Getting started with SINAMICS V90 PN on S7-1500 Motion Control

Introduction

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Configure the axis

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This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent
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symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are
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**WARNING**
indicates that death or severe personal injury may result if proper precautions are not taken.

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indicates that minor personal injury can result if proper precautions are not taken.

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described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the
information in this publication is reviewed regularly and any necessary corrections are included in subsequent
editions.
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Fundamental safety instructions

1.1 General safety instructions

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<tr>
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</tr>
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<tbody>
<tr>
<td>Danger to life if the safety instructions and residual risks are not observed</td>
</tr>
<tr>
<td>The non-observance of the safety instructions and residual risks stated in the associated hardware documentation can result in accidents with severe injuries or death.</td>
</tr>
<tr>
<td>• Observe the safety instructions given in the hardware documentation.</td>
</tr>
<tr>
<td>• Consider the residual risks for the risk evaluation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WARNING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Danger to life caused by machine malfunctions caused by incorrect or changed parameterization</td>
</tr>
<tr>
<td>Incorrect or changed parameterization can cause malfunctions on machines that can result in injuries or death.</td>
</tr>
<tr>
<td>• Protect the parameterization (parameter assignments) against unauthorized access.</td>
</tr>
<tr>
<td>• Respond to possible malfunctions by applying suitable measures (e.g. EMERGENCY STOP or EMERGENCY OFF).</td>
</tr>
</tbody>
</table>
1.2 Industrial security

**Note**

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**WARNING**

Danger as a result of unsafe operating states resulting from software manipulation

Software manipulation (e.g. by viruses, Trojan horses, malware, worms) can cause unsafe operating states to develop in your installation which can lead to death, severe injuries and/or material damage.

- Keep the software up to date.
  - Information and newsletters can be found at: http://support.automation.siemens.com
- Incorporate the automation and drive components into a state-of-the-art, integrated industrial security concept for the installation or machine.
  - For more detailed information, go to: http://www.siemens.com/industrialsecurity
- Make sure that you include all installed products into the integrated industrial security concept.
1.3 Danger to life due to software manipulation when using removable storage media

**WARNING**

**Danger to life due to software manipulation when using removable storage media**

The storage of files on removable storage media involves a high risk of infection, e.g. via viruses or malware. Incorrect parameter assignment can cause machines to malfunction, which can lead to injuries or death.

- Protect the files on removable storage media against harmful software through appropriate protective measures, e.g. virus scanners.
Introduction

2.1 Drive system - Overview

This document describes the engineering of a SINAMICS V90 PN integrated in the TIA Portal. This engineering can be installed later with the HSP 0185 hardware support package. SINAMICS V90 PN with this engineering can be operated only on a technology object (TO) for the Axis type of a SIMATIC S7-1500 and must be interconnected with this via PROFINET.

Configuration and parameter assignment

The TIA Portal is available for the configuration and parameter assignment of the SINAMICS V90 PN drive system.

With the TIA Portal and SINAMICS V90 PN, you can perform the following tasks, for example:

- Create a project.
- Add the drive system to the project and interconnect it with a higher-level controller.
- Configure the drives (selection of the variants).
- Create a technology object.
- Go online on the drive and test the parameter assignment via the axis control panel.
- Perform diagnostics when an error occurs.

User interface

The graphic user interface provides support during the configuration and parameter assignment:

- Select the drive in the hardware catalog.
- In the "Network view", interconnect the drive with a higher-level controller and assign parameters for the communication via PROFINET.
- In online mode, test the drive with the drive control panel and load the parameter assignment to the drive.
Further information at a glance

**Getting Started**
- SINAMICS V90 PROFINET, SIMOTICS S-1FL6 Getting Started

**Device documentation**
- SINAMICS V90 PN / SIMOTICS S-1FL6 operating instructions

2.2 "Getting started" objectives

"Getting Started" provides an introduction to configuring SINAMICS V90 PN in conjunction with a technology object Axis of a SIMATIC S7-1500 in the TIA Portal Engineering System. You create a simple sample project by performing the typical optimization and configuration steps for the device, drive and axis configuring. You become acquainted with the most important tools that the TIA Portal provides for the configuring, commissioning and diagnostics of the SINAMICS V90 PN.

2.3 Sample project

Create a simple sample project based on "Getting Started".

Configuration steps

**Preparing the configuration**
- If necessary, restore the factory settings [Page 12] for the devices.
- You configure the interface for the network communications [Page 25] of the PG/PC with SINAMICS V90 PN and SIMATIC S7-1500.

**Creating a project, configuring the devices and the network communications with the PG/PC**
- Create a project [Page 13].
- Create SINAMICS V90 PN and SIMATIC S7-1500 [Page 15] and define the communications between the PG/PC and devices [Page 16].

**Configuring SIMATIC S7-1500 and the technology object Positioning axis**
- Configure a SIMATIC S7-1500 controller [Page 19].
- Define an axis [Page 25].
- Interconnect the axis with the drive [Page 25].
Commissioning and optimizing a drive

- Commission the drive and perform the optimization (Page 21).
- Test the axis with the axis control panel (Page 31).

Figure 2-1  SINAMICS V90 PN on S7-1500 Motion Control
Prepare the configuration

3.1 Requirements

Device requirements

You require the following components to create the sample project:

- SINAMICS V90 PN with a 1FL6 motor
- SIMATIC S7-1500
- PG/PC with free Ethernet interface
- TIA Portal Engineering System as of V14 with the associated HSP 0185 (SINAMICS V90 PN)

Preparing the system

Your system is prepared for configuring with the TIA Portal:

- The hardware is preassembled and wired.
- The latest firmware of the V90 PN is available.
- PG/PC is connected directly with the PROFINET interface of the controller (S7-1500) via the Ethernet line.
- TIA Portal (at least V14) is installed on the PG/PC.
- HSP 0185 (SINAMICS V90 PN) is installed on the PG/PC.
- The TIA Portal is open. The portal view is open on the PG/PC screen.
3.2 Restoring factory settings

The reset to the factory settings is not normally necessary. If the current settings of the drive are not known or the settings cause errors that can no longer be reproduced, you can restore the factory settings of the drive. You so restore the default parameters.

If required you can restore the factory settings of the drive with "Online & diagnostics" > "Save/reset".

The following parameters are not affected by the factory settings:

- p8920[0...239] PN: Name of station
- p8921[0...3] PN: IP address of station
- p8922[0...3] PN: Default gateway of station
- p8923[0...3] PN: Subnet mask of station

If necessary, also reset these interface parameters to the factory settings via "Online & Diagnostics" > "Functions" > "Reset interface parameters".

3.3 Result of the preparations

- The devices are prepared and the requirements have been checked.
- If necessary, the devices are reset to the factory settings.
- The requirements for online communication are satisfied.
Create a project

4.1 Overview

In this "Getting started" section, you create the "Sample_1" sample project in the TIA Portal. All of the subsequent configuring steps refer to this sample project.

4.2 Create new project

After opening the TIA Portal, you find yourself in the portal view. The portal view offers a task-oriented view of the tools, and provides the basic functions for the individual task areas.
To create a new project

You begin a new configuring by creating a new project in the TIA Portal.

1. Select "Start" > "Create new project" in the portal view navigation. The "Create new project" dialog opens.

2. Enter the project name at "Project name", e.g. "Sample_1".

3. Enter the project location at "Path". The default path is already set.

4. Confirm with "Create". Your project is now created.

4.3 Result in the sample project

The sample project is created in the TIA Portal. You find yourself in the portal view of the TIA Portal.
5 Creating devices

5.1 Adding devices from the hardware catalog

To add devices directly from the hardware catalog:

1. Open the project view of the TIA Portal by clicking the “Open project view” button and double-click “Devices and networks” in the Project Navigator.

   The network view opens. The hardware catalog appears on the right-hand side.

2. Select an appropriate controller (S7-1500) from “Controller” > “CPU” in the hardware catalog and drag it with drag-and-drop to the network view.

3. Select an appropriate SINAMICS V90 PN from “SINAMICS drives” in the hardware catalog and drag it with drag-and-drop to the network view.

   Result

   Both devices are now in the network view.

Cyclic data exchange

Telegram 105 will be added automatically when the drive is created. If necessary, you can select a different telegram from “Properties” > “General” > "Cyclic data exchange”.

Configuring the hardware interface (Page 25) describes how you use the telegram. The cyclic data exchange has not yet been parameterized at this time. This is set automatically after creating a positioning axis / synchronous axis and assigning the drive for the axis. The sequence with which you add devices does not matter.

Motor selection

The creation of the drive specifies the motor selection as the default setting. Further information is available at Setting parameters.
5.2 Connecting devices

After adding the drive, it must first be assigned to an IO Controller or to a PLC. This automatically makes the assignment to an appropriate subnet.

Provided no subnet has been assigned the drive, it will be displayed as "not assigned device" in the Project Navigator (PNV). The nodes of a subnet form a PROFINET IO system. To synchronize the PROFINET IO devices, a sync domain is also required. The sync domain assures that all nodes are synchronized. The creation of the subnet creates a new sync domain.

- Assign the drive to the controller. Click the "Not assigned" link in the network view and select an interface (PLC_1.PROFINET-interface_1) to which you assign the drive.

![Assigning a drive](image1)

**Result**

After assigning the drive, a sync domain and a PROFINET IO system are created automatically.

![The drive is assigned](image2)
Automatic generation of the IP addresses

The default IP address device setting is 0.0.0.0. When creating a device in the TIA Portal, a new IP address is generated by the TIA Portal and the appropriate subnet mask set. You can see this in the "General" > "Ethernet addresses" tab.

Both the controller and the drive receive the same IP addresses (e.g. 192.168.0.1) and subnet mask (255.255.255.0). This means no communication is possible.

Because the IP addresses are adapted automatically when connecting the devices in the network view or assigning the drive to the controller, a valid combination is set automatically. The drive receives a new IP address, e.g. 192.168.0.2.
5.3 Operate devices in isochronous mode

Use the isochronous PROFINET interface X150 on the V90 PN and the PROFINET interface X1 on the controller. Switch to the topology view and connect the appropriate interface ports on the drive with the interface on the controller per drag-and-drop.

5.4 Result in the sample project

The devices have been created. The Ethernet addresses have been defined and the topology configured. The drive is stored in the "Not grouped devices" folder in the Project Navigator.
6.1 Overview

The following step of the example concerns both the optimization of the drive in conjunction with an S7-1500 controller and also with a drive not assigned to any controller.

6.2 Connect online

The drive is connected with the controller

If the drive is connected with the controller via isochronous interfaces, it goes into cyclic operation automatically in accordance with the wiring and configuration.

Establish an online connection:

1. Select the drive in the Project Navigator.
2. To do this, click the Go online button.
3. Enter the PG/PC interface type and the PG/PC interface in the "Connect online" window.
4. Select "PN/IE_1" from "Connection with interface/subnet".
5. Click "Start search".
6.3 Checking drive configuration

In online mode, check the drive settings, especially the settings for motor and encoder type.

1. In the drive settings, open the dialog "Parameter" > "Motor and encoder".
2. Make the settings for your deployed motor under "Motor".
3. If necessary, modify additional parameters, e.g. Basic settings or Brake control.
4. Load the configuration to the device.

**Note**

The drive configuration has to be checked before starting or optimizing the drive.
6.4 Performing an optimization

Optimize the drive by performing a turning measurement with coupled load. The appropriate procedure is described in the following section.

The "Optimization" window is opened from "Drive" > "Commissioning" > "Control panel / optimization" in the Project Navigator; select the second tab at the top right.

1. First fetch master control.

2. Configure the settings and, if necessary, the extended settings.
   - Set the maximum motion angle for each direction manually (phase 2 of the measurement). We recommend that you enter 360 degrees manually.

   **Note**
   When setting the maximum motion angle, consider how the axis should move with coupled load.

3. Click the "Start optimization" button.
   - The turning measurement is performed.

4. Return the master control after the successful optimization.

5. Load the data to the drive to save the settings permanently.

---

**WARNING**

Danger for persons and machinery caused by a turning motor.

The motor must be able to turn freely by +/-720 degrees for incremental encoders.
6.5 Loading the optimized data from the device

Result of the optimization

After performing the optimization, the new and old values are displayed as follows. The new values are transferred automatically unless you reset them to their original values by clicking the button at the bottom in the screen. After checking the values, the data still needs to be loaded from the device [Page 23].
6.5 Loading the optimized data from the device

After the optimization, the optimized values are located in the volatile memory on the device. You can change the online value directly and then copy it to the drive. The actual value can also be changed for directly editable parameters. The change is transferred directly to the drive.

6.6 Saving data in the drive

The online values are located in the volatile work memory of the drive whose content is lost when switched off. To store the values permanently in the drive, copy the data from memory card to the drive.

**Note**

The "Save data in the drive" function saves not only the values changed by the optimization, but also all values in the drive.

To do this, navigate to:
- "Commissioning" > "Optimization"
- Save the data.
- Then save the project.

![Save data in the drive](image)

Figure 6-4 Copying RAM to ROM

The same function can be called from "Online & Diagnostics" > "Save/Reset" > "Save data in the drive".

6.7 Result in the sample project

You have created and optimized a drive. The data that results from the optimization is saved in the drive and in the project.
Configure the axis

7.1 Overview

This section describes how you create and configure a positioning axis in the project, and interconnect it with the SINAMICS V90 PN drive.

Requirement

You have created the drive as described in the Creating devices (Page 15) section.

7.2 Technology object axis

Technology objects (TOs) represent the associated real objects (e.g. a positioning axis) in the controller.

The technology object Positioning axis / Synchronous axis provides a technological view of the drive and the encoder (actuator and sensor), provides technological functions for them and contains the concrete hardware interconnection.

The technology object Positioning axis / Synchronous axis contains extensive functionality, e.g. communication with the drive, actual value processing, position control, and positioning functionality. It executes control and motion commands and indicates states and actual values.

Technological limitations and values for the mechanical system for the axis and encoder are set on the axis. You can then work exclusively with technological variables.
7.3 Creating an axis

Create the "PositioningAxis_1" axis for the sample project. Assign a drive to the axis.

How to create an axis in the project

1. Open the Controller folder in the Project Navigator and select "Technology objects".
2. Double-click "Add new object". The "Add new object" dialog opens.
3. Select from "Motion Control" a "TO_PositioningAxis" positioning axis.
4. Enter a name for the axis. Use the designation "PositioningAxis_1" for the axis of the sample project.
5. Leave the other preset values to their default values.
6. Click "OK".

The "Basic parameters" window opens in the function view.

See also

Configuring and optimizing a SINAMICS V90 PN (Page 19)

7.4 Configuring the hardware interface

To complete the configuration of the axis, you must assign a drive to it. The red icon in the configuration of the axis indicates that no assignment to the drive has been made (see figure).

Figure 7-1 The hardware interface is incomplete.
Icons in the area navigation

Icons in the area navigation of the configuration show additional details about the status of the configuration:

<table>
<thead>
<tr>
<th>Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔️</td>
<td>The configuration contains preset values and is complete. The configuration contains only preset values. With these preset values you can use the technology object without additional changes.</td>
</tr>
<tr>
<td>✔️</td>
<td>The configuration contains user-defined or automatically adapted values and is complete. All input fields of the configuration contain valid values and at least one preset value has been changed.</td>
</tr>
<tr>
<td>❌</td>
<td>The configuration is incorrect. At least one input field or drop-down list contains an invalid value. The corresponding field or the drop-down list is displayed on a red background. Clicking the field shows the roll-out error message that indicates the cause of error.</td>
</tr>
</tbody>
</table>

Assigning a drive

- Open the "Hardware interface". The "Drive" window opens:

- Assign the drive as follows:
  Select the drive.

Setting the encoder type

The encoder type is not compared with the data adaptation. Configure the encoder type (incremental, absolute or cyclic absolute) in the "Encoder" configuration window.
Data exchange between the drive and controller

Data is exchanged between the drive and controller for the data adaptation. The data adaptation on the axis is selected with HSP by default when a V90 PN is used. During the data adaptation, the reference values and motor/encoder data are compared with the drive/encoder parameterization required for the data exchange. The "Automatic transfer of the drive parameters" and "Automatic transfer of the encoder parameters" settings to the TO Axis are set only when they are connected with the drive in the offline project. The setting for the drive (actuator) or encoder can be activated or deactivated independently of each other.
Which data is adapted?

All actuator and encoder data that must be set identical in the technology object Axis to the associated data in the drive is adapted:

- Actuator data on the TO Axis: "Reference speed", "Reference torque", "Maximum speed"
- Encoder data on the TO Axis: "Increments per revolution", "Number of revolutions", "Fine resolution Xact1", "Fine resolution Xact2"

The following is always performed for activated adaptation:

- For each TO Power up (after controller power up or loading the TO to the controller).
- For each restoration after drive failure, namely always after a station restoration of the drive that belongs to the associated technology object.
- For each restart of a technology object.

After a successful adaptation

After a successful adaptation, the actual values of the adapted data are overwritten in the associated TO-DB. The adapted data, however, is not stored automatically on the memory card of the drive and also not transferred as initial values in an offline project.

If the adapted data should not be stored permanently, the following two possibilities are available:

- **Save the adapted data in the offline project and the subsequent download**: If the adapted data should be saved in the offline project, TIA Portal functions can be used: Call the "Snapshot of the actual values" function to store the actual values of the associated TO-DB as snapshot in the offline project, then call the "Copy the momentary values to the initial values" function to transfer them to the initial values of the associated TO-DB in the offline project and finally load the TO-DB stored in the offline project to the CPU.
- **Save the adapted data on the memory card**: Call the SFC "WRIT_DBL" in the user program to save the actual values of the adapted data on the memory card.
Setting the position control

Ensure that position control in the drive (DSC enabled) is set. Dynamic Servo Control (DSC) depends on the deployed drive telegram. The setting acts only after the telegram selection (5, 6, 105 or 106). Use "Position control on the PLC" for all other telegrams.

Result

The drive is assigned and the configuration is complete.

7.5 Result in the sample project

The technology object Axis is fully configured.
Going online with devices

Load the sample project with the axis configuration to the controller so that the function of the axis can be tested with the axis control panel in the next step.

Load the project

1. Save the project
2. Compile the project
3. Select the controller in the Project Navigation.
4. Load the project to the device.

The "Going online" dialog opens:

![Figure 8-1 Connect online](image)

Going online

To permit an online connection, your PG/PC and the controller must be in the same subnet. The TIA Portal supports you if your PG/PC does not have any appropriate settings by setting them automatically.

1. Select the appropriate PG/PC interface type and the PG/PC interface. In the example, PN/IE and Intel(R) Gigabit Network Connection (the name of the network card).
2. Select the appropriate interface on the controller.
3. Search for accessible network nodes.
4. Connect with the appropriate node (appropriate S7-1500 controller).
Test the axis with the axis control panel

9.1 Overview

In this "Getting Started" section, you test the configured axis. TIA Portal provides the axis control panel for this purpose.

Requirements

- The devices have been created and configured, see Section Creating devices on Page 15.
- You have configured the motor in the drive, see Configuring and optimizing a SINAMICS V90 PN on Page 19.
- The drive configuration is loaded to the device, see Configuring and optimizing a SINAMICS V90 PN on Page 19.
- Motor, encoder and motor holding brake are connected to the drive.
- The drive is supplied with power, 24 V and 230/400 V.
- The ports of the PROFINET interfaces are wired in accordance with the port interconnection.
- The STO must be connected correctly.
- An axis in the sample project has been created and configured, see Section Configure the axis on Page 24.
- The project with the axis configuring is loaded to the target system.
- The axis is not switched on via a motion command (MC_Power).

Note

Further information concerning the requirements

Further information for the V90 PN is available in the SINAMICS V90, SIMOTICS S-1FL6 operating instructions.

Further information concerning technology objects and motion topics is available in the online help for the TIA Portal at "Deploying technology functions" > "Motion control".
9.2 Working with the axis control panel

You traverse individual axes with the axis control panel. A user program is not necessary for the operation of the axis control panel. With the axis control panel, you take over master control for a technology object and control the axis motions.

⚠️ **WARNING**

**Uncontrolled axis motions**

During operation with the axis control panel, the axis can execute uncontrolled motions (e.g. due to erroneous configuration of the drive, or of the technology object). Furthermore, any synchronized following axis is moved as well when moving a leading axis with the axis control panel.

Therefore, perform the following protective measures before operation with the axis control panel:

- Ensure that the EMERGENCY OFF switch is within the reach of the operator.
- Enable the hardware limit switches.
- Enable the software limit switches.
- Ensure that following error monitoring is enabled.
- Make sure that no following axis is coupled to the axis to be moved.

**Traversing the drive with the axis control panel**

1. Open the axis control panel of the technology object Positioning axis from "Technology object > Commissioning" in the Project Navigator. The "Axis control panel" window opens.

2. Fetch master control.

3. Set the drive enable.

4. Select "Jogging" operating mode.
5. Click the "Forward" or "Backward" button to start a motion.

![Axis control panel](image)

**Note**

Changes made to the axis configuration performed online have no effect on operation with the axis control panel.

**Note**

No transfer of the parameters

The configured parameter values are discarded when master control is returned. Transfer the values as needed into your configuration.

If you have changed configuration values with the axis control panel during operation, they have no effect on the operation of the axis control panel.

### 9.3 Result in the sample project

You have traversed the axis of the sample project with the axis control panel and thus ensured its correct functioning. Configuring the axis is thus completed.
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