Implement the PROFINET CBA Communication Concept with PROFINET IO

PROFINET

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Caution
The functions and solutions described in this article confine themselves predominantly to the realization of the automation task. Furthermore, please take into account that corresponding protective measures have to be taken in the context of Industrial Security when connecting your equipment to other parts of the plant, the enterprise network or the internet. Further information can be found in Entry ID 50203404.

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Question

How can you implement the PROFINET CBA communication concept with PROFINET IO?

Answer

The instructions and notes listed in this document provide a detailed answer to this question.

Table of Contents

1 Introduction

1.1 PROFINET CBA

Within PROFINET, PROFINET CBA (Component Based Automation) is an automation concept with the following major features:

- Implementation of modular applications
- Machine-machine communication

With PROFINET CBA you create a distributed automation solution based on prepared components and partial solutions. This concept meets the demands for increased modularization in machine and plant construction through extensive decentralization of the intelligent processing.

With Component Based Automation you implement complete technological modules as standardized components that can be used in large-scale plants.

You create the modular intelligent components for PROFINET CBA in an engineering tool that can differ from device manufacturer to device manufacturer. You then interconnect the PROFINET components with the SIMATIC iMap cross-vendor engineering tool.

1.2 PROFINET IO

Within PROFINET, PROFINET IO is a communication concept for implementing modular, remote applications.

Using PROFINET IO you create automation solutions that you know and are familiar with from PROFIBUS DP.

Implementation of PROFINET IO is based on the PROFINET standard for automation devices (IEC 71158-x-10).

The STEP 7 engineering tool supports you in setting up and configuring an automation solution.

Figure 1-1 shows the devices used to compose a PROFINET IO system.

Figure 1-1

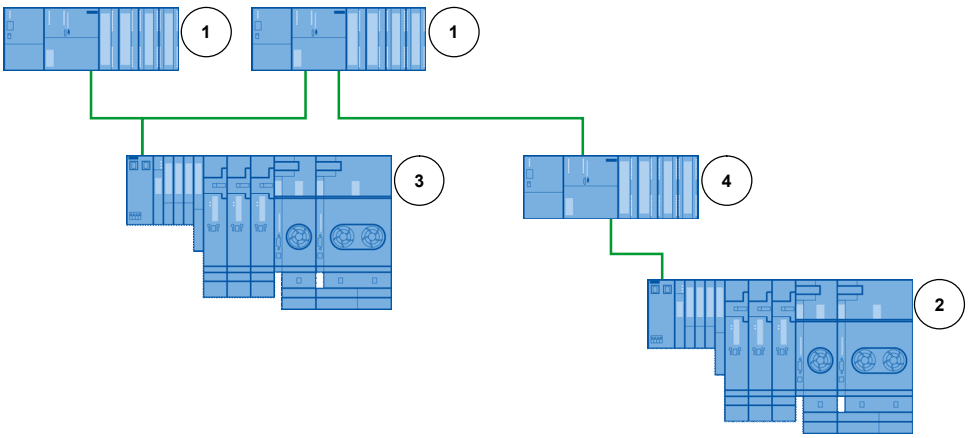


Table 1-1

No.	Device	Description
1	IO controller	The IO controller is a controller in which the automation program runs and by means of which the connected IO devices are addressed. In other words, the IO controller exchanges input and output signals with field devices.
2	IO device	The IO device is a remote field device assigned to one of the IO controllers such as distributed IO, valve terminals frequency converters and switches with integrated PROFINET IO function.
3	Shared device	Using the "Shared device" function an IO device can make its data available to multiple IO controllers.
4	I device	Using the "I device" function you can use an IO controller also as IO device and thus establish a separate lower-level PROFINET IO system. An I device can also be used as a shared device.

Note More information about PROFINET CBA and PROFINET IO is available in the manual "SIMATIC PROFINET System Description" at this link:

http://support.automation.siemens.com/WW/view/en/19292127

1.3 Validity

This document is valid as basic documentation for SIMATIC S7, SINUMERIK and STEP 7.

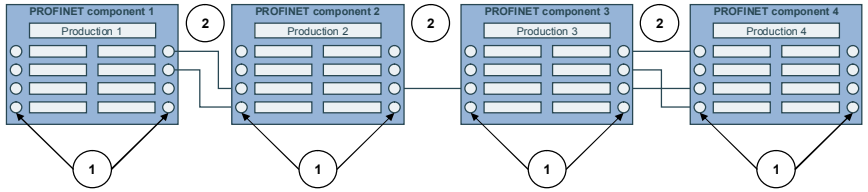
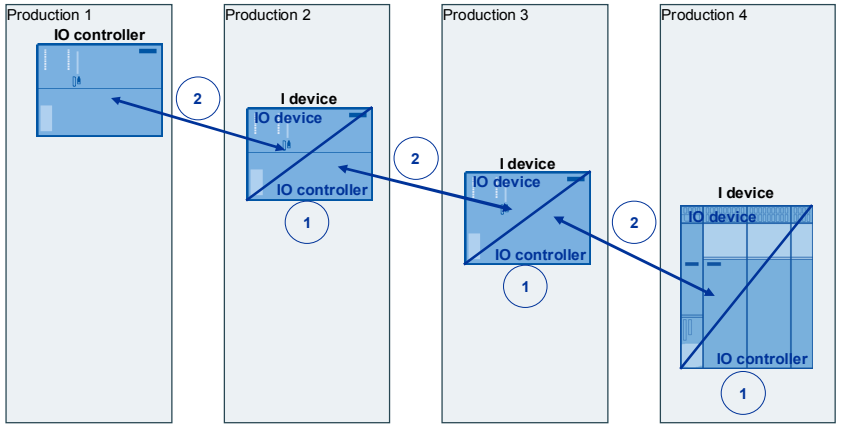
2 Concepts

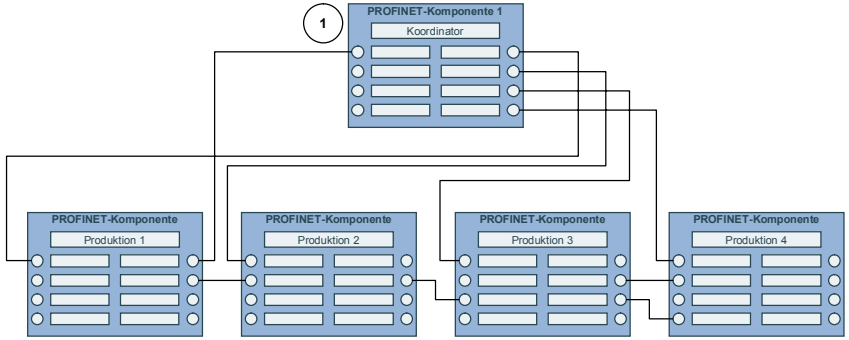
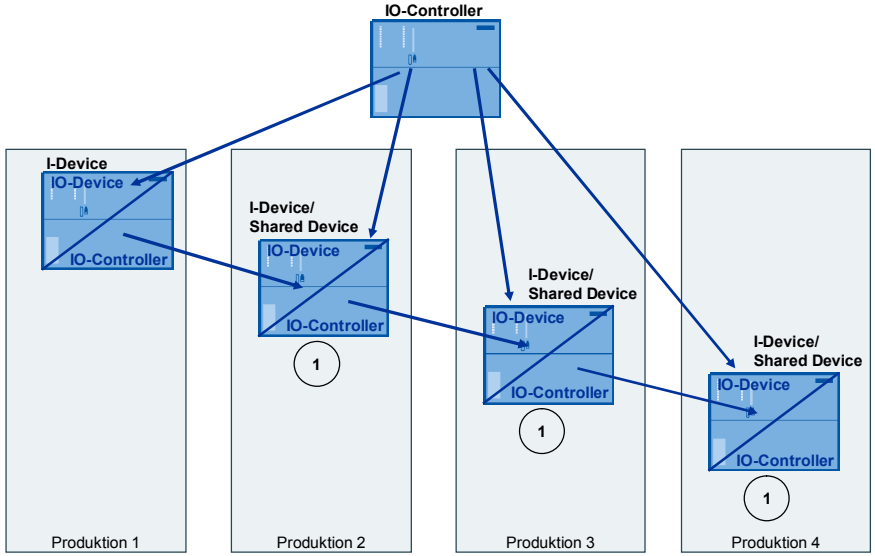
This chapter shows you how you can implement a line structure and complex communication structures in a PROFINET CBA and PROFINET IO network.

2.1 Line Structure

Table 2-1 shows the configuration of a line structure in a PROFINET CBA and PROFINET IO network.

Table 2-1

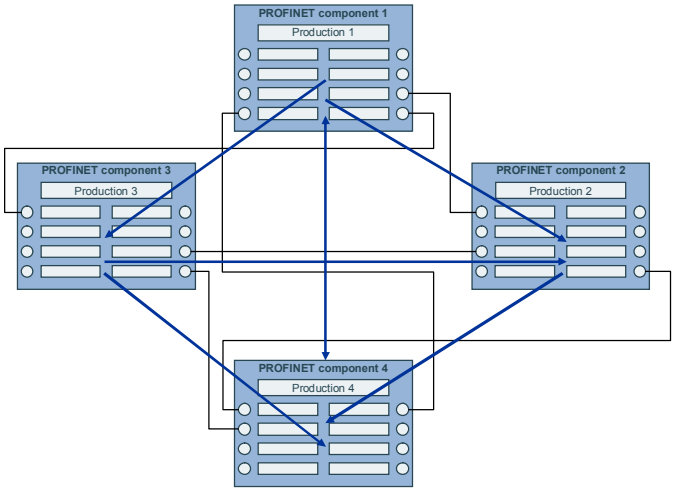
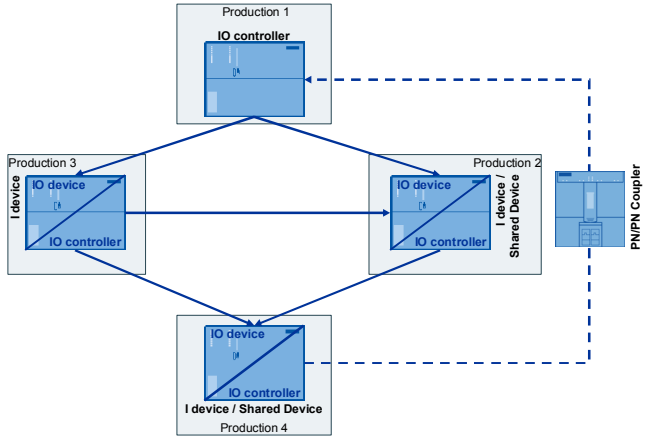
PROFINET CBA		PROFINET IO	
The figure below shows the implementation of a line structure with PROFINET CBA with a 1:1 interconnection between the PROFINET components. 		The figure below shows the implementation of a simple line structure with PROFINET IO by means of a PROFINET IO controller and I device. 	
1	The technological function of the PROFINET components includes the interface to other PROFINET components in the form of interconnectable inputs and outputs.	1	As IO device the I device makes its data available to a higher-level IO controller. At the same time as IO controller it accesses the data of the lower-level I device.

<table>
<tr><th colspan="2">PROFINET CBA</th><th colspan="2">PROFINET IO</th></tr>
<tr><td>2</td><td>You configure the communication connections between the PROFINET components graphically as interconnection lines in SIMATIC iMap.</td><td>2</td><td>The PROFINET devices and data exchange are configured in STEP 7.
IO data is exchanged between IO controller and I device. The logical assignment of the IO addresses between IO controller and I device is done in the hardware configuration.</td></tr>
<tr><td colspan="2">The figure below shows the implementation of a line structure with PROFINET CBA with a 1:n interconnection between the PROFINET components.
 
</td><td colspan="2">The figure below shows the implementation of a line structure with PROFINET IO by means of PROFINET IO controller, I device and shared device.
 
</td></tr>
<tr><td>1</td><td>A PROFINET component acts as coordinator and exchanges its data with multiple PROFINET components.</td><td>1</td><td>The I device is also implemented as shared device and thus makes the data of separate submodules exclusively available to two different IO controllers.
The I device is imported into the hardware catalog by means of the GSDML (General Station Description Markup Language). This enables you to use the I device in multiple projects.</td></tr>
</table>

2.2 Complex Communication Structure

Table 2-2 shows the configuration of a complex communication structure in a PROFINET CBA and PROFINET IO network.

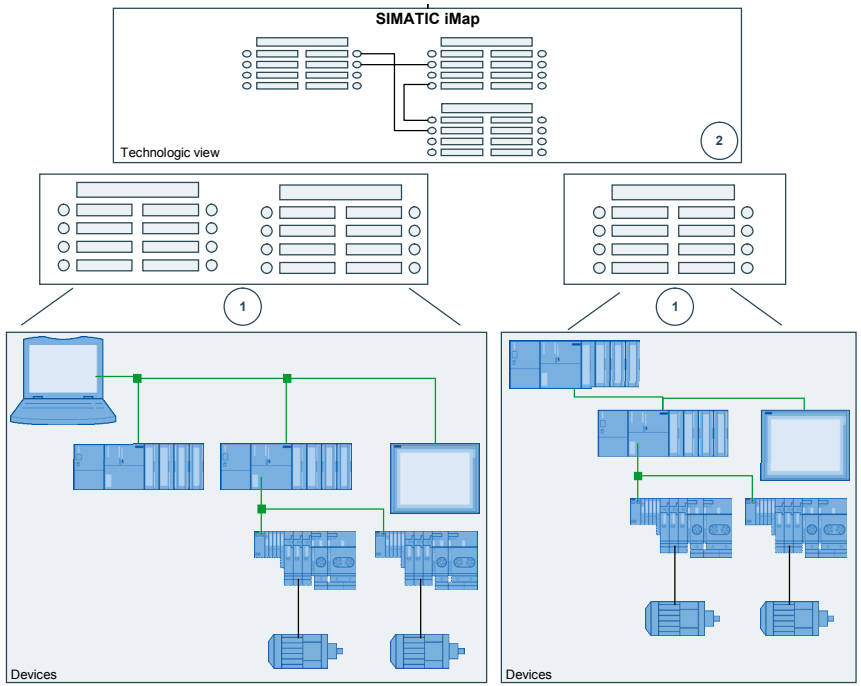
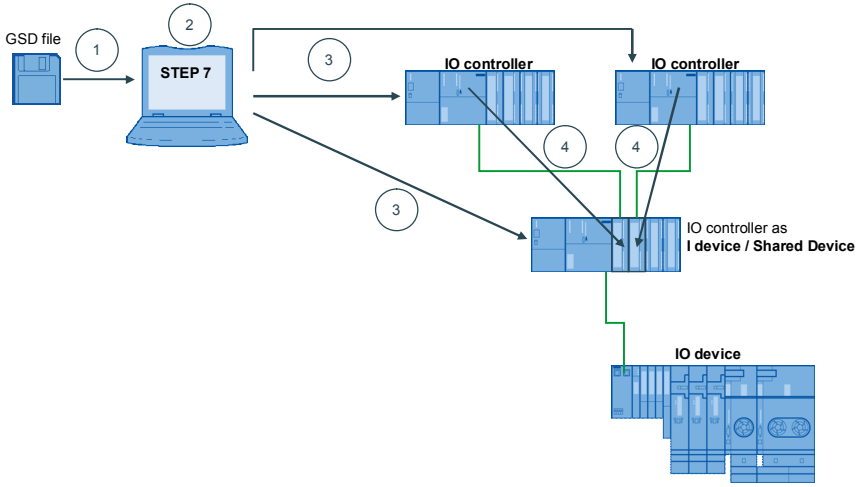
Table 2-2

PROFINET CBA	PROFINET IO
The figure below shows you how you can implement a complex communication structure in a PROFINET CBA network. In the plant, each PROFINET component exchanges its data with all other PROFINET components. There is an n:n interconnection between the PROFINET components.  	Using I device, shared device and the PN/PN coupler you can implement complex communication structures in a PROFINET IO network. A maximum of two IO controllers can access the IO addresses of the submodules of a shared device. With the PN/PN coupler you can implement data exchange between two PROFINET IO controllers. In this way you can implement n:n interconnections with I device, shared device and PN/PN couplers. Data transfer over the PN/PN coupler enables acyclic transmission (data record transfer) of data up to 4096 bytes per slot from one IO controller (sender) to another IO controller (receiver). This acyclic data transfer permits you to exceed the cyclic IO data transfer of 1024 bytes of inputs and outputs (in total) per module. The figure below shows you the configuration of a complex communication structure in a PROFINET IO network. 

PROFINET CBA	PROFINET IO
	Production 1 The IO controller accesses the IO data of the IO controller configured as I device and shared device in Production 2 and 3. Over a PN/PN coupler the IO controller exchanges IO data with the IO controller in Production 4. **Production 2** The IO controller is configured as I device on the IO controller in Production 1 and 3. In this way, as I device and shared device, it makes its IO data available to both IO controllers. At the same time, the IO controller accesses the IO data of the IO controller configured as I device and shared device in Production 4. **Production 3** The IO controller is configured as I device on the IO controller in Production 1 and makes its IO data available to it. At the same time, the IO controller accesses the IO data of the IO controller configured as I device and shared device in Production 4. **Production 4** The IO controller is configured as I device on the IO controller in Production 2 and 3. In this way, as I device and shared device, it makes its IO data available to both IO controllers. Over a PN/PN coupler the IO controller exchanges IO data with the IO controller in Production 1.

3 Engineering

Table 3-1

PROFINET CBA	PROFINET IO
The figure below graphically shows the steps required to configure a PROFINET CBA plant. 	The figure below graphically shows the steps required to configure a PROFINET IO system. 
The configuration of the plant is split into the steps below and is done in two different engineering tools. • vendor-specific engineering tool like STEP 7 • vendor-independent engineering tool: SIMATIC iMAP	The configuration of the plant is split into the steps below and is done in STEP 7 or NCM PC.

PROFINET CBA		PROFINET IO	
1	**Component generation with vendor-specific engineering tool** You do the following with a vendor-specific engineering tool like STEP 7: • Configure the automation devices or field devices of the technological function. • Program the user program of the technological function. • Create a PROFINET component from the configuration of the devices and the user program. A PROFINET component includes all the data of the hardware configuration, the parameters of the modules and the associated user program for utilization in PROFINET CBA. The PROFINET component is composed as follows: • Technological function The technological function includes the interface to other PROFINET components in the form of interconnectable inputs and outputs. • Device The device is the representation of the physical automation device or field device including the IO, sensors and actuators, the mechanics and the device firmware. A PROFINET Component Description (PCD) file is created in XML.	1	**GSDML import** New PROFINET devices are imported by way of the GSDML (General Station Description Markup Language) into the hardware catalog. The properties of the PROFINET device are described in this XML file. In this way the GSDML file contains all the information required for the configuration.

PROFINET CBA		PROFINET IO	
2	**Configuration of the complete plant in a cross-vendor engineering tool** The PROFINET components can be merged graphically in SIMATIC iMap and displayed throughout the plant. • Import the PCD in SIMATIC iMap to add the PROFINET components and interconnect them with other PROFINET components. • You configure the communications connections between the PROFINET components graphically as interconnection lines. In this way you can simply integrate products of different manufacturers in a plant using PROFINET. **Note** You can store PROFINET components in a SIMATIC iMap library and re-use them. When you re-use the PROFINET components, you simply have to modify them to meet the new conditions (instancing).	2	**Engineering** In STEP 7 you configure the PROFINET devices as IO controllers and IO devices. Add the I devices to the IO system of the higher-level controller In this way the IO controller can access the assigned IO addresses of the IO devices. **Note** • For the IO controllers configured as I device or shared device you must create and install the GSDML file in the hardware configuration of STEP 7. With this GSDML file the I device or shared device is inserted in the IO system of the higher-level IO controller. • In the hardware configuration you distribute access to the submodules of the shared device between the separate IO controllers. Each submodule of the shared device can be assigned exclusively to one IO controller.
		3	**Configuration and transfer of the user program** Create the user program that processes the input and output data of the IO devices. Transfer the configuration and the user program to the IO controllers.
		4	**Data exchange** Once you have assigned a device name to the IO device, data is exchanged automatically between IO controller and IO device. **Note** You do no have to assign the device name for IO devices whose PROFINET function "Replace device without interchangeable medium/PG" has been configured.

4 Real-time Communication

Industrial communication, in particular in production automation and process automation, demands precisely timed and deterministic transfer of data.

Real-time communication (RT) delivers the basis for real-time communication for the remote IO area (PROFINET IO) and for the PROFINET component model (PROFINET CBA).

Table 4-1

PROFINET CBA	PROFINET IO
With PROFINET CBA, the transfer of time-critical data is performed at guaranteed time intervals. For this PROFINET CBA provides an optimized communication channel for real-time communication and in this way supports the real-time requirements of the production industry. It is ensured that smooth communication can take place over other standard protocols in the same network.	PROFINET IO uses real-time communication (RT) for the cyclic exchange of time-critical IO user data and isochronous real-time communication (IRT) for synchronized data exchange at reserved time intervals. Real-time communication provides the required real-time capability. In compliance with the IEEE802.1Q the PROFINET IO messages are prioritized compared to standard messages. This ensures the determinism required in automation technology. In this procedure the data is transferred by means of prioritized Ethernet messages. Isochronous real-time communication (IRT) is a synchronized transmission procedure for cyclic exchange of IRT data between PROFINET devices. There is a bandwidth reserved for the IRT data within the transmitter clock. The reserved bandwidth guarantees that the IRT data can be transmitted at reserved, clock-synchronized intervals even when the network is otherwise heavily loaded (with TCP/IP communication or additional real-time communication, for example). This means that IRT enables synchronous data exchange with PROFINET.

5 Notes on the Functions with PROFINET IO

5.1 Isochronous mode (IRT)

The components below cannot be operated synchronously.

- Shared device
- I device on higher-level IO controller
- PROFINET components with PROFINET CBA

5.2 I Device and Shared Device

The I device and shared device functions are support only with PROFINET IO.

6 Diagnostics

PROFINET CBA with SIMATIC iMap provides a simple way of determining diagnostics data.

Compared with PROFINET CBA, PROFINET IO provides various ways of accessing diagnostics data. You can proceed as follows for diagnostics:

- React to an error (event-related diagnostics, evaluation of alarms)
- Determine the current status of your automation system (status-related diagnostics)

Table 6-1 gives you an overview of the diagnostics options available with PROFINET CBA and PROFINET IO.

Table 6-1

PROFINET CBA	PROFINET IO
Diagnostics using the SIMATIC iMap engineering tool Using SIMATIC iMap you can query process and diagnostics data of the devices during commissioning and during operation. The diagnostics data of process variables and faults in the technological functions and of the devices and the interconnections are displayed in three tabs in the diagnostics window. Possible errors in the functions and devices are identified with symbols in the plant and network views. The type of error is described in the diagnostics window in each case. • Error type of functions - The interconnection has failed. - The interconnection must be downloaded. • Error type of devices - The device is not accessible. - The device has failed. - The program must be downloaded.	**Diagnostics using the STEP 7 engineering tool** STEP 7 provides the options below for accessing the diagnostics data of the PROFINET devices. • Online diagnostics with a PG/PC/HMI device to evaluate the current status of the automation system. • Signaling of system errors to display the diagnostics data in the form of messages in the HMI device or web server. More information about diagnostics using STEP 7 is available in section 6.1.
	Evaluation of the diagnostics in the user program In the user program you can evaluate the diagnostics status and alarms. This gives you the following diagnostics options: • Reading system status lists (SSLs) in the user program to locate an error using the SSLs. • Reading diagnostics data records (Records) to obtain detailed information from the diagnostics data records about the type and source of the error. • Diagnostic interrupt to evaluate diagnostics in the user program. More information about evaluating diagnostics in the user program is available in section 6.2.
	Diagnostics with the web server The web server enables you to retrieve

PROFINET CBA	PROFINET IO
	diagnostic information in a standard web browser, comfortably.

6.1 Diagnostics Using STEP 7

There are different methods for diagnostics in STEP 7:

- If you open the Online View in the hardware configuration, in STEP 7 you can obtain an overview of the current status of your system.
- If you call the "PLC → Display Accessible Nodes" menu in the SIMATIC Manager, a list of the PROFINET devices is displayed.
- If you call the "PLC → Diagnostic/Setting → Hardware Diagnostics" menu in the SIMATIC Manager, an overview of the defective devices is displayed.
- If you call the "PLC → Diagnostic/Setting → Module Information" menu in the SIMATIC Manager, detailed diagnostics information is displayed.
  - Device status
  - Device name
  - Device type
  - Fault location (slot, module, submodule, channel)
  - Channel error type
  - Remedy with error clearance (for some modules)
- The STEP 7 Function "Report system error" provides a convenient way to display the diagnostics information provided by the component in the form of messages.
  STEP 7 automatically generates the necessary blocks and message texts. You simply have to download the generated blocks into the CPU and transfer the texts to the connected HMI devices.

6.2 Diagnostics in the User Program

Evaluation of the diagnostics status

If you want to know about the current status of your automation system, you should read out the system status lists (SSLs).

These SSLs give you a complete overview of the available PROFINET IO systems and you can locate defective stations or stations requesting maintenance or needing maintenance within a PROFINET IO system.

Using parts lists you can narrow down the error to a module/submodule.

Using SFB 52 (Read data record) you can then read out various data records (Records) directly from the module concerned giving you detailed error information.

Figure 6-1

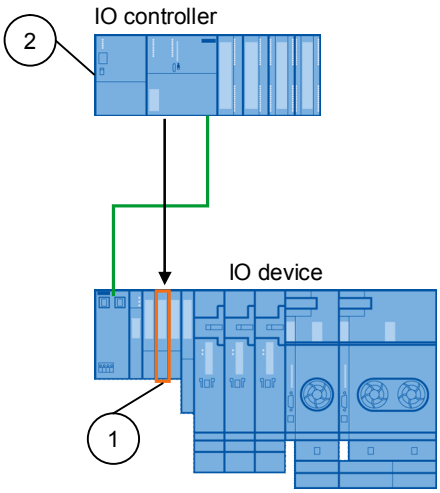


Table 6-2

No.	Description
1	Each individual error is collected in a data record on the interface module.
2	In your user program, SFB 52 reads the complete station status asynchronously directly from the IO device.

Evaluation of alarms

If an error/alarm occurs, an error organization block (error OB) is called. The OB number and Start information already give you information about the cause and location of the error. Detailed information about the error event is given in this error OB with SFB 54 (Read additional alarm information).

Figure 6-2

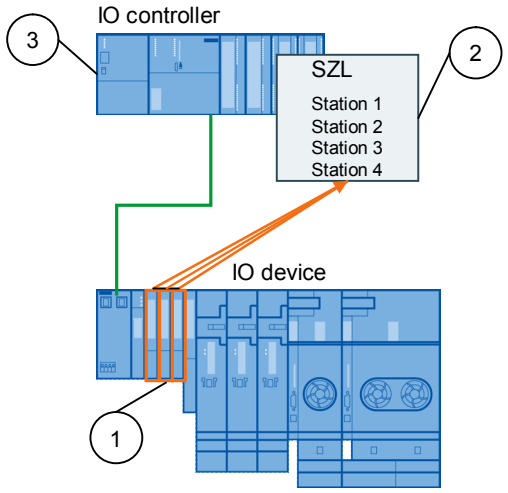


Table 6-3

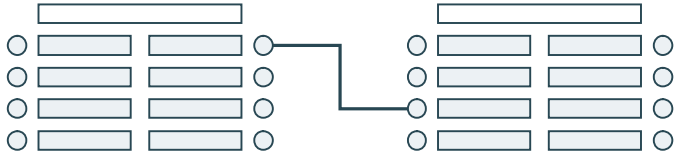
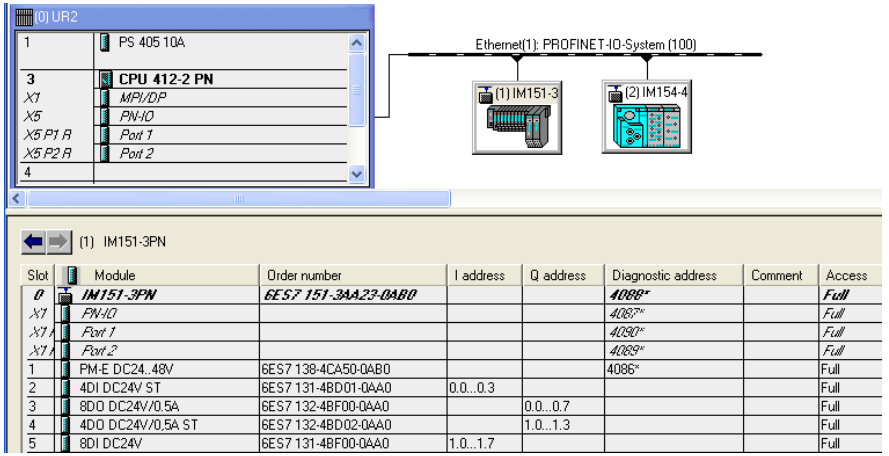
No.	Description
1	Each error is sent separately to the IO controller as channel diagnostics in the form of an alarm.
2	The module status data is update automatically in the IO controller and the error OB (OB 82) is started.
3	In your user program, in the error OB (OB 82), SFB 54 reads the error synchronously from the IO controller with addressing the IO device.

7 Properties of PROFINET CBA and PROFINET IO

PROFINET IO and CBA are two different views of the automation devices in the Industrial Ethernet.

Table 7-1 gives an overview of the properties of the two systems PROFINET CBA and PROFINET IO.

Table 7-1

PROFINET CBA	PROFINET IO
PROFINET CBA supports component-based communication by way of TCP/IP real-time communication to meet the real-time requirements in modular plant configuration. The component concept enables you to divide a complete plant into different technological functions. 	PROFINET IO is a communication concept that supports real-time communication (RT) and clock-synchronized isochronous real-time communication (IRT) with the remote IO. The remote IO is added as IO device to the IO system of a higher-level IO controller. In this way the IO controller can access the IO addresses of the connected IO devices. With the modular, remote configuration and the IO data exchange PROFINET IO provides a picture of the plant that is a very similar to the PROFIBUS view. 
To configure a PROFINET CBA plant you need a vendor-specific engineering tool like STEP 7, for example, and SIMATIC iMap, the vendor-independent engineering tool.	You need only one single engineering tool for configuring a PROFINET IO system.

PROFINET CBA	PROFINET IO
You configure the devices and program the user program of the technological function. Together with the user program the devices form an independent technological module. You create a PROFINET component out of the technological module.	You configure the separate PROFINET devices and create the user program for processing the IO data.
The plant-wide interconnection of the PROFINET components is done with communications connections that you configure graphically as interconnection lines.	For IO data exchange you assign the IO addresses of the submodules of the IO device logically to the IO controller.
The description of the interfaces of the technological function is stored in the PCD (PROFINET Component Description) when the PROFINET components are created. The PCD is an XML file.	The properties of an IO device are described by the device manufacturer in the GSDML (Generic Station Description Markup Language). The GSDML is an XML file.
The vendor-independent engineering permits you to incorporate products of different manufacturers in the PROFINET communication system. Manufacturers of field and automation devices simply have to add the device-independent engineering tool to their programming and configuration tools.	You can add IO devices of different manufacturers to a PROFINET IO system. To do this you import and install the GSDML of the IO devices in your engineering tool.
The interfaces of the PROFINET components can be interconnected as you wish in SIMATIC iMap and can be re-used as often as you wish in different automation solutions. This enables you to configure complex communication structures.	With PROFINET IO you can implement complex communication structures with I device, shared device and PN/PN couplers. **Note** • A maximum of two PROFINET IO controllers can access the IO addresses of the submodule of a shared device. • For data exchange, the PROFINET IO device is limited to 64 submodules and 1024 bytes of user data per submodule. • The maximum number of IO devices you can connect depends on the IO controller. The size of the IO address area of the IO controller influences the maximum number of IO devices that can be connected.
PROFINET CBA with SIMATIC iMap provides a simple way of determining diagnostics data.	PROFINET IO provides various ways of accessing diagnostics data.
Transfer of F data is **not** possible with PROFINET CBA.	Transfer of F data (PFOFIsafe) is possible with PROFINET IO. **Example** The IO device consists of F modules and standard modules. Access to the separate modules is assigned to an IO controller of an F-CPU, for example. If the IO device supports the Shared Device function, access to the F and standard modules can be split between two IO controllers, between an F-CPU and a standard CPU, for example.

8 Additional Information

More information about configuring PROFINET CBA plants and PROFINET IO systems is available in the manuals below.

Table 8-1

Manual	Link
SIMATIC PROFINET System Description	http://support.automation.siemens.com/WW/view/en/19292127
SIMATIC iMap STEP 7 AddOn Creating PROFINET Components	http://support.automation.siemens.com/WW/view/en/22762278
SIMATIC iMap Getting Started	http://support.automation.siemens.com/WW/view/en/22761964
SIMATIC iMap Configuring Plants	http://support.automation.siemens.com/WW/view/en/22762190
From PROFIBUS DP to PROFINET IO	http://support.automation.siemens.com/WW/view/en/19289930