OMRON

Connection Guide
Integration of 3G3M1-ECT to NX-safety via FSoE

3G3M1-ECT

CONTENTS

1.   *Introduction*

Thank you for using the Connection guide: **Integration of 3G3M1-ETC Connection Guide FSoE Safety V1.0.3**.

Use it when programming with the automation software Sysmac Studio.

This manual contains information that is necessary to use the product as is and/or together with Sysmac Studio.

1.1.   Intended Readers

This manual is intended for the following personnel.

Those who have knowledge of electrical systems (an electrical engineer or the equivalent) and also are qualified for one of the following:

• Personnel in charge of introducing the control equipment

• Personnel in charge of designing the control systems

• Personnel in charge of installing and maintaining the control equipment

• Personnel in charge of managing the control systems and facilities

1.2.   Notice

This manual describes the necessary information to get started with the 3G3M1. Refer also to the following manual's for more information.

Name	Catalog No.	Model	Application	Description
Sysmac Studio Version 1 Operation Manual	W504	SYSMACSE2□□□	To learn about how to operate Sysmac Studio and its features.	Describes how to operate Sysmac Studio.
Sysmac Studio Version V1 Drive Functions Operation Manual	I589	SYSMACSE2□□□	To learn about how to set and adjust the servo driver.	Describes how to operate Sysmac Studio.
3G3M1 EtherCAT Type User's Manual	I670	3G3M1 ECT	Multi-function Compact Inverter	Describes the installation/wiring of the 3G3M1 Series Inverter, and parameter setting method which is required for the operation, as well as troubleshooting and inspection methods.
NX-series Safety Control Unit User's Manual	Z930	NX-SL□□□□ NX-SI□□□□ NX-SO□□□□	To learn about how to operate Sysmac Studio and its features	Describes how to operate and use NX-series Safety Control Units

Please read and understand this manual before using the 3G3M1 EtherCAT Type. Keep this manual in a safe place where it will be available for reference during operation.

▍1.3. Terms and Conditions Agreement

1 NO WARRANTY

1）The functions and function block Library is distributed as a sample in the hope that it will be useful, but without any warranty. It is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. The entire risk as to the quality and performance of the function block is with you. Should the function block prove defective, you assume the cost of all necessary servicing, repair or correction.

2）In no event unless required by applicable law the author will be liable to you for damages, including any general, special, incidental or consequential damages arising out of the use or inability to use the function block (including but not limited to loss of data or data being rendered inaccurate or losses sustained by you or third parties or a failure of the function block to operate with any other programs), even if the author has been advised of the possibility of such damages.

2 LIMITATION OF LIABILITY
  1) OMRON SHALL HAVE NO LIABILITY FOR DEFECT OF THE SOFTWARE.
  2) OMRON SHALL HAVE NO LIABILITY FOR SOFTWARE PARTS DEVELOPED BY THE USER OR ANY THIRD PARTY USING THE FUNCTION BLOCK DESCRIBED ON THIS MANUAL.

3 APPLICABLE CONDITIONS
  USER SHALL NOT USE THE SOFTWARE FOR THE PURPOSE THAT IS NOT PROVIDED IN THE ATTACHED USER MANUAL.

4 CHANGE IN SPECIFICATION
The software specifications and accessories may be changed at any time based on improvements and other reasons.

5 ERRORS AND OMISSIONS
  The information in this manual has been carefully checked and is believed to be accurate; however, no responsibility is assumed for clerical, typographical, or proofreading errors, or omissions.

1.4. Safety Precautions

Definition of Precautionary Information

The following notation is used in this manual to provide precautions required to ensure safe usage of 3G3M1 EtherCAT Type.
The safety precautions that are provided are extremely important to safety. Always read and heed the information provided in all safety precautions.

The following notation is used.

⚠ WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury. Additionally, there may be severe property damage.

⚠ Caution	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury, or property damage.

Precautions for Safe Use

Indicates precautions on what to do and what not to do to ensure safe usage of the product.

Precautions for Correct Use

Indicates precautions on what to do and what not to do to ensure proper operation and performance.

Additional Information

Additional information to read as required.
This information is provided to increase understanding or make operation easier.

Explanation of Symbols

	🚫 This symbol indicates a prohibited item (an item you must not do). The specific instruction is indicated using an illustration or text inside or near 🚫. The symbol shown to the left indicates "non-specific general prohibitions."
	🚫 This symbol indicates a prohibited item (an item you must not do). The specific instruction is indicated using an illustration or text inside or near 🚫. The symbol shown to the left indicates "disassembly prohibited."
	△ This symbol indicates caution and warning. The specific instruction is indicated using an illustration or text inside or near △. The symbol shown to the left indicates "Caution against electric shock."
	△ This symbol indicates caution and warning. The specific instruction is indicated using an illustration or text inside or near △. The symbol shown to the left indicates "Caution against fire."

	△ This symbol indicates caution and warning. The specific instruction is indicated using an illustration or text inside or near △. The symbol shown to the left indicates "general caution."
	△ This symbol indicates caution and warning. The specific instruction is indicated inside △ as well as by using text. The symbol shown to the left indicates "risk of hot surface."
	● This symbol indicates a compulsory item (an item that must be done). The specific instruction is indicated using an illustration or text inside or near ●. The symbol shown to the left indicates a "general compulsory item."
	● This symbol indicates a compulsory item (an item that must be done). The specific instruction is indicated inside ● as well as by using text. The symbol shown to the left indicates "grounding required."

Warning list

⚠ WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury. Additionally, there may be severe property damage.

Be sure to ground the ground terminal of the inverter. (200-V class: type-D grounding, 400-V class: type-C grounding) Not doing so may result in a serious injury due to an electric shock or fire.	⏚
Do not remove the surface cover during inverter power supply and for 10 minutes after power shut off. Doing so may result in a serious injury due to an electric shock. Switch various switches, change wiring and perform inspections at least 10 minutes after the power supply has been shut off	⚡
There is a risk of severe injury due to electric shock. Wiring work must be carried out only by qualified personnel. Do not touch cables when the power supply is turned ON. Additionally, only designated personnel should perform maintenance or inspections, or replace parts.	⚡
There is a risk of severe injury due to electric shock. After confirming that the power supply is OFF, wait at least 10 minutes and then perform wiring.	⚡
Do not operate the Operator or switches with wet hands. Also, remove metal objects (watches, rings, etc.) before starting work, and use insulating tools when using tools. Not doing so may result in a serious injury due to an electric shock.	⚡
Do not touch the cooling fins, braking resistors and the motor, which become too hot during the power supply and for some time after the power shut off. Doing so may result in a burn.	♨
Inspection of the inverter must be conducted after the power supply was turned off. Not doing so may result in a serious injury due to an electric shock. The main power supply is not necessarily shut off even if the safety stop function is activated.	⚡
There is a risk of severe injury. Do not enter the operating area during operation.	⚠
There is a risk of severe injury due to electric shock. Do not perform maintenance while the power supply is ON.	⚡
Although this product is manufactured under strict quality control, install equipment to ensure safety when used with applications in which serious accidents or property damage can be anticipated in the event of its failure. Not doing so may result in accidents.	⚠
The Multi-function Compact Inverter (3G3M1 Series) is designed to drive a three-phase induction motor and synchronous motor. Do not use it for single-phase motors or for other purposes. Doing so may result in fire or accident.	⚠

Install the inverter on a non-flammable material such as metallic wall. Also, do not place flammable object nearby. Doing so may result in fire.	
Be sure to perform wiring after installing the inverter unit. Also, tighten terminals with specified torque. Not doing so may result in injury, electric shock or fire.	
Ensure that the specifications of the input power of the product match the power supply to which the product is to be connected. Not doing so may result in fire or accidents.	
Be sure to use the wire of specified size. Not doing so may result in fire.	
When wiring each inverter to the power supply, install a molded-case circuit breaker or earth leakage circuit breaker (with overcurrent protection function). Use recommended molded-case circuit breakers or earth leakage circuit breakers that do not exceed the recommended current capacity. Not doing so may result in fire.	
If no suitable equipment to detect leakage is installed in the upstream power supply line, in order to avoid the entire power supply system's shutdown due to operation of devices such as earth leakage circuit breaker as this is undesirable to operation, install an earth leakage circuit breaker individually to inverters to break the individual inverter power supply lines only. Not doing so may result in fire.	
When the capacity of the power transformer is 500 kVA or more and 10 times or more than the rated capacity of the inverter, ensure that a DC reactor is connected. Not doing so may result in fire.	
Never connect the power lines to the inverter output terminals U, V, or W. Doing so may result in fire.	
When connecting a braking resistor, do not connect it to any terminal other than terminals P(+) and DB. Doing so may result in fire or accident.	
Do not bundle multiple cables as one cable. Doing so may result in fire.	
Do not connect a surge suppressor to the output lines of the inverter. Doing so may result in fire.	
In general, sheaths of the control signal wires do not use reinforced insulation, therefore if a control signal wire comes into direct contact with a live part of the main circuit, the insulation of the sheath might break down. In these cases, there is a danger of the control signal wire being exposed to high voltage from the main circuit, therefore ensure that the control signal wires will not come into contact with live parts of the main circuit. Not doing so may result in electric shock or accidents.	

Even if the inverter has interrupted power to the motor, if the voltage is applied to the main circuit input terminals L1/R, L2/S and L3/T, voltage may be output to inverter output terminals U, V and W. This may result in a serious injury due to an electric shock.	⚠
Even if the motor is stopped due to DC braking or pre-excitation, voltage is output to inverter output terminals U, V and W. This may result in a serious injury due to an electric shock.	⚠
Starting auto-tuning involves motor rotation. Sufficiently check that motor rotation carries with it no danger beforehand. Not doing so may result in injury or accidents.	⚠
The inverter may operate with acceleration/deceleration time or speed different from as set due to stall prevention function. Design the machine so that safety is ensured even in such cases. Not doing so may result in accidents.	⚠
The inverter can easily have high-speed operation set. When changing the speed setting, carefully check the specifications of motors or machine beforehand. Additionally, set the parameters only after fully understanding the User's Manual. If the user recklessly changes the parameters and then operates the inverter, the motor may rotate at a torque or speed not permitted for the machine. This may result in injury.	⚠
If you enable the "Restart mode after momentary power failure" (F014 = 3 or 4), then the inverter automatically restarts running the motor when the power is recovered. Design the machine so that safety is ensured even after such restarts. Not doing so may result in injury or accidents.	⚠
The STOP key on the Operator may be disabled due to parameter setting, etc. Provide an emergency stop switch separately. Not doing so may result in accidents.	⚠
If the motor stops as a result of a trip, the inverter may automatically restart and drive the motor depending on the parameter setting. Design the machine so that human safety and the safety of surroundings is ensured at the time of restarting. Not doing so may result in accidents.	⚠
Remove any cause of the protective functions operating, then check the RUN command is OFF and cancel the alarm. Canceling the alarm when the RUN command is ON means that the inverter will supply power to the motor, which may start rotation thus posing a danger. This may result in accidents.	⚠
When switching start methods or speed by external input, the motor may start suddenly or the speed may abruptly change. This may result in injury or accidents.	⚠
Input terminals have functions such as run, stop and speed change. If the parameters are changed while signals are input to the input terminals, the motor operation may suddenly change. Ensure that you change parameters only after fully securing safety. Not doing so may result in injury or accidents.	⚠
The branch circuit protection being open may indicate an interruption in the fault current. In order to reduce the danger of fire and electric shock, inspect energized parts and other controller components, and replace if damaged. In the event of the overload relay current element burning out, the entire overload relay must be replaced. Not doing so may result in a serious injury due to an electric shock or fire.	⚠

Output terminals (ROA, ROB) use relays, and may remain ON, OFF or undetermined when their lifetime is reached. For safety, equip the inverter with an external protective function. Not doing so may result in fire or accidents.	⚠
Do not dismantle, repair or modify the product. Doing so may result in injury or electric shock.	🚫
Always carry out the daily and periodic inspections described in the User's Manual. Use other inverter for long periods of time without carrying out regular inspections could result in malfunction or damage of the inverter, and an accident or fire could occur. This may result in fire or accident.	⚠
It is recommended that parts for periodic replacement be replaced in accordance with the standard replacement frequency indicated in the User's manual. Use of the inverter for long periods of time without replacement could result in malfunction or damage of the inverter, and an accident or fire could occur. This may result in fire or accident.	⚠
It is recommended that periodic inspections be carried out every one to two years, however, they should be carried out more frequently depending on the usage conditions. Not doing so may result in fire or accident.	⚠
When using a DC reactor, AC reactor, braking resistor or noise filter, etc., there is the possibility that a human body may touch the main circuit terminal block (live parts). In such cases, take measures such as installing the inverters in an location not easily accessible by humans. Not doing so may result in a serious injury due to an electric shock.	⚡
There are conditions for compliance with the EU Low Voltage Directive and Machinery Directive. Strictly observe the conditions listed in the instruction manual or user's manual. Not doing so may result in a serious injury due to an electric shock or fire.	⚡

Caution list

⚠ Caution	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury, or property damage.

If connecting a commercially available braking resistor or regenerative braking unit, this may result in a moderate burn due to the heat generated in the braking resistor or regenerative braking unit. In case of a braking resistor, install a thermal relay that monitors the temperature of the resistor. Configure a sequence that enables the inverter power to turn OFF when unusual over heating is detected in the braking resistor or regenerative braking unit.	⚠
The inverter has high voltage parts inside which, if short-circuited, might cause damage to itself or other property. Place covers on the openings or take other precautions to make sure that no metal objects such as cutting bits or lead wire scraps go inside when installing and wiring.	❗
Install a stop motion device to ensure safety. Not doing so might result in a minor injury. (A holding brake is not a stop motion device designed to ensure safety.)	⚠
Be sure to confirm safety before conducting maintenance, inspection or parts replacement.	❗
A breakdown of the built-in braking transistor could result in braking resistor heating or damage to the inverter's internal units. Shut off the main power of the inverter using Braking transistor broken signal (DBAL).	⚠
A breakdown of the built-in braking transistor or misconnection of the braking resistor could result in braking resistor heating or damage to the inverter's internal units. If the inverter does not start up or continue being undervoltage (LU) after the main power of the inverter is turned ON, shut off the main power of the inverter.	⚠
When installing the product, use only the specified screws. Not doing so may result in fire or accidents.	❗
Do not install or operate an inverter with damaged external or internal components. Doing so may result in injury, fire or accidents.	🚫
Prevent lint, paper fibers, sawdust, dust, metallic chips, or other foreign materials from getting into the inverter or from accumulating on the cooling fin. Not doing so may result in fire or accidents.	⚠
Support the inverter case or cooling fin instead of the surface cover during transportation. Not doing so may result in injury due to the inverter dropping.	⚠
The inverter, motor and wiring generate electric noise. Be careful about malfunction of the nearby sensors and devices. Take noise control measures to prevent them from malfunctioning. Not doing so may result in accidents.	⚠
The inverter has an overload protection function. Set the protection level using parameters.	❗

The brake function of the inverter does not provide any holding mechanism. Provide a separate holding brake if necessary. Not doing so may result in injury.	●
Comply with the local ordinance and regulations when disposing of the product. Not doing so may result in injury.	●
UL and cUL compliance is subject to conditions. Strictly observe the conditions listed in the instruction manual or user's manual. Not doing so may result in fire or accidents.	⚠

1.5. Change Log

Revision	Date	Correction
1.0.0	March 2024	Original
1.0.1	May 2025	Minor changes in text
1.0.2	June 2025	Change errors in the Safety Code
1.0.3	July 2025	Minor changes in text, changes of Safety standards

2.   Overview

This document describes the procedure for connecting the 3G3M1-ECT to a NX-series safety master via FSoE and provide the quick setup procedure.

3.   Safety Function

The safety function is designed so that the safety stop function of category 0 (uncontrolled stop) is used to meet the safety standards of PL-e under ISO 13849-1. The M1 Series Inverter EtherCAT type has the following two STO functions. Use either of the functions according to the configuration of the safety devices.

- STO function by safety input signal (see "Connection Guide Integration of 3G3M1 to NX-safety (Hardwired)"
- STO function via EtherCAT communication

📝 **Precautions for Correct Use**

The Safety part of the 3G3M1 is only working when the main power is ON. If the drive is powered by an external 24vdc power supply the safety part is not active.

3.1. Safety

Function	Standard
STO (Safe Torque Off)	EN/IEC 61800-5-2

3.2. Response Time

Response time		Remarks
STO response time	50 ms or less	Time from when the SF1/SF2 signal state changes to STO up to when power to the motor is cut off
EDM response time	50 ms	Time from when the SF1/SF2 signal state changes to STO up to when the EDM signal state changes to ON
STO function via EtherCAT communication response time	80 ms max	Time from when the FSoE state changes to STO up to when power to the motor is cut off

### 3.3. Safety Related Parameters

Parameter	Value	Standard
PL	e	EN/ISO 13849-1
Cat	3	
MTTFd	>62 year	
DCavg	Medium	

| Parameter		Value	Standard
SIL		3	EN/IEC 61508-1 to -7
HFT		1	EN/IEC 61800-5-2
SFF		>90%	
STO Function by Safe Input Signal	PFH	3.00×10^{-9}	
	PFD	4.00×10^{-5}	
	Mission time	20 years	
STO Function via EtherCAT Communications	PFH	1.10×10^{-8}	
	PFD	2.20×10^{-4}	
	Mission time	20 years	

4. Configuration and setup

4.1. EtherCAT wiring between 3G3M1-ECT and NX-safety

In this documentation the 3G3M1-ECT and NX safety is communicating via EtherCAT.
The safety controller in our case is connected to a NX-ECC203.
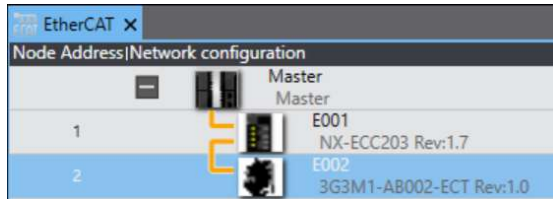
4.1. 3G3M1-ECT Safety Function Input Signal Settings

Turn on the safety function selector switch SW9 when the inverter power supply is turned OFF.
Set SW9 to enabled (OFF) or disabled (ON) so that both sides are at the same position at all times.
This is to disable or enable the physical terminals of STO on the 3G3M1-ECT. Nothing that we
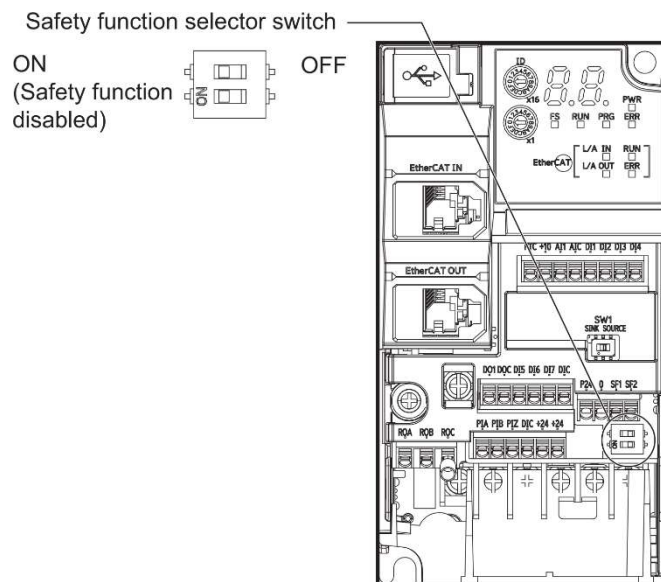
To activate Safety over EtherCAT (FSoE) on 3G3M1, change both switches on SW9 to ON (Left), like picture below.

4.2. PDO Mapping (Safety Function)

This is the mapping for using the safety function (FSoE) through EtherCAT communications.

RxPDO: 273th receive PDO Mapping (1710 hex)	FSoE Master CMD (E700-01 hex), STO command (6640 hex), Error Acknowledge (6632 hex), FSoE Master CRC_0 (E700-03 hex), and FSoE Master Conn_ID (E700-02 hex)
TxPDO: 273th transmit PDO Mapping (1B10 hex)	FSoE Slave CMD (E600-01 hex), STO command (6640 hex), Error Acknowledge (6632 hex), Safety Connection Status (E601-01 hex), FSoE Slave CRC_0 (E600-03 hex), and FSoE Slave Conn_ID (E600-02 hex)

The PDO mapping is done via the EtherCAT under the Configurations and Setup.

1.	Multiview explorer -> Configurations and Setup -> **EtherCAT**
2.	Select the correct node.
3.	In the Node information click on the **Edit PDO Map Settings.**
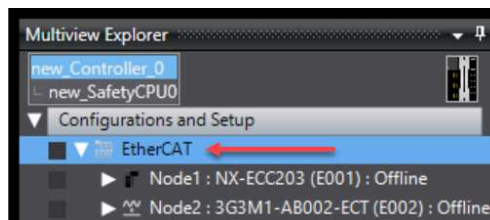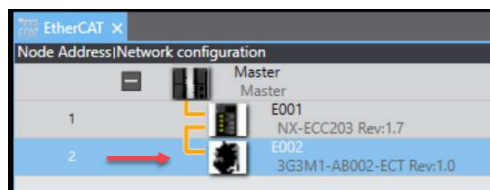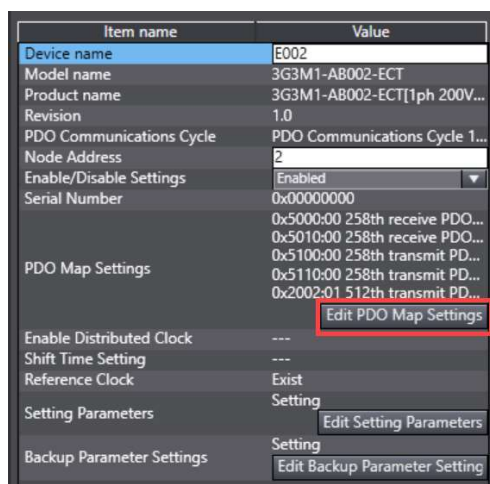
4.	Select the:
	Output: 273th receive PDO Mapping
	Input: 273th transmit PDO Mapping
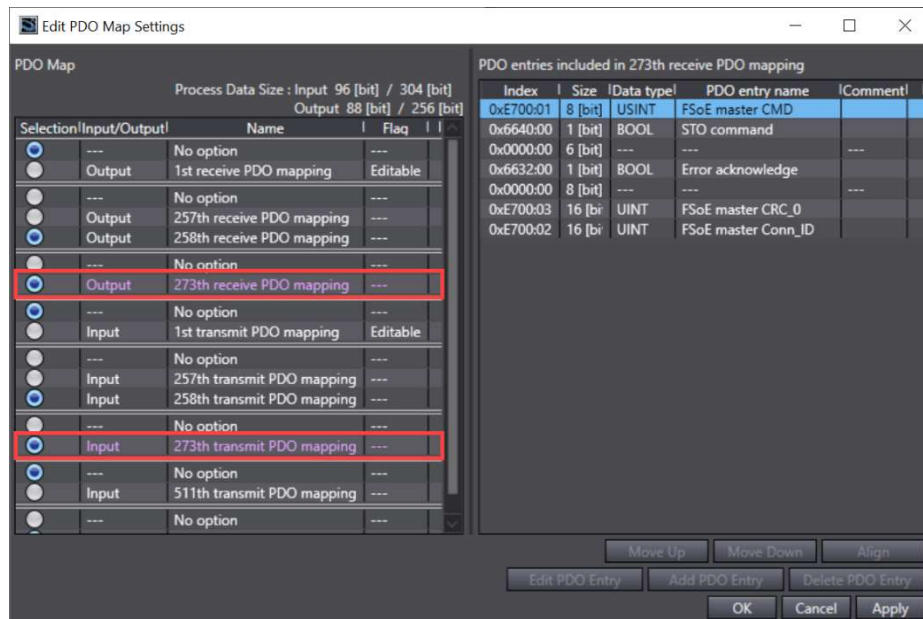
And click **Apply.**

4.1. Selecting a Safety CPU and Safety Input and Output devices

This example will demonstrate how to add a double channel mechanical E-stop together with a reset button.

1.	In this example the Safety units are located on a NX-ECC203 node. To add the safety units, go to the **Multiview explorer** -> EtherCAT -> Select the correct node and double click.
2.	Add the Safety CPU and Safety In- and output devices. In this example we have: NX-SL3300 NX-SIH400 NX-SOD400
3	The inputs that are added to this project are one emergency stop button and one reset.
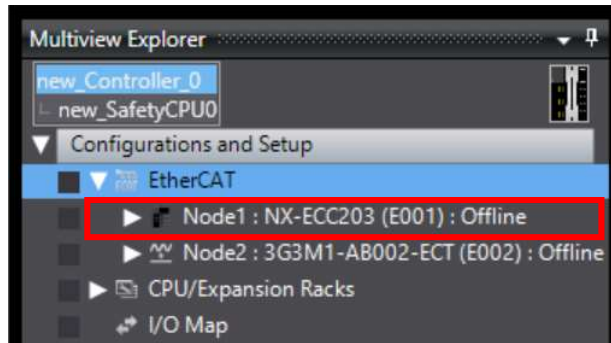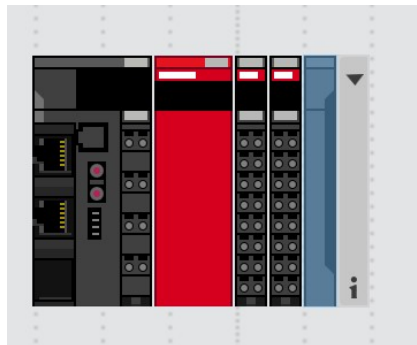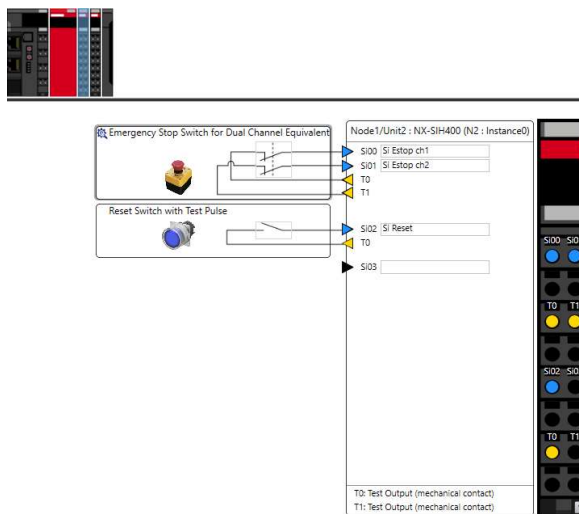
4.1. 3G3M1 FSoE slave address

In the 3G3M1 there is a parameter that needs to be setup for the FSoE slave address.
By entering FSoE slave address , FSoE are activated on 3G3M1

1.	To get the unique FSoE slave address right click on the Safety I/O and select **Edit**.
2.	In this example the FSoE slave address is **3.**
3.	Open the **parameters** of the 3G3M1-ECT inverter.
4.	Select the parameter Index **H483**.
5.	Add the FSoE slave address no **3.** Download the parameters to the 3G3M1-ECT.
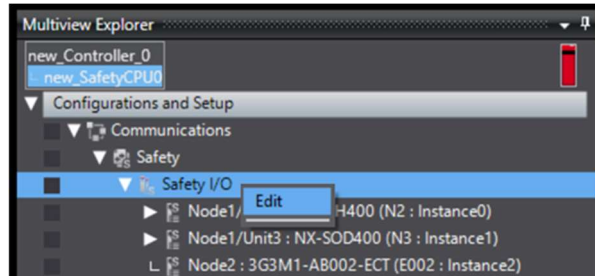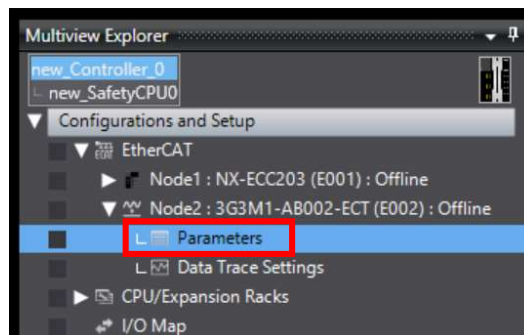
5. Safety configuration and programming

5.0. I/O Map

Map the safety variables for the Safety part.

|	
1.	Select **Safety CPU** and then **I/O Map** in the Configuration and Setup window.
2.	Enter the wanted variable names manually. The Variable Comment comes from the Parameter setup made for the different units.
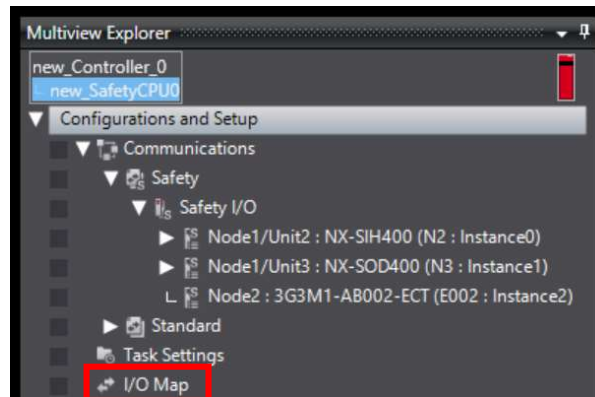
5.1. Program

This program example will be created via the automatically programming feature inside of Sysmac Studio.

1.	To automatically generate a safety program right-click on the Programs and select **Automatic programming function**
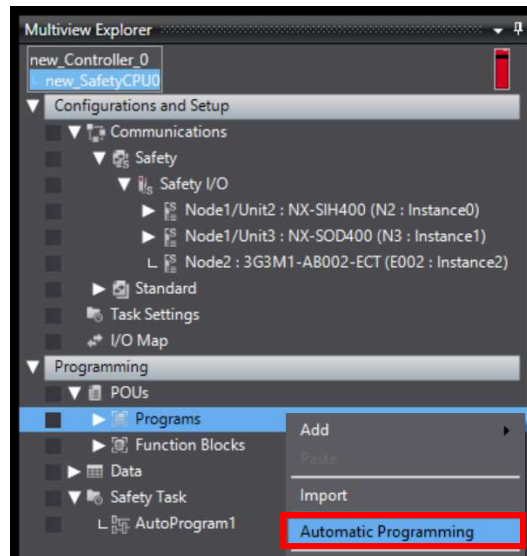
2.	Register all variables that are assigned as SAFEBOOL, cause no Safety units are selected for safety In- or Output devices.
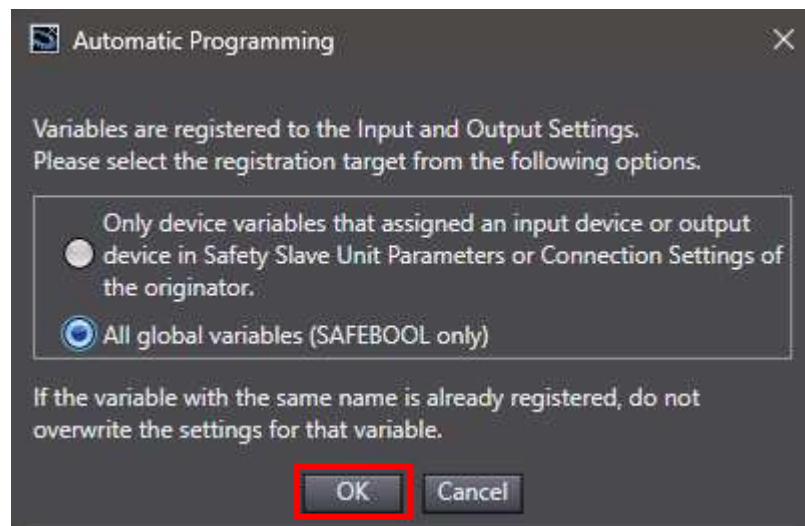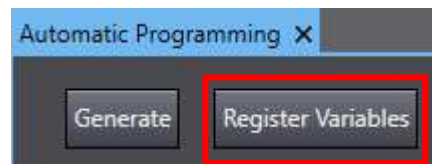
3.	Select Reset signal
	After registering the variables, we need to select SF Function block to ESTOP of 3G3M1*, SF_EmergencyStop*. Then it is time to Generate the code.

4.	A program called Autoprogram_ is now generated. Check so that correct variables is connected to FB in the code, based on the I/O map settings.
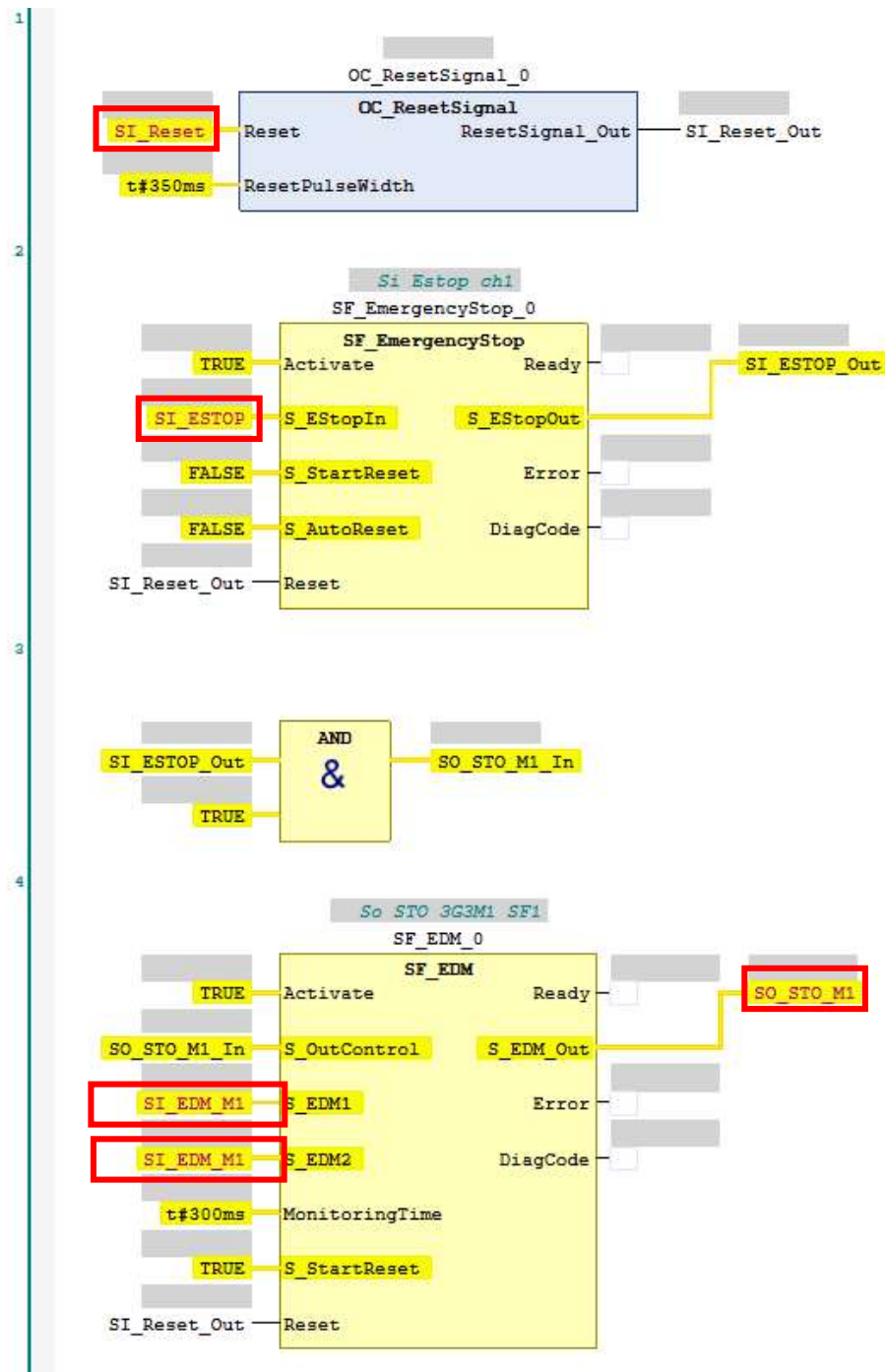
📑 **Additional Information**

The Safety program is just an example and is created by the Automatic programming function in Sysmac studio. For further details about how to setup and program the NX-SL[][][][] Safety controller please refer to NX Safety Controller (Cat. No. Z930) and the NX Safety Instructions Reference Manual (Cat. No. Z931).