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Configuration Control with S7-1500 and ET 200SP

S7-1500, ET 200SP, LCC

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1 Task

Introduction

High cost pressure associated with project planning, design, wiring and documentation leads to modularization and standardization of hardware and software for the various configurations and variants of a machine.
The requirements - customized configuration of a station and flexible expansions while retaining the configuration and the control program - that seem conflicting at first glance are met by configuration control (option handling).

For modular machine concepts, for example, in series machine building, configuration control offers savings potential for the creation, commissioning and documentation.

Until now, this has only been possible on the distributed IO systems ET 200S and ET 200pro. Expanding the ET 200 portfolio and the new firmware for the S7-1200 and S7-1500 has significantly expanded the options.

In the course of this process, a library, **LCC**, was developed for TIA Portal. The blocks included in it support you in parameterizing and implementing configuration control (central/distributed) for all usable modules.

This application shows the use of this library.

Overview of the automation task

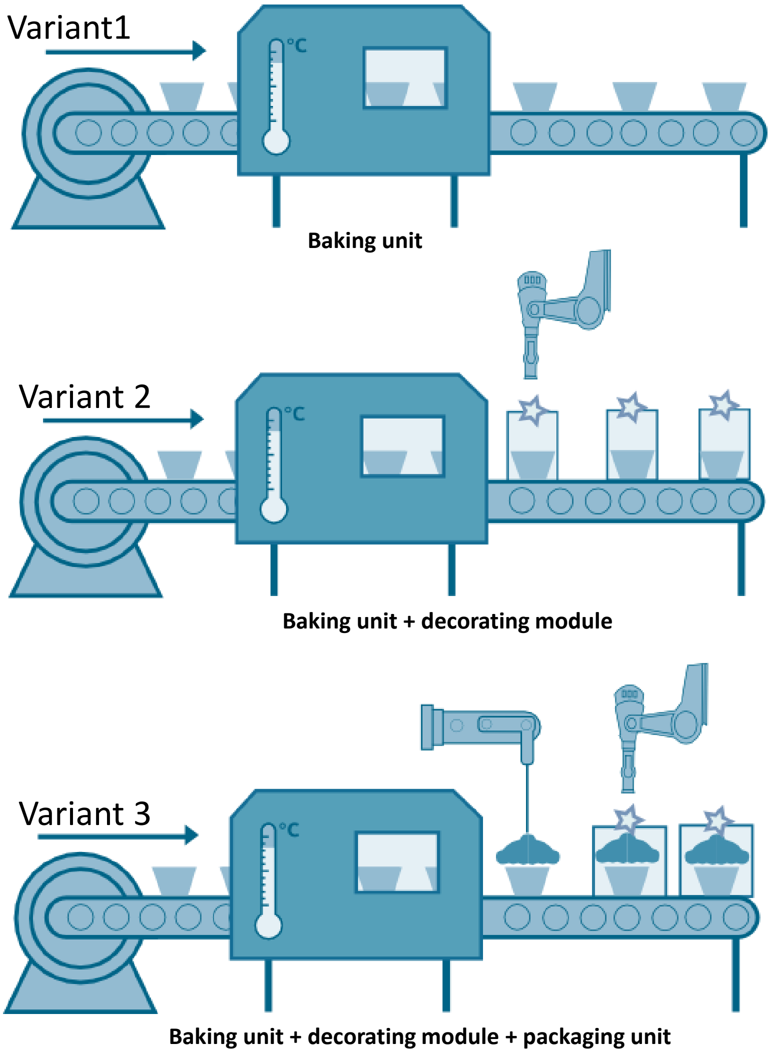
The automation task simulates a fictitious muffin production plant.
This production plant includes

- a "baking unit",
- a "decorating module",
- a "packaging unit"

To be able to offer different types of muffins, the following variants are conceivable:

- Variant 1: Muffins **without** decorations and **without** packaging.
- Variant 2: Muffins **without** decorations and **with** packaging.
- Variant 3: Muffins **with** decorations and **with** packaging.

Figure 1-1


Variant1
°C
Baking unit
Variant 2
°C
Baking unit + decorating module
Variant 3
°C
Baking unit + decorating module + packaging unit

Description of the automation task

"Muffin production" is used for the application example.

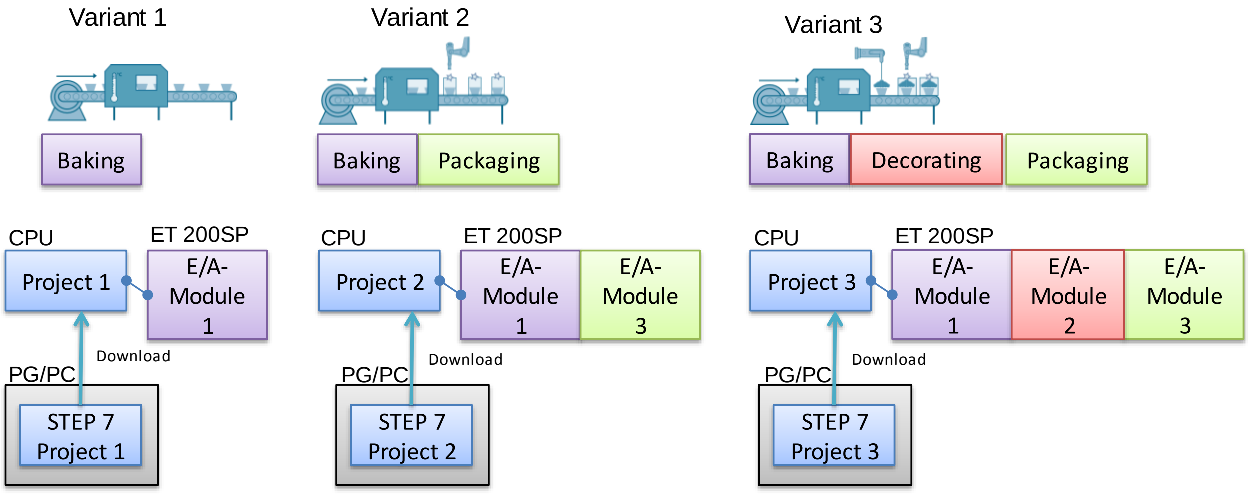
A central controller with a distributed IO device (here: an ET 200SP) is used to control the production plant.

The input and output modules of the distributed IO device supply the actuators and sensors of the following production parts:

- "Baking unit",
- "decorating module",
- "packaging unit".

Depending on the muffin variation, a different configuration of the distributed IO device and a separate STEP 7 project are necessary.

Figure 1-2

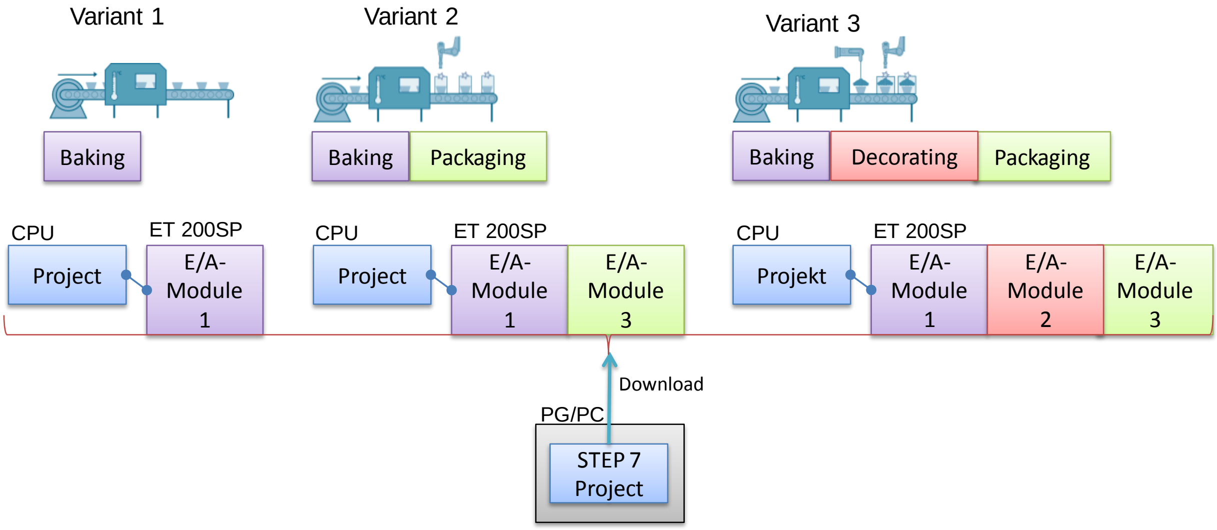


Objective of the automation task

Now the task is to automate all variations with the same STEP 7 project.

The figure below illustrates the correlations.

Figure 1-3



In specific terms, the aim is to achieve the following objectives:

- Retrofitting variants without reconfiguring the station.
- Enabling IO modules by the PLC program.
- Easy diagnostics of all occurring errors, regardless of the current configuration variant - without program modifications.
- **One** STEP 7 project for all variations.

2 Solution

2.1 Principle

2.1.1 Presentation of the solution

Description

With configuration control (option handling), SIMATIC offers a solution to the above-described task: A single STEP 7 project covers all production variants.

This is made possible by a configurable assignment of configured to physically existing station modules by means of a control data record that is transferred to the affected device if necessary.

For this purpose, configuration control uses different methods:

- Configuration control for central configuration (central processing unit).
- Configuration control for distributed configuration (distributed IO device).

Advantages

- Easier project handling and commissioning due to the use of a single STEP 7 project for all variations.
- Easier handling in terms of maintenance, versioning and upgrade.
- Savings in hardware costs: Only IO modules necessary for the current variant of the machine are installed in the ET 200SP.

Topics not covered in this application

This application does not include a description of the following:

- Configuring the hardware and using TIA Portal.
- Programming SIMATIC S7.
- Network technology and protocols.
- Contents and principle of operation of the **LCC**.

Basic knowledge of these topics is required.

In addition, this application does not focus on programming muffin production but on implementing configuration control and the parameterization and configuration steps associated with it.

Note The **LCC** and a library description can be found on the same HTML page as this document (see \2\).

Assumed knowledge

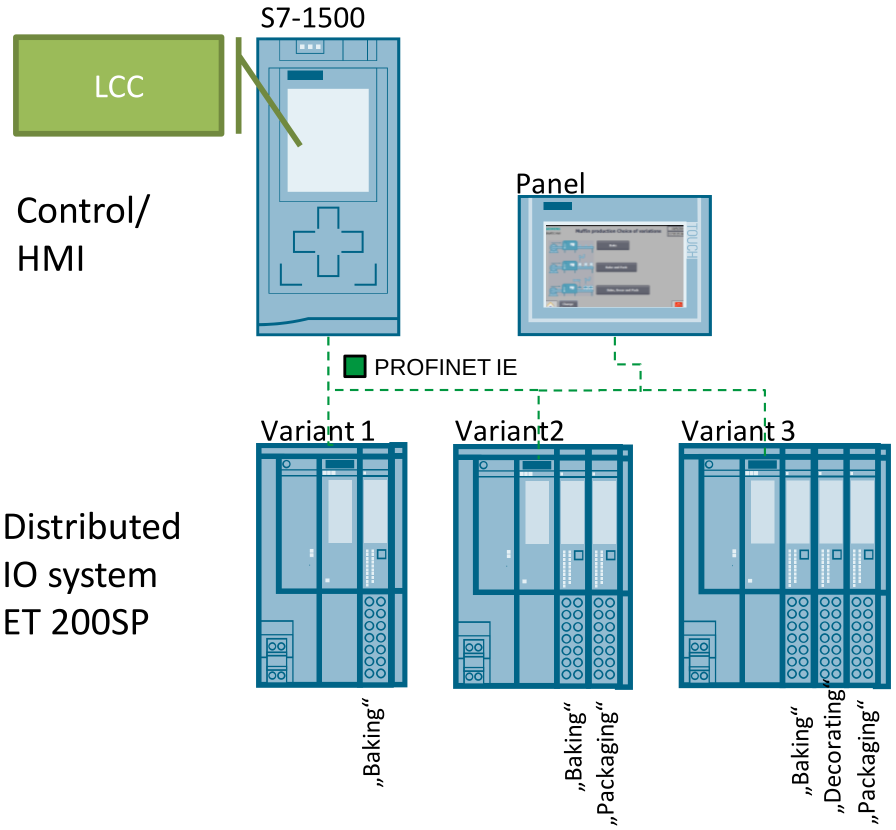
Basic knowledge of the SIMATIC automation system and ET 200SP is required. Advanced knowledge of the TIA Portal engineering software is also necessary.

2.1.2 Real hardware configuration of the production plant

Diagrammatic representation

The diagrammatic representation below shows the **real** components involved in the solution:

Figure 2-1



Configuration

The production plant is automated by the following devices:

- the S7-1500 central control unit
- the ET 200SP distributed IO system
- the TP 700 operating panel.

The control unit consists of the CPU 1516-3 central processing unit.

The ET 200SP distributed IO device is represented by the IM155-3 ST interface module and - depending on the variant - equipped with various input and output modules.

The operating panel TP 700 Comfort is used for selecting the variants.

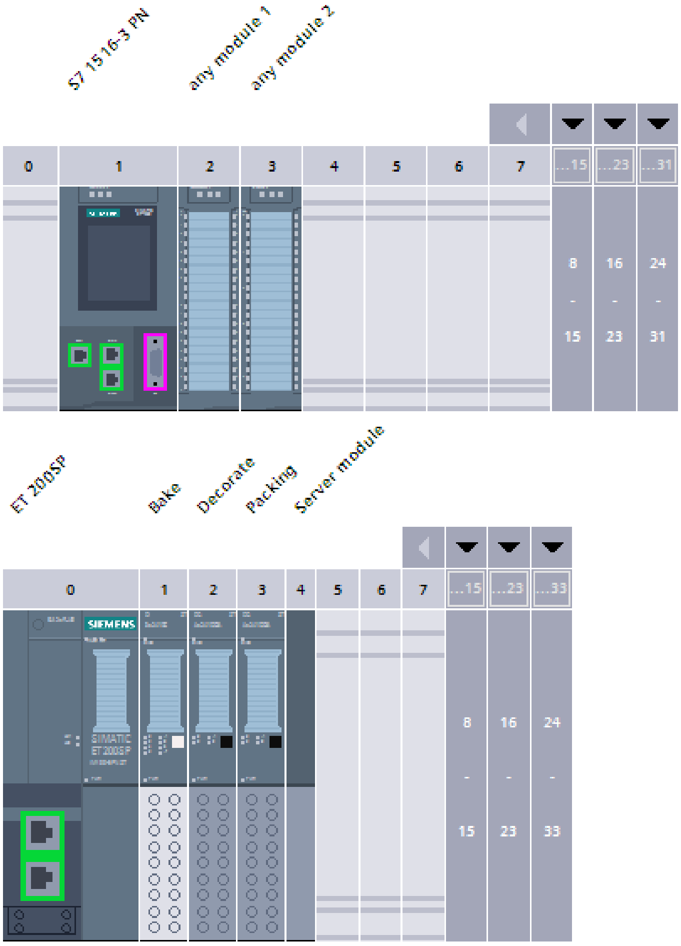
A single STEP 7 project is created that is applicable to all muffin variants. The blocks of the **LCC** are used for configuration control.

2.1.3 Configured hardware configuration of the STEP 7 project

Diagrammatic representation

For comparison, the diagrammatic representation below shows the **configured** hardware (the HMI panel is not presented here) in the shared STEP 7 project.

Figure 2-2



Configuration

The hardware configuration of the production plant contains the S7-1516-3PN central control unit with any number of input and output modules.

Note

The IO modules of the S7-1516-3PN are not relevant to the actual muffin production. They serve only to illustrate configuration control also for central configuration.

The ET 200SP distributed IO device is configured in the maximum configuration, including all the input and output modules the muffin variations require in total.

Which input and output modules are used for the desired variant is defined during runtime via the control data record.

2.2 Description of the core functionality

The basic idea of this application is the use of a shared STEP 7 project despite differently equipped IO modules of the distributed IO system - due to the muffin variations.

This is made possible by configuration control.

Due to configuration control, the distributed IO device or the central processing unit can be configured in the maximum configuration and still be operated with missing IO modules. If missing IO modules are retrofitted at a later time, reconfiguring and therefore reloading the hardware configuration are not required.

The basis for this is a configurable assignment of configured to physically existing station modules by means of a control data record that is transferred to the controller or interface module if necessary.

Sequence of the core functionality

The specific sequence provided by the application is as follows:

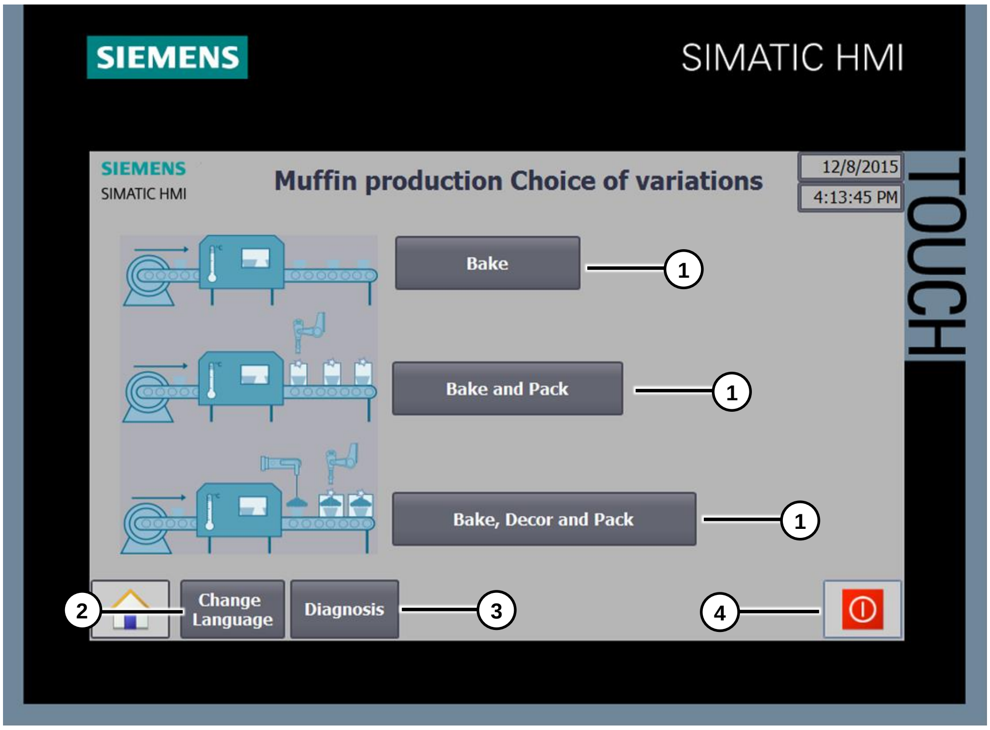
1. In the STEP 7 project, the distributed IO is configured in the maximum configuration and the controller is configured with any IO modules.
2. In a central database,
   a. for all muffin variations
   b. for the central control unit,

   in each case with the aid of the ready-made PLC data types from the **LCC**, a separate data structure has been created that contains the current setpoint configuration.
3. The desired muffin variant is selected using an HMI visualization.
4. The user program is designed such that the necessary control data record is sent to the device (CPU or ET 200SP) at the right time with the aid of the function block from the **LCC**.

HMI visualization

The muffin variation is selected with the HMI. A very simple screen has been developed for this purpose. It is displayed in the following screenshot:

Figure 2-3



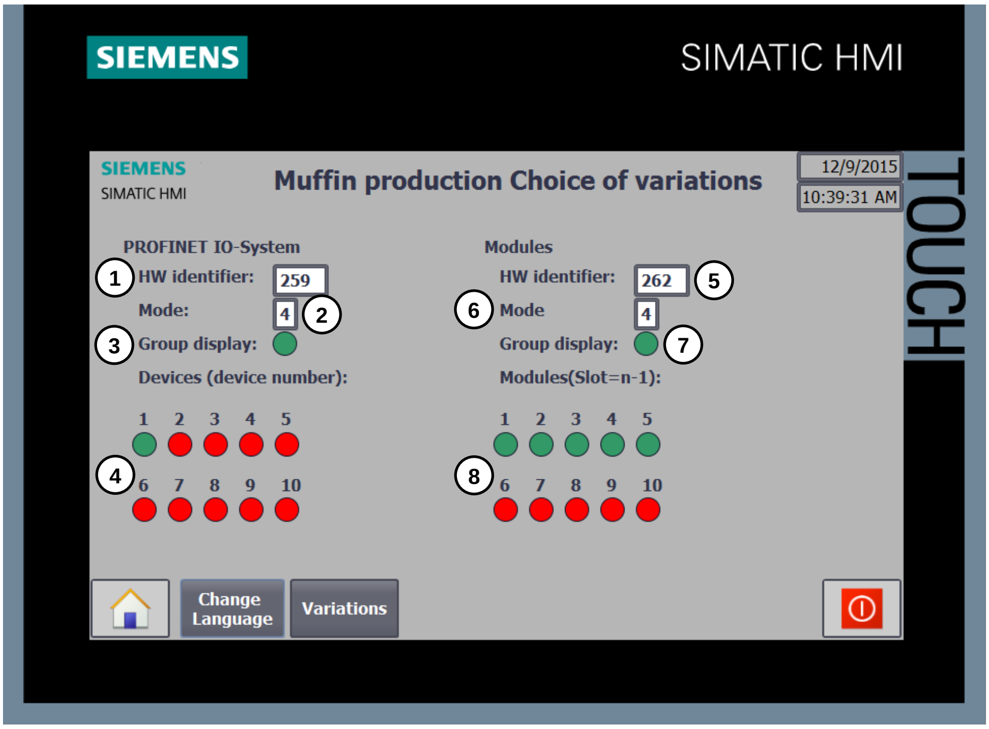
The meaning of the numbers is illustrated in the following table:

Table 2-1

Number	Function
1.	Selecting the muffin variation via buttons
2.	Language switching (German / English)
3.	Switchover to diagnostics
4.	Stop runtime

Visualization of the diagnostics information of the modules and devices in the application example is carried out via the HMI. It is displayed in the following screenshot:

Figure 2-4



Muffin production Choice of variations

12/9/2015
10:39:31 AM

PROFINET IO-System
HW identifier: 259
Mode: 4
Group display: 🟩
Devices (device number):

Modules
HW identifier: 262
Mode 4
Group display: 🟩
Modules(Slot=n-1):

Table 2-2

Number	Function
1.	Selecting the HW identifier of the PROFINET IO system to be diagnosed
2.	Selecting the mode for the PROFINET IO system diagnostics
3.	Group diagnostics for the PROFINET IO system diagnostics
4.	Representation of the diagnostics information for each device in the PROFINET IO system (n=device number)
5.	Selecting the HW identifier of the device to be diagnosed
6.	Selecting the mode for the device diagnostics
7.	Group diagnostics for the device diagnostics
8.	Representation of the diagnostics information for each module of the device (Slot=n-1)

2.3 Hardware and software components

2.3.1 Validity

This application is valid for

- STEP 7 V14 SP1 or higher
- S7-1500 CPU (firmware version V1.5 or higher)
- ET 200SP distributed IO device

2.3.2 Components used

The application has been created with the following components:

Hardware components

Table 2-3

Component	No.	Order number	Note
CPU 1516-3 PN/DP	1	6ES7 516-3AN00-0AB0	Or other CPU
IM 155-6 PN ST	1	6ES7 155-6AU00-0BN0	ET 200SP interface module
DI 8x24VDC ST	1	6ES7 131-6BF00-0BA0	For the "baking unit"
DQ 4x24VDC/2A ST	1	6ES7 132-6BD20-0BA0	For the "decorating module"
DQ 8x24VDC/0.5A ST	1	6ES7 132-6BF00-0BA0	For the "packaging unit"
BU15-P16+A10+2D	1	6ES7 193-6BP20-0DA0	Type A0 BASEUNIT with new load group
BU15-P16+A10+2B	2	6ES7 193-6BP20-0BA0	Type A0 BASEUNIT
TP700 Comfort Panel	1	6AV2124-0GC01-0AX0	In this application, the panel is simulated by the HMI-Runtime.

Software components

Table 2-4

Component	Order number	Note
TIA Portal V14	6ES7822-1AA04-0YA5	The link to the current updates for TIA Portal can be found here: \3\.
WinCC V14	6AV210.-....4-0	

Sample files and projects

The following list includes all files and projects that are used in this example.

Table 2-5

Component	Note
29430270_Config-Control-Modular_CODE_V31.zip	This zip file contains the STEP 7 project.
29430270_Config-Control-Modular_DOC_V31_en.pdf	This document.

3 Configuration Control Basics

3.1 What is configuration control?

3.1.1 Description

Configuration control facilitates the automation of machines with different configurations of the distributed IO system or the central processing unit. This becomes clear when one looks at the different methods.

Without configuration control - the configuration of the station is configured in STEP 7. The real configuration of the stations on the machine must match the configured configuration.
A STEP 7 project can only be used for **a single** real configuration.

With configuration control - the configuration of the stations is also configured in STEP 7. However, this configuration includes all the IO modules of all the variants of the machine. Different real configurations of stations can be operated with a single STEP 7 project or a single configuration (maximum configuration).
A **single** STEP 7 project can therefore be used for **multiple** real configurations of stations.

3.1.2 Applicable methods

Configuration control uses different methods. The starting point is the maximum configuration configured in STEP 7.

Hiding IO modules

This method allows you to hide configured slots (modules) in the real station. The real station is then set up without these hidden slots (modules).

Advantage: Only IO modules necessary for variant x of the machine have to be installed in the real station.

Free slot assignment

This method allows you to assign the configured slots (modules) to any real slots in the real station.

Advantage: This method allows you to install, for example, optional IO modules at the end of the station. Installation in the configured slot at the center of the station is not necessary. This avoids complicated lateral moving of wired parts of a station.

Using empty slots (ET 200SP only)

Instead of configured IO modules, this method uses BU covers in the real ET 200SP. The BU covers are used as dummies for IO modules to be inserted later.

Advantage: This method allows you to prewire optional IO modules. When retrofitting the ET 200SP station at a later time, only the BU covers will be replaced by these IO modules. Modification of the ET 200SP station is not necessary.

Note: A slot with a BU cover is called an empty slot.

Opening a new potential group (ET 200SP only)

This method allows you to open new potential groups anywhere in the real ET 200SP.

Advantage: This results in a high degree of flexibility in the design of potential groups.

Combining the methods

For a station, all the above-listed methods can also be used simultaneously.

Methods used in this application

The following methods are used in this application example:

- Hiding IO modules (S7-1500 and ET 200SP): All input and output modules that are not needed in the real configuration are hidden via the control data record.
- Free slot assignment (ET 200SP): Muffin production of variant 2 (muffins **without** decorations and **with** packaging) does not require the decorating module. Therefore, the packaging unit can use this slot.

3.2 Function principle

To be able to use configuration control, two steps are of importance:

1. Enabling configuration control in the module.
2. Programming and writing the control data record.

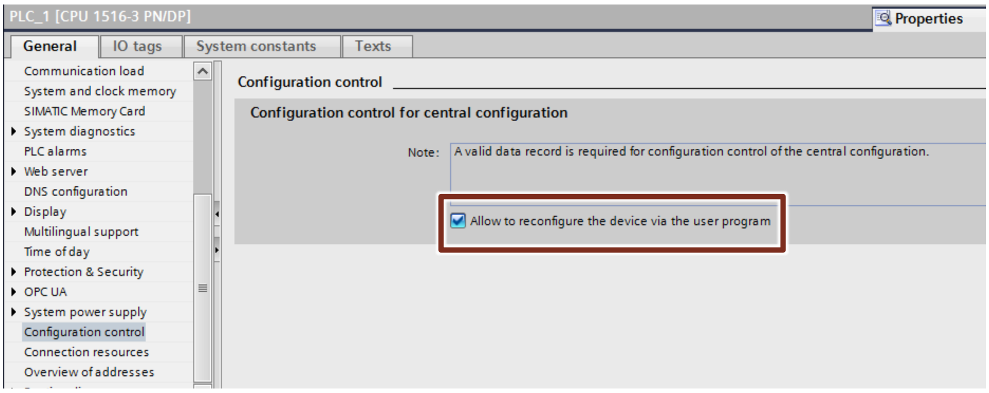
3.2.1 Enabling configuration control

Reconfiguring the device via the user program must be explicitly enabled in the hardware configuration of the distributed IO device or central processing unit.

Central processing units

For the S7-1500/S7-1200 central processing units, the parameter can be found in the properties of the central processing unit in the "Configuration control" section.

Figure 3-1



Configuration control

Configuration control for central configuration

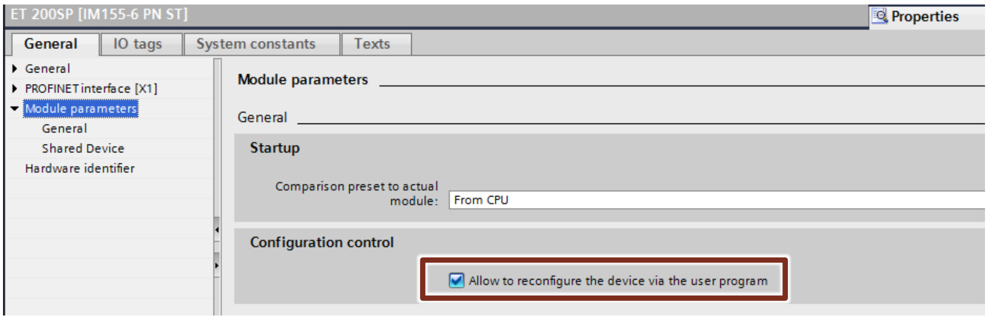
Note: A valid data record is required for configuration control of the central configuration.

☑ Allow to reconfigure the device via the user program

Distributed IO (except ET 200S)

For the ET 200SP/MP/AL/pro distributed IO devices, the parameter can be found in the properties of the interface module in the "Module parameters" > "Configuration control" section.

Figure 3-2



Module parameters

General

Startup

Comparison preset to actual module: From CPU

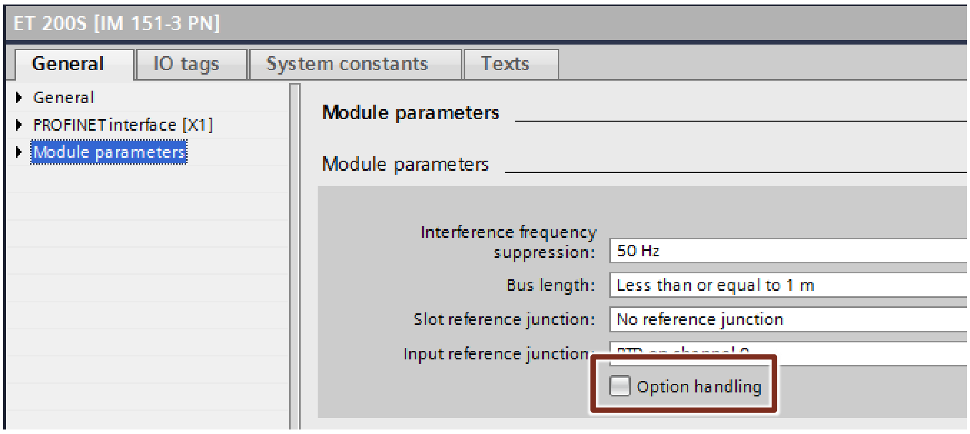
Configuration control

☑ Allow to reconfigure the device via the user program

Distributed IO (only ET 200S)

For the ET 200S distributed IO device, the parameter can be found in the properties of the interface module in the "Module parameters" section.

Figure 3-3



Module parameters

Module parameters

Interference frequency suppression: 50 Hz

Bus length: Less than or equal to 1 m

Slot reference junction: No reference junction

Input reference junction:

□ Option handling

3.2.2 Reconfiguration via the control data record

Mode of Operation

Reconfiguring the device configuration during runtime requires control data record 196 that contains the slot assignment of the setpoint configuration. Depending on the module, this assignment must be created with a permanently defined pattern.

The central processing unit or the interface module compares the real actual configuration to the slot assignment from the control data record (setpoint configuration). If setpoint and actual configuration do not match, a diagnostic message appears.

Configuration control is only ready to run with a valid control data record.

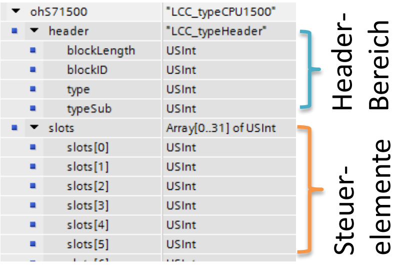
Structure of the control data record

The control data record consists of two parts: A header area, followed by the control elements.
In each element, the control elements describe which real slot in the PN device is assigned to the configured slot.

The header structure is identical for all control data records. The structure of the control elements differs; depending on the module, they follow a predefined pattern.

The following screenshot shows an excerpt from a control data record for the S7-1500:

Figure 3-4



```
▼ ohS71500            "LCC_typeCPU1500"
  ▼ header            "LCC_typeHeader"
      blockLength     USInt
      blockID         USInt
      type            USInt
      typeSub         USInt
  ▼ slots             Array[0..31] of USInt
      slots[0]        USInt
      slots[1]        USInt
      slots[2]        USInt
      slots[3]        USInt
      slots[4]        USInt
      slots[5]        USInt
```

Writing the control data record

With the aid of the "WRREC" system function block, the control data record is written to the module in the program of the S7 CPU.

To address the module, "WRREC" requires the identification number of the hardware component. The following rule applies:

- For interface modules of a **distributed IO device**, the **hardware identifier of the head** has to be used.
- For configuration control in **central configuration**, **hardware identifier 33** (dec) has to be used.

The control data record is stored retentively in the CPU/in the interface module.

Library LCC

Aside from a universal function block for writing the control data record, the **LCC** also contains predefined data structures for the different slot assignments of all possible modules.

With these PLC data types, the control data records can be configured quickly and easily. In addition, they reduce the susceptibility to errors when parameterizing.

Note A more detailed description of the blocks of the **LCC** can be found in the library description on the same HTML page as this document (see \2\).

3.2.3 Characteristics

Behavior in configuration control

First commissioning:
If no valid control data record exists in the CPU/interface module, configuration control is not ready to run.

In this case, the CPU returns from startup to STOP mode.

In the distributed IO, all IO modules of the station have failed and the interface module is in the process of exchanging data.

Changes in the configuration:
When writing the control data record with a changed configuration, a station failure occurs in the distributed IO (cyclic data exchange is aborted) and subsequently the station restarts with the changed configuration.

When writing a control data record with a changed configuration, a CPU responds with a general reset, followed by startup with this changed configuration.

Time of writing

The time for writing the control data record to the module depends on whether the module is a distributed IO device or a central processing unit.

The following rule applies:

- Centralized IO: It is mandatory to transfer a valid control data record already in the **startup OB** (OB 100).
- Distributed I/O: A call in the **startup OB** is recommended during first commissioning. The transfer of a valid control data record can also take place in the **cyclic user program**.

Diagnostics

The hardware configuration (maximum configuration) - not the real actual configuration that differs from it - is always used for online display and display in the diagnostic buffer.

Example: An IO module provides the following diagnostics: "missing module". This IO module is configured in slot 4; in the real configuration, it is located in slot 3. In the TIA Portal online view, a configured slot 4 is indicated as incorrect; in the real configuration, the IO module's LED display indicates an error in slot 3.

If IO modules are entered as missing in the control data record, the behavior of the automation system is as follows:

- IO modules marked as non-existent do not provide diagnostics; their status and the value status are always OK.
- Read or write direct access to the inputs or outputs or the process image of the non-existent inputs or outputs has no effect.
- Writing a data record to a non-existent IO module has no effect.
- When reading a data record from a non-existent IO module, an error is signaled as no valid data record can be returned.

3.3 Diagnostics using function blocks

"DeviceStates"

The "Device States" instruction reads out specific status information of all modules in a PROFINET IO System or a DP master system.

Five different modes can be selected to evaluate the status information required. A Boolean value shows whether the status selected is true.

"ModuleStates"

The "ModuleStates" instruction reads out specific status information of modules of a PROFINET IO device or of a PROFIBUS DP-Slave.

Five different modes can be selected to evaluate the status information required. A Boolean value shows whether the status selected is true.

Parameters

The following table describes the parameters of the "DeviceStates" and "ModuleStates" instructions.

Table 3-1

Name	Declaration	Data type	Description
LADDR	Input	"DeviceStates" HW_IOSYSTEM "ModuleStates" HW_DEVICE	HW identifier of the PROFINET IO or DP master system. HW identifier of the IO device or DP slave to be diagnosed.
MODE	Input	UINT	Selecting the status information to be read by selecting a mode (seeTable 3-2).
RET_VAL	Return_	Int	Instruction status (see Table 3-3)
STATE	InOut	Variant	Buffer for the status information of modules / IO devices / DP slaves.

MODE (selection of the status information)

The following table explains the five modes for the "DeviceStates" and "ModuleStates" blocks:

Table 3-2

Mode	Status information	Output value TRUE
1.	Modules / IO devices / DP slaves are configured	The module / IO device / DP slave is in the device configuration of the project
2.	Modules / IO devices / DP slaves are faulty	Error in the module / IO device / DP slave or module / IO device / DP slave is missing
3.	Modules / IO devices / DP slaves are deactivated	The modules / IO devices / DP slaves are deactivated via the user program or device configuration.
4.	Modules / IO devices / DP slaves exist	The modules / IO devices / DP slaves exist in the real hardware configuration.
5.	A problem has occurred in the modules / IO devices / DP slaves	The modules / IO devices / DP slaves are not accessible, not available. Maintenance is required/recommended or an error has occurred.

RET_VAL (Return value)

The following table describes the return values of the "DeviceStates" and "ModuleStates" instructions.

Table 3-3

Return value (hex)	Description
0	No error.
8091	HW ID specified not available in the project.
8092	LADDR addresses no IO device or DP slave / PROFINET IO or DP master system.
8093	Invalid data type at the STATE parameter.
80B1	The "ModuleStates" / "DeviceStates" instruction is not supported by the CPU.
80B2	The CPU used for the system does not support the MODE parameter selected for the IO device or DP slave / IO system entered at the LADDR parameter.
8452	The complete status information does not match the tag configured at the STATE parameter.

STATE (Status information)

At the STATE parameter, the status information selected via the MODE parameter is output as a Boolean value.

If the status applies to an IO device / DP slave / module, the following values are set to "1" at the STATE parameter:

- Bit 0:
  The bit 0 is used as a group display. It is set as soon as the bit n of at least one IO device / DP slave / IO system is set to "1".
- Bit n:
  "DeviceStates"

  The status selected via MODE applies to IO device / DP slave, and n corresponds to the device number / PROFIBUS address of IO device / DP slave.

  "ModuleStates"

  The status selected via MODE applies to the module in slot n-1.

The following data types can be used at the STATE parameter:

- Bool:
  Only the bit for group display of the status information is output.
- Array of Bool:
  Status displays for all modules / IO devices / DP slaves are output.
  "DeviceStates"
  The maximum length is 1024 bits for a PROFINET IO system and 128 bits for a DP master system.

  "ModuleStates"
  Die maximum length per module is 128 bits.

4 Principle of Operation and Parameterization

4.1 General overview

Externally, the application example consists of multiple functions/program blocks:

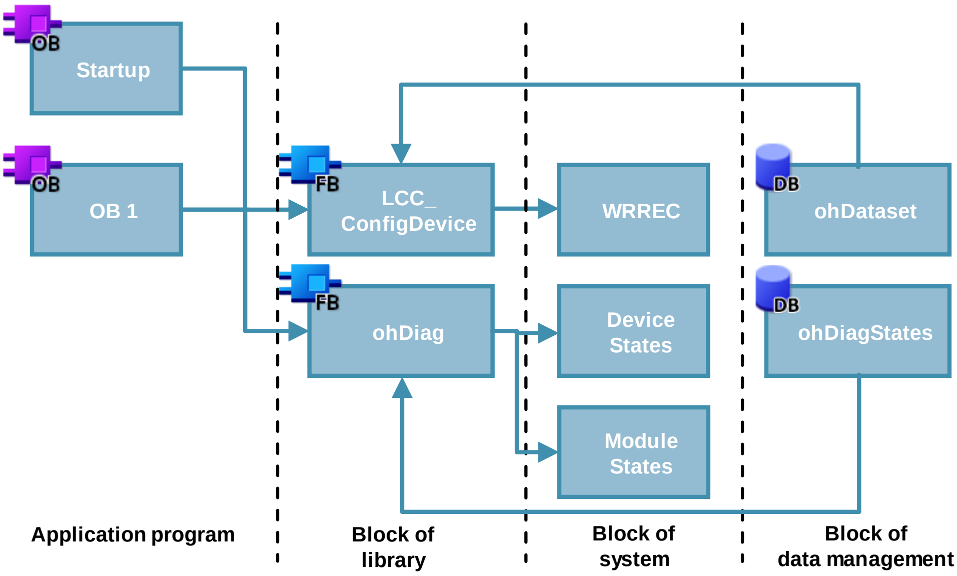
- FB 2 "LCC_ConfigDevice": Function block of the **LCC** for writing the control data record.
- FB 10 "ohDiag" function block for extended diagnostics of the configuration via the "DeviceStates" and "ModuleStates" function blocks.
- Startup OB: Call of FB 2 for first commissioning by the central processing unit and ET 200SP.
- OB 1: Simulated changes of variations during muffin production by repeated calls of FB 2.
- PLC data structures, "LCC_typeCPU1500" and "LCC_typeET200SP", as a template for the control data records.

The "ohDataset" data block is used for data management (central database).

4.2 Program overview

Diagrammatic representation

Figure 4-1



Complete overview of the program blocks

Table 4-1

Symbolic name	Description	Type
Startup OB	Creates a defined initial state for configuration control.	OB (LAD)
OB 1 (Main)	Block to operate the application: When the muffin variation is changed, "configuration control" is used.	OB (LAD)
LCC_ConfigDevice	Writes the control data record to the module.	FB (SCL)
WRREC	System function to write the data record.	SFC
ohDataset	Central database for the control data records.	DB
ohDiag	Bundles the diagnostics in a function block	FB (SCL)
ModuleStates	System function used for module status diagnostics.	FC
DeviceStates	System function used for diagnostics of IO systems.	FC
ohDiagStates	Central database for diagnostics.	DB

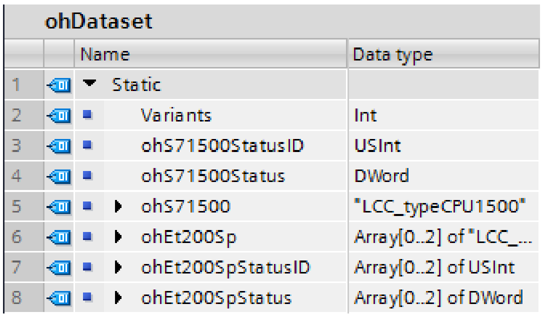
The "ohDataset" data block

The "ohDataset" data block (DB) is the central database of the application. It contains all control data records for configuration control.

- Three control data records for the ET 200SP - due to the different hardware configurations of the muffin variations (stored in an array).
- One control data record for the S7-1500 for hiding the configured IO modules.

In addition to the above-listed data, the DB also contains status bytes. They allow you to see whether writing the control data record has been completed successfully or with an error.

Figure 4-2



ohDataset

	Name	Data type
1	▼ Static	
2	Variants	Int
3	ohS71500StatusID	USInt
4	ohS71500Status	DWord
5	▶ ohS71500	"LCC_typeCPU1500"
6	▶ ohEt200Sp	Array[0..2] of "LCC_...
7	▶ ohEt200SpStatusID	Array[0..2] of USInt
8	▶ ohEt200SpStatus	Array[0..2] of DWord

Note

> The ready-made PLC data structures from the "LCC" library were used to create the control data records. In specific terms, these are the PLC data types "LCC_typeET200SP" and "LCC_typeCPU1500".

The muffin variation is selected with the HMI. For this purpose, the "Variants" tag is linked with the HMI visualization and stores the selected muffin variation numerically. This value corresponds to the respective field number from the "OH_ET200SP" array.

Note The "Variants" tag must be stored with the attribute "remanent" in the data block to avoid data loss in case of power failure.

The "ohDiagStates" data block

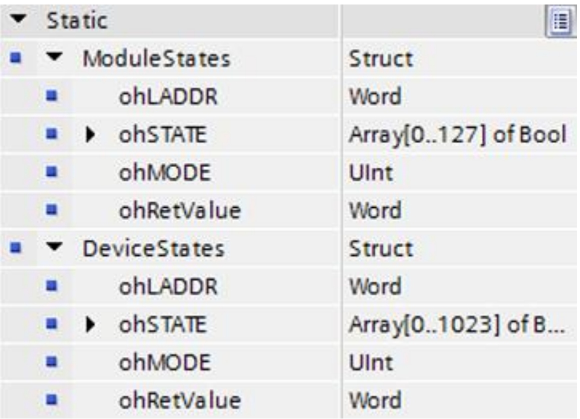
The "ohDiagStates" data block contains all status information of the diagnostics from the "ohDiag" FB.

- A struct ("ModuleStates") used to operate parameters of the "ModuleStates" FB
- A struct ("DeviceStates") used to operate parameters of the "DeviceStates" FB

Apart from the status information, the DB also contains the selection for the mode of the diagnostics blocks (see Table 3-2).

The following figure shows the structs of the "ohDiagStates" data block.

Figure 4-3



▼ Static	
▼ ModuleStates	Struct
ohLADDR	Word
▶ ohSTATE	Array[0..127] of Bool
ohMODE	UInt
ohRetValue	Word
▼ DeviceStates	Struct
ohLADDR	Word
▶ ohSTATE	Array[0..1023] of B...
ohMODE	UInt
ohRetValue	Word

The "LCC_ConfigDevice" library block

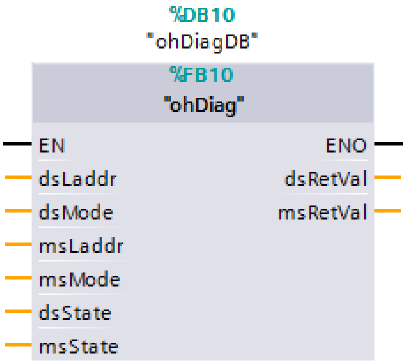
The function block and the associated PLC data types will not be described in detail at this point.
More information on the blocks of the **LCC** can be found in the library description on the same HTML page as this document (see \2\).

The "ohDiag" function block

The "ohDiag" function block is used for the extended configuration diagnostics. For this purpose, the "ModuleStates" und "DeviceStates" function blocks are called (see Chapter 3.3).

The following figure shows the call of the "ohDiag" function block in OB 1.

Figure 4-4



Startup OB

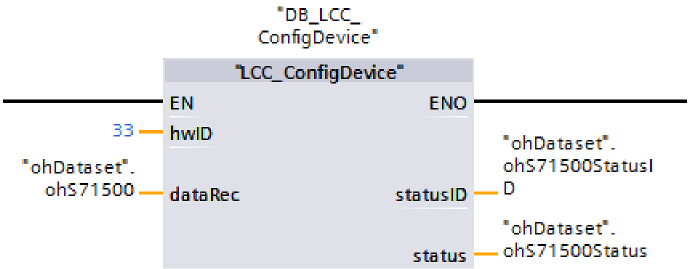
When the CPU has been switched on, it executes a startup program - if there is one - in the so-called startup OBs before it starts executing the user program.

For configuration control in central configuration, it is essential that a valid control data record is sent to the CPU already in the startup program. Otherwise, the CPU returns to STOP mode.

In this application, two control data records are sent already in the startup OB.

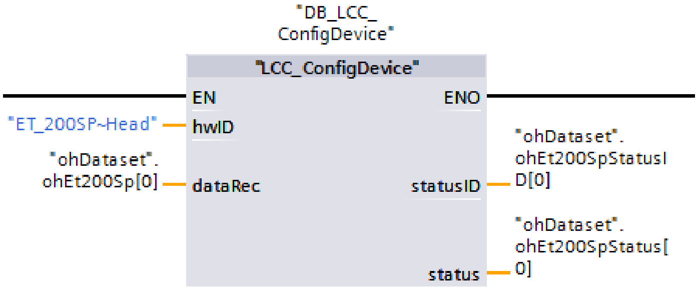
- Control data record for the S7-1500 for declaration of the configured IO modules as "non-existent" (for more information, please refer to Chapter 4.3.1).

  Figure 4-5



- Control data record for the ET 200SP that contains the slot assignment of the real hardware configuration. Der Hardware configuration for the first commissioning corresponds to the Variant 1 (for more information, please refer to Chapter 4.3.2 and Chapter5.1).

  Figure 4-6



OB 1

OB 1 contains the cyclic program of the application.

The different variations of muffin production can be selected with buttons in the HMI visualization; processing is carried out via OB 1.

The indirect addressing with the "Variants" tag from the "ohDataset" data block requires only calling up FB 2 "LCC_ConfigDevice" for the three muffin variations.

Depending on the value of the "Variants" tag, the control data record of the ET 200SP for the selected variant is referenced, and the function block is released for processing.

If writing the control data record has been completed without an error ("STATUS" has the value "0"), the block release is reset.

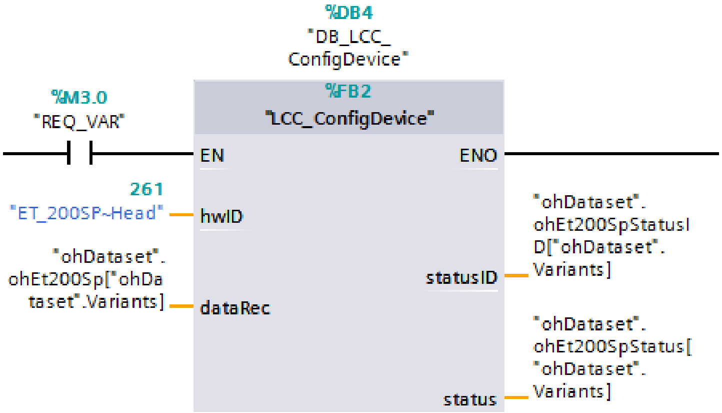
The call of the "ohDiag" diagnostics function block FB 10 is carried out in OB1. The HMI is used for the output of status information and the mode selection of the two diagnostics blocks.

Note

> If the "STATUS" tag displays a value not equal to zero, refer to the library description for a detailed error analysis.

The following screenshot shows the function block call of "ohConfigCtrl":

Figure 4-7



4.3 Control data records

The control data records are the basis for configuration control. They contain the configurable assignment of configured to physically existing station modules.

For each module, the structure of the control data record is predefined and must not be changed.

4.3.1 Control data record for the S7-1500

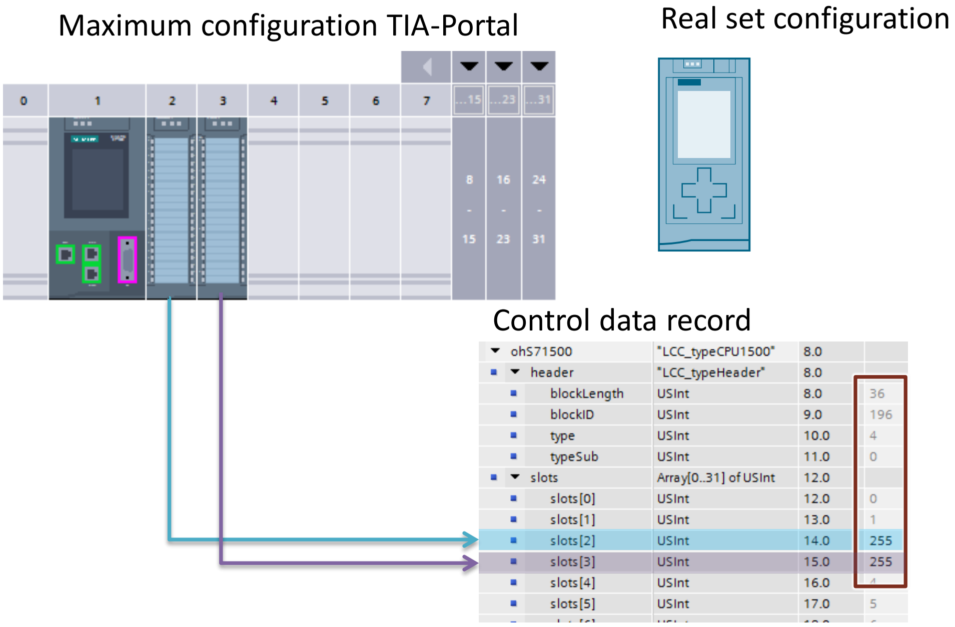
Representation

To demonstrate configuration control for central configuration, the S7-1500 station is configured with any input and output modules. However, these modules do not exist in the real configuration.

Therefore, the configured IO modules have to be declared as "non-existent" via the control data record.

The graphic representation below shows the configuration of the S7-1500 in TIA Portal and the required control data record:

Figure 4-8



ohS71500	"LCC_typeCPU1500"	8.0	
header	"LCC_typeHeader"	8.0	
blockLength	USInt	8.0	36
blockID	USInt	9.0	196
type	USInt	10.0	4
typeSub	USInt	11.0	0
slots	Array[0..31] of USInt	12.0	
slots[0]	USInt	12.0	0
slots[1]	USInt	13.0	1
slots[2]	USInt	14.0	255
slots[3]	USInt	15.0	255
slots[4]	USInt	16.0	4
slots[5]	USInt	17.0	5

Description

IO modules that do not exist in the real configuration are encoded in the control data record in the appropriate slot with the value "255".

The values for the power module (slot 0; value "0") and the CPU (slot 1, value "1") indicate the real slot and must not be changed.

4.3.2 Control data records for the ET 200SP

Representation

Depending on the muffin production variant, the ET 200SP is equipped with different input and output modules.

For each variant, a separate control data record is required to transfer the assignment between the configured configuration and the physically existing configuration to the interface module.

- IO modules not required by a muffin variation must be declared as "unused".
- IO modules whose slot in the real configuration differs from the one in the configured configuration must be specified with the real slot number.

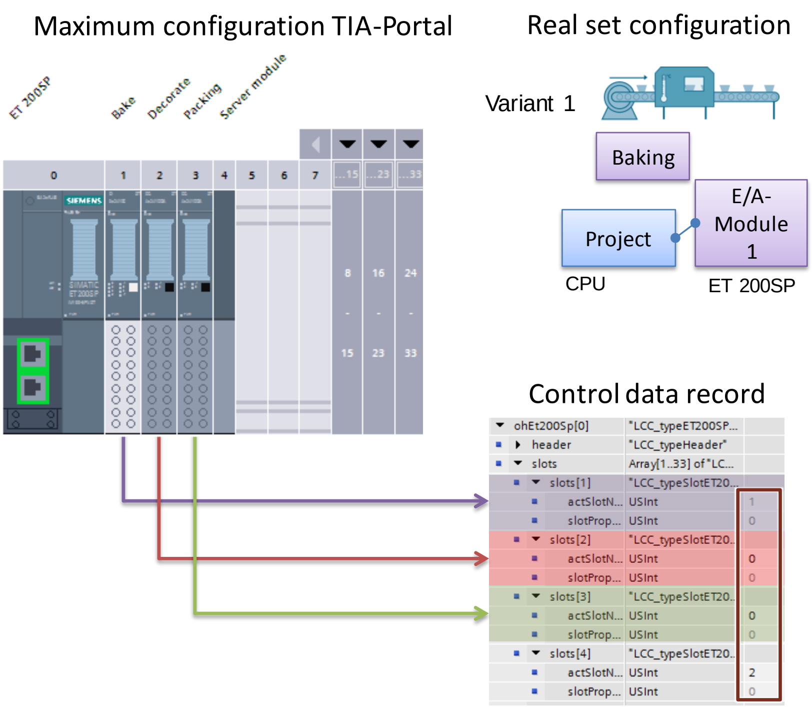
Note The server module does not exist in the control data record and must always be configured in the hardware configuration and inserted in the real configuration.

The following graphics show the configuration of the ET 200SP in TIA Portal and the required control data records for the three variations:

Variant 1

Variant 1 produces muffins without decorations and without packaging. This variant requires only the "baking unit" (module 1 in slot 1). Modules that are not required are declared as "unused" by the value "0".

Figure 4-9

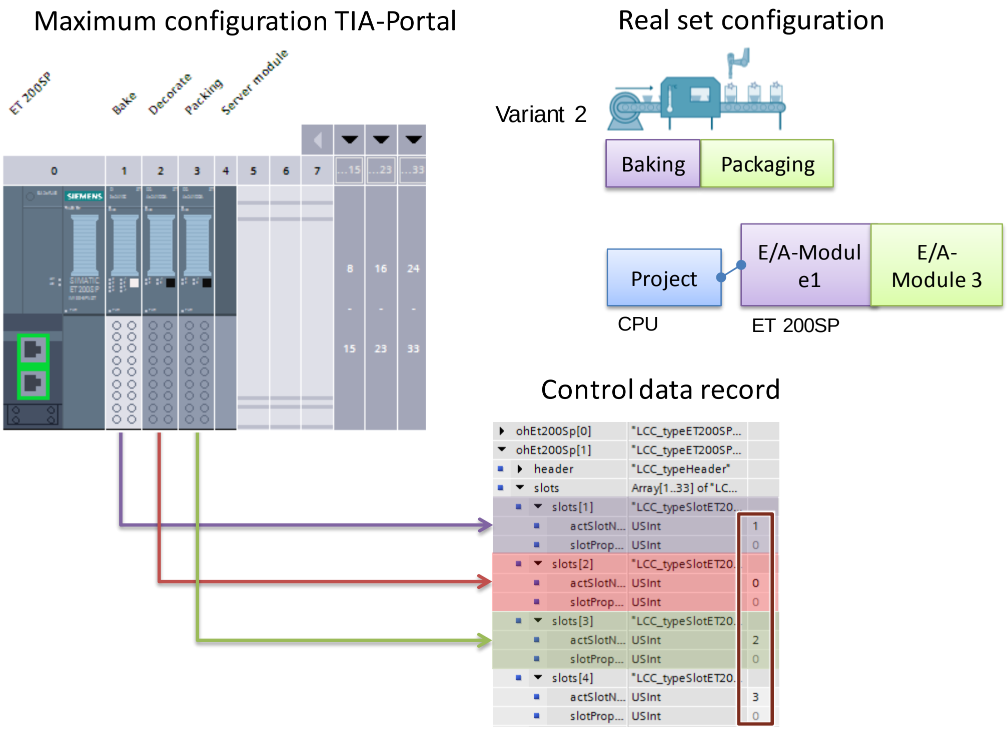


ohEt200Sp[0]	"LCC_typeET200SP...	
header	"LCC_typeHeader"	
slots	Array[1..33] of "LC...	
slots[1]	"LCC_typeSlotET20...	
actSlotN...	USInt	1
slotProp...	USInt	0
slots[2]	"LCC_typeSlotET20...	
actSlotN...	USInt	0
slotProp...	USInt	0
slots[3]	"LCC_typeSlotET20...	
actSlotN...	USInt	0
slotProp...	USInt	0
slots[4]	"LCC_typeSlotET20...	
actSlotN...	USInt	2
slotProp...	USInt	0

<u>Variant 2:</u>

Variant 2 produces muffins without decorations but with packaging. This variant requires the "baking unit" (module 1 in slot 1) and the packaging unit (module 3 now in slot 2). The decorating module that is not required is declared as "unused" by the value "0".

Figure 4-10

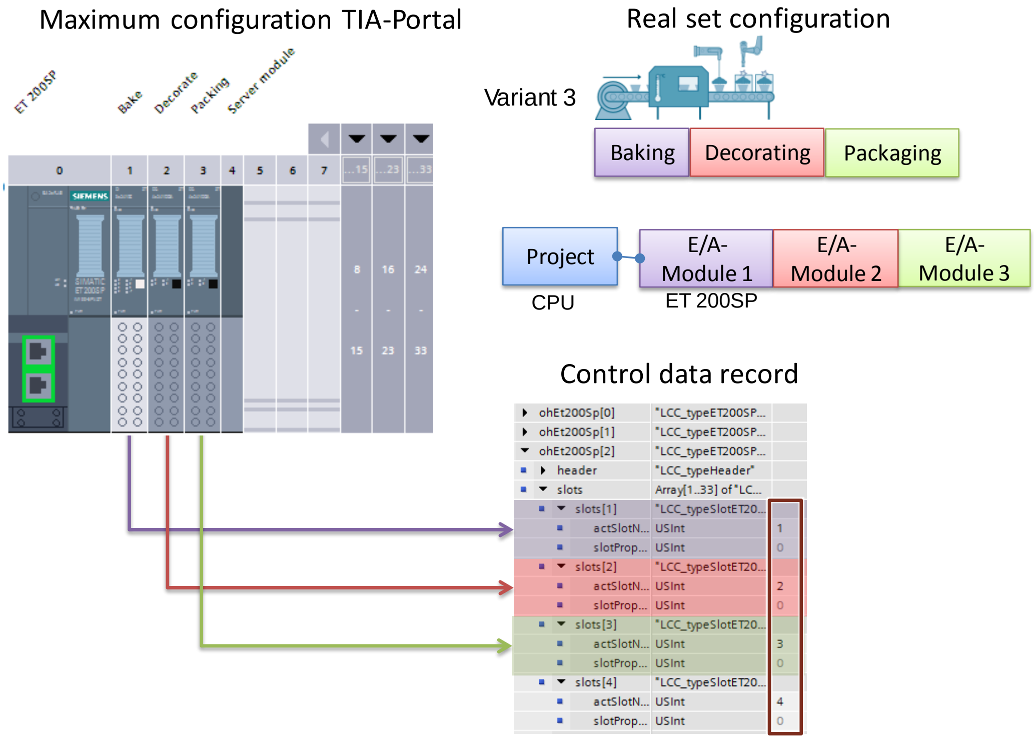


ohEt200Sp[0]	"LCC_typeET200SP...	
ohEt200Sp[1]	"LCC_typeET200SP...	
header	"LCC_typeHeader"	
slots	Array[1..33] of "LC...	
slots[1]	"LCC_typeSlotET20...	
actSlotN...	USInt	1
slotProp...	USInt	0
slots[2]	"LCC_typeSlotET20...	
actSlotN...	USInt	0
slotProp...	USInt	0
slots[3]	"LCC_typeSlotET20...	
actSlotN...	USInt	2
slotProp...	USInt	0
slots[4]	"LCC_typeSlotET20...	
actSlotN...	USInt	3
slotProp...	USInt	0

<u>Variant 3:</u>

Variant 3 produces muffins with decorations and with packaging. This variant requires all units.

Figure 4-11



ohEt200Sp[0]	"LCC_typeET200SP...	
ohEt200Sp[1]	"LCC_typeET200SP...	
ohEt200Sp[2]	"LCC_typeET200SP...	
header	"LCC_typeHeader"	
slots	Array[1..33] of "LC...	
slots[1]	"LCC_typeSlotET20...	
actSlotN...	USInt	1
slotProp...	USInt	0
slots[2]	"LCC_typeSlotET20...	
actSlotN...	USInt	2
slotProp...	USInt	0
slots[3]	"LCC_typeSlotET20...	
actSlotN...	USInt	3
slotProp...	USInt	0
slots[4]	"LCC_typeSlotET20...	
actSlotN...	USInt	4
slotProp...	USInt	0

Description

IO modules that do not exist in the real configuration are encoded in the control data record in the appropriate slot with the value "0".

For IO modules where the real slot and the configured one are identical, the current slot number is specified.

For IO modules whose slot in the real configuration differs from the one in the configured configuration, the (new) real slot number must be specified.

5 Installation and Commissioning

This chapter describes the steps necessary to start up the example using the code from the download and the hardware list.

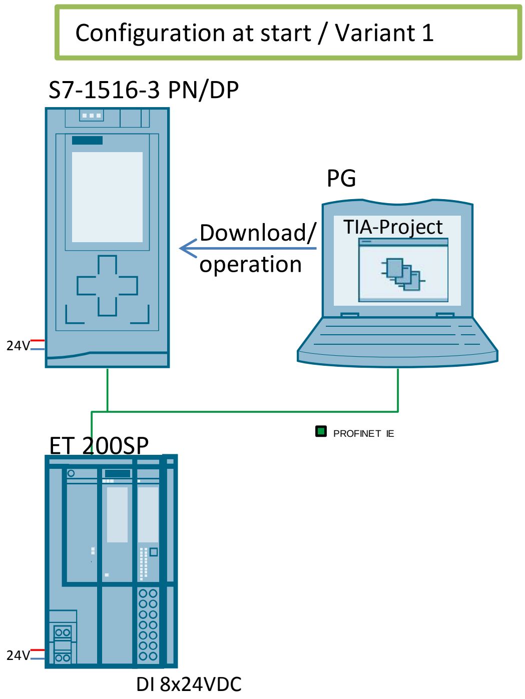
Note This application does not use a real panel. TIA WinCC Runtime is used for HMI visualization.

5.1 Installing the hardware

Overview of the initial configuration/variant 1

The figure below shows the hardware configuration of the application for first commissioning/muffin production, variant 1.

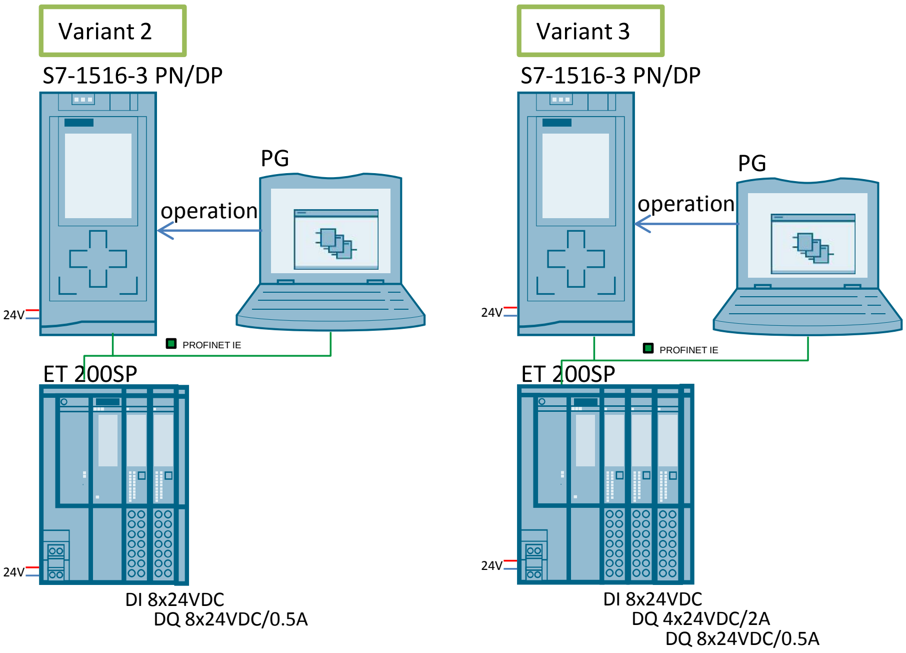
Figure 5-1



Overview of variant 2 and variant 3

The figure below shows the hardware configuration of the application for muffin production: variant 2 and variant 3.

Figure 5-2



Installation for first commissioning

As the initial configuration, set up the hardware in the production plant according to variant 1.

1. Supply power to the CPU, the ET 200SP and, if necessary, the PG.
2. If necessary, mount the ET 200SP onto a DIN rail and assemble the device as follows:
   a. The interface module.
   b. The DI 8x24VDC IO module; plugged onto a white BaseUnit (new load group).
   c. The server module that completes setting up the ET 200SP.
3. Connect the ET 200SP to the CPU (RJ45) via PROFINET. To do this, use port 1 of interface 1 (X1) of the CPU.
4. Connect the PG to the CPU (RJ45) via Ethernet. To do this, use port 2 of interface 1 (X1) of the CPU.

Note Always follow the installation guidelines for all components.

5.2 Installing TIA Portal

1. Install STEP 7 V14 SP1 on your programming unit. Follow the instructions of the program.
2. Download the sample application to your programming unit and unzip the **29430270_Config-Control-Modular_CODE_V31.zip** archive.
3. Open the TIA Portal project.

5.3 Commissioning

5.3.1 IP address assignment

Overview

In the application example, the following IP addresses are used:

Table 5-1

Component	IP address	Subnet mask
PG	192.168.0.3	255.255.255.0
CPU S7 1516-3 PN/DP	192.168.0.1	
ET 200SP	192.168.0.2	

Change the network setting on the PC to the IP address assigned to it.

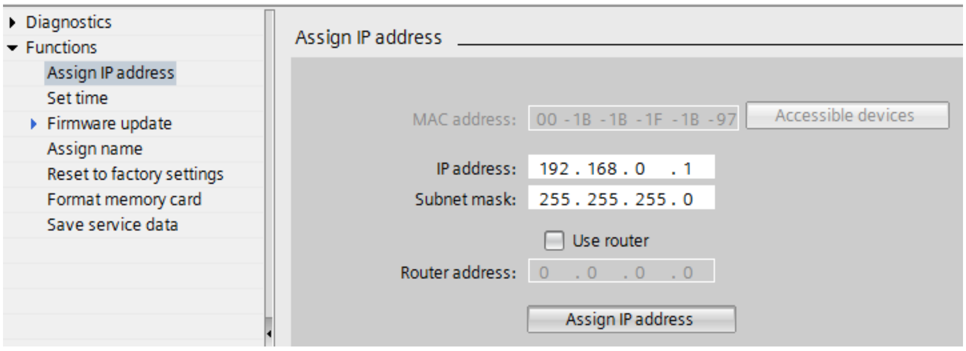
Assigning the IP address to the CPU/ET 200SP

To assign the specified IP address to the CPU/ET 200SP, proceed as follows:

1. Open the Project view of TIA Portal and in the project tree, click the "Online access" folder.
2. Click the arrow icon to the left of the interface to show all objects located below the interface.
3. Double-click the "Update accessible devices" command below the interface.

Result:
All devices that can be accessed through this interface are displayed in the project tree.

4. Open the Online and Diagnostics view of the CPU.
5. In the "Functions" folder, select the "Assign IP address" group.
6. Enter the IP parameters.
7. Click the "Assign IP address" button.



MAC address: 00 - 1B - 1B - 1F - 1B - 97

IP address: 192 . 168 . 0 . 1

Subnet mask: 255 . 255 . 255 . 0

□ Use router

Router address: 0 . 0 . 0 . 0

8. Repeat steps 4 through 7 for the ET 200SP.

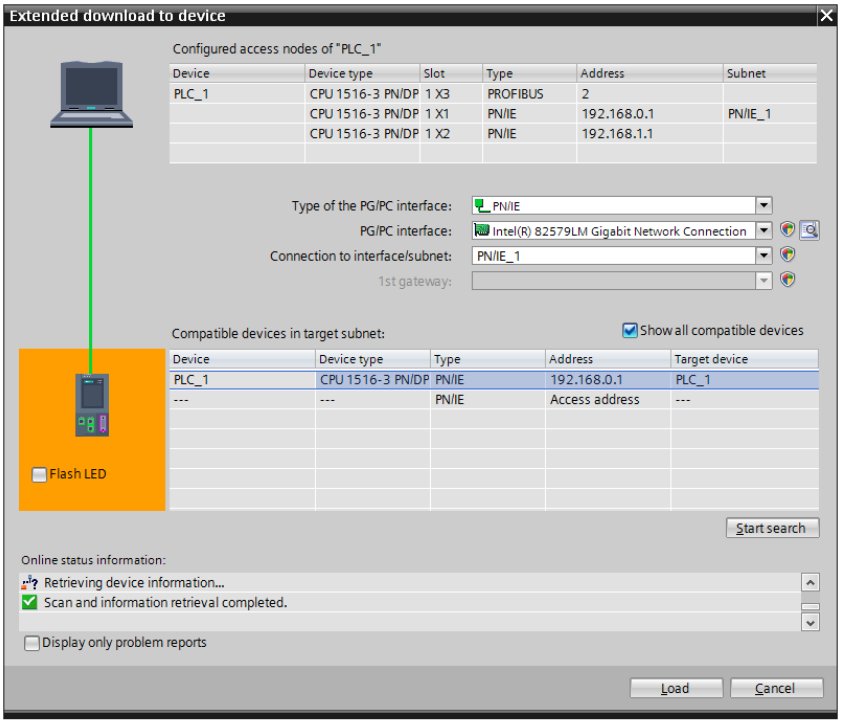
Result:
The IP address is permanently assigned to the Ethernet port. It is also retained after startup or a power failure.

5.3.2 Loading the project

To set up the automation station, the project data is downloaded to the connected devices.

Proceed as follows:

1. In the project tree, select the **PLC_1** CPU.
2. Select "Edit" > "Compile" to compile the project.
3. Select "Online" > "Download to device" to download the project to the automation station.
4. If an online connection had not yet been established, the "Extended download to device" dialog opens. In this case, set all the parameters necessary for the connection and click the "Start search" button to search for compatible devices. Click "Load".



Extended download to device

Configured access nodes of "PLC_1"

Device	Device type	Slot	Type	Address	Subnet
PLC_1	CPU 1516-3 PN/DP	1 X3	PROFIBUS	2	
	CPU 1516-3 PN/DP	1 X1	PN/IE	192.168.0.1	PN/IE_1
	CPU 1516-3 PN/DP	1 X2	PN/IE	192.168.1.1	

Type of the PG/PC interface: PN/IE

PG/PC interface: Intel(R) 82579LM Gigabit Network Connection

Connection to interface/subnet: PN/IE_1

1st gateway:

Compatible devices in target subnet:

☑ Show all compatible devices

Device	Device type	Type	Address	Target device
PLC_1	CPU 1516-3 PN/DP	PN/IE	192.168.0.1	PLC_1
---	---	PN/IE	Access address	---

□ Flash LED

Start search

Online status information:

Retrieving device information...

✓ Scan and information retrieval completed.

□ Display only problem reports

Load Cancel

5. Set the CPU to RUN.

6 Operating the Application

HMI visualization

The application is controlled with the HMI visualization integrated in the project.

Mark the HMI in the project navigation and start Runtime with the respective icon in the menu bar.

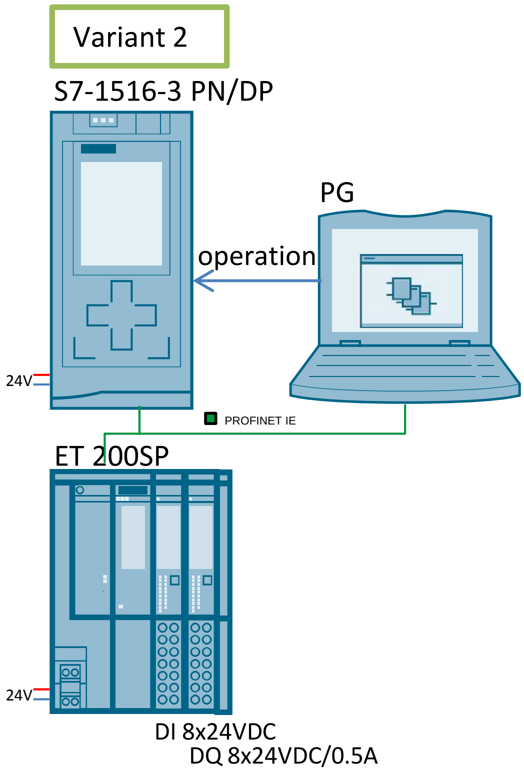
Initial configuration/variant 1

For first commissioning, the ET 200SP was equipped with the modules for variant 1 and, in OB 100, the appropriate control data record was transferred to the interface module.

Variant 2

To produce muffins according to variant 2, proceed as follows:

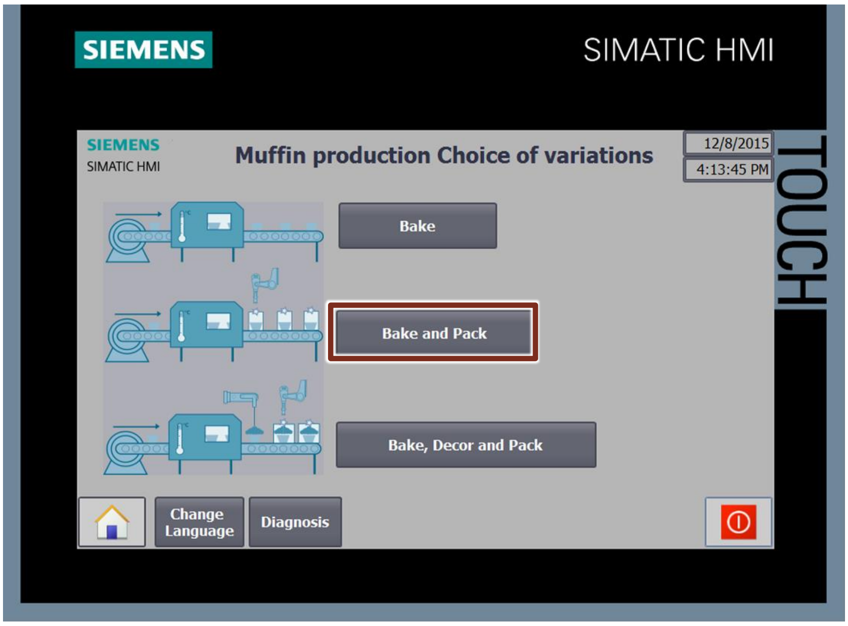
1. Switch off the power supply of the ET 200SP.
2. Re-equip the hardware of the ET 200SP distributed IO device according to variant 2.



3. Switch the power supply of the ET 200SP back on.

Result:
The CPU and the interface module signal an error as the real hardware configuration does not match the configured one.

4. Activate the button for variant 2 in the HMI visualization.



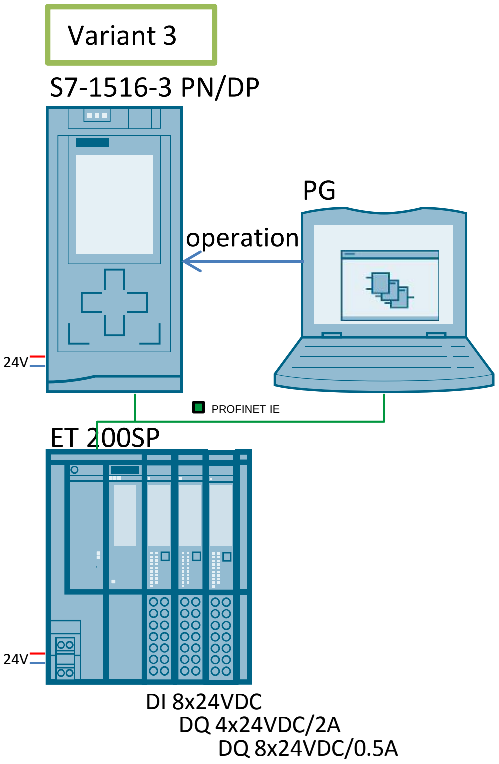
Result:
The control data record for the slot assignment for variant 2 has been sent to the interface module. When the write operation was successful (the value of the **"ohDataset".ohET200SPStatus[1]"** tag is "0"), the error LED goes out.

Note If the **"ohDataset".ohET200SPStatus[1]"** tag displays a value not equal to zero, refer to the library description for a detailed error analysis.

Variant 3

To produce muffins according to variant 3, proceed as follows:

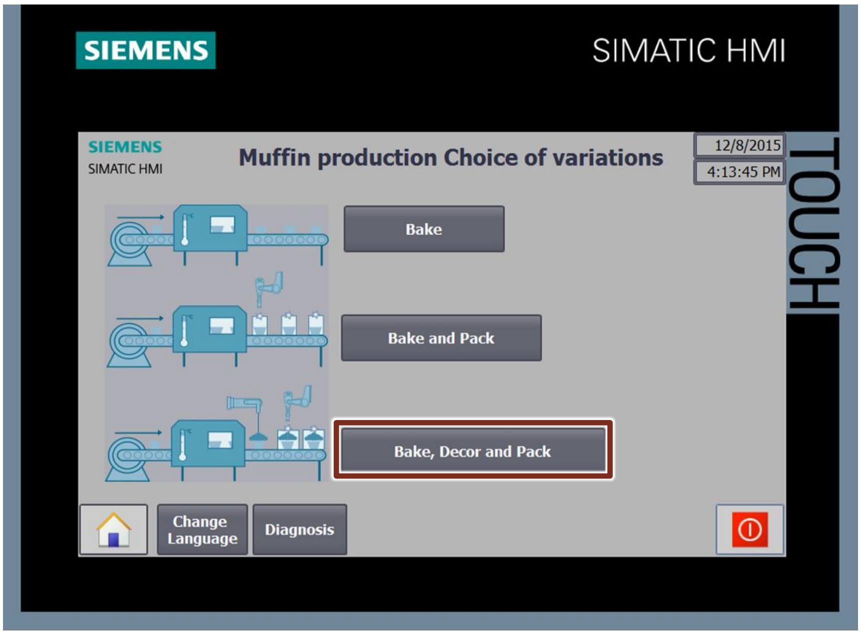
1. Switch off the power supply of the ET 200SP.
2. Re-equip the hardware of the ET 200SP distributed IO device according to variant 3.



3. Switch the power supply of the ET 200SP back on.

Result:
The CPU and the interface module signal an error as the real hardware configuration does not match the configured one.

4. Activate the button for variant 3 in the HMI visualization.



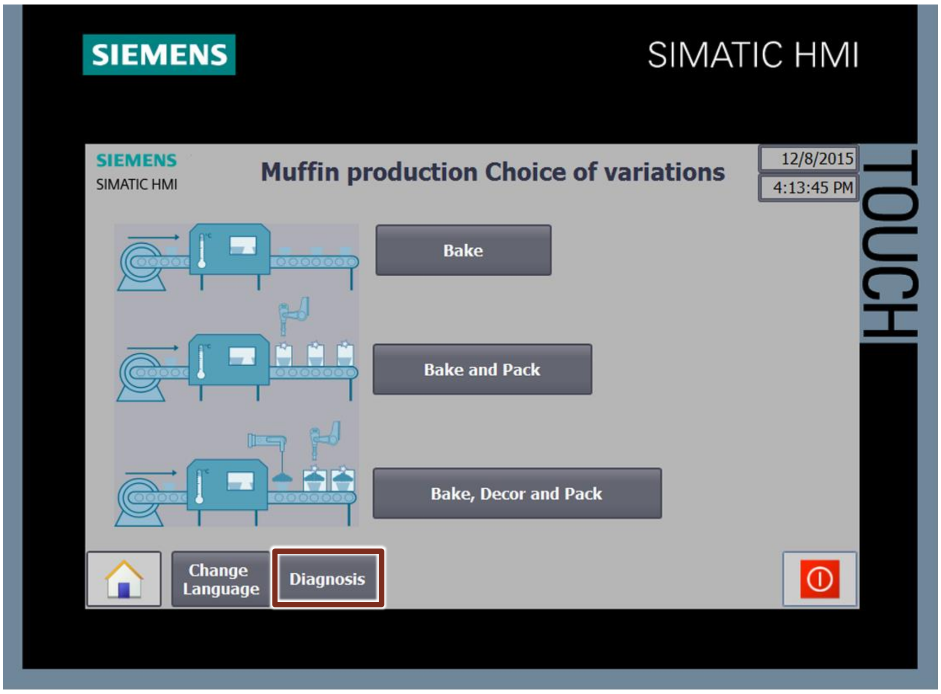
Result:
The control data record for the slot assignment for variant 3 has been sent to the interface module. When the write operation was successful (the value of the **"ohDataset".ohET200SPStatus[2]"** tag is "0"), the error LED goes out.

Note If the **"ohDataset".ohET200SPStatus[2]"** tag displays a value not equal to zero, refer to the library description for a detailed error analysis.

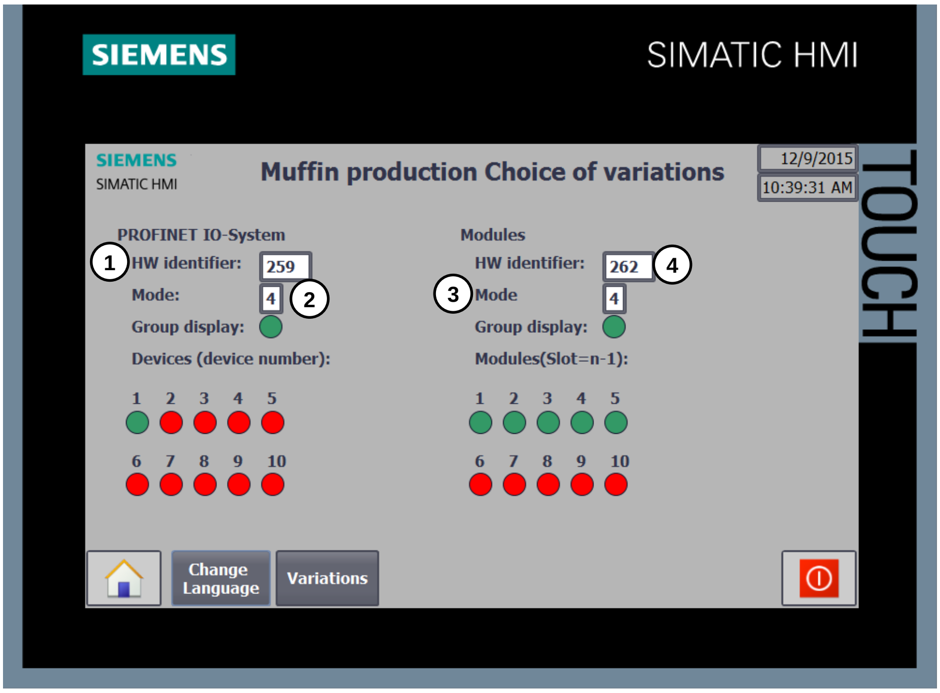
Diagnostics

In order to display the diagnostics, proceed as follows:

1. In the HMI visualization, click on the "Diagnosis" button:



2. You are now on the diagnostics page.



SIEMENS
SIMATIC HMI
Muffin production Choice of variations
12/9/2015
10:39:31 AM

PROFINET IO-System
HW identifier: 259
Mode: 4
Group display: 🟢
Devices (device number):
1 🟢 2 🔴 3 🔴 4 🔴 5 🔴
6 🔴 7 🔴 8 🔴 9 🔴 10 🔴

Modules
HW identifier: 262
Mode 4
Group display: 🟢
Modules(Slot=n-1):
1 🟢 2 🟢 3 🟢 4 🟢 5 🟢
6 🔴 7 🔴 8 🔴 9 🔴 10 🔴

The following points explain the diagnostics display and how you can adjust the diagnostics.

1. Input of the HW identifier, which IO system is diagnosed. The HW identifier can be found in "PLC tags" > "System constants".

Note For the PROFINET IO system diagnostics with the "DeviceStates" function block, the data type of the HW identifier used must be "HW_IoSystem".

2. Selecting the mode ("DeviceStates").
3. Input of the HW identifier, which module is diagnosed The HW identifier can be found in "PLC tags" > "System constants".

Note For the diagnostics of the modules with the "ModuleStates" function block, the data type of the HW identifier used must be "HW_Device".

4. Selecting the mode ("ModuleStates").

Note More information on the diagnostics can be found in Chapter 3.3.

7 Appendix

7.1 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:
https://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:
https://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:
https://support.industry.siemens.com/cs/sc

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:
https://support.industry.siemens.com/cs/ww/en/sc/2067

7.2 Links and Literature

Table 7-1

	Topic	Title
\1\	Siemens Industry Online Support	http://support.automation.siemens.com
\2\	Download page of the entry	https://support.industry.siemens.com/cs/ww/en/view/29430270
\3\	Updates for TIA Portal	http://support.automation.siemens.com/ww/view/en/90466591

7.3 Change documentation

Table 7-2

Version	Date	Modifications
V1.0	09/2014	First version
V2.0	01/2016	Adding the diagnostics functions
V3.0	03/2017	Update to STEP 7 V14
V3.1	10/2018	• Update to STEP 7 V14 SP1 and V15 • Update of used library "LCC"