Redundancy for control systems
Possibilities and examples

Version: 1.16 (October 2019)
Model no.: MAREDSYS-ENG

Translation of the original documentation

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1 General information

The basic differentiation in terms of redundancy is made between controller and network redundancy. In the case of POWERLINK, network redundancy can either be executed as ring redundancy or as cable redundancy. A combination of controller and network redundancy maximizes protection against failures across the entire automation system.

**Information:**

In this document, the term "controller redundancy" will be used exclusively (synonymous with "CPU redundancy").

Aside from the use of controller and network redundancy for increasing operational safety, there is also the option of setting up the power supply for controller components with redundancy:

- In the X20 system, supply modules can be utilized with redundancy to safeguard X2X Link power supply and the supply of X20 standalone devices and X20 bus controllers.
- In the X67 system, the X67 system supply module with redundancy can be utilized to safeguard the X2X Link (see the X67 user's manual).
- The redundant power supply of I/O modules and their sensors/actuators is not possible through the redundant use of X20 power supply modules, but via power supply redundancy (see power supply data sheets).

1.1 Controller redundancy

B&R's redundant control solution ensures maximum availability for entire systems as well as individual machines. Controller redundancy allows data to be synchronized within microseconds, whereby max. 2 cycles pass when switching over to the other controller. This functionality is seamlessly integrated in the real-time operating system and easy to use. A second, identical X20 CPU is added to the existing control topology which is configured as redundant via software. An interface module (redundancy link module) handles data exchange completely automatically. Configuration and visualization remain the same for the user. Maximum machine availability really is only a mouse click away. Additional protection against failure is achieved by combining controller redundancy with network redundancy (ring or cable redundancy).
Controller redundancy offers the following advantages:

- Switchover times of max. 2 cycles
- Microsecond synchronization
- Seamlessly integrated
- X20 standard CPUs
- One-click configuration
- Bumpless software update
- Replace CPU without stopping machine

Note: For controller redundancy system requirements, see section Project management → Controller redundancy in Automation Help.

Controller redundancy without I/O systems

Redundant controllers can also be used purely as communication controllers without an I/O system.

If, in this case, POWERLINK masters (X20IF2181-2) should be configured, then they must be cabled together: otherwise, bumpless redundancy operation will not be achieved.

Licensing

**Information:**

It is important to note that a controller redundancy TG license (1TG10X0.1) is required for each controller (primary and secondary). The license must be located on the Technology Guard (dongle) that is connected to the CPUs.

If the necessary licenses are missing, a corresponding entry is made in the logbook. Blinking LEDs on the controller also indicate they are missing.

1.2 POWERLINK cable redundancy

With this type of network redundancy, two physically separate lines run through the plant. Each network node is connected to both lines via a link selector. If a cable error occurs, the system automatically switches to the line that is still functioning. This also allows the lines to be run over separate paths, as it is often specified for process technology. The manager redundancy capabilities of POWERLINK allow cable redundancy to be combined with controller redundancy, which ensures a redundancy solution that offers maximum machine and system availability.

POWERLINK cable redundancy offers the following advantages:

- Suitable for process and plant automation
- Seamlessly integrated
- X20 standard components
- Possible to replace components during runtime
- Separate line routing possible
1.3 POWERLINK ring redundancy

Ring redundancy is a simple and inexpensive form of network redundancy. Here, the POWERLINK devices are connected in a line, with the last unit connected back to the manager. Thus the ring is closed. The ring redundancy manager immediately registers any interruption at any point and then handles the data supply from both sides. This guarantees that communication to all nodes remains intact whenever an interruption occurs. The manager recognizes when the ring is closed again and responds accordingly, with data once again only being supplied from one side of the ring.

POWERLINK ring redundancy offers the following advantages:

- Simple design
- Seamlessly integrated
- X20 standard components
- Partial ring possible
- Can be combined with slip ring

Partial ring

A partial ring is when only a certain part of the topology is laid out as a redundant ring. Any type of standard topology, such as a star, tree or line, can branch off from the ring using a hub. The image above shows an example of a partial ring.

Combination with slip ring

Rotating applications, such as a turntable where rigid cable connections cannot be used and slip rings are required for bus and power connections, can be safeguarded through ring redundancy. Consisting of a static and a rotating component, a slip ring transmits a signal either via brushes or a capacitive coupling. Different types provide different numbers of channels. The redundant POWERLINK ring is run through the slip ring to incorporate the hub on the rotating part of the machine.
2 Hardware

**Important!**
Malfunction due to faulty wiring!
Suitable organizational measures (e.g. color coding of the cables and connectors on the device) can prevent wiring errors.

2.1 Overview of modules that can be used

Some B&R modules for creating redundant systems (controller / cable / ring redundancy):

<table>
<thead>
<tr>
<th>Standard module</th>
<th>Coated module</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller redundancy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X20CP3584</td>
<td>X20cCP3584</td>
<td>Controller redundancy is supported by the X20 CPUs listed on the left.</td>
</tr>
<tr>
<td>X20CP3585</td>
<td>-</td>
<td>Notes and constraints regarding controller redundancy:</td>
</tr>
<tr>
<td>X20CP3586</td>
<td>X20cCP3586</td>
<td>• Local I/Os cannot be used.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The X20IF10X0 redundancy link module needs to be in the first (left) slot of the rCPU.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The integrated POWERLINK interfaces are only supported when the redundant controllers are operated in Ethernet mode (TCP/UDP/IP). The X20IF2181-2 interface module must be used to connect redundant controllers to a POWERLINK network.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• NC Manager is currently not supported on redundant controllers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• X20SLLxx10 modules may not be used together with redundant controllers.</td>
</tr>
<tr>
<td>X20IF10X0</td>
<td>X20cIF10X0</td>
<td>Redundancy link module for synchronization of application data.</td>
</tr>
</tbody>
</table>

### General modules for setting up various network topologies

| X20HB8880 | X20cHB8880 | Modular X20 hub with up to 2 slots for hub expansion modules: |
| X20HB2880 | X20cHB2880 | • X20HB2880 / X20cHB2880 |
| | | • X20HB1881 |
| | | • X20HB2881 / X20cHB2881 |

### Modules for setting up redundant network topologies

| X20IF2181-2 | X20cIF2181-2 | 1x POWERLINK managing or controlled node; 2x Fast Ethernet RJ45 |
| X20HB8884 | X20cHB8884 | Depending on how it is configured, this module can be used as follows: |
| X20BC8084 | X20cBC8084 | |

### Passive hub expansion modules:

| X20HB2880 | X20cHB2880 | • X20HB2880 / X20cHB2880 |
| X20HB1881 | | • X20HB1881 |
| X20HB2881 / X20cHB2881 | | • X20HB2881 / X20cHB2881 |

### Active hub expansion modules:

| X20HB2885 | X20cHB2885 | • X20HB2885 / X20cHB2885 |
| X20HB2886 | X20cHB2886 | • X20HB2886 / X20cHB2886 |

### Bus controller with integrated link selector with up to 2 slots for hub expansion modules:

| X20HB1881 | |
| X20HB2885 / X20cHB2885 | |
| X20HB2886 / X20cHB2886 | |

| X20IF1082 | X20cIF1082-2 | 1x POWERLINK managing or controlled node; 2x Fast Ethernet RJ45 |

Depending on how it is configured, this module can be used as follows:

| X20HB1881 | |
| X20HB2885 / X20cHB2885 | |
| X20HB2886 / X20cHB2886 | |
2.2 Controller redundancy in various network topologies

Controller redundancy can be implemented with the following X20 CPUs:

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X20CP3584</td>
<td>X20 CPU, Atom 0.6 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included, order application memory separately!</td>
</tr>
<tr>
<td>X20CP3585</td>
<td>X20 CPU, Atom 1.0 GHz, 256 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included, order application memory separately!</td>
</tr>
<tr>
<td>X20CP3586</td>
<td>X20 CPU, Atom 1.6 GHz, 512 MB DDR2 RAM, 1 MB SRAM, removable application memory: CompactFlash, 3 insert slots for X20 interface modules, 2 USB interfaces, 1 RS232 interface, 1 Ethernet interface 10/100/1000BASE-T, 1 POWERLINK interface, including power supply module, 1x terminal block X20TB12, slot covers and X20 end cover plate X20AC0SR1 (right) included, order application memory separately!</td>
</tr>
</tbody>
</table>

Redundancy link module

Every redundant controller requires a redundancy link module in order to provide controller redundancy. This module is responsible for synchronizing the application data on both CPUs:

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X20IF10X0</td>
<td>X20 interface module, 1 redundancy link interface 1000BASE-SX, CPU-CPU data synchronization module for controller redundancy</td>
</tr>
</tbody>
</table>
POWERLINK interfaces

The X20IF2181-2 interface module is required in order to use redundant X20 CPUs in a POWERLINK network:

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X20IF2181-2</td>
<td>X20 interface module, 1x link selector for POWERLINK cable redundancy, POWERLINK functions: - Managing node - Controlled node for iCN operation - Redundant managing node for controller redundancy - Ring redundancy - 2x hub - Multi ASend - PRC function 2x RJ45</td>
</tr>
</tbody>
</table>

The interfaces integrated in the X20 CPUs are only supported when the redundant controllers are operated in Ethernet mode (TCP/UDP/IP).

### 2.2.1 Controller redundancy in a basic POWERLINK network

This takes care of the following error:

- Failure of one of the two redundant controllers

Note regarding X20IF2181-2 module configuration:

- Network redundancy mode must be set to "No network redundancy".
2.2.2 Controller redundancy in a POWERLINK ring

This takes care of the one of the following errors:

- Failure of one of the two redundant controllers (= interruption of ring)
- Interruption of ring caused by failed cable or failed node

Note regarding X20IF2181-2 module configuration:

- Network redundancy mode must be set to "Ring redundancy".

2.2.3 Controller redundancy in a system with POWERLINK cable redundancy

This takes care of the following errors:

- Failure of one of the two redundant controllers
- Interruption of one of the networks caused by failed cable, failed node or failed hub

Note regarding X20IF2181-2 module configuration:

- Network redundancy mode must be set to "Cable redundancy".
2.3 System with POWERLINK cable redundancy

Redundant network cabling is often essential to safe operation, especially in processing plants. The potential for danger, especially to the lines that run through the plant, can be disproportionately high in relation to the need to keep communication active in all operating situations. Redundant cabling and separate cable routing are effective ways to help reduce this risk.

POWERLINK cable redundancy is based on the principle of doubling the communication lines as well as providing continuous and simultaneous monitoring. A mechanism feeds data simultaneously into two cable lines. The same mechanisms are used to receive this data from the redundant network.

**Information:**

Networks 1 and 2 must always have the same topology and run parallel from a logical standpoint. The following characteristics of the two networks must be identical:

- Number of hubs
- Logical arrangement of hubs
- Cable lengths of the two networks
- Direction of telegram transfer

The double cabling used with POWERLINK cable redundancy makes it possible to bypass one or more errors on a network. At any given time, the errors must be isolated to only one of the two networks. Errors occurring on both networks at the same time can cause nodes to fail.

The following modules can be used to set up a POWERLINK network with cable redundancy:

- X20IF2181-2 interface module
- X20HB8884 compact link selector
- X20BC8084 bus controller

### 2.3.1 X20IF2181-2 - Interface module

Interface module X20IF2181-2 is used to connect X20 CPUs to a POWERLINK network with cable redundancy.

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X20IF2181-2</td>
<td>X20 interface module, 1x link selector for POWERLINK cable redundancy, POWERLINK functions: - Managing node - Controlled node for iCN operation - Redundant managing node for controller redundancy - Ring redundancy - 2x hub - Multi ASend - PRC function 2x RJ45</td>
</tr>
</tbody>
</table>

Examples of connecting a managing or controlled node to a POWERLINK network with cable redundancy:

Note regarding X20IF2181-2 module configuration:

- Network redundancy mode must be set to "Cable redundancy".
2.3.2 X20HB8884 - Compact link selector

Nodes can be connected to a POWERLINK cable redundancy system via the X20HB8884 compact link selector and hub expansion modules:

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X20HB8884</td>
<td>X20 compact link selector, 2x RJ45, order bus base, power supply module and terminal block separately.</td>
</tr>
<tr>
<td>X20HB2880</td>
<td>X20 hub expansion module, integrated 2-port hub, 2x RJ45</td>
</tr>
<tr>
<td>X20HB1881</td>
<td>X20 hub expansion module, integrated 1-port hub, for multimode fiber optic cable</td>
</tr>
<tr>
<td>X20HB2881</td>
<td>X20 hub expansion module, integrated 2-port hub, for fiber optic cable</td>
</tr>
<tr>
<td>X20HB2885</td>
<td>X20 hub expansion module, integrated active 2-port hub, 2x RJ45</td>
</tr>
<tr>
<td>X20HB2886</td>
<td>X20 hub expansion module, integrated active 2-port hub, 2 fiber optic interfaces</td>
</tr>
</tbody>
</table>

Information:
When using X20HB2881 or X20HB2886 modules, observe the derating requirements for the operating temperature (see data sheet)!

Operating principle

N1/N2 are connected to cable-redundant network segment. In contrast, Nx can only be used to branch off or connect to a non-redundant network segment.

2.3.2.1 X20HB8884 with passive hub expansion modules

This section contains examples of how an X20HB8884 compact link selector and passive hub expansion modules can be used to connect individual nodes to a POWERLINK network with cable redundancy:

X20HB8884 with passive hub expansion module X20HB2880
X20HB8884 with passive hub expansion module X20HB2881

X20HB8884 with X20HB1881 passive hub expansion modules
2.3.2.2 X20HB8884 with active hub expansion modules

This section contains examples of how an X20HB8884 compact link selector and active hub expansion modules can be used to connect individual nodes to a POWERLINK network with cable redundancy:

**X20HB8884 with X20HB2885 or X20HB2886 active hub expansion modules**

![Diagram of X20HB8884 with X20HB2885 or X20HB2886 active hub expansion modules]

**X20HB8884 with X20HB2885 and X20HB2886 active hub expansion modules**

![Diagram of X20HB8884 with X20HB2885 and X20HB2886 active hub expansion modules]
2.3.3 X20BC8084 - Bus controller with integrated link selector

The X20BC8084 bus controller with built-in link selector and active hub expansion modules can be used to connect remote I/O nodes to a POWERLINK network with cable redundancy:

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X20BC8084</td>
<td>X20 bus controller, 1 POWERLINK interface, 1x link selector for POWERLINK cable redundancy, supports expansion with active X20 hub modules, 2 RJ45, order bus base, power supply module and terminal block separately.</td>
</tr>
<tr>
<td>X20HB1881</td>
<td>X20 hub expansion module, integrated 1-port hub, for multimode fiber optic cable</td>
</tr>
<tr>
<td>X20HB2885</td>
<td>X20 hub expansion module, integrated active 2-port hub, 2x RJ45</td>
</tr>
<tr>
<td>X20HB2886</td>
<td>X20 hub expansion module, integrated active 2-port hub, 2 fiber optic interfaces</td>
</tr>
</tbody>
</table>

*) The X20HB1881 hub expansion module can be operated on the X20BC8084 bus controller with hardware revision >D0.

Information:

When using the X20HB2886 module, observe the derating requirements for the operating temperature (see the corresponding data sheet)!

Operating principle

N1/N2 are connected to cable-redundant network segment.

2.3.3.1 X20BC8084 in combination with Cu cable
The X20BC8084 bus controller can be used to create a cable-redundant branch to a network node.

When connecting two X20BC8084 bus controllers with only one network cable, keep the following in mind:

- Interruption between network 2 and managing node
  - This node is no longer connected to the network
  - Via N1, this node is still connected to the network
2.3.3.2 X20BC8084 in combination fiber optic cable

*) The X20HB1881 hub expansion module can be operated on the X20BC8084 bus controller with hardware revision >D0.
2.3.3.3 X20BC8084 in combination with different transmission media

POWERLINK network 1
POWERLINK network 2
PSBC8084
RJ45
RJ45
...
X20 modules

POWERLINK network 2
POWERLINK network 1
HB2885
RJ45
RJ45
Hub
HB2885
RJ45
RJ45
Hub
HB2886
FO
FO
Hub
HB2886
FO
FO
Hub
N1
N2
N1
N2

2.4 POWERLINK ring redundancy

General information

When using POWERLINK ring redundancy, multiple nodes are connected in a ring. The ring manager must be located within the ring. During normal operation, the ring manager checks the integrity of the ring. In order to keep packets from being circulated endlessly around the ring, the ring manager does not forward them on.

If a node or cable fails, then the test packets sent from one of the ring manager’s connections are not received on its other connection. From that point on, the ring manager sends packets in both directions.

Diagram of a ring topology

Information on ring topologies

Notes regarding operation:

• The IF module used must be configured for ring redundancy.
• The managing node (ring manager) must be a station in the ring.
• Poll-response chaining (PRC) is currently only possible within the ring and only when using interface module X20IF2181-2 as the ring manager. PRC does not work for nodes that are connected to the ring via a hub (such as nodes 10 and 11 in the figure "Diagram of a ring topology" above).
• Combining dynamic node allocation (DNA) and ring redundancy is not possible.
• Both transfer directions must be taken into account when calculating the response time.
Notes regarding potential errors:

- The network is protected against interruptions caused by cable failure within the ring, and this will not cause any nodes to fail.
- If a node in the ring fails, the other nodes will continue to be supplied with data.
- In the example above, if the hub fails, then Node 10 and any subsequent nodes will be disconnected from the network.
- If the ring is interrupted in two places, then all nodes in between will be disconnected from the network.

POWERLINK ring redundancy combined with controller redundancy

- See "Controller redundancy in a POWERLINK ring" on page 9.

Interface module as managing node

The following interface modules can be used as managing nodes (ring managers):

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X20IF1082</td>
<td>X20 interface module, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function</td>
</tr>
<tr>
<td>X20IF1082-2</td>
<td>X20 interface module, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function PRC function</td>
</tr>
<tr>
<td>X20IF2181-2</td>
<td>X20 interface module, 1x link selector for POWERLINK cable redundancy, POWERLINK functions: Managing node - Controlled node for iCN operation - Redundant managing node for controller redundancy - Ring redundancy - 2x hub - Multi ASend - PRC function 2x RJ45</td>
</tr>
<tr>
<td>5LS182.6-1</td>
<td>Logic scanner, PCI half-size module, 1 POWERLINK (V1/V2) interface, managing or controlled node, integrated 2-port hub, ring redundancy function, 1 MB SRAM (Automation Runtime), order 1x TB704 terminal block separately</td>
</tr>
<tr>
<td>5LS182.6-2</td>
<td>Logic scanner, PCI half-size module, 1 POWERLINK (V1/V2) interface, managing or controlled node, integrated 2-port hub, ring redundancy function, PRC function, 1 MB SRAM (Automation Runtime), order 1x TB704 terminal block separately</td>
</tr>
</tbody>
</table>

Additionally, any other manager that has a 2-port hub and supports ring redundancy can be used.

2.4.1 Controlled node in a ring
Interface modules

The following interface modules can be used as a network interface within a ring in a controlled node:

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X20IF1082</td>
<td>X20 interface module, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function</td>
</tr>
<tr>
<td>X20IF1082-2</td>
<td>X20 interface module, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function</td>
</tr>
<tr>
<td>X20IF2181-2</td>
<td>X20 interface module, 1x link selector for POWERLINK cable redundancy, POWERLINK functions: - Managing node - Controlled node for iCN operation - Redundant managing node for controller redundancy - Ring redundancy - 2x hub - Multi ASEND - PRC function 2x RJ45</td>
</tr>
<tr>
<td>SLS182.6-1</td>
<td>Logic scanner, PCI half-size module, 1 POWERLINK (V1/V2) interface, managing or controlled node, integrated 2-port hub, ring redundancy function, 1 MB SRAM (Automation Runtime), order 1x TB704 terminal block separately</td>
</tr>
<tr>
<td>SLS182.6-2</td>
<td>Logic scanner, PCI half-size module, 1 POWERLINK (V1/V2) interface, managing or controlled node, integrated 2-port hub, ring redundancy function, PRC function, 1 MB SRAM (Automation Runtime), order 1x TB704 terminal block separately</td>
</tr>
</tbody>
</table>

Note regarding interface module configuration:

- Network redundancy mode must be set to "No network redundancy".
- Note: In Automation Studio, the network redundancy mode "Ring redundancy" is not available for selection when a module is in "Controlled node" mode.

Additionally, any other manager that has a 2-port hub can be used.

2.4.2 X20 bus controller as a node in a ring

X20 - Bus controller

The following X20 bus controllers can be used as a controlled node in a POWERLINK ring:

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X20BC0083</td>
<td>X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, 2x RJ45, bus base, order power supply module and terminal block separately!</td>
</tr>
<tr>
<td>X20BC1083</td>
<td>X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, supports X20 interface module expansions, 2 RJ45, order bus base, power supply module and terminal block separately</td>
</tr>
<tr>
<td>X20BC8083</td>
<td>X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, supports expansion with X20 hub modules, 2 RJ45, order bus base, power supply module and terminal block separately</td>
</tr>
</tbody>
</table>

Hub expansion module for X20BC8083

Bus controller X20BC8083 with 2-port hub can be extended up to a 6-port hub with the following hub expansion module:

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X20HB2880</td>
<td>X20 hub expansion module, integrated 2-port hub, 2x RJ45</td>
</tr>
</tbody>
</table>

Information:

Modules X20HB1881, X20HB2881 and X20HB1882 are not suitable for POWERLINK ring redundancy applications.
Example with X20BC8083 and 2x X20HB2880 with hub expansion modules

![POWERLINK ring diagram](image)

### 2.4.3 Other devices as nodes in a ring

The following X67 bus controllers with POWERLINK interfaces have a 2-port hub:

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X67BC81RT.L12</td>
<td>X67 bus controller, 2 POWERLINK interfaces, X2X Link power supply 15 W, reACTION Technology module, 2 digital inputs, 24 VDC, &lt; 1 µs, configurable as inputs or outputs, 2 digital channels, 24 VDC, 0.4 A, &lt; 1 µs, configurable as inputs or outputs, 2 analog inputs ±10 V, 5 µs 200 kHz sampling frequency, 13-bit converter resolution (including sign), configurable input filter, 1 analog output ±10 V, 2.5 µs, 13-bit converter resolution (including sign), M12 connectors, high-density module</td>
</tr>
<tr>
<td>X67BC8321.L12</td>
<td>X67 bus controller, 1 POWERLINK interface, X2X Link power supply 15 W, 16 digital channels configurable as inputs or outputs, 24 VDC, 0.5 A, configurable input filter, 2 event counters 50 kHz, M12 connectors, high-density module</td>
</tr>
<tr>
<td>X67BC8513.L12</td>
<td>X67 bus controller, 1 POWERLINK interface, X2X Link power supply 15 W, 12 digital channels configurable as inputs or outputs, 24 VDC, 0.5 A, configurable input filter, 1 event counters 50 kHz, 1 analog input 0 to 20 mA, 12-bit, M12 connectors, high-density module</td>
</tr>
</tbody>
</table>

Additionally, any other device with a POWERLINK interface (with a 2-port hub) can be operated in a POWERLINK ring.
Hardware

2.5 Hubs for POWERLINK networks

2.5.1 8-port industrial hub (layer 2)

The following B&R products can be used as a hub in an Ethernet network (e.g. POWERLINK network):

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0AC808.9-1</td>
<td>8-port industrial hub (layer 2), 24 VDC, 10/100 Mbit/s with autonegotiation, automatic MDIX, order TB704 terminal block separately!</td>
</tr>
</tbody>
</table>

2.5.2 Modular X20 Ethernet hub

The following X20 modules can be used to create a modular hubs with 2-6 ports:

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X20HB8880</td>
<td>X20 base hub module, integrated 2-port hub, 2x RJ45</td>
</tr>
<tr>
<td>X20HB2880</td>
<td>X20 hub expansion module, integrated 2-port hub, 2x RJ45</td>
</tr>
<tr>
<td>X20HB2881</td>
<td>X20 hub expansion module, integrated 2-port hub, for fiber optic cable</td>
</tr>
<tr>
<td>X20HB1881</td>
<td>X20 hub expansion module, integrated 1-port hub, for multimode fiber optic cable</td>
</tr>
</tbody>
</table>

**Information:**

When using the X20HB2881 module, observe the derating requirements for the operating temperature (see the corresponding data sheet)!

2.5.2.1 X20HB8880 with X20HB2880

Options for combining an X20HB8880 base hub module with RJ45 hub expansion modules:

<table>
<thead>
<tr>
<th>Hub configuration</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-port hub</td>
<td>6x RJ45</td>
</tr>
<tr>
<td>4-port hub</td>
<td>4x RJ45</td>
</tr>
<tr>
<td>2-port hub</td>
<td>2x RJ45</td>
</tr>
</tbody>
</table>

*) With Hardware Revision H0 or higher, the X20HB8880 base hub module can be operated independently (without hub expansion module).
2.5.2.2 X20HB8880 with X20HB2881 and X20HB1881

Options for combining the X20HB8880 base hub module with fiber optic hub expansion modules:

![Diagram showing combinations of X20HB8880, X20HB2881, and X20HB1881 modules]

2.5.2.3 X20HB8880 with X20HB2880, X20HB2881 and X20HB1881

Options for combining the X20HB8880 base hub module with RJ45 and fiber optic hub expansion modules:

![Diagram showing combinations of X20HB8880, X20HB2880, X20HB2881, and X20HB1881 modules]
2.6 Redundant supply of controller components

This section will describe redundant X2X Link power supply and the redundant supply of the following components:

- X20 hub base module with additional hub expansion modules
- X20 compact link selector with additional hub expansion modules
- X20 bus controller with additional expansion modules

A redundant use of X20 power supply modules for I/O power supply is not possible. Additionally, the non-redundant supply is also documented in this section for your information.

2.6.1 Non-redundant supply of X20 standalone devices

The X20PS8002 supply module may be used exclusively for the non-redundant supply of X20 stand-alone devices.

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X20PS8002</td>
<td>X20 power supply module for standalone hub and compact link selector</td>
</tr>
</tbody>
</table>

X20 standalone devices include the following products:

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X20HB8880</td>
<td>X20 base hub module, integrated 2-port hub, 2x RJ45</td>
</tr>
<tr>
<td>X20HB8884</td>
<td>X20 compact link selector, 2x RJ45, order bus base, power supply module and terminal block separately</td>
</tr>
</tbody>
</table>

2.6.1.1 X20HB8880: Non-redundant supply

An appropriate X20 bus base must be selected depending on how many hub expansion modules\(^1\) are being operated on the X20HB8880:

\[\text{Diagram showing X20 bus base configuration for X20HB8880} \]

2.6.1.2 X20HB8884: Non-redundant supply

An appropriate X20 bus base must be selected depending on how many hub expansion modules\(^2\) are being operated on the X20HB8884:

\[\text{Diagram showing X20 bus base configuration for X20HB8884} \]

---

\(^1\) For hub expansion modules permitted on the X20HB8880, see "Modular X20 Ethernet hub" on page 22.
\(^2\) For hub expansion modules permitted on the X20BC8084, see "X20HB8884 - Compact link selector" on page 11.
2.6.1.3 Wiring

A detailed description and technical data for the X20PS8002 can be found on the data sheet.

2.6.2 Redundant supply of X20 standalone devices

2 supply modules (1x X20PS9400 and 1x X20PS33x0) are required for the redundant supply of X20 standalone devices:

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X20PS9400</td>
<td>X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply</td>
</tr>
<tr>
<td>X20PS3300</td>
<td>X20 power supply module, for X2X Link and internal I/O power supply</td>
</tr>
<tr>
<td>X20PS3310</td>
<td>X20 power supply module, for X2X Link and internal I/O power supply, integrated microfuse</td>
</tr>
</tbody>
</table>

X20 standalone devices include the following products:

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X20HB8880</td>
<td>X20 base hub module, integrated 2-port hub, 2x RJ45</td>
</tr>
<tr>
<td>X20HB8884</td>
<td>X20 compact link selector, 2x RJ45, order bus base, power supply module and terminal block separately.</td>
</tr>
</tbody>
</table>

2.6.2.1 X20HB8880: Redundant supply

An appropriate X20 bus base must be selected depending on how many hub expansion modules\(^3\) are being operated on the X20HB8880:

\(^3\) For hub expansion modules permitted on the X20HB8880, see "Modular X20 Ethernet hub" on page 22.
2.6.2.2 X20HB8884: Redundant supply

An appropriate X20 bus base must be selected depending on how many hub expansion modules\(^4\) are being operated on the X20HB8884:

![Diagram showing redundant supply configuration]

2.6.2.3 Wiring

A detailed description of the supply module and related technical data can be found in the corresponding data sheet.

![Diagram showing wiring configuration]

1) The jumpers are required for the correct operation of Error LEDs of the two supply modules.

---

\(^4\) For hub expansion modules permitted on the X20BC8084, see "X20HB8884 - Compact link selector" on page 11.
2.6.3 Non-redundant supply of X20 bus controllers

One of the following supply modules can be used for the non-redundant supply of X20 bus controllers:

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X20PS9400</td>
<td>X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply</td>
</tr>
<tr>
<td>X20PS9402</td>
<td>X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated</td>
</tr>
</tbody>
</table>

X20 POWERLINK bus controller:

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X20BC0083</td>
<td>X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, 2x RJ45, bus base, order power supply module and terminal block separately!</td>
</tr>
<tr>
<td>X20BC1083</td>
<td>X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, supports X20 interface module expansions, 2 RJ45, order bus base, power supply module and terminal block separately</td>
</tr>
<tr>
<td>X20BC6083</td>
<td>X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, supports expansion with X20 hub modules, 2 RJ45, order bus base, power supply module and terminal block separately</td>
</tr>
<tr>
<td>X20BC6084</td>
<td>X20 bus controller, 1 POWERLINK interface, 1x link selector for POWERLINK cable redundancy, supports expansion with active X20 hub modules, 2 RJ45, order bus base, power supply module and terminal block separately</td>
</tr>
</tbody>
</table>

The power supply of X2X Link and bus controllers including expansion modules described in this section can also be used for other X20 bus controllers that are operated on a BB80, BB81 or BB82 X20 bus base.

2.6.3.1 X20BC8084: Non-redundant supply

An appropriate X20 bus base must be selected depending on how many hub expansion modules\(^5\) are being operated on the X20BC8084:

---

\(^5\) For hub expansion modules permitted on the X20BC8084, see "X20BC8084 - Bus controller with integrated link selector" on page 14.
2.6.3.2 Wiring

A detailed description and technical data for the X20PS940x can be found on the data sheet.

**Variant 1**

![Variant 1 Diagram]

**Variant 2**

![Variant 2 Diagram]
Variant 3

1) The jumper is required for X2X Link power supply via the X20PS940x supply module.
2.6.4 Redundant supply of X20 bus controllers

Information:

Only the supply of the bus controllers and the X2X Link can be executed with redundancy.

The redundant use of supply modules for I/O power supply is not possible.

Two power supply modules (1x X20PS9400 and 1x X20PS33x0) are required for the redundant supply of X20 bus controllers:

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X20PS9400</td>
<td>X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply</td>
</tr>
<tr>
<td>X20PS3300</td>
<td>X20 power supply module, for X2X Link and internal I/O power supply</td>
</tr>
<tr>
<td>X20PS3310</td>
<td>X20 power supply module, for X2X Link and internal I/O power supply, integrated microfuse</td>
</tr>
</tbody>
</table>

X20 POWERLINK bus controller:

<table>
<thead>
<tr>
<th>Model number</th>
<th>Short description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X20BC0083</td>
<td>X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, 2x RJ45, bus base, order power supply module and terminal block separately!</td>
</tr>
<tr>
<td>X20BC1083</td>
<td>X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, supports X20 interface module expansions, 2 RJ45, order bus base, power supply module and terminal block separately</td>
</tr>
<tr>
<td>X20BC6083</td>
<td>X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, supports expansion with X20 hub modules, 2 RJ45, order bus base, power supply module and terminal block separately</td>
</tr>
<tr>
<td>X20BC6084</td>
<td>X20 bus controller, 1 POWERLINK interface, 1x link selector for POWERLINK cable redundancy, supports expansion with active X20 hub modules, 2 RJ45, order bus base, power supply module and terminal block separately</td>
</tr>
</tbody>
</table>

The power supply of X2X Link and bus controllers including expansion modules described in this section can also be used for other X20 bus controllers that are operated on a BB80, BB81 or BB82 X20 bus base.

2.6.4.1 X20BC8084: Redundant supply

An appropriate X20 bus base must be selected depending on how many hub expansion modules are being operated on the X20BC8084:

---

6) For hub expansion modules permitted on the X20BC8084, see "X20BC8084 - Bus controller with integrated link selector" on page 14.
2.6.4.2 Wiring

A detailed description of the supply module and related technical data can be found in the corresponding data sheet.

**Variant 1**

![Diagram of Variant 1]

1) The jumper is required for the correct operation of the error LED of the X20PS9400 supply module.
2) The external fuse is only required when using the X20PS3300 A fuse is integrated into the X20PS3310 supply module.

**Variant 2**

![Diagram of Variant 2]

1) The jumper is required for the correct operation of the error LED of the X20PS9400 supply module.
2) The external fuse is only required when using the X20PS3300 A fuse is integrated into the X20PS3310 supply module.
1) Jumper 1 is required for the correct operation of the error LED of the X20PS9400 supply module.
2) Jumper 2 is required for X2X Link power supply via the X20PS33x0 supply module.
3) The external fuse is only required when using the X20PS3300 A fuse is integrated into the X20PS3310 supply module.
3 Problematic cases

This section documents a number of problematic cases that should be kept in mind when designing a network topology.

Well-planned wiring prevents malfunctions:

**Important!**

- Malfunction due to faulty wiring!
- Suitable organizational measures (e.g. color coding of the cables and connectors on the device) can prevent wiring errors.

### 3.1 Cable redundancy in a ring topology

In the following example, two X20 CPUs are providing controller redundancy. The two X20 CPUs are located on the POWERLINK network which is set up in a ring topology. Some segments of the network utilize cable redundancy. Although this topology would function in theory, it is not permitted:

In the case of the error shown, (Network 1 and Network 2 interrupted at two different locations), the ring manager would detect the interruption of the ring and send data on both POWERLINK interfaces.

Were this to happen, not only a limited number of nodes would fail. Under certain conditions, the entire POWERLINK network might fail.

**Warning!**

- It is not permitted to set up segments of a POWERLINK ring topology with cable redundancy.
The same problem occurs even if controller redundancy is not used.

3.2 Multiple errors in a network with cable redundancy

In a network with cable redundancy, certain errors may result in the failure of one or more nodes:

Due to the two interruptions, the marked network cables are no longer carrying data. As a result, 2 nodes are separated from the network.

**Warning!**

Redundant networks only serve their intended purpose when the entire network is monitored constantly and corrective measures are taken promptly in the event of an error.
3.3 Multiple errors in a ring topology

In a ring topology, multiple errors can result in the failure of individual nodes or entire network segments:
4 Topologies

The previous sections described the basic usage of the hardware and how it can be implemented in individual cases. This section contains more in-depth examples for topologies.

4.1 Cable redundancy with redundant managing node connection

![Diagram of cable redundancy with redundant managing node connection]

Key:
- Network 1
- Network 2
- Non-redundant network
4.2 Cable redundancy with non-redundant managing node connection

Key:
- Network 1
- Network 2
- Non-redundant network

X20CP158x (managing node)  
X20HB8884 with 2x X20HB2885  
POWERLINK Network 1  
X20BC8084 with 2x X20HB2885  
X20HB8884 with 2x X20HB2885  
X20BC8084 with 2x X20HB2885  
X20HB8884 with 1x X20HB2880  
X67BC8321-1

Powerlink Network 1  
Powerlink Network 2

Motion control
ACOPOSmulti

Motion control
ACOPOSinverter P84
4.3 Controller redundancy combined with cable redundancy I

Key:
- Redundancy link
- Network 1
- Network 2
- Non-redundant network

Controller redundancy
- X20CP3586
- X20IF10X0
- X20IF2181-2

Redundant controller (managing node)

Hub for Network 1
- X20HB8880
- X20HB2880
- X20HB1881

Hub for Network 2
- X20HB8880
- X20HB2880
- X20HB1881

Compact link selector
- X20HB8884
- X20HB2880

Compact link selector with FO connections
- X20HB8884
- 2x X20HB1881

Fiber optic cable
4.4 Controller redundancy combined with cable redundancy II

Legend:
- Redundancy link
- Network 1
- Network 2
- Non-redundant network
4.5 Controller redundancy combined with ring and cable redundancy

Legend:
- Redundancy link
- Ring topology
- Redundant fiber optic network
- Non-redundant network

Ring topology

Controller redundancy
X20CP3585
X20IF10X0
X20IF2181-2

Fiber optic cable (redundant)

Controller redundancy (managing nodes)

Redundant controllers

Remote I/Os:
X20BC0083
+ PS and various I/Os

Remote I/Os:
X20BC1083
+ PS and various I/Os

Hub:
1x X20HB8880
2x X20HB2880

Remote I/Os:
X20BC0083
+ PS and various I/Os

Compact link selector:
1x X20HB8884
2x X20HB2886

Remote I/Os:
X20BC0083
+ PS and various I/Os

Legend:
- Redundancy link
- Ring topology
- Redundant fiber optic network
- Non-redundant network
4.6 Controller redundancy combined with double ring redundancy

The application must include logic to determine which network ring is used as the active ring.

Instead of the two X20IF2181-2 interface modules, it is also possible to use other interface modules that support ring redundancy (e.g.: X20IF1082-2). It is recommended to use two identical interface modules within a controlled node.
## Appendix A

### A.1 Overview of hardware revisions

<table>
<thead>
<tr>
<th>Model number</th>
<th>Ring redundancy(^1)</th>
<th>Cable redundancy</th>
<th>Controller redundancy(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>X20 system</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X20BC0083</td>
<td>≥K0</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>X20BC0083</td>
<td>≥K0</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>X20BC0883</td>
<td>≥K0</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>X20BC0883</td>
<td>≥K0</td>
<td>x</td>
<td></td>
</tr>
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<td>X20BC0884</td>
<td>x</td>
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<td>X20BC1083</td>
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<td>&gt;F0</td>
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<td>X20HB2880</td>
<td>&gt;F0</td>
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<td>X20HB2881</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>X20HB2885</td>
<td>&gt;G0</td>
<td>x</td>
<td></td>
</tr>
<tr>
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<td>&gt;G0</td>
<td>x</td>
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<td></td>
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<td>X20HB8815</td>
<td>≥F0</td>
<td>x</td>
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<td>X20HB8880</td>
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<td>X20HB8884</td>
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<td>X20IF1082</td>
<td>≥F0</td>
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<tr>
<td>X20IF1082-2</td>
<td>≥F0</td>
<td>x(^2)</td>
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<tr>
<td>X20IF1082-2</td>
<td>≥D0</td>
<td>x(^2)</td>
<td></td>
</tr>
<tr>
<td>X20IF2181-2</td>
<td>≥D0</td>
<td>x</td>
<td></td>
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<tr>
<td>X20IF2181-2</td>
<td>≥D0</td>
<td>x</td>
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<tr>
<td><strong>X67 system</strong></td>
<td></td>
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<tr>
<td>X67BC8321.L12</td>
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<td>X67BC81RT.L12</td>
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<td><strong>Safety</strong></td>
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<td>X20SL8100</td>
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<tr>
<td>X20SL8110</td>
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</tr>
<tr>
<td><strong>Logic scanners</strong></td>
<td></td>
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<tr>
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1) For ring redundancy, the latest firmware must always be used due to continuous product improvements.
2) Controlled node only (managing node not supported)