X67 system

User's manual

Version: **4.00 (March 2022)**
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Translation of the original documentation

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1 General information

1.1 Manual history

Version	Date	Comment[1)]
4.00	March 2022	New edition • Restructured general sections. • Removed all module data sheets. Revised module overviews. • Linked module names to downloads from the B&R website. • Added safety modules to module overviews.
3.30	March 2019	Updated section "Mechanical and electrical configuration". • Added missing fuses in figures. Updated section "Accessories". Updated section "International and national certifications". Updated section "Additional information". • I/O modules on the bus controller • NetTime Technology Updated data sheets. • Corrected input/output circuit diagram for bus controllers. • Updated technical data.
3.20	March 2018	Added new module. • X67BC8780.L12 Updated section "Accessories". Updated data sheets.
3.10	July 2017	Added new module. • X67HB8880.L12 Corrected cable color error in data sheets. Updated data sheets.
3.00	March 2017	New edition • Revised all sections. • Modified section structure. ° Added separate section "Safety guidelines" after "General information". ° Moved all data sheets after section "Standards and certifications". ° Combined module overviews and B&R ID index into common section. ° Added new section "Additional information" after section "Data sheets". ° Removed model number index, index and appendices. • Revised and updated section "Standards and certifications". ° Added detailed overview of standards and testing requirements. ° Added links to certificates on B&R website. ° Added "Applicable standards" for individual certifications. ° Updated names of standards throughout book. • Updated all data sheets ° Updated or added register descriptions. ° Added pinouts and connection examples. ° Updated technical data.
2.01	April 2009	Additions/Corrections: BC5321, MM2436, SM2436, SM4320

Version	Date	Comment[1)]
2.00	March 2009	Added new module groups: • Motor modules (MM2436, SM2436, SM4320) • Other modules (DC1198, IF1121, UM1352) Updated existing module groups: • Bus controller modules (BC4321-1, BC8331, BC8321 replaced by BC8321-1) • Digital output modules (DO9332.L12) • Digital mixed modules (DM9321) • Analog input modules (AI2744, AI4850) New sections and appendices: • System characteristics • Mechanical and electrical configuration • Standards and certifications • Abbreviations • B&R ID codes Updated section "General information" (safety guidelines). Updated section "Accessories". • Cables • Male connector • Other accessories
1.40	April 2006	Added new modules (BC4321, BC5321, BC6321, BC6321.L08, BC6321.L12, BC8321, DI1371.L08, DI1371.L12, DM1321.L08, DM1321.L12, DM9331.L12, DV1311.L08, DV1311.L12, AI1223, AI1323, AO1223, AO1323) Replaced BC7321 with BC7321-1. Added software filter description for AM1223 and AM1323.
1.3	May 2003	Added new modules (BC7321, AT1322, AT1402). Added software description for DO1332 and AM1323. Added digital and analog sensor cables.
1.2	August 2002	Added cable description.
1.1	July 2002	Added software description for DI1371, DM1321 and AM1223.
1.0	June 2002	First edition

1) Column "Comment" contains only the most important changes in this user's manual. Several updates, corrections and format variations are not included.

1.2 Definition of this term

Term	Description
SG4	System Generation 4 (SG4) - Controllers with Intel processors or ARM. • **X20 system** X20CPx48x(-1), X20(c)CP04xx(-1), X20(c)CP13xx(-RT), X20(c)CPx58x, X20CPx68x(X), X20EMx61x • **Power Panels** C30, C50, C70, C80 • **Automation PCs** APC910, APC2100, APC2200, APC3100, MPC3100 • **Panel PCs** PPC900, PPC2100, PPC2200, PPC3100
SG3	System Generation 3 (SG3) - Controllers with Motorola processors. • **Control systems** System 2003 System 2005 System 2010 • **Power Panels** PP15, PP21, PP35, PP41
SGC	System Generation Compact (SGC) - Controllers with Motorola processors (embedded µP). • **X20 system** X20CP02xx, X20XC02xx

1.3 Abbreviations

The following abbreviations appear throughout the user's manual, for example in data tables or descriptions of pinouts.

Abbreviation	Stands for	Description
NC	Normally closed	Normally closed relay contact.
	Not connected	Used in pinout descriptions if a terminal or pin is not connected to a module.
ND	Not defined	In data tables, this stands for a value that has not been defined. This may be because a cable manufacturer does not provide certain technical data, for example.
NO	Normally open	Normally open relay contact.
TBD	To be defined	Used in technical data tables when certain information is not yet available. The value will be provided later.

1.4 Other applicable documents

Other applicable documents

Document name	Title
MAEMV	Installation / EMC guide

2 Safety notices

Programmable logic controllers, operating/monitoring devices (e.g. industrial PCs, Power Panels, Mobile Panels, etc.) as well as uninterruptible power supplies have all been designed, developed and manufactured by B&R for conventional use or for use with increased safety requirements (safety technology) in industry. They were not designed, developed and manufactured for any use involving serious risks or hazards that could lead to death, injury, serious physical damage or loss of any kind without the implementation of exceptionally stringent safety precautions. In particular, such risks and hazards include the use of these devices to monitor nuclear reactions in nuclear power plants, their use in flight control or flight safety systems as well as in the control of mass transportation systems, medical life support systems or weapons systems.

When using programmable logic controllers or operating/monitoring devices as control systems together with a Soft PLC (e.g. B&R Automation Runtime or comparable product) or Slot PLC (e.g. B&R LS251 comparable product), safety precautions relevant to industrial control systems (e.g. the provision of safety devices such as emergency stop circuits, etc.) must be observed in accordance with applicable national and international regulations. The same applies for all other devices connected to the system, e.g. drives.

All tasks such as the installation, commissioning and servicing of devices are only permitted to be carried out by qualified personnel. Qualified personnel are those familiar with the transport, mounting, installation, commissioning and operation of devices who also have the appropriate qualifications (e.g. IEC 60364-1). National accident prevention regulations must be observed.

The safety notices, connection descriptions (type plate and documentation) and limit values listed in the technical data are to be read carefully before installation and commissioning and must be observed.

2.1 Intended use

Electronic devices are never completely failsafe. If the programmable logic controller, operating/monitoring device or uninterruptible power supply fails, the user is responsible for ensuring that other connected devices such as motors are brought to a safe state.

In all cases, it is necessary to observe and comply with all applicable national and international standards and guidelines, such as machinery directive 2006/42/EC.

2.2 Safety products

Information:

For safety products, the safety guidelines in section "Safety technology" in Automation Help must also be observed in addition to the information in this manual.

2.3 Protection against electrostatic discharges

Electrical components that can be damaged by ESD (**E**lectro**S**tatic **D**ischarges) must be handled properly.

2.3.1 Packaging

- Electrical components with a housing
  ...do not require special ESD packaging but must be handled properly
  (see "Electrical components with a housing" on page 10).
- Electrical components without a housing
  ...are protected by ESD-suitable packaging.

2.3.2 Guidelines for proper ESD handling

Electrical components with a housing

- Do not touch the male connector contacts on the device (bus data contacts).
- Do not touch the male connector contacts on connected cables
- Do not touch the contact tips on circuit boards

Electrical components without a housing

The following points apply in addition to the points listed under "Electrical components with a housing":

- Any persons handling electrical components or devices with installed electrical components must be grounded.
- Components are only permitted to be touched on their narrow sides or front plate.
- Components must always be placed on or stored in a suitable medium (ESD packaging, conductive foam, etc.).

> **Information:**
>
> **Metallic surfaces are not suitable storage surfaces.**

- Components must not be subjected to electrostatic discharge (e.g. caused by charged plastics).
- Observe a minimum distance of 10 cm from monitors and television sets.
- Measuring instruments and equipment must be grounded.
- Probe tips of galvanically isolated measuring instruments must be temporarily discharged on suitably grounded surfaces before taking measurements.

Individual components

- ESD protective measures for individual components are thoroughly implemented at B&R (conductive floors, footwear, arm bands, etc.).
- Increased ESD protective measures for individual components are not required for handling B&R products at customer locations.

2.4 Transport and storage

During transport and storage, devices must be protected against undue stress (mechanical loads, temperature, moisture, corrosive atmospheres, etc.).

Devices contain components sensitive to electrostatic charges that can be damaged by improper handling. It is therefore necessary to provide the required protective measures against electrostatic discharge when installing or removing these devices (see "Protection against electrostatic discharges" on page 9).

2.5 Mounting orientation

- Installation must be performed according to this documentation using suitable equipment and tools.
- Devices are only permitted to be installed by qualified personnel without voltage applied.
- General safety guidelines and national accident prevention regulations must be observed.
- Electrical installation must be carried out in accordance with applicable guidelines (e.g. line cross sections, fuses, protective ground connections).
- Take the necessary steps to protect against electrostatic discharges (see "Protection against electrostatic discharges" on page 9).

2.6 Operation

2.6.1 Protection against touching electrical parts

> **Danger!**
>
> **In order to operate programmable logic controllers, operating and monitoring devices and the uninterruptible power supply, it is necessary for certain components to carry dangerous voltages. Touching one of these components can result in a life-threatening electric shock. There is a risk of death, serious injury or damage to property.**

Before switching on the programmable logic controllers, operating and monitoring devices and uninterruptible power supply, it must be ensured that the housing is properly connected to ground potential (PE rail). The ground connection must also be made if the operating and monitoring device and uninterruptible power supply are only connected for testing purposes or only operated for a short time!

Before switching on the device, all voltage-carrying components must be securely covered. During operation, all covers must remain closed.

2.7 Organization of safety notices

Safety notices in this manual are organized as follows:

Safety notice	Description
Danger!	Disregarding these safety guidelines and notices can be life-threatening.
Caution!	Disregarding these safety guidelines and notices can result in severe injury or substantial damage to property.
Warning!	Disregarding these safety guidelines and notices can result in injury or damage to property.
Information:	This information is important for preventing errors.

Table 1: Organization of safety notices

3 System characteristics

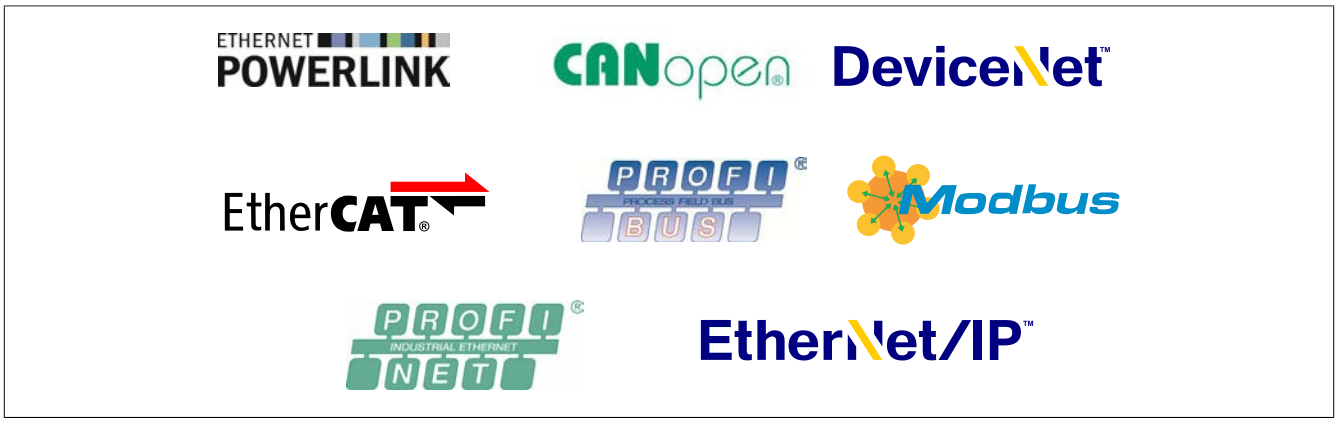
Decentralized machine concepts call for distributed I/O concepts. Ideally, these components are installed directly on-site on nearly any area of the machine. To accomplish this, however, the I/O modules must be rated IP67.

The remote X67 system meets these demands perfectly. This system also makes it possible to reduce costs in many areas, including cabling, the control cabinet, commissioning and service. With a completely distributed structure, the X67 system provides the highest level of flexibility.

To get the most out of a remote I/O system, performance is key. The X67 meets this prerequisite with update times under one millisecond for 1000 digital and 50 analog inputs and outputs!

A maximum of 253 modules can be operated on a single line, with a distance up to 100 m between 2 modules.

Traditional I/O systems are located centrally in the control cabinet, with extensive wiring required for sensors and actuators. In addition, modular machine designs often require intermediate connections with multi-pin connectors. Remote I/O modules can only reach their full potential, however, if additional distribution boxes can be eliminated completely. This is why the optimal solution has to include I/O modules with robust IP67 protection that can be placed directly in harsh industrial environments.



3.1 The X67 system

The X67 system consists of bus controller, I/O, function and system supply modules that can be wired using standard M8 and M12 connectors.

Bus controllers

Bus controllers are the components used to connect to fieldbus systems. Equipped with digital interfaces that can be configured as inputs or outputs, they are already full-fledged I/O modules.

The ability to connect additional modules makes bus controllers extremely flexible and efficient. Like a modular system, the fieldbus device can be expanded. From the point of view of the fieldbus, it still remains a single device. The integrated X2X Link connection makes it possible to effortlessly connect various X67 modules over long distances.

The X67 system is extremely effective in addition to inexpensive. If the fieldbus needs to be changed, only the bus controller changes. The rest stays the same – on the machine and throughout the documentation.

Digital modules

There are many different types of X67 digital modules available:

- 8-/16-channel input modules
- 8-channel output modules. Each channel can handle 2 amps. The maximum total load is 8 amps.
- 8-/16-channel mixed modules with individually configurable channels
- Valve control modules
- Motor modules

This flexibility reduces the number of modules while simplifying logistics and stock management. The number of inputs and outputs can always be tailored exactly to requirements.

Analog modules

The X67 system offers input and output modules, as well as mixed modules with 4 channels each for measuring current or voltage signals.

Modules for measuring temperature using a resistance temperature detector or thermocouple round out the product range. A special male M12 connector for temperature compensation of the measurement point is also available as an accessory for these modules.

One feature common to all analog modules is the complete shielding. The cable shield has seamless 360° contact with the shielding on the module.

Function modules

The X67 system offers special function modules:

- Multifunctional counter module for absolute and incremental encoder and more
- Communication module: Combining RS232 or RS485/RS422 and digital I/O is a compact solution for many types of applications. This makes it possible to connect barcode readers and the corresponding trigger sensor with just one module.

System power supply

The ability to perform diagnostic functions must remain in every operating mode. This is an extremely important aspect of operational safety for the entire machine. For this reason, the power supply for I/O is completely isolated from the power supply for communication on X67 systems. Even if the I/O power supply is interrupted, communication and diagnostic capabilities remain. Flexible system supply modules are used for this purpose. A system supply module can supply 2 lines. Any number of system supply modules can be used in an X67 installation, allowing maximum availability by implementing a redundant supply design.

3.2 General product features

X67 modules have a plastic housing for use in harsh industrial environments. The devices are fully sealed and are therefore extremely resistant to mechanical stress. Integrated LEDs provide clear status indications on the machine, logically distributed on the individual channels, for the X2X Link status and the entire I/O section. Solutions such as central fastening using two screws allow easy installation, even when using wedge nuts in standard aluminum frames.

Open
X67 is an I/O solution for all standard fieldbus systems and for direct connections to B&R controllers. The fieldbus may change, but the I/O system always remains the same.

Adaptable
Digital channels that can be configured as inputs or outputs allow the solution to be tailored to the requirements and reduce the total number and variety of modules needed.

Compact
Optimal ergonomics and an extremely compact design allow the X67 system to fit anywhere on the machine.

Unmistakable
Visual status indicators on the modules and advanced status messages via the bus enable clear-cut diagnostics. Warning and error thresholds for I/O power supply, single-channel diagnostics and open-circuit detection are just a few examples.

Flexible
100 m module spacing without limitations offers sufficient reserves, regardless of whether modules sit close together or distances must be covered.

Robust
These completely sealed modules are the epitome of robustness, with features for maximizing electromagnetic immunity (EMC) hidden inside.

Fast
Cycle times well below one millisecond ensure the necessary reserves for your application. Synchronous I/O processing is a matter of course.

Plug-and-run
Pre-assembled standard cables and automatic module identification reduce installation and commissioning work to an absolute minimum.

Safe
Communication and I/Os are completely galvanically isolated. Disturbances or voltage drops on the I/O side have no influence on the functionality of the bus. Diagnostics is always possible.

Protected
Integrated reverse polarity protection, short-circuit protection, protection when switching inductances – the highest degree of protection for the electronics as well.

Powerful
I/O power via 2 pairs of leads provides up to 8 amps for outputs or supplies additional modules.

Well-supplied
Many sensors and actuators require a 24 VDC power supply. With X67 modules, this is integrated in all digital connections and also provides protection against short circuits.

Shielded
Seamless 360° shield grounding from the cable over the connector directly on the threading of the M12 connector, through to the metal backplane of the module and over the mounting screws straight to the machine provides a complete ground connection for all bus and analog signals.

Centered
The central position of the two mounting screws prevents misalignment of the housing in standard aluminum frames with wedge nut installations.

Expandable
X67 systems can be expanded by 250 modules with up to 100 m between them.

Multi-talented
Synchronous I/O processing, adjustable software filters, integrated counter functions, flexible standard functions and more – these are intelligent products perfect for the most versatile applications.

3.3 Flexibility

Reduced wiring
Instead of having to extensively wire each individual sensor or actuator to the control cabinet over long distances, the X67 system reduces the amount of work down to a single bus cable and a 24 VDC power supply. This applies to the entire machine.

One system for all machine designs
Whether a compact machine or a large plant, this I/O system can be adapted to the machine's architecture to meet every demand for every level of performance. The X67 system offers ultimate freedom.

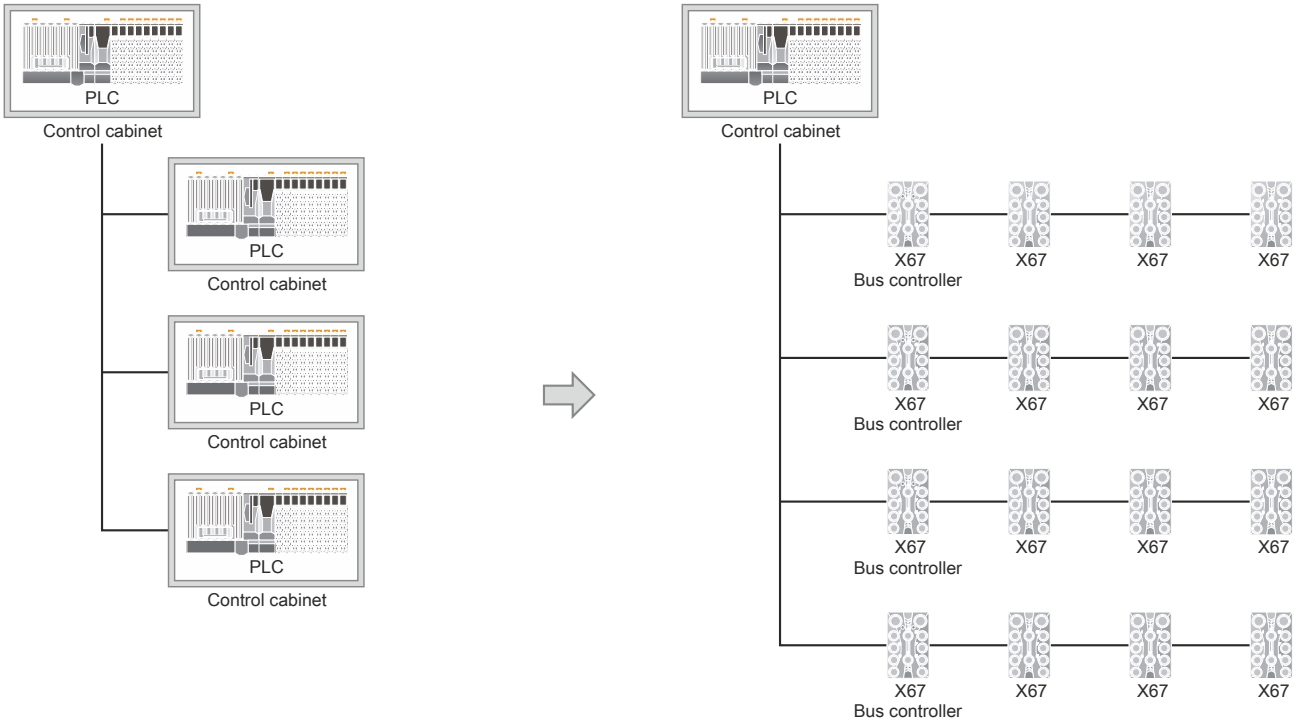
Simple service
Easy error correction, as sensors and actuators can be replaced individually and quickly by means of plug-in connections. Extensive diagnostic options allow errors to be detected immediately.

Minimum control cabinet space
This system opens up the space normally needed for laying cables or placing terminals, I/O modules or additional distribution boxes.

Short commissioning time
Connection via the mechanical, pre-assembled standard cables make this possible. Wiring errors are a thing of the past. Preparation for operation starts with the construction of the machine. Lengthy inspection of the wiring is no longer necessary.

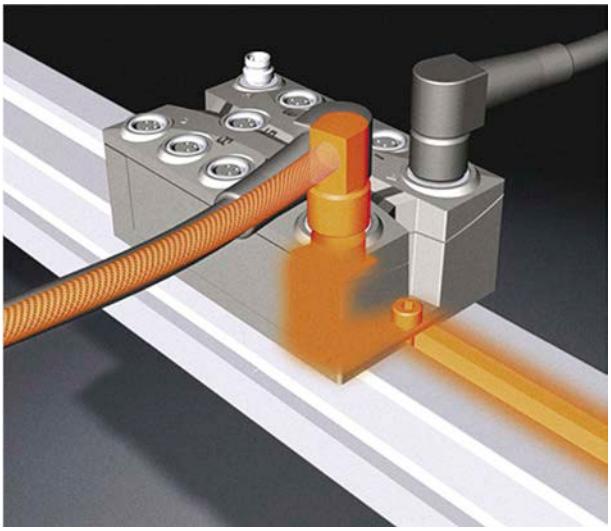
Unlimited expansion possibilities
The X67 system is extremely flexible, handling removable machine modules, optional expansions and even future upgrades to the machine architecture with ease.

Open communication
POWERLINK, CAN bus, CANopen, DeviceNet, PROFIBUS DP, etc. – regardless of the selected fieldbus, the I/O system remains X67.



3.4 EMC concept

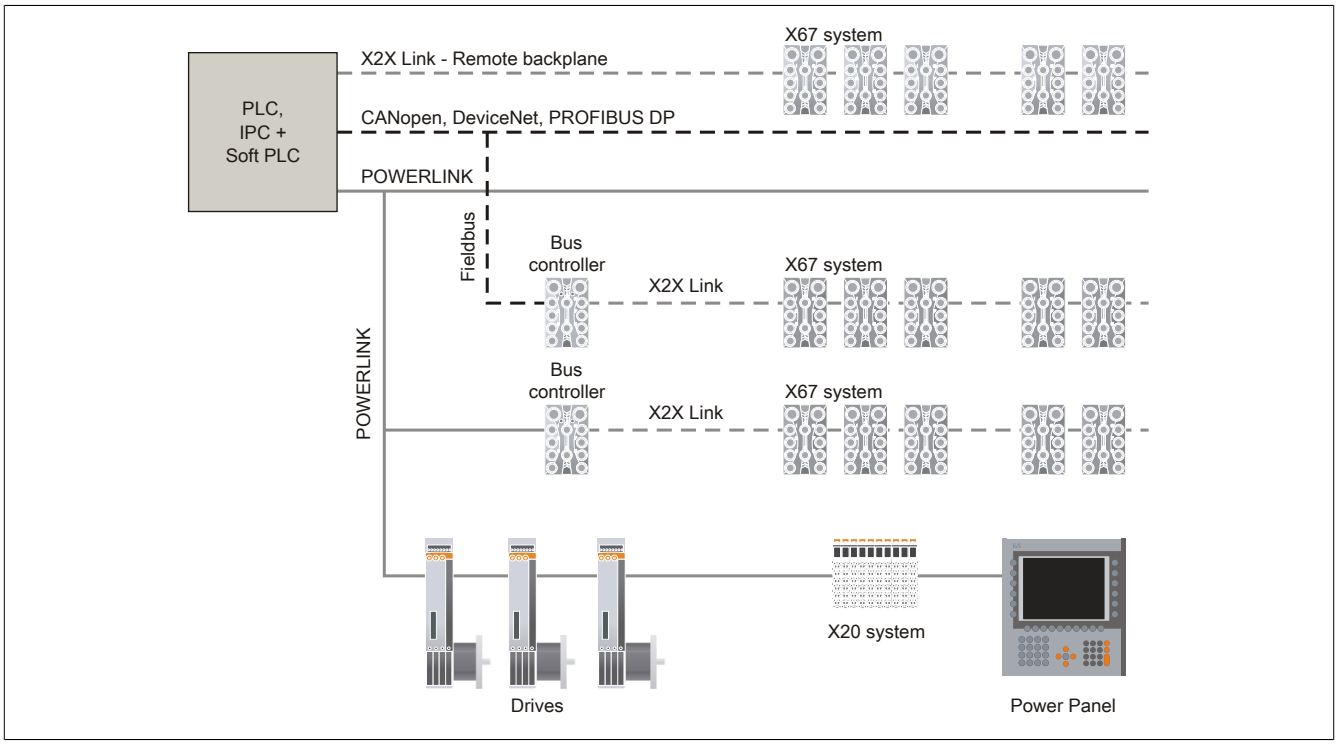
An important feature of the X67 construction is the sophisticated EMC concept. The cable shield is brought into the X67 module via the connector (complete 360° shielding). Inside the X67 housing, all components including the base plate make contact with the same ground. The final link in the chain is the connection between the base plate mounting screw and the machine which completes the ground contact from the cable to the machine. This is done for bus connections and analog connections using M12 connectors.



3.5 Communication

The goal of development was to detach individual modules from the backplane to achieve a real remote system . The X67 system uses a cable to replace the conventional backplane and connect the modules together. The name of this "decentralized backplane" is **"X2X Link"**.

The X67 system offers many connection options: X2X Link for direct connection of controllers or IPCs with aPCI modules or PCI cards. Indirect connections or connections to non-B&R controllers utilize the various fieldbus systems POWERLINK, CAN, CANopen, DeviceNet and PROFIBUS DP.

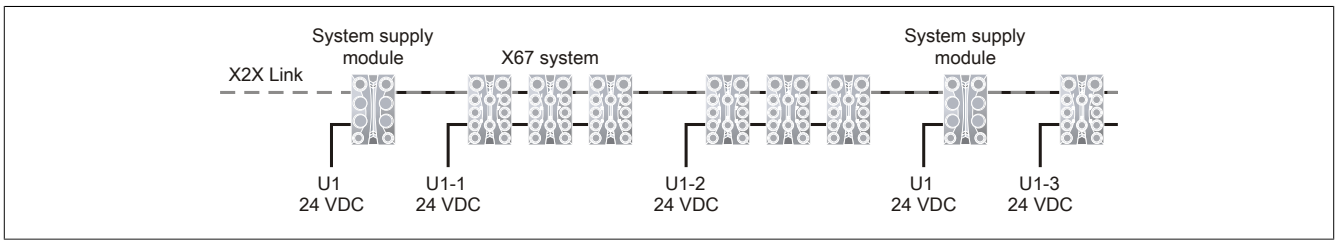


3.6 System power supply

The X67's decentralized structure allows modules to be placed in different power supply groups as needed. For example, this allows various modules to be connected to different voltage protection circuits or different emergency stop groups to be implemented.

The entire X2X Link network is operated totally independently of the I/O power supply. In addition to the communication lines, the connection cable contains 2 wires to supply power to the X2X Link electronics of each module. This is fully galvanically isolated from the I/O component. For this reason, power failures on the I/O side (e.g. due to short circuit, open circuit or emergency stop) only stop operation of the I/O section. The bus section continues to function with the corresponding status messages being sent to the controller. This feature is essential in allowing errors to be analyzed quickly and corrected.

The X2X Link power supply is guaranteed by system supply modules.

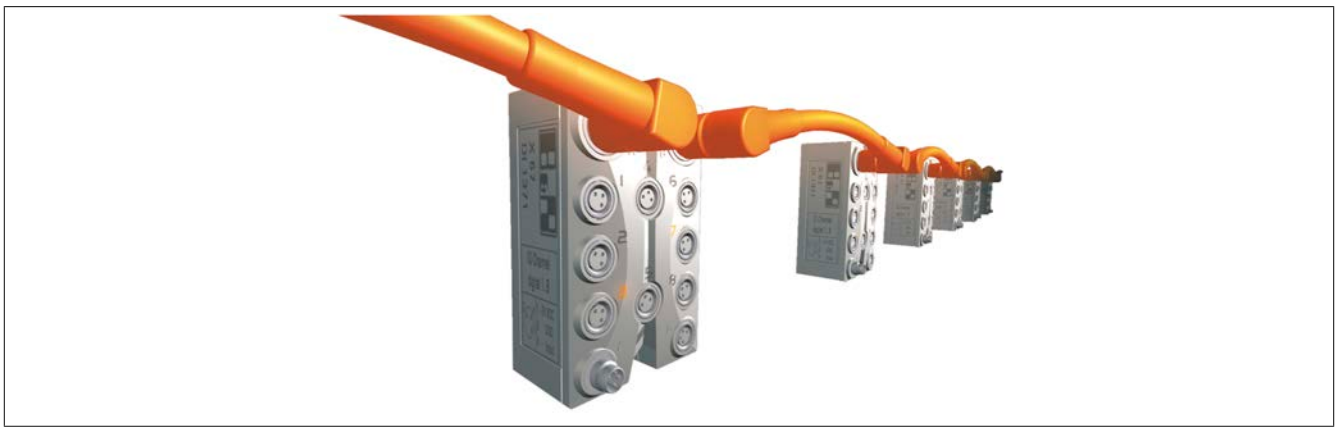


3.7 X2X Link

All connections are made using standard M8 or M12 connectors. The X2X Link connectors are keyed to prevent mix-ups with the M12 analog connectors.

X2X Link is based on shielded copper cables. Each module has one integrated male and female connector, one X2X Link input and one X2X Link output. An additional T-connector is not needed. Each module is operated synchronously. That means reading inputs or writing outputs takes place synchronous to the X2X Link cycle. In addition to cyclic communication, X2X Link also offers acyclic communication, e.g. to load parameters onto the module.

By default, it is not necessary to configure the node number switches on X67 modules. The modules are automatically identified by the system when started up using their X2X Link position.

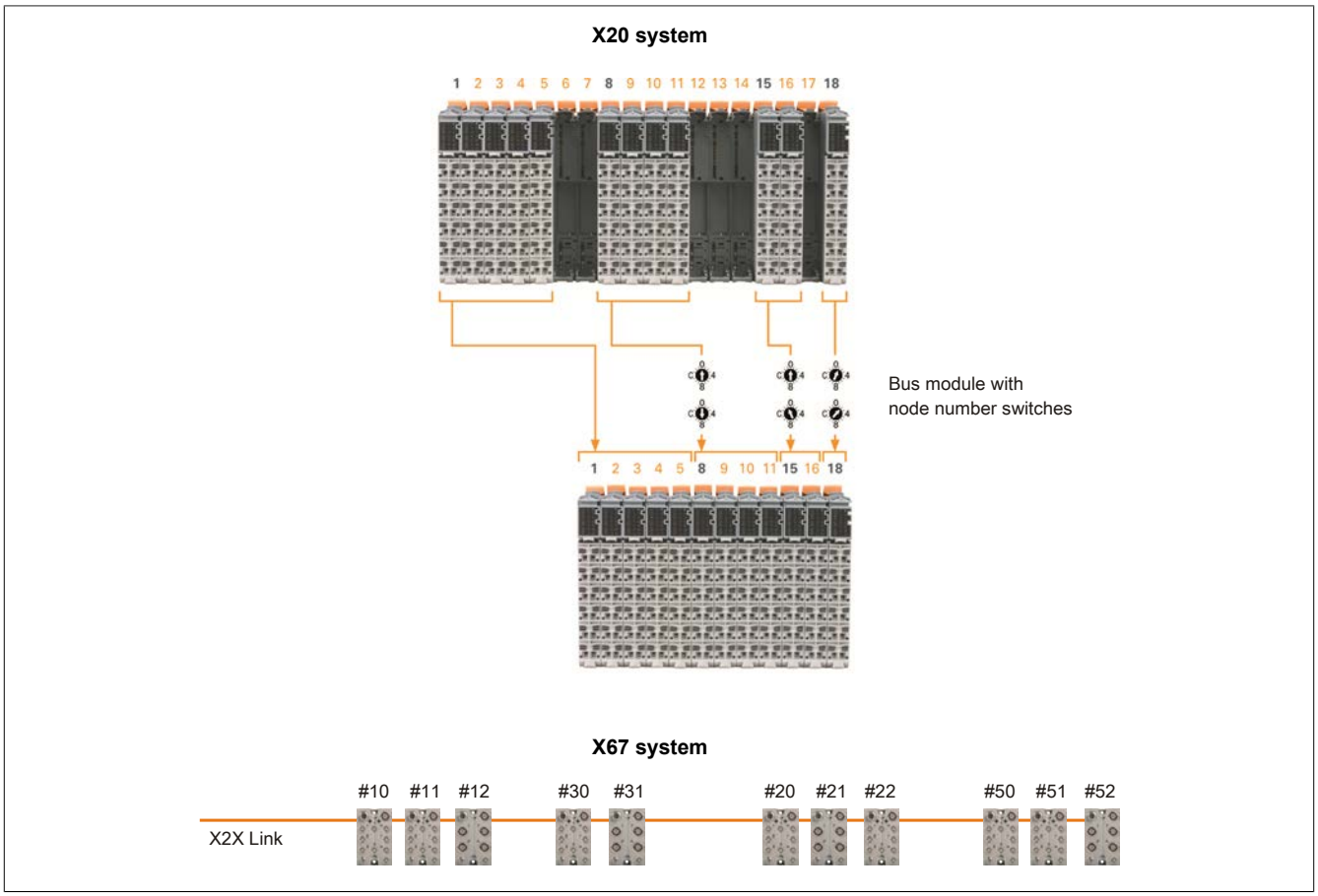


Configurable X2X Link address

The remote X2X Link backplane, which connects the individual I/O modules with each other, is set up to be self-addressing. Because of this, it is not necessary to set the node numbers. The module address is assigned according to its position in the X2X Link line.

In certain cases, e.g. when configurations of modular machines change, it is necessary to define specific module groups at a fixed address, regardless of the preceding modules in the line.

For this purpose, there are modules in both the X20 system and the X67 system with node number switches that allow the X2X Link address to be set. All subsequent modules refer to this offset and use it automatically for addressing purposes.



4 Module overviews

4.1 Standard modules

4.1.1 Module overview: Alphabetical

Order number	Module type	Description	Special functions
X67AI1223	Analog input module	• 4 inputs, ±10 V, 12-bit converter resolution	• Configurable input filter • Open-circuit detection
X67AI1233	Analog input module	• 4 inputs, ±10 V, 16-bit converter resolution	• Configurable input filter • Open-circuit detection
X67AI1323	Analog input module	• 4 inputs, 0 to 20 mA or 4 to 20 mA, 12-bit converter resolution	• Configurable input filter
X67AI1333	Analog input module	• 4 inputs, 0 to 20 mA or 4 to 20 mA, 16-bit converter resolution	• Configurable input filter
X67AI2744	Analog input module	• 2 full-bridge strain gauge inputs, 10 V, 24-bit converter resolution	
X67AI4850	Analog input module	• 4 potentiometer displacement gauges, 14-bit converter resolution	
X67AM1223	Analog mixed module	• 2 analog inputs • 2 analog outputs, ±10 V, 12-bit converter resolution	• Configurable input filter • Open-circuit detection on the inputs
X67AM1323	Analog mixed module	• 2 analog inputs • 2 analog outputs, 0 to 20 mA, 12-bit converter resolution	• Configurable input filter
X67AO1223	Analog output module	• 4 outputs, ±10 V, 12-bit converter resolution	
X67AO1323	Analog output module	• 4 outputs, 0 to 20 mA, 12-bit converter resolution	
X67AT1311	Temperature input module	• 4 resistance measurement inputs, Pt100, resolution 0.01K	• 2- or 4-wire measurement
X67AT1322	Temperature input module	• Resistance measurement inputs, Pt100, Pt1000, KTY10, KTY84, resolution 0.1 K	• 2- or 4-wire measurement
X67AT1402	Temperature input module	• 4 thermocouple inputs, type J, K, N, R, S, resolution 0.1 K	
X67BC4321-10	Bus controller	• 1 CANopen interface • X2X Link power supply 3 W • M8 connectors	• Integrated digital mixed module X67DM1321 • CAN bus galvanically isolated
X67BC4321.L08-10	Bus controller	• 1 CANopen interface • X2X Link power supply 15 W • M8 connectors	• Integrated digital mixed module X67DM1321.L08 • CAN bus galvanically isolated • High-density module
X67BC4321.L12-10	Bus controller	• 1 CANopen interface • X2X Link power supply 15 W • M12 connectors	• Integrated digital mixed module X67DM1321.L12 • CAN bus galvanically isolated • High-density module
X67BC5321	Bus controller	• 1 DeviceNet interface • X2X Link power supply 3 W • M8 connectors	• Integrated digital mixed module X67DM1321
X67BC6321	Bus controller	• 1 PROFIBUS DP interface • X2X Link power supply 3 W • M8 connectors	• Integrated digital mixed module X67DM1321
X67BC6321.L08	Bus controller	• 1 PROFIBUS DP interface • X2X Link power supply 15 W • M8 connectors	• Integrated digital mixed module X67DM1321.L08 • High-density module
X67BC6321.L12	Bus controller	• 1 PROFIBUS DP interface • X2X Link power supply 15 W • M12 connectors	• Integrated digital mixed module X67DM1321.L12 • High-density module
X67BC7321-1	Bus controller	• 1 CAN I/O interface • X2X Link power supply 3 W • M8 connectors	• Integrated digital mixed module X67DM1321 • Extended CAN I/O functionality

Order number	Module type	Description	Special functions
X67BC81RT.L12	Bus controller reACTION Technology module	• 2 POWERLINK interface • X2X Link power supply 15 W • M12 connectors	• 2 digital inputs, 24 VDC, <1 µs, • 3 digital inputs/outputs, 5 VDC, <1 µs • 2 digital inputs/outputs, 24 VDC, 0.4 A, <1 µs • 2 analog inputs ±10 V, 5 µs 200 kHz sampling frequency, 13-bit converter resolution, configurable input filter • 1 analog output ±10 V, 2.5 µs, 13-bit converter resolution • High-density module
X67BC8321-1	Bus controller	• 1 POWERLINK interface • X2X Link power supply 3 W • M8 connectors	• Integrated digital mixed module X67DM1321
X67BC8321.L12	Bus controller	• 1 POWERLINK interface • X2X Link power supply 15 W • M12 connectors	• Integrated digital mixed module X67DM1321.L12 • High-density module
X67BC8331	Bus controller	• 1 POWERLINK interface • X2X Link power supply 3 W • M8 connectors	• 8 digital inputs/outputs, 24 VDC, 2 A, configurable input filter
X67BC8513.L12	Bus controller	• POWERLINK interface • X2X Link power supply 15 W • M12 connectors	• 12 digital inputs/outputs, 24 VDC, 0.5 A, configurable input filter, 1 event counter 50 kHz • 1 analog input, 0 to 20 mA, 12-bit converter resolution • High-density module
X67BC8513.L12-1	Bus controller	• 1 POWERLINK interface • X2X Link power supply 15 W • M12 connectors	• 6 digital input channels • 6 digital output channels, 24 VDC, 0.5 A, propagation delay measurement • 1 analog input, 0 to 20 mA, 12-bit converter resolution, configurable analog input filter • High-density module
X67BC8780.L12	Bus controller	• POWERLINK interface • 1x CAN interface • M12 connectors	• CAN interface with active wiring aid for 8x connections (star wiring) • High-density module
X67BCD321.L12	Bus controller	• EtherNet/IP interface • X2X Link power supply 15 W • M12 connectors	• Integrated digital mixed module X67DM1321.L12 • High-density module
X67BCD321.L12-1	Bus controller	• 1 EtherNet/IP interface • X2X Link power supply 15 W • M12 connectors - pinning variant	• Integrated digital mixed module X67DM1321.L12 • High-density module
X67BCE321.L12	Bus controller	• 1 PROFINET interface • X2X Link power supply 15 W • M12 connectors	• Integrated digital mixed module X67DM1321.L12 • High-density module
X67BCG321.L12	Bus controller	• 1 EtherCAT interface • X2X Link power supply 15 W • M12 connectors	• Integrated digital mixed module X67DM1321.L12 • High-density module
X67BCJ321.L12	Bus controller	• 1 Modbus TCP/UDP interface • X2X Link power supply 15 W • M12 connectors	• Integrated digital mixed module X67DM1321.L12 • High-density module
X67DC1198	Digital counter module	• 2x 3 inputs 5 V for SSI 1 Mbit/s or ABR 250 kHz, • 8 digital inputs/outputs 24 VDC, 0.1 A • Optionally configurable: – 8 inputs/outputs – 4 AB counters, 100 kHz – 4 comparator outputs – 2 PWM outputs	• Local time measurement functions
X67DC2322	Resolver module	• 2x 14-bit resolver input BRX/BRT • 2 digital inputs, 24 VDC, sink • 2 digital outputs, 0.5 A, source	
X67DI1371	Digital input module	• 8 inputs, 24 VDC, sink	• Input filter 1 ms
X67DI1371.L08	Digital input module	• 16 inputs, 24 VDC, sink • M8 connectors	• Input filter 1 ms • High-density module
X67DI1371.L12	Digital input module	• 16 inputs, 24 VDC, sink • M12 connectors	• Input filter 1 ms • High-density module
X67DI1372	Digital input module	• 8 inputs, 24 VDC, source	• Input filter 1 ms
X67DM1321	Digital mixed module	• 8 digital inputs/outputs, 24 VDC, 0.5 A	• Configurable input filter • 2 event counters, 50 kHz
X67DM1321.L08	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M8 connectors	• Configurable input filter • 2 event counters, 50 kHz • High-density module
X67DM1321.L12	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M12 connectors	• Configurable input filter • 2 event counters, 50 kHz • High-density module

Module overviews

Order number	Module type	Description	Special functions
X67DM1321.L12-1	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M12 connectors - pinning variant	• Configurable input filter • 2 event counters, 50 kHz • High-density module
X67DM9321	Digital mixed module	• 8 digital inputs/outputs, 24 VDC, 0.5 A • X2X Link address switch	• Configurable input filter • 2 event counters, 50 kHz
X67DM9321.L12	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M12 connectors, • X2X Link address switch	• Configurable input filter • 2 event counters, 50 kHz • High-density module
X67DM9331.L12	Digital mixed module	• 8 digital inputs/outputs, 24 VDC, 2 A • M12 connectors • X2X Link address switch	• Configurable input filter • Single-channel sensor/actuator power supply monitoring • High-density module
X67DO1332	Digital output module	• 8 digital outputs, 24 VDC, 2 A	• Readable output status
X67DO9332.L12	Digital output module	• 8 outputs, 24 VDC, 2 A • M12 connectors • X2X Link address switch	• Single-channel actuator power supply monitoring • High-density module
X67DS438A	Digital signal module	• 4x IO-Link master V1.1, also usable as digital inputs/outputs	• 3-wire connections • NetTime function
X67DV1311.L08	Digital valve control module	• 16 digital outputs, 24 VDC, 0.1 A, 1 M16 connector • 16 digital inputs, 24 VDC, sink • M8 connectors	• Configurable input filter • High-density module
X67DV1311.L12	Digital valve control module	• 16 digital outputs, 24 VDC, 0.1 A, 1 M16 connector • 16 digital inputs, 24 VDC, sink • M12 connectors	• Configurable input filter • High-density module
X67HB8880.L12	Hub module	• 8-port industrial hub (layer 2), 8 to 32 VDC • M12 connectors	
X67IF1121-1	Interface module	• 1 RS232 interface • 1 RS422/485 interface • 2 digital inputs/outputs, 24 VDC, 0.5 A • 2 digital inputs, 24 VDC, sink	• Configurable input filter
X67MM2436	PWM motor module	• I/O power supply 24 to 38.5 VDC ±25% • 2 PWM motor bridges, 3 A continuous current, 5 A peak current • 2x 3 digital inputs 24 VDC, sink, configurable as incremental encoder	
X67PS1300	System supply module	• 24 VDC • X2X Link power supply 15 W	• Reverse polarity protection, short-circuit proof, overload-proof, parallel connection possible, redundancy operation possible
X67SM2436	Stepper motor module	• I/O power supply 24 to 38.5 VDC ±25% • 2 motor connections, 3 A continuous current, 5 A peak current • 2x 3 digital inputs 24 VDC, sink, configurable as incremental encoder	• NetTime function
X67SM2446-1	Stepper motor module	• Module power supply 24 to 48 VDC ±25% • 2 motor connections, 4 A continuous current, 8 A peak current • 6 digital inputs 24 VDC, sink, configurable as incremental encoder	• Current reduction function • NetTime function
X67SM4320	Stepper motor module	• I/O power supply 24 VDC ±25% • 4 motor connections, 1 A continuous current, 1.5 A peak current	• NetTime function
X67UM1352	Universal mixed module	• 1 input for evaluation of full-bridge strain gauge, 24-bit converter resolution • 4 digital inputs 24 VDC, sink • 1 digital output, 0.5 A, source • 1 digital output, 1 A, source	

4.1.2 Module overview: Grouped

4.1.2.1 Analog outputs

Order number	Module type	Description	Special functions
X67AM1223	Analog mixed module	• 2 analog inputs • 2 analog outputs, ±10 V, 12-bit converter resolution	• Configurable input filter • Open-circuit detection on the inputs
X67AM1323	Analog mixed module	• 2 analog inputs • 2 analog outputs, 0 to 20 mA, 12-bit converter resolution	• Configurable input filter
X67AO1223	Analog output module	• 4 outputs, ±10 V, 12-bit converter resolution	
X67AO1323	Analog output module	• 4 outputs, 0 to 20 mA, 12-bit converter resolution	

4.1.2.2 Analog inputs

Order number	Module type	Description	Special functions
X67AI1223	Analog input module	• 4 inputs, ±10 V, 12-bit converter resolution	• Configurable input filter • Open-circuit detection
X67AI1233	Analog input module	• 4 inputs, ±10 V, 16-bit converter resolution	• Configurable input filter • Open-circuit detection
X67AI1323	Analog input module	• 4 inputs, 0 to 20 mA or 4 to 20 mA, 12-bit converter resolution	• Configurable input filter
X67AI1333	Analog input module	• 4 inputs, 0 to 20 mA or 4 to 20 mA, 16-bit converter resolution	• Configurable input filter
X67AI2744	Analog input module	• 2 full-bridge strain gauge inputs, 10 V, 24-bit converter resolution	
X67AI4850	Analog input module	• 4 potentiometer displacement gauges, 14-bit converter resolution	
X67AM1223	Analog mixed module	• 2 analog inputs • 2 analog outputs, ±10 V, 12-bit converter resolution	• Configurable input filter • Open-circuit detection on the inputs
X67AM1323	Analog mixed module	• 2 analog inputs • 2 analog outputs, 0 to 20 mA, 12-bit converter resolution	• Configurable input filter
X67UM1352	Universal mixed module	• 1 input for evaluation of full-bridge strain gauge, 24-bit converter resolution • 4 digital inputs 24 VDC, sink • 1 digital output, 0.5 A, source • 1 digital output, 1 A, source	

4.1.2.3 Analog mixed modules

Order number	Module type	Description	Special functions
X67AM1223	Analog mixed module	• 2 analog inputs • 2 analog outputs, ±10 V, 12-bit converter resolution	• Configurable input filter • Open-circuit detection on the inputs
X67AM1323	Analog mixed module	• 2 analog inputs • 2 analog outputs, 0 to 20 mA, 12-bit converter resolution	• Configurable input filter

4.1.2.4 Bus controller

Order number	Module type	Description	Special functions
X67BC4321-10	Bus controller	• 1 CANopen interface • X2X Link power supply 3 W • M8 connectors	• Integrated digital mixed module X67DM1321 • CAN bus galvanically isolated
X67BC4321.L08-10	Bus controller	• 1 CANopen interface • X2X Link power supply 15 W • M8 connectors	• Integrated digital mixed module X67DM1321.L08 • CAN bus galvanically isolated • High-density module
X67BC4321.L12-10	Bus controller	• 1 CANopen interface • X2X Link power supply 15 W • M12 connectors	• Integrated digital mixed module X67DM1321.L12 • CAN bus galvanically isolated • High-density module
X67BC5321	Bus controller	• 1 DeviceNet interface • X2X Link power supply 3 W • M8 connectors	• Integrated digital mixed module X67DM1321

Module overviews

Order number	Module type	Description	Special functions
X67BC6321	Bus controller	• 1 PROFIBUS DP interface • X2X Link power supply 3 W • M8 connectors	• Integrated digital mixed module X67DM1321
X67BC6321.L08	Bus controller	• 1 PROFIBUS DP interface • X2X Link power supply 15 W • M8 connectors	• Integrated digital mixed module X67DM1321.L08 • High-density module
X67BC6321.L12	Bus controller	• 1 PROFIBUS DP interface • X2X Link power supply 15 W • M12 connectors	• Integrated digital mixed module X67DM1321.L12 • High-density module
X67BC7321-1	Bus controller	• 1 CAN I/O interface • X2X Link power supply 3 W • M8 connectors	• Integrated digital mixed module X67DM1321 • Extended CAN I/O functionality
X67BC81RT.L12	Bus controller reACTION Technology module	• 2 POWERLINK interface • X2X Link power supply 15 W • M12 connectors	• 2 digital inputs, 24 VDC, <1 µs, • 3 digital inputs/outputs, 5 VDC, <1 µs • 2 digital inputs/outputs, 24 VDC, 0.4 A, <1 µs • 2 analog inputs ±10 V, 5 µs 200 kHz sampling frequency, 13-bit converter resolution, configurable input filter • 1 analog output ±10 V, 2.5 µs, 13-bit converter resolution • High-density module
X67BC8321-1	Bus controller	• 1 POWERLINK interface • X2X Link power supply 3 W • M8 connectors	• Integrated digital mixed module X67DM1321
X67BC8321.L12	Bus controller	• 1 POWERLINK interface • X2X Link power supply 15 W • M12 connectors	• Integrated digital mixed module X67DM1321.L12 • High-density module
X67BC8331	Bus controller	• 1 POWERLINK interface • X2X Link power supply 3 W • M8 connectors	• 8 digital inputs/outputs, 24 VDC, 2 A, configurable input filter
X67BC8513.L12	Bus controller	• POWERLINK interface • X2X Link power supply 15 W • M12 connectors	• 12 digital inputs/outputs, 24 VDC, 0.5 A, configurable input filter, 1 event counter 50 kHz • 1 analog input, 0 to 20 mA, 12-bit converter resolution • High-density module
X67BC8513.L12-1	Bus controller	• 1 POWERLINK interface • X2X Link power supply 15 W • M12 connectors	• 6 digital input channels • 6 digital output channels, 24 VDC, 0.5 A, propagation delay measurement • 1 analog input, 0 to 20 mA, 12-bit converter resolution, configurable analog input filter • High-density module
X67BC8780.L12	Bus controller	• POWERLINK interface • 1x CAN interface • M12 connectors	• CAN interface with active wiring aid for 8x connections (star wiring) • High-density module
X67BCD321.L12	Bus controller	• EtherNet/IP interface • X2X Link power supply 15 W • M12 connectors	• Integrated digital mixed module X67DM1321.L12 • High-density module
X67BCD321.L12-1	Bus controller	• 1 EtherNet/IP interface • X2X Link power supply 15 W • M12 connectors - pinning variant	• Integrated digital mixed module X67DM1321.L12 • High-density module
X67BCE321.L12	Bus controller	• 1 PROFINET interface • X2X Link power supply 15 W • M12 connectors	• Integrated digital mixed module X67DM1321.L12 • High-density module
X67BCG321.L12	Bus controller	• 1 EtherCAT interface • X2X Link power supply 15 W • M12 connectors	• Integrated digital mixed module X67DM1321.L12 • High-density module
X67BCJ321.L12	Bus controller	• 1 Modbus TCP/UDP interface • X2X Link power supply 15 W • M12 connectors	• Integrated digital mixed module X67DM1321.L12 • High-density module
X67HB8880.L12	Hub module	• 8-port industrial hub (layer 2), 8 to 32 VDC • M12 connectors	

4.1.2.5 Digital outputs

Order number	Module type	Description	Special functions
X67DM1321	Digital mixed module	• 8 digital inputs/outputs, 24 VDC, 0.5 A	• Configurable input filter • 2 event counters, 50 kHz
X67DM1321.L08	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M8 connectors	• Configurable input filter • 2 event counters, 50 kHz • High-density module
X67DM1321.L12	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M12 connectors	• Configurable input filter • 2 event counters, 50 kHz • High-density module
X67DM1321.L12-1	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M12 connectors - pinning variant	• Configurable input filter • 2 event counters, 50 kHz • High-density module
X67DM9321	Digital mixed module	• 8 digital inputs/outputs, 24 VDC, 0.5 A • X2X Link address switch	• Configurable input filter • 2 event counters, 50 kHz
X67DM9321.L12	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M12 connectors, • X2X Link address switch	• Configurable input filter • 2 event counters, 50 kHz • High-density module
X67DM9331.L12	Digital mixed module	• 8 digital inputs/outputs, 24 VDC, 2 A • M12 connectors • X2X Link address switch	• Configurable input filter • Single-channel sensor/actuator power supply monitoring • High-density module
X67DO1332	Digital output module	• 8 digital outputs, 24 VDC, 2 A	• Readable output status
X67DO9332.L12	Digital output module	• 8 outputs, 24 VDC, 2 A • M12 connectors • X2X Link address switch	• Single-channel actuator power supply monitoring • High-density module
X67DV1311.L08	Digital valve control module	• 16 digital outputs, 24 VDC, 0.1 A, 1 M16 connector • 16 digital inputs, 24 VDC, sink • M8 connectors	• Configurable input filter • High-density module
X67DV1311.L12	Digital valve control module	• 16 digital outputs, 24 VDC, 0.1 A, 1 M16 connector • 16 digital inputs, 24 VDC, sink • M12 connectors	• Configurable input filter • High-density module
X67MM2436	PWM motor module	• I/O power supply 24 to 38.5 VDC ±25% • 2 PWM motor bridges, 3 A continuous current, 5 A peak current • 2x 3 digital inputs 24 VDC, sink, configurable as incremental encoder	
X67SM2436	Stepper motor module	• I/O power supply 24 to 38.5 VDC ±25% • 2 motor connections, 3 A continuous current, 5 A peak current • 2x 3 digital inputs 24 VDC, sink, configurable as incremental encoder	• NetTime function
X67SM2446-1	Stepper motor module	• Module power supply 24 to 48 VDC ±25% • 2 motor connections, 4 A continuous current, 8 A peak current • 6 digital inputs 24 VDC, sink, configurable as incremental encoder	• Current reduction function • NetTime function
X67SM4320	Stepper motor module	• I/O power supply 24 VDC ±25% • 4 motor connections, 1 A continuous current, 1.5 A peak current	• NetTime function
X67UM1352	Universal mixed module	• 1 input for evaluation of full-bridge strain gauge, 24-bit converter resolution • 4 digital inputs 24 VDC, sink • 1 digital output, 0.5 A, source • 1 digital output, 1 A, source	

4.1.2.6 Digital inputs

Order number	Module type	Description	Special functions
X67DI1371	Digital input module	• 8 inputs, 24 VDC, sink	• Input filter 1 ms
X67DI1371.L08	Digital input module	• 16 inputs, 24 VDC, sink • M8 connectors	• Input filter 1 ms • High-density module
X67DI1371.L12	Digital input module	• 16 inputs, 24 VDC, sink • M12 connectors	• Input filter 1 ms • High-density module
X67DI1372	Digital input module	• 8 inputs, 24 VDC, source	• Input filter 1 ms
X67DM1321	Digital mixed module	• 8 digital inputs/outputs, 24 VDC, 0.5 A	• Configurable input filter • 2 event counters, 50 kHz
X67DM1321.L08	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M8 connectors	• Configurable input filter • 2 event counters, 50 kHz • High-density module
X67DM1321.L12	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M12 connectors	• Configurable input filter • 2 event counters, 50 kHz • High-density module

Order number	Module type	Description	Special functions
X67DM1321.L12-1	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M12 connectors - pinning variant	• Configurable input filter • 2 event counters, 50 kHz • High-density module
X67DM9321	Digital mixed module	• 8 digital inputs/outputs, 24 VDC, 0.5 A • X2X Link address switch	• Configurable input filter • 2 event counters, 50 kHz
X67DM9321.L12	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M12 connectors, • X2X Link address switch	• Configurable input filter • 2 event counters, 50 kHz • High-density module
X67DM9331.L12	Digital mixed module	• 8 digital inputs/outputs, 24 VDC, 2 A • M12 connectors • X2X Link address switch	• Configurable input filter • Single-channel sensor/actuator power supply monitoring • High-density module
X67UM1352	Universal mixed module	• 1 input for evaluation of full-bridge strain gauge, 24-bit converter resolution • 4 digital inputs 24 VDC, sink • 1 digital output, 0.5 A, source • 1 digital output, 1 A, source	

4.1.2.7 Digital mixed modules

Order number	Module type	Description	Special functions
X67DM1321	Digital mixed module	• 8 digital inputs/outputs, 24 VDC, 0.5 A	• Configurable input filter • 2 event counters, 50 kHz
X67DM1321.L08	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M8 connectors	• Configurable input filter • 2 event counters, 50 kHz • High-density module
X67DM1321.L12	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M12 connectors	• Configurable input filter • 2 event counters, 50 kHz • High-density module
X67DM1321.L12-1	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M12 connectors - pinning variant	• Configurable input filter • 2 event counters, 50 kHz • High-density module
X67DM9321	Digital mixed module	• 8 digital inputs/outputs, 24 VDC, 0.5 A • X2X Link address switch	• Configurable input filter • 2 event counters, 50 kHz
X67DM9321.L12	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M12 connectors, • X2X Link address switch	• Configurable input filter • 2 event counters, 50 kHz • High-density module
X67DM9331.L12	Digital mixed module	• 8 digital inputs/outputs, 24 VDC, 2 A • M12 connectors • X2X Link address switch	• Configurable input filter • Single-channel sensor/actuator power supply monitoring • High-density module
X67UM1352	Universal mixed module	• 1 input for evaluation of full-bridge strain gauge, 24-bit converter resolution • 4 digital inputs 24 VDC, sink • 1 digital output, 0.5 A, source • 1 digital output, 1 A, source	

4.1.2.8 Digital valve control

Order number	Module type	Description	Special functions
X67DV1311.L08	Digital valve control module	• 16 digital outputs, 24 VDC, 0.1 A, 1 M16 connector • 16 digital inputs, 24 VDC, sink • M8 connectors	• Configurable input filter • High-density module
X67DV1311.L12	Digital valve control module	• 16 digital outputs, 24 VDC, 0.1 A, 1 M16 connector • 16 digital inputs, 24 VDC, sink • M12 connectors	• Configurable input filter • High-density module

4.1.2.9 Hub system

Order number	Module type	Description	Special functions
X67HB8880.L12	Hub module	• 8-port industrial hub (layer 2), 8 to 32 VDC • M12 connectors	

4.1.2.10 Communication modules

Order number	Module type	Description	Special functions
X67IF1121-1	Interface module	• 1 RS232 interface • 1 RS422/485 interface • 2 digital inputs/outputs, 24 VDC, 0.5 A • 2 digital inputs, 24 VDC, sink	• Configurable input filter

4.1.2.11 Motor modules

Order number	Module type	Description	Special functions
X67MM2436	PWM motor module	• I/O power supply 24 to 38.5 VDC ±25% • 2 PWM motor bridges, 3 A continuous current, 5 A peak current • 2x 3 digital inputs 24 VDC, sink, configurable as incremental encoder	
X67SM2436	Stepper motor module	• I/O power supply 24 to 38.5 VDC ±25% • 2 motor connections, 3 A continuous current, 5 A peak current • 2x 3 digital inputs 24 VDC, sink, configurable as incremental encoder	• NetTime function
X67SM2446-1	Stepper motor module	• Module power supply 24 to 48 VDC ±25% • 2 motor connections, 4 A continuous current, 8 A peak current • 6 digital inputs 24 VDC, sink, configurable as incremental encoder	• Current reduction function • NetTime function
X67SM4320	Stepper motor module	• I/O power supply 24 VDC ±25% • 4 motor connections, 1 A continuous current, 1.5 A peak current	• NetTime function

4.1.2.12 Multifunction

Order number	Module type	Description	Special functions
X67DC1198	Digital counter module	• 2x 3 inputs 5 V for SSI 1 Mbit/s or ABR 250 kHz, • 8 digital inputs/outputs 24 VDC, 0.1 A • Optionally configurable: – 8 inputs/outputs – 4 AB counters, 100 kHz – 4 comparator outputs – 2 PWM outputs	• Local time measurement functions
X67DC2322	Resolver module	• 2x 14-bit resolver input BRX/BRT • 2 digital inputs, 24 VDC, sink • 2 digital outputs, 0.5 A, source	

4.1.2.13 reACTION I/O modules

Order number	Module type	Description	Special functions
X67BC81RT.L12	Bus controller reACTION Technology module	• 2 POWERLINK interface • X2X Link power supply 15 W • M12 connectors	• 2 digital inputs, 24 VDC, <1 µs, • 3 digital inputs/outputs, 5 VDC, <1 µs • 2 digital inputs/outputs, 24 VDC, 0.4 A, <1 µs • 2 analog inputs ±10 V, 5 µs 200 kHz sampling frequency, 13-bit converter resolution, configurable input filter • 1 analog output ±10 V, 2.5 µs, 13-bit converter resolution • High-density module

4.1.2.14 Other functions

Order number	Module type	Description	Special functions
X67DS438A	Digital signal module	• 4x IO-Link master V1.1, also usable as digital inputs/outputs	• 3-wire connections • NetTime function
X67UM1352	Universal mixed module	• 1 input for evaluation of full-bridge strain gauge, 24-bit converter resolution • 4 digital inputs 24 VDC, sink • 1 digital output, 0.5 A, source • 1 digital output, 1 A, source	

4.1.2.15 System power supply

Order number	Module type	Description	Special functions
X67PS1300	System supply module	• 24 VDC • X2X Link power supply 15 W	• Reverse polarity protection, short-circuit proof, overload-proof, parallel connection possible, redundancy operation possible

4.1.2.16 Temperature measurement

Order number	Module type	Description	Special functions
X67AT1311	Temperature input module	• 4 resistance measurement inputs, Pt100, resolution 0.01K	• 2- or 4-wire measurement
X67AT1322	Temperature input module	• Resistance measurement inputs, Pt100, Pt1000, KTY10, KTY84, resolution 0.1 K	• 2- or 4-wire measurement
X67AT1402	Temperature input module	• 4 thermocouple inputs, type J, K, N, R, S, resolution 0.1 K	

4.1.2.17 Counter functions

Order number	Module type	Description	Special functions
X67DC1198	Digital counter module	• 2x 3 inputs 5 V for SSI 1 Mbit/s or ABR 250 kHz, • 8 digital inputs/outputs 24 VDC, 0.1 A • Optionally configurable: – 8 inputs/outputs – 4 AB counters, 100 kHz – 4 comparator outputs – 2 PWM outputs	• Local time measurement functions
X67DC2322	Resolver module	• 2x 14-bit resolver input BRX/BRT • 2 digital inputs, 24 VDC, sink • 2 digital outputs, 0.5 A, source	
X67DM1321	Digital mixed module	• 8 digital inputs/outputs, 24 VDC, 0.5 A	• Configurable input filter • 2 event counters, 50 kHz
X67DM1321.L08	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M8 connectors	• Configurable input filter • 2 event counters, 50 kHz • High-density module
X67DM1321.L12	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M12 connectors	• Configurable input filter • 2 event counters, 50 kHz • High-density module
X67DM1321.L12-1	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M12 connectors - pinning variant	• Configurable input filter • 2 event counters, 50 kHz • High-density module
X67DM9321	Digital mixed module	• 8 digital inputs/outputs, 24 VDC, 0.5 A • X2X Link address switch	• Configurable input filter • 2 event counters, 50 kHz
X67DM9321.L12	Digital mixed module	• 16 digital inputs/outputs, 24 VDC, 0.5 A • M12 connectors, • X2X Link address switch	• Configurable input filter • 2 event counters, 50 kHz • High-density module

4.2 Safety module

4.2.1 Safety module overview

Order number	Module type	Description	Special functions
X67SC4122.L12	Safe digital mixed module	• 8 safe type A digital inputs, configurable input filter • 8 pulse outputs, 24 VDC • 4 safe type B1 digital outputs, 24 VDC, 2 A, OSSD <500 µs • M12 connectors	• High-density module
X67SI8103	Safe digital input module	• 2x M12 interface with 2 safe type A digital inputs each, configurable input filter and 2 pulse outputs, 24 VDC, • 2x standardized 8-pin M12 device interface each with 1 digital input without safety function and 2 safe type A digital input, configurable input filter and 2 pulse outputs, 24 VDC and 1 digital output without safety function, 24 VDC, 0.6 A and 1 device power supply, 24 VDC, 2 A	

5 Dimensioning

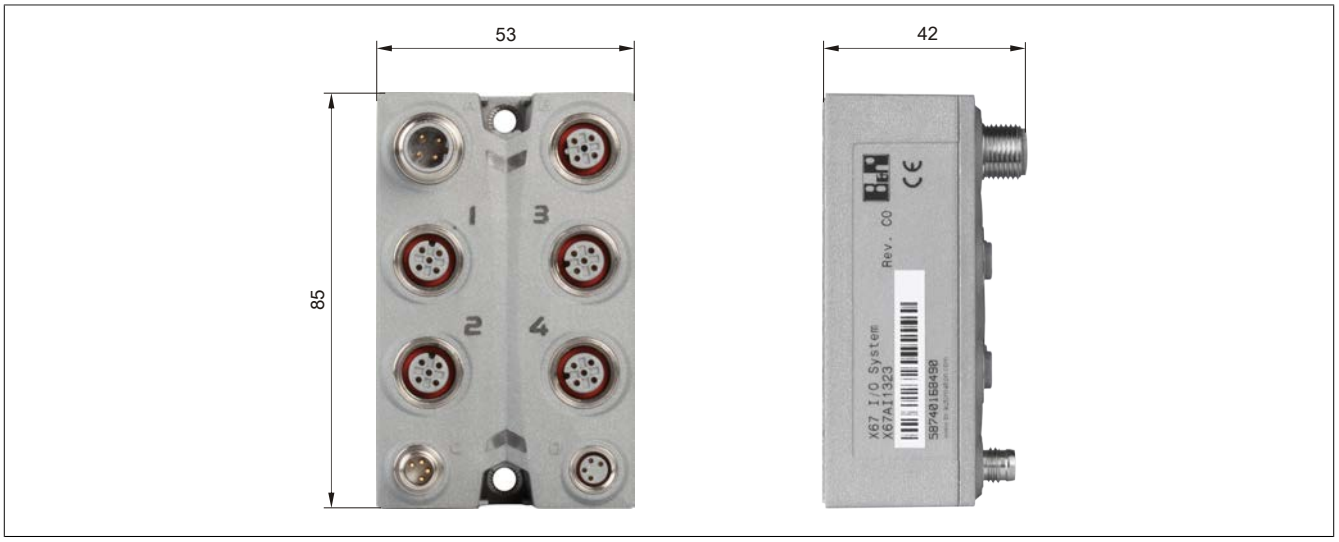
5.1 CAD support

To ensure CAD support, the dimensions are included in the ECAD macros in 2D. STEP data is available to allow 3D viewing.

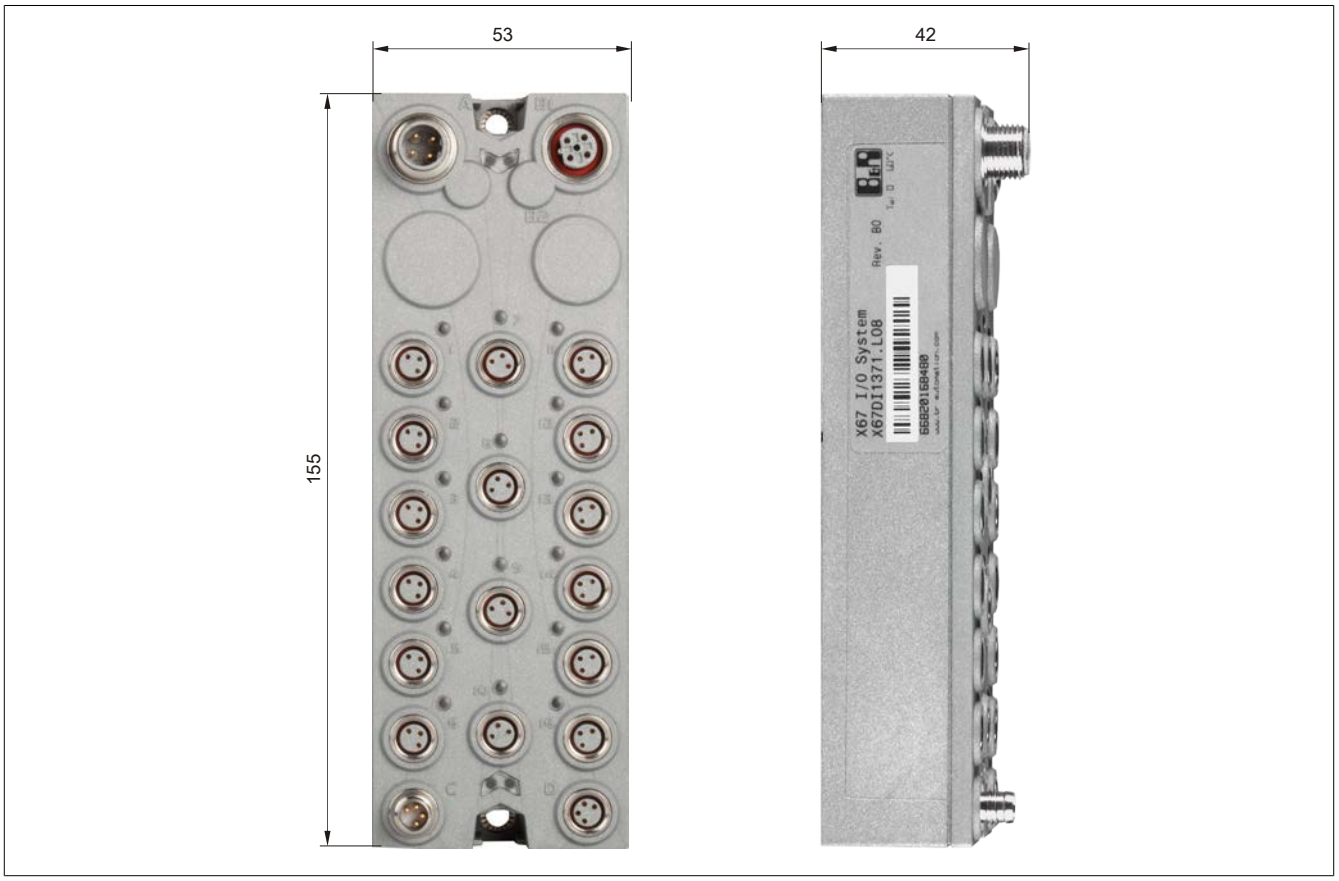
The STEP data can be downloaded from the B&R website (www.br-automation.com) in the Downloads section for the respective module.

5.2 Dimensions

X67 modules



X67 high-density modules



6 Installation and wiring

6.1 Installation

X67 modules can be installed in several different ways:

- "Installing on an aluminum frame" on page 33
- "Top-hat rail installation" on page 33
- "Installation on a mounting plate or directly on the machine " on page 34

Notice!

Since electromagnetic disturbances are deflected via the base plate on the back, it is important to ensure that the mounting location has good conductivity!

The mounting location must also be connected with ground potential with good conductivity.

Information:

The following must be taken into consideration to ensure IP67 protection:

- **The union nuts on female/male connectors must be tightly secured with the specified tightening torque. The tightening torque value can be found in the module data sheet or the section "Connectors" on page 35.**
- **Female/Male connectors that are not being used must be closed with threaded caps!**
  - **Threaded caps M8, 50 pcs.: X67AC0M08**
  - **Threaded caps M12, 50 pcs.: X67AC0M12**

Information:

Shock and vibration resistance values (see "International and national certifications" on page 96) apply only if cables are installed securely.

Attaching an X67 module

The thickness of the base plate (1.5 mm) should be taken into consideration when defining the screw length.

The grooved imprint in the base plate ensures that the screws do not become loose, even without an additional retaining ring.

The recommended tightening torque for the M4 screw is 0.6 Nm.

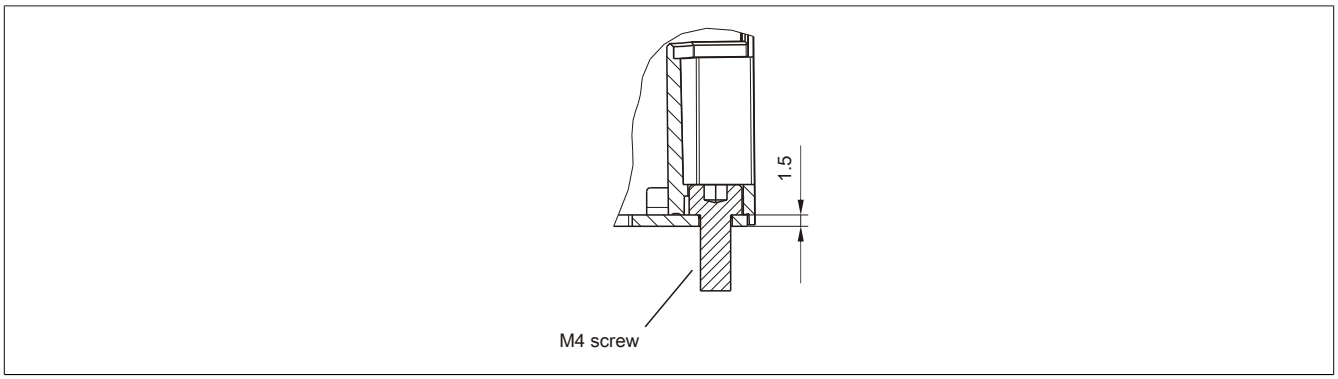


Figure 1: X67 system - Fastening an X67 module

6.1.1 Installing on an aluminum frame

Installation on an aluminum frame is done using 2 wedge nuts and M4 screws.

Figure 2: Installation on an aluminum frame

Notice!

For coated or anodized surfaces, the isolating coated or anodized layer in the area of the base plate for X67 modules must be removed.

6.1.2 Top-hat rail installation

An X67 module can be installed on a top-hat rail using top-hat rail mounting plate X67ACTS35.

Figure 3: Top-hat rail installation

6.1.3 Installation on a mounting plate or directly on the machine

X67 modules can also be mounted on a mounting plate or directly on the machine.

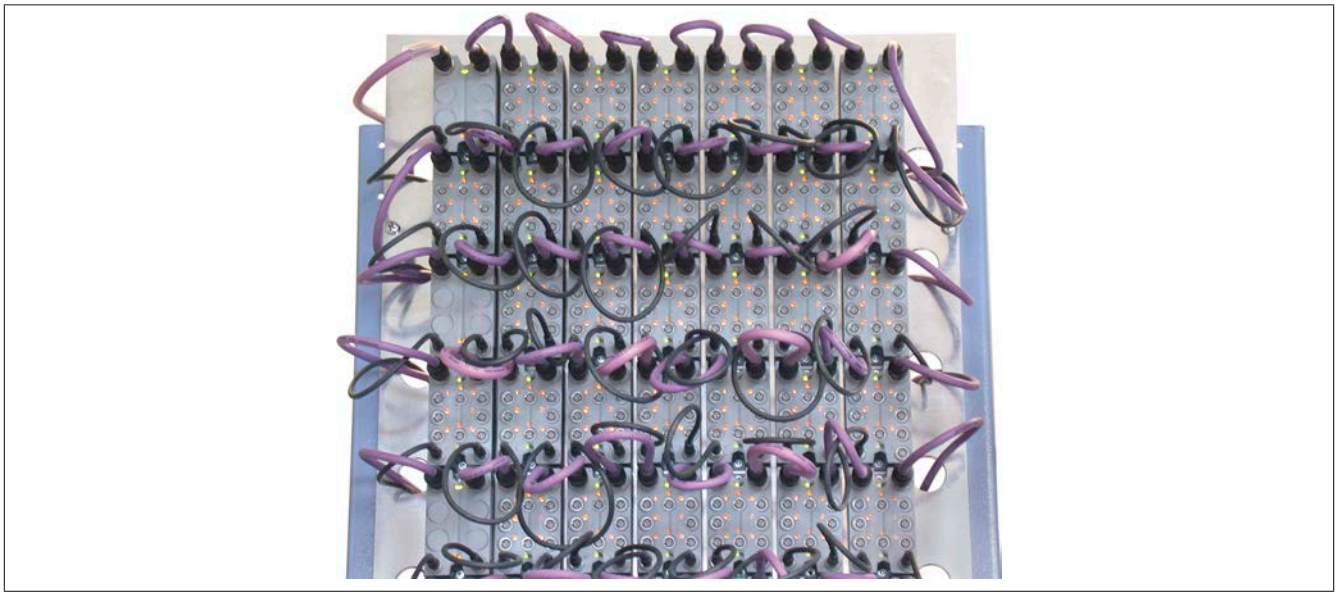
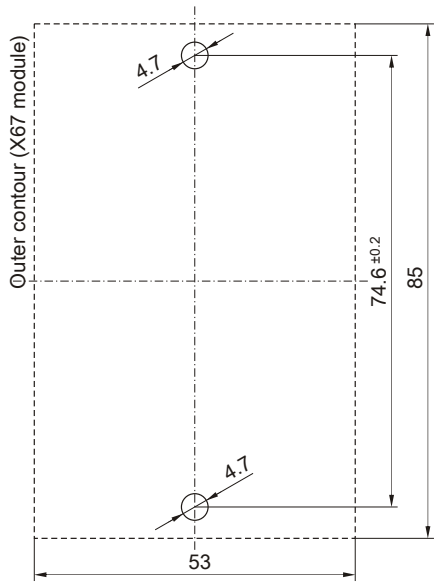
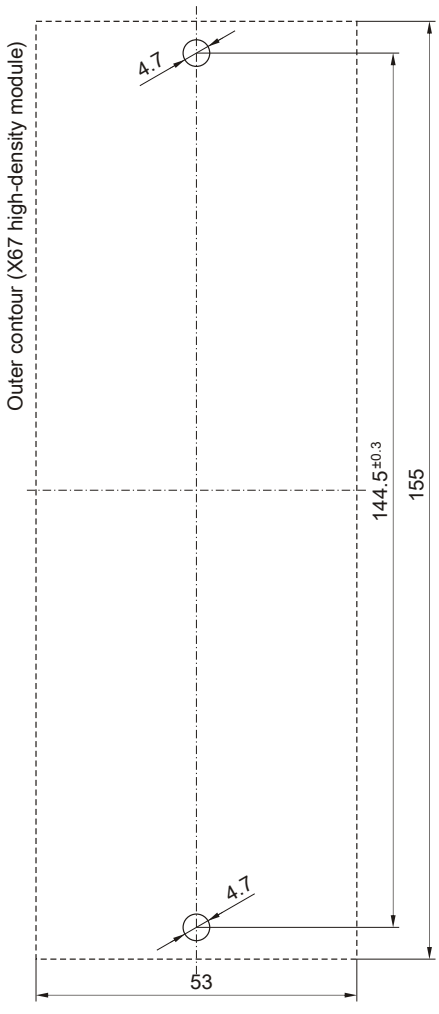


Figure 4: Installation on a mounting plate

6.1.3.1 Drilling template for X67 modules

The modules are mounted using M4 screws.

X67 modules	X67 high-density modules
	

6.2 Shielding and grounding

When using standard cables available from B&R, the cable shield is brought into the X67 module via the connector (complete 360° shielding). Inside the X67 housing, all components including the base plate make contact with the same ground. The final link in the chain is the mounting screw, which connects the base plate and the machine part / mounting plate and completes the seamless ground contact from the cable to the machine part / mounting plate. A contact with good conductivity between the X67 module base plate and the machine part / mounting plate is absolutely required.

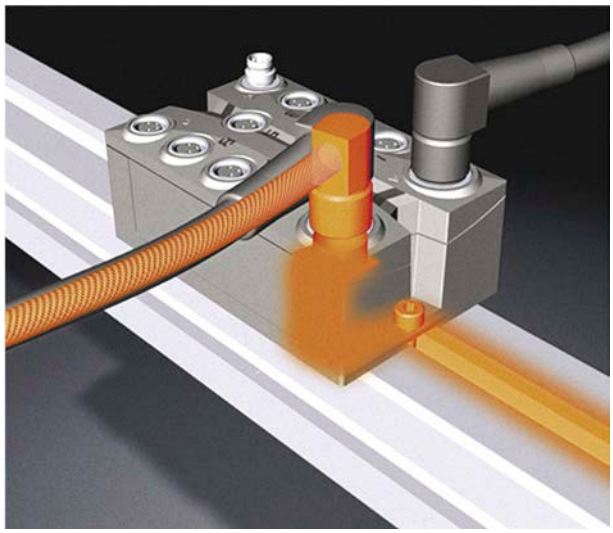


Figure 5: X67 system - Shielding and grounding

Notice!

The shielding at both ends of the cable must be professionally grounded on field-assembled cables!

6.3 Connectors

The connectors for the X67 system are designed as circular connectors. In addition to field-assembled male connectors, B&R also offers pre-assembled cables for X2X Link, fieldbus and I/O functions.

The following connectors are used with the X67 system:

Threads	Tightening torque
M8	0.4 Nm
M12	0.6 Nm
M16	1.0 Nm

Information:

When using third-party connectors, we strongly recommend ensuring that the contacts are gold (Au) coated.

B&R connectors are designed for use with X67 components (see "General overview" on page 62).

6.4 X67 system cabling

Due to the high degree of flexibility offered by the X67 system, a few things must be taken into consideration when wiring:

- Maximum number of X67 modules in one X2X line (253)
- Maximum distance between X67 modules
- Distance between the system supply modules
- Station number assignment
- Permissible current consumption
- Suitable connectors must be used for the X67 system (see section "Connectors" on page 35).

Possibilities for cabling the X67 system:

- X2X Link power supply with X67 system supply, X67 bus controller or X20 bus transmitter
- Isolated X2X Link and I/O power supply
- Creating electrical potential groups

6.4.1 X2X Link cabling

X2X Link connections:

- X67 module: M12, B-keyed connections (A → Input, B → Output)
- Interface module / master system: 4-pin terminal block

The maximum distance between 2 X67 stations is 100 meters.

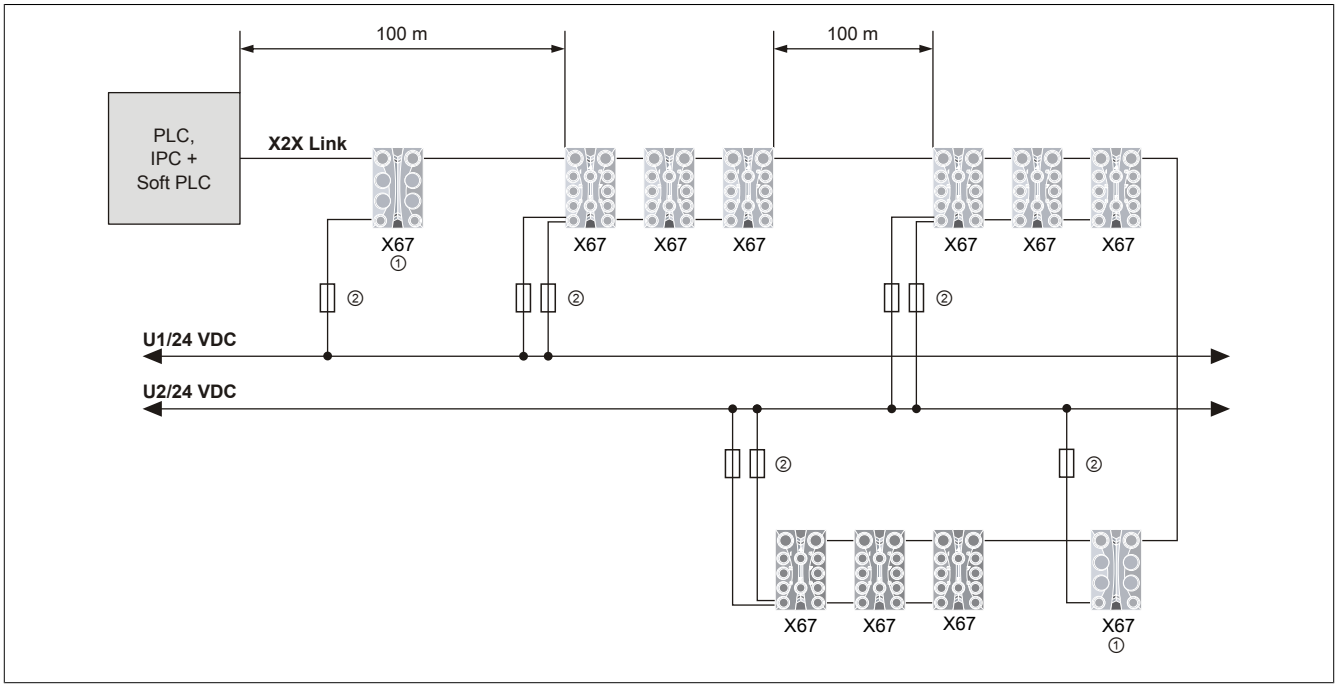
Information:

System supply module X67PS1300 cannot be used to bridge distances since it does not regenerate the signal.

Station numbers are automatically assigned according to the order of X67 modules (cable sequence).

Information:

All subsequent station numbers are shifted when an X67 station is connected/removed. The system supply module is not included in this calculation, however, and does not receive its own station number!



Legend

① System supply module
② Fuse, 4 A slow-blow

The supply voltage for the X2X Link is reduced by line resistance (line length).

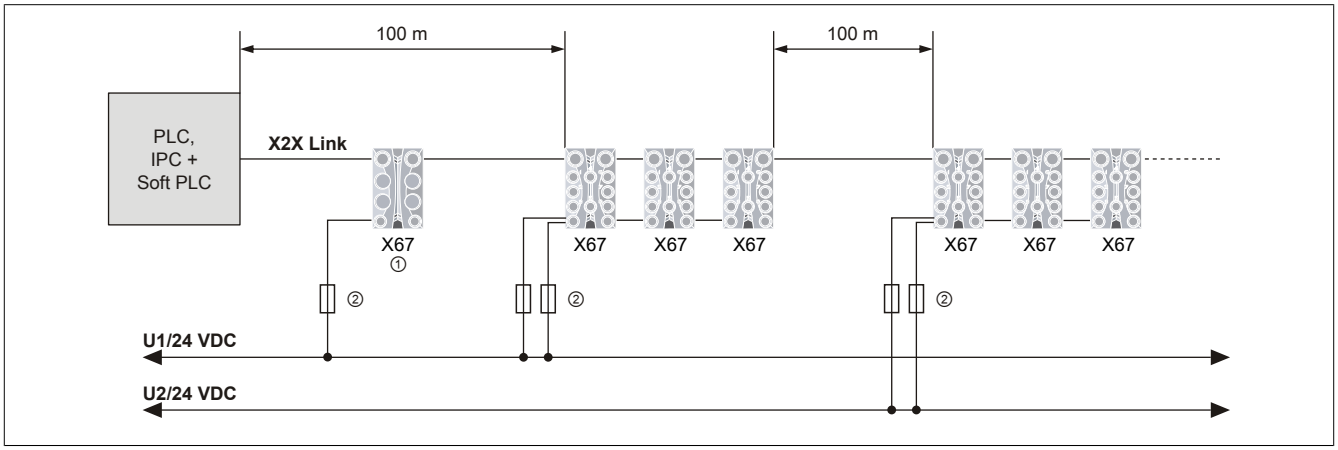
Information:

Be aware of voltage drops in the line!

Depending on the power consumption and type of modules being used, 15 or more X67 modules can be supplied by system supply module X67PS1300. However, this does not mean that 100 m distance between each station is possible (i.e. a total length of n x 100 m).

Information:

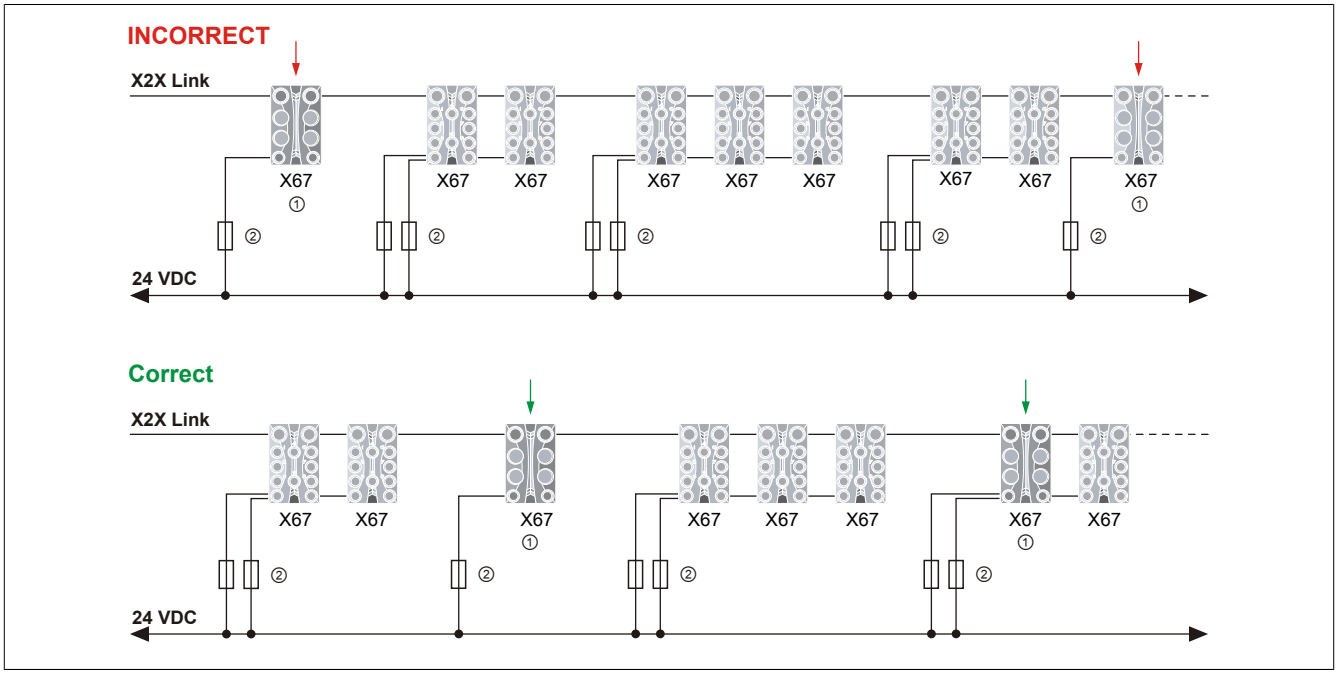
Regardless of the number of stations, the supply voltage is affected at total lengths over 100 m. Therefore, additional system supply modules must be added when necessary.



Legend

① System supply module
② Fuse, 4 A slow-blow

All system supply modules integrated in an X67 system must be distributed accordingly along the length of the line to avoid excessive voltage drops caused by the line length!



Legend

① System supply module
② Fuse, 4 A slow-blow

Information:

All system supply modules must be distributed evenly throughout the system!

6.4.2 X2X Link cabling on the bus controller

X2X Link connections:

- X67 module: M12, B-keyed connections (A → Input, B → Output)
- Bus controller: M12, B-keyed connection (B → Output)

Additional X67 stations can be connected without system supply module X67PS1300 depending on the power output of the bus controller.

The I/O image is made according to the order (cable sequence) of the X67 modules.

Information:

All subsequent I/O slots are shifted when an X67 station is connected/removed.

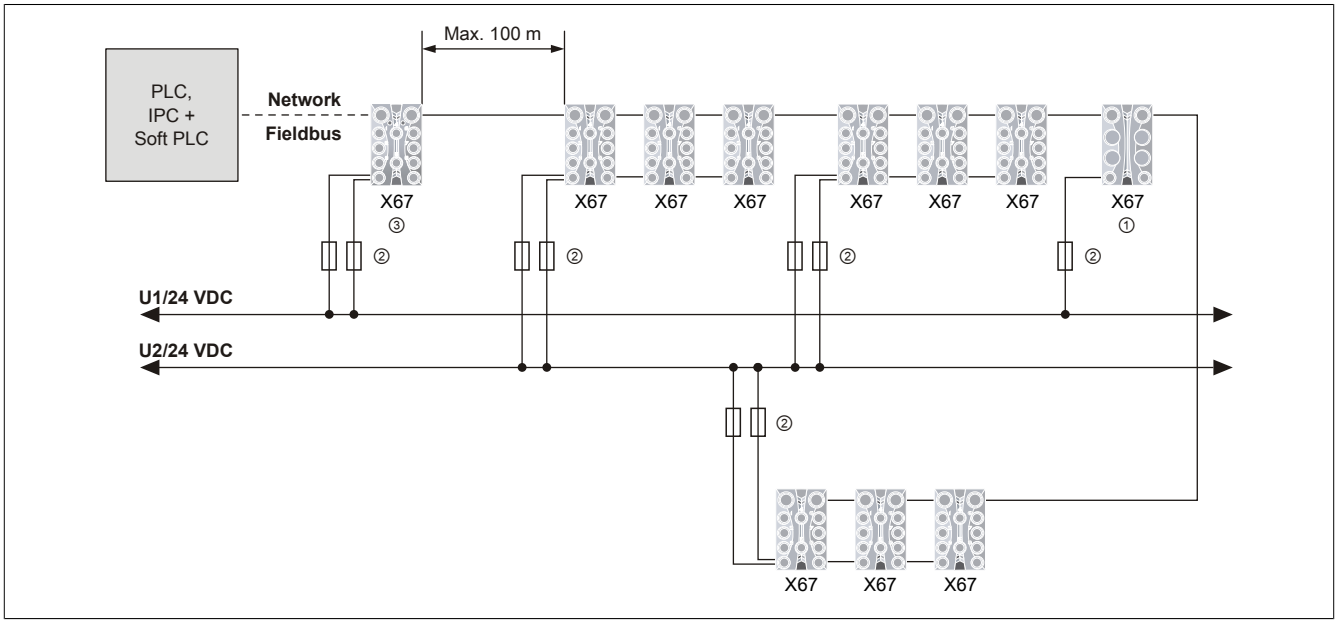


Figure 6: X2X Link cabling - Supply via bus controller

Legend

① System supply module
② Fuse, 4 A slow-blow
③ Bus controller

6.4.3 X2X Link cabling on bus transmitter X20BT9400

X2X Link connections:

- X67 module: M12, B-keyed connections (A → Input, B → Output)
- X20BT9400: X20 terminal block

Depending on the mounting orientation of the X20 system, 8 (horizontal installation) or 6 (vertical installation) X67 stations can be connected without system supply module X67PS1300.

Information:

All subsequent station numbers are shifted when an X67 station is connected/removed.

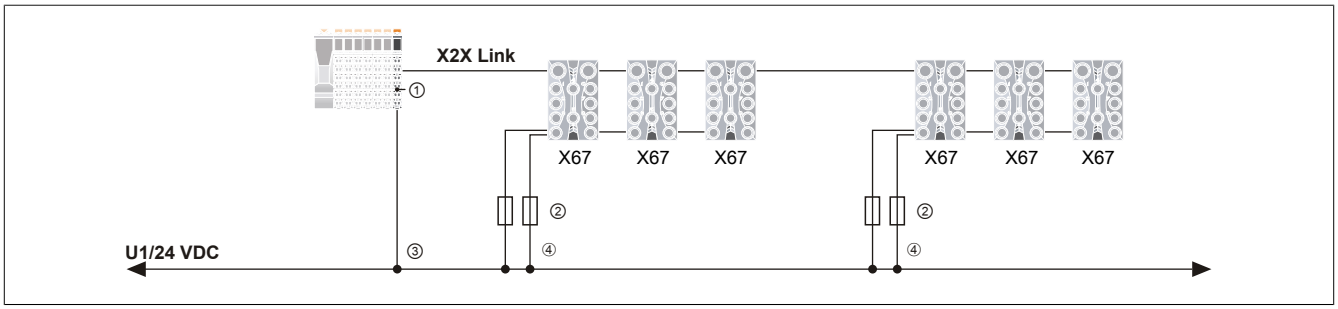


Figure 7: X2X Link cabling - Supply via bus transmitter X20BT9400

Legend

① X20 bus transmitter X20BT9400
② Fuse, 4 A slow-blow
③ X2X Link power supply
④ I/O power supply

If more than 8 or 6 X67 stations are connected to bus transmitter X20BT9400, then only the X67PS1300 system supply modules being used can be included when calculating the power requirements.

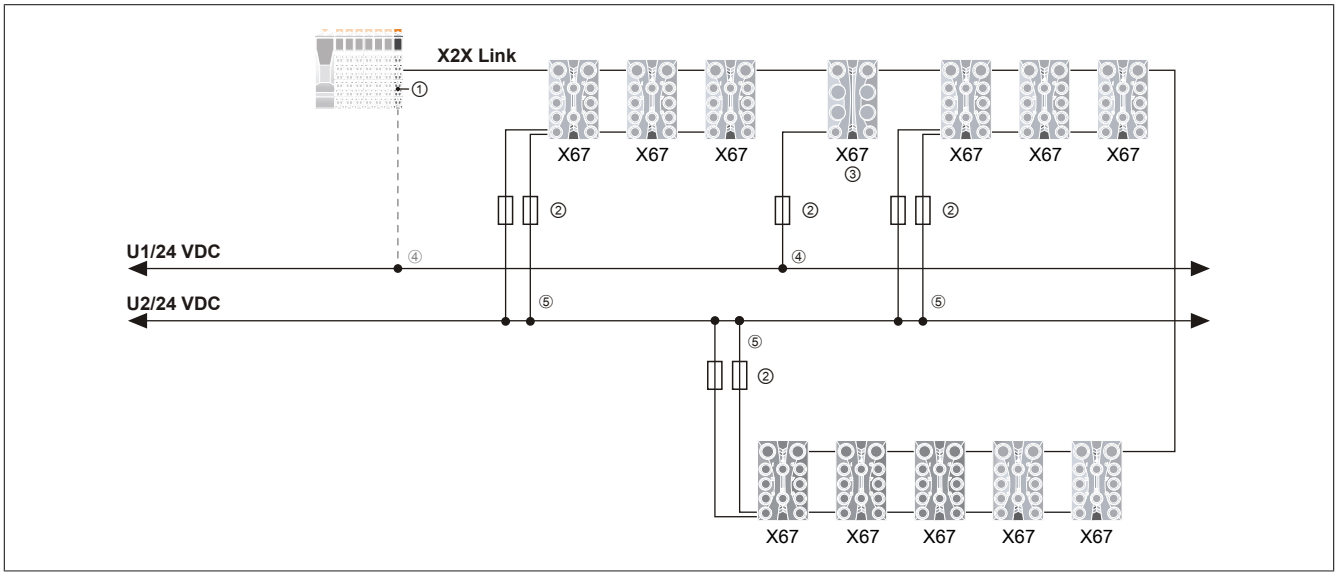


Figure 8: X2X Link cabling - Supply via X20 bus transmitter and X67 system supply

Legend

① X20 bus transmitter X20BT9400
② Fuse, 4 A slow-blow
③ System supply module
④ X2X Link power supply
⑤ I/O power supply

6.4.4 I/O power supply cabling

X67 module power supply connectors[1)]:

- I/O modules, system supply:
  Connections C (input) and D (routing) are equal (pins connected).
- Bus controller:
  Connection C: 1 pair for I/O power supply, 1 pair for X2X Link supply
  Connector D: Routing of I/O power supply

Permissible [1)] current consumption

- I/O modules: 8 A (without temperature derating)
- Bus controller: 4 A (without temperature derating)

Without the I/O power supply, the application has no access to the data points (see section "Failure of I/O supply (ModuleOK)" on page 42)! Only the node number is secured by an intact X2X Link power supply. The must account for this accordingly if the I/O power supply is integrated in the emergency stop design (see section "The power supply concept" on page 41).

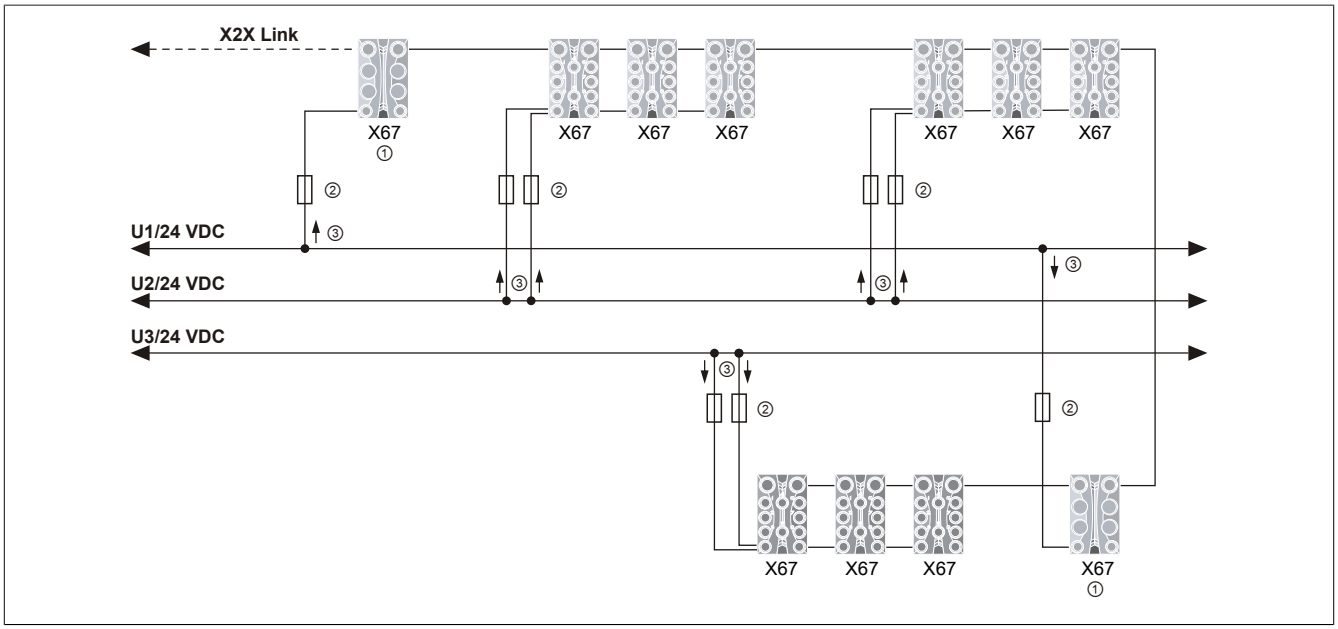


Figure 9: I/O power supply cabling - Isolated X2X Link and I/O power supply

Legend

① System supply module
② Fuse, 4 A slow-blow
③ Maximum 4 A

[1)] For exact or possibly deviating technical data, please refer to the documentation for the corresponding X67 module.

7 Mechanical and electrical configuration

7.1 The power supply concept

Danger!

In order to ensure a defined power supply, a SELV or PELV power supply unit per IEC 61010-2-201 must be used for the bus, SafeIO and SafeLOGIC power supply. This also applies to all digital signal sources that are connected to the modules.

If the power supply is grounded (PELV system), then only a GND connection is permitted for grounding. Grounding types that have ground connected to +24 VDC are not permitted.

The X67's decentralized structure allows modules to be placed in different power supply groups as needed. This allows various modules to be connected to different voltage protection circuits or different emergency stop groups to be implemented.

The X2X Link network is operated totally independently of the I/O power supply. In addition to the communication lines, the connection cable contains 2 wires to supply power to the X2X Link electronics of each module. This is fully galvanically isolated from the I/O component. For this reason, power failures on the I/O side (e.g. due to short circuit, open circuit or emergency stop) only stop operation of the I/O section. The X2X Link network continues to work, and the corresponding status messages are sent to the controller. This allows fault events to be quickly analyzed and corrected.

The X2X Link power supply is guaranteed by system supply modules.

A potential group involves multiple X67 modules that are supplied via a shared supply feed.

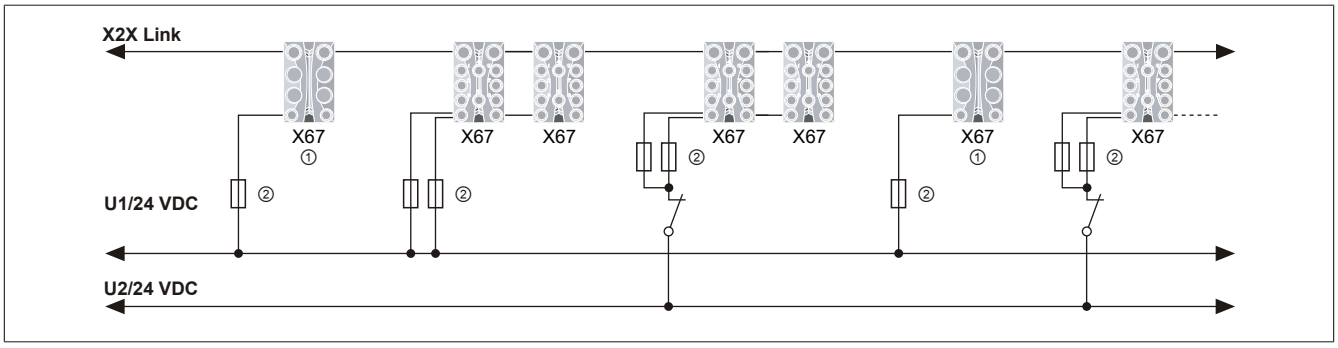


Figure 10: Power supply design with the help of 2 different potential groups

Legend

① System supply module
② Fuse, 4 A slow-blow

X67 I/O modules are power consumers on the X2X Link. System supply modules feed in the power. System supply modules should be planned according to the calculated power requirements. Since they supply voltage in both directions, they can be arranged either at the beginning or between the consumers. Redundant configurations are also possible by adding more system supply modules.

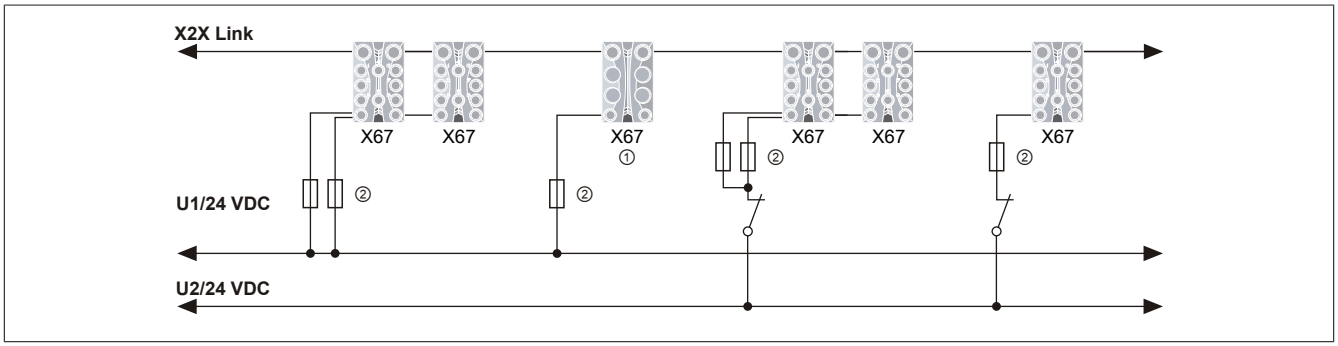


Figure 11: X2X Link power supply through flexible application of system supply modules

Legend

① System supply module
② Fuse, 4 A slow-blow

The bus controllers can supply several modules on the X2X Link without an additional system supply module.

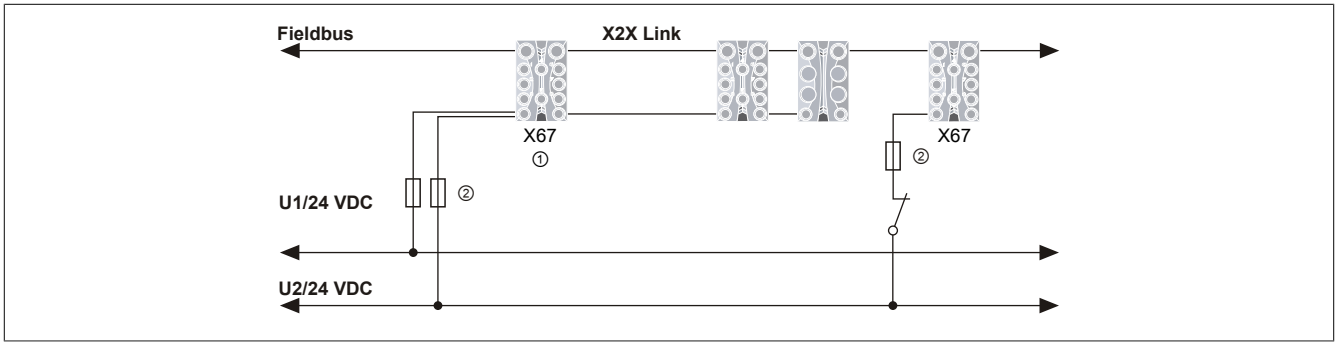


Figure 12: X2X Link power supply via bus controllers

Legend

① System supply module
② Fuse, 4 A slow-blow

7.1.1 Failure of I/O supply (ModuleOK)

Status "ModuleOK" consists of different module parameters and is available for monitoring the X67 modules. When the I/O supply voltage is lost, data point "ModuleOK" provides the value 0 (false).

7.2 Safe cutoff of a potential group

Information:

B&R keeps user's manuals as current as possible. From a safety standpoint however, the current certified version of the document must be used.

The current certified document is available for download under Website > Downloads > Certificates > Safety technology > X20, X67 > Safe cutoff of potential groups.

7.2.1 Description of function

The operating principle "Safe cutoff of a potential group" enables the user to execute safety-related functions within a B&R system in combination with an external safety relay.
The safety function is limited to cutting off or interrupting the power to connected actuators.

Functionality

An external safety relay is connected to the I/O power supply for the potential group or an X20SP1130 power supply module is used. When the functional safe state is requested or state "Failsafe" occurs, then this feed cuts off the I/O power supply of the potential group. The power is then also cut off for all actuators connected to this potential group. However, module-internal energy storage devices (e.g. capacitors) remain charged and must be taken into account in the assessment of the safety function.

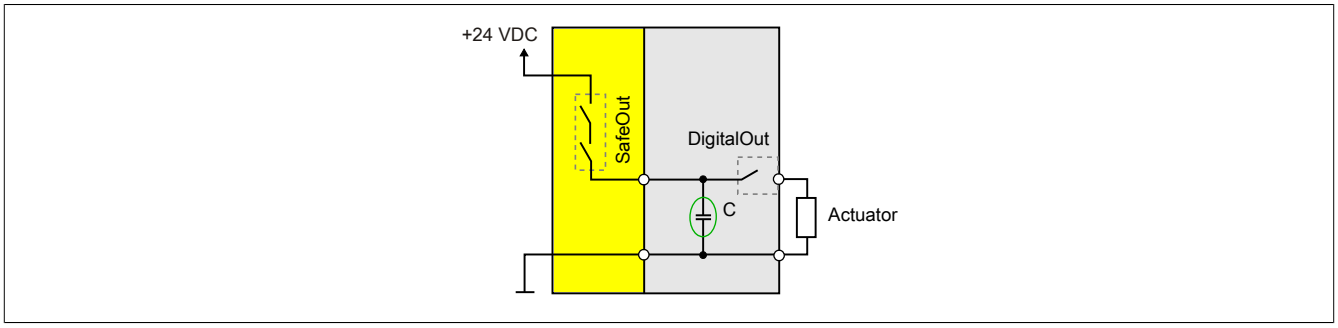


Figure 13: Functionality with internal energy storage

7.2.2 Scope of application / Standards referenced

The operating principle is confined to machine manufacturing applications and therefore implicitly to the following standards:

- EN ISO 13849-1:2015 / EN ISO 13849-2:2012

Requirements of other standards are not taken into consideration.

7.2.3 Intended use

Danger!

Danger from incorrect use of safety-related products/functions

Proper functionality is only ensured if the products/functions are used in accordance with their intended use by qualified personnel and the provided safety information is taken into account. The aforementioned conditions must be observed or covered by supplementary measures on your own responsibility in order to ensure the specified protective functions.

7.2.3.1 Qualified personnel

Use of safety-related products is restricted to the following persons:

- Qualified personnel who are familiar with relevant safety concepts for automation technology as well as applicable standards and regulations
- Qualified personnel who plan, develop, install and commission safety equipment in machines and systems

Qualified personnel in the context of this manual's safety guidelines are those who, because of their training, experience and instruction combined with their knowledge of relevant standards, regulations, accident prevention guidelines and operating conditions, are qualified to carry out essential tasks and recognize and avoid potentially dangerous situations.
In this regard, sufficient language skills are also required in order to be able to properly understand this manual.

7.2.3.2 Area of application

The safety-related B&R control components described in this manual were designed, developed and manufactured for special applications for machine and personnel protection. They are not suitable for any use involving serious risks or hazards that could result in the injury or death of several people or serious environmental impact without the implementation of exceptionally stringent safety precautions. In particular, this includes the use of these devices to monitor nuclear reactions in nuclear power plants, flight control systems, air traffic control, the control of mass transport vehicles, medical life support systems and the control of weapon systems.

When using safety-oriented control components, the safety precautions applying to industrial control systems (e.g. the provision of safety devices such as emergency stop circuits, etc.) must be observed in accordance with applicable national and international regulations. The same applies for all other devices connected to the system, e.g. drives or light curtains.

The safety guidelines, information about connection conditions (nameplate and documentation) and limit values specified in the technical data must be read carefully before installation and commissioning and must be strictly observed.

7.2.3.3 Cybersecurity disclaimer for products

B&R products communicate via a network interface and were developed for secure connection with internal and, if necessary, other networks such as the Internet.

Information:

In the following, B&R products are referred to as "product" and all types of networks (e.g. internal networks and the Internet) are referred to as "network".

It is the sole responsibility of the customer to establish and continuously ensure a secure connection between the product and the network. In addition, appropriate security measures must be implemented and maintained to protect the product and entire network from any security breaches, unauthorized access, interference, digital intrusion, data leakage and/or theft of data or information.

B&R Industrial Automation GmbH and its subsidiaries are not liable for damages and/or losses in connection with security breaches, unauthorized access, interference, digital intrusion, data leakage and/or theft of data or information.

The aforementioned appropriate security measures include, for example:

- Segmentation of the network (e.g. separation of the IT network from the control network[1)])
- Use of firewalls
- Use of authentication mechanisms
- Encryption of data
- Use of anti-malware software

Before B&R releases products or updates, they are subjected to appropriate functional testing. Independently of this, we recommend that our customers develop their own test processes in order to be able to check the effects of changes in advance. Such changes include, for example:

- Installation of product updates
- Significant system modifications such as configuration changes
- Deployment of updates or patches for third-party software (non-B&R software)
- Hardware replacement

These tests should ensure that implemented security measures remain effective and that systems in the customer's environment behave as expected.

1) The term "control network" refers to computer networks used to connect control systems. The control network can be divided into zones, and there can be several separate control networks within a company or site. The term "control systems" refers to all types of B&R products such as controllers (e.g. X20), HMI systems (e.g. Power Panel T30), process control systems (e.g. APROL) and supporting systems such as engineering workstations with Automation Studio.

7.2.3.4 Safety technology disclaimer

The proper use of all B&R products must be guaranteed by the customer through the implementation of suitable training, instruction and documentation measures. The guidelines set forth in system user's manuals must be taken into consideration here as well. B&R has no obligation to provide verification or warnings with regard to the customer's purpose of using the delivered product.

Changes to the devices are not permitted when using safety-related components. Only certified products are permitted to be used. Currently valid product versions in each case are listed in the corresponding certificates. Current certificates are available on the B&R website (www.br-automation.com) in the Downloads section for the respective product. The use of non-certified products or product versions is not permitted.

All relevant information regarding these safety products must be read in the latest version of the related data sheet and the corresponding safety notices observed before the safety products are permitted to be operated. Certified data sheets are available on the B&R website (www.br-automation.com) in the Downloads section for the respective product.

B&R and its employees are not liable for any damages or loss resulting from the incorrect use of these products. The same applies to misuse that may result from specifications or statements made by B&R in connection with sales, support or application activities. It is the sole responsibility of the user to check all specifications and statements made by B&R for proper application as it pertains to safety-related applications. In addition, the user assumes sole responsibility for the proper design of the safety function as it pertains to safety-related applications.

7.2.3.5 Installation notes for X20 safety modules

Products must be protected against impermissible dirt and contaminants. Products are protected from dirt and contaminants up to pollution degree II as specified in the IEC 60664 standard.

Pollution degree II can usually be achieved in an enclosure with IP54 protection, but uncoated modules are NOT permitted to be operated in condensing relative humidity and temperatures under 0°C.

The operation of coated modules is allowed in condensing relative humidity.

Danger!

Pollution levels higher than specified by pollution degree II in standard IEC 60664 can result in dangerous failures. It is extremely important that you ensure a proper operating environment.

Danger!

In order to ensure a defined power supply, a SELV or PELV power supply unit per IEC 61010-2-201 must be used for the bus, SafeIO and SafeLOGIC power supply. This also applies to all digital signal sources that are connected to the modules.

If the power supply is grounded (PELV system), then only a GND connection is permitted for grounding. Grounding types that have ground connected to +24 VDC are not permitted.

The supply of X20 potential groups must generally be protected using a fuse with a maximum of 10 A.
For additional information, see chapter "Mechanical and electrical configuration" in the X20 or X67 user's manual.

Module functionality is no longer guaranteed at voltages outside the range of the supply voltage or I/O voltage specified in the technical data.
Up to a voltage of 60 VDC (SELV power supply unit), it is ensured that no dangerous error occurs.

7.2.3.6 Installation notes for X67 safety modules

Danger!

The following points must be taken into account to ensure IP67 protection:

- **The union nuts on female/male connectors must be tightly secured with the specified tightening torque. For the tightening torque, see the X67 system user's manual.**
- **Female/Male connectors that are not being used must be closed with threaded caps!**
  - **Threaded caps M8, 50 pcs.: X67AC0M08**
  - **Threaded caps M12, 50 pcs.: X67AC0M12**

Danger!

The shock and vibration resistance values (see chapter "International and national certifications" in the X67 system user's manual) apply if cables are laid solidly.

Danger!

In order to ensure a defined power supply, a SELV or PELV power supply unit per IEC 61010-2-201 must be used for the bus, SafeIO and SafeLOGIC power supply. This also applies to all digital signal sources that are connected to the modules.

If the power supply is grounded (PELV system), then only a GND connection is permitted for grounding. Grounding types that have ground connected to +24 VDC are not permitted.

The power supply of X67 potential groups must generally be protected using a fuse with a maximum of 10 A.
For additional information, see chapter "Mechanical and electrical configuration" in the X20 or X67 user's manual.

Module functionality is no longer guaranteed at voltages outside the range of the supply voltage or I/O voltage specified in the technical data.
Up to a voltage of 60 VDC (SELV power supply unit), it is ensured that no dangerous error occurs.

Danger!

Unused female connectors must be covered with threaded caps (X67AC0M08 or X67AC0M12 accessory). Otherwise, hazardous conditions may arise if the module fails to function properly.

7.2.3.7 Safe state

If an error is detected by the module (internal or wiring error), the modules enable the safe state. The safe state is structurally designed as a low state or cutoff and cannot be modified.

Applications in which the safe state must actively switch on an actuator cannot be implemented with this module. In these cases, other measures must be taken to meet this safety-related requirement (e.g. mechanical brakes for hanging load that engage on power failure).

The following limitations exist when using SafeMOTION modules:

- A SafeMOTION module basically corresponds to a safe node.[2)] Additionally, each drive module equates to **one POWERLINK node**.
- The safe state is implemented in B&R safety modules by cutting off the output. This is a design feature of the modules and cannot be changed.
  This is particularly important for SafeMOTION modules since the safe state cuts off the torque on the motor!

Danger!

After the safe state (STO) is enabled or in state FAIL SAFE, the drive is not supplied with power; the motor therefore no longer exerts torque or force.

If the motor was moving before STO is activated, it is only stopped by a safe motor holding brake (if available) or by the friction of the complete system!

[2)] ACOPOSmulti SafeMOTION inverter modules: A SafeMOTION module is integrated into a single-axis inverter module, i.e. **one safe node**. A 2-axis inverter module has two integrated SafeMOTION modules, i.e. **two safe nodes**.

Danger!

Situations involving external forces (e.g. suspended loads) can result in dangerous movements! If this poses a safety risk, then the user must implement the necessary equipment to eliminate the risk (e.g. mechanical brakes)! This equipment must correspond to the required safety level!

Danger!

The safety response time must be taken into consideration since this has a substantial effect on the residual distances and remaining times to be considered!

In order to calculate the total safety response time, the user must validate the rundown time of the complete system! .

7.2.4 System-specific information

The operating principle applies to a potential group.

All potential groups are generally only permitted to be supplied by 1 power supply module. The possible further processing of the power supply on the module is not permitted to result in multiple supply instances.

In the X20 system, only modules of type X20BM01, X20BM23 and X20BM26 that ensure the interruption of the internal I/O power supply to the left are permitted to be used as bus modules for power supply modules.
On modules X20PS9400 and X20PS3300, only the I/O power supply (+24 V I/O) is permitted to be switched with the safety relay. The bus power supply (+24 V BC/X2X L.) must be isolated.

When using module X67PS1300 to supply power to the X67 potential group, only the I/O power supply (+24 V I/O) is permitted to be switched with the safety relay. The bus power supply (+24 V BC/X2X L.) must be isolated.

The operating principle is limited to the modules listed in the following certificate.

Certificate
Website > Downloads > Certificates > Safety technology > X20, X67 > Safe cutoff of potential groups

7.2.5 Safety guidelines

This section provides a summary of safety notices for the user.

Danger!

Failure of the safety function due to misuse

Observe the following safety guidelines. Failure to observe any of the following notices can result in the failure of the safety function and may result in serious injury.

- **When using the operating principle, it is the user's responsibility to adhere to the relevant standards and safety directives. In addition, the guidelines for proper use must be observed.**
- **For all potentials supplying the modules, SELV/PELV power supplies must be used.**
- **The potential groups for which the operating principle is applied are only permitted to contain modules listed from certificate "Safe cutoff of potential groups".**
- **Uncoated X20 modules in which the operating principle is used are not permitted to be operated in condensing air humidity or at temperatures below 0°C.**
- **It is not permitted to mix modules from different systems (X20, X67, 7XV) within a potential group.**
- **It is not permitted to install multiple power supplies in a potential group (particularly with regard to power supply modules that also supply the bus supply).**
- **Ensure that the upstream safety relay is wired properly.**
- **Ensure that ALL sensors and actuators connected to the potential group are wired properly.**
- **Note possible impairments of the safety function due to the internal energy storage devices. If this is sufficient to enable a connected actuator and subsequently results in a dangerous state, the protection objective is not given and alternatives or supplementary measures must be installed.**
- **The switch-off time must be verified by a control measurement!**
- **For modules with isolated I/O potential for sensors and actuators, the upstream safety relay must shut off the supply for both the sensors and actuators.**
- **The ground connections should be used as functional ground and not as protective ground and must not be connected to the 24 V supply voltage (GND is permitted). In addition, no protective components are permitted to be used between the ground and the 24 V supply voltage.**

7.2.5.1 Capacitances within the potential group

The module-internal capacitances remain charged at the time of shutdown. The total capacitance of the potential group results from the sum of the capacitances of the individual modules, upstream external safety relay and actuator.

$$C_{total} = \sum_{i=1}^{n} C_i$$

The capacitances of the corresponding B&R modules are listed in the certificate.

Certificate
Website > Downloads > Certificates > Safety technology > X20, X67 > Safe cutoff of potential groups

At the time a safety function is requested, it is not ensured that the standard outputs are enabled. If an output is disabled at the time of the request, the affected module-internal capacitances remain permanently charged. If the output is enabled by the standard application, an unexpected voltage peak occurs on the output.

In connection with the supply voltage, the total capacitance present in the system results in a charge that must be taken into account during cutoff. In the worst case scenario, it can be assumed that the total capacitance present in the system buffers each output present in the potential group. This behavior is not permitted to result in a safety-critical state due to actuators in the potential group; alternatives or supplementary corrective measures must be installed.

7.2.5.2 Potential group structure

The potential group is only permitted to be made up of modules listed in the following certificate. Modules not listed in this certificate endanger the "absence of feedback" of the external cutoff and therefore the safety function.

Certificate
Website > Downloads > Certificates > Safety technology > X20, X67 > Safe cutoff of potential groups

To ensure clarity and that the external cutoff is triggered when a fault occurs, installing multiple power supply sources in a potential group is not permitted.

SELV/PELV power supplies must be used for both the bus supply (X2X) and the I/O power supply; otherwise, safety-related malfunctions can occur due to overvoltages.

For modules with isolated I/O potential for sensors and actuators, the upstream safety relay must shut off the supply for both the sensors and actuators; otherwise, feedback cannot be excluded.

7.2.5.3 Circuit examples

Single-channel without feedback

The following example shows a load being cutoff using the emergency stop safety function. Only safe actuators such as motors or input "Enable" of an ACOPOS/ACOPOSmulti drive are permitted to be used as the load in this case.

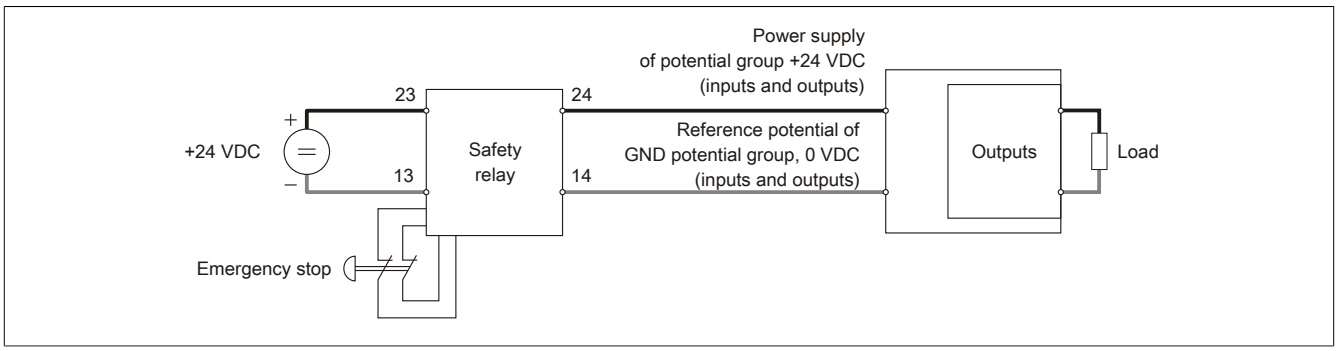


Figure 14: Circuit example: 1-channel without feedback

Provided that the external components being used (emergency stop switch, safety relay, load) satisfy the respective requirements, this example can achieve PL e (performance level as specified in EN ISO 13849-1:2015).

Dual-channel with feedback

The following example shows a load being cutoff using the emergency stop safety function. Feedback allows errors in the actuator to also be detected, and a cutoff is also possible if a fault event occurs due to the full dual-channel design. Whether or not 2 fully isolated potential groups – as shown in the example – are necessary depends on the application and how the safety solution is designed.

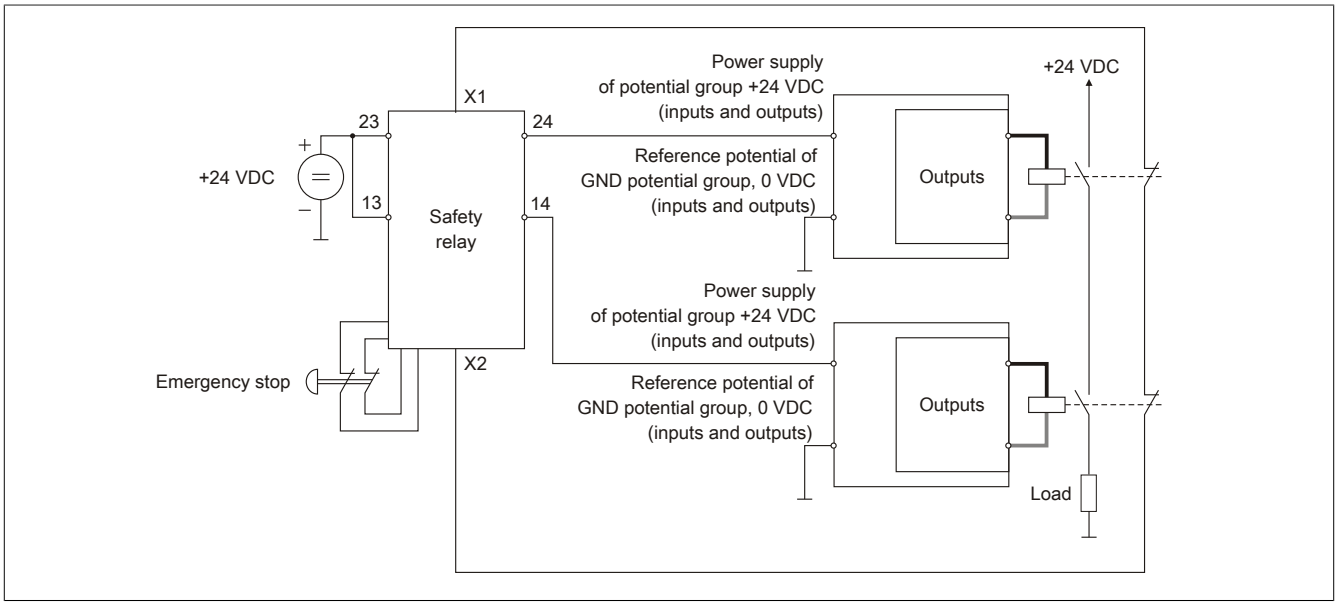


Figure 15: Circuit example: 2-channel with feedback

Provided that the external components being used (emergency stop switch, safety relay, load) satisfy the respective requirements, this example can achieve PL e.

Example with power supply module X20SP1130

The following examples show a load being cut off using safe power supply module X20SP1130 along with safe input module X20SI4100 and the "emergency stop" safety function.

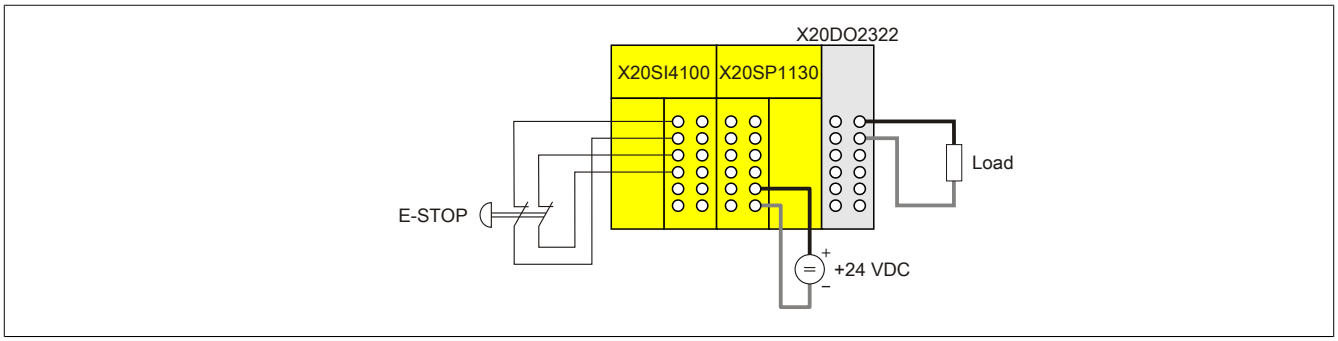


Figure 16: Circuit example with power supply module X20SP1130

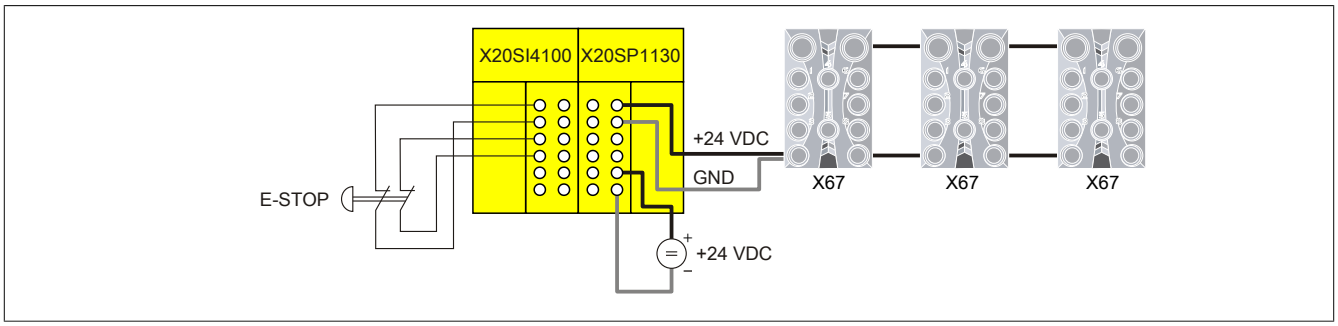


Figure 17: Circuit example with power supply module X20SP1130 and X67

Provided that the external components being used (emergency stop switch, load) satisfy the respective requirements, these examples can achieve PL e.

7.2.5.4 Wiring information

The operating principle "Safe cutoff of a potential group" only applies to the B&R modules being used. All other parts of the safety chain such as the application, upstream sensors or downstream actuators are NOT included in this principle.

For this reason, it is important to take the following points into account:

- Ensure proper wiring of the safety relays with the I/O supply. A short circuit between the output of the safety relay and an external 24 V voltage source can cause an unintended supply of 24 V to the internal supply voltage of the potential group. As a result, the safety function can no longer be ensured, i.e. **ALL** channels of the potential group can no longer be switched off by the upstream safety relay.
- Ensure proper wiring of **ALL** input and output channels of the potential group and the connected sensors or actuators. A short circuit between an input or output of the potential group and an external 24 V voltage source can cause the unintended feedback of 24 V to the internal supply voltage of the potential group. As a result, the safety function can no longer be ensured, i.e. **ALL** output channels of the potential group can no longer be switched off by the upstream safety relay.
- In accordance with EN ISO 13849-2:2012, appendix D.2, table D.4, a short circuit between any 2 conductors can be excluded, provided that:
    - They are permanently installed and protected against external damage (e.g. using a cable duct or armored conduit)
    - OR they are in separate plastic-sheathed cables
    - OR they are installed within an electrical enclosure. This requires that the lines as well as the area for electrical equipment meet the respective requirements [see EN 60204-1]
    - OR they are individually shielded with a ground connection.

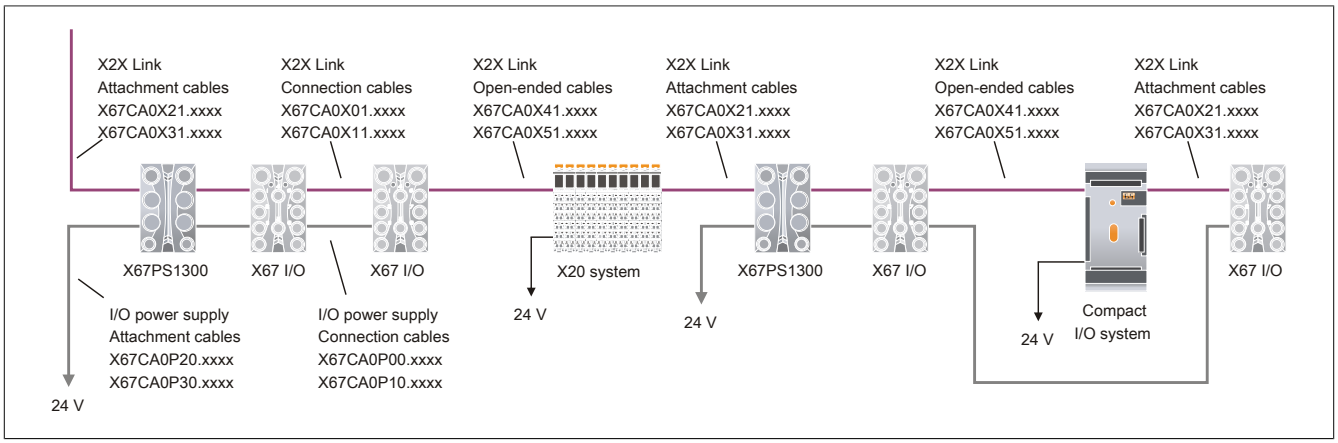
7.3 Combining X2X Link systems

The X2X Link provides a complete remote backplane, which is used for communicating between bus modules and over the X2X Link cable. Systems based on X2X Link can be combined with one another as needed.

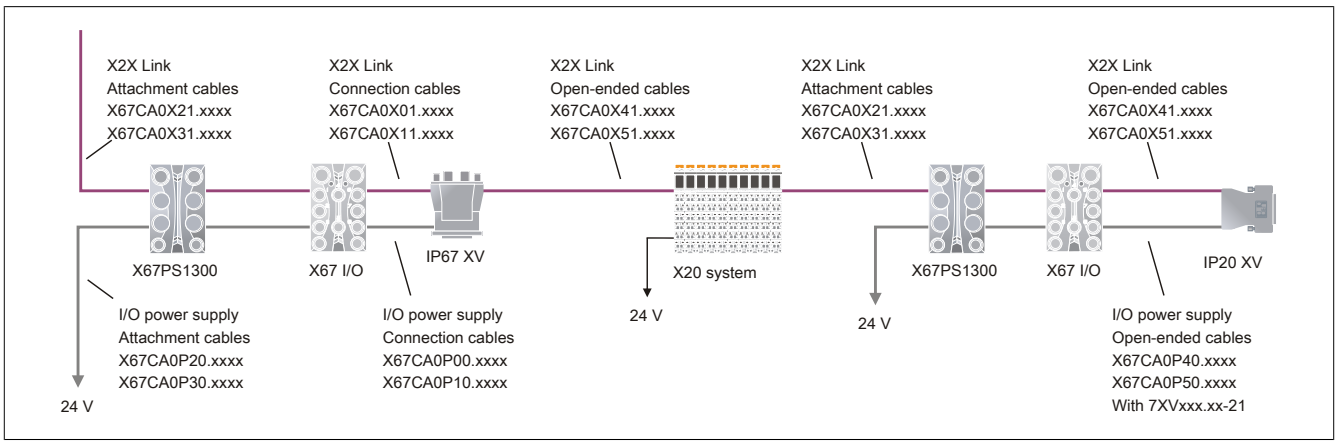
7.3.1 Connection overviews

The following connection overviews illustrate combinations of different systems that are based on X2X Link. The model numbers indicate which standard cables available from B&R can be used to connect with one another.

Combining X20, X67 and compact I/O system



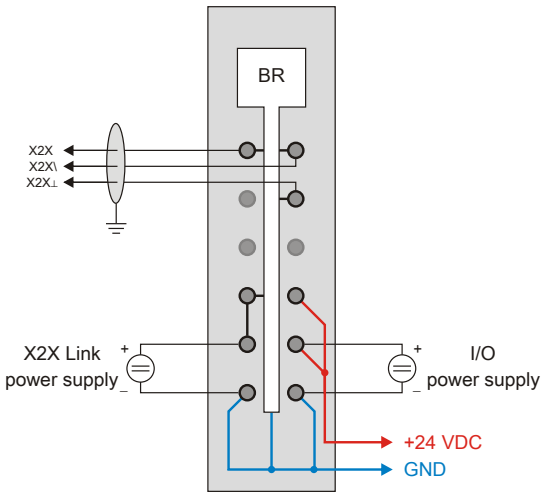
Combining X20, X67 and valve terminal connections



7.3.2 Connection examples

7.3.2.1 X20 system

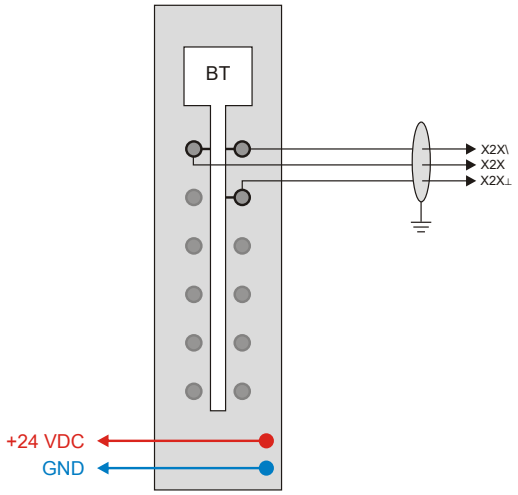
Connection example with bus receiver X20BR9300



Signal	Cable type	Model number
X2X Link In	Open-ended cables [1]	X67CA0X41.xxxx
		X67CA0X51.xxxx
	Cable for custom assembly	X67CA0X99.xxxx

1) In connection with X67 modules.

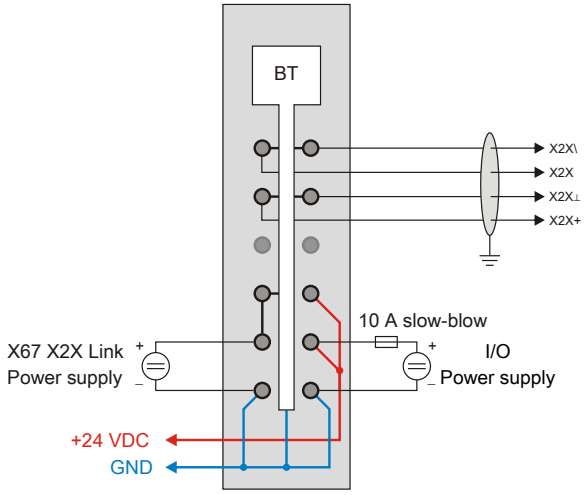
Connection example with bus transmitter X20BT9100



Signal	Cable type	Model number
X2X Link Out	Attachment cables [1]	X67CA0X21.xxxx
		X67CA0X31.xxxx
	Cable for custom assembly	X67CA0X99.xxxx

1) In connection with X67 modules.

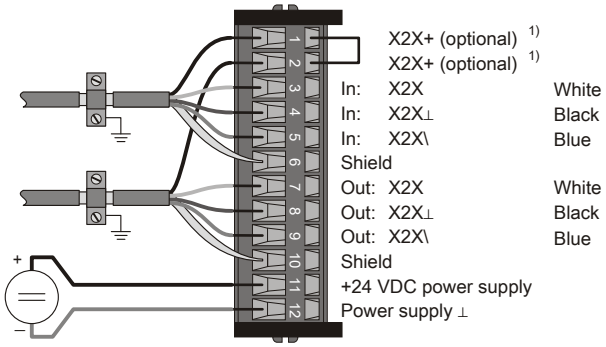
Connection example with bus transmitter X20BT9400



Signal	Cable type	Model number
X2X Link Out	Attachment cables [1]	X67CA0X21.xxxx
		X67CA0X31.xxxx
	Cable for custom assembly	X67CA0X99.xxxx

1) In connection with X67 modules.

7.3.2.2 Compact I/O system



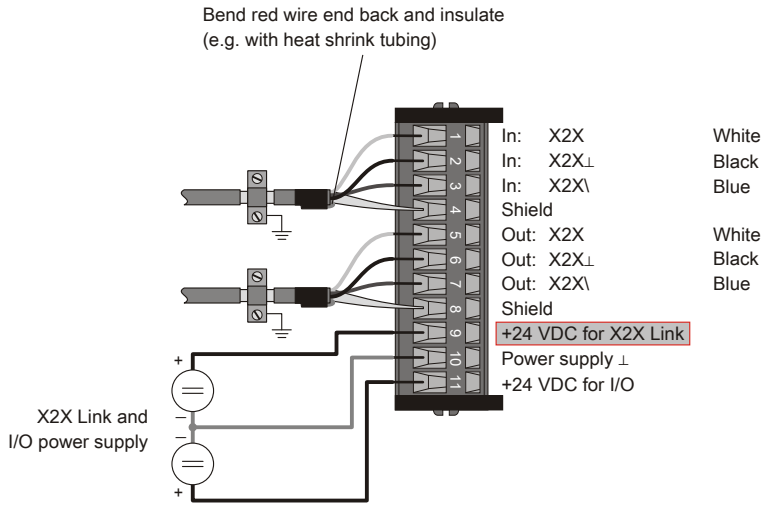
1) Used to forward the X2X Link power supply when using IP67 modules.

Signal	Cable type	Model number
X2X Link In	Open-ended cables[1]	X67CA0X41.xxxx
		X67CA0X51.xxxx
X2X Link Out	Attachment cables[1]	X67CA0X21.xxxx
		X67CA0X31.xxxx
X2X Link in/out	Cable for custom assembly	X67CA0X99.xxxx

1) Bridge for X2X+ in connection with X67 modules.

7.3.2.3 Valve connection

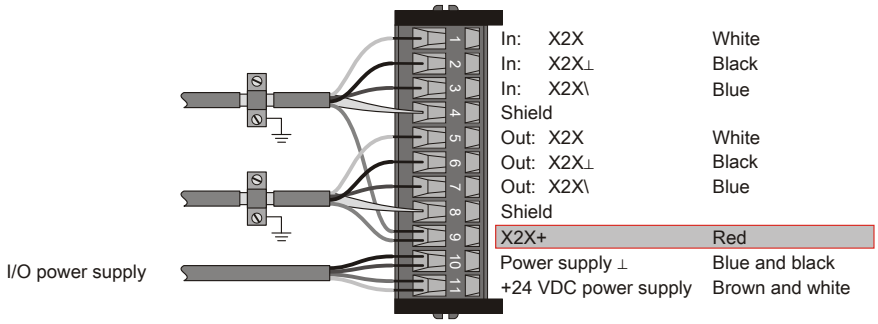
Connection example with 7XVxxx.xx-11/-12



Signal	Cable type	Model number
X2X Link In	Open-ended cables[1)]	X67CA0X41.xxxx
		X67CA0X51.xxxx
X2X Link Out	Attachment cables[1)]	X67CA0X21.xxxx
		X67CA0X31.xxxx
X2X Link in/out	Cable for custom assembly	X67CA0X99.xxxx

1) In connection with X67 modules.

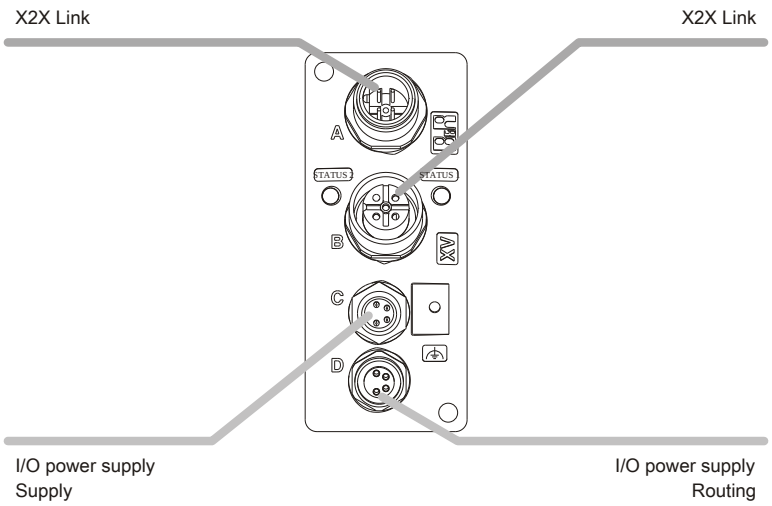
Connection example with 7XVxxx.xx-21



Signal	Cable type	Model number
X2X Link In	Open-ended cables[1)]	X67CA0X41.xxxx
		X67CA0X51.xxxx
X2X Link Out	Attachment cables[1)]	X67CA0X21.xxxx
		X67CA0X31.xxxx
X2X Link in/out	Cable for custom assembly	X67CA0X99.xxxx
I/O power supply	Open-ended cables[1)]	X67CA0P40.xxxx
		X67CA0P50.xxxx

1) In connection with X67 modules.

Connection example with 7XVxxx.xx-51/-62



Signal	Cable type	Model number
X2X Link	Connection cables[1)]	X67CA0X01.xxxx
		X67CA0X11.xxxx
I/O power supply	Connection cables[1)]	X67CA0P00.xxxx
		X67CA0P10.xxxx

1) In connection with X67 modules.

7.3.2.4 Connection of X2X Link interfaces with internal power supply

Information:

Power is supplied to the X2X Link network via the red wire. Power is supplied to the X2X Link network internally on the IF789 or LS189. An external power supply is therefore not needed.

In order to prevent short circuits on the housing, braided shield or cable shield, the red wire end must be insulated, e.g. using a heat shrink tubing.

To improve EMC immunity, the cable shield must be grounded on both sides. The supply line to the IF789 and LS189 should be grounded over a wide area close to the shield. The grounding on the X67 side is done via the connector on pre-assembled cables.

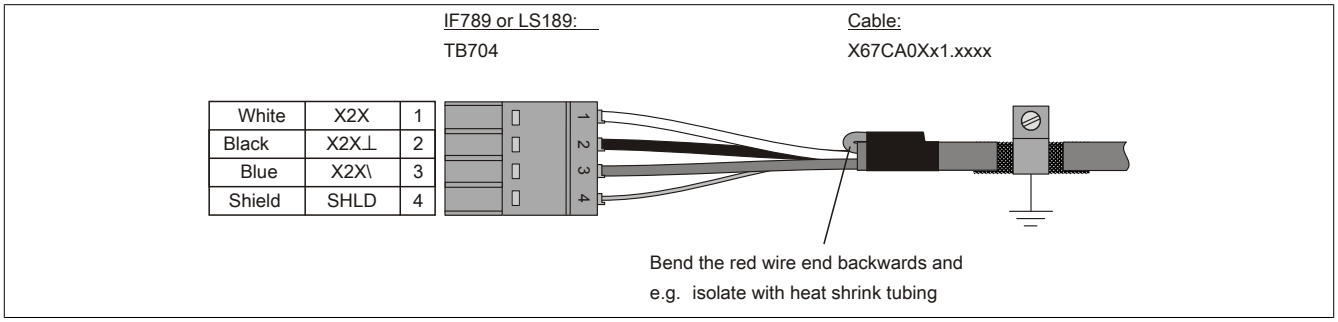


Figure 18: X2X Link attachment cable - Installation diagram

Information:

If the cable shield is not grounded, transmission errors may occur when strong electromagnetic interference occurs.

7.4 Calculating the power requirements

The power provided by the bus controllers and system supply modules is shown with a "+" sign. The power required by modules is shown with a "-" sign. To calculate the power requirements, the positive and negative power values must be added together. The sum is not permitted to be less than zero.

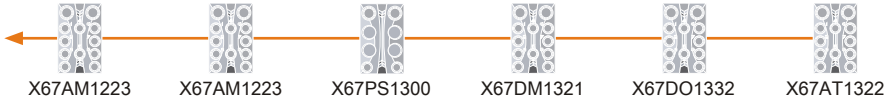
7.4.1 Example 1

Calculation of the X2X Link power requirements and the module power required internally on the basis of the given hardware configuration. The X2X Link power requirements are balanced. X67PS1300 is not necessary. The internal module power consumption and the sensor/actuator power supply must come from the external power supply.

Module	X2X Link performance [W]	Internal module power [W]
X67BC7321-1	+3.00	10.30
X67DM1321	-0.75	2.50
X67DM1321	-0.75	2.50
X67DI1371	-0.75	1.00
Total	**+0.75**	**+16.30**

7.4.2 Example 2

Calculation of the X2X Link power requirements and the module power required internally on the basis of the given hardware configuration. The X2X Link power requirements calculation produces a surplus of +11,25 W. Therefore, one X67PS1300 is sufficient. The internal module power consumption and the sensor/actuator power supply must come from the external power supply.



Module	X2X Link performance [W]	Internal module power [W]
X67AM1223	-0.75	3.00
X67AM1223	-0.75	3.00
X67PS1300	+15.00	3.00 + 15.00
X67DM1321	-0.75	2.50
X67DO1332	-0.75	2.00
X67AT1322	-0.75	1.50
Total	**+11.25**	**+30.00**

8 Accessories

8.1 General overview

B&R offers pre-assembled cables, connectors and other accessories for the various connections on X67 modules.

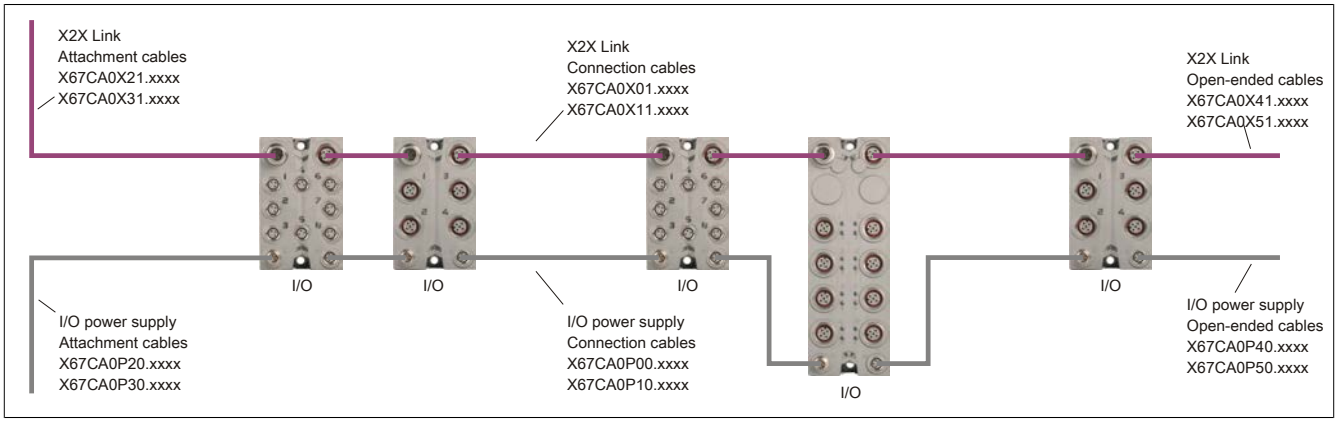
Information:

The color of the wires used in field-assembled cables may deviate from the standard. Make sure to check the proper pinout.

Additional information about the various cables can be found in the respective documentation (see "Pre-assembled cables" on page 65) or the pinouts in the respective data sheets.

The following overview shows all available accessories for each connector or fieldbus.

8.1.1 X2X Link and I/O power supply



X2X Link

M12 cable, 5-pin	Model number	Information
Attachment cables	X67CA0X21.xxxx	0.5 to 50 m; straight connector
	X67CA0X31.xxxx	2 to 25 m; angled connector
Connection cables	X67CA0X01.xxxx	0.25 to 50 m; straight connector
	X67CA0X11.xxxx	0.25 to 50 m; angled connector
Open-ended cables	X67CA0X41.xxxx	2 to 15 m; straight connector
	X67CA0X51.xxxx	2 to 5 m; angled connector
Free cable	X67CA0X99.xxxx	100 to 500 m
Field-assembled connectors	**Model number**	**Information**
Input	X67AC0X01-1	Push-in
	X67AC2X01	Screw clamp connection
Output	X67AC0X21-1	Push-in
	X67AC2X21	Screw clamp connection
Other	**Model number**	
Threaded caps	X67AC0M12	

I/O power supply

M8 cable, 4-pin	Model number	Information
Attachment cables	X67CA0P20.xxxx	0.25 to 50 m; straight connector
	X67CA0P30.xxxx	0.25 to 50 m; angled connector
Connection cables	X67CA0P00.xxxx	0.25 to 15 m; straight connector
	X67CA0P10.xxxx	0.25 to 15 m; angled connector
Open-ended cables	X67CA0P40.xxxx	0.25 to 5 m; straight connector
	X67CA0P50.xxxx	0.25 to 5 m; angled connector
Field-assembled connectors	**Model number**	**Information**
Input	X67AC0P00	Piercing connection
Output	X67AC0P20	Piercing connection
Other	**Model number**	
Threaded caps	X67AC0M08	

8.1.2 Module connections

M8, 3-pin; Digital inputs/outputs

M8 cable, 3-pin	Model number	Information
Attachment cables	X67CA0D40.xxxx	2 to 20 m; straight connector
	X67CA0D50.xxxx	2 to 20 m; angled connector
Male connector	**Model number**	**Information**
Input	X67AC0D00	Piercing connection
Other	**Model number**	
Threaded caps	X67AC0M08	

M12, 5-pin; Analog and digital inputs and outputs, motor, communication

M12 cable, 5-pin	Model number	Information
Attachment cables	X67CA0A41.xxxx	2 to 20 m; straight connector
	X67CA0A51.xxxx	2 to 20 m; angled connector
Male connector	**Model number**	**Information**
Input	X67AC0A00-1	Cage clamp connection
	X67AC2A00	Screw clamp connection
	X67AC9A02	Thermocouple connector
Other	**Model number**	
Threaded caps	X67AC0M12	

M12, 12-pin; counter, encoder

M12 cable, 12-pin	Model number	Information
Attachment cables	X67CA0I41.xxxx	2 to 10 m; straight connector
	X67CA0I51.xxxx	2 to 5 m; angled connector
Other	**Model number**	
Threaded caps	X67AC0M12	

8.1.3 Fieldbus systems

CAN bus / DeviceNet

M12 cable, 5-pin	Model number	Information
Attachment cables	X67CA0C22.xxxx	5 to 50 m; straight connector
	X67CA0C32.xxxx	5 to 50 m; angled connector
Connection cables	X67CA0C02.xxxx	2 to 40 m; straight connector
Field-assembled connectors	**Model number**	**Information**
Input	X67AC0C21-1	Cage clamp connection
	X67AC2C21	Screw clamp connection
Output	X67AC0C01-1	Cage clamp connection
	X67AC2C01	Screw clamp connection
Other	**Model number**	
Terminating resistor	X67AC9C03	
Y-connector	X67AC8C00	
Threaded caps	X67AC0M12	

PROFIBUS DP

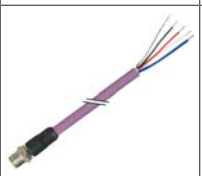
M8 cable, 4-pin	Model number	Information
Attachment cables	X67CA0B22.xxxx	5 to 50 m; straight connector
	X67CA0B32.xxxx	5 to 50 m; angled connector
Connection cables	X67CA0B12.xxxx	0.5 to 15 m; straight connector
Open-ended cables	X67CA0B52.xxxx	5 to 50 m; straight connector
Field-assembled connectors	**Model number**	**Information**
Input	X67AC0X01-1	Push-in
	X67AC2X01	Screw clamp connection
Output	X67AC0X21-1	Push-in
	X67AC2X21	Screw clamp connection
Other	**Model number**	
Terminating resistor	X67AC9B03	
Y-connector	X67AC8C00	
Threaded caps	X67AC0M12	

POWERLINK

M12 cable, 5-pin	Model number	Information
Attachment cables	X67CA0E41.xxxx	1 to 50 m; straight connector
	X67CA3E41.xxxx	15 m; straight connector; can be used in cable drag chains
Connection cables	X67CA0E61.xxxx	1 to 20 m; straight connector
Field-assembled connectors	**Model number**	**Information**
Inputs/Outputs	X67AC2E01	Insulation piercing connection
Other	**Model number**	
Threaded caps	X67AC0M12	

8.2 Pre-assembled cables

8.2.1 X2X Link cables

	Short description, model number					
Length	**X2X Link connection cable**		**X2X Link attachment cable**		**X2X Link open-ended cables**	
0.25 m	X67CA0X01.0002	X67CA0X11.0002				
0.3 m	X67CA0X01.0003					
0.5 m	X67CA0X01.0005	X67CA0X11.0005	X67CA0X21.0005			
1 m	X67CA0X01.0010	X67CA0X11.0010	X67CA0X21.0010		X67CA0X41.0010	
2 m	X67CA0X01.0020	X67CA0X11.0020		X67CA0X31.0020	X67CA0X41.0020	X67CA0X51.0020
5 m	X67CA0X01.0050	X67CA0X11.0050	X67CA0X21.0050	X67CA0X31.0050	X67CA0X41.0050	X67CA0X51.0050
10 m	X67CA0X01.0100	X67CA0X11.0100		X67CA0X31.0100	X67CA0X41.0100	
15 m	X67CA0X01.0150	X67CA0X11.0150	X67CA0X21.0150	X67CA0X31.0150		
20 m			X67CA0X21.0200			
25 m	X67CA0X01.0250	X67CA0X11.0250				
50 m	X67CA0X01.0500	X67CA0X11.0500	X67CA0X21.0500	X67CA0X31.0500		
						

1) Standard length = 0.2 m.

Length	**Tolerances for cable lengths**
0 to <1 m	+2 cm
1 m to <10 m	+5 cm
10 m to xx m	+10 cm

	Short description, model number
Length	X2X Link cable for custom assembly
100 m	X67CA0X99.1000
500 m	X67CA0X99.5000
	

8.2.1.1 Technical data

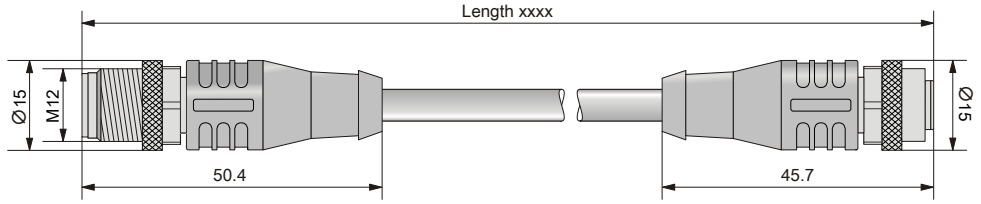
Product ID	X67CA0X01	X67CA0X11	X67CA0X21	X67CA0X31	X67CA0X41	X67CA0X51	X67CA0X99
General information							
Note	Halogen-free						
Durability	Flame resistant						
Connection	M12, 4-pin, straight	M12, 4-pin, angled	M12, 4-pin, straight	M12, 4-pin, angled	M12, 4-pin, straight	M12, 4-pin, angled	-
Type	Connection cables		Attachment cables		Open-ended cables		-
Cable cross section							
Data cables							
AWG	2x 24 AWG						
mm²	2x 0.25 mm²						
Supply lines							
AWG	2x 22 AWG						
mm²	2x 0.34 mm²						
Cable construction							
Signal lines							
Shield	Paired shield with aluminum foil						
Stranding	No						
Cable stranding	0.35 mm² (22 AWG) with filler						
Complete shielding	Tinned copper braiding, coverage >85%						
Outer sheathing							
Material	Thermoplastic polyurethane (TPU)						
Color	Violet						
Type	Tinned copper ETB1 Data line: fine stranded wire (19x 0.13 mm) Supply line: Fine stranded wire (19x 0.15 mm)						
Wire colors							
Data cables	Blue, white						
Supply lines	Red, black						
Wire insulation							
Data cables	Cell polyethylene (PE)						
Supply lines	Polyethylene (PE)						
Electrical characteristics							
Nominal current	Max. 4 A / contact at 40°C						
Operating voltage	Max. 250 V						
Degree of insulation	Category II in accordance with IEC 61076-2						
Conductor resistance	Data line: ≤78 Ω/km Supply line: ≤55 Ω/km						
Insulation resistance	≥100 MΩ						
Operating conditions							
EN 60529 protection							
Connector/Coupling	IP67, only when screwed in						-
Environmental conditions							
Temperature							
Transport	-40 to 80°C						
Fixed installation	-40 to 80°C						
Flexible installation[1)]	-25 to 60°C						
Mechanical characteristics							
Dimensions							
Length	Various						
Diameter	6.9 mm ±0.2 mm						
Bend radius	≥15x outer diameter						
Drag chain data							
Acceleration	Max. 4 m/s²						
Flex cycles	Min. 2 million						
Speed	Max. 3 m/s						
Weight	0.063 kg/m						

Table 2: X67CA0Xxx - Technical data

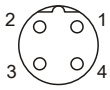
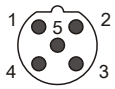
1) In cable drag chain operation.

8.2.1.2 X67CA0X01.xxxx

Dimensions



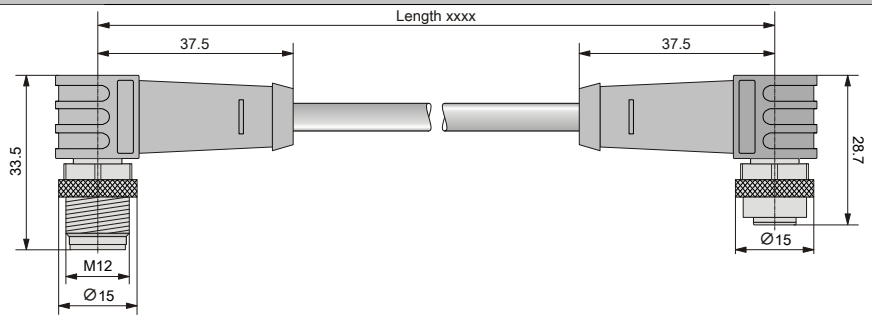
Pinout

Male connector	Pin	Description	Wire colors	Female connector
 B-coded	1	X2X+	Red	 B-coded
	2	X2X	White	
	3	X2X⊥	Black	
	4	X2X\	Blue	
	5	NC	-	
	M12 [1]	SHLD	-	

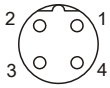
1) Shielding 360° around M12 knurled-head screw.

8.2.1.3 X67CA0X11.xxxx

Dimensions



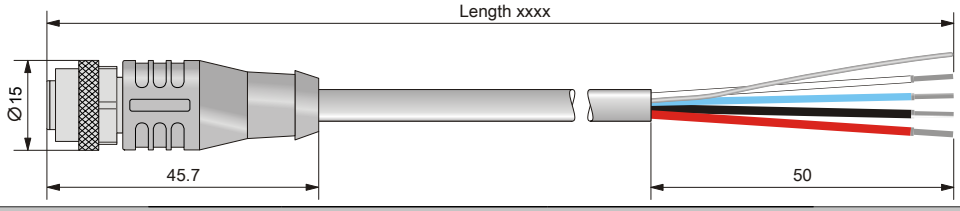
Pinout

Male connector	Pin	Description	Wire colors	Female connector
 B-coded	1	X2X+	Red	 B-coded
	2	X2X	White	
	3	X2X⊥	Black	
	4	X2X\	Blue	
	5	NC	-	
	M12 [1]	SHLD	-	

1) Shielding 360° around M12 knurled-head screw.

8.2.1.4 X67CA0X21.xxxx

Dimensions



Pinout

Female connector	Pin	Description	Wire colors	Open-ended
 B-coded	1	X2X+	Red	For custom Wiring
	2	X2X	White	
	3	X2X⊥	Black	
	4	X2X\	Blue	
	5	NC	-	
	M12 [1]	SHLD	-	

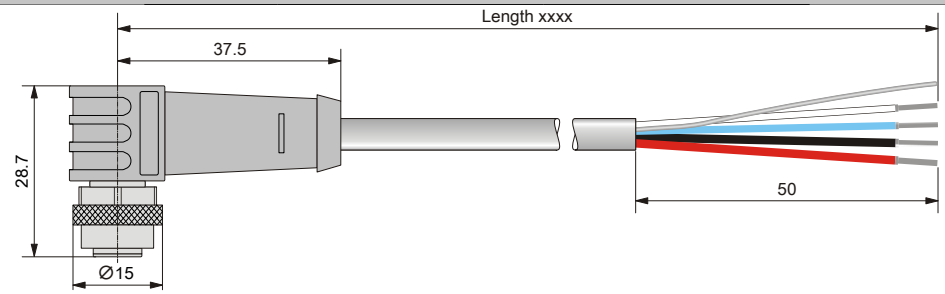
1) Shielding 360° around M12 knurled-head screw.

Information:

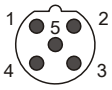
See note in section "Connection of X2X Link interfaces with internal power supply" on page 60.

8.2.1.5 X67CA0X31.xxxx

Dimensions



Pinout

Female connector	Pin	Description	Wire colors	Open-ended
 B-coded	1	X2X+	Red	For custom Wiring
	2	X2X	White	
	3	X2X⊥	Black	
	4	X2X\	Blue	
	5	NC	-	
	M12 [1]	SHLD	-	

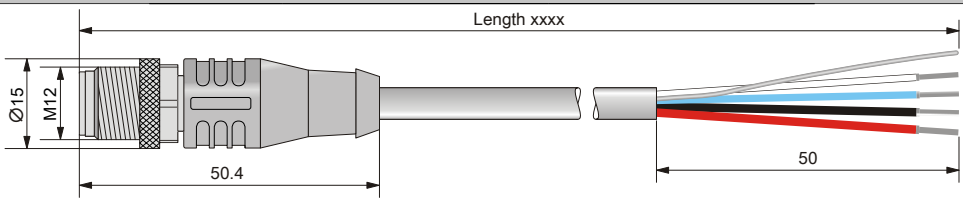
1) Shielding 360° around M12 knurled-head screw.

Information:

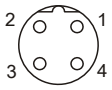
See note in section "Connection of X2X Link interfaces with internal power supply" on page 60.

8.2.1.6 X67CA0X41.xxxx

Dimensions



Pinout

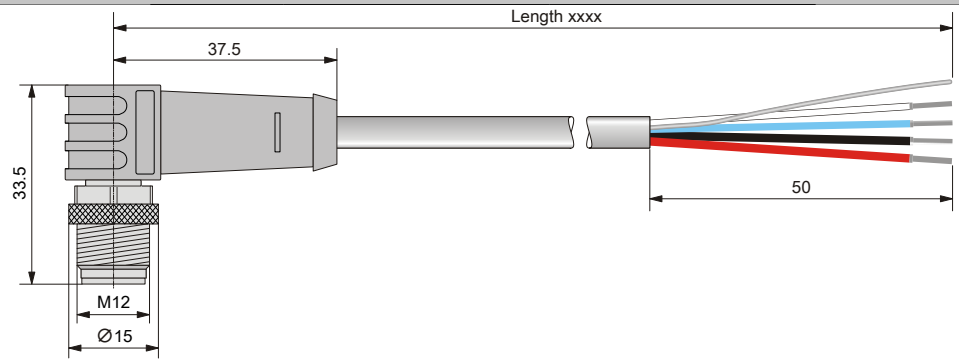
Male connector	Pin	Description	Wire colors	Open-ended
 B-coded	1	X2X+	Red	For custom Wiring
	2	X2X	White	
	3	X2X⊥	Black	
	4	X2X\	Blue	
	M12 [1]	SHLD	-	

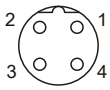
1) Shielding 360° around M12 knurled-head screw.

Information:

See note in section "Connection of X2X Link interfaces with internal power supply" on page 60.

8.2.1.7 X67CA0X51.xxxx

Dimensions


Pinout				
Male connector	**Pin**	**Description**	**Wire colors**	**Open-ended**
 B-coded	1	X2X+	Red	For custom Wiring
	2	X2X	White	
	3	X2X⊥	Black	
	4	X2X\	Blue	
	M12 [1)]	SHLD	-	

1) Shielding 360° around M12 knurled-head screw.

Information:

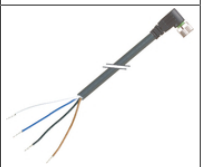
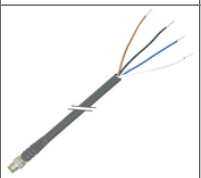
See note in section "Connection of X2X Link interfaces with internal power supply" on page 60.

8.2.1.8 X67CA0X99.xxxx

Dimensions


Pinout			
	Description	**Wire colors**	
For custom Wiring	X2X+	Red	For custom Wiring
	X2X	White	
	X2X⊥	Black	
	X2X\	Blue	
	SHLD	-	

8.2.2 I/O power supply cables

	Short description, order number					
Length	Power connection cable		Power attachment cable		Power open-ended cable	
0.25 m[1]	X67CA0P00.0002	X67CA0P10.0002	X67CA0P20.0002	X67CA0P30.0002	X67CA0P40.0002	X67CA0P50.0002
0.4 m						X67CA0P50.0004
0.5 m	X67CA0P00.0005	X67CA0P10.0005				
1 m	X67CA0P00.0010	X67CA0P10.0010	X67CA0P20.0010			
1.5 m	X67CA0P00.0015					
2 m	X67CA0P00.0020	X67CA0P10.0020		X67CA0P30.0020	X67CA0P40.0020	X67CA0P50.0020
5 m	X67CA0P00.0050	X67CA0P10.0050	X67CA0P20.0050	X67CA0P30.0050	X67CA0P40.0050	X67CA0P50.0050
10 m	X67CA0P00.0100	X67CA0P10.0100	X67CA0P20.0100	X67CA0P30.0100		
15 m	X67CA0P00.0150	X67CA0P10.0150	X67CA0P20.0150	X67CA0P30.0150		
20 m	X67CA0P00.0200		X67CA0P20.0200	X67CA0P30.0200		
25 m			X67CA0P20.0250			
30 m	X67CA0P00.0300					
50 m			X67CA0P20.0500	X67CA0P30.0500		
						

1 Standard length = 0.2 m.

Length	Tolerances for cable lengths
0 to <1 m	+2 cm
1 m to <10 m	+5 cm
10 m to xx m	+10 cm

8.2.2.1 Technical data

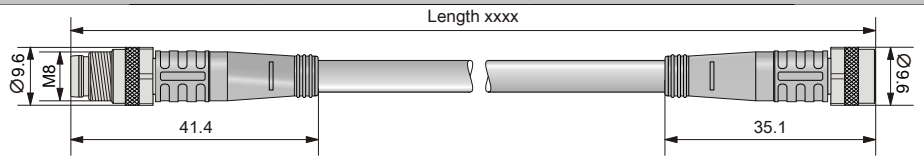
Product ID	X67CA0P00	X67CA0P10	X67CA0P20	X67CA0P30	X67CA0P40	X67CA0P50
General information						
Note	PVC- and silicone-free LABS- (PWIS-) and halogen-free					
Durability	Good chemical and oil resistance Flame resistant Good UV and ozone resistance					
Connection	M8, 4-pin, straight	M8, 4-pin, angled	M8, 4-pin, straight	M8, 4-pin, angled	M8, 4-pin, straight	M8, 4-pin, angled
Type	Connection cables		Attachment cables		Open-ended cables	
Cable cross section						
AWG	4x 22 AWG					
mm²	4x 0.34 mm²					
Cable construction						
Complete shielding	Not shielded					
Outer sheathing						
Material	Polyurethane (PUR)					
Color	Black					
Labeling	B&R X67CA0Pxx.xxxx Rev. G0 ESCHA FC[1)]					
Lines						
Wire insulation	Polypropylene (PP) 9Y					
Wire colors	Brown, black, blue, white					
Type	Uncoated copper ETP1 Fine stranded wire (42x 0.1 mm / 42x 38 AWG), class 5					
Stranding	4-wire twisted pair					
Electrical characteristics						
Nominal current	Max. 4 A in accordance with EN / contact at 40°C Max. 3 A in accordance with UL / contact					
Operating voltage	Max. 60 V					
Degree of insulation	Category II in accordance with IEC 61076-2					
Conductor resistance	≤57 Ω/km					
Insulation resistance	≥100 MΩ					
Operating conditions						
EN 60529 protection						
Connector/Coupling	IP67, only when screwed in					
Environmental conditions						
Temperature						
Transport	-40 to 90°C					
Fixed installation	-30 to 90°C					
Flexible installation[2)]	-25 to 60°C					
Mechanical characteristics						
Dimensions						
Length	Various					
Diameter	4.7 mm ±0.2 mm					
Bend radius	≥10x outer diameter					
Drag chain data						
Acceleration	Max. 5 m/s²					
Flex cycles	5 million					
Speed	Max. 3.3 m/s					

Table 3: X67CA0Pxx - Technical data

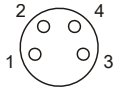
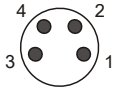
1) xx.xxxx: Group number and cable length.
2) In cable drag chain operation.

8.2.2.2 X67CA0P00.xxxx

Dimensions

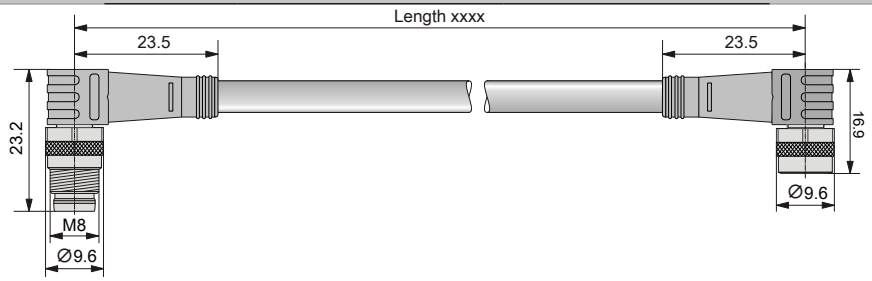


Pinout

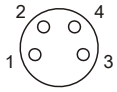
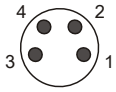
M8 male connector, 4-pin	Pin	Name	Wire colors	M8 female connector, 4-pin
	1	24 VDC	Brown	
	2	24 VDC	White	
	3	GND	Blue	
	4	GND	Black	

8.2.2.3 X67CA0P10.xxxx

Dimensions

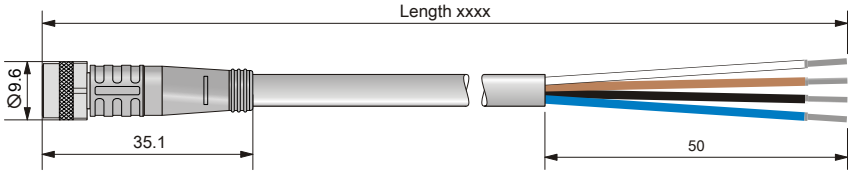


Pinout

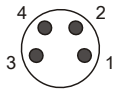
M8 male connector, 4-pin	Pin	Name	Wire colors	M8 female connector, 4-pin
	1	24 VDC	Brown	
	2	24 VDC	White	
	3	GND	Blue	
	4	GND	Black	

8.2.2.4 X67CA0P20.xxxx

Dimensions



Pinout

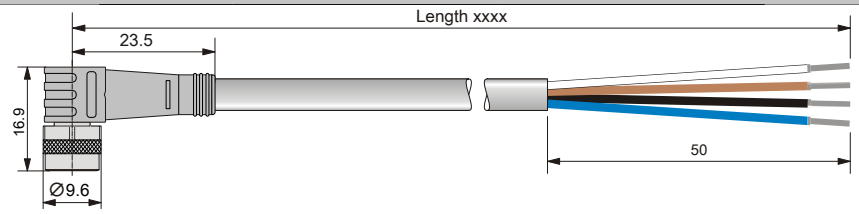
M8 female connector, 4-pin	Pin	Name	Wire colors	Open
	1	24 VDC	Brown	For custom wiring
	2	24 VDC	White	
	3	GND	Blue	
	4	GND	Black	

Information:

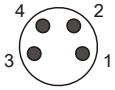
Both wires must be used since the current load is split.

8.2.2.5 X67CA0P30.xxxx

Dimensions



Pinout

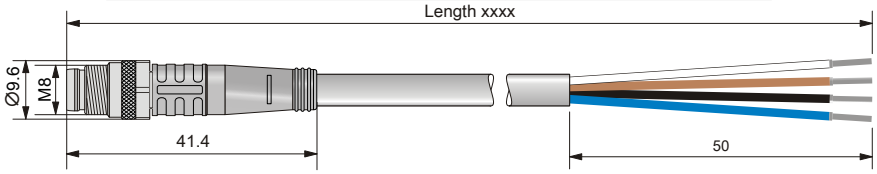
M8 female connector, 4-pin	Pin	Name	Wire colors	Open
	1	24 VDC	Brown	For custom wiring
	2	24 VDC	White	
	3	GND	Blue	
	4	GND	Black	

Information:

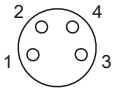
Both wires must be used since the current load is split.

8.2.2.6 X67CA0P40.xxxx

Dimensions



Pinout

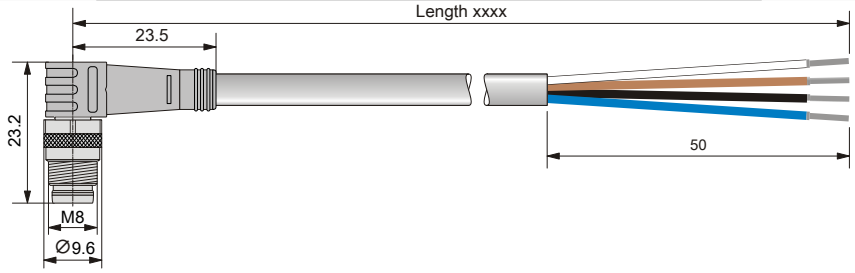
M8 male connector, 4-pin	Pin	Name	Wire colors	Open
	1	24 VDC	Brown	For custom wiring
	2	24 VDC	White	
	3	GND	Blue	
	4	GND	Black	

Information:

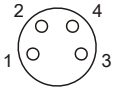
Both wires must be used since the current load is split.

8.2.2.7 X67CA0P50.xxxx

Dimensions



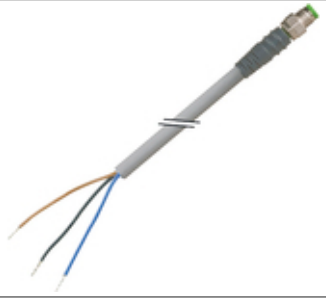
Pinout

M8 male connector, 4-pin	Pin	Name	Wire colors	Open
	1	24 VDC	Brown	For custom wiring
	2	24 VDC	White	
	3	GND	Blue	
	4	GND	Black	

Information:

Both wires must be used since the current load is split.

8.2.3 M8 sensor cables

	Short description	
Length	M8 sensor cables	
2 m	X67CA0D40.0020	X67CA0D50.0020
5 m	X67CA0D40.0050	X67CA0D50.0050
10 m	X67CA0D40.0100	X67CA0D50.0100
15 m	X67CA0D40.0150	X67CA0D50.0150
20 m	X67CA0D40.0200	X67CA0D50.0200
		

Length	Tolerances for cable lengths
0 to <1 m	+2 cm
1 m to <10 m	+5 cm
10 m to xx m	+10 cm

8.2.3.1 Technical data

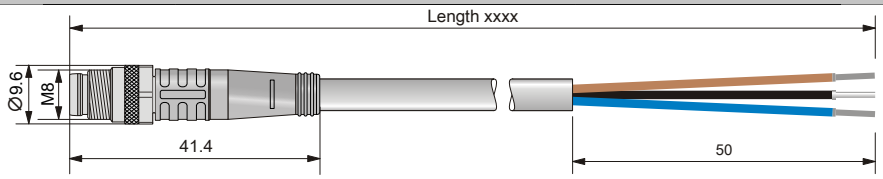
Product ID	X67CA0D40	X67CA0D50
General information		
Note	PVC- and silicone-free PWIS- and halogen-free	
Durability	Good chemical and oil resistance Flame-retardant Good UV and ozone resistance	
Connection	M8, 3-pin, straight	M8, 3-pin, angled
Type	Attachment cables	
Cable cross section		
AWG	3x 22 AWG	
mm²	3x 0.34 mm²	
Cable construction		
Cable shield	Not shielded	
Outer jacket		
Material	Polyurethane (PUR)	
Color	Gray	
Labeling	B&R X67CA0Dxx.xxxx Rev. G0 ESCHA FC[1)]	
Wires		
Wire insulation	Polypropylene (PP) 9Y	
Wire colors	Brown, black, blue	
Type	Uncoated copper ETP1 Fine stranded wire (42x 0.1 mm / 42x 38 AWG), class 5	
Stranding	3-wire twisted pair	
Electrical properties		
Nominal current	Max. 4 A / Contact at 40°C	
Operating voltage	Max. 60 V	
Degree of insulation	Category II per IEC 61076-2	
Conductor resistance	≤57 Ω/km	
Insulation resistance	≥100 MΩ	
Operating conditions		
Degree of protection per EN 60529		
Connector/Coupling	IP67, only when screwed in	
Ambient conditions		
Temperature		
Transport	-40 to 90°C	
Fixed installation	-30 to 90°C	
Flexible installation[2)]	-25 to 60°C	
Mechanical properties		
Dimensions		
Length	Various	
Diameter	4.3 mm ±0.2 mm	
Bend radius	≥10x outer diameter	
Drag chain data		
Acceleration	Max. 5 m/s²	
Flex cycles	5 million	
Velocity	Max. 3.3 m/s	

Table 4: X67CA0Dxx - Technical data

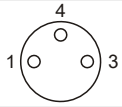
1) xx.xxxx: Group number and cable length
2) In cable drag chain operation

8.2.3.2 X67CA0D40.xxxx

Dimensions

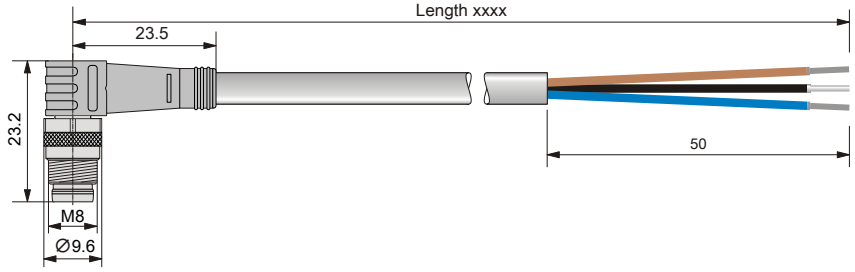


Pinout

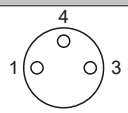
Connector	Pin	Name	Wire colors	Open-ended
	1	Sensor/actuator power supply 24 VDC	Brown	For custom wiring
	3	GND	Blue	
	4	Input/Output x	Black	

8.2.3.3 X67CA0D50.xxxx

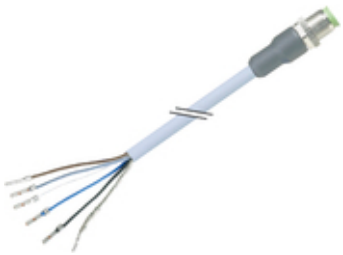
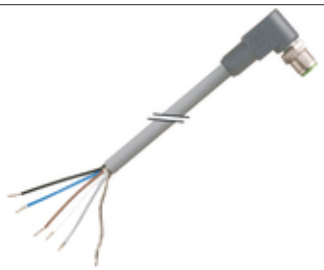
Dimensions



Pinout

Connector	Pin	Name	Wire colors	Open-ended
	1	Sensor/actuator power supply 24 VDC	Brown	For custom wiring
	3	GND	Blue	
	4	Input/Output x	Black	

8.2.4 M12 sensor cables

	Short description	
Length	M12 sensor cables	
2 m	X67CA0A41.0020	X67CA0A51.0020
5 m	X67CA0A41.0050	X67CA0A51.0050
10 m	X67CA0A41.0100	X67CA0A51.0100
15 m	X67CA0A41.0150	X67CA0A51.0150
20 m	X67CA0A41.0200	X67CA0A51.0200
		

Length	Tolerances for cable lengths
0 to <1 m	+2 cm
1 m to <10 m	+5 cm
10 m to xx m	+10 cm

8.2.4.1 Technical data

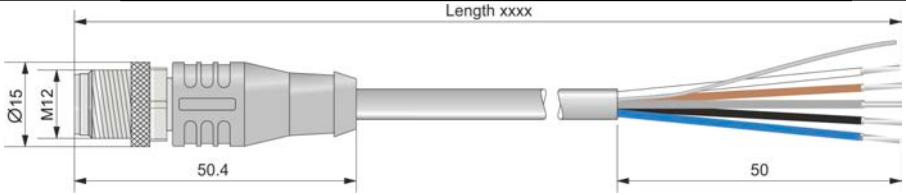
Product ID	X67CA0A41	X67CA0A51
General information		
Note	PVC- and silicone-free LABS- (PWIS-) and halogen-free	
Durability	Good chemical and oil resistance Flame resistant Good UV and ozone resistance	
Connection	M12, 5-pin, straight	M12, 5-pin, angled
Type	Attachment cables	
Cable cross section		
AWG	5x 22 AWG	
mm²	5x 0.34 mm²	
Cable construction		
Complete shielding	Tinned copper braiding, coverage 84%, 0.25 mm² with filler	
Outer sheathing		
Material	Polyurethane (PUR) UL	
Color	Gray	
Labeling	B&R X67CA0Axx.xxxx Rev. G0 ESCHA FC[1)]	
Lines		
Wire insulation	Polypropylene (PP) 9Y	
Wire colors	Brown, black, blue, white, gray	
Type	Uncoated copper ETP1 Fine stranded wire (42x 0.1 mm / 42x 38 AWG), class 5	
Stranding	5 wires stranded using filler	
Electrical characteristics		
Nominal current	Max. 4 A / contact at 40°C	
Operating voltage	Max. 60 V	
Degree of insulation	Category II in accordance with IEC 61076-2	
Conductor resistance	≤57 Ω/km	
Insulation resistance	≥100 MΩ	
Operating conditions		
EN 60529 protection		
Connector/Coupling	IP67, only when screwed in	
Environmental conditions		
Temperature		
Transport	-40 to 90°C	
Fixed installation	-30 to 90°C	
Flexible installation[2)]	-25 to 60°C	
Mechanical characteristics		
Dimensions		
Length	Various	
Diameter	5.6 mm ±0.2 mm	
Bend radius	≥12x outer diameter	
Drag chain data		
Acceleration	Max. 5m/s²	
Flex cycles	2 million	
Speed	Max. 1.6 m/s	

Table 5: X67CA0Axx - Technical data

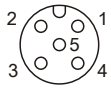
1) xx.xxxx: Group number and cable length.
2) In cable drag chain operation.

8.2.4.2 X67CA0A41.xxxx

Dimensions



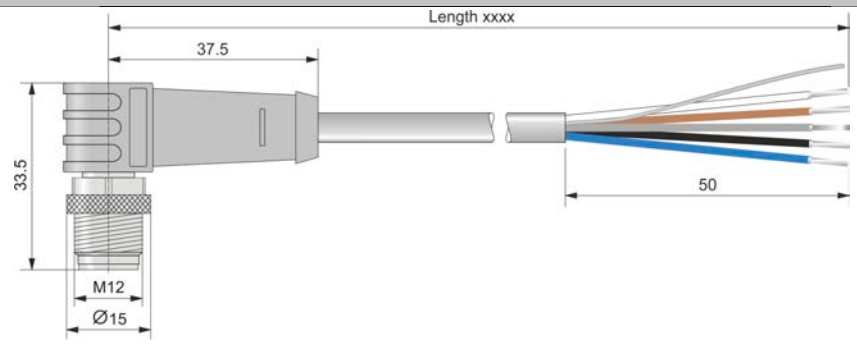
Pinout

Male connector	Pin	Name	Wire colors	Open
 A-keyed	1	Pinout, see module description	Brown	For custom wiring
	2		White	
	3		Blue	
	4		Black	
	5 [1)]		Gray	
	M12 [2)]	SHLD	-	

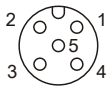
1) Do not use the gray connecting line in connection with X67 modules for which pin 5 is used as a shield connection. The cable shield for this cable is connected using a union nut.
2) Shield on M12 knurled-head screw in 360° design

8.2.4.3 X67CA0A51.xxxx

Dimensions

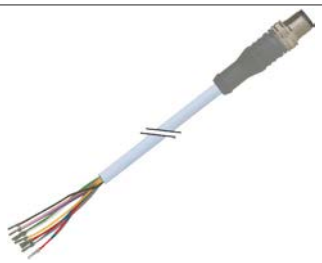


Pinout

Male connector	Pin	Name	Wire colors	Open
 A-keyed	1	Pinout, see module description	Brown	For custom wiring
	2		White	
	3		Blue	
	4		Black	
	5 [1)]		Gray	
	M12 [2)]	SHLD	-	

1) Do not use the gray connecting line in connection with X67 modules for which pin 5 is used as a shield connection. The cable shield for this cable is connected using a union nut.
2) Shield on M12 knurled-head screw in 360° design

8.2.5 Multifunction cables

	Short description	
Length	Multifunction attachment cable	
2 m	X67CA0I41.0020	X67CA0I51.0020
5 m	X67CA0I41.0050	X67CA0I51.0050
10 m	X67CA0I41.0100	
		

Length	Tolerances for cable lengths
0 to <1 m	+2 cm
1 m to <10 m	+5 cm
10 m to xx m	+10 cm

8.2.5.1 Technical data

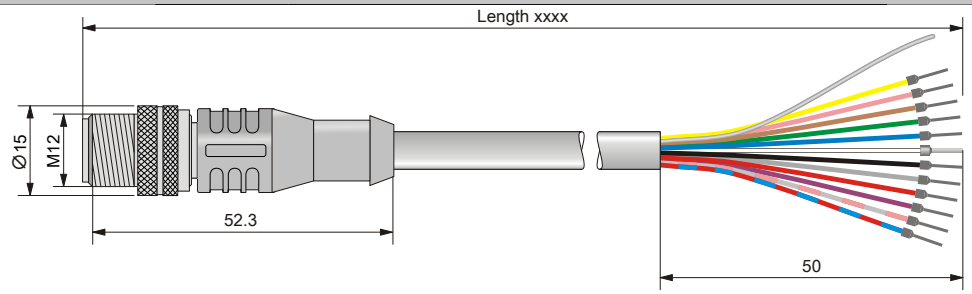
Product ID	X67CA0I41	X67CA0I51
General information		
Note	Halogen-free Free of CFCs and cadmium	
Durability	Oil resistant in accordance with VDE 0472, Part 803 Flame-retardant in accordance with VDE 0472, Part 804 / B Salt water resistant	
Connection	M12, 12-pin, straight	M12, 12-pin, angled
Type	Attachment cables	
Cable cross section		
AWG	12x 28 AWG	
mm²	12x 0.14 mm²	
Cable construction		
Complete shielding	Copper braiding, coverage >84%	
Outer sheathing		
Material	Polyether polyurethane (PUR)	
Color	Gray	
Labeling	B&R X67CA0Ixx.xxxx Rev. G0 yyyyyyy ESCHA FC[1)]	
Lines		
Wire insulation	Polypropylene (PP) 9Y	
Wire colors	Brown, black, blue, white, gray, green, pink, yellow, red, violet, gray/pink, red/blue	
Type	El copper bare conductors Fine stranded wire (72x 0.05 mm / 72x 44 AWG)	
Stranding	12-wire twisted pair	
Electrical characteristics		
Nominal current	1.5 A / Contact in accordance with IEC 60512-3	
Operating voltage	30 V	
Insulation resistance	>10⁹Ω in accordance with IEC 60512-2	
Operating conditions		
EN 60529 protection		
Connector/Coupling	IP67, only when screwed in, in accordance with IEC 60529	
Environmental conditions		
Temperature		
Transport	-40 to 90°C	
Fixed installation	-40 to 90°C	
Flexible installation	0 to 90°C	
Mechanical characteristics		
Dimensions		
Length	Various	
Diameter	6.2 mm ±0.15 mm	
Bend radius	≥10x outer diameter	

Table 6: X67CA0Ixx - Technical data

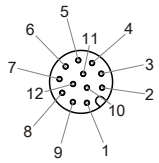
1) xx.xxxx: Group number and length of the cable;
yyyyyyy: Cable number

8.2.5.2 X67CA0I41.xxxx

Dimensions

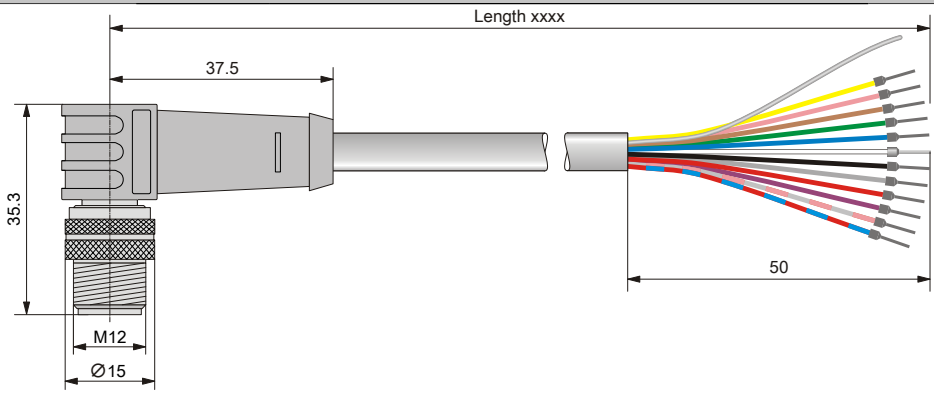


Pinout

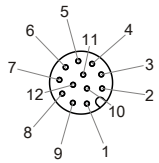
Male connector	Pin	Name	Wire colors	Open
 A-keyed	1	Pinout, see module description	Brown	For custom wiring
	2		Blue	
	3		White	
	4		Green	
	5		Pink	
	6		Yellow	
	7		Black	
	8		Gray	
	9		Red	
	10		Purple	
	11		Gray/Pink	
	12		Red/Blue	

8.2.5.3 X67CA0I51.xxxx

Dimensions



Pinout

Male connector	Pin	Name	Wire colors	Open
 A-keyed	1	Pinout, see module description	Brown	For custom wiring
	2		Blue	
	3		White	
	4		Green	
	5		Pink	
	6		Yellow	
	7		Black	
	8		Gray	
	9		Red	
	10		Purple	
	11		Gray/Pink	
	12		Red/Blue	

8.2.6 CAN bus / DeviceNet cables

	Short description, model number		
Length	Connection cables	Attachment cables	
2 m	X67CA0C02.0020		
5 m	X67CA0C02.0050	X67CA0C22.0050	X67CA0C32.0050
10 m	X67CA0C02.0100		
15 m	X67CA0C02.0150	X67CA0C22.0150	X67CA0C32.0150
20 m	X67CA0C02.0200		
35 m	X67CA0C02.0350		
40 m	X67CA0C02.0400		
50 m		X67CA0C22.0500	X67CA0C32.0500
			

Length	Tolerances for cable lengths
0 to <1 m	+2 cm
1 m to <10 m	+5 cm
10 m to xx m	+10 cm

8.2.6.1 Technical data

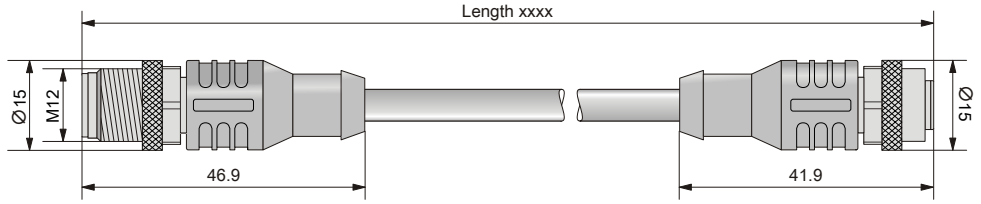
Product ID	X67CA0C02	X67CA0C22	X67CA0C32
General information			
Note	Halogen-free		
Durability	Flame resistant		
Connection	M12, 4-pin, straight	M12, 4-pin, straight	M12, 4-pin, angled
Type	Connection cables	Attachment cables	
Cable cross section			
Data cables			
AWG	2x 24 AWG		
mm²	2x 0.25 mm²		
Supply lines			
AWG	2x 22 AWG		
mm²	2x 0.34 mm²		
Cable construction			
Signal lines			
Shield	Paired shield with aluminum foil		
Stranding	Twisted pair wires		
Cable stranding	0.35 mm² (22 AWG) with filler		
Complete shielding	Tinned copper braiding, coverage >85%		
Outer sheathing			
Material	Thermoplastic polyurethane (TPU)		
Color	Violet		
Labeling	B&R X67CA0Cxx.xxxx Rev. G0 ESCHA FC[1)]		
Lines			
Type	Tinned copper ETB1 Data line: fine stranded wire (19x 0.13 mm) Supply line: Fine stranded wire (19x 0.15 mm)		
Wire colors			
Data cables	Blue, white		
Supply lines	Red, black		
Wire insulation			
Data cables	Cell polyethylene (PE)		
Supply lines	Polyethylene (PE)		
Electrical characteristics			
Nominal current	Max. 4 A / contact at 40°C		
Operating voltage	Max. 250 V		
Degree of insulation	Category II in accordance with IEC 61076-2		
Conductor resistance	Data line: ≤78 Ω/km Supply line: ≤55 Ω/km		
Insulation resistance	≥100 MΩ		
Operating conditions			
EN 60529 protection			
Connector/Coupling	IP67, only when screwed in		
Environmental conditions			
Temperature			
Transport	-40 to 80°C		
Fixed installation	-40 to 80°C		
Flexible installation[2)]	-25 to 60°C		
Mechanical characteristics			
Dimensions			
Length	Various		
Diameter	6.9 mm ±0.2 mm		
Bend radius	TBD		
Drag chain data			
Acceleration	Max. 4 m/s²		
Flex cycles	2 million		
Speed	Max. 3 m/s		
Weight	0.063 kg/m		

Table 7: X67CA0Cxx - Technical data

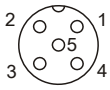
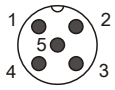
1) xx.xxxx: Group number and cable length.
2) In cable drag chain operation.

8.2.6.2 X67CA0C02.xxxx

Dimensions

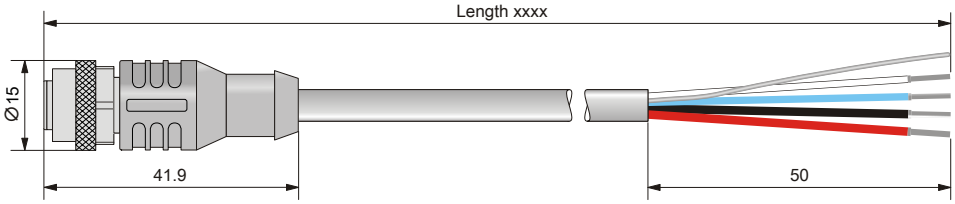


Pinout

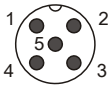
Male connector	Pin	Name	Wire colors	Female connector
 A-keyed	1	SHLD	Tracer wire / Shield	 A-keyed
	2	V+	Red	
	3	CAN GND	Black	
	4	CAN_H	White	
	5	CAN_L	Light blue	

8.2.6.3 X67CA0C22.xxxx

Dimensions

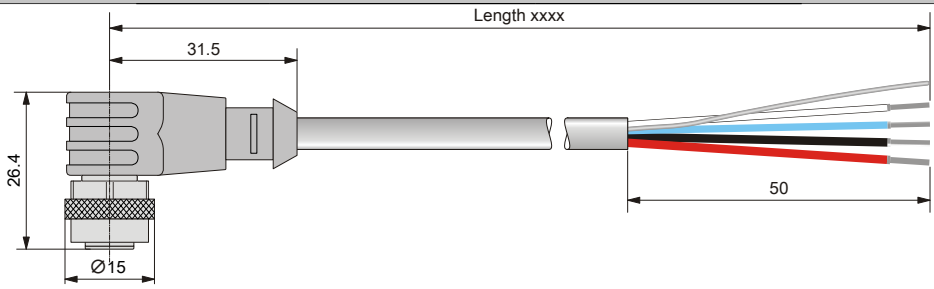


Pinout

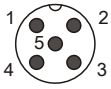
Female connector	Pin	Name	Wire colors	Open
 A-keyed	1	SHLD	Tracer wire / Shield	For custom wiring
	2	V+	Red	
	3	CAN GND	Black	
	4	CAN_H	White	
	5	CAN_L	Light blue	

8.2.6.4 X67CA0C32.xxxx

Dimensions



Pinout

Female connector	Pin	Name	Wire colors	Open
 A-keyed	1	SHLD	Tracer wire / Shield	For custom wiring
	2	V+	Red	
	3	CAN GND	Black	
	4	CAN_H	White	
	5	CAN_L	Light blue	

8.2.7 PROFIBUS DP cables

	Short description, model number			
Length	Connection cables	Attachment cables		Open-ended cables
0.5 m	X67CA0B12.0005			
2 m	X67CA0B12.0020			
5 m	X67CA0B12.0050	X67CA0B22.0050	X67CA0B32.0050	X67CA0B52.0050
10 m	X67CA0B12.0100			
15 m	X67CA0B12.0150	X67CA0B22.0150	X67CA0B32.0150	X67CA0B52.0150
50 m		X67CA0B22.0500	X67CA0B32.0500	X67CA0B52.0500
				

Length	Tolerances for cable lengths
0 to <1 m	+2 cm
1 m to <10 m	+5 cm
10 m to xx m	+10 cm

8.2.7.1 Technical data

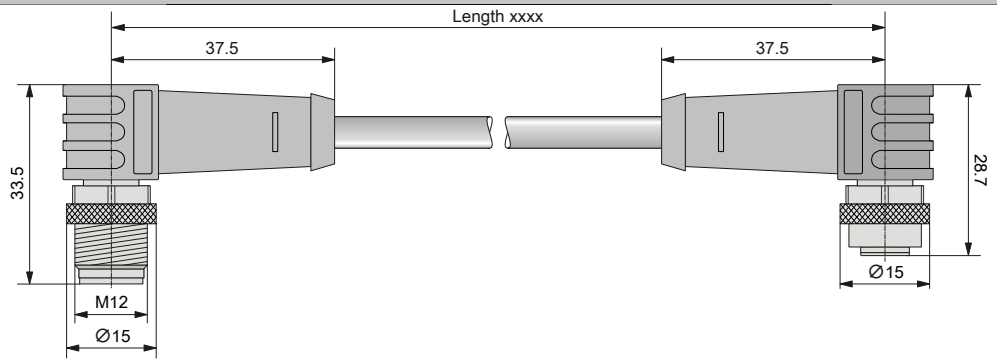
Product ID	X67CA0B12	X67CA0B22	X67CA0B32	X67CA0B52
General information				
Note	PVC- and silicone-free LABS- (PWIS-) and halogen-free			
Durability	Good chemical and oil resistance Flame resistant			
Connection	M12, 4-pin, angled	M12, 4-pin, straight	M12, 4-pin, angled	M12, 4-pin, angled
Type	Connection cables	Attachment cables		Open-ended cables
Cable cross section				
AWG	2x 22 AWG			
mm²	2x 0.34 mm²			
Cable construction				
Complete shielding	Tinned copper braiding, coverage >85%			
Outer sheathing				
Material	Polyurethane (PUR)			
Color	Violet			
Labeling	B&R X67CA0Bxx.xxxx Rev. G0 ESCHA FC[1)]			
Lines				
Wire insulation	Foam polyethylene (PE) with skin layer			
Wire colors	Red, green			
Type	Uncoated copper ETB1 Fine stranded wire (19x 0.15 mm), class 5			
Stranding	2-wire twisted pair			
Electrical characteristics				
Nominal current	Max. 4 A / contact at 40°C			
Operating voltage	Max. 60 V			
Degree of insulation	Category II in accordance with IEC 61076-2			
Conductor resistance	≤55 Ω/km			
Insulation resistance	≥100 MΩ			
Operating conditions				
EN 60529 protection				
Connector/Coupling	IP67, only when screwed in			
Environmental conditions				
Temperature				
Transport	-40 to 80°C			
Fixed installation	-25 to 80°C			
Flexible installation[2)]	-25 to 60°C			
Mechanical characteristics				
Dimensions				
Length	Various			
Diameter	7.6 mm ±0.3 mm			
Bend radius	≥10x outer diameter			
Drag chain data				
Acceleration	Max. 5m/s²			
Flex cycles	Min. 1 million			
Speed	Max. 3.3 m			

Table 8: X67CA0Bxx - Technical data

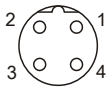
1) xx.xxxx: Group number and cable length.
2) In cable drag chain operation.

8.2.7.2 X67CA0B12.xxxx

Dimensions



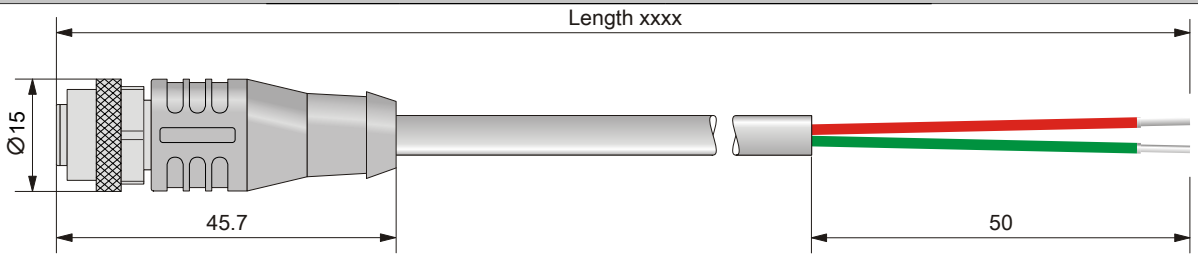
Pinout

Male connector	Pin	Name	Wire colors	Female connector
	1	NC	-	
	2	A	Green	
	3	NC	-	
	4	B	Red	
B-keyed	M12[1)]	SHLD	-	B-keyed

1) Shield on M12 knurled-head screw in 360° design

8.2.7.3 X67CA0B22.xxxx

Dimensions



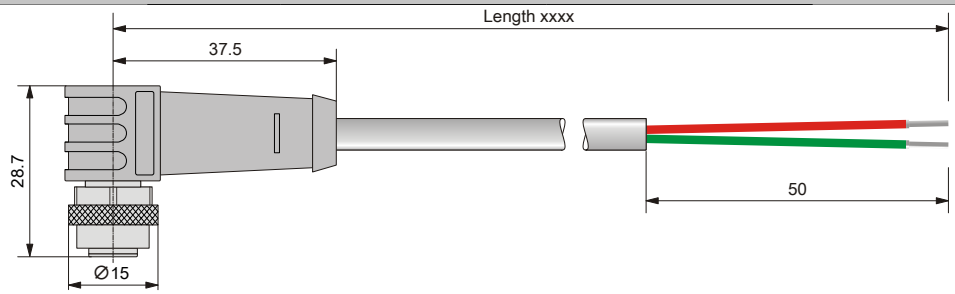
Pinout

Female connector	Pin	Name	Wire colors	Open
	1	NC	-	For custom wiring
	2	A	Green	
	3	NC	-	
	4	B	Red	
B-keyed	M12[1)]	SHLD	-	

1) Shield on M12 knurled-head screw in 360° design

8.2.7.4 X67CA0B32.xxxx

Dimensions



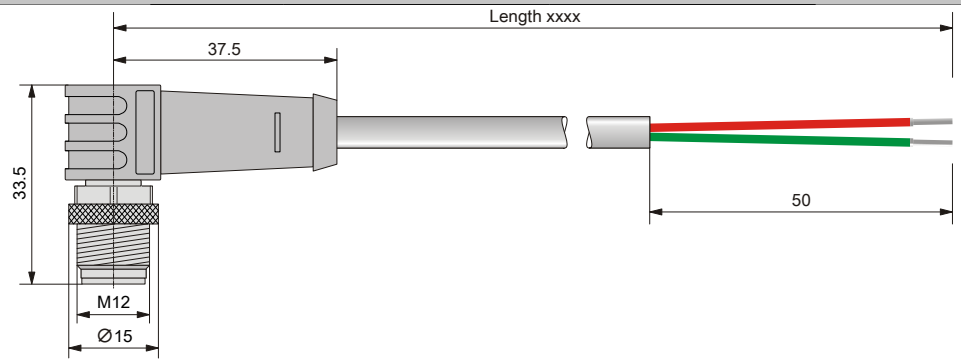
Pinout

Female connector	Pin	Name	Wire colors	Open
	1	NC	-	For custom wiring
	2	A	Green	
	3	NC	-	
	4	B	Red	
B-keyed	M12	SHLD	-	

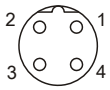
1) Shield on M12 knurled-head screw in 360° design

8.2.7.5 X67CA0B52.xxxx

Dimensions



Pinout

Male connector	Pin	Name	Wire colors	Open
 B-keyed	1	NC	-	For custom wiring
	2	A	Green	
	3	GND	-	
	4	B	Red	
	M12[1)]	SHLD	-	

1) Shield on M12 knurled-head screw in 360° design

8.2.8 X67 POWERLINK/Ethernet cables

	Short description, order number	
Length	Attachment cables - RJ45 to M12	Connection cables - M12 to M12
1 m	X67CA0E41.0010	X67CA0E61.0010
2 m	X67CA0E41.0020	X67CA0E61.0020
3 m	X67CA0E41.0030	
5 m	X67CA0E41.0050	X67CA0E61.0050
10 m		X67CA0E61.0100
15 m	X67CA0E41.0150 X67CA3E41.0150	X67CA0E61.0150
20 m		X67CA0E61.0200
50 m	X67CA0E41.0500	
		

Length	Tolerances for cable lengths
0 to <10 m	+10 cm
10 m to <50 m	+2% of the length

8.2.8.1 Technical data

Order number	X67CA0E41.xxxx	X67CA0E61.xxxx	X67CA3E41.xxxx
Short description			
Accessories	POWERLINK/Ethernet connection cable, RJ45 to M12, 4-pin, straight	POWERLINK/Ethernet connection cable, M12, 4-pin, straight	POWERLINK/Ethernet connection cable, RJ45 to M12, 4-pin, straight
General information			
Note	Halogen-free		
Durability	Flame-retardant per IEC 60332-1-2		
Type	Connection cables		
Cable cross section			
AWG	4x 22 AWG		
mm²	4x 0.34 mm²		
Cable construction			
Cable shield	Overlapping aluminum-clad foil, tinned copper braiding, 85% coverage		
Outer jacket			
Material	Polyurethane (PUR)		
Color	Green		
Wires			
Wire insulation	Polyethylene (PE)		
Wire colors	White, yellow, blue, orange		
Type	Tinned copper stranded wire Fine stranded wire (7x 0.25 mm / 7x 30 AWG)		
Stranding	4-wire twisted pair		
Electrical properties			
Conductor resistance	≤120 Ω/km at 20°C		
Transfer properties	Category 5 / Class D up to 100 MHz per ISO/IEC 11801 (EN 50173-1), ISO/IEC 24702 (EN 50173-3)		
Transfer rate	10/100 Mbit/s		
Insulation resistance	≥500 MΩ/km at 20°C		
Operating conditions			
Degree of protection per EN 60529			
Cables	IP67		
Male M12 connector	IP67, only when screwed in		
RJ45 connector	IP20, only when properly connected		
Ambient conditions			
Temperature			
Transport	-40 to 70°C		
Fixed installation	-25 to 60°C		
Flexible installation	-20 to 60°C		
Mechanical properties			
Dimensions			
Diameter	6.5 mm ±0.2 mm		
Bend radius			
After installation	≥7x outer diameter		
During installation	≥3x outer diameter		

Table 9: X67CA0E41.xxxx, X67CA0E61.xxxx, X67CA3E41.xxxx - Technical data

Order number	X67CA0E41.xxxx	X67CA0E61.xxxx	X67CA3E41.xxxx
Drag chain data			
Acceleration	-		4 m/s²
Flex cycles	-		Min. 3 million
Velocity	-		4 m/s
Weight	0.064 kg/m	0.062 kg/m	0.064 kg/m

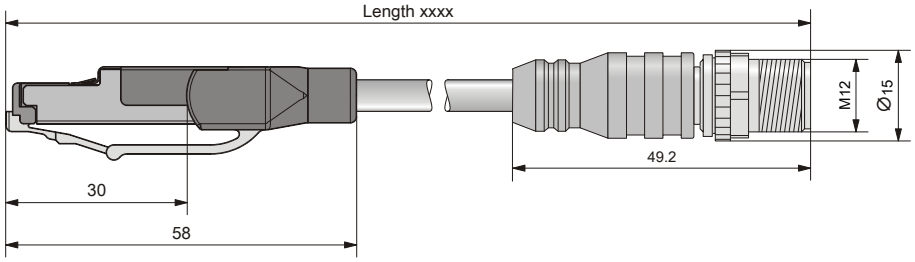
Table 9: X67CA0E41.xxxx, X67CA0E61.xxxx, X67CA3E41.xxxx - Technical data

8.2.8.2 X67CA0E41.xxxx and X67CA3E41.xxxx

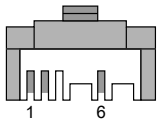
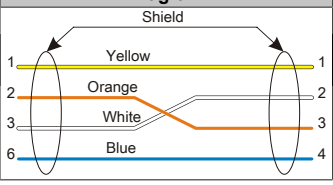
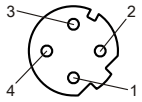
This cable is offered in 2 variants:

- X67CA0Exx: Standard variant
- X67CA3Exx: Can be used in cable drag chains

Dimensions



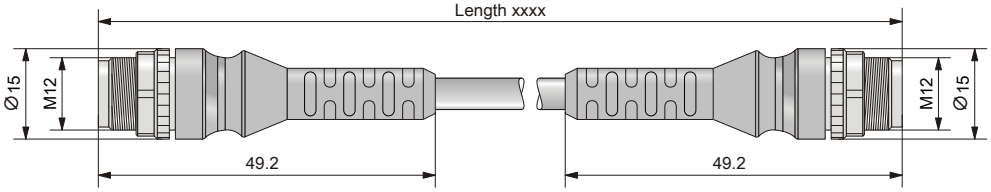
Pinout

Male RJ45 connector	Pin	Name	Diagram	M12 connector
	1 - 1	TXD		
	2 - 3	TXD\		
	3 - 2	RXD		
	6 - 4	RXD\		

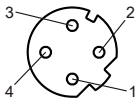
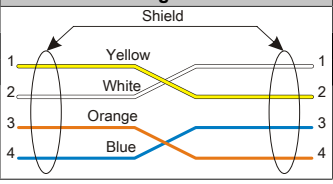
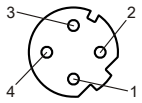
D-coded

8.2.8.3 X67CA0E61.xxxx

Dimensions



Pinout

Connector	Pin	Name	Diagram	Connector
	1 - 2	TXD		
	2 - 1	RXD		
	3 - 4	TXD\		
	4 - 3	RXD\		

D-coded

D-coded

8.3 Field-assembled connectors

8.3.1 I/O power supply

Order number	Short description	Figure
	I/O supply	
X67AC0P00	X67 male M8 connector, 4-pin, piercing connection	

Table 10: X67AC0P00 - Order data

Order number	Short description	Figure
	I/O supply	
X67AC0P20	X67 female M8 connector, 4-pin, piercing connection	

Table 11: X67AC0P20 - Order data

8.3.2 Sensors/Actuators

Order number	Short description	Figure
	Sensors / actuators	
X67AC0D00	X67 male M8 connector, 3-pin, piercing connection	

Table 12: X67AC0D00 - Order data

Order number	Short description	Figure
	Sensors / actuators	
X67AC0A00-1	X67 male M12 connector, 5-pin, A-coded, cage clamp connection	

Table 13: X67AC0A00-1 - Order data

Order number	Short description	Figure
	Sensors / actuators	
X67AC2A00	X67 male M12 connector, 5-pin, A-keyed, screw clamp connection	

Table 14: X67AC2A00 - Order data

8.3.3 Special-purpose connectors

Order number	Short description	Figure
	Special plugs	
X67AC9A02	X67 M12 thermocouple connector, for temperature compensation at measurement points, screw clamp connections	

Table 15: X67AC9A02 - Order data

8.3.4 CAN bus / DeviceNet

Order number	Short description	Figure
	CAN bus / DeviceNet	
X67AC0C01-1	X67 male M12 connector, 5-pin, A-coded, shielded, cage clamp connection	

Table 16: X67AC0C01-1 - Order data

Order number	Short description	Figure
	CAN bus / DeviceNet	
X67AC2C01	X67 male M12 connector, 5-pin, A-keyed, shielded, screw clamp connection	

Table 17: X67AC2C01 - Order data

Order number	Short description	Figure
	CAN bus / DeviceNet	
X67AC0C21-1	X67 female connector, M12, 5-pin, A-coded, shielded, cage clamp connection	

Table 18: X67AC0C21-1 - Order data

Order number	Short description	Figure
	CAN bus / DeviceNet	
X67AC2C21	X67 female M12 connector, 5-pin, A-keyed, shielded, screw clamp connection	

Table 19: X67AC2C21 - Order data

8.3.5 PROFIBUS DP / X2X Link

Order number	Short description	Figure
	PROFIBUS DP / X2X Link	
X67AC0X01-1	X67 male M12 connector, 5-pin, B-coded, shielded, push-in	

Table 20: X67AC0X01-1 - Order data

Order number	Short description	Figure
	PROFIBUS DP / X2X Link	
X67AC2X01	X67 male M12 connector, 5-pin, B-keyed, shielded, screw clamp connection	

Table 21: X67AC2X01 - Order data

Order number	Short description	Figure
	PROFIBUS DP / X2X Link	
X67AC0X21-1	X67 female M12 connector, 5-pin, B-coded, shielded, push-in	

Table 22: X67AC0X21-1 - Order data

Order number	Short description	Figure
	PROFIBUS DP / X2X Link	
X67AC2X21	X67 female M12 connector, 5-pin, B-keyed, shielded, screw clamp connection	

Table 23: X67AC2X21 - Order data

8.3.6 POWERLINK/Ethernet

Order number	Short description	Figure
	POWERLINK/Ethernet	
X67AC2E01	X67 male M12 connector, 4-pin, D-keyed, shielded, insulation piercing connection	

Table 24: X67AC2E01 - Order data

8.4 Other accessories

8.4.1 Terminating resistor

Order number	Short description	Figure
	Terminating resistor	
X67AC9C03	X67 CAN M12 terminating resistor	

Table 25: X67AC9C03 - Order data

Order number	Short description	Figure
	Terminating resistor	
X67AC9B03	X67 PROFIBUS DP M12 terminating resistor	

Table 26: X67AC9B03 - Order data

8.4.2 Connectors

Order number	Short description	Figure
	Connectors	
X67AC8C00	X67 CAN Y-connector	

Table 27: X67AC8C00 - Order data

Order number	Short description	Figure
	Connectors	
X67AC8B01	X67 PROFIBUS DP Y-connector	

Table 28: X67AC8B01 - Order data

8.4.3 Threaded caps

Model number	Short description	Figure
	Threaded caps	
X67AC0M08	X67 M8 threaded caps, 50 pcs.	
X67AC0M12	X67 M12 threaded caps, 50 pcs.	

Table 29: X67AC0M08, X67AC0M12 - Order data

8.4.4 Plain text tags

Order number	Short description	Figure
	Plain text tag	
X67AC0SH1	X67 plain text tag	

Table 30: X67AC0SH1 - Order data

8.4.5 Mounting plates for top-hat rails

Order number	Short description	Figure
	Mounting plates for DIN rails	
X67ACTS35	X67 top-hat rail mounting plate	
X67ACTS35.0010	X67 top-hat rail mounting plate, 10 pcs.	

Table 31: X67ACTS35, X67ACTS35.0010 - Order data

8.4.6 Installation tool

The connectors and couplings of pre-assembled X67 cables have additional width across flats on the knurled-head screw that can be used for an installation tool. A torque wrench set with M8 or M12 insert is available as an accessory for optimal assembly. It can be used to ensure the absolute safety of the connection to the X67 module.

Order number	Short description	Figure
	Mounting tools	
X67ACTQMX	X67 torque wrench set, for X67 M8 and M12 connectors, for hex-head connectors	

Table 32: X67ACTQMX - Order data

9 International and national certifications

B&R products and services comply with applicable standards. This includes international standards from organizations such as ISO, IEC and CENELEC, as well as national standards from organizations such as UL, CSA, DNV, etc. We are committed to ensuring the reliability of our products in industrial environments.

Information:

Certifications that apply to a particular module are available at the following places:

- **The data sheet's technical data under "Certifications".**
- **At www.br-automation.com under "Products" in the "General information → Certifications" area of the technical data**
- **On the side of the module housing**

9.1 Overview of certifications

Mark	Explanation	Certificate authority	Region
CE	CE marking	Notified bodies	Europe (EU)
open SAFETY certified product	Functional safety (CE)	Notified bodies	Europe (EU)
Ex	Explosion protection (CE)	Notified bodies	Europe (EU)
c UL us LISTED	Underwriters Laboratories Inc. (UL) (certification for US and Canada)	UL	Canada USA
SA C US Hazardous locations	Canadian Standards Association (CSA) (certification for US and Canada)	CSA	Canada USA
EAC	Eurasian Conformity (EAC)	Federal agency on technical regulating and metrology	Eurasian Economic Union
KC	Korean Conformity (KC)	Radio Research Agency (RRA)	Korea
RCM	Regulatory Compliance Mark (RCM)	ACMA	Australia Oceania

9.2 EU directives and standards (CE)

CE marking

Europe (EU)

The respective product complies with all applicable EU directives and relevant harmonized standards.

Certification of these products is performed in cooperation with accredited testing laboratories.

EMC directive 2014/30/EU

All devices satisfy the protection requirements of the "EMC Directive" and are designed for industrial use.

Applicable standards from this directive:

EN 61131-2	Programmable logic controllers - Part 2: Equipment requirements and tests
EN 61000-6-2	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments
EN 61000-6-4	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments

Low voltage directive 2014/35/EU

The low voltage directive applies to electrical equipment with a nominal voltage from 50 to 1000 VAC and from 75 to 1500 VDC.
All devices within the area of application of this directive satisfy the its protection requirements.

Applicable standard from this directive:

EN 61131-2	Programmable logic controllers - Part 2: Equipment requirements and tests

The corresponding declaration of conformity is available for download from the B&R website. For information about the versions of applicable standards, see the declaration of conformity.

Declaration of conformity

Website > Downloads > Certificates > Declarations of conformity > Declaration of conformity - PLC

Machinery directive 2006/42/EC

Functional safety

open SAFETY certified product

Europe (EU)

In accordance with the machinery directive, safety technology products are designed, developed, tested and labeled for special applications providing protection to machinery and personnel.

Certification of these products is performed exclusively in cooperation with EU-authorized bodies (Notified Bodies).

Applicable standards from this directive:

SIL 3:	
IEC 61508-1	Functional safety of electrical / electronic / programmable electronic safety-related systems - Part 1: General requirements
IEC 61508-2	Functional safety of electrical / electronic / programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
IEC 61508-3	Functional safety of electrical / electronic / programmable electronic safety-related systems - Part 3: Software requirements
IEC 61508-4	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 4: Definitions and abbreviations
EN 62061	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
IEC 61511-1	Functional safety - Safety instrumented systems for the process industry sector - Part 1: Framework, definitions, system, hardware and software requirements
PL e, Cat. 4:	
EN ISO 13849-1	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
EN 61131-2	Programmable logic controllers - Part 2: Equipment requirements and tests

Declarations of conformity, certificates and any other safety-related documentation can be downloaded from the B&R website. For information about the versions of applicable standards, see the declaration of conformity.

Declaration of conformity

Website > Downloads > Certificates > Declarations of conformity > Declaration of conformity - FS PLC

Certificates

FS EN 50156 certificate - SafeLOGIC, SafeIO
FS certificate - SafeDESIGNER, SafeLOGIC, SafeIO
Safe cutoff of potential groups

User's manual

Website > Downloads > Safety technology > Integrated safety technology user's manual

ATEX directive 2014/34/EU

ATEX / Zone 2

II 3G Ex nA nC IIA T5 Gc

Europe (EU)

Products with this mark are suitable for use in potentially explosive atmospheres. The X20 system is certified for use in environments with explosive gases with a normal level of safety (Zone 2).

Certification of these products is performed exclusively in cooperation with EU-authorized bodies (Notified Bodies).

Each module is also accompanied by an information sheet providing detailed installation and safety guidelines.

Applicable standards from this directive:

EN 60079-0	Explosive atmospheres Part 0: Equipment - General requirements
EN 60079-15	Explosive atmospheres - Part 15: Equipment protection by type of protection "n"

The declaration of conformity and certificate can be downloaded from the B&R website. For information about the versions of applicable standards, see the declaration of conformity.

Declaration of conformity

Website > Downloads > Certificates > Declaration of conformity > Declaration of conformity - ATEX X67

Certificate

Website > Downloads > Certificates > ATEX > X67 > TÜV 05 ATEX 7201 X

9.2.1 Overview of standards

Standard	Description
EN ISO 13849-1	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
EN 55011 (CISPR 11)	Industrial, scientific and medical equipment - Radio frequency disturbance characteristics - Limits and methods of measurement
EN 55016-2-1 (CISPR 16-2-1)	Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-1: Methods of measurement of disturbances and immunity - Conducted disturbance measurements
EN 55016-2-3 (CISPR 16-2-3)	Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-3: Methods of measurement of disturbances and immunity - Radiated disturbance measurements
EN 55022 (CISPR 22)	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement
EN 60068-2-6	Environmental testing - Part 2-6: Procedures - Test Fc: Vibration (sinusoidal)
EN 60068-2-27	Environmental testing - Part 2-27: Test procedure - Test Ea and guidance: Shock
EN 60068-2-31[1)]	Environmental testing - Part 2-31: Test procedure - Test Ec: Rough handling shocks, mainly for devices
EN 60079-0	Explosive atmospheres Part 0: Equipment - General requirements
EN 60079-15	Explosive atmospheres - Part 15: Equipment protection by type of protection "n"
EN 60529	Degrees of protection provided by enclosures (IP code)
EN 60664-1	Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests
EN 60721-3-2	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 2: Transport and handling
EN 60721-3-5	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities - Section 5: Usage on and in land vehicles
EN 61000-4-2	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test
EN 61000-4-3	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test
EN 61000-4-4	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test
EN 61000-4-5	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measuring techniques - Surge immunity test
EN 61000-4-6	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields
EN 61000-4-8	Electromagnetic compatibility (EMC) - Part 4-8: Testing and measuring techniques - Power frequency magnetic field immunity test
EN 61000-4-11	Electromagnetic compatibility (EMC) - Part 4-11: Testing and measuring techniques - Voltage dips, short interruptions and voltage variations
EN 61000-4-29	Electromagnetic compatibility (EMC) - Part 4-29: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests
EN 61000-6-2	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments
EN 61000-6-4	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
EN 61131-2	Programmable logic controllers - Part 2: Guidance for inspection and routine testing
IEC 61508-1	Functional safety of electrical / electronic / programmable electronic safety-related systems - Part 1: General requirements
IEC 61508-2	Functional safety of electrical / electronic / programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
IEC 61508-3	Functional safety of electrical / electronic / programmable electronic safety-related systems - Part 3: Software requirements
IEC 61508-4	Functional safety of electrical / electronic / programmable electronic safety-related systems - Part 4: Definitions and abbreviations
IEC 61511-1	Functional safety - Safety instrumented systems for the process industry sector - Part 1: Framework, definitions, system, hardware and software requirements
EN 62061	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems

1) Replacement for EN 60068-2-32

9.2.2 Requirements for immunity to disturbances

Immunity	Test carried out in accordance with	Requirements in accordance with
Electrostatic discharge (ESD)	EN 61000-4-2	EN 61131-2: Product standard - Programmable logic controllers
		EN 61000-6-2: Generic standard - Immunity to disturbances in industrial sectors
High-frequency electromagnetic fields (HF field)	EN 61000-4-3	EN 61131-2: Product standard - Programmable logic controllers
		EN 61000-6-2: Generic standard - Immunity to disturbances in industrial sectors
High-speed transient electrical disturbances (Burst)	EN 61000-4-4	EN 61131-2: Product standard - Programmable logic controllers
		EN 61000-6-2: Generic standard - Immunity to disturbances in industrial sectors
Surge voltages (Surge)	EN 61000-4-5	EN 61131-2: Product standard - Programmable logic controllers
		EN 61000-6-2: Generic standard - Immunity to disturbances in industrial sectors
Conducted disturbances	EN 61000-4-6	EN 61131-2: Product standard - Programmable logic controllers
		EN 61000-6-2: Generic standard - Immunity to disturbances in industrial sectors
Magnetic fields with electrical frequencies	EN 61000-4-8	EN 61131-2: Product standard - Programmable logic controllers
		EN 61000-6-2: Generic standard - Immunity to disturbances in industrial sectors
Voltage dips (AC) Short-term interruptions (AC) Voltage fluctuations (AC)	EN 61000-4-11	EN 61131-2: Product standard - Programmable logic controllers
		EN 61000-6-2: Generic standard - Immunity to disturbances in industrial sectors
Short-term interruptions (DC) Voltage fluctuations (DC)	EN 61000-4-29	EN 61131-2: Product standard - Programmable logic controllers

Evaluation criteria for performance

Criteria	During testing	After testing
A	The PLC system shall continue to operate as intended. No loss of function or performance.	The PLC system shall continue to operate as intended.
B	Degradation of performance accepted. No change of operating mode. No irreversible loss of stored data.	The PLC system shall continue to operate as intended. Temporary degradation of performance must be self-recoverable.
C	Loss of functions accepted, but no destruction of hardware or software (programme or data).	The PLC system shall continue to operate as intended automatically, after manual restart or power off/power on.
D	Degradation or failure of functionality that can no longer be restored.	PLC system permanently damaged or destroyed.

Electrostatic discharge (ESD)

Test carried out in accordance with EN 61000-4-2	Requirements in accordance with EN 61131-2 / Zone B	Requirements in accordance with EN 61000-6-2
Contact discharge (CD) to conductive external parts	±4 kV Criteria B	
Air discharge (AD) to insulating external parts	±8 kV Criteria B	

High-frequency electromagnetic fields (HF field)

Test carried out in accordance with EN 61000-4-3	Requirements in accordance with EN 61131-2 / Zone B	Requirements in accordance with EN 61000-6-2
Housing, completely wired	80 MHz to 1 GHz, 10 V/m 1.4 GHz to 2 GHz, 3 V/m 2 GHz to 2.7 GHz, 1 V/m Criteria A	

High-speed transient electrical disturbances (Burst)

Test carried out in accordance with EN 61000-4-4	Requirements in accordance with EN 61131-2 / Zone B	Requirements in accordance with EN 61000-6-2
AC power inputs	±2 kV / 5 kHz Criteria B	
AC power outputs	±2 kV / 5 kHz[1)] Criteria B	±2 kV / 5 kHz Criteria B
AC other I/Os	±2 kV / 5 kHz[1)] Criteria B	-
DC mains inputs/outputs	±2 kV / 5 kHz[1)] Criteria B	
Other I/Os and interfaces	±1 kV / 5 kHz[1)] Criteria B	

1) Only for connections with a permitted line length >3 m.

Surge voltages (Surge)

Test carried out in accordance with EN 61000-4-5	Requirements in accordance with EN 61131-2 / Zone B	Requirements in accordance with EN 61000-6-2
AC mains inputs/outputs Line / line	±1 kV Criteria B	
AC mains inputs/outputs Line / ground	±2 kV Criteria B	
DC mains inputs/outputs Line / line	±0.5 kV[1)] Criteria B	±0.5 kV Criteria B
DC power inputs Line / ground	±0.5 kV[1)] Criteria B	±0.5 kV Criteria B
DC power outputs Line / ground	±0.5 kV[1)] Criteria B	±0.5 kV Criteria B
Signal connections, unshielded Line / ground	±1 kV[1)] Criteria B	
All shielded lines Line / ground	±1 kV[1)] Criteria B	-

1) Only for connections with a permitted line length >30 m.

Conducted disturbances

Test carried out in accordance with EN 61000-4-6	Requirements in accordance with EN 61131-2 / Zone B	Requirements in accordance with EN 61000-6-2
AC mains inputs/outputs	10 V 150 kHz to 80 MHz 80% AM (1 kHz) Criteria A	
DC mains inputs/outputs	10 V 150 kHz to 80 MHz 80% AM (1 kHz) Criteria A	
Other I/Os and interfaces	10 V[1)] 150 kHz to 80 MHz 80% AM (1 kHz) Criteria A	

1) Only for connections with a permitted line length >3 m.

Magnetic fields with electrical frequencies

Test carried out in accordance with EN 61000-4-8	Requirements in accordance with EN 61131-2 / Zone B	Requirements in accordance with EN 61000-6-2
Housing, completely wired	30 A/m 3 axes (x, y, z) 50/60 Hz[1)] Criteria A	

1) Mains frequency per manufacturer data

Voltage dips

Test carried out in accordance with EN 61000-4-11	Requirements in accordance with EN 61131-2 / Zone B	Requirements in accordance with EN 61000-6-2
AC power inputs	0% residual voltage 250/300 periods (50/60 Hz)[1] 20 attempts Criteria C	
	40% residual voltage 10/12 periods (50/60 Hz)[1] 20 attempts Criteria C	
	70% residual voltage 25/30 periods (50/60 Hz)[1] 20 attempts Criteria C	

1) Mains frequency per manufacturer data

Short-term interruptions

Test carried out in accordance with EN 61000-4-11 / EN 61000-4-29	Requirements in accordance with EN 61131-2 / Zone B	Requirements in accordance with EN 61000-6-2
AC power inputs	0% residual voltage 0.5 periods (50/60 Hz)[1] 20 interruptions Criteria A	0% residual voltage 1 period (50/60 Hz)[1] 3 interruptions Criteria B
DC power inputs	0% residual voltage ≥10 ms (PS2) 20 interruptions Criteria A	-

1) Mains frequency per manufacturer data

Voltage fluctuations

Test carried out in accordance with EN 61000-4-11 / EN 61000-4-29	Requirements in accordance with EN 61131-2 / Zone B	Requirements in accordance with EN 61000-6-2
AC power inputs	-15% / +10% Test duration per 30 minutes Criteria A	-
DC power inputs	-15% / +20% Test duration per 30 minutes Criteria A	-

9.2.3 Emission requirements

Phenomenon	Test carried out in accordance with	Limits in accordance with
Emissions related to lines	EN 55011 / EN 55022 EN 55016-2-1	EN 61131-2: Product standard - Programmable logic controllers
		EN 61000-6-4: Generic standard - Emissions in industrial sectors
Radiated emissions	EN 55011 / EN 55022 EN 55016-2-3	EN 61131-2: Product standard - Programmable logic controllers
		EN 61000-6-4: Generic standard - Emissions in industrial sectors

Emissions related to lines

Test carried out in accordance with EN 55011 / EN 55022 / EN 55016-2-1	Limits in accordance with EN 61131-2 / Zone B	Limits in accordance with EN 61000-6-4
AC mains connection 150 kHz to 30 MHz	150 kHz to 500 kHz 79 dB (µV) quasi-peak value 66 dB (µV) average value	
	500 kHz to 30 MHz 73 dB (µV) quasi-peak value 60 dB (µV) average value	
Telecommunications / network connection 150 kHz to 30 MHz	-	150 kHz to 500 kHz 97 to 87 dB (µV) quasi-peak value 53 to 40 dB (µA) quasi-peak value 84 to 74 dB (µV) average value 40 to 30 dB (µA) average value
	-	500 kHz to 30 MHz 87 dB (µV) quasi-peak value 43 dB (µA) quasi-peak value 74 dB (µV) average value 30 dB (µA) average value

Radiated emissions

Test carried out in accordance with EN 55011 / EN 55022 / EN 55016-2-3	Limits in accordance with EN 61131-2 / Zone B	Limits in accordance with EN 61000-6-4
Electric field / Measured from 10 m 30 MHz to 1 GHz	30 MHz to 230 MHz 40 dB (µV/m) quasi-peak value	
	230 MHz to 1 GHz 47 dB (µV/m) quasi-peak value	
Electric field / Measured from 3 m 1 GHz to 6 GHz[1)]	-	1 GHz to 3 GHz[1)] 76 dB (µV/m) peak value 56 dB (µV/m) average value
	-	3 GHz to 6 GHz[1)] 80 dB (µV/m) peak value 60 dB (µV/m) average value

1) Depending on highest internal frequency

9.2.4 Mechanical conditions

Testing	Test carried out in accordance with	Requirements in accordance with
Vibration (sinusoidal) / Operation	EN 60068-2-6	EN 61131-2: Product standard - Programmable logic controllers
		EN 60721-3-5 / Class 5M3
Shock / Operation	EN 60068-2-27	EN 61131-2: Product standard - Programmable logic controllers
		EN 60721-3-5 / Class 5M3
Vibration (sinusoidal) / Transport (packaged)	EN 60068-2-6	EN 60721-3-2 / Class 2M1
		EN 60721-3-2 / Class 2M2
		EN 60721-3-2 / Class 2M3
Shock / Transport (packaged)	EN 60068-2-27	EN 60721-3-2 / Class 2M1
		EN 60721-3-2 / Class 2M2
Free fall / Transport (packaged)	EN 60068-2-31[1)]	EN 61131-2: Product standard - Programmable logic controllers
		EN 60721-3-2 / Class 2M1
Toppling / Transport (packaged)	EN 60068-2-31	EN 60721-3-2 / Class 2M1
		EN 60721-3-2 / Class 2M2
		EN 60721-3-2 / Class 2M3

1) Replacement for EN 60068-2-32

Vibration (sinusoidal) / Operation

Test carried out in accordance with EN 60068-2-6	Requirements in accordance with EN 61131-2		Requirements in accordance with EN 60721-3-5 / Class 5M3	
Vibration (sinusoidal) / Operation[1)]	**Frequency**	**Amplitude**	**Frequency**	**Amplitude**
	5 to 8.4 Hz	Deflection 3.5 mm	2 to 8 Hz	Deflection 7.5 mm
	8.4 to 150 Hz	Acceleration 1 g[2)]	8 to 200 Hz	Acceleration 2 g[2)]
	-	-	200 to 500 Hz	Acceleration 4 g[2)]
	20 sweeps for each axis[3)]			

1) Uninterrupted duty with movable frequency in all 3 axes (x, y, z); 1 octave per minute
2) 1 g = 10 m/s²
3) 2 sweeps = 1 frequency cycle (fmin → fmax → fmin)

Shock / Operation

Test carried out in accordance with EN 60068-2-27	Requirements in accordance with EN 61131-2	Requirements in accordance with EN 60721-3-5 / Class 5M3
Shock / Operation[1)]	Acceleration 15 g Duration 11 ms 18 shocks	Acceleration 30 g Duration 11 ms 18 shocks

1) Pulse (half-sine) stress in all 3 axes (x, y, z)

Vibration (sinusoidal) / Transport (packaged)

Test carried out in accordance with EN 60068-2-6	Requirements in accordance with EN 60721-3-2 / Class 2M1		Requirements in accordance with EN 60721-3-2 / Class 2M2		Requirements in accordance with EN 60721-3-2 / Class 2M3	
Vibration (sinusoidal) / Transport (packaged)[1)]	**Frequency**	**Amplitude**	**Frequency**	**Amplitude**	**Frequency**	**Amplitude**
	2 to 9 Hz	Deflection 3.5 mm	2 to 9 Hz	Deflection 3.5 mm	2 to 8 Hz	Deflection 7.5 mm
	9 to 200 Hz	Acceleration 1 g[2)]	9 to 200 Hz	Acceleration 1 g[2)]	8 to 200 Hz	Acceleration 2 g[2)]
	200 to 500 Hz	Acceleration 1.5 g[2)]	200 to 500 Hz	Acceleration 1.5 g[2)]	200 to 500 Hz	Acceleration 4 g[2)]
	20 sweeps for each axis[3)]					

1) Uninterrupted duty with movable frequency in all 3 axes (x, y, z); 1 octave per minute
2) 1 g = 10 m/s²
3) 2 sweeps = 1 frequency cycle (fmin → fmax → fmin)

Shock / Transport (packaged)

Test carried out in accordance with EN 60068-2-27	Requirements in accordance with EN 60721-3-2 / Class 2M1	Requirements in accordance with EN 60721-3-2 / Class 2M2
Shock / Transport (packaged)[1)]	Type I Acceleration 10 g Duration 11 ms 18 shocks	
	Type II -	Type II Acceleration 30 g Duration 6 ms 18 shocks

1) Pulse (half-sine) stress in all 3 axes (x, y, z)

Free fall / Transport (packaged)

Tests in accordance with EN 60068-2-31	Requirements in accordance with EN 61131-2 with shipping packaging		Requirements in accordance with EN 61131-2 with shipping packaging		Requirements in accordance with EN 60721-3-2 / Class 2M1	
Free fall / Transport (packaged)	**Weight**	**Height**	**Weight**	**Height**	**Weight**	**Height**
	<10 kg	1.0 m	<10 kg	0.3 m	<20 kg	0.25 m
	10 to 40 kg	0.5 m	10 to 40 kg	0.3 m	20 to 100 kg	0.25 m
	>40 kg	0.25 m	>40 kg	0.25 m	>100 kg	0.1 m
	5 attempts					

1) Replacement for EN 60068-2-32

Toppling / Transport (packaged)

Test carried out in accordance with EN 60068-2-31	Requirements in accordance with EN 60721-3-2 / Class 2M1		Requirements in accordance with EN 60721-3-2 / Class 2M2		Requirements in accordance with EN 60721-3-2 / Class 2M3	
Toppling / Transport (packaged)	**Weight**	**Required**	**Weight**	**Required**	**Weight**	**Required**
	<20 kg	Yes	<20 kg	Yes	<20 kg	Yes
	20 to 100 kg	-	20 to 100 kg	Yes	20 to 100 kg	Yes
	>100 kg	-	>100 kg	-	>100 kg	Yes
	Topple on all edges					

9.2.5 Electrical safety

Overvoltage category

Requirement per EN 61131-2	Definition per EN 60664-1
Overvoltage category II	Equipment of "Overvoltage category II" is energy-consuming equipment to be supplied by the fixed installation.

Pollution degree

Requirement per EN 61131-2	Definition per EN 60664-1
Pollution degree 2	Only non-conductive pollution occurs. Occasionally, however, temporary conductivity caused by condensation is to be expected.

Protection rating provided by enclosure (IP code)

Requirement per manufacturer	Meaning of codes per EN 60529	Meaning for the protection of equipment	Meaning for the protection of personnel
IP67	First number IP**6**x	Dust-proof	Protected against touching dangerous parts with conductor.
	Second number IPx**7**	Protected against the effects of temporary submersion in water.	

9.3 UL / CSA

UL

Ind. Cont. Eq.
E115267

Canada / USA

Underwriters Laboratories (UL)

Products with this mark are tested by Underwriters Laboratories and listed as "industrial control equipment" in category NRAQ (programmable controllers) with file number E115267.

The mark is valid for the USA and Canada and facilitates the certification of your machines and systems in this economic area.

Standards applied:

UL 508	Standard for industrial control equipment
UL 61010-1	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements
UL 61010-2-201	Standard for safety requirements for electrical equipment for measurement, control and laboratory use - Part 2-201: Particular requirements for control equipment
CSA C22.2 No. 142-M1987	Process control equipment
CSA C22.2 No. 61010-1	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements
CSA C22.2 No. 61010-2-201	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 2-201: Particular requirements for control equipment

Certificate

Website > Downloads > Certificates > UL > X67 > E115267 UL Certificate of Compliance - X67

CSA HazLoc

Hazardous locations

HazLoc Cl. I, Div. 2
Group ABCD
0-60°C T5

Canada / USA

Canadian Standards Association (CSA)

Products with this mark are certified by the Canadian Standard Association and suitable for use in potentially explosive atmospheres.
The products are listed in CLASS 2258 (Process control equipment - For hazardous locations) with file number 244665.
The X20 system has a hazardous locations certification for class I, division 2.
Each certified module is accompanied by an information sheet providing detailed installation and safety guidelines.

The mark is valid for the USA and Canada and facilitates the certification of your machines and systems in this economic area.

Standards applied:

CSA C22.2 No. 0-M1991	General requirements - Canadian electrical code part II
CSA C22.2 No. 142-M1987	Process control equipment
CSA C22.2 No. 213-M1987	Nonincendive electrical equipment for use in class I, division 2 hazardous locations
UL Std No. 916:2007	Energy management equipment
ANSI/ISA 12.12.01:2007	Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Division 1 and 2 Hazardous (Classified) Locations

Certificate

Website > Downloads > Certificate > HazLoc > CSA > X20, X67 > 244665 CSA HazLoc Certificate of Compliance - X20, X67

9.4 Other certifications

EAC

Eurasian Conformity (EAC)

Products with this marking have been tested by an accredited testing laboratory and approved for import (based on EU compliance) to the newly founded Eurasian Economic Union (Russia, Belarus, Kazakhstan, etc.).

KC

Korean Conformity (KC)

Products with this marking have been tested by an accredited testing laboratory and approved for import to the Korean market (based on EU compliance).

RCM

Regulatory Compliance Mark (RCM)

Products with this marking have been tested by an accredited testing laboratory and certified by the ACMA. This marking is valid in Australia/Oceania and simplifies the certification of your machines and systems in these areas (based on EU compliance).

10 Environmentally friendly disposal

All B&R control components are designed to inflict as little harm on the environment as possible.

10.1 Separation of materials

It is necessary to separate different materials so the device can undergo an environmentally friendly recycling process.

Component	Disposal
X67 modules, Cables	Electronics recycling
Cardboard box / Paper packaging	Cardboard box / Paper recycling

Disposal must comply with applicable legal regulations.

11 Additional information

11.1 Using I/O modules on the bus controller

If an I/O module is used after a bus controller, the X2X module registers and functions that can be used depend on the bus controller used.

- **Non-configurable bus controllers**
  By default, "Function model 254 - Bus controller" is used here. This includes:
  - **CAN I/O bus controllers:** X20BC0073, X67BC7321, X67BC7321-1
  - **DeviceNet bus controllers:** X20BC0053, X67BC5321

- **PROFIBUS bus controllers**
  Only the X2X module registers listed in the PROFIBUS user's manual can be used for the supported modules. The PROFIBUS user's manual can be downloaded from the B&R website.

- **PROFINET bus controllers**
  Only the X2X module registers listed in the GSDML file can be used for the supported modules. This file can be downloaded from the B&R website. The PDF document included in the GSDML package lists all available X2X module registers.

- **Using the automatic configuration**
  With all other bus controllers, "Function model 254 - Bus controller" is used by default when using the automatic configuration.

- **Fully configurable bus controllers**
  When operating an I/O module on a fully configurable bus controller (e.g. X20BC0043-10), all available functions and registers of the respective I/O module can be used. In this case, "Function model 0 - Standard" is used as the default setting when adding X2X modules in Automation Studio.
  If additional function models are available in the I/O module (e.g. "Function model OSP" for digital output modules), they can also be used as long as it makes sense to use them with the bus controller. Full configurations for CANopen, Modbus, EtherCAT, EtherNet/IP and POWERLINK can be made with Automation Studio V4.3 or later.

> ### Information:
>
> **Automation Studio can be downloaded at no cost from the B&R website (www.br-automation.com). The evaluation license is permitted to be used to create complete configurations for fieldbus bus controllers at no cost.**

Overview of possible configuration types

	CANopen	EtherNet/IP	PROFIBUS	OPC UA	EtherCAT
	X20BC0043-10 X20BC0143-10 X67BC4321-10 X67BC4321.L08-10 X67BC4321.L12-10	X20(c)BC0088 X67BCD321.L12	X20BC0063 X67BC6321 X67BC6321.L08 X67BC6321.L12	X20BC008U	X20BC00G3 X67BCG321.L12
Automatic configuration	•	•		•	•
Full configuration	•	•	•	•	•

	Modbus	PROFINET	DeviceNet	CAN I/O	POWERLINK
	X20(c)BC0087 X20BC0087-10 X67BCJ321.L12	X20(c)BC00E3 X67BCE321.L12	X20BC0053 X67BC5321	X20BC0073 X67BC7321 X67BC7321-1	X20BC0083
Automatic configuration	•		•	•	•
Full configuration	•	•			•

11.2 General data points

In addition to the registers listed in the register description, X67 modules also have other more general data points. These registers are not specific to the module but contain general information such as serial number and hardware version.

11.2.1 FirmwareVersion

Name:
FirmwareVersion

The firmware version of the module can be read using this data point.

The last two positions correspond to the number after the decimal point.

Example: 345 corresponds to 3.45.

Data type	Values	Information
UINT	1 to 99	Release version of older modules or developmental versions of new modules
	100 to 29999	Release version
	30000 to 59999	Test version

11.2.2 HardwareVariant

Name:
HardwareVariant

The hardware variant of the module can be read using this data point.

Data type	Values
UINT	0 to 65,535

11.2.3 ModuleID

Name:
ModuleID

The module ID of the module can be read using this data point. The module hardware ID can be found in the corresponding module documentation (B&R ID code in the technical data). In addition, a serial number is printed on each electronics module; the module hardware ID corresponds to the first 4 positions of the serial number. (See figure: Hardware ID is also colored black.)

Data type	Values
UINT	0 to 65,535

Information:

IDs beginning from 9999 are printed as hexadecimal numbers and must be converted to their decimal values for comparison!

11.2.4 SerialNumber

Name:
SerialNumber

The module's unique serial number can be read using this data point.

The complete serial number is made up of ModuleID and SerialNumber as follows: Serial number = (Hardware ID * 1E+7) + SerialNumber

The serial number is printed in decimal form on the module's housing.

Example

Hardware ID = (decimal) 1213

Serial number = (decimal) 671339

Module serial number = 1213 * 10000000 + 671339 = 12130671339

Data type	Values
UDINT	0 to 4,294,967,295

11.2.5 ModuleOK

Name:
ModuleOK

Whether the module is physically present in the slot or not can be read from this register.

Data type	Value	Information
BOOL	0	Module not ready for operation
	1	Module connected and configured

11.2.6 StaleData

Name:
StaleData

Whether the transferred data originates from the current cycle or a previous cycle can be read using this data point.

This error can result from cycle times that are too short or disturbances in module communication, for example.

Information:

This data point is only valid if ModuleOK = 1.

Data type	Value	Information
BOOL	0	Data originates from the current cycle
	1	Data does not originate from the current cycle

11.3 NetTime Technology

NetTime refers to the ability to precisely synchronize and transfer system times between individual components of the controller or network (controller, I/O modules, X2X Link, POWERLINK, etc.).

This allows the moment that events occur to be determined system-wide with microsecond precision. Upcoming events can also be executed precisely at a specified moment.

11.3.1 Time information

Various time information is available in the controller or on the network:

- System time (on the PLC, Automation PC, etc.)
- X2X Link time (for each X2X Link network)
- POWERLINK time (for each POWERLINK network)
- Time data points of I/O modules

The NetTime is based on 32-bit counters, which are increased with microsecond resolution. The sign of the time information changes after 35 min, 47 s, 483 ms and 648 µs; an overflow occurs after 71 min, 34 s, 967 ms and 296 µs.

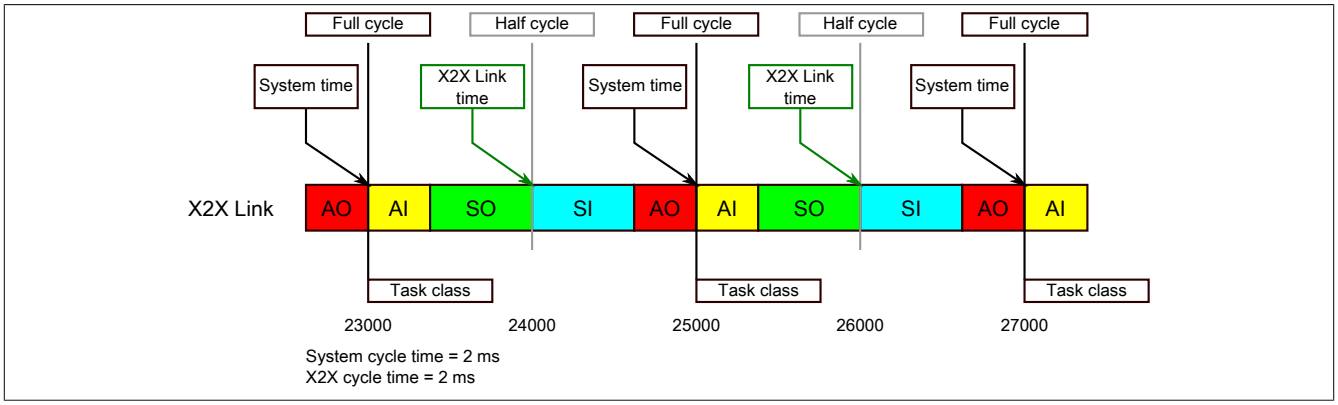
The initialization of the times is based on the system time during the startup of the X2X Link, the I/O modules or the POWERLINK interface.

Current time information in the application can also be determined via library AsIOTime.

11.3.1.1 Controller data points

The NetTime I/O data points of the controller are latched to each system clock and made available.

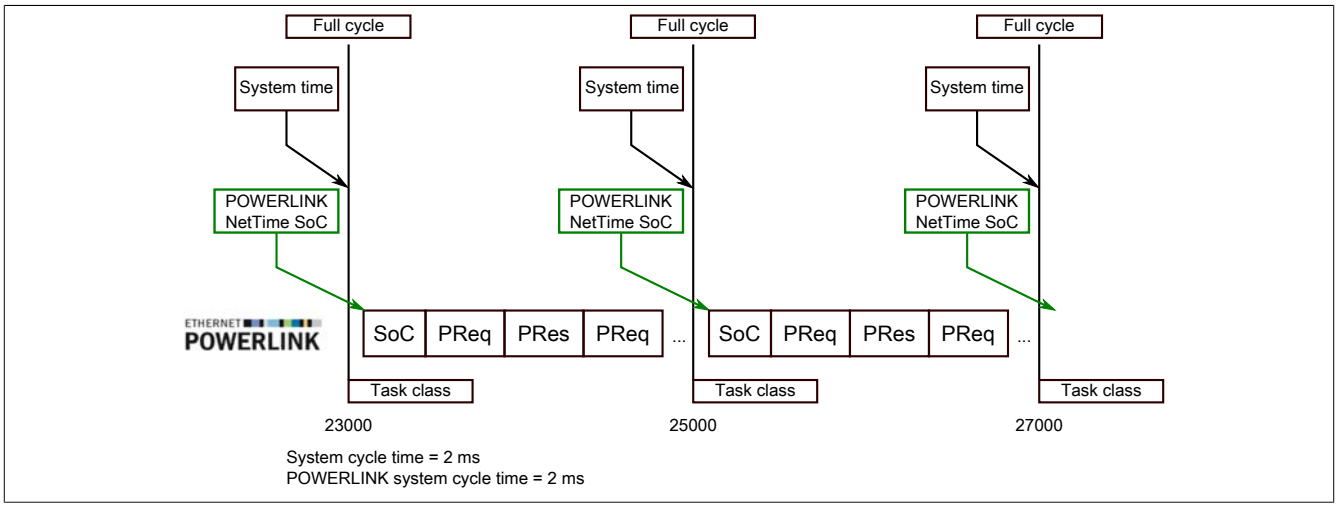
11.3.1.2 X2X Link - Reference moment



The reference moment on the X2X Link network is always calculated at the half cycle of the X2X Link cycle. This results in a difference between the system time and the X2X Link reference moment when the reference time is read out.

In the example above, this results in a difference of 1 ms, i.e. if the system time and X2X Link reference moment are compared at time 25000 in the task, then the system time returns the value 25000 and the X2X Link reference moment returns the value 24000.

11.3.1.3 POWERLINK reference moment

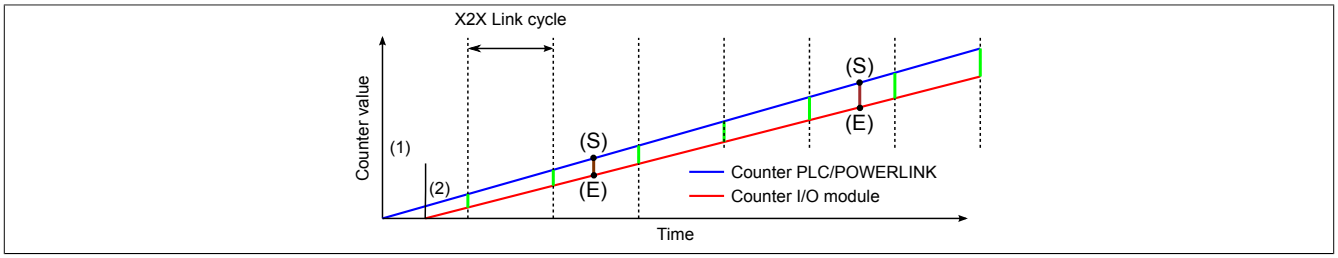


The reference moment on the POWERLINK network is always calculated at the start of cycle (SoC) of the POWERLINK network. The SoC starts 20 µs after the system tick. This results in the following difference between the system time and the POWERLINK reference time:

POWERLINK reference time = System time - POWERLINK cycle time + 20 µs.

In the example above, this means a difference of 1980 µs, i.e. if the system time and POWERLINK reference moment are compared at time 25000 in the task, then the system time returns the value 25000 and the POWERLINK reference moment returns the value 23020.

11.3.1.4 Synchronization of system time/POWERLINK time and I/O module



At startup, the internal counters for the controller/POWERLINK (1) and the I/O module (2) start at different times and increase the values with microsecond resolution.

At the beginning of each X2X Link cycle, the controller or POWERLINK network sends time information to the I/O module. The I/O module compares this time information with the module's internal time and forms a difference (green line) between the two times and stores it.

When a NetTime event (E) occurs, the internal module time is read out and corrected with the stored difference value (brown line). This means that the exact system moment (S) of an event can always be determined, even if the counters are not absolutely synchronous.

Note

The deviation from the clock signal is strongly exaggerated in the picture as a red line.

11.3.2 Timestamp functions

NetTime-capable modules provide various timestamp functions depending on the scope of functions. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the controller, including this precise moment, the controller can then evaluate the data using its own NetTime (or system time), if necessary.
For details, see the respective module documentation.

11.3.2.1 Time-based inputs

NetTime Technology can be used to determine the exact moment of a rising edge at an input. The rising and falling edges can also be detected and the duration between 2 events can be determined.

> **Information:**
>
> **The determined moment always lies in the past.**

11.3.2.2 Time-based outputs

NetTime Technology can be used to specify the exact moment of a rising edge on an output. The rising and falling edges can also be specified and a pulse pattern generated from them.

> **Information:**
>
> **The specified time must always be in the future, and the set X2X Link cycle time must be taken into account for the definition of the moment.**

11.3.2.3 Time-based measurements

NetTime Technology can be used to determine the exact moment of a measurement that has taken place. Both the starting and end moment of the measurement can be transmitted.

11.4 Flatstream communication

11.4.1 Introduction

B&R offers an additional communication method for some modules. "Flatstream" was designed for X2X and POWERLINK networks and allows data transfer to be adapted to individual demands. Although this method is not 100% real-time capable, it still allows data transfer to be handled more efficiently than with standard cyclic polling.

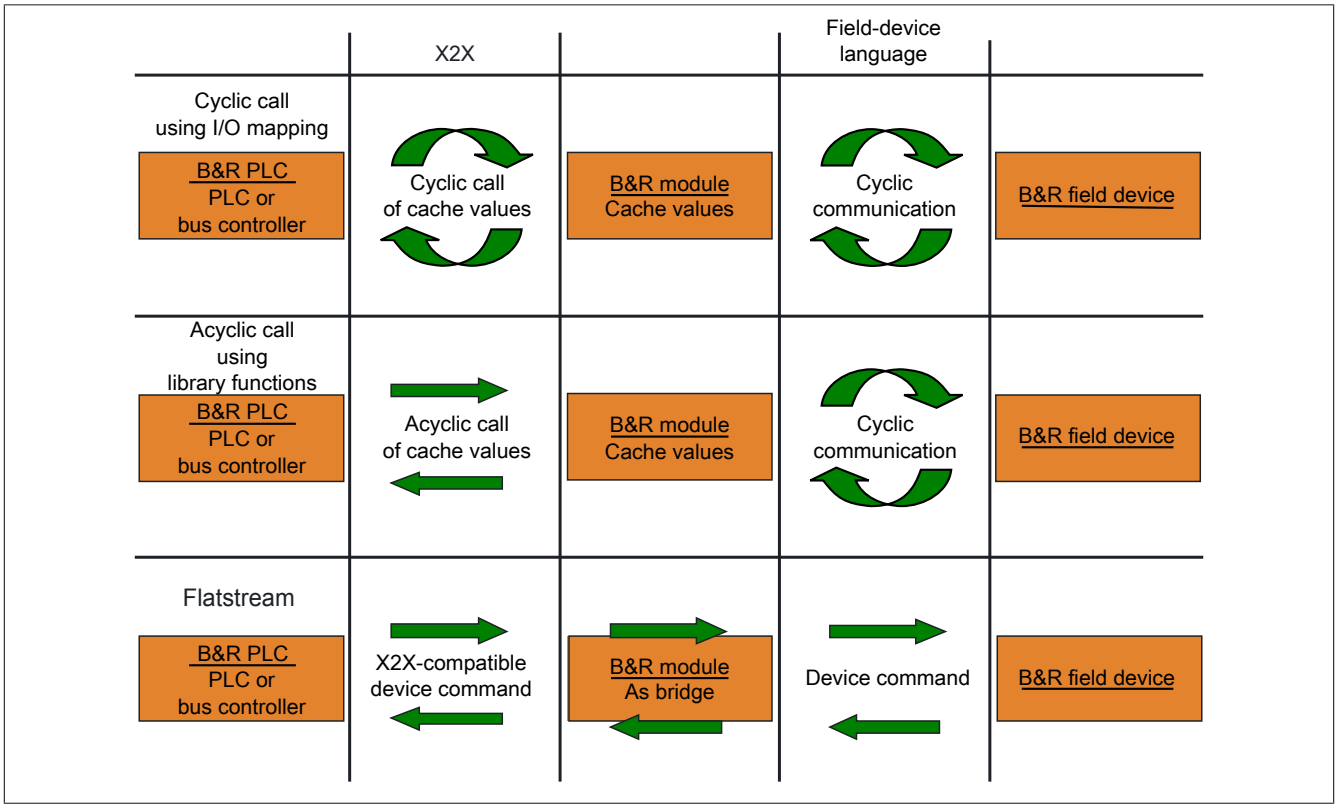


Figure 19: 3 types of communication

Flatstream extends cyclic and acyclic data queries. With Flatstream communication, the module acts as a bridge. The module is used to pass controller requests directly on to the field device.

11.4.2 Message, segment, sequence, MTU

The physical properties of the bus system limit the amount of data that can be transmitted during one bus cycle. With Flatstream communication, all messages are viewed as part of a continuous data stream. Long data streams must be broken down into several fragments that are sent one after the other. To understand how the receiver puts these fragments back together to get the original information, it is important to understand the difference between a message, a segment, a sequence and an MTU.

Message

A message refers to information exchanged between 2 communicating partner stations. The length of a message is not restricted by the Flatstream communication method. Nevertheless, module-specific limitations must be considered.

Segment (logical division of a message):

A segment has a finite size and can be understood as a section of a message. The number of segments per message is arbitrary. So that the recipient can correctly reassemble the transferred segments, each segment is preceded by a byte with additional information. This control byte contains information such as the length of a segment and whether the approaching segment completes the message. This makes it possible for the receiving station to interpret the incoming data stream correctly.

Sequence (how a segment must be arranged physically):

The maximum size of a sequence corresponds to the number of enabled Rx or Tx bytes (later: "MTU"). The transmitting station splits the transmit array into valid sequences. These sequences are then written successively to the MTU and transferred to the receiving station where they are put back together again. The receiver stores the incoming sequences in a receive array, obtaining an image of the data stream in the process.
With Flatstream communication, the number of sequences sent are counted. Successfully transferred sequences must be acknowledged by the receiving station to ensure the integrity of the transfer.

MTU (Maximum Transmission Unit) - Physical transport:

MTU refers to the enabled USINT registers used with Flatstream. These registers can accept at least one sequence and transfer it to the receiving station. A separate MTU is defined for each direction of communication. OutputMTU defines the number of Flatstream Tx bytes, and InputMTU specifies the number of Flatstream Rx bytes. The MTUs are transported cyclically via the X2X Link network, increasing the load with each additional enabled USINT register.

Properties

Flatstream messages are not transferred cyclically or in 100% real time. Many bus cycles may be needed to transfer a particular message. Although the Rx and Tx registers are exchanged between the transmitter and the receiver cyclically, they are only processed further if explicitly accepted by register "InputSequence" or "OutputSequence".

Behavior in the event of an error (brief summary)

The protocol for X2X and POWERLINK networks specifies that the last valid values should be retained when disturbances occur. With conventional communication (cyclic/acyclic data queries), this type of error can generally be ignored.
In order for communication to also take place without errors using Flatstream, all of the sequences issued by the receiver must be acknowledged. If Forward functionality is not used, then subsequent communication is delayed for the length of the disturbance.
If Forward functionality is being used, the receiving station receives a transmission counter that is incremented twice. The receiver stops, i.e. it no longer returns any acknowledgments. The transmitting station uses SequenceAck to determine that the transfer was faulty and that all affected sequences must be repeated.

11.4.3 The Flatstream principle

Requirement

Before Flatstream can be used, the respective communication direction must be synchronized, i.e. both communication partners cyclically query the sequence counter on the opposite station. This checks to see if there is new data that should be accepted.

Communication

If a communication partner wants to transmit a message to its opposite station, it should first create a transmit array that corresponds to Flatstream conventions. This allows the Flatstream data to be organized very efficiently without having to block other important resources.

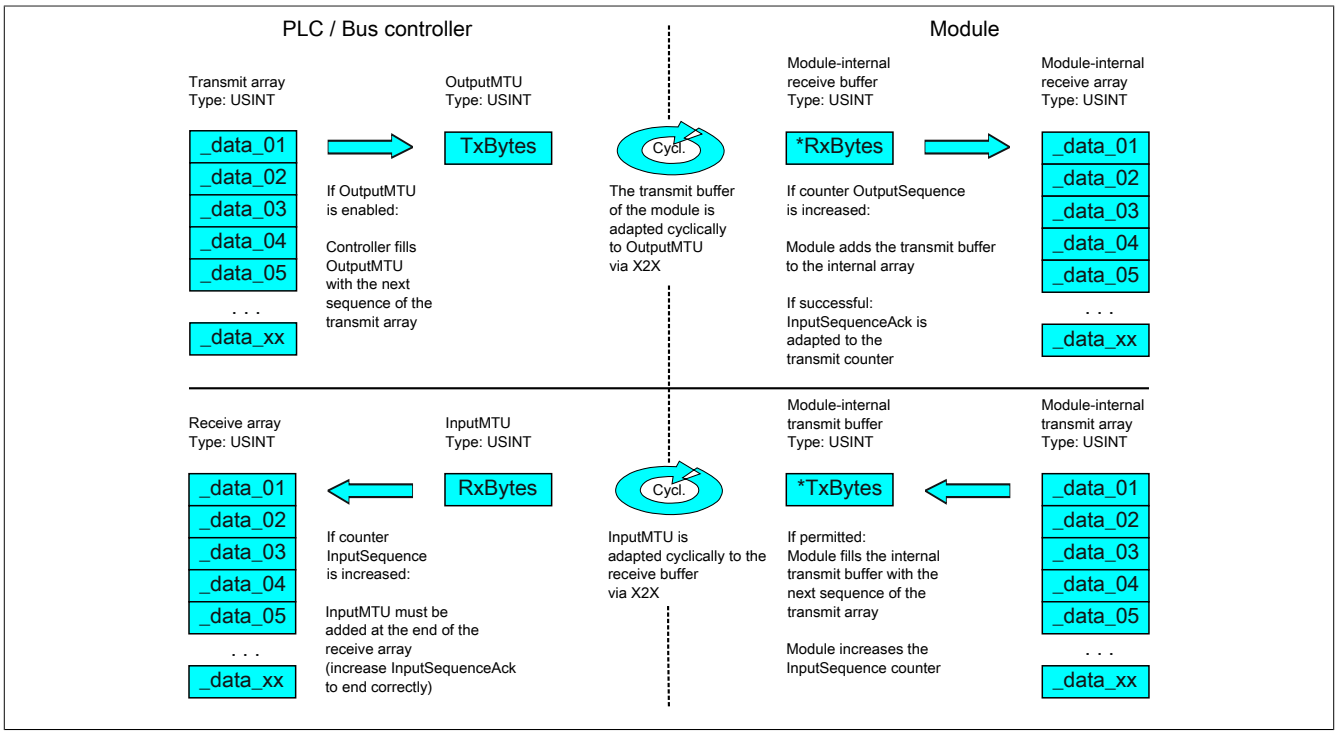


Figure 20: Flatstream communication

Procedure

The first thing that happens is that the message is broken into valid segments of up to 63 bytes, and the corresponding control bytes are created. The data is formed into a data stream made up of one control bytes per associated segment. This data stream can be written to the transmit array. The maximum size of each array element matches that of the enabled MTU so that one element corresponds to one sequence.
If the array has been completely created, the transmitter checks whether the MTU is permitted to be refilled. It then copies the first element of the array or the first sequence to the Tx byte registers. The MTU is transported to the receiver station via X2X Link and stored in the corresponding Rx byte registers. To signal that the data should be accepted by the receiver, the transmitter increases its SequenceCounter.
If the communication direction is synchronized, the opposite station detects the incremented SequenceCounter. The current sequence is appended to the receive array and acknowledged by SequenceAck. This acknowledgment signals to the transmitter that the MTU can now be refilled.

If the transfer is successful, the data in the receive array will correspond 100% to the data in the transmit array. During the transfer, the receiving station must detect and evaluate the incoming control bytes. A separate receive array should be created for each message. This allows the receiver to immediately begin further processing of messages that are completely transferred.

11.4.4 Registers for Flatstream mode

5 registers are available for configuring Flatstream. The default configuration can be used to transmit small amounts of data relatively easily.

Information:

The controller communicates directly with the field device via registers "OutputSequence" and "InputSequence" as well as the enabled Tx and Rx bytes. For this reason, the user needs to have sufficient knowledge of the communication protocol being used on the field device.

11.4.4.1 Flatstream configuration

To use Flatstream, the program sequence must first be expanded. The cycle time of the Flatstream routines must be set to a multiple of the bus cycle. Other program routines should be implemented in Cyclic #1 to ensure data consistency.

At the absolute minimum, registers "InputMTU" and "OutputMTU" must be set. All other registers are filled in with default values at the beginning and can be used immediately. These registers are used for additional options, e.g. to transfer data in a more compact way or to increase the efficiency of the general procedure.

The Forward registers extend the functionality of the Flatstream protocol. This functionality is useful for substantially increasing the Flatstream data rate, but it also requires quite a bit of extra work when creating the program sequence.

Information:

In the rest of this description, the names "OutputMTU" and "InputMTU" do not refer to the registers names. Instead, they are used as synonyms for the currently enabled Tx or Rx bytes.

Information:

Registers are described in section "Flatstream communication" in the respective data sheets.

11.4.4.2 Flatstream operation

When using Flatstream, the communication direction is very important. For transmitting data to a module (output direction), Tx bytes are used. For receiving data from a module (input direction), Rx bytes are used.
Registers "OutputSequence" and "InputSequence" are used to control and ensure that communication is taking place properly, i.e. the transmitter issues the directive that the data should be accepted and the receiver acknowledges that a sequence has been transferred successfully.

Information:

Registers are described in section "Flatstream communication" in the respective data sheets.

11.4.4.2.1 Format of input and output bytes

Name:

"Format of Flatstream" in Automation Studio

On some modules, this function can be used to set how the Flatstream input and output bytes (Tx or Rx bytes) are transferred.

- **Packed:** Data is transferred as an array.
- **Byte-by-byte:** Data is transferred as individual bytes.

11.4.4.2.2 Transport of payload data and control bytes

The Tx and Rx bytes are cyclic registers used to transport the payload data and the necessary control bytes. The number of active Tx and Rx bytes is taken from the configuration of registers "OutputMTU" and "InputMTU", respectively.
In the user program, only the Tx and Rx bytes from the controller can be used. The corresponding counterparts are located in the module and are not accessible to the user. For this reason, the names were chosen from the point of view of the controller.

- "T" - "Transmit" → Controller *transmits* data to the module.
- "R" - "Receive" → Controller *receives* data from the module.

11.4.4.2.2.1 Control bytes

In addition to the payload data, the Tx and Rx bytes also transfer the necessary control bytes. These control bytes contain additional information about the data stream so that the receiver can reconstruct the original message from the transferred segments.

Bit structure of a control byte

Bit	Name	Value	Information
0 - 5	SegmentLength	0 - 63	Size of the subsequent segment in bytes (default: Max. MTU size - 1)
6	nextCBPos	0	Next control byte at the beginning of the next MTU
		1	Next control byte directly after the end of the current segment
7	MessageEndBit	0	Message continues after the subsequent segment
		1	Message ended by the subsequent segment

SegmentLength

The segment length lets the receiver know the length of the coming segment. If the set segment length is insufficient for a message, then the information must be distributed over several segments. In these cases, the actual end of the message is detected using bit 7 (control byte).

Information:

The control byte is not included in the calculation to determine the segment length. The segment length is only derived from the bytes of payload data.

nextCBPos

This bit indicates the position where the next control byte is expected. This information is especially important when using option "MultiSegmentMTU".
When using Flatstream communication with multi-segment MTUs, the next control byte is no longer expected in the first Rx byte of the subsequent MTU, but transferred directly after the current segment.

MessageEndBit

"MessageEndBit" is set if the subsequent segment completes a message. The message has then been completely transferred and is ready for further processing.

Information:

In the output direction, this bit must also be set if one individual segment is enough to hold the entire message. The module will only process a message internally if this identifier is detected.
The size of the message being transferred can be calculated by adding all of the message's segment lengths together.

Flatstream formula for calculating message length:

Message [bytes] = Segment lengths (all CBs without ME) + Segment length (of the first CB with ME)	CB	Control byte
	ME	MessageEndBit

11.4.4.2.3 Communication status

The communication status is determined via registers "OutputSequence" and "InputSequence".

- OutputSequence contains information about the communication status of the controller. It is written by the controller and read by the module.
- InputSequence contains information about the communication status of the module. It is written by the module and should only be read by the controller.

11.4.4.2.3.1 Relationship between OutputSequence and InputSequence

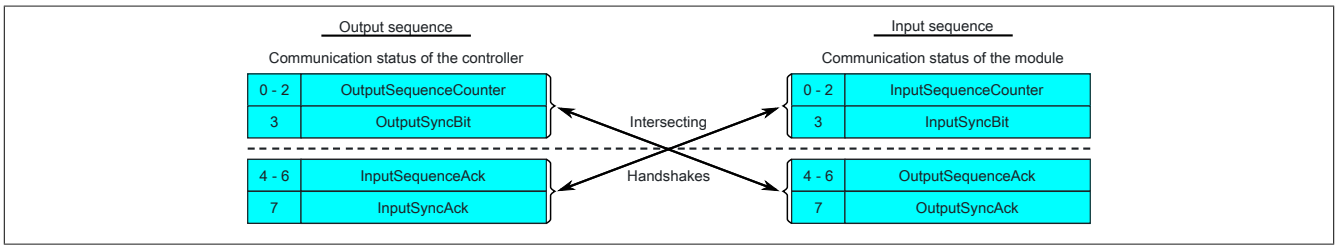


Figure 21: Relationship between OutputSequence and InputSequence

Registers OutputSequence and InputSequence are logically composed of 2 half-bytes. The low part indicates to the remote station whether a channel should be opened or whether data should be accepted. The high part is to acknowledge that the requested action was carried out.

SyncBit and SyncAck

If SyncBit and SyncAck are set in one communication direction, then the channel is considered "synchronized", i.e. it is possible to send messages in this direction. The status bit of the opposite station must be checked cyclically. If SyncAck has been reset, then SyncBit on that station must be adjusted. Before new data can be transferred, the channel must be resynchronized.

SequenceCounter and SequenceAck

The communication partners cyclically check whether the low nibble on the opposite station changes. When one of the communication partners finishes writing a new sequence to the MTU, it increments its SequenceCounter. The current sequence is then transmitted to the receiver, which acknowledges its receipt with SequenceAck. In this way, a "handshake" is initiated.

Information:

If communication is interrupted, segments from the unfinished message are discarded. All messages that were transferred completely are processed.

11.4.4.3 Synchronization

During synchronization, a communication channel is opened. It is important to make sure that a module is present and that the current value of SequenceCounter is stored on the station receiving the message.
Flatstream can handle full-duplex communication. This means that both channels / communication directions can be handled separately. They must be synchronized independently so that simplex communication can theoretically be carried out as well.

Synchronization in the output direction (controller as the transmitter):

The corresponding synchronization bits (OutputSyncBit and OutputSyncAck) are reset. Because of this, Flatstream cannot be used at this point in time to transfer messages from the controller to the module.

Algorithm

1) The controller must write 000 to OutputSequenceCounter and reset OutputSyncBit. The controller must cyclically query the high nibble of register "InputSequence" (checks for 000 in OutputSequenceAck and 0 in OutputSyncAck).
The module does not accept the current contents of InputMTU since the channel is not yet synchronized. *The module matches OutputSequenceAck and OutputSyncAck to the values of OutputSequenceCounter and OutputSyncBit.*
2) If the controller registers the expected values in OutputSequenceAck and OutputSyncAck, it is permitted to increment OutputSequenceCounter. The controller continues cyclically querying the high nibble of register "OutputSequence" (checks for 001 in OutputSequenceAck and 0 in InputSyncAck).
The module does not accept the current contents of InputMTU since the channel is not yet synchronized. *The module matches OutputSequenceAck and OutputSyncAck to the values of OutputSequenceCounter and OutputSyncBit.*
3) If the controller registers the expected values in OutputSequenceAck and OutputSyncAck, it is permitted to increment OutputSequenceCounter. The controller continues cyclically querying the high nibble of register "OutputSequence" (checks for 001 in OutputSequenceAck and 1 in InputSyncAck). **Note:** Theoretically, data can be transferred from this point forward. However, it is still recommended to wait until the output direction is completely synchronized before transferring data.
The module sets OutputSyncAck.
The output direction is synchronized, and the controller can transmit data to the module.

Synchronization in the input direction (controller as the receiver):

The corresponding synchronization bits (InputSyncBit and InputSyncAck) are reset. Because of this, Flatstream cannot be used at this point in time to transfer messages from the module to the controller.

Algorithm

The module writes 000 to InputSequenceCounter and resets InputSyncBit. *The module monitors the high nibble of register "OutputSequence" and expects 000 in InputSequenceAck and 0 in InputSyncAck.*
1) The controller is not permitted to accept the current contents of InputMTU since the channel is not yet synchronized. The controller has to match InputSequenceAck and InputSyncAck to the values of InputSequenceCounter and InputSyncBit.
If the module registers the expected values in InputSequenceAck and InputSyncAck, it increments InputSequenceCounter. *The module monitors the high nibble of register "OutputSequence" and expects 001 in InputSequenceAck and 0 in InputSyncAck.*
2) The controller is not permitted to accept the current contents of InputMTU since the channel is not yet synchronized. The controller has to match InputSequenceAck and InputSyncAck to the values of InputSequenceCounter and InputSyncBit.
If the module registers the expected values in InputSequenceAck and InputSyncAck, it sets InputSyncBit. *The module monitors the high nibble of register "OutputSequence" and expects 1 in InputSyncAck.*
3) The controller is permitted to set InputSyncAck. **Note:** Theoretically, data could already be transferred in this cycle. If InputSyncBit is set and InputSequenceCounter has been increased by 1, the values in the enabled Rx bytes must be accepted and acknowledged (see also "Communication in the input direction").
The input direction is synchronized, and the module can transmit data to the controller.

11.4.4.4 Transmitting and receiving

If a channel is synchronized, then the opposite station is ready to receive messages from the transmitter. Before the transmitter can send data, it needs to first create a transmit array in order to meet Flatstream requirements.

The transmitting station must also generate a control byte for each segment created. This control byte contains information about how the subsequent part of the data being transferred should be processed. The position of the next control byte in the data stream can vary. For this reason, it must be clearly defined at all times when a new control byte is being transmitted. The first control byte is always in the first byte of the first sequence. All subsequent positions are determined recursively.

Flatstream formula for calculating the position of the next control byte:

Position (of the next control byte) = Current position + 1 + Segment length

Example

3 autonomous messages (7 bytes, 2 bytes and 9 bytes) are being transmitted using an MTU with a width of 7 bytes. The rest of the configuration corresponds to the default settings.

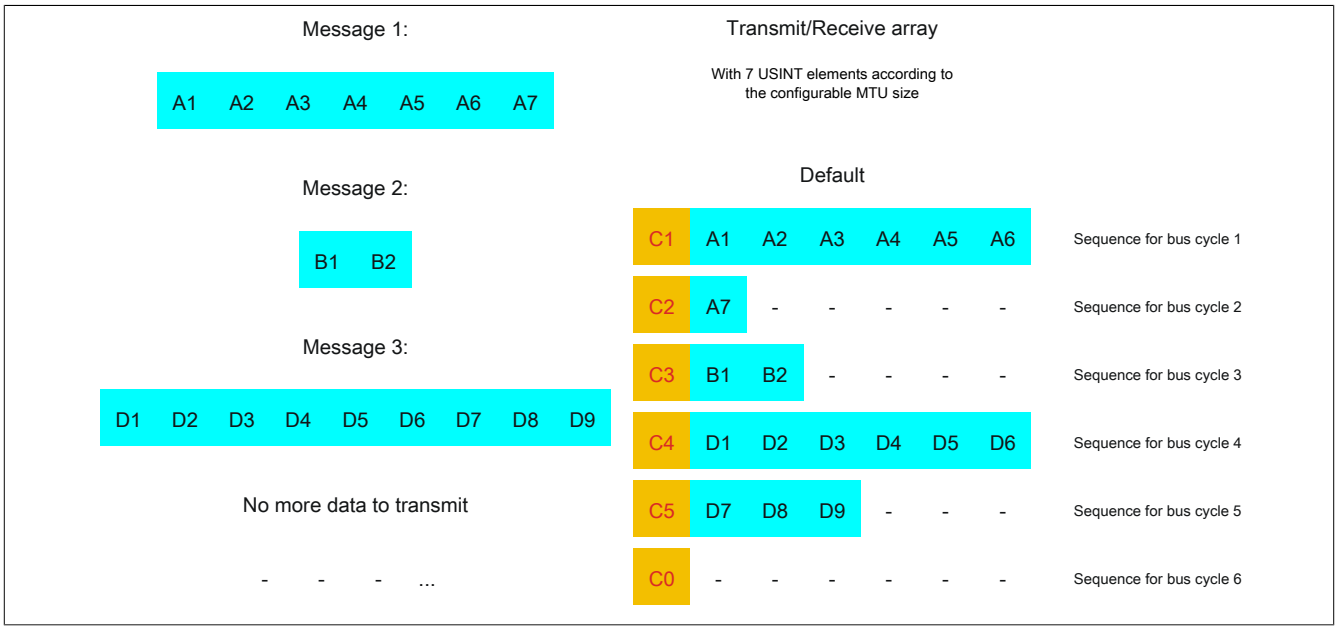


Figure 22: Transmit/Receive array (default)

First, the messages must be split into segments. In the default configuration, it is important to ensure that each sequence can hold an entire segment, including the associated control byte. The sequence is limited to the size of the enable MTU. In other words, a segment must be at least 1 byte smaller than the MTU.

MTU = 7 bytes → Max. segment length = 6 bytes

- Message 1 (7 bytes)
  - ⇨ First segment = Control byte + 6 bytes of data
  - ⇨ Second segment = Control byte + 1 data byte
- Message 2 (2 bytes)
  - ⇨ First segment = Control byte + 2 bytes of data
- Message 3 (9 bytes)
  - ⇨ First segment = Control byte + 6 bytes of data
  - ⇨ Second segment = Control byte + 3 data bytes
- No more messages
  - ⇨ C0 control byte

A unique control byte must be generated for each segment. In addition, the C0 control byte is generated to keep communication on standby.

C0 (control byte 0)			**C1 (control byte 1)**			**C2 (control byte 2)**		
- SegmentLength (0)	=	0	- SegmentLength (6)	=	6	- SegmentLength (1)	=	1
- nextCBPos (0)	=	0	- nextCBPos (0)	=	0	- nextCBPos (0)	=	0
- MessageEndBit (0)	=	0	- MessageEndBit (0)	=	0	- MessageEndBit (1)	=	128
Control byte	Σ	0	Control byte	Σ	6	Control byte	Σ	129

Table 33: Flatstream determination of the control bytes for the default configuration example (part 1)

C3 (control byte 3)			**C4 (control byte 4)**			**C5 (control byte 5)**		
- SegmentLength (2)	=	2	- SegmentLength (6)	=	6	- SegmentLength (3)	=	3
- nextCBPos (0)	=	0	- nextCBPos (0)	=	0	- nextCBPos (0)	=	0
- MessageEndBit (1)	=	128	- MessageEndBit (0)	=	0	- MessageEndBit (1)	=	128
Control byte	Σ	130	Control byte	Σ	6	Control byte	Σ	131

Table 34: Flatstream determination of the control bytes for the default configuration example (part 2)

11.4.4.4.1 Transmitting data to a module (output)

When transmitting data, the transmit array must be generated in the application program. Sequences are then transferred one by one using Flatstream and received by the module.

Information:

Although all B&R modules with Flatstream communication always support the most compact transfers in the output direction, it is recommended to use the same design for the transfer arrays in both communication directions.

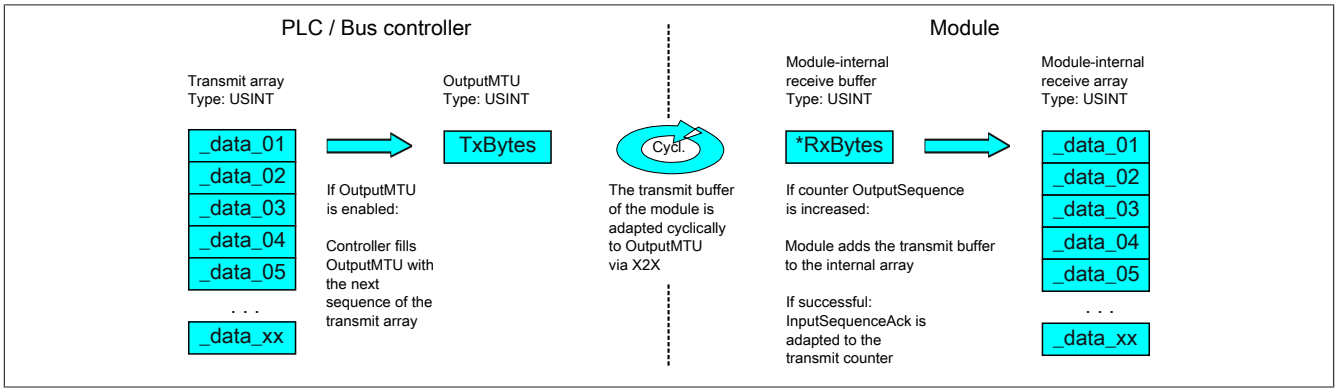


Figure 23: Flatstream communication (output)

Message smaller than OutputMTU

The length of the message is initially smaller than OutputMTU. In this case, one sequence would be sufficient to transfer the entire message and the necessary control byte.

Algorithm

Cyclic status query: *- The module monitors OutputSequenceCounter.*
0) Cyclic checks: - The controller must check OutputSyncAck. → If OutputSyncAck = 0: Reset OutputSyncBit and resynchronize the channel. - The controller must check whether OutputMTU is enabled. → If OutputSequenceCounter > InputSequenceAck: MTU is not enabled because the last sequence has not yet been acknowledged.
1) Preparation (create transmit array): - The controller must split up the message into valid segments and create the necessary control bytes. - The controller must add the segments and control bytes to the transmit array.
2) Transmit: - The controller transfers the current element of the transmit array to OutputMTU. → OutputMTU is transferred cyclically to the module's transmit buffer but not processed further. - The controller must increase OutputSequenceCounter.
Reaction: *- The module accepts the bytes from the internal receive buffer and adds them to the internal receive array.* *- The module transmits acknowledgment and writes the value of OutputSequenceCounter to OutputSequenceAck.*
3) Completion: - The controller must monitor OutputSequenceAck. → A sequence is only considered to have been transferred successfully if it has been acknowledged via OutputSequenceAck. In order to detect potential transfer errors in the last sequence as well, it is important to make sure that the length of the *Completion* phase is run through long enough. **Note:** To monitor communication times exactly, the task cycles that have passed since the last increase of OutputSequenceCounter should be counted. In this way, the number of previous bus cycles necessary for the transfer can be measured. If the monitoring counter exceeds a predefined threshold, then the sequence can be considered lost. (The relationship of bus to task cycle can be influenced by the user so that the threshold value must be determined individually.) - Subsequent sequences are only permitted to be transmitted in the next bus cycle after the completion check has been carried out successfully.

Message larger than OutputMTU

The transmit array, which must be created in the program sequence, consists of several elements. The user has to arrange the control and data bytes correctly and transfer the array elements one after the other. The transfer algorithm remains the same and is repeated starting at the point *Cyclic checks*.

General flowchart

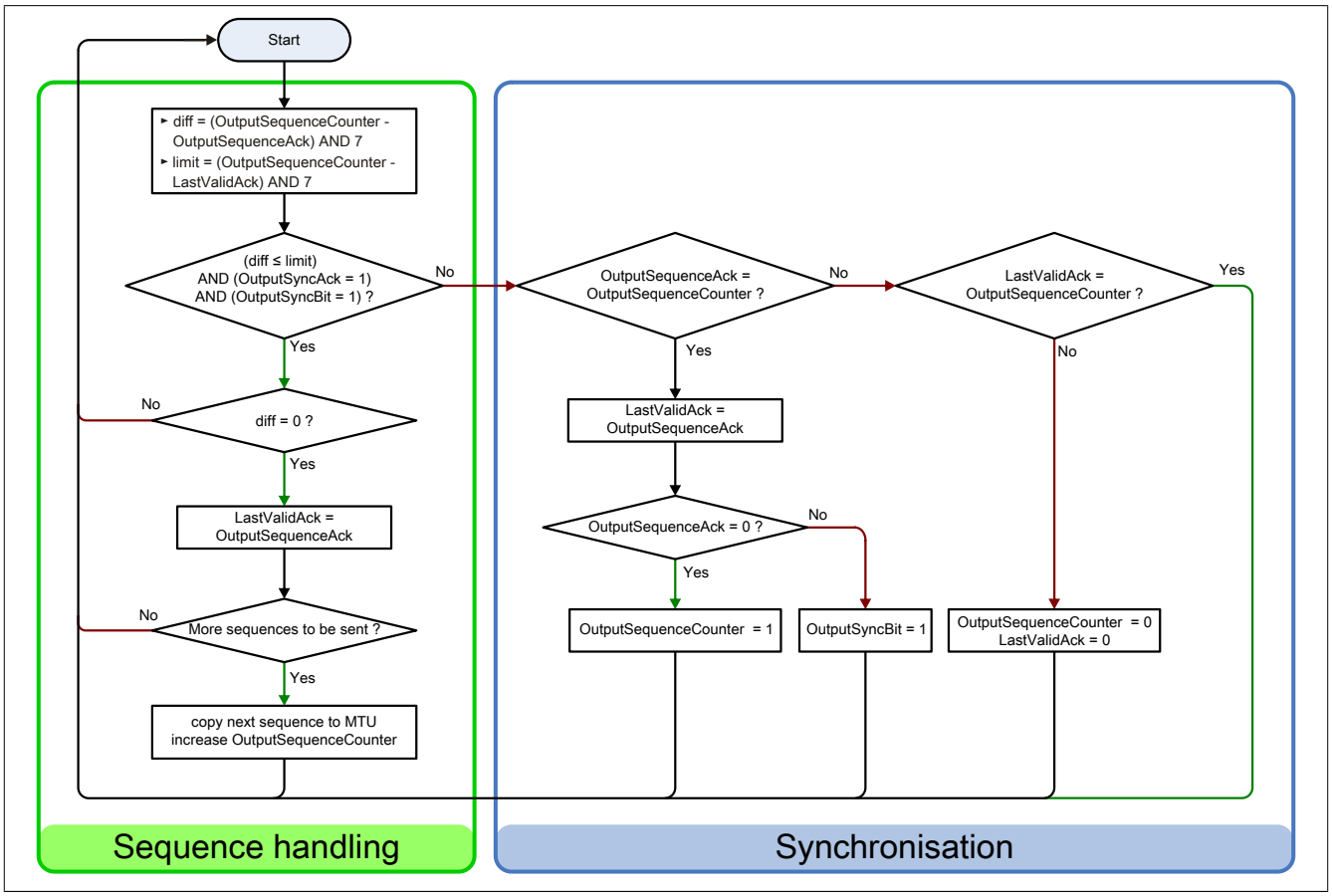


Figure 24: Flowchart for the output direction

11.4.4.4.2 Receiving data from a module (input)

When receiving data, the transmit array is generated by the module, transferred via Flatstream and must then be reproduced in the receive array. The structure of the incoming data stream can be set with the mode register. The algorithm for receiving the data remains unchanged in this regard.

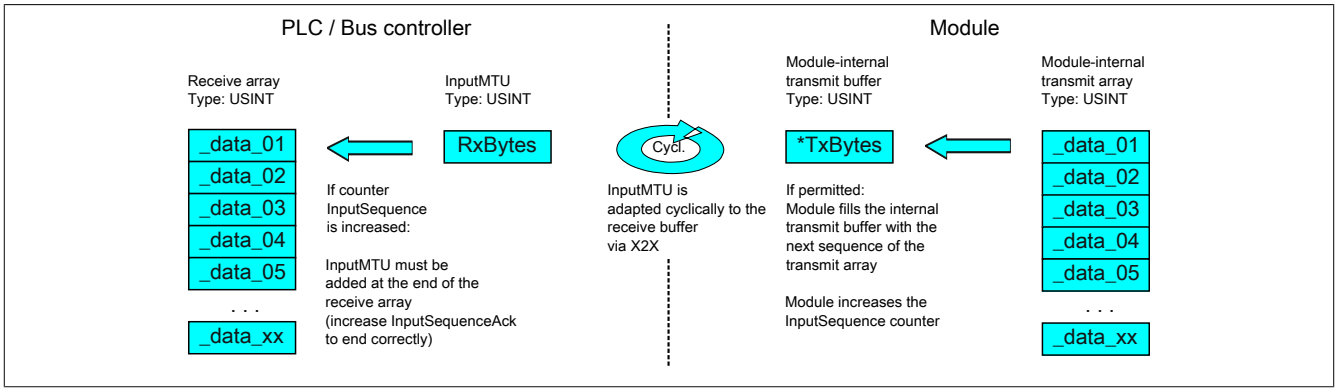


Figure 25: Flatstream communication (input)

Algorithm

0) Cyclic status query: - The controller must monitor InputSequenceCounter.
Cyclic checks: *- The module checks InputSyncAck.* *- The module checks InputSequenceAck.*
Preparation: *- The module forms the segments and control bytes and creates the transmit array.*
Action: *- The module transfers the current element of the internal transmit array to the internal transmit buffer.* *- The module increases InputSequenceCounter.*
1) Receiving (as soon as InputSequenceCounter is increased): - The controller must apply data from InputMTU and append it to the end of the receive array. - The controller must match InputSequenceAck to InputSequenceCounter of the sequence currently being processed.
Completion: *- The module monitors InputSequenceAck.* *→ A sequence is only considered to have been transferred successfully if it has been acknowledged via InputSequenceAck.* *- Subsequent sequences are only transmitted in the next bus cycle after the completion check has been carried out successfully.*

General flowchart

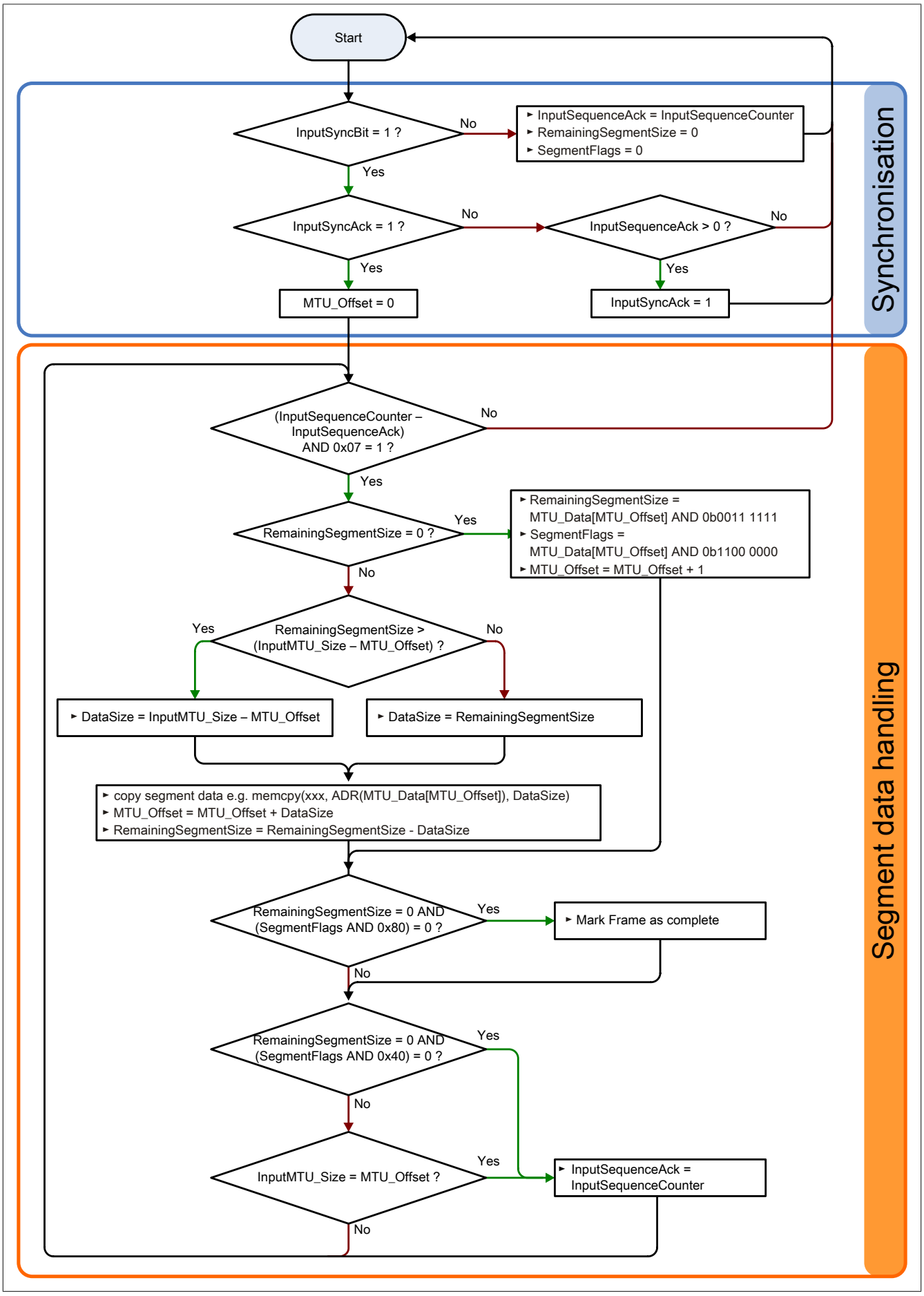


Figure 26: Flowchart for the input direction

11.4.4.4.3 Details

It is recommended to store transferred messages in separate receive arrays.

After a set MessageEndBit is transmitted, the subsequent segment should be added to the receive array. The message is then complete and can be passed on internally for further processing. A new/separate array should be created for the next message.

> ## Information:
>
> **When transferring with MultiSegmentMTUs, it is possible for several small messages to be part of one sequence. In the program, it is important to make sure that a sufficient number of receive arrays can be managed. The acknowledge register is only permitted to be adjusted after the entire sequence has been applied.**

If SequenceCounter is incremented by more than one counter, an error is present.

In this case, the receiver stops. All additional incoming sequences are ignored until the transmission with the correct SequenceCounter is retried. This response prevents the transmitter from receiving any more acknowledgments for transmitted sequences. The transmitter can identify the last successfully transferred sequence from the opposite station's SequenceAck and continue the transfer from this point.

> ## Information:
>
> **This situation is very unlikely when operating without "Forward" functionality.**

Acknowledgments must be checked for validity.

If the receiver has successfully accepted a sequence, it must be acknowledged. The receiver takes on the value of SequenceCounter sent along with the transmission and matches SequenceAck to it. The transmitter reads SequenceAck and registers the successful transmission. If the transmitter acknowledges a sequence that has not yet been dispatched, then the transfer must be interrupted and the channel resynchronized. The synchronization bits are reset and the current/incomplete message is discarded. It must be sent again after the channel has been resynchronized.

11.4.4.5 Flatstream mode

In the input direction, the transmit array is generated automatically. Flatstream mode offers several options to the user that allow an incoming data stream to have a more compact arrangement. These include:

- Standard
- MultiSegmentMTUs allowed
- Large segments allowed

Once enabled, the program code for evaluation must be adapted accordingly.

Information:

All B&R modules that offer Flatstream mode support options "Large segments" and "MultiSegmentMTUs" in the output direction. Compact transfer must be explicitly allowed only in the input direction.

Standard

By default, both options relating to compact transfer in the input direction are disabled.

1. The module only forms segments that are at least one byte smaller than the enabled MTU. Each sequence begins with a control byte so that the data stream is clearly structured and relatively easy to evaluate.
2. Since a Flatstream message is permitted to be any length, the last segment of the message frequently does not fill up all of the MTU's space. By default, the remaining bytes during this type of transfer cycle are not used.

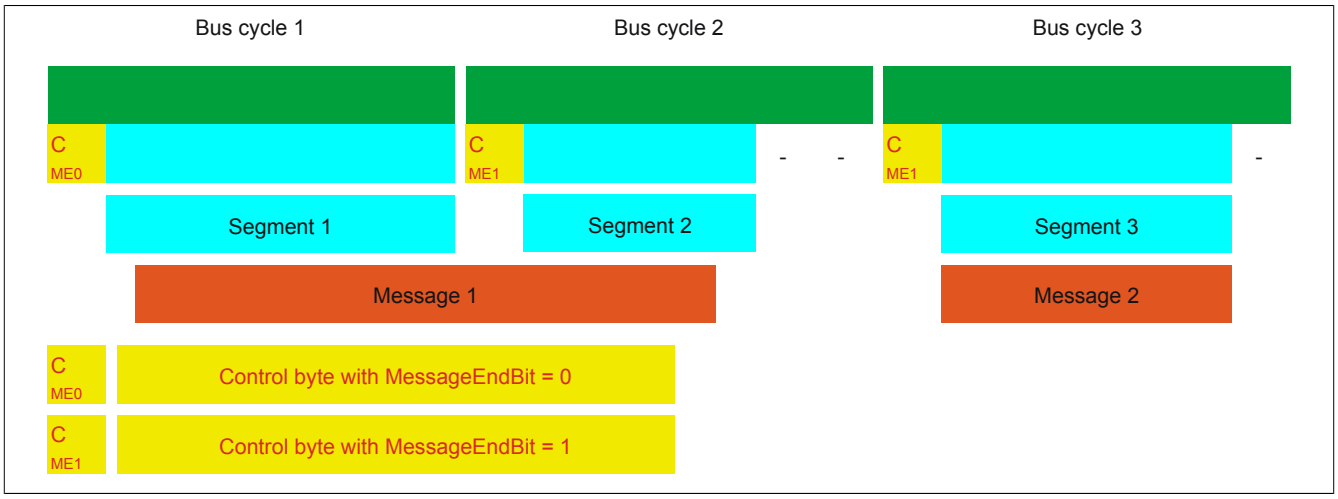


Figure 27: Message arrangement in the MTU (default)

MultiSegmentMTUs allowed

With this option, InputMTU is completely filled (if enough data is pending). The previously unfilled Rx bytes transfer the next control bytes and their segments. This allows the enabled Rx bytes to be used more efficiently.

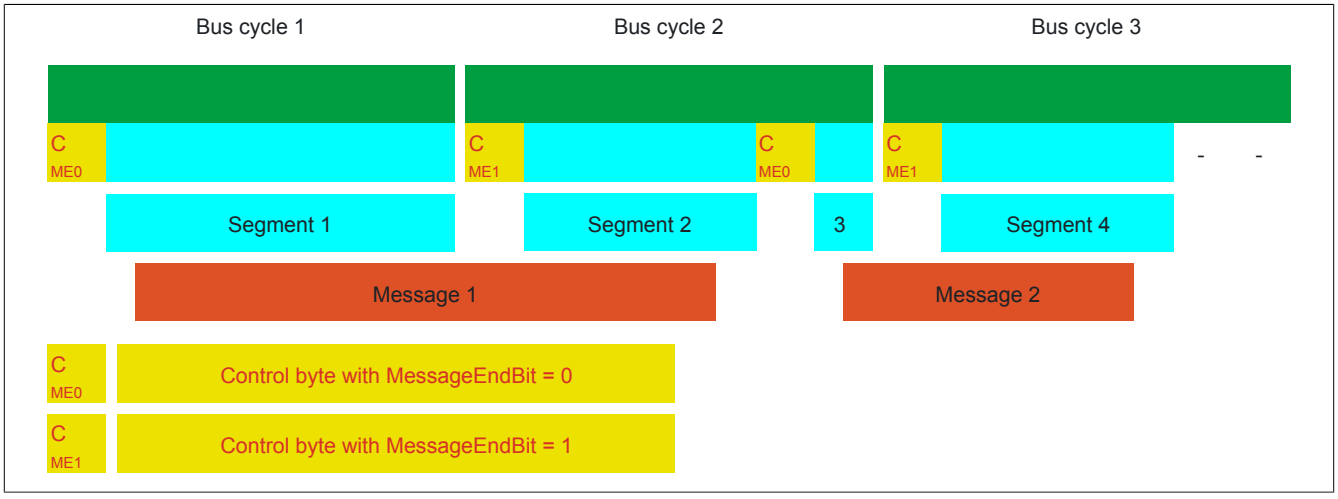


Figure 28: Arrangement of messages in the MTU (MultiSegmentMTUs)

Large segments allowed

When transferring very long messages or when enabling only very few Rx bytes, then a great many segments must be created by default. The bus system is more stressed than necessary since an additional control byte must be created and transferred for each segment. With option "Large segments", the segment length is limited to 63 bytes independently of InputMTU. One segment is permitted to stretch across several sequences, i.e. it is possible for "pure" sequences to occur without a control byte.

Information:

It is still possible to split up a message into several segments, however. If this option is used and messages with more than 63 bytes occur, for example, then messages can still be split up among several segments.

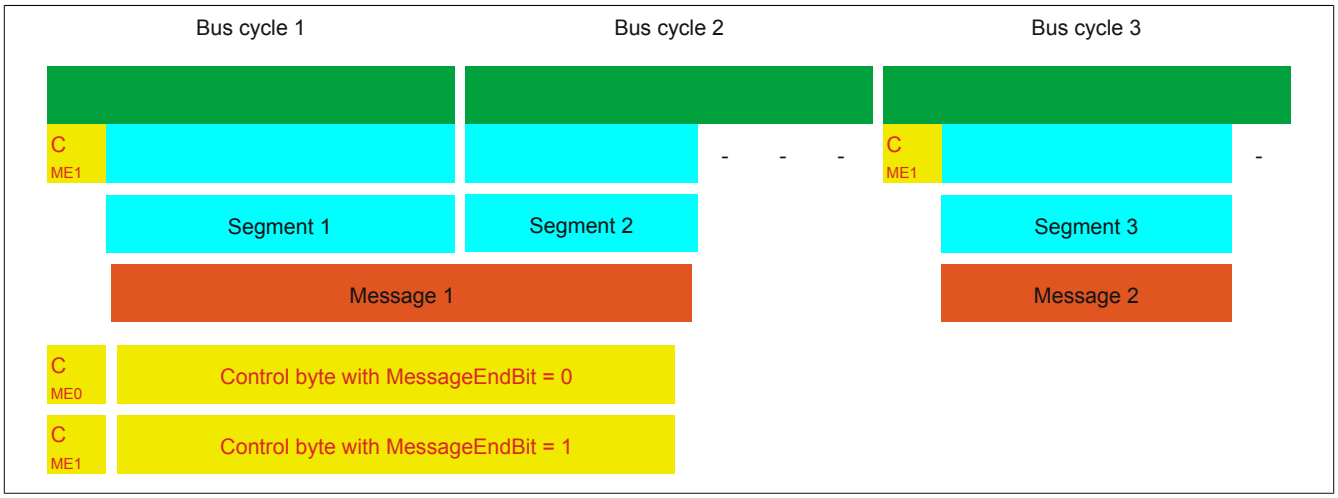


Figure 29: Arrangement of messages in the MTU (large segments)

Using both options

Using both options at the same time is also permitted.

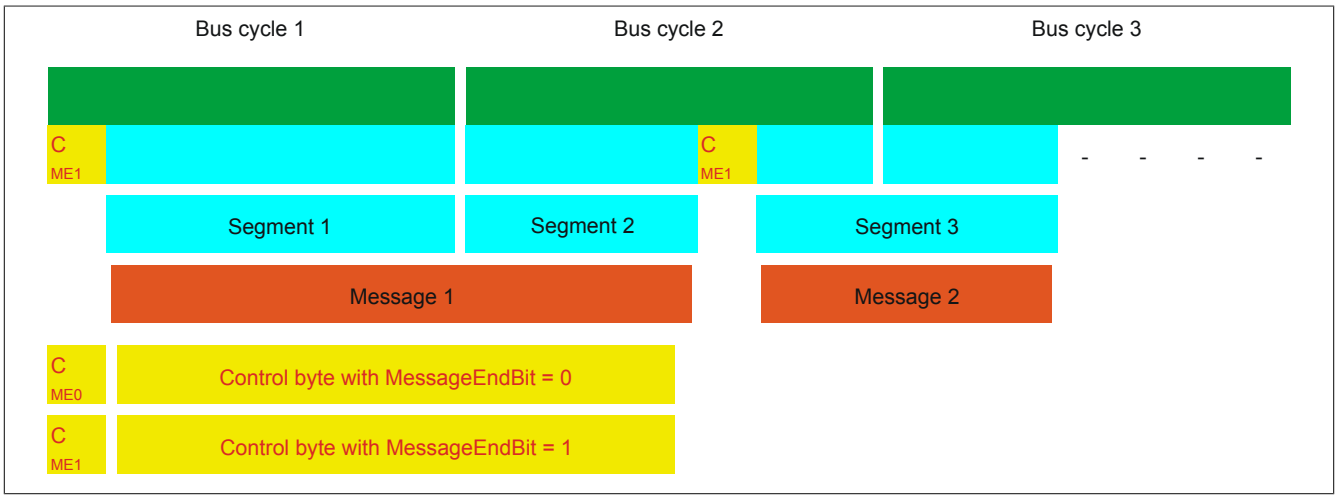


Figure 30: Arrangement of messages in the MTU (large segments and MultiSegmentMTUs)

11.4.4.6 Adjusting the Flatstream

If the way messages are structured is changed, then the way data in the transmit/receive array is arranged is also different. The following changes apply to the example given earlier.

MultiSegmentMTU

If MultiSegmentMTUs are allowed, then "open positions" in an MTU can be used. These "open positions" occur if the last segment in a message does not fully use the entire MTU. MultiSegmentMTUs allow these bits to be used to transfer the subsequent control bytes and segments. In the program sequence, the "nextCBPos" bit in the control byte is set so that the receiver can correctly identify the next control byte.

Example

3 autonomous messages (7 bytes, 2 bytes and 9 bytes) are being transmitted using an MTU with a width of 7 bytes. The configuration allows the transfer of MultiSegmentMTUs.

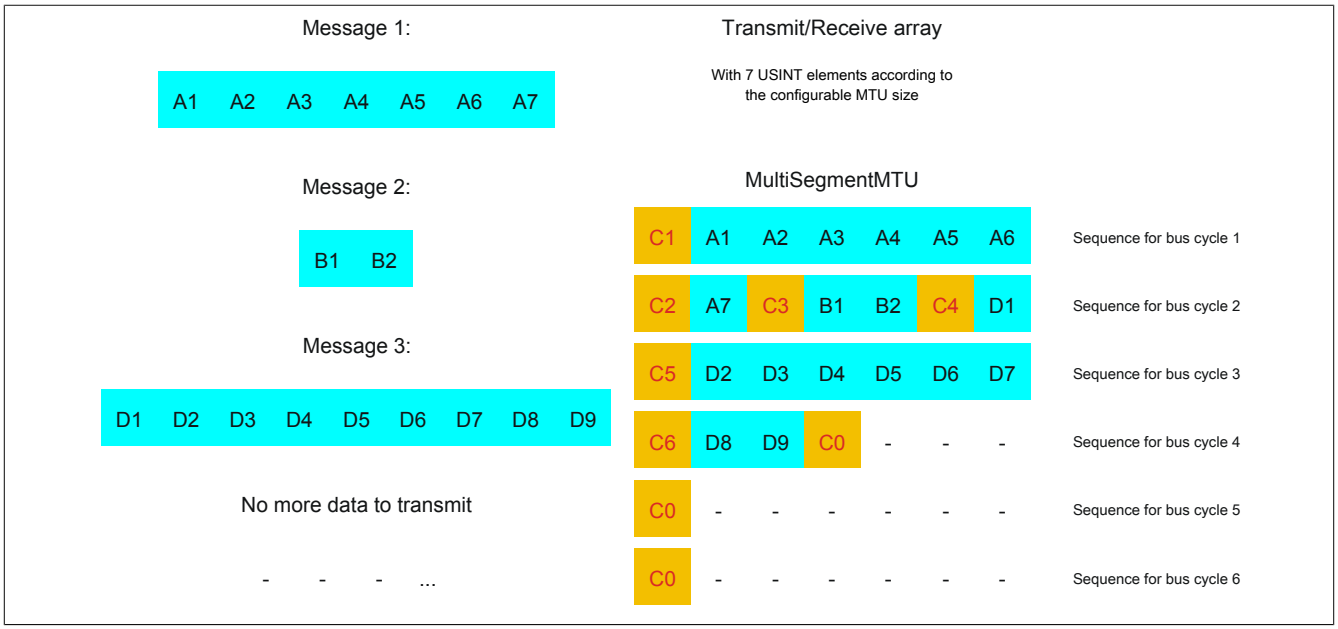


Figure 31: Transmit/receive array (MultiSegmentMTUs)

First, the messages must be split into segments. As in the default configuration, it is important for each sequence to begin with a control byte. The free bits in the MTU at the end of a message are filled with data from the following message, however. With this option, the "nextCBPos" bit is always set if payload data is transferred after the control byte.

MTU = 7 bytes → Max. segment length = 6 bytes

- Message 1 (7 bytes)
  - ⇨ First segment = Control byte + 6 bytes of data (MTU full)
  - ⇨ Second segment = Control byte + 1 byte of data (MTU still has 5 open bytes)
- Message 2 (2 bytes)
  - ⇨ First segment = Control byte + 2 bytes of data (MTU still has 2 open bytes)
- Message 3 (9 bytes)
  - ⇨ First segment = Control byte + 1 byte of data (MTU full)
  - ⇨ Second segment = Control byte + 6 bytes of data (MTU full)
  - ⇨ Third segment = Control byte + 2 bytes of data (MTU still has 4 open bytes)
- No more messages
  - ⇨ C0 control byte

A unique control byte must be generated for each segment. In addition, the C0 control byte is generated to keep communication on standby.

C1 (control byte 1)			C2 (control byte 2)			C3 (control byte 3)		
- SegmentLength (6)	=	6	- SegmentLength (1)	=	1	- SegmentLength (2)	=	2
- nextCBPos (1)	=	64	- nextCBPos (1)	=	64	- nextCBPos (1)	=	64
- MessageEndBit (0)	=	0	- MessageEndBit (1)	=	128	- MessageEndBit (1)	=	128
Control byte	Σ	70	Control byte	Σ	193	Control byte	Σ	194

Table 35: Flatstream determination of the control bytes for the MultiSegmentMTU example (part 1)

Warning!

The second sequence is only permitted to be acknowledged via SequenceAck if it has been completely processed. In this example, there are 3 different segments within the second sequence, i.e. the program must include enough receive arrays to handle this situation.

C4 (control byte 4)			C5 (control byte 5)			C6 (control byte 6)		
- SegmentLength (1)	=	1	- SegmentLength (6)	=	6	- SegmentLength (2)	=	2
- nextCBPos (6)	=	6	- nextCBPos (1)	=	64	- nextCBPos (1)	=	64
- MessageEndBit (0)	=	0	- MessageEndBit (1)	=	0	- MessageEndBit (1)	=	128
Control byte	Σ	7	Control byte	Σ	70	Control byte	Σ	194

Table 36: Flatstream determination of the control bytes for the MultiSegmentMTU example (part 2)

Large segments

Segments are limited to a maximum of 63 bytes. This means they can be larger than the active MTU. These large segments are divided among several sequences when transferred. It is possible for sequences to be completely filled with payload data and not have a control byte.

Information:

It is still possible to subdivide a message into several segments so that the size of a data packet does not also have to be limited to 63 bytes.

Example

3 autonomous messages (7 bytes, 2 bytes and 9 bytes) are being transmitted using an MTU with a width of 7 bytes. The configuration allows the transfer of large segments.

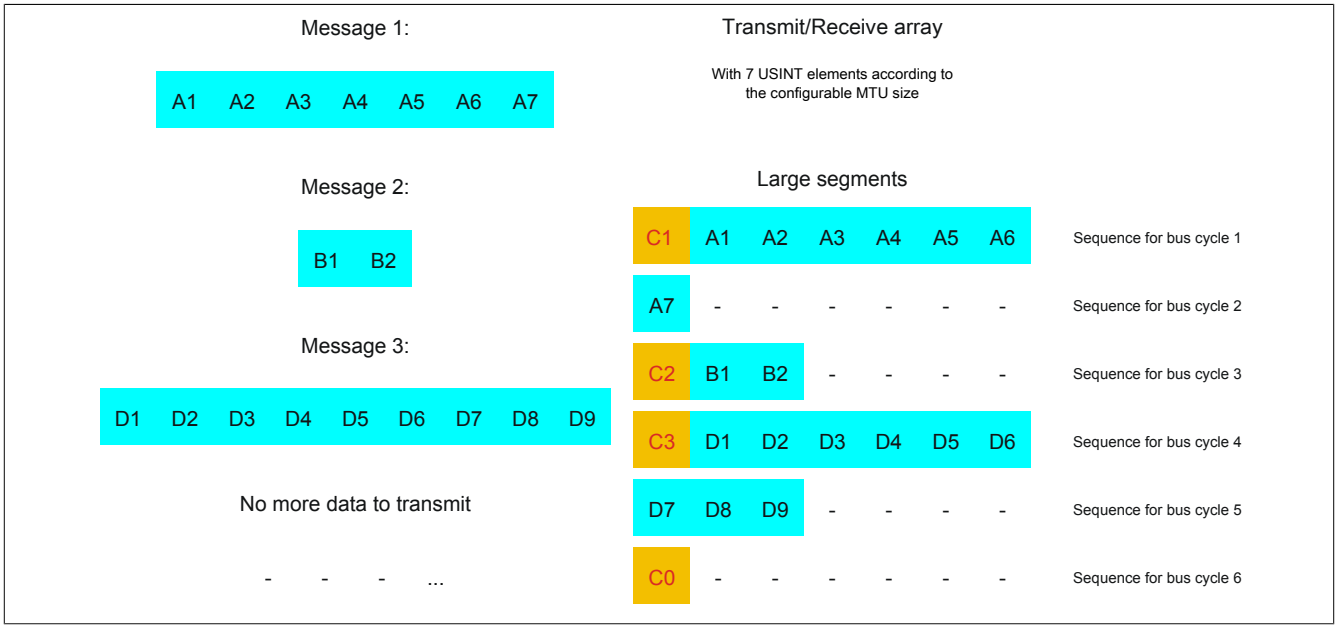


Figure 32: Transmit/receive array (large segments)

First, the messages must be split into segments. The ability to form large segments means that messages are split up less frequently, which results in fewer control bytes generated.

Large segments allowed → Max. segment length = 63 bytes

- Message 1 (7 bytes)
  - ⇨ First segment = Control byte + 7 bytes of data
- Message 2 (2 bytes)
  - ⇨ First segment = Control byte + 2 bytes of data
- Message 3 (9 bytes)
  - ⇨ First segment = Control byte + 9 bytes of data
- No more messages
  - ⇨ C0 control byte

A unique control byte must be generated for each segment. In addition, the C0 control byte is generated to keep communication on standby.

C1 (control byte 1)			**C2 (control byte 2)**			**C3 (control byte 3)**		
- SegmentLength (7)	=	7	- SegmentLength (2)	=	2	- SegmentLength (9)	=	9
- nextCBPos (0)	=	0	- nextCBPos (0)	=	0	- nextCBPos (0)	=	0
- MessageEndBit (1)	=	128	- MessageEndBit (1)	=	128	- MessageEndBit (1)	=	128
Control byte	Σ	135	Control byte	Σ	130	Control byte	Σ	137

Table 37: Flatstream determination of the control bytes for the large segment example

Large segments and MultiSegmentMTU

Example

3 autonomous messages (7 bytes, 2 bytes and 9 bytes) are being transmitted using an MTU with a width of 7 bytes. The configuration allows transfer of large segments as well as MultiSegmentMTUs.

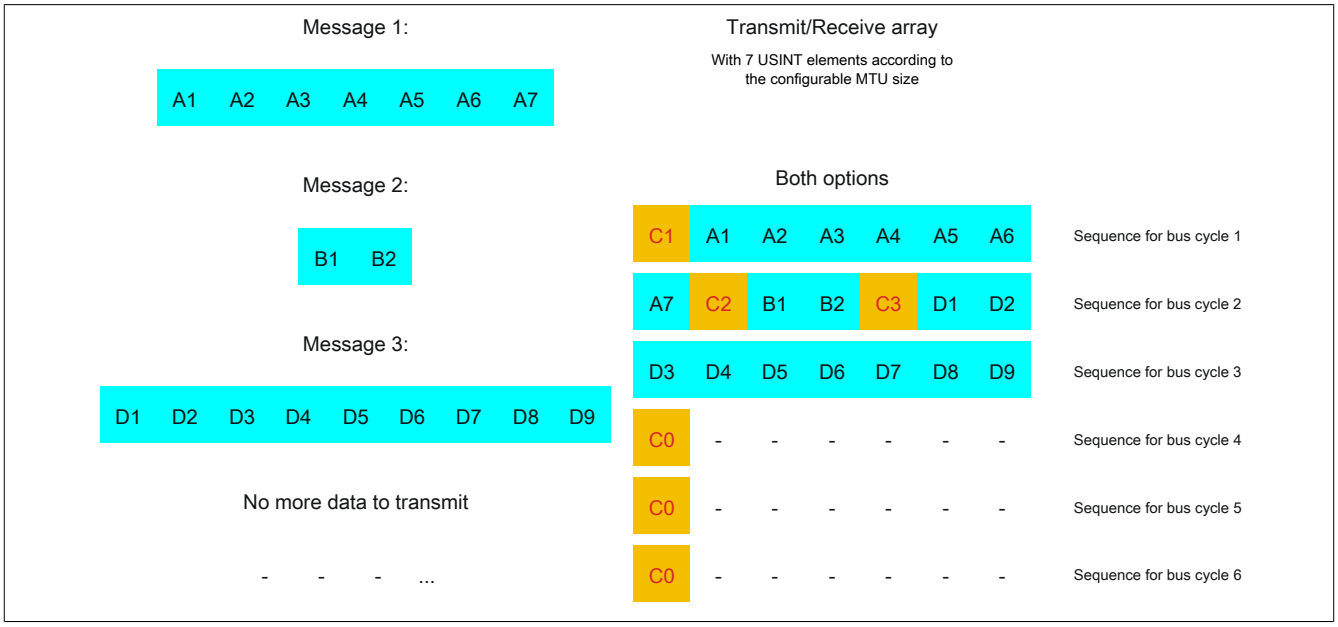


Figure 33: Transmit/receive array (large segments and MultiSegmentMTUs)

First, the messages must be split into segments. If the last segment of a message does not completely fill the MTU, it is permitted to be used for other data in the data stream. Bit "nextCBPos" must always be set if the control byte belongs to a segment with payload data.
The ability to form large segments means that messages are split up less frequently, which results in fewer control bytes generated. Control bytes are generated in the same way as with option "Large segments".

Large segments allowed → Max. segment length = 63 bytes

- Message 1 (7 bytes)
  - ⇨ First segment = Control byte + 7 bytes of data
- Message 2 (2 bytes)
  - ⇨ First segment = Control byte + 2 bytes of data
- Message 3 (9 bytes)
  - ⇨ First segment = Control byte + 9 bytes of data
- No more messages
  - ⇨ C0 control byte

A unique control byte must be generated for each segment. In addition, the C0 control byte is generated to keep communication on standby.

C1 (control byte 1)			C2 (control byte 2)			C3 (control byte 3)		
- SegmentLength (7)	=	7	- SegmentLength (2)	=	2	- SegmentLength (9)	=	9
- nextCBPos (0)	=	0	- nextCBPos (0)	=	0	- nextCBPos (0)	=	0
- MessageEndBit (1)	=	128	- MessageEndBit (1)	=	128	- MessageEndBit (1)	=	128
Control byte	Σ	135	Control byte	Σ	130	Control byte	Σ	137

Table 38: Flatstream determination of the control bytes for the large segment and MultiSegmentMTU example

11.4.5 Example of function "Forward" with X2X Link

Function "Forward" is a method that can be used to substantially increase the Flatstream data rate. The basic principle is also used in other technical areas such as "pipelining" for microprocessors.

11.4.5.1 Function principle

X2X Link communication cycles through 5 different steps to transfer a Flatstream sequence. At least 5 bus cycles are therefore required to successfully transfer the sequence.

	Step I	Step II	Step III	Step IV	Step V
Actions	Transfer sequence from transmit array, increase SequenceCounter	Cyclic matching of MTU and module buffer	Append sequence to receive array, adjust SequenceAck	Cyclic synchronization MTU and module buffer	Check SequenceAck
Resource	Transmitter (task to transmit)	Bus system (direction 1)	Receiver (task to receive)	Bus system (direction 2)	Transmitter (task for Ack checking)

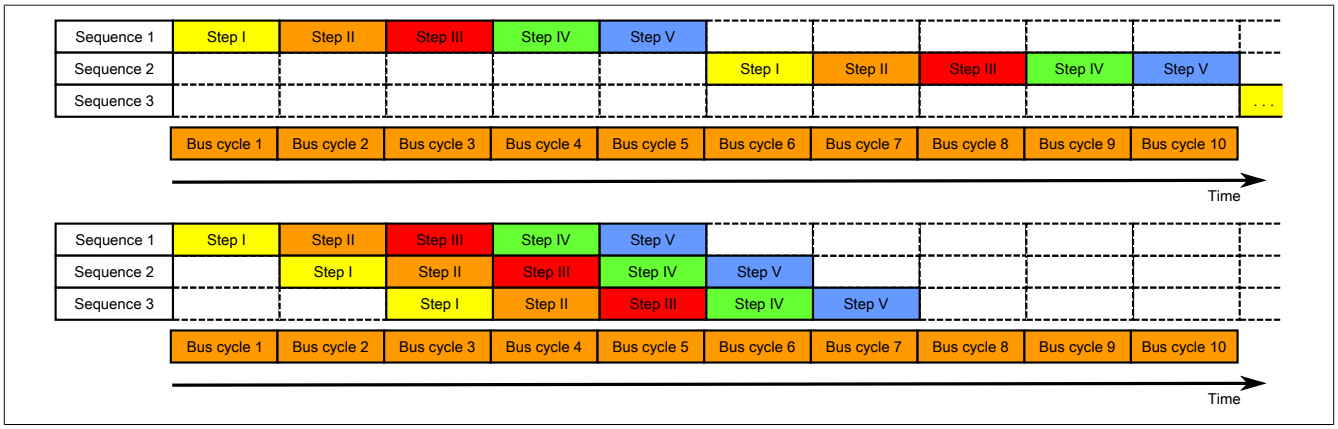


Figure 34: Comparison of transfer without/with Forward

Each of the 5 steps (tasks) requires different resources. If Forward functionality is not used, the sequences are executed one after the other. Each resource is then only active if it is needed for the current sub-action.
With Forward, a resource that has executed its task can already be used for the next message. The condition for enabling the MTU is changed to allow for this. Sequences are then passed to the MTU according to the timing. The transmitting station no longer waits for an acknowledgment from SequenceAck, which means that the available bandwidth can be used much more efficiently.
In the most ideal situation, all resources are working during each bus cycle. The receiver still has to acknowledge every sequence received. Only when SequenceAck has been changed and checked by the transmitter is the sequence considered as having been transferred successfully.

11.4.5.2 Configuration

The Forward function must only be enabled for the input direction. Flatstream modules have been optimized in such a way that they support this function. In the output direction, the Forward function can be used as soon as the size of OutputMTU is specified.

Information:

Registers are described in section "Flatstream communication" in the respective data sheets.

11.4.5.2.1 Delay time

The delay time is specified in microseconds. This is the amount of time the module has to wait after sending a sequence until it is permitted to write new data to the MTU in the following bus cycle. The program routine for receiving sequences from a module can therefore be run in a task class whose cycle time is slower than the bus cycle.

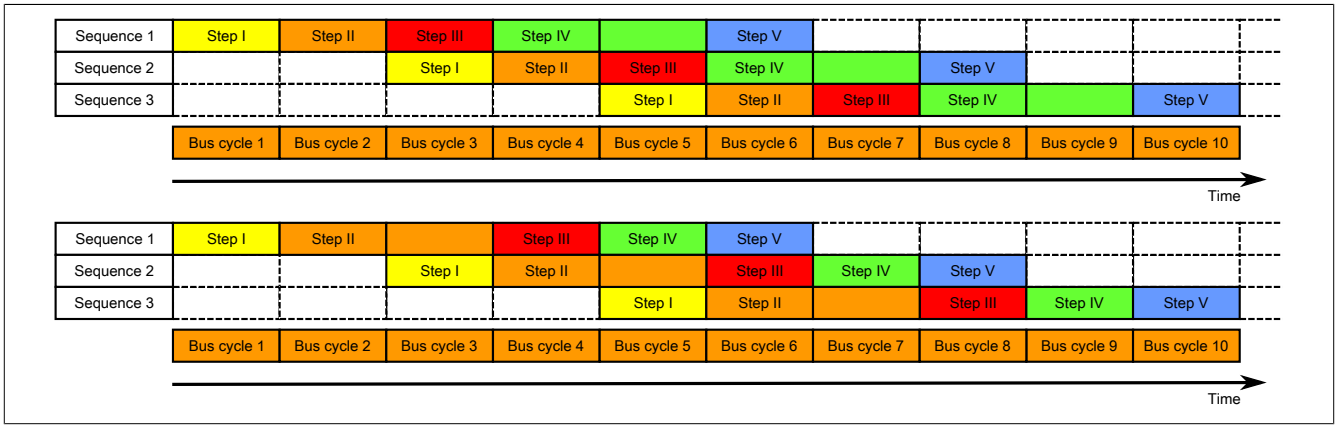


Figure 35: Effect of ForwardDelay when using Flatstream communication with the Forward function

In the program, it is important to make sure that the controller is processing all of the incoming InputSequences and InputMTUs. The ForwardDelay value causes delayed acknowledgment in the output direction and delayed reception in the input direction. In this way, the controller has more time to process the incoming InputSequence or InputMTU.

11.4.5.3 Transmitting and receiving with Forward

The basic algorithm for transmitting and receiving data remains the same. With the Forward function, up to 7 unacknowledged sequences can be transmitted. Sequences can be transmitted without having to wait for the previous message to be acknowledged. Since the delay between writing and response is eliminated, a considerable amount of additional data can be transferred in the same time window.

Algorithm for transmitting

Cyclic status query: *- The module monitors OutputSequenceCounter.*
0) Cyclic checks: - The controller must check OutputSyncAck. → If OutputSyncAck = 0: Reset OutputSyncBit and resynchronize the channel. - The controller must check whether OutputMTU is enabled. → If OutputSequenceCounter > OutputSequenceAck + 7, then it is not enabled because the last sequence has not yet been acknowledged.
1) Preparation (create transmit array): - The controller must split up the message into valid segments and create the necessary control bytes. - The controller must add the segments and control bytes to the transmit array.
2) Transmit: - The controller must transfer the current part of the transmit array to OutputMTU. - The controller must increase OutputSequenceCounter for the sequence to be accepted by the module. - The controller is then permitted to *transmit* in the next bus cycle if the MTU has been enabled.
The module responds since OutputSequenceCounter > OutputSequenceAck: *- The module accepts data from the internal receive buffer and appends it to the end of the internal receive array.* *- The module is acknowledged and the currently received value of OutputSequenceCounter is transferred to OutputSequenceAck.* *- The module queries the status cyclically again.*
3) Completion (acknowledgment): - The controller must check OutputSequenceAck cyclically. → A sequence is only considered to have been transferred successfully if it has been acknowledged via OutputSequenceAck. In order to detect potential transfer errors in the last sequence as well, it is important to make sure that the algorithm is run through long enough. **Note:** To monitor communication times exactly, the task cycles that have passed since the last increase of OutputSequenceCounter should be counted. In this way, the number of previous bus cycles necessary for the transfer can be measured. If the monitoring counter exceeds a predefined threshold, then the sequence can be considered lost (the relationship of bus to task cycle can be influenced by the user so that the threshold value must be determined individually).

Algorithm for receiving

0) Cyclic status query: - The controller must monitor InputSequenceCounter.
Cyclic checks: *- The module checks InputSyncAck.* *- The module checks if InputMTU for enabling.* *→ Enabling criteria: InputSequenceCounter > InputSequenceAck + Forward*
Preparation: *- The module forms the control bytes / segments and creates the transmit array.*
Action: *- The module transfers the current part of the transmit array to the receive buffer.* *- The module increases InputSequenceCounter.* *- The module waits for a new bus cycle after time from ForwardDelay has expired.* *- The module repeats the action if InputMTU is enabled.*
1) Receiving (InputSequenceCounter > InputSequenceAck): - The controller must apply data from InputMTU and append it to the end of the receive array. - The controller must match InputSequenceAck to InputSequenceCounter of the sequence currently being processed.
Completion: *- The module monitors InputSequenceAck.* *→ A sequence is only considered to have been transferred successfully if it has been acknowledged via InputSequenceAck.*

Details/Background

1. Illegal SequenceCounter size (counter offset)
   Error situation: MTU not enabled
   If the difference between SequenceCounter and SequenceAck during transmission is larger than permitted, a transfer error occurs. In this case, all unacknowledged sequences must be repeated with the old Sequence-Counter value.
2. Checking an acknowledgment
   After an acknowledgment has been received, a check must verify whether the acknowledged sequence has been transmitted and had not yet been unacknowledged. If a sequence is acknowledged multiple times, a severe error occurs. The channel must be closed and resynchronized (same behavior as when not using Forward).

   > **Information:**
   >
   > **In exceptional cases, the module can increment OutputSequenceAck by more than 1 when using Forward.**
   > **An error does not occur in this case. The controller is permitted to consider all sequences up to the one being acknowledged as having been transferred successfully.**

3. Transmit and receive arrays
   The Forward function has no effect on the structure of the transmit and receive arrays. They are created and must be evaluated in the same way.

11.4.5.4 Errors when using Forward

In industrial environments, it is often the case that many different devices from various manufacturers are being used side by side. The electrical and/or electromagnetic properties of these technical devices can sometimes cause them to interfere with one another. These kinds of situations can be reproduced and protected against in laboratory conditions only to a certain point.

Precautions have been taken for X2X Link transfers if this type of interference occurs. For example, if an invalid checksum occurs, the I/O system will ignore the data from this bus cycle and the receiver receives the last valid data once more. With conventional (cyclic) data points, this error can often be ignored. In the following cycle, the same data point is again retrieved, adjusted and transferred.

Using Forward functionality with Flatstream communication makes this situation more complex. The receiver receives the old data again in this situation as well, i.e. the previous values for SequenceAck/SequenceCounter and the old MTU.

Loss of acknowledgment (SequenceAck)

If a SequenceAck value is lost, then the MTU was already transferred properly. For this reason, the receiver is permitted to continue processing with the next sequence. The SequenceAck is aligned with the associated SequenceCounter and sent back to the transmitter. Checking the incoming acknowledgments shows that all sequences up to the last one acknowledged have been transferred successfully (see sequences 1 and 2 in the image).

Loss of transmission (SequenceCounter, MTU):

If a bus cycle drops out and causes the value of SequenceCounter and/or the filled MTU to be lost, then no data reaches the receiver. At this point, the transmission routine is not yet affected by the error. The time-controlled MTU is released again and can be rewritten to.
The receiver receives SequenceCounter values that have been incremented several times. For the receive array to be put together correctly, the receiver is only permitted to process transmissions whose SequenceCounter has been increased by one. The incoming sequences must be ignored, i.e. the receiver stops and no longer transmits back any acknowledgments.
If the maximum number of unacknowledged sequences has been sent and no acknowledgments are returned, the transmitter must repeat the affected SequenceCounter and associated MTUs (see sequence 3 and 4 in the image).

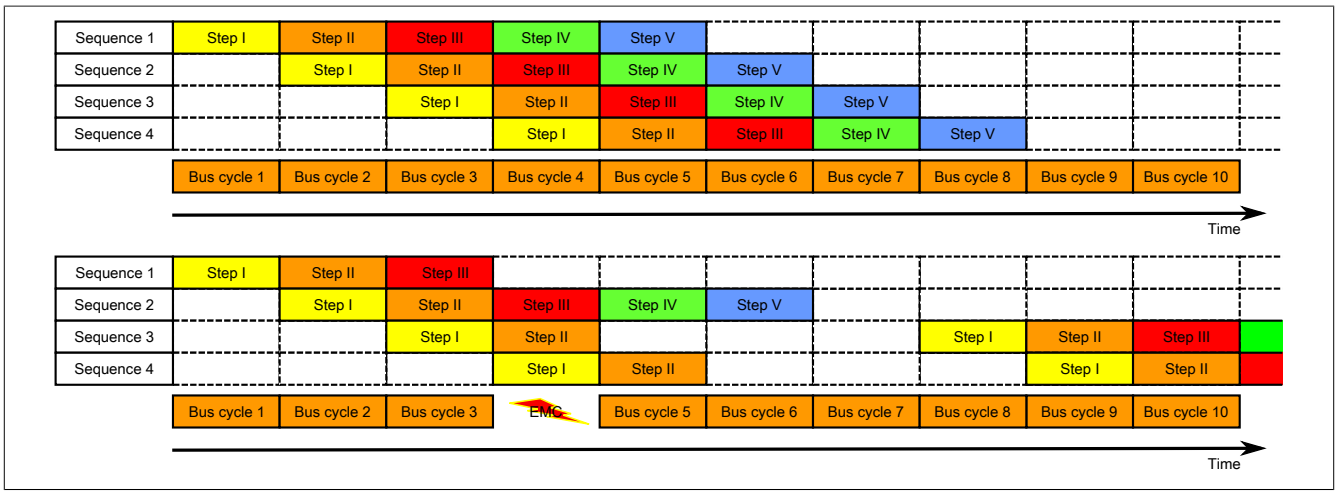


Figure 36: Effect of a lost bus cycle

Loss of acknowledgment

In sequence 1, the acknowledgment is lost due to disturbance. Sequences 1 and 2 are therefore acknowledged in Step V of sequence 2.

Loss of transmission

In sequence 3, the entire transmission is lost due to disturbance. The receiver stops and no longer sends back any acknowledgments.
The transmitting station continues transmitting until it has issued the maximum permissible number of unacknowledged transmissions.
5 bus cycles later at the earliest (depending on the configuration), it begins resending the unsuccessfully sent transmissions.