APPLICATION NOTE

AC500-S safety PLC
Unbundled S500 safety I/Os
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1. Introduction

1.1. Purpose

In this application note, we present an overview on how S500 unbundled safety I/Os DX581-S (-XC) and DIS81-S (-XC) with CI502-PNIO (-XC) PROFINET IO device can be used with PROFINET IO controllers / PROFIsafe F-Hosts.

1.2. Document history

<table>
<thead>
<tr>
<th>Rev.</th>
<th>Description of version / changes</th>
<th>Who</th>
<th>Date</th>
</tr>
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<tr>
<td>A (V1.0.0)</td>
<td>First release</td>
<td>ABB</td>
<td>27.04.2017</td>
</tr>
<tr>
<td>B</td>
<td>Company name was changed. Various typos were corrected and various improvements in the texts and illustrations were made.</td>
<td>ABB</td>
<td>15.09.2021</td>
</tr>
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</table>

1.3. Validity

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ABB assumes no liability or responsibility for any consequences arising from the use of this document information. ABB is in particular in no way liable for missed profits, loss of income, loss of life, loss of use, loss of production, capital costs or costs associated with an interruption of operation, the loss of expected savings or for indirect or follow up damages or losses no matter of what kind.

1.4. Important user information

This documentation is intended for qualified personnel familiar with functional safety. You must read and understand safety concepts and requirements presented in AC500-S safety User Manual [1] as well as further referenced documents listed in chapter 1.6 of this document prior to operating S500 safety I/O modules.

1.5. Definitions, expressions, abbreviations

<table>
<thead>
<tr>
<th>AC500</th>
<th>ABB PLC, refer also to <a href="http://www.abb.com/PLC">www.abb.com/PLC</a> for further details</th>
</tr>
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<tr>
<td>AC500-S</td>
<td>ABB safety PLC, refer also to <a href="http://www.abb.com/PLC">www.abb.com/PLC</a> for further details</td>
</tr>
<tr>
<td>CPU</td>
<td>Central Processing Unit</td>
</tr>
<tr>
<td>CRC</td>
<td>Cyclic Redundancy Check</td>
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<tr>
<td>F_iPar_CRC</td>
<td>Fail-safe iParameter CRC according to PROFIsafe specification</td>
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<td>IEC</td>
<td>International Electro-technical Commission Standard</td>
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</table>
1.6. References / related documents


[9.] PROFIsafe System Description, Version November 2010, Order Number 4.342 or newer version


2. Unbundled S500 I/O modules

2.1. Overview

Figure 1 provides an overview of ABB unbundled S500 safety and standard I/O modules:

- **CI502-PNIO (-XC)** is a standard PROFINET IO device module [2.];
- **TU508-ETH (-XC)** is a terminal unit for CI502-PNIO (-XC) module [5.];
- Optional standard I/O module with a standard terminal unit from AC500 PLC (refer to [3.] for more information);
- **DX581-S (-XC)** is a safety binary input/output module [1.] with 8 safety output channels (up to SIL 3 or PL e) and 8 safety input channels (up to SIL 2 or PL d) or 4 safety input channels (up to SIL3 or PL e) with 4 test pulse output channels;
- **DI581-S (-XC)** is a safety binary input module [1.] with 16 safety input channels (up to SIL 2 or PL d) or 8 safety input channels (up to SIL 3 or PL e) with 8 test pulse output channels;
- **TU582-S (-XC)** is a terminal unit [1.] for DI581-S (-XC) and DX581-S (-XC) modules.

![WARNING]

**Removal / Insertion under power**

S500 safety and standard I/O modules are not designed for removal or insertion under power. Because of unforeseeable consequences, it is not allowed to plug or unplug devices with the power being ON.

Make sure that all voltage sources (supply and process voltage) are switched off before you:

- connect or disconnect any signal or terminal block;
- remove, mount or replace a module.

Disconnecting any powered devices while energized in a hazardous location could result in an electric arc, which could create a flammable ignition resulting in fire or explosion.

Make sure that power is removed and that the area has been thoroughly checked to ensure that flammable materials are not present prior to proceeding.

S500 safety and standard I/O modules must not be opened when in operation.
Figure 1. Overview of unbundled S500 safety and standard I/O modules

More technical details about AC500 PLC and AC500-S safety PLC can be found in [13.] and [3.].

**Major benefits of using unbundled S500 safety I/Os:**

- Ability to reduce wiring efforts and operation costs;
- Increase machine / cell productivity and reduce machine / cell downtime using the following S500 safety I/O features:
  - A single safety I/O channel can be individually reintegrated, which provides higher machine productivity and availability;
  - Each safety I/O channel LED not only indicates the process state but also the fault state, which saves operation costs and simplifies maintenance work;
  - Extreme condition (-XC) modules are available (see chapter 2.2), which allows cost-savings on control cabinets;
  - Front panel rotary switch for PROFIsafe address [9.], which reduces maintenance efforts because one can see all pre-set PROFIsafe addresses directly looking at the front cover of the module (no need to disassemble safety I/Os to see PROFIsafe address value or use engineering PC);
  - Ability to do wiring on safety I/O terminal units (TU582-S (-XC)) even if safety I/O modules are not yet available or procured (field wiring and module placement / replacement actions are independent of each other), which results in shorter commissioning and maintenance time.
2.2. XC - eXtreme Conditions version

Extreme condition versions of CI502-PNIO, TU508-ETH, DX581-S, DI581-S and TU582-S modules are:

- CI502-PNIO-XC, TU508-ETH-XC, DX581-S-XC, DI581-S-XC and TU582-S-XC, respectively.

XC versions of S500 modules were developed for harsh environments, e.g., extended temperature, shock and vibration range, etc. More details about technical characteristics and supported standards can be found in [1.] and [13.].

2.3. Ordering data

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Order code</th>
</tr>
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<tbody>
<tr>
<td>CI502-PNIO</td>
<td>CI502-PNIO (V3):S500, PROFINET® bus module with 8 DI, 8 DO and 8 DC</td>
<td>1SAP 220 700 R0001</td>
</tr>
<tr>
<td>CI502-PNIO-XC</td>
<td>CI502-PNIO-(V3)-XC:S500, PROFINET® bus module with 8 DI, 8 DO and 8 DC, Extreme Conditions</td>
<td>1SAP 420 700 R0001</td>
</tr>
<tr>
<td>TU508-ETH</td>
<td>TU508-ETH:S500, ETH terminal unit, spring terminals</td>
<td>1SAP 214 000 R0001</td>
</tr>
<tr>
<td>TU508-ETH-XC</td>
<td>TU508-ETH-XC:S500, ETH terminal unit, spring terminals, Extreme Conditions</td>
<td>1SAP 414 000 R0001</td>
</tr>
<tr>
<td>DI581-S</td>
<td>DI581-S:S500, Safety digital input module 16SDI</td>
<td>1SAP 284 000 R0001</td>
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<tr>
<td>DI581-S-XC</td>
<td>DI581-S-XC:S500, Safety digital input module 16SDI, Extreme Conditions</td>
<td>1SAP 484 000 R0001</td>
</tr>
<tr>
<td>DX581-S</td>
<td>DX581-S:S500, Safety digital I/O module 8SDI/SDO</td>
<td>1SAP 284 100 R0001</td>
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<tr>
<td>DX581-S-XC</td>
<td>DX581-S-XC:S500, Safety digital I/O module 8SDI/SDO, Extreme Conditions</td>
<td>1SAP 484 100 R0001</td>
</tr>
<tr>
<td>TU582-S</td>
<td>TU582-S:S500, Safety I/O terminal unit, 24V DC</td>
<td>1SAP 281 200 R0001</td>
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<td>TU582-S-XC</td>
<td>TU582-S-XC:S500, Safety I/O terminal unit, 24V DC, Extreme Conditions</td>
<td>1SAP 481 200 R0001</td>
</tr>
</tbody>
</table>

2.4. PROFINET IO device

2.4.1. CI502-PNIO (-XC)

Technical information on CI502-PNIO (-XC) modules:

- Installation instructions [4.];
- Technical information [2.];
- Relevant industrial standards and certifications [13.];
- PNO PROFINET certificate [14.];
- Detailed AC500/S500 platform related information [3].
2.4.2. TU508-ETH (-XC) terminal unit
Technical information on TU508-ETH (-XC) modules:
- Installation instructions [5.];
- Relevant industrial standards and certifications [13.];
- Detailed AC500/S500 platform related information [3.].

2.5. Safety I/O modules

2.5.1. DX581-S (-XC) module
Technical information on DX581-S (-XC) modules:
- Installation instructions [6.];
- Detailed technical information including functional safety aspects [1.];
- PNO PROFIsafe certificate [16.];
- TÜV certificate with relevant functional safety standards [17.];
- Relevant industrial standards and certifications [13.].

2.5.2. DI581-S (-XC) module
Technical information on DI581-S (-XC) modules:
- Installation instructions [7.];
- Detailed technical information including functional safety aspects [1.];
- PNO PROFIsafe certificate [15.];
- TÜV certificate with relevant functional safety standards [17.];
- Relevant industrial standards and certifications [13.].

2.5.3. TU582-S (-XC) terminal unit
Technical information on TU582-S (-XC) modules:
- Installation instructions [8.];
- Detailed technical information [1.];
- Relevant industrial standards and certifications [13.].

2.5.4. Important safety I/O module information
The following information about unbundled S500 safety I/O modules shall be taken into account in safety applications:
- Safety values for DX581-S (-XC) and DI581-S (-XC) modules (refer to chapter 2.4 in [1.]). For more detailed safety values, refer to [18.];
- Diagnosis data (refer to chapter 3.2.4 in [1.]);
- Safety times (refer to chapter 5 in [1.]);
- Relevant items in checklists for commissioning of safety I/Os (refer to chapters 6.3 and 6.4 in [1.]);
- System data for XC versions of DX581-S and DI581-S (refer to Appendix A in [1.]).
3. Module configuration

3.1. Overview

3.1.1. General

Standard configuration steps, as defined by PROFIsafe standard [9.], are needed to configure DI581-S (-XC) and DX581-S (-XC) safety I/O modules with CI502-PNIO (-XC) PROFINET IO device.

3.1.2. Module configuration with ABB robot controller IRC5

Steps on how to configure unbundled S500 safety I/O modules with ABB Robot Controller IRC5 are described in details in a separate document [19.]

3.2. AC500-S F_iPar_CRC calculator

AC500-S F_iPar_CRC Calculator is a free-of-charge software add-on for PROFINET IO controllers / PROFIsafe F-Hosts engineering tools. AC500-S F_iPar_CRC Calculator software shall be used to calculate F_iPar_CRC value to enable safe module and channel parameter configuration of DI581-S (-XC) and DX581-S (-XC) modules in PROFINET IO controller / PROFIsafe F-Host engineering tools. F_iPar_CRC is defined in [9.]

AC500-S F_iPar_CRC Calculator can be downloaded from [12.] (see also ReadMe file [10.] for more information).

3.3. Configuration steps

Steps on how to configure unbundled S500 safety I/O modules with PROFINET IO controllers / PROFIsafe F-Hosts engineering tools:

1. Download and install up-to-date ABB GSDML file (refer to [11.] or the download area from www.abb.com/PLC) in your PROFINET IO controllers / PROFIsafe F-Hosts engineering tool;
2. Download and install AC500-S F_iPar_CRC Calculator software (refer to [12.] or the download area from www.abb.com/PLC) on your engineering PC;
3. Instantiate ABB CI502-PNIO (-XC) PROFINET IO device communication module to the selected CPU with PROFINET/PROFIsafe interface in your engineering tool;
4. Set PROFINET device name for CI502-PNIO (-XC) module (see [2.] for more details) and relevant PROFINET parameters in your engineering tool;
5. Attach DX581-S (-XC) and/or DI581-S (-XC) safety I/O module(s) to CI502-PNIO (-XC) communication module; Maximum 10 safety I/O modules can be attached;
6. Configure PROFIsafe F-Parameters (refer to [1.] for more details) for DX581-S (-XC) and/or DI581-S (-XC) safety I/O modules;
7. Set module and channel parameters (so-called iParameters, refer to [1.] for more details) for all AC500 and AC500-S I/O modules; Make sure that only valid channel configurations, as it is specified in [1.], are used for DX581-S (-XC) and/or DI581-S (-XC) safety I/O modules to avoid configuration errors;
8. Make sure that all module and channel parameters (iParameters) and destination addresses F_Dest_Add (part of PROFIsafe F-Parameters) are correctly set; Calculate F_iPar_CRC value for given module and channel parameter configurations of DX581-S (-XC) and/or DI581-S (-XC) modules by starting AC500-S F_iPar_CRC Calculator software for selected DX581-S (-XC) or DI581-S (-XC) module, e.g., use “Start device tool …” option and then select “calculate F_iPar_CRC” or similar functions in your PROFINET IO controller / PROFIsafe F-Host engineering tool;

9. In the “AC500-S F-iPar_CRC Calculation” window, check all device parameters for their correctness and activate the check box “I have checked all device parameters. They are correctly set!”

10. Copy the calculated F_iPar_CRC value from AC500-S F_iPar_CRC Calculator and paste it to the PROFIsafe F-Parameter F_iPar_CRC for the given DX581-S (-XC) or DI581-S (-XC) module in your engineering tool; Close AC500-S F_iPar_CRC Calculator; Do this operation for all DX581-S (-XC) and/or DI581-S (-XC) modules; The configuration of unbundled S500 safety I/Os is complete now.

Various aspects to consider when S500 unbundled safety I/Os are used with PROFINET IO controllers / PROFIsafe F-Hosts:

a) Two options for usage of S500 safety I/O error codes are available:
   - PROFINET process alarms;
   - PROFINET standard diagnosis.
   Select for CI502-PNIO (-XC) module a suitable method for error codes and implement (if required in your PROFINET IO controller) calls of special functions or function blocks to transfer S500 safety I/O error codes to the PROFINET IO controller diagnostic buffer; Contact ABB technical support, if questions arise;

b) Take into account S500 safety I/O states like INIT, SAFE STOP, RUN (ok), RUN (user acknowledge request), RUN (module passivation), RUN (channel passivation & reintegration), RUN (module passivation with a command) and transitions between states (refer to [1.] for more details) in your application;

c) To enable channel-granular passivation and reintegration, S500 safety I/O modules support the following additional safety data for your safety application:
   - Safe diagnostic bits / bytes (refer to [1.] for more details), which can be used in your safety application with your PROFIsafe F-Host;
   - Reintegration request bits / bytes and acknowledge reintegration bits / bytes for S500 safety I/O channels (refer to [1.] for more details), which can be used in your safety application with your PROFIsafe F-Host.