dummy output at the end of the I/O data section can be used to retrigger the bus supervision and has no effect on the HW outputs.

Fixed I/O Mapping

In case of fixed I/O mapping the following predefined register table is used:

Register (hex)	Description	Readable by Modbus function code	Writeable by Modbus function code
1000	Inputs CI	3, 4, 23	x
1100	Inputs 1.EXP	3, 4, 23	x
...	...		x
1A00	Inputs 10.EXP	3, 4, 23	x
2000	Outputs CI	3, 23	6, 16, 23

Register (hex)	Description	Readable by Modbus function code	Writeable by Modbus function code
2100	Outputs 1.EXP	3, 23	6, 16, 23
...	...		
2A00	Outputs 10.EXP	3, 23	6, 16, 23
2B00	Dummy output	3, 23	6, 16, 23

If a certain expansion module has no inputs or outputs the corresponding registers remain empty.

Dynamic I/O Mapping

In case of dynamic mapping only the start addresses of inputs and outputs are predefined:

Register (hex)	Description	Readable by Modbus function code	Writeable by Modbus function code
1000	Inputs CI	3, 4, 23	x
...	...		x
2000	Outputs CI	3, 23	6, 16, 23
...	...		
2B00	Dummy output	3, 23	6, 16, 23

The register addresses of the connected expansion modules are calculated dynamically based on the number of inputs and outputs of the previous modules (each module starts directly on the next register after the previous module).

The register addresses of each module can be read out via the common device register (see *Chapter 1.2.1.2.2.2 “The Common Device Information Registers” on page 81*).

Comparative Example for Fixed and Dynamic Mapping

The difference between fixed mapping and dynamic mapping is shown in the following table.

For this comparison a cluster with CI522, AX522, DC532, AX521, DC523, DC532, AO523, AI523, DI524, AX522 and DC523 is used.

Fixed Mapping					Dynamic Mapping			
Register (hex)	Description	Type	Data		Register (hex)	Description	Type	Data
1000	Inputs CI	8 DC, 8 DI, FC	4 BYTE + 4 WORD		1000	Inputs CI	8 DC, 8 DI, FC	4 BYTE + 4 WORD
1100	Inputs AX522	8 AI	8 WORD		1006	Inputs AX522	8 AI	8 WORD
1200	Inputs DC532	16 DI, 16 DC	4 BYTE		100E	Inputs DC532	16 DI, 16 DC	4 BYTE
1300	Inputs AX521	4 AI	4 WORD		1010	Inputs AX521	4 AI	4 WORD
1400	Inputs DC523	24 DC	3 BYTE		1014	Inputs DC523	24 DC	3 BYTE
1500	Inputs DC532	16 DI, 16 DC	4 BYTE		1016	Inputs DC532	16 DI, 16 DC	4 BYTE
1600	Inputs AO523	---	---		---	Inputs AO523	---	---
1700	Inputs AI523	16AI	16 WORD		1018	Inputs AI523	16AI	16 WORD
1800	Inputs DI524	32 DI	4 BYTE		1028	Inputs DI524	32 DI	4 BYTE
1900	Inputs AX522	8 AI	8 WORD		102A	Inputs AX522	8 AI	8 WORD
1A00	Inputs DC523	24 DC	3 BYTE		1032	Inputs DC523	24 DC	3 BYTE
2000	Outputs CI	8 DC, 8DO, FC	4 BYTE + 8 WORD		2000	Outputs CI	8 DC, 8DO, FC	4 BYTE + 8 WORD
2100	Outputs AX522	8 AO	8 WORD		200A	Outputs AX522	8 AO	8 WORD
2200	Outputs DC532	16 DC	2 BYTE		2012	Outputs DC532	16 DC	2 BYTE
2300	Outputs AX521	4 AO	4 WORD		2013	Outputs AX521	4 AO	4 WORD
2400	Outputs DC523	24 DC	3 BYTE		2017	Outputs DC523	24 DC	3 BYTE
2500	Outputs DC532	16 DC	2 BYTE		2019	Outputs DC532	16 DC	2 BYTE
2600	Outputs AO523	16 AO	16 WORD		201A	Outputs AO523	16 AO	16 WORD

Fixed Mapping					Dynamic Mapping			
Register (hex)	Description	Type	Data		Register (hex)	Description	Type	Data
2700	Outputs AI523	---	---		---	Outputs AI523	---	---
2800	Outputs DI524	---	---		---	Outputs DI524	---	---
2900	Outputs AX522	8 AO	8 WORD		202A	Outputs AX522	8 AO	8 WORD
2A00	Outputs DC523	24 DC	3 BYTE		2032	Outputs DC523	24 DC	3 BYTE

Process Data Structure CI521-MODTCP

I/O data (Inputs 19 BYTEs)

Signal	DATA TYPE	Description
AI0	WORD	Input value of the 1st analogue input
AI1	WORD	Input value of the 2nd analogue input
AI2	WORD	Input value of the 3rd analogue input
AI3	WORD	Input value of the 4th analogue input
DI	BYTE	Input value of the DI channels
Fast counter actual value counter 1	DWORD	↳ *Chapter 1.1.8.1 “Fast Counters in AC500 Devices” on page 68*
Fast counter actual value counter 2	DWORD	
Fast counter state counter 1	BYTE	
Fast counter state counter 2	BYTE	

I/O data (Outputs 23 BYTEs)

Signal	DATA TYPE	Description
AO0	WORD	Output value of the 1st analogue input
AO1	WORD	Output value of the 2nd analogue input

Signal	DATA TYPE	Description
DO	BYTE	Output value of the DO channels
Fast counter start value counter 1	DWORD	*Chapter 1.1.8.1 “Fast Counters in AC500 Devices” on page 68*
Fast counter end value counter 1	DWORD	
Fast counter start value counter 2	DWORD	
Fast counter end value counter 2	DWORD	
Fast counter control counter 1	BYTE	
Fast counter control counter 2	BYTE	

Process Data Structure CI522-MODTCP

I/O data (Inputs 12 BYTEs)

Signal	DATA TYPE	Description
DC	BYTE	Input value of the DC channels
DI	BYTE	Input value of the DI channels
Fast counter actual value counter 1	DWORD	*Chapter 1.1.8.1 “Fast Counters in AC500 Devices” on page 68*
Fast counter actual value counter 2	DWORD	
Fast counter state counter 1	BYTE	
Fast counter state counter 2	BYTE	

I/O data (Outputs 20 BYTEs)

Signal	DATA TYPE	Description
DC	BYTE	Output value of the DC channels
DO	BYTE	Output value of the DO channels
Fast counter start value counter 1	DWORD	*Chapter 1.1.8.1 “Fast Counters in AC500 Devices” on page 68*
Fast counter end value counter 1	DWORD	
Fast counter start value counter 2	DWORD	
Fast counter end value counter 2	DWORD	
Fast counter control counter 1	BYTE	
Fast counter control counter 2	BYTE	

1.2.1.2.4 Parameter Data (Acyclic Data)

Register (hex)	Description	Readable by Modbus function code	Writeable by Modbus function code
3000	Parameters CI	3	6, 16
3080	Stored parameters CI	3	x
3100	Parameters 1. EXP	3	6, 16
3180	Stored parameters 10. EXP	3	x
...			
3A00	Parameters 10. EXP	3	6, 16
3A80	Stored parameters 10. EXP	3	x
3B00	controlword/statusword	3	6, 16

For each connected module the following parameter data are defined (the parameters are represented as ARRAY OF BYTE):

- Actual used parameter for each module
  In these sections the actual parameters are stored. This section is also used to write parameters to the module (For a description on how to parameterize see *Chapter 1.2.1.3.2 “Parameterization” on page 98*).
- Stored parameters for each module
  If the module has stored nonvolatile parameters these can be read out using the corresponding registers.

The controlword/statusword is used to trigger a parameterization process. The single bits have the following meaning:

Bit	Meaning
0	End of parameterization use parameters
1	store parameters temporarily, use stored parameters after bus reconnect
2	store parameters in flash, use stored parameters after power cycle
3	reserved
4	delete stored parameters in flash
5	ignore parameter errors for saving
6	reserved
7	reserved
8	new diagnosis available
9	new parameters are available
10	reserved
11	reserved
12	reserved
13	reserved
14	reserved
15	reserved

The direction of the first 8 bits is client to server (master to slave).

The direction of the second 8 bits is server to client (slave to master). A description of the bits can be found in chapter behavior *Chapter 1.2.1.3.2 “Parameterization” on page 98*.

The parameter register sections (actual and stored parameters) have the structure as explained in the *hardware description* of the corresponding module.

Short Description of the CI521-MODTCP Parameters

Parameter	Single parameter index	Description	Additional Info
0		Module ID (high Byte)	Fixed, must be 16#1C
1		Module ID (low Byte)	Fixed, must be 16#E8
2		Ignore Module	Reserved, must be 0
3		Length of following parameter block	Fixed, must be 16#3F
4	0	Error LED / Failsafe	See *hardware description*
5	1	Master IP Byte 0	IP Address for write restrictions (*“Configurable Write Restriction” on page 100*)
6		Master IP Byte 1	
7		Master IP Byte 2	
8		Master IP Byte 3	

Parameter	Single parameter index	Description	Additional Info
9	2	Master IP 1 Byte 0	IP Address for write restrictions (*“Configurable Write Restriction” on page 100*)
10		Master IP 1 Byte 1	
11		Master IP 1 Byte 2	
12		Master IP 1 Byte 3	
13	3	Master IP 2 Byte 0	IP Address for write restrictions (*“Configurable Write Restriction” on page 100*)
14		Master IP 2 Byte 1	
15		Master IP 2 Byte 2	
16		Master IP 2 Byte 3	
17	4	Master IP 3 Byte 0	IP Address for write restrictions (*“Configurable Write Restriction” on page 100*)
18		Master IP 3 Byte 1	
19		Master IP 3 Byte 2	
20		Master IP 3 Byte 3	
21	5	Master IP 4 Byte 0	IP Address for write restrictions (*“Configurable Write Restriction” on page 100*)
22		Master IP 4 Byte 1	
23		Master IP 4 Byte 2	
24		Master IP 4 Byte 3	
25	6	Master IP 5 Byte 0	IP Address for write restrictions (*“Configurable Write Restriction” on page 100*)
26		Master IP 5 Byte 1	
27		Master IP 5 Byte 2	
28		Master IP 5 Byte 3	
29	7	Master IP 6 Byte 0	IP Address for write restrictions (*“Configurable Write Restriction” on page 100*)
30		Master IP 6 Byte 1	
31		Master IP 6 Byte 2	
32		Master IP 6 Byte 3	
33	8	Master IP 7 Byte 0	IP Address for write restrictions (*“Configurable Write Restriction” on page 100*)
34		Master IP 7 Byte 1	
36		Master IP 7 Byte 2	
36		Master IP 7 Byte 3	
37	9	Timeout	Timeout for bus supervision in 10ms steps if set to 0 no bus supervision is active
38	10 (read only)	I/O Mapping Structure	See *hardware description*

Parameter	Single parameter index	Description	Additional Info
39	11	Reserved	Reserved, must be 0
40	12	Reserved	Reserved, must be 0
41	13	Reserved	Reserved, must be 0
42	14	Check supply	See *hardware description*
43	15	Analogue data format	Reserved, must be 0
44	16	Input delay	See *hardware description*
46	17	Fast counter	
46	18	Short circuit detection	
47	19	Behavior binary outputs at com. fault	
48	20	Substitute value binary outputs	
49	21	Overvoltage monitoring	
50	22	Behavior analogue outputs	
51	23	Channel Config AI0	
52	24	Check Channel AI0	
53	25	Channel Config AI1	
54	26	Check Channel AI1	
55	27	Channel Config AI2	
56	28	Check Channel AI2	
57	29	Channel Config AI3	
58	30	Check Channel AI3	
59	31	Channel Config AO0	
60	32	Check Channel AO0	
61	33	Substitute value AO0 (high Byte)	
62		Substitute value AO0 (low Byte)	
63	34	Channel Config AO1	
64	35	Check Channel AO1	
65	36	Substitute value AO1 (high Byte)	
66		Substitute value AO1 (low Byte)	

Short Description of the CI522-MODTCP Parameters

Parameter	Single parameter index	Description	Additional Info
0		Module ID (high Byte)	Fixed, must be 16#1C
1		Module ID (low Byte)	Fixed, must be 16#ED
2		Ignore Module	Reserved, must be 0
3		Length of following parameter block	Fixed, must be 16#2F
4	0	Error LED / Failsafe	See *hardware description*
5	1	Master IP Byte 0	IP Address for write restrictions (↬ *"Configurable Write Restriction" on page 100*)
6		Master IP Byte 1	
7		Master IP Byte 2	
8		Master IP Byte 3	
9	2	Master IP 1 Byte 0	IP Address for write restrictions (↬ *"Configurable Write Restriction" on page 100*)
10		Master IP 1 Byte 1	
11		Master IP 1 Byte 2	
12		Master IP 1 Byte 3	
13	3	Master IP 2 Byte 0	IP Address for write restrictions (↬ *"Configurable Write Restriction" on page 100*)
14		Master IP 2 Byte 1	
15		Master IP 2 Byte 2	
16		Master IP 2 Byte 3	
17	4	Master IP 3 Byte 0	IP Address for write restrictions (↬ *"Configurable Write Restriction" on page 100*)
18		Master IP 3 Byte 1	
19		Master IP 3 Byte 2	
20		Master IP 3 Byte 3	
21	5	Master IP 4 Byte 0	IP Address for write restrictions (↬ *"Configurable Write Restriction" on page 100*)
22		Master IP 4 Byte 1	
23		Master IP 4 Byte 2	
24		Master IP 4 Byte 3	
25	6	Master IP 5 Byte 0	IP Address for write restrictions (↬ *"Configurable Write Restriction" on page 100*)
26		Master IP 5 Byte 1	
27		Master IP 5 Byte 2	
28		Master IP 5 Byte 3	
29	7	Master IP 6 Byte 0	IP Address for write restrictions (↬ *"Configurable Write Restriction" on page 100*)
30		Master IP 6 Byte 1	

Parameter	Single parameter index	Description	Additional Info
31		Master IP 6 Byte 2	
32		Master IP 6 Byte 3	
33	8	Master IP 7 Byte 0	IP Address for write restrictions (*“Configurable Write Restriction” on page 100*)
34		Master IP 7 Byte 1	
36		Master IP 7 Byte 2	
36		Master IP 7 Byte 3	
37	2	Timeout	Timeout for bus supervision in 10ms steps if set to 0 no bus supervision is active
38	3 (read only)	I/O Mapping Structure	See *hardware description*
39	4	Reserved	Reserved, must be 0
40	5	Reserved	
41	6	Reserved	
42	7	Check supply	See *hardware description*
43	8	Input delay	
44	9	Fast counter	See *hardware description*
46	10	Short circuit detection	
46	11	Behavior binary outputs at com. fault	
47	12	Substitute value binary outputs (high byte)	
48		Substitute value binary outputs (low byte)	
49	13	Voltage feedback monitoring	
50	14	Overvoltage monitoring	

Parameters of Connected Expansion Modules

The parameters of the connected expansion modules are represented as byte array (the parameters valid for “CPU” in the *hardware description* of the corresponding module are used):

Parameter	Description	Additional Info
0	Module ID (high byte)	Fixed, see *hardware description* of corresponding module (the module ID of FBP is used)
1	Module ID (low byte)	Fixed, see *hardware description* of corresponding module (the module ID of FBP is used)
2	Ignore module	Reserved must be 0
3	Length of following parameter block	Fixed, see *hardware description* of corresponding module
4...	The rest of the parameter are described in the corresponding module	

1.2.1.2.5 Special Functionality

This section contains special services like firmware update or single parameterization.

Register (hex)	Description	Readable by Modbus function code	Writeable by Modbus function code
4000	Firmware download	3	16
4100	Firmware download state	3	x
5000	Write single parameterization of CI	x	16
5100	Write single parameterization of 1. EXP	x	16
...			
5A00	Write single parameterization of 10. EXP	x	16
6000	Read single parameterization of CI	3	16
6100	Read single parameterization of 1. EXP	3	16
...			
6A00	Read single parameterization of 10. EXP	3	16

1.2.1.3 Behavior

1.2.1.3.1 IP Address Assignment

The delivery IP address of the CI52x-MODTCP is 192.168.0.xx (xx is the hardware address switch position of the device.

The devices support BOOTP, DHCP and fixed IP address setting (these can be set individual or together). If BOOTP and DHCP are enabled the following priority takes place:

- If DHCP configuration fails, the device will fall back to BOOTP.
- In case of a BOOTP failure, the fixed IP address will be used.

A new IP address (or changing of BOOTP and DHCP) can be set in two different ways:

- With the address switches of the corresponding module
- With the *IP Configuration Tool*

Using the Address Switches

With the address switches only the last byte of the IP address can be changed.

The IP address can only be set via the address switches in case of factory default or in case of the last byte of the IP address is set to zero with the *IP Configuration Tool*. The not allowed IP addresses are mapped as followed:

- Address switch position 255 is mapped to fixed IP 192.168.0.254 independent of other stored settings (by IP Configuration Tool).
  This is a backup so the module can always get a valid IP address and can be configured by the IP Configuration Tool.
- Address switch position 0 is mapped to last byte equal 1 and DHCP enabled.

Using the IP Configuration Tool

With the *IP Configuration Tool* a network scan can be executed, and the found devices can be assigned with new settings, e.g. enable BOOTP or DHCP and set a new fixed IP. If the last byte of the IP address of the CI52x-MODTCP devices is set to 0 with the IP Configuration Tool the address switch position is used instead (see *Chapter 1.2.1.3.1.1 “Using the Address Switches” on page 98*).

1.2.1.3.2 Parameterization

The parameterization is done via the corresponding registers explained in the Modbus TCP registers *Chapter 1.2.1.2.4 “Parameter Data (Acyclic Data)” on page 91*.

In addition to that the parameters can be directly transferred via Automation Builder (see documentation of Automation Builder for that).

There are two different parameter sections with different behaviour.

Actual used parameters

After startup this section contains the following data:

- Default parameters (only module id and parameter length set all others zero) if no valid stored parameters are available (no or invalid parameters stored).
- Actual used / stored parameters if valid parameters are stored nonvolatile.

These parameters can be read out and changed by reading or writing of the corresponding registers, but will not be used automatically after writing them, the use of new written parameters has to be triggered by writing the parameter control word with the corresponding bits set (see below).

Stored parameters

This section always contains a copy of the nonvolatile stored parameters, if no parameters are stored nonvolatile this sections will be 0.

Controlword/statusword parameter

This parameter can be used to trigger and save new parameters.

The direction of the first 8 bit is client to server (master to slave). The direction of the second 8 bits is server to client (slave to master).

Bit	Meaning	Description
0	Use parameters / start parameterization	If this bit is set the CI Device starts the parameterization with the parameters in the actual parameters registers.
1	Store parameters volatile	If this bit is set the CI device will use the parameters temporarily, which means after a bus error detection and reconnection the parameters will be used again. **This bit should always be set.** **This bit is only evaluated when bit 0 is set.**
2	Store parameters nonvolatile	If this bit is set the CI device will store the parameters nonvolatile, which means after a power cycle the stored parameter data will be used again. **This bit is only evaluated when bit 0 is set.**
3	Reserved	
4	Delete nonvolatile stored parameters	If this bit is set the CI device will delete its nonvolatile stored parameters. **This bit is only evaluated when bit 0 is set**.
5	Ignore parameter error for nonvolatile parameter storage	If this bit is set a parameter error during nonvolatile storage of parameters will be ignored, and the parameters will be stored. **This bit can only be set in combination with bit 0 and bit 2.**
6	Reserved	
7	Reserved	
8	New diagnosis available	The device will set this bit if new diagnosis data are available in the diagnosis data section.
9	New parameters available	The device will set this bit if new parameters are available in the actual parameter data section and these were not activated by setting bit 0 in the control word.
10...15	Reserved	

1.2.1.3.3 Cyclic I/O Data Exchange

The I/O data can be exchanged cyclic by the master by reading, writing the corresponding registers.

I/O data exchange is only possible after successful parameterization of the device.

For writing of outputs **bus failure detection** can be activated by setting the corresponding parameter. This bus failure detection is described in the following chapter.

Bus Failure Detection

If the parameter “ *“timeout”*” in the module parameters of the CI52x-MODTCP is set, the module will supervise the Modbus TCP "write telegrams".

After the first "write telegram" the bus will be supervised. If no new "write telegram" arrives at the CI52x-MODTCP within the configured time, the module will detect a bus failure and switch off its outputs or switch them to the configured failsafe state (see module parameter *“Failsafe CI521”* and *“Failsafe CI522”* for details).

Configurable Write Restriction

With the module parameters “Master IP”- “Master IP 7” it is possible to set write restrictions on the CI52x-MODTCP device.

If none of the parameters is set, all masters / clients in the network have read and write rights on the CI52x-MODTCP device and its connected expansion modules.

If at least one parameter is set only the configured masters / clients have write rights on the CI52x-MODTCP device.

All other masters / clients still have read access to the CI52x-MODTCP device.

1.2.1.3.4 Diagnosis behavior

Each diagnosis message signals if this error is coming or going , so it is possible to create a list in the master of actual pending diagnosis.

Diagnosis messages will be transferred again after a bus failure detection and reconnection.

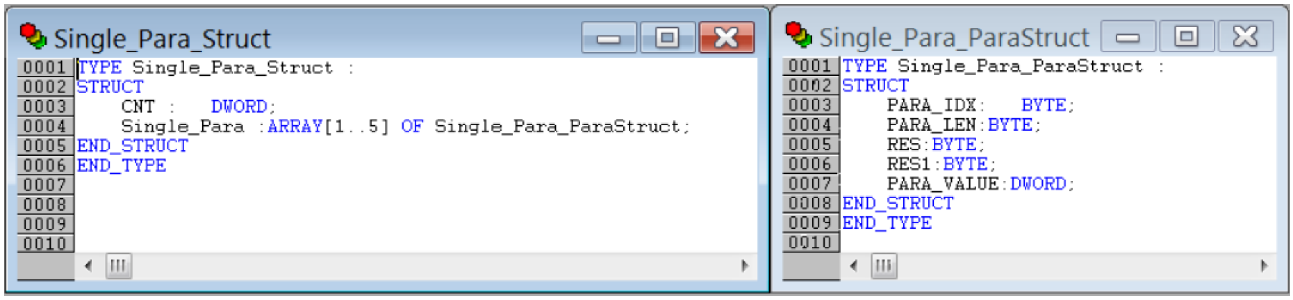
Diagnosis messages can be read out with function code 3,4,23. Function codes 3 and 4 can always read out diagnosis messages, function code 23 can only read out after successful parameterization of the device. See also table *Chapter 1.2.1.2.3.2 “Diagnosis Data” on page 85*.

1.2.1.3.5 Single Parameterization

The single parameterization services can be used to read or write parameters during runtime of device without the need of triggering a new parameterization process.

For indexes used for single parameterization services see parameter lists in section Modbus TCP registers of this document.

The read and write parameterization services are explained below, for each module (CI52x-MODTCP and connected expansion modules) a different section for read and write is defined see chapter Modbus TCP registers in this document). Both services are using the following data structure:



The length of the read / write service depends on the count of parameters that should be transferred (length = 4+ count*8).

Reading of Single Parameters

The read single parameterization works in two steps:

- Writing of a request list containing the indexes that should be read using the structure explained above.
  Only CNT and PARA_IDX has to be set.
  Up to 5 parameters can be requested with one telegram.
  The length of the write service depends on the count of parameters that should be transferred (length = 4+ count*8).
- Reading of the parameters list with the same length then the previous write request.
  If the internal reading process inside the CI52x-MODTCP device is done the data will be read out.
  If the internal reading process inside the CI52x-MODTCP device is not yet finished the read service will be rejected with Modbus TCP exception code 6 (device busy).

Writing of Single Parameters

For writing of single parameters only one step is necessary, the parameters are transferred with one write request using the structure described above.

The length of the write service depends on the count of parameters that should be transferred (length = 4+ count*8).

In case of write of single parameters the following values have to be set:

- CNT: number of parameters to be set
- And for each parameter:
  Parameter index
  Parameter length
  New parameter value

Written single parameters are not stored volatile and not stored nonvolatile. That means after a bus reconnection or power cycle the written parameters will be discarded.

1.2.1.4 Commissioning Example

Set IP Address:

- The setting of the IP address is the first step to integrate the CI52x-MODTCP devices into a running system.
- The setting of the IP address of the CI52x-MODTCP devices is described in the chapter ↳ *Chapter 1.2.1.3.1 “IP Address Assignment” on page 97* in this document.

Set Parameters (optional read parameters):

- The second step in configuring the CI52x-MODTCP devices is to set the module and channel parameters.
- A read of parameters is optional but can be used the get the module IDs and the parameter length.
- The reading and or writing of parameters is described in chapter ↳ *Chapter 1.2.1.3.2 “Parameterization” on page 98*.

Set Control Word:

- After setting the parameter data these have to be activated by writing the control word.
- The meaning and usage of the control word is described in chapter ↳ *Chapter 1.2.1.3.2 “Parameterization” on page 98*.

Exchange data:

- After setting and activating the parameters the CI52x-MODTCP device is ready for data exchange.
- The registers for data exchange are described in chapter ↳ *Chapter 1.2.1.2.3 “I/O / Process Data and Diagnosis Section (Cyclic Data)” on page 82*.

1.2.1.5 Hot Swap

With hot swap for AC500 and S500 it is possible to exchange expansion modules (with same type) during runtime.

1.2.1.5.1 Preconditions for Using Hot Swap

Hot Swap

H = **H**ot swap

Hot swap

Preconditions for hot swapping I/O modules:

- *Hot-swappable terminal units have the appendix TU5xx-**H**.*
- *I/O modules as of index F0.*
- *Communication interface modules CI5xx as of index F0.*

The index of the module is in the right corner of the label.

NOTICE!

Risk of damage to I/O modules!

Modules with index below F0 can be damaged when inserted or removed from the terminal unit in a powered system.

Hot swapping is only allowed for I/O modules.

Processor modules and communication interface modules must not be removed or inserted during operation.

NOTICE!

Risk of damage to I/O modules!

Do not perform any hot swap action if any at least one I/O module with firmware version lower 3.0.14 (for index see table below) is contained in the affected cluster.

Device	Min required device index for I/O module FW Version as of 3.0.14
DO573, FM562, DI572	A1
DO526 DC562 DO562	A2
DO526 (-XC)	A0
CD522 (-XC)	D1
DO524 (-XC)	A3
AI531	D4
DA501 (-XC), DI524 (-XC), DC532 (-XC), DC523 (-XC), DC522 (-XC), AX521 (-XC), AO523 (-XC), AI523 (-XC), AX522 (-XC), AI531-XC, DX531, DX522 (-XC),	D2

Device	Min required device index for I/O module FW Version as of 3.0.14
AI561, AI562, AO561, AX561, DC561, DI561, DI562, DI571, DO561, DO572, DX561	B2
AI563, DO571, DX571	B3

1.2.1.5.2 System Behavior

If an expansion module is removed or defective during run time, the input data of this module will be set to “0” and the module state will be set to the corresponding value (see *Chapter 1.2.1.2.3 “I/O / Process Data and Diagnosis Section (Cyclic Data)” on page 82*). A diagnosis message will be created in that case (see hardware description of CI521 / CI522 for diagnosis messages).

In case a module is replaced, the new module will automatically be parameterized with the last parameters of the removed module (if single parameters were written to the previously removed module, this parameters will be ignored).

During pulling or plugging of a certain module, all other module will continue to operate with one limitation: The reaction time of modules connected to the right of the affected module will be bigger in that case (up to 50 ms).

If the bus failure detection is active for CI52x and failsafe is configured (see *Chapter 1.2.1.3.3 “Cyclic I/O Data Exchange” on page 99*) the following behavior applies if a module is removed and replugged during failsafe condition:

- Last value configured for output:
  - After a bus failure is detected, failsafe will be activated and the output will remain at its last value.
  - If the module is removed and plugged again, the output will remain off, and not be kept its last value, as the last value of the new module is “0” in that case.
- Substitute value configured for output:
  - After a bus failure is detected, failsafe will be activated and the output will be according to the configured substitute value.
  - If the module is removed and plugged again now, the output will be set according to the configured substitute value again.
- Substitute value for x seconds configured for output:
  - After a bus failure is detected, failsafe will be activated and the output will be according to the configured substitute value for the configured time.
  - If the module is removed and plugged again now, the output will be set according to the configured substitute value again, and the configured time starts again.

1.2.1.5.3 Mandatory Rules for Hot Swapping

Mandatory rules for hot swapping:

- Between two pull and / or plug operations of I/O modules a pause of at least 1 second must be observed.
  - That means if a module is pulled or plugged there has to be at least a break of 1 second before the next module is pulled or plugged.
- At boot up of CI52x all configured expansion modules have to be physically available.
  - Start up with missing modules is not supported.
- As there is no special configuration available for hot swap terminal units, there is no possibility for the CI52x to generate diagnosis messages if there is no hot swap terminal unit available.
  - This has to be checked by application:
    Best way for checking if a hot swap terminal unit is available or not, is reading out the common device information registers (see *Chapter 1.2.1.2.2 “Information Data Section (Acyclic Data)” on page 79*). If the CI52x rejects this read out the CI52x doesn’t support hot swap at all.