HIRSCHMANN
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User Manual

Redundancy Configuration
Industrial ETHERNET Gigabit Switch
PowerMICE, MACH 4000

Technical Support
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Contents

About this Manual

The “Redundancy Configuration” user manual contains all the information you need to select a suitable redundancy procedure and configure it.

The “Installation” user manual contains a device description, safety instructions, a description of the display, and all the other information that you need to install the device before you begin with the configuration of the device.

The “Basic Configuration” user manual contains all the information you need to start operating the switch. It takes you step by step from the first startup operation through to the basic settings for operation in your environment.

The “Industrial Protocols” user manual describes how the Switch is connected by means of a communication protocol commonly used in the industry, such as EtherNet/IP or PROFINET.

The “Routing Configuration” user manual contains all the information you need to start operating the routing function. It takes you step by step from a small router application through to the router configuration of a complex network.
The manual enables you to configure your router by following the examples.

If you use Network Management Software HiVision you have further opportunities to:

- have an event logbook.
- configure the „System Location“ and „System Name“.
- configure the network address range and SNMP parameters.
- save the configuration on the Switch.
- simultaneous configuration of several Switches.
- configure the relevant ports to be displayed red if there is no link state.

You will find detailed descriptions of how to operate the individual functions in the “Web-based Interface” and “Command Line Interface” reference manuals

Key

The designations used in this manual have the following meanings:

- ▶ List
- ☐ Work step
- ■ Subheading

Indicates a cross-reference with a stored link.

Note: A note emphasizes an important fact or draws your attention to a dependency.

`Courier font` ASCII representation in user interface

Execution in the Web-based Interface user interface

Execution in the Command Line Interface user interface

Symbols used:

Router

Switch

Bridge

Hub

A random computer

Configuration computer

Server

Introduction

The Switch contains a wide variety of redundancy functions:

- Link Aggregation
- HIPER-Ring
- Redundant coupling of HIPER-Rings and network segments
- Rapid Spanning Tree Algorithm

There are three tools for operating these functions:

- Web-based Management (supplied with the switch)
  for easy configuration of the agent (see "Web-based Interface" reference manual).
- Command Line Interface (supplied with the Switch)
  for setting basic functions (see "Command Line Interface" manual).
- HiVision Network Management
  for easy configuration of all agents (see "HiVision Hirschmann Network Management" manual).

Comparison of the Redundancy Procedures

	RSTP	**HiPER Ring Version 1, 2**	**HiPER Ring Version 3**	Redundant Coupling	Link Aggregation
Switch-over time	< 30 s, < 1 s typically (STP < 30 s) Heavily dependent on the number of switches	< 0,5 s Practically independent of the number of switches	< 10 ms With 5 Switches in the ring. With more than 5 Switches, the switching time increases.	typically 0.15 s	-
Network topology	Random structure	Ring	Ring	Coupling of network segment/rings via a main line and a redundant line	Coupling of network segments via multiple active lines with dynamic load distribution

Table 1: Features of the Redundancy Procedures

1 Link Aggregation

There is link aggregation when there are at least two link cables between two switches and when these link cables are combined to one logical link. The complete bandwidth of link cables is available for data transmission. The load distribution of the link lines is effected dynamically. All link lines together are referred to as the „trunk".

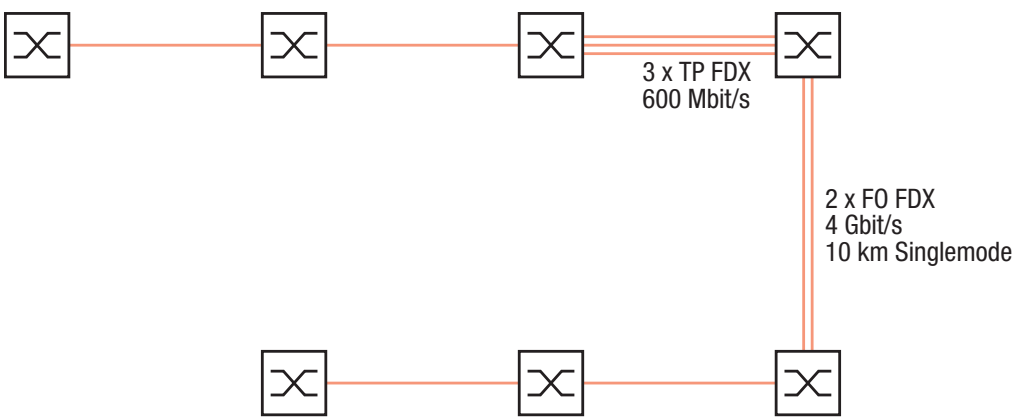


Fig. 1: Example of link aggregation

Any combination of twisted pair and LWL cables can be used as the connection lines of a trunk. It is only necessary that for all the connections, the transmission speed and the duplex settings of the related ports are the same.
You can use link aggregation to combine into a trunk up to 8 (optimally up to 4) connection lines between switches. These links increase the data rate, and, in the event that a link should fail, the remaining links take over the entire data traffic.
A maximum of 7 trunks can exit a switch.

1.1 Configuring the link aggregation

Note: A link aggregation always has two switches. Therefore, you configure the link aggregation on each of the two switches involved.

- From the switches involved in a link aggregation, you define the switch that has the most switches between itself and the switch to which the configuration PC is connected. You begin the configuration at this switch – otherwise the LACP can block ports and disconnect switches from the network.
  In the example below (see Fig. 2), you configure the link aggregation first on switch S3 and then on S2. If you disconnect switch S3 from the network by using an incorrect configuration sequence, you can access it again by selecting “Allow static link aggregation” in the `Redundancy: Link Aggregation` dialog in switch S2.

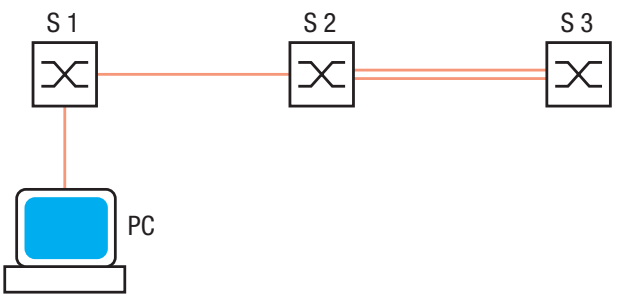


Fig. 2: Example: Defining the first switch

- During the configuration phase, you only connect one connection line between the switches. This is to avoid loops.

- On the first switch to be configured, you select the dialog `Redundancy: Link Aggregation` (see Fig. 3).

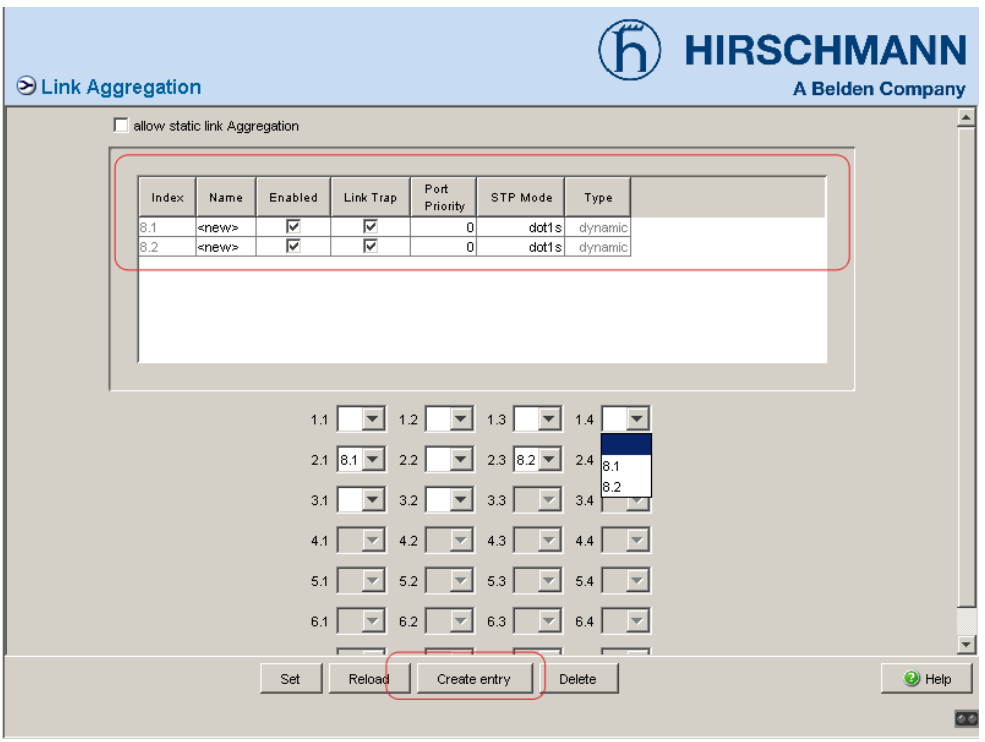


Fig. 3: Setting the link aggregation

☐ Select “Allow static link aggregation” if the partner switch does not support the Link Aggregation Control Protocol (LACP) (e.g. MACH 3000).
Switches that support LACP prevent loops when they are coupled via multiple connection lines.

☐ Click “Create entry” to set up a new link aggregation connection.

☐ The `Index` column shows you the name under which the switch uses a link aggregation (a trunk) as a virtual port.

☐ The `Name` column allows you to assign a name to this connection.

☐ The `Enabled` column allows you to activate or deactivate a set link aggregation connection.

☐ Select `Link Trap` if you want the switch to generate an alarm if all the connections of the link aggregation are interrupted.

- ☐ In the column "STP-Mode" select
  `dot1d`, if the link aggregation connection is integrated into a standard Spanning Tree.
  `fast`, if the link aggregation connection is integrated into a Rapid Spanning Tree.
  `dot1s`, if the link aggregation connection is integrated into a multiple Rapid Spanning Tree (VLAN dependent).
  `off`, if no Spanning Tree is active.

- ☐ "Type" displays whether this link aggregation connection was established manually (`allow static link aggregation` is selected) or dynamically by using LACP (`allow static link aggregation` is not selected).
  Comment: If there are multiple connections between switches that support LACP, and if `Allow static link aggregation` is nevertheless selected, `dynamic` is still displayed, because in this case the switches automatically switch to dynamic.

- ☐ Select
  on the ports participating in the link aggregation
  the index of the link aggregation connection which the port is to be a part of (see Fig. 4).

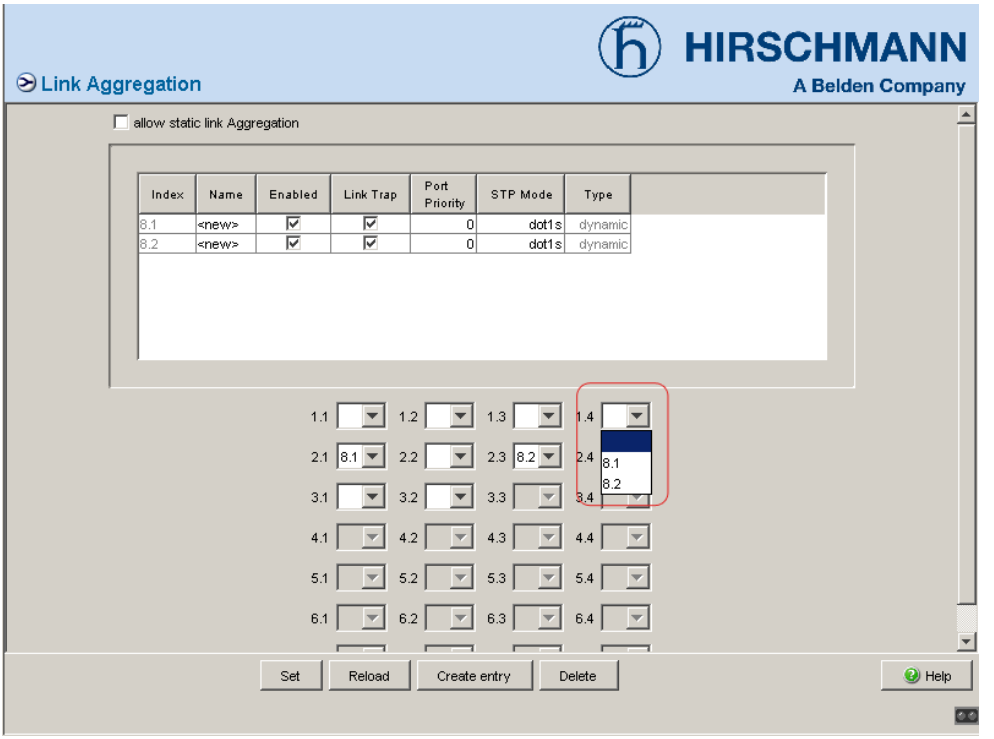


Fig. 4: Selecting ports

☐ Set all the ports participating in the link aggregation to the same speed and full-duplex settings. For this you select the `Basics:Port Configuration`.

☐ Now you configure the partner switch in the same way.

☐ Now you connect the other connection line(s) between the switches.

Note: To increase the safety of particularly critical connections, the redundancy functions HIPER-Ring and link aggregation can be combined.

Note: For redundancy safety reasons, a combination of network/ring coupling and link aggregation is not possible at the same port.

1.2 HIPER-Ring and Link Aggregation

To increase the safety of particularly critical connections, the redundancy functions HIPER-Ring (see “Redundant ring structure – HIPER-Ring” on page 19) and link aggregation can be combined.

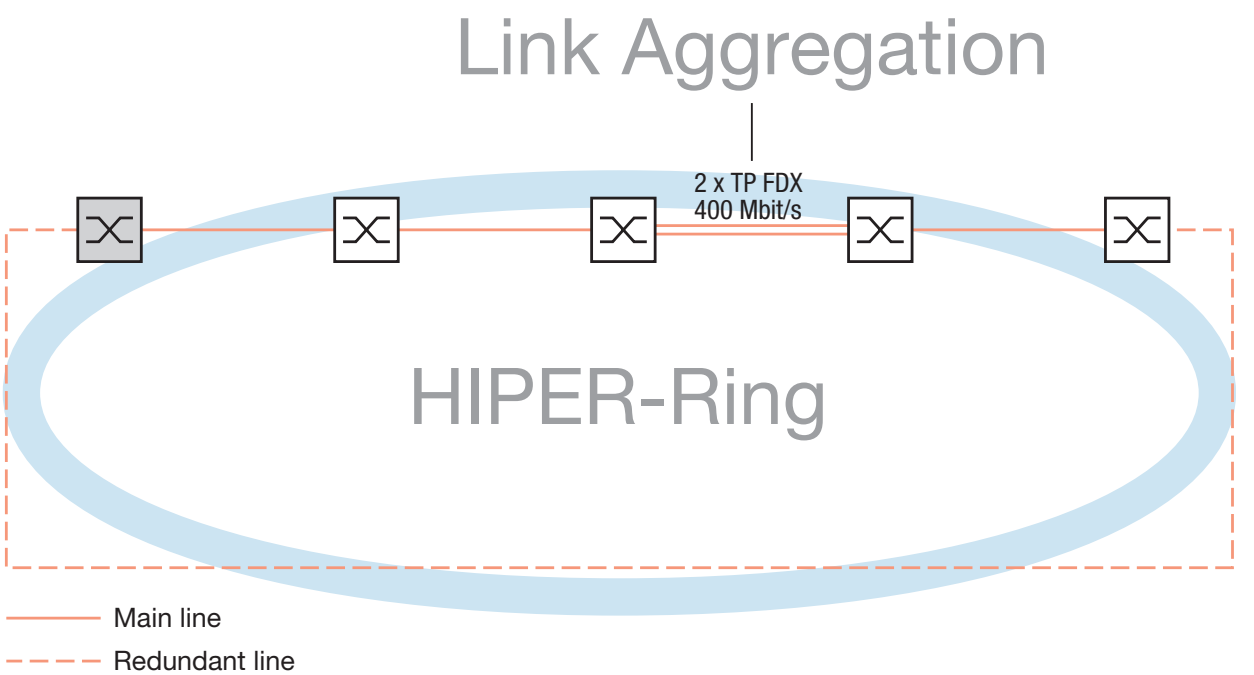


Fig. 5: Example of a HIPER-Ring combined with link aggregation

The example above illustrates a HIPER-Ring. A link aggregation connection forms a segment of the ring. The HIPER-Ring function does not activate the redundant link of the ring until all connecting links of the link aggregation connection have been interrupted.

Note: Please note that the respective HIPER-Ring port is involved in the selected link aggregation.

2 Redundant ring structure – HIPER-Ring

2.1 The HIPER-Ring

The concept of the HIPER-Ring enables the construction of high-availability, ring-shaped network structures.
By using the RM function (Redundancy Manager) of a switch with software L2E, L2P, L3E or L3P, both ends of a backbone in a line-type configuration can be closed to create a redundant ring - the HIPER-Ring (see Fig. 6).
For HIPER-Ring Version 1 it is possible to mix the RS1, RS2-../.., RS2-16M, RS2-4R, RS20, RS30, RS40, MICE, PowerMICE, MS 20, MS 30, RSR20, RSR30, MACH 1000, MACH 3000 and MACH 4000 in any combination within the HIPER-Ring.
For HIPER-Ring Version 2 (MRP Draft) it is possible to mix the devices that support this function in any combination within the HIPER-Ring.
For HIPER-Ring Version 3 it is possible to mix the RSR20, RSR30 and MACH 1000 in any combination within the HIPER-Ring.

If a section is down, the ring structure of a

- HIPER-Ring Version 1 or Version 2 of up to 50 Switches typically transforms back to a line structure within 150 ms (maximum 500 ms).
- HIPER-Ring Version 3 of up to 5 Switches typically transforms back to a line structure within 5 ms (maximum 10 ms). If a larger number of Switches is being used, the reconfiguration time increases.

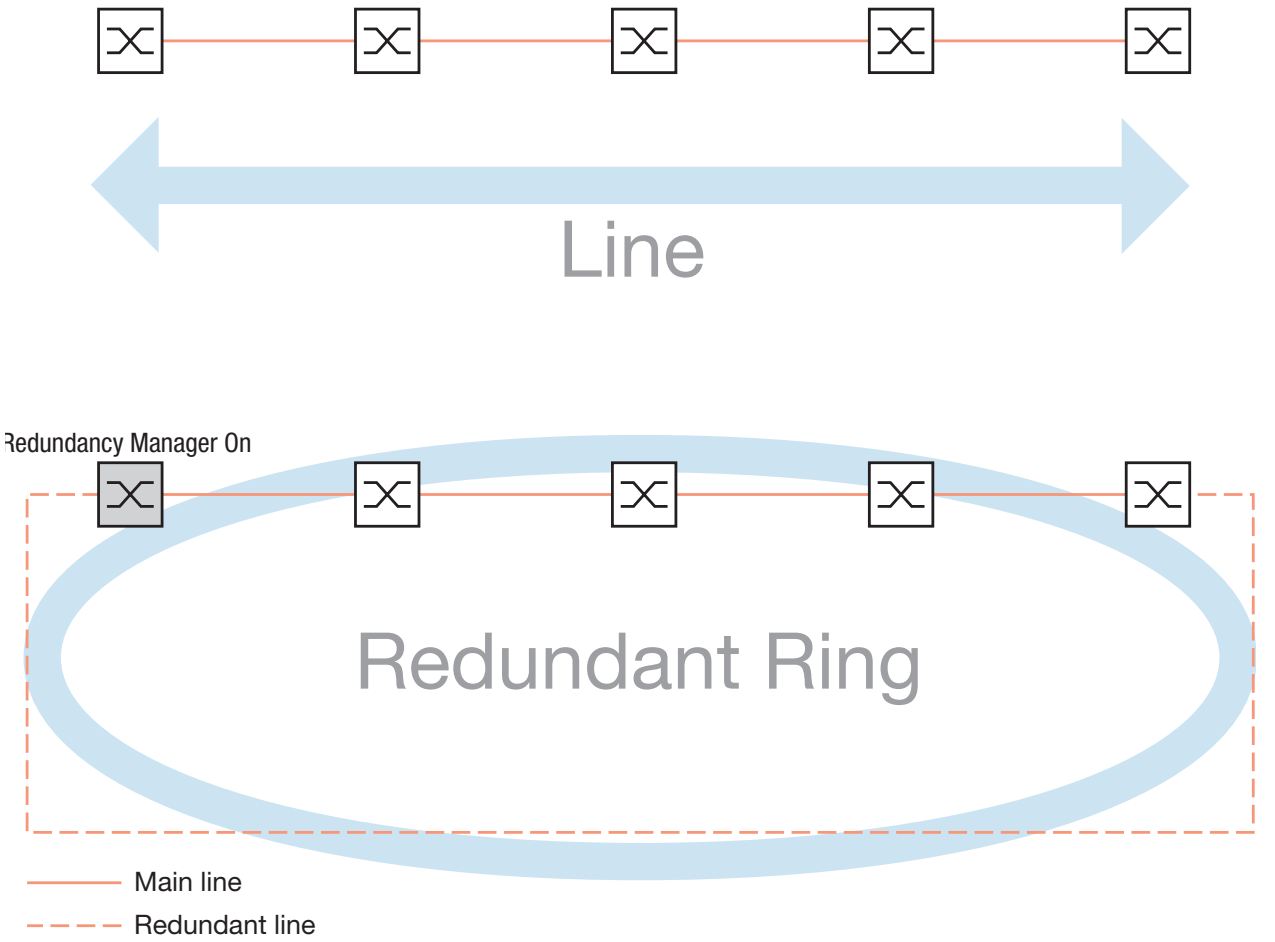


Fig. 6: Line and redundant ring

2.1.1 Configuring the HIPER-Ring Version 1

☐ Set up the network to meet your requirements.

Note: Before you connect the redundant line, you must complete the configuration of the HIPER-Ring Version 1.
You thus avoid loops during the configuration phase

☐ Select the `Redundancy:HIPER-Ring` dialog.

☐ Select `Version 1`.

Note: As an alternative to using software to configure the HIPER-Ring Version 1, you can also enter a number of settings for the HIPER-Ring Version 1 with a DIP switch. You can use this DIP switch to enter a setting for the switches MS 20, MS 30 and PowerMICE, whether the configuration via DIP switch or the configuration via software has priority. The state on delivery is “Software Configuration”

☐ For each switch, you enter the desired ring ports 1 and 2.
The following settings are required for the ring ports (for this you select the `Basics:Port Configuration` dialog):

Bit rate	100 Mbit/s	1000 Mbit/s
Duplex	full	–
Autonegotiation (Automatic Configuration)	off	on
Port	on	on

Table 2: Port settings for ring ports

Note: When you use 100 Mbit/s and full-duplex with twisted pair cables, the autocrossing function is deactivated. You therefore use crossover cables.

Display in “Operation” field:
Active: this port is switched on and has a link
Inactive: this port is switched off or has no link

☐ At exactly one switch, you switch the Redundancy Manager on at the ends of the line.

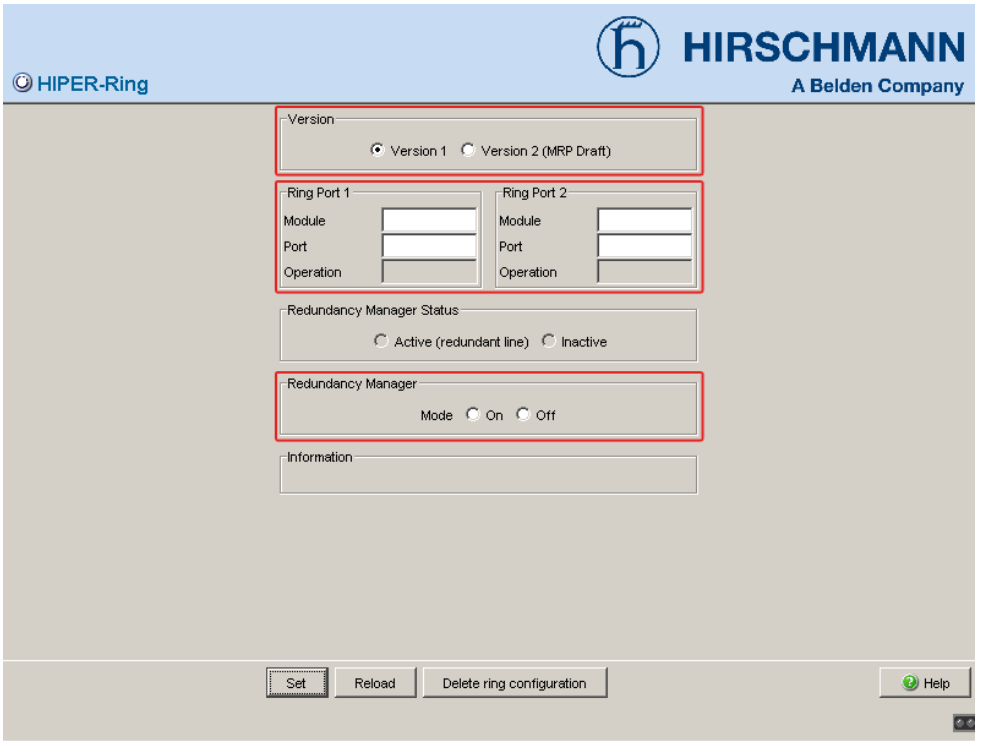


Fig. 7: Selecting the HIPER-Ring version, entering the Rng Ports and switching on/off the Redundancy Manager

Note: Deactivate the spanning tree protocol on the ports connected to the redundant ring, since spanning tree and ring redundancy operate at different reaction times.

Note: If you have activated the HIPER-Ring function via the DIP switches, RSTP will be switched off automatically.

☐ Now you connect the line to the ring. To do this, you connect the two switches to the ends of the line using their ring ports.

The displays in the “Status of the redundancy manger” frame mean:
– “Active (redundant line)”: The ring is open, which means that a data cable or a network component within the ring is down.
– “Inactive”: The ring is closed, which means that the data lines and network components are working.

The displays in the “Information” frame mean:

– “Redundancy working”: One of the lines affected by the function can fail, as then the redundant line will take over the function of the failed line.

– “Configuration error”: The function is incomplete or incorrectly configured.

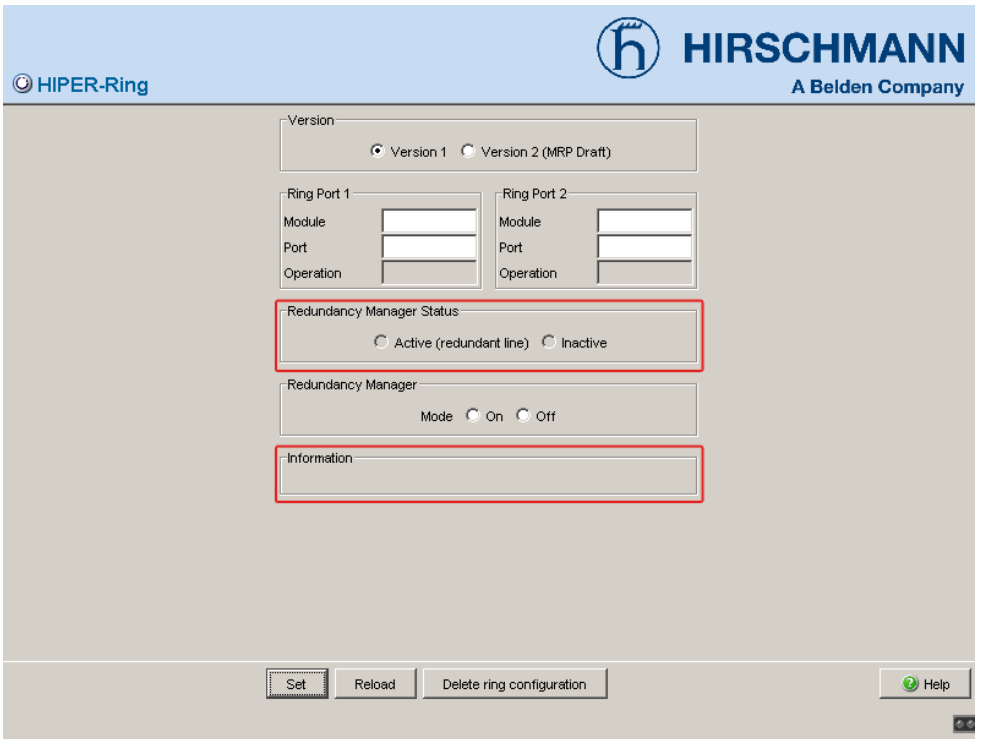


Fig. 8: Selecting the Redundancy Manager status and Information

Note: If there are VLANs configured, then consider the VLAN configuration of the ring ports.
In the HIPER-Ring configuration, select for the ring ports
– VLAN ID 1 and
– VLAN affiliation U in the static VLAN table.

Note: If you wish to use link aggregation together with HIPER-Ring, then enter the index of the desired link aggregation entry for the module and port.

Note: When you switch from a normal port to a ring port with the DIP switch, the device makes the required settings for the ring ports in the configuration table. The port which has been switched from a ring port to a normal port keeps the ring port settings. These settings remain changeable for all ports.

2.1.2 Configuring the HIPER-Ring Version 2 (MRP Draft)

☐ Set up the network to meet your requirements.

Note: Before you connect the redundant line, you must complete the configuration of the HIPER-Ring.
You thus avoid loops during the configuration phase.

☐ Select the `Redundancy:HIPER-Ring` dialog.

☐ Select `Version 2 (MRP Draft)`..

☐ For each switch, you enter the desired ring ports 1 and 2.
The following settings are required for the ring ports (for this you select the `Basics:Port Configuration` dialog):

Bit rate	100 Mbit/s	1000 Mbit/s
Duplex	full	–
Autonegotiation (automatic configuration)	Off	On
Port	On	On

Table 3: Port settings for ring ports

Note: When you use 100 Mbit/s and full-duplex with twisted pair cables, the autocrossing function is deactivated. You therefore use crossover cables.

Display in “Operation” field:
forwarding: this port is switched on and has a link.
blocked: this port is blocked and has a link.
disabled: this port is switched off
not-connected: this port does not have a link.

☐ At exactly one switch, you switch the redundancy manager on at the ends of the line.

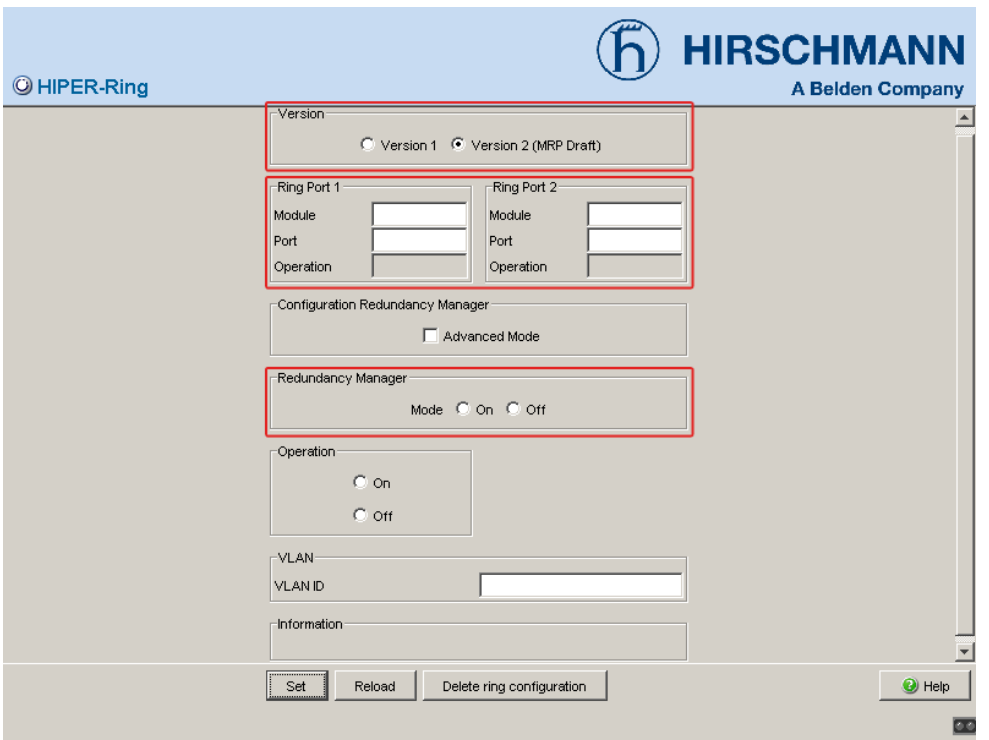


Fig. 9: Selecting the HIPER-Ring version, entering the Rng Ports and switching on/off the Redundancy Manager

If a switch in the ring does not support the advanced mode for fast switching times, you deactivate the advanced mode in the redundancy manager, in the “Configuration” frame.
All Hirschmann switches that support the HIPER-Ring Version 2 (MRP Draft) also support the advanced mode.

Note: Deactivate the Spanning Tree protocol for the ports connected to the redundant ring, because Spanning Tree and ring redundancy work with different reaction times.

The “VLAN” frame enables you to assign the MRP-Ring to a VLAN.

☐ If VLANs are configured, you make the following selections in the “VLAN” frame:
– VLAN-ID 0, if the MRP-Ring configuration is not to be assigned to a VLAN.
Note the VLAN configuration of the ring ports: Then select for the ring ports
– VLAN ID 1 and
– VLAN membership U in the static VLAN table.
– VLAN-ID >0, if the MRP-Ring configuration is to be assigned to this VLAN.
Select this VLAN ID in the MRP-Ring configuration for all devices in this MRP-Ring.
Note the VLAN configuration of the ring ports: Then you select for all ring ports in this MRP-Ring
– this VLAN ID and
– VLAN membership U in the static VLAN table.

☐ Activate the function in the “Operation” frame.

☐ Now you connect the line to the ring. To do this, you connect the two switches to the ends of the line using their ring ports.

The displays in the “Information” frame mean:
– “Redundancy working”: One of the lines affected by the function can fail, as the redundant line will then take over the function of the failed line.
– “Configuration error”: The function is incomplete or incorrectly configured.

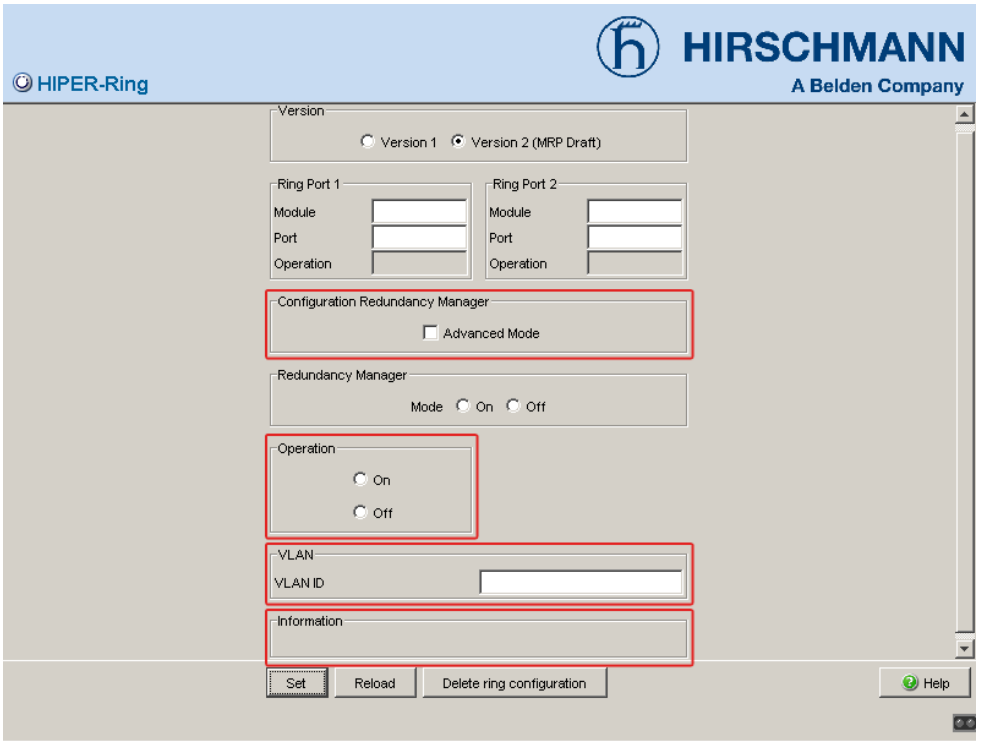


Fig. 10: Entering Configuration Redundancy Manager, selecting Operation and Information and entering VLAN ID

3 Redundant coupling

3.1 The Variants of Redundant Coupling

The control intelligence built into the Switch allows the redundant coupling of HIPER-Rings and network segments.
Two rings/network segments are connected over two separate paths with one of the following switches:

- RS2-16M,
- RS20, RS30, RS40,
- MICE (Rel. 3.0 or higher) or
- PowerMICE,
- MS20, MS30,
- RSR20, RSR30,
- MACH 1000,
- MACH 3000 (ab Rel. 3.3),
- MACH 4000.

The redundant coupling is effected by the **one-switch coupling** of two ports of **one** switch in the first ring/network segment, to one port each of two switches in the second ring/network segment (see Fig. 12).
Immediately after the main line fails, the switch opens the redundant line. When the main line is OK again, the main line is opened again and the redundant line is re-blocked.
An error is detected and eliminated within 500 ms (typically 150 ms).

The redundant coupling is effected by the **two-switch coupling** of one port each from **two** switches in the first ring/network segment, to one port each of two switches in the second ring/network segment (see Fig. 18) .
The switch in the redundant line and the switch in the main line inform each other about their operating states by using control frames via the Ethernet or the control line.

Immediately after the main line fails, the redundant switch switches to the redundant line. As soon as the main line is restored to normal operation, the switch in the main line informs the redundant switch. The main line is re-activated, and the redundant line is re-blocked.
An error is detected and eliminated within 500 ms (150 ms typically).

The type of coupling primarily depends on the topological conditions and the desired level of safety (see Table 4 on page 30).

	One-switch coupling	Two-switch coupling	Two-switch coupling with control line
Use	The two switches are in impractical topological positions. Putting the lines down between them would involve a lot of work for two-switch coupling.	The two switches are in practical topological positions. Putting down a control line would involve a lot of work.	The two switches are in practical topological positions. Putting down a control line would not involve much work.
Disadvantage	If the switch configured for the redundant coupling fails, no connection remains between the networks.	Much work involved in connecting the two switches to the network (compared with one-switch coupling).	Much work involved in connecting the two switches to the network (compared with one-switch and two-switch coupling).
Advantage	Less work involved in connecting the two switches to the network (compared with two-switch coupling).	If one of the switches configured for the redundant coupling fails, there is still a connection between the networks.	If one of the switches configured for the redundant coupling fails, there is still a connection between the networks.

Table 4: Selection criteria for the variants of the redundant coupling

3.2 Configuring the Redundant Coupling

3.2.1 STAND-BY Switch

The Switches have a STAND-BY switch for selecting between the main coupling and the redundant coupling. Depending on the Switch, this switch is a DIP switch or a software switch (`Redundancy:Ring/Network Coupling` dialog), or you can use a switch to select one of the two options.

Switch	STAND-BY switch
RS2-../..	DIP switch
RS2-16M	DIP switch
RS20/RS30/RS40	DIP switch
MICE/PowerMICE	Can be switched between DIP switch and software switch
MS 20/MS 30	Can be switched between DIP switch and software switch
RSR20/RSR30	Software switch
MACH 1000	Software switch
MACH 3000/MACH 4000	Software switch

Table 5: STAND-BY switches of the Switches

Depending on the Switch used, you choose between the main coupling and the redundant coupling (see Table 6 on page 32).

Switch with	Choice of main coupling or redundant coupling
DIP switch	“STAND-BY” on DIP switch
DIP switch/software switch option	According to the option selected - “Stand-by” on the DIP switch or in the - `Redundancy:Ring/Network Coupling` dialog, by selecting in “Select configuration”. `Note`: These devices have a DIP switch, with which you can choose between the software configuration and the DIP configuration. If the software configuration is set, the other DIP switches have no effect.
Software switch	In the `Redundancy:Ring/Network Coupling` dialog

Table 6: Choice of main coupling or redundant coupling

☐ Select the dialog `Redundancy:Ring/Network Coupling.`

☐ You first select the configuration you want: One-switch coupling (“1”), two-switch coupling (“2”) or two-switch coupling with control line (“3”), (see Fig. 11).

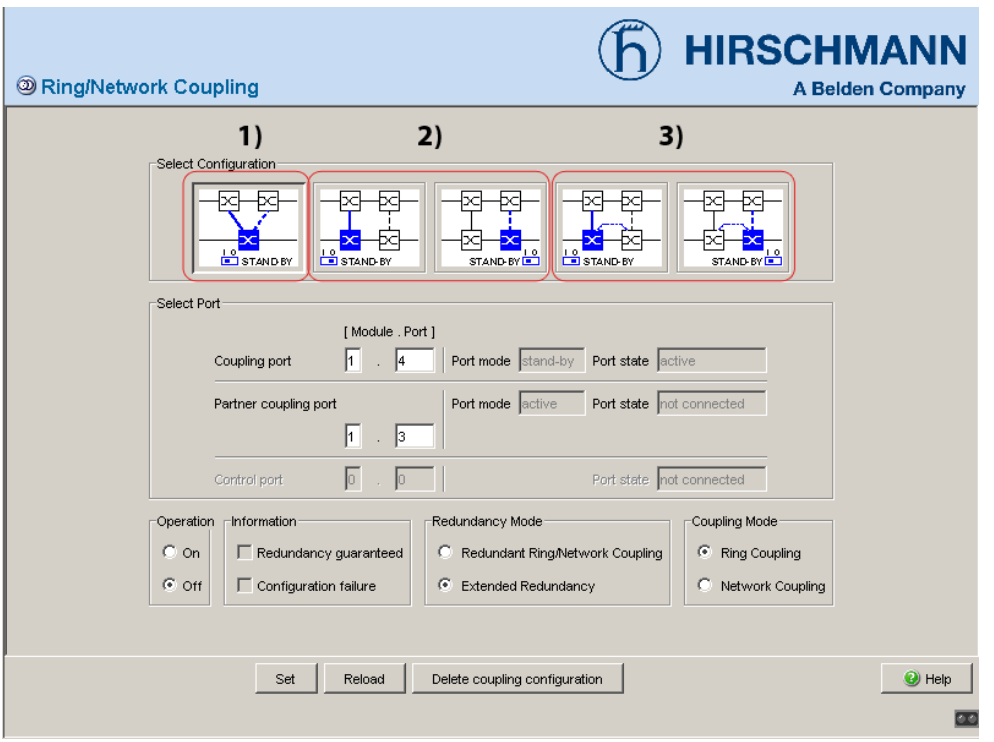


Fig. 11: Selecting the configuration

Note: The dialog shows, dependent on the STANDBY DIP switch position, the not possible configuration options grey-backed. If you want to select one of this grey-backed configurations, you put the STANDBY DIP switch on the Switch into the appropriate position.

Note: One-switch coupling: The redundancy function is assigned to the switch via the “Stand-by” setting in the DIP switch, or via the Management.

Note: Two-switch coupling: The redundancy function is assigned to the switch in the redundant line via the “Stand-by” setting in the DIP switch, or via the Management.

Note: Some devices have a DIP switch, with which you can choose between the software configuration and the DIP configuration. If the software configuration is set, the other DIP switches have no effect.

Note: The choice of configuration primarily depends on the topological conditions and the desired level of safety (see Table 4 on page 30).

Note: For redundancy security reasons, a combination of Rapid Spanning Tree and ring/network coupling is not possible.

3.2.2 One-switch coupling

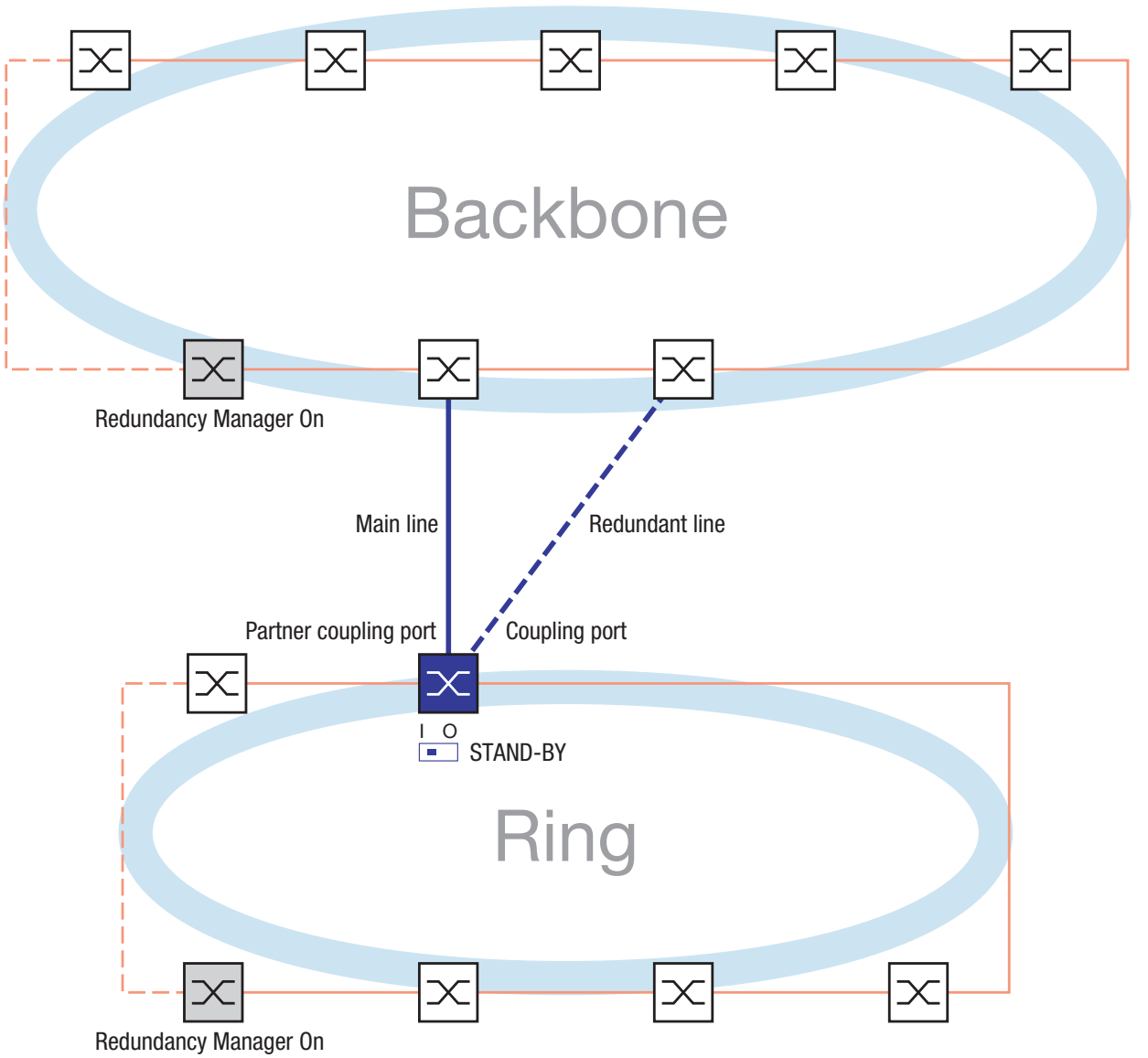


Fig. 12: Example one-switch coupling

The coupling between two networks is effected by the main line (thick blue line), which is connected to the partner coupling port. If the main line fails, the redundant line (thick, blue dashed line), which is connected to the coupling port, takes over coupling the two networks. The coupling is effected by **one** Switch.

☐ Select the dialog `Redundancy:Ring/Network Coupling.`

☐ Select the one-switch main coupling (see Fig. 13)

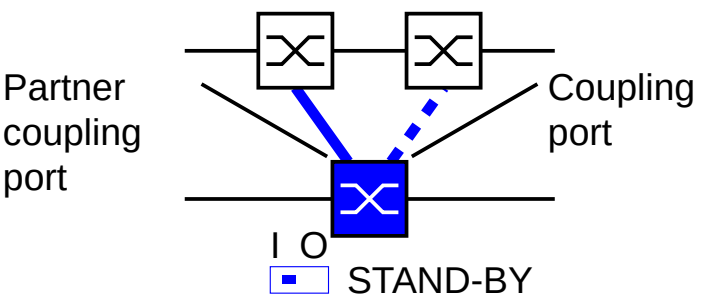


Fig. 13: One-switch coupling

The following settings apply to the switch displayed in blue in the selected graphic.

☐ Select the partner coupling port (see Fig. 14), (see Table 7 on page 36).
With "partner coupling port" you specify at which port you are connecting the main line.

Switch	Partner coupling port
RS2-../..	Not possible
RS2-16M	Adjustable for all ports (state on delivery: Port 2)
RS20/RS30/RS40	Adjustable for all ports (state on delivery: Port 1.3)
MICE	Adjustable for all ports (state on delivery: Port 1.3)
PowerMICE	Adjustable for all ports (state on delivery: Port 1.3)
MS 20	Adjustable for all ports (state on delivery: Port 1.3)
MS 30	Adjustable for all ports (state on delivery: Port 2.3)
RSR20/RSR30	Adjustable for all ports (state on delivery: Port 1.3)
MACH 1000	Adjustable for all ports (state on delivery: Port 1.3)
MACH 3000	Adjustable for all ports
MACH 4000	Adjustable for all ports (state on delivery: Port 1.3)

Table 7: Port assignment one-switch coupling

Note: Configure the partner coupling port and the HIPER-Ring ports on different ports.

☐ Select the coupling port (see Fig. 14), (see Table 8 on page 36). With "coupling port" you specify at which port you are connecting the main line.

Switch	Coupling port
RS2-../..	Not possible
RS2-16M	Adjustable for all ports (state on delivery: Port 1)
RS20/RS30/RS40	Adjustable for all ports (state on delivery: Port 1.4)
MICE	Adjustable for all ports (state on delivery: Port 1.4)
PowerMICE	Adjustable for all ports (state on delivery: Port 1.4)
MS20	Adjustable for all ports (state on delivery: Port 1.4)
MS30	Adjustable for all ports (state on delivery: Port 2.4)
RSR20/RSR30	Adjustable for all ports (state on delivery: Port 1.4)
MACH 1000	Adjustable for all ports (state on delivery: Port 1.4)
MACH 3000	Adjustable for all ports
MACH 4000	Adjustable for all ports (state on delivery: Port 1.4)

Table 8: Port assignment one-switch coupling

Note: Configure the coupling port and the HIPER-Ring ports on different ports.

☐ Switch on the function In the frame "Operation" (see Fig. 14).

☐ You now connect the redundant line.

The displays in the “Select port” frame mean (see Fig. 14):
– “Port mode”: The port is either active or in stand-by mode.
– “Port status”: The port is either connected or not connected.

The displays in the “Information” frame mean (see Fig. 14):
– “Redundancy working”: One of the lines affected can fail, as then a redundant line will take over the function of the failed line.
– “Configuration error”: The function is incomplete or incorrectly configured.

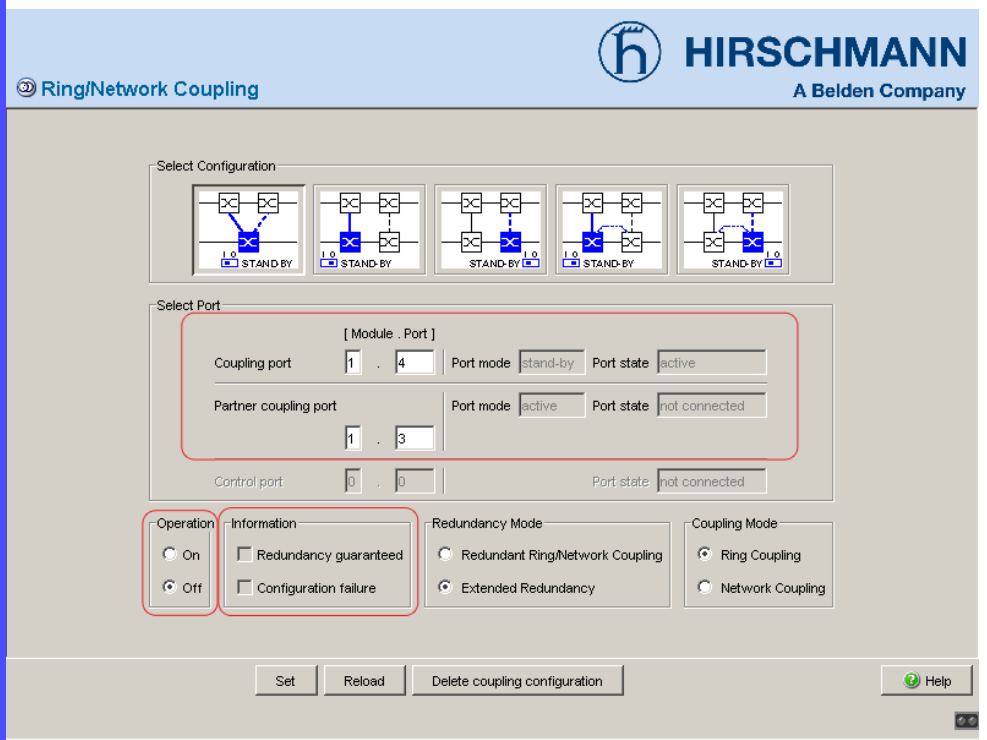


Fig. 14: Selecting the port and switching on/off the function

Note: The following settings are required for the coupling ports (for this select the dialog `Basics:Port Configuration`):
– Port: on
– Autonegotiation: on,
when using a twisted-pair connection
– Manual configuration: 100 Mbit/s FDX ,
when using a fiber connection

Note: If there are VLANs configured, then consider the VLAN configuration of the coupling and partner coupling ports.
In the Ring/Network Coupling configuration, select for the coupling and partner coupling ports
– VLAN ID 1 and "Ingress Filtering" disabled in the port table and
– VLAN affiliation U in the static VLAN table.

Redundancy mode

☐ Select in the frame "Redundany mode“ (see Fig. 15)
– "Redundant Ring/Network Coupling“ or
– "Extended Redundancy“

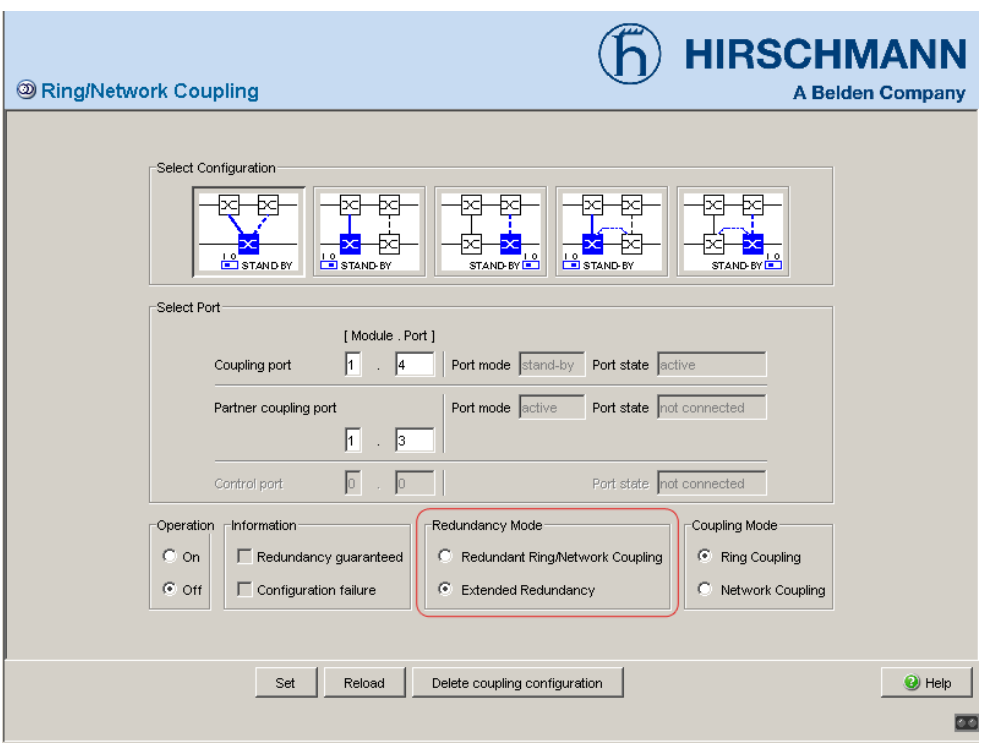


Fig. 15: Selecting the redundany mode

With the "Redundant Ring/Network Coupling" setting, either the main line or the redundant line is active. Both lines are never active simultaneously.

With the "Extended Redundancy" setting, the main line and the redundant line are simultaneously active if the connection line between the switches in the connected network fails (see Fig. 16). During the reconfiguration period, there may be package duplications. Therefore only select this setting if your application detects frame duplications.

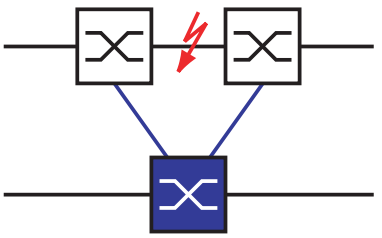


Fig. 16: Extended Redundancy

Coupling mode

Coupling mode refers to the type of coupled network.

☐ Select in the frame "Coupling mode“ (see Fig. 17)
– "Ring coupling“ or
– "network coupling“

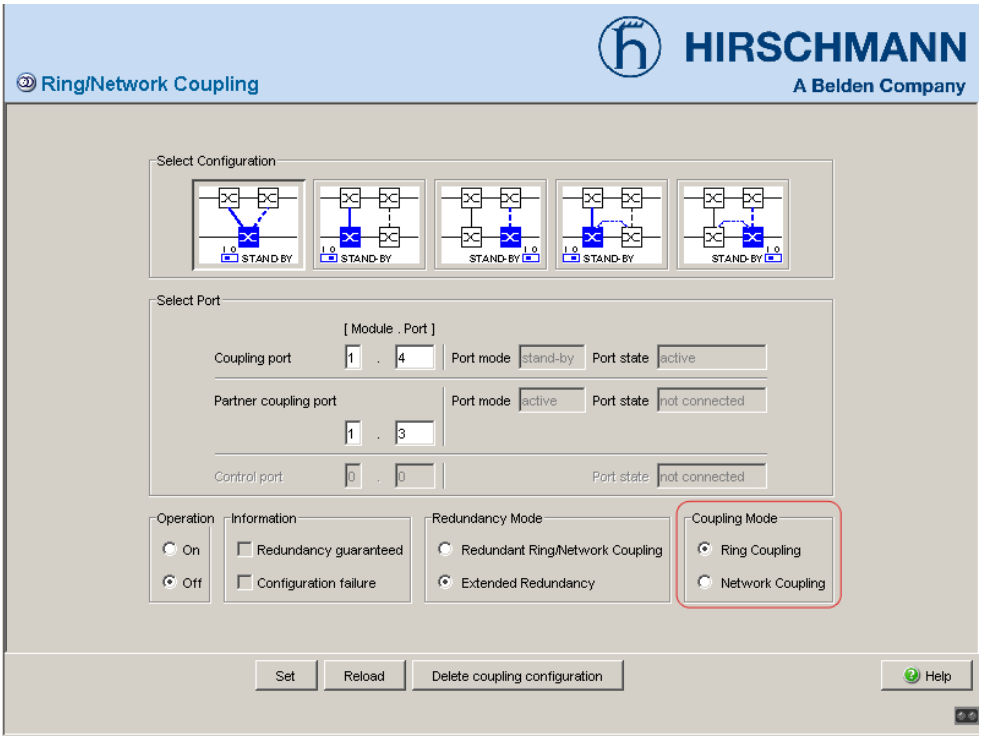


Fig. 17: Selecting the coupling mode

☐ Select "Ring coupling“, if you wish to couple a HIPER-Ring.

☐ Select "network coupling“, if you wish to couple a line-type configuration.

Delete coupling configuration

☐ The “Delete coupling configuration” button in the dialog allows you to restore all the default coupling settings of the device (state on delivery).

3.2.3 Two-switch coupling

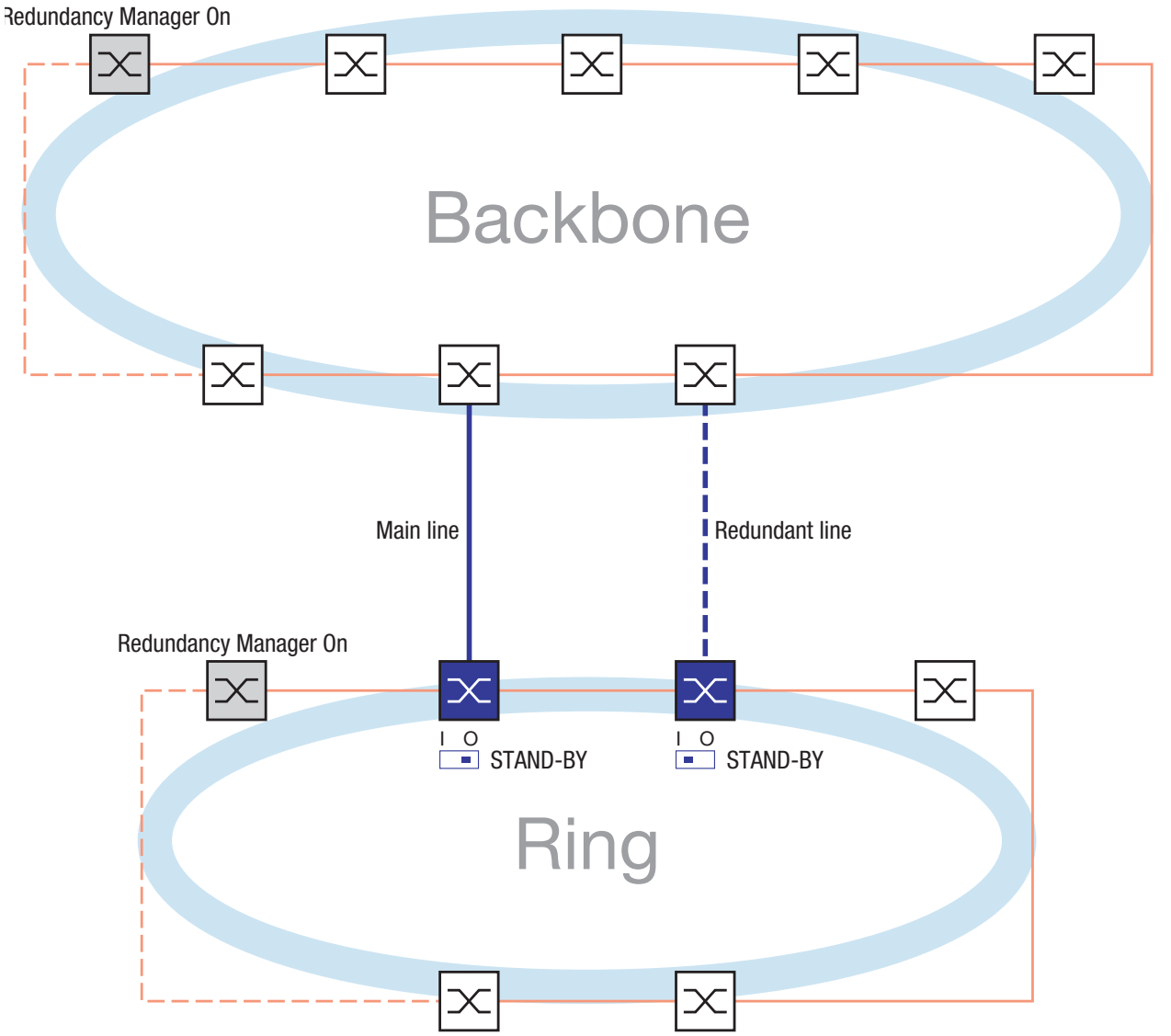


Fig. 18: Example two-switch coupling

The coupling between two networks is effected by the main line (thick blue line). If the main line fails, the redundant line (thick, blue dashed line) takes over coupling the two networks. The coupling is effected by two switches. The switches send their control packages via the Ethernet.
The switch to which you connect the main line, and the switch to which you connect the redundant line, are partners concerning the coupling.

☐ Connect the two partners via their ring ports..

☐ Select the dialog `Redundancy:Ring/Network Coupling.`

☐ Select the two-switch main coupling (see Fig. 19).

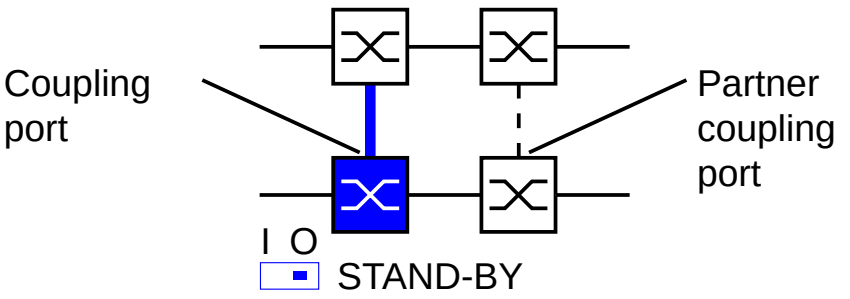


Fig. 19: Two-switch coupling

The following settings apply to the switch displayed in blue in the selected graphic.

☐ Select the coupling port (see Fig. 20), (see Table 9 on page 42). With "Coupling port" you specify at which port you are connecting the network segments. If the STANDBY DIP switch is OFF, connect the main line to the coupling port.

Switch	Coupling port
RS2-../..	Port 1
RS2-16M	Adjustable for all ports (state on delivery: Port 1)
RS20/RS30/RS40	Adjustable for all ports (state on delivery: Port 1.4)
MICE	Adjustable for all ports (state on delivery: Port 1.4)
PowerMICE	Adjustable for all ports (state on delivery: Port 1.4)
MS 20	Adjustable for all ports (state on delivery: Port 1.4)
MS 30	Adjustable for all ports (state on delivery: Port 2.4)
RSR20/RSR30	Adjustable for all ports (state on delivery: Port 1.4)
MACH 1000	Adjustable for all ports (state on delivery: Port 1.4)s
MACH 3000	Adjustable for all ports
MACH 4000	Adjustable for all ports (state on delivery: Port 1.4)

Table 9: Port assignment two-switch coupling

Note: Configure the coupling port and the HIPER-Ring ports on different ports.

☐ Switch on the function In the frame "Operation" (see Fig. 20).

☐ You now connect the redundant line.

The displays in the “Select port” frame mean (see Fig. 20):
– “Port mode”: The port is either active or in stand-by mode.
– “Port status”: The port is either connected or not connected.
– “IP address”: The IP address of the partner, if it is already operating in the network.

The displays in the “Information” frame mean (see Fig. 20):
– “Redundancy working”: One of the lines affected can fail, as then a redundant line will take over the function of the failed line.
– “Configuration error”: The function is incomplete or incorrectly configured

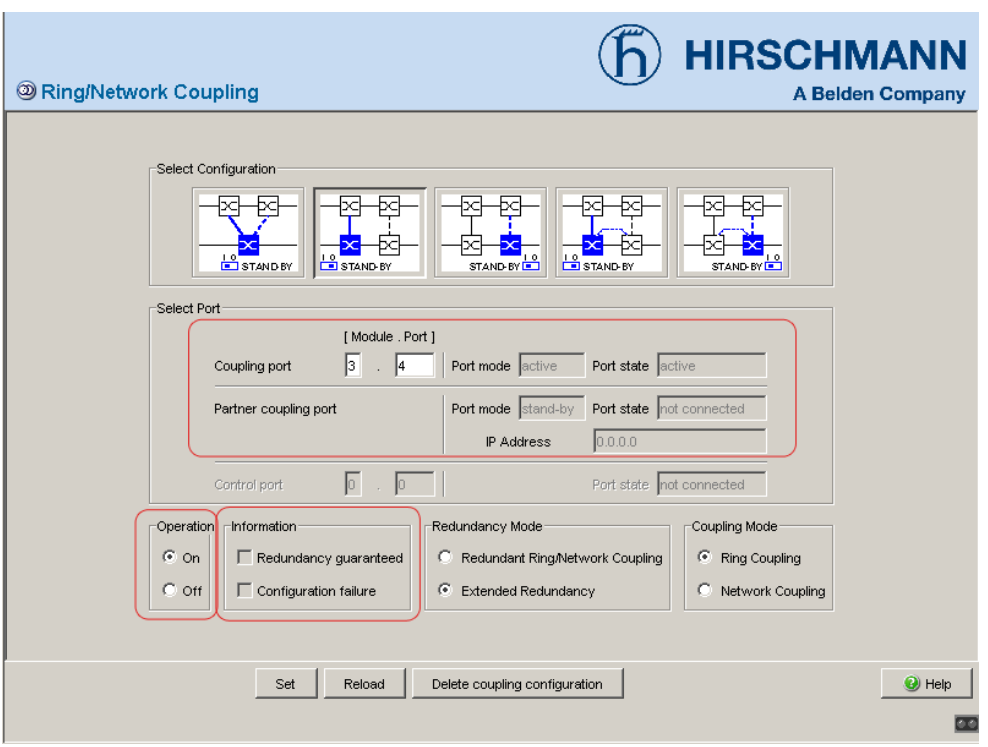


Fig. 20: Selecting the port and switching on/off the function

To avoid continuous loops, the switch sets the port status of the coupling port to off, if you:
– switch off the function or
– change the configuration
while the connections at these ports are operating.

Note: The following settings are required for the coupling ports (for this select the dialog `Basics:Port Configuration`):

- Port: on
- Autonegotiation: on,
  when using a twisted-pair connection
- Manual configuration: 100 Mbit/s FDX ,
  when using a fiber connection

Note: If there are VLANs configured, then consider the VLAN configuration of the coupling and partner coupling ports.
In the Ring/Network Coupling configuration, select for the coupling and partner coupling ports
– VLAN ID 1 and "Ingress Filtering" disabled in the port table and
– VLAN affiliation U in the static VLAN table.

Note: Using the redundancy manager and redundant two-switch coupling functions at the same time runs the risk of a loop.

☐ Select the two-switch redundant coupling (see Fig. 21).

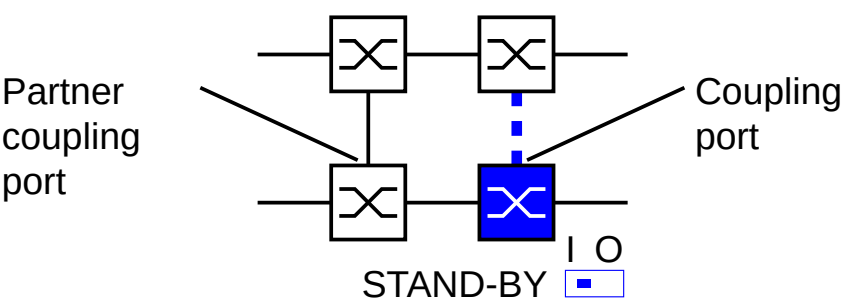


Fig. 21: Two-switch coupling

The following settings apply to the switch displayed in blue in the selected graphic.

☐ Select the coupling port (see Fig. 20), (see Table 9 on page 42). With "Coupling port" you specify at which port you are connecting the network segments. If the STANDBY DIP switch is ON, connect the redundant line to the coupling port.

☐ Proceed in the same way as with "Two-switch main coupling“, Seite 42.

Redundancy mode

☐ Select in the frame "Redundany mode“ (see Fig. 22)
– „Redundant Ring/Network Coupling“ or
– „Extended Redundancy.

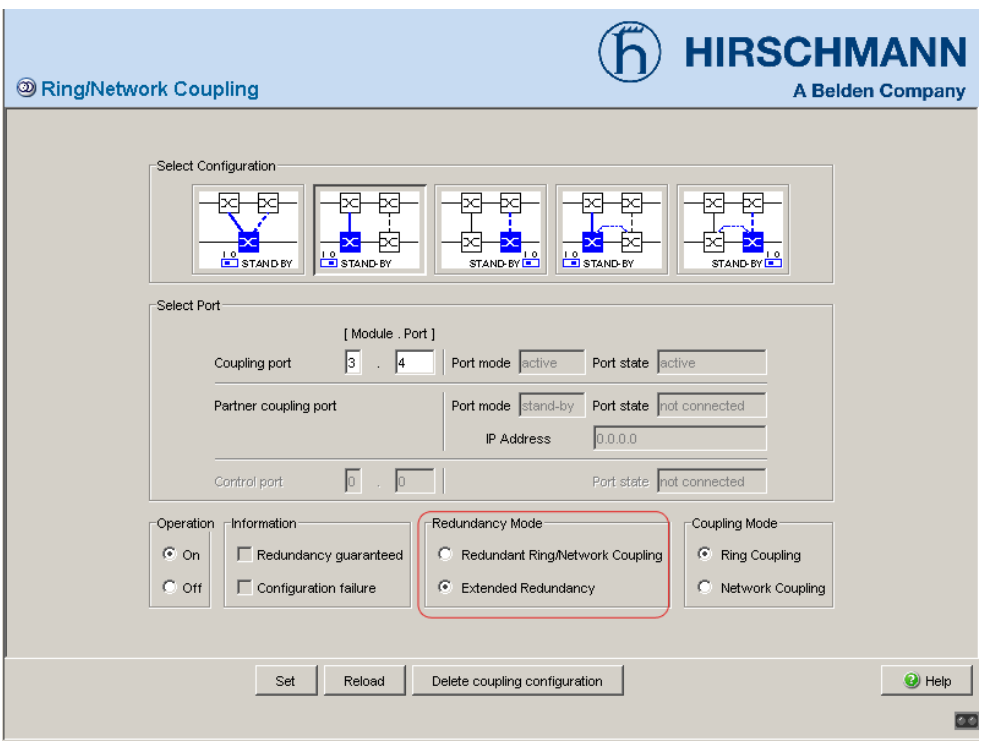


Fig. 22: Selecting the redundany mode

With the "Redundant Ring/Network Coupling" setting, either the main line or the redundant line is active. Both lines are never active simultaneously.

With the "Extended Redundancy" setting, the main line and the redundant line are simultaneously active if the connection line between the switches in the connected network fails (see Fig. 23). During the reconfiguration period, there may be frame duplications.Therfore only select this setting if your application detects frame duplications.

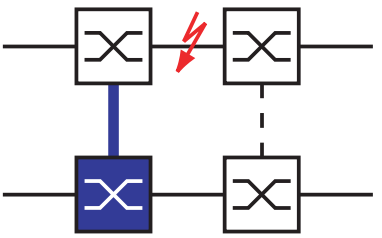


Fig. 23: Extended Redundancy

Coupling Mode

Coupling mode refers to the type of coupled network.

☐ Select in the frame "Coupling Mode“ (see Fig. 24)
– „Ring Coupling“ or
– „Network Coupling

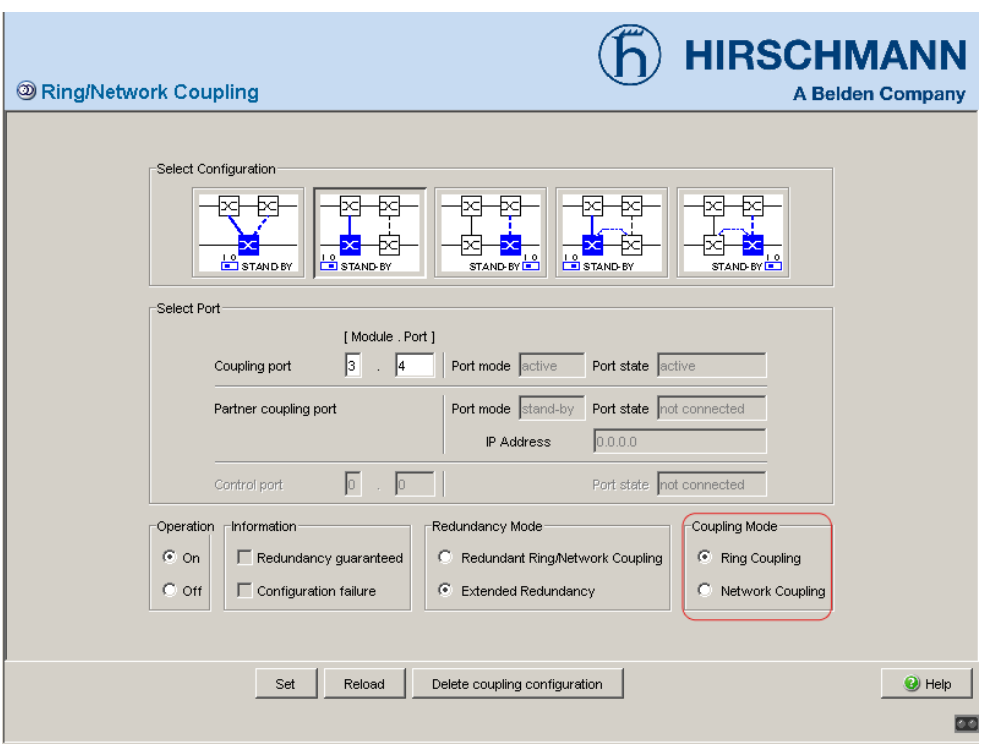


Fig. 24: Selecting the coupling mode

- ☐ Select "**Ring Coupling**", if you wish to couple a HIPER-Ring.
- ☐ Select "**Network Coupling**", if you wish to couple a line-type configuration.

Delete coupling configuration

- ☐ The “Delete coupling configuration” button in the dialog allows you to restore all the default coupling settings of the device (state on delivery).

3.2.4 Two-switch coupling with control line

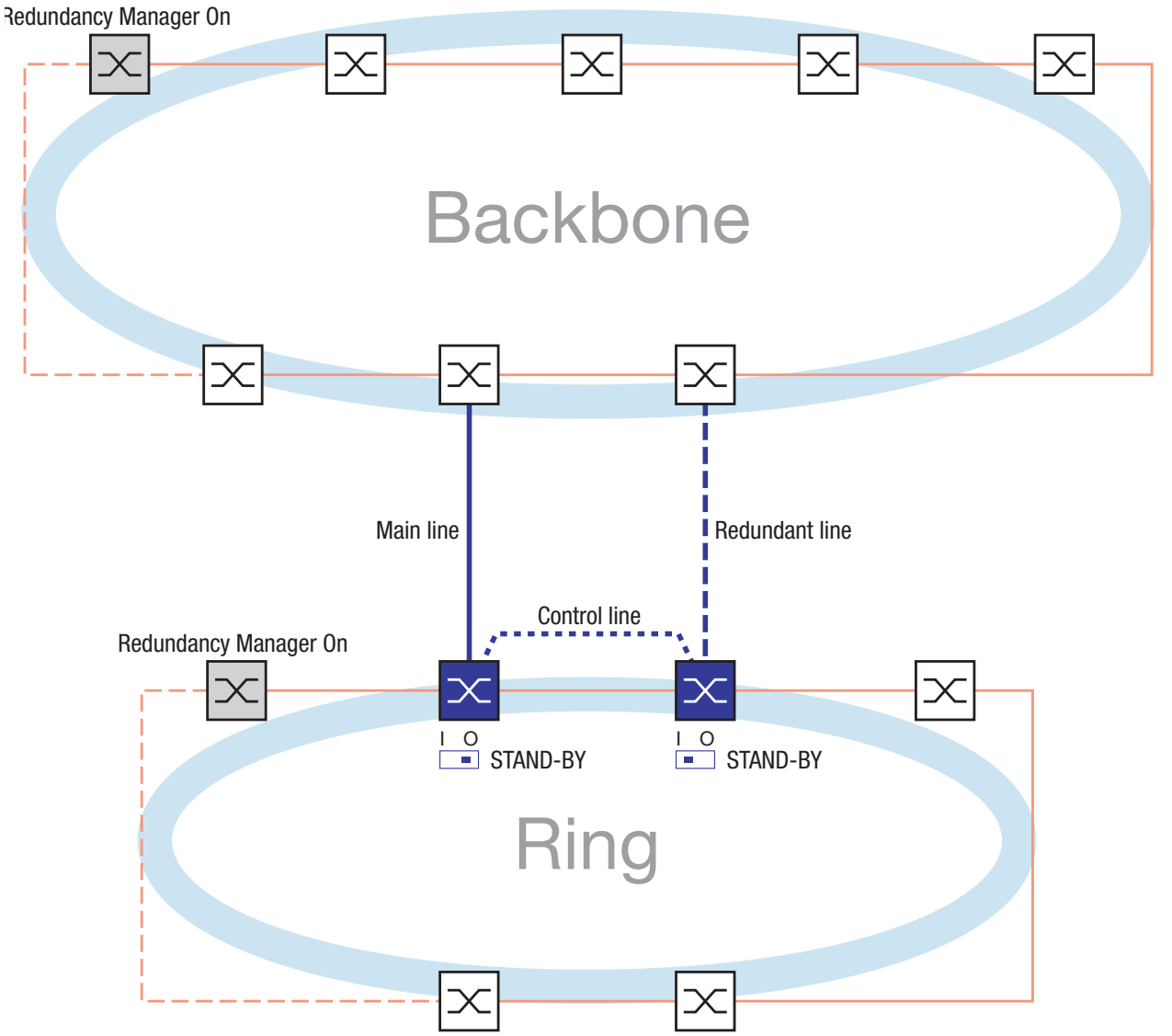


Fig. 25: Example two-switch coupling with control line

The coupling between two networks is effected by the main line (thick blue line). If the main line fails, the redundant line (thick, blue dashed line) takes over coupling the two networks. The coupling is effected by two switches. The switches send their control packages via the contol line.
The Switch to which you connect the main line, and the switch to which you connect the redundant line, are partners concerning the coupling.

☐ Connect the two partners via their ring ports.

☐ Select the dialog `Redundancy:Ring/Network Coupling.`

☐ Select the two-switch main coupling with control line (see Fig. 26).

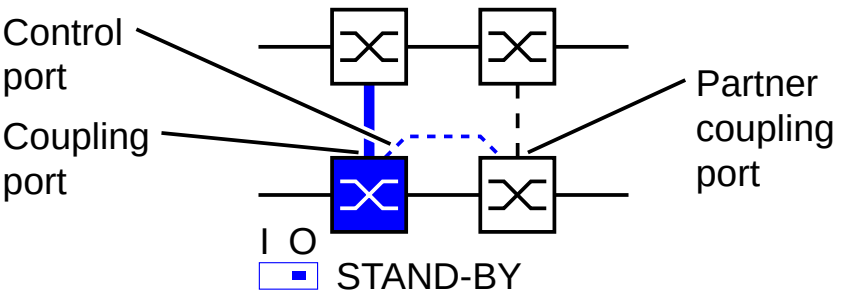


Fig. 26: Two-switch coupling with control line

The following settings apply to the switch displayed in blue in the selected graphic.

☐ Select the coupling port (see Fig. 27), (see Table 10 on page 50). With "Coupling port" you specify at which port you are connecting the network segments. If the STANDBY DIP switch is OFF, connect the main line to the coupling port.

☐ Select the control port (see Fig. 27), (see Table 10 on page 50). With "Control port" you specify at which port you are connecting the control line.

Switch	Coupling port	Contol port
RS2-../..	Port 1	Stand-by port (can only be combined with the RS2-../..)
RS2-16M	Adjustable for all ports (state on delivery: Port 1)	Adjustable for all ports (state on delivery: Port 2)
RS20/RS30/ RS40	Adjustable for all ports (state on delivery: Port 1.4)	Adjustable for all ports (state on delivery: Port 1.3)
MICE	Adjustable for all ports (state on delivery: Port 1.4)	Adjustable for all ports (state on delivery: Port 1.3)
PowerMICE	Adjustable for all ports (state on delivery: Port 1.4)	Adjustable for all ports (state on delivery: Port 1.3)
MS20	Adjustable for all ports (state on delivery: Port 1.4)	Adjustable for all ports (state on delivery: Port 1.3)
MS30	Adjustable for all ports (state on delivery: Port 2.4)	Adjustable for all ports (state on delivery: Port 2.3)
RSR20/RSR30	Adjustable for all ports (state on delivery: Port 1.4)	Adjustable for all ports (state on delivery: Port 1.3)

Switch	Coupling port	Contol port
MACH 1000	Adjustable for all ports (state on delivery: Port 1.4)	Adjustable for all ports (state on delivery: Port 1.3)
MACH 3000	Adjustable for all ports	Adjustable for all ports
MACH 4000	Adjustable for all ports (state on delivery: Port 1.4)	Adjustable for all ports (state on delivery: Port 1.3)

Table 10: Port assignment two-switch coupling with control line

Note: Configure the coupling port and the HIPER-Ring ports on different ports.

☐ Switch on the function In the frame "Operation" (see Fig. 27).

☐ You now connect the redundant line and the control line.

The displays in the “Select port” frame mean (see Fig. 27):
– “Port mode”: The port is either active or in stand-by mode.
– “Port status”: The port is either connected or not connected.
– “IP address”: The IP address of the partner, if it is already operating in the network

The displays in the “Information” frame mean (see Fig. 27):
– “Redundancy working”: One of the lines affected can fail, as then a redundant line will take over the function of the failed line.
– “Configuration error”: The function is incomplete or incorrectly configured.

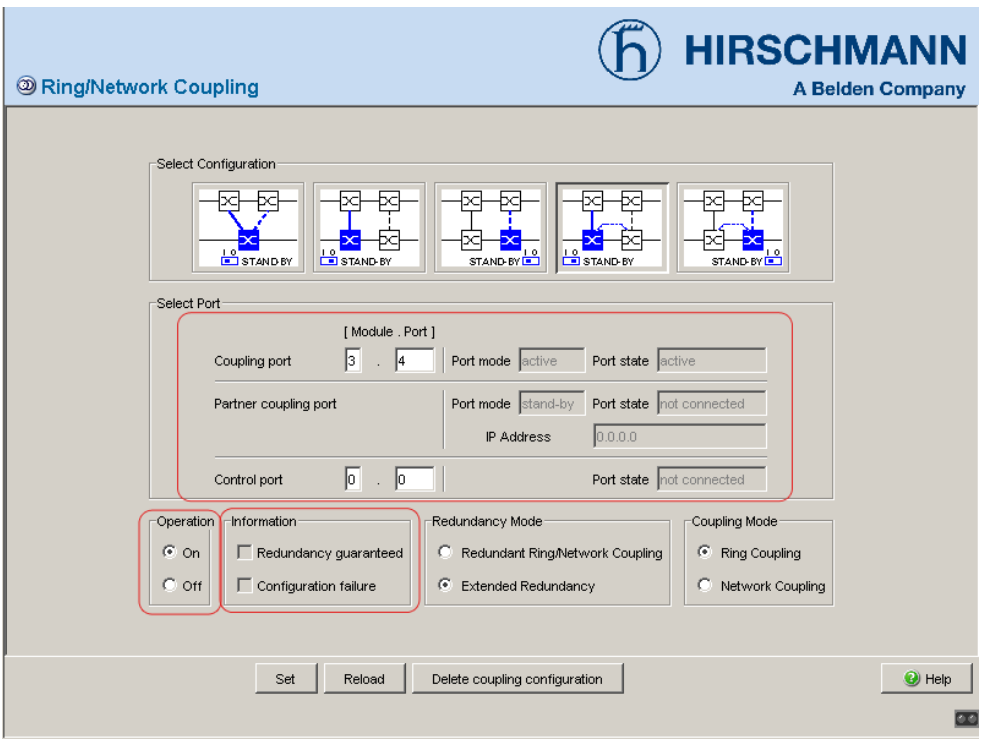


Fig. 27: Selecting the port and switching on/off the function

To avoid continuous loops, the switch sets the port status of the control and coupling ports to off, if you:
– switch off the function or
– change the configuration
while the connections to these ports are operating.

Note: The following settings are required for the coupling ports (for this select the dialog `Basics:Port Configuration`):

- Port: on
- Autonegotiation: on,
  when using a twisted-pair connection
- Manual configuration: 100 Mbit/s FDX ,
  when using a fiber connection

Note: If there are VLANs configured, then consider the VLAN configuration of the coupling and partner coupling ports.
In the Ring/Network Coupling configuration, select for the coupling and partner coupling ports
– VLAN ID 1 and "Ingress Filtering" disabled in the port table and
– VLAN affiliation `U` in the static VLAN table.

☐ Select the two-switch redundant coupling with control line (see Fig. 28).

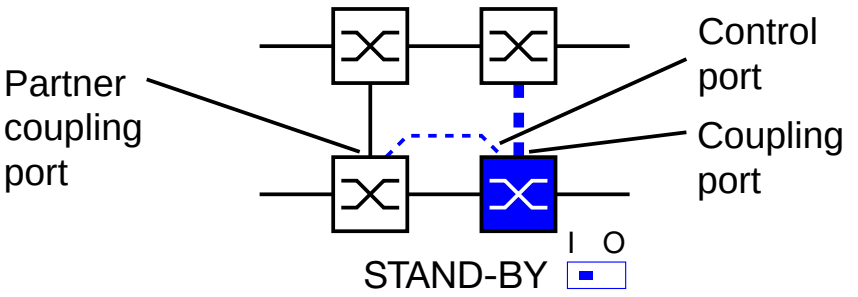


Fig. 28: Two-switch coupling with control line

The following settings apply to the switch displayed in blue in the selected graphic.

☐ Select the coupling port (see Fig. 27), (see Table 10 on page 50). With "Coupling port" you specify at which port you are connecting the network segments. If the STANDBY DIP switch is ON, connect the main line to the coupling port.

☐ Proceed in the same way as with "Two-switch main coupling with control line“, Seite 49.

Redundancy mode

☐ Select in the frame "Redundany mode“ (see Fig. 22)
– "Redundant Ring/Network Coupling“ or
– "Extended Redundancy"

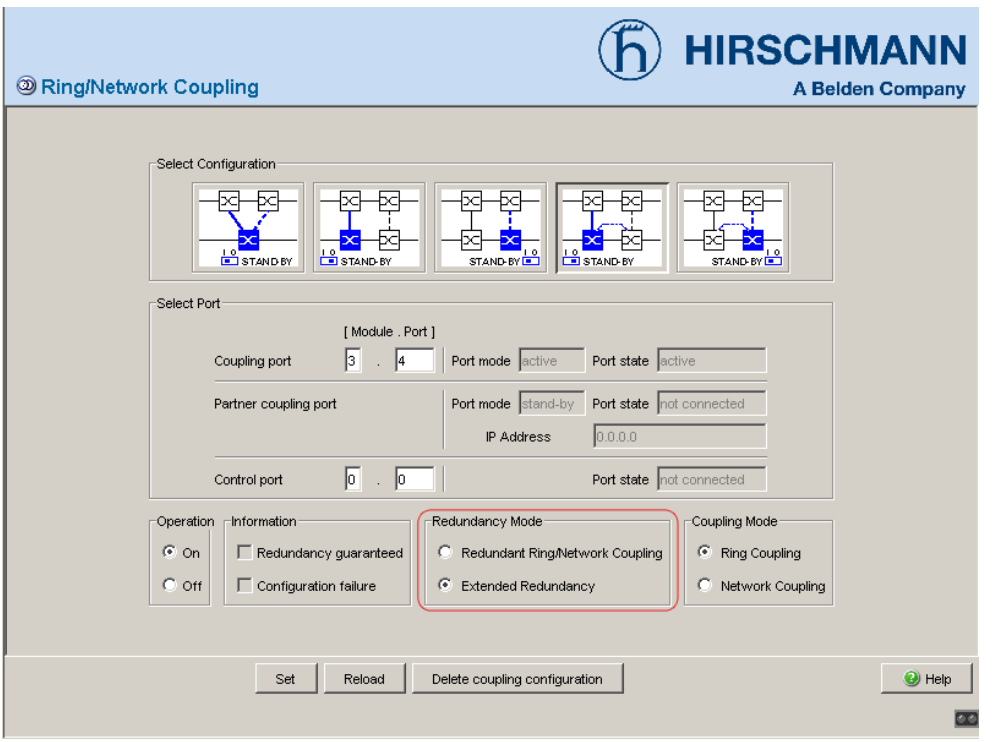


Fig. 29: Selecting the redundany mode

With the "Redundant Ring/Network Coupling" setting, either the main line or the redundant line is active. Both lines are never active simultaneously.

With the "Extended Redundancy" setting, the main line and the redundant line are simultaneously active if the connection line between the switches in the connected network fails (see Fig. 23). During the reconfiguration period, there may be frame duplications.Therfore only select this setting if your application detects frame duplications.

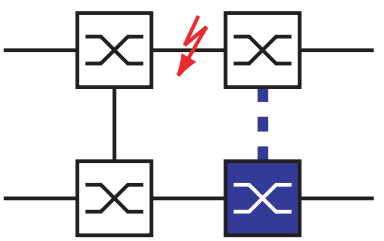


Fig. 30: Extended Redundancy

Coupling Mode

Coupling mode refers to the type of coupled network.

☐ Select in the frame "Coupling Mode“ (see Fig. 24)
– „Ring Coupling“ or
– „Network Coupling“

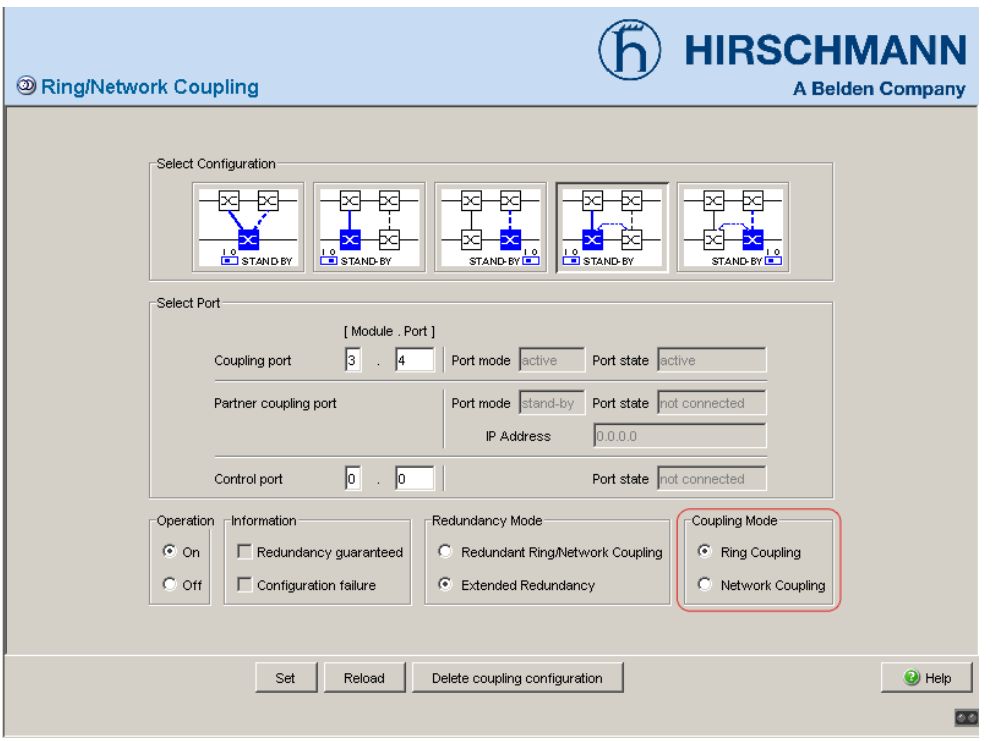


Fig. 31: Selecting the coupling mode

☐ Select "**Ring coupling**", if you wish to couple a HIPER-Ring.

☐ Select "**Network coupling**", if you wish to couple a line-type configuration.

Delete coupling configuration

☐ The “Delete coupling configuration” button in the dialog allows you to restore all the default coupling settings of the device (state on delivery).

4 Rapid Spanning Tree

Note: The Spanning Tree protocol and the Rapid Spanning Tree protocol are protocols for MAC bridges. They are described in the standards IEEE 802.1D-2004 and IEEE 802.1w. For this reason, the following description of these protocols usually employs the term bridge instead of switch.

Local area networks are becoming ever larger. This is true both for their geographic size as well as for the number of stations they include. As the networks become larger, there are reasons why it often makes sense to implement several bridges:

- reduce network load in subnetworks,
- create redundant connections and
- overcome distance.

Using many bridges with multiple, redundant connections between the subnetworks can lead to loops and thus to the complete failure of the network. The (Rapid) Spanning Tree Algorithm was developed to prevent this. The Rapid Spanning Tree Protocol (RSTP) enables redundancy by interrupting loops.

RSTP is a further development of the Spanning Tree Protocol (STP) and is compatible with it. If a connection or a bridge fails, the STP requires up to 30 seconds to reconfigure. This was no longer acceptable in time-sensitive applications. The STP was therefore developed into the RSTP, leading to reconfiguration times of less than a second.

Note: The standard demands that all bridges of a network have to work with the (Rapid) Spanning Tree Algorithm. If, however, both protocols are used simultaneously, there are no advantages to using the faster reconfiguration with RSTP.

4.1 The Spanning Tree Protocol

Because RSTP is a further development of the STP, all the following descriptions of the STP also apply to the RSTP.

4.1.1 The Tasks of the STP

The Spanning Tree Algorithm reduces network topologies that are set up using bridges, and that have ring structures with redundant connections, to a tree structure. In doing this, STP divides up the ring structures on the basis of specified rules by deactivating redundant paths. If a path is interrupted by mistake, the STP activates the path just deactivated. This enables redundant connections for increased data safety.
In forming the tree structure, the STP determines what is known as a root bridge. This forms the basis of the STP tree structure.

Features of the STP algorithm:

- it reconfigures automatically the tree structure in case of a bridge failure or break in a data path,
- It stabilizes the tree structure up to the maximum network size (up to 39 hops, depending on the setting for “Max. Age”),
- It stabilizes within a short, known time,
- It produces a reproducible topology that can be pre-defined by management,
- It is transparent to the terminal equipment,
- by creating a tree structure it results in a low network load compared to the available transmission capacity.

4.1.2 The bridge parameters

Each bridge is uniquely described by the following parameters:

- Bridge Identifier,
- Root path costs of the bridge ports
- Port Identifier.

Bridge Identifier

The bridge identifier is 8 bytes long. The two highest-value bytes are the priority number. The default setting for the priority number is 32 768, but the Management Administrator can change this when configuring the network. The six lowest-value bytes of the bridge identification are the MAC address of the bridge. The MAC address guarantees that every bridge has a different bridge identification.
The bridge with the numerically lowest-value bridge identifier has the highest priority.

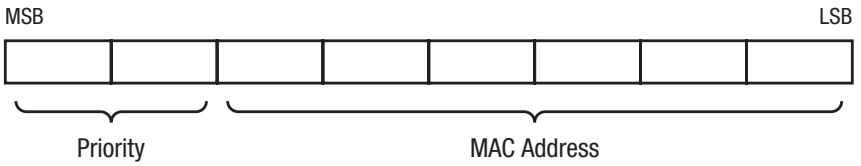


Fig. 32: Bridge identifier

Root path costs

Each path connecting two bridges has transmission costs assigned to it. The management administrator sets this value and specifies it for each path when configuring a bridge (see Table 11 on page 58). It assigns the higher path costs to paths with lower transmission speeds.

Alternatively, the Management Administrator can define the path costs. Like the switch, it assigns the higher path costs to paths with lower transmission speeds. Because he essentially has a free hand in specifying this value, he has a tool for ensuring that in case of redundant paths one path will be favored over the others.

The root path costs are calculated by adding up the individual path costs for the paths that a data packet must traverse between the port of a bridge and the root.

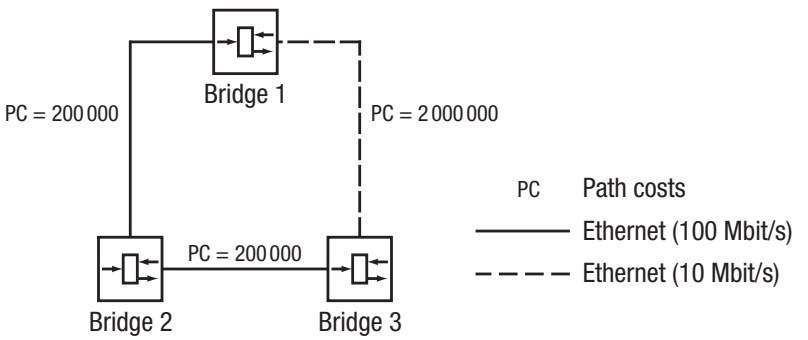


Fig. 33: Path costs

Data rate	Recommended value	Recommended range	Possible range
<=100 KBit/s	200 000 000*	20 000 000-200 000 000	1-200 000 000
1 MBit/s	20 000 000*	2 000 000-200 000 000	1-200 000 000
10 MBit/s	2 000 000*	200 000-20 000 000	1-200 000 000
100 MBit/s	200 000*	20 000-2 000 000	1-200 000 000
1 GBit/s	20 000	2 000-200 000	1-200 000 000
10 GBit/s	2 000	200-20 000	1-200 000 000
100 GBit/s	200	20-2 000	1-200 000 000
1 TBit/s	20	2-200	1-200 000 000
10 TBit/s	2	1-20	1-200 000 000

Table 11: Recommended path costs of RSTP according to the data rate
** Bridges conformant to IEEE Std 802.1D, 1998 Edition, i.e., that support only 16 bit values for path cost, should use 65 535 as the path cost for these link speeds when used in conjunction with bridges that support 32 bit path cost values.*

Note: If link aggregation (see “Link Aggregation” on page 13) is used to combine the connection lines between switches into a trunk, then the path costs are reduced in accordance with the number of connections that are combined in a trunk.

- Port identification
  The port identification consists of two bytes. One part, the lower-value byte, reflects a fixed relationship to the physical port number. This part ensures that no port in a bridge receives the same designation as another port in the same bridge. The second part contains the priority number which is set by the management administrator (default:128). It is also true here that the port with the lowest numerical value for its port identifier is the one with the highest.

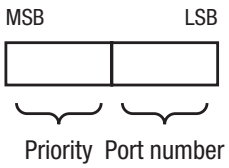


Fig. 34: Port identification

4.1.3 Rules for creating the tree structure

- Bridge information
  In order to compute their tree structures, the bridges need information about other bridges that are present in the network. This information is obtained by each bridge sending a BPDU (Bridge Protocol Data Unit) to all other bridges.

  Along with other information, the BPDU contains the

  - bridge identifier,
  - root path costs, and
  - port identification

  (see IEEE 802.1D).

Building the tree structure

- The bridge with the numerically smallest bridge identifier is made the root bridge. It forms the root of the tree structure.
- The structure of the tree depends upon the root path costs. The structure that is chosen is the one that provides the lowest path costs between each individual bridge and the root bridge.
- If there are multiple paths with the same root path costs, the priorities of the bridge identifications for the bridges connected to this path determine which bridge is blocked.
- If there are two paths leading away from a single bridge with the same root path costs, the port identification is used as the last criterion for determining which path is used (see Fig. 34). It decides which port is selected.

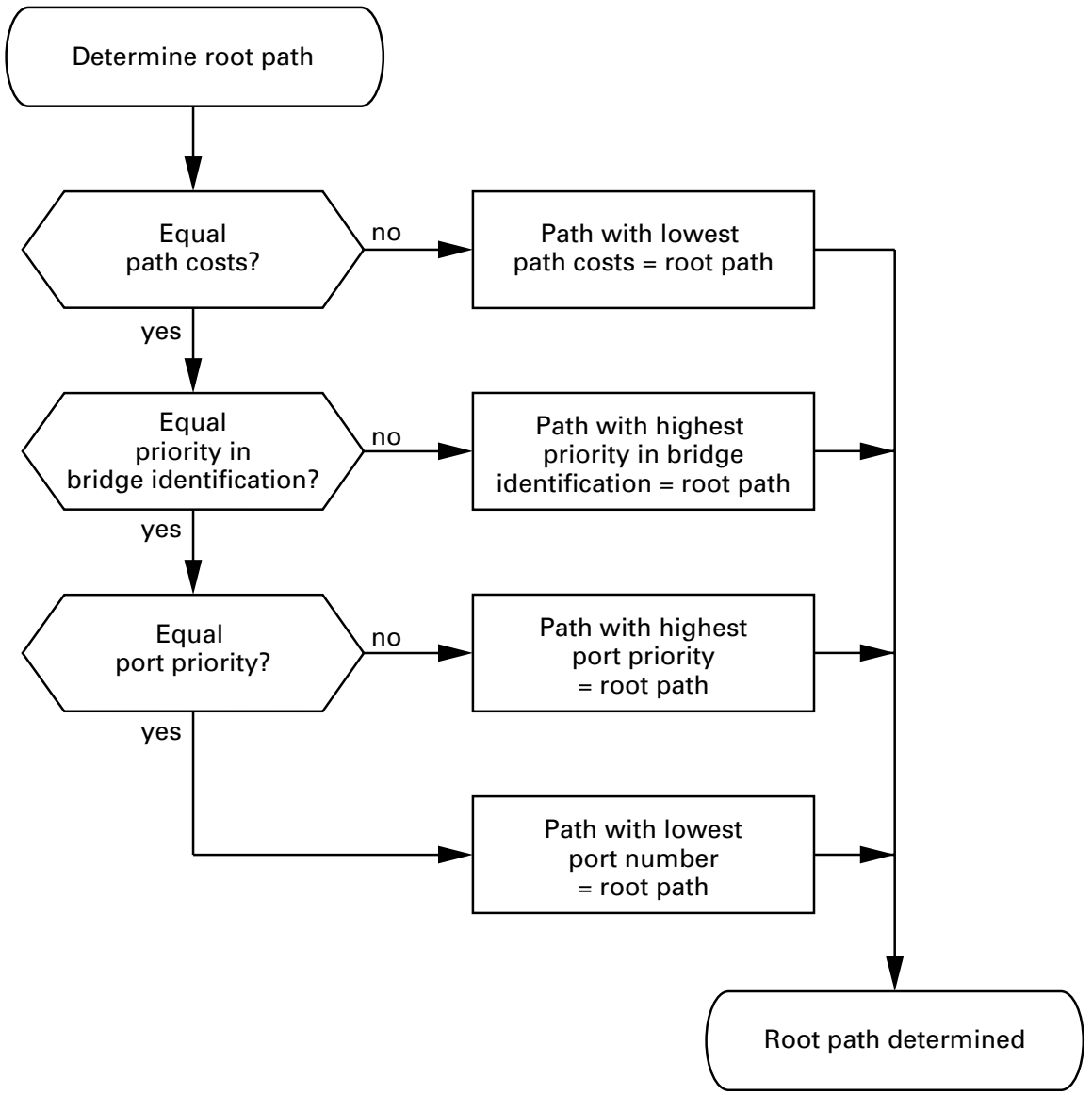


Fig. 35: Flow chart for determining root path

4.1.4 Example: determination of root paths

Using the network diagram (see Fig. 36), it is possible to follow the logic in the flow chart (see Fig. 35) for determining the root path. The Administrator defined a different priority in the bridge identification for each bridge. The bridge with the numerically smallest bridge identification (in this case, bridge 1) is selected as the root bridge. In this example the partial paths all have the same path costs. The path between bridge 2 and bridge 3 is removed because a connection from bridge 3 to the root bridge via bridge 2 would result in twice the path costs.

The path from bridge 6 to the root bridge is interesting:

- The path via bridges 5 and 3 generates the same root path costs as the path via bridges 4 and 2.
- The path via bridge 4 is selected because the numerical value 28 672 for the priority in the bridge identifier is less than the numerical value 32 768.
- There are however two paths between bridge 6 and bridge 4. In this case, the larger port priority is decisive.

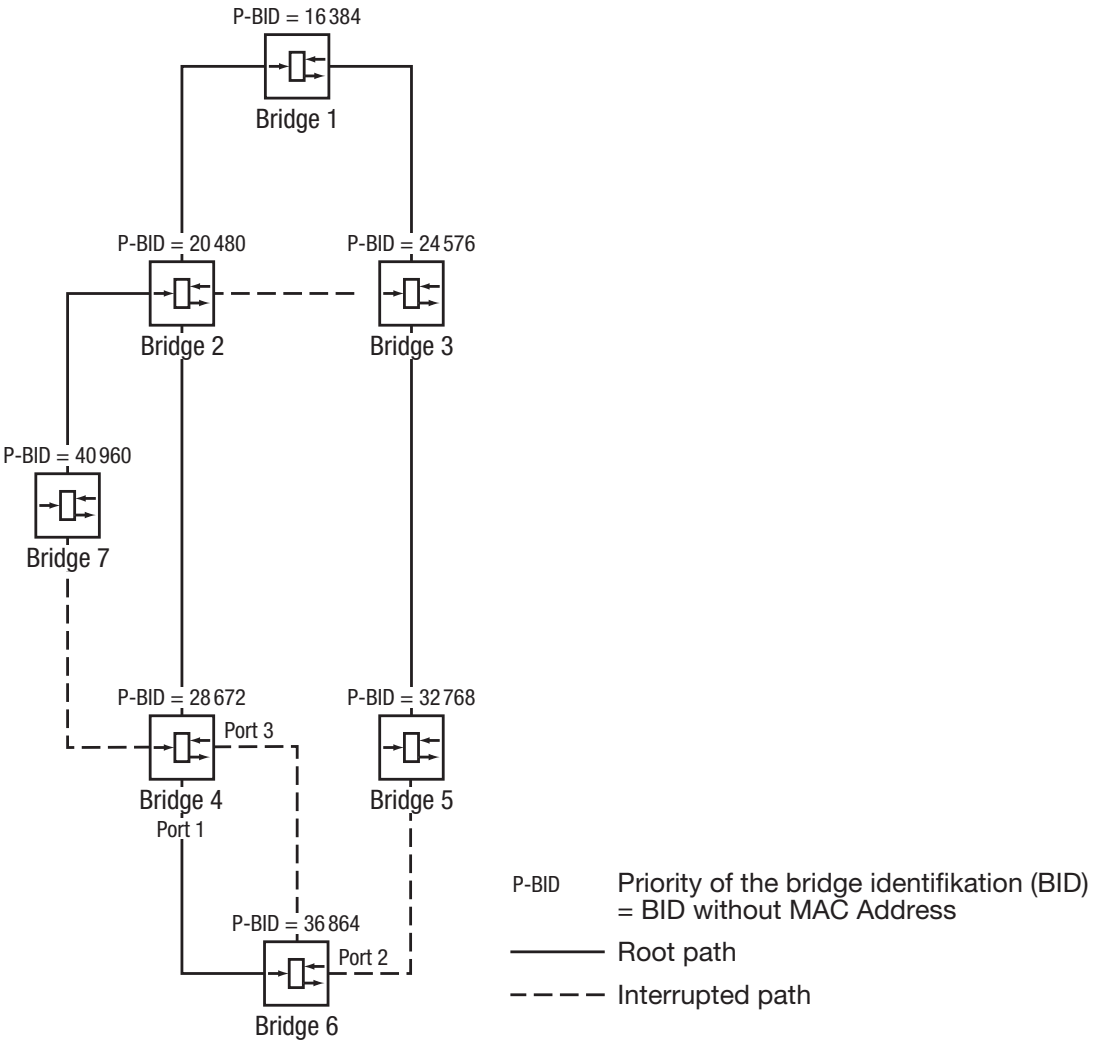


Fig. 36: Root path determination example

4.1.5 Example: manipulation of root paths

Using the network diagram (see Fig. 37), it is possible to follow the logic in the flow chart (see Fig. 35) for determining the root path.
The Administrator
– left the default value of 32 768 for each bridge apart from bridge 1, and

– gave bridge 1 the value 16 384, thus making it the root bridge.
In this example the partial paths all have the same path costs. The path between bridge 2 and bridge 3 is removed because a connection from bridge 3 to the root bridge via bridge 2 would result in twice the path

The path from bridge 6 to the root bridge is interesting:

- The path via bridges 5 and 3 generates the same root path costs as the path via bridges 4 and 2.
- STP selects the path using the bridge that has the lowest MAC address in the bridge identification (bridge 4 in the illustration).
- There are however two paths between bridge 6 and bridge 4. In this case, the larger port priority is decisive.

Note: Because the Administrator does not change the default values for the priorities of the bridges in the bridge identification, apart from the root bridge, the MAC address in the bridge identification alone determines which bridge becomes the new root bridge if the root bridge goes down.

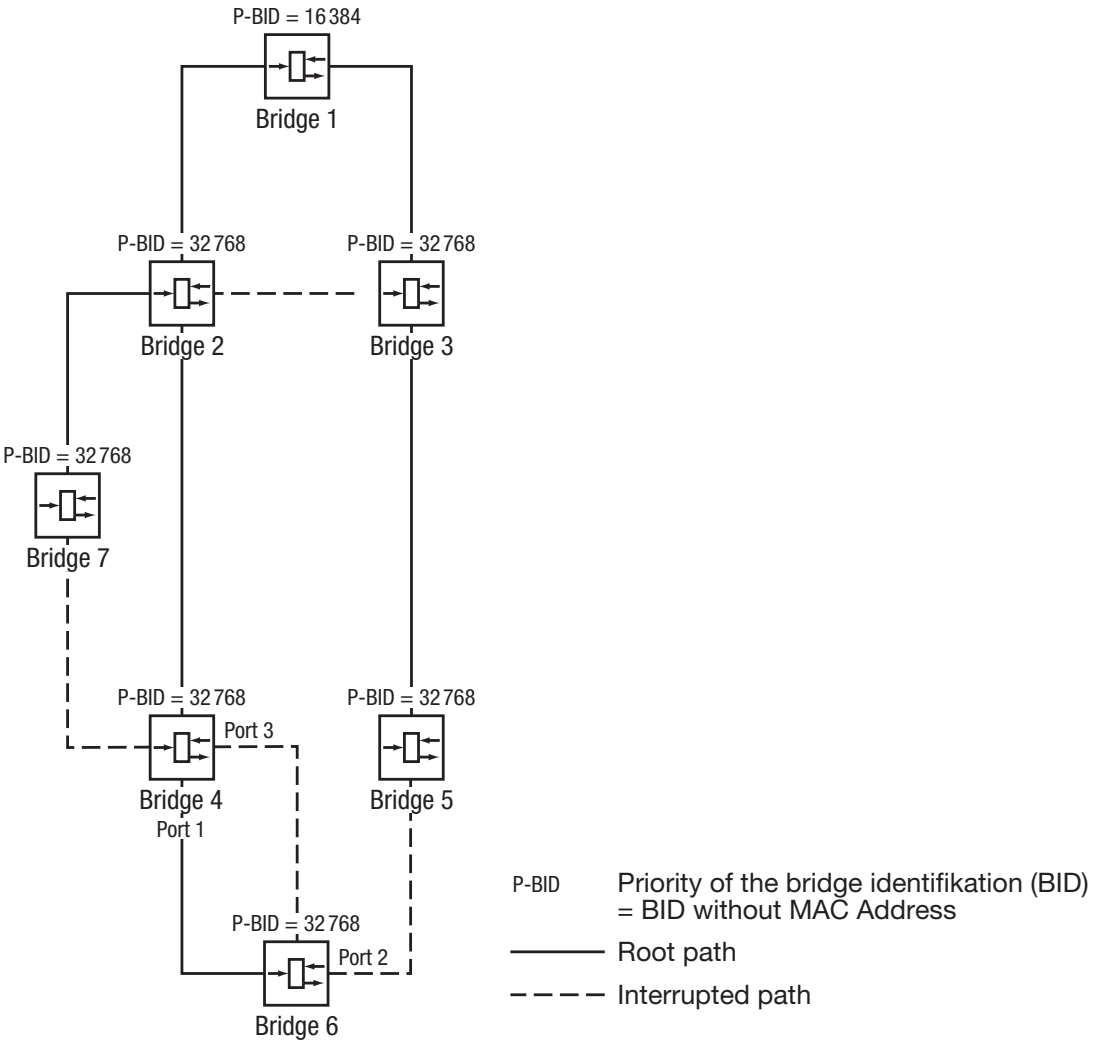


Fig. 37: Example of a root path manipulation

4.1.6 Example: manipulation of a tree structure

The management administrator of the network soon discovers that this configuration, with bridge 1 as its root bridge (see “Example: determination of root paths” on page 62) , is unfavorable. The control packets that bridge 1 sends to the other bridges are concentrated on the paths between bridge 1 and bridge 2 and between bridge 1 and bridge 3.
If the management administrator raises bridge 2 to the root bridge, the load caused by the control packets will be more evenly distributed among the subnetworks. This would result in the configuration shown (see Fig. 38). The paths between the individual bridges and the root bridge have become shorter.

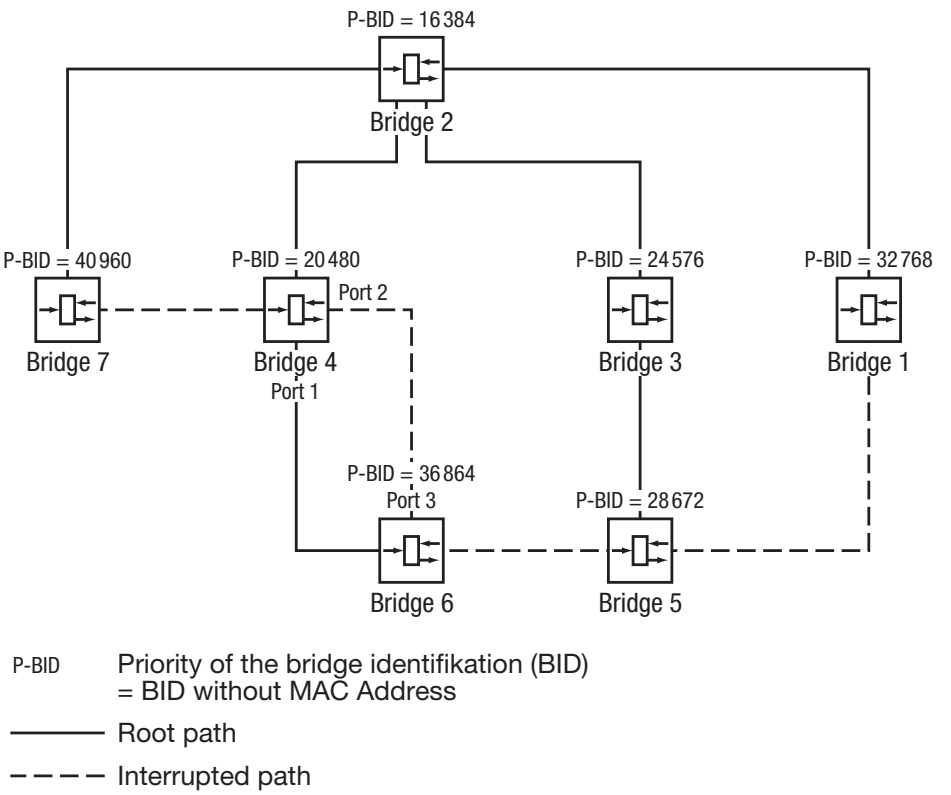


Fig. 38: Example of a tree structure manipulation

4.2 The Rapid Spanning Tree Protocol

RSTP does not change the STP tree structure calculation. RSTP only alters parameters, adds new parameters and mechanisms that accelerate the re-configuration in the event of an error.
The ports play a major role within this context.

4.2.1 Port roles

RSTP assigns one of the following roles to each bridge port (see Fig. 39):

- Root-Port
  This is the port at which a bridge receives data packets with the lowest path costs from the root bridge.
  If there are several ports with the same low path costs, the bridge identification determines which port is the root port.
  If there is also more ports with the same low path costs and the same bridge identification, the port identification determines which port is the root port (see Fig. 35).
  The root bridge does not have a root port itself.
- Designated Port
  The bridge in a network segment that has the lowest root bridge costs is the Designated Bridge. If a number of bridges have the same root bridge costs, then the bridge with the smallest value for the bridge identification becomes the designated bridge. The port on this bridge that connects it to a network segment that leads from the root bridge, is the designated port.

- Edge Port
  Each network segment in which there is no further RSTP bridge is connected to exactly one designated port. This designated port then functions as an (edge port) at the same time. Characteristic of an edge port is the fact that it does not receive any RSTP BPDUs (Rapid Spanning Tree Bridge Protocol Data
- Alternate port
  This is a blocked port that takes over the function of the root port if the connection to the root bridge fails. The alternative port re-establishes a reliable connection from the bridge to the root
- Backup port
  This is a blocked port that is available as a replacement in case the connection to the designated port of this network segment (without RSTP bridge) fails.
- Disabled-Port,
  This is a port that has no meaning within the Spanning Tree operation as it is switched-off or has no connection.

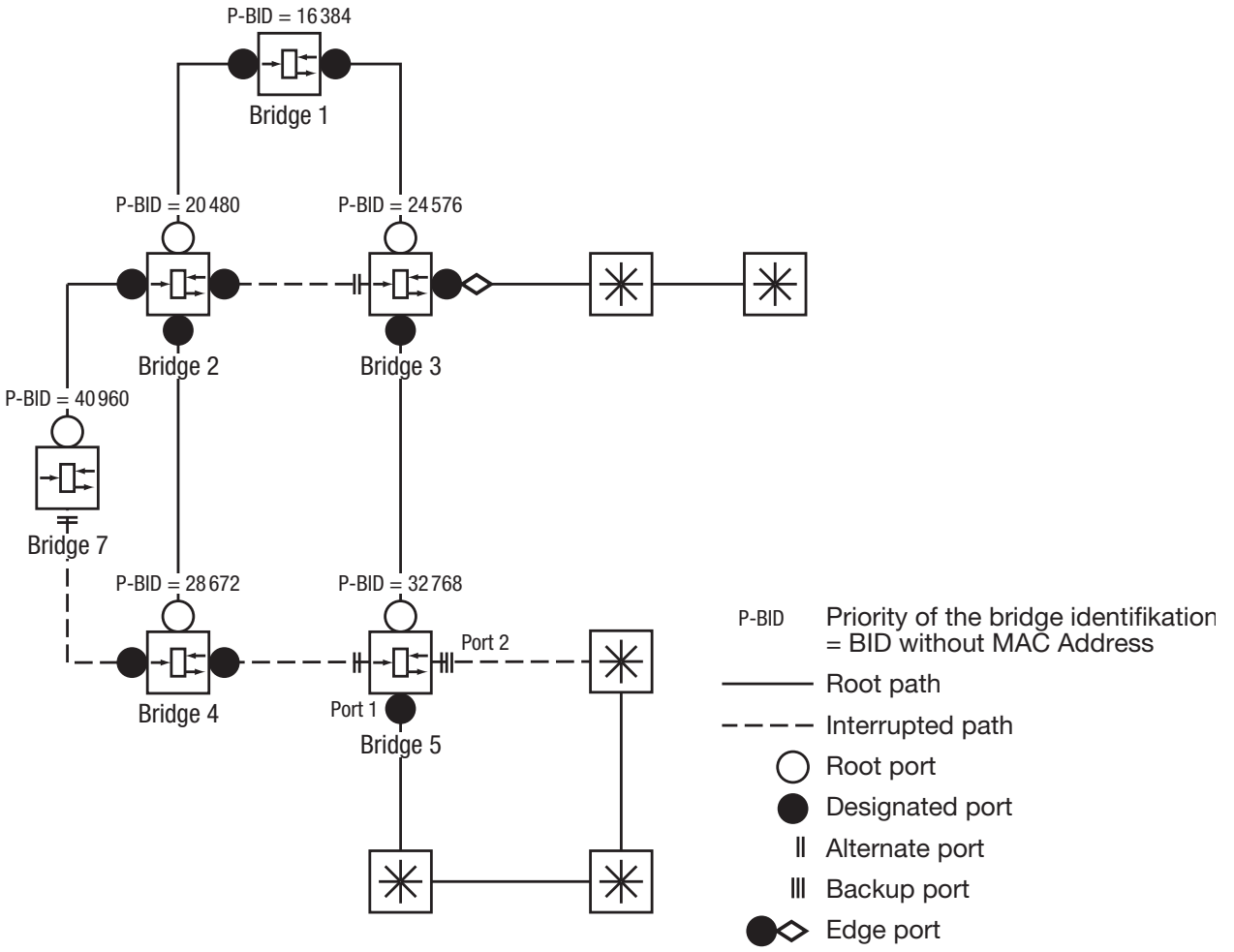


Fig. 39: Port role assignment

4.2.2 Port states

According to the tree structure and the status of the selected connection routes, RSTP assigns their statuses to the ports

STP Port State	Administrative Bridge Port-State	MAC Operational	RSTP Port-State	Active Topology (Port Role)
DISABLED	Disabled	FALSE	Discarding*	Excluded (Disabled)
DISABLED	Enabled	FALSE	Discarding*	Excluded (Disabled)
BLOCKING	Enabled	TRUE	Discarding**	Excluded (Alternate, Backup)
LISTENING	Enabled	TRUE	Discarding**	Included (Root, Designated)
LEARNING	Enabled	TRUE	Learning	Included (Root, Designated)
FORWARDING	Enabled	TRUE	Forwarding	Included (Root, Designated)
MANUALFWD	Enabled	TRUE	ManualFwd	Excluded (Disabled)

Table 12: Relationship between the port-status values in the STP and RSTP
** the dot1d-MIB shows „Disabled“*
*** the dot1d-MIB shows „Blocked“*

Meaning of the RSTP port states:

- Disabled = port does not belong to the active topology
- Discarding = no address learning in FDB and no data traffic apart from sending and receiving
- Learning = address learning active (FDB) and no data traffic apart from BPDUs
- Forwarding = address learning active (FDB) and sending and receiving active from all frames (not only BPDUs)

4.2.3 Spanning Tree Priority Vector

To assign roles to the ports, the RSTP bridges exchange configuration information between themselves. This information is known as a "Spanning Tree Priority Vector". It contains the following

- Bridge identification of the root bridge
- Root path costs of the transmitting bridge
- Bridge identification of the transmitting bridge
- Port identification of the port through which the message was sent
- Port identification of the port through which the message was received

Based on this information, the bridges involved in the RSTP are capable of calculating port roles by themselves and defining the port status of their own ports.

4.2.4 Fast reconfiguration

Why can RSTP react faster than STP to an interruption of the root path?

- Introduction of edge ports
  When reconfiguring RSTP switches to forwarding mode after after the expiration of three seconds (see Table 13 on page 77). RSTP waits then for "Hello Time" to be sure, that no BPDU sending bridge is connected.
  If the user is sure, that an DTE is connected to this port and still remains, he can switch off RSTP on this port. Thus there will be no latency at this port in the case of reconfiguration.
- Introduction of alternate ports
  Since the port roles are already distributed in regular operation, a bridge can switch over immediately from the root port to the alternative port after having lost the connection to the root bridge.
- Communicating with neighboring bridges (point-to-point connections)
  The decentralized, direct communication between neighboring bridges permits immediate reaction to changes in state of the Spanning Tree architecture.
- Filter table
  When STP is used, the age of the entries in the table determines what is to be updated. The RSTP deletes the entries of the ports immediately and specifically that are affected by reconfiguration.

- Reaction to events
  Without having to adhere to any time specifications, RSTP reacts immediately to events such as connection interruption, connection established, etc.

Note: The price for this fast reconfiguration is the risk that data packets may be duplicated or misplaced during the reconfiguration phase. If you cannot accept such a risk in your application, switch back to the slower Spanning Tree Protocol or select one of the other redundancy procedures described in this manual.

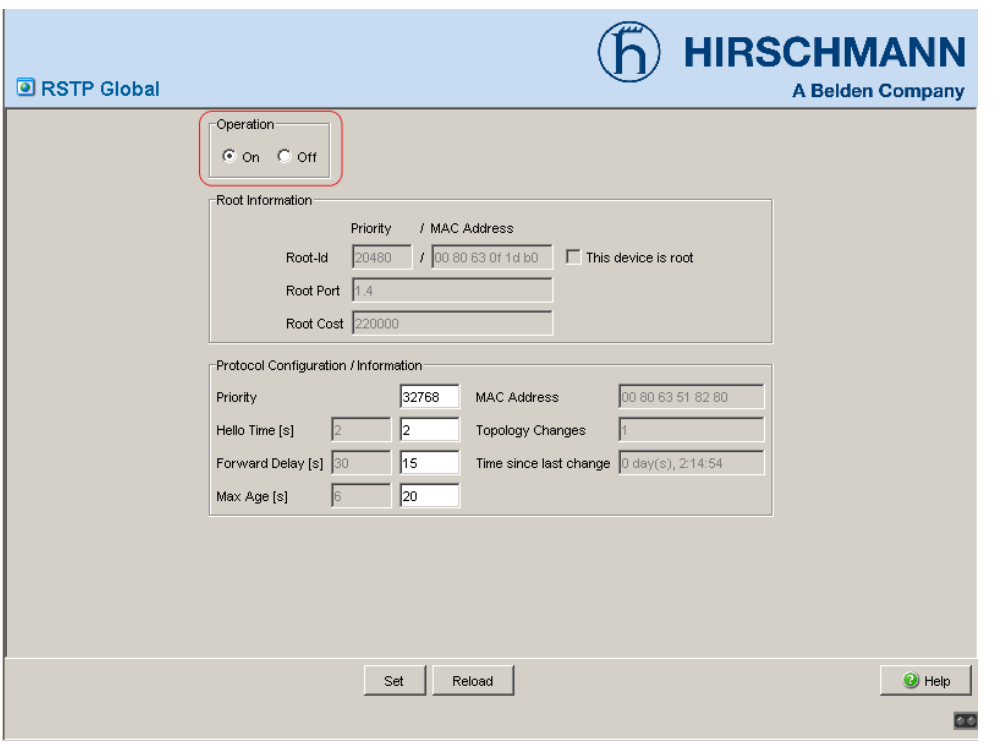
4.3 Configuring the Rapid Spanning Tree

☐ Set up the network to meet your requirements.

Note: Before you connect the redundant lines, you must complete the configuration of the RSTP.
You thus avoid loops during the configuration phase.

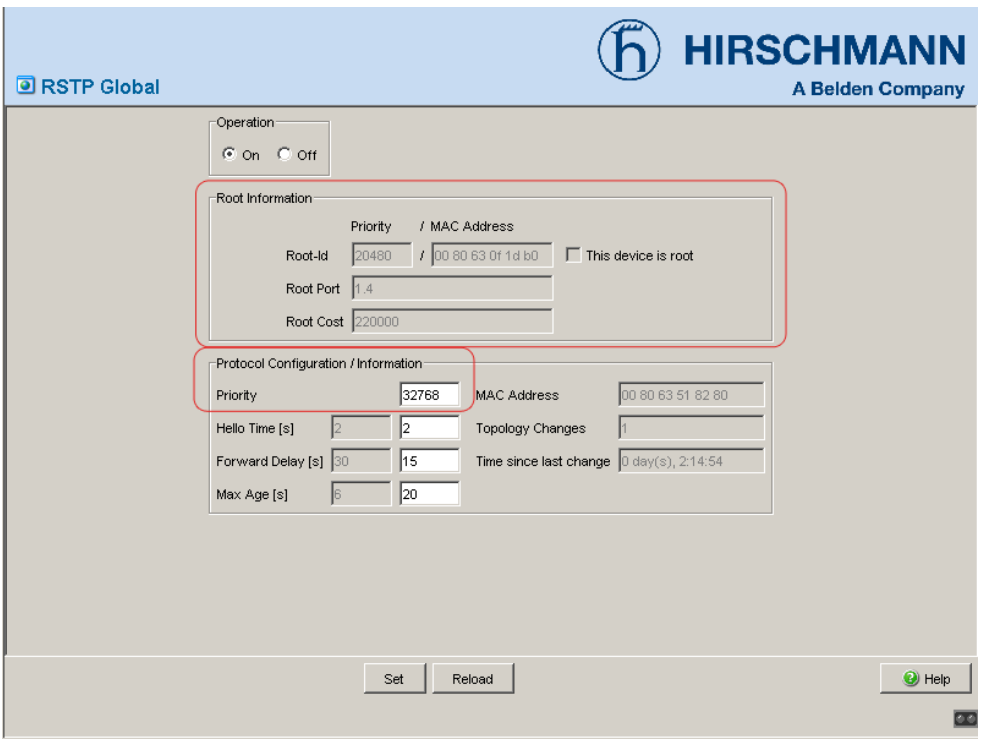
☐ In the `Redundancy:Rapid Spanning Tree` dialog, select: `Global.`

☐ Switch on RSTP on every device

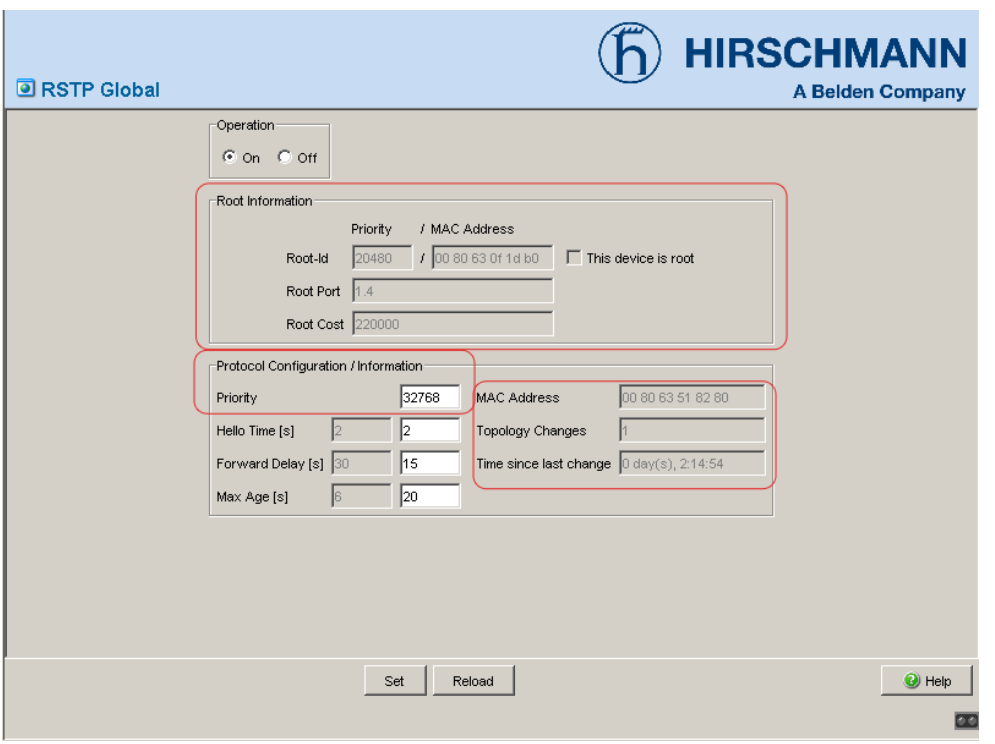


☐ You now connect the redundant lines.

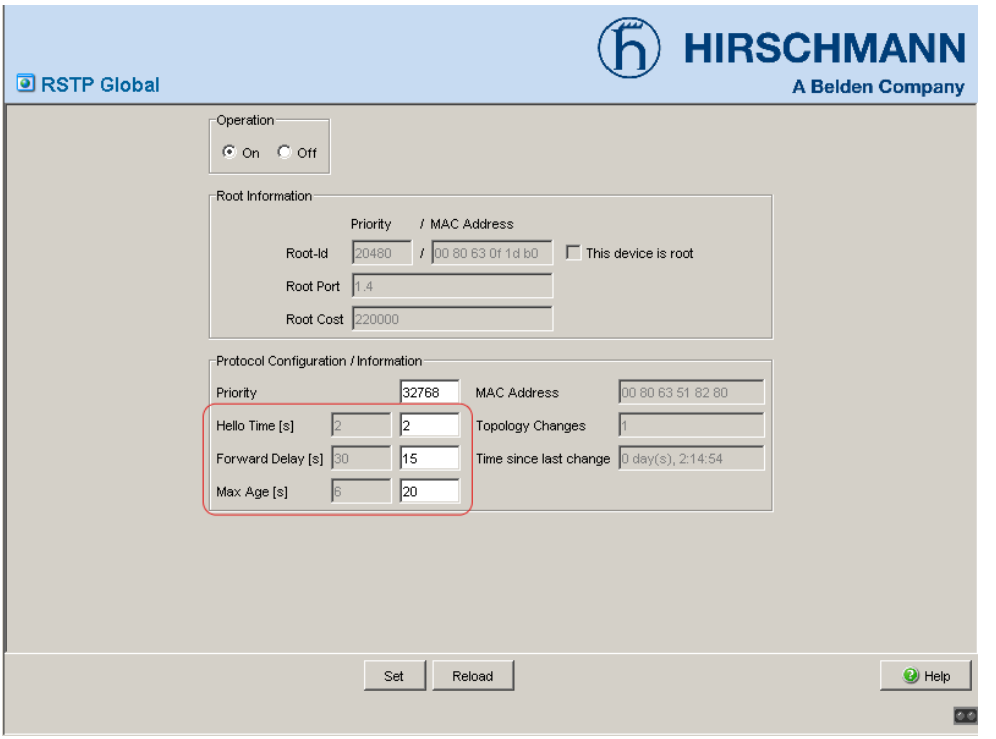
☐ Define the desired switch as the root switch by assigning it the lowest priority in the bridge information among all the switches in the network, in the “Protocol Configuration/Information” frame. Note that only multiples of 4096 can be entered for this value (see Table 13 on page 77).
In the “Root Information” frame, the dialog shows this device as the root.
A root switch has no root port and no root costs.



☐ As required, you change the default priority value of 32768 in other switches in the network in the same way to the value you want (multiple of 4096).
For each of these switches, check the display
in the “Root Information” frame:
– Root ID: Displays the bridge identification of the root bridge
– Root port: Displays the port that leads to the root switch
– Root costs: Displays the root costs to the root switch
in the “Protocol Configuration/Information” frame:
– Priority: Displays the priority in the bridge identification for this switch
– MAC address: Displays the MAC address of this switch
– Topology changes: Displays the number of changes since the start of RSTP
– Time since last change: Displays the time that has elapsed since the last reconfiguration of the network



☐ As desired, you can change the values to be set for "Hello Time", "Forward Delay" and "Max. Age" in the root switch. The root switch then transfers this data to the otherswitches. The dialog displays the data received from the root switch in the left column. In the right column you enter the values which shall apply when this switch becomes a root switch. For the configuration, you should note Tabelle 13 auf Seite 77.



The time entries in the Global dialog are in units of 1 s. Example: Max Age = 20 amounts to 20 seconds.

Variable	Meaning	Possible values	State on delivery
Priority	The priority and the MAC address go together to make up the bridge identification.	0 < n*4 096 < 61 440	32 768

Variable	Meaning	Possible values	State on delivery
Hello Time	The switch sends configuration messages (Configuration Bridge Protocol Data Units, CBPDU) if it is the root switch. Hello Time is the time in seconds between the sending of two configuration messages (Configuration Bridge Protocol Data Units, CBPDU). This is the current value being used by the switch.	1 - 10	2
Forward Delay	The condition diagram of the Spanning Tree Protocol has four possible conditions: disabled, blocking, learning, forwardingl. A certain amount of time passes when switching from one condition to another. This is the current value being used by the bridge. The condition change from normal to blocking occurs without a time lapse.	4 - 30	30
Max Age	After the "Max Age" time period has passed, a BPDU is invalid and discarded.	6 - 40	6

Table 13: Global RSTP settings

☐ As required, change and verify the settings and displays that relate to each individual port (menu bar: Rapid Spanning Tree - Port)..

Note: Deactivate the spanning tree protocol on the ports connected to a redundant ring, since spanning tree and ring redundancy operate at different reaction.

Variable	Meaning	Possible values	State on delivery
STP State Enable	Switching RSTP on/off at this port. Switch STP off when connecting a terminal device in order to avoid unnecessary waiting periods. See also “Fast reconfiguration” on page 71.	on, off	on
Port State	Display ot the port state	disabled, forwarding, discarding, blocking, learning, manualFwd (see Table 12 on page 70)	-
Priority	Enter of the first byte of the port identification. See also “Port identification” on page 59.	16 < n*16< 240	128
Admin Pathcost	Enter the path costs to indicate preference for redundant paths. If the value is "0", the switch automatically calculates the path costs depending on the transmission rate. See also “The bridge parameters” on page 57.	0 - 200 000 000	0
Admin Edge Port	Enter whether a terminal device (= true) or an RSTP bridge (= false) shall be connected to this port. During reconfiguration, the Edge Port at a terminal device can switch to forwarding within 3 seconds. See also “Port roles” auf Seite 67.	true, false	false
Oper Edge Port	Shows whether an RSTP switch is connected at this port. Independently of the value set under “Soll Edge Port”, the switch detects a connected RSTP switch. Then it sets Edge Port = false.) See also “Port roles” on page 67.	true, false	-

Variable	Meaning	Possible values	State on delivery
Oper PointToPoint	Shows whether at this port the connection between two RSTP switches is a half-duplex connection (true) or not (false). (The point-to-point connection makes a direct connection between 2 RSTP switches. The direct, decentral communication between the two switches results in a fast reconfiguration time.)	true, false	auto (calculated thus: FDX = true HDX = false)
Designated Root	Display of the bridge identification of the designated root switch for this port.	Bridge identification (hexadecimal)	-
Designated Costs	Display of the costs of the path from this port to the root switch.	Costs (siehe Tab. 11 auf Seite 58)	-
Designated Port	Display of the port identification of the port that creates the connection to the root switch for this port (on the designated switch).	Port identification (hexadecimal) and port numbe	-

Table 14: Port-related RSTP settings and displays

☐ You now connect the redundant lines. You can avoid loops and network failures during the configuration phase by first configuring the switches and only then connecting the redundant lines.

5 VRRP/HiVRRP

The Virtual Router Redundancy Protocol (VRRP) is a procedure that enables the system to react to the failure of a router.
VRRP is used in networks with terminal devices that only support one entry for the “Default Gateway”. If the “Default Gateway” fails, then VRRP ensures that the terminal devices find a redundant gateway.

Note: You will find detailed information on VRRP and HiVRRP in the "Routing Configuration" user manual.

5.1 Configuring the VRRP

With this dialog you can enter both general settings and settings for each port for the VRRP.

5.1.1 General settings

- ☐ Function: Switch the VRRP function on and off.
- ☐ Version: Display the VRRP version.
- ☐ Send VRRP Master Trap: As soon as the Switch takes over the VRRP master function, it sends a master trap.
- ☐ Send VRRP Authentication Trap: As soon as the Switch receives a VRRP message with incorrect authentication, it sends a VRRP authentication error trap.

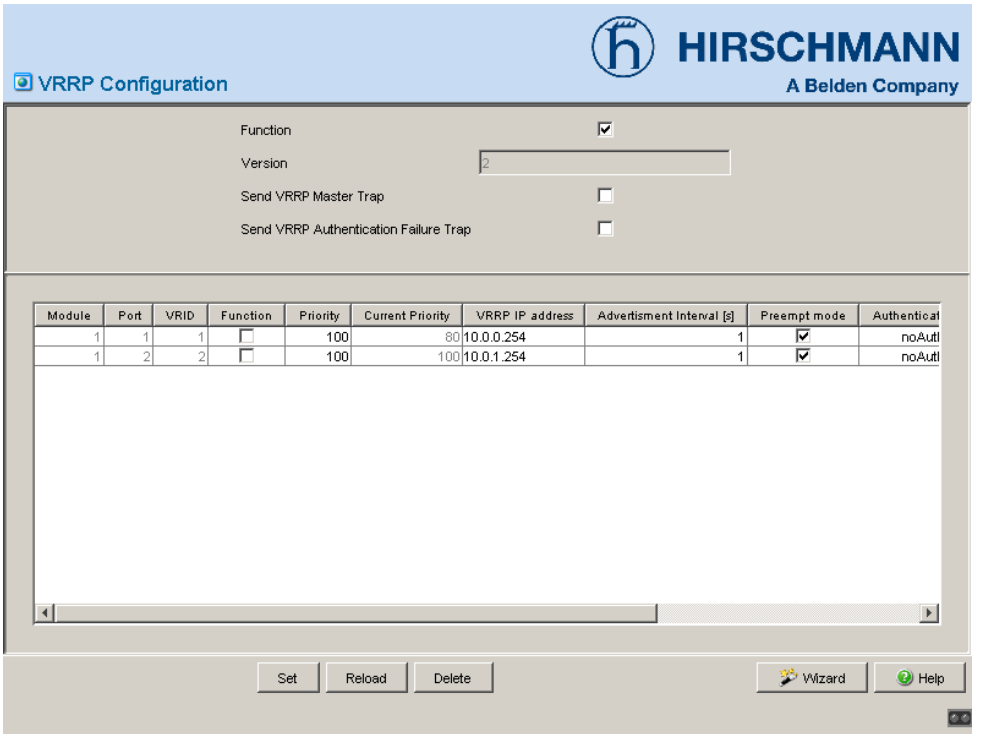


Fig. 40: Dialog Configuration

5.1.2 Settings per port

Parameter	Meaning
Module	Module of the Switch
Port	Port to which this entry applies
VRID	Virtual router ID
Function	Switch the VRRP function at this port on and off
Priority	VRRP priority set (value: 1-255; default: 100). The router with the highest value is the master. If the virtual router IP address is the same as the IP address of the router interface, then this router is the "owner". If an owner exists, then VRRP assigns the owner the VRRP priority 255 and thus declares it the master. .
Current Priority	VRRP priority actually used (value: 1-255). This value is usually the same as the VRRP priority set, but it can be smaller if monitored tracking objects have the "down" status
VRRP IP address	Primary virtual router IP address.
Advertisement Interval	Interval for sending out messages (advertisements) as the master (value for VRRP: 1-255 s, value for HiVRRP: 100-255000 ms, default setting: 1 s).
Preempt Mode	This setting specifies whether this Switch, as a backup router, will take over the master role from a master router with a lower VRRP priority. If the preempt mode is switched off, this Switch only takes on the master role if the IP Multicast message from the existing master does not appear.
Authentication	Type of authentication used: – “noAuthentication”: VRRP information is exchanged without authentication. – “simpleTextPassword”: VRRP information is exchanged with plain text password authentication. – “ipAuthenticationHeader”: VRRP uses the IP authentication header to authenticate VRRP information.
Key	Password for authentication. In order to communicate, the Switches with the same virtual router IP addresses must have the same authentication setting.
State	VRRP status – “initialize”: VRRP is in the initialization phase. No master has been named yet. – “backup”: The Switch sees the possibility of becoming master. – “master”: The Switch is master.
Master IP Address	Actual router interface IP address of the master.

Table 15: VRRP configuration table

5.1.3 Setting up the VRRP router interface

- ☐ In the `Redundancy: VRRP: Configuration` dialog, click on "Wizard" at the bottom right.
- ☐ In the table in the Wizard dialog, select a port row and enter the virtual router ID in the VRID row.
- ☐ Click on “Next”.
- ☐ In the wizard window, you enter:
  – the VRRP IP address of the virtual router
  – the VRRP priority
  – the authentication type
  – the authentication key
  – the advertisment interval.
  Select the preempt mode if you require.
  Activate the VRRP function.
  If you want
  – switching times of less than 3 s or
  – the routers to use Unicasts to communicate with one another,
  you activate the "HiVRRP" field and fill the "HiVRRP message interval" and "HiVRRP destination address" fields.
  The HiVRRP message interval has a range from 100 to 255000 ms.
  The HiVRRP destination address is the IP address of the partner HiVRRP router.
- ☐ Click on “Finish” to transfer the VRRP router interface into the VRRP router interface table.
  or

☐ Click on "Next" to assign tracking objects to the virtual router in the "Tracking" window. If a tracking object changes to the "down" status, the VRRP priority is decremented.
Select an existing track entry and click "Add". You can add up to eight tracking objects. Make sure that the sum of the decrements of all the assigned track entries is less than the VRRP priority of this VRRP interface.

Note: As the IP address owner has the fixed VRRP priority 255 by definition, the VRRP tracking function requires the IP addresses of the VRRP router interfaces to differ from the virtual router IP address.

Note: You activate the preempt mode so that, after the decremetation of the VRRP priority of the master via the tracking function, the backup router can take over the master role.

☐ Click on "Next" if you want to enter additional IP addresses in the "Associated IP Addresses" (Multinetting) window. Then click on "Finish" to transfer the VRRP router interface into the VRRP router interface table.

5.1.4 Configuring the VRRP router interface

- ☐ Double-click in the `Redundancy: VRRP: Configuration`on dialog a cell in the table and edit the entry, or
  right-click on a cell and select a value..

- ☐ As an alternative to editing directly in the table, you can mark a row in the table and use the Wizard to edit it.

5.1.5 Deleting the VRRP router interface

- ☐ Select in the `Redundancy: VRRP: Configuration`on dialog a row and click on “Delete”. You thus delete the row.

5.2 Statistics

The VRRP statistics window displays the numbers on counters that count events relevant to VRRP.

Parameter	Meaning
Checksum errors	Number of VRRP messages received with the wrong check sum.
Version errors	Number of VRRP messages received with an unknown or unsupported version number.
VRID errors	Number of VRRP messages received with an invalid VRID for this virtual router.

Table 16: VRRP statistics for all ports

Parameter	Meaning
Module	Module of the Switch.
Port	Port of the module of the Switch.
VRID	Virtual router ID
Become Master	Number of times the Switch has become the master.
Advertise receives	Number of VRRP messages received.
Advertise Interval errors	Number of VRRP messages received by the Switch outside the message interval.
Authentication failures	Number of VRRP messages received with authentication errors.
IP TTL errors	Number of VRRP messages received with an IP-TTL not equal to 255.
Priority Zero packets receive	Number of VRRP messages via a VRRP participant with priority 0.
Priority Zero packets sent	Number of VRRP messages that the Switch sent with priority 0.
Invalid Type packets receive	Number of VRRP messages received with an invalid type
Address list errors	Number of VRRP messages received for which the address list does not match the address list configured locally for the virtual router.
Invalid Authentication type	Number of VRRP messages received with an invalid authentication type.
Authentication type mismatch	Number of VRRP messages received with an incorrect authentication type
Packet length errors	Number of VRRP messages received with an incorrect packet length.

Table 17: VRRP port statistics table

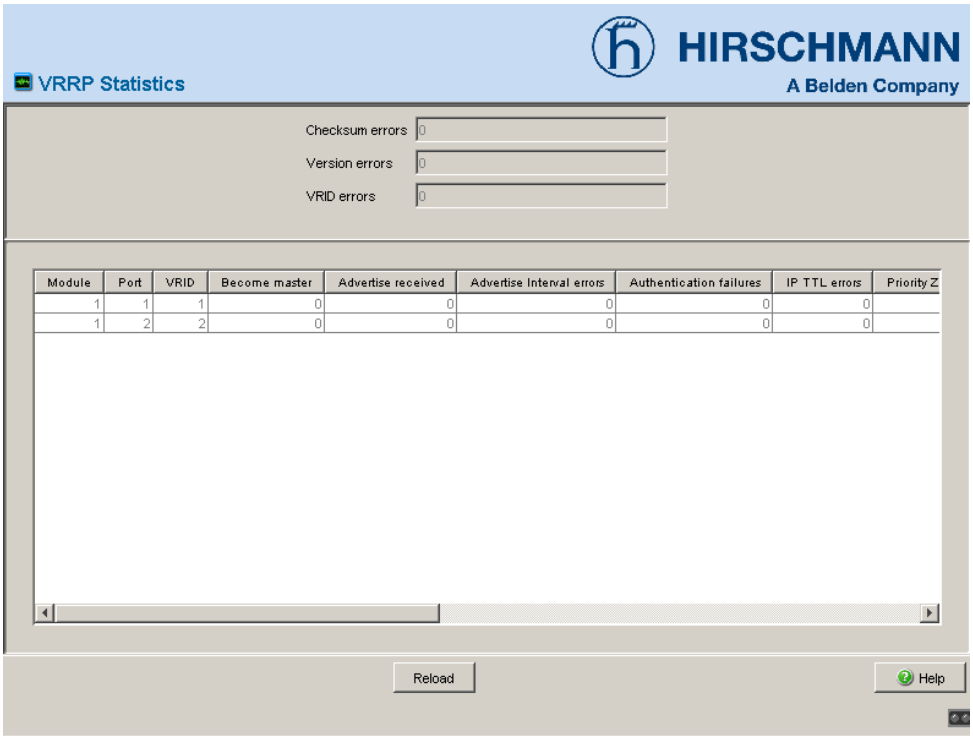


Fig. 41: Dialog Statistics

5.3 Tracking

The VRRP Tracking window displays the status of all the tracking objects assigned to VRRP objects.

Parameter	Meaning
Port	Port to which this entry applies, in the form <Slot>.<Port>
VRID	Virtual router ID of the assigned virtual router.
TrackId	ID number of the tracking object.
Track Decrement	Value by which the current VRRP priority of the assigned VRRP priority is reduced when the tracking object gets the status "down".
Status	Current status of the tracking object: "up" or "down".
Active	Entry is displayed as "active" if the tracking object is completely set up and is activated. If the entry is active, you can find more information about it in the Reference Manual Web-based Interface, Chapter Routing"Tracking". If the entry is not active, its status is always "up". .

Table 18: VRRP tracking table

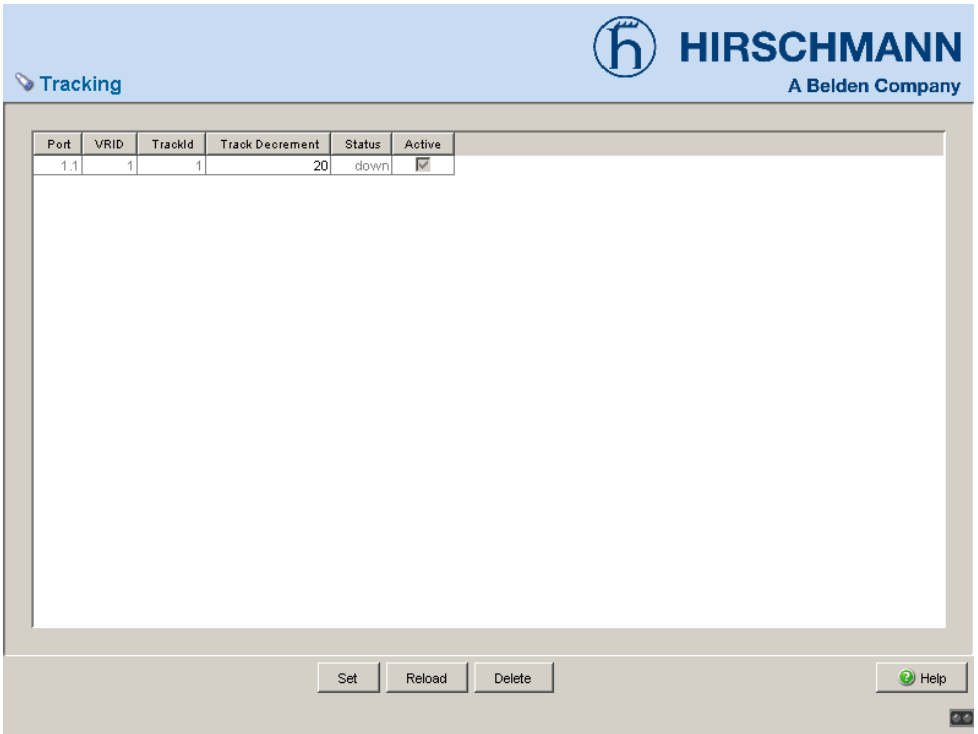


Fig. 42: Dialog Tracking

A Appendix

Hirschmann Competence

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Your **assessment** of this manual:

	excellent	good	atisfactory	mediocre	poor
Accuracy	O	O	O	O	O
Readability	O	O	O	O	O
Comprehensibility	O	O	O	O	O
Examples	O	O	O	O	O
Structure/Layout	O	O	O	O	O
Completeness	O	O	O	O	O
Graphics	O	O	O	O	O
Drawings	O	O	O	O	O
Tables	O	O	O	O	O

Did you discover an error in the manual?
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