

# **Redundancy for control systems**

## **Implementation possibilities and examples**

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# 1 General information

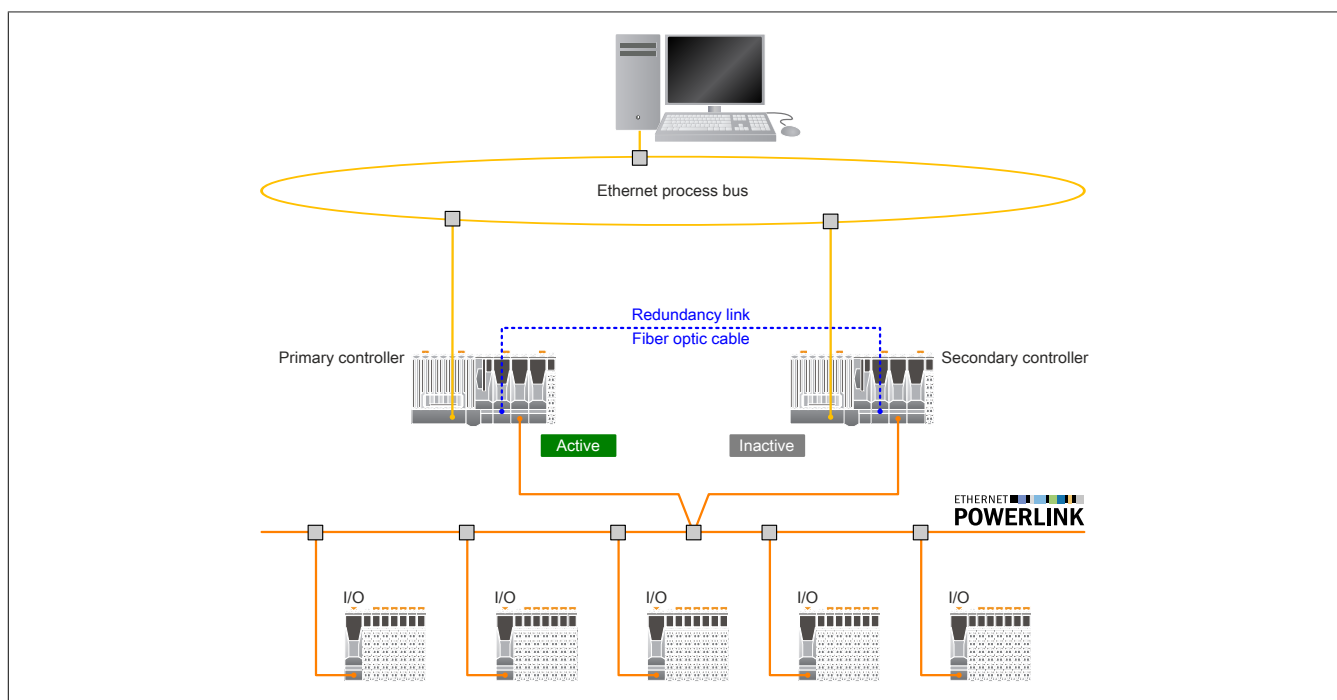
The basic differentiation in terms of redundancy is made between controller and network redundancy. In the case of POWERLINK, network redundancy can either be executed as ring redundancy or as cable redundancy. A combination of controller and network redundancy maximizes protection against failures across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

**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

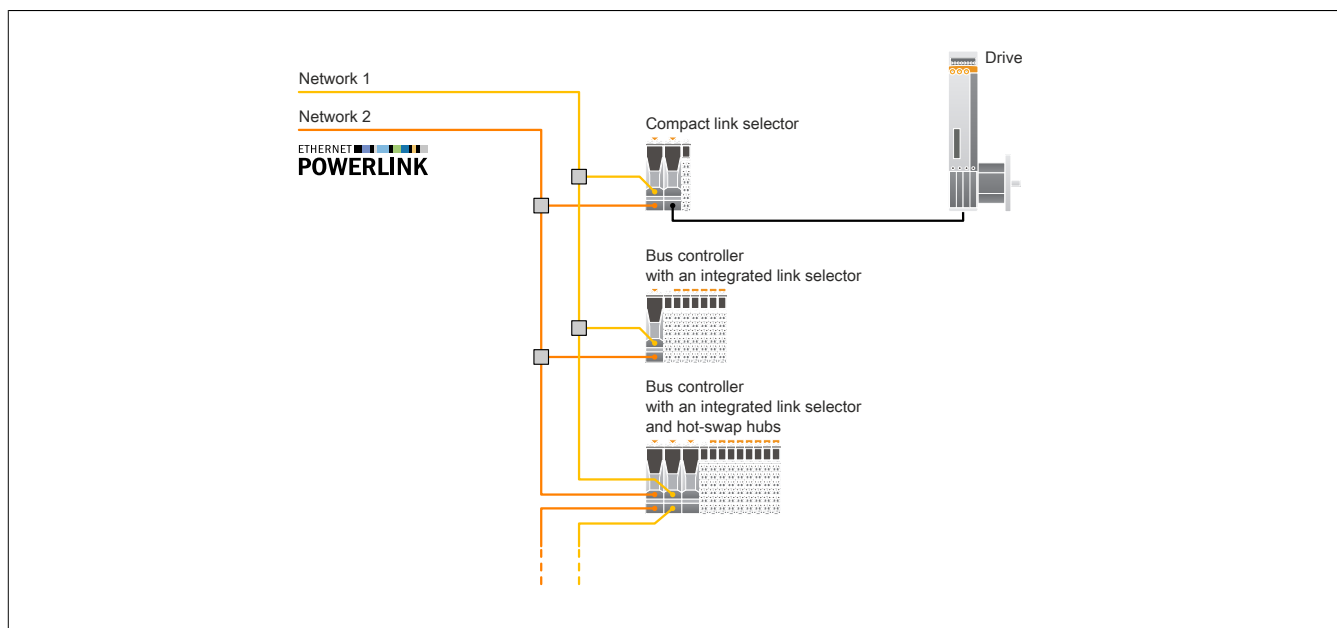
Note: For controller redundancy system requirements, see section *Project management* → *Controller redundancy* in Automation Help.

### 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.

## 1.2 POWERLINK cable redundancy

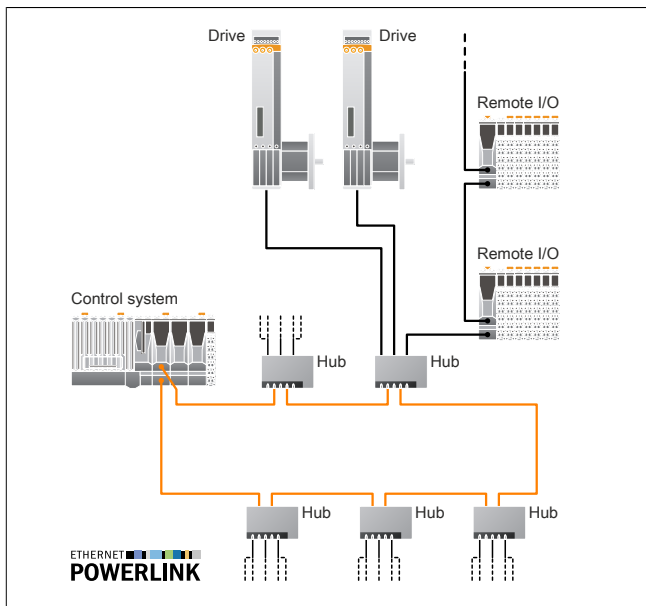


With this type of network redundancy, two physically separate lines run through the plant. Each network node is connected to both lines via a link selector. If a cable error occurs, the system automatically switches to the line that is still functioning. This also allows the lines to be run over separate 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:

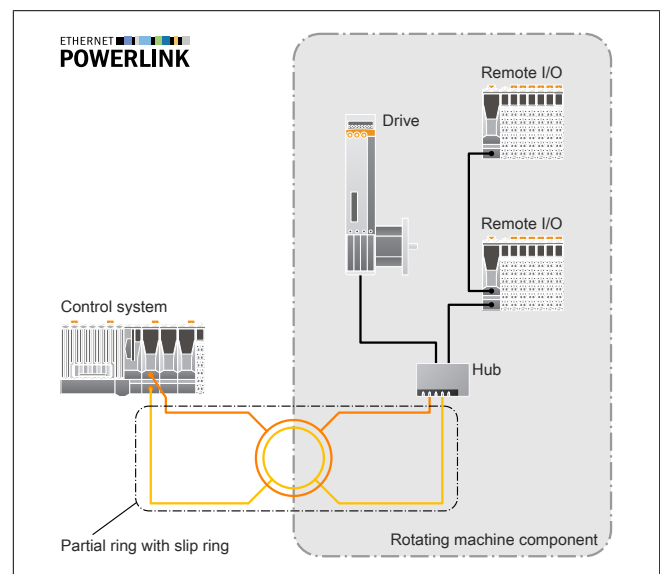
- Simple design
- Seamlessly integrated
- X20 standard components
- Partial ring possible
- Can be combined with slip ring

#### 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

### 2.1 Overview of modules that can be used

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

Standard module	Coated module	Notes
Controller redundancy <sup>1)</sup>		
X20CP3584	X20cCP3584	Controller redundancy is supported by the X20 CPUs listed on the left. Notes and constraints regarding controller redundancy: <ul style="list-style-type: none"><li>Local I/Os cannot be used.</li><li>The X20IF10X0 redundancy link module needs to be in the first (left) slot of the rCPU.</li><li>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.</li><li>NC Manager is currently not supported on redundant controllers.</li><li>X20SLXx10 modules may not be used together with redundant controllers.</li></ul>
X20CP3585	-	
X20CP3586	X20cCP3586	
X20IF10X0	X20cIF10X0	Redundancy link module for synchronization of application data.
General modules for setting up various network topologies		
X20HB8880	X20cHB8880	Modular X20 hub with up to 2 slots for hub expansion modules: <ul style="list-style-type: none"><li>X20HB2880 / X20cHB2880</li><li>X20HB1881</li><li>X20HB2881 / X20cHB2881</li></ul>
X20HB2880	X20cHB2880	Hub expansion module: 2x Fast Ethernet RJ45
X20HB1881	-	Hub expansion module: 1x Fast Ethernet fiber optic connection
X20HB2881	X20cHB2881	Hub expansion module: 2x Fast Ethernet fiber optic connections
OAC808.9-1	-	8-port industrial hub (layer 2)
Modules for setting up redundant network topologies		
X20IF2181-2	X20cIF2181-2	1x POWERLINK managing or controlled node: 2x Fast Ethernet RJ45 Depending on how it is configured, this module can be used as follows: <ul style="list-style-type: none"><li>in a system with POWERLINK cable redundancy</li><li>in a POWERLINK ring</li><li>in a basic POWERLINK network</li></ul>
X20HB8884	X20cHB8884	POWERLINK compact link selector with up to 2 slots for hub expansion modules: Passive hub expansion modules: <ul style="list-style-type: none"><li>X20HB2880 / X20cHB2880</li><li>X20HB1881</li><li>X20HB2881 / X20cHB2881</li></ul> Active hub expansion modules: <ul style="list-style-type: none"><li>X20HB2885 / X20cHB2885</li><li>X20HB2886 / X20cHB2886</li></ul>
X20BC8084	X20cBC8084	Bus controller with integrated link selector with up to 2 slots for hub expansion modules: <ul style="list-style-type: none"><li>X20HB1881<sup>2)</sup></li><li>X20HB2885 / X20cHB2885</li><li>X20HB2886 / X20cHB2886</li></ul>
X20HB2885	X20cHB2885	Active hub expansion module: 2x Fast Ethernet RJ45
X20HB2886	X20cHB2886	Active hub expansion module: 2x Fast Ethernet fiber optic connections
X20IF1082	-	1x POWERLINK managing or controlled node: 2x Fast Ethernet RJ45 Depending on how it is configured, this module can be used as follows: <ul style="list-style-type: none"><li>in a POWERLINK ring</li><li>in a basic POWERLINK network</li></ul>
X20IF1082-2	X20cIF1082-2	
Modules for setting up non-redundant network topologies		
X20BC8083	X20cBC8083	Bus controller: POWERLINK controlled node with up to 2 slots for hub expansion modules: <ul style="list-style-type: none"><li>X20HB2880 / X20cHB2880</li><li>X20HB1881</li><li>X20HB2881 / X20cHB2881</li></ul>
Additional B&R products		
The above list is only an excerpt can be expanded by other devices: <ul style="list-style-type: none"><li>Any device with 2 POWERLINK interfaces and an internal hub can be directly integrated (with no additional hub) into a line or ring topology (e.g.: X20BC0083, X20BC1083, SafeLOGIC X20SL81xx).</li><li>Power Panel 500 and Automation PC 510/511 devices equipped with an interface module (such as the 5PP5IF.FPLM-00 interface board) can also be used as a managing node in a ring topology.</li><li>All POWERLINK components can be used as nodes in a POWERLINK network, regardless of whether or not controller redundancy is involved.</li></ul>		

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

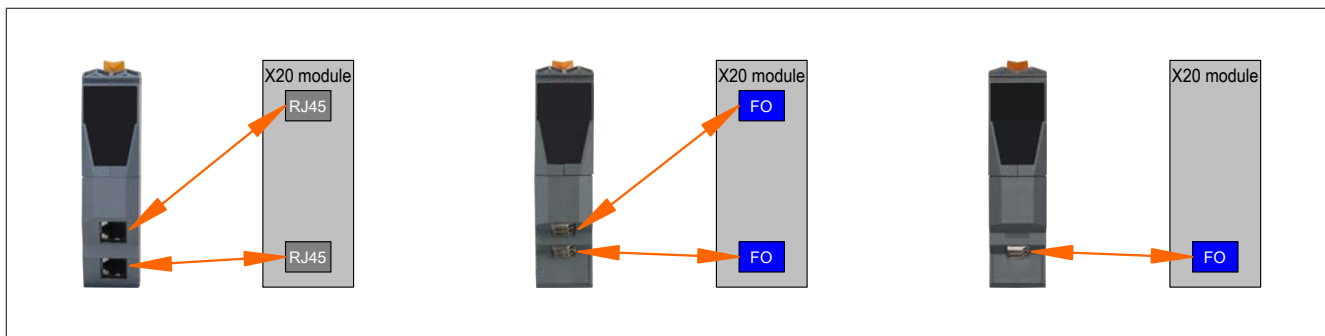
2) The X20HB1881 hub expansion module can be operated on the X20BC8084 bus controller with hardware revision >D0.

Technical data and detailed descriptions of the listed modules can be found in their respective data sheets.

**All X20 modules used in the examples can also be replaced by the corresponding "coated module" (X20c...), if available.**

## Key for symbolic images used

Symbolic images of the modules are used to describe their functionality and connection options. X20 modules used to connect to a network have 1 or 2 connections. The following graphic illustrates which connections on the symbolic images correspond to which ports on the module:



## 2.2 Controller redundancy in various network topologies

### Redundancy-capable X20 CPUs

Controller redundancy can be implemented with the following X20 CPUs:

Model number	Short description
X20CP3584	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, incl. supply module, 1x X20TB12 terminal block, slot cover and X20AC0SR1 end cover plate (right) included, order application memory separately.
X20CP3585	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, incl. supply module, 1x X20TB12 terminal block, slot cover and X20AC0SR1 end cover plate (right) included, order application memory separately.
X20CP3586	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, incl. supply module, 1x X20TB12 terminal block, slot cover and X20AC0SR1 end cover plate (right) included, order application memory separately.

### 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:

Model number	Short description
X20IF10X0	X20 interface module, 1 redundancy link interface 1000BASE-SX, CPU-CPU data synchronization module for controller redundancy

### POWERLINK interfaces

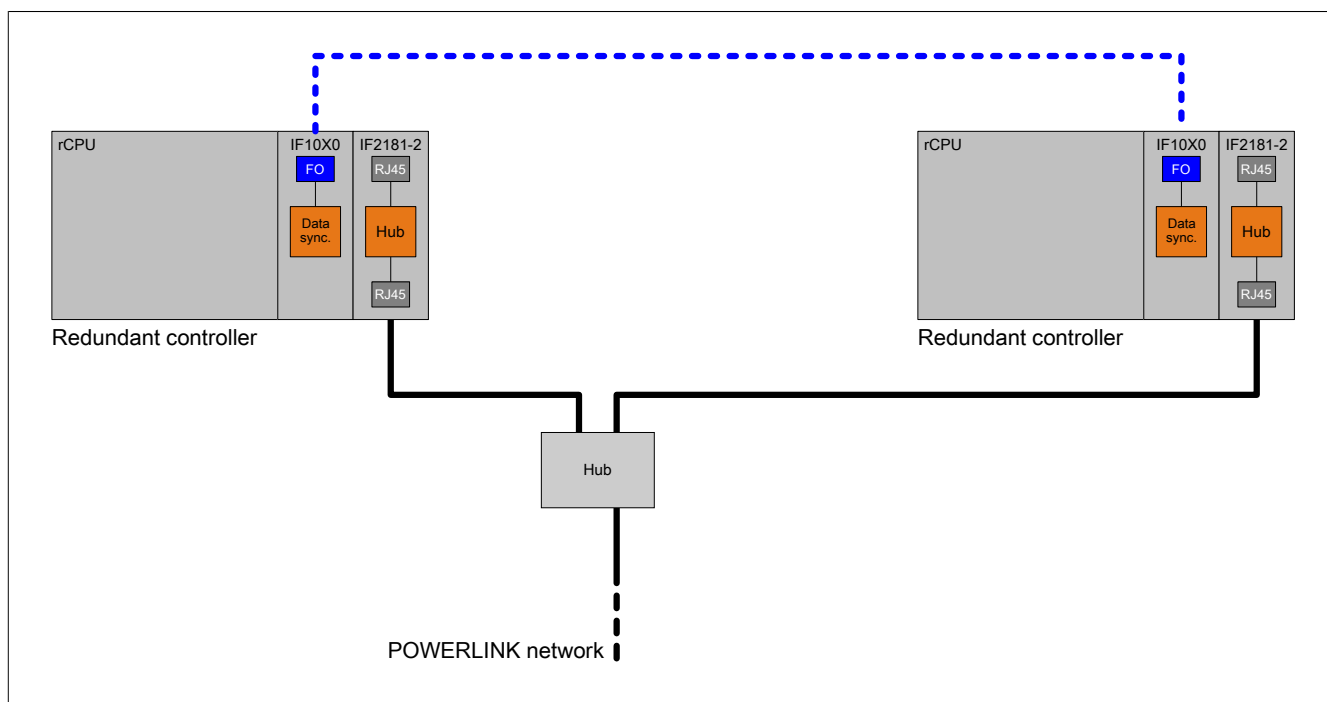
The X20IF2181-2 interface module is required in order to use redundant X20 CPUs in a POWERLINK network:

Model number	Short description
X20IF2181-2	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

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



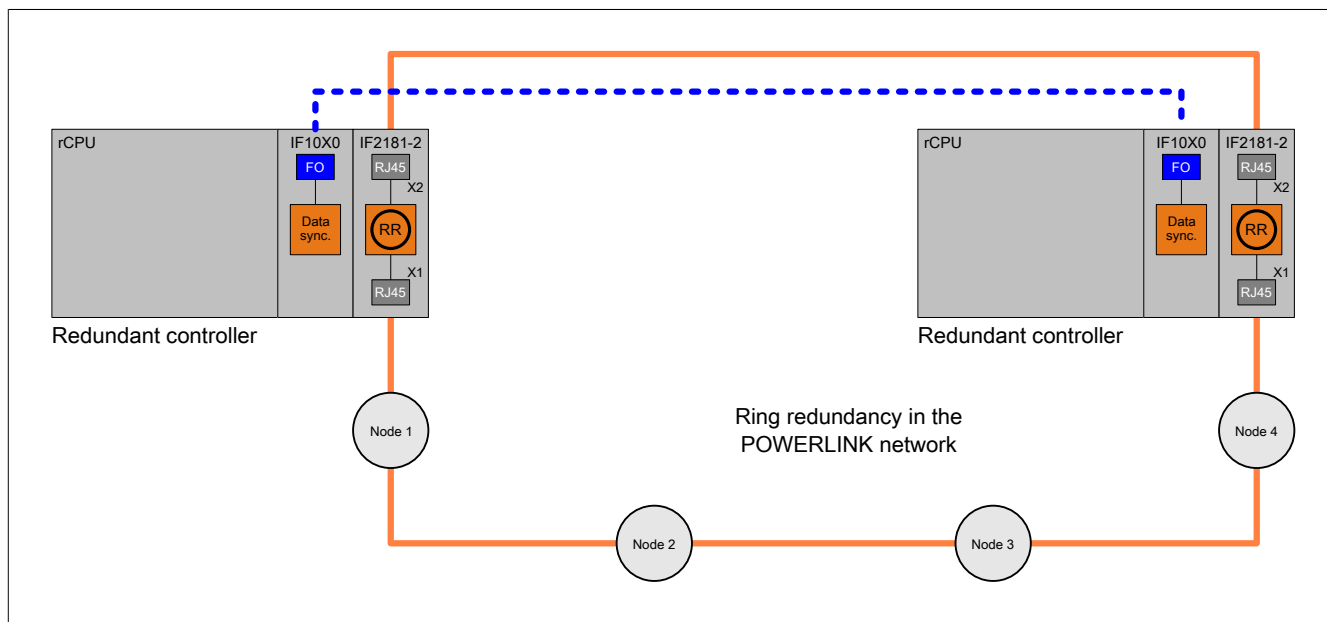
This takes care of the following error:

- 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



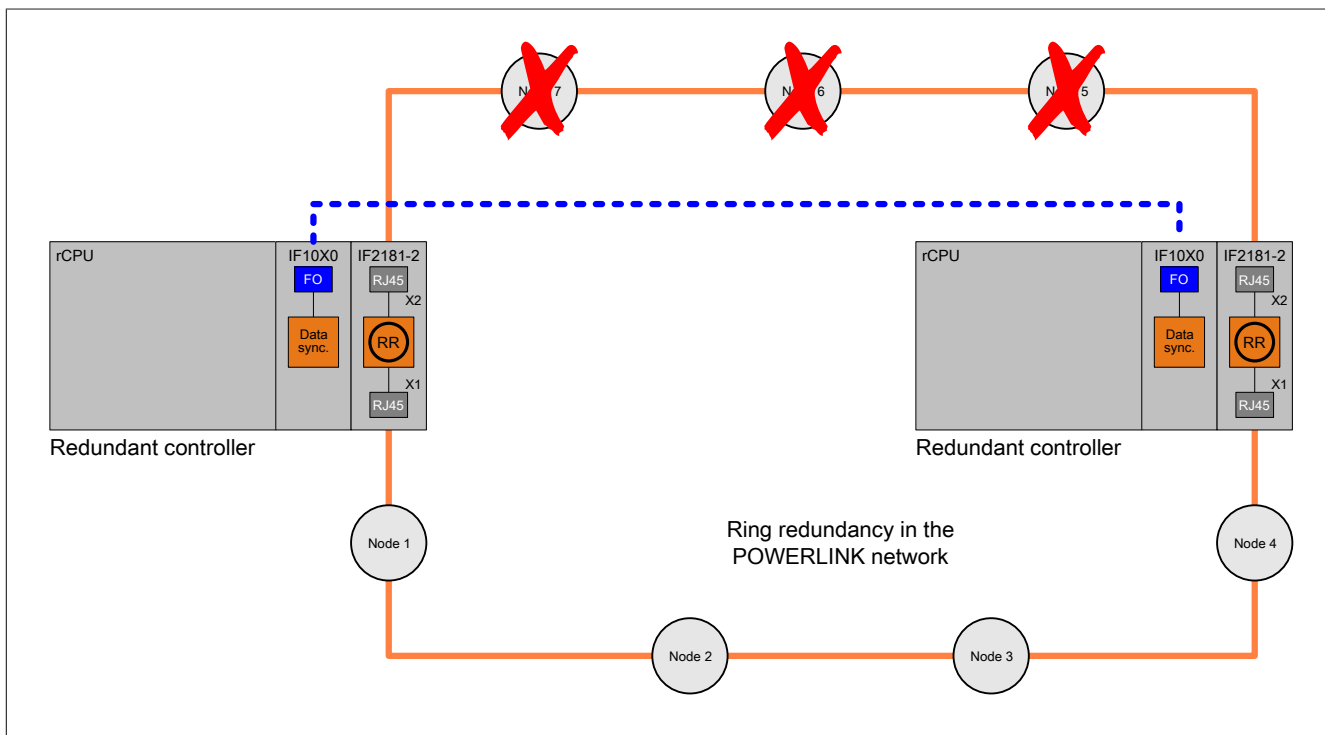
This takes care of the one of the following errors:

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

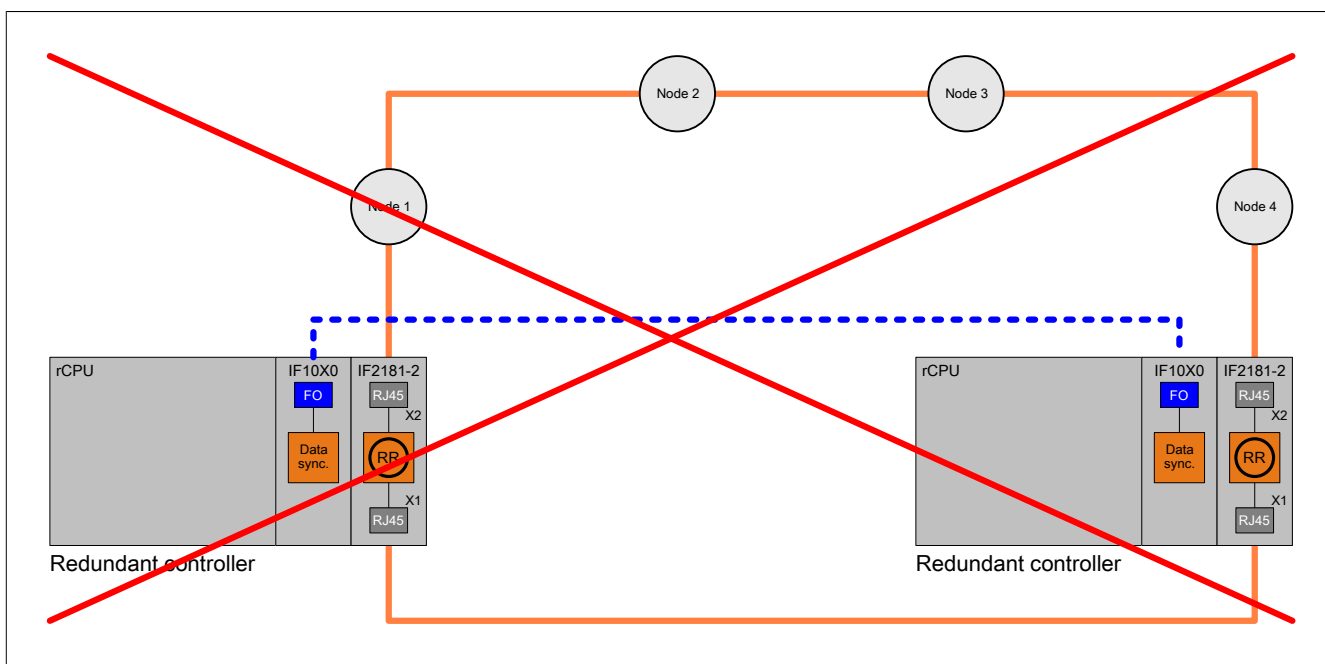
Note regarding X20IF2181-2 module configuration:

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

The 2 redundant controllers must be located next to each other in the ring; otherwise, stations may fail on a redundancy switchover:



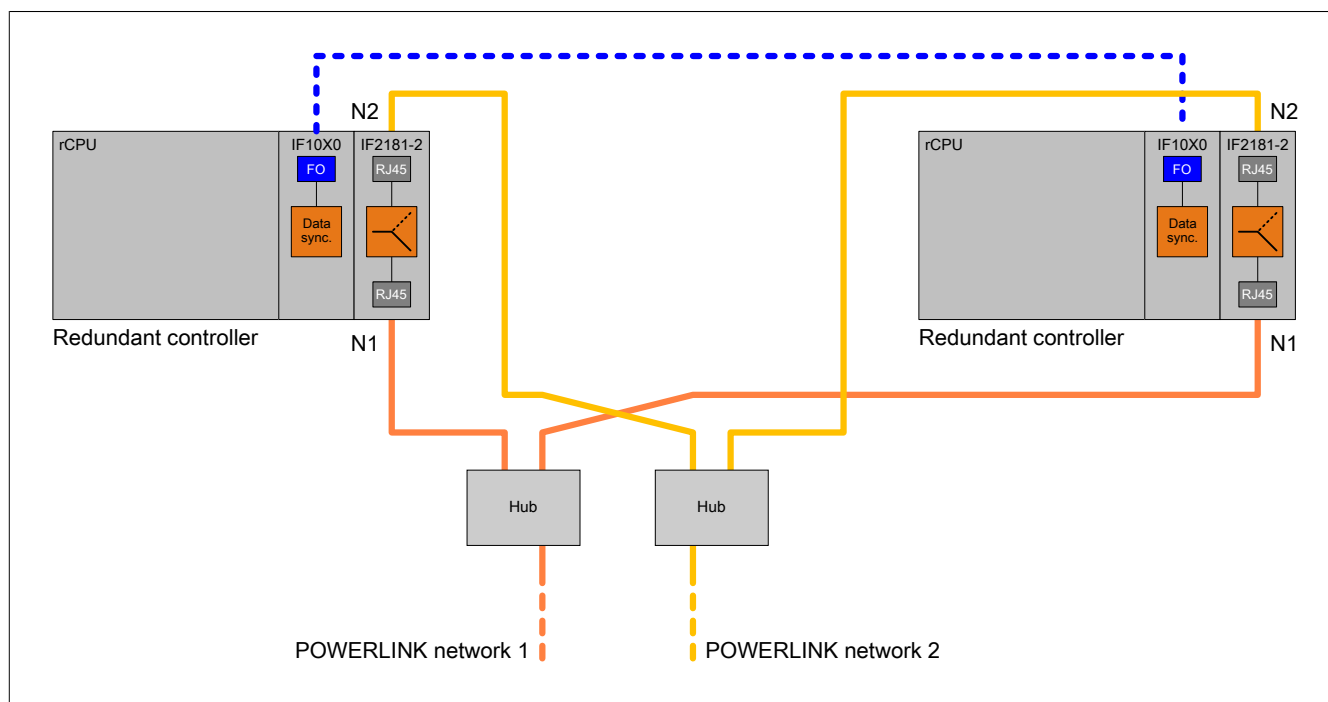
The following structure is also not permitted since it can likewise result in stations failing on a redundancy switchover:



## Important!

When using controller redundancy in a POWERLINK ring, it is important to make sure that the POWERLINK connection directly between the 2 controllers is established using connector X2 on both of the IF2181-2 interface modules.

## 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:

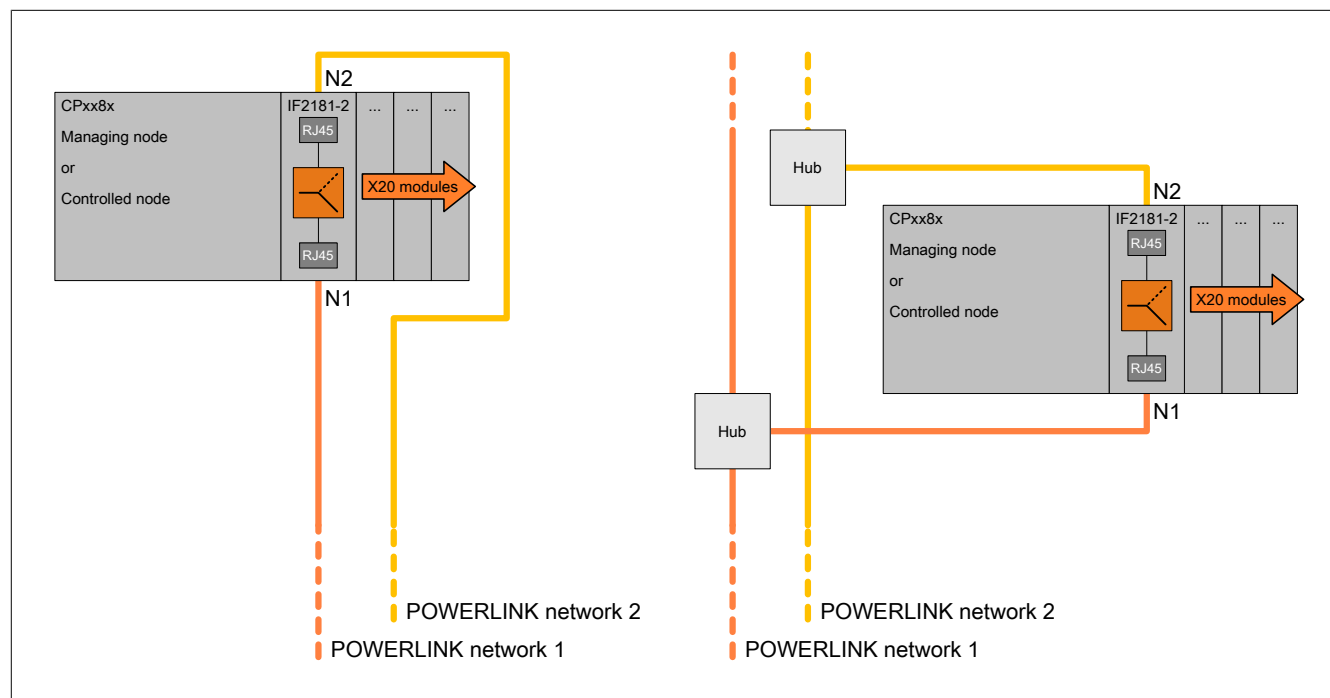
- X20IF2181-2 interface module
- X20HB8884 compact link selector
- X20BC8084 bus controller

### 2.3.1 X20IF2181-2 - Interface module

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

Model number	Short description
X20IF2181-2	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

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".

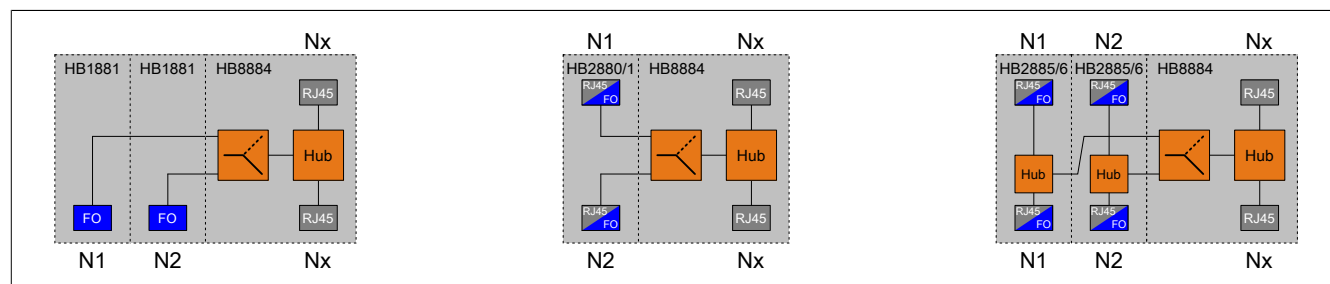
### 2.3.2 X20HB8884 - Compact link selector

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

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

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

#### Operating principle

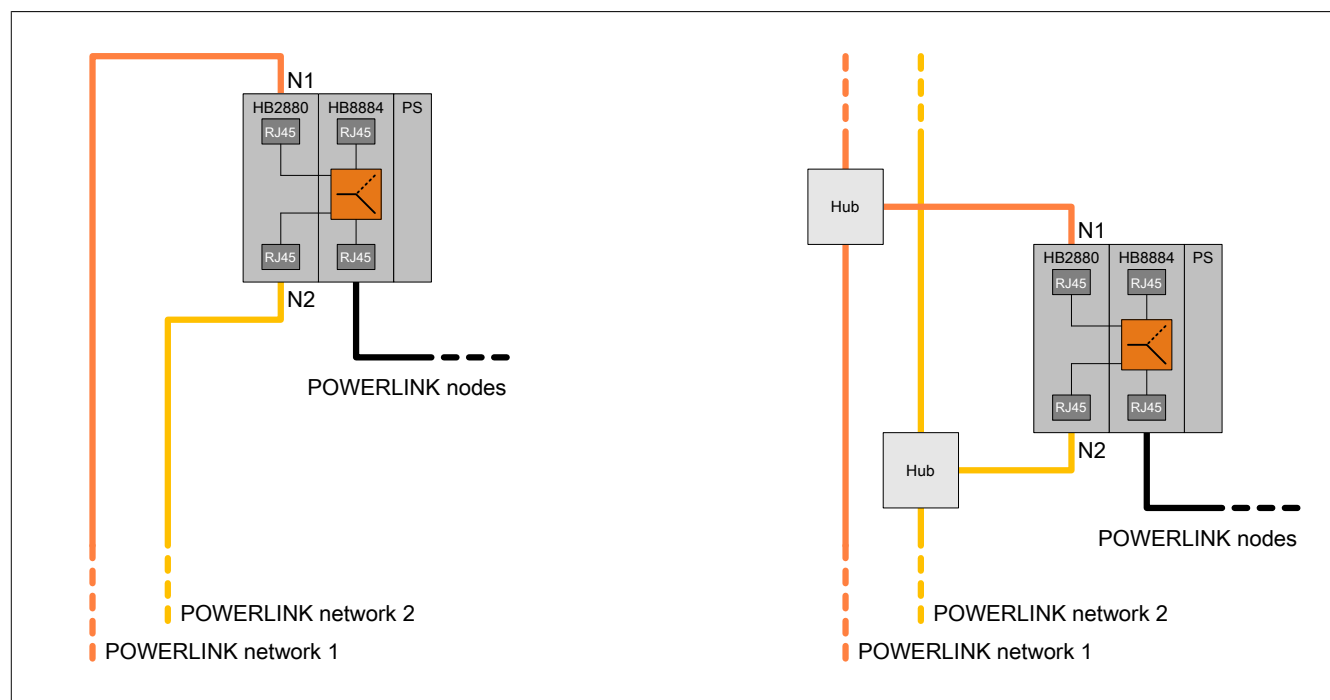


N1/N2 are connected to cable-redundant network segment. In contrast, Nx can only be used to branch off or connect to a non-redundant network segment.

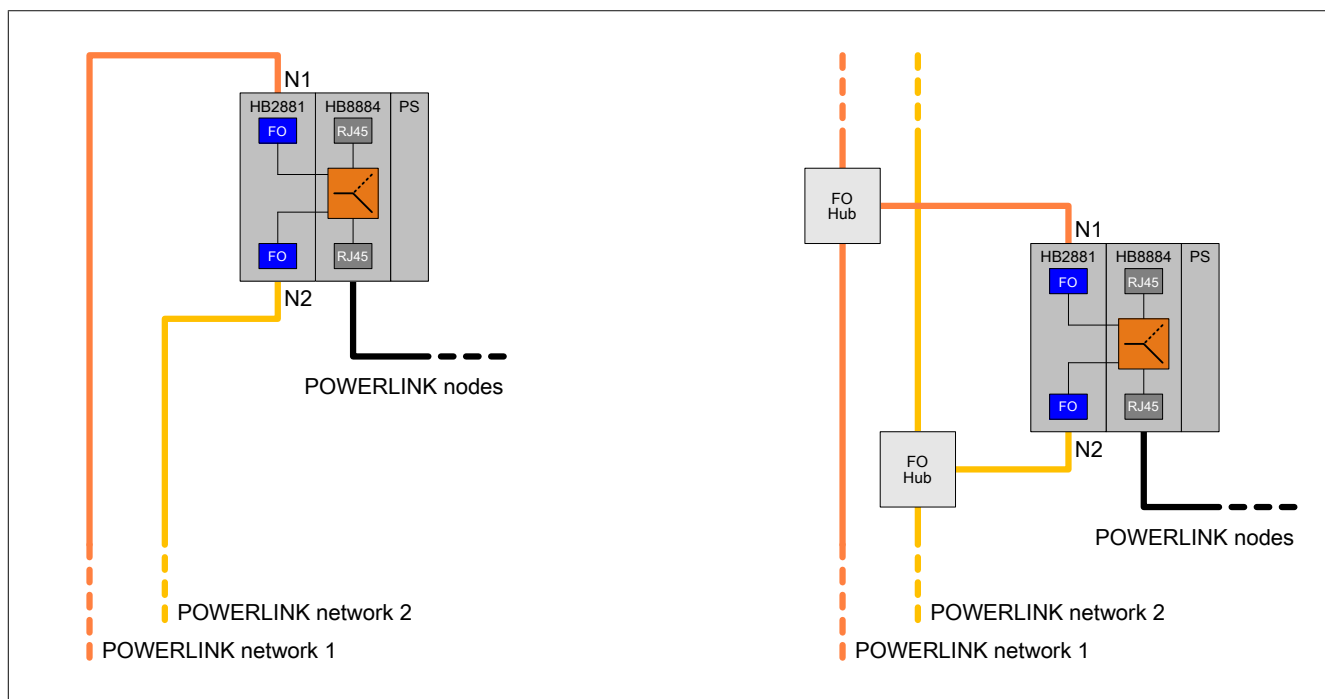
#### 2.3.2.1 X20HB8884 with passive hub expansion modules

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:

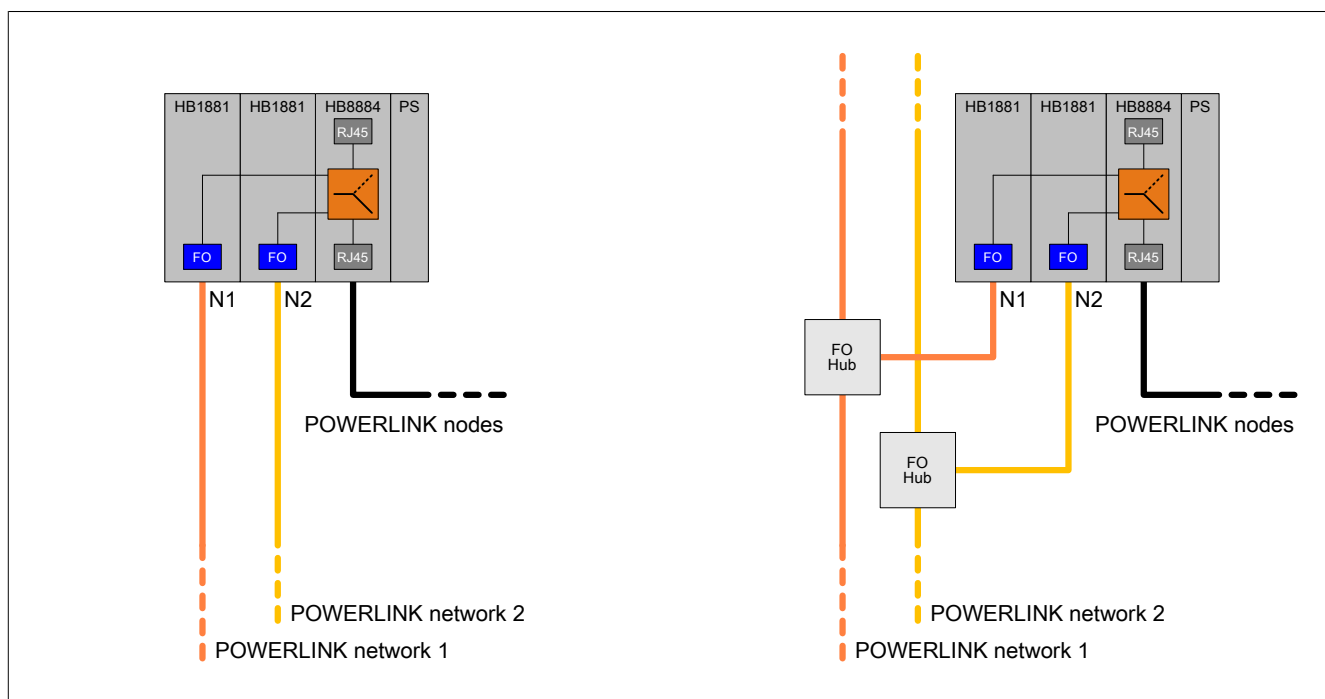
##### X20HB8884 with passive hub expansion module X20HB2880



### X20HB8884 with passive hub expansion module X20HB2881



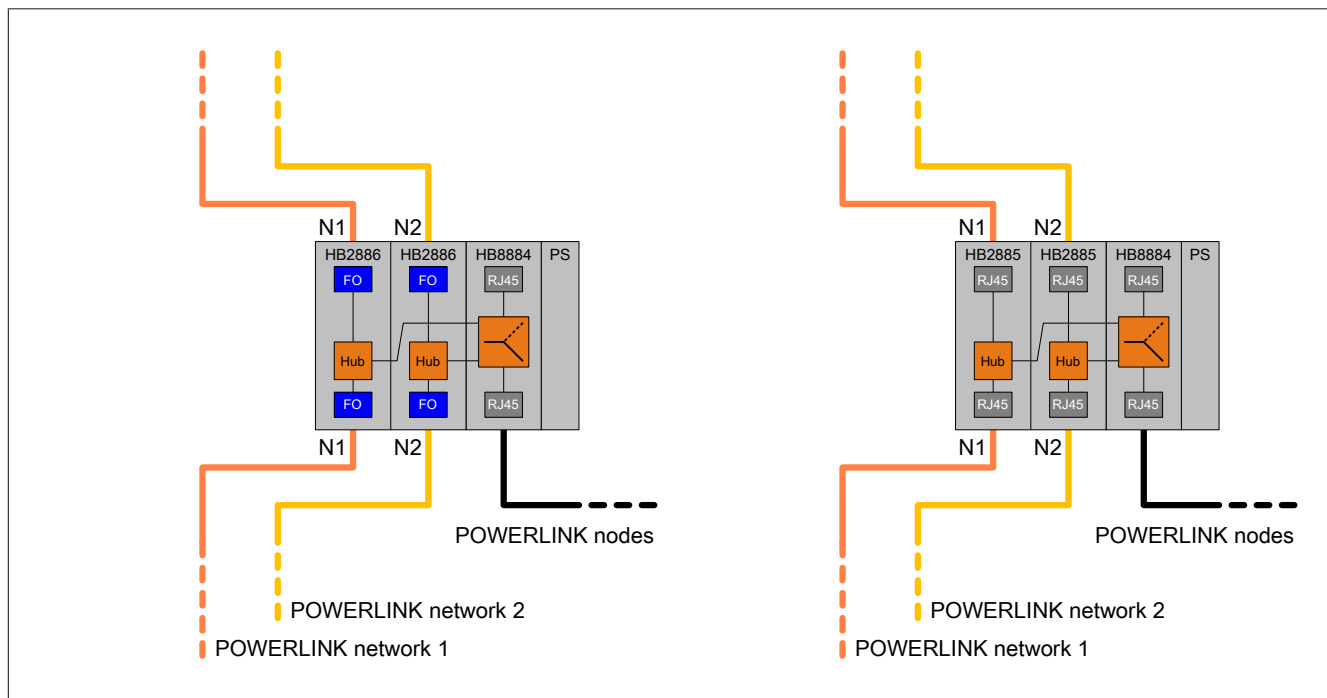
### X20HB8884 with X20HB1881 passive hub expansion modules



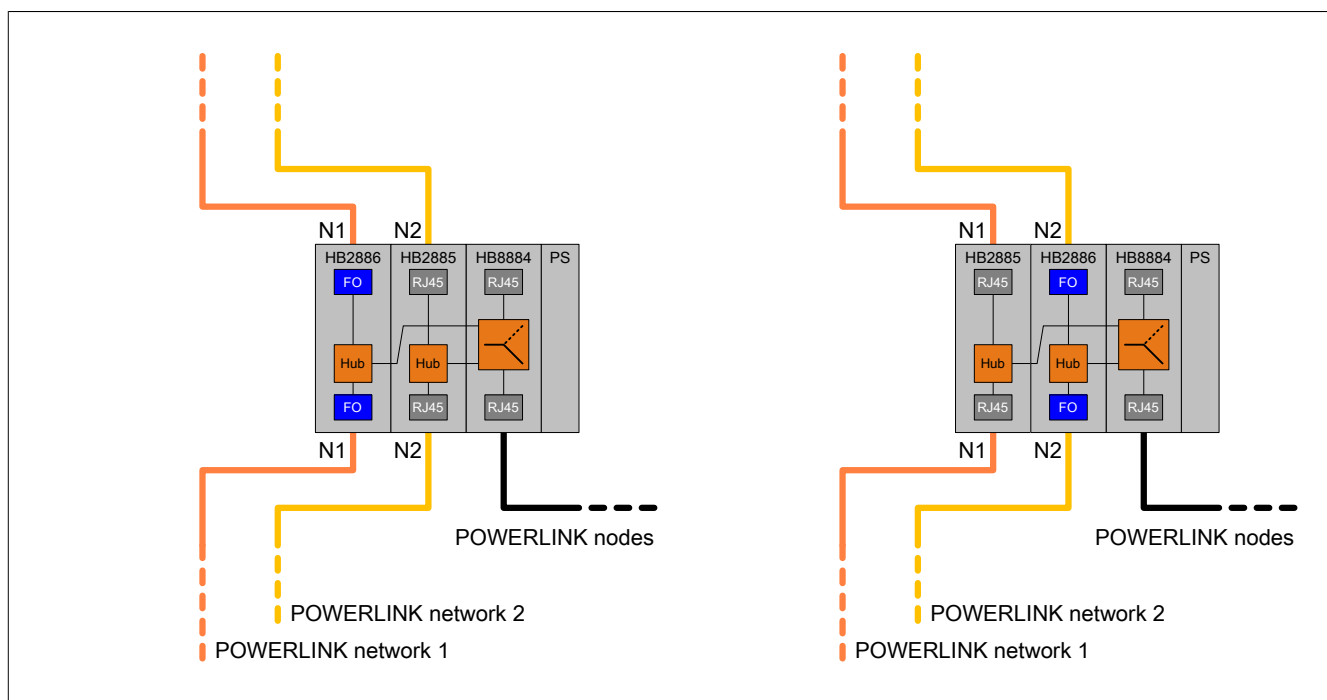
### 2.3.2.2 X20HB8884 with active hub expansion modules

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



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



### 2.3.3 X20BC8084 - Bus controller with integrated link selector

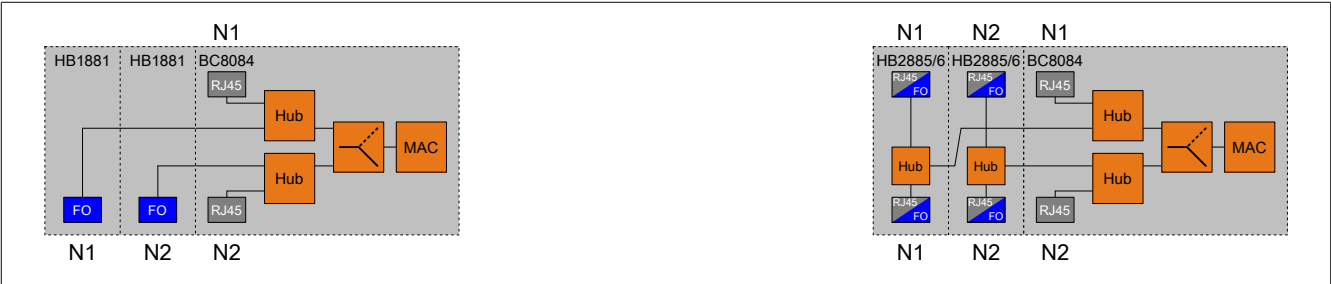
The X20BC8084 bus controller with built-in link selector and active hub expansion modules can be used to connect remote I/O nodes to a POWERLINK network with cable redundancy:

Model number	Short description
X20BC8084	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.
X20HB1881	X20 hub expansion module, integrated 1-port hub, for fiber optic cable
X20HB2885	X20 hub expansion module, integrated active 2-port hub, 2x RJ45
X20HB2886	X20 hub expansion module, integrated active 2-port hub, 2 fiber optic interfaces

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

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

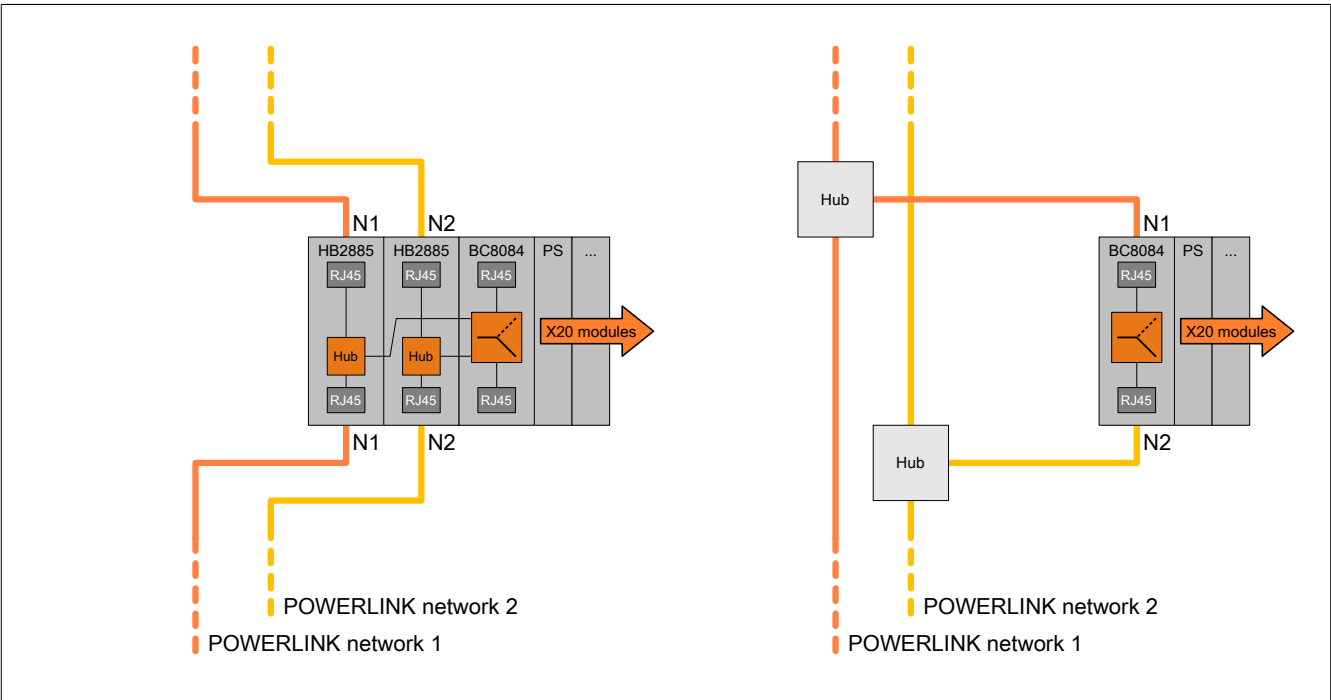
#### Operating principle



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

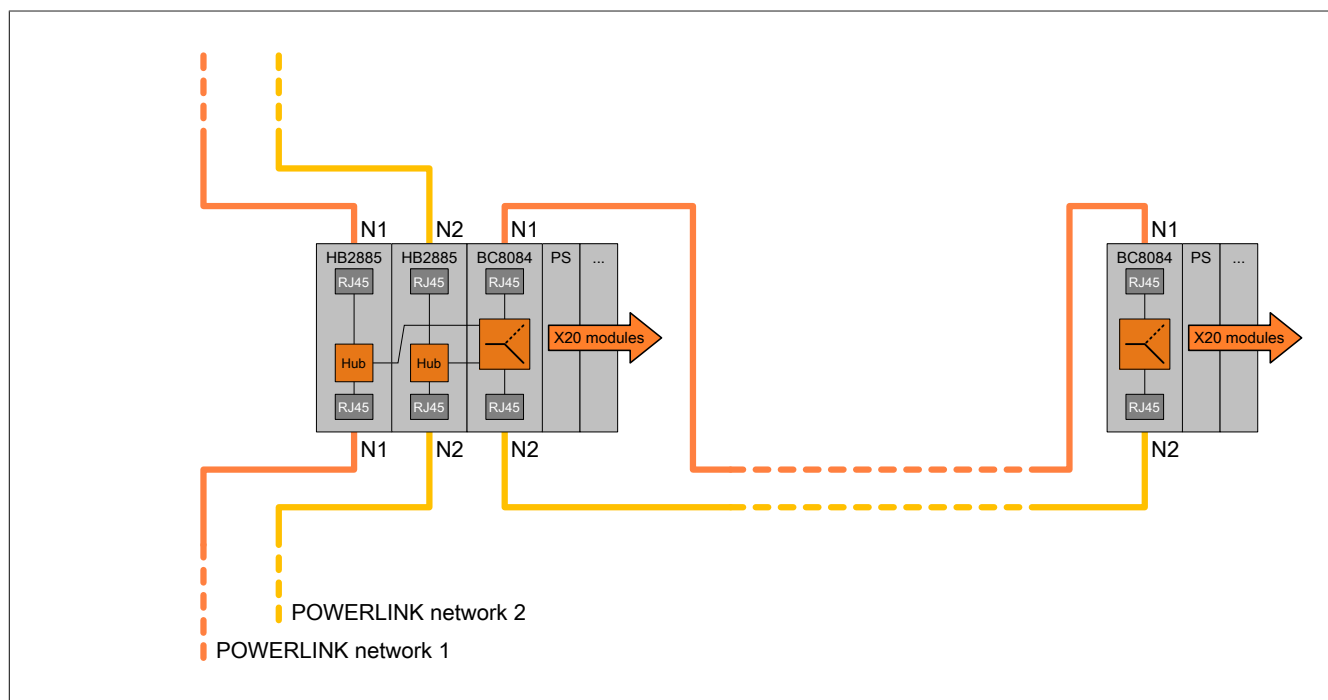
N1/N2 are connected to cable-redundant network segment.

#### 2.3.3.1 X20BC8084 in combination with Cu cable

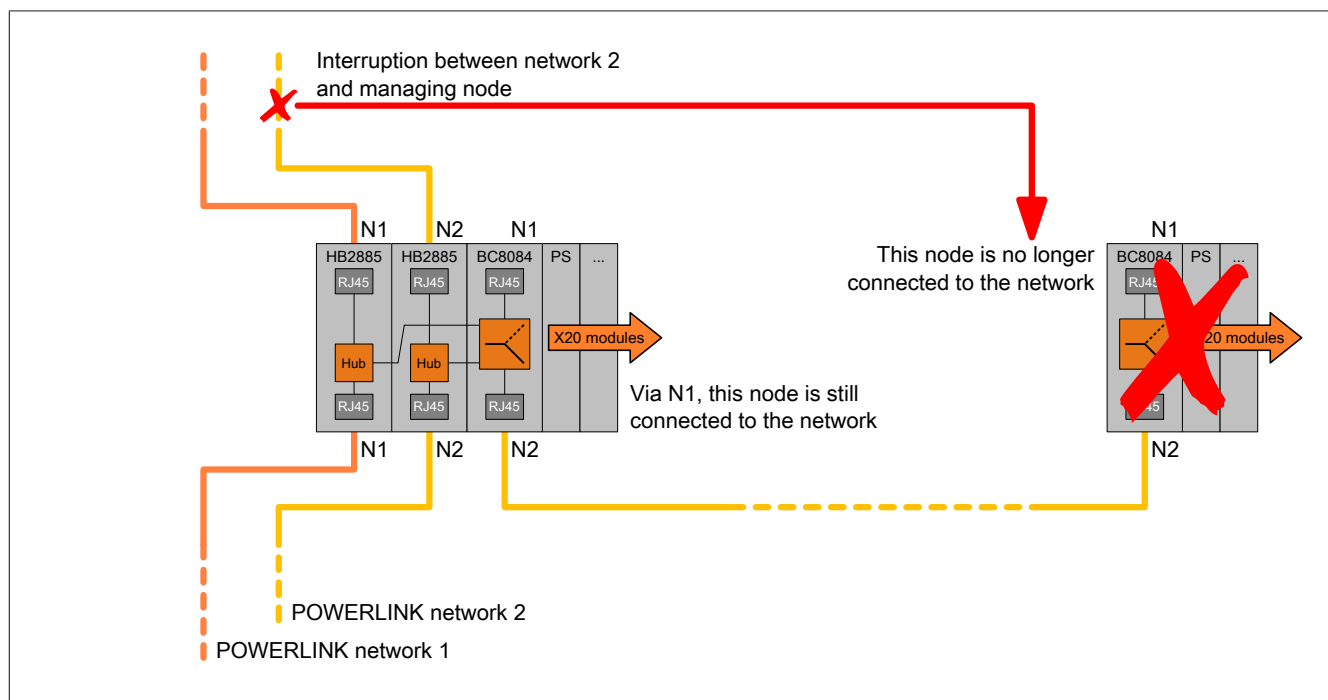




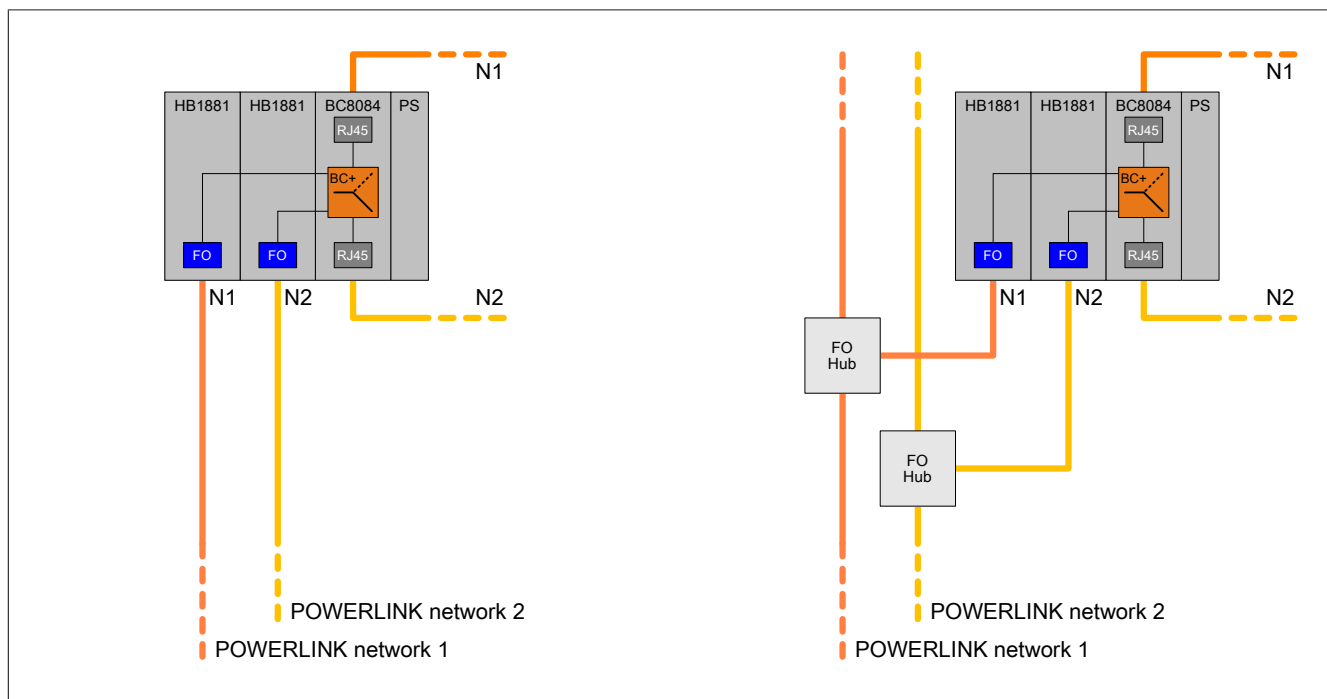
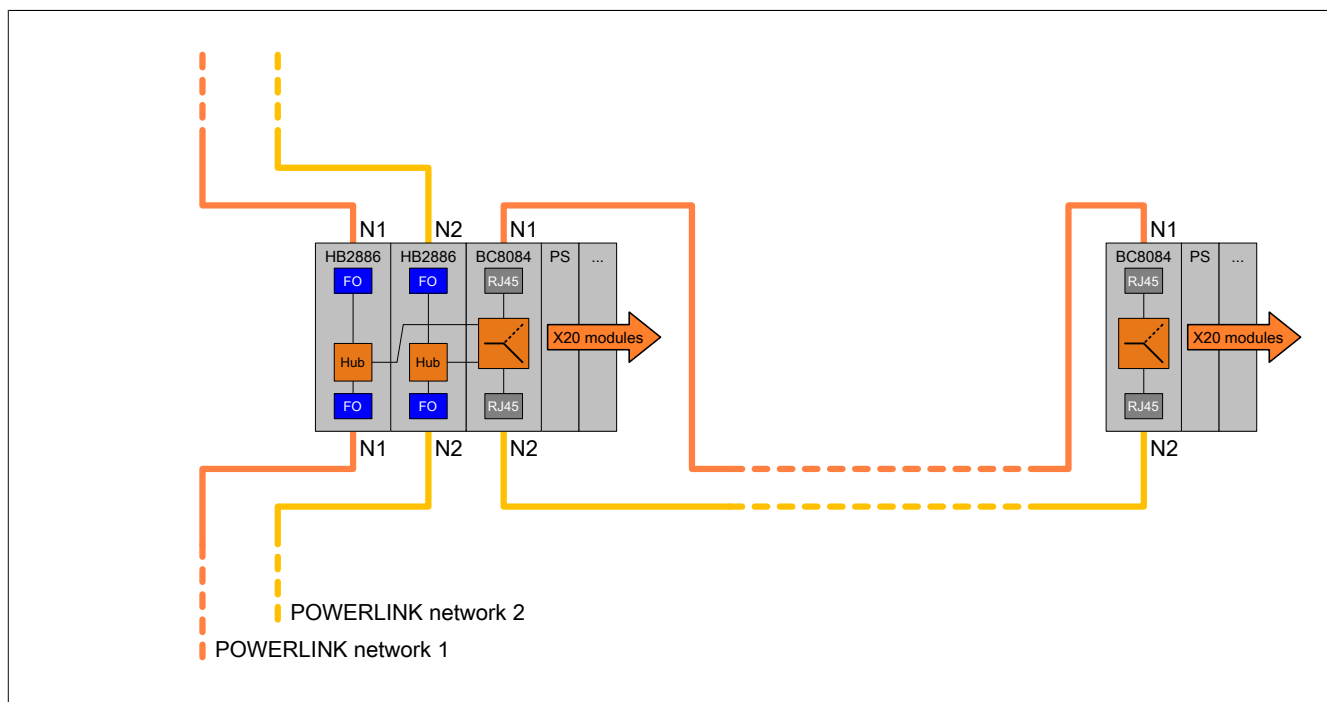
The X20BC8084 bus controller can be used to create a cable-redundant branch to a network node.



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

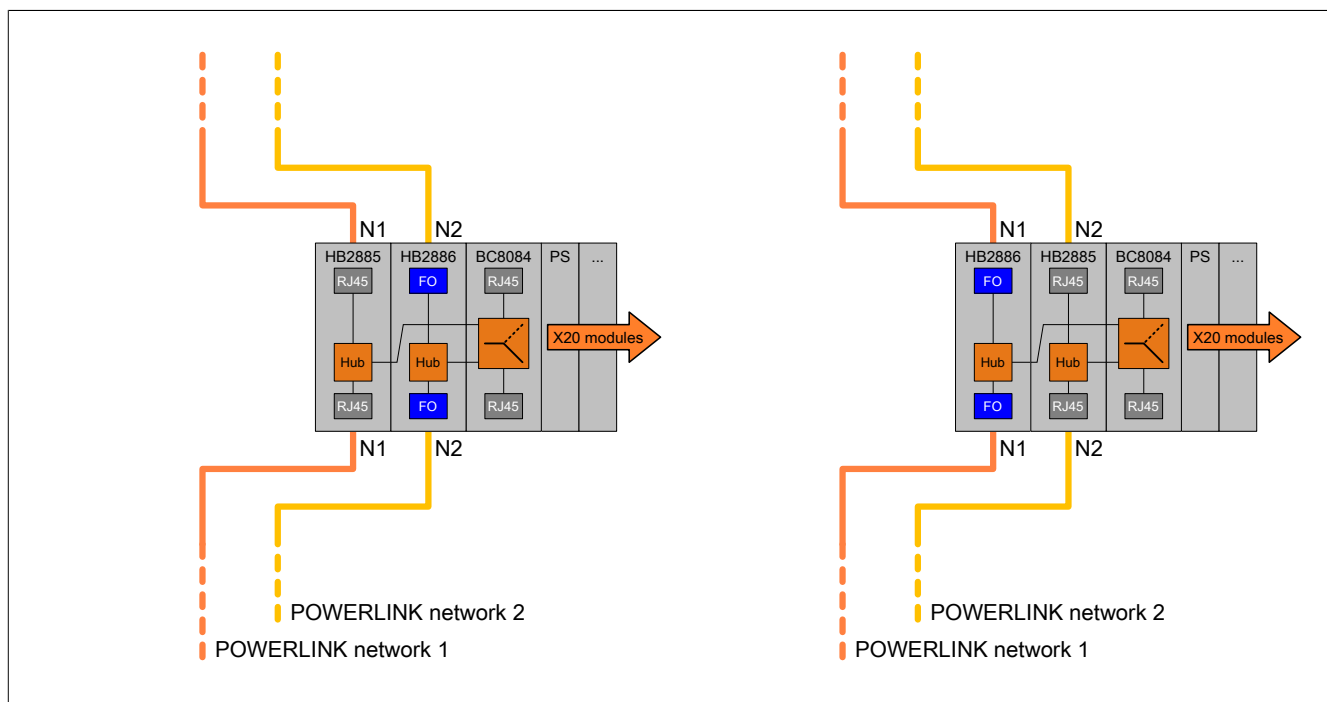


## 2.3.3.2 X20BC8084 in combination fiber optic cable



\*) 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

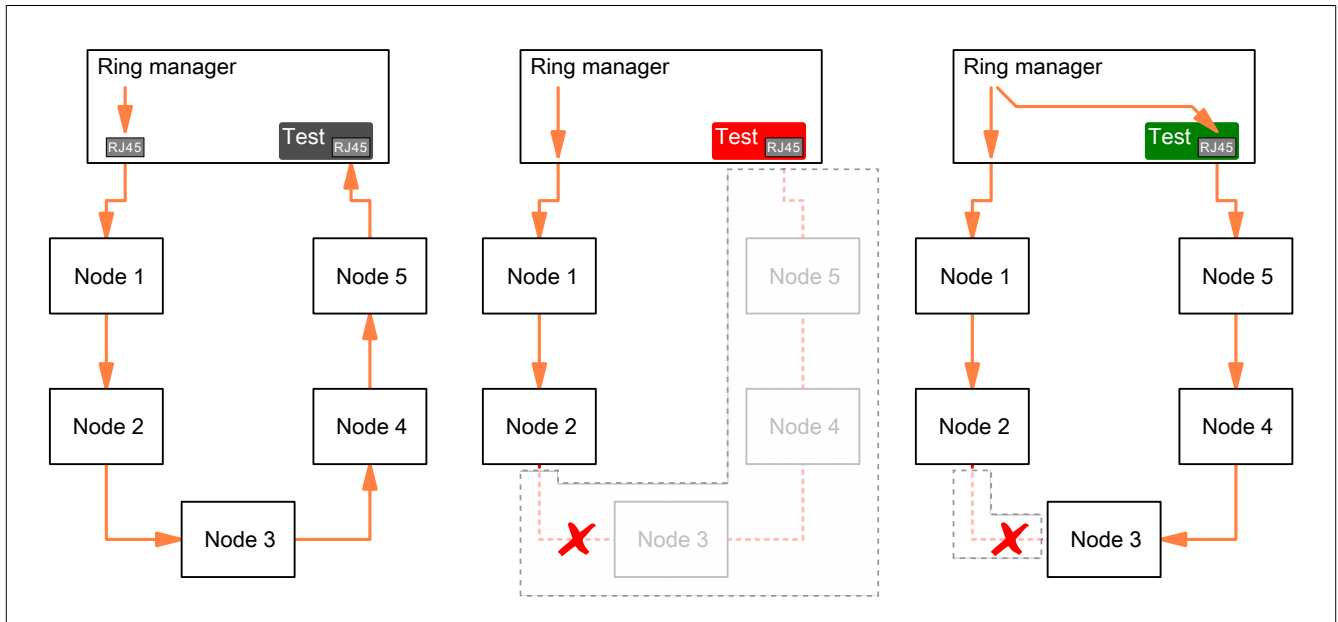


## 2.4 POWERLINK ring redundancy

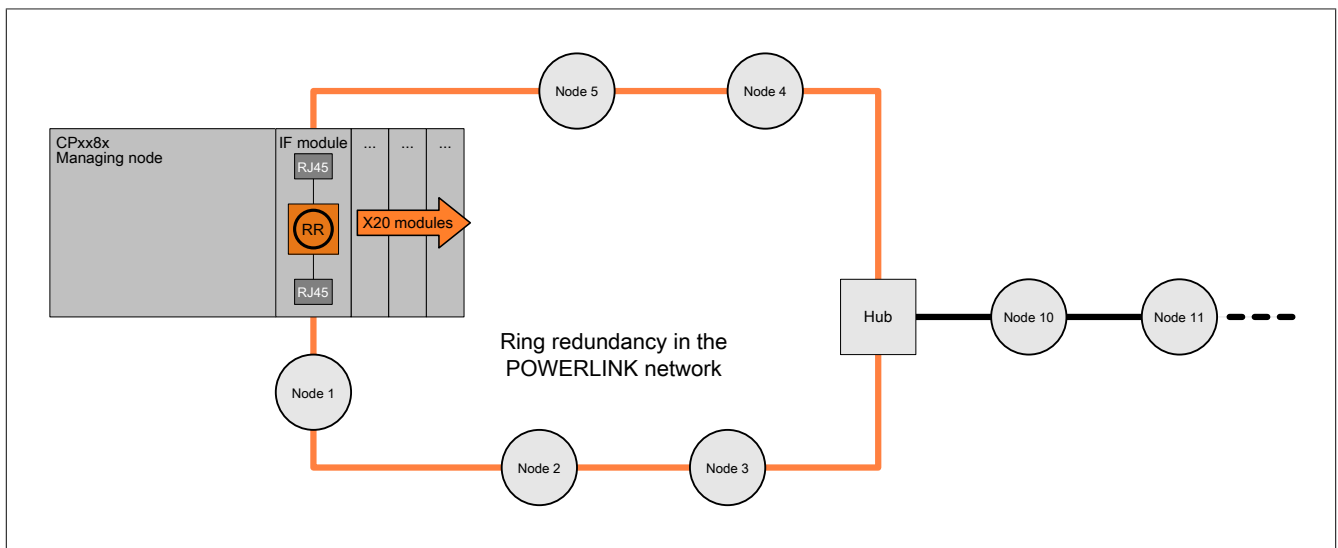
### General information

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 the X20IF2181-2 interface module as the ring manager. PRC does not work for nodes connected to the ring via a hub (like nodes 10 and 11 in above figure "Diagram of a ring topology").

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.

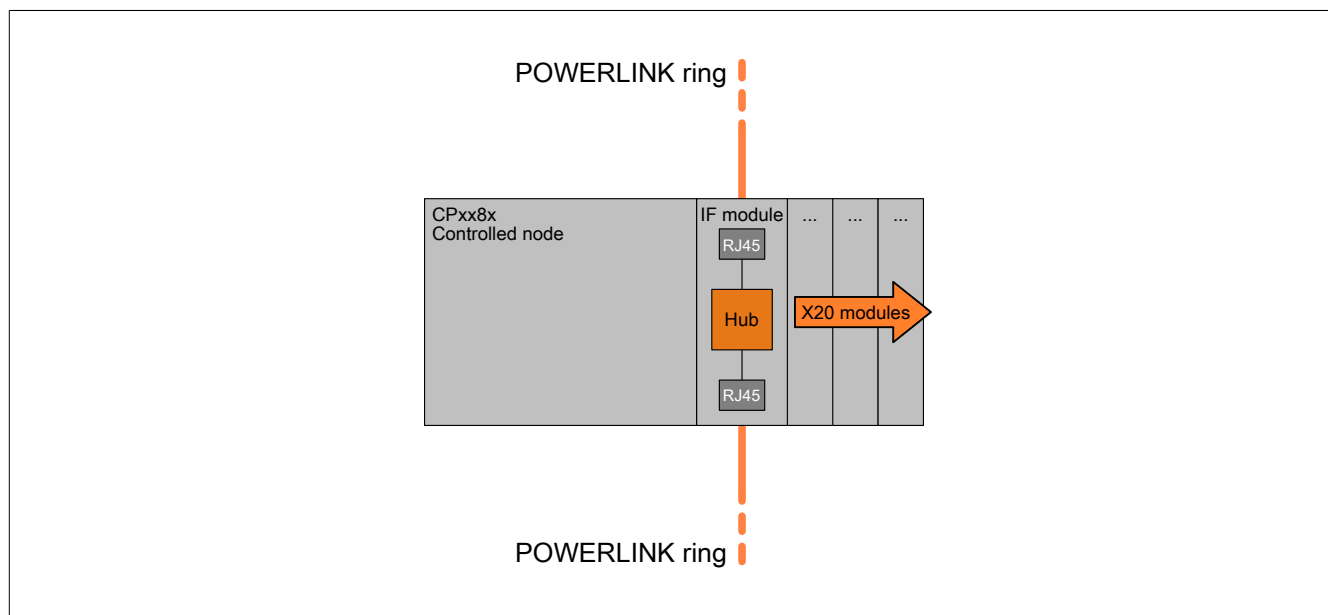
### Interface module as managing node

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

Model number	Short description
X20IF1082	X20 interface module, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function
X20IF1082-2	X20 interface module, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function PRC function
X20IF2181-2	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
5LS182.6-1	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
5LS182.6-2	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

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:

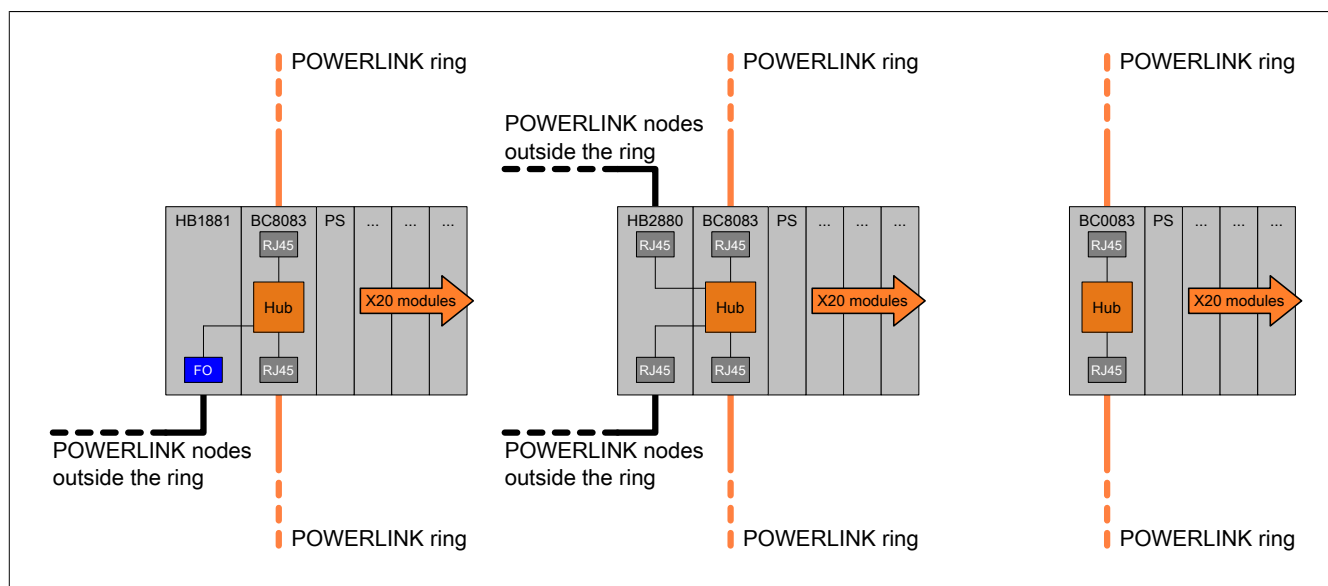
Model number	Short description
X20IF1082	X20 interface module, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function
X20IF1082-2	X20 interface module, 1 POWERLINK interface, managing or controlled node, integrated 2-port hub, ring redundancy function PRC function
X20IF2181-2	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
5LS182.6-1	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
5LS182.6-2	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

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:

Model number	Short description
X20BC0083	X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, 2x RJ45, order bus base, power supply module and terminal block separately.
X20BC1083	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
X20BC8083	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.

### Hub expansion module for X20BC8083

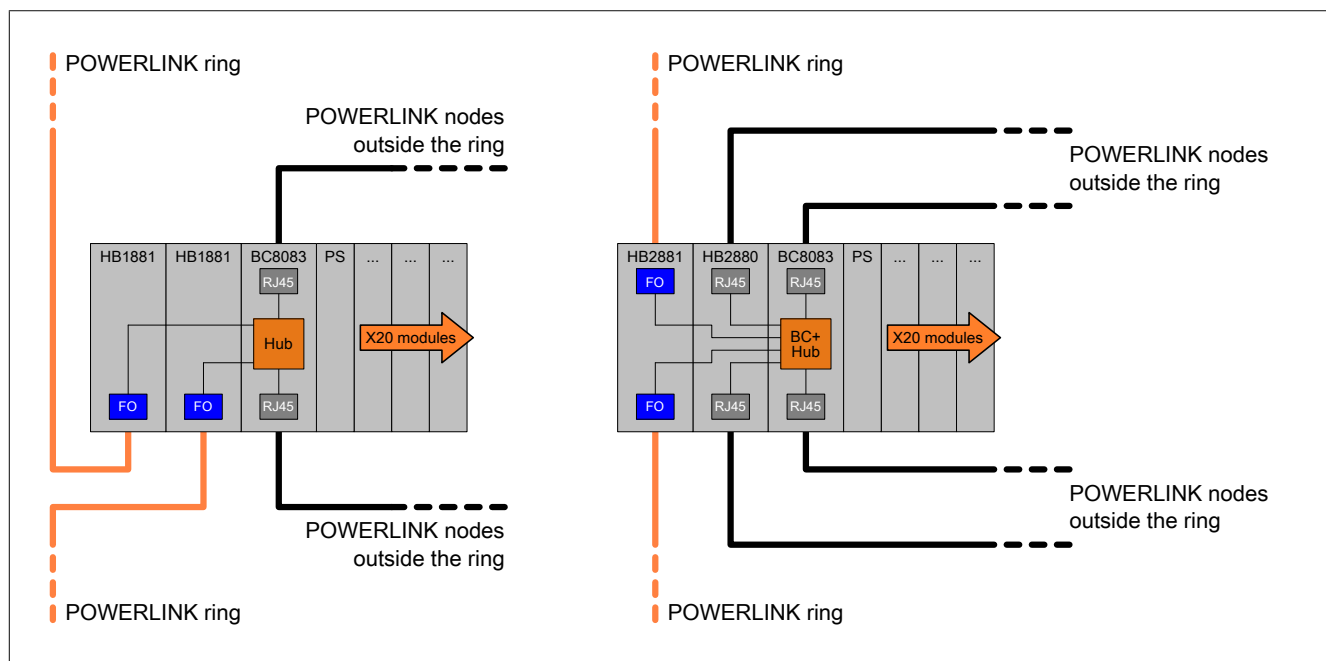
The X20BC8083 bus controller with a 2-port hub can be expanded to up to 6 ports using the following hub expansion modules:

Model number	Short description
X20HB2880	X20 hub expansion module, integrated 2-port hub, 2x RJ45
X20HB1881	X20 hub expansion module, integrated 1-port hub, for fiber optic cable
X20HB2881	X20 hub expansion module, integrated 2-port hub, for fiber optic cable

Up to two hub expansion modules can be connected to the X20BC8083 bus controller in any order and combination.

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

## Further examples using hub expansion modules



### 2.4.3 Other devices as nodes in a ring

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

Model number	Short description
X67BC81RT.L12	X67 bus controller, 2 POWERLINK interfaces, X2X Link power supply 15 W, reACTION Technology module, 2 digital inputs, 24 VDC, <1 $\mu$ s, 3 digital channels, 5 VDC, <1 $\mu$ s, configurable as inputs or outputs, 2 digital channels, 24 VDC, 0.4 A, <1 $\mu$ s, configurable as inputs or outputs, 2 analog inputs $\pm 10$ V, 5 $\mu$ s 200 kHz sampling frequency, 13-bit converter resolution (including sign), configurable input filter, 1 analog output $\pm 10$ V, 2.5 $\mu$ s, 13-bit converter resolution (including sign), M12 connectors, high-density module
X67BC8321.L12	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
X67BC8513.L12	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

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

## 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):

Model number	Short description
0AC808.9-1	8-port industrial hub (layer 2), 24 VDC, 10/100 Mbit/s with autonegotiation, automatic MDIX, order TB704 terminal block separately

### 2.5.2 Modular X20 Ethernet hub

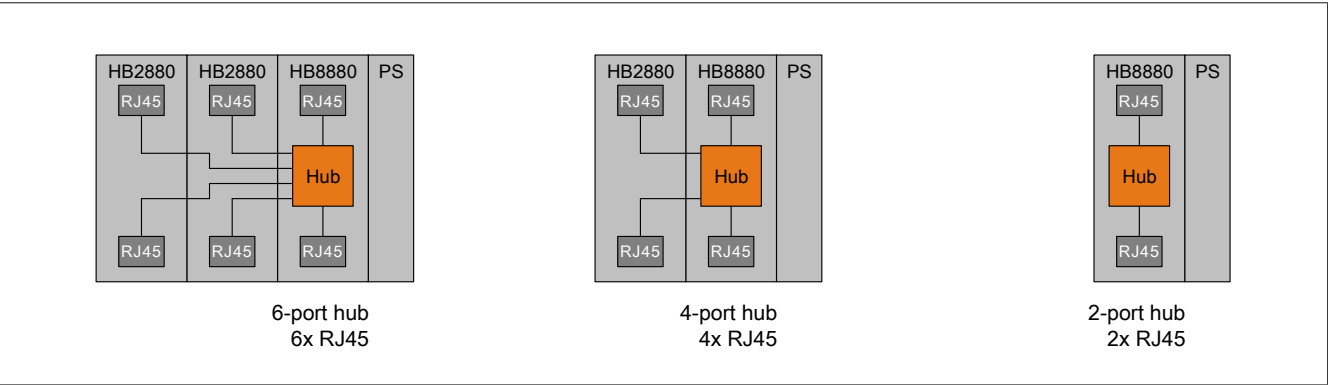
The following X20 modules can be used to create a modular hubs with 2-6 ports:

Model number	Short description
X20HB8880	X20 base hub module, integrated 2-port hub, 2x RJ45
X20HB2880	X20 hub expansion module, integrated 2-port hub, 2x RJ45
X20HB2881	X20 hub expansion module, integrated 2-port hub, for fiber optic cable
X20HB1881	X20 hub expansion module, integrated 1-port hub, for fiber optic cable

**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:

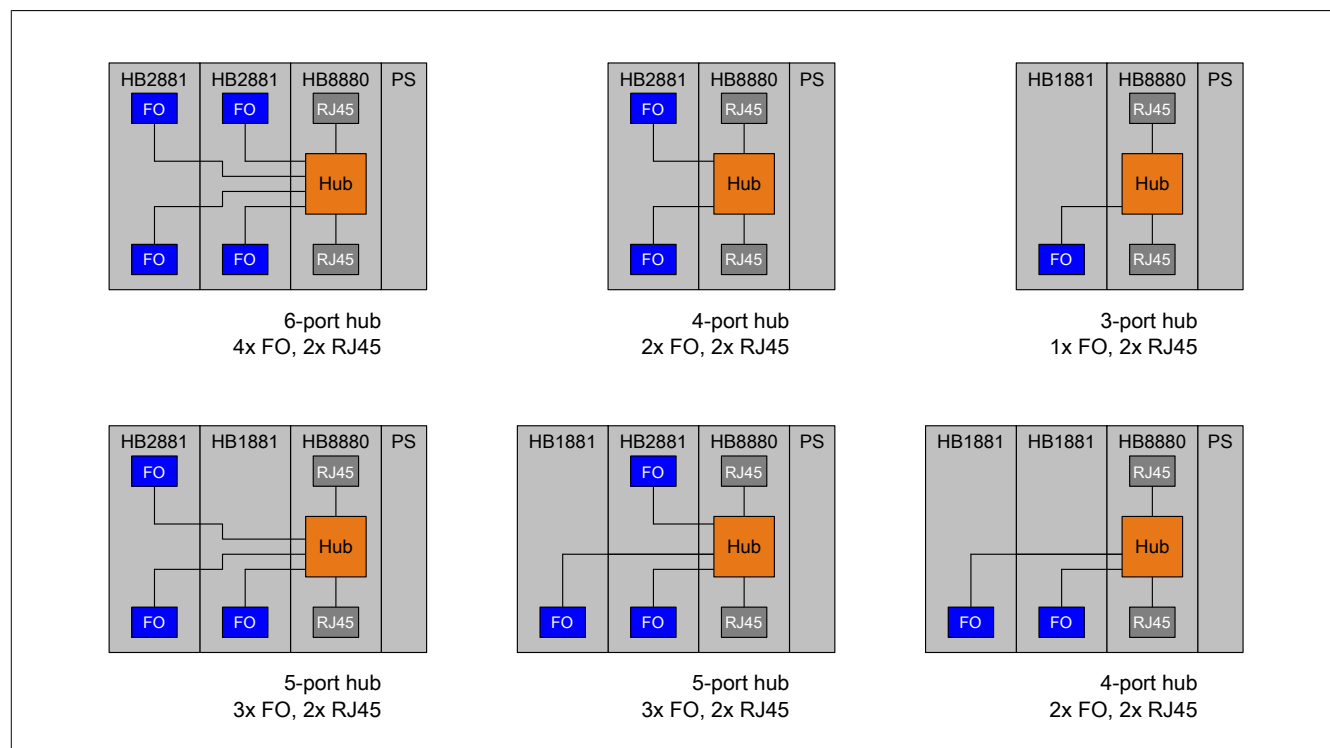


\*) With Hardware Revision H0 or higher, the X20HB8880 base hub module can be operated independently (without hub expansion module).



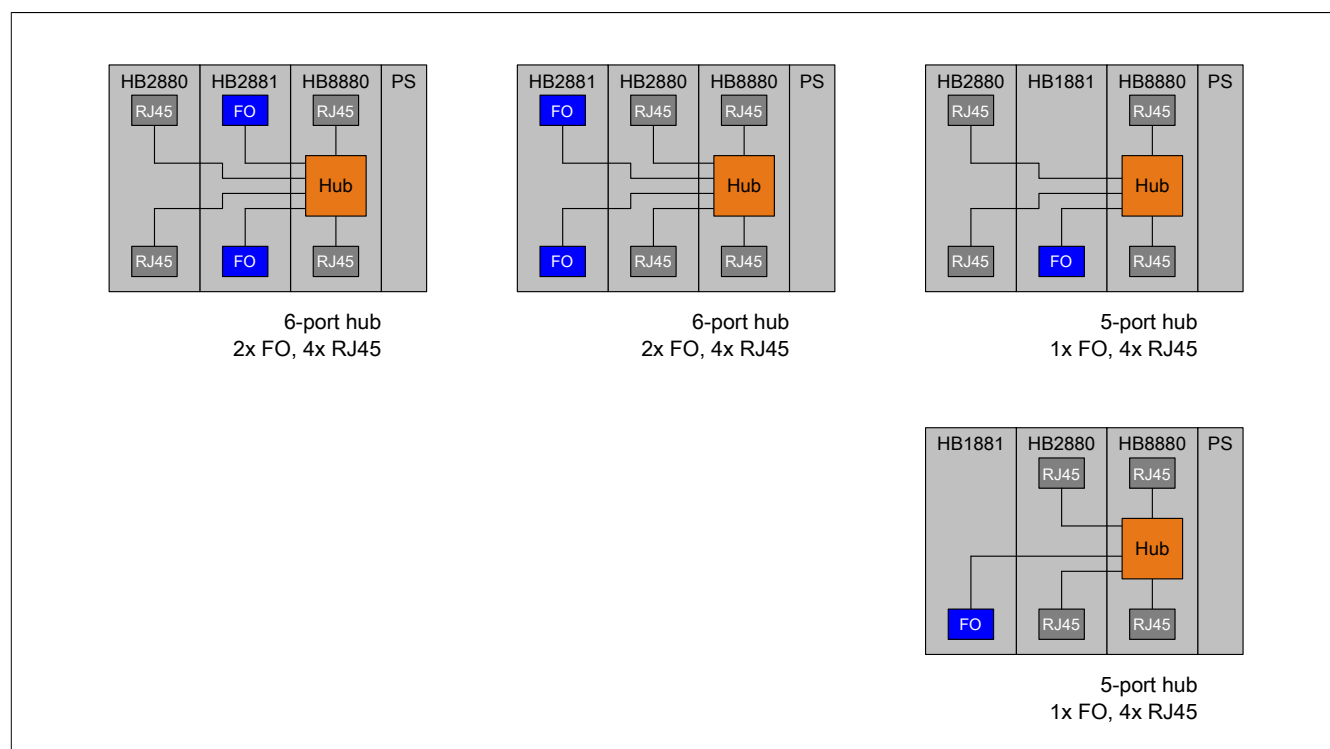
### 2.5.2.2 X20HB8880 with X20HB2881 and X20HB1881

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



### 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:



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.

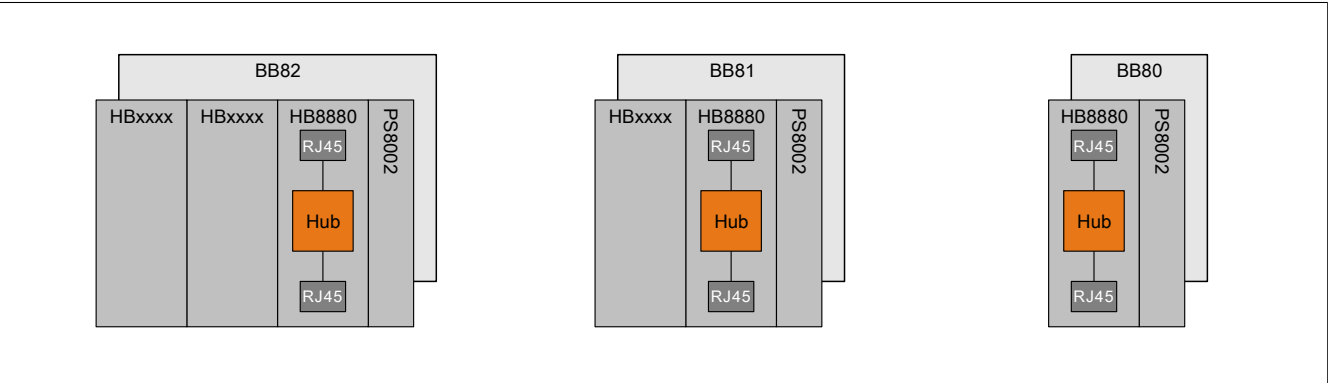
Model number	Short description
X20PS8002	X20 power supply module for standalone hub and compact link selector

X20 standalone devices include the following products:

Model number	Short description
X20HB8880	X20 base hub module, integrated 2-port hub, 2x RJ45
X20HB8884	X20 compact link selector, 2x RJ45, order bus base, power supply module and terminal block separately.

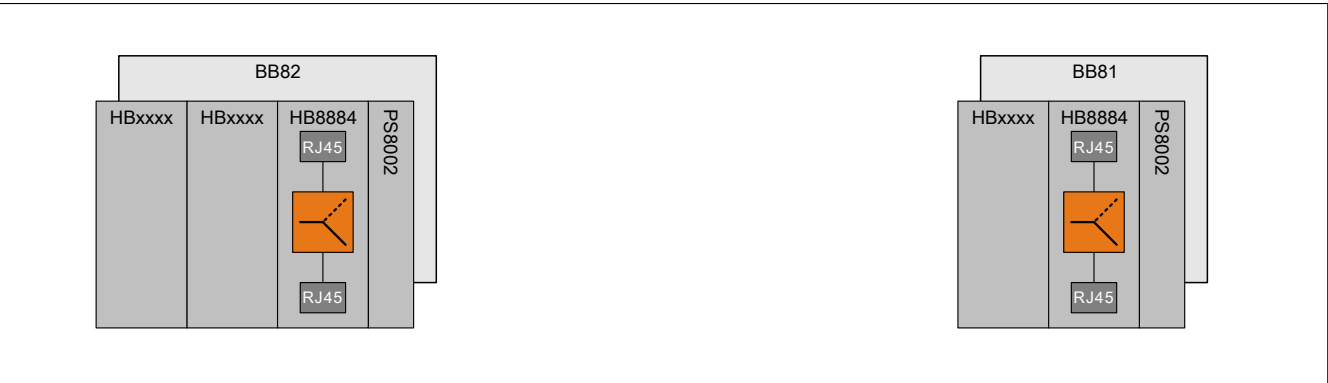
2.6.1.1 X20HB8880: Non-redundant supply

An appropriate X20 bus base must be selected depending on how many hub expansion modules<sup>1)</sup> are being operated on the X20HB8880:



2.6.1.2 X20HB8884: Non-redundant supply

An appropriate X20 bus base must be selected depending on how many hub expansion modules<sup>2)</sup> are being operated on the X20HB8884:

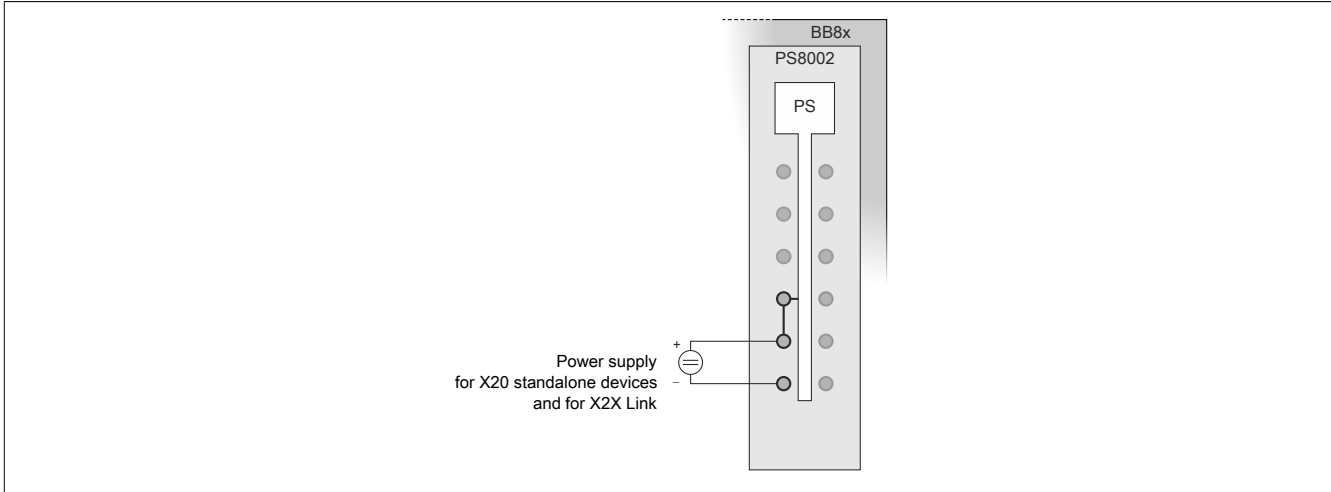


<sup>1)</sup> For hub expansion modules permitted on the X20HB8880, see "Modular X20 Ethernet hub" on page 24.

<sup>2)</sup> For hub expansion modules permitted on the X20BC8084, see "X20HB8884 - Compact link selector" on page 13.

### 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:

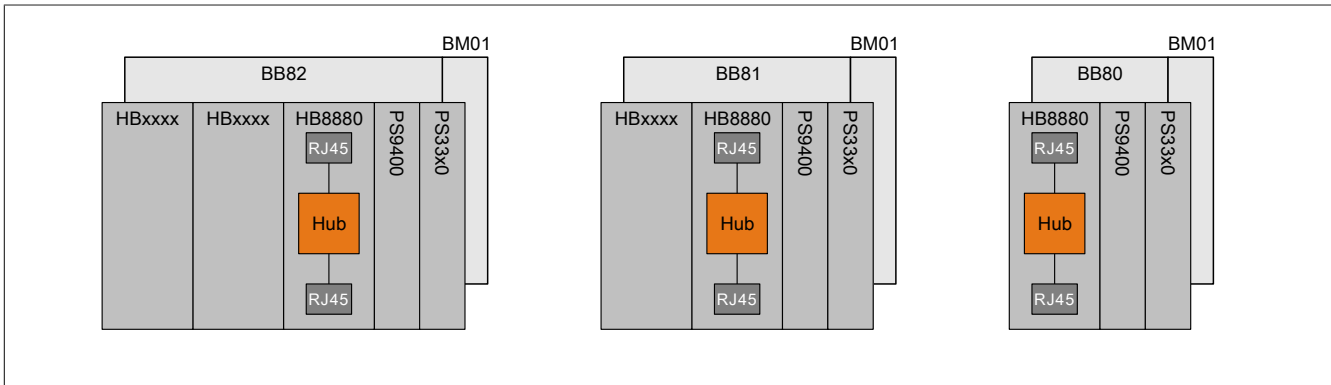
Model number	Short description
X20PS9400	X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply
X20PS3300	X20 power supply module, for X2X Link and internal I/O power supply
X20PS3310	X20 power supply module, for X2X Link and internal I/O power supply, integrated microfuse

X20 standalone devices include the following products:

Model number	Short description
X20HB8880	X20 base hub module, integrated 2-port hub, 2x RJ45
X20HB8884	X20 compact link selector, 2x RJ45, order bus base, power supply module and terminal block separately.

#### 2.6.2.1 X20HB8880: Redundant supply

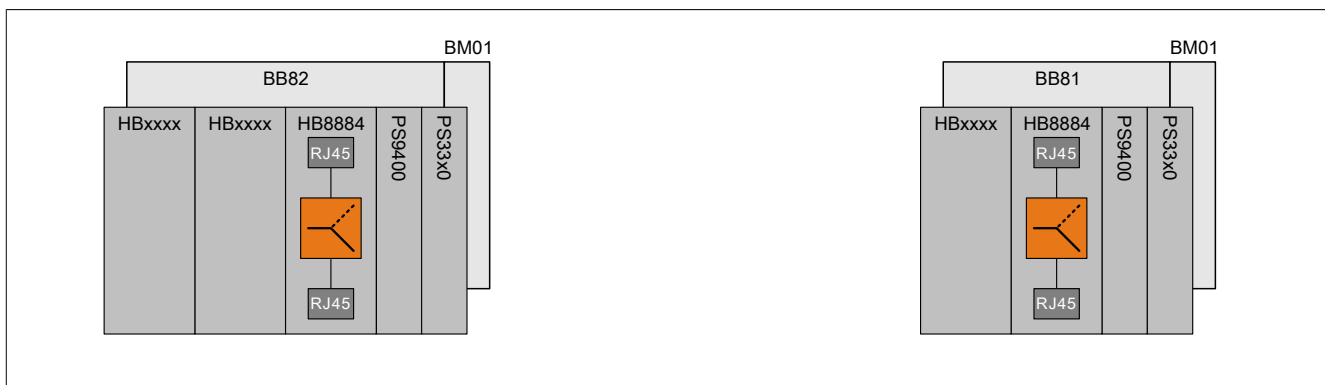
An appropriate X20 bus base must be selected depending on how many hub expansion modules<sup>3)</sup> are being operated on the X20HB8880:



<sup>3)</sup> For hub expansion modules permitted on the X20HB8880, see "Modular X20 Ethernet hub" on page 24.

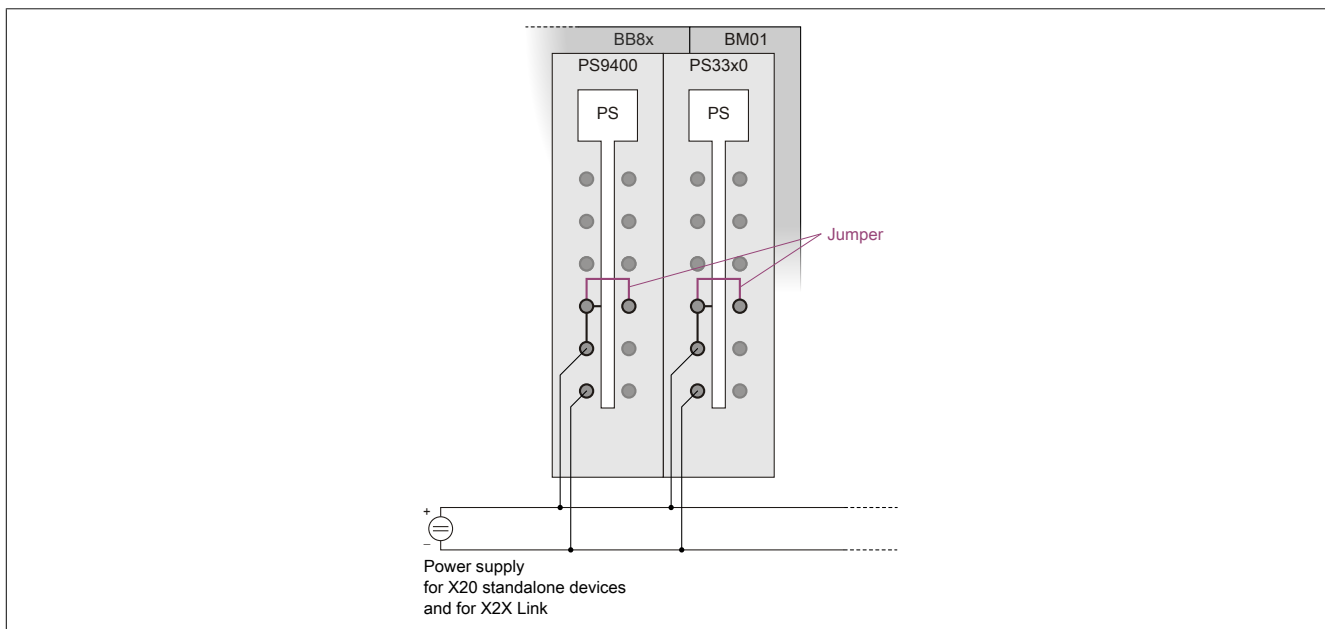
### 2.6.2.2 X20HB8884: Redundant supply

An appropriate X20 bus base must be selected depending on how many hub expansion modules<sup>4)</sup> are being operated on the X20HB8884:



### 2.6.2.3 Wiring

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



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

<sup>4)</sup> For hub expansion modules permitted on the X20BC8084, see "X20HB8884 - Compact link selector" on page 13.

## 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:

Model number	Short description
X20PS9400	X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply
X20PS9402	X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply, supply not electrically isolated

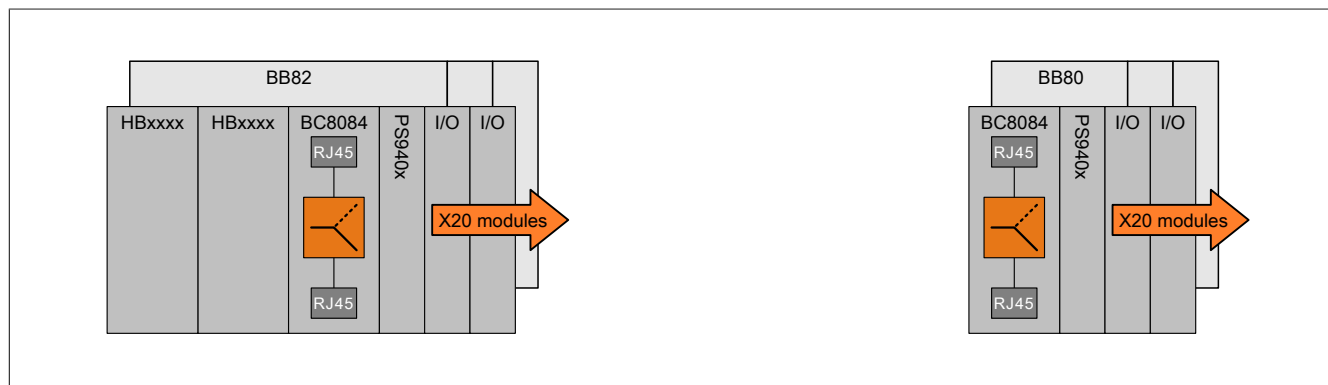
X20 POWERLINK bus controller:

Model number	Short description
X20BC0083	X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, 2x RJ45, order bus base, power supply module and terminal block separately.
X20BC1083	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
X20BC8083	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.
X20BC8084	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.

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<sup>5)</sup> are being operated on the X20BC8084:

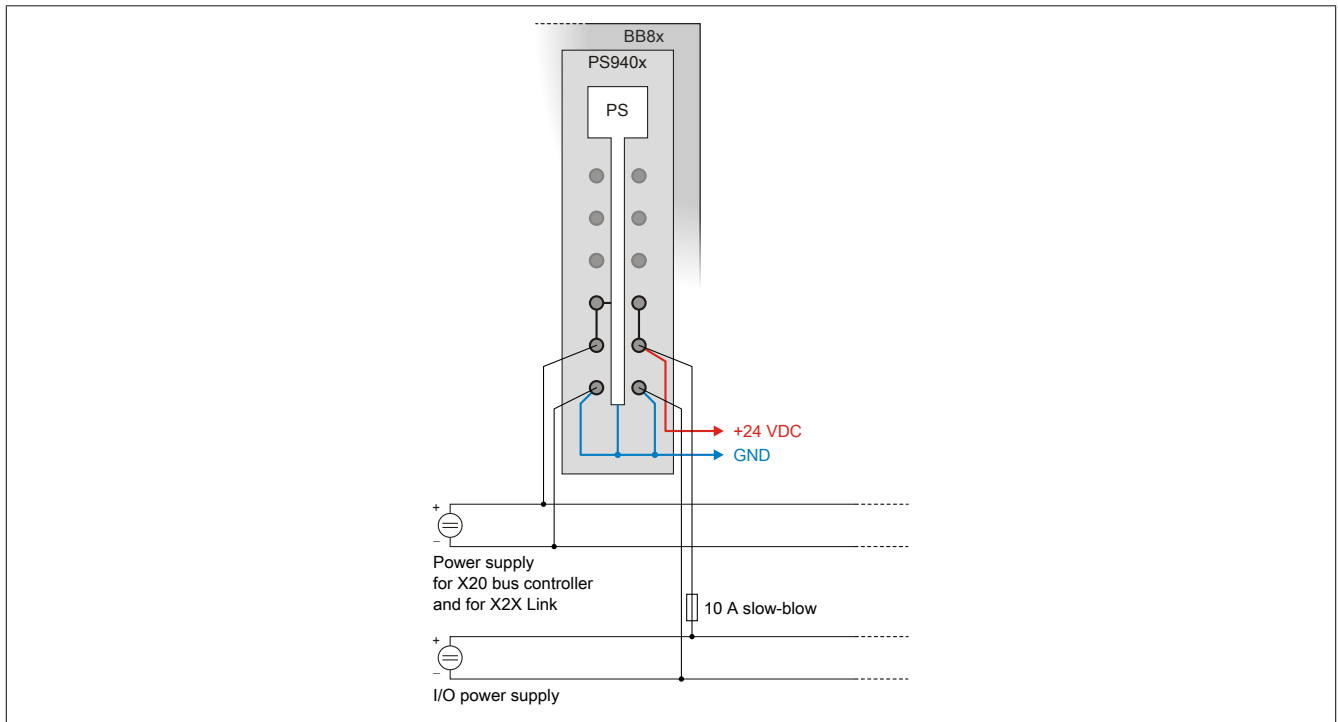


<sup>5)</sup> For hub expansion modules permitted on the X20BC8084, see "X20BC8084 - Bus controller with integrated link selector" on page 16.

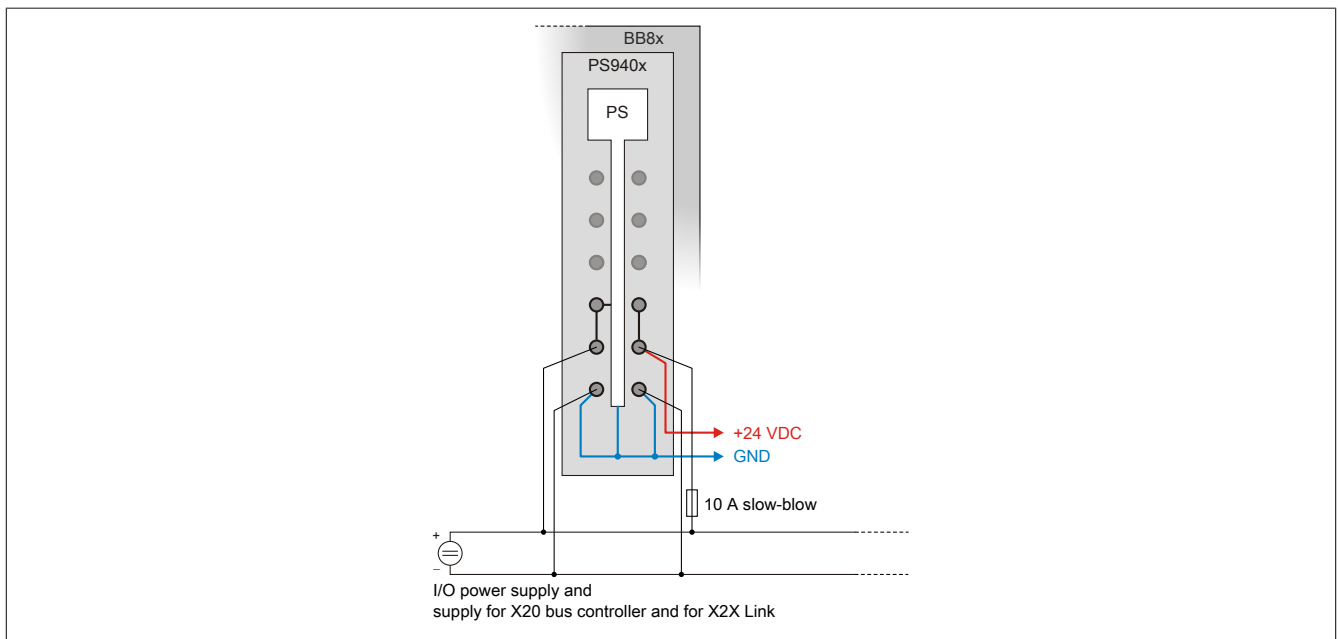
### 2.6.3.2 Wiring

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

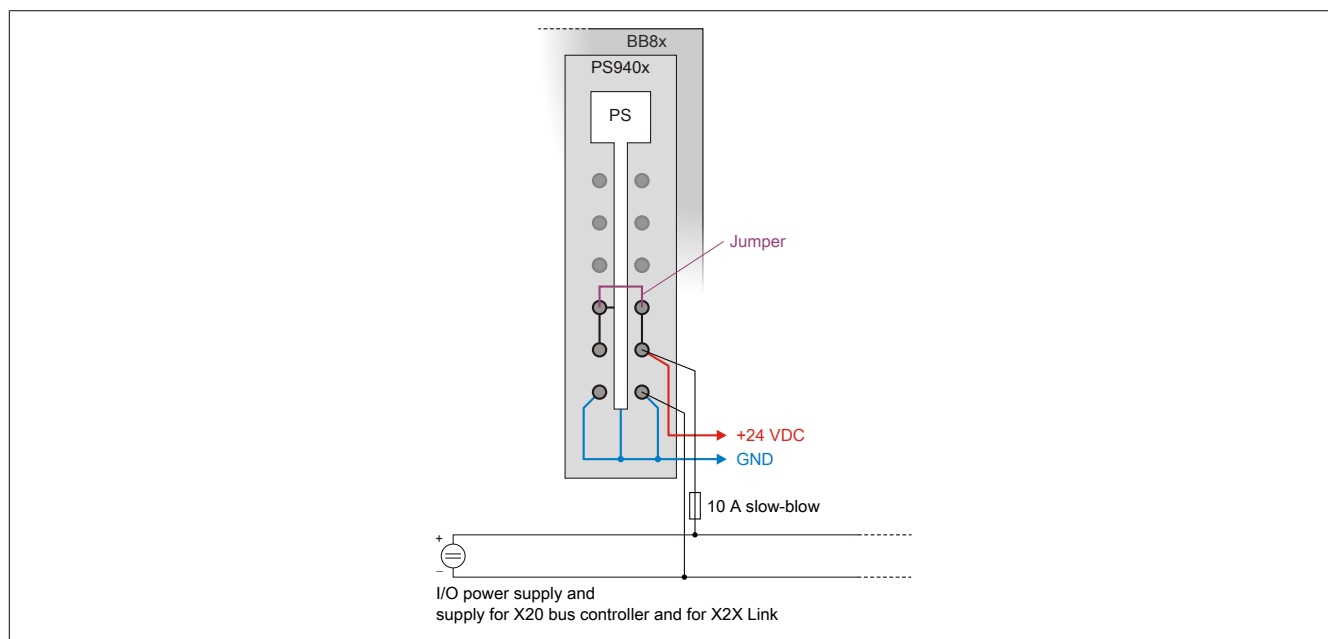
#### Variant 1



#### Variant 2



## 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

**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:

Model number	Short description
X20PS9400	X20 power supply module, for bus controller and internal I/O power supply, X2X Link power supply
X20PS3300	X20 power supply module, for X2X Link and internal I/O power supply
X20PS3310	X20 power supply module, for X2X Link and internal I/O power supply, integrated microfuse

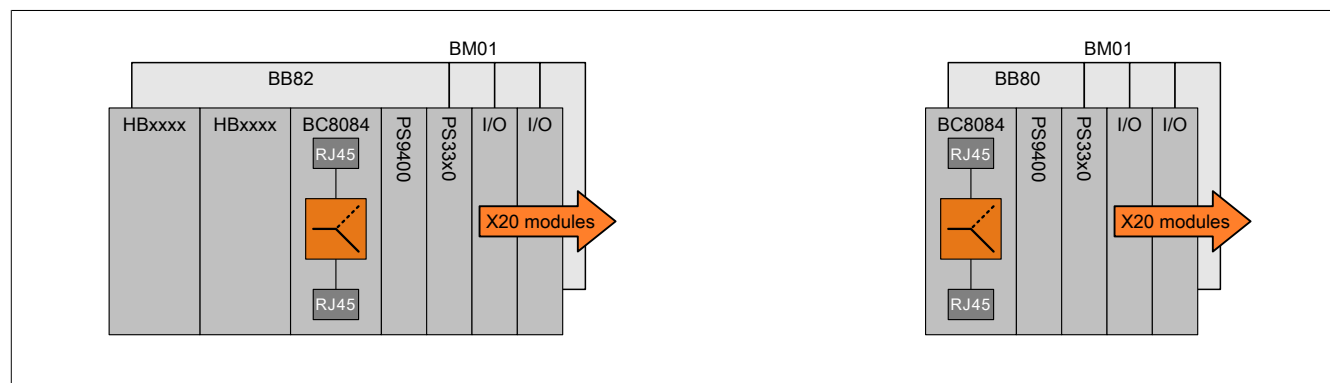
X20 POWERLINK bus controller:

Model number	Short description
X20BC0083	X20 bus controller, 1 POWERLINK interface, integrated 2-port hub, 2x RJ45, order bus base, power supply module and terminal block separately.
X20BC1083	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
X20BC8083	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.
X20BC8084	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.

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<sup>6)</sup> are being operated on the X20BC8084:



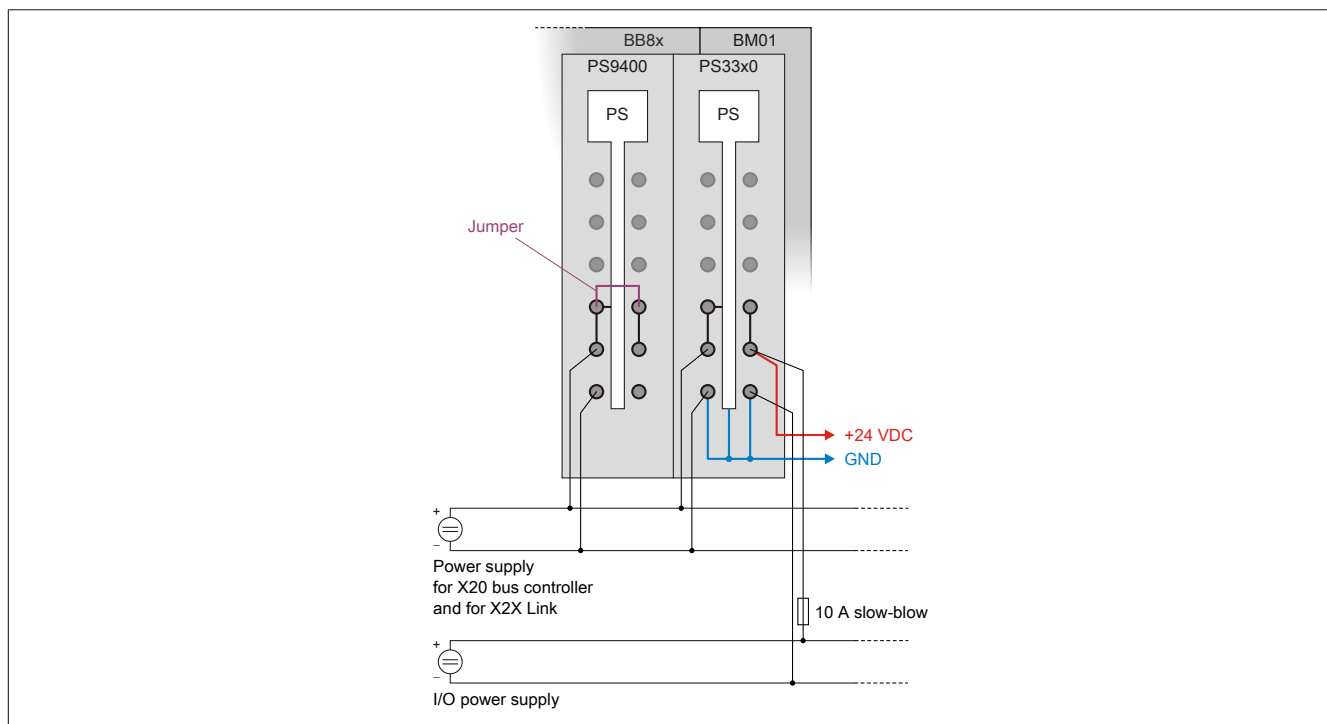
<sup>6)</sup> For hub expansion modules permitted on the X20BC8084, see "X20BC8084 - Bus controller with integrated link selector" on page 16.



### 2.6.4.2 Wiring

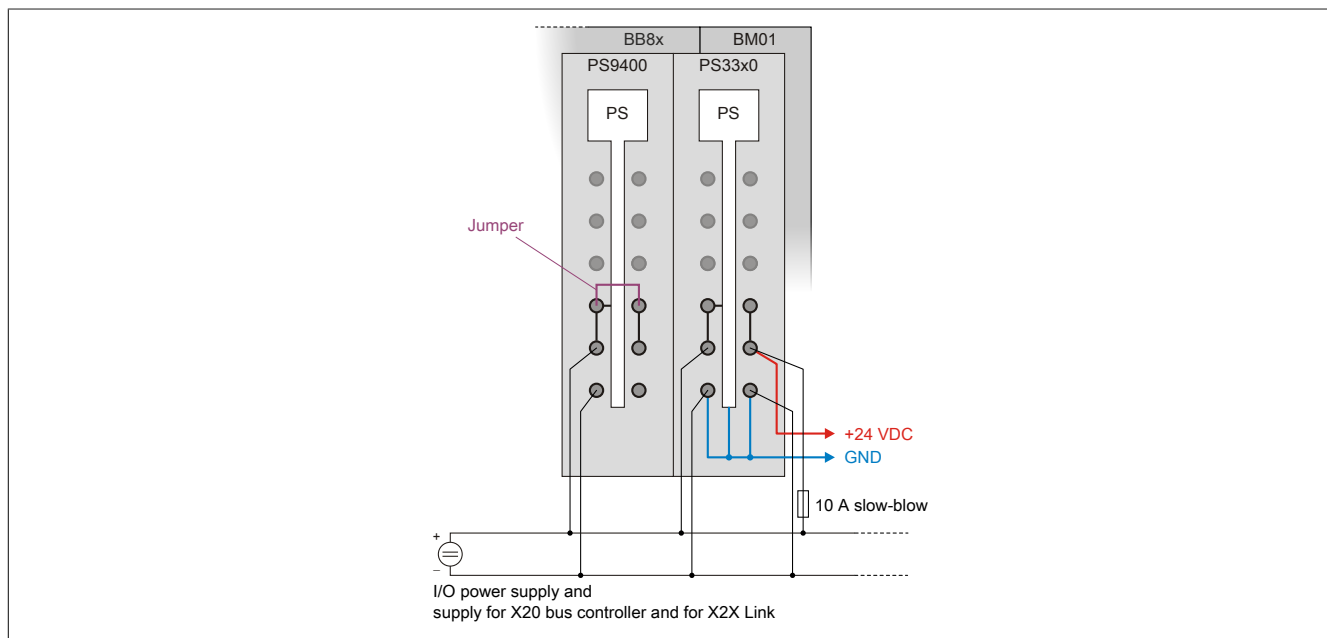
A detailed description of the supply module and related technical data can be found in the corresponding data sheet.

#### Variant 1



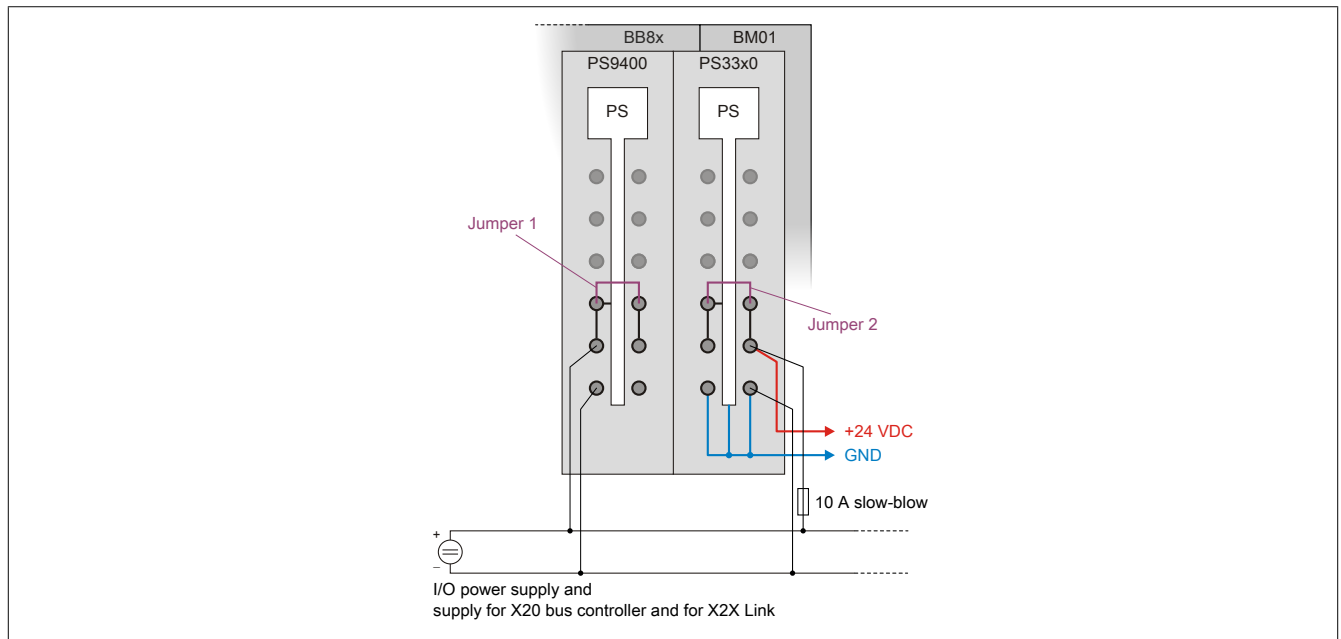
- 1) The jumper is required for the correct operation of the error LED of the X20PS9400 supply module.
- 2) The external fuse is only required when using the X20PS3300 A fuse is integrated into the X20PS3310 supply module.

#### Variant 2



- 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 3



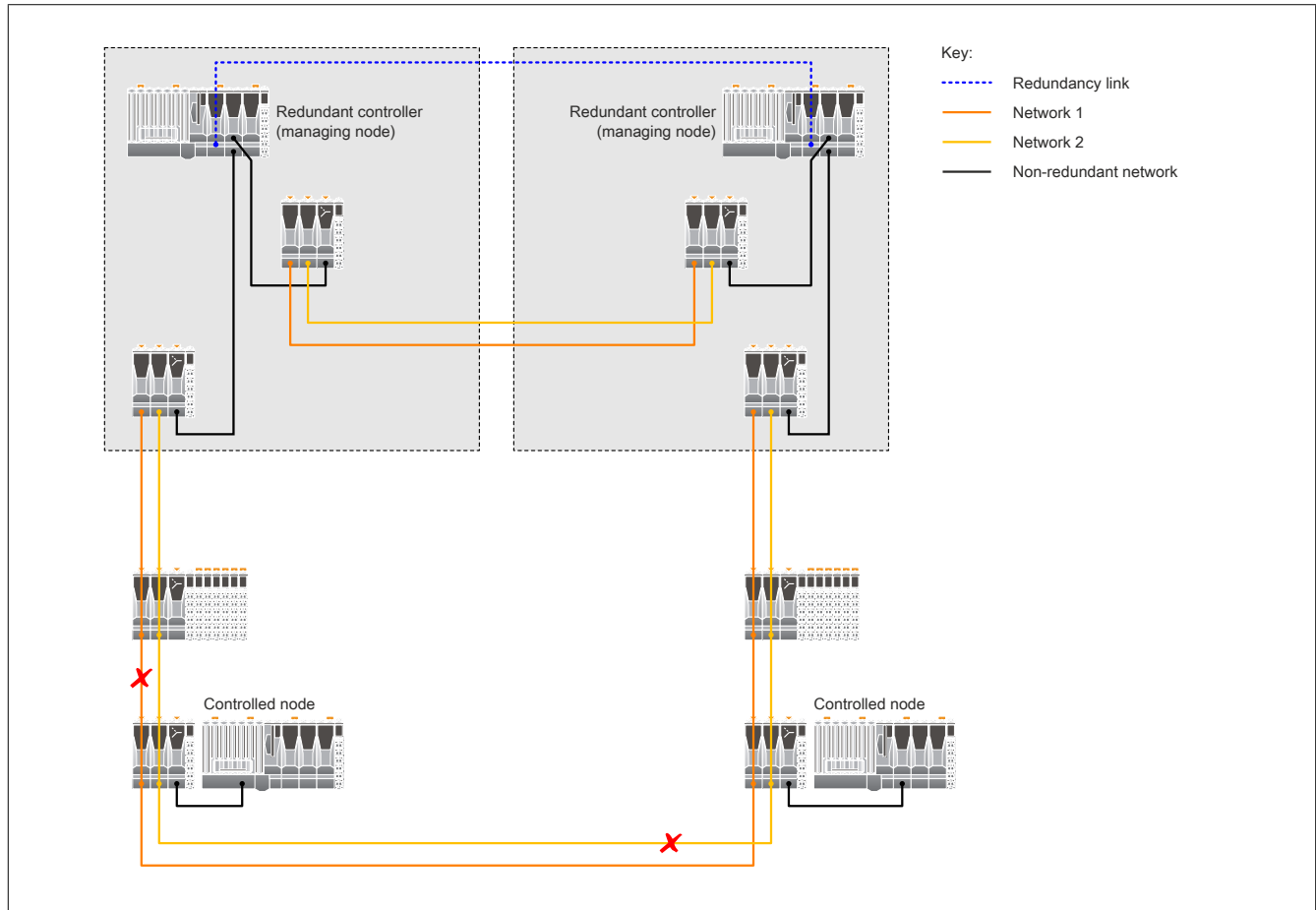
- 1) Jumper 1 is required for the correct operation of the error LED of the X20PS9400 supply module.
- 2) Jumper 2 is required for X2X Link power supply via the X20PS33x0 supply module.
- 3) The external fuse is only required when using the X20PS3300 A fuse is integrated into the X20PS3310 supply module.

## 3 Problematic cases

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

### 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:



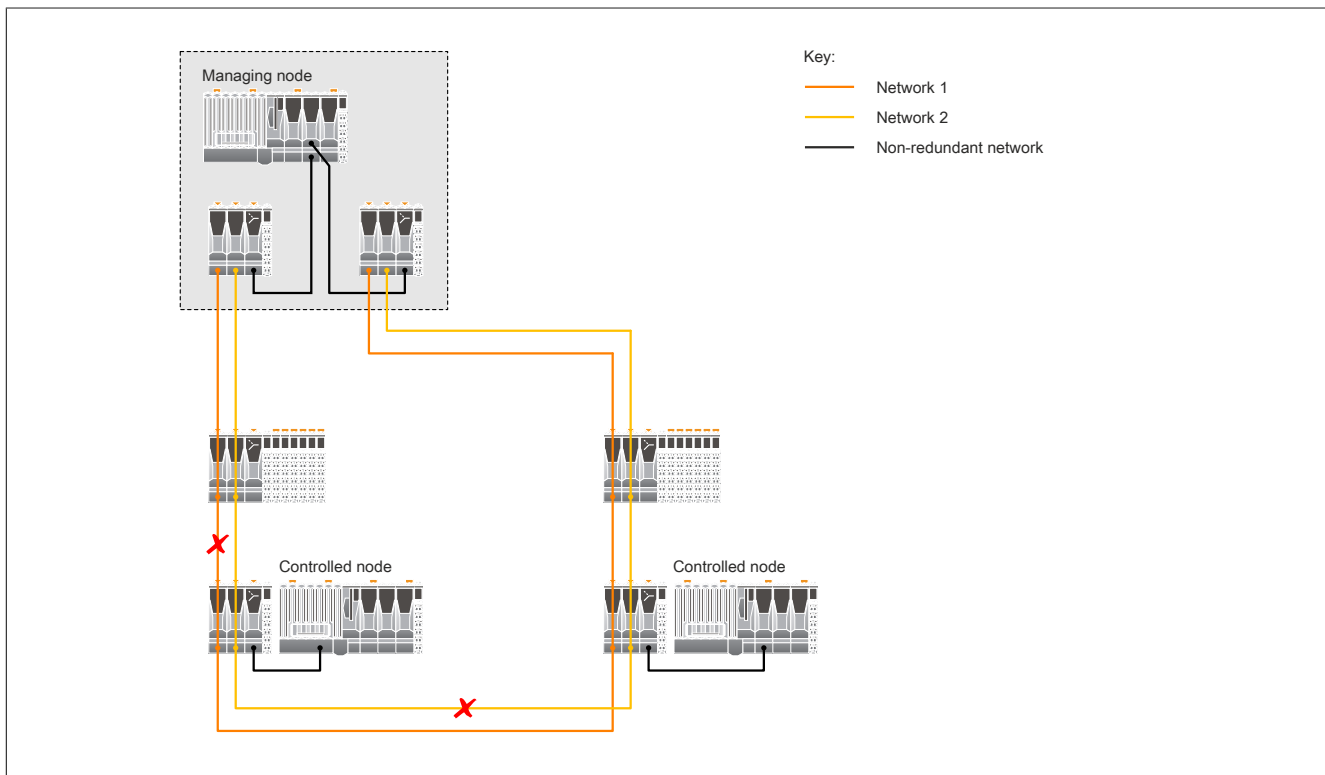
In the case of the error shown, (Network 1 and Network 2 interrupted at two different locations), the ring manager would detect the interruption of the ring and send data on both POWERLINK interfaces.

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

#### Warning!

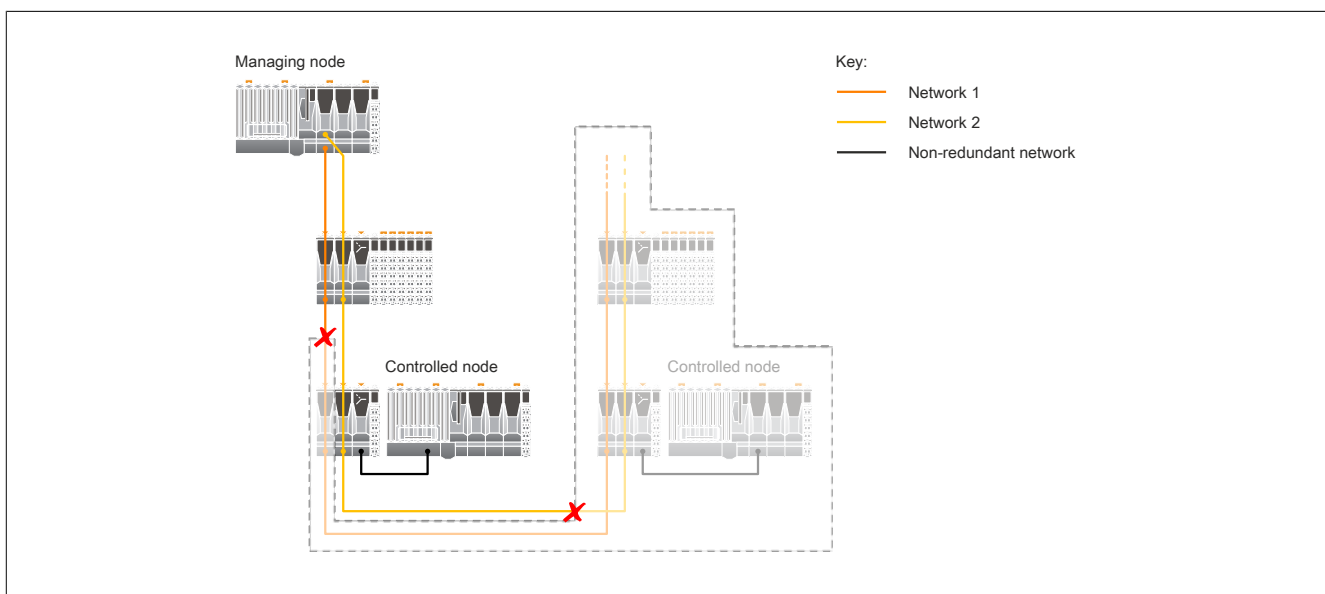
It is not permitted to set up segments of a POWERLINK ring topology with cable redundancy.

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:



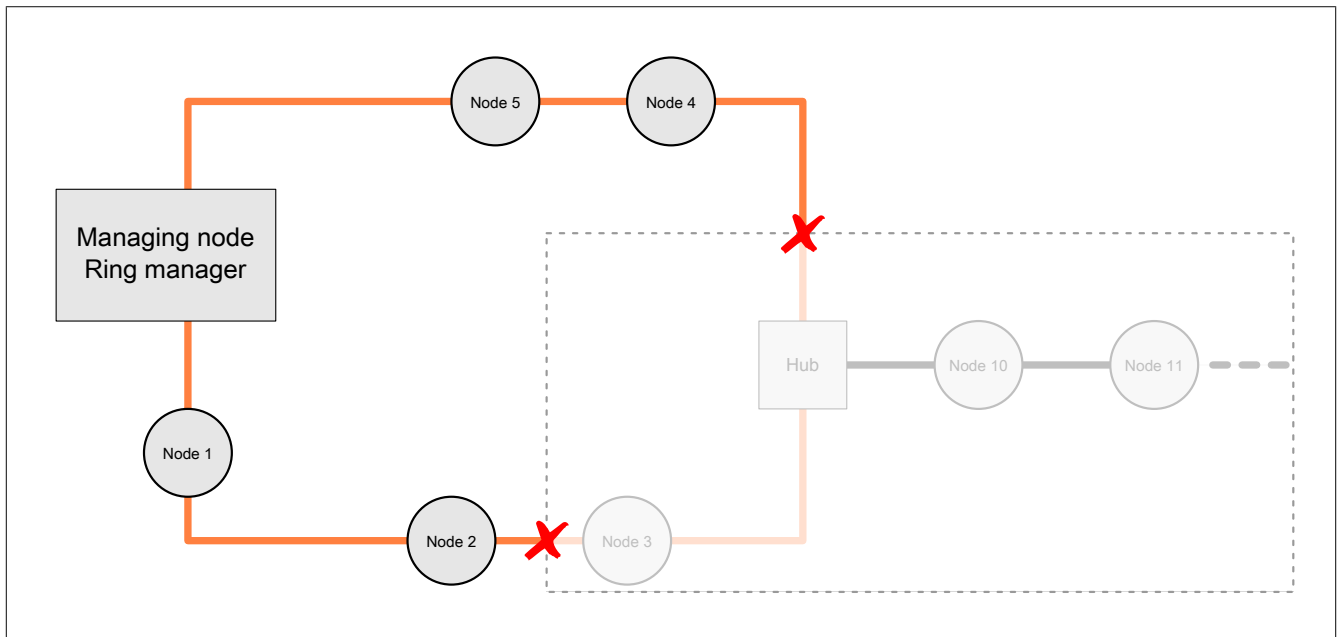
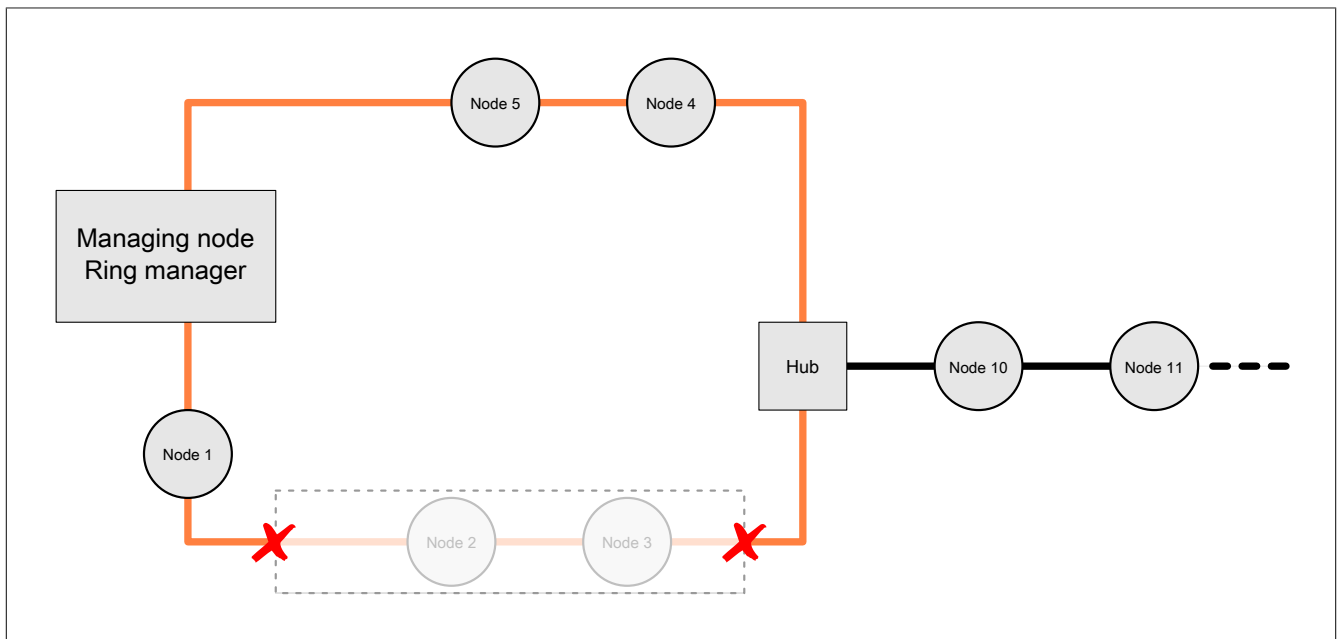
Due to the two interruptions, the marked network cables are no longer carrying data. As a result, 2 nodes are separated from the network.

### 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

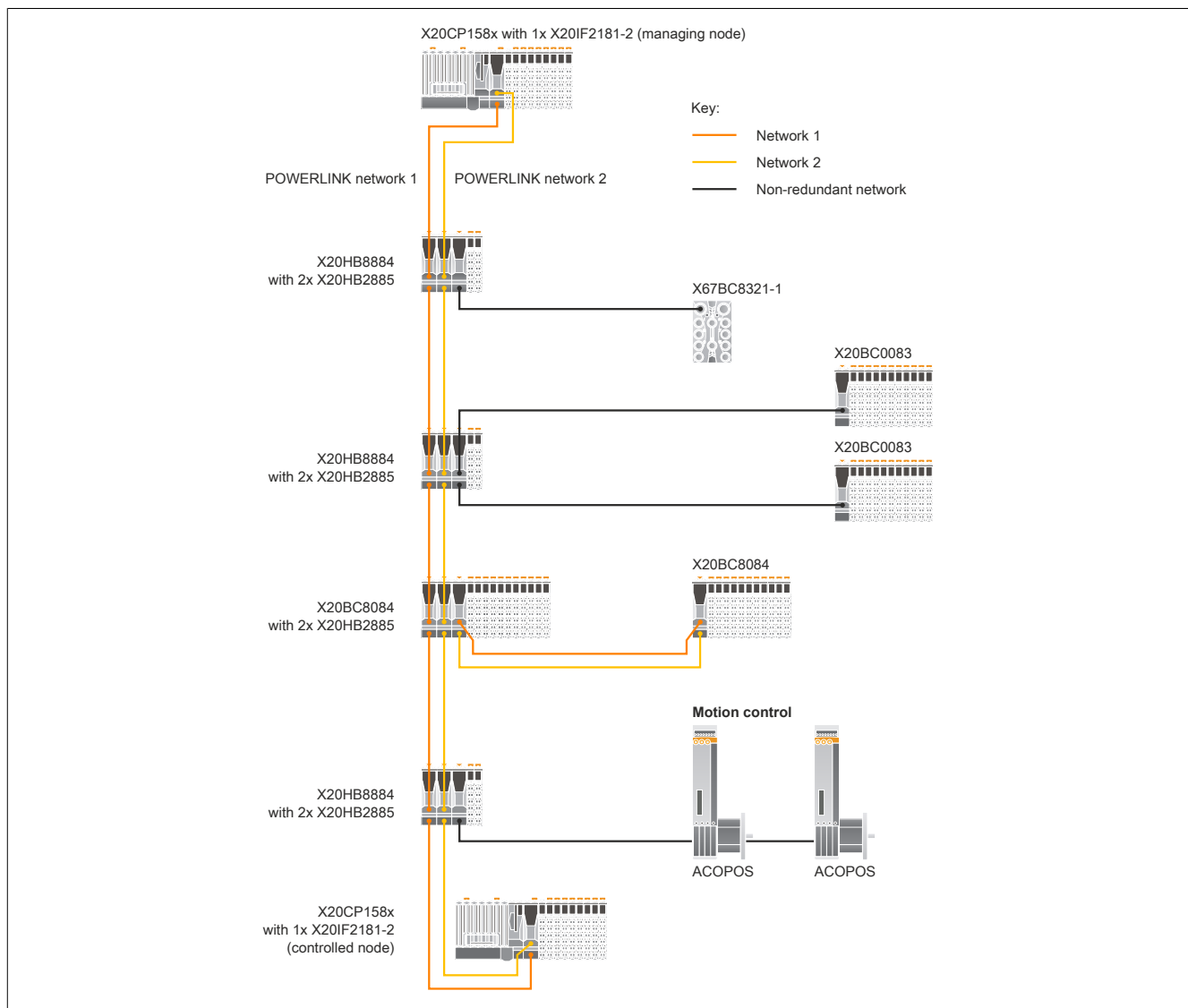
In a ring topology, multiple errors can result in the failure of individual nodes or entire network segments:



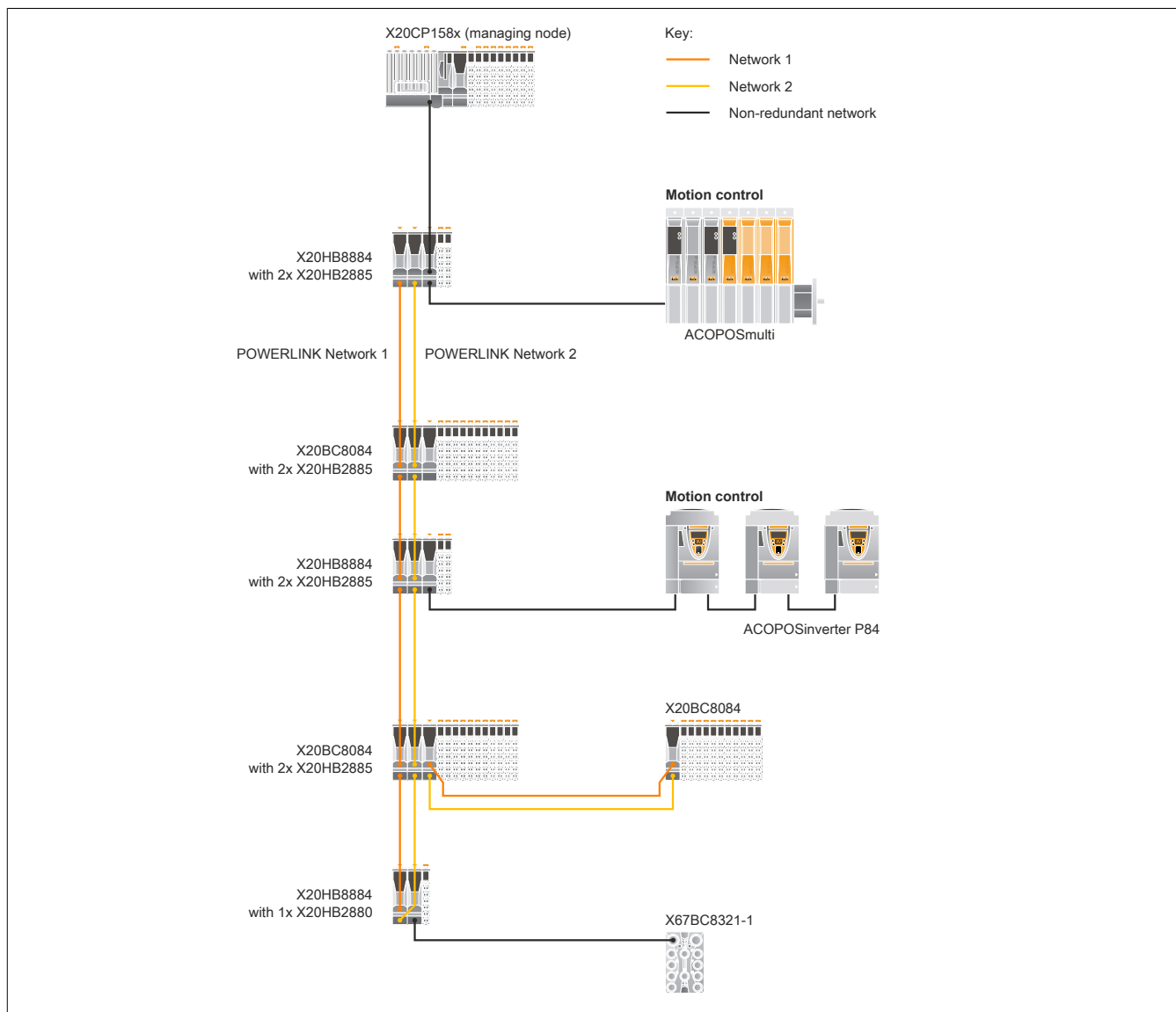
# 4 Topologies

The previous sections have described the characteristics and uses of the various hardware components. This section will provide more in-depth examples of various topologies.

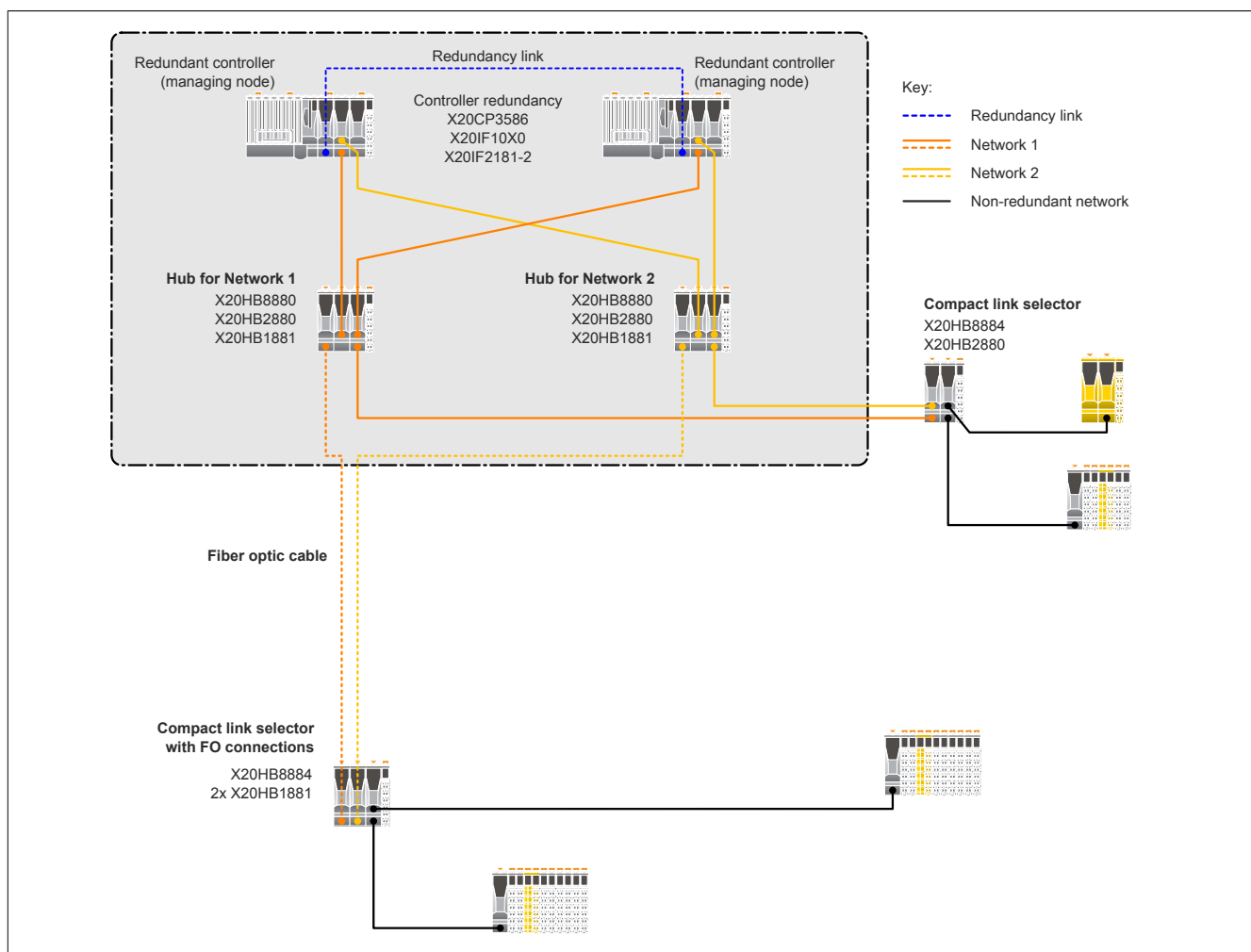
## 4.1 Cable redundancy with redundant managing node connection



## 4.2 Cable redundancy with non-redundant managing node connection

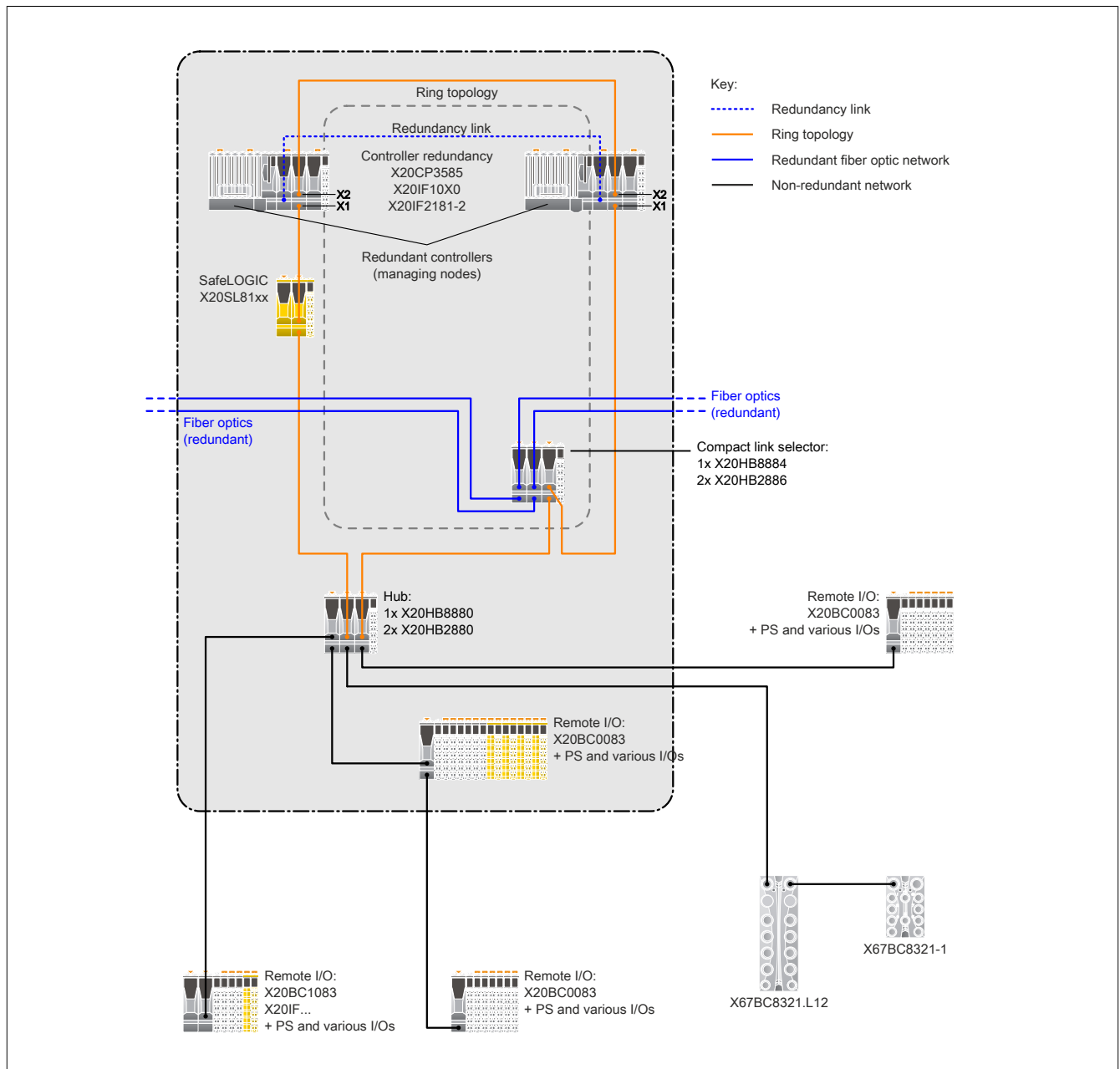


### 4.3 Controller-redundancy combined with cable redundancy

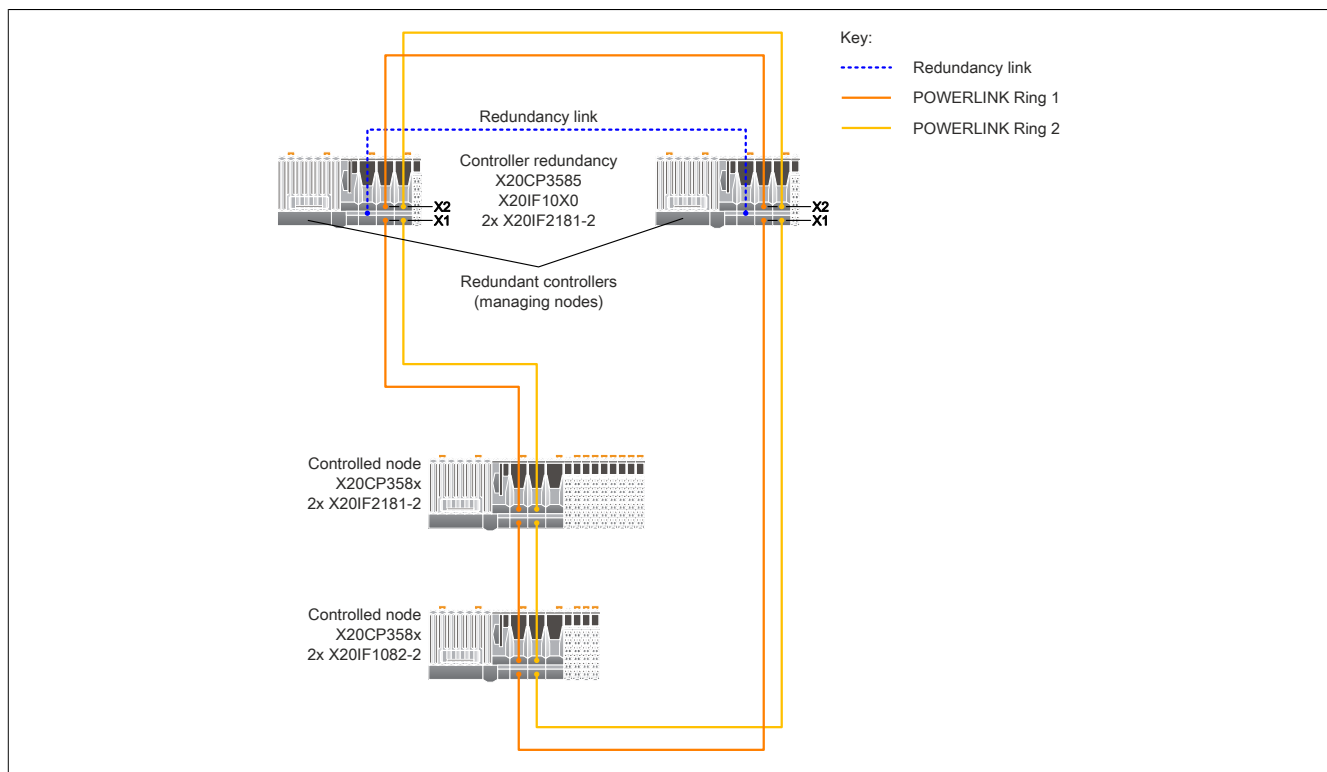




#### 4.4 Controller redundancy combined with ring and cable redundancy



## 4.5 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.