Station Gateway

SIEMENS

Configuration and operation manual

Document version: 1.44 (19.08.2015)

Document History

Version	Description of Rev.	Date	Prepared
1.23	Adapted documentation to Station Gateway	29.11.2012	P.Hensel
1.24	Minor changes	30.11.2012	P.Hensel
1.25	Minor changes	06.12.2012	P.Hensel
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1.27	Added Command Configuration in PCS7 blocks	09.01.2013	P. Hensel
1.28	Added time settings	16.04.2013	P. Hensel
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1.33	Added TrgOp	04.03.2014	D. Khaev
1.39	Time Settings Proposal changed	25.03.2014	P. Hensel
1.44	StatCon Configuration Tool	25.03.2015	P. Hensel

Table of Contents

1 Overview

The Station Gateway connects IEC 61850 devices from different vendors to the PCS7 system.

There are two basic interfaces: The IEC 61850 interface is connected to the Ethernet network with the protection relays using the protocol IEC 61850. The S7-Interface is connected to the PCS7 Controllers via the PCS7 plant bus Industrial Ethernet. On both Ethernet networks the IP protocol is used with fixed IP addresses for the communication partners.

Note: For IEC 61850 communication, MMS telegrams based on TCP/IP stack are used. The Station Gateway does not support IEC 61850 GOOSE or Sampled Values. So there are no special Ethernet switches required for the communication of the Gateway.

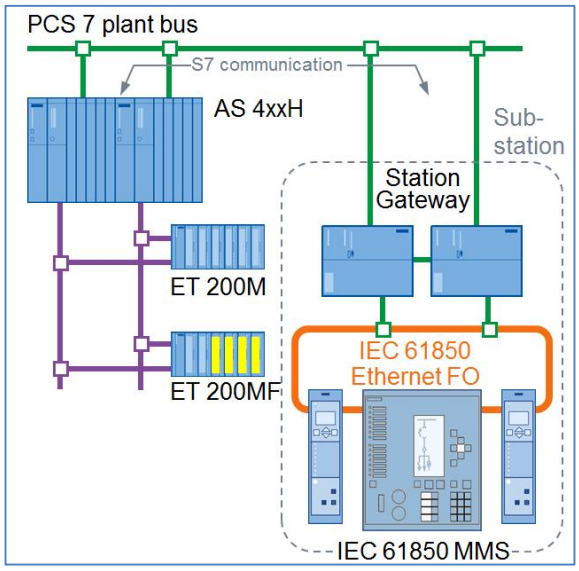


Image 1: Overview Station Gateway

The following transfer procedures are supported:

- Messages/Alarms with timestamp via IEC61850 reporting
  The Station Gateway buffers messages with timestamp from the protection relays and transfers them via a PCS7 Controller to the alarm system of the PCS 7 Operator Station. This is done by the SFB ALARM_8P.

- Cyclic Data
  Different types of data are transferred cyclically from the protection relays to outputs of special function blocks in a PCS7 automation station. The data types in PCS7 are: BOOL, REAL, INT, DINT(or bit string with 32 bits). The scan time is one second or greater.

- Commands
  Binary commands are transferred from inputs of special function blocks in a PCS7 automation station to the designated protection relays.

1.1 Product MLFBs

This document applies to the following products:

Product description	MLFB
Station Gateway (single device)	9AE4100-1EC00
Station Gateway (redundant pair)	9AE4100-1EC10

1.2 Configuration

The configuration for the Station Gateway contains only the local IP addresses of the Station Gateway itself in the connected networks and some IEC specific settings.

These communication settings of the Station Gateway can be configured either via the StatCon configuration tool or via linux command shell.

After the IP configuration which requires a restart, the Station Gateway can operate online, while new connections between protection relays and PCS7 are added and established. All specific parameters for the communication between the protection relays and PCS7 are located in the PCS7 automation system. They are configured and saved in the PCS7 engineering system and can be changed there easily.

1.3 Redundancy

In redundant mode, the gateways are working as two IEC 61850 clients with separate connections. The function block for a protection relay in the PCS7 station automatically coordinates the redundant Station Gateways. To setup a redundancy connection, each Station Gateway needs to know its partners IP address. If a redundant Station Gateway pair is ordered, the Extension Module EM-PC (2x) is included in the package.

A separate network connection via the EM-PC is recommended for redundancy.

The redundant Station Gateways are independent clients of a protection relay. The data of a protection relay is not transferred between the redundant Station Gateways. Only a few internal data, like the current time, for coordination are exchanged via the redundancy connection. Both Station Gateways are receiving data from each protection relay at the same time. But only one Station Gateway transfers the data to the PCS7 station and only one Station Gateways writes commands into the appointed protection relay. The data transfer to the PCS7 station and to the protection relay is not necessarily concentrated in one Station Gateway for all protection relays. Each Station Gateway may transfer the data of some protection relays. The role of a Station Gateway for a protection relay is managed in the PCS7 station by the function block for this protection relay.

If redundancy is projected the LED U3 lights up. U2 lights up, if the partner could not be reached.

1.4 Environment in PCS7

S7 400 / S7 400 H

The Station Gateway is designed for automation stations S7-400 and S7-400H.

BSEND and BRCV

The PCS7 function blocks for the communication with the Station Gateway are using the system function blocks BSEND and BRCV in the S7 CPU. They are built in in each S7-400 CPU module.

Safety program

The communication blocks cannot be located inside a safety program. Signals from a safety program and commands into a safety program must be transformed before they are exchanged between a safety program and a standard program in the PCS7 CPU.

SFC

SFC programs in PCS7 are not supported. Signals from a SFC program and commands into a SFC program must be transferred by additional software for the CFC chart, where the communication blocks are placed.

2 Hardware

2.1 Interfaces and fitting dimensions

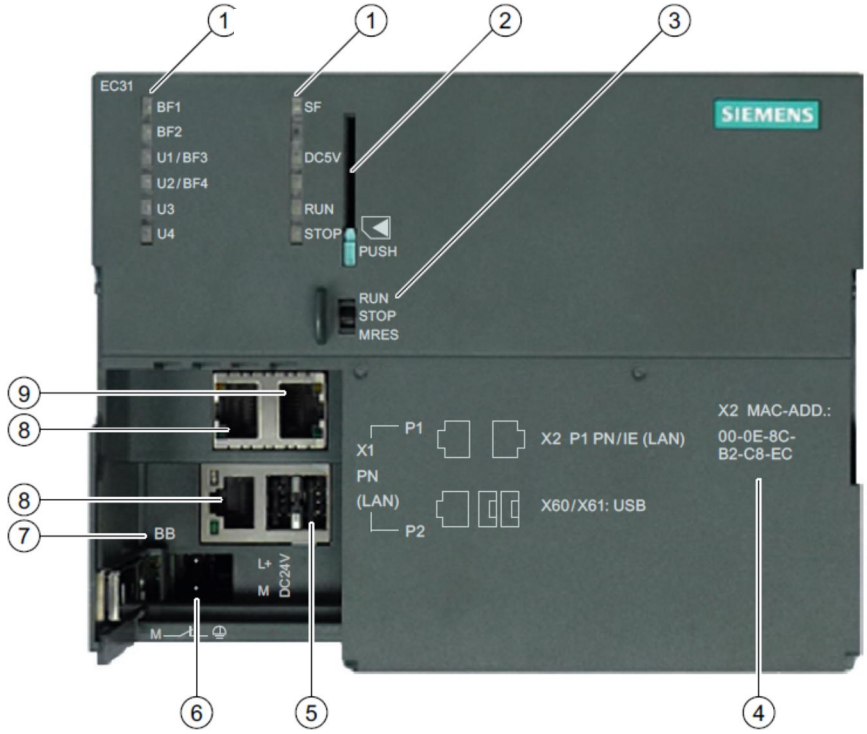


Image 2: Front view of main module

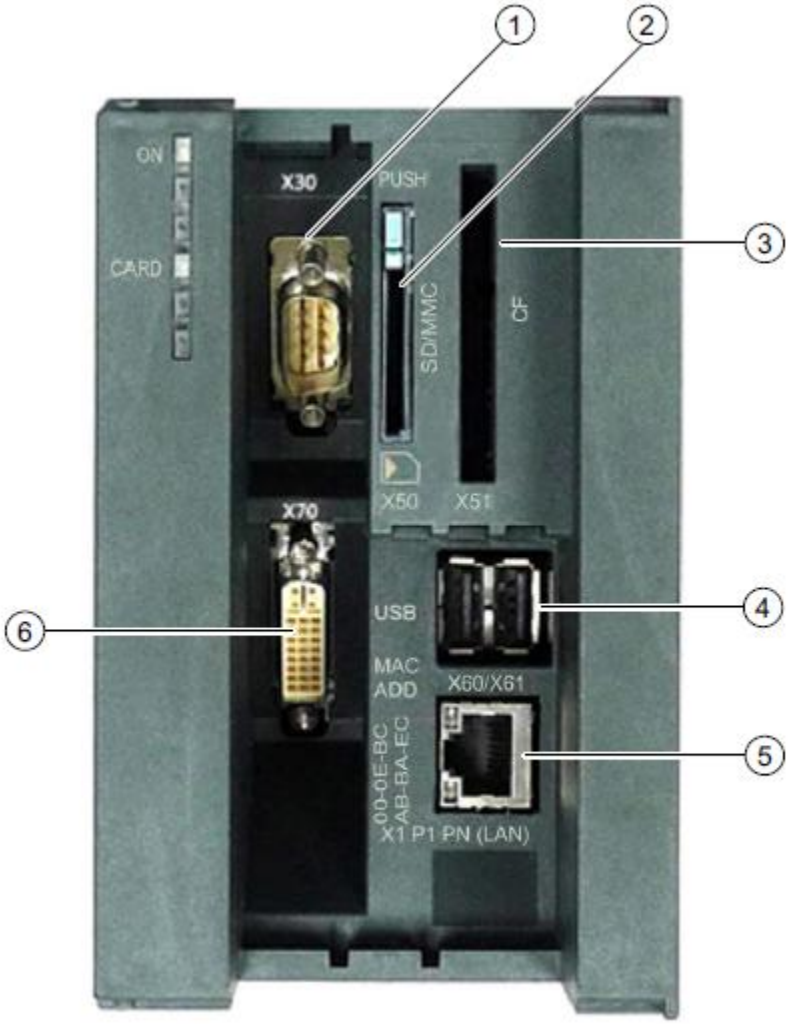
Dimensions

Width:	160mm
Height:	125mm
Depth	115mm

Interfaces

No	Element
1	LED display
2	Slot fort the Multi Media Card, including the ejector (not used)
3	Mode selector switch (not used)
4	MAC address of the standard Ethernet controller (X2 IEC Interface)
5	USB 2.0 ports
6	Power supply connection
7	Product variant identification (N/A)
8	Ethernet Connection 1 (lower port not in use, upper port used for connection to S7 network)
9	Ethernet Connection 2 (used for IEC-Connections)

The redundant Station Gateway pair comes with EM-PC Extension modules, which have to be plugged in on the left side of the EC31.



Dimensions:

Width: 80mm

Height: 125mm

Depth 115mm

Interfaces:

No	Element
1	COM Port (not in use)
2	Slot for SD card (not in use)
3	Slot for CF card (not in use)
4	USB 2.0 ports
5	Gigabit LAN port (used for redundancy)
6	DVI-port (can be used for local console)

2.2 General Technical Data

The general technical data of the base hardware EC31 are also valid for the Station Gateway.

Please refer to the corresponding information provided in the equipment manual for the EC 31 devices.

In deviation to S7-300 the Station gateway can only operate from 0-50°C and only in horizontal mounting position.

For additional information refer to the S7-mEC operation manual.

2.3 Power supply

A power supply from 20,4V to 28,8V is possible, 24V are recommended. Power losses shorter than 5ms can be sustained.

2.4 Interruption of the power supply

The flash memory is write-protected during normal operation. The write-protection is only temporarily disabled while the configuration. The write protection ensures that after switching off the power supply, the Station Gateway will properly restart again with untouched system data.

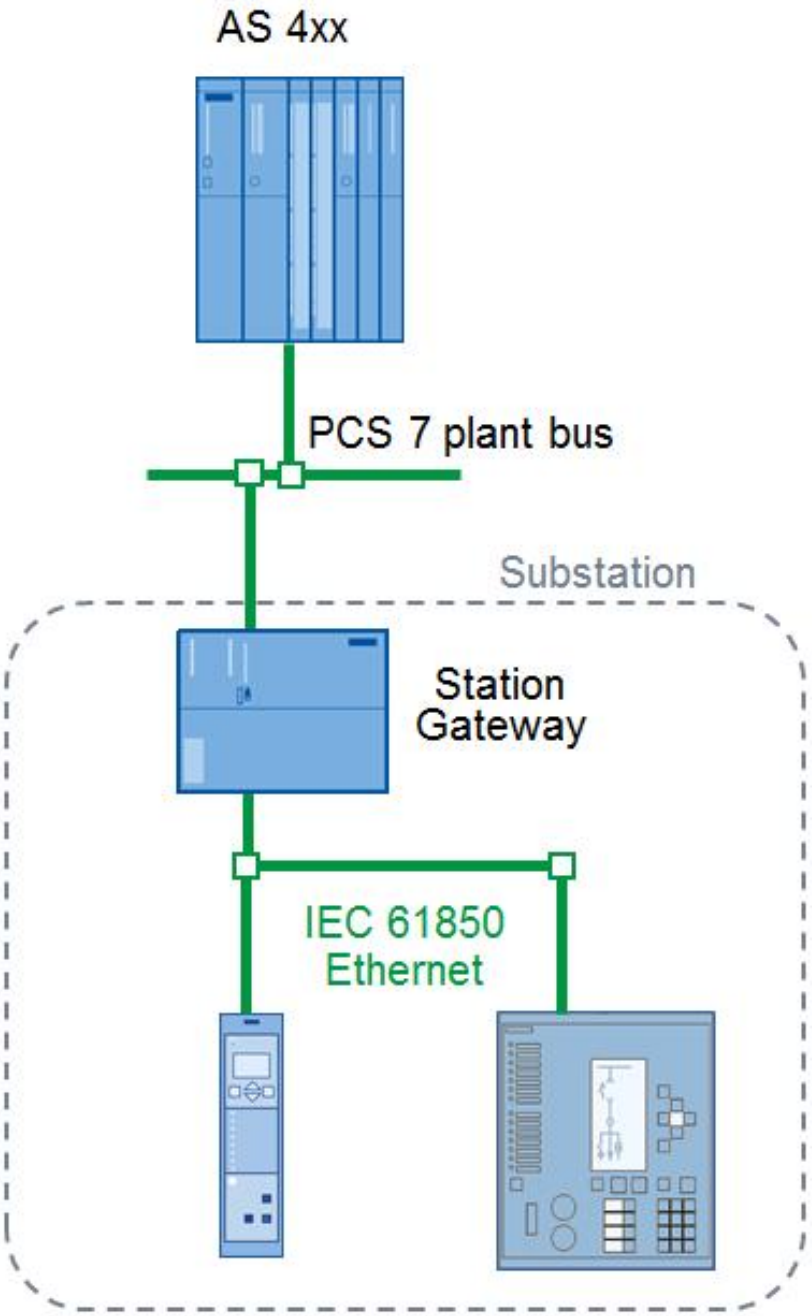
2.5 LED Assignment

LED	Action	Description
RUN	green continuous lighting	Gateway up and running
RUN	green flashing	Command flash via STEP7 (N/A)
STOP	green flashing	Command flash via STEP7 (N/A)
DC5V		Not used
SF	red continuous lighting	Critical Configuration error
BF1	red continuous lighting	No S7 Connections active
BF2	red continuous lighting	One or more IEDs could not be reached
BF2	Red flashing	One or more IEDs are initiated
U1		Not used
U2	red continuous lighting	No connection to redundancy partner
U3	Yellow continuous lighting	Redundancy configured
U3	Dark	No Redundancy projected
U4	Green flashing	Gateway is booting

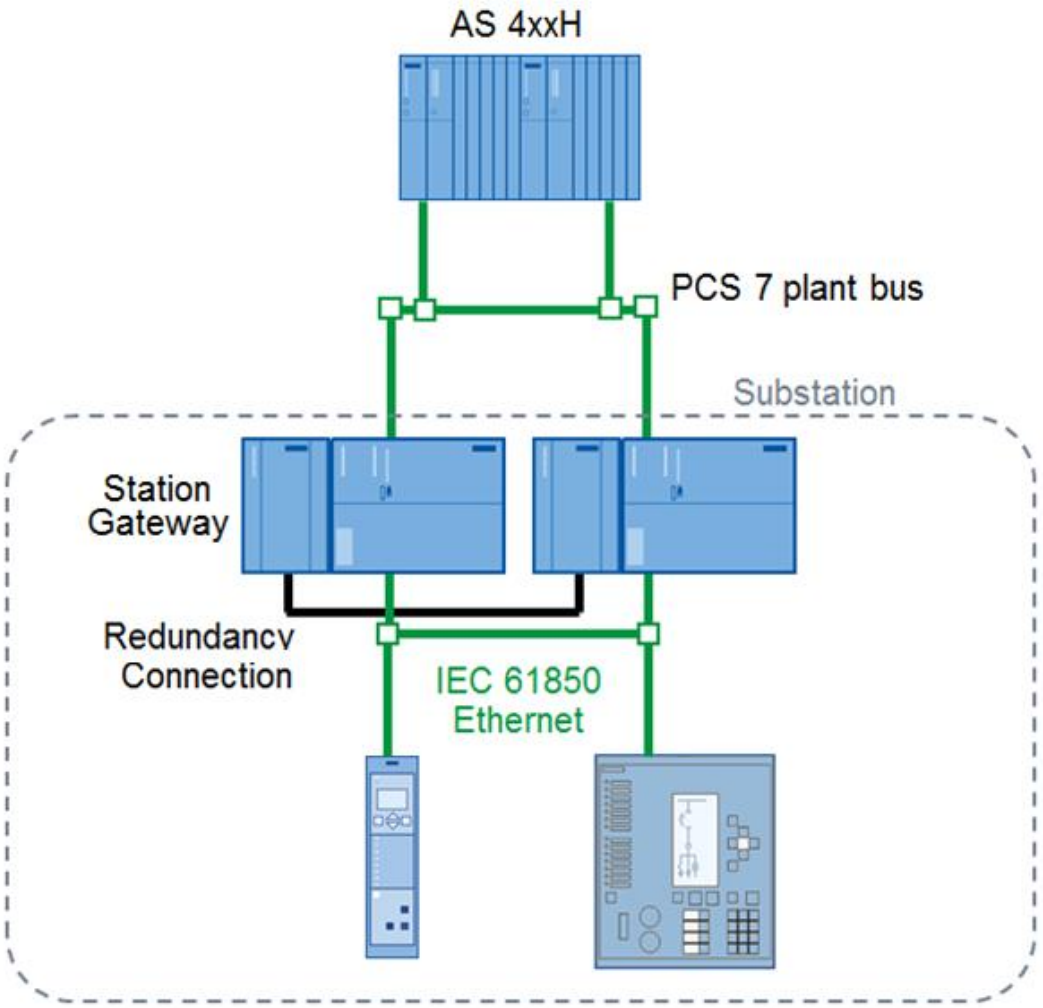
Note: The LEDs do not change while the Gateway is shutting down!

3 Network Layout

Typical layout Single Station Gateway:

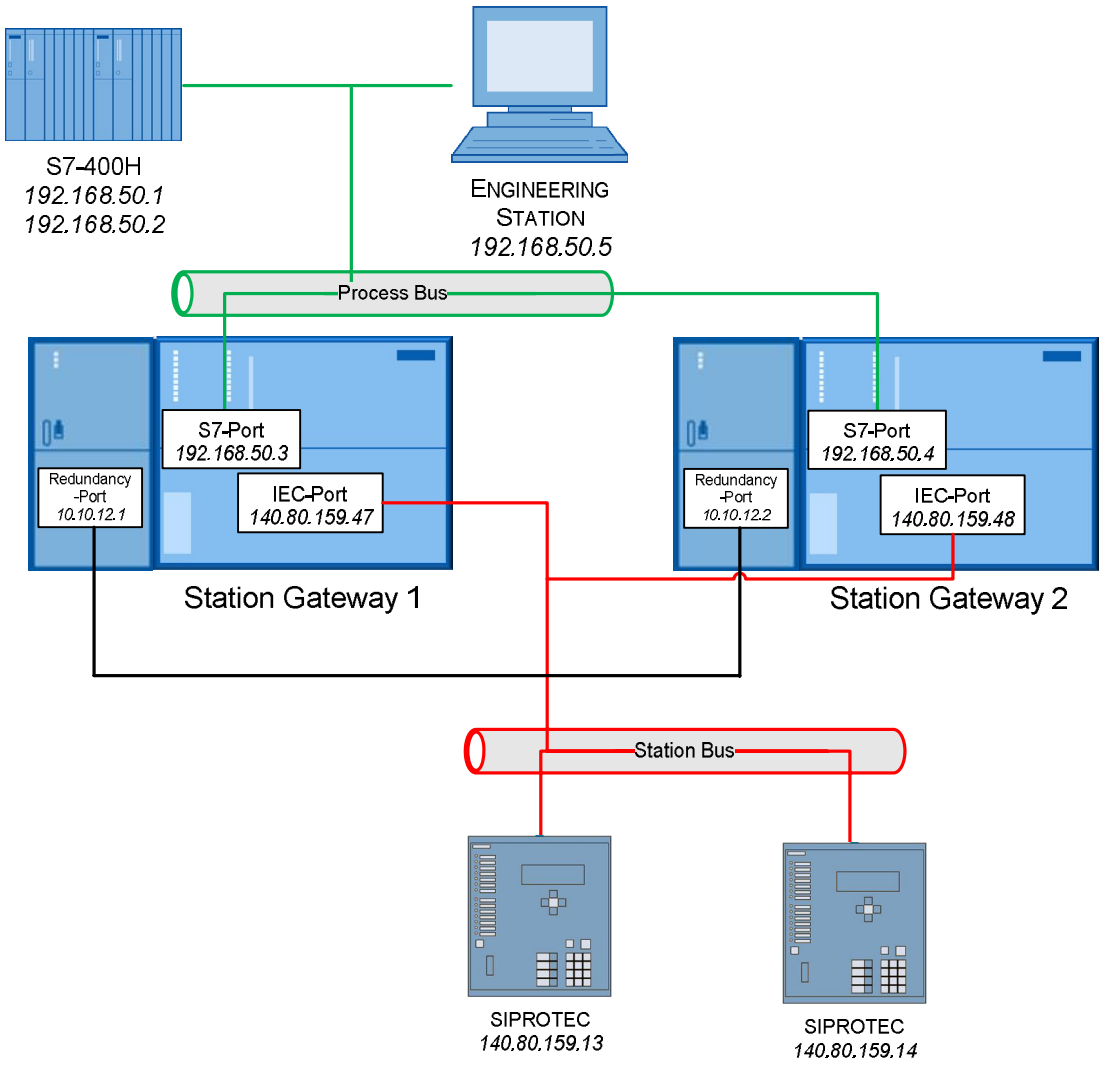


Typical layout redundant Station Gateway pair:



Note: Station Gateway works properly only with setting **Auto Negotiation** on the switch or other network communication device.

3.1 Redundancy Configuration with module EM-PC (recommended)



3.1.1 Shell commands (if StatCon is not used)

Station Gateway 1

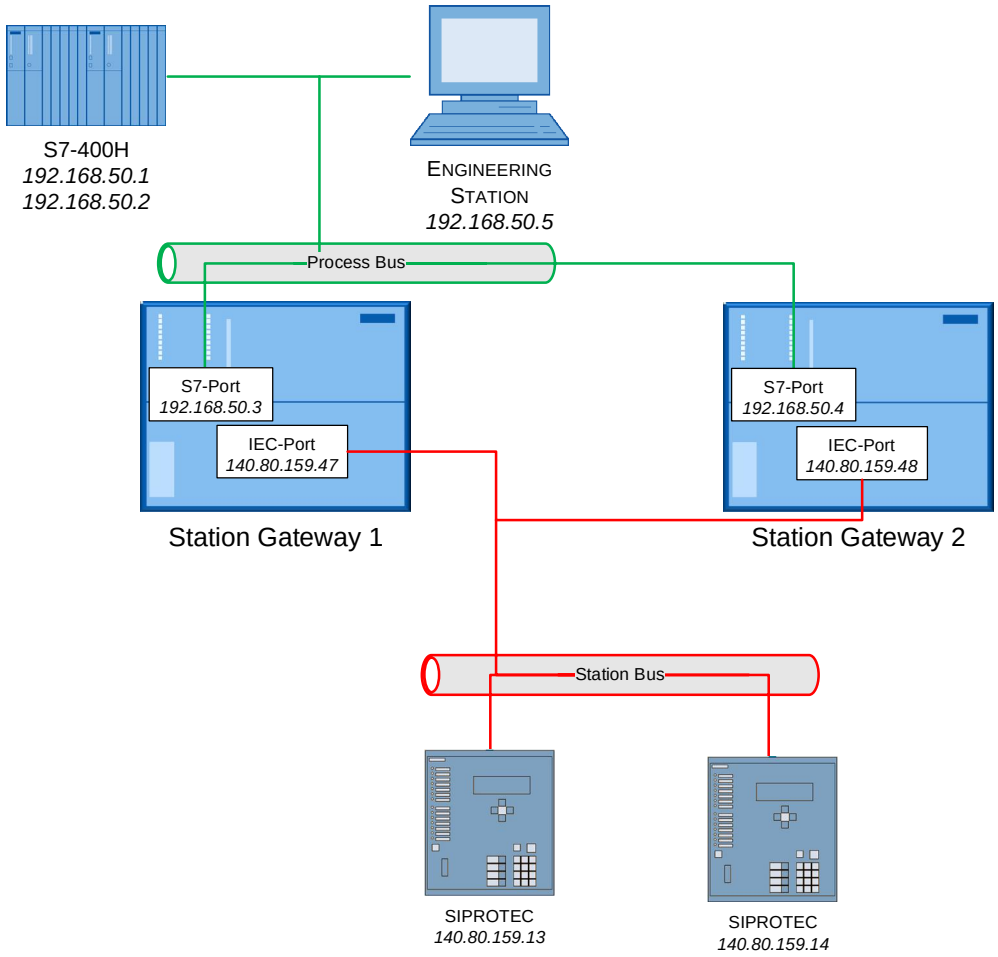
```
login as: config
config@192.168.50.3's password: config
Linux debianmec 2.6.32-5-686 #1 SMP Sun Sep 23 09:49:36 UTC 2012 i686

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
config@debianmec:~$ sudo config.sh
Please enter new ip for IEC-port!
140.80.159.47
Please enter subnet mask for IEC-port!
255.255.0.0
Please enter gateway for IEC-Port! (press enter for none)

Please enter new IP for S7-port!
192.168.50.3
Please enter subnet mask for S7-port!
255.255.255.0
Please enter gateway for S7-Port! (press enter for none)

Set trigger options? (Say no if you don't know what is it) y/N
N
Is redundancy needed? y/N
y
Please enter new IP for redundancy Port!
10.10.12.1
Please enter Redundancy-IP for partner Gateway!
10.10.12.2
################################################################################
Station Gateway is rebooted! Press Ctrl+C to break the reboot or ENTER to
reboot...
################################################################################
```

Station Gateway 2

```
login as: config
config@192.168.50.3's password: config
Linux debianmec 2.6.32-5-686 #1 SMP Sun Sep 23 09:49:36 UTC 2012 i686

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
config@debianmec:~$ sudo config.sh
Please enter new ip for IEC-port!
140.80.159.48
Please enter subnet mask for IEC-port!
255.255.0.0
Please enter gateway for IEC-Port! (press enter for none)

Please enter new IP for S7-port!
192.168.50.4
Please enter subnet mask for S7-port!
255.255.255.0
Please enter gateway for S7-Port! (press enter for none)

Set trigger options? (Say no if you don't know what is it) y/N
N
Is redundancy needed? y/N
y
Please enter new IP for redundancy Port (or type enter for connection via S7)!
10.10.12.2
Please enter Redundancy-IP for partner Gateway!
10.10.12.1
################################################################################
Station Gateway is rebooted! Press Ctrl+C to break the reboot or ENTER to
reboot...
################################################################################
```

3.2 Redundancy Configuration without module EM-PC

In this configuration, the redundancy is handled via the S7-Port. So the own Redundancy IP address has to be left blank.



3.2.1 Shell commands (if StatCon is not used)

Station Gateway 1

```
login as: config
config@192.168.50.3's password: config
Linux debianmec 2.6.32-5-686 #1 SMP Sun Sep 23 09:49:36 UTC 2012 i686

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Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
config@debianmec:~$ sudo config.sh
Please enter new ip for IEC-port!
140.80.159.47
Please enter subnet mask for IEC-port!
255.255.0.0
Please enter gateway for IEC-Port! (press enter for none)

Please enter new IP for S7-port!
192.168.50.3
Please enter subnet mask for S7-port!
255.255.255.0
Please enter gateway for S7-Port! (press enter for none)

Set trigger options? (Say no if you don't know what is it) y/N
N
Is redundancy needed? y/N
y
Please enter new IP for redundancy Port (or type enter for connection via S7)!

Please enter Redundancy-IP for partner Gateway!
192.168.50.4
################################################################################
Station Gateway is rebooted! Press Ctrl+C to break the reboot or ENTER to
reboot...
################################################################################
```

Station Gateway 2

```
login as: config
config@192.168.50.3's password: config
Linux debianmec 2.6.32-5-686 #1 SMP Sun Sep 23 09:49:36 UTC 2012 i686

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
config@debianmec:~$ sudo config.sh
Please enter new ip for IEC-port!
140.80.159.48
Please enter subnet mask for IEC-port!
255.255.0.0
Please enter gateway for IEC-Port! (press enter for none)

Please enter new IP for S7-port!
192.168.50.4
Please enter subnet mask for S7-port!
255.255.255.0
Please enter gateway for S7-Port! (press enter for none)

Set trigger options? (Say no if you don't know what is it) y/N
N
Is redundancy needed? y/N
y
Please enter new IP for redundancy Port!

Please enter Redundancy-IP for partner Gateway!
192.168.50.3
################################################################################
Station Gateway is rebooted! Press Ctrl+C to break the reboot or ENTER to
reboot...
################################################################################
```

4 Configuration

4.1 Communication settings

The configuration of all basic communication settings can be done either with the StatCon Configuration Tool (recommended) or via linux shell commands.

4.1.1 Configuration via StatCon Tool(recommended)

The first step is to assign the IP-address of the S7-interface. This can be done via “Online”/”Accessible devices”. After this, this IP address can be used for downloading the other settings.

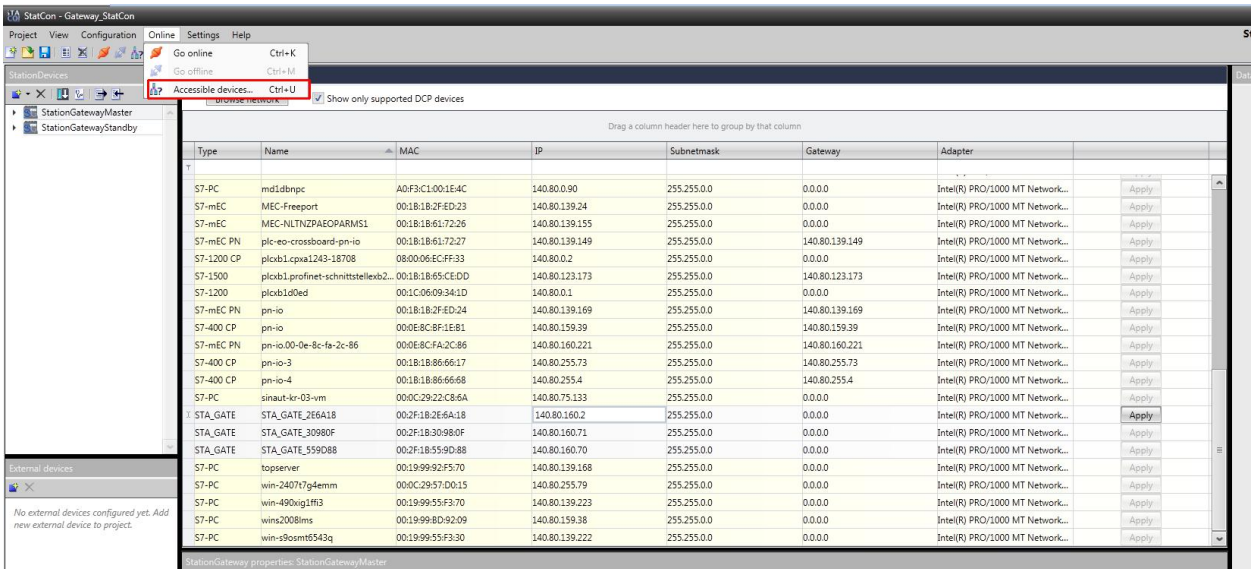


Image 3: Accessible devices

The settings of the Station Gateway can be configured within the property window of the Gateway device. The general handling of the StatCon Tool is described in the separate StatCon manual.

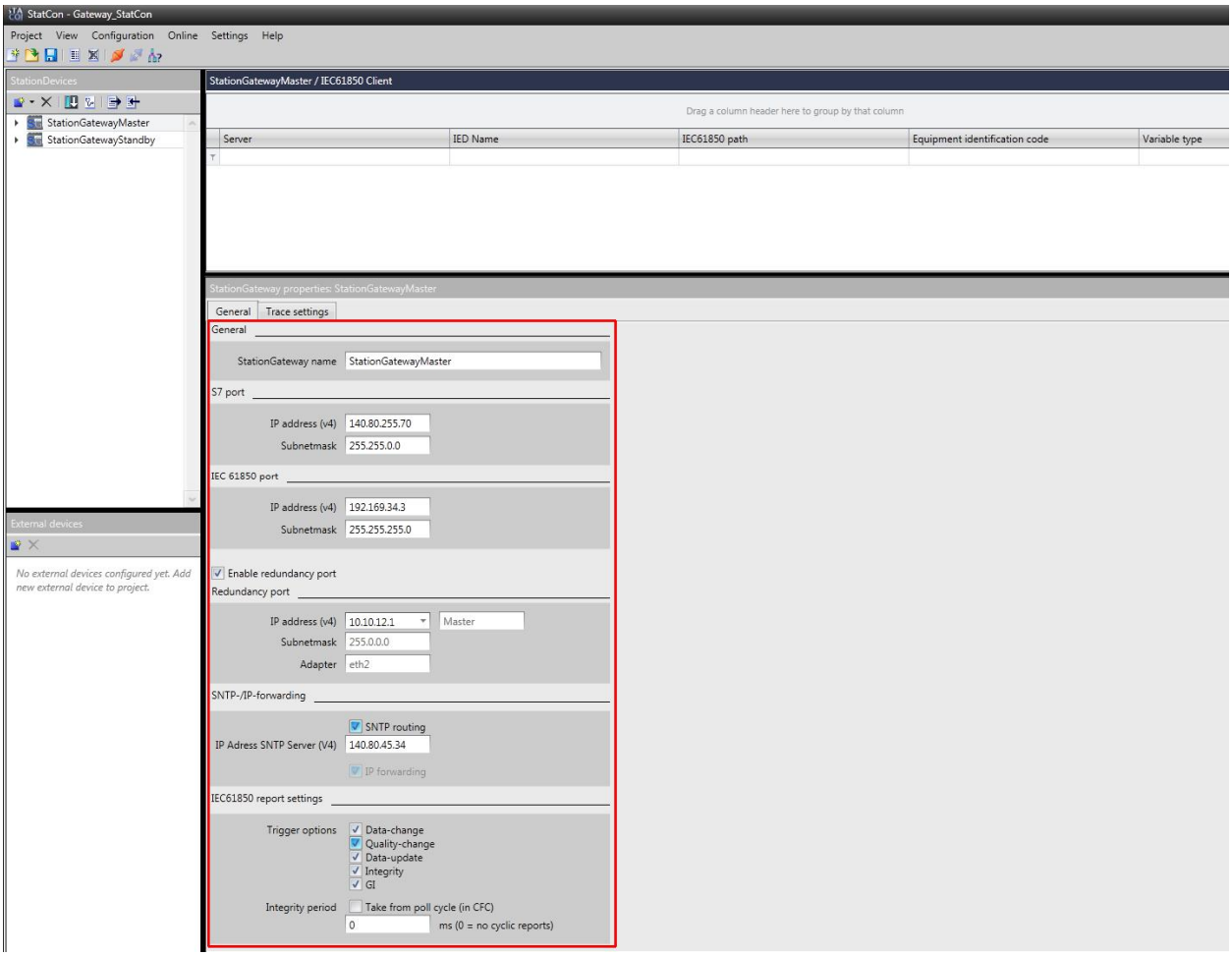


Image 4: Station Gateway property window

After configuration, all settings have to be downloaded to the Gateway.

4.1.2 Configuration via linux shell

There are two ways to access the Station Gateway with shell commands, which can be used to set the parameters in the configuration file.

1. Local display and keyboard plugged in the EM PC (only redundant Station Gateway).
   Note: the display has to be plugged in before power on!
2. Remote access via SSH (e.g. PuTTY) to any of the Station Gateways IP addresses.

If no EM-PC is available and the current IP-address of the Station Gateway is unknown or has to be changed to reach the device, the IP-address of the S7-Interface can also be changed via STEP 7 or StatCon Tool.
To do so, open “Edit Ethernet Node...” in SIMATIC Manager. Browse for your Station gateway (STA_GATEXX_XX) and change the IP address.
Afterwards you can connect via ssh using the configured address.

If a local display or a Remote Terminal is connected you are prompted to log into the Station Gateway. The Login name and the associated password both are "*config*“.

Gateway login: **config**

Password: **config** (The password does not appear on the screen)

To change the configuration, the command ***“sudo config.sh”*** *has to be used.*
The script will ask for new IP addresses and subnet masks for the IEC and S7-Ports and the redundancy port if applicable.
The default gateway should be left blank.

If the interfaces are connected to physically separated networks, it is necessary to assign IP addresses in different subnets to each interface.

Examples can be found in the appendix.

4.1.3 Default IP addresses

The default IP-addresses are:

Interface	IP-Address (single or first redundant)	IP-Address (second redundant)	Subnet mask
X1 (S7-Port)	192.168.50.3	192.168.50.4	255.255.255.0
X2 (IEC-Port)	140.80.159.47	140.80.159.48	255.255.0.0
X1 P1 PN EM-PC (Redundancy Port)	10.10.12.1	10.10.12.2	255.0.0.0

4.1.4 Trigger options

If you use IEC devices with limited support of trigger options (e.g. ABB REF615 does not support trigger option “data-update”) you can specify the trigger options in StatCon or with the shell command configuration script. If the Shell is used,all settings must be done anew.

Example StatCon:

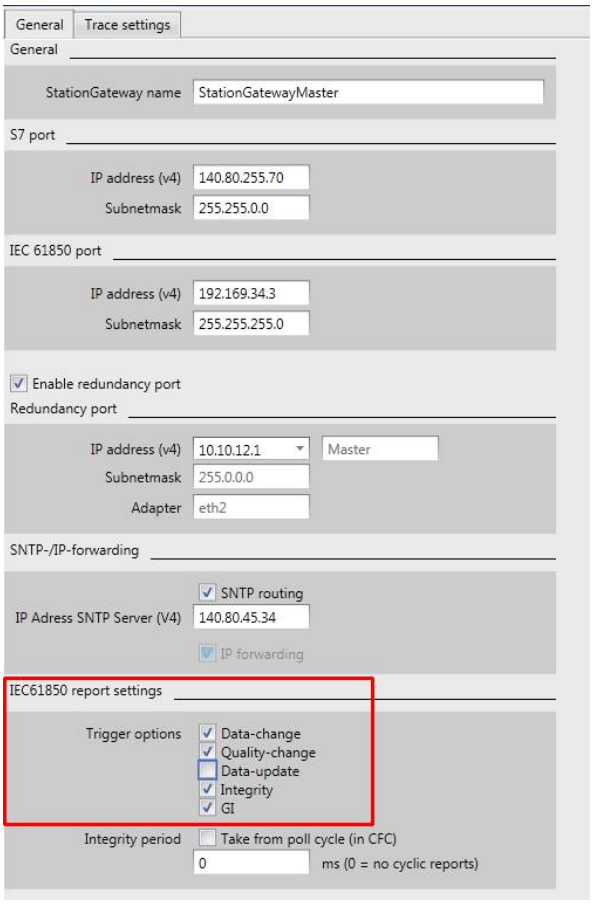


Image 5: Trigger options StatCon

Example Shell:

Following commands should be executed on Station Gateway

```
login as: config
config@192.168.50.3's password: config
Linux debianmec 2.6.32-5-686 #1 SMP Sun Sep 23 09:49:36 UTC 2012 i686

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
config@debianmec:~$ sudo config.sh
Please enter new ip for IEC-port!
```

```
140.80.159.48
Please enter subnet mask for IEC-port!
255.255.0.0
Please enter gateway for IEC-Port! (press enter for none)

Please enter new IP for S7-port!
192.168.50.4
Please enter subnet mask for S7-port!
255.255.255.0
Please enter gateway for S7-Port! (press enter for none)

Set trigger options? (Say no if you don't know what is it) y/N
Y
Please enter hex trigger options (0x7C - all options, 0x6C - without data-
update):
0x6c
Is redundancy needed? y/N
N
Is EM PC installed? y/N
N
################################################################################
Station Gateway is rebooted! Press Ctrl+C to break the reboot or ENTER to
reboot...
################################################################################
```

You can use following combination of bits to define the trigger options:

Value	Name
0x80	reserved
0x40	data-change
0x20	quality-change
0x10	data-update
0x08	integrity
0x04	general interrogation

E.g. trigger options without data-update have value 0x6c.

4.1.5 Second S7 Ethernet interface

You can use Expansion Module EM-PC (MLFB - 6ES7677-1DD50-2AA0) to enable second S7 interface on the Station Gateway.

To setup IP address for this interface you should execute configuration script:

Following commands should be executed on Station Gateway

```
login as: config
config@192.168.50.3's password: config
Linux debianmec 2.6.32-5-686 #1 SMP Sun Sep 23 09:49:36 UTC 2012 i686
```

```
The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
config@debianmec:~$ sudo config.sh
Please enter new ip for IEC-port!
140.80.159.48
Please enter subnet mask for IEC-port!
255.255.0.0
Please enter gateway for IEC-Port! (press enter for none)

Please enter new IP for S7-port!
192.168.50.4
Please enter subnet mask for S7-port!
255.255.255.0
Please enter gateway for S7-Port! (press enter for none)

Set trigger options? (Say no if you don't know what is it) y/N
N
Is redundancy needed? y/N
N
Is EM PC installed? y/N
Y
Please enter new IP for the second S7-Interface:
192.168.60.4
Please enter subnet mask for the second S7-Interface:
255.255.255.0
Please enter default gateway for the second S7-Interface (leave empty if
none):

Gateway is not used for the second S7-Interface
################################################################################
Station Gateway is rebooted! Press Ctrl+C to break the reboot or ENTER to
reboot...
################################################################################
```

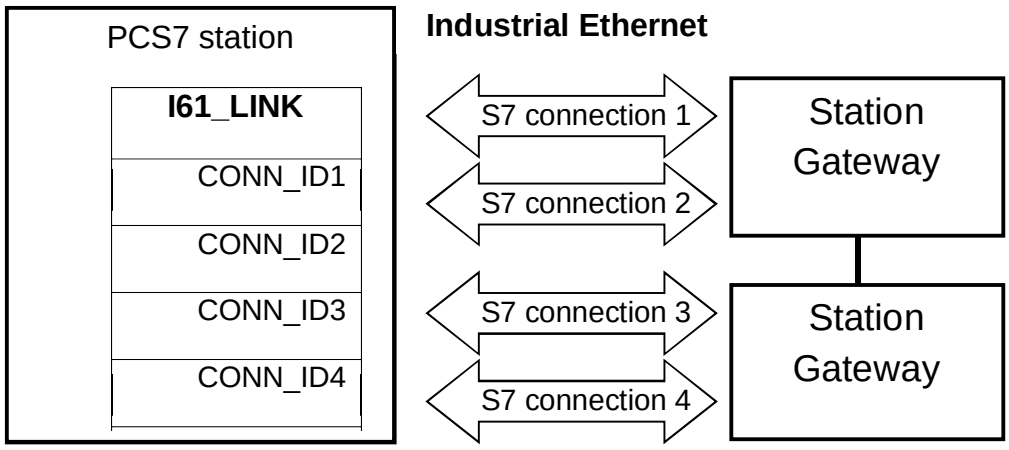
4.2 Configuration of S7-Connections

4.2.1 Settings in NetPro

The communication partners (CPU and Station Gateway) are participants of the common Ethernet network and have fixed IP addresses.

In the Station Gateway only the IP address must be defined for the communication with the S7 CPU. All other communication parameters for a S7 connection are engineered in the PCS7 system, especially in the PCS7 software tool NetPro. The PCS7 station establishes an S7 connection to the Station Gateway.

Then the function block I61_LINK starts the communication sending a BSEND telegram. The function block I61_LINK uses the S7 connections engineered with NetPro.



The complete engineering of a connection between the PCS7 station and the Station Gateway is located in the PCS7 software tool NetPro. Only the corresponding IP address of the Station Gateway must be entered in NetPro as the end point of a S7 connection.

The Parameters in PCS7 NetPro

for each connection to a Station Gateway

Fixed parameters

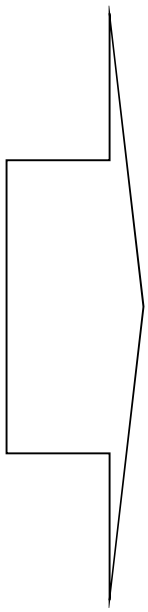
- S7 connection
- unspecified partner
- active role in the PCS7 station
- TCP/IP used

Specific parameters

- Via a CP443-1 card of the PCS7 Station
- IP address of the used Station Gateway interface

Arbitrary parameters (set by NetPro automatically)

- RTSAP and LTSAP



The Station Gateway accepts each request for a connection from the PCS7 station. The Station Gateway needs no connection parameters from PCS7.

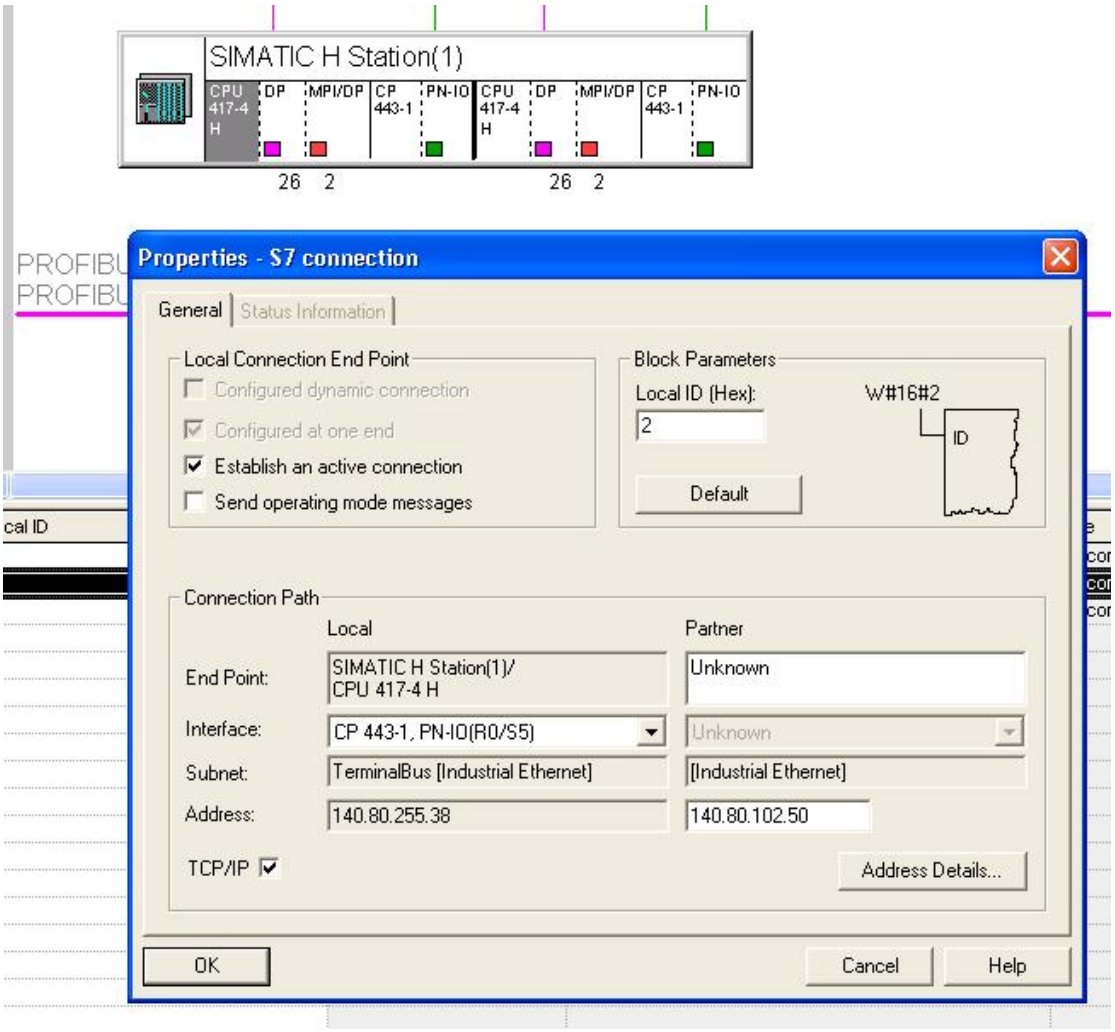
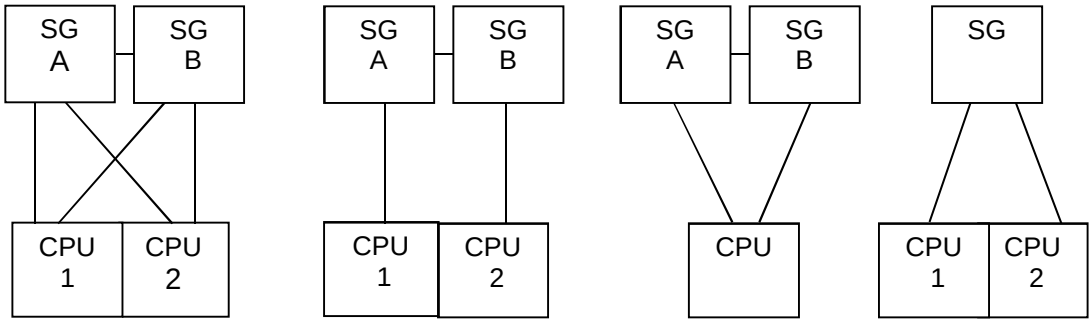


Image 6 : Parameter for a connection to the Station Gateway in the engineering tool NetPro

4.2.2 Redundancy

The function blocks are running in single and in redundant systems according to the redundancy functions of the host system PCS7. The function block I61_LINK manages the redundant communication with up to four S7 connections. Each S7 connection is engineered as a single connection. All S7 connections together constitute a redundant connection. For a redundant Station Gateway pair at least two S7 connections with one I61_LINK block must be engineered.

Several redundancy configurations are possible.



Each S7 connection is watched with live sign telegrams from both systems. One S7 connection is sufficient for the complete data transfer in both directions. If two S7 connections are available, one S7 connection (via one CP443-1 card) is dedicated for sending data only and the other S7 connection (via the other CP443-1 card) for receiving data only.

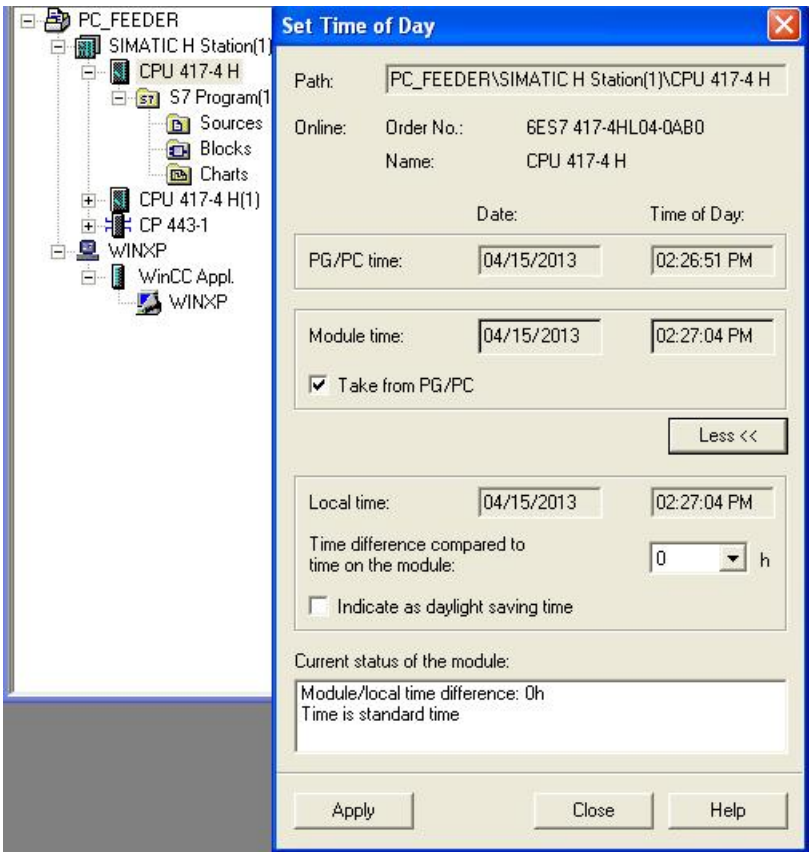
The data transfer is switched over to another S7 connection to the same Station Gateway, after a data package is not acknowledged by the receiver.

4.3 Time settings

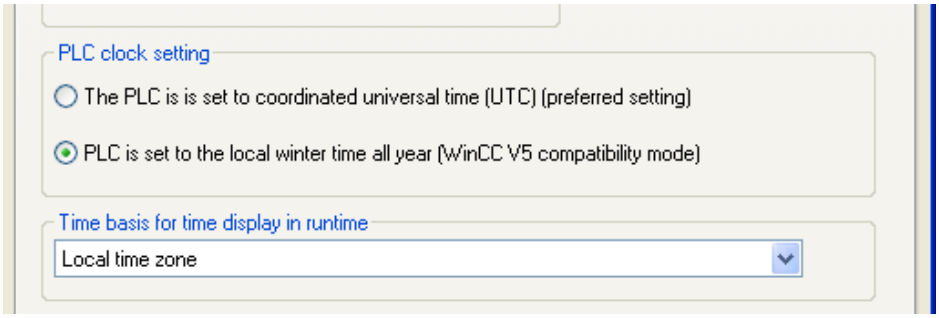
Siemens Siprotec devices can be configured to use the local time on the display. However, the timestamps sent via IEC 61850 are UTC time. Since the standard time setting of a PCS 7 PLC is also UTC time, no changes have to be made in this case.

However, if the protection devices are sending the IEC 61850 time stamps in local time format, we recommend the following settings in the PCS 7 system:

Configure the S7-400 Controller to run also in local time zone:



Adjust the settings in WinCC (Computer/Properties/Parameters):



With these settings, the messages created in the PLC and in the SIPROTEC are displayed with the correct timestamp in WinCC alarm display.

4.4 SNTP Routing

It is possible to allow time synchronization of protection devices with any SNTP server through the Station Gateway. This can be configured via StatCon or via shell commands.

Note: The system time of the Station Gateway cannot be synchronized. However, this time is not used since the timestamps from the IEC 61850 devices are used.

Example StatCon:

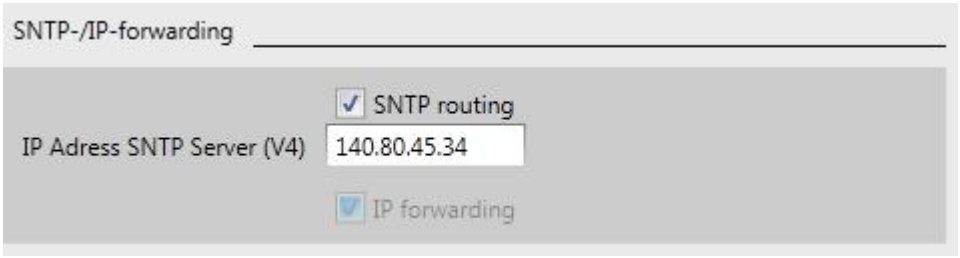


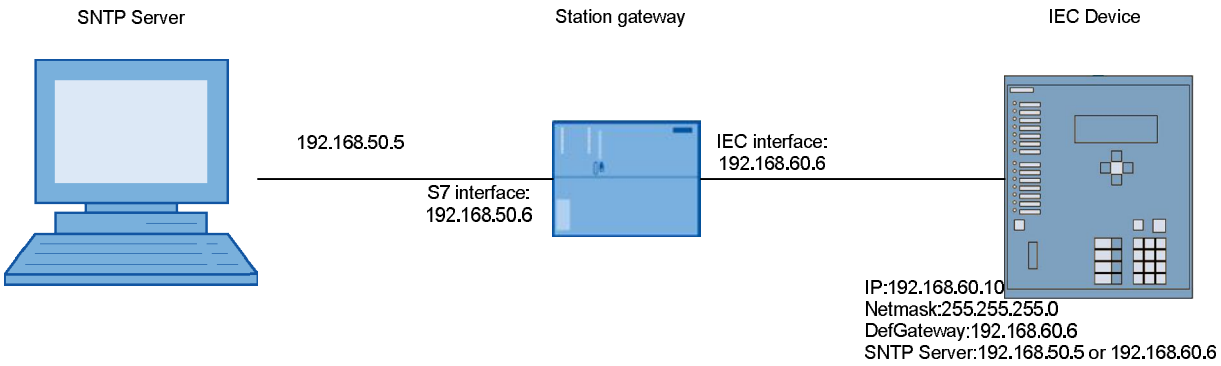
Image 7: SNTP settings StatCon

Example Shell commands:

Following commands should be executed on Station Gateway (the commands itself is marked ***bold***)

To show possible options
 	
`config@debianmec:~$ ***sudo SNTP_route***`
`usage: sudo SNTP_route ip_address_sntp_server`
`ip_address_sntp_server = time synchronization with respective SNTP server`
`NONE = disable time synchronization`
 	
To enable SNTP routing
 	
`config@debianmec:~$ ***sudo SNTP_route <IP-Adress of SNTP server>***`
`SNTP IP-forwarding has been enabled`
 	
To disable SNTP routing
 	
`config@debianmec:~$ ***sudo SNTP_route NONE***`
`SNTP IP-forwarding has been disabled`

Example:



To enable SNTP routing with the addresses in the example above, the command

“sudo SNTP_route 192.168.50.5” has to executed.

4.5 IP forwarding

It is also possible to open the gateway for forwarding of IP packets.

Note: If SNTP routing is on, so the IP routing is enabled automatically.

Example StatCon:

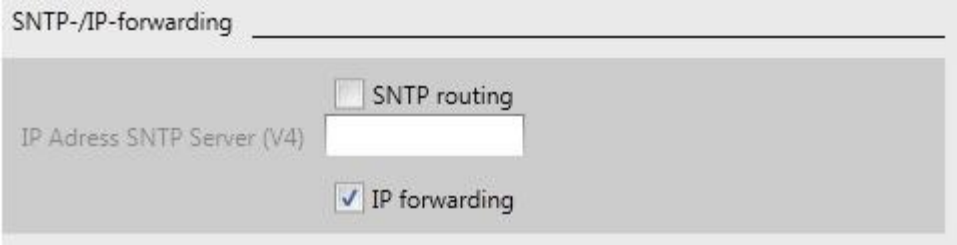


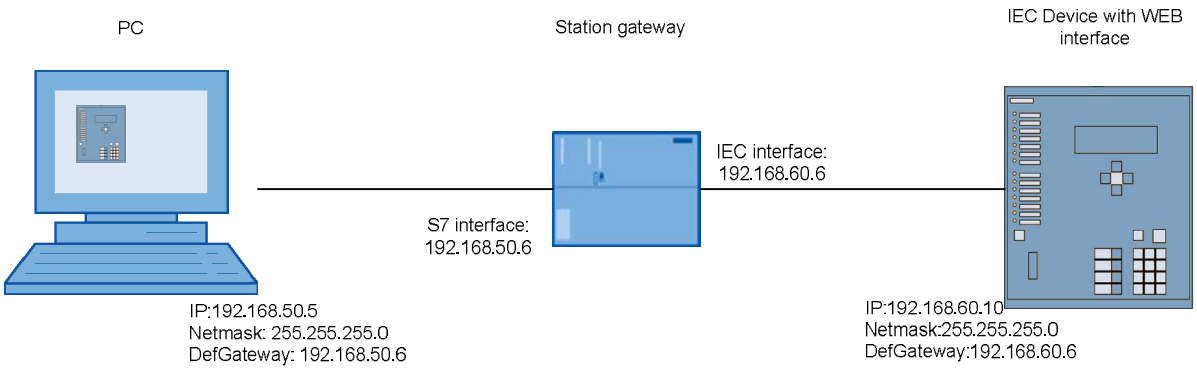
Image 8: IP-Forwarding StatCon

Example Shell commands:

Following commands should be executed on Station Gateway (the commands itself is marked ***bold***)

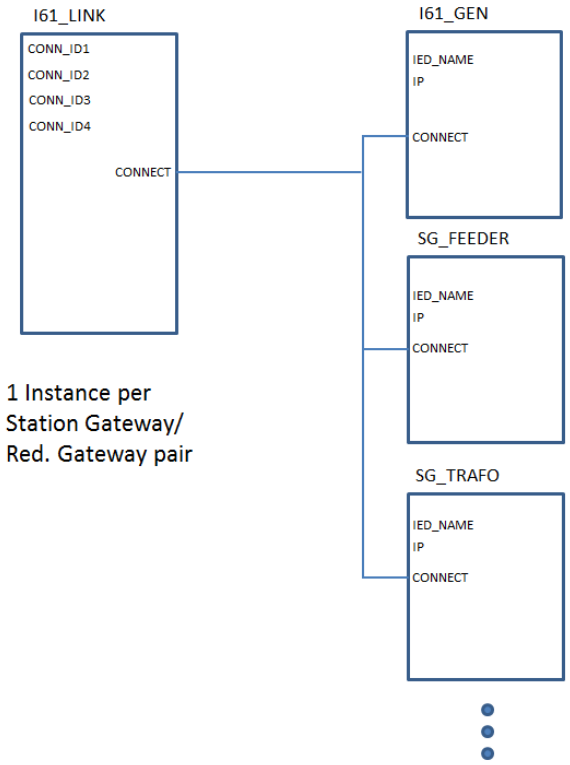
To show possible options
 	
`config@debianmec:~$ ***sudo ip_forwarding***`
`usage:  sudo ip_forwarding state`
`  state = on - enable IP forwarding`
`  state = off - disable IP forwarding`
 	
To enable IP routing
 	
`config@debianmec:~$ ***sudo ip_forwarding on***`
`IP-forwarding has been enabled`
 	
To disable IP routing
 	
`config@debianmec:~$ ***sudo ip_forwarding off***`
`IP-forwarding has been disabled`

However, in this case no masquerading is set as in case of SNTP routing.



4.6 PCS7 Engineering

In the program of the S7-PLC, the blocks of the SG_LINK library have to be configured. The following image shows the principle of the layout:



The block I61_LINK has to be configured once per Station Gateway/Station Gateway pair. For every IEC 61850 device, a device driver block has to be configured and connected to the I61_LINk block via the “CONNECT” structure.

4.6.1 Engineering of the function block I61_LINK

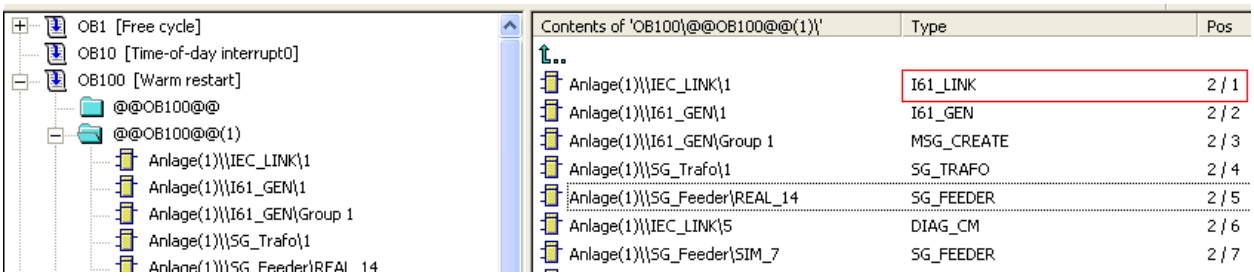
The S7 function blocks I61_LINK is the gate to the Station Gateway for the specific function blocks. It coordinates and executes the data exchange between the PCS7 function blocks and the Station Gateway. The inputs CONN_IDx contain the ID of the used S7 connections.

Note: The I61_LINK block needs a S7 connection exclusively only for itself. Therefore an ID of a S7 connection can be used only once in an input CONN_IDx.

The specific PCS7 function blocks are connected with a Station Gateway by binding the input element CONNECT to the output element CONNECT in the I61_LINK block. In the configuration program CFC, the connection is graphically established by mouse-clicking on the output and the input.

The I61_LINK accepts 100 connected function blocks. The cycle time for the cyclic operation in the S7 CPU should be shorter than 1 second. The connected function blocks may run in a slower cycle as the I61_LINK block.

Each specific function block needs a registration in the connected function block I61_LINK. While the registration is not finished, the function block consumes additional operation time for executing the registration. To avoid an operation time overflow the additional operation time in each cycle is limited. Therefore the registration of all function blocks needs many cycles. The registration can be accelerated by using the OB 100. The function blocks have the property “S7_tasklist := OB100”. According to this property they are inserted in OB100 automatically by the engineering tool CFC. When the CPU starts up, all function blocks in OB100 perform their registration before the cyclic operation is started. But this is only successful, if the function block **I61_LINK is placed in OB100 at top** of the specific function blocks.



Note: In the sequence of the function blocks in the OB100 the function block I61_LINK must be on top of the Gateway-specific blocks.

4.6.1.1 I61_LINK I/Os

I61_LINK		
Name	Type	Function
Inputs		
CONN_ID1	BYTE	ID of a S7 connection to the Station Gateway

CONN_ID2	BYTE	ID of a S7 connection to the Station Gateway
CONN_ID3	BYTE	ID of a S7 connection to the Station Gateway
CONN_ID4	BYTE	ID of a S7 connection to the Station Gateway
Outputs		
CON_ERR	BOOL	
RED_ERR	BOOL	
STAT1	STRING[4]	Status of the S7 connection with the ID CONN_ID1
STAT2	STRING[4]	Status of the S7 connection with the ID CONN_ID2
STAT3	STRING[4]	Status of the S7 connection with the ID CONN_ID3
STAT4	STRING[4]	Status of the S7 connection with the ID CONN_ID4
A_CON_1	BOOL	Alarm: S7 connection with the ID CONN_ID1 failed
A_CON_2	BOOL	Alarm: S7 connection with the ID CONN_ID2 failed
A_CON_3	BOOL	Alarm: S7 connection with the ID CONN_ID3 failed
A_CON_4	BOOL	Alarm: S7 connection with the ID CONN_ID4 failed
REDS_ERR	BOOL	Redundancy connection between the CM via serial cable failed
CONNECT	DWORD	Connecting point for up to 100 function blocks, which transfer data of a specified IEC61850 device
BLOCKS	INT	Number of the connected function blocks at CONNECT

4.6.1.2 Code for the status of the S7 connections

The string outputs STAT1, STA2, STA3 and STAT4 display the actual status of the S7 connections, that are entered in the inputs CONN_ID1, CONN_ID2, CONN_ID3 and CONN_ID4. A connection fault is displayed with a negative number. The error free states are displayed with several symbols. Example: A1>

Symbol in STATn	Meaning
X or Y	Connection established to one (X) or two (X and Y) CM without a fixed role.
1	Connection via the Ethernet CP (CP443-1) with the lower IP address
2	Connection via the Ethernet CP (CP443-1) with the higher IP address
>	Connection is used for sending data only
<	Connection is used for receiving data only
*	Connection is used for sending and receiving data
--	No connection has been configured (CONN_IDx = 0)
-"Number“	Error code

Error codes STATn	Meaning
-11	Error indication from the BSEND function
-12	Timeout while sending to the CM
-13	Error indication from the BRCV function
-14	Timeout while receiving from the CM
-20 … -29	CM not accepting the I61_LINK
-30	Configuration of the redundant connections to the CM is inconsistent
-50	CM not responding
-51... - 69	Formal error in the data telegram from the CM

5 PCS7 Device driver blocks

The function blocks in PCS7 for the communication with protection relays are designed for CFC charts, but can also be engineered in the software tool KOP/AWL/FUP.

For the communication via the Station Gateway the function blocks need a connection of their input CONNECT with the output CONNECT of the I61_LINK block.

The following table gives an overview of the block types:

Block name	FB Number	Description
I61_LINK	FB900	Link block to manage the communication to the Station Gateway module
I61_COMM	FB901	Data exchange with a protection relay via IEC61850 – called within the device specific blocks
I61_GEN	FB902	Generic device driver block for data exchange with a IEC61850 device
DIAG_CM	FB903	Block for diagnosis and alarming of the Station Gateway module (connections, device status, redundancy)
MSG_CREATE	FB904	Dummy/Example block for creating a MSG_EV_ID type “alarm_t” for calling the ALARM_8P in the device driver.
I61_XXX	FB905….	Device specific driver blocks for connecting IEC61850 devices
SG_FEEDER	FB2540	Driver block to connect the technological block PC_FEEDER of the PowerControl Library
SG_TRAFO	FB2542	Driver block to connect the technological block PC_TRAFO of the PowerControl Library
SG_SYNC	FB2543	Driver block to connect the technological block PC_SYNC of the PowerControl Library
SG_LINE	FB2544	Driver block to connect the technological block PC_LINE of the PowerControl Library

5.1 IP and IED_NAME

A protection relay is addressed by its IP address (input IP). The IED Name of the protection relay is used to confirm the addressing. If the parameterized name in the input IED_NAME does not match the name of the addressed protection relay, no communication is performed.

Important note: Do not use leading nulls in the IP addresses. E.g. 192.168.05.1 or 010.020.030.1 is invalid.

5.2 Configuring IEC Addresses

The IEC 61850 address of each transferred object is parameterized in a STRING[66] input. The inputs are bundled in structures that contain the addresses of a definite data type:

Input structure	Description
BOOL_DEF	Definition of cyclic binary values
REAL_DEF	Definition of cyclic real values
BS32_DEF	Definition of cyclic Bitstring32 or DINT values
INT_DEF	Definition of cyclic integer values
BCMD_DEF	Definition of binary command objects
BMSG_DEF	Definition of message/alarm objects

For each transferred object, that is defined in a STRING[66] input, the function block contains designated outputs with status information about the object.

The objects defined in BMSG_DEF are created in the dataset for the buffered reporting.

5.2.1 Exchange of the character $ in CFC with the character §

The addresses of an IEC61850 device are located in STRING inputs of the assigned function block. The symbol $ is often used in such addresses. This symbol must be replaced by § in the address strings of the function blocks, because $ is not an accepted symbol in the engineering tool CFC.

Example:

original address IEC 61850	MEAS/MMXU1MXA$phsA$cValmagf
address string in PCS7	MEAS/MMXU1§MX§A§phsA§cVal§mag§f

5.3 IEC 61850 Reporting

The Station Gateway uses the buffered/unbuffered reporting functionality of IEC61850. This ensures that all changes of messages and alarms are received, even if there were more than one changes of the signal in one cycle.

Another big advantage of the reporting functionality is that the timestamps displayed in WinCC are exactly the timestamps of the IEC61850 device.

Every configured message/alarm is connected with an Alarm_8P call which transfers the information to WinCC.

The function block needs the name of the dataset and report control blocks used for the buffered reporting of the messages/alarms. If the configured datasets are not available in the device, the gateway tries to create them (dynamic datasets). If a redundant Station Gateway set is used, the same Dataset for both devices can be configured

Important Note: In some devices, this creation is not possible. Then pre-defined (static datasets) datasets have to be used.

Input	Description	Default Value
DATSET1	Dataset name for the first Station Gateway	/CM104A§DataSetBR
BRCB1	Report control block for the dataset of the first Station Gateway	CTRL/LLN0§BR§brcbA01
DATSET2	Dataset name for the second Station Gateway	/CM104B§DataSetBR
BRCB2	Report control block for the dataset of the second Station Gateway	CTRL/LLN0§BR§brcbB01

To check if report control blocks (RCB) are used after configuration, check the variables with IEC Browser BRCB1+RepEna and BRCB2+RepEna (e.g. DEV_CTRL/LLN0BRbrcbA01$RptEna). It should be “true” or “1”. If RptEna is not “true” after 5 minutes something wrong with the configuration and it must be investigated.

5.4 MSG_EVID_XX, Alarming Concept

The I61_XX blocks have a special alarming concept that allows the user to assign different alarms of one device to different technological blocks/objects.

The Messages configured in “BMSG_DEF_XX” inputs are connected to ALARM_8P calls inside the block. With this mechanism, the signals and the timestamps from the device are transferred to WinCC.

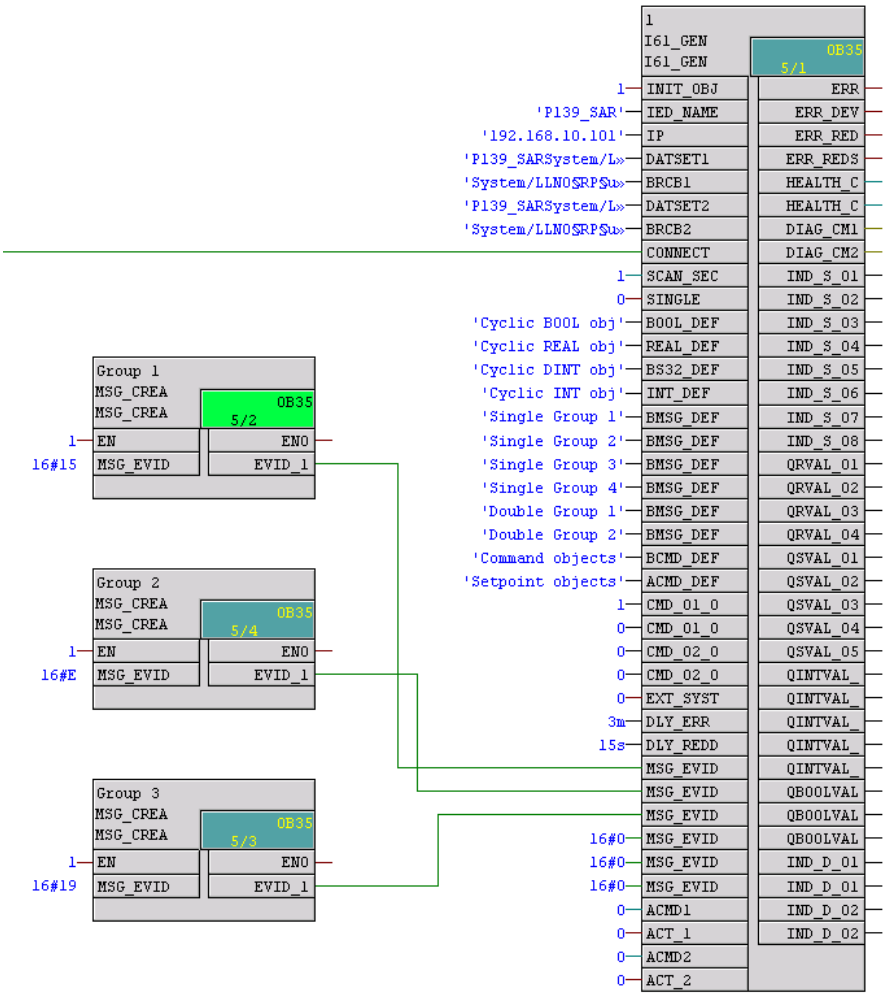
The ALARM_8P blocks use the values from the inputs MSG_EVID_XX as Message Event ID´s. So the alarms can be grouped, and the messages and message classes can be configured at the blocks where the Message Event Id´s are created.

For creation of the Message Event IDs and configuring the alarms, the block MSG_CREATE can be used. There has to be one instance per alarm group.

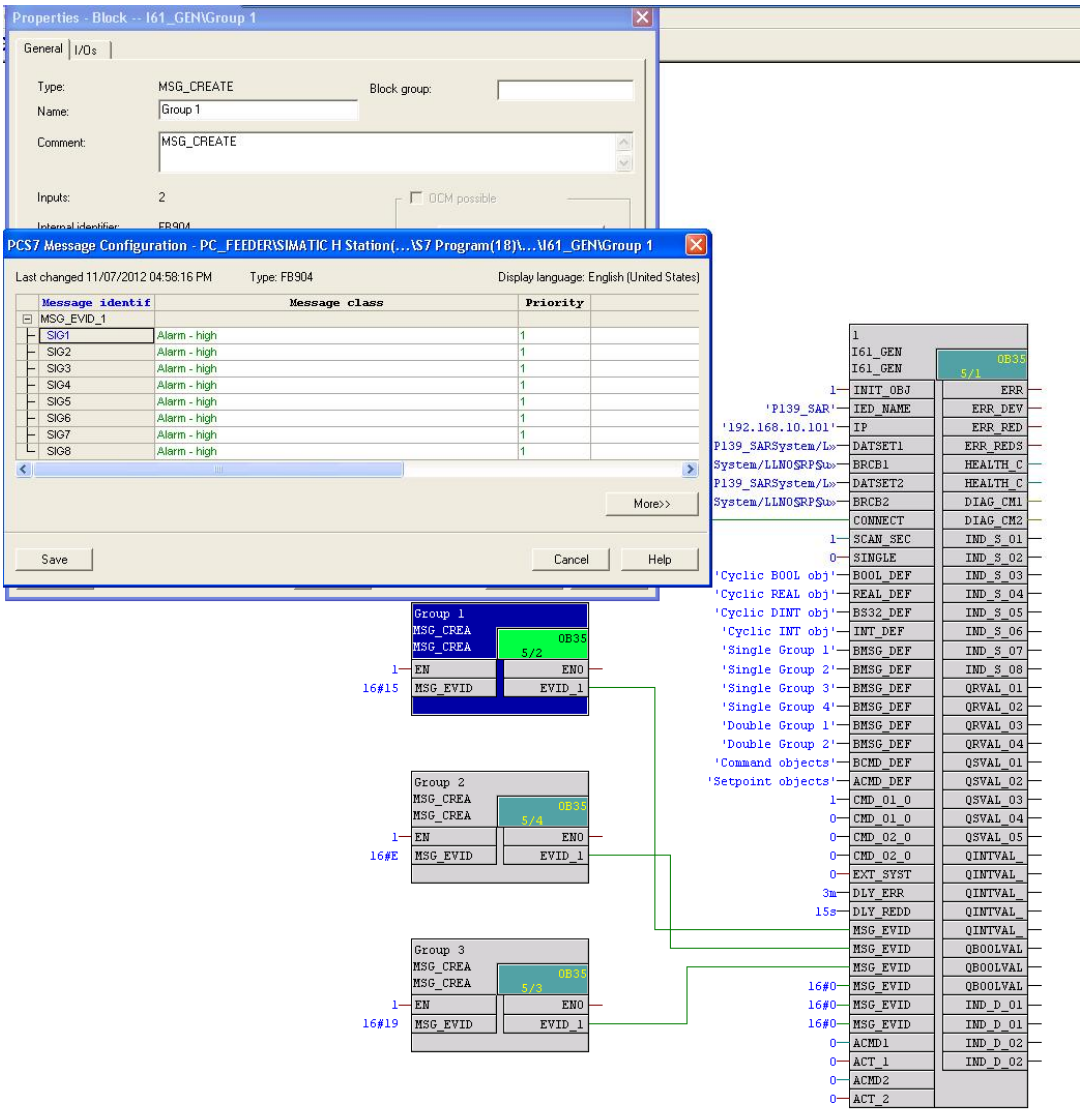
It is also possible to use custom blocks for creating the MSG_EV_IDs. Therefore the blocks have to have the following input parameter in scl source code:

```
MsgEvId_1  {S7_visible := 'false'; S7_param := 'false'; S7_link  := 'false';
            S7_server := 'alarm_archiv'; S7_a_type :='alarm_t'}
            :DWORD := 16#00000004; // Message Event ID
```

The following drawing shows the mechanism in detail:



The alarm texts and the message classes are defined in the blocks “MSG_CREATE”, the ALARM_8P call is done within the I61_GEN block.



5.5 EXT_SYSTEM_ACTIVE, Forwarding of alarms

If the alarms should be forwarded to a foreign, non-WinCC system, the Gateway should not buffer the alarms when WinCC is down.

The Input "EXT_SYSTEM_ACTIVE" indicates if the foreign system for receiving alarms is active.

The Outputs ALM_GRP_XXX(type UDT_ALM_GRP) are used to forward the alarms to the other system.

The following logic is used for the acknowledgment/buffering of the alarms:

Status WinCC	**Status Foreign system (EXT_SYSTEM_ACTIVE)**	**Behavior**
Active	True	Alarms are acknowledged in the Station Gateway as soon as they are transferred to WinCC. Then the next alarm appears in the Outputs ALM_GRP_XXX.
Not active	True	Alarms are acknowledged after one cycle, no buffering in the Station Gateway.
Active	False	Alarms are acknowledged in the Station Gateway as soon as they are transferred to WinCC. Then the next alarm appears in the Outputs ALM_GRP_XXX.
Not active	False	Station Gateway buffers the alarms until either WinCC or the other system is online again.

5.6 Cyclic Data

The following Data types can be configured for cyclic reading:

- BOOL
- REAL
- INT
- DINT

Cyclic data comes without timestamp and is polled every cycle configured in “SCAN_SEC”.

5.6.1 SCAN_SEC

The Station Gateway cyclically reads the objects that are addressed in the structures BOOL_DEF, REAL_DEF, DINT_DEF and INT_DEF. All defined objects are polled with the same scan time. The common scan time can be set with the parameter SCAN_SEC in steps of one second. The parameter SCAN_SEC is transferred into the Station Gateway when the object parameters (all addresses) are loaded. After changing the parameter SCAN_SEC it is required to load the Station Gateway again. The communication with the protection relay is stopped during loading.

5.7 Loading the object parameters (addresses) into the Station Gateway

All specific parameters for the communication between the protection relay and the function block are located in the inputs of the device driver blocks.

After changing the new object parameters are not jet active in the CM. It is necessary to download them into the Station Gateway. The download is started by rising edge of the input INIT_OBJ.

Additionally the download of the object parameters is started automatically:

- after the restart of a Station Gateway
- after the restart of the PCS 7 controller
- after a communication interrupt of more than 3 minutes

The download of the object parameters can be suppressed with INIT_OBJ=0. During online operation the input INIT_OBJ must remain the value 1. The value 0 is allowed only while changing the address inputs or temporarily for creating a rising edge to start the download.

The download may need some seconds up to a minute, depending from the number of loading function blocks.

During initialization, no process data is transferred between the function block and the Station Gateway. The Station Gateway will continue storing messages with timestamp (buffered reports) of the protection relay and will send them to PCS7 after the download and initializing is finished.

If only one Station Gateway of a redundant pair is switched off and on, only this Station Gateway will be initialized with the object parameters, while the other Station Gateway continues the communication with the protection relay.

5.8 Structured In- and Outputs

The Inputs and the Outputs of the device specific driver blocks are APL-structures, so they contain the value and the quality code of the signal.

Inputs are only valid for the block if the quality code is 0x80.

5.9 Display of cyclic transferred data in outputs

For each cyclic transferred data from the protection relay a group of output structures is provided in the function block. This output structures contain the process value and a quality byte.

5.10 Quality indication of transferred process data

For each IEC 61850 address parameter STRING[66] there is a quality indication ".St" within the structure of the specific output. The quality is of data type byte and can have the following values:

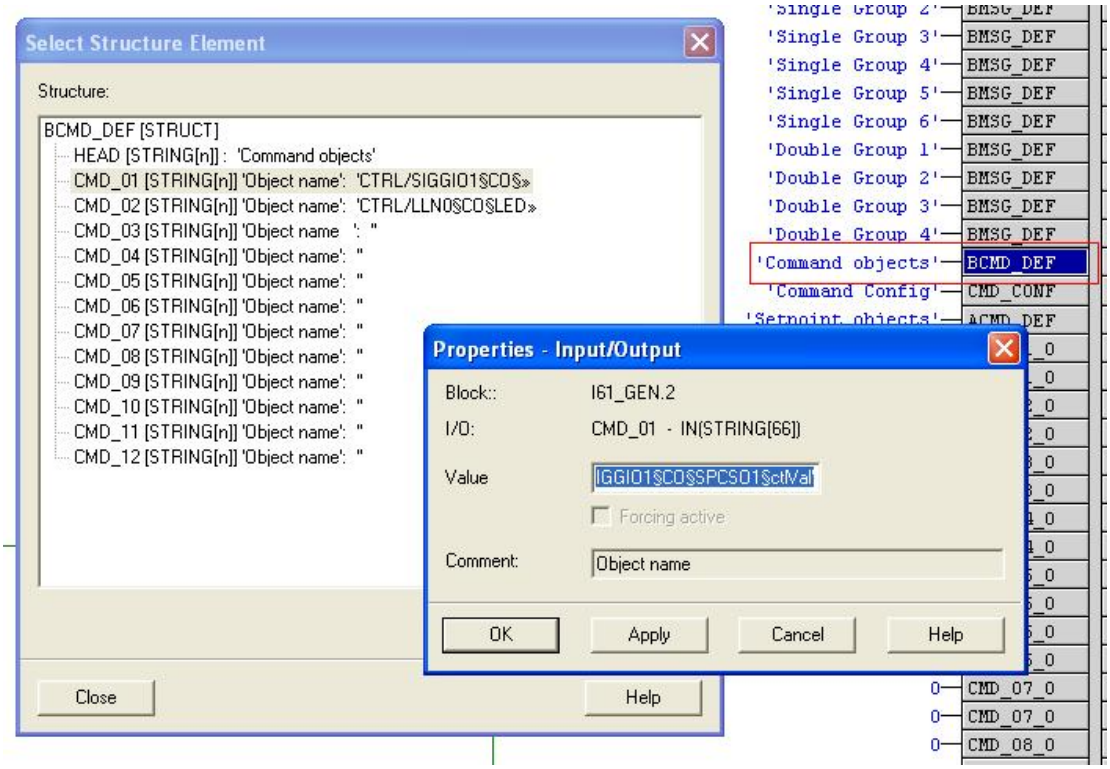
Quality Code	Meaning
16#14	Invalid(indication from IED invalid)
16#80	Valid
16#60	simulated
16#18	IEC 61850 address not supported by the connected device
16#00	not used, no actualization

16#08	No Connection to IED or to Station Gateway

Table: Quality indication in the function blocks

5.11 Commands

The IEC addresses of Binary commands are configured on the input “BCMD_DEF”:



A typical IEC address example for a switch command is:

'CTRL/Q0CSWI1§CO§Pos§Oper§ctlVal'

5.11.1 Select before operate

If the control mode of the command is “select before operate”, the address of the SBOw§ctlVal has to be configured. The Station Gateway then uses the Select before operate mechanism automatically.

Example:

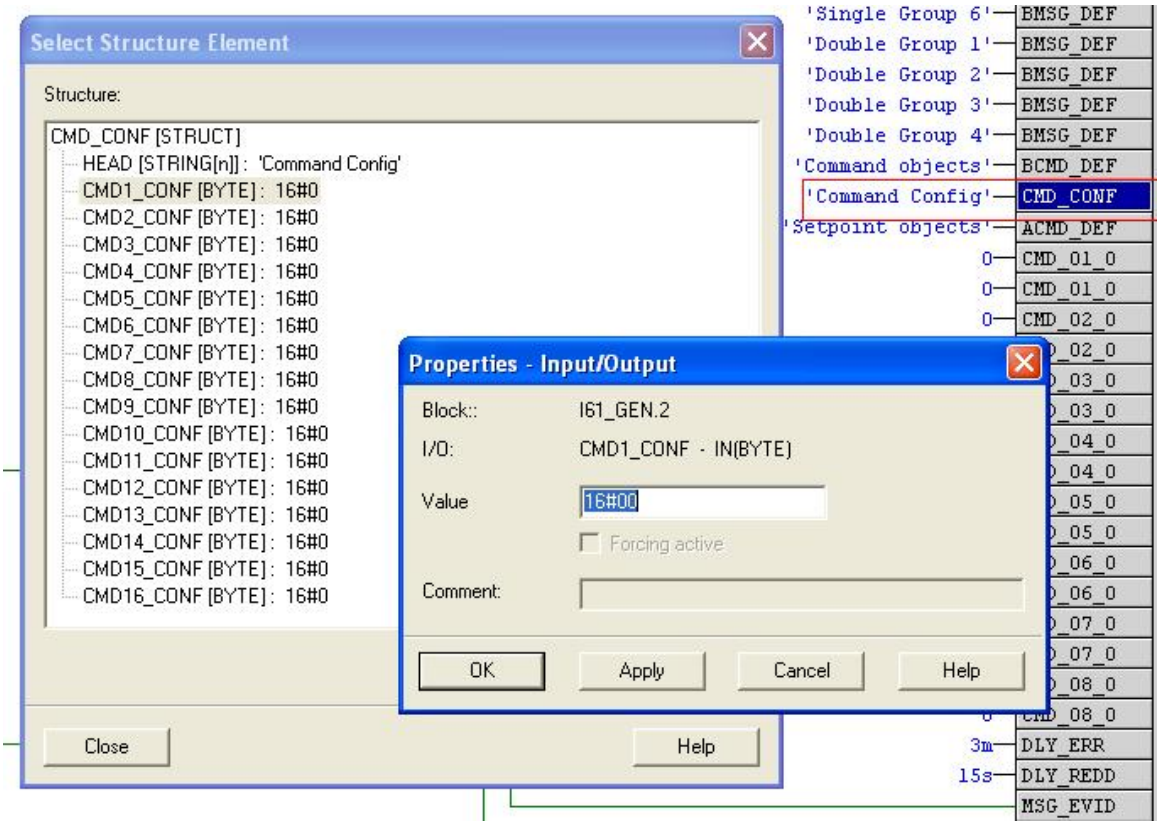
'CTRL/Q0CSWI1§CO§Pos§**SBOw**§ctlVal'

5.11.2 Command configuration

The IEC protocol provides 3 additional configuration bits which are sent with the command (see also IEC61850 documentation)

- Check interlocking: If this bit is set, the IEC device checks the local interlocks before processing the command
- Synchrocheck: If this bit is set, the IEC device performs a synchrocheck before processing the command
- Test: If this bit is set, the IEC device performs only a test of the command

These bits can be configured in the Station Gateway per configured command on the Input “CMD_CONF”:



There is a byte for each command. The byte has the following allocation:

Bit 0(0x01): Check Interlocking

Bit 1(0x02): Synchrocheck

Bit 3(0x04): Test

E.g. 0x03 for interlocking and Synchrocheck

5.12 ° Outputs for the indication of errors

The individual function blocks do not watch the S7 connections to the Station Gateway. The error indication for the S7 connections is done by the I61_LINK block. The individual function blocks that are placed behind the I61_LINK block, watch the data exchange with the Station Gateway, regardless of the number of S7 connections used by the function block I61_LINK.

5.12.1 ERR, ERR_DEV, ERR_CONN

The output ERR is set, if the data exchange with the protection relay fails completely. The output ERR is zero(“OK” in CFC), if the data exchange with the protection relay is working via at least one S7 connection and one CM.

The output ERR_CONN is set, if no CM is reachable. The output ERR_DEV is set, if no reachable Station Gateway can exchange data with the designated protection relay.

5.12.2 HEALTH_CM1/2

The Outputs HEALTH_CM1/2 display the value of the IEC Address CTRL/LLN0STHealth$stVal, which is the global status of the device. HEALTH_CM1 comes from the first Station Gateway, HEALTH_CM2 from the second.

0(“N/A” in CFC)	-> Undefined
1(“OK” in CFC)	-> OK
2	-> Warning
3	-> Error
255	-> No Connection to the device

5.12.3 DIAG_CM1/2

The DIAG Outputs display the status of the buffered reporting for the Boolean values and the alarms. If the reporting is set up successfully and the communication is running, the CFC shows “OK” on these outputs. If not, there is a hexadecimal error code. The explanation of the different error codes is done in the appendix of this document.

5.12.4 ERR_RED, ERR_REDC, ERR_REDD and ERR_REDS

The output ERR_RED indicates a loss of redundancy. Not each loss of a S7 connection, which is indicated by the function block I61_LINK, causes an error indication in the specific function block. The output ERR_RED is the sum of ERR_REDC, ERR_REDD and ERR_REDS. In the case of a non-redundant configuration ERR_RED is always true.

ERR_REDC is set, if not both redundant Station Gateway have a valid connection with the function block. ERR_REDD is set, if one Station Gateway indicates an error of the data exchange with the designated protection relay. ERR_REDS is set, if one Station Gateway has lost its connection to the redundant Station Gateway via Ethernet.

Error name	Description
ERR_RED	Is 1 if ERR_REDC or ERR_REDD or ERR_REDS are not zero
ERR_REDC	One Station Gateway is not connected with AS/CPU
ERR_REDD	Protection relay is not connected with one or both Station Gateways
ERR_REDS	No redundancy connection between Station Gateways

5.12.5 STAT_CM1 and STAT_CM2

The outputs STAT_CM1 and STAT_CM2 show a reason for an error indicated by ERR_REDC = 1 or ERR_CONN = 1. The value 0 means no error. In a non-redundant configuration ERR_REDC will always be set. In this case only ERR_CONN and STAT_CM1 are relevant.

STAT_CMx	Meaning
-1	initial value, no operation in the PCS7 station
0	no error
1	No connected data block at the input CONNECT
2	Input CONNECT is not connected with a I61_LINK block
3	Too many blocks connected with one I61_LINK block
4	No connection with a Station Gateway
6	Error while sending to a Station Gateway
7	Error while receiving from a Station Gateway
10	Waiting for the start of the communication with a Station Gateway
11, 12	Error during loading of IED_NAME or IP
14, 15	Error during loading of the object parameter
16, 17	Error during loading of message object parameter

18, 19	Error during loading of REAL object parameter
20, 21	Error during loading of BS32 object parameter
22, 23	Error during loading of binary command object parameter
24, 25	Error during loading of analog command object parameter

Table: Indications of STAT_CM1 and STAT_CM2 in the function block

5.13 IO-Overview of I61_GEN

I61_GEN		
Name	Type	Function
Inputs		
INIT_OBJ	BOOL	Start loading the parameters for the transfer objects (IEC 61850 addresses) to the Station Gateway when changing from 0 to 1. INIT_OBJ must be set to 1 during online operation.
IED_NAME	STRING[30]	Name of the protection relay in the IEC 61850 protocol.
IP	STRING[15]	IP address of the protection relay. Example: 192.168.11.12
DATSET1	STRING[66]	Data set name for buffered reports in the protection relay used by Station Gateway 1
BRCB1	STRING[66]	Path name for buffered reports in the protection relay used by Station Gateway 1
DATSET2	STRING[66]	Data set name for buffered reports in the protection relay used by Station Gateway 2
BRCB2	STRING[66]	Path name for buffered reports in the protection relay used by Station Gateway 2
CONNECT	ANY	Connection with the output CONNECT of a I61_LINK block
SCAN_SEC	INT	Scan time in seconds for reading the cyclic values
EXT_SYSTEM_ACTIVE	BOOL	Indicates if the foreign system for receiving alarms is active

BOOL_DEF	STRUCT	IEC 61850 addresses of cyclic read BS32 values.		
		HEAD	STRING[16]	Constant label: 'Cyclic BOOL obj'
		S01_ID	STRING[66]	Address of the transfer object 1
		S02_ID	STRING[66]	Address of the transfer object 2
		S03_ID	STRING[66]	Address of the transfer object 3
		:	:	:
REAL_DEF	STRUCT	IEC 61850 addresses of cyclic read REAL values.		
		HEAD	STRING[16]	Constant label: 'Cyclic REAL obj'
		R01_ID	STRING[66]	Address of the transfer object 1
		R02_ID	STRING[66]	Address of the transfer object 2
		R03_ID	STRING[66]	Address of the transfer object 3
		R04_ID	STRING[66]	Address of the transfer object 4
		:	:	:
		:	:	:
		R15_ID	STRING[66]	Address of the transfer object 15
BS32_DEF	STRUCT	IEC 61850 addresses of cyclic read BS32 values.		
		HEAD	STRING[16]	Constant label: 'Cyclic BS32 obj'

		S01_ID	STRING[66]	Address of the transfer object 1
		S02_ID	STRING[66]	Address of the transfer object 2
		S03_ID	STRING[66]	Address of the transfer object 3
		S04_ID	STRING[66]	Address of the transfer object 4
		:	:	:
		:	:	:
		S10_ID	STRING[66]	Address of the transfer object 10
BMSG_DEF_x_x	STRUCT	IEC 61850 addresses of messages of the message groups.		
		HEAD	STRING[16]	Constant label 'Message objects'
		C_FIELD_Man	STRING[66]	Address of the signal
		…		
		…		
BCMD_DEF	STRUCT	IEC 61850 addresses of binary commands		
		HEAD	STRING[16]	Constant label: 'Command objects'
		CB01_ID	STRING[66]	Address of the command 1
		CB02_ID	STRING[66]	Address of the command 2

		CB03_ ID	STRING[66]	Address of the command 3
		CB04_ ID	STRING[66]	Address of the command 4
CMD1_ON	BOOL	Activation command address CB01_ID with value 1		
CMD1_OFF	BOOL	Activation command address CB01_ID with value 0		
:	:	:		
:	:	:		
CMD4_ON	BOOL	Activation command address CB04_ID with value 1		
CMD4_OFF	BOOL	Activation command address CB04_ID with value 0		
Outputs				
ERROR	BOOL	1 = no communication with the protection relay ERROR := ERR_DEV or ERR_CON		
ERR_DEV	BOOL	1 = no answer or no life signal from the protection relay		
ERR_CONN	BOOL	1 = no communication with a Station Gateway		
ERR_RED	BOOL	1 = redundancy not available ERR_RED := ERR_REDC or ERR_REDD or ERR_REDS		
ERR_REDC	BOOL	1 = the communication with at least one Station Gateway is disturbed		
ERR_REDD	BOOL	1 = at least one Station Gateway is not connected with the protection relay		
ERR_REDS	BOOL	1 = the link between the redundant Station Gateways is disturbed		
OBJ_CM1	BOOL	1 = parameters loaded into the first connected Station		

		Gateway
OBJ_CM2	BOOL	1 = parameters loaded into the second connected Station Gateway
STAT_CM1	INT	Error code in the case of a communication errors, 0= no error
STAT_CM2	INT	Error code in the case of a communication errors, 0= no error
STAT_DEV	INT	status of the IEC61850 device, 1 = o.k.
HEALTH_CM1	INT	Health of device from CM1
HEALTH_CM2	INT	Health of device from CM2
DIAG_CM1	BYTE	Error Code buffered reporing CM1
DIAG_CM2	BYTE	Error Code buffered reporing CM2
RTCM_01	WORD	Time counter from the CM in steps of 0,01 seconds.
RACT_01	WORD	Time counter from the function block in steps of 3 seconds.
RQLY_01	BYTE	Quality code for the process value of the address R01_ID
RBAD_01	BOOL	Indication: value good =0 or bad=1
RVAL_01	REAL	Process value of the address R01_ID
ALM_GRP_XXX	STRUCT	Outputs for forwarding the alarms to a foreign system

6 Appendix

6.1 Connecting a Remote Terminal

It is possible to connect to the Station Gateway with any ssh-client, like PuTTY. Any network interface with its corresponding IP address can be used.

Default IP Addresses:

X1 (upper port)	10.10.12.1/2
X2	140.80.159.47/48
X1 P1 PN (on the EM PC)	192.168.50.3/4

6.2 Reading the software version in the Station Gateway

The firmware version can be read with StatCon Tool or via shell command.

Shell command:

Messages from the communication software are displayed in the file /var/log/syslog. Behind some pages of restart logs from the operating system the following lines appear in the file syslog:

```
S7IEC61850: ****************************************
S7IEC61850: ******      C M  S T A R T U P        ******
S7IEC61850: ******      PCS7 <-> IEC 61850        ******
S7IEC61850: ****** Version V X.Y      dd.mm.yyyy  ******
S7IEC61850: ****************************************
```

Example: `****** Version V 01.00     27.04.2010`

The command **cat /var/log/syslog | grep Version** displays only the version information

6.3 General console commands

The local monitor provides several consoles in parallel. The key combination "Alt“ + "Fx“, x=1,2..5, can be used to switch from one console to another. The console 8 ("Alt“+ "F8“) is used to display operation messages.

Tail -f /var/log/syslog : Display of logging.

Cat /var/log/syslog | grep Version : Display version information

cat /etc/S7_Gtw.conf : Display of network settings

cd /name : Change directory: Absolute address including path.

cd name : Change directory: Directory under the working directory.

cp file1 file2 : Copy file1 to file2

df -h : Display free memory

ls : Display all file names in the directory without attributes

ls -l : Display all files in the directory including attributes

ls -l S7* : Display the files with “Gt” at the beginning of their name

top : Display processes and resources. Terminated by „q“.

pwd : Display the actual working directory

rm file1 : Remove “file1”

logout : End of the session started with login “username”

date –s h:m:s : Set Time h:min:sec

date –s “M/D/Y h:m:s“: Set Date and Time

/sbin/ifconfig : Display current network settings

To restart the Station Gateway, either switch the power off and on, or log in to the Station Gateway and type *sudo reboot.*

6.4 Firmware Update

The easiest way to update the firmware is using the “Online and diagnostics” tab of StatCon Tool. There the button “Update firmware” can be used.

How to install updates via USB

1. Copy SGupdateX.XX.tgz on any USB flash drive
2. Connect the flash drive to the Station Gateway
3. login either per ssh or locally with user “config”, password “config”
4. execute “sg_setup X.XX usb”
5. wait for the Station Gateway to reboot

How to install updates via FTP

1. Login via FTP user *config* password *config*
2. Transfer SGupdateX.XX.tgz to configs home directory
3. login either per ssh or remote
4. execute “sg_setup X.XX”
5. wait for the Station Gateway to reboot

6.5 How to get logs and config files via ftp

The easiest way to update the firmware is using the “Online and diagnostics” tab of StatCon Tool. There the button “Create diagnose ZIP” can be used.

The Station Gateway provides an ftp server to download logs and config files.

You can connect to any of the Gateways IP addresses via any ftp client (e.g. FileZilla).

The login is password protected, the login name is *config* with password *config*

The relevant config file is /etc/S7_Gtw.conf.

The relevant log is /var/log/syslog.

6.6 Troubleshooting

If more than one red LED is on, the one first mentioned here should be dealt with first!

Behavior	Possible cause	Solution
SF is on	EM PC not installed	Install the provided EM PC run *sudo setup.sh* and restart the Gateway
	Critical configuration error	run *sudo config.sh*
BF1 is on	CPU is not running	Put CPU in Run
	CPU cannot be reached	Check physical network connection Check IP addresses Check NetPro configuration
BF2 is on	IED cannot be reached	Check physical network connection

	Wrong configuration at function block	Check IP configuration Check IED name and IP address at function block
U2 on	No redundancy connection Wrong configuration	Check physical network connection Run *sudo config.sh* on both partners
U3 on in single or off in redundant system	Configuration error	Run *sudo config.sh*

6.7 Error Codes of Function Block Outputs DIAG_CM1/2

00 - MMSd_Client_SUCCESS,

01 - MMSd_Client_ERR_NULL_SERVER,

02 - MMSd_Client_ERR_NOT_CONNECTED,

03 - MMSd_Client_ERR_NO_CONNECTION,

04 - MMSd_Client_ERR_FLOW_CONTROLLED,

05 - MMSd_Client_ERR_MAX_SERVICES_EXCEEDED,

06 - MMSd_Client_ERR_NO_READ_DATA,

07 - MMSd_Client_ERR_MEMORY,

08 - MMSd_Client_ERR_ENCODING,

09 - MMSd_Client_ERR_BAD_TRANSACTION,

0A - MMSd_Client_ERR_NO_TRANSACTIONS,

0B - MMSd_Client_ERR_CONNECTION_CLOSED,

0C - MMSd_Client_ERR_TIMED_OUT,

0D - MMSd_Client_ERR_CONNECTION_STATE,

0E - MMSd_Client_ERR_APPLICATION,

0F - MMSd_Client_ERR_PARAMETERS,

10 - MMSd_Client_ERR_CONFIRMED_ERROR,

11 - MMSd_Client_ERR_REJECT

64 - IEC61850_DATA_OBJECT_INVALIDATED

65 - IEC61850_DATA_HARDWARE_FAULT

66 - IEC61850_DATA_TEMPORARILY_UNAVAILABLE

67 - IEC61850_DATA_OBJECT_ACCESS_DENIED

68 - IEC61850_DATA_OBJECT_UNDEFINED

69 - IEC61850_DATA_INVALID_ADDRESS

6A - IEC61850_DATA_TYPE_UNSUPPORTED

6B - IEC61850_DATA_TYPE_INCONSISTENT

6C - IEC61850_DATA_OBJECT_ATTRIBUTE_INCONSISTENT

6D - IEC61850_DATA_OBJECT_ACCESS_UNSUPPORTED

6E - IEC61850_DATA_OBJECT_NON_EXISTENT

e.g. configured report control block is not existent

6F - IEC61850_DATA_OBJECT_VALUE_INVALID

FF - No Connection to device