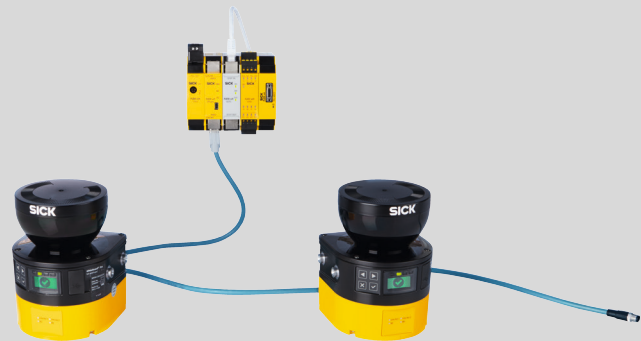


EFI-pro

Safe device communication via the network

SICK
Sensor Intelligence.



Product described

EFI-pro

Safe device communication via the network

Manufacturer

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Original document

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1 About this document

1.1 Purpose of this document

This technical information gives an overview of the options, functional extensions and technical implementation of safety-related applications with the enhanced function interface-pro (EFI-pro) from SICK.

This technical information is not a replacement for the operating instructions of the described electro-sensitive protective devices (ESPE), safety controllers or the EFI-pro gateway.

1.2 Further information

<http://www.sick.com>

The following information is available via the Internet:

Table 1: Further information

Title	Part number
Other language versions of this technical information	8022340
Guide for Safe Machinery Six steps to a safe machine	8024365
Safety Designer Software for configuring safety solutions made by SICK AG	Download Safety Designer
Operating instructions	
Flexi Soft modular safety controller Hardware	8012999
Flexi Soft in Safety Designer Configuration software	8013926
Flexi Soft gateways Hardware	8012662
Flexi Soft Gateways in Safety Designer Configuration software	8018170
microScan3 - EFI-pro Safety laser scanner	8021911

1.3 Symbols and document conventions

The following symbols and conventions are used in this document:

Safety notes and other notes



DANGER

Indicates a situation presenting imminent danger, which will lead to death or serious injuries if not prevented.



WARNING

Indicates a situation presenting possible danger, which may lead to death or serious injuries if not prevented.



CAUTION

Indicates a situation presenting possible danger, which may lead to moderate or minor injuries if not prevented.

**NOTICE**

Indicates a situation presenting possible danger, which may lead to property damage if not prevented.

**NOTE**

Indicates useful tips and recommendations.

Instructions to action

- ▶ The arrow denotes instructions to action.
- 1. The sequence of instructions for action is numbered.
- 2. Follow the order in which the numbered instructions are given.
- ✓ The check mark denotes the result of an instruction.

2 Product description

EFI-pro (enhanced function interface pro) enables safe device communication via the network. The EFI-pro network technology is based on EtherNet/IP™ with CIP Safety™.

EtherNet/IP™ (EtherNet Industrial Protocol) is an Ethernet-based network used in industrial automation.

EtherNet/IP™ implements the CIP™ (Common Industrial Protocol) based on the Ethernet and TCP/IP protocol family.

EtherNet/IP™ with the CIP Safety™ protocol extension is also suitable for safety-related data communication.

The following standards and technologies are used and build upon each other:

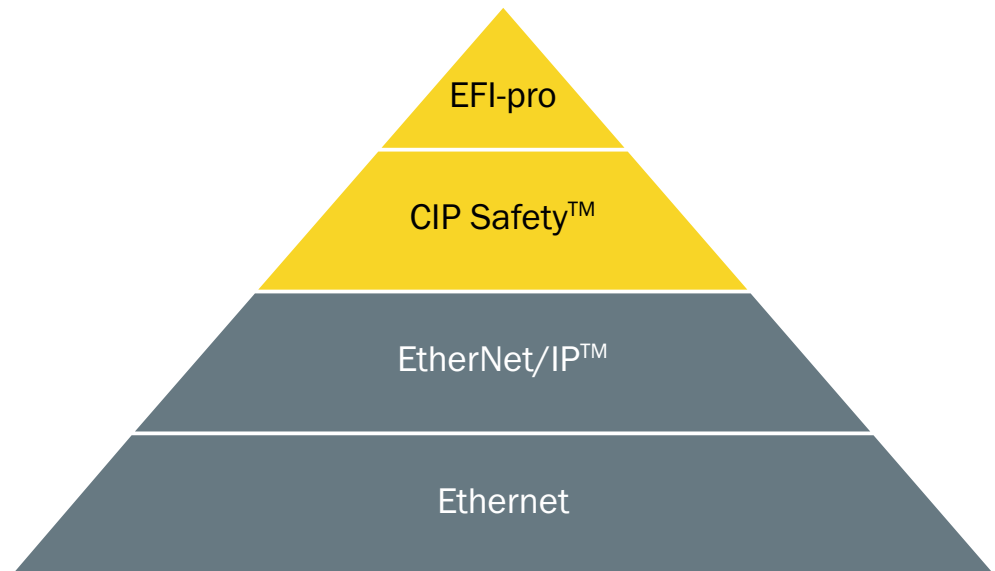


Figure 1: EFI-pro concept

EFI pro: Safe SICK device communication via the network for industrial automation

CIP Safety™: Extension of CIP for safety applications up to SIL3 (IEC 61508)

EtherNet/IP™: Implementation of CIP based on Ethernet (standards under management of ODVA)

Ethernet: Standard network technology (in accordance with IEEE 802.3)

EFI-pro or EtherNet/IP™ CIP Safety™ communication is transmitted to the so-called black channel via Ethernet. In doing so, an additional safety protocol checks and ensures the integrity of the transmitted data.

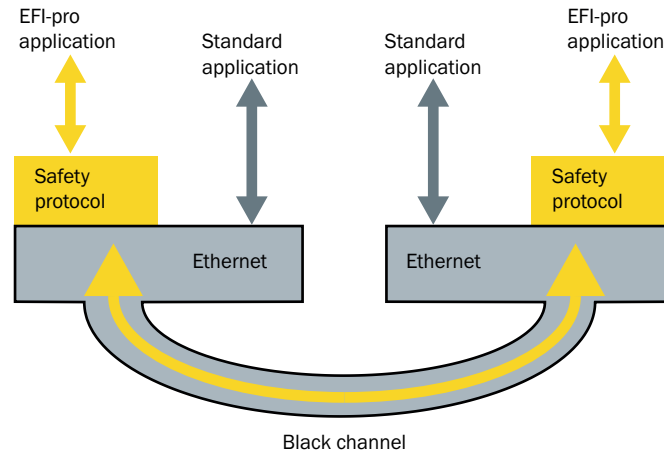


Figure 2: Implementation of CIP Safety™ via Ethernet

Components of an EFI-pro system

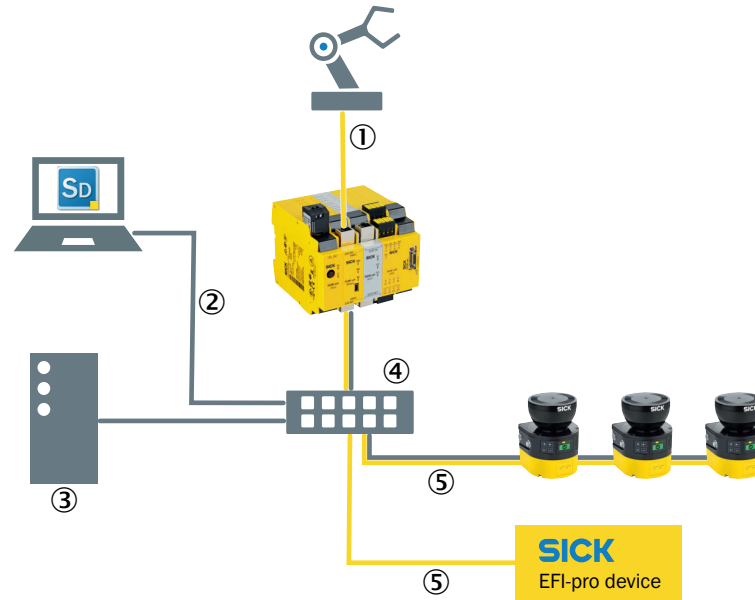


Figure 3: Components of an EFI-pro system

- ① Safe connection via EtherNet/IP™ CIP Safety™
- ② Ethernet connection
- ③ Industrial PC, e.g. for evaluating measurement data
- ④ Switch
- ⑤ Safe communication via EFI-pro

An EFI-pro system can contain the following components:

- Flexi Soft system with FX3-GEPR EFI-pro gateway
- microScan3 EFI-pro safety laser scanner
- Other EFI-pro-compatible devices
- Computer with Safety Designer configuration software
- Switches
- Devices from third-party manufacturers such as PLC, robot controls, etc.

EFI-pro devices in an EFI-pro network offer the following additional functions for easier handling during commissioning, operation and diagnostics:

- Ethernet-based, safety-related and non-safety-related communication
- Flexible topology and simple cabling

- Quick commissioning: Easy device identification, addressing and configuration
- Quick diagnosis using remote access
- Central and quick access to all devices
- Time synchronization ¹⁾

Networking of device from third-party manufacturers is also possible via EtherNet/IP™ CIP Safety™.

Detailed information on CIP Safety™ can be found at www.odva.org and in the CIP Safety™ “The CIP Networks Library Volume 5: CIP Safety” specifications or ODVA.

¹⁾ A time encoder (a UTC server or a device in the project, e.g. a gateway or microScan3) must be available. The IP address of the time encoder is defined in the project settings.

3 Network infrastructure

3.1 Devices in the EtherNet/IP™ network

Originator

An originator is the device which initiates the establishment of a connection. The originator, e.g. a Flexi Soft system with an EFI-pro gateway (FX3-GEPR), sends a connection request to a target.



NOTE

Devices with originator function are also called scanners in the EtherNet/IP™ specifications. The term originator is used consistently in this document.

Target

A target is a device which receives and answers a connection request, e.g. a microScan3 EFI-pro.



NOTE

Devices with target function are also called adapters in the EtherNet/IP™ specifications. The term target is used consistently in this document.

3.2 Cables

Cabling requirements

- Type: 100Base-TX
- Twisted pair Ethernet cable (Cat 5 cable or higher), maximum length 100 m in accordance with EN 50173
- Shielded cables recommended



NOTE

- The use of WLAN connections is not recommended due to long transmission times and the high susceptibility to malfunctions.

3.3 Switches

Switches can be used in an EFI-pro network. It is possible to implement both safe and non-safe communication using a switch.



NOTE

Using managed switches is recommended for industrial use to prevent faults and downtime.

Managed switches offer various configuration options for the management, optimization and diagnostics of network operation, including the option of dividing up the data flow in a network into classes with different priorities.

3.4 Subnets and routers

All EFI-pro devices must be in the same sub-network for cyclical communication (for process data and safety-related data) (without intermediary routers). Otherwise, communication between the devices will not be possible.

The IP address must be assigned either in the same subnet or via USB. A network scan with Safety Designer to search for EFI-pro devices only works if the computer is in the same subnet with Safety Designer and the devices.

Acyclical data (configuration, diagnostics) can also be transmitted via a router if the IP address of the device is directly entered in Safety Designer. A router can be used to segment networks or to access the devices from a higher-level network.

3.5 Ports

A network scan using the Safety Designer configuration software is performed via UDP. The EFI-pro devices are configured via TCP. That is why the ports required for these protocols must be enabled on the computer with the Safety Designer configuration software and must not be blocked (e.g. by a firewall).

Table 2: Protocols and required ports

Protocol	Ports
UDP	30718 to 30738
TCP	2122 and 2123

3.6 Network topologies



NOTE

- Some EFI-pro-compatible devices have two Ethernet connection which are connected over an internal switch.

The following network topologies are possible:

- Star
Point-to-point connections from a switch going to a device
- Line
The connection is made from one device to the next. Except for the last device in a line, each of the devices used must have two Ethernet connections.
- A mixed form of star and line



NOTE

Device level ring (DLR)

Availability can be increased using a DLR topology. An additional EtherNet/IP™ ring supervisor is required. This function is included in some controls. EFI-pro devices do not offer this function.

A DLR topology can only be implemented if all used devices have at least two Ethernet connections. Otherwise the ring cannot be closed.



NOTE

EFI-pro does not support simultaneous operation of several fieldbuses in the same network. For example, operation of PROFINET and EFI-pro in the same network is not possible.

4 Configuration of safe connections

This chapter describes the configuration of the following types of safe connections using the FX3-GEPR:

- EFI-pro connections of the FX3-GEPR with microScan3 EFI-pro safety laser scanners
- EFI-pro connections of the FX3-GEPR with other FX3-GEPRs
- Connections of the FX3-GEPR with devices from third-party manufacturers via EtherNet/IP™ CIP Safety™



NOTE

Non-safe connections via EtherNet/IP™ are also possible with the FX3-GEPR. Compared with safe connections, the FX3-GEPR only acts as a target in non-safe connections.

The FX3-GEPR differs from the functions of the FX0-GENT EtherNet/IP™ gateway.

For detailed information on the functions of the FX0-GENT and the FX3-GEPR as well as the configuration of connections via EtherNet/IP™, see the “Flexi Soft Gateways in the Safety Designer Configuration Software“ operating instructions (SICK part number 8018170).


4.1 Basics

Communication options

The FX3-GEPR Flexi Soft gateway can act as both an originator and a target for EFI-pro and CIP Safety™. It can also be used as a target for non-safe EtherNet/IP™ connections. The following connections are therefore possible:

Table 3: Connection options via EFI-pro and EtherNet/IP™ CIP Safety™

Originator	Target	Type of connection
Flexi Soft (FX3-GEPR EFI-pro gateway)	EFI-pro-compatible SICK sensors such as microScan3 EFI-pro	EFI-pro, safe connection
Flexi Soft (FX3-GEPR EFI-pro gateway)	Flexi Soft (FX3-GEPR EFI-pro gateway)	EFI-pro, safe connection
Flexi Soft (FX3-GEPR EFI-pro gateway)	Device from a third-party manufacturer	EtherNet/IP™ CIP Safety™, safe connection

Originator	Target	Type of connection
Control from a third-party manufacturer 	Flexi Soft (FX3-GEPR EFI-pro gateway)	EtherNet/IP™, non-safe connection or EtherNet/IP™ CIP Safety™, safe connection

Several different connection types can be combined.

Limitations

- Only one FX3-GEPR EFI-pro gateway is possible per Flexi Soft system.
- The FX3-GEPR has a maximum of ten dynamic input assemblies and ten dynamic output assemblies. A static input assembly and a static output assembly are also available. ²⁾
- Maximum 48 bytes of input data (data from network to gateway) and 50 bytes of output data (data from gateway to the network) ³⁾
- A maximum of ten direct communication partners is possible on an EFI-pro gateway.
- A maximum of six microScan3 EFI-pro safety laser scanners can be connected on an EFI-pro gateway. 8 bytes of input/output are transmitted per microScan3 EFI-pro. With six microScan3 EFI-pro devices, the maximum number of 48 bytes of cyclical I/O data is reached.

Addressing

The following address data is needed for communication in an EFI-pro network or via EtherNet/IP™ CIP Safety™:

- IP address
- Subnet mask
- Default gateway
- Safety network number (SNN)



NOTE

The IP address range, the subnet mask, the default gateway and the safety network number can be automatically preset for all devices of a project in the main window of the Safety Designer under **Settings > Network**.

IP address

The IP address identifies the device in the network. Each IP address must only be assigned only once in a subnet. IPv4 addresses are used. Example: 192.168.1.2.

Subnet mask

The subnet mask determines whether a device is located in the local subnet or a remote network. Example: 255.255.255.0.

Default gateway

This is the IP address of the router for connecting to another subnet.

²⁾ An assembly is a pre-defined combination of data. Each assembly is identified with a unique instance number. Assemblies are also determined by their size and type. There are input assemblies (which receive data), output assemblies (which provide data) and configuration assemblies.

³⁾ This is the the respective maximum total amount of all cyclical data to be transmitted in dynamic and static assemblies including the non-safe data which may be transmitted via EtherNet/IP™.

Safety network number (SNN)

Each device in an EtherNet/IP™ CIP Safety™ network or in an EFI-pro network must be configured with an SNN. The SNN is a hexadecimal number consisting of 6 bytes. Example: 432D_0226_A17B.

Each device which, as an originator, establishes a connection to a target should have the same SNN as the target.

**NOTE**

The use of several SNNs within a project is possible in certain cases, but is not recommended.

4.2 EFI-pro**4.2.1 Flexi Soft with microScan3 EFI-pro****Hardware**

A FX3-GEPR Flexi Soft gateway (EFI-pro gateway) is used as an originator. Up to six microScan3 EFI-pro safety laser scanners with full functionality can be connected as targets.

Two RJ45 interfaces for connecting the devices are available on the EFI-pro gateway.

The microScan3 EFI-pro safety laser scanners can be connected in a line topology. The default Ethernet cables (M12, 4-pin, D-coded) are used here. Alternatively, a star topology can be implemented using a switch.

Software configuration

Creating the devices in Safety Designer

1. In the Safety Designer main window, create one or more microScan3 EFI-pro safety laser scanners and a modular Flexi Soft safety controller as devices.
2. An FX3-GEPR EFI-pro gateway can be added in the device window of the Flexi Soft safety controller.

All devices must be in the same subnet and have the same safety network number (SNN).

Connecting devices together

There are two ways to connect a gateway and a safety laser scanner together:

- Click on **Connections** in the Safety Designer main window
This is the recommended procedure.
- In the Flexi Soft safety controller device window
This procedure is required, for example, to edit or replace existing connections or if EFI-pro devices in more complex projects are to be connected with several Flexi Soft systems.

Connecting the devices in the Safety Designer main window

1. Click on **Connections** in the Safety Designer main window.
 - ✓ The available EFI-pro connections are displayed on the device tiles of all EFI-pro-compatible devices. Devices which act as an originator have an EFI-pro connection at the bottom. Devices which act as a target have an EFI-pro connection at the top. The FX3-GEPR EFI-pro gateway can act as both an originator and a target. The device tile of a Flexi Soft system with an FX3-GEPR therefore has two EFI-pro connections.
2. Make a connection to the EFI-pro connection of a microScan3 EFI-pro from the lower EFI-pro connection of the Flexi Soft system.
 - ✓ An EFI-pro connection is established between the two devices.

3. Repeat the last step for all safety laser scanners in the project.

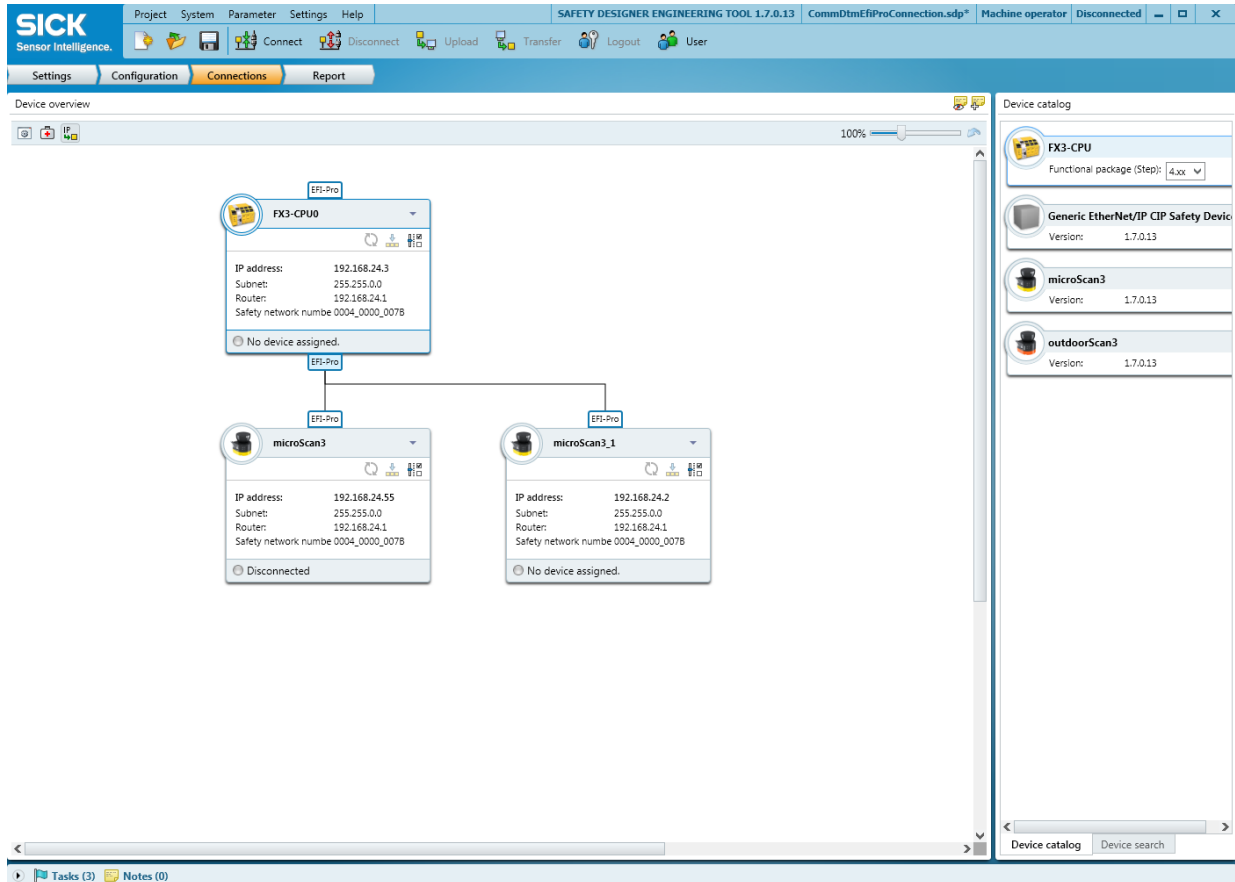


Figure 4: Efi-pro connections in the Safety Designer main window



NOTE

The connection structure shown in Safety Designer does not have to correspond to the network topology. Instead, the logical connection of two connected devices is displayed using a direct connection line between these devices.

If there is a Flexi Soft system with several connected microScan3 Efi-pro devices, this results in a star-shaped connection structure in Safety Designer, even if several or all microScan3 are cabled together in a linear manner.

- ✓ An assembly is automatically created in the FX3-GEPR corresponding to each input and output assembly of a microScan3 Efi-pro and connected to the assembly in the microScan3 Efi-pro. The tag names from the assemblies of the microScan3 Efi-pro are then automatically adopted the assemblies in the FX3-GEPR. The data of the input and output assemblies of the microScan3 Efi-pro safety laser scanner connected to the Flexi Soft system is available as inputs and outputs in the logic editor of the Flexi Soft system.



NOTE

You can find more information in the “Flexi Soft Gateways in the Safety Designer Configuration Software” operating instructions (SICK part number 8018170).

Connecting the devices in the Flexi Soft device window

1. In the device window of the Flexi Soft system, click on **Configuration** and then on the **Connection creation** menu item of the FX3-GEPR Efi-pro gateway.
- ✓ The Flexi Soft system (FX3-CPU0) is displayed at the top in the center of the win-

dow. The other devices available in the project are initially displayed in the lower area of the device window.

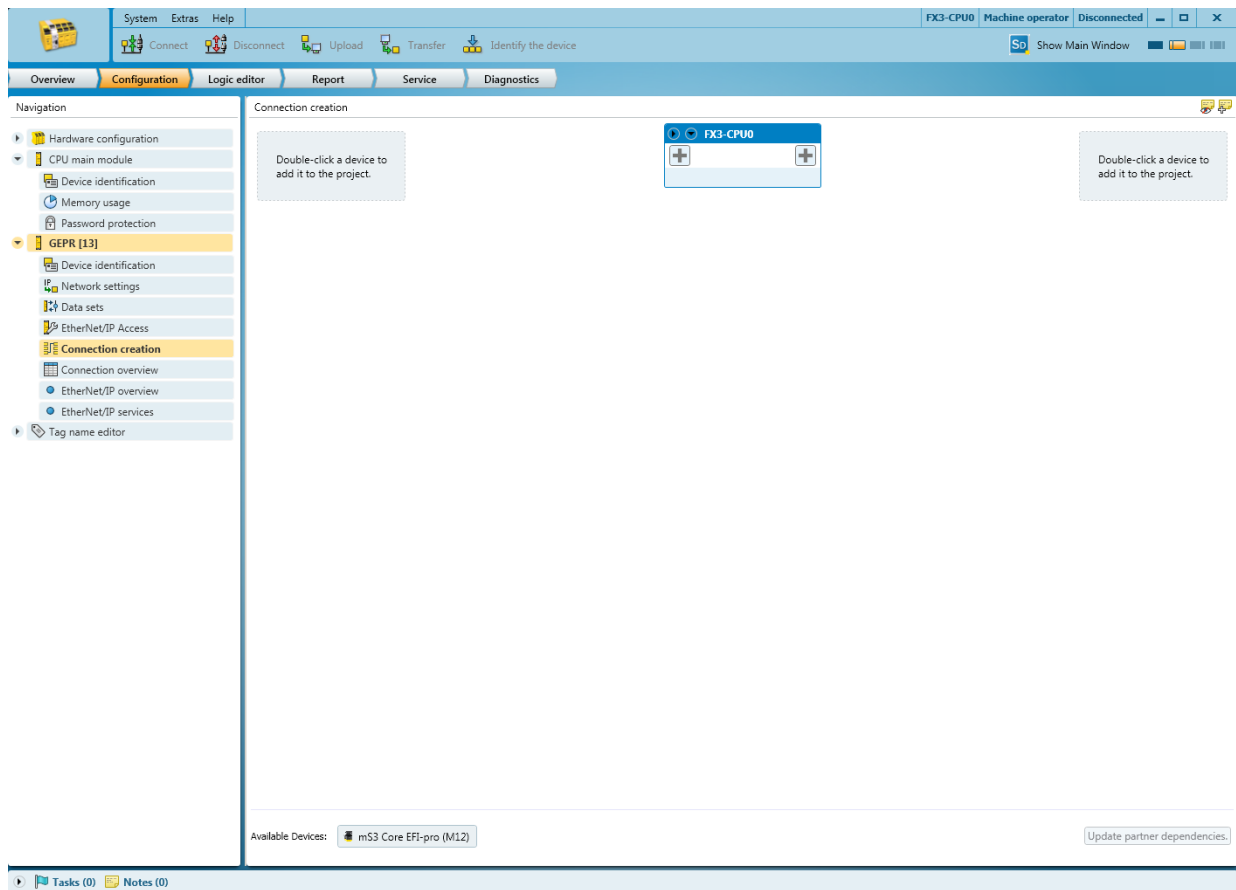


Figure 5: microScan3 EFI-pro in connection creation of the FX3-GEPR

2. Double-click on the desired microScan3 EFI-pro to include it in connection creation.
 - ✓ At the top left, the output assembly (data to the gateway) of the selected microScan3 EFI-pro is displayed, at the top right is the input assembly (data from the gateway).
3. Drag the assemblies of the microScan3 EFI-pro to the opposite plus icon of the Flexi Soft system using drag-and-drop.
 - ✓ An assembly is created in the FX3-GEPR corresponding to each input and output assembly of a microScan3 EFI-pro and connected to the assembly in the microScan3 EFI-pro. The tag names from the assemblies of the microScan3 EFI-pro are then automatically adopted the assemblies in the FX3-GEPR.



NOTE

If the FX3-GEPR was already connected with a microScan3 EFI-pro, then it might already contain one or several corresponding assemblies. Instead of creating new assemblies, you can connect the existing assemblies to the assemblies of the microScan3 EFI-pro via drag-and-drop.

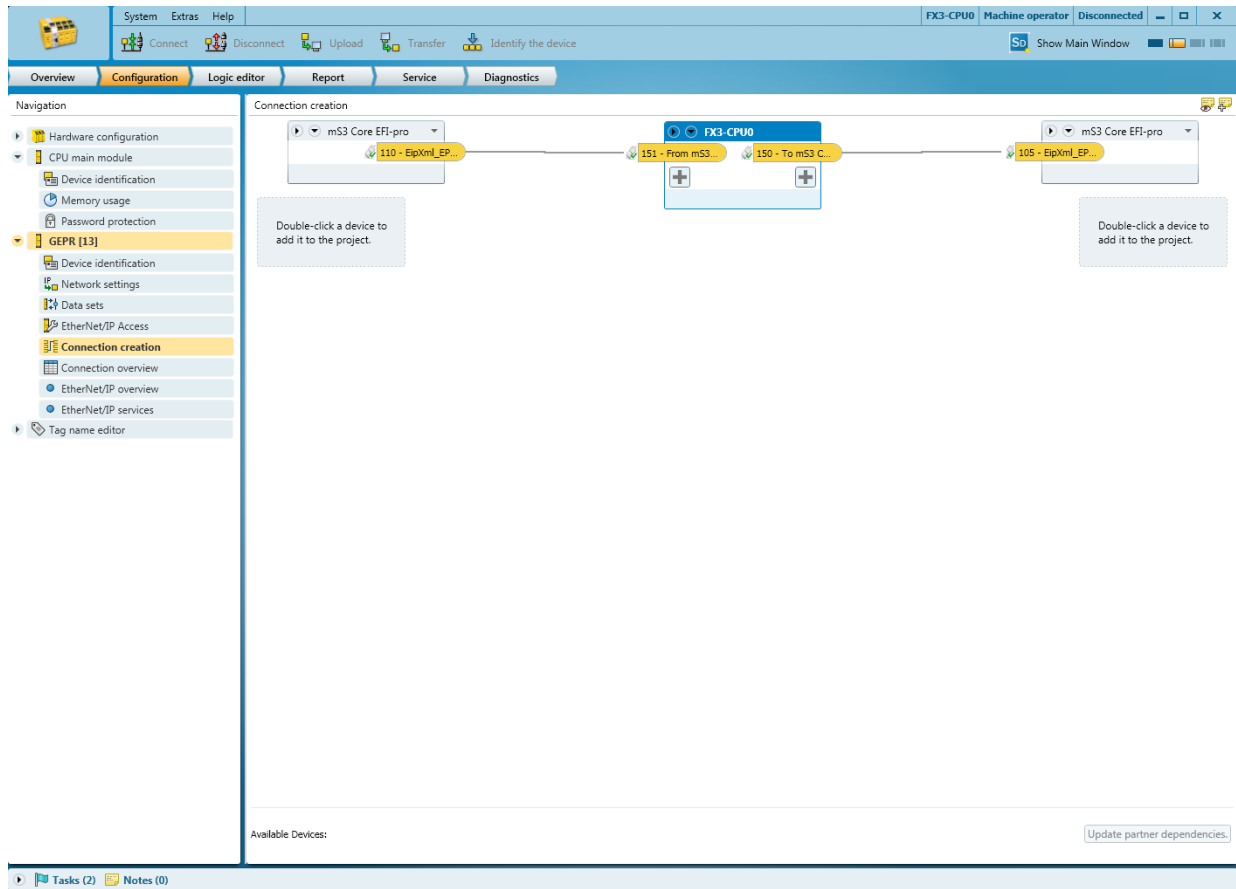


Figure 6: Connecting the assemblies of the microScan3 EFI-pro to the FX3-GEPR

The data of the input and output assemblies of the microScan3 EFI-pro safety laser scanner connected to the Flexi Soft system is available as inputs and outputs in the logic editor of the Flexi Soft system.



NOTE

More information can be found in the “microScan3 – EFI-pro Safety Laser Scanner” operating instructions (SICK part number 8021911).

The cut-off paths of the microScan3 EFI-pro in the logic editor

The cut-off paths of the microScan3 EFI-pro are assigned to the output signals in the **Monitoring cases** menu item. In the example, two protective fields and a warning field are configured, which are laid on the **Safe output 1, 2 and 3** output signals.

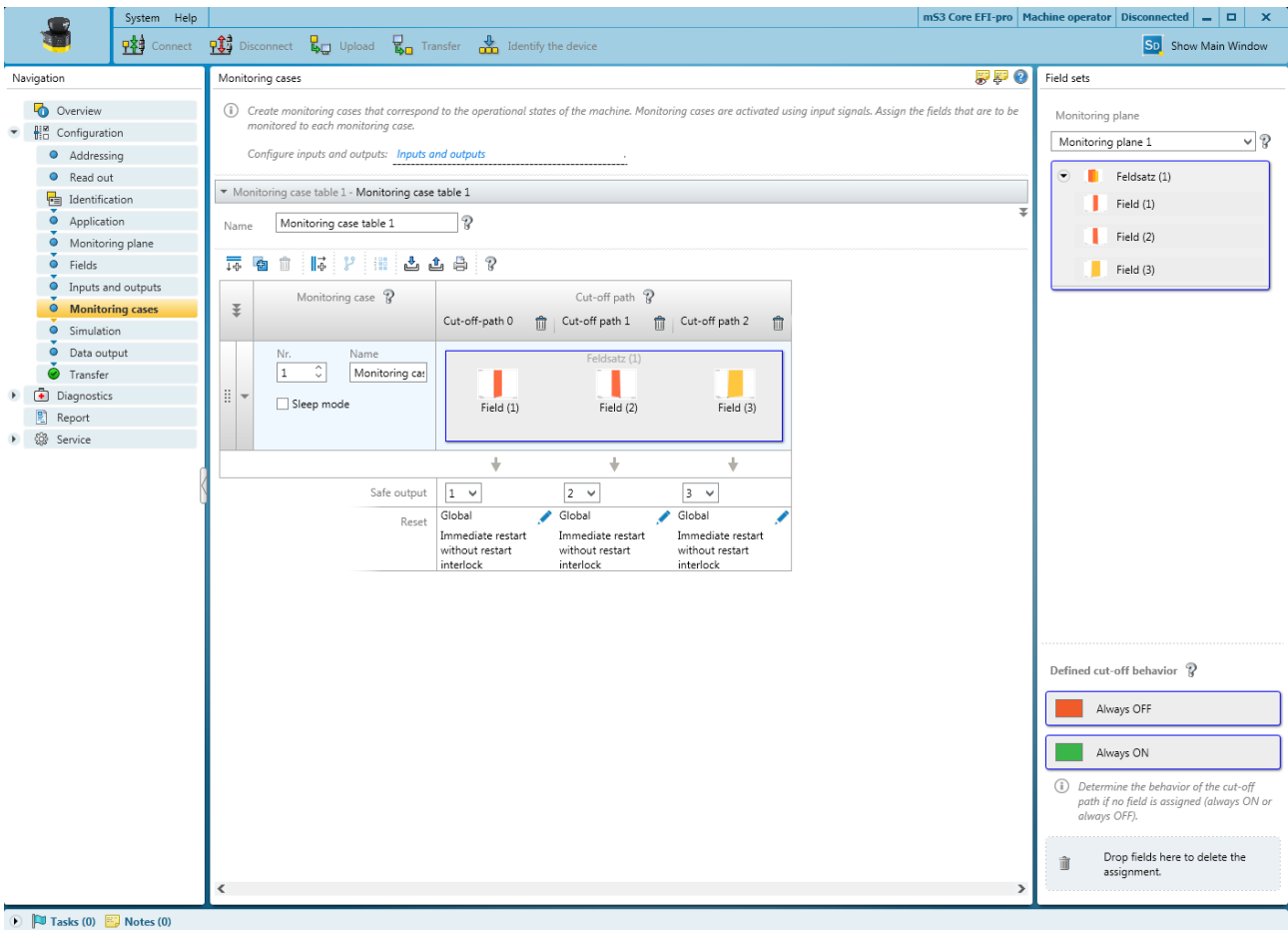


Figure 7: Cut-off paths of the microScan3 EFI-pro



NOTE

2 bits are transmitted for each cut-off path. Of which one is marked in the logic editor of the Flexi Soft system as **safety-related** by means of its tag name, the other as **non-safety related**.

If a protective field has been assigned to the cut-off path, both bits are always switched if there is a field violation. That means, when the protective field is free, both bits are 1; if the protective field is violated, then both bits go to 0. The evaluation of the safety-related bits is sufficient for safety-related functions.

If a warning field has been assigned to the cut-off path, the safety-related bit is always 0. The non-safety-related bit is 1 if the warning field is free and goes to 0 if the warning field is violated.

The output signals of the microScan3 EFI-pro are found in the logic editor of the Flexi Soft system under the **Inputs** tab. The output signals can be dragged to a logic page via drag-and-drop.

The following assignment results from the example:

- Protective field PF1 > Safe output 1 > Cut-off path 1 (safety-related)
- Protective field PF2 > Safe output 2 > Cut-off path 2 (safety-related)
- Warning field WF > Safe output 3 > Cut-off path 3 (non-safety-related)

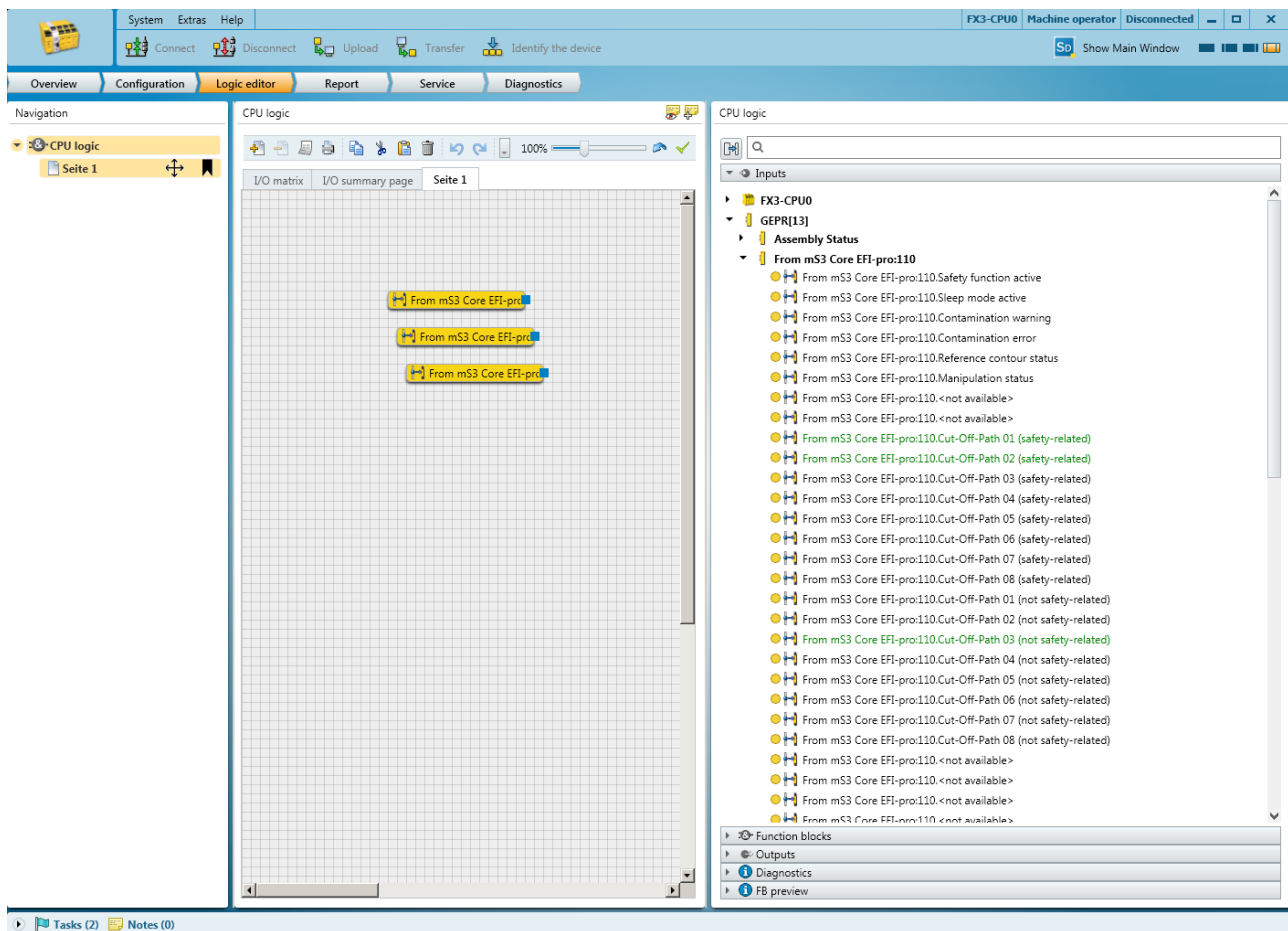


Figure 8: Cut-off paths of the microScan3 EFI-pro in the logic editor

4.2.2 Flexi Soft with Flexi Soft

Hardware

If two Flexi Soft stations are each connected to a FX3-GEPR EFI-pro gateway, one of the two gateways acts as an originator and the other as a target for this connection.

Software configuration

Creating the devices in Safety Designer

1. In the main window of the Safety Designer, create the desired number of modular Flexi Soft safety controllers as devices.
2. An FX3-GEPR EFI-pro gateway can be added to each Flexi Soft safety controller.

All devices must be in the same subnet and have the same safety network number (SNN).

Connecting devices together

There are two ways to connect two gateways:

- Click on **Connections** in the Safety Designer main window. This is the recommended procedure for simple applications.
- In the Flexi Soft safety controller device window
For example, this procedure is required to edit or replace existing connections or if the static assemblies are to be used or if several assemblies or assemblies other than the automatically created ones are needed.

Connecting the devices in the Safety Designer main window

1. Click on **Connections** in the Safety Designer main window.
- ✓ The available EFI-pro connections are displayed on the device tiles of all EFI-pro-compatible devices. Devices which act as an originator have an EFI-pro connection at the bottom. Devices which act as a target have an EFI-pro connection at the top. The FX3-GEPR EFI-pro gateway can act as both an originator and a target. The device tile of a Flexi Soft system with an FX3-GEPR therefore has two EFI-pro connections.
2. Make a connection to the upper EFI-pro connection of another Flexi Soft system from the lower EFI-pro connection of the Flexi Soft system that should act as an originator.
- ✓ A dynamic input assembly and a dynamic output assembly are automatically created in both the originator and target and connected to the corresponding assembly of the other device. The automatically established assemblies are 4 bytes in size and are 8-bit or Boolean data types.
3. If necessary, repeat the last step for all Flexi Soft systems contained in the project which are to be connected to one another.

**NOTE**

- Two Flexi Soft system can be connected multiple times. In doing so, each of the two systems can act as an originator and the other as a target for one or several connections.
- The connection structure shown in Safety Designer does not have to correspond to the network topology. Instead, the logical connection of two connected devices is displayed using a direct connection line between these devices.

The bits of the input and output assemblies of the connected Flexi Soft systems are available in the logic editor as inputs and outputs.

**NOTE**

You can find more information in the “Flexi Soft Gateways in the Safety Designer Configuration Software” operating instructions (SICK part number 8018170).

Connecting the devices in the Flexi Soft device window

- ▶ Open the device window of the Flexi Soft system which should act as a target and click on **Configuration**.

Configuring static assemblies (optional)

1. If static assemblies are to be used in the target, click on the **EtherNet/IP access** menu item of the FX3-GEPR.
2. Select the desired static assembly in the **CIP Safety** area. Both an assembly with 4 bytes or an assembly with 10 bytes are available for each transmission direction.
3. Select **For EFI-pro** in the right-hand drop-down menu to activate the desired static assemblies for use in the EFI-pro network.

Configuring dynamic assemblies (optional)

1. If dynamic assemblies should be used, click on the **Connection creation** menu item of the FX3-GEPR.
2. Click on one of the two plus icons of the Flexi Soft system (FX3-CPU0) displayed in the top center of the window to open the assembly editor to create new assemblies. You can create input assemblies using the left-hand plus icon and output assemblies using the right-hand plus icon.

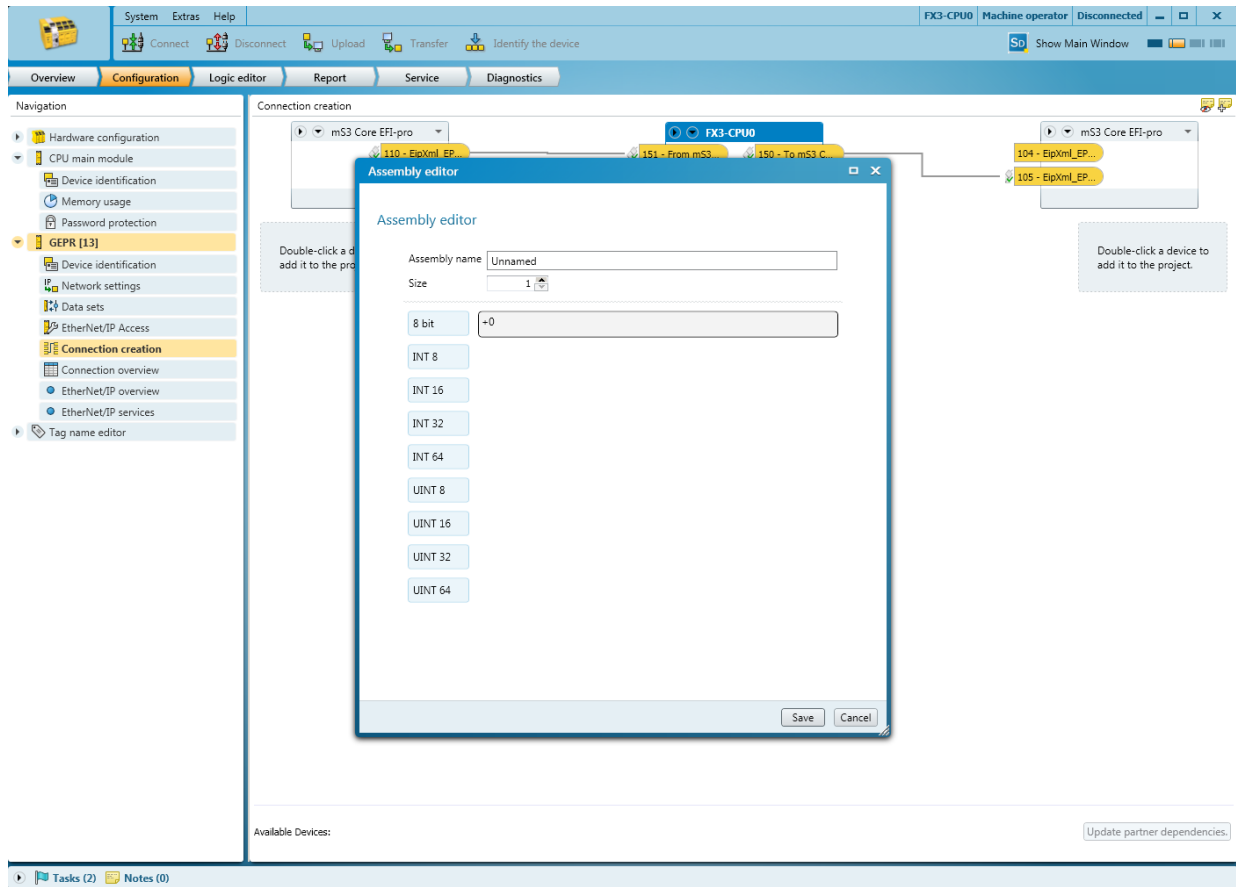


Figure 9: The assembly editor

3. Enter a name for the new assembly, select the size in bytes and assign all bytes to a data type from the left-hand selection list using drag-and-drop. The 8 bit data type is usually suitable.



NOTE

An assembly can contain various data types.

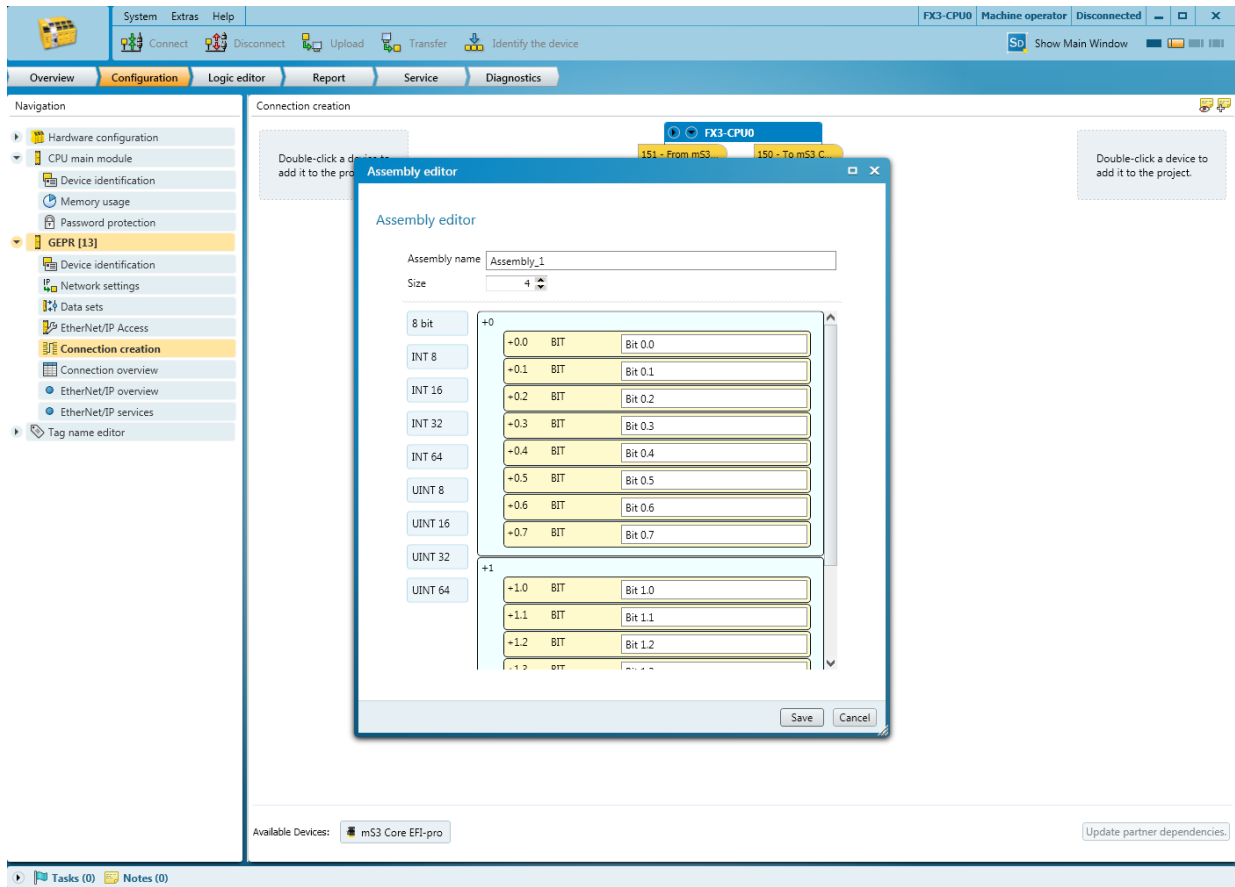


Figure 10: Defining an assembly in the assembly editor

4. Click on **Save** to close the editor and create the new assembly.
5. Create all required assemblies in this way.

Establishing EFI-pro connections

1. Open the device window of the Flexi Soft system which should act as an originator and click on **Configuration**.
2. If static assemblies are to be used in the originator, configure these as described.
3. Then click on the **Connection creation** menu item of the FX3-GEPR EFI-pro gateway.
- ✓ The Flexi Soft system as FX3-CPU0 acting as an originator is displayed at the top center of the window. The devices available as targets in the project are initially displayed in the lower area of the device window.
4. Double-click on the desired Flexi Soft system to include it in the establishment of the connection as the target.
- ✓ The output assemblies of the newly-added Flexi Soft system is shown at the top right, the input assemblies at the top left.
5. Drag the input and output assemblies of the targets which are to be connected to the opposite plus icon of the originator using drag-and-drop.
- ✓ A dynamic assembly is created in the originator corresponding to each input and output assembly of the target and connected to the target assembly. The tag names from the assemblies of the target are then automatically adopted in the assemblies in the originator.



NOTE

- Instead of creating new dynamic assemblies, you can connect existing static or dynamic assemblies to one another using drag-and-drop.
- Static assemblies must be configured under **EtherNet/IP access** of the respective FX3-GEPR before they can be used.
- Assemblies can only be connected if the size and data type match.
- The Flexi Soft system in whose device window the connection was established acts as an originator for each connection between two assemblies.
- If several assemblies of two Flexi Soft system are connected to one another, you can select individually for each connection which of the two Flexi Soft systems should act as an originator.

The data of the connected input and output assemblies is available in the logic editors of the two connected Flexi Soft systems as inputs and outputs.

4.2.3 Editing EFI-pro connections

Editing connection settings

1. Open the device window of the originator of the connection in question.
2. Click on **Configuration** and then on the **Connection creation** menu item of the FX3-GEPR.
3. Move the mouse cursor to the connection to be edited. A pop-up dialog window appears.
4. In this pop-up dialog window of the connection line, click on **Edit**. The **Settings of the safety connection** dialog window opens.

The following parameters can be configured:

- Connection name
- RPI
- Max. lost packets
- Network delay
- SCID mechanism

The resulting **response time via the network** of the connection is also shown.



NOTE

These parameters are also displayed under the **Connection overview** menu item of the FX3-GEPR in table form for all connections for which the FX3-GEPR acts as an originator and can also be edited there. The cycle times between the network and the main module (CPU) are also displayed here.

Connection name

The preset name of the connection can be changed here if needed.

RPI

The **requested packet interval (RPI)** determines how often data is sent. It is specified in milliseconds and influences the response time.

Max. lost packets

The number of **maximum lost packets** determines the tolerance against transmission faults. It influences the response time.

Network delay

The **network delay** enables additional fault tolerance of the connection. It is specified in percent of the requested packet interval (RPI) and influences the response time.

SCID mechanism

This is optional additional protection against unwanted changes to the configuration. If the **Use SCID mechanism** is activated, the originator compares its safety configuration ID (SCID) with the SCID saved in the target. If the checksums of the two SCIDs do not match, meaning the configuration of both devices has been changed, no communication occurs.

The SCID is a combination of a checksum and the date stamp of the safety configuration. It can be read in the device window of the Flexi Soft system under **Configuration, GEPR, EtherNet/IP overview**.



NOTE

The **Use SCID mechanism** option cannot be configured in the **Connection overview** but only in the **Safety connection settings** under **Connection creation**.

Response time via network

The **response time via the network** is the maximum time which can pass until the transmitted data is successfully updated. If this response time is exceeded, it is evaluated as a fault.

The response time is calculated using the following formula:

$$\text{Response time} = \text{RPI} \times \text{max. lost packets} + \text{RPI} \times \text{network delay}/100$$

Connection status

Under the **Connection overview** menu item of the FX3-GEPR, the **connection status** is shown for all connections for which the FX3-GEPR acts as an originator.

Deleting the connection

Deleting connection in the main window

1. Click on **Connections** in the Safety Designer main window.
2. Move the mouse cursor to the connection you want to delete. The connection line is highlighted in blue and a recycling bin icon appears on the target connection.
3. Click on the recycling bin icon to delete the connection.

Or:

4. Click on **Delete** in the context menu of the connection line.

Deleting connection in the device window

1. Open the device window of the originator of the connection you want to delete.
2. Click on **Configuration** and then on the **Connection creation** menu item of the FX3-GEPR.
3. Move the mouse cursor to the connection you want to delete. A pop-up dialog window appears.
4. In this pop-up dialog window of the connection line, click on **Delete**.



NOTE

The assemblies whose connection was deleted remain. They have to be deleted separately in the **Connection creation** of the FX3-GEPR if desired.

4.3 EtherNet/IP™ CIP Safety™

4.3.1 Flexi Soft with devices from third-party manufacturers



NOTE

SICK provides example configuration files on request for easy configuration of various devices from third-party manufacturers. Information is available from your SICK subsidiary. Current versions of the Safety Designers have sample files for the **generic EtherNet/IP CIP safety device**.

Hardware

An FX3-GEPR EFI-pro gateway (EFI-pro gateway) can establish a connection with a devices of a third-party manufacturer via EtherNet/IP™ CIP Safety™. The device of the third-party manufacturer acts as a target in this connection.

Software configuration

The **generic EtherNet/IP CIP safety device** is available in the device catalog of the Safety Designer for connecting an EFI-pro gateway with devices from third-party manufacturers via EtherNet/IP™ CIP Safety™.

Safety functions, such as remote I/O or robots can be used with the help of the **generic EtherNet/IP CIP safety device**.

Creating a generic Ethernet/IP CIP safety device

- ▶ Double-click on **Generic Ethernet/IP CIP safety device** in the device catalog in Safety Designer.
- ✓ A device tile for the **generic Ethernet/IP CIP safety device** is added in the device overview.

Configuring a generic Ethernet/IP CIP safety device

1. In Safety Designer, click on the device tile for the **generic Ethernet/IP CIP safety device** to open the associated device window.
2. In the **General** tab, make the following settings:

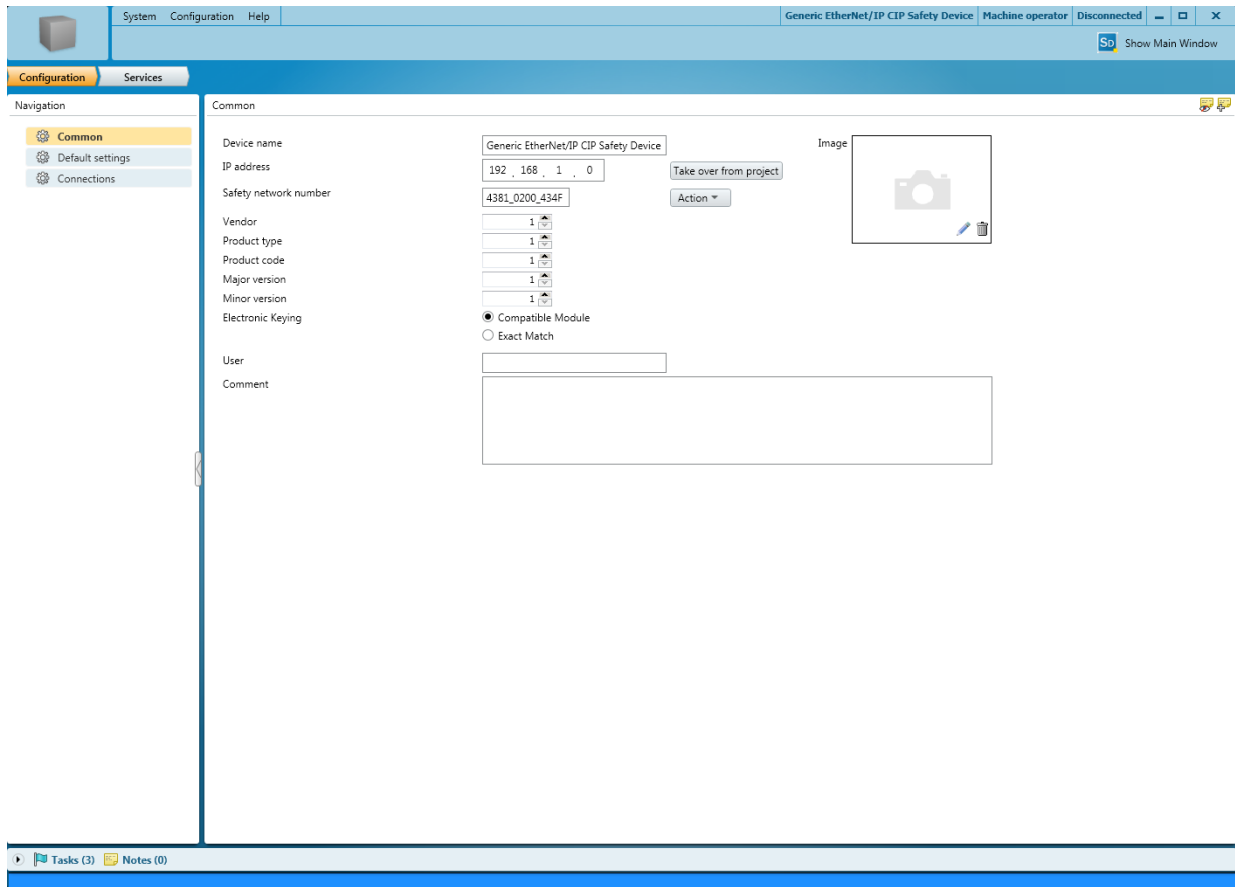


Figure 11: Configuration window of the generic Ethernet/IP CIP safety device, general

- ▷ Enter a **device name** and assign an image to the device where applicable.
- ▷ Enter the device **IP address** and the project **safety network number**.
- ▷ Enter the general characteristics of the new device (**supplier, product type, product code, main version, and minor version**). You can find this data in the manual or the EDS file for the device. ⁴⁾

Using this characteristic data, a **version test** is performed when establishing the communication between the originator, i.e. the FX3-GEPR, and the third-party manufacturer device as a target. In doing so, the originator sends the characteristic data and the mode of the version test to the target. The target tests the characteristic data and reports the result of the version test to the originator. If the version test fails, no connection can be established.

- ▷ Specify the mode for the **version test**.
 - **Compatible module:** The target uses the received characteristic data to test whether it is identical or compatible with the device expected by the originator. The type of compatibility testing is dependent only on the target.
 - **Exact match:** A connection can only be made if the characteristic data sent from the originator exactly matches the characteristic data of the target.
- ▷ Optionally, enter a **user** and/or a **comment**.

3. In the **Default settings** tab, make the following settings:

4) The EZ-EDS software of ODVA can be used to read the EDS file. It is not possible to read in the EDS file using Safety Designer. The data must be manually entered in the configuration window of the generic Ethernet/IP CIP safety device.

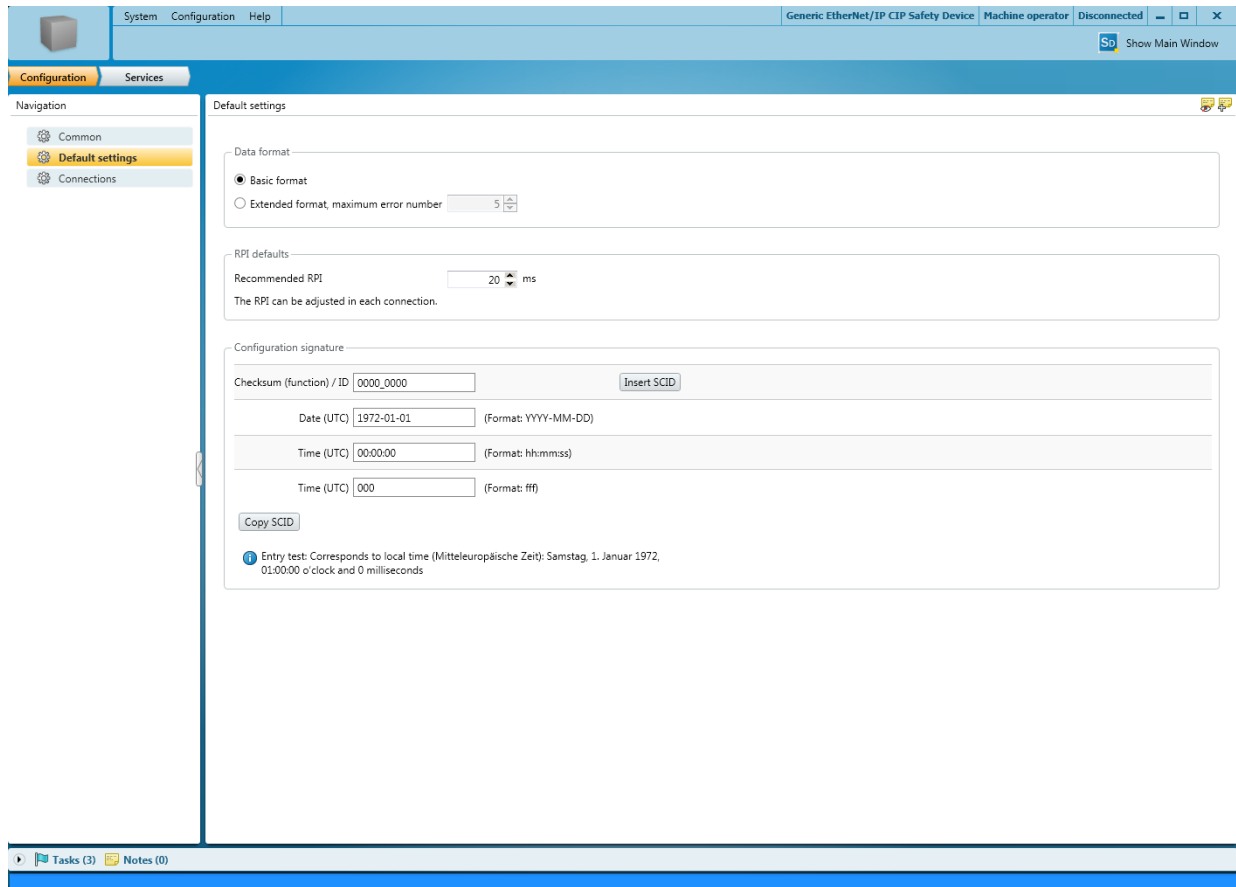


Figure 12: Configuration window of the generic Ethernet/IP CIP safety device, standard settings

- ▷ Enter the general connection parameters. This includes the **data format** as well as, where applicable, the **Extended format**, **maximum fault number** and the **standard RPI**. You can find this data in the manual or the EDS file for the device. ⁵⁾ The RPI can be adjusted individually for each connection, see "[Editing EtherNet/IP™ CIP Safety™ connections](#)", page 33.
 - ▷ You can also enter a **configuration signature** as an option.
4. In the **Connections** tab, configure the connection paths of the new device. You can automatically generate the connection paths for the safety capable input and the safety output from the assembly data of the device (can be found in the manual or the EDS file).

⁵⁾ The RPI is often displayed as the EPI (expected packet interval) in the EDS file of the device.

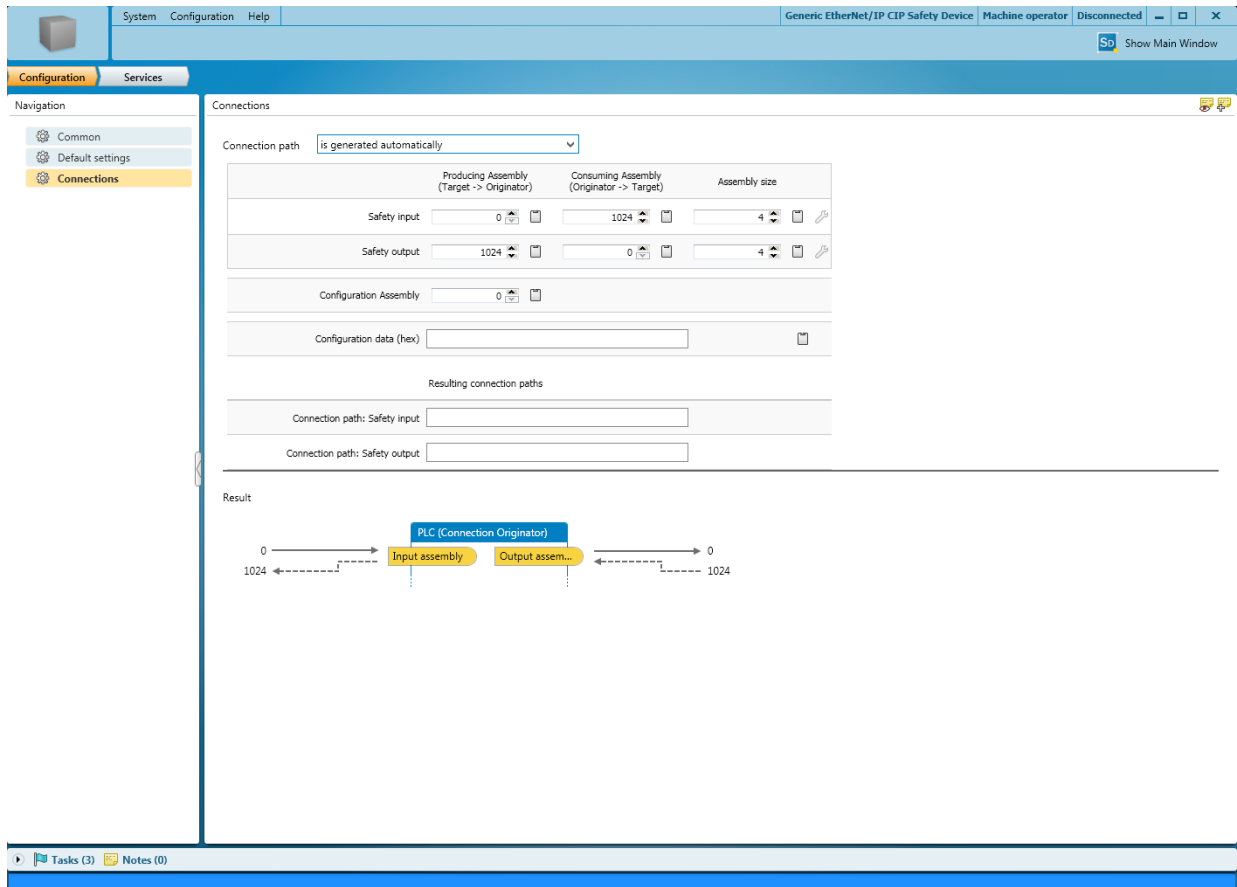


Figure 13: Generating connection paths

Alternatively, you can enter the hexadecimal connections paths directly under Define connection path.

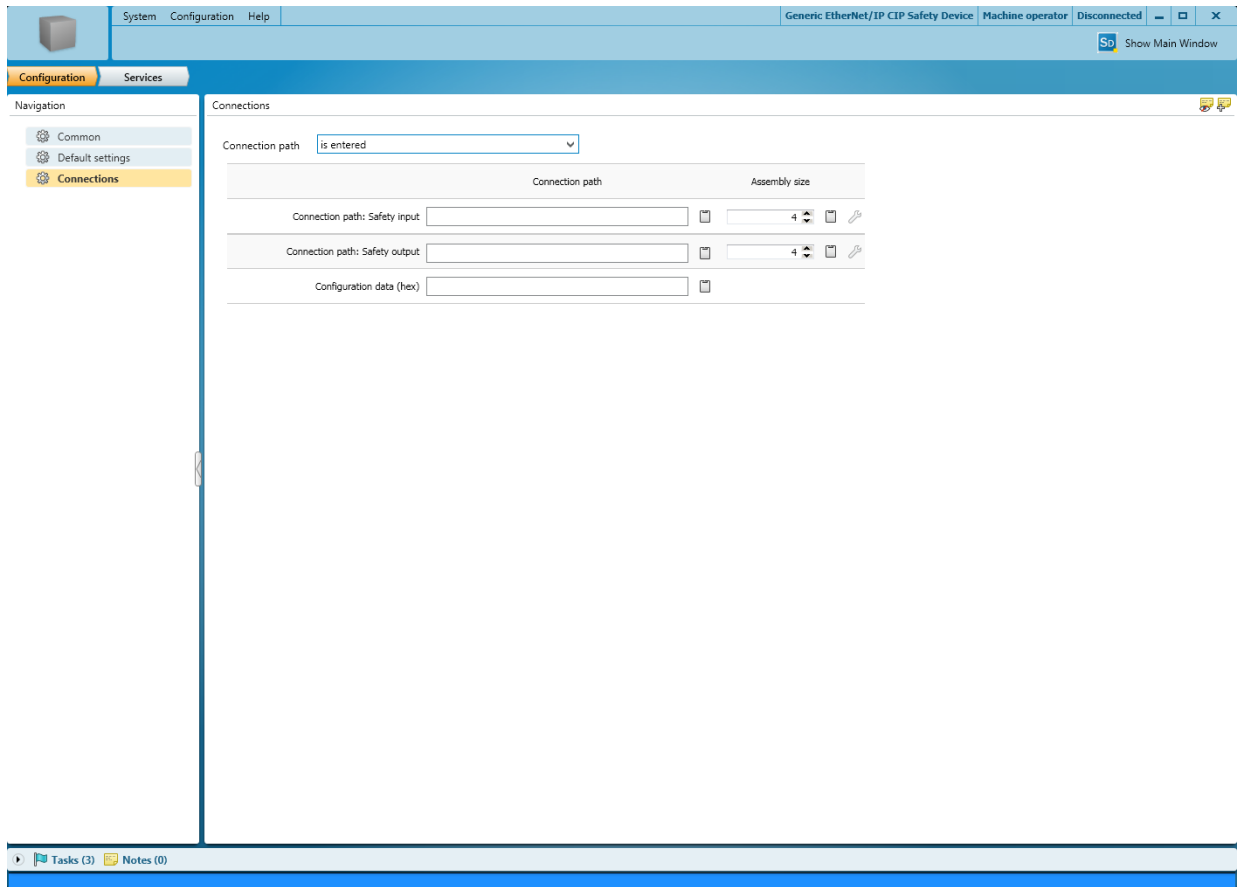


Figure 14: Entering connection path directly

You can find the connection path for the safety capable input and the safety output in the EDS file under Connection Manager. The connection paths contain information about classes, instances and attributes which are needed for establishment of the connection.

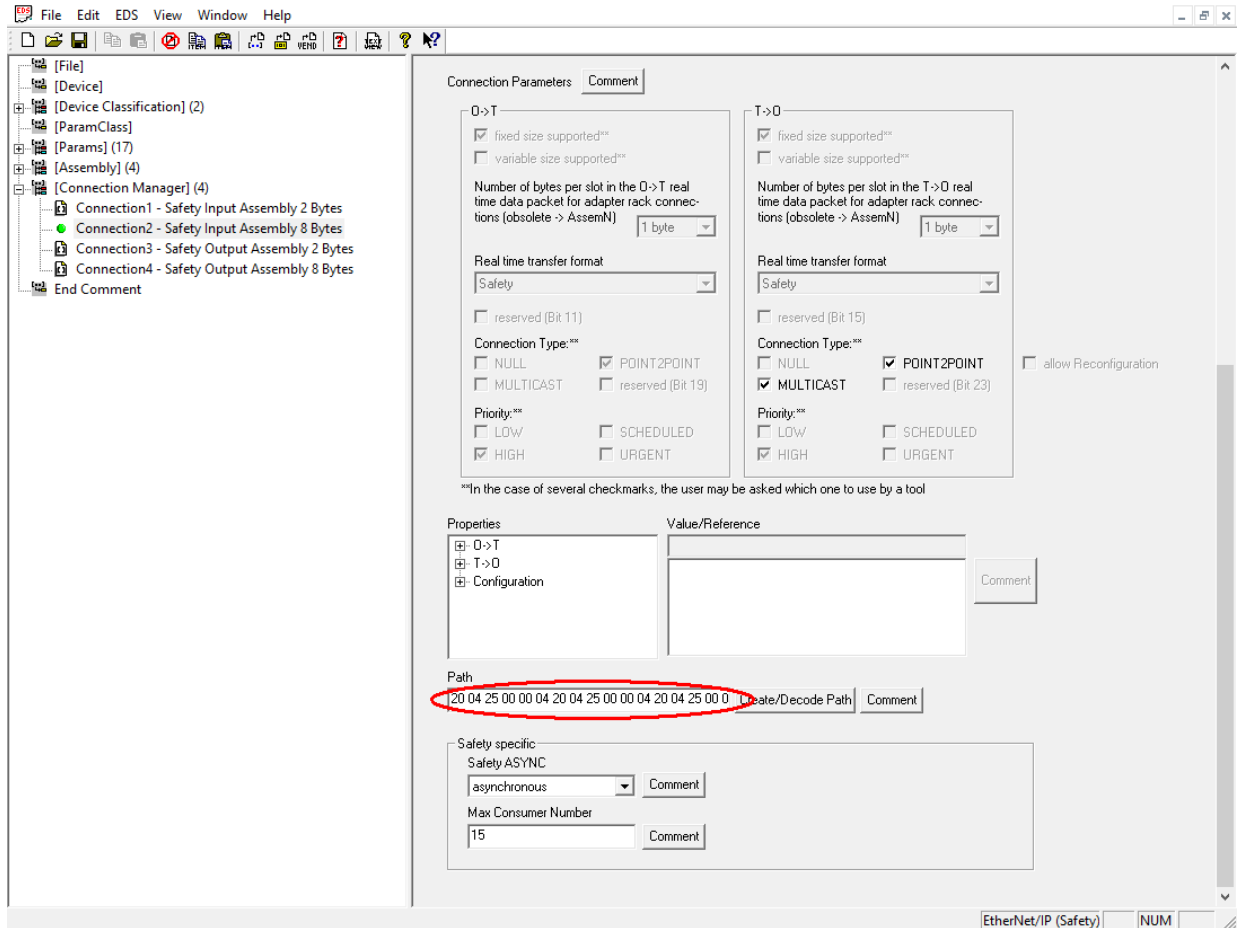


Figure 15: Connection path in the EDS file in EZ-EDS



NOTE

Regardless of whether the connection path is entered manually or generated by Safety Designer, the **assembly size** must always be entered in byte.

Connecting devices together

There are two ways to connect a gate with a device from a third-party manufacturer:

- Click on **Connections** in the Safety Designer main window. This is the recommended procedure for simple applications.
- In the Flexi Soft safety controller device window
For example, this procedure is required to edit or replace existing connections or if the static assemblies of the FX3-GEPR are to be used or if several assemblies are to be connected.

Connecting the devices in the Safety Designer main window

1. Click on **Connections** in the Safety Designer main window.
- ✓ The available EFI-pro connections are displayed on the device tiles of all suitable devices. Devices which act as an originator have an EFI-pro connection at the bottom. Devices which act as a target have an EFI-pro connection at the top. The FX3-GEPR EFI-pro gateway can act as both an originator and a target. The device tile of a Flexi Soft system with an FX3-GEPR therefore has two EFI-pro connections. Devices from third-party manufacturers can only work as a target and therefore have only one EFI-pro connection at the top.

2. Make a connection to the EFI-pro connection of the third-part manufacturer device from the lower EFI-pro connection of the Flexi Soft system that should act as an originator.
- ✓ In the FX3-GEPR, a dynamic input assembly and a dynamic output assembly are automatically created and connected with the respective assembly of the third-party manufacturer device. The automatically created assemblies correspond to the size of the assemblies of the third-party manufacturer devices and are 8-bit or Boolean types.
The bits of the input and output assemblies of the connected devices are available in the logic editor as inputs and outputs.



NOTE

You can find more information in the “Flexi Soft Gateways in the Safety Designer Configuration Software” operating instructions (SICK part number 8018170).

Connecting the devices in the Flexi Soft device window

- ▶ Open the device window of the new Flexi Soft system and click on **Configuration**.

Configuring static assemblies (optional)

1. If static assemblies of the FX3-GEPR should be used, click on the **Ethernet access** menu item of the FX3-GEPR.
2. Select the desired static assembly in the **CIP Safety** area. An alternative assembly with 4 bytes or an assembly with 10 bytes are available for each transmission direction.
3. Select **For EFI-pro** in the right-hand drop-down menu to activate the desired static assemblies for use in during connection creation.

Configuring dynamic assemblies (optional)

1. If dynamic assemblies should be used, click on the **Connection creation** menu item of the FX3-GEPR.
2. Click on one of the two plus icons to open the assembly editor to create new assemblies. You can create input assemblies using the left-hand plus icon and output assemblies using the right-hand plus icon.

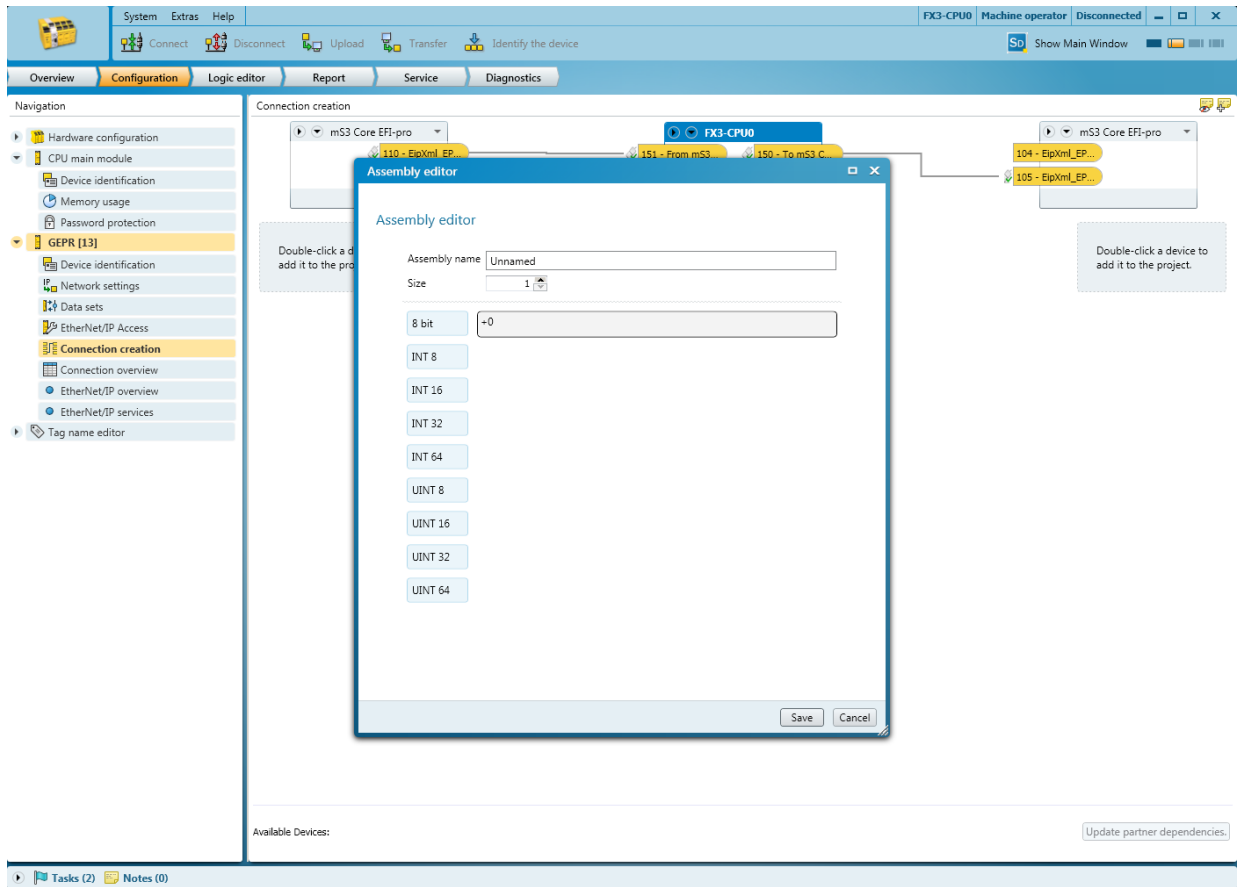


Figure 16: The assembly editor

3. Enter a name for the new assembly, select the size in bytes and assign all bytes to a data type from the left-hand selection list using drag-and-drop. The 8 bit data type is usually suitable.



NOTE

An assembly can contain various data types.

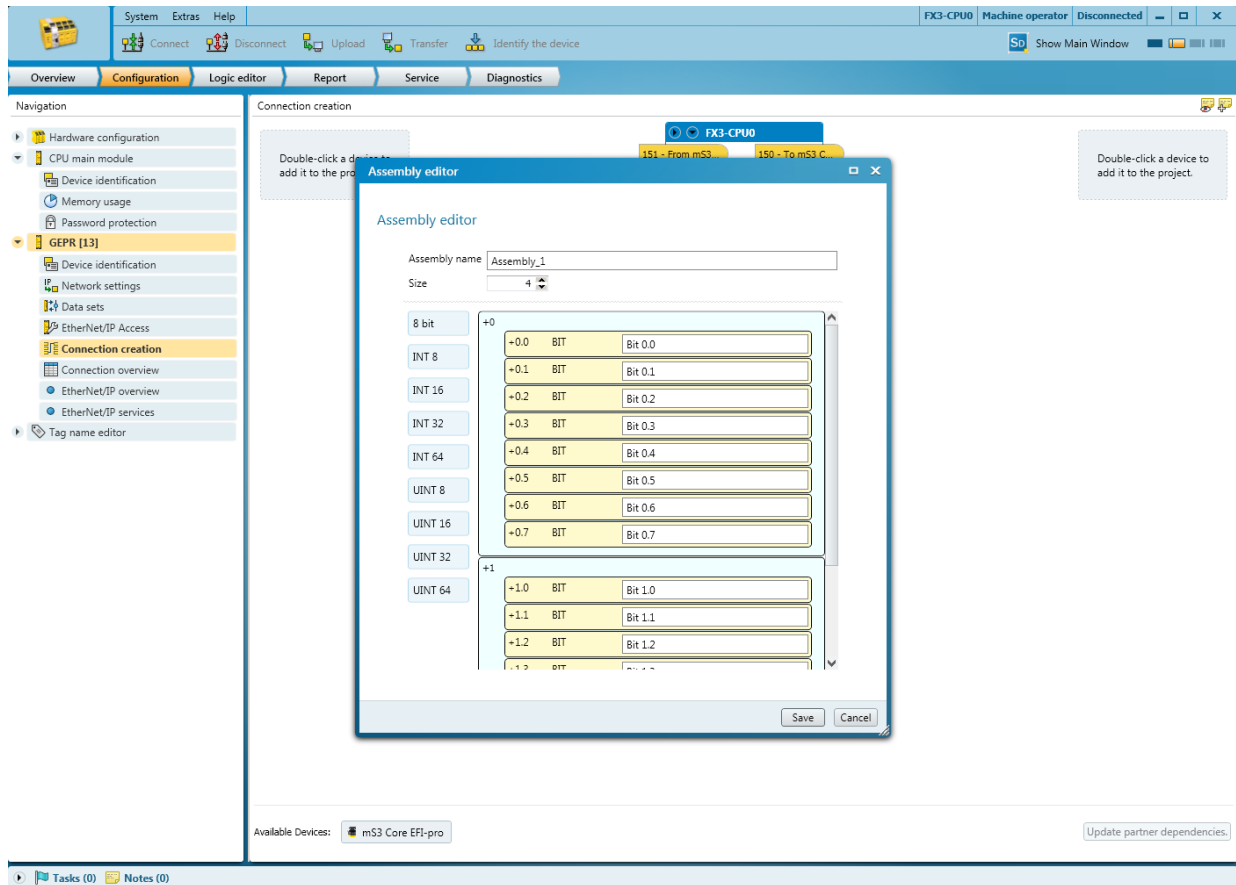


Figure 17: Defining an assembly in the assembly editor

4. Click on **Save** to close the editor and create the new assembly.
5. Create all required assemblies in this way.

Establishing a connection

1. Open the device window of the new Flexi Soft system and click on **Configuration**. In connections with third-party manufacturer devices, the Flexi Soft system always acts as an originator and the other device as a target.
2. If static assemblies are to be used in the originator, configure these as described.
3. Then click on the **Connection creation** menu item of the FX3-GEPR EFI-pro gateway. The Flexi Soft system is displayed as FX3-CPU0 in the center of the window.
- ✓ The devices available as targets in the project are initially displayed in the lower area of the device window.
4. Double-click on the desired device to include it in the establishment of the connection as the target.
- ✓ The output assemblies of the newly-added device is shown at the top right, the input assemblies at the top left.
5. Drag the input and output assemblies of the targets which are to be connected to the opposite plus icon of the originator using drag-and-drop.
- ✓ A dynamic assembly is created in the originator corresponding to each input and output assembly of the target and connected to the target assembly. The tag names from the assemblies of the target are then automatically adopted in the assemblies in the originator.

**NOTE**

- Instead of creating new dynamic assemblies, already existing static or dynamic assemblies of the FX3-GEPR can be connected to the assemblies of the target using drag-and-drop.
- Static assemblies must be configured under **EtherNet/IP access** of the respective FX3-GEPR before they can be used.
- Two assemblies can only be connected if the size and data type match.

The data of the connected input and output assemblies are available in the Flexi Soft logic editor as inputs and outputs.

4.3.2 Editing EtherNet/IP™ CIP Safety™ connections

Editing connection settings

1. Open the device window of the originator of the connection in question.
2. Click on **Configuration** and then on the **Connection creation** menu item of the FX3-GEPR.
3. Move the mouse cursor to the connection to be edited. A pop-up dialog window appears.
4. In this pop-up dialog window of the connection line, click on **Edit**. The **Settings of the safety connection** dialog window opens.

The following parameters can be configured:

- Connection name
- RPI
- Max. lost packets
- Network delay
- SCID mechanism

The resulting **response time via the network** of the connection is also shown.

**NOTE**

These parameters are also displayed under the **Connection overview** menu item of the FX3-GEPR in table form for all connections for which the FX3-GEPR acts as an originator and can also be edited there. The cycle times between the network and the main module (CPU) are also displayed here.

Connection name

The preset name of the connection can be changed here if needed.

RPI

The **requested packet interval (RPI)** determines how often data is sent. It is specified in milliseconds and influences the response time.

Max. lost packets

The number of **maximum lost packets** determines the tolerance against transmission faults. It influences the response time.

Network delay

The **network delay** enables additional fault tolerance of the connection. It is specified in percent of the requested packet interval (RPI) and influences the response time.

SCID mechanism

This is optional additional protection against unwanted changes to the configuration. If the **Use SCID mechanism** is activated, the originator compares its safety configuration ID (SCID) with the SCID saved in the target. If the checksums of the two SCIDs do not match, meaning the configuration of both devices has been changed, no communication occurs.

The SCID is a combination of a checksum and the date stamp of the safety configuration. It can be read in the device window of the Flexi Soft system under **Configuration, GEPR, EtherNet/IP overview**.

The SCID of a **generic EtherNet/IP CIP safety device** can be read and edited under **Standard settings**.



NOTE

The **Use SCID mechanism** option cannot be configured in the **Connection overview** but only in the **Safety connection settings** under **Connection creation**.

Response time via network

The **response time via the network** is the maximum time which can pass until the transmitted data is successfully updated. If this response time is exceeded, it is evaluated as a fault.

The response time is calculated using the following formula:

$$\text{Response time} = \text{RPI} \times \text{max. lost packets} + \text{RPI} \times \text{network delay}/100$$

Connection status

Under the **Connection overview** menu item of the FX3-GEPR, the **connection status** is shown for all connections for which the FX3-GEPR acts as an originator.

Deleting the connection

Deleting connection in the main window

1. Click on **Connections** in the Safety Designer main window.
2. Move the mouse cursor to the connection you want to delete. The connection line is highlighted in blue and a recycling bin icon appears on the target connection.
3. Click on the recycling bin icon to delete the connection.

Or:

4. Click on **Delete** in the context menu of the connection line.

Deleting connection in the device window

1. Open the device window of the originator of the connection you want to delete.
2. Click on **Configuration** and then on the **Connection creation** menu item of the FX3-GEPR.
3. Move the mouse cursor to the connection you want to delete. A pop-up dialog window appears.
4. In this pop-up dialog window of the connection line, click on **Delete**.



NOTE

The assemblies whose connection was deleted remain. They have to be deleted separately in the **Connection creation** of the FX3-GEPR if desired.

4.3.3 EtherNet/IP™ services

Three services for external devices are available in Safety Designer. These are required for establishing the communication with a device from a third-party manufacturer if no configuration software (SNCT) is available for this device. This is the often case with robot controls in particular. The TUNID (target unique node identifier) must be set by an originator.

The following services are available:

- Removing target owner link to a safety controller
- Resetting the safety configuration
- Setting a target unique node identifier (TUNID)

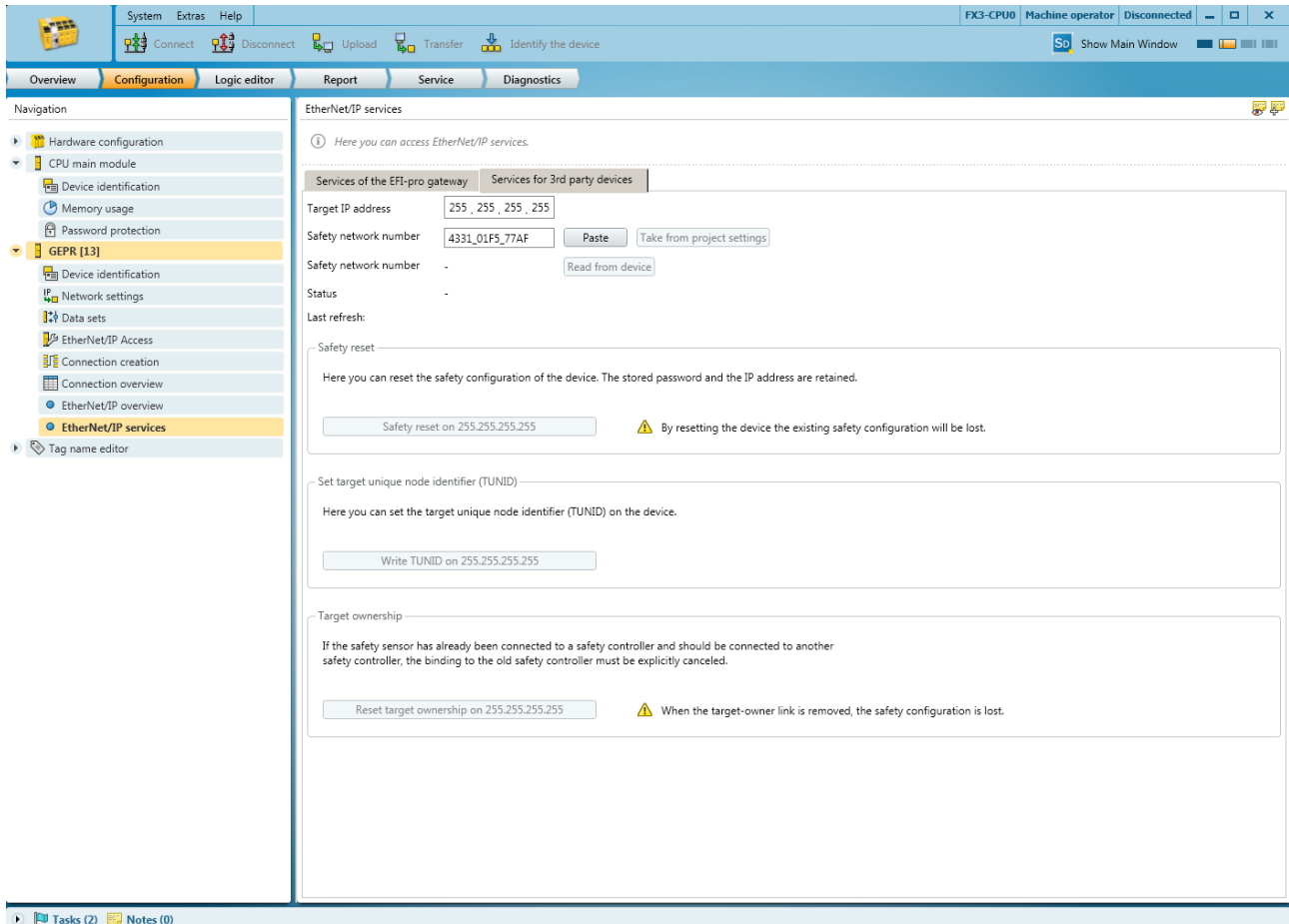


Figure 18: Services for external devices



NOTE

To use the EtherNet/IP™ services, the EFI-pro gateway must be connected to the third-party manufacturer device. Both devices must be in the same subnet.

Removing target owner link to a safety controller

If the external device has already established a connection to another originator, the old target-owner link must first be removed.



NOTE

Prerequisites for removing the target-owner link:

- The external device (target) must be in **Idle** mode.
- The external device must not have a current connection to another originator.

If there is still a connection to an originator:

- ▶ If applicable, separate the connection to the originator by disconnecting the communication cable.

Or:

- ▶ Transmit an empty configuration to the EFI-pro gateway.

1. Enter the current IP address of the target in Safety Designer.
2. Click on the **Target-owner link to [IP address]** button.

Resetting the safety configuration

If a TUNID is already configured in a device, it can not simply be overwritten. In this case, the safety configuration must be reset.

In order to reset the safety configuration of the external device, a type 2 safety reset is executed in line with the EtherNet/IP™ CIP Safety™ specifications.

1. Enter the current IP address of the target in Safety Designer.
 2. Click on the **Reset safety configuration to [IP address]** button.
- ✓ The safety configuration of the external device is irrevocably deleted.



NOTICE

By resetting, the device loses its existing safety configuration. If required, the device must then be reconfigured using the configuration software provided by the manufacturer.

Setting TUNID

To set a new TUNID, the current IP address of the external device and the new SNN must be entered.

1. Enter the current IP address of the target in Safety Designer.
 2. Enter the new SNN of the target in Safety Designer.
 3. Click on the **Write TUNID on [IP address]** button.
- ✓ The new TUNID is set in the external device.

Transitions of the EtherNet/IP™ device statuses

A device can be in the following states or brought to these states using the Safety Designer or the configuration software of the third-party manufacturer device:

Table 4: Transitions of the EtherNet/IP™ device statuses

Previous state	Action or condition	Resulting state
The device performs a self-test after switching on. If this is successful, there are three options.	Device contains TUNID and configuration	Idle
	The device contains no TUNID	Waiting for valid TUNID
	Device contains TUNID, but no configuration	Configuring
Waiting for valid TUNID	Set TUNID	Configuring ¹⁾
Configuring	Reset the safety configuration	Waiting for valid TUNID
	Write the safety configuration in the device ²⁾	Idle

Previous state	Action or condition	Resulting state
Idle	Reset the safety configuration	Waiting for valid TUNID
	Remove the target-owner link	Configuring ¹⁾
	Establishment of connection by originator ³⁾	Executing

1) Many robot controls have a fixed pre-configuration. After setting a TUNID or after resetting the safety configuration, the devices skip the **Configuring** state and change directly to **Idle**.

2) This is carried out using the configuration software of the external device if necessary.

3) E.g. by an FX3-GEPR EFI-pro gateway.

5 Technical data

5.1 Response time of an EFI-pro system

All paths must be considered for calculation of the response times within an EFI-pro system.

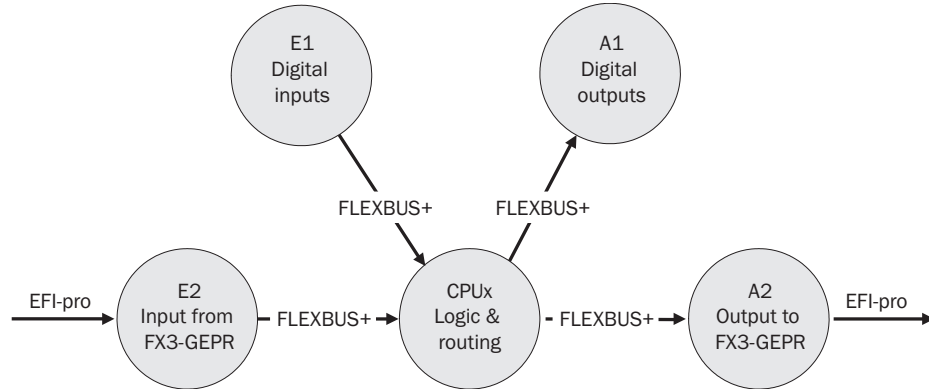


Figure 19: Response times in an EFI-pro system

FLEXB Internal backplane bus of the Flexi Soft system
US+

Calculation of the response time

The following table can be used to calculate the response time of the connection paths within the Flexi Soft system.

Table 5: Calculation of the maximum response time of the Flexi Soft system

1. Inputs	Response time of the observed input in the signal path	E1 or E2 (see corresponding table)	
2. Logic	a) Response time of the main module logic (FX3-CPUx logic)	2 × logic execution time ¹⁾ Delay due to logic application ²⁾ (e.g. switch-on delay or switch-off delay function block)	
	b) Routing response time (only applicable on A2 output to the FX3-GEPR)	No delay time	0 ms
3. Outputs	Response time of the observed output in the signal path	A1 or A2 (see corresponding table)	
Total response time			

¹⁾ Take the values from the report in the configuration software.

²⁾ The time values have a tolerance of 10 ms plus the logic execution time. That means that 10 ms must be added to every selected value to calculate the response time. E.g. 32 ms must be used for calculation for a switch-off delay of 10 ms and a logic execution time of 12 ms.



NOTE

Depending on the overall configuration, it may be necessary to consider other times for the calculation of the total response time of a Flexi Soft system.

Calculation of the total response time of a Flexi Soft system is described in detail in the “Flexi Soft Modular Safety Controller Hardware” operating instructions (SICK part number 8012999).

Digital inputs (E1)

Table 6: Calculation of the response time for the digital inputs (E1)

General	Sensor response time ¹⁾	
General	Input processing time	6.5 ms
If on-off filter is active	+ Min. filter time ²⁾	
If I1 ... I8 connected to test output X1 ... X8	+ Max. OFF-ON delay ³⁾ of the test output to be used	
a) Safety step detector mats and bumpers	+ Test period ³⁾ of the test output, use higher value of the two test outputs	
b) Testable sensors type 4 (e.g. L41)	+ Test periods ³⁾ of the test output	
c) All other sensors	+ Test gap ³⁾ of the test output (if test gap ³⁾ > 1 ms)	
Sum total E1		

- 1) Take the value from the relevant operating instructions.
- 2) Switching off is delayed until the signal has been low for at least the selected filter time. For FX3-XTIO and FX3-XTDI firmware version ≤ V3.00.0, the filter time is fixed at 8 ms.
- 3) Take the values from the report in the configuration software.

Digital outputs (A1)

Table 7: Calculation of the response time for the digital outputs (A1)

General	Response time of the actuator ¹⁾	
General	Output processing time a) From the logic (via FLEXBUS+): + 4.5 ms b) From fast shut-off: + 1.5 ms	
If single-channel outputs are used	Potential switch-off delay for internal faults depending on whether an extended fault detection time for switching capacitive loads has been configured: + 10 ms or + 50 ms ²⁾	
Sum total A1		

- 1) Take the value from the relevant operating instructions.
- 2) See “Flexi Soft Modular Safety Controller Hardware” operating instructions (SICK part number 8012999).

Input from a FX3-GEPR (E2)

Table 8: Calculation of the response time for the input from an FX3-GEPR (E2)

General	Response time of the communication partner via EFI-pro (e.g. microScan3 EFI-pro safety laser scanner ¹⁾) or Ether-Net/IP™ CIP Safety™	
General	Network response time for data to the gateway ²⁾	
General	2 x internal update interval for data from the gateway to the main module ³⁾	
General supplement	+5 ms	
Deduction when using a 2nd gateway ⁴⁾	-4 ms	
Sum total E2		

- 1) The response time of the considered microScan3 EFI-pro scanner of the scan cycle time, multiple evaluation, etc. can be taken from its configuration or the report in Safety Designer. See also the "microScan3 – EFI-pro Safety Laser Scanner" operating instructions (SICK part number 8021911).
- 2) Response time via the network (RPI, number of lost packets, etc.). The response time via the network depends on the settings for the respective connection. It can be found in the **connection overview** of the EFI-pro gateway, which acts as an originator for this connection, or in the Safety Designer report.
- 3) The update interval between the main module and a Flexi Soft gateway depends on the quantity of the data to be transmitted and the number of gateways in the system. Take the values from the Safety Designer area. The update interval is a multiple of 4 ms for a respective 10 bytes which are to be transmitted in or out of the gateway if the system contains a gateway. When two gateways are used, the update interval is a multiple of 8 ms.
- 4) E.g. FX0-GENT, FX0-GMOD, FX0-GPNT, FX0-GETC or FX0-GCAN. Only one FX3-GEPR EFI-pro gateway can be used per Flexi Soft system.

Output to a FX3-GEPR (A2)

Table 9: Calculation of the response time for the output to an FX3-GEPR(A2)

General	Response time via network for data from the gateway (e.g. to the PLC or another FX3-GEPR) ¹⁾	
General	2 x internal update interval for data from the main module to the gateway ²⁾	
General supplement	+ 8 ms	
Deduction when using a 2nd gateway ³⁾	-4 ms	
Sum total A2		

- 1) Response time via the network (RPI, number of lost packets, etc.). The response time via the network depends on the settings for the respective connection. It can be found in the **connection overview** of the EFI-pro gateway, which acts as an originator for this connection, or in the Safety Designer report.
- 2) The update interval between the main module and a Flexi Soft gateway depends on the quantity of the data to be transmitted and the number of gateways in the system. Take the values from the Safety Designer area. The update interval is a multiple of 4 ms for a respective 10 bytes which are to be transmitted in or out of the gateway if the system contains a gateway. When two gateways are used, the update interval is a multiple of 8 ms.
- 3) E.g. FX0-GENT, FX0-GMOD, FX0-GPNT, FX0-GETC or FX0-GCAN. Only one FX3-GEPR EFI-pro gateway can be used per Flexi Soft system.

6 List of abbreviations

ESPE

Electro-sensitive protective equipment (e.g., microScan3)

EDS

Electronic data sheet = generic station description, [see "Flexi Soft with devices from third-party manufacturers", page 24.](#)

EFI-pro

Enhanced function interface pro = safe SICK device communication via the network

EPI

Expected packet interval. Synonym for requested packet interval (RPI)

(F)PLC

(Failsafe) programmable logic controller

RPI

Requested packet interval = expected update rate of data transmission in the network, [see "Flexi Soft with devices from third-party manufacturers", page 24.](#)

SCID

Safety configuration identifier = ID of the safety configuration of a device in an EtherNet/IP™ CIP Safety™ network consisting of a checksum of the configuration and its date stamp. Component of the EtherNet/IP™ CIP Safety™ safety mechanism, used to uncover undesired changes to the configuration, [see "Editing EFI-pro connections", page 22](#), [see "Editing EtherNet/IP™ CIP Safety™ connections", page 33.](#)

SNN

Safety network number = common ID for identifying all devices in a EtherNet/IP™ CIP Safety™ network. The use of different SNNs in a safety network is possible in certain cases. However, the originator and target of an EtherNet/IP™ CIP Safety™ connection must always have the same SNN, [see "Basics", page 11.](#)

Target-owner link

Safety mechanism under EtherNet/IP™ CIP Safety™, [see "EtherNet/IP™ services", page 35.](#)

TUNID

Target unique node identifier = a unique ID which the originator can use to identify the target. Component of the EtherNet/IP™ CIP Safety™ safety mechanism, [see "EtherNet/IP™ services", page 35.](#)

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