

ControlNet Fiber Repeater

User Manual

A-CFR

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Revision 1.1



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Revision History

Revision	Date	Comment
1.0	6 August 2024	Initial document
1.1	8 September 2025	Added Propagation Delay, and Notes on Redundancy

1. PREFACE

1.1. INTRODUCTION TO THE CONTROLNET FIBER REPEATER

This manual describes the installation, operation, and diagnostics of the Aparian ControlNet Fiber Repeater module (A-CFR).

A pair of A-CFR modules can be used to physically extend a ControlNet network by up to 3km using standard industrial multi-mode fiber.

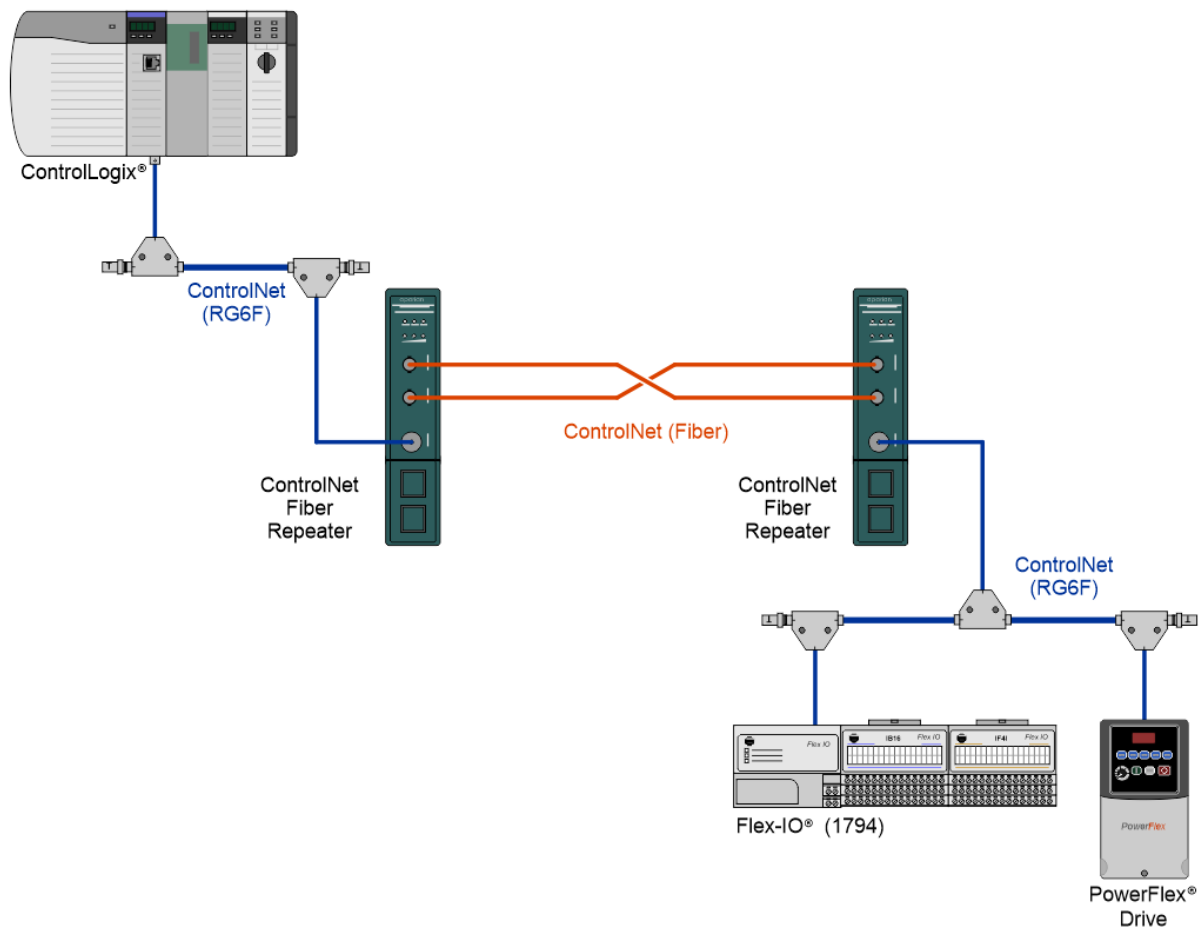


Figure 1.1 – ControlNet Fiber Repeater Example

1.2. FEATURES

- Extend ControlNet up to 3 km (1.86 miles).
- Can be duplicated for Redundant ControlNet applications.
- Supports common industrial fiber cables:
 - OM1 - 62.5/125 μm
 - OM2 - 50/125 μm
- Wide operating voltage: 10 – 32 VDC.
- Small form factor – DIN rail mounted.

1.3. ARCHITECTURE

The ControlNet Fiber Repeater can be used in both non-redundant and redundant ControlNet applications.

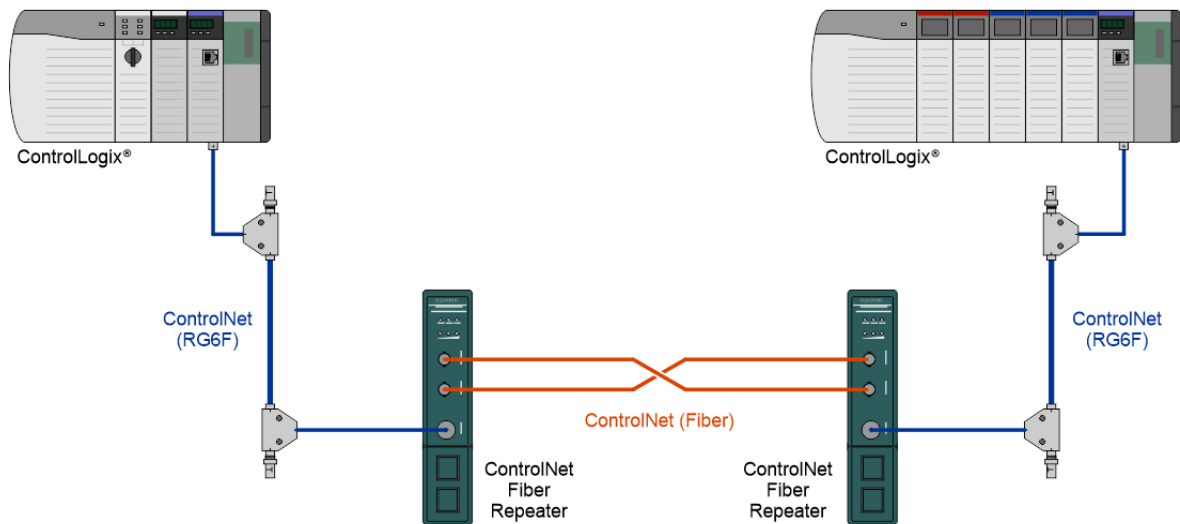


Figure 1.2 – Non-Redundant ControlNet Media

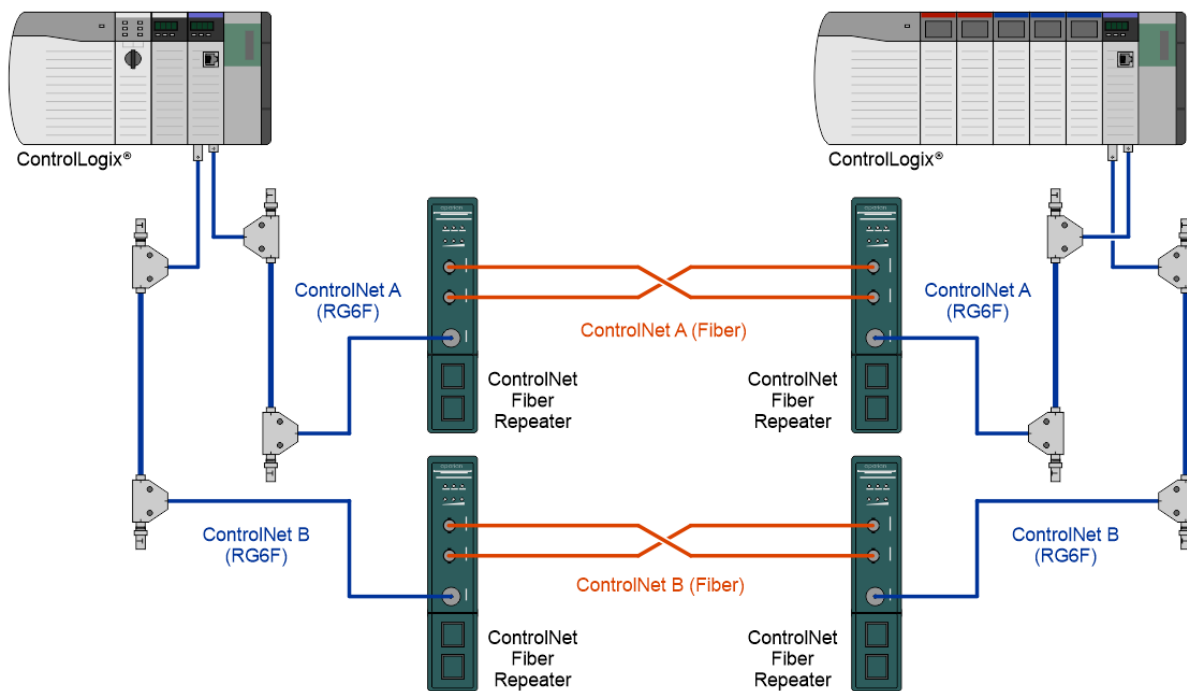


Figure 1.3. – Redundant ControlNet Media

1.4. ADDITIONAL INFORMATION

The following documents contain additional information that can assist the user with the module installation and operation.

Resource	Link
Slate Installation	http://www.aparian.com/software/slate
ControlNet Router User Manual ControlNet Router Datasheet Example Code & UDTs	http://www.aparian.com/products/controlnetrouter
ControlNet	http://www.odva.org
ControlNet Cabling	ControlNet Coax Media Planning and Installation Guide https://literature.rockwellautomation.com/idc/groups/literature/documents/in/cnet-in002_-en-p.pdf

Table 1.1. - Additional Information

1.5. SUPPORT

Technical support is provided via the Web (in the form of user manuals, FAQ, datasheets etc.) to assist with installation, operation, and diagnostics.

For additional support the user can use either of the following:

Resource	Link
Contact Us web link	https://aparian.com/controlnet-fiber-repeater
Support email	support@aparian.com

Table 1.2. – Support Details

2. INSTALLATION

2.1. MODULE LAYOUT

The module has one 3-way power connector at the bottom of the enclosure as shown in the figure below.

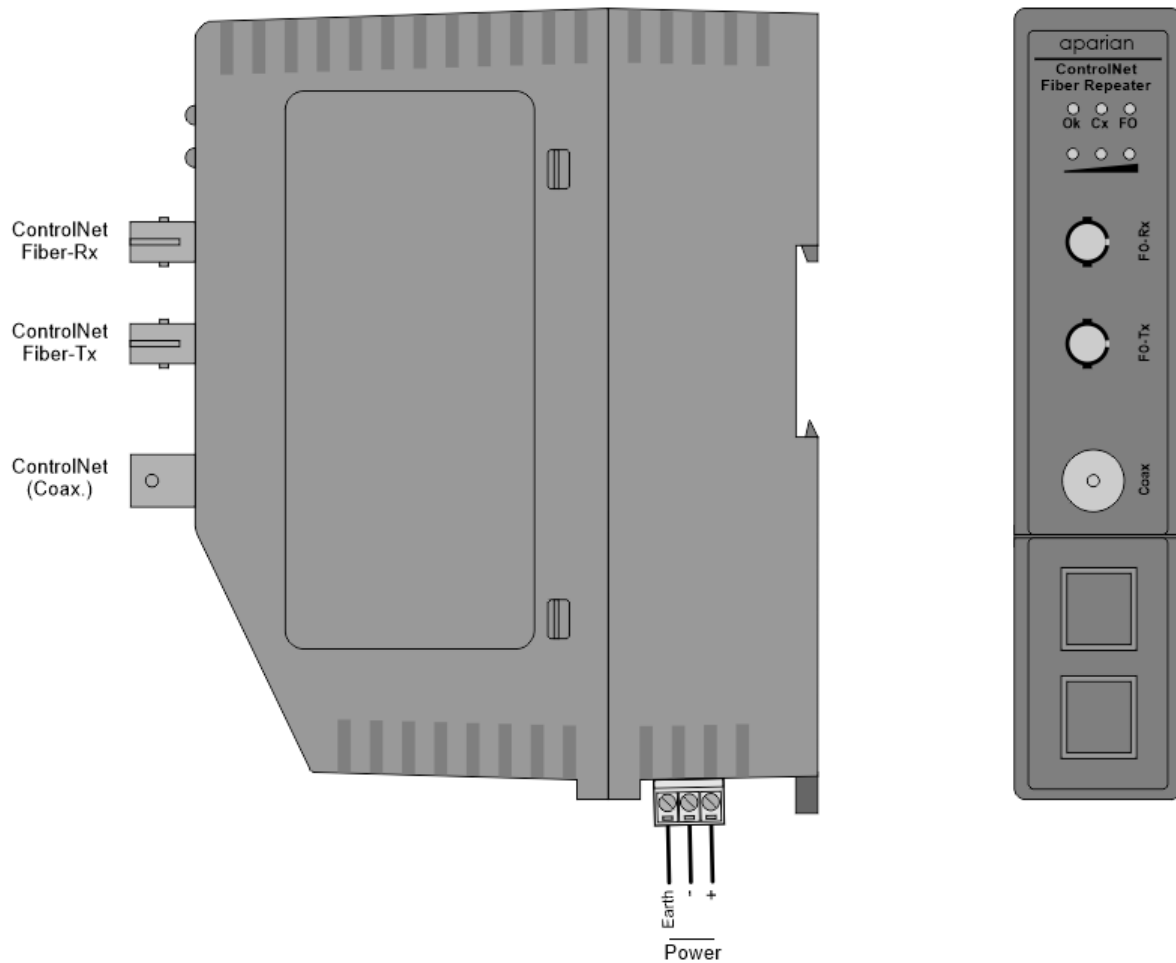


Figure 2.1. – ControlNet Fiber Repeater side and front view

There is one ControlNet BNC connector in the front of the module for the ControlNet (coaxial) copper connection.

There are two ControlNet fiber ports (ST) on the front of the module, for fiber Transmit (Tx) and Receive (Rx) respectively.

The module provides six diagnostic LEDs on the front of the module. These LEDs are used to provide information regarding the module system operation, the ControlNet port statuses and the ControlNet fiber receive strength and activity.

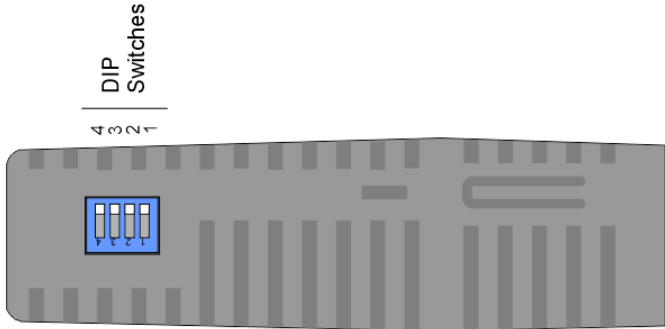


Figure 2.2 – ControlNet Router top view

The module provides four DIP switches at the top of the enclosure as shown in the top view figure above.

DIP Switch	Description															
DIP Switch 1 / 2	Fiber Transmitter Attenuation Used to reduce the transmitted optical power. <table><tr><th>Sw 2</th><th>Sw 1</th><th>Description</th></tr><tr><td>Off</td><td>Off</td><td>Full Power</td></tr><tr><td>Off</td><td>On</td><td>Reduce Power by 2.5 dB</td></tr><tr><td>On</td><td>Off</td><td>Reduce Power by 2.5 dB</td></tr><tr><td>On</td><td>On</td><td>Reduce Power by 8.3 dB</td></tr></table> Note: In most applications it is recommended to set the transmitter to full power. The attenuation may be temporarily selected to test the optical margin available.	Sw 2	Sw 1	Description	Off	Off	Full Power	Off	On	Reduce Power by 2.5 dB	On	Off	Reduce Power by 2.5 dB	On	On	Reduce Power by 8.3 dB
Sw 2	Sw 1	Description														
Off	Off	Full Power														
Off	On	Reduce Power by 2.5 dB														
On	Off	Reduce Power by 2.5 dB														
On	On	Reduce Power by 8.3 dB														
DIP Switch 3	Reserved															
DIP Switch 4	Tx Test Mode Used to force the module into Tx-Test Mode. When this switch is on, the fiber optic Transmitter is switched on permanently and no longer modulating ControlNet data. This mode can be used to measure the received optical signal strength across a cable using an external optical power meter. Note: Once this mode has been invoked the ControlNet link will be interrupted. Note: Once the test mode has been de-activated, both this module and its fiber partner will need to be power-cycled.															

Table 2.1. - DIP Switch Settings

2.2. MODULE MOUNTING



NOTE: This module is an open-type device and is meant to be installed in an enclosure suitable for the environment such that the equipment is only accessible with the use of a tool.

The module provides a DIN rail clip to mount onto a 35mm DIN rail.

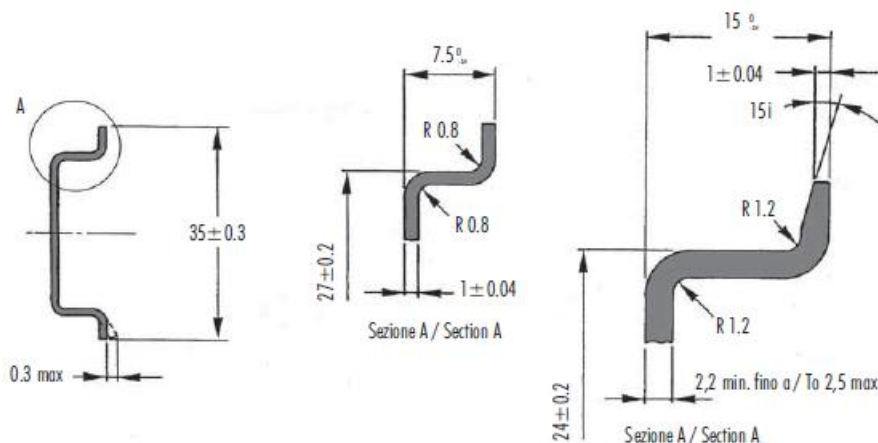


Figure 2.3 - DIN rail specification

The DIN rail clip is mounted on the bottom of the module at the back as shown in the figure below. Use a flat screwdriver to pull the clip downward. This will enable the user to mount the module onto the DIN rail. Once the module is mounted onto the DIN rail the clip must be pushed upwards to lock the module onto the DIN rail.

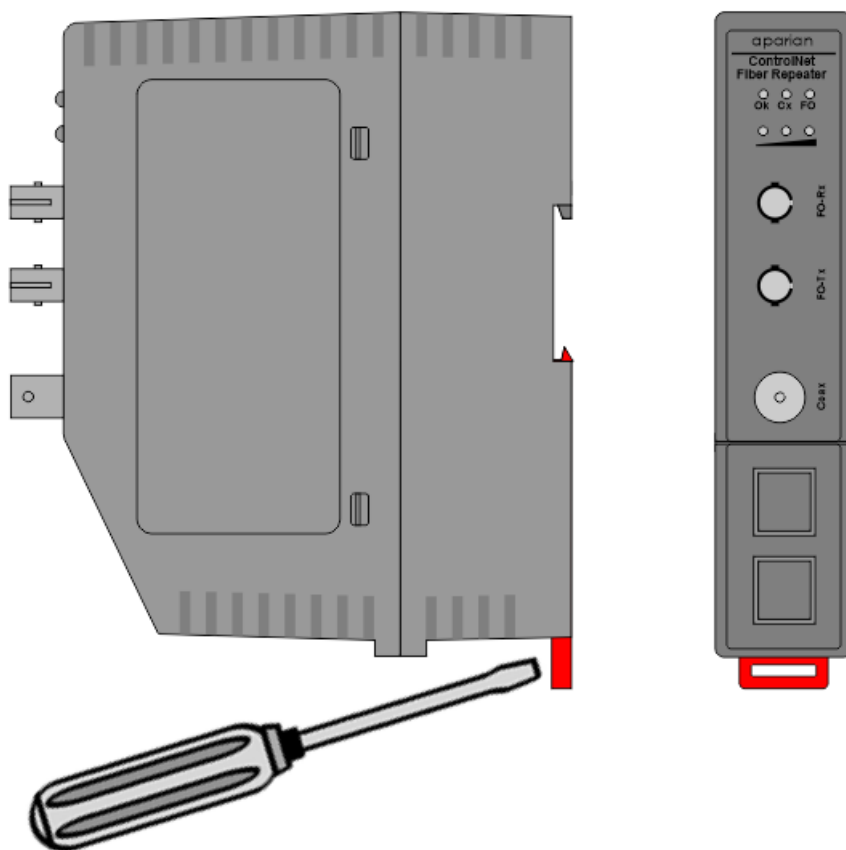


Figure 2.4 - DIN rail mouting

2.3. POWER

A 3-way power connector is used to connect Power+, Power– (GND), and earth. The module requires an input voltage of 10 – 32Vdc. **Refer** to the technical specifications section in this document.



Figure 2.5 - Power connector

2.4. CONTROLNET

ControlNet uses a coax media system. The ControlNet coax. connector should be wired according to industry standards. **Refer** to the additional information section in this document for further details.

2.5. FIBER PORTS

The ControlNet fiber ports access the 820 nm transmitter and receiver respectively. Both connectors are ST-type and can be connected to either 50/125 μm , or 62.5/125 μm fiber cables.

The fiber ports of one ControlNet Fiber Repeater must be connected to another ControlNet Fiber Repeater such that the FO-Tx port of the one is connected to the FO-Rx port of the other, and vice versa.

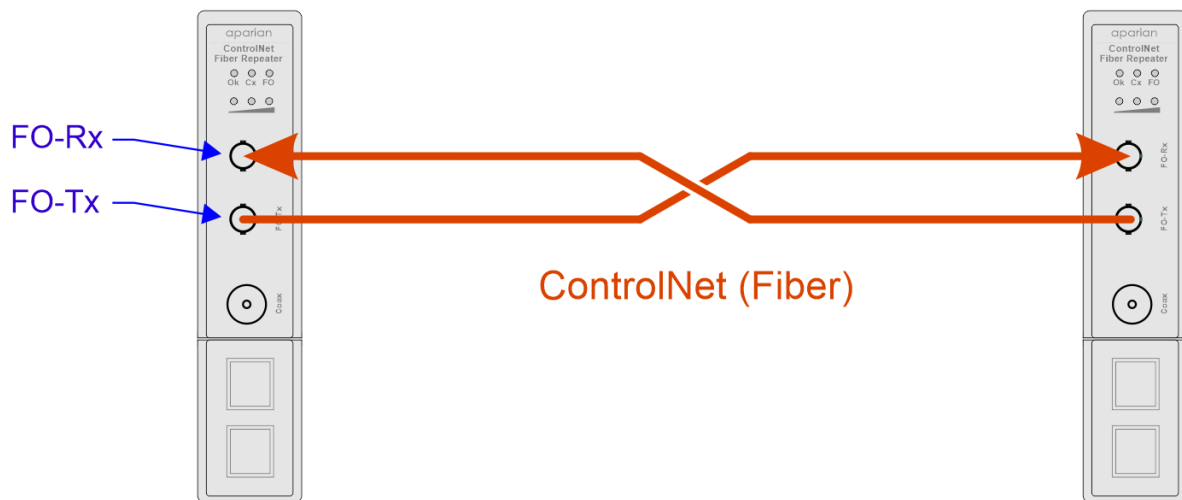


Figure 2.6 – Fiber connection



NOTE: This ControlNet Fiber Repeater's fiber ports must be connected to another ControlNet Fiber Repeater. The module **cannot** be connected to another type of fiber repeater (e.g. 1786-RPFM, 1786-RPFS, 1786-RPFL etc.).

2.6. FIBER CABLE

A pair of ControlNet Fiber Repeaters are connected by means of a pair of multi-mode fibers, either:

- OM1 - 62.5/125 μm
- OM2 - 50/125 μm

The total optical loss of the fiber link must be calculated and confirmed to be within the optical budget of the module. This total optical loss includes the loss associated with the length of fiber, all splices and all connectors in between.

Specification	OM1 - 62.5/125 μm	OM2 - 50/125 μm
Optical Budget (A-CFR)	13.0 dB	9.0 dB
Fiber Transmission Loss (typical)	3.2 dB/km	2.7 dB/km
Connector Loss (typical) per connector	0.7 dB	0.7 dB
Fiber Solace Loss (typical) per splice	0.3 dB	0.3 dB

Table 2.2 – Optical Budget Data

2.6.1. EXAMPLE

A fiber installation makes use of OM1 multi-mode cable to connect two PLC cabinets. Each cabinet has a fiber patch panel, and ST-ST patch fibers are used to connect the patch panel to the ControlNet Fiber Repeater (A-CFR). The total length of fiber cable is 6240 ft (1.9 km) and contains two splices (one at each patch panel).

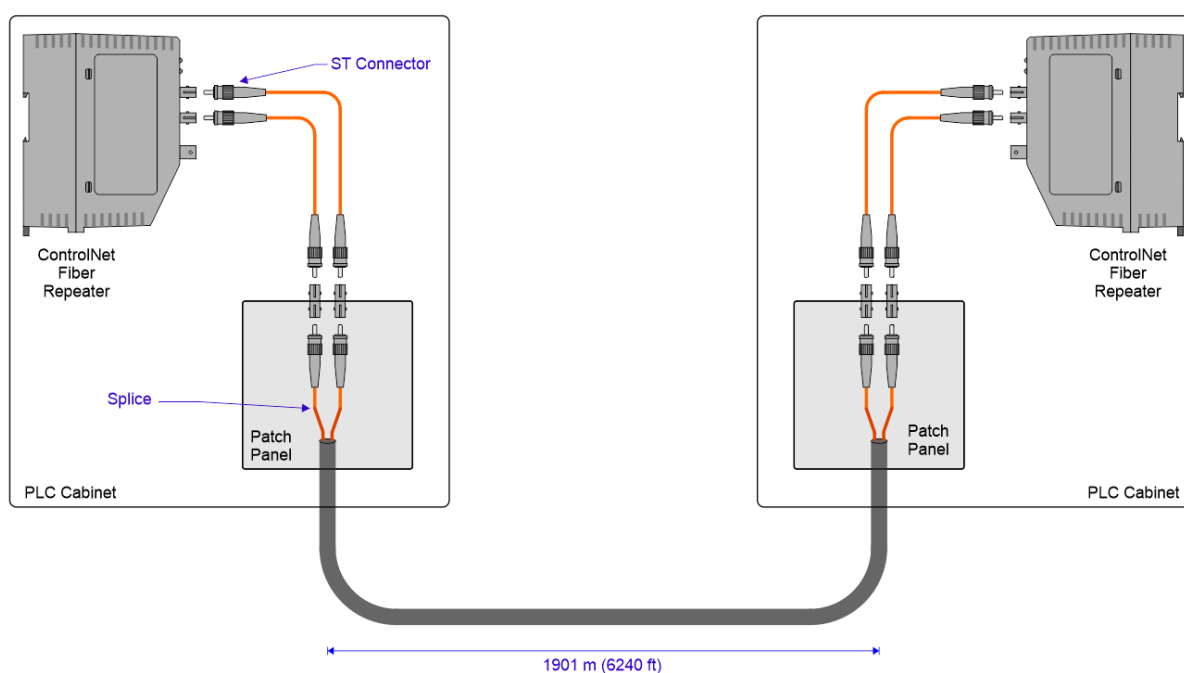


Figure 2.7 – Fiber layout example

The total optical loss is calculated as follows:

Description	Unit Loss	Quantity	Total (dB)
Transmission Loss	3.2 dB/km	1.9	6.1
Connector Loss	0.7 dB	6	4.2
Splice Loss	0.3 dB	2	0.6

Total Estimated Loss	10.9
Optical Budget (A-CFR)	13.0
Available Optical Margin	2.1

Table 2.3 – Optical Budget Example

The total estimated optical loss of this installation is **10.9 dB**, which is less than the optical budget of 13.0 dB by a margin of 2.1 dB.

Depending on the quality of the installation (splices etc.) and cables used, the actual total loss may be different from the theoretical estimate. It is therefore recommended to have a margin of at least 1-2 dB.

2.7. CONTROLNET REDUNDANCY

When using ControlNet Redundancy, a pair of ControlNet Fiber Repeaters is required for each fiber link, as indicated in the diagram below.

All the standard ControlNet redundant media planning rules must be followed, as described in the Rockwell Automation document “ControlNet Coax Media Planning and Installation Guide” (see reference in section 1.4.).

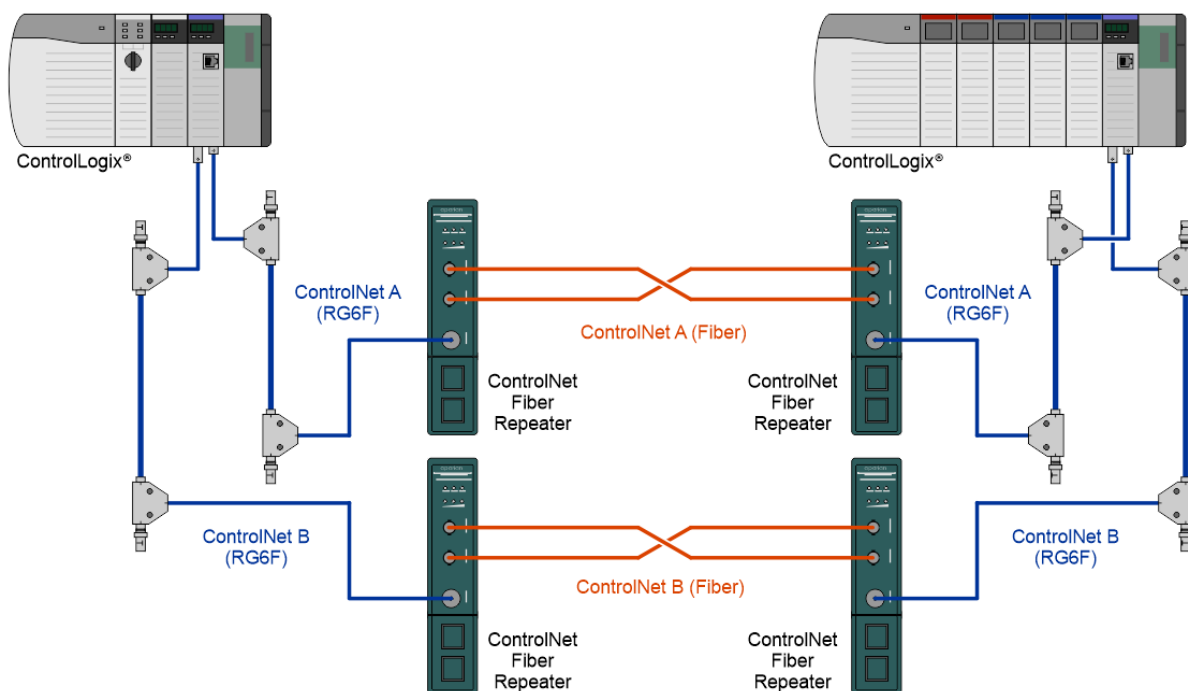


Figure 2.8. – Redundant ControlNet Media



NOTE: When using redundant ControlNet, the difference in total propagation delay between the entire trunk of network A and the entire trunk of network B must not exceed 1.6 μ s. These delays include the delay introduced by the coax cable, fiber cable and all the repeaters.

By using the same type of repeaters, and same lengths of coax and fiber cable, for A and B, the resulting delay difference will be zero.



NOTE: Using different types of repeaters for the A and B trunks may result in the total delay difference exceeding the acceptable level, resulting in network errors and instabilities.

Typical propagation delays are tabulated below:

Description	Quantity	Delay (μ s)
A-CFR	1 unit	0.822
1786-RPA	1 unit	0.901
1786-RPFM	1 unit	0.153
RG6F Coax Cable	1000 m	4.170
Fiber Cable	1000 m	5.010

Table 2.4 – Typical Propagation Delays

3. OPERATION

A pair of ControlNet Fiber Repeaters provides a transparent link between two ControlNet copper (coax.) segments. Although transparent, it is important that when scheduling a ControlNet network (using either RSNetworkx for ControlNet or Aparian Slate,) that the media is correctly configured. This is required to ensure the resulting media delays are incorporated in the scheduling calculations.

3.1. SCHEDULING WITH APARIAN SLATE

When using Aparian Slate to schedule the network, add the pair of ControlNet Fiber Repeaters (A-CFR) and the length of fiber cable, in the media section as shown below:

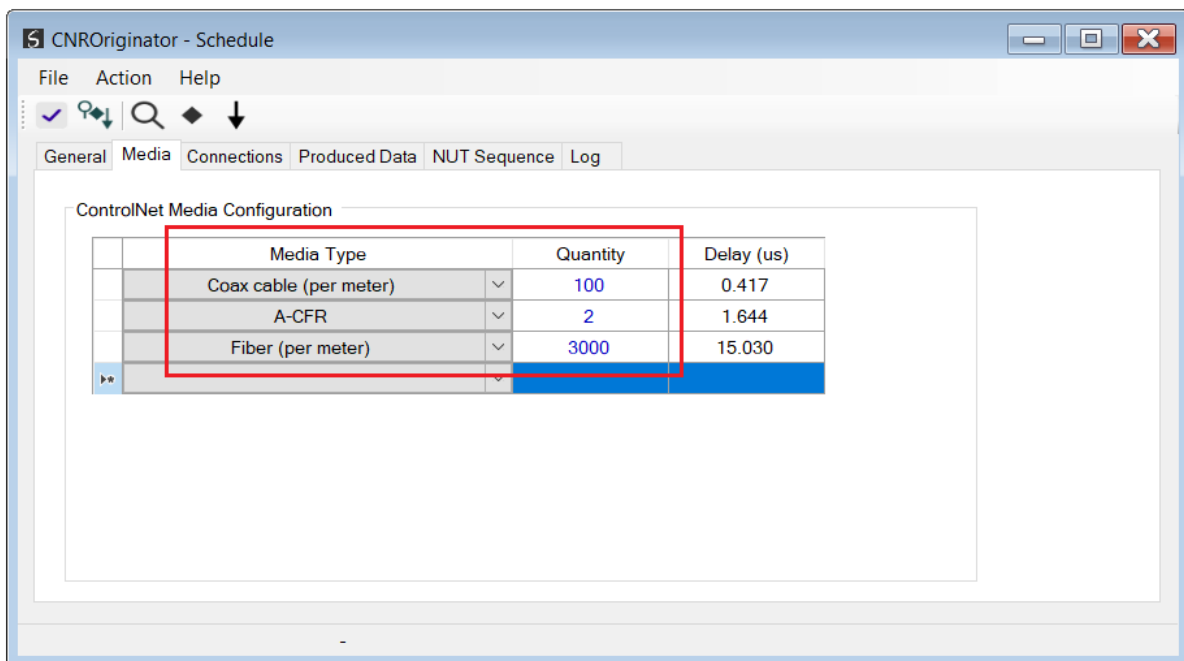


Figure 3.1 – Slate Scheduling - Media configuration

3.2. SCHEDULING WITH RSNETWORKX FOR CONTROLNET

When using Rockwell Automation's RSNetworkx for ControlNet to schedule the network, the pair of ControlNet Fiber Repeaters (A-CFR) can be emulated by adding a pair of 1786-RPA and a pair of 1786-RPFM as below:

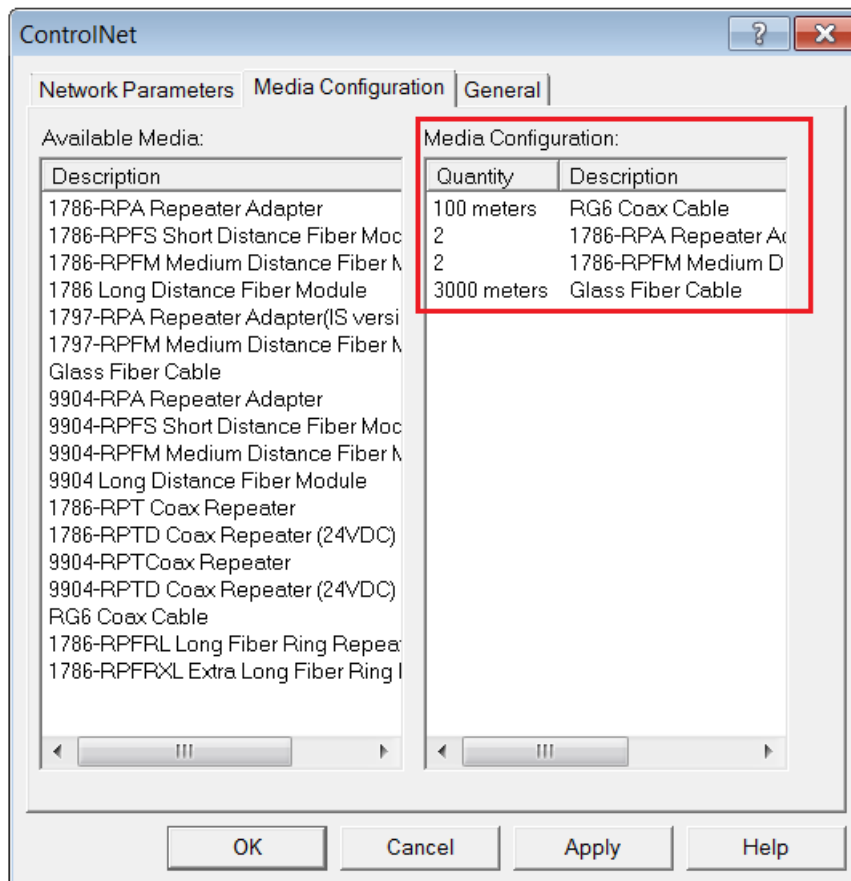


Figure 3.2 – RSNetworkx for ControlNet Scheduling - Media configuration

4. DIAGNOSTICS

4.1. LEDS

The module provides six LEDs for diagnostics purposes as shown in the front view figure below. A description of each LED is given in the table below.

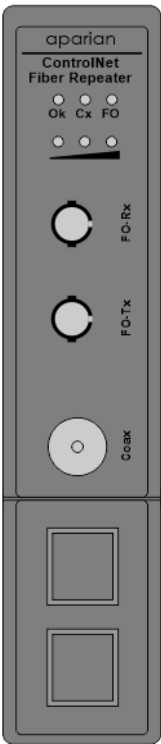


Figure 4.1 – ControlNet Fiber Repeater front view

LED	Description
Ok	Power Indication Solid Green - The module is powered up correctly.
Cx	The status of the ControlNet copper (Coax.) link. Note: When the Cx and FO LEDs are flashing together, then use the ControlNet Combined Channel LED State table below. Flashing Red-Green: Bad network configuration Flashing Red-Off: Cable fault or lonely. Flashing Green-Off: Temporary network errors. Solid Green: Channel Ok

FO	The status of the ControlNet Fiber link. Note: When the Cx and FO LEDs are flashing together, then use the ControlNet Combined Channel LED State table below. Flashing Red-Green: Bad network configuration Flashing Red-Off: Cable fault or lonely. Flashing Green-Off: Temporary network errors. Solid Green: Channel Ok
	The lower 3 LEDs provide an indication of the activity and received optical signal strength. These LEDs may flash when the ControlNet equipment is powering up, but once the link is established at least 2 of the 3 LEDs should be solid green.

Table 4.1 - Module LED operation

The following table indicates the state of the module:

Mode / State	LED Pattern	"Cx" LED		"FO" LED	
		Flash Phase 0	Flash Phase 1	Flash Phase 0	Flash Phase 1
Reset	Both Off	Off		Off	
Module Fault	Both Red	Red		Red	
Self Test	Railroad Red/Green	Red	Green	Green	Red
Duplicate Node	Railroad Red/Off	Red	Off	Off	Red
Normal	Solid Green	Green		Green	

Table 4.2 – ControlNet Combined Channel LED States

5. TECHNICAL SPECIFICATIONS

5.1. DIMENSIONS

Below are the enclosure dimensions as well as the required DIN rail dimensions. All dimensions are in millimetres.

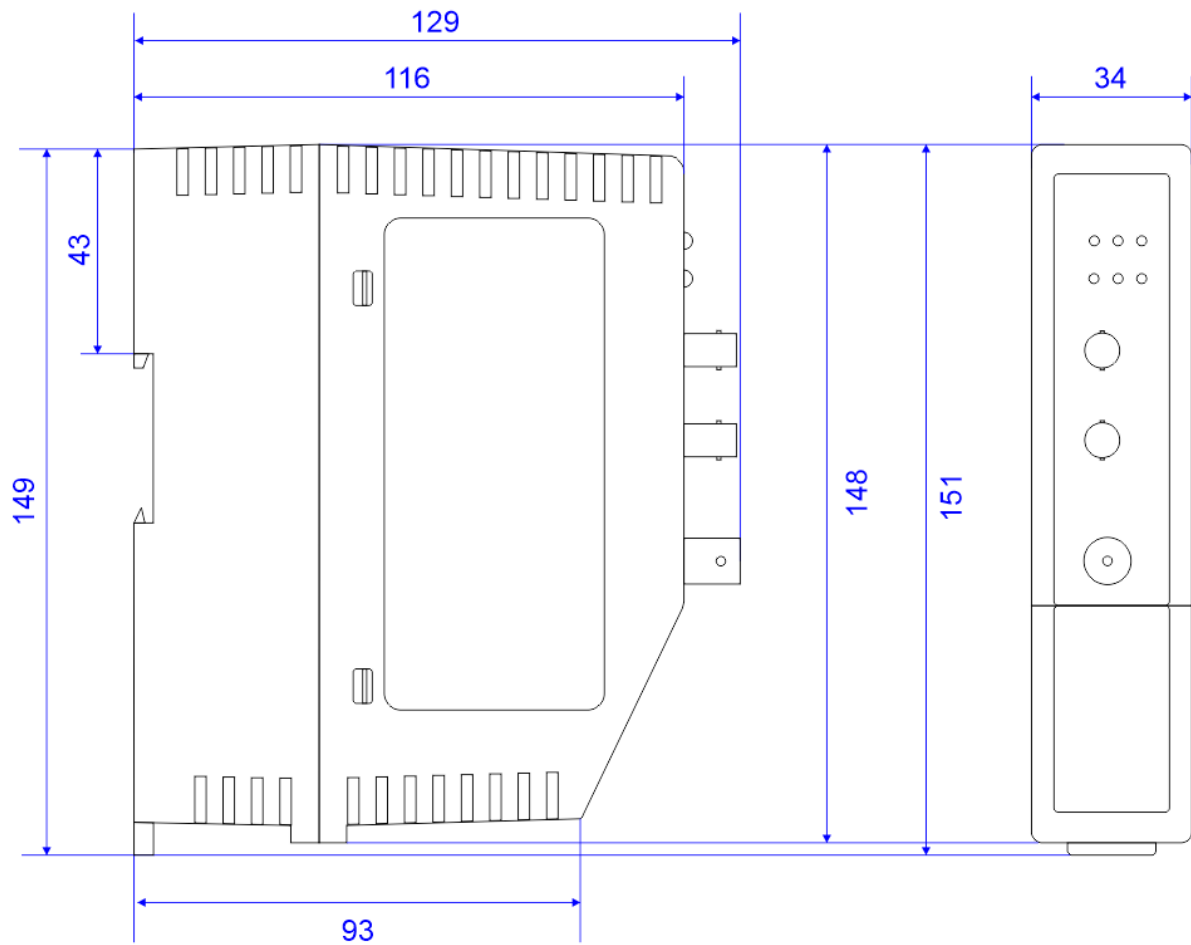


Figure 5.1 – ControlNet Fiber Repeater enclosure dimensions

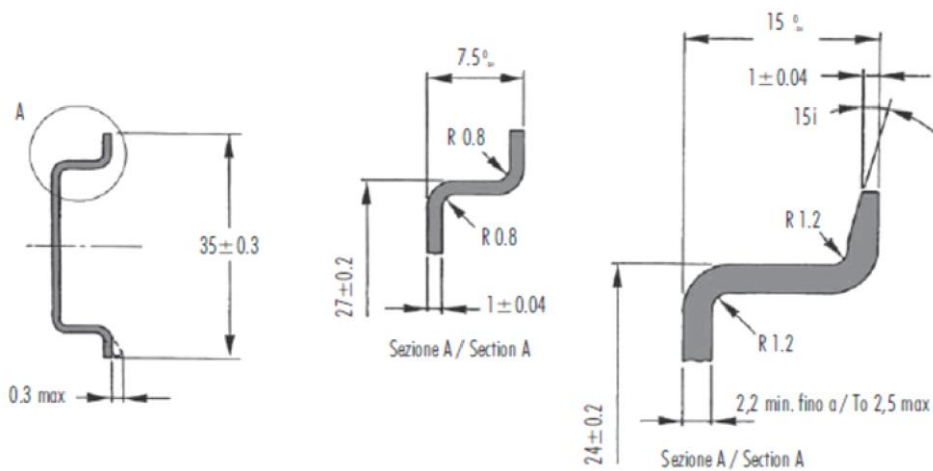


Figure 5.2 - Required DIN Rail dimensions

5.2. ELECTRICAL

Specification	Rating
Power requirements	Input: 10 – 32V DC, (70 mA @ 24 VDC)
Power consumption	1.7 W (max)
Connector	3-way terminal
Conductors	24 – 18 AWG
Enclosure rating	IP20, NEMA/UL Open Type
Temperature	0 – 70 °C
Earth connection	Yes, terminal based
Emissions	IEC61000-6-4
ESD Immunity	EN 61000-4-2
Radiated RF Immunity	IEC 61000-4-3
EFT/B Immunity	EFT: IEC 61000-4-4
Surge Immunity	Surge: IEC 61000-4-5
Conducted RF Immunity	IEC 61000-4-6

Table 5.1 - Electrical specification

5.3. CONTROLNET (COPPER)

Specification	Rating
Connectors	1 x BNC connectors (ControlNet A and B).
Recommended Cable	Quad shield RG-6F coaxial cable

Table 5.2 – ControlNet Copper specification

5.4. CONTROLNET (FIBER)

Specification	Rating
Connectors	2 x ST-Type connectors (FO-Tx and FO-Rx).
Wavelength	820 nm
Transmission Mode	Multi-mode
Supported Fiber Cables	OM1 - 62.5/125 μ m OM2 - 50/125 μ m
Maximum Distance	3000 m
Transmit Power (at 1m of fiber)	OM1 - 62.5/125 μ m -9 dBm (max.) -12 dBm (typ.) -17 dBm (min.) OM2 - 50/125 μ m -12.8 dBm (max.) -15.8 dBm (typ.) -20 dBm (min.)
Optical Budget	13.0 dB (for OM1 - 62.5/125 μ m) 9.0 dB (for OM2 - 50/125 μ m)
Propagation Delay	0.822 μ s (per module) 1.644 μ s (per module pair)

Table 5.3 – ControlNet Fiber specification

5.5. CERTIFICATIONS

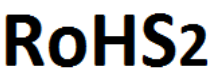
Certification	Mark
CE Mark	
RoHS2 Compliant	
UKCA	

Table 5.4 – Certifications

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