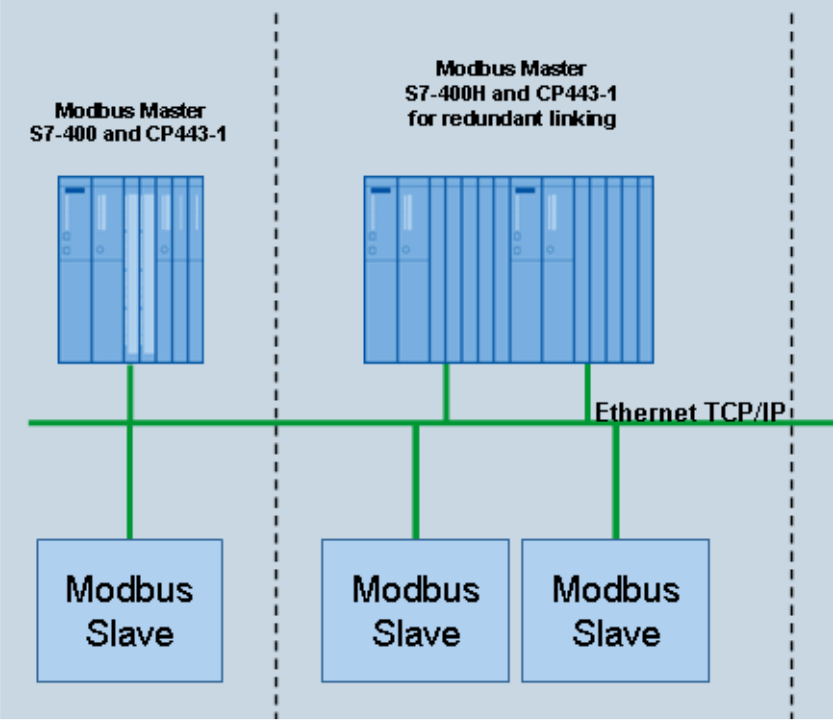
Modbus TCP/IP
PCS 7 driver blocks

SIEMENS

Documentation

**Driver block library for the
SIMATIC S7-400 or S7-400H / PCS7 V7 automation systems
for coupling with a Modbus slave via TCP/IP**

Version: 1.163



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1 System requirements

1.1 License

A license is required for the driver library.

1.2 Software

The library requires PCS7 V7.1 / SIMATIC STEP7 V5.4 SP4 or higher.

1.3 Hardware

The blocks can be executed in S7-41x (non redundant) or S7-41xH CPUs with connected CP443-1 EX20.

2 General information

2.1 Step 7 block library

The driver blocks are installed with a setup as STEP 7 library.

The target directory

<installation directory>SIEMENS\STEP7\S7libs

is specified by default.

Following the installation, the driver blocks are available in the block library.

In the SIMATIC Manager, you can then open the library via

File → Open → Library

and thus access the function blocks.

2.2 Supported functionalities

The current library supports the following functionalities:

- Integration of the driver blocks in a S7-400 or S7-400H CPU
- Modbus communication with remote Modbus slave devices via a TCP/IP connection
- The "Public Function Codes" 1 to 6 and 15 to 16 are supported
- The entire theoretic scope of external registers can be addressed, i.e. registers with the numbers 40001 to 105536 can be addressed if the Modbus slave device provides them
- No CPU restart is required after making changes to the parameters of the Modbus TCP/IP blocks

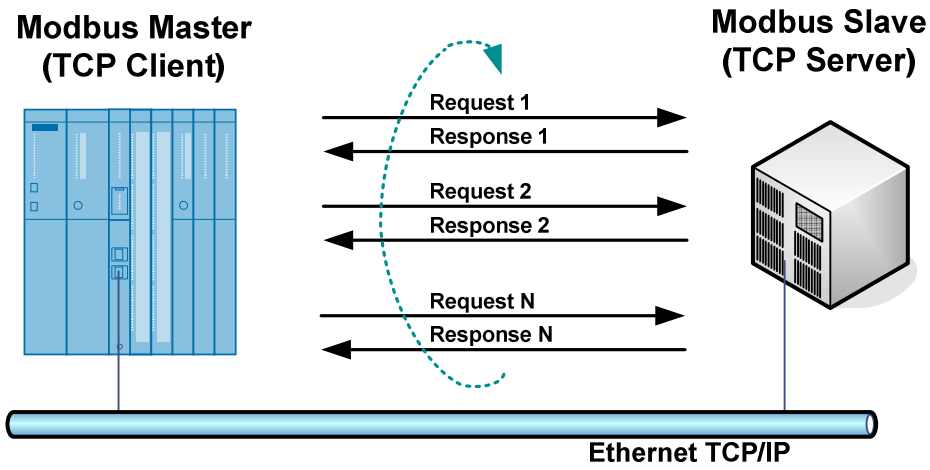
The following functions are not supported:

- Other codes besides the above-mentioned "Public Function Codes", "User-Defined Function Codes", and "Reserved Function Codes" are not supported

2.3 Communication principle

The Modbus communication between the S7-400 system and the devices is based on the Request/Response communication principle between client and servers.

The S7-400 system acts as client and every Modbus slave device behaves like a server. The S7-400 system (the Modbus master) sends the requests to the connected devices (the Modbus slaves) and receives the responses to the requests and evaluates their content.

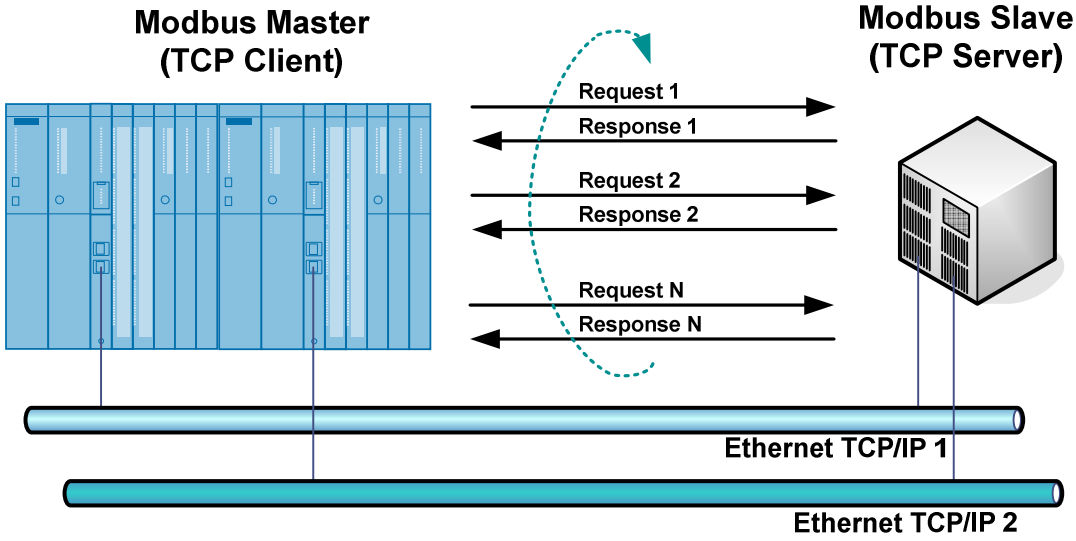


The request/response or send/receive communication is implemented based on the connection type TCP.

The communication is processed sequentially. The Master sends a request and expects the respective response before sending the next request to the slave. If a request times out, the next request is send out. The number of request blocks connected to the communication block determines the length of the request list. After the last request block from the list has been processed the cycle starts all over.

With redundant utilization, the communication of an S7-400H with a Modbus Slave can take place via both the CP in Rack0 and in Rack1, regardless of which CPU is currently the master.

A redundant communication layout can be implemented in various forms. Thus, for example, one slave can be used with 2 connections or a slave pair can be used with one connection each.



Example of a redundant communications layout

2.4 Quantity structure

Max. number of Modbus slave partners per S7-400:

16 were tested, up to 64 are theoretically possible

Max. number of Modbus slave partners per S7-400H:

8 were tested, up to 64 are theoretically possible

Maximum number of data points:

10*127 words or 10*2032 coils per slave

2.5 Performance

An S7-400H CPU with the MLFB 6ES7 417-4HL01-0AB0 and firmware V3.1.4 was used for the performance tests. A CP 443-1 (6GK7 443-1EX20-0XE0) was used as CP.

8 logical connections from the CPU to 4 different PCs were configured. Two Modbus TCP slave simulation programs with different ports were started on each PC.

Refresh speed

During normal operation the MODTCP_COMRED block requires four cycles per request / response telegram pair (per request block). This means that four cycles pass by between two outgoing request telegrams. The request is sent, and the response telegram is received and evaluated within the four cycles.

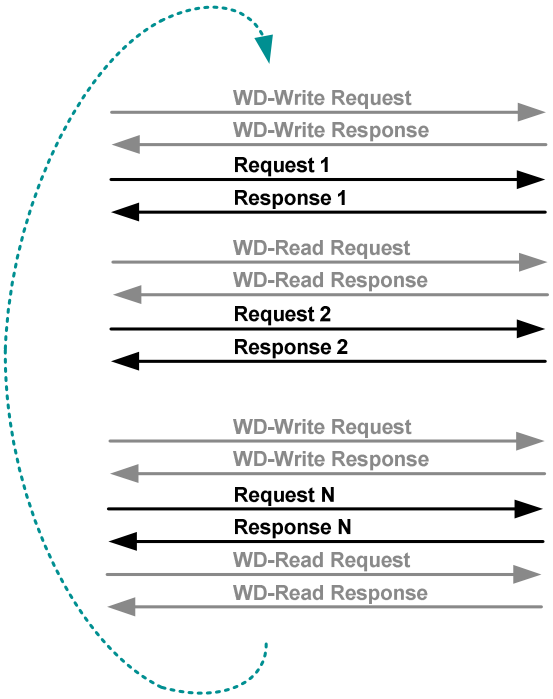
Example with function blocks in 100 ms cycle:

Count of orders	Read update every	Confirmed write update every
1	400 ms	400 ms
2	800 ms	800 ms
N	N*400 ms	N*400 ms

with N <= 10

If it is necessary to process as many requests as possible with a high update rate, multiple connections between Modbus Master and Modbus Slave can be used. The slave has to support multiple parallel connections. The respective logical connections have to be configured and their respective ID's have to be used at the communication blocks.

If a watchdog is used for monitoring the functionality of the Modbus slave (see 4.1.2.1), additional requests are necessary, which must be sent and which must each await a response. The use of a watchdog will also cause additional delays until a request message frame is sent again, because all of the message frames are processed sequentially.



Example: Function blocks in a 100ms cycle and watchdog being used

Number of requests	Update cycle of one Read value	Confirmed WRITE of one value
1	1200 ms	1200 ms
2	1600 ms	1600 ms
M	2*M*400 ms	2*M*400 ms
N	(2*N+1)*400 ms	(2*N+1)*400 ms

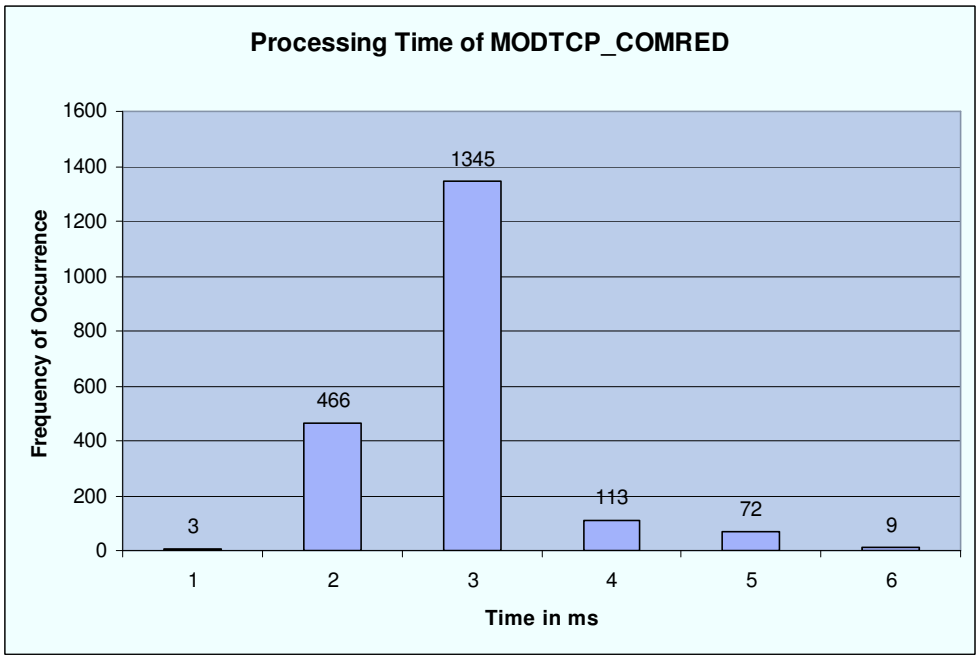
with M is even and N is odd and <= 10

Multiple connections can improve performance. The Watchdog could be used with a completely separate communication block.

Cycle time required per block instance

function block	Needed cycle time
MODTCP_COMRED	max. 6 ms
MODTCP_WRITE	0,4 ms
MODTCP_READ	0,4 ms

The MODTCP_COMRED block requires max. 6 ms of cycle time independent of the amount of used connections and connected request blocks.



The cycle time requirement of a MODTCP_COMRED block (using a total of 8 connections and 10 interconnected request blocks per connection)

Memory requirement per block

function block	work- memory	load-memory
MODTCP_COMRED	5606 Byte	7322 Byte
MODTCP_WRITE	3718 Byte	4294 Byte
MODTCP_READ	5070 Byte	6208 Byte

Reconfiguration time

The reconfiguration time is the time required for the telegram traffic to start after a specific event.

Event	needed time
after starting the communication via the block input STRT_COM	≤ 10 s
after a RESET	≤ 10 s
after loss of connection/reestablishing the connection	≤ 10 s
after complete failure and restart of the entire PCS7 system	≤ 10 s
after redundancy- including communication switchover as the result of an HCiR	≤ 10 s
after redundancy- including communication switchover as the result of an stop of the previously active CPU	≤ 10 s
after communication switchover as the result of an LAN failure on the previous active connection **including** the use of the watchdog functionality	≤ 10 s
after communication switchover as the result of an LAN failure on the previous active connection **excluding** the use of the watchdog functionality	≤ 40 s

Influence:

Due to their limited communications performance, each CPU can only process a certain number of parallel operator control and monitoring tasks with sufficient performance. If the resulting communication load is correspondingly high, a high number of send/receive connections operated in parallel can increase this operator control and monitoring load. This overloads the CPU and all requests (Send/Receive and operator control and monitoring requests) are processed slower. (The communication load can be set at the CPUs).

With H systems, additional synchronizations are required to maintain synchronous operation. This increases the block runtime and reduces the communication performance. Therefore, the performance limit is reached earlier. If the redundantly operating H system is no longer operating at the performance limit, the rule that the performance is 2 to 3 times less than the standard system applies.

2.6 Communication blocks used

Data is sent from a CP via the LAN to a partner station or received from a partner station and then it must be transmitted from the CP to the CPU. If the user data length is 241 bytes or higher, the AG_LSEND and AG_LRECV FCs must be used to execute this task.

The following blocks of the SIMATIC_NET_CP library were therefore used for implementing the Modbus TCP/IP block library (S7-400H):

- AG_CNTRL (Version 1.0)
- AG_LSEND (Version 3.0 / Version 3.1 using PCS7 V7.1 SP2 or higher)
- AG_LRECV (Version 3.0 / Version 3.1 using PCS7 V7.1 SP2 or higher)

Information about which CP supports the AG_CNTRL with which firmware version can be found under Ethernet-CP and AG_CNTRL.

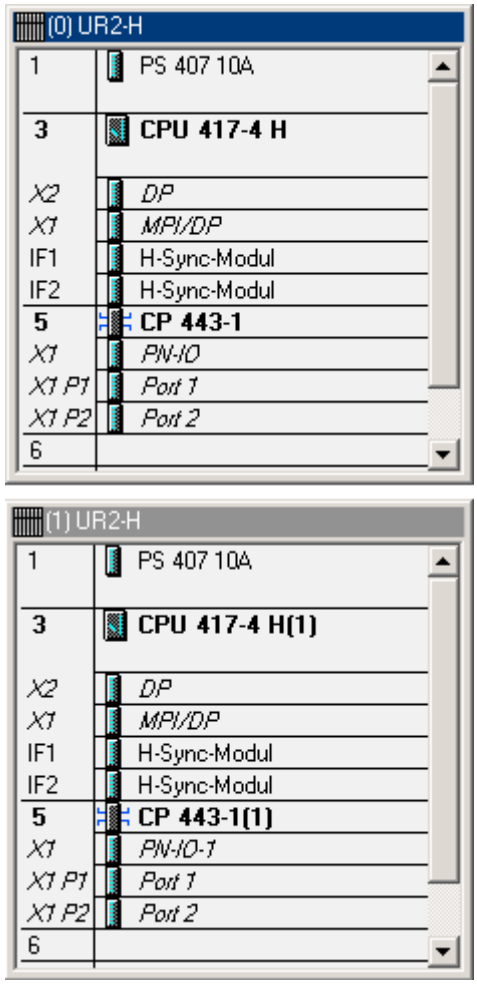
Note:

The CP443-1 (EX11) does not support the AG_CNTRL functionality. However, test with STEP7 V5.4 SP3 (PCS7 V7.0) have proven successful when the CP443-1 (EX11) was in the S7/PCS 7 project but the physical hardware was a CP443-1 (EX20).

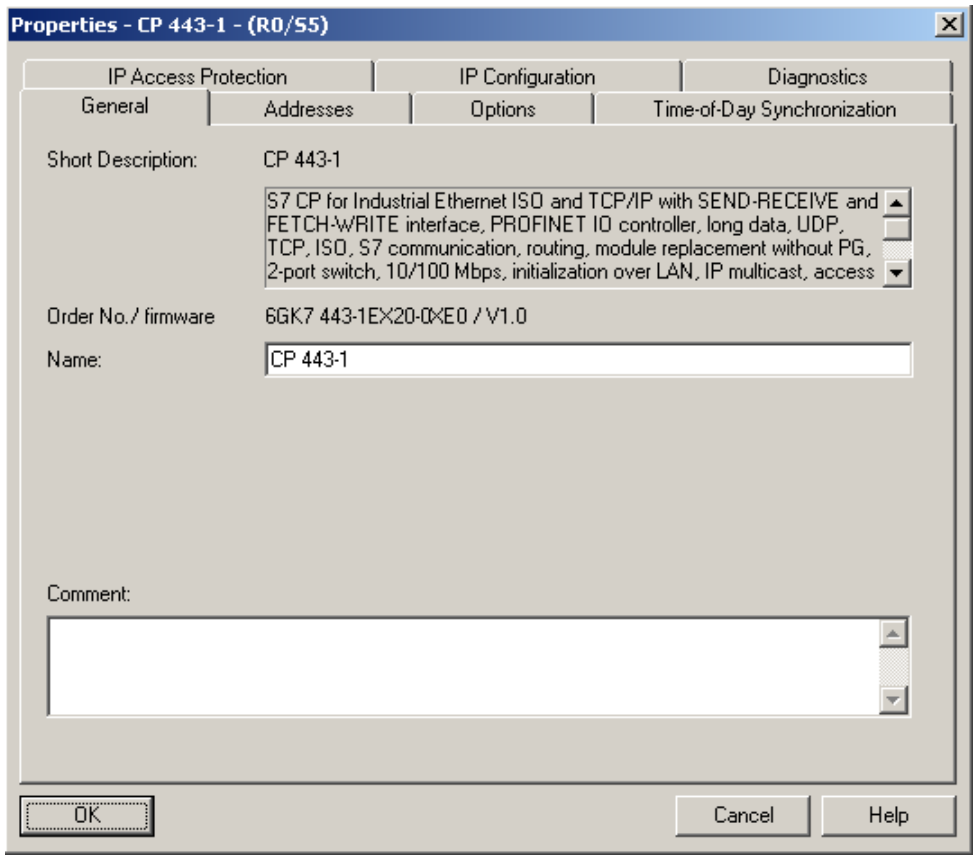
3 Configuring the hardware

3.1 General configuration instructions

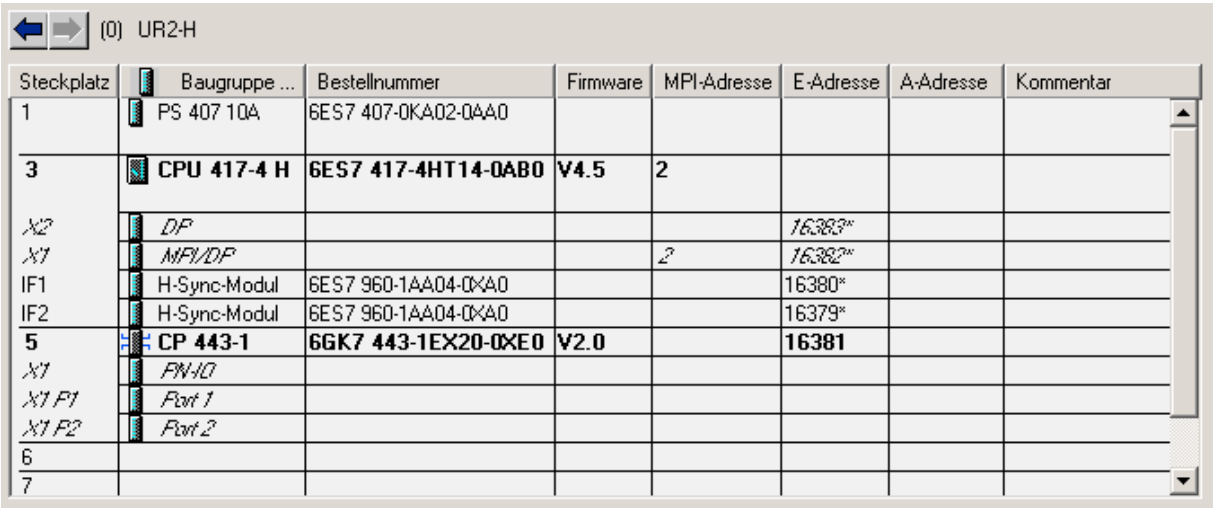
3.2 HW Config



Example of hardware configuration for the connection of Modbus slave partners



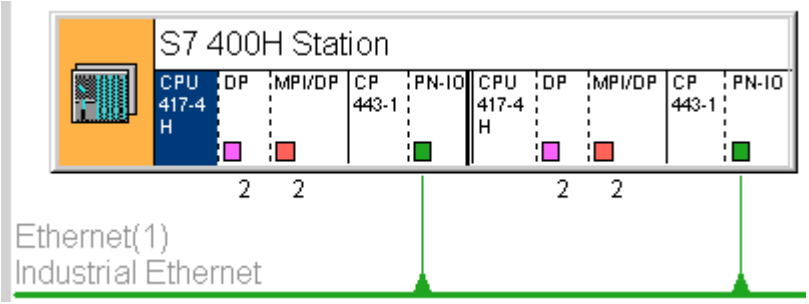
Example of CP 443-1 settings in the hardware configuration



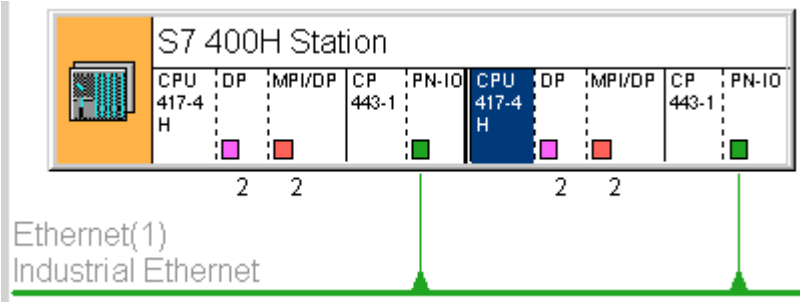
Example of configuration with a 417H CPU and an Ethernet CP 443-1

3.3 NetPro-Config

The hardware must be configured properly in NetPro to be able to establish a connection via Ethernet.



Example of NetPro configuration (CPU in Rack0 is selected)



Example of NetPro configuration (CPU in Rack1 is selected)

For the SIMATIC station, the TCP connections must then be configured using NetPro. This permits the CPU to address the Modbus slaves. The figure below shows an example of a logical connection. This is how it must be configured between a Modbus slave and an S7 CPU per communication connection.

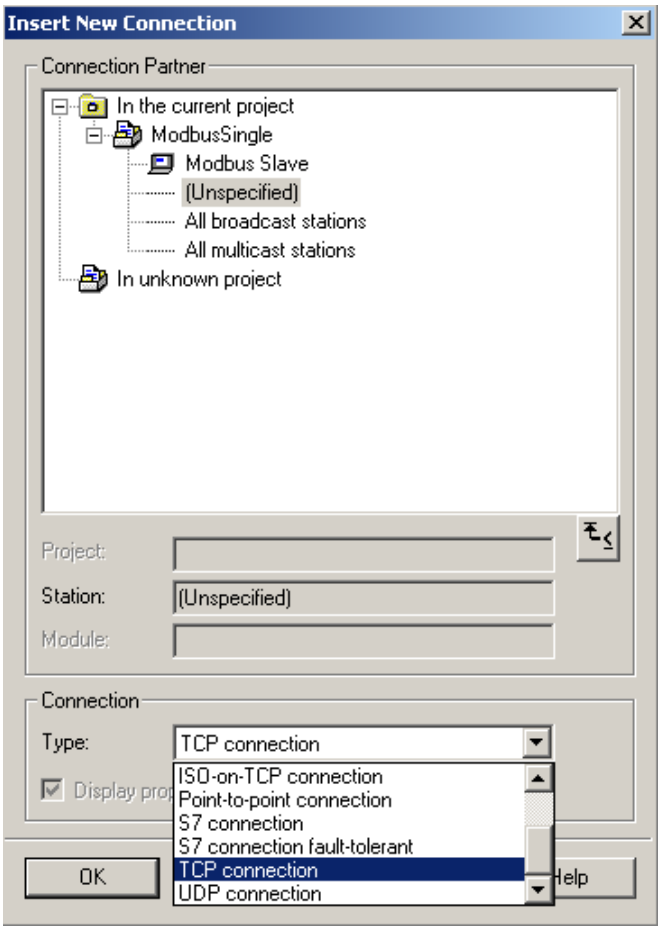
Lokale ID	Partner ID	Partner	Typ	Aktiver V	Betrie	Subnetz	Lokale	Partner Schnittstelle	Lokale Adres	Partner Adres
0001 A050		TCP-Verbindung-1	TCP-...	ja	-	Ethernet(1)...	PN-IO	--	192.168.0.1	192.168.0.2

Example of a logical connection of the CPU above marked in blue (in Rack0)

Lokale ID	Partner ID	Partner	Typ	Aktiver V	Subnetz	Lokale	Partner Schnittstelle	Lokale Adresse	Partner Adres
0001 A051		TCP-Verbindung-101	TCP-...	ja	Ethernet(1)...	PN-I...	--	192.168.0.101	192.168.0.2

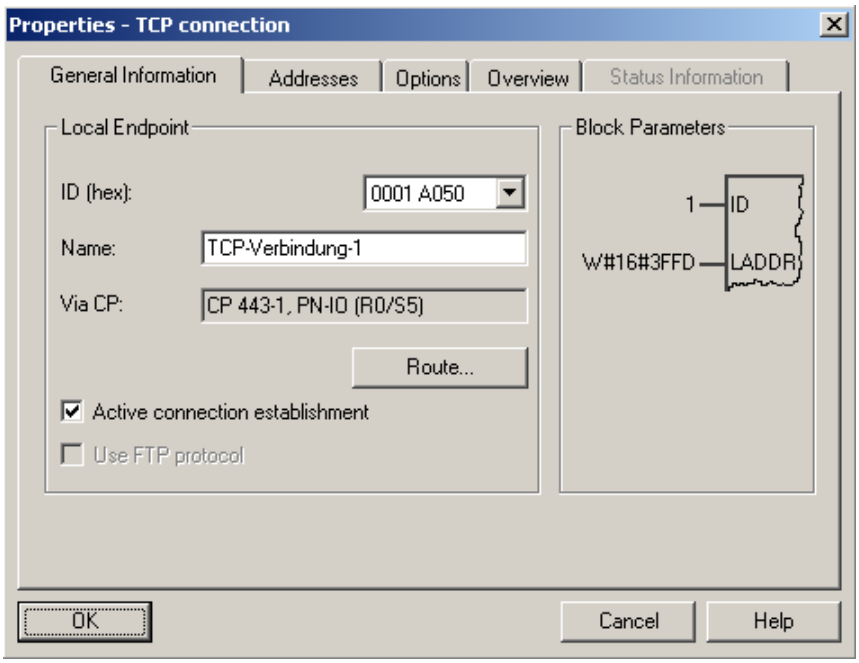
Example of a logical connection of the CPU above marked in blue (in Rack1)

Create a new connection to an "unspecified station" and select "TCP connection" as connection type. Confirm with OK to create the connection and to open the properties dialog of the new connection.



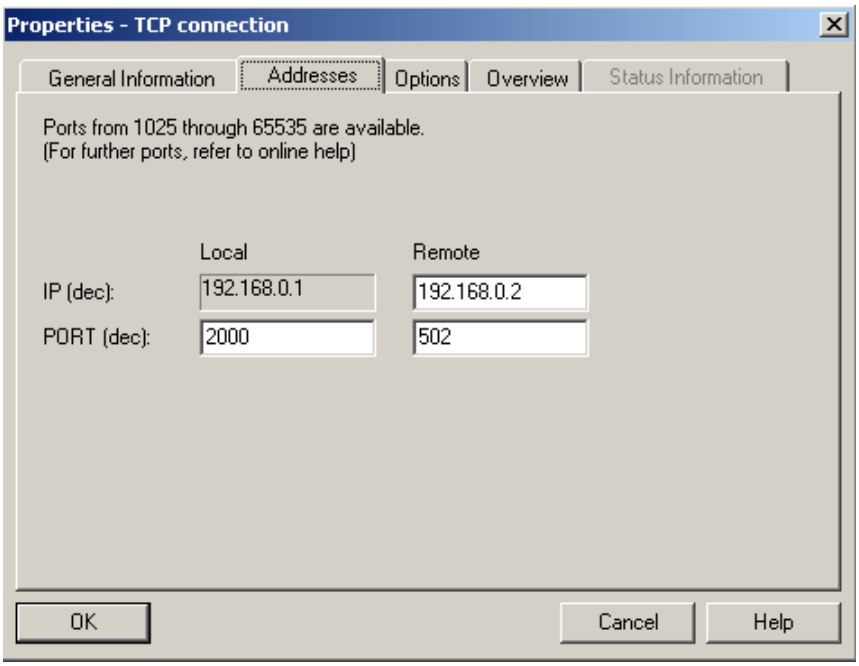
Inserting a new logical connection

In the properties dialog, the checkbox for the "Active connection establishment" must be set if the S7-400 as TCP/IP client is to communicate with the Modbus slaves as socket server.



Setting the "Active connection establishment" with important parameters for the subsequent block parameterization

The IP address of the Modbus slave (the remote partner) and its port must be entered under the "Addresses" tab (the standard port for the Modbus slave is 502).



Setting the IP address and ports of the remote partner

For the redundant scenario, the TCP connections of both CPUs of an S7-400H station must be configured with the Modbus slaves in this manner.

After that you can compile and load the NetPro configuration into the CPU.

4 Description of the function blocks

4.1 MODTCP_COMRED – communication block

Type/number FB 516

4.1.1 Function and mode of operation

This block serves as central header block for controlling the communication via Modbus TCP/IP.

The function block handles the communication between an S7-400H and a Modbus slave (communication partner) and must be interconnected with further blocks (the request telegram blocks). The communication block can only be used on a SIMATIC S7-41x or S7-41xH CPU with TCP/IP CPs (CP443-1 EX20). Furthermore, the CPU must be capable of signaling via ALARM_8P.

Max. 10 possible request blocks, which are sequentially processed, are connected to the MODTCP_COMRED block.

4.1.2 Parameterizing and interconnecting

In the CFC, the MODTCP_COMRED block is interconnected via its **CONNECT** output with the CONNECT inputs of the MODTCP_WRITE and/or MODTCP_READ request blocks to be processed.
A defined processing sequence of the individual requests might be required in certain applications. The processing sequence can be configured through the run sequence of the request blocks in the CFC.

If more than 10 request blocks are connected, any connected blocks from the eleventh position on are not considered. These unconsidered request blocks can be recognized by their set error output QLNKF.
Incorrectly parameterized request blocks are also not considered for communication.

The number of valid connected request blocks is indicated at the QBLOCKS output.

The important parameters for communication must be entered at the inputs **LADDR0**, **LADDR1**, **CONN_ID0, CONN_ID1**. The logical address of the CPs (LADDRx) and the value of the CONN_IDx parameters can be obtained from the block parameters in the properties dialog of the NetPro connection.
In case multiple communication blocks are used, each block should have its own logical connection.

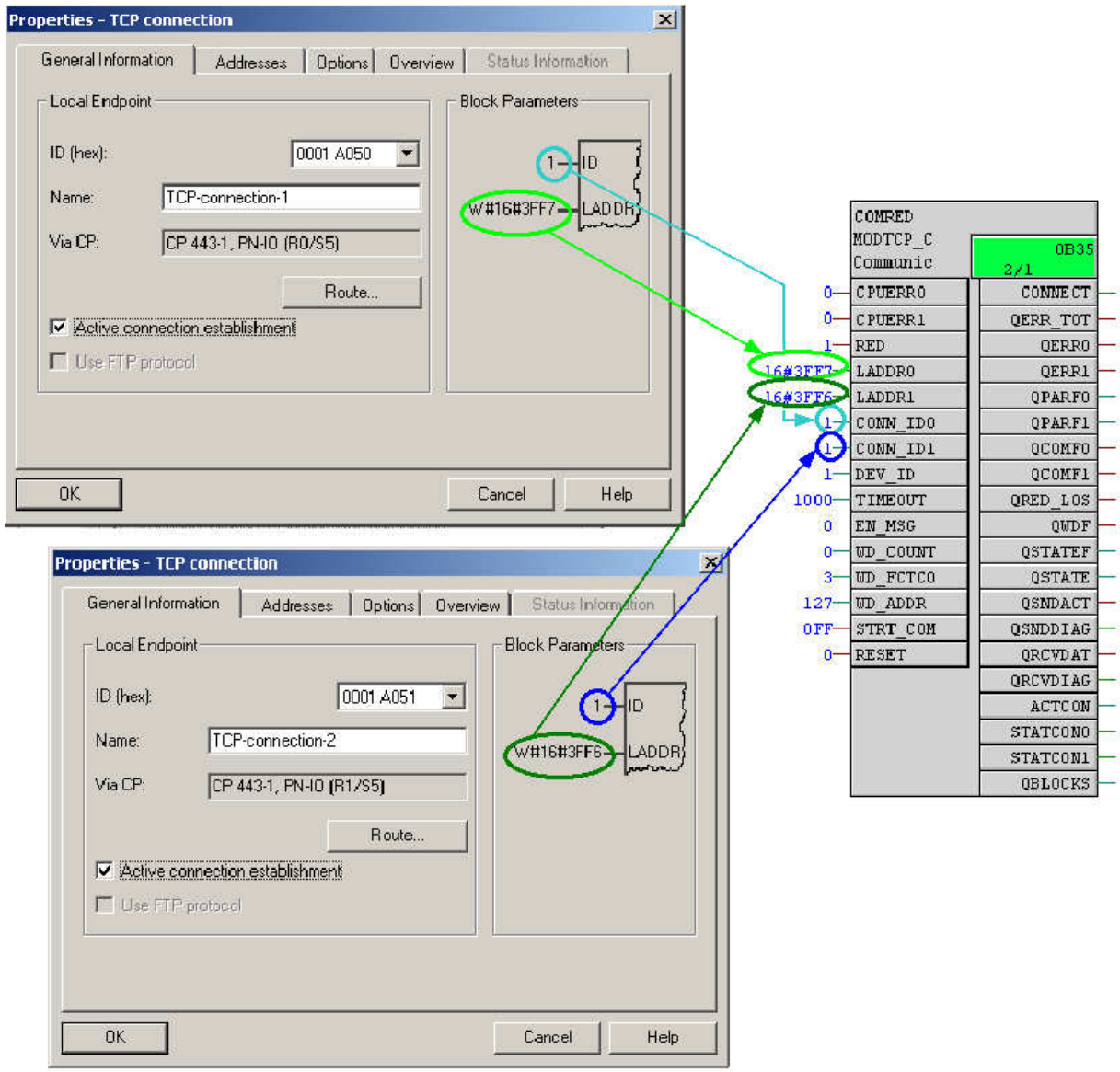
The communication can be started and stopped via the **STRT_COM** switch. A reinitialization of the program run or restart of the communication can be enforced with the input **RESET**.

The inputs **CPUERR0** and **CPUERR1** must be connected with the outputs CPUERR_0 and CPUERR_1 of the OB_BEGIN from the PCS7 Basis Library in order to detect and take into

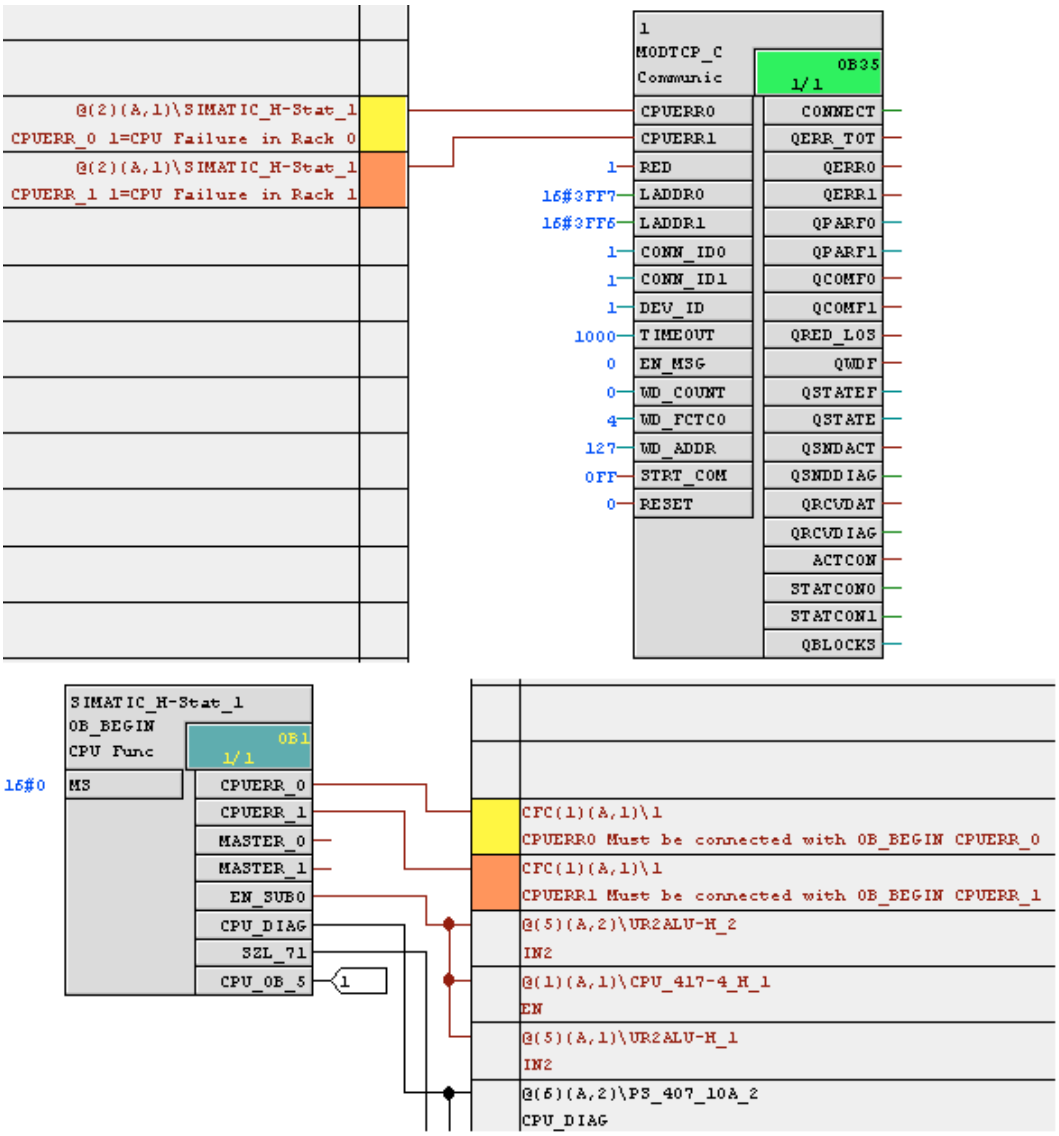
consideration any CPU errors in Rack0 or Rack1 for a required switchover of the communication connection being used as the result of a loss of CPU redundancy.

The block OB_BEGIN is automatically inserted into a system chart using the "generate rack" function, but the connection between the OB_BEGIN and the MODTCP_COMRED must be drawn manually (see 4.1.2.3).

The **DEV_ID** parameter is the device ID (frequently also referred to as slave address or unit identifier) of the Modbus slave device.



Setting the LADDR0, LADDR1, CONN_ID0 und CONN_ID1 block parameters with the values from NetPro the CPs from Rack0 and Rack1



Drawing the two connections between the MODTCP_COMRED and the OB_BEGIN blocks

4.1.2.1 Further configurations

The parameter **TIMEOUT** specifies the time (in msec) to wait for a response after a request has been send. The Parameter **RETRYREQ** specifies the number of retries before alarming a timeout. All requests of the request list are processed sequentially, even if the requests have timed out and have already been alarmed.

If a watchdog is required for monitoring the connected Modbus slaves, this can be parameterized on the MODTCP_COMRED block. For this purpose, the frequency (**WD_COUNT** > 0) with which a previously written value may be unequal to the read value in the respective register (or coil) of the slave until a watchdog error is reported must be specified. In addition, the function code **WD_FCTCOD** and the address **WD_ADDR** of the watchdog register or number of the watchdog coil must be specified. The watchdog monitoring functionality is defined for exactly one register or one coil and can also be used for monitoring the active connection. This allows a quicker response to the loss of a connection. The detection of a lost connection by the CP alone with AG_CNTRL (i.e. without the use of a watchdog) takes approximately 30 seconds.
When a watchdog error occurs, the communication is switched over <= 10s from the cur-

rently active connection to the standby connection, assuming that the standby connection has not already been reported as faulted at this time.

The parameter **ACTCONIN** forces the active connection (0 for CP0 and 1 for CP1) for communication. Automatic switch over of connections is only activated when ACTCON = -1.

The MODTCP_COMRED block can also be used for a non-redundant system. To this end, the redundancy can be disconnected via the input **RED**. When doing this, ensure that the block parameters with a 0 at the end of their names are the relevant parameters for this application, and the parameters with a 1 at the end of their names are not taken into consideration. Only CP0 is used for communication.

4.1.2.2 Additional information

If there is no response to the request telegrams for all connected request blocks within the specified timeout and the specified number of retries, or if responses cannot be interpreted because there are unexpected data in the receive buffer of the CP, the connection to the Modbus slave will be restarted. This automatic reset is only carried out, however, if this condition continues for double the timeout value during the program run.

The following outputs are used for analyzing

- the internal program sequence
  QSTATEF and QSTATE
- for alerting
  QMSG_ERR, QMSG_DONE, QMSG_SUP, QMSG_STAT and QMSG_ACK
- for indicating the slots
  QRACK_NO0, QRACK_NO1, QSLOT_NO0 and QSLOT_NO1
- for analyzing the communication.
  QSNDACT, QSNDDIAG, QRCVDAT and QRCVDIAG
- and for analyzing the connection status.
  ACTCON, STATCON0 and STATCON1

QSNDACT =1 means that 'data are being sent' and QRCVDAT = 1 means that 'data are being received'. ACTCON indicates an active connection. With 0, communication with the Modbus slave takes place via the connection from the CP in Rack0; with 1, via the CP in Rack1.

In QSNDDIAG, the STATUS of AG_LSEND is displayed and in QRCVDIAG, the STATUS of AG_LRECV is displayed. In STATCON0, the connection status of the CP in Rack0 with the communication partner is indicated with the aid of the AG_CNTRL and in STATCON1, a corresponding indication is given for the connection from the CP in Rack1. The information is returned in RESULT1 for CMD=1 by calling up AG_CNTRL.

Information regarding the STATUS and RESULT values are available in the respective online help of AG_ LSEND, AG_LRECV and AG_CNTRL or in the SIMTIC NET Manual.

To accept changed LADDR and CONN_ID parameter values, a restart of the communication or RESET is required.

Blocks called from the interface are:

- FB511 (MODTCP_BuildReq)
- FB512 (MODTCP_ParseReq)
- FB513 (MODTCP_ProgLogic)
- FB514 (MODTCP_Link)
- FB521 (MODTCP_ConnStat)
- FB522 (MODTCP_ConnRes)
- SFB35 (ALARM_8P)

Blocks called from the code are:

- FC10 (AG_CNTRL)*
- FC50 (AG_LSEND)
- FC60 (AG_LRECV)
- SFC6 (RD_SINFO)
- SFC20 (BLKMOV)*
- SFC49 (LGC_GADR)

*MODTCP_COMRED uses AG_CNTRL indirectly via FB521 and FB522.

*MODTCP_COMRED uses BLKMOV indirectly via FB511 and FB512.

4.1.2.3 Creating module drivers

When compiling a CFC, the function "Generate module drivers" must be used for signal processing in PCS 7. This function generates new system charts (with names assigned by the system "@..."), in which only driver blocks are inserted by the driver generator.

After the hardware is configured using HW Config and the technological functions are configured in the CFC, this function automatically generates, interconnects and parameterizes the necessary module drivers. These module drivers are responsible for the diagnosing and reporting of errors during signal processing.

With the setup for the MODTCP_COMRED block, an object list and an action list are installed in the form of two XML files. This allows the driver generator to also automatically insert the necessary OB_BEGIN block (into a system chart).

The two installed metafiles (here for PCS7 V7.1) are:

<ProgramFiles>\SIEMENS\STEP7\S7DATA\driver\action\07010000\al_chn_modtcp_comred.xml

<ProgramFiles>\SIEMENS\STEP7\S7DATA\driver\object\07010000\chn_modtcp_comred.xml

The connections between the OB_BEGIN and the MODTCP_COMRED block must, however, still be drawn manually, because the assignment of the "channel" block to its associated diagnostic block cannot be made known to the driver generator.

Generating the module driver the warning ‘Cannot find driver block for the signal processing block %blockname%’ will be shown for each MODTCP_COMRED block. This warning can be ignored.

After a change to the HW configuration, the driver generator must be restarted.

4.1.3 Calling OBs

The calling OB is the cyclic interrupt OB3x, into which you integrate the block (e.g. OB 35) and the following OBs, into which the block is also integrated (automatically in the CFC):

- OB100 Restart (warm restart)
- OB102 Restart (cold restart)

4.1.4 Error handling

The following error statuses are specified as flags:

A general error status is displayed in **QERR0** and **QERR1**. If both are set, then **QERR_TOT** is set. This summarizing general error status is forwarded to the request blocks so that their output can be set corresponding to QBAD. If you dispense with the redundancy using RED = 0, only the status of QERR0 is taken into consideration for this. QERRx is set by one of the following errors.

QCOMF0 and **QCOMF1** signals faulty communication.
QWDF indicates a watchdog error.
Possible incorrect parameterizations are indicated via **QPARF0** and **QPARF1**.

QPARFx	Output	Description
0	0	No error
1	Spare	Reserved
2	Dev_Id	DEV_ID invalid (valid are 1 - 255)
3	WDFctCod	WD_FCTCOD invalid (valid are 1 and 3)
4	WDCount	WD_COUNT invalid (valid are values >= 0)
5	WDAddr	WD_ADDR invalid
6	LAddr	Incorrect LADDR module start address
7	Conn_Id	Invalid CONN_ID
8°	Timeout	TIMEOUT must be at least 5*cycle time of the OB
9°	RetryReq	RETRYREQ is invalid (values >= 0 are valid)
10°	RunupCyc	RUNUPCYC is invalid (values >= 0 are valid)

° only applies for QPARF0

4.1.5 Signaling behavior

The input **EN_MSG** = 1 activates the messaging capability (default setting=0). Individual signals for the messaging capability are activated or hidden via the input **EN_SIGS** (default setting =16#7E, with 6 of 7 possible signals activated). A number of cycles can be set using the parameter **RUNUPCYC** for which no messages are generated during the start.

The MODTCP_COMRED block generates control messages via the ALARM_8P for the OS with the following assignments of the message texts, including the auxiliary values for its block parameters.

Assigning the message text to the block parameters

Message block Alarm_8P	Msg. no.	Predefined message text	Can be activated by resp. bit in EN_SIGS	Respective parameter
MSG_EVID	1	Timeout for Request No. @7%d@ on connection @8%d@	xxxx xxx**0** (default is OFF)	-
	2	Spare [Rack@3%d@/Slot@4%d@ error with connection @8%d@]	xxxx xx**1**x	-
	3	Parameter error (@5%d@) for connection 0	xxxx x**1**xx	QPARF0
	4	Parameter error (@6%d@) for connection 1	xxxx **1**xxx	QPARF1
	5	Communication error (LADDR=0x@1W%X@, CONN_ID=@2%d@) for connection @8%d@	xxx**1** xxxx	QCOMF0 or QCOMF1
	6	Watchdog error	xx**1**x xxxx	QWDF
	7	Redundant communication connection failed	x**1**xx xxxx	QRED_LOST*
	8			

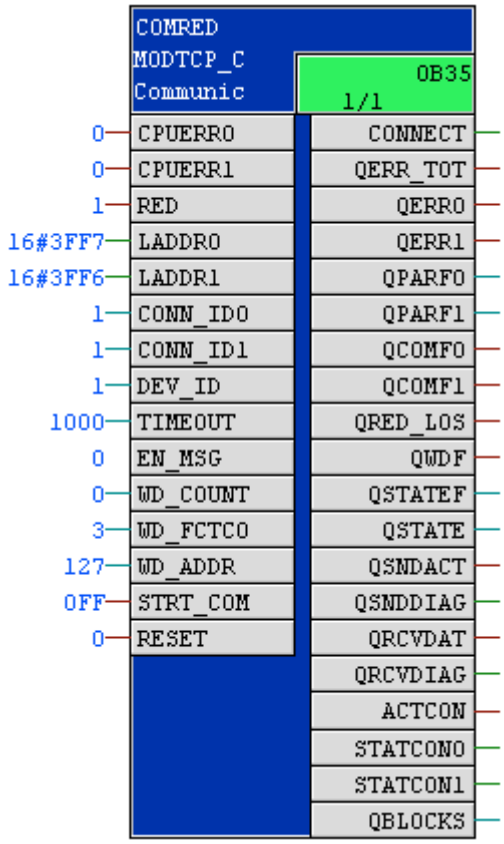
*With message number 7, the failure of the redundant communication connection is reported. There does not have to be a redundancy failure for this (stop or failure of a CPU). The time of this message can be delayed compared to the actual cause. A redundancy failure can be reported using standard blocks (e.g. OB_BEGIN), if necessary.

Message number 1 is switched off by default, because it occurs frequently for a failed (last active) communication connection until the communication is switched over to another intact connection.

Assigning the associated values to the block parameters

Message block Alarm_8P	Associated value	Block parameter
MSG_EVID	1	Logical CP I/O address
	2	Connection ID
	3	Rack Nummer
	4	Slot Nummer
	5	Parameter error number
	6	Current request number

4.1.6 CFC block representation



4.1.7 Parameter list

IO	Parameter	IO-Typ	Default	Comment
I	CPUERR0	BOOL		Must be connected with OB_BEGIN CPUERR_0
I	CPUERR1	BOOL		Must be connected with OB_BEGIN CPUERR_1
I	RED	BOOL	1	1: redundant; 0: non redundant
I	LADDR0	WORD	16#3FF7	Logical CP I/O address from CP0
I	LADDR1	WORD	16#3FF6	Logical CP I/O address from CP1 (not used if RED=0)
I	CONN_ID0	INT	1	Connection ID from CP0
I	CONN_ID1	INT	1	Connection ID from CP1 (not used if RED=0)
I	DEV_ID	INT	1	Device ID / slave address
I	TIMEOUT	DINT	1000	Timeout in milliseconds
I	SAMPLE_T	REAL		Sample time input (system input)
I	EN_MSG	BOOL	0	1 = enable alarm
I	EN_SIGS	BYTE	16#7E	Alarm_8P enable or disable each of the 7 signals
I	MSG_EVID	DWORD	2	System input for alarming
I	RUNUPCYC	INT	3	Count startcyles (hide messages during start)

IO	Parameter	IO-Typ	Default	Comment
I	RETRYREQ	INT	3	Max. attempts for a request before signal a timeout
I	WD_COUNT	INT	0	Watchdog Counter
I	WD_FCTCOD	INT	3	Function code for watchdog: 1or 3
I	WD_ADDR	DINT	127	Register or coil number used for watchdog
I	ACTCONIN	INT	-1	CP number (0 or 1) where the connection should be active, -1 means automatic
IO	STRT_COM	BOOL	0	1 = start communication
IO	RESET	BOOL	0	1 = reset function block
O	CONNECT	DWORD	0	Connection to input CONNECT of Telegramm blocks
O	QERR_TOT	BOOL	0	1 = total error (no connection alive)
O	QERR0	BOOL	0	1 = general error in connection 0
O	QERR1	BOOL	0	1 = general error in connection 1
O	QPARF0	INT	0	Parameter error at connection 0
O	QPARF1	INT	0	Parameter error at connection 1
O	QCOMF0	BOOL	0	1 = communication error at connection 0
O	QCOMF1	BOOL	0	1 = communication error at connection 1
O	QRED_LOST	BOOL	0	1 = redundancy lost
O	QWDF	BOOL	0	1 = watchdog error
O	QSTATEF	INT	0	Internal state error
O	QSTATE	INT	0	Internal state
O	QSNDACT	BOOL	0	1 = data sent
O	QSNDDIAG	WORD	0	Detailed send status
O	QRCVDAT	BOOL	0	1 = data received
O	QRCVDIAG	WORD	0	Detailed receive status
O	QMSG_ERR	BOOL	0	1 = ALARM_8P Error
O	QMSG_DONE	BOOL	0	1 = ALARM_8P Done
O	QMSG_SUP	BOOL	0	1 = Message suppression active
O	QMSG_STAT	WORD	0	ALARM_8P: STATUS Output
O	QMSG_ACK	WORD	0	ALARM_8P: ACKNOWLEDGE Output
O	QRACK_NO0	INT	0	CP0 Rack-Number
O	QRACK_NO1	INT	0	CP1 Rack-Number
O	QSLOT_NO0	INT	0	CP0 Slot-Number
O	QSLOT_NO1	INT	0	CP1 Slot-Number
O	ACTCON	INT	1	CP number where the connection is active
O	STATCON0	WORD	0	Status of Connection 0
O	STATCON1	WORD	0	Status of Connection 1

IO	Parameter	IO-Typ	Default	Comment
O	QBLOCKS	INT	0	Count of connected valid blocks
O	WD_VAL	WORD	0	Value read because of watchdog

4.2 MODTCP_WRITE - request block

Type/number FB 518

4.2.1 Function and mode of operation

The MODTCP_WRITE block is used to compile Modbus write requests and its attached data are sent to the Modbus slave.

The MODTCP_WRITE block is used together with the MODTCP_COMRED block for writing data into so-called coils (bits) or registers (words) of the Modbus slave device via a TCP/IP connection using the Modbus protocol.

It writes the pending data at the inputs and any data in a parameterized data block into the corresponding register(s) or coil(s).

4.2.2 Parameterizing and interconnecting

The parameter **FCTCODE** of the MODTCP_WRITE request block, which is connected to the MODTCP_COMRED block in the CFC via **CONNECT**, determines what is written.

FCTCODE	Function name	Description
5	Write single coil	Write a bit
6	Write single register	Write a register
15	Write multiple coils	Write up to 2032 bits
16	Write multiple registers	Write up to 127 registers

STRTADD specifies the start address of the register or coil, and
QUANTITY specifies the number of coils or registers to be written.

4.2.2.1 Further configurations

If the values to be sent are not obtained from the inputs **VAL1 - VAL127** but instead from a data block, the number of the data block and the start address must be specified in **DB_STRTADD** via the parameter **DB_NO**. If DB_NO = 0, the values from the inputs are used.

4.2.2.2 Additional information

The number of bytes to be written can be determined via the output **BYTECNT**.

Blocks called from the code are:

- FC29 (NE_STRING)
- SFC20 (BLKMOV)

4.2.3 Calling OBs

The calling OB is the cyclic interrupt OB3x in which you integrate the block (e.g. OB 35).

4.2.4 Error handling

QLNKF indicates an error when the connection to the MODTCP_COMRED block is faulty or when the MODTCP_WRITE block itself could not be registered internally, e.g. because more than 10 request blocks are already connected.

QBAD indicates that the write request was invalid. It is TRUE when QLNKF is TRUE or QERR at the MODTCP_COMRED block is TRUE. Furthermore it is TRUE when the write request came back with a response code <> 0 and <> 15 (refer QRESPCOD).

Possible incorrect parameterizations are indicated via **QPARF**.

QPARF	Output	Description
0	0	No error
1	Spare	Reserved
2	Spare	Reserved
3	Fctcode	FCTCODE invalid (valid are 5,6,15,16)
4	StartAdd	STRTADD invalid (valid are values >= 0 and < 0xFFFF)
5	CoilQnty	For FCTCODE 5 or 15, QUANTITY is invalid (valid are values > 0 and <= 2032)
6	RegQnty	For FCTCODE 6 or 16, QUANTITY is invalid (valid are values > 0 and <= 127)
7	Db_No	Data block with DB_NO is not loaded
8	Db_Strta	DB_STRTADD is invalid

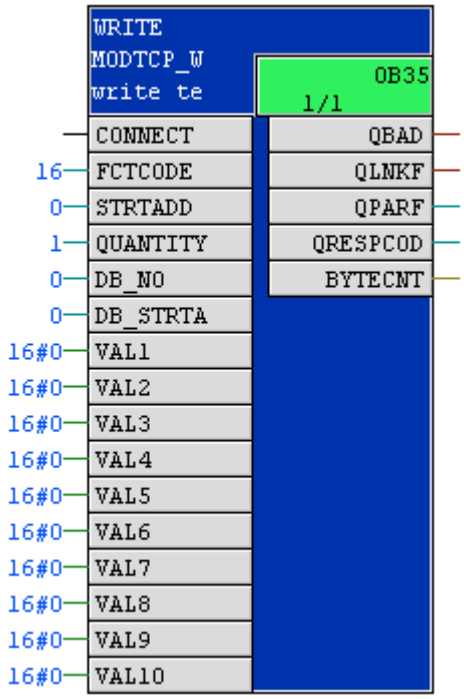
Status information received in the response is displayed via **QRESPCOD**.

QRESPCOD	Output	Description
0	OK	No error
1	ILLEGAL FCT	Illegal function call
2	ADDR ERR	Illegal address
3	DATA ERR	Illegal data value
4	DEV ERR	Error in the device that cannot be eliminated
5	TIMEOUT	Timeout
15		Waiting for Response

4.2.5 Signaling behavior

The block has no signaling behavior.

4.2.6 CFC block representation



4.2.7 Parameter list

IO	Parameter	IO type	Default	Comment
I	CONNECT	ANY		CFC connection to MODTCP_COMRED block
I	FCTCODE	INT	16	Function code: [5, 6, 15, 16]
I	STRTADD	DINT	0	Register starting address [0..0xFFFF]
I	QUANTITY	INT	1	Quantity of outputs (coils or registers)
I	DB_NO	INT	0	DB number with data to be copied; if 0 does not copy
I	DB_STRTADD	INT	0	In the DB, start address of the data
I	VAL1	WORD	0	1st word value to write (single value, if FC is 5 or 6)
	...			
I	VAL127	WORD	0	127th word value to write
O	QBAD	BOOL	0	General error / quality code
O	QLNKF	BOOL	0	Link failure
O	QPARF	INT	0	Parameter error
O	QRESPCOD	INT	0	See Table in error handling
O	BYTECNT	BYTE	0	Count of bytes used to write

4.3 MODTCP_READ - request block

Type/number FB 517

4.3.1 Function and mode of operation

The MODTCP_READ block is used to compile Modbus read requests and to process the data received via the TCP connection in the associated response.

The MODTCP_READ block is used together with the MODTCP_COMRED block for reading data from so-called coils (bits) or registers (words) of the Modbus slave device via a TCP/IP connection using the Modbus protocol.

The received data are displayed at the block outputs or can be transferred to an optionally specified data block.

4.3.2 Parameterizing and interconnecting

On the CFC level, the **CONNECT** input of the request block MODTCP_READ must be connected to the CONNECT output of the MODTCP_COMRED.

The **FCTCODE** parameter of the request block determines the type of data access as follows:

FCTCODE	Function name	Description
01	Read coils	Reading of up to 2032 bits (output status)
02	Read discrete inputs	Reading of up to 2032 bits (input status)
03	Read holding registers	Reading of up to 127 output registers
04	Read inputs registers	Reading of up to 127 input registers

STRTADD specifies the start address of the register or coil, and
QUANTITY specifies the number of coils or registers to be read.

4.3.2.1 Further configurations

Output of values

If the received values are not written at the outputs **VAL1 - VAL127** but instead into a data block, the number of the data block and the start address must be specified in **DB_STRTADD** via the parameter **DB_NO**. If DB_NO = 0, the values at the outputs are written.

Substitute values

Substitute values can be specified for the MODTCP_READ block via the inputs **SUB_VAL1 – SUB_VAL127**. If **SUB_ACT** = TRUE in the event of communication problems QBAD = TRUE,

these values can be copied to the outputs. Only as many values as specified via QUANTITY (considering the FCTCODE) are copied.

Simulation values

Simulation values can be specified for the MODTCP_READ block via the inputs **SIM_VAL1 – SIM_VAL127**. If **SIM_ACT** = TRUE, these values are copied to the outputs. Only as many values as specified via QUANTITY (considering the FCTCODE) are copied. Values that may have been read from the Modbus slave or replacement values are overwritten by the simulation values.

Byte and word sequence

Since it is not exactly specified in the Modbus specification how data is to be stored in the registers, some manufacturers implement their Modbus devices such that first the High byte and then the Low byte is stored and transferred. Other devices, on the other hand, save and transfer the Low byte first.

The same applies to words if registers were combined in 32-bit data types. Some devices save the High word in the first register and the Low word in the second register. In other devices, on the other hand, this is implemented in the reverse order.

An example is the 32-bit unsigned integer 2923517522, which can be arranged in four different ways:

AE41 5652 : high byte first, high word first
5652 AE41 : high byte first, low word first
41AE 5256 : low byte first, high word first
5256 41AE : low byte first, low word first

It does not matter in which order the bytes or words are sent as long as this can be considered at the receiver end.

Therefore, the values can be adapted at the outputs with the MODTCP_READ block with the **CHG_BYTE** and **CHG_WORD** switches. The switches are only considered if FCTCODE = 3 or 4. Substitute values and simulation values are not modified.
With CHG_BYTE = TRUE, the High byte and Low byte of an output value (also in any specified DB) are interchanged. With CHG_WORD = TRUE, the High word and Low word of a double word are interchanged. The double word is then put together through two consecutive outputs. The same applies to values in any specified DB. When using CHG_WORD, make sure that an even number of registers to be read is available.

4.3.2.2 Additional information

Blocks called from the code:

- FC29 (NE_STRING)
- SFC20 (BLKMOV)

4.3.3 Calling OBs

The calling OB is the cyclic interrupt OB3x in which you integrate the block (e.g. OB 35).

4.3.4 Error handling

QLNKF indicates an error when the connection to the MODTCP_COMRED block is faulty or when the MODTCP_READ block itself could not be registered internally, e.g. because more than 10 request blocks are already connected.

QBAD indicates that the read request was invalid. It is TRUE when QLNKF is TRUE or QERR at the MODTCP_COMRED block is TRUE. Furthermore it is TRUE when the read request came back with a response code <> 0 and <> 15 (refer QRESPCOD).

Possible incorrect parameterizations are indicated via **QPARF**.

QPARF	Output	Description
0	0	No error
1	Spare	Reserved
2	Spare	Reserved
3	Fctcode	FCTCODE invalid (1,2,3,4 are valid)
4	StartAdd	STRTADD invalid (valid are values >= 0 and < 0xFFFF)
5	CoilQnty	For FCTCODE 1 or 2, QUANTITY is invalid (valid are values > 0 and <= 2032)
6	RegQnty	For FCTCODE 3 or 4, QUANTITY is invalid (valid are values > 0 and <= 127)
7	Db_No	Data block with DB_NO is not loaded
8	Db_Strta	DB_STRTADD is invalid

Status information received in the response is displayed via **QRESPCOD**.

QRESPCOD	Output	Description
0	OK	No error
1	ILLEGAL FCT	Illegal function call
2	ADDR ERR	Illegal address
3	DATA ERR	Illegal data value
4	DEV ERR	Error in the device that cannot be eliminated
5	TIMEOUT	Timeout
15		Waiting for Response

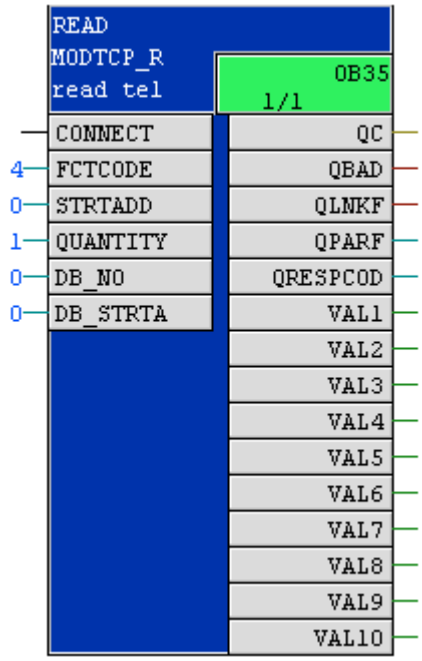
A quality code is shown for all output values together via **QC**.

QC	Description
16#80	Valid value
16#60	Simulation value
16#48	Substitute value
16#00	Invalid value

4.3.5 Signaling behavior

The block has no signaling behavior.

4.3.6 CFC block representation

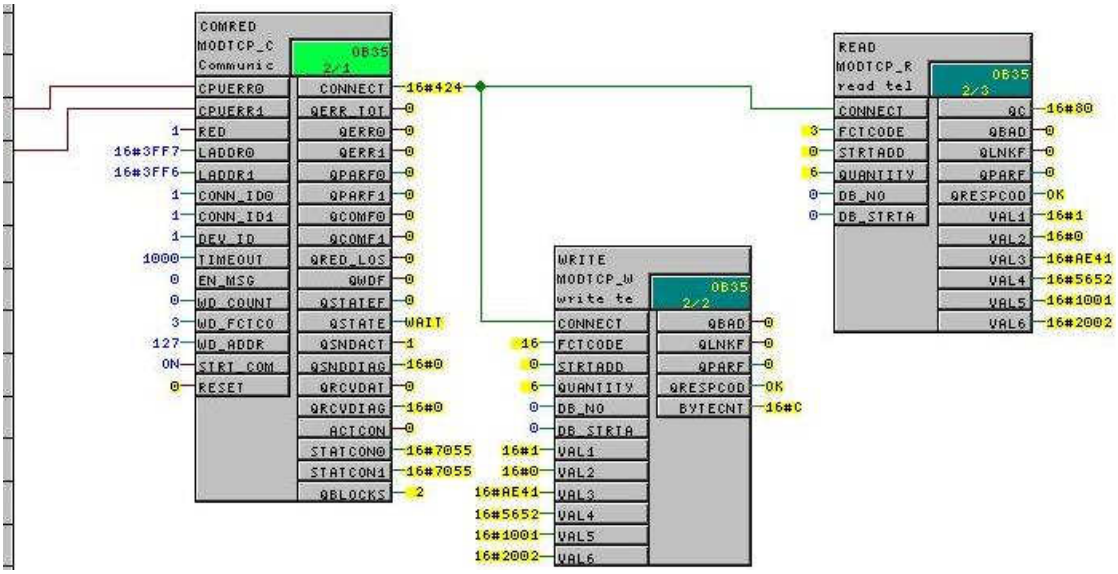


4.3.7 Parameter list

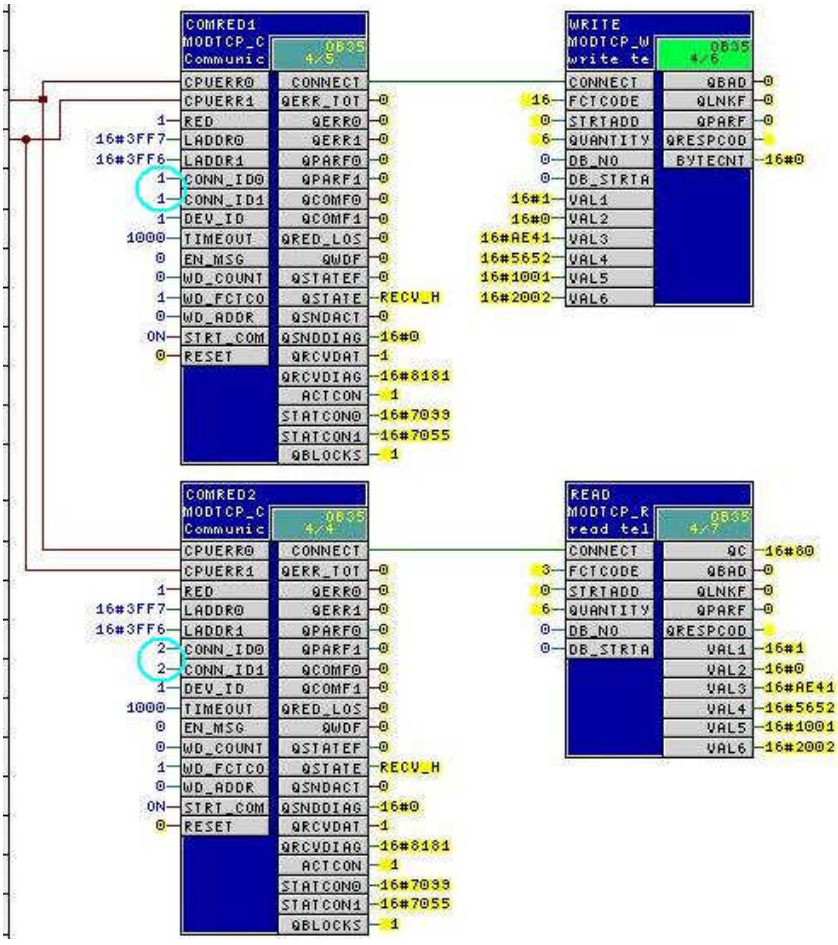
IO	Parameter	IO type	Default	Comment
I	CONNECT	ANY		CFC connection to MODTCP_COMRED block
I	FCTCODE	INT	4	Function code [1, 2, 3, 4]
I	STRTADD	DINT	0	Register starting address [0..0xFFFF]
I	QUANTITY	INT	1	Quantity of coils (<=2032 bits) or registers (<=127 words)
I	DB_NO	INT	0	Number of the DB where to copy the data; if 0 don't copy
I	DB_STRTADD	INT	0	In the DB, start address for the data
I	CHG_BYTE	BOOL	0	Interchange Low and High bytes in each word from the output values (allowed with FCTCODE 3 and 4)
I	CHG_WORD	BOOL	0	Interchange Low and High words in each double word from the output values (allowed with FCTCODE 3 and 4, QUANTITY should be even)
I	SUB_ACT	BOOL	0	Activate substitution values, if QBAD is true
I	SUB_VAL1	WORD	0	1st word substitution value
I	...			
I	SUB_VAL127	WORD	0	127th word substitution value

I	SIM_ACT	BOOL	0	Activate simulation values (overrides normal and substitution values)
I	SIM_VAL1	WORD	0	1st word simulation value
I	...			
I	SIM_VAL127	WORD	0	127th word simulation value
O	QC	BYTE	0	Quality code (one for all values)
O	QBAD	BOOL	0	General error / quality code
O	QLNKF	BOOL	0	Link failure
O	QPARF	INT	0	Parameter error
O	QRESPCOD	INT	0	See Table in error handling
O	VAL1	WORD	0	1st word value read
O	...			
O	VAL127	WORD	0	127th word value read

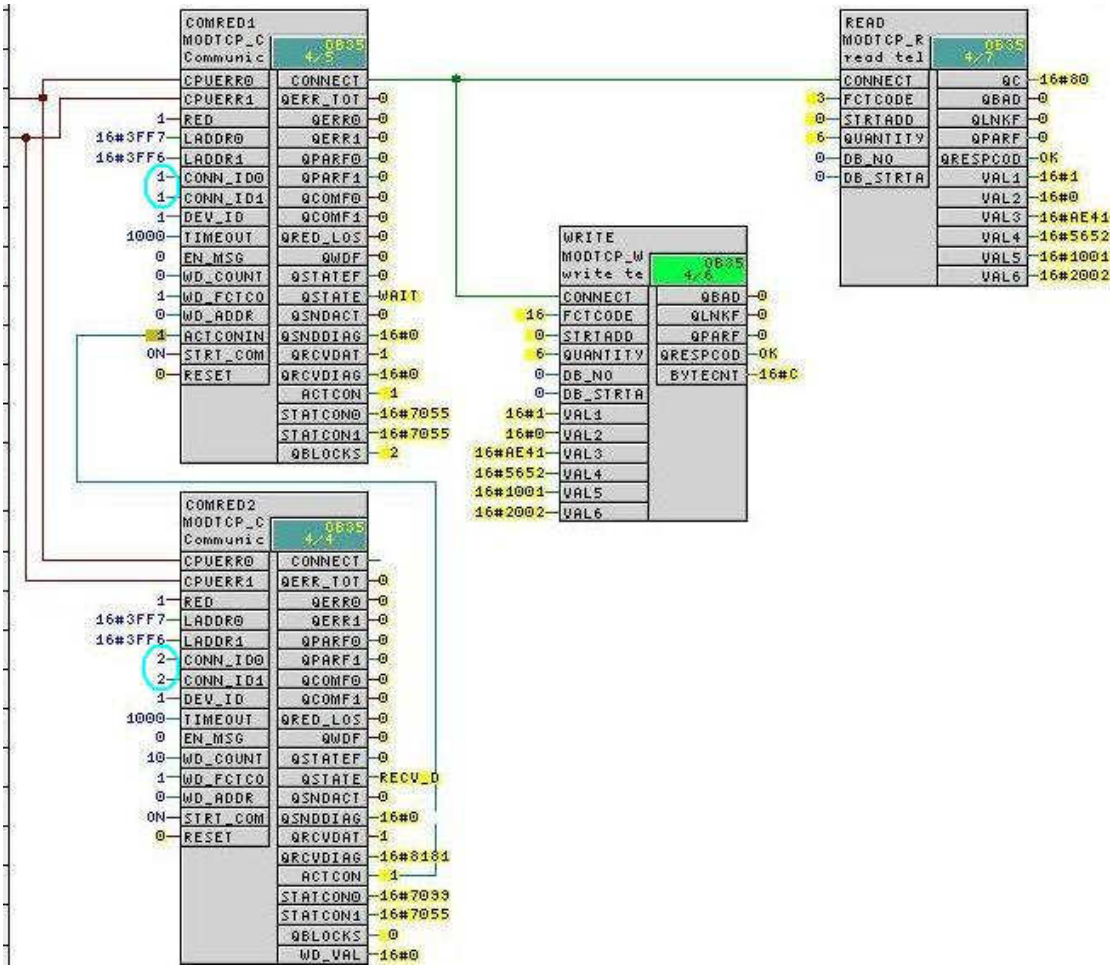
4.4 Example applications



Example 1 where 6 values from address 0 in a Modbus slave, here this corresponds to the register numbers 40001 to 40006, are written and read again.



Example 2 using an additional communication block to increase update speed (Ref. 2.5).



Example 3 - Using an additional communication block to explicitly monitor the connection with the watchdog. In case of a connection failure a connection switch over will be forced.

Attention: In example 3, with the forwarding of the ACTCON to the ACTCONIN parameter for connection switching, the same physical connections must be used for both communication blocks. Be careful in setting the LADDRx and CONN_IDx parameters. The parameters LADDRx have to be identical on both blocks as seen in this example LADDR0=16#3FF7 and LADDR1=16#3FF6. The logical connection for x=0 must start from the same CP (normally CP0). This is also valid for x=1 (normally CP1). COMRED1 handles the actual data communication using two connections. In this case they both have ID=1. COMRED2 handles only the watchdog communication using two connections with ID=2.

If you are using more than one communication block like in example 2 and 3 each block requires a separate logical connection between Modbus Master and Slave for communication (see highlighted parameters). CONN_ID0 and CONN_ID1 don’t have to be the same as in the examples.

The connections for CPUERR0 and CPUERR1 are interconnected with the outputs CPUERR_0 and CPUERR_1 of the CPU Function Blocks 'OB_BEGIN', which have been automatically inserted in a system chart via the "Generate module driver" function.

4.5 W1R_SCALE - Conversion block

Type/number FB 519

4.5.1 Function and mode of operation

This block is used for converting a 16-bit value (provided by a word) into a REAL value, taking into account a specified linear scaling. The values processed by this block are usually analog values.

The algorithm is as follows:

PV_OUT := ((HI_RANGE - LO_RANGE)*((X - MIN_RAW)* 1/(MAX_RAW-MIN_RAW)) + LO_RANGE)* FACTOR;

X stands for the input value (PV_IN) that was converted into the REAL data type.

4.5.2 Parameterizing and interconnecting

The 16-bit input value (the measured variable) is specified in **PV_IN**.
The range of the input value corresponds to the range of values of a 16-bit integer (-32768 [8000] to +32767 [7FFF]).

The limit value for the upper range of the measuring signal is specified in **HI_RANGE**.

The limit value for the lower range of the measuring signal is specified in **LO_RANGE**.

The upper limit of the measuring range is specified in **MAX_RAW**.

The lower limit of the measuring range is specified in **MIN_RAW**.

An amplification factor can be specified in **FACTOR**.

The calculated output variable (measuring signal) is output to **PV_OUT**.

The values at the input can be adapted by means of the **CHG_BYTE** switch. With CHG_BYTE = TRUE, the High byte and Low byte of the input word are interchanged.

4.5.3 Calling OBs

The calling OB is the cyclic interrupt OB3x into which you integrate the block (e.g. OB 35) and the following OB into which the block is also integrated (automatically in the CFC):

- OB100 Restart (warm restart)

4.5.4 Error handling

Possible incorrect parameterizations are indicated via **QPARF**.

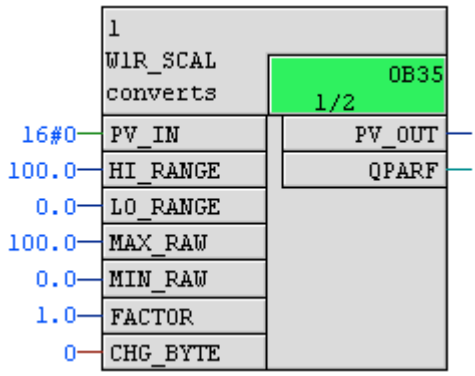
QPARF	Output	Description
0	0	No error
1	InvRange	Invalid range indicated (HI_RANGE must be greater than LO_RANGE)

QPARF	Output	Description
2	InvRawLi	Invalid limits for the raw values (MAX_RAW must be greater than MIN_RAW and MAX_RAW <= 32767.0 and MIN_RAW >= -32768.0 apply)

4.5.5 Signaling behavior

The block has no signaling behavior.

4.5.6 CFC block representation



4.5.7 Parameter list

IO	Parameter	IO type	Default	Comment
I	PV_IN	WORD	0	Input value
I	HI_RANGE	REAL	100	High range of process value
I	LO_RANGE	REAL	0	Low range of process value
I	MAX_RAW	REAL	100	Max. raw value of process value
I	MIN_RAW	REAL	0	Min. raw value of process value
I	FACTOR	REAL	1	Scaling factor
I	CHG_BYTE	BOOL	0	1: Interchange Low and High byte in PV_IN
O	PV_OUT	REAL		Process value as real
O	QPARF	INT	0	Parameter error

4.6 W2R_SCALE - conversion block

Type/number FB 520

4.6.1 Function and mode of operation

This block is used for converting a 32-bit value (comprising two words) into a REAL value, taking into account a specified linear scaling. The values processed by this block are usually analog values.

The algorithm is as follows:

PV_OUT := ((HI_RANGE - LO_RANGE)*((X - MIN_RAW)* 1/(MAX_RAW-MIN_RAW)) + LO_RANGE)* FACTOR;

X stands for the input value (comprising PV_IN1 as high word and PV_IN2 as low word) that was converted into the REAL data type.

4.6.2 Parameterizing and interconnecting

The 32-bit input value (the measured variable) is specified in **PV_IN** (as high word) and **PV_IN2** (as low word).
The range of the input value (given by the 2 words in PV_IN1 and PV_IN2) corresponds to the range of values of a 32-bit integer (-2 147 483 648 [8000 FFFF] to +2 147 483 647 [7FFF FFFF]).

The limit value for the upper range of the measuring signal is specified in **HI_RANGE**.

The limit value for the lower range of the measuring signal is specified in **LO_RANGE**.

The upper limit of the measuring range is specified in **MAX_RAW**.

The lower limit of the measuring range is specified in **MIN_RAW**.

An amplification factor can be specified in **FACTOR**.

The calculated output variable (measuring signal) is output to **PV_OUT**.

The values at the inputs can be adapted with the switches **CHG_BYTE** and **CHG_WORD**. With CHG_BYTE = TRUE, the High byte and Low byte of both input words are interchanged. With CHG_WORD = TRUE, the High word and Low word in the double word are interchanged. The double word is put together using the two words at the input. Usually the word at the PV_IN1 input is the high word and the word at the PV_IN2 input is the low word.

4.6.3 Calling OBs

The calling OB is the cyclic interrupt OB3x into which you integrate the block (e.g. OB 35) and the following OB into which the block is also integrated (automatically in the CFC):

- OB100 Restart (warm restart)

4.6.4 Error handling

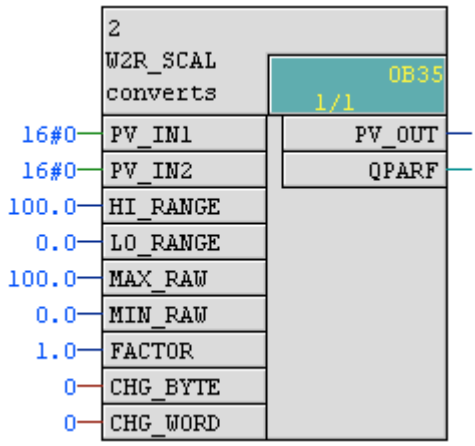
Possible incorrect parameterizations are indicated via **QPARF**.

QPARF	Output	Description
0	0	No error
1	InvRange	Invalid range indicated (HI_RANGE must be greater than LO_RANGE!)
2	InvRawLi	Invalid limits for the raw values (MAX_RAW must be greater than MIN_RAW and MAX_RAW <= 2 147 483 647.0 and MIN_RAW >= -2 147 483 648.0 apply

4.6.5 Signaling behavior

The block has no signaling behavior.

4.6.6 CFC block representation



4.6.7 Parameter list

IO	Parameter	IO type	Default	Comment
I	PV_IN1	WORD	0	Input value1 (High Word)
I	PV_IN2	WORD	0	Input value2 (Low Word)
I	HI_RANGE	REAL	100	High range of process value
I	LO_RANGE	REAL	0	Low range of process value
I	MAX_RAW	REAL	100	Max. raw value of process value
I	MIN_RAW	REAL	0	Min. raw value of process value
I	FACTOR	REAL	1	Scaling factor
I	CHG_BYTE	BOOL	0	1: Interchange Low and High byte in PV_IN1 and PV_IN2

IO	Parameter	IO type	Default	Comment
I	CHG_WORD	BYTE	0	1: Interchange High (PV_IN1) and Low Word (PV_IN2)
O	PV_OUT	REAL		Process value as real
O	QPARF	INT	0	Parameter error

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