SCE Training Curriculum
for Integrated Automation Solutions
Totally Integrated Automation (TIA)

Siemens Automation Cooperates with Education

TIA Portal Module 030-040
Extended Diagnostics and Error OBs
with SIMATIC S7-300
Suitable SCEtrainer packages for these training curriculums

**SIMATIC controllers**
- **SIMATIC S7-300 with CPU 314C-2PN/DP**
  Order no.: 6ES7314-6EH04-4AB3
- **SIMATIC S7-300 with CPU 314C-2PN/DP (upgrade)**
  Order no.: 6ES7314-6EH04-4AB4
- **SIMATIC S7-300 with CPU 315F-2PN/DP**
  Order no.: ES7315-2FH14-4AB1
- **SIMATIC ET 200S with CPU IM151-8 F PN/DP**
  Order no.: 6ES7151-8FB00-4AB1

**SIMATIC STEP 7 software for training**
- **SIMATIC STEP 7 Professional V11 - Single license**
  Order no.: 6ES7822-1CC01-4YA5
- **SIMATIC STEP 7 Professional V11 - Classroom license (up to 12 users)**
  Order no.: 6ES7822-1AA01-4YA5
- **SIMATIC STEP 7 Professional V11 - Upgrade license (up to 12 users)**
  Order no.: 6ES7822-1AA01-4YE5
- **SIMATIC STEP 7 Professional V11 - Student license (up to 20 users)**
  Order no.: 6ES7822-1AC01-4YA5

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**Additional information regarding SCE**
[siemens.com/sce](http://siemens.com/sce)

**Information regarding usage**
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1. **Preface**

The SCE_EN_030-040 module contents form part of the 'Advanced functions for PLC programming' training unit and explain how organization blocks are used for error handling in SIMATIC S7. Additional functions for error diagnostics, such as the Web server integrated in CPU 315F-2 PN/DP, are presented.

**Learning objective:**

This module describes the use of the various organization blocks with SIMATIC S7. For this purpose an error is added to the project 'DB_Lager' from the module SCE_EN_030-030_R1201__data blocks in order to illustrate the options for error handling.

A diagnostics-capable module is also used to diagnose hardware faults. The error is displayed in the integrated Web server of the CPU 315F-2 PN/DP.

- Organization blocks for error handling Notes on programming in the SIMATIC S7-300
- Error diagnostics using the TIA Portal
- System diagnostics with SIMATIC S7-300
- Integrated Web server of the CPU 315F-2 PN/DP

**Requirements:**

To successfully work through this module, the following knowledge is required:

- Basic information on PLC programming with the TIA Portal and information on block types of the S7-300 and data blocks. (for example, module SCE_EN_020-010_R1110_Startup Programming SIMATIC S7-300, Module SCE_EN_030-010_R1201__Block types with SIMATIC S7-300 and Module SCE_EN_030-030_R1201__Data blocks with SIMATIC S7-300)
Required hardware and software

1. PC Pentium 4, 1.7 GHz 1 (XP) – 2 (Vista) GB RAM, approx. 2 GB of free hard disk space
   Operating system Windows XP Professional SP3 / Windows 7 Professional / Windows 7 Enterprise / Windows 7 Ultimate / Windows 2003 Server R2 / Windows Server 2008 Premium SP1, Business SP1, Ultimate SP1
3. Ethernet connection between the PC and CPU 315F-2 PN/DP
4. SIMATIC S7-300 PLC, e.g., CPU 315F-2PN/DP with 16DI/16DO signal module. The inputs must be fed out to a control panel.
5. Digital input module 16DI with process and diagnostic error interrupt
2. Notes on programming the SIMATIC S7-300

2.1 SIMATIC S7-300 automation system

The SIMATIC S7-300 automation system is a modular microcontroller system for the low and medium performance range. A comprehensive range of modules is available to optimally adapt the system to the automation task. The S7 controller consists of a power supply, a CPU, and input and output modules for digital and analog signals. If necessary, communication processors and function modules are also used for special tasks such as stepper motor control.

The programmable logic controller (PLC) uses the S7 program to monitor and control a machine or a process. The S7 program scans the I/O modules via input addresses (%I) and addresses their output addresses (%Q).

The system is programmed with the STEP 7 software.

2.2 STEP 7 Professional V11 (TIA Portal V11) programming software

The STEP 7 Professional V11 (TIA Portal V11) software is the programming tool for the following automation systems:
- SIMATIC S7-1200
- SIMATIC S7-300
- SIMATIC S7-400
- SIMATIC WinAC

STEP 7 Professional V11 provides the following functions for plant automation:
- Configuration and parameter assignment of the hardware
- Specification of the communication
- Programming
- Testing, commissioning, and servicing with operational/diagnostic functions
- Documentation
- Creation of visualizations for SIMATIC Basic Panels using the integrated WinCC Basic software.
- Visualization solutions for PCs and other panels can also be created with other WinCC software packages

Support is provided for all functions in a comprehensive online help system.
3. Error organization blocks with SIMATIC S7-300

In the SIMATIC S7-300 CPUs there are error organization block that can be called when an error occurs. If this block is not available in the CPU, it goes to STOP.

OB 81 for power supply errors is an exception.

Calls of error organization blocks are also displayed in the diagnostics buffer of the CPU.

The errors are divided into two error classes:

**Synchronous errors**

A synchronous error is generated by the CPU operating system if an error occurs that is directly related to the program processing. Synchronous errors are divided into programming error and access errors. If a synchronous error occurs the operating system calls the associated error organization block.

**Asynchronous errors**

Asynchronous errors are errors that can occur independently of the program processing. If an asynchronous error occurs the operating system calls the associated error organization block.

3.1 Synchronous errors

Synchronous errors are determined directly during the processing of an instruction. If, for example, access to a DB2 data block is programmed in the program and if the block is not available in the CPU, a synchronous error has occurred.

With such a programming error, the organization block **OB121** is called; if this is not available the CPU goes to STOP and the red SF LED (group error) lights up.

An access error is triggered by a direct access to a defect or non-available module.

This happens, for example, if a faulty address is programmed for the access to an analog input is programmed via peripheral input and outputs (see module SCE_EN_030-050_R1201_Analog value processing with SIMATIC S7-300) an incorrect address is programmed.

The operating system calls OB 122 when there is an access error; if this OB is not available the CPU goes to STOP.
3.2 Asynchronous errors

Asynchronous errors cannot be assigned to any specific program position as these are triggered by failures and faults in the hardware used. In other words, they occur asynchronously to the program processing.

Examples of asynchronous errors are:

<table>
<thead>
<tr>
<th>Type of error:</th>
<th>Examples:</th>
<th>Error OB:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time error</td>
<td>Exceeding the max. cycle time</td>
<td>OB 80</td>
</tr>
<tr>
<td>Diagnostic error interrupt</td>
<td>Wire break at input of a diagnostics capable module</td>
<td>OB 82</td>
</tr>
<tr>
<td>Remove/insert interrupt</td>
<td>Remove/insert a module</td>
<td>OB 83</td>
</tr>
<tr>
<td>Program execution error</td>
<td>Error when the operating system accesses a block</td>
<td>OB 85</td>
</tr>
<tr>
<td>Rack failure (S7-400 only)</td>
<td>Failure of a DP master system or a station with distributed I/O modules (PROFIBUS DP or PROFINET IO) or the rack with the S7-400.</td>
<td>OB 86</td>
</tr>
<tr>
<td>Communications errors</td>
<td>Wrong frame identification</td>
<td>OB 87</td>
</tr>
</tbody>
</table>

Note: Additional information regarding asynchronous errors is available in the online help of the TIA Portal.
4. Examples of OB121 synchronous errors (programming errors)

For our example we will build a programming error into the project ‘DB_Lager’ from module SCE_EN_030-030_R1201_Data blocks with SIMATIC S7-300 in OB1.

In the following section a project is to be opened for SIMATIC S7-300, the project is to be stored under a different name and adapted to the new requirements:

1. The central tool is the ‘Totally Integrated Automation Portal’, which is opened here with a double-click. (→ Totally Integrated Automation Portal V1)

2. Open the ‘DB_Store’ project from the SCE_EN_030_030 module in the portal view as a template for this program. (→ Open existing project → DB_Store → Open)
3. ‘First steps’ for configuring are now suggested. We want to ‘Open the project view’. (→ Open the project view)

4. Start by saving the project under a different name. (→ Project → Save as)
5. 'Save' the project under the new name 'DB_Store_Diagnostics'.
   (→ DB_Store_Diagnostics → Save)

6. To make the changes, double-click the 'Main [OB1]' block to open it. (→ Main [OB1])
7. To simulate a programming error, change the configuration of the IN tag `assignment_lp1` to `DB2.DBW0`. This causes an access to a data block that does not exist in the CPU 315F-2 PN/DP. (→ assignment_lp1 → DB2.DBW0)
8. To load your entire program to the CPU, first select the 'PLC_1 [CPU 315F-2 PN/DP]' folder and then click the Download to device icon. (→ PLC_1 [CPU 315F-2 PN/DP] → )
9. If you forgot to specify the PG/PC interface beforehand, a window appears where it can be specified. (→ PG/PC interface for loading → Load)

### Extended download to device

**configured access nodes of "PLC_1"**

<table>
<thead>
<tr>
<th>Device</th>
<th>Device type</th>
<th>Type</th>
<th>Address</th>
<th>Subnet</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLC_1</td>
<td>CPU 315F-2 PN/DP</td>
<td>PPIE</td>
<td>192.168.0.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CPU 315F-2 PN/DP</td>
<td>MPI</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

**Type of the PG/PC interface**
- [ ] PPIE
- [ ] RS232C
- [ ] Ethernet

**Connect to subnet**
- [ ] Local PPIE
- [ ] Remote PPIE

**1st gateway**

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### Accessible devices in target subnet

<table>
<thead>
<tr>
<th>Device</th>
<th>Device type</th>
<th>Type</th>
<th>Address</th>
<th>Target device</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLC_1</td>
<td>CPU 315F-2 PN/DP</td>
<td>PPIE</td>
<td>192.168.0.1</td>
<td>PLC_1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Access address</td>
<td></td>
</tr>
</tbody>
</table>

Online status information:
- [ ] Connected to address 192.168.0.1
- [ ] Scanning ended.
10. Then, click 'Load' again. The status of the load operation will be displayed in a window. (→ Load)

11. The successful load result is now displayed in a window. Now click 'Finish'. This will also restart the CPU. (→ Finish)
12. By clicking the icon, you can connect the TIA Portal with the CPU for the diagnostics views. (→ Go online)
13. Under 'Online & Diagnostics' you can now view the alarm associated with the error event in the 'Diagnostics buffer'. The event with the number 1 is a consequence of the actual error 'DB not loaded' under no. 2. Here you can also see which organization block is requested by this event.

(→ PLC_1 [CPU 315F-2 PN/DP] → Online & Diagnostics → Diagnostics → Diagnostics buffer)

**Note:** The CPU goes to STOP here, as the requested program error OB121 is not available in the CPU.
14. We will now create the corresponding OB121 to prevent our CPU from going to STOP when our error occurs. (→ PLC_1 [CPU 315F-2 PN/DP] → Program blocks → Add new block → Organization block → Fault interrupts → PROG_ERR [OB 121] → FBD → OK)
15. All details about the call event are available in the temporary tags within the block **PROG_ERR [OB 121]**. If necessary, you can react here depending on the various errors in the program. We now load [Icon: Insert Image] this empty organization block **PROG_ERR [OB 121]** into the controller.

(→ **PROG_ERR [OB 121]** [Icon: Insert Image])

16. Then, click 'Load' again. The status of the load operation will be displayed in a window.

(→ Load)
17. The successful load result is now displayed in a window. Now click 'Finish'. This will also restart the CPU. (→ Finish)

18. Now, despite the error, the CPU does not go to STOP. However, two entries are written to the 'Diagnostics buffer' during each processing cycle, as DB2 is missing and there is therefore also no access to the data word 0 in this DB. The diagnostics LED SF is still lit up red.  
(→ PLC_1 [CPU 315F-2 PN/DP] → Online & Diagnostics → Diagnostics → Diagnostics buffer)
5. Configuring Web server and system diagnostics for the CPU 315F-2 PN/DP

The system diagnostics function in the hardware configuration of the CPU can be used to create the fault organization blocks to the asynchronous errors and to automatically generate error messages to the hardware faults.

These messages can be viewed conveniently in the Web server along with other information using the integrated Web server of the CPU 315F-2 PN/DP.

In the following section the system diagnostics will be activated for the CPU 315F-2 PN/DP and the Web browser created:

1. First we want to create a 'WatchTable_Store', in order to view this as well in the Web browser later. For more information on the watch and force tables, refer to the module SCE_EN_020_060. (PLC_1 [CPU 315F-2 PN/DP] → Watch and force tables → WatchTable_Store → "DB_StoreAssignment.LP1" → ... → "DB_StoreAssignment.LP8")
2. We open the 'Device configuration' and activate the 'Web server' there in the properties of the CPU 315F-2 PN/DP. (PLC_1 [CPU 315F-2 PN/DP] → Device configuration → PLC_1 [CPU 315F-2 PN/DP] → Properties → General → Web server → Activate Web server on this module)

3. It is generally true that remote access to a PLC represents a security risk. Take this into consideration in your network structure; for example, set a firewall to ensure that only authorized persons have access and then confirm the security prompt. (→ OK)
4. Then activate system diagnostics. The information from the system diagnostics can also be displayed in the Web server. (→ Yes)

5. Numerous properties have to be set for the Web server. Here we activate the 'automatic update' and 'English' as language for the Web server. English is then also assigned as 'Project language'. (→ Automatic update → ☑ Activate → Languages → ☑ English → Project language: English)
6. In the item 'Watch tables' we enter our previously created 'WatchTable_Store'. (→ Watch tables → WatchTable_Store → ☑)

![Watch tables screenshot](image)

7. We leave the defaults in place in the details to the properties of the 'System diagnostics'. We compile the changes in our station 'PLC_1Conveyor [CPU 315F-2 PZN/DP]'. We can see the created OBs in the Program blocks folder.

(Scene diagnostics → PLC_1Conveyor [CPU 315F-2 PN/DP] → Compile → Program blocks)

![Program blocks screenshot](image)
8. To be able to simulate hardware faults in our station, we enter an additional signal module 'DI16 x DC24V, Alarm', which supports hardware and diagnostic error interrupts, in the 'Device configuration'. (→ PLC_1 [CPU 315F-2 PN/DP] → Device configuration → DI → DI16 x DC24V, Interrupt → 6ES7 321-7BH01-0AB0)

Note: With this module, we can very simply simulate a hardware error by removing the 24V power supply.
9. In the activities of this module 'DI16 x DC24V, Alarm' we activate the option 'Diagnostic error interrupt'. To load your entire program to the CPU now, first select the 'PLC_1 [CPU 315F-2 PN/DP]' folder and then click the Download to device icon. (→ DI16 x DC24V, Interrupt → Properties → Inputs → Diagnostic error interrupt → PLC_1 [CPU 315F-2 PN/DP] → Download)

10. Then, click 'Load' again. The status of the load operation will be displayed in a window. (→ Load)
11. The successful load result is now displayed in a window. Now click 'Finish'. This will also restart the CPU. (\rightarrow Finish)
6. **Diagnostics for the CPU 315F-2 PN/DP via the Web**

Information can be conveniently displayed with the integrated Web server of the CPU 315F-2 PN/DP. Many websites are created solely through the activation of the Web server. Users can also create customized contents with any HTML editor.

In the following section you will learn how to access the standard pages of the CPU 315F-2 PN/DP via the Web.

1. To be able to access the Web server of the CPU 315F-2 PN/DP we open any Web browser on a PC that is connected via TCP/IP with the CPU.

2. There we enter the IP address of the CPU315F-2 PN/DP, (→ 192.168.0.1)
3. First, select the language on the displayed Web page, then ENTER'. (→ English → ENTER)

4. On the 'Home page' we get general information on the PLC and its status. (→ Home page)
5. Hardware, firmware version and serial numbers are displayed beside other information at 'Identification'. (→ Identification)

6. At 'Diagnostics buffer' you obtain reliable information on all events in the CPU. Event messages are registered in a cyclic buffer. The most recent alarm is displayed in the top line. (→ Diagnostics buffer)

Note: Here we see our cyclically occurring programming error in the OB1.
7. The status of the individual modules of our SIMATIC S7-300 is displayed with additional details in the 'Module status' view. (→ Module status)

8. The alarm texts generated in the CPU 315F-2 PN/DP are available in 'Alarms'.

(→ Alarms)

Note: Here we see the failure of the power supply on the digital input module 16DI with activated diagnostic error interrupt. This alarm only appears if the hardware configuration of the CPU 315F-2 PN/DP was activated in system diagnostics.
9. Details about communications settings and communications errors are displayed in 'Communication'. (→ Communication)

10. Devices that are connected to the individual ports of the CPU 315F-2 PN/DP and the addresses of these devices can be displayed under 'Topology'. There are various views for this. In the case of larger network structures the entire network structure of a plant can be displayed and faulty connections shown in the status provided this function is supported by the individual components. (→ Topology → Graphic view)
11. Values of the individuals tags can be displayed under 'Tag status'.
   (→ Tag status)

12. 'Tag tables' such as the 'WatchTable_Store', which are linked with the Web server, can also be displayed. Individually created pages to visualize and also to operate processes can be viewed under 'User pages'. (→ Tag tables → WatchTable_Store)