



# Fiber Distributed Data Interface

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## Network Configuration Guidelines

Order Number:

EK-DFDDI-CG-001



# Fiber Distributed Data Interface

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## Network Configuration Guidelines

November 1991

This manual describes the guidelines for connecting devices to an FDDI network. It also includes network configuration examples.

Supersession/Update Information:  
This is a new manual.

**digital**™

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## Preface

This manual provides the rules for connecting Fiber Distributed Data Interface (FDDI) devices to the network. This manual also contains examples of FDDI network configurations built on Digital's implementation of the EIA/TIA 568 wiring standard for commercial buildings.

### Intended Audience

This manual is for network system managers, network planners, installers, and others who set up, manage, and troubleshoot FDDI networks and network devices.

### Document Structure

This manual contains three chapters and an appendix:

- Chapter 1 Provides rules for connecting FDDI devices to the network.
- Chapter 2 Provides FDDI network configuration examples.
- Chapter 3 Lists FDDI and cable specifications.
- Appendix A Lists related documents.

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## FDDI Network Connection Rules

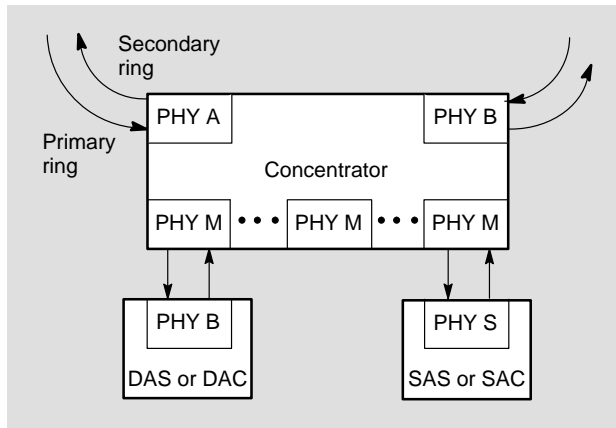
The FDDI standards specify four physical port (PHY port) types: A, B, M, and S.

### 1.1 PHY Port Connection Rules

Figure 1–1, a simplified diagram of a concentrator, shows the various PHY ports. FDDI defines the PHY ports as follows:

- **PHY A**—Connects to the incoming primary ring and the outgoing secondary ring of the FDDI dual ring. This port is part of a dual attachment station (DAS) or a dual attachment concentrator (DAC). This port also connects to PHY M of a concentrator as the backup path in a dual homing topology.
- **PHY B**—Connects to the outgoing primary ring and the incoming secondary ring of the FDDI dual ring. This port is part of a DAS or a DAC. This port also connects to PHY M of a concentrator as the primary path in a dual homing topology.
- **PHY M**—Connects a concentrator to a single attachment station (SAS), DAS, or another concentrator. This port is implemented only in the concentrator.
- **PHY S**—Connects a SAS to a PHY M of a concentrator. PHY S also connects to a DAS or another SAS, but these configurations are not always recommended.

**Figure 1–1: PHY-Port Types**



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The FDDI standards specify connection rules to prevent illegal topologies. Connections between stations have the status of in use or not in use. When a cable is connected, the system decides whether to use the cable in the token path. Figure 1–2 shows the ring-connection rules for Digital devices. **This Node** is the reference point for all connection decisions.

**Figure 1–2: FDDI Connection Rules Matrix**

		This Node				
		PHY port	A	B	M	S
Other Node	A	No	Rule 1	Yes	Yes	
	B	Rule 2	No	Yes	Yes	
	M	Rule 3	Yes Note 1	No	Yes	
	S	Yes	Yes	Yes	Yes Note 3	

Yes = Accepts this connection.  
No = Does not accept this connection.

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Rule 1: PHY B of **This Node** accepts connection to PHY A of **Other Node** if:

- PHY A of **This Node** is not connected, or
- PHY A of **This Node** is connected to PHY B or PHY S of another node.

Rule 2: PHY A of **This Node** accepts connection to PHY B of **Other Node** if:

- PHY B of **This Node** is not connected, or
- PHY B of **This Node** is connected to PHY A or PHY S of another node.

See also Note 2.

Rule 3: PHY A of **This Node** accepts the connection to PHY M of **Other Node** if:

- PHY B of **This Node** is not connected, or
- PHY B of **This Node** is connected to PHY A or PHY S of another node.

See also Note 2.

**Note 1:** The following conditions apply for a backup tree connection (dual homing).

The connection of PHY B of **This Node** to PHY M of **Other Node** always supersedes the connection of PHY A of **This Node** to PHY M of another node.

Any connection between PHY A of **This Node** and a PHY M or PHY B of another node is disconnected when PHY B of **This Node** connects to PHY M of **Other Node**.

If the connection breaks between PHY B of **This Node** and PHY M of **Other Node**, the system reestablishes the connection between PHY A of **This Node** and PHY M of another node.

**Note 2:** Tree connections come before dual ring connections when only one of two connections may be accepted.

The connection of PHY A or B of **This Node** to PHY M of **Other Node** always supersedes the connection of the remaining PHY (A or B) of **This Node** to PHY A or PHY B of another node.

The system disconnects the connection between the remaining PHY (A or B) of **This Node** and PHY A or PHY B of another node when PHY A or PHY B of **This Node** connects to PHY M of **Other Node**.

**Note 3:** The shielded twisted-pair and ThinWire PMD specifications support only connections from PHY M to PHY S. The specifications do not support connections from PHY S to PHY S.

## 1.2 FDDI Station Connection Guidelines

Use the following guidelines when connecting a SAS or DAS concentrator, bridge, bridge/router or adapter into an FDDI network.

Distance requirements:

- Maximum distance between FDDI stations must not exceed:
  - 2 km (1.2 mi) for ANSI multimode
  - 1 km (0.62 mi) for low-power multimode
  - 40 km (24.8 mi) for single-mode
  - 100 m (330 ft) for single segment point-to-point ThinWire and shielded twisted-pair links.

Distances include cables connected between the patch panel and the device. However, the maximum distance for ThinWire is reduced when patch cables are added.

- Total length of the network must not exceed 200 km (124.2 mi), regardless of media type. This distance must include the length of the secondary ring, if you have implemented a dual ring.

Attenuation:

- Maximum attenuation between an FDDI port and its neighbor is:
  - 11 dB for ANSI multimode.
  - 7 dB for low-power multimode.
  - 22 dB for single-mode connections. Minimum attenuation for single-mode is 12 dB.
  - 11/5 dB @ 62.5 MHz for ThinWire.
  - 12 dB @ 62.5 MHz for shielded twisted-pair.

Number of stations and connections:

- Maximum number of stations in an FDDI dual ring is 500 (1000 Physical layer entities). Digital recommends at most 100 stations in a dual ring or dual ring of trees. A station can have one Physical layer entity (SAS), two Physical layer entities (DAS), or multiple Physical layer entities (concentrator).
- Maximum number of Physical layer entities that can connect to the ring limits both the number of stations in an FDDI network (dual ring of trees and dual ring) and the maximum number of concentrator sublevels in a tree structure.

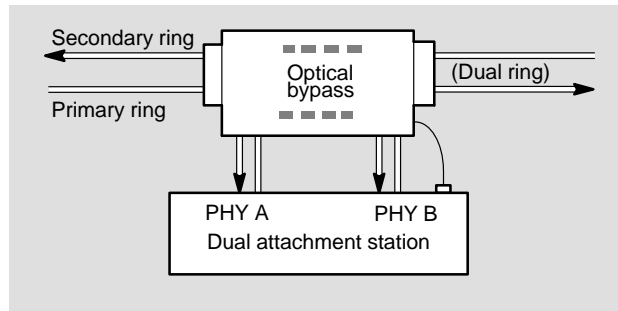
Bridges and adapters:

- SAS bridges or bridge/routers should connect to a PHY M port on an FDDI concentrator to work in an FDDI ring. You can connect DAS bridges or bridge/routers directly to the dual ring or dual home them through PHY M ports on two concentrators.
- The extended LAN can support up to seven bridges between stations.
- SAS adapters should connect to a concentrator PHY M port to work in an FDDI ring. In a standalone concentrator configuration, you can connect an adapter PHY S port to a concentrator PHY A or PHY B port. (Digital does not recommend this configuration.)

### 1.3 Optical Bypass Relay

Figure 1–3 shows an optical bypass relay which, can maintain connectivity of the FDDI ring if there is no power or if something is wrong in a node. The bypass relay allows the light to bypass the optical transmitter and receiver in the faulty node.

**Figure 1–3: Installed Optical Bypass Relay**



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Use of optical bypass relays may cause the maximum allowable distance or maximum loss between stations to become greater than the system allows. When operating in bypass mode, optical bypass relays serially link two cableplant segments and adds loss.

Each sequential relay adds another cableplant segment. A loss is attributed to the segment and to the addition of the relay. This limits the number of serially connected relays in the ring.

The total loss of the serially linked cableplant must not exceed 11 dB. The total length of the serially linked cableplant must not exceed 2 km (1.2 mi). See section 3.2 for additional information.

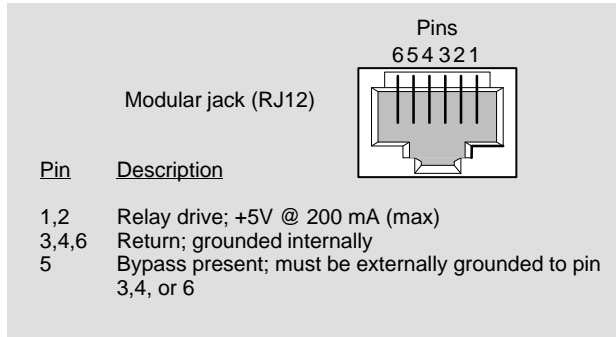
Other considerations when using optical bypass relays include:

- Bypass relays do not amplify or restore the bit stream.
- Bypass relays can be less than reliable because they are mechanical devices.

- Bypass relay technology provides for only a few consecutively bypassed stations. The exact number depends on the configuration and the station. In a building, this number ranges from zero to three.

Refer to the optical bypass connector signal information in Figure 1–4 when selecting optical bypass devices.

**Figure 1–4: Optical Bypass Connector Signals**



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## FDDI Network Configurations

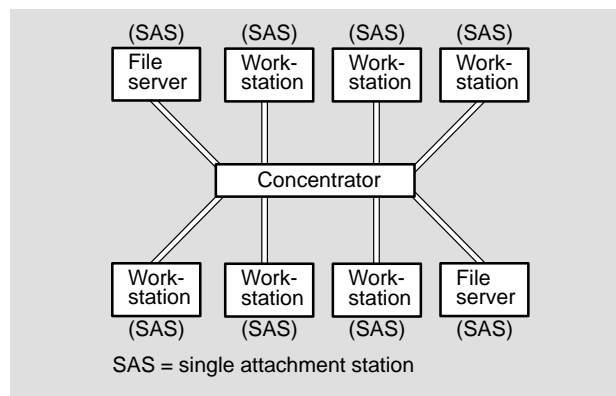
The EIA/TIA 568 wiring standard for commercial buildings provides an infrastructure for FDDI networks. This chapter contains examples of FDDI network configurations built on Digital's implementation of that wiring standard.

These configurations allow the use of star wiring, which can use existing structured cabling.

### 2.1 Standalone Configurations Using Concentrators

Figure 2-1 shows a concentrator installed in a standalone workgroup. While SAS devices are preferred for this configuration, the stations can be either SAS or DAS devices. This configuration is useful for compute-intensive applications shared by a limited number of users in a small geographical area, or where security is paramount. This configuration can have up to 12 connections through fiber optic cable, or up to 18 connections through ThinWire or shielded twisted-pair cable.

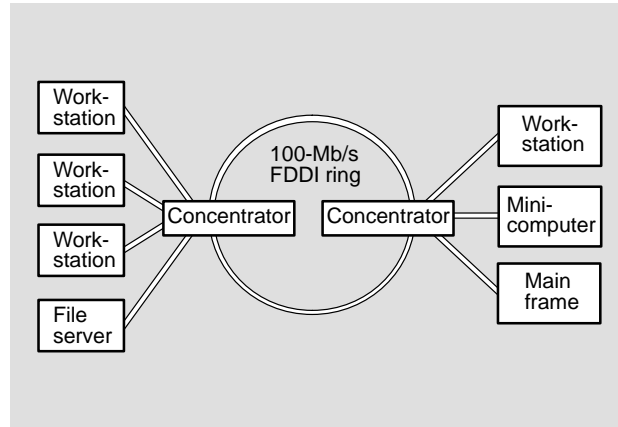
**Figure 2-1: Standalone Workgroup Installation**



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Figure 2-2 shows a dedicated network on a dual ring. The attached workstations, file server, minicomputer, and mainframe are SAS devices. This configuration serves the same purpose as the standalone configuration and extends the geographical area.

**Figure 2-2: Dedicated Network in a Dual Ring Installation**



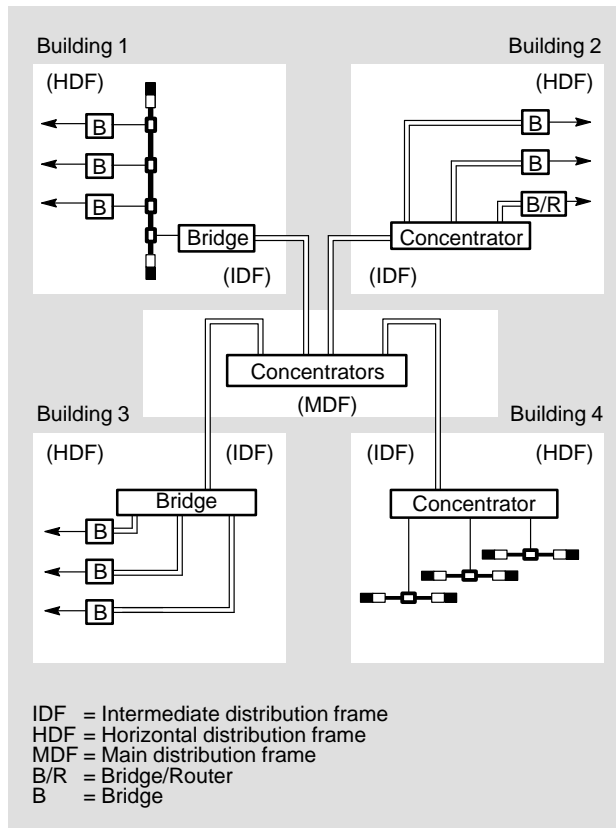
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## 2.2 Tree Configurations Using Concentrators and Bridges

Use tree configurations when wiring large groups of user devices together. Wire concentrators and bridges (single-port or multiport) in a star topology with one or more concentrators serving as the root of the tree.

Figure 2-3 shows a tree of concentrators with bridges and a bridge/router installed in a campus configuration wired with Digital's implementation of the EIA/TIA 568 wiring standard.

**Figure 2-3: Tree of Concentrators in a Campus**

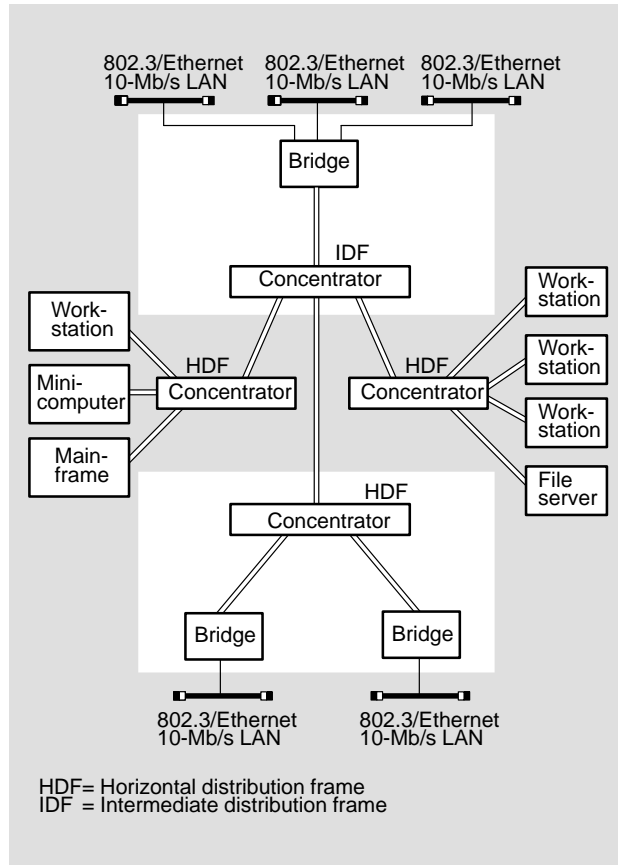


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Figure 2-4 shows a tree of concentrators installed in a building with multiple horizontal distribution frames (HDFs).

**Figure 2-4: Tree of Concentrators in a Building**



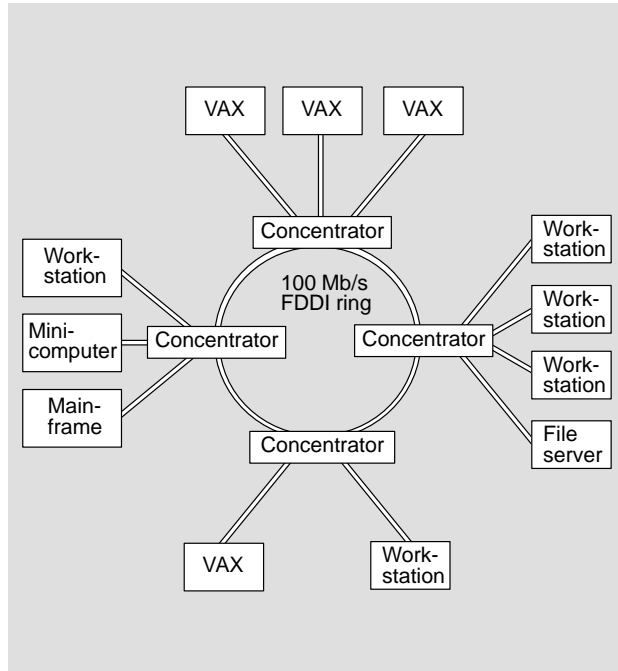
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### 2.3 Dual Ring Configuration

A dual ring of concentrators allows multiple devices to be attached to the dual ring through the concentrators.

Figure 2-5 shows a dual ring of concentrators installed in a building. The concentrators can be located in the MDF or IDF of a building.

**Figure 2-5: Dual Ring of Concentrators Installed in a Building**

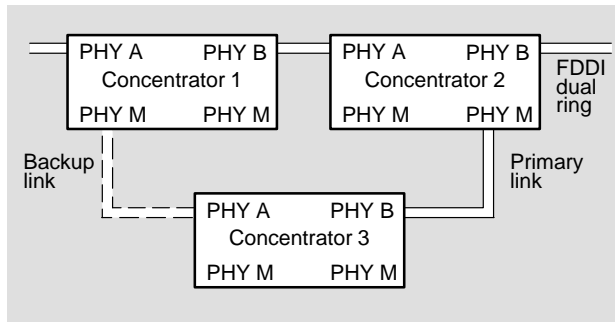


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## 2.4 FDDI Dual Homing

Figure 2-6 shows three concentrators installed in a dual homing configuration. Note that, if concentrator 2 or the primary link to concentrator 3 fails, the backup link to concentrator 3, through concentrator 1, takes over. This ensures that the devices connected to concentrator 3 have uninterrupted service.

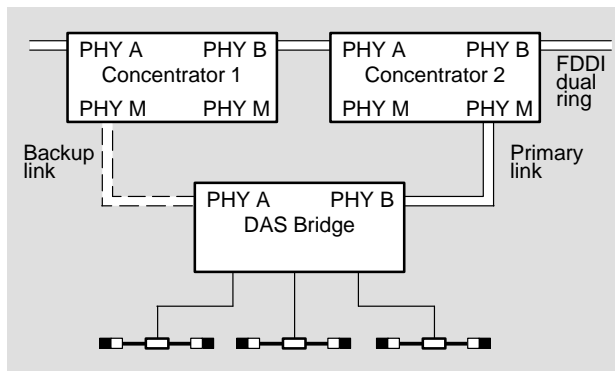
**Figure 2-6: Concentrators Installed for Dual Homing**



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Figure 2-7 shows a DAS bridge installed in a dual homing configuration. Note that, if concentrator 2 or the primary link to the bridge fails, the backup link to the bridge, through concentrator 1, takes over. This ensures that the devices on the LANs connected to the bridge have uninterrupted service.

**Figure 2-7: DAS Bridge Installed for Dual Homing**

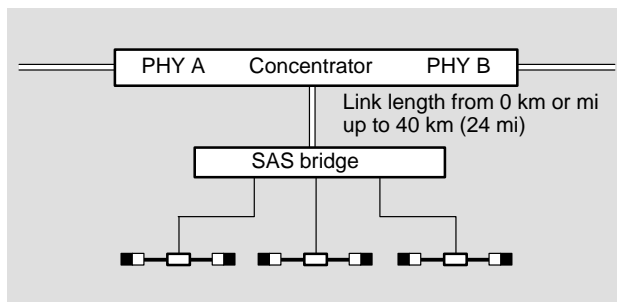


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## 2.5 Single-Mode Fiber Configurations

Figure 2-8 shows a SAS bridge connected to a dual ring through a long-distance single-mode fiber cable. This is the recommended method to connect remote sites through FDDI.

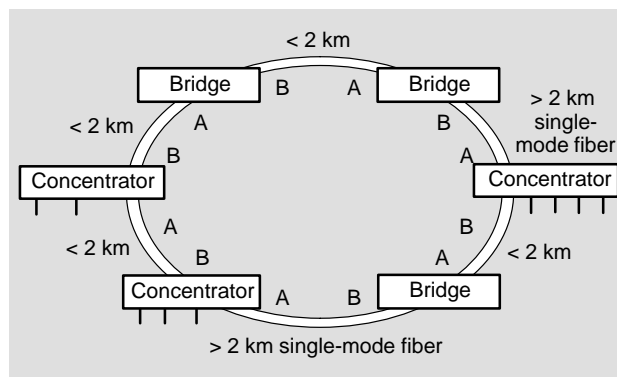
**Figure 2-8: Connecting to the Dual Ring Through a Single-Mode Link**



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Figure 2-9 shows a dual ring that requires some links to be longer than 2 km (1.2 mi). In this configuration, the total length of all links must not exceed 100 km (62 mi).

**Figure 2-9: Dual Ring with Mixed Link Lengths**



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# 3

## FDDI Specifications

The following tables list the FDDI general specifications, multimode and single-mode fiber optic cable specifications, and copper cable specifications. This chapter also contains a table that helps calculate the loss associated with optical bypass relays.

### 3.1 FDDI and Cable Specifications

Table 3–1 lists the FDDI general specifications.

**Table 3–1: FDDI General Specifications**

Attribute	Value
Transmission rate	125 megabaud (100 Mb/s at the data link)
Physical layer entities <sup>1</sup>	1000 (max)
Total Ring length	200 km (124 mi) (max)
Transmission medium	Fiber optic or copper cable
Network topology	Dual ring of trees
Media access method	Timed-token passing

<sup>1</sup>Digital recommends 100 stations, where a station can have one Physical layer entity (SAS), two Physical layer entities (DAS), or multiple Physical layer entities (concentrators).

Table 3–2 lists the optical system general requirements.

**Table 3–2: Optical System General Specifications**

Attributes	Values
<b>ANSI multimode <sup>1</sup></b>	
Link length	2.0 km (1.2 mi) (max)
Transmit launch signal	–20 dBm to –14 dBm (max)
Receive input signal	–31 dBm to –14 dBm (max)
Link-loss range	0 dB to 11 dB
<b>Low-power multimode<sup>1</sup></b>	
Link length	1.0 km (0.62 mi) (max)
Transmit launch signal	–22 dBm to –14 dBm (max)
Receive input signal	–29 dBm to –14 dBm (max)
Link-loss range	0 dB to 7 dB
<b>Single-mode</b>	
Link length	40 km (24.8 mi) (max)
Transmit launch signal	–8.0 dBm to –2.5 dBm (max)
Receive input signal	–30 dBm to –14 dBm (max)
Link-loss range	12 dB to 22 dB

<sup>1</sup>Assumes the use of 62.5- $\mu$ m multimode fiber optic cable. See Table 3–5 and Table 3–6 for information about alternate  $\mu$ m fiber optic cable.

Table 3–3 and Table 3–4 list multimode and single-mode fiber optic cable specifications.

**Table 3–3: Multimode Fiber Optic Cable Specifications**

Attributes	Values
Core diameter	62.5 ± 3.0 μm
Cladding diameter	125.0 ± 2.0 μm
Numerical aperture	0.275 ± 0.015
Optical power attenuation	1.5 dB/km @ 1300 nm, 3.5 dB/km @ 850 nm
Modal bandwidth (min)	500 MHz•km @ 1300 nm, 160 MHz•km @ 850 nm
Chromatic dispersion requirements	<u>ZDW</u> <sup>1</sup> <u>Dispersion Slope</u> 1295 nm   0.105 ps/(nm <sup>2</sup> •km) 1300 nm   0.110 ps/(nm <sup>2</sup> •km) 1348 nm   0.110 ps/(nm <sup>2</sup> •km) 1365 nm   0.093 ps/(nm <sup>2</sup> •km)

<sup>1</sup>The zero dispersion wavelength (ZDW) and dispersion slope must fall within the bounds shown in the table when plotted as wavelength (x axis) and dispersion slope (y axis) on a graph.

**Table 3–4: Single-Mode Fiber Optic Cable Specifications**

Attributes	Values
Mode Field diameter	8.2 μm to 10.5 μm
Cladding diameter	125 μm ± 2 μm
Fiber cladding noncircularity	2% (max)
Core to cladding concentricity error	1 μm (max)
Nominal operating wavelength	1300 nm
Fiber cutoff wavelength	1270 nm (max)
Zero dispersion wavelength	1300 to 1322 nm
Zero dispersion slope	0.095 ps/(nm <sup>2</sup> km) (max)
Optical power attenuation	≤ 0.40 dB per km @ 1310 nm

Table 3–5 lists the specifications for 100/140- $\mu\text{m}$  multimode fiber optic cable.

**Table 3–5: FDDI 100/140- $\mu\text{m}$  Multimode Fiber Optic Cable Specifications**

100/140- $\mu\text{m}$ Attributes	Values
Core diameter	100 $\pm$ 4.0 $\mu\text{m}$
Cladding diameter	140 $\mu\text{m}$ $\pm$ 6.0 $\mu\text{m}$
Numerical aperture	0.290 $\pm$ 0.02
Modal bandwidth (min)	500 MHz•km @ 1300 nm
ANSI multimode	
Link length	1.6 km (0.96 mi) <sup>1</sup>
Transmit launch signal	–20 dBm to –11 dBm (max)
Receive input signal	–31 dBm to –14 dBm (max)
Link-loss range	3 dB to 11.0 dB <sup>2</sup>
Low-power multimode	
Link length	1 km (0.62 mi) <sup>3</sup>
Transmit launch signal	–22 dBm to –11 dBm (max)
Receive input signal	–29 dBm to –14 dBm (max)
Link-loss range	3 dB to 7.0 dB <sup>2</sup>
<sup>1</sup> The link length can be 1.6 km (0.96 mi) if the cable meets the minimum modal bandwidth. If the modal bandwidth of the fiber is unknown, then a 500-m distance can be supported.	
<sup>2</sup> The use of 100- $\mu\text{m}$ fiber may launch excessive light into the fiber. This fiber requires a guaranteed minimum of 3 dB of link loss for proper operation.	
<sup>3</sup> The link length can be 1.0 km (0.62 mi) if the cable meets the minimum modal bandwidth. If the modal bandwidth of the fiber is unknown, then a 500-m distance can be supported.	



Table 3–6 lists the specification for 50/125- $\mu\text{m}$  multimode fiber optic cable.

**Table 3–6: FDDI 50/125- $\mu\text{m}$  Multimode Fiber Optic Cable Specifications**

<b>50/125-<math>\mu\text{m}</math> Attributes</b>	<b>Values</b>
Core diameter	50 $\mu\text{m} \pm 3.0 \mu\text{m}$
Cladding diameter	125 $\mu\text{m} \pm 2.0 \mu\text{m}$
Numerical aperture	0.200 $\pm 0.015$
Modal bandwidth (min)	500 MHz•km @ 1300 nm
ANSI multimode	
Link length	2 km (1.2 mi) <sup>1</sup>
Transmit launch signal	–25 dBm to –14 dBm (max)
Receive input signal	–31 dBm to –14 dBm (max)
Link-loss range	0 dB to 6.0 dB <sup>2</sup>
Low-power multimode	
Link length	1 km (0.62 mi)
Transmit launch signal	–26 dBm to –14 dBm (max)
Receive input signal	–29 dBm to –14 dBm (max)
Link-loss range	0 dB to 3.0 dB <sup>2</sup>

<sup>1</sup>The link length can be 2 km (1.2 mi) if the cable meets the chromatic dispersion requirements in Table 3–3. If the chromatic dispersion characteristics of the cable plant are unknown, then a 1.6 km (0.96 mi) distance can be supported

<sup>2</sup>The minimum values shown are worst-case values.

Table 3–7 lists the specifications for ThinWire and shielded twisted-pair cable. Note: ThinWire refers to ThinWire coax cable supplied by Digital.

**Table 3–7: ThinWire and Shielded Twisted-Pair Cable Specifications**

Attributes	Values
<b>Characteristic Impedance</b>	
ThinWire	$Z_0 = 50 \Omega \pm 2 \Omega$
Shielded twisted-pair	$Z_0 = 150 \Omega \pm 15\%$
<b>Supported Cable</b>	
ThinWire	Digital ThinWire Coax
IEEE 807.5 Token Ring shielded twisted-pair	Types 1 & 2 behind the wall Type 6 for patch cables
<b>Interstation link length (behind the wall cable)<sup>1</sup></b>	
ThinWire	90 m (315 ft) (max) <sup>2</sup>
Shielded twisted-pair	90 m (315 ft) (max)
<b>Cross-connect configuration<sup>1</sup></b>	
ThinWire	99 m (325 ft) (max) <sup>2</sup>
Shielded twisted-pair	99 m (325 ft) (max)
<b>Link-loss budget (cross-connect configurations)</b>	
ThinWire	11.5 dB (max loss) @ 62.5 MHz
Shielded twisted-pair	12 dB (max loss) @ 62.5 MHz

<sup>1</sup>Refer to the EIA/TIA 568 Commercial Building Wiring Standard for details.

<sup>2</sup>The maximum lengths obtained for ThinWire are configuration sensitive.

### 3.2 Optical Bypass Link Loss

Installed optical bypass relays operating in bypass mode introduce additional loss to the cableplant. Use the following procedure to determine the allowable link loss per cableplant segment.

1. Obtain from the vendor the worst-case loss (Lwc) for the optical bypass relay when the device is in bypass mode.
2. Multiply the number of serially linked optical bypass relays by the known Lwc.
3. Subtract the calculated Lwc from the available 11-dB link-loss budget.
4. Divide the result by the number of intervening cable-plant segments.

The result equals the allowable link loss per cableplant segment.

Table 3–8 shows the formula to determine allowable link loss as a function of the number of bypass relays.

**Table 3–8: Calculating Allowable Link-Loss Budget**

Number of Serially Bypassed Stations	Allowable Link Loss Calculation
1	$\frac{11 \text{ dB} - L_{wc}}{2} = \text{link loss}$
2	$\frac{11 \text{ dB} - (2 \bullet L_{wc})}{3} = \text{link loss}$
3	$\frac{11 \text{ dB} - (3 \bullet L_{wc})}{4} = \text{link loss}$
4	$\frac{11 \text{ dB} - (4 \bullet L_{wc})}{5} = \text{link loss}$

If the exact link loss is known for the cable segments:

1. Calculate the total Lwc for the concatenated cable-plant.
2. Add the known link loss for each segment to the total Lwc.

The link-loss budget for the concatenated cableplant must be less than or equal to the available link-loss budget of 11 dB.

# A

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## Related Documents

For additional information about FDDI products offered by Digital, refer to the following documents:

- *Networks Buyer's Guide*
- *Fiber Distributed Data Interface System Level Description* (Order No. EK-DFSLD-SD)
- *Bridge and Extended LAN Reference* (Order No. EK-DEBAM-HR)
- *DECnet/OSI Routing Overview* (Order No. AA-PCU9A-TE)

The following documents provide information concerning other Digital network offerings:

- *DECconnect System Fiber Optic Planning and Configuration* (Order No. EK-DECSY-FP)
- *DECconnect System Fiber Optic Installation* (Order No. EK-DECSY-FI)
- *Networks and Communications Product Documentation* (Order No. EK-NACPD-RE)
- *Network Wiring and Application Guidebook* (Order No. EB-K2411-4290)
- *Network Solutions Guidebook* (Order No. EB-32600-78)

For information on miscellaneous networking topics, refer to the following documents:

- *Guide to DECnet-VAX Networking* for DECnet node information
- *Introduction to Network Performance* for network performance information

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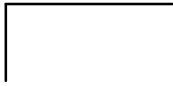
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