Configuration Control (Option Handling) for ET 200S and PROFINET

SIMATIC S7

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Configuration Control for ET 200S and PROFINET

Application Description

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1 Problem

1.1 Starting point

The following situation occurs frequently in series machine building:

- X number of different variants exist for 1 machine

The special variant of a machine is determined when

- the machine is delivered
- a machine that is already in use is retrofitted.

The variants of a machine differ in the following respects:

- Mechanical design of the machine
- Automation:
  - Different configuration of existing ET 200 distributed stations
  - Different STEP 7 projects

If different STEP 7 projects are required for different variants of a machine, the disadvantages are as follows:

- Increased overhead when creating and maintaining the software
- A separate STEP 7 project must be downloaded for each variant.

1.2 Problem

A single STEP 7 project (STEP 7 basic project) is to cover all variants of a machine:

- Different ET 200 hardware configurations
- Different programs for automation

SIMATIC offers a solution to the above problem:

- Configuration control (option handling) with ET 200

1.3 Example

A lathe that is available in 3 variants is used as an example:

- Variant 1: Lathe
- Variant 2: Lathe with coolant supply
- Variant 3: Lathe with coolant supply and tool holding magazine

Starting point

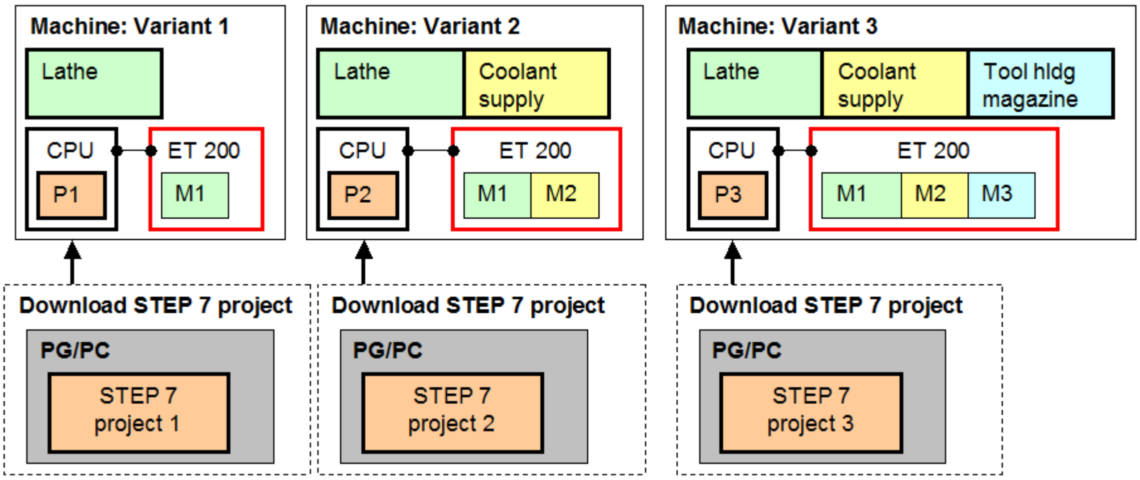
The variants are automated with an S7 CPU and an ET 200 station. A separate STEP 7 project exists for each variant:

Table 1-1

Variant	ET 200 configuration	STEP 7 project
Variant 1	Module 1 (M1)	STEP 7 project 1 (P1)
Variant 2	Module 1 (M1), module 2 (M2)	STEP 7 project 2 (P2)
Variant 3	Module 1 (M1), module 2 (M2), module 3 (M3)	STEP 7 project 3 (P3)

Figure 1-1 shows the correlations:

Figure 1-1



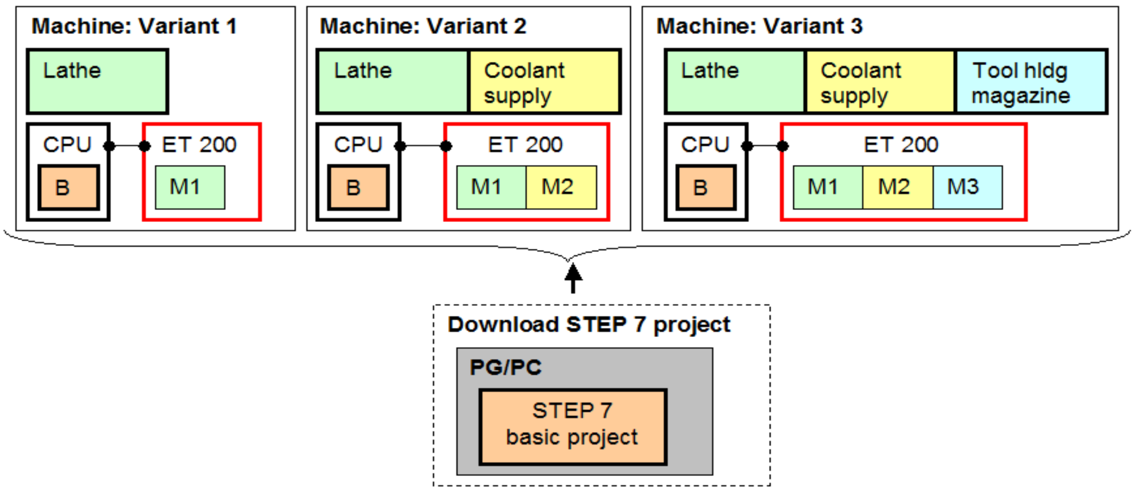
Problem

All variants are to be automated with the same STEP 7 project:

- STEP 7 basic project (B)

The figure shows the correlations:

Figure 1-2



2 Solution

2.1 Principle

With configuration control (option handling), SIMATIC offers a solution to the above-described problem:

A single STEP 7 project (STEP 7 basic project) covers all variants of a machine.

Configuration control (option handling) uses different methods:

- With reserve modules (RM)
- Without reserve modules (RM)

With reserve modules

This method uses reserve modules as spacekeeping modules for modules that are to be inserted into the ET 200 station at a later time.

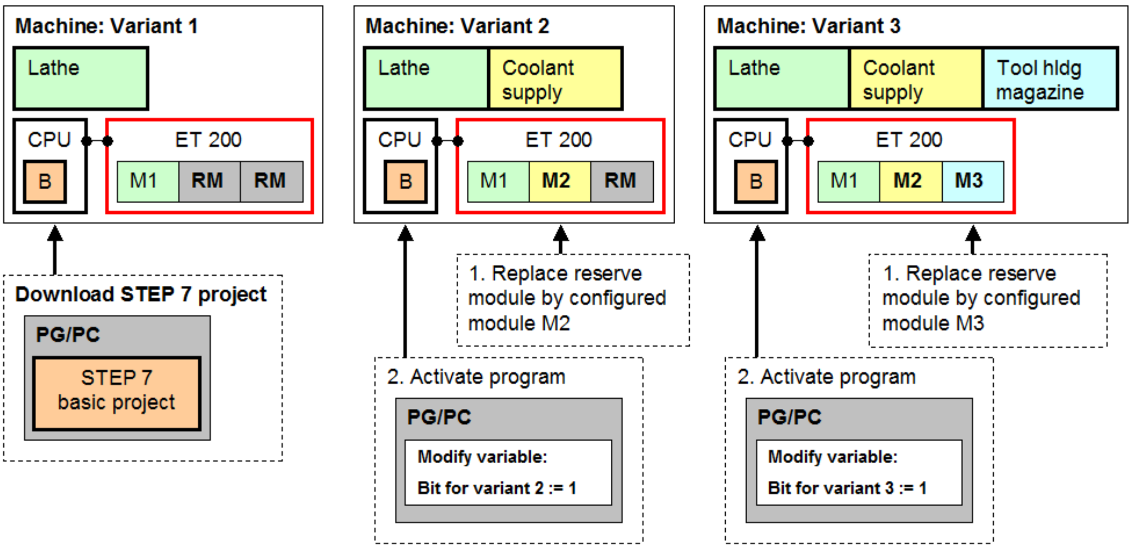
Basic procedure:

- Single download of a STEP 7 project (STEP 7 basic project) to the S7 CPU of variant 1
- Replacement of the reserve modules by the configured modules of variant x
- Activation of the program of variant x (for example via a bit)

Modification (*1) of the ET 200 station is not necessary.

The figure shows the correlations:

Figure 2-1



(*1): Here, modification means:

- To add / remove slots (terminal modules)
- To change the wiring

Without reserve modules

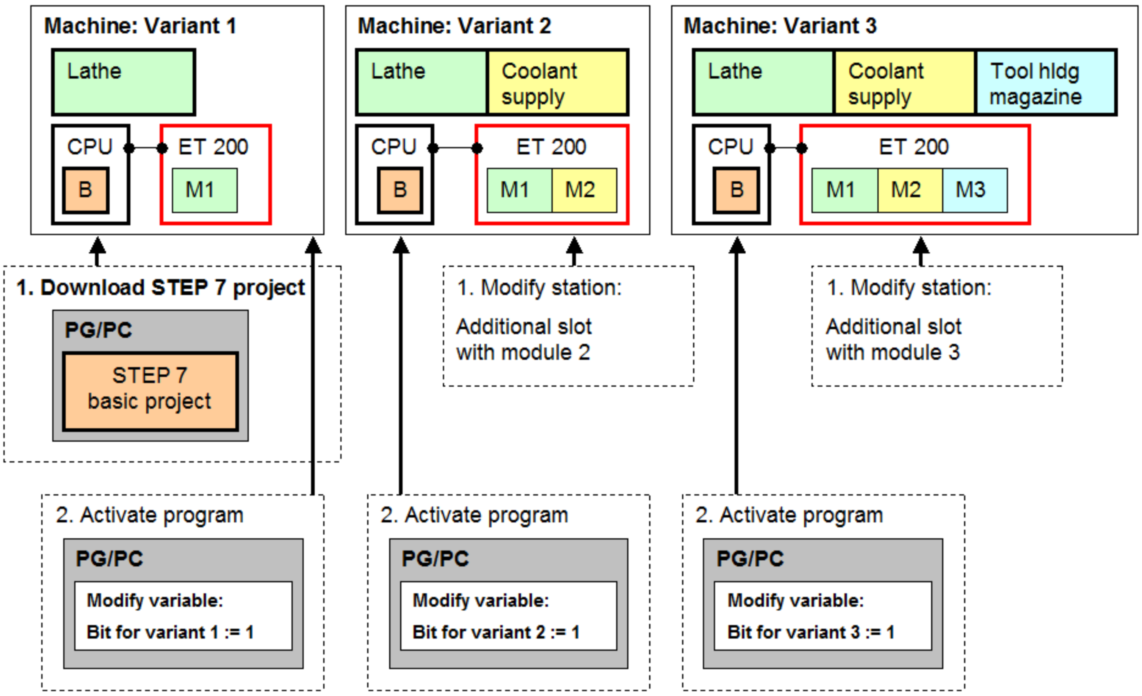
This method hides configured modules in the ET 200 station or assigns them to any slots.

Basic procedure:

- Single download of a STEP 7 project (STEP 7 basic project) to the S7 CPU of variant 1
- Modification (*1) of the ET 200 station
- Activation of the program of variant x (for example via a bit)

The figure shows the correlations:

Figure 2-2



(*1): Here, modification means:

- To add / remove slots (terminal modules)
- To change the wiring

2.2 Advantages

The solution of configuration control (option handling) with ET 200 presented here offers the following advantages:

Table 2-1

<table>
<tr><th>Advantage</th><th>Reason</th></tr>
<tr><td>Easier project handling
and commissioning</td><td rowspan="2">A single STEP 7 project is used for all variants of a machine.</td></tr>
<tr><td>Easier handling when maintaining, versioning and upgrading</td></tr>
<tr><td>Savings in hardware</td><td>Only the modules that are necessary for the current variant of the machine are installed in the ET 200 station.</td></tr>
<tr><td rowspan="2">Easier change of variants</td><td><u>When using reserve modules:</u>
Only reserve modules are replaced by optional modules.
Modification (*1) of the ET 200 station is not necessary.</td></tr>
<tr><td><u>When not using reserve modules:</u>
Optional modules can be installed at the end of the ET 200 station. This avoids complicated lateral moving of wired parts of an ET 200 station.</td></tr>
</table>

(*1): Here, modification means:

- To add / remove slots (terminal modules)
- To change the wiring

2.3 Functionality of the application

2.3.1 Subject

The application shows configuration control (option handling) for the following boundary conditions:

- ET 200S distributed stations
- Communication via PROFINET

The document describes all configuration control (option handling) methods:

- Hiding modules
- Free slot assignment
- Using reserve modules
- Combination of the above methods

The application (/4/) consists of:

- Documentation (this document)
- Code (STEP 7 project)

The document describes the basics of configuration control.
The code actually applies the individual configuration control methods.

Basic knowledge of the following topics is required:

- ET 200S
- PROFINET
- STEP 7 V5.x

2.3.2 Functional scope of the code

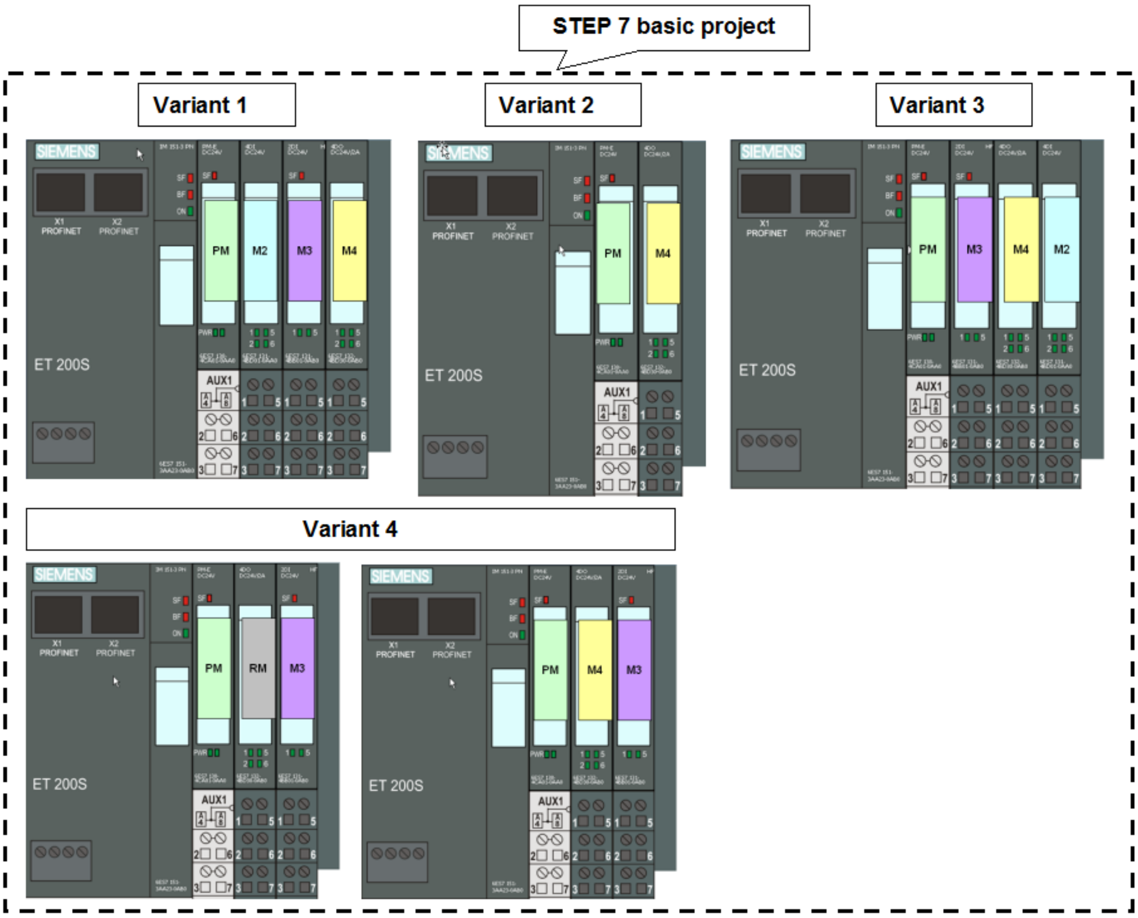
Functional scope

The different configuration control (option handling) methods are used in the STEP 7 project of the application (code).

The STEP 7 project (STEP 7 basic project) comprises four different variants of an ET 200S station on PROFINET.

Chapter 4.4 explains the individual variants.

Figure 2-3



Explanations of the figure

The modules are colored for reasons of clarity.

The same colors mean the same modules:

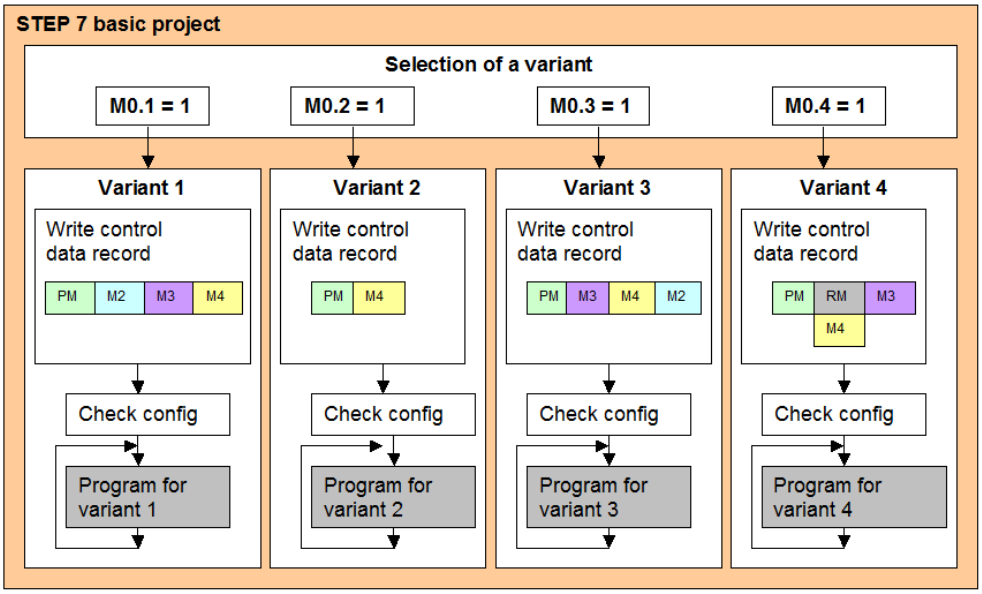
Power module (PM) Reserve module (RM) Module 2 (M2) Module 3 (M3) Module 4 (M4)

On the PG/PC, use “Modify variable” to select variant x:

- Positive edge at the M0.x flag

The figure shows the principle:

Figure 2-4



When selecting variant x, the following actions are triggered in the code:

- Write the control data record for variant x
- Check whether the ET 200S configuration is correct:
  - Read the feedback data record of the ET 200S
  - Compare it to the setpoint feedback data record of variant x
- Cyclic call of the program for variant x
  (actual automation program for variant x)

Note on the selection of modules for the ET 200S station

In this application, the configuration of the ET 200S stations is deliberately kept small. This makes the application clearer and facilitates showing the configuration control (option handling) principle.

In practical operation, more or other modules are, of course, usually used in an ET 200S station.

There is no practical constraint with regard to the number, combination and type (*1) of modules for the different configuration control (option handling) variants. Only the technical constraints of the ET 200S system (maximum number of slots, ...) have to be considered.

The code can be easily adapted to real applications.

(*1): This also applies to standard modules and F modules

2.4 Hardware and software used

The application was created with the following components:

Hardware components

Table 2-2

Component	Name (*1)	Quantity	MLFB/order number	Firmware
CPU315-2 PN/DP		1	6ES7 315-2EH14-0AB0	V3.2
IM151-3 PN		1	6ES7 151-3AA23-0AB0	V7.0
MMC for CPU (e.g., 2 Mbytes)		1	6ES7953-8LLxx-0AA0	
MMC for IM (e.g., 64 Kbytes)		1	6ES7953-8LFxx-0AA0	
PM-E 24VDC	Power module (PM)	1	6ES7 138-4CA00-0AA0	
4DI 24VDC ST	Module 2 (M2)	1	6ES7 131-4BD01-0AA0	
2DO 24VDC/0.5A HF	Module 3 (M3)	1	6ES7 132-4BB00-0AB0	
4DO 24VDC/0.5A ST	Module 4 (M4)	1	6ES7 132-4BD01-0AA0	
Reserve module (15 mm)	Reserve module (RM)	1	6ES7 138-4AA01-0AA0	

(*1): These names and colors are later used for the description of the variants.

Software components

Table 2-3

Component	Quantity	MLFB/order number	Remark
STEP 7 V5.5	1	6ES7810-4CC10-...	Configuration and programming of SIMATIC standard components

Downloads for the application

Table 2-4 contains all downloads of the application (/4/).

Table 2-4

Component	Contents
29430270_OH_ET200S_PN_CODE_v10.zip	STEP 7 project (code).
29430270_OH_ET200S_PN_DOKU_v10_en.pdf	Description for the application.

3 Basics

3.1 Principle of operation

3.1.1 What is configuration control?

Configuration control (option handling) facilitates the automation of machines with different configurations of ET 200S stations. This becomes clear when one considers the different procedures.

Procedure <u>without</u> configuration control

The configuration of the ET 200S stations is configured in the STEP 7 hardware configuration. The real configuration of the ET 200S stations on the machine must match the configured configuration.

A STEP 7 project can only be used for a single real configuration.

Procedure <u>with</u> configuration control

Here too, the configuration of the ET 200S stations is configured in the STEP 7 hardware configuration. However, this configuration comprises all modules of all variants of the machine. Different real configurations of ET 200S stations are then operated with a single STEP 7 project (STEP 7 basic project) or a single hardware configuration (maximum configuration).

A single STEP 7 project can thus be used for multiple real configurations of ET 200S stations.

3.1.2 Overview of the methods

Configuration control uses different methods.

Hiding modules

The starting point is the maximum configuration configured in the STEP 7 hardware configuration.

This method enables you to hide configured slots (modules) in the real ET 200S station. The real station is then initially set up without these hidden slots (modules).

<u>Advantage:</u>

Only the modules that are necessary for variant x of the machine must be installed in the real ET 200S station.

Free slot assignment

The starting point is the maximum configuration configured in the STEP 7 hardware configuration.

This method allows you to assign the configured slots (modules) any real slots in the real ET 200S.

<u>Advantage</u>

Using this method, optional modules can be installed at the end of the ET 200S station. Installation on the configured slot at the center of the station is not necessary. This avoids complicated lateral moving of wired parts of an ET 200S station.

Using reserve modules

The starting point is the maximum configuration configured in the STEP 7 hardware configuration.

Instead of configured modules, this method uses reserve modules (3.1.4) in the real ET 200S station. These reserve modules are then used as spacekeeping modules for modules that are to be inserted at a later time.

Advantage

Allows prewiring of optional modules. When retrofitting the ET 200S station at a later time, only the reserve modules will be replaced by these modules. Modification of the ET 200S station is not necessary.

Combination of the methods

For an ET 200S station, all above-listed methods can also be used simultaneously.

3.1.3 Examples

The following example shows the options of configuration control:

The configured configuration of the ET 200S has the following properties:

- One power module (PM) and three other modules (M2, M3, M4)

Table 3-1 shows the configured configuration and examples of real configurations of the ET 200S (variants 1 to 4).

Table 3-1

<table>
<tr><th colspan="3" rowspan="2"></th><th colspan="4">Slot number of the ET 200S</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr><td colspan="3">Configured configuration of the ET 200S (maximum configuration)</td><td>PM</td><td>M2</td><td>M3</td><td>M4</td></tr>
<tr><td rowspan="5">Real configu-ration of the ET 200S</td><td colspan="2">Variant 1</td><td>PM</td><td>M2</td><td>M3</td><td>M4</td></tr>
<tr><td colspan="2">Variant 2</td><td>PM</td><td>M4</td><td>--- (*1)</td><td>--- (*1)</td></tr>
<tr><td colspan="2">Variant 3</td><td>PM</td><td>M3</td><td>M4</td><td>M2</td></tr>
<tr><td rowspan="2">Variant 4</td><td>With reserve module (RM)</td><td>PM</td><td>RM</td><td>M3</td><td>--- (*1)</td></tr>
<tr><td>Without reserve module (RM)</td><td>PM</td><td>M4</td><td>M3</td><td>--- (*1)</td></tr>
</table>

(*1): The slot does not exist in the real station (---)

Table 3-2 describes which configuration control methods are used and which characteristics the real configurations of the ET 200S have.

Table 3-2

Variant	Method	Characteristic
Variant 1	---	Matches the configured configuration
Variant 2	Hiding modules	Module 2 and 3 hidden
Variant 3	Free slot assignment	Different module order
Variant 4	Combination of the methods: • Hiding modules • Free slot assignment • Using reserve modules	• Module 2 hidden • Module 4 or RM in slot 2

All variants are implemented with a single STEP 7 project (STEP 7 basic project).

3.1.4 Reserve module

Purpose

Reserve modules (/7/) are spacekeeping modules for electronic modules. Reserve modules are available in different widths:

Table 3-3

Width	MLFB
15 mm	6ES7138-4AA01-0AA0
30 mm	6ES7138-4AA11-0AA0

Pinout

The reserve module has no connection to the terminals of the terminal module. This allows complete prewiring of the terminal module.

Substitute values of the reserve module in the process image

Substitute value for digital inputs: 0

Substitute value for analog inputs: 7FFF hexadecimal

3.2 Requirements

To be able to use configuration control (option handling) for ET 200S, specific hardware and software requirements have to be met.

Hardware

Interface modules are required that support option handling.

Table 3-4

IM 151-3	MLFB	Firmware	Use of reserve modules
STANDARD	As of 6ES7151-3AA23-0AB0	V7.0	x
FO	As of 6ES7151-3AB23-0AB0	V7.0	---
HIGH FEATURE	As of 6ES7151-3BA23-0AB0	V7.0	x

Software

STEP 7 engineering tool:

- STEP 7 V5.5 and higher

Note

For STEP 7 V5.5 and higher, no GSD files are required for option handling.

3.3 Basic procedure

To use configuration control (option handling), the following has to be done in STEP 7:

- Configuration
- Programming

3.3.1 Configuration

The following configurations must be made in the STEP 7 hardware configuration:

- Maximum configuration of the ET 200S station
- Interface module (IM) configuration

ET 200S maximum configuration

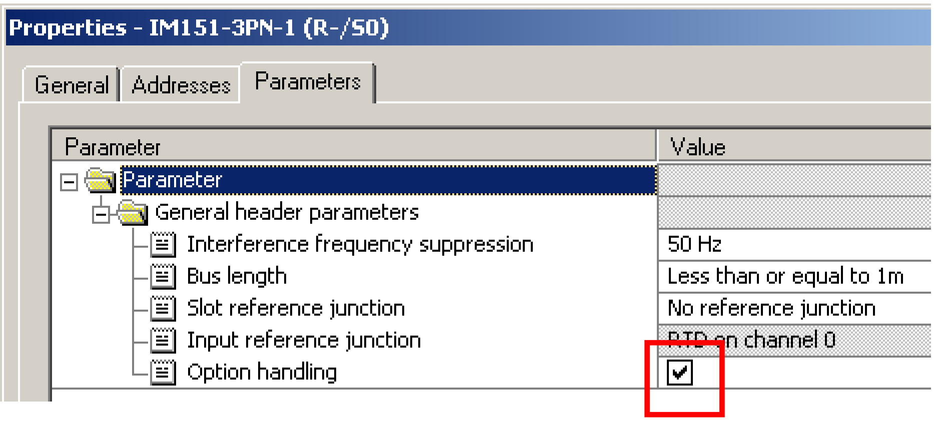
The maximum configuration of the ET 200S station is configured in the hardware configuration.

IM configuration

The following operations are required for the configuration:

- Open the “Properties” dialog box
- Select the “Parameters” tab
- Selections in the tab:
  - Check “Option handling” “Option handling”

Figure 3-1



3.3.2 Programming

The following programming must be performed in STEP 7:

- Write control interface

The following programming is optional:

- Read feedback interface

Write control interface

A control data record that describes the setpoint configuration of the station must be written to the ET 200S station (for details, see chapter 3.4.2).

The data record is written in the program of the S7 CPU with the aid of an SFB: SFB 53 (WRREC), write data record 196

Read feedback interface

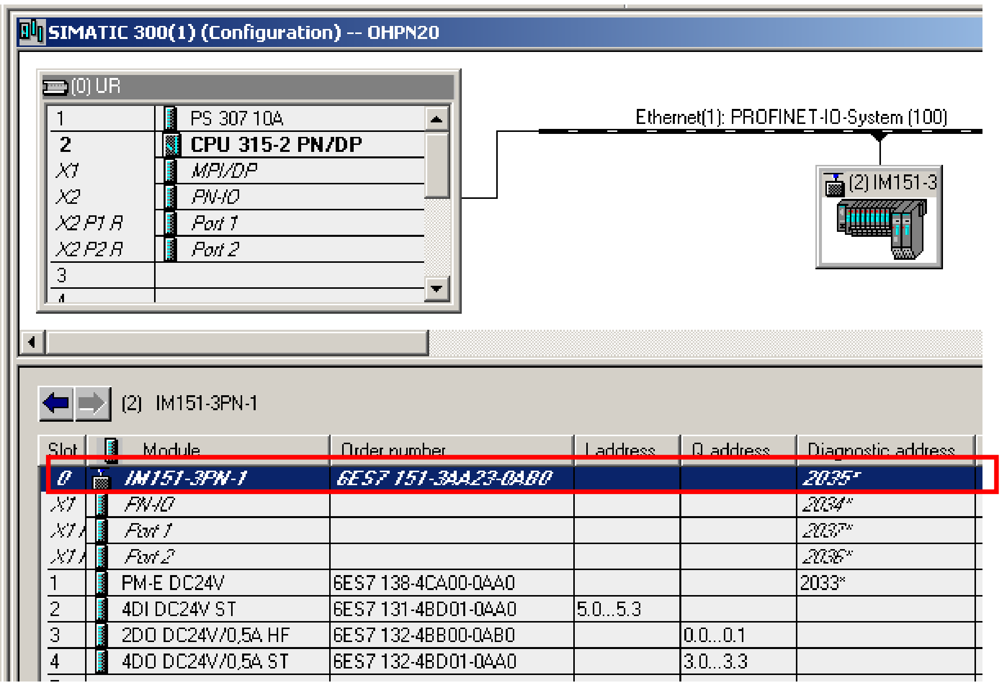
A feedback data record that describes the actual configuration of the station can be read out of the ET 200S station (for details, see chapter 3.4.3).

The data record is read in the program of the S7 CPU with the aid of an SFB: SFB 52 (RDREC), read data record 197

Addressing the IM on the SFBs

An address must be specified for the above SFBs. For this address, please refer to the hardware configuration (diagnostic address of the IM). The following figure shows where to find the address (in the example: 2035).

Figure 3-2



Addressing the ET 200S modules

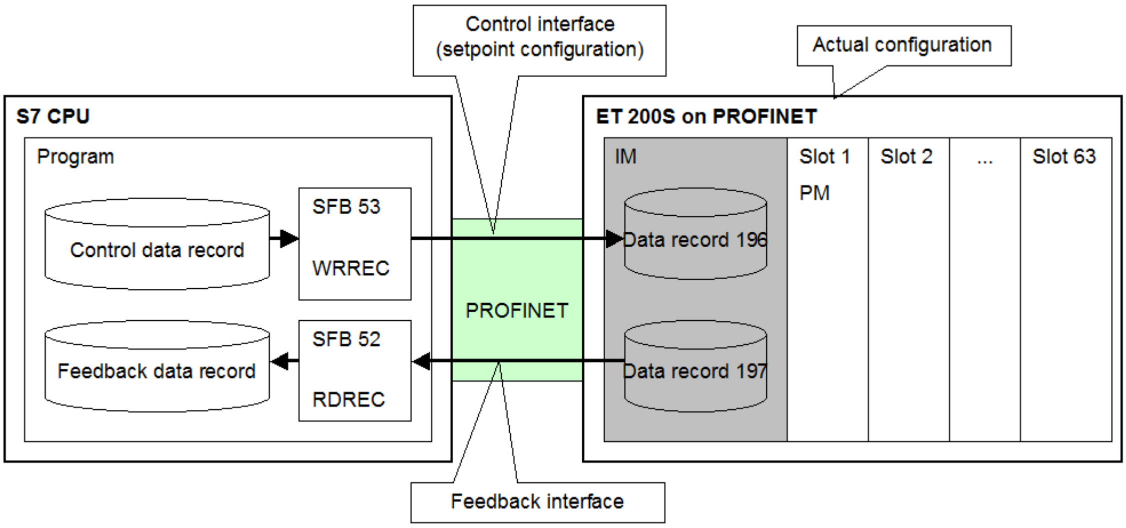
The modules of all variants of the ET 200S are addressed in the program of the STEP 7 basic project. The addressing of the modules in the program corresponds to the maximum configuration configured in the hardware configuration.

3.4 Control and feedback interface

3.4.1 Overview

On PROFINET, the ET 200S features a control interface and a feedback interface. Data records are exchanged via these interfaces.

Figure 3-3



3.4.2 Control data record

Function

With the control data record, the IM must be informed of the ET 200S station configuration (setpoint configuration). The IM checks the real configuration (actual configuration) against this configuration (setpoint configuration). If setpoint configuration and actual configuration do not match, diagnostics will be indicated.

The control data record describes the setpoint configuration of the ET 200S. The reference point is the maximum configuration configured in the STEP 7 hardware configuration. Slot x configured there is represented by a byte in the control data record. The following assignments are coded per byte:

- The module configured for the configured slot x does not exist in the real configuration
- The module configured for the configured slot x is inserted into the real slot y
- The module configured for the configured slot x is inserted into the real slot y or a reserve module is inserted into the real slot y

The control data record must be written:

- When first commissioning the ET 200S station (*1)
- When making changes to the configuration of the ET 200S station (*2)

(*1): For the ET 200S station to work properly, the control data record must be written at least once. Until that time, all modules of the station are out of service (the SF LED is on).

(*2): When writing the control data record with a changed configuration, a station failure (cyclic data exchange will be aborted) and subsequent restart of the station will occur.

The control data record is stored retentively in the ET 200S station.

Structure

Table 3-5 shows the structure of the control data record.

Table 3-5

Byte number	Meaning
0, 1, 2, 3	Header
4	Assignment for configured slot 1
5	Assignment for configured slot 2
...	...
x + 3	Assignment for configured slot **x**

In the control data record, one byte represents one configured slot:
Byte 4 to byte (**x**+3) represent slot 1 to slot **x**

Possible slots: Slot 1 to slot 63

Special case slot 1:

- Always contains a power module
- A reserve module is not permissible

Coding

Table 3-6 shows the coding of the bytes in the control data record.

Table 3-6

Coding of the bytes for slot x		Meaning
Bit 7	Bit 6 to 0	
0	0	The module configured for the configured slot x does not exist in the real configuration
0	y	The module configured for the configured slot x is inserted into the real slot y
1	y	The module configured for the configured slot x is inserted into the real slot y and a reserve module is permissible in the real slot y

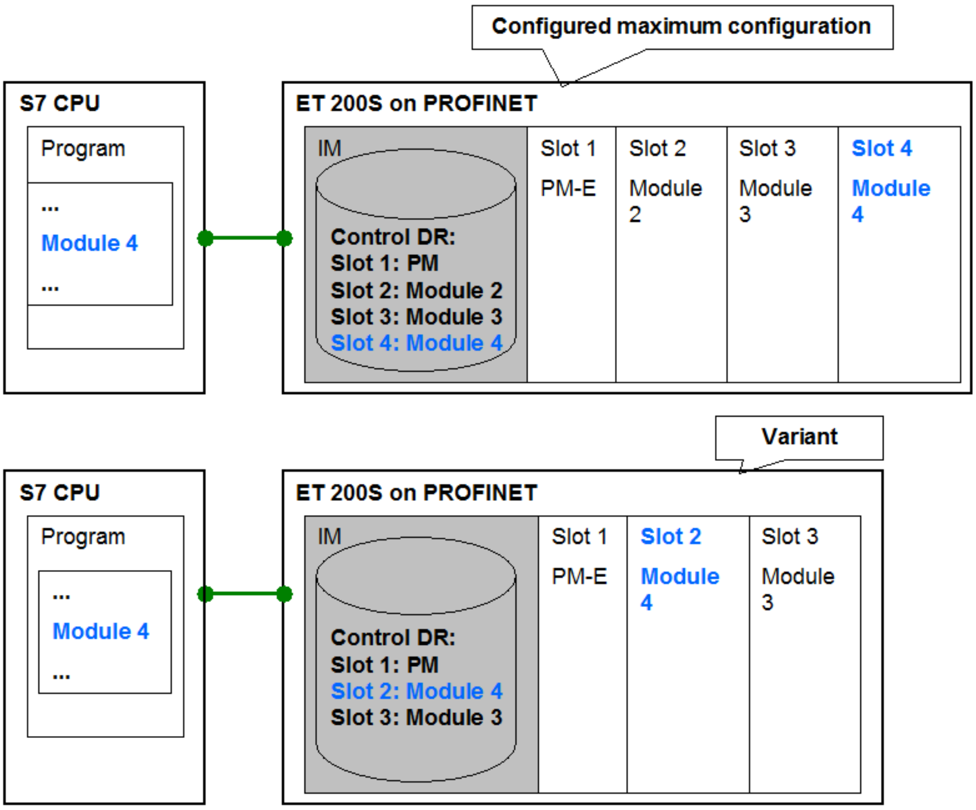
Examples

For examples to illustrate the codings, please refer to chapter 3.5.

Correlation between addressing and control data record

The addressing of the modules is adapted to the real configuration in the IM with the aid of the control data record. The following figure shows the principle.

Figure 3-4



The program in the S7 CPU addresses module 4, irrespective of the variant of the ET 200S station.

With the aid of the control data record, it is made known to the IM which address the module actually has in the ET 200S station for the special variant.

3.4.3 Feedback data record

Function

By reading the feedback data record, the real configuration of the station can be checked in the program of the S7 CPU.

The feedback data record contains information on whether the real configuration of the station matches the configuration, which is defined by:

- Configuration (maximum configuration) and
- control data record

Structure

Table 3-7 shows the structure of the feedback data record.

Table 3-7

Byte number	Meaning
0, 1, 2, 3	Header
4	Status for configured slot 1
5	Status for configured slot 2
...	
x + 3	Status for configured slot **x**

In the feedback data record, one byte represents one configured slot:
Byte 4 to byte (**x**+3) represent slot 1 to slot **x**

Possible slots: Slot 1 to slot 63

Coding

Table 3-8 shows the coding of the bytes in the feedback data record.

The coding depends on the coding of the bytes in the control data record.

Table 3-8

Coding of the byte in the control data record for slot x	**Coding of the byte in the feedback data record for slot x**		**Meaning**
	Bit 7 to 6	**Bit 0**	
The module configured for the configured slot x does not exist in the real configuration:	0	0	The configured module does not exist in the real ET 200S station
The module configured for the configured slot x is inserted into the real slot y:	0	0	An incorrect module is inserted into slot y of the real station
	0	1	The correct module is inserted into slot y of the real station
The module configured for the configured slot x is inserted into the real slot y or a reserve module is inserted into the real slot y:	0	0	There are two possibilities: • A reserve module is inserted into slot y of the real station • An incorrect module (*1) is inserted into slot y of the real station
	0	1	The correct module is inserted into slot y of the real station

(*1): In this case, the red SF LED is lit on the IM of the ET 200S station and on the CPU.

Examples

For examples to illustrate the codings, please refer to chapter 3.5.

3.5 Examples of the coding

This chapter uses specific examples to show how the control data record and the feedback data record are coded.

Preliminary remark

The examples use tables with a uniform structure. The following section explains the structure of these tables. The following table is an example of a table.

Table 3-9

(1)	**ET 200S configuration**	**Slot 1**	**Slot 2**	**Slot 3**	**Slot 4**	**Slot 5**
(2)	Configured configuration	PM	M2	M3	M4	M5
(3)	Real configuration	PM	M2	M5	M4	M3
(4)	**Control data record**	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
(5)	Coding (hexadecimal)	1 (01H)	2 (02H)	5 (05H)	4 (04H)	3 (03H)
(6)	**Feedback data record**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
(7)	Coding	1	1	1	1	1

Rows (1) to (3)

The rows describe the configuration of the ET 200S:

(1): Slot numbers in the ET 200S

(2): Maximum configuration configured in the STEP 7 hardware configuration

(3): Real configuration of the ET 200S (variant)

Table 3-9 uses the following abbreviations:

Table 3-10

Abbreviation	Meaning
PM	Power module
Mx	Module x
RM	Reserve module

For better discrimination, the modules are silhouetted in color. Hidden modules are exceptions, they are not silhouetted in color.

Rows (4) to (5)

The rows describe the associated control data record:

(4): Byte numbers in the control data record

(5): Coding of the bytes

Rows (6) to (7)

The rows describe the feedback data record for the real configuration:

(6): Byte numbers in the feedback data record

(7): Coding of the bytes

Hiding modules

The example shows how to hide slots.

Table 3-11

ET 200S configuration	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7
Configured configuration	PM	M2	M3	M4	M5	M6	M7
Real configuration	PM	M2	M5	M7	---	---	---
Control data record	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**	**Byte 9**	**Byte 10**
Coding (hexadecimal)	1 (01H)	2 (02H)	0 (00H)	0 (00H)	3 (03H)	0 (00H)	4 (04H)
Remarks		(*1)	(*2)				
Feedback data record	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**	**Byte 9**	**Byte 10**
Coding	1	1	0	0	1	0	1
Remarks		(*3)	(*4)				

Remarks on Table 3-11:

Table 3-12

(*1)	The module (M2) configured for the configured slot 2 is inserted into the real slot 2.
(*2)	The module (M3) configured for the configured slot 3 is not inserted in the real configuration.
(*3)	The correct module (M2) is inserted into the real slot 2.
(*4)	The configured module (M3) is not inserted in the real configuration.

Free slot assignment

The example shows how free slot assignment works.

Table 3-13

ET 200S configuration	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5
Configured configuration	PM	M2	M3	M4	M5
Real configuration	PM	M2	M5	M4	M3
Control data record	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Coding (hexadecimal)	1 (01H)	2 (02H)	5 (05H)	4 (04H)	3 (03H)
Remark			(*1)		
Feedback data record	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**
Coding	1	1	1	1	1
Remark			(*2)		

Remarks on Table 3-13:

Table 3-14

(*1)	The module (M3) configured for the configured slot 3 is inserted into the real slot 5.
(*2)	The correct module (M3) is inserted into the real slot 5.

Using reserve modules

The example shows the use of reserve modules.

Table 3-15

ET 200S configuration	**Slot 1**	**Slot 2**	**Slot 3**	**Slot 4**
Configured configuration	PM	M2	**M3**	M4
Real configuration with RM	PM	M2	**RM**	M4
Real configuration with mod-ule	PM	M2	**M3**	M4
Control data record	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Coding (hexadecimal)	1 (01H)	2 (02H)	**3+0x80 (83H)**	4 (04H)
Remarks			(*1)	
Feedback data record: Real configuration with RM	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Coding	1	1	**0**	1
Remarks			(*2)	
Feedback data record: Real configuration with module	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Coding	1	1	**1**	1
Remarks			(*3)	

Remarks on Table 3-15:

Table 3-16

(*1)	The module (M3) configured for the configured slot 3 is inserted into the real slot 3 and a reserve module (RM) is permissible in the real slot 3.
(*2)	A reserve module (RM) is inserted into the real slot 3.
(*3)	The correct module (M3) is inserted into the real slot 3.

Combination of the methods

The example shows a combination of the previously described methods.

Table 3-17

ET 200S configuration	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7	Slot 8	Slot 9
Configured configuration	PM	M2	M3	M4	**M5**	M6	M7	M8	M9
Real configuration with RM	PM	M2	**RM**	M6	M9	M8			
Real configuration with module	PM	M2	**M5**	M6	M9	M8			
Control data record	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**	**Byte 9**	**Byte 10**	**Byte 11**	**Byte 12**
Coding (hexadecimal)	1 (01)H	2 (02)H	0 (00)H	0 (00)H	**3+0x80** (83)H	4 (04)H	0 (00)H	6 (06)H	5 (05)H
Remarks		(*1)	(*2)		(*3)			(*4)	
Feedback data record: Real configuration with RM	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**	**Byte 9**	**Byte 10**	**Byte 11**	**Byte 12**
Coding	1	1	0	0	**0**	1	0	1	1
Remarks		(*5)	(*6)		(*7)			(*8)	
Feedback data record: Real configuration with module	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**	**Byte 8**	**Byte 9**	**Byte 10**	**Byte 11**	**Byte 12**
Coding	1	1	0	0	**1**	1	0	1	1
Remarks					(*9)				

Remarks on Table 3-17:

Table 3-18

(*1)	The module (M2) configured for the configured slot 2 is inserted into the real slot 2.
(*2)	The module (M3) configured for the configured slot 3 is not inserted in the real configuration.
(*3)	The module (M5) configured for the configured slot 5 is inserted into the real slot 3 and a reserve module (RM) is permissible in the real slot 3.
(*4)	The module (M8) configured for the configured slot 8 is inserted into the real slot 6.
(*5)	The correct module (M2) is inserted into the real slot 2.
(*6)	The configured module (M3) is not inserted.
(*7)	A reserve module (RM) is inserted into the real slot 3.
(*8)	The correct module (M8) is inserted into the real slot 6.
(*9)	The correct module (M5) is inserted into the real slot 3.

4 Functional Mechanisms of the Application

4.1 Overview of the functional scope

Chapter 2.3 describes the functional scope.

4.2 Code description

4.2.1 Preliminary remark

Representation of the flowcharts

In the document, the code (STEP 7 program) is described with the aid of flow-charts. The description uses uniform elements:

Example:

Figure 4-1

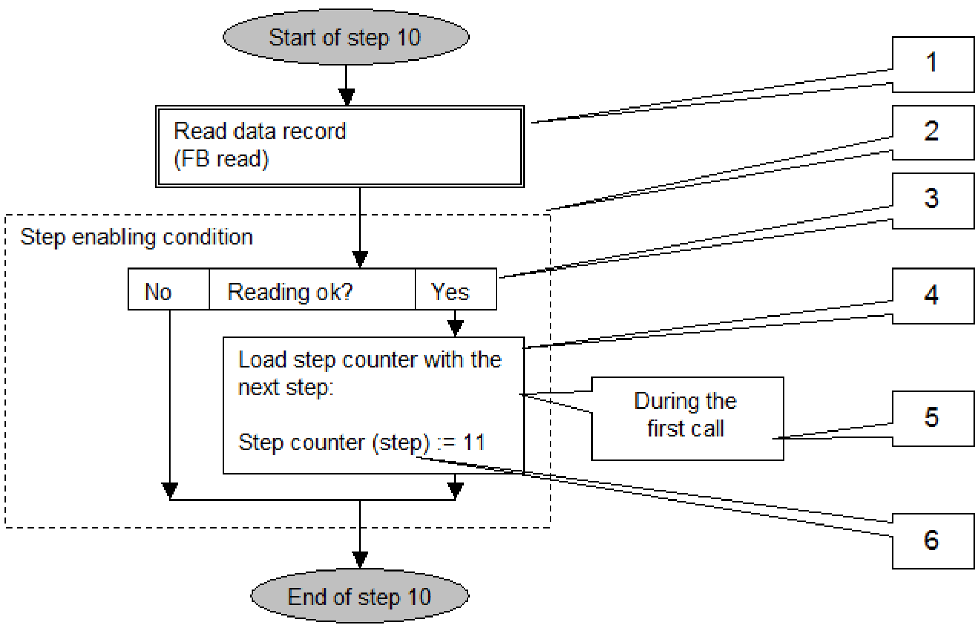


Table 4-1

	Meaning
(1)	Call of the function block
(2)	Name (summary) of a code sequence
(3)	Queries or branches
(4)	Description of an action
(5)	Additional comment on the action
(6)	To facilitate reference to the STEP 7 program, important symbols of the program are listed in brackets. In the example: (step) Assignments are represented with ":=". In the example, the step counter is assigned the value 11.

Comments on the steps in the STEP 7 program

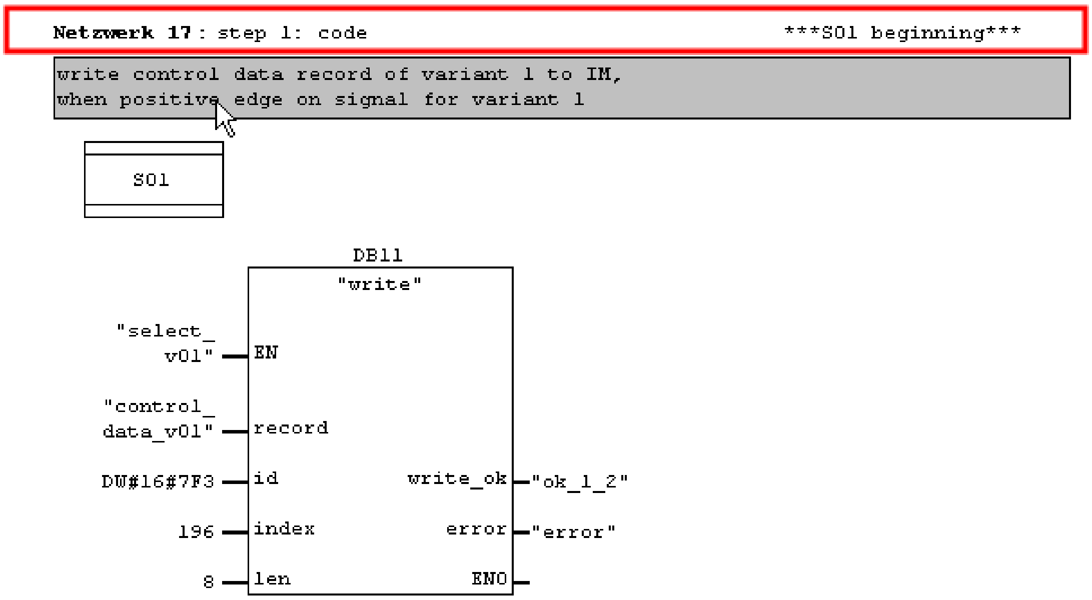
The STEP 7 program is implemented as a sequencer and consists of several steps. For better readability of the STEP 7 program, uniform network comments are used per section of a step.

Table 4-2

Step section	Network	Network comment
Code	First network	step x: code ***S0x beginning***
	Other networks	step x: code
Error	All networks	step x: error handling
Step enabling condition	All networks	step x: step enabling condition
End of step	Network	step x: end of step *** S0x end***

Example: First network for step 1

Figure 4-2



Note: Chapter 4.2.3 explains the structure of a step.

4.2.2 Concept

The program for configuration control (option handling) is implemented as a sequencer that is executed in OB1.

Sequencer principle

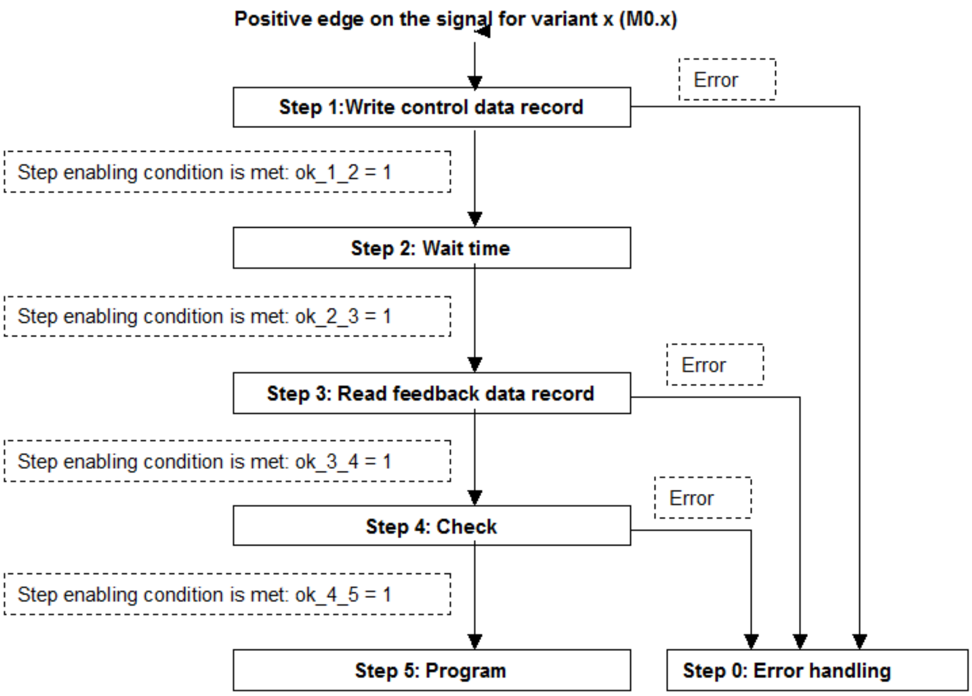
The sequencer in OB1 consists of steps and step enabling conditions.

Sequencer characteristics:

- Functions are executed in the steps.
- A step is exited under the following conditions:
  - The step enabling condition is met
  - An error has occurred

The following figure shows the time sequence of the steps.

Figure 4-3



Functions of the steps

In the steps, the following functions are implemented:

Table 4-3

Step	Name	Function
Step 0	Error handling	If errors occur, there will be a branching to this step.
Step 1	Write control data record	Write control data record for variant x to the ET 200S station.
Step 2	Wait time	Wait until the wait time has elapsed.
Step 3	Read feedback data record	Read feedback data record out of the ET 200S station.
Step 4	Check	Check whether the read feedback data record matches the setpoint feedback data record for variant x.
Step 5	Program	Cyclic call of the actual automation program for vari-ant x.

Note: Step 0 and step 5 are not exited.

Step enabling conditions

If the step enabling condition is met (ok_x_y = 1), a transition takes place from step x to step y. The following step enabling conditions exist in the program:

Table 4-4

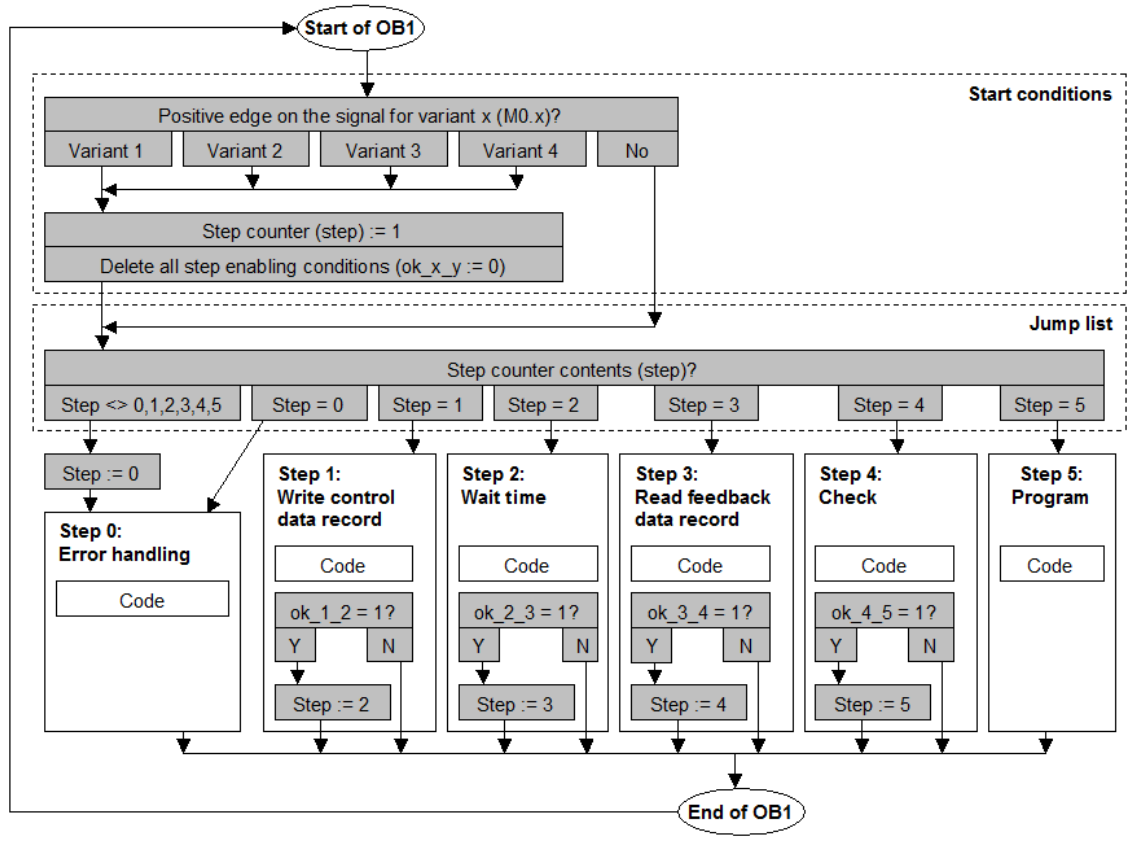
Step enabling condition		Transition
Name	Condition for meeting the step enabling condition	
ok_1_2	Write control data record without errors	Step 1 -> step 2
ok_2_3	Wait time has elapsed	Step 2 -> step 3
ok_3_4	Read feedback data record without errors	Step 3 -> step 4
ok_4_5	Read feedback data record matches the setpoint feedback data record for variant x	Step 4 -> step 5

Note: Step 0 and step 5 have no step enabling condition.

Implementation of the sequencer

The sequencer is implemented in OB1. The following figure shows the structure of the program. The program parts that are silhouetted in gray in the figure are used to control (manage) the sequencer.

Figure 4-4

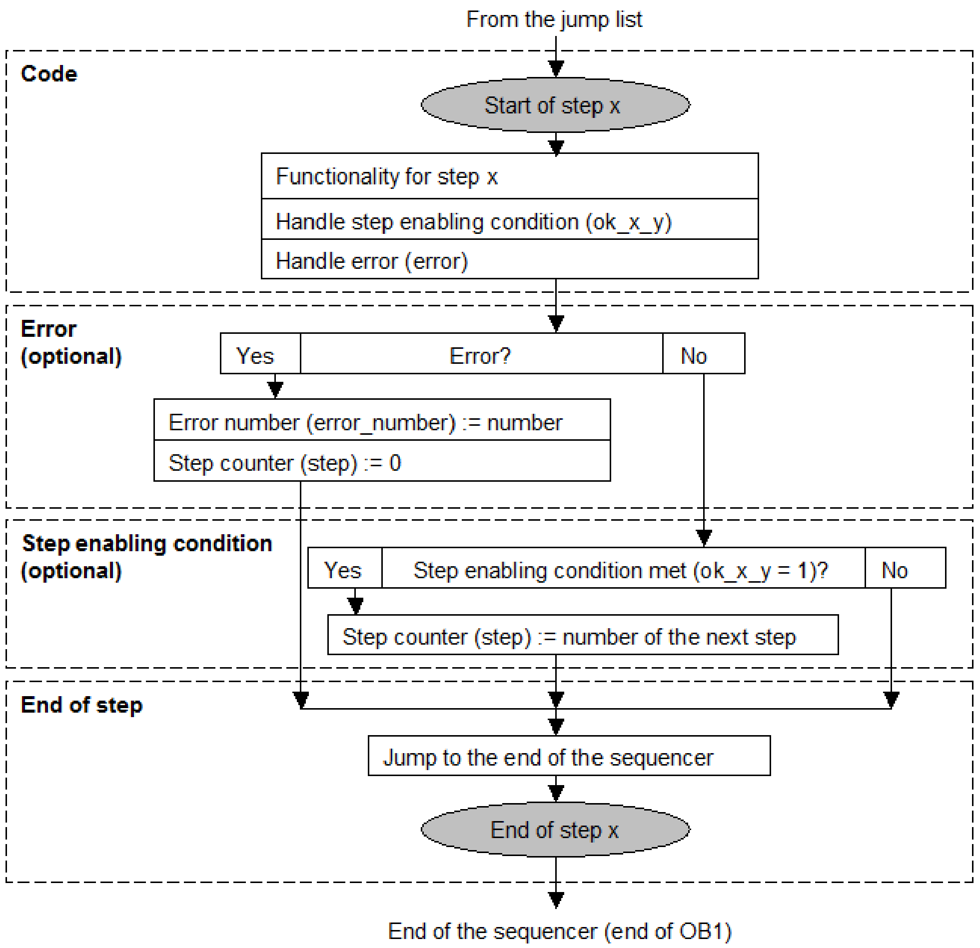


The following chapters describe the basic structure of a step, the individual steps and the function blocks (FBs) used in these steps.

4.2.3 Structure of a step

A step consists of different sections. Some sections are optional.

Figure 4-5



Code section

The first network contains a jump label to which the jump list jumps (Figure 4-4).

In the other networks, the following tasks are performed:

- Execution of the actual functionality of the step (e.g., write control data record)
- Decision whether the next step is to be enabled
- Check whether an error has occurred.

Error section (optional)

If an error was detected in the Code section, an error number will be stored here and the step counter will be loaded with zero. The sequencer will branch to step 0 (error handling).

Step enabling condition section (optional)

If the step enabling condition is met (ok_x_y = 1), the step counter will be loaded with the number of the next step.

End of step section

At the end of the step, a jump to the end of the sequencer takes place. At the same time, this is the end of OB1.

4.2.4 Step 0: Error handling

Call of the step

First call: The step is activated when an error has occurred in the jump list or a step (see Table 4-5).

Subsequent calls: The step is called permanently, i.e. the sequencer ends here.

Function

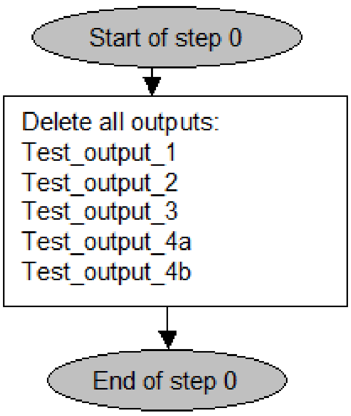
Deletion of all outputs used in the program.

Blocks called

None

Flowchart

Figure 4-6



Overview of the errors

Table 4-5

Error number	Cause of the error	Location of origin
1	Invalid step number	Jump list
2	Error when writing the control data record	Step 1
3	Error when reading the feedback data record	Step 3
4	Error when comparing the read feedback data record to the setpoint feedback data record	Step 4

4.2.5 Step 1: Write control data record

Call of the step

First call: The step is activated when a positive edge is detected on the signal of variant x (M0.x).

Subsequent calls: The step is repeated until the complete control data record has been written to the ET 200S station.

This is necessary since SFB 53 WRREC (write data record) is called in the step. SFB 53 operates asynchronously. This means that the SFB generally runs over several OB1 cycles.

Function

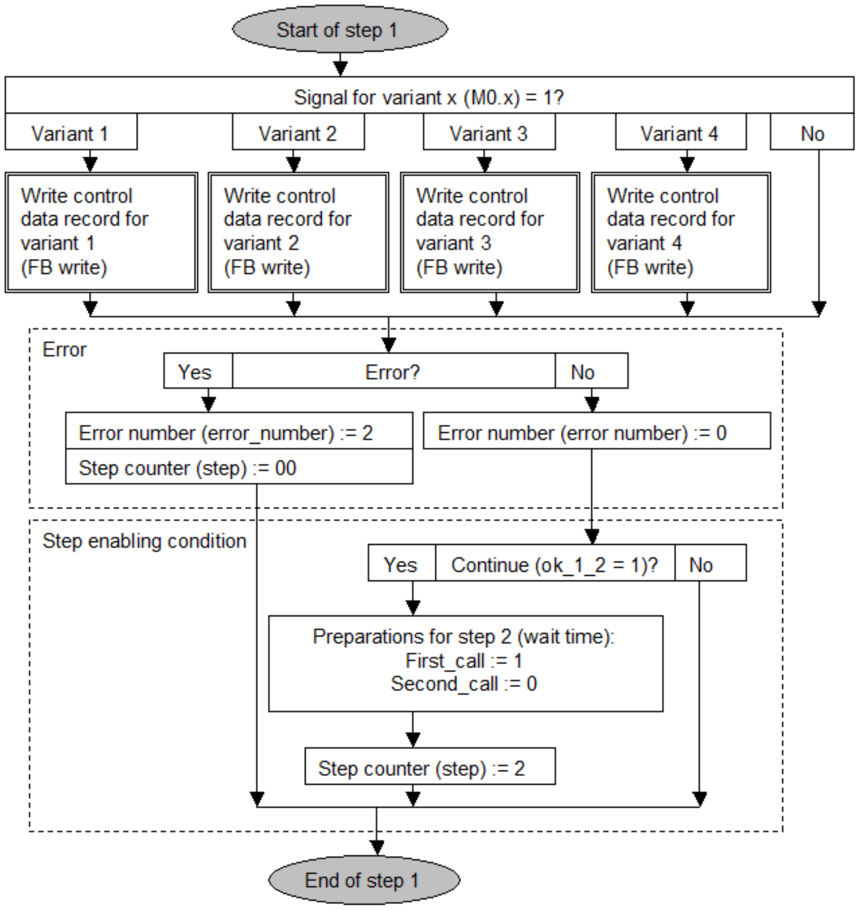
The step writes the control data record for variant x to the ET 200S station. If the data record is written without errors, step 2 will be enabled. If an error occurs, the sequencer will branch to step 0.

Blocks called

FB write (see chapter 4.2.10)

Flowchart

Figure 4-7



4.2.6 Step 2: Wait time

Call of the step

First call

This step is activated when the control data record has been successfully written to the ET 200S (step 1).

Subsequent calls

The step is repeated until the wait time has elapsed.

Function

If a changed or new control data record is written to the ET 200S, a station failure and subsequent restart of the station will occur.

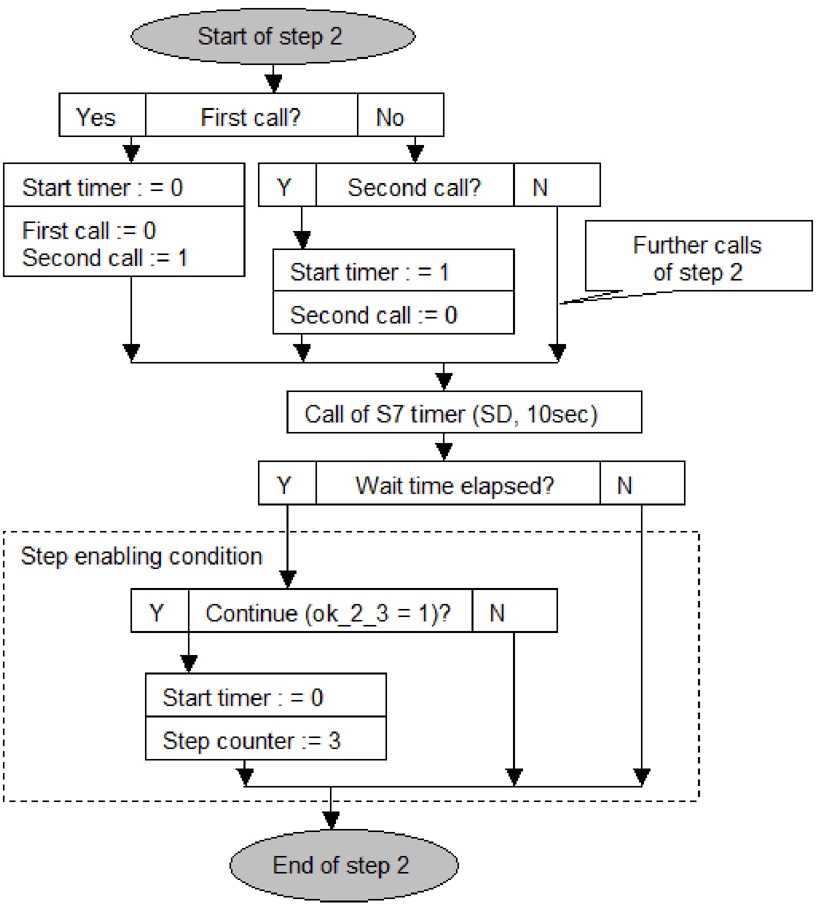
The wait time ensures that there is enough time after writing the control data record (step 1) and before reading the feedback data record (step 3).

Blocks called

None

Flowchart

Figure 4-8



4.2.7 Step 3: Read feedback data record

Call of the step

First call

The step is activated when the wait time has elapsed (step 2).

Subsequent calls

The step is repeated until the complete feedback data record of the ET 200S station has been read.

This is necessary since SFB 52 RDREC (read data record) is called in the step. SFB 52 operates asynchronously. This means that the SFB generally runs over several OB1 cycles.

Function

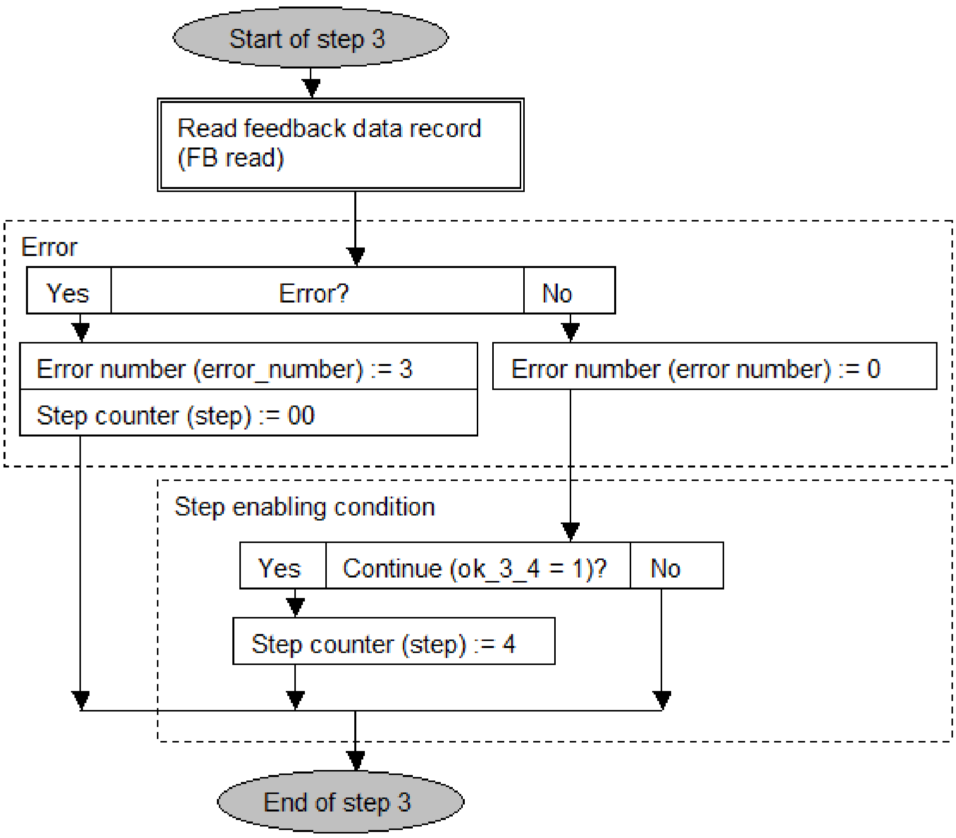
The step reads the feedback data record out of the ET 200S station and stores it in a data block. If the data record is read without errors, step 4 will be enabled. If an error occurs, the sequencer will branch to step 0.

Blocks called

FB read (see chapter 4.2.11)

Flowchart

Figure 4-9



4.2.8 Step 4: Check

Call of the step

First call

The step is activated when reading the feedback data record out of the ET 200S station was successful (step 3).

Subsequent calls

There are no subsequent calls. The step is processed in an OB1 cycle.

Function

The step checks whether the real configuration of the ET 200S matches the configuration of the selected variant.

For this purpose, it compares the following data records:

- The feedback data record read in step 2
- The feedback data record to be expected (setpoint feedback data record)

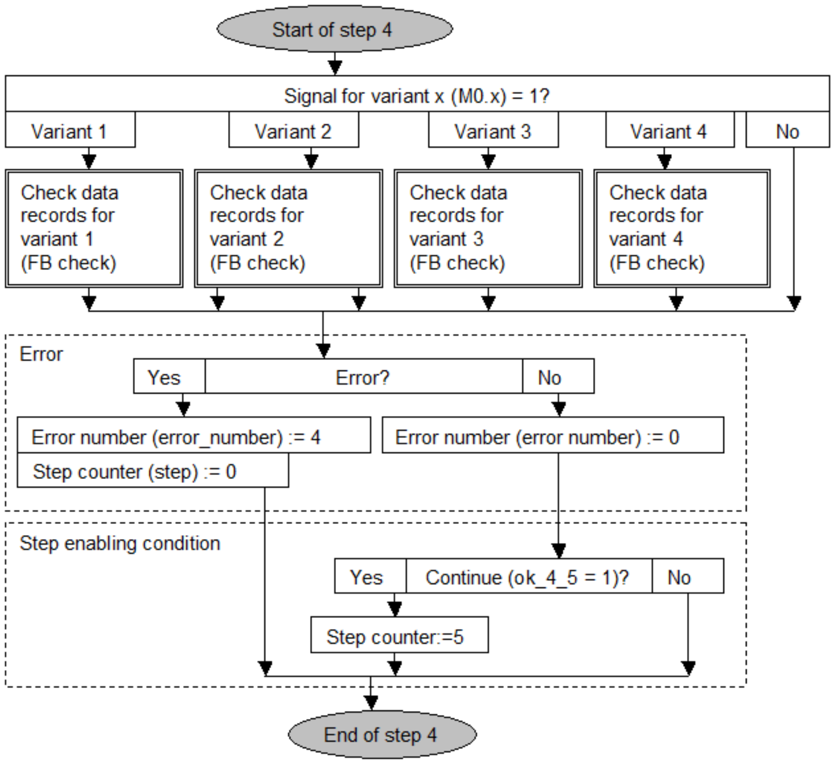
If there is a match, step 5 will be enabled.
If an error occurs, the sequencer will branch to step 0.

Blocks called

FB check (see chapter 4.2.12)

Flowchart

Figure 4-10



4.2.9 Step 5: Program

Call of the step

First call

The step is activated when the result of the check in step 4 was that the real configuration matches the configuration of the selected variant.

Subsequent calls

The step is called permanently, i.e. the sequencer ends here.

Function

The step calls the automation program for variant x.

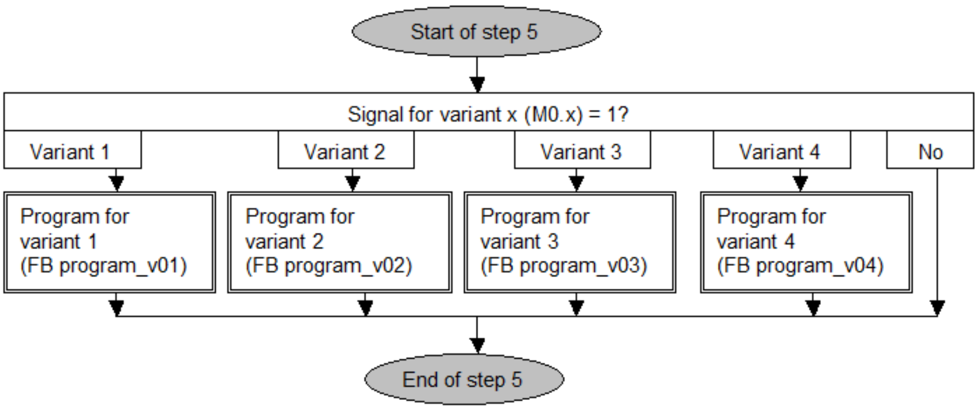
Blocks called

Depending on the variant:

FB user_program_v01, FB user_program_v02,
FB user_program_v03, FB user_program_v04

Flowchart

Figure 4-11



4.2.10 FB write

Call of the FB

The FB is called in step 1.

In the step, a separate call is programmed for each variant.

Function

The function block writes the control data record of variant x (source) to the ET 200S station (destination):

- Data block control_data_v0x is the source
- Data record 196 is the destination on the ET 200S

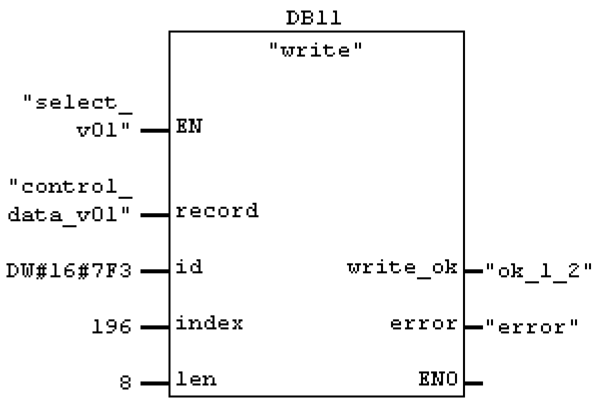
Blocks called

SFB 53 WRREC (write data record)

Parameters

The figure shows the call for variant 1.

Figure 4-12



The parameters of the function block:

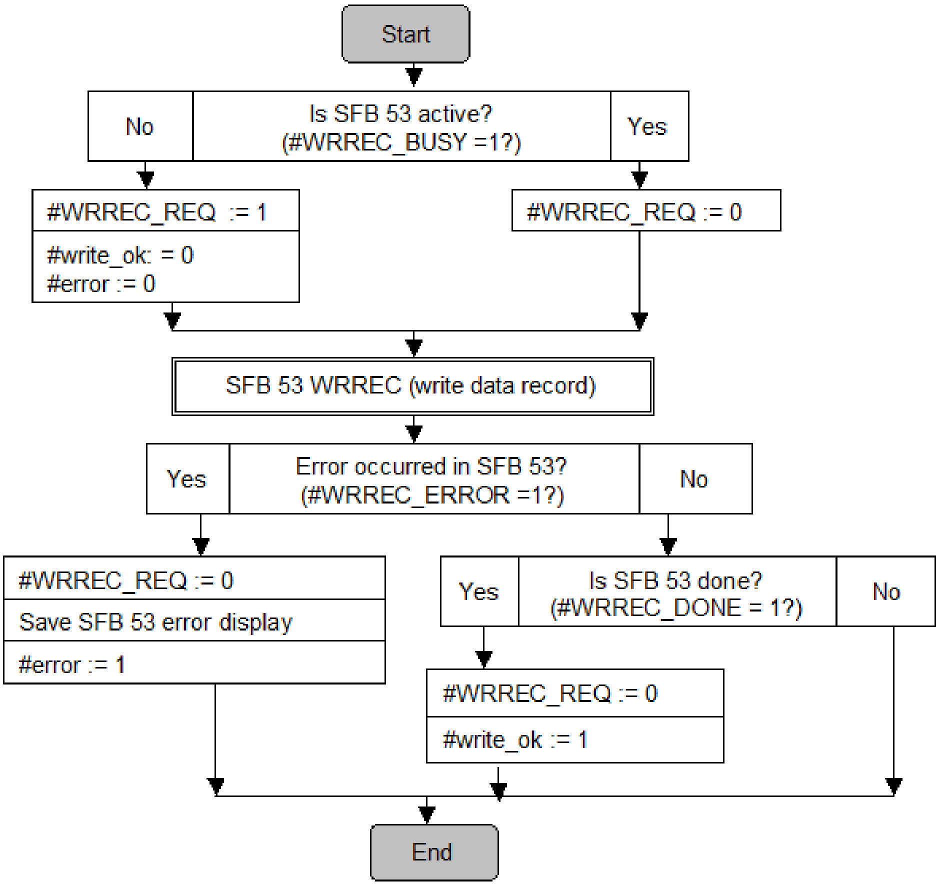
Table 4-6

Parameter	Declaration	Type	Meaning
record	IN	ANY	Pointer to the control data record to be written (source)
id	IN	DWORD	Address of the ET 200S station (*1)
index	IN	INT	Data record number (destination)
len	IN	IN	Data record length
write_ok	OUT	BOOL	“1” if writing has been successfully completed
error	OUT	BOOL	“1” if an error has occurred

(*1): For the address, please refer to the STEP 7 hardware configuration (see chapter 3.3.2)

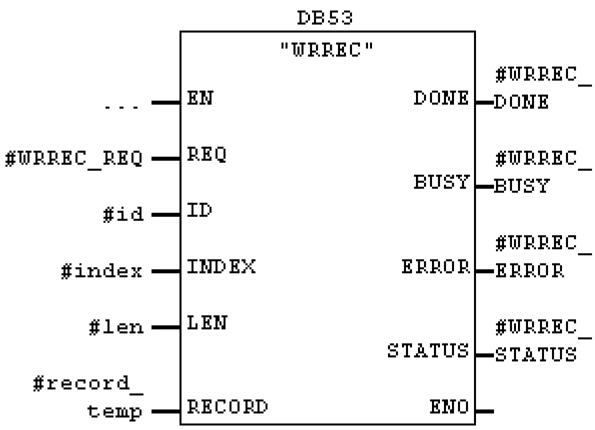
Flowchart

Figure 4-13



SFB 53 call interface:

Figure 4-14



4.2.11 FB read

Call of the FB

The FB is called in step 3.

Function

The function block reads the feedback data record out of the ET 200S station (source) and stores it in a data block (destination):

- Data record 197 on the ET 200S is the source
- Data block actual_feedback_data is the destination

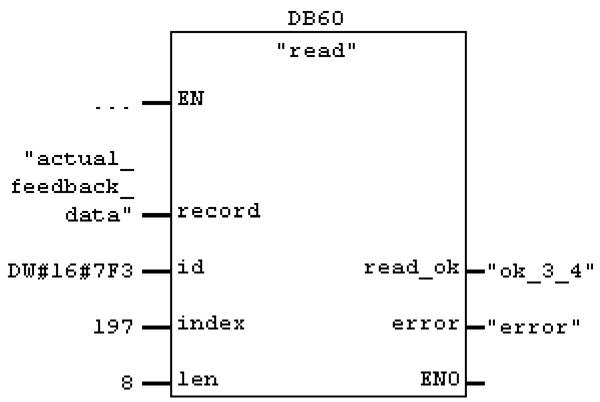
Blocks called

SFB52 RDREC (read data record)

Parameters

The figure shows the call.

Figure 4-15



The parameters of the function block:

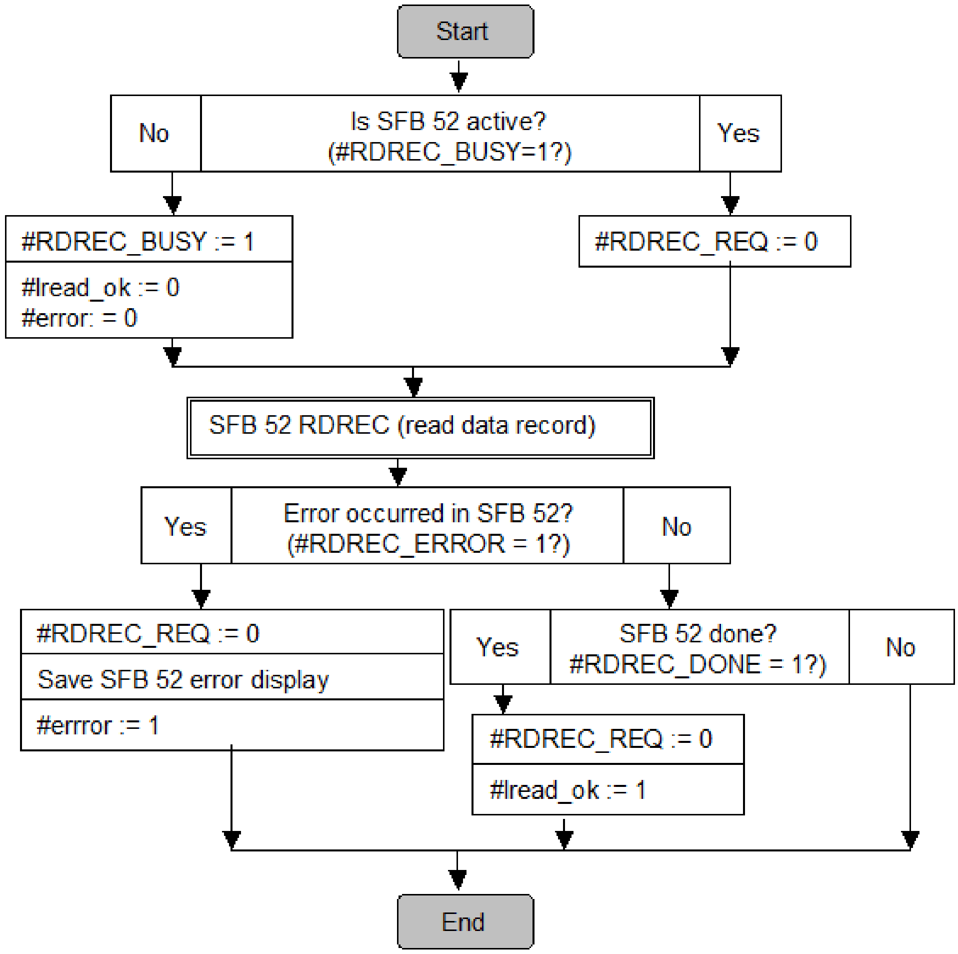
Table 4-7

Parameter	Declaration	Type	Description
record	IN	ANY	Pointer to the destination of the feedback data record to be read (destination)
id	IN	DWORD	ET 200S address (*1)
index	IN	INT	Data record number (source)
len	IN	INT	Data record length
read_ok	OUT	BOOL	“1” if reading has been successfully completed
error	OUT	BOOL	“1” if an error has occurred

(*1): For the address, please refer to the STEP 7 hardware configuration (see chapter 3.3.2)

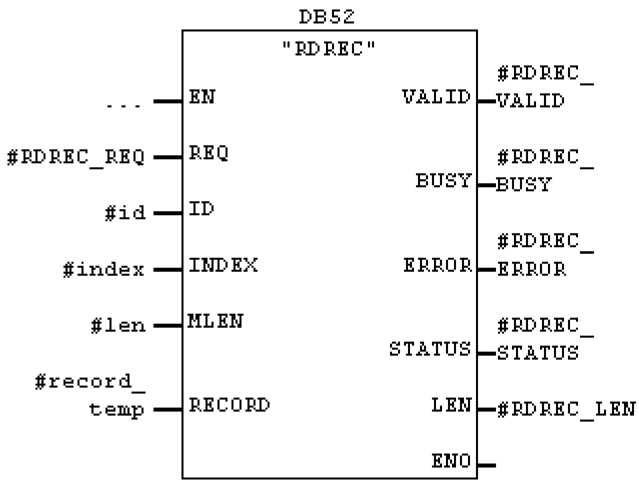
Flowchart

Figure 4-16



SFB 52 call interface:

Figure 4-17



4.2.12 FB check

Call of the FB

The FB is called in step 4.

In the step, a separate call is programmed for each variant.

Function

The function block compares the two data records:

- Feedback data record of the ET 200S station: actual_feedback_data
- Setpoint feedback data record for variant x: set_feedback_data_v0x

Both data records are stored in data blocks with the following structure:

- Byte 0 to 3: Header
- Byte 4 to 7: Identifiers for slot 1 to slot 4 (configured maximum configuration)

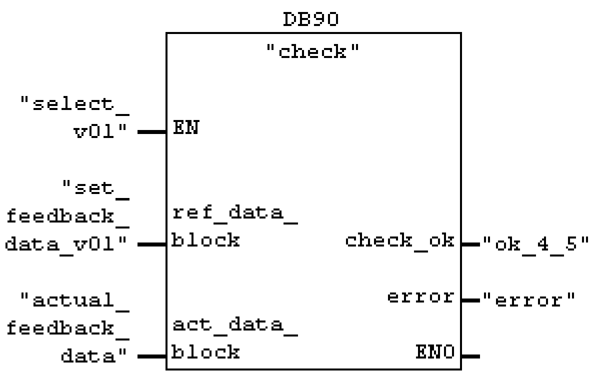
Blocks called

None

Parameters

The figure shows the call for variant 1:

Figure 4-18



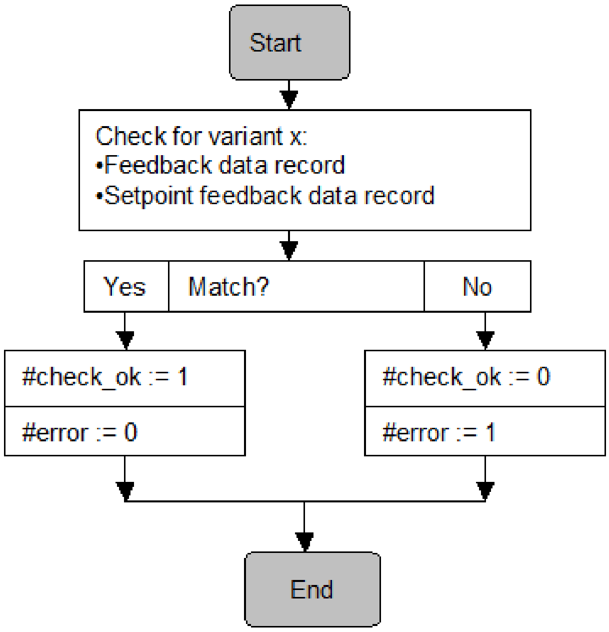
The parameters of the FB:

Table 4-8

Parameter	Declaration	Type	Description
ref_data_block	IN	BLOCK_DB	Setpoint feedback data record
act_data_block	IN	BLOCK_DB	Feedback data record
check_ok	OUT	BOOL	“1” if both data records match
error	OUT	BOOL	“1” if an error has occurred

Flowchart

Figure 4-19



4.2.13 FB program_v0x

A separate FB exists for each variant:

FB program_v01, FB program_v02, FB program_v03, FB program_v04

Call of the FB

The FB is called in step 5.

Function

The FB contains the automation program for variant x.

Depending on the variant, different outputs of the ET 200S station are set in the function block. On the ET 200S, these outputs enable the user to see which variant is activated.

Blocks called

None

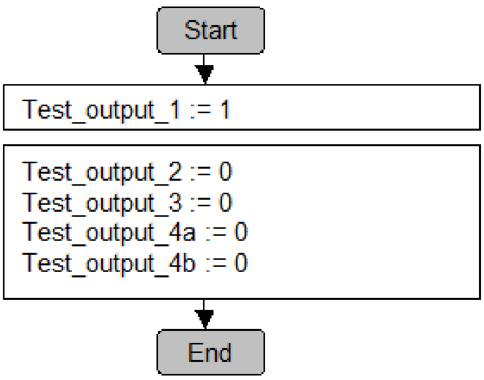
Parameters

The figure shows the call for variant 1:

Figure 4-20

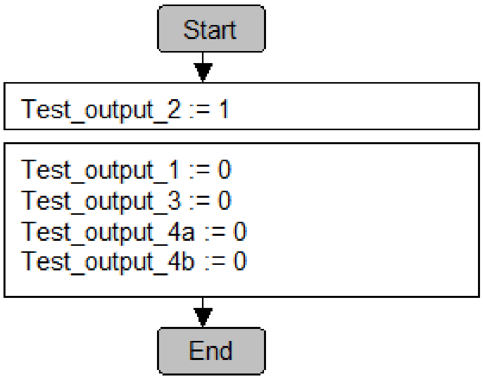
Flowchart for variant 1 (program_v01)

Figure 4-21



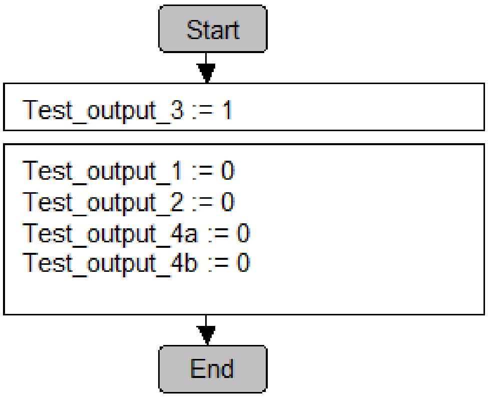
Flowchart for variant 2 (program_v02)

Figure 4-22



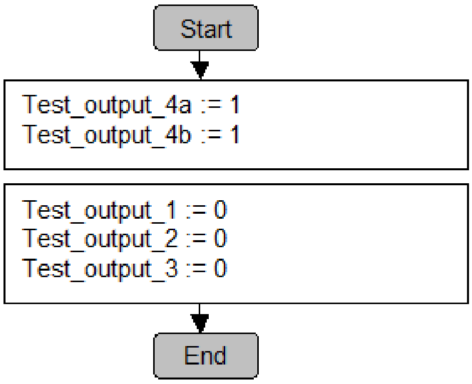
Flowchart for variant 3 (program_v03)

Figure 4-23



Flowchart for variant 4 (program_v04)

Figure 4-24



Overview of the test signals

See also chapter 6.6.

Table 4-9

Variant		Module 4 (4DO)	Module 3 (2DO)
Variant 1		LED 1 (Q3.0)	---
Variant 2		LED 5 (Q3.1)	---
Variant 3		LED 2 (Q3.2)	---
Variant 4	with RM: RM inserted instead of module 4	---	LED 1 (Q0.0)
	without RM: Module 4 inserted instead of RM	LED 6 (Q3.3)	LED 1 (Q0.0)

4.2.14 Overview of the blocks

Block container contents

Screen shot from the STEP 7 project:

Figure 4-25

Object name	Symbolic name	Creat...	Size i...	Type
Systemdaten	---	---	---	SDB
OB1	cycle	FBD	1600	Organization Block
OB82	I/O_FLT1	FBD	38	Organization Block
OB83	I/O_FLT2	FBD	38	Organization Block
OB86	RACK_FLT	FBD	38	Organization Block
OB100	COMPLETE RESTART	FBD	50	Organization Block
FB1	program_v01	FBD	78	Function Block
FB2	program_v02	FBD	78	Function Block
FB3	program_v03	FBD	78	Function Block
FB4	program_v04	FBD	80	Function Block
FB10	write	FBD	326	Function Block
FB20	read	FBD	334	Function Block
FB30	check	FBD	186	Function Block
DB11		DB	64	Instance data block for FB 10
DB12		DB	64	Instance data block for FB 10
DB13		DB	64	Instance data block for FB 10
DB14		DB	64	Instance data block for FB 10
DB20	control_data_v01	DB	44	Data Block
DB21	control_data_v02	DB	44	Data Block
DB22	control_data_v03	DB	44	Data Block
DB23	control_data_v04	DB	44	Data Block
DB30	actual_feedback_data	DB	44	Data Block
DB31	fault_WRREC	DB	40	Data Block
DB32	fault_RDREC	DB	40	Data Block
DB40	set_feedback_data_v01	DB	44	Data Block
DB41	set_feedback_data_v02	DB	44	Data Block
DB42	set_feedback_data_v03	DB	44	Data Block
DB43	set_feedback_data_v04	DB	44	Data Block
DB52		DB	64	Instance data block for SFB 52
DB53		DB	62	Instance data block for SFB 53
DB60		DB	68	Instance data block for FB 20
DB90		DB	58	Instance data block for FB 30
DB91		DB	58	Instance data block for FB 30
DB92		DB	58	Instance data block for FB 30
DB93		DB	58	Instance data block for FB 30
DB95		DB	36	Instance data block for FB 1
DB96		DB	36	Instance data block for FB 2
DB97		DB	36	Instance data block for FB 3
DB98		DB	36	Instance data block for FB 4
VAT_00	VAT_00		---	Variable Table

Overview of the blocks

Table 4-10 shows the blocks for all variants.

Table 4-10

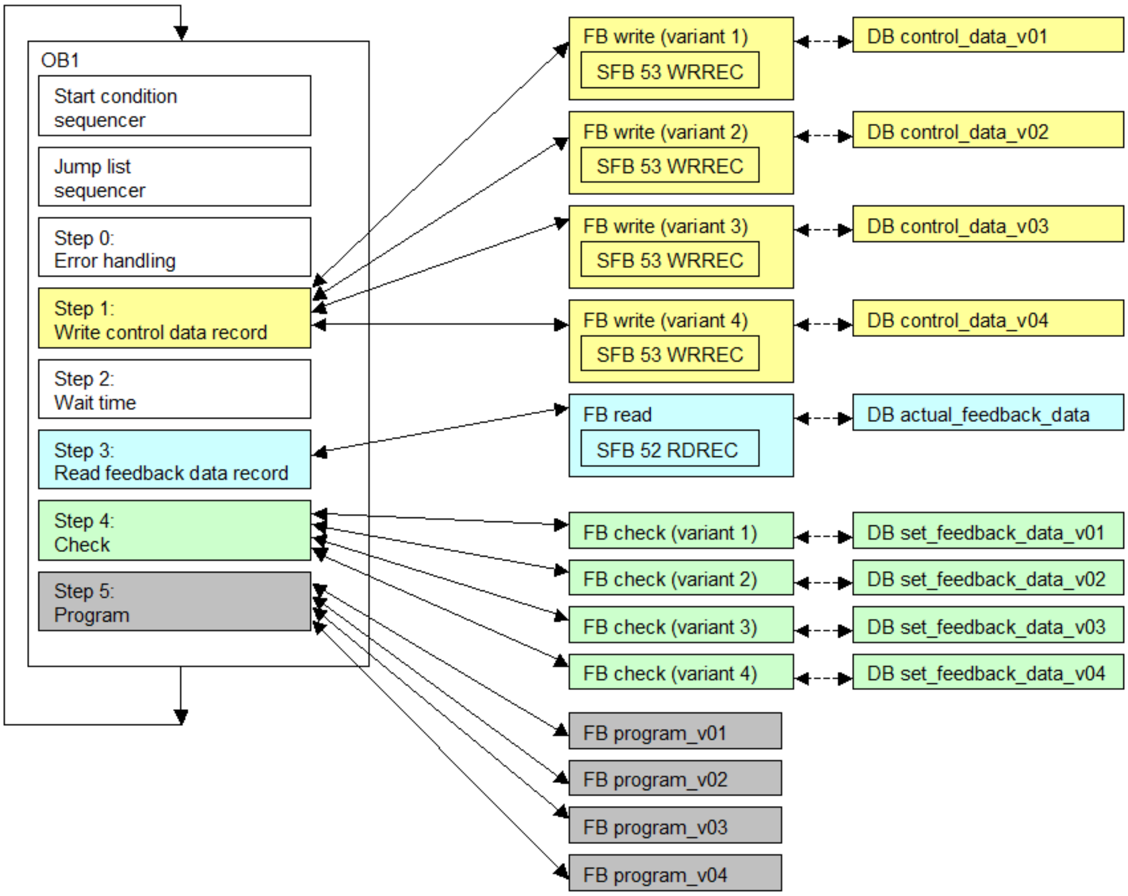
Block type	Name	Function
FB	program_v01	Program of variant 1 of the machine
	program_v02	Program of variant 2 of the machine
	program_v03	Program of variant 3 of the machine
	program_v04	Program of variant 4 of the machine
	write	Write control data record
	read	Read feedback data record
	check	Compare feedback data to setpoint feedback data
DB	control_data_v01	Control data record of variant 1 of the machine
	control_data_v02	Control data record of variant 2 of the machine
	control_data_v03	Control data record of variant 3 of the machine
	control_data_v04	Control data record of variant 4 of the machine
	actual_feedback_data	Feedback data record
	set_feedback_data_v01	Setpoint feedback data record of variant 1
	set_feedback_data_v02	Setpoint feedback data record of variant 2
	set_feedback_data_v03	Setpoint feedback data record of variant 3
	set_feedback_data_v04	Setpoint feedback data record of variant 4
	fault_WRREC	Fault indication when writing data record (for test)
	fault_RDREC	Fault indication when reading data record (for test)
OB	OB82	OB for diagnostics
	OB83	OB for removing/inserting modules
	OB86	OB for rack failure
	OB100	OB for startup

4.2.15 Program structure

Overview

Figure 4-26 shows the call structure of the blocks in OB1. For better orientation, the individual steps are silhouetted in color.

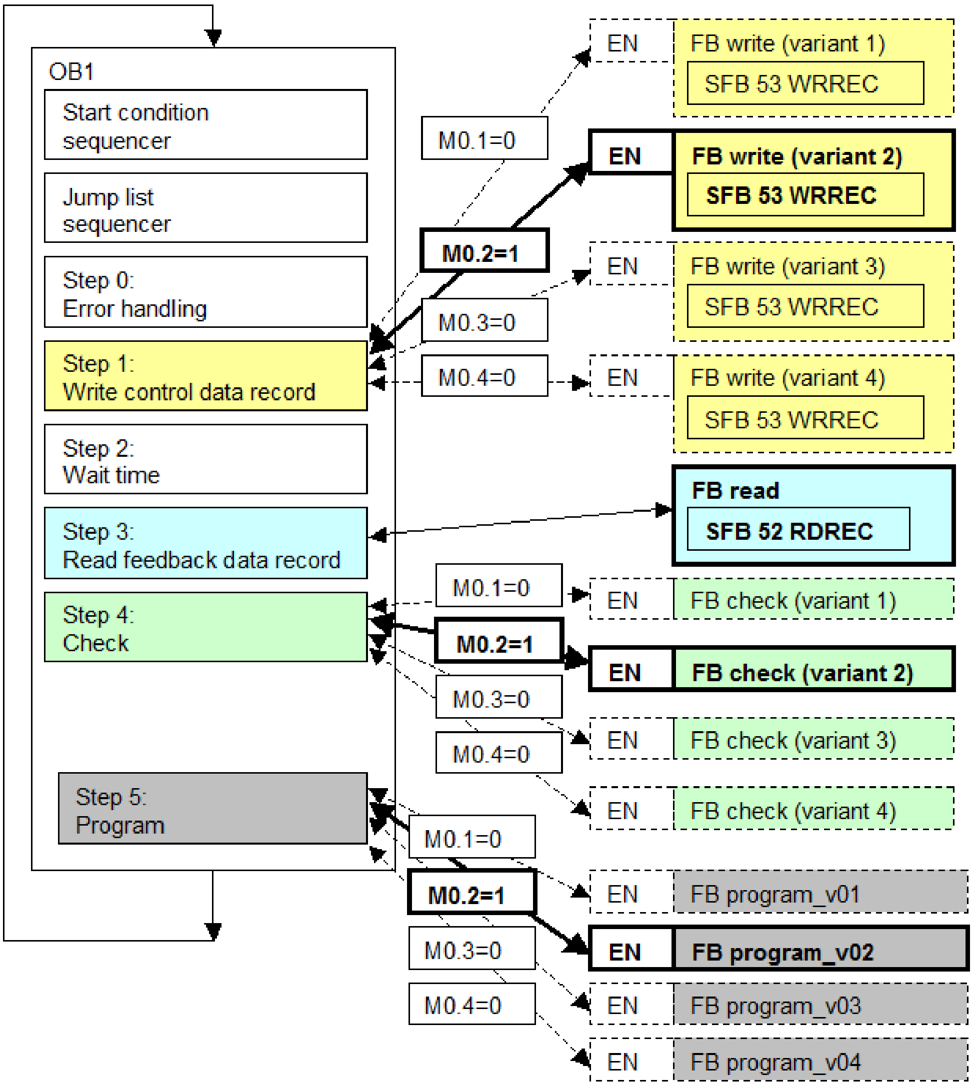
Figure 4-26



Blocks of a variant

Figure 4-27 shows which blocks are called when, for example, variant 2 has been selected (M0.2 = 1). For reasons of clarity, the figure indicates the Enable inputs of the blocks (EN).

Figure 4-27



4.3 Code customization

The code has a modular structure; therefore, it is relatively easy to adapt it to different requirements:

- Different configuration of the ET 200S station
- Other variants of the machine

The following section lists the essential points where changes have to be made.

Customizing the modules in the ET 200S

Table 4-11

Step	Modification
Step 1: Write control data record	Customize data blocks with the control data records (control_data_v0x) Customize the length parameter on FB write
Step 2: Wait time	Customize the wait time if necessary
Step 3: Read feedback data record	Customize the data block for the current feedback data record (actual_feedback_data) Customize the length parameter on FB read
Step 4: Check	Customize data blocks with setpoint feedback data record (set_feedback_dat_v0x) Customize the code for FB check
Step 5: Program	Customize automation programs (program_v0x)

Customizing the variants of the machine

Table 4-12

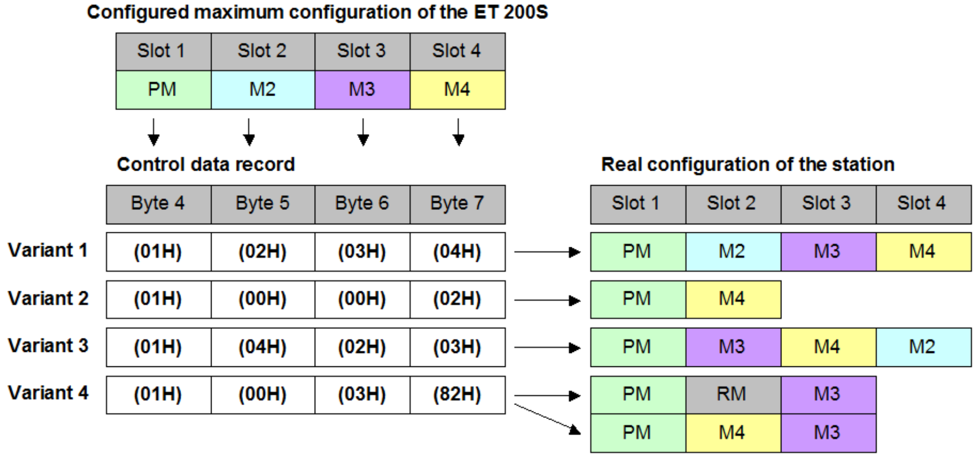
Step	Modification
Step 1: Write control data record	Customize the number of calls for FB write Additional data blocks with control data records (control_data_v0x)
Step 2: Wait time	---
Step 3: Read feedback data record	---
Step 4: Check	Customize the number of calls for FB check Additional data blocks with setpoint feedback data records (set_feedback_data_v0x)
Step 5: Program	Customize the number of calls and contents for FB program_v0x

4.4 Implemented variants

4.4.1 Overview

Figure 4-28 shows all variants implemented in the application and the associated control data records.

Figure 4-28



<u>Explanations of the figure:</u>

The figure shows only byte 4 (slot 1) to byte 7 (slot 4) of the control data.

PM: Power module

RM: Reserve module

Mx: Module x

(xyH): hexadecimal

Table 4-13 shows which configuration control (option handling) methods are used.

Table 4-13

Variant	Method
Variant 1	The ET 200S configuration matches the configured maximum configuration.
Variant 2	Hiding modules
Variant 3	Free slot assignment
Variant 4	Hiding modules, free slot assignment, using reserve module

All variants are implemented in the code.

For the specific modules that are used in the ET 200S, please refer to chapter 2.4.

The following sections provide a detailed description of the implemented variants.

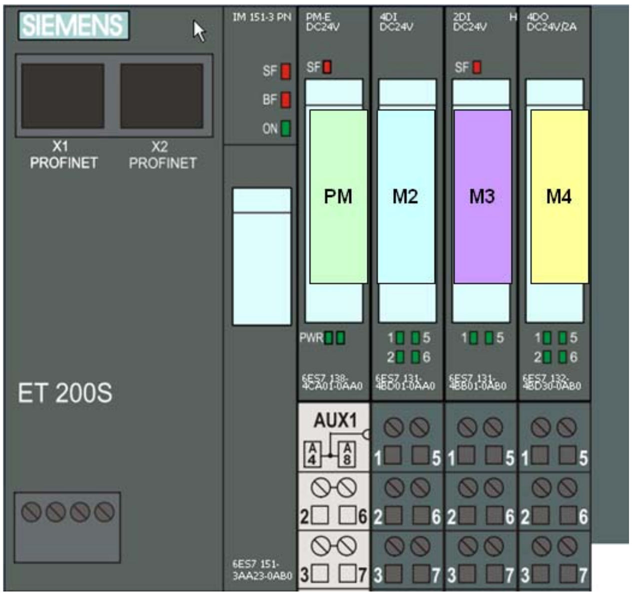
4.4.2 Variant 1

Real configuration

Characteristic of the variant:

The ET 200S configuration matches the configured maximum configuration.

Figure 4-29



Control data record and feedback data record

Table 4-14

ET 200S configuration	Slot 1	Slot 2	Slot 3	Slot 4
Configured configuration	PM	M2	M3	M4
Real configuration	PM	M2	M3	M4
Control data record	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Coding (hexadecimal)	1 (01H)	2 (02H)	3 (03H)	4 (04H)
Feedback data record (*1)	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Coding	1	1	1	1

(*1): Used in the code as a setpoint feedback data record.

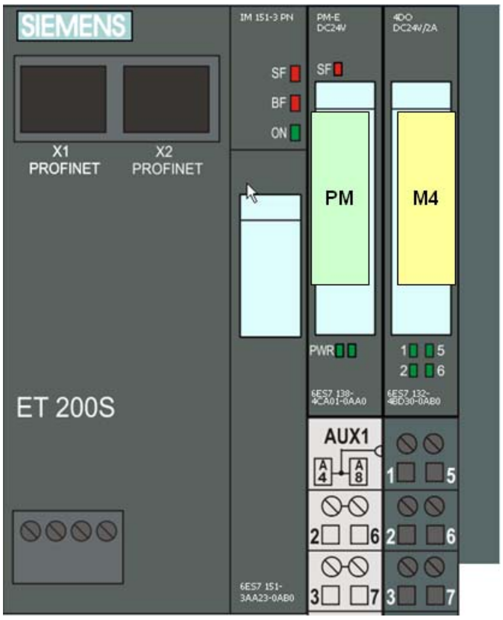
4.4.3 Variant 2

Real configuration

Characteristic of the variant:

Module 2 and module 3 are hidden.

Figure 4-30



Control data record and feedback data record

Table 4-15

ET 200S configuration	Slot 1	Slot 2	Slot 3	Slot 4
Configured configuration	PM	M2	M3	M4
Real configuration	PM	M4	---	---
Control data record	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Coding (hexadecimal)	1 (01H)	0 (00H)	0 (00H)	2 (02H)
Feedback data record (*1)	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Coding	1	0	0	1

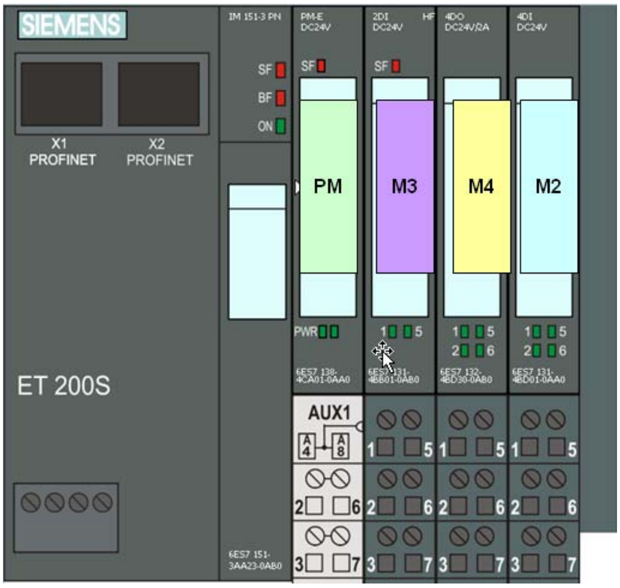
(*1): Used in the code as a setpoint feedback data record.

4.4.4 Variant 3

Real configuration

Characteristic of the variant: Free slot assignment of the modules.

Figure 4-31



Control data record and feedback data record

Table 4-16

ET 200S configuration	Slot 1	Slot 2	Slot 3	Slot 4
Configured configuration	PM	M2	M3	M4
Real configuration	PM	M3	M4	M2
Control data record	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Coding (hexadecimal)	1 (01H)	4 (04H)	2 (02H)	3 (03H)
Feedback data record (*1)	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Coding	1	1	1	1

(*1): Used in the code as a setpoint feedback data record.

4.4.5 Variant 4

Real configuration

Characteristic of the variant:

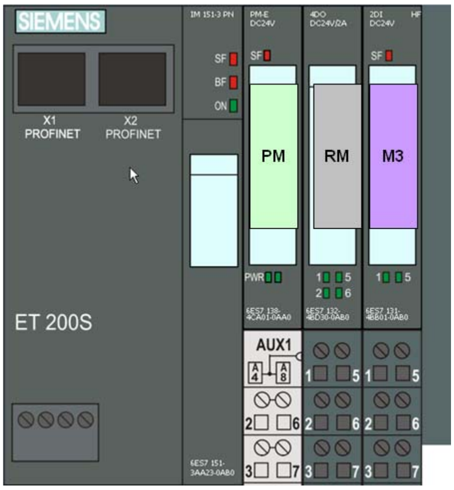
Combination of the methods: Hiding modules, free slot assignment, using reserve module.

In this case, two real configurations of the ET 200S are permissible. Both configurations have the same number of slots but different modules:

- With the reserve module instead of the configured module
- With the configured module instead of the reserve module

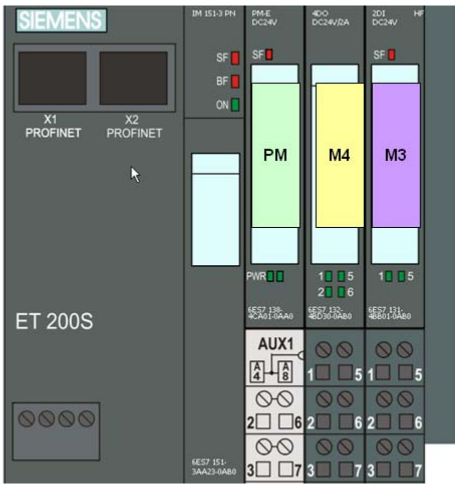
Configuration: Reserve module (RM) inserted

Figure 4-32



Configuration: Module 4 (M4) inserted

Figure 4-33



Control data record and feedback data record

Table 4-17

ET 200S configuration	Slot 1	Slot 2	Slot 3	Slot 4
Configured configuration	PM	M2	M3	**M4**
Real configuration with RM	PM	**RM**	M3	---
Real configuration with module	PM	**M4**	M3	---
Control data record	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Coding (hexadecimal)	1 (01H)	0 (00H)	3 (03H)	**2+0x80** (82H)
Feedback data record: Real configuration with RM (*1)	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Coding	1	0	1	**0**
Feedback data record: Real configuration with module	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Coding	1	0	1	**1**

(*1): Used in the code as a setpoint feedback data record.

5 Installation

5.1 Overview

The following steps are necessary for the installation:

- Installing the hardware
- Installing the code on the PG/PC
- Setting the PG/PC interface
- Downloading the code to the CPU

The following chapters describe the steps.

5.2 Installing the hardware

For the necessary hardware components, please refer to chapter 2.4. The ET 200S in variant 1 is set up first.

Installation

Table 5-1 shows the procedure to install the hardware.

Table 5-1

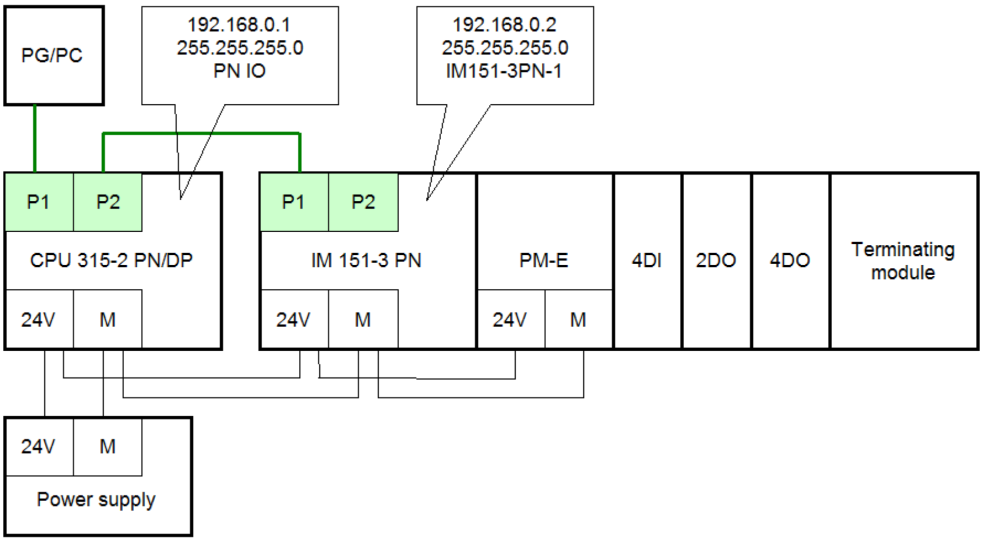
No.	Hardware	Action
1.	S7 CPU and MMC	Delete the SIMATIC Micro Memory Card (MMC) for the CPU and insert the MMC into the CPU.
2.	IM and MMC	Delete the SIMATIC Micro Memory Card (MMC) for the IM and insert the MMC into the IM of the ET 200S.
3.	S7-300 mounting rail	Mount the following devices on the mounting rail: PS, CPU
4.	ET 200S	Assemble the modules in the described order: • IM151-3 PN interface module • Terminal modules for power module and electronic modules • Terminating module Insert the modules into the terminal modules in the described order: • PM-E 24VDC • 4 DI 24VDC ST • 2 DO 24VDC/0.5A HF • 4 DO 24VDC/0.5A ST
5.	PROFINET cable	Connect S7 CPU, IM and PG/PC.
6.	Power supply (PS)	Complete all necessary connections.

NOTICE **Follow the installation guidelines for PROFINET (/3/), ET 200S (/1/) and S7-300 (/2/). Refer to the relevant manuals.**

Configuration

The figure schematically shows the configuration of the application.

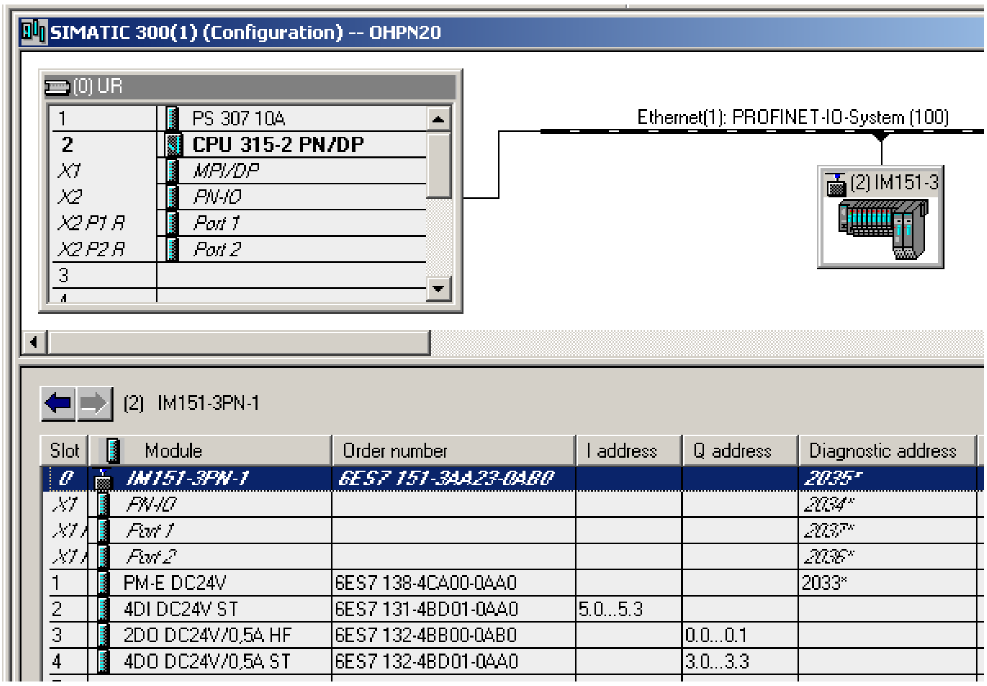
Figure 5-1



Hardware configuration

Figure 5-2 shows the associated STEP 7 hardware configuration.

Figure 5-2



5.3 Installing the code on the PG/PC

For the necessary software components and downloads for the application (code), please refer to chapter 2.4.

To install the code (STEP 7 project) on the PG/PC, the following operations are necessary:

- Download the
  “29430270_OH_ET200S_PN_CODE_v10.zip”
  code to any directory on the PG/PC.
- Retrieve the file in the “SIMATIC Manager”:
  “File > Retrieve”

5.4 Setting the PG/PC interface

Prerequisites:

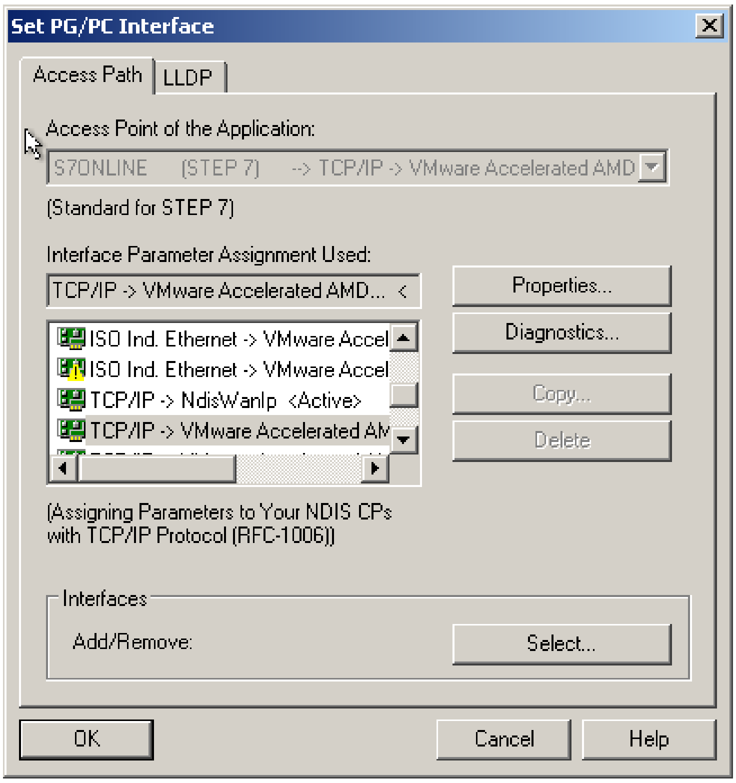
- The PG/PC has been connected to the CPU via PROFINET

The following operations are necessary in the “SIMATIC Manager”:

- “Options > Set PC/PG Interface”
- Select the used network card.

Result (example):

Figure 5-3



5.5 Downloading the code to the CPU

Prerequisites:

- The hardware has been installed
- The PG/PC has been connected to the CPU via PROFINET

Note: The following operations apply provided that all components are in the condition at delivery from the plant (with factory settings):

- General CPU reset has been performed
- MMC of CPU and ET 200 have been deleted
- CPU has been reset (without IP address and device name)
- IM has been reset (without IP address and device name)

If the components are not in the condition at delivery from the plant, the following operations may differ.

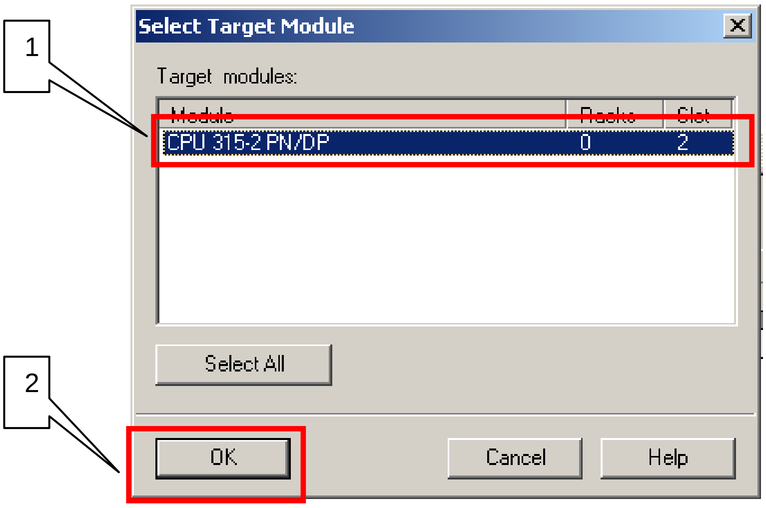
Downloading the hardware configuration

The following operations are necessary in the "SIMATIC Manager":

- Open the "SIMATIC Manager"
- Open the STEP 7 project of the application (code)
- Open "HW Config"
- "PLC > Download"

Result:

Figure 5-4

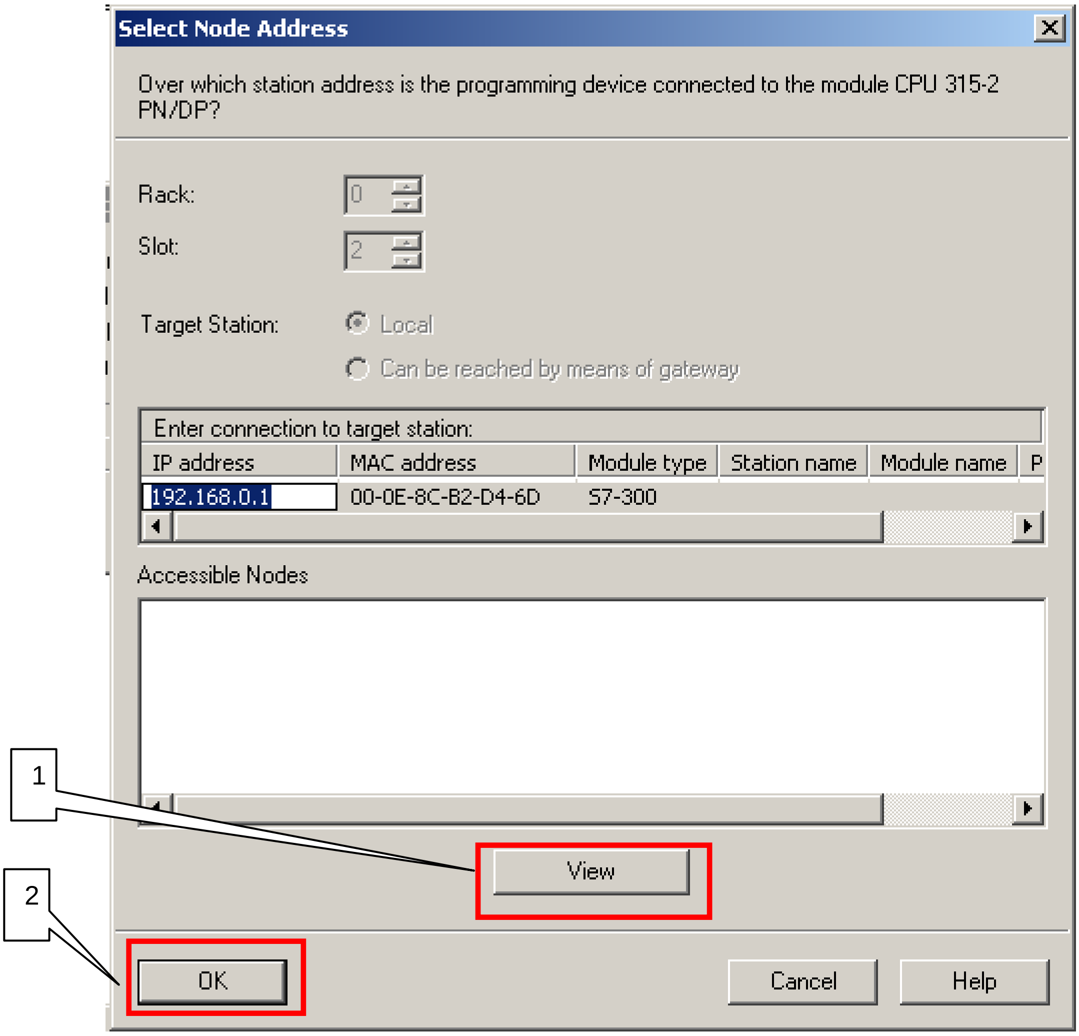


Further operations:

- (1): In the "Select Target Module" window, select the line.
- (2): Select the "OK" button.

<u>Result:</u>

Figure 5-5

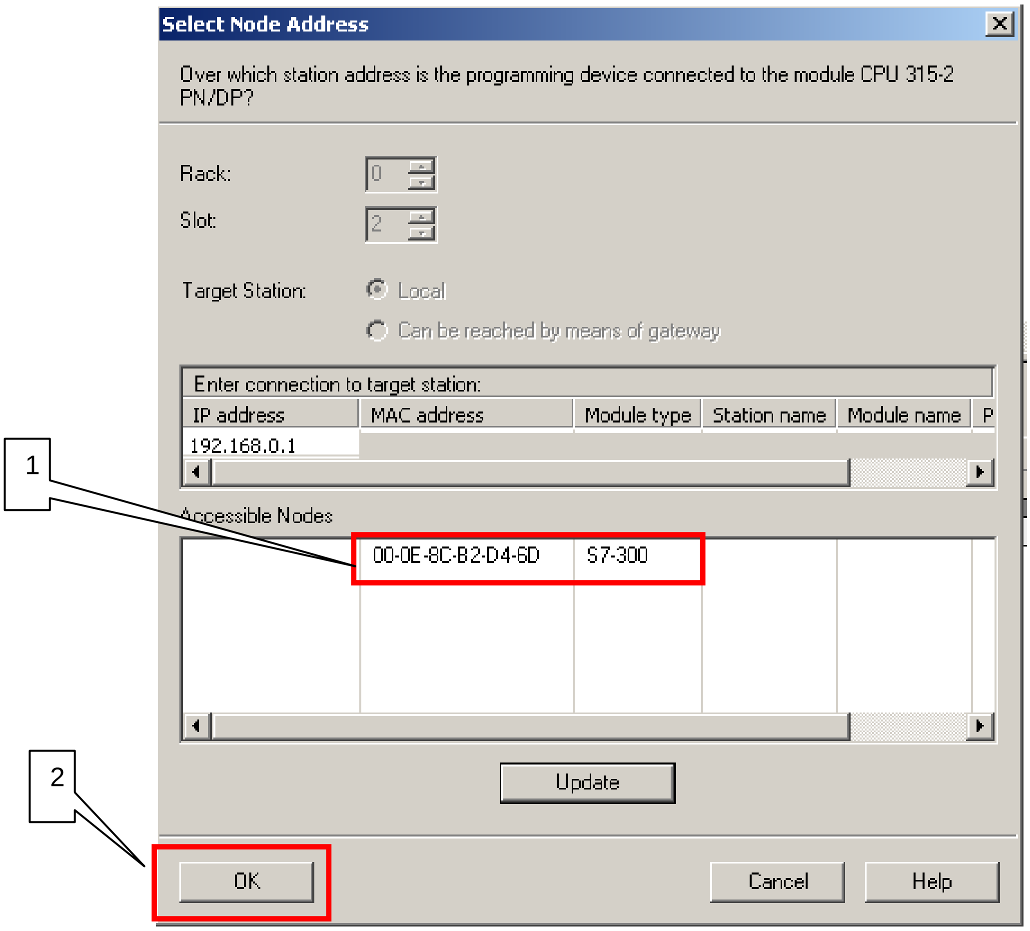


Further operations:

- (1): In the “Select Node Address” window, select the “View” button.
- (2): Select the “OK” button.

Result:

Figure 5-6

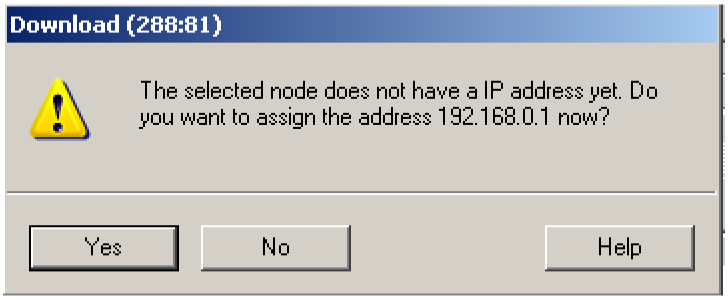


Further operations:

- (1): In the "Select Node Address" window in "Accessible nodes", select the line with "S7-300".
- (2): Select the "OK" button.

Result:

Figure 5-7



Further operations:

- In the “Download” window, select the “Yes” button.

Result:

- The download of the hardware configuration is performed.
- After the successful download, the BF LED on the CPU and IM flashes.

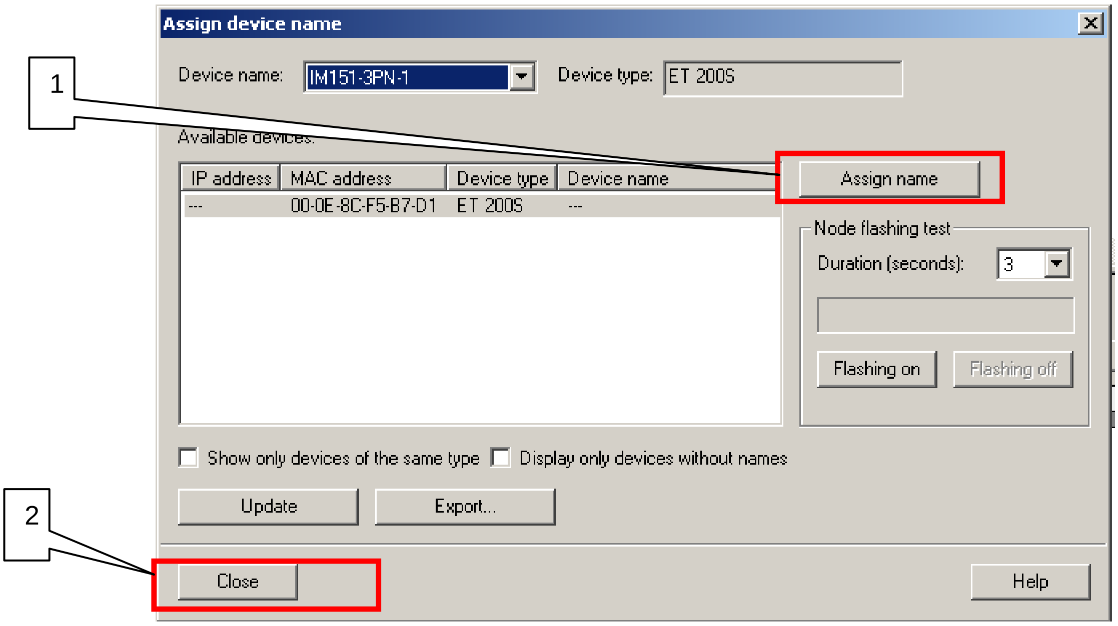
Assigning device names to the IM

The following operations are necessary:

- Open “HW Config”
- Select the PROFINET IO system
- “PLC > Ethernet > Assign device name”

Result:

Figure 5-8



Further operations:

- (1): In the “Assign device name” window, select the “Assign name” button.
- (2): Select the “Close” button.

Result:

- The BF LED of CPU and IM is off.

Control (optional)

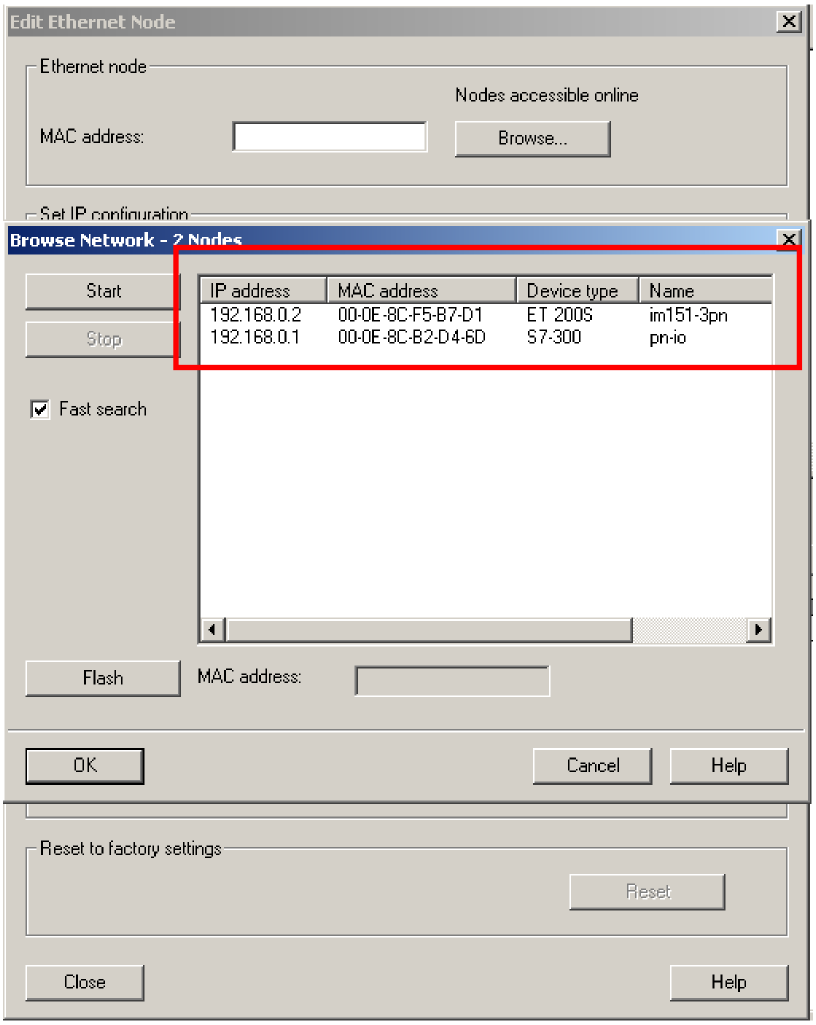
The following operations are necessary:

- Open “HW Config”
- “PLC > Ethernet > Edit Ethernet Node”
- In the “Edit Ethernet Node” window, select the “Browse” button

Result:

- If everything is correct, IP address and device names of CPU and IM will be displayed.

Figure 5-9



Downloading blocks

The following operations are necessary:

- In the SIMATIC Manager: Select the block container
- "PLC > Download"

Result:

- BF LED on CPU and IM is off
- SF LED on CPU is on
- SF LED on 2DO HF is on

Further procedure

The application is now ready for operation (hardware and software).

The following chapter describes how to operate the application.

6 Operation of the Application

Prerequisite:

- Hardware and software have been installed as described in chapter 5.

6.1 Variable table

The application can be operated and tested with the aid of the VAT_00 variable table.

Variable table

The variable table has the following structure:

Figure 6-1

	Address	Symbol	Display format
1	//select variant		
2	M 0.1	"select_v01"	BOOL
3	M 0.2	"select_v02"	BOOL
4	M 0.3	"select_v03"	BOOL
5	M 0.4	"select_v04"	BOOL
6	//step counter		
7	MW 10	"step"	HEX
8	//step enabling conditions		
9	M 100.1	"ok_1_2"	BOOL
10	M 100.2	"ok_2_3"	BOOL
11	M 100.3	"ok_3_4"	BOOL
12	M 100.4	"ok_4_5"	BOOL
13	//wait time for step 2		
14	T 1	"wait_time"	SIMATIC_TIME
15	//test outputs		
16	Q 3.0	"test_output_1"	BOOL
17	Q 3.1	"test_output_2"	BOOL
18	Q 3.2	"test_output_3"	BOOL
19	Q 3.3	"test_output_4a"	BOOL
20	Q 0.0	"test_output_4b"	BOOL
21	//feedback data		
22	DB30.DBB 4	"actual_feedback_data".realer_Slot_1	HEX
23	DB30.DBB 5	"actual_feedback_data".realer_Slot_2	HEX
24	DB30.DBB 6	"actual_feedback_data".realer_Slot_3	HEX
25	DB30.DBB 7	"actual_feedback_data".realer_Slot_4	HEX
26	// error		
27	M 103.0	"error"	BOOL
28	MB 104	"error_number"	HEX
29	DB31.DBD 0	"fault_WRREC".WRREC	HEX
30	DB32.DBD 0	"fault_RDREC".RRREC	HEX

Sections of the variable table

The variable table is divided into the following sections:

Table 6-1

Section		Purpose
1	Select variant	Selection of a variant by generating a positive edge on the respective signal (M0.x).
2	Step counter	Display of the step counter
3	Step enabling conditions	Display of the step enabling conditions
4	Wait time	Display of the wait time that elapses
5	Test outputs	Display of the test signals
6	Feedback data	Display of the feedback data record
7	Error	Display of errors

To change or select variants, only section 1 is necessary.

Chapter 6.2 describes how to activate a variant.

Sections 2 to 7 can be used for test purposes.

6.2 Activating variant 1

Prerequisite:

- The configuration of the ET 200S station matches variant 1

Opening the variable table

Operations:

- Open the VAT_00 variable table
- Select the “Monitor Variable” button

Result:

Figure 6-2

		Address	Symbol	Display format	Status value
1		//select variant			
2		M 0.1	"select_v01"	BOOL	false
3		M 0.2	"select_v02"	BOOL	false
4		M 0.3	"select_v03"	BOOL	false
5		M 0.4	"select_v04"	BOOL	false
6		//step counter			
7		MW 10	"step"	HEX	W#16#0000
8		//step enabling conditions			
9		M 100.1	"ok_1_2"	BOOL	false
10		M 100.2	"ok_2_3"	BOOL	false
11		M 100.3	"ok_3_4"	BOOL	false
12		M 100.4	"ok_4_5"	BOOL	false
13		//wait time for step 2			
14		T 1	"wait_time"	SIMATIC_TIME	S5T#0ms
15		//test outputs			
16		Q 3.0	"test_output_1"	BOOL	false
17		Q 3.1	"test_output_2"	BOOL	false
18		Q 3.2	"test_output_3"	BOOL	false
19		Q 3.3	"test_output_4a"	BOOL	false
20		Q 0.0	"test_output_4b"	BOOL	false
21		//feedback data			
22		DB30.DBB 4	"actual_feedback_data".realer_Slot_1	HEX	B#16#01
23		DB30.DBB 5	"actual_feedback_data".realer_Slot_2	HEX	B#16#01
24		DB30.DBB 6	"actual_feedback_data".realer_Slot_3	HEX	B#16#01
25		DB30.DBB 7	"actual_feedback_data".realer_Slot_4	HEX	B#16#01
26		// error			
27		M 103.0	"error"	BOOL	false
28		MB 104	"error_number"	HEX	B#16#00
29		DB31.DBD 0	"fault_WRREC".WRREC	HEX	DW#16#00000000
30		DB32.DBD 0	"fault_RDREC".RRREC	HEX	DW#16#00000000

Positive edge on the signal for variant 1

Operations:

- Modify all signals for the variants (select_v0x) to “0”
- Modify the signal for variant 1 (select_v01) to “1”

Result:

- On the ET 200S station, LED 1 on module 4 (4DO) is lit. This indicates that the program for variant 1 is active (see chapter 6.6).

Figure 6-3

VAT_00 -- @OHPN30\SIMATIC 300(1)\CPU 315-2 PN/DP\S7-Programm(1) ONLINE

	Address	Symbol	Display format	Status value	Modify value
1	//select variant				
2	M 0.1	"select_v01"	BOOL	true	true
3	M 0.2	"select_v02"	BOOL	false	
4	M 0.3	"select_v03"	BOOL	false	
5	M 0.4	"select_v04"	BOOL	false	
6	//step counter				
7	MW 10	"step"	HEX	W#16#0005	
8	//step enabling conditions				
9	M 100.1	"ok_1_2"	BOOL	true	
10	M 100.2	"ok_2_3"	BOOL	true	
11	M 100.3	"ok_3_4"	BOOL	true	
12	M 100.4	"ok_4_5"	BOOL	true	
13	//wait time for step 2				
14	T 1	"wait_time"	SIMATIC_TIME	S5T#0ms	
15	//test outputs				
16	Q 3.0	"test_output_1"	BOOL	true	
17	Q 3.1	"test_output_2"	BOOL	false	
18	Q 3.2	"test_output_3"	BOOL	false	
19	Q 3.3	"test_output_4a"	BOOL	false	
20	Q 0.0	"test_output_4b"	BOOL	false	
21	//feedback data				
22	DB30.DBB 4	"actual_feedback_data".realer_Slot_1	HEX	B#16#01	
23	DB30.DBB 5	"actual_feedback_data".realer_Slot_2	HEX	B#16#01	
24	DB30.DBB 6	"actual_feedback_data".realer_Slot_3	HEX	B#16#01	
25	DB30.DBB 7	"actual_feedback_data".realer_Slot_4	HEX	B#16#01	
26	// error				
27	M 103.0	"error"	BOOL	false	
28	MB 104	"error_number"	HEX	B#16#00	
29	DB31.DBD 0	"fault_WRREC".WRREC	HEX	DW#16#00000000	
30	DB32.DBD 0	"fault_RDREC".RRREC	HEX	DW#16#00000000	

6.3 Activating variant 2

The ET 200S station is modified.

Starting point:

- ET 200S has the configuration for variant 1
- Variant 1 is activated

Procedure for the change:

- Switch it off (power off)
- Modify the ET 200S to variant 2: Module 4 in slot 2
- Switch it on (power on)
- Call variable table VAT_00:
  - Modify all signals for the variants (select_v0x) to “0”
  - Modify the signal for variant 2 (select_v02) to “1”

Result:

- The program for variant 2 (FB program_v02) is called cyclically
- On the ET 200S station, LED 5 on module 4 (4DO) is lit. This indicates that the program for variant 2 is active (see chapter 6.6).

6.4 Activating variant 3

The ET 200S station is modified.

Starting point:

- ET 200S has the configuration for variant 2
- Variant 2 is activated

Procedure for the change:

- Switch it off (power off)
- Modify the ET 200S to variant 3:
  M3 in slot 2, M4 in slot 3, M2 in slot 4
- Switch it on (power on)
- Call variable table VAT_00:
  - Modify all signals for the variants (select_v0x) to “0”
  - Modify the signal for variant 3 (select_v03) to “1”

Result:

- The program for variant 3 (FB program_v03) is called cyclically
- On the ET 200S station, LED 2 on module 4 (4DO) is lit. This indicates that the program for variant 3 is active (see chapter 6.6).

6.5 Activating variant 4

In slot 2 of the station, the control data record for variant 4 allows either a reserve module (RM) or module 4 (M4).

First the ET 200S is set up with a reserve module, then the reserve module is replaced by module 4.

Setup with reserve module

The ET 200S station is modified.

Starting point:

- ET 200S has the configuration for variant 3
- Variant 3 is activated

Procedure for the change:

- Switch it off (power off)
- Modify the ET 200S to variant 4: RM in slot 2, M3 in slot 3
- Switch it on (power on)
- Call variable table VAT_00:
  - Modify all signals for the variants (select_v0x) to “0”
  - Modify the signal for variant 4 (select_v04) to “1”

Result:

- The program for variant 4 (FB program_v04) is called cyclically
- On the ET 200S station, LED 1 on module 3 (2DO) is lit. This indicates that the program for variant 4 is active (see chapter 6.6).

Setup with module 4

The reserve module is replaced by module 4.

Starting point:

- ET 200S has the configuration for variant 4, the reserve module is inserted
- Variant 4 is activated

Procedure for the change:

- Remove the reserve module
- Insert module 4

Result:

- The program for variant 4 (FB program_v04) is still called cyclically.
- On the ET 200S station, LED 1 on module 3 (2DO) and LED 6 on module 4 (4DO) are lit.

Note: Switching off (power off) is not necessary.

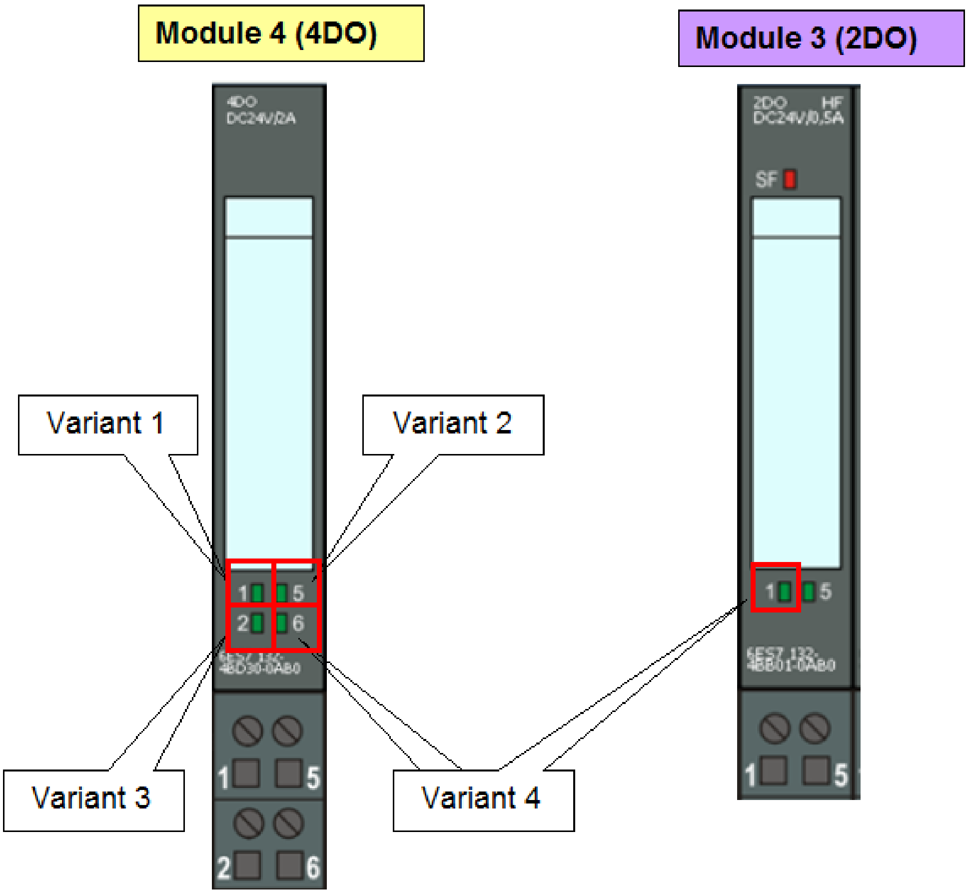
6.6 Indication of the active variant

When variant x is activated, the program for variant x is called cyclically. In the program for variant x, outputs are set in the ET 200S.

The LEDs of the ET 200S DO modules make it easy to determine which variant is active.

The figure shows the assignment of the LEDs to the variants.

Figure 6-4



7 Notes / Characteristics

This chapter includes notes and characteristics concerning configuration control (option handling) of an ET 200S on PROFINET.

Isochronous mode

In isochronous mode, the configured maximum configuration always applies for the time calculation.

Packing addresses

Configuration control (option handling) can be combined with the Pack function (grouping modules within a byte).

However, the slot order of packed modules can then not be changed.

Shared Device

For Shared Device, the configuration control (option handling) function refers exclusively to the modules of the IO controller that has subscribed to the header module.

Modules that have been assigned to another IO controller are therefore not relevant in the control data record. 1 to 1 assignment is implicitly assumed for these modules.

PROFIenergy

When configuration control (option handling) is used together with PROFIenergy, the structure of control data record 196 and data record 3 (PROFIenergy) must be consistent with regard to the slot numbers.

This means that the number of the slot in data record 3 must match the number of the real slot.

Diagnostics

Diagnostics (Report System Error) do not indicate the number of the real slot but the number of the configured slot.

The number of the real slot can be determined in the STEP 7 program by combining the configuration (STEP 7 basic project) with the contents of the control data record (contains the information on the real configuration).

Using F modules

The basic principle of configuration control (option handling) with F modules is identical to the handling with standard modules.
In addition, the mechanisms of passivation and reintegration of F modules have to be observed.

8 Glossary

Table 8-1

Abbreviation / term in the document	Meaning
Actual configuration	The feedback data describes the actual configuration
BF LED	Bus Fault LED
F modules	Failsafe modules
IM	Interface module of the ET 200 station
MMC	SIMATIC Micro Memory Card
Modules	Electronic modules of the ET 200S
PG/PC	SIMATIC programming unit / PC with STEP 7
PM	Power module for electronic modules of the ET 200S
RM	Reserve module for the ET 200S
Setpoint configuration	The control data describes the setpoint configuration
SF LED	Group Fault LED
STEP 7 basic project	STEP 7 project that covers all variants
STEP 7 project	Hardware configuration and program (user program)
STEP 7	Engineering tool for programming and configuration

9 References

Table 9-1

(*1)	Topic	Link
	Notes in the document	
/1/	SIMATIC Distributed I/O System ET 200S Operating Instructions	http://support.automation.siemens.com/WW/view/en/1144348
/2/	S7-300, CPU 31xC and CPU 31x: Installation Operating Instructions	http://support.automation.siemens.com/WW/view/en/13008499
/3/	PROFINET System Manual	http://support.automation.siemens.com/WW/view/en/19292127
/4/	Collection of applications dealing with configuration control (option handling)	http://support.automation.siemens.com/WW/view/en/29430270
/5/	SIMATIC ET 200S distributed I/O interface module IM151-3 PN (6ES7151-3AA23-0AB0) Manual	http://support.automation.siemens.com/WW/view/en/30598131
/7/	SIMATIC ET 200S distributed I/O, RESERVE module, manual	http://support.automation.siemens.com/WW/view/en/25388602
	General notes	
---	STEP 7 Online Help	---
---	Siemens I IA/DT Customer Support	http://support.automation.siemens.com
	FAQs	
---	Configuration and Diagnostics of a PROFINET IO System Application Description	http://support.automation.siemens.com/WW/view/en/22981197
---	SIMATIC PROFINET CPU 314C-2 PN/DP, 315-2 PN/DP, 317-2 PN/DP, 319-3 PN/DP: Configuring the PROFINET interface	http://support.automation.siemens.com/WW/view/en/48080216
---	SIMATIC PROFINET CPU 317-2 PN/DP: Configuring an ET 200S as PROFINET IO device	http://support.automation.siemens.com/WW/view/en/19290251
---	SIMATIC PROFINET CPU 314C-2 PN/DP, 315-2 PN/DP, 317-2 PN/DP, 319-3 PN/DP: Configuring the PROFINET interface	http://support.automation.siemens.com/WW/view/en/48080216

10 History

Table 10-1

Version	Date	Modification
V1.0	11/2011	First edition