Installation Instructions

Allen-Bradley

# ControlNet Fiber-optic Ring Repeater Modules

Catalog Numbers 1786-RPFRL/B, 1786-RPFRXL/B



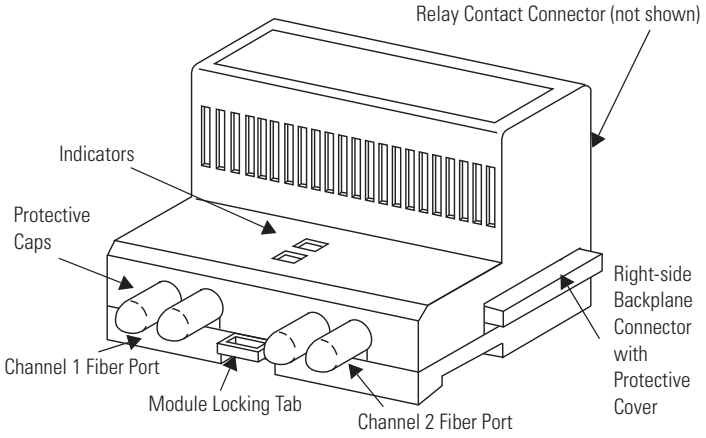
## About the Module

The ControlNet Fiber-optic Ring Repeater module supports fiber media redundancy by using a ring topology. The fiber-optic technology permits long (1786-RPFRL/B module) or very long (1786-RPFRXL/B module) transmission ranges. Both modules provide optimum protection against EMI effects along the transmission link and at the repeaters themselves. The fiber link provides ground isolation between nodes and is less susceptible to noisy environments than traditional copper media.

The 1786-RPFRL/B and 1786-RPFRXL/M modules provide the following:

- Two fiber channels
- Activity status indicators for each fiber channel
- Relay contact connector for communication and system status

**Figure 1- Module Components**




Both sides of the module contain a backplane connector. 42546

## About Fiber Topology

The 1786-RPFRL/B or 1786-RPFRXL/B long or extra-long modules can be used to create a redundant optical link between segments. When used in a ring topology, a single media failure between any two repeater modules in a ring will not impact the communication link.

The repeaters detect the failure of an optical link. When a failure occurs, the affected channel port status indicator will be one of the following:

- Red, indicating a faulty link
- Flashing green/off, indicating no network activity is present

Refer to Interpret the Status Indicators on page 28 for more information.

In addition, a relay contact connector on the 1786-RPFRL/B and 1786-RPFRXL/B modules indicates a remote faulty link. See page 32 for more information on the relay contact connector.

We recommend that you install the duplex optical cables of the two optical channels along different routes. For more information on cabling, refer to the ControlNet Fiber Media Planning and Installation Guide, publication CNET-IN001.

The fiber repeater consists of the following:

• A 1786-RPA/B repeater adapter

• Up to two 1786-RPFRL/B or 1786-RPFRXL/B long or extra-long fiber repeater modules

• Up to four 1786-RPCD copper fiber repeater modules

• Up to four 1786-RPFS or 1786-RPFM short- or medium-distance fiber repeater modules

The maximum number of repeater modules (in any combination) you can use in a configuration is dependent on the current draw of each repeater module. Total current draw supplied by the 1786-RPA/B repeater adapter cannot exceed 1.6 A @ 5V DC.

In addition to using the fiber repeater in a ring topology, you can do the following:

- Extend the total length of your segment
- Create a point-to-point or star configuration (multiple directions from one point)
- Provide electrical isolation and immunity to interference
- Use in hazardous areas

The number of fiber repeaters and cable length total limit depends on your network topology.

## Example Topology Application

See page 10 for an example topology.

For more information on topology application rules in relation to fiber rings, refer to the ControlNet Fiber Media Planning and Installation Guide, publication CNET-IN001.

| | |
|---|---|
| **IMPORTANT** | You cannot have media redundancy if you have a closed loop ring installation anywhere in the network. You may use the 1786-RPFRL/B, 1786-RPFRXL/B, 1786-RPFM, or 1786-RPFS modules in a linear fiber topology.<br>Do not mix fiber repeater modules to achieve a ring topology and 1786-RPFM modules to achieve a redundant media topology in one configuration.<br>For additional topology configurations, refer to Allowable Configurations When Using Repeaters in a Ring Topology on ControlNet, Knowledgebase Technical Note ID 32215. |

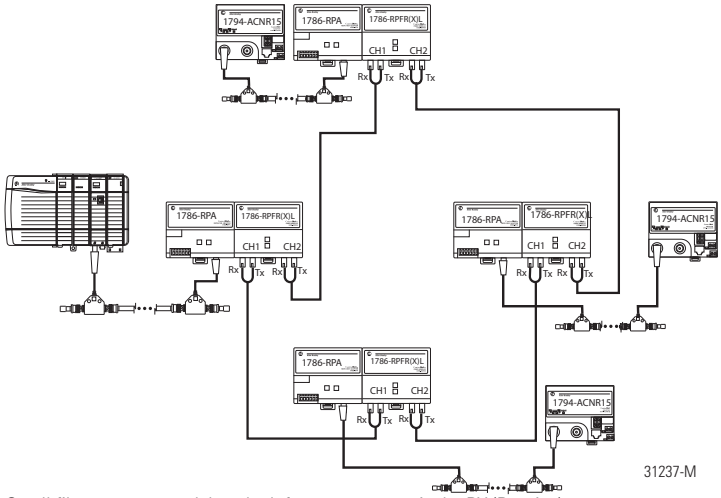
## *Fiber-optic Ring Topology*

Use this configuration for long distances. A fiber-optic ring may contain as many as 20 member modules. These member modules (four shown in Figure 2) include the following:

- 1786-RPA/B repeater adapter module
- 1786-RPFRL/B long-distance ring repeater module
- 1786-RPFRXL/B extra long-distance ring repeater module

**TIP** You cannot exceed 20 repeater modules in a series. If a ring is broken, whether accidentally or on purpose for testing, the configuration then becomes linear and the number of repeaters depends on where the ring is broken. Most likely you will have as many repeaters as in the original ring, such as the four shown in Figure 2.

**Figure 2 - Fiber Ring Topology Example**




On all fiber repeater modules, the leftmost connector is the RX (Receive) port; the rightmost connector is the TX (Transmit) port.

**ATTENTION:** Be certain that the adapter and repeater modules are secured together with DIN rail anchors. Failure to do so may result in the loss of communication and/or cause damage to the modules.

The total number of modules that can be attached to the 1786-RPA/B repeater adapter cannot exceed four or the total power consumption of the modules cannot exceed 1.6 A @ 5V DC, whichever comes first. The 1786-RPFRL/B and 1786-RPFRXL/B modules require 570 mA each, therefore you can attach only two of these modules to a 1786-RPA/B repeater module.

If you exceed the module or power limit, you may cause damage to the modules and repeater adapter.

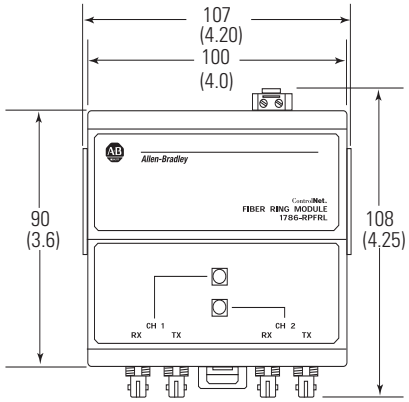
## Mount the Fiber Modules

This section explains how to mount the module.

**TIP** Horizontal mounting is preferred. Vertical mounting is allowed. We recommend that the 1786-RPA/B module be mounted at the top if vertical mounting is chosen.

**ATTENTION:** This product is grounded through the DIN rail to chassis ground. Use zinc plated yellow-chromate steel DIN rail to assure proper grounding. The use of other DIN rail materials (for example, aluminum or plastic) that can corrode, oxidize, or are poor conductors, can result in improper or intermittent grounding. Secure DIN rail to mounting surface approximately every 200 mm (7.8 in.) and use end-anchors appropriately.

**Figure 3 - Mounting Dimensions**




Dimensions are in mm (in.). 31532-M

Horizontal mounting requirements are determined by using the following formula:

RPA/B width + (4.2 inches x number of RPFR(X)L + 2 inches

For more information, see the ControlNet Modular Repeater Adapter Installation Instructions, publication 1786-IN013.

| **IMPORTANT** | Maintain adequate separation from other equipment to guarantee that ambient temperature is within the operating range of this module. You must follow applicable separation codes for safe operation. |
|---|---|

Do these steps to mount a module.

1. Position the module on a 35 x 7.5 mm (1.38 x 0.30 in.) DIN rail, Allen- Bradley part number 199- DR1; 46277- 3; EN 50022).

**ATTENTION:** Do not discard the end cap. Use this end cap to cover the exposed interconnections on the last repeater module on the DIN rail. Failure to do so could result in equipment damage or injury from electric shock.

## Choose Fiber-optic Cable for the Module

The type of fiber cable you choose to use depends on the network environment. Consult your installation professional to determine the best type of cable to use for your environmental conditions. Refer to the ControlNet Fiber Media Planning and Installation Guide, publication CNET-IN001, for details.

### Understand the Maximum Optical Power Budget

This table shows the maximum optical power budget available for different cable types. Note that the 1786-RPFRL/B module cannot be used with single-mode fiber.

| Module | Cable Type | Optical Power Budget | Termination Type |
|---|---|---|---|
| 1786-RPFRL/B | 62.5/125 µm, multimode, 1300 nm, graded index | 15 dB | ST connectors, plastic or ceramic; no metal connectors |
| 1786-RPFRXL/B | 62.5/125µm, multimode, 1300 nm, graded index | 10.5 dB | |
| | 9/125 µm, single mode, 1300 nm, graded index | | |

See page 20 for formulas to determine your optical power budget.

The sample formulas in the example illustrate how you can determine the total loss for fiber-optic cables in your system configuration. The values we use in the formulas are typical: yours may vary, depending on your application.

### EXAMPLE Determining total loss for fiber-optic cables

The total loss of the fiber-optic cable between two modules must not exceed the optical power budget. The total loss is the sum of each connector loss plus the loss of the fiber plus the loss associated with the splices in the system, if any. The total loss can be determined as follows:

**Total loss = [(loss per connector) x (the number of connectors)] + [(loss per km of fiber) x (km of fiber)] + [(other losses)]**

For example, with 2 connectors, each having 0.3 dB of loss, 10 km of multimode fiber with a loss of 1 dB/km, and no splices, the total loss is 10.6 dB. See the following formula:

**Total loss = [(0.3 dB x 2) + (1 dB/km x 10 km)]**

**Total loss = 10.6 dB**

This fiber-optic cable is acceptable for use between two 1786-RPFRL/B modules because the total loss is less than the optical power budget of 15 dB. However, this cable could not be used with the 1786-RPFRXL/B module because the total loss exceeds the optical power budget of 10.5 dB.

## Determine Maximum Network Length

The quality of the fiber cable determines the maximum distance between modules in a networked system. The delay in the system (described in the following table) determines the maximum length you can achieve with your network.

The worst-case delay (between any nodes) must be less than 121 µs. This table lists worst-case delays for physical layer components.

**Table 1 -Worst-case Delay**

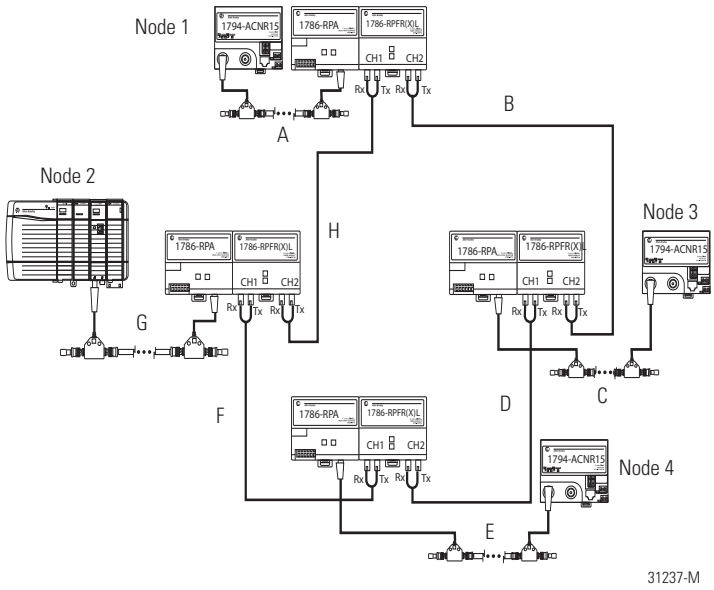
| Component | Delay |
|---|---|
| Coaxial cable | 4.17 ns/m |
| Fiber | 5.01 ns/m |
| 1786-RPA/B module | 901 ns |
| 1786-RPFM module | 153 ns |
| 1786-RPFS module | 94 ns |
| 1786-RPCD module | 100 ns |
| 1786-RPFRL/B<br>1786-RPFRXL/B modules | 100 ns |

**TIP** When determining the worst-case delay for your system, consider how many components you want to use. You can use as many as twenty fiber repeater modules in a ring or series as long as you do not exceed the maximum network length, as determined by the worst-case delay.

The maximum cable distance (that is, the longest route between any two adjacent or non-adjacent nodes) is limited by the ControlNet protocol to 20 km or less. Refer to Determine Maximum Network Length on page 21 for more information.

See Figure 4 on page 22 and the example on page 23 to understand how to determine the worst-case delay for your system.

**Figure 4 -Determine Worst-case Delay**




| Segment | Length |
|---|---|
| A | 200 m |
| B | 2 km |
| C | 10 m |
| D | 1 km |
| E | 20 m |
| F | 5 km |
| G | 20 m |
| H | 200 m |

**EXAMPLE Determining worst-case delay**

To determine the worst-case delay in a ring topology, first disregard the shortest fiber segment in the system.

In Figure 4 on page 22, the shortest segment is segment H, with the 200 m fiber. Remove segment H. You will see that the worst-case delay is now between nodes 1 and 2.

You must account for worst-case delays introduced by physical media when setting up the media configuration screen in RSNetWorx software. If too many components with too great a delay are entered into RSNetWorx for ControlNet software, the delay becomes too great for the bandwidth RSNetWorx software has available. This affects system performance and limits network length. If you do not account for all media components in the worst-case delay path, erratic network operation will result. Refer to the documentation supplied with RSNetWorx for ControlNet software for more information.

This example shows you in a simple way how to account for system delays. In this example, you enter the total length of all media components between nodes 1 and 2 into RSNetWorx for ControlNet software. The totals of the components between nodes 1 and 2 are as follows, as specified in Table 1 on page 21:

**Coax media delay:** 200 m (A) + 20 m (G) = 220 m x 4.17 ns

Fiber media delay: 2 km (B) + 1 km (D) + 5 km (F) = 8 km x 5.01 ns

**1786-RPA/B module delay:** 1 (at node 1) + 1 (at node 3) + 1 (at node 4) +1 (at node 2) = 4 x 901 ns

**1786-RPFRL/B or 1786-RPFRXL/B module:** 1 (at node 1) + 1 (at node 3) + 1 (at node 4) +1 (at node 2) = 4 x 100 ns

**In summary:**

**Worst-case delay** = 220 x 4.17 + 8000 x 5.01 + 4 (901) + 4 (100) = 45 µs

This delay is acceptable because 45 µs is less than the maximum allowable delay of 121 µs.

# Specifications

### Technical Specifications - 1786-RPFRL/B, 1786-RPFRXL/B

| Attribute | 1786-RPFRL/B, 1786-RPFRXL/B |
|---|---|
| All supply voltages or voltage ranges | Input: 570 mA @ 5V DC, max<br>Relay: 900 mA @ 30V DC, max resistive |
| Backplane power requirements | 2.8 W (3.02 W, max)(1) |
| Communication rate | 5 Mbps |
| Mounting orientation | Any mounting orientation |
| Relay contact connector voltage | 30V DC, max |
| Relay contact connector current consumption | 1 mA, min; 900 mA, max |
| Relay contact load type | Resistive only |
| Isolation voltage | 50V (continuous), Basic insulation type, Relay contacts to system |
| Optical power budget | See the optical power budget table on page 19 |
| Wire size | 0.25... 2.5 $mm^2$ (22...14 AWG) solid or stranded copper wire rated at 75 °C (167 °F ), or greater, 1.2 mm (3/64 in.) insulation max for relay connections |
| Wiring category | 2 - on signal ports(2) |
| Enclosure type rating | None (open-style) |
| North American temp code | T5 |

(1) Operational power is provided from the 1786-RPA/B module. For application within the U.S., supply the 1786-RPA/B module from a power supply that is appropriately certified Class 2 per the definition in the National Electrical Code, ANSI/NFPA 70, Article 725. For applications outside the U.S., supply the 1786-RPA/B module from a safety extra low voltage (SELV) power supply. SELV output is built with appropriate isolation to withstand single fault conditions. The output cannot exceed 30V rms, 42.4V peak, or 60V DC under fault conditions.

(2) Use this Conductor Category information for planning conductor routing. Refer to Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

### Environmental Specifications - 1786-RPFRL/B, 1786-RPFRXL/B

| Attribute | 1786-RPFRL/B, 1786-RPFRXL/B |
|---|---|
| Temperature, operating<br><br>IEC 60068-2-1 (Test Ad, Operating Cold),<br>IEC 60068-2-2 (Test Bd, Operating Dry Heat),<br>IEC 60068-2-14 (Test Nb, Operating Thermal Shock) | 0…60 °C (32…140 °F) |
| Temperature, surrounding air, max | 60 °C (140 °F) |
| Temperature, nonoperating<br><br>IEC 60068-2-1 (Test Ab, Unpackaged Nonoperating Cold),<br>IEC 60068-2-2 (Test Bb, Unpackaged Nonoperating Dry Heat),<br>IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock) | -40…85 °C (-40…185 °F) |
| Relative humidity<br><br>IEC 60068-2-30 (Test Db, Unpackaged Damp Heat) | 5...95% noncondensing |
| Vibration<br><br>IEC60068-2-6 (Test Fc, Operating) | 5 g @ 10...500 Hz |
| Shock, operating<br><br>IEC60068-2-27 (Test Ea, Unpackaged Shock) | 30 g |
| Shock, nonoperating<br><br>IEC60068-2-27 (Test Ea, Unpackaged Shock) | 50 g |
| Emissions<br><br>CISPR 11 | Group 1, Class A |
| ESD immunity<br><br>IEC 61000-4-2 | 6 kV contact discharges<br>8 kV air discharges |

**Environmental Specifications - 1786-RPFRL/B, 1786-RPFRXL/B**

| Attribute | 1786-RPFRL/B, 1786-RPFRXL/B |
|---|---|
| Radiated RF immunity<br><br>IEC 61000-4-3 | 10V/m with 1 kHz sine-wave 80% AM from 80…2000 MHz<br>10V/m with 200 Hz 50% Pulse 100% AM at 900 and 1890 MHz<br>1V/m with 1 kHz sine-wave 80% AM from 2000…2700 MHz |
| EFT/B immunity<br><br>IEC 61000-4-4 | ±4 kV at 5 kHz on signal ports |
| Surge transient immunity<br><br>IEC 61000-4-5 | ±1 kV line-line (DM) and ±2 kV line-earth (CM) on signal ports |
| Conducted RF Immunity<br><br>IEC 61000-4-6 | 10V rms with 1 kHz sine-wave 80% AM from 150 kHz…80 MHz |

### Certifications(1) - 1786-RPFRL/B, 1786-RPFRXL/B

| Certification(2) | 1786-RPFRL/B, 1786-RPFRXL/B |
|---|---|
| c-UL-us(3) | UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E194810. |
| CE(4) | European Union 2004/108/EC EMC Directive, compliant with:<br>• EN 61326-1; Meas./Control/Lab., Industrial Requirements<br>• EN 61000-6-2; Industrial Immunity<br>• EN 61000-6-4; Industrial Emissions<br>• EN 61131-2; Programmable Controllers (Clause 8, Zone A & B) |
| C-Tick | Australian Radiocommunications Act, compliant with:<br>• AS/NZS CISPR 11; Industrial Emissions |

(1) When product is marked.

(2) See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

(3) To comply with UL restrictions, the relay connection must be powered from a source compliant with Class 2 or Limited Voltage/Current.

(4) To comply with the CE Low Voltage Directive (LVD), the relay connection must be powered from a source compliant with safety extra low voltage (SELV) or protected extra low voltage (PELV).