ROBOTICS

Application manual

I/O Engineering

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Application manual
I/O Engineering
RobotWare 7.13

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Original instructions.

Table of contents

Table of contents

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

Reference	Document ID
Application manual - CC-Link IE Field Basic	*3HAC082295-001*
Application manual - EtherNet/IP Scanner/Adapter	*3HAC066565-001*
Application manual - PROFINET Controller/Device	*3HAC066558-001*
Application manual - RobotWare add-ins	*3HAC070207-001*
Technical reference manual - System parameters	*3HAC065041-001*
Technical reference manual - RAPID Overview	*3HAC065040-001*
Product manual - OmniCore C30	*3HAC060860-001*
Product manual - OmniCore C90XT	*3HAC073706-001*
Product manual - OmniCore V250XT Type B	*3HAC087112-001*
Product manual - OmniCore V400XT	*3HAC081697-001*
Operating manual - OmniCore	*3HAC065036-001*
Operating manual - RobotStudio	*3HAC032104-001*

Revisions

Revision	Description
A	Released with RobotWare 7.7.

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Continued

Revision	Description
B	Released with RobotWare 7.8. • Section *Working with I/O projects on page 29* updated with information about how to select industrial networks for an I/O project.
C	Released with RobotWare 7.10. • Updated the section *Symbols on page 19*. • New section: *Create safety group signals on page 50*.
D	Released with RobotWare 7.12. • New section: *Merging I/O projects on page 34*. • New section: *Write I/O configuration from add-in on page 32* • EtherNet/IP added in list of industrial networks in *Introduction on page 13*.
E	Released with RobotWare 7.13. • Information about Transfer Data added in *I/O System node on page 18* and *Transferring data on page 63*. • New sections: *Import device template files on page 40* and *Adding I/O devices and modules to a network on page 41*. • New section: *Working with virtual networks on page 59*

Product documentation

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*.

Product manuals

Manipulators, controllers, DressPack, 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.
- Troubleshooting.
- 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.

Continues on next page

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- 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

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 Basic
- EtherNet/IP

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 49* and *Working with cross connections on page 53*.
- 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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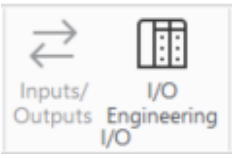
2 Software overview

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**.



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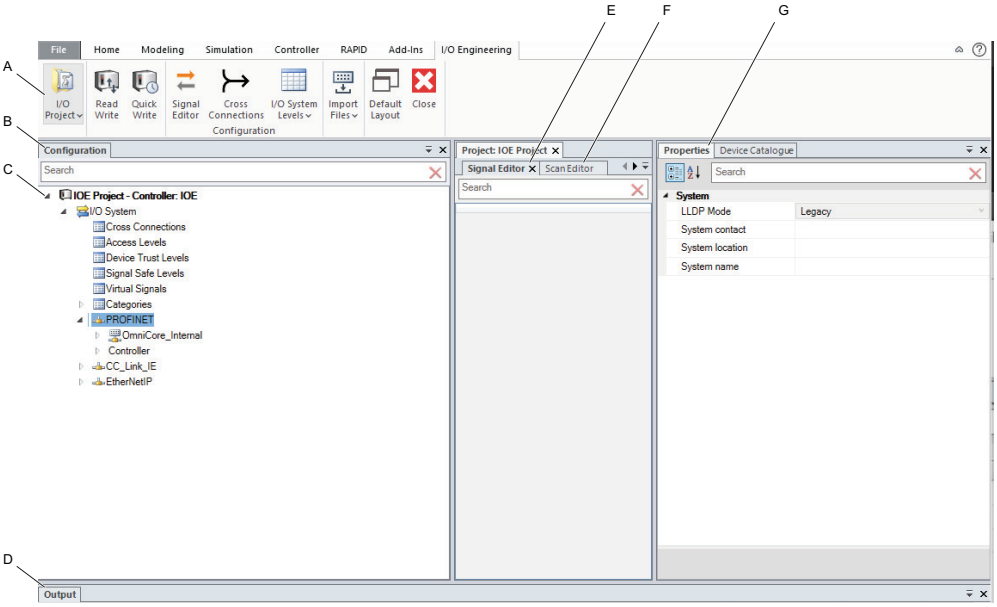
Overview of the user interface

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



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	Parts	Description
A	Ribbon	Displays command buttons organized in a logical sequence of function.
B	**Configuration** browser	Displays the I/O configuration tree with information of I/O system and its parameters.
C	**I/O System node**	Displays parameters for I/O devices and signals.
D	**Output** window	Displays the information about the events that occur in controller and I/O devices.

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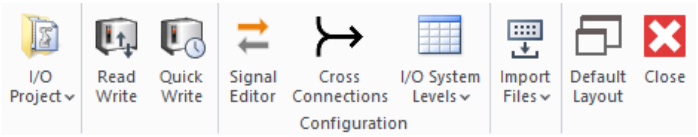
2.1.1 The user interface
Continued

	Parts	Description
E	**Signal Editor**	Displays the signals assigned to the selected I/O device. Enables to add or delete signals of I/O device.
F	**Scan Editor**	Displays the information of the I/O devices that are found on the network seen through the given port in the bus definition.
G	**Properties** browser	Displays all available properties and settings of the selected I/O device or Configuration nodes. The following tabs are available: • **Properties** tab - displays the properties of the selected I/O device. • **Device Catalogue** tab - displays the device catalogues used for configuring the I/O devices.

2.1.2 The ribbon

Layout of the ribbon

This section describes the functions of the command buttons.



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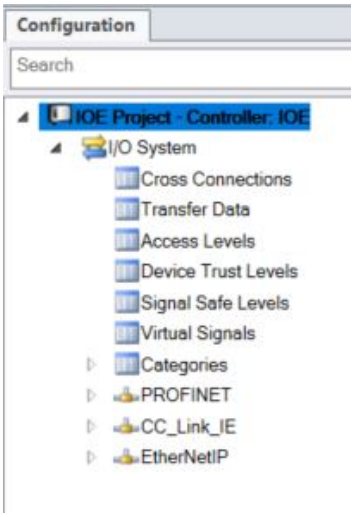
The ribbon contains following command buttons:

Button	Functions used for
I/O Project	Menu for access to I/O Project functions such as **New Project**, **Open Project**, **Save Project** and **Project Settings**.
Read/Write	Writes configuration to the controller and the pending changes to the controller. **Note** Needs write access.
Quick Write	Writes the selected project to the associated controller.
Signal Editor	Opens the **Signal Editor** which displays the signals assigned to the I/O device.
Cross Connections	Opens the **Cross Connections** view in which cross connections can be created or modified.
I/O System Levels	Menu that opens the views for **Access Levels**, **Device Trust Levels** and **Signal Safe Levels**.
Import Files	Select to import the following files: • **GSD Files** (PROFINET). • **EDS Files** (EtherNet/IP). • **CSP+ Files** (CC-Link).
Default Layout	Restores the default layout.
Close	Closes the I/O Engineering view.

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.



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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.

Element	Description
Cross Connections	Opens the **Cross Connections** tab, where cross connections can be maintained.
Transfer Data	Opens the **Transfer Data** tab, where data transfer orders can be maintained.
Access Levels	Opens the **Access Levels** tab, where access levels can be maintained.
Device Trust Levels	Opens the **Device Trust Levels** tab, where device trust levels can be maintained.
Signal Safe Levels	Opens the **Signal Safe Levels** tab, where signal safe levels can be maintained.
Virtual Signals	Opens the **Signal Editor** tab, where signals can be maintained. Virtual signals are signals without any connection to a device.

Continues on next page

Element	Description
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.

Symbol	Explanation
	Indicates an error. The configuration cannot be saved before the error is removed.
	Indicates incomplete information. You can enter the pending information in the **Properties** tab.
	Indicates that there are unsaved changes.
	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).
	Identifier for an I/O device.
	Identifier for a safety I/O device.
	Indicates that a device, module or signal is configured as protected in the safety configuration. See *Application manual - Functional safety and SafeMove*.
	Identifies an unknown I/O device which is not mapped to a device description file.

Note

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

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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):

Setting	Description
Delete	Removes the I/O device from the **Configuration** browser structure.

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 50* 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.

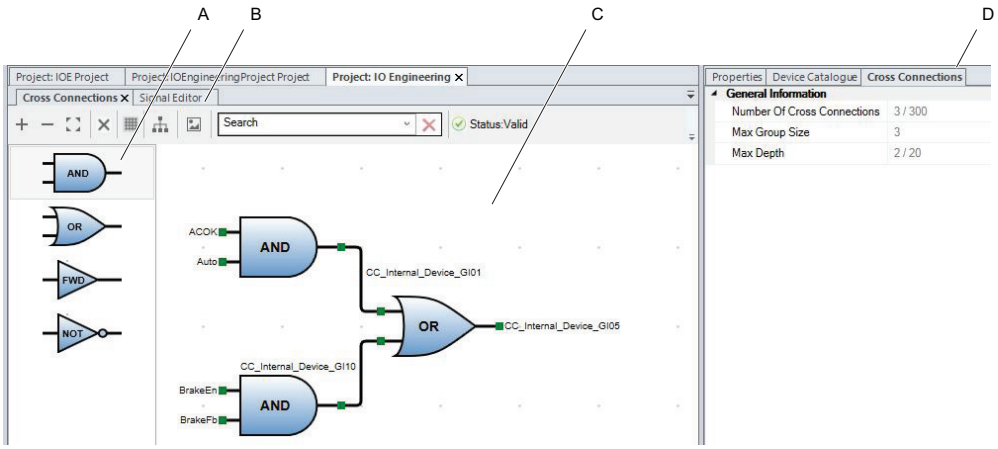
The **Scan Editor** tab displays the I/O devices discovered in the controller network scan. It displays information such as *MAC*, *Station Name*, *IP*, *Subnet*, *Gateway*, *Vendor Id*, and *Device Id*.

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*.

2.1.7 Cross Connection interface

2.1.7.1 Cross Connection overview

Overview



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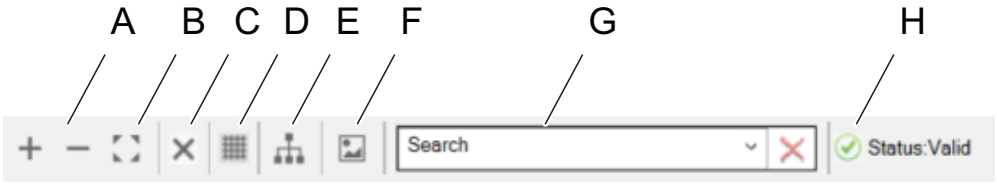
	Views	Description
A	**Operators**	Contains the four operators: **AND**, **OR**, **FWD**, **NOT**. Drag and Drop the wanted operators from the **Cross Connection Operators** into the **Cross Connection View**. Each operator is one *Cross Connection*.
B	**Toolbar**	Contains the Cross Connection tools, for example **Zoom**, **Delete** and **Search**.
C	**Main view**	The main view, in which the operators can be dragged and dropped. It is also possible to connect a line from the *Resultant* to the *Actor* to create a *Virtual Signal*. It is only possible to connect from a *Resultant* to an *Actor*.
D	**Tab (general information)**	Contains the details for the selected operator. The properties can be assigned, for example **Name**, **Number of Actors**, **Actor Signal** and **Resultant Signal**.

2.1.7.2 Cross Connection toolbar

Cross Connection toolbar



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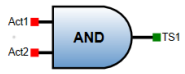
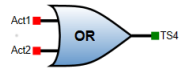
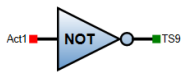
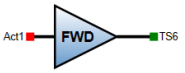
	Tool	Description
A	Zoom in/out	Click **+** and **-** or use the mouse wheel to zoom in/out.
B	Fit to window	Click **Fit to window** to adjust the main window to show all the cross connections.
C	Delete	Click **Delete** to delete all the selected operators and connections.
D	Show/Hide Grid	Click **Show**/**Hide Grid** to toggle between showing or hiding the grid. The operators will always snap to the grid, even if the grid is hidden.
E	Align Operators	Click **Align Operators** to adjust the operators to be placed in a structured way.
F	Export	Click **Export** to export all cross connections to a vector-based xps-format, that can be viewed for example in Adobe Acrobat Reader.
G	Search	Enter search text to search for a signal or a cross connection name. All matching cross connections will be indicated.
H	Status	Shows **Valid** if all cross connections are connected to a valid signal, otherwise shows **Invalid**.

2.1.7.3 Cross Connection operators

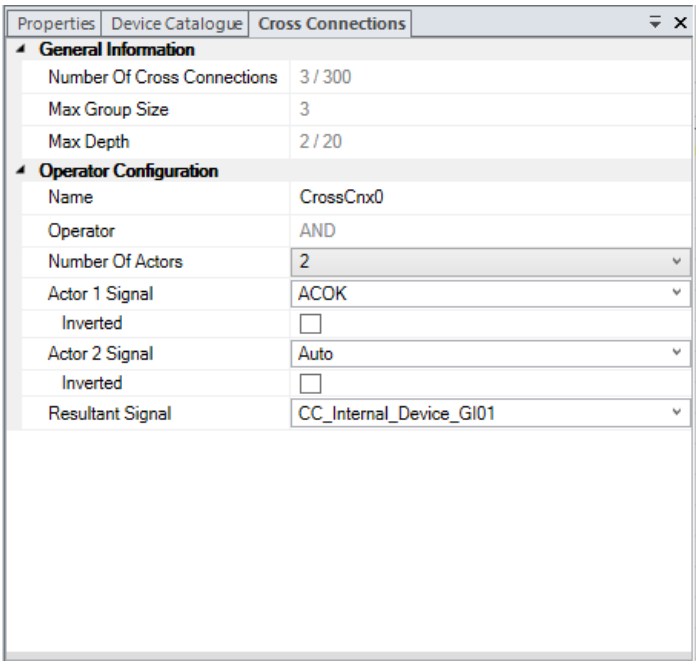
Cross Connection operators

Type	Symbol	Description
AND		The operator **AND** can connect 2-5 *Actors Signals* and combine them into a *Resultant Signal*.
OR		The operator **OR** can connect 2-5 *Actors Signals* and combine them into a *Resultant Signal*.
NOT		The operator **NOT** inverts one *Actors Signal* into a *Resultant Signal*.
FWD		The operator **FWD** maps one *Actors Signal* into a *Resultant Signal*.

2.1.7.4 Cross Connections tab

Cross Connections tab

The **Cross Connections** tab displays information for the selected operator.



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Field	Description
Number of Cross Connections	Shows the total number of cross connections (max 300). If the maximum number is exceeded, this is indicated with a red frame.
Max Group Size	Shows the size of the largest group of connected cross connections.
Max Depth	Shows the highest depth value among all cross connections (max 20). If the maximum number is exceeded, an error will be indicated.
Name	Shows the name of the selected cross connection. A maximum of 32 characters is allowed.
Operator	Shows the type of operator used in the selected cross connection.
Number of Actors	Shows the number of actors used in the selected cross connection. **Note** For the operators **AND** and **OR**, the number of actors can be 2-5.
Actor Signal	Select an available actor signal from the drop down list.
Inverted	Select the check box to invert the actor signal.
Resultant Signal	Select an available resultant signal from the drop down list.

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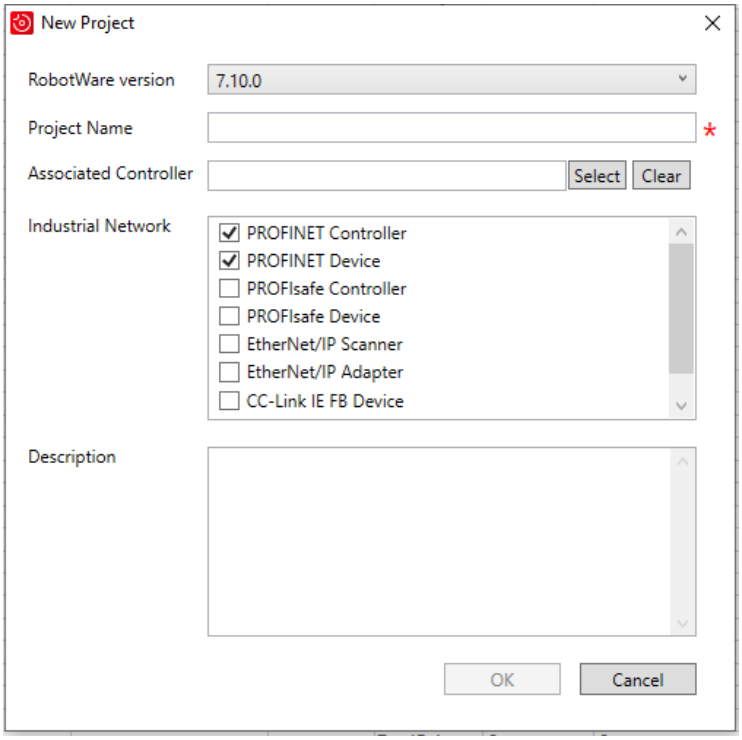
3 Working with I/O projects

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:



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Complete the following fields and select **OK**:

Field	Description
RobotWare version	Select the RobotWare version to be used for the project.
Project Name	Enter a unique project name.
Associated Controller	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.
Industrial Network	Select the industrial networks to be used for the project.
Description	If applicable, enter a project description.

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

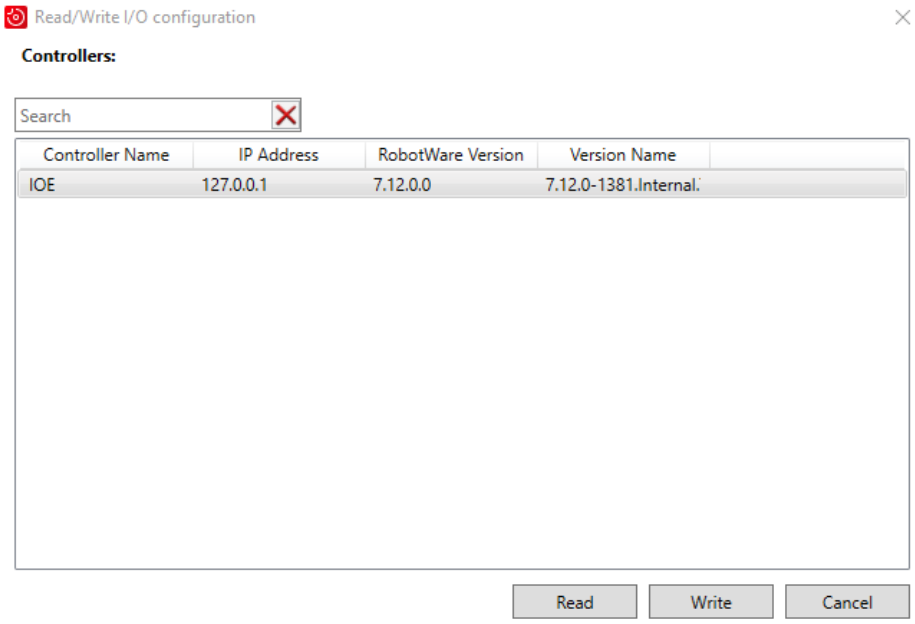
- An added robot controller in the **Controller** tab in RobotStudio.
- The I/O project must be saved.
- Request write access to the controller.

> **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 ribbon of the **I/O Engineering** tab, select **Read/Write** to write the configuration to a controller. The **Read/Write I/O configuration** window is displayed:



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2 Select a controller and click **Write** 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** function is selected.

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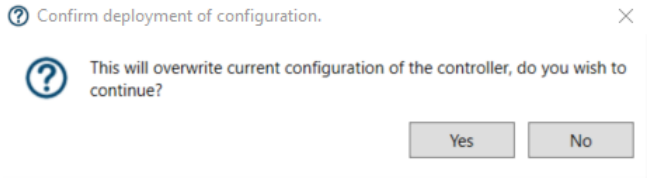
3 The project configuration has now been written to the selected controller.

Replace I/O configuration using Quick Write

1 In the ribbon of the **I/O Engineering** tab, select **Quick Write**. The **Quick Write** window is displayed:



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2 Select **Replace** to confirm that the current I/O configuration should be written to the associated controller.

> **Note**
>
> See *Defining an associated controller to an I/O project on page 39* for information about associated controllers.

Write I/O configuration from add-in

The `install_io_project` command can be used to install I/O project files from an add-in so the controller will start up with all the needed I/O configurations.

See *Application manual - RobotWare add-ins* for information about this procedure.

3.4 Reading an I/O configuration to a project file

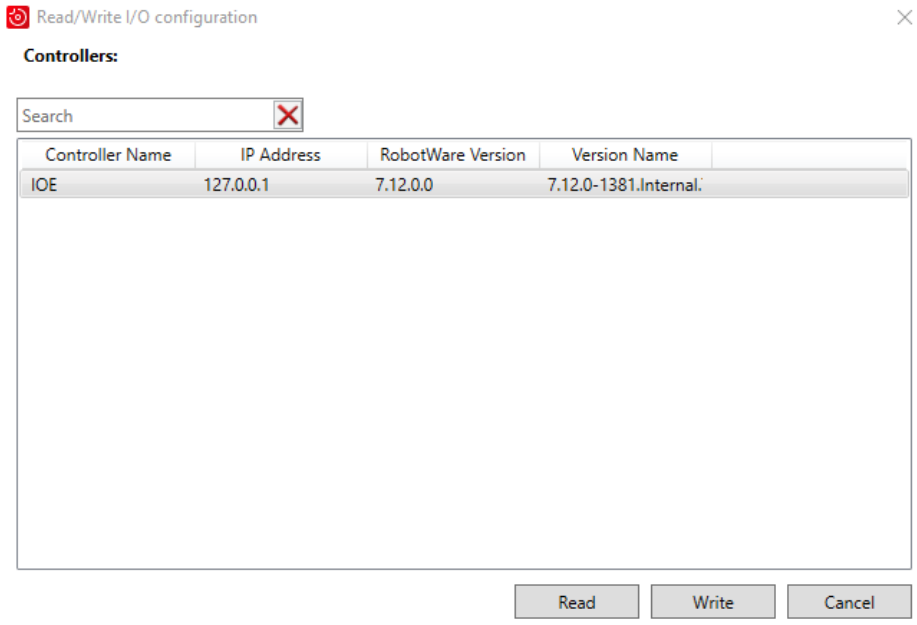
Prerequisites

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:



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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.

3.5 Merging I/O projects

Overview

The following types of projects merges can be made:

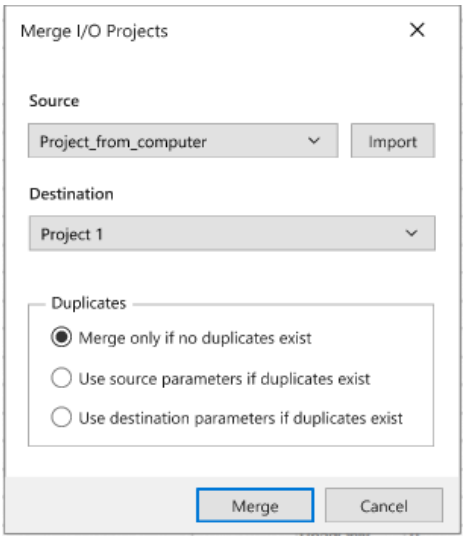
- Merge of two offline projects
- Controller project merged with an offline project
- Offline project merged with a controller project

Merging offline projects

This section describes how to merge two offline projects.

1 In the **I/O Project** menu, select **Merge Project**.

2 In the **Merge I/O Projects** window, complete the following fields:



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Field	Description
Source	Select the source project using one of the following options: • Use drop down to select a project that is open in I/O Engineering. • Select **Import** to select a project from another location.
Destination	Select the destination project. **Note** Displays pre-selected projects.
Duplicates	Select one of the following options indicating how duplicates should be treated during the merge: • Merge only if no duplicates exist. **Note** If duplicates exist, the merge will fail. See detailed message in the **Output** window. • Use source parameters if duplicates exist. • Use destination parameters if duplicates exist.

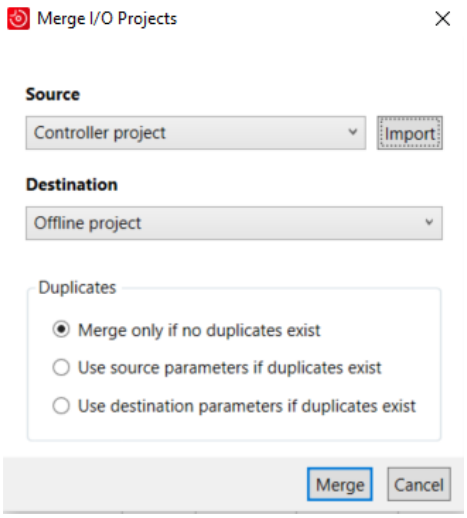
Continues on next page

3 Select **Merge** to complete the merge of the projects. The destination project is now opened in the **Configuration** browser.

Merging controller with an offline project

This section describes how to merge a project with an associated controller with an offline project.

1 In the ribbon of the **I/O Engineering** tab, open the controller project in one of the following ways:
   - Make sure the controller is connected and then select **I/O Project** > **Open Project**.
   - Select **Read & Write** to read the I/O configuration from the selected controller.
2 In the **I/O Project** menu, select **Merge Project**.
3 In the **Merge I/O Projects** window, select **Import** and open the offline project.
4 The offline project can now be selected in the **Merge I/O Projects** dialog. Complete the following fields:



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Field	Description
Source	Select the controller project.
Destination	Select the offline project to which the information should be merged.
Duplicates	Select one of the following options indicating how duplicates should be treated during the merge: • Merge only if no duplicates exist. **Note** If duplicates exist, the merge will fail. See detailed message in the **Output** window. • Use source parameters if duplicates exist. • Use destination parameters if duplicates exist.

Continues on next page

5 Select **Merge** to complete the merge of the projects. The destination project is now opened in the **Configuration** browser.

Merging offline project with controller

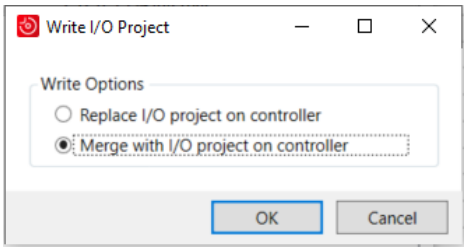
This section describes how to merge an offline project with a controller project.

1 In the **I/O Project** menu, select **Open Project** to open the offline project.

2 In the ribbon of the **I/O Engineering** tab, select **Read & Write**.

3 The **Read & Write I/O configuration** window displays all available controllers on the network. Select a controller and tap **Write**.

4 The **Write I/O Project** window is displayed:



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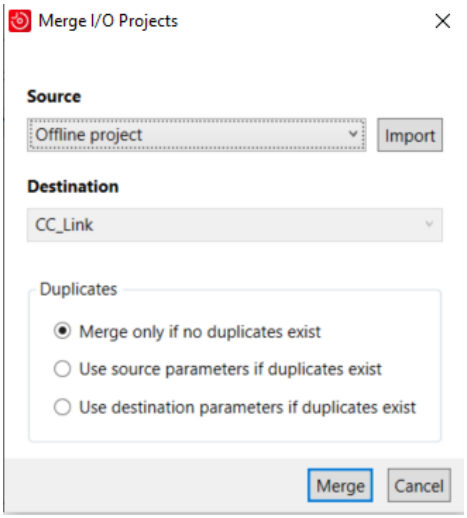
Select **Merge with I/O project on controller** and then **OK**.

5 The **Merge I/O Projects** window is displayed:



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Complete the following fields:

Field	Description
Source	Select the offline project.
Destination	Select the controller to which the information should be merged.

Continues on next page

Field	Description
Duplicates	Select one of the following options indicating how duplicates should be treated during the merge: • Merge only if no duplicates exist.  **Note** If duplicates exist, the merge will fail. See detailed message in the **Output** window. • Use source parameters if duplicates exist. • Use destination parameters if duplicates exist.

6 Select **Merge** to complete the merge of the projects. The destination project is now opened in the **Configuration** browser.

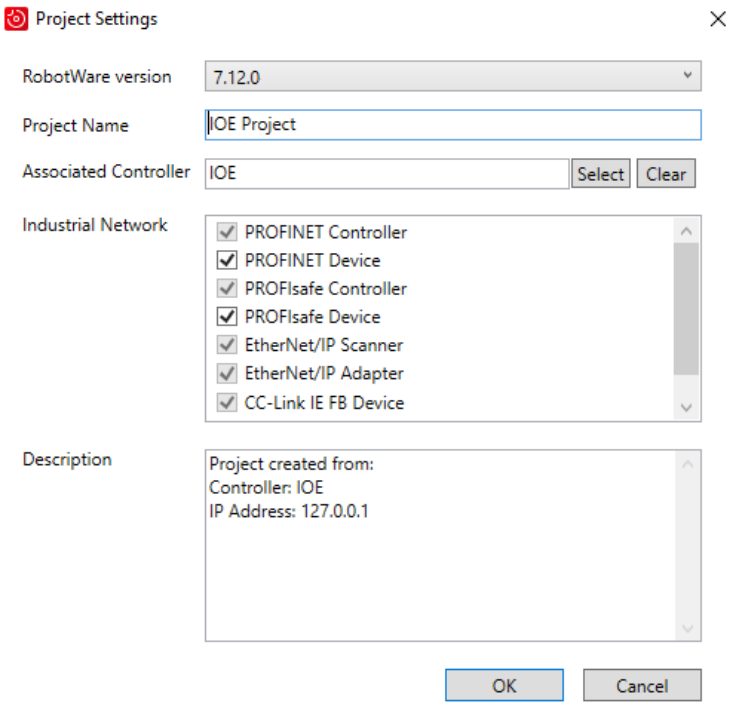
3.6 Changing RobotWare version for an I/O project file

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:



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2 Select a new **RobotWare version** to used for the project file and click **OK**.

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

3.7 Defining an associated controller to an I/O project

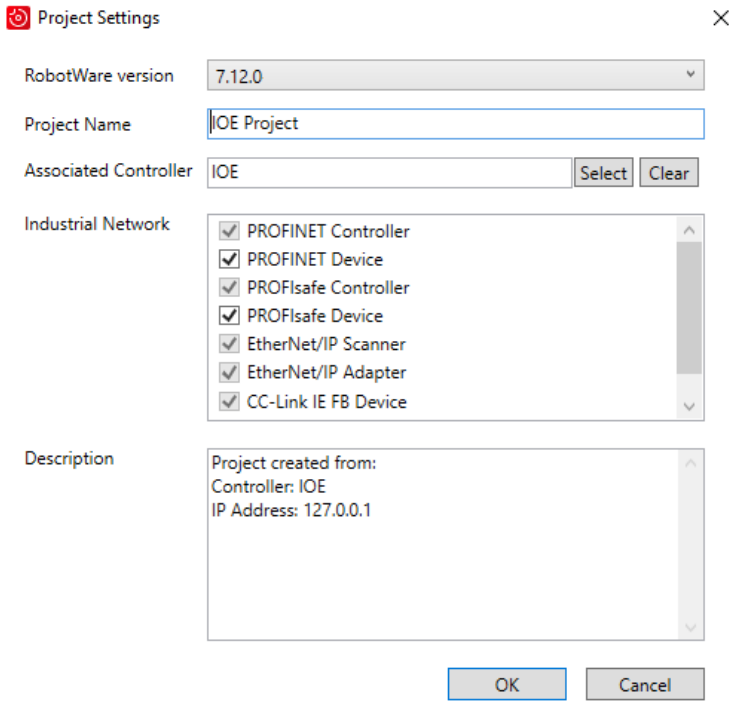
Note

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:



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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.

3.8 Importing device template files

Import device template files

Device template files contain data about a specific device. This type of file must be imported to the I/O project for all devices that should be added.

> **Note**
>
> Device template files can also be imported in advance for devices that may be added later to the I/O project.

Different template files are used depending on the industrial network:

Industrial network	Device template file
PROFINET	GSD
CC-Link IE Field Basic	CSP+
EtherNet/IP	EDS

1. In the **I/O Engineering** tab, select **Import files** > **GSD/CSP+/EDS Files**, or right-click on the industrial network (under I/O system) and select **Manage GSD/CSP+/EDS Files**.
2. The **GSD/CSP+/EDS Files** window is displayed. Click **Import** and browse for a template file, or select **Import** > **Folder** to import a complete folder with template files.

> **Note**
>
> The **Used GSD/CSP+/EDS files...** window shows all template files that are used in the current I/O project.
>
> The **Imported GSD/CSP+/EDS files...** window shows all template files that are imported into the I/O project but are not used in the configuration.

> **Note**
>
> When a new I/O project is opened, only the used template files will be shown in the **Imported GSD/CSP+/EDS files...** window. Select **Update** to display all previously imported, but not used, template files.

4 Working with devices

Adding I/O devices and modules to a network

1 In the **I/O Project** menu, select **Open Project** and open the project for which devices should be added.

2 In the **Configuration** browser, select the industrial network.

3 Select the **Device Catalogue** tab to show a list of available devices.

> **Note**
>
> The device template files that have been imported to the project define what devices can be selected. See *Import device template files on page 40*.

4 Double-click the I/O device to add it to the selected industrial network.

5 The I/O device is now added to the network. To add I/O modules to the device, select the device and double-click on the I/O modules in the **Device Catalogue**.

6 The **Configuration** window displays all devices and modules that have been added to the network. Device and module settings can be configured in the **Properties** browser. See the application manual for the respective industrial network.

Configuring I/O devices and modules

For information about how to configure the I/O devices, see the application manual for the respective industrial network:

- *Application manual - CC-Link IE Field Basic*
- *Application manual - PROFINET Controller/Device*
- *Application manual - EtherNet/IP Scanner/Adapter*

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5 Working with I/O system levels

5.1 Configuring access levels

Overview

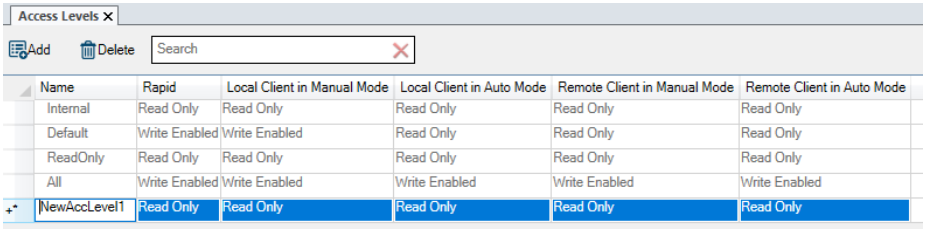
The *Access Level* defines the write access to I/O signals for categories of I/O controlling clients connected to the robot controller.

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:



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

Parameter	Value
Name	Enter a unique name for the access level. **Note** The name can only be 32 characters long and contain alphanumeric and '_' characters, always beginning with an alphabetic character.
Rapid	Select one of the following options, indicating if the access level should be read only or write enabled: • **Read Only** • **Write Enabled**
Local Client in Manual Mode	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: • **Read Only** • **Write Enabled**
Local Client in Auto Mode	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: • **Read Only** • **Write Enabled**

Continues on next page

Parameter	Value
Remote Client in Manual Mode	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: • **Read Only** • **Write Enabled**
Remote Client in Auto Mode	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: • **Read Only** • **Write Enabled**

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

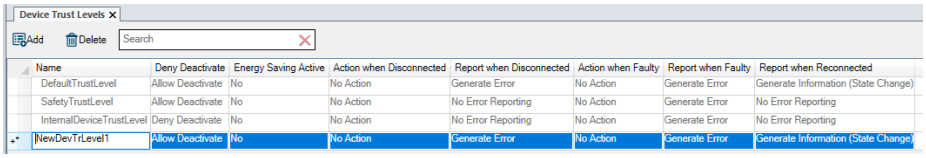
Overview

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:



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

Parameter	Value
Name	Enter a unique name for the device trust level. **Note** The name can only be 32 characters long and contain alphanumeric and '_' characters, always beginning with an alphabetic character.
Deny Deactivate	Select **Deny Deactivate** or **Allow Deactivate**, indicating if it is possible to deactivate the I/O device.
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

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

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

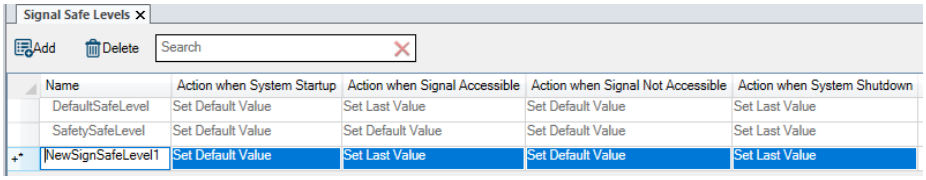
The *Signal Safe Level* defines the behavior of logical output, digital, group and analog signals at the following execution situations in the robot system:

- 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:



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

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

Continues on next page

Parameter	Value
Action when System Shutdown	Select one of the following options, specifying the the value for a logical output signal when the robot system is shutdown: • **Set zero value** • **Set default value** • **Set last value**

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

Overview

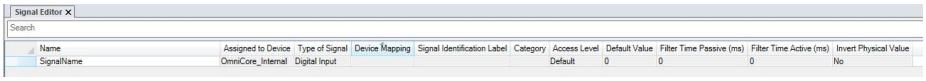
I/O signals can be added to I/O devices in a project, either on module level or submodule level.

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

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 (module or sub-module) for which signals are to be created and complete the fields.



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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.

	Name	Assigned to Device	Type of Signal	Device Mapping
+*	g1	IM_155_6_PN_ST_V1_0	Group Input	0-16
+*	s1	IM_155_6_PN_ST_V1_0	Digital Input	0
+*	s2	IM_155_6_PN_ST_V1_0	Digital Input	1
+*	s3	IM_155_6_PN_ST_V1_0	Digital Input	3
+*	sm2	IM_155_6_PN_ST_V1_0	Digital Input	16
		IM_155_6_PN_ST_V1_0	Digital Input	

xx2000000487

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

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

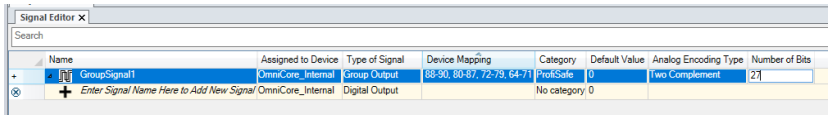
Create safety group signals

Safety 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 safety group signal is to be added.
3. Complete the following:
   - **Name**: Enter a name for the safety group signal.
   - **Number of Bits**: Select the size of the signal.

Note

When the signal size is selected, the **Device Mapping** will automatically be rearranged accordingly. The signal with the highest size will be placed first, and the signal with the lowest size placed last.



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

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

6.3 Assigning categories to signals

Description

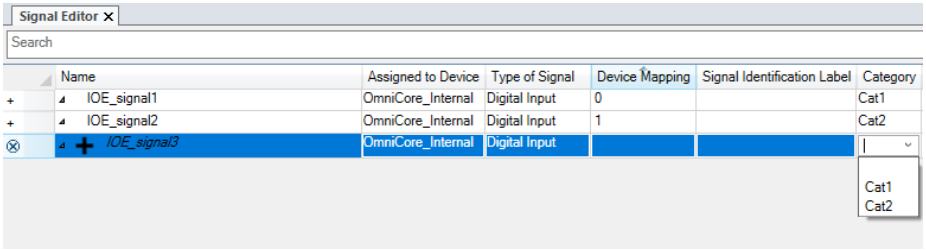
With categories it is possible to group signals or virtual signals under different categories defined by the user.

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

> **Note**
>
> Safe signals are assigned the category **ProfiSafe** by default. It is recommended not to change this category.

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**:



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> **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.

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.

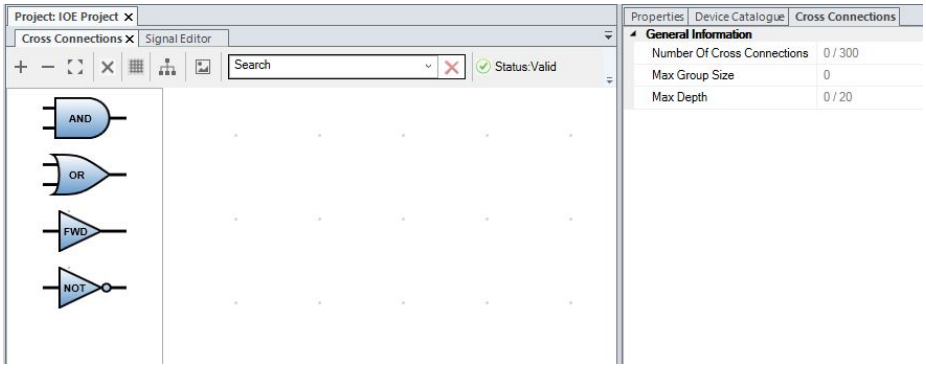
Limitations

- 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.

7.2 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:



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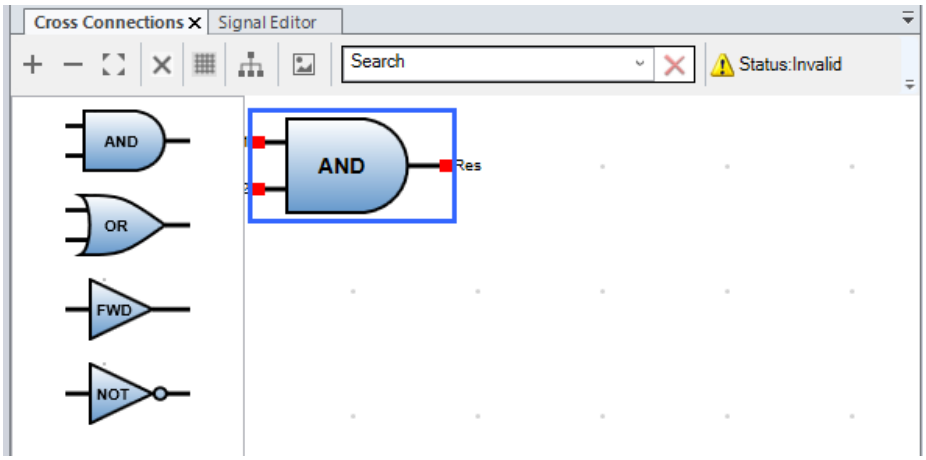
2 Drag operators (AND, OR, FWD or NOT) from the left side and drop in the **Cross Connection View**:



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Tip

Use the tool **Align Operators** to adjust the operators to be placed in a structured way.

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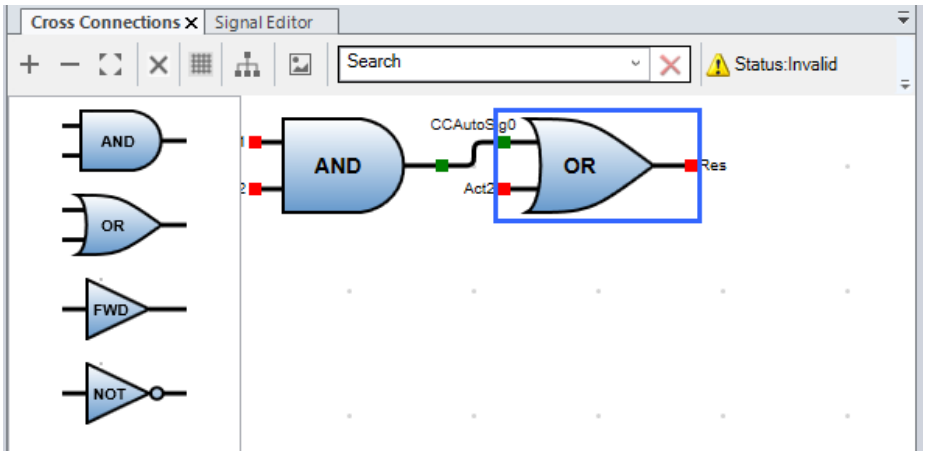
3 Connect the resultant to an actor using the mouse (click, drag and connect):



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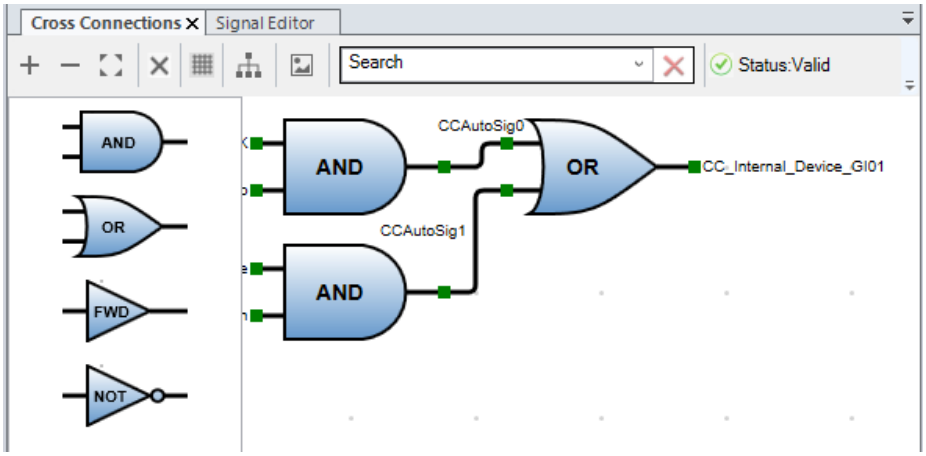
Note

- 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:



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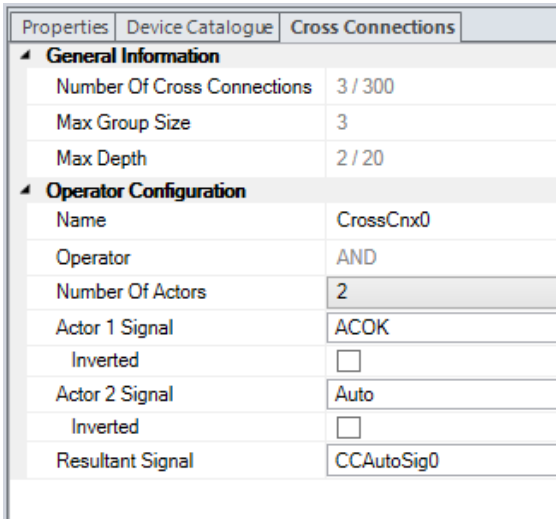
5 Select an operator in the cross connection and configure the properties in the **Cross Connections** tab:



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The following properties can be configured:

Field	Description
Name	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.
Number of Actors	Select the number of actors to be used for the selected operator. For the operators **AND** and **OR**, the number of actors can be 2-5.
Actor Signal	Select an available actor signal from the drop down list. New signals can be created in the **Signal Editor**.
Inverted	Select the check box to invert the actor signal.
Resultant Signal	Select an available resultant signal from the drop down list. New signals can be created in the **Signal Editor**.

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

Export cross connections

1. In the **I/O Commissioning** tab, select **Cross Connections**. The **Cross Connections** window is displayed with the current connections.
2. 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.
3. Specify the location where the exported file should be saved and select **Save**.

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8 Working with virtual networks

Overview

Virtual networks makes it possible to prepare network configurations offline or virtually. Using this functionality, you can add and configure signals in I/O Engineering without defined physical devices.

When the configuration is completed, the virtual network can be merged with an I/O project connected to an industrial network. The virtual devices will then be connected to corresponding physical devices in I/O Engineering.

Terminology	Description
Physical device	A device in I/O Engineering with a referring device description file and IP address
Virtual device	A device in I/O Engineering without connection to hardware (no IP-address, device description file or other hardware related parameters)
Virtual signal	A signal connected to a virtual device or a signal without a connection to a device

Suggested workflow

The following steps describe a possible process of creating and merging virtual I/O projects with physical devices connected to industrial networks:

1. Start a new IO project and add virtual devices and signals with a device map. See *Creating virtual network projects on page 59* and *Configuring virtual networks on page 60*.
2. Add I/O system configuration (signals, trust levels, cross-connections). See the respective section in this application manual.
3. Save the virtual I/O project. See *Saving an I/O project on page 30*.
4. Start a new I/O project and add device descriptions files and physical devices with IP addresses. See *Working with I/O projects on page 29*.
5. Save the physical I/O project. See *Saving an I/O project on page 30*.
6. Merge the virtual and the physical I/O projects. See *Merging virtual devices with physical devices on page 61*.

Creating virtual network projects

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

   Complete the following fields and select **OK**:

Field	Description
RobotWare version	Select the RobotWare version to be used for the project.
Project Name	Enter a unique project name.
Associated Controller	Optional.
Industrial Network	Optional.
Description	If applicable, enter a project description.

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Continued

2 A new project has now been created that is not connected to any industrial network.

To configure the project, see *Configuring virtual networks on page 60*.

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

Configuring virtual networks

Devices and signals can be added to the virtual network in I/O Engineering in the same way as for industrial networks. See the respective sections in this application manual.

1 In the **I/O Project** menu, select **Open Project** and open the project for the virtual network.

2 In the **Configuration** browser, select the virtual network **Virtual** (under I/O system).

3 In the **Properties** browser, you can configure the following for the network:

Parameter	Description	Allowed values
Identification Label	This parameter is an optional way to provide a label that will help the operator to identify the virtual network.	A string with maximum 80 characters.

4 Select the **Device Catalogue**. Double-click to add the virtual device to the virtual network.

> **Note**
>
> Up to 50 virtual devices can be added to the virtual network.

5 The I/O device is now added to the network. The device settings can be configured in the **Properties** browser.

6 In the **Properties** browser, you can configure the following for the device:

Parameter	Description	Allowed values
Name	Enter the name to be used for the device.	A string with maximum 32 characters.
Identification Label	This parameter is an optional way to provide a label that will help the operator to identify the device.	A string with maximum 80 characters.
Input Size	Enter the input size.	0 - 1440
Output Size	Enter the output size.	0 - 1440
Trust Level	Define the trust level to be used for this device. For more information about trust levels, see *Technical reference manual - System parameters*.	

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Parameter	Description	Allowed values
State when System Startup	Define the logical state I/O device state at system startup: • **Activated** Establish communication • **Deactivated** Do not establish communication • **Last state** Restore the previously stored logical state for the I/O device at system shutdown	

7 Save the project, see *Saving an I/O project on page 30*.

Merging virtual devices with physical devices

To connect the virtual devices to physical devices, see *Merging I/O projects on page 34*. After the merge, all physical devices and signals will appear in the correct order according to the device map.

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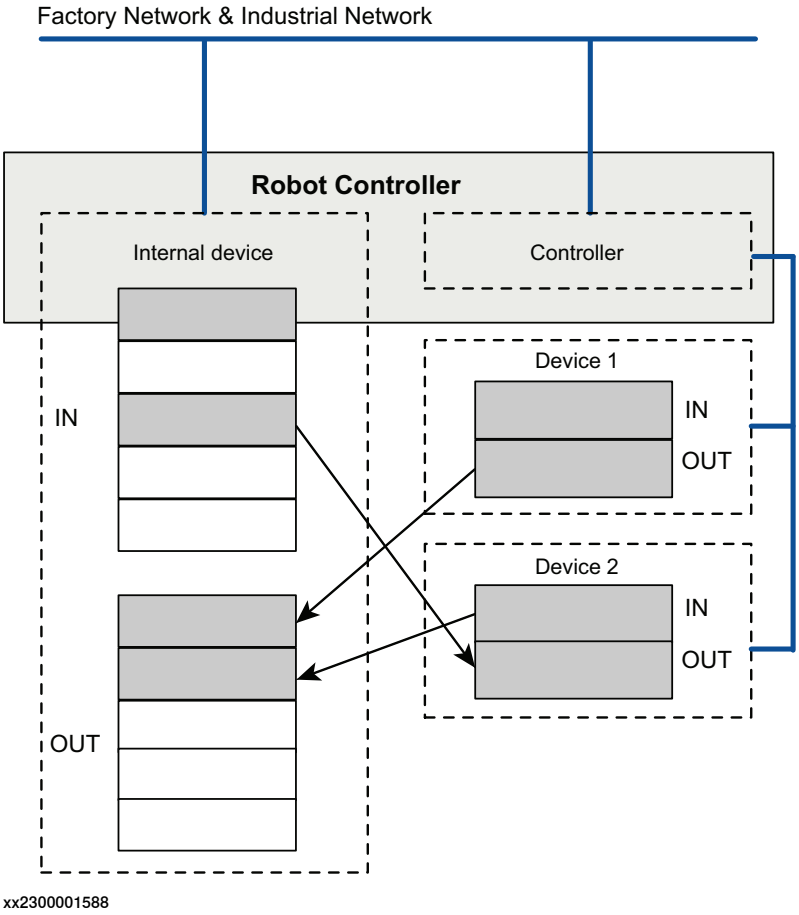
9 Transferring data

Overview

Transfer Data is a way to move data from one device to another without any need of configured I/O signals in the I/O system.

The transfer areas can be used to transfer a part of (or the whole) input, or output, area of one *source device* to a part of (or the whole) output area of another *destination device*.

The following image shows an example of a transfer data setup:



Limitations

- When transferring data from a source device, the specified area in the destination device must not contain any signals.
- Safe data can be source, but not destination.
- Data transfer is not supported for devices on the ICI network or RobICI network.
- Loops are not allowed. The destination area may not be the same as the source area in the configuration.
- The maximum number of allowed transfer areas is 50.

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Add Transfer Data order

1 In the **I/O Project** menu, select **Open Project** and open the project for which data should be transferred.

2 In the configuration window, select **Transfer Data**.

3 In the **Transfer Data** window, select **Add** to add a new Transfer Data order.

Complete the following fields:

Field	Description
Name	The name of the Transfer Data order. **Note** An autogenerated name is proposed, but can be changed.
Source Device	Select the source device from which data should be transferred. **Note** Devices within the project containing input data are displayed.
Source Device Area	Select **Input** or **Output**, defining if input or output data should be transferred.
Source Start Bit	Enter a number indicating the start bit of the source device for the transfer order. **Note** The selected start bit must be within the available area of the source device. The **Input Size** and **Output Size** of the device indicate the available area.
Bit Size	Enter a number indicating the number of bits for the transfer order. **Note** The selected number of bits must be within the available area of the source/destination device.
Destination Device	Select the destination device to which data should be transferred. **Note** Devices within the project containing output data are displayed.
Destination Start Bit	Enter a number indicating the start bit of the destination device for the transfer order.

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

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

10 Troubleshooting

10.1 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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