Connecting a SIMATIC HMI panel with a SIMATIC S7-400H

WinCC (TIA Portal) V16 and STEP 7 V5.6

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1 Task

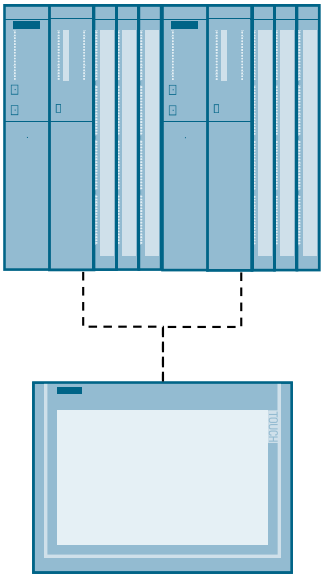
Introduction

You wish to connect a SIMATIC HMI panel with a SIMATIC H-station.

Overview of the automation task

The following Figure provides an overview of the automation task.

Figure 1-1

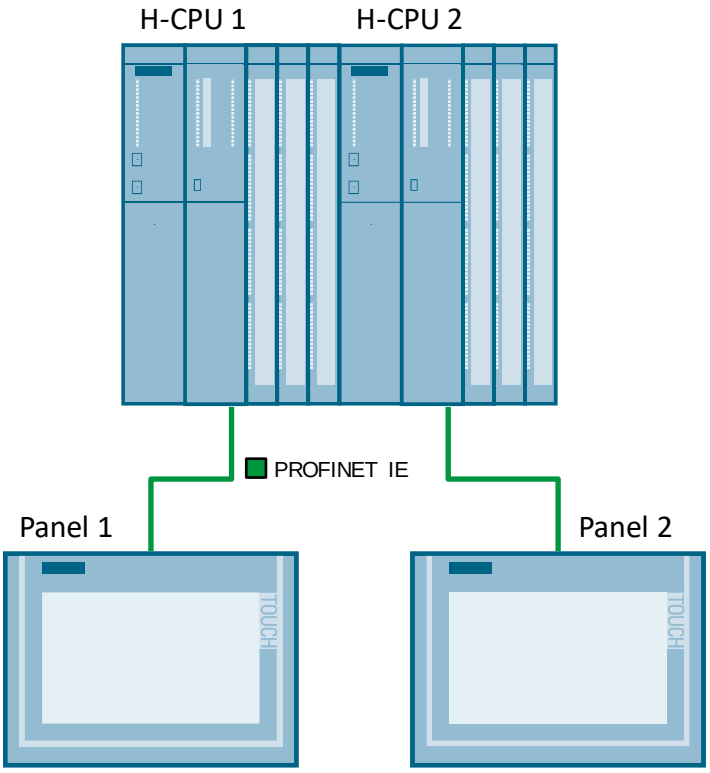


2 Solutions

2.1 Connecting the panels redundantly

You will connect a panel to each H CPU.

Figure 2-1



2.2 Connecting a script-capable panel with a "software solution" to both H CPUs

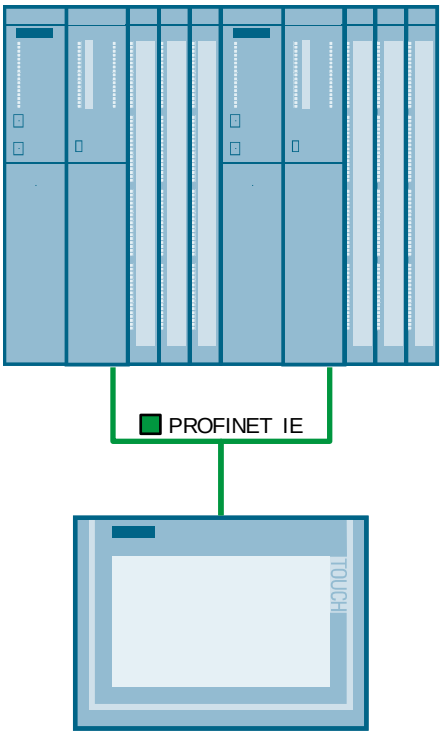
You are connecting an operator device with both H CPUs.

Scripts are used to define which H CPU the operator device will be connected with.

The connection will be switched over automatically in the event of the following fault conditions:

- Online CPU STOP
- CP failure
- Cable fault
- EMC

Figure 2-2



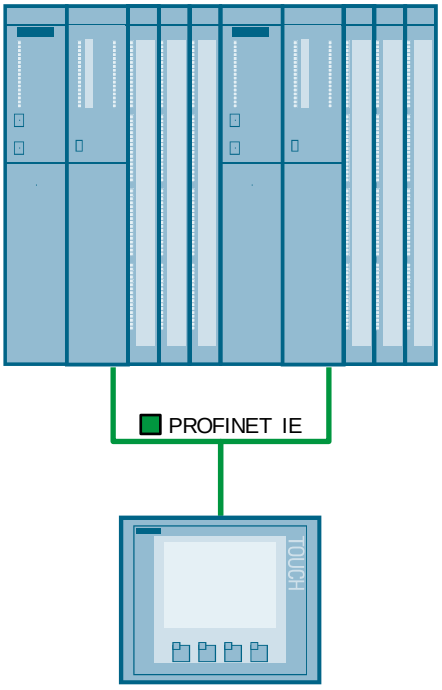
You can find a more detailed description of this solution in chapter 3 "Software solution with scripts".

2.3 Connecting a script-incompatible panel with a "software solution" to both H CPUs

You are connecting an operator device with both H CPUs.

The status of the H CPU (Master/Reserve) defines which H CPU the operator device will be connected with.

Figure 2-3



You can find a more detailed description of this solution in chapter 4 "Software solution without scripts".

2.4 Comparison of the solutions

Table 2-1

Solution	Advantage	Disadvantage
Chapter 2.1 Connecting the panels redundantly	High availability	Higher hardware costs
Chapter 2.2 Connecting a script-capable panel with a "software solution" to both H CPUs	Lower hardware costs	Longer response times
Chapter 2.3 Connecting a script-incompatible panel with a "software solution" to both H CPUs	Lower hardware costs	No switchover in the event of communication faults

3 Software solution with scripts

3.1 Components used

Hardware components

Table 3-1

Component	Qty.	Item number	Note
PS 407 10A	2	6ES7407-0KA02-0AA0	
CPU 416-5H PN/DP	2	6ES7416-5HS06-0AB0	
TP1200 Comfort	1	6AV2124-0MC01-0AX0	
SCALANCE X204-2	1	6GK5204-2BB10-2AA3	

Software components

Table 3-2

Component	Qty.	Item number	Note
STEP 7 V5.6	1	6ES7810-4C.11-..	
WinCC Comfort V16	1	6AV2101-0AA06-0AA5	

Sample files and projects

Table 3-3

Component	Note
96837136_WinCC_TIA_redundant_communication_v2_en.pdf	This document
96837136_Panel_H-PLC_Library_v2.zip	This compressed file contains a WinCC (TIA Portal) library.

3.2 Principle of operation

The operator device is connected to both H CPUs over a network.

Scripts are used to check in the operator device which of the controllers is reachable.

If the H CPU that is currently connected to the panel fails, or if the communication between the panel and the currently connected H CPU fails, the connection is automatically switched over to the other H CPU.

You can find the following script templates in the library "96837136_Panel_H-PLC_Library_v2.zip":

- Script_connection_PLC1
- Script_connection_PLC2
- Script_connection_lost

Script_connection_PLC1 and Script_connection_PLC2

Both scripts are functionally identical and differ only in their connection parameters.

The following functions are executed in the scripts "Script_connection_PLC1" and "Script_connection_PLC2":

1. Initializing:
   The connection that reaches the trigger condition writes the connection name to the tag for the connection memory of the data connection.
2. Reset:
   The connection state tag is set to 1 to attain "OK" status.
3. Fault detection:
   The connection state tag of the other connection is incremented. After a few cycles, this procedure detects an active fault in the other connection, and checks for a necessary data connection switchover.
4. Switchover:
   If the other connection cannot reset the connection state tag, then it reaches a limit. A check is then run for whether the data connection is on this failed connection.
   If this is the case, the connection is switched over.
5. Restore:
   This section addresses a restore after a total connection loss. The first connection to be active again switches the data connection over to itself.

Script_connection_lost

In the event of a complete connection loss, there is no longer a fast trigger on the panel to run scripts.

In order to detect a total failure and display it, the Scheduled tasks is used on a one-minute cycle. The script used in the Scheduled tasks (Script_connection_lost) contains the following functions:

1. Error marking:
   The connection state tag is set to 5 for both connections. If both connections are active, the intervention once every minute has no effect. 5 corresponds to the connection status "OK".
2. Disable:
   If the connection state tags for the two connections are at 5 or higher, they are set to 100. 100 corresponds to the connection status "disabled".
   "Script_connection_lost" is written to the connection memory of the data connection.

Status of the connection state tags:

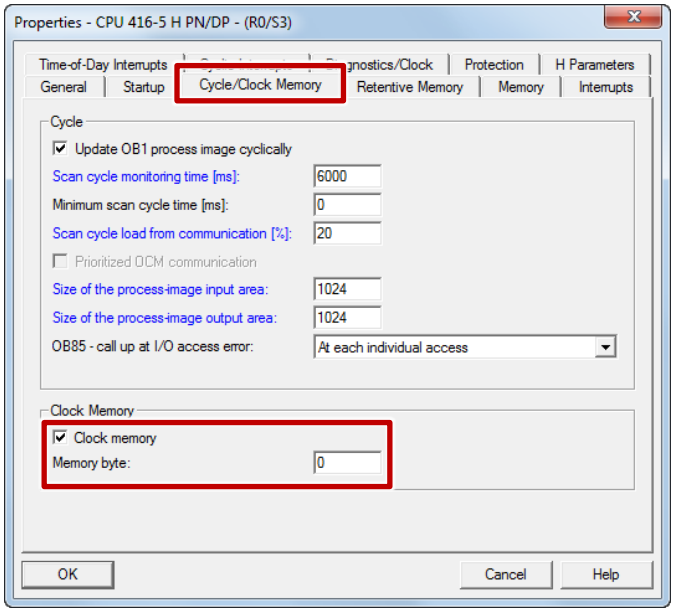
Table 3-4

Values	Status
0	Initializing, waiting for first trigger
1 to 5	OK
6 to 10	Fault
11 to 20	Failed
100	Disabled

3.3 Configuration

3.3.1 STEP 7 configuration

Table 3-5

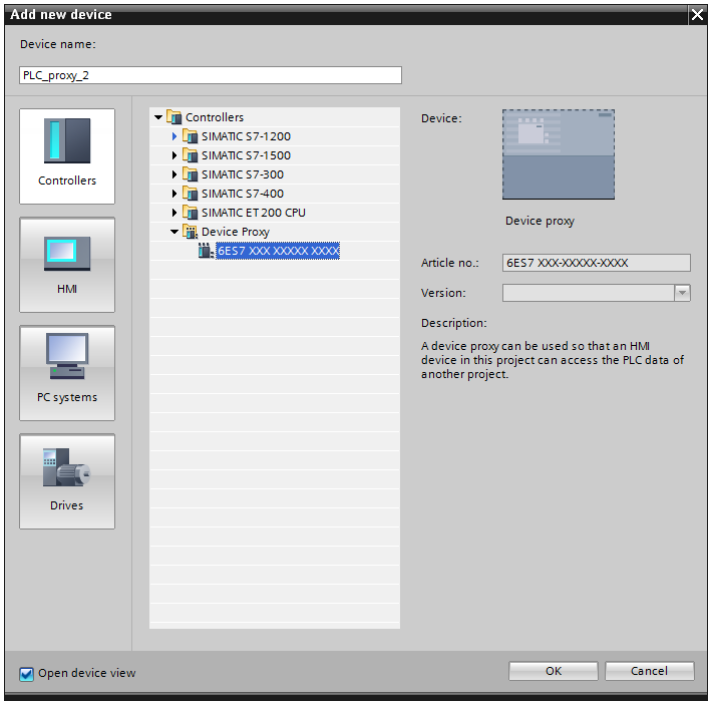
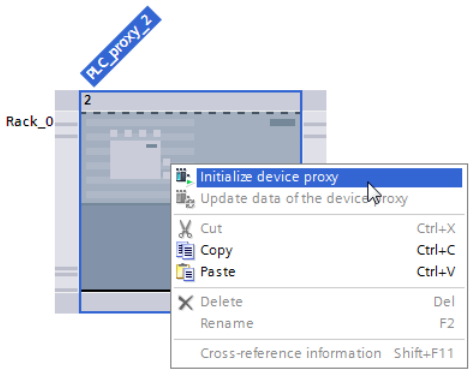
No.	Action
1.	Configure your fault-tolerant system as normal with STEP 7 V5.x
2.	Open the properties of the H CPU.
3.	In the "Cycle/Clock Memory" tab, enable the clock memory and enter the desired memory byte. This example uses memory byte 0. 

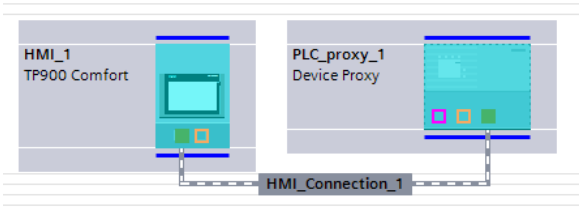
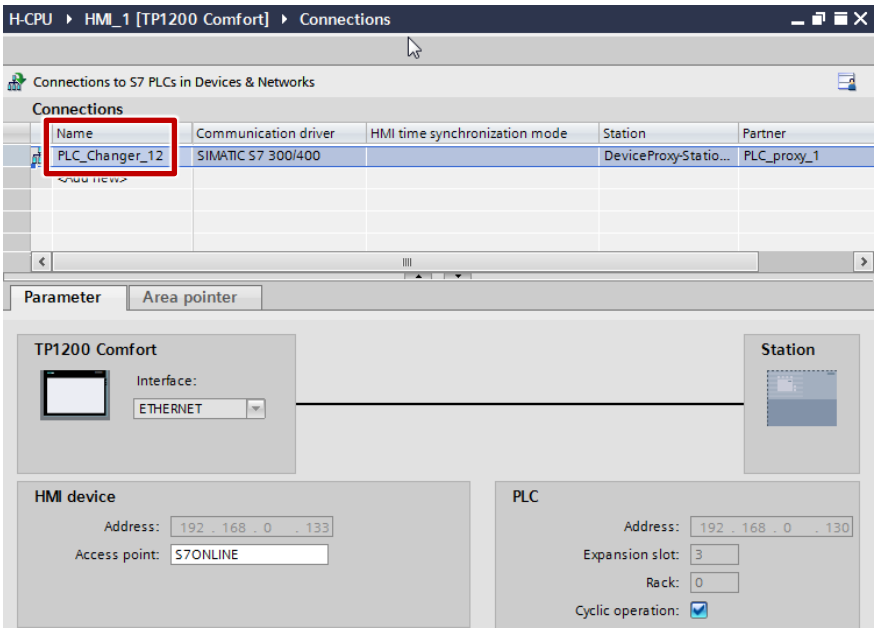
The proxy PLC in WinCC (TIA Portal) is used to connect the operator device to the H CPU. For this reason, no further steps are needed in the STEP 7 project.

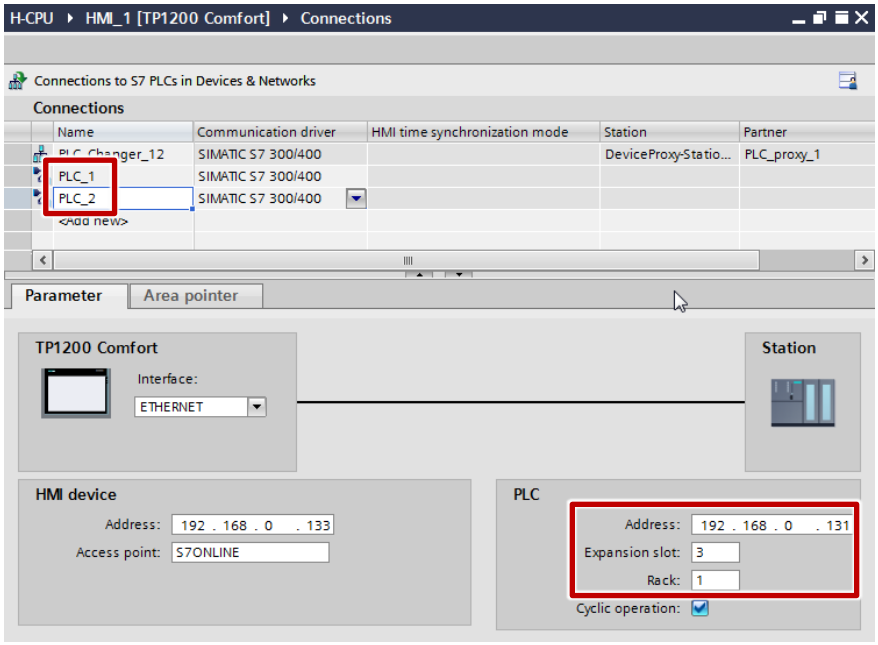
A prerequisite for using the proxy PLC is a consistent STEP 7 V5.x project. Additional information on using the proxy PLC can be found in the article at \3\.

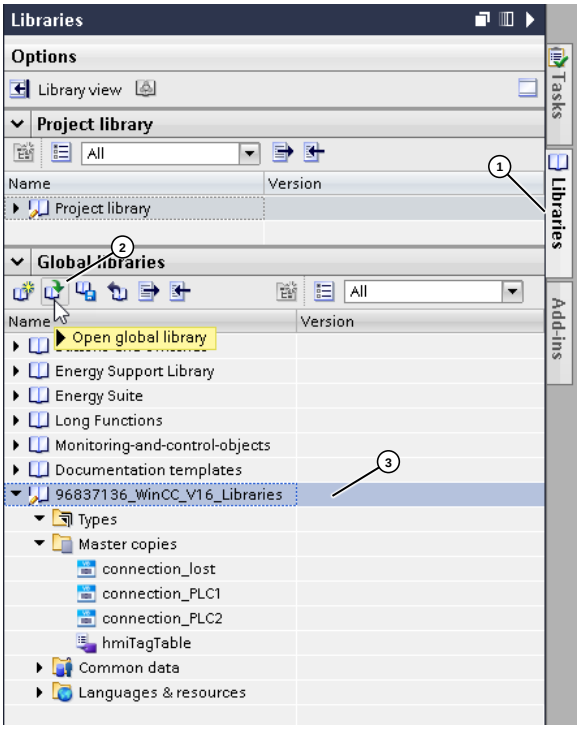
3.3.2 WinCC configuration

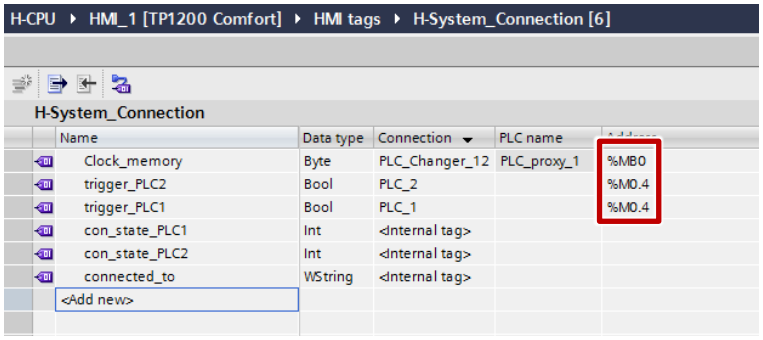
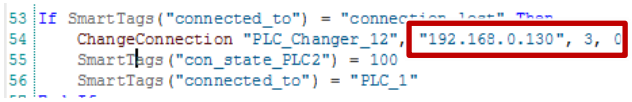
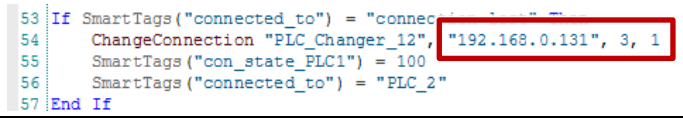
Table 3-6

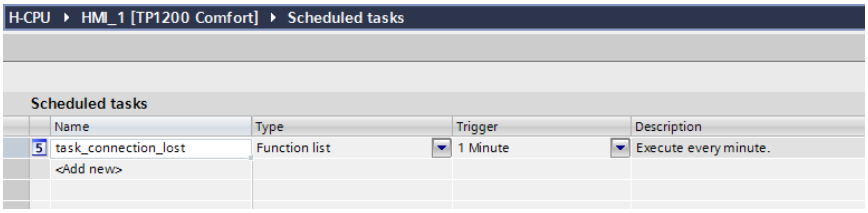
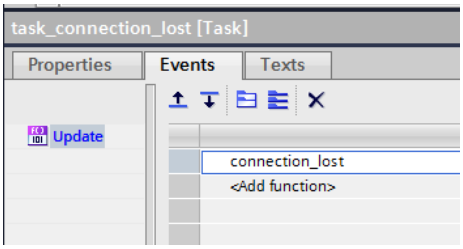
No.	Action
1.	Open the WinCC (TIA Portal) project with the Comfort Panel that you wish to connect to the H CPU.
2.	Add a new device of type "Device proxy". 
3.	Right-click the proxy PLC and select "Initialize device proxy". 
4.	Select the STEP 7 V 5.x project.

No.	Action
5.	Open the Network view and create an HMI connection between the operator device and the proxy PLC. 
6.	Open the "Connections" editor rename the connection you created to "PLC_Changer_12".  The panel will communicate with the H CPU via this connection.

No.	Action
7.	Create two more connections, "PLC_1" and "PLC_2". Adjust the connection settings (IP address, component rack and slot number) for both H CPUs. In this example: PLC_1: 192.168.0.130 (Slot 3, component rack 0) PLC_2: 192.168.0.131 (Slot 3, component rack 1) 

No.	Action
8.	Open the global library "96837136_Panel_H-PLC_library", downloadable from the downloads page of this article. https://support.industry.siemens.com/cs/ww/en/view/96837136  (1) Open the "Libraries" tab (2) Open global library (3) View of the opened library
9.	Drag the tag table "hmiTagTable" and the VB scripts into your HMI project by dragging and dropping.

No.	Action
10.	Open the tag table "hmiTagTable". Change the addresses of the tags • "trigger_PLC1" • "trigger_PLC2" • "Clock_memory", if you did not use memory byte "0" as clock memory. 
11.	Open the script "Script_connection_PLC1". In lines 40 and 54, change the address parameters of the connection "PLC_Changer_12" to the address parameters of your "PLC1". 
12.	Open the script "Script_connection_PLC2". In lines 40 and 54, change the address parameters of the connection "PLC_Changer_12" to the address parameters of your "PLC2". 

No.	Action
13.	Open the Scheduled tasks. Add a new task with the trigger "1 Minute".  Under "Events > Run", add the script "Script_connection_lost".  The call of the scripts "Script_connection_PLC1" and "Script_connection_PLC2" is already configured for the event "Value change" of the "trigger_PLC1" and "trigger_PLC2" tags.
14.	Download the project to your operator device.

3.4 Example scenarios

Initialization

Connections "PLC_1" and "PLC_2" are both active.

Per the default, the connection "PLC_Changer_12" is interconnected to "PLC_1" ("connected_to" = PLC_1).

Fault detection and resetting

The scripts "Script_connection_PLC1" and "Script_connection_PLC2" are triggered by reading the triggers ("trigger_PLC1" und "trigger_PLC2").

- Every time it is run, "Script_connection_PLC1" increments the connection state tag for the connection to PLC_2 by 1, and sets its own connection state tag to 1.
  - con_state_PLC2 = con_state_PLC2 + 1
  - con_state_PLC1 = 1
- Every time it is run, "Script_connection_PLC2" increments the connection state tag for the connection to PLC_1 by 1, and sets its own connection state tag to 1.
  - con_state_PLC1 = con_state_PLC1 + 1
  - con_state_PLC2 = 1

Scenario 1

Due to an error, the connection to PLC_1 is lost.

- The trigger can no longer be read via this connection.
- The script "Script_connection_PLC1" is no longer executed.
- The script "Script_connection_PLC2" continues to be executed cyclically.

The connection state tag for the connection PLC_1 ("con_state_PLC1") is no longer reset, so the connection state tag reaches the limit of 11 (see Table 3-4).

The script "Script_connection_PLC2" checks the connection memory "connected_to". Because this memory is on PLC_1, the "ChangeConnection" function switches the data connection over to the parameters of the PLC_2 connection. The connection memory is set to PLC_2.

- connected_to = PLC_2

Scenario 2

The PLC_2 connection also fails due to a fault, therefore the script "Script_connection_PLC2" can no longer be run.

Scheduled tasks runs the script "Script_connection_lost" once every minute.

Both connection state tags are set to 5 in the first cycle.

- con_state_PLC1 = 5
- con_state_PLC2 = 5

Both connection state tags are set to 100 in the second cycle; the connection memory to "Script_connection_lost".

- con_state_PLC1 = 100
- con_state_PLC2 = 100
- connected_to = connection_lost

→ A complete connection loss has occurred.

4 Software solution without scripts

4.1 Components used

Hardware components

Table 4-1

Component	Qty.	Item number	Note
PS 407 10A	2	6ES7407-0KA02-0AA0	
CPU 416-5H PN/DP	2	6ES7416-5HS06-0AB0	
KTP400 Basic PN	1	6AV2123-2DB03-0AX0	
SCALANCE X204-2	1	6GK5204-2BB00-2AA3	

Software components

Table 4-2

Component	Qty.	Item number	Note
STEP 7 V5.5 + SP4	1	6ES7810-4CC10-0YA5	
WinCC Comfort V16	1	6AV2101-0AA06-0AA5	

4.2 Principle of operation

By evaluating the status of the H CPU (Master/Reserve) and with the internal system function "ChangeConnection" [DE "*WechseleVerbindung*"], it is possible to connect one panel to one H CPU.

To do this, you must set different addresses for the H CPUs.

If the SIMATIC H station detects the failure of one H CPU (e.g. H-CPU_1), a connection is established to the other H CPU using the "ChangeConnection" function.

The "ChangeConnection" function severs the connection to the PLC in use and establishes a new connection to the given PLC.

You have two ways of employing the "ChangeConnection" function:

- Manual switchover with a function key: Configure the system function "ChangeConnection" on the "Print" event.
- Automatic switchover: Automatic call of "ChangeConnection", e.g. at the event "On exceeding" of a process tag.

Note Please remember that when using this solution, no switchover will take place if there are communication failures.

4.3 Configuration

4.3.1 STEP 7 configuration

The FB523 function block enables the output of the "RUN/STOP" operating modes and the "Master/Reserve" status for a fault-tolerant system.

Table 4-3

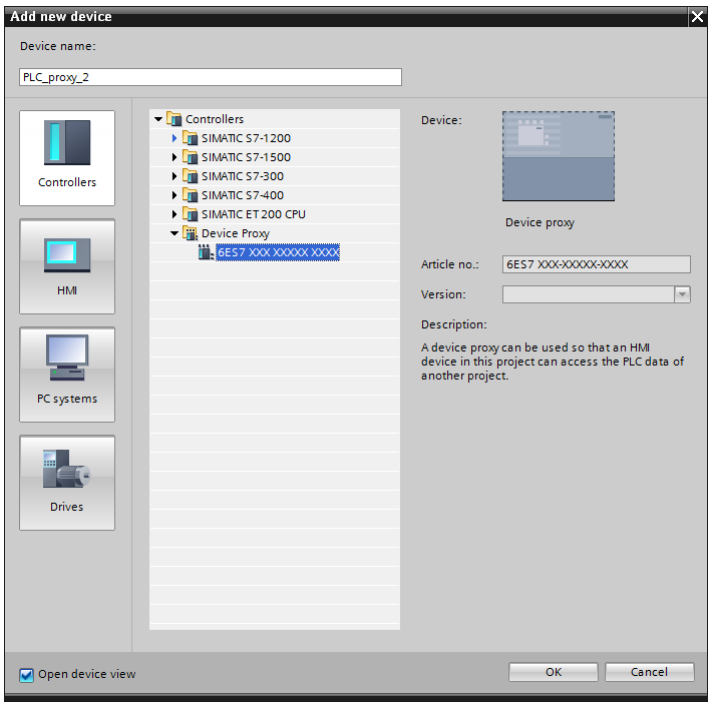
No.	Action
1.	Download the library from link \4 and add it to your project as described in the article.
2.	Define tags for the outputs "R0_MSTR" and "R1_MSTR" (in this example: DB1.DBX4.0 and DB1.DBX5.0)

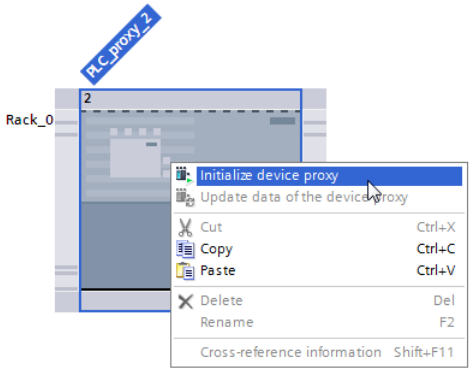
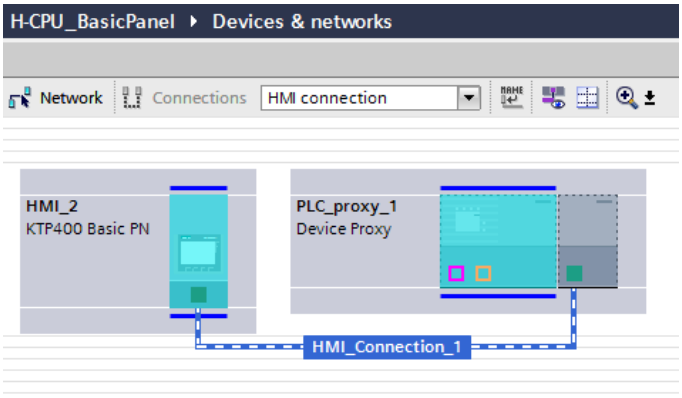
The proxy PLC in WinCC (TIA Portal) is used to connect the operator device to the H CPU. For this reason, no further steps are needed in the STEP 7 project.

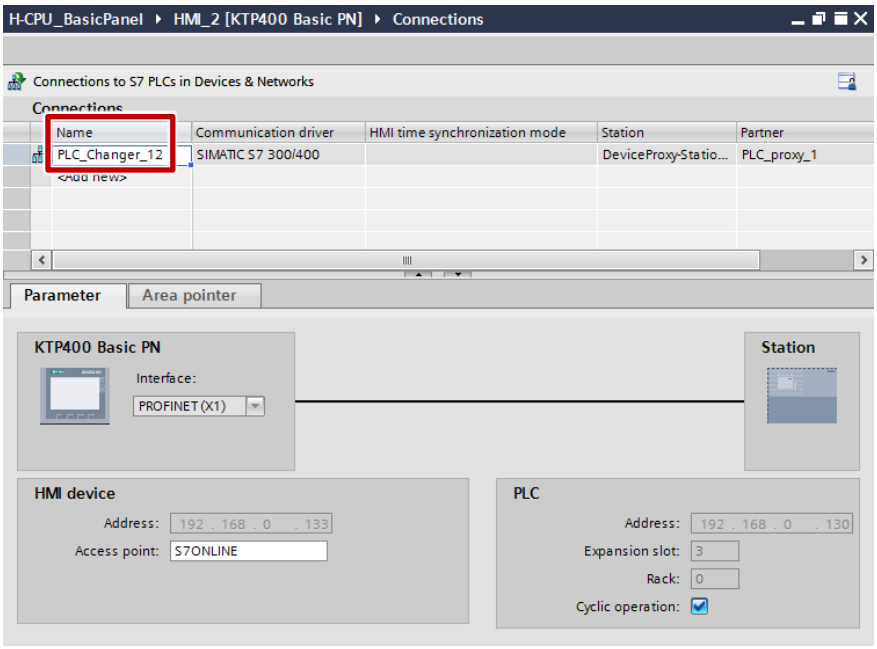
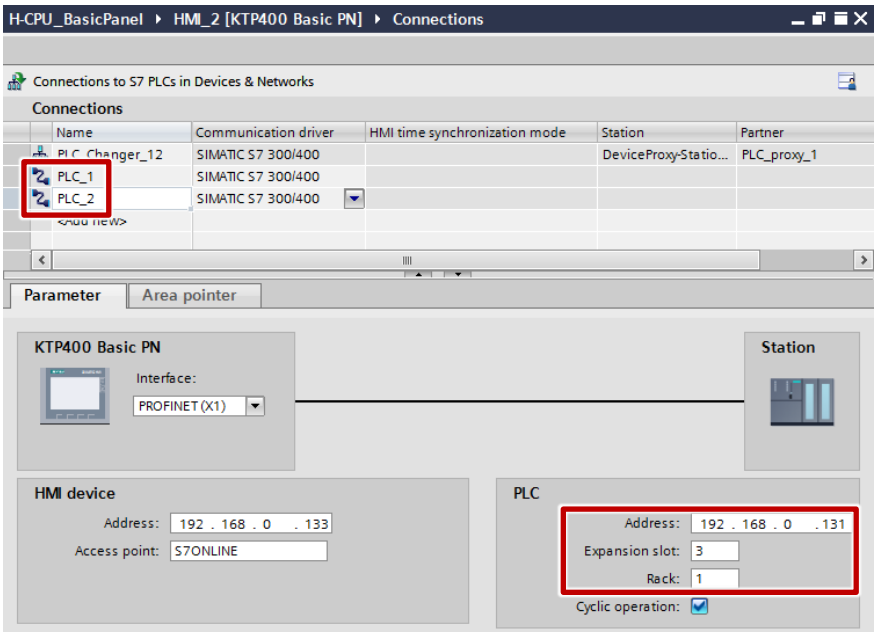
A prerequisite for using the proxy PLC is a consistent STEP 7 V5.x project. Additional information on using the proxy PLC can be found in the article at \3\.

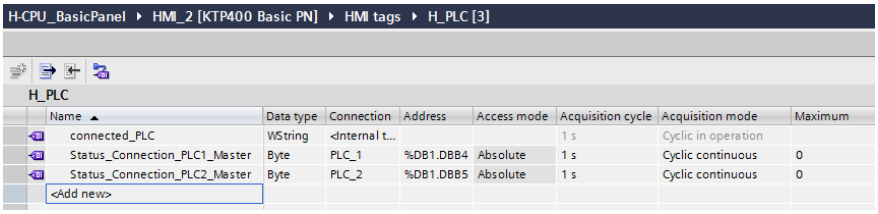
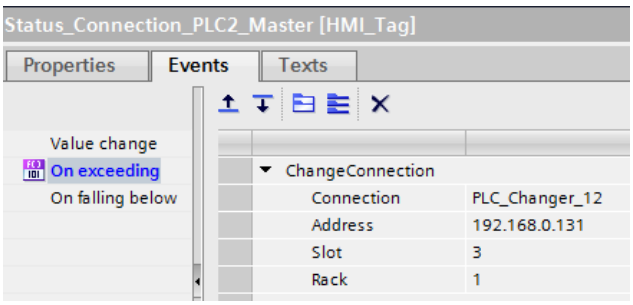
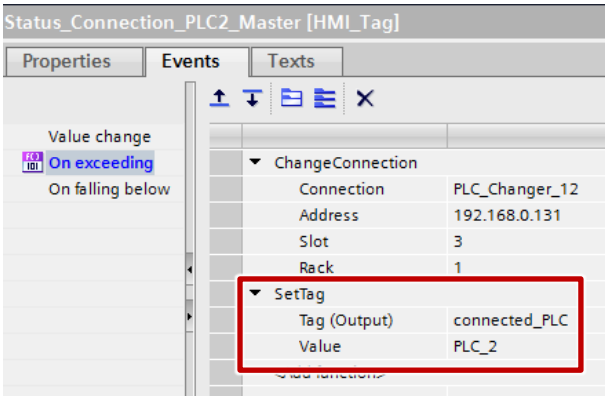
4.3.2 WinCC configuration

Table 4-4

No.	Action
1.	Open the WinCC (TIA Portal) project with the operator device that you wish to connect to the H CPU.
2.	Add a new device of type "Device proxy". 

No.	Action
3.	Right-click the proxy PLC and select "Initialize device proxy". 
4.	Select the STEP 7 V 5.x project.
5.	Open the Network view and create an HMI connection between the operator device and the proxy PLC. 

No.	Action
6.	Open the "Connections" editor rename the connection you created to "PLC_Changer_12".  The panel will communicate with the H CPU via this connection.
7.	Create two more connections, "PLC_1" and "PLC_2". Adjust the connection settings (IP address, component rack and slot number) for both H CPUs. In this example: PLC_1: 192.168.0.130 (Slot 3, component rack 0) PLC_2: 192.168.0.131 (Slot 3, component rack 1) 

No.	Action
8.	Open an HMI tag table and add the following tags. • **Status_Connection_PLC1_Master**: Data type: byte, connection: PLC_1, address: DB1.DBB4, acquisition mode: Cyclic continuous, maximum: "0" • **Status_Connection_PLC2_Master**: Data type: byte, connection: PLC_2, address: DB1.DBB5, acquisition mode: Cyclic continuous, maximum: "0" • **Connected_PLC**: Data type: WString, connection: Internal tag Length: 15 
9.	Under "Events > On exceeding", configure the system function "ChangeConnection" for the tags "Status_Connection_PLC1_Master" and "Status_Connection_PLC2_Master". For the connection "PLC_Changer_12", enter the connection parameters of each connection "PLC_1" and "PLC_2". 
10.	Also configure the system function "SetTag" to the event "On exceeding" for both tags. Describe the tag "connected_PLC" with the name of the respective controller. 

4.4 Example scenarios

Table 4-5

H CPU	Address	Bit status	Result
PLC_1	DB1.DBX4.0	1	Master
PLC_2	DB1.DBX5.0	0	Reserve
PLC_1	DB1.DBX4.0	0	Reserve
PLC_2	DB1.DBX5.0	1	Master

PLC_1 is Master

The operator device evaluates the upper limit of the tag "DB1.DBB4" (limit: 0). If the bit "DB1.DBX4.0" is set, the limit is exceeded and the function "ChangeConnection" is run.

The connection switches from the defined connection of "PLC_Changer_12" to the parameterized connection parameters of "PLC_1".

The connection to PLC_1 is established.

PLC_2 is Master:

The operator device evaluates the upper limit of the tag "DB1.DBB5" (limit: 0). If the bit "DB1.DBX5.0" is set, the limit is exceeded and the function "ChangeConnection" is run.

The connection switches from the defined connection of "PLC_Changer_12" to the parameterized connection parameters of "PLC_2".

The connection to PLC_2 is established.

Note In order to test the function, you can manually switch the Master CPU to STOP mode.

5 Appendix

5.1 Service and support

Industry Online Support

Do you have any questions or need assistance?

Siemens Industry Online Support offers round the clock access to our entire service and support know-how and portfolio.

The Industry Online Support is the central address for information about our products, solutions and services.

Product information, manuals, downloads, FAQs, application examples and videos – all information is accessible with just a few mouse clicks:
https://support.industry.siemens.com

Technical Support

The Technical Support of Siemens Industry provides you fast and competent support regarding all technical queries with numerous tailor-made offers – ranging from basic support to individual support contracts. Please send queries to Technical Support via Web form:
www.siemens.com/industry/supportrequest

SITRAIN – Training for Industry

We support you with our globally available training courses for industry with practical experience, innovative learning methods and a concept that's tailored to the customer's specific needs.

For more information on our offered trainings and courses, as well as their locations and dates, refer to our web page:
www.siemens.com/sitrain

Service offer

Our range of services includes the following:

- Plant data services
- Spare parts services
- Repair services
- On-site and maintenance services
- Retrofitting and modernization services
- Service programs and contracts

You can find detailed information on our range of services in the service catalog web page:
Fehler! Linkreferenz ungültig.

Industry Online Support app

You will receive optimum support wherever you are with the "Siemens Industry Online Support" app. The app is available for Apple iOS, Android and Windows Phone:
Fehler! Linkreferenz ungültig.

5.2 Links and Literature

Table 5-1

No.	Subject
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Link to the article page of the application example https://support.industry.siemens.com/cs/ww/en/view/96837136
\3\	Combined configuration with WinCC (TIA Portal) and STEP 7 V5.x https://support.industry.siemens.com/cs/ww/en/view/73502293
\4\	How do you read out the operating state and status of an H system? https://support.industry.siemens.com/cs/ww/en/view/19537149

5.3 Change documentation

Table 5-2

Version	Date	Change
V1.0	02/2015	First edition
V2.0	09/2020	Adapted for WinCC V16