

MiCOM Px4x

Dual Redundant Ethernet Board (Upgrade)

Px4x/EN REB(U)/C11

Data Pack G, I, J, H

User Guide

Note

The technical manual for this device gives instructions for its installation, commissioning, and operation. However, the manual cannot cover all conceivable circumstances or include detailed information on all topics. In the event of questions or specific problems, do not take any action without proper authorization. Contact the appropriate Schneider Electric technical sales office and request the necessary information.

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DUAL REDUNDANT ETHERNET BOARD (UPGRADE)

CHAPTER 1

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Software Version &
Hardware Suffix: Data Pack G, I, J, H
Connection Diagrams: 10Px4001

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1 INTRODUCTION

The redundant Ethernet board assures redundancy at IED level. It is fitted into the following IEDs.

- P141, P142, P143, P144, P145
- P241, P242, P243
- P341, P342, P343, P344, P345
- P442, P443, P444, P445, P446
- P543, P544, P545, P546
- P642, P643, P645
- P741, P743, P746
- P841

1.1 Standard Safety Statements

For safety information please see the Safety Information chapter of the relevant Px4x Technical Manual.

2 HARDWARE DESCRIPTION

IEC 61850 and DNP3 work over Ethernet. Two boards are available, the single Ethernet board and the Redundant Ethernet board (ZN0071). Both are required for communications but the redundant Ethernet board allows an alternative path to be always available, providing bumpless redundancy.

Industrial network failure can be disastrous. Redundancy provides increased security and reliability, but also devices can be added to or removed from the network without network downtime.

The following list shows Schneider Electric's implementation of Ethernet redundancy, which has six variants with embedded IEC 61850 or DNP3 over Ethernet, plus SHP, RSTP and DHP redundancy protocols.

- Self Healing Protocol (SHP) with 1300 nm multi mode 100BaseFx fiber optic Ethernet ports (ST connector) and **modulated** IRIG-B input. Part number ZN0071 001.
- SHP with 1300 nm multi mode 100BaseFx fiber optic Ethernet ports (ST connector) and **unmodulated** IRIG-B input. Part number ZN0071 002.

<i>Note</i>	<i>Both of these boards offer compatibility with C264-SWR202 and MiCOM H35x multi-mode switches. Self Healing Protocol is a Schneider Electric proprietary solution providing extremely fast recovery time.</i>
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- Rapid Spanning Tree Protocol (RSTP IEEE 802.1D 2004) with 1300 nm multi mode 100BaseFx fiber optic Ethernet ports (ST connector) and **modulated** IRIG-B input. Part number ZN0071 005.
- RSTP (RSTP IEEE 802.1D 2004) with 1300 nm multi mode 100BaseFx fiber optic Ethernet ports (ST connector) and **unmodulated** IRIG-B input. Part number ZN0071 006.

<i>Note</i>	<i>Both of these boards offer compatibility with any RSTP device.</i>
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- Dual Homing Protocol (DHP) with 1300 nm multi mode 100BaseFx fiber optic Ethernet ports (ST connector) and **modulated** IRIG-B input. Part number ZN0071 007.
- DHP with 1300 nm multi mode 100BaseFx fiber optic Ethernet ports (ST connector) and **unmodulated** IRIG-B input. Part number ZN0071 008.

<i>Note</i>	<i>Both of these boards offer compatibility with C264-SWD202 and H36x multi-mode switches. Dual Homing Protocol is a Schneider Electric solution providing bumpless redundancy to the IED.</i>
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The redundant Ethernet board is fitted into Slot A of the IED, which is the optional communications slot. Each Ethernet board has two MAC addresses, one for the managed embedded switch and one for the IED. The MAC address of the IED is printed on the rear panel of the IED.

For information concerning installation, refer to the Best Practice document *GP02 Ethernet Wiring*.

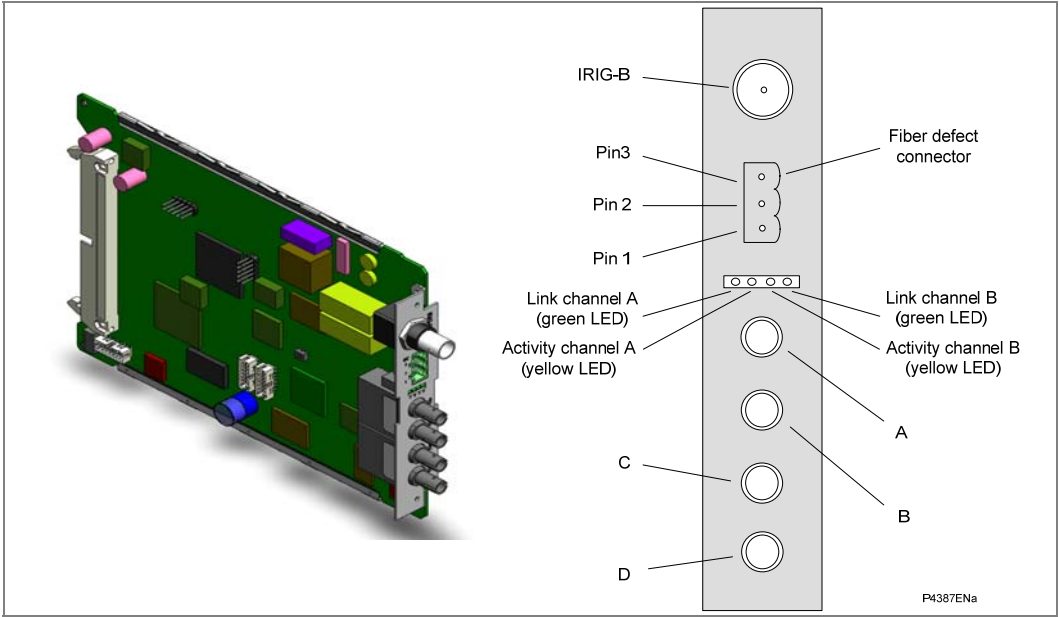


Figure 1 - Redundant Ethernet board connectors

2.1 IRIG-B Connector

Available as a modulated or demodulated input. See section 6.1.

2.2 Fiber Defect Connector (Watchdog Relay)

Pin	Closed	Open
1-2	Link fail Channel 1 (A)	Link ok Channel 1 (A)
2-3	Link fail Channel 2 (B)	Link ok Channel 2 (B)

Table 1 - RSTP configuration parameters range and default values

2.3 LEDs

LED	Function	On	Off	Flashing
Green	Link	Link ok	Link broken	
Yellow	Activity	SHP running		RSTP or DHP traffic

Table 2 - LED functionality

2.4 Optical Fiber Connectors

Uses 1300 nm multi mode 100BaseFx and ST connectors. See Figure 1 and section 6.1.

Connector	DHP	RSTP	SHP
A	R _{XA}	R _{X1}	R _P
B	T _{XA}	T _{X1}	E _S
C	R _{XB}	R _{X2}	R _S
D	T _{XB}	T _{X2}	E _P

Table 3 - Optical fiber connector functionality

3 REDUNDANCY PROTOCOLS

There are three redundancy protocols available:

- RSTP (Rapid Spanning Tree Protocol)
- SHP (Self Healing Protocol)
- DHP (Dual Homing Protocol)

3.1

Rapid Spanning Tree Protocol (RSTP)

Rapid Spanning Tree Protocol (RSTP) is a standard used to quickly reconnect a network fault by finding an alternative path, allowing loop-free network topology. Although RSTP can recover network faults quickly, the fault recovery time depends on the number of devices and the topology. The recovery time also depends on the time taken by the devices to determine the root bridge and compute the port roles (discarding, learning, forwarding). The devices do this by exchanging Bridge Protocol Data Units (BPDUs) containing information about bridge IDs and root path costs. See the IEEE 802.1D 2004 standard for further information.

The Px4x redundant Ethernet board uses the RSTP protocol (802.1w), so a Px4x can attach onto a network as shown in Figure 2.

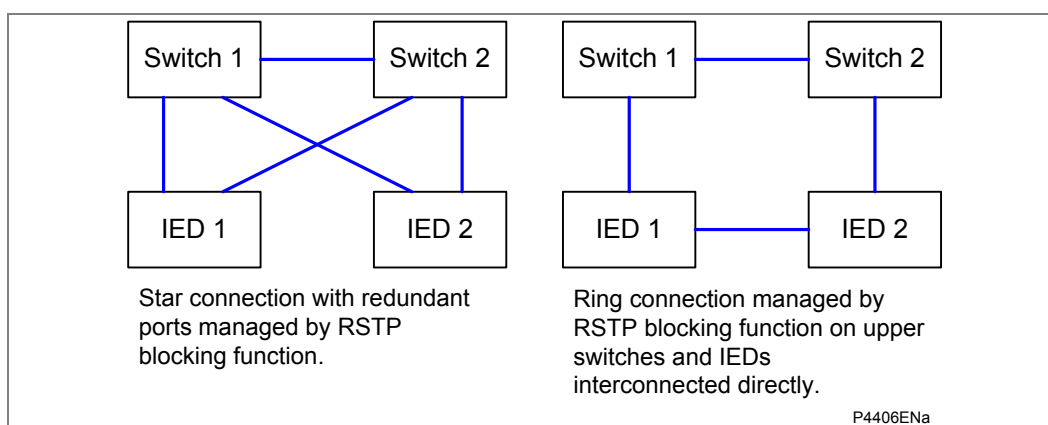


Figure 2 - Px4x attached to a redundant Ethernet star or ring circuit

The RSTP solution is based on open standards. It is therefore compatible with other IEDs that use the RSTP protocol. The RSTP recovery time is typically 300 ms but it increases with network size. However, the Schneider Electric Dual Homing Protocol (DHP) and Self Healing Protocol (SHP) solutions respond to the constraints of critical time applications such as GOOSE.

3.2 Self Healing Protocol (SHP)

Self Healing Protocol (SHP) is applied to double ring network topologies. When a fiber is broken, both end stations detect the break. Using both the primary and redundant networks the ring is automatically reclosed.

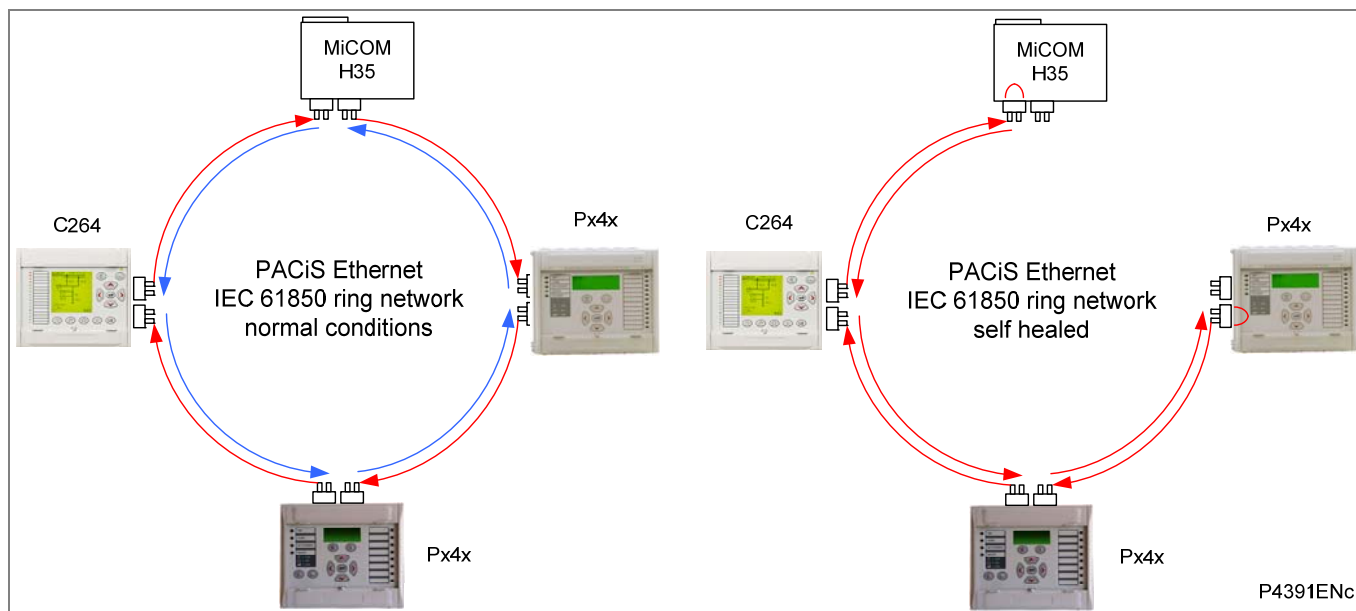


Figure 3 - MiCOM Px4x, Px3x, C264 and Hx5x Ethernet switch with self healing ring facilities

The MiCOM Px4x, Px3x, C264 and Hx5x are repeaters with a standard 802.3 Ethernet switch plus the Self Healing Manager (SHM). Figure 4 shows the internal architecture of such a device.

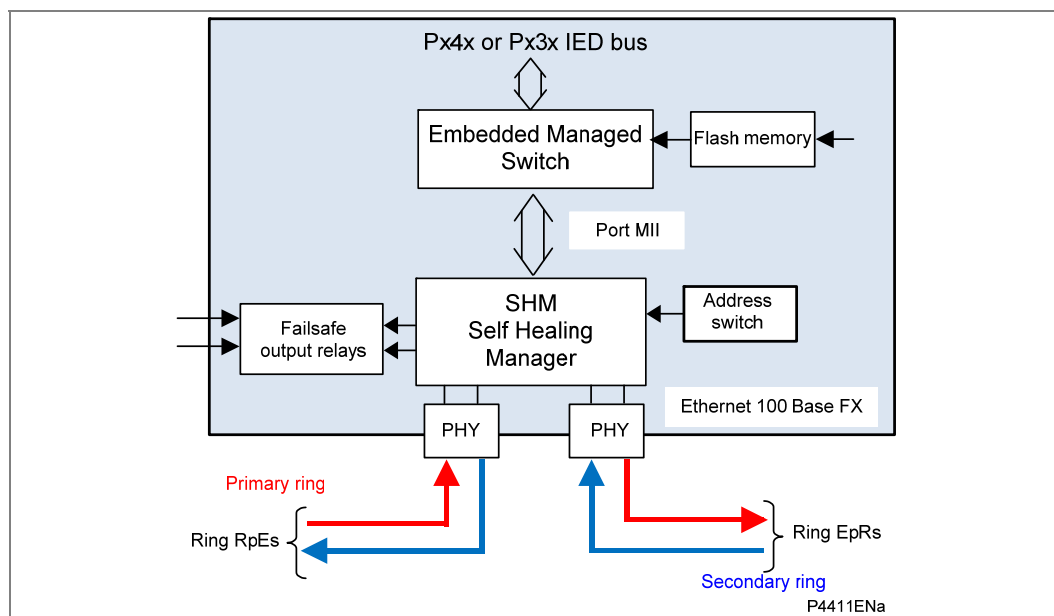


Figure 4 - Internal architecture of MiCOM Px4x, Px3x, C264 and Hx5x

The SHM functions manage the ring. If the fiber optic connection between two devices is broken, the network continues to run correctly.

Normally the Ethernet packets travel on the primary fiber in the same direction, and only a checking frame (4 octets) is sent every 5 μ s on the secondary fiber in the opposite direction.

If the link goes down, both SHMs immediately start the network self-healing. At one side of the break, received messages are no longer sent to the primary fiber but are sent to the secondary fiber. On the other side of the break, messages received on the secondary fiber are sent to the primary fiber and the new topological loop is closed in less than 1 ms.

It is therefore possible to extend the number of devices, or the size of a sub-station network, without stopping the network. The loop is opened and it self heals, then new equipment is connected and it self heals again, closing the loop.

To increase the reliability some specific mechanisms are used:

- The quality of transmission is monitored. Each frame (Ethernet packet or checking frame) is controlled by the SHM. If a large error rate is detected, the self healing starts and the fault is eliminated.
- Even if there is no traffic in the primary link, the secondary link is still supervised by sending out checking frames every 5 μ s.

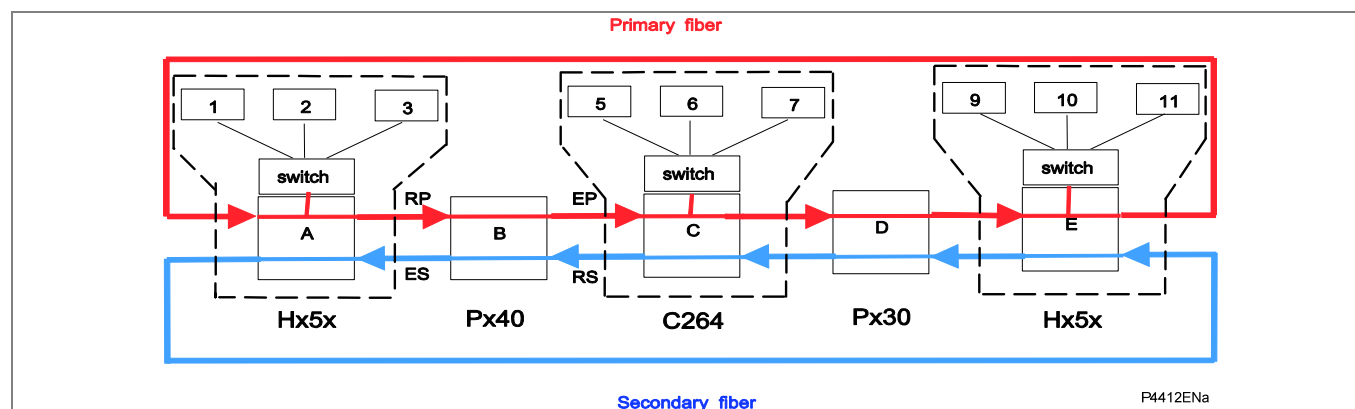


Figure 5 - Nominal redundant Ethernet ring architecture with MiCOM Px4x, Px3x, C264 and Hx5x switches

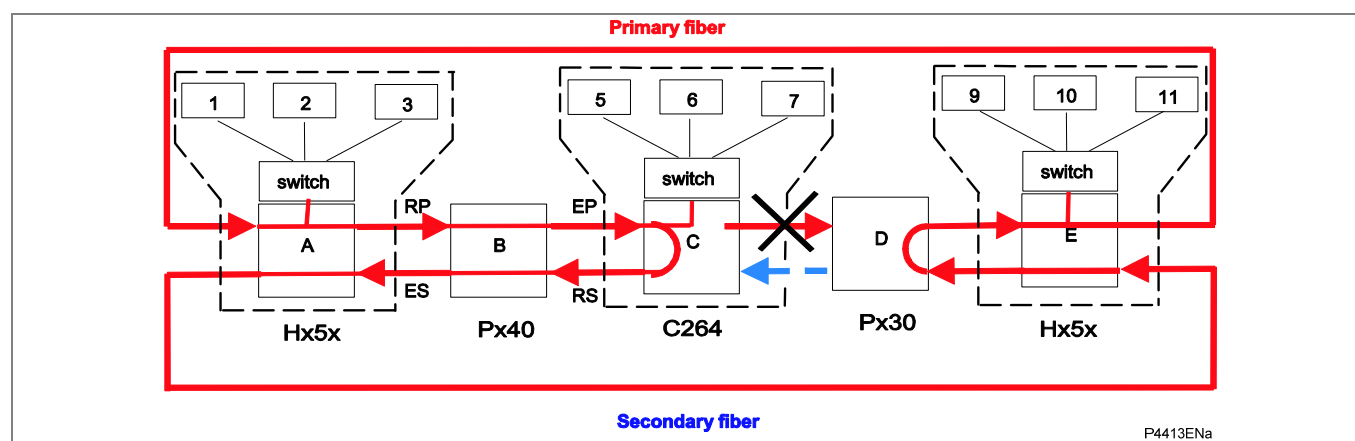


Figure 6 - Ethernet ring architecture with MiCOM Px4x, Px3x, C264 and Hx5x switches after failure

3.3

Dual Homing Protocol (DHP)

The Dual Homing Manager (DHM) functions manage the double star. If the optical fiber connection between two devices is broken, the network continues to operate correctly.

The DHM handles topologies where a device is connected to two independent networks. One is the main link, the other is the backup. Both are active at the same time.

In sending mode, packets from the device are sent by the DHM to the two networks. In receive mode, the duplicate discard principle is used. This means that when both links are up, the MiCOM H16x receives the same Ethernet frame twice. The DHM transmits the first frame received to upper layers for processing, and the second frame is discarded. If one link is down, the frame is sent through the link, received by the device, and passed to upper layers for processing.

Schneider Electric's dual homing mechanism fulfils automation requirements by delivering a very fast recovery time for the entire network (less than 1 ms).

To increase reliability some specific mechanisms are used:

- Each frame carries a sequence number which is incremented and inserted into both frames.
- Specific frames are used to synchronize the discard mechanism.

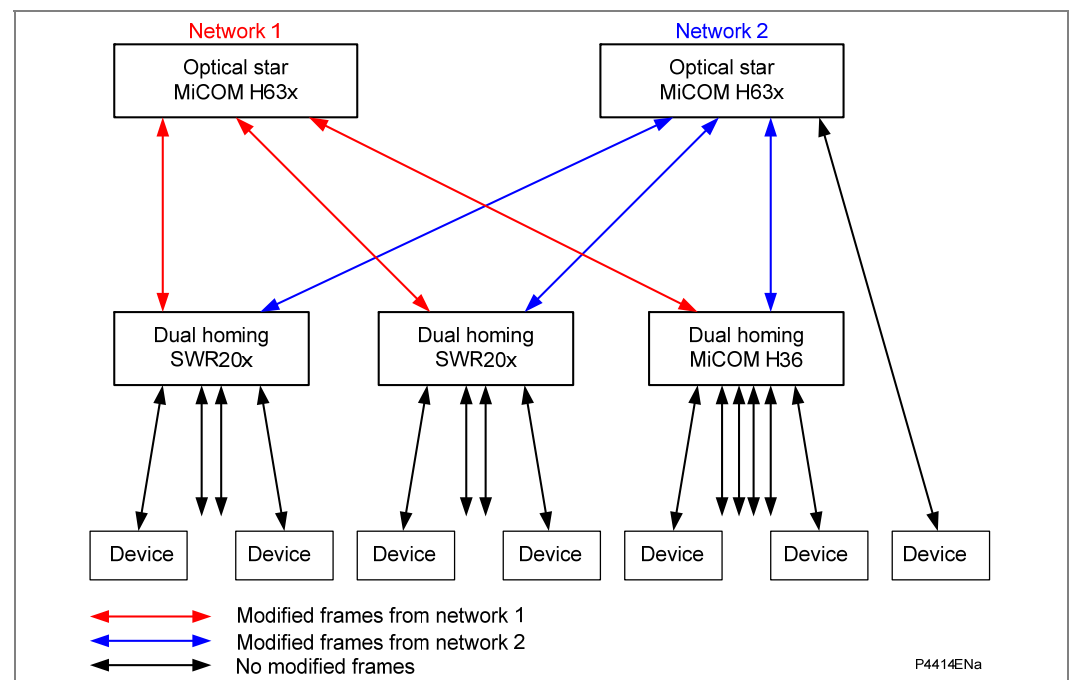


Figure 7 - Dual homing mechanism

The MiCOM H36x is a repeater with a standard 802.3 Ethernet switch, plus the dual homing manager. Figure 8 shows the internal architecture of such a device.

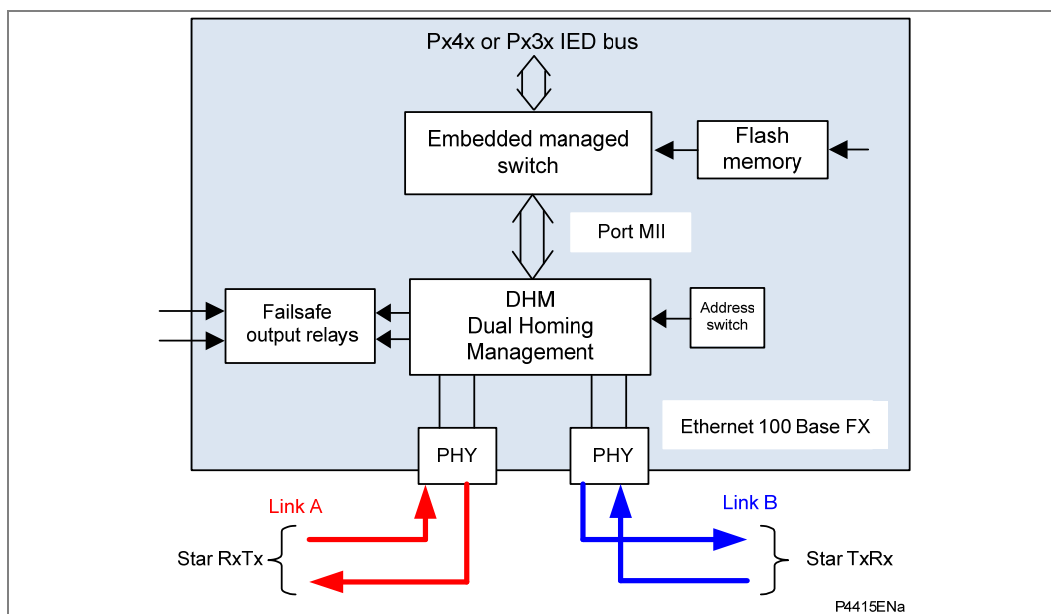


Figure 8 - Internal architecture of MiCOM Px4x, Px3x, C264 and H36x

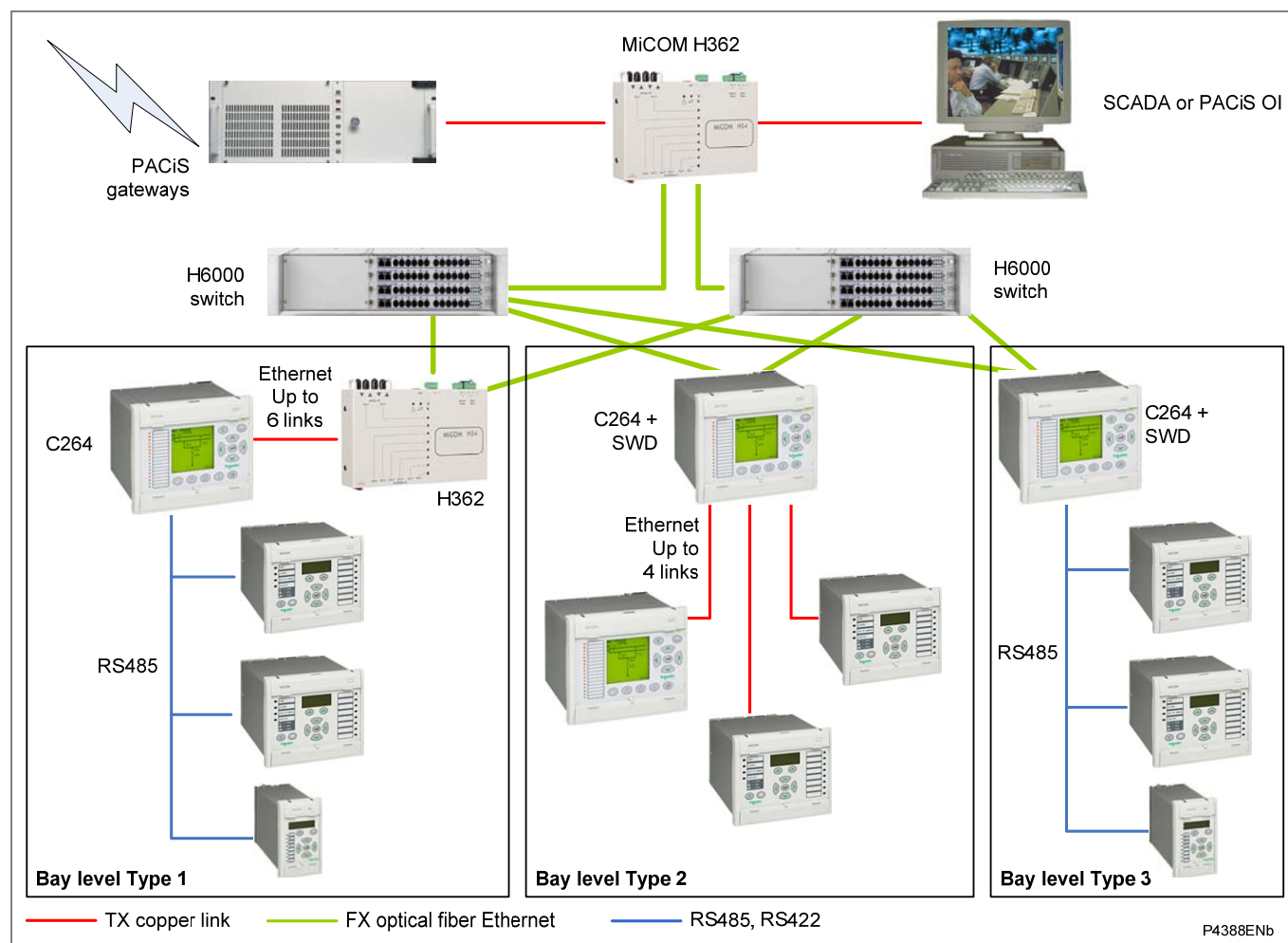


Figure 9 - Application of dual homing star at substation level

3.4 Generic Functions for all Redundant Ethernet Boards

The following apply to all three redundant Ethernet protocols (RSTP, SHP and DHP).

3.4.1 Ethernet 100Base Fx

The fiber optic ports are full duplex 100 Mbps ST connectors.

3.4.2 Forwarding

The MiCOM Px4x, Px3x, C264, Hx1x and Hx5x switches support store and forward mode. The MiCOM switch forwards messages with known addresses to the appropriate port. The messages with unknown addresses, the broadcast messages and the multicast messages are forwarded out to all ports except the source port. MiCOM switches do not forward error packets, 802.3x pause frames or local packets.

3.4.3 Priority Tagging

802.1p priority is enabled on all ports.

3.4.4 Simple Network Management Protocol (SNMP)

Simple Network Management Protocol (SNMP) is the network protocol developed to manage devices in an IP network. SNMP relies on a Management Information Base (MIB) that contains information about parameters to supervise. The MIB format is a tree structure, with each node in the tree identified by a numerical Object Identifier (OID). Each OID identifies a variable that can be read or set using SNMP with the appropriate software. The information in the MIBs is standardized.

3.4.4.1 Redundant Ethernet Board MIB Structure

The SNMP MIB consists of distinct OIDs, each of which refers to a defined collection of specific information used to manage devices on the Schneider Electric ring. The Schneider Electric MIB uses three types of OID.

Address												Name	
0												Ccitt	
	1											ISO	
		3										Org	
			6									DOD	
				1								Internet	
					2							mgmt	
						1						Mib-2	
							1					sys	
								1				sysDescr	Schneider Electric repeater
									3			sysUpTime	xday yh:zm:zs:yymms
										4		sysName	

Table 4 - Redundant Ethernet board MIB Structure

3.4.5 RMON

Address												Name
0												Ccitt

Address											Name
1											ISO
	3										Org
		6									DOD
			1								Internet
				2							mgmt
					1						Mib-2
						16					Rmon
							1				stat
								1			etherstat
									1	9	Port number (*)
										10	etherStatsIndex etherStatsUndersizePkts
										12	etherStatsIndex etherStatsOversizePkts
										13	etherStatsIndex etherStatsJabbers
										14	etherStatsIndex etherStatsCollisions
										15	etherStatsIndex etherStatsPkts64Octets
										16	etherStatsIndex etherStatsPkts65to127Octets
										17	etherStatsIndex etherStatsPkts128to255Octets
										18	etherStatsIndex etherStatsPkts256to511Octets
										19	etherStatsIndex etherStatsPkts512to1023Octets

Table 5 - Redundant Ethernet board MIB Structure

*Port number: 1 to 6 for the RJ45, port 7 management, port 8 ring

Various SNMP client software tools can be used with the MiCOM Px4x, C264 and Hx5x range. Schneider Electric recommends using an SNMP MIB browser which can perform the basic SNMP operations such as GET, GETNEXT, RESPONSE.

To access the network using SNMP, use the IP address of the embedded switch in the redundant Ethernet board. See section 4.2.

3.4.6

Simple Network Time Protocol (SNTP)

Simple Network Time Protocol (SNTP) is supported by both the IED and the redundant Ethernet switch. SNTP is used to synchronize the clocks of computer systems over packet-switched, variable-latency data networks. A jitter buffer is used to reduce the effects of variable latency introduced by queuing in packet switched networks, ensuring a continuous data stream over the network.

The IED receives the synchronization from the SNTP server. This is done using the IP address of the SNTP server entered into the IED from the IED Configurator software.

4 CONFIGURATION

An Internet Protocol (IP) address is a logical address assigned to devices in a computer network that uses the Internet Protocol for communication between nodes. IP addresses are stored as binary numbers but they are usually displayed in the following format.

10 . 86 . 254 . 85

Both the IED and the redundant Ethernet board each have their own IP address. Figure 10 shows the IED as IP1 and the redundant Ethernet board (REB) as IP2. Note that IP1 and IP2 must be different and are in the same subnet mask.

The switch IP address must be configured through the network.

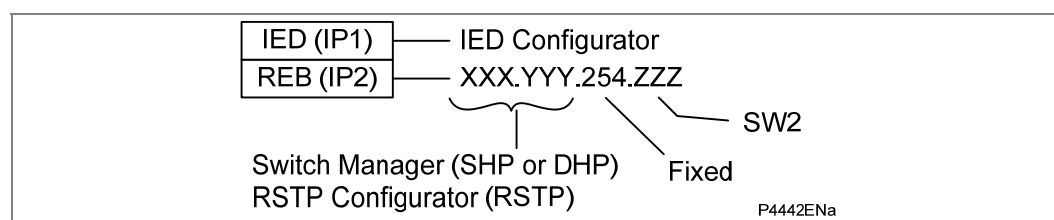


Figure 10 - IED and redundant Ethernet board IP address configuration

4.1 Configuring the IED IP Address

The IP address of the IED is configured using the IED Configurator software in MiCOM S1 Studio. If using IEC 61850 the IED IP address is set using the IED Configurator. If using DNP3 over Ethernet, the IED IP address is managed directly through the DNP3 file. The available range is 128 to 254 in the last octet of the IED IP address.

Note: In the IED Configurator, set the port type to **Copper**, not **Fiber**.

4.2 Configuring the Board IP Address

The IP address of the redundant Ethernet board is configured in both software and hardware, as shown in Figure 10. Therefore this must be configured before connecting the IED to the network to avoid an IP address conflict.

4.2.1 Configuring the First Two Octets of the Board IP address

If using Self Healing Protocol or Dual Homing Protocol, the first two octets are configured using Switch Manager (see section 4.3) or an SNMP MIB browser (see section 3.4.4). An H35 (SHP) or H36 (DHP) network device is needed in the network to configure the Px40 redundant Ethernet board IP address using SNMP.

If using Rapid Spanning Tree Protocol, the first two octets are configured using the RSTP Configurator software tool (see section 4.4) or using an SNMP MIB browser (see section 3.4.4).

4.2.2 Configuring the Third Octet of the Board IP Address

The third octet is fixed at 254, regardless of the protocol.

4.2.3

Configuring the Last Octet of the Board IP Address

The last octet is configured using board address switch SW2 on the board. It is necessary to first remove the IED front cover to gain access to the board address switch, regardless of the redundant protocol.

1. Refer to the safety section of the IED.
2. Switch the IED off. Disconnect the power and all connections.
3. Before the front cover is removed take precautions to prevent electrostatic discharge damage, according to the ANSI/ESD-20.20 -2007 standard.
4. Wear a 1 M Ω earth strap and connect it to the ground (earth) point on the back of the IED. See Figure 11.

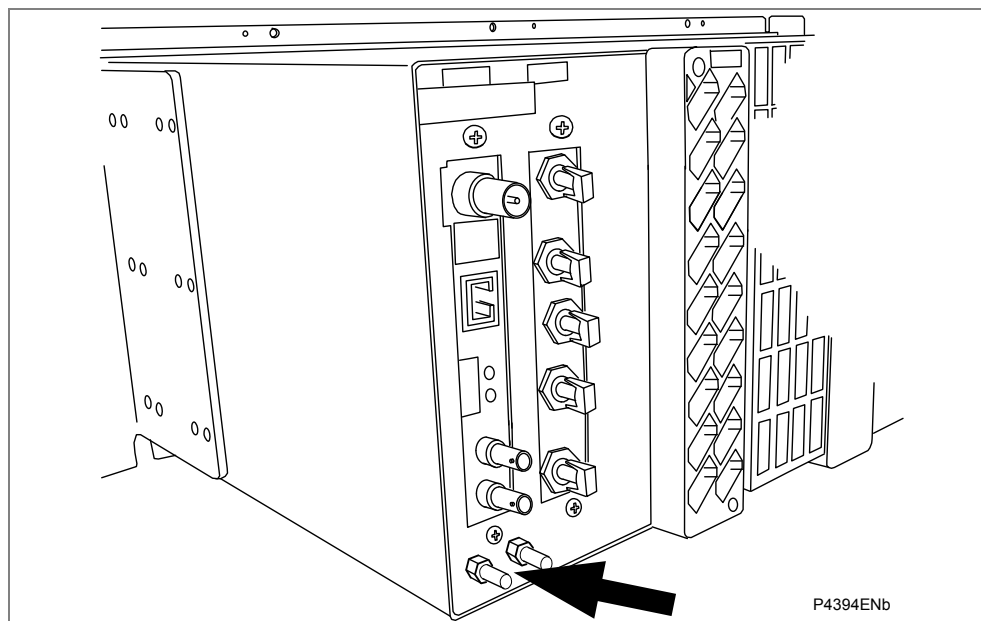


Figure 11 - IED earth (ground) point

5. Remove the six screws securing the front panel.

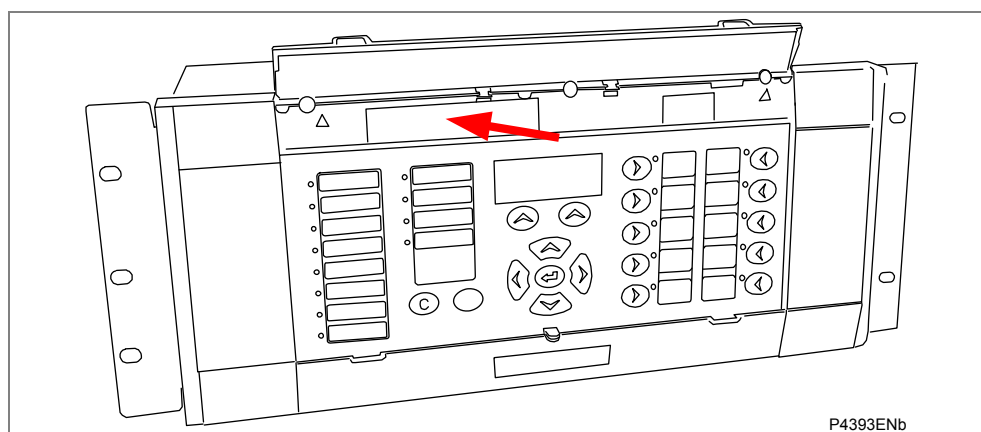


Figure 12 - IED front panel

6. Remove the front panel and disconnect the ribbon cable from the front panel. You now have access to the address switches on the dual Ethernet board.

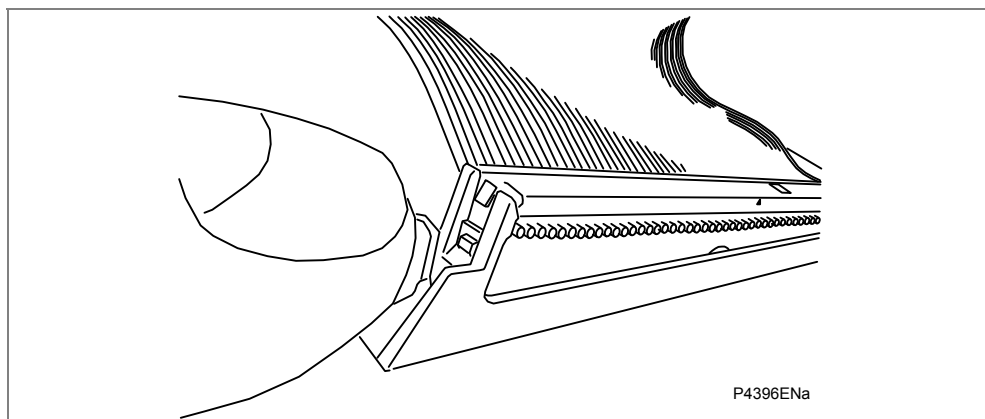


Figure 13 - Ribbon cable connector

7. Set the last octet of the board IP address. The available address range is 1 to 127. See Figure 14.

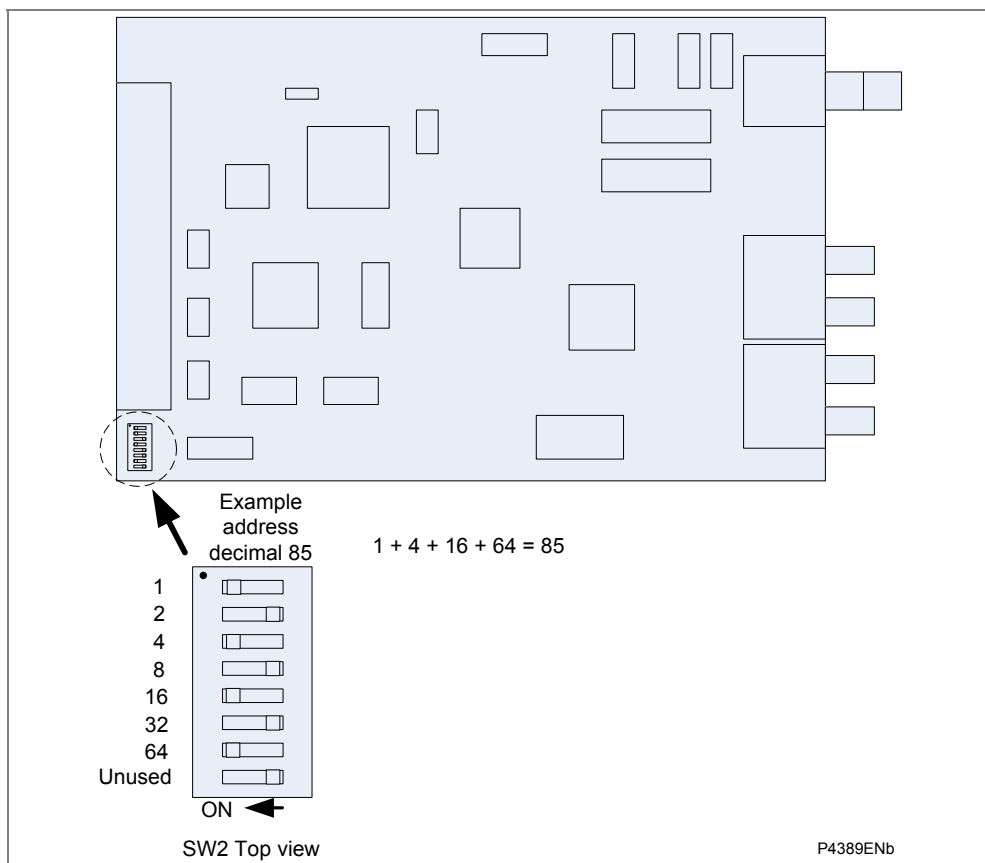


Figure 14 - Dual Ethernet board address switches (SW2)

8. Once the IP address of the board is changed, reassemble the relay in the reverse order. Take care not to damage the pins of the ribbon cable connector on the front panel when reinserting the ribbon cable.

4.3 Switch Manager Software

For further information see the *Switch Manager Operation Guide*.

4.4 RSTP Configurator Software

When running the RSTP protocol, the RSTP Configurator software is used to identify a device, configure the IP address, configure the SNTP IP address and configure RSTP settings.

4.4.1 Connecting the IED to a PC

Connect the IED to the PC on which RSTP Configurator will run. This connection is done through an Ethernet switch or through a media converter. See Figure 15.

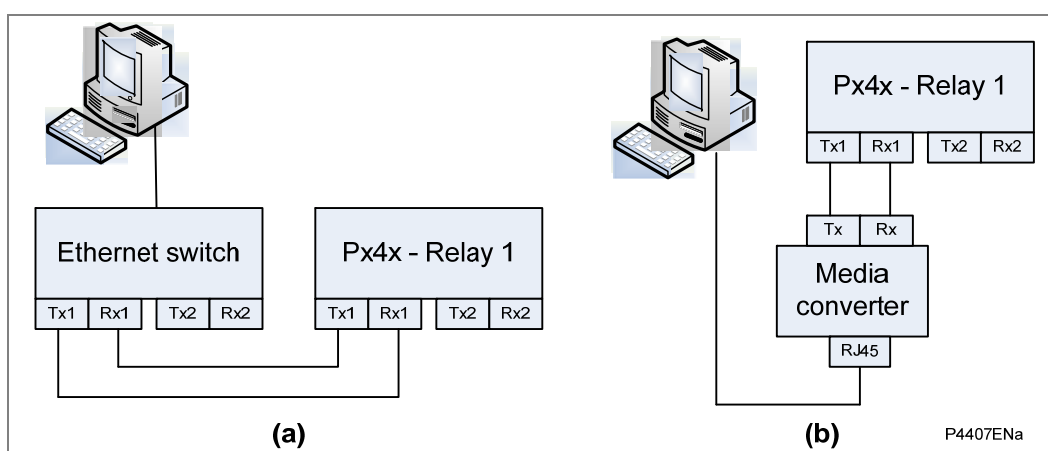


Figure 15 - Connection using (a) an Ethernet switch and (b) a media converter

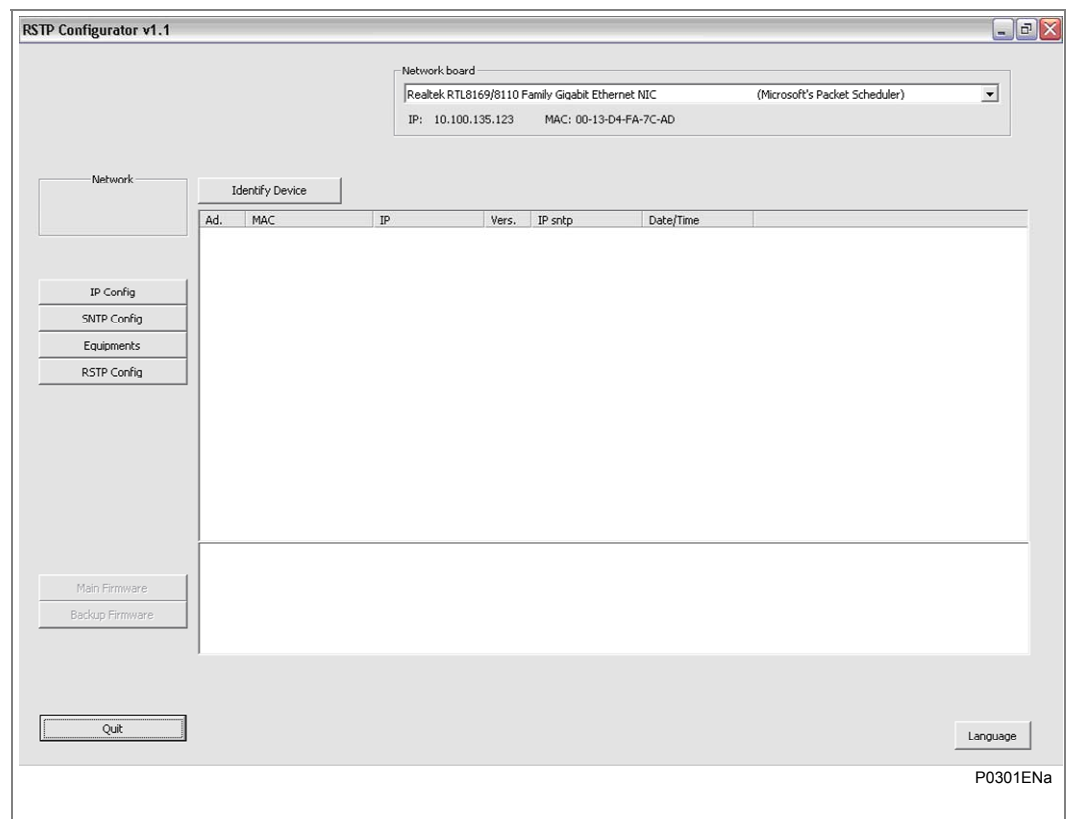
4.4.2 Installing RSTP Configurator

9. Double click **WinPcap_4_0.exe** to install WinPcap.
10. Double click **Schneider-RSTP Configurator.msi** to install the RSTP Configurator.
11. The setup wizard appears. Click **Next** and follow the on-screen instructions to run the installation.

4.4.3

Starting the RSTP Configurator

1. To start the RSTP Configurator, select **Programs > RSTP Configurator > RSTP Configurator**.
2. The Login screen appears. For user mode login, enter the **Login name** as **User** and click **OK** with no password.
3. If the login screen does not appear, check all network connections.
4. The main window of the RSTP Configurator appears. The **Network Board** drop-down list shows the Network Board, IP Address and MAC Address of the PC in which the RSTP Configurator is running.



4.4.4

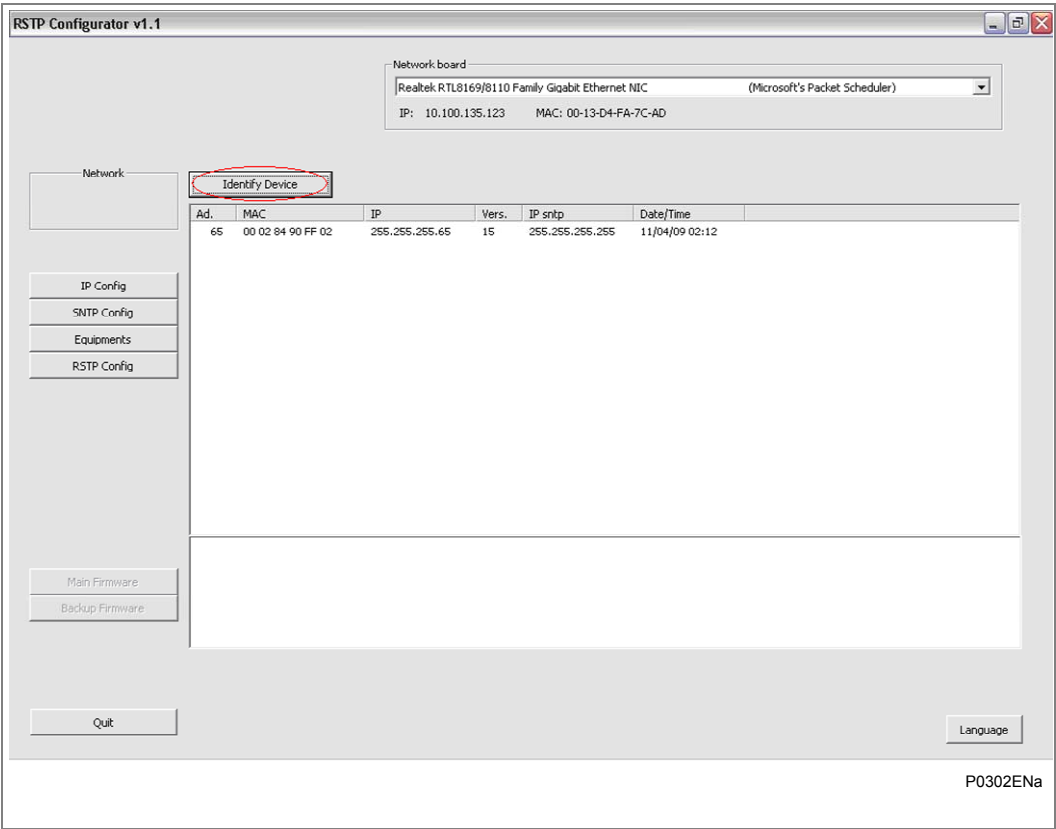
Device Identification

To configure the redundant Ethernet board, go to the main window and click **Identify Device**.

Note Due to the time needed to establish the RSTP protocol, it is necessary to wait 25 seconds between connecting the PC to the IED and clicking the **Identify Device** button.

The redundant Ethernet board connected to the PC is identified and its details are listed.

- Device address
- MAC address
- Version number of the firmware
- SNTP IP address
- Date & time of the real-time clock, from the board.

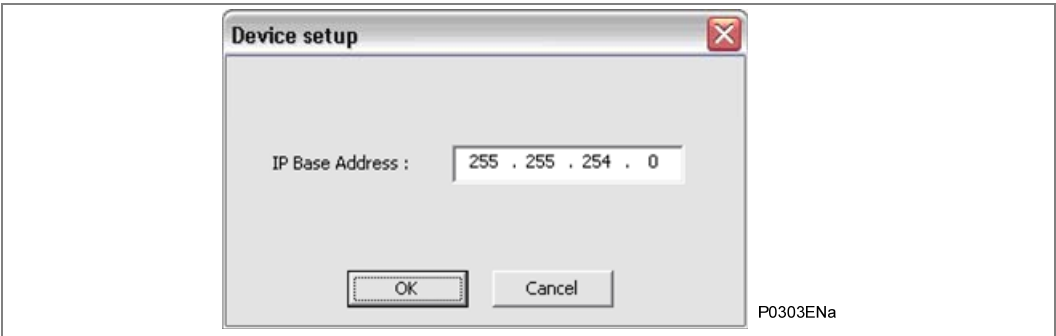


4.4.5 IP Address Configuration

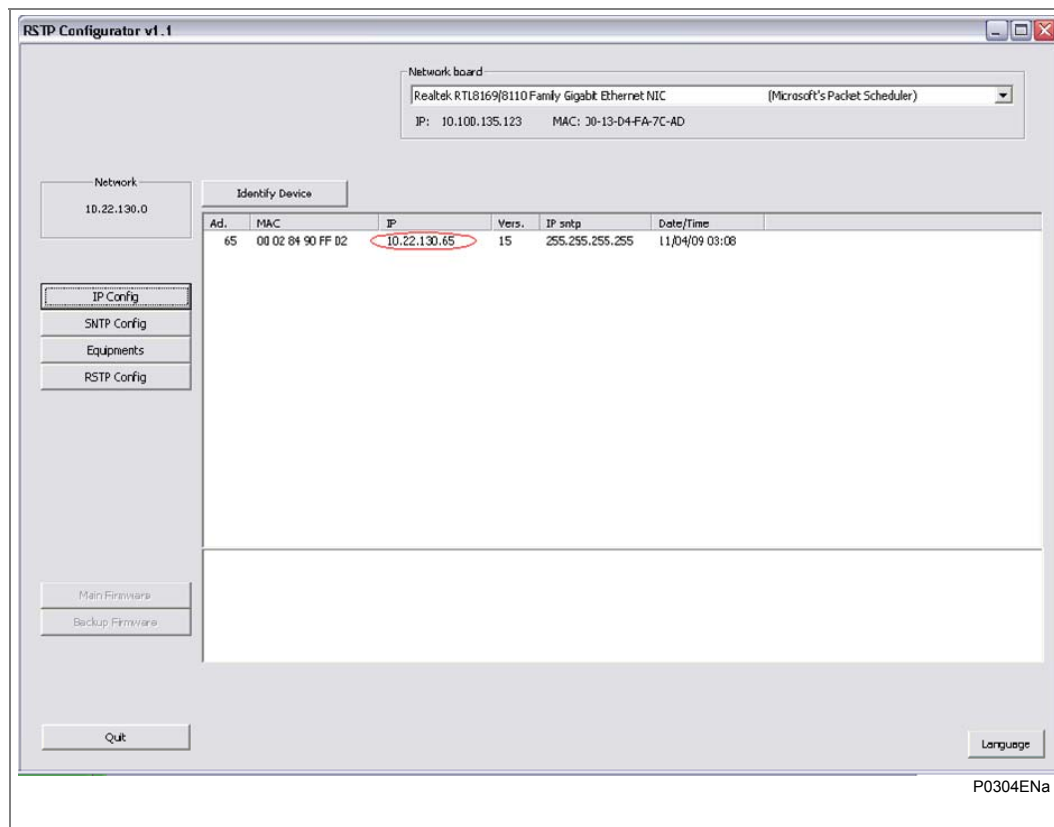
To change the network address component of the IP address, go to the main window and click the **IP Config** button.

The **Device setup** screen appears. The first three octets of the board IP address can be configured. The last octet is set using the DIP switches (SW2) next to the ribbon connector. See Figure 14.

Enter the required board IP address in the IP Base Address box, then click **OK**.



The board network address is updated and displayed in the main window.

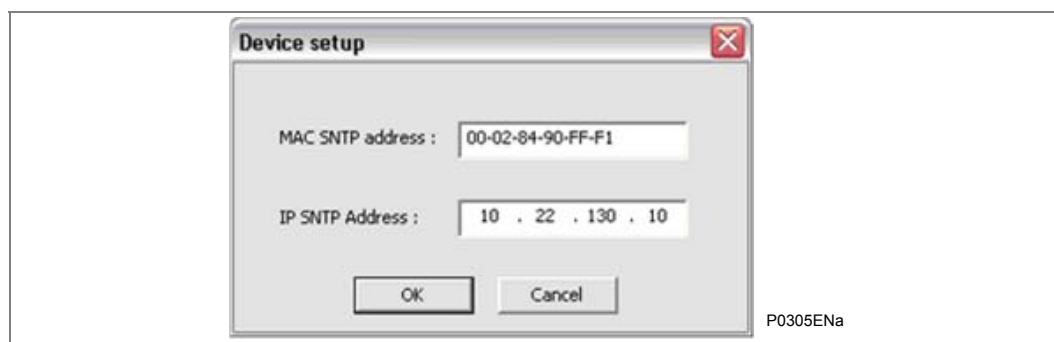


4.4.6

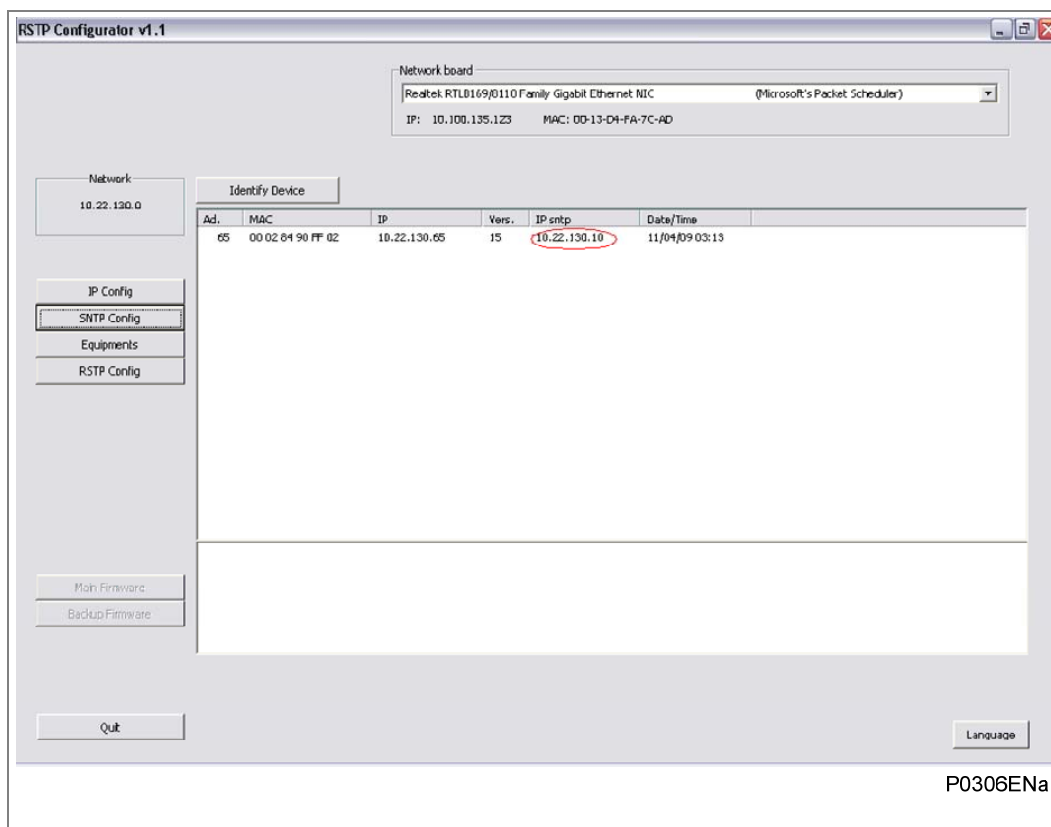
SNTP IP Address Configuration

To Configure SNTP server IP address, go to the main window and click the **SNTP Config** button. The **Device setup** screen appears.

Enter the required SNTP MAC and server IP address. Then click **OK**.



The updated SNTP server IP address appears in the main screen.

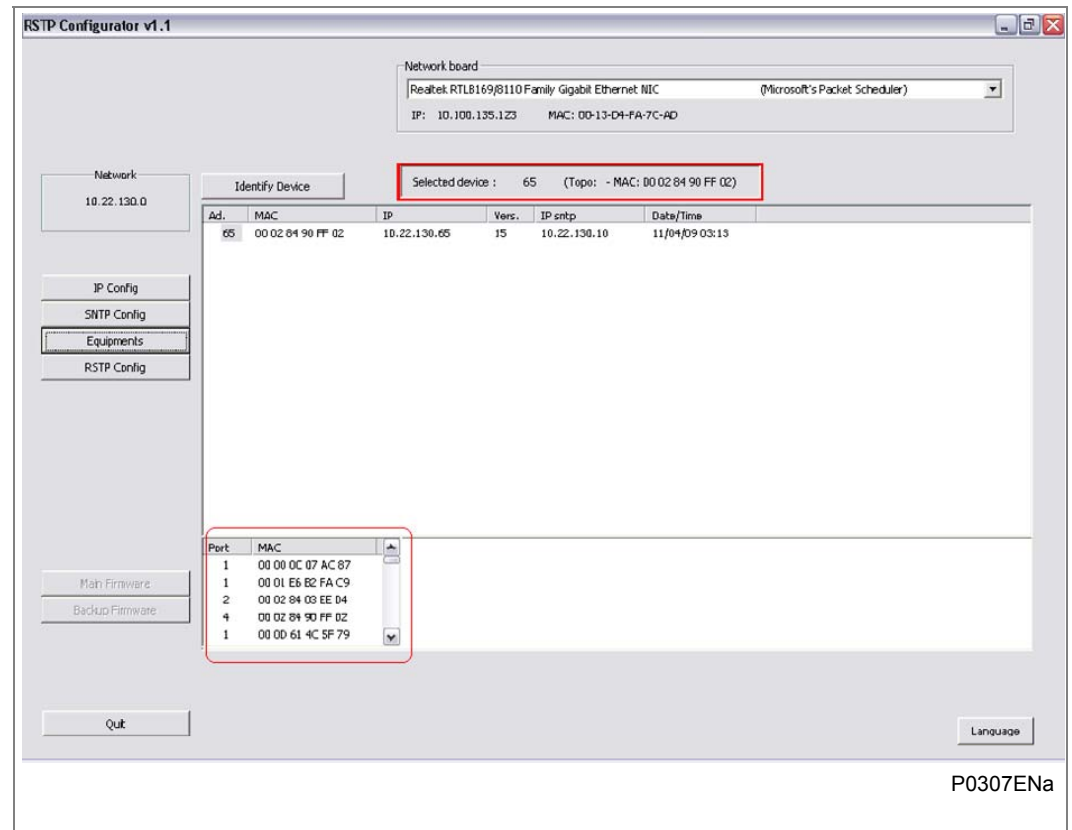


4.4.7

Equipment

To view the MAC addresses learned by the switch, go to the main window and click the **Identify Device** button. The selected device MAC address then appears highlighted.

Click the **Equipment** button. The list of MAC addresses learned by the switch and the corresponding port number are displayed.

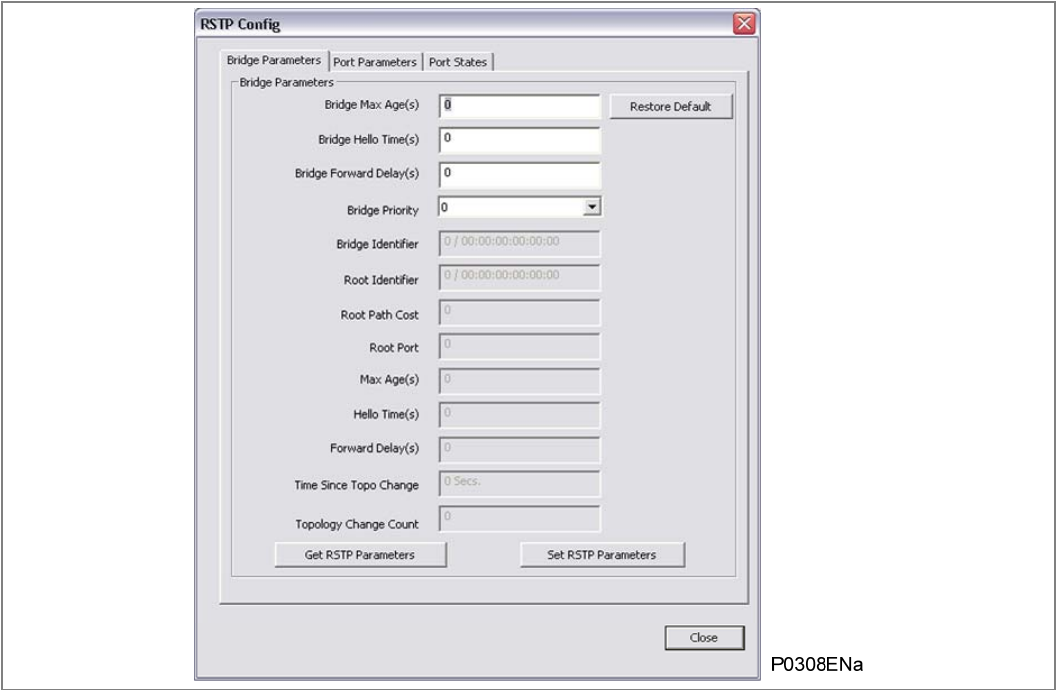


4.4.8

RSTP Configuration

To view or configure the RSTP Bridge Parameters, go to the main window and click the device address to select the device. The selected device MAC address appears highlighted.

Click the **RSTP Config** button. The RSTP Config screen appears.



To view the available parameters in the board that is connected, click the **Get RSTP Parameters** button.

To set the configurable parameters such as **Bridge Max Age**, **Bridge Hello Time**, **Bridge Forward Delay**, and **Bridge Priority**, modify the parameter values according to Table 1 and click **Set RSTP Parameters**.

S.No	Parameter	Default value (second)	Minimum value (second)	Maximum value (second)
1	Bridge Max Age	20	6	40
2	Bridge Hello Time	2	1	10
3	Bridge Forward Delay	15	4	30
4	Bridge Priority	32768	0	61440

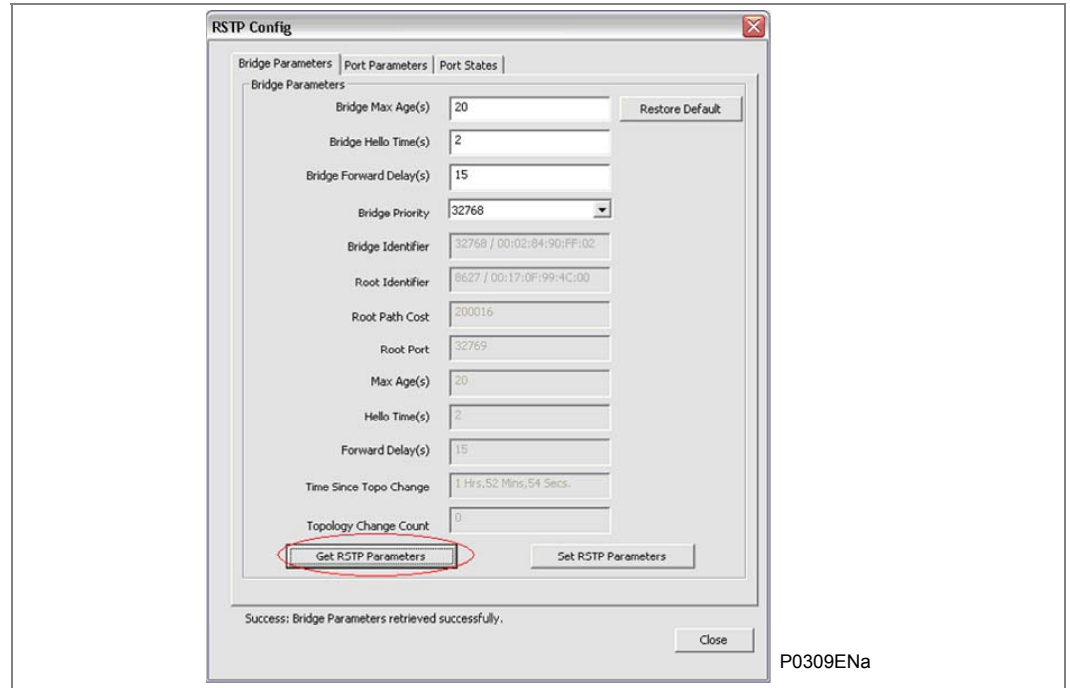
Table 6 - RSTP configuration parameters range and default values

4.4.8.1

Bridge Parameters

To read the RSTP bridge parameters from the board, go to the main window and click the device address to select the device. The **RSTP Config** window appears and the default tab is **Bridge Parameters**.

Click the **Get RSTP Parameters** button. This displays all the RSTP bridge parameters from the Ethernet board.



To modify the RSTP parameters, enter the values according to Table 6 and click **Set RSTP Parameters**.

To restore the default values, click **Restore Default** and click **Set RSTP Parameters**.

The grayed parameters are read-only and cannot be modified.

4.4.8.2

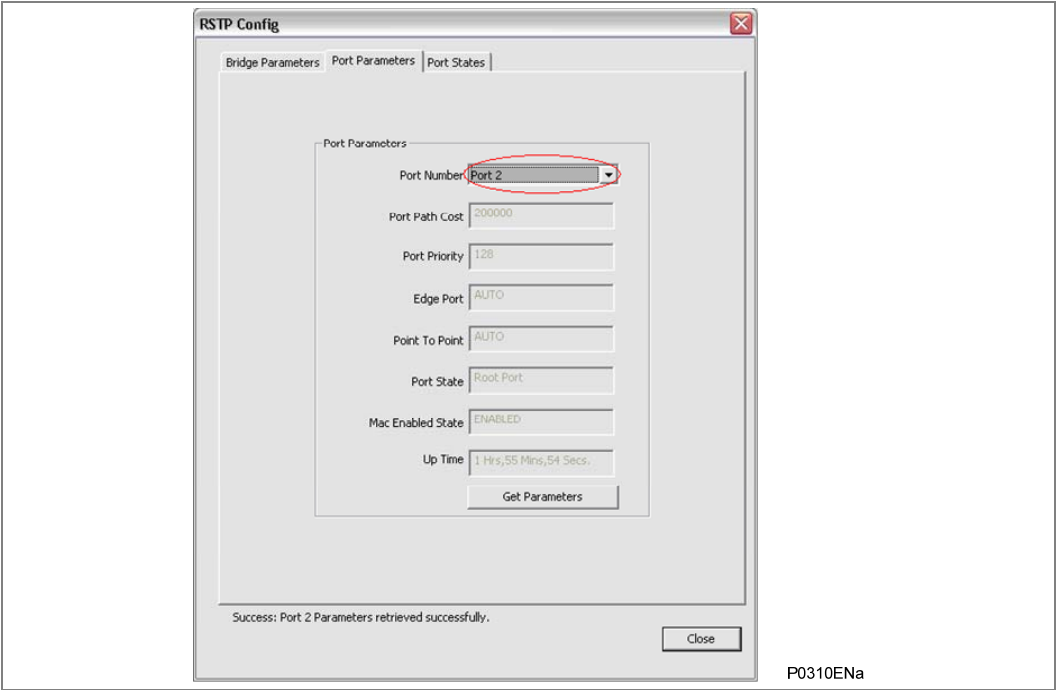
Port Parameters

This function is useful if you need to view the parameters of each port.

From the main window, click the device address to select the device and the **RSTP Config** window appears.

Select the **Port Parameters** tab, then click **Get Parameters** to read the port parameters.

Alternatively, select the port numbers to read the parameters.



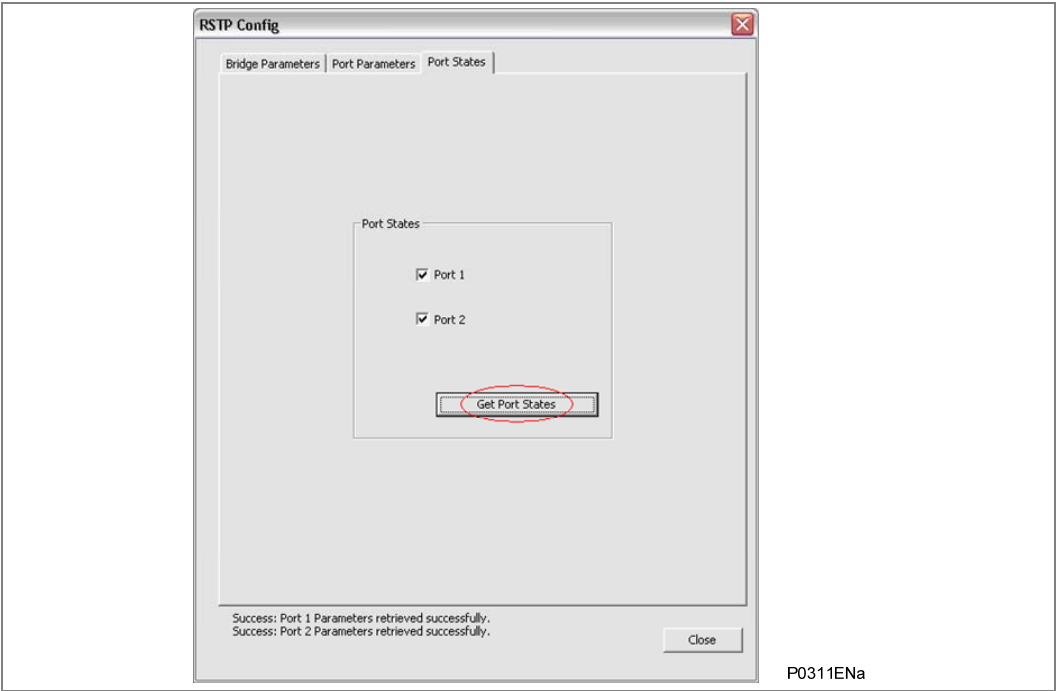
4.4.8.3

Port States

This is used to see which ports of the board are enabled or disabled.

From the main window, click the device address to select the device. The **RSTP Config** window appears.

Select the **Port States** tab then click the **Get Port States** button. This lists the ports of the Ethernet board. A tick shows they are enabled.



5 COMMISSIONING

5.1 SHP Ring Connection

Connect Es to Rs and Ep to Rp until it makes a ring, as shown in Figure 16.

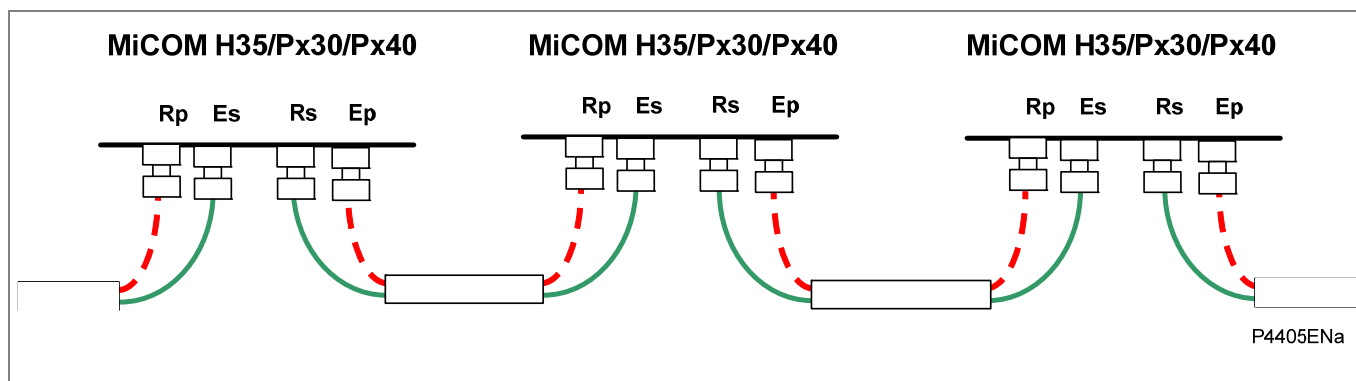


Figure 16 - Dual Ethernet ring connections

5.2 DHP Star Connection

Connect Tx to Rx and Rx to Tx on each device until it makes a star, as shown in the following diagram.

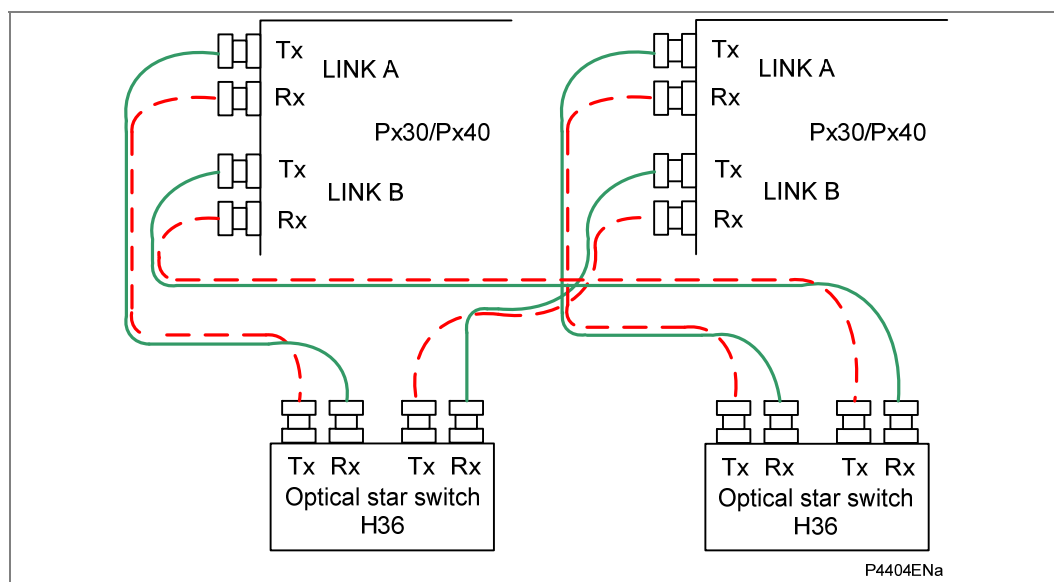


Figure 17 - Dual Ethernet star connections

5.3

RSTP Ring Connection

Figure 18 shows the Px4x IEDs (Px4x – IED 1 to IED N) with the RSTP variant of redundant Ethernet boards connected in a ring topology. The ring topology can have one or more high-end RSTP-enabled Ethernet switches to interface with another network or control center. The Ethernet switch is an RSTP enabled switch with a higher number of ports.

The Ethernet switch, which is connected to the controlling PC, should be configured as the root bridge. The bridge priority of the Ethernet switch should be configured to the minimum value in the network shown in Figure 18.

The maximum number of IEDs that can be connected in the ring network depends on the Max Age parameter configured in the root bridge, see Figure 20.

The Max Age parameter can be varied from 6 to 40 seconds.

If Max Age = 6 seconds, the minimum number of IEDs in the ring is $6 - 1 = 5$.

If Max Age = 40 seconds, the maximum number of IEDs in the ring is $40 - 1 = 39$.

Therefore the number of IEDs that can be connected in the ring can vary from 5 to 39.

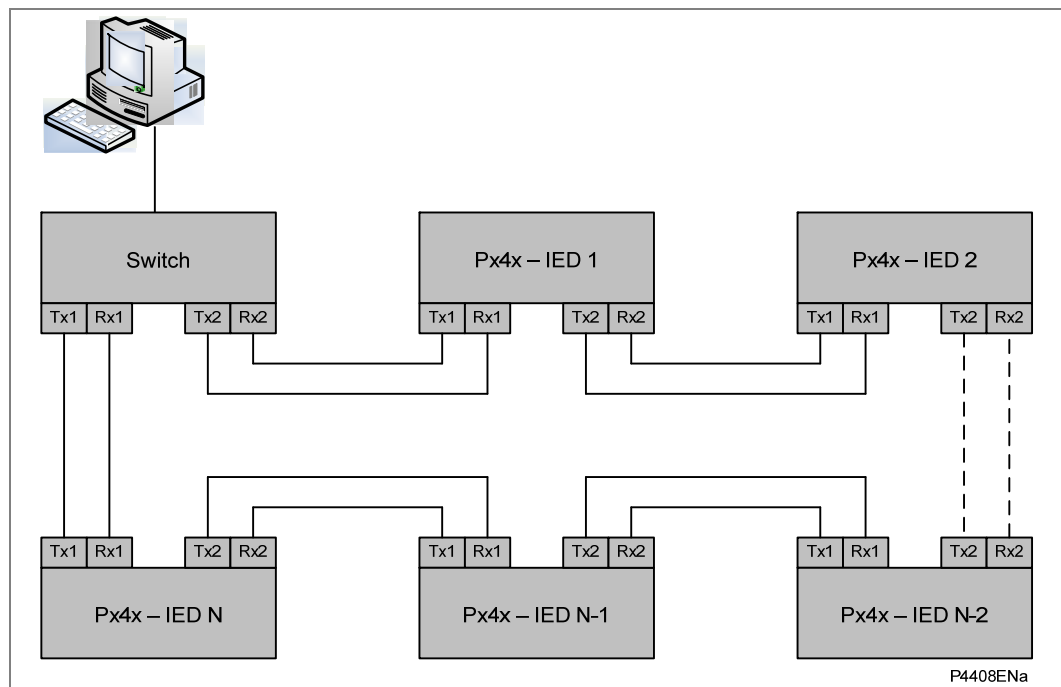


Figure 18 - Dual Ethernet ring topology

5.4

RSTP Star Connection

Figure 19 shows the Px4x IEDs (Px4x – IED 1 to IED N) with the RSTP variant of redundant Ethernet boards connected in a star topology. The star topology can have one or more high-end RSTP-enabled Ethernet switches to interface with other networks, control centers, or Px4x IEDs. The Ethernet switch is an RSTP enabled switch with a greater number of ports. The Ethernet switch, which is connected to the controlling PC, should be configured as the root bridge. The bridge priority of the Ethernet switch should be configured to the minimum value in the network shown in Figure 20.

The Px4x IEDs are placed at two hop distance from the root bridge, therefore the Max Age parameter has no impact on star topology.

The maximum number of IEDs that can be connected in the star network depends on the number of ports available in the Ethernet switch, provided that the hop count from the root bridge is less than the Max Age parameter.

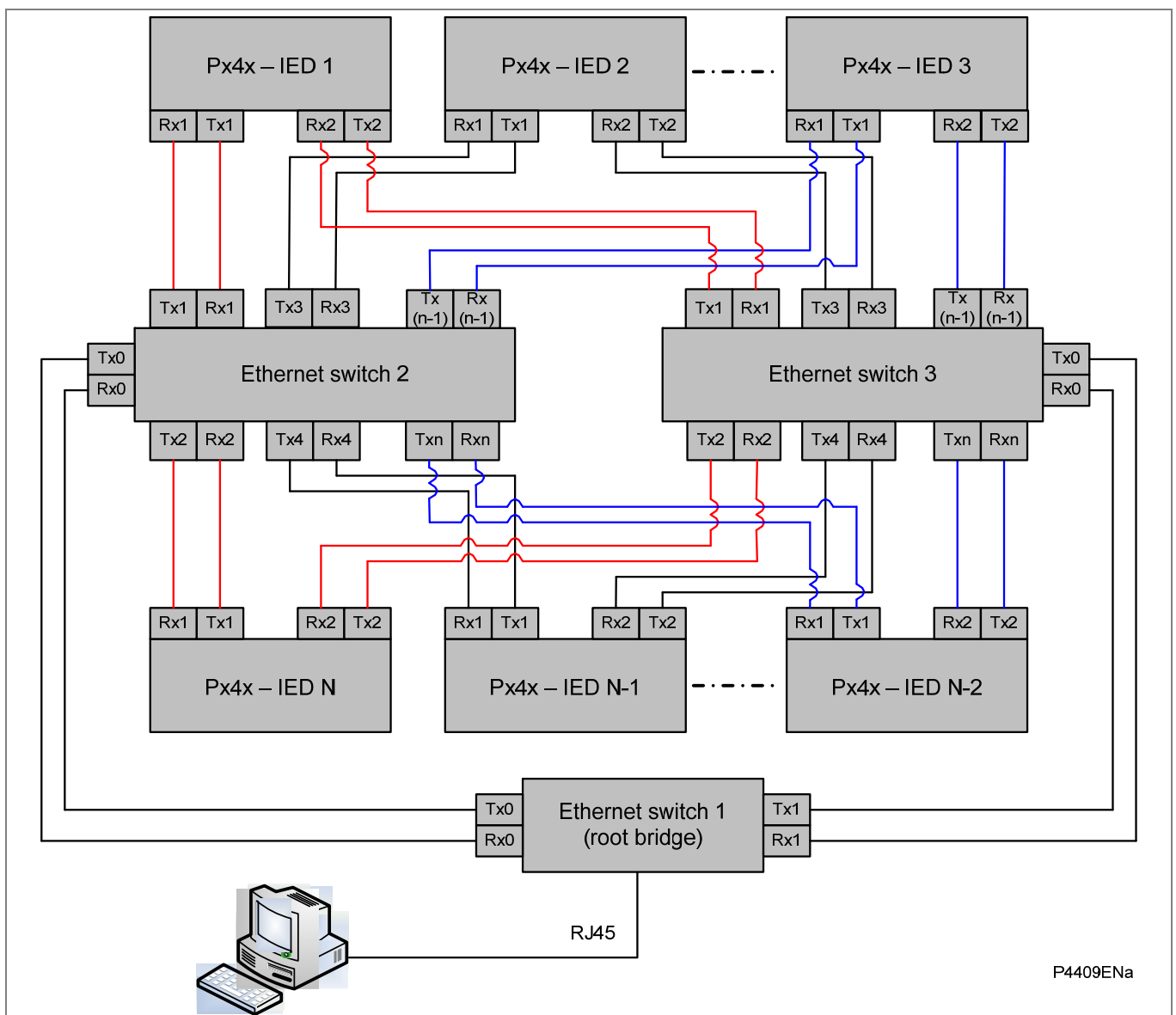


Figure 19 - Dual Ethernet star topology

5.5

Large RSTP Networks Combining Star and Ring

Figure 20 shows a star of four rings. Each ring is connected to the root bridge. The root bridge is a high-end RSTP enabled bridge with the maximum number of ports as required. The devices A1, A2...Anmax, B1, B2...Bnmax, C1, C2...Cnmax, D1, D2...Dnmax, represent the RSTP variant of redundant Ethernet boards.

The maximum number of boards that can be connected in single ring in an RSTP-enabled network depends on the Max Age parameter. The hop count from the root bridge can not be greater than the Max Age parameter.

The maximum number of RSTP bridges in a ring is given by

$$N_{\max} = (\text{Max Age} - 1)$$

Where:

$N_{\max}$ = maximum number of devices in a ring

Max Age = Max Age value configured in the root bridge.

Assuming the default value of Max Age as 20 seconds in the topology shown 0, the maximum number of devices that can be connected in ring A is 19.

If Max Age is configured as 40 seconds, the maximum number of IEDs that can be connected in the network is $(40-1) = 39$. According to the IEEE 802.1D 2004 standard, the maximum value for the Max Age parameter is limited to 40. To use the maximum number of IEDs in the ring, the following configuration should be used.

Max Age	40 seconds
Forward Delay	30 seconds
Hello Time	2 seconds

Bridge Priority As required by the end user.

The IEEE 802.1D 2004 standard defines the relation between Max Age and Forward Delay as:

$$2 * (\text{Forward Delay} - 1.0 \text{ seconds}) \geq \text{Max Age}$$

To have the maximum number of nodes in the RSTP network, the number of rings can be increased, depending on the number of ports available in the root bridge.

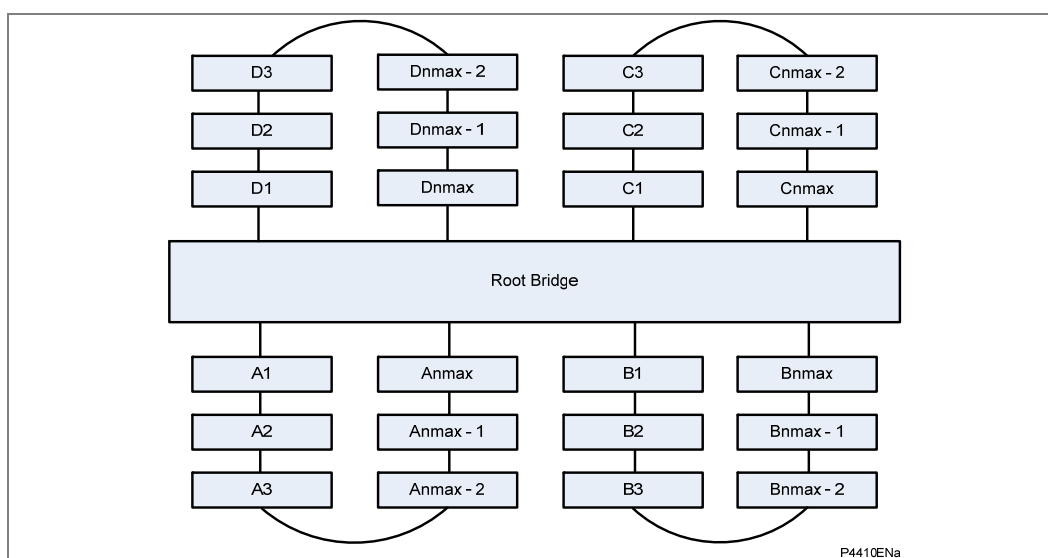


Figure 20 - Combined RSTP star and ring topology

6 TECHNICAL DATA

The technical data applies to a redundant Ethernet board fitted into the following IEDs.

- P141, P142, P143, P144, P145
- P241, P242, P243
- P341, P342, P343, P344, P345
- P442, P443, P444, P445, P446
- P543, P544, P545, P546
- P642, P643, P645
- P741, P743, P746
- P841

6.1 Board Hardware

6.1.1 100 Base FX Interface (in accordance with IEEE802.3 and IEC 61850)

Optical fiber cable	multi-mode 50/125 μm or 62.5/125 μm
Center wavelength	1310 nm
Connector style	BFOC 2.5 -(ST [®])
Maximum distance	6.4 km
Full Duplex	100 Mbps

Table 7 - 100 Base FX interface

6.1.2 Transmitter Optical Characteristics

Parameter	Sym	Min.	Typ.	Max.	Unit
Output Optical Power BOL 62.5/125 μm , NA = 0.275 Fiber EOL	PO	-19 -20	-16.8	-14	dBm avg.
Output Optical Power BOL 50/125 μm , NA = 0.20 Fiber EOL	PO	-22.5 -23.5	-20.3	-14	dBm avg.
Optical Extinction Ratio				10 -10	% dB
Output Optical Power at Logic "0" State	PO ("0")			-45	dBm avg.

BOL - Beginning of life EOL - End of life

Table 8 - Tx optical characteristics

6.1.3 Receiver Optical Characteristics

Parameter	Sym	Min.	Typ.	Max.	Unit
Input Optical Power Minimum at Window Edge	PIN Min. (W)		-33.5	-31	dBm avg.
Input Optical Power Minimum at Eye Center	PIN Min. (C)		-34.5	-31.8	dBm avg.
Input Optical Power Maximum	PIN Max.	-14	-11.8		dBm avg.

Table 9 - Rx optical characteristics

6.1.4 Fiber Defect Connector (Watchdog Relay)

Connector (3 terminals)	2 NC contacts potential free
Rated voltage	250 VAC
Rated continuous current	5 A
Make current	Max. 30 A and carry for 3s
Breaking capacity AC	1500 VA resistive (cos F = unity) 1500 VA inductive (cos F = 0.5)
Breaking capacity DC	50 W, 250 VDC resistive 25 W inductive (L/R=40 ms)

Table 10 - Fiber defect connector characteristics**6.1.5 IRIG-B and Real-Time Clock****6.1.5.1 Performance**

Year 2000: Compliant

Real time accuracy: < ± 1 second / day

External clock synchronization: Conforms to IRIG standard 200-98, format B

6.1.5.2 Features

Real time 24 hour clock settable in hours, minutes and seconds

Calendar settable from January 1994 to December 2092

Clock and calendar maintained via battery after loss of auxiliary supply

Internal clock synchronization using IRIG-B Interface for IRIG-B signal is BNC

6.1.5.3 Optional Rear IRIG-B interface (Modulated or Unmodulated)

BNC plug

Isolation to SELV level.

50 ohm coaxial cable.

6.2 Type Tests**6.2.1 Insulation**

As for EN 60255-27: 2005 (incorporating corrigendum March 2007):

Insulation resistance > 100 M Ω at 500 Vdc (Using only electronic/brushless insulation tester).

6.2.2 Creepage Distances and Clearances

EN 60255-27: 2005 (incorporating corrigendum March 2007)

Pollution degree 3,

Overvoltage category III,

Impulse test voltage 5 kV.

6.2.3 High Voltage (Dielectric) Withstand

(EIA RS-232 ports excepted and normally-open contacts of output relays excepted).

- (i) As for EN 60255-27: 2005 (incorporating corrigendum March 2007), 2 kV rms AC, 1 minute:
 - Between terminals of all independent circuits.
 - Between all case terminals connected together, and the case earth (ground).
 - 1 kV rms AC for 1 minute, across open watchdog contacts.
 - 1 kV rms AC for 1 minute, across open contacts of changeover output relays.
 - 1 kV rms AC for 1 minute for all D-type EIA(RS)-232 or EIA(RS)-485 ports between the communications port terminals and protective (earth) conductor terminal.
- (ii) As for ANSI/IEEE C37.90-1989 (reaffirmed 1994):
 - 1.5 kV rms AC for 1 minute, across open contacts of normally open output relays.
 - 1k V rms AC for 1 minute, across open watchdog contacts.
 - 1k V rms AC for 1 minute, across open contacts of changeover output relays.

6.2.4 Impulse Voltage Withstand Test

As for EN 60255-27: 2005 (incorporating corrigendum March 2007):

Front time: 1.2 μ s, Time to half-value: 50 μ s,

Peak value: 5 kV, 0.5 J

Between all independent circuits.

Between all independent circuits and case earth ground).

EIA(RS)-232 & EIA(RS)-485 ports and normally open contacts of output relays excepted.

6.3 ElectroMagnetic Compatibility (EMC)

6.3.1 1 MHz Burst High Frequency Disturbance Test

As for EN 60255-22-1: 2008, Class III

Common-mode test voltage: 2.5 kV

Differential test voltage: 1.0 kV

Test duration: 2 s, Source impedance: 200 Ω (EIA(RS)232 ports excepted)

6.3.2 100 kHz Damped Oscillatory Test

EN 61000-4-18: 2007: Level 3

Common mode test voltage: 2.5 kV

Differential mode test voltage: 1 kV

6.3.3 Immunity to Electrostatic Discharge

As for EN 60255-22-2: 1997, Class 4.

15 kV discharge in air to user interface, display, communication ports and exposed metalwork.

8 kV point contact discharge in air to all communications ports.

6 kV point contact discharge to any part of the front of the product.

6.3.4 Electrical Fast Transient or Burst Requirements

As for IEC 60255-22-4, Class B:

Power supply: Amplitude: 2 kV, Burst frequency: 5 kHz
Inputs / Outputs: Amplitude: 2 kV, Burst frequency: 5 kHz
Communication: Amplitude: 1 kV, Burst frequency: 5 kHz

As for DIN EN 61000-4-4, severity level 4:

Power supply: Amplitude: 4 kV, Burst frequency: 2.5 kHz and 5 kHz
Inputs / Outputs: Amplitude: 2 kV, Burst frequency: 5 kHz
Communication: Amplitude: 2 kV, Burst frequency: 5 kHz
Rise time of one pulse: 5 ns
Impulse duration (50% value): 50 ns
Burst duration: 15 ms
Burst cycle: 300 ms
Source impedance: 50 Ω

6.3.5 Surge Withstand Capability

As for IEEE/ANSI C37.90.1: 2002:

4 kV fast transient and 2.5 kV oscillatory applied directly across each output contact, optically isolated input, and power supply circuit.

6.3.6 Surge Immunity Test

(EIA(RS)232 ports excepted)

As for EN 61000-4-5: 2006 Level 4,

Time to half-value: 1.2 to 50 μ s,
Amplitude: 4 kV between all groups and case earth (ground),
Amplitude: 2 kV between terminals of each group.

6.3.7 Immunity to Radiated Electromagnetic Energy

As for EN 61000-4-3:2002 and EN 60255-22-3:2001, Class 3

Test field strength, frequency band 80 to 1000 MHz: 10 V/m,
Test using AM: 1 kHz / 80%, Spot tests at 80, 160, 450, 900 MHz

As for IEEE/ANSI C37.90.2: 2004:

25, 80 MHz to 1000 MHz, zero and 100% square wave modulated, 1 kHz 80% am and am pulse modulated.
Field strength 35 V/m.

6.3.8 Radiated Immunity from Digital Communications

As for EN61000-4-3: 2002, Level 4:

Test field strength, frequency band 800 to 960 MHz, and 1.4 to 2.0 GHz:

30 V/m,
Test using AM: 1 kHz/80%.

6.3.9 Radiated Immunity from Digital Radio Telephones

As for EN 61000-4-3: 2002: 10 V/m, 900 MHz and 1.89 GHz.

6.3.10 Immunity to Conducted Disturbances Induced by Radio Frequency Fields

As for EN 61000-4-6: 1996, Level 3, Disturbing test voltage: 10 V.

6.3.11 Power Frequency Magnetic Field Immunity

As for EN 61000-4-8: 2001, Level 5,

100 A/m applied continuously,
1000 A/m applied for 3 s.

As for EN 61000-4-9: 2001, Level 5,

1000 A/m applied in all planes.

As for EN 61000-4-10: 2001, Level 5,

100 A/m applied in all planes at 100 kHz to 1 MHz with a burst duration of 2 s.

6.3.12 Conducted Emissions

As for EN 55022: 1998 Class A:

0.15 - 0.5 MHz, 79 dB μ V (quasi peak) 66 dB μ V (average)

0.5 - 30 MHz, 73 dB μ V (quasi peak) 60 dB μ V (average).

6.3.13 Radiated Emissions

As for EN 55022: 1998 Class A:

30 to 230 MHz, 40 dB μ V/m at 10 m measurement distance

230 to 1 GHz, 47 dB μ V/m at 10 m measurement distance.

6.4 Environmental Conditions

Ambient Temperature Range

As for EN 60255-6: 1988

Operating temperature range: -25°C to +55°C (or -13°F to +131°F).

Storage and transit: -25°C to +70°C (or -13°F to +158°F).

Ambient Humidity Range

As for IEC 60068-2-3: 1969: 56 days at 93% relative humidity and +40°C

As for IEC 60068-2-30: 1980: Damp heat cyclic, six (12 + 12) hour cycles,
93% RH, +25 to +55°C

6.5 EU Directives**6.5.1 EMC Compliance**

As for 2004/108/EC:

Compliance to the European Commission Directive on EMC is demonstrated using
a Technical File.

Product Specific Standards were used to establish conformity:

EN 50263: 2000

6.5.2 Product Safety

Refer to MiCOM Px4x Safety Section or four languages Safety Guide (SFTY/4L M/F11)

Compliance to the European Low Voltage Directive 2006/95/EC demonstrated by reference to product safety standard:

**6.5.3 R&TTE Compliance**

Radio and Telecommunications Terminal Equipment (R & TTE) directive 99/5/EC.

Compliance demonstrated by compliance to both the EMC directive and the Low voltage directive, down to zero volts.

Applicable to rear communications ports.

6.5.4 Other Approvals

For ATEX Potentially Explosive Atmospheres directive 94/9/EC compliance, consult Schneider Electric.

For other approvals such as UL / CUL / CSA, consult Schneider Electric.

6.6 Mechanical Robustness**6.6.1 Vibration Test**

As for EN 60255-21-1: 1996:

Response Class 2
Endurance Class 2

6.6.2 Shock and Bump

As for EN 60255-21-2: 1996:

Shock response Class 2
Shock withstand Class 1
Bump Class 1

6.6.3 Seismic Test

As for EN 60255-21-3: 1995:

Class 2

7

CORTEC

This is a generic Cortec to cover all IEDs using the redundant Ethernet board.

Variants	Order Number	1	2	3	4	5	6	7	8	9	10	11	12-13	14	15
MiCOM Protection		P													
Application/Platform :															
Feeder management		1	4	*											
Motor protection		2	4	*											
Generator protection relay		3	4	*											
Distance protection relay		4	4	*											
Current Differential		5	4	*											
Transformer		6	4	*											
Busbar		7	4	*											
Breaker Fail		8	4	*											
Vx Aux Rating :															
24 - 48 Vdc									1						
48 - 110 Vdc (40 - 100 Vac)									2						
110 - 250 Vdc (100 - 240 Vac)									3						
In/Vn Rating :									*						
Hardware Options :															
Standard : no options									1						
IRIG-B only (modulated)									2						
Fibre optic converter only									3						
IRIG-B (modulated) & fibre optic converter									4						
Ethernet (10Mbit/s)									5						
Ethernet with 100Mbit/s fibre optic port									6						
2nd Rear Comms Port (Courier EIA232/EIA485/k-bus)									7						
2nd Rear Comms Port + IRIG-B (Courier EIA232/EIA485/k-bus)									8						
Ethernet (100Mbit/s) + IRIG-B (modulated)									A						
Ethernet (100Mbit/s) + IRIG-B (de-modulated)									B						
IRIG-B (de-modulated)									C						
IRIG-B (De-modulated) plus Second Rear Comms									D						
InterMiCOM + Courier Rear Port									E						
InterMiCOM + Courier Rear Port + IRIG-B modulated									F						
Redundant Ethernet Self-Healing Ring, 2 multi-mode fibre ports + Modulated IRIG-B									G						
Redundant Ethernet Self-Healing Ring, 2 multi-mode fibre ports + Un-modulated IRIG-B									H						
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Modulated IRIG-B									I						
Redundant Ethernet RSTP, 2 multi-mode fibre ports + Un-modulated IRIG-B									J						
Redundant Ethernet Dual-Homing Star, 2 multi-mode fibre ports + Modulated IRIG-B									K						
Redundant Ethernet Dual-Homing Star, 2 multi-mode fibre ports + Un-modulated IRIG-B									L						
									M						
Product Specific Options									*						
Protocol Options :															
K-Bus/Courier									1						
Modbus									2						
IEC60870-5-103 (VDEW)									3						
DNP3.0									4						
UCA2 + Courier via rear RS485 port									5						
IEC61850 over Ethernet and Courier via rear K-Bus/RS485									6						
IEC61850 over ethernet with CS103 rear port RS485 protocol									7						
DNP3 over Ethernet with Courier rear port K-Bus/RS485 protocol									8						
Mounting Options :															
Panel Mounting													M		
Rack Mounting													N		
Language Options :															
Multilingual - English, French, German, Spanish														0	
Multilingual - English, French, German, Italian														4	
Multilingual - English, French, German, Russian														5	
Chinese, English or French via HMI, with English or French via Communications port														C	
Software Version:														*	*
Settings Files															
Default														0	
Customer version														A	
Design Suffix :															*

8 EXTERNAL CONNECTION DIAGRAM

This applies to all IEDs using the redundant Ethernet board.

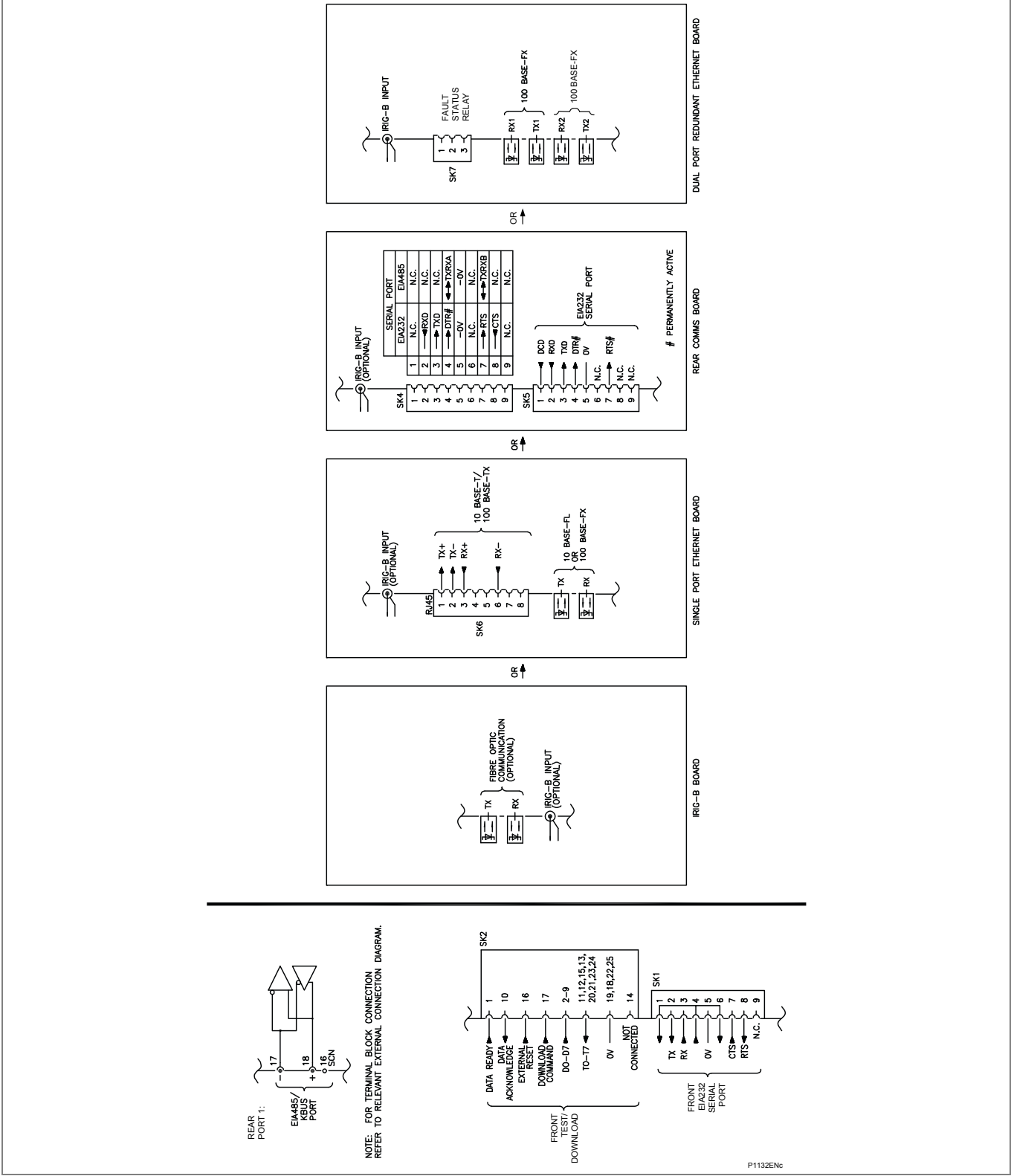


Figure 21 - Comms options for the MiCOM Px4x platform



Customer Care Centre

<http://www.schneider-electric.com/ccc>

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Publication: Px4x/EN REB(U)/C11 Data Pack G, I, J, H

Publisher: Schneider Electric

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