Configuration of an MRP ring with SIMOCODE and SIMATIC S7-1500

SIMOCODE pro V PN, SIMATIC S7-1500

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1 Introduction

1.1 Overview

SIMOCODE pro is a flexible, modular motor management system for motors with constant rotation speed in the low voltage range.

Via PROFINET, the basic device SIMOCODE pro V PN can be integrated into a higher-level automation system like the SIMATIC S7-1500.

To ensure high plant availability, the devices are connected with each other in an MRP ring (Media Redundancy Protocol). As a result, the remaining devices are still accessible in the event of a device or line failure.

In addition to the MRP ring, the PROFINET function "Device replacement without removable medium/PD" is used in this application example. If a device is exchanged, the IO controller automatically assigns configured parameters to the new device. Therefore, the service personal does not need to load the configuration into the new device and downtime is reduced.
1.2 Mode of operation

The "Media Redundancy Protocol" (MRP) is a protocol for high-availability networks that are usually required for critical automation applications. By establishing a ring topology, single failures of a switch or a line can be compensated with MRP.

In an MRP ring, a redundancy manager (in this application example the SIMATIC S7-1500) sends special test packages and checks, whether the ring is closed. If an MRP ring component fails, the test packages sent by a port do not reach the respective other port. The redundancy manager then informs the switches about the altered topology and forwards their packages to both directions.

Advantages

MRP offers the following advantages:

- Fast detection of a network error and less reconfiguration time of the network (about 200 ms for 50 devices).
- Can be implemented for small and very large networks
- Cost-effective due to reduced wiring involved
- Clear and simply structured wiring
- Plant can be expanded during operation
- Standardized protocol enables communication between devices from different manufacturers.

Note

All components interconnected in the ring need to support MRP as per IEC 62439.
1.3 Components used

This application example has been created with the following hardware and software components:

Table 1-1: Hardware components

<table>
<thead>
<tr>
<th>Component</th>
<th>Qty</th>
<th>Article number</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIMOCODE PRO V PN</td>
<td>3</td>
<td>3UF7011-1AB00</td>
<td></td>
</tr>
<tr>
<td>SIMATIC S7-1500</td>
<td>1</td>
<td>6ES7516-3AN01-0AB0</td>
<td>V1.8</td>
</tr>
<tr>
<td>SCALANCE XB208</td>
<td>1</td>
<td>6GK5208-0BA00-2AB2</td>
<td></td>
</tr>
<tr>
<td>STEP 7 Professional V13 SP1</td>
<td>1</td>
<td>6ES7822-1AA03-0YB5</td>
<td>Update 9</td>
</tr>
<tr>
<td>SIMOCODE ES V13 Basic</td>
<td>1</td>
<td>3ZS1322-4CE11-0YB5</td>
<td></td>
</tr>
</tbody>
</table>

This application example consists of the following components:

Table 1-2: Components of the application example

<table>
<thead>
<tr>
<th>Component</th>
<th>File name</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Documentation</td>
<td>109742280_SIMOCODE-MRP-Ring_DOC_V10_de.pdf</td>
<td>This document</td>
</tr>
<tr>
<td>TIA Portal project</td>
<td>109742280_SIMOCODE-MRP-Ring_PROJ_V10.zip</td>
<td></td>
</tr>
</tbody>
</table>
2 Engineering

2.1 Hardware setup

The figure below shows the hardware configuration after the commissioning. Interconnect your devices only after loading the configuration.

Figure 2-1: Topology

Table 2-1: Port connection

<table>
<thead>
<tr>
<th>Component Name</th>
<th>Port</th>
<th>Neighbor Name</th>
<th>Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCALANCE</td>
<td>Port 1</td>
<td>PLC1</td>
<td>Port 2</td>
</tr>
<tr>
<td>PLC1</td>
<td>Port 1</td>
<td>SIMOCODE3</td>
<td>Port 2</td>
</tr>
<tr>
<td>SIMOCODE3</td>
<td>Port 1</td>
<td>SIMOCODE2</td>
<td>Port 2</td>
</tr>
<tr>
<td>SIMOCODE2</td>
<td>Port 1</td>
<td>SIMOCODE1</td>
<td>Port 2</td>
</tr>
<tr>
<td>SIMOCODE1</td>
<td>Port 1</td>
<td>SCALANCE</td>
<td>Port 2</td>
</tr>
</tbody>
</table>
2.2 Configuration

Prerequisite

In the following, only the required steps for configuring MRP and the PROFINET function “Device replacement without removable medium/PD” are described. The general configuration of a SIMOCODE basic device is not part of this application example.

For the configuration, the following requirements are assumed:

- You have already created a TIA Portal project with all the required hardware components.
- You have configured the SIMOCODE basic devices according to your application.

2.2.1 Configuring the MRP

Table 2-2: Configuring the MRP

<table>
<thead>
<tr>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Open your project in the TIA Portal and go to the project view, if necessary.</td>
</tr>
<tr>
<td>2. Open &quot;Devices &amp; networks&quot; from the project navigation.</td>
</tr>
<tr>
<td>3. Assign each device a unique IP address. To simplify the commissioning and expansion of the MRP ring, do not use the factory-set IP address of the SIMOCODE (192.168.0.3).</td>
</tr>
<tr>
<td>4. Assign the SCALANCE switch and the SIMOCODE basic devices to the IO controller.</td>
</tr>
<tr>
<td>5. Double click on the PROFINET connection &quot;PN/IE_1&quot;.</td>
</tr>
<tr>
<td>6. Open the area navigation &quot;Domain Management &gt; MRP domains &gt; mrpdomain-1 &gt; Device&quot;.</td>
</tr>
</tbody>
</table>
7. For each device, assign an MRP role.

<table>
<thead>
<tr>
<th>Device</th>
<th>MRP domain</th>
<th>MRP role</th>
<th>Ring port 1</th>
<th>Ring port 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLC1 PROFINET</td>
<td>mpdr domain-1</td>
<td>Manager (auto)</td>
<td>Port_1 [X1 P1 R]</td>
<td>Port_2 [X1 P2 R]</td>
</tr>
<tr>
<td>Scalance</td>
<td>mpdr domain-1</td>
<td>Client</td>
<td>Port_1 [X1 P1 R]</td>
<td>Port_2 [X1 P2 R]</td>
</tr>
<tr>
<td>SIMOCODE1</td>
<td>mpdr domain-1</td>
<td>Client</td>
<td>Port_1 [X1 P1 R]</td>
<td>Port_2 [X1 P2 R]</td>
</tr>
<tr>
<td>SIMOCODE2</td>
<td>mpdr domain-1</td>
<td>Client</td>
<td>Port_1 [X1 P1 R]</td>
<td>Port_2 [X1 P2 R]</td>
</tr>
<tr>
<td>SIMOCODE3</td>
<td>mpdr domain-1</td>
<td>Client</td>
<td>Port_1 [X1 P1 R]</td>
<td>Port_2 [X1 P2 R]</td>
</tr>
</tbody>
</table>

8. For the SCALANCE switch, determine which ports are used for the MRP ring.

The configuration of the MRP ring is now complete.

2.2.2 Configuring Device replacement without removable medium/PD

The PROFINET function "Device replacement without removable medium/PD" is activated in the IO controller by default. In order to use the function, you must also configure the topology. At the same time, configuring the topology also facilitates troubleshooting in the event of an MRP ring failure.

To configure a topology, proceed as follows:

<table>
<thead>
<tr>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Open &quot;Devices &amp; networks&quot; from the project navigation.</td>
</tr>
<tr>
<td>2. Double click on the IO controller.</td>
</tr>
<tr>
<td>Action</td>
</tr>
<tr>
<td>--------</td>
</tr>
</tbody>
</table>
| 4. In the area navigation, open "Advanced Options > Interface Options". Check, whether the property "Support device replacement without removable medium" is activated.

![Interface options](image)

| 5. Switch to the topology view. |
| 6. Connect the ports of the components just like in your actual hardware configuration. |

```
Scalance
SCALANCE X820B
PLC1

PLC1
CPU 1516-3 PN...  

SIMOCODE 1
SIMOCODE pro...
PLC1

SIMOCODE 2
SIMOCODE pro...
PLC1

SIMOCODE 3
SIMOCODE pro...
PLC1
```

The configuration of the function "Device replacement without removable medium/PD" is now complete.
2.2.3 Configuring the control of the SIMOCODE basic devices

The supplied application example contains a program with which you can control the SIMOCODE basic devices. If you have already programmed the control, the following steps are not required.

Control unit "Remote" settings

For this application example, the default parameterization has not been changed. The following settings are required only if you do not use the default parameterization of SIMOCODE.

Table 2-4: Control unit "Remote" settings

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Open a SIMOCODE basic device in the project navigation and open &quot;Parameters&quot;.</td>
<td></td>
</tr>
<tr>
<td>2. Open &quot;Motor control &gt; Control station&quot; in the area navigation.</td>
<td></td>
</tr>
<tr>
<td>3. Under &quot;Mode Selector&quot;, set the input bit that switches S1.</td>
<td></td>
</tr>
<tr>
<td>4. Under &quot;PLC/PCS [PN]&quot;, set the input bits via which the SIMOCODE basic device is remote-controlled.</td>
<td></td>
</tr>
<tr>
<td>5. Set, that in the operating mode &quot;remote&quot;, switch-on and switch-off is allowed.</td>
<td></td>
</tr>
<tr>
<td>6. Repeat the steps for further SIMOCODE basic devices.</td>
<td></td>
</tr>
</tbody>
</table>
2 Engineering

Integrating the sample program

Table 2-5: Creating the program

<table>
<thead>
<tr>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Open the supplied example project in a second instance of the TIA portal.</td>
</tr>
<tr>
<td>2. Copy the following components of the project example to your project:</td>
</tr>
<tr>
<td>- Function block &quot;OperateMotor&quot;</td>
</tr>
<tr>
<td>- Data block &quot;Control&quot;</td>
</tr>
<tr>
<td>- Data type &quot;typeControl&quot;</td>
</tr>
<tr>
<td>- Data type &quot;typeStatus&quot;</td>
</tr>
<tr>
<td>- Watch table &quot;ControlStatus&quot;</td>
</tr>
<tr>
<td>3. Open the data block &quot;Control&quot; and adjust the limits of the &quot;simocode&quot; array to the number of your SIMOCODE basic devices.</td>
</tr>
<tr>
<td>4. Add the function block &quot;OperateMotor&quot; to an empty network in OB1 and create an instance data block.</td>
</tr>
<tr>
<td>5. Connect the inputs of the function block with the tags from the data block &quot;Control&quot;.</td>
</tr>
<tr>
<td>6. Connect the outputs of the function block with the respective input bits of the SIMOCODE basic device.</td>
</tr>
<tr>
<td>7. Repeat steps 4 to 6 for further SIMOCODE basic devices.</td>
</tr>
</tbody>
</table>

2.2.4 Loading the configuration

If the IO devices (SCALANCE switch and SIMOCODE basic devices) are in their delivery state during the commissioning and have not yet been assigned a PROFINET device name, the IO controller automatically assigns a device name during the connection of the IO devices and loads the configuration.

For this, load the project into the IO controller and successively connect the IO devices with the IO controllers at the configured ports.

If during the commissioning, the IO devices are not in their delivery state, load every device individually, as usual.
2.3 Operation

Testing the MRP ring

The following steps apply only if you use the program blocks from the supplied example project.

Table 2-6: Testing the MRP ring

<table>
<thead>
<tr>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Interrupt the MRP ring at any point.</td>
</tr>
<tr>
<td>2. Open the watch table &quot;ControlStatus&quot; and activate monitoring.</td>
</tr>
<tr>
<td>3. Set the &quot;Control[x].on[x]&quot; tags of each SIMOCODE basic device to TRUE. The SIMOCODE basic devices are accessible, despite the interruption.</td>
</tr>
<tr>
<td>4. Close the MRP ring.</td>
</tr>
</tbody>
</table>

Testing the neighborhood detection

Table 2-7: Testing the neighborhood detection

<table>
<thead>
<tr>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Disconnect any SIMOCODE basic device from the MRP ring.</td>
</tr>
<tr>
<td>2. Reset the SIMOCODE basic device to factory settings (see [3]).</td>
</tr>
<tr>
<td>3. Connect the SIMOCODE basic device to a free port of the switch, outside the MRP ring.</td>
</tr>
<tr>
<td>4. Open the &quot;Online access&quot; in the project navigation and select the interface that in connected to the SCALANCE switch.</td>
</tr>
<tr>
<td>5. Click &quot;Update accessible devices&quot; and check the configuration. The SIMOCODE basic device is displayed as accessible device with the IP address 192.168.0.3. No PROFINET device name has been assigned to the device yet.</td>
</tr>
<tr>
<td>6. Re-integrate the SIMOCODE basic device into the MRP ring at the same spot.</td>
</tr>
<tr>
<td>7. Click &quot;Update accessible devices&quot; again and check the configuration. The configuration has been automatically loaded into the reset SIMOCODE basic device.</td>
</tr>
</tbody>
</table>
2.4 Diagnostics

You can view the MRP ring status in many places in the TIA portal. Some of these places are shown below.

Online and Diagnostics

Open "Online & diagnostics" of the MRP manager (IO controller).
Under "Diagnostics > PROFINET interface [X1] > Domains > MRP domain", the status of the MRP ring is displayed.

Figure 2-2: MRP ring status
Diagnostic buffer

If you have created a topology, a message is created in the IO controller's diagnostic buffer in the event of a line or device failure.

Figure 2-2: Diagnostic message if an error has been detected in the topology

Topology view

If you have created a topology, the ring’s status is displayed in the topology view.

Figure 2-3: Diagnostics of the MRP ring via the topology view
3 Valuable Information

3.1 Basics

3.1.1 Media redundancy (Media Redundancy Protocol)

Overview
To increase the network availability of an Industrial Ethernet network, you can connect a line topology to create a ring topology.

At least one device of such a ring then assumes the role of the redundancy manager. All other devices in the ring are redundancy clients.

In the redundancy manager, one of the two ring ports is blocked during an interruption-free network operation, so that no data telegrams are going round. From the point of view of the data transmission, the ring topology then looks like a line.

The default media redundancy protocol in SIMATIC is MRP (Media Redundancy Protocol) with a reconfiguration time of usually 200 ms. Up to 50 devices per ring can participate.

Prerequisite

The following conditions are required for smooth operation with the media redundancy method MRP:

- The ring for which you want to use MRP must consist only of devices supporting this function.
- “MRP” needs to be activated for all devices in the ring.
- All devices must be connected to each other via their ring ports.
- The ring must consist of a maximum of 50 devices.
- The connection settings (transfer medium/duplex) must be set to “full duplex” for all ring ports and to a minimum of 100 Mbit/s. Otherwise, a data traffic failure may occur.

Further Information

Further information about media redundancy in SIMATIC can be found in the system manual "PROFINET system description" at \\


3.1.2 Configuring Device replacement without removable medium/PD

IO devices that support the PROFINET function “Device replacement without removable medium/PD” can be swapped without there being the need for an removable device with a stored device name (e.g. Micro Memory Card) to be inserted, or the device name with the PG to be assigned. The swapped IO device does no longer receive its device name from the removable medium or from the PG, but from the IO controller.

For this, the IO controller and the neighboring PROFINET devices of the exchanged IO device must also support the PROFINET function "Device replacement without removable storage medium/PC".

For the assignment of the device name, the IO controller uses the configured topology and the neighborhood relations detected by the IO devices.

Note

All IO devices that automatically receive their device name by their respective IO controller, need to be in delivery state (reset to factory settings) and the set topology needs to match the actual topology.

If there is an removable medium (Micro Memory Card, C-PLUG) with a valid device name present in the module insert of the swapped IO device, or if, prior to the swapping, it had once been configured for a prioritized startup, then this device will continue to use its already assigned valid device name.

For further information about the PROFINET function “Device replacement without removable medium/PD”, refer to the system manual "PROFINET system description" at [6].

3.2 Alternative solutions

In this configuration, the SCALANCE switch may also act as MRP manager.

For this, you must assign the role of the MRP manager To the SCALANCE switch instead of the IO controller, as described in Table 2-2.

Figure 3-1: SCALANCE switch as MRP manager
4 Appendix

4.1 Service and Support

Industry Online Support
Do you have any questions or need support?
Siemens Industry Online Support offers access to our entire service and support know-how as well as to our services.
Siemens Industry Online Support is the central address for information on our products, solutions and services.
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https://support.industry.siemens.com

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Service offer
Our service offer comprises, among other things, the following services:
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- Plant Data Services
- Spare Parts Services
- Repair Services
- On Site and Maintenance Services
- Retrofit & Modernization Services
- Service Programs and Agreements
Detailed information on our service offer is available in the Service Catalog:
https://support.industry.siemens.com/cs/sc

Industry Online Support app
Thanks to the "Siemens Industry Online Support" app, you will get optimum support even when you are on the move. The app is available for Apple iOS, Android and Windows Phone.
https://support.industry.siemens.com/cs/ww/en/sc/2067
## 4.2 Links and Literature

Table 4-1

<table>
<thead>
<tr>
<th>No.</th>
<th>Topic</th>
</tr>
</thead>
</table>
| 1. | Siemens Industry Online Support  
https://support.industry.siemens.com |
| 2. | Link to this entry  
| 3. | System Manual SIMOCODE pro PROFINET  
| 4. | Application Example "Configuration of a Ring Topology Based on MRP"  
| 5. | System manual "PROFINET System Description"  
Chapter "Media redundancy"  
| 6. | System manual "PROFINET System Description"  
Chapter "Device replacement without removable medium/PD"  

## 4.3 Change documentation

Table 4-2

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Modifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1.0</td>
<td>01/2017</td>
<td>First version</td>
</tr>
</tbody>
</table>