Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

**DANGER**
indicates that death or severe personal injury will result if proper precautions are not taken.

**WARNING**
indicates that death or severe personal injury may result if proper precautions are not taken.

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

**NOTICE**
indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by personnel qualified for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

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Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

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We have reviewed the contents of this publication to ensure consistency with the hardware and software 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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Introduction

The Getting Started S7-1500 Motion Control guides you through the implementation of the motor-supported parts of the "Color mixing station" automation task. It will familiarize you with the basic functions of S7-1500 Motion Control. You configure the drive interfaces with general station description files (GSD), create technology objects and program these using instructions in your user program.

This Getting Started is based on the Getting Started S7-1500. A corresponding sample project is included.

The supplied sample project includes blocks and objects that have already been prepared. You can amend and edit these blocks and objects according to the specifications of this Getting Started for practice. You can also copy the prepared blocks and objects from the global library into the project and use them.

The Getting Started includes both comprehensive step-by-step instructions and the faster procedure of copying the objects from the library.

Task

The agitator and the conveyor of a color mixing station are to be operated with S7-1500 Motion Control.

The "Color_Filling_Station" project is to be expanded by the axes "Conveyor" (conveyor belt) and "Mixer" (agitator) for this purpose. The basic control logic for the axes is already available in the user program. The axes are integrated into the existing user program by two interface blocks. These blocks are to execute the instructions for the respective axes and provide feedback to the user program.
Preparations

2.1 Requirements

Hardware requirements

You need the following hardware components to run the Getting Started:

- 1 × CPU 1511-1 PN (6ES7511-1AK00-0AB0)
- 1 × S7-1500 load current supply PM 70W 120/230VAC (6EP1332-4BA00)
- 1 × mounting rail (6ES7590-1AB60-0AA0)
- 1 × digital input module DI 16x24VDC SRC BA (6ES7521-1BH50-0AA0)
- 1 × digital output module DQ 16x24VDC/0.5A ST (6ES7522-1BH00-0AB0)
- 2 × front connectors (6ES7592-1AM00-0XB0)
- 1 × SIMATIC Memory Card with at least 4 MB (e.g. 6ES7954-8LBxx-0AA0)
- 1 × Ethernet cable

The hardware mentioned above is also part of the following starter package:

**Starter package S7-1500 with software** (6ES7511-1AK00-4YB5)

You can configure and program the Getting Started without any additional hardware.

To commission the configured Motion Control-specific system parts, however, you need two drives in addition to the hardware requirements listed above. The drives must be configured and commissioned beforehand.

The drives must each support one of the following PROFIdrive frames:

- PROFIdrive frame 3 for positioning of the conveyor
- PROFIdrive frame 1 for speed control of the agitator

The following drives were selected for the Getting Started as an example:

- 1 × SINAMICS S120 CU310-2 PN V4.5 drive (6SL3 040-1LA01-0AA0)
- 1 × SINAMICS G120 CU240E-2 PN(-F) V4.5 drive (6SL3 244-0BB1x-1FA0)

Software requirements

You need the following software components to run the Getting Started:

- SIMATIC STEP 7 Professional V12
- SIMATIC WinCC Advanced V12 or SIMATIC WinCC Professional V12
2.2 Basic procedure

Sample project

You need the following project files to run the Getting Started:

- Sample project "Color_Filling_Station"
  You will find the source project as ZIP file on the Siemens website
  [https://www.automation.siemens.com/salesmaterial-as/interactive-manuals/getting-started_simatic-s7-1500/project/color_filling_station.zip].

- Library "MotionLib_Color_Filling_Station"
  You will find the library as ZIP file on the Siemens website
  [https://www.automation.siemens.com/salesmaterial-as/interactive-manuals/getting-started_simatic-s7-1500/project/color_filling_station_mc.zip]. The ZIP file contains the library and the final project to this Getting Started.

2.2 Basic procedure

Starting with the sample project "Color_Filling_Station", configure the drives and technology objects with the TIA Portal. Then you create a STEP 7 user program that allows you to control the movement of the drives.

The procedure is divided into the following basic steps:

- Configuring drives
- Creating technology objects
- Programming the PLC
- Testing a function
2.3 Opening a project

The included sample project "Color_Filling_Station" is the starting point for further action. Open the project in the project view.

![Diagram showing project opening options]

- Devices & networks: Configure a device
- PLC programming: Write PLC program
- Motion & technology: Configure technology objects
- Visualization: Configure an HMI screen
- Project view: Open the project view
2.4 Swapping the start screen

The visualization of the project has been expanded for the Getting Started S7-1500 Motion Control. To use this expansion, you simply need to swap the start screen of the visualization.

Procedure

To swap the start screen of the visualization, follow these steps:

1. Open the global library "MotionLib_Color_Filling_Station".
2. Open the folder "Master copies > Start" in the "MotionLib_Color_Filling_Station" global library.
3. Drag the "Start screen" to the respective screen in the "Color_Mixing_HMI > Screens" folder.

The "Paste" dialog opens.

4. Select the option "Replace existing objects and move to this location".
5. Click "OK" to confirm.
Expanding the start screen

The start screen has been expanded by the area "PLC with drive or HMI demo only" with the following buttons:

- **Drive Mixer exists: Yes/No**
- **Drive Conveyor exists: Yes/No**

<table>
<thead>
<tr>
<th>PLC with Drive or HMI demo only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive Mixer exists</td>
</tr>
<tr>
<td>Drive Conveyor exists</td>
</tr>
</tbody>
</table>

If you want to test the color mixing station with the drives, switch the buttons to "Yes". The program is switched to use of the actual drives. The program uses the position of the drive for positioning the cans.

If you want to test the color mixing station without the drives, switch the buttons to "No". The program uses a calculated position for positioning the cans.

If an error occurs at the drive or the technology object, the display text is changed and highlighted in red.

<table>
<thead>
<tr>
<th>PLC with Drive or HMI demo only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive Mixer exists</td>
</tr>
<tr>
<td>Drive Conveyor Fault</td>
</tr>
</tbody>
</table>

You acknowledge errors with the following stop/reset button after the cause of the error has been removed:
2.5 Pasting blocks

The following program blocks have been prepared to simplify the step sequences and avoid repetitions:

- Organization block "Main"
- Function block "Ctrl_PosAxis"
- Function block "Ctrl_SpeedAxis"

You only have to copy these program blocks from the global library into the project.

Procedure

To copy the program blocks into the project, follow these steps:

1. Open the "Color_Mixing_CPU > Program blocks" folder in the project tree.
2. Open the folder "Master copies > Start" in the "MotionLib_Color_Filling_Station" global library.
3. Drag-and-drop the "Main" organization block to the corresponding block in the "Program blocks" folder.
   The "Paste" dialog opens.
4. Select the option "Replace existing objects and move to this location".
5. Click "OK" to confirm.
6. Drag-and-drop the "Ctrl_PosAxis" and "Ctrl_SpeedAxis" function blocks to the "Program blocks" folder.
7. Compile the CPU software.
Preparations

2.5 Pasting blocks
3.1 Configuring SINAMICS S120

The SINAMICS S120 drive is used in the color mixing station for moving the conveyor. The drive is integrated via a general station description file (GSD).

In the following example, the IRT communication is prepared with a send clock of 2 ms. IRT is isochronous real-time communication between the CPU and the drive.

Creating a drive

To create the drive in the network view, follow these steps:

1. Open the network view of the TIA Portal.
2. In the "Hardware catalog" task card, open the folder "Other field devices > PROFINET IO > Drives > Siemens AG > SINAMICS".

![Hardware catalog screenshot]
3. Select the drive "SINAMICS S120 CU310-2 PN V4.5".

4. Drag-and-drop the drive into the network view.

The drive is inserted in the network view.
Connecting the drive

To connect the drive to the CPU, follow these steps:

1. Select the PROFINET interface of the CPU.

2. In the Inspector window, open the tab "Properties > General > Advanced options > Real-time settings".

3. Select the value 2 ms in the "IO communication" area of the "Send clock" drop-down list.

4. Select "Sync master" in the "Synchronization" area of the "Synchronization role" drop-down list.
5. Assign the CPU as IO controller to the drive.

A PROFINET IO system is automatically created.

The drive is assigned to the PROFINET IO system as an IO device. The CPU is assigned to the drive as an IO controller.
6. Open the topology view.

7. Hold down the mouse button and draw a connection between a PROFINET port of the drive and a PROFINET port of the CPU.

The ports of the PROFINET interfaces are interconnected. The port interconnection is necessary to use IRT when communicating with the drive. The bandwidth required for IRT communication can be more precisely determined with the port interconnection. This usually leads to better performance.
Assigning a standard frame

To assign a standard frame to the drive, proceed as follows:

1. Double-click on the SINAMICS S120 drive in the topology view.

   The device view of the drive opens.

2. In the hardware catalog, select the drive object "DO Servo".

   The TIA Portal automatically checks whether you can add the selected object. If you can assign the object to the drive, a blue marker is shown in the device view.
3. Double-click the selected drive object.

The "DO Servo" drive object is assigned to the drive and appears in the device overview.

4. Assign "Drive_Conveyor" as the name of the drive object in the drive overview.

A unique name makes it easier to assign the drive object to the technology object later.

5. In the hardware catalog, double-click on the "Standard telegram 3, PZD-5/9" for PROFIdrive.

Frame 3 is assigned to the "DO Servo" drive object and appears in the device overview.

6. Select the drive in the device view.

7. In the Inspector window, open the tab "Properties > PROFINET Interface [X1] > Advanced options > Isochronous mode".
8. Select the "Isochronous mode" check box.

9. In the "Detail overview" list, select the "Isochronous mode" check box for the list item "GSD_Device_1/Standard frame 3".

The bus times are automatically calculated and displayed with the settings for isochronous mode.
3.2 Configuring SINAMICS G120

The SINAMICS G120 drive is used in the color mixing station for the speed control of the agitator.

The drive is integrated via a general station description file (GSD). The SINAMICS G120 is also part of the commissioning software SINAMICS Startdrive.

In the following example, the drive is added to the existing PROFINET IO system. Simple cyclical communication between the CPU and the drive is sufficient for this application. IRT communication is not necessary.

Creating a drive

To create the drive in the network view, follow these steps:

1. Open the network view of the TIA Portal.
2. In the "Hardware catalog" task card, open the folder "Other field devices > PROFINET IO > Drives > Siemens > SINAMICS".
3. Select the drive "SINAMICS G120 CU240E-2 PN(-F) V4.5".
4. Drag-and-drop the drive into the network view.

The drive is inserted in the network view.
Connecting the drive to the network

To connect the drive to the CPU, follow these steps:

1. Assign the CPU as IO controller to the drive.

The drive is assigned to the PROFINET IO system as an IO device. The CPU is assigned to the drive as an IO controller.
Inserting a standard frame

To assign a standard frame to the drive, proceed as follows:

1. Double-click on the SINAMICS G120 drive in the network view.
   The device view of the drive opens.

2. Assign "Drive_Mixer" as the name of the drive object in the device overview.
   A unique name makes it easier to assign the drive object to the technology object later.

3. In the hardware catalog, double-click on the "Standard telegram 1, PZD-2/2".

   Standard frame 1 is assigned to the drive and appears in the device overview.
3.3 Using prepared drives

You can shorten the described procedure by inserting the drives from the global library into the project by means of the prepared device description files and connecting them accordingly.

Inserting drives

To insert the drives from the global library into the project, follow these steps:

1. Open the network view of the TIA Portal.
2. Open the folder "Master copies > Final" in the "MotionLib_Color_Filling_Station" global library.
3. Drag-and-drop the drives "SINAMICS-S120-CU310PN-V4.5" and "SINAMICS-G120-CU240E-V4.5" into the network view.

Connecting drives

To connect the drives to the CPU, follow these steps:

1. Select the PROFINET interface of the CPU.
2. In the Inspector window, open the tab "Properties > General > Advanced options > Real-time settings".
3. Select the value 2 ms in the "IO communication" area of the "Send clock" drop-down list.
4. Select "Sync master" from the "Synchronization role" drop-down list.
5. Assign the CPU as IO-Controller to the drives.
6. Open the topology view.
7. Hold down the mouse button and draw a connection between a PROFINET port of the SINAMICS S120 drive and a PROFINET-Port of the CPU.
8. Select the drive in the topology view.
9. In the Inspector window, open the tab "Properties > PROFINET Interface [X1] > Advanced options > Isochronous mode".
10. Select the "Isochronous mode" check box.

11. In the "Detail overview" list, select the "Isochronous mode" check box for the list item "GSD_Device_1/Standard frame 3".
4 Creating technology objects

4.1 Configuring the positioning axis

The positioning axis technology object enables the position-controlled positioning of a drive. You can assign positioning jobs for the conveyor with Motion Control instructions in your user program.

In the following example, you create a positioning axis technology object and assign it to the previously configured SINAMICS S120 drive. You assign the drive interface with PROFIdrive frame 3. The properties of the drive interface are set automatically with this step.

The organization blocks "MC-Servo" and "MC-Interpolator" are automatically created in the project when you create the technology object.

Creating a positioning axis

To create the positioning axis, follow these steps:

1. Open the "Color_Mixing_CPU > Technology objects" folder in the project tree.
2. Double-click the "Add new object" command.
The "Add new object" dialog box opens.

3. Select the "TO_PositioningAxis" object.
4. Enter "TO_Conveyor" as the name of the technology object.
5. Confirm your entry with "OK".

The technology object is created and opened in the project view.
Assigning a drive

To assign a drive to the positioning axis and configure the necessary parameters, proceed as follows:

1. Open the configuration window "Hardware interface > Drive".

2. In the "Drive" list, select the entry "Drive_Conveyor" of the PROFINET drive SINAMICS S120.

The positioning axis is connected to the drive. The process image of the drive is assigned to the process image partition "TPA OB Servo".

3. Open the configuration window "Hardware interface > Data exchange".

4. Check the settings for the data exchange. If necessary, adapt the settings to match those of the drive and the encoder.
4.2 Configuring a speed axis

The speed axis technology object enables you to specify the speed for a drive. You can assign motion jobs for the agitator with Motion Control instructions in your user program.

In the following example, you create a speed axis technology object and assign it to the previously configured SINAMICS G120 drive. You assign the drive interface with PROFIdrive frame 1. The properties of the drive interface are set automatically with this step.

The organization blocks "MC-Servo" and "MC-Interpolator" were already created when you created the positioning axis.
Creating a speed axis

To create the speed axis, follow these steps:

1. Open the "Color_Mixing_CPU > Technology objects" folder in the project tree.
2. Double-click the "Add new object" command.

3. Select the "TO_SpeedAxis" object.
4. Enter "TO_Mixer" as the name of the technology object.
5. Confirm your entry with "OK".

The technology object is created and opened in the project view.
Assigning a drive

For this example, you can use the default values of the configuration. You only need to assign the corresponding drive to the speed axis.

To assign a drive to the speed axis, proceed as follows:

1. Open the configuration window "Hardware interface > Drive".

![Configuration Window](image)

2. In the "Drive" list, select the entry "Drive_Mixer" of the PROFINET drive SINAMICS G120.

![Drive Selection](image)

The speed axis is connected to the drive. The process image of the drive is assigned to the process image partition "TPA OB Servo".

3. Open the configuration window "Hardware interface > Data exchange".

4. Check the reference speed. If necessary, adapt the reference speed to match the drive setting.

Compiling a project

Compile the project to check the configuration. The compilation should take place without errors.
4.3 Using prepared technology objects

You can shorten the described procedure by inserting the prepared technology objects from the global library into the project and assigning the corresponding drives.

Inserting technology objects

To insert the technology objects from the global library into the project, follow these steps:

1. Open the folder "Master copies > Final" in the "MotionLib_Color_Filling_Station" global library.

2. Drag-and-drop the "TO_Mixer" and "TO_Conveyor" technology objects to the "Color_Mixing_CPU > Technology objects" folder.

3. Open the configuration window "Hardware interface > Drive" for each technology object.

4. In the "Drive" list, select the entry "Drive_Conveyor" of the PROFINET drive SINAMICS S120 for the positioning axis.

5. In the "Drive" list, select the entry "Drive_Mixer" of the PROFINET drive SINAMICS G120 for the speed axis.

6. Check the settings for the data exchange. If necessary, adapt the settings to match those of the drives.

7. Compile the project to check the configuration.

   The compilation should take place without errors.
Creating technology objects

4.3 Using prepared technology objects
5.1 Structure of the user program

In this example, the user program of the corresponding axis is created in a separate function block.

The required Motion Control instructions are inserted as instances into the function blocks. The function blocks are then called in the cyclic user program.

5.2 Adding Motion Control instructions

5.2.1 Adding Motion Control instructions for a positioning axis

Insert the following Motion Control instructions in the "Ctrl_PosAxis" function block for the user program to control the positioning axis:

- MC_Power
- MC_Reset

The following Motion Control instructions have already been inserted and interconnected with the corresponding tags:

- MC_Home
- MC_MoveRelative
- MC_MoveAbsolute

A network for transfer of error messages is also already in place.
Opening function blocks

To open the function block, follow these steps:

1. Open the "Color_Mixing_CPU > Program blocks" folder in the project tree.

2. Double-click the function block "Ctrl_PosAxis".

The function block opens.

The following tags have been created in the "Interface" area:

- "Axis" - transfer variable for the technology object when the function block is called in the cyclic user program
- "Turn_On_Drive" - for switching on the drive with the "MC_Power" instruction
- "Move_Can_Cycle" - for starting the axis movement with the "MC_MoveRelative" instruction
- "Goto_Fillpos" - for starting the axis movement with the "MC_MoveAbsolute" instruction
- "Reset" - for error acknowledgment
- "Can_Cycle_Done" - feedback of the "MC_Relative" instruction
- "Fillpos_Reached" - feedback of the "MC_MoveAbsolute" instruction
- "Error" - error message
- "temp_Status_power" - further interconnection of the feedback of the "MC_Power" instruction to the "MC_Home" instruction
- "temp_Position" - reading out the actual position to use for visualization
Inserting MC_Power

To insert the Motion Control instruction "MC_Power" in the function block, follow these steps:

1. In the "Instructions" task card, open the "Technology > Motion Control > S7-1500 Motion Control" folder.

2. Insert the Motion Control instruction "MC_Power" into network 1 using drag-and-drop. The "Call options" dialog opens.
3. Click the "Multi instance" button.

4. Confirm your entry with "OK".

The Motion Control instruction "MC_Power" is added to network 1.

5. Drag-and-drop the "Axis" tag from the "Interface" area to the "Axis" parameter of the Motion Control instruction.

6. Drag-and-drop the "Turn_On_Drive" tag to the "Enable" parameter of the Motion Control instruction.

7. Drag-and-drop the "temp_Status_power" tag to the "Status" parameter of the Motion Control instruction.
**Inserting MC_Reset**

To insert the Motion Control instruction "MC_Reset" in the function block, follow these steps:

1. Insert the Motion Control instruction "MC_Reset" into an empty network according to steps 1 to 5 of the operating instruction "Insert MC_Power".

2. Drag-and-drop the "Reset" tag to the "Execute" parameter of the Motion Control instruction.
5.2.2 Adding Motion Control instructions for a speed axis

Insert the following Motion Control instruction in the "Ctrl_SpeedAxis" function block for the user program to control the speed axis:

- MC_Power
- MC_Reset

The Motion Control instruction "MC_MoveVelocity" has already been inserted and linked with the corresponding tags.

A network for transfer of error messages is also already in place.

Opening function blocks

To open the function block, follow these steps:

1. Open the "Color_Mixing_CPU > Program blocks" folder in the project tree.

2. Double-click the function block "Ctrl_SpeedAxis".

   The function block opens.

   The following tags have been created in the "Interface" area:

   - "Axis" - transfer variable for the technology object when the function block is called in the cyclic user program
   - "Start_Mixing" - for switching on the drive with the "MC_Power" instruction
   - "Reset" - for error acknowledgment
   - "Error" - error message
   - "temp_Status_power" - further interconnection of the feedback of the "MC_Power" instruction to the "MC_MoveVelocity" instruction
Inserting MC_Power

To insert the Motion Control instruction "MC_Power" in the function block, follow these steps:

1. In the "Instructions" task card, open the "Technology > Motion Control > S7-1500 Motion Control" folder.

2. Insert the Motion Control instruction "MC_Power" into network 1 using drag-and-drop. The "Call options" dialog opens.
3. Click the "Multi instance" button.
4. Confirm your entry with "OK".

The Motion Control instruction "MC_Power" is added to network 1.

5. Drag-and-drop the "Axis" tag from the "Interface" area to the "Axis" parameter of the Motion Control instruction.

6. Drag-and-drop the "Start_Mixing" tag to the "Enable" parameter of the Motion Control instruction.

7. Drag-and-drop the "temp_Status_power" tag to the "Status" parameter of the Motion Control instruction.
Inserting MC_Reset

To insert the Motion Control instruction "MC_Reset" in the function block, follow these steps:

1. Insert the Motion Control instruction "MC_Reset" into an empty network according to steps 1 to 5 of the operating instruction "Insert MC_Power".
2. Drag-and-drop the "Reset" tag to the "Execute" parameter of the Motion Control instruction.

The reset instruction is used to reset acknowledge errors.
5.2.3 Using prepared function blocks

You can shorten the described procedure by inserting the prepared function blocks from the global library into the project and interconnecting the corresponding tags.

Inserting function blocks

To insert the function blocks from the global library into the project, follow these steps:

1. Open the folder "Master copies > Final" in the "MotionLib_Color_Filling_Station" global library.

2. Drag-and-drop both the "Ctrl_SpeedAxis" and "Ctrl_PosAxis" function blocks to the function blocks with the same name in the "Color_Mixing_CPU > Program blocks" folder. The "Paste" dialog opens.

3. Select the option "Replace existing objects and move to this location".

4. Click "OK" to confirm.
5.3 Integrating Motion Control instructions in the cyclic user program

5.3.1 Integrating Motion Control instructions for a positioning axis

The Motion Control instructions created to control the positioning axis are integrated in the cyclic user program through the corresponding function block. The function block is inserted into the "Main [OB35]" organization block and interconnected to the appropriate parameters.

Inserting a function block

To insert the function block in the cyclic user program, follow these steps:

1. Open the "Color_Mixing_CPU > Program blocks" folder in the project tree.
2. Open the organization block "Main [OB35]".

The control logic of the conveyor is located in network 5 (SCL_Valve_Conveyor).
3. Drag-and-drop the "Ctrl_PosAxis" function block from the project tree into network 11 "Motion Control - Positioning Axis (Conveyor)".

The "Call options" dialog opens.

4. Click "OK" to confirm.
Interconnecting the function block

To interconnect the function block with the appropriate parameters, follow these steps:

1. Open the "Color_Mixing_CPU > Technology objects" folder in the project tree.

2. Drag-and-drop the technology object "TO_Conveyor" to the "Axis_Name" parameter in the project tree.

3. At the "Turn_On_Drive" parameter, select the "HMI_Conv_Sim" tag.

4. Keep the <Ctrl> key pressed and drag-and-drop the "Conveyor_Move_Cycle" tag (network 5) to the "Move_Can_Cycle" parameter.

5. Keep the <Ctrl> key pressed and drag-and-drop the "Conveyor_Find_Fillposition" tag (network 5) to the "Goto_Fillpos" parameter.

6. Keep the <Ctrl> key pressed and drag-and-drop the "STOP_RESET_Filling_Process" tag (network 5) to the "Reset" parameter.

7. Keep the <Ctrl> key pressed and drag-and-drop the "Conveyor_Cycle_Done" tag (network 5) to the "Can_Cycle_Done" parameter.
8. Keep the <Ctrl> key pressed and drag-and-drop the "Conveyor_Fillposition_found" tag (network 5) to the "Fillpos_Reached" parameter.

9. At the "Error" parameter, select the "ERROR_Conveyor" tag.
5.3.2 Integrating Motion Control instructions for a speed axis

The Motion Control instructions used to control the speed axis are integrated in the cyclic user program through the corresponding function block. The function block is inserted into the "Main [OB35]" organization block and interconnected to the appropriate parameters.

Inserting a function block

To insert the function block in the cyclic user program, follow these steps:

1. Open the "Color_Mixing_CPU > Program blocks" folder in the project tree.

2. Open the organization block "Main [OB35]".

The control logic of the agitator (LAD_Mixer) is located in network 4.
3. Drag-and-drop the "Ctrl_SpeedAxis" function block from the project tree into network 10 "Motion Control Speed Axis (Mixer)".

The "Call options" dialog opens.

4. Click "OK" to confirm.
Interconnecting the function block

To interconnect the function block with the appropriate parameters, follow these steps:

1. Open the "Color_Mixing_CPU > Technology objects" folder in the project tree.

2. Drag-and-drop the technology object "TO_Mixer" to the "Axis_Name" parameter in the project tree.

3. Keep the <Ctrl> key pressed and drag-and-drop the "Mixer_ON" tag (network 4) to the "Start_Mixing" parameter.

4. Add an AND logic operation with the "HMI_Mix_Sim" tag to the "Mixer_ON" tag at the "Start_Mixing" parameter.
5. Keep the <Ctrl> key pressed and drag-and-drop the "STOP_RESET_Filling_Process" tag (network 5) to the "Reset" parameter.

6. At the "Error" parameter, select the "ERROR_MIXER" tag.
5.3 Integrating Motion Control instructions in the cyclic user program

5.3.3 Using the prepared OB35

You can shorten the described procedure by inserting the prepared "Main [OB35]" organization block from the global library into the project.

"Inserting "Main [OB35]""

To insert the "Main [OB35]" organization block from the global library into the project, follow these steps:

1. Open the folder "Master copies > Final" in the "MotionLib_Color_Filling_Station" global library.
2. Drag-and-drop the "Main" organization block to the corresponding organization block in the "Color_Mixing_CPU > Program blocks" folder. The "Paste" dialog opens.
3. Select the option "Replace existing objects and move to this location".
4. Click "OK" to confirm.
5.4 Compiling and loading the project

Compile the project and download it to the CPU to test the functions of the axes in the next step.

Procedure

To compile the project, follow these steps:

1. Compile the hardware and software of all devices in the project.
2. Load all devices.
5.4 Compiling and loading the project
Testing a function

6.1 "Positioning axis" axis control panel

You use the axis control panel and tuning for the function test and commissioning of the positioning axis to position the conveyor belt.

The procedure is divided into the following actions:

- Enabling the technology object
- Checking the direction of rotation
- Checking the distance evaluation
- Checking the velocity evaluation
- Optimizing gain
- Applying gain to project
- Evaluating errors

Requirement

- The drive has been commissioned and is ready for operation.
- The drive has been assigned a PROFINET device name.

Enabling the technology object

To enable the positioning axis with the axis control panel, follow these steps:

1. Open the "Color_Mixing_CPU > Technology objects" folder in the project tree.
2. Open the commissioning window "Configuration > Extended parameters > Control loop" of the technology object "TO_Conveyor".
3. Enter the value 0.0 in the "Gain (Kv factor)" box.

You can compare the actual value and the setpoint of the velocity directly with each other if there is no gain of the control loop. Optimize the gain once you have checked the velocity evaluation and apply it to your project.

4. Compile the CPU software.
5. Load the CPU.
6. Open the commissioning window of the technology object "TO_Conveyor".

7. To create an online connection and take over the master control of the technology object, click the "Fetch" button.

   A warning message is displayed.

8. Confirm with "Yes".

9. To enable the technology object, click the "Enable" button.

   The drive is turned on and the speed setpoint zero is output.
Checking the direction of rotation

To move the axis with the axis control panel and check the direction of rotation, follow these steps:

1. Select the "Jog" mode in the axis control panel.

2. Enter a velocity setpoint as well as the required values for acceleration, deceleration and jerk.

3. Click the "Forward" or "Backward" button to execute a movement in the positive or negative direction.

The motion is executed as long as you press the mouse button.

4. Check whether the actual direction of rotation is the same as the specified direction of rotation.

   If necessary, you can invert the direction of rotation under "Technology object > Configuration > Hardware interface > Data exchange".

5. Check the actual speed in the drive or use an external tachometer to measure the speed directly at the motor shaft.

   If the actual speed deviates significantly from the specified setpoint, check the reference speed and the parameter assignment of the encoder.
Checking the distance evaluation

To move the axis with the axis control panel and check the distance evaluation, follow these steps:

1. Mark the current mechanical position of the axis.
2. Select the "Homing setposition" mode in the axis control panel.
3. Enter a defined value (e.g. 0.0 mm) in the "Position" box.
4. Click the "Position setpoint" button to set the actual position to the value specified in "Position".
5. Select "Positioning relative" mode.
6. Enter only small values for the distance and the velocity (e.g. 10 mm and 100 mm/s).
7. To move the axis in the positive direction, click the "Forward" button.

8. Use the selection on the axis to check whether the current position displayed matches the actually traveled distance.

If the displayed current position deviates from the actually traveled distance, check the configuration of the encoder and the gearbox ("Technology object > Configuration > Extended parameters > Mechanics").
Checking the velocity evaluation

To move the axis with the axis control panel and check the velocity, follow these steps:

1. Select the "Speed setpoint" mode in the axis control panel.
2. Enter a small value (e.g. 100 mm/s) for the velocity setpoint.
3. To move the axis in the positive direction, click the "Forward" button.
4. Check whether the displayed current velocity matches the velocity setpoint.
   If the displayed current velocity deviates significantly from the velocity setpoint, adjust the reference speed (Technology object > Hardware interface > Data exchange).
5. Click the "Stop" button to stop the movement.
Testing a function

6.1 “Positioning axis” axis control panel

Optimizing gain

The “Tuning” function supports you in determining the optimum gain (Kv factor) for the position control of the axis. For this purpose, the axis velocity profile is recorded by means of the Trace function for the duration of a configurable positioning movement. Then you can evaluate the recording and adapt the gain accordingly.

To determine the gain factor with the tuning, follow these steps:

1. Open the tuning in the commissioning window.

2. If necessary, configure values for the distance, duration, and dynamics of a test step.

3. Enter a start value for the gain. Start with a low value.
4. Click the "Forward" or "Backward" button to start a test step for the tuning in positive or negative direction.

A setpoint is output for the specified duration according to the specified distance. The axis moves by the specified distance. A trace recording of the motion (setpoint and actual values) is created automatically.

5. Evaluate the curve of the trace recording. Adapt the gain incrementally. Click the "Forward" or "Backward" button after each value that you input. This applies the value and starts a new movement and trace recording each time.

When adjusting the gain, pay attention to the following properties of the curve:

- The curve shows a brief compensation time.
- The curve does not show any motion reversal of the actual value.
- When approaching the setpoint, no overshoot occurs.
- The curve shows stable overall behavior (oscillation-free curve).

### Applying gain to project

To apply the determined gain (Kv) to your project, follow these steps:

1. Click on the icon next to the "Gain" box.

   A drop-down list is displayed.

2. Enter the value of the determined gain in the "Project start value" box of the drop-down list.

3. To disable the technology object, click the "Block" button.

4. Click the "Relinquish" button to return master control to your user program.

5. Compile the CPU software.

6. Load the CPU.
Testing a function

6.1 "Positioning axis" axis control panel

Evaluating errors

If an error occurs during control of the technology object with the axis control panel, this is indicated by the "Error" status.

To evaluate an error, follow these steps:

1. Select the "Receive alarms" check box in the shortcut menu of the CPU to display the error messages in the alarm display.

2. To display the error bits of the technology object, click the "More" button.

3. Evaluate any pending errors and remove the cause of the error.

4. Click the "Confirm" button in the axis control panel to acknowledge an error.

Note

Adapt following error limits

If error messages are repeatedly displayed from following error monitoring, temporarily adapt the following error limits.
6.2 "Speed axis" axis control panel

You use the axis control panel for the function test and commissioning of the speed axis to control the agitator.

The procedure is divided into the following actions:
- Enabling the technology object
- Moving and checking the axis
- Evaluating errors

Requirement
- The drive has been commissioned and is ready for operation.
- The drive has been assigned a PROFINET device name.

Enabling the technology object

To enable the speed axis with the axis control panel, follow these steps:
1. Open the "Color_Mixing_CPU > Technology objects" folder in the project tree.
2. Open the commissioning window of the technology object "TO_Mixer".
3. To create an online connection and take over the master control of the technology object, click the "Fetch" button.

   A warning message is displayed.

   ![Warning Message]

4. Confirm with "Yes".

5. To enable the technology object, click the "Enable" button.

   The drive is turned on and the speed setpoint zero is output.

### Moving and checking the axis

To move the axis with the axis control panel and to control the movement, follow these steps:

1. Select the "Jog" mode in the axis control panel.
2. Enter a speed setpoint as well as the required values for acceleration, deceleration and jerk.
3. Click the "Forward" or "Backward" button to execute a movement in the positive or negative direction.

The motion is executed as long as you press the mouse button.

![Axis Control Panel]

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4. Check whether the actual direction of rotation is the same as the specified direction of rotation.
   If necessary, you can invert the direction of rotation under "Technology object > Configuration > Hardware interface > Data exchange".

5. Check the actual speed in the drive or use an external tachometer to measure the speed directly at the motor shaft.
   If the actual speed deviates significantly from the specified setpoint, check the reference speed and the parameter assignment of the encoder.

6. To disable the technology object, click the "Block" button.

7. Click the "Relinquish" button to return master control to your user program.

**Evaluating errors**

If an error occurs during control of the technology object with the axis control panel, this is indicated by the "Error" status.

![Axis status]

To evaluate an error, follow these steps:

1. Select the "Receive alarms" check box in the shortcut menu of the CPU to display the error messages in the alarm display.

2. To display the error bits of the technology object, click the "More" button.

3. Evaluate any pending errors and remove the cause of the error.

4. Click the "Confirm" button in the axis control panel to acknowledge an error.
6.3 Testing the function in the start screen

You test the function of your user program by using the start screen of the visualization.

Procedure

To test the function of your user program, follow these steps:

1. Save the project.
2. Download the program to the CPU.
3. Start the CPU.
4. Press the "Drive Mixer exists" button in the start screen of the project.
5. Press the "Start mixing" button in the start screen of the project.

The drive of the agitator is switched on by the Motion Control instruction "MC_Power".

When the technology object is enabled ("MC_Power.Status" = TRUE), a job is triggered with the Motion Control instruction "MC_MoveVelocity". The "MC_MoveVelocity" instruction specifies the configured speed (100 rpm). The technology object calculates speed setpoints and sends them to the drive. The drive executes the received setpoints and turns the agitator.

The release by the control program is revoked after 3 seconds. The drive is stopped and switched off.

You can change the speed by defining the "Velocity" parameter at the "MC_MoveVelocity" instruction. You can also adjust the dynamics in the configuration of the technology object under "Extended parameters > Dynamic default values".
6. Press the "Drive Conveyor exists" button in the start screen of the project.

   The drive of the conveyor is switched on by the Motion Control instruction "MC_Power". With the enable "MC_Power.Status" = TRUE, a job is triggered with the Motion Control instruction "MC_Home". The current position value is applied as valid position. This references the technology object.

7. Press the "Fill cans with color mixture" button in the start screen of the project.

   The can below the fill nozzle is filled and then moved forward by one can. This procedure is repeated until the set number of cans has been filled (see figure "Recipes").
Testing a function

6.3 Testing the function in the start screen
Additional information

Diagnostics/troubleshooting

Incorrect operation, incorrect wiring or inconsistent parameter assignment can cause errors. The S7-1500 Motion Control function manual includes descriptions of how to diagnose such errors and alarms.

Service & Support on the Internet

In addition to our range of documentation, you can also make use of our comprehensive online knowledge base on the Internet [http://www.siemens.com/automation/service&support].

There you will find:

- The newsletter that provides you with latest information relating to your products.
- The right documents for you, using the Service & Support search engine.
- A forum in which users and specialists worldwide exchange their know-how.
- Your local contact partner for Automation & Drives, using our contact partner database.
- Information about on-site services, repairs, spare parts.