Application manual
I/O Engineering
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Overview of this manual

About this manual
This manual describes I/O Engineering and contains instructions on how to configure the I/O system.

Usage
This manual should be used during installation and configuration of the I/O system.

Who should read this manual?
This manual is intended for:
- Personnel that are responsible for installations and configurations of industrial network hardware/software.
- Personnel that make the configurations of the I/O system.
- System integrators.

Prerequisites
The reader should have the required knowledge of:
- I/O system configuration
- OmniCore controller
- RobotStudio

References

<table>
<thead>
<tr>
<th>Reference</th>
<th>Document ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application manual - CC-Link IE Field Network Basic</td>
<td>3HAC082295-001</td>
</tr>
<tr>
<td>Application manual - PROFINET Controller/Device</td>
<td>3HAC066558-001</td>
</tr>
<tr>
<td>Technical reference manual - System parameters</td>
<td>3HAC065041-001</td>
</tr>
<tr>
<td>Technical reference manual - RAPID Overview</td>
<td>3HAC065040-001</td>
</tr>
<tr>
<td>Product manual - OmniCore C30</td>
<td>3HAC060860-001</td>
</tr>
<tr>
<td>Product manual - OmniCore C90XT</td>
<td>3HAC073706-001</td>
</tr>
<tr>
<td>Product manual - OmniCore V250XT</td>
<td>3HAC073447-001</td>
</tr>
<tr>
<td>Operating manual - OmniCore</td>
<td>3HAC065036-001</td>
</tr>
<tr>
<td>Operating manual - RobotStudio</td>
<td>3HAC032104-001</td>
</tr>
</tbody>
</table>

Revisions

<table>
<thead>
<tr>
<th>Revision</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Released with RobotWare 7.7.</td>
</tr>
</tbody>
</table>
Categories for user documentation from ABB Robotics

The user documentation from ABB Robotics is divided into a number of categories. This listing is based on the type of information in the documents, regardless of whether the products are standard or optional.

Tip

All documents can be found via myABB Business Portal, [www.abb.com/myABB](http://www.abb.com/myABB).

Product manuals

Manipulators, controllers, DressPack/SpotPack, and most other hardware is delivered with a **Product manual** that generally contains:

- Safety information.
- Installation and commissioning (descriptions of mechanical installation or electrical connections).
- Maintenance (descriptions of all required preventive maintenance procedures including intervals and expected life time of parts).
- Repair (descriptions of all recommended repair procedures including spare parts).
- Calibration.
- Decommissioning.
- Reference information (safety standards, unit conversions, screw joints, lists of tools).
- Spare parts list with corresponding figures (or references to separate spare parts lists).
- References to circuit diagrams.

Technical reference manuals

The technical reference manuals describe reference information for robotics products, for example lubrication, the RAPID language, and system parameters.

Application manuals

Specific applications (for example software or hardware options) are described in **Application manuals**. An application manual can describe one or several applications.

An application manual generally contains information about:

- The purpose of the application (what it does and when it is useful).
- What is included (for example cables, I/O boards, RAPID instructions, system parameters, software).
- How to install included or required hardware.
- How to use the application.
- Examples of how to use the application.
Operating manuals

The operating manuals describe hands-on handling of the products. The manuals are aimed at those having first-hand operational contact with the product, that is production cell operators, programmers, and troubleshooters.
Safety

Safety regulations

Before beginning mechanical and/or electrical installations, ensure you are familiar with the safety information in the product manuals for the robot.

The integrator of the robot system is responsible for the safety of the robot system.
Network security

This product is designed to be connected to and to communicate information and data via a network interface. It is your sole responsibility to provide, and continuously ensure, a secure connection between the product and to your network or any other network (as the case may be).

You shall establish and maintain any appropriate measures (such as, but not limited to, the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB Ltd and its entities are not liable for damage and/or loss related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.
1 Introduction

I/O Engineering

The I/O Engineering functionality in RobotStudio can be used for configuration of I/O devices from the following industrial networks:

- PROFINET
- CC-Link IE Field Network Basic

See the application manuals for the respective industrial networks for more information.

I/O Project

Using the I/O Project functionality, I/O configuration can be made without a controller connected. The configuration can be prepared offline and later be written to a selected controller. It is also possible to read/load an existing configuration from a controller to an I/O project.

Prerequisites

For configuration in I/O Engineering, the user grant Modify configuration is required. See Operating manual - RobotStudio, section Managing user rights and write access on a controller.

Note

Manual request of write access is not required as I/O Engineering requests write access automatically when writing a configuration to the controller.

Recommended process

The following process is recommended:

- Create an I/O project, see Creating a new project on page 29.
- Configure the project:
  - Configure the internal controller and external devices. See application manual for respective industrial network.
  - Configure signals and creating cross connections, see Working with signals on page 45 and Working with cross connections on page 49.
- Save project, see Saving an I/O project on page 30.
- Write I/O configuration to controller, see Writing an I/O configuration to the controller on page 31.
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2 Software overview

2.1 I/O Engineering user interface

2.1.1 The user interface

Start I/O Engineering

1. Start RobotStudio and connect to the robot system to configure.
2. In the ribbon of the Controller tab, select I/O Engineering.

Overview of the user interface

This section presents an overview of the I/O Engineering graphical user interface.

<table>
<thead>
<tr>
<th>Parts</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Ribbon</td>
<td>Displays command buttons organized in a logical sequence of function.</td>
</tr>
<tr>
<td>B Configuration browser</td>
<td>Displays the I/O configuration tree with information of I/O system and its parameters.</td>
</tr>
<tr>
<td>C I/O System node</td>
<td>Displays parameters for I/O devices and signals.</td>
</tr>
<tr>
<td>D Output window</td>
<td>Displays the information about the events that occur in controller and I/O devices.</td>
</tr>
<tr>
<td>E Signal Editor</td>
<td>Displays the signals assigned to the selected I/O device. Enables to add or delete signals of I/O device.</td>
</tr>
</tbody>
</table>
2 Software overview

2.1.1 The user interface

Continued

<table>
<thead>
<tr>
<th>Parts</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Scan Editor</td>
</tr>
<tr>
<td>G</td>
<td>Properties browser</td>
</tr>
</tbody>
</table>
2.1.2 The ribbon

Layout of the ribbon

This section describes the functions of the command buttons.

The ribbon contains following command buttons:

<table>
<thead>
<tr>
<th>Button</th>
<th>Functions used for</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/O Project</td>
<td>Menu for access to I/O Project functions such as New Project, Open Project, Save Project and Project Settings.</td>
</tr>
<tr>
<td>Write config</td>
<td>Writes configuration to the controller and the pending changes to the controller.</td>
</tr>
<tr>
<td></td>
<td>Note</td>
</tr>
<tr>
<td></td>
<td>Needs write access.</td>
</tr>
<tr>
<td>Signal Editor</td>
<td>Opens the Signal Editor which displays the signals assigned to the I/O device.</td>
</tr>
<tr>
<td>Cross Connections</td>
<td>Opens the Cross Connections view in which cross connections can be created or modified.</td>
</tr>
<tr>
<td>I/O System Levels</td>
<td>Menu that opens the views for Access Levels, Device Trust Levels and Signal Safe Levels.</td>
</tr>
<tr>
<td>GSD Files</td>
<td>Opens the GSD Files window from which GSD files can be managed.</td>
</tr>
<tr>
<td>Default Layout</td>
<td>Restores the default layout.</td>
</tr>
<tr>
<td>Close</td>
<td>Closes the I/O Engineering view.</td>
</tr>
</tbody>
</table>
2.1.3 Configuration browser

Introduction

The Configuration browser displays hierarchical structure of controller and configuration elements in the I/O Engineering tab. You can click each node in the tree structure to view the parameters and edit the selected parameter in the Properties tab.

I/O Engineering Controller node

The I/O Engineering Controller node is the top node for the I/O Engineering project containing all the I/O configuration.

If an Associated Controller is defined for the I/O project, the name of this robot controller will be displayed in the controller node.

I/O System node

The I/O System node contains parameters for I/O devices and signals. You can configure generic I/O devices and safe I/O devices in the I/O System node.

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross Connections</td>
<td>Opens the Cross Connections tab, where cross connections can be maintained.</td>
</tr>
<tr>
<td>Access Levels</td>
<td>Opens the Access Levels tab, where access levels can be maintained.</td>
</tr>
<tr>
<td>Device Trust Levels</td>
<td>Opens the Device Trust Levels tab, where device trust levels can be maintained.</td>
</tr>
<tr>
<td>Signal Safe Levels</td>
<td>Opens the Signal Safe Levels tab, where signal safe levels can be maintained.</td>
</tr>
</tbody>
</table>
Virtual Signals
Opens the Signal Editor tab, where signals can be maintained. Virtual signals are signals without any connection to a device. See Technical reference manual - System parameters for more information about virtual signals.

Categories
Opens the Signal Editor tab, and displays all currently defined signal categories.

Industrial Network node
Displays the industrial network that is used in the controller, for example PROFINET. The parameters of the corresponding industrial network is visible in the Properties tab.

Controller
The Controller node represents an industrial network where the robot controller acts as controller (for example controller/scanner/master). Under the Controller node are representations of all I/O devices that are connected to the industrial network where the robot controller acts as controller. You can configure the parameters of the I/O devices in the Properties tab.

For detailed descriptions of the elements, see Technical reference manual - System parameters.

Symbols
The following symbols display the status of the I/O device, controller or entity.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>🎯</td>
<td>Indicates an error. The configuration cannot be saved before the error is removed.</td>
</tr>
<tr>
<td>🚨⚠️</td>
<td>Indicates incomplete information. You can enter the pending information in the Properties tab.</td>
</tr>
<tr>
<td>*</td>
<td>Indicates that there are unsaved changes.</td>
</tr>
<tr>
<td>🎮</td>
<td>Indicates a sub-module belonging to an I/O device. The sub-module is used configure some parameters for the I/O device (e.g. input delay).</td>
</tr>
<tr>
<td>🟢</td>
<td>Identifier for an I/O device.</td>
</tr>
<tr>
<td>🟣</td>
<td>Identifier for a safety I/O device.</td>
</tr>
<tr>
<td>🎮❓</td>
<td>Identifies an unknown I/O device which is not mapped to a device description file.</td>
</tr>
</tbody>
</table>

Note
Point to the error or warning symbol to view the corresponding validation information.

Continues on next page
2 Software overview

2.1.3 Configuration browser

Continued

**Right-click menu**

Within the **Configuration** browser tree structure, you can right-click the I/O device to show a shortcut menu with various operations (not all are available for all I/O devices):

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delete</td>
<td>Removes the I/O device from the <strong>Configuration</strong> browser structure.</td>
</tr>
</tbody>
</table>
2.1.4 Properties browser

**Properties tab**

The Properties tab displays the parameters of the I/O System node. You can configure the parameters visible in the Properties tab. For more information about parameters, see *Technical reference manual - System parameters* and the respective industrial network application manual.

**Device Catalogue tab**

The Device Catalogue tab displays the predefined device templates used to configure the I/O device.
2.1.5 Signal Editor

Overview

The Signal Editor tab displays the signals that are assigned to the I/O device. It is used to view existing signals and to add new signals to the I/O device.

It is also possible to define group signals that cover signals for several modules. See Create group signals on page 46 for information about group signal configuration.

For more information about the signal attributes, see Technical reference manual - System parameters.
2.1.6 Scan Editor

Overview

Note

The Scan Editor is a specific function used for PROFINET configurations.

The Scan Editor tab displays the I/O devices discovered in the controller network scan. It displays information such as MAC, Station Name, IP, Subnet, Gateway, Vendor Id, and Device Id.

When scan network is run, Scan Editor displays all the I/O devices connected to the given network port for the PROFINET network. You can then configure the I/O devices that are found but not already configured in the controller. For more information, see Application manual - PROFINET Controller/Device.
2 Software overview

2.1.7 Cross Connection interface

2.1.7.1 Cross Connection overview

Overview

<table>
<thead>
<tr>
<th>Views</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Operators</td>
</tr>
<tr>
<td>B</td>
<td>Toolbar</td>
</tr>
<tr>
<td>C</td>
<td>Main view</td>
</tr>
<tr>
<td>D</td>
<td>Tab (general information)</td>
</tr>
</tbody>
</table>
## 2.1.7.2 Cross Connection toolbar

### Cross Connection toolbar

<table>
<thead>
<tr>
<th>Tool</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Zoom in/out</td>
</tr>
<tr>
<td>B</td>
<td>Fit to window</td>
</tr>
<tr>
<td>C</td>
<td>Delete</td>
</tr>
<tr>
<td>D</td>
<td>Show/Hide Grid</td>
</tr>
<tr>
<td>E</td>
<td>Align Operators</td>
</tr>
<tr>
<td>F</td>
<td>Export</td>
</tr>
<tr>
<td>G</td>
<td>Search</td>
</tr>
<tr>
<td>H</td>
<td>Status</td>
</tr>
</tbody>
</table>
### Cross Connection operators

<table>
<thead>
<tr>
<th>Type</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AND</td>
<td><img src="image" alt="AND Symbol" /></td>
<td>The operator <strong>AND</strong> can connect 2-5 Actors Signals and combine them into a Resultant Signal.</td>
</tr>
<tr>
<td>OR</td>
<td><img src="image" alt="OR Symbol" /></td>
<td>The operator <strong>OR</strong> can connect 2-5 Actors Signals and combine them into a Resultant Signal.</td>
</tr>
<tr>
<td>NOT</td>
<td><img src="image" alt="NOT Symbol" /></td>
<td>The operator <strong>NOT</strong> inverts one Actors Signal into a Resultant Signal.</td>
</tr>
<tr>
<td>FWD</td>
<td><img src="image" alt="FWD Symbol" /></td>
<td>The operator <strong>FWD</strong> maps one Actors Signal into a Resultant Signal.</td>
</tr>
</tbody>
</table>
2.1.7.4 Cross Connections tab

The Cross Connections tab displays information for the selected operator.

### Field Description

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Cross Connections</td>
<td>Shows the total number of cross connections (max 300). If the maximum number is exceeded, this is indicated with a red frame.</td>
</tr>
<tr>
<td>Max Group Size</td>
<td>Shows the size of the largest group of connected cross connections.</td>
</tr>
<tr>
<td>Max Depth</td>
<td>Shows the highest depth value among all cross connections (max 20). If the maximum number is exceeded, an error will be indicated.</td>
</tr>
<tr>
<td>Name</td>
<td>Shows the name of the selected cross connection. A maximum of 32 characters is allowed.</td>
</tr>
<tr>
<td>Operator</td>
<td>Shows the type of operator used in the selected cross connection.</td>
</tr>
<tr>
<td>Number of Actors</td>
<td>Shows the number of operators used in the selected cross connection.</td>
</tr>
</tbody>
</table>

**Note**

For the operators AND and OR, the number of actors can be 2-5.

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actor Signal</td>
<td>Select an available actor signal from the drop down list.</td>
</tr>
<tr>
<td>Inverted</td>
<td>Select the check box to invert the actor signal.</td>
</tr>
<tr>
<td>Resultant Signal</td>
<td>Select an available resultant signal from the drop down list.</td>
</tr>
</tbody>
</table>
This page is intentionally left blank
3 Working with I/O projects

3.1 Creating a new project

Creating a new project

1. Select I/O Project and then New Project. The New Project window is displayed:

![New Project window](image)

Complete the following fields and select OK:

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RobotWare version</td>
<td>Select the RobotWare version to be used for the project.</td>
</tr>
<tr>
<td>Project Name</td>
<td>Enter a unique project name.</td>
</tr>
<tr>
<td>Associated Controller</td>
<td>Select a controller to be associated with the project. If defined, the associated controller will automatically be selected in certain functions such as writing the configuration to a controller or scanning for devices that are connected to the controller.</td>
</tr>
<tr>
<td>Description</td>
<td>If applicable, enter a project description.</td>
</tr>
</tbody>
</table>

2. A new project has now been created.

To configure the project, see the Application manual for the respective industrial network.

To save the project, see Saving an I/O project on page 30.
3.2 Saving an I/O project

Save the I/O project

**Note**

The I/O Project cannot be saved if errors are detected (see *Symbols on page 19*). It is, however, possible to save projects with warnings.

1. In the I/O Project menu, select one of the following:
   - Select **Save Project** to update the last saved project version.
   - Select **Save Project As** to save the project file with a new project name.

2. When the configuration has been completed and the project file is saved, continue by writing the configuration to the controller. See *Writing an I/O configuration to the controller on page 31*. 
3.3 Writing an I/O configuration to the controller

Prerequisites

- An added robot controller in the Controller tab in RobotStudio.
- The I/O project must be saved.
- Request write access to the controller.

Note

I/O Engineering automatically requests write access when a configuration is written to the controller. If write access is not granted, the configuration will not be written to the controller.

- The correct options must be installed in the controller.
- The validation error on each element in the Configuration browser must be corrected.

Write the I/O configuration to the controller

1. In the I/O Project menu, select Read/Write Configuration to write the configuration to a controller. The Read/Write I/O configuration window is displayed:
2 Select a controller and click **Write to Controller** to write the current project to the controller.

**Note**

If an **Associated Controller** is defined for the I/O project, this controller will automatically be selected when the **Read/Write Configuration** function is selected.

3 The project configuration has now been written to the selected controller.
3.4 Reading an I/O configuration to a project file

Prerequisites

An added robot controller in the Controller tab in RobotStudio.

Note

This functionality resembles saving the configuration parameters to an EIO.cfg file from the Controller tab in RobotStudio. However, using the I/O Engineering read function, the entire project including all the configuration data needed for the I/O configuration will be saved, not just the cfg file.

Read the I/O configuration to the project file

1. In the I/O Project menu, select Read/Write Configuration. The Read/Write I/O configuration window is displayed:

2. Select a controller and click Read from Controller to read the I/O configuration from the selected controller and save to a project file.

3. In the Save As dialog, select the project file to which the configuration should be written, or create a new I/O project name. Click Save. The controller I/O configuration has now been written to the selected project.
3 Working with I/O projects

3.5 Changing RobotWare version for an I/O project file

3.5 Changing RobotWare version for an I/O project file

Prerequisites

The robot controller and the I/O project must have the same RobotWare version. If this is not the case, the I/O project must be updated to the same version so that it is possible to write the I/O configuration to the robot controller.

Change RobotWare version for a project file

1. In the I/O Project menu, select Project Settings. The Project Settings window is displayed:

   ![Project Settings window]

   1. Select a new RobotWare version to used for the project file and click OK.
   2. Select I/O Project/Save Project to save the changes.
3.6 Defining an associated controller to an I/O project

**Note**

If an Associated Controller is defined for the I/O project, this controller will automatically be selected when the Read/Write Configuration function is selected.

**Associate a controller to a project file**

1. Open the I/O project to which a controller should be associated.
2. In the I/O Project menu, select Project Settings. The Project Settings window is displayed:

   ![Project Settings Window](image)

   Click Select to browse for a controller to be associated with the project, and then click OK.
3. In the Save As dialog, select the project file to which the configuration should be written, or create a new I/O project name. Click Save. The controller I/O configuration has now been written to the selected project.
4. Select I/O Project/Save Project to save the changes.
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4 Working with devices

Configuring I/O devices

For information about how to configure the internal controller, internal device and external devices, see the application manual for respective industrial network:

- Application manual - CC-Link IE Field Network Basic
- Application manual - PROFINET Controller/Device
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5 Working with I/O system levels

5.1 Configuring access levels

Overview

The Access Level defines the write access to I/O signals for categories of I/O controlling clients connected to the robot controller.

This is used to limit the write access to I/O signals from clients. The access level settings differentiates local clients (for example, FlexPendant) from remote clients (for example, RobotStudio).

For detailed information about the Access Level, see Technical reference manual - System parameters.

Creating access levels

1 In the ribbon of the I/O Engineering tab, expand I/O System Levels and select Access Levels. The Access Levels tab is displayed:

2 Select Add to create a new access level. Complete the following fields:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Enter a unique name for the access level.</td>
</tr>
<tr>
<td></td>
<td>Note: The name can only be 32 characters long and contain alphanumeric and '.' characters, always beginning with an alphabetic character.</td>
</tr>
<tr>
<td>Rapid</td>
<td>Select one of the following options, indicating if the access level should be read only or write enabled:</td>
</tr>
<tr>
<td></td>
<td>• Read Only</td>
</tr>
<tr>
<td></td>
<td>• Write Enabled</td>
</tr>
<tr>
<td>Local Client in Manual Mode</td>
<td>Select one of the following options, indicating if the access level should be read only or write enabled for the local client in manual mode:</td>
</tr>
<tr>
<td></td>
<td>• Read Only</td>
</tr>
<tr>
<td></td>
<td>• Write Enabled</td>
</tr>
<tr>
<td>Local Client in Auto Mode</td>
<td>Select one of the following options, indicating if the access level should be read only or write enabled for the local client in auto mode:</td>
</tr>
<tr>
<td></td>
<td>• Read Only</td>
</tr>
<tr>
<td></td>
<td>• Write Enabled</td>
</tr>
</tbody>
</table>

Continues on next page
5 Working with I/O system levels

5.1 Configuring access levels

Continued

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote Client in Manual Mode</td>
<td>Select one of the following options, indicating if the access level should be read only or write enabled for the remote client in manual mode:</td>
</tr>
<tr>
<td></td>
<td>• Read Only</td>
</tr>
<tr>
<td></td>
<td>• Write Enabled</td>
</tr>
<tr>
<td>Remote Client in Auto Mode</td>
<td>Select one of the following options, indicating if the access level should be read only or write enabled for the remote client in auto mode:</td>
</tr>
<tr>
<td></td>
<td>• Read Only</td>
</tr>
<tr>
<td></td>
<td>• Write Enabled</td>
</tr>
</tbody>
</table>

3 Select I/O Project/Save Project to save the changes.

4 If applicable, write the configuration to the controller. See Writing an I/O configuration to the controller on page 31.

Assigning an access level to a signal

The Access Level to be used for a signal is defined in the Signal Editor for each signal.
5.2 Configuring device trust levels

Overview

The Device Trust Level defines the behavior for I/O devices at different execution situations in the robot controller. It controls the behavior of the robot system and event generation for I/O devices.

For detailed information about the Device Trust Level, see Technical reference manual - System parameters.

Creating new device trust levels

1. In the ribbon of the I/O Engineering tab, expand I/O System Levels and select Device Trust Levels. The Device Trust Levels tab is displayed:

2. Select Add to create a new device trust level. Complete the following fields:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Enter a unique name for the device trust level.</td>
</tr>
<tr>
<td></td>
<td>Note: The name can only be 32 characters long and contain alphanumeric and '_' characters, always beginning with an alphabetic character.</td>
</tr>
<tr>
<td>Deny Deactivate</td>
<td>Select Deny Deactivate or Allow Deactivate, indicating if it is possible to deactivate the I/O device.</td>
</tr>
</tbody>
</table>
| Action when Disconnected| Select one of the following options, indicating what system action to be performed when the communication with an I/O device is lost:  
|                         | • No Action  
|                         | • Generate "System Stop"  
|                         | • Generate "System Halt"  
|                         | • Generate "System Fail"  
| Report when Disconnected| Select one of the following options, specifying the event reporting when the communication with an I/O device is lost:  
|                         | • No Error Reporting  
|                         | • Generate Error  
|                         | • Generate Information (State Change)  
|                         | • Generate Warning  

Continues on next page
### 5.2 Configuring device trust levels

**Continued**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action when Faulty</td>
<td>Select one of the following options, indicating what system action to be performed when the signals are not accessible and the I/O device is changed to a bad state:</td>
</tr>
<tr>
<td></td>
<td>• No Action</td>
</tr>
<tr>
<td></td>
<td>• Generate &quot;System Stop&quot;</td>
</tr>
<tr>
<td></td>
<td>• Generate &quot;System Halt&quot;</td>
</tr>
<tr>
<td></td>
<td>• Generate &quot;System Fail&quot;</td>
</tr>
<tr>
<td>Report when Faulty</td>
<td>Select one of the following options, specifying the event reporting when an I/O device is changed to a bad state:</td>
</tr>
<tr>
<td></td>
<td>• No Error Reporting</td>
</tr>
<tr>
<td></td>
<td>• Generate Error</td>
</tr>
<tr>
<td></td>
<td>• Generate Information (State Change)</td>
</tr>
<tr>
<td></td>
<td>• Generate Warning</td>
</tr>
<tr>
<td>Report when Reconnected</td>
<td>Select one of the following options, specifying the event reporting when the communication with an I/O device is re-established:</td>
</tr>
<tr>
<td></td>
<td>• No Error Reporting</td>
</tr>
<tr>
<td></td>
<td>• Generate Error</td>
</tr>
<tr>
<td></td>
<td>• Generate Information (State Change)</td>
</tr>
<tr>
<td></td>
<td>• Generate Warning</td>
</tr>
</tbody>
</table>

3 Select I/O Project/Save Project to save the changes.

4 If applicable, write the configuration to the controller. See [Writing an I/O configuration to the controller on page 31](#).

**Assigning a device trust level to a controller**

The *Device Trust Level* to be used for a controller is defined in the controller properties for an I/O device.
5.3 Configuring signal safe levels

Overview

The *Signal Safe Level* defines the behavior of logical output, digital, group and analog signals at the following execution situations in the robot system:

- during system startup
- when signal becomes accessible
- when signal is not accessible
- during system shutdown

For detailed information about the *Signal Safe Level*, see [Technical reference manual - System parameters](#).

Creating signal safe levels

1. In the ribbon of the I/O Engineering tab, expand I/O System Levels and select Signal Safe Levels. The Signal Safe Levels tab is displayed:

   ![Signal Safe Levels tab](#)

2. Select Add to create a new signal safe level. Complete the following fields:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Enter a unique name for the signal safe level.</td>
</tr>
<tr>
<td></td>
<td><strong>Note</strong></td>
</tr>
<tr>
<td></td>
<td>The name can only be 32 characters long and contain alphanumeric and '_' characters, always beginning with an alphabetic character.</td>
</tr>
<tr>
<td>Action When System Startup</td>
<td>Select one of the following options, specifying the value for a logical output signal after startup of the robot system:</td>
</tr>
<tr>
<td></td>
<td>• Set zero value</td>
</tr>
<tr>
<td></td>
<td>• Set default value</td>
</tr>
<tr>
<td></td>
<td>• Set last value</td>
</tr>
<tr>
<td>Action when Signal Accessible</td>
<td>Select one of the following options, specifying the value for a logical output signal when its physical state becomes accessible:</td>
</tr>
<tr>
<td></td>
<td>• Set zero value</td>
</tr>
<tr>
<td></td>
<td>• Set default value</td>
</tr>
<tr>
<td></td>
<td>• Set last value</td>
</tr>
<tr>
<td>Action when Signal Not Accessible</td>
<td>Select one of the following options, specifying the value for a logical output signal when its physical state becomes not accessible:</td>
</tr>
<tr>
<td></td>
<td>• Set zero value</td>
</tr>
<tr>
<td></td>
<td>• Set default value</td>
</tr>
<tr>
<td></td>
<td>• Set last value</td>
</tr>
</tbody>
</table>

Continues on next page
### 5.3 Configuring signal safe levels

#### Parameter Table

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action when System Shutdown</td>
<td>Select one of the following options, specifying the value for a logical output signal when the robot system is shutdown:</td>
</tr>
<tr>
<td></td>
<td>• Set zero value</td>
</tr>
<tr>
<td></td>
<td>• Set default value</td>
</tr>
<tr>
<td></td>
<td>• Set last value</td>
</tr>
</tbody>
</table>

3. Select I/O Project/Save Project to save the changes.

4. If applicable, write the configuration to the controller. See *Writing an I/O configuration to the controller on page 31*.

#### Assigning a signal safe level to a signal

The *Signal Safe Level* to be used for a signal is defined in the Signal Editor for each signal.
6 Working with signals

6.1 Creating I/O signals

Prerequisites

An I/O device must be added to the I/O project.

Create I/O signals

1. In the ribbon of the I/O Engineering tab, select Signal Editor.
2. In the Configuration browser, select the I/O device for which signals are to be created and complete the fields.

For detailed descriptions of all signal parameters, see Technical reference manual - System parameters.

3. Select I/O Project/Save Project to save the changes.
6.2 Creating group signals

Create group signals

Group signals can be created on device level and on module level.

1. Open the Signal Editor.
2. In the Configuration browser, select the I/O device for which a group signal is to be added.
3. Complete the following:
   - **Name**: Enter a name for the group signal.
   - **Device Mapping**: Define the span of signals to be included in the group.
     For example, if 0-16 is defined, all signals with a device mapping value within this span will be included in the group.
4. Select **I/O Project/Save Project** to save the changes.

For detailed descriptions of group signals, see *Technical reference manual - System parameters*.
6.3 Assigning categories to signals

Description
With categories it is possible to group signals or virtual signals under different categories defined by the user.

For example, categories make it easy to find several virtual signals belonging to a specific application as they are grouped.

Assign categories to signals

1. Open the Signal Editor.
2. Select the signal for which a category should be defined. Select an existing category, or create a new by typing a name in field Category:

![Signal Editor Screen]

Note
In the I/O System tree, expand Categories to view all existing categories and the assigned signals.

3. Select I/O Project/Save Project to save the changes.
4. If applicable, write the configuration to the controller.
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7 Working with cross connections

7.1 Overview

Usage

A cross connection is a logical connection between I/O signals of type digital (DO, DI) or group (GO, GI), that allow one or several I/O signals to automatically affect the state of other I/O signals.

Using cross connections is a simple way to interconnect I/O signals and let the robot system handle I/O activity without having to execute any RAPID code. Cross connecting I/O signals is a good alternative if there is an input I/O signal in the process that, when activated, automatically activates one or several output I/O signals.

It is also possible to construct more complex conditions by combining up to five different actor I/O signals with operators. The actor I/O signals can also be inverted.

Limitations

- The maximum number of cross connections handled by the robot system is 300.
- Cross connections must not form a chain that is deeper than 20 levels. A chain is formed when cross connections are interlinked so that an I/O signal that is part of a resultant expression in one cross connection is also part of the actor expression of another cross connection, and so on. The depth of such chain is the number of transitions from the first actor I/O signal to the last resultant I/O signal.
- Cross connections must not form closed chains since that would cause infinite evaluation and oscillation. A closed chain appears when cross connections are interlinked so that the chain of cross connections forms a circle.
- Ambiguous resultant I/O signals are not allowed since the outcome would depend on the order of evaluation (which cannot be controlled). Ambiguous resultant I/O signals occur when the same I/O signal is resultant in several cross connections.
- The resultant I/O signal in a cross connection must not have an overlapping device map with any inverted actor I/O signals defined in the cross connection. Using I/O signals with overlapping device map in a cross connection can cause infinity signal setting loops.
- Mixed crossed connections are not allowed. If mixed cross connections are loaded from a previous version, these will automatically be converted to several cross connections.
- The parameters Default Value and Signal Safe Level do not affect signals that are a resultant in a cross connection. The resultant signal is only affected by the actor signal values in the cross connection.
7 Working with cross connections

7.2 Creating cross connections

Create cross connections

1. In the ribbon of the I/O Engineering tab, select Cross Connections. The Cross Connections window is displayed:

2. Drag operators (AND, OR, FWD or NOT) from the left side and drop in the Cross Connection View:

Tip

Use the tool Align Operators to adjust the operators to be placed in a structured way.
3 Connect the resultant to an actor using the mouse (click, drag and connect):

![Diagram showing cross connections with actors and resultants]

**Note**

- All actors and resultants must be connected to a valid signal. If not, this is indicated with a red signal and a warning that the status is invalid.
- For the operators **AND** and **OR**, the number of actors can be 2-5. This can be changed in the properties window, field **Number of Actors**. Default is 2.
- If the resultant is not connected to an actor (**Unassigned**), a virtual signal will be created. Virtual signals are not connected to external equipment, but only exist internally in the controller.

4 Configure the cross connections until all signals are valid:

![Diagram showing configured cross connections]
5 Select an operator in the cross connection and configure the properties in the *Cross Connections* tab:

The following properties can be configured:

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Enter a name for the selected cross connection. A maximum of 32 characters is allowed. The string must follow the RAPID rules described in Technical reference manual - RAPID Overview. The name must be unique among all named objects in the I/O system configuration.</td>
</tr>
<tr>
<td>Number of Actors</td>
<td>Select the number of actors to be used for the selected operator. For the operators <strong>AND</strong> and <strong>OR</strong>, the number of actors can be 2-5.</td>
</tr>
<tr>
<td>Actor Signal</td>
<td>Select an available actor signal from the drop down list. New signals can be created in the Signal Editor.</td>
</tr>
<tr>
<td>Inverted</td>
<td>Select the check box to invert the actor signal.</td>
</tr>
<tr>
<td>Resultant Signal</td>
<td>Select an available resultant signal from the drop down list. New signals can be created in the Signal Editor.</td>
</tr>
</tbody>
</table>

**Note**

Invalid properties are indicated with a red frame.

6 Select **I/O Project/Save Project** to save the changes.

7 If applicable, write the configuration to the controller. See *Writing an I/O configuration to the controller on page 31*. 
7.3 Exporting cross connections

In the I/O Commissioning tab, select Cross Connections. The Cross Connections window is displayed with the current connections.

Select the tool Export to export all cross connections to a vector-based xps-format, that can be viewed for example in Adobe Acrobat Reader.

Specify the location where the exported file should be saved and select Save.
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8 Troubleshooting

8.1 Loading mixed cross connections from previous RobotWare versions

Overview

If more than two actor I/O signals are used in one cross connection, the evaluation is made from left to right. This means that the operation between Actor 1 and Actor 2 is evaluated first and the result from that is used in the operation with Actor 3. If all operators in one cross connection are of the same type (only AND or only OR) the evaluation order has no significance. However, mixing AND and OR operators, without considering the evaluation order, may give an unexpected result.

For this reason, in this cross connection interface, several cross connections are used instead of mixing AND and OR in the same cross connection. This separation is made automatically when cross connections from previous versions of RobotWare are loaded.
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