Diagnostics in the User Program with S7-1500

TIA Portal, S7-1500

https://support.industry.siemens.com/cs/ww/en/view/98210758

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Table of Contents

1 Introduction

In the SIMATIC environment, diagnostics of devices and modules are grouped under the term ‘system diagnostics’. The monitoring functions are automatically derived from the hardware configuration.

All SIMATIC products have integrated diagnostic functions that allow you to detect and clear faults. The components automatically report a fault during operation and provide additional detailed information. Plant-wide diagnostics can minimize unscheduled downtimes.

Diagnostics with the user program enables you to identify faulty devices and modules. This allows you to program responses to diagnostic alarms in the user program.

Note If diagnostic information is only displayed on different visual display devices and not used in the user program, it is recommended to use the S7-1500 controllers’ integrated system diagnostics. For more information about integrated system diagnostics, please refer to the following application example:
“System Diagnostics with S7-1500 and TIA Portal”

https://support.industry.siemens.com/cs/ww/en/view/68011497

1.1 Overview

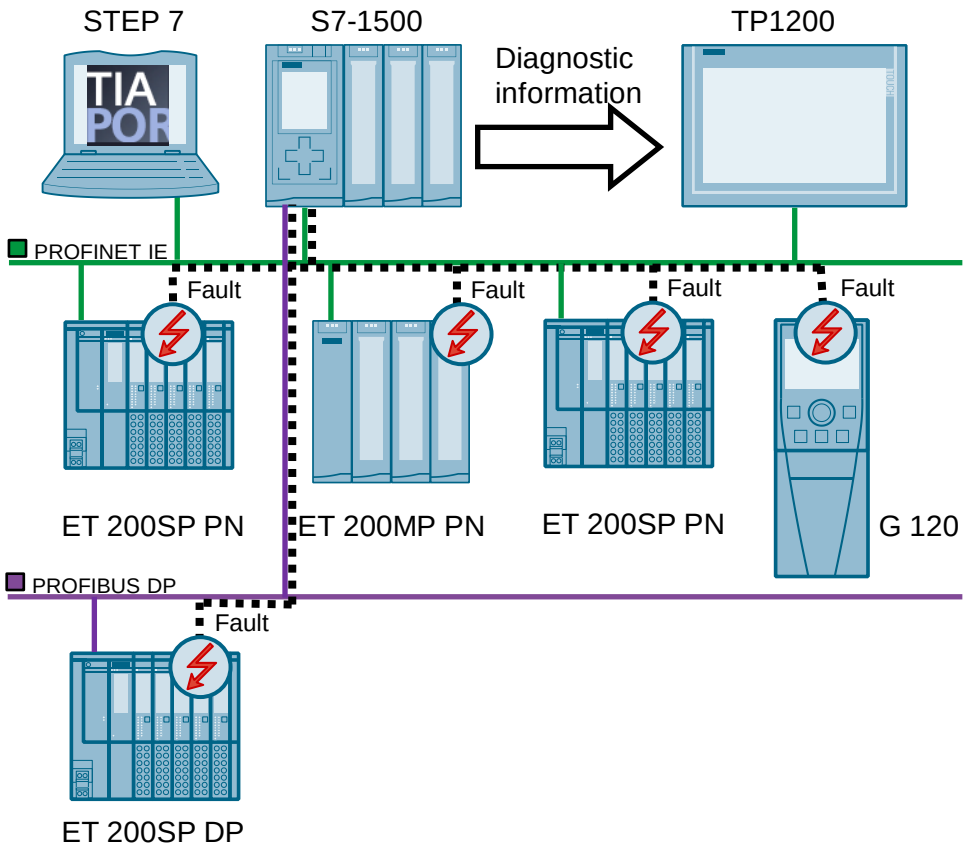
This application example describes how to monitor a PROFINET IO system and a PROFIBUS DP master system with different devices in the user program. The devices are connected to an S7-1500 controller via PROFINET IO / PROFIBUS DP. The devices detect faults on their modules and send the diagnostic data to the assigned controller. The controller evaluates this diagnostic information with the diagnostic instructions in the user program and saves it to a global data block. The operator panel graphically displays the evaluated diagnostic information in one view per IO system or in a device view.

It considers the following states:

- State OK
- State FAULTY
- State LOST CONNECTION
- State DEACTIVATED
- State PROBLEM / MAINTENANCE
- State WAS FAULTY
- State HAD LOST CONNECTION
- State WAS DEACTIVATED
- State WAS PROBLEM / MAINTENANCE

The following figure shows the hardware that was used for testing.

Figure 1-1: Hardware overview



Note This application example influences the cycle time of your program. The cycle time extension size depends on the plant configuration to be monitored and the CPU used. Therefore, no approximate values can be given at this point.

You can copy the PLC objects of the application example directly to your project. All you have to do is customize the constants to define the size of the diagnostic structure (highest device number or slave address in the IO system). In addition, customize the hardware ID of your CPU and IO system.

1.2 Components used

This application example was created with the following hardware and software components:

Table 1-1: Hardware and software components

Component	No.	Article no.	Note
CPU 1516-3 PN/DP	1	6ES7516-3AN01-0AB0	Alternatively, any other S7-1500 CPU can be used.
Memory card, 12 Mbytes	1	6ES7954-8LE02-0AA0	-
Digital input module, DI 32x24VDC HF	1	6ES7521-1BL00-0AB0	Configurable diagnostics
Front connector, screw-type, 40-pin	2	6ES7592-1AM00-0XB0	-
Digital output module, DQ 32x24VDC/0.5A ST	1	6ES7522-1BL00-0AB0	Configurable diagnostics
Analog input module, AI 8xU/I/RTD/TC ST	1	6ES7531-7KF00-0AB0	Configurable diagnostics
Front connector, push-in type, 40-pin	1	6ES7592-1BM00-0XB0	-
IM 155-5 PN ST	1	6ES7155-5AA00-0AB0	ET 200MP
Digital input module, DI 32x24VDC HF	1	6ES7521-1BL00-0AB0	Configurable diagnostics
Digital output module, DQ 32x24VDC/0.5A ST	1	6ES7522-1BL00-0AB0	Configurable diagnostics
Analog input module, AI 8xU/I/RTD/TC ST	1	6ES7531-7KF00-0AB0	Configurable diagnostics
Front connector, screw-type, 40-pin	2	6ES7592-1AM00-0XB0	-
Front connector, push-in type, 40-pin	1	6ES7592-1BM00-0XB0	-
IM 155-6 PN ST, incl. server module, incl. bus adapter 2xRJ45	1	6ES7155-6AA00-0BN0	ET 200SP
DI 8x24VDC HF	1	6ES7131-6BF00-0CA0	Configurable diagnostics
DQ 8x24VDC/0.5A HF	1	6ES7132-6BF00-0CA0	Configurable diagnostics
AQ 4xU/I ST	1	6ES7135-6HD00-0BA1	Configurable diagnostics
BU type A0, 16 push-in, 2 infeed terminals separated (digital/analog, max. 24VDC/10A)	1	6ES7193-6BP00-0DA0	-
BU type A0, 16 push-in, 2 infeed terminals bridged (digital/analog, 24VDC/10A)	2	6ES7193-6BP00-0BA0	-
IM 155-6 PN ST, incl. server module, incl. bus adapter 2xRJ45	1	6ES7155-6AA00-0BN0	ET 200SP
DI 16x24VDC ST	1	6ES7131-6BH00-0BA0	Configurable diagnostics

Component	No.	Article no.	Note
BU type A0, 16 push-in, 2 infeed terminals separated (digital/analog, max. 24VDC/10A)	1	6ES7193-6BP00-0DA0	-
IM 155-6 DP HF incl. server module, incl. DP connector	1	6ES7155-6BA00-0CN0	ET 200SP DP
DI 8x24VDC HF	1	6ES7131-6BF00-0CA0	Configurable diagnostics
AI 4xRTD/TC HF	1	6ES7134-6JD00-0CA1	Configurable diagnostics
BU type A0, 16 push-in, 2 infeed terminals separated (digital/analog, max. 24VDC/10A)	1	6ES7193-6BP00-0DA0	-
BU type A0, 16 push-in, 2 infeed terminals bridged (digital/analog, 24VDC/10A)	1	6ES7193-6BP00-0BA0	-
TP1200 Comfort	1	6AV2124-0MC01-0AX0	-
CU240E-2 PN-F	1	6SL3244-0BB13-1FA0	G120 drive
PM340	1	6SL3210-1SB14-0UA0	Power module
STEP 7 Professional V14 SP1	1	6ES7822-1..04-..	-
WinCC Professional V14 SP1	1	6AV210.-….4-0	-
SINAMICS Startdrive V14 SP1	1	6SL3072-4EA02-0X.0	-
STEP 7 Professional V15.1 Update 1	1	6ES7822-1..05-..	-
WinCC Professional V15.1 Update 1	1	6AV210.-….5-0	-
SINAMICS Startdrive V15.1	1	6SL3072-4FA02-0X..	-

Hinweis

For the application example you need the free software package SINAMICS Startdrive Basic. You can download SINAMICS Startdrive under the following link:

https://support.industry.siemens.com/cs/ww/en/view/109760845

This application example consists of the following components:

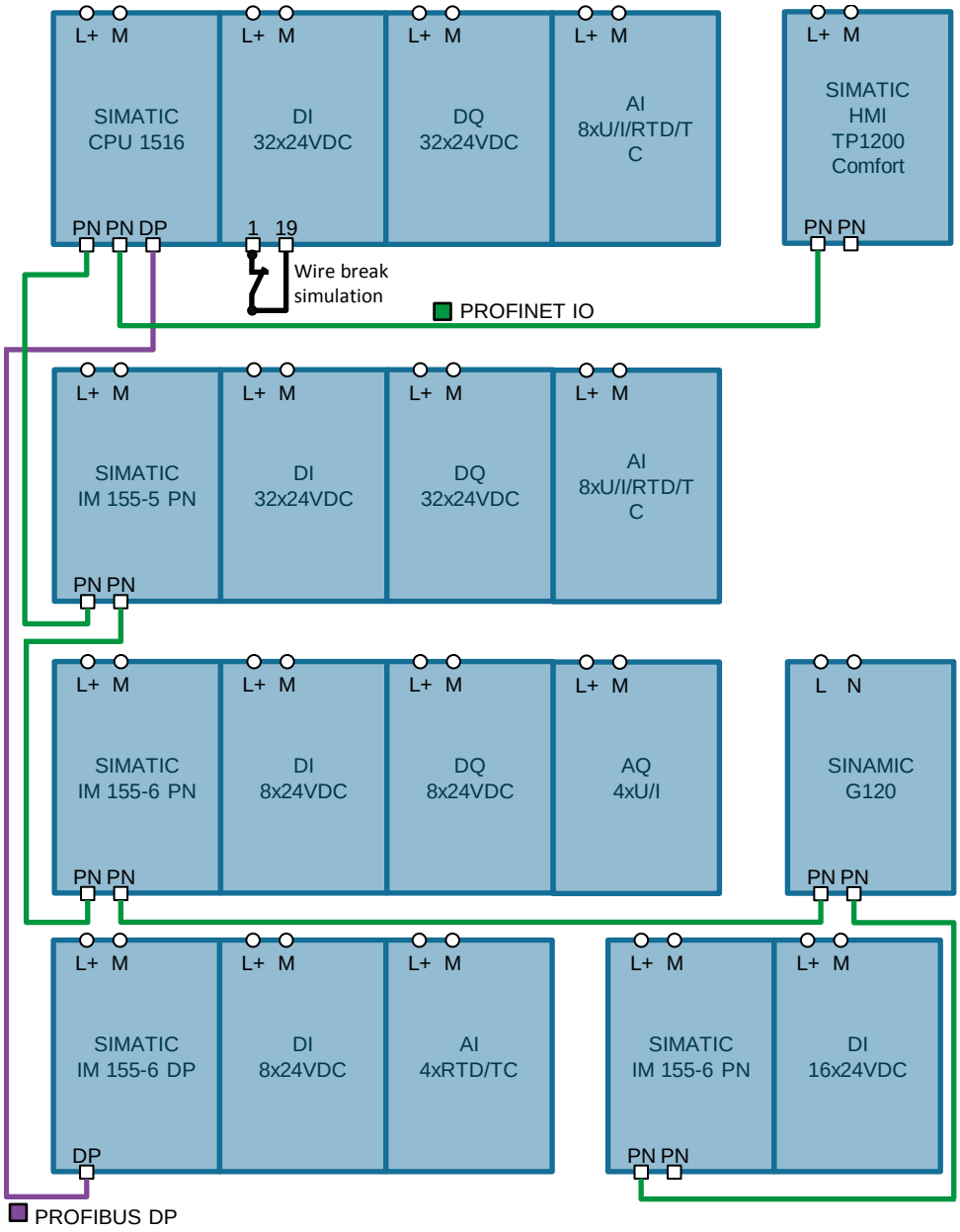
Table 1-2: Components of the application example

Component	File name
Documentation	98210758_User_defined_diagnostics_DOC_V34_en.pdf
STEP 7 project TIA V14 SP1	98210758_Diag1500_TIAV14SP1_PROJ_V32.zip
STEP 7-Projekt TIA V15.1 for WinCC Advanced	98210758_Diag1500_TIAV15.1_Adv_PROJ_V34.zip
STEP 7-Projekt TIA V15.1 for WinCC Professional	98210758_Diag1500_TIAV15.1_Prof_PROJ_V34.zip

2 Test Project Engineering

2.1 Hardware configuration of the test project

Figure 2-1: Hardware configuration of the test project



2.2 Configuring the diagnostic settings

You can enable the module-specific diagnostic settings separately for each module of your project. You can configure the diagnostic settings in the device view in the module properties.

The following diagnostic settings can be made:

- No supply voltage L+
- Wire break
- Short circuit to ground
- etc.

Note For examples of how to configure the diagnostic settings, please refer to the following application example:
"System Diagnostics with S7-1500 and TIA Portal"

https://support.industry.siemens.com/cs/ww/en/view/68011497

2.3 IP addresses, PROFIBUS addresses and device names

The application example uses the following device numbers, device names, IP addresses and PROFIBUS addresses:

Table 2-1: Overview of IP addresses, PROFIBUS addresses and device names

Component	Device number	IP address	PROFIBUS address	Device name
SIMATIC CPU 1516	0	192.168.0.1	2	PLC_1
SIMATIC IM 155-6 PN	2	192.168.0.2	-	ET200SP_1
SIMATIC IM 155-5 PN	3	192.168.0.3	-	ET200MP_2
SIMATIC IM 155-6 PN	10	192.168.0.10	-	ET200SP_10
SINAMICS G120	30	192.168.0.30	-	Drive_1
SIMATIC HMI TP1200	-	192.168.0.4	-	HMI_1
SIMATIC PC station	-	192.168.0.40	-	PC System_1
SIMATIC IM 155-6 DP	-	-	8	Slave_8

2.4 Setting the PROFIBUS DP address

For the controller to communicate with the PROFIBUS devices, set the PROFIBUS DP address using the DIP switches on the interface module of the ET 200SP.

Note For more information, please refer to the "SIMATIC ET 200SP IM 155-6 DP HF interface module" manual, chapter "Setting the PROFIBUS DP address".

https://support.industry.siemens.com/cs/ww/en/view/73098660/75117321227.

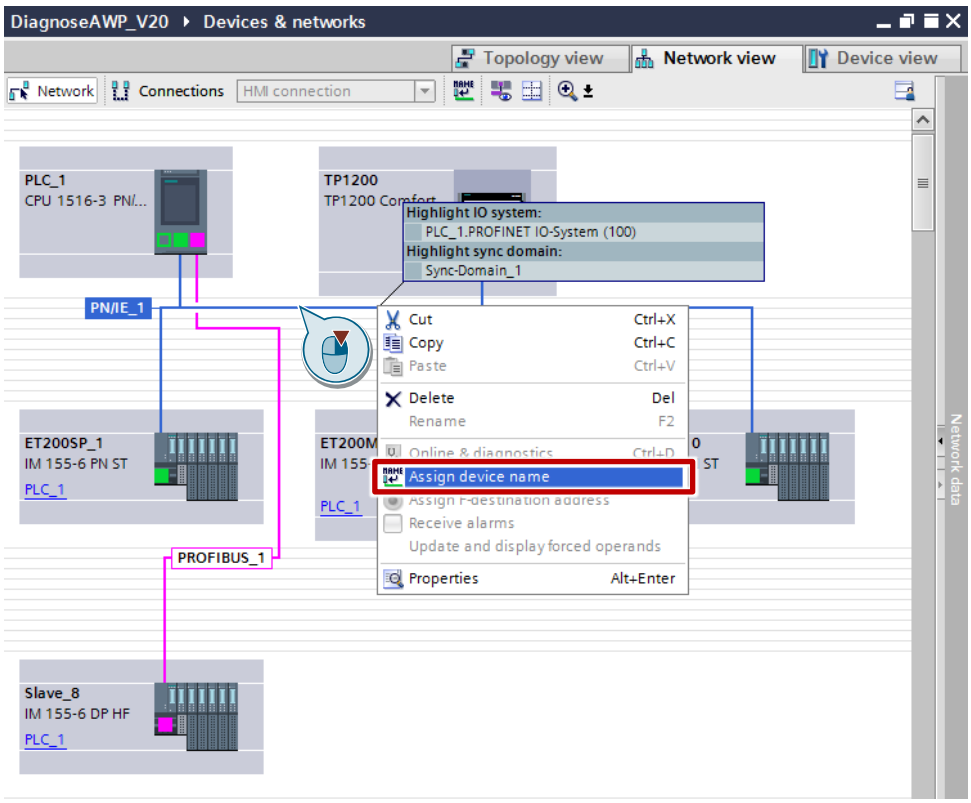
2.5 Assigning the PROFINET device names

For all PROFINET devices to communicate with each other, assign a PROFINET device name to the devices.

To do this, proceed as follows:

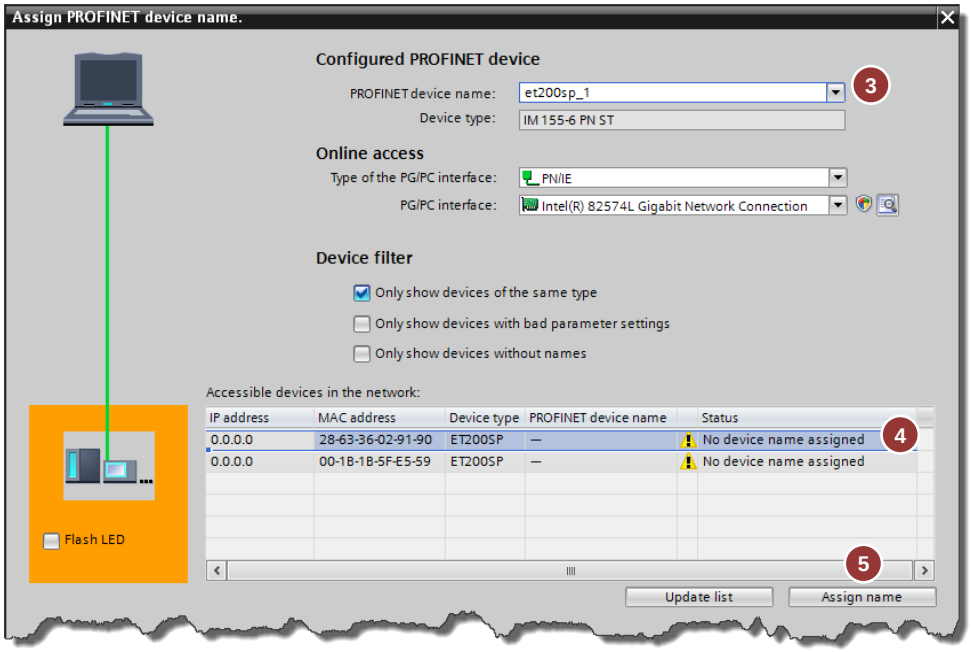
1. Open the network view.
2. Right-click the PROFINET connection line and select “Assign device name”. The “Assign PROFINET device name” dialog is displayed.

Figure 2-2: Network view



3. In “PROFINET device name”, select the device name.
4. From the list of accessible devices, select the device to which you want to assign the PROFINET device name. You can update the list by clicking “Update list”.
5. Click “Assign name”.
   This assigns the device name.

Figure 2-3: “IO Systems” screen



6. Repeat steps 3 through 5 for all devices.

2.6 Integration into the user project

The application example described here can be fully integrated into your project. The necessary steps are described below.

Note Chapter 3.3 describes how the program blocks work.

2.6.1 Integrating PLC objects

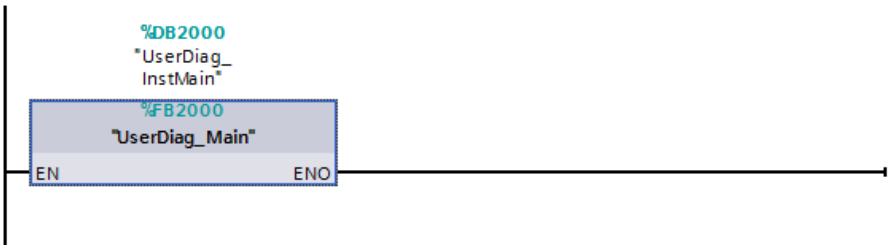
Copying PLC objects

You can integrate the PLC objects of the application example directly into your project.

To do this, proceed as follows:

1. Use TIA Portal to open your project.
2. Open the application example in a second instance of TIA Portal. Alternatively, you can open the application example as a reference project for your project.
3. In the application example, “PLC_1 > PLC tags”, copy the “UserDiag” folder and paste the folder into the same location in your project.
4. In the application example, “PLC_1 > PLC data types”, copy the “UserDiag” folder and paste the folder into the same location in your project.
5. In the application example, “PLC_1 > Program blocks”, copy the “UserDiag” folder and paste the folder into the same location in your project.
6. Call the FB "UserDiag_Main" in the first network of the OB "Main".

Figure 2-4: Call in OB "Main"



7. Close the second instance of TIA Portal with the application example.

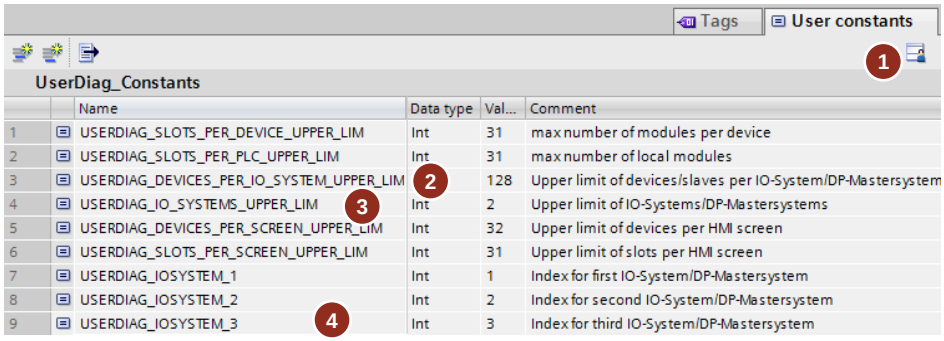
Customizing constants to the project

The user constants allow you to customize the size of the diagnostic structures in the “UserDiag_DiagnosticsData” DB to your project.

To do this, proceed as follows:

1. In “PLC_1 > PLC tags > UserDiag > UserDiag_Constants”, open the “User constants”.
2. Optional: If the highest device number/slave address in your project is greater than 128, modify the “USERDIAG_DEVICES_PER_ IO_SYSTEM_UPPER_LIM” constant to the highest device number/slave address.
3. Modify the “USERDIAG_IO_SYSTEMS_UPPER_LIM” constant to the number of IO systems in your project.
4. Create new constants for additional IO systems.
   For example, “USERDIAG_IOSYSTEM_3” Int 3

Figure 2-5: “User constants”



Customizing the call of the diagnostic blocks to the project

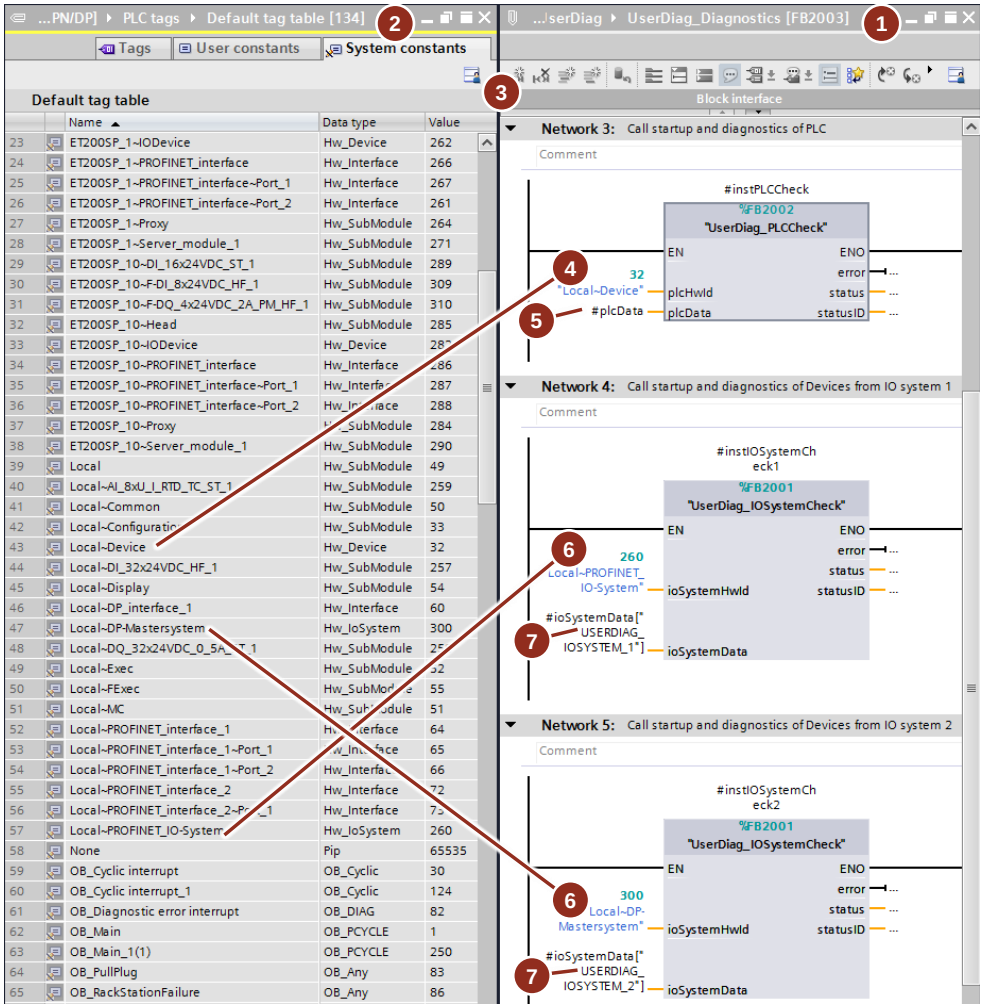
The hardware IDs of the controller and the IO systems in your project may differ from the hardware IDs in the application example. The hardware IDs are customized when calling the diagnostic blocks in the "UserDiag_Diagnostics" FB.

Note If you upgrade TIA Portal V13 SP1 projects to TIA Portal V14, you will not find a hardware ID for the PLC named “Local~Device” in the system constants. In this case, assign the value “32” to the “plcHwId” parameter of the “UserDiag_PLCCheck” FB (see step 4).

To do this, proceed as follows:

1. Open the "UserDiag_Diagnostics" FB.
2. In “PLC_1 > PLC tags > Default tag table”, open the system constants.
3. Vertically split the editor area.
4. Use drag and drop to assign the PLC hardware ID to the “plcHwId” parameter of the “UserDiag_PLCCheck” FB.
5. The PLC’s diagnostic structure has already been assigned to the “plcData” parameter of the “UserDiag_PLCCheck” FB.
6. Use drag and drop to assign the IO system hardware ID to the “ioSystemHwId” parameter of the “UserDiag_IOSystemCheck” FB.
7. The diagnostic structure of the appropriate IO system (PROFINET IO system or DP master system) has already been assigned to the “ioSystemData” parameter of the “UserDiag_IOSystemCheck” FB.
   Please note that each IO system gets its own index, for example “IO_SYSTEM1”.
8. Repeat steps 6 and 7 for the DP master system.
9. If necessary, insert more instances of the “UserDiag_IOSystemCheck” FB into the “UserDiag_Main” FB and repeat steps 6 and 7.
   An instance of the “UserDiag_IOSystemCheck” FB must be created for each IO system.

Figure 2-6: Customizing the call to the project



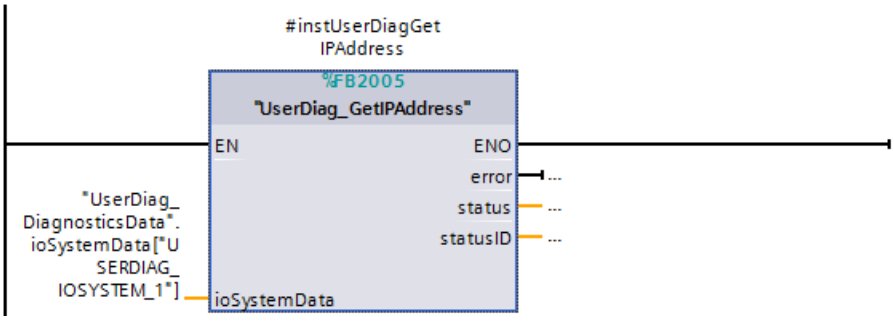
Calling "UserDiag_GetIPAddress"

With the FB "UserDiag_GetIPAddress" you can read the IP addresses of the devices of a PROFINET IO system.

Insert additional instances of the FB "UserDiag_GetIPAddress" in the FB "UserDiag_Main" as needed. For each PROFINET IO system a separate instance of the FB "UserDiag_GetIPAddress" is necessary.

Notice that each IO system requires a unique index, e.g. "USERDIAG_IOSYSTEM_1".

Figure 2-7: Call of "UserDiag_GetIPAddress"



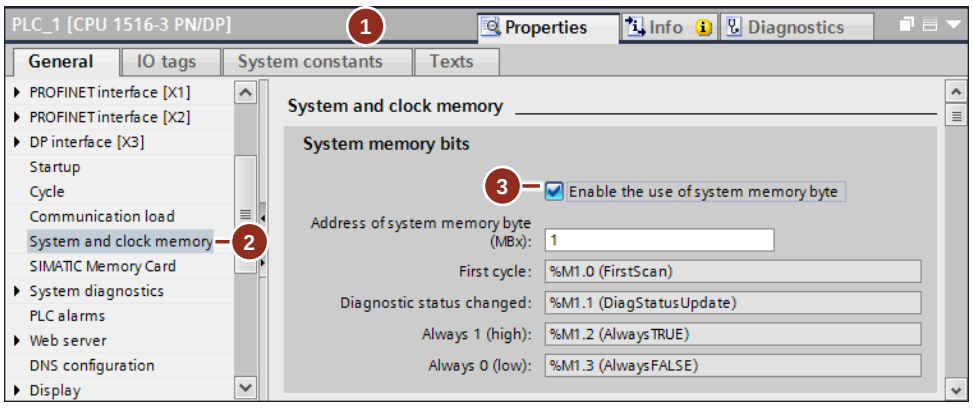
Enable System memory

The system memory bit "DiagStatusUpdate" is used in the application example to evaluate the diagnosis at change of the diagnostic state. Therefore you have to enable the system memory of the PLC.

To do this, proceed as follows:

1. Open the properties of the PLC.
2. Navigate to "System and clock memory".
3. Enable "Enable the use of system memory byte".

Abbildung 2-8: Enable System memory



2.6.2 Integrating HMI objects (TP 1200)

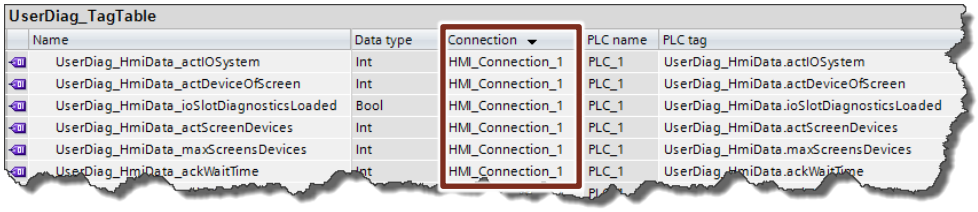
Note Alternatively, you can copy the entire HMI from the application example to your project.

You can integrate the HMI objects of the application example directly into your project.

To do this, proceed as follows:

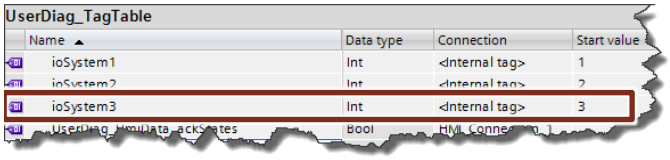
1. Use TIA Portal to open your project.
2. Open the application example in a second instance of TIA Portal. Alternatively, you can open the application example as a reference project for your project.
3. In the application example, “HMI_1 > HMI tags”, copy the “UserDiag” folder and paste the folder into the same location in your project.
4. Open the “UserDiag_TagTable” HMI tag table and in the “Connection” column, set the HMI connection of your HMI.

Figure 2-9: “UserDiag_TagTable” HMI tag table



5. If you want to create more IO systems, open the “UserDiag_TagTable” HMI tag table and create one new HMI tag for each additional IO system (e.g., “ioSystem3” Int 3).

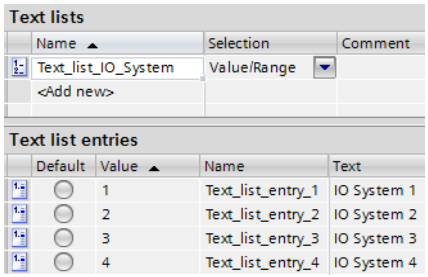
Figure 2-10: “UserDiag_TagTable” HMI tag table



6. In the application example, “HMI_1 > Scripts > VB scripts”, copy the “UserDiag” folder and paste the folder into the same location in your project.
7. In the application example, “HMI_1 > Screen management > Pop-up screens”, copy the “UserDiag” folder and paste the folder into the same location in your project.
8. In the application example, “HMI_1 > Screens > 001_Application”, copy the “Topic_001.0_PLC”, “Topic_002.0_IO_System” and “Topic_003.0_Messages” screens and paste the screens into your project.

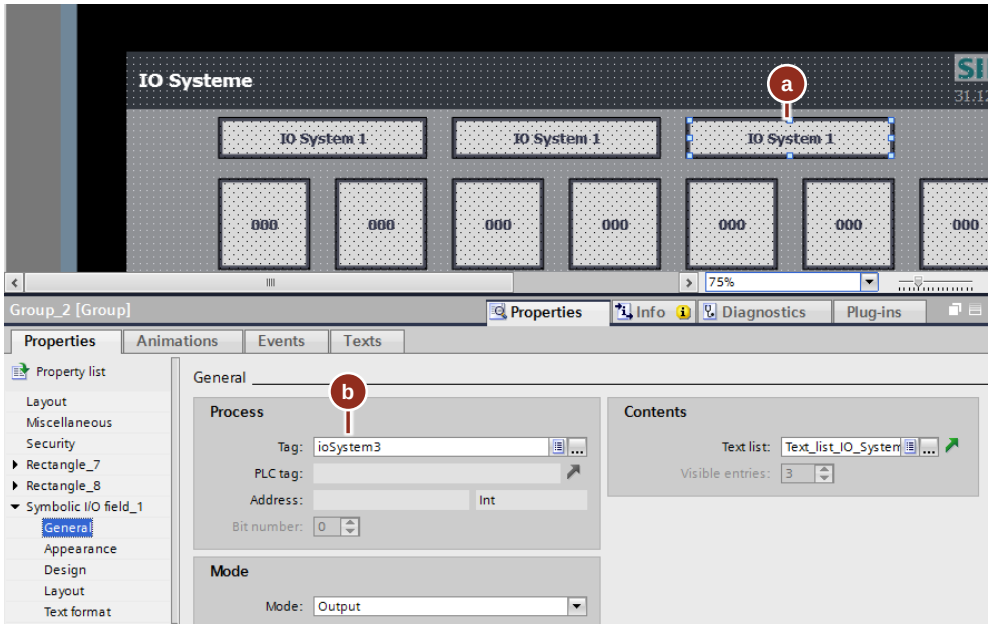
9. In the screens' properties, select your template or no template.
   You can also copy the templates in "HMI_1 > Screen management > Templates" to your project.
10. To be able to open the screens on the operator panel, integrate the screens into your screen navigation.
11. In "HMI_1 > Text and graphic lists", change the "Text_list_IO_System" text list to the number of your IO systems. The text list is used for displaying the IO system in the "Topic_002.0_IO_System" screen.
    The text list has already been created for four IO systems.

Figure 2-11: "Text_list_IO_System" text list



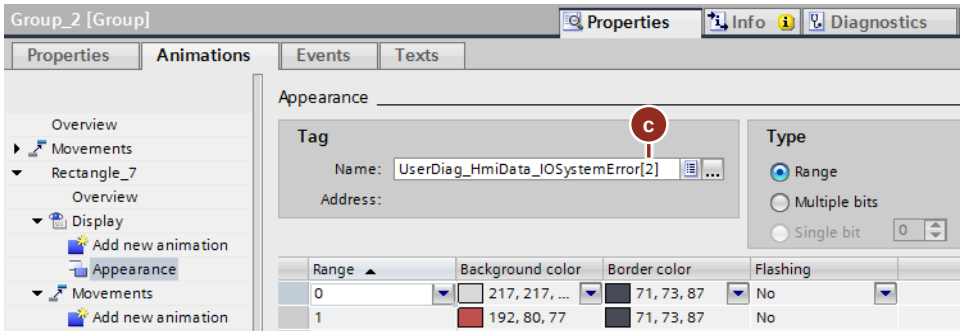
12. If you want to integrate another IO system, open the "Topic_002.0_IO_System" screen.
    a. Copy the group for another IO system.
    b. Enter the HMI tag for your additional IO system.

Figure 2-12: "Topic_002.0_IO_System" screen



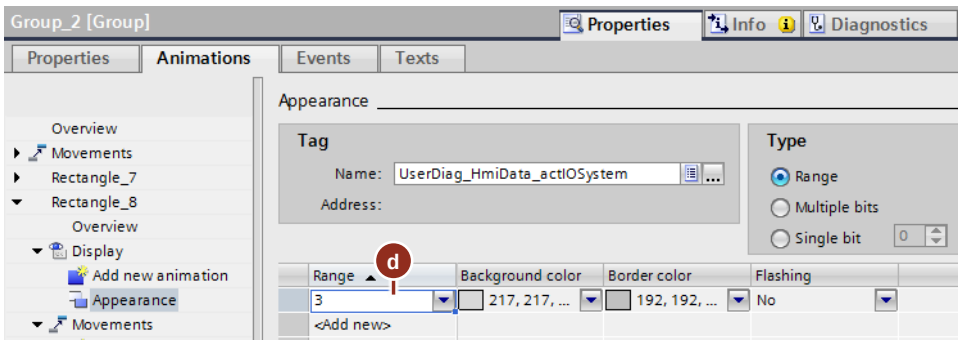
c. Customize the index to your additional IO system.
Please note: The array for the HMI starts at the lower limit 0 and not, as is the case in the STEP 7 user program, at 1.

Figure 2-13: “Topic_002.0_IO_System” screen



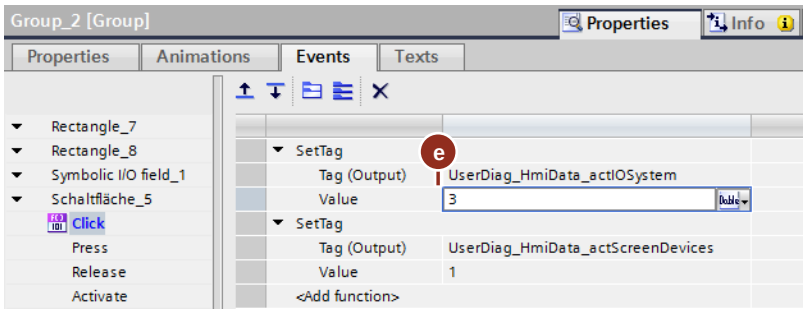
d. Customize the range to your additional IO system.

Figure 2-14: “Topic_002.0_IO_System” screen



e. Customize the value to your additional IO system.

Figure 2-15: “Topic_002.0_IO_System” screen



2.6.3 Integrating HMI objects (PC station)

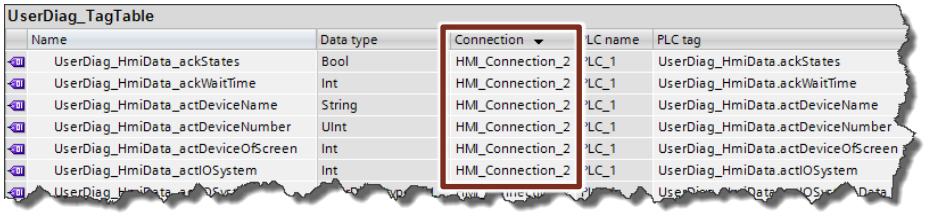
Note Alternatively, you can copy the entire PC station from the application example to your project.

You can integrate the HMI objects of the application example directly into your project.

To do this, proceed as follows:

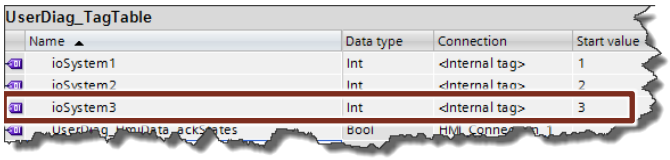
1. Use TIA Portal to open your project.
2. Open the application example in a second instance of TIA Portal. Alternatively, you can open the application example as a reference project for your project.
3. In the application example, “PC-System_1 > HMI_RT_2 > HMI tags”, copy the “UserDiag” folder and paste the folder into the same location in your project.
4. Open the “UserDiag_TagTable” HMI tag table and in the “Connection” column, set the HMI connection of your PC station.

Figure 2-16: “UserDiag_TagTable” HMI tag table



5. If you want to create more IO systems, open the “UserDiag_TagTable” HMI tag table and create one new HMI tag for each additional IO system (e.g., “ioSystem3” Int 3).

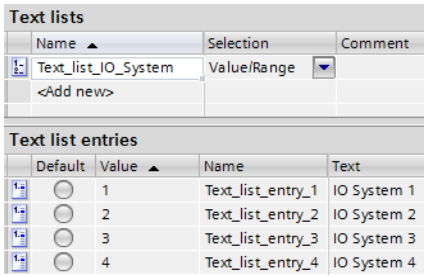
Figure 2-17: “UserDiag_TagTable” HMI tag table



6. In the application example, “PC-System_1 > HMI_RT_2 > Scripts > VB scripts”, copy the “UserDiag” folder and paste the folder into the same location in your project.
7. In the application example, “PC-System_1 > HMI_RT_2 > Screens”, copy the “Pop-Up” and “Slide-in” folders and paste the folders into the same location in your project.
8. In the application example, “PC-System_1 > HMI_RT_2 > Screens > 001_Application”, copy the “Topic_0010_PLC”, “Topic_0020_IO_System” and “Topic_0030_Messages” screens and paste the screens into your project.
9. To be able to open the screens in Runtime, integrate the screens into your screen navigation.

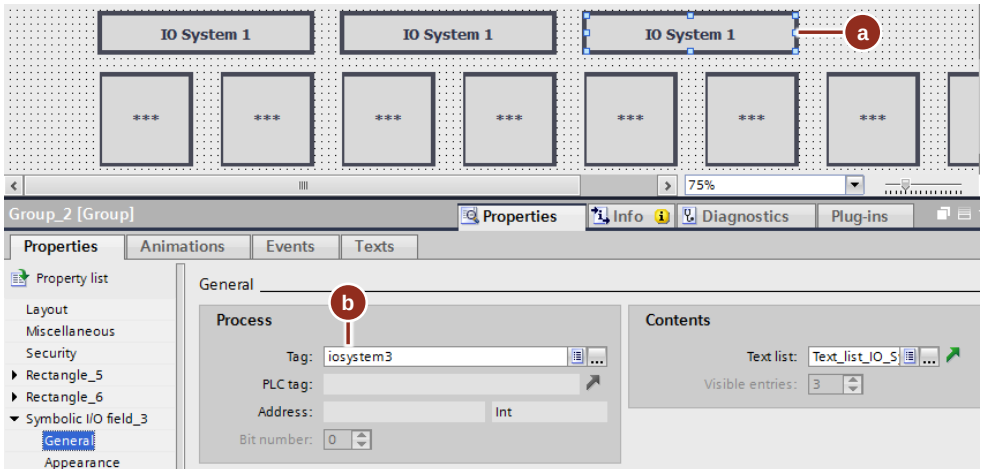
10. In “PC-System_1 > HMI_RT_2 > Text and graphic lists”, change the “Text_list_IO_System” text list to the number of your IO systems. The text list is used for displaying the IO system in the “Topic_0020_IO_System” screen. The text list has already been created for four IO systems.

Figure 2-18: “Text_list_IO_System” text list



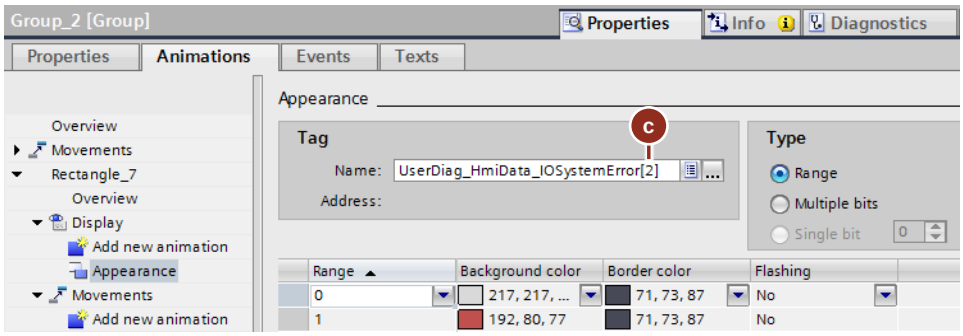
11. If you want to integrate another IO system, open the “Topic_002.0_IO_System” screen.
    a. Copy the group for another IO system.
    b. Enter the HMI tag for your additional IO system.

Figure 2-19: “Topic_002.0_IO_System” screen



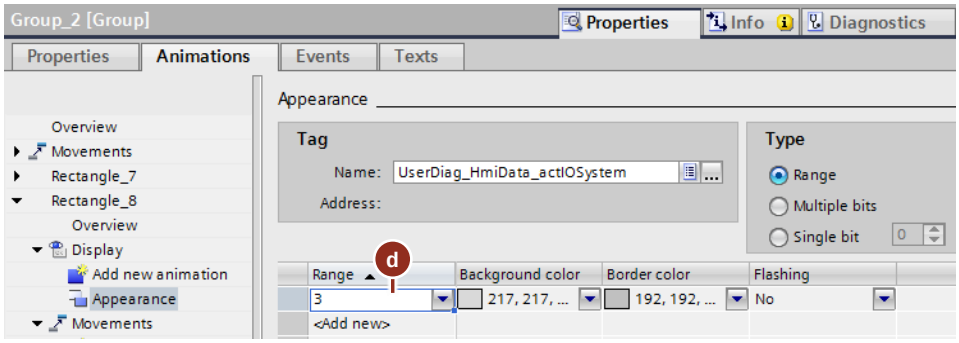
    c. Customize the index to your additional IO system.
    Please note: The array for the HMI starts at the lower limit 0 and not, as is the case in the program, at 1.

Figure 2-20: “Topic_002.0_IO_System” screen



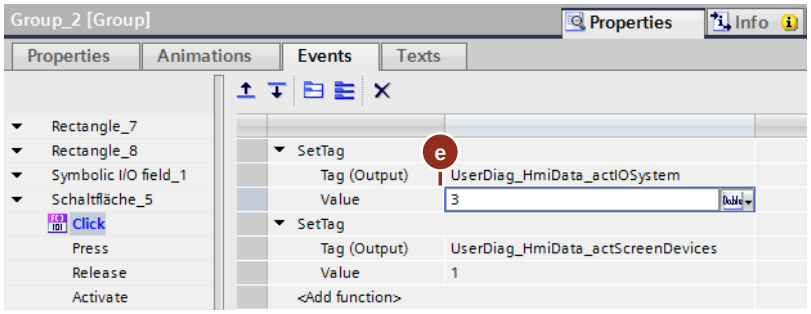
d. Customize the range to your additional IO system.

Figure 2-21: “Topic_002.0_IO_System” screen



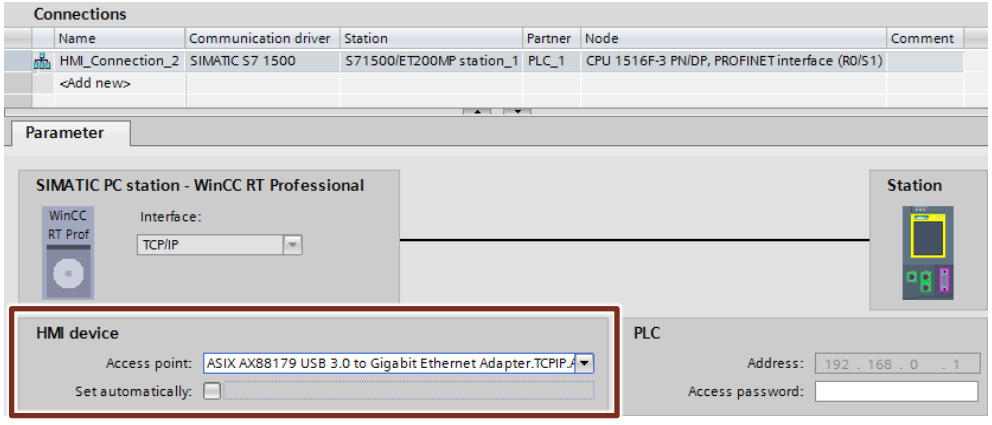
e. Customize the value to your additional IO system.

Figure 2-22: “Topic_002.0_IO_System” screen



12. In “Connections”, “Access point”, select the desired interface and uncheck the “Set automatically” check box.

Figure 2-23: “Topic_002.0_IO_System” screen



Note

For more information about connections, please refer to the FAQ titled “Why does communication not work between WinCC Professional Runtime and S7-1200?”:

https://support.industry.siemens.com/cs/ww/en/view/62612087

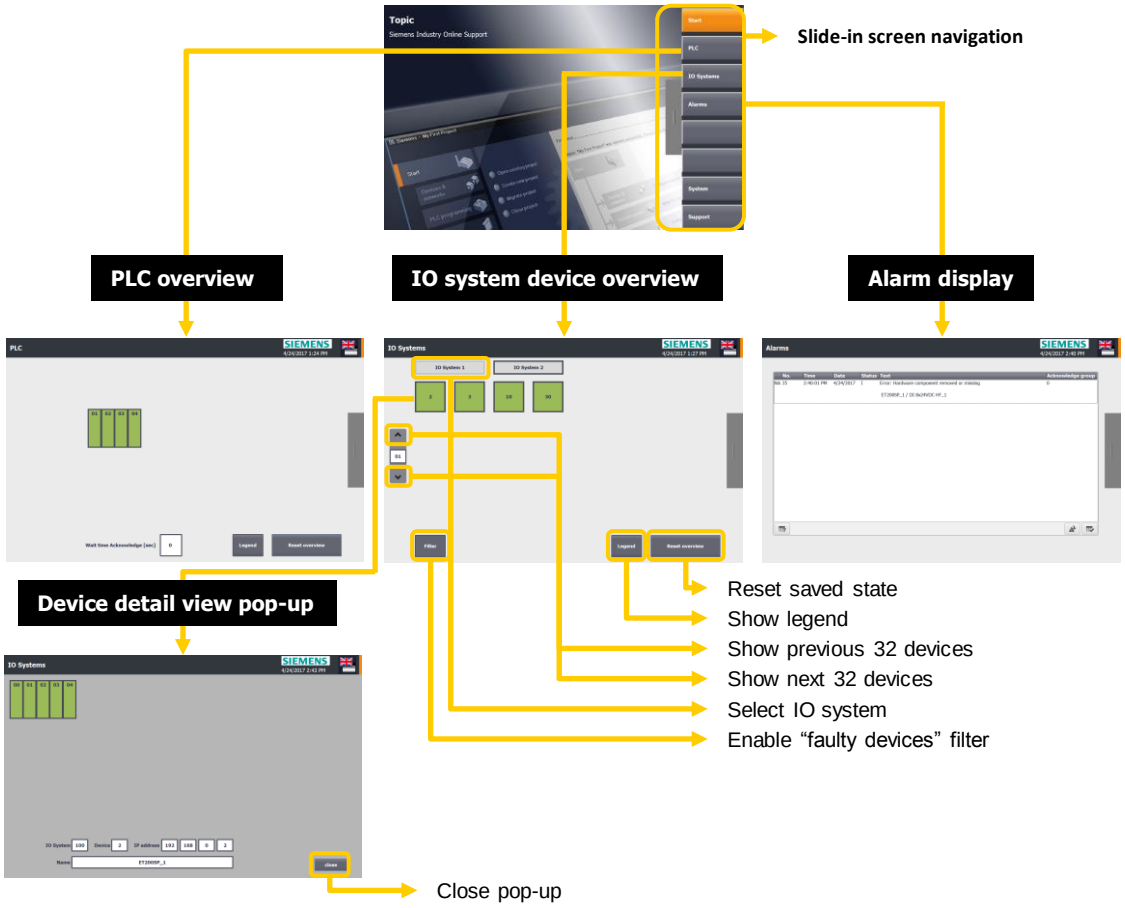
2.7 Operation

Operation is shown using the TP1200 Comfort operator panel.

2.7.1 Overview

The following figure shows the user interface of the TP1200 Comfort.

Figure 2-24: HMI screens overview



Start screen

The “Topic” screen shows the start screen of the application example.

Screen navigation

The slide-in screen is used for screen navigation.

PLC overview

The “PLC” screen shows the diagnostic information of the controller and its modules.

- Clicking the “Legend” button opens the pop-up screen with the different appearances of the icons for the devices and modules and their meaning.
- The “Reset overview” button allows you to delete the saved state of the controller.
- In the “Wait time Acknowledge” input field, you can enter a wait time after startup for automatic reset of the saved error state.

Overview of the devices in the IO system

The “IO-Systems” screen shows the configured devices of the selected IO system.

- The “IO System x” buttons allow you to select the IO systems.
- Click the “v” button to view the next 32 devices. Clicking the “^” button displays the previous 32 devices.
- The “Filter” button allows you to view only faulty devices.
- Clicking the “Legend” button opens the pop-up screen with the different appearances of the icons for the devices and modules and their meaning.
- The “Reset overview” button allows you to delete the saved state of the current IO system.
- Clicking the button of a device opens the pop-up screen with the detail view of the device.

Detail view of a device

The pop-up screen displays:

- Diagnostic information of the modules of a device
- Index of the IO system
- Device number / slave address
- IP address
- Device name

Clicking the “close” button closes the pop-up screen.

Alarms

The “Alarms” screen shows the alarms window with the alarms.

Legend

The pop-up screen shows the different appearances of the icons for the devices and modules and their meaning.

2.7.2 Devices and module icon legend

The devices and modules can each have different states. The following table shows the appearance of the icons and their meaning.

Table 2-2: Icon legend

State	Appearance	Meaning
1		State OK
2		State FAULTY
3		State LOST CONNECTION
4		State DEACTIVATED
5		State PROBLEM / MAINTENANCE
12		State WAS FAULTY
13		State HAD LOST CONNECTION
14		State WAS DEACTIVATED
15		State WAS PROBLEM / MAINTENANCE

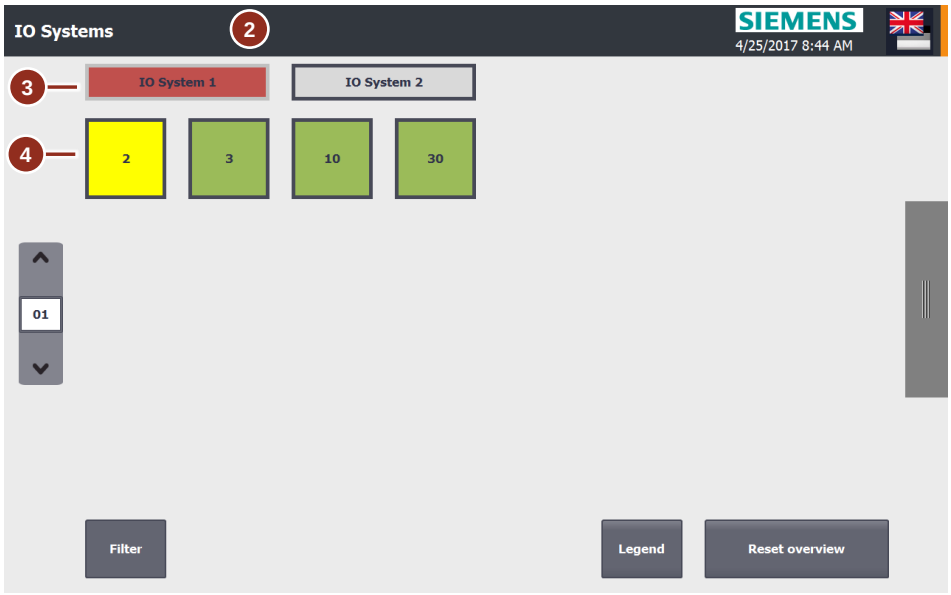
2.7.3 Diagnostics on the operator panel

Diagnostics of “missing module on ET200SP_1”

To diagnose the fault, proceed as follows:

1. Remove the DQ8 module from slot 2 of the ET200SP_1.
2. On the operator panel, open the “IO Systems” screen.
3. Click the “IO System 1” button.
   The screen displays the fault on the device with device number 2.
4. For detailed information about the fault, click the button of device 2.

Figure 2-25: “IO Systems” screen

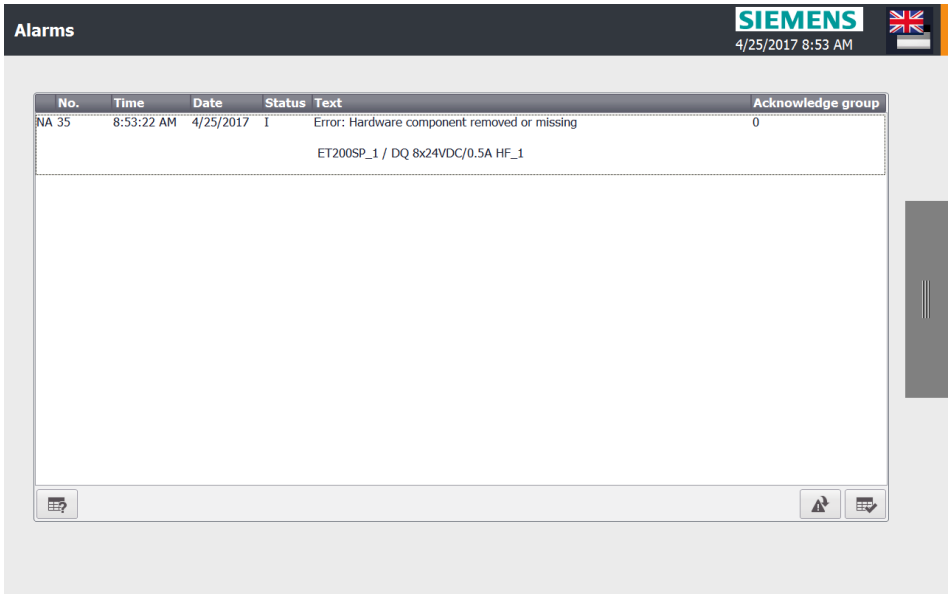


5. The pop-up screen with the detail view of device 2 opens. The view displays an error on slot 2, the index of the IO system, the device number, the IP address and the device name.
   Clicking “close” closes the pop-up screen.

Figure 2-26: Pop-up screen with the detail view of the device

6. Open the “Alarms” screen if you want to view the alarm for the fault.

Figure 2-27: “Alarms” screen



7. Reinsert the module into slot 2.
   The icon of device 2 turns green with a yellow border. This means that the device was faulty and the fault has been cleared.
   Clicking “Reset overview” deletes the saved state and the border color returns to black.

Figure 2-28: “IO Systems” screen

2.7.4 Evaluating the diagnostic information

This chapter uses an example to show you where to find the diagnostic information in the event of an error. Retrieving this information in your program allows you to program specific responses to certain faults in the plant.

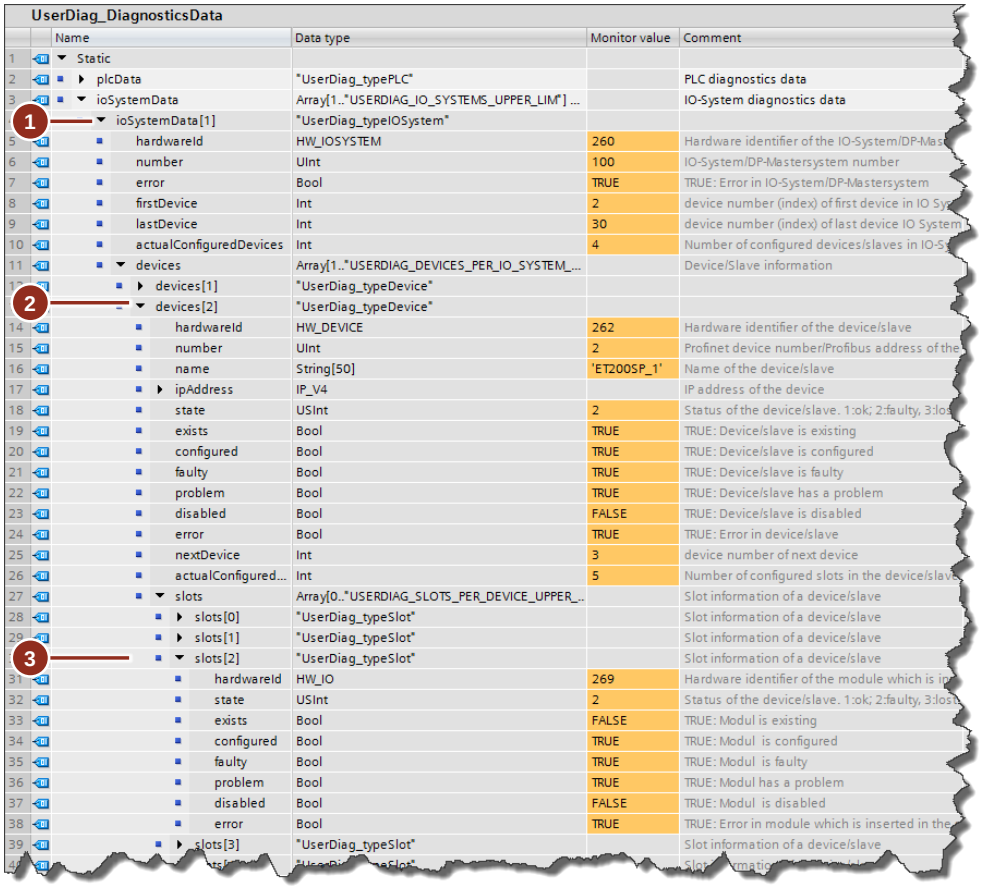
Evaluating the “missing module on ET200SP_1” diagnostic information

Remove the DQ8 module from slot 2 of the ET200SP_1 to cause a fault. The fault is saved in the “UserDiag_DiagnosticsData” DB. Clicking the “Monitor all” button allows you to view the actual values of the tags.

The data in the “UserDiag_DiagnosticsData” DB have to be interpreted as follows:

1. The “ioSystemData > ioSystemData[1]” structure displays the saved diagnostic information of the entire IO system. The “error = TRUE” tag indicates a fault in the IO system.
2. The “devices > devices[2]” structure displays the saved diagnostic information of the device with device number 2. The “error = TRUE” tag indicates a fault in the device.
3. The “slot > slot[2]” structure displays the saved diagnostic information of the module on slot 2. The “error = TRUE” tag indicates the fault in the module. The “exists = FALSE” tag indicates that the module is missing.

Figure 2-29: Diagnostic information about the fault in the “UserDiag_DiagnosticsData” DB



3 Valuable Information

3.1 Basics of system diagnostics for S7-1500 PLCs

System diagnostics allow you to analyze errors in the system and generate alarms with a textual error description and the error location.

System diagnostics are integrated in the S7-1500 PLC's firmware and operate independently of the cyclic user program. Therefore, system diagnostics are also available in STOP mode of the PLC. Faults are detected immediately and reported to the higher-level HMI devices, the web server, the S7-1500 PLC's display, the LED displays on the relevant module and TIA Portal even in STOP mode. This ensures that system diagnostics are always synchronized with the actual plant status.

All connected diagnostic display media are supplied with the same system diagnostic information by a uniform mechanism.

Note For more information about integrated system diagnostics, please refer to the following application example:
"System Diagnostics with S7-1500 and TIA Portal"

https://support.industry.siemens.com/cs/ww/en/view/68011497

3.2 Diagnostic instructions

If you want to retrieve the diagnostic information of a device in the user program, STEP 7 provides the following instructions:

Table 3-1: Diagnostic instructions overview

Instruction	Description
RD_SINFO	Read start information of current OB
RT_INFO	Read runtime statistics (not part of this application)
LED	Read LED status
Get_IM_Data	Read identification and maintenance data
GET_NAME	Read name of a module
GetStationInfo	Read information of an IO device
DeviceStates	Read module status information in an IO system
ModuleStates	Read module status information of a module
GEN_DIAG	Generate diagnostic information (not part of this application example)
GET_DIAG	Read diagnostic information (not part of this application example)
Get_Alarm	Read pending alarm

Note For more information about the diagnostic instructions, please refer to the STEP 7 Professional V14 SP1 system manual:

https://support.industry.siemens.com/cs/ww/en/view/109747136

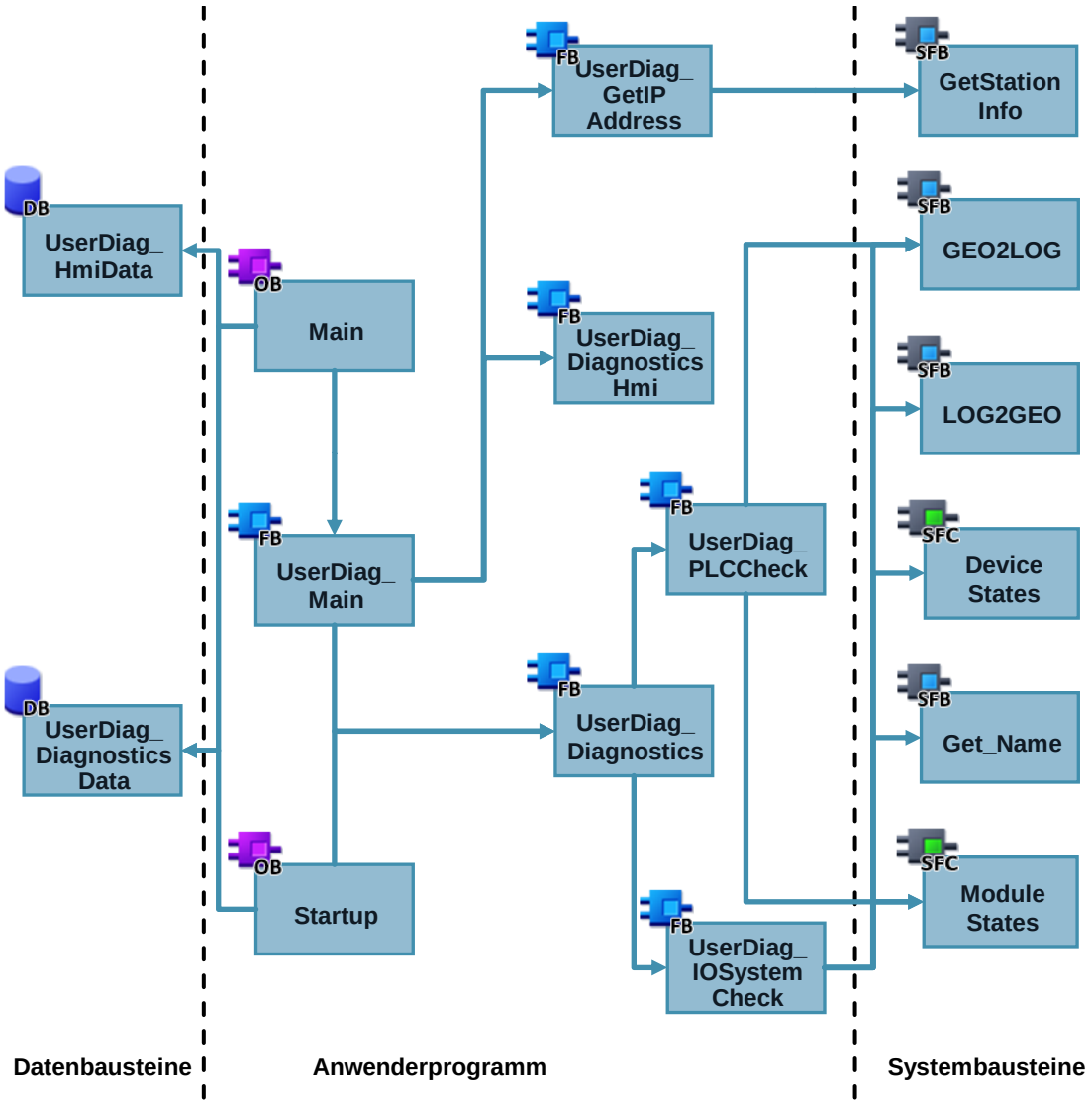
3.3 Details about how the program blocks work

This chapter describes the program blocks of the application example.

3.3.1 Complete overview

The following figure shows the program structure of the entire STEP 7 project.

Figure 3-1: Program structure



3.3.2 “UserDiag_Constants” tag table

The “UserDiag_Constants” table defines the user constants. With the user constants, you define the size of the diagnostic structures in the “UserDiag_DiagnosticsData” DB.

Table 3-2: “UserDiag_Constants” tag table

Constant	Type	Value	Meaning
USERDIAG_SLOTS_ PER_DEVICE_UPPER_LIM	Int	31	Maximum number of modules per device.
USERDIAG_SLOTS_ PER_PLC_UPPER_LIM	Int	31	Maximum number of local modules.
USERDIAG_DEVICES_ PER_IO_SYSTEM_UPPER_LIM	Int	128	Upper array limit for devices per IO system.
USERDIAG_IO_SYSTEMS_ UPPER_LIM	Int	2	Upper array limit for IO systems.
USERDIAG_DEVICES_ PER_SCREEN_UPPER_LIM	Int	32	Upper array limit for number of devices per HMI screen.
USERDIAG_SLOTS_ PER_SCREEN_UPPER_LIM	Int	31	Upper array limit for number of slots per HMI screen.
USERDIAG_IO_SYSTEM_1	Int	1	Index for first IO system.
USERDIAG_IO_SYSTEM_2	Int	2	Index for second IO system.

3.3.3 “UserDiag_DiagnosticsData” DB

The “UserDiag_DiagnosticsData” DB saves the hardware IDs and the diagnostic information of the controller and the IO systems.

The following table shows the structure of the “UserDiag_DiagnosticsData” DB.

Table 3-3: “UserDiag_DiagnosticsData” DB

Tag name	Data type	Meaning
plcData	UserDiag_typePLC	Diagnostic data of the PLC. (See plcData [UserDiag_typePlc])
ioSystemData	Array [1.. USERDIAG_IO_ SYSTEMS_UPPER_LIM] of UserDiag_typeIoSystem	Diagnostic data of the IO systems. (See ioSystemData [UserDiag_typeIoSystem])
startDiag	Bool	Start Diagnostics.

For greater clarity, the individual tags of the components were grouped into the following PLC data types.

plcData [UserDiag_typePlc]

The PLC data type contains the information of the controller and the modules in the local slots.

Table 3-4: “UserDiag_typePlc” PLC data type

Tag name	Data type	Meaning
hardwareId	HW_DEVICE	Hardware ID of the PLC.
error	Bool	Error pending.
actualConfigured Slots	Int	Number of configured local slots.
slots	Array [0..USERDIAG_SLOTS_ PER_PLC_UPPER_LIM] of "UserDiag_typeSlot"	See slots [UserDiag_typeSlot].

slots [UserDiag_typeSlot]

The PLC data type contains the information of a module (slot).

Table 3-5: “UserDiag_typeSlot” PLC data type

Tag name	Data type	Meaning
hardwareId	HW_IO	Hardware ID of the module in the slot
state	USInt	Module state (see 2.7.2)
exists	Bool	Module exists
configured	Bool	Module configured
faulty	Bool	Module faulty
problem	Bool	Module has a problem
disabled	Bool	Module disabled
error	Bool	Error in the module

ioSystemData [UserDiag_typeIoSystem]

The PLC data type contains the information of an IO system.

Table 3-6: “UserDiag_typeIoSystem” PLC data type

Tag name	Data type	Meaning
hardwareId	HW_IOSYSTEM	Hardware ID of the IO system.
number	UInt	Number of the IO system / DP master system.
error	Bool	Error in the IO system / DP master system.
firstDevice	Int	Number of the first device in the IO system / DP master system.
lastDevice	Int	Number of the last device in the IO system / DP master system.
actualConfigured Devices	Int	Number of configured devices in the IO system / DP master system.
devices	Array [0..USERDIAG_DEVICES_ PER_IO_SYSTEM_UPPER_LIM] of "UserDiag_typeDevice"	Diagnostic structure of the devices. See devices [UserDiag_typeDevice].

Note The array index of the “device” tag corresponds to the device number.

devices [UserDiag_typeDevice]

The PLC data type contains the information of a device (device or slave).

Table 3-7: “UserDiag_typePlc” PLC data type

Tag name	Data type	Meaning
hardwareId	HW_DEVICE	Hardware ID of the device.
number	UInt	Device number / PROFIBUS address.
name	String[50]	Device name.
ipAddress	IP_V4	IP address of the device (for IO system only).
state	USInt	Device state. (See 2.7.2)
exists	Bool	Device exists.
configured	Bool	Device configured.
faulty	Bool	Device faulty.
problem	Bool	Device has a problem.
disabled	Bool	Device disabled.
error	Bool	Error in the device.
nextDevice	Int	Number of the next device.
actualConfigured Slots	Int	Number of configured slots of the device.
slots	Array [0..USERDIAG_SLOTS_ PER_DEVICE_UPPER_LIM] of "UserDiag_typeSlot"	Diagnostic structure of the modules. See slots [UserDiag_typeSlot].

Note The array index of the “slots” tag corresponds to the slot number on the device.

3.3.4 “UserDiag_HmiData” DB

The “UserDiag_HmiData” DB serves as an interface to the visualization. The DB is of the PLC data type "UserDiag_typeHmiData".

[UserDiag_typeHmiData]

Table 3-8: “UserDiag_typeHmiData” PLC data type

Tag name	Data type	Meaning
actIOSystem	Int	Index of the selected IO system.
actDeviceOf Screen	Int	Index of the selected device in the screen.
ioSlotDiagnostics Loaded	Bool	“Device detail view” screen open.
actScreenDevices	Int	Current device overview screen of the selected IO system.
maxScreens Devices	Int	Maximum number of device overview screens of the selected IO system.
ackWaitTime	Int	Wait time after startup for automatic reset of the saved error state in [s].
ackStates	Bool	Reset saved error state.
actIOSystemData	UserDiag_typeActIOSystem	Diagnostic data of the selected IO system. (See actIOSystemData [UserDiag_typeActIOSystem])
actDeviceNumber	UInt	Device number of the selected device.
actDeviceName	String[50]	Device name of the selected device.
actIPAddress	IP_V4	IP address of the selected device.
errorAtLower Screen	Bool	Error on the previous device overview screen of the selected IO system.
errorAtUpper Screen	Bool	Error on the next device overview screen of the selected IO system.
filterErrorDevices	Bool	Filter, only faulty devices are displayed.
ioSystemError	Array [0..USERDIAG_IO_ SYSTEMS_UPPER_LIM] of Bool	Error in the IO system.

actIOSystemData [UserDiag_typeActIOSystem]

The data type contains the information of the selected IO system and the selected device or the information of the controller.

Table 3-9: “UserDiag_typeActIOSystem” PLC data type

Tag name	Data type	Meaning
actIoSystem Number	Int	Number of the selected IO system.
actIODevice Numbers	Array [1..USERDIAG_DEVICES_ PER_SCREEN_UPPER_LIM] of UInt	Device numbers / PROFIBUS addresses of the selected IO system.
actIODeviceState	Array [1..USERDIAG_DEVICES_ PER_SCREEN_UPPER_LIM] of USInt	State of the devices of the selected IO system.
actDeviceSlots Used	Array [0..USERDIAG_SLOTS_ PER_SCREEN_UPPER_LIM] of Bool	Slots used of the selected device. (Determined during startup.)
actDeviceSlots State	Array [0..USERDIAG_SLOTS_ PER_SCREEN_UPPER_LIM] of USInt	State of the slots of the selected device.

3.3.5 “UserDiag_PLCCheck” FB

During the first call, the “UserDiag_PLCCheck” FB determines the hardware IDs of the local components. The FB reads the status information of the local modules and evaluates it.

Interfaces

Figure 3-2: Call in "UserDiag_Diagnostics"

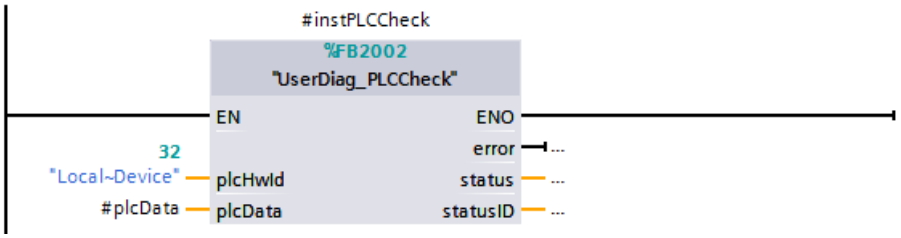


Table 3-10: Parameters of the block interface

Type	Parameter	Data type	Description
Input	plcHwId	HW_DEVICE	Hardware ID of the controller.
InOut	plcData	UserDiag_typePlc	Diagnostic data of the controller and its local modules.
Output	error	Bool	An error occurred while processing the FB. The “status” and “statusID” outputs provide related information about locating the error cause.
	status	Word	Error code of the FB or of a diagnostic instruction that was called internally. The error location within the FB can be additionally read via the “statusID” output.
	statusID	Word	Specifies an additional error code for locating the error cause within the FB.

“status” error code

The following table describes the possible error code:

Table 3-11: Error code at the “status” output

Error code	Description
16#0000	No error.
16#8xxx	Error (RET_VAL) of the diagnostic instructions.
16#8400	Internal error: The number of configured modules exceeds the array limit, “USERDIAG_SLOTS_PER_PLC_UPPER_LIM”.

“statusID” error sources

The following table describes the error sources:

Table 3-12: Error source at the “statusID” output

statusID	Meaning	Note
0	No error.	-
1	Internal error of the FB.	-
2	Error while reading the status information of the modules with “ModuleStates” in mode “1: Modules are configured”.	Reserve
3	Error while reading the status information of the modules with “ModuleStates” in mode “2: Modules are faulty”.	-
4	Error while reading the status information of the modules with “ModuleStates” in mode “5: A problem has occurred in the modules”.	-
5	Error while reading the status information of the modules with “ModuleStates” in mode “4: Modules exist”.	-

Functional description

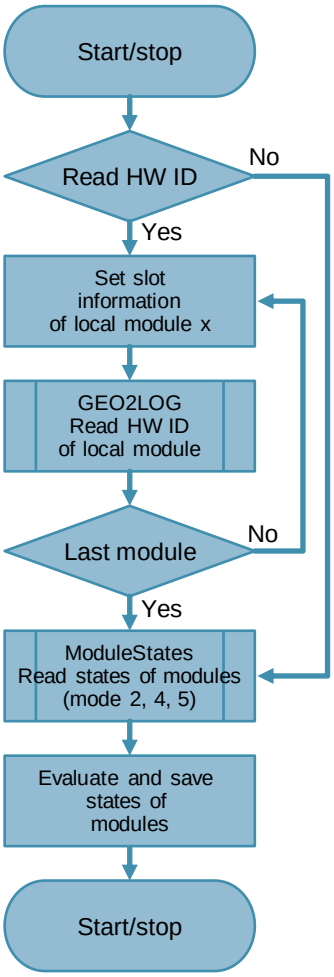
The FB is used to automatically determine the hardware IDs of the local components using the “GEO2LOG” instruction based on the slot information. The slot information is rewritten with a tag of the “GEOADDR” system data type before each call of the instruction.

The “ModuleStates” instruction reads the status information of the local modules for different modes. The FB evaluates this status information.

The hardware IDs and the evaluated diagnostic information are saved in the appropriate structure in the “UserDiag_DiagnosticsData” global data block.

The following figure shows the basic program flow of the FB.

Figure 3-3: Program flow of the FB



3.3.6 “UserDiag_IOSystemCheck” FB

During the first call, the “UserDiag_IOSystemCheck” FB determines the hardware IDs of the components of an IO system. The FB reads the status information of the distributed devices and their modules and evaluates it.

Interfaces

Figure 3-4: Call in the "UserDiag_Diagnostics" FB for IO system 1 and IO system 2

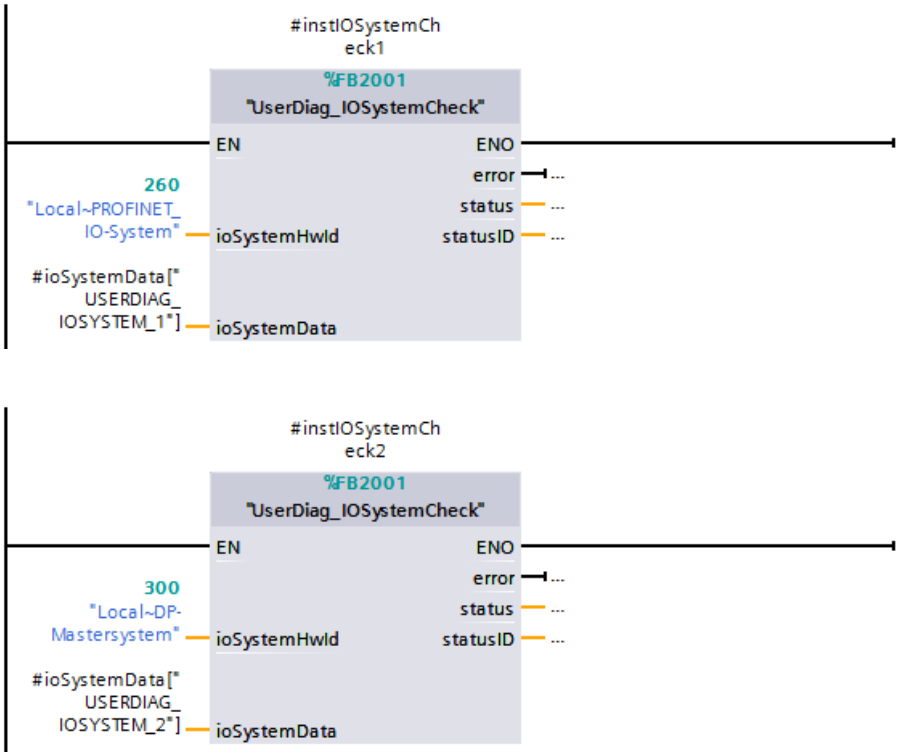


Table 3-13: Parameters of the block interface

Type	Parameter	Data type	Description
Input	ioSystemHwId	HW_IOSYSTEM	Hardware ID of the IO system.
InOut	ioSystemData	UserDiag_typeIOSystem	Diagnostic data of the IO system.
Output	error	Bool	An error occurred while processing the FB. The “status” and “statusID” outputs provide related information about locating the error cause.
	status	Word	Error code of the FB or of a diagnostic instruction that was called internally. The error location within the FB can be additionally read via the “statusID” output.
	statusID	Word	Specifies an additional error code for locating the error cause within the FB.

“status” error code

The following table describes the possible error code:

Table 3-14: Error code at the “status” output

Error code	Description
16#0000	No error.
16#8xxx	Error (RET_VAL) of the diagnostic instructions.
16#8400	Internal error: The number of configured modules exceeds the array limit, “USERDIAG_SLOTS_PER_DEVICE_UPPER_LIM”.
16#8401	Internal error: The number of configured devices exceeds the array limit, “USERDIAG_DEVICES_PER_IO_SYSTEM_UPPER_LIM”.

“statusID” error sources

The following table describes the error sources:

Table 3-15: Error source at the “statusID” output

statusID	Meaning	Note
0	No error.	-
1	Internal error of the FB.	-
2	Error while reading the status information of the modules with “ModuleStates” in mode “1: Modules are configured”.	Reserve
3	Error while reading the status information of the modules with “ModuleStates” in mode “2: Modules are faulty”.	-
4	Error while reading the status information of the modules with “ModuleStates” in mode “5: A problem has occurred in the modules”.	-
5	Error while reading the status information of the modules with “ModuleStates” in mode “4: Modules exist”.	-
6	Error while reading the status information of the devices with “DeviceStates” in mode “1: Devices are configured”.	-
7	Error while reading the status information of the devices with “DeviceStates” in mode “2: Devices are faulty”.	-
8	Error while reading the status information of the devices with “DeviceStates” in mode “5: A problem has occurred in the devices”.	-
9	Error while reading the status information of the devices with “DeviceStates” in mode “4: Devices exist”.	-
10	Error while reading the status information of the devices with “DeviceStates” in mode “3: Devices disabled”.	-
11	Error while reading the device name with “GET_NAME”.	-

Functional description

The FB is used to automatically determine the hardware IDs of the devices and modules of an IO system using the “GEO2LOG” instruction based on the slot information. The slot information is rewritten with a tag of the “GEOADDR” system data type before each call of the instruction.

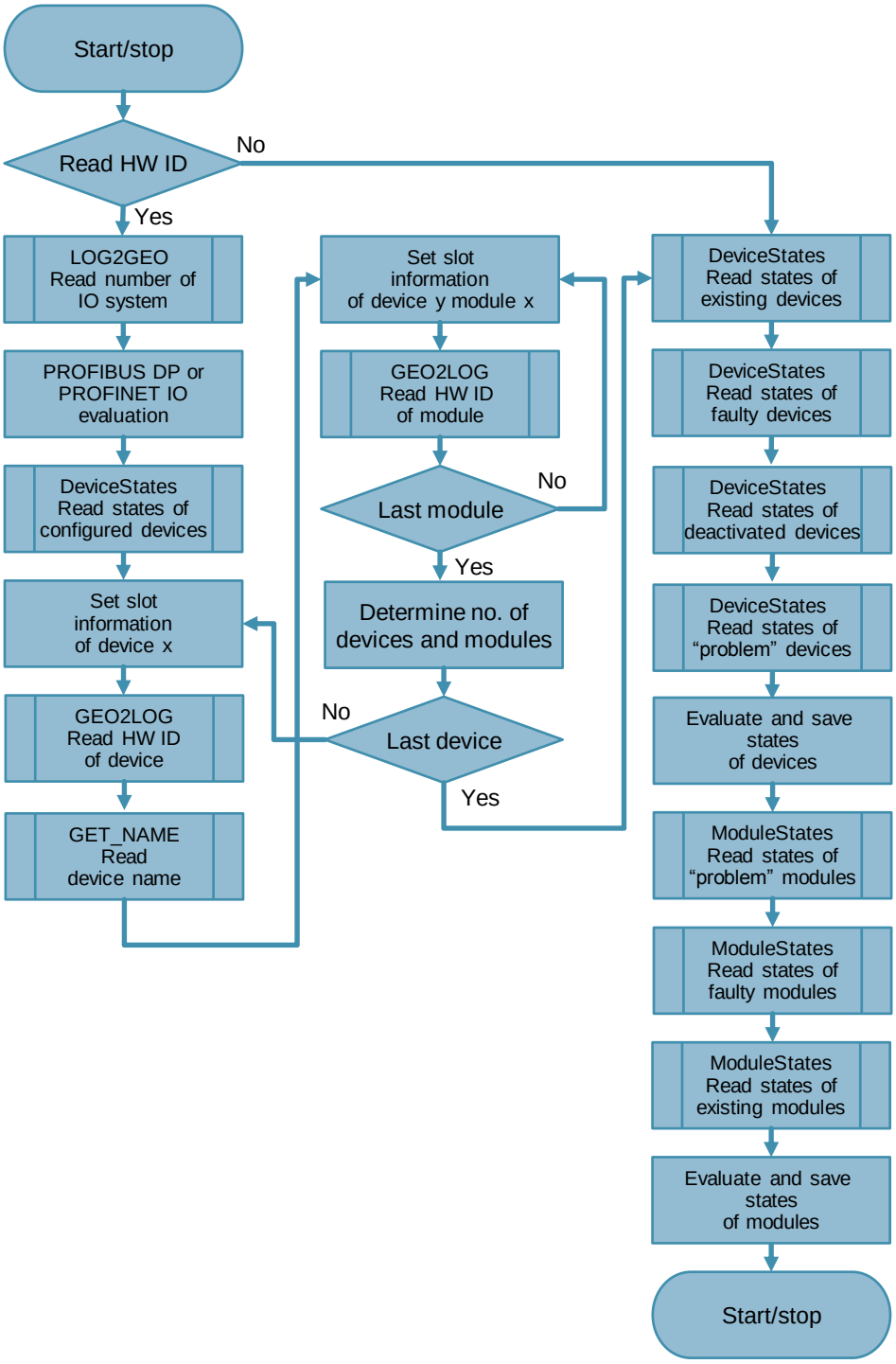
The “GET_NAME” instruction reads the names of the PROFIBUS DP slaves / PROFINET IO devices.

The “DeviceStates” and “ModuleStates” instructions read the status information of the devices and their modules for different modes. The FB evaluates the status information.

The hardware IDs and the evaluated status information are saved in the appropriate structure in the “UserDiag_DiagnosticsData” global data block.

The following figure shows the basic program flow of the FB.

Figure 3-5: Program flow of the FB



3.3.7 "UserDiag_Diagnostics" FB

The "UserDiag_Diagnostics" FB calls all diagnostic blocks of the controller and the IO systems.

Interfaces

Figure 3-6: Call in "UserDiag_Main" FB

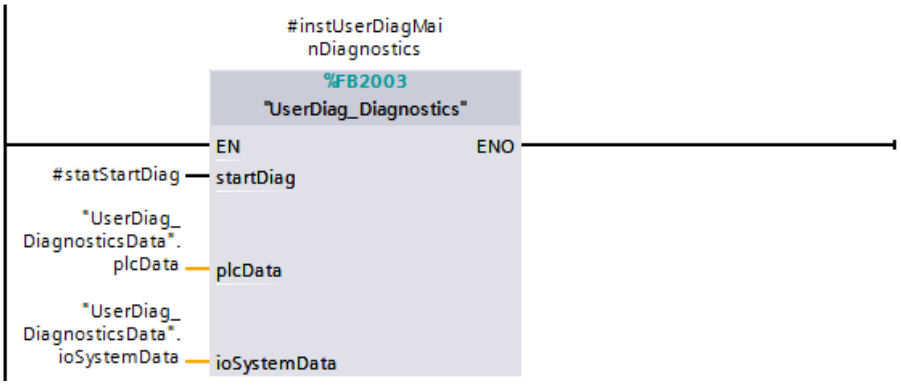


Table 3-16: Parameters of the block interface

Type	Parameter	Data type	Description
InOut	startDiag	Bool	Start Diagnostics.
	plcData	UserDiag_typePlc	Diagnostic data of the controller and its local modules.
	ioSystemData	Array [1.. USERDIAG_IO_SYSTEMS_UPPER_LIM] of UserDiag_typeIoSystem	Diagnostic data of the IO systems. (See ioSystemData [UserDiag_typeIoSystem])

The “UserDiag_Diagnostics” FB is called by the following program blocks:

- "UserDiag_Main"
- "Startup"

Functional description

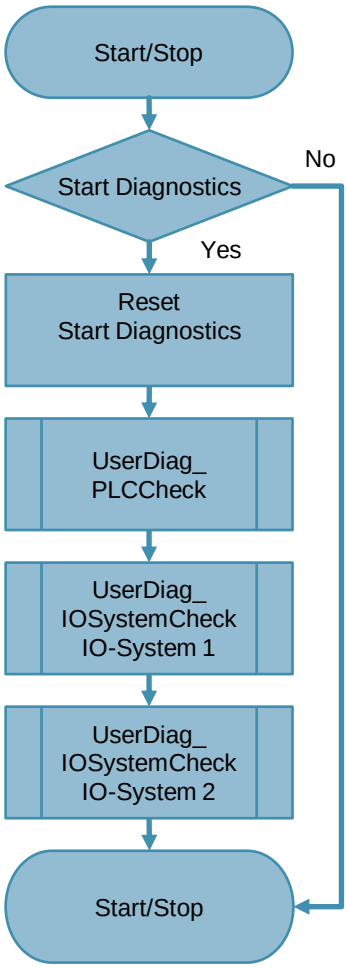
The diagnostics in the FB "UserDiag_Diagnostics" are only executed, if "statStartDiag" is set to "TRUE" by the system memory bit "DiagStatusUpdate" or by "UserDiag_DiagnosticsData".startDiag.

The “UserDiag_Diagnostics” FB calls the “UserDiag_PLCCheck” FB to evaluate the diagnostic information of the controller and the “UserDiag_IOSystemCheck” FB for each IO system to evaluate the diagnostic information of the IO systems.

NOTE If you activate a device which is not connected to the bus system with the instruction “D_ACT_DP”, it is possible that the system memory bit “DiagStatusUpdate” is not be properly set upon activation. In this case you must start the evaluation of the diagnosis by setting the variable “UserDiag_DiagnosticsData”.startDiag in the user program.

The following figure shows the basic program flow of the FB.

Figure 3-7: Program flow of the FB



3.3.8 FB "UserDiag_GetIPAddress"

The FB "UserDiag_GetIPAddress" reads the IP addresses of the devices of a PROFINET IO system.

Interfaces

Figure 3-8: Call in "UserDiag_Main" FB

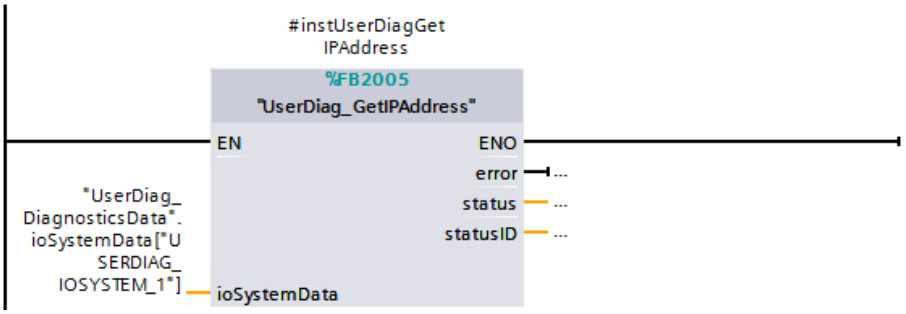


Table 3-17: Parameters of the block interface

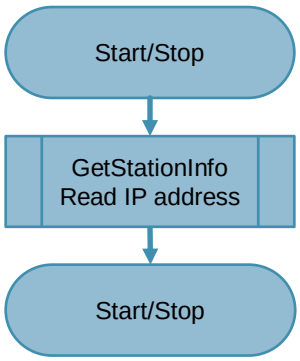
Type	Parameter	Data type	Description
InOut	ioSystemData	UserDiag_ typeIOSystem	Diagnostic data of the IO system.
Output	error	Bool	An error occurred while processing the FB. The “status” and “statusID” outputs provide related information about locating the error cause.
	status	Word	Error code of the instruction "GetStationInfo".
	statusID	Word	ID of the instruction "GetStationInfo".

Functional description

The instruction "GetStationInfo" reads the IP addresses of the PROFINET IO devices of a PROFINET IO system.

The following figure shows the basic program flow of the FB.

Figure 3-9: Program flow of the FB



3.3.9 “UserDiag_DiagnosticsHmi” FB

The “UserDiag_DiagnosticsHmi” FB responds to the inputs made on the HMI and provides the required diagnostic information to the visualization.

Interfaces

Figure 3-10: Call in the “UserDiag_Main” FB

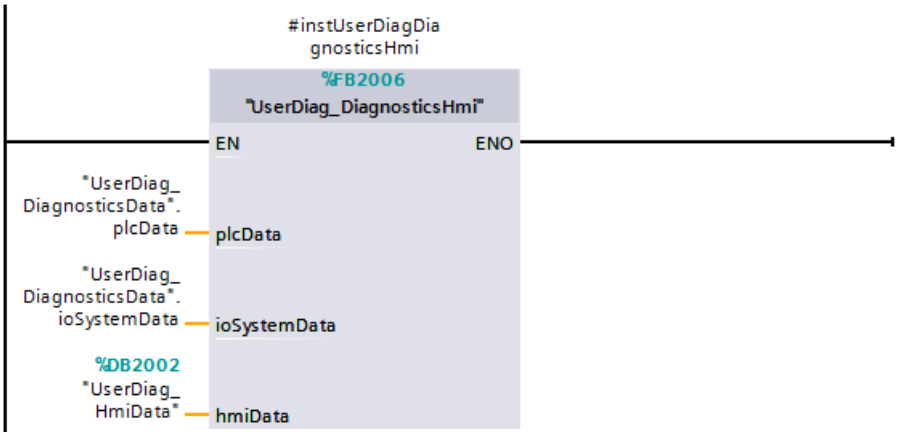


Table 3-18: Parameters of the block interface

Type	Parameter	Data type	Description
InOut	plcData	UserDiag_typePlc	Diagnostic data of the controller and its local modules.
	ioSystemData	Array [1..USERDIAG_IO_SYSTEMS_UPPER_LIM] of UserDiag_typeIo System	Diagnostic data of the IO systems. (See ioSystemData [UserDiag_typeIoSystem])
	actIOSystemData	UserDiag_typeHmiData	Informations for the visualization. (See [UserDiag_typeHmiData])

Functional description

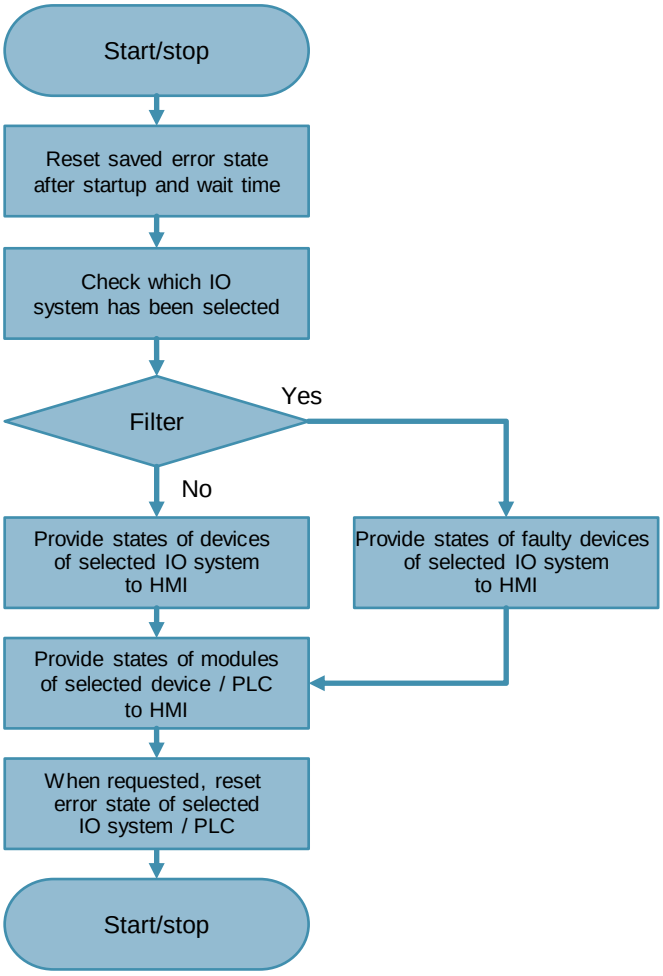
After startup and a wait time, the “UserDiag_DiagnosticsHmi” FB resets the saved error state.

The FB responds to the inputs made on the HMI. Following the request, the FB resets the saved error state and supplies the visualization with the requested data, for example:

- Diagnostic information of the controller and its local modules
- Diagnostic information of the IO system
- Diagnostic information of the devices and their modules

The following figure shows the basic program flow of the FB.

Figure 3-11: Program flow of the FB



3.3.10 "UserDiag_Main" FB

The FB "UserDiag_Main" calls all program blocks that are required for diagnostics.

Interfaces

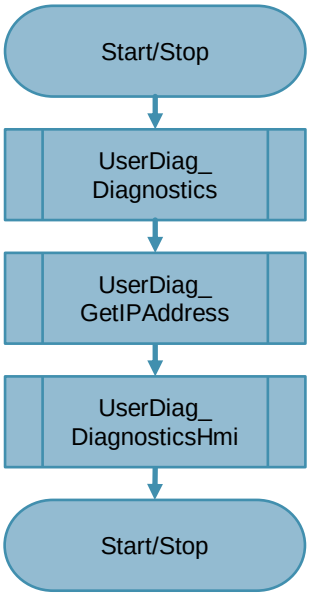
Figure 3-12: Call in "Main" OB

Functional description

The FB calls the FBs "UserDiag_Diagnostics", "UserDiag_DiagnosticsHMI" and "UserDiag_GetIPAddresses" for evaluating and visualizing the diagnostics information of the controller.

The following figure shows the basic program flow of the FB.

Figure 3-13: Program flow of the FB



Note Call the FB "UserDiag_Main" before the processing of your user program, e.g. in the first network of the OB "Main". Thus, the evaluated diagnostics information is consistent for the duration of the cycle.

4 Appendix

4.1 Service and Support

Industry Online Support

Do you have any questions or do you need support?

With Industry Online Support, our complete service and support know-how and services are available to you 24/7.

Industry Online Support is the place to go to for information about our products, solutions and services.

Product Information, Manuals, Downloads, FAQs and Application Examples – all the information can be accessed with just a few clicks:
https://support.industry.siemens.com

Technical Support

Siemens Industry's Technical Support offers you fast and competent support for any technical queries you may have, including numerous tailor-made offerings ranging from basic support to custom support contracts.

You can use the web form below to send queries to Technical Support:
www.siemens.com/industry/supportrequest.

Service offer

Our service offer includes the following services:

- Product Training
- Plant Data Services
- Spare Part Services
- Repair Services
- Field & Maintenance Services
- Retrofit & Modernization Services
- Service Programs & Agreements

For detailed information about our service offer, please refer to the Service Catalog:
https://support.industry.siemens.com/cs/sc

Industry Online Support app

The "Siemens Industry Online Support" app provides you with optimum support while on the go. The app is available for Apple iOS, Android and Windows Phone:
https://support.industry.siemens.com/cs/ww/en/sc/2067

4.2 Links and literature

Table 4-1

No.	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Link to the entry page of the application example https://support.industry.siemens.com/cs/ww/en/view/98210758
\3\	System Diagnostics with S7-1500 and TIA Portal https://support.industry.siemens.com/cs/ww/en/view/68011497
\4\	STEP 7 Professional V14 SP1 System Manual https://support.industry.siemens.com/cs/ww/en/view/109747136
\5\	SIMATIC STEP 7 Basic/Professional V15.1 and SIMATIC WinCC V15.1 https://support.industry.siemens.com/cs/ww/en/view/109755202
\6\	S7-1500 System Manual https://support.industry.siemens.com/cs/ww/en/view/59191792
\7\	SINAMICS Startdrive https://support.industry.siemens.com/cs/ww/en/view/109760845

4.3 Change documentation

Table 4-2

Version	Date	Modifications
V1.0	09/2014	First version
V2.0	04/2015	New version with evaluation of errors in error OBs
V2.1	04/2016	New version with SINAMICS G120 and structured HMI tags
V2.2	07/2016	New version: Error analysis modified
V2.3	10/2016	New version: Minor error correction
V3.0	05/2017	Complete revision
V3.1	01/2018	Evaluation of the diagnostics in OB "Main". The evaluation is triggered by the system memory bit "DiagStatusUpdate".
V3.2	02/2018	Minor error correction
V3.3	03/2019	Upgrade to TIA Portal V15.1 Update 1
V3.4	09/2019	HMI: Reset of "ioSlot Diagnostics Loaded" even if module overview is not closed via "close"