ROBOTICS

Application manual

EtherCAT

Trace back information:
Workspace 24D version a27
Checked in 2025-01-17
Skribenta version 5.6.018

Application manual

EtherCAT

RobotWare 7.17

Document ID: 3HAC090257-001

Revision: C

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Table of contents

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Overview of this manual

About this manual

This manual describes the following options and contains instructions on how to configure them in an OmniCore system.

- 3075-2 *EtherCAT Device*
- 3076-2 *Safety over EtherCAT Device*

> **Note**
>
> It is the responsibility of the integrator to provide safety and user guides for the robot system.

Usage

This manual should be used during installation and configuration of the option for EtherCAT.

> **Note**
>
> Before any work on or with the robot is performed, the safety information in the product manual for the controller and manipulator must be read.

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:

- EtherCAT network
- I/O system configuration
- OmniCore controller
- RobotStudio

References

ABB documents

Reference	Document ID
Application manual - I/O Engineering	*3HAC082346-001*
Technical reference manual - System parameters	*3HAC065041-001*
Product manual - OmniCore V250XT Type B	*3HAC087112-001*
Product manual - OmniCore V400XT	*3HAC081697-001*

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Reference	Document ID
Operating manual - OmniCore	*3HAC065036-001*
Operating manual - RobotStudio	*3HAC032104-001*
Operating manual - Integrator's guide OmniCore	*3HAC065037-001*

Other references

Reference	Description
https://www.ethercat.org	EtherCAT Technology Group

Revisions

Revision	Description
A	First edition. Released with RobotWare 7.15.1.
B	Released with RobotWare 7.16. • Minor updates in *Introduction on page 11*. • Information about support for E line controller added.
C	Released with RobotWare 7.17. • Updated the section *Input and output size on page 19*.

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.

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1 Introduction

1.1 What is EtherCAT

General

EtherCAT® and Safety over EtherCAT® are registered trademarks and patented technologies, licensed by Beckhoff Automation GmbH, Germany.

EtherCAT is a protocol suitable for both hard and soft real-time computing requirements in automation technology. It is governed by the EtherCAT Technology Group.

EtherCAT operates by sending a telegram that passes through each node. Each EtherCAT device reads the data addressed to it and inserts its data into the frame as it moves downstream. The last node in a segment detects an open port and sends the message back to the master using full-duplex Ethernet technology.

Many types of topologies are supported by EtherCAT, such as line, tree, star, and daisy-chain.

Standardization

EtherCAT and Safety over EtherCAT conform to the following international standards:

- International Standard: ISO, ISO15745-5
- International Standard: IEC, IEC61158 and IEC61784

Communication profiles

EtherCAT supports various communication profiles to cater to different devices and application layers:

- CAN Application Protocol over EtherCAT (CoE): Used for communication with CANopen devices.
- Servo Drive Profile (SoE): According to IEC 61800-7-204, this profile is for servo drives.
- Ethernet over EtherCAT (EoE): Enables communication with Ethernet devices.
- File Access over EtherCAT (FoE): Allows file transfer between devices.
- ADS over EtherCAT (AoE): Used for communication with TwinCAT systems.
- EtherCAT Automation Protocol (EAP): Supports automation-specific communication.
- Integration of other Bus Systems: EtherCAT can integrate with other fieldbus systems.

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ESI file

EtherCAT uses ESI files for configuration. The ESI file that comes with the device is XML based and contains the complete description of its network accessible properties, such as process data and their mapping options, the supported mailbox protocols including optional features, as well as the supported modes of synchronization. The ESI file is used to set up the communication between the PLC/controller and the devices.

Note

The ESI file for the internal device is automatically added.

Data

The following table specifies a number of EtherCAT data:

Network type	Ethernet based
Communication profile	EtherCAT
Installation	Standard Off the Shelf (COTS) Ethernet cables and connectors. 10/100/1000 Mbit/s TX Ethernet cable or fibre optics.
Speed	100 Mbit/s
Hardware requirements	No specialized hardware required.
Number of devices per EtherCAT segment	Up to 65535

1.2 EtherCAT for OmniCore

General

The EtherCAT network is running on the OmniCore main computer and does not require any additional hardware.

Options

EtherCAT is available for the OmniCore E line and V line controllers. In order to run EtherCAT, the following options are required:

- 3075-2 *EtherCAT Device*

> **Note**
>
> In this manual, the 3075-2 *EtherCAT Device* is referred to as *internal device*.

> **Note**
>
> When option *EtherCAT Device* is enabled for OmniCore E line, WAN1 and WAN2 cannot be used for other Ethernet protocols.

The following options are available for Safety over EtherCAT:

- 3076-2 *Safety over EtherCAT Device*

Compatibility

EtherCAT

The EtherCAT device is certified by the EtherCAT Technology Group.

The EtherCAT device is certified for the EtherCAT version 2.5.4.

Safety over EtherCAT

The following version is supported: FSoE Protocol specification (ETG5100): V1.2.0

The Safety over EtherCAT device was executed in accordance with the following:

- ETG.5101 FSoE Implementation Guide
- FSoE Conformance Test

Predefined internal device

When the robot system is installed with the EtherCAT option, a predefined network with the name **EtherCAT** and a device with the name **EC_Internal_Device** are created at system startup.

The internal device can be configured using I/O Engineering in RobotStudio. For example, you can define device names, identification labels, input and output sizes and edit signals, see *Configuring the EtherCAT system on page 25*.

Application protocols

For information about application protocols and port numbers, see section "OmniCore application protocols" in *Operating manual - Integrator's guide OmniCore*.

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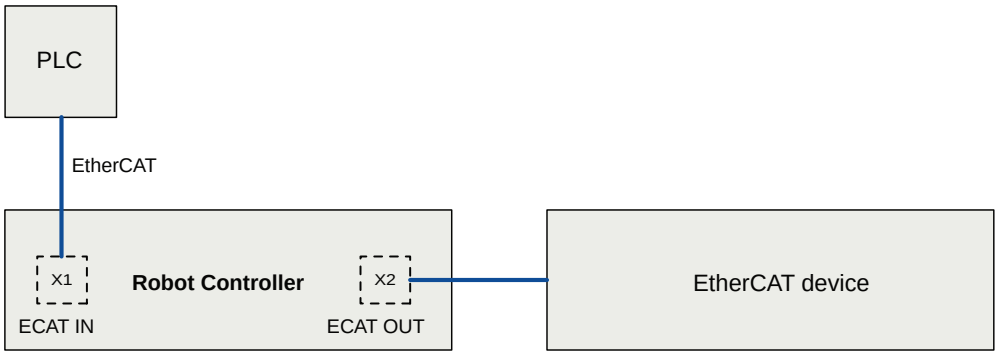
Network connections

EtherCAT daisy chain topology

The following figure illustrates a daisy chain topology with the robot controller in the middle:



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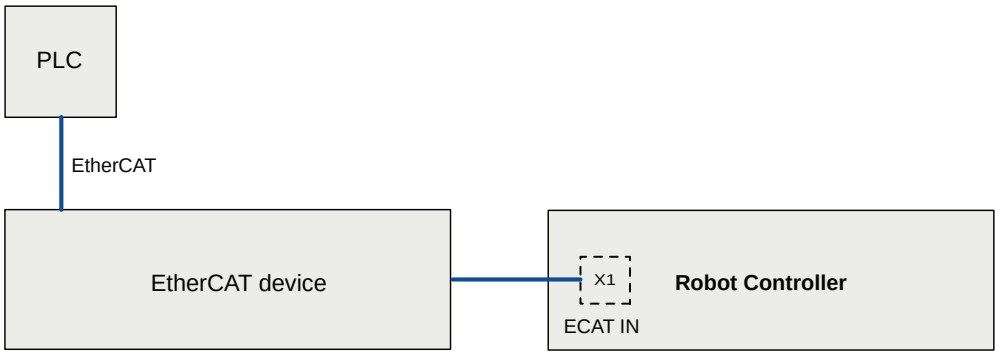
EtherCAT with controller as end device

The following figure illustrates a topology with the robot controller as the end device:



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Limitations

The following is not supported by OmniCore:

- Explicit Device Identification
- DC (Distributed Clock) Mode
- No communication profiles are supported

2 Hardware overview

2.1 I/O devices

Limitations

It is possible to connect most types of EtherCAT compliant I/O device on the EtherCAT controller network. All I/O devices should comply with the EtherCAT standard and be conformance tested by EtherCAT Technology Group. I/O devices may be mounted inside the controller.

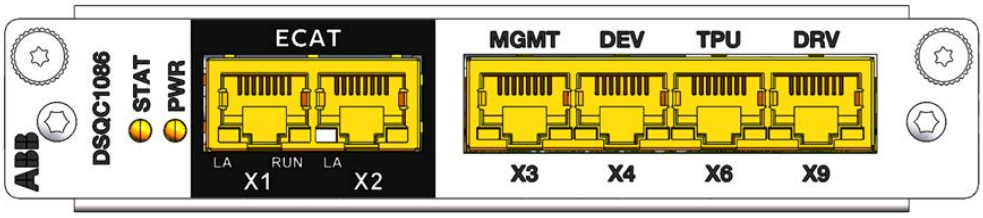
Safety I/O devices

Safety over EtherCAT supports safety modules. It is possible to configure safety I/O devices and create safety signals to the I/O devices. For more information, see *Application manual - Functional safety and SafeMove*.

2.2 OmniCore controller

EtherCAT connectors and indicators on V line controller

The connectors and indicators used for EtherCAT are placed on the processor board of the main computer in the controller:



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X1	ECAT IN
X2	ECAT OUT
LA	Link/Activity LED (yellow)
RUN	RUN LED (green)

Link/Activity LED

The EtherCAT communication status is indicated by the Link/Activity LEDs (A):

LED status	Description
Yellow flashing	Link and activity, data exchange with devices in the EtherCAT network.
Yellow steady	Link to EtherCAT network established without activity.
Off	No connection to EtherCAT network.

RUN LED

The EtherCAT RUN state is indicated by the RUN LEDs (B):

LED status	SubDevice status	Description
Off	INIT	Initialization of the controller EtherCAT functions.
Green flashing	PRE-OPERATIONAL	Communication is possible.
Green single flash	SAFE-OPERATIONAL	Process data communication is possible. Input data is updated cyclically, while outputs remain in safe state.
Green steady	OPERATIONAL	Process data communication is possible. Input data is updated cyclically, output data is copied to the local outputs of the units.

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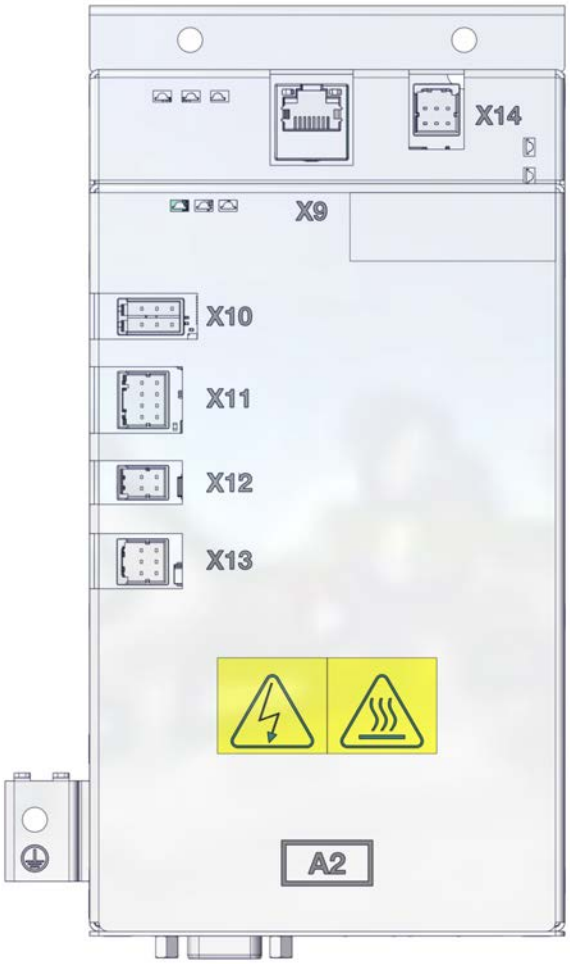
EtherCAT connectors and indicators on E line controller

The connector used for EtherCAT is placed on the computer and logic unit in the controller:



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X9	EtherCAT_IN

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3 Software overview

3.1 Information about the internal device

General

To use the EtherCAT internal device, the OmniCore controller must be installed with the option 3075-2 *EtherCAT Device*. If safe modules shall be added, the option 3076-2 *Safety over EtherCAT Device* must also be installed.

The EtherCAT internal device can be used to:

- connect an OmniCore controller to a PLC.
- connect an OmniCore controller to another OmniCore controller which acts as a EtherCAT controller.

Predefined network

When the robot system is installed with the EtherCAT option, a predefined network with the name *EtherCAT* is created at system startup.

Use I/O Engineering to configure the EtherCAT network for initial use. For example, by setting the correct network name and IP settings. The DCP protocol can also be used to set station name and IP-address when running as a device.

Input and output size

EtherCAT has an internal device with maximum 2048 digital input/output signals. Apart from this, if Safety over EtherCAT is used, 64 safety digital input/output signals can also be added.

The following table shows the possible modules that can be configured for the internal device:

Module	Possible modules	Comment
Default_Module	IO 8 bytes IO 16 bytes IO 32 bytes IO 64 bytes IO 128 bytes IO 256 bytes	**Note** Both input and output signals.
Safe_Module	IO 8 bytes	**Note** Both input and output signals.

Tip

If a configuration mismatch between the connecting PLC and the internal device occurs, an event message is generated on the FlexPendant or the RobotStudio. This event message informs the user of the present module configuration of the internal device.

Continues on next page

Note

The *Input Size* sets the size on digital outputs and *Output Size* sets the size on digital inputs, seen from the PLC's point of view.

3.2 Software for configuring a device

General

The EtherCAT internal device needs to be configured in I/O Engineering before it can be connected to a PLC/controller. Furthermore, the connecting PLC/controller might need a PC software tool to configure all connection parameters used to connect to the OmniCore system.

ESI file for configuring the internal device for an EtherCAT controller

The provided ESI file for the OmniCore EtherCAT device is used to inform the connecting PLC /controller of supported connection parameters.

The ESI file, *esi.xml*, for the internal device can be obtained from the RobotStudio or the OmniCore controller.

- **In the RobotWare installation folder in RobotStudio**:
  ...\DistributionPackages\ABB.RobotWare-x.x.x-xxx\RobotPackages\RobotControl_x.x.xxx\utility\service\ESI
- **On the OmniCore Controller**:
  ...\products\RobotControl_x.x.x\utility\service\ESI

Note

Navigate to the RobotWare installation folder from the RobotStudio **Add-Ins** tab, by right-clicking on the installed RobotWare version in the **Add-Ins** browser and selecting **Open Package Folder**.

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4 Setting up your EtherCAT system

Log in with configuration grant

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*.

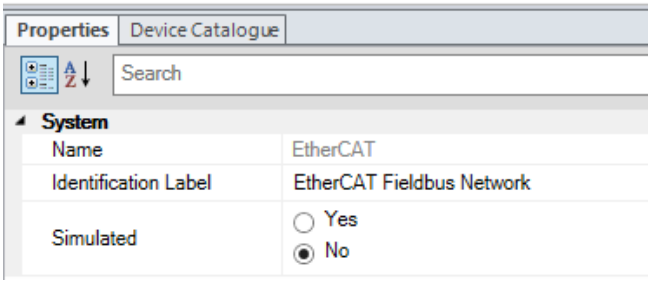
Start I/O Engineering

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

   See *Application manual - I/O Engineering* for more information.

Configure the network properties

1. In the **Controller** tab in RobotStudio, select **I/O Engineering**. The **I/O Engineering** tab is displayed.
2. In the **Configuration** browser, select **EtherCAT** (under I/O system).
3. In the **Properties** browser, you can configure the following:



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Parameter	Description	Allowed values
Identification Label	This parameter is an optional way to provide a label that will help the operator to identify the internal device.	A string with maximum 80 characters.
Simulated	Select **Yes** or **No**, indicating if the industrial network and all its connected I/O devices should be treated as simulated.	The default value is No.

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5 Configuring the EtherCAT system

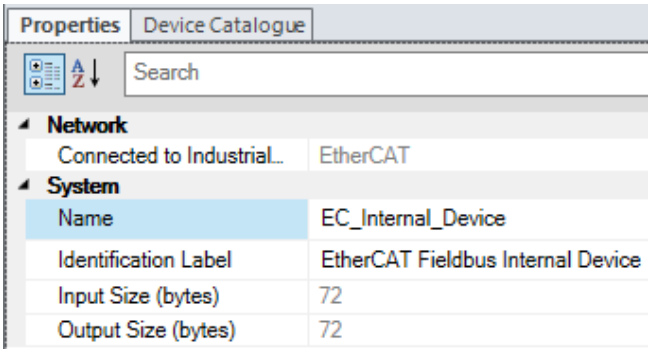
5.1 Configuring the internal device properties

Prerequisites

Before configuring the internal device, make sure to set up your system according to *Setting up your EtherCAT system on page 23*.

Configure the internal device properties

1. In the **Controller** tab in RobotStudio, select **I/O Engineering**. The **I/O Engineering** tab is displayed.
2. In the **Configuration** browser, select the internal device.
3. In the **Properties** browser, you can configure the following:



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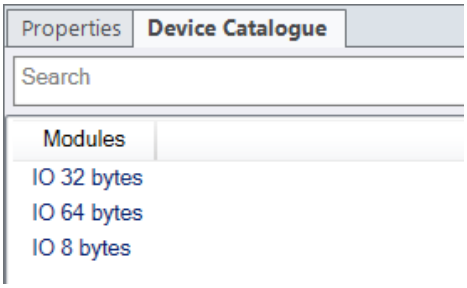
Parameter	Description	Allowed values
Name	Enter the name to be used for the device.	A string with maximum 32 characters.
Identification Label	This parameter is an optional way to provide a label that will help the operator to identify the device.	A string with maximum 80 characters.

5.2 Adding I/O modules to the internal device

Add I/O modules to internal device

1. In the **Configuration** browser, expand **EtherCAT** and select the internal device for which I/O modules should be added.
2. Select **Device Catalogue** to view a list of available I/O modules.



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3. Double-click the I/O module in the list to be added to the internal device.

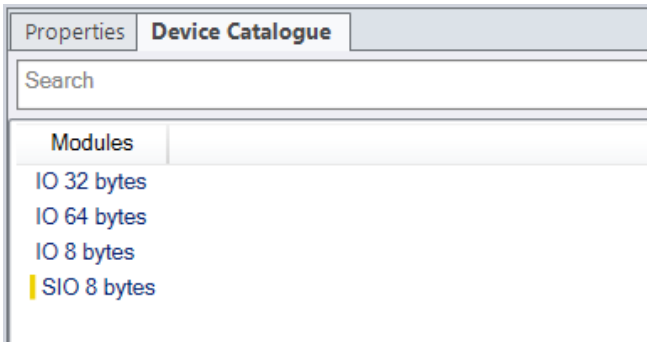
> **Note**
>
> I/O modules with the size 8, 16, 32 and 64 can be selected.

4. When the configuration is finished, save the I/O project and write the configuration to the robot controller.

   For more information about working with I/O projects, see *Application manual - I/O Engineering*.

Add safety I/O modules to internal device (for option 3076-2 *Safety Over EtherCAT Device*)

1. In the **Configuration** browser, expand **EtherCAT** and select the internal device for which safe I/O modules should be added.
2. Select **Device Catalogue** to view a list of available safe I/O modules.



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3 Double-click the safe I/O modules in the list to be added to the internal device.

> **Note**
>
> A yellow marking beside the module symbol indicates a safe I/O module. If any safe module is included in the internal device, a yellow marker is shown by the internal device as well.

4 When the configuration is finished, save the I/O project and write the configuration to the robot controller.

For more information about working with I/O projects, see *Application manual - I/O Engineering*.

> **Note**
>
> Since a safe I/O module has been added to the internal device, the PLC/master device configuration must be updated. See *Configuring safety I/O modules (for option 3076-2 Safety Over EtherCAT Device) on page 28*.

5.3 Configuring safety I/O modules (for option 3076-2 *Safety Over EtherCAT Device*)

Recommended work process

In order to use the safety I/O module in your configuration, the following work process is recommended:

- Add safety I/O modules to the internal device, see *Add safety I/O modules to internal device (for option 3076-2 Safety Over EtherCAT Device) on page 26*.
- Configure the safety I/O modules, see *Configuring safety I/O modules (for option 3076-2 Safety Over EtherCAT Device) on page 28*.

> **Note**
>
> When working with safety I/O modules, the configuration tool will update and download a new safety configuration to the controller.

- After the configuration, verify and copy the application parameters in the **ABB Safety Configuration Report**, see *Configuring safety I/O modules (for option 3076-2 Safety Over EtherCAT Device) on page 28*.

> **CAUTION**
>
> The user must confirm that all configuration data of the safe I/O module was downloaded correctly by reading out all parameters from the module and visually inspect the content.

- Validate the configuration of the safety I/O module according to the validation process as described in *Application manual - Functional safety and SafeMove*.

> **WARNING**
>
> All downloaded configurations must be validated by user testing before the installation can be regarded as safe. User testing is the means by which all downloads are validated.

> **WARNING**
>
> The total intended safety functionality applied by the originator must be confirmed at commissioning of the safety I/O module.

> **CAUTION**
>
> After the safety I/O module is configured, the user must check that ownership has been assigned to the right originator.

- When the set-up and configuration is done, see *Application manual - Functional safety and SafeMove* for instructions on how to work with the safety configuration.

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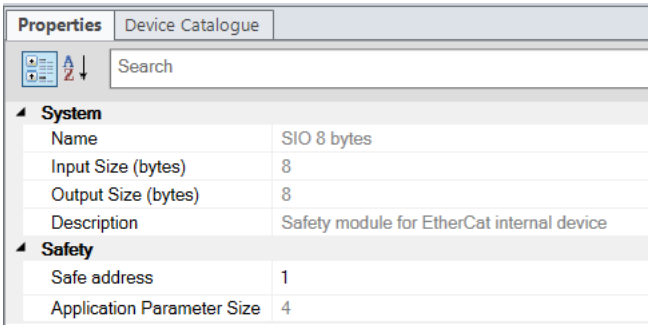
Configuring safety I/O modules

1 In the **Configuration** browser, expand **EtherCAT** and select the internal device for which safe I/O modules should be configured.

2 Select the safe I/O module in the **Configuration** browser and configure the **Properties**:



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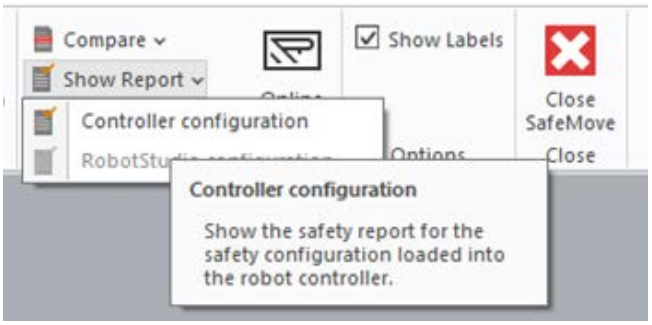
Parameter	Description	Allowed values
Safe address	Select an address that uniquely identifies the module within the network.	Valid range is 1 to 65534.

3 If there are safety related updates, a new safety configuration is generated with new checksums and the prompt **Controller Configuration Changed** is displayed. Select **Yes** to load the controller configuration.

4 In the **Controller** ribbon, select **Safety** > **Visual SafeMove**.

5 In the **Visual SafeMove** tab, select **Show report** > **Controller configuration** to open the **ABB Safety Configuration Report**.



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6 In section **Networks** > **Devices** > **EC_Internal_Device**, copy the two checksum values in field **Application Parameters**.

7 Insert the copied **Application Parameters** in your master device configuration.

5.4 Working with signals

Overview

For internal devices, all signals are preloaded at installation. You can, however, edit the signals.

For more information about working with signals, see *Application manual - I/O Engineering*.

Index

ABB AB
Robotics & Discrete Automation
S-721 68 VÄSTERÅS, Sweden
Telephone +46 10-732 50 00

ABB AS
Robotics & Discrete Automation
Nordlysvegen 7, N-4340 BRYNE, Norway
Box 265, N-4349 BRYNE, Norway
Telephone: +47 22 87 2000

ABB Engineering (Shanghai) Ltd.
Robotics & Discrete Automation
No. 4528 Kangxin Highway
PuDong New District
SHANGHAI 201319, China
Telephone: +86 21 6105 6666

ABB Inc.
Robotics & Discrete Automation
1250 Brown Road
Auburn Hills, MI 48326
USA
Telephone: +1 248 391 9000

abb.com/robotics

3HAC090257-001, Rev C, en