Modicon 140 NRP 954 00 and 140 NRP 954 01C

Fiber Optic Repeater Modules User Guide

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Failure to use Schneider Electric software or approved software with our hardware products may result in injury, harm, or improper operating results.

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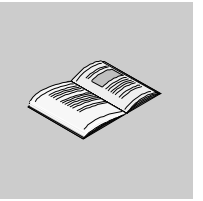
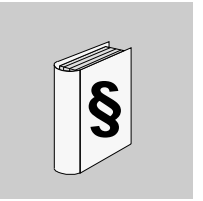


Safety Information



Important Information

NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a Danger safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, **will result in** death or serious injury.

⚠ WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, **can result in** death or serious injury.

⚠ CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, **can result in** minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical injury.

PLEASE NOTE

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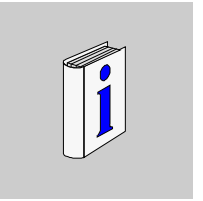
A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

About the Book



At a Glance

Document Scope

This document is the reference guide for the Quantum 140 NRP 954 0• fiber optic repeater modules of the Quantum automation system.

Validity Note

This documentation is valid from Unity Pro V7.0 or higher.

Related Documents

Title of Documentation	Reference Number
Modicon Remote I/O Cable System Planning and Installation Guide	35014629 (Eng), 35014630 (Fre), 35014632 (Ger), 35014633 (Spa)
Modicon Quantum Hot Standby System User Manual	35010533 (Eng), 35010534 (Fre), 35010535 (Ger), 35010536 (Spa), 35013993 (Ita), 35012188 (Chs)
Quantum With Unity Pro Experts and communication Reference Manual	35010574 (Eng), 3501575 (Fre), 3501576 (Ger), 3501577 (Spa), 3504012 (Ita), 35012187 (Chs)

Quantum With Unity Pro Hardware Reference Manual	35010529 (Eng), 35010530 (Fre), 35010531 (Gre), 35010532 (Spa), 35013975 (Ita), 35012184 (Chs)
Quantum Operating System Upgrade and Update Procedure Guide	EIO0000000064 (Eng)
Unity Pro OS Loader User Manual	35006156 (Eng), 35006157 (Fre), 35006158 (Ger), 35006159 (Spa), 33003672 (Ita), 33003673 (Chs)
Modicon Fiber Optic Repeater's User Guide	GM-FIBR-OPT

You can download these technical publications and other technical information from our website at www.schneider-electric.com.

Product Related Information

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

The application of this product requires expertise in the design and programming of control systems. Only persons with such expertise should be allowed to program, install, alter, and apply this product.

Follow all local and national safety codes and standards.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

User Comments

We welcome your comments about this document. You can reach us by e-mail at techcomm@schneider-electric.com.

Architectures

1

Overview

This chapter provides general information on remote I/O architectures using 140 NRP 954 0• fiber optic repeater modules.

What Is in This Chapter?

This chapter contains the following topics:

Introduction

Overview

This chapter will give you general information to understand where and when you can use the 140 NRP 954 0• fiber optic repeater modules.

The 140 NRP 954 0• fiber optic repeater modules can be inserted in a RIO network.

There are 2 models of fiber optic repeaters each supporting one type of fiber optic cables:
- 140 NRP 954 00 supports multimode optical fiber cable.
- 140 NRP 954 01C supports single-mode optical fiber cable.

RIO Networks

Modicon Quantum RIO network is a high speed (1.544 Mbit/s) local area network (LAN) using coaxial cables. The RIO network supports communication between a PLC and one or more drops of I/O modules dispersed throughout the local area, e.g., the manufacturing or processing facility.

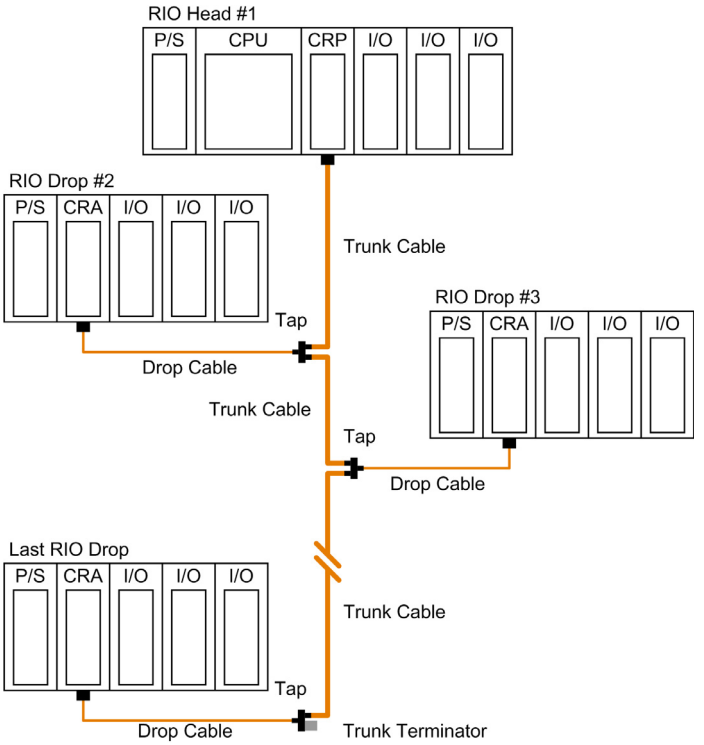
There are many possible native topologies that may be used for RIO networks:
- Linear cable topologies (see the *Remote I/O Cable System Planning and Installation Guide* for information about RIO coaxial cable networks.):
  - Standard single-cable RIO cable systems
  - Redundant RIO cable systems
  - Dual cable systems
- Hot Standby cable topologies (see the *Modicon Quantum Hot standby System User Manual* for information about Hot Standby coaxial cable networks.):
  - Single-cable Hot Standby system
  - Redundant Hot Standby cable system

The fundamental architecture of a RIO cable system is as follows:
- the RIO processor is called the head
- the network is made of one (linear) or two (dual or redundant) trunk cable(s)

Taps are installed along the length of the trunk cable(s), and a drop cable runs from a tap to a drop adapter.

A proper impedance match is maintained across the network with 75 Ω trunk terminators.

The following figure shows the basis of a standard single-cable RIO system:



The part number table *(see page 22)* gives references for the basic components that may be used in a RIO topology.

140 NRP 954 0• Fiber Optic Repeaters Insertion

The insertion of fiber optic cables in a RIO network allows to:

- extend the total length of the RIO network, e.g., RIO drops in distant separate blocks of a factory without exceeding the attenuation limit of the coaxial cable system.
- significantly improve the noise immunity characteristics of the installation.
- create topologies that couldn't work properly with one coaxial cable.
- resolve distant grounding issues, e.g., when using different ground references is mandatory, e.g., between two buildings.

In addition to the general application listed above:

- The insertion of 140 NRP 954 00 fiber optic repeaters in an existing RIO network that already use 490NRP954 fiber optic repeaters allows to expand the RIO network without additional pulse width distortion (or jitter).
  The 490NRP954 fiber optic repeater is a multimode fiber optic repeater. Refer to the *Modicon Fiber Optic Repeater's User Guide* for details on the 490NRP954.

A single-mode fiber optic repeatear must be connected to a single-mode fiber optic repeater. A multimode fiber optic repeater must be connected to a multimode fiber optic repeater.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Do not connect a single-mode fiber optic repeater module 140 NRP 954 01C to a multimode fiber optic repeater module 490NRP954.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

- The replacement of 490NRP954 by 140 NRP 954 00 fiber optic repeaters *(see page 33)* allows to enhance broken fiber optic diagnostic and EMC withstand in your RIO network.

Typical System Layout

Overview

The insertion of fiber optic repeaters in a RIO network allows transition from coaxial to fiber optic cable then back again to coaxial in a trunk and/ or drop cable.

Depending on its place in the RIO network, the 140 NRP 954 0• module can be:

- A head NRP
- A drop NRP

NOTE: There is no electrical specificity for the head or drop NRP. The RIO port on a fiber optic repeater has the same electrical specifications and restrictions as a RIO head processor, e.g., the RIO receiver dynamic range is the same as the 140 CRA 9•• •• and 140 CRP 9•• •• modules.

A single-mode head NRP must be connected to a single-mode drop NRP. A multimode head NRP must be connected to a multimode drop NRP.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Do not connect a single-mode fiber optic repeater module 140 NRP 954 01C to a multimode fiber optic repeater module 140 NRP 954 00.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

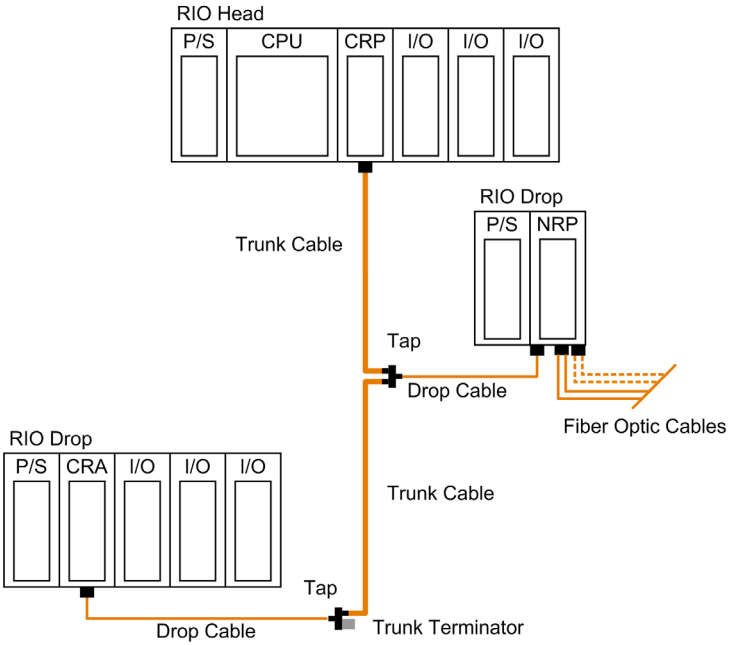
Drop NRP Definition

The 140 NRP 954 0• fiber optic repeater that has a hard-wired (coaxial) connection to the RIO head processor at the top of the RIO network is called the drop NRP.

The coaxial cable running into the drop NRP is a drop cable (coming off a tap from the trunk cable).

The trunk cable must be terminated by a trunk terminator.

The following figure shows a drop NRP in a RIO network:



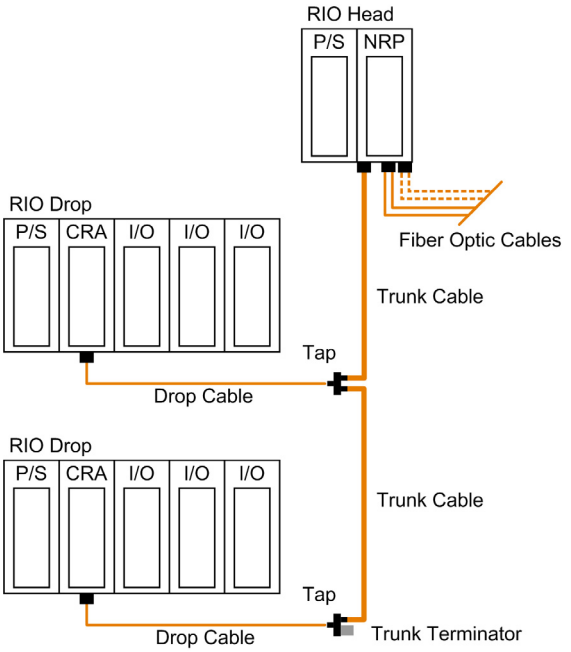
Head NRP Definition

The 140 NRP 954 0• fiber optic repeater that has a hard-wired (coaxial) connection to RIO drops is called the head NRP.

The coaxial cable coming out of the head NRP is a trunk cable and taps must be connected to it to support the drops.

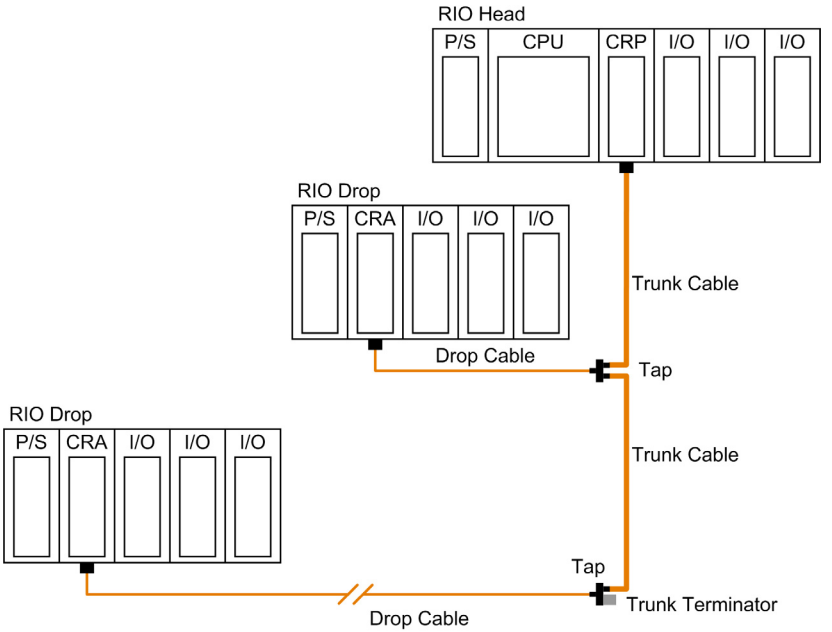
The trunk cable must be terminated by a trunk terminator.

The following figure shows a head NRP in a RIO network:



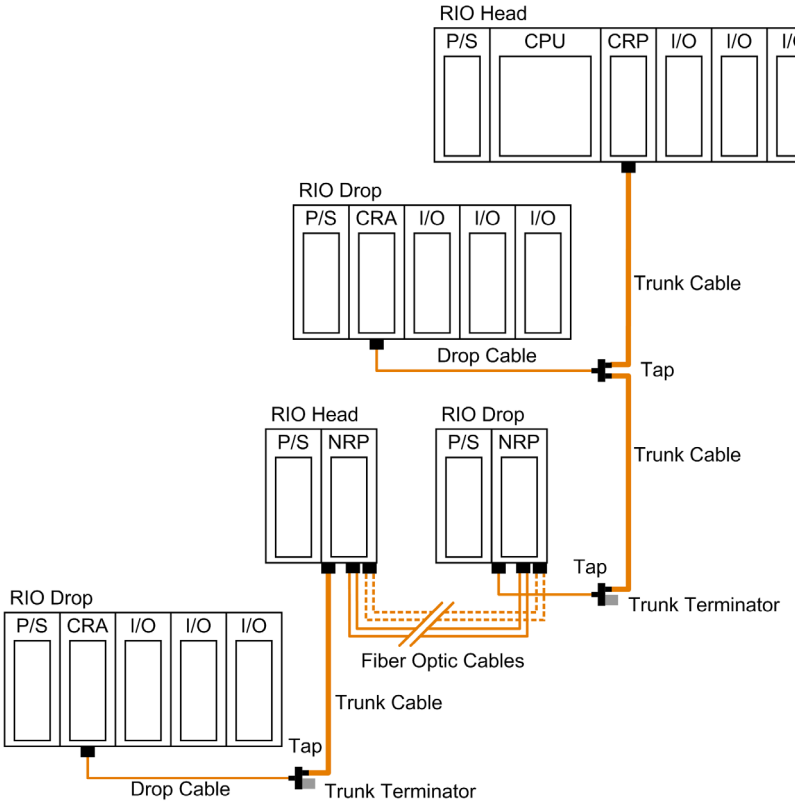
Insertion of Fiber Optic Repeaters in a Drop Cable

The following figure shows a RIO network with the second RIO drop connected to the trunk cable using a long drop cable:



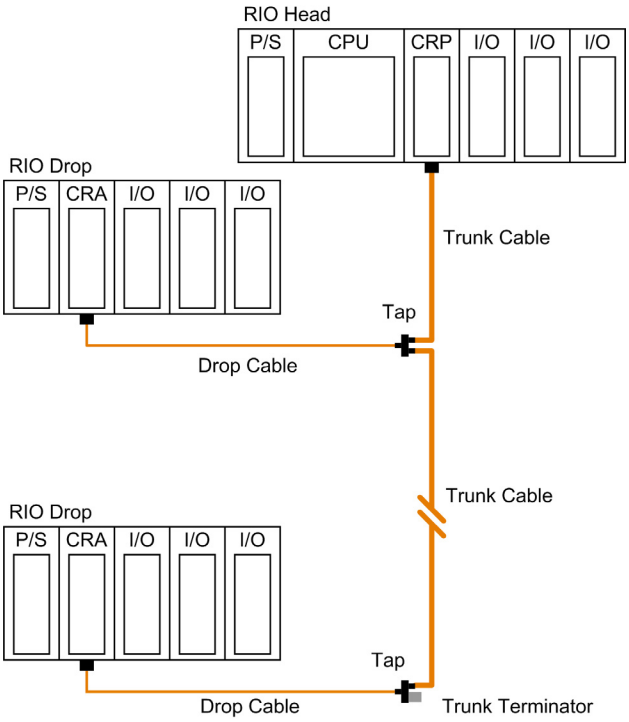
To avoid attenuation, noise and/or distant ground in case of a long drop cable, it can be useful to install fiber optic repeaters.

The following figure shows the architecture after insertion of two 140 NRP 954 0• modules in a drop cable according to the RIO network topology rules:



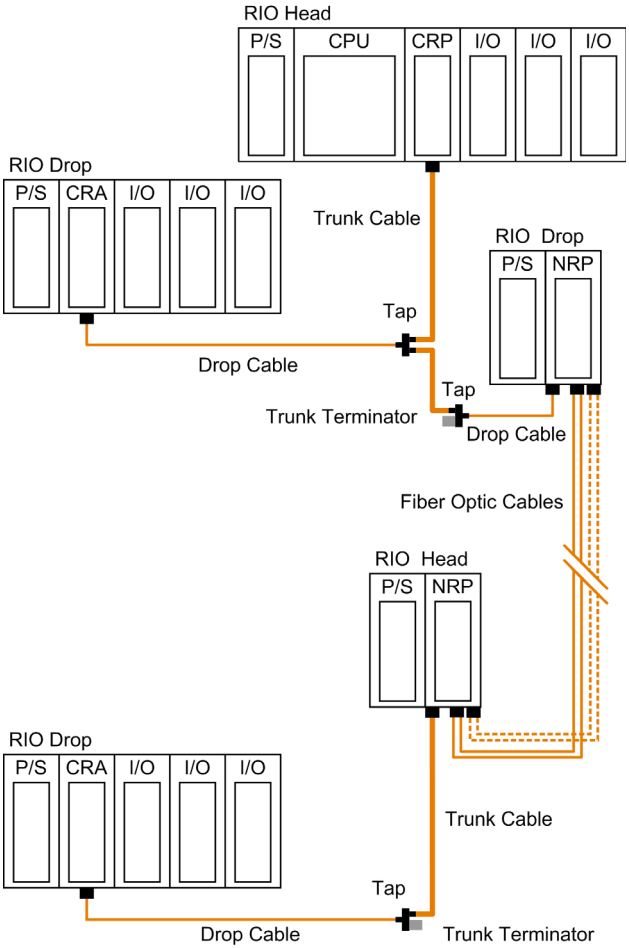
Insertion of Fiber Optic Repeaters in a Trunk Cable

The following figure shows a RIO network with a long trunk cable between two RIO drops:



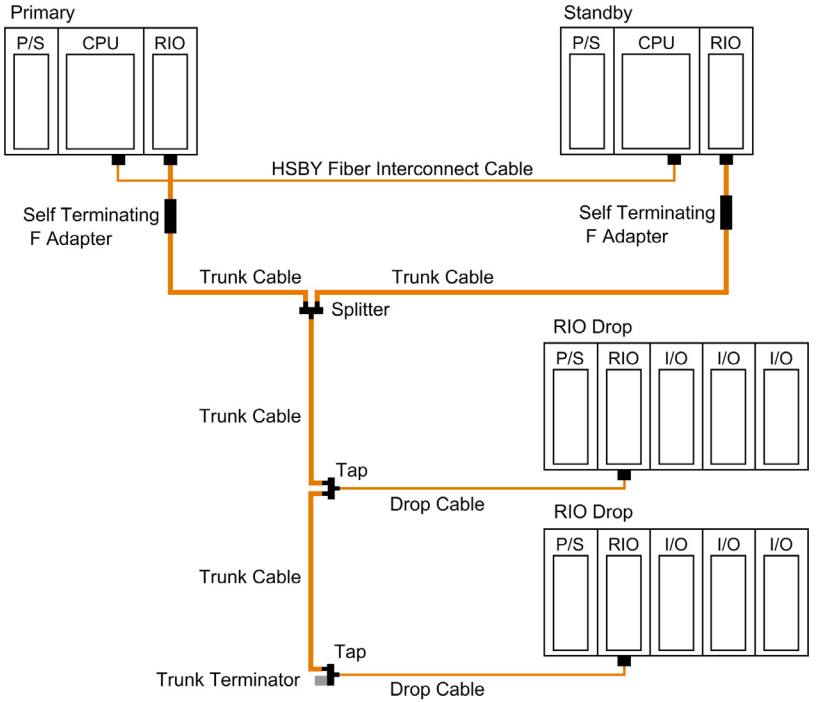
To avoid attenuation, noise and/or distant ground in case of a long trunk cable, it can be useful to install fiber optic repeaters.

The following figure shows the architecture after insertion of two 140 NRP 954 0• modules in a trunk cable according to the RIO network topology rules:



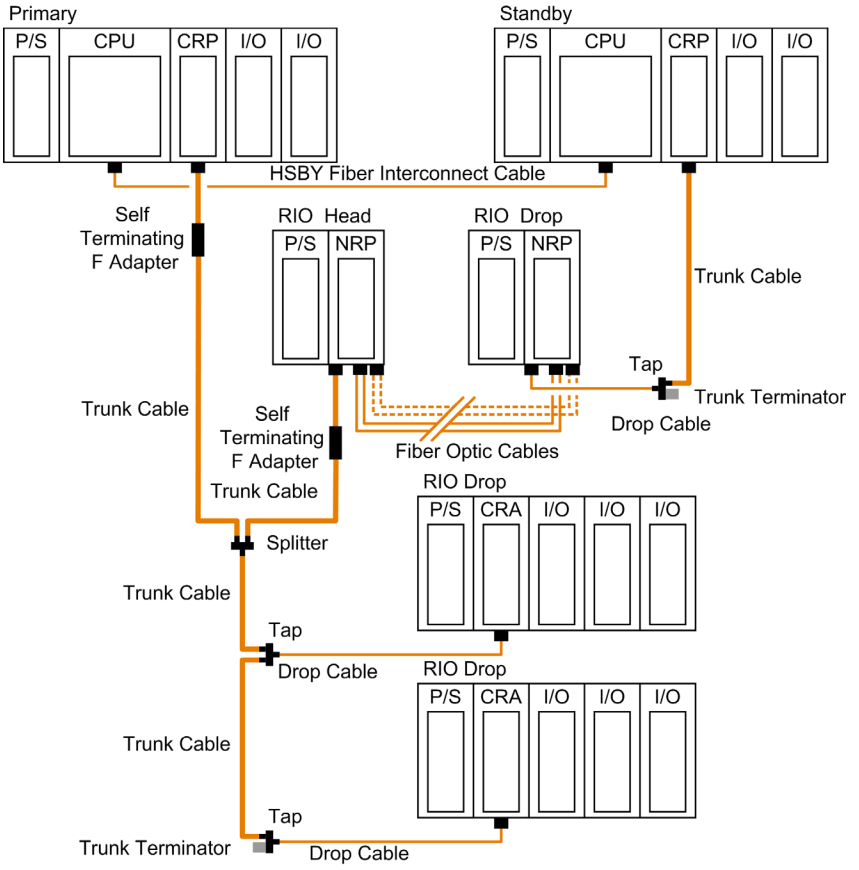
Insertion of Fiber Optic Repeaters in a Hot Standby System

The following figure shows a single-cable Hot Standby (HSBY) system, (for example with the HSBY processor 140CPU67261). The RIO heads are connected via a splitter:



To avoid noise, attenuation and/or distant ground in case of long distances between both RIO heads of the HSBY system, it can be useful to install fiber optic repeaters.

The following figure shows the architecture after insertion of two 140 NRP 954 0• modules in the trunk cable according to the rules of the Hot Standby topologies:



Part Numbers

Part numbers for basic components that may be used in RIO topologies are listed below to familiarize readers:

Description	Part Number
Head RIO	140 CRP 9•• ••
Drop RIO	140 CRA 9•• ••
Drop and Head NRP	140 NRP 954 0•
Trunk Cable	RG-11 cable (highly recommended)
Drop Cable	RG-6 cable
Self Terminating F Adapter	52-0399-000 for non quad shielded cable
	52-0411-000 for quad shielded cables
Splitter	MA-0186-100 for Hot Standby trunk merge
	MA-0331-000 for RIO trunk split
Tap	60-0545-000
Trunk Terminator	52-0422-000
Tap Terminator	52-0402-000
Ground Block *(see page 54)*	60-0545-000

Topologies Using Fiber Optic Repeaters

Additionally to native topologies *(see page 10)* that may be used for RIO networks, there are topologies using fiber optic repeaters according to the insertion principles stated above:

- Point-to-point topology
- Bus topology
- Tree topology
- Self-healing ring topology

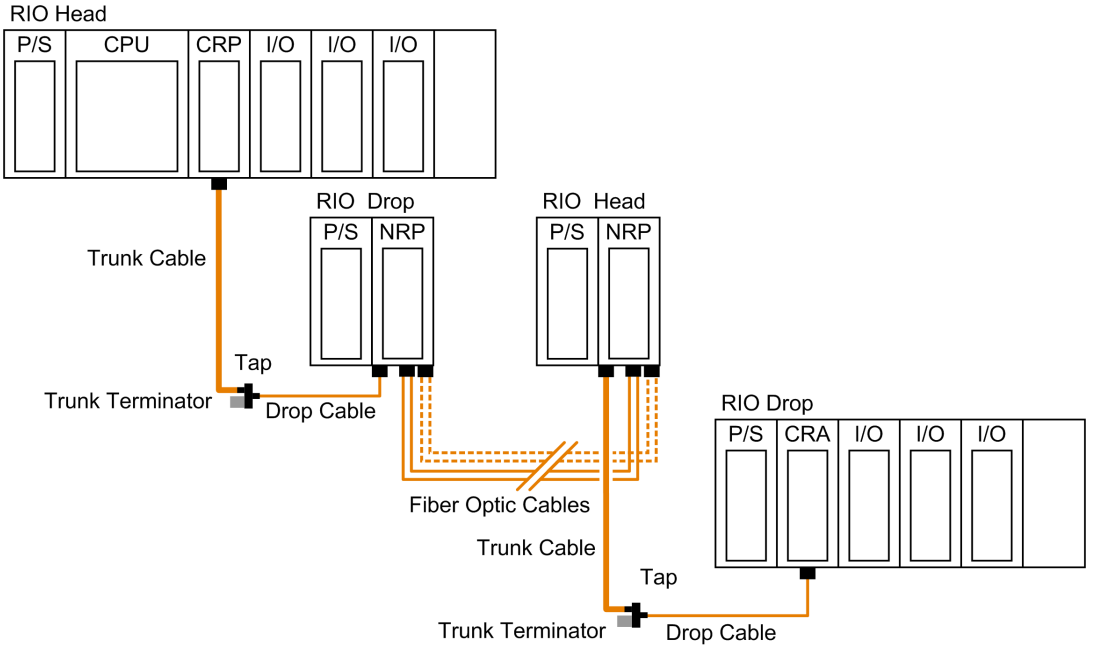
NOTE: if both optical fiber pairs are installed, a point-to-point topology becomes a self-healing ring topology.

Quantum Rack Integration

Principle

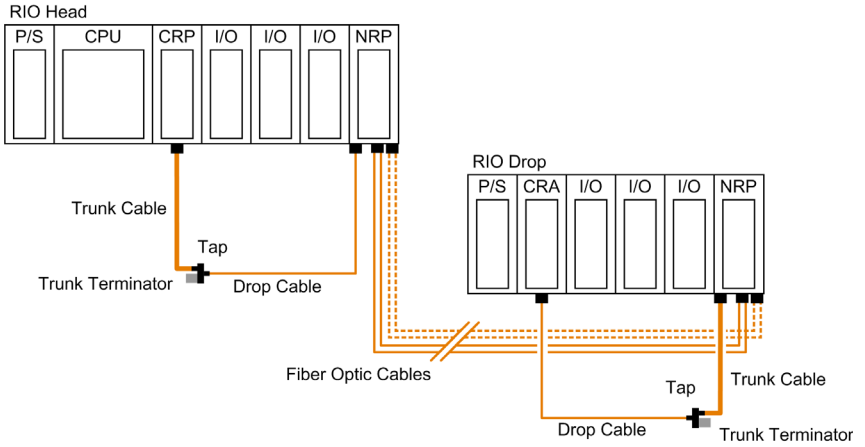
Instead of placing each fiber optic repeater modules with its own power supply module(s) in a standalone backplane, you can take the advantage of the quantum form factor.

The following figure shows two segments of RIO coaxial cable connected point-to-point by two 140 NRP 954 0• fiber optic repeaters before rack integration. The RIO head and RIO drop are located on Quantum racks with at least one spare slot on the backplane:



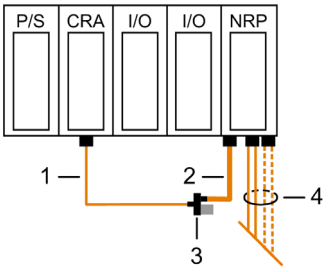
Each 140 NRP 954 0• can be placed on the racks where the RIO head and RIO drop modules are located.

The following figure illustrates the integration of the fiber optic repeater modules in the respective backplanes:



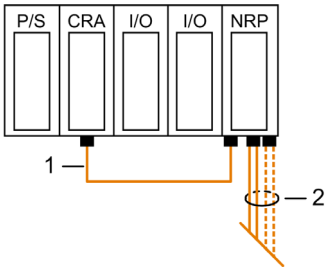
Short Coaxial Cable

The coaxial cables with tap and trunk terminator between a 140 CRP 9•• ••/140 CRA 9•• •• and a 140 NRP 954 0• in the same backplane can be replaced by a short coaxial cable:



1 Drop cable
2 Trunk cable
3 Tap wih trunk terminator
4 Fiber optic cables

Or



1 Short coaxial cable
2 Fiber optic cables

The short coaxial cable is a RG-6 cable fitted with type F female connectors. The maximum length of this cable is 30 cm (11.8 in.).

NOTE: You can use the pre-assembled short coaxial RG-6 cable of the kit (reference RPXKITCRP) or prepare your own short coaxial cable, for details refer to chapter *Installing an RIO network*.

Integration Planning

The following are the key elements to be considered when you plan to integrate the 140 NRP 954 0• fiber optic repeater modules:

- Spare slots and power budget must be available on the rack of the head and/or drop modules where you plan to integrate fiber optic repeater modules. This step can be performed during module configuration *(see page 67)*.
- The minimum bend radius specified for the coaxial cables must not be exceeded. If the cable is bent more than the allowable bend radius or if the installation is not adequately supported, then the center conductor, the dielectric and the cable shield might be damaged.

⚠ CAUTION

POSSIBLE EQUIPMENT FAILURE

Do not exceed minimum bend radius specified for the coaxial cables.

Failure to follow these instructions can result in injury or equipment damage.

- The physical cable installation must be well supported, and cable pull strength must be considered. If the cable is pulled beyong the maximum allowable limits, the cable will stretch or break causing an impedance mismatch.

⚠ CAUTION

POSSIBLE EQUIPMENT FAILURE

Do not exceed maximum pull strength allowable limits specified for the coaxial cables.

Failure to follow these instructions can result in injury or equipment damage.

Refer to the chapter *Planning and Designing an RIO Cable System* to perform the routing plan and installation of the hardware components of your RIO system.

Fiber Optic Diagnostic Architecture

Introduction

The 140 NRP 954 0• fiber optic repeater module is equipped with a diagnostic relay *(see page 40)*.

The behavior of this diagnostic relay allows the application to detect internal or external error and its output may be used like a general purpose dry contact digital output.

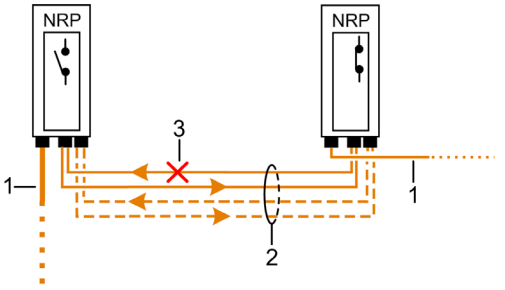
The main goal of this diagnostic is to detect broken fiber optic cable.

By wiring in serial or parallel the output of the diagnostic relays you may have a global or detailed broken fiber optic cable diagnostic.

Principle

When one of the optical fiber port input is inactive while activity is detected or has been detected on the other optical port input, it opens the contacts of the diagnostic relay. If a fiber optic cable is broken between two NRP, it opens the diagnostic relay contacts of the receiver NRP.

The following figure illustrates the diagnostic relay principle in a point-to-point topology example:



1 Coaxial cable
2 2 pair of fiber optic cables
3 Broken fiber optic cable
NRP 140 NRP 954 0• Fiber optic repeater module

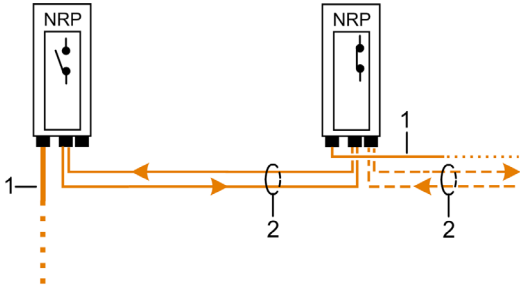
The diagnostic relay contacts of one NRP (receiver side of the broken fiber) are opened while the diagnostic relay contacts of the other NRP (transmitter side of the broken fiber) are closed.

NOTE: When there is no traffic on the RIO network (PLC in stop for example) then the state of the diagnostic relay is frozen.

Limits

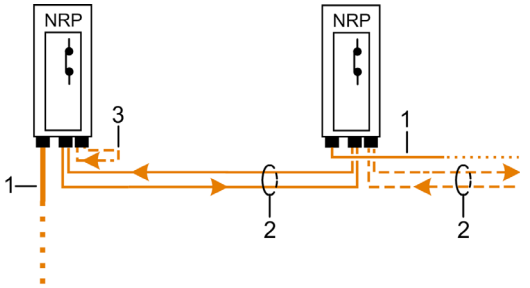
According to this principle, when only one pair of fiber optic cables is connected to the 140 NRP 954 0• module, the relay diagnostic contacts opens and masks a possible diagnostic of the used fiber optic cables.

The diagnostic relay contacts of the NRP on the left side of the following figure is open even if there is no broken fiber optic cable:



1 Coaxial cable
2 Pair of fiber optic cables
NRP 140 NRP 954 0• Fiber optic repeater module

To allow the diagnostic of the fiber optic cables between the two NRP of the following figure, connect the output to the input of the unused fiber optic port *(see page 40)* with appropriate cable:



1 Coaxial cable
2 Pair of fiber optic cables
3 Loop back fiber optic cable
NRP 140 NRP 954 0• Fiber optic repeater module

Note: You may have unused fiber optic port(s) in the following cases when using fiber optic repeater in an RIO system:

- First and last module in a bus topology.
- When only one pair of fiber optic cables are used in tree and point-to-point topologies.

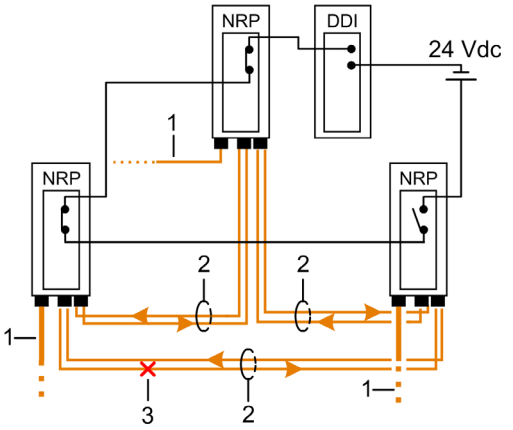
Global Diagnostic

Wiring in serial the output of the diagnostic relays of the 140 NRP 954 0• fiber optic repeaters located in the RIO network to a digital input (for example) provides a global diagnostic of the fiber optic cables.

In a self-healing ring topology, where the first failure has no effect on the communication, the global diagnostic is a low cost and easy implementation diagnostic solution.

NOTE: With a global diagnostic you will know that there is a failure, but visual investigations will be needed on the 140 NRP 954 0• modules in order to find where the failure is located.

The following figure shows a self-healing ring topology with all three diagnostic relay outputs connected in serial to the input of a digital module:

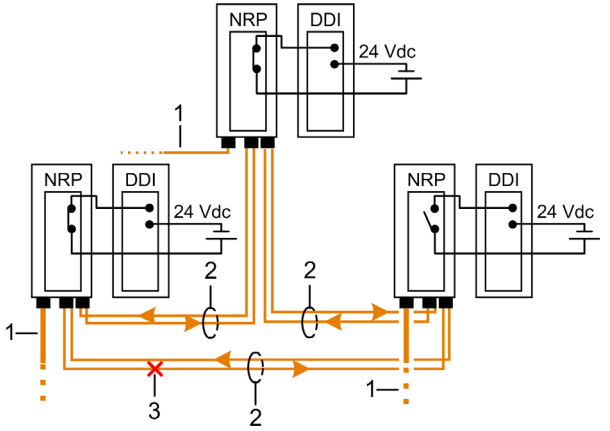


1 Coaxial cable
2 Pair of fiber optic cables
3 Broken fiber optic cable
NRP 140 NRP 954 0• Fiber optic repeater module
DDI 140 DDI ••• •• DC input 24 Vdc module

Detailed Diagnostic

Wiring in parallel the output of the diagnostic relays of the 140 NRP 954 0• fiber optic repeaters located in the RIO network to digital inputs (for example) provides a detailed diagnostic of the fiber optic cables.

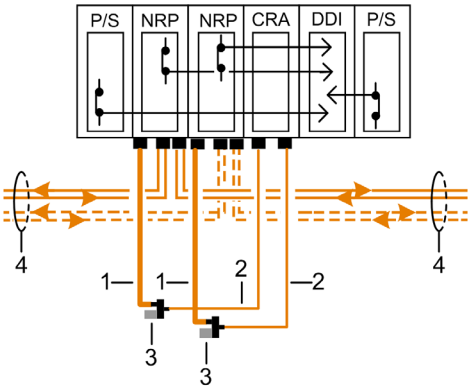
The following figure shows a self-healing ring topology with all three diagnostic relay outputs connected in parallel to three digital input modules:



1 Coaxial cable
2 Pair of fiber optic cables
3 Broken fiber optic cable
NRP 140 NRP 954 0• Fiber optic repeater module
DDI 140 DDI ••• •• DC input 24 Vdc module

Application Example

The following example will show you the architecture of a highly diagnosed rack inserted in a redundant bus topology and power supplies (AC and DC). This architecture allows to warn and interpret remotely which availability has been lost (power supply, fiber optic cable...):



1 Trunk cable
2 Drop cable
3 Tap with trunk terminator
4 2 pairs of fiber optic cables
P/S 140 CPS 124 00 and 140 CPS 224 00 Redundant power supply modules
NRP 140 NRP 954 0• Fiber optic repeater module
CRA 140 CRA 932 00 Remote I/O drop dual channel module
DDI 140 DDI 353 00 DC input 24 Vdc module

The 140 NRP 954 0• fiber optic repeaters are chained together to extend the length of the redundant fiber link (for example in a tunnel). The diagnostic relays of the redundant power supplies (AC and DC) and NRP modules are connected to the DDI module. All diagnostic relay status available in the DDI module are transmitted on the RIO network via the CRA module.

NOTE: In this example the modules are installed in a 6-slot Quantum backplane (140 XBP 006 00) or more.

Please refer to the *Modicon Quantum Automation Series Hardware Reference Guide* for details on power supply, remote I/O drop, DC input modules and backplane.

Expansion of Topologies Using 490NRP954 Fiber Optic Repeaters

Overview

The 490NRP954 is a multimode fiber optic repeater. It is not compatible with the 140 NRP 954 01C single-mode fiber optic repeater module.

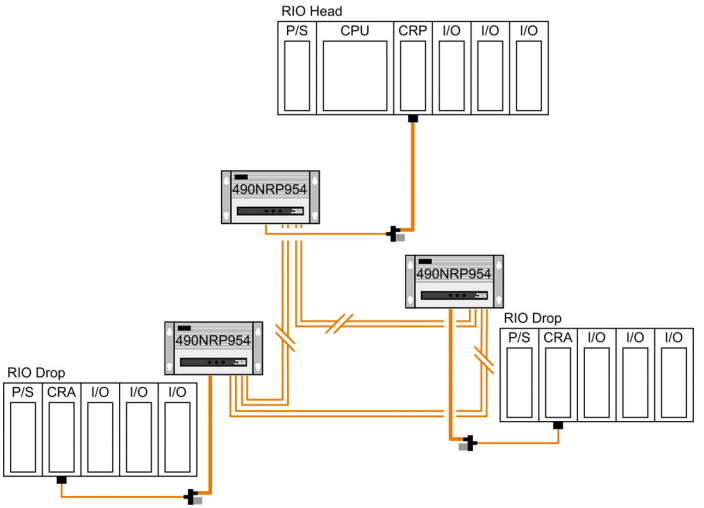
To expand existing topologies built with 490NRP954 fiber optic repeater, you can use the 140 NRP 954 00 fiber optic repeater module.

> **⚠ WARNING**
>
> **UNINTENDED EQUIPMENT OPERATION**
>
> Do not connect a 140 NRP 954 01C single-mode fiber optic repeater module to a 490NRP954 fiber optic repeater.
>
> **Failure to follow these instructions can result in death, serious injury, or equipment damage.**

490NRP954 Fiber Optic Repeater

The 490NRP954 fiber optic repeater is passive.There is no regeneration of the received signal in the repeater and no additional delay to the signal produced by the repeater. Due to the cumulative effects of reactive components, a maximum number of five 490NRP954 repeaters is recommended in a linear network. This number may be reduced due to the system's total pulse width distortion (jitter).

The following figure shows a self-healing ring topology with 3 490NRP954 fiber optic repeaters:



140 NRP 954 00 Fiber Optic Repeater Module

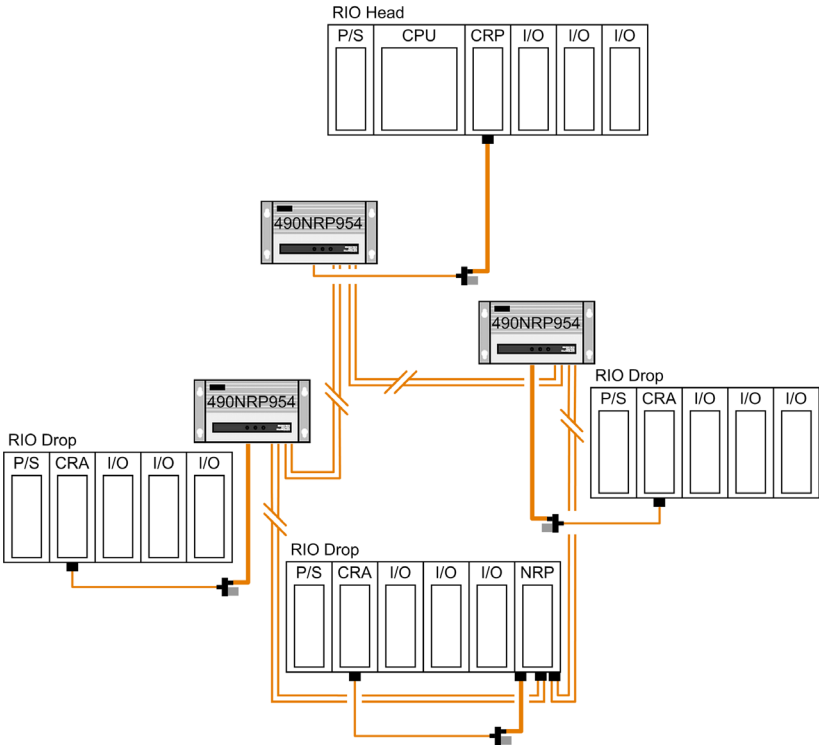
The 140 NRP 954 00 fiber optic repeater module is active.The received signal is regenerated in the repeater and no additional delay to the signal is produced.

The attenuation in the optical path gives the limitations *(see page 43)* of the number and/or distance using 140 NRP 954 00 fiber optic repeater modules.

Compatibility

Fiber optic repeaters compatibility allows to add RIO drops with 140 NRP 954 00 in an existing RIO network using 490NRP954 fiber optic repeaters.

The following figure shows how a new RIO drop has been connected in the self-healing ring architecture using both fiber optic repeaters:



NOTE: Depending on the architecture topology, some restrictions may appear on the diagnostic relay features *(see page 26)* when 140 NRP 954 00 and 490NRP954 fiber optic repeaters are connected together.

Replacement of a 490NRP954 by a 140 NRP 954 00 Fiber Optic Repeater

Overview

This section will gives the equivalent minimum set to replace 490NRP954 fiber optic repeater(s) by 140 NRP 954 00 fiber optic repeater module(s) in a:

- standard single-cable system
- redundant cable system

Although the redundant cable system allows to increase the communication availability on an RIO network, a good “high availability” system can be achieved when redundant cable system and redundant power supplies *(see page 34)* functionalities are non interrelated.

By replacing the 490NRP954 by the 140 NRP 954 00 module the RIO architecture can be planned to achieve a high system availability.

NOTE: To install the 140 NRP 954 00, follow the instructions in the Installation chapter *(see page 49)* .

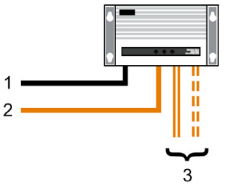
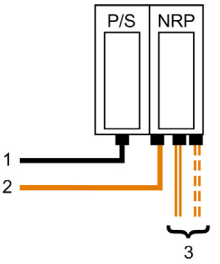
Standard Single-cable System

In a single-cable system (coaxial), you can replace each 490NRP954 fiber optic repeater by a minimum set constituted of:

Qty	Part Number	Designation
1	140 NRP 954 00	Fiber optic repeater module
1	140 CPS ••• ••	Quantum power supply module
1	140 XBP 002 00	2-slot Quantum backplane

Please refer to the *Modicon Quantum Automation Series Hardware Reference Guide* for details on power supply modules and backplane.

The following figure illustrates the cable architecture with the two fiber optic repeater references in a single-cable system:

490NRP954	140 NRP 954 00
	
1 Power source **2** Coaxial cable **3** Fiber optic cables (2 pairs) **P/S** Power supply module (140 CPS ••• ••) **NRP** Fiber optic repeater module (140 NRP 954 00)	

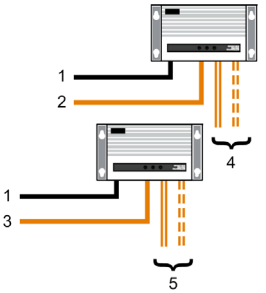
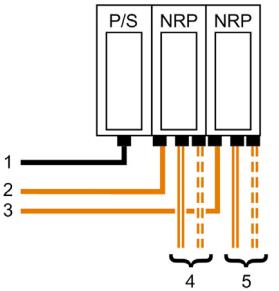
Redundant Cable System

In a redundant cable system (coaxial), you can replace each pair of 490NRP954 fiber optic repeaters by a minimum set constituted of:

Qty	Part Number	Designation
2	140 NRP 954 00	Fiber optic repeater modules
1	140 CPS ••• ••	Quantum power supply module
1	140 XBP 003 00	3-slot Quantum backplane

Please refer to the *Modicon Quantum Automation Series Hardware Reference Guide* for details on power supply modules and backplane.

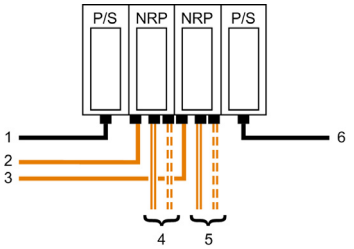
The following figure illustrates the cable architecture with the two fiber optic repeater references in a redundant cable system:

490NRP954	140 NRP 954 00
	

1 Power source
2 Coaxial cable A
3 Coaxial cable B
4 & 5 Fiber optic cables (2 pairs)
P/S Power supply module (140 CPS ••• ••)
NRP Fiber optic repeater modules (140 NRP 954 00)

Power Redundancy

After replacing the 490NRP954 fiber optics repeaters by 140 NRP 954 00 modules in a redundant cable system, you can achieve a high system availability by adding redundant power supply modules in the backplane:



1 & 6 Power sources
2 Coaxial cable A
3 Coaxial cable B
4 & 5 Fiber optic cables (2 pairs)
P/S Redundant power supply modules (140 CPS ••• ••)
NRP Fiber optic repeater modules (140 NRP 954 00)

NOTE: When power supply redundancy is needed, the fiber optic repeater modules and redundant power supply modules are installed in the same backplane.

Please refer to the *Modicon Quantum Automation Series Hardware Reference Guide* for details on backplane and power supply modules.

Integration

Instead of replacing each 490NRP954 by its equivalent, the Quantum form factor allows to integrate fiber optic repeater modules *(see page 23)* whenever spare slots and spare power budget are available on the rack of the head and/or drop modules.

Module Description

2

Overview

This chapter provides a general description of the 140 NRP 954 00 multimode fiber optic repeater module and the 140 NRP 954 01C single mode fiber optic repeater module.

What Is in This Chapter?

This chapter contains the following topics:

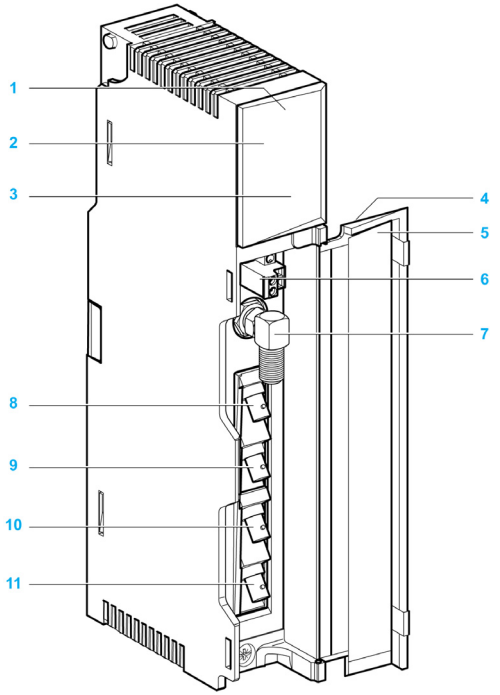
140 NRP 954 00 and 140 NRP 954 01C Presentation

Function

The 140 NRP 954 0• fiber optical repeater module provides communication between two or more RIO nodes or segments of networks over a fiber optic medium. Each repeater contains one electrical RIO interface and two fiber optic transceivers.

140 NRP 954 00 Module Description

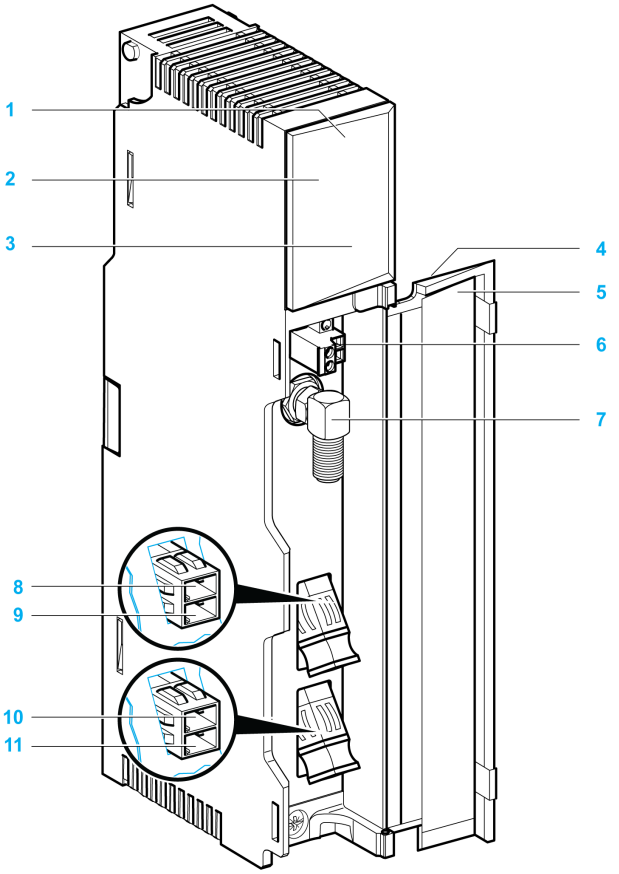
The following figure shows the 140 NRP 954 00 multimode fiber optic repeater module parts:



1 Version label
2 Model number, module description, color code
3 LED area
4 Removable door
5 Customer identification label (Fold label and place it inside door)
6 Diagnostic relay port
7 Electrical coaxial port (“F” type connector)
8 Transmitter optical fiber port - FPort 1 Tx (ST type connector)
9 Receiver optical fiber port - FPort 1 Rx (ST type connector)
10 Receiver optical fiber port - FPort 2 Rx (ST type connector)
11 Transmitter optical fiber port - FPort2 Tx (ST type connector)

140 NRP 954 01C Module Description

The following figure shows the 140 NRP 954 01C single-mode fiber optic repeater module parts:

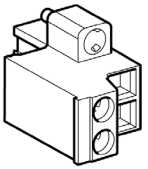


1 Version label
2 Model number, module description, color code
3 LED area
4 Removable door
5 Customer identification label (Fold label and place it inside door)
6 Diagnostic relay port
7 Electrical coaxial port (“F” type connector)
8 Receiver optical fiber port - FPort 1 Rx (LC type connector)
9 Transmitter optical fiber port - FPort 1 Tx (LC type connector)
10 Receiver optical fiber port - FPort 2 Rx (LC type connector)
11 Transmitter optical fiber port - FPort2 Tx (LC type connector)

Diagnostic Relay Port

A normally closed relay contact, rated at 220 Vac 6 A or 30 Vdc 5 A, is available on the terminals of the diagnostic relay port via its connector. This allows to use the diagnostic relay behavior *(see page 42)* in the application.

The following figure shows the 2 terminals of the diagnostic relay connector:



Electrical Coaxial Port

The 140 NRP 954 0• fiber optic repeater module is equiped with an electrical coaxial RIO interface using an "F"-style connector. In order to maintain bend radius tolerance on coaxial cable the electrical coaxial port is equiped with a right-angle F adapter.

The electrical coaxial port has the same network connections, specifications and restrictions as other remote I/O devices, and must be treated accordingly. See *Remote I/O Cable System Planning and Installation Guide* for information regarding planning your network configuration as well as the installation of the network electrical coaxial cable.

⚠ CAUTION

CONNECTIVITY COMPLIANCE

To maintain CE compliance with the European Directive on EMC (89/336/EEC), the 140 NRP 954 0• module must be connected using quad shielded cable (see the ***Remote I/O Cable System Planning and Installation Guide***).

Failure to follow these instructions can result in injury or equipment damage.

Optical Ports

The 140 NRP 954 0• fiber optic repeater module is equiped with two optical ports (FPort1 and FPort2).

One pair of fiber optic cables are connected to one fiber optic port using for the:

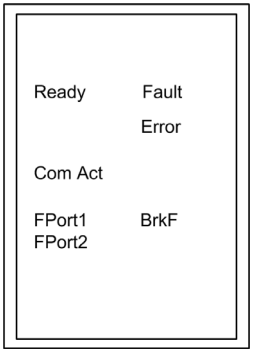
140 NRP 954 00 two low-loss industrial ST-type connectors (one for the transmitter signal (Tx) and one for the receiver signal (Rx)).

140 NRP 954 01C one LC duplex connector (one for the transmitter signal (Tx) and one for the receiver signal (Rx)).

LED Indicators and Diagnostic Relay Behavior

Illustration

The following figure shows the LED indicators for the 140 NRP 954 0• fiber optic repeater module:



LED Indicators

The following table describes the status LEDs of the 140 NRP 954 0• module:

LED	Color	State	Indication
Ready	Green	OFF	The module is unpowered or the internal logic is out of order.
		ON	The module is powered and the internal logic is available.
ComAct	Green	OFF	No activity on the coaxial cable.
		ON	Activity is detected on the coaxial cable.
FPort1	Green	OFF	No activity on the optical fiber port 1 reception.
		ON	Activity is detected on the fiber port 1 reception.
FPort2	Green	OFF	No activity on the optical fiber port 2 reception.
		ON	Activity is detected on the fiber port 2 reception.
Fault	Red	OFF	No error (internal or external) detected.
		ON	An error (internal or external) has been detected.
Error	Red	OFF	No internal error detected.
		ON	An internal error has been detected.
BrkF	Red	OFF	Activity is detected on both optical port inputs OR no activity has ever been detected on any optical port input.
		ON	One of the optical fiber port input is inactive (see FPort• LED OFF) while activity is detected or has been detected on the other optical port input (see FPort• LED ON).

Diagnostic Relay Behavior

The contacts of the relay are open whenever an error is detected (internal or external), and the Fault LED is ON. In fact the status of the diagnostic relay provides an electric information when the Fault LED status provides a visual status when an error is detected (internal or external).

Futhermore when the contacts of the diagnostic relay are open,

- if the detected error is internal the Error LED is ON.
- if the detected error is external the BrkF LED is ON.

NOTE: When the 140 NRP 954 0• is not powered, the contacts of the diagnostic relay are open.

General Specifications

Introduction

This section gives the 140 NRP 954 0• fiber optic repeater module specifications.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Do not exceed any of the rated values specified in the following tables.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

General Specifications

Item	140 NRP 954 00	140 NRP 954 01C
Bus Current Required	700 mA	750 mA
Power Dissipation (Typical)	5 W	5 W
Inrush Current	1 A typical @ 5 Vdc	1.8 A typical @ 5 Vdc
Data Transfer Rate	1.544 Mb for remote I/O with Manchester encoded data	
Bit Error Rate	10^{-9} over specified Optical Receiver Dynamic Range	
Optical Interface	ST-Type connector	LC-Type connector
Wavelength	820 nm	1300 nm
Power Loss Budget (includes 3 dB of system margin)	50/125 µm fiber –7.0 dB 62.5/125 µm fiber –11 dB 100/140 µm fiber –16.5 dB	9/125 µm fiber –8.0 dB
Maximum Distance for Point–to–Point Connection	2 km over 50/125 µm fiber @ 3.5 dB/km 3 km over 62.5/125 µm fiber @ 3.5 dB/km 3 km over 100/140 µm fiber @ 5 dB/km	16 km over 9/125 µm fiber @ 0.45 dB/km
Limits in Bus or Self-Healing Ring Configurations	12 fiber optic repeater modules with a maximum length of fiber optic cables of 16 km (back-loop included in Self-healing ring configuration). **NOTE:** The maximum length is between the CRP module (the farther one in a Hot Standby (HSBY) system) and the last CRA module.	
Coaxial Interface	F type female connector with a right-angle F adapter connector **NOTE:** Required torque to fasten the right-angle F adapter is 0.46...0.60 N•m (4.1...5.3 lbf-in).	
Coaxial Termination	Internal 75 ohms	
Coaxial Shield	Tied to ground *(see page 54)*	

Item	140 NRP 954 00	140 NRP 954 01C
Coaxial Dynamic Range	35 dB	
Coaxial Sensitivity	70 mV pk-pk max	
Relay Diagnostic	Rated at 220 Vac 6 A / 30 Vdc 5 A	

NOTICE

DESTRUCTION OF ADAPTER

- Before tightening the locknut to the torque 0.46...0.60 N•m (4.1...5.3 lbf-in) be sure to properly position the right-angle F adapter connector.
- During tightening be sure to maintain the connector securely.
- The locknut must be loosened before handling the connector. For this reason, it is recommended to attach the S908 coaxial cable to the chassis to avoid any mechanical stress on the right-angle F adapter connector.
- Do not tighten the right-angle F adapter beyond the specified torque.

Failure to follow these instructions can result in equipment damage.

Optical Transmitter Specifications

Item	140 NRP 954 00	140 NRP 954 01C
Optical Power (Measured with 1 m test fiber)	–13.0...–20.0 dBm average power in 50/125 µm fiber cable –10.0...–16 dBm average power in 62.5/125 µm fiber cable –4.0...–10.5 dBm average power in 100/140 µm fiber cable	–8.0...–15.0 dBm average power in 9/125 µm fiber cable
Rise/Fall Time	20 nsec or better	20 nsec or better
Silence (OFF Leakage)	–43 dBm	–45 dBm

Optical Receiver Specifications

Item	140 NRP 954 00	140 NRP 954 01C
Receiver Sensitivity	–30 dBm average power	–25 dBm average power
Dynamic Range	20 dB	20 dB
Detected Silence	–36 dBm	–45 dBm

Reliability

Item	140 NRP 954 00	140 NRP 954 01C
MTBF (in continuous)	1,300,000 hours (minimum) @ 30 °C, assuming fixed ground and component stress within maximum specifications.	

Mechanical and Electrical Specifications

Mechanical Specifications

Weight	1 kg (2 lb) max
Dimensions (H x D x W)	250 x 103.85 x 40.34 mm (9.84 x 4.09 x 1.59 in)
Wire Size	1-14 AWG or 2-16 AWG max. 20 AWG min.
Material (Enclosures and Bezels)	Polycarbonates
Space Requirements	1 rack slot (only HE-CPUs need 2 rack slots)

Electrical Specifications

RFI Immunity (IEC 1000-4-3)	80 ...1000 MHz, 10 V/m
Ground Continuity (IEC 1000-4-5)	2 kV shield to ground
Electrostatic Discharge (IEC 1000-4-2)	8 kV air / 4 kV contact
Flammability	Wiring connector: 94V-0 module enclosure: 94V-1

Agency Approvals

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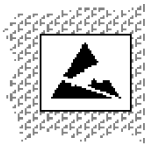
UL 508
CSA 22.2-142
Factory Mutual Class 1, Div 2
European Directive on EMC 89/336/EEC (CE)

NOTE: Quantum system modules contain static-sensitive components. Each module is labeled with the following static-sensitive symbol.



Operating and Storage Conditions

Operating Conditions

Temperature	0 ... 60 °C (32 ... 140 °F)
Humidity	90 ... 95% RH non-condensing at 6 °C
Chemical interactions	Enclosures and terminal strips are made of polycarbonates. This material can be damaged by strong alkalis and various hydrocarbons, esters, halogens and ketones in combination with heat. Common products containing these include detergents, PVC products, petroleum products, pesticides, disinfectants, paint removers, and spray paints.
Altitude	2,000 m. When the altitude exceeds this, reduce the 60 °C maximum operating temperature by 6 °C/1000 m of additional elevation.
Vibration	10 ... 57 Hz at 0.075 mm constant displacement amplitude 57 ... 150 Hz at 1 g
Shock	+/-15 g peak, 11 ms, half-sine wave

Storage Conditions

Temperature	-40 ... 85 °C. C -40 ... 185 °F
Humidity	0 ... 95% RH noncondensing at 60 °C
Free Fall	1 m (3 ft)

Gas Resistance in Conformally Coated Modules

This table shows the results of the mixed flowing gas test, 22 days exposure

Standard	**Gas**	**Test Requirement**	**Actual Exposure**
EIA364-65 Level lll	CL2 (chlorine)	20 PPB, +/- 5 PPB	20 PPB
	NO2 (nitric oxide)	200 PPB, +/- 50 PPB	1250 PPB
	H2S (hydrogen sulfide)	100 PPB, +/- 20 PPB	100 PPB
	SO2 (sulfur oxide)	N/A	300 PPB
ISA-S71.04 (GX Severe)	CL2 (chlorine)	10 PPB	20 PPB
	NO2 ((nitric oxide)	1250 PPB	1250 PPB
	H2S (hydrogen sulfide)	50 PPB	100 PPB
	O2 (sulfur oxide)	300 PPB	300 PPB

Installation

3

Overview

This chapter provides information on planning, designing and installing 140 NRP 954 0• fiber optic repeater modules in a RIO cable system.

What Is in This Chapter?

This chapter contains the following topics:

Selecting Fiber Optic Cable

Overview

If you are using Fiber Optic Repeaters in your RIO network, there are several parameters you need to consider, among them cable attenuation and cable bandwidth. Parameters are specified by the cable manufacturer and are based on:

- the cable index—use graded-index cable only
- the wavelength of the optical signal in the RIO optical link—
  multimode: 820 nm
  single-mode: 1300 nm
- the fiber size—
  multimode: 50/125 μm, 62.5/125 μm, or 100/140 μm
  single-mode: 9/125 μm

For most optical cable links in multimode, the use of 62.5/125 μm cable is recommended because of its relatively low loss and signal distortion. In applications where high optical power is required—e.g., to support additional optical devices such as splitters or star couplers—the 100/140 μm cable should be used. Refer to Calculating Attenuation on an Optical Path *(see page 51)* for more details on design considerations.

Many cable vendors offer multiple choices for a variety of code ratings:

- From the variety of cables, e.g., AMP or Belden offerings—select the one that meets the demands of your application. Wherever possible, Modicon recommends that a multiconductor cable be considered, since it is inexpensive; it provides a backup in case a cable gets cut in the process of pulling it; and you will always find uses for the extra path(s), be it for voice, video, other communications, and/or other control applications.
- Most 62.5/125 μm cables are rated at 3.5 dB loss per km. With a multiconductor cable, all the pairs usually come with an attenuation specification as measured, which may be significantly less than 3.5 dB/km.
- Most 9/125 μm cables are rated at 0.45 dB loss per km.

Attenuation Considerations in an Optical Path

Overview

Attenuation that occurs on an RIO fiber optic link is independent from attenuation on the coaxial cable system. Signals that are attenuated no more than 35dB after traveling through a coaxial cable section are converted in the fiber repeater circuitry to levels usable in the fiber link. Attenuation occurs on the fiber optic link. Receiving fiber repeaters convert the signal back to a full strength coaxial cable signal. An 35 dB attenuation level will be available for use over the next copper section.

As with coaxial cable, size and components used will determine a fiber optic link attenuation. The table below shows allowable attenuation or power loss budget for the connecting repeaters to operate properly. The specified power loss budget is in addition to loss introduced by two connectors. Other components such as splices and the fiber cable loss must be subtracted from the budget.

Fiber Type	Core Diameter	Attenuation	Optical Power Loss Budget
Single mode	9/125 μm	0.45 dB/km	8.0 dB
Multimode	50/125 μm	3.5 dB/km	7.0 dB
	62.5/125 μm	3.5 dB/km	11.0 dB
	100/140 μm	5.0 dB/km	16.5 dB

To illustrate the fiber optic loss, an uninterrupted run of 50/125 μm fiber optic cable that has an attenuation of 3.5 dB/km could be 2 km long.

Minimum Distance between Repeaters

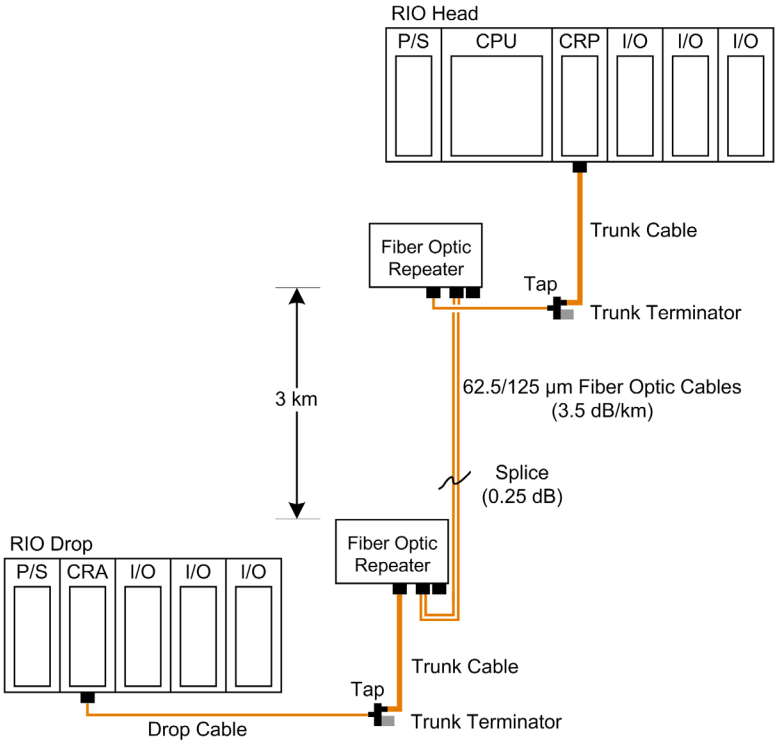
There is no minimum distance requirement when using 50/125 or 62.5/125 μm fiber cable.

If the larger diameter 100/140 μm cable is used, it is possible to overload a repeater's receiver port circuitry. When no components are added in the fiber link made up of this sized cable, minimum distance between repeaters is 1.2 km. Fiber link length may be reduced proportionately as components are introduced.

NOTE: For measurements purposes, note that repeater transmitters have a maximum optical power of –4 dBm when 100/140 μm cable is used. Maximum repeater received signal is –10 dBm for any cable size used.

Example—Attenuation on a Simple Optical Link

The following figure shows an example of a point-to-point optical connection that uses 3 km of 62.5/125 µm multimode fiber cable. There is one splice in the cable connection:



The specified power loss budget for a link using this optical cable is 11 dB. We know that the cable's attenuation over 3 km is 3.5 dB/km x 3 = 10.5 dB, and we are given an attenuation of 0.25 dB for the cable splice. Thus, we have a total optical power loss of 10.75 dB on the fiber optic link, which is under power loss budget and therefore conform to the expectations.

Recommended Materials for Multimode Fiber Optic Links

Overview

Modicon does not manufacture fiber optic products such as cables, connectors, or special tools. However, we have experience with third party suppliers of materials and can provide some guidelines on what will work with our products.

Connectors

The following table shows recommended connectors.

Connector Type	Part Number	Operating Temperature
ST Bayonet (Epoxy)	3M 6105	–40...+80 °C (–40...+176 °F)
ST Bayonet (Hot Melt)	3M 6100	–40...+80 °C (–40...+176 °F)
ST Bayonet (Epoxy)	AMP 501380 Series	–30...+70 °C (–22...+158 °F)
ST Cleave and Crimp	AMP 504034 Series	–40...+65 °C (–40...+149 °F)
Mechanical Line Splice (one size fits all)	3M 2529 Fiberlok™ II	–40...+80 °C (–40...+176 °F)

Termination Kits

The following table indicates recommended termination kits.

Kit Type	Part Number	Description
Bayonet or Push-Pull ST (Hot Melt)	3M 6355	110 Vac, only for 3M connectors
Bayonet ST (Epoxy)	AMP 501258-7	110 Vac, only for AMP connectors
Bayonet ST (Epoxy)	AMP 501258-8	220 Vac, only for AMP connectors
Mechanical Line Splice	3M 2530	Fiber Splice Prep Kit, complete with cleaving tool

Light Sources, Power Meters

For Photodyne light sources and power meter products, contact 3M Telecom Systems Division. See RIO Cable Material Suppliers for contact information.

Grounding Considerations

Introduction

DANGER

SAFETY REGULATIONS

In case of dispute, safety regulations take precedence over EMC constraints.

Failure to follow these instructions will result in death or serious injury.

A low impedance earth ground is required on RIO cable systems to assure safety for maintenance personnel and RIO users.

Besides the safety of the personnel, which is a LF (Low Frequency) constraint, equipotentiality between equipments must be satisfactory.

DANGER

HAZARD OF ELECTRIC SHOCK

Make sure that the RIO cable are securely connected to the protective ground (PE).

The ground connection for cable shields must always run through the entire cable.

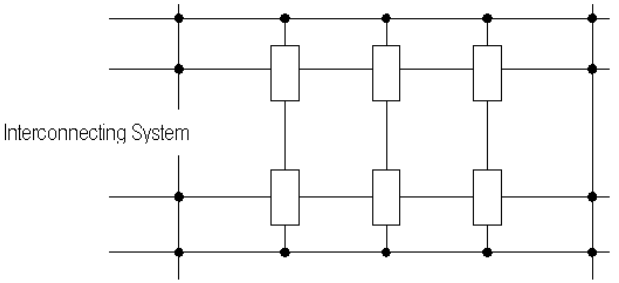
Failure to follow these instructions will result in death or serious injury.

For details and guidelines for the configuration of the grounding, earthing and lightening protection in a plant, refer to the chapter *Grounding, Earthing and Lightening Protection*.

Grounding System

The 140 NRP 954 0• is designed to be installed in a grid-type grounding system. The shield of the coaxial cable of the 140 NRP 954 0• is directly tied to the backplane.

Grid-type grounding system:

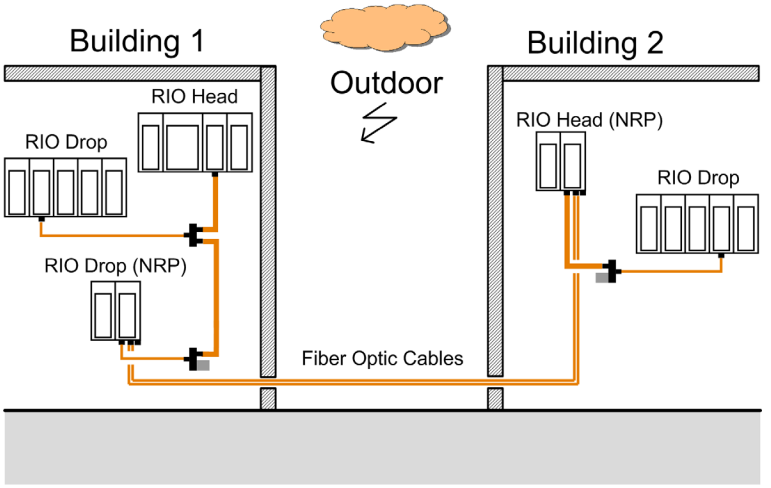


This creates a perfectly meshed system. The connections are arranged between the devices ground, cable runs, existing or under construction metal structures etc. Shielding, filtering devices, return conductors, etc. are directly connected to the ground cable.

Distant Ground Connections

A RIO network is not always accommodated within one building, but can stretch across two or more buildings. This means there are power and/or signal cables going from one building to another. If both buildings have independent ground connections and grounding systems, it can lead to an interfering potential difference between the end points of a line running between buildings.

Even if the local building codes may require that the cable shield must be tied to earth ground whenever the cable system exists and/or enters a new building (NEC Article 820-33), the best way to ensure that everything works properly is to insert fiber optic repeaters each time buildings have independant ground connections and/or grounding systems.



If this is not possible because of the system or construction specific reasons the best way to ensure that everything works properly is to maintain good equipotentiality between equipments using equipotential conductor.

⚠ ⚠ DANGER

ELECTRIC SHOCK

Ensure that distant ground connections have a differential voltage inferior to the conventional limit (25 V or 50 V).

Failure to follow these instructions will result in death or serious injury.

140 NRP 954 0• Grounding Principle

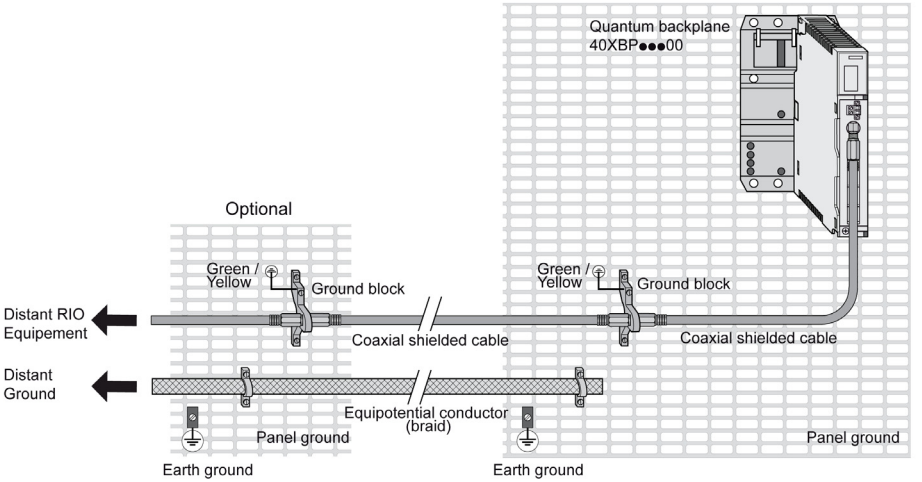
The required grounding configurations for 140 NRP 954 0• fiber optic reapeaters are shown in the following illustrations.

A cable system must be grounded at all times to ensure safety for the personnel and proper operation of the nodes on the network.

If the RIO cable is removed from the 140 NRP 954 0• fiber optic repeater module, as the ground connection to the backplane is linked to the RIO cable, the ground connection does not exist anymore. An optional Modicon 60-0545-000 ground block *(see page 58)* provides earth ground connection.

The main grounding point (or ground reference plane) is the local common connection of the panel ground, equipment ground, and earth grounding electrode.

The following figure shows the ground principle to follow:



Legend:

Distant RIO equipment Head or drop RIO module

Distant Ground This is the ground connection of the head or drop RIO module.

Optional Ground blocks may also be used at other ground points along the trunk and drop cables if required.

To assure an efficient grounding of the system, the intervals across the total run length of the coaxial shielded cable and the equipotential conductor (braid) must be the smallest possible.

NOTE: When the 140 NRP 954 0• is integrated in the head or drop backplane *(see page 23)* , the distant RIO equipment and the NRP are installed in the same backplane then it's not necessary to install a ground block in the local area of the NRP. In this case ground the Modicon MA-0185-100 tap assuring that the cable system is permanently grounded even when disconnected.

Detailed Grounding Connections

The ground block 60-0545-000 consists of two female in-line F connectors and a separate screw hole binding for attaching a ground wire. The grounding block has two mounting holes, allowing it to be mounted to a flat surface.

⚠ ⚠ DANGER

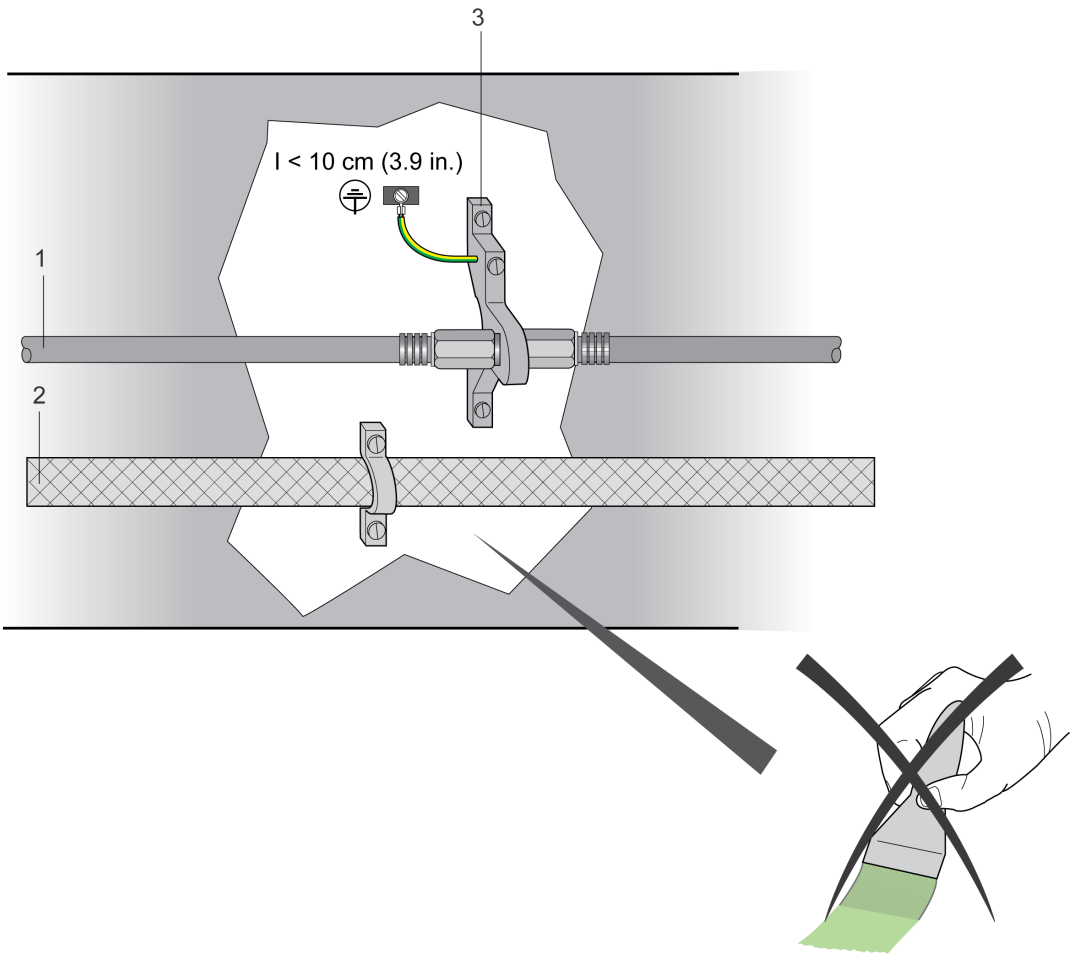
ELECTRIC SHOCK-IMPROPER GROUNDING

- Each ground block must be linked to the protective ground (PE).
- Use a green/yellow wire with a minimum section of 2.5 mm^2 (12 AWG) and with the shortest length possible.
- Install to conform to all local and national codes.

Failure to follow these instructions will result in death or serious injury.

To assure a proper contact to the ground, refer to the chapter *Guidelines for Creating Ground Connections*.

The following figure shows how to install the ground block and the equipotential braid to the ground reference plane:



1 Coaxial cable
2 Braid (equipotential bonding conductor)
3 Ground block

⚠⚠ DANGER

ELECTRIC SHOCK

Connect the equipotential bonding conductor to the protective ground (PE).

Failure to follow these instructions will result in death or serious injury.

Replacing a Drop 490NRP954 Fiber Optic Repeater

The 490NRP954 fiber optic repeater module is generally installed in a RIO cable topology whose environment withstand depends on the legacy single-point grounded principle. You can set the shield-to-ground jumper switch appropriately to specify the repeater's relationship to chassis ground (neutral, isolated or connected to).

In the 140 NRP 954 00 fiber optic repeater module, the RIO cable shield is natively connected to the chassis ground which is connected at the protective earth.

The 140 NRP 954 00 is designed to be installed in a grid-type grounding system according to Schneider principles.

Replacing a 490NRP954 module using legacy single point grounding by a 140 NRP 954 00 module could lead to communication issues. The grounding principle of the installation has to be reconsidered as follows:

- Remove the nut and the washer from the electrical coaxial port of the 140 NRP 954 00 to electrically disconnect the coaxial cable shield from the quantum backplane plate.
- The RIO coaxial cable becomes distant earth.

NOTE: Contrarily, removing the nut and the washer from the electrical coaxial port of the 140 NRP 954 01C does not electrically disconnect the coaxial cable shield from the quantum backplane plate.

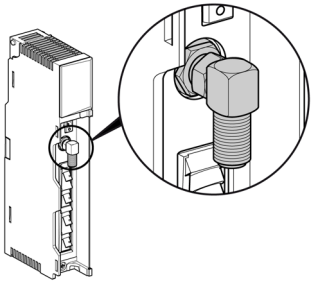
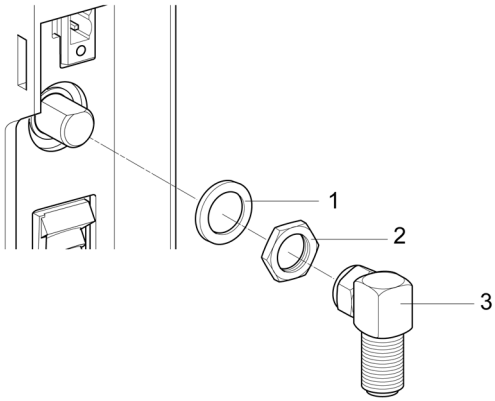
The following table describes actions to electrically disconnect the coaxial cable shield from the quantum backplane plate for the 140 NRP 954 00:

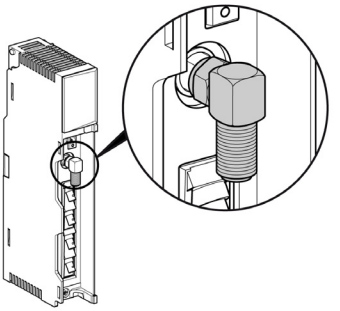
⚠⚠ DANGER

HAZARD OF ELECTRIC SHOCK

Do not remove the nut if you are not a qualified person.

Failure to follow these instructions will result in death or serious injury.

Step	Action
1	Unscrew the right-angle F adapter and its locknut from the140 NRP 954 00 fiber optic repeater. For the nut you can use a 0.5 in. wrench. 
2	Remove the washer (1) and the nut (2). Keep the right-angle F adapter (3). 

Step	Action
3	Replace only the right-angle F adapter on the RIO connector of the 140 NRP 954 00 fiber optic repeater and screw it. **NOTE:** Finger tightening is not sufficient. Recommended torque is 0.46...0.60 N.m (4.1...5.3 lbf-in). 

NOTICE

DESTRUCTION OF ADAPTER

- Before tightening the locknut to the torque 0.46...0.60 N•m (4.1...5.3 lbf-in) be sure to properly position the right-angle F adapter connector.
- During tightening be sure to maintain the connector securely.
- The locknut must be loosened before handling the connector. For this reason, it is recommended to attach the S908 coaxial cable to the chassis to avoid any mechanical stress on the right-angle F adapter connector.
- Do not tighten the right-angle F adapter beyond the specified torque.

Failure to follow these instructions can result in equipment damage.

Generally, the central ground point is a tap, a splitter or ground block within 6 m (20 ft) of the RIO processor.

Disconnecting the system from ground will create an unfavorable floating ground condition.

⚠ ⚠ DANGER

HAZARD OF ELECTRIC SHOCK

Do not disconnect the single-point grounding of your cable system.

Failure to follow these instructions will result in death or serious injury.

Installation

Observing Safety Precautions

Before installing the 140 NRP 954 0• fiber optic repeater module, read the warning messages below. Follow them at all times during the installation of the fiber optic repeater.

⚠ DANGER

SEVERE EYE DAMAGE

Do not view the ends of fiber optic cable under magnification while a transmit signal is present on the cable.

Failure to follow these instructions will result in death or serious injury.

NOTICE

INOPERABLE EQUIPMENT

Do not remove the protective coverings from the optical cable port and optical cable tips until immediately fiber cable connection to the cable port.

After removing the protective coverings, never touch exposed parts such as the ferrule.

After connecting the fiber cable, retain the protective coverings for future use.

Do not remove the protective covering from the unused connector.

Failure to follow these instructions can result in equipment damage.

Before Starting

Prior to installing 140 NRP 954 0• fiber optic repeater, network cables must be prepared and installed to the repeater's site with their connectors.

To prepare optic cables:

- Follow the cable manufacturer's recommendations for routing, installing, and testing the cable. Take care when terminating the ends of each fiber optic cable in order to minimize loss of optical signal. Follow the manufacturer's guidelines for installing optical connectors.
- Test the cable for proper attenuation prior to the connection of the fiber optic repeaters. The cable ends should be accessible at each fiber optic installation site. Allow sufficient cable length for a service loop and strain reliefs.
- Label each cable end to facilitate future maintenance.

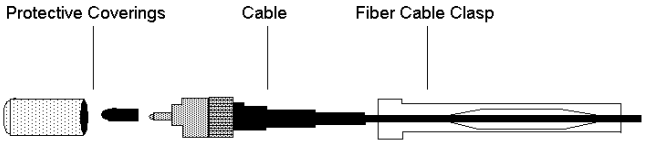
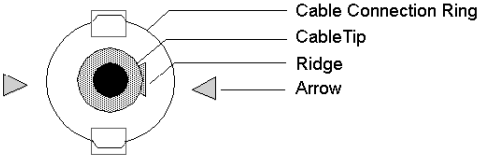
To prepare and install coaxial cables, refer to *Remote I/O Cable System Planning and Installation Guide*.

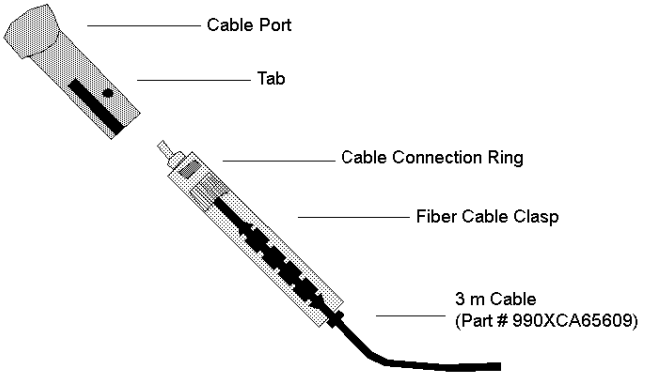
Mounting the 140 NRP 954 0•

Mount the 140 NRP 954 0• fiber optic repeater module in the Quantum backplane observing general installation requirements. For details, refer to chapter *Hardware Installation*.

Installation of the Multimode Fiber Optic Cables

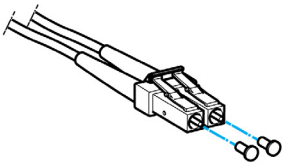
Install the fiber optic cable to the 140 NRP 954 00 module's ST connectors as described in the following table:

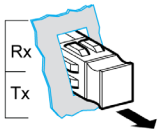
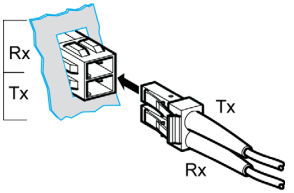
Step	Action
1	Remove the protective plastic coverings from the cable ports and the tips of the cable. Snap one of the fiber cable clasps (shipped with the module) over the cable so that the wider end of the tool is closest to the cable end. 
2	Turn the connection ring so that one of the arrows on the side of the ring lines up with the ridge inside. 

Step	Action
3	**a.** Slide the tool up to the connection ring. **b.** Gripping the cable with the plastic cable clasp, slide the cable end onto the lower cable port. The arrow and the ridge on the connection ring should lineup with the slot on the left of the cable port. **c.** Use the clasp to push the cable over the tab on top of the port. **d.** Turn the cable to the right, so that the tab locks securely **e.** Remove the clasp. **f.** Repeat this process with the remaining strand of cable. 

Installation of the Single-mode Fiber Optic Cables

Install the fiber optic cable to the 140 NRP 954 01C module's LC duplex connectors as described in the following table:

Step	Action
1	Remove the dust plugs from the LC connectors of the fiber optic cable as shown in the following figure:  **NOTE:** Save the dust plugs for future use.
2	Inspect and clean the fiber optic end faces of the LC connectors.

Step	Action
3	Remove the dust plugs from the LC duplex connector as shown in the following figure: 
4	Immediately attach the fiber optic cable to the LC duplex connector of the module as shown in the following figure: 

Applying Power

Before applying power to the backplane, verify that all power connections, electrical cable connections and fiber optic connections are correctly installed for your application.

When the backplane power is applied to the 140 NRP 954 0• fiber optic repeater module, the LED Ready will illuminate on the module LED indicators *(see page 41)*.

Reading the Network Indicators

After applying power to the 140 NRP 954 0• fiber optic repeater, LED indicators *(see page 41)* will illuminate.

The LED ComAct lights when a signal is received at the repeater's electrical port.

Each fiber port LED indicator (FPort1, FPort2) lights when a signal is received at the fiber Rx port.

If a port indicator fails to illuminate, it can indicate a lack of transmitted signal from another network node. Before replacing the 140 NRP 954 0• fiber optic repeater, check the cable connections for a possible incorrect or loose connection. Also check the indicators on other devices on the signal path to see if the signal loss is external to the repeater. For details refer to the chapter Troubleshooting *(see page 69)*.

Configuration with Unity Pro

Validity

The following information are valid for Unity Pro V7.0 or higher.

Module Configuration

When the 140 NRP 954 0• fiber optic repeater module is integrated *(see page 23)* in an I/O station (local or remote), you can match the physical layout of the backplane with Unity Pro configuration. Refer to chapter *Module Configuration* for details on procedure to follow.

If one or more power supply modules is configured, the Unity Pro software displays the power budget of all configured modules (140 NRP 954 0• included when mapped in the I/O station).

NOTE: The 140 NRP 954 0• fiber optic repeater module doesn't require parameter configuration.

Compatibility Rules

Overview

Depending on the PV (Product Version) and SV (Software Version) of the CRA modules, the 140 NRP 954 01C may be incompatible.

The 140 NRP 954 00 is compatible with all versions of CRA modules.

140 NRP 954 01C Compatibility Rules

The following table gives the compatibility rules between the 140 NRP 954 01C and CRA modules:

CRA Module Reference	PV	SV	Compatibility	
			Communication	Remote OS Update via S908 Bus
140 CRA 93• 00	≤08	2.0	Yes	Yes
	09	2.0	No(1)	No(2)
	≥ 10	2.1	Yes	No(2)

PV Product version
SV Software version

(1) An upgrade of the SV to 2.1 makes the module communication compatible.
NOTE: Upgrading the software version of the CRA module from 2.0 to 2.1 for CRA modules PV 09 is mandatory before using 140 NRP 954 01C in the RIO network.

(2) For CRA module with SV ≥2.0, OS update is only possible out of the RIO network.

The 140 CRA 93• 00 firmware upgrade is done through Modbus or Modbus Plus using the Unity Pro OS loader tool. The procedure to follow is described in the *Quantum Operating System Upgrade and Update Procedure*.

Maintenance

4

Overview

This chapter provides troubleshooting and hot swapping informations to maintain the 140 NRP 954 0• fiber optic repeater module.

What Is in This Chapter?

This chapter contains the following topics:

Hot Swapping

Overview

The 140 NRP 954 0• fiber optic repeater module can be removed under power (hot swapped) without damaging modules or the backplane.

NOTE: You need to understand and plan for the consequences of hot-swapping a repeater module. Disconnecting a repeater module will interrupt communication to the connected remote I/Os.

Be sure that you know which remote I/Os are connected to the fiber optic repeater module, and the impact that this disconnection would have on your machine or process before attempting a hot-swap operation.

⚠ WARNING

HOT SWAPPING RESTRICTION

Do not hot swap modules in a Class 1, Division 2 environment.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Hot Swapping Procedure

⚠ WARNING

HAZARD OF ELECTRIC SHOCK

Before hot-swapping make sure that the coaxial cable is securely connected to the protective ground (PE).

Failure to follow these instructions can result in death, serious injury, or equipment damage.

The following table describes how to hot-swap a 140 NRP 954 0• fiber optic repeater module:

Step	Action
1	Disconnect the coaxial cable.
2	Disconnect the fiber optic cables. **NOTE:** Place the protective coverings on the connectors of the fiber optic cables and of the 140 NRP 954 0• fiber optic repeater module.
3	Remove the 140 NRP 954 0• module from the Quantum backplane.
4	Install the new 140 NRP 954 0• module to the free slot of the backplane.
5	Connect all the network cables to the new module.

Troubleshooting

Overview

As a general method, always start investigations by checking the RIO head module transmission propagation through the whole path until reception on each drop. In a second step, connect and check each drop module transmission back to the RIO head. Refer to the chapter *Testing and Maintaining an RIO Network*, for more details.

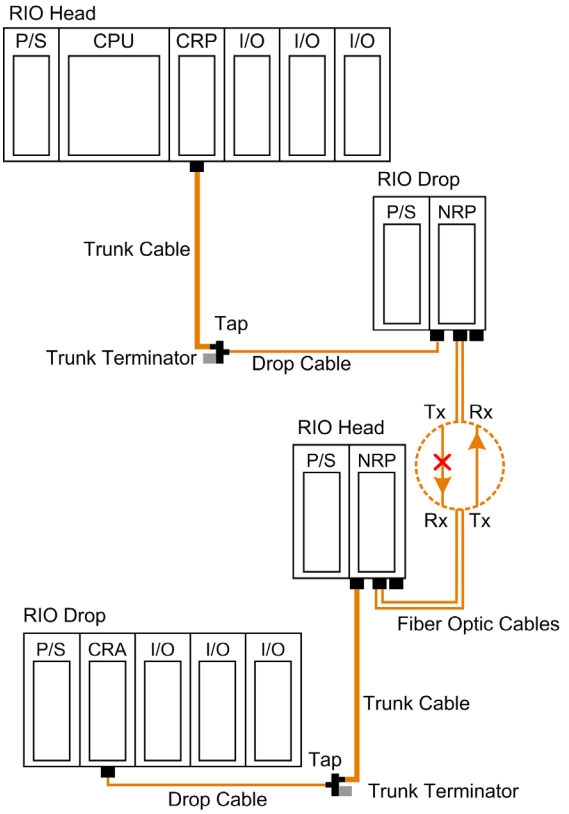
There are well documented procedures for analyzing the wire side characteristics of RIO network application, and it is recommended that they be used as a first line of attack and afterward whenever trouble is suspected.

The troubleshooting tables in this section cover the most likely encountered issues with 140 NRP 954 0• fiber optic repeater module.

Broken Cable Detection and Remedies

Unlike coaxial cable, fiber optic cable contains physically separated transmit and receive lines.

It is possible to loose communications through the receive line while the transmit line remains intact, as depicted here:



A break in the receive line as shown above will deprive the PLC of input data. Under ordinary circumstances, the PLC will continue to drive outputs via the intact transmit line. This could lead to outputs turning ON or OFF due to invalid (INPUT STATE: 0) input data.

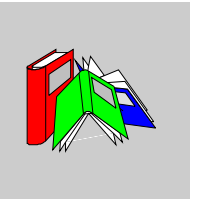
From this fact, it is highly recommended to use a self-healing ring topology, and to monitor the 140 NRP 954 0• diagnostic relay *(see page 26)*.

Troubleshooting Table

Identify the fact in the left columns and then follow the action to take in response in the right column:

Fact	Diagnostic	Action
All LEDs are OFF.	The 140 NRP 954 0• is not powered	Check the power supply module
All LEDs are OFF while other modules on the backplane show normal behavior.	140 NRP 954 0• internal loss of power.	Change 140 NRP 954 0• module
Ready LED is OFF.	The internal logic is not available.	Change 140 NRP 954 0• module
Fault LED is ON and the contact of the diagnostic relay are closed.	The relay is not operational.	Change 140 NRP 954 0• module
Fault LED is OFF and the contact of the diagnostic relay are open.	Fault LED or relay is not operational or diagnostic cable is disconnected.	Check diagnostic relay cable integrity. If ok, change 140 NRP 954 0• module
Contact of the diagnostic relay are open and Error LED is ON	An internal failure has been detected. The module is not operational.	Change 140 NRP 954 0• module
ComAct LED, and both FPort1, FPort2 LEDs are OFF.	The 140 NRP 954 0• doesn't detect any activity, and therefore doesn't transmit anything.	Depending on the function of the 140 NRP 954 0• in RIO network, check where the head communication is supposed to come from. (and checked that the PLC is not in a STOP state)
BrkF LED is ON, Fault LED is ON and the contact of the diagnostic relay are open.	One of the optic fiber reception port doesn't detect activity while the other fiber optic reception port detects or has detected activity.	Check that FPort1 Rx and FPort Rx 2 are connected *(see page 27)*. Check that the ComAct LED and one FPort• LED is ON. Check which FPort• LED is OFF, and check the associated Rx connector and optical fiber integrity.

Glossary



A

attenuation

Signal loss through an electrical circuit or conductor (*see also* **signal loss**).

B

bandwidth

A range of frequencies.

bend radius

The radius of the arc along which a cable may be bent.

bit error rate

The number of bits received in an error divided by the total number of bits received.

braid

A wire mesh used to construct the shield of a coaxial cable.

bus

A single cable connecting multiple ports.

C

cable shield

The outer conductor of a coaxial cable used to protect the signal on the cable from noise.

center conductor

The center wire in a coaxial cable, usually made of copper or copper-clad metal.

characteristic impedance

The ratio of signal voltage to signal current on a transmission line.

coaxial cable

A type of transmission line having a center conductor surrounded by an insulator (a dielectric), then an outer shield.

D

drop

An address on the RIO network. *See also* **node**.

drop cable

The cable that runs between a tap in the trunk cable and the connector to the RIO drop adapter at the drop.

dual cable

An RIO network topology in which two cable systems are run from the head processor in a PLC to two different groups of drop adapter nodes. A dual cable topology requires dual RIO comm ports in the RIO processor node and a single RIO comm port in each drop adapter. *See also* **redundant cable**.

E

earth ground

A connection to earth, usually through structural steel or water pipes.

F

fiber

A thin filament of glass. an optical waveguide consisting of a core and a cladding is capable of carrying information in the form of light.

fiber optics

Light transmission through optical fibers for communications or signaling.

G

graded-index

Fiber design in which the refractive index of the core is lower toward the outside of the fiber core and increases toward the center of the core. It bends the rays inward and allows them to travel faster in the lower index-of-refraction region. This type of fiber provides high bandwidth capabilities.

H

Hot Standby System

A 984 capability in which two identically configured PLCs are connected to the same process via RIO cable systems. One primary PLC controls the process while the other standby constantly monitors the process. If the primary controller fails, the backup controller takes over system control operations.

I

impedance

See **characteristic impedance**.

input module

A device used to connect field inputs. This module mounts into an I/O housing at a drop/channel location.

L

LAN (local area network)

A short-distance data communications network.

M

multimode fiber

An optical waveguide in which light travels down the cable in multiple paths. The light beam is bounced off the cladding as it travels down the core. Typical core/cladding sizes (measured in microns) are 50/125, 62.5/125, and 100/140.

N

network

A system consisting of the cable media components and the communication nodes.

node

An intelligent unit or option on the RIO network, either an RIO processor or a drop adapter.

noise

EMI/RFI generated outside the media by electrical devices and induced on the cable system.

P

point-to-point

A connection established between two specific locations, as between two buildings.

pull strength

The maximum allowable torque that may be used to pull a cable through a conduit or enclosure.

R

redundant cable

An RIO network topology in which two cable systems are run from the RIO processor in a PLC to the same group of drop adapter nodes. A dual cable topology requires dual RIO comm ports in the RIO processor node and in all the adapters. *See also* **dual cable**.

remote I/O drop adapter

A node at each remote drop that connects to the coaxial cable system, processes messages from the remote I/O processor, and updates the I/O at the drop. *See also* **node**.

remote I/O head processor

The master node for the RIO network; it processes commands for the PLC, and it sends messages to/receives messages from the adapter nodes on the network.

repeater

A device that consists of a transmitter and receiver or transceiver, used to amplify a signal to increase signal length.

RG-11

A standard coaxial cable type, providing good shielding and medium to low signal loss.

RG-6

A standard coaxial cable type, providing good shielding and fair signal loss.

S

self terminating F adapter

A device used on a drop cable to provide proper termination in the event that the node is disconnected from the drop cable.

signal loss

The amount of signal lost through media devices. *See also* **attenuation**.

single-mode fiber

Unlike the multimode, single-mode fiber does not take multiple paths. The single light beam is transmitted down the fiber and does not interact with the cladding/core boundary. Typical core/cladding size (measured in microns) is 9/125.

T

tap

A passive device used to isolate a node from the trunk cable. It allows only a portion of the signal to be transmitted through a port on the tap.

terminator

A piece of hardware containing a 75 Ω resistor, used at the ends of the trunk cable, at each node, and at each tap outlet to match the characteristic impedance of the cable. *See also* **characteristic impedance**.

topology

The complete media specification. The topology should be mapped into a log with all installation details for future reference.

trunk cable

The main cable running from the RIO processor upon which taps are installed, permitting the drop adapters to connect to the cable system.

trunk terminator

A precision terminator used at the two ends of the trunk cable. *See also* **terminator**.

W

wavelength

The distance between the same point on adjacent waves.

Index

N

R

T