



Nexto Safety User Manual

MU214602 Rev. D

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Contents

| | | |
|----------|---|----|
| 1. | Introduction | 1 |
| 1.1. | Standards and Directives | 1 |
| 1.2. | Nexto Safety Features | 2 |
| 1.2.1. | Module List | 2 |
| 1.2.1.1. | Safety CPUs – Safety Central Processing Units (SCPUs) | 2 |
| 1.2.1.2. | Safety Input Modules (SDIMs) | 2 |
| 1.2.1.3. | Safety Output Modules (SDOMs) | 2 |
| 1.2.1.4. | Software | 2 |
| 1.2.2. | Innovative Features | 2 |
| 1.2.3. | Architecture | 3 |
| 1.2.3.1. | CPU | 3 |
| 1.2.3.2. | SCPU | 4 |
| 1.2.3.3. | Power Supply Module (PSU) | 4 |
| 1.2.3.4. | Backplane Bus | 4 |
| 1.2.3.5. | Backplane Racks | 4 |
| 1.2.3.6. | Safety I/O Modules | 4 |
| 1.2.3.7. | Fieldbus Head | 5 |
| 1.2.3.8. | Fieldbus Interface | 5 |
| 1.3. | Warning Messages Used in this Manual | 5 |
| 1.4. | Documents Related to this Manual | 5 |
| 1.5. | Visual Inspection | 7 |
| 1.6. | Technical Support | 7 |
| 1.7. | Personnel Qualification <SRSREQ999> <SRSREQ666> <SRSREQ937> | 7 |
| 2. | Overview of Nexto Safety System | 8 |
| 2.1. | Definition of Safety System | 9 |
| 2.2. | Safety Function | 9 |
| 2.2.1. | Safe State | 9 |
| 2.3. | Safety Parameters | 9 |
| 2.3.1. | PFD _{AVG} | 9 |
| 2.3.2. | PFH | 9 |
| 2.3.3. | PST | 9 |
| 3. | NX3810 - Nexto Safety CPU | 10 |
| 3.1. | Panels and Connections | 10 |
| 3.1.1. | Graphic LCD Display <NSREQ44> | 10 |
| 3.1.1.1. | Region A | 11 |
| 3.1.1.2. | Region B | 11 |
| 3.1.1.3. | Region C | 11 |
| 3.1.1.4. | Region D and E | 11 |
| 3.2. | Physical Dimensions <SRSREQ1> | 12 |

| | | |
|------------|---|----|
| 3.3. | Technical Data | 13 |
| 3.4. | Compatibility with other Products | 14 |
| 3.5. | Performance | 14 |
| 3.5.1. | Safety Function Response Time <SRSREQ21> | 14 |
| 3.5.1.1. | Excel Spreadsheet for SFRT Calculation | 15 |
| 3.5.1.1.1. | Tab "CPU Parameters" | 15 |
| 3.5.1.1.2. | Tab "Safety Input" | 15 |
| 3.5.1.1.3. | Tab "Safety Output" | 15 |
| 3.5.1.1.4. | Tab "SFRT" | 16 |
| 3.5.1.2. | Example of Spreadsheet Usage | 16 |
| 3.5.1.3. | Additional Delays for SFRT | 17 |
| 3.5.1.4. | SFRT for Multiple Inputs or Outputs | 17 |
| 3.5.2. | Safety Program Cycle <SRSREQ29> | 17 |
| 4. | NX1800 - Nexto Safety Digital Input Module | 18 |
| 4.1. | Panels and Connections | 18 |
| 4.1.1. | LCD Display<NSREQ650> | 18 |
| 4.1.2. | Connector Pinout <SRSREQ601> | 19 |
| 4.2. | Physical Dimensions <SRSREQ599> | 20 |
| 4.3. | Technical Data | 21 |
| 4.4. | Operation <SRSREQ625> <SRSREQ626> <SRSREQ630> <SRSREQ631> | 23 |
| 4.4.1. | Digital Inputs | 23 |
| 4.4.2. | Pulse Outputs <SRSREQ628> | 23 |
| 4.4.3. | External Power Supply Failure <SRSREQ632> | 23 |
| 4.5. | Safety Response Times | 24 |
| 4.5.1. | Safe State | 24 |
| 4.6. | Compatibility with other Products <NSREQ2505> | 25 |
| 4.7. | Compatibility with Sensors <SRSREQ679> <NSREQ680> <NSREQ681> <NSREQ682> | 25 |
| 4.8. | Connection Diagrams <SRSREQ684> | 25 |
| 4.8.1. | Single input with test pulse | 26 |
| 4.8.2. | Paired antivalent inputs with individual test pulses | 27 |
| 4.8.3. | Paired equivalent inputs with individual test pulses | 28 |
| 4.8.4. | Paired equivalent inputs with shared test pulse | 29 |
| 4.8.5. | Paired antivalent inputs with shared test pulse | 30 |
| 4.8.6. | Single input without test pulse | 31 |
| 4.8.7. | Paired inputs without test pulse | 32 |
| 5. | NX2800 - Nexto Safety Digital Output Module | 33 |
| 5.1. | Panels and Connections | 33 |
| 5.1.1. | LCD Display <NSREQ921> | 33 |
| 5.1.2. | Connector Pinout <SRSREQ877> | 34 |
| 5.2. | Physical Dimensions <SRSREQ875> | 36 |
| 5.3. | Technical Data | 37 |
| 5.4. | Operation | 39 |
| 5.4.1. | Digital Outputs <SRSREQ900> <NSREQ901> <SRSREQ902> <NSREQ903> <SRSREQ1615> <SRSREQ1239> | 39 |
| 5.4.2. | External Power Supply <SRSREQ904> <SRSREQ905> | 39 |
| 5.5. | Safety Response Times | 39 |
| 5.6. | Compatibility with other Products <NSREQ3572> | 40 |
| 5.7. | Compatibility with Actuators <SRSREQ894><SRSREQ950> <SRSREQ951> | 40 |
| 5.8. | Connection Diagrams <SRSREQ953> | 40 |
| 5.8.1. | Control of two contactors using two outputs | 41 |

| | | |
|----------|--|----|
| 5.8.2. | Control of two contactors using one output | 42 |
| 5.8.3. | Control of two contactors using one output | 43 |
| 5.8.4. | Control of two contactors using two outputs | 44 |
| 6. | Configuration | 45 |
| 6.1. | Configuring SDIM/SDOM PROFIsafe address <SRSREQ606> <SRSREQ882> | 45 |
| 6.2. | Configuration Steps <SRSREQ648> <SRSREQ649> <SRSREQ919> <SRSREQ920> | 46 |
| 6.2.1. | STEP 1 – Start a new Safety Project | 46 |
| 6.2.2. | STEP 2 - Add a PROFIBUS DP slave | 46 |
| 6.2.3. | STEP 3 – Add Safety I/Os | 47 |
| 6.2.4. | STEP 4 – Safety I/Os Configuration | 47 |
| 6.2.5. | STEP 5 – Create the safety logic | 49 |
| 6.2.6. | STEP 6 – Import the Safety Project to a Mastertool IEC XE project | 50 |
| 6.2.7. | STEP 7 – Upload the Safety Application to NX3810 | 50 |
| 6.3. | SDIM Configuration <SRSREQ645> <SRSREQ646> | 51 |
| 6.4. | SDOM Configuration <SRSREQ916> <SRSREQ917> | 52 |
| 6.5. | Using Nexto SCPU with Third-party Safety I/O | 53 |
| 6.6. | Using Nexto SDIM with Third-party Safety CPUs | 53 |
| 6.7. | Using Nexto SDOM with Third-party Safety CPUs | 56 |
| 7. | Installation | 58 |
| 7.1. | Mechanical Assembly | 58 |
| 7.2. | Spacing between other equipments <SRSREQ1003> <SRSREQ672> <SRSREQ943> | 58 |
| 8. | Maintenance | 60 |
| 8.1. | General Diagnostics | 60 |
| 8.1.1. | LCD Display | 60 |
| 8.1.2. | One Touch Diag (OTD) <NSREQ45> <NSREQ651> <NSREQ922> | 61 |
| 8.2. | NX3810 Diagnostics <SRSREQ1022> | 61 |
| 8.2.1. | DG LED Indicator | 61 |
| 8.2.2. | Diagnostics via WEB | 62 |
| 8.2.3. | Diagnostic via Variables <NSREQ1612> | 62 |
| 8.3. | NX1800 Diagnostics | 65 |
| 8.3.1. | General Diagnostics <SRSREQ643> | 65 |
| 8.3.2. | Detailed Diagnostics | 65 |
| 8.3.2.1. | Channel Specific Diagnostics <SRSREQ644> | 67 |
| 8.4. | NX2800 Diagnostics | 68 |
| 8.4.1. | General Diagnostics <SRSREQ914> | 68 |
| 8.4.2. | Detailed Diagnostics | 68 |
| 8.4.2.1. | Channel Specific Diagnostics <SRSREQ915> | 70 |
| 8.5. | Preventive Maintenance | 70 |
| 8.6. | Decommissioning <SRSREQ1008> <SRSREQ685> <SRSREQ954> | 71 |
| 8.7. | Disposal <NSREQ1009> <NSREQ686> <NSREQ955> | 71 |
| 8.8. | Transport <SRSREQ1010> <SRSREQ687> <SRSREQ956> | 71 |
| 8.9. | Repair of Devices and Modules <SRSREQ1011> <SRSREQ688> <SRSREQ957> | 71 |
| 8.10. | Expiration of Proof-Test Interval <SRSREQ1012> <SRSREQ689> <SRSREQ958> | 71 |
| 9. | Programming | 72 |
| 9.1. | Programming Overview | 72 |

1. Introduction

Nexto Safety Modules were designed to comply with the most accepted standards for functional safety applications today, being fully compatible with the well-known Nexto Series PLC.

All Nexto Safety Modules are equipped with 1oo2D architecture, several diagnostics mechanisms and equipped with reliable hardware, reducing the probability of dangerous undetected failures to occur. Due to this, those modules were able to reach up to SIL3 according IEC61508:2010 and PLe / Category 4 according ISO13849:2012, and can be used in low, high and continuous demand applications. The Nexto Safety solution is accredited by TÜV Rheinland. <SRSREQ17> <SRSREQ660> <SRSREQ931>

This document provide a set of requirements that need to be fulfilled in order to ensure the right use of the modules and, moreover, ensure the safety of the system where Nexto Safety modules are going to be applied.

1.1. Standards and Directives

All modules were designed to comply at least with the standards and directives listed on Table 1.

| Standard | Description |
|---------------------|---|
| ISO 13849-1:2015 | Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design |
| ISO 13849-2:2012 | Safety of machinery – Safety-related parts of control systems – Part 2: Validation |
| IEC 61508-1:2010 | Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements |
| IEC 61508-2:2010 | Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems |
| IEC 61508-3:2010 | Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 3: Software requirements |
| IEC 61508-4:2010 | Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 4: Definitions and abbreviations |
| IEC 61508-5:2010 | Functional safety of electrical/electronic/programmable electronic safety related systems - Part 5: Examples of methods for the determination of safety integrity levels |
| IEC 61508-6:2010 | Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 6: Guidelines on the application of IEC 61508-2 and IEC 61508-3 |
| IEC 61508-7:2010 | Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 7: Overview of techniques and measures |
| IEC 62061:2015 | Safety of machinery – functional safety of safety related electrical, electronic and programmable electronic control systems. |
| IEC 61784-3-3:2017 | Industrial communication networks – Profiles – Part 3-3: Functional safety fieldbuses – Additional specifications for CPF 3 |
| IEC 61131-2:2017 | Programmable Controllers - Equipment Requirements and Tests. |
| IEC 61131-3:2013 | Programming Industrial Automation System. |
| IEC 61131-6:2012 | Functional safety. |
| IEC 61511:2017 | Safety instrumented systems for the process industry |
| IEC 60068-2-6:2008 | Environmental testing: Vibration |
| IEC 60068-2-27:2008 | Environmental testing: Mechanical Shock |
| IEC 61000-6-2:2010 | Electromagnetic compatibility (EMC) - Immunity for industrial environments |
| IEC 61000-6-4:2011 | Electromagnetic compatibility (EMC) - Emission for industrial environments |
| 2014/30/EU | Electromagnetic Compatibility (EMC) Directive |

| Standard | Description |
|------------|--|
| 2014/35/EU | Low-Voltage Directive (LVD) |
| 2006/42/EC | Machinery Directive |
| 2011/65/EU | Restriction of Hazardous Substances in Electrical and Electronic Equipment |

Table 1: Standards and Directives applied to Nexto Safety Modules

1.2. Nexto Safety Features

1.2.1. Module List

Following is the complete list of safety modules. Please contact your sales representative to check availability and lead times. For further information, please refer to the product documentation of each module.

1.2.1.1. Safety CPUs – Safety Central Processing Units (SCPU)

- **NX3810:** Nexto Safety CPU Module

1.2.1.2. Safety Input Modules (SDIMs)

- **NX1800:** Nexto Safety Digital Input Module

1.2.1.3. Safety Output Modules (SDOMs)

- **NX2800:** Nexto Safety Digital Output Module

1.2.1.4. Software

- **MT8800:** MasterTool Safety

1.2.2. Innovative Features

Nexto Series brings to the user many innovations regarding utilization, supervision and system maintenance. These features were developed focusing a new concept in industrial automation.



Battery Free Operation: Nexto Series does not require any kind of battery for memory maintenance and real time clock operation. This feature is extremely important because it reduces the system maintenance needs and allows the use in remote locations where maintenance can be difficult to be performed. Besides, this feature is environmentally friendly.



Easy Plug System: Nexto Series has an exclusive method to plug and unplug I/O terminal blocks. The terminal blocks can be easily removed with a single movement and with no special tools. In order to plug the terminal block back to the module, the frontal cover assists the installation procedure, fitting the terminal block to the module.



Multiple Block Storage: Several kinds of memories are available to the user in Nexto Series CPUs, offering the best option for any user needs. These memories are divided in volatile memories and non-volatile memories. For volatile memories, Nexto Series CPUs offer addressable input (%I), addressable output (%Q), addressable memory (%M), data memory and redundant data memory. For applications that require non-volatile functionality, Nexto Series CPUs bring retain addressable memory (%Q), retain data memory, persistent addressable memory (%Q), persistent data memory, program memory, source code memory, CPU file system (doc, PDF, data) and memory card interface.



One Touch Diag: One Touch Diag is an exclusive feature that Nexto Series brings to PLCs. With this new concept, the user can check diagnostic information of any module present in the system directly on CPU's graphic display with one single press in the diagnostic switch of the respective module. OTD is a powerful diagnostic tool that can be used offline (without supervisor or programmer), reducing maintenance and commissioning times.

OFD – On Board Full Documentation: Nexto Series CPUs are capable of storing the complete project documentation in its own memory. This feature can be very convenient for backup purposes and maintenance, since the complete information is stored in a single and reliable place.

ETD – Electronic Tag on Display: Another exclusive feature that Nexto Series brings to PLCs is the Electronic Tag on Display. This new functionality brings the process of checking the tag names of any I/O pin or module used in the system directly to the CPU's graphic display. Along with this information, the user can check the description, as well. This feature is extremely useful during maintenance and troubleshooting procedures.

DHW – Double Hardware Width: Nexto Series modules were designed to save space in user cabinets or machines. For this reason, Nexto Series delivers two different module widths: Double Width (two backplane rack slots are required) and Single Width (only one backplane rack slot is required). This concept allows the use of compact I/O modules with a high-density of I/O points along with complex modules, like CPUs, fieldbus masters and power supply modules.

High-speed CPU: All Nexto Series CPUs were designed to provide an outstanding performance to the user, allowing the coverage of a large range of applications requirements. For example: Nexto CPUs can execute a sum, multiplication and subtraction instruction in less than 15 ns for integer type values and in less than 23 ns for real type values. Nexto CPUs are able to perform 1,000 PID loops in less than 5 ms.



iF Product Design Award 2012: Nexto Series was the winner of iF Product Design Award 2012 in industry + skilled trades group. This award is recognized internationally as a seal of quality and excellence, considered the Oscars of the design in Europe.

1.2.3. Architecture

Nexto Safety Series is capable of addressing many different applications ranging from small high-speed machinery automation to large complex process automation. For this reason, the system is very flexible and modular, enabling many different configurations without compromising cost and performance.

The safety architecture is divided in the following main components:

1.2.3.1. CPU

The CPU is responsible for the execution of all logic and control functions of standard I/Os. It is also responsible to act as a router for PROFIsafe data from/to SCP. The basic CPU cycle is composed by: reading inputs, running application algorithms and logic, writing outputs and providing communication processes with the supervision system and fieldbus networks.

1.2.3.2. SCPU

Safety CPU (SCPU) is a co-processor of Nexto CPU and is responsible for the execution of all safety logic and safety control functions. The basic SCPU cycle is composed by: reading safety inputs, running safety application algorithms and logic, writing safety outputs and providing communication processes with the supervision system and fieldbus networks.



Figure 1: NX3810 - Nexto Safety CPU

1.2.3.3. Power Supply Module (PSU)

The power supply module provides power to the modules installed on the backplane racks. Each rack must have its own power supply module. In case of high availability requirements, the system can operate with two power supply modules. When one power supply module fails, the second power supply module will keep the system active. Application power requirements are shown in the configuration tool.

1.2.3.4. Backplane Bus

A typical system consists of a local rack (CPU and its local I/O modules) and remote racks (sets of remote I/O modules). For the local rack, Nexto Series architecture delivers a state-of-the-art high-speed real-time 100 Mbps Ethernet backplane bus technology. Since it is Ethernet based, the local rack bus can be easily extended to remote racks using standard Ethernet cables (up to 100 m) and devices called bus expansion modules. These devices convert the internal signals to the standard Ethernet 100BASE-TX media. Bus expansions can be used in redundant mode to obtain an extremely reliable architecture. Each backplane rack can have up to 24 modules and the system can address up to 25 racks.

1.2.3.5. Backplane Racks

The backplane racks have special aluminum chassis with a printed circuit board where all modules are connected. They are assembled directly to the panel and deliver high immunity against EMI and ESD (if the recommended grounding rules are performed during installation phase).

1.2.3.6. Safety I/O Modules

The safety I/O modules are plugged into the racks for adapting the different types of field signals to the safety CPU or fieldbus heads. Nexto Safety I/O Modules and Safety CPU cannot be installed together in the same Backplane Rack. However, Nexto Safety I/O modules can be used with third-party safety CPUs. Due to isolation features, some I/O modules must be supplied by external power supplies.



1.2.3.7. Fieldbus Head

The fieldbus heads connect Nexto Safety Series modules to different fieldbus networks. They can communicate with CPUs from different vendors, supporting only PROFIBUS-DP.

1.2.3.8. Fieldbus Interface

The fieldbus interfaces are fieldbus master nodes and allow the access to remote modules or other equipment based on major industry fieldbus, like PROFIBUS-DP, MODBUS and others. The fieldbus interfaces are plugged into local racks and use two I/O module slots.

1.3. Warning Messages Used in this Manual

In this manual, the warning messages will be presented in the following formats and meanings:

DANGER:
Reports potential hazard that, if not detected, may be harmful to people, materials, environment and production.

CAUTION:
Reports configuration, application or installation details that must be taken into consideration to avoid any instance that may cause system failure and consequent impact.

ATTENTION:
Identifies configuration, application and installation details aimed at achieving maximum operational performance of the system.

1.4. Documents Related to this Manual

In order to obtain additional information regarding the Nexto Series, other documents (manuals and technical features) besides this one, may be accessed. These documents are available in its last version on the site <http://www.altus.com.br>.

Each product has a document designed by Technical Features (CE), where the product features are described. Furthermore, the product may have Utilization Manuals (the manuals codes are listed in the CE).

The following table lists all documents related to Nexto Series:

| Code | Description | Language |
|----------|---|------------|
| MU214602 | Nexto Safety User Manual | English |
| CE114699 | Nexto Safety CPU – Technical Characteristic | English |
| CT114699 | Nexto UCP de Segurança – Características Técnicas | Portuguese |
| CS114699 | Nexto UCP de Seguridad – Especificaciones y Configuraciones | Spanish |

| Code | Description | Language |
|-----------------|---|------------|
| CE114305 | Safety 24 Vdc 8 DI Module – Technical Characteristic | English |
| CT114305 | Módulo 24 Vdc 8 ED de Segurança – Características Técnicas | Portuguese |
| CS114305 | Módulo 24 Vdc 8 ED de Seguridad – Especificaciones y Configuraciones | Spanish |
| CE114404 | Safety 24 Vdc 4 DO Transistor Module – Technical Characteristic | English |
| CT114404 | Módulo 24 Vdc 4 SD Transistor de Segurança – Características Técnicas | Portuguese |
| CS114404 | Módulo 24 Vdc 4 SD Transistor de Seguridad – Especificaciones y Configuraciones | Spanish |
| MU214605 | Nexto Series CPUs User Manual | English |
| MU214100 | Manual de Utilização UCPs Série Nexto | Portuguese |

Table 2: Safety Related documents

| Code | Description | Language |
|-----------------|---|------------|
| CE114000 | Nexto Series – Technical Characteristics | English |
| CT114000 | Série Nexto – Características Técnicas | Portuguese |
| CS114000 | Serie Nexto – Especificaciones y Configuraciones | Spanish |
| CE114100 | Nexto Series CPUs Technical Characteristics | English |
| CT114100 | Características Técnicas UCPs Série Nexto | Portuguese |
| CS114100 | Especificaciones y Configuraciones UCPs Serie Nexto | Spanish |
| CE114902 | Nexto Series PROFIBUS-DP Master Technical Characteristics | English |
| CT114902 | Características Técnicas do Mestre PROFIBUS-DP da Série Nexto | Portuguese |
| CS114902 | Características Técnicas del Módulo Profibus-DP Maestro | Spanish |
| CE114700 | Nexto Series Backplane Racks Technical Characteristics | English |
| CT114700 | Características Técnicas dos Bastidores da Série Nexto | Portuguese |
| CS114700 | Características Técnicas de los Bastidores de la Serie Nexto | Spanish |
| MU214000 | Manual de Utilização Série Nexto | Portuguese |
| MU214605 | Nexto Series CPUs User Manual | English |
| MU214100 | Manual de Utilização UCPs Série Nexto | Portuguese |
| MU299609 | MasterTool IEC XE User Manual | English |
| MU299048 | Manual de Utilização MasterTool IEC XE | Portuguese |
| MP399609 | MasterTool IEC XE Programming Manual | English |
| MP399048 | Manual de Programação MasterTool IEC XE | Portuguese |
| MU214601 | NX5001 PROFIBUS DP Master User Manual | English |
| MU214001 | Manual de Utilização Mestre PROFIBUS-DP NX5001 | Portuguese |
| MU214608 | Nexto PROFIBUS-DP Head User Manual | English |
| MU214108 | Manual de Utilização da Cabeça PROFIBUS-DP Nexto | Portuguese |

Table 3: Documents Related

1.5. Visual Inspection

Before resuming the installation process, it is advised to carefully visually inspect the equipment, verifying the existence of transport damage. Verify if all parts requested are in perfect shape. In case of damages, inform the transport company or Altus distributor closest to you.

CAUTION:

Before taking the modules off the case, it is important to discharge any possible static energy accumulated in the body. For that, touch (with bare hands) on any metallic grounded surface before handling the modules. Such procedure guaranties that the module static energy limits are not exceeded.

It's important to register each received equipment serial number, as well as software revisions, in case they exist. This information is necessary, in case the Altus Technical Support is contacted.

1.6. Technical Support

For Altus Technical Support contact in São Leopoldo, RS, call +55 51 3589-9500. For further information regarding the Altus Technical Support existent on other places, see <https://www.altus.com.br/en/> or send an email to altus@altus.com.br.

If the equipment is already installed, you must have the following information at the moment of support requesting:

- The model from the used equipments and the installed system configuration
- The product serial number
- The equipment revision and the executive software version, written on the tag fixed on the product's side
- CPU operation mode information, acquired through MasterTool IEC XE
- The application software content, acquired through MasterTool IEC XE
- Used programmer version

ATENÇÃO:

In case a safety critical error is detected, the error has to be analyzed. If the end-user concludes or suspects that the error arose from any Nexto Safety device, Altus has to be reported of this error within 3 working days.

1.7. Personnel Qualification <SRSREQ999> <SRSREQ666> <SRSREQ937>

The products and systems described in this document must be operated only by personnel qualified for the specific task in accordance with the relevant documentation for the specific task, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Operators and machine and system manufacturers are responsible for ensuring that Altus safety systems are safely operated in automated systems and plants. Machine and system manufacturers must sufficiently validate that the Altus systems were properly programmed.

2. Overview of Nexto Safety System

Nexto Safety System offers robustness and high reliability. The modules are able to receive safely data from sensors on field, process and act over actuators to ensure the safety of your system.

On the figure bellow is presented the basic system architecture of Nexto Safety System, showing how each module is positioned on the system: <SRSREQ4073> <SRSREQ667> <SRSREQ938> <NSREQ594> <NSREQ674> <NSREQ945>

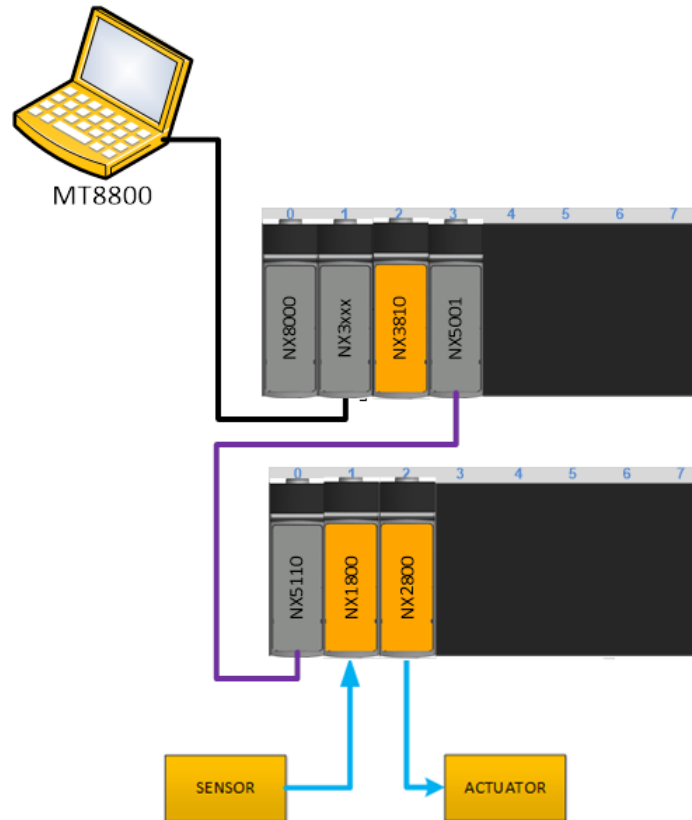


Figure 2: Minimal Nexto Safety System

The components of the main PLC rack are:

- **NX8000:** PSU module for backplane bus (and its attached modules)
- **NX3xxx:** Standard CPU module
- **NX3810:** Safety CPU module
- **NX5001:** PROFIBUS master module

The remote I/O rack of this example is composed by:

- **NX5110:** PROFIBUS slave interface module with integrated PSU
- **NX1800:** Safety Digital Input module
- **NX2800:** Safety Digital Output module

ATTENTION: <SRSREQ683> <SRSREQ982>

The Safety level of the complete control system depends not only on Nexto Safety PLC, but also on the sensors and actuators which must meet all Safety requirements to achieve the specified SIL and Category/PL.

The Safety CPU shall be installed always after (right side) the PSU and standard CPU. The Safety I/O modules shall be installed always after (right side) the PROFIBUS Slave Head interface module, and can be mixed with standard I/O modules on same rack. The Programming System performs these verifications.

WARNING:

The external 24Vdc power supplies used for powering the main/remote rack PSUs, modules and external I/O signals must meet SELV/PELV specification. Additionally, only devices with safe electrical separation that meets this specification may be connected to the Safety system PROFIBUS DP Network.

Disturbances on 24Vdc line, like short voltage interruptions, can cause change in state of digital I/O of the system.

The wiring between the external 24Vdc Power Supply and any power supply input of Nexto PLC must be no longer than 30 meters and must be located inside a building. Otherwise, an extra surge suppressor must be installed to support 2 kV CM high energy surge pulses.

<SRSREQ1005> <SRSREQ1006> <SRSREQ1007> <SRSREQ675> <SRSREQ676> <SRSREQ677> <SRSREQ946> <SRSREQ947> <SRSREQ948>

The Safety CPU acts as a PROFIsafe Master, using the PROFIBUS DP network as medium to exchange PROFIsafe data with safety input and output modules (PROFIsafe slaves) located at the PROFIBUS remote I/O racks. The safety I/O communication is implemented using PROFIsafe V2-mode safety protocol in conformity with the PROFIsafe profile as specified in the IEC 61784-3-3 standard. <SRSREQ1014> <SRSREQ603> <SRSREQ879> <SRSREQ1015> <SRSREQ604> <SRSREQ880>

The safety application is developed using the Safety Programming System called MasterTool Safety (MT8800) and is uploaded together with the standard application to NX3xxx and then redirected to NX3810. The standard CPU is also responsible to route the PROFIsafe data to and from NX3810.

2.1. Definition of Safety System

Every safety system is designed to reduce the human and environment exposure to dangerous conditions. On automated processes, each functional safety device has its proper safety function and depends on this to ensure the overall safety of the process. Functional safety is achieved when random, systematic and common cause failures are controlled (do not lead to fail to danger).

2.2. Safety Function

It is defined as the function of a safety related system to reduce the risk in an application with the objective to achieve or keep a safe state. For example, consider a press machine fed manually by an operator; also consider that somehow the operator pushes the iron sheet ahead the safe zone. Even having a light curtain installed to detect an intrusion on the hazard area; the operator can be injured if the actuation time is not taking into account. In this example the safety function is disable the press movement in a time lower than the minimum time that an operator can reach the hazard zone.

2.2.1. Safe State

State of the equipment under control when safety is achieved. Each module of a safety related system has its own safe state and all combined must ensure the safety function of the system. Safe states of Nexto Safety Modules are defined under specific module's chapter in this manual.

2.3. Safety Parameters

This section lists some important safety parameters that have to be considered while developing a safety system

2.3.1. PFD_{AVG}

Acronym for average probability of failure on demand. It is used to determine the target safety integrity level (SIL), but it is not the only parameter to calculate SIL.

2.3.2. PFH

Acronym for probability of failure per hour. It is inversely proportional to the mean time to failure. PFH is also required to determine SIL.

2.3.3. PST

Acronym for Process Safety Time. It is defined by standards as the period of time between a failure and the required time to prevent the hazardous event occurring.

3. NX3810 - Nexto Safety CPU

Nexto Safety CPU was designed to fulfill needs on functional safety applications up to SIL3, according IEC 61508, and PLe category 4, according ISO 13849. Equipped with several diagnostics and built with reliable components, NX3810 is suitable for oil, gas, machinery and other applications.

The following sections detail the technical characteristics of Nexto Safety CPU and how to integrate with Nexto Safety Digital I/O modules and with third-party PROFIsafe modules.

3.1. Panels and Connections

The following figure shows NX3810 front panel.



Figure 3: NX3810 - Nexto Safety CPU

As it can be seen on the figure, on the front panel upper part is placed the graphic display used to show the whole safety system status and diagnostics.

Just below the graphic display, there are a bicolor LED (indicated as DG on used to indicate alarm diagnostics and actual state).

3.1.1. Graphic LCD Display <NSREQ44>

The graphic display of Safety CPUs is used to show operation status and also to inform diagnostic codes through symbols "D" and "E" (which are described on [Maintenance](#) section). The display on NX3810 is split in regions as shown in bellow figure.

| | | | |
|---|---|--|---|
| A | B | | D |
| C | | | E |

Figure 4: NX3810 - LCD regions

Where:

- **Region A:** Safety application state
- **Region B:** Indicates that variables are being forced via MasterTool Safety

- **Region C:** Safety controller states
- **Region D:** Indicates existing diagnostics on NX3810
- **Region E:** Indicates error on NX3810

3.1.1.1. Region A

On this region, the following status can appear:

- **RUN:** Safety application is running
- **STOP:** Safety application is paused
- **ENDED:** Safety application has been ended (because of an error or it was unloaded).
- **ERROR:** Indicates an internal system error. In this case the product is not operational anymore and needs to be power cycled. If the error persists, it shall be sent to repair.

3.1.1.2. Region B

- **F:** There are variables being forced via MasterTool Safety

3.1.1.3. Region C

- **SAFE:** Safety application is running in normal conditions
- **UNSAFEBA:** There is a Boot application in flash which matches the current application running in RAM and this application it's being manipulated remotely via MasterTool Safety.
- **UNSAFEDL:** The current application is only in RAM (it doesn't have a matching application programmed in Flash). In case of a power down, the last boot application stored in Flash will be loaded.
- **UNLOADED:** The application was unloaded from RAM and it is not running.
- **EXCEPTION:** The current application is in exception state due to some error (for example, a division by zero).

3.1.1.4. Region D and E

- The behavior of these two symbols are standard of Nexto Series, which is described on [Maintenance](#) section.

3.2. Physical Dimensions <SRSREQ1>

Nexto User Manual – MU214600 should be consulted for general measurement of installation panel.
Dimensions in mm.

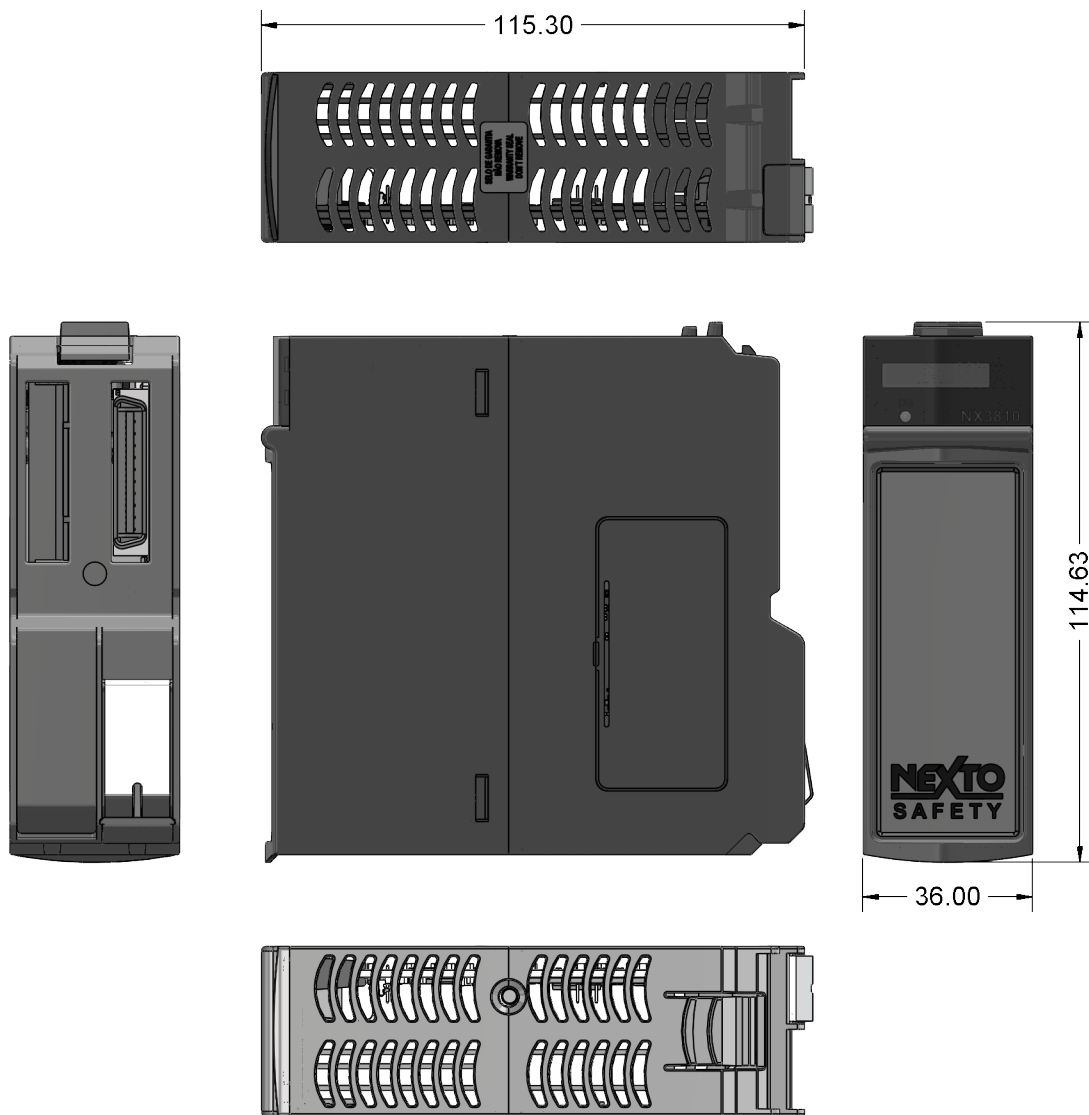



Figure 5: NX3810 - Physical Dimensions

3.3. Technical Data

| | NX3810 |
|--|--|
| Backplane rack occupation | 2 sequential slots |
| Programming Language | Function Block Diagram (FBD) |
| Safety function blocks available | PLC Open Safety POU's |
| Supported safety protocols | PROFIsafe V2 |
| Task types | Cyclical (periodic) |
| Hot swap support | Yes |
| Cycle time | 10 ms to 100 ms |
| Watchdog | Yes |
| Safe state | Interruption of communication (no PROFIsafe messages are sent) |
| Status and diagnostics indication | Graphic display, LEDs |
| One Touch Diag (OTD) | Yes |
| Electronic Tag on Display (ETD) | Yes |
| PROFIsafe Address | 1 |
| Isolation Logic to protective earth  | 1500 Vac / 1 minute |
| Current consumption from backplane rack power supply | 300 mA |
| IP Level | IP 20 |
| Operation temperature | 0 to 60 °C |
| Storage temperature | -25 to 70 °C |
| Operation and storage relative humidity | 5% to 96%, non-condensing |
| Conformal coating | Yes |
| Classification <SRSREQ190> IEC 61508 IEC 62061 ISO 13849 | SIL 3 SIL 3 PLe Cat. 4 |
| Proof Test Interval (PTI) | 20 years <SRSREQ16> |
| Failure probability Low demand (PFD _{avg}) High demand (PFH) | < 5X10 ⁻⁵ (5% of PFD _{avg} max. for SIL 3) <SRSREQ13> < 5X10 ⁻⁹ (5% of PFH max. for SIL 3) <SRSREQ14> |
| MTTFd (Mean Time to Failure dangerous) | High (>30 years) <SRSREQ15> |
| DC _{avg} | Higher than 99% <SRSREQ11> |
| Standards <SRSREQ1018> <SRSREQ2> - (Incl. Climatic and Mechanical req.) | IEC 61131-2:2017 IEC 61131-6:2012 IEC 61508:2010 IEC 62061:2005 EN ISO 13849-1:2012 IEC 61784-3-3:2010 |
| EMC Compliance <SRSREQ6> | IEC 61131-2:2017 Zone B IEC 61131-6:2012 General EMC Environment IEC61326-3-1:2017 IEC61000-6-4:2006+AMD1:2010 CE –2014/35/EU (LVD) and 2014/30/EU (EMC) |


| | NX3810 |
|---------------------------------------|---|
| RoHS directive |  RoHS 2002/95/EC |
| Module dimensions (W x H x D) | 36.00 x 114.63 x 115.30 mm |
| Package dimensions (W x H x D) | 44.00 x 122.00 x 147.00 mm |
| Weight | 100 g |
| Weight with package | 150 g |

Table 4: NX3810 - General Features

Notes:

Safe state: In case of an internal failure or a backplane power failure, NX3810 will interrupt the PROFIsafe communication, resulting in PROFIsafe watchdog. <SRSREQ4>

Isolation: The Logic term refers to the internal interfaces such as processors, memories and backplane rack interfaces.

Proof Test Interval (PTI): Period of time which the module must be replaced so the PFD limits of SIL-3 is not exceeded.

Diagnostic Coverage (DC): Defines internal tests effectiveness considering all possible failure modes.

Conformal Coating: Conformal coating protects the electronic components inside the product from moisture, dust and other harsh elements to electronic circuits.

3.4. Compatibility with other Products

Nexto Safety CPU acts as a co-processor of the Nexto CPU. It receives the data from fail-safe inputs process and delivers the expected data to the fail-safe outputs.

Aimed to ensure the safety on applications using Nexto Safety modules, the following table provides a list of compatible tools and modules with its respective product revision and/or software version.

| | Software version | Product revision |
|---------------|-------------------|------------------|
| MT8800 | 1.00 or higher | AA or higher |
| MT8500 | 3.03 or higher | AY or higher |
| NX5110 | 1.1.2.3 or higher | AK or higher |

Table 5: Compatibility with Other Products

3.5. Performance

The performance of NX3810 is affected by:

- User safety application time;
- Safety application interval;
- Amount of modules (process data, inputs/outputs, among others).

NX3810 is designed to support 1000 bytes of PROFIsafe input and 1000 bytes of PROFIsafe output data. PROFIsafe V1-mode is not supported by NX3810.

3.5.1. Safety Function Response Time <SRSREQ21>

The Safety Function Response Time (SFRT) is the worst case response time of a safety function, elapsed since a demand occurs in a safety sensor until the associated actuator is in safe state.

The calculation of SFRT assumes at most one failure in safety components (SCPU, safety input device, safety output device). In the other hand, there is no limit for the number of simultaneous failures in non-safety components, like those that implement the black-channel for tunneling the PROFIsafe protocol.

To achieve the Functional Safety level for the control system, the calculated SFRT must be smaller than Process Safety Time (PST).

3.5.1.1. Excel Spreadsheet for SFRT Calculation

An Excel spreadsheet (SFRT_NX3810.xlsx) is used for calculating SFRT, and also for calculating PROFIsafe watchdogs of safety input and safety output devices.

The following subsections describe each tab of this spreadsheet, the parameters that must be filled in by the user, and the calculated results.

The spreadsheet has the following general features:

- Yellow cells must be filled in by the user (all other cells are blocked for edition);
- Blue cells show intermediate values;
- Green cells show final results useful for the user.

3.5.1.1.1. Tab "CPU Parameters"

In this tab, the user must fill in the following parameters, related to SCPU, STDCPU and PROFIBUS master:

- **Tcy_{F-Host} [ms]**: this is the cycle time of SCPU in milliseconds (also called SPCYC, configured in Mastertool Safety in the Safety Task item);
- **Tcy_{STDCPU} [ms]**: this is the cycle time of STDCPU in milliseconds (the MainTask Interval setting in Mastertool IEC XE program);
- **PROFIBUS baud [Mbps]**: bit rate of PROFIBUS network in Mbps;
- **PROFIBUS remote stations**: quantity of slave remote stations in the PROFIBUS network.

3.5.1.1.2. Tab "Safety Input"

In this tab, the user must fill in the following parameters related to safety sensor and safety input:

- **WCDT_{sens} [ms]**: this is the worst case delay time in milliseconds of safety sensor. This delay must be informed in the safety manual of the sensor;
- **TBUS_{in} [ms]**: if the safety input is inside a module of a modular PROFIBUS remote station, this parameter represents the worst case bus delay in milliseconds between this module and the PROFIBUS slave interface. This delay must be informed in the safety manual of the safety input device;
- **DAT_{in} [ms]**: this is the Device Acknowledgment Time of safety input device in milliseconds. The concept of DAT is defined in PROFIsafe specification (IEC 61784-3-3). This parameter must be informed in the safety manual of the safety input device;
- **WCDT_{in} [ms]**: this is the worst case delay time in milliseconds of safety input device. This delay must be informed in the safety manual of the safety input device;
- **OFDT_{in} [ms]**: this is the one fault delay time in milliseconds of safety input device. This delay must be informed in the safety manual of the safety input device;
- **Watchdog Safety Margin (%)**: this safety margin (%) is applied over the minimum calculated value of PROFIsafe watchdog of safety input device. A small margin (e.g.: 10%) is recommended to decrease probability of spurious activation of safety function, considering that minimum watchdog already consider worst case delays of black-channel.

This tab also shows the following relevant calculated values:

- **F_WD_Time_{in} [ms]**: this is PROFIsafe watchdog that must be configured for the safety input device.

3.5.1.1.3. Tab "Safety Output"

In this tab, the user must fill in the following parameters related to safety actuator and safety output:

- **WCDT_{act} [ms]**: this is the worst case delay time in milliseconds of safety actuator. This delay must be informed in the safety manual of the actuator;
- **TBUS_{out} [ms]**: if the safety output is inside a module of a modular PROFIBUS remote station, this parameter represents the worst case bus delay in milliseconds between this module and the PROFIBUS slave interface. This delay must be informed in the safety manual of the safety output device;
- **DAT_{out} [ms]**: this is the Device Acknowledgment Time of safety output device in milliseconds. The concept of DAT is defined in PROFIsafe specification (IEC 61784-3-3). This parameter must be informed in the safety manual of the safety output device;
- **WCDT_{out} [ms]**: this is the worst case delay time in milliseconds of safety output device. This delay must be informed in the safety manual of the safety output device;
- **OFDT_{out} [ms]**: this is the one fault delay time in milliseconds of safety output device. This delay must be informed in the safety manual of the safety output device;
- **Watchdog Safety Margin (%)**: this safety margin (%) is applied over the minimum calculated value of PROFIsafe watchdog of safety output device. A small margin (e.g.: 10%) is recommended to decrease probability of spurious activation of safety function, considering that minimum watchdog already consider worst case delays of black-channel.

This tab also shows the following relevant calculated values:

- **F_WD_Time_{out} [ms]**: this is PROFIsafe watchdog that must be configured for the safety output device;

3.5.1.1.4. Tab "SFRT"

This tab shows the calculated SFRT in milliseconds.

3.5.1.2. Example of Spreadsheet Usage

The following screen captures show an example of usage of the spreadsheet.

| | | | | | | | |
|----------------------------|------|--------------------------------------|-------|---------------------------------------|-------|--|--------|
| CPU Parameters | | Safety Input | | Safety Output | | SFRT | |
| Tcy _{F-Host} [ms] | 10 | WCDT _{sens} [ms] | 12 | WCDT _{act} [ms] | 25 | SFRT [ms] | 229 |
| TcystDCPU [ms] | 10 | TBUS _{in} [ms] | 8 | TBUS _{out} [ms] | 8 | WCDT _{IP} [ms] | 15,00 |
| PROFIBUS baud [Mbps] | 12 | DAT _{in} [ms] | 2 | DAT _{out} [ms] | 2 | WCDT _{IC} [ms] | 44,94 |
| PROFIBUS remote stations | 5 | WCDT _{IP} [ms] | 3 | WCDT _{act} [ms] | 2 | WCDT _{SCPU} [ms] | 10,00 |
| HAT [ms] | 10 | OFDT _{IP} [ms] | 9 | OFDT _{act} [ms] | 2 | WCDT _{OC} [ms] | 34,94 |
| Tcy _{Host} [ms] | 2,47 | Watchdog Safety Margin (%) | 10% | Watchdog Safety Margin (%) | 10% | WCDT _{OP} [ms] | 27,00 |
| | | F_WD_Time _{in} [ms] | 97 | F_WD_Time _{out} [ms] | 97 | OFDT _{IP} [ms] | 21,00 |
| | | TD _{in} [ms] | 32,94 | TD _{out} [ms] | 32,94 | OFDT _{IC} [ms] | 141,94 |
| | | minimum F_WD_Time _{in} [ms] | 87,87 | minimum F_WD_Time _{out} [ms] | 87,87 | OFDT _{SCPU} [ms] | 10,00 |
| | | | | | | OFDT _{OC} [ms] | 131,94 |
| | | | | | | OFDT _{OP} [ms] | 27,00 |
| | | | | | | OFDT _{IP} - WCDT _{IP} [ms] | 6,00 |
| | | | | | | OFDT _{IC} - WCDT _{IC} [ms] | 97,00 |
| | | | | | | OFDT _{SCPU} - WCDT _{SCPU} [ms] | 0,00 |
| | | | | | | OFDT _{OC} - WCDT _{OC} [ms] | 97,00 |
| | | | | | | OFDT _{OP} - WCDT _{OP} [ms] | 0,00 |

Figure 6: Example of usage of spreadsheet for SFRT and PROFIsafe watchdog calculation

In this particular example an input module NX1800 and an output module NX2800 were used in the PROFIBUS network. The values in Safety Input tab were filled from NX1800 characteristics and the values in Safety Output tab were filled from NX2800 characteristics (with the exception of WCDT_{sens} and WCDT_{act} that are characteristics of sensor and actuator used in the safety function, with respective values of 12 ms and 25 ms). The Watchdog Safety Margin was chosen to 10% for both input and output, to support possible variation in black channel communication performance.

The Safety Input data is from an NX1800 module, using the configuration:

- Paired input with individual external test pulse

The WCDT and OFDT for this configuration is found in Table 8:

- WCDT:** 3 ms
- OFDT:** 9 ms

The DAT and TBUS are independent of the configuration and are found in Table 7:

- TBUS:** 8 ms
- DAT:** 2 ms

The Safety Output data is from an NX2800 module, using the configuration:

- Output with open load detection

The WCDT, OFDT, DAT and TBUS are not dependant of the configuration combination in this module. The WCDT and OFDT are found in Table 12. DAT and TBUS area available in Table 11:

- WCDT:** 2 ms
- OFDT:** 2 ms
- TBUS:** 8 ms
- DAT:** 2 ms

The configuration in CPU tab is chosen to reflect a typical small setup:

- Tcy_{F-Host}:** Safety CPU running with 10 ms Task Cycle Interval
- TcystDCPU:** Standard CPU running with 10 ms Task Cycle Interval
- PROFIBUS baud:** 12 Mbps
- PROFIBUS remote stations:** 5 remote stations in the network

In this example, the following results were calculated:

- PROFIsafe watchdog for safety input:** 97 ms
- PROFIsafe watchdog for safety output:** 97 ms
- SFRT:** 229 ms

When using third party modules, the values from these modules must be input in the spreadsheet. Moreover, the SFRT is per safety loop (inputs - SCPU processing - outputs), so the SFRT will depend on the inputs and outputs combinations of input and output modules used and their configuration. Multiple SFRT calculations has to be done in such situations and the biggest value will be the one considered.

3.5.1.3. Additional Delays for SFRT

The previous calculations considers that the SCPU application software takes a single SCPU cycle ($T_{cyF-Host}$) for executing any safety function.

In some cases, the user may include additional delays in the SCPU application software, for instance, timers (TOF, TON). In such cases, these delays must be added to the SFRT.

3.5.1.4. SFRT for Multiple Inputs or Outputs

If a safety function contains M safety inputs and N safety outputs, it is necessary to calculate $M * N$ values of SFRT, for each combination of input and output, as explained in the example. Afterwards, the maximum value of SFRT must be considered.

3.5.2. Safety Program Cycle <SRSREQ29>

Safety Program Cycle (SPCYC) is defined as the interval in which the safety task is performed periodically. It affects directly the safety function response time (SFRT)

The selected value of SPCYC must be tested in the SFRT calculation, described in previous section. If SFRT is bigger than PST, one possible action is to reduce SPCYC.

There is also dependence between the SPCYC and the amount of safety application data used on the safety application. Usually the default value of 20 ms of SPCYC can be used for the vast majority of the applications, but for small applications, this value can be reduced to 10 ms (which is the smallest possible value). When using several safety slave I/O modules or when the application logic is considerably dense, the value of SPCYC can be raised up to 100 ms to allow all the PROFIsafe data and logic to be processed. This will increase the SFRT time.

4. NX1800 - Nexto Safety Digital Input Module

Nexto Safety Digital Input modules were designed to fulfill all requirements to be used in applications up to SIL3 according IEC 61508 and Category 4 PLe according ISO 13849.

This chapter provides the module technical capabilities and all instructions for a proper operation, parametrization and addressing of the module, allowing to ensure the safety of system where it is used.

4.1. Panels and Connections

The following figure shows NX1800 front panel.



Figure 7: NX1800 - Nexto Safety Digital Input Module

4.1.1. LCD Display<NSREQ650>

The module have a standard LCD Display found on other I/O modules from Nexto Series. It is used to indicate the state of each digital input channel through symbols 0 to 7 and also to inform diagnostic codes through symbols "D" and "E" (which are described on [Maintenance](#) section). For paired inputs, the status indication have a specific behavior described on [Operation](#) <SRSREQ625> <SRSREQ626> <SRSREQ630> <SRSREQ631> section.

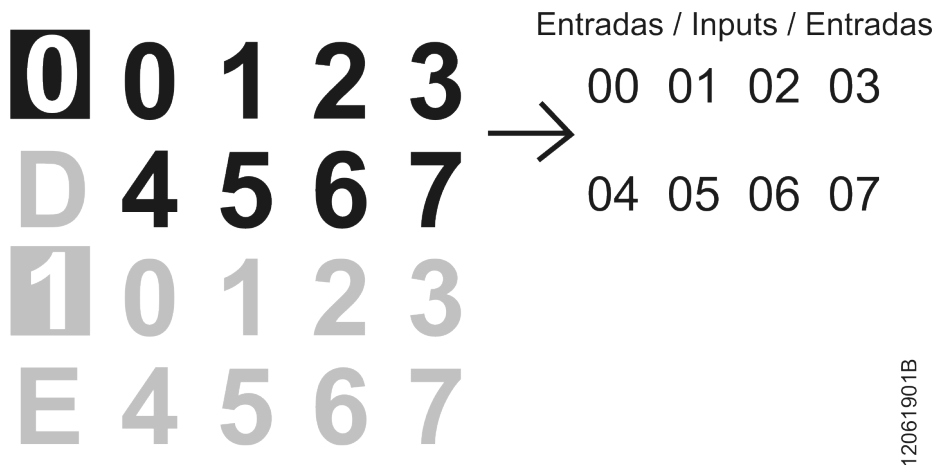


Figure 8: LCD Display of NX1800

4.1.2. Connector Pinout <SRSREQ601>



Figure 9: Connector Pinout

The following table shows the description of each connector terminal:

| Terminal Number | Name | Description |
|-----------------|------|--------------------------------------|
| 1 | I00 | Input 00 |
| 2 | I01 | Input 01 |
| 3 | I02 | Input 02 |
| 4 | I03 | Input 03 |
| 5 | I04 | Input 04 |
| 6 | I05 | Input 05 |
| 7 | I06 | Input 06 |
| 8 | I07 | Input 07 |
| 9 | T0 | Test pulse output 0 |
| 10 | T1 | Test pulse output 1 |
| 11 | T0 | Test pulse output 0 |
| 12 | T1 | Test pulse output 1 |
| 13 | T0 | Test pulse output 0 |
| 14 | T1 | Test pulse output 1 |
| 15 | T0 | Test pulse output 0 |
| 16 | T1 | Test pulse output 1 |
| 17 | V1 | External power supply input (24 Vdc) |
| 18 | V1 | External power supply input (24 Vdc) |
| 19 | N1 | External power supply input (0 Vdc) |
| 20 | N1 | External power supply input (0 Vdc) |

Table 6: Connector Pinout NX1800

4.2. Physical Dimensions <SRSREQ599>

Nexto User Manual – MU214600 should be consulted for general measurement of installation panel.
Dimensions in mm.

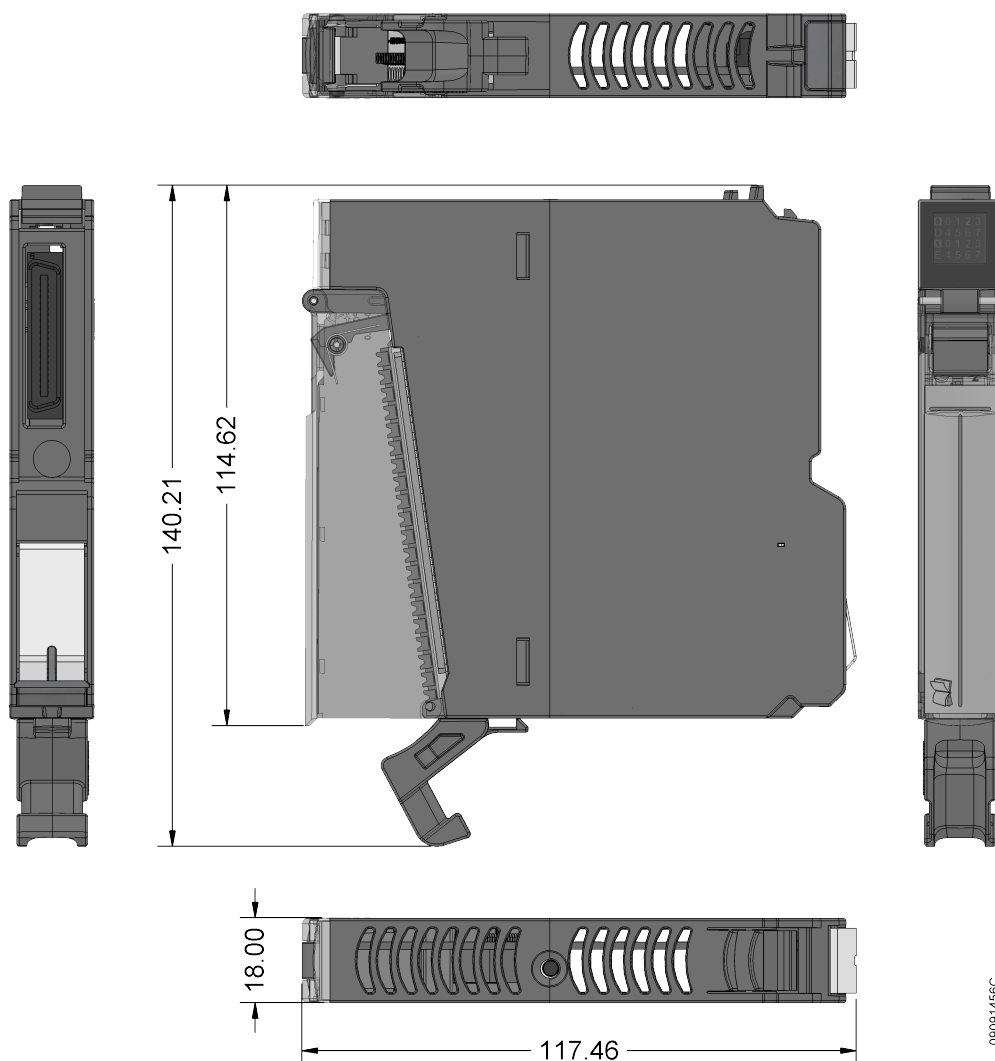




Figure 10: Physical Dimensions

4.3. Technical Data

| | NX1800 |
|---|--|
| Backplane rack occupation | 1 slot |
| Input type | Monitored sink type 1 input with integrated test outputs for switches |
| Safe state | 0 logic level sent by PROFIsafe or interruption of communication |
| Input logic treatment | Switch valence discrepancy and shared test output |
| Number of inputs | 8 |
| Input voltage | 24 Vdc 15 to 31.2 Vdc logic level 1 <SRSREQ615> 0 to 5 Vdc logic level 0 <SRSREQ614> |
| Input current | 4.6 mA at 24 Vdc |
| Input update time (WCDT) <SRSREQ654> Single input with no external test pulse Single input with external test pulse Paired inputs with no to external test pulse Paired inputs with individual external test pulse Paired inputs with shared external test pulse | 6 ms 9 ms 3 ms 3 ms 9 ms |
| External power supply Voltage range Consumption Type | 18 to 31.2 Vdc <NSREQ621> 1W + consumption of T0/T1 outputs <NSREQ621> SELV/PELV <SRSREQ633> |
| Cables | 0.5 mm ² (20 AWG), 200 meter maximum <NSREQ678> |
| Configurable parameters Channel | Yes, test pulses, input pairing, valence and shared test pulses |
| PROFIsafe version | V2-mode only (V1-mode is not supported) |
| PROFIsafe address | Configurable, between 1 and 65534 |
| TBUS | 8 ms <NSREQ652> |
| DAT | 2 ms <NSREQ653> |
| Inputs state indication | Yes |
| One Touch Diag (OTD) | Yes |
| Module Protection | Yes, protection against polarity inversion at external power supply, protection against high energy surge, detection of loss of power supply, protection against overtemperature |
| Channel Protection | Yes, protection against overload at test pulses outputs, detection of input short circuit |
| Max. current on each test pulse output | 300 mA at 24 Vdc <SRSREQ618> |
| Isolation Inputs/Pulse Out to logic Inputs/Pulse Out to protective earth  Logic to protective earth  | 1500 Vac / 1 minute <SRSREQ617> <SRSREQ619> 1500 Vac / 1 minute 1500 Vac / 1 minute |
| Current consumption of backplane rack power supply | 200 mA <NSREQ620> |
| IP Level | IP 20 |
| Operation temperature | 0 to 60 °C |


| | NX1800 |
|--|--|
| Storage temperature | -25 to 70 °C |
| Operating and storage relative humidity | 5% to 96%, non-condensing |
| Conformal coating | Yes |
| Classification <SRSREQ656> IEC 61508 IEC 62061 ISO 13849 | SIL 3 SIL 3 PLe Cat. 4 |
| Proof Test Interval (PTI) | 20 years <SRSREQ657> |
| Failure probability Low demand (PFD _{avg}) High demand (PFH) | < 5X10 ⁻⁵ (5% of PFD _{avg} max. for SIL 3) <SRSREQ658> < 5X10 ⁻⁹ (5% of PFH max. for SIL 3) <SRSREQ659> |
| MTTF _d (Mean Time To Failure dangerous) | High (>30 years) <SRSREQ661> |
| DC _{avg} | Higher than 99% <SRSREQ662> |
| Standards <SRSREQ622> <SRSREQ624> - (Incl. Climatic and Mechanical req.) | IEC 61131-2:2017 IEC 61131-6:2012 IEC 61508:2010 IEC 62061:2005 EN ISO 13849:2012 IEC 61784-3-3:2010 |
| EMC Compliance <SRSREQ623> | IEC 61131-2:2017 Zone B IEC 61131-6:2012 General EMC Environment IEC61326-3-1:2017 IEC61000-6-4:2006+AMD1:2010 CE –2014/35/EU (LVD) and 2014/30/EU (EMC) |
| RoHS directive |  RoHS 2002/95/EC |
| Module dimensions (W x H x D) | 18.00 x 114.62 x 117.46 mm |
| Package dimensions (W x H x D) | 44.00 x 122.00 x 147.00 mm |
| Weight | 100 g |
| Weight with package | 150 g |

Table 7: NX1800 - General Features

Notes:

Input type: Test pulses are two digital outputs (T0 and T1) that generate pulses to detect if the input is short-circuited with power supply lines when connected to an input. They are both replicated on the connector.

Safe state: In case of fault detection, NX1800 will report the input value as 0 logic level or in some cases it will interrupt communication with safety CPU, resulting in PROFIsafe watchdog. <SRSREQ634>

ATTENTION:
Safety function must consider the safe state of NX1800.

Input update time (WCDT): This is the total update time of an input channel (worst case), which also considers (additionally to the internal scan time) the internal low level software filter that rejects pulses with duration shorter than 2ms.

Proof Test Interval (PTI): Period in which the module must be replaced so the PFD limits of SIL-3 is not exceeded.

Conformal Coating: Conformal coating protects the electronic components inside the product from moisture, dust and other harsh elements to electronic circuits.

TBUS and DAT: Delay of remote backplane (TBUS) is the maximum time of communication between PROFIBUS head and safety module. PROFIsafe Device Acknowledgement Time (DAT) is the maximum time between the reception of a PROFIsafe request message and the response of a new PROFIsafe telegram.

ATTENTION:

Both TBUS and DAT do not directly impact in safety response time but must be considered for PROFIsafe watchdog definition which is part of system's response time.

4.4. Operation <SRSREQ625> <SRSREQ626> <SRSREQ630> <SRSREQ631>

4.4.1. Digital Inputs

Each digital input channel of SDIM can be used as standalone (single input) or paired with another input (paired inputs). All the physical input signals pass through a low-level filtering hardware/software stage before going to the other stages. This is done to eliminate spurious transitions that may occur with some sensors like OSSD, however it introduces a transition delay. The digital input update time is described on [Safety Response Times](#) section.

When using single inputs, the value reported in PROFIsafe response is "0" for safe state and "1" for energized state.

When using paired inputs, the first input must be even-numbered and the second must be the subsequent odd-numbered (I00 and I01 for example). In this case, only the respective even bit (I00) will represent the input value while the odd (I01) bit will keep with 0 logical level. This behavior is reflected on the value reported on PROFIsafe response ("00" for safe state and "10" for energized state) and will also be observed on LCD display (I00 will change accordingly, while I01 will be always off). Two types of paired input can be selected:

- Equivalent: equal logical values are normally expected at paired input pins. If values are different a discrepancy occurs.
 - "00": safe state without discrepancy
 - "01": safe state with discrepancy
 - "10": safe state with discrepancy
 - "11": energized state without discrepancy
- Antivalent: opposite logical values are normally expected at paired input pins. If values are equal a discrepancy occurs.
 - "00": safe state with discrepancy
 - "01": safe state without discrepancy
 - "10": energized state without discrepancy
 - "11": safe state with discrepancy

The input discrepancy check is performed using a timeout parameter. If the discrepancy lasts longer than the configured timeout plus a tolerance time, a discrepancy timeout diagnostic is set for the corresponding pair. This tolerance time is added due to internal low-level software filtering, and its value depends if test pulses are used or not (described on [SDIM Configuration <SRSREQ645> <SRSREQ646>](#) section).

To quit this diagnostic, the discrepancy must be eliminated and the inputs of the pair must also come back to the safe state without discrepancy ("00" for equivalent / "01" for antivalent).

4.4.2. Pulse Outputs <SRSREQ628>

The SDIM offers two pulse outputs that provide power for feeding the external sensors. The pulse outputs turn off periodically for a short time, allowing then to detect short circuits on the external circuit between the module and the sensor. The test pulses have approximately 4ms of duration and repeat every 32ms. If the module does not sense the input turning off when executing the test pulse, a short circuit diagnostic will be generated for the respective input channel.

The external pulse test can be enabled individually for each input channel, where output T0 must be used to feed sensors connected to even-numbered inputs (I00, I02, I04, I06) and T1 for the odd-numbered inputs (I01, I03, I05, I07).

4.4.3. External Power Supply Failure <SRSREQ632>

The SDIM checks if the voltage of external 24 V power supply is above the minimum value defined on Technical Data table. If the voltage is below the minimum specified, the SDIM reports a Device_Fault diagnostic on PROFIsafe communication and generates diagnostic. Then, when the Safety CPU detects that Device_Fault is reported, it assumes all inputs in safe state.

4.5. Safety Response Times

| | NX1800 |
|---|--------|
| WCDT – Worst Case Delay Time <SRSREQ654> | |
| Single input with no external test pulse | 6 ms |
| Single input with external test pulse | 9 ms |
| Paired inputs with no external test pulse | 3 ms |
| Paired inputs with individual external test pulse | 3 ms |
| Paired inputs with shared external test pulse | 9 ms |
| OFDT – One Fault Delay Time <SRSREQ655> | |
| Single input with no external test pulse | 35 ms |
| Single input with external test pulse | 38 ms |
| Paired inputs with no external test pulse | 6 ms |
| Paired inputs with individual external test pulse | 9 ms |
| Paired inputs with shared external test pulse | 9 ms |

Table 8: NX1800 - Safety Response Times

Notes:

WCDT – Worst Case Delay Time: maximum delay between a demand (change input pin state) and a PROFIsafe response with the current input state. This parameter does not consider the presence of any fault in the module.

OFDT – One Fault Delay Time: maximum delay between a demand (change input pin state) and a PROFIsafe response with the current input state or fault detection and safe actuation. This parameter considers the presence of one external or internal fault in the module.

ATTENTION:

When using antivalent input a change of state in the input signal must occur in at maximum 8 hours period. Otherwise, must be considered the OFDT of single inputs due to Category 4 characteristic.

4.5.1. Safe State

The safe state corresponds to logical level “0” at:

- single input pins
- even numbered input pins of paired inputs (equivalent or antivalent)
- odd numbered input pins of equivalent paired inputs

The safe state corresponds to logical level “1” at:

- odd numbered input pins of antivalent paired inputs

4.6. Compatibility with other Products <NSREQ2505>

The following product can be used with this product:

| | Software version | Product revision |
|--------|-------------------|------------------|
| MT8800 | 1.00 or higher | AA or higher |
| MT8500 | 3.03 or higher | AY or higher |
| NX5110 | 1.1.2.3 or higher | AK or higher |

Table 9: Compatibility with Other Products

| |
|--|
| ATTENTION: Only certified PROFIBUS Head modules shall be used with SDIM modules. <small><SRSREQ1235></small> |
|--|

4.7. Compatibility with Sensors <SRSREQ679> <NSREQ680> <NSREQ681> <NSREQ682>

The sensors must comply with the electrical characteristics described on [Technical Data](#) table (voltage threshold, current, cables, etc...).

When using external pulses, the connected inputs must switch to level 0 up to 2 ms after the pulse activation (falling edge). A longer time may cause unexpected short circuit detection. In the same way, the connected inputs must switch back to level 1 up to 2ms after the pulse deactivation (rising edge). In this case, a longer rise time may cause unexpected transition of the input to safe state.

When using semiconductor sensors with OSSD outputs, the pulse width must be shorter than 2ms and the period of the OSSD signal must be greater than 6ms.

4.8. Connection Diagrams <SRSREQ684>

This section lists possible wiring with sensors and the maximum SIL achievable in each configuration.

4.8.1. Single input with test pulse

Maximum achievable safety level: SIL 3 / Cat.3 PLd

Figure below shows an example of connection of a single input.

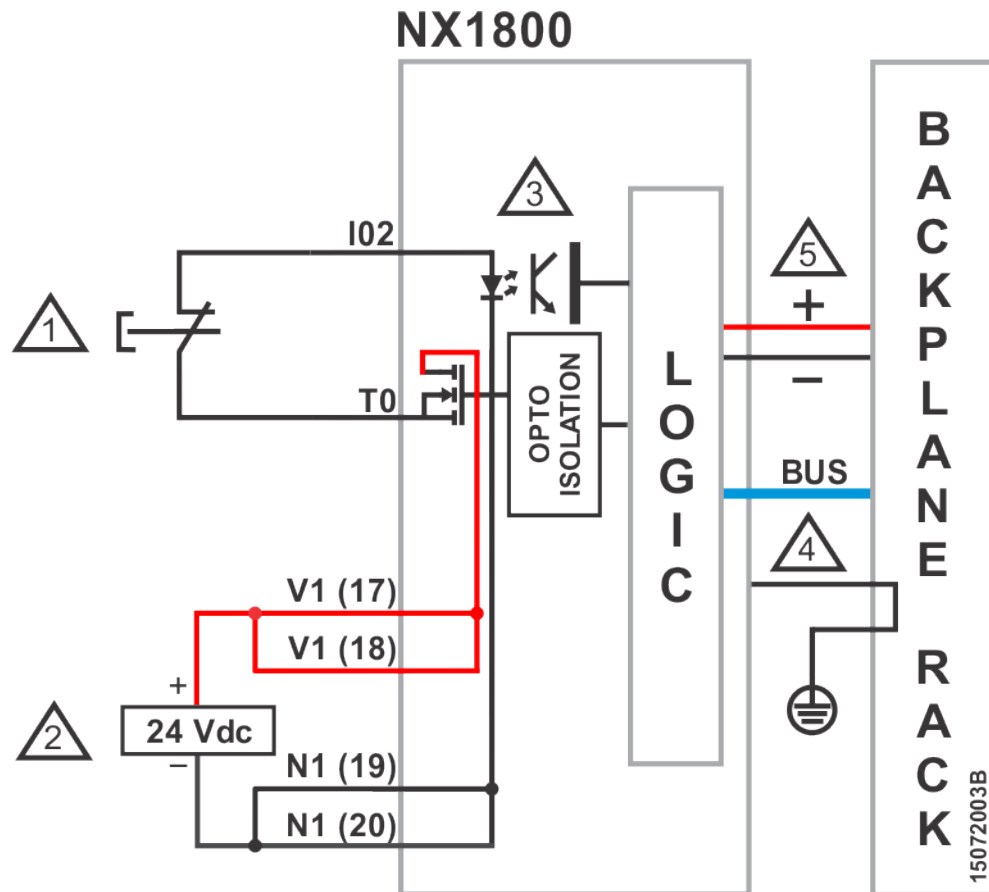


Figure 11: Single input with test pulse

Diagram Notes:

1. Always use appropriate switch depending on your application. External dangerous cross circuits of I02 against the respective external test pulse or other inputs of this SDIM powered by this same external test pulse (T0 in this example) cannot be detected. Such problems must be avoided routing the input signals with special care (e.g.: separate shielded lines, separate cable ducts, ferrules in wire terminals).
2. External power supply to feed the outputs. V1s are connected to +24 Vdc, and N1s are connected to 0 Vdc. The power supply used must be of SELV/PELV type.
3. Input is only synk type.
4. The module is grounded through the Nexto Series backplane racks.
5. The module power supply is derived from the connection to the backplane rack, not requiring external connections.

4.8.2. Paired antivalent inputs with individual test pulses

Maximum achievable safety level: SIL 3 / Cat.4 PLe

Figure below shows an example of connection of paired antivalent inputs.

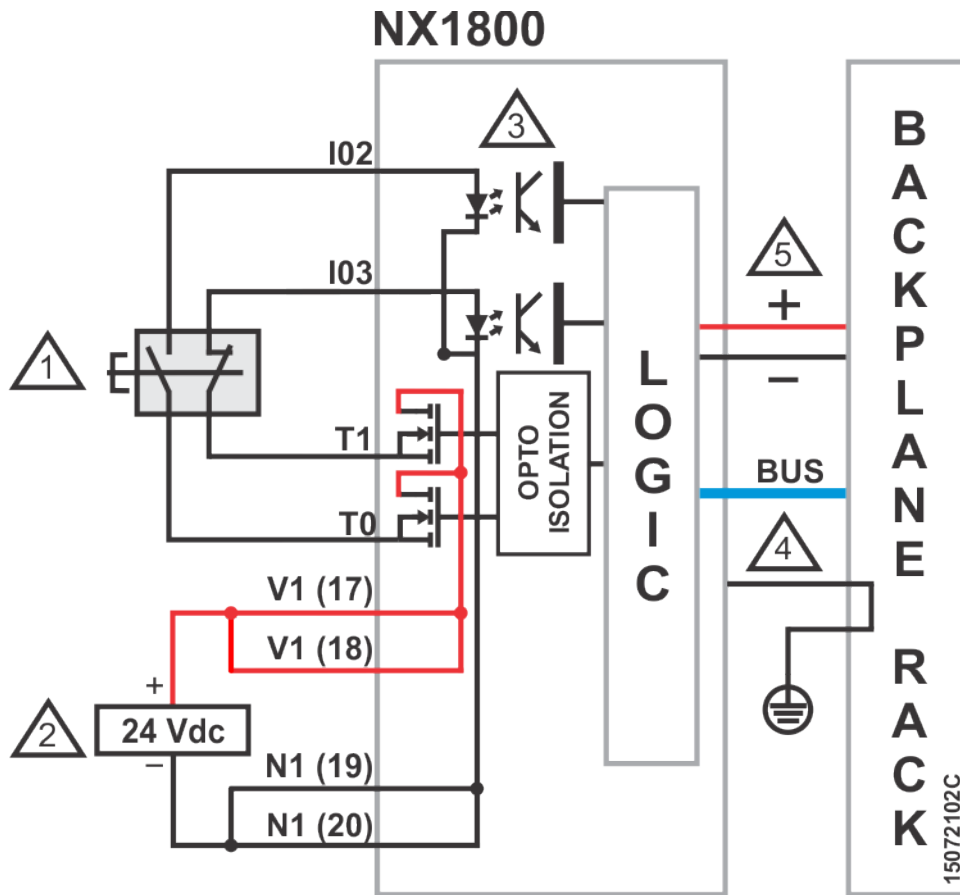


Figure 12: Paired antivalent inputs with individual test pulses

Diagram Notes:

1. Always use appropriate switch depending on your application. External dangerous cross circuits of I02/I03 against the respective external test pulse or other inputs of this SDIM powered by the same external test pulse cannot be detected. Such problems must be avoided routing the input signals with special care (e.g.: separate shielded lines, separate cable ducts, ferrules in wire terminals).
When using antivalent input a change of state must occur in at maximum an 8-hours period. Otherwise, must be considered the OFDT of single inputs due to Category 4 characteristic.
During operation, with no discrepancy detected, the input value will be value present in the even input and consequently the opposite to the odd input.
2. External power supply to feed the outputs. V1s are connected to +24 Vdc, and N1s are connected to 0 Vdc. The power supply used must be of SELV/PELV type.
3. Input is only sink type.
4. The module is grounded through the Nexto Series backplane racks.
5. The module power supply is derived from the connection to the backplane rack, not requiring external connections.

4.8.3. Paired equivalent inputs with individual test pulses

Maximum achievable safety level: SIL 3 / Cat.4 PLe

Figure below shows an example of connection of paired equivalent inputs.

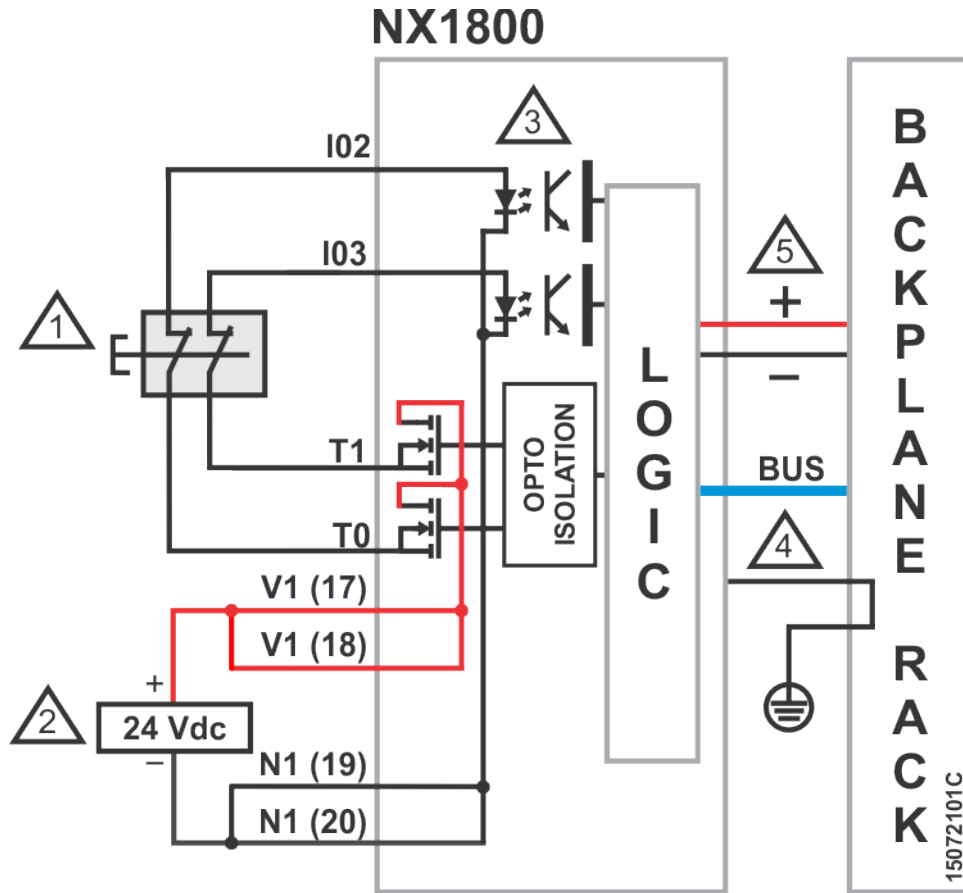


Figure 13: Paired equivalent inputs with individual test pulses

Diagram Notes:

1. Always use appropriate switch depending on your application. External dangerous cross circuits of I02/I03 against the respective external test pulse or other inputs of this SDIM powered by the same external test pulse cannot be detected. Such problems must be avoided routing the input signals with special care (e.g.: separate shielded lines, separate cable ducts, ferrules in wire terminals).
2. External power supply to feed the outputs. V1s are connected to +24 Vdc, and N1s are connected to 0 Vdc. The power supply used must be of SELV/PELV type.
3. Input is only synk type.
4. The module is grounded through the Nexto Series backplane racks.
5. The module power supply is derived from the connection to the backplane rack, not requiring external connections.

4.8.4. Paired equivalent inputs with shared test pulse

Maximum achievable safety level: SIL 3 / Cat.4 PLe

Figure below shows an example of connection of paired equivalent inputs.

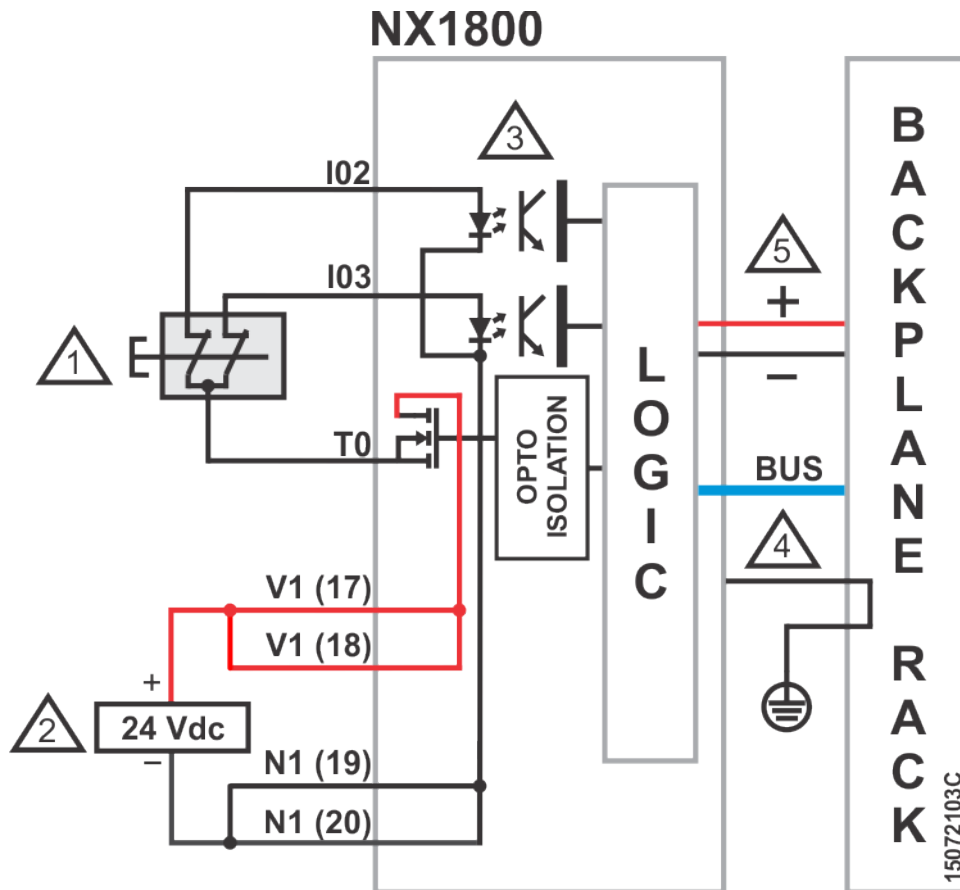


Figure 14: Paired equivalent inputs with shared test pulse

Diagram Notes:

1. Always use appropriate switch depending on your application. External dangerous cross circuits of I02/I03 against the respective external test pulse or other inputs of this SDIM powered by the same external test pulse cannot be detected. Such problems must be avoided routing the input signals with special care (e.g.: separate shielded lines, separate cable ducts, ferrules in wire terminals).
2. External power supply to feed the outputs. V1s are connected to +24 Vdc, and N1s are connected to 0 Vdc. The power supply used must be of SELV/PELV type.
3. Input is only sink type.
4. The module is grounded through the Nexto Series backplane racks.
5. The module power supply is derived from the connection to the backplane rack, not requiring external connections.

4.8.5. Paired antivalent inputs with shared test pulse

Maximum achievable safety level: SIL 3 / Cat.4 PLe

Figure below shows an example of connection of paired antivalent inputs.

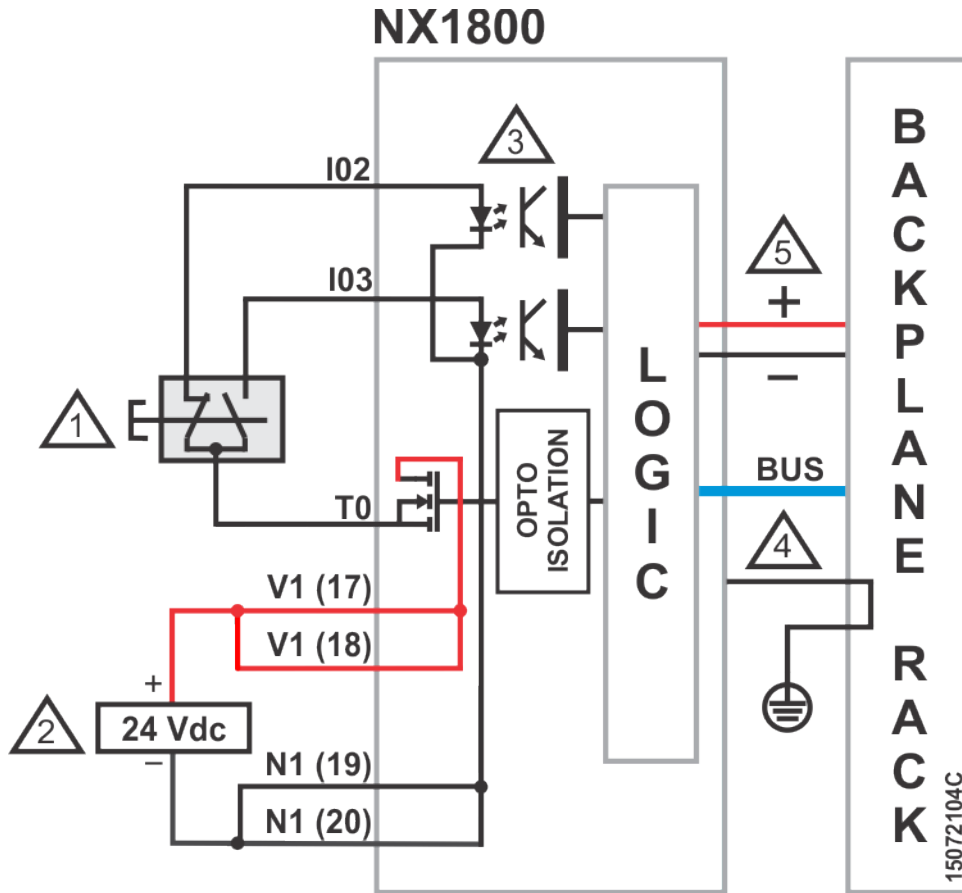


Figure 15: Paired antivalent inputs with shared test pulse

Diagram Notes:

1. Always use appropriate switch depending on your application. External dangerous cross circuits of I02/I03 against the respective external test pulse or other inputs of this SDIM powered by the same external test pulse cannot be detected. Such problems must be avoided routing the input signals with special care (e.g.: separate shielded lines, separate cable ducts, ferrules in wire terminals).
When using antivalent input a change of state must occur in at maximum an 8-hours period. Otherwise, must be considered the OFDT of single inputs due to Category 4 characteristic.
During operation, with no discrepancy detected, the input value will be value present in the even input and consequently the opposite to the odd input.
2. External power supply to feed the outputs. V1s are connected to +24 Vdc, and N1s are connected to 0 Vdc. The power supply used must be of SELV/PELV type.
3. Input is only sink type.
4. The module is grounded through the Nexto Series backplane racks.
5. The module power supply is derived from the connection to the backplane rack, not requiring external connections.

4.8.6. Single input without test pulse

Maximum achievable safety level: SIL 3 / Cat.3 PLd

Figure below shows an example of connection of a single input without external test pulses.

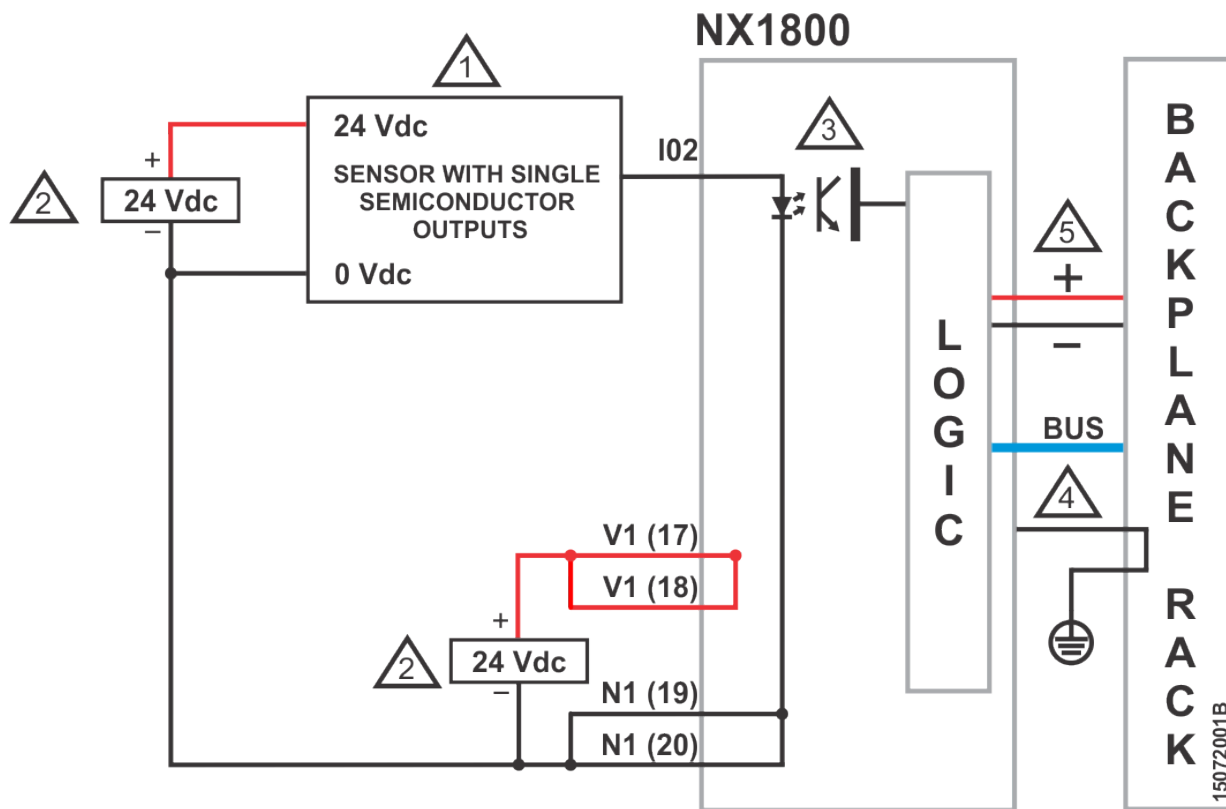


Figure 16: Single input without test pulse

Diagram Notes:

1. Always use appropriate switch depending on your application. External dangerous cross circuits of I02 against the external power supply cannot be detected. Such problems must be avoided routing the input signals with special care (e.g.: separate shielded lines, separate cable ducts, ferrules in wire terminals).
2. External power supply to feed the outputs. V1s are connected to +24 Vdc, and N1s are connected to 0 Vdc. The power supply used must be of SELV/PELV type.
3. Input is only synk type.
4. The module is grounded through the Nexto Series backplane racks.
5. The module power supply is derived from the connection to the backplane rack, not requiring external connections.

4.8.7. Paired inputs without test pulse

Maximum achievable safety level: SIL 3 / Cat.4 PLe

Figure below shows an example of connection of paired inputs without external test pulses.

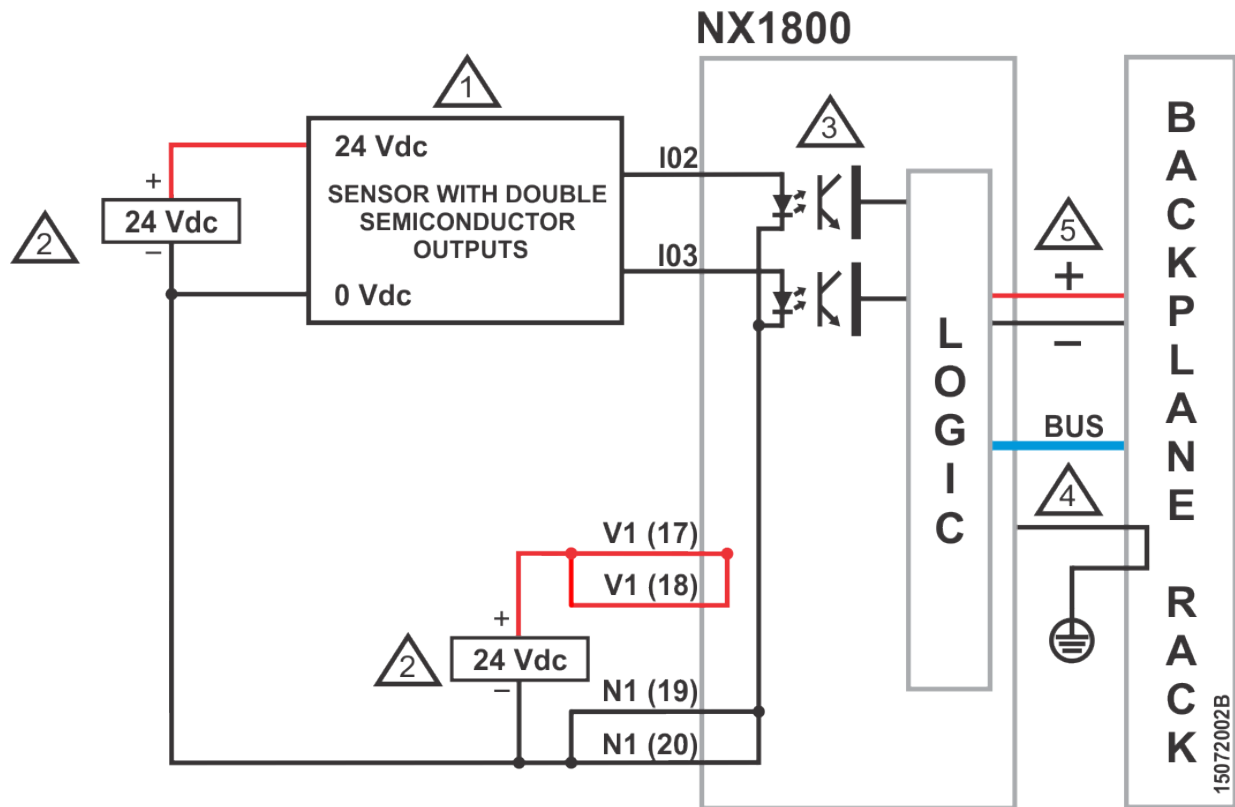


Figure 17: Paired inputs without test pulse

Diagram Notes:

1. Always use appropriate switch depending on your application. External dangerous cross circuits of I02/I03 against the external power supply cannot be detected. Such problems must be avoided routing the input signals with special care (e.g.: separate shielded lines, separate cable ducts, ferrules in wire terminals).
2. External power supply to feed the outputs. V1s are connected to +24 Vdc, and N1s are connected to 0 Vdc. The power supply used must be of SELV/PELV type.
3. Input is only synk type.
4. The module is grounded through the Nexto Series backplane racks.
5. The module power supply is derived from the connection to the backplane rack, not requiring external connections.

5. NX2800 - Nexto Safety Digital Output Module

Nexto Safety Digital Output modules were designed to fulfill all requirements to be used in applications up to SIL3 according IEC 61508 and Category 4 Plc according ISO 13849.

This chapter provides the module technical capabilities and all instructions for a proper operation, parametrization and addressing of the module, allowing to ensure the safety of system where it is used.

5.1. Panels and Connections

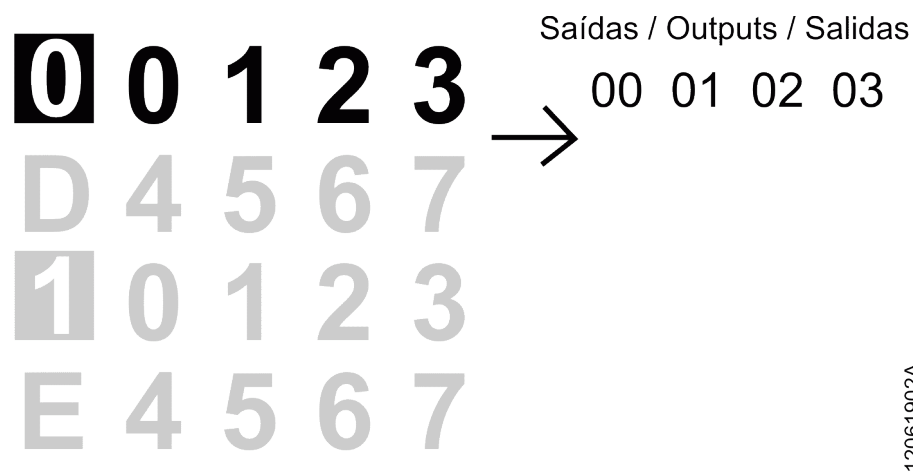
The following figure shows NX2800 front panel.



Figure 18: NX2800 - Nexto Safety Digital Output Module

5.1.1. LCD Display <NSREQ921>

The module have a standard LCD Display found on other I/O modules from Nexto Series. It is used to indicate the state of each digital output channel through symbols 0 to 3 and also to inform diagnostic codes through symbols "D" and "E" (which are described on [Maintenance](#) section).



12061902A

Figure 19: Display of NX2800

5.1.2. Connector Pinout <SRSREQ877>



Figure 20: Connector Pinout

The following table shows the description of each connector terminal:

| Terminal Number | Name | Description |
|-----------------|------|--------------------------------------|
| 1 | Q00+ | Output Q00 (positive) |
| 2 | Q00- | Output Q00 (negative) |
| 3 | NC | |
| 4 | Q01+ | Output Q01 (positive) |
| 5 | Q01- | Output Q01 (negative) |
| 6 | NC | |
| 7 | Q02+ | Output Q02 (positive) |
| 8 | Q02- | Output Q02 (negative) |
| 9 | NC | |
| 10 | Q03+ | Output Q03 (positive) |
| 11 | Q03- | Output Q03 (negative) |
| 12 | NC | |
| 13 | V1 | External power supply input (24 Vdc) |
| 14 | V1 | External power supply input (24 Vdc) |
| 15 | V1 | External power supply input (24 Vdc) |
| 16 | V1 | External power supply input (24 Vdc) |
| 17 | N1 | External power supply input (0 Vdc) |
| 18 | N1 | External power supply input (0 Vdc) |
| 19 | N1 | External power supply input (0 Vdc) |
| 20 | N1 | External power supply input (0 Vdc) |

Table 10: Connector Pinout NX2800

Note:

NC: Internally not connected terminal.

5.2. Physical Dimensions <SRSREQ875>

Nexto User Manual – MU214600 should be consulted for general measurement of installation panel.
Dimensions in mm.

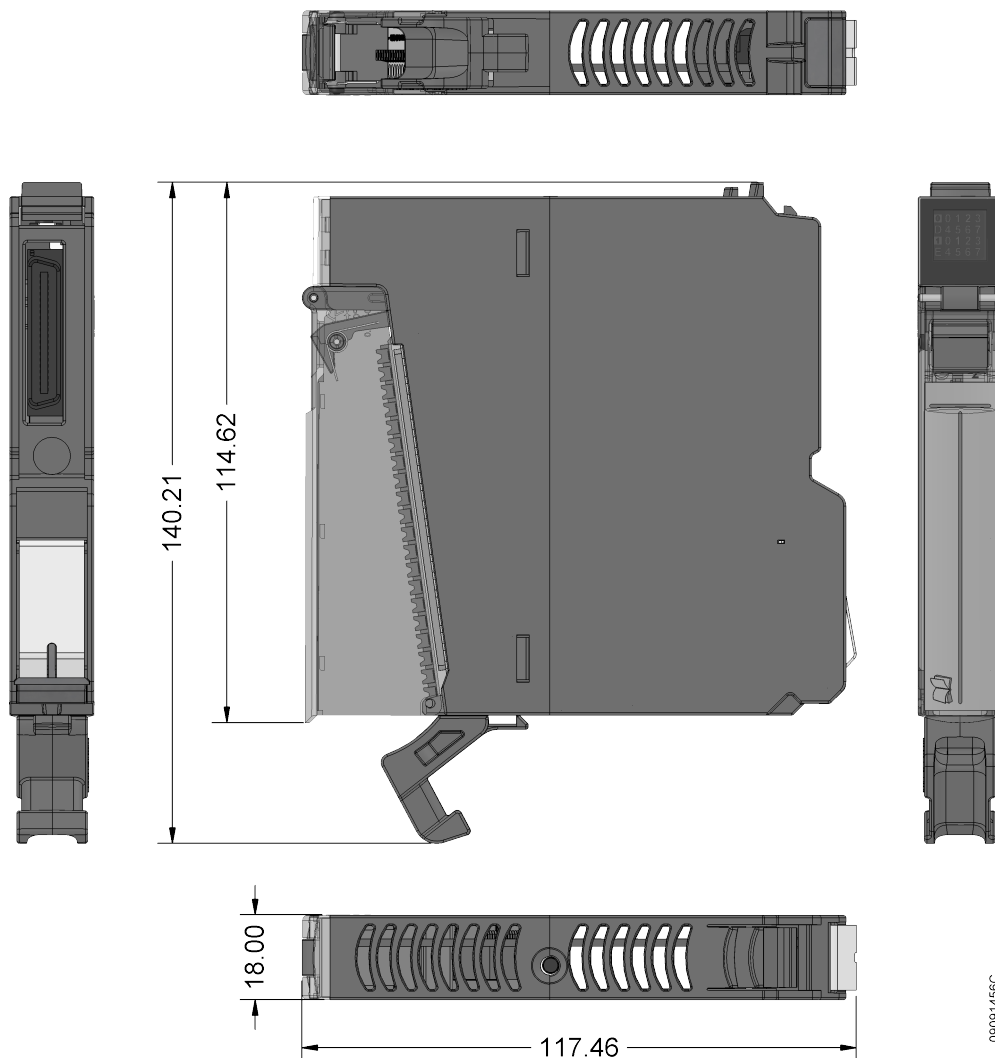




Figure 21: Physical Dimensions

5.3. Technical Data

| | NX2800 |
|---|---|
| Output type | Monitored transistor output source/sink type |
| Backplane rack occupation | 1 slot |
| Safe state | Outputs disabled |
| Number of outputs | 4 |
| Maximum output current | 2 A per channel <SRSREQ890> 6 A total |
| Output voltage range | Defined by the external power supply input <SRSREQ890> |
| Minimum load current | 2 mA <SRSREQ891> |
| Maximum leakage current | 1 mA <SRSREQ892> |
| Output update time (WCDT) | 2 ms <SRSREQ925> |
| External power supply | |
| Voltage range | 18 to 31.2 Vdc <NSREQ896> |
| Consumption | 3W + outputs consumption <NSREQ896> |
| Type | SELV/PELV <SRSREQ905> |
| Cables | 0.5 mm ² (20 AWG), 200 meter maximum <NSREQ949> |
| Configurable parameters | |
| Channel | Yes, disable open load detection |
| PROFIsafe version | V2-mode only (V1-mode is not supported) |
| PROFIsafe address | Configurable, between 1 and 65534 |
| TBUS | 8 ms <NSREQ923> |
| DAT | 2 ms <SRSREQ924> |
| Output state indication | Yes |
| One Touch Diag (OTD) | Yes |
| Module Protection | Yes, protection against polarity reversal at power supply, protection against voltage surge and short circuit, detection and protection against under and overvoltage, protection against overtemperature |
| Channel Protection | Yes, protection against overload, detection of open load and load short circuit |
| Dark pulse duration | 1 ms (approximately) |
| Isolation | |
| Outputs to logic | 1500 Vac / 1 minute |
| Outputs to protective earth  | 1500 Vac / 1 minute |
| Logic to protective earth  | 1500 Vac / 1 minute |
| Current consumption from backplane rack power supply | 200 mA <NSREQ895> |
| IP Level | IP 20 |
| Operation temperature | 0 to 60 °C |
| Storage temperature | -25 to 70 °C |
| Operating and storage relative humidity | 5% to 96%, non-condensing |
| Conformal coating | Yes |
| Classification <SRSREQ927> | |
| IEC 61508 | SIL 3 |
| IEC 62061 | SIL 3 |
| ISO 13849 | PLe Cat. 4 |
| Proof Test Interval (PTI) | 20 years <SRSREQ928> |
| Failure probability | |
| Low demand (PFD _{avg}) | < 5X10 ⁻⁵ (5% of PFD _{avg} max. for SIL 3) <SRSREQ929> |


| | NX2800 |
|---|--|
| High demand (PFH) | $< 5 \times 10^{-9}$ (5% of PFH max. for SIL 3) <SRSREQ930> |
| MTTF_d (Mean Time To Failure dangerous) | High (>30 years) <SRSREQ932> |
| DC_{avg} | Higher than 99% <SRSREQ933> |
| Standards <SRSREQ897> <SRSREQ899> - (Incl. Climatic and Mechanical req.) | IEC 61131-2:2017 IEC 61131-6:2012 IEC 61508:2010 IEC 62061:2005 EN ISO 13849:2012 IEC 61784-3-3:2010 |
| EMC Compliance <SRSREQ898> | IEC 61131-2:2017 Zone B IEC 61131-6:2012 General EMC Environment IEC61326-3-1:2017 IEC61000-6-4:2006+AMD1:2010 CE –2014/35/EU (LVD) and 2014/30/EU (EMC) |
| RoHS directive |  RoHS 2002/95/EC |
| Module dimensions (W x H x D) | 18.00 x 114.62 x 117.46 mm |
| Package dimensions (W x H x D) | 44.00 x 122.00 x 147.00 mm |
| Weight | 100 g |
| Weight with package | 150 g |

Table 11: NX2800 - General Features

Notes:

Safe state: In case of fault detection, NX2800 will disable the outputs. <SRSREQ906>

ATTENTION:
Safety function must consider the safe state of NX2800.

Output update time (WCDT): This is the total update time of an output channel (worst case), which defines the worst case time between receiving a PROFIsafe request and changing the physical state of the digital output.

Configurable Parameters: To check for situations where a short circuit can be present, the NX2800 module periodically tries to turn off the load; first the P side, then the N side and by last, both sides. For high speed actuators which do not support off periods of less than 1 ms, the pulse tests must be disabled. For high impedance loads or not used channels, the open load detection should be disabled. More details at section ??.

In case of fault detection to output switch off: The response time in case of failure to output switch off comprehends the time between the fault detection and the module entering safe mode.

Proof Test Interval (PTI): Period which the module must be replaced so the PFD limits of SIL-3 is not exceeded.

Diagnostic Coverage (DC): Defines internal tests effectiveness considering all possible failure modes.

Conformal Coating: Conformal coating protects the electronic components inside the product from moisture, dust and other harsh elements to electronic circuits.

TBUS and DAT: Delay of remote backplane (TBUS) is the maximum time of communication between PROFIBUS head and safety module. PROFIsafe Device Acknowledgement Time (DAT) is the maximum time between the reception of a PROFIsafe request message and the response of a new PROFIsafe telegram.

ATTENTION:
Both TBUS and DAT do not directly impact in safety response time but must be considered for PROFIsafe watchdog definition which is part of system's response time.

Channel protection: The overload protection is activated when channel output current exceeds 15% (approximately) of the nominal maximum current, and applies only to Q- output. This protection will not actuate on loads connected directly from Q+ to GND. The Q+ output also have an internal overload protection (with its own diagnostic message), but it uses thermal principle (slow) and its activation threshold is much higher and not precise (current around 8A), so it is used only to prevent damage to the module internal circuit.

ATTENTION:

Capacitive loads may cause malfunction of internal fault detection mechanisms and must be avoided.

5.4. Operation

5.4.1. Digital Outputs <SRSREQ900> <NSREQ901> <SRSREQ902> <NSREQ903> <SRSREQ1615> <SRSREQ1239>

Each output of the SDOM is composed by two independent electronic switches which connects the Qxx+ and Qxx- to +24Vdc and to 0V rails respectively (provided by the external power supply). The safe state for a given output is correspondent to value "0" in PROFIsafe request frame from SCPU. Also, the SDOM module puts all outputs in safe state "0" if it hasn't received PROFIsafe request frames from SCPU during a time longer than PROFIsafe watch-dog (F-Parameter F_WD_Time). Additionally, the failure detection mechanisms implemented by this module can also put outputs in safe state. Each output channel has the ability to detect the following faults:

- Short Circuit
- Open Switch
- Overload
- Open load

This is achieved by using internal voltage and current sensors that monitors each output signal, together with a Dark Test pulse mechanism that periodically deactivates the outputs when turned on. There are 3 different pulse types, each one with duration of 1ms, each one performed for each output every 1 minute, taking up to 180s to traverse the 8 switches of the 4 outputs.

Once occurred, the diagnostics of overload, open load, short circuit and open switch will be cleared only after a reset of PROFIsafe communication. This is intended to improve the diagnostic detection for scenarios with intermitent failures.

The Short Circuit verification is aimed to detect improper activation of internal Qxx+ and Qxx switches, or also external short circuits that drives these signals to the power rails. This verification is performed in two conditions:

- When the output Qxx is turned off (logical state 0). In this case, maximum detection time is 100 ms.
- When the output Qxx is turned on (logical state 1). In this case, maximum detection time is 11 minutes.

The Open Switch verification is aimed to detect the non-activation of internal Qxx+ and Qxx switches. After the output is turned on, the module checks for the voltage on each output. The maximum detection time is 100 ms.

The Overload verification protects the outputs against load currents above the maximum values specified for the module. The overload protection is activated immediately when channel output current of Q- output exceeds approximately 15% of the nominal maximum current. Once activated, this protection turns the output off for short time periods reducing the overall current. This protection will not actuate on loads connected directly from Q+ to GND. Additionally, the Q+ output also have an internal overload protection (with its own diagnostic message), but it uses thermal principle (slow) and its activation threshold is much higher and not precise (current around 8A), so it is used only to prevent damage to the module internal circuit.

The Open Load verification is aimed to detect the absence of load on the digital output. This verification can only be detected when the actuator is connected to Qxx+ pin, otherwise it must be disabled on module configuration to avoid spurious detection. The internal mechanism can take up to 12 minutes to detect an Open Load condition.

5.4.2. External Power Supply <SRSREQ904> <SRSREQ905>

The external power supply must comply with SELV/PELV specification, which ensures that the output voltage will not exceed 60Vdc in case of failure and guarantees the safe state of SDOM outputs in this situation.

The SDOM checks if the voltage of external 24 V power supply is above the minimum value defined on Technical Data table. If the voltage is below the minimum specified, the module puts all outputs to safe state, indicates the respective diagnostic and reports a Device_Fault diagnostic on PROFIsafe communication.

5.5. Safety Response Times

| | NX2800 |
|--|--------|
| WCDT – Worst Case Delay Time <SRSREQ925> | 2 ms |
| OFDT – One Fault Delay Time <SRSREQ926> | 2 ms |

Table 12: NX2800 - Safety Response Times

Notes:

WCDT – Worst Case Delay Time: maximum delay between a demand (change output logical value received in a PROFIsafe telegram) and the deactivation of the respective output. This parameter does not consider the presence of any fault in the module.

OFDT – One Fault Delay Time: maximum delay between a demand (change output logical value received in a PROFIsafe telegram) and the deactivation of the respective output. This parameter considers the presence of one external or internal fault in the module.

5.6. Compatibility with other Products <NSREQ3572>

The following product can be used with this product:

| | Software version | Product revision |
|---------------|-------------------|------------------|
| MT8800 | 1.00 or higher | AA or higher |
| MT8500 | 3.03 or higher | AY or higher |
| NX5110 | 1.1.2.3 or higher | AK or higher |

Table 13: Compatibility with Other Products

ATTENTION:

Only certified PROFIBUS Head modules shall be used with SDOM modules. <SRSREQ1237>

5.7. Compatibility with Actuators <SRSREQ894><SRSREQ950> <SRSREQ951>

The actuators must comply with the electrical characteristics described on [Technical Data](#) table (rated voltage, maximum current, minimum load current, and leakage current, cables, etc...). Actuators may be resistive, capacitive or inductive loads. Lamps also may be connected to SDOM outputs.

ATTENTION:

Inductive loads must have conformance to IEC 60947-5-1, DC13. For higher inductive loads, an external diode or RC circuit must be used. Varistor based protection devices MUST NOT be used.

Capacitive loads may cause malfunction of internal fault detection mechanisms and must be avoided.

The actuator must tolerate dark test pulses with 1 ms duration. If the actuator response time is faster than 1ms, it might interpret the test pulse as the output being turned off and false trips might occur.

5.8. Connection Diagrams <SRSREQ953>

This section lists possible wiring with actuators and the maximum SIL achievable in each configuration.

5.8.1. Control of two contactors using two outputs

Maximum achievable safety level: SIL 3 / Cat.4 PLe

The following figure shows the electrical diagram of using two contactors using two outputs.

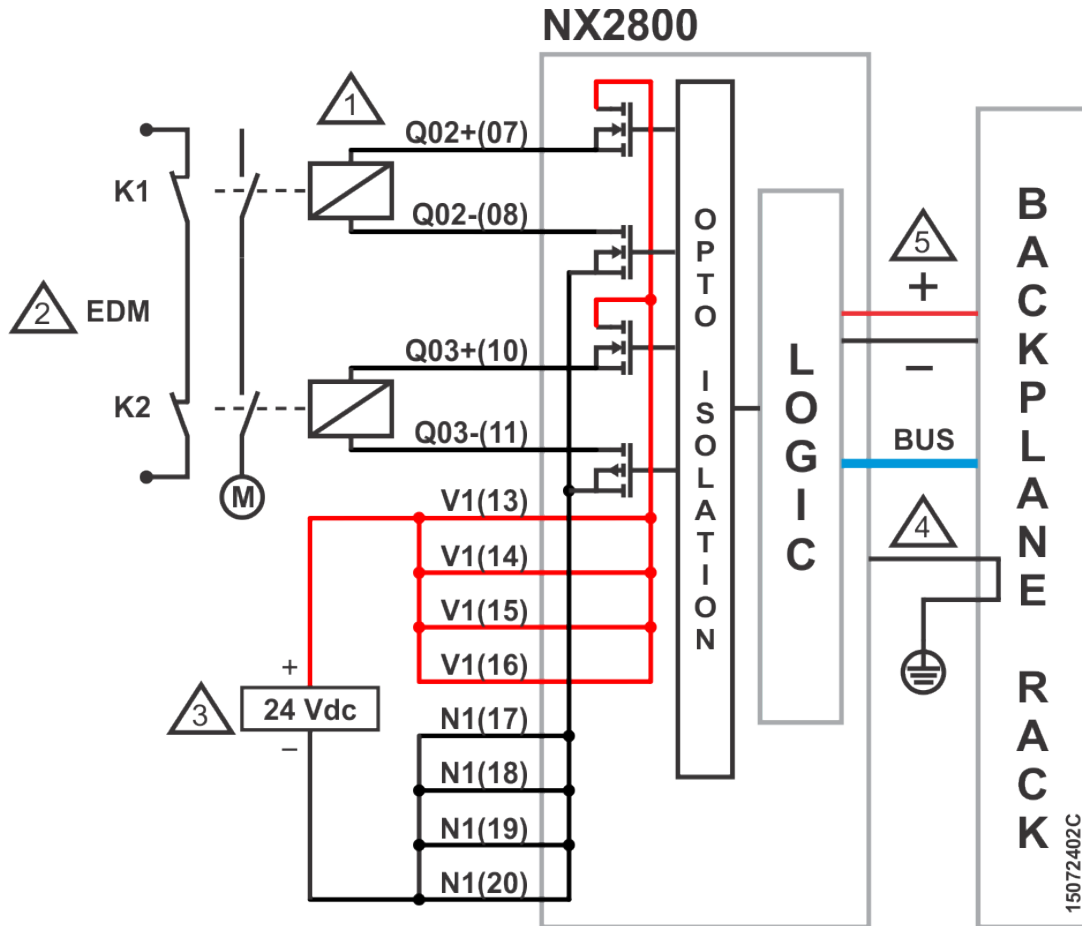


Figure 22: Control of two contactors using two outputs

Diagram Notes:

1. Typical sink-source output configuration.
2. Electronic Device Monitoring (relay states must be monitored by digital inputs in auxiliary contacts or other means).
3. External power supply to feed the outputs. V1 connected to +24 Vdc, and N1 connected to 0 Vdc. All V1 and N1 connections must be used. The power supply used must be of SELV/PELV type.
4. The module is grounded through the Nexto Series backplane racks.
5. The module power supply is derived from the connection to the backplane rack, not requiring external connections.

5.8.2. Control of two contactors using one output

Maximum achievable safety level: SIL 3 / Cat.4 PLe

The following figure shows the electrical diagram of using two contactors using one output.

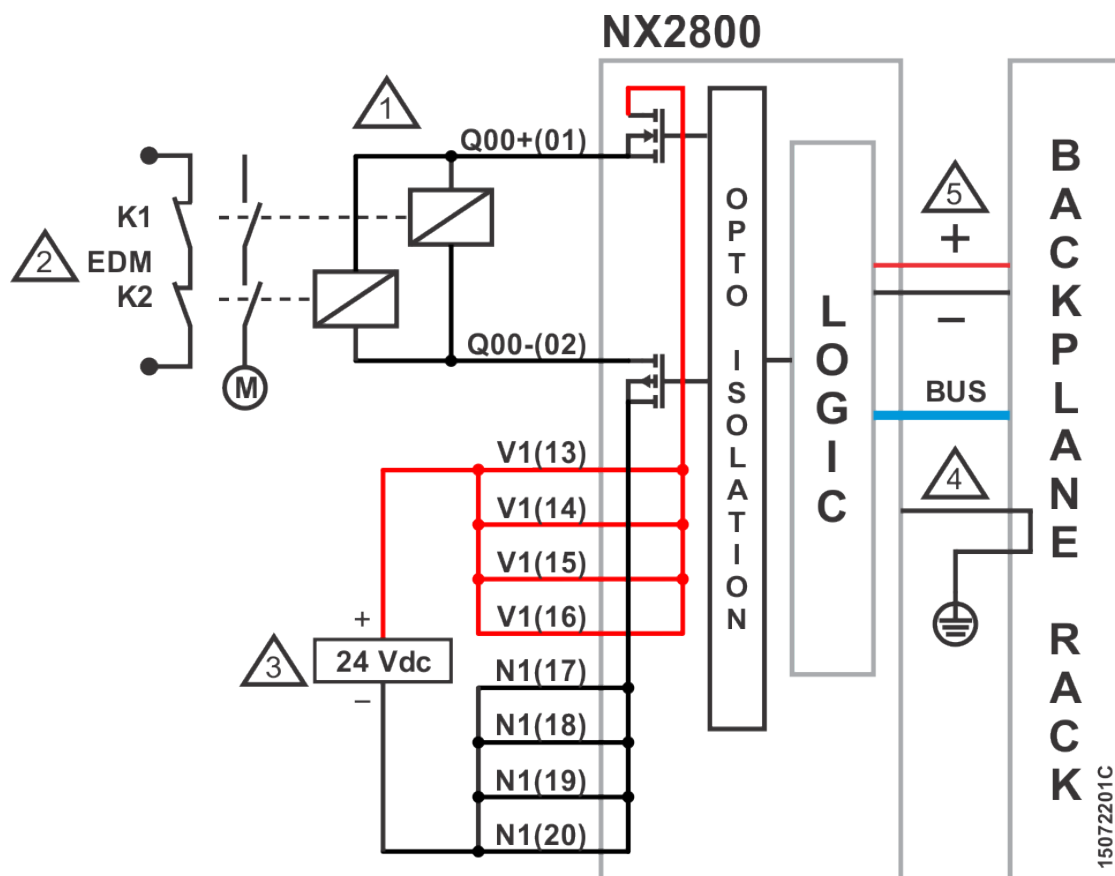


Figure 23: Control of two contactors using one output

Diagram Notes:

1. Typical sink-source output configuration.
2. Electronic Device Monitoring (relay states must be monitored by digital inputs in auxiliary contacts or other means).
3. External power supply to feed the outputs. V1 connected to +24 Vdc, and N1 connected to 0 Vdc. All V1 and N1 connections must be used. The power supply used must be of SELV/PELV type.
4. The module is grounded through the Nexto Series backplane racks.
5. The module power supply is derived from the connection to the backplane rack, not requiring external connections.

5.8.3. Control of two contactors using one output

Maximum achievable safety level: SIL 3 / Cat.4 PLe

The following figure shows the electrical diagram of using two contactors using one output.

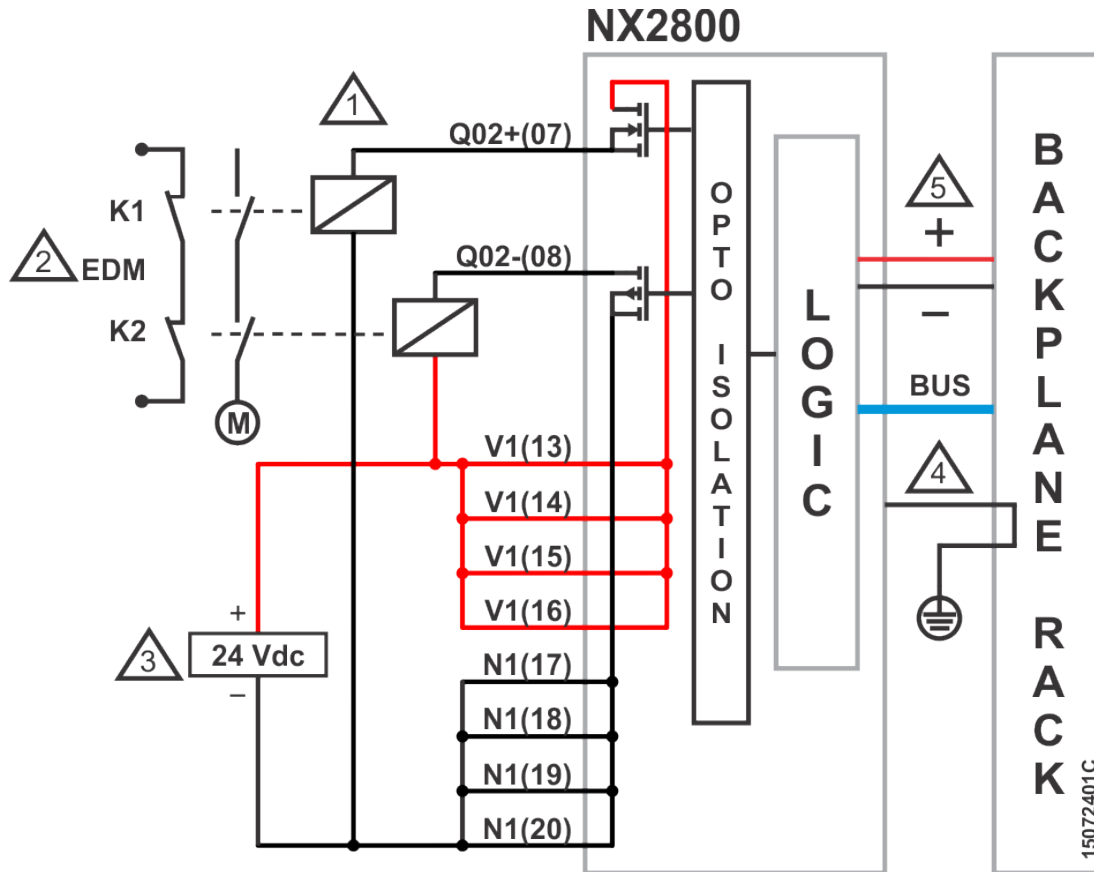


Figure 24: Control of two contactors using one output

Diagram Notes:

1. Typical sink-source output configuration.
Cables must be routed to avoid short circuit between Q+ and Q-, otherwise SDOM cannot switch off the actuator. Such problem must be avoided routing the output signals with special care (e.g.: separate shielded lines, separate cable ducts, ferrules in wire terminals).
2. Electronic Device Monitoring (relay states must be monitored by digital inputs in auxiliary contacts or other means).
3. External power supply to feed the outputs. V1 connected to +24 Vdc, and N1 connected to 0 Vdc. All V1 and N1 connections must be used. The power supply used must be of SELV/PELV type.
4. The module is grounded through the Nexto Series backplane racks.
5. The module power supply is derived from the connection to the backplane rack, not requiring external connections.

5.8.4. Control of two contactors using two outputs

Maximum achievable safety level: SIL 3 / Cat.4 PLe

The following figure shows the electrical diagram of using two contactors using two outputs.

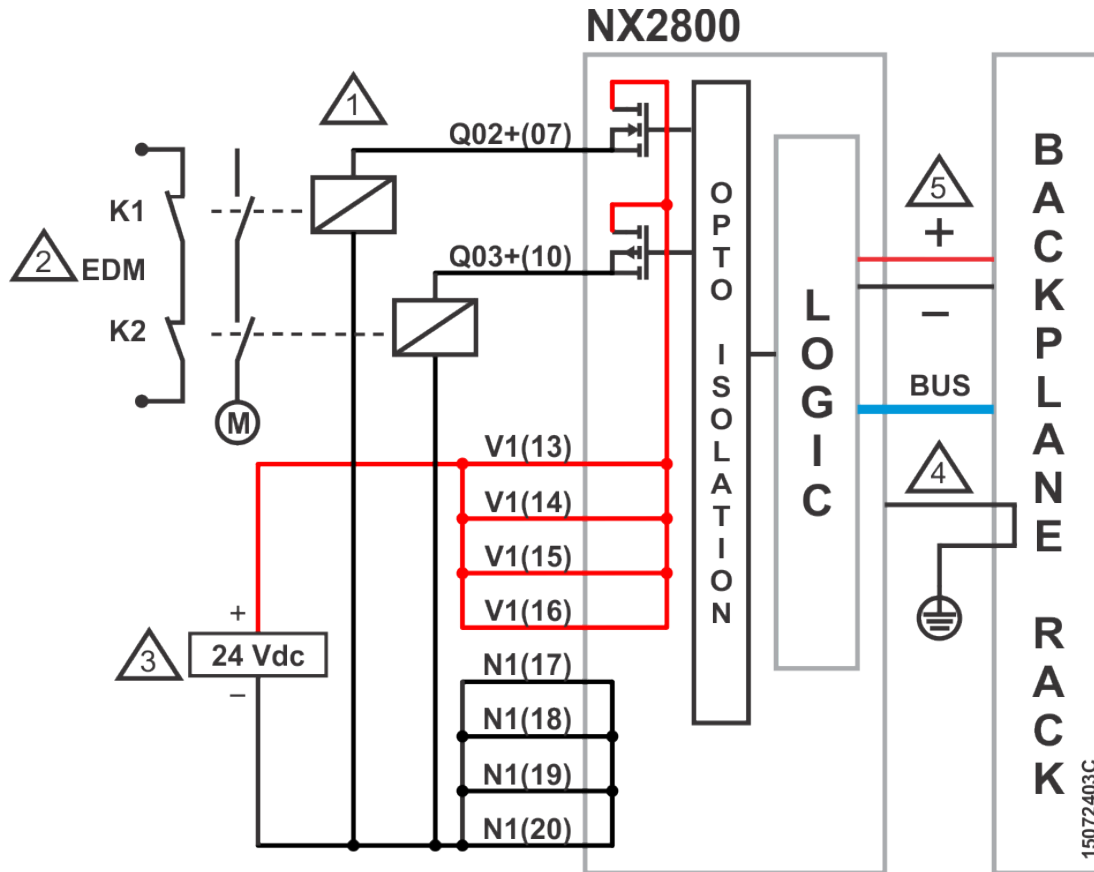


Figure 25: Control of two contactors using two outputs

Diagram Notes:

1. Typical sink-source output configuration.
Cables must be routed to avoid short circuit between outputs and +24 Vdc, otherwise SDOM cannot switch off the actuator. Such problem must be avoided routing the output signals with special care (e.g.: separate shielded lines, separate cable ducts, ferrules in wire terminals).
2. Electronic Device Monitoring (relay states must be monitored by digital inputs in auxiliary contacts or other means).
3. External power supply to feed the outputs. V1 connected to +24 Vdc, and N1 connected to 0 Vdc. All V1 and N1 connections must be used. The power supply used must be of SELV/PELV type.
4. The module is grounded through the Nexto Series backplane racks.
5. The module power supply is derived from the connection to the backplane rack, not requiring external connections.

6. Configuration

This chapter explains how to proceed in order to create a safety application on NX3810, using NX1800 (safety digital input module) and NX2800 (safety digital output module). It's advised to use the reading of the technical characteristics documents and specific manuals, to allow the series devices in all its flexibility and to ensure its safe usage.

Focusing on ensure that the safety application will not be affected by modifications on the standard application; Altus developed Mastertool Safety as an independent programming tool. Due to this, it's advised to use MasterTool IEC XE and Mastertool Safety for development of safety applications.

The safety application will be created in Mastertool Safety. Once it is finished, the engineer encharged of the standard application will import it on Mastertool IEC XE.

6.1. Configuring SDIM/SDOM PROFIsafe address <SRSREQ606> <SRSREQ882>

Every F-Device has its own PROFIsafe address. On Nexto SDIM/SDOM, the address is set and visualized using OTD button and LCD visor, and its stored on the module's internal non-volatile memory.

The module has basically two operating modes: the Normal Operating Mode (NOM) and the Address Programming Mode (APM), which is activated by powering on the module with the OTD button pressed at the same time. <SRSREQ2554> <NSREQ2555> <SRSREQ3567> <NSREQ3568>

To enter in the address edition mode, it is necessary to detach the module from the backplane (or power off the whole backplane) and reattach (or reenergize) it, holding the OTD-Button for 2 seconds after the module is powered on by the backplane. Once the module enters address edition mode, D and E segments turn on and 0 and 1 segments turn off, as shown below.

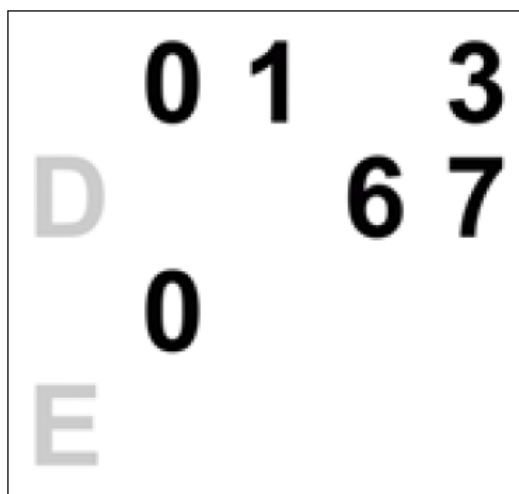


Figure 26: PROFIsafe address

The top-most octet corresponds to the address bits 0 to 7. The bottom octet corresponds to the address bits 8-15. On the example shown above, the address shown is 000 0001 1100 1011 in binary, which corresponds to 459 in decimal.

By short pressing the OTD button (pressing for less than one second) segment 0 starts blinking. Every short press allows the user to jump to the next segment/bit. Every long press switches the bit value. Once the most-significant segment/bit is reached, another short press will store the address and segment 0 will start blinking again.

ATTENTION:

Once address edition mode is activated, the module does not operate, e.g. PROFIsafe communication is deactivated and firmware does not accept any PROFIsafe parametrization. This mode is intended only to verify, set or change the PROFIsafe address.

WARNING:

Before starting PROFIsafe address edition, certify that the safety PLC is not running.

6.2. Configuration Steps <SRSREQ648> <SRSREQ649> <SRSREQ919> <SRSREQ920>

The configuration is performed using the standard Programming System (called MasterTool IEC XE, MT8500) for the i-Parameters and the Safety Programming System (called MasterTool Safety, MT8800), which is used specifically for safe edition of F-Parameters and development of safety application.

Nexto Safety CPU and Safety I/O modules can be used with third-party systems that have PROFIBUS DP network and PROFIsafe V2-mode (V1-mode is not supported). The configuration procedure for these cases are described further on this section. <SRSREQ116> <SRSREQ668> <SRSREQ939>

The basic steps for setting-up a Nexto Safety system are:

6.2.1. STEP 1 – Start a new Safety Project

Launch Mastertool Safety and start a new project (*CTRL+N*). Choose a name for the project.

Then it is necessary to choose the Nexto CPU which will be NX3810's master. This example will use a NX3030.

6.2.2. STEP 2 - Add a PROFIBUS DP slave

At the left-hand side, should appear a tree containing the chosen standard CPU, NX5001 and NX3810 modules, if not, press *ALT+0*. Locate the NX5001 (PROFIBUS DP Master Module), right click over it then click in *Add Device...*

To add a PROFIBUS DP slave, NX5110 for instance. Click on NX5110 and then in *Add Device...* button.

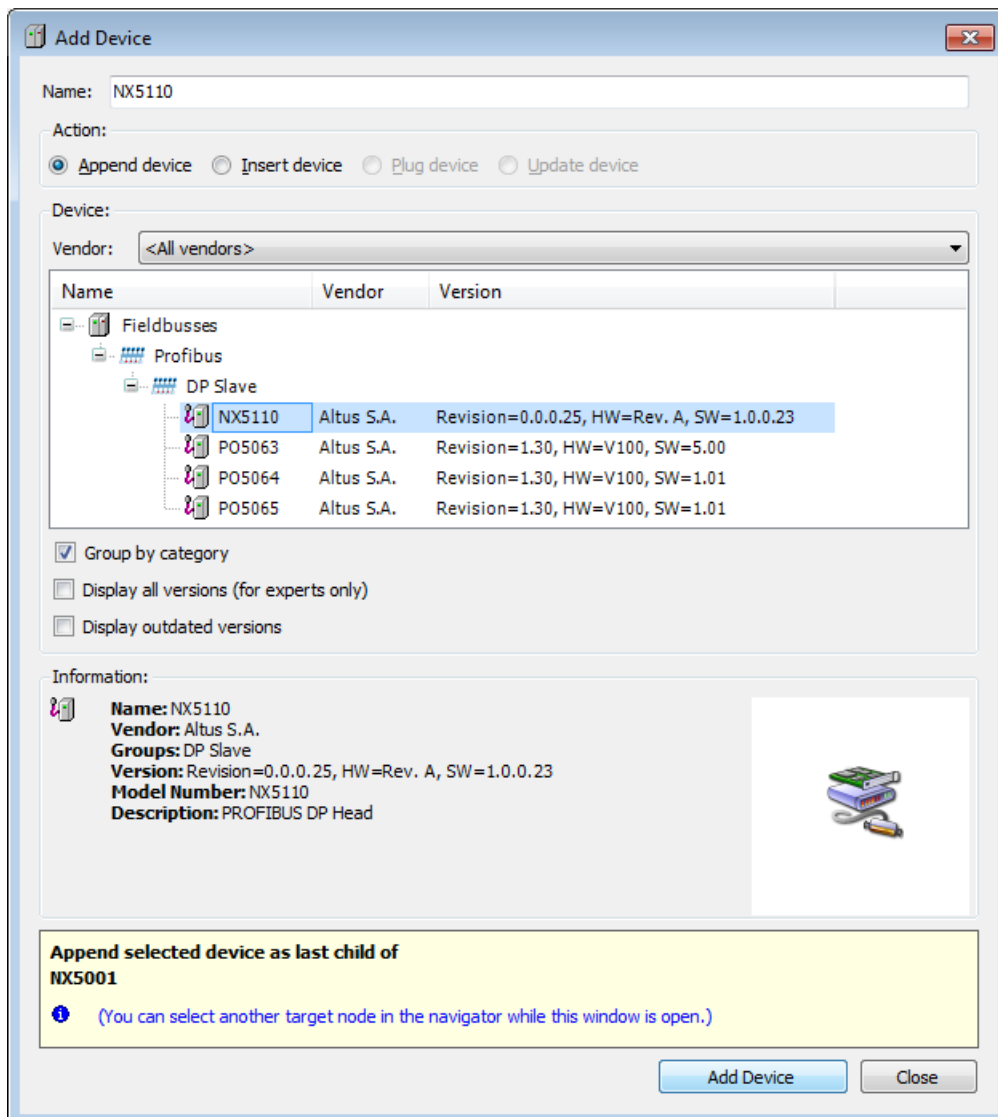


Figure 27: Adding PROFIBUS Slave

6.2.3. STEP 3 – Add Safety I/Os

By clicking on NX5110 added in project tree the *Add Device* window will change, showing the attachable devices. Open *F-Modules*, select *NX1800* and click the *Add Device* button.

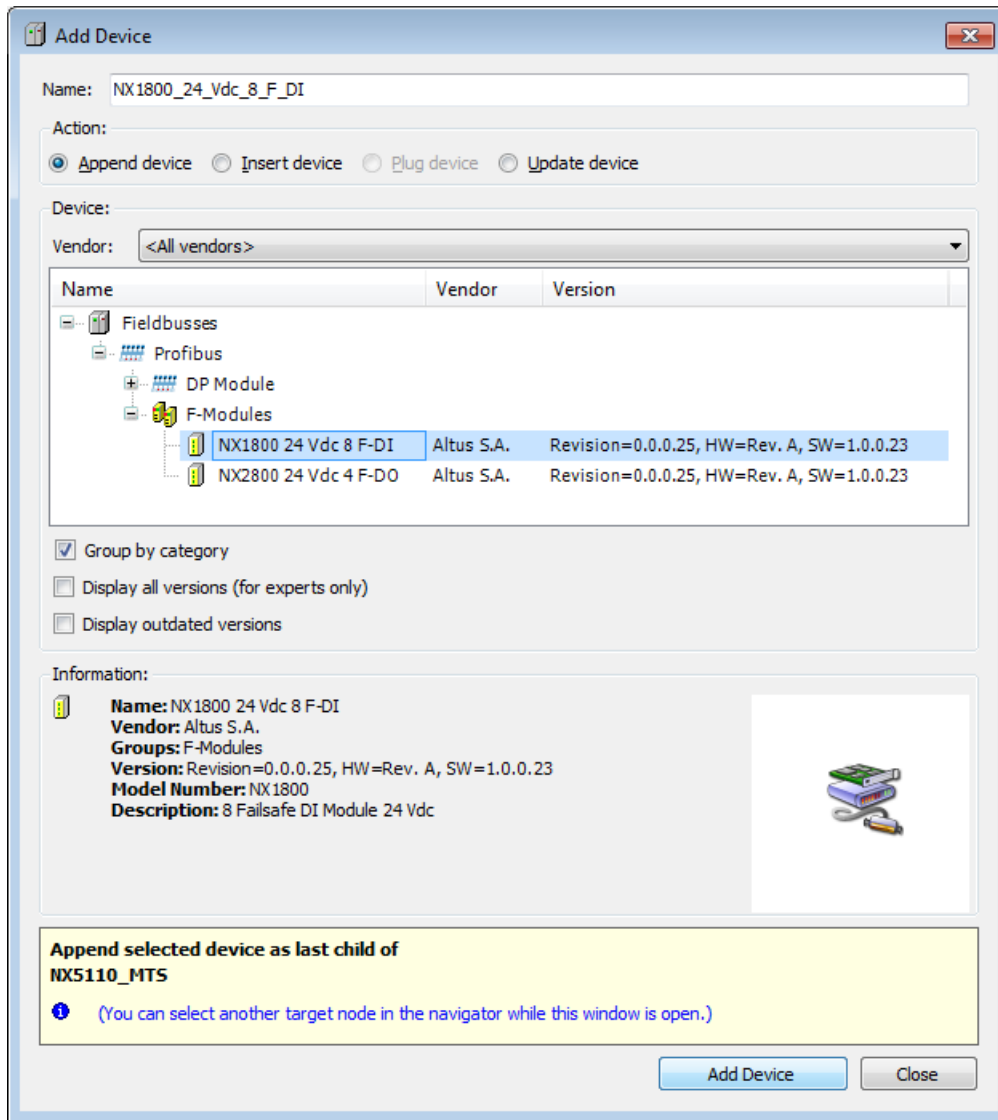


Figure 28: Adding safety I/Os

Repeat the process to add *NX2800* and then close the *Add Device* window.

6.2.4. STEP 4 – Safety I/Os Configuration

Notice that during the step 3, on the device tree, under *SafetyApp - Logical I/Os*, two modules were attached. There it is possible to find all the safety parametrization of the PROFIsafe slaves. Check the PROFIsafe destination address and the desired watchdog of all devices. This example assigns PROFIsafe address 2 for NX1800 and 3 for NX2800.

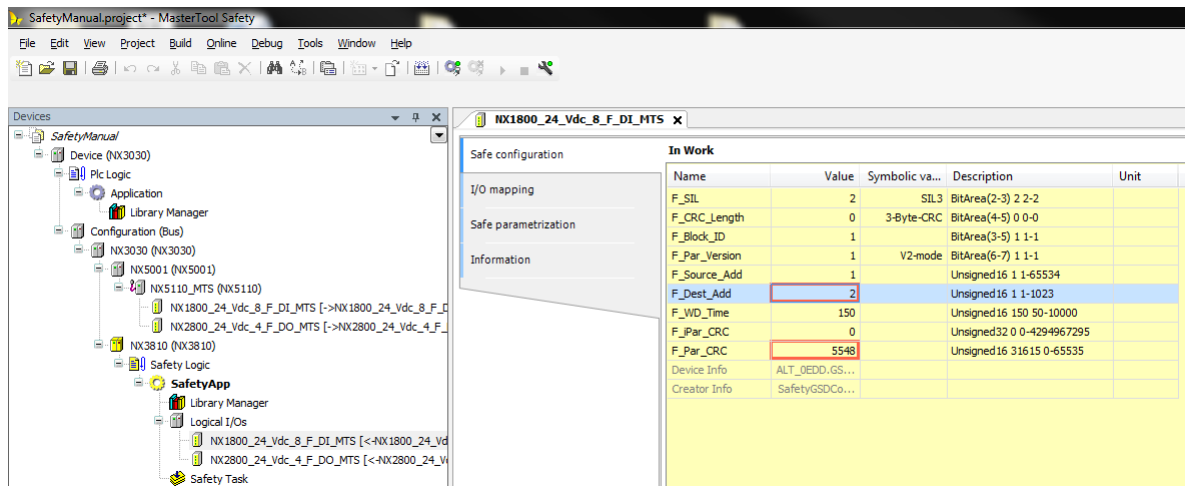


Figure 29: Configuration of NX1800

Under the tab *Safety parametrization*, it is possible to configure module-specific parameters, e.g. use of test pulses, dark pulses, enable/disable inputs/outputs. For every change made on the safety parameters, a new *iParCRC* (*L_Par_CRC32* field) is calculated. Once finished the parametrization, it is necessary to copy the *L_Par_CRC32* to the *F_iPar_CRC* field in the *Safe configuration* tab. If this step is not executed, the module will detect CRC mismatch and will not operate, indicating the appropriate diagnostic.

Disable all unused inputs and outputs. On the disabled I/Os, disable also its diagnostics (external test pulses in case of digital inputs module, dark pulses and overload detection in case of digital output modules).

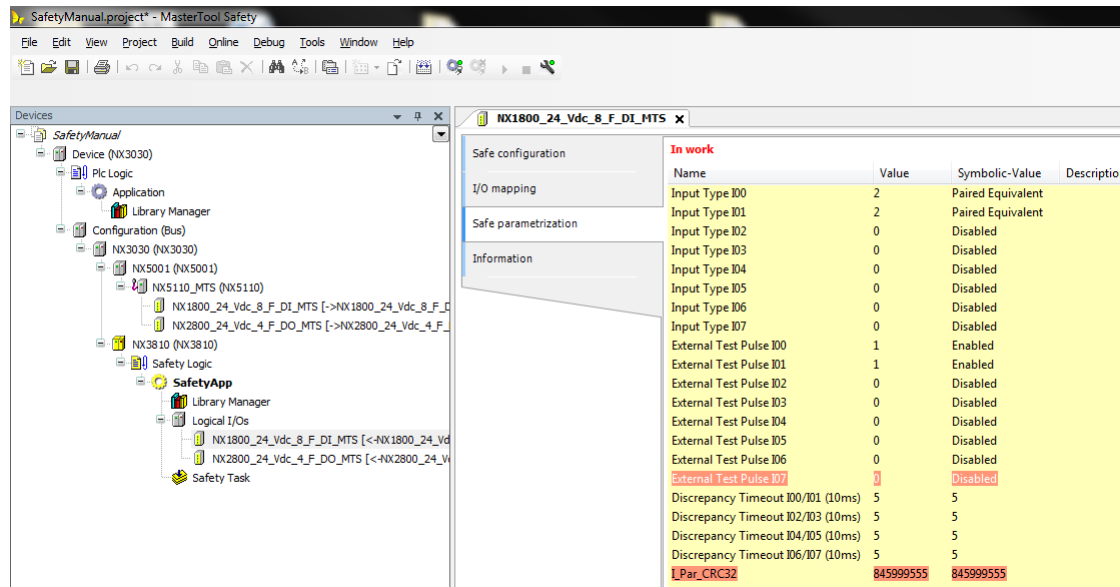


Figure 30: Parametrization of NX1800

In the tab *I/O mapping*, it is possible to assign global tags to the inputs and outputs for later use in the safety POU. This example uses *I0_0* and *Q0_0* for *I0*, *I1* (when using equivalent or antivalent option, only must use the even input) and *Q0*, respectively.

| Variable | Chan... | Type | Unit | Comment | Description |
|----------|---------|---------|------|---------|-------------|
| IO_0 | Input | SAFE... | | | |
| ... | ... | ... | | | |
| ... | ... | ... | | | |
| ... | ... | ... | | | |
| ... | ... | ... | | | |
| ... | ... | ... | | | |
| ... | ... | ... | | | |
| ... | ... | ... | | | |

| Variable | Chan... | Type | Unit | Comment | Description |
|----------|---------|---------|------|---------|-------------|
| Q0_0 | Output | SAFE... | | | |
| ... | ... | ... | | | |
| ... | ... | ... | | | |
| ... | ... | ... | | | |
| ... | ... | ... | | | |
| ... | ... | ... | | | |
| ... | ... | ... | | | |
| ... | ... | ... | | | |

Figure 31: I/O mapping of NX1800 and NX2800

6.2.5. STEP 5 – Create the safety logic

Once the modules are configured, it is possible to start creating the logic. In *Devices* window, right-click on *SafetyApp* and then click on *Add Object* and then on *Basic POU Safety*. A configuration window will pop, click on *Add button* to create the *POU*.

With the *POU* created, a new menu *Safety-FBD* will appear on menu bar. Use it to add new networks or add new operators (boxes). When finished, it is necessary to build it. This example just shows an emergency stop button with two *NC* contacts, connected to *I0* and *I1*, which act over a relay, connected to *Q0*. In order to monitor the actual status of the safety digital I/Os, on the first two networks were used the so-called block *ProfisafeHost*, one assigned to NX1800 and the other to NX2800. The third network shows *I0* and *I1* (equivalent, represented by *IO_0*) connected to *Q0* and consequently the relay.

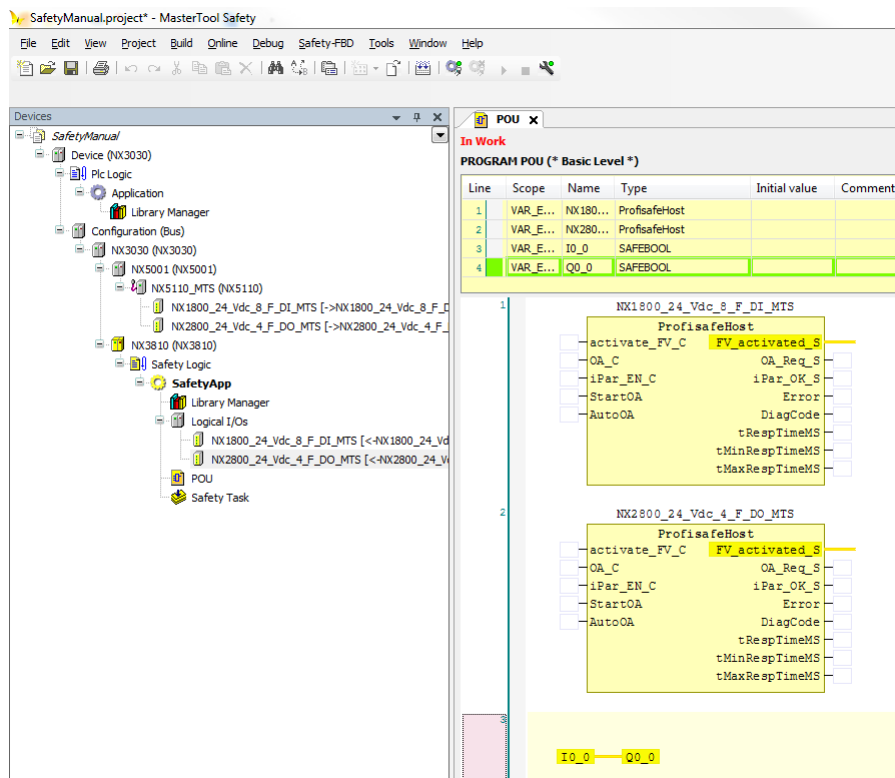


Figure 32: Safety logic example

After finished editing the logic, press *F11* to generate the code (or access it via menu bar).

Check the message window to see if there are errors or warnings. If none were found, its possible to proceed with connection setup. In *Devices* window, double click on *Device* (NX3030) and set the connection to the standard CPU. More information about it can be found in User's Manual of the standard CPU (MU214605 in case of NX3030).

6.2.6. STEP 6 – Import the Safety Project to a Mastertool IEC XE project

Save the current safety project (*CTRL+S*) and open Mastertool IEC XE. Start a new project with the desired configuration. More information about how to setup a Mastertool IEC XE project is found in Nexto Series User Manual (MU214600).

On menu bar, click on *Project* then in *Import Safety Project...*

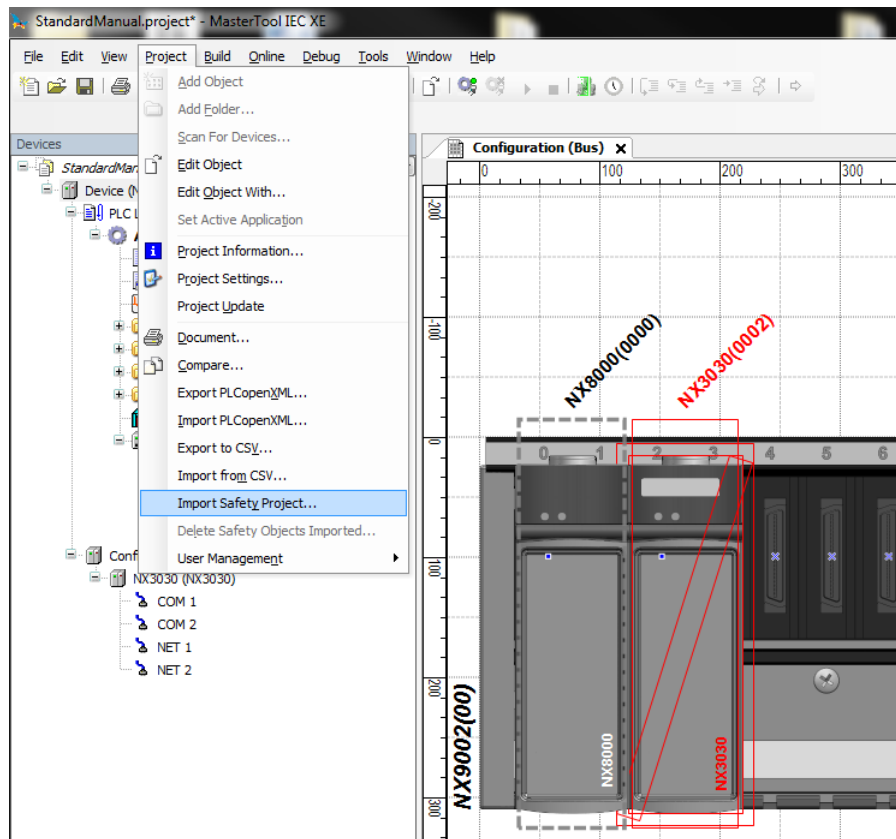




Figure 33: Importing safety project to Mastertool IEC XE

Mastertool IEC XE will import the whole configuration of the safety devices. Now it is necessary to set the connection to the standard CPU and upload the project to it. Click on the  button to upload the application and go online with the standard CPU. Save the project on Mastertool IEC XE (*CTRL+S*) and switch back to Mastertool Safety.

6.2.7. STEP 7 – Upload the Safety Application to NX3810

On Mastertool Safety, click on the  button to upload the application, inform the instance identification (serial number of the NX3810) and go online with the safety CPU. Check the behavior of the safety application. If all is working as expected, proceed creating the boot application: On menu bar, click on *Online*; then click on *Create boot application*.

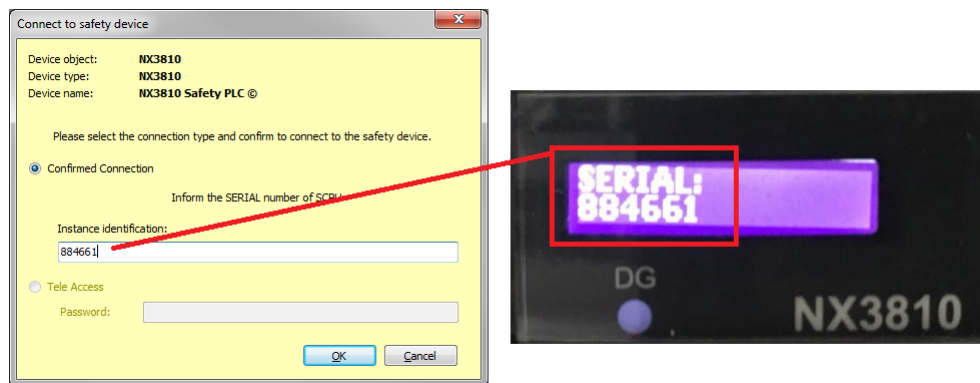


Figure 34: Instance identification

To check if the boot application was successfully loaded, on *Devices* window, double-click on *NX3810* (NX3810). On the new window opened at the right side, click in *Refresh* button. The information about the current boot application will be refreshed.

6.3. SDIM Configuration <SRSREQ645> <SRSREQ646>

The configuration of module parameters must be done inside MasterTool Safety or in a third party configuration tool. There are two groups of parameters: safe configuration and safe parameterization.

The list of safe configuration parameters is described below:

| Name | Description | Options | Standard value |
|---------------|--|--------------------------------|----------------|
| F_SIL | Sets the highest SIL required by application using this module. This parameter is fixed at SIL 3 for this module (value 2). | 2 = SIL3 | 2 |
| F_CRC_Lenght | Sets the CRC2 signature length. The length must be 3 bytes in PROFIsafe V2-mode for this module (value 0). | 0 = 3 bytes CRC | 0 |
| F_Block_ID | Sets which optional parameters are used in the F Parameters block. In this module, option "F_iPar_CRC, no F_WD_Time_2" must be selected for PROFIsafe V2-mode (value 1). | 1 = F_iPar_CRC, no F_WD_Time_2 | 1 |
| F_Par_Version | Sets the version of the F Parameters. In this module, PROFIsafe V2-mode must be selected (value 1). | 1 = V2 mode | 1 |
| F_Source_Add | Sets the PROFIsafe address of SCPU. | 1 – 65534 | 1 |
| F_Dest_Add | Sets the PROFIsafe address of SDIM. This address must match with the PROFIsafe address configured in the SDIM in non volatile memory. | 1 – 65534 | 1 |
| F_WD_Time | Sets the watchdog time for PROFIsafe communication. | 50 – 10000 [ms] | 150 |
| F_iPar_CRC | Sets the CRC for iParameters. | 0 – 4294967295 | 0 |
| F_Par_CRC | Sets the CRC for F Parameters. | 0 – 65535 | 31615 |

Table 14: SDIM safe configuration parameters

The list of safe parameterization parameters is described below:

| Name | Description | Options | Standard value |
|---|---|--|----------------|
| Input Type I [00..07] | Sets the input type | Disabled Single Input Paired Equivalent Paired Antivalent | Single Input |
| External Test Pulse I [00..07] | Enables or disables external test pulse | Disabled Enabled Shared | Enabled |
| Discrepancy Timeout I [0/1; 2/3; 4/5 or 6/7] (10ms) | Sets the discrepancy timeout of an input pair. The value is multiplied by 10 ms | 0 – 255 (0 to 2550 ms) | 5 (50 ms) |

Table 15: SDIM safe parameterization parameters

Notes:

Input Type I [00..07]: When using antivalent input a change of state in the input signal must occur in at maximum 8 hours period. Otherwise, must be considered the OFDT of single inputs due to Category 4 characteristic.

External Test Pulse I [00..07]: When configured as Enabled, the sensor equipment must be supplied by one of the two test pulse outputs T0 or T1. Sensors connected to I00, I02, I04 and I06 must be supplied by T0 while sensors connected to I01, I03, I05 and I07 must be supplied by T1.

The option Shared is valid only for paired inputs. In this case, T0 must be used.

Discrepancy Timeout I [0/1; 2/3; 4/5 or 6/7] (10ms): This field determines the maximum allowable time which the input paired can be in discrepancy state. Discrepancy state is the situation which each input is indicating a different value. In case of antivalent pair, discrepancy state is the situation which both inputs are indicating the same value. The effective timeout value will be up to 14ms higher for connections using external test pulses, and up to 8ms higher for connections with no test pulses.

When the module detects discrepancy state, it immediately considers the respective input pair in safe state. It only back to normal operation when both inputs read the safe value.

6.4. SDOM Configuration <SRSREQ916> <SRSREQ917>

configuration tool. There are two groups of parameters: safe configuration and safe parameterization.

The list of safe configuration parameters is described below:

| Name | Description | Options | Standard value |
|---------------|--|--------------------------------|----------------|
| F_SIL | Sets the highest SIL required by application using this module. This parameter is fixed at SIL 3 for this module (value 2). | 2 = SIL3 | 2 |
| F_CRC_Lenght | Sets the CRC2 signature length. The length must be 3 bytes in PROFIsafe V2-mode for this module (value 0). | 0 = 3 bytes CRC | 0 |
| F_Block_ID | Sets which optional parameters are used in the F Parameters block. In this module, option “F_iPar_CRC, no F_WD_Time_2” must be selected for PROFIsafe V2-mode (value 1). | 1 = F_iPar_CRC, no F_WD_Time_2 | 1 |
| F_Par_Version | Sets the version of the F Parameters. In this module, PROFIsafe V2-mode must be selected (value 1). | 1 = V2 mode | 1 |

| Name | Description | Options | Standard value |
|--------------|---|-----------------|----------------|
| F_Source_Add | Sets the PROFIsafe address of SCPU. | 1 – 65534 | 1 |
| F_Dest_Add | Sets the PROFIsafe address of SDOM. This address must match with the PROFIsafe address configured in the SDOM in non volatile memory. | 1 – 65534 | 1 |
| F_WD_Time | Sets the watchdog time for PROFIsafe communication. | 50 – 10000 [ms] | 150 |
| F_iPar_CRC | Sets the CRC for iParameters. | 0 – 4294967295 | 0 |
| F_Par_CRC | Sets the CRC for F Parameters. | 0 – 65535 | 31615 |

Table 16: SDOM safe configuration parameters

The list of safe parameterization parameters is described below:

| Name | Description | Options | Standard value |
|--------------------------------|---|---------------------|----------------|
| Open Load Detection Q [00..03] | Enables or disables open load detection per channel | Disabled Enabled | Disabled |

Table 17: SDOM safe parameterization parameters

Note:

Open Load Detection Q [00..03]: Open load detection requires dark test pulse, of the respective output, enabled.

6.5. Using Nexto SCPU with Third-party Safety I/O

The NX3810 Module is designed to be a master device on a PROFIsafe network. As a PROFIsafe master device, NX3810 is able to communicate and process data with any PROFIsafe device, even third-party devices.

The integration is easily done with MasterTool Safety. First of all, it is necessary to import the third-party modules global description file to MasterTool Safety. Once imported, the user can place the module inside the safety project as any other Altus safety modules (please refer to chapter 0). After place the module inside the project, user must insert manually its *iParCRC* according the desired configuration of each third-party module loaded into the project.

WARNING:

When using third-party modules, it is necessary to follow their safety manuals, consider their response times to calculate the PLC reaction time and all other safety parameters in order to ensure the safety of the system.

For systems using the complete Safety solution from Altus, i.e. NX3810 connected to NX1800 and NX2800 modules, the iParameters CRC are calculated automatically by MasterTool Safety.

6.6. Using Nexto SDIM with Third-party Safety CPUs

PROFIsafe devices are configured via *F-Parameters*, which allows to configure which and how diagnostics are used. This configuration is ensured by a 16-bit CRC, called *F_Par_CRC*. To use Nexto Safety Digital Input Module in an existing PLC with third-party safety CPUs, it is required a computer with MasterTool Safety installed on it. On the programming tool, it is possible to calculate the correct CRC for the *F-Parameters*.

To proceed with the configuration, follow the steps 1 and 2 of the [Configuration](#) section to create a new project with a PROFIBUS slave module. Then proceed as follows:

- Append a new SDIM Module to the Project. By right-clicking on *NX5110* and selecting *Add Device*, the window below will appear. Select the *NX1800* module and then click in *Add Device* button (at the bottom-right side of the window). The module will be added and the *Add Device* window can be closed.

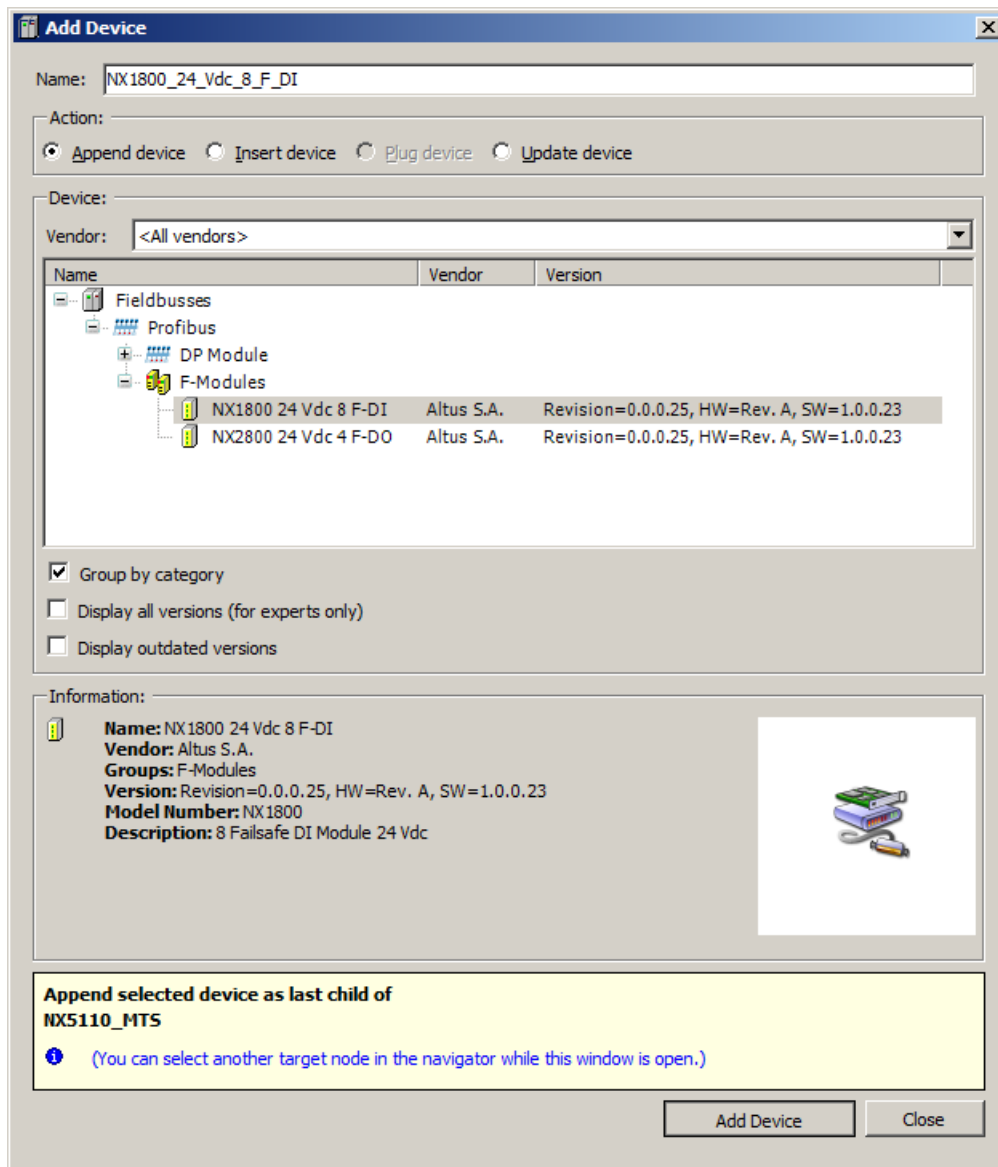


Figure 35: Appending a new SDIM Module to the Project

- Configure the SDIM Module. On the *Devices* window, under NX3810, an object called NX1800 was created. By double-clicking on it, a window to configure the SDIM will pop.
 - On the *Safe Configuration* tab, adjust the PROFIsafe address of the SDIM (*F_Dest_Add*), PROFIsafe Master device address (*F_Source_Add*) and the SDIM watchdog time (*F_WD_Time*).
 - At the *Safe parametrization* tab, it's possible to configure SDIM according to specific application where it will be used. Inputs can be enable, disabled, set as paired equivalent, paired antivalent or simply as single input. Also, external test pulses and discrepancy timeout can be adjusted. Once the parametrization is finished, it is required to write down the calculated CRC for iParameters (*I_Par_CRC32*).

| NX1800_24_Vdc_8_F_DI_MTS_1 X | | | | |
|------------------------------|------------------------------------|------------|-------------------|-------------|
| Safe configuration | In work | | | |
| I/O mapping | Name | Value | Symbolic-Value | Description |
| Safe parametrization | Input Type I00 | 2 | Paired Equivalent | |
| Information | Input Type I01 | 2 | Paired Equivalent | |
| | Input Type I02 | 1 | Single Input | |
| | Input Type I03 | 1 | Single Input | |
| | Input Type I04 | 3 | Paired Antivalent | |
| | Input Type I05 | 3 | Paired Antivalent | |
| | Input Type I06 | 1 | Single Input | |
| | Input Type I07 | 0 | Disabled | |
| | External Test Pulse I00 | 2 | Shared | |
| | External Test Pulse I01 | 2 | Shared | |
| | External Test Pulse I02 | 1 | Enabled | |
| | External Test Pulse I03 | 0 | Disabled | |
| | External Test Pulse I04 | 1 | Enabled | |
| | External Test Pulse I05 | 1 | Enabled | |
| | External Test Pulse I06 | 0 | Disabled | |
| | External Test Pulse I07 | 0 | Disabled | |
| | Discrepancy Timeout I00/I01 (10ms) | 5 | 5 | |
| | Discrepancy Timeout I02/I03 (10ms) | 5 | 5 | |
| | Discrepancy Timeout I04/I05 (10ms) | 20 | 20 | |
| | Discrepancy Timeout I06/I07 (10ms) | 5 | 5 | |
| | I_Par_CRC32 | 3209479300 | 3209479300 | |

Figure 36: Parametrization of NX1800 input channels

- Back on *Safe configuration* tab, the *I_Par_CRC32* need to be inserted in *F_iPAR_CRC* field. Once inserted *F_iPar_CRC*, the *F-Parameters CRC* will be automatically calculated.

| NX1800_24_Vdc_8_F_DI_MTS_1 X | | | | | |
|------------------------------|----------------|------------------------|-----------------|---------------------------|------|
| Safe configuration | In Work | | | | |
| I/O mapping | Name | Value | Symbolic val... | Description | Unit |
| Safe parametrization | F_SIL | 2 | SIL3 | BitArea(2-3) 2 2-2 | |
| Information | F_CRC_Length | 0 | 3-Byte-CRC | BitArea(4-5) 0 0-0 | |
| | F_Block_ID | 1 | | BitArea(3-5) 1 1-1 | |
| | F_Par_Version | 1 | V2-mode | BitArea(6-7) 1 1-1 | |
| | F_Source_Add | 1 | | Unsigned16 1 1-65534 | |
| | F_Dest_Add | 2 | | Unsigned16 1 1-1023 | |
| | F_WD_Time | 150 | | Unsigned16 150 50-10000 | |
| | F_iPar_CRC | 3209479300 | | Unsigned32 0 0-4294967295 | |
| | F_Par_CRC | 32629 | | Unsigned16 31615 0-65535 | |
| | Device Info | ALT_0EDD.GSD, NX18... | | | |
| | Creator Info | SafetyGSDConverter.... | | | |

Figure 37: NX1800 - F-Parameters CRC calculated

- Write the calculated values in the third-party programming tool. Once calculated the CRC values for *iParameters* and *F-Parameters*, it is possible to use it on the third-party programming tool.

ATTENTION:

If the SDIM configuration is modified in third-party application, this process needs to be repeated. Every change in the SDIM parametrization, has its specific *F-Parameters* and *iParameters* CRCs.

6.7. Using Nexto SDOM with Third-party Safety CPUs

PROFIsafe devices are configured via *F-Parameters*, which allows to configure which and how diagnostics are used. This configuration is ensured by a 16-bit CRC, called *F_Par_CRC*. To use Nexto Safety Digital Output Module in an existing PLC with third-party safety CPUs, it is required a computer with MasterTool Safety installed on it. On the programming tool, it is possible to calculate the correct CRC for the *F-Parameters*.

To proceed with the configuration, follow the steps 1 and 2 of the [Configuration](#) section to create a new project with a PROFIBUS slave module. Then proceed as follows:

- Append a new SDOM Module to the Project. By right-clicking on *NX5110* and selecting *Add Device*, the window below will appear. Select the *NX2800* module and then click in *Add Device* button (at the bottom-right side of the window). The module will be added and the *Add Device* window can be closed.

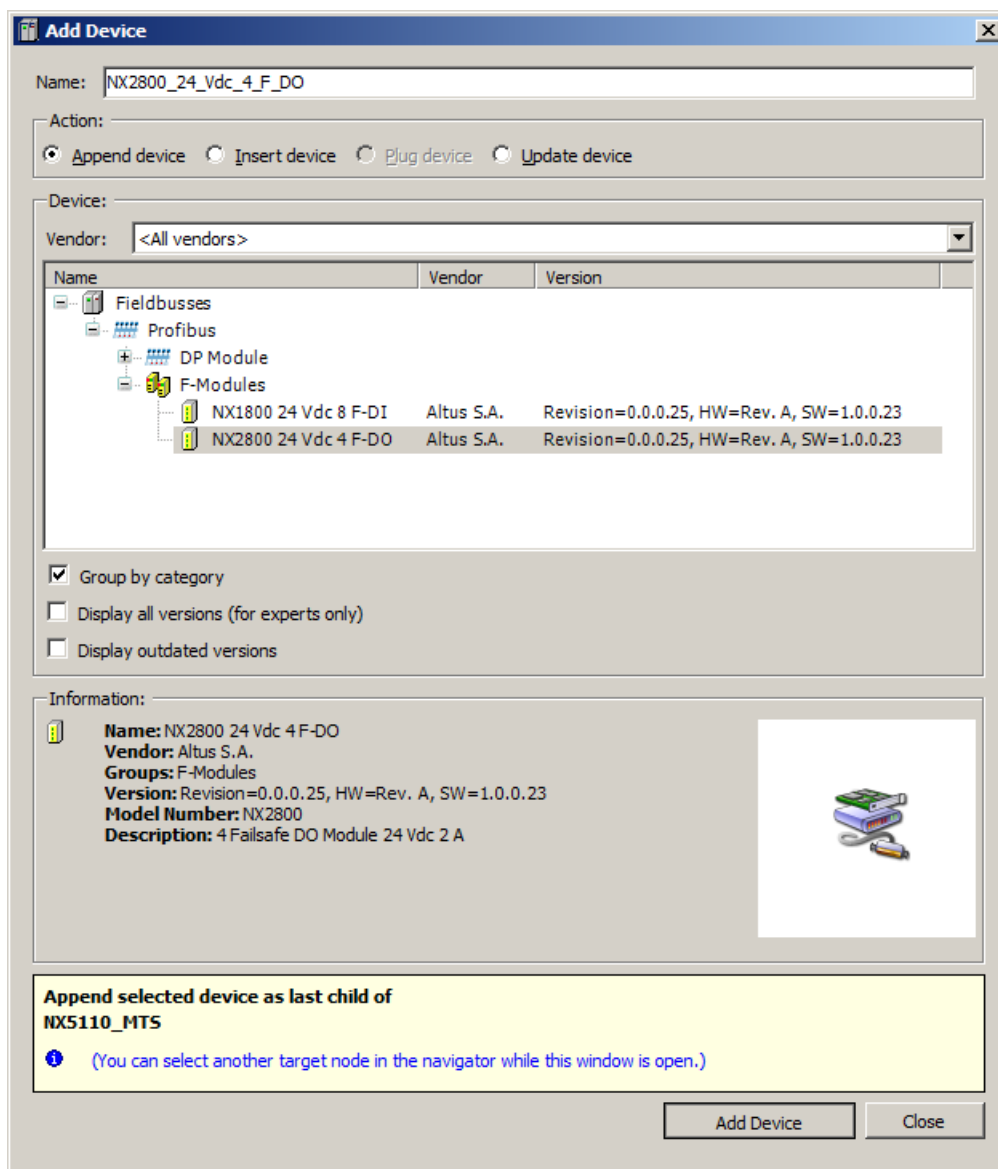


Figure 38: Appending a new SDOM Module to the Project

- Configure the SDOM Module. On the *Devices* window, under *NX3810*, an object called *NX2800* was created. By double-clicking on it, a window to configure the SDOM will pop.
 - On the *Safe Configuration* tab, adjust the PROFIsafe address of the SDOM (*F_Dest_Add*), PROFIsafe Master device address (*F_Source_Add*) and the SDOM watchdog time (*F_WD_Time*).
 - At the *Safe parametrization* tab, it's possible to configure SDOM according to specific application where it will be used. Outputs open load detection can be activated or deactivated. Once the parametrization is finished, it is required to write down the calculated CRC for iParameters (*I_Par_CRC32*).

| NX2800_24_Vdc_4_F_DO_MTS x | | | | |
|----------------------------|-------------------------|------------|----------------|-------------|
| Safe configuration | In work | | | |
| I/O mapping | | | | |
| Safe parametrization | | | | |
| Information | | | | |
| | Name | Value | Symbolic-Value | Description |
| | Open Load Detection Q00 | 1 | Enabled | |
| | Open Load Detection Q01 | 0 | Disabled | |
| | Open Load Detection Q02 | 0 | Disabled | |
| | Open Load Detection Q03 | 0 | Disabled | |
| | I_Par_CRC32 | 2361699757 | 2361699757 | |

Figure 39: Parametrization of NX2800 input channels

- Back on *Safe configuration* tab, the *I_Par_CRC32* need to be inserted in *F_iPAR_CRC* field. Once inserted *F_iPar_CRC*, the *F-Parameters CRC* will be automatically calculated.

| NX2800_24_Vdc_4_F_DO_MTS x | | | | |
|----------------------------|----------------|-------------------------------------|----------------|---------------------------|
| Safe configuration | In Work | | | |
| I/O mapping | | | | |
| Safe parametrization | | | | |
| Information | | | | |
| | Name | Value | Symbolic value | Description |
| | F_SIL | 2 | SIL3 | BitArea(2-3) 2 2-2 |
| | F_CRC_Length | 0 | 3-Byte-CRC | BitArea(4-5) 0 0-0 |
| | F_Block_ID | 1 | | BitArea(3-5) 1 1-1 |
| | F_Par_Version | 1 | V2-mode | BitArea(6-7) 1 1-1 |
| | F_Source_Add | 1 | | Unsigned16 1 1-65534 |
| | F_Dest_Add | 3 | | Unsigned16 1 1-65534 |
| | F_WD_Time | 150 | | Unsigned16 150 50-10000 |
| | F_iPar_CRC | 2361699757 | | Unsigned32 0 0-4294967295 |
| | F_Par_CRC | 56147 | | Unsigned16 31615 0-65535 |
| | Device Info | ALT_0EDD.GSD, NX2800 24 Vdc 4 F-... | | |
| | Creator Info | SafetyGSDConverter.plugin, V4.1.2.0 | | |

Figure 40: NX2800 - F-Parameters CRC calculated

- Write the calculated values in the third-party programming tool. Once calculated the CRC values for *iParameters* and *F-Parameters*, it is possible to use it on the third-party programming tool.

ATTENTION:

If the SDOM configuration is modified in third-party application, this process needs to be repeated. Every change in the SDOM parametrization, has its specific *F-Parameters* and *iParameters* CRCs.

7. Installation

This chapter presents the steps to install the Safety Modules.

7.1. Mechanical Assembly

The Nexto Safety modules are compatible with all Nexto Series backplane models, which must be mounted in horizontal position as shown below: <SRSREQ1002> <SRSREQ671> <SRSREQ942>

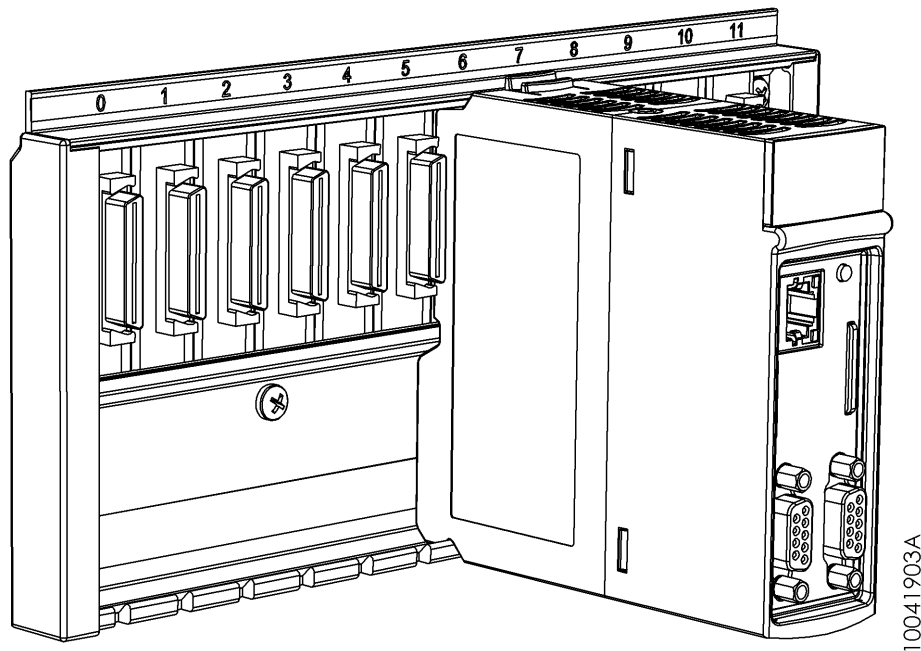


Figure 41: Module Correctly Placed in the Backplane Rack

The complete instructions for mechanical assembly and installation can be found on User Manual of Nexto Series (doc code MU214600), which also describes the list backplane models, measures to protect these backplane racks against dirt, dust and short circuits and the minimum panel depth. <NSREQ1001> <NSREQ670> <NSREQ941> <NSREQ1077> <NSREQ673> <NSREQ944>

The standard IP protection degree of Nexto Series modules is IP20. According ISO1349-2 table D.5, the minimum IP protection degree required is IP54, to avoid faults like short circuits. To achieve this requirement, the equipment must be installed inside closed panels with the required IP protection degree. The panel must have an appropriate thermal design to keep the internal temperature within the limits specified by climatic requirements of Nexto Safety modules and other equipment installed in the panel. <SRSREQ1000> <SRSREQ669> <SRSREQ940>

7.2. Spacing between other equipments <SRSREQ1003> <SRSREQ672> <SRSREQ943>

The PLC requires some free space around itself. This is necessary to allow the correct device handling. Besides, such space must be respected to allow the air flow through the PLC, in the convection form, in order to keep the equipment temperature.

Figure 42 and Table 18 indicate the necessary spacing for the Nexto Series modules.

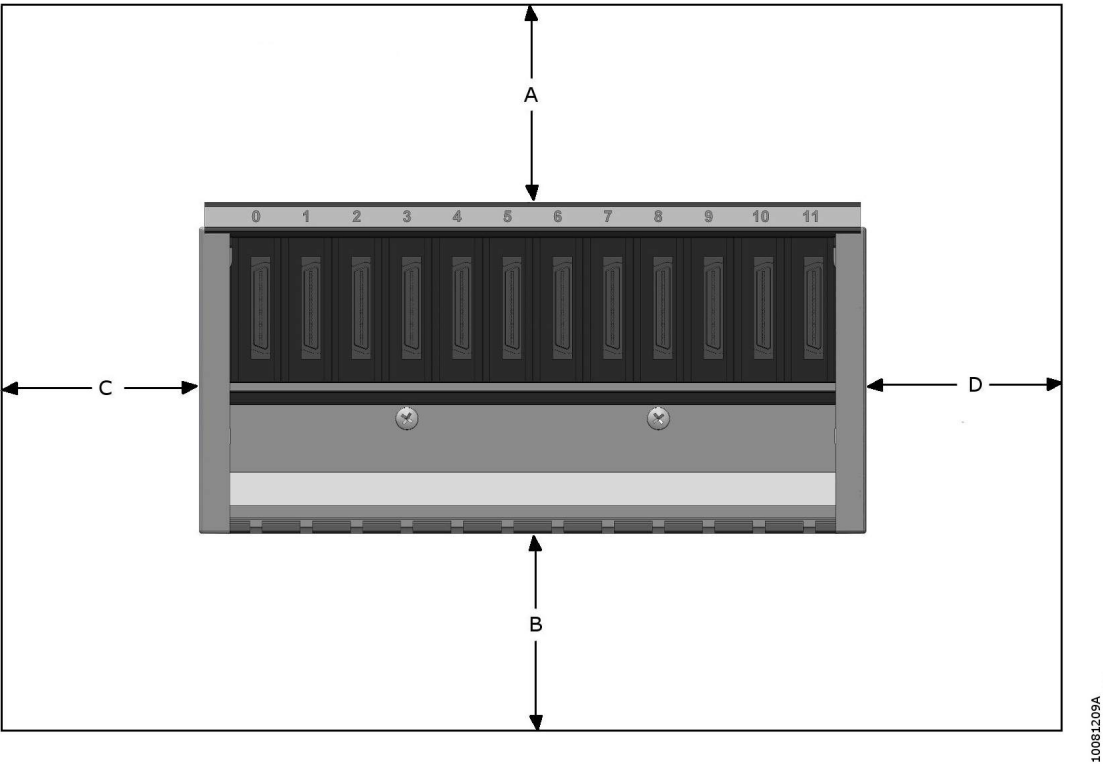


Figure 42: Free space around the PLC

| Dimension A | Dimension B | Dimension C | Dimension D |
|-------------|-------------|-------------|-------------|
| 10 cm | 10 cm | 4 cm | 4 cm |

Table 18: Free space dimension around the PLC

Note:

Dimension C and D: It’s recommended to use a space at least 4cm wide to allow the side rack ends to fit. If necessary, this width can be decreased.

8. Maintenance

8.1. General Diagnostics

The Nexto Series offers several indication forms for diagnostics which vary from user application variables, web pages, LEDs to LCDs. The next sections describes each of these possibilities.

WARNING: <NSREQ1021> <NSREQ642> <NSREQ913>

Diagnostics described in this section are intended for helping the user to identify and repair faults.

The diagnostic information is not a safe data. So, although some diagnostics will be activated in the event of failures that resulted on modules going to safe state, this information must not be used for safety interlock in the SCPU application.

Therefore, diagnostics must not be used for achieving safe state or for a safety function.

8.1.1. LCD Display

All modules of Nexto Series have a display with a group of common symbols "D" and "E". These symbols are used to indicate the main diagnostics and have a standardized behavior described below.

| D | E | Description | Cause | Solution | Priority |
|-------------|-------------|---|--|--|-----------|
| Off | Off | Disconnected modules or display failure | Module off, external power supply failure or hardware failure | Check if the module is completely connected to the backplane rack and if the backplane rack is supplied by an external power supply. | - |
| On | Off | Normal use | - | - | 9 (Lower) |
| Blinking 1x | Off | Active Diagnostics | There is at least one active diagnostic related to the module | Check what the active diagnostic is. More information can be found at ?? section of this document. | 8 |
| Blinking 2x | Off | CPU in STOP mode | CPU in STOP mode. If the module is in a Remote PROFIBUS, Master is in Clear state. | Check if CPU is in RUN mode or if PROFIBUS Master is in OPERATE mode. More information can be found on CPU's or PROFIBUS Master's documentation. | 7 |
| Blinking 3x | Off | Reserved | - | - | 6 |
| Blinking 4x | Off | Non-fatal fault | Failure in some hardware or software component, which does not have impact on the basic functionality of the product | Check the module diagnostic information. If it is a hardware fault, provide the replacement of this part. If it is a software fault, please contact the Technical Support. | 5 |
| Off | Blinking 1x | Parameterization error | The module isn't parameterized or didn't receive the parameterization | Check if the module parameterization is ok. | 2 |
| Off | Blinking 2x | Loss of master | Loss of communication between module and CPU or module and PROFIBUS head | Check if the module is completely connected to the backplane rack. Check if CPU is in RUN mode or if PROFIBUS head is Active. | 4 |

| D | E | Description | Cause | Solution | Priority |
|-----|-------------|----------------------|----------------|---|------------|
| Off | Blinking 3x | Reserved | - | - | 3 |
| Off | Blinking 4x | Fatal hardware fault | Hardware fault | In this case, the module should return to the manufacturer. | 1 (Higher) |

Table 19: Status of Symbols D and E

Notes:

Master loss: Indicates that the module is not being accessed by the local bus master (standard CPU or PROFIBUS Head) through the backplane local bus. This can happen when the local bus master fails and stops to scan the modules on the backplane (in this case, all modules will indicate this same diagnostic). However, it may also be possible that the local bus master is working normally and the failure is located specific local bus circuitry of the module. In this case, the local bus master will indicate absent module diagnostic for this slot position. If this failure happens, please contact Altus support. <SRSREQ638> <SRSREQ909>

Fatal error: Indicates that there was an internal failure caused by hardware or software malfunction. If this failure happens, please contact Altus support. <SRSREQ1019> <SRSREQ638> <SRSREQ909>

Segments I0I and I1I are usually switched off, however, when the module is in diagnostics mode (Electronic Tag on Display and One Touch Diag), these two segments start flashing.

8.1.2. One Touch Diag (OTD) <NSREQ45> <NSREQ651> <NSREQ922>

This is another innovative resource of Nexto Series. With this new concept, the user can visually check the module diagnostics with just one touch on the diagnostic button of corresponding module. "OTD" is a powerful tool that can be used offline (without supervisory application or programmer), making the process of locating and solving problems more effective and faster.

For the Safety CPU, a short press on the OTD button will show:

- SCPU state
- General diagnostics related to SCPU
- Forced variables on SCPU logic

For the I/O modules, a short press on module's OTD button will show the detailed diagnostic messages on the PROFIBUS Slave Head display. Additionally, short presses allows to navigate through each I/O point to check channel-specific diagnostics.

A complete description of OTD feature can be found on Nexto Series User Manual - MU214600.

8.2. NX3810 Diagnostics <SRSREQ1022>

Additionally to the general diagnostic features described previously, the Safety CPU offers other ways to display diagnostics generated by the system, which are:

- [DG LED Indicator](#)
- [Graphic LCD Display](#) <NSREQ44>
- [Diagnostics via WEB](#)
- [Diagnostic via Variables](#) <NSREQ1612>

8.2.1. DG LED Indicator

Diagnostic LED indicator (DG) is a green/red LED mounted on the front panel of the module. The Table 20 indicates the meaning of each possible state.

| Green | Red | Description | Causes | Priority |
|-------|-----|--|--|-------------|
| Off | Off | Not used | No Power Supply or hardware malfunction | 0 (Highest) |
| Off | On | Application stopped (Stop Mode or Ended) | Application is paused or ended due a runtime error | 1 |

| Green | Red | Description | Causes | Priority |
|--------------------|------------|-------------------------------------|---|----------|
| Blinking 1x | Off | Run and other diagnostics | Application is running with presence of diagnostics | 2 |
| On | Off | All applications running (RUN Mode) | Valid when there are no diagnostics | 3 |

Table 20: DG LED Indicator

8.2.2. Diagnostics via WEB

Nexto Safety CPU, as the Nexto Standard CPUs, supports also diagnostics via WEB. As SCPU was designed without Ethernet port, the all diagnostics are send from SCPU to STDCPU. STDCPU, in turn, organizes all SCPU related information in a separated WEB page.

The access to the desired Safety CPU WEB page, follow the steps below:

- Connect a computer to the STDCPU
- Launch any web browser
- On the address bar, type the IP address of the STDCPU
- Locate and click on tab System Overview
- Locate the specific NX3810 by looking to the rack slot, then click on it
- Check the diagnostics and status by clicking on the respective tabs

8.2.3. Diagnostic via Variables <NSREQ1612>

SCPU diagnostic variables can be consulted in Standard CPU Application. As the SCPU is an slave module, its diagnostics variables are found in *DG_NX3810* at *Module_Diagnostics* GVL.

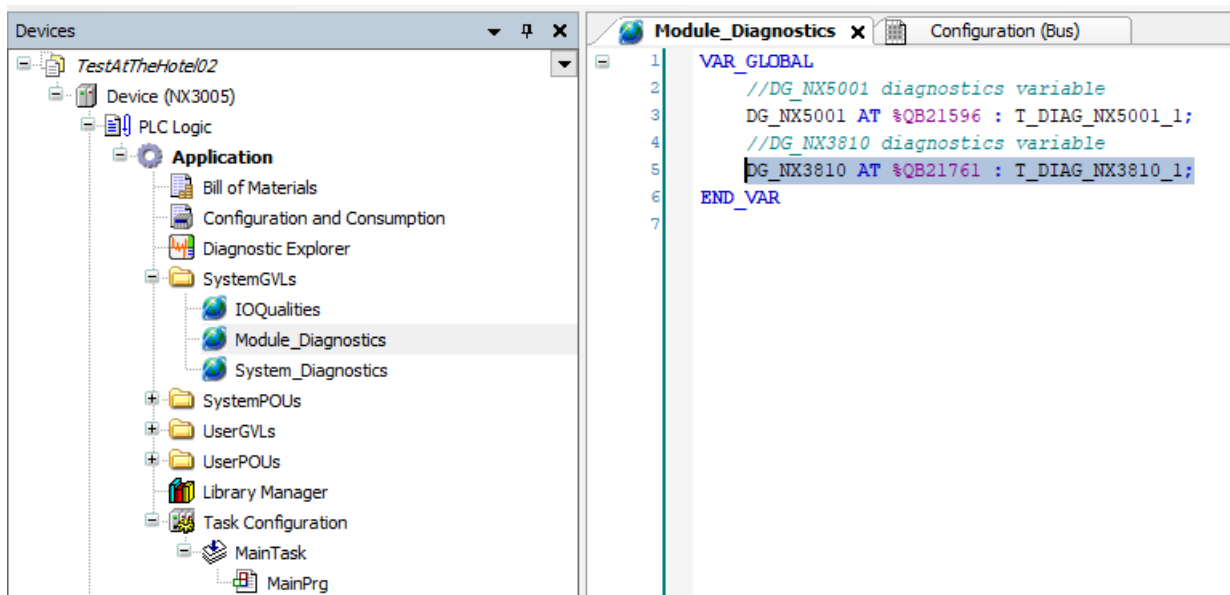


Figure 43: Diagnostic via Variables

The description of *T_DIAG_NX3810_1* is depicted below:

| Direct Variable | | Diagnostic Message | Symbolic Variable DG_NX3810.tGeneral.* | Description/Comment |
|-----------------|-----|--------------------------|---|---|
| Variable | Bit | | | |
| %QB(n) | 0 | - | bReserved_08 | Reserved |
| | 1 | - | bReserved_09 | Reserved |
| | 2 | - | bReserved_10 | Reserved |
| | 3 | - | bReserved_11 | Reserved |
| | 4 | - | bReserved_12 | Reserved |
| | 5 | - | bReserved_13 | Reserved |
| | 6 | - | bReserved_14 | Reserved |
| | 7 | - | bReserved_15 | Reserved |
| %QB(n+1) | 0 | MODULE W/ DIAGNOSTICS | bActiveDiagnostics | TRUE – There is an active diagnostic which can be any of the following: - OTD Button Error - Application Status is not “Run” - Controller Status is not “Safe” - IO structure mismatch is TRUE |
| | | NO DIAG | | FALSE – Module doesn’t have active diagnostic |
| | 1 | MODULE W/ FATAL ERROR | bFatalError | TRUE – A fatal error is present which can be caused by any of the following: - I/O communication timeout between ETHMCU and SMCU1 - Error codes of SMCUs not equal to 0 - Fault detected by ETHMCU (according other Nexto Modules) |
| | | - | | FALSE – No fatal error |
| | 2 | CONFIG. MISMATCH | bConfigMismatch | TRUE – Parameterization error It was not possible to configure EtherCAT ASIC for data exchange (I/O’s out of bounds, too many I/O’s to handle). |
| | | - | | FALSE – Parameterization ok |
| | 3 | - | bReserved_03 | Reserved |
| | 4 | OTD SWITCH ERROR | bOTDSwitchError | TRUE – Module has diagnostic switch failure SCPU detected that OTD button was pressed longer than 10s. |
| | | - | | FALSE – Diagnostic switch ok |
| | 5 | - | bReserved_05 | Reserved |
| | 6 | - | bReserved_06 | Reserved |
| | 7 | - | bReserved_07 | Reserved |

Table 21: NX3810 - General Diagnostics

| Direct Variable | Symbolic Variable DG_NX3810.tDetailed.* | Description/Comment |
|------------------------------|--|---|
| %QB(n+2) | byAppStatus | Application Status Values: 0 – APP_STATUS_UNKNOWN 1 - APP_STATUS_STOP 2 - APP_STATUS_RUN 3 – APP_STATUS_ENDED |
| %QB(n+3) | bySMCUStatus | Controller status Values: 0 – SMCU_STATUS_UNKNOWN 1 - SMCU_STATUS_UNLOADED 2 - SMCU_STATUS_SAFE 3 – SMCU_STATUS_UNSAFE_DL 4 - SMCU_STATUS_UNSAFE_BA 5 - SMCU_STATUS_EXCEPTION 6 - SMCU_STATUS_UNSAFE_DEBUG |
| %QB(n+4) | byForceStatus | Forced Values: 0 – FORCE_FALSE 1 - FORCE_TRUE |
| %QB(n+5) | byIOConfigStatus | PROFIsafe I/O structure mismatch Values: 0 – CONFIG_OK 1 - CONFIG_MISMATCH |
| %QB(n+6) .. %QB(n+9) | udiSafetyTaskInterval | Safety Task Interval. The configured value of Safety Task interval, in microseconds. |
| %QB(n+10) .. %QB(n+13) | udiSafetyTaskMinCycleTime | Tmix SSC. Minimum time taken to execute the application, in microseconds. |
| %QB(n+14) .. %QB(n+17) | udiSafetyTaskMaxCycleTime | Tmax SSC. Maximum time taken to execute the application, in microseconds. |
| %QB(n+18) .. %QB(n+21) | udiSafetyTaskLastCycleTime | Tlast SSC. Last time time taken to execute the application, in microseconds. |
| %QB(n+22) .. %QB(n+25) | udiReserved | Reserved for future usage. |
| %QB(n+26) .. %QB(n+29) | tErrorInfo[0] | DIAG - Internal Status 1 Internal status, not oriented to end-user. Used only for remote support. |
| %QB(n+30) .. %QB(n+33) | tErrorInfo[1] | DIAG - Internal Status 2 Internal status, not oriented to end-user. Used only for remote support. |

Table 22: NX3810 - Detailed Diagnostics

8.3. NX1800 Diagnostics

The following sections describes the general and channel specific diagnostics of the SDIM module.

When using Altus Safety CPU, the PROFIBUS diagnostic message data is automatically decoded and the programming system provides a symbolic variable data structure that reflects these tables.

When using third party Safety CPU, the diagnostics must be retrieved using channel and code of PROFIBUS message, as defined in the right most column of these tables.

8.3.1. General Diagnostics <SRSREQ643>

| Direct Variable | | Symbolic Variable DG_NX1800.tGeneral.* | Description | PROFIBUS Message Code |
|-----------------|-----|---|--|-----------------------------|
| Variable | Bit | | | |
| %QB(n) | 0 | bActiveDiagnosticsInput00 | There is an active diagnostic for I00. | - |
| | 1 | bActiveDiagnosticsInput01 | There is an active diagnostic for I01. | - |
| | 2 | bActiveDiagnosticsInput02 | There is an active diagnostic for I02. | - |
| | 3 | bActiveDiagnosticsInput03 | There is an active diagnostic for I03. | - |
| | 4 | bActiveDiagnosticsInput04 | There is an active diagnostic for I04. | - |
| | 5 | bActiveDiagnosticsInput05 | There is an active diagnostic for I05. | - |
| | 6 | bActiveDiagnosticsInput06 | There is an active diagnostic for I06. | - |
| | 7 | bActiveDiagnosticsInput07 | There is an active diagnostic for I07. | - |
| %QB(n+1) | 0 | bActiveDiagnostics | There is an active diagnostic for the module as a whole. | - |
| | 1 | bFatalError | Internal Failure: Indicates that there was an internal failure caused by hardware or software malfunction. | 31, 25 |
| | 2 | bReserved_02 | Reserved | - |
| | 3 | bReserved_03 | Reserved | - |
| | 4 | bOTDSwitchError | OTD Button Error: When the OTD button is stuck in the pressed mode. | 31, 28 |
| | 5 | bReserved_05 | Reserved | - |
| | 6 | bReserved_06 | Reserved | - |
| | 7 | bReserved_07 | Reserved | - |

Table 23: NX1800 - General Diagnostics

8.3.2. Detailed Diagnostics

| Direct Variable | | Symbolic Variable DG_NX1800.tDetailed.* | Description | PROFIBUS Message Code |
|-----------------|-----|--|--|-----------------------------|
| Variable | Bit | | | |
| | 0 | bActiveFault | Active fault: When this bit is set, there is at least one active device fault. The diagnostic indicating which failure has happened will be kept active in order to help the user to identify it, even though the failure is not active anymore and thus this bit was cleared. | 32, 16 |
| | 1 | bOperatorAcknowledgmentRequested | PROFIsafe master is signaling Operator Acknowledge Requested (OA_Req). | 32, 17 |
| | 2 | bNoExternalSupply | Loss of External Power Supply (note 1) | 32, 18 |

| Direct Variable | | Symbolic Variable DG_NX1800.tDetailed.* | Description | PROFIBUS Message Code |
|-----------------|------|--|--|-----------------------------|
| Variable | Bit | | | |
| %QB (n+2) | 3 | bInactiveDataExchange | Reserved | - |
| | 4 | bPROFIsafeWDTIMEOUT | ROFIsafe watchdog problem was detected by SDIM. | 32, 20 |
| | 5 | bPROFIsafeCRCError | PROFIsafe communication error (bad CRC) was detected by SDIM. | 32, 21 |
| | 6 | bNoValidParameterization | PROFIsafe parameters has errors or were not received yet since startup. This diagnostic covers F-Parameters and iParameters. | 32, 22 |
| | 7 | bInvalidFParHeader | Invalid F-Parameters header. | 32, 23 |
| %QB (n+3) | 0 | bInvalidFCheckSeqNr | Invalid F_Check_SeqNr (must be 0). | 32, 24 |
| | 1 | bInvalidFCheckiPar | Invalid F_Check_iPar (must be 0). | 32, 25 |
| | 2 | bInvalidFSIL | Invalid F_SIL (must indicate SIL 3). | 32, 26 |
| | 3 | bInvalidFCRCLength | Invalid F_CRC_Length (must be 0, indicating 3 bytes CRC). | 32, 27 |
| | 4 | bInvalidFBlockID | Invalid F_Block_ID (must be 1, indicating presence of F-iPar_CRC in the F-Parameters). | 32, 28 |
| | 5 | bInvalidFParVersion | Invalid F_Par_Version (must be 1, indicating PROFIsafe V2-mode). | 32, 29 |
| | 6 | bInvalidFSourceAdd | Invalid F_Source_Add (valid range = 1 ... 65534). | 32, 30 |
| | 7 | bInvalidFDestAdd | Invalid F_Dest_Add (valid range = 1 ... 65534). | 32, 31 |
| %QB (n+4) | 0 | bInvalidFParCRC | Bad F-Par_CRC for F-Parameters. | 33, 16 |
| | 1 | bInvalidFWDTime | Invalid F_WD_Time (must be higher than 0 ms). | 33, 17 |
| | 2 | bFiParCRCMismatch | Bad F-iPar_CRC for iParameters. | 33, 18 |
| | 3 | bPROFIsafeAddressMismatch | Mismatch between F_Dest_Add and module's non-volatile configured PROFIsafe address. | 33, 19 |
| | 4 | bReserved_04 | Reserved | - |
| | 5 | bReserved_05 | Reserved | - |
| | 6 | bReserved_06 | Reserved | - |
| | 7 | bReserved_07 | Reserved | - |
| %QB (n+5) | 0..7 | byReserved_03 | Reserved | - |

Table 24: NX1800 - Detailed Diagnostics

Note:

Loss of External Power Supply: This diagnostic will be cleared only when the power supply is restored and PROFIsafe communication reestablished.

Faults associated to most of these diagnostics cause safe state in all the 8 inputs of SDIM. The only exception is the fault associated to "OTD Button Error" diagnostic that doesn't passivate any input.

Some specific module diagnostics may not be reported in the PROFIBUS Head LCD display or in the Standard CPU via PROFIBUS DP messages. For example: if the PROFIBUS Head cannot communicate with SDIM through EtherCAT backplane, or if Standard CPU cannot communicate with PROFIBUS Head over PROFIBUS DP. In these cases, other existing diagnostics of Nexto Series report such failures (e.g. "Absent Module" or "Absent Remote Station"). These diagnostics are described on User Manuals of Standard CPU and PROFIBUS Head.

8.3.2.1. Channel Specific Diagnostics <SRSREQ644>

| Direct Variable | | Symbolic Variable DG_NX1800.tDetailed .tChannel_XX.* | Description | PROFIBUS Message Code |
|-----------------------|-----|--|---|-----------------------------|
| Variable | Bit | | | |
| %QB (n+6+ 2*XX) | 0 | bReserved_08 | Reserved | - |
| | 1 | bReserved_09 | Reserved | - |
| | 2 | bReserved_10 | Reserved | - |
| | 3 | bReserved_11 | Reserved | - |
| | 4 | bReserved_12 | Reserved | - |
| | 5 | bReserved_13 | Reserved | - |
| | 6 | bReserved_14 | Reserved | - |
| | 7 | bReserved_15 | Reserved | - |
| %QB (n+7+ 2*XX) | 0 | bShortCircuit24VInput | Short circuit at I00: short circuit at I00 detected by external test pulse. This diagnostic may be caused by short circuit to 24 V or some cross circuits. It's only detected when external test pulse is enabled for this input. | XX, 24 |
| | 1 | bDiscrepancyTimeout | Discrepancy Timeout at I00/I01: discrepancy timeout exceeded for paired inputs I00 and I01. This diagnostic cause safe state only for the associated input pair. See description at section SDIM Configuration <SRSREQ645> <SRSREQ646>. | XX, 25 |
| | 2 | bTestPulseConfigMismatch | Invalid iParameter "external test pulse option" for disabled I00 (disabled input I00 must have external test pulse disabled) | XX, 26 |
| | 3 | bSharedTestPulseConfigMismatch | Invalid iParameter "external test pulse option" for non-paired I00 (single input I00 must not have shared external test pulse) | XX, 27 |
| | 4 | bPairedInputsMismatch | iParameters difference I00/I01 for paired inputs (all iParameters of paired inputs I00 and I01 must be equal) | XX, 28 |
| | 5 | bInvalidTestPulseConfiguration | Invalid iParameter "external test pulse option" value for I00 (unexpected bit pattern "11" for external test pulse option – valid options are "00", "01" and "10") | XX, 29 |
| | 6 | bReserved_06 | Reserved | - |
| | 7 | bReserved_07 | Reserved | - |

Table 25: NX1800 - Channel Detailed Diagnostics

Notes:

XX: Represents the number of channel.

Channel Specific Diagnostics: Once occurred, the diagnostic of short circuit will be cleared only after a reset of PROFIsafe communication. This is intended to improve the diagnostic detection for scenarios with intermittent failures.

Faults associated to most of the previous diagnostics cause safe state in all the 8 inputs of SDIM, even if detected for a single input. The only exception is the fault associated to "discrepancy timeout" diagnostic that passivates only the associated input pair.

8.4. NX2800 Diagnostics

The following sections describes the general and channel specific diagnostics of the SDOM module.

When using Altus Safety CPU, the PROFIBUS diagnostic message data is automatically decoded and the programming system provides a symbolic variable data structure that reflects these tables.

When using third party Safety CPU, the diagnostics must be retrieved using channel and code of PROFIBUS message, as defined in the right most column of these tables.

8.4.1. General Diagnostics <SRSREQ914>

| Direct Variable | | Symbolic Variable DG_NX2800.tGeneral.* | Description | PROFIBUS Message Code |
|-----------------|-----|---|--|-----------------------------|
| Variable | Bit | | | |
| %QB(n) | 0 | bActiveDiagnosticsOutput00 | There is an active diagnostic for Q00. | - |
| | 1 | bActiveDiagnosticsOutput01 | There is an active diagnostic for Q01. | - |
| | 2 | bActiveDiagnosticsOutput02 | There is an active diagnostic for Q02. | - |
| | 3 | bActiveDiagnosticsOutput03 | There is an active diagnostic for Q03. | - |
| | 4 | bReserved_12 | Reserved | - |
| | 5 | bReserved_13 | Reserved | - |
| | 6 | bReserved_14 | Reserved | - |
| | 7 | bReserved_15 | Reserved | - |
| %QB(n+1) | 0 | bActiveDiagnostics | There is an active diagnostic for the module as a whole. | - |
| | 1 | bFatalError | Internal Failure: Indicates that there was an internal failure caused by hardware or software malfunction. | 31, 25 |
| | 2 | bReserved_02 | Reserved | - |
| | 3 | bReserved_03 | Reserved | - |
| | 4 | bOTDSwitchError | OTD Button Error: When the OTD button is stuck in the pressed mode. | 31, 28 |
| | 5 | bReserved_05 | Reserved | - |
| | 6 | bReserved_06 | Reserved | - |
| | 7 | bReserved_07 | Reserved | - |

Table 26: NX2800 - General Diagnostics

8.4.2. Detailed Diagnostics

| Direct Variable | | Symbolic Variable DG_NX2800.tDetailed.* | Description | PROFIBUS Message Code |
|-----------------|-----|--|--|-----------------------------|
| Variable | Bit | | | |
| | 0 | bActiveFault | Active fault: When this bit is set, there is at least one active device fault. The diagnostic indicating which failure has happened will be kept active in order to help the user to identify it, even though the failure is not active anymore and thus this bit was cleared. | 32, 16 |
| | 1 | bOperatorAcknowledgmentRequested | PROFIsafe master is signaling Operator Acknowledge Requested (OA_Req). | 32, 17 |
| | 2 | bNoExternalSupply | Loss of External Power Supply (note 1) | 32, 18 |

| Direct Variable | | Symbolic Variable DG_NX2800.tDetailed.* | Description | PROFIBUS Message Code |
|-----------------|------|--|--|-----------------------------|
| Variable | Bit | | | |
| %QB (n+2) | 3 | bInactiveDataExchange | Reserved | - |
| | 4 | bPROFIsafeWDTIMEOUT | ROFIsafe watchdog problem was detected by SDOM. | 32, 20 |
| | 5 | bPROFIsafeCRCError | PROFIsafe communication error (bad CRC) was detected by SDOM. | 32, 21 |
| | 6 | bNoValidParameterization | PROFIsafe parameters has errors or were not received yet since startup. This diagnostic covers F-Parameters and iParameters. | 32, 22 |
| | 7 | bInvalidFParHeader | Invalid F-Parameters header. | 32, 23 |
| %QB (n+3) | 0 | bInvalidFCheckSeqNr | Invalid F_Check_SeqNr (must be 0). | 32, 24 |
| | 1 | bInvalidFCheckiPar | Invalid F_Check_iPar (must be 0). | 32, 25 |
| | 2 | bInvalidFSIL | Invalid F_SIL (must indicate SIL 3). | 32, 26 |
| | 3 | bInvalidFCRCLength | Invalid F_CRC_Length (must be 0, indicating 3 bytes CRC). | 32, 27 |
| | 4 | bInvalidFBlockID | Invalid F_Block_ID (must be 1, indicating presence of F-iPar_CRC in the F-Parameters). | 32, 28 |
| | 5 | bInvalidFParVersion | Invalid F_Par_Version (must be 1, indicating PROFIsafe V2-mode). | 32, 29 |
| | 6 | bInvalidFSourceAdd | Invalid F_Source_Add (valid range = 1 ... 65534). | 32, 30 |
| | 7 | bInvalidFDestAdd | Invalid F_Dest_Add (valid range = 1 ... 65534). | 32, 31 |
| %QB (n+4) | 0 | bInvalidFParCRC | Bad F-Par_CRC for F-Parameters. | 33, 16 |
| | 1 | bInvalidFWDTime | Invalid F_WD_Time (must be higher than 0 ms). | 33, 17 |
| | 2 | bFiParCRCMismatch | Bad F-iPar_CRC for iParameters. | 33, 18 |
| | 3 | bPROFIsafeAddressMismatch | Mismatch between F_Dest_Add and module's non-volatile configured PROFIsafe address. | 33, 19 |
| | 4 | bReserved_04 | Reserved | - |
| | 5 | bReserved_05 | Reserved | - |
| | 6 | bReserved_06 | Reserved | - |
| | 7 | bReserved_07 | Reserved | - |
| %QB (n+5) | 0..7 | byReserved_03 | Reserved | - |

Table 27: NX2800 - Detailed Diagnostics

Note:

Loss of External Power Supply: This diagnostic will be cleared only when the power supply is restored and PROFIsafe communication reestablished.

Faults associated to most of the previous diagnostics cause safe state in all the 4 outputs of SDOM. The only exception is the fault associated to "OTD Button Error" diagnostic that doesn't passivate any output.

Some specific module diagnostics may not be reported in the PROFIBUS Head LCD display or in the Standard CPU via PROFIBUS DP messages. For example: if the PROFIBUS Head cannot communicate with SDIM through EtherCAT backplane, or if Standard CPU cannot communicate with PROFIBUS Head over PROFIBUS DP. In these cases, other existing diagnostics of Nexto Series report such failures (e.g. "Absent Module" or "Absent Remote Station"). These diagnostics are described on User Manuals of Standard CPU and PROFIBUS Head.

8.4.2.1. Channel Specific Diagnostics <SRSREQ915>

| Direct Variable | | Symbolic Variable DG_NX2800.tDetailed .tChannel_XX.* | Description | PROFIBUS Message Code |
|-----------------------|-----|--|---|-----------------------------|
| Variable | Bit | | | |
| %QB (n+6+ 2*XX) | 0 | bReserved_08 | Reserved | - |
| | 1 | bReserved_09 | Reserved | - |
| | 2 | bReserved_10 | Reserved | - |
| | 3 | bReserved_11 | Reserved | - |
| | 4 | bReserved_12 | Reserved | - |
| | 5 | bReserved_13 | Reserved | - |
| | 6 | bReserved_14 | Reserved | - |
| | 7 | bReserved_15 | Reserved | - |
| %QB (n+7+ 2*XX) | 0 | bOverloadQP | Overload at Q00+: the current at switch Q00+ of the output exceeds 2A | XX, 24 |
| | 1 | bOverloadQN | Overload at Q00-: the current at switch Q00- of the output exceeds 2A | XX, 25 |
| | 2 | bOpenLoadQP | Open Load at Q00+: load not connected to Q00+ | XX, 26 |
| | 3 | bShortCircuit24VQP | Short Circuit between Q00+ and 24V: read back of Q00+ switch indicates it is closed while it should be opened | XX, 27 |
| | 4 | bShortCircuit0VQN | Short Circuit between Q00- and 0V: read back of Q00- switch indicates it is closed while it should be opened | XX, 28 |
| | 5 | bOpenSwitchQP | Open Switch Q00+: read back of Q00+ switch indicates it is opened while it should be closed | XX, 29 |
| | 6 | bOpenSwitchQN | Open Switch Q00-: read back of Q00- switch indicates it is opened while it should be closed | XX, 30 |
| | 7 | bReserved_07 | Reserved | - |

Table 28: NX2800 - Channel Detailed Diagnostics

Notes:

XX: Represents the number of channel.

Channel Specific Diagnostics: Once occurred, the diagnostics of overload, open load, short circuit and open switch will be cleared only after a reset of PROFIsafe communication. This is intended to improve the diagnostic detection for scenarios with intermittent failures.

Faults associated to all output channel diagnostics cause safe state in all the 4 outputs of SDOM, even if detected for a single output.

8.5. Preventive Maintenance

- It must be checked, every year, if the interconnection cables have its connections tight, without dust deposits, mainly on the protection devices.
- In environments subjected to excessive contamination, the equipment must be cleaned periodically, removing particles, dust, etc.
- The varistors used for protection against transients caused by atmospheric discharges must be checked periodically, as they might be damaged or destroyed in case the absorbed energy is above limit. In many cases, the failure may not be

clear or easily visible. In critical applications, it's recommended the varistors periodic replacement, even the ones which don't present visible failures.

8.6. Decommissioning <SRSREQ1008> <SRSREQ685> <SRSREQ954>

Nexto Safety Modules can be decommissioned through the following alternative methods:

- removing it from backplane (hot swap), if the specific backplane model supports hot swap;
- removing the 24V supply voltage of backplane PSU module before removing the Safety Module from the backplane.

Safety I/O modules must have its I/O connector disconnected from the module only after the module is fully de-energized.

8.7. Disposal <NSREQ1009> <NSREQ686> <NSREQ955>

End-users are responsible for correctly disposing of decommissioned Altus hardware. Upon request, a disposal agreement can be arranged with Altus.

All materials must be disposed in an ecologically sound manner.

- Housing components can be sent for plastic recycling;
- Metal parts must be separated and sent for recycling;
- Electronic parts and circuit boards must be disposed according local regulations.

Modules of Nexto series comply with RoHS directives.

8.8. Transport <SRSREQ1010> <SRSREQ687> <SRSREQ956>

In order to prevent mechanical damage, Altus products must be transported in a protected packaging. Inside this packaging, the product must be stored in its original product box. This box also provides protection against electrostatic discharge.

ATTENTION:
The product box alone is not suitable for transport.

8.9. Repair of Devices and Modules <SRSREQ1011> <SRSREQ688> <SRSREQ957>

End-users are not authorized to repair devices and modules of Altus systems. Defective Altus equipment must be returned to Altus for repair after being tested on site with a brief description of the fault.

Equipment with a safety certificate is safety-relevant. The validity of the certificate expires if unauthorized repair is performed to safety-related devices of the Altus system. The warranty is void and no legal responsibility is taken for unauthorized repair.

8.10. Expiration of Proof-Test Interval <SRSREQ1012> <SRSREQ689> <SRSREQ958>

Once PTI of a Nexto Safety module expires, it must be decommissioned and disposed as described above.

9. Programming

9.1. Programming Overview

Mastertool Safety supports the developer in the creation of a standard-compliant safety application through:

- promotion of good programming techniques;
- prohibition of non-safe language features;
- promotion of code comprehensibility;
- facilitated testability;
- code documentation procedure.

The programming of a safety application takes place in POU's, GVLs and the task object.


In the POU's the program code is implemented in the IEC 61131-3 FBD language (function block diagram). FBD is characterized by clarity, ease of recognition of programming errors and clear dataflow.

The user interface and handling of the Mastertool Safety FBD editor correspond to Mastertool Standard.

ATTENTION:

The FBD-specific commands of CODESYS Safety are described with the respective language elements.

FREQUENTLY USED SYMBOLS:

Input Assistant: the  symbol, also called ellipse, marks a button that opens the "Input Assistant" dialog window when actuated.