# DECconnect SYSTEM

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## Fiber Optic Planning and Configuration

May 1990

This manual provides an overview of Digital Equipment Corporation's structured wiring cable plant. In addition, it provides guidelines for designing structured fiber optic wiring subsystems. Also included are planning and configuration guidelines, application descriptions and examples, fiber optic design, and cable and component descriptions.

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# Preface

This manual describes Digital's DECconnect System structured fiber optic wiring. In addition, it provides planning and configuration guidelines to implement a structured fiber optic network.

This manual is written for network designers. It provides guidelines that meet international requirements. Most countries regulate construction through strictly enforced local building and electrical codes.

This manual refers to certain codes, such as the *National Electrical Codes (NEC)*, that have been adopted by local jurisdictions across the United States. However, it is beyond the scope of this document to address specific local codes.

**NOTE**

> It is the responsibility of the designer to understand, implement, and conform to local building and electrical codes.

## Objectives of This Manual

This manual provides:

- An introduction to Digital's structured fiber optic wiring to people who are considering using structured wiring in their campus or building.
- Descriptions, guidelines, and procedures to help:
  - Design fiber optic distribution subsystems for structured wiring cable plants.
  - Integrate active network equipment into structured wiring (for example, FDDI and fiber optic Ethernet).

## Intended Audience

This manual is for network designers responsible for:

- Deciding to use structured wiring at a campus or building.
- Planning and designing campus and building wiring.

## Structure of This Manual

This manual has thirteen chapters, seven appendixes, a glossary, and an index. The first two chapters provide architectural and general guidelines for structured wiring. The remaining chapters provide detailed design and planning for the cable plant. The appendixes provide design and applications information, and component ordering information.

| | |
|---|---|
| **Chapter 1** | Provides an overview of Digital's structured fiber optic wiring. |
| **Chapter 2** | Introduces the general requirements for planning and designing a structured wiring cable plant. |
| **Chapter 3** | Describes the concept diagram that defines how the buildings and floors will be interconnected into a structured wiring cable plant. |
| **Chapter 4** | Describes the administration subsystem and Digital's implementation strategy for structured fiber optic wiring. |
| **Chapter 5** | Describes how to design the fiber links and create the network schematic diagram. |
| **Chapter 6** | Describes how to design the fiber optic work area wiring subsystem. |
| **Chapter 7** | Describes how to design the fiber optic horizontal wiring subsystem cables and cable routing. |
| **Chapter 8** | Describes how to design the fiber optic building backbone subsystem cables and cable routing. |
| **Chapter 9** | Describes how to design the campus backbone subsystem cables and cable routing. |
| **Chapter 10** | Describes how to design the distribution frames. |
| **Chapter 11** | Describes Digital's fiber optic products and lists other sources of fiber products. |
| **Chapter 12** | Contains worksheets for ordering fiber products. |
| **Chapter 13** | Provides a preinstallation checklist. |
| **Appendix A** | Provides design considerations when using 50/125 or 100/140 micron fiber. |

**Appendix B** Provides information on using FDDI and ORnet products with IEEE 802.3/Ethernet networks.

**Appendix C** Provides information on using Digital's remote bridges and repeaters.

**Appendix D** Provides general information on connecting sites together or connecting remote sites together.

**Appendix E** Provides information on special distance situations where the inter-building distances are greater than allowed for a site.

**Appendix F** Provides a summary of the *National Electrical Codes (NEC)* cabling requirements.

**Appendix G** Provides information for ordering reference documents.

**Glossary** Defines the technical terms used in this manual.

## DECconnect System Documentation

Ordering information for Digital documents is provided in the back of this manual. The following briefly describes the contents of this reference material:

- *DECconnect System Fiber Optic Installation* (EK-DECSY-FI)

  Provides guidelines for installing fiber optic cable and passive components as well as preinstallation and postinstallation certification procedures.

- *DECconnect System Illustrated Parts Breakdown* (EK-DECON-IP)

  Provides a complete parts breakdown for Digital's copper and fiber optic passive cable plant components.

- *DECconnect System H3111-xx Modular Wallbox Installation Instructions* (EK-DECSY-WI)

  Provides guidelines for installing the H3111-*xx* wallbox and that wallbox's snap-in/slide-in connector panels for fiber and copper.

- *DECconnect System General Description* (EK-DECSY-GD)

  Provides a general overview of the products and services that make up Digital's DECconnect System and reviews the planning and installation processes for building a comprehensive communications network.

- *DECconnect System Requirements Evaluation Workbook* (EK-DECSY-EG)

  Describes how to evaluate network requirements prior to planning a DECconnect System.

- *DECconnect System Planning and Configuration Guide* (EK-DECSY-CG)

Contains planning requirements and guidelines for configuring DECconnect System Ethernet LANs using copper and fiber. Includes detailed product information for all DECconnect System copper wiring products.

- *DECconnect System Facilities Cabling Installation Guide* (EK-DECSY-FC)

  Provides procedures for installing copper wiring products (Ethernet coaxial cables, twisted-pair data and voice cables, ThinWire cables, transceivers, and wallboxes) within a DECconnect System.

- *DECconnect System Satellite Equipment Room (SER) Installation Guide* (EK-DECSY-SR)

  Describes how to install an SER, including racks and active and passive equipment used with copper wiring.

- *DECconnect System Office Communications Cabinet (OCC) Installation Guide* (EK-DECSY-OC)

  Describes how to install an OCC used with copper wiring.

- *DECconnect System Stand-Alone ThinWire Networks: Planning and Installation Guide* (EK-DECSY-TG)

  Describes how to plan for and install a stand-alone ThinWire network.

### Other Digital Documentation

- *Networks and Communications Product Documentation* (EK-NACPD-RE)

  Lists the title and order number for each publication associated with Digital's networks and communications products.

- *Networks and Communications Buyer's Guide*

  Lists and describes the complete line of Digital's available networking products.

- *Introduction to Network Performance* (EK-NETWK-TM)

  Helps the network designer set reasonable performance expectations while designing, implementing, or reconfiguring a network, by providing a base from which to formulate performance requirements and evaluate the results.

## Other Reference Documentation

Consult the following reference during the structured wiring design process.

- The Building Industry Consulting Service, International (BICSI) *BICSI Telecommunications Distribution Methods Manual*

Appendix E provides ordering information for this reference as well as other reference documents not listed here.

# CHAPTER 1

# 1 Overview

**NOTE**

There are common terms in this manual (for example, campus, support, building) that are used in applications specific to the manual. To understand their meanings as they apply to this manual, review the terms in the Glossary.

The introduction of Digital's DECconnect System has contributed to changing the way building and campus wiring solutions are installed for local area networks (LANs). Until now, the DECconnect System building wiring solutions have supported predominantly copper media for IEEE 802.3/Ethernet and point-to-point (including fiber) solutions to LAN communication. Copper solutions include ThinWire, standard Thickwire coaxial cable, RG-58, twisted-pair, and shielded or unshielded cable.

With the evolution of fiber optic technology, building and campus wiring is moving to the use of fiber optic cables. This allows the wiring to support new, high-capacity data communication technologies such as Fiber Distributed Data Interface (FDDI).

Factors contributing to the copper-to-fiber migration in campus and building wiring include:

- A much higher data transfer rate
- Protection from ground potential differences and electromagnetic interference (EMI)
- Smaller diameter and lighter weight cables

- Accommodation of greater distances for high-speed data transfer
- Decreasing fiber optic cable and component costs

## 1.1 DECconnect System Structured Wiring

The DECconnect System has evolved into an application-independent approach to structured wiring for the campus environment that complies with and expands on the *EIA / TIA-568 Commercial Building Wiring Standard*. Therefore, the DECconnect System's concept:

- Serves current campus and building communication requirements
- Provides for future communication needs
- Provides easy maintenance of campus and building wiring

The DECconnect System's structured wiring supports fiber and copper solutions as follows:

- Defines a wiring system that allows connecting the communication devices and computer equipment in one building to the communication devices and computer equipment in any building within the campus.
- Provides for all building wiring structure (cabling and associated distribution components) from work area equipment to mainframe computers.
- Specifies the connectors, cables, passive components, and installation guidelines that provide for reliability, quality, and compatibility.
- Can be used for applications such as:
  - Data (high- or low-speed)
  - Imaging (plotters, facsimile machines, and graphics stations)
  - Sensing (building management)
  - Video (interactive teleconferencing or security needs)
  - Voice (telephone and intercom)

Digital's DECconnect System structured wiring is a cost-effective approach to the design and management of the cable plant.

## 1.2 Fiber Optic Structured Wiring

The DECconnect System's approach to fiber optic structured wiring is to:

- Identify a set of passive fiber optic components for use in campus and building wiring
- Define the design and installation guidelines to combine fiber optic components to form EIA/TIA-compliant wiring structure
- Provide a design model for integrating active networking equipment (such as FDDI and Fiber Optic Ethernet) with the structured wiring

**NOTE**

> Digital recommends 62.5/125 dual window multimode fiber for all new installations. For support of 50/125 or 100/140 fiber size, see Appendix A.

As an EIA/TIA-compliant approach to structured wiring, the DECconnect System's structured fiber optic wiring allows:

- An application-independent system
- The interconnection of many different types of communication devices
- Easy reconfiguration and cable management

In addition, Digital's use of an EIA/TIA-compliant structured wiring permits installing fiber optic wiring based on current needs that can still:

- Grow with the user's networking requirements
- Accommodate advances in fiber optic technology

## 1.3 Structured Versus Unstructured Wiring

A costly approach to network growth is to install more wiring into the cable plant with little thought about future requirements. The major risk of unstructured wiring is no maintenance capabilities and high replacement cost for all new cabling solutions.

The following comparison chart describes some advantages of structured wiring:

| Unstructured Wiring | Structured Wiring |
|---|---|
| ■ Application dependent. | ■ Application independent. |
| ■ Often requires rewiring when moving people or equipment. | ■ Allows movement of people and equipment without rewiring. |
| ■ Does not allow for growth or change. | ■ Allows growth and change. |
| ■ Difficult to reconfigure wiring and communication equipment. | ■ Easy to reconfigure wiring and communication equipment. |
| ■ Nonmodular, inflexible system. | ■ Modular design allows flexibility. |
| ■ Limited management and problem isolation capabilities. | ■ Allows for administration and maintenance of the cable plant. Facilitates the isolation of equipment and cable problems. |
| ■ Dedicated to specific purposes that become obsolete. | ■ Supports a multiproduct environment. |

## 1.4 Industry Standards

Digital's structured wiring complies with the *EIA/TIA-568 Commercial Building Wiring Standard*. Complying with this industry standard ensures that a uniform building wiring platform is established that supports a multiproduct environment.

The following documents may provide helpful information during the structured wiring design process:

- The Building Industry Consulting Service, International (BICSI) *BICSI Telecommunications Distribution Methods Manual*
- The National Fire Protection Agency (NFPA) *National Electrical Code (NEC)*

### 1.4.1 EIA/TIA-568 Commercial Building Wiring Standard

The EIA/TIA-568 standard addresses the structure of the wiring and provides guidelines and restrictions for designing passive structured wiring. The standard includes guidelines and restrictions concerning the physical topology, fiber optic media size (62.5/125 micron), and the use of copper and fiber in structured wiring.

### 1.4.2 *BICSI Telecommunications Distribution Methods Manual*

This manual provides technical information, design guidelines, and recommendations for the building facilities needed to support structured wiring. It covers everything from grounding, bonding, and electrical protection with detailed descriptions of equipment room requirements.

Consult the BICSI manual for various installation methods for the structured wiring cable plant.

### 1.4.3 National Electrical Code (NEC)

The NEC's purpose is to safeguard people and property from hazards arising from the use of electricity, electrical equipment, and conductors. This advisory code (updated every three years) regulates the installation of electrical equipment and conductors within buildings.

The NEC is routinely adopted by communities across the United States as part of their local building codes. Some communities have local requirements that differ from the NEC. (Local codes supersede the NEC.) Copies of the NEC and relevant local building codes are needed during the design process. Appendix D provides a summary of NEC cabling requirements. The current NEC manual is the 1990 version.

## 1.5 Structured Wiring Architecture

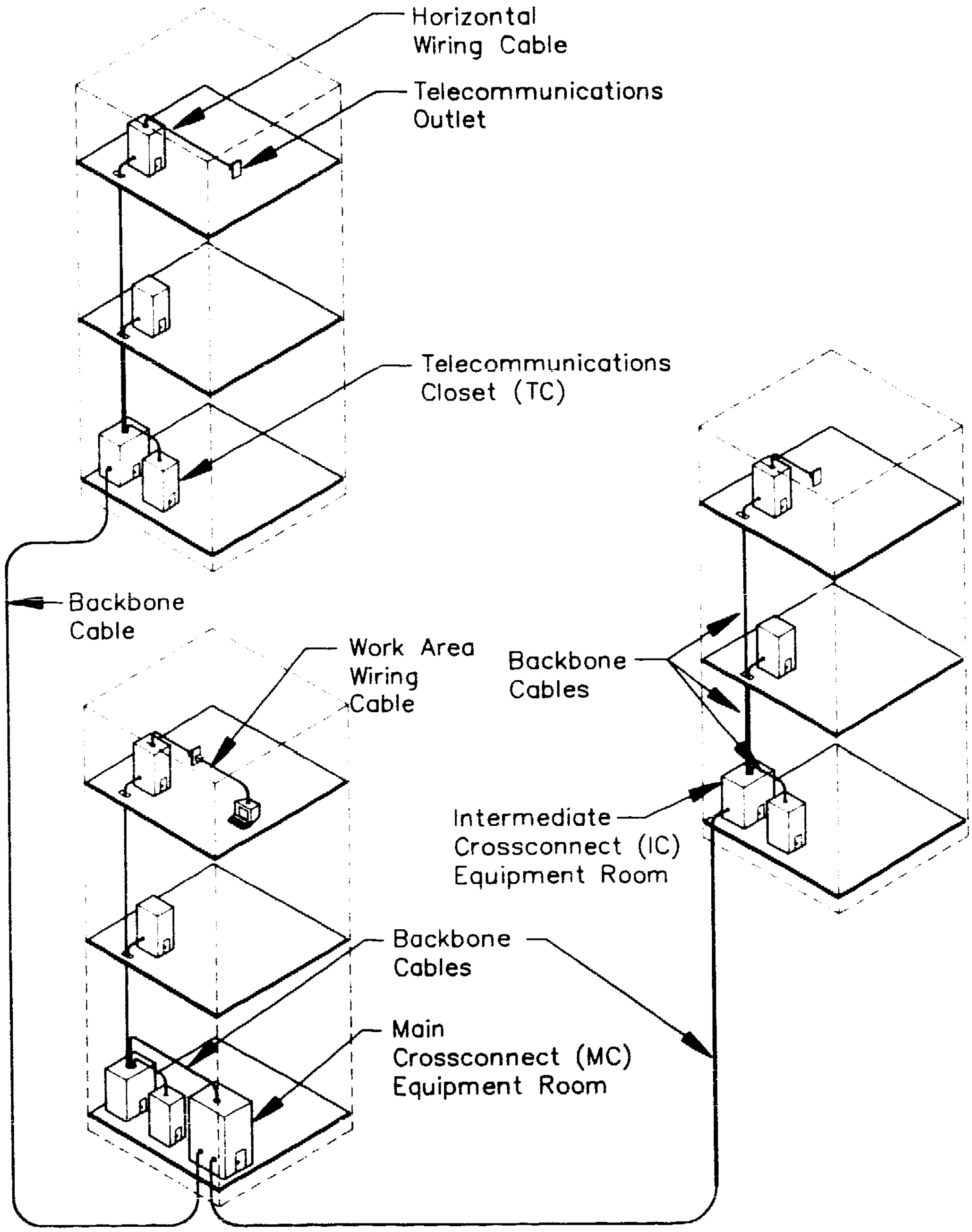
Table 1–1 shows where the DECconnect System's structured wiring complies with, or expands on, the EIA/TIA architecture.

**Table 1–1: Structured Wiring Architecture**

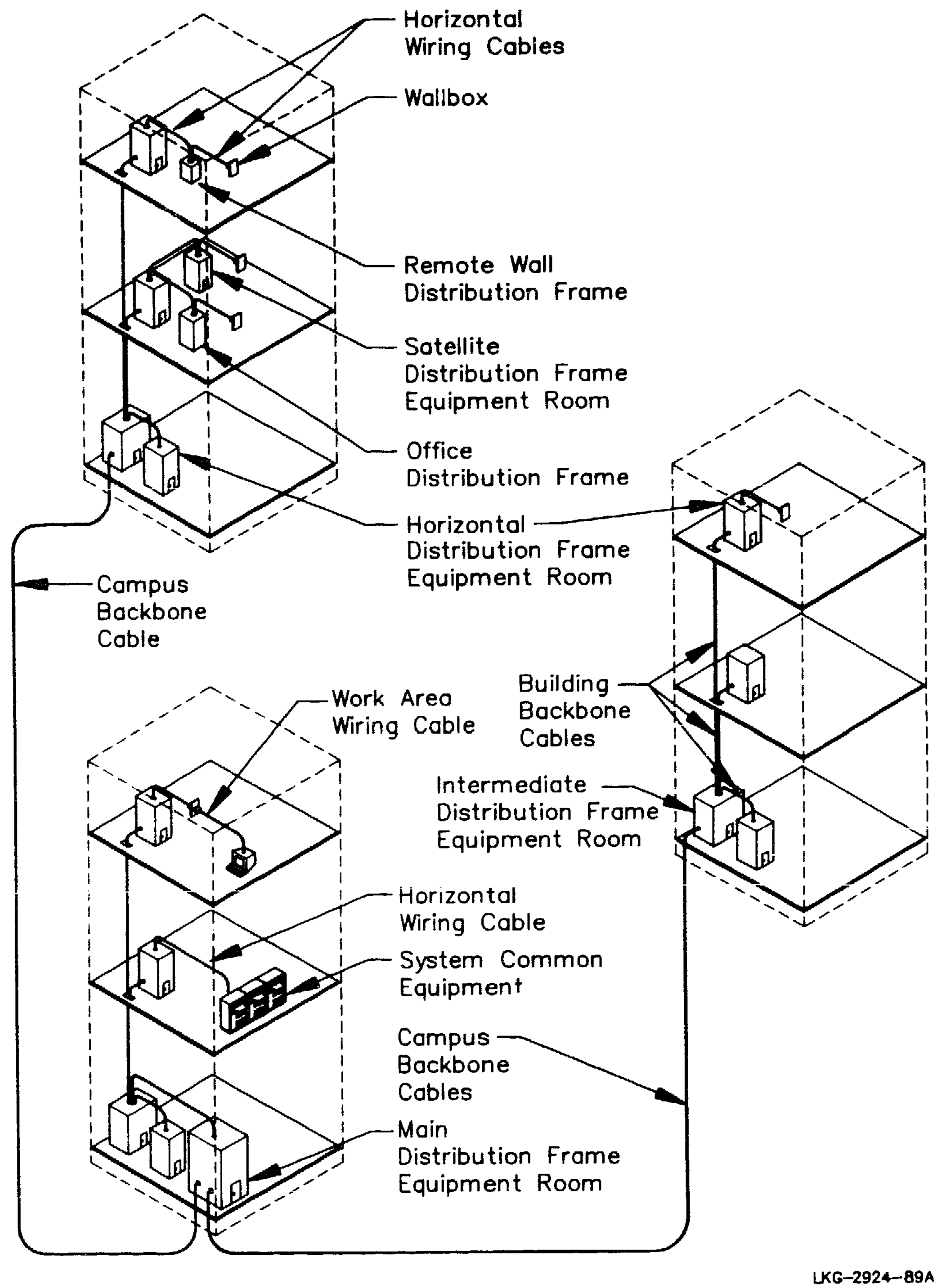
| EIA/TIA-568 Standard | DECconnect System |
|---|---|
| Uses the hierarchical physical star topology. | Complies. |
| Administration subsystem: consists of the hardware involved in connecting the subsystems and documentation to manage and maintain end-to-end connectivity. | Complies. |
| Backbone subsystem: consists of the backbone cables, main and intermediate crossconnects (MCs and ICs), mechanical terminations, and interbuilding entrance facilities that provide for connecting the horizontal wiring subsystems together into a structured wiring cable plant. | Complies with and expands on the standard by dividing the single EIA/TIA backbone subsystem into two separate backbones: a campus backbone, covering the interbuilding portion of the EIA/TIA backbone, and a building backbone, covering the intrabuilding portion. |
| Horizontal wiring subsystem: consists of a telecommunications closet (TC), telecommunication outlets, and the horizontal wiring cables that connect the TC to the telecommunication outlets. | Complies with and expands on the standard by using the horizontal wiring system to connect system common equipment (host computers, or central voice or data equipment) and computer room equipment to the structured wiring, either through a wallbox or through direct cable connection with the system common equipment or computer room equipment. |
| Work area subsystem: connects the station equipment to the telecommunications outlet end of the horizontal wiring subsystem. | Complies. |

Figure 1–1 illustrates the EIA/TIA-568 standard distribution subsystem structure. Figure 1–2 illustrates the overall DECconnect System structure.

**Figure 1–1: EIA/TIA-568 Standard Distribution Subsystem Structure**



## Figure 1–2: DECconnect System Structure



### 1.5.1 Backbone Subsystem Architecture

The backbone connects to the horizontal wiring subsystems. Table 1–2 compares the EIA/TIA-568 standard with the DECconnect System backbone architecture.

**Table 1–2: Backbone Subsystem Architecture**

| EIA/TIA-568 Standard | DECconnect System |
|---|---|
| A single backbone subsystem using the hierarchical physical star topology. | Complies with and expands on the architecture by dividing the single EIA/TIA backbone into campus and building backbones. |
| A main crossconnect (MC) connects the backbone together. | Complies by using a main distribution frame (MDF) to contain the MC function. |
| An intermediate crossconnect (IC) connects the intrabuilding and interbuilding portions of the backbone. | Complies by using an intermediate distribution frame (IDF) to contain the IC function. |
| Allows up to two hierarchical levels of crossconnects within a backbone link, and no more than three crossconnects in the backbone links between any two horizontal wiring subsystems. | Complies by allowing crossconnects in the campus backbone's MDF and the building backbone's IDF. |
| Supports using 62.5/125 micron fiber while referencing other fiber sizes. | Complies with and expands on the standard by supporting the installation of single-mode fiber for future applications. See Appendix A for information about using 50/125 or 100/140 micron fiber. |
| Allows a total backbone distance of 2000 meters (6560 feet), with up to 500 meters (1640 feet) available to a backbone's intrabuilding link. | Complies with and expands on the standard by allowing backbone distances greater than 2000 meters (6560 feet). See Appendix E for information about special distance situations. |
| Supports using active devices in connecting multiple sites. The active device connections are outside the scope of the standard. | Complies with and expands on the standard by describing how to connect multiple sites together. |
| Provides fiber optic link specifications at 850 nm and 1300 nm operation. | Complies with and expands on the standard by defining fiber optic link-loss models and budget planning numbers for 850 nm and 1300 nm operation. |

Figure 1–3 and Figure 1–4 illustrate the EIA/TIA and DECconnect System backbone approaches.

**Figure 1–3: EIA/TIA-568 Standard Backbone Architecture**

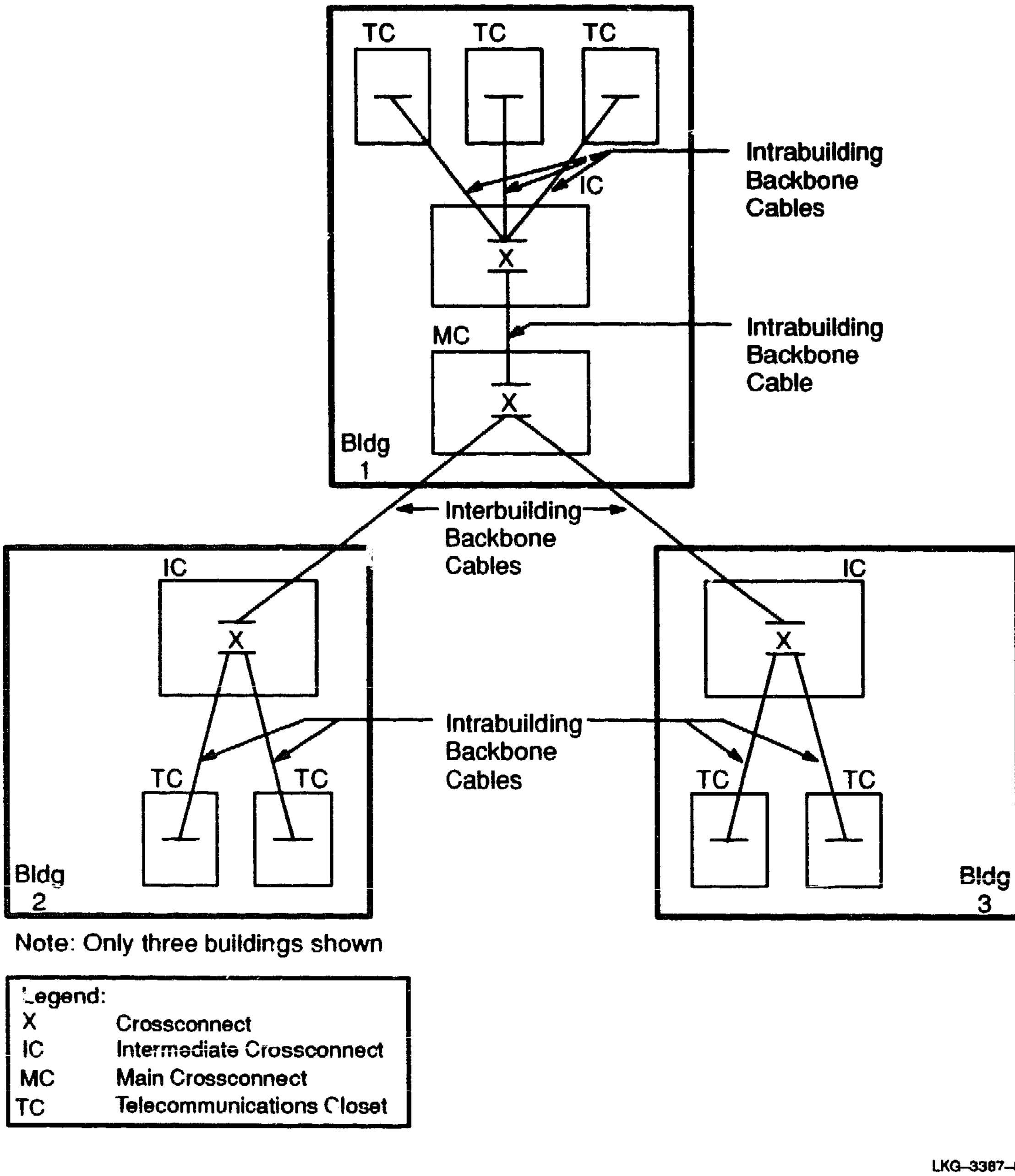
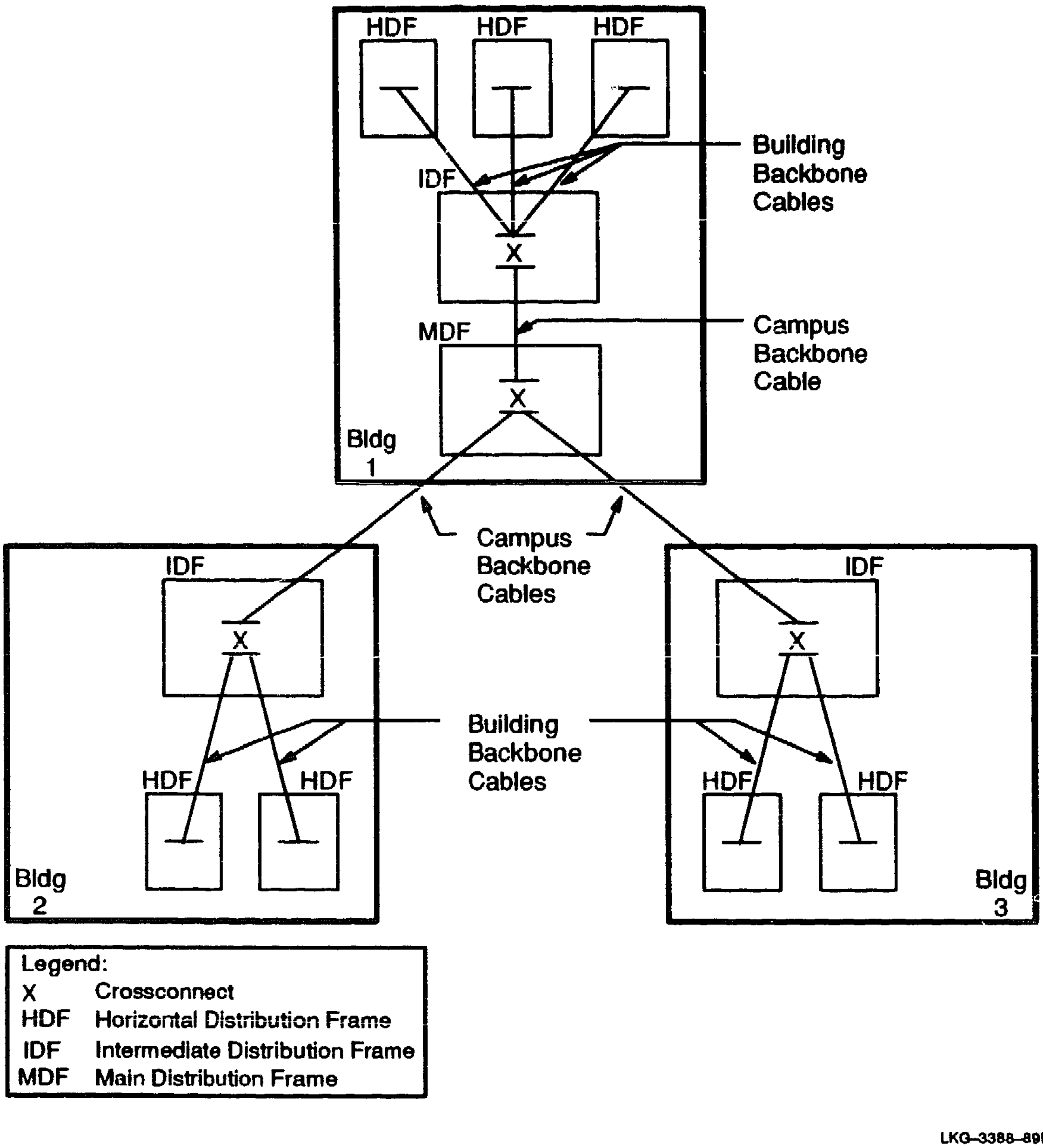


**Figure 1–4: DECconnect System Backbone Architecture**



### 1.5.2 Horizontal Wiring Subsystem Architecture

The horizontal wiring connects:

- The active equipment in the work area to the backbone.
- System common equipment and computer room equipment to the backbone.

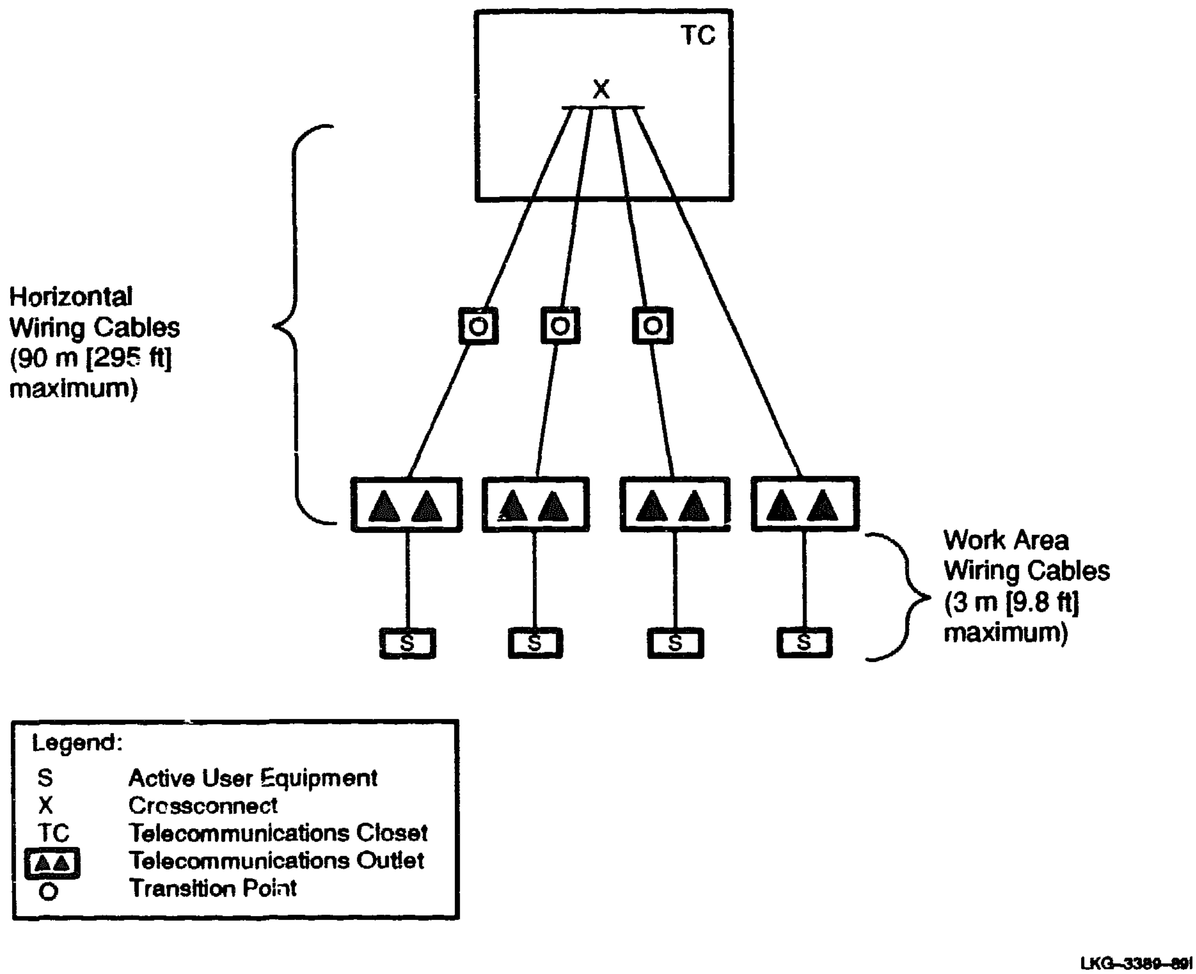
Table 1–3 compares the EIA/TIA-568 standard with the DECconnect System horizontal wiring architecture.

**Table 1–3: Horizontal Wiring Subsystem Architecture**

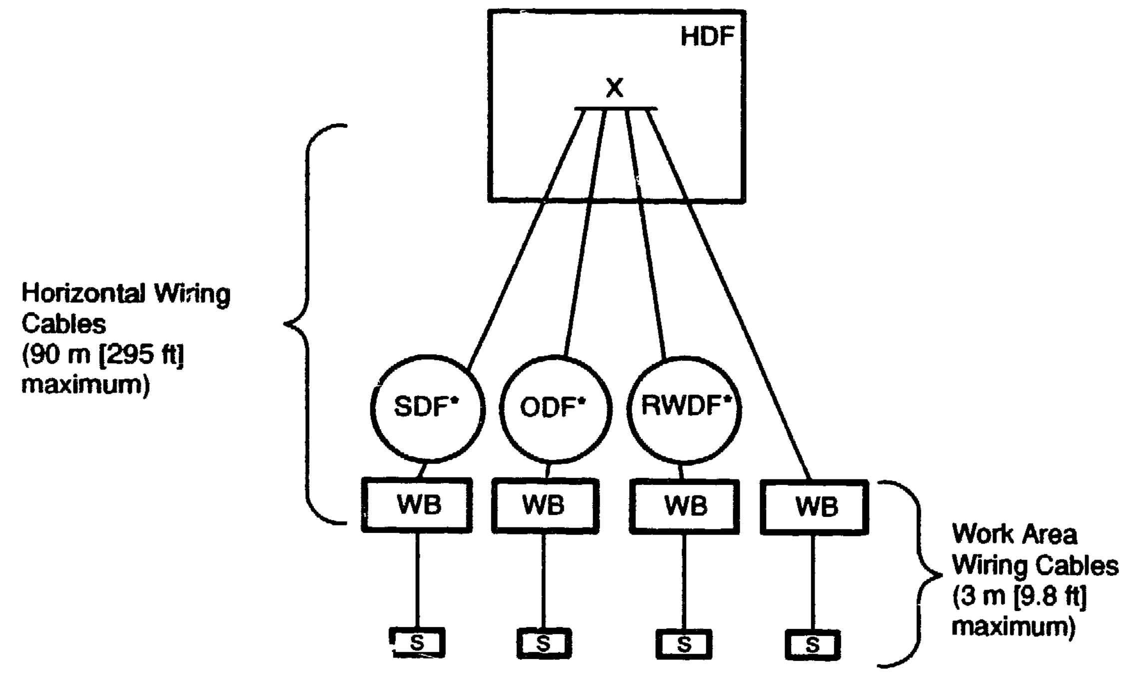
| EIA/TIA-568 Standard | DECconnect System |
|---|---|
| Allows a single crossconnect in a horizontal wiring link at the telecommunications closet (TC) connection between the horizontal wiring and backbone cables. | Complies with and expands on the standard by allowing the link's single horizontal wiring crossconnect to occur at a satellite distribution frame (SDF) or office distribution frame (ODF) when active networking equipment is used in the horizontal distribution frame (HDF). |
| Specifies a 90-meter (295-foot) maximum horizontal cable length. | Complies. |
| Allows a single transition point between the telecommunications outlet and the telecommunications closet for connecting similar cables together. | Complies with and expands on the standard by allowing the transition to occur at an SDF, ODF, or remote wall distribution frame (RWDF). The transition can take the form of administration interconnects (at the SDF, ODF, or RWDF) or crossconnects (at the SDF or ODF). |
| Connects to the work area wiring through a telecommunications outlet. | Complies by using a wallbox to perform the telecommunications outlet function. |

Figure 1–5 and Figure 1–6 illustrate the EIA/TIA and DECconnect System's horizontal wiring approaches.

**Figure 1–5: EIA/TIA-568 Standard Horizontal Wiring Architecture**



## Figure 1–6: DECconnect System Horizontal Wiring Architecture




*These transition point distribution frames are equal in hierarchy.

| Legend: | |
|---|---|
| S | Active User Equipment |
| X | Crossconnect |
| HDF | Horizontal Distribution Frame |
| ODF | Office Distribution Frame |
| RWDF | Remote Wall Distribution Frame |
| SDF | Satellite Distribution Frame |
| WB | Wallbox |

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## 1.6 Structured Wiring Subsystems

As described in Table 1–1, Digital's structured wiring architecture contains the following subsystems:

- Campus backbone
- Building backbone
- Horizontal wiring
- Work area wiring
- Administration

The following sections briefly describe each of the subsystems.

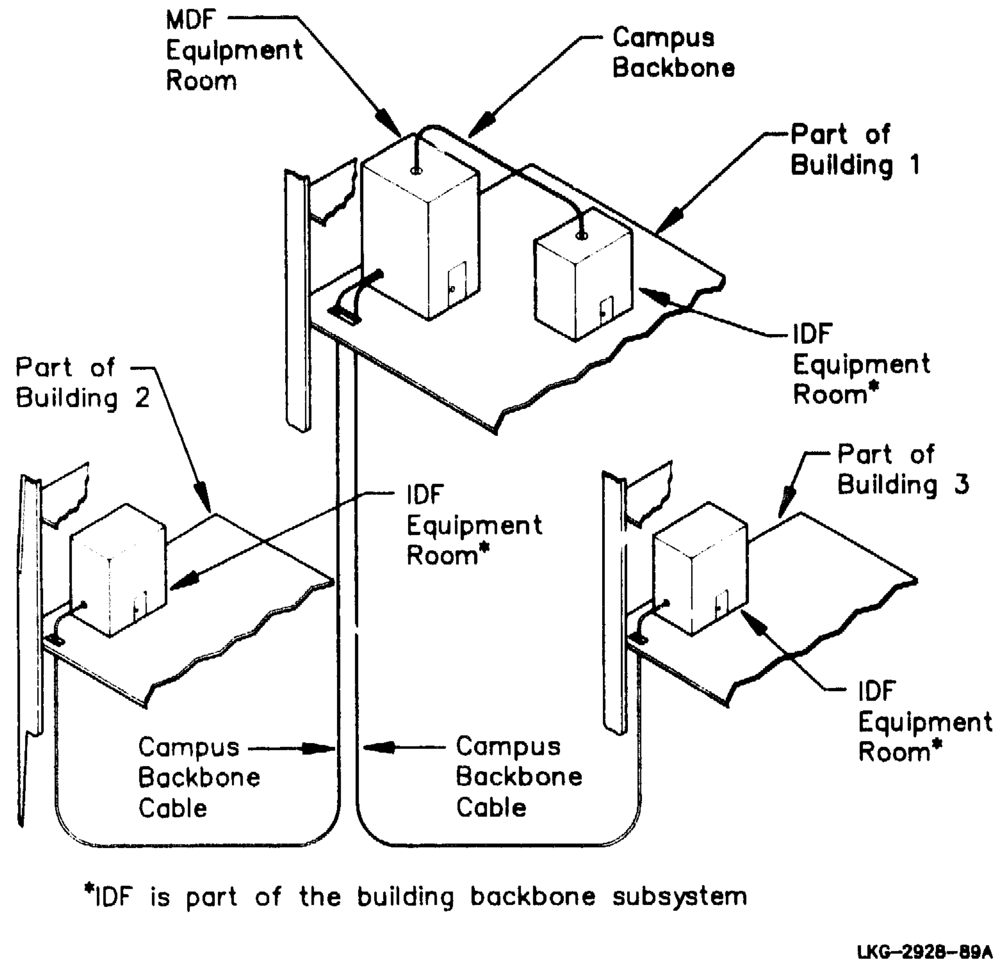
### 1.6.1 Campus Backbone Subsystem

This subsystem connects the buildings of the site and consists of the following:

- Main distribution frame (MDF) - located in an equipment room; consists of the active, passive, and support components that provide the connection between the site's building IDFs.
- Campus backbone cables - provides the interbuilding connections.

Figure 1–7 illustrates a campus subsystem.

## Figure 1–7: Campus Backbone Subsystem



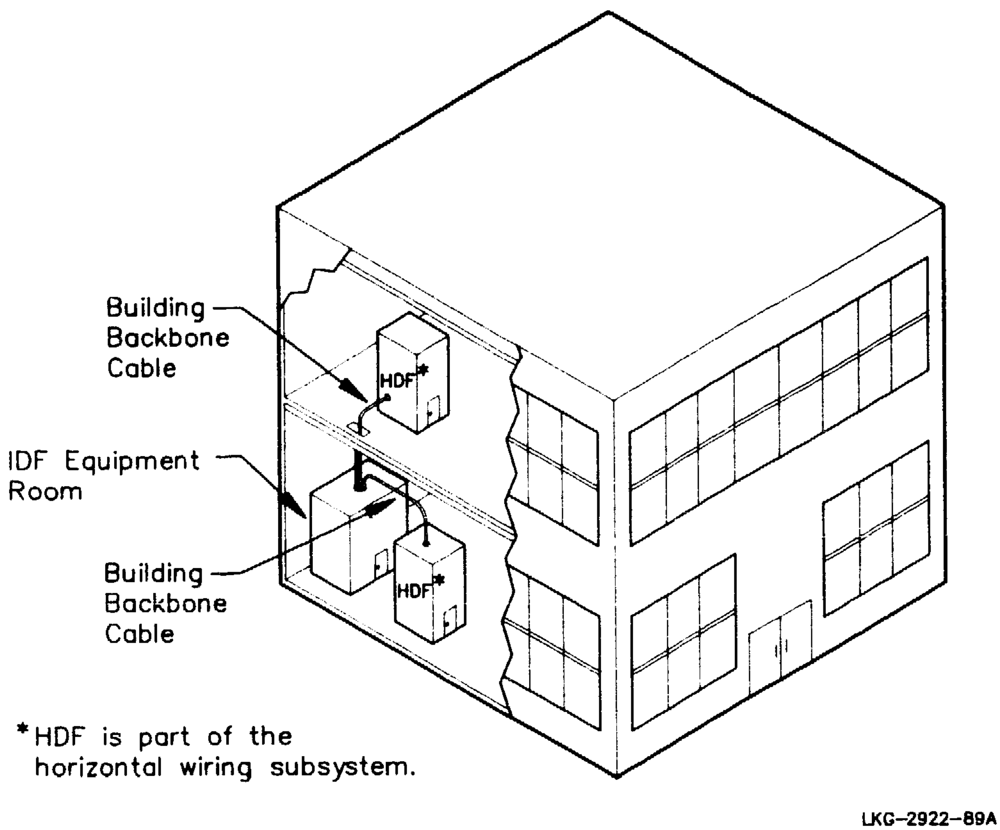
### 1.6.2 Building Backbone Subsystem

This subsystem connects the building's horizontal wiring subsystems to the campus backbone. The building backbone subsystem consists of the following:

- Intermediate distribution frame (IDF) - located in an equipment room; consists of the active, passive, and support components that provide the connection between the building and campus backbones. The IDF also provides the connection within the building backbone cabling.
- Building backbone cables - connects the IDF to each horizontal wiring subsystem.

Figure 1–8 illustrates a building backbone subsystem for a multistory building.

## Figure 1–8: Building Backbone Subsystem



### 1.6.3 Horizontal Wiring Subsystem

This subsystem connects the building backbone to the work area wiring and includes the following:

- Horizontal distribution frame (HDF) - consists of the active, passive, and support components that provide for the connection between the horizontal wiring and the building backbone.
- Other distribution frames - provide for a transition point within the horizontal wiring between the wallbox and the HDF. The transition point can take any of the following forms:
  - Satellite distribution frame (SDF) - an open-rack distribution frame located in an equipment room.
  - Office distribution frame (ODF) - an enclosed rack that is usually located in the office area.
  - Remote wall distribution frame (RWDF) - a small wall-mounted cabinet.

  The transition point at an SDF or ODF can be either an administration interconnect or crossconnect. The crossconnect at the SDF or ODF connects wallbox cable fiber to HDF cable fiber when active networking equipment is connecting the horizontal wiring and building backbone cables at the HDF. An administration interconnect at the SDF or ODF connects active equipment to the horizontal wiring.
- Wallbox (WB) - also referred to as the faceplate, information outlet, or telecommunications outlet, the wallbox provides an interconnection between the work area wiring and horizontal wiring.
- Horizontal wiring cables - connects the various elements of the horizontal wiring together, such as the HDF, SDFs, ODFs, RWDFs, and wallboxes. Can also be used to directly connect the HDF to the computer room or to system common equipment (central computer, data, voice, or video equipment).

Figure 1–9 illustrates the horizontal wiring distribution subsystem used to connect the building backbone to the work area wiring. This figure shows the four Digital-supported ways of connecting the horizontal wiring subsystems to the building backbone and to the work area wiring:

- HDF-to-wallbox
- HDF-to-SDF-to-wallbox

- HDF-to-ODF-to-wallbox
- HDF-to-RWDF-to-wallbox

**Figure 1–9: Horizontal Wiring Subsystem**

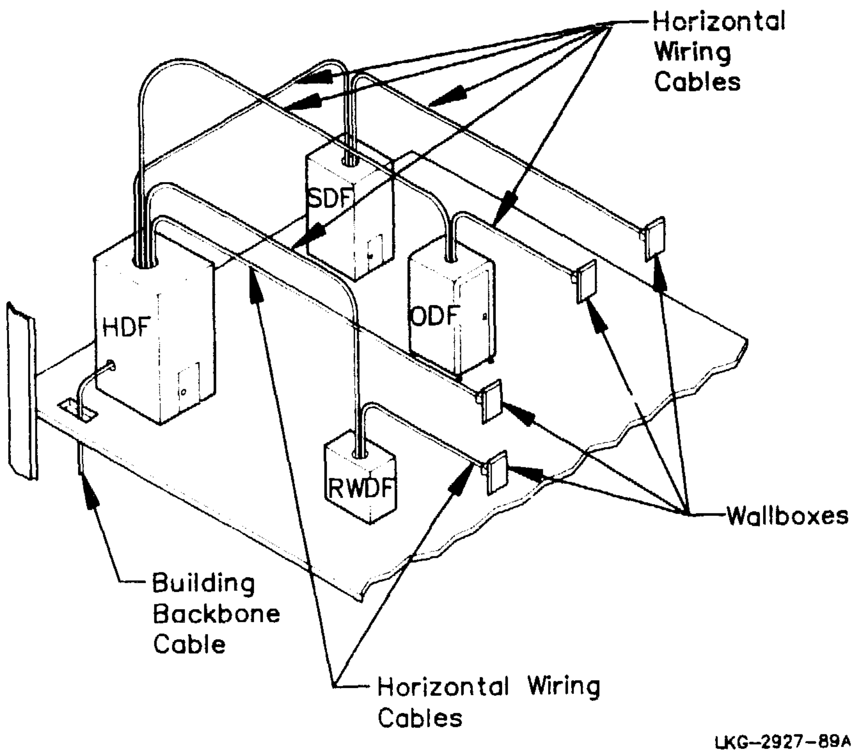
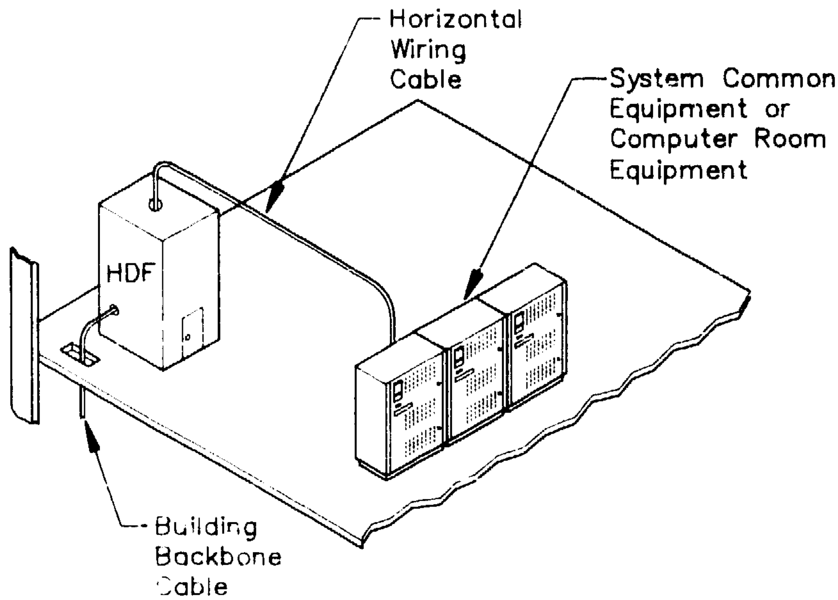



Figure 1–10 illustrates how the horizontal wiring subsystem can connect to computer room equipment or system common equipment and to the building backbone.

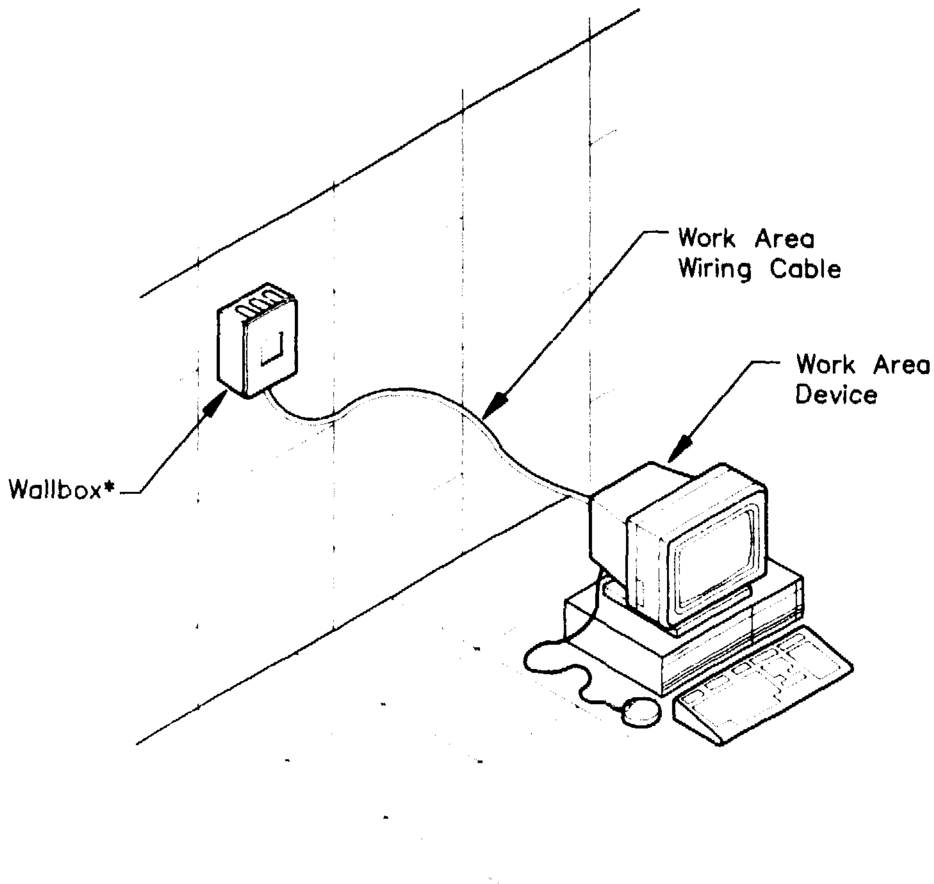
**Figure 1–10: Computer Room and System Common Equipment Connections**



### 1.6.4 Work Area Wiring Subsystem

As shown in Figure 1–11, this subsystem consists of the wiring needed to connect the work area active equipment to the horizontal wiring wallbox.

**Figure 1–11: Work Area Wiring Subsystem**




*Wallbox is part of horizontal wiring subsystem.

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### 1.6.5 Administration Subsystem

This subsystem consists of crossconnects and interconnects to link the five distribution subsystems. This crossconnect/interconnect provides administration to allow connection of the structured wiring to various parts of the building as needs change.

For example, wallboxes are interconnects between the horizontal wiring subsystem and work area wiring subsystems. Wallboxes enable the relocation of station devices by plugging them into a new wallbox. Network communication can then be rerouted to the new wallbox by the crossconnect at HDF.

Crossconnects are where two cables from the same or different subsystem connect together at a patch panel using panel-mounted couplers and a patch cable. Crossconnects can only be used to connect fibers at the:

- Campus subsystem's main distribution frame (MDF)
- Building backbone's intermediate distribution frame (IDF)
- Horizontal wiring distribution frame.

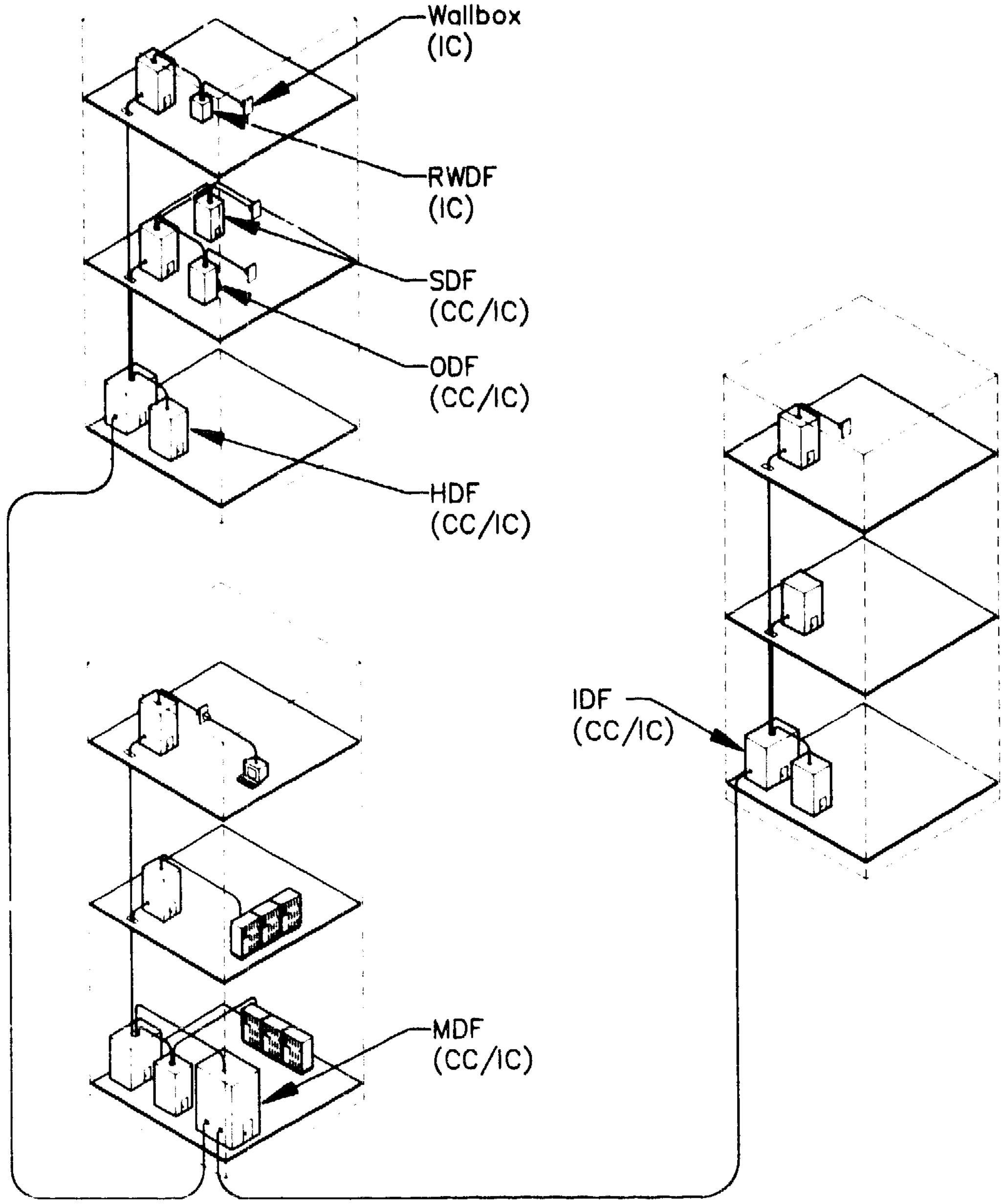
**NOTE**

> The horizontal wiring subsystem has only one crossconnect. The crossconnect can be located at the HDF, SDF, or ODF.

Interconnects join two cables with a single pair of connectors using a panel-mounted fiber optic coupler or wallbox-mounted fiber optic coupler. A wallbox, for example, is an interconnect point, as is the connection between a patch panel and active networking equipment.

Figure 1–12 illustrates the interconnects and crossconnects within a site. As shown, the wallboxes and remote wall distribution frames (RWDFs) are interconnect points only, while the MDF, IDF, HDF, SDF, and ODF can have crossconnects or interconnects.

**Figure 1–12: Administration Subsystem**



## 1.7 Topology

The topology is the physical arrangement of the structured cabling and components used for connecting a site's buildings and floors together. Digital's topology is the hierarchical physical star.

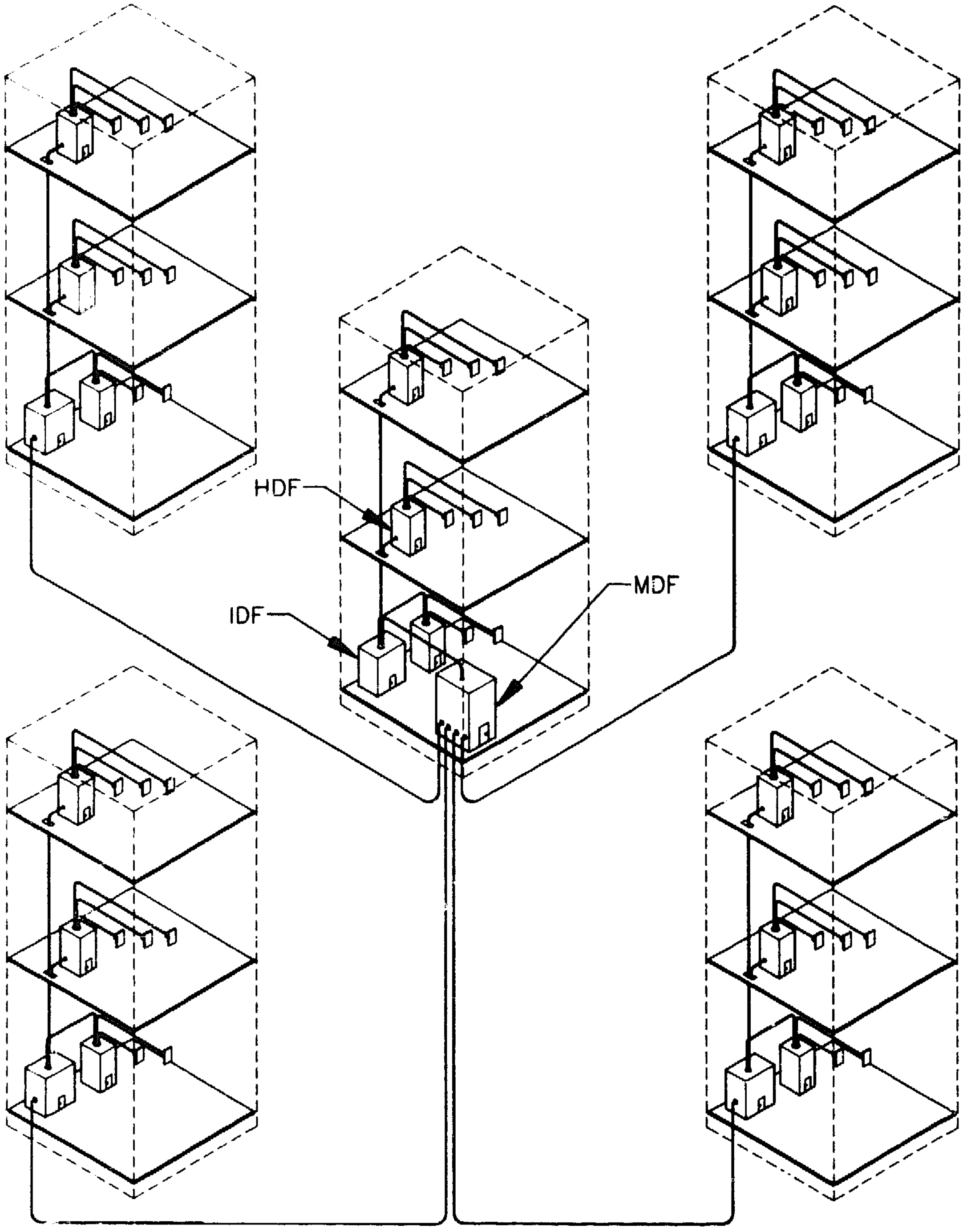
Figure 1–13 illustrates a site that is connected using the hierarchical physical star topology:

- The highest point in the hierarchical physical star topology is the campus backbone subsystem's MDF. It radially connects the buildings into the star topology using campus backbone cable.
- The buildings connect to the topology using building backbone subsystem IDFs. They radially connect the floors into the star topology using building backbone connections.
- The floors connect to the topology using horizontal wiring subsystem HDFs. They radially connect the wallboxes into the star topology using the horizontal wiring. This wiring is the end point in the hierarchical physical star topology.

The following are advantages of this hierarchical physical star topology:

- Easily configures to support a wide range of active equipment configurations
- Provides central management and maintenance points
- Allows for modular nondisruptive system growth

**Figure 1–13: Campus Connected Through the Hierarchical Physical Star Topology**



## 1.8 Configurations

The cable plant wiring infrastructure is a cabling arrangement which supports active equipment configurations. Some of the different types of configurations are:

- Point-to-point
- Star
- Ring
- Tree

The hierarchical physical star topology supports the use of different configurations within the same structured wiring cable plant. For example, a ring configuration for the campus and building backbones; a star or tree configuration for the horizontal wiring.

### 1.8.1 Point-to-Point Configuration

The point-to-point cabling configuration has no central administration but is a typical unstructured wiring arrangement as shown in Figure 1–14. Figure 1–15 illustrates point-to-point configurations that are supported over a hierarchical physical star. As illustrated, the MDF becomes the central administration for each of the point-to-point links to the IDFs.

Figure 1–14: Point-to-Point Configuration

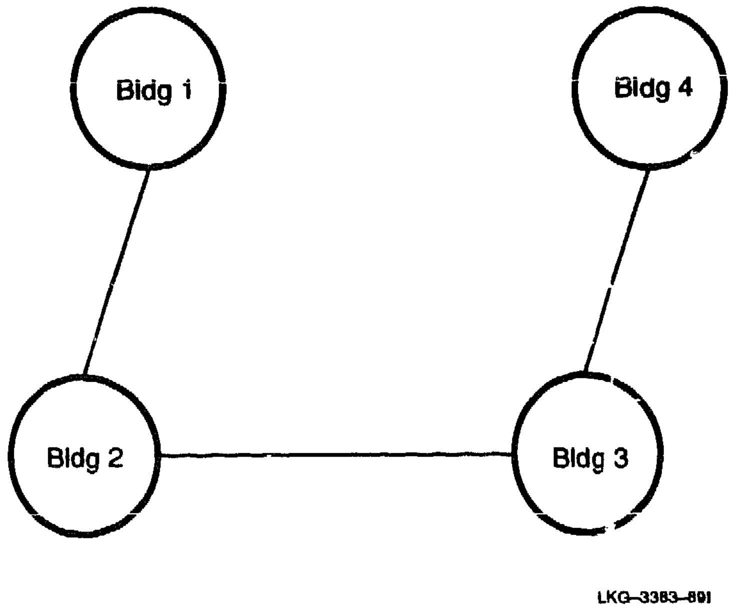
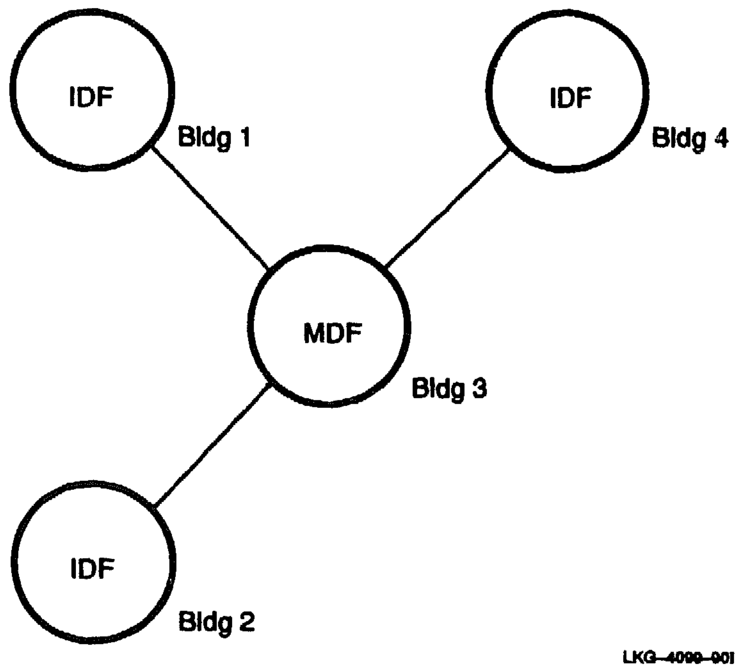


**Figure 1–15: Hierarchical Star Supporting a Point-to-Point Configuration**

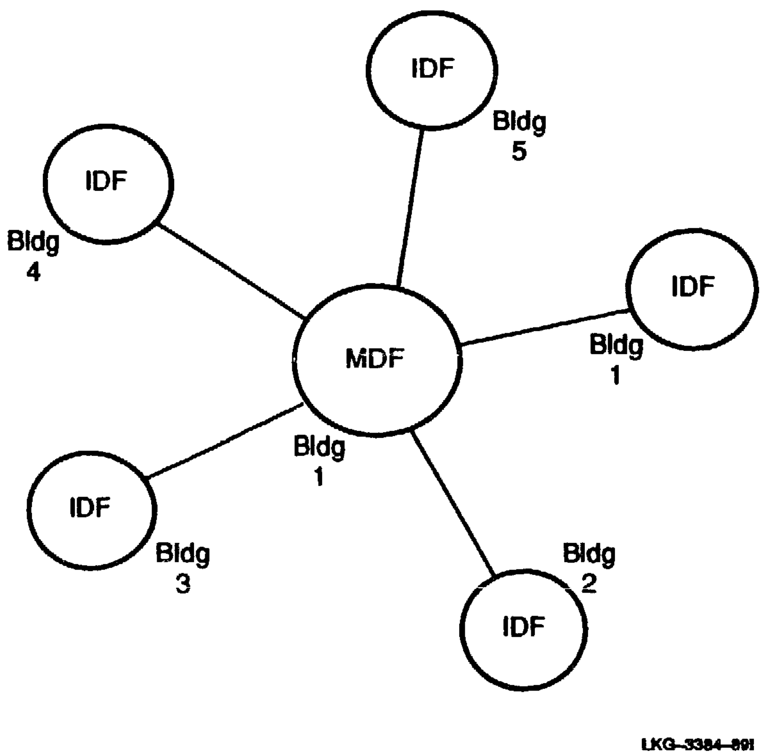


### 1.8.2 Star Configuration

This cabling configuration is a collection of point-to-point links sharing a central administration area. Figure 1–16 illustrates a star configuration.

The star configuration is directly supported over the hierarchical physical star by defining the various hierarchical levels of administration. In this case, the central administration area is defined as the MDF.

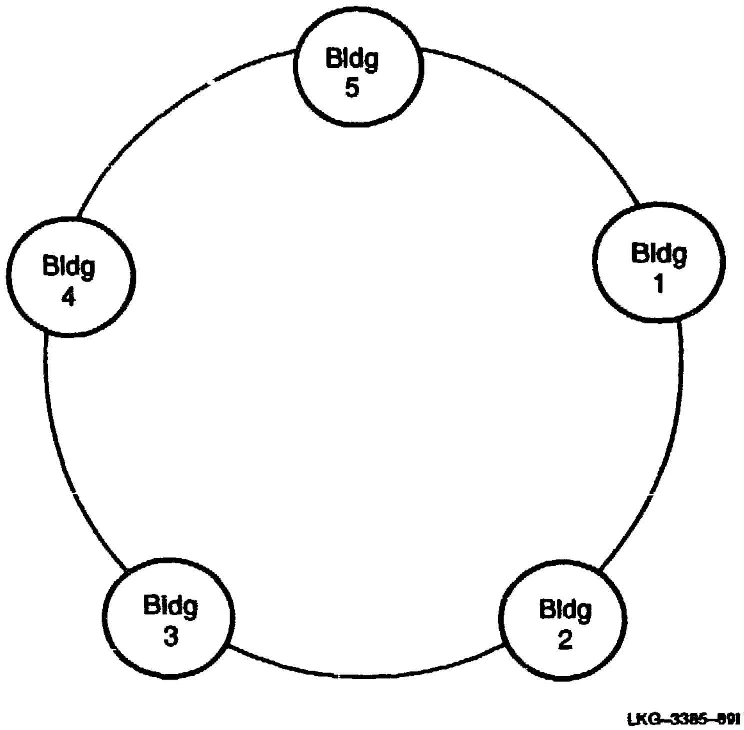
**Figure 1–16: Star Configuration**



### 1.8.3 Ring Configuration

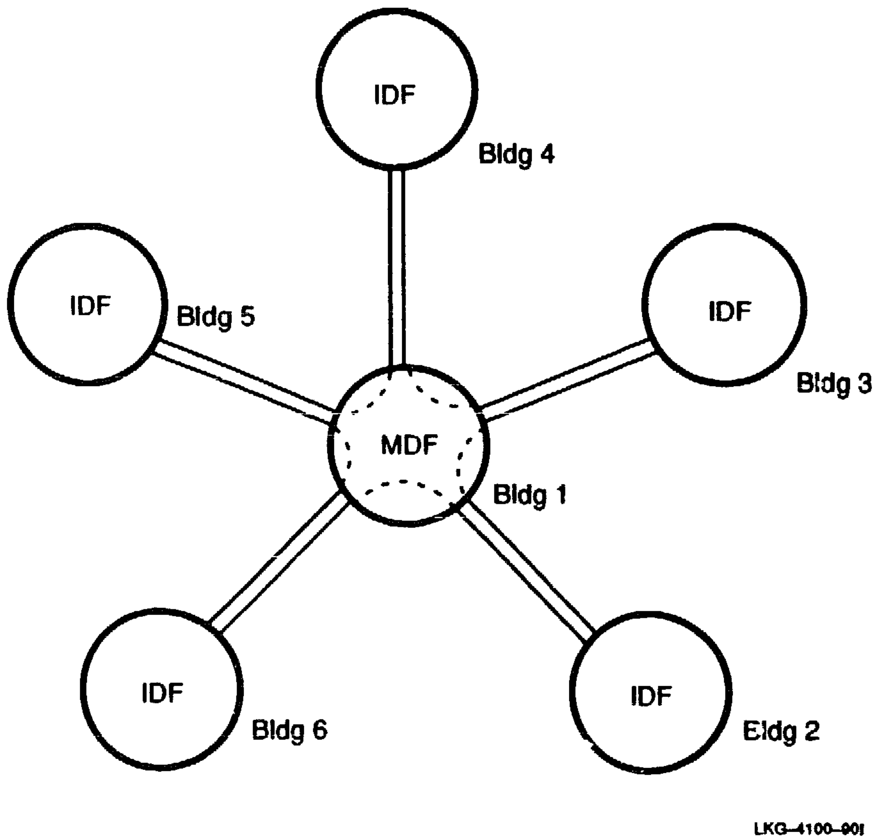
In a ring configuration, the cabling is arranged so that all the buildings are connected together to form a complete loop as shown in Figure 1–17.

**Figure 1–17: Ring Configuration**



As shown in Figure 1–18, the hierarchical star topology can support a ring cabling configuration.

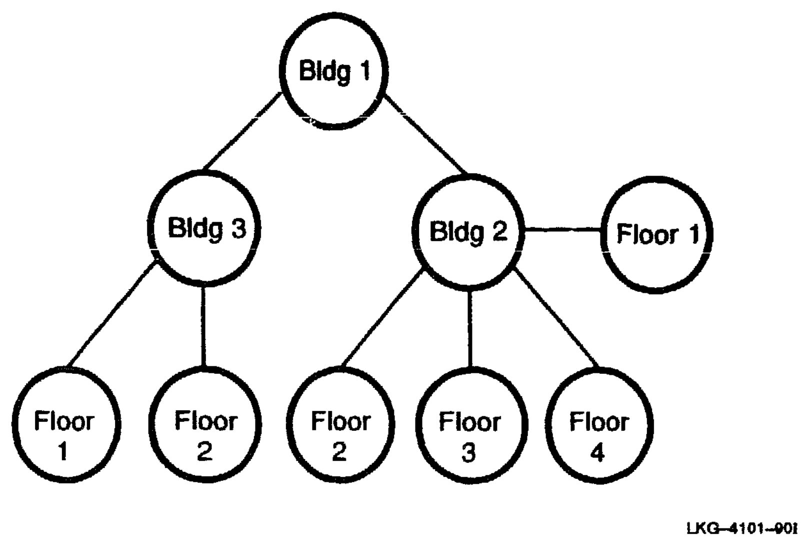
**Figure 1–18: Hierarchical Star Supporting a Ring Configuration**



### 1.8.4 Tree Configuration

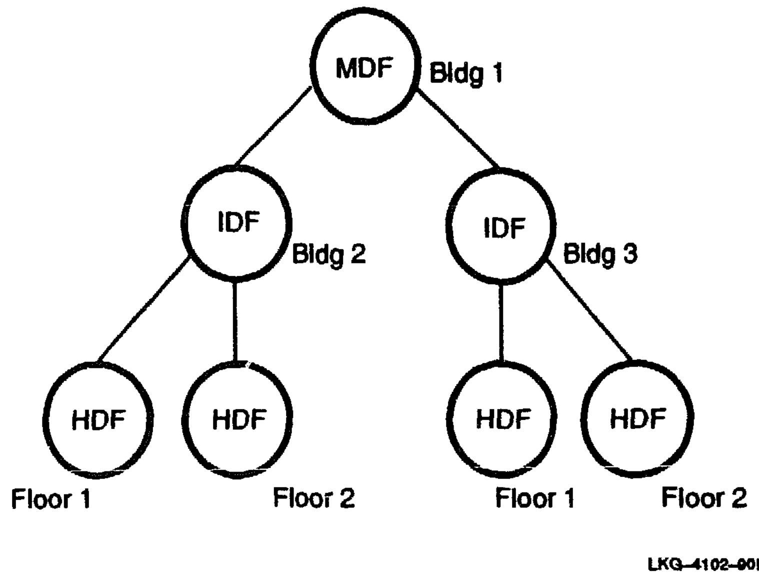
In a tree configuration, the cabling is arranged radially from each of the buildings and floors. Figure 1–19 illustrates a tree configuration.

**Figure 1–19: Tree Configuration**




The hierarchical star supports this configuration by defining levels of hierarchy in the tree. As shown in Figure 1–20, the MDF always connects to the IDF and the IDF always connects to the HDF through the cabling.

Figure 1–20: Hierarchical Star Supporting a Tree Configuration



# CHAPTER 2

# 2 General Planning

This chapter provides general information on the planning, design, fiber optic installation methods, and cable plant hardware for DECconnect structured wiring. Each of the process steps are described as follows:

- Preplanning process. Reviews the actions to be taken before starting the design of a DECconnect System structured wiring cable plant.
- Planning and Design process. Reviews the concept diagram, fiber optic link, fiber optic subsystem planning and design processes, and provides an introduction to administration planning.
- Installation methods. Reviews the fiber optic cables and passive cable plant components as well as the termination and splicing methods that can be used in the structured wiring cable plant.

## 2.1 DECconnect Process Outline

This section outlines the major actions taken when planning and designing a structured wiring cable plant. This action involves either a known application process or an unknown application process.

To plan and design only the structured wiring infrastructure, follow the unknown application design process (see Section 2.1.1). If planning to implement active equipment into the fiber optic structured wiring, follow the known application design process (see Section 2.1.2).

### 2.1.1 Unknown Application Design Process

Table 2–1 outlines the steps to plan and design a site where only the fiber optic cabling and passive hardware are to be installed. No active equipment is planned in this process. Some items include information for both unknown and known application design processes. Follow only the unknown application design process for each section.

**Table 2–1: Unknown Application Design Process**

| Process Step | Reference | Description |
|---|---|---|
| Preplanning | Section 2.2 | Perform site survey; review safety, grounding, and space requirements. |
| Cable plant design process | Section 2.3 | Review process for concept diagram, network schematic, subsystem design, design worksheets, and administration planning. |
| Fiber optic cable plant components | Section 2.4 | Review outdoor and indoor fiber optic cabling and fiber optic passive hardware. |
| Fiber optic installation methods | Section 2.5 | Review connector termination and splicing methods. |
| Concept diagram creation | Chapter 3 | Create the concept diagram by following configuration rules, recommendations, and defined symbology. |
| Administration planning | Chapter 4 | Review the DECconnect fiber optic implementation strategy, administrative connections, and labeling. |
| Fiber optic cable plant design | Sections 5.1, 5.2.3, 5.3, 5.5, 5.7, 5.9 | Create network schematic and calculate link certification loss value. Includes DECconnect System optical budget planning number. |
| Work area wiring design | Chapter 6 | Design work area wiring subsystem. Includes information on work area wiring connections to the wallbox and bill of materials worksheet. |
| Horizontal wiring design | Chapter 7 | Design horizontal wiring subsystem. Includes wallbox requirements, cable routing, cable selection, and bill of materials worksheet. |

**Table 2–1 (Cont.): Unknown Application Design Process**

| Process Step | Reference | Description |
|---|---|---|
| Building backbone design | Chapter 8 | Design building backbone subsystem. Includes cable routing requirements, cable selection, and bill of materials worksheet. |
| Campus backbone design | Chapter 9 | Design campus backbone subsystem. Includes cable routing and cable entrance splice closure requirements, cable selection, and bill of materials worksheet. |
| Distribution frame design | Chapter 10 | Design distribution frames. Includes passive equipment layout and requirements, equipment room requirements, and bill of materials worksheet. |
| How to order cable plant components | Chapters 11 and 12 | Ordering guide for DECconnect fiber optic passive components. |
| Complete preinstallation procedures | Chapter 13 | Handling project management tasks. |

### 2.1.2 Known Application Design Process

Table 2–2 outlines the steps to plan and design a site where both active network hardware and the cable plant system are to be installed. Some steps include information for both unknown and known application design process. Follow only the known application design processes for each section.

**Table 2–2: Known Application Design Process**

| Process Step | Reference | Description |
|---|---|---|
| Preplanning | Section 2.1 | Create logical network design; perform site survey; review safety, grounding, and space requirements. |
| Cable plant design process | Section 2.3 | Review process for concept diagram, network schematic, subsystem design, design worksheets, and administration planning. |
| Fiber optic cable plant components | Section 2.4 | Review outdoor and indoor fiber optic cabling and fiber optic passive hardware. |
| Fiber optic installation methods | Section 2.5 | Review connector termination and splicing methods. |
| Concept diagram creation | Chapter 3 | Create concept diagram by following configuration rules, recommendations, and using defined symbology. |
| Administration planning | Chapter 4 | Review the DECconnect fiber optic implementation strategy, administrative connections, and labeling. |
| Fiber optic cable plant design | Chapter 5 | Create network schematic. Includes link-loss calculation, link certification loss-value calculation, link-loss model, and application information connecting active equipment to the structured wiring cable plant. |
| Work area wiring design | Chapter 6 | Design work area wiring subsystem. Includes information on work area wiring connections to the wallbox and bill of materials worksheet. |
| Horizontal wiring design | Chapter 7 | Design horizontal wiring subsystem. Includes wallbox requirements, cable routing, cable selection, and bill of materials worksheet. |

**Table 2–2 (Cont.): Known Application Design Process**

| Process Step | Reference | Description |
|---|---|---|
| Building backbone design | Chapter 8 | Design building backbone subsystem. Includes cable routing requirements, cable selection, and bill of materials worksheet. |
| Campus backbone design | Chapter 9 | Design campus backbone subsystem. Includes cable routing, cable entrance splice closure requirements, cable selection, and bill of materials worksheet. |
| Distribution frame design | Chapter 10 | Design distribution frames. Includes passive equipment layout and requirements, equipment room requirements, and bill of materials worksheet. |
| How to order cable plant components | Chapters 11 and 12 | Ordering guide for DECconnect fiber optic passive components. |
| Complete preinstallation procedures | Chapter 13 | Handling project management tasks. |

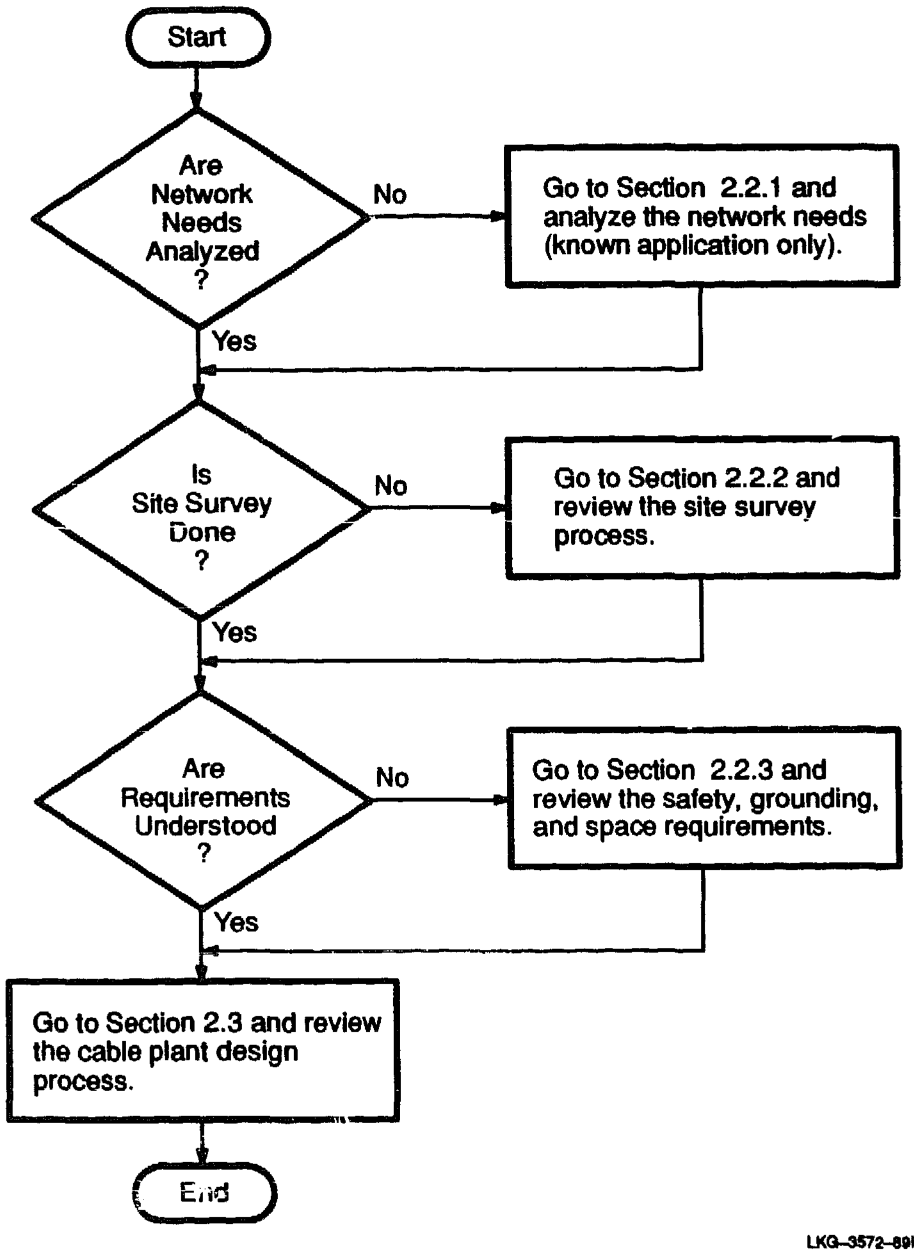
## 2.2 Preplanning Process

The preplanning process consists of actions that must be taken before the design of the structured wiring can begin:

- Analyze the logical network requirements (for known applications only). Determine the types of active equipment that the structured wiring needs to support; create a logical network diagram that provides a conceptual view of how to connect active equipment.
- Perform the site survey. Physically inspect the site and record information necessary to the design process.
- Review safety, grounding, and space requirements. Identify issues that must be considered when designing a structured wiring cable plant.

The flow chart shown in Figure 2–1 provides an overview of the preplanning process.

**Figure 2–1: Overview of the Preplanning Process**



### 2.2.1 Network Analysis

When considering known application requirements, the network analysis process determines the communication and configuration requirements for the site and for the individual subsystems within the site. The following factors can affect the site's communications needs:

- Existing or planned buildings
- Size and growth

The results of the network analysis and definition process is a logical network design diagram. This diagram accounts for the different types of data communication services, network performance requirements, and active network hardware that the structured wiring must support. This logical network design diagram is required in the design process for known applications.

#### 2.2.1.1 Logical Network Design

When planning and designing a structured cable plant with requirements to define active equipment, complete a logical network design. (This process is outside the scope of this manual.) For detailed information on the logical network design process, see the following Digital documents:

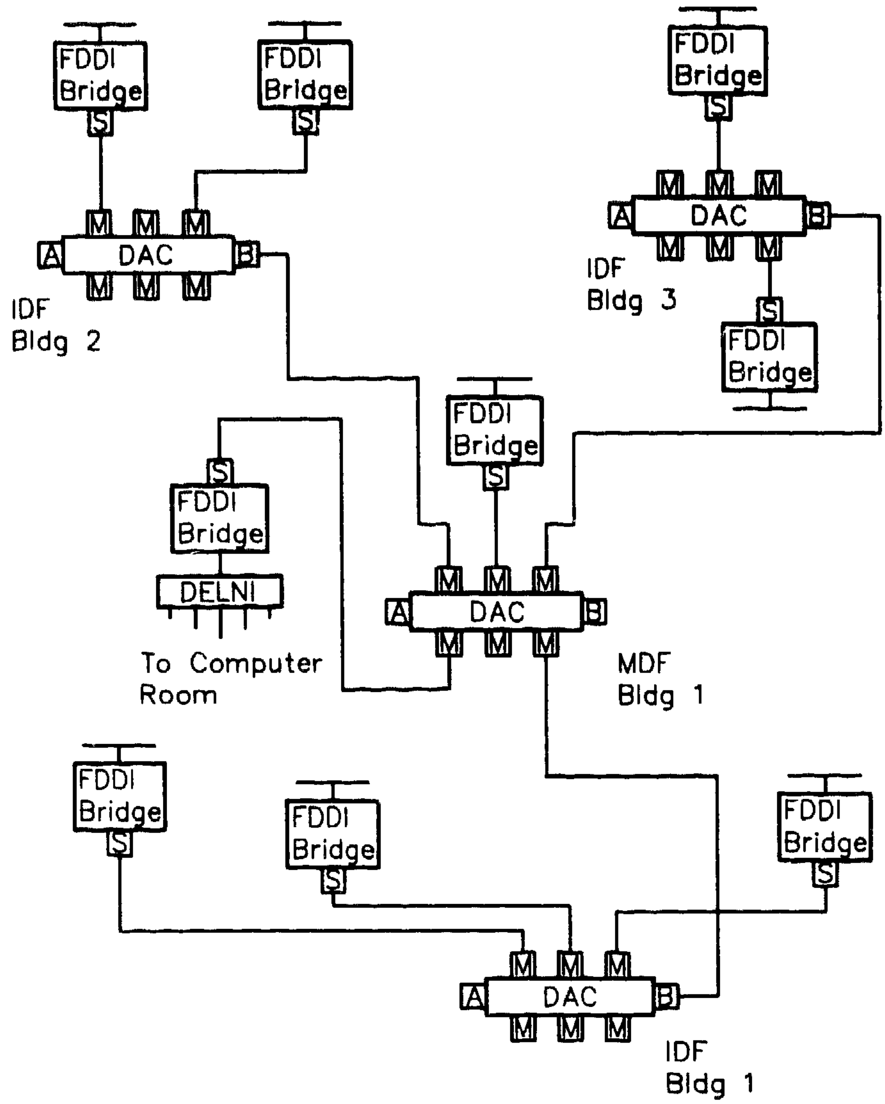
- *Networks and Communications Buyer's Guide*
- *Introduction to Network Performance* (EK-NETWK-TM)

The logical network design begins with analyzing of the types of data communication that need to be provided by the network. This analysis requires understanding the services and applications, communication protocols, and signaling schemes that must be supported in the current or proposed network.

Once the network requirements are determined, the next step is to determine the computing and active networking equipment (such as FDDI or Fiber Optic Ethernet) needed to provide for those services. This process requires understanding the performance criteria of the equipment to be used.

The final step in the logical design process is to create a diagram that provides a conceptual view of how the defined active equipment is connected. Figure 2–2 provides an example:

**Figure 2–2: Logical Network Design Example**




Legend:

| | |
|---|---|
| DAC | Dual Attachment Concentrator |
| DELNI | Local Network Interface |
| FDDI | Fiber Distributed Data Interface |
| FDDI Bridge | FDDI–to–Ethernet Bridge |
| IDF | Intermediate Distribution Frame |
| MDF | Main Distribution Frame |

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#### 2.2.1.2 Existing or Planned Buildings

A building that is in the planning stages (or one that is currently being constructed or renovated) offers an ideal opportunity to design a well-concealed distribution system in a timely and cost-effective manner.

When an existing building already has a distribution system, four questions about the current arrangements must be answered when planning for communications needs:

- How much of the current system can be used?
- How much is technically capable of meeting the long-term interests and planning considerations?
- What must be altered or added to accommodate the communications needs?
- What is the cost of determining how much existing cable and distribution hardware can be used, compared to the cost of installing new cable and hardware?

To adapt the new requirements to a current distribution system without sacrificing service, efficiency, and appearance, examine all aspects of the existing system as follows:

- System arrangement.
- Type of cable entrance.
- Building backbone and horizontal wiring subsystems.
- Number, size, and locations of equipment rooms, including each room's wall space, power supplies, and support hardware.

### 2.2.1.3 Size and Growth

The size of a structured wiring cable plant depends on the type and use of the site, the diversity of communications requirements, and anticipated growth.

The size of the initial installation affects other planning aspects, including the location and size of the building entrance area (the cable entrance point); the size of the equipment rooms and strength of their floors; the need, number, and size of the riser and satellite locations.

Take future growth into account when planning the size of a system. Because of advancing technology and the ever-increasing communications needs of building's occupants, a distribution system planned to accommodate only current requirements may become obsolete.

Often buildings are constructed without knowing the exact requirements. The DECconnect System provides guidelines suitable for a wide range of applications to adopt when exact requirements are not known. This allows wiring to be installed during construction that will lower costs.

## 2.2.2 Site Survey

The site survey is a critical phase of the preplanning process. A cost-effective installation of a fiber optic cable plant relies on a comprehensive site survey. This survey, which is completed using the *DECconnect System Requirements Evaluation Workbook* (EK-DECSY-EG), records information about the site's buildings (existing or planned). In addition, the survey provides details needed for the layout of the structured wiring cable plant.

### 2.2.2.1 Survey Process

The site survey requires the following actions:

- Walk through all the buildings and examine all possible cable routes.
- Ask about future building plans.
- Obtain to-scale site and building floor plans and any other important documents that define the site's existing or planned cable requirements.
- Record all information pertinent to the design and installation of a structured wiring cable plant.

#### 2.2.2.2 Survey Information

The information recorded during the site survey describes the intrabuilding and interbuilding physical construction issues. Use the worksheets in the *DECconnect System Requirements Evaluation Workbook* to:

- Identify contacts and record important dates.
- Identify and outline environmental issues affecting the site.
- Identify existing and proposed intrabuilding and interbuilding cable routing and cable support structures as well as physical obstacles to cable routing.
- Identify equipment rooms and their physical dimensions.

The survey information helps the network designer plan the cable plant, create bid specifications and project management checklists, and complete the installation documentation for finished installations.

### 2.2.3 Review Documentation on Safety, Grounding, and Space Requirements

Before the design process begins, have available for review reference documents for safety, grounding, and space requirements.

The required documents are:

- Site plan. To-scale drawing of the site is necessary for the design process. If a site plan is not available, it must be created, since it is used during the design process to record:
  - Cable routing methods (existing and planned) for the interbuilding cable runs and the location of support hardware (such as utility hole covers and telephone poles).
  - Location of the cable entrance points for the site buildings.
- Floor plans. To-scale layouts of the floors within each of the buildings are needed during the design process to record:
  - Location of the building's network cable entrance.
  - Location of distribution elements (distribution frames and wallboxes) within each floor.
  - Routing of cables between distribution elements (distribution frames and wallboxes) and within equipment rooms.

- Copies of the *DECconnect System Requirements Evaluation Workbook* (EK-DECSY-EG) worksheets. These worksheets, filled in during the site survey (see Section 2.2.2), provide reference information on the existing and planned buildings, floors, and work areas.
- The *BICSI Telecommunications Distribution Methods Manual*. Provides information on all types of building and cable plant requirements, including:
  - Cable entrance points and associated grounding, bonding, and electrical protection requirements.
  - Equipment rooms for distribution frames (such as MDF, IDF, HDF, or SDF).
  - Routing methods for campus or building backbone cable runs.
  - Fiber optic cable and cable plant hardware descriptions
- *The National Electrical Code (NEC)* and local codes. Provides rules concerning building, fire, and electrical code requirements.

## 2.3 Cable Plant Design Process

The cable plant design is a step-by-step process that begins with an initial layout of the site and ends with the design of a complete, manageable cable plant. The design process for fiber optic subsystems within a structured wiring cable plant includes the following major steps:

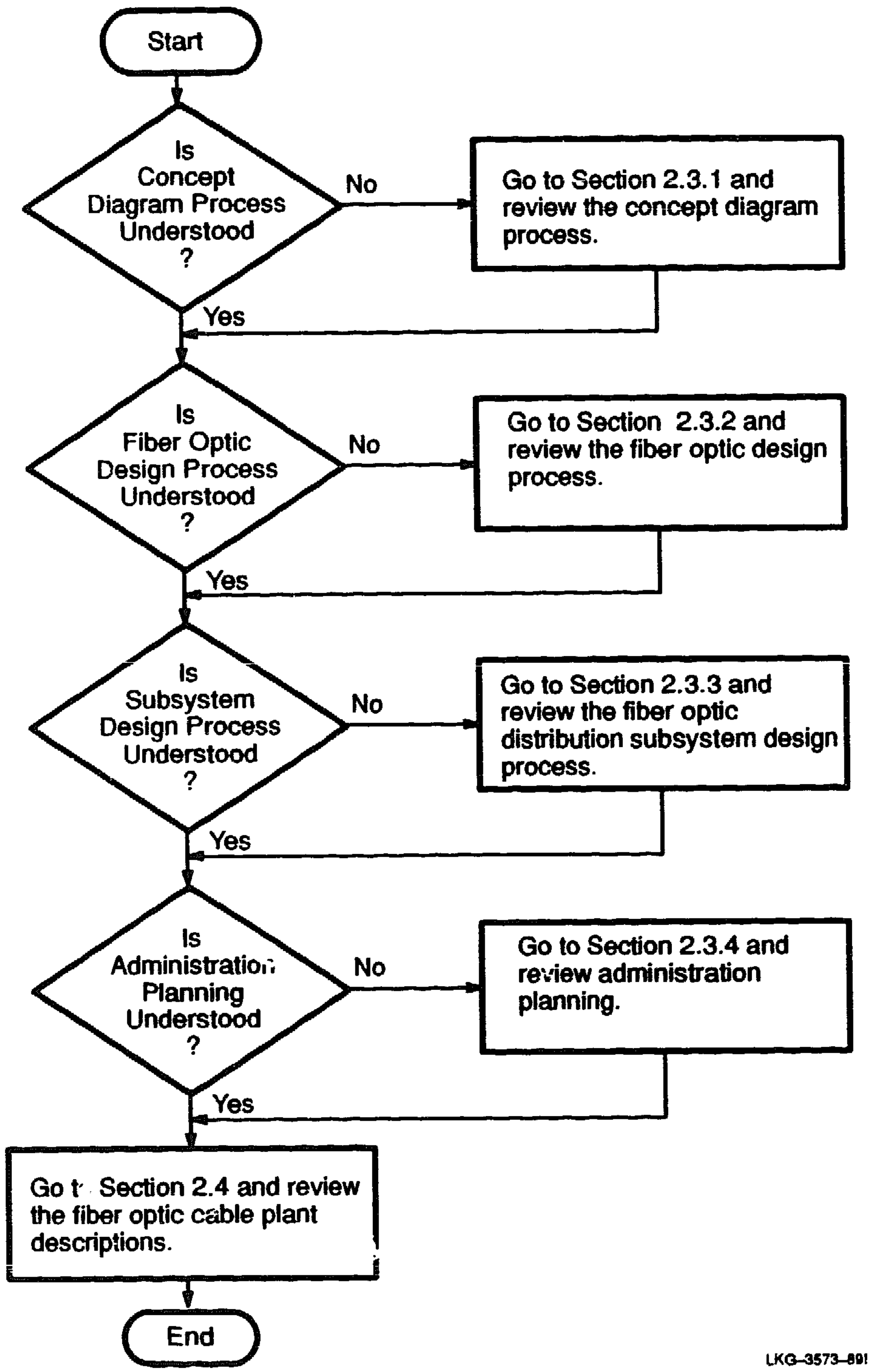
**NOTE**

> This manual provides information on designing fiber optic subsystems within a structured wiring cable plant. For information on designing copper-based structured wiring subsystems, see the *DECconnect System Planning and Configuration Guide* (EK-DECSY-CG).

- Create concept diagrams that illustrate how the structured wiring will connect the site into a single cable plant.
- Fiber optic cable plant design process for known and unknown applications:
  - For known applications, use the fiber optic link-loss models to define the structure of the fiber optic links, and to create network schematics that detail how the active fiber optic networking equipment connects to the structured wiring cable plant.
  - For unknown applications, a schematic is created detailing the passive connections in the wall at each of the distribution subsystems.
- For subsystem design, define the fiber optic cable and other cable plant hardware that is required to carry out the cable plant design illustrated in the concepts diagram and cable plant schematics.
- Identify and label administration subsystems that allow management of the structured wiring cable plant

The flow chart in Figure 2–3 provides an overview of a cable plant design process.

## Figure 2–3: Overview of a Cable Plant Design Process



### 2.3.1 Concept Diagram Overview

The concept diagram depicts the framework of the physical topology to be used in connecting the distribution subsystem into a structured wiring cable plant.

**NOTE**

For a description of concept diagrams, including samples, see Chapter 3.

The concept diagrams show:

- How the structured wiring subsystems' distribution elements (distribution frames and wallboxes) are connected.
- How many links will be between each distribution element what fiber type and size will be used in each link, and what the fiber count will be for each link.
- Where the distribution elements are located.

### 2.3.2 Fiber Optic Cable Plant Design Overview

The fiber optic cable plant design process results in the creation of a network schematic and the calculation of the link certification value for each of the fiber optic links. A network schematic is similar to an electrical schematic. A network schematic illustrates all of the passive fiber optic hardware. For known applications, it indicates the connection of the active hardware into the structured wiring.

- For the unknown application design, use the concept diagram and optical planning budget numbers to help create the network schematic.
- For the known application design, the logical design diagram, concept diagram, link-loss models, link-loss calculations, the optical parameters of the active hardware contribute to creating the network schematic. Application information is included for specific network products such as FDDI and the fiber optic Ethernet systems.

In both cases, complete a worksheet indicating the link certification values used to provide acceptance criteria for the installed cable plant. Acceptance procedures are included in the *DECconnect System Fiber Optic Installation* manual.

**NOTE**

For a description of network schematics, including samples, see Chapter 5.

### 2.3.3 Fiber Optic Distribution Subsystem Design Overview

The fiber optic distribution subsystem design involves selecting the fiber optic cable plant components (including cable) that are needed to create the physical structured wiring cable plant.

The subsystem design is divided into five major design processes in this manual:

- Work area wiring design (Chapter 6)
- Horizontal wiring cabling design (Chapter 7)
- Building backbone cabling design (Chapter 8)
- Campus backbone cabling design (Chapter 9)
- Distribution frame design (Chapter 10)

Each subsystem design defines all of the requirements for that particular part of the structured wiring cable plant. At the end of each subsystem design, a bill of materials (BOM) is created for ordering hardware components.

The distribution frame design process (Chapter 10) provides step-by-step procedures for defining all of the cable plant component requirements of each of the structured wiring distribution frames, including cable routing hardware requirements within all distribution frame equipment rooms.

The other four design processes provide all of the procedures for defining each subsystem's cable and cable routing hardware requirements.

#### 2.3.3.1 Fiber Optic Subsystem Design Worksheets

During the design of each fiber optic distribution subsystem, fill out a set of worksheets. These worksheets define the fiber optic cables and cable plant components needed to carry out the subsystem's design, including:

- Cable types
- Cable routing and cable support
- Equipment rack layouts
- Passive fiber optic hardware components

Also use the worksheets to summarize all the components into bills of material (BOMs).

**NOTE**

A blank BOM for ordering Digital fiber optic cable plant components from Digital (or other vendors) is provided in Chapter 12.

#### 2.3.3.2 Subsystem Design Reference Documents

The following references are available for the subsystem design process:

- Documents discussed in Section 2.2.3.
- Concept diagrams and network schematics created during the design process to define requirements for each subsystem's cable and cable plant.
- Chapter 11, which provides descriptions of fiber optic cable plant components available from Digital, as well as other vendor components approved for use in a DECconnect System structured wiring cable plant.

### 2.3.4 Administration Planning Overview

Administration planning is used in both design and installation processes. This planning, described in Chapter 4, is a twofold process that enables:

- The development and implementation of physical labeling for the cables and passive components of the DECconnect System structured wiring.
- The definition of administration points within the structured wiring where each of the subsystems are connected together through connection rules.

#### 2.3.4.1 Cable Plant Labeling

Labeling provides physical addresses for cables and cable plant components. These physical addresses allow the designer, cable plant installer, network manager, and service personnel to convey information to one another about the connectivity that must take place in the installation of the structured wiring cable plant as follows:

- The designer assigns unique labels to the equipment rooms, cables, splices, and connections of the equipment using the methods described in Chapter 4.

- The installer affixes these labels to the components of the cable plant using the methods described in the *DECconnect System Fiber Optic Installation* guide (EK-DECSY-FI).

#### 2.3.4.2 Administration Points

For known applications, the designer is responsible for selecting administration points (crossconnects and interconnects) for the different distribution frames within the structured wiring cable plant. At each of these points, either passive connections connect the subsystems together through crossconnects or active equipment connects to each subsytem through interconnects.

For unknown applications, crossconnects and interconnects are added at a future time when active equipment is connected to the cable plant.

## 2.4 Fiber Optic Cable Plant Components

This section provides brief descriptions of the different types of fiber optic cables and fiber optic cable plant hardware that can be used in a structured wiring system.

**NOTE**

Digital recommends 62.5/125 dual window multimode fiber for all new installations. For support of 50/125 or 100/140 fiber size, see Appendix A.

### 2.4.1 Fiber Optic Cables

A site's structured wiring can use all fiber or a mix of fiber and copper segments.

**NOTE**

For information on copper cabling, refer to the *DECconnect System Facilities Cabling Installation* guide (EK-DECSY-FC).

The following subsections describe the types of fiber optic cable that Digital recommends for use in a structured wiring system:

- Loose-tube and slotted-core outdoor cables
- Stranded tight-buffered indoor cables

**Also provided is information on environmental and other issues that affect the indoor and outdoor cables, as well as cable routing considerations for all fiber optic cable types.**

**NOTE**

> **For information on other types of fiber optic cables to use in indoor and outdoor environments, see the *BICSI Telecommunications Distribution Methods Manual.***

### 2.4.1.1 Outdoor Cable

The Digital-recommended outdoor cables (loose-tube and slotted-core) are available in:

- Single-mode and/or multimode fiber
- Armored or all-dielectric

#### Loose-Tube Cables

Loose-tube cables are typically used only in outdoor applications. In these cables, the optical fibers are placed inside buffer tubes within the cable, isolating the fibers from outside forces. The buffer tubes are then stranded around an antibuckling member at the center of the cable.

**NOTE**

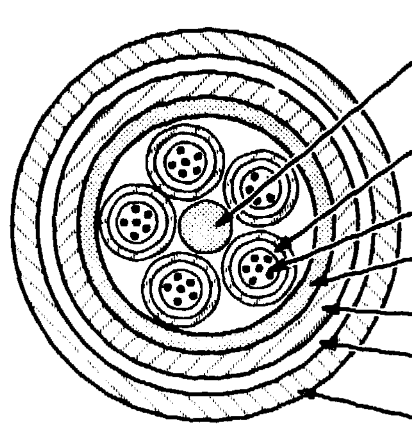
> The *National Electrical Codes* allow a loose-tube cable to extend into a building from outside the building for routing to an equipment room. The NEC routing requirements for that indoor portion of the interbuilding loose-tube cable are outlined in the mixed (indoor/outdoor) environmental description in Section 2.4.1.3.

Figure 2–4 illustrates the elements of a typical loose-tube cable. The steel-tape armor element shown in this figure is present only in armored versions.

**NOTE**

> The *National Electrical Codes* require that the armored portion of the cable must be grounded at the building entrance points. Refer to the *BICSI Telecommunications Distribution Methods Manual* for more information.

**Figure 2–4: Loose-Tube Cable Elements**




### Slotted-Core Cables

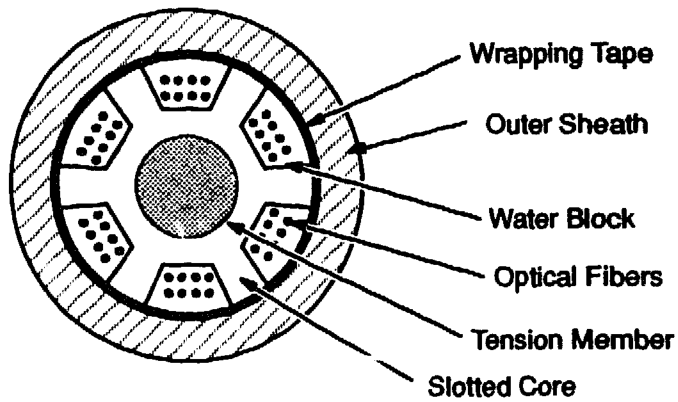
Slotted-core cables are typically used as outdoor cables. In a typical slotted-core cable, the optical fibers are placed inside water-blocked slots in a core. At the center of the core is a tension member. The core, and the slots containing the optical fibers, is enclosed in wrapping tape and an outer sheath. Other versions include cables that have Kevlar reinforcement members or consist of several slotted-core segments bundled into a single cable.

**NOTE**

> The *National Electrical Codes* allow a slotted-core cable to extend into a building from outside the building for routing to an equipment room. The NEC routing requirements for that indoor portion of the interbuilding slotted-core cable are outlined in the mixed (indoor/outdoor) environmental description in Section 2.4.1.3.

Figure 2–5 illustrates the elements of a typical 20-to-60 fiber slotted-core cable. The actual construction of the slotted-core cable varies based on the fiber count.

Figure 2–5: Slotted-Core Cable Elements




### Outdoor Cable Applications

Outdoor cables (loose-tube or slotted-core) are not usually constructed of materials that are acceptable to building fire codes. Typical applications for outdoor cables include:

- Direct buried. Outdoor cable that is rodent- and crush-resistant. Some direct-buried versions of outdoor cable are armored (contain a metal protective member).
- Buried conduit. All-dielectric (no metallic elements) outdoor cable that runs in conduit eliminates the need for grounding the cable at a building entrance. This type of cable can run next to power cables without voltages being induced.
- Aerial. Armored outdoor cable strung between buildings and poles is designed to withstand wind and ice-load conditions as well as the deteriorating effect of direct exposure to the sun.
- Underwater. Versions of the outdoor cable that are specifically designed for running under water (such as ponds or rivers).

#### 2.4.1.2 Indoor Cable

Indoor cables (single-mode, multimode, or mixed multimode/single-mode fiber) are available in one form: tight-buffered.

Tight-buffered cables are used for the following applications:

- Building backbones
- Horizontal wiring
- Work area wiring
- Distribution frame patch cable assemblies

Tight-buffered cables are available in two forms: light-duty cable and heavy-duty cable.

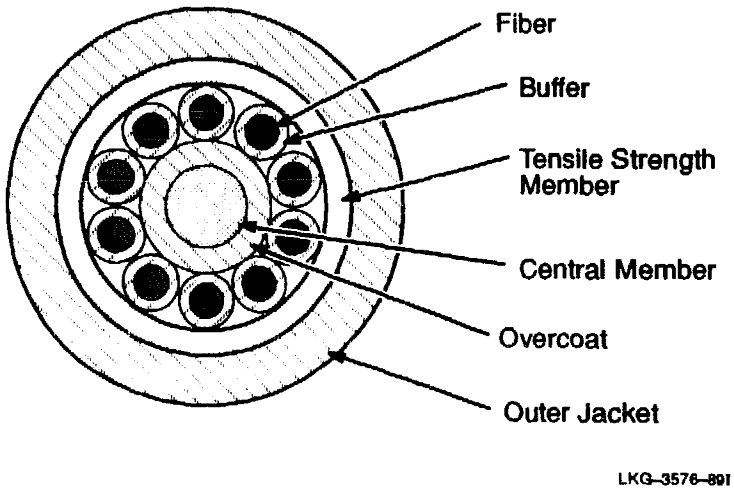
Light-duty cables are used in applications where pulling tension of the cable does not exceed 45.36 kilograms (100 pounds). Light-duty cables are constructed from fibers stranded directly around a central cable member and then jacketed with one of the following:

- Polyvinyl Chloride (PVC) (for general use cable) material
- Riser-grade thermoplastic material
- Plenum-grade thermoplastic material

Heavy-duty cables are used in applications were pulling tension on the cable does not exceed 113.4 kilograms (250 pounds). They are constructed similar to the light-duty cable except that each fiber strand has an additional layer of thermoplastic material. The additional buffering provides more protection to allow for higher pulling tension.

Figure 2–6 illustrates the elements of a typical light-duty stranded tight-buffered cable.

Figure 2–6: Light-Duty Stranded Tight-Buffered Cable Elements




### Building Backbone and Horizontal Wiring Cable

Use tight-buffered cable in building backbone and horizontal wiring applications. These cables are rugged, easy to handle and pull through conduit.

Three types of cable jackets are available for the building backbone and horizontal wiring cables:

- General use cable (nonplenum). Has outer jacket that meets the NEC requirements for cable that passes through nonenvironmental airspace.
- Riser. Has outer jacket that meets the NEC requirements for cable that passes between floors in a vertical shaft.
- Plenum. Has outer jacket that meets the NEC requirements for cable that passes through environmental airspace.

**NOTE**

Environmental airspace are areas that act as return systems for a building's heating, ventilation, and air conditioning systems. For more information on environmental and nonenvironmental airspaces, and plenum and nonplenum cable jackets, see the summary of NEC cabling requirements provided in Appendix E.

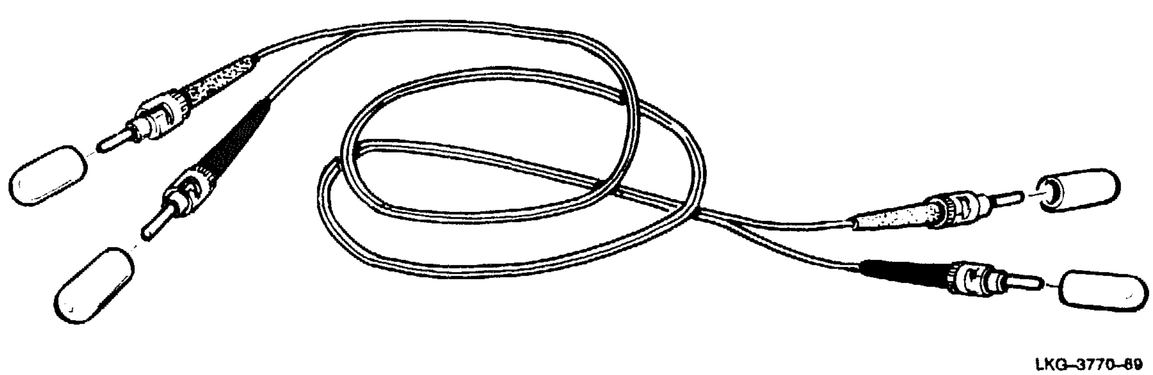
**Work Area Wiring and Administration Subsystem Patch Cables**

Work area wiring and patch cables usually contain two fibers that are used as:

- Work area wiring connections between the user active equipment and wallboxes
- Patch cables for crossconnects and interconnects at distribution frames

These cables are available as complete, factory terminated assemblies. Figure 2–7 illustrates a dual 2.5 mm bayonet ST-type connector cable assembly that can be used (depending on length) as patch or work area wiring cables.

**Figure 2–7: Work Area Wiring or Patch Cable Factory-Terminated Assembly**




### 2.4.1.3 Cable Considerations

Selecting a cable requires more than a simple understanding of the types of cables available and their general use. This section describes cable considerations to take into account when planning the cable to be used at a site.

### Indoor Environmental Considerations

Tight-buffered cable is recommended for indoor environments. The major considerations for indoor cabling are the same for each cable run within a site:

- Environment. Consider whether plenum-grade cable is needed for the cable run being studied, as well as whether building backbone, horizontal wiring, office, or patch cable is needed.
- Cable strength. Consider whether the cable run requires an additional strength member for long vertical runs.

### Outdoor Environmental Considerations

The type of cable to be used is defined by the application (aerial, underwater, buried conduit, or direct buried). Additional considerations for outdoor cable runs are:

- Location of utility hole covers for access to the cable or cable conduit
- Location of any aerial supports
- Location of building cable entrance points

### Mixed (Indoor/Outdoor) Environmental Considerations

A mixed environment exists when any outdoor cable extends more than 15 meters (50 feet) into a building. In such cases, the NEC allows routing the cable used in a campus backbone link from the cable entrance point to the distribution frame (where the cable terminates) as long as that cable is marked with the fire resistance rating described in section F.2 in Appendix F. Cables with no marking must be routed inside a metal enclosure. Digital recommends using metal conduit with inner duct to route the outdoor cable to the distribution frame.

**NOTE**

> Splicing indoor cable to the outdoor cable at the cable entrance point is not recommended by Digital. This additional splice in the link is too costly in terms of optical loss and monetary expense.

### Cable Slack Considerations

Cable slack is cable in excess of the amount needed to interconnect a cable at both ends. Cable slack is needed at each end of a fiber optic cable run in order to bring the cable end to a suitable work area or surface for performing splicing or field-termination procedures. Cable slack also provides a service loop for future maintenance and repairs.

Digital recommends specific cable slack for the following situations:

- At outdoor splice points: 9.0 meters (29.5 feet) for each cable to be spliced.
- At distribution frames: 4.5 meters (14.8 feet) for each distribution frame cable end.
- Computer rooms and system common equipment: 4.5 meters (14.8 feet) for each cable end.
- At wallboxes: 0.6 meters (2 feet) for each wallbox cable end.

#### 2.4.1.4 Cable Routing Considerations

Follow these guidelines when installing any type of fiber optic cable:

- Make sure the minimum bend radius for all cable routing support and attachment systems is not less than specified by the cable manufacturer as the long-term minimum bend radius.
- Always use split-mesh grips to support a fiber optic cable's weight in vertical cable runs particularly at a point where the cable makes a transition from a vertical run to a horizontal run.
- Fiber optic cable that is installed horizontally within a building without the physical support of cable trays, raceways, conduit, or innerduct, should be suspended above the ceiling using the building's structural steel beams. Directly attach the cable or use J-hooks and guidewires to attach the cable to the beam. Support the cable along the beam every 2 meters (7 feet) to 3 meters (10 feet).
- Vertical runs should be attached or supported every 10 meters (30 feet) or less.
- The maximum length of the vertical run for any cable is directly related to the maximum pulling tension that the cable manufacturer specifies for the cable. For example, when the cable is rated at 57 kilograms (125 pounds) and the cable weighs 372 gram/meter (0.25 pound/foot), then the maximum length of that cable's vertical run is 152 meters (500 feet).
- Fiber optic cable are installed in an innerduct when they run through conduit. The innerduct is an extruded, semirigid, corrugated, plastic duct in the conduit. It helps guide the fiber optic cable through the conduit to avoid exceeding the minimum bend radius.

The diameter of innerduct is between 2.54 centimeters (1.00 inches) and 3.17 centimeters (1.25 inches) and is manufactured in 1640-meter (5380-foot) lengths. The innerduct fill ratio is 40%.

Other possible applications for innerduct include using it to route fiber optic cable through plenum airspaces. Spare innerduct can be installed in conduit in anticipation of future fiber optic cable installations. This reserves space in the conduit for future cable runs so that it can be pulled through the conduit easily.

**NOTE**

Innerduct is designed to handle a one-time installation of a bundle of fiber optic cables. Pulling cables through an innerduct already containing fiber optic cables is not recommended.

The following guidelines apply to the fill ratio for conduit or enclosed raceways. These are designed to help prevent damage to the cables during installation:

**NOTE**

The fill ratio guidelines are critical when installing fiber optic cables in a conduit or enclosed raceway where the minimum bend radius and pulling tension exerted on the cable must not be exceeded. Permanent damage to the cable is possible.

- A maximum fill ratio of 50% is recommended for communication cable installed within a conduit or enclosed raceway.
- The 50% fill ratio allows for two 90° bends along the length of the conduit or enclosed raceway, with or without pullboxes installed at each of the two bends.
- If a conduit or enclosed raceway has more than two 90° bends, then the fill ratio of 50% must be derated by 15% for each additional bend.

### 2.4.2 Fiber Optic Cable Plant Hardware Overview

This section describes the hardware that can be used in a site's fiber optic structured wiring subsystems. Cable plant hardware includes:

- Termination shelves
- Splice shelves

- Storage shelves
- Combination shelves
- Fiber optic remote wall enclosures
- Splice closure
- Wallboxes
- Equipment racks

**NOTE**

The cable plant hardware also includes connectors used to terminate the cables. The fiber optic connectors are described in Section 2.5.

All shelves come with hardware that mounts on a wall or in an equipment rack (19 or 23-inch). Rack mounting is used where communication equipment is to be installed. Use wall mounting when rack space is not available.

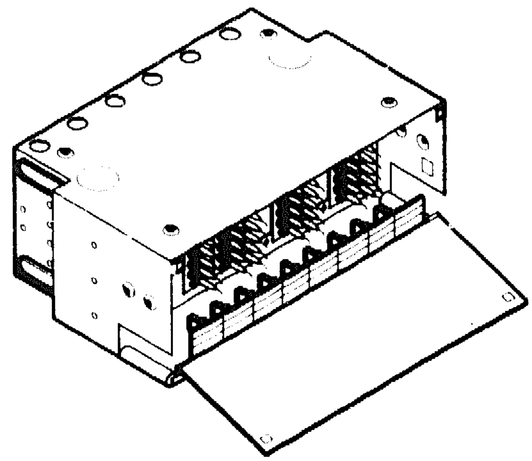
**NOTE**

Chapter 11 provides more detailed information about Digital's passive components, fiber optic cables, and cable assemblies.

#### 2.4.2.1 Termination Shelf

Provides for patch panel termination of indoor and outdoor cable. Each termination shelf can contain up to 12 connector panels, with each connector panel connecting up to 6 fibers, for a total of up to 72 connections. Figure 2–8 shows the termination shelf.

Figure 2–8: Termination Shelf



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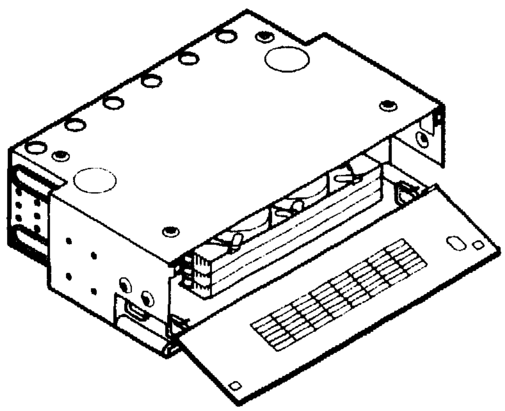
### 2.4.2.2 Splice Shelf

Provides for storing mechanical or fusion splices. Each splice shelf can contain up to 3 splice organizer trays, with each organizer tray storing up to 24 splices, for a total of up to 72 splices. Figure 2–9 shows the splice shelf.

**Figure 2–9: Splice Shelf**



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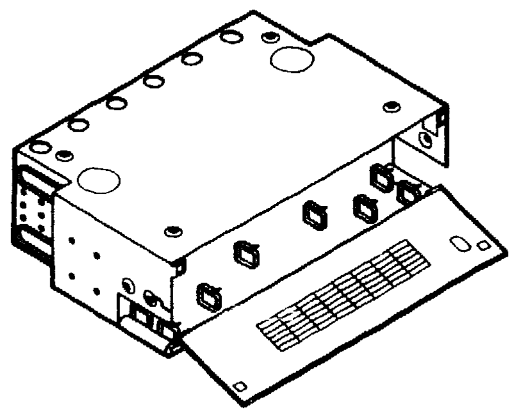
#### 2.4.2.3 Storage Shelf

Provides for storing terminated jumpers or buffered cable. Figure 2–10 shows the storage shelf.

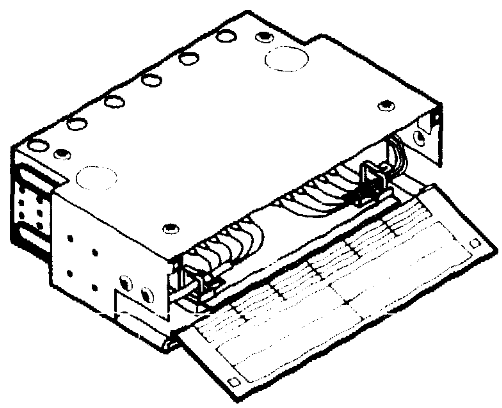
**Figure 2–10: Storage Shelf**



### 2.4.2.4 Combination Shelf

Provides for storing splice or terminated indoor or outdoor cable. Each combination shelf has a capacity of 24 fibers. Figure 2–11 shows the combination shelf.

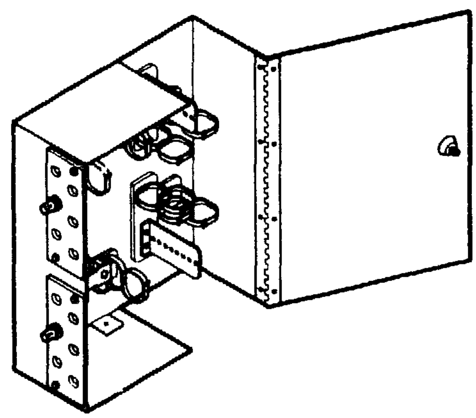
**Figure 2–11: Combination Shelf**



### 2.4.2.5 Fiber Optic Remote Wall Enclosure

Provides for wall-mounted splicing or termination of fiber optic cable. The enclosure has a capacity of 12 fibers, with 2 connector panels of 6 fibers each. Figure 2–12 is an illustration of a fiber optic remote wall enclosure.

**Figure 2–12: Fiber Optic Remote Wall Enclosure**



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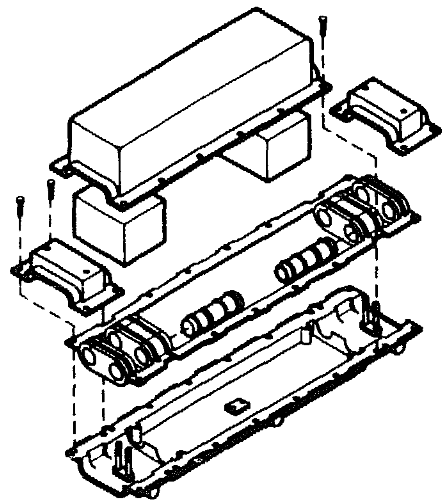
### 2.4.2.6 Splice Closure

A sealable unit used for splicing indoor and outdoor cable. It can be used to splice indoor-to-indoor, outdoor-to-outdoor, or indoor-to-outdoor cables. Figure 2–13 is an illustration of a splice closure.

**Figure 2–13: Splice Closure**



### 2.4.2.7 Wallbox

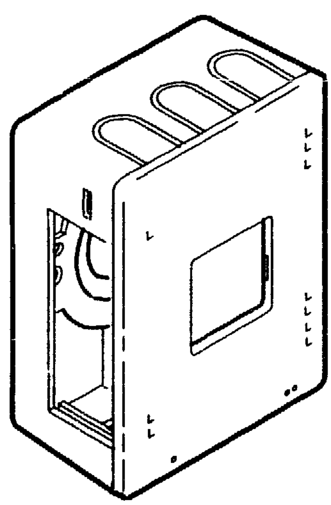
The wallbox is the interconnection point between the horizontal and work area distribution subsystems within the structured wiring. It is the point where active equipment in the work area connects to the structured wiring system.

Digital requires using the DECconnect System H3111-GA (gray), H3111-GB (white), or H3111-GC (ivory) wallbox. Each order number includes a kit of eight wallboxes. Figure 2–14 shows the wallbox.

**NOTE**

> The H3111-GA/GB/GC wallbox allows for copper or fiber connections at the work area's active equipment.

**Figure 2–14: Wallbox**

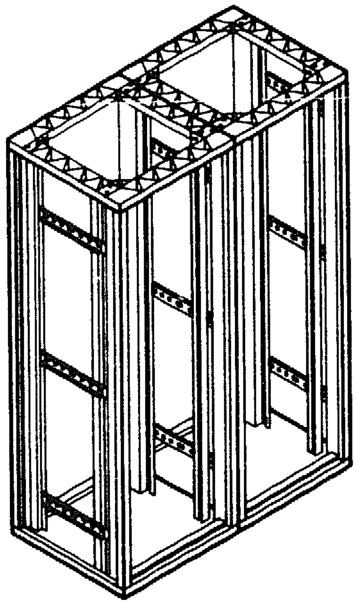


### 2.4.2.8 Equipment Racks

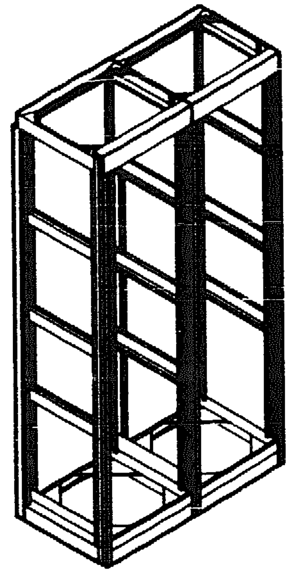
Structured wiring can use two types of DECconnect System Satellite Equipment Room (SER) open racks in MDF, IDF, and HDF locations and an H9646-*xx* DECconnect communications cabinet in ODF locations. All three racks provide for mounting and housing both active and passive devices, when those devices are specifically designed for rack mounting. Figure 2–15 shows the equipment racks.

**Figure 2–15: Equipment Racks**

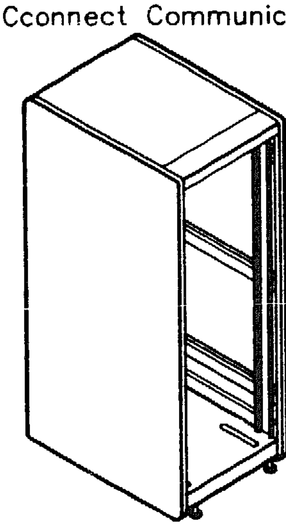
H3130–xx 183 cm (72 in) Rack



H3120–xx 218 cm (86 in) Rack



H9646–xx DECconnect Communications Cabinet



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## 2.5 Fiber Optic Cable Installation Methods

This section provides brief descriptions of the following:

- Connector termination methods
- Fiber connectors
- Splicing methods

**NOTE**

> Only Digital-recommended methods or components are described. Other methods or components are described in the *BICSI Telecommunications Distribution Methods Manual*.

### 2.5.1 Connector Termination Methods

As described in Section 2.5.2, Digital recommends terminating 2.5 mm bayonet ST-type connectors on all fiber installed inside the wall. For these installations, use the field termination method.

This section provides information on the field termination method only. Two other methods that can be used are:

- Pigtail splicing
- Installing factory-terminated cable assemblies

These other methods are described in the *BICSI Telecommunications Distribution Methods Manual*.

**NOTE**

> Digital does not recommend factory-terminated cable assemblies for inside the wall wiring. The DECconnect System structured wiring uses factory-terminated assemblies as patch cables at the distribution frame panels and as work area wiring cables. Patch and work area wiring cables are not part of the inside the wall wiring.

#### Field Termination

Field termination requires that the fiber be terminated by the installer at the site by terminating 2.5 mm bayonet ST-type connectors to the ends of the optical fibers. The installer must:

- Epoxy the fiber into the selected connector
- Polish the fiber end

Once the fiber is epoxied into place and heat cured in the selected connector, the installer uses a polishing surface and fine grit paper to polish the small length of optical fiber that is protruding from the connector end until the fiber and the connector faces are a smooth surface.

### 2.5.2 Fiber Connectors

Digital recommends the use of 2.5 mm bayonet ST-type connectors on all fiber between distribution subsystems. The H3111-*xx* wallbox fiber optic insert panels use ST-type couplers to connect to the inside wall wiring, as do all of the patch panels used at the distribution frames.

**NOTE**

FDDI, SMA-type, and Biconic connectors can be used on patch or work area wiring cable assemblies to connect active equipment to the DECconnect System structured wiring. FDDI-to-2.5 mm bayonet ST-type cable assemblies are available for interconnecting FDDI equipment to the structured wiring. Custom cable assemblies need to be ordered for interconnecting SMA-type or Biconic active equipment.

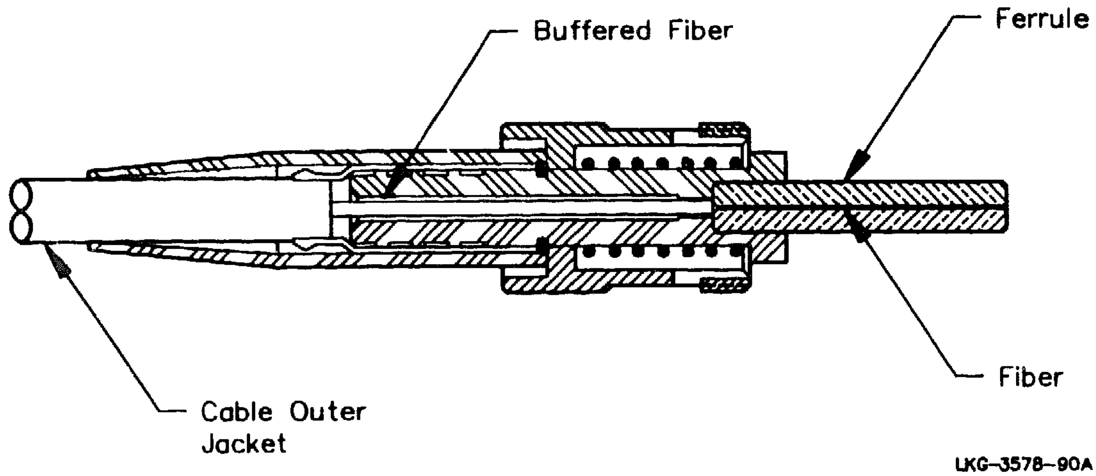
FDDI, SMA-type, Biconic, and ST-type connectors are described in the *BICSI Telecommunications Distribution Methods Manual*.

#### 2.5.2.1 2.5 mm Bayonet ST-type Connectors

The 2.5 mm bayonet ST-type connector is a keyed, spring-loaded connector with the key slot providing for quicker mating and remating. The spring-loaded assembly attaches to a coupling bushing like a coaxial BNC connector. The spring is attached to the ferrule so that the ends of the mated connectors make contact, with the force of contact between the connector fibers determined by the spring's tension and not by the tightness of the connector's ends or other securing mechanisms.

Figure 2–16 illustrates a 2.5 mm bayonet ST-type connector.

**Figure 2–16: 2.5 mm Bayonet ST-type Connector**




### 2.5.2.2 Field Termination Criteria for 2.5 mm Bayonet ST-type Connectors

Two additional criteria must be taken into account when ordering connectors that will be field terminated:

- Ferrule size
- Backshell size

**Ferrule Size**

The inside diameter size of the ferrule depends on the cladding diameter of the fibers to be terminated:

- 50/125 micron, multimode
- 62.5/125 micron, multimode
- 100/140 micron, multimode
- Single-mode

A single-size ferrule with a nominal inside diameter of 128 microns is used with multimode 50/125 and 62.5/125 multimode fibers, as these fibers have a tolerance of up to ± 3 microns. However, 100/140 fiber and single-mode fiber have different ferrule size requirements:

- 100/140 micron fiber requires a ferrule specifically designed to accommodate 140-micron cladding.
- Single-mode fiber requires greater precision in the ferrule fit for single-mode over multimode fiber for ferrules sized at 125, 126, or 127 microns.

The outside diameter of the ferrule is fixed at 2.5 millimeters.

#### Backshell Size

The backshell is the part of the connector that secures the cable to the connector, with most connectors designed for use on either an individually jacketed or unjacketed fiber.

When placing a connector onto an individually jacketed fiber, or when using fan-out tubing, the installer must ensure that the connector is compatible with the jacket's outside diameter. The three commonly accepted sizes for the outer diameter of jacketed fibers are:

- 2.0 millimeters
- 2.4 millimeters
- 2.9 millimeters

Some connectors accept any size without modification, while other connectors accept only one size. In addition, other connectors that accept only one size can use fan-out tubing to build up a jacket to the acceptable size (for example, building up 2.0 millimeter jacket to a 2.4 millimeter or 2.9 millimeter diameter).

When placing a connector onto an unjacketed fiber, the installer must check that:

- The manufacturer's specifications ensure that the connector can be properly secured to unjacketed cable.
- Additional fan-out tubing is not needed.

### 2.5.2.3 Connector Optical Losses

All connectors have typical and maximum optical power loss values. These values are used during application design and link-loss calculation processes (see Chapter 5) to determine the optical loss values for each of the structured wiring fiber optic links. Digital recommends calculating connector loss for the link using the connector's maximum loss values.

Table 2–3 compares the typical and maximum loss values for the 2.5 mm bayonet ST-type connector against the loss values for SMA and Biconic connectors when used with single-mode or multimode fiber. This table shows that the 2.5 mm bayonet ST-type connector is superior in optical loss to the other connector types.

**Table 2–3: Connector Loss Values**

| Cable Type | Connector Type | Loss in dB (Typical/Maximum) |
|---|---|---|
| Multimode | 2.5 mm bayonet ST-type | 0.35/0.7 |
| | SMA | 0.8/1.8 |
| | Biconic | 0.7/1.5 |
| Single-mode | All | 0.7/1.3 |

### 2.5.3 Splicing Methods

Digital recommends using single-fiber capillary splice method to splice fiber optic cables together. This section provides information on the single-fiber capillary splicing method only. Other types of splicing methods that can be used include:

- Fusion
- Single-fiber polished ferrule
- Multiple-fiber array mechanical

These splicing methods are described in the *BICSI Telecommunications Distribution Methods Manual*, as is the single-fiber capillary splicing method.

**NOTE**

Whenever possible, eliminate splices from the installation by ordering continuous lengths of cable for all cable runs. This is an economical and convenient solution. However, splices cannot always be avoided: repairs may be needed for broken fiber optic cables.

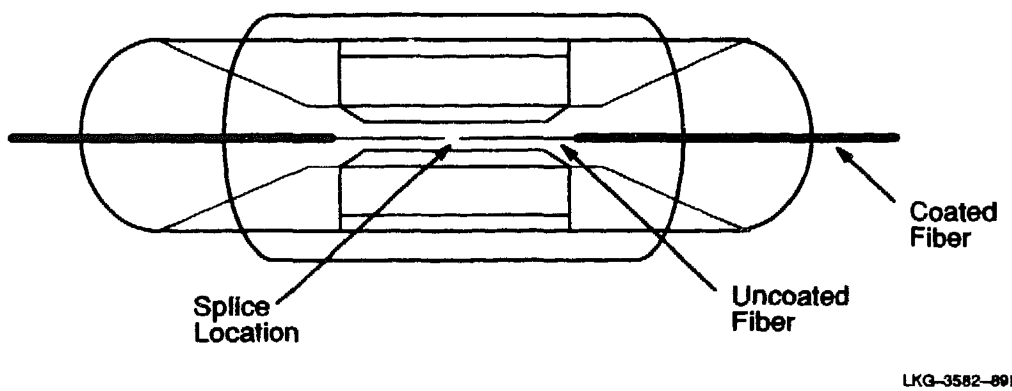
### Single-Fiber Capillary

Single-fiber capillary splices rely on the alignment of the outer diameter of the fibers. This makes the core and cladding concentricity of the aligned fibers critical to achieving low splice optical losses.

The single-fiber capillary splice method aligns the two fiber ends to a common center line, thereby aligning the fiber cores. After each fiber is stripped of its coating, the fiber ends are cleaved and the fiber inserted into an alignment tube. The ends are then butted together and index-matched to reduce reflections (and the loss) at the splice point.

Figure 2–17 illustrates a single-fiber capillary splice.

**Figure 2–17: Single-Fiber Capillary Splice**



# CHAPTER 3

# 3

# Concept Diagram

This chapter describes how to create the concept diagrams for structured fiber optic wiring.

**NOTE**

> The chapter focuses on fiber optic cabling only. For information on copper cabling, see the *DECconnect System Planning and Configuration Guide* (EK-DECSY-CG).

The concept diagrams are conceptual views of how distribution subsystems will connect a site's buildings, floors, and work areas into a structured wiring cable plant. The concept diagrams are valuable tools for design and installation processes as they:

- Identify the building, floor, and horizontal wiring within the structured wiring.
- Define the types of cables and distribution elements (distribution frames and wallboxes) that will make up the passive structured wiring.
- Provide a baseline for developing the network schematics (Chapter 5) that defines the actual physical connections within the structured wiring cable plant, including how active networking devices will connect to the structured wiring (FDDI, Ethernet), for the known applications design process.

## 3.1 Concept Diagram Overview

Two basic types of concept diagrams are created for a site:

- Horizontal - shows a horizontal wiring subsystem's connections with work area wiring, computer rooms, and system common equipment, with one concept diagram for each of the site's horizontal wiring subsystems.
- Backbone - a single diagram that shows how the site's horizontal wiring subsystems will connect through the campus and building backbone subsystems.

**NOTE**

The backbone diagram can be broken down into campus (showing the interbuilding connections) and building (showing the connections between the building backbone and the horizontal wiring subsystems) concept diagrams.

Both types of concept diagrams show the same basic information:

- The distribution frames and wallboxes that provide the connection points
- The cables that provide the links, including:
  - — Number of cables for each link
  - — Types of fiber (single-mode, multimode, or mixed)
  - — Fiber size (50/125, 62.5/125, or 100/140 micron for multimode)

**NOTE**

Digital recommends installing 62.5/125 dual window multimode fiber for all new installations. For support of 50/125 or 100/140 fiber size see Appendix A.

  - — Fiber count (for fiber optic cables) or wire count (for copper cables)
  - — Estimated cable lengths

## 3.2 Concept Diagram Design Process

The concept diagram design process requires understanding the following:

- The hierarchical structure of the DECconnect System's structured wiring.
- The symbols used in the concept diagrams.
- The layout guidelines that can affect the distribution subsystems within the structured wiring.

Both types of concept diagrams (horizontal and backbone) are created using the same process:

- A base concept diagram is drawn showing:
  - Symbols that define the types of cables and distribution elements (distribution frames and wallboxes) that will be used in each of the cable links within the diagrammed portion of the structured wiring.
  - The structured wiring topology, including which distribution elements will be directly connected and how many cables will be used between the elements.
  - The building and floor location of each distribution frame, with the locations written inside each distribution frame's symbol.
- The base diagram is modified to define the cable distance and fiber count.

The differences between the concept diagrams are:

- The portion of the structured wiring that the concept diagram defines.
- The types of distribution elements used in the illustrated links.
- The layout guidelines that affect the illustrated structured wiring subsystems.

After the concept diagram is created, refer to Chapter 4. It explains how additional labeling information is added to the concept diagram.

Figure 3–1 provides a flow chart overview of the complete concept diagram design process.

**Figure 3–1: Concept Diagram Design Process Flow Chart**

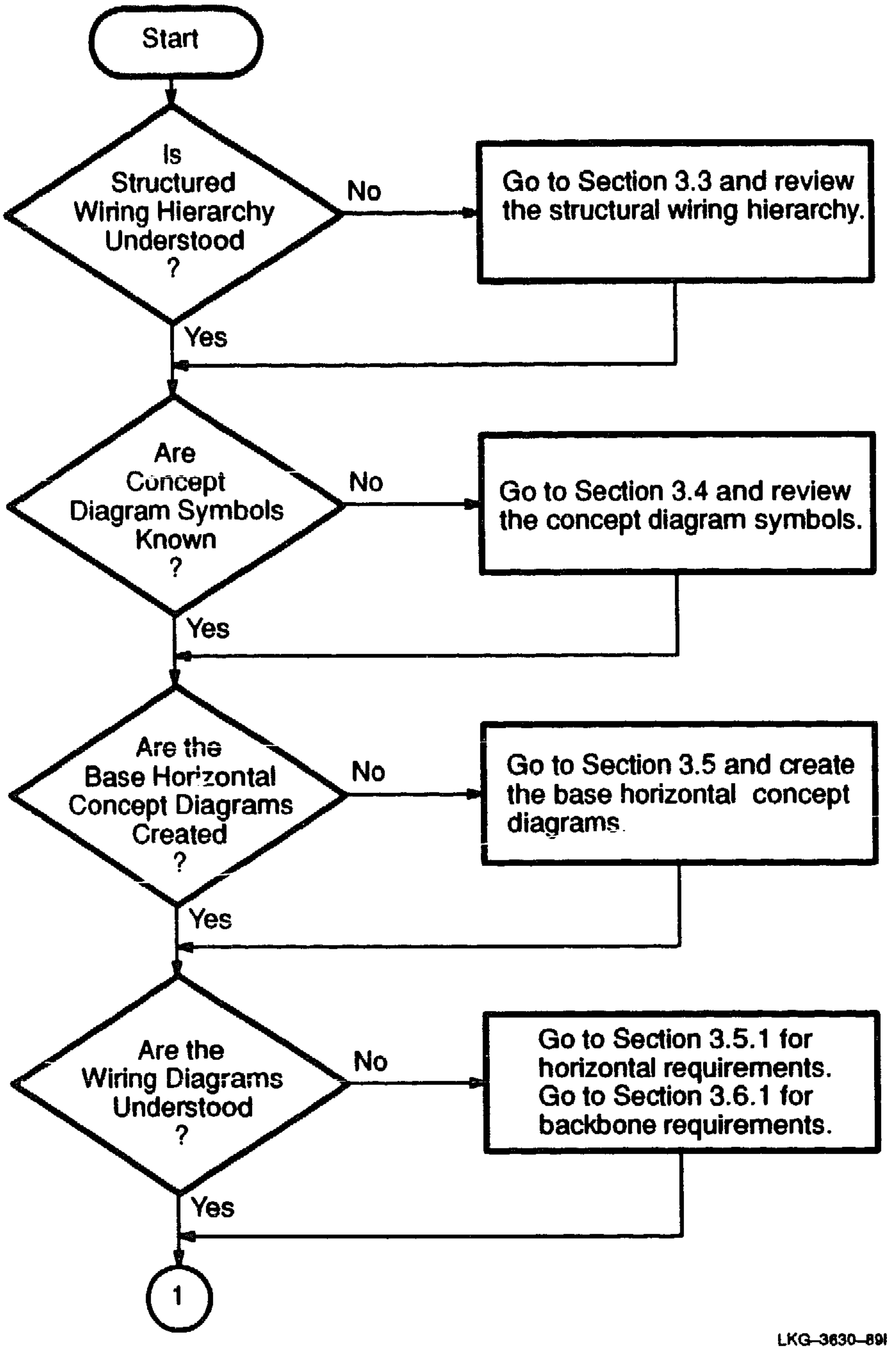
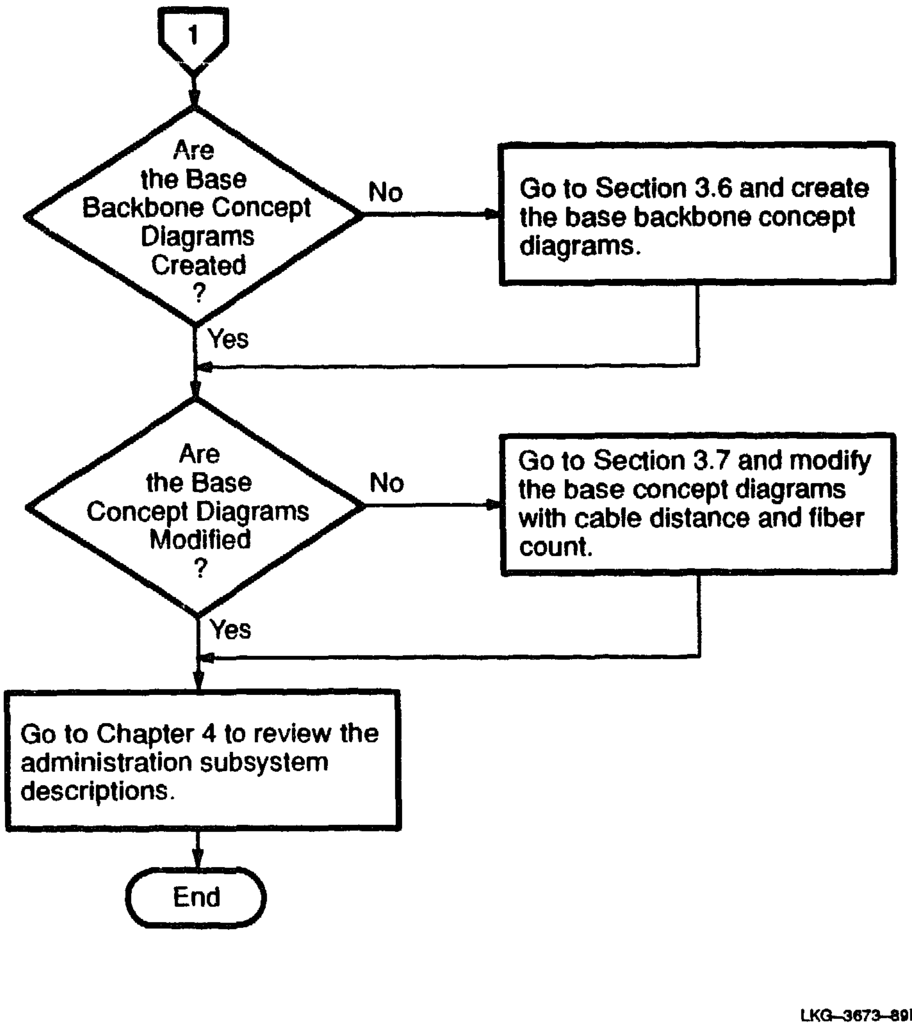



**Figure 3–1 Cont'd on next page**

Figure 3–1(Cont.): Concept Diagram Design Process Flow Chart

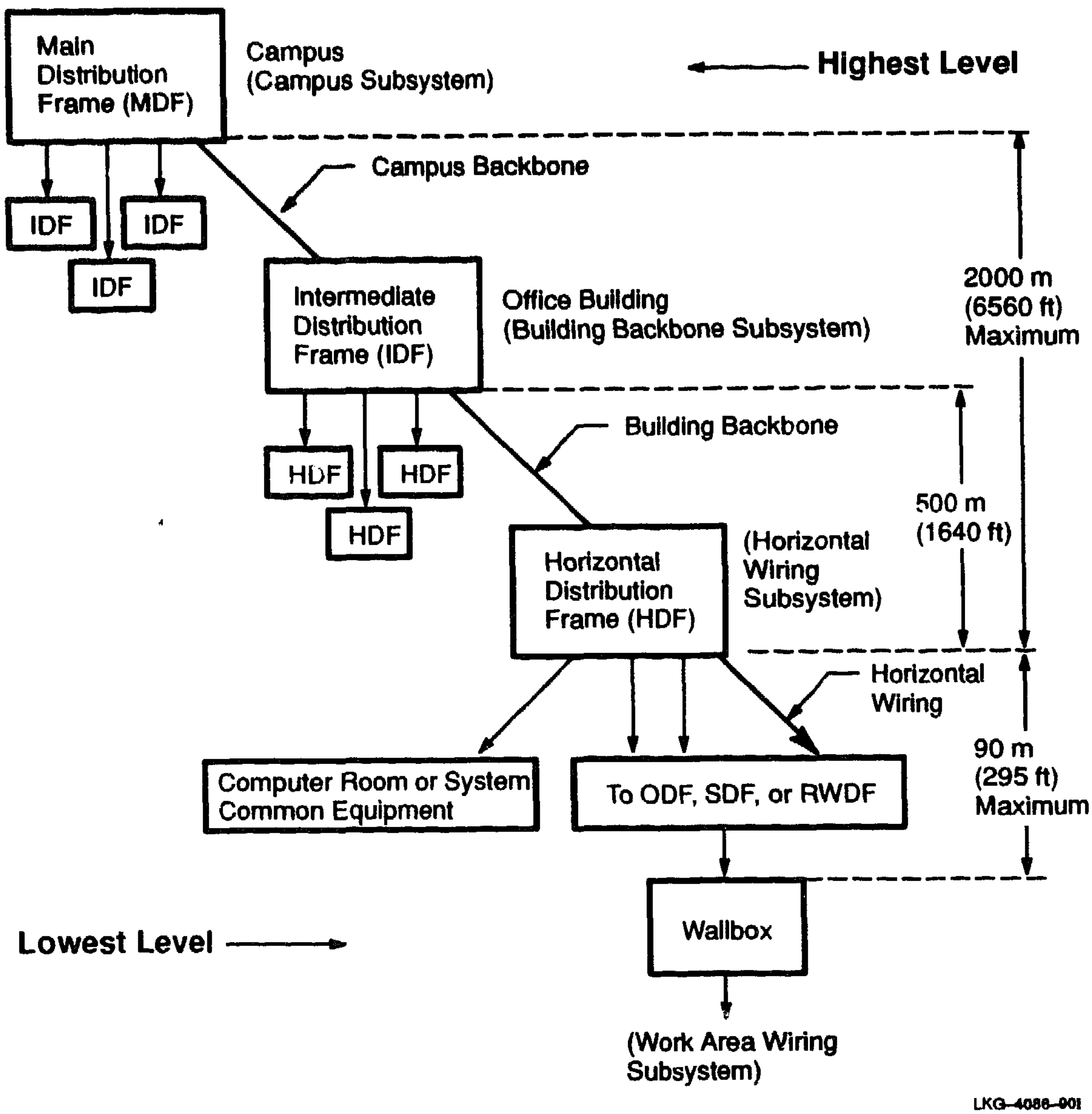


## 3.3 Structured Wiring Hierarchy

All distribution elements (distribution frames and wallboxes) within Digital's DECconnect System structured wiring have a hierarchical relationship to each other that must be maintained when designing a site. Figure 3–2 illustrates a block diagram of the distribution hierarchical relationship. This figure shows the overall hierarchy of the structured wiring and identifies the link relationships between the distribution elements. These link relationships, which must be maintained in the concept diagrams, are as follows:

- The Main Distribution Frame (MDF), the higher-most distribution element in the hierarchy, can only connect to building backbone Intermediate Distribution Frames (IDFs).
- IDFs always connect to an MDF and to Horizontal Distribution Frames (HDFs) for multibuilding sites.
- HDFs always connect to an IDF and to any of the following:
  - A satellite (SDF), office (ODF), or Remote Wall Distribution Frame (RWDF)
  - Wallbox
  - Computer room equipment
  - System common equipment
- The wallbox, the lower-most distribution element in the hierarchy, connects to a distribution frame (HDF, SDF, ODF, or RWDF) and to work area wiring.

Figure 3–2: Distribution Hierarchical Relationship



## 3.4 Concept Diagram Symbols

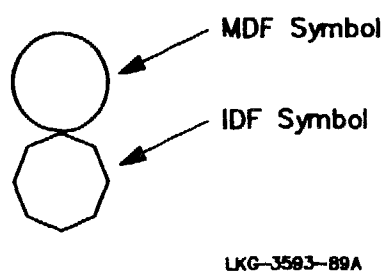
The concept diagrams use two basic types of symbols:

- Distribution element symbols
- Cable symbols

Figure 3–4 illustrates the symbols used in the concept diagrams for the distribution elements and the fiber optic cables. The following should be noted about the symbols:

- When different types of distribution frames share an equipment room, the symbols are drawn in the concept diagram so that they are touching, with no space between them. An example of an MDF and IDF sharing an equipment room is shown in Figure 3–3.

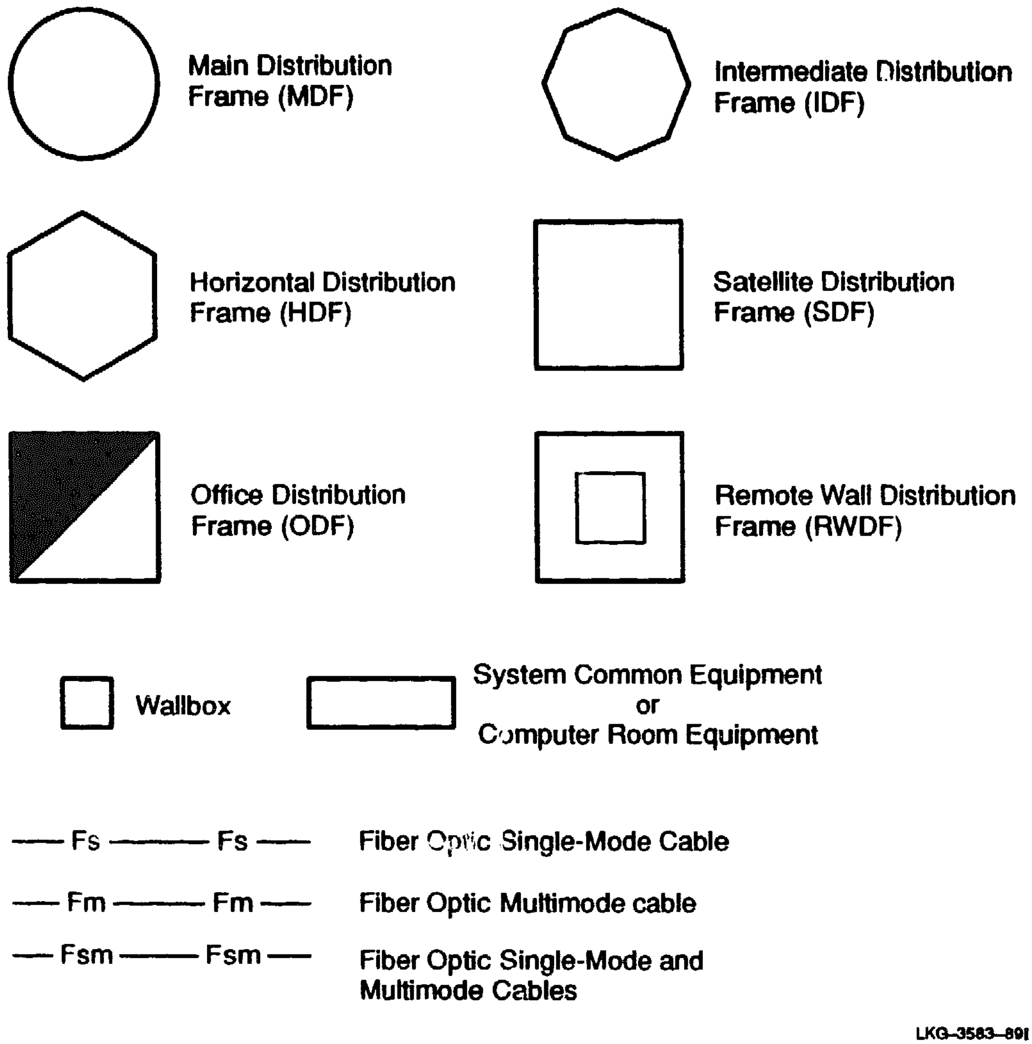
**Figure 3–3: MDF and IDF Sharing Equipment Room**




Touching symbols, therefore, indicate that the distribution frames share the same equipment room and are connected with patch cables.

- Each fiber type and size used within the cable is identified. When more than two cables are used between distribution frames, each cable is shown in the concept diagram and identified. Figure 3–4 shows the codes for fiber optic cable.

**Figure 3–4: Concept Diagram Symbols**



## 3.5 Creating the Base Horizontal Concept Diagram

A horizontal concept diagram is created for each existing and planned horizontal wiring subsystem that will be used to connect work area wiring, computer room equipment, or system common equipment to the structured wiring.

**NOTE**

Information about existing horizontal wiring subsystems is recorded on worksheets in the *DECconnect System Requirements Evaluation Workbook* during the site survey process.

During the base horizontal concept diagram creation process:

- The site's horizontal wiring subsystem requirements are defined.
- A base concept diagram is created for each subsystem.

### 3.5.1 Defining Horizontal Wiring Subsystem Requirements

The first step in creating the base horizontal concept diagrams is to use horizontal wiring distance, cable link configuration, and layout rules to define:

- How many horizontal wiring subsystems are needed for each floor. Digital recommends only one horizontal wiring subsystem for each floor, except when:
  - A floor is too large for a single horizontal wiring subsystem to service without violating horizontal wiring distance restrictions. In this case a floor is divided into smaller areas called zones. Each zone is serviced by its own horizontal wiring subsystem which is compliant with the horizontal wiring distances.
  - Multiple building backbones exist, such as when separate cabling is needed to support separate LANS that are designed for security reasons.

#### 3.5.1.1 Horizontal Wiring Distance

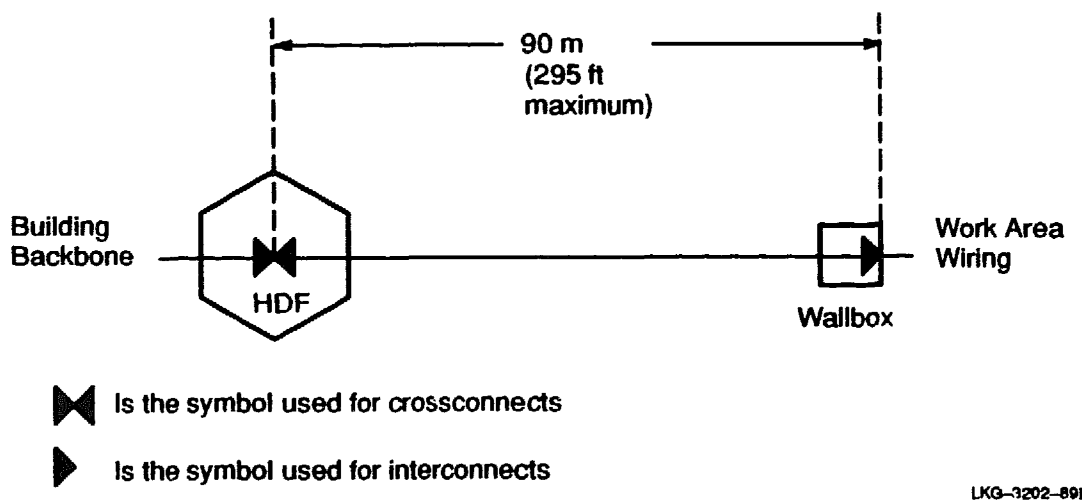
A floor is too large for a single horizontal wiring subsystem when the distance between an HDF and a wallbox exceeds the maximum distance of 90 meters (295 feet) for the horizontal wiring.

As shown in Figure 3–5, the 90-meter (295-foot) distance applies to the total horizontal wiring, including any patch cable at the HDF, SDF, or ODF that is in the overall HDF-to-wallbox link.

**NOTE**

> No other distribution frames are used in HDF-to-computer rooms or HDF-to-system common equipment links. For such links, the 90-meter (295-foot) distance applies to the cable and to any patch cable at the HDF.

**Figure 3–5: Horizontal Wiring Distance Restriction**



### 3.5.1.2 Horizontal Wiring Cable Link Configuration Design

This section contains factors to consider when designing the horizontal wiring topology. They are:

- Cable restrictions
- Planning for future growth
- Wallbox connectors

#### Cable Restrictions

The following restrictions apply to cables used in the horizontal wiring:

- The cable between any two horizontal wiring components (for example, HDF-to-wallbox or HDF-to-SDF) must be a complete, unspliced cable.
- The use of breakout-type links within the horizontal wiring is not recommended.

#### Planning for Future Growth

A horizontal wiring subsystem can be configured to meet only the current requirements. When considering only initial costs, this is the least expensive method of design. However, a little planning at the initial design phase of the horizontal wiring can save time and money when the network expands.

For planning horizontal wiring growth potential, Digital recommends that cables with the following fiber counts be used in the horizontal wiring:

- 2- or 4-fiber multimode cable in the wallbox links for support of known applications
- 6-fiber multimode cable in the links between the HDF and an SDF or ODF
- 12-fiber multimode cable in the links between an HDF and an RWDF
- 12-fiber multimode and 4-fiber single mode in the link between the HDF and system common equipment or computer rooms

### Wallbox Connectors

When using fiber optic horizontal wiring, a minimum of two wallboxes are recommended for each work area wiring location:

- One wallbox for the fiber optic connector used for the data communications
- One wallbox for all copper wiring connections

In some applications, such as video, additional connectors are needed. In most cases, these additional connectors can be handled by the same wallbox as used for the telephone connector.

**NOTE**

> Digital's H3111-GA/GB/GC wallbox has slide-in connector panels. In copper horizontal wiring, the panels are inserted into a single wallbox which can deliver voice, data, and other applications to the work area. In fiber optic horizontal wiring, a single wallbox is required for each fiber optic connector panel. A separate wallbox, or wallboxes, is needed in the work area to deliver voice and other applications.

## 3.5.1.3 Horizontal Wiring Topology

The three basic type of horizontal wiring subsystem links are:

- HDF-to-wallbox
- HDF-to-computer rooms
- HDF-to-system common equipment

The HDF-to-wallbox link can be expanded by using any one of three other distribution frames in the overall HDF-to-wallbox link, as follows:

- HDF-to-SDF-to-wallbox
- HDF-to-ODF-to-wallbox
- HDF-to-RWDF-to-wallbox

**NOTE**

> Digital does not recommend using other distribution frames (SDF, ODF, or RWDF) in a link between the HDF and computer rooms or the system common equipment. All HDF-to-computer room links and HDF-to-system common equipment links should be single, direct unspliced cable.

Which distribution frame (SDF, ODF, RWDF), if any, is used in a horizontal wiring's topology depends on:

- Whether or not active equipment will be mounted in the distribution frame

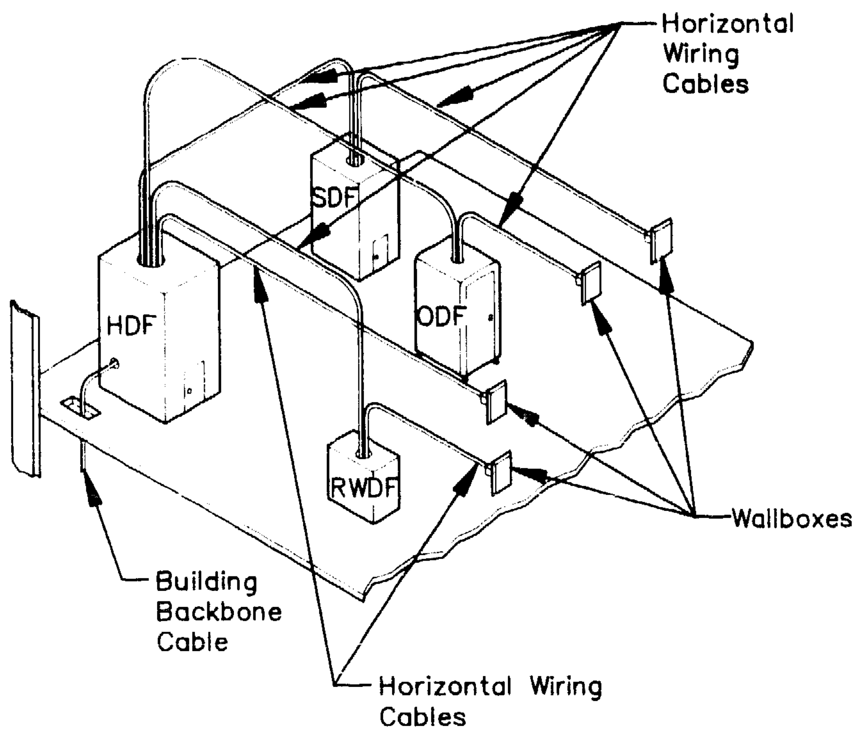
  **NOTE**

  > The SDF and ODF can be used to house and connect active networking equipment to the horizontal wiring. The RWDF is only used for interconnections between wallbox and HDF cable fibers. Active equipment is not supported at the RWDF.

- The facilities (for example, an equipment room is needed for each SDF)
- The number of 2-fiber wallbox terminations to be served by the distribution frame

Figure 3–6 illustrates the four different types of overall HDF-to-wallbox links.

**Figure 3–6: Horizontal Wiring Subsystem**

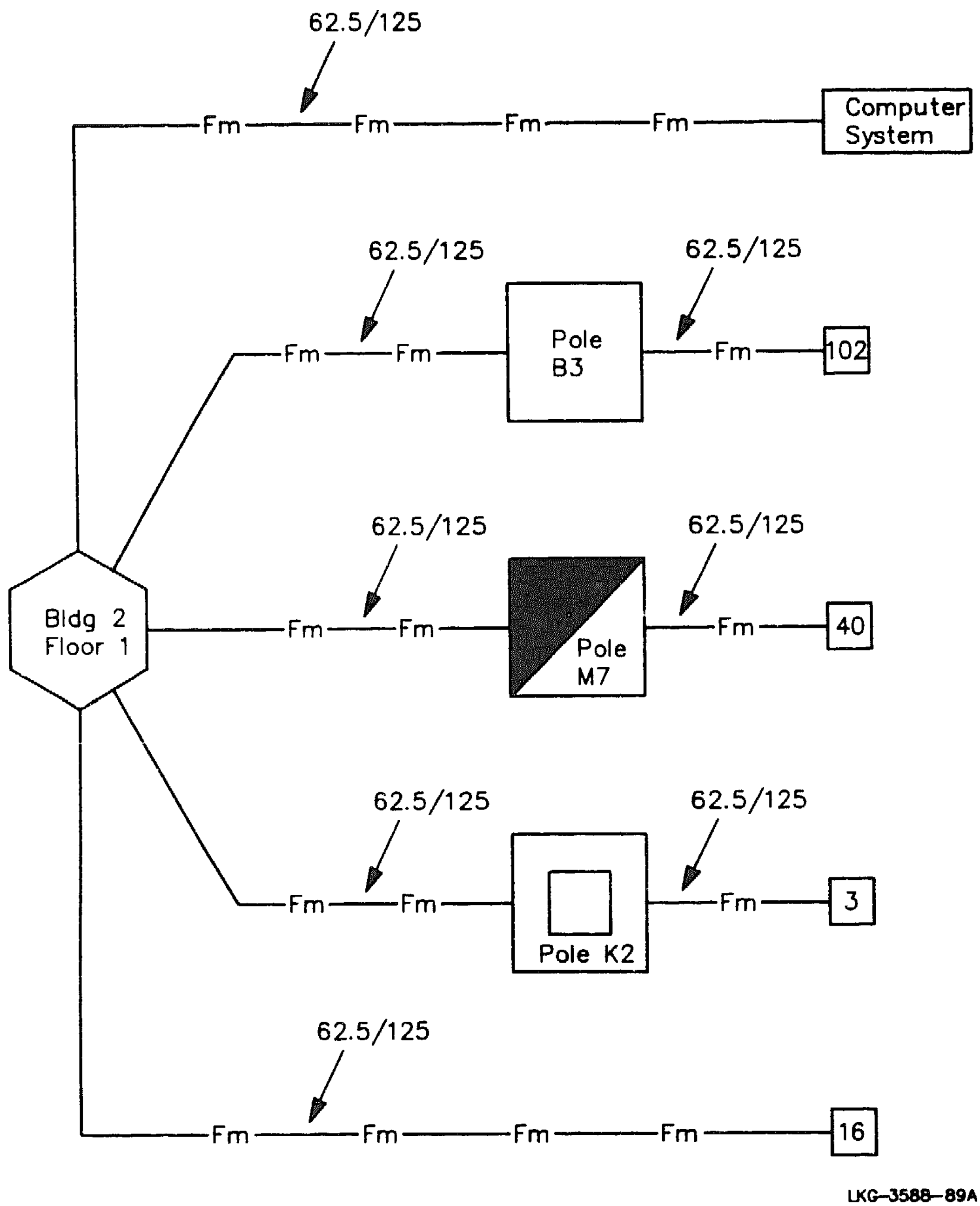


### 3.5.2 Base Horizontal Concept Diagrams

Once the horizontal wiring subsystem distance and topology requirements are understood, a base concept diagram is created for each of the site's horizontal wiring subsystems. Figure 3–7 provides a sample horizontal concept diagram. As shown in this sample, each horizontal concept diagram identifies:

- The symbol for the subsystem's HDF with the building and floor location written inside that symbol. (See Figure 3–4 for symbol definitions.)
- The symbols for any and all other distribution frames (SDFs, ODFs, or RWDFs) used in the topology with the floor location written inside each distribution frame's symbol.
- Each HDF-to-computer room link.
- Each HDF-to-SDF, ODF, and RWDF link.
- A single wallbox symbol for each distribution frame with a number inside the wallbox symbol that identifies the total number of wallboxes the distribution frame is connecting to.
- The symbol for the type of fiber optic cable to be used in each of the diagrammed links.
- The fiber size (50/125, 62.5/125, or 100/140 micron) of any multimode cable.

**Figure 3–7: Sample Horizontal Wiring Concept Diagram**



## 3.6 Creating the Base Backbone Concept Diagram

A single backbone concept diagram is created for a site's existing and planned campus and building backbone links.

**NOTE**

> Information about existing buildings and building backbone riser systems is recorded in the *DECconnect System Requirements Evaluation Workbook* during the site survey process.

During the base backbone concept diagram creation process:

- The site's backbone link requirements are defined
- A base concept diagram is created illustrating those links

### 3.6.1 Defining Backbone Link Requirements

The first step in creating the base backbone concept diagram is to use distance, cable link configuration, and layout rules to define how the buildings and floors will be connected together.

#### 3.6.1.1 Backbone Distance

The distance restrictions apply to the total length of cable used to connect campus and building backbone cables, as follows:

- Campus backbone distance restrictions apply to the length of cable between the campus backbone's Main Distribution Frame (MDF) and each building backbone cable at Intermediate Distribution Frames (IDFs). This includes the patch cable used at the IDF to crossconnect the campus and building backbone cables.
- Building backbone distance restrictions apply to the length of cable between the IDF panel and a horizontal wiring subsystem's HDF panel, and does not include any patch cable lengths at either the IDF or the HDF.

**NOTE**

> The patch cable used in the HDF to connect the building backbone cable to the horizontal wiring is considered part of the horizontal wiring and is included in that subsystem's distance restriction.

### Active Networking Equipment Considerations

When designing a cable plant, where known applications are being considered, some fiber optic links can exceed the passive distance restrictions. These links are considered dedicated to specific active networking equipment requirements and may not function in a multiproduct environment. For further information on designing dedicated links see Appendix E, *Special Distance Situations*.

### Distance Restrictions

The campus and building backbone distance restrictions are interrelated, as follows:

- An overall campus and building backbone link (MDF-to-IDF-to-HDF cabling) cannot exceed a combined distance of 2000 meters (6560 feet).
- Up to 500 meters (1640 feet) of the overall backbone link's 2000-meter (6560-foot) limit can be used for the building backbone (IDF-to-HDF cabling) portion of the link.
- The remainder of the 2000-meter (6560-foot) distance restriction is available to the campus backbone (MDF-to-IDF cabling).

Only two parts of the distance restriction are fixed:

- The 2000-meter (6560-foot) total available to the overall backbone link
- The 500-meter (1640-foot) limitation on the building backbone

The distance available is the total overall backbone limit of 2000 meters (6560 feet) minus the length of the longest MDF-to-IDF cable link. This can be expressed as a simple formula:

$$2000 - CB = BB$$

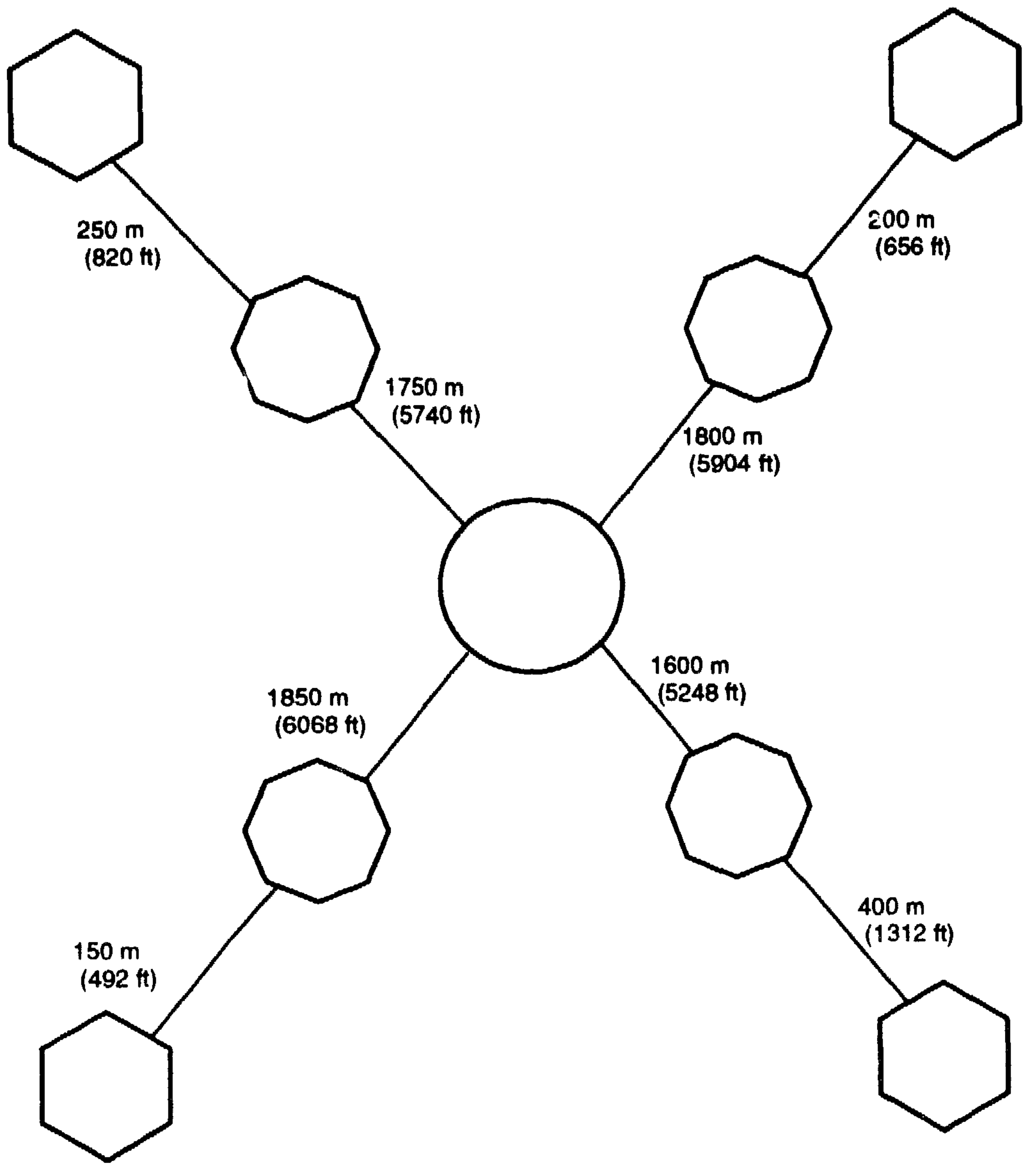
Where:

- 2000 is the 2000-meter (6560-foot) maximum for an overall backbone
- CB is the length of the longest campus backbone between the MDF-to-IDF
- BB is the length available to the building backbone IDF-to-HDF link in the building (not to exceed 500 meters (1640 feet)

When an IDF-to-HDF link uses the maximum 500 meters (1640 feet), then only 1500 meters (4921 feet) is available for the building's campus backbone cable link with the MDF. If the longest IDF-to-HDF link in the building is 100 meters (328 feet) then the building's IDF can connect with the MDF using up to 1900 meters (6234 feet) of cable. This assumes that the active networking equipment in the IDF-to-MDF link can operate over 1900 meters (6234 feet) of cable if the application is known.

Figure 3–8 illustrates a sample site layout showing different building connections which all fall within the distance restrictions.

**Figure 3–8: Distances Within a DECconnect System Site**




Note: All of the links that are shown use the full 2000 meters (6850 feet) available to the campus and building backbones.

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### 3.6.1.2 Backbone Cable Link Configuration Design

This section provides information that should be kept in mind when designing the campus and building backbone cable links:

- Single cable versus breakout cable links
- Maximum growth
- Alternate cable routing

#### Single Cable Versus Breakout Cable Links

Single cable links and breakout cable links are described as follows:

- A single cable link is a single fiber cable segment with connectors at each end. It has no splices except for required repairs.
- A breakout cable link is a point in the fiber optic link where fibers from several cables are spliced together within a splice closure.

Digital recommends the use of single cable links in the building backbone and the campus backbone.

In a campus backbone, breakout cable links are used as follows:

- Breakout (through splices) one cable run from the MDF to connect with cables from several buildings closely spaced together. For example; run a 144-fiber cable from the MDF to an outdoor fiber transition enclosure, then splice three 48-fiber cables (one from each building) to the 144-fiber cable from the MDF.

Digital recommends that all cable links between buildings be single cable links because splices used for breakout cable links are costly in terms of money, time, and optical performance.

Figure 3–9 illustrates a site with campus backbone single cable links. Figure 3–10 illustrates a site with breakout cable links.

**Figure 3–9: Campus Backbone Single Cable Links - Recommended**

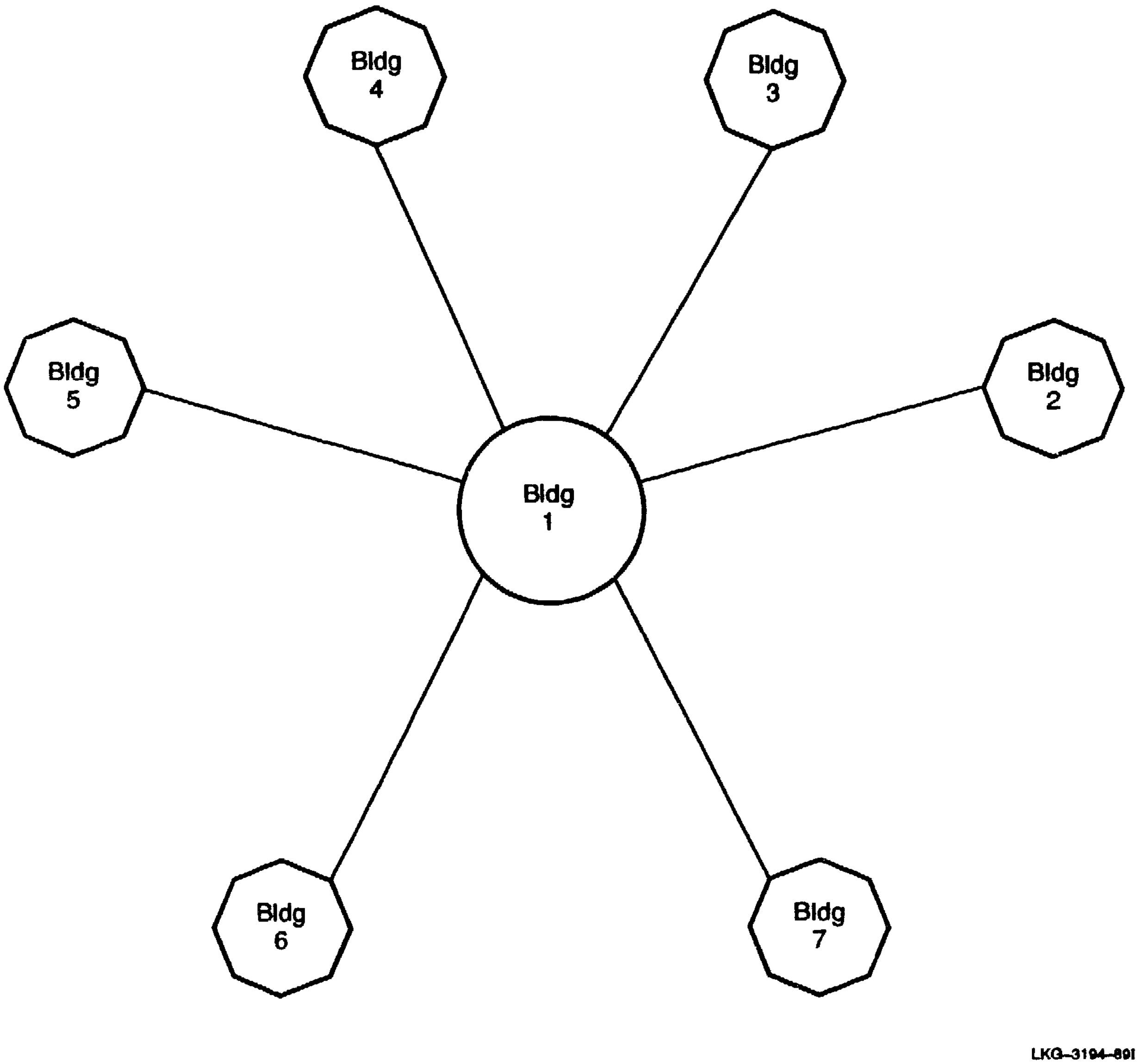
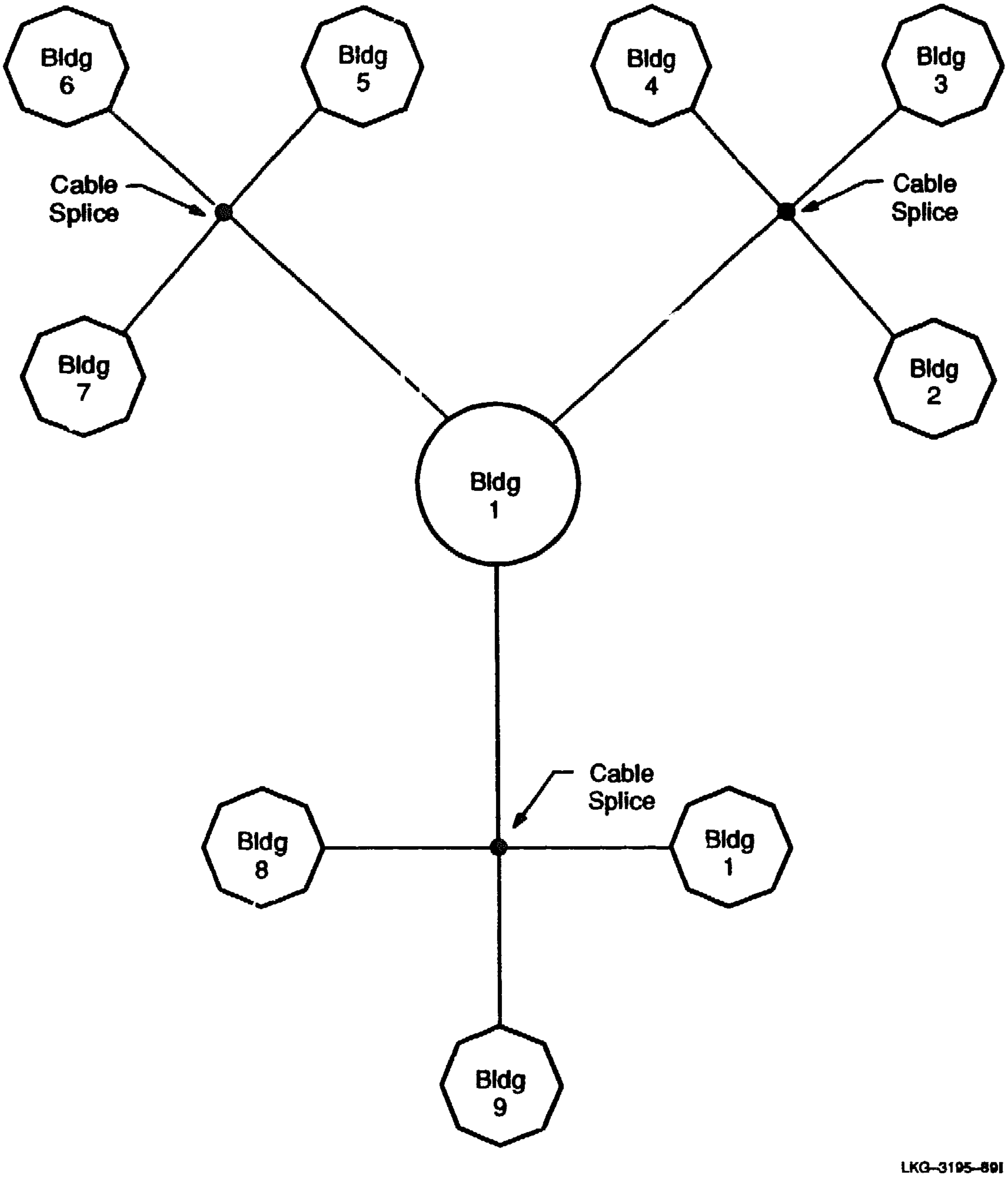


**Figure 3–10: Campus Backbone Breakout Cable Links - Not Recommended**



### Planning for Future Growth

The campus and building backbones can be configured to meet only the current cabling requirements. When considering only initial costs, this is the least expensive method of design. However, a little planning at the initial design can maximize reliability and provide for future growth which can save time and money when the network expands.

The campus backbone maximum growth factors are as follows:

- Design single-mode and multimode cables for each campus backbone link - this allows the site to take advantage of fiber optic technology advances.
- Use 48 fibers of multimode and 12 fibers of single-mode cable for each link (24 and 6 for each of the separate links). This ensures that the site meets initial cable requirements and provides for future growth.
- Design redundant sets of cables in physically separate paths, complete with cable routing hardware, for each campus backbone. This approach, known as alternate cable routing, provides an alternate path in case of campus backbone cable damage.

Alternate cable routing is recommended for fiber optic links carrying critical communication services.

The building backbone maximum growth factors are as follows:

- Design single-mode and multimode cables for each building backbone link. This allows the site to take advantage of fiber optic technology advances.
- Install 24 fibers of multimode and 6 fibers of single-mode for each link. This fiber count ensures that the site meets all cabling requirements and maximizes future growth potential.

## 3.6.1.3 Site Layout

The Digital-supported topology for the structured wiring is the hierarchical physical star. This topology uses a single campus backbone subsystem to connect the site's buildings together into a structured wiring cable plant.

However, some sites can exceed the maximum backbone distance restriction if a single hierarchical physical star topology is used for the design. In such cases, the overall site must be broken into smaller sites. The multiple sites are then connected together. For further information on connecting sites see Appendix D.

### 3.6.2 Base Backbone Concept Diagram

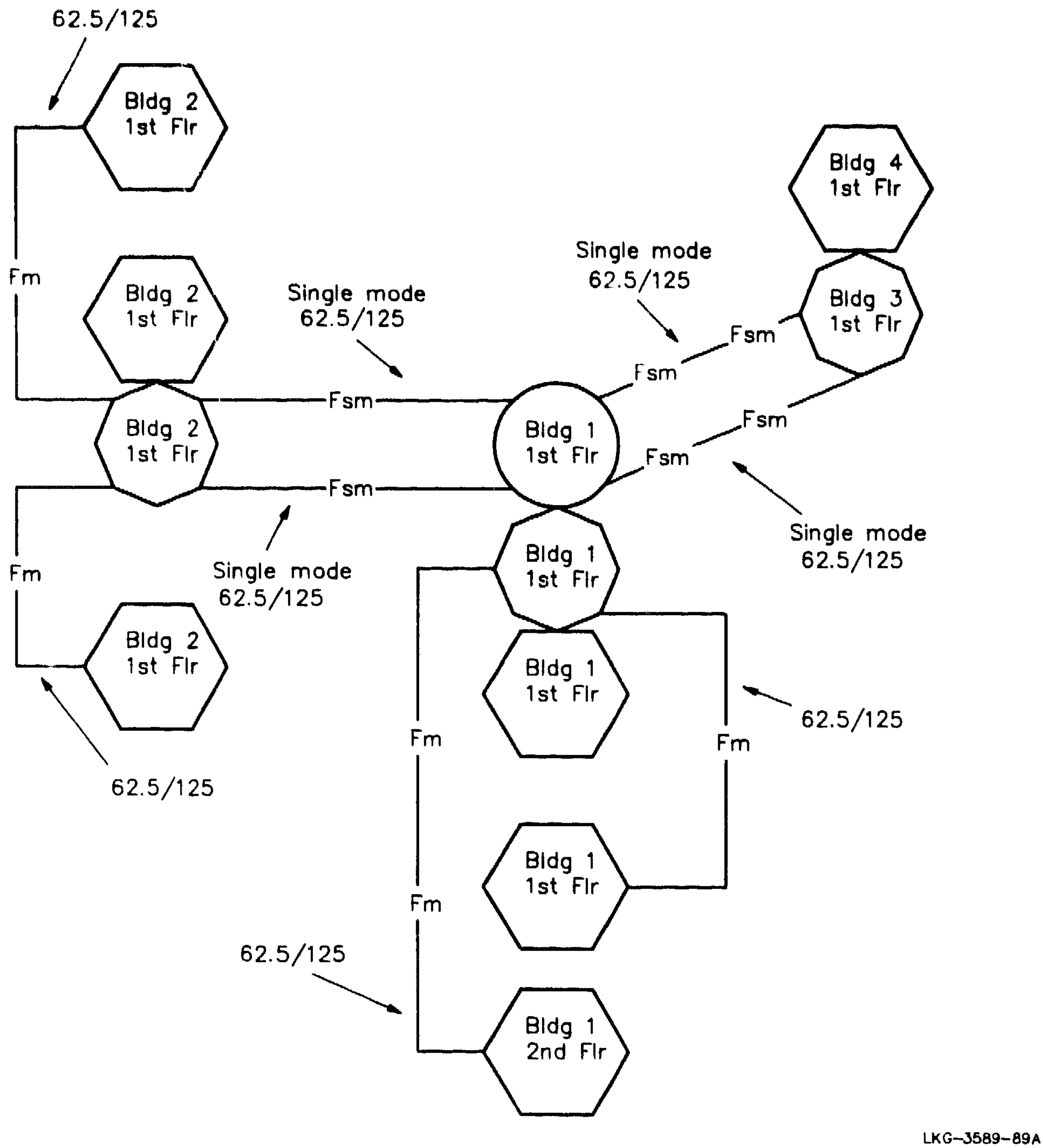
Once the backbone distance and layout requirements are understood, a base concept diagram is created for the site's campus and building backbone subsystems. Figure 3–11 provides a sample concept diagram for a simple three-building single-site. As shown in this sample, each backbone concept diagram identifies:

- The symbol for each distribution frame (MDF, IDF, or HDF) with the building and floor location written inside each distribution frame's symbol.
- Each MDF-to-IDF and IDF-to-HDF link, including any alternative cabling routing (such as for redundant cabling), is used for a single distribution frame-to-distribution frame link.
- The fiber type - multimode, single mode, or mixed.
- The fiber size (50/125, 62.5/125, or 100/140 micron) of any multimode cable.

**NOTE**

> The sample diagram shows only fiber optic subsystems. If copper subsystems are used (copper-based Ethernet building backbone), copper wiring symbols are used to indicate copper links (ThinWire, shielded or unshielded twisted-pair).

**Figure 3–11: Sample Backbone Concept Diagram**



## 3.7 Modifying the Base Concept Diagrams

Once the base horizontal and backbone concept diagrams are created, the following information is added:

- Cable distances
- Fiber count

### 3.7.1 Cable Distances

Cable distances are important to know when defining the amount of cable needed to carry out the structured wiring design. The cable distances are added to the two types of concept diagrams as follows:

- Horizontal
  - HDF-to-SDF, -ODF, or -RWDF, HDF-to-computer room, or HDF-to-system common equipment cables; the actual cable distance including the distance affected by known or planned cable routing methods from the HDF to the distribution frame, computer room, or system common equipment.)
  - HDF-, SDF-, ODF-, or RWDF-to-wallbox cables; the average distance of cabling between the distribution frame and the wallbox that the distribution frame services.
- Backbone
  - The actual cable distance, including distance affected by known or planned cable routing methods.

It is not always possible to identify exactly how long a cable will be. This is particularly true when cable routing methods are still unplanned. However, it is necessary to make the best estimate possible, with each cable estimate including the appropriate cable slack requirements:

**NOTE**

Cable slack requirements must be considered in the overall length of cables and when determining if a link exceeds the maximum distance requirements. For example, the maximum building backbone cable distance of 500 meters is actually 9.0 meters (29.5 feet) of cable slack and 491 meters (1610 feet) of distance available to routing the cable between the IDF and HDF.

- 9.0 meters (29.5 feet) for distribution frame-to-distribution frame links, 4.5 meters (15 feet) of cable slack at both ends of the cable. This also includes computer room and system common equipment links.
- 5.1 meters (16.7 feet) for distribution frame-to-wallbox links, 4.5 meters (15 feet) of cable slack at the distribution frame and 0.6 meters (2 feet) at the wallbox.

**NOTE**

The concept diagram cable distances are used in creating the network schematic (Chapter 5), and are, therefore, critical to the link-loss calculations for known applications. The link-loss calculations are used to verify that fiber optic links meet their active equipment maximum allowable system loss budget.

### 3.7.2 Fiber Count

After the base concept diagrams are modified for cable distances, they are modified for fiber count, and fiber size. For example, the notation 24 - 62.5/125 indicates a cable with 24 multimode fibers, each with a size of 62.5/125 microns.

The fiber count of a link is determined in two basic ways:

- When the applications that the link needs to support are known - by adding up the fiber count needed for each application.
- When the applications that the link needs to support are unknown - by using the DECconnect System recommended fiber counts for each type of link.

**NOTE**

A fiber count worksheet is provided in Figure 3–14 for determining fiber count by known application requirements.

#### Fiber Count Growth Considerations

The fiber count of cable used in the structured wiring is critical to current and future cabling needs and solutions. Many of the fiber optic cables installed for today's technology will be integrated into communications networks of future technologies. Therefore, the number of fibers in each installed cable must be carefully considered.

The decision regarding the minimum number of fibers an installed cable will have depends on the following:

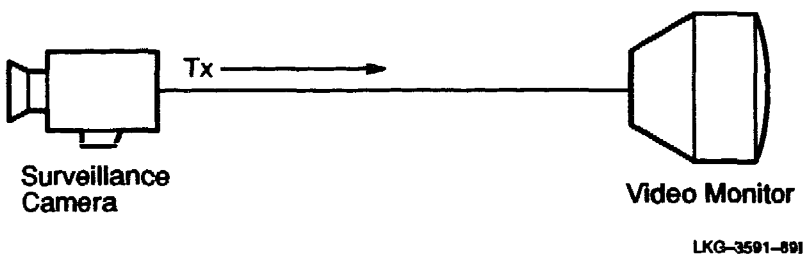
- The intended end-user applications, if known
- The active equipment needed to support those applications, if known

Since installation of building wiring is expensive, and any future cabling can add significantly to a network's costs, Digital recommends adding 50% to 100% to the actual fiber count to account for spare fibers needed for future growth. Digital also recommends that single-mode fiber optic cable be installed along with the multimode cable, with at least one single-mode fiber for every four multimode fibers.

#### Fiber Count Application Requirements

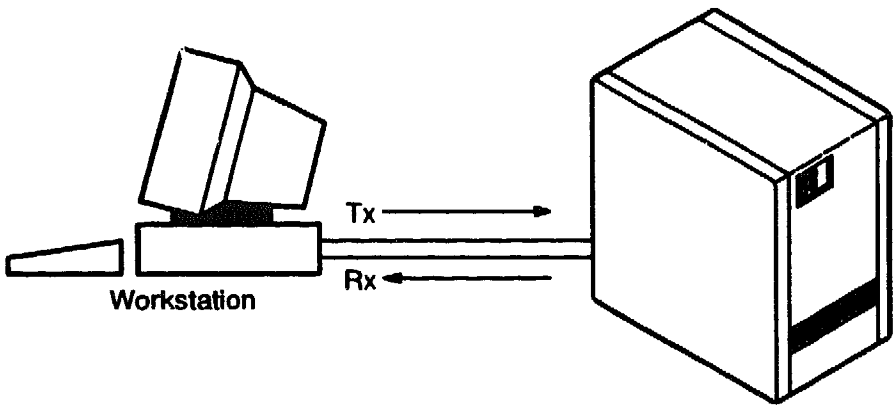
Some applications, such as video or telemetry, require only a single fiber to transmit signals from a source device to a receiving unit (see Figure 3–12).

**Figure 3–12: Video Applications**




However, most current applications, such as data or voice communications, require at least two fibers for two-way communications: one fiber for transmit and one for receive (see Figure 3–13).

Figure 3–13: Data Application




In some data communication networks, a second set of fibers is added to the application requirements. FDDI is an example of a configuration that uses four fibers (two pairs) in its dual ring backbone application.

Table 3–1 identifies the fiber count needed for each individual application.

Table 3–1: Fiber Count Requirements by Application

| Application | One Fiber | Two Fibers | Four Fibers |
|---|---|---|---|
| Voice (two-way) | | X | |
| Voice (intercom) | X | | |
| Video (security) | X | | |
| Video (interactive) | | X | |
| Telemetry | X | X | |
| Data multiplexing | | X | |
| Channel extension | | X | |
| Ethernet | | X | |
| 802.5 Ring | | X | X |
| FDDI | | X | X |

### DECconnect System Recommended Fiber Count for Unknown Applications

The DECconnect System recommends fiber counts for each fiber optic distribution subsystem link. These counts are recommended for a cable when the fiber count requirements of the link cannot be determined. In addition, the recommended fiber counts are based on:

- The types of applications that can be run over each type of link and the fiber count required for each of those applications.
- Maximizing the ability of the cable plant to meet future growth requirements without new fiber needing to be installed.

Table 3–2 lists the DECconnect System recommended fiber count by type of link and type of fiber.

**Table 3–2: DECconnect System Recommended Fiber Counts for Unknown Applications**

| Type of Link | Multimode Cable Fibers | Single-mode Cable Fibers |
|---|---|---|
| MDF-to-IDF | 48 | 12 |
| IDF-to-HDF | 24 | 6 |
| HDF-to-SDF | 6 | — |
| HDF-to-ODF | 6 | — |
| HDF-to-RWDF | 12 | — |
| HDF-to-System common equipment | 12 | 4 |
| HDF-to-computer room | 12 | 4 |

### Recommended DECconnect System Horizontal Wiring Fiber Count Support

The recommended fiber count between the HDF and an SDF or ODF is six fibers. This assumes future installation of active equipment support at the SDF or ODF.

The recommended fiber count for the RWDF, which does not support active equipment, is based on the 12-fiber maximum capacity of the RWDF.

**NOTE**

The recommended fiber count to the wallboxes is two or four fibers depending on the support of the known applications. This allows for any of the following applications:

- Fiber optic Ethernet application
- FDDI single-attachment station (SAS) application
- FDDI dual-attachment station (DAS) application
- Fiber optic video application
- Fiber optic voice application

#### Recommended DECconnect System Building Backbone Fiber Count Support

The recommended fiber count for building backbone IDF-to-HDF links is 24 multimode fibers using two 12-fiber multimode cables. This count allows fibers for the following applications:

- Fiber Optic Ethernet - two fibers
- FDDI - four fibers
- Video - two fibers (interactive)
- Voice - four fibers for two voice channels (two fibers per channel)
- Intercom - two fibers for two intercom channels (one fiber per channel)
- Ring - two fibers
- Telemetry - two fibers
- Spares - six fibers

In addition, Digital recommends that a single-mode cable be run for each IDF-to-HDF link with this cable having at least six single-mode fibers (one single-mode fiber for every four multimode fibers) to support future applications.

#### Recommended DECconnect System Campus Backbone Fiber Count Support

The recommended fiber count for campus backbone MDF-to-IDF links is 48 multimode fibers. This includes:

- One set of 24 fibers providing the same application capabilities as listed for the IDF-to-HDF links.
- A second, separately routed redundant set of 24 fibers.

In addition, Digital recommends that a single-mode cable be run for each of the 24-fiber multimode cable links, with each single-mode cable having at least six single-mode fibers (one single-mode fiber for every four multimode fibers) to support future applications.

#### Fiber Count Worksheet for Known Applications

Figure 3–14 provides a blank copy of the Fiber Optic Worksheet. Copy and use this worksheet to determine the fiber count for known applications (refer to Table 3–1), as follows:

- Identify the project.
- Identify the link.
- List each application the cable needs to support.
- List the fiber count for each application.
- List the fiber count allocated for multimode and single mode fibers.
- Add up the fiber count entries to determine the minimum fiber count needed by the cable to support the application requirements of that cable's link.

### 3.7.3 Modified Concept Diagrams

Figure 3–15 shows sample horizontal and backbone concepts that are modified for cable distances and fiber counts.

## Figure 3–14: Fiber Count Worksheet

I. Project Identification:

Project ID: ______________ Page ____ of ____

Designer: ____ ______________ Date: ______________

II. Link Description:

III. List applications and fiber count for each application:

| Application | Required Count |
|---|---|
| | |
| | |
| | |
| | |
| | |
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## Figure 3–15: Concept Diagrams Modified for Link Distances and Fiber Counts

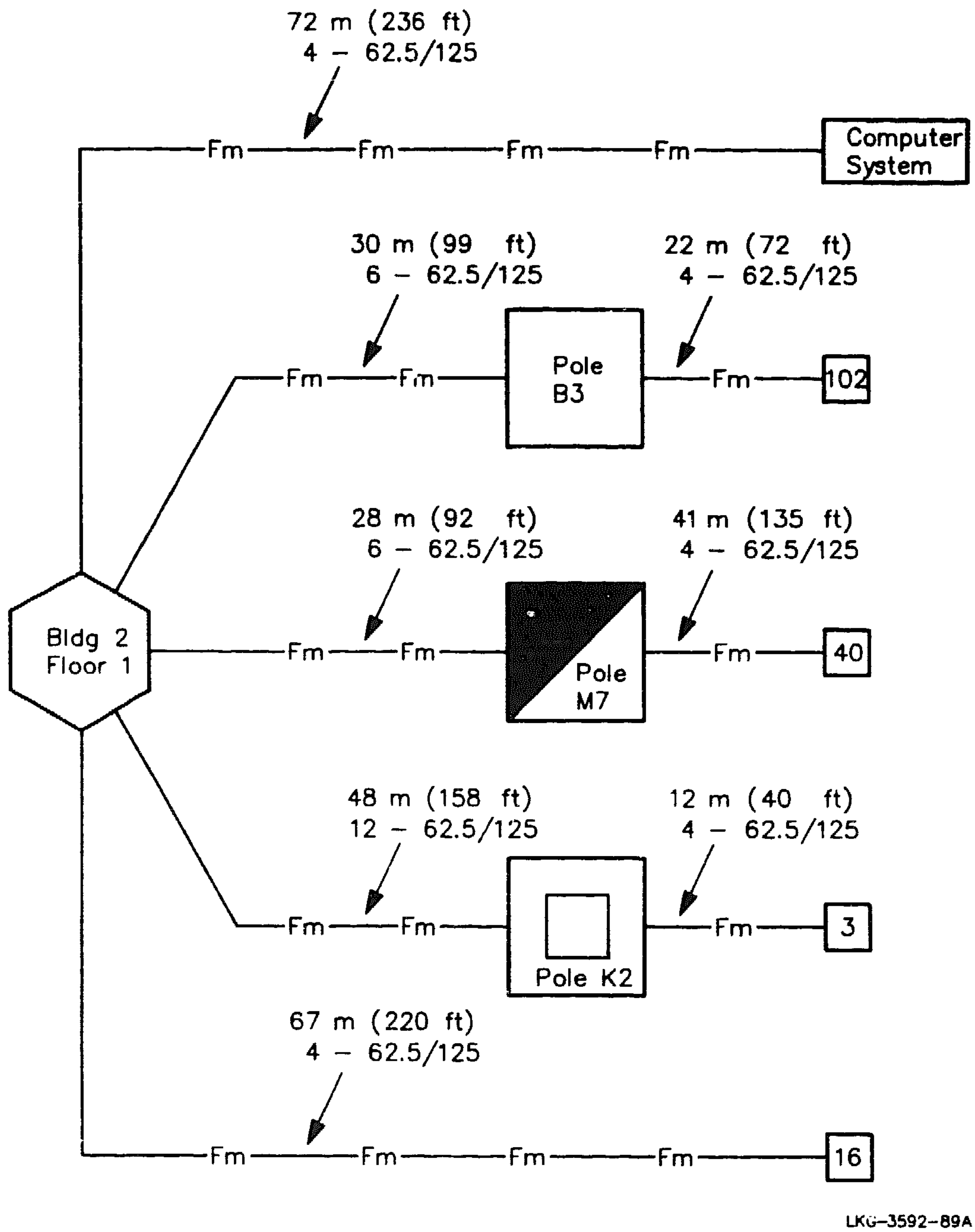
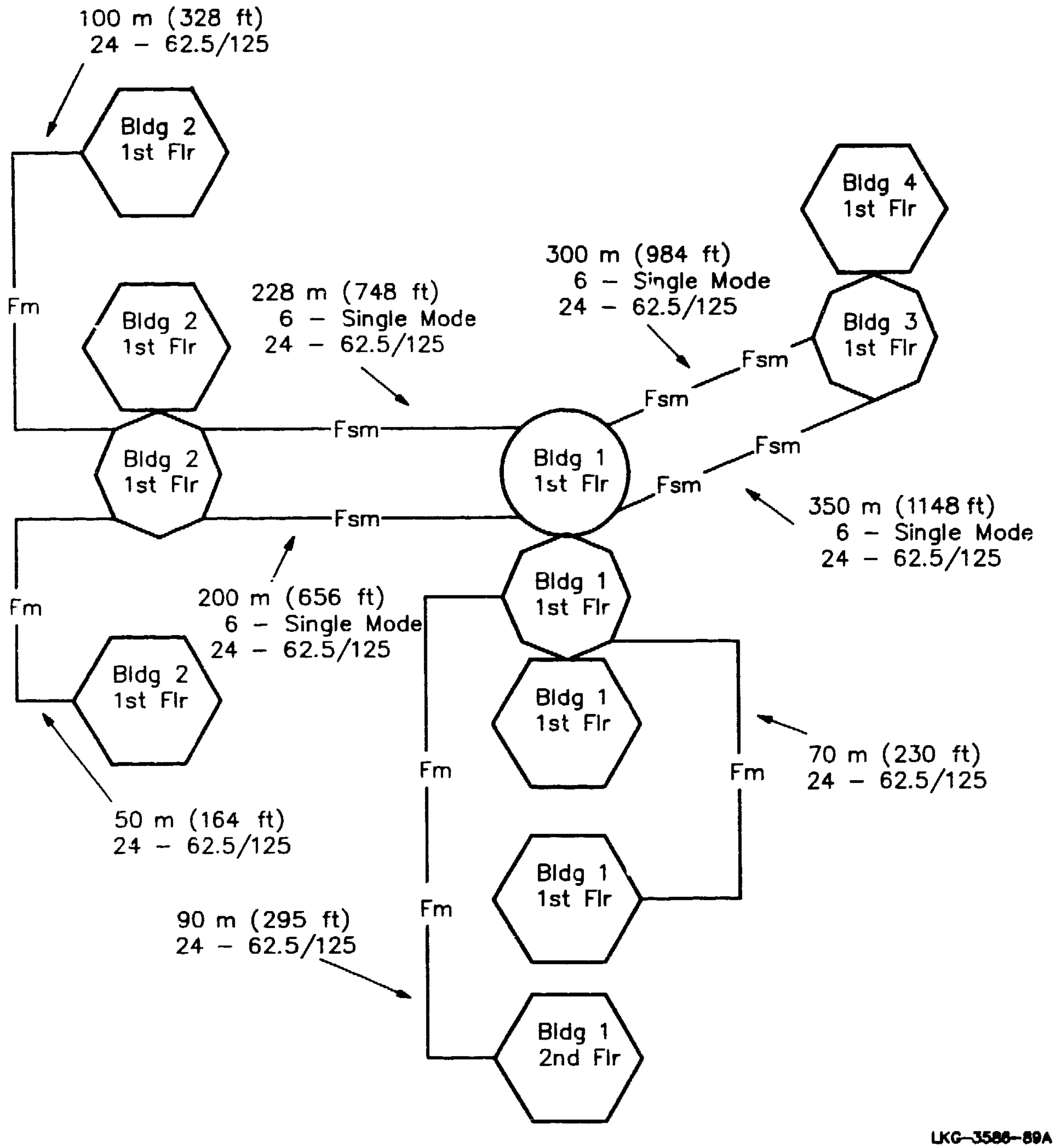



**Figure 3–15 Cont'd on next page**

Figure 3–15(Cont.): Concept Diagrams Modified for Link Distances and Fiber Counts



# CHAPTER 4

# 4

# Administration Subsystem

The concept diagram (created in Chapter 3) defines the distribution subsystem wiring structure for the site. The administration subsystem consists of the hardware and documentation for managing the distribution subsystem structure as follows:

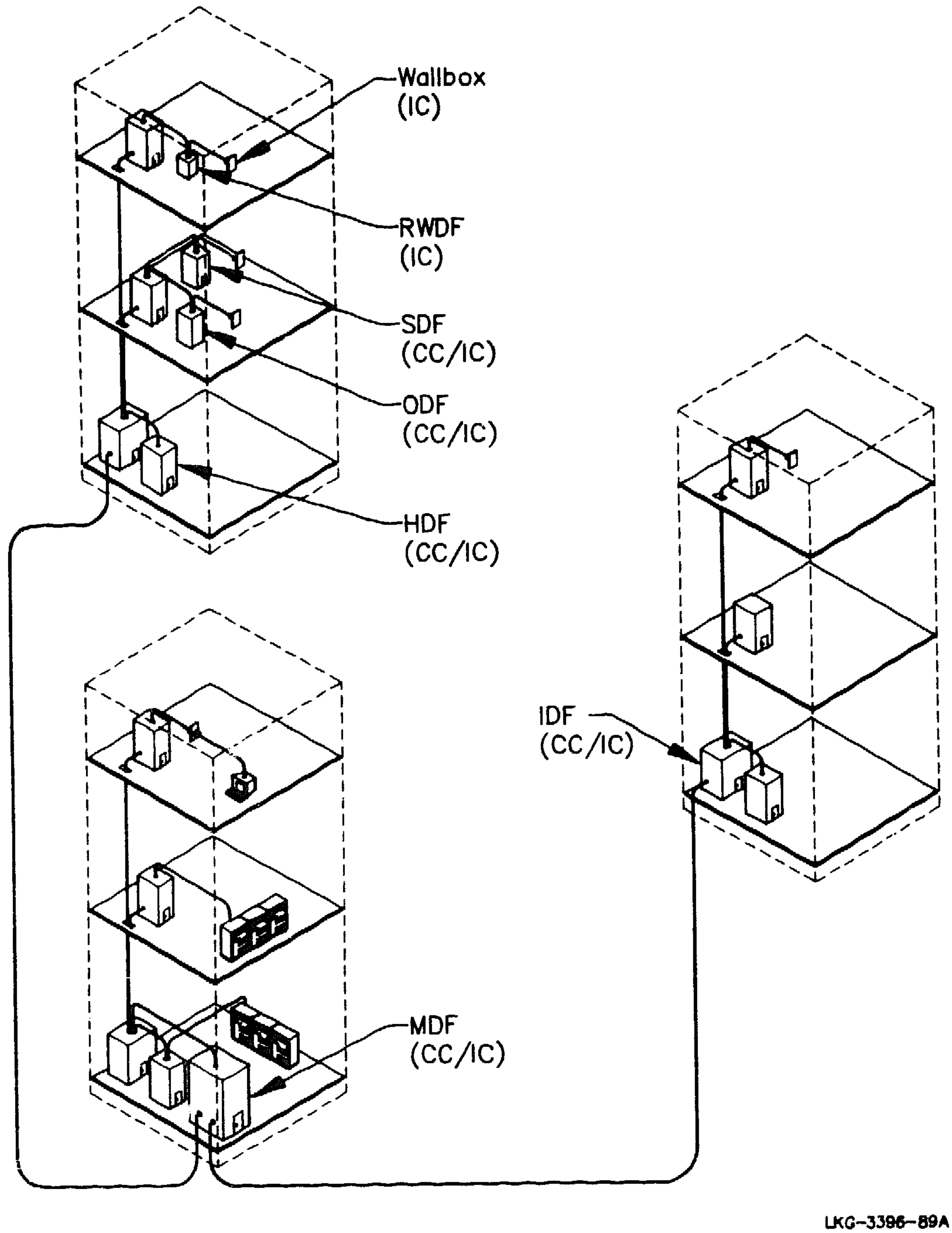
- Crossconnects and interconnects provide the administration points within the structured wiring system's hierarchy. These administration points provide the connections between the inside wall wiring at the distribution elements (distribution frames and wallboxes).
- Administration documentation defines the labeling and helps provide the maintainability of the end-to-end connectivity within the structured wiring cable plant.

This chapter identifies and describes the administration subsystem, including information on the administration function, as well as the administration subsystem's hardware and documentation. This chapter also identifies and describes:

- The fiber optic wiring strategy for the DECconnect System's fiber optic structured wiring.
- The cable plant labeling plan that Digital recommends, including labeling documentation that must be completed before the cable plant installation process can begin.

Figure 4–1 illustrates the location of the crossconnect (CC) and interconnect (IC) administration points within the DECconnect System structured wiring cable plant.

**Figure 4–1: Administration Subsystem**



## 4.1 Structured Wiring Hierarchy

The administration subsystem, its related documentation, labeling, and wiring strategy, are all based on a higher-to-lower hierarchical approach to the wiring structure.

As described in Section 3.3, Structured Wiring Hierarchy:

- The higher-most distribution element within the structured wiring hierarchy is the Main Distribution Frame (MDF), the point where all campus backbone subsystem cables are connected together.
- The lower-most distribution element is the wallbox, the point where the active user equipment connects to the structured wiring through the work area wiring.

The higher-to-lower hierarchy of the structured wiring cable plant is important for:

- The location of crossconnect and interconnect administration points within the structured wiring.
- The connection of active networking equipment to the structured wiring cable plant.
- The labeling scheme for the structured wiring cable plant.

## 4.2 Crossconnects

Crossconnects are structured wiring administration points. Crossconnects can occur at the following distribution frames:

- Main Distribution Frame (MDF) - to connect campus backbone fibers together.
- Intermediate Distribution Frame (IDF) - to connect building backbone and campus backbone fibers. IDF crossconnects can also connect:
  - Fibers from two different building backbone cables.
  - Two fibers from the same building backbone cable.
- Horizontal Distribution Frame (HDF) - to connect horizontal wiring and building backbone cable fibers. HDF crossconnects can also connect:
  - Fibers from two different horizontal wiring cables.
  - Two fibers from the same horizontal wiring cable.
- Satellite or Office Distribution Frame (SDF or ODF) - to connect wallbox and HDF cable fibers in the horizontal wiring. SDF or ODF crossconnects can also connect fibers from two different wallbox cables.

**NOTE**

A crossconnect, which is usually in the HDF, is allowed in the horizontal wiring. This crossconnect can occur in the SDF or ODF when the HDF interconnects active networking equipment to the link. Crossconnects cannot occur at the wallbox or at the horizontal wiring subsystem's remote wall distribution frame (RWDF).

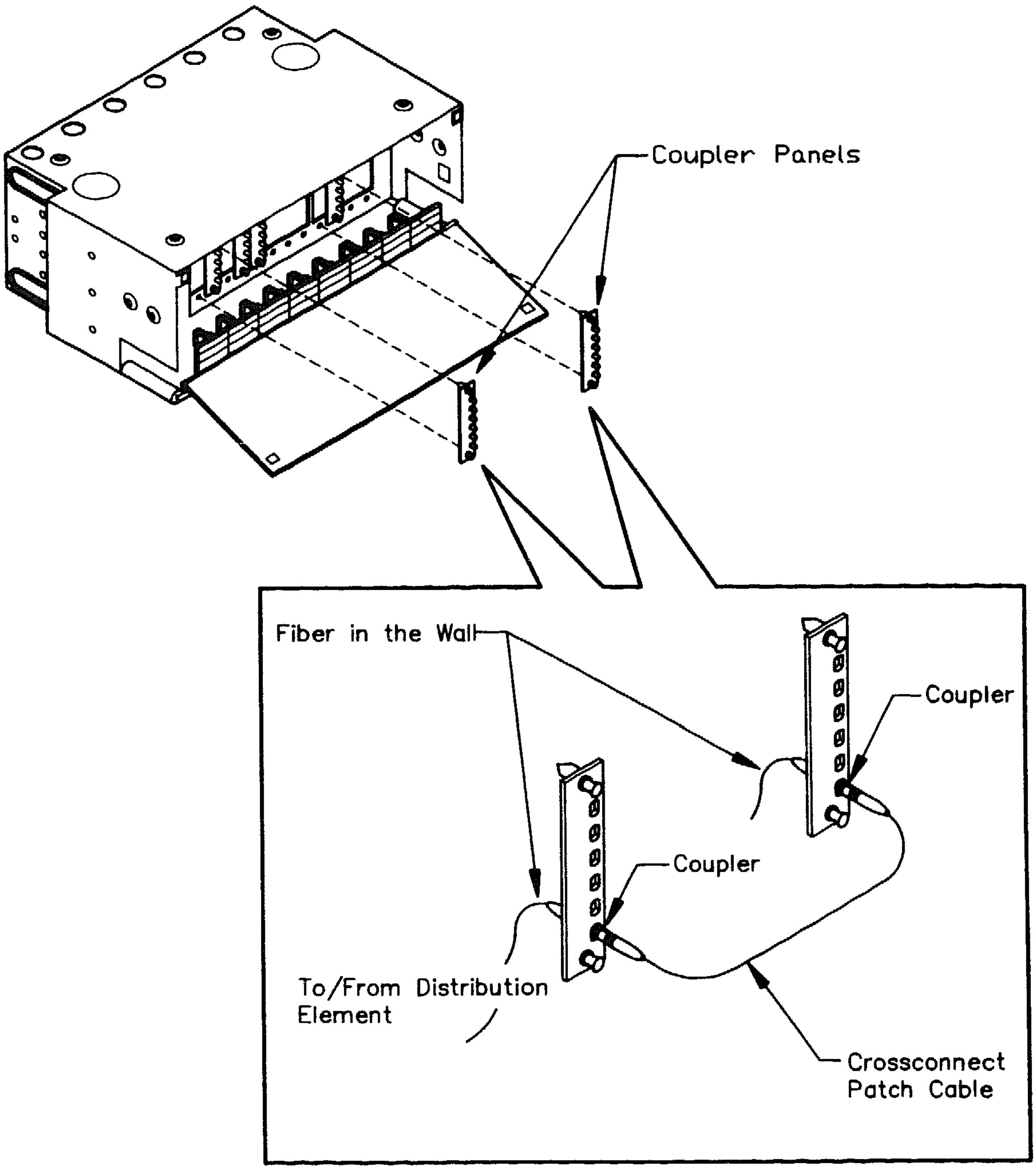
Each fiber optic crossconnect in the structured wiring is a patch cable connection between two separate fibers. As such, each involves a patch panel, two panel couplers, a patch cable, and four connectors (two connectors for the fibers installed into the rear of the patch panel and two connectors for the patch cable fiber), as follows:

- The panel couplers mount to the patch panel.

- The two terminated fibers connect to the back side of the panel-mounted couplers as follows:
  - A fiber coming to the distribution frame from a point that is higher in the structured wiring hierarchy than the distribution frame mounts its connector to a panel coupler at the left side (facing the panel) of the panel. For example, at an IDF a campus backbone cable fiber connects to the left side of the IDF's patch panel.
  - A fiber coming from a lower hierarchical point mounts to a coupler on the right side of the panel. For example, a building backbone cable fiber connects to the right side of the IDF's patch panel.
- The patch cable connects to the front side of the panel-mounted couplers to provide the crossconnect administration point's connection between the fibers in the wall.

Figure 4–2 illustrates the components involved in a crossconnect administration point.

## Figure 4–2: Crossconnect Components

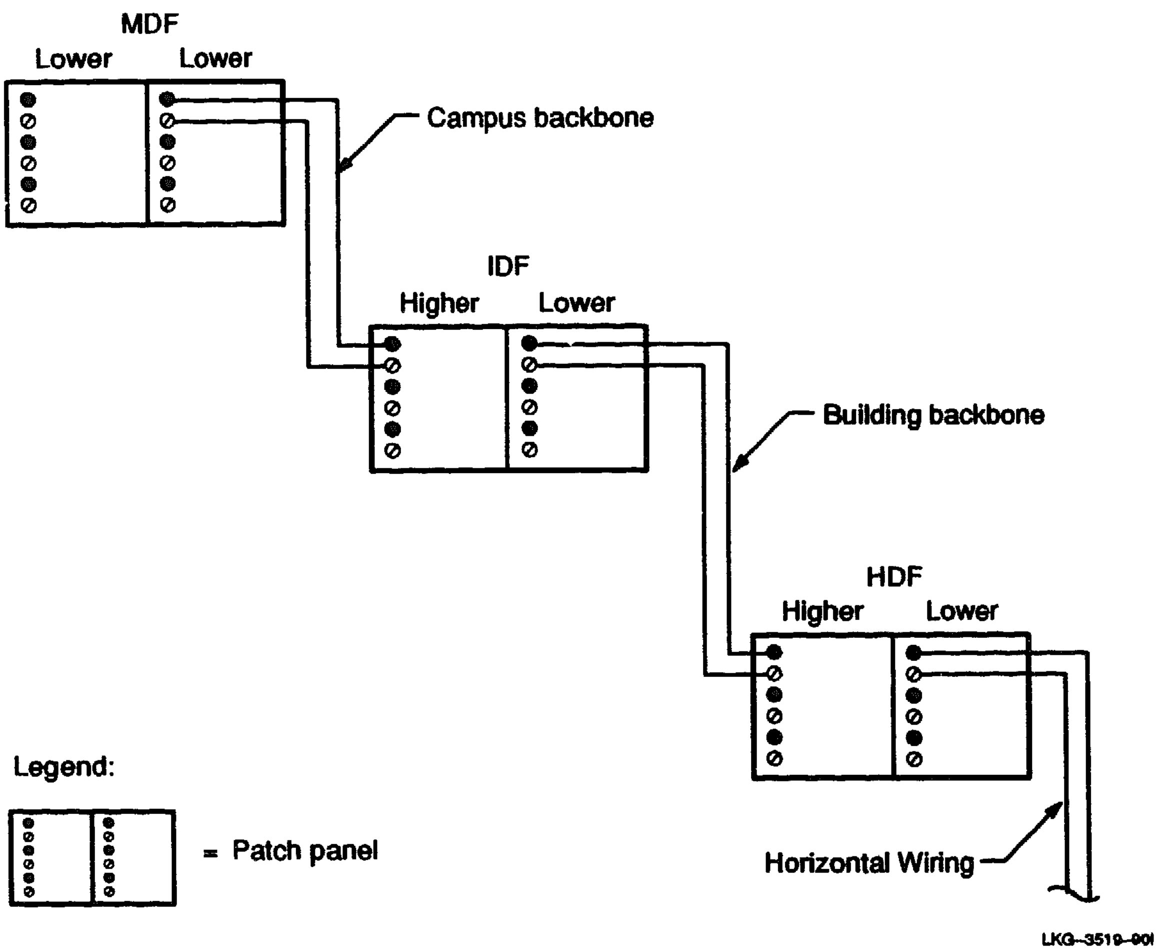


**NOTE**

It is important to maintain this right-side/left-side panel separation strategy at all patch panels. This strategy is necessary for the correct labeling, installation, and management of the structured wiring.

Figure 4–3 illustrates the right-side/left-side patch panel separation stategy.

**Figure 4–3: Right-Side/Left-Side Patch Panel Separation**

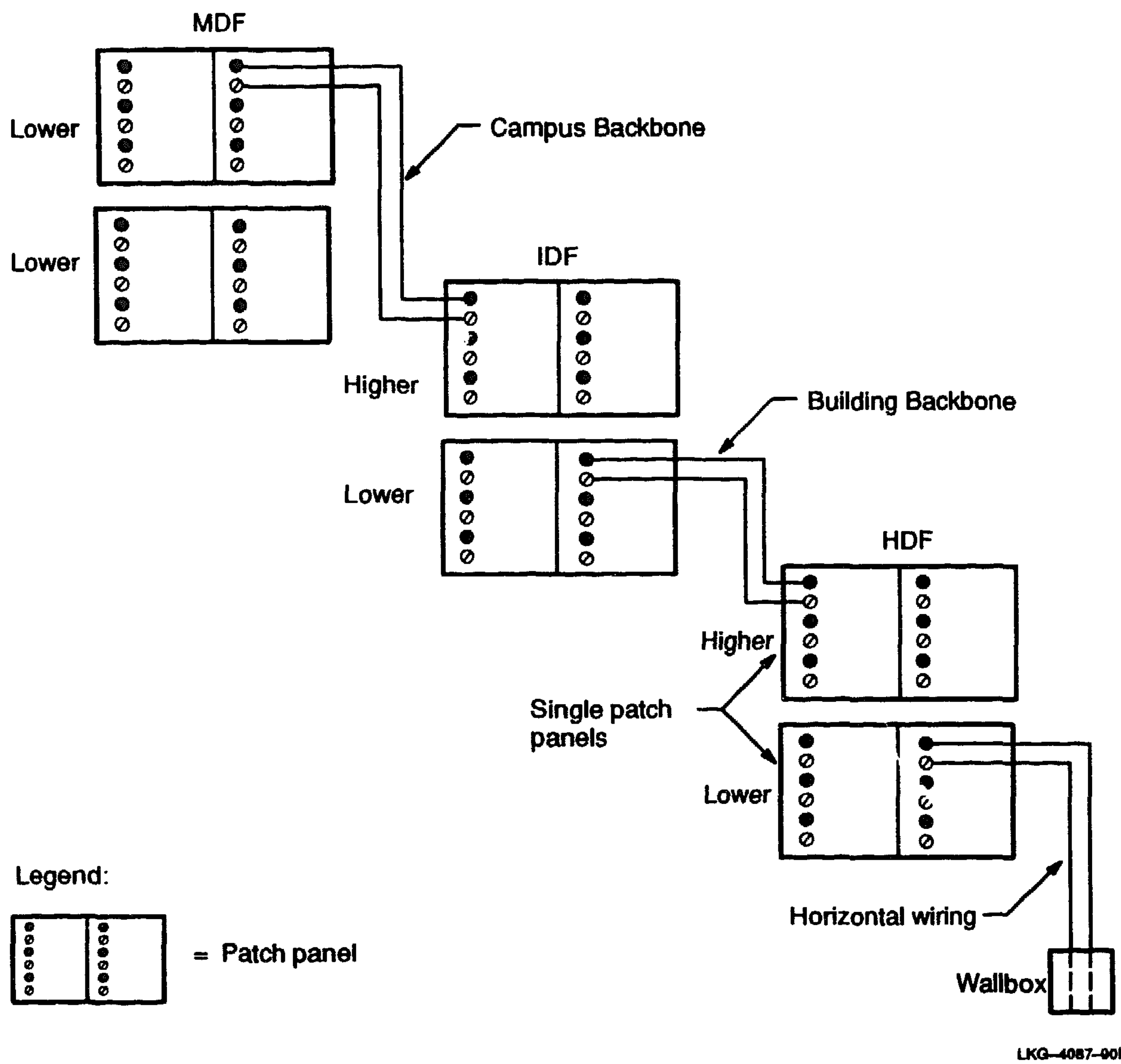


Exceptions to the left-side/right-side patch panel separation strategy can occur as follows:

- At an MDF where all campus backbone fibers are of lower hierarchical value.
- At an MDF, individual patch panels are used for connection to each site buildings and patching is done between the patch panels.
- At a distribution subsystem where a large number of fibers coming from another distribution subsystem require an entire patch panel. In this case, fibers coming from a higher distribution point and those coming from a lower distribution point are connected in separate patch panels. Patching is done between these separate patch panels.

Figure 4–4 illustrates the individual patch panel strategy.

## Figure 4–4: Individual Patch Panels



## 4.3 Interconnections

Interconnects are administration points that can be used to:

- Connect cable or cable segments directly together.
- Interconnect active networking equipment to the structured wiring at distribution frame patch panels.

The DECconnect System structured wiring uses interconnects for directly connecting cables together at only two points:

- Wallbox - to connect the horizontal wiring and work area wiring cable fibers.
- RWDF - to connect wallbox and HDF cable fibers.

Active equipment can connect to the structured wiring using interconnects at any of the following distribution frames:

- Main Distribution Frame (MDF) - to connect campus backbone cable fiber to active networking equipment (bridges, concentrators).
- Intermediate Distribution Frame (IDF) - to connect building backbone and campus backbone cable fibers through active equipment.
- Horizontal Distribution Frame (HDF) - to connect horizontal wiring and building backbone cable fibers through active equipment.
- Satellite or Office Distribution Frame (SDF or ODF) - to connect wallbox and HDF cable fibers through active equipment.

Each fiber optic interconnect in the structured wiring is a connection between two separate fibers, as follows:

- At the wallbox, the horizontal wiring and work area wiring cable fibers connect to a coupler mounted on a snap-in insert.
- At the RWDF, the HDF and wallbox cable fibers connect to a panel-mounted coupler.

- At active networking equipment:
  - Each fiber in the wall connects to a panel-mounted coupler at the distribution frame, with the fibers connected to the panel in the same left-side/right-side panel mounting strategy as used for crossconnect points (Section 4.2): a fiber from a higher point in the hierarchy mounts to the left side of the patch panel, and a fiber from a lower hierarchical point mounts to the right side.

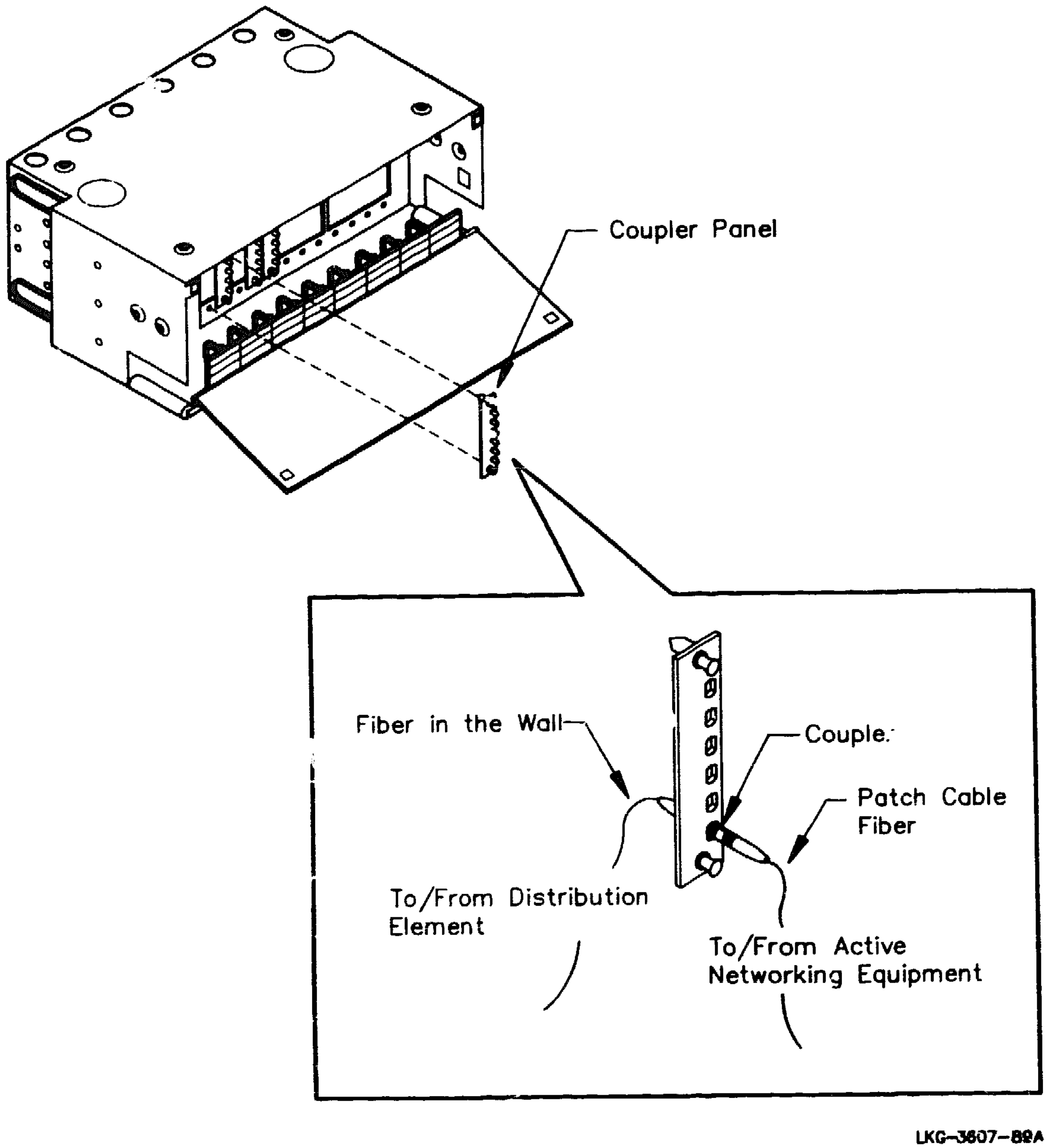
    **NOTE**

    As previously noted in Section 4.2 the right-side/left-side patch panel separation strategy is crucial to the overall wiring, labeling, and management strategies. This right-side/left-side patch panel mounting strategy must be maintained at all distribution frame patch panels within the structured wiring. The exceptions also apply to interconnects.

  - Patch cables connect each fiber's panel-mounted coupler to the active equipment's connectors.

Figure 4–5 shows the components involved in an active networking equipment interconnect administration point.

## Figure 4–5: Active Networking Equipment Interconnect Components



## 4.4 Horizontal Administration Zones

This section describes how to define the administration zones for the horizontal wiring subsytem. Defining these zones, and understanding the administration zone structure, is important to planning the horizontal structure.

Each horizontal wiring subsystem in the cable plant is an administration zone. Within the zone, the administration of the offices (wallbox connections) can be done at the horizontal distribution frame (HDF) or at the satellite, office, or remote wall distribution frames (SDFs, ODFs, or RWDFs).

The site's concept diagrams (created in Chapter 3) show all of the site's HDFs. These diagrams must be updated to identify the administration zones. This is done by labeling each diagrammed HDF with a two-digit numeric code that defines the HDF's zone number:

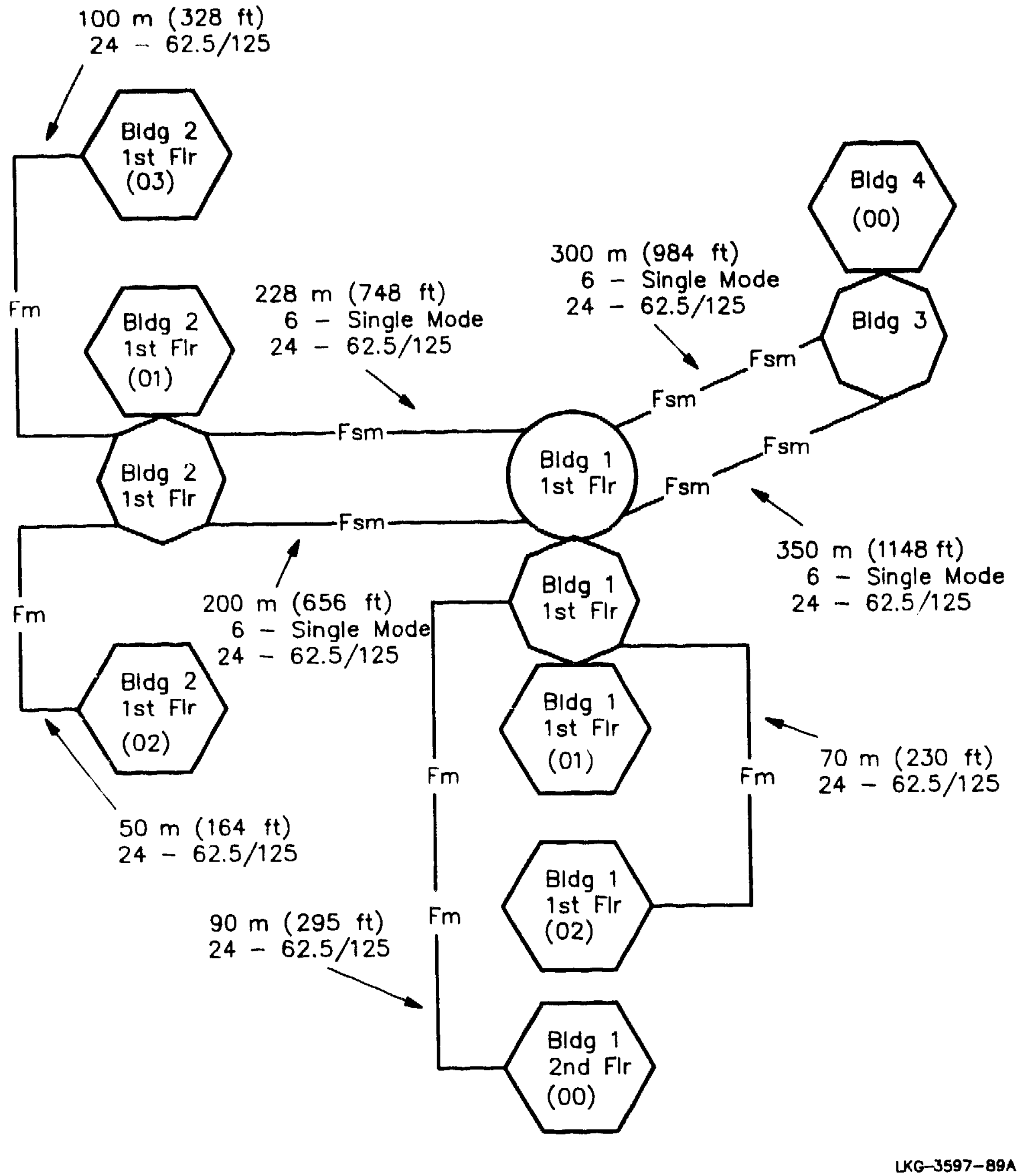
- If only one HDF is on a floor, that HDF's administration code is 00.
- If multiple zones exist on a floor, each zone has an HDF that is labeled with a sequential two-digit code, starting with 00, so on a floor with four zones, the HDFs are numbered 00, 01, 02, and 03.

**NOTE**

> Chapter 3 provides greater detail on the process of laying out the horizontal wiring subsystems for the site's floors.

Figure 4–6 illustrates a sample backbone concept diagram updated with the HDF administration zone numbers.

Figure 4–6: Administration Zone Numbers Added to a Backbone Concept Diagram



## 4.5 Fiber Optic Structured Wiring Strategy

The DECconnect System's fiber optic approach to a site's structured wiring affects all of the following:

- The design of fiber optic crossconnect and interconnect administration points at the structured wiring's distribution frames.
- The labeling of cable and distribution components.
- The installation of structured wiring cables and components.
- The management of the administration points.

This section defines and describes the DECconnect System's fiber optic structured wiring strategy by providing descriptions of the following:

- Fiber cable color code.
- Distribution subsystem field color.
- The fiber optic crossover.
- The rules for the structured wiring strategy.

### 4.5.1 Fiber Cable Color Codes

The DECconnect System fiber optic color code identifies separate colors for each of the fibers in a pair. The first fiber of the pair is an odd-numbered fiber and the second fiber of the pair is an even-numbered fiber. For data communications one fiber in the pair is defined as the transmit fiber and the other fiber is defined as the receive fiber. This fiber pairing is maintained throughout the structured wiring cable plant.

The fiber optic cables use a 12 color-code system for coding each fiber. In a cable with more than 12 fibers, the fibers are combined into bundles with a maximum of 12 fibers.

The bundles are color-coded with either a colored yarn wrapped around the fibers or a colored outer protective buffer.

Fiber color-code information is used for the following:

- Splice Description Worksheets (Section 4.6.3).
- Distribution Subsystem Connection Worksheet (Figure 10–13).

Table 4–1 lists the fiber color code for DECconnect System indoor cables. In addition, the table shows:

- The fiber number associated with each color code.
- The pair letter associated with each fiber pair.
- The recommended color code for outdoor cables.

**Table 4–1: Fiber Optic Cable Color Coding**

| Fiber or Unit Number | Pair Letter | Indoor Cable Fiber Colors | Outdoor Cable Fiber Colors |
|---|---|---|---|
| 1 | a | Blue | Blue |
| 2 | a | Orange | Orange |
| 3 | b | Green | Green |
| 4 | b | Brown | Brown |
| 5 | c | Slate | Slate |
| 6 | c | White | White |
| 7 | d | Red | Red |
| 8 | d | Black | Black |
| 9 | e | Yellow | Yellow |
| 10 | e | Violet | Violet |
| 11 | f | Light Blue | Natural with Blue dashes |
| 12 | f | Light Orange | Natural with Orange dashes |

Table 4–2 describes the distribution of fibers within fiber bundles. It shows:

- Typical and nontypical cable fiber counts
- The number of fiber bundle units for each fiber count
- The color code for each fiber bundle unit
- The number of fibers in each bundle unit for each fiber count

**NOTE**

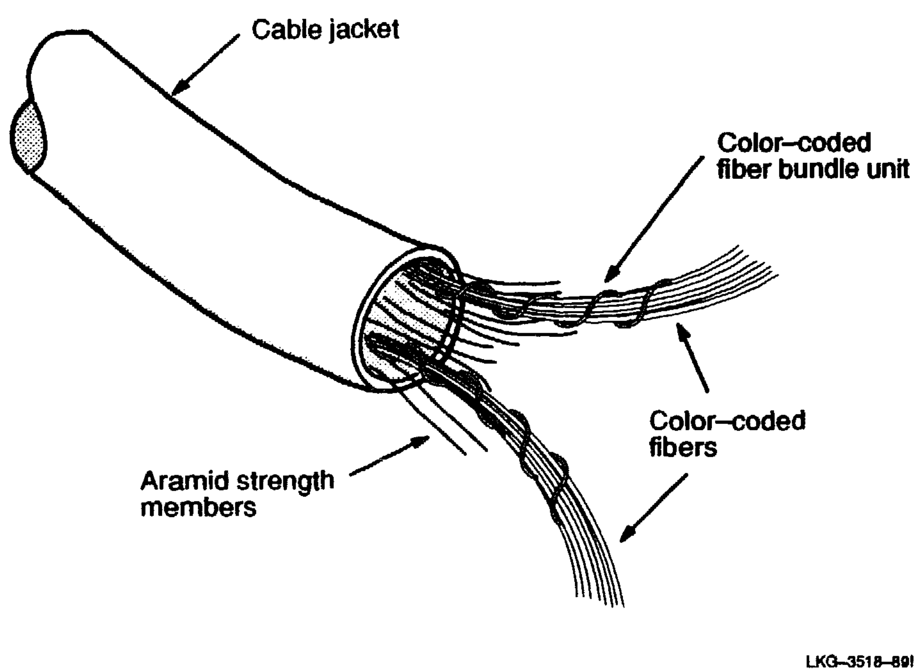
Table 4–2 lists even-numbered fiber counts up to 72 (6 bundles). Higher fiber counts (always even-numbered to account for transmit and receive fiber pairing) can be achieved by adding fiber bundles (for example, a red unit for up to 84, a black unit for up to 96, a yellow bundle for up to 108). The use of such high-count cables is limited.

Figure 4–7 illustrates the fiber cable color-code construction.

## Table 4–2: Fiber Bundle Distribution and Color Coding

| Fiber Count | Number of Fiber Bundles | Unit 1 (Blue) Fibers | Unit 2 (Orange) Fibers | Unit 3 (Green) Fibers | Unit 4 (Brown) Fibers | Unit 5 (Slate) Fibers | Unit 6 (White) Fibers |
|---|---|---|---|---|---|---|---|
| 2 | 1 | 2 | - | - | - | - | - |
| 4 | 1 | 4 | - | - | - | - | - |
| 6 | 1 | 6 | - | - | - | - | - |
| 8 | 1 | 8 | - | - | - | - | - |
| 10 | 1 | 10 | - | - | - | - | - |
| 12 | 1 | 12 | - | - | - | - | - |
| 14 | 2 | 8 | 6 | - | - | - | - |
| 16 | 2 | 8 | 8 | - | - | - | - |
| 18 | 2 | 12 | 6 | - | - | - | - |
| 20 | 2 | 12 | 8 | - | - | - | - |
| 22 | 2 | 12 | 10 | - | - | - | - |
| 24 | 2 | 12 | 12 | - | - | - | - |
| 26 | 3 | 12 | 8 | 6 | - | - | - |
| 28 | 3 | 12 | 8 | 8 | - | - | - |
| 30 | 3 | 12 | 12 | 6 | - | - | - |
| 32 | 3 | 12 | 12 | 8 | - | - | - |
| 34 | 3 | 12 | 12 | 10 | - | - | - |
| 36 | 3 | 12 | 12 | 12 | - | - | - |
| 38 | 4 | 12 | 12 | 8 | 6 | - | - |
| 40 | 4 | 12 | 12 | 8 | 8 | - | - |
| 42 | 4 | 12 | 12 | 12 | 6 | - | - |
| 44 | 4 | 12 | 12 | 12 | 8 | - | - |
| 46 | 4 | 12 | 12 | 12 | 10 | - | - |
| 48 | 4 | 12 | 12 | 12 | 12 | - | - |
| 60 | 5 | 12 | 12 | 12 | 12 | 12 | - |
| 72 | 6 | 12 | 12 | 12 | 12 | 12 | 12 |

**Figure 4–7: Fiber Cable Color-Code Construction**




### 4.5.2 Distribution Subsystem Field Color

Each of the distribution subsystems is defined by a color field. These color fields help provide:

- Identification of the distribution frame
- Higher and lower hierarchy indentification at each distribution frame
- Easy identification of cables between distribution subsystems

The five color-coded field definitions for use within the distribution subsystems are as follows:

- White field - Campus and building backbone cable connections at the MDF, IDF, and HDF
- Brown field - The termination field of a campus backbone cable at an IDF
- Gray field - Horizontal wiring cable connections between the HDF-to-SDF, HDF-to-ODF, or HDF-to-RWDF
- Purple field - Horizontal wiring cable connections between the HDF-to-computer room and HDF-to-system common equipment
- Blue field - Horizontal wiring cable connections between the HDF-to-wallbox, SDF-to-wallbox, ODF-to-wallbox, or RWDF-to-wallbox

During the installation process, color labels are added to each panel coupler at each of the patch panels.

Information on labeling the field colors at the distribution frames is given in Section 4.6.

Figure 4–8 illustrates the distribution subsystem field color-coding at each of the distribution frames.

## Figure 4–8: Distribution Subsystem Field Color-Coding

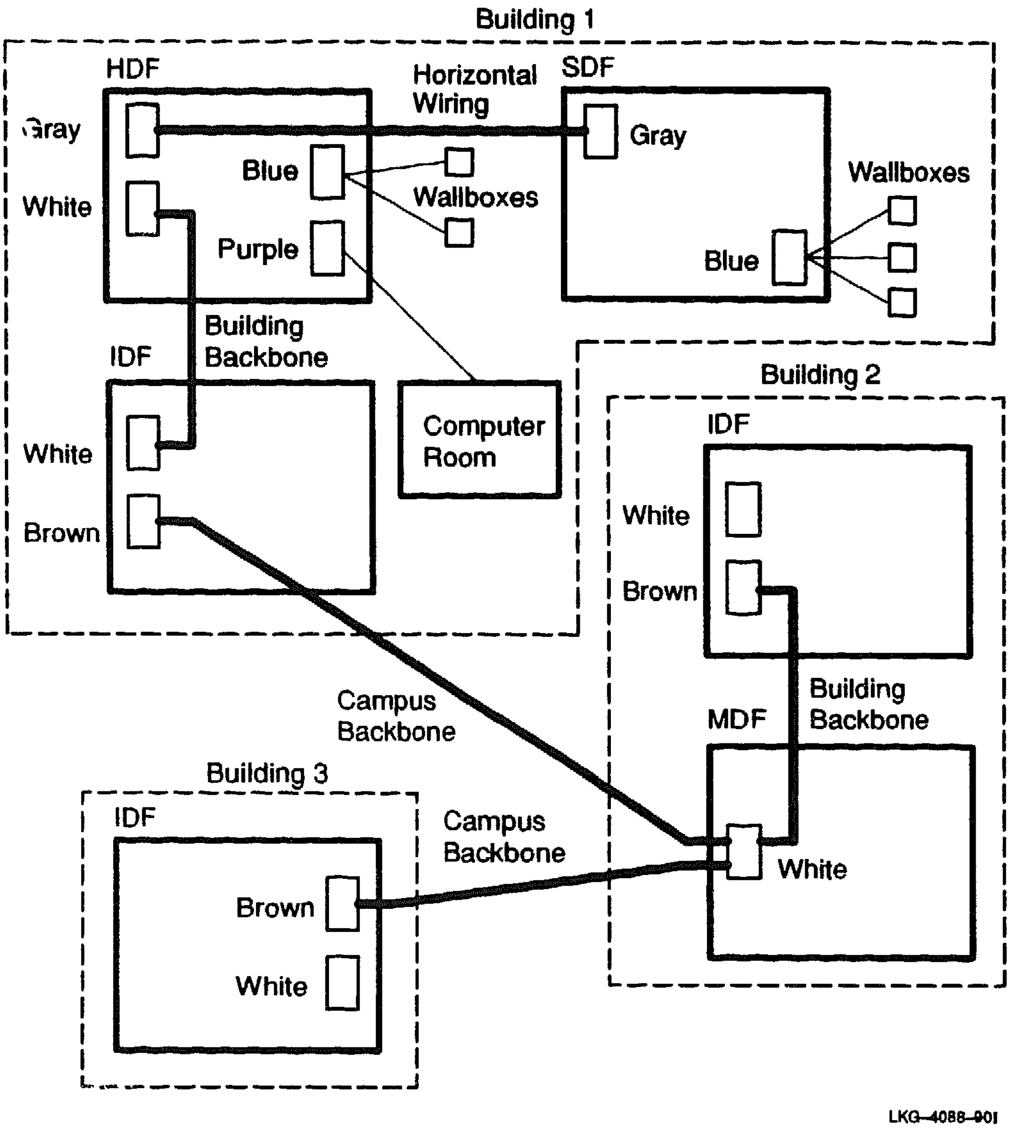


Table 4–3 identifies the higher and lower field colors at each distribution frame.

**Table 4–3: Higher/Lower Color Fields**

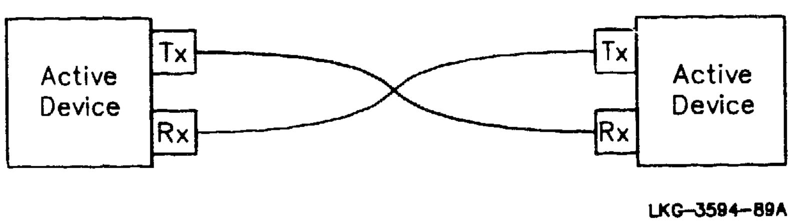
| Distribution Frame | Higher | Lower |
|---|---|---|
| MDF | — | White |
| IDF | Brown | White |
| HDF | White | Gray |
| | White | Purple |
| | White | Blue |
| SDF | Gray | Blue |
| ODF | Gray | Blue |
| RWDF | Gray | Blue |

### 4.5.3 Fiber Optic Crossover

The definition of a fiber optic crossover is an administration point in a device-to-device link where the transmit fiber of of one device becomes the receive fiber of the other device.

At the simplest level, all communications within a network are point-to-point. That is, a signal sent by one device is received by another. This concept is illustrated in Figure 4–9, which shows two active devices hard-wired together for communications.

**Figure 4–9: Crossover Wiring**



As shown in Figure 4–9, at some point in any device-to-device link the fiber going from one device's transmit output must become a fiber going to the other device's receive input. This transmit-to-receive switch, called a crossover, must occur if the communications between the two devices is to work. Since all communications are essentially point-to-point within the structured wiring cable plant, and all point-to-point links require a crossover to function correctly, part of the DECconnect System's fiber optic administration strategy is to manage those crossovers.

### 4.5.4 Rules of the Fiber Optic Structured Wiring Strategy

Successful crossover management requires understanding and keeping in mind the following rules when designing fiber optic subsystems and installing fiber optic cable and components:

- The one-to-one fiber optic wiring rule
- The crossover rules for crossconnects and interconnects

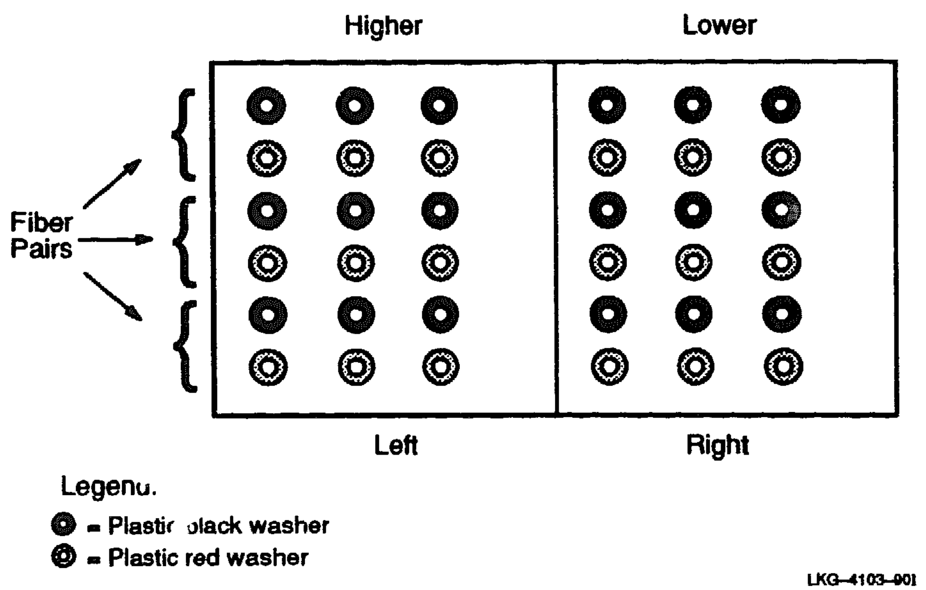
#### 4.5.4.1 One-to-One Fiber Optic Wiring Rule

The one-to-one rule requires that the fiber pairs installed in the wall between distribution elements maintain a one-to-one relationship. No crossovers can occur between a fiber pair in the wall. The connection worksheet in Figure 10–13 tracks the one-to-one connection of fiber pairs between the distribution subsystem patch panels. A black and red washer is installed on the couplers at each of the patch panels to differentiate between fibers in the fiber pairs. Each fiber pair has an odd-number and an even-number fiber (see Table 4–1). The odd-numbered fiber is connected to the black washer coupler and the even-numbered fiber is connected to the red washer coupler. Figure 4–10 illustrates the placement of the black and red washers at the patch panel couplers.

**NOTE**

> The red and black washers used for installation on the couplers can be ordered from vendors listed in the auxiliary section in Chapter 11.

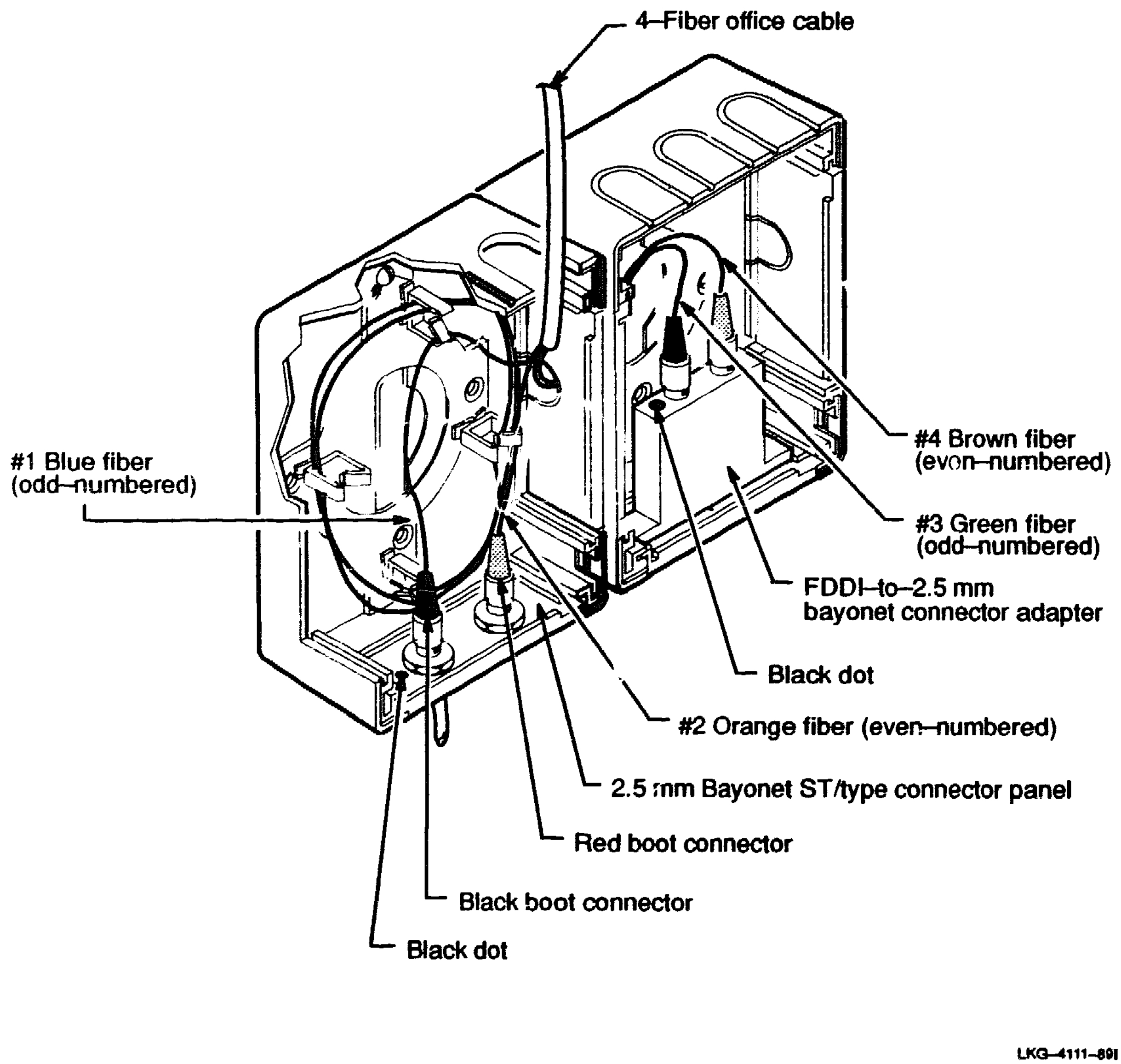
**Figure 4–10: Black and Red Washer Placements at Panel Couplers**




The one-to-one rule applies to the fiber pair connection at the wallbox. Each wallbox insert identifies its fiber pair transmit connector with a black dot. The odd-numbered fiber connects to the coupler with the black dot and the even-numbered fiber connects to the other coupler. The receive input of the user active device connects to the black dot coupler (Figure 4–11). More information about connecting the user's active equipment or station device to the wallbox is provided in Chapter 6.

The one-to-one rule is critical to the correct installation of the fiber optic cabling. As such, the installation rules and guidelines outlined in the *DECconnect System Fiber Optic Installation* guide are based on ensuring that the one-to-one connection of the fiber optic wiring is maintained.

Figure 4–11: Fiber Connections to the Wallbox



### 4.5.4.2 Crossover Rules for Crossconnects and Interconnects

The crossover rules define how crossconnects and interconnect patch cables are used to connect the subsystems together. These rules, which depend on the hierarchical relationship of the fibers installed inside the wall to the distribution frame, are as follows:

**NOTE**

The DECconnect System's hierarchy is described in greater detail in Section 3.3, Structured Wiring Hierarchy.

- Passive connection rules - define how crossconnect patch cables are connected to each of the distribution patch panels.
  - — Higher-to-lower (passive) rule - when a crossconnect connects a pair of fibers in the wall that are higher in hierarchy than the distribution frame to a pair of fibers in the wall that are a lower hierarchy, no crossover must occur in the patch cable. Figure 4–12 illustrates a higher to lower passive connection rule.
  - — Lower-to-lower (passive) rule - when a crossconnect connects a pair of fibers in the wall that are both lower in hierarchy than the distribution frame, a crossover must occur in the patch cable. Figure 4–13 illustrates a lower to lower passive rule connection.
- Active connection rules - define how interconnect patch cables are used for connecting active equipment to the structured wiring:
  - — When an interconnect connects an active device to a pair of fibers in the wall that are higher in hierarchy than the distribution frame, a crossover must occur in the patch cable.
  - — When an interconnect connects an active device to a pair of fiber in the wall that is lower in hierarchy than the distribution frame, no crossover occurs in the patch cable.

  Figure 4–14 illustrates active equipment connection rules.

**NOTE**

In the DECconnect System's structured wiring, higher-to-lower and lower-to-lower are the only hierarchical relationships that can occur. Each of these are defined by the field colors as indicated in Table 4–3. Figure 4–15 illustrates the distribution subsystem higher and lower connections.

## Figure 4–12: Higher-to-Lower (Passive) Connection Rules

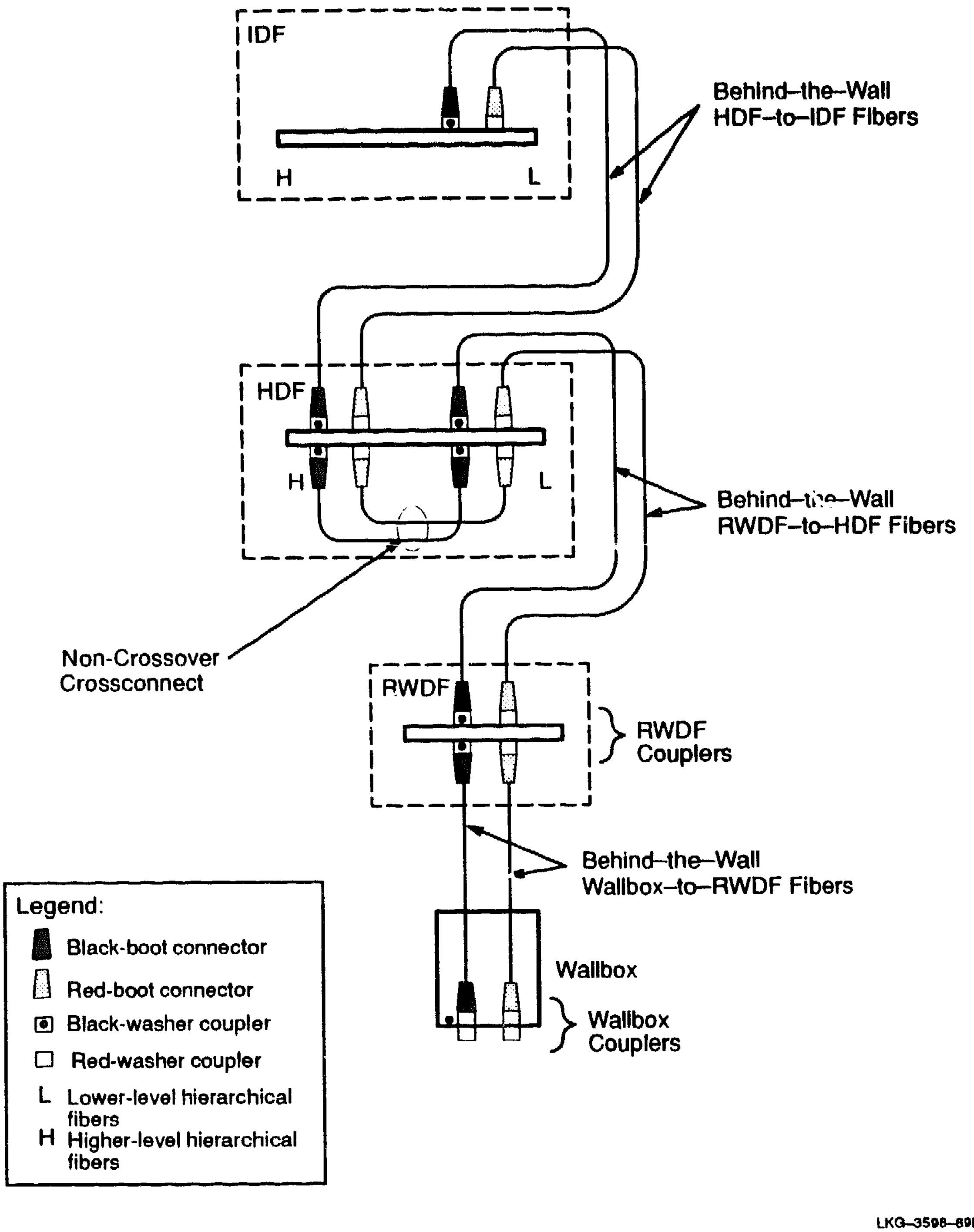


**Figure 4–13: Lower-to-Lower (Passive) Connection Rules**

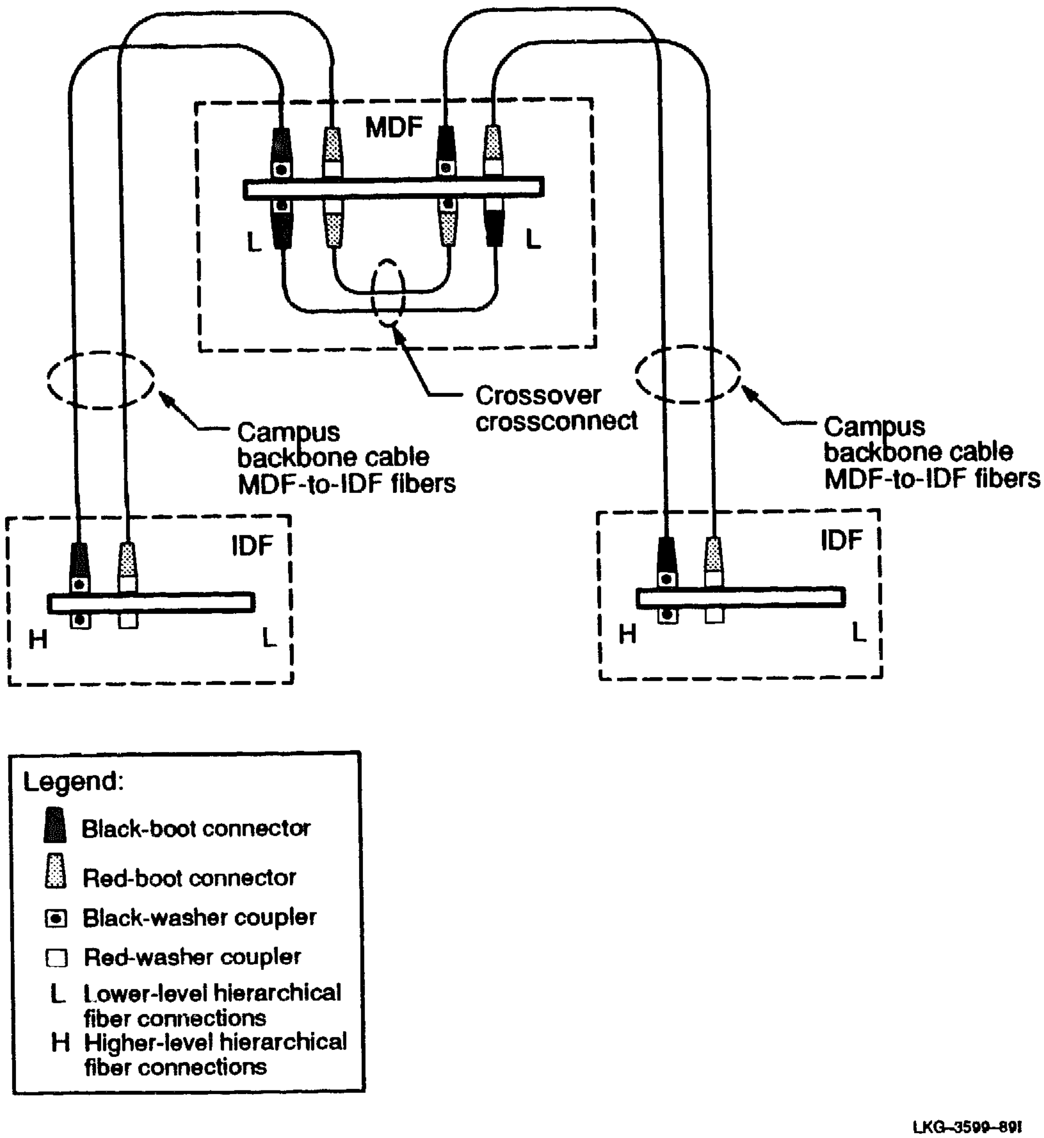


**Figure 4–14: Active Equipment Connection Rules**

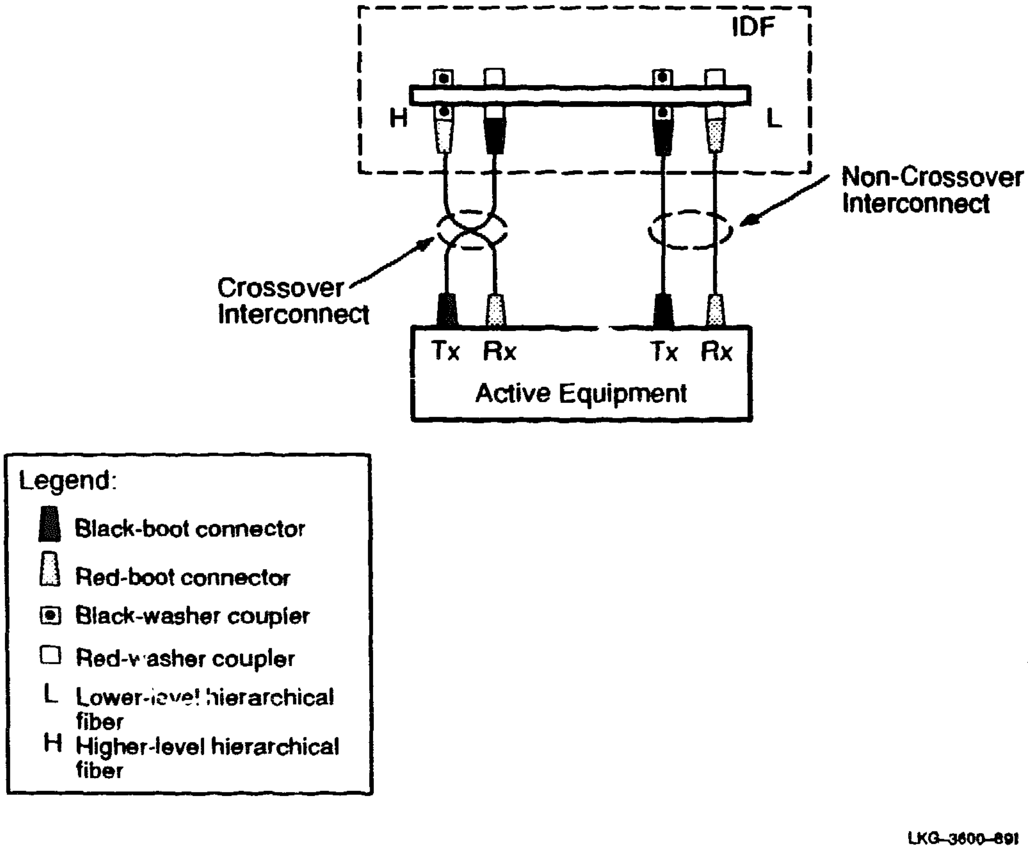
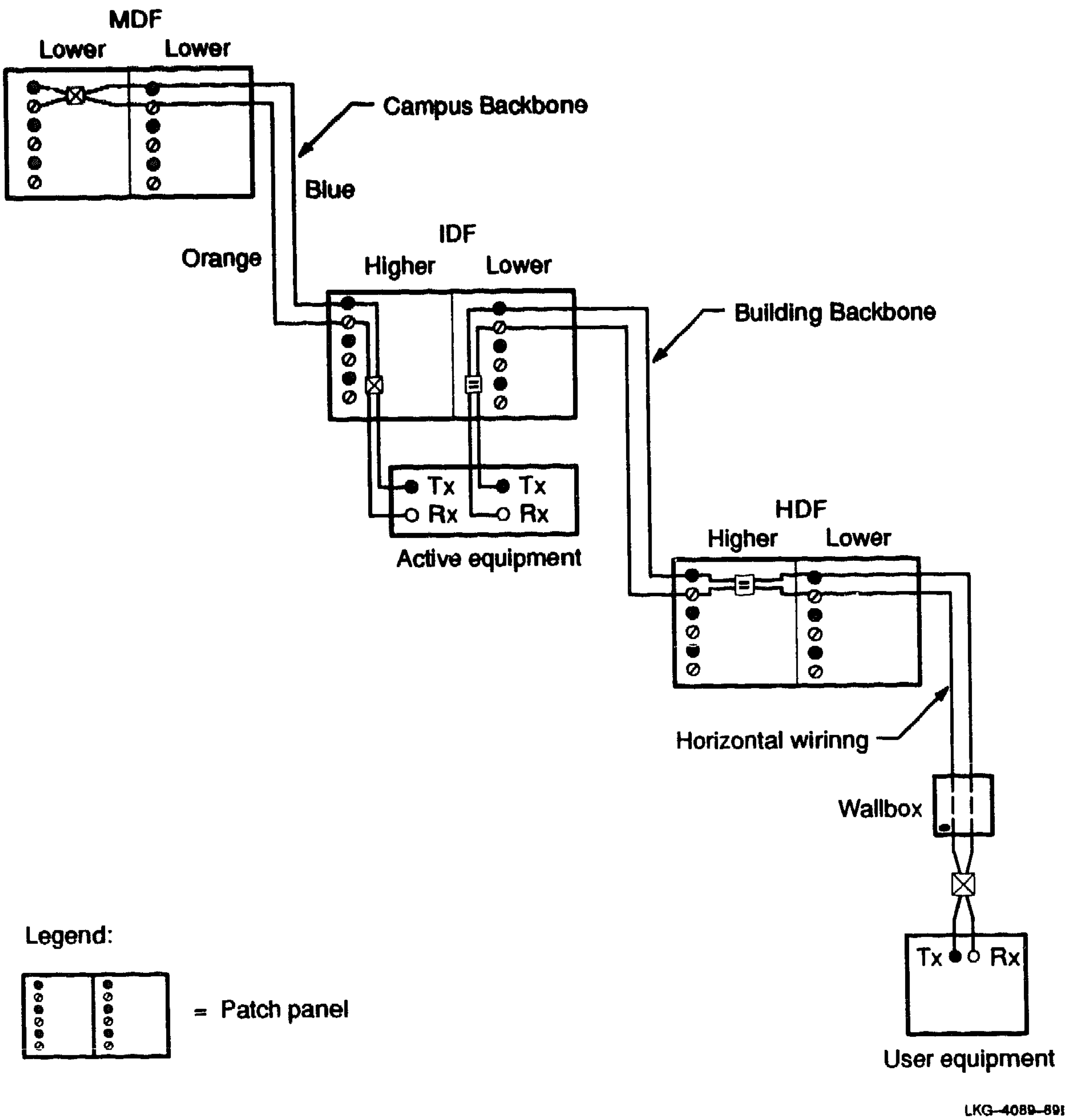


**Figure 4–15: Distribution Subsystem Higher and Lower Connections**



## 4.6 Labeling

The labeling strategy consists of two separate but interrelated processes:

- Identifier definition process - during this process, the network designer:
  - Uses the concept diagram (created in Chapter 3) to assign identifiers to all of the structured wiring cable and distribution elements (distribution frames and wallboxes). The assigned identifiers are recorded on a set of worksheets.
  - Uses the Cable Identifier Worksheet (Figure 4–18) to fill in Splice Description Worksheet (Section 4.6.3)for planned structured wiring splice points.
  - Uses the Cable Identifier Worksheet during the distribution frame design (provided in Chapter 10) to create the Distribution Subsystem Connection Worksheet (Figure 10–13) that defines all of the fiber connections at each distribution frame's patch panels and defines the field color locations.
  - Includes all of the filled-in worksheets (cable identifier, connection, and splice description) and connection label maps with the installation documents.
- Label creation process - during this process, the installer:
  - Uses the Cable Identifier Worksheet to transfer the information to the wallbox and cable labels.
  - Uses the Splice Description Worksheet to splice the cables together as defined in the worksheet and create the splice component labels.
  - Uses the panel connection label maps and worksheets in Chapter 10 to connect the fibers to the distribution frame patch panels and create the panel labels.
  - Attaches all labels to the cable and distribution elements.

The following subsections provide descriptions of:

- Identifier Worksheets
- DECconnect System Identifiers
- Splice Description Worksheet

- Distribution Subsystem Connection Worksheet Process
- Label Creation Process

### 4.6.1 Identifier Worksheets

This section provides the four types of identifier worksheets to photocopy and fill in during the label definition process:

- Backbone Identifier Worksheet (Figure 4–16). Describes the identifier information for the campus and building backbones, as follows:
  - Section I Project Identification. Identifies the project, page number of the worksheet, designer, and date.
  - Section II Main Distribution Frame (MDF) Identifiers. Identifies each site's MDF by building, floor, and equipment room identification number. Records the DECconnect System identifier for the MDF, and identifies the total number of cables that will be connected to that MDF.
  - Section III Intermediate Distribution Frame (IDF) Identifiers. Identifies each of the site's IDFs by building, floor, and equipment room identification number. Records the DECconnect System identifier for each IDF, and identifies the total number of cables that will be connected to that IDF.
- Horizontal Wiring Identifier Worksheet (Figure 4–17). Identifies the project and each of a building's horizontal wiring distribution frames by floor, type of distribution frame (HDF, SDF, ODF, or RWDF), and equipment room identification number. Records the DECconnect System identifier for the distribution frame, and identifies the total number of cables that will be connected to that distribution frame.
- Cable Identifier Worksheet (Figure 4–18). Identifies the project and each of the building's cables by its distribution element (distribution frame or wallbox) connections, identifies the cable's type and fiber count, and records the DECconnect System identifier for each cable.
- Wallbox Identifier Worksheet (Figure 4–19). Identifies the project and horizontal wiring subsystem, and records the DECconnect System wallbox identifier. It identifies the distribution frame, the patch panel shelf location, the fiber pair that connects with the wallbox, the wallbox office location, cable type, and the snap-in connector.

## Figure 4–16: Backbone Identifier Worksheet

I. Project Identification:

Project ID: ______________ Page ____ of ____

Designer: ____________________ Date: ______________

II. Main Distribution Frame (MDF) Identifiers:

| Building ID | Floor Number | ER ID | MDF Identifier | Number of Cables | Comments |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

III. Intermediate Distribution Frame (IDF) Identifiers:

| Building ID | Floor Number | ER ID | IDF Identifier | Number of Cables | Comments |
|---|---|---|---|---|---|
| | | | | | |
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## Figure 4–17: Horizontal Wiring Identifier Worksheet

I. Project Identification:

Project ID: ______________ Page ____ of ____

Designer: ____________________ Date: ______________

II. Distribution Elements Location:

Building Identifier: ______________

III. Identifiers:

| Floor Number | Type of Frame | ER ID | Distribution Frame Label ID | Number of Cables | Equipment |
|---|---|---|---|---|---|
| | | | | | |
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## Figure 4–18: Cable Identifier Worksheet

I. Project Identification:

Project ID: ____________ Page ___ of ___

Designer: ________________ Date: ____________

II. Cable Location:

Building Identifier: ____________ Indoor or Campus Backbone: ____________

III. Identifiers:

| Higher-Level Distribution Element ID | Lower-Level Distribution Element ID | Number of Fibers | Cable Type | Cable Identifier |
|---|---|---|---|---|
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## Figure 4–19: Wallbox Identifier Worksheet

I. Project Identification:

Project ID: ______________ Page ____ of ____

Designer: ____________________ Date: ______________

II. Subsystem Identification:

Building Identifier: ______________ HDF Identifier: ______________

III. Identifiers:

| Wallbox Label ID | Distribution Frame | | | | | Cable ID | Media Type | Wallbox Snap-in Type |
|---|---|---|---|---|---|---|---|---|
| | Identifier | Shelf No. | Pair Letter | Column Letter | Row No. | | | |
| | | | | | | | | |
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### 4.6.2 DECconnect System Identifiers

The DECconnect System Identifiers define the types of identifiers that can be used for the structured wiring distribution elements (distribution frames and wallboxes) and cables.

Use the DECconnect System identifiers and the concept diagrams, which define the site's distribution element structure, to do the following:

- Define the distribution element identifiers and record those identifiers in the the Backbone, Horizontal Wiring, and Wallbox Identifier Worksheets.
- Use the distribution element identifiers to define and record cable identifiers in the Cable Identifier Worksheets.
- Add the identifiers for the cables that connect to each wallbox to the Wallbox Identifier Worksheets.
- Add the distribution frame patch panel numbers that each wallbox connects with to the Wallbox Identifier Worksheets.

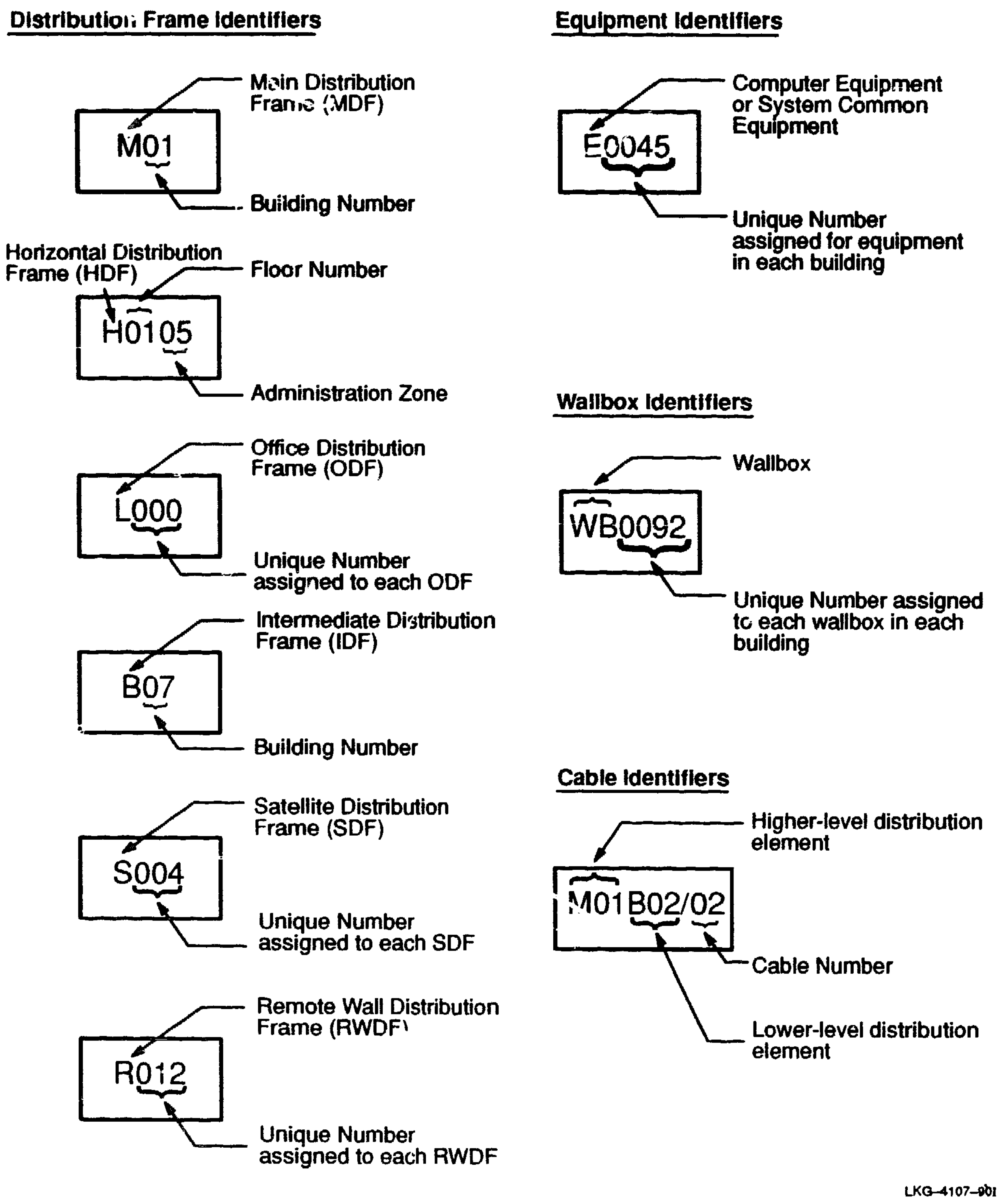
**NOTE**

The patch panel numbers are not added to the Wallbox Identifier Worksheets until the distribution frame component layout diagrams are created. These procedures are explained in Chapter 10.

The completed identifier worksheets are used to create the Distribution Subsystem Connection Worksheet in the procedures in Chapter 10.

Figure 4–20 provides a summary of the DECconnect System Identifiers.

**Figure 4–20: DECconnect System Identifier Summary Sheet**



#### 4.6.2.1 Distribution Frame Identifiers

Three subsystems use at least one type of distribution frame:

- Campus backbone - contains main distribution frame (MDF) only.
- Building backbone - contains intermediate distribution frames (IDFs) only.
- Horizontal wiring - contains one horizontal distribution frame (HDF) and any (or none) of the following distribution frames:
  - Satellite distribution frame (SDF)
  - Office distribution frame (ODF)
  - Remote wall distribution frame (RWDF)

##### Campus Backbone MDF Identifiers

Make a photocopy of the Backbone Identifier Worksheet and fill in Section I (project identification). Then use Section II (MDF identifiers) to:

- Identify the MDF by its building, floor, and equipment room ID numbers.
- Define and record the identifier for each MDF.
- Identify the total number of cables that will connect to each MDF.

The MDF identifiers use a capital letter M and a two-digit numeric code that is equal to the MDF's building number. For example:

M07 is the identifier for an MDF in building 7.

M16 is the identifier for an MDF in building 16.

##### Building Backbone IDF Identifiers

Use Section III (IDF identifiers) of the Backbone Identifier Worksheet to:

- Identify each IDF by its building, floor, and equipment room ID numbers.
- Define and record the identifier for each IDF.
- Identify the total number of cables that will connect to each IDF.

The IDF identifiers use a capital letter B (for building) and a two-digit numeric code that is equal to the IDF's building number. For example:

B03 is the identifier for an IDF in building 3.

B22 is the identifier for an IDF in building 22.

**NOTE**

Use B instead of I to avoid confusion with the number 1.

#### Horizontal Wiring Distribution Frame Identifiers

Photocopy the Horizontal Wiring Identifier Worksheet (Figure 4–17) and fill in the project (Section I) and building identifications (Section II). Then use the identifiers section (Section III) to:

- Identify all distribution frames by floor and equipment room ID numbers. List in this order:
  1. All HDFs
  2. All SDFs
  3. All ODFs
  4. All RWDFs
- Define and record the horizontal wiring distribution frame identifiers.
- Identify the total number of cables that will connect to each distribution frame.

The HDF identifiers use a capital letter H and a four-digit code. The first two digits identify the HDF by it's floor number. For example:

H04XX indicates the HDF is on the fourth floor.

H20XX indicates the HDF is on the twentieth floor.

The second two digits of the HDF's four-digit code identify the administration zone number with "00" code as the administration zone number for the first HDF on a floor. For example:

H0401 indicates the HDF is for administration zone one of the two administration zones on the fourth floor.

H2000 indicates the HDF is the first HDF on the twentieth floor.

**NOTE**

Administration zone numbers were defined (and recorded in the site's concept diagrams) in Section 4.4.

The SDF, ODF, and RWDF identifiers use single letters with numeric codes: a three-digit codes for all SDFs, ODFs, and RWDFs. The letters used in the codes are: S for SDF; L (local) for ODF; and R for RWDF.

**NOTE**

Use the L instead of O; the capital letter O is often mistaken for the number 0.

Develop the numeric code of the SDF, ODF, and RWDF identifiers as follows:

- Start with 001 and sequentially number all of the SDFs so that each SDF in the building has a unique code.
- Repeat the process for all of the ODFs.
- Repeat the process for all of the RWDFs.

The SDF, ODF, and RWDF identifiers are independent of each other and of their location within the building.

#### Equipment Identifiers

Computer room equipment and system common equipment indentifiers use a single letter with a four-digit code. The letter used in the code is E for the computer or system common equipment.

The numeric code starts with 0001 and sequentially numbers the equipment in each building.

**NOTE**

Assign an identifier to computer and system common equipment involved in direct link with an HDF only. Computer and system common equipment that connects to the structured wiring at wallboxes does not require an identifier.

These identifiers are recorded on the worksheet under the equipment line for an HDF which services this equipment.

### Wallbox Identifiers

Make at least one photocopy of the Wallbox Identifier Worksheet for each horizontal wiring subsystem in each building and fill in the project (Section I) and subsystem identifications (Section II). Then use the identifiers (Section III) to:

- Define and record the wallbox identifiers.
- Record the distribution frame identifier, the patch panel shelf location, the fiber pair letter, and the column/row position of the fiber pair that connect to the wallbox.

**NOTE**

The patch panel shelf location and fiber pair connections are added to the worksheet during procedures outlined in Chapter 10, Distribution Frame Design. In Section 10.3, Distribution Frame Layout Diagrams, each patch panel shelf is identified by a number. In Section 10.7, the cable connections in the wall are defined for each of the distribution frame patch panels. The number for the patch panel shelf and fiber pair connection that each wallbox connects to is added to the Wallbox Identifier Worksheet at that time.

- Record the office identification number of the wallbox location, as well as the cable media and wallbox snap-in connector.

The wallbox identifiers use the capital letters WB and a four-digit code. Develop the code as follows:

- Start at the HDF in administration zone 00 of the first floor (H0100) with the code 0001 and sequentially number the building's wallboxes. For example, if H0100 has 86 wallboxes, the wallbox identifiers for the horizontal wiring subsystem are WB0001 through WB0086.
- Go through the building, one administration zone at a time, sequentially number each new administration zone's wallboxes, with the starting number in each new sequence dependent on the last number used in the previous

administration zone sequence. For example, when H0100 has 86 wallboxes, the first number in the wallbox sequence for H0201 is WB0087.

**NOTE**

> To add a wallbox to a zone at a future date, use the next available sequential wallbox number for the building. For example, if the last wallbox number assigned in the building was WB0756, then additional wallboxes begin with the identifier value of WB0757. The exact sequence of the wallbox identifiers in a zone is not important. It is important, however, that each wallbox in a building has its own unique identifier value.

#### 4.6.2.2 Cable Identifiers

Fill in a Cable Identifier Worksheet for:

- Each building's IDF-to-HDF cables.
- All of the site's MDF-to-IDF cables.
- Each of the horizontal wiring subsystem cables.

For each Cable Identifier Worksheet fill in:

- The project identification section (Section I).
- The cable location section (Section II) to identify the building and whether the worksheet is for indoor or campus backbone cables.
- Use the identifiers section (Section III) to:
  - — Identify each cable by its distribution frame, wallbox, computer room, or system common equipment identifiers, as well as by its fiber count and cable type.
  - — Define and record the identifiers for each cable.

  The cable identifiers use a three-part code that identifies:

  - — The hierarchically higher-level distribution element from which the cable is coming.

— The hierarchically lower-level distribution element to which the cable is going.

**NOTE**

In the case of an HDF-to-computer room or HDF-to-system common equipment cable, the computer room or system common equipment identifier is listed as the lower-level distribution element.

— A two-digit cable number. If only one cable is going between the defined distribution link points, the cable number is 01. The cable numbers are always sequential. For example, if four cables are going between the same two distribution elements, then the cables are numbered 01, 02, 03, and 04.

**NOTE**

For information on defining the cable identifiers, see the descriptions for multiple-segment and breakout link cables later in this section.

Examples of cable identifiers are:

H1203S089/02 identifies the cable as the second cable in a link between the HDF in zone 3 of the twelfth floor and SDF 089.

M01B02/02 identifies the cable as the second cable in a link between an MDF in building 1 and an IDF in building 2.

B04H0200/01 identifies the cable as the first (or only) cable in a link between building 4's IDF and the HDF on floor 2 of the building.

H0201E02/02 identifies the cable as the second cable in an HDF-to-system common equipment link in administration zone one of the second floor.

Once all the cable identifiers for a building are defined and recorded, use the Cable Identifier Worksheets to update the Wallbox Identifier Worksheets.

#### Multiple-Segment Cable Identifiers

When a single link is made up of two or more cable segments spliced together, each cable has the same identifier except that a letter is added to the two-digit cable number. For example, for a link that is made up of three segments and has the basic identifier of M03B02/01, one segment's cable is M03B02/01A, the second segment is M03B02/01B, and the third segment's cable is M03B02/01C. Which segment cable in the link is labeled with A, B, or C is not important. It is important, however, that each cable has a unique cable identifier that identifies it as part of a multiple-segment cable link.

#### Breakout Link Identifiers

When a breakout link is used in the campus backbone, the cables going from IDFs to the breakout point do not need special labels. Each of the IDF-to-breakout link cables is going to a single MDF. Therefore, each cable label simply lists the MDF and IDF identifiers and the number of the cable. For example, M02B03/2 is the cable identifier for the second cable from the IDF in building 3 going to the MDF in building 2 by way of the breakout link.

However, the cable going from the MDF to the breakout point needs an identifier that shows it is going to more than one IDF. To create this identifier, add both IDF identifiers to the label for the cable that goes from the MDF to the breakout point. For example, M02B03B06/2 is the second MDF cable in a breakout link between the MDF in building 2 and the IDFs in buildings 3 and 6.

### 4.6.3 Splice Description Worksheet

A Splice Description Worksheet is only filled out for splice points where a direct color-to-color splice relationship cannot be maintained between the splice cables. For example:

- At a splice closure that will be used for a campus backbone breakout link between two 24-fiber cables and a single 48-fiber cable.
- At an RWDF where a single 12-fiber cable from the HDF is spliced to three 4-fiber wallbox cables.

In both cases, the color-to-color relationship cannot be directly carried out: either different-colored fibers will be spliced together (in the case of the RWDF's splice) or fibers from different-colored bundles will be spliced (as in the case of the breakout link splice closure).

This section provides instructions for filling in the Splice Description Worksheets. Photocopy the worksheet in Figure 4–21. Use one copy of the worksheet for each splice point that does not keep a direct color-to-color splice relationship.

#### Section I Project Identification

Identify the project, worksheet page number, designer, and date.

### Section II Splice Component Identification

Identify the splice point with a two-digit identifier developed as follows:

- Assign a sequentially developed two-digit identifier (starting with 01) to each splice point using the letter code SC (for splice component).
- Update the site or building floor plan to show the location of each splice point and each splice point's identifier.
- Record the splice point identifier on the worksheet.

### Section III Splice Descriptions

Use this section to define how the cables will be spliced together, as follows:

- Use the Cable Identifier Worksheets to identify the cable identifiers for all cables involved in the splice.
- List the fibers for the hierarchically higher-level cable by cable label, fiber bundle color, and fiber color within that bundle. For example, in a 24-fiber MDF cable the blue bundle fibers are listed first followed by the orange bundle fibers.
- Define which fibers in the hierarchically lower-level cables connect to each of the higher-level cable's individual fiber. For example, for two 12-fiber IDF cables from B01 and B02, define the 12-fiber cable from B01 as splicing one-to-one to the same color fibers in the blue MDF cable bundle, and define the fibers from B02 as splicing one-to-one to the same color fibers in the MDF cable's orange bundle.

**NOTE**

> For additional information on fiber optic color codes, see the color code information that is given in Section 4.5.1.

### Section IV Comments

Use this section to provide any additional descriptions or special instructions regarding the splice point being defined.

**Figure 4–21: Splice Description Worksheet**

I. Project Identification:

Project ID: ________________ Page ____ of ____

Designer: __________________________________ Date: ______________

II. Splice Component Identifier: ______________

III. Splice Descriptions:

| Higher-Level Cable | | | Lower-Level Cable | | |
|---|---|---|---|---|---|
| Identifier | Fiber | Bundle | Identifier | Fiber | Bundle |
| | | | | | |
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IV. Comments

LKG–3637–89I

### 4.6.4 Distribution Subsystem Connection Worksheet Process

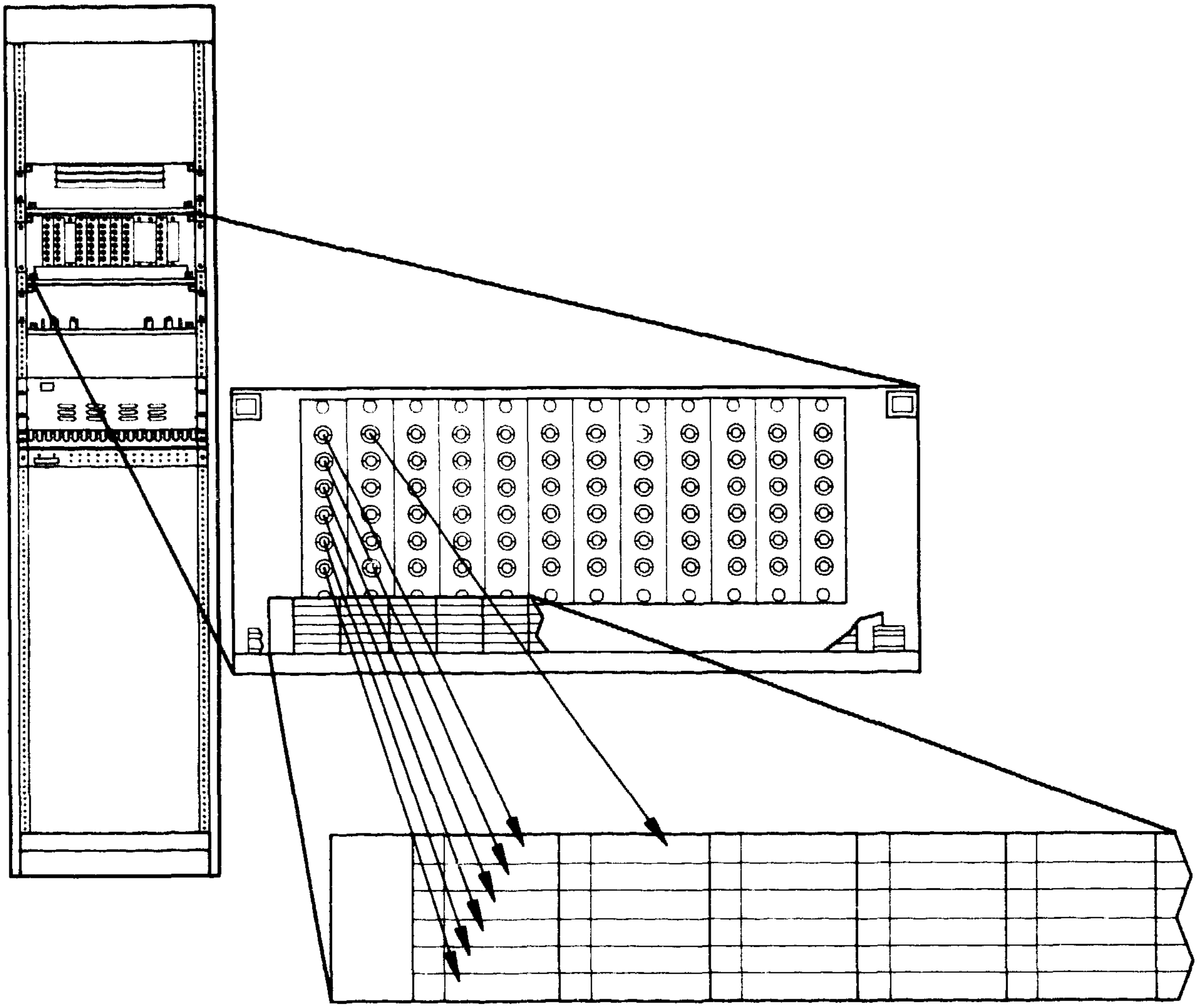
This section provides an overview of the connection worksheet process, a process that is completed during the distribution frame design (Chapter 10).

Each distribution frame has at least one patch panel. A connection worksheet must be completed in order to provide a connection map between the patch panels located at each of the distribution subsystems. These worksheets are used during the installation to:

- Identify which fiber of which cable connects to each panel position.
- Maintain the fiber pair relationship.
- Identify the higher and lower field colors at each distribution panel.
- Fill in the physical labels that attach to each panel.

Figure 4–22 shows a patch panel label with its corresponding positions in the patch panel. See Chapter 10 for more details about the patch panel connection label map used by the installer to create this label.

Figure 4–22: Patch Panel Label



### 4.6.5 Label Creation Process

During the label creation process, the installers use the identifier and splice description worksheets, as well as the patch panel connection label maps, to:

- Label each cable.
- Label each wallbox.
- Perform splicing at splice points where direct color-to-color relationships cannot be maintained and create labels for those splice point components.
- Connect the cables to the distribution frame and create the labels for each distribution frame patch panel.

**NOTE**

Labels for each of the distribution elements can be ordered from vendors listed in the auxiliary section in Chapter 11.

In addition, the installation of black and red washers at the distribution frame patch panels identify which coupler positions are connected with even-numbered (red) or odd-numbered (black) fibers of a cable fiber pair in the wall (see Table 4–1).

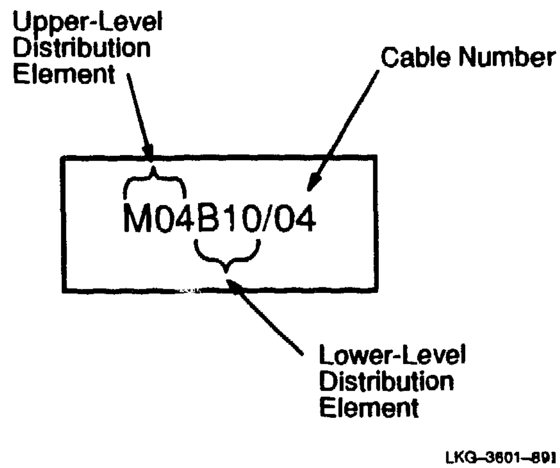
#### 4.6.5.1 Labeling the Cables

The identifier for each cable is listed in the Cable Identifier Worksheets. During the installation of each cable, the installer:

- Refers to the appropriate Cable Identifier Worksheet to find the cable identification recorded in the worksheet for that cable.
- Transfers the identifier to a cable label and attaches that label to each end of the cable, with the label attached far enough in from the cable end so that it will not be removed from the cable during the cable connector termination.

Figure 4–23 shows a sample cable label and identifies the illustrated identifier values.

**Figure 4–23: Sample Cable Label**




Each of the cable labels may be color coded to provide easy identification of the type of cable. These color coded labels would follow the distribution subsystem field colors identified in Section 4.5.2. The label colors are listed in Table 4–4.

**Table 4–4: Label Colors**

| Label Color | Cable Color Description |
|---|---|
| White | Campus backbone or building backbone |
| Gray | Horizontal wiring between HDF-to-SDF, HDF-to-ODF, HDF-to-RWDF |
| Purple | Horizontal wiring between HDF-to-computer rooms, and HDF-to-system common equipment |
| Blue | Horizontal wiring between HDF-to-Wallbox, SDF-to-Wallbox, ODF-to-Wallbox, RWDF-to-Wallbox |

#### 4.6.5.2 Labeling the Wallboxes

Each wallbox has a small white label that attaches to the front cover. The identifier information needed for each wallbox label is listed in the Wallbox Identifier Worksheets and includes:

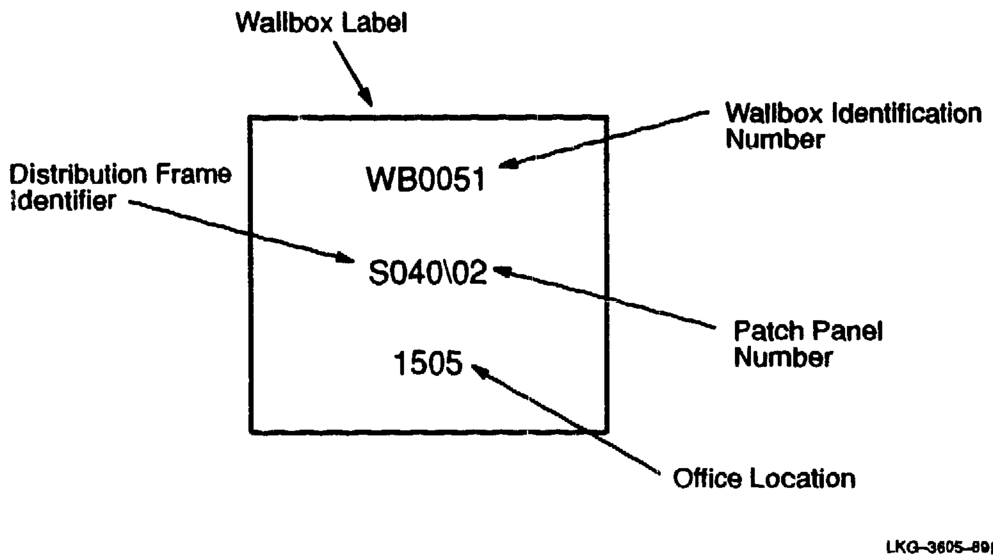
- The wallbox identifier.
- The identifier for the distribution frame that the wallbox connects to, including the patch panel number at that distribution frame.
- The office number.

**NOTE**

> The wallbox labels are often typed up separate from the actual wallbox installation process. The office number is added to the label primarily as a means of identifying where the label itself is to be installed. It also provides a means of identifying an office location when no other physical identification is provided for that office, such as during the early stages of a floor's layout.

Figure 4–24 shows a sample wallbox label and identifies the label values.

Figure 4–24: Sample Wallbox Label




### 4.6.5.3 Using the Splice Description Worksheets

Splice Description Worksheets are filled in by the designer for all splice points where direct color-to-color splice relationships cannot be maintained. The installer uses the worksheets to:

- Perform the splices as defined in the worksheet.
- Create the physical label for the splice component.

### 4.6.5.4 Using the Distribution Subsystem Connection Worksheet

The connection worksheet (Figure 10–13) created during the distribution frame design process (Chapter 10) defines exactly which cable fiber goes to which distribution frame patch panel. During the distribution frame installation, the installer:

- Refers to the connection worksheet for each distribution frame patch panel and connects the cable fibers to that patch panel exactly as identified by column letter and row number.
- Fills in the patch panel label to show where the fiber is connected.

- Provides color identification to the patch panel labels to distinguish the higher and lower hierarchy and attaches the color labels to the coupler panels.

# CHAPTER 5

5

# Fiber Optic Cable Plant Design

This chapter describes the fiber optic design process used to create the network schematic and calculate the link certification loss value acceptance criteria for the installed cable plant.

**NOTE**

> For copper-based structured wiring, refer to the *DECconnect System Planning and Configuration Guide* (EK-DECSY-CG).

The design process for known applications is a procedure for creating network schematics that define the location of the active equipment, connector pairs, and splices in the structured wiring cable plant.

Creating the schematics for known applications requires understanding:

- Fiber optic link structure and design factors
- DECconnect System cable plant requirements
- Fiber optic link-loss models
- Product application information for the active networking equipment
- Link-loss calculations
- Link certification values

Designing a structured wiring cable plant where there is an unknown application requires understanding:

- DECconnect System cable plant requirements
- Fiber optic segment optical budget planning numbers
- Link certification values

Figure 5–1 provides an overview flow chart of the design process for both known and unknown applications.

**Figure 5–1: Design Process Flow Chart**

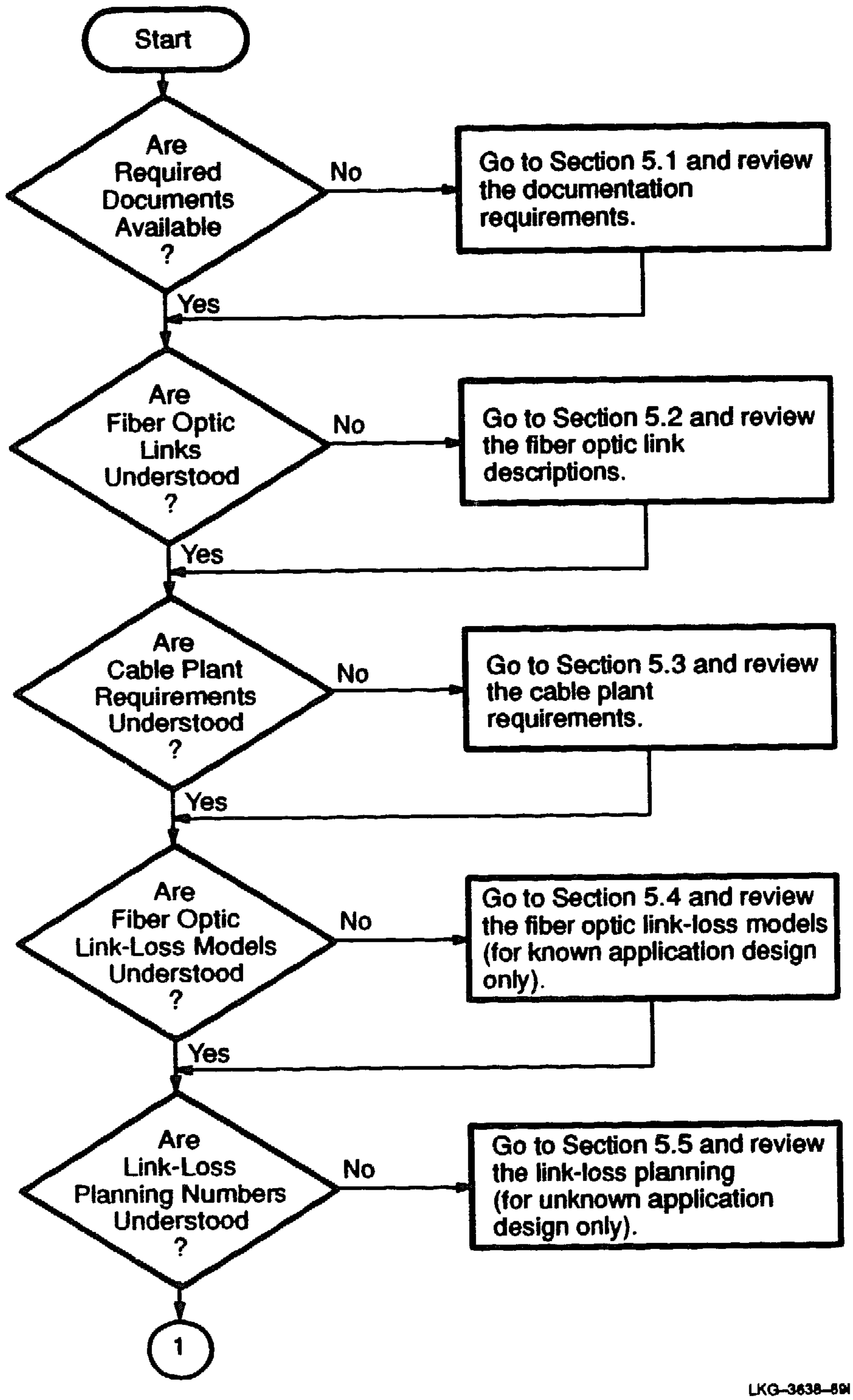
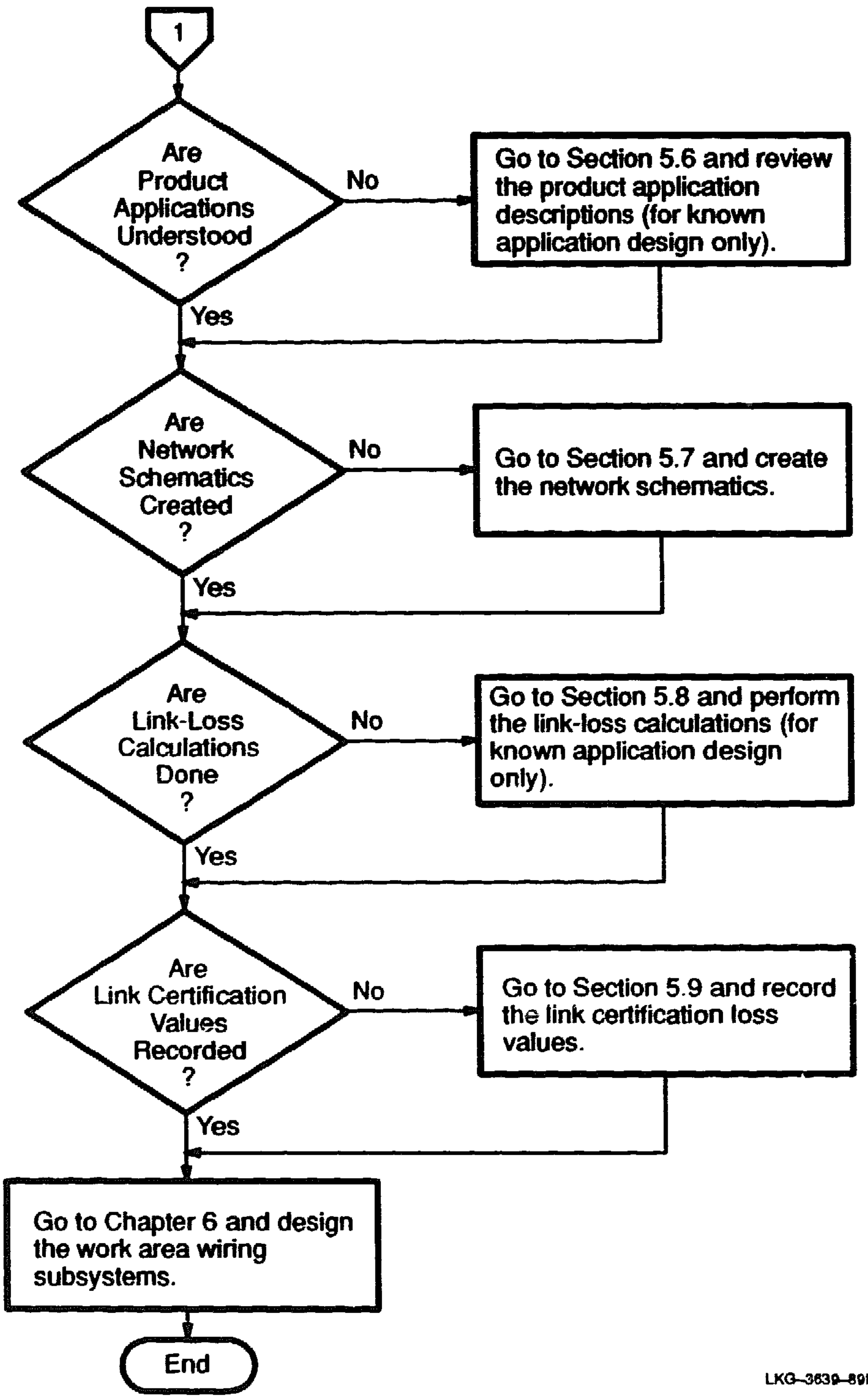



**Figure 5–1 Cont'd on next page**

**Figure 5–1 (Cont.): Design Process Flow Chart**



## 5.1 Required Documents

The following documents are needed during the design process:

- The network logical diagram created in Chapter 2 - defines the network's active equipment for known application design only.
- The concept diagram created in Chapter 3 - defines the distribution subsystem structure of the cable plant.
- Active equipment product documentation - used for referencing any active equipment specifications during the design process for known application design only.

## 5.2 Fiber Optic Links

When designing the fiber optic link with the active equipment, it is important to understand all of the design factors involved. These factors include:

- Fiber optic link structure
- Optical link design factors
- System design factors

### 5.2.1 Fiber Optic Link Structure

Each structured wiring cable plant is a series of links. The physical layer of the fiber optic network has three fundamental parts:

- Optical transmitters
- Fiber optic links
- Optical receivers

The optical transmitters and receivers are contained in the active networking devices. The fiber optic links include the cable and all other passive fiber optic cable plant components needed to connect the active equipment to the structured wiring cable plant.

### 5.2.2 Optical Link Design Factors

The optical link design factors provide the information necessary to evaluate the following:

- The maximum transmission distance.
- The ability of the cable plant to integrate various active equipment.
- The optical transmission performance required to guarantee a bit error rate that meets the applicable product standard requirements.

The optical link design factors that can affect the above listed items are:

- Power budget
- Optical loss
- Wavelength
- Bandwidth

#### 5.2.2.1 Power Budget

The power budget, is specific to the active equipment connected to the link. The active equipment contains the transmitter and receiver components.

- The optical transmitter specification defines the average output power (including a minimum and maximum tolerance) for the equipment. Power is specified in decibels per milliwatt (dBm, with 0 dBm equaling one milliwatt) for a particular fiber core size and numerical aperture. The minimum output power is determined by subtracting the minimum tolerance from the average output power.

- The receiver specification defines the receiver sensitivity. Sensitivity is defined as the minimum optical power level at which the bit error rate of the received signal does not exceed a specified value. The receiver sensitivity is specified in dBm, and usually is indicated for a particular fiber core size and numerical aperture.

The total power budget for the active equipment is therefore equal to the difference between the minimum amount of power the transmitter can launch into the fiber and the sensitivity of the receiver. The power budget is usually expressed in decibels (dB) and represents the active equipment's allowable system loss specification.

#### 5.2.2.2 Optical Loss

The optical loss, which is specific to the cable plant, is the optical signal attenuation in the fiber optic link between the transmitter and receiver. Each cable, splice, and connector within the fiber optic link adds loss to the system. The loss is expressed in dB for connectors and splices and in dB/km for cable. Each of these component losses for the DECconnect System are defined in Section 5.8.

**NOTE**

Digital requires that a cable plant system loss margin of 1.0 dB be added to the optical loss. This system loss margin allows for optical loss variability due to:

- Connector/splice mechanical coupling
- Connector polishing
- Cable aging
- Wavelength correction

#### 5.2.2.3 Wavelength

Wavelength, which is specific to the active equipment, refers to the center wavelength of the optical emitter expressed in nanometers (nm). For Local Area Networks (LANs), the operating wavelengths are at two windows:

- The first window has center wavelengths between 790 nm and 910 nm.
- The second window has center wavelengths between 1270 nm and 1380 nm.

**NOTE**

> Digital recommends 62.5/125 dual-window multimode fiber for all new installations. All of the fiber cables described in the product descriptions in Chapter 11 specify dual-window fibers.

The fiber optic cable loss is specified for 850 nm and 1300 nm, and the wavelength of the optical emitter can vary over a specified range. This requires adding a wavelength correction to the optical loss discussed in Section 5.2.2.2.

#### 5.2.2.4 Bandwidth

Bandwidth, which is specific to the cable plant and the optical source, is a measure of the information transmission capacity of the optical fiber.

The information transmission capacity of multimode fiber is important to the system design. The capacity to transmit information is limited by the dispersion or pulse broadening that occurs in fiber. Short duration light pulses are broadened (dispersed in time) as they travel through fiber.

There are two types of dispersion that can occur in multimode fiber with LED light sources:

- Modal
- Chromatic

The combined effect of these two dispersions creates the bandwidth limitations within a fiber optic link.

The modal bandwidth of the fiber is expressed as a frequency-distance product (MHz•km). For example, a fiber specified for 200 MHz•km allows the transmission of a 200 Megahertz (MHz) signal for a distance of one kilometer (km). Modal dispersion is primarily due to the different fiber modes traveling at different effective speeds. This creates the broadening of the optical pulse.

Chromatic dispersion is caused by different wavelengths of the LED light source traveling at slightly different speeds within the fiber. This causes broadening of the optical pulse. Chromatic dispersion is expressed in units of ps/(nm•km).

Fiber cable suppliers usually report only the modal bandwidth as the fiber bandwidth. It is important to note that the fiber bandwidth is limited by both the modal and chromatic dispersion. Therefore, the chromatic bandwidth must also be taken into account to understand the total system limitations.

**NOTE**

> All of the fiber cables identified and described in Chapter 11 have both modal and chromatic bandwidths specified for the fiber's two operating windows, which are also listed in Table 5–2.

The fiber bandwidth limitations are sometimes represented as an additional dB/km loss factor called the bandwidth derating or dispersion penalty. This loss factor must be included with the fiber's attenuation when performing the link-loss calculation.

**NOTE**

> Except for ORnet, DEBET-*xx*, and DEREP-*xx* products, Digital fiber optic active networking equipment has the bandwidth derating factor designed into the active equipment's power budget.

### 5.2.3 System Design Factors

The following system design factors should be taken into account during the planning and design of the fiber optic cable plant:

- For known applications, verify that the attenuation associated with the fiber optic connectors that plug directly into the active equipment is accounted for in the power budget of that active equipment specification. If they are accounted for in the power budget, do not add them to the loss calculations.
- Do not mix fiber sizes or grades. If it is unavoidable to mix fiber grades, design the entire link as though it uses the lower (or lowest) grade specifications.
- Avoid mixing connector types or splice types. This simplifies planning, installation, and maintenance, and reduces the kinds of tools and the amount of inventory.
- It cannot be overemphasized that the quality of the polished end of the fiber is the major cause of connector loss. Connector loss is significantly increased by dirt, scratches, finger smudges, and so on. Keep the connector ends clean by using the connector cleaning process described in the instruction manual and included in the 2.5 mm bayonet ST-type connector tool kit.

- Keep the fiber optic connectors covered when not in use.

**NOTE**

Chapter 11 describes the H8102-AA (110 volt) and H8102-AC (220 volt) 2.5 mm bayonet ST-type connector tool kits available from Digital (or Digital-authorized vendors).

- Do not exceed the bend radius specification of the cable when determining the cable's routing methods.

## 5.3 Cable Plant Requirements

The fiber optic link design requires that all cable plant components be within specifications. This is important to acceptable performance of the structured wiring fiber optic links.

Each of Digital's structured wiring fiber optic cable plant components meet specific environmental and optical parameter specifications. This section identifies those cable plant component specifications.

### 5.3.1 Environmental Specifications

Table 5–1 lists and describes each of the environmental specifications for Digital's fiber optic cable plant components.

**Table 5–1: Cable Plant Environmental Specifications**

| Specification | Value |
|---|---|
| Storage temperature | Indoor: -20° to 70° C (-4° to 158° F) |
| | Outdoor: -40° to 70° C (-40° to 158° F) |
| Operating temperature | Indoor: 0° to 50° C (32° to 122° F) |
| | Outdoor: -40° to 70° C (-40° to 158° F) |
| Relative humidity | Storage: 5% to 95%, noncondensing<br>Operation: 10% to 80%, noncondensing |
| Altitude | Storage: 0 - 50,000 ft<br>Operation: 0 - 10,000 ft |
| Cable plant life expectancy | 20 years |

### 5.3.2 Component Requirements

Table 5–2 lists specific Digital cable plant components and describes optical and other specifications for those components.

**Table 5–2: Component Requirements**

| Component | Specifications |
|---|---|
| Multimode optical fiber, 62.5/125 micron (See ANSI/EIA/TIA-492AAAA specification) Additional information is provided in Appendix E. | All specifications are over full operating temperature range (see Table 5–1):<br>Numerical Aperture (NA) - 0.275 ±.015 microns<br>Indoor cable attenuation - 3.75 dB/km maximum at 850 nm and 1.5 dB/km maximum at 1300 nm<br>Outdoor cable attenuation - 3.50 dB/km maximum at 850 nm and 1.5 dB/km maximum at 1300 nm<br>Bandwidth - 160 MHz•km minimum at 850 nm and 500 MHz•km minimum at 1300 nm<br>Chromatic dispersion requirements: the zero dispersion wavelength and dispersion slope must fall below the following bounds when plotted as wavelength (x points) versus dispersion slope (y points) on a graph:<br>1295 nm, 0.105 ps/(nm²·km)<br>1300 nm, 0.110 ps/(nm²·km)<br>1348 nm, 0.110 ps/(nm²·km)<br>1365 nm, 0.093 ps/(nm²·km) |
| Single-mode optical fiber | All specifications are over full operating temperature range (see Table 5–1):<br>Buffer size - 250 microns (± 15)<br>Cladding size - 125 microns (± 2)<br>Mode field diameter - 8.7 to 10.0 microns (± 0.5)<br>Cable attenuation - 0.4 dB/km maximum at 1310 nm and 0.3 dB/km maximum at 1550 nm<br>Cutoff wavelength - $\lambda_{cc} \leq$ 1270 nm<br>Chromatic dispersion - zero dispersion wavelength within the range of 1300 to 1322 nm and zero dispersion slope $\leq$ 0.095 ps/(nm²·km) |

Table 5-2 (Cont.): Component Requirements

| Component | Specifications |
|---|---|
| Indoor cable | Digital offers two versions of indoor fiber optic cable: The light-duty has a maximum pull tension of 100 lbs, and the heavy-duty has a maximum pull tension of 250 lbs. The following listings identify both heavy- and light-duty cable by cable jacket type and fiber count, and defines the fiber color code: |

| Cable Type | Fiber Count |
|---|---|
| Light-duty riser PVC, OFNR-rated | 4-fiber<br>6-fiber<br>12-fiber |
| Light-duty plenum, OFNP-rated | 4-fiber<br>6-fiber<br>12-fiber |
| Heavy-duty riser PVC, OFNR-rated | 4-fiber<br>6-fiber<br>12-fiber |
| Heavy-duty plenum, OFNP-rated | 4-fiber<br>6-fiber<br>12-fiber |

| Fiber or Unit Number | Color Code |
|---|---|
| 1 | Blue |
| 2 | Orange |
| 3 | Green |
| 4 | Brown |
| 5 | Slate |
| 6 | White |
| 7 | Red |
| 8 | Black |
| 9 | Yellow |
| 10 | Violet |
| 11 | Light Blue (indoor) |
| 12 | Light Orange (indoor) |
| 11 | Natural with Blue dashes (outdoor) |
| 12 | Natural with Orange dashes (outdoor) |

**Table 5–2 (Cont.): Component Requirements**

| Component | Specifications |
|---|---|
| Splice loss | 0.4 dB maximum loss over the outdoor operating temperature range (see Table 5–1). The splice should be made in the field in less than two minutes (average time), and require less than 10% remakes done with existing splices. |
| Field installable 2.5 mm bayonet ST-type connector, option number H3114-FA | 0.7 dB maximum loss over the indoor operating temperature range (see Table 5–1). The 2.5 mm bayonet ST-type connector is field mountable in eight minutes (or less), has a cable pull-out strength greater than 20 lbs, and a loss change 0.2 dB (or less) for 100 reconnections without cleaning. |
| FDDI connector | See *ANSI X3T9.5 FDDI PMD Standard.* (Additional information is given in Appendix E.) |

## 5.4 Fiber Optic Link-Loss Models for Known Application Design

This section provides DECconnect System fiber optic link-loss models for known application design process based on the following distances:

- 2000 meters (6560 feet) maximum for campus backbone cables only
- 2000 meters (6560 feet) maximum for campus and building backbone cables
- 90 meters (295 feet) for horizontal wiring cables
- 3 meters (10 feet) for work area wiring cables

The models do not cover extended interbuilding connections where the building connections are greater than the 2000-meter (6560-foot) backbone limits.

**NOTE**

For information on extended interbuilding distances see Appendix E *Special Distance Situations.*

The models are provided for two operating wavelengths:

- 850 nm
- 1300 nm

Configuration guidelines are provided with each model. These guidelines indicate where fiber optic networking equipment is required in the distribution subsystems to achieve link operation with the optical losses specified by the models. Each link between distribution subsystems requires two splices to budget for any future repairs.

**NOTE**

> Before designing specific fiber optic network equipment for the cable plant, the active equipment's allowable system loss should equal or exceed the optical losses specified in the link models. This helps ensure that the active equipment operates correctly in the network. Further information on the fiber optic link-loss calculations is provided in Section 5.8.

### 5.4.1 Fiber Link-Loss Model 850 nm Operation

This section provides two link-loss models for fiber optic active networking equipment operating with a center wavelength between 790 nm to 910 nm.

- The first model, shown in Figure 5–2, is for a maximum-length backbone of 2000 meters (6560 feet). The maximum allowable system loss for the active equipment is 11.5 dB.

  **NOTE**

  > The first model also assumes that indoor cable (with a higher cable attenuation than outdoor cable, and, therefore, a greater loss factor) is used for campus backbone cable. This can occur, for example, when the campus cable is run in a pedestrian tunnel (either elevated or underground) between the buildings.

- The second model, shown in Figure 5–3, is for a maximum-length building backbone and horizontal cable distance. The maximum allowable system loss for the active equipment is 10.33 dB.

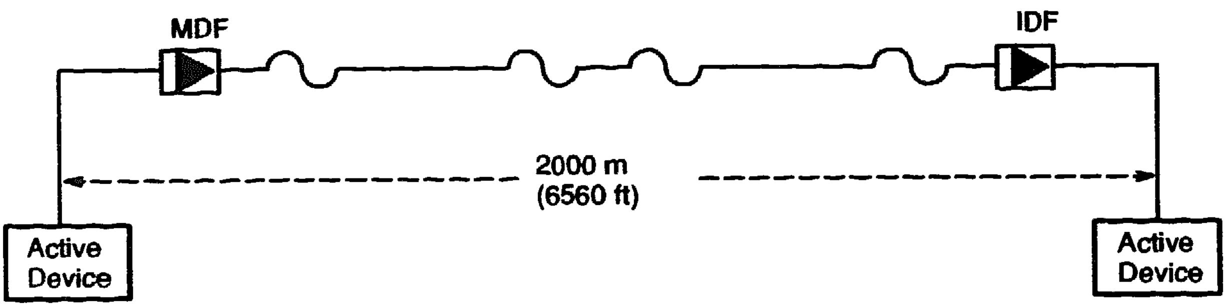
The configuration rules for the 850 nm operation links (Figures 5–2 and 5–3) are:

- All cables are 62.5/125 micron fiber
- Indoor cable, with a maximum attenuation of 3.75 dB/km, is used for all links
- Interconnects have a maximum loss of 0.7 dB
- Crossconnects have a maximum loss of 1.4 dB
- Splices have a maximum loss of 0.4 dB
- Active equipment is required at the MDF and the IDF
- Active equipment is connected to the distribution subsystem with interconnects
- An interconnect is used at a RWDF to connect the cable from the wallbox to the cable going to the HDF
- A 1.0 dB system loss margin is added to each link.

**Figure 5–2: Campus Backbone 850 nm Link-Loss Model**

**Symbol Definition Loss:**

| Symbol | Definition | Loss |
|---|---|---|
| ▶ | Interconnect | 0.7 dB |
| ∿ | Splice | 0.4 dB |
| — | Fiber Cable | 3.75 dB/km |




**Budget Table:**

| | | |
|---|---|---|
| Total fiber cable 2000 m (6560 ft) | = | 7.50 dB |
| Total pigtail splices 2 x 0.4 dB | = | 0.80 dB |
| Total service splices 2 x 0.4 dB | = | 0.80 dB |
| Total interconnects 2 x 0.7 | = | 1.40 dB |
| Cable plant system loss margin | = | 1.00 dB |
| Total link loss: | | 11.50 dB |

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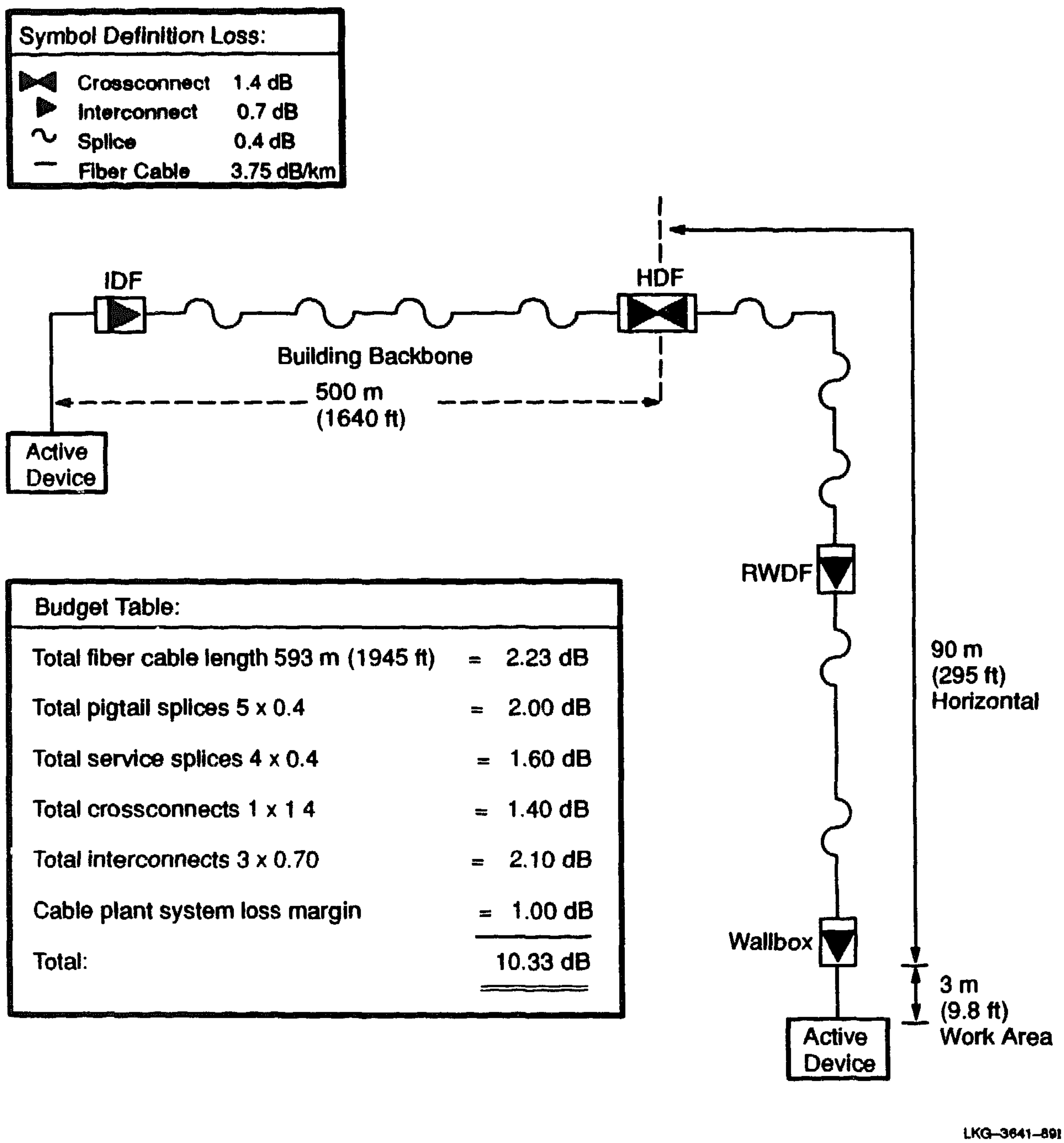
**Figure 5–3: Building Backbone and Horizontal Wiring 850 nm Link-Loss Model**




Budget Table:

| | | |
|---|---|---|
| Total fiber cable length 593 m (1945 ft) | = | 2.23 dB |
| Total pigtail splices 5 x 0.4 | = | 2.00 dB |
| Total service splices 4 x 0.4 | = | 1.60 dB |
| Total crossconnects 1 x 1 4 | = | 1.40 dB |
| Total interconnects 3 x 0.70 | = | 2.10 dB |
| Cable plant system loss margin | = | 1.00 dB |
| Total: | | 10.33 dB |

### 5.4.2 Fiber Link-Loss Model 1300 nm Operation

This section provides two link-loss models for fiber optic active networking equipment operating with a center wavelength between 1270 nm to 1380 nm.

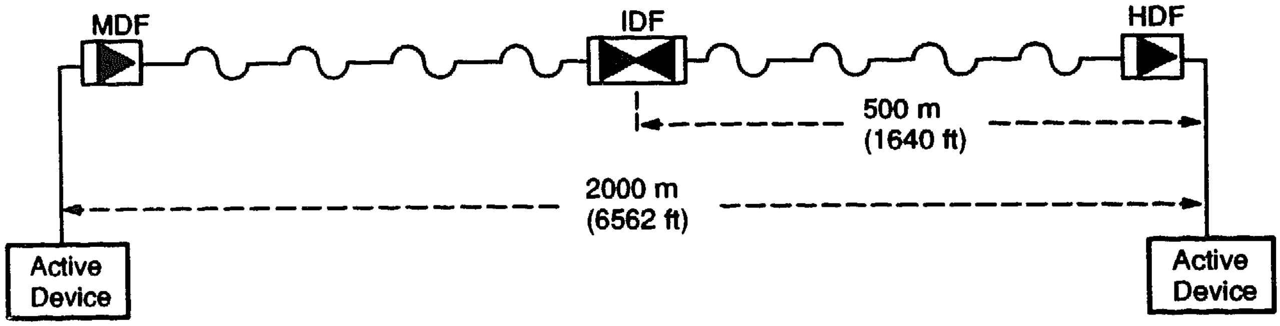
- The first model, shown in Figure 5–4, is for a maximum-length backbone of 2000 meters (6560 feet). The maximum allowable system loss for the active equipment is 10.0 dB.
- The second model, shown in Figure 5–5, is for a maximum-length building backbone and horizontal cable distance. The maximum allowable system loss for the active equipment is 9.0 dB.

The configuration rules for the 1300 nm operation links (Figures 5–4 and 5–5) are:

- All cables are 62.5/125 micron fiber
- All cable has a maximum attenuation of 1.5 dB/km
- Interconnects have a maximum loss of 0.7 dB
- Crossconnects have a maximum loss of 1.4 dB
- Splices have a maximum loss of 0.4 dB
- Active equipment is connected to the distribution subsystem with interconnects only
- An interconnect is used at a RWDF to connect cable from the wallbox to cable to the HDF
- A crossconnect exists in the MDF when there is no MDF active equipment
- A crossconnect exists in the IDF when there is no IDF active equipment
- A 1.0 dB system loss margin is added to each link

## Figure 5–4: Campus and Building Backbone 1300 nm Link-Loss Model

| Symbol Definition Loss: | |
|---|---|
| Crossconnect | 1.4 dB |
| Interconnect | 0.7 dB |
| Splice | 0.4 dB |
| Fiber Cable | 1.5 dB/km |




| Budget Table: | |
|---|---|
| Total fiber cable length 2000 m (6560 ft) | = 3.00 dB |
| Total pigtail splices 4 x 0.4 dB | = 1.60 dB |
| Total service splices 4 x 0.4 dB | = 1.60 dB |
| Total crossconnects 1 x 1.4 | = 1.40 dB |
| Total interconnects 2 x 0.7 | = 1.40 dB |
| Cable plant system loss margin | = 1.00 dB |
| Total: | 10.00 dB |

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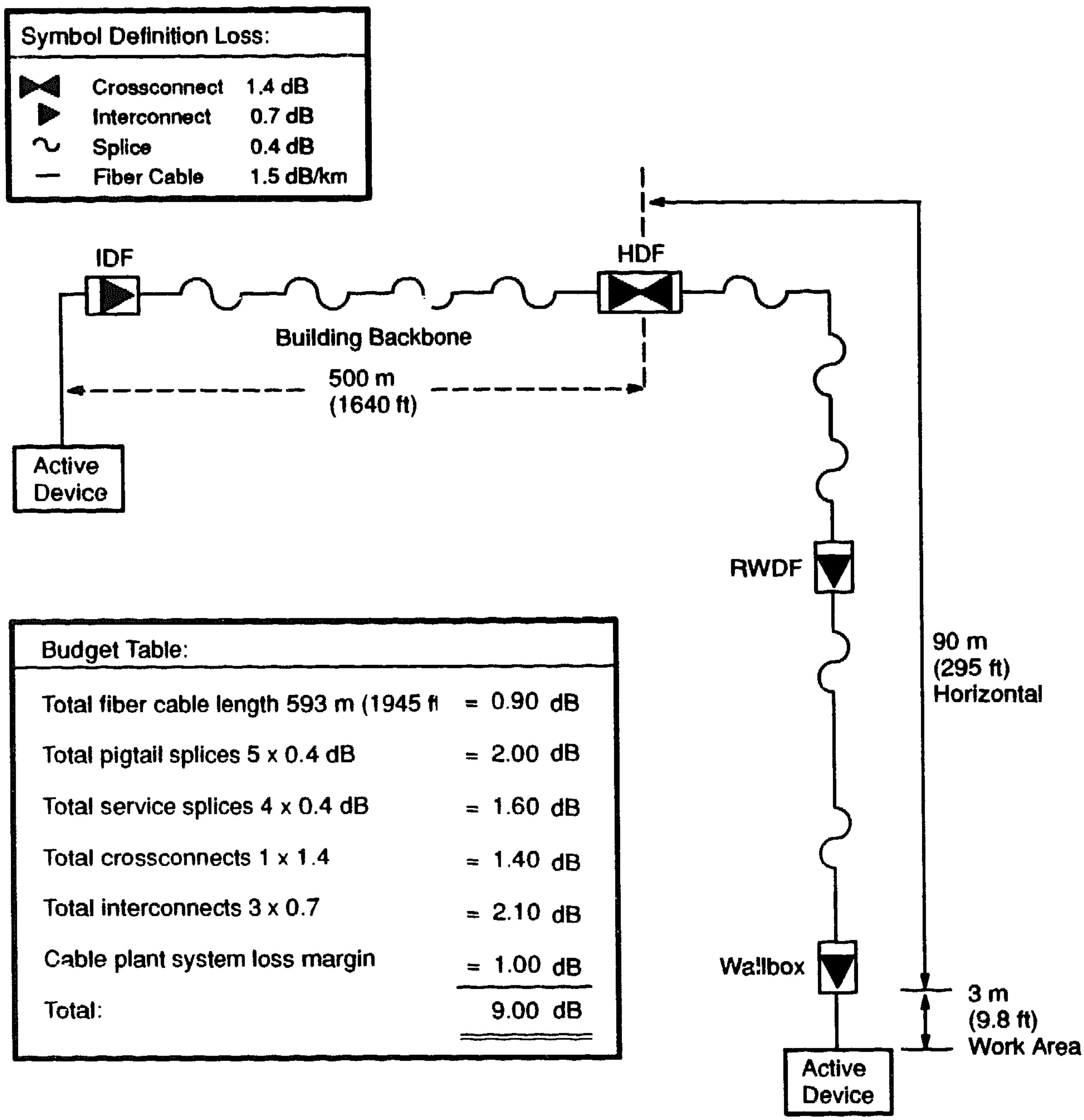
## Figure 5–5: Building Backbone and Horizontal Wiring 1300 nm Link-Loss Model




Budget Table:

| | |
|---|---|
| Total fiber cable length 593 m (1945 ft | = 0.90 dB |
| Total pigtail splices 5 x 0.4 dB | = 2.00 dB |
| Total service splices 4 x 0.4 dB | = 1.60 dB |
| Total crossconnects 1 x 1.4 | = 1.40 dB |
| Total interconnects 3 x 0.7 | = 2.10 dB |
| Cable plant system loss margin | = 1.00 dB |
| Total: | 9.00 dB |

## 5.5 Link-Loss Planning for Unknown Application Design

This section provides DECconnect system fiber optic link-loss planning for the unknown application design process based on the following distances:

- 2000 meters (6560 feet) maximum for campus backbone cables only
- 2000 meters (6560 feet) maximum for campus and building backbone cables
- 500 meters (1640 feet) maximum for building backbone cables
- 90 meters (295 feet) for horizontal wiring cables
- 3 meters (10 feet) for work area wiring cables

The configuration rules for planning unknown application design links between distribution subsystems are:

- All cables are 62.5/125 micron dual-window fiber
- Indoor cable with a maximum attenuation of 3.75 dB/km is used for all links
- Crossconnects have a maximum loss of 1.4 dB
- Interconnects have a maximum loss of 0.7 dB
- Splices have a maximum loss of 0.4 dB
- A 1.0 dB system loss margin is added to each link
- Each link between distribution systems requires two splices to budget for any future repair

**NOTE**

Each fiber optic link between subsystems should not have more than four allocated splices (two for service, two for pigtails). Exceptions: (1) when a breakout cable is used in the backbone where additional splices may be required, or (2) in the horizontal wiring where an SDF, ODF, or RWDF have splices. There should be no more than two connectors in each cable segment.

Table 5–3: Maximum Link-Loss Planning for Unknown Applicatons

| Distribution Subsystem | 850 nm Wavelength (loss) | 1300 nm Wavelength (loss) |
|---|---|---|
| MDF-to-IDF | 11.5 dB | 7.0 dB |
| IDF-to-HDF | 5.9 dB | 4.8 dB |
| HDF-to-work area† | 6.2 dB | 6.0 dB |

†This includes a crossconnect if used at an SDF or ODF.

## 5.6 Product Applications

When designing for known applications, the product specification for the active equipment to be used in the network must be reviewed for optical and configuration information that defines the following:

- How the active equipment's allowable system loss and operational factors impacts the fiber optic link designs.
- How the equipment connects to the structured wiring cable plant.

This section provides detailed descriptions of Digital's FDDI and ORnet fiber optic active networking equipment as follows:

- Gives overviews of each product application.
- Illustrates logical and wiring diagrams for both FDDI and ORnet applications.
- Provides a table that defines the achievable cable link distances based on:
  - The active equipment's allowable system loss.
  - Indoor cable use.
  - The number of splices in the link.
  - The number of connector pairs in the link.
  - The cable plant system loss margin of 1.0 dB.
- Discusses and shows examples of how the Digital products integrate into the structured wiring's hierarchical physical star topology.

**NOTE**

This information is based on using the FDDI and ORnet products with 62.5/125 dual-window fiber.

Appendix A provides information on using FDDI and ORnet products with 50/125 and 100/140 fiber. Appendix B provides information on using FDDI and ORnet products to integrate copper and fiber structured wiring subsystems.

Appendix C provides information on Digital's IEEE 802.3/Ethernet bridge and repeater products. When using other vendor's active equipment, refer to the product's specifications and review optical and other operational factors that could affect the network application design.

### 5.6.1 FDDI Product Applications

Connecting the FDDI product set to the DECconnect System structured wiring network requires understanding:

- The FDDI interface connections.
- The administration interconnect points needed at the cable plant's distribution frames to integrate the FDDI logical configurations into the DECconnect System structured wiring.

#### 5.6.1.1 FDDI Interface Connections

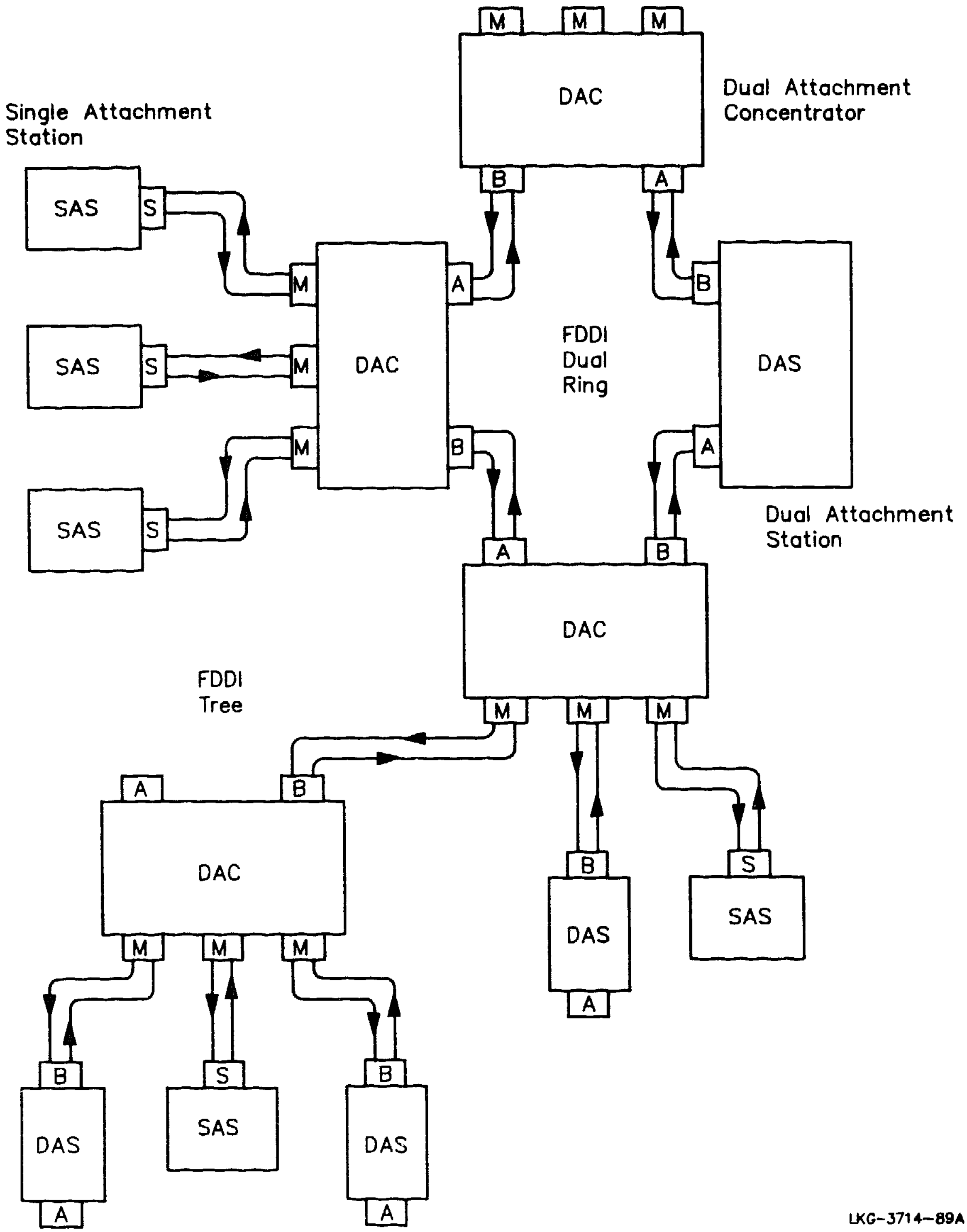
The FDDI active equipment includes the following devices:

- Dual-attachment concentrators (DAC)
- Dual-attachment stations (DAS)
- Single-attachment stations (SAS)

Refer to the specific vendor operation manuals for complete information on configuring these products.

As shown in Figure 5–6, the FDDI DAC, DAS, and SAS equipment can be configured into a dual ring of trees.

**Figure 5–6: FDDI Logical Diagram Example**



#### Dual-Attachment Connections

The FDDI equipment's dual-attachment interface uses Port A and Port B optical connector pairs as follows:

- Port A connection - the primary ring optical input (PI) and the secondary ring optical output (SO) connections.
- Port B connection - the primary ring optical output (PO) and the secondary ring optical input (SI) connections.

Figure 5–6 shows FDDI equipment connected to a dual-ring configuration. The Port A (PI/SO) of one FDDI dual-attachment device connects to the Port B (PO/SI) of a second dual-attachment device. This sequence continues until all of the FDDI dual-attachment devices are interconnected. Two fibers are involved in each of the Port A to Port B connections.

#### Single-Attachment Connections

The FDDI equipment's single-attachment interface uses Port S and Port M optical connector pairs as follows:

- Port M connection - located on the FDDI concentrator (Dual-Attachment Concentrator on DAC).
- Port S connection - located on the FDDI single-attachment station (SAS) equipment.

As shown in Figure 5–6, the FDDI SAS equipment Port S may be connected to the Port M on the FDDI DAC. Also, FDDI dual-attachment station (DAS) device's Port B may be connected to the Port M of an FDDI DAC. This configures the DAS device for use as a SAS.

### 5.6.1.2 FDDI Administration Interconnection Points

The FDDI active equipment connects to the structured wiring using interconnect patch cables. To connect the FDDI DAS, SAS, and DAC equipment to the structured wiring, use the following process:

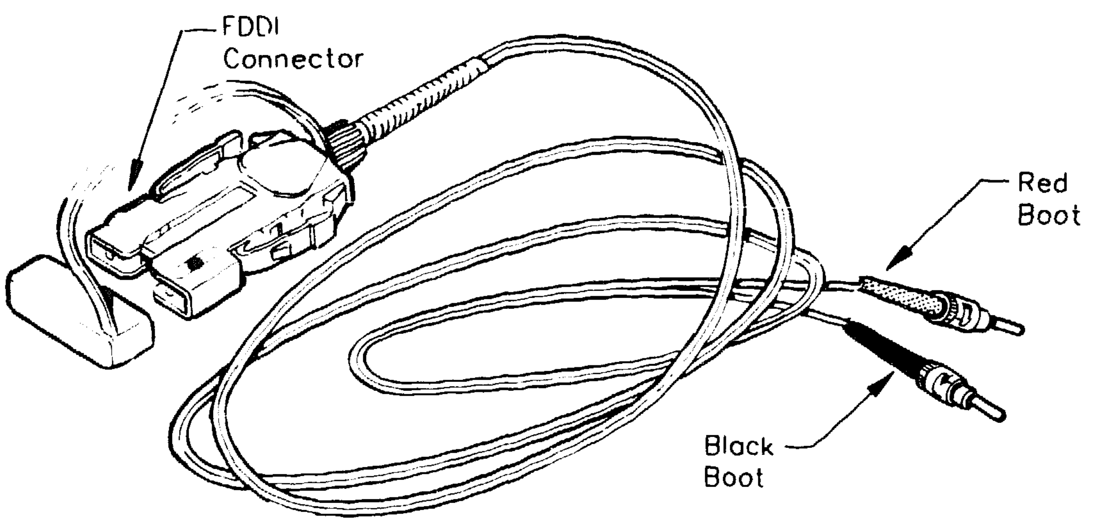
- Follow all the connection rules outlined in Chapter 4, Section 4.5.4.2.
- Provide an additional label for each FDDI device interconnection with a distribution frame panel with this label which indicates what kind of FDDI connection (Port A, B, M, or S) is being made at the panel position.

- As shown in Figure 5–7, the FDDI connection to a distribution frame patch panel uses a BN24D-*xx* FDDI-to-2.5 mm bayonet ST-type connector cable assembly. This BN24D-*xx* cable assembly has a keyed FDDI Media Interface Connector (MIC) on one end and two 2.5 mm bayonet ST-type connectors on the other end. One of the 2.5 mm bayonet ST-type connector has a black boot which indicates it is associated with the optical output of the FDDI equipment. The other 2.5 mm bayonet ST-type connector has a red boot and is associated with the optical input to the FDDI equipment.

**NOTE**

To plug into the receptable on the FDDI active equipment, key the FDDI MIC connector for the appropriate type of FDDI connection. The MIC connectors can be keyed for Port A, B, M, or S connections. Refer to the specific vendor instructions for keying the FDDI MIC connectors.

**Figure 5–7: FDDI-to-2.5 mm Bayonet ST-type Cable Assembly**



- The 2.5 mm bayonet ST-type connectors on the other end of the FDDI patch cable assembly have black and red boots that identify the 2.5 mm bayonet ST-type connections to the panel for non-crossover and crossover connections:

**NOTE**

Non-crossover connections occur when active equipment uses a patch cable to connect with fiber that is coming from a distribution element (distribution frame or wall-box) that is lower in hierarchy than the patch panel. Crossover connections occur when connecting the active equipment to higher level fibers.

  — Non-crossover connections - the black-booted connector goes to the fiber pair's black-washer (or black-marker) panel coupler at the patch panel and the red-booted connector goes to the red-washer (or red-marker) panel coupler of the fiber pair.

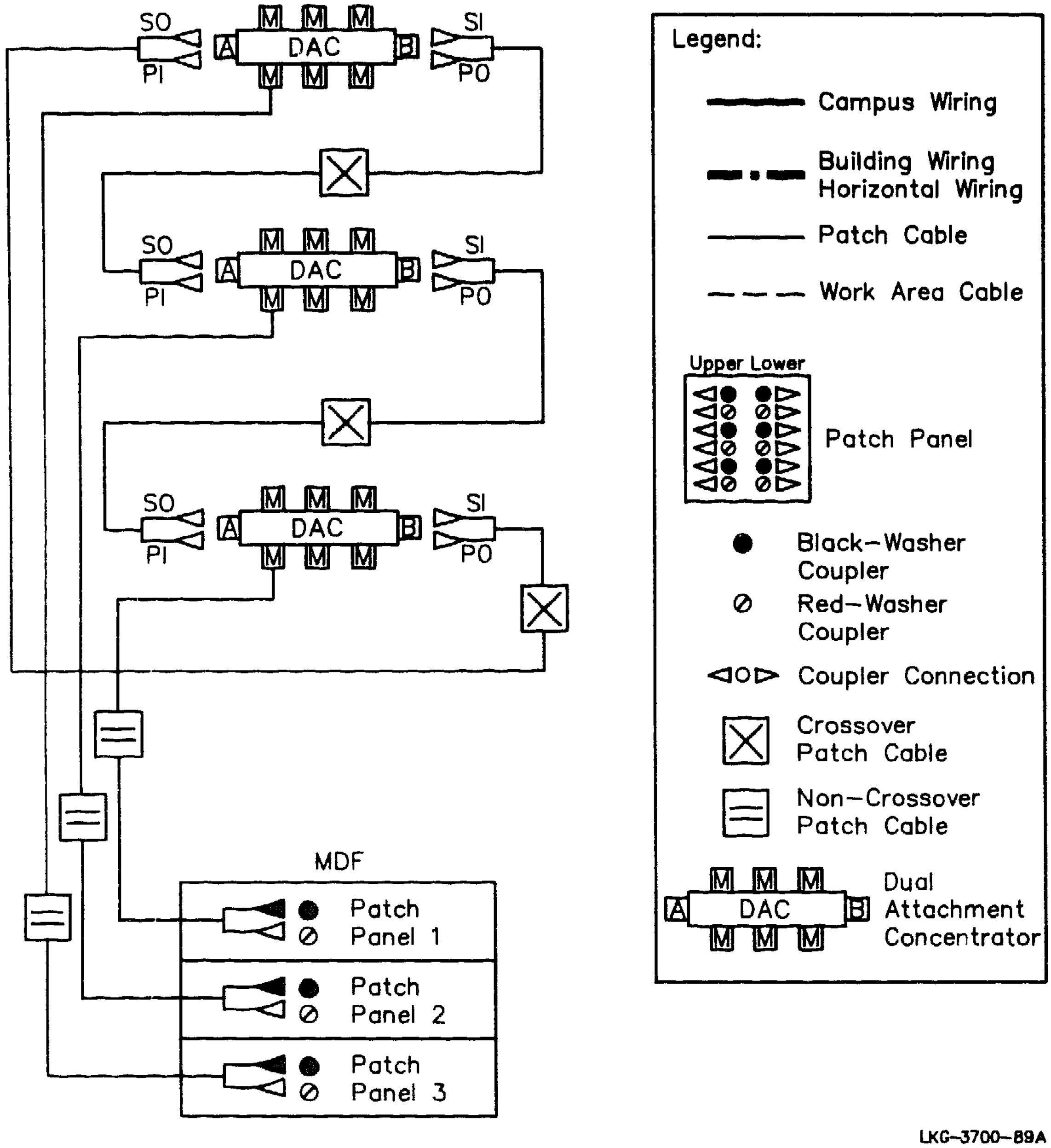
  — Crossover connections - the interconnection is reversed. The red-booted connector goes to the black-washer (or marker) panel coupler and the black-booted connector goes to the red washer panel coupler of the fiber pair.

- As shown in Figure 5–8, a BN24B-*xx* FDDI-to-FDDI crossover cable assembly connects the Port A and Port B of the DACs together when two or more FDDI DACs are connected into a dual ring at the same point in the structured wiring network.

In a dual-ring configuration, the Port A and Port B MIC connections of the FDDI equipment should form complete primary and secondary rings.

For a tree configuration, the Port M MIC connections on the FDDI DACs are connected to the Port S MIC connections on the FDDI SAS equipment or to the Port B MIC connection on the FDDI DAS equipment. For FDDI DACs in the tree configuration, the Port M MIC connection of the dual-ring DAC can connect to the Port B MIC connection of the FDDI DAC (refer to Figure 5–6).

## Figure 5–8: Direct FDDI-to-FDDI Equipment DAC Interconnections



#### 5.6.1.3 FDDI Product Implementations

This section describes the optical parameters affecting FDDI operation. It also provides the following concept and network schematic diagrams:

**NOTE**

> FDDI products use the 1300 nm wavelength. The optical parameters given in this section are for FDDI products with dual-window 62.5/125 micron fiber. Appendix A provides information about FDDI products with dual-window 50/125 and 100/140 micron fiber and FDDI products with fiber (50/125, 62.5/125, or 100/140 micron) that do not meet the optical requirements for 1300 nm operation.

- Figure 5–9 - provides a concept diagram for a 2-kilometer (6560-foot) campus and building backbone tree configuration that uses Port M to Port S connections between a DAC in an MDF and FDDI-to-Ethernet bridges at HDFs.
- Figure 5–10 - provides an example of a network schematic for the configuration identified in Figure 5–9.
- Figure 5–11 - provides a concept diagram for a 2-kilometer (6560-foot) dual ring campus backbone that uses Port A to Port B connections between DACs located in the building IDFs and a passive MDF. This figure also shows building backbone tree configuration Port M to Port B connections between the DACs in the IDFs and DACs in the HDFs.
- Figure 5–12 - provides an example of a network schematic for the configuration identified in Figure 5–11.
- Figure 5–13 - provides a concept diagram for a horizontal wiring SAS or DAS configuration.
- Figure 5–14 - provides an example of a network schematic for the configuration identified in Figure 5–13.

**FDDI Product Description**

- Application - FDDI
- Fiber size - 62.5/125 micron
- Wavelength - 1300 nm
- Maximum link length - 2000 m (6560 ft)

- Maximum allowable system loss - 11.0 dB
- Bandwidth derating - 0.00 db/km

Table 5–4 provides a method to determine a link's maximum distance based on the number of splices and connector pairs designed for the link. Be sure to add two splices for each link to budget service splices. The table includes a 1.0 dB cable plant system loss margin and uses the indoor cable attenuation.

**Table 5–4: FDDI Link-Loss Table**

| Number of Splices | Number of Connector Pairs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 2 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 |
| 3 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 |
| 4 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 1866 |
| 5 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 1599 |
| 6 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 1799 | 1333 |
| 7 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 1533 | 1066 |
| 8 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 1733 | 1266 | 799 |
| | Distance in Meters | | | | | | | | |

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**NOTE**

Table 5–4 shows how the maximum link distance can be affected by splices and connector pairs used at interconnect and crossconnect administration points. It does not mean to imply that Digital recommends or supports links that consist of multiple small segments.

**Figure 5–9: Example FDDI Backbone Concept Diagram for a Tree Configuration**

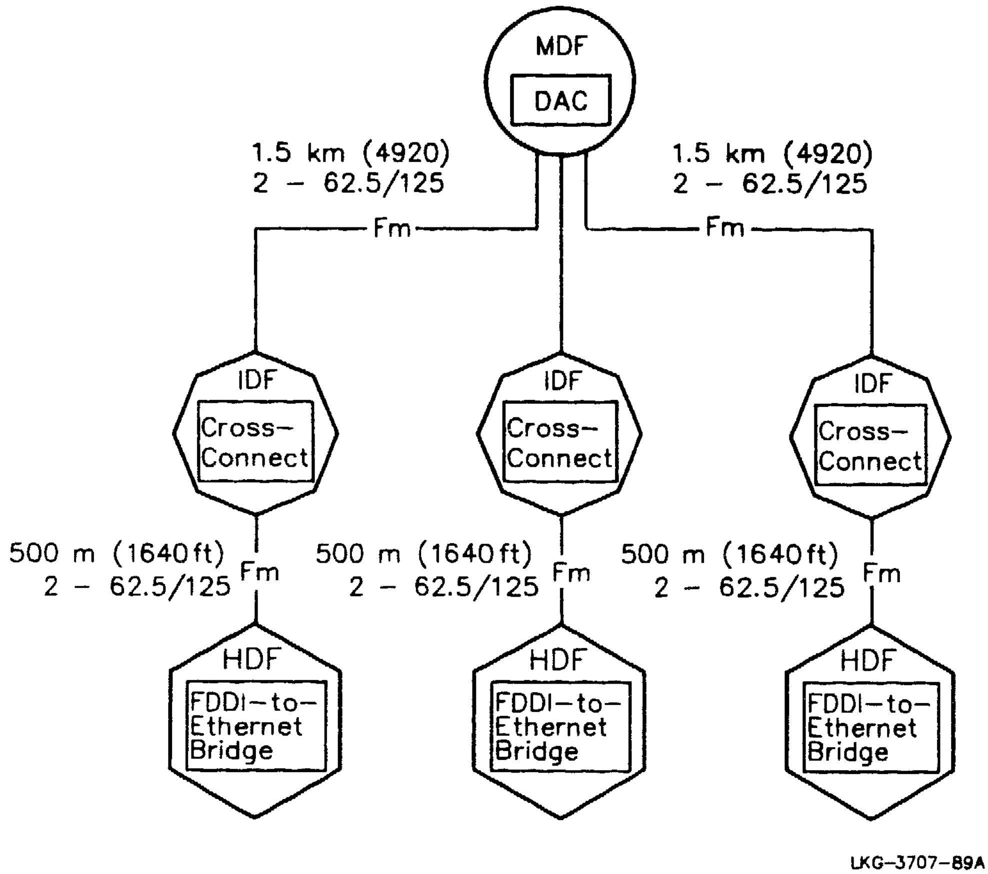


**Figure 5–10: Example FDDI Backbone Network Schematic for a Tree Configuration**

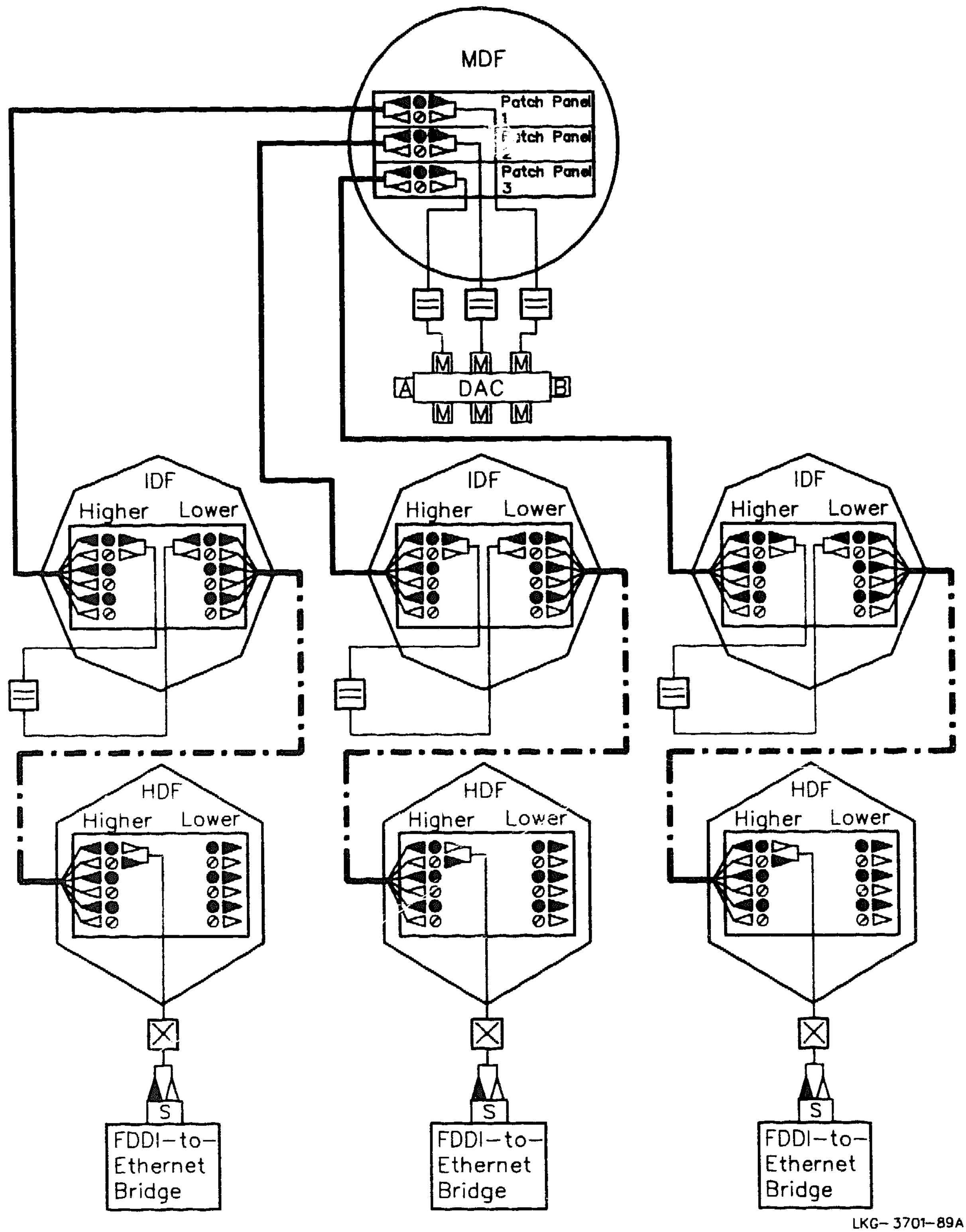
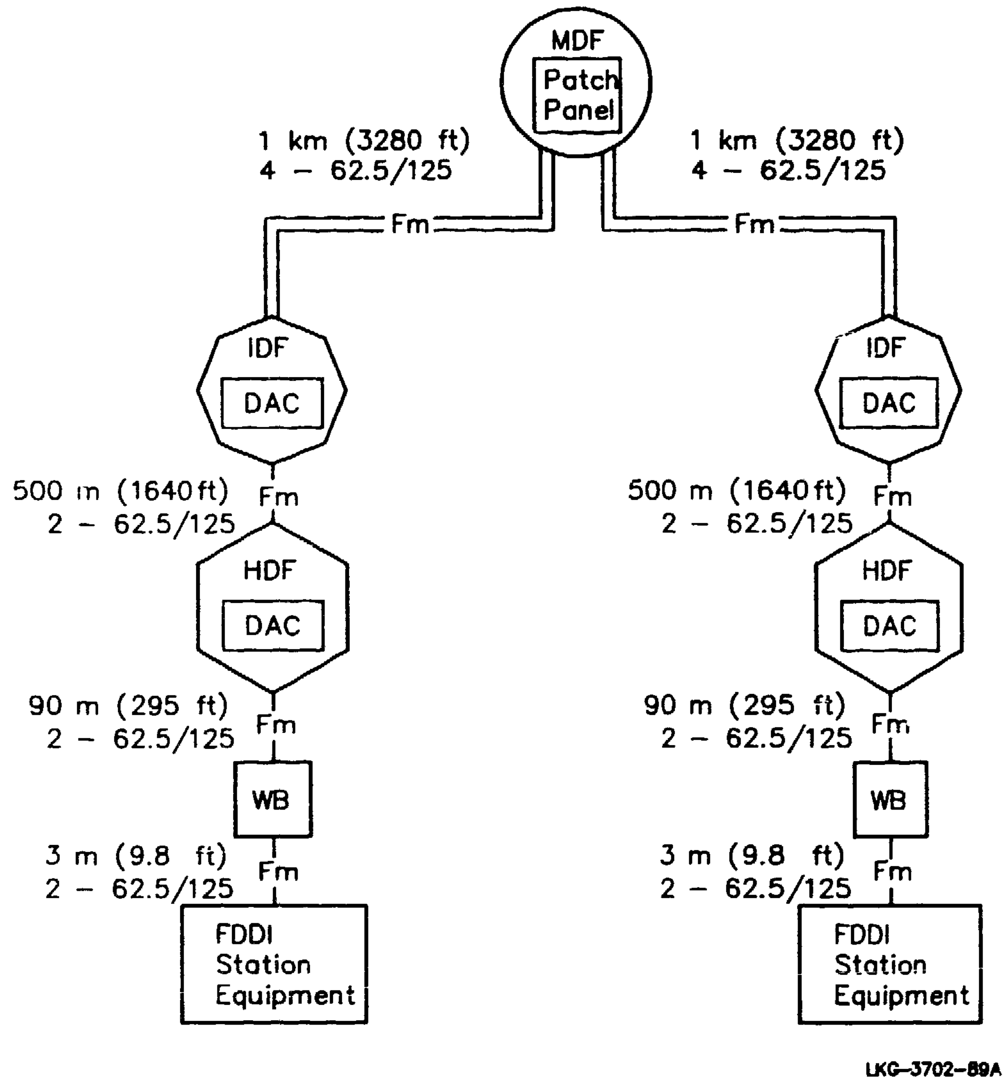


**Figure 5–11: Example FDDI Dual Ring Campus Backbone Concept Diagram**



## Figure 5–12: Example FDDI Dual Ring Campus Backbone Network Schematic

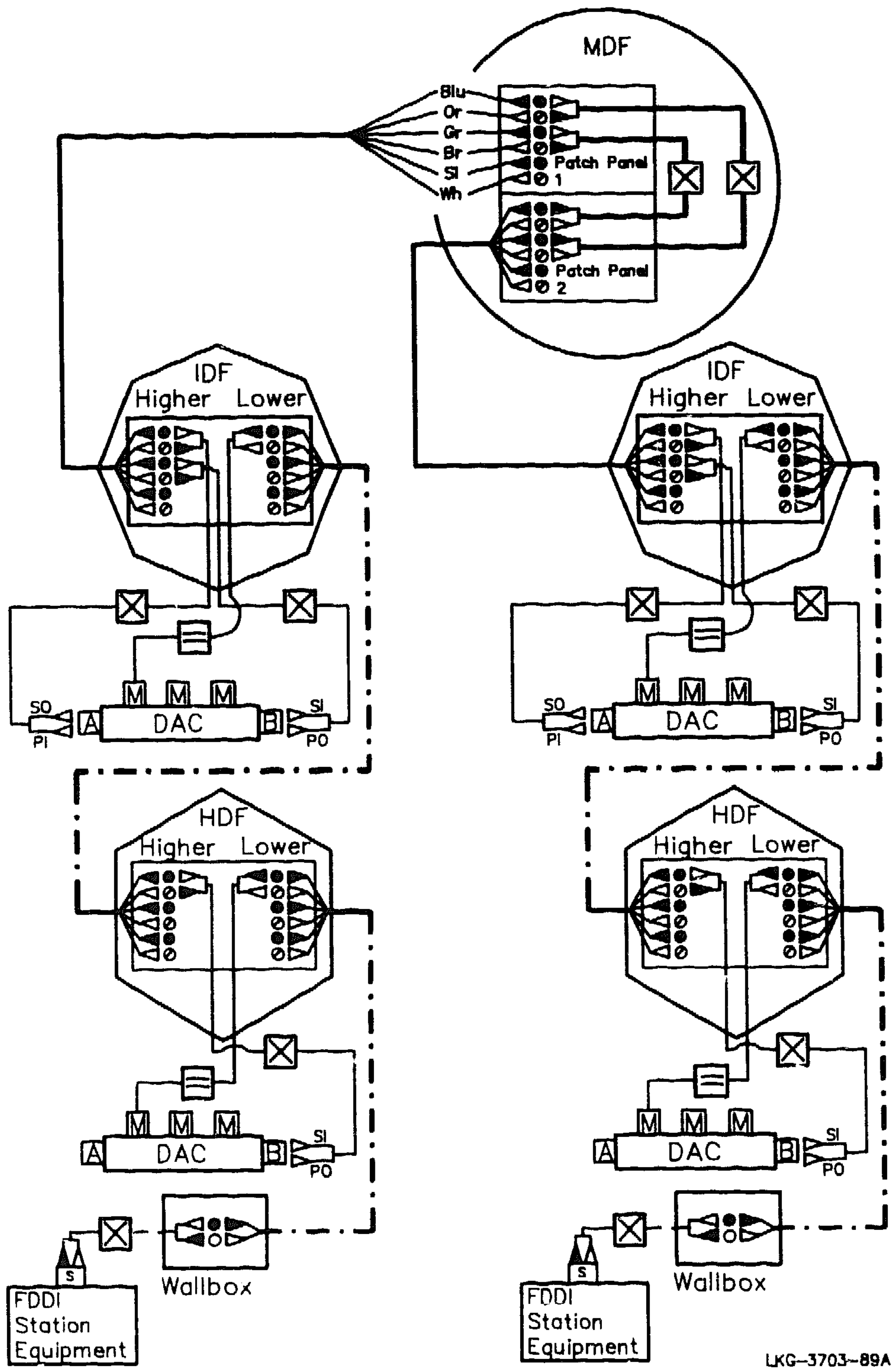
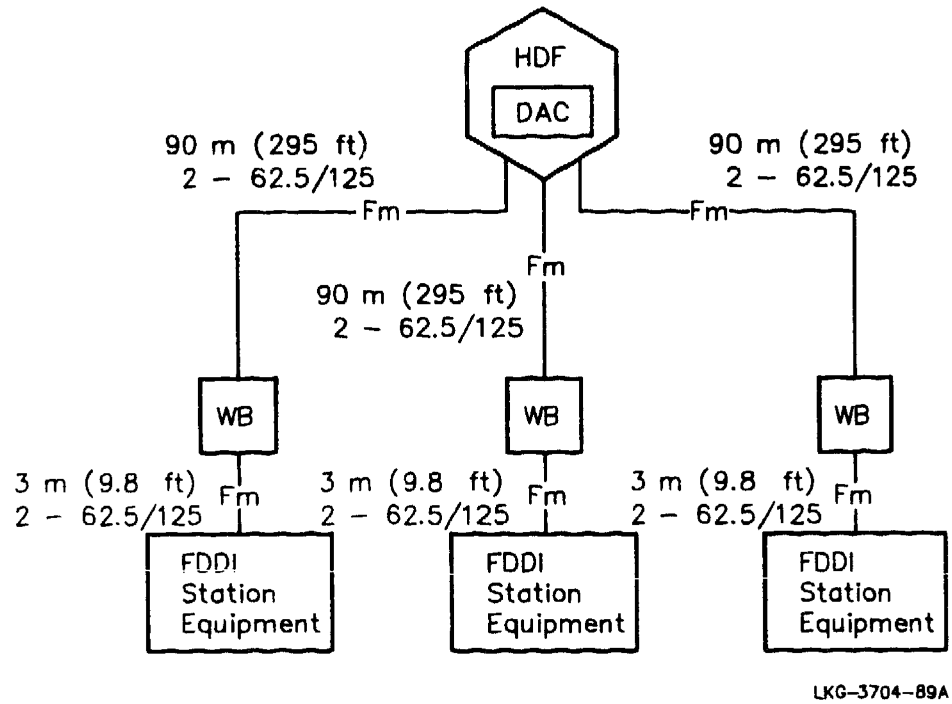
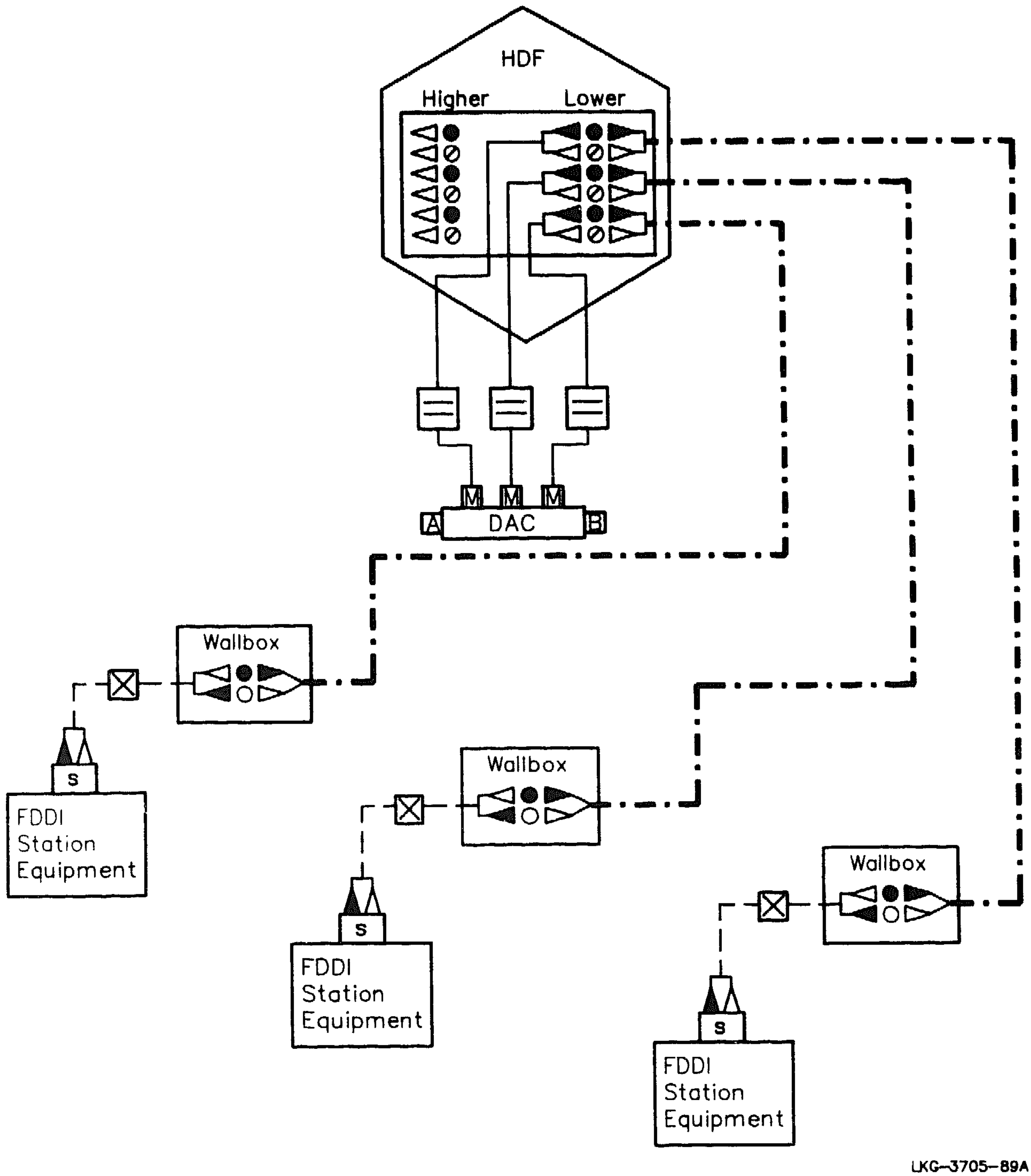


**Figure 5–13: Example FDDI Horizontal Wiring SAS or DAS Concept Diagram**



## Figure 5–14: Example FDDI Horizontal Wiring SAS or DAS Network Schematic



### 5.6.2 ORnet Product Applications

ORnet products provide a fiber optic Ethernet system with the capability of distributing an Ethernet backbone over a structured fiber optic cable plant without the need for baseband coaxial cable. ORnet products use interconnect patch cables to connect to the structured wiring cable plant.

**NOTE**

ORnet products are manufactured by Chipcom Corporation and are sold by Digital under the Chipcom label.

#### 5.6.2.1 ORnet Configuration

Traditionally, Ethernet uses a bus topology. ORnet products allow using Ethernet in a hierarchical physical star topology. This allows the Ethernet backbone to radially connect from a fiber optic multiport active star, to other active stars within a building, or in other buildings within a site.

#### 5.6.2.2 ORnet Components

The ORnet fiber optic Ethernet system consists of two types of active components:

- A fiber optic multiport star with transceivers with either eight or fourteen ports.
- A fiber-to-copper transceiver.

ORnet products operate over 62.5/125 micron fiber, using ST-type connectors. Digital recommends 62.5/125 dual-window multimode fiber for all new installations.

#### 5.6.2.3 ORnet Administration Interconnect Points

ORnet active equipment connects to the structured wiring cable plant using interconnect points. Use the following process to connect the ORnet equipment to the cable plant:

- Follow the connection rules outlined in Chapter 4, Section 4.5.4.2.
- Connect the patch cables to the ORnet equipment as follows:
  - — The red-booted connector goes to the ORnet equipment receive (Rx) port.

— The black-booted connector goes to the ORnet equipment transmit (Tx) port.

- The 2.5 mm bayonet ST-type connectors on the other end of the cable connect to the patch panel and provide non-crossover or crossover connections:

**NOTE**

Non-crossover connections occur when active equipment uses an interconnect cable to connect with fiber that is coming from a distribution element (distribution frame or wallbox) that is lower in hierarchy than the panel. Crossover connections occur when the active equipment is connected to higher level fibers.

— Non-crossover connections - the black-booted connector connects to the fiber pair's black-washer (or black-marker) panel coupler at the patch panel. The red-booted connector connects to the red-washer (or red-marker) panel coupler of the fiber pair.

— Crossover connections - the interconnection is reversed. The red-booted connector connects to the black-washer (or black marker) panel coupler, and the black-booted connector connects to the red washer (or red marker) panel coupler of the fiber pair.

### 5.6.2.4 ORnet Product Implementations

This section provides the following:

- A description of the optical parameters affecting ORnet product operation.
- A sample concept diagram (Figure 5–15) of an ORnet configuration.
- A sample network schematic (Figure 5–16) provides an example of the configuration shown in Figure 5–15).

**ORnet Product Description**

- Application - fiber optic Ethernet
- Fiber size - 62.5/125 micron
- Wavelength - 820 nm
- Maximum link length - 2000 m
- Maximum allowable system loss - 10.75 dB†
- Bandwidth derating - 0.25 db/km

Table 5–5 provides a method of determining the maximum length for a link with a number of splices and connector pairs. Add two splices for each link to budget service splices. The table includes a 1.0 dB cable plant system loss margin and uses the indoor cable attenuation.

† The maximum power budget for the ORnet product does not meet the link-loss requirements for the DECconnect System structured wiring and may be limited to an operating link distance on the order of 1500 meters (4920 feet) when used in a structured wiring cable plant with crossconnects and interconnects.

**Table 5–5: ORnet Link-Loss Table**

| Number of Splices | Number of Connector Pairs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 2 | 2000 | 2000 | 1887 | 1712 | 1537 | 1362 | 1187 | 1012 | 837 |
| 3 | 2000 | 1962 | 1787 | 1612 | 1437 | 1262 | 1087 | 912 | 737 |
| 4 | 2000 | 1862 | 1687 | 1512 | 1337 | 1162 | 987 | 812 | 637 |
| 5 | 1937 | 1762 | 1587 | 1412 | 1237 | 1062 | 887 | 712 | 537 |
| 6 | 1837 | 1662 | 1487 | 1312 | 1137 | 962 | 787 | 612 | 437 |
| 7 | 1737 | 1562 | 1387 | 1212 | 1037 | 862 | 687 | 512 | 337 |
| 8 | 1637 | 1462 | 1287 | 1112 | 937 | 762 | 587 | 412 | 237 |
| | Distance in Meters | | | | | | | | |

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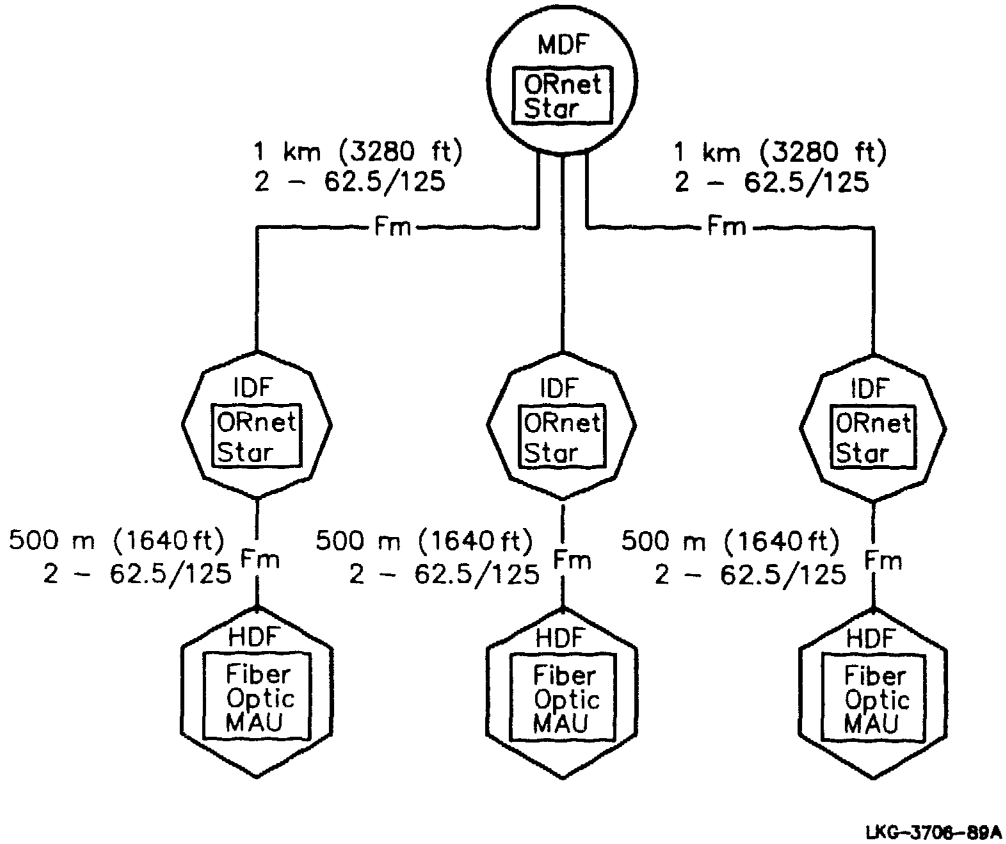
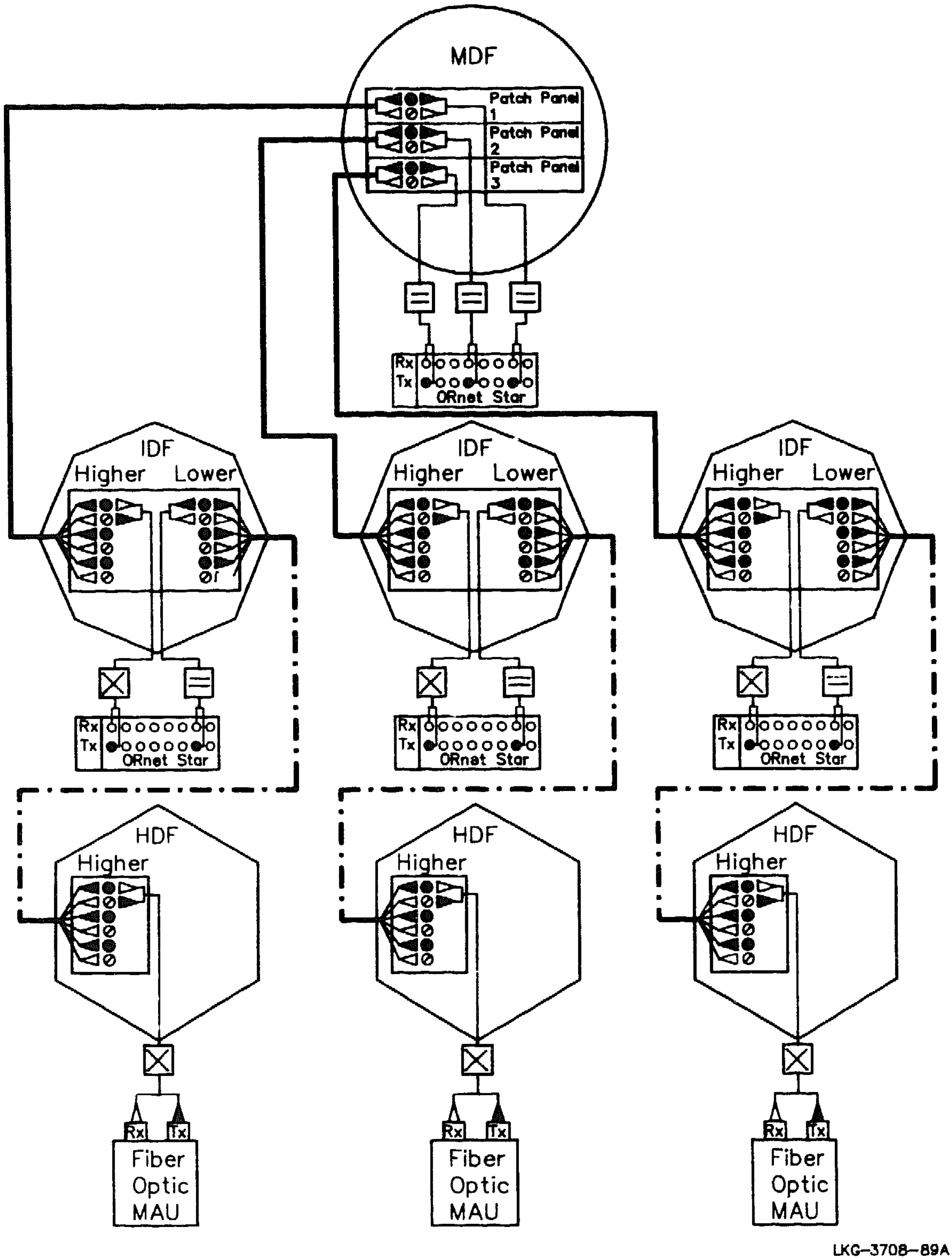
**NOTE**

Table 5–5 shows how the maximum link distance can be affected by the use of splices and by connector pairs used at interconnect and crossconnect administration points. The table does not mean to imply that Digital recommends or supports links that are made up of multiple small segments.

**Figure 5–15: ORnet Concept Diagram**



## Figure 5–16: ORnet Network Schematic



## 5.7 Creating the Network Schematics

The creation of the network schematics completes the planning phase of the site design process. This planning phase consists of creating the three diagrams that define the structured wiring as follows:

- The network logical diagram (created in Chapter 2) that defines the network's active networking equipment requirements for known applications.
- The concept diagram (created in Chapter 3) that defines the cable plant distribution subsystem structure.
- The network schematics that define:
  - Where and how the active networking equipment, identified in the network logical diagram, connects to the structure wiring for known applications.
  - The crossconnects, interconnects, and splices needed to connect the subsystem structure identified in the concept diagram together into a structured wiring cable plant.

Once the network schematic is completed (and each diagrammed link is verified using link-loss calculation information provided in Section 5.8 for known application design), the rest of the design process consists of the following actions:

- Calculate the link certification loss value for each link and record these values in the Summary Worksheet (Section 5.9).
- Select the cables and other passive cable plant components that each subsystem requires to physically carry out the planned site:
  - Chapters 6 through 10 provide the procedures needed to select the cable plant components.
  - Chapter 11 provides descriptions of the cable plant components available from Digital or from other vendors.

**NOTE**

> The concept diagrams and network schematics are used during the cable plant component selection process. They define the types of components needed to carry out the site design.

- Order the cable plant components (Chapter 12).

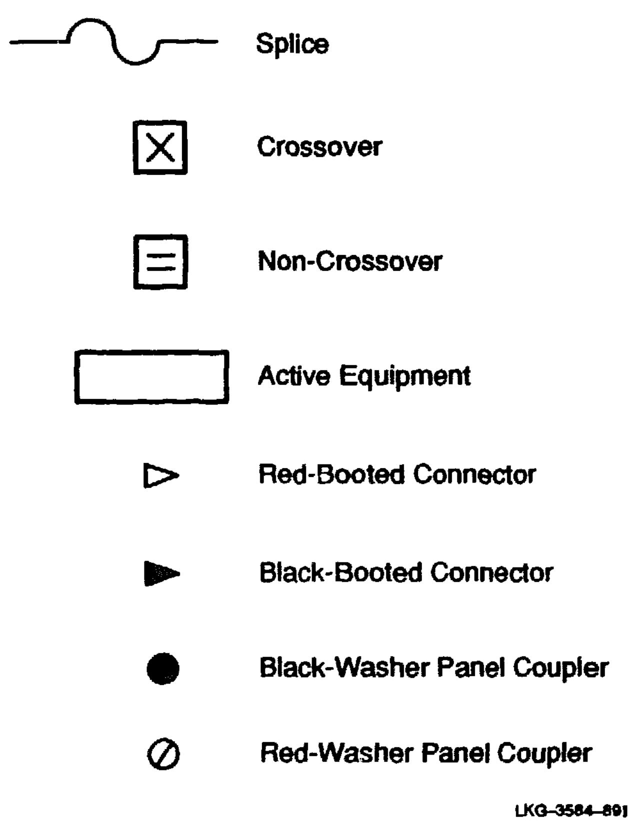
- Perform the preinstallation procedures (Chapter 13).

### 5.7.1 Network Schematic Symbols

The network schematic uses a set of specific symbols. Using these symbols ensures that a standardized network schematic is created that can be easily interpreted by anyone familiar with the symbol set.

Figure 5–17 illustrates and defines all of the symbols that can be used in a network schematic.

**Figure 5–17: Network Schematic Symbols**



### 5.7.2 Network Schematics

The structured wiring is a series of point-to-point cables connected at distribution elements (distribution frames and wallboxes) by crossconnect or interconnect patch cables. Interconnect patch cables are also used at the distribution frames to connect the active networking equipment to the structured wiring cable plant.

#### 5.7.2.1 Types of Network Schematics

Different types of network schematics are created for different parts of the structured wiring cable plant:

- Campus - defines the crossconnect, interconnect, and splice points for the site's MDF-to-IDF links and shows how any active equipment at the MDF or IDFs are connected to the structured wiring.
- Building - defines the crossconnect, interconnect, and splice points for the IDF-to-HDF links and shows how any active equipment at the IDF or HDFs is connected to the structured wiring.

**NOTE**

> At small sites, the campus and building network schematics can be combined into a single schematic.

- Horizontal - defines the crossconnect, interconnect, and splice points for each of the site's horizontal wiring subsystem cables and shows how any active equipment at the HDF, SDF, or ODF is connected to the structured wiring.

#### 5.7.2.2 Network Schematic References

For known applications, the active equipment's optical and other network product application information must be understood before the network schematic diagram can be created.

- If the network will be using active fiber optic networking equipment available from Digital, review the application descriptions given in Section 5.6 and Appendix C for each type of active equipment.
- If the network will be using active equipment that is not available from Digital, review that equipment's product documentation to understand the optical and configuration constraints for each type of active equipment.

#### 5.7.2.3 Network Schematic Information

Each type of network schematic (campus, building, or horizontal) shows the following types of information for each of the links:

- What active equipment is at each distribution frame for known applications and:
  - — How interconnects are used to connect that equipment to the structured wiring.
  - — The total fiber count required to connect each piece of active equipment to the cable plant.
- The total length of the cable in each link and each cable's fiber count.
- The number of splices within each distribution frame.
- The number of splices in the links between the distribution elements
- The number of connector pairs at each distribution frame for the administration crossconnects and interconnects.

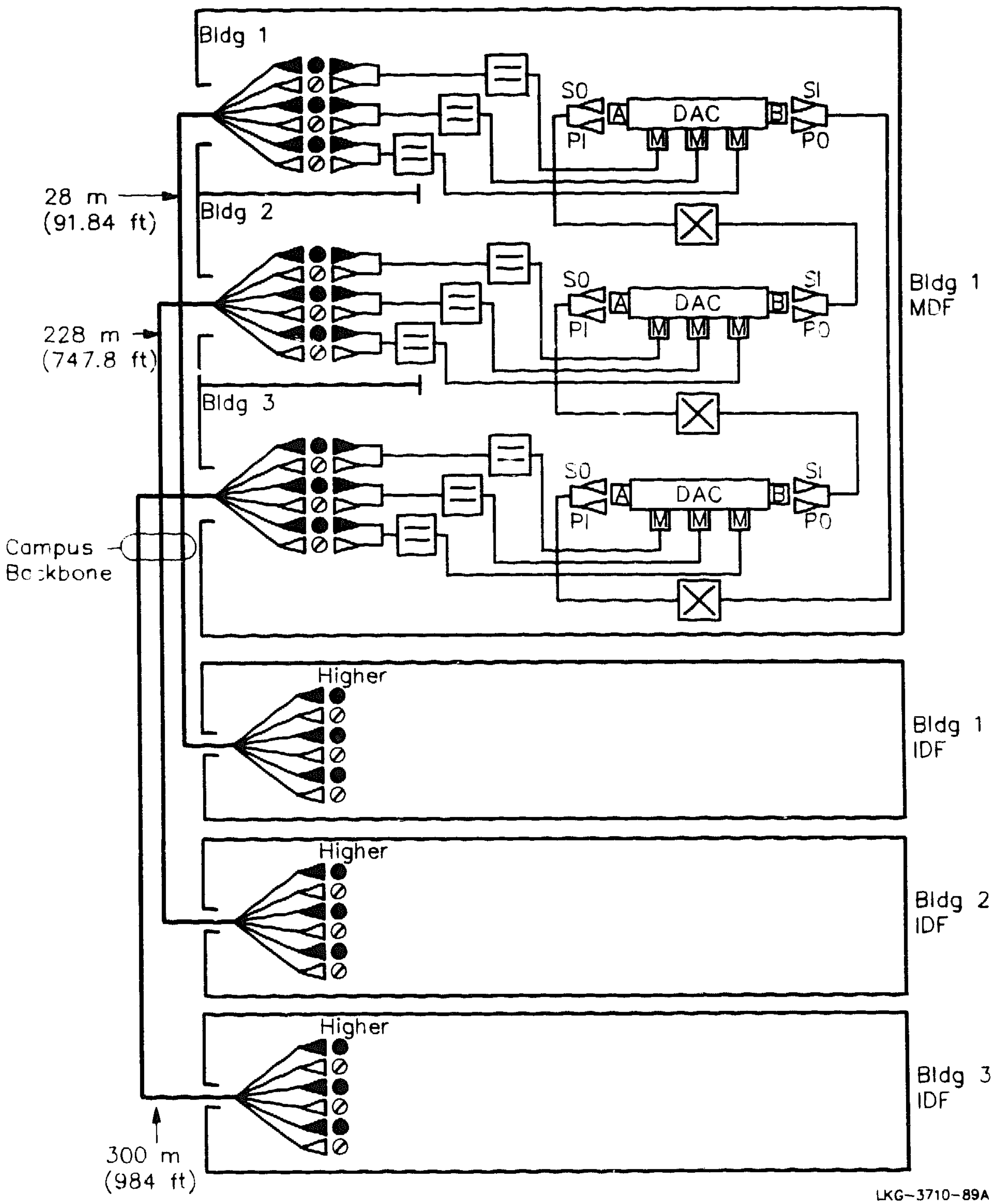
#### 5.7.2.4 Network Schematics Creation Process - Known Applications

In general, the process used in creating the network schematics for known applications is as follows:

- Review the product application information for optical and other restrictions, as well as for information that defines the application's logical network configuration connection guidelines and rules.
- Verify that the cable and other passive cable plant components planned for the links meet the DECconnect System's cable plant requirements (Section 5.3).
- Create the schematics.
- Use the link-loss calculation information given in Section 5.8 to verify that each of the links diagrammed in all of the network schematics meet the allowable system loss requirements of the link's active equipment.

Figure 5–18 provides a sample campus network schematic. Figure 5–19 provides a sample building network schematic. Figure 5–20 provides a sample horizontal network schematic.

**Figure 5–18: Sample Campus Network Schematic**



## Figure 5-19: Sample Building Network Schematic

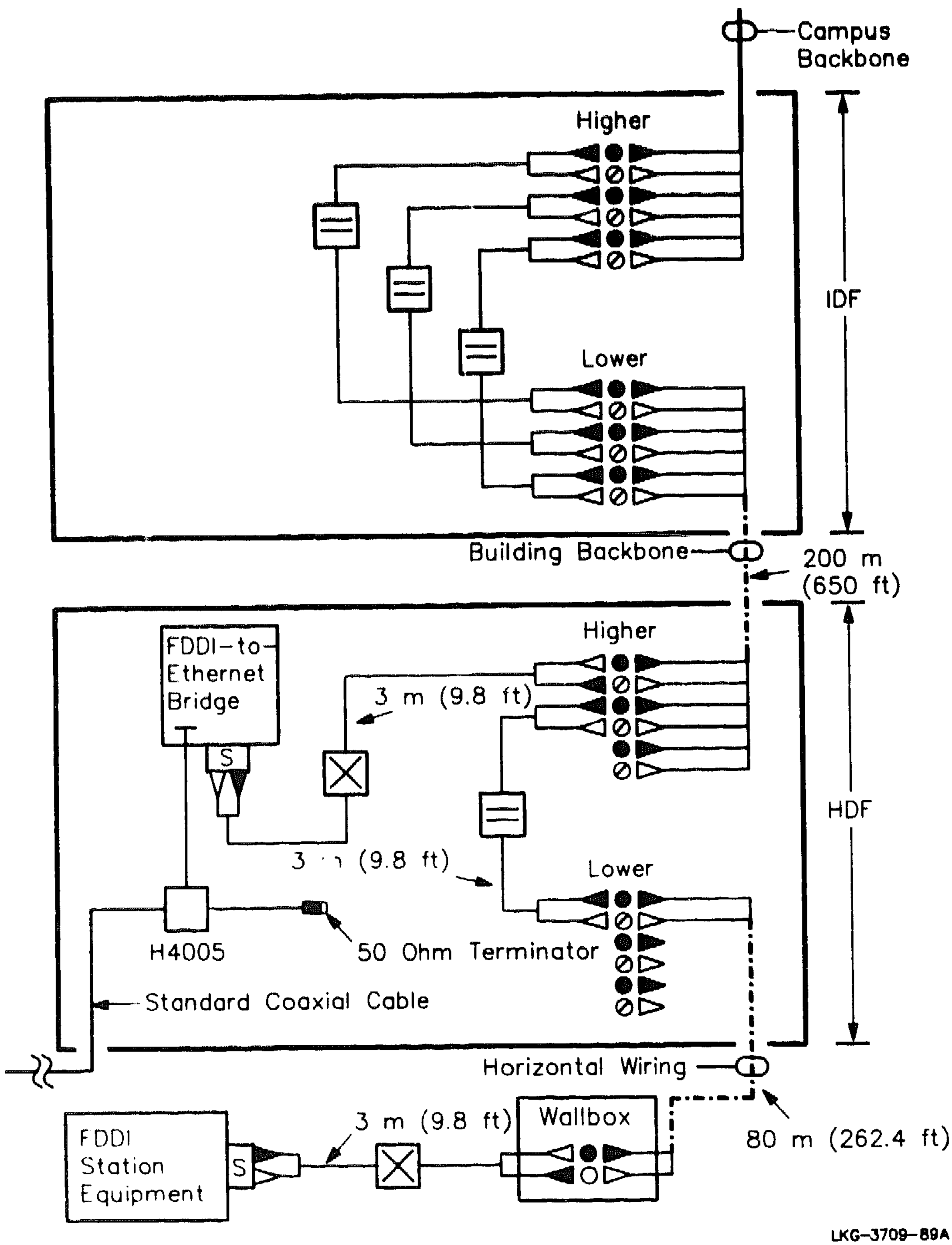
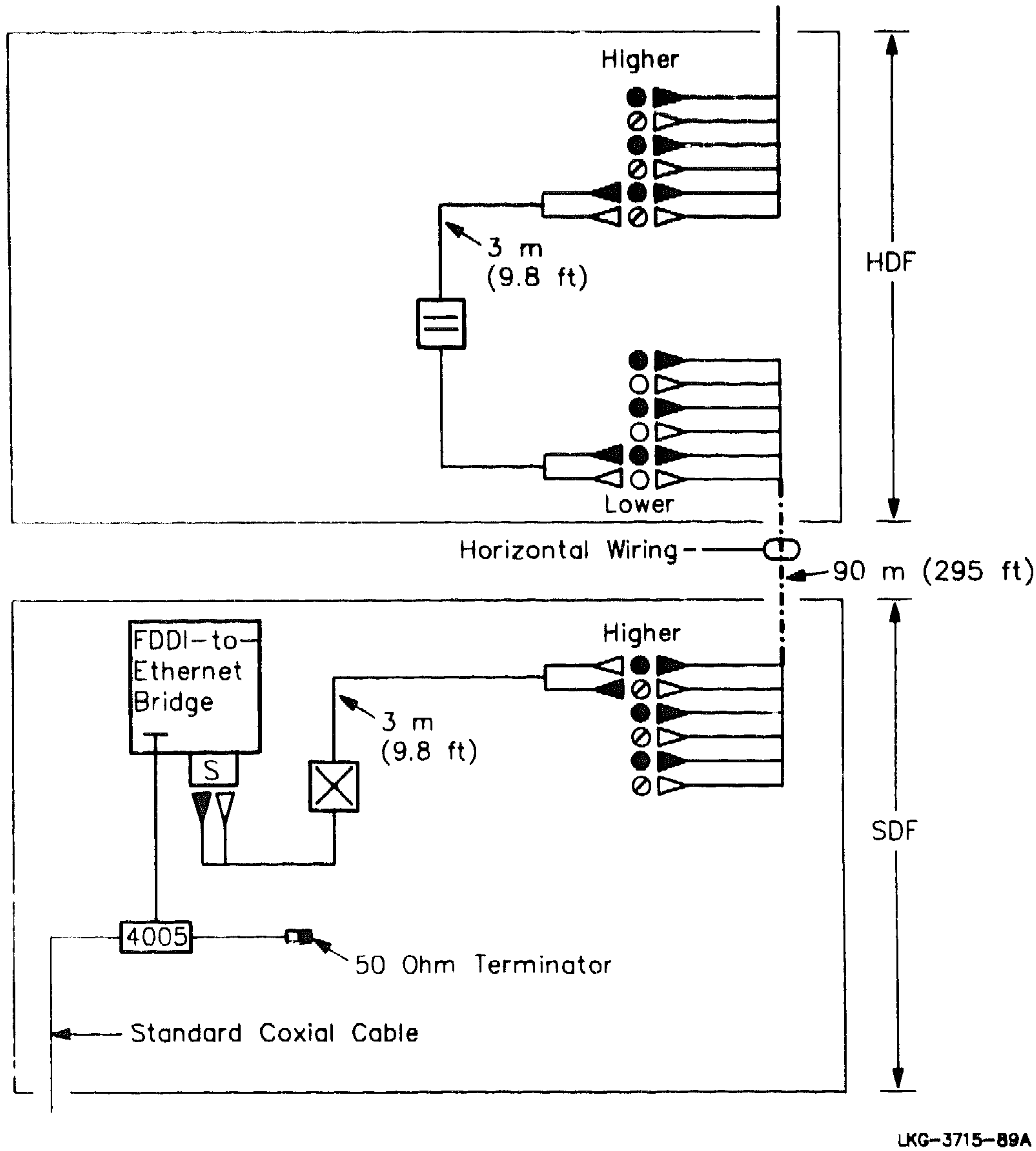


**Figure 5–20: Sample Horizontal Network Schematic**



### 5.7.2.5 Network Schematic Creation Process - Unknown Applications

In general, the process used in creating the network schematics for unknown applications is as follows:

- Verify that the cable and other passive cable plant components planned for the links meet the DECconnect System's cable plant requirements (Section 5.3)
- Create the schematic
- Verify that each link between distribution subsystems does not exceed the link-loss planning numbers given in Table 5–3

## 5.8 Fiber Optic Link-Loss Calculations - Known Applications

A link-loss calculation, which is a simple arithmetic process, is used to determine if the active equipment's allowable system loss supports the designed fiber optic link. The calculation is based on optical specifications for the active equipment and the cable plant, including:

- The active equipment's allowable system loss specification
- The bandwidth derating loss value for the active equipment
- Splice losses
- Connector pair losses
- Cable attenuation
- Cable plant system loss margin

The active equipment's allowable system loss is a product-specific value that defines the maximum amount of loss that can occur in the fiber optic link between that active equipment's transmit optical connection with the link, and the optical receiver's connection at the other end of the link.

### 5.8.1 Link-Loss Calculation Process

A link-loss calculation must be done for each fiber optic link in the structured wiring cable plant. The calculation ensures that the link does not exceed the allowable system loss for the active equipment involved in the link.

If a link does not meet the allowable system loss for the active equipment, then the link needs to be redesigned. The actions that can be taken in the redesign are:

- Use active equipment with a higher allowable system loss.
- Reduce the number of splices or connectors in the link, if possible.
- Use a high-grade fiber optic cable that has a cable attenuation that is less than that for standard cables.
- Design a new cable route for the cable if rerouting the cable can cut down on the distance enough to meet the allowable system loss
- Redesign the subsystem structure to cut the distance, if possible.

### 5.8.2 Link-Loss Calculation Methods

Two methods of doing the link-loss calculation are provided:

- Link-loss tables
- Link-loss calculation worksheet

#### 5.8.2.1 Link-Loss Tables

The FDDI and ORnet product descriptions (Section 5.6) both include a link-loss table. Each table defines a maximum link distance that is based on using 62.5/125 micron indoor multimode cable and takes into account the equipment's allowable system loss and bandwidth derating values, as well as the cable plant system loss margin (1.0 dB). Remember to add two splices for each link to budget for service splices.

**NOTE**

> When using other than the Digital-recommended 62.5/125 micron fiber size (50/125 or 100/140), with Digital FDDI or ORnet equipment, refer to Appendix A to determine the maximum link lengths for the active equipment.

To use the link-loss tables:

- Determine the number of connector pairs (one pair for each interconnect, two pairs for each crossconnect) in the link.

**NOTE**

Do not count the active equipment's connector on Digital's products, or the patch cable connector that connects directly to the active equipment. These connectors are already accounted for in the design of the active equipment allowable system loss. Do not add in their losses again. For products not made by Digital, refer to the vendor's technical manual for this connector information.

- Determine the number of splices in the link (including the two service splices that are required to be budgeted for).
- Find the link's maximum length in the link-loss table's column and row that corresponds to the connector pair and splice numbers.
- Compare the maximum length from the table with the actual link length.

If the actual link length is not greater than the link-loss table value, then the link is within the active equipment's allowable system loss.

#### 5.8.2.2 Link-Loss Calculation Worksheet

The link-loss calculation worksheet evaluates the design of each fiber optic link in the structured wiring cable plant when:

- Fiber optic Ethernet or FDDI products are used.
- Active equipment not available from Digital is used.
- The link-loss tables in Section 5.6 cannot be used because a different cable attenuation is used.

This section provides instructions on how to use the Link-Loss Calculation Worksheet shown in Figure 5–21. Make one photocopy of the worksheet for each link-loss calculation. The result of the calculation is the maximum allowed fiber optic cable length which can be installed with that specific link.

The worksheet contains several numbered entries. Each of these requires action, as follows:

1. Enter the allowable system loss value for the active equipment.
2. Enter the number of splices in the link, multiply that number by 0.4 dB (the maximum allowable loss for DECconnect System splices), and record the result. For example, three splices result in a total splice loss of 1.2 dB.
3. Enter the number of connector pairs (one pair for each interconnect, two pairs for each crossconnect), multiply the number of pairs by 0.7 dB (the maximum allowable loss for DECconnect System connectors), and record the result. For example, a link with two interconnects and one crossconnect has 4 connector pairs, with a total loss of 2.8 dB.
4. Enter a value equal to 0.4 dB for each planned maintenance splice (Digital recommends that two maintenance splices be planned for each link, with a maintenance splice loss value of 0.8 dB).
5. Enter the cable plant system loss margin (1.0 dB).
6. Add the splice (line 2), connector (line 3), maintenance splice (line 4), and system margin (line 5) loss values together and record the result.
7. Subtract the fixed loss value recorded on line 6 from the allowable system loss value on line 1 and record the remaining value.
8. Record the cable attenuation value of the cable to be used in the link. For example, record 1.5 dB when using outdoor multimode 62.5/125 micron fiber optic cable in a 1300 nm product application.
9. Include the bandwidth derating value.

**NOTE**

> If the bandwidth derating value is unknown for the active device, consult the equipment specifications or, if necessary, the vendor, for the bandwidth derating value.

9. Add the cable attenuation (line 8) to the bandwidth derating value (line 9) and record the result.
10. Determine the maximum link length by dividing the cable power budget recorded in line 7 by the length dependent losses recorded in line 10 and record the result.

## Figure 5–21: Link-Loss Calculation Worksheet

I. Project Identification: ______________

Project ID: ______________ Page ____ of ____

Designer: ________________ Date: ____________

II. Cable Link Identification:

Cable Identifier: ____________

III. Link Loss Calculation:

(1) Allowable System Loss: ________ dB

**Fixed Losses:**

(2) Splice Loss: No. of Splices: ________ X 0.4 dB = ________ dB

(3) Connector Loss: No. of Pairs: ________ X 0.7 dB = ________ dB

(4) Planned Maintenance Splice Loss: ________ dB

(5) System Loss Margin: ________ dB

(6) Total Fixed Losses (add lines 2, 3, 4 and 5): ________ dB

(7) Cable Power Budget (subtract line 6 from line 1): ________ dB

**Length Dependent Losses:**

(8) Cable Attenuation: ________ dB/km

(9) Other Losses, such as Bandwidth Derating (if applicable): ________ dB/km

(10) Total Dependent Losses (add lines 8 and 9): ________ dB/km

(11) Maximum Link Length (divide line 7 by line 10): ________ km

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## 5.9 Link Certification Loss Values

A link certification loss value for both 850 nm and 1300 nm wavelengths must be calculated for each fiber optic cable link between the structured wiring distribution elements (distribution frames and wallboxes). Two worksheets are used in calculating and recording the link certification loss values:

- Link Certification Loss Value Worksheet Figure 5–22 - provides the step-by-step arithmetic process for determining the loss values for each cable link.
- Link Certification Loss Value Summary Worksheet Figure 5–22 - provides a means of summarizing the loss values.

The Link Certification Loss Value Summary Worksheet should be included with the installation documents. These worksheets are used during the installation acceptance process outlined in the *DECconnect System Fiber Optic Installation* guide (EK-DECSY-FI). During the cable plant acceptance procedures, the link-loss for each complete fiber optic cable link is measured and compared against the value recorded in the summary worksheet. These results are part of the acceptance criteria for the installed cable plant.

### 5.9.1 Link Certification Loss Value Worksheet

This section provides instructions for using the Link Certification Loss Value Worksheet Figure 5–22. The worksheet provides a simple arithmetic process for determining a loss value for a fiber optic cable link. The loss values are recorded on the Link Certification Loss Value Summary Worksheet.

#### Section I Project Identification

Identify the project, designer, and date.

#### Section II Cable Link Identification

Identify the cable link by the cable identifier.

### Section III Loss Calculations

This section of the worksheet has three main parts:

- Splice and Connector Loss - determines the total dB loss for the link's splices and connector pairs through a self-explanatory three-step (Steps 1 through 3) arithmetic process.
- 1300 nm Cable Loss - determines the loss value for 1300 nm wavelength operation through a self-explanatory seven-step (Steps 4 through 10) arithmetic process.
- 850 nm Cable Loss - determines the loss value for 850 nm wavelength operation through a self-explanatory seven-step (Steps 11 through 17) arithmetic process.

## Figure 5–22: Link Certification Loss Value Worksheet

I. Project Identification:__________________

Project ID: __________________ Page ____ of ____

Designer: ______________________ Date: _______________

II. Cable Link Identification:

Cable Identifier _______________

III. Loss Calculations:

**Splice and Connector Loss:**

| | | | | |
|---|---|---|---|---|
| (1) Number of splices: | ________ | X 0.4 = | ________ | dB |
| (2) Number of connector pairs: | ________ | X 0.7 = | ________ | dB |
| (3) Total loss (add lines 1 and 2): | | | ________ | dB |

**850 nm Cable Loss:**

| | | |
|---|---|---|
| (4) Length of cable link: | ________ | km |
| (5) Cable attenuation (3.75 indoor or 3.5 outdoor cable): | ________ | dB |
| (6) Attenuation loss (multiply line 4 by line 5): | ________ | dB |
| (7) Total splice/connector loss from line 3: | ________ | dB |
| (8) Attenuation/splice/connector loss (add lines 6 and 7): | ________ | dB |
| (9) Certification measurement margin: | 0.5 | dB |
| (10) 850 nm certification loss value (subtract line 9 from line 8): | ________ | dB |

**1300 nm Cable Loss:**

| | | |
|---|---|---|
| (11) Length of cable link: | ________ | km |
| (12) Cable attenuation: | 1.5 | dB |
| (13) Attenuation loss (multiply line 11 by line 12): | ________ | dB |
| (14) Total splice/connector loss from line 3: | ________ | dB |
| (15) Attenuation/splice/connector loss (add lines 13 and 14): | ________ | dB |
| (16) Certification measurement margin: | 0.5 | dB |
| (17) 1300 nm certification loss value (subtract line 16 from line 15): | ________ | dB |

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### 5.9.2 Link Certification Loss Value Summary Worksheet

This section provides instructions for filling in the Link Certification Loss Value Summary Worksheet (Figure 5–23). It provides a means of recording the 1300 nm and 850 nm link-loss values for all of the fiber optic cable links in the structured wiring cable plant. Fill in a separate worksheet for each building's cables. Fill in one worksheet for all of the campus backbone cable.

#### Section I Project Identification

Identify the project, worksheet page number, designer, and date.

#### Section II Subsystem Identification

Fill in the IDF identifier, if the worksheet is for building backbone or horizontal wiring.

Fill in the MDF identifier, if the worksheet is for the campus backbone cables.

#### Section III Link Certification Values

Fill in the 850 nm and 1300 nm calculated certified loss values from each of the Link Certification Loss Value Worksheets (Figure 5–22) by cable identifier.

**NOTE**

> The remainder of the worksheet is filled in during certification procedures performed after the site has been completely installed. For more information on the installation link acceptance process, see Chapter 7 of the *DECconnect System Fiber Optic Installation* guide (EK-DECSY-FI).

## Figure 5–23: Link Certification Loss Value Summary Worksheet

I. Project Identification:

Project ID: ____________ Page ____ of ____

Name: ______________________________ Date: ____________

II. Subsystem Identification:

Identifier: ____________

III. Link Certification Values:

| Cable Identifier | Calculated Certified Loss Value | | Total Corrected Cable Loss | | Value Differences | |
|---|---|---|---|---|---|---|
| | 850 | 1300 | 850 | 1300 | 850 | 1300 |
| | | | | | | |
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# CHAPTER 6

# 6

# Work Area Wiring Design

This chapter provides work area wiring recommendations and procedures needed to:

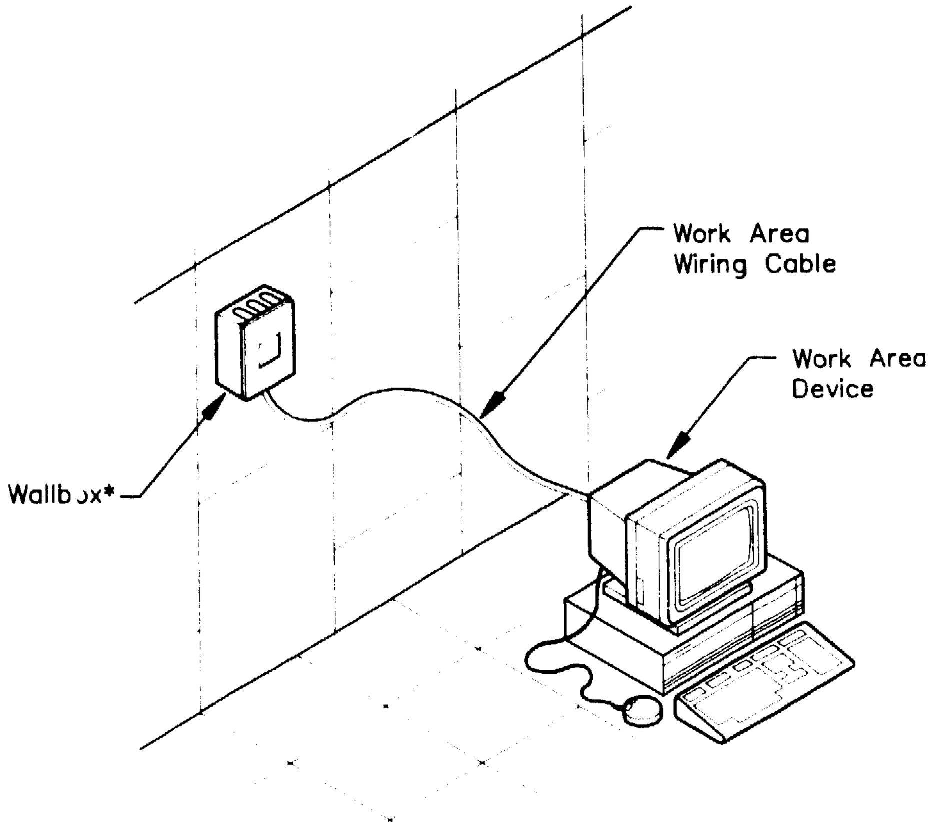
- Define wallbox locations and mounting procedures.
- Define cable requirements.
- Define work area wiring connections to the wallbox.
- Create a bills of materials (BOM) for cable requirements.

Each work area wiring subsystem is a cable assembly (or assemblies) that connects the active equipment device to a horizontal wiring subsystem's wallbox. The construction of work area wiring cables is identical to patch panel cables used at the distribution frames. Each type of cable assembly contains:

- A length of 2-fiber cable.
- On the fibers at one end of the cable, FDDI 2.5 mm bayonet ST-type or SMA-type connectors for connection to the active device.
- On the fibers at the other end of the cable, either 2.5 mm bayonet ST-type connectors (for connection to the H3111-GA/GB/GC wallbox's H3114-FF 2.5 mm bayonet ST-type connector panel) or an FDDI connector (for connection to the H3111-GA/GB/GC wallbox's H3114-FE FDDI connector panel).

Figure 6–1 illustrates a work area wiring subsystem.

**Figure 6–1: Work Area Wiring Subsystem**




*Wallbox is part of horizontal wiring subsystem.

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## 6.1 Required Documents

The following documents are used during the work area wiring design process:

- Floor plans - Updated to show all wallbox locations.
- The Work Area Wiring Worksheet filled in during the site survey (*DECconnect System Requirements Evaluation Workbook* (EK-DECSY-EG)).
- The Wallbox Identifier Worksheets filled in during the labeling process in Chapter 4, Section 4.6.

## 6.2 Work Area Wiring Guidelines

The following guidelines apply to the work area wiring design:

- Cable length - Digital recommends that work area wiring be a maximum length of 3 meters (10 feet).
- Cable bend radius - wherever possible, use cable ties or cable clamps to secure the work area wiring cables. This will help prevent damage due to sharp bends of the fiber optic cable. The bend radius should not be smaller than 3.8 centimeters (1.5 inches).

## 6.3 Defining Component Locations

The present or planned location of the wallboxes and the active equipment that connect to those wallboxes is important to the work area wiring design. Therefore, on the floor plans for each building, clearly mark all existing wallboxes and active equipment. Update the floor plans to show present locations.

**NOTE**

> Wallboxes are identified in the floor plans by their identifier values. These values were defined during the wallbox identifier process (Chapter 4) and recorded in Wallbox Identifier Worksheets.

## 6.4 Wallbox Installation Recommendations

Wallboxes should be located within 15 centimeters to 30 centimeters (6 to 12 inches) of a work area's duplex electrical receptacle. When the wallbox is installed, it should be at the same level as that receptacle.

The following types of wallbox mounting can be used:

- Installed onto a standard U.S. electrical box mounted in the wall. The minimum dimensions of the electrical box are 8.9 cm (3.5 inches) high by 5.3 cm (2.1 inches) wide by 6.4 cm (2.5 inches) deep.
- Installed onto an international electrical box with hole spacing of 60.45 mm (2.38 inches).
- Installed directly on the wall surface using mounting components included in the wallbox kit.
- Installed in movable partition offices by referring to the partition manufacturer's recommended methods for attaching communications receptacles to their partitions.

## 6.5 Work Area Wiring Connection to Wallbox

Proper operation of the user's active equipment in the fiber optic network requires correct installation of the work area wiring to the wallbox and to the user's active equipment. This requires understanding:

- The location of the fiber optic transmit and receive connectors on the user's active equipment or station device.
- The proper connection of the user's active equipment or station device to the wallbox.

Connection of the FDDI receptical on the user's active equipment to an H3111-GA/GB/GC wallbox with an H3114-FF FDDI connector panel requires a BN24B-*xx* FDDI-to-FDDI crossover cable. The ends of the cable have keyed FDDI connectors so that they insert into the FDDI receptical at the active equipment and wallbox the correct way.

Some active equipment have individual fiber optic ST or SMA-type connectors for transmit and receive. These connectors are usually identified by the symbols or terms shown in Figure 6–2.

**Figure 6–2: User's Active Equipment Connection Labels**

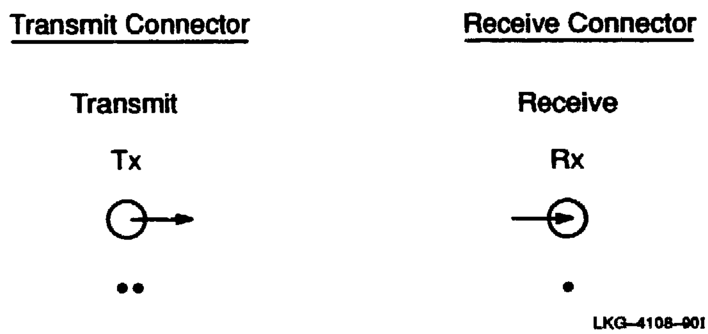



Figure 6–3 shows the proper connections to the H3114-FF 2.5 mm bayonet ST-type connector panel on the wallbox. On the front of each wallbox is a single-dot symbol (bottom left side) and a two-dot symbol (bottom right side). The active equipment transmit connector connects to the wallbox 2.5 mm bayonet ST-type coupler with the two-dot symbol above it. The active equipment receive connector connects to the other wallbox coupler with the single-dot symbol above it.

When using a BN24D-*xx* FDDI-to-2.5mm bayonet ST-type connector cable to connect active equipment with an FDDI receptacle to a wallbox with a ST connector insert, the active equipment transmit connector is the ST connector with the black boot. The active equipment receive connector is the red boot connector. The black boot ST connector is connected to the wallbox ST-type coupler with the two-dot symbol above it and the red boot connector is connected to the coupler with the single-dot symbol above it. See Figure 6–4 for an illustration of the connections.

Figure 6–3: H3114-FF 2.5mm Bayonet ST-type Wallbox Connections

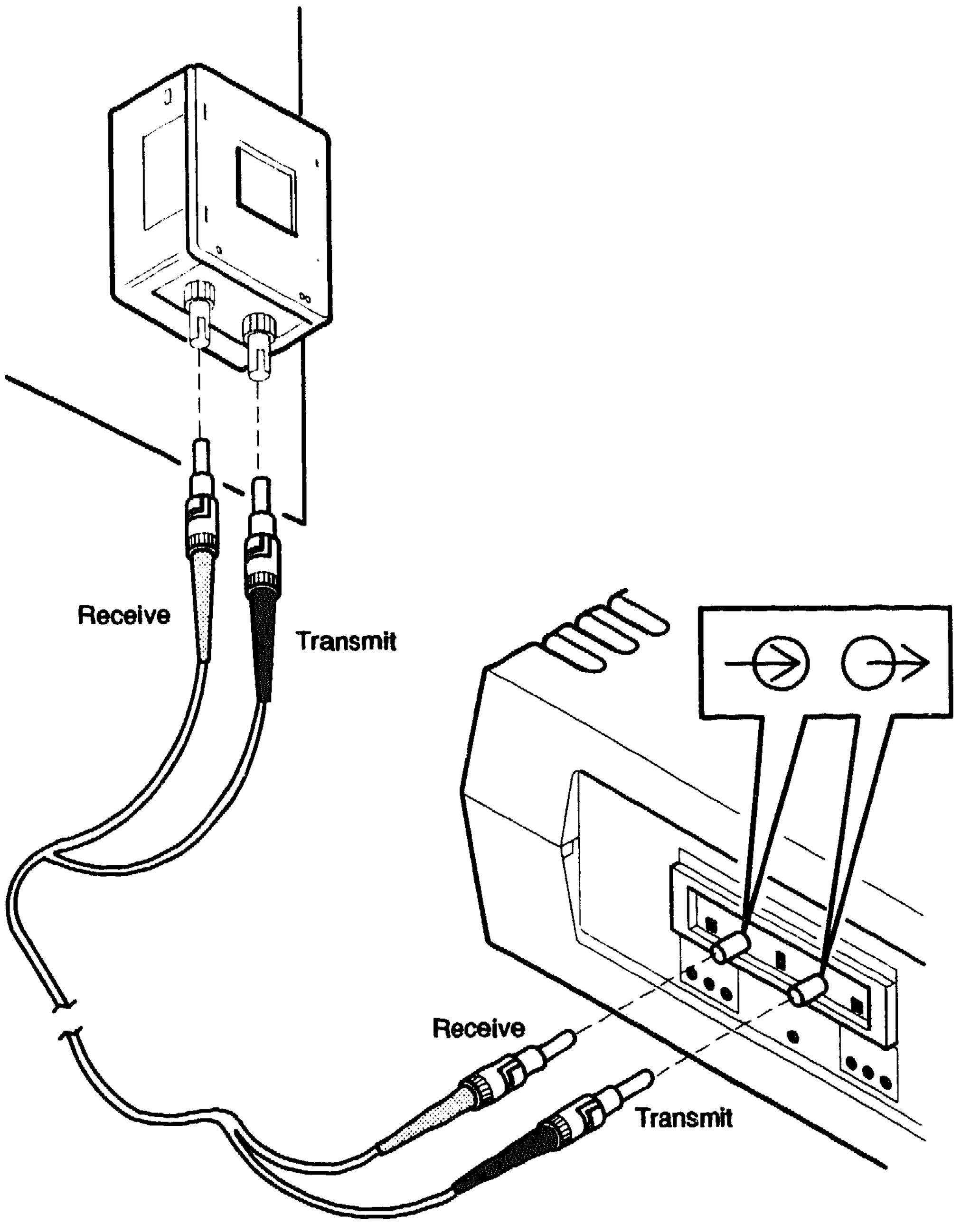
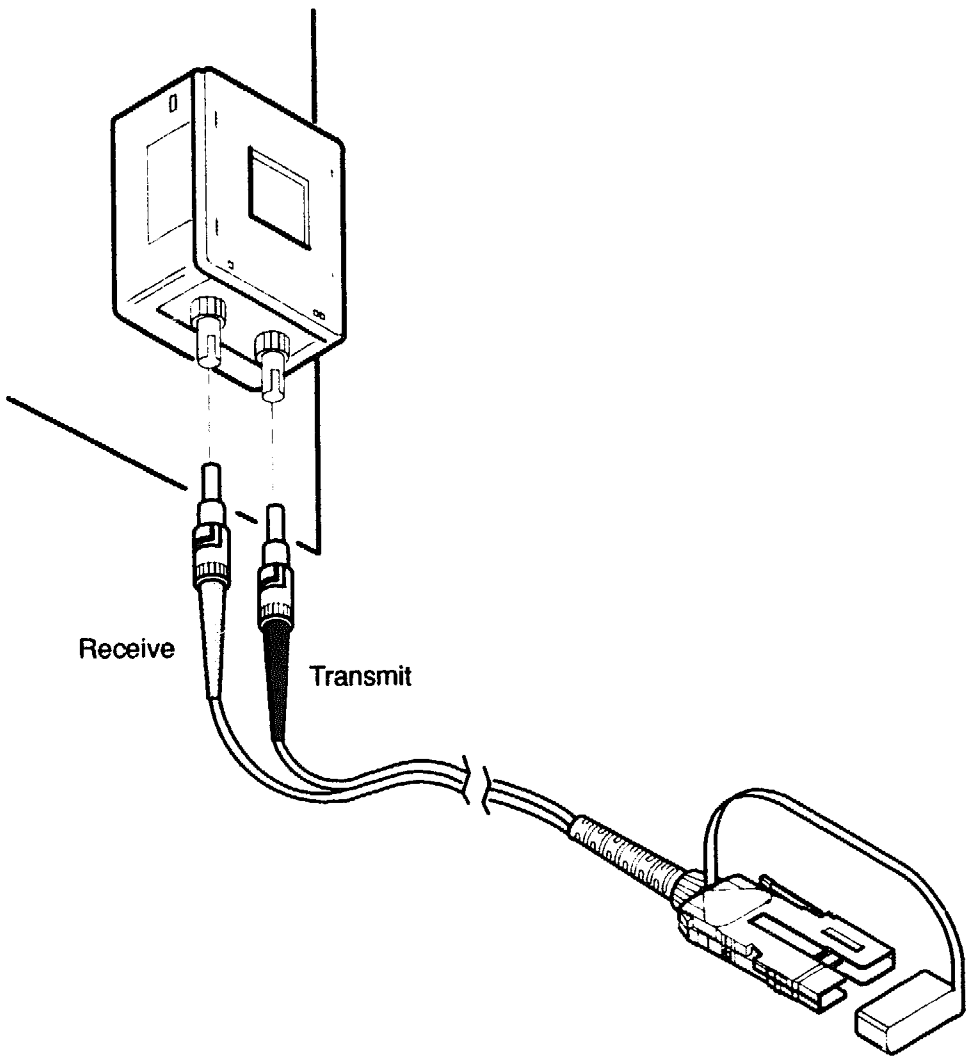


**Figure 6–4: BN24D-*xx* FDDI-to-2.5mm Bayonet ST-type Wallbox Connections**

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## 6.6 Design Process Overview

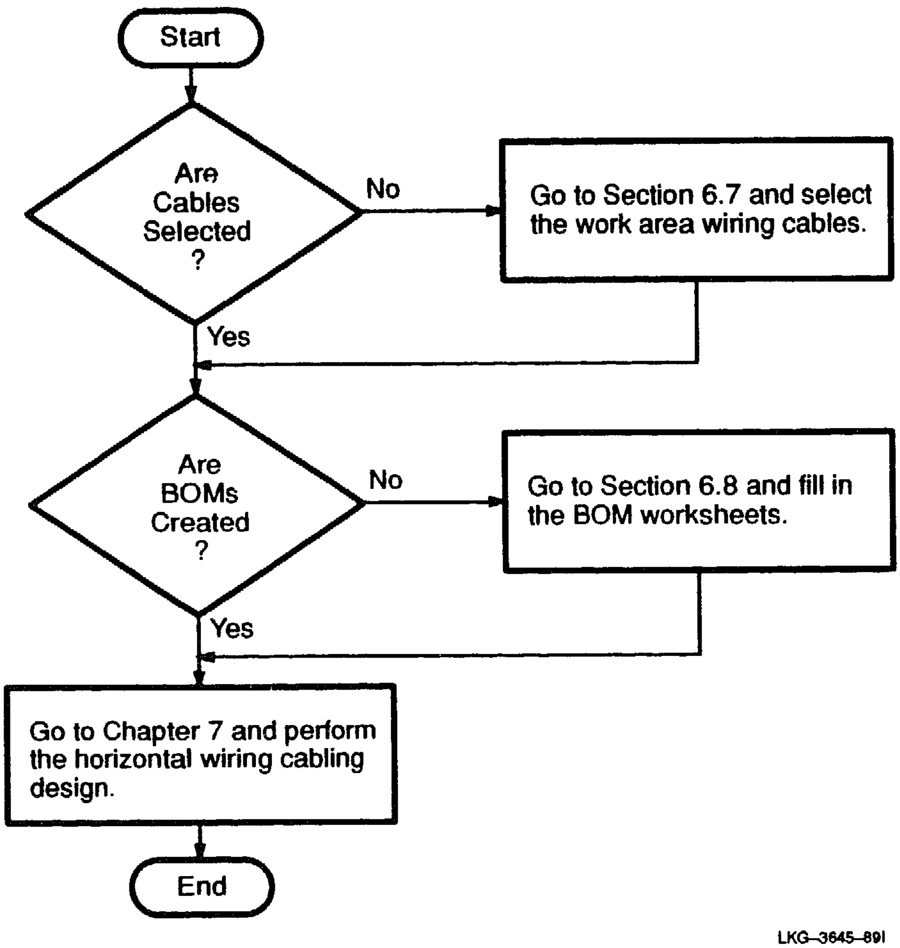
The work area wiring design process is done on a horizontal wiring subsystem-to-subsystem basis. That is, the work area wiring cables that connect to a specific horizontal wiring subsystem's wallboxes are designed as a single unit.

The result of the design is a worksheet set that defines all of the work area wiring requirements for a single horizontal wiring subsystem as follows:

- Work Area Wiring Cable Worksheet - defines the cable requirements.
- Work Area Wiring BOM Worksheet - provides a bill of materials for all of the requirements identified in the cable worksheet.

Figure 6–5 provides a flow chart overview of the work area wiring design process.

**Figure 6–5: Work Area Wiring Design Flow Chart**




## 6.7 Selecting Work Area Wiring Cables

During this phase of the design:

- Review the work area wiring cable options.
- Photocopy and fill in a Work Area Wiring Cable Worksheet Figure 6–6 for each of the site's horizontal wiring subsystems.

- Use one worksheet for each horizontal wiring subsystem to define the work area wiring cables.

### 6.7.1 Cable Options

Each work area wiring cable is defined by three major factors:

- Recommended cable length (to a maximum of 3 meters (10 feet)).
- The active equipment connectors (FDDI 2.5 mm bayonet ST-type or SMA-type).
- The wallbox connector type.

Additional factors that can be important are the cable's jacket type (PVC or plenum) and fiber size (50/125, 62.5/125, or 100/140).

Two options exist for selecting and ordering the cables:

- Cable assemblies terminated with connectors.
- Custom cables

#### 6.7.1.1 Cable Assemblies

Cable assemblies come in specific lengths and are terminated with the connectors needed for both the wallbox and active equipment cable ends. Three types of terminated cable assemblies are available from Digital for use as work area wiring (or patch cables):

**NOTE**

> Terminated cable assemblies for connecting SMA-type active equipment are not available directly from Digital. They are ordered as custom cables (see Section 6.7.1.2).

- BN24-*xx* dual 2.5 mm bayonet ST-type connector cable (for connecting ST-type active devices to a 2.5 mm bayonet ST-type connector panel at the wallbox)
- BN24D-*xx* FDDI-to-2.5 mm bayonet ST-type connector cable (for connecting FDDI active devices to a 2.5 mm bayonet ST-type connector panel at the wallbox)

- BN24B-*xx* FDDI-to-FDDI crossover cable (for connecting an FDDI device to an FDDI connector panel at the wallbox)

**NOTE**

The H3111-GA/GB/GC wallbox (the only wallbox Digital supports in the DECconnect System fiber optic structured wiring) uses an H3114-FF 2.5 mm bayonet ST-type connector panel or an H3114-FE FDDI connector panel for fiber optic connections. Work area fiber optic cables must have either 2.5 mm bayonet ST-type connectors (for the H3114-FF panel) or an FDDI connector (for the H3114-FE panel) on the wallbox end of the cable.

These cable assemblies, described in Chapter 11, come in various lengths and are all PVC-jacketed, with 62.5/125 micron fiber.

**NOTE**

Only 3 meter (10 feet) or shorter versions of the cable assemblies are recommended for use as work area wiring cables. The longer versions described in Chapter 11 are for use as distribution frame patch cables. They are supported for use in work area wiring if the link-loss calculations in Chapter 5 allow longer lengths.

#### 6.7.1.2 Custom Cables

Digital does not recommend the field-assembly of custom work area wiring cables. They can be ordered from vendors listed in the auxiliary section of Chapter 11.

For example the following work area cables can be ordered as custom, factory-built assemblies:

— Cables that use 50/125 or 100/140 micron fiber

— Cables with SMA-type or Biconic-type connectors

— Custom-length cables

**NOTE**

Digital does not recommend using custom cable assemblies that exceed the 3-meter (10-foot) maximum length for work area wiring.

### 6.7.2 Cable Worksheet

This section provides instructions for the Work Area Wiring Cable Worksheet (Figure 6–6). Photocopy and fill in a cable worksheet for each horizontal wiring subsystem. This defines the work area wiring cable requirements for connecting to the horizontal wiring's wallboxes.

**NOTE**

> Consult the cable vendor to solve any unique cable requirements not covered in this chapter.

#### Section I Project Identification

Identify the project, worksheet page number, designer, and date.

#### Section II Subsystem Identification

Identify the horizontal wiring subsystem work area wiring with the building IDF and horizontal wiring HDF cable identifiers.

#### Section III Component Requirements

Identify the work area wiring cable and connector requirements as follows:

- List the wallbox identifier for each wallbox.
- Define the active device's connector type.
- Define the wallbox connector type (H3114-FF for 2.5 mm bayonet ST-type connectors or an H3114-FE for FDDI connectors).
- Define the fiber length (3 meters (10 feet) maximum), fiber type (50/125, 62.5/125, or 100/140), and jacket type (PVC or plenum).
- Use the Comments column to indicate any special issues, such as the listed cable components for a field-assembled custom cable.

#### Section IV Cable Routing Methods

Describe any special cable routing requirements within the work area.

## Figure 6–6: Work Area Wiring Cable Worksheet

I. Project Identification:

Project ID: ______________ Page ____ of ____

Name: ______________________________________ Date: ______________

II. Subsystem Identification:

IDF Identifier: ______________ HDF Identifier: ______________

III. Component Requirements:

| Wallbox Identifier | Active Device Connector | Wallbox Connector | Wallbox Panel Type | Fiber Length | Fiber Type | Jacket Type | Comments |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
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IV: Cable Routing Methods:

______________________________________________

______________________________________________

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## 6.8 Bill of Materials (BOM) Worksheet

This section provides instructions for the Work Area Wiring BOM Worksheet (Figure 6–7). Photocopy and fill in a BOM worksheet for the work area wiring that connects to a single horizontal wiring subsystem's wallboxes. Each BOM worksheet is compiled from the Workstation Wiring Cable Worksheet.

### Section I Project Identification

Identify the project, worksheet page number, designer, and date.

### Section II Subsystem Identification

Identify the horizontal wiring subsystem by its IDF and HDF cable identifiers.

### Section III Component Requirements

List each cable assembly, cable, or connector component by:

- Component description (for example, 62.5/125, 3-meter, PVC-jacketed, FDDI-to-2.5 mm, bayonet ST-type connector cable assembly)
- Order number (for example, BN24D-03 is the order number for the 3-meter PVC-jacketed 62.5/125 micron FDDI-to-2.5 mm bayonet ST-type connector cable assembly)
- Quantity required
- Unit price
- Total price (quantity multiplied by the unit price)

Then summarize the total cost of the listed components.

## Figure 6–7: Work Area Wiring BOM Worksheet

I. Project Identification:

Project ID: ______________ Page ____ of ____

Designer: ______________________________ Date: ______________

II. Subsystem Identification:

IDF Identifier: ______________ HDF Identifier: ______________

III. Component Requirements:

| Item Number | Part Number | Description | Quantity | Unit Price | Total Price |
|---|---|---|---|---|---|
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Total Cost: ______

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# CHAPTER 7

# 7

# Horizontal Wiring Cabling Design

This chapter provides the horizontal wiring recommendations, procedures, and worksheets needed to:

- Define wallbox requirements.
- Select cable routing methods.
- Define cable and connector requirements.
- Create bills of materials (BOMs) for the component requirements.

Each horizontal wiring subsystem has the following main components:

- A horizontal distribution frame (HDF) - the connection points between the horizontal wiring and building backbone cables.
- The wallboxes - the connection point between the horizontal and work area wiring cables.
- The horizontal wiring cables - the cables between the horizontal wiring's distribution elements (distribution frames and wallboxes).
- The support hardware for routing the cables.

The DECconnect System's horizontal wiring can also include direct-cable connections between the HDF and computer equipment and the HDF and system common equipment, as well as any of the following other distribution frames:

- Satellite distribution frame (SDF) - an open-rack distribution frame located within an equipment room.

- Office distribution frame (ODF) - a free-standing, enclosed cabinet.
- Remote wall distribution frame (RWDF) - a small wall-mounted cabinet.

**NOTE**

The SDF, ODF, RWDF can only be used in wallbox links. Digital does not support using distribution frames in HDF-to-computer rooms or HDF-to-system common equipment links.

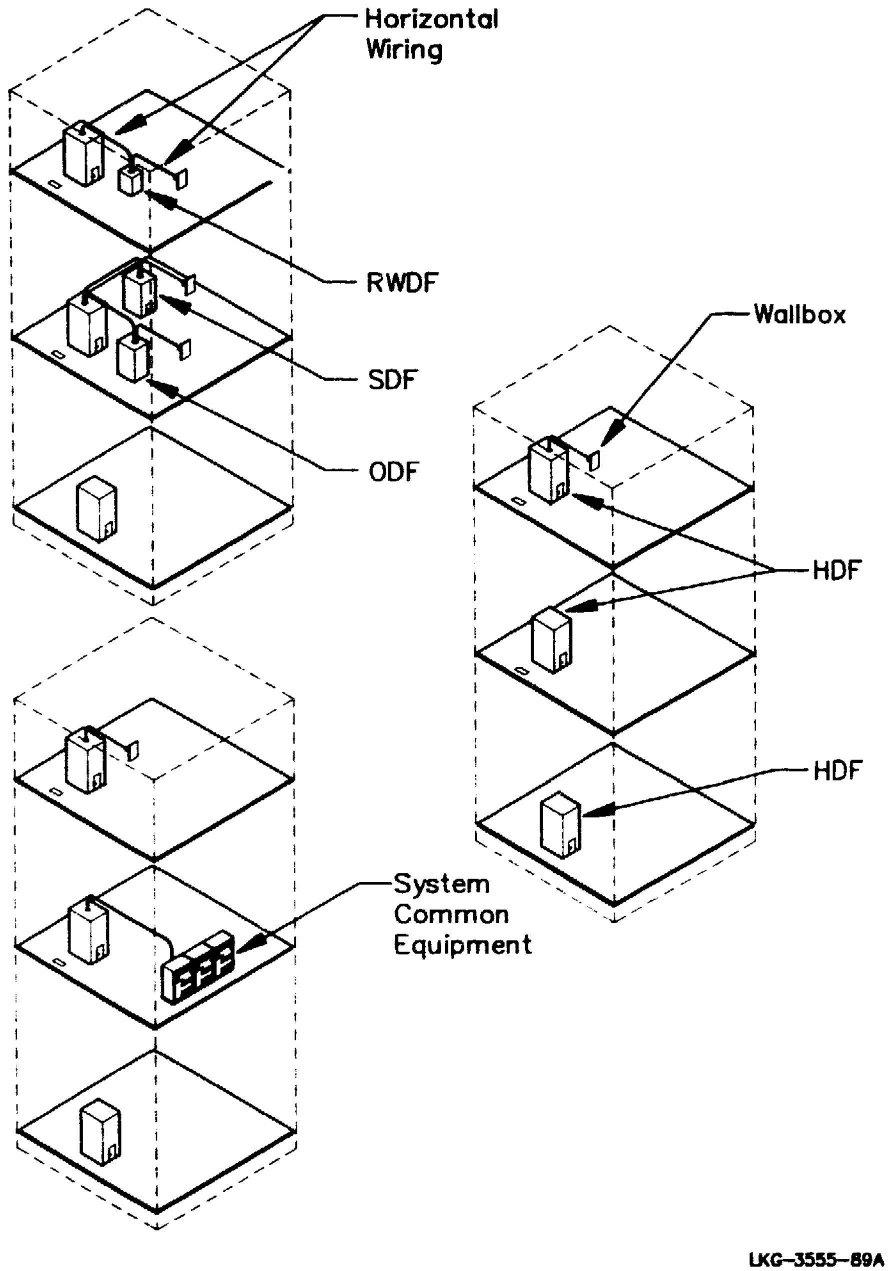
The RWDF is used only for interconnecting or splicing cables from wallboxes to the HDF. The SDF and ODF can be used for interconnecting active networking equipment to the structured wiring or for crossconnects between the wallbox and HDF cable fiber.

**NOTE**

Only one crossconnect is allowed in the horizontal wiring. Usually that crossconnect is in the HDF. When an interconnect is used in the HDF (for connecting active networking equipment to the link) the horizontal wiring's crossconnect can be in an SDF or ODF.

Figure 7–1 illustrates the horizontal wiring components.

**Figure 7–1: Horizontal Wiring Distribution Subsystem**



## 7.1 Required Documents

The following documents are used during the horizontal wiring design process:

- Floor plans - Updated during the design process to show the existing or planned locations of all distribution frames and wallboxes and all cable routing methods.
- The identifier worksheets filled in during the labeling procedure in Chapter 4, Section 4.6.
- The Horizontal Wiring Information Worksheet filled in during the site survey *from the DECconnect System Requirements Evaluation Workbook*.
- *BICSI Telecommunications Distribution Methods Manual* - for reference when designing the cable routing.
- *NEC* and local building codes - for reference during the design process.

## 7.2 Defining Component Locations

The exact existing or planned locations of the horizontal components (HDF, SDFs, ODFs, RWDFs, wallboxes, computers, and system common equipment that connects directly to an HDF) are very important to the design of the horizontal wiring subsystems. Therefore, on the floor plans for each building, check to see that each existing or planned location of the distribution frame, computer room equipment, or system common equipment that directly connects to the HDF is clearly marked. If not, update the floor plans by adding any missing distribution frame (computer room or system common equipment) locations.

**NOTE**

**The floor plans were updated to show the wallbox locations in Chapter 6. The distribution frames are identified in the floor plans by their identifier values. These values were defined during the distribution frame identifier process (Chapter 4) and recorded in the Horizontal Wiring Identifier Worksheets.**

## 7.3 Design Process Overview

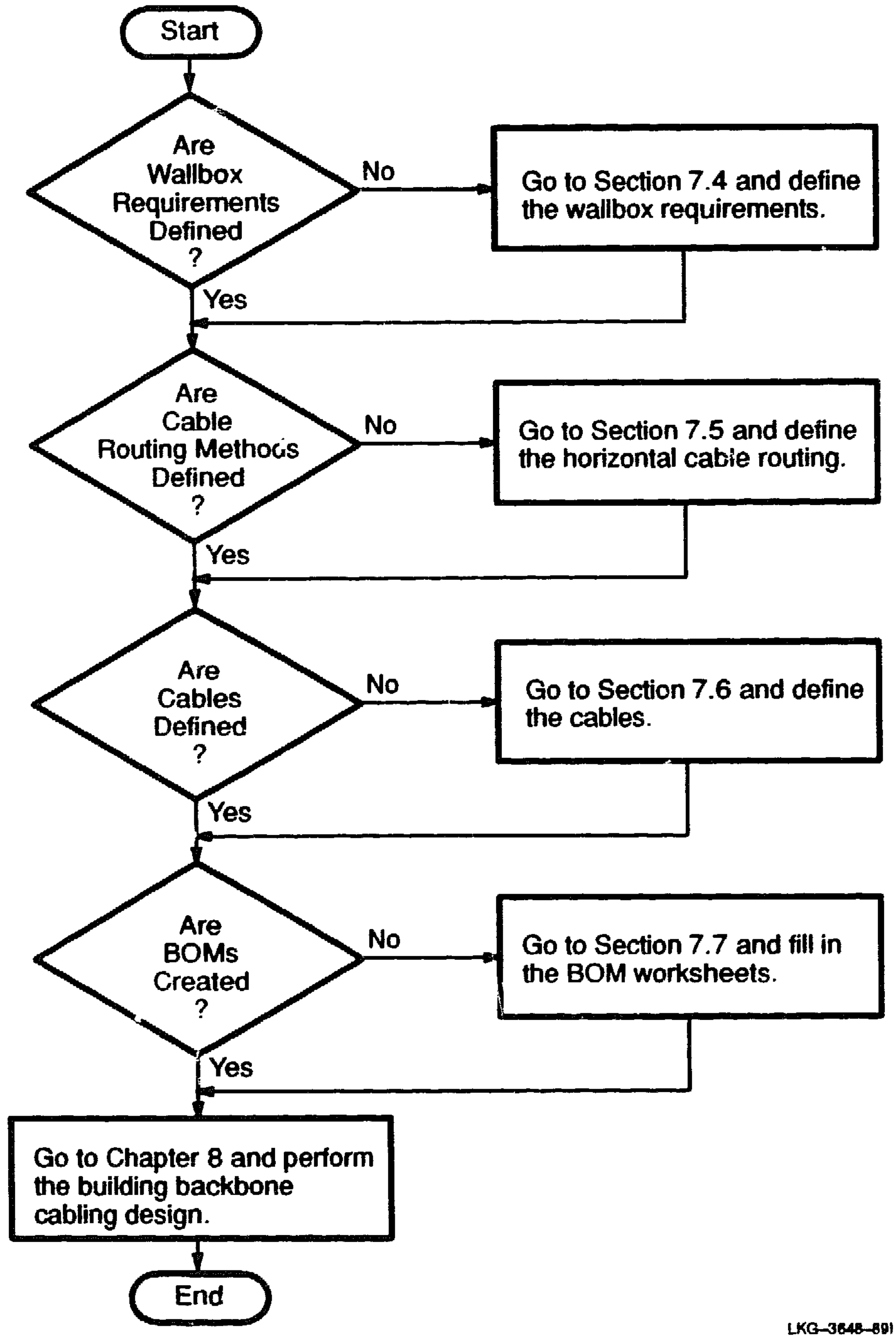
The horizontal wiring design process is done on a subsystem-by-subsystem basis. The result of each subsystem design is a worksheet set that defines all of the subsystem's wallbox, cable routing, cable, and connector requirements, as follows:

- Wallbox Requirements Worksheet (Figure 7–3) - defines the wallbox and snap-in connector panel requirements.
- Horizontal Wiring Cable Routing Worksheet (Figure 7–5) - defines the routing methods and any hardware needed for those methods.
- Horizontal Wiring Cable Worksheet (Figure 7–6) - defines the cable and connector requirements.
- Horizontal Wiring BOM Worksheet (Figure 7–7) - provides a bill of materials for all of the components.

In addition, building floor plans are updated during the design process to reflect the design.

Figure 7–2 provides a flow chart overview of the horizontal wiring design process.

## Figure 7–2: Horizontal Wiring Design Flow Chart



## 7.4 Wallbox Requirements

This section provides instructions for the Wallbox Requirements Worksheet (Figure 7–3). Photocopy and fill in a worksheet for each horizontal wiring subsystem to identify the subsystem's wallbox and snap-in connector panel requirements.

### Section I Project Identification

Identify the project, worksheet page number, designer, and date.

### Section II Subsystem Identification

Identify the subsystem by its IDF and HDF identifiers.

### Section III Component Requirements

List each wallbox by its identifier (for example, WB0134), and describe the type of snap-in connector panel (or panels) the wallbox needs (such as voice, video, twisted-pair data, ThinWire, or fiber optic data).

### Section IV Comments

Describe any special issues concerning the wallboxes.

## Figure 7–3: Wallbox Requirements Worksheet

I. Project Identification:

Project ID: ______________ Page ____ of ____

Designer: ____________________________________ Date: ______________

II. Horizontal Wiring Subsystem Identification:

IDF Identifier: ________________ HDF Identifier: ________________

III. Component Requirements:

| Wallbox Identifier | Type of Snap-in/Slide-in Connector Panel(s) | Wallbox Identifier | Type of Snap-in/Slide-in Connector Panel(s) |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
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IV. Comments:

______________________________________________

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## 7.5 Defining Cable Routing Methods

During this phase of the design:

- Select the routing method for each cable between the horizontal wiring connection points.
- Fill in a Horizontal Wiring Cable Routing Worksheet for each horizontal wiring subsystem to:
  - Define all of the routing methods for the cables.
  - Identify each cable that uses each defined method.
  - Identify any support components needed for the routing methods.

### 7.5.1 Selecting Cable Routing Methods

This section provides descriptions of the:

- Overall process for determining horizontal cable routing requirements.
- The Digital-recommended horizontal cable routing method.

**NOTE**

> Cable routing considerations are described in Chapter 2, Section 2.4.1.4. Review those guidelines before designing any cable routing.

#### 7.5.1.1 Cable Routing Methods Selection Process

During this phase of the design:

- Refer to the site plans and to the *DECconnect System Requirements Evaluation Workbook* Horizontal Wiring Information Worksheet or visually inspect the building to see if a routing method exists that the cable can use.
- If a routing method exists, verify that there is enough room for running new cable using that method's hardware.

For example, if existing conduit is selected, make sure there is enough room in the conduit to pull in an inner duct. This inner duct is required for isolating the fiber optic cable from other cables in the conduit. If there is room, indicate on the building floor plan that inner duct is needed. If there is no room, design a new conduit run for the cable, or select another routing method.

- If no routing method exists, or existing methods cannot be used:
  - Refer to the building's floor plans or visit the site to identify any obstacles that can affect the cable routing.

    **NOTE**

    A visit to the building with the cable installation contractor is recommended. The contractor can point out issues that can affect the selection of the routing methods, which are not readily apparent.

  - Review the horizontal cable routing method description in Section 7.5.1.2.
  - Mark the floor plans to show the routing method, as well as to identify any hardware needed and where it is needed (such as the location of cable trays).

#### 7.5.1.2 Horizontal Cable Routing Methods

This section provides a brief description of the above-ceiling cable tray method (Figure 7–4) for the horizontal cable routing recommended by Digital.

Keep the following points in mind when designing an above-ceiling cable routing run:

- Stubbed conduit should be installed in the wall from the wallbox to just above the dropped ceiling line. This helps avoid having to fish the fiber optic cable from the cable tray and through the wall to the wallbox.
- Proper fire blocking procedures must be observed when running cable through any wall that is designated as a fire stop.

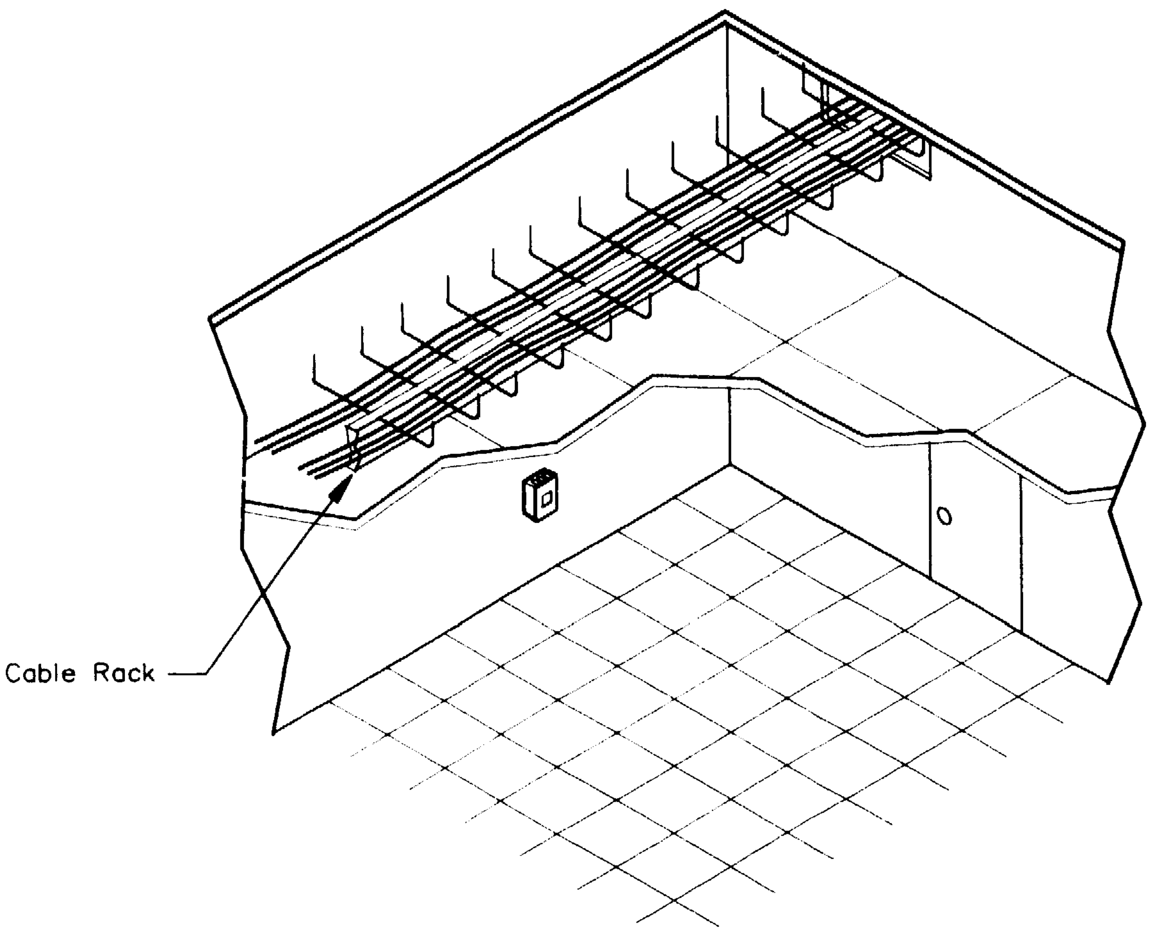
**NOTE**

Information on fire blocking is provided in the *BICSI Telecommunications Distribution Methods Manual.* This manual also describes other types of horizontal cable routing methods, and the above-ceiling cable trays method.

### Above-Ceiling Cable Trays

With this routing method, the cables are run to cable trays that are in the ceiling and routed through the horizontal wiring area. When a cable reaches the distribution frame or wallbox that it will connect with, it drops down from the trays to that frame or wallbox. In the case of the wallbox, the cable usually drops down from the cable tray to the wallbox through stubbed conduit (conduit that runs from just above the dropped ceiling line to the wallbox location).

## Figure 7–4: Cable Tray

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### 7.5.2 Cable Routing Worksheet

This section provides instructions for the Horizontal Wiring Cable Routing Worksheet (Figure 7–5). Photocopy and fill in a worksheet for each horizontal wiring subsystem to define the subsystem's routing methods and hardware requirements.

**NOTE**

Consult with the cable routing hardware vendor or contractor to solve any unique requirements not covered in this chapter.

#### Section I Project Identification

Identify the project, worksheet page number, designer, and date.

#### Section II Subsystem Identification

Identify the subsystem by its IDF and HDF identifiers.

#### Section III Cable Routing Methods Descriptions

Describe each type of routing method to be used, its status (existing or planned), and the identifiers for the cables that use the method.

If only one method is used, the entry should list that method and its status, while the cable identifier entry should state, "All."

#### Section IV Component Requirements

Describe any hardware needed for the routing methods (such as trays, cable ties, or cable clamps), and the quantity of each listed item.

#### Section V Comments

Describe any special issues concerning any of the cable routing methods.

## 7.6 Defining Cables

The horizontal concept diagrams identify some of the requirements for each horizontal wiring cable:

- Fiber type (multimode)

**Figure 7–5: Horizontal Wiring Cable Routing Worksheet**

I. Project Identification:

Project ID: ______________ Page ____ of ____

Designer: ______________________________ Date: ______________

II. Subsystem Identification:

IDF Identifier: ________________ HDF Identifier: ________________

III. Cable Routing Method Descriptions:

| Routing Method | Status | Identifiers for Cables Using Method |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

IV. Component Requirements:

| Component | Quantity |
|---|---|
| | |
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| | |

V. Comments:

______________________________________________

______________________________________________

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- Fiber count
- Fiber size
- Estimated cable lengths (in the case of the wallbox cables, only the average length is listed in the concept diagram)

The cable definition process consists of the following:

- Define each cable's jacket type (PVC or plenum)
- Verify the exact cable lengths
- Define the connector requirements for each cable

The result of the process is a filled in Horizontal Wiring Cable Worksheet that defines a single horizontal wiring subsystem's cable and connector requirements. The process is repeated for all of the site's horizontal wiring subsystems.

### 7.6.1 Cable Jackets

Each cable can have either a PVC jacket or a plenum jacket. The type of jacket depends on whether the cable runs through environmental (plenum-jacketed cable) or only nonenvironmental airspace (PVC-jacketed cable).

**NOTE**

> For more information on environmental and nonenvironmental airspace, see Appendix F.

### 7.6.2 Cable Lengths

During the horizontal concept diagram process (Chapter 3), estimated cable length values were defined and recorded on the diagrams. However, the actual length of cable needed for each horizontal wiring cable is determined as follows:

- Determine the length of cable required to go between the distribution connection points (distribution frame, wallbox, computer room or system common equipment) using the selected cable routing method.
- Add 4.5 meters (14.8 feet) of cable slack for each distribution frame, computer room, or system common equipment end of the cable, or 0.6 meters (2 feet) of slack for a wallbox cable end.

Once the actual cable length is determined:

- Record the length on the cable worksheet.
- Verify that the overall HDF-to-wallbox (HDF-to-computer room or HDF-to-system common equipment) cable length, including all cables in the wall and patch cables at the HDF, SDF, or ODF, does not exceed the 90-meter (295-foot) maximum length for a horizontal wiring. If the overall HDF-to-wallbox (HDF-to-computer room, or system common equipment) cable is greater than 90 meters (295 feet), including the patch cables used in the link, the link must be redesigned.
- If the length recorded on the cable worksheet is greater than the length recorded on the horizontal concept diagram, review the Link-Loss Calculation Worksheet (Figure 5–21)that was filled out for the link and ensure that the allowable system loss for the active equipment can support the additional cable length (the difference in length between the worksheet and concept diagram lengths).

### 7.6.3 Cable Worksheet

This section provides instructions for the Horizontal Wiring Cable Worksheet (Figure 7–6). Photocopy and fill in a worksheet for each horizontal wiring subsystem to define that subsystem's cable and connector requirements. Each worksheet compiles and expands on information from the subsystem's horizontal concept diagram.

**NOTE**

Consult with the cable vendor to solve any unique cable requirements not covered in this section.

**Section I Project Identification**

Identify the project, worksheet page number, designer, and date.

**Section II Subsystem Identification**

Identify the subsystem by its IDF and HDF identifiers.

**Section III Environmental Considerations**

Describe any environmental factors that can affect the cables.

**Section IV Cable Descriptions:**

Define the cable and connector requirements as follows:

- Refer to the horizontal concept diagram and list each cable by its identifier, fiber type, fiber count, and fiber size.
- Define the cable jacket (plenum for environmental airspace or PVC for non-environmental airspace).
- Refer to the subsystem's cable routing worksheet and identify the cable routing method the cable uses.
- Use the procedure in Section 7.6.2 to verify and record each cable's length.
- Define the cable connection as either heavy-duty, light-duty, or zip conductor.
- Define the cable's connector requirements by:
  - Quantity: two connectors are needed for each fiber that connects to panels at the distribution frame or to a wallbox, and no connectors are needed for spare wallbox fibers.
  - Type: the connector type is 2.5 mm bayonet ST-type.

**Section V Comments**

Describe any special issues concerning the cables or connectors.

## Figure 7–6: Horizontal Wiring Cable Worksheet

I. Project Identification:

Project ID: ______________ Page ____ of ____

Designer: ____________________________________ Date: ______________

II. Subsystem Identification:

IDF Identifier: ______________ HDF Identifier: ______________

III. Environmental Considerations:

Describe: ________________________________________________

IV. Cable Descriptions:

| Cable Identifier | Fiber Type | Fiber Count | Fiber Size | Cable Jacket | Routing Method | Cable Const. | Length | Connectors | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Quantity | Type |
| | | | | | | | | | |
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V. Comments: ________________________________________________

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## 7.7 Bill of Materials (BOM) Worksheet

This section provides instructions for the Horizontal Wiring BOM Worksheet (Figure 7–7). Photocopy and fill in a BOM worksheet for each horizontal wiring subsystem's wallbox, cable, connector, and cable routing hardware requirements. Each BOM worksheet is compiled from the component requirements defined in the subsystem's wallbox requirements, cable routing, and cable worksheets.

#### Section I Project Identification

Identify the project, worksheet page number, designer, and date.

#### Section II Horizontal Wiring Subsystem Identification

Identify the subsystem by its IDF and HDF identifiers.

#### Section III Component Requirements

List each component by:

- Component description (for example, 2.5 mm bayonet ST-type connector kit)
- Order number (the number is H3114-FA for the 2.5 mm bayonet ST-type connector kits given in the example component description)
- Quantity required (for the example, 2.5 mm bayonet ST-type connector kits, one kit is needed for every six 2.5 mm bayonet ST-type connectors required)
- Unit price
- Total price (quantity multiplied by the unit price)

Then summarize the total cost of the listed components.

## Figure 7–7: Horizontal Wiring BOM Worksheet

I. Project Identification:

Project ID: ______________ Page ____ of ____

Designer: ______________________________ Date: ______________

II. Subsystem Identification:

IDF Identifier: ________ HDF Identifier: ________

III. Component Requirements:

| Item Number | Part Number | Description | Quantity | Unit Price | Total Price |
|---|---|---|---|---|---|
| | | | | | |
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| | | | | | |
| | | | | Total Cost: | |

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# CHAPTER 8

8

# Building Backbone Cabling Design

This chapter contains information for design of indoor building backbone (intra-building) cabling. It includes recommendations, procedures, and worksheets to:

- Select building backbone cable routing methods.
- Define cable and connector requirements.

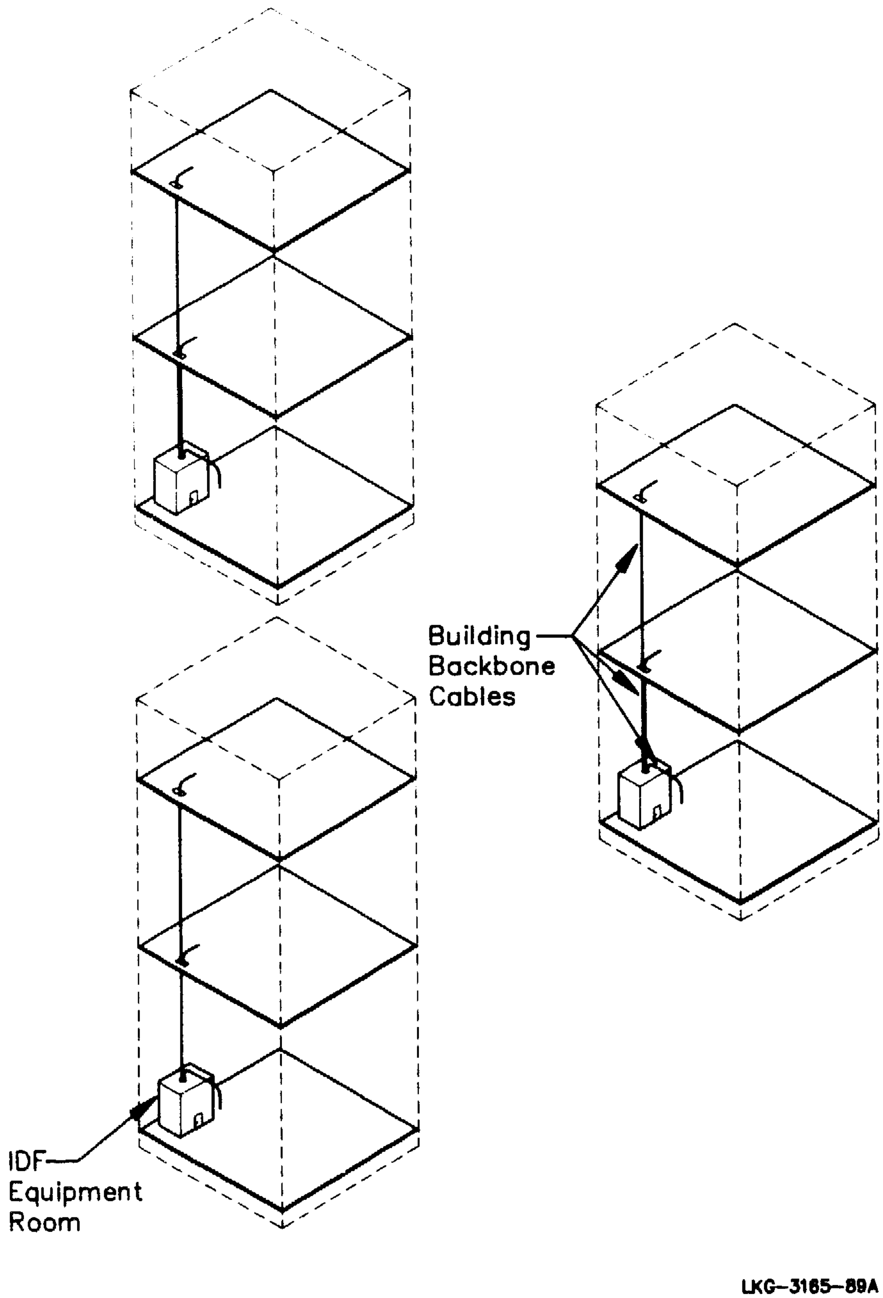
This chapter also provides instructions on how to create a bills of material (BOM) for all of the building backbone's component requirements.

Each building backbone subsystem has the following components:

- An intermediate distribution frame (IDF) - the connection point between the building and campus backbone cables.
- The building backbone cables - the cable between the IDF and the building's horizontal distribution frames (HDFs).
- The support hardware for routing the cables.

Figure 8–1 illustrates the building backbone components.

## Figure 8–1: Building Backbone Distribution Subsystem



## 8.1 Required Documents

The following documents are used during the design process:

- Floor plans - Updated during the design process to show the existing or planned locations of all IDFs and all indoor IDF-to-HDF cable routing methods.
- The identifier worksheets filled in during the labeling procedure in Chapter 4, Section 4.6.
- The Building Backbone Information Worksheet filled in during the site survey *from the DECconnect System Requirements Evaluation Workbook*.
- *BICSI Telecommunications Distribution Methods Manual* - for reference when designing the cable routing.
- *NEC* and local building codes - for reference during the design process.

## 8.2 Defining Component Locations

The exact existing or planned locations of the IDF and HDFs in a building are very important to the design of the building backbone subsystems. Therefore, check to see that each existing or planned IDF is clearly marked on the floor plans for each building. If not, update the floor plans by adding the missing IDF locations.

**NOTE**

> The IDFs are identified on the floor plans by their identifier values. These values were defined during the distribution frame identifier process (Chapter 4) and recorded in the Backbone Identifier Worksheets.

## 8.3 Design Process Overview

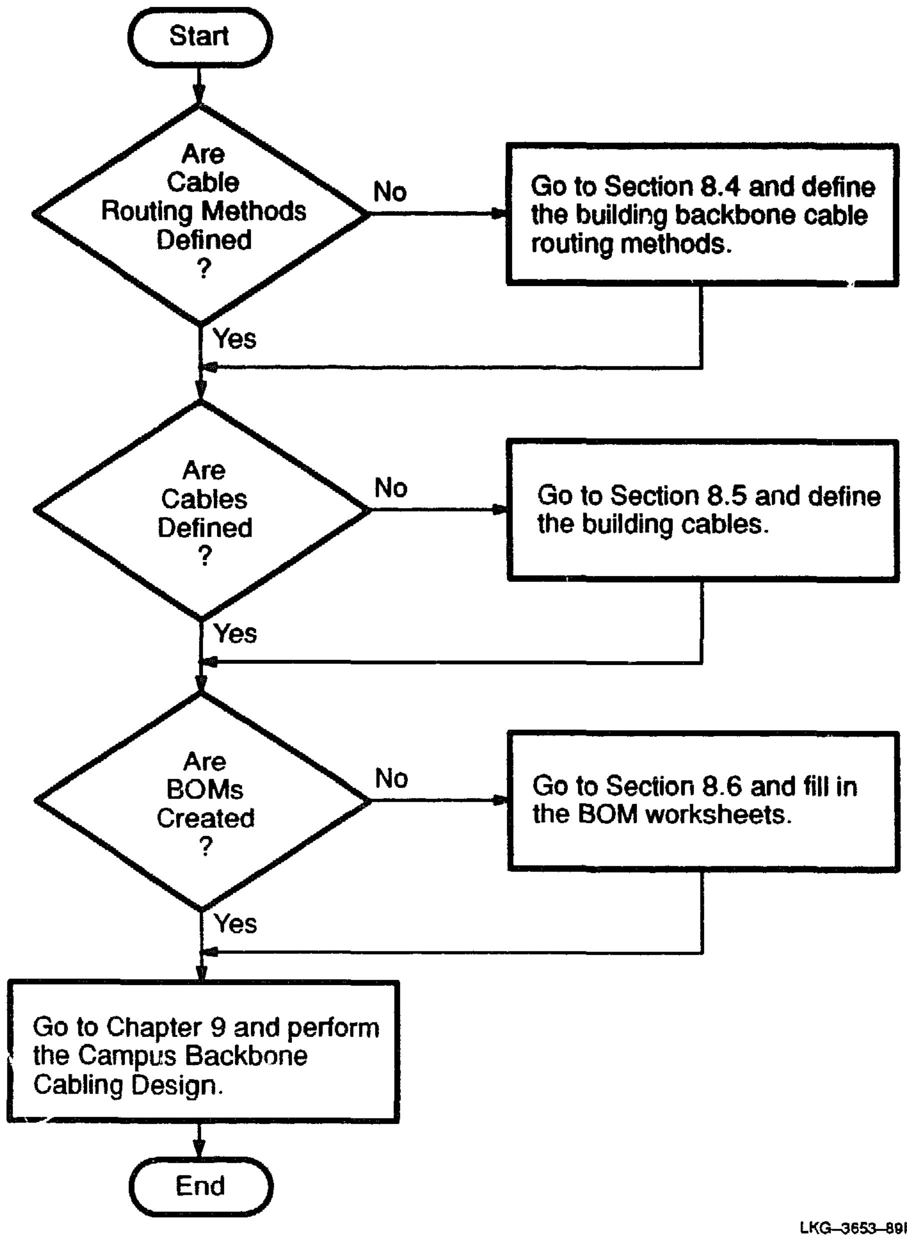
The building backbone design process is done on a subsystem-by-subsystem basis. The result of each subsystem design is a worksheet set that defines the subsystem's cable routing, cable, and connector requirements as follows:

- Building Backbone Cable Routing Worksheet (Figure 8–4) - defines the indoor cable routing methods and any needed hardware.
- Building Backbone Cable Worksheet (Figure 8–5) - defines the indoor cable and connector requirements.
- Building Backbone BOM Worksheet (Figure 8–6) - provides a bill OF material for the components.

In addition, site and floor plans are updated during the design process.

Figure 8–2 provides a flow chart overview of the building backbone design process.

**Figure 8–2: Building Backbone Design Flow Chart**



## 8.4 Defining Building Backbone Cable Routing Methods

During this phase of the design:

- Select the routing method for each indoor backbone cable.
- Fill in a Horizontal Wiring Cable Routing Worksheet (Figure 7–5) for each subsystem to:
  - — Define all indoor routing methods for the cables.
  - — Identify each cable that uses each defined method.
  - — Identify any support components needed for the routing methods.

**NOTE**

> The procedures, gu[illegible], and worksheets in this section, in conjunction with the campus backbone cabling design (Chapter 9), can be used to design indoor building backbone cable routing methods and cable routing of indoor MDF-to-IDF links.

### 8.4.1 Selecting Building Backbone Cable Routing Methods

This section provides descriptions of the:

- Overall process for determining each building backbone cable routing requirements.
- The Digital-recommended building backbone cable routing methods.

**NOTE**

> Cable routing considerations are described in Chapter 2, Section 2.4.1.4. Review those guidelines before designing any cable routing.

#### 8.4.1.1 Building Backbone Cable Routing Methods Selection Process

During this phase of the design:

- Refer to the floor plans and the backbone information worksheets *from the DECconnect System Requirements Evaluation Workbook* or visually inspect the building to see if a routing method exists that the cable segment can use.

- If a routing method exists, verify that there is enough room for running new cable using that method's hardware.

  For example, if existing conduit is selected, make sure there is enough room in the conduit to pull in an inner duct. This inner duct is required for isolating the link's fiber optic cable from other cables in the conduit. If there is room, indicate on the building floor plan that inner duct is needed. If there is no room, design a new conduit run for the link, or select another routing method.

- If no routing method exists, or existing methods cannot be used:

  — Refer to the building's floor plans or visit the site to identify any obstacles that can affect the cable routing.

  **NOTE**

  A visit to the building with the cable installation contractor is recommended. The contractor can point out issues that can affect the selection of the routing methods, issues which are not readily apparent.

  — Review the routing methods descriptions in Section 8.4.1.2.

  — Mark the floor plans to show the method, as well as to identify any hardware that is needed and where it is needed (such as the location of sleeves or cable trays).

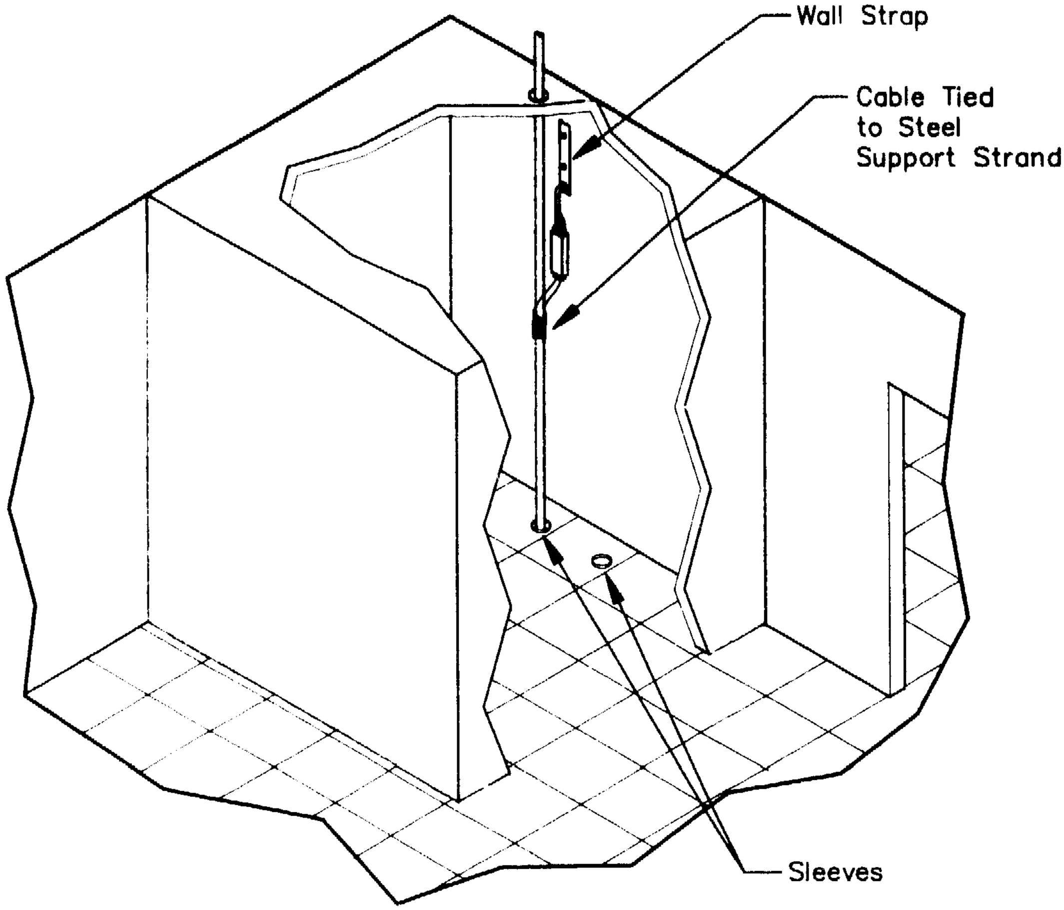
#### 8.4.1.2 Building Backbone Cable Routing Methods

Digital recommends the sleeve cable routing method (Figure 8–3) for vertical backbone cable runs and the above-ceiling cable tray method for horizontal backbone cables. This section provides a brief description of the sleeve method only. The above-ceiling cable tray method is described in Chapter 7, Section 7.5.1.2. Other types of vertical and horizontal building backbone cable routing methods are described in the *BICSI Telecommunications Distribution Methods Manual*, as are the Digital-recommended methods (sleeve and above-ceiling cable trays).

##### Sleeve

Used in vertically aligned riser shaft systems, sleeves are short lengths of conduit, usually made of rigid metal pipe. The sleeves are placed in the concrete floor as the concrete is being poured, and project up to 10.16 centimeters (4 inches) above the floor. This above-the-floor projection allows protection against water spilling into the riser shaft openings.

## Figure 8–3: Building Backbone Cable Routing




Sleeve systems, which are easy to firestop, usually include a steel support strand that runs through the vertically aligned riser shaft and sleeves. The support strand is bolted to a wall on each floor with a metal strap. The fiber optic cables are tied to the support strand using cable ties.

### 8.4.2 Cable Routing Worksheet

This section provides instructions for the Building Backbone Cable Routing Worksheet (Figure 8–4). Photocopy and fill in a worksheet to define a subsystem's routing methods and hardware requirements.

**NOTE**

Consult with the cable routing hardware vendor or contractor to solve any unique requirements not covered in this chapter.

#### Section I Project Identification

Identify the project, worksheet page number, designer, and date.

#### Section II Subsystem Identification

Identify the subsystem by its distribution frame identifier.

#### Section III Cable Routing Methods Descriptions

Describe each type of routing method to be used, its status (existing or planned), and the identifiers for the cables that use the method.

**NOTE**

If only one method is used, list that method and its status, while the cable identifier entry should state "All."

#### Section IV Component Requirements

Describe any hardware needed for the routing methods (such as racks, conduits, or inner duct), and the quantity of each listed item.

#### Section V Comments

Describe any special issues concerning any of the cable routing methods.

## Figure 8–4: Building Backbone Cable Routing Worksheet

I. Project Identification:

Project ID: ______________ Page ____ of ____

Designer: ________________________________ Date: ______________

II. Subsystem Description:

Distribution Frame Identifier: ________________

III. Cable Routing Method Descriptions:

| Routing Method | Status | Cable Identifiers |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

IV. Component Requirements:

| Item | Quantity |
|---|---|
| | |
| | |
| | |
| | |
| | |

V. Comments: ____________________________________________

____________________________________________________________

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## 8.5 Defining Cables

The backbone concept diagram identifies some of the cable requirements for each building backbone link:

- Fiber type ( multimode or single-mode)
- Fiber count
- Fiber size
- Estimated cable lengths

The cable definition process consists of the following actions:

- Define each cable's jacket type (PVC or plenum).
- Define the cable's construction (riser or nonriser).
- Verify the exact cable lengths.
- Define the connector requirements for each cable.

The result of the process is a Building Backbone Cable Worksheet that defines a single subsystem's cable and connector requirements, with the process repeated for each one of the site's subsystems that have building backbone cable requirements.

### 8.5.1 Cable Jackets

Each cable can have either a PVC jacket or a plenum jacket. The type of jacket depends on whether the cable runs through environmental (plenum-jacketed cable) or only nonenvironmental airspace (PVC-jacketed cable).

**NOTE**

Information on environmental and nonenvironmental airspace is given in Appendix F.

### 8.5.2 Cable Construction

Digital supports using only heavy-duty tight-buffered cable in vertical building backbone cable runs. For horizontal building backbone cables, Digital recommends using heavy-duty cable, and supports the use of light-duty cable in short horizontal runs.

### 8.5.3 Cable Lengths

During the backbone concept diagram process (Chapter 3), estimated cable length values were defined and recorded on the diagrams. Each of the IDF-to-HDF cable lengths must be reverified as actually being under the 500-meter (1640-foot) maximum length, including the cable slack of 9.0 meters (29.5 feet). The overall campus and building backbone cable (MDF-to-IDF-to-HDF) must be verified as being under the 2000-meter (6560-foot) maximum, including all cable slack.

The cable length verification is done when filling in the cable worksheets (Section 8.5.4) by actually going to the site, or by using the to-scale floor plans and figuring out how much cable is needed for each link, as follows:

- Determine how much cable is required to go from the IDF to the HDF using the selected cable routing method.
- For cable slack and connector termination requirements, add 9.0 meters (29.5 feet) to the cable length (4.5 meters (14.8 feet) for each end of the cable).
- Record the length on the cable worksheet.
- Check the length against the backbone concept diagram length. If the length is greater than that listed in the concept diagram, make sure the:
  - IDF-to HDF cable is 500 meters (1640 feet) or less
  - Total campus and building backbone cable (MDF-to-IDF-to-HDF) is 2000 meters (6560 feet) or less
  - Allowable system loss for the active networking equipment can support the corrected cable length for the IDF-to-HDF link

If the added length results in an IDF-to-HDF cable that is greater than 500 meters (1640 feet), or an MDF-to-IDF-to-HDF cable that is greater than 2000 meters (6560 feet), the link must be redesigned. This requires modifying the backbone concept diagram (Chapter 3) and redoing the building network schematic (Chapter 5).

### 8.5.4 Cable Worksheet

This section provides instructions for the Building Backbone Cable Worksheet (Figure 8–5). Photocopy and fill in a worksheet to define a subsystem's building backbone cable and connector requirements. Each worksheet compiles and expands on the information from the backbone concept diagram.

**NOTE**

> Consult with the cable vendor to solve any unique cable requirements not covered in this section.

#### Section I Project Identification

Identify the project, worksheet page number, designer, and date.

#### Section II Subsystem Identification

Identify the subsystem by distribution frame identifier.

#### Section III Environmental Considerations

Describe any environmental factors that can affect the cables.

#### Section IV Cable Descriptions

Define the cable and connector requirements as follows:

- Refer to the backbone concept diagram and list each cable by its identifier, fiber type, fiber count, and fiber size.
- Define the cable jacket (plenum for environmental airspace or PVC for non-environmental airspace).
- Use the procedure in Section 8.5.3 to verify and record each cable's length.
- Refer to the subsystem's cable routing worksheet and identify the cable routing method that the cable uses.

- Define the cable construction (riser or nonriser).
- Define the cable's connector requirements by:
  - Quantity: two connectors are needed for each fiber, one connector for each end.
  - Type: the connector type is 2.5 mm bayonet ST-type.

#### Section V Comments

Describe any special issues concerning the cables or connectors.

## Figure 8–5: Building Backbone Cable Worksheet

I. Project Identification:

Project ID: ____________ Page ____ of ____

Designer: ______________________________ Date: ____________

II. Building Backbone Subsystem Description:

Distribution Frame Identifier: ______________

III. Environmental Considerations:

Describe: ____________________________________________________________

IV. Cable Descriptions:

| Cable Identifier | Cable Type | Fiber Count | Fiber Size | Cable Jacket | Routing Method | Cable Const. | Length | Connectors | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Quantity | Type |
| | | | | | | | | | |
| | | | | | | | | | |
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| | | | | | | | | | |

V. Comments: ____________________________________________________________

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## 8.6 Bill of Materials (BOM) Worksheet

This section provides instructions for the Building Backbone BOM Worksheet (Figure 8–6). Photocopy and fill in a worksheet for each building backbone subsystem's cable, connector, and cable routing hardware requirements. Each BOM worksheet is compiled from the component requirements defined in the subsystem's building backbone cable routing and cable worksheets.

### Section I Project Identification

Identify the project, worksheet page number, designer, and date.

### Section II Subsystem Identification

Identify the subsystem by its IDF identifier.

### Section III Component Requirements

List each component by:

- Component description (for example, 12-fiber heavy-duty plenum building cable)
- Order number (for the 12-fiber heavy-duty building cable given as an example, the number is 17-02535-01 when ordered from Digital
- Quantity required (total the lengths of all the example cable to order the cable in bulk form)
- Unit price
- Total price (quantity multiplied by the unit price)

Then summarize the total cost of the listed components.

**Figure 8–6: Building Backbone BOM Worksheet**

I. Project Identification:

Project ID: ______________ Page ____ of ____

Designer: ______________________________ Date: ______________

II. Subsystem Identification:

IDF Identifier: ____________

III. Component Requirements:

| Item Number | Part Number | Description | Quantity | Unit Price | Total Price |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
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| | | | | | |
| | | | | | |

Total Cost: ______

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# CHAPTER 9

# 9

# Campus Backbone Cabling Design

This chapter provides information on designing campus backbone cabling (interbuilding). It includes recommendations, procedures, and worksheets needed to:

- Select campus backbone cable routing methods.
- Define cable entrance point, splice closure, cable, and connector requirements.

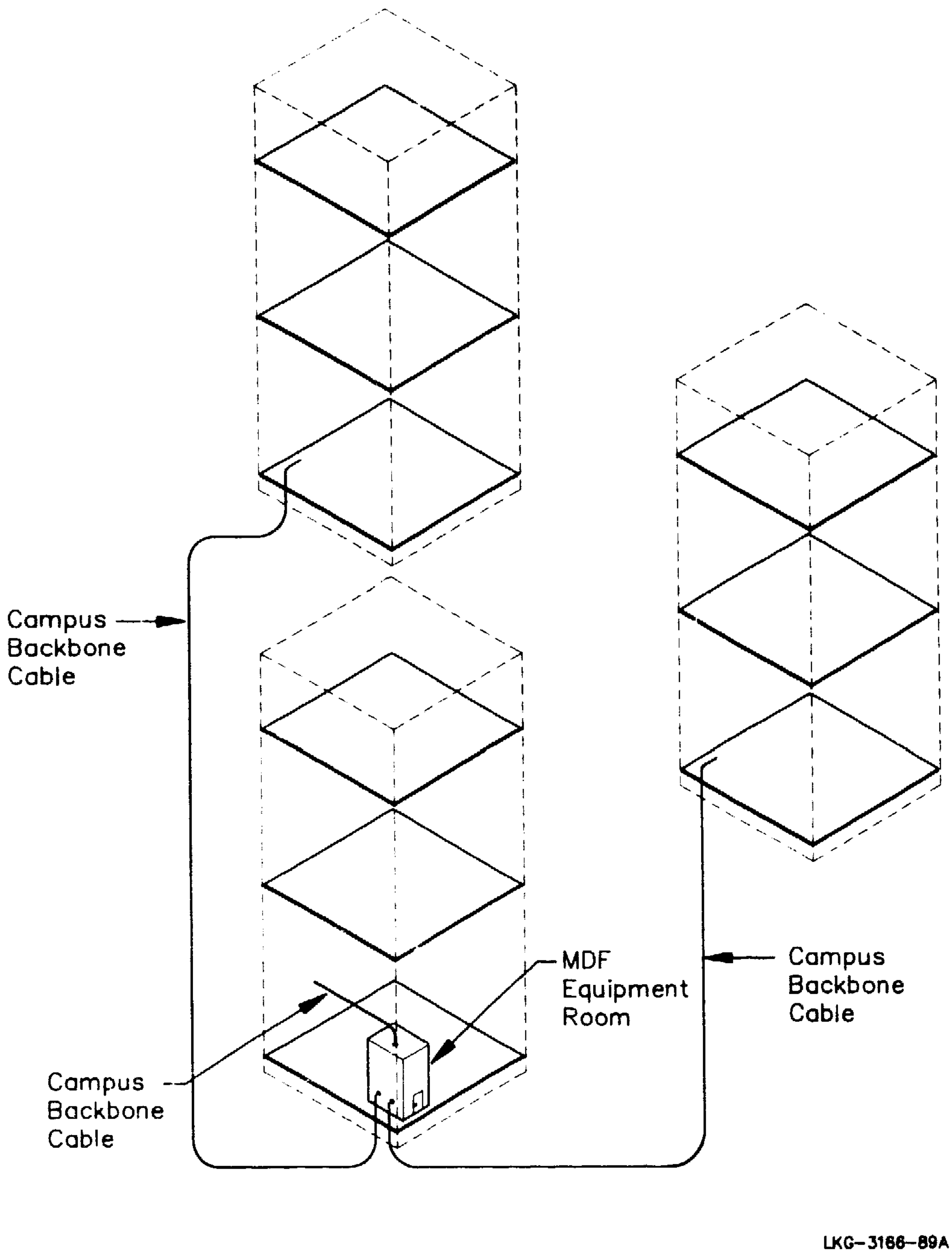
Also, the chapter contains instructions on how to use the building backbone cable and cable routing information in Chapter 8 to design cable between an MDF and IDF inside the same building, and how to create a bill of materials (BOM) for each campus subsystem's component requirements.

Each campus backbone subsystem has the following components:

- A main distribution frame (MDF) - the connection point between the campus backbone cables.
- The campus backbone cables - the cables between the MDF and the building's intermediate distribution frames (IDFs).
- The support hardware for routing the cables.

Figure 9–1 illustrates the campus backbone components.

**Figure 9–1: Campus Backbone Distribution Subsystem**



## 9.1 Required Documents

The following documents are used during the design process:

- Floor plans - Updated during the design process to show the existing or planned locations of all MDFs, cable entrance points, and indoor cable routing methods.
- Site plans - Updated during the design process to show the existing or planned locations of cable entrance points and outdoor cable routing methods.
- The identifier worksheets filled in during the labeling procedure given in Chapter 4, Section 4.6.
- The Campus Backbone Information Worksheets filled in during the site survey *from the DECconnect System Requirements Evaluation Workbook*.
- *BICSI Telecommunications Distribution Methods Manual* - for reference when designing the cable routing.
- *NEC* and local building codes - for reference during the design process.

## 9.2 Defining Component Locations

The exact existing or planned locations of the MDFs, IDFs, and cable entrance points are very important to the design of the campus backbone subsystems. Therefore, on the floor plans for each building, check to see that each existing or planned MDF is clearly marked. If not, update the floor plans by adding the missing MDF locations.

**NOTE**

> The floor plans, which were updated for IDF location in Chapter 8, are updated for cable entrance points in Section 9.5. The MDF is identified in the floor plans by its identifier value. This value was defined during the distribution frame identifier process (Chapter 4) and recorded in the Backbone Identifier Worksheets.

## 9.3 Design Process Overview

The campus backbone design process is done on a subsystem-by-subsystem basis. The result of each subsystem design is a completed worksheet set that defines the subsystem's routing, cable, and connector requirements as follows:

- Cable Entrance Point Worksheet (Figure 9–3) - defines the cable entrance point hardware needed, including the routing hardware needed to route cables from the entrance point to MDFs and IDFs and any hardware needed for grounding armored cable at the entrance point.
- Campus Backbone Cable Routing Worksheet (Figure 9–5) - defines the outdoor cable routing methods and any hardware needed for the methods.
- Campus Backbone Cable Worksheet (Figure 9–7) - defines the outdoor cable and connector needs.
- Campus Backbone BOM Worksheet (Figure 9–8) - provides a bill of materials for all of the indoor, outdoor, and cable entrance components.
- Building Backbone Cable Routing Worksheet - defines the cable routing methods and any hardware needed for indoor MDF-to-IDF cables.
- Building Backbone Cable Worksheet - defines the cable and connector needs for any indoor MDF-to-IDF cables.

**NOTE**

> The building backbone routing and cable worksheets are filled in using cabling design procedures described in Chapter 8. The building backbone procedures are needed only when designing a campus backbone subsystem that includes connections between an MDF and IDF that are in different equipment rooms within the same building.

In addition, site and building floor plans are updated during the design process to reflect the design.

Figure 9–2 provides a flow chart overview of the campus backbone design process.

**Figure 9–2: Campus Backbone Design Flow Chart**

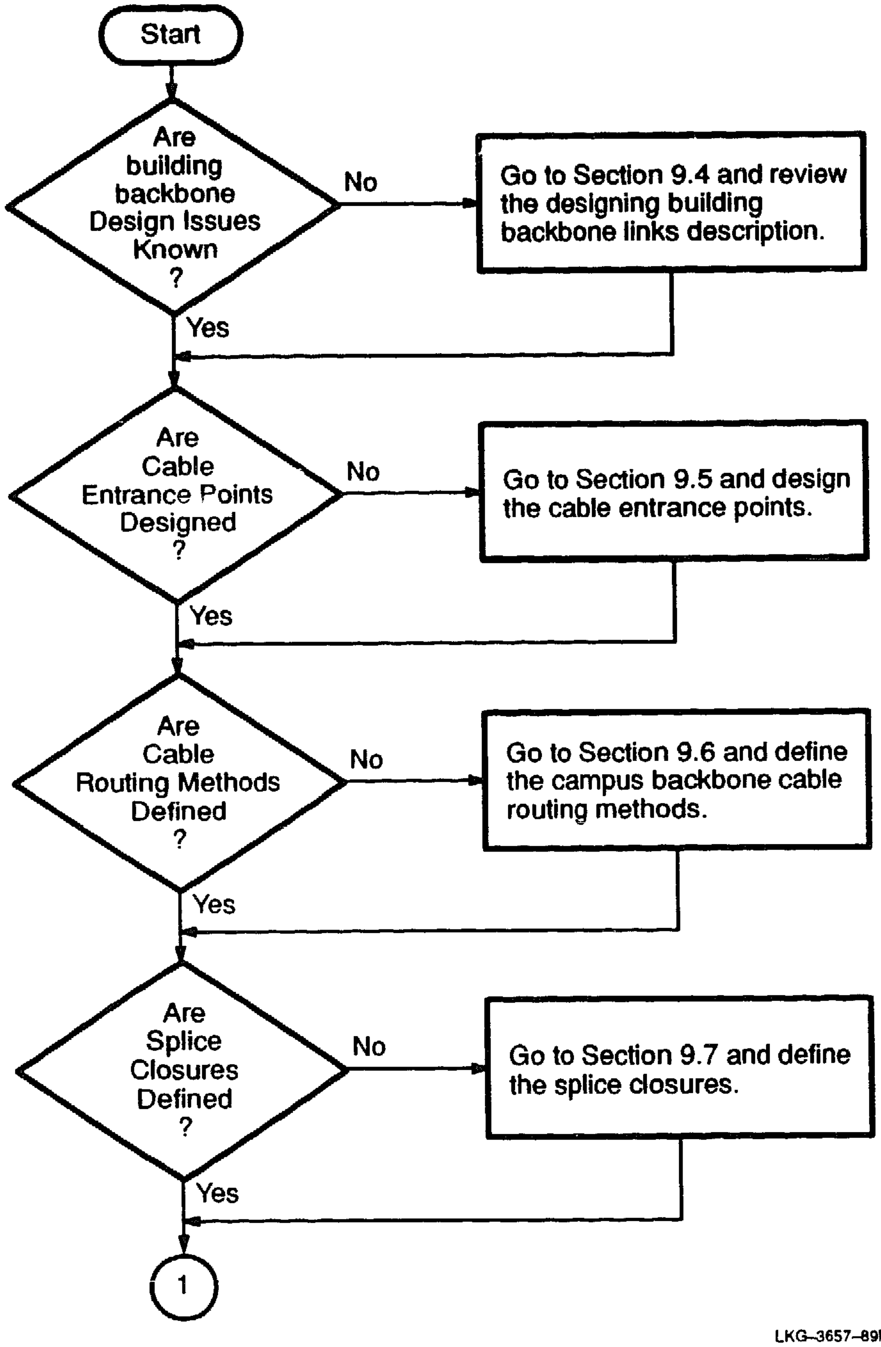
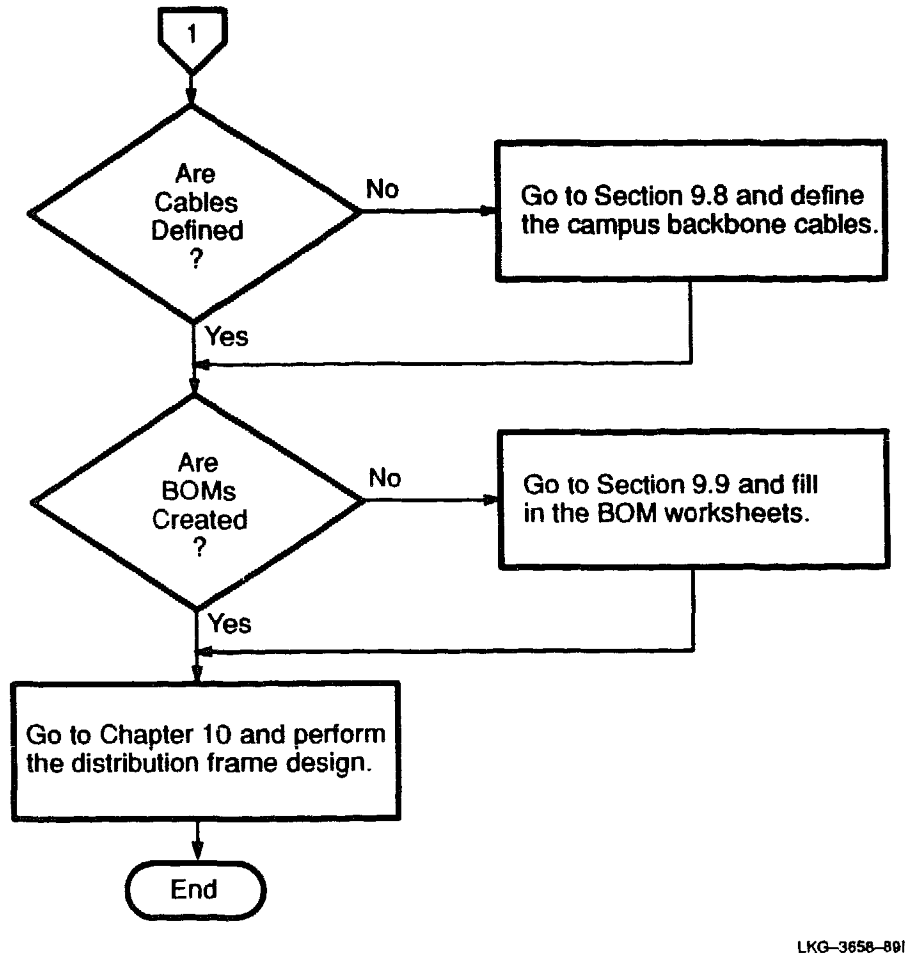



Figure 9–2 Cont'd on next page

## Figure 9–2(Cont.): Campus Backbone Design Flow Chart



## 9.4 Designing Building Backbone Links

For most campus backbone subsystems, all of the MDF-to-IDF cables are outdoor (interbuilding) cabling. The MDF and the IDF that are in the same building will usually be located in the same equipment room where they can connect through patch cables. However, in some cases, such as when upgrading a building that has existing separate IDF and MDF equipment rooms, the MDF-to-IDF cable is designed using building backbone cable routing and cable procedures.

When designing a campus backbone subsystem that has an indoor MDF-to-IDF cable, the procedures provided in Chapter 8 for building backbone cables are used, as follows:

- The building backbone cable routing section (Section 8.4) — for filling in a Building Backbone Cable Routing Worksheet that defines the indoor cable routing methods and hardware needed for the methods.
- The building backbone cable section (Section 8.5) - for filling in a Building Backbone Cable Worksheet that defines the indoor cable and connector requirements.

## 9.5 Designing Cable Entrance Points

The cable entrance point is an area that provides space for the cables coming into a building. Ideally, it is located at an MDF or IDF equipment room. When the cable entrance point is not part of an equipment room, it is usually located in an enclosed basement room or wall space.

**NOTE**

If fiber optic cable containing any metallic elements is used in the campus backbone cable, the *National Electrical Code (NEC)* requires that the armored portion of the cable be grounded at the building entrance point. This grounding helps protect the building against electrical surges. After the outdoor cables are designed using the procedures in Section 9.8, indicate on the site plans any cable entrance points that require grounding of metallic cable elements.

For more information on grounding requirements, and on cable entrance points, see the *BICSI Telecommunications Distribution Methods Manual*.

### 9.5.1 Cable Entrance Point Design Process

Information on cable entrance design is recorded on a worksheet (Figure 9–3), one for each building's cable entrance point. Each worksheet defines:

- Any hardware needed for the cable entrance point, including hardware needed to ground metallic cable elements.
- Any hardware needed for routing the cable from the entrance point to the distribution frame where the cable terminates.

### 9.5.2 Modifying Floor Plans for Cable Entrance Point Design

Ideally, the cable entrance point is inside the building's MDF or IDF equipment room. In this case, the cable routing methods are designed during the distribution frame design process described in Chapter 10. When the entrance point is not in the equipment room where the MDF or IDF is located, mark each building's floor plans to show:

- Hardware needed at the cable entrance point (such as conduit, inner duct, or grounding hardware).
- The routing method the cable uses to go from the entrance point to the equipment room, and any hardware needed and where it is needed.

#### 9.5.2.1 Cable Entrance Point Requirements

Each cable entrance point is essentially a hole in the building through which the campus backbone cable enters from the outside. The minimum requirements for any entrance point are:

- Existing conduit - protective encasement that provides the cable entrance point structure
- Inner duct - to isolate the campus backbone cable from any cables that are in the conduit (or will be in the conduit)
- Grounding hardware - for grounding metallic cable elements

In some cases, the cable entrance point needs to be constructed, either because none currently exists, or an existing cable entrance cannot be used. These cases require defining the entrance point construction and ordering the construction material, including the conduit and inner duct.

**NOTE**

Consult with the cable installation contractor to determine the exact materials needed for grounding requirements or for constructing a new cable entrance point.

#### 9.5.2.2 Entrance Point Cable Routing Methods

Digital does not support the use of transition components (splice or interconnect hardware) at cable entrance points. These components, which are used to connect indoor-type cable from the distribution frame to the outdoor-type campus backbone cable at the entrance point, are costly in terms of component costs, splice costs, and optical budget costs.

Digital recommends the distribution frame be located at the entrance point. When this is not possible, route all campus backbone cables as follows:

- When the distribution frame is more than 15 meters (50 feet) from the cable entrance. In accordance with *NEC* requirements, any outdoor-type (loose-tube or slotted-core) cable without markings (see Section F.2, Appendix F) must be routed to the distribution frame in a metal enclosure. Digital recommends using metal conduit with inner duct.
- In accordance with *NEC* requirements, when the distribution frame is less than 15 meters (50 feet) from the cable entrance, no special cable routing method is required.

### 9.5.3 Cable Entrance Point Worksheet

This section provides instructions for filling in the Cable Entrance Point Worksheet (Figure 9–3). Photocopy and fill in a worksheet to define each building's cable entrance and related cable routing hardware requirements.

#### Section I Project Identification

Identify the project, worksheet page number, designer, and date.

#### Section II Cable Entrance Point Location

Identify the cable entrance point building number. Use the actual building number and not an IDF or MDF identifier.

#### Section II Cable Entrance Point Component Requirements

List all of the hardware and other material needed for the cable entrance point, as well as material needed to ground metallic cable elements.

**NOTE**

> Grounding material requirements usually are added to the worksheet after the campus backbone cables are defined in Section 9.8. These requirements are identified after the cables that use the cable entrance point are defined.

#### Section IV Cable Routing Component Requirements

List all of the hardware needed to route the cables from the entrance point to the distribution frames where the cables terminate.

#### Section V Comments

Define any special issues affecting the entrance point of the cable routing methods associated with it.

## Figure 9–3: Cable Entrance Point Worksheet

I. Project Identification:

Project ID: ______________ Page ____ of ____

Designer: ________________________________ Date: ______________

II. Cable Entrance Point Location:

Building Number: ______________

III. Cable Entrance Point Component Requirements:

| Item | Quantity |
|---|---|
| | |
| | |
| | |
| | |
| | |

IV. Cable Routing Component Requirements:

| Item | Quantity |
|---|---|
| | |
| | |
| | |
| | |
| | |

V. Comments: ________________________________

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## 9.6 Defining Campus Backbone Cable Routing Methods

During this phase of the design:

- Select the routing method to be used for each outdoor cable segment.

**NOTE**

Although Digital recommends that each campus backbone cable use only buried conduit as the routing method, some cables may require two or more routing methods. A description of multiple-segment links is in this section.

- Fill in a Campus Backbone Cable Routing Worksheet (Figure 9–5) for each subsystem to:
  - — Define all outdoor routing methods for the cables.
  - — Identify each cable that uses each defined method.
  - — Identify any support components needed for the routing methods.

### 9.6.1 Selecting Cable Routing Methods

This section provides descriptions of the:

- Overall process for determining each campus backbone cable's routing requirements.
- The Digital-recommended campus backbone cable routing method.

**NOTE**

Cable routing considerations are described in Chapter 2, Section 2.4.1.4. Review those guidelines before designing any cable routing.

### 9.6.1.1 Cable Routing Methods Selection Process

During this phase of the design:

- Refer to the site plans and to the *DECconnect System Requirements Evaluation Workbook* backbone information worksheets.
- If a routing method exists, verify that there is enough room to run new cable using that method's hardware.

  For example, if existing conduit is selected, make sure that there is enough room in the conduit to pull in an inner duct. This inner duct is required for isolating the link's fiber optic cable from other cables in the conduit. If there is room, indicate on the site plan that inner duct is needed. If there is no room, design a new conduit run for the link, or select another routing method.

- If no routing method exists, or existing methods cannot be used:
  - Refer to the site plans or visit the site to identify any obstacles that can affect the cable routing.

    **NOTE**

    Visiting the site with the cable installation contractor is recommended. The contractor can point out issues that affect the selection of the routing methods.

  - Review the routing methods descriptions in Section 9.6.1.3.
  - Mark the site plans to show the method, as well as to identify any hardware needed and where it is needed (such as the location of conduit).

#### 9.6.1.2 Multiple-Segment Links

Some campus backbone links can be designed using two or more routing methods. For example, using existing aerial poles to bridge a stream and then using conduit to go from the poles to the buildings.

When designing multiple-segment links, treat each of the routing methods in the link as if it were a completely separate cable link as follows:

- Different types of cable are required for different types of campus backbone cable routing methods, as the cable stress and environmental factors that affect the cables are different for each method.
- Assign the same basic cable identifier to each type of cable in the link, but use a letter after each segment cable's identifier code to differentiate that cable from the other segment cables.

**NOTE**

The procedure for assigning an identifier to cables is provided in Chapter 4, Section 4.6.2.2.

- Determine where the different cable construction types will be spliced together (cable-segment junctions) and fill in a Splice Description Worksheets (Figure 4–21) for each of the splice closures to be used at the cable-segment junctions.

**NOTE**

Procedures for defining the splice closures needed when using multiple-segment links are provided in Section 9.7. Procedures for filling in the Splice Description Worksheet (Figure 4–21) that the closures need are provided in Chapter 4, Section 4.6.3.

#### 9.6.1.3 Cable Routing Methods

Digital recommends using buried conduit as the campus backbone cable routing method. This section provides a brief description of the buried conduit method.

Refer to the *BICSI Telecommunications Distribution Methods Manual* for additional details on direct buried conduit and for other types of campus backbone cable routing methods.

##### Buried Conduit Method

The buried conduit method is an underground system of conduit and utility covers that interconnects the site's buildings.

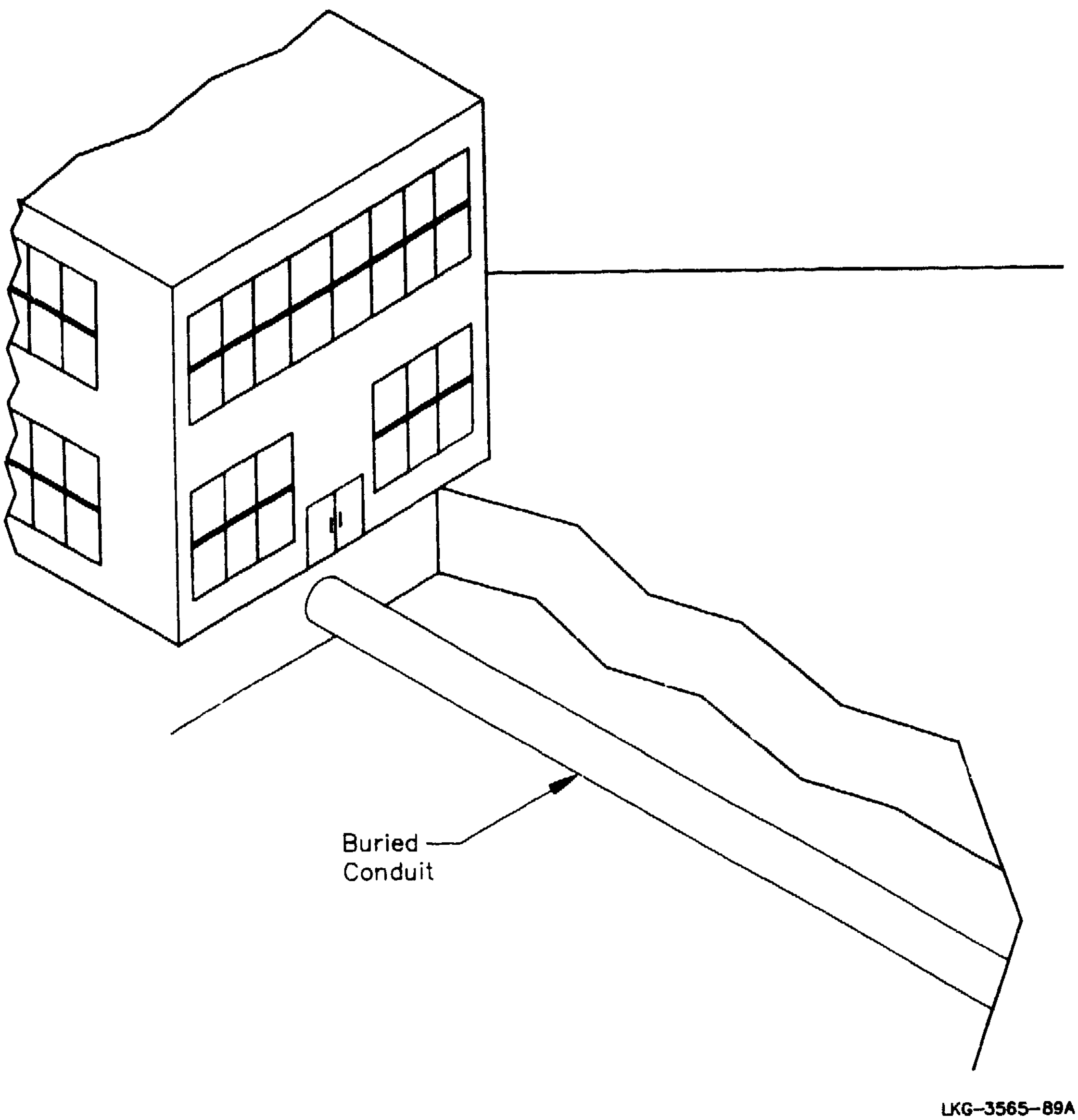
The conduit is made of corrosion-resistant material and provides a routing method that gives maximum mechanical protection to the campus backbone cables. In addition, the fact that the conduit is buried helps preserve the site's appearance.

When using the buried conduit method, it is important to remember that:

- The conduit's location, as well as the location of any utility hole covers, must be planned well in advance of the construction start date to avoid unnecessary disruption of the completed installation.
- The local codes provide strict guidelines that govern the placement of the buried conduit.

Figure 9–4 illustrates the buried conduit routing method.

**Figure 9–4: Buried Conduit Routing Method**



### 9.6.2 Cable Routing Worksheet

This section provides instructions for the Campus Backbone Cable Routing Worksheet (Figure 9–5). Photocopy and fill in the worksheet to define a subsystem's routing methods and hardware requirements.

**NOTE**

> Consult with the cable routing hardware vendor or contractor to solve any unique requirements not covered in this chapter.

#### Section I Project Identification

Identify the project, worksheet page number, designer, and date.

#### Section II Subsystem Identification

Identify the subsystem by its distribution frame identifier.

#### Section III Cable Routing Methods Descriptions

Describe each type of routing method to be used, its status (existing or planned), and the identifiers for the cables that use the method.

**NOTE**

> If only one method is used, list that method and its status, while the cable identifier entry should state "All."

#### Section IV Component Requirements

Describe any hardware needed for the routing methods (such as utility hole covers, conduit, or inner duct), and the quantity of each listed item.

#### Section V Comments

Describe any special issues concerning any of the cable routing methods.

## Figure 9–5: Campus Backbone Cable Routing Worksheet

I. Project Identification:

Project ID: ______________ Page ____ of ____

Designer: ________________________________ Date: ______________

II. Subsystem Description:

Distribution Frame Identifier: __________________

III. Cable Routing Method Descriptions:

| Routing Method | Status | Cable Identifiers |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

IV. Component Requirements:

| Item | Quantity |
|---|---|
| | |
| | |
| | |
| | |
| | |

V. Comments:

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## 9.7 Defining Splice Closures

Digital recommends that the campus backbone cables be complete, nonspliced cables from end-to-end whenever possible. However, outdoor splicing, and, therefore, splice closures, may be needed, as follows:

- To splice cables used in long distance intersite links that are greater than 2000 meters (6560 feet).
- At the transition between different types of cable used in a multiple-segment link. For example, aerial cable splicing to direct-buried caole.
- At the breakout point of a breakout link.

### 9.7.1 Splice Closure Design Process

During this phase of the design:

- Make sure that for each of the outdoor splice closures:
  - — The splice closure has an identifier.
  - — The site plans show the location of each splice closure and that closure's identifier.
  - — A Splice Definition Worksheet exists for the closure.

**NOTE**

Procedures for assigning splice closure identifiers and filling in the Splice Definition Worksheet are provided in Chapter 4, Section 4.6.3.

- Fill in a Splice Closure Worksheet (Figure 9–6) for the subsystem to:
  - — Identify each splice closure by its identifier.
  - — Define the environmental and cable routing factors that can affect each closure.
  - — Define the type of cover each closure needs.

### 9.7.2 Splice Closure Hardware

The splice closure must meet the following functional requirements:

- Can splice up to four cables, two cables at each end of the closure.
- Accommodates up to 144 individual, fiber-to-fiber mechanical splices, or 192 individual, fiber-to-fiber fusion splices.

**NOTE**

Digital offers a fiber transition closure kit (22-00493-01) for outdoor splice closure functions. However, different covers are required for the closure, depending on what environmental factors the cover must protect against. These covers are not available directly from Digital.

Chapter 11 provides a description of the fiber transition closure kit that is available. Chapter 11 also provides a list of auxiliary items available from other sources, and their part numbers. The closure covers are listed in Chapter 11.

### 9.7.3 Splice Closure Worksheet

This section provides instructions for filling in the Splice Closure Worksheet (Figure 9–6). Photocopy and fill in the worksheet.

#### Section I Project Identification

Identify the project, worksheet page number, designer, and date.

#### Section II Cable Identifier

List the MDF to IDF cable identifier.

#### Section III Environmental Considerations

List by number all of the environmental considerations that can affect the splice closures defined in the worksheet.

#### Section IV Splice Closure Descriptions

List each splice closure by its identifier and:

- Use the numbers assigned to the environmental factors listed in Section III to identify the factors that can affect the closure.

- Define the type of cover the closure needs based on the environmental factors (for example, watertight).

### Section V Comments

Describe any special issues concerning the splice closures, including any additional hardware needed by a splice enclosure.

**NOTE**

> Additional splice closure hardware is listed in the auxiliary list in Chapter 11.

**Figure 9–6: Splice Closure Worksheet**

I Project Identification:

Project ID: ______________ Page ____ of ____

Designer: ________________________________ Date: ______________

II. Cable Identifier:

MDF to IDF Cable Identifier: ______________

III. Environmental Considerations:

1. ______________________ 6. ______________________
2. ______________________ 7. ______________________
3. ______________________ 8. ______________________
4. ______________________ 9. ______________________
5. ______________________ 10. ______________________

IV. Splice Closure Descriptions:

| Closure Identifier | Environmental Factors | Cover Type | Closure Identifier | Environmental Factors | Cover Type |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

V. Comments: ______________________________________________

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## 9.8 Defining Cables

The backbone concept diagram identifies some of the cable requirements for each campus backbone link:

- Fiber ( multimode, single-mode, or mixed types)
- Fiber count
- Fiber size
- Estimated cable lengths

The cable definition process consists of the following actions:

- Define the cable's construction (loose-tube, slotted-core, or tight-buffered).
- Verify the exact cable lengths.
- Define the connector requirements for each cable.

The result of the process is a completed Campus Backbone Cable Worksheet (Figure 9–7) that defines all of the cable and connector requirements for all campus backbone cables.

### 9.8.1 Cable Construction

Outdoor cables come in two basic types of construction:

- Loose-tube
- Slotted-core

For a description of both types of outdoor cable construction, see the outdoor cable descriptions in Chapter 2.

Digital does not recommend the use of indoor cables (tight-buffered) in campus backbone links except in very limited situations where the cable will never be exposed to outdoor cable stress or environmental factors. For example, tight-buffered cable can be used in an campus backbone link when the cable is run through a pedestrian tunnel that joins the buildings.

**NOTE**

When using indoor (tight-buffered) cable, the cable jacket type must also be included in the cable construction entry in the Campus Backbone Cable Worksheet described in Section 9.8.3. The entry for cable that passes through environmental airspace could read indoor-plenum or buffered-plenum, while nonenvironmental airspace cable could be listed as indoor-PVC or buffered-PVC.

### 9.8.2 Cable Lengths

During the backbone concept diagram process (Chapter 3), estimated cable length values were defined and recorded on the diagrams. Each of the overall MDF-to-IDF-to-HDF cable lengths must be verified as actually being under the 2000-meter (6560-foot) maximum for the campus and building backbone cable.

Verify the cable length when filling in the Campus Backbone Cable Worksheets (Figure 9–7) at the actual site, or by using the to-scale floor plans. Compute how much cable is needed for each link as follows:

- Determine how much cable is required to go from the MDF to the IDF using the selected cable routing method.
- For cable slack and connector termination requirements, add 9.0 meters (29.5 feet) to the cable length, 4.5 meters (14.8 feet) for each end of the cable.
- Record the length on the cable worksheet.
- Check the length against the backbone concept diagram length and, if the length is greater than that listed in the concept diagram, make sure the total campus and building backbone cable (MDF-to-IDF-to-HDF) is 2000 meters (6560 feet) or less, and that the allowable system loss for the active networking equipment can support the longer MDF-to-IDF cable.

If the added length results in an overall MDF-to-IDF-to-HDF cable that is greater than 2000 meters (6560 feet), the link must be redesigned. This requires modifying the backbone concept diagram (Chapter 3) and redoing the campus network schematic (Chapter 5).

### 9.8.3 Campus Backbone Cable Worksheet

This section provides instructions for the Campus Backbone Cable Worksheet (Figure 9–7). Photocopy and fill in a worksheet to define the campus backbone cable and connector requirements. Each worksheet compiles and expands on the information from the backbone concept diagram.

**NOTE**

> Consult with the cable vendor to solve any unique cable requirements not covered in this section.

#### Section I Project Identification

Identify the project, worksheet page number, designer, and date.

#### Section II Subsystem Identification

Identify the subsystem by its distribution frame identifier.

#### Section III Environmental Considerations

List by number all of the environmental factors that can affect any of the subsystem's campus backbone cables (such as exposure to temperature extremes, water, acid soil, or ice and snow loads).

#### Section IV Cable Descriptions

Define the cable and connector requirements as follows:

- Refer to the backbone concept diagram and list each cable by its identifier, fiber type, fiber count, and fiber size.
- Use the procedure in Section 9.8.2 to verify and record each cable's length.
- Refer to the Cable Routing Worksheet (Figure 9–5) and identify the cable routing method the cable uses.
- Define the cable construction (for example, loose-tube, slotted-core, indoor-PVC, or indoor-plenum).
- Define the cable's connector needs by:
  - Quantity: two connectors for each fiber when the fiber terminates at both ends at a distribution frame, one connector for each fiber in a cable that is spliced at one end, and no connectors for a cable that is spliced at both ends.

— Type: the connector type is 2.5 mm bayonet ST-type.

### Section V Comments

Describe any special issues concerning the cables or connectors.

**Figure 9–7: Campus Backbone Cable Worksheet**

I. Project Identification: Page ____ of ____

Designer: ______________________________ Date: ____________

II. Subsystem Description:

Distribution Frame Identifier: ____________

III. Environmental Considerations:

1. ____________________ 6. ____________________

2. ____________________ 7. ____________________

3. ____________________ 8. ____________________

4. ____________________ 9. ____________________

5. ____________________ 10. ____________________

IV. Cable Descriptions:

| ID | Cable Type | Fiber Count | Fiber Size | Environmental Factors | Routing Method | Cable Construction | Length | Connectors | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Quantity | Type |
| | | | | | | | | | |
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V. Comments: ______________________________________________

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## 9.9 Bill of Materials (BOM) Worksheet

This section provides instructions for the Campus Backbone BOM Worksheet (Figure 9–8). Photocopy and fill in a worksheet to define each campus backbone subsystem's cable, connector, cable entrance point, and cable routing hardware requirements. Each BOM worksheet is compiled from the component requirements defined in the subsystem's campus and building backbone cable routing, cable, and cable entrance worksheets.

#### Section I Project Identification

Identify the project, worksheet page number, designer, and date.

#### Section II Subsystem Identification

Identify the subsystem by its MDF identifier.

#### Section III Component Requirements

List each component by:

- Component description (for example, 24-fiber slotted-core cable)
- Order number (list the vendor's part number for the component)
- Quantity needed (for example, for cable, total the lengths of all the specific type of cable needed to order the cable in bulk form)
- Unit price
- Total price (quantity multiplied by the unit price)

Then summarize the total cost of the listed components.

## Figure 9–8: Campus Backbone BOM Worksheet

I. Project Identification:

Project ID: ______________ Page ____ of ____

Designer: ________________________________ Date: ______________

II. Subsystem Identification:

MDF Identifier: ______________

III. Component Requirements:

| Item Number | Part Number | Description | Quantity | Unit Price | Total Price |
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| | | | | Total Cost: | |

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# CHAPTER 10

# 10

# Distribution Frame Design

This chapter provides recommendations and procedures for defining each of the structured wiring cable plant distribution frame's:

- Passive fiber optic cable plant components
- Equipment room cable routing requirements
- Passive cable plant and active equipment connections
- Physical location within the equipment room
- General equipment room and equipment cabinet electrical, thermal, and acoustic requirements

The chapter also provides procedures for creating diagrams, connection maps, and distribution frame bill of materials (BOMs).

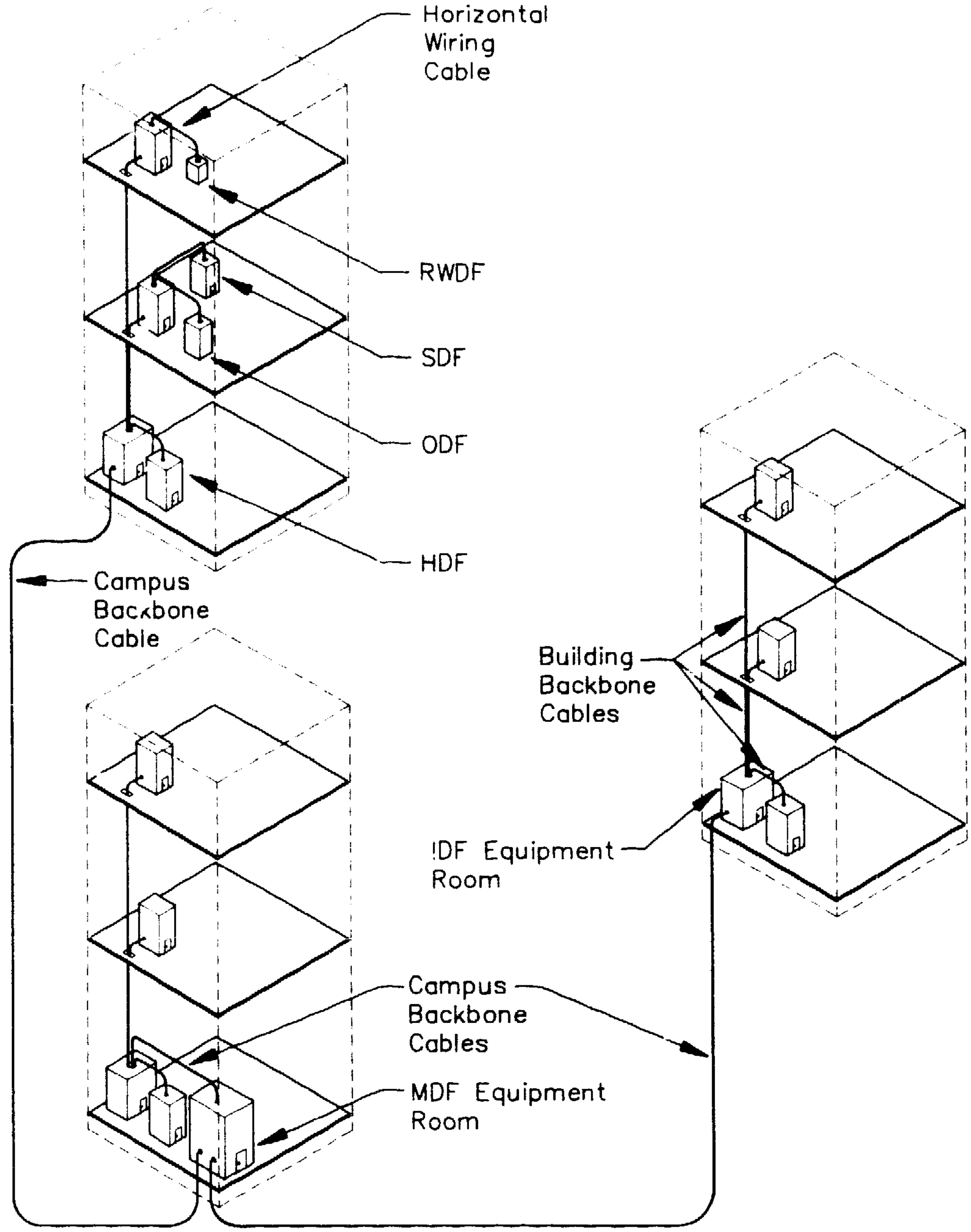
The five types of distribution frames are:

- Main distribution frame (MDF). A part of the campus backbone subsystem. It contains the active and passive components that connect buildings together. It can also contain the components used to connect other areas on a campus or provide connections with remote buildings.
- Intermediate distribution frame (IDF). A part of the building backbone subsystem. It contains the active and passive components that connect the building backbone cables to the campus backbone cables. The building backbone cables connect the building's floors to the IDF and the campus backbone cables connect the IDFs to the MDF.

- Horizontal distribution frame (HDF). A part of the horizontal wiring subsystem. It contains the active and passive components that connect the horizontal wiring cables to the IDF through the building backbone cable.
- Satellite distribution frame (SDF). It is located in an equipment room and contains crossconnect hardware or passive components used to interconnect active networking equipment to the horizontal wiring between an HDF and wallboxes.
- Office distribution frame (ODF). An enclosed, free-standing equipment cabinet that contains crossconnect hardware or passive components used to interconnect active networking equipment to the horizontal wiring between an HDF and wallboxes.
- Remote wall distribution frame (RWDF). A small wall-mounted cabinet. It is a passive-only component used to interconnect wallbox cables to an HDF cable.

Figure 10–1 shows where distribution frames occur in the structured wiring cable plant.

**Figure 10–1: Distribution Frame Locations**



## 10.1 Required Documents

The following documents are used during the design process:

- Floor plans - Updated during the distribution subsystem cabling design processes (Chapters 6 through 9) to show the existing or planned location of all distribution frames.
- Network schematic diagrams - identify the active and passive equipment for each distribution frame when applications are known. For unknown applications only passive equipment is identified for each distribution frame.
- Concept diagrams - identify the cable links between each distribution frame, including the number of cables and each cable's fiber count.
- Identifier worksheets filled in during the labeling procedure in Chapter 4, Section 4.6.
- Copies of the equipment room and computer/common equipment room worksheets from the *DECconnect System Requirements Evaluation Workbook's* filled in during the site survey.
- *BICSI Telecommunications Distribution Methods Manual* - for reference information on equipment rooms.
- *NEC* and local building codes - for reference during the design process.

## 10.2 Design Process Overview

The distribution frame design process creates layout diagrams, connection worksheets, connection label maps, and a BOM worksheet for each distribution frame as follows:

- Distribution frame layout diagram - defines the passive and active components that make up the distribution frame and the arrangement of the components within the mounting racks.
- Footprint diagram - defines the location of the mounting racks within equipment rooms, or in office (ODF) or wall areas (RWDF).
- Equipment room routing diagram - defines how cables route to and from equipment room distribution frame components.

- Distribution subsystem connection worksheet - fill out to provide a map for the installer to connect the fibers at each of the distribution subsystem patch panels to other distribution subsystem patch panels. It also helps provide information to create the panel connection label map.
- Panel connection label maps - provide labeling information on the location of a far end connection of a fiber pair.
- Crossconnect/interconnect maps - define how patch cables connect to the patch panels to provide the administration crossconnect and interconnect points at the distribution frame.
- BOM worksheet - provides a bill of materials for all of the passive fiber optic and cable routing hardware requirements defined in the diagrams and maps.

In addition, site and floor plans are updated during the design process to reflect the design.

Figure 10–2 provides a flow chart overview of the distribution frame design process.

**Figure 10–2: Distribution Frame Design Flow Chart**

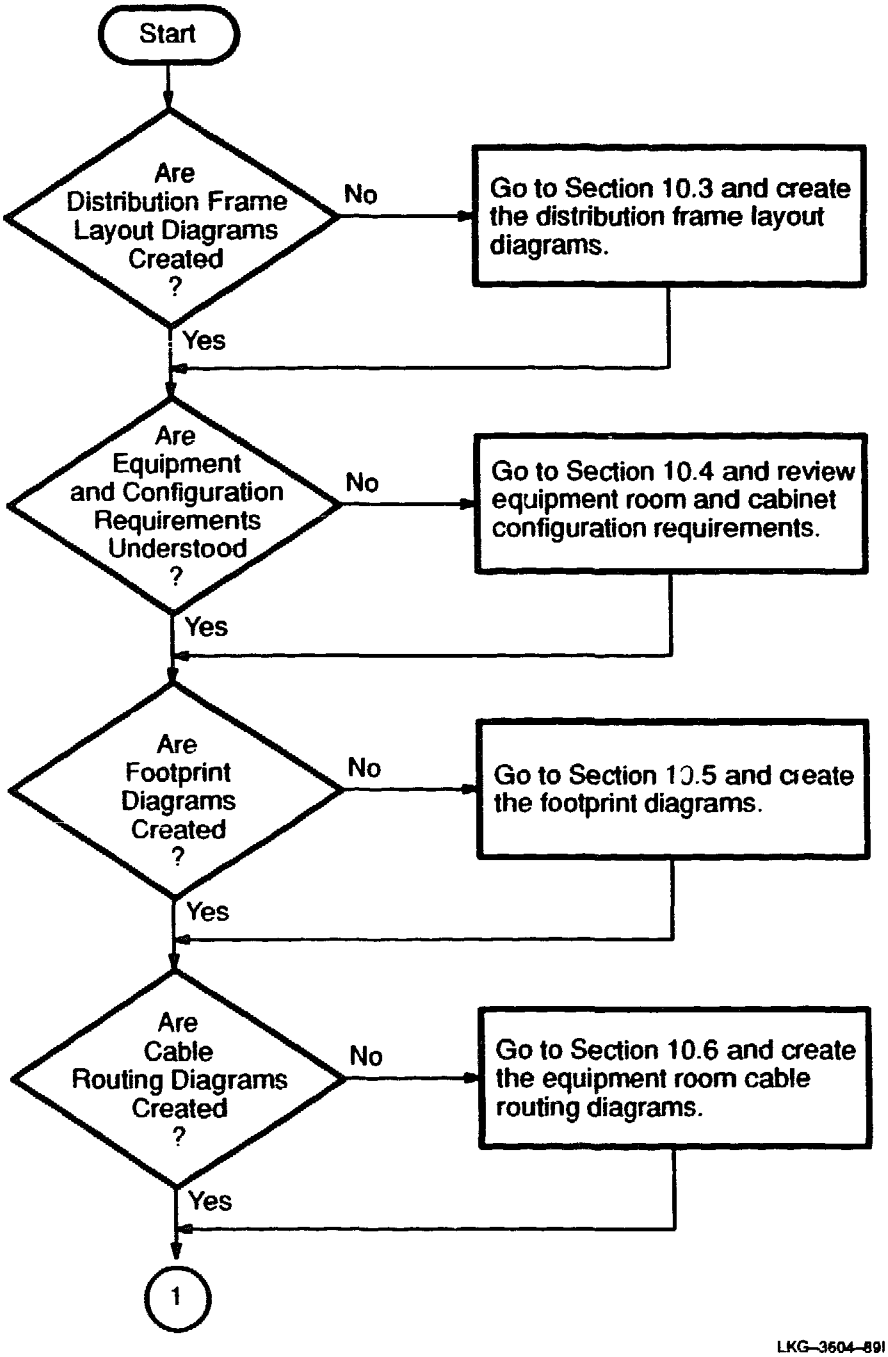
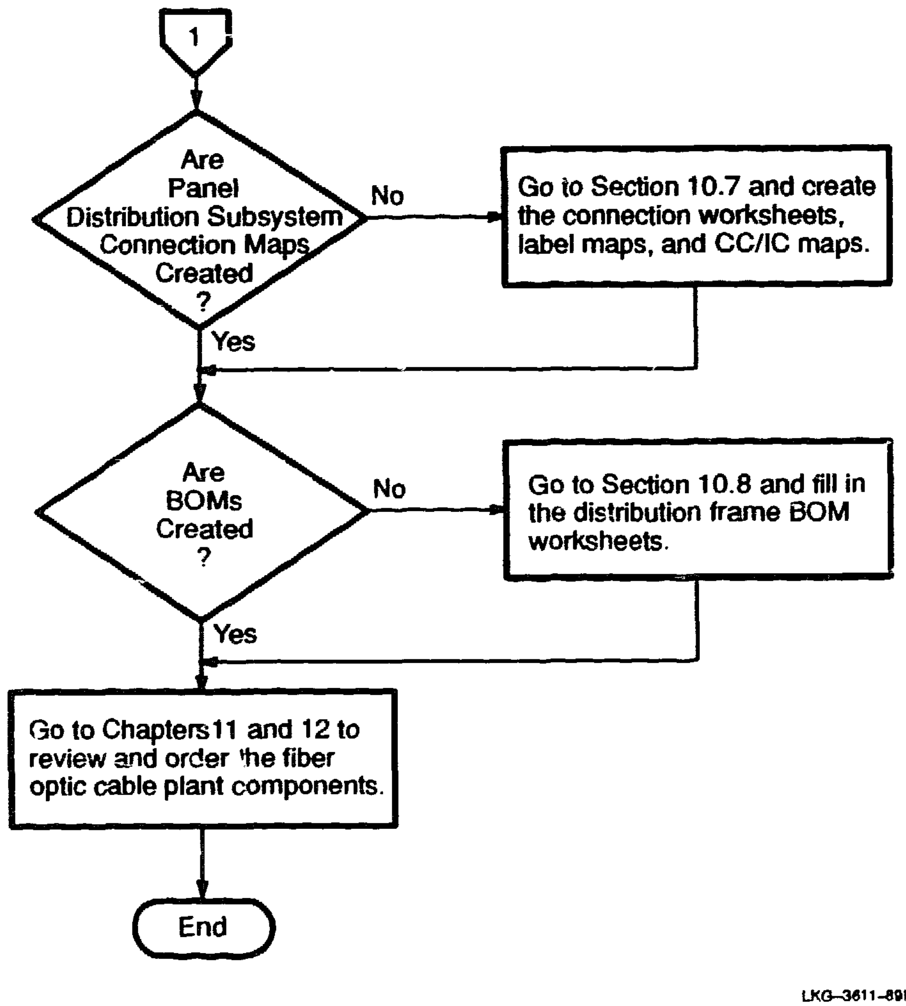



Figure 10–2 Cont'd on next page

Figure 10–2(Cont.): Distribution Frame Design Flow Chart



## 10.3 Distribution Frame Layout Diagram

A layout diagram, which is created for each distribution frame, identifies:

- The active (for known applications only) and passive components that make up the distribution frame.
- Where the components mount in the distribution frame's rack (or racks).
- The patch panel shelf numbers for termination and combination shelves.
- The identification of the cables that connect to each patch panel.

**NOTE**

No layout diagram is needed for RWDFs.

This section describes how to create the distribution frame layout diagram by:

- Describing the types of components that can be used in a distribution frame.
- Providing the rack guidelines that can affect how components are mounted in distribution frame racks.
- Providing layout diagram examples.

### 10.3.1 Distribution Frame Components

Each distribution frame can contain the following:

- Active networking equipment (for known applications only)
- Passive cable plant hardware
- Mounting racks

**NOTE**

The RWDF is a wall-mounted unit and does not use active networking equipment or mounting racks.

#### 10.3.1.1 Active Networking Equipment

The network schematic diagrams created in Chapter 5 define what active equipment is part of which distribution frames for known applications.

The part of the distribution frame design that involves the active networking equipment is limited to defining:

- Thermal requirements for rack-mounted active equipment.
- Locations of the active equipment in the mounting racks.
- How the active equipment connects to the structured wiring cable plant at the distribution frames.

The guidelines for defining the active equipment locations within the distribution frame racks are provided in Section 10.3.2. The procedures for defining the active equipment connections to the distribution frames is provided in Section 10.7.

#### 10.3.1.2 Passive Cable Plant Hardware

The distribution frame passive hardware consists of the components needed to:

- Connect the wiring to the rear of the patch panel at each of the distribution frames.
- Connect the patch cables used for the crossconnect and interconnect administration points.

For all distribution frames (except the RWDF) the cable plant hardware can include the:

- Termination shelf - provides for connecting up to 72 fibers. The termination shelf is recommended for use at:
  - — MDF - one termination shelf for each building, with all multimode and single-mode cable fibers from the building's IDF connection to the termination shelf at the MDF.
  - — IDFs - at least one termination shelf for all of the campus backbone multimode and single-mode fibers.
  - — HDFs - at least one termination shelf for connecting building backbone and horizontal wiring fibers.

— SDFs or ODFs - at least one termination shelf for interconnecting active equipment to the horizontal wiring or for providing crossconnects.

- Storage shelf - at least one storage shelf, which provides for storing wiring and patch cable slack, is needed for each termination shelf used at a distribution frame.

- Splice shelf - provides for protective storage of spliced fibers, with one shelf required for every 72 splices.

**NOTE**

Splice shelves are used only for storing splices when using pigtail assemblies. When fiber is field-terminated with a 2.5 mm bayonet ST-type connector, splice shelves are not required in the distribution frame.

- Combination shelf - provides for connecting up to 24 fibers, and includes splice termination protection and storage space for organizing cable slack. The combination shelf is recommended for use in low-fiber count termination capacity situations (such a MDF, IDF, HDF).

- Splice hardware - used for splicing pigtail assemblies to the wiring inside the wall.

- Cable clamps and management hardware - used to secure and manage cables within the distribution frame's racks.

- Patch cable assemblies - prefabricated cable assemblies for interconnecting active equipment to the patch panels, or for use in crossconnects.

- Panel couplers - for mounting fibers to the termination or combination shelf patch panels and for connecting the patch cables to the patch panels. One coupler is used for each fiber.

For an RWDF, the components consist of:

- A wall-mounted unit which allows up to 12 fiber connections.

- The patch panel couplers or splice hardware needed to interconnect the HDF-cable and wallbox-cable fibers at the RWDF panels.

**NOTE**

Chapter 11 contains descriptions of the distribution frame passive cable plant components available directly from Digital or from authorized Digital distributors. It also lists components approved for use in the DECconnect System structured wiring cable plant that are not directly available from Digital.

#### 10.3.1.3 Mounting Racks

The RWDF is a wall-mounting unit that does not use mounting racks. The ODF uses an enclosed, 152 centimeter (60 inch) high, 48 centimeter (19 inch) rack. All other distribution frames (MDFs, IDFs, HDFs, and SDFs) can use open mounting racks for mounting the active and passive components.

Three different types of open racks are approved for used in the equipment room:

- 183 centimeters (72 inches) high, 48 centimeter (19 inch) rack - for mounting active and passive components.
- 213 centimeters (84 inches) high, 48 centimeter (19 inch) rack - for mounting active and passive components.
- 58 centimeter (23 inch) rack - for mounting passive components only.

The RWDF, ODF enclosed rack, and the open 48 centimeter (19 inch) racks are available directly from Digital or authorized Digital distributors. The 58 centimeter (23 inch) rack is not. (See Chapter 11 for a list of resources.)

### 10.3.2 Rack Layout Guidelines

The layout guidelines that can affect the design of a distribution frame are:

- Basic mounting-rack layouts
- Rack installation guidelines

The rack-mounting of active equipment within a distribution frame can also be affected by the requirements outlined in Section 10.4.

#### 10.3.2.1 Basic Mounting-Rack Layouts

There are two basic mounting-rack layouts for distribution frames:

- Separate-rack layouts - in this recommended layout, active and passive components are mounted in separate racks. That is, any given distribution frame rack has only one type of component mounted in it: active or passive.

- Mixed-rack layout - in this layout, active and passive components are mounted in the same rack. This layout is the only possibility for ODFs.

#### 10.3.2.2 Rack Installation Guidelines

When planning the location of active and passive equipment within a distribution frame's mounting rack, follow the guidelines listed below:

- Plan for installing the fiber optic shelves, involved in storing and terminating the same group of fibers together, in a logical group within the mounting rack. For example, a termination shelf and storage shelf grouping (when fibers are terminated using the Digital-recommended field-termination procedures) or a splice shelf, termination shelf, and storage shelf grouping (when fibers are terminated using pigtail assemblies).

- Always mount the splice shelves above the termination shelves to maintain the cable routing from the top to the bottom of the rack.

- Always mount the storage shelves below the termination shelves for storing behind-the-wall fibers and patch cable fibers.

- For stability, bolt racks to the floor or walls. Plan on mounting equipment in the rack based on the weight of the equipment. Mount lighter equipment towards the top of a rack and heavier equipment towards the bottom.

**NOTE**

> In mixed-rack layouts, passive equipment always mounts at the top of the rack because it is lighter than active equipment.

- Plan for the cable clamp and other cable management hardware (such as cable management raceways) locations within the rack. Make sure that space is left in the rack for access to the management hardware locations.

- Plan for the separation of all fiber optic active and passive equipment from any copper based equipment within each rack. This helps separate management of the fiber optic wiring from the copper wiring.

**NOTE**

For information on distribution frame mounting rack layouts, see the rack installation guidelines in Chapter 4 of the *DECconnect System Fiber Optic Installation* guide (EK-DECSY-FI)).

### 10.3.2.3 Layout Diagram Examples

The following figures provide distribution frame layout diagram examples for each type of distribution frame (except the RWDF) used in the DECconnect System's structured wiring cable plant:

- Figure 10–3 shows an MDF that connects to 5 IDF using active fiber optic Ethernet equipment.
- Figure 10–4 shows an IDF that connects to 6 HDFs using an FDDI concentrator.
- Figure 10–5 shows an HDF that connects to 4 SDFs using an FDDI concentrator.
- Figure 10–6 shows an SDF that connects to 32 wallboxes using active fiber optic Ethernet stars. Also shown is copper-based network equipment separate from the fiber optic equipment.
- Figure 10–7 shows an ODF that connects to wallboxes using active fiber optic Ethernet stars. Also shown is copper-based network equipment separate from the fiber optic equipment.

No splice shelves are shown in any of the examples because it is assumed that the fiber will be field-terminated. Splice shelves are usually required only when fibers are terminated using pigtail assemblies.

In addition, the MDF, IDF, and HDF examples assume that other active equipment (such as voice, video, telemetry, or security) will be mounted in the distribution frame's active rack.

**Figure 10–3: MDF Layout Diagram Example**

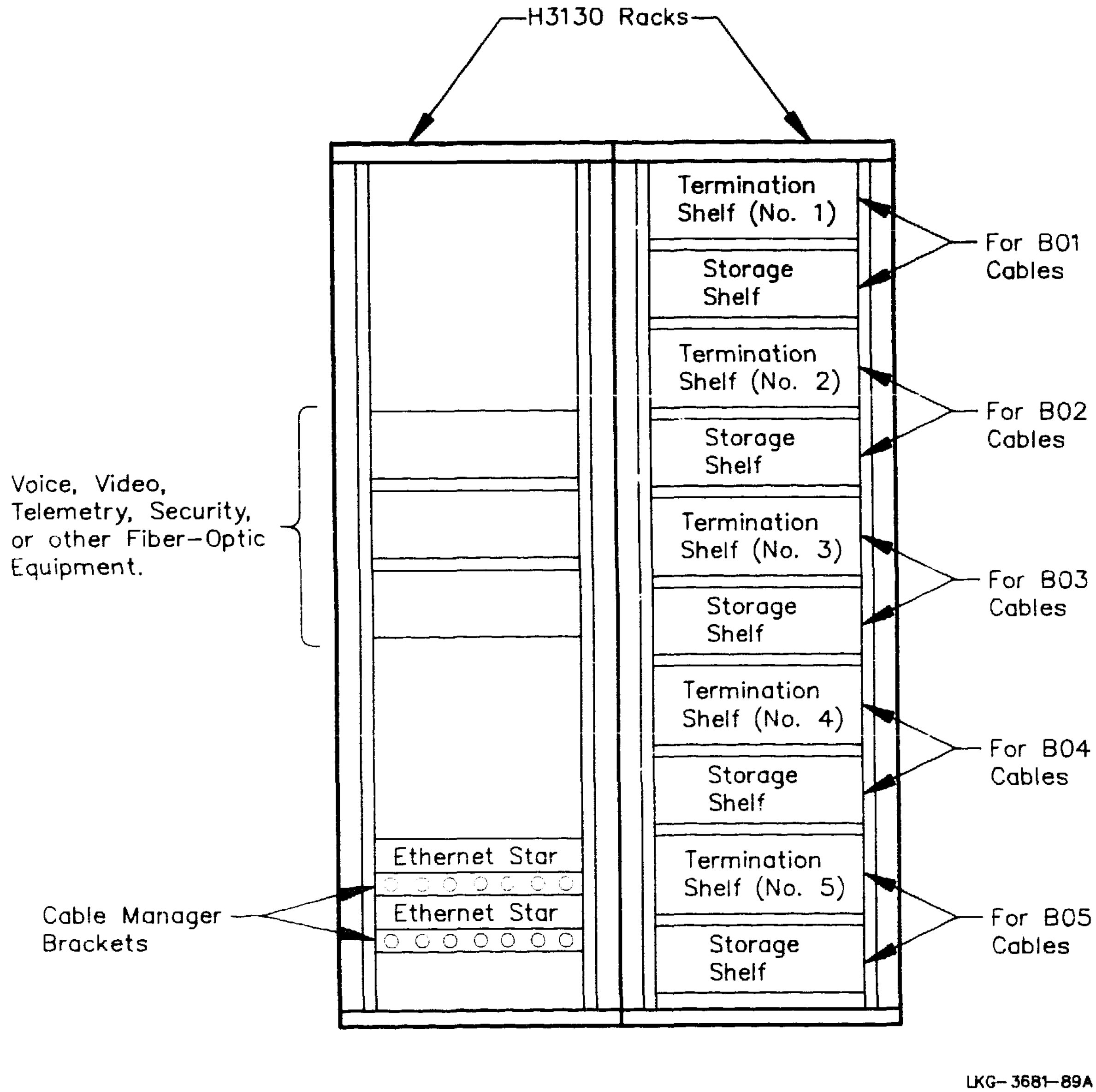


**Figure 10–4: IDF Layout Diagram Example**

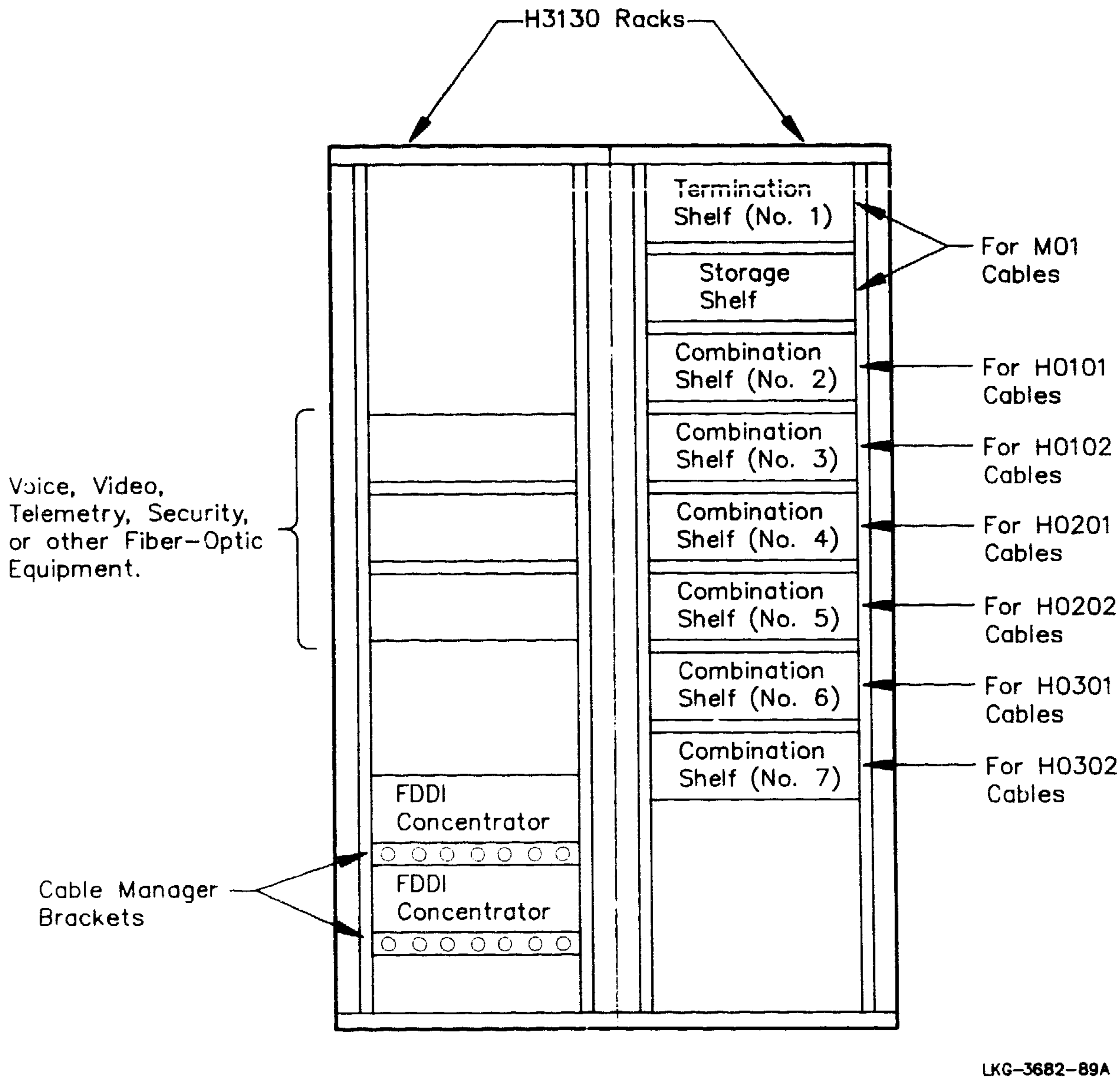


**Figure 10–5: HDF Layout Diagram Example**

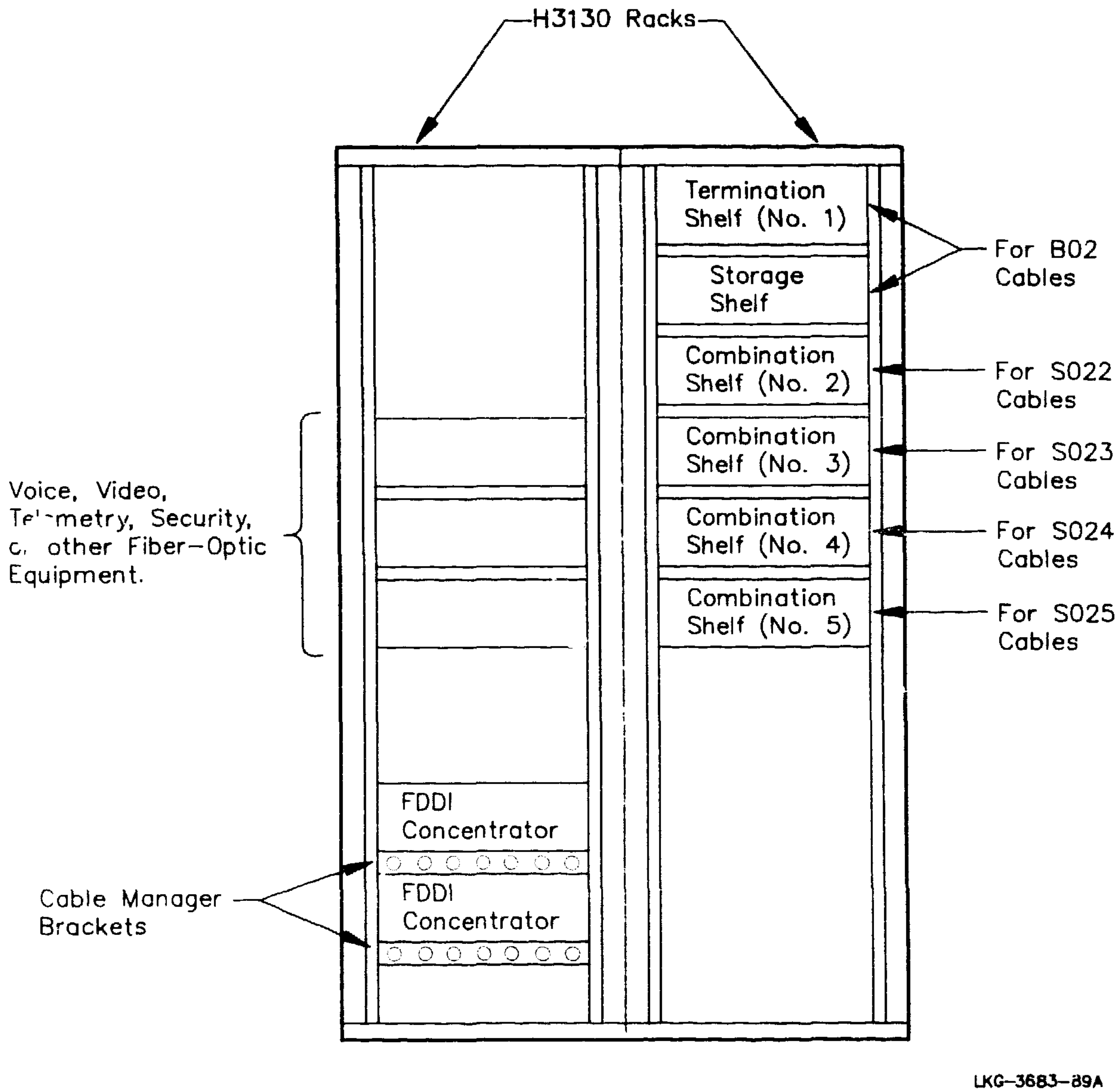
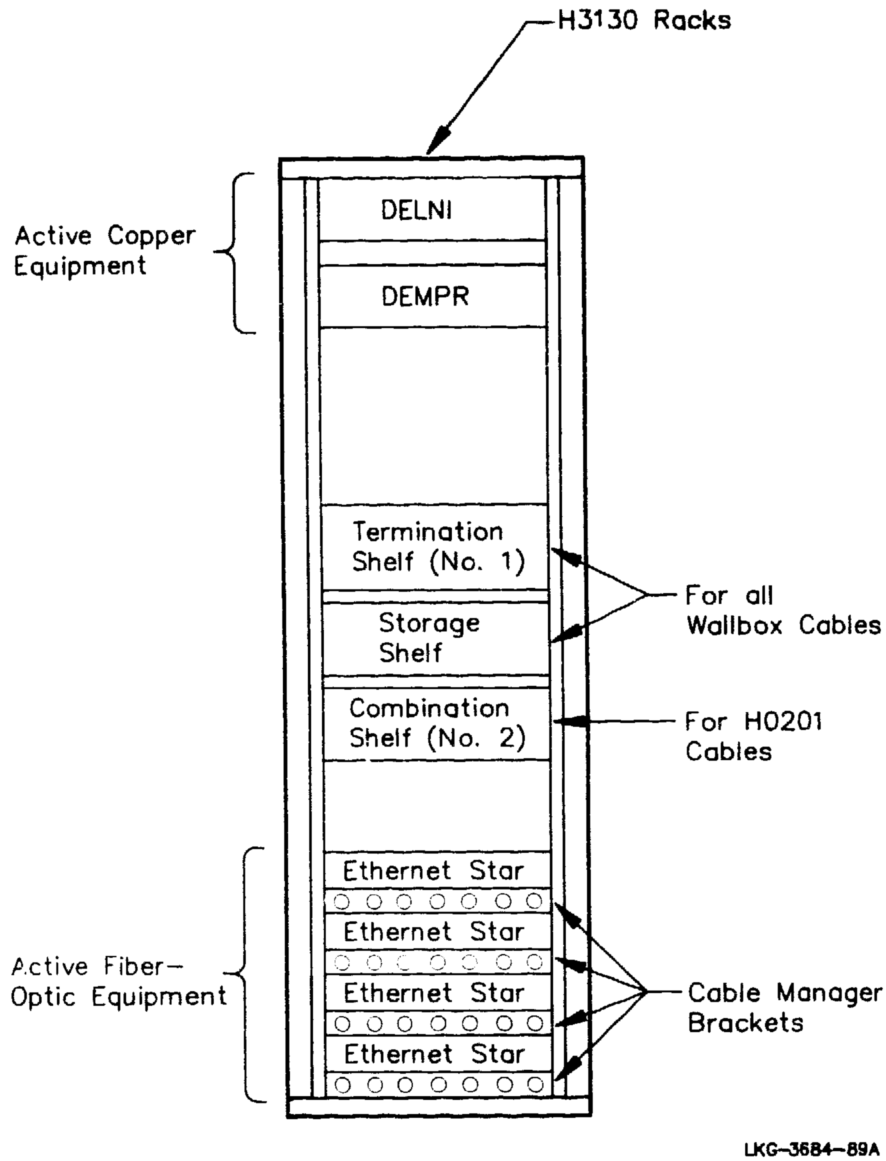
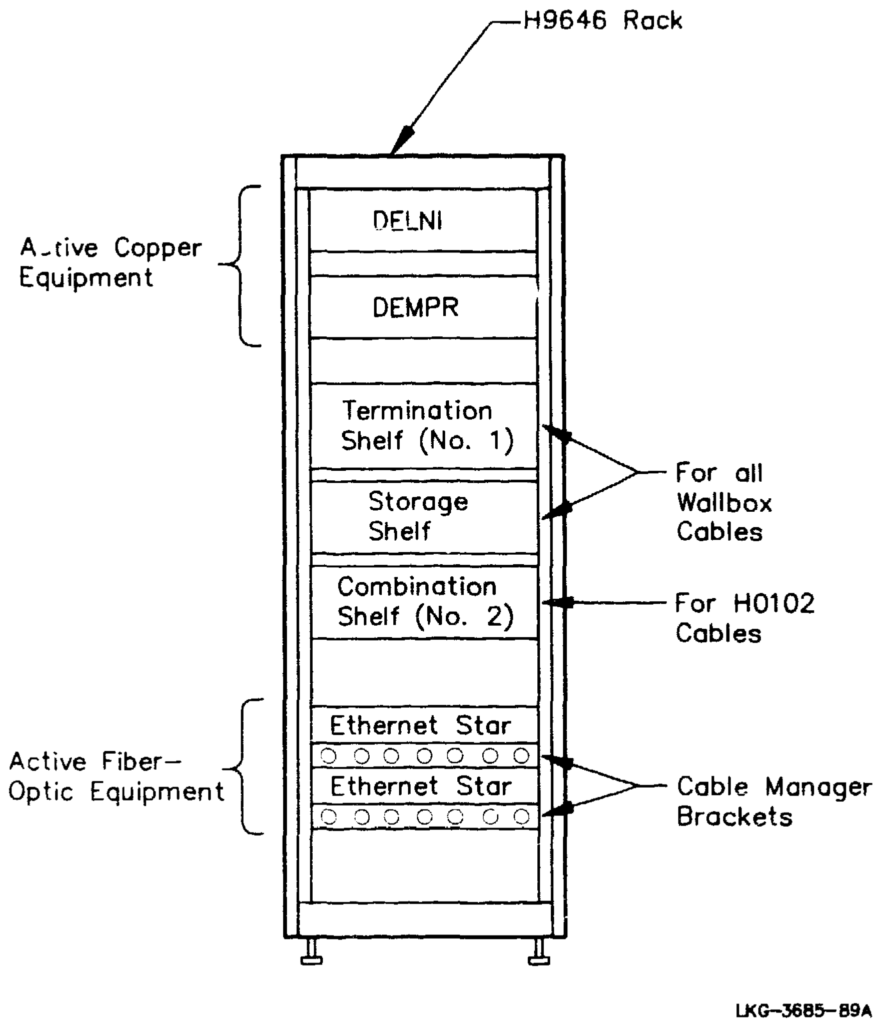


**Figure 10–6: SDF Layout Diagram Example**



## Figure 10–7: ODF Layout Diagram Example



## 10.4 Equipment Room and Cabinet Configuration—Electrical, Thermal, and Acoustic Requirements

This section provides requirements and guidelines for equipment rooms and the ODF cabinets.

- Configuration requirements for equipment rooms and ODF cabinets
- Power requirements for equipment rooms and ODF cabinets
- Thermal requirements for equipment rooms and ODF cabinets
- Acoustic requirements for ODF cabinets

The configuration and thermal guidelines for equipment rooms are based on using two racks for layout of the active and passive distribution frame equipment.

### 10.4.1 Configuration Requirements

This section describes the configuration requirements for:

- Equipment rooms
- ODFs

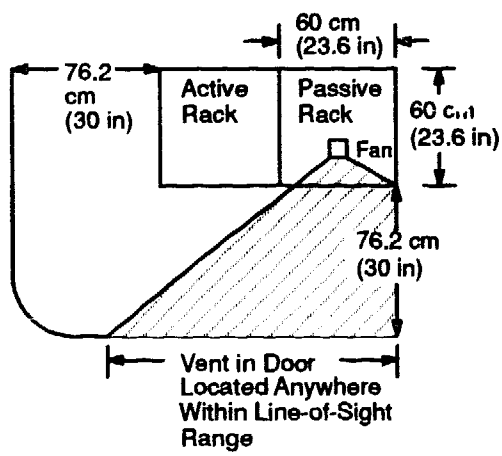
#### 10.4.1.1 Equipment Room Configuration Requirements

The following configuration requirements apply to all equipment rooms in which the MDF, IDF, HDF, and SDF are located:

- The ceiling must be at least 2.6 meters (8.5 feet) high.
- There must be a lockable door with a sign reading: WARNING - QUALIFIED PERSONNEL ONLY.
- The distribution frame mounting racks must be located along the wall opposite the door.
- Adequate lighting is required, and must include an emergency light that turns on automatically whenever the power to the room is lost.
- There must be no storage of material or equipment not directly related to the cabling system, especially flammable material.

- Avoid locating the mounting racks within 15 centimeters (6 inches) of high-voltage power lines or any other possible source of electromagnetic interference (EMI).
- The equipment room must be large enough to accommodate location of the distribution frame's mounting racks and a minumum footprint space for installed mounting racks. Figure 10–8 illustrates the required clearances.

**Figure 10–8: Equipment Clearances**




As shown, the clearances outlined by the solid lines must be provided for the mounting racks. Also, there must be an air vent located anywhere within the illustrated line-of-sight (shaded area) for the equipment room's fan.

If the equipment room has to accommodate voice, video, or other data equipment, the 76 centimeters (30 inches) of clear wall space shown in Figure 10–8 can be used for mounting telephone punchdown blocks or other equipment.

- The floor should have a nonporous surface (such as linoleum, vinyl, tile, or sealed concrete) and be suitable for accepting the lag bolts that are used to secure the mounting racks to the floor.

- Digital strongly recommends that the room include a telephone that allows service personnel to communicate with other service personnel at the site or with their home office.

**NOTE**

For more information on equipment room configuration requirements, refer to the *BICSI Telecommunications Distribution Methods Manual*.

#### 10.4.1.2 ODF Configuration Requirements

The following configuration requirements apply to the ODF cabinet:

- Avoid locating an ODF cabinet within 15 centimeters (6 inches) of high-voltage power lines or any other possible source of electromagnetic interference (EMI).

- Each ODF must be installed in a manner that allows the ODFs to have the minimum footprint space required for these cabinets.

  The clearances outlined by the solid lines in Figure 10–9 must be provided for proper ventilation and for service access to the ODF components.

### 10.4.2 Electrical Requirements

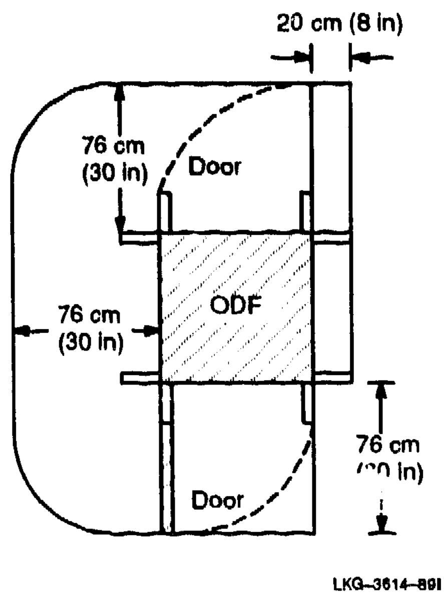
This section describes the electrical requirements for:

- Equipment rooms
- ODFs

**NOTE**

Equipment room and ODF electrical requirements vary from country to country. The requirements listed in this chapter are for U.S. installations.

Figure 10–9: ODF Space Requirements




#### 10.4.2.1 Equipment Room Electrical Requirements

The equipment room requires the following provisions for ac power:

- Voltage: 120 Vac nominal
- Frequency: 60 Hz
- Service: two dedicated (from a circuit-breaker panel) 15-ampere power circuits, each terminated with a NEMA 5-15R outlet. The outlets must be within 0.6 meters (2 feet) of the active equipment rack location. Both outlets must have an earth ground.

**NOTE**

> The distribution frame racks are grounded through the outlet earth grounds; no further grounding of the racks is necessary.

In addition, a 15-ampere duplex outlet that is not on the dedicated power circuits should be available for use by service personnel. This outlet should be within 0.9 meters (3 feet) of the active equipment rack.

#### 10.4.2.2 ODF Electrical Requirements

A 120 Vac nominal, 12 ampere, 60 Hz power source outlet is required for the ODF. This outlet must be within 0.9 meters (3 feet) of the cabinet. In addition, a second 15-ampere duplex outlet that is not on the same circuit as the ODF should be available for use by service personnel. This outlet should also be within 0.9 meters (3 feet) of the cabinet.

### 10.4.3 Thermal Requirements

This section describes the thermal requirements for:

- Equipment rooms
- ODFs

#### 10.4.3.1 Equipment Room Thermal Requirements

The equipment room is specified to handle approximately 1100 watts and must have a forced-air ventilation system to flush the room's air. The forced-air ventilation system must meet the following requirements:

- The room must have an exhaust fan with a 7.1 cubic meter per minute (250 cubic feet per minute) capacity. This is based on an 8° C (14.4° F) temperature rise between class A (15° to 32° C (59° to 90° F)) environment outside the room and the class B (10° to 40° C (50° to 104° F)) environment inside the room. If a lower limit is required, then a higher cubic meter per minute capacity is recommended.

**NOTE**

> For higher CMM capacity systems, including air conditioning, contact the HVAC contractor.

- The room's air inlet must be placed at floor level in the equipment room door and must have an minimum opening size of at least 0.233 square meters (2.5 square feet).

#### 10.4.3.2 ODF Thermal Requirements

Digital recommends using an H9646-EA (110 Vac) or H9646-EB (220 Vac) DECconnect communications cabinet for the ODF. This cabinet has a thermal capacity of 650 watts and can be placed in a class B environment (10° C to 40° C, 50° F to 104° F) and a humidity range of 10% to 90% (noncondensing).

### 10.4.4 ODF Acoustic Requirements

The ODF cabinet is placed in office or other end-user environments where the noise generated by active equipment mounted in the cabinet can have an environmental impact. Table 10–1 lists the recommended A-weighted sound power level values (expressed as LwA) for both open office areas and computer room environments.

**NOTE**

A special installation consideration, such as installing an H9646-*xx* DECconnect communications cabinet in an office or work area that requires more noise control than a normal office area, requires consulting an acoustical engineer for guidance.

**Table 10–1: ODF Acceptable Acoustical Values**

| Environment | Recommended LwA Maximum Levels |
|---|---|
| Open office (large office, drafting areas, or office with multiple desks) | Up to 6.5 bels |
| Computer room (dedicated equipment room for computer or other system common equipment) | Up to 7.5 bels |

**NOTE**

The LwA values identified in Table 10–1 are measured in accordance with the *ANSI S12.10-1985 Standard* or the *ISO 7999 Standard*.

## 10.5 Footprint Diagram

A to-scale footprint diagram is created for each distribution frame. The diagram identifies exactly where:

- Racks are to be installed in the equipment room (MDF, IDF, HDF, and SDF).
- The ODF is to be placed in the office area.
- The RWDF is to be wall-mounted.

Each footprint diagram also shows the clearance that must be maintained around the racks for service access. The clearance for distribution frame racks is 76 centimeters (30 inches) at the rear and at one side.

For the ODF and RWDF, however, the access requirements are different:

- ODF - requires 76 centimeters (30 inches) of clearance at the front, back, and on one side of the ODF cabinet for service access and ventilation.
- RWDF - requires service clearance in front of the RWDF only.

Figure 10–10 shows an example of a footprint diagram for an ODF. Figure 10–11 shows an example of a footprint diagram for a typical two-rack equipment room.

**NOTE**

> The minimum space requirements for an ODF footprint are described in Section 10.4.1.2, ODF Configuration Requirements. The minimum space requirements for a two-rack MDF, IDF, HDF, or SDF footprint are described in Section 10.4.1.1, Equipment Room General Requirements.

## Figure 10–10: ODF Footprint Diagram Example

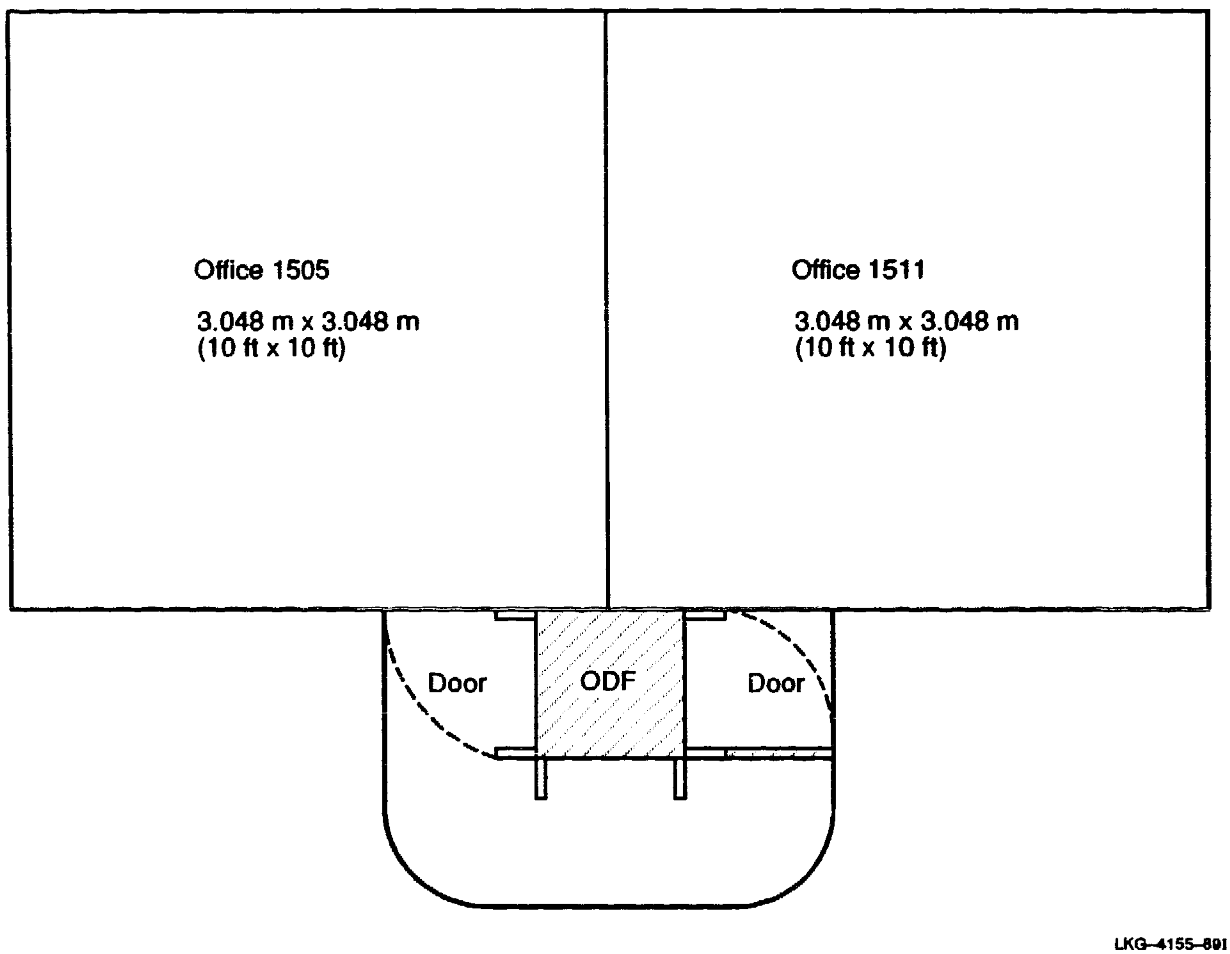
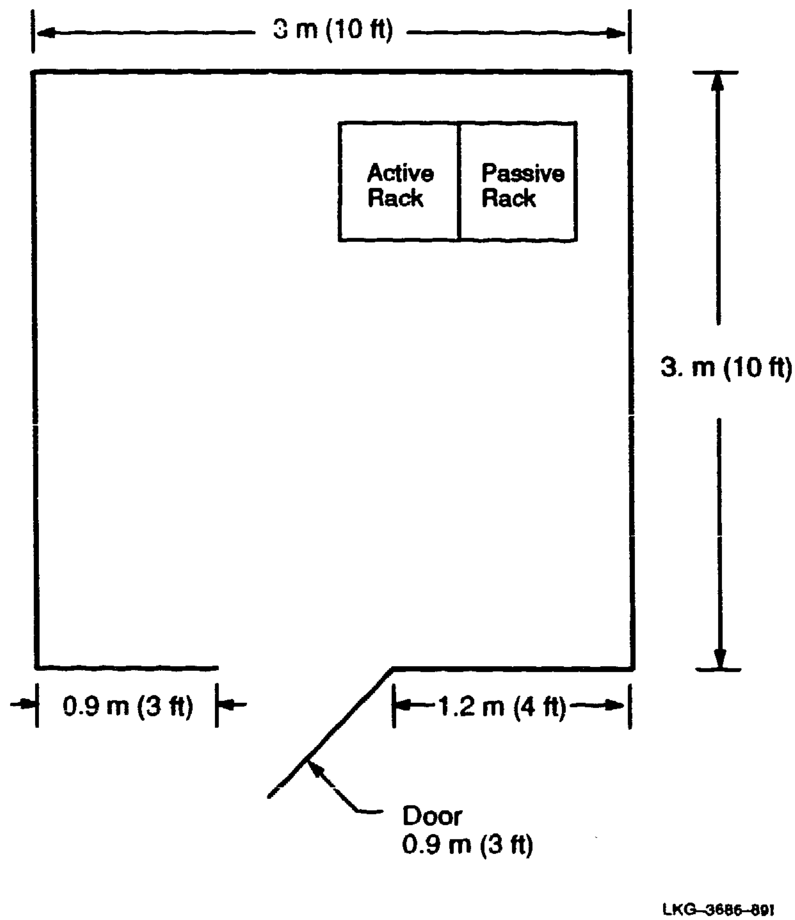


Figure 10–11: Equipment Room Footprint Diagram Example



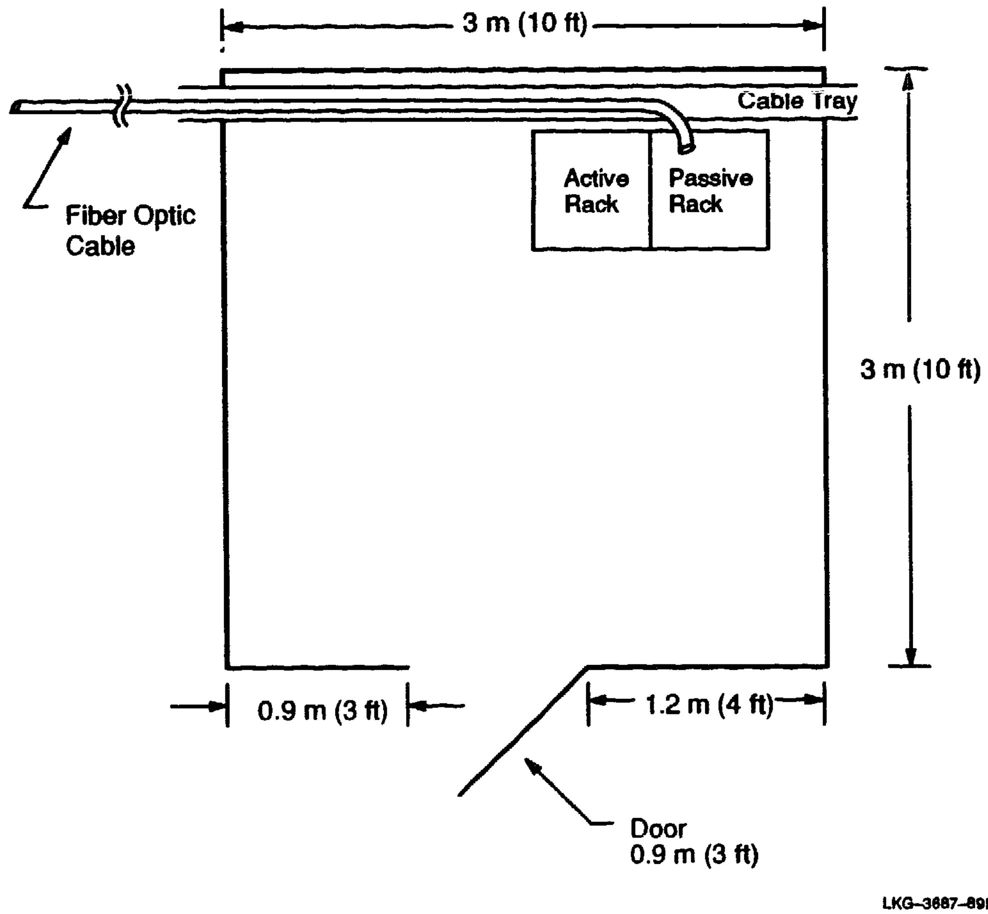

## 10.6 Equipment Room Cable Routing Diagram

Each distribution frame (MDF, IDF, HDF, or SDF) needs a to-scale diagram of the equipment room that shows exactly how the cables will be routed to and from the distribution frame racks within the room. In most cases, the cable routing diagram can be created as an update of the footprint diagram.

Digital recommends using the above-ceiling cable tray horizontal routing method. In addition, the cable routing should deliver the cable to the left-rear corner of each rack.

Figure 10–12 provides an example for using a cable rack to route cables to the passive rack in a typical two-rack equipment room.

**Figure 10–12: Equipment Room Cable Routing Diagram Example**



## 10.7 Distribution Subsystem Connection Maps

This section provides information on connecting the individual fiber pairs to each subsystem's patch panel, labeling maps for the combination and termination shelf at each distribution frame, and connection maps for the crossconnect and interconnect patch cables. During this process the network designer completes:

- Distribution subsystem connection worksheet
- Patch panel connection label maps
- Crossconnect/interconnect maps (for known applications only)

### 10.7.1 Distribution Subsystem Connection Worksheet

This worksheet (Figure 10–13) provides a connection map for the installer to connect each fiber pair to its proper location at each of the distribution frame patch panel shelves. (Photocopy the worksheet.)

The following documents and information are used to complete the worksheet.

- Network schematics.
- Concept diagrams.
- Identifier worksheets.
- The patch panel numbers assigned for each termination shelf and combination shelf from the distribution frame layout diagram in Section 10.3.
- The distribution frame higher/lower color fields identified in Table 4–3.
- Th identification of which cables connect to which patch panel shelf from the distribution frame layout diagram in Section 10.3.
- Termination and combination shelf layout (Figure 10–14 and Figure 10–15.)

The designer fills out the worksheet as follows:

#### Section 1, Project Identification

Identify the project, worksheet page number, designer, and date.

#### Section 2, Distribution Frame Location

Identify the building number(s) where the distribution frames are located.

Section 3, Distribution Subsystem Connection Map

- Provide the cable information. This includes the cable ID, the cable bundle unit color, the fiber pair letter, and the fiber color involved in the connection with the subsystem patch panel.

- Provide the higher level distribution frame ID. This includes the shelf number, the coupler column/row position, and the distribution frame field color to which one end of the cable connects.

- Provide the lower level distribution frame ID. This includes the shelf number, the coupler column/row position, and the distribution field color to which the other end of the cable connects.

When connecting fibers to a termination or combination shelf from cables coming from two different points in the structured wiring, the fiber coming from the higher cable connects to the left-most panels and the fibers coming from the lower cable connects to the right-most panels. For more information on this left-side/right-side panel connection strategy and exceptions see Section 4.2.

**NOTE**

> The additional information required for the Wallbox Identifier Worksheet must be completed at this point. (This worksheet was partially completed in Section 4.6.1 with wallbox identifier information). These worksheets contain complete connection information for the installer. Include them with the installation documentation.

### 10.7.2 Patch Panel Connection Label Maps

This section provides information for filling in the two types of patch panel connection label maps:

- Termination shelf panel connection label map (Figure 10–14)

- Combination shelf panel connection label map (Figure 10–15)

Photcopy each type of connection label map and follow these instructions. The difference between the two label maps is the number and arrangement of the patch panels each shelf can have.

## Figure 10–13: Distribution Subsystem Connection Worksheet

I. Project Identification:

Project ID: ____________ Page ___ of ___

Designer: ______________________________ Date: ____________

II. Distribution Frame Location:

Building Identifier: ____________

III. Distribution Subsystem Connection Map

| Cable Information | | | | Higher Level Distribution Frame ID______ | | | | Lower Level Distribution Frame ID______ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cable No. | Unit Color | Pair Letter | Fiber Color | Shelf No. | Column Letter | Row No. | Field Color | Shelf No. | Column Letter | Row No. | Field Color |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
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A connection label map is filled in for each termination and combination shelf at a distribution frame. These label maps are used by the installer to transfer the label identifier to the labels at each of the patch panel shelves. They also identify the fiber pairing for installation of the black and red washers at the termination and combination shelves. Each map has three parts:

- A map identification section that is filled in to define:
  - The project identifier.
  - The designer.
  - The distribution frame patch panel number that the map is for (the layout diagram for each distribution frame identifies a patch panel number for each termination and combination shelf).
  - The distribution frame's identifier.
  - The building number (the actual building number identified on the site plans—not the identifier of the building's MDF or IDF).
- An illustration of the shelf's coupler panels identifying each coupler position with a row number and a column letter.
- A chart of the coupler positions and a place to fill in the label identifier for each fiber in a pair that connects at each position.

The identifier that is filled in for each coupler position is created by using information from the distribution subsystem connection worksheets created earlier in this section.

## Figure 10–14: Termination Shelf Connection Label Map

**Map Identification**

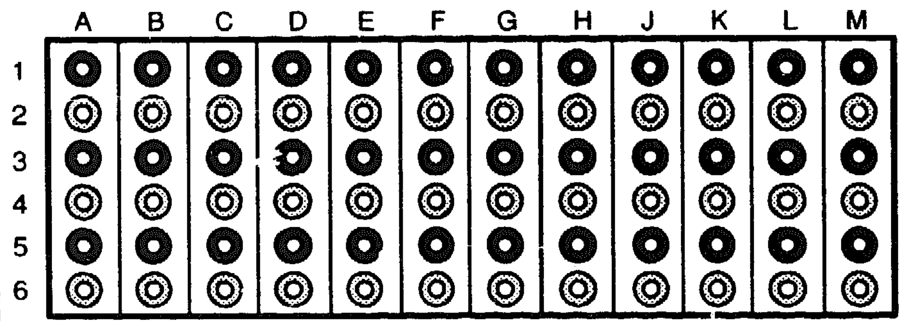
Project ID: ____________

Designer: ____________

Panel No.: ____________

Frame ID: ____________

Building No.: ____________




| Patch Panel Position | Identifier | Pair Letter | Field Color | Patch Panel Position | Identifier | Pair Letter | Field Color |
|---|---|---|---|---|---|---|---|
| A1 | | | | D1 | | | |
| A2 | | | | D2 | | | |
| A3 | | | | D3 | | | |
| A4 | | | | D4 | | | |
| A5 | | | | D5 | | | |
| A6 | | | | D6 | | | |
| B1 | | | | E1 | | | |
| B2 | | | | E2 | | | |
| B3 | | | | E3 | | | |
| B4 | | | | E4 | | | |
| B5 | | | | E5 | | | |
| B6 | | | | E6 | | | |
| C1 | | | | F1 | | | |
| C2 | | | | F2 | | | |
| C3 | | | | F3 | | | |
| C4 | | | | F4 | | | |
| C5 | | | | F5 | | | |
| C6 | | | | F6 | | | |

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**Figure 10–14 Cont'd on next page**

**Figure 10–14(Cont.): Termination Shelf Connection Label Map**

| Patch Panel Position | Identifier | Pair Letter | Field Color | Patch Panel Position | Identifier | Pair Letter | Field Color |
|---|---|---|---|---|---|---|---|
| G1 | | | | K1 | | | |
| G2 | | | | K2 | | | |
| G3 | | | | K3 | | | |
| G4 | | | | K4 | | | |
| G5 | | | | K5 | | | |
| G6 | | | | K6 | | | |
| H1 | | | | L1 | | | |
| H2 | | | | L2 | | | |
| H3 | | | | L3 | | | |
| H4 | | | | L4 | | | |
| H5 | | | | L5 | | | |
| H6 | | | | L6 | | | |
| J1 | | | | M1 | | | |
| J2 | | | | M2 | | | |
| J3 | | | | M3 | | | |
| J4 | | | | M4 | | | |
| J5 | | | | M5 | | | |
| J6 | | | | M6 | | | |

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## Figure 10–15: Combination Shelf Connection Label Map

**Map Identification**

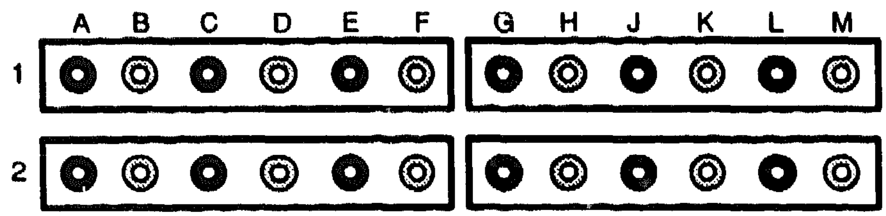
Project ID: ____________

Designer: ____________

Panel No.: ____________

Frame ID: ____________

Building No.: ____________




| Patch Panel Position | Identifier | Pair Letter | Field Color | Patch Panel Position | Identifier | Pair Letter | Field Color |
|---|---|---|---|---|---|---|---|
| A1 | | | | G1 | | | |
| B1 | | | | H1 | | | |
| C1 | | | | J1 | | | |
| D1 | | | | K1 | | | |
| E1 | | | | L1 | | | |
| F1 | | | | M1 | | | |
| A2 | | | | G2 | | | |
| B2 | | | | H2 | | | |
| C2 | | | | J2 | | | |
| D2 | | | | K2 | | | |
| E2 | | | | L2 | | | |
| F2 | | | | M2 | | | |

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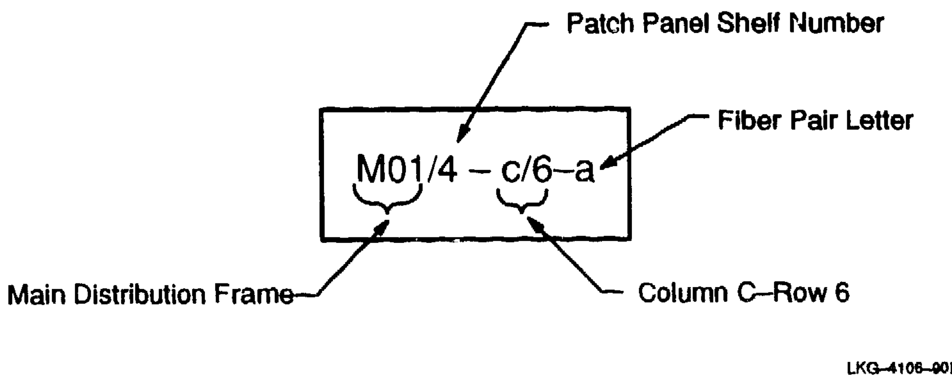
The connection label map information is printed on a label attached to the patch panel door. It indicates connection information for the other end of the cable. Figure 10–16 is an example of the information shown on the label.

**Figure 10–16: Sample Connection Label Map**




## 10.7.3 Crossconnect/Interconnect Maps - Known Applications Only

A crossconnect/interconnect map is created for:

- Each termination shelf at the distribution frame
- Each combination shelf at the distribution frame
- Each RWDF

Except at the RWDF, where wallbox cable fibers connect directly to panel-mounted HDF cable fibers, terminated cable assemblies are used at distribution frame panels for the administration crossconnect and interconnect points that connect the behind-the-wall fibers at the panel coupler into a structured wiring cable plant.

**NOTE**

The fiber connections at the panel coupler are defined by the distribution subsystem connection worksheet described in Section 10.7.1.

The crossconnect/interconnect maps define how patch cables connect at the patch panels to provide the crossconnect and interconnect points. These maps are used during the installation of the patch cables to the coupler positions.

#### Crossconnect/Interconnect Map Procedure

This section provides instructions for filling in three types of crossconnect/interconnect maps. (Photocopy the maps.)

- Termination shelf crossconnect/interconnect map (Figure 10–17)
- Combination shelf crossconnect/interconnect map (Figure 10–18)
- RWDF interconnect map (Figure 10–19)

### 10.7.3.1 Termination and Combination Shelf Maps

A crossconnect/interconnect map is completed for each termination shelf (Figure 10–17) and combination shelf (Figure 10–18) at a distribution frame.

**NOTE**

When creating the crossconnect/interconnection maps, review the crossover rules outlined in Chapter 4 to determine the crossover and non-crossover fiber pair connections.

Each map has three parts:

- A filled-in map identification section that defines:
  - The project identifier.
  - The designer.
  - The number distribution frame's patch panel number. (The layout diagram for each distribution frame identifies a patch panel number for each termination and combination shelf.)
  - The distribution frame's identifier.

— The building number (the actual building number identified on the site plans—not the building's MDF or IDF identifier).

- An illustration of the shelf's patch panel, identifying each coupler position by a row number and column letter.

- A chart that has the following:

  — From Identifier (fiber pair letter and coupler position number) - fill in the pair letter, and the row numbers and column letters that the patch cable connects to.

  — To Identifier - fill in the identification of the point where the other end of the patch cable connects:

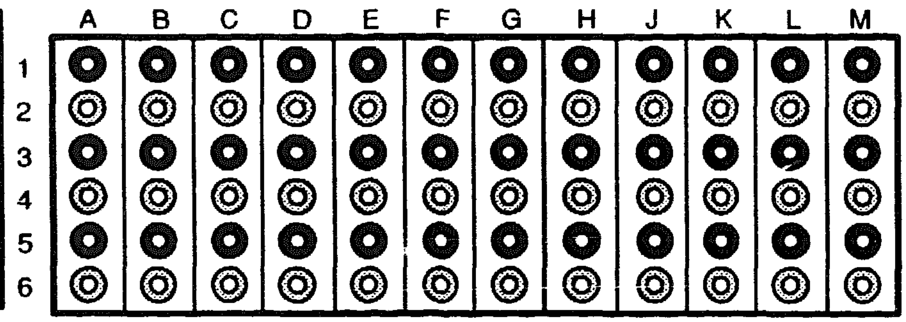
    For active equipment, identify the equipment by number and connector.

    For a coupler position at another termination or combination shelf, identify the patch panel number, pair letter, and the row numbers and column letters.

  — Patch Cable - fill in with a description of the cable assembly to be used. If it is a dual-fiber assembly, indicate the assembly connector that connects to the coupler pair by the color code of the connector's boot. For example, an FDDI-to-ST connector cable assembly connects to a coupler pair at the panel, with one position defined as black boot, and the other as red boot.

## Figure 10–17: Termination Shelf Crossconnect/Interconnect Map

| Map Identification |
|---|
| Project ID: ____________ |
| Designer: ____________ |
| Panel No.: __________ |
| Frame ID: __________ |
| Building No.: __________ |




| From | | | To | | | |
|---|---|---|---|---|---|---|
| Panel Position | Pair Letter | Field Color | Panel Position | Pair Letter | Field Color | Cable Description |
| A1 | | | | | | |
| A2 | | | | | | |
| A3 | | | | | | |
| A4 | | | | | | |
| A5 | | | | | | |
| A6 | | | | | | |
| B1 | | | | | | |
| B2 | | | | | | |
| B3 | | | | | | |
| B4 | | | | | | |
| B5 | | | | | | |
| B6 | | | | | | |
| C1 | | | | | | |
| C2 | | | | | | |
| C3 | | | | | | |
| C4 | | | | | | |
| C5 | | | | | | |
| C6 | | | | | | |
| D1 | | | | | | |
| D2 | | | | | | |
| D3 | | | | | | |
| D4 | | | | | | |
| D5 | | | | | | |
| D6 | | | | | | |
| E1 | | | | | | |
| E2 | | | | | | |
| E3 | | | | | | |
| E4 | | | | | | |
| E5 | | | | | | |
| E6 | | | | | | |
| F1 | | | | | | |
| F2 | | | | | | |
| F3 | | | | | | |

**Figure 10–17 Cont'd on next page**

## Figure 10–17(Cont.): Termination Shelf Crossconnect/Interconnect Map

| From | | | To | | | |
|---|---|---|---|---|---|---|
| Panel Position | Pair Letter | Field Color | Panel Position | Pair Letter | Field Color | Cable Description |
| F4 | | | | | | |
| F5 | | | | | | |
| F6 | | | | | | |
| G1 | | | | | | |
| G2 | | | | | | |
| G3 | | | | | | |
| G4 | | | | | | |
| G5 | | | | | | |
| G6 | | | | | | |
| H1 | | | | | | |
| H2 | | | | | | |
| H3 | | | | | | |
| H4 | | | | | | |
| H5 | | | | | | |
| H6 | | | | | | |
| J1 | | | | | | |
| J2 | | | | | | |
| J3 | | | | | | |
| J4 | | | | | | |
| J5 | | | | | | |
| J6 | | | | | | |
| K1 | | | | | | |
| K2 | | | | | | |
| K3 | | | | | | |
| K4 | | | | | | |
| K5 | | | | | | |
| K6 | | | | | | |
| L1 | | | | | | |
| L2 | | | | | | |
| L3 | | | | | | |
| L4 | | | | | | |
| L5 | | | | | | |
| L6 | | | | | | |
| M1 | | | | | | |
| M2 | | | | | | |
| M3 | | | | | | |
| M4 | | | | | | |
| M5 | | | | | | |
| M6 | | | | | | |

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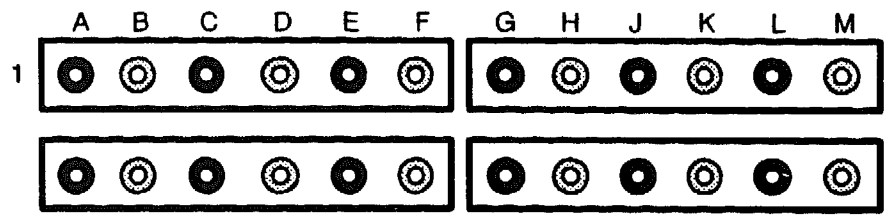
## Figure 10–18: Combination Shelf Crossconnect/Interconnect Map

| Map Identification |
|---|
| Project ID: ______________ |
| Designer: ______________ |
| Panel No.: ______________ |
| Frame ID: ______________ |
| Building No.: ______________ |




| From | | | To | | | |
|---|---|---|---|---|---|---|
| Panel Position | Pair Letter | Field Color | Panel Position | Pair Letter | Field Color | Cable Description |
| A1 | | | | | | |
| B1 | | | | | | |
| C1 | | | | | | |
| D1 | | | | | | |
| E1 | | | | | | |
| F1 | | | | | | |
| A2 | | | | | | |
| B2 | | | | | | |
| C2 | | | | | | |
| D2 | | | | | | |
| E2 | | | | | | |
| F2 | | | | | | |
| G1 | | | | | | |
| H1 | | | | | | |
| J1 | | | | | | |
| K1 | | | | | | |
| L1 | | | | | | |
| M1 | | | | | | |
| G2 | | | | | | |
| H2 | | | | | | |
| J2 | | | | | | |
| K2 | | | | | | |
| L2 | | | | | | |
| M2 | | | | | | |

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#### 10.7.3.2 RWDF Interconnect Map

An interconnect map is completed for each RWDF (Figure 10–19). Each map has three parts.

The first part includes:

- The map identification section
- A panel illustration that identifies the coupler positions with row numbers and column letters

The second part is an RDWF interconnect map that defines:

- Which HDF cable fibers connect to the rear of each coupler position (inside the RWDF)
- Which wallbox cable fibers connect to each coupler position on the outside of the RWDF

The third section defines the cable connections as follows:

- The HDF cable fiber connection to each coupler position is identified by the HDF cable's identifier with a fiber color code.
- The wallbox cable connections to the panel positions are identified with the same cable-label/fiber-color entry.

## Figure 10–19: RWDF Interconnect Map

**Map Identification**

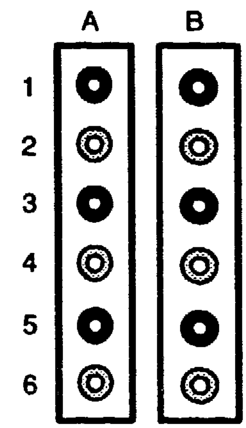
Project ID: ______________

Designer: ______________

Panel No.: __________

Frame ID: __________

Building No.: __________




| Panel Position | Pair Letter | Fiber Connection Inside Panel | Pair Letter | Fiber Connection Outside Panel |
|---|---|---|---|---|
| A1 | | | | |
| A2 | | | | |
| A3 | | | | |
| A4 | | | | |
| A5 | | | | |
| A6 | | | | |
| B1 | | | | |
| B2 | | | | |
| B3 | | | | |
| B4 | | | | |
| B5 | | | | |
| B6 | | | | |

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## 10.8 Bill of Materials (BOM) Worksheet

This section provides instructions for the Distribution Frame BOM Worksheet (Figure 10–20). Photocopy and complete a BOM worksheet completed for each distribution frame's passive fiber optic cable plant and cable routing hardware requirements. Each BOM worksheet is compiled from the component requirements defined in the distribution frame's layout diagram, Equipment Room Cable Routing Diagram, panel connection worksheets, and crossconnect/interconnect map.

#### Section I Project Identification

Identify the project, worksheet page number, designer, and date.

#### Section II Distribution Frame Identification

Identify the distribution frame by its identifier and building number (the actual building number—not the building's MDF or IDF identifier).

#### Section III Component Requirements

List each component by:

- Component description (for example, FDDI-to-2.5 mm baycnet ST-type connector cable, 10 meter (33 foot))
- Order number (for ordering the 10 meter (33 foot) FDDI-to-2.5 mm cable from Digital, or an authorized Digital distributor, the order number is BN24D-10)
- Quantity needed (total all of the 10 meter (33 foot) FDDI-to-2.5 mm cables listed in the distribution frame's crossconnect/interconnect maps)
- Unit price
- Total price (quantity multiplied by the unit price)

Summarize the total cost of the listed components.

**Figure 10–20: Distribution Frame BOM Worksheet**

I. Project Identification:

Project ID: ______________ Page ____ of ____

Designer: ___________________________________ Date: ______________

II. Distribution Frame Identification:

Building Number: _______ Floor Number: _________ Distribution Frame Identifier: ________

III. Component Requirements:

| Item Number | Part Number | Description | Quantity | Unit Price | Total Price |
|---|---|---|---|---|---|
| | | | | | |
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| | | | | | |
| | | | | Total Cost: | |

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# CHAPTER 11

# 11

# Fiber Optic Cable Plant Product Descriptions

This chapter identifies and describes the cables and passive components that are available as part of the DECconnect System fiber optic cable plants. This information is provided in the form of product descriptions.

## 11.1 Ordering Parts

The Digital products listed and described in this chapter can be ordered from a Digital Sales Representative, DECdirect, or an authorized DECconnect System distributor.

**NOTE**

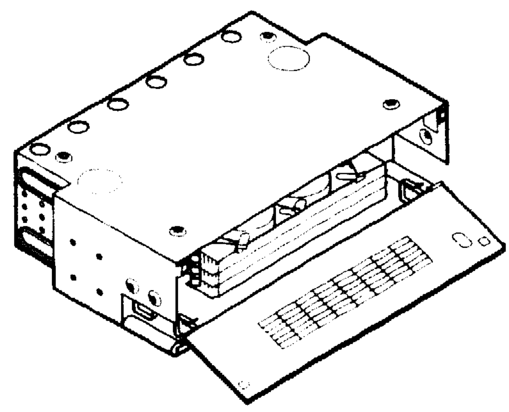
Blank order sheets, which list all of the parts available from Digital by Digital part number, are provided in Chapter 12.

## 11.2 Product Descriptions

Two types of products are described in this chapter: Digital products and auxiliary items.

- Digital products — individual descriptions are provided for each Digital product. Each description includes some or all of the following information:
  - Functional description
  - Physical specification
  - Environmental specification
  - Ordering information
- Auxiliary items — a list at the end of the chapter identifies products that are not directly available from Digital, but that are approved for use in Digital's fiber optic structured wiring. The auxiliary items list includes:
  - Part descriptions
  - Vendor identification
  - Vendor part number

# Splice Shelf




## Ordering Information

Order No.

*H3107–G*

***Includes:***

- Recessed access brackets (2)
- Universal mounting brackets (2)
- Routing rings
- Metal door
- Shelf subassembly
- Splice label
- Splice organizer trays (3)
- 3-tray housing
- Mounting hardware
- Instructions

**Physical Specifications**

Height: 12.5 cm (5 in)
Width: 42.5 cm (17 in)
Depth: 27.5 cm (11 in)

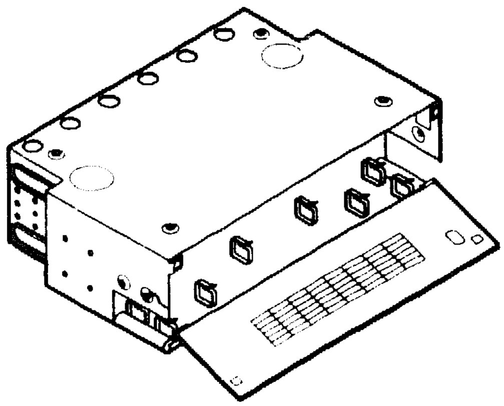
The splice shelf is used to store mechanical or fusion splices. This rack mounted unit has a capacity of 3 splice organizer trays, each of which can contain 24 splices for a total capacity of 72 splices. Indoor and outdoor cable can be secured to the shelf using the supplied cable clamps.

The supplied splice organizer tray can accommodate, but does not include, the Digital recommended splice (Order No. H3114–FG).

With the brackets supplied, the splice shelf can be mounted in an Office Communications Cabinet (Order No. H9646–EA), Satellite Equipment Room Rack (Order No. H3120), or 19-inch RETMA and 23-inch standard telecommunications racks.

Refer to the Auxiliary Items section for accessory items.

# Storage Shelf




## Ordering Information

**Order No.**

*H3107-H*

***Includes:***

- Recessed access brackets (2)
- Universal mounting brackets (2)
- 5-inch shelf assembly
- Metal door
- Fiber routing rings
- Mounting hardware
- Instructions

**Physical Specifications**

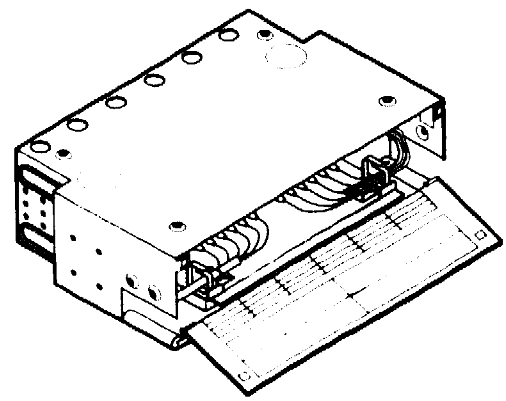
Height: 12.5 cm (5 in)
Width: 42.5 cm (17 in)
Depth: 27.5 cm (11 in)

The storage shelf is used for the storage of preconnectorized jumpers, field-made jumpers, or buffered cable. Fiber routing rings are used to organize and provide strain relief for fibers.

With the brackets supplied, the storage shelf can be mounted in an Office Communications Cabinet (Order No. H9646-EA), Satellite Equipment Room Rack (Order No. H3120), or 19-inch RETMA and 23-inch standard telecommunications racks.

Refer to the Auxiliary Items section for accessory items.

# Combination Shelf




## Ordering Information

**Order No.** *H3107–J*

***Includes:***

- Recessed access brackets (2)
- Universal mounting brackets (2)
- 5-inch shelf assembly
- Connector panels (4)
- Metal door
- Splice label
- Splice organizer tray (1)
- Fiber routing rings
- Mounting hardware
- Instructions

**Physical Specifications**

| | |
|---|---|
| Height: | 12.5 cm (5 in) |
| Width : | 42.5 cm (17 in) |
| Depth: | 27.5 cm (11 in) |

The combination shelf is used for splicing and termination of indoor or outdoor cable. This rack mounted unit has a capacity of 24 fibers. A maximum of 4 connector panels (each with a capacity of 6 couplers) can be installed in the upper shelf area. An extendable shelf housing contains a single splice organizer tray. Routing rings are used to organize fibers and provide strain relief.

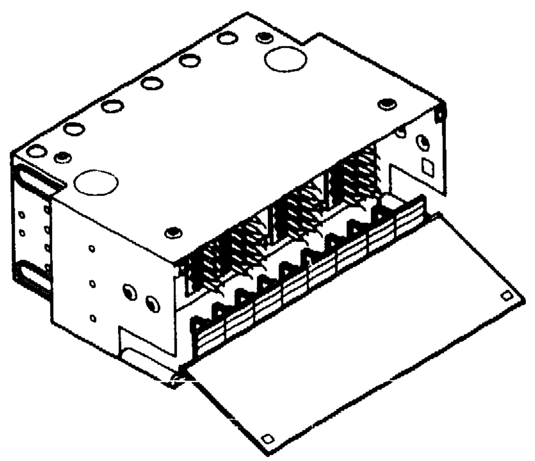
The 4 supplied connector panels can accommodate, but do not include, 2.5 mm bayonet ST-type connector couplers (Order Nos. H3114–FC and H3114–FH).

The supplied splice organizer tray can accommodate, but does not include, the Digital recommended splice (Order No. H3114–FG).

With the brackets supplied, the combination shelf can be mounted in an Office Communications Cabinet (Order No. H9646–EA), Satellite Equipment Room Rack (Order No. H3120), or 19-inch RETMA and 23-inch standard telecommunications racks.

Refer to the Auxiliary Items section for accessory items.

# Termination Shelf




## Ordering Information

**Order No.** *H3107-K*

***Includes:***

- Recessed access brackets (2)
- Universal mounting brackets (2)
- Shelf subassembly, with hinges
- Connector panel (twelve 6-capacity panels)
- Front and rear ring stand and routing rings
- Label and label bracket
- Plexiglass door
- Mounting hardware
- Instructions

**Physical Specifications**

| | |
|---|---|
| Height: | 17.5 cm (7 in) |
| Width: | 42.5 cm (17 in) |
| Depth: | 27.5 cm (11 in) |

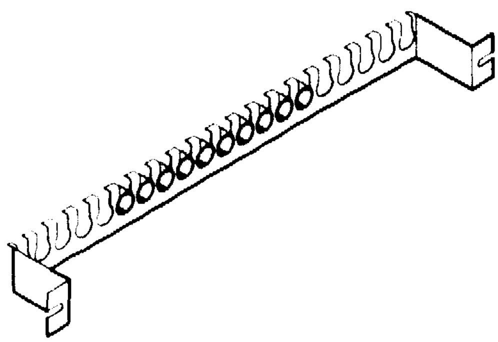
The termination shelf is used for the termination of indoor or outdoor cable. A maximum of 12 coupler panels (each with a capacity of 6 couplers) can be installed, providing the capability for terminating 72 fibers. The shelf has provisions for storing fiber, while fiber routing rings are used to organize and provide strain relief. The shelf includes a label bracket and blank label for identifying cable terminations.

The 12 supplied coupler panels can accommodate, but do not include, 2.5 mm bayonet ST-type connector couplers (Order Nos. H3114-FC and H3114-FH).

With the brackets supplied, the termination shelf can be mounted in an Office Communications Cabinet (Order No. H9646-EA), Satellite Equipment Rack (Order No. H3120), or in 19-inch RETMA and 23-inch standard telecommunications racks.

Refer to the Auxiliary Items section for accessory items.

# Cable Manager Bracket




## Ordering Information

| Order No. | Description |
|---|---|
| *H3108–AA* | *DECconnect System Cable Manager Kit* |

***Includes:***

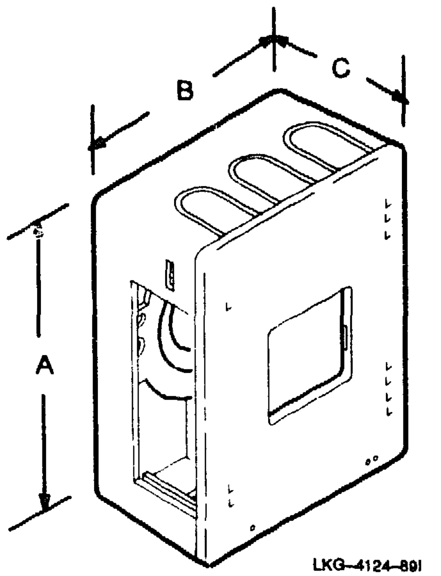
- Cable organizer bracket with 20 cutouts
- 20 bushings
- 2 U-nuts
- 2 rack mounting screws

**Physical Specifications**

Height: 3.81 cm (1.5 in)
Depth: 6.35 cm (2.5 in)
Width: 22.86 cm (9 in) (rack width)

The DECconnect System cable manager bracket provides strain relief for patching cables and guides to the rear of the cabinet for cable management. The bracket mounts into any standard 19-inch rack.

# Modular Office Wallbox Kit




## Ordering Information

**Order No.**

*H3111-GA*
*H3111-GB*
*H3111-GC*

**Quantity:** 8 wallboxes per kit

***Each kit includes:***

- Blank panels
- Wiring clips
- Dual inserts
- Blank plugs
- Cover
- Base unit
- Labels
- Label cover
- Mounting hardware
- Installation instructions

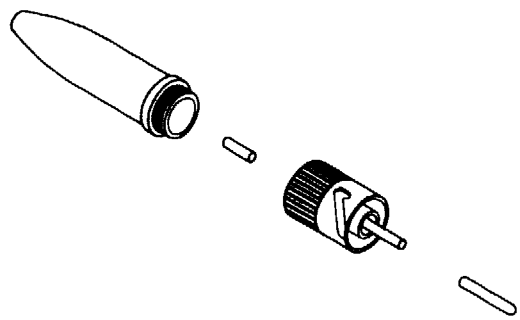
**Physical Specifications**

| | |
|---|---|
| Height : | A = 10 cm (4 in) |
| Width : | B = 7.5 cm (3 in) |
| Depth: | C = 4.7 cm (1–7/8 in) |

| Description | Color |
|---|---|
| H3111-GA | Digital Grey |
| H3111-GB | White |
| H3111-GC | Ivory |

The modular office wallbox is a wall-mountable receptacle that provides the connection point for office communications equipment. The wallbox accepts all DECconnect System modular connector systems for both copper and fiber.

# Field-Installable 2.5 mm Bayonet ST-type Fiber Optic Connector Kit




Typical connector, actual kits may differ.

## Ordering Information

**Order No.**

*H3114-FA*

**Quantity:** 6 connectors per kit

***Includes:***

- 2.5 mm bayonet ST-type connector, black boot (3)
- 2.5 mm bayonet ST-type connector, red boot (3)

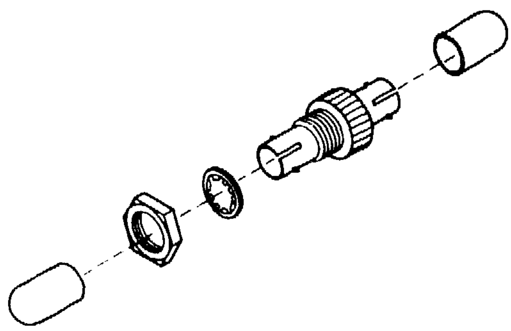
**Physical Specifications**

- Maximum loss after coupling: less than or equal to 0.7 dB per connector pair at 20° C.
- Operating Temperature range: -20° C to 55° C.
- Terminated using fiber optic termination tool kit (Order No. H8102–AA [110 volt] or Order No. H8102–AC [220 volt]).
- Average termination time: less than 10 minutes per connector.
- Works with 2.0 mm, 2.4 mm, or 3 mm breakout cables, with aramid strength members, or 900 micron-buffered fiber or 250 micron-coated fiber.
- Requires H8102–AB consumables kit (material for 100 terminations).
- This connector is for 62.5/125 micron fiber.
- This connector is compatible with the AT&T ST2 connector.

The 2.5 mm bayonet ST-type connector is used in cable-to-cable or cable-to-equipment applications, providing high performance, low cost, and easy field-mounting in a rugged compact package.

See the Auxiliary Items section for additional information.

# 2.5 mm Bayonet ST-type Connector Coupler Kit


LKG-3545-89A

## Ordering Information

**Order No.**

*H3114–FC*

**Quantity**: 12 couplers per kit

**Physical Specifications**

– Operating temperature range: –20° C to 55° C
– Compatible with H3114–FA connectors
– Used with H3131–C, H3107–J, and H3107–K kits

This 2.5 mm bayonet ST-type connector coupler is used in termination shelves, combination shelves, and remote wall enclosures.

# Splice Tool Kit

## Ordering Information

Order No.

*H3114–FD*

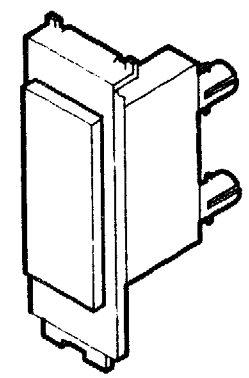
***Includes:***

- Base and splice tool hardware
- Magnifier
- Optical fiber stripping tool
- Cleaving tool
- Splice tool
- Alcohol dispenser
- Scissors
- Mandrel tool
- Epoxy dispensing tool with coupling gel and dipensing tip

This splice tool kit contains all the tools needed to mount a mechanical splice. Used in conjunction with the H3114–FG splice kit.

Replacement parts for kit replenishment are available directly from the suppliers listed in the Auxiliary Items section.

# FDDI-to-Dual 2.5 mm Bayonet ST-type Connector Panel for the Modular Office Wallbox




## Ordering Information

**Order No.**

*H3114–FE*

**Quantity:** 8 panels per kit

***Each unit includes:***

- FDDI-to-dual 2.5 mm bayonet ST-type connector adapter mounted on a modular wallbox standard insert.

The FDDI-to-dual 2.5 mm bayonet ST-type connector panel is designed for installation in the modular office wallbox. This panel provides for using the ANSI-standard FDDI connector and transition to 2.5 mm bayonet ST-type connectors, which are used in LAN field installations.

The panel comes premounted on the modular wallbox standard insert with a spring-loaded dust protection door.

# Dual 2.5 mm Bayonet ST-type Connector Panel for the Modular Office Wallbox

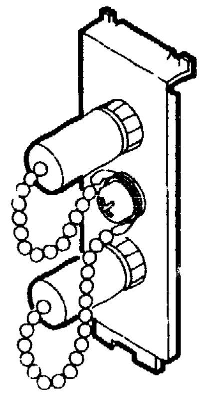



Figure shown may differ from the actual product.

## Ordering Information

**Order No.**

*H3114–FF*

**Quantity:** 8 panels per kit

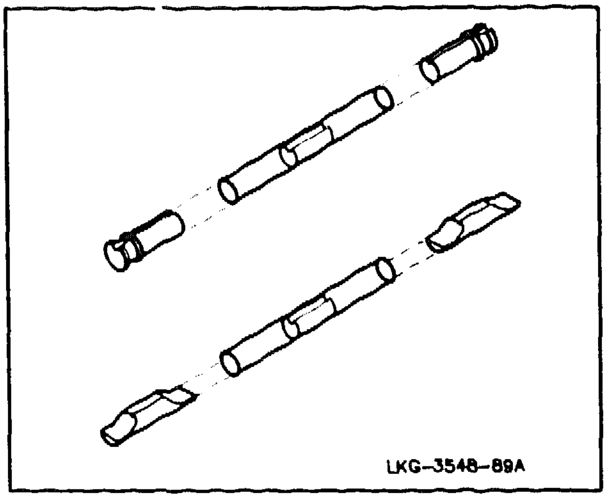
***Each unit includes:***

- 8 Dual 2.5 mm bayonet ST-type connector panel for the modular wallbox.

The dual 2.5 mm bayonet ST-type connector panel is designed for installation in the modular office wallbox. This panel provides the office interface to dual 2.5 mm bayonet ST-type connectors.

The panels come premounted on the modular wallbox standard insert and include tethered dust covers.

# Splice Kit




## Ordering Information

**Order No.**

*H3114-FG*

***Includes:***

- **12 mechanical splices with adapter chocks per kit.**

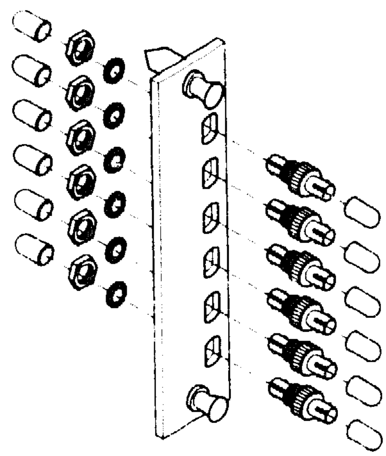
**Specifications**

- Operating temperature range: –40° C to +70° C
- Average splice time: less than 5 minutes
- Splices can be "redone" to reduce loss
- Maximum loss less than or equal to .04 dB

This splice kit contains all the materials needed to mount mechanical splices. Used in conjunction with the H3114–FD splice tool kit.

See the Auxiliary Items section for accessory items.

# Panel for Termination Shelf and Combination Shelf



LKG–3547–89A

## Ordering Information

**Order No.**

*H3114–FH*

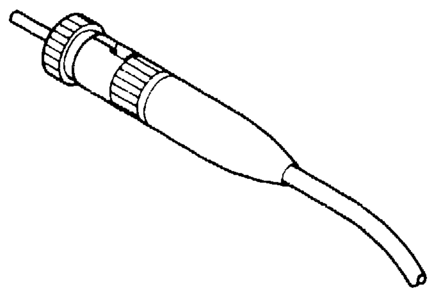
**Quantity:** 2 panels per kit

***Each unit includes:***

- Panels loaded with six 2.5 mm ST-type bayonet connector couplers

The panel, used in the H3107–K termination shelf and H3107–J combination shelf, is supplied loaded with six 2.5 mm bayonet ST-type connector couplers.

# 2.5 mm Bayonet ST-type Splice Pigtails



LKG-3546-89A

## Ordering Information

**Order No.**

*H3118-FA*

**Quantity:** 6 pigtails per kit

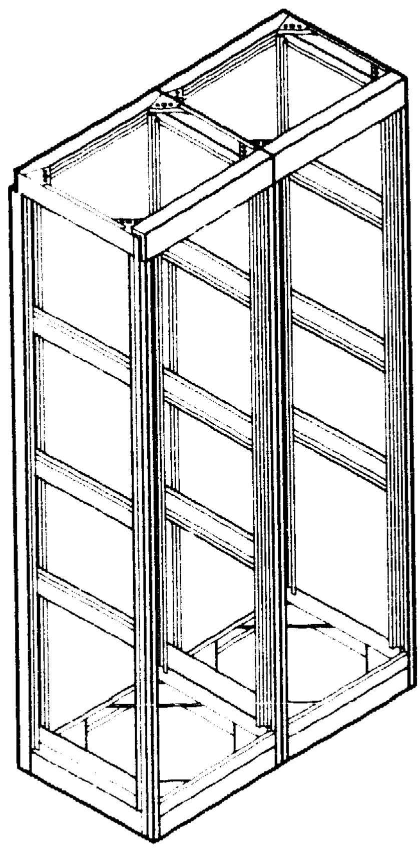
**Physical Specifications**

Operating temperature range: –20° C to 55° C

The splice pigtail consists of a preconnectorized 2.5 mm bayonet ST-type connector and 62.5/125 µm tight buffered cable (3 meter [9.8 foot] length) suitable for splice applications.

See the Auxiliary Items section for other pigtail designs.

## H3120 86-inch Rack


LKG–3549–89A

### Ordering Information

| Order No. | Description |
|---|---|
| *H3120* | *86-inch rack* |

*Includes:*

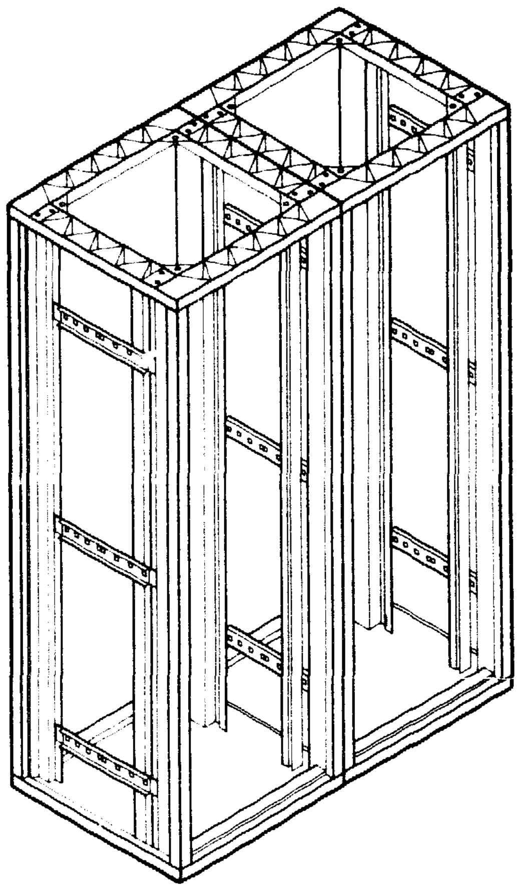
- Two 19-inch RETMA racks
- Two eight-outlet power strips
- Cable management hardware
- Installation instructions

**Physical Specifications**

| | |
|---|---|
| Height: | 215 cm (86 in) |
| Depth: | 57.5 cm (23 in) |
| Width: | 115 cm (46 in) |

The H3120 86-inch rack is two industry standard 19-inch RETMA racks attached side-by-side. The H3120 ships complete with two steel racks, two 8-outlet power strips, miscellaneous hardware, and installation instructions.

## H3130–XX 72-inch Rack




### Ordering Information

| Order No. | Description |
|---|---|
| *E0–H3130–CB* | *72-inch rack, open active and open passive bays* |
| *E0–H3130–C3* | *72-inch rack, open active bay* |
| *E0–H3130–D3* | *72-inch rack, open passive bay* |
| *E0–H3130–CA* | *72-inch rack, enclosed active and enclosed passive bays* |
| *E0–H3130–C2* | *72-inch rack, enclosed active bay* |
| *E0–H3130–D2* | *72-inch rack, enclosed passive bay* |
| *E0–H3130–X2* | *Side panels to enclose C2 or D2* |

*Includes:*

- Two 16-outlet power strips (220 V)

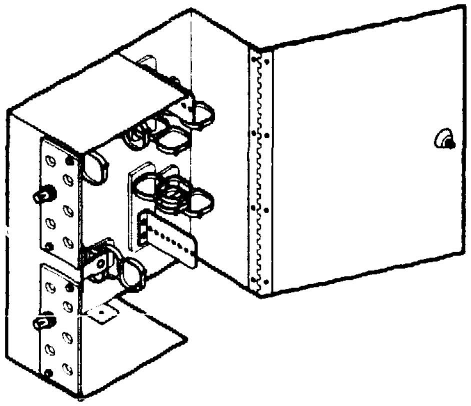
**Physical Specifications**

| | |
|---|---|
| Height: | 178.8 cm (70.4 in) |
| Depth: | 60.0 cm (23.6 in) |
| Width: | 120.0 cm (47.2 in) |
| Weight: | E0–H3130–CA 154 kg |
| | E0–H3130–CB 76 kg |

The H3130 72-inch rack is two single bay 19-inch racks that are bolted together. It is available in open or enclosed configurations or in a combination of both. Enclosed configurations include steel side and rear panels, and safety glass front doors. Two 16-outlet power strips are also included.

Note: This rack is available only from DECDirect Europe.

# Remote Wall Enclosure for Fiber


LKG-3542-89A

## Ordering Information

**Order No.**

*H3131-C*

***Includes:***

- Remote wall enclosure
- Splice label
- Fiber routing rings
- Connector panels (2)
- Mounting hardware
- Instruction booklet

**Physical Specifications**

| | |
|---|---|
| Height: | 21.875 cm (8-3/4 in) |
| Width: | 19.06 cm (7-5/8 in) |
| Depth: | 7.5 cm (3 in) |

The remote wall enclosure for fiber is a wall-mountable module designed for the splicing, termination, and storage of fiber optic cable. This unit has a capacity of 12 fibers. The unit contains 2 coupler panels (12 coupler total capacity), and 8 double-fiber routing rings. Units can be ganged together for large installations.

The two supplied coupler panels can accommodate, but do not include, 2.5 mm bayonet ST-type connector couplers (Order No. H3114-FC).

A splice adapter kit is available. Refer to the Auxiliary Items section for ordering information.

# 2.5 mm Bayonet ST-type Connector Termination Tool Kit

## Ordering Information

**Order No.**

*H8102–AA (110 volt)*

*H8102–AC (220 volt)*

***Includes:***

- Crimping tool
- Stripping tool
- Curing oven
- Microscope
- Polishing tool
- Connector holders
- Holder block
- Cleaving tool
- Scissors
- Glass plate
- Eye loupe
- Carrying case

**Specifications**

- Terminates H3114–FA field-installable connectors
- Tool kit is compatible with the AT&T ST2 series connector
- An international 220 volt version (Order No. H8102–AC) is available

This tool kit contains all the tools needed to mount the connectors provided in the field-installable 2.5 mm bayonet ST-type connector kit (Order No. H3114–FA). Used in conjunction with the H8102–AB consumables kit.

Replacement parts for kit replenishment are available directly from the suppliers listed in the Auxiliary Items section.

# 2.5 mm Bayonet ST-type Connector Consumables Kit

## Ordering Information

Order No.

*H8102–AB*

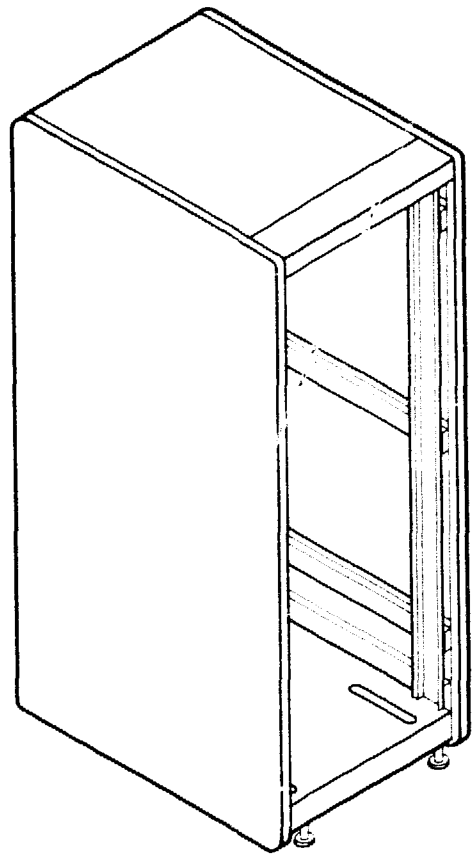
***Includes:***

- 5 µm polishing paper
- 1 µm polishing paper
- Wipes
- Epoxy Dispensing Tools
- Dispensing tips
- Epoxy

This tool kit contains all the consumables needed to mount 100 of the 2.5 mm bayonet ST-type connectors. Used in conjunction with the H8102–AA/–AC 2.5 mm bayonet ST-type connector termination tool kit and the H3114–FA field-installable 2.5 mm bayonet ST-type connector kit.

See the Auxiliary Items section for additional information.

# H9646–XX DECconnect Communications Cabinet




## Ordering Information

| Order No. | Description |
|---|---|
| *H9646–EA* | *DECconnect Communications Cabinet (110 V)* |
| *H9646–EB* | *DECconnect Communications Cabinet (220 V)* |

***The H9646–EA/EB includes:***

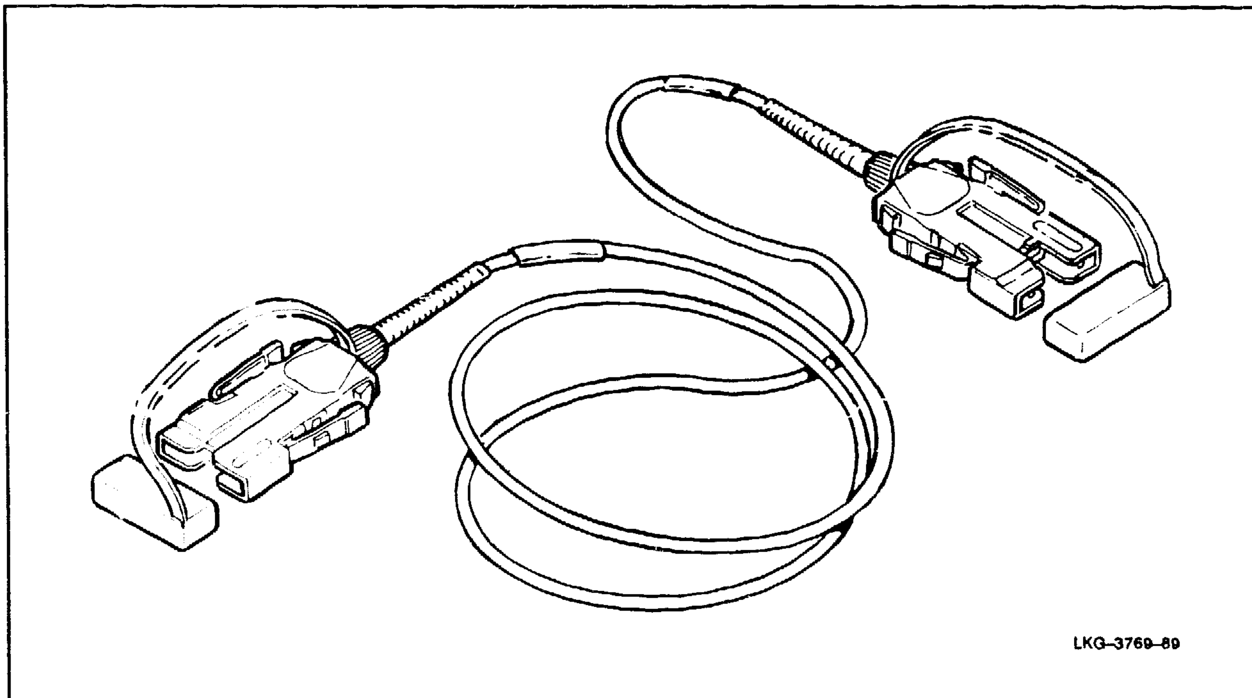
- Cabinet (enclosed/lockable)
- Power strip
- Stabilizer feet
- Installation instructions

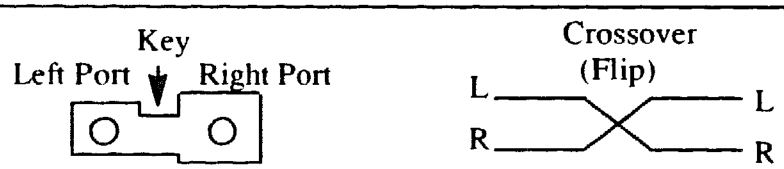
**Physical Specifications**

| | |
|---|---|
| Height: | 151.3 cm (60.5 in) |
| Depth: | 95 cm (38.0 in) |
| Width: | 56.3 cm (22.5 in) |

The DECconnect Communications Cabinet is a stand-alone wiring cabinet suitable for the office environment. This product is ideal for small sites that plan on expanding and require a secure environment for their network products. The cabinet can accommodate a variety of active and passive devices.

## FDDI-to-FDDI Patch Cables




## Ordering Information

| Order No. | Wiring Description | Length |
|---|---|---|
| *BN24B-01* | *Crossover* | *1 m (3.3 ft)* |
| *BN24B-03* | *Crossover* | *3 m (9.9 ft)* |
| *BN24B-4E* | *Crossover* | *4.5 m (14.85 ft)* |
| *BN24B-10* | *Crossover* | *10 m (32.8 ft)* |
| *BN24B-20* | *Crossover* | *20 m (65.6 ft)* |
| *BN24B-30* | *Crossover* | *30 m (98.4 ft)* |

## FDDI-to-FDDI Patch Cables (Con't)

The FDDI-to-FDDI patch cable is available in several lengths: 1 meter (3.3 feet), 3 meters (9.8 feet), 4.5 meters (14.85 feet), 10 meters (32.8 feet), 20 meters (65.5 feet) and 30 meters (98.4 feet). The patch cable consists of a dual 62.5/125 μm fiber of round construction for flexibility. The FDDI connectors have field-programmable keying and are supplied with tethered dust covers.

**Physical Specifications**

- Number of fibers: 2
- Core/clad diameter: 62.5/125 μm
- Cable minimum bend radius (inches) long term=1.5
- FDDI connector meets ANSI FDDI PMD requirements
- Bandwidth: 160/500 MHz–km for 850/1300 nm wavelength
- Chromatic Dispersion Requirements:
  The zero dispersion wavelength and dispersion slope must fall below the following bounds when plotted as wavelength ($x$ points) versus dispersion slope ($y$ points) on a graph:

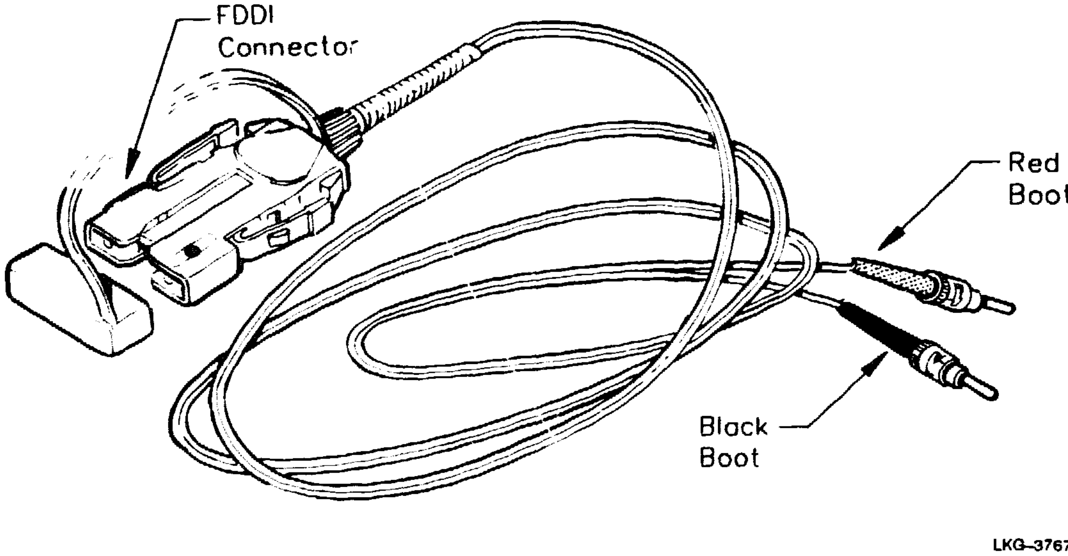
  1295 nm, 0.105 ps/(nm$^2$•km)
  1300 nm, 0.110 ps/(nm$^2$•km)
  1348 nm, 0.110 ps/(nm$^2$•km)
  1365 nm, 0.093 ps/(nm$^2$•km)

**Environmental Specifications**

- Operating temperature range: –10° C to 55° C
- Storage temperature range: –20° C to 70° C
- Operating relative humidity range: 5% to 85%
- Storage relative humidity range: 5% to 95%

# Patch Cables (Con't)

## FDDI-to-2.5 mm Bayonet ST-type Connector Patch Cables




### Ordering Information

| Order No. | Description |
|---|---|
| *BN24D-01* | *1 m (3.2 ft)* |
| *BN24D-03* | *3 m (9.9 ft)* |
| *BN24D-4E* | *4.5 m (14.85 ft)* |
| *BN24D-10* | *10 m (32.8 ft)* |
| *BN24D-20* | *20 m (65.6 ft)* |
| *BN24D-30* | *30 m (98.4 ft)* |

# Patch Cables (Con't)

## FDDI-to-2.5 mm Bayonet ST-type Connector Patch Cables (Con't)

**Physical Specifications**

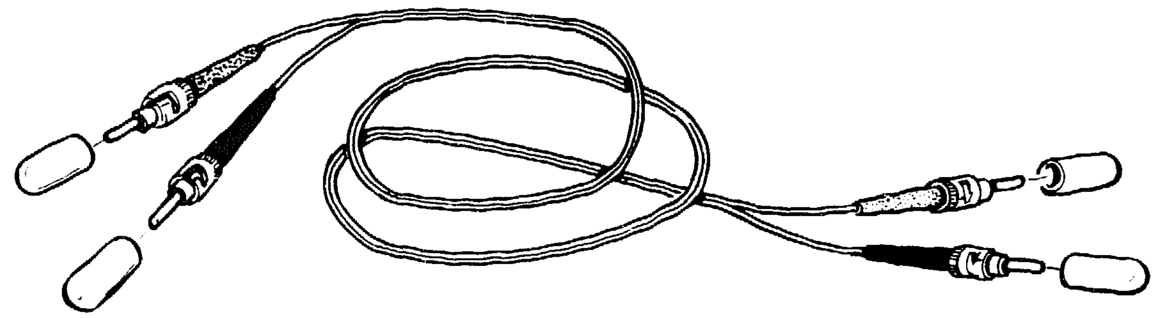
- Number of fibers: 2
- Core/clad diameter: 62.5/125 µm
- Cable minimum bend radius (inches) long term=1.5
- Bandwidth: 160/500 MHz–km for 850/1300 nm wavelengths
- Chromatic Dispersion Requirements:
  The zero dispersion wavelength and dispersion slope must fall below the following bounds when plotted as wavelength (x points) versus dispersion slope (y points) on a graph:
  - 1295 nm, 0.105 ps/(nm$^2$•km)
  - 1300 nm, 0.110 ps/(nm$^2$•km)
  - 1348 nm, 0.110 ps/(nm$^2$•km)
  - 1365 nm, 0.093 ps/(nm$^2$•km)

**Environmental Specifications**

- Operating temperature range: –10° C to 55° C
- Storage temperature range: –20° C to 70° C
- Operating relative humidity range: 5% to 85%
- Storage relative humidity range: 5% to 95%

The FDDI-to-2.5 mm bayonet ST-type connector patch cable is available in several lengths: 1 meter (3.2 feet), 3 meter (9.9 feet), 4.5 meter (14.85 feet), 10 meter (32.8 feet), 20 meter (65/6 feet) and 30 meter (98.4). It consists of a dual 62.5/125 µm fiber of zipcord construction for flexibility. Each patch cable is color coded with red and black connector boots for easy identification. The FDDI connector is coded with a black identification mark that corresponds with the 2.5 mm bayonet ST-type connector black boot for easy line tracing. The FDDI connector has field-programmable keying and is supplied with an integral dust cover.

## Dual 2.5 mm Bayonet ST-type Connector Patch Cables




### Ordering Information

| Order No. | Description |
|---|---|
| *BN24E–01* | *1 m (3.2 ft)* |
| *BN24E–03* | *3 m ( 9.9 ft)* |
| *BN24E–4E* | *4.5 m (14.85 ft)* |
| *BN24E–10* | *10 m (32.8 ft)* |
| *BN24E–20* | *20 m (65.6 ft)* |
| *BN24E–30* | *30 m (98.4 ft)* |

**Physical Specifications**

- Number of fibers: 2
- Core/clad diameter: 62.5/125 µm
- Cable minimum bend radius (inches): long term=1.5
- Bandwidth: 160/500 MHz–km for 850/1300 nm wavelengths
- Chromatic Dispersion Requirements:
  The zero dispersion wavelength and dispersion slope must fall below the following bounds when plotted as wavelength ($x$ points) versus dispersion slope ($y$ points) on a graph:

  1295 nm, 0.105 ps/(nm$^2$•km)
  1300 nm, 0.110 ps/(nm$^2$•km)
  1348 nm, 0.110 ps/(nm$^2$•km)
  1365 nm, 0.093 ps/(nm$^2$•km)

# Patch Cables (Con't)

## Dual 2.5 mm Bayonet ST-type Connector Patch Cables (Con't)

**Environmental Specifications**

- Operating temperature range: –10° C to 55° C
- Storage temperature range: –20° C to 70° C
- Operating relative humidity range: 5% to 85%
- Storage relative humidity range: 5% to 95%

The dual 2.5 mm bayonet ST-type connector patch cable is available in several lengths: 1 meter, 3 meters, 4.5 meters, 10 meters, 20 meters, and 30 meters. It consists of a dual 62.5/125 µm fiber of zipcord construction for flexibility. Each patch cable is color coded with red and black connector boots for easy identification. The zipcord can also be "ripped down" to create two separate patch cables.

# Cables for Horizontal Wiring

## 4-Fiber Cable (Light-Duty)

### Ordering Information

| Order No. | Description | Application |
|---|---|---|
| *17–02432–01* | *Plenum* | *Splicing, light-duty pulling* |
| *17–02433–01* | *PVC* | *Splicing, light-duty pulling* |

Length supplied as requested by the customer.

**Specifications**

- Number of fibers: 4
- Core/clad diameter: 62.5/125 µm
- Cable outside diameter (inches): 0.180 nominal
- Maximum pulling tension (lbs): 100
- Cable minimum bend radius (inches): short term=2.0 long term=4.0
- Individual buffered fiber bend radius (inches): long term=0.75
- Insertion loss: 3.75/1.5 dB/km at 850/1300 nm wavelengths
- Flammability: PVC meets UL Type OFNR requirements; plenum meets UL Type OFNP requirements
- Bandwidth: 160/500 MHz–km for 850/1300 nm wavelengths
- Chromatic Dispersion Requirements:
  The zero dispersion wavelength and dispersion slope must fall below the following bounds when plotted as wavelength ($x$ points) versus dispersion slope ($y$ points) on a graph:

  1295 nm, 0.105 ps/(nm$^2$•km)
  1300 nm, 0.110 ps/(nm$^2$•km)
  1348 nm, 0.110 ps/(nm$^2$•km)
  1365 nm, 0.093 ps/(nm$^2$•km)

**Environmental Specifications**

Operating temperature range: –10° C to +55° C
Storage temperature range: –40° C to +70° C
Operating relative humidity range: 5% to 85%
Storage relative humidity range: 5% to 95%

The 4-fiber light-duty cable contains four 62.5/125 micron fibers. The fibers are buffered up to 900 microns, which in addition to providing fiber protection also facilitates fiber identification through color coding. The fibers are stranded, covered by an aramid yarn and an overjacket of either PVC or plenum-grade thermoplastic, according to the application.

Note: These cables are not available through DECdirect USA. Contact Anixter Bros. Inc. (approved cable manufacturers) or other authorized DECconnect System distributors.

# Cables for Horizontal Wiring (Con't)

## 4-Fiber Cable (Heavy-Duty)

### Ordering Information

| Order No. | Description | Application |
|---|---|---|
| *17–02491–01* | *Plenum* | *Connectorization, heavy-duty pulling* |
| *17–02490–01* | *PVC* | *Connectorization, heavy-duty pulling* |

Length supplied as requested by the customer.

**Physical Specifications**

- Number of fibers: 4
- Core/clad diameter: 62.5/125 µm
- Cable outside diameter (inches): 0.235 nominal
- Maximum pulling tension (lbs): 250
- Cable minimum bend radius (inches): short term= 3.0, long term=5.0
- Individual buffered fiber bend radius (inches): long term=0.75
- Insertion loss: 3.75/1.5 dB/km at 850/1300 nm wavelengths
- Flammability: PVC meets UL Type OFNR requirements; plenum meets UL Type OFNP requirement
- Bandwidth: 160/500 MHz–km for 850/1300 nm wavelengths
- Chromatic Dispersion Requirements:
  The zero dispersion wavelength and dispersion slope must fall below the following bounds when plotted as wavelength (*x* points) versus dispersion slope (*y* points) on a graph:
  - 1295 nm, 0.105 ps/(nm$^2$•km)
  - 1300 nm, 0.110 ps/(nm$^2$•km)
  - 1348 nm, 0.110 ps/(nm$^2$•km)
  - 1365 nm, 0.093 ps/(nm$^2$•km)

**Environmental Specifications**

Operating temperature range: –10° C to +55° C
Storage temperature range: –40° C to +70° C
Operating relative humidity range: 5% to 85%
Storage relative humidity range: 5% to 95%

The 4-fiber heavy-duty cable contains four 62.5/125 micron fiber subunits. Each 900 micron buffered fiber is covered by an aramid yarn, and by an inner jacket of either PVC or plenum-grade thermoplastic, according to the application. An overjacket of PVC or plenum-grade thermoplastic is applied over cabled bundles containing a central strength member.

Note: These cables are not available through DECdirect USA. Contact Anixter Bros. Inc. (approved cable manufacturers) or other authorized DECconnect System distributors.

## 12-Fiber Building Backbone Cable (Heavy-Duty)

### Ordering Information

| Order No. | Description | Application |
|---|---|---|
| *17–02535–01* | *Plenum* | *Connectorization, heavy-duty pulling* |
| *17–02534–01* | *PVC* | *Connectorization, heavy-duty pulling* |

Length supplied as requested by the customer.

**Physical Specifications**

- Number of fibers: 12
- Core/clad diameter: 62.5/125 µm
- Cable outside diameter (inches): 0.425 nominal
- Maximum pulling tension (lbs): 125
- Cable minimum bend radius (inches): short term=6.0 long term=10.0
- Individual buffered fiber bend radius (inches): long term=0.75
- Insertion loss: 3.75/1.5 dB/km at 850/1300 nm wavelengths
- Flammability: PVC meets UL Type OFNR requirements; plenum meets UL Type OFNP requirements
- Bandwidth: 160/500 MHz–km for 850/1300 nm wavelengths
- Chromatic Dispersion Requirements:
  The zero dispersion wavelength and dispersion slope must fall below the following bounds when plotted as wavelength (*x* points) versus dispersion slope (*y* points) on a graph:

  1295 nm, 0.105 ps/(nm$^2$•km)
  1300 nm, 0.110 ps/(nm$^2$•km)
  1348 nm, 0.110 ps/(nm$^2$•km)
  1365 nm, 0.093 ps/(nm$^2$•km)

**Environmental Specifications**

- Operating temperature range: –10° C to +55° C
- Storage temperature range: –40° C to +70° C
- Operating relative humidity range: 5% to 85%
- Storage relative humidity range: 5% to 95%

The 12-fiber building backbone cable contains twelve 62.5/125 micron fibers. Each fiber is covered by an aramid yarn and an inner jacket of either PVC or plenum-grade thermoplastic, according to the application. An overjacket of PVC or plenum-grade thermoplastic is applied over cabled bundles containing a central strength member.

Note: These cables are not available through DECdirect USA. Contact Anixter Bros. Inc. (approved cable manufacturers) or other authorized DECconnect System distributors.

## 12-Fiber Building Backbone Cable (Light-Duty)

### Ordering Information

| Order No. | Description | Application |
|---|---|---|
| *17–02537–01* | *Plenum* | *Splicing, light-duty* |
| *17–02536–01* | *PVC* | *Splicing, light-duty* |

Length supplied as requested by the customer.

**Physical Specifications**

- Number of fibers: 12
- Core/clad diameter: 62.5/125 μm
- Cable outside diameter (inches): 0.290 nominal
- Maximum pulling tension (lbs): 125
- Cable minimum bend radius (inches): short term=2.5 long term=5.0
- Individual buffered fiber bend radius (inches): long term=0.75
- Insertion loss: 3.75/1.5 dB/km at 850/1300 nm wavelengths
- Flammability: PVC meets UL Type OFNR requirements; plenum meets UL Type OFNP requirements
- Bandwidth: 160/500 MHz–km for 850/1300 nm wavelengths
- Chromatic Dispersion Requirements:
  The zero dispersion wavelength and dispersion slope must fall below the following bounds when plotted as wavelength ($x$ points) versus dispersion slope ($y$ points) on a graph:

  1295 nm, 0.105 ps/(nm$^2$•km)
  1300 nm, 0.110 ps/(nm$^2$•km)
  1348 nm, 0.110 ps/(nm$^2$•km)
  1365 nm, 0.093 ps/(nm$^2$•km)

**Environmental Specifications**

- Operating temperature range: −10° C to +55° C
- Storage temperature range: −40° C to +70° C
- Operating relative humidity range: 5% to 85%
- Storage relative humidity range: 5% to 95%

The 12-fiber building backbone cable contains twelve 62.5/125 micron fibers. The fibers are buffered up to 900 microns, which in addition to providing fiber protection also facilitates fiber identification through color coding. The fibers are stranded around a nonrigid central strength member, covered by an aramid yarn and an overjacket of either PVC or plenum-grade thermoplastic, according to the application.

Note: These cables are not available through DECdirect USA. Contact Anixter Bros. Inc. (approved cable manufacturers) or other authorized DECconnect System distributors.

## 6-Fiber Building Backbone Cable (Light-Duty)

### Ordering Information

| Order No. | Description | Application |
|---|---|---|
| *17–02538–01* | *Plenum* | *Splicing, light-duty* |
| *17–02539–01* | *PVC* | *Splicing, light-duty* |

Length supplied as requested by the customer.

**Physical Specifications**

- Number of fibers: 6
- Core/clad diameter: 62.5/125 μm
- Cable outside diameter (inches): 0.220 nominal
- Maximum pulling tension (lbs): 125
- Cable minimum bend radius (inches): short term=2.0 long term=4.0
- Individual buffered fiber bend radius (inches): long term=0.75
- Insertion loss: 3.75/1.5 dB/km at 850/1300 nm wavelengths
- Flammability: PVC meets UL Type OFNR requirements; plenum meets UL Type OFNP requirements
- Bandwidth: 160/500 MHz–km for 850/1300 nm wavelengths
- Chromatic Dispersion Requirements:
  The zero dispersion wavelength and dispersion slope must fall below the following bounds when plotted as wavelength (*x* points) versus dispersion slope (*y* points) on a graph:

  1295 nm, 0.105 ps/(nm$^2$•km)
  1300 nm, 0.110 ps/(nm$^2$•km)
  1348 nm, 0.110 ps/(nm$^2$•km)
  1365 nm, 0.093 ps/(nm$^2$•km)

**Environmental Specifications**

- Operating temperature range: –10° C to +55° C
- Storage temperature range: –40° C to +70° C
- Operating relative humidity range: 8% to 85%
- Storage relative humidity range: 5% to 95%

The 6-fiber building backbone cable contains six 62.5/125 micron fibers. The fibers are buffered up to 900 microns, which in addition to providing fiber protection also facilitates fiber identification through color coding. The fibers are stranded around a nonrigid central strength member, covered by an aramid yarn and an overjacket of either PVC or plenum-grade thermoplastic, according to the application.

Note: These cables are not available through DECdirect USA. Contact Anixter Bros. Inc. (approved cable manufacturers) or other authorized DECconnect System distributors.

## 6-Fiber Building Backbone Cable (Heavy-Duty)

### Ordering Information

| Order No. | Description | Application |
|---|---|---|
| *17–02540–01* | *Plenum* | *Connectorization, heavy-duty pulling* |
| *17–02541–01* | *PVC* | *Connectorization, heavy-duty pulling* |

Length supplied as requested by the customer.

**Physical Specifications**

- Number of fibers: 6
- Core/clad diameter: 62.5/125 µm
- Cable outside diameter (inches): 0.280 nominal
- Maximum pulling tension (lbs): 250
- Cable minimum bend radius (inches): short term=4.0, long term=6.0
- Individual buffered fiber bend radius (inches): long term=0.75
- Insertion loss: 3.75/1.5 dB/km at 850/1300 nm wavelengths
- Flammability: PVC meets UL Type OFNR requirements; plenum meets UL Type OFNP requirements
- Bandwidth: 160/500 MHz–km for 850/1300 nm wavelengths
- Chromatic Dispersion Requirements:
  The zero dispersion wavelength and dispersion slope must fall below the following bounds when plotted as wavelength (*x* points) versus dispersion slope (*y* points) on a graph:

  1295 nm, 0.105 ps/(nm$^2$•km)
  1300 nm, 0.110 ps/(nm$^2$•km)
  1348 nm, 0.110 ps/(nm$^2$•km)
  1365 nm, 0.093 ps/(nm$^2$•km)

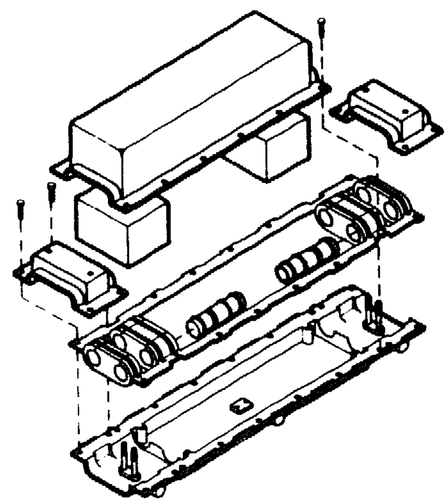
**Environmental Specifications**

- Operating temperature range: –10° C to +55° C
- Storage temperature range: –40° C to +70° C
- Operating relative humidity range: 5% to 85%
- Storage relative humidity range: 5% to 95%

The 6-fiber building backbone cable contains six 62.5/125 micron fiber subunits. Each fiber is covered by an aramid yarn and an inner jacket of either PVC or plenum-grade thermoplastic, according to the application. An overjacket of PVC or plenum-grade thermoplastic is applied over cabled bundles containing a central strength member.

Note: These cables are not available through DECdirect USA. Contact Anixter Bros. Inc., (approved cable manufacturers) or other authorized DECconnect System distributors.

# Fiber Transition Enclosure Kit


LKG-3543-89A

## Ordering Information

*See note below.*

***Includes:***

- Base
- Cover
- Cable clamps
- Grommets
- Splice organizer trays
- Wall mounting bracket

**Physical Specifications**

Height: 12.5 cm (5 in)

Length: 22.5 cm (22.5 in)

Width: 13.75 cm (5.5 in)

The fiber transition enclosure kit is a sealable unit used for splicing indoor and outdoor fiber optic cables in building entrance and noncorrosive aerial applications. An optional housing is available for buried and underground applications. The unit is wall- or rack-mountable and can accommodate indoor or outdoor cables up to 144 mechanical splices or 192 fusion splices.

Lightning protection and grounding features are incorporated into the design, allowing both non-isolated and isolated unit/cable grounding.

Refer to the Auxiliary Items section for accessory items for this enclosure. Additional cable sealing grommets are required. Select these grommets after determining the cables to be used.

Note: This item is not available through DECdirect USA. Contact Anixter Bros. Inc., AT&T, or other authorized DECconnect System distributors.

## 2.5 mm Bayonet Connector Kit
## Digital Order No. H3114–FA

| Accessory | Supplier | Supplier P/N | Qty | Description |
|---|---|---|---|---|
| 2.5 mm ST2 Connector | AT&T | 105 143 911 | 1 | |

## PVC Buffer Tubing and Unit Splitter

Note: This accessory must be purchased from the supplier.

| Accessory | Supplier | Supplier P/N | Qty | Description |
|---|---|---|---|---|
| PVC Buffer Tubing and Unit Splitter | AT&T | 105 317 549 | 1 | Used to buffer 125 micron fiber for field installation of connectors on coated fibers only. Contains enough material to buffer 100 fibers (average of 21" per fiber). Includes unit splitter for blocking and organizing fiber termination of outdoor cable at patch panel. |

## 2.5 mm Bayonet Connector Tool Kit
## Digital Order No. H8102-AA/AC

| Accessory | Supplier | Supplier P/N | Qty | Description |
|---|---|---|---|---|
| 102A crimping tool | AT&T | 104 389 903 | 1 | |
| 200A curing oven | AT&T | 104 055 058 | 1 | |
| 300B microscope | AT&T | 104 412 077 | 1 | |
| 400B polishing tool | AT&T | 105 246 185 | 1 | |
| MSN-08-5B5 stripping tool | AT&T | 105 257 414 | 1 | |
| 600A connector holders | AT&T | 104 153 937 | 12 | |
| 700A stripping tool | AT&T | 104 278 478 | 1 | |
| 971-A holder blocks | AT&T | 104 229 398 | 2 | |
| 975A cleaver tool | AT&T | 103 808 770 | 1 | |
| Scissors | AT&T | 105 257 364 | 2 | |
| 6-inch scale | AT&T | 105 257 356 | 5 | |
| Alcohol bottle | AT&T | 105 257 463 | 2 | |
| Instruction manual | AT&T | 845 831 114 | 1 | |
| Polishing glass plate | AT&T | 105 075 618 | 2 | |
| Carrying case | AT&T | 845 769 264 | 1 | |
| Stripping tool (R4366) | AT&T | 105 114 581 | 1 | |

## 2.5 mm Bayonet Connector Consumables Kit
## Digital Order No. H8102-AB

| Accessory | Supplier | Supplier P/N | Qty | Description |
|---|---|---|---|---|
| Texwipes | AT&T | 105 205 678 | 250 | |
| Music wire in vial | AT&T | 105 071 013 | 4 | |
| Dispensing tips | AT&T | 105 157 879 | 5 | |
| Epoxy | AT&T | 105 489 355 | 15 | |
| Polishing paper (type A) | AT&T | 105 488 175 | 100 | |
| Polishing paper (type C) | AT&T | 105 076 798 | 100 | |

## Splice Tool Kit
## Digital Order No. H3114–FD

| Accessory | Supplier | Supplier P/N | Qty | Description |
|---|---|---|---|---|
| Base and splice tool hardware | 3M | 80–6104–4365–9 | 1 | Does not include splice tool. |
| Cleaving tool | 3M | 80–6104–4364–2 | 1 | |
| Splice tool | 3M | 80–6104–4363–4 | 1 | |
| Cable strippers | 3M | 80–6104–4314–7 | 1 | |
| Cleaning alcohol bottle | 3M | 80–6104–4329–5 | 1 | |
| Instruction manual | 3M | 78–6900–1804–5 | 1 | |
| Scissors | 3M | 80–6104–4754–4 | 1 | |
| No–Nik fiber stripper (0.008) | 3M | 80–6104–4808–8 | 1 | |
| Epoxy dispensing tool with coupling gel and dispensing tip | 3M | 80–6104–4809–6 | 1 | |
| Mandrel tool for 45 mm splice | 3M | 80–6105–7014–7 | 1 | Dorran #08–009–78 |
| Pipe cleaners | 3M | 80–6104–4349–3 | 50/pkg | |
| Lint-free cloth | 3M | 80–6104–4324–6 | 100/pkg | |
| Magnifier, cleaver fiber inspection | 3M | 80–6104–4799–9 | 1 | |
| Splice tool hardware only | 3M | 80–6104–4332–9 | 1 | |
| Video NTSC VHS (USA) | 3M | 80–6104–4814–6 | 1 | Instruction |
| Video PAL VHS (Europe) | 3M | 80–6104–5374–4 | 1 | Instruction |

## Splice Kit
## Digital Order No. H3114–FG

| Accessory | Supplier | Supplier P/N | Qty | Description |
|---|---|---|---|---|
| Dorran mechanical splice | 3M | 80–6105–7012–2 | 1 | 45 mm mechanical splice. Dorran #07–000–75 |
| In-line protective splice cover | 3M | 80–6104–5374–0 | 1 | |

## Termination Shelf
## Digital Order No. H3107-K

| Accessory | Supplier | Supplier P/N | Qty | Description |
|---|---|---|---|---|
| 1000 ST connector 1x6 unit | AT&T | 105 392 005 | 1 | |
| 1000 ST connector 1x6 unit | AT&T | 105 428 486 | 12 | |
| 12A1 clamps | AT&T | 104 384 490 | 1/cable | Outdoor cable clamp |
| 1x6 for biconics | AT&T | 105 383 830 | 1 | Connector coupler panel |
| 1x6 for biconics | AT&T | 105 428 478 | 12 | Connector coupler panel |
| 1x6 for SMA | AT&T | 105 428 239 | 1 | Connector coupler panel |

## Splice Shelf
## Digital Order No. H3107-G

| Accessory | Supplier | Supplier P/N | Qty | Description |
|---|---|---|---|---|
| Fusion splice tray (LT1A-F/F) | AT&T | 105 339 899 | 1 | |
| Mechanical splice tray (LT1A-M/M) | AT&T | 105 339 907 | 1 | |
| 12A1 clamps | AT&T | 104 384 490 | 1/cable | |

## Storage Shelf
## Digital Order No. H3107-H

| Accessory | Supplier | Supplier P/N | Qty | Description |
|---|---|---|---|---|
| 12A1 clamps | AT&T | 104 384 490 | 1/cable | |

## Combination Shelf
## Digital Order No. H3107-J

| Accessory | Supplier | Supplier P/N | Qty | Description |
|---|---|---|---|---|
| 12A1 clamps | AT&T | 104 384 490 | 1/cable | |
| 1000 ST connector 1x6 unit | AT&T | 105 392 005 | 1 | |
| 1000 ST connector 1x6 unit | AT&T | 105 428 386 | 12 | |
| Fusion splice tray (LT1A-F/F) | AT&T | 105 339 899 | 1 | |
| Mechanical splice tray (LT1A-M/M) | AT&T | 105 339 907 | 1 | |

## Remote Wall Enclosure for Fiber
## Digital Order No. H3131-C

| Accessory | Supplier | Supplier P/N | Qty | Description |
|---|---|---|---|---|
| 12A1 clamps | AT&T | 104 384 490 | 1/cable | |
| 10A ST coupler panel | AT&T | 104 141 858 | 1 | |
| Coupler panel blank | AT&T | 105 276 570 | 1 | |
| D181706 mechanical splice adaptor | AT&T | 105 289 656 | 1/12 fibers | |
| Mechanical splice organizer tray | AT&T | 105 356 570 | 10/pkg | |
| D181707 fusion splice adaptor | AT&T | 105 289 664 | 1/16 fibers | |
| Fusion splice holder | AT&T | 105 356 562 | 10/pkg | |
| Dual unit mounting bracker | AT&T | 105 483 218 | 1/2 units | For ganged installations |

## Fiber Transition Enclosure Kit

Based on the AT&T UCB–1 concept:

- Consult AT&T for technical assistance with the UCB–1 implementation.
- Consult Hysol Corporation for proper implementation of cable clamping through grip and grommet kits.

## AT&T

The following is a brief listing of accessories available from AT&T:

| Accessory | Supplier | Supplier P/N | Qty | Description |
|---|---|---|---|---|
| UCB–1 | AT&T | 103 921 946 | 1 | |
| Closure gasket | AT&T | 845 628 775 | 1 | |
| Blank plugs | AT&T | 845 771 252 | 2 | |
| 3-ounce B sealant | AT&T | 400 494 811 | 1 | |
| *Complementary Products:* | | | | |
| UC–SS/M1 mechanical splice tray | AT&T | 105 040 661 | 1 | |
| 51B wall mounting bracket | AT&T | 100 013 705 | 1 | |
| UC–SS/F1 fusion splice tray kit | AT&T | 104 375 063 | 1 | |
| 2000/LG 7/20 outer closure | AT&T | 105 037 550 | | For underground or buried applications |
| *For cable clamping of 0.41 inch outside diameter cable:* | | | | |
| UC–41 grommet and grip kit | AT&T | 103 922 035 | 1 | Can accommodate rodent and lightning proof designs |
| UC–41/41 grommet and grip kit | AT&T | 105 150 247 | 1 | Accommodates two cables of 0.41 inch outside diameter |

| Accessory | Supplier | Supplier P/N | Qty | Description |
|---|---|---|---|---|
| ***For cable clamping of 0.48 inch outside diameter cable:*** | | | | |
| UC–48 grommet and grip kit | AT&T | 103 922 043 | 1 | For crossply sheath ribbon cable without sheath terminating hardware and Lightpack™ cable with 50 or more fibers including rodent and lightning protection. |
| UC–41/48 grommet and grip kit | AT&T | 105 150 254 | 1 | Accommodates one cable of 0.41 inch outside diameter and 1 cable of 0.48 inch outside diameter. |
| ***For cable clamping of 0.50 inch outside diameter cable:*** | | | | |
| UC–50 LXE grommet and grip kit | AT&T | 105 389 258 | 1 | |
| ***For cable clamping of 0.58 inch outside diameter cable:*** | | | | |
| UC–58 LXE grommet and grip kit | AT&T | 105 439 376 | 1 | |
| ***For cable clamping of 0.59 inch outside diameter cable:*** | | | | |
| UC–59 grommet and grip kit | AT&T | 105 323 679 | 1 | Accommodates crossply ribbon cable with guaranteed fiber count greater than 72. |
| ***For cable clamping of 0.65 inch outside diameter cable:*** | | | | |
| UC–65 grommet and grip kit | AT&T | 103 922 050 | 1 | Accommodates single ply sheath, 3 unit stranded cable |

| Accessory | Supplier | Supplier P/N | Qty | Description |
|---|---|---|---|---|
| ***For cable clamping of 0.75 inch outside diameter cable:*** | | | | |
| UC-75 grommet and grip kit | AT&T | 103 922 068 | 1 | Accommodates crossply sheath, 3 unit stranded cable |
| ***For cable clamping of 0.79/0.82 inch outside diameter cable:*** | | | | |
| UC-79 grommet and grip kit | AT&T | 103 922 076 | 1 | Rodent/lightning sheath, 3 unit stranded cable |
| UC-82 grommet and grip kit | AT&T | 104 145 016 | 1 | Single ply sheath, 6 unit stranded cable |
| ***For cable clamping of 0.95/0.98 inch outside diameter cable:*** | | | | |
| UC-98 grommet and grip kit | AT&T | 104 145 024 | 1 | Rodent/lightning sheath, 6 unit stranded cable |
| UC-95/98 grip kit | AT&T | 845 771 385 | 5 | |
| ***For cable clamping building cable:*** | | | | |
| BC12-1 grommet kit | AT&T | 104 316 716 | 1 | One LGBC-012A cable |
| BC12-2 grommet kit | AT&T | 104 316 708 | 1 | Two LGBC-012A cables |
| BC6-3 grommet kit | AT&T | 104 316 690 | 1 | Three LGBC-012A cables |
| BC4-6 grommet kit | AT&T | 104 316 658 | 1 | Six LGBC-012A cables |

## Hysol

For specialized grommet and grip requirements and for other enclosure and cable accommodating, contact Hysol at the following address:

Hysol
Aerospace and Industrial Products Division
164 Folly Mill Road
Seabrook, NH 03874
Attn: Technical services

The following is a brief listing of accessories available from Hysol:

| Accessory Description | Supplier | Supplier P/N | Qty | Description |
|---|---|---|---|---|
| Grip block insert | Hysol | CL–0060 | 10/box | Accommodates 0.230 inch to 0.405 inch cable, or 5.8 mm to 10.3 mm cable. |
| Grip block insert | Hysol | CL–0061 | 10/box | Accommodates 0.410 inch to 0.585 inch cable, or 10.4 mm to 14.9 mm cable. |
| Grip block insert | Hysol | CL–0062 | 10/box | Accommodates 0.590 inch to 0.765 inch cable, or 15.0 mm to 9.4 mm cable. |
| Fiber optic cable adaptor kit | Hysol | CL–0601 | 1 | Diameter for 0.230 inch to 0.405 inch cable. |
| Fiber optic cable adaptor kit | Hysol | CL–0602 | 1 | Diameter for 0.410 inch to 0.585 inch cable. |
| Fiber optic cable adaptor kit | Hysol | CL–0603 | 1 | Diameter for 0.590 inch to 0.765 inch cable. |

## SMA Accessories

for your SMA interconnection needs, Digital recommends that you contact one of the following:

Amphenol Corporation
1925 Ohio Street
Lisle, IL 60532
(312) 810-5636

AMP Incorporated
Worldwide Headquarters
Harrisburg, PA 17105
(717) 564-0100

## Mixed Connector Patch Cables, Alternate Fiber Size Patch Cables, and Custom Lengths

For cables requiring different fiber optic connectors (SMA, Biconic, and ST), or for patch cables requiring 100/140 or 50/125 fiber or custom lengths, contact one of the following:

AMP Incorporated
Worldwide Headquarters
Harrisburg, PA 17015
(717) 564-0100

Computer Crafts
57 Thomas Rd.
Hawthorne, NJ 07507
(201) 423-3500

Anixter Bros.
4711 Golf Road
Skokie, IL 60076
(312) 677-2600
1-800-323-8164

## Two-Fiber Zipcord Cable for Custom Patch Cable Use

Digital Part No. 17-02492-01

Contact one of the following:

Berk-Tek
Box 888
R.D. 1
New Holland, PA 17557
(717) 354-6200

*or*

Chromatic Technologies
P.O. Box 578
31 Hayward Street
Franklin, MA 02038
(508) 520-1200

## Single-Mode Connectors and Consumables

Digital recommends using the AT&T STII single-mode connector. Contact AT&T for single-mode information and consumables.

The ST2 single-mode connector can be used with the 2.5 mm bayonet connector tool kit in the DECconnect Fiber Optic structured wiring.

## DECconnect Labels for Cables and Patch Panels

Brady Part No. Brady TMK-1

Contact:

W. H. Brady Company
2221 W. Camden Road
P. O. Box 2131
Milwaukee, WI 53201
(414) 351-6630
In Wisconsin: 1-414-228-1456
FAX 1-800-292-2289

## Identification Washers (red and black)

Red and black identification washers used in DECconnect labeling can be obtained from:

Computer Crafts
57 Thomas Rd.
Hawthorne, NJ 07507
(201) 423-3500

Part No. RI-11389 (package of 100 red and 100 black washers)

## Alternative Pigtail Constructions

- ST-type pigtails using only 900 micron buffered fiber are available in 12 different colors and in any desired length.
- Pigtails with other connector types (SMA, Biconic, etc.) are available on request.

Contact one of the following:

Computer Crafts
57 Thomas Rd.
Hawthorne, NJ 07507
(201) 423-3500

AMP Incorporated
Worldwide Headquarters
Harrisburg, PA 17015
(717) 564-0100

## Alternative 2.5 mm Bayonet Connectors for 62.5/125 Fiber

The following suppliers have alternative 2.5 mm Bayonet Connectors approved for use in DECconnect System Fiber Optic structured wiring.

These connectors require the use of the individual supplier's tool kits and assembly procedures.

Contact the individual suppliers for more information:

OFTI:
5 Fortune Drive
Billerica, MA 01821
(508) 663–6629

AT&T:
2000 Northeast Expressway
Norcross, GA 30071
1-800-824-1931

3M Fiber Optic products:
10 Industrial Way East
Eatontown, NJ 07724
(201) 544–0938

Amphenol Fiber Optics:
Amphenol Corporation
1925 Ohio Street
Lisle, IL 60532
(312) 810–5636

AMP:
AMP Incorporated
Worldwide Headquarters
Harrisburg, PA 17105
(717) 564–0100

## Alternative Mechanical Splices

The following suppliers have alternative mechanical splices approved for use in the DECconnect System Fiber Optic structured wiring.

These splices require the use of the individual supplier's tool kit, consumables, and procedures.

Contact the individual suppliers for more information:

3M/Dorran Mechanical Splice:

3M Fiber Optic Products
10 Industrial Way East
Eatontown, NJ 07724
(201) 544–0938

Siecor "C" Splice:

Siecor
489 Siecor Park
Hickory, NC 28603–0489
(704) 327-5000

AT&T Rotary Mechanical Splice:

AT&T
2000 Northeast Expressway
Norcross, GA 30071
1-800-824-1931

## Alternative Patch Panels

Each of the following suppliers offer a complete patch panel system approved for use in DECconnect fiber optic structured wiring:

AT&T
2000 Northeast Expressway
Norcross, GA 30071
1-800-824-1931

BICC Network Solutions, Inc.*
910 Boston Turnpike Road
Shrewsbury, MA 01545
(508) 842-7300

*The BICC patch panel system is not compatible with the DECconnect patch panel components. Contact the supplier for additional information.

## Approved Fiber Optic Cable Manufacturers

The following manufacturers have fiber optic cable approved for use in the DECconnect System Fiber Optic structured wiring. Contact Digital Equipment Corporation for additional authorized manufacturers.

AT&T
2000 Northeast Expressway
Norcross, GA 30071
1-800-824-1931

Siecor
489 Siecor Park
Hickory, NC 28603-0489
(704) 327-5000

BELDEN/Cooper Industries
P.O. Box 1980
Richmond, IN 47375
(317) 983-5200

Chromatic Technologies
P.O. Box 578
31 Hayward St.
Franklin, MA 02038
(508) 520-1200

# CHAPTER 12

# 12

# Ordering DECconnect System Fiber Optic Components

This chapter contains blank order worksheets. Use these worksheets to order cable and components needed for the structured wiring installation.

**NOTE**

Descriptions of the cables and components listed on the order worksheets are provided in Chapter 10. Information about Digital's communications components (both active and passive) is available in the *Networks and Communications Buyer's Guide*.

## 12.1 Using the Order Worksheets

The order worksheets are organized by part number. Only Digital parts identified in Chapter 10 are listed in the worksheets. Make photocopies of the worksheets for ordering the needed cables and components.

## 12.2 Compiling Order Information from the Design Worksheets

To use the order worksheets:

- Organize the completed design worksheets by building and floor.
- Use the worksheets to total the cables (types and lengths) and components needed to build the passive portion of the structured wiring.
- Enter the results in the order worksheets.

- When the total requirements for the cable plant have been specified in the order worksheets, contact a sales representative to review the requirements and to place the order.

## 12.3 Component Sources

Use the following guidelines when ordering fiber optic cable plant components:

- All items can be ordered through authorized distributors, such as Anixter Bros. Inc. See Section 12.4 for the address and phone number of the distributor.
- Items with order numbers — numbers beginning with H (H3107–J, for example) or BN (BN2D–01, for example) — are also available through DECdirect USA.
- Auxiliary items can be ordered directly from the manufacturer (see Auxiliary Items section in Chapter 11):
  - SMA accessories are available from Amphenol Corporation.
  - Mixed connector patch cables, alternate fiber size patch cables, and custom lengths are available from AMP Inc., Computer Crafts, and Anixter Bros. Inc.
  - Single-mode connectors and consumables are available from AT&T.
  - Alternative 2.5 mm bayonet connectors are available from OFTI, AT&T, 3M Corporation, Amphenol Corporation, and AMP Inc.
  - Alternative mechanical splices are available from AT&T, 3M Corporation, and Siecor.

## 12.4 Distributors and Manufacturers

Amphenol Corporation
1925 Ohio Street
Lisle, IL 60532
(312) 810–5636

AMP Incorporated
Worldwide Headquarters
Harrisburg, PA 1705
(717) 564–0100

AT&T
2000 Northeast Expressway
Norcross, GA 30071
1–800–824–1931

Anixter Bros. Inc.
4711 Golf Road
Skokie, IL 60076
(312) 677–2600
1–800–323–8164

Berk–Tek
Box 888
R.D. 1
New Holland, PA 17557
(717) 354–6200

Chromatic Technologies
P.O. Box 578
31 Hayward Street
Franklin, MA 02038
(508) 520–1200

Computer Crafts
57 Thomas Rd.
Hawthorne, NJ 07507
(201) 423–3500

HYSOL
Aerospace and Industrial Products Division
164 Folly Mill Road
Seabrook, NH 03874
(603) 474–5541
Attn: Technical Services

OFTI
5 Fortune Drive
Billerica, MA 01821
(508) 663–6629

Siecor
489 Siecor Park
Hickory, NC 28603–0489
(704) 327–5000

3M Fiber Optic Products
10 Industrial Way East
Eatontown, NJ 07724
(201) 544–0938

| Option Digital P/N | Description | Quantity | Unit Price | Total Price |
|---|---|---|---|---|
| BN24B–01 | FDDI-to-FDDI Jumper Crossover Cable 1 m (3.3 ft) | | | |
| BN24B–03 | FDDI-to-FDDI Jumper Crossover Cable 3 m (9.9 ft) | | | |
| BN24B–4E | FDDI-to-FDDI Jumper Crossover Cable 4.5 m (14.85 ft) | | | |
| BN24B–10 | FDDI-to-FDDI Jumper Crossover Cable 10 m (32.8 ft) | | | |
| BN24B–20 | FDDI-to-FDDI Jumper Crossover Cable 20 m (65.6 ft) | | | |
| BN24B–30 | FDDI-to-FDDI Jumper Crossover Cable 30 m (98.4 ft) | | | |
| BN24D–01 | FDDI-to-2.5 mm Bayonet Connector Jumper Cable, 1 m (3.2 ft) | | | |
| BN24D–03 | FDDI-to-2.5 mm Bayonet Connector Jumper Cable, 3 m (9.9 ft) | | | |
| BN24D–4E | FDDI-to-2.5 mm Bayonet Connector Jumper Cable, 4.5 m (14.85 ft) | | | |
| BN24D–10 | FDDI-to-2.5 mm Bayonet Connector Jumper Cable, 10 m (32.8 ft) | | | |
| BN24D–20 | FDDI-to-2.5 mm Bayonet Connector Jumper Cable, 20 m (65.6 ft) | | | |
| BN24D–30 | FDDI-to-2.5 mm Bayonet Connector Jumper Cable, 30 m (98.4 ft) | | | |

| Option Digital P/N | Description | Quantity | Unit Price | Total Price |
|---|---|---|---|---|
| BN24E–01 | Dual–2.5 mm Bayonet Connector Jumper Cable, 1 m (3.2 ft) | | | |
| BN24E–03 | Dual–2.5 mm Bayonet Connector Jumper Cable, 3 m (9.9 ft) | | | |
| BN24E–10 | Dual–2.5 mm Bayonet Connector Jumper Cable, 10 m (32.8 ft) | | | |
| BN24E–20 | Dual–2.5 mm Bayonet Connector Jumper Cable, 20 m (65.6 ft) | | | |
| BN24E–30 | Dual–2.5 mm Bayonet Connector Jumper Cable, 30 m (98.4 ft) | | | |
| BN24E–4E | Dual–2.5 mm Bayonet Connector Jumper Cable, 4.5 m (14.85 ft) | | | |
| E0–H3130–CA | 72-inch Rack, enclosed active and enclosed passive bay[1] | | | |
| E0–H3130–CB | 72-inch Rack, active and passive bay, open[1] | | | |
| E0–H3130–C3 | 72-inch Rack, open active bay[1] | | | |
| E0–H3130–D3 | 72-inch Rack, open passive bay[1] | | | |
| E0–H3130–D2 | 72-inch Rack, enclosed passive bay[1] | | | |
| E0–H3130–C2 | 72-inch Rack, enclosed active bay[1] | | | |
| E0–H3130–X2 | Side panels (for C2 or D2) | | | |
| H3107–G | Splice Shelf | | | |

| Option Digital P/N | Description | Quantity | Unit Price | Total Price |
|---|---|---|---|---|
| H3107–H | Storage Shelf | | | |
| H3107–J | Combination Shelf | | | |
| H3107–K | Termination Shelf | | | |
| H3111–GA | Modular Office Wallbox Kit, color: DEC068 grey (8 wallboxes per kit) | | | |
| H3111–GB | Modular Office Wallbox Kit, color: white (8 wallboxes per kit) | | | |
| H3111–GC | Modular Office Wallbox Kit, color: ivory (8 wallboxes per kit) | | | |
| H3114–FA | Field-Installable 2.5 mm Bayonet Fiber Optic Connector Kit (6 connectors per kit) | | | |
| H3114–FC | 2.5 mm Bayonet Connector Coupler Kit (12 couplers per kit) | | | |
| H3114–FD | Splice Tool Kit | | | |
| H3114–FE | FDDI-to-Dual 2.5 mm Bayonet Connector Coupler for the Modular Office Wallbox (8 couplers per kit) | | | |
| H3114–FF | Dual 2.5 mm Bayonet Connector Coupler Panel for the Modular Office Wallbox (8 couplers per kit) | | | |
| H3114–FG | Splice Kit (12 splices per kit) | | | |
| H3114–FH | Coupler Panel Kit for Termination Shelf and Combination Shelf (12 loaded panels of 6 couplers per kit) | | | |

| Option Digital P/N | Description | Quantity | Unit Price | Total Price |
|---|---|---|---|---|
| H3118-FA | 2.5 mm Bayonet Connector Pigtails (3 m length) (6 pigtails per kit) | | | |
| H3120 | 86-Inch Satellite Equipment Room Rack | | | |
| H3131-C | Remote Wall Enclosure for Fiber | | | |
| H8102-AA | 2.5 mm Bayonet Connector Termination Tool Kit (110 volt) | | | |
| H8102-AC | 2.5 mm Bayonet Connector Termination Tool Kit (220 volt) | | | |
| H8102-AB | 2.5 mm Bayonet Connector Consumables Kit | | | |
| H9646-EA | Office Communication Cabinet (OCC) (100 volt) | | | |
| H9646-EB | Office Communication Cabinet (OCC) (220 volt)[1] | | | |
| 17-02432-01 | 4-Fiber Cable (light-duty) Plenum[2] | | | |
| 17-02433-01 | 4-Fiber Cable (light-duty) PVC[2] | | | |
| 17-02490-01 | 4-Fiber Cable (heavy-duty) PVC[2] | | | |
| 17-02491-01 | 4-Fiber Cable (heavy-duty) Plenum[2] | | | |
| 17-02534-01 | 12-Fiber Cable (heavy-duty) PVC[2] | | | |
| 17-02535-01 | 12-Fiber Cable (heavy-duty) Plenum[2] | | | |
| 17-02536-01 | 12-Fiber Cable (light-duty) PVC[2] | | | |
| 17-02537-01 | 12-Fiber Cable (light-duty) Plenum[2] | | | |
| 17-02438-01 | 6-Fiber Cable (light-duty) Plenum[2] | | | |

| Option Digital P/N | Description | Quantity | Unit Price | Total Price |
|---|---|---|---|---|
| 17-02439-01 | 6-Fiber Cable (light-duty) PVC[2] | | | |
| 17-02540-01 | 6-Fiber Cable (heavy-duty) Plenum[2] | | | |
| 17-02541-01 | 6-Fiber Cable (heavy-duty) PVC[2] | | | |
| 22-00493-01 | Fiber Transition Enclosure Kit[2] | | | |

[1]Available only from DECdirect Europe
[2]Available only from authorized distributors and manufacturers, such as Anixter Bros. Inc.

See Auxiliary Items section in Chapter 11 for additional accessories and replacement parts.

# CHAPTER 13

# 13

# Preinstallation Procedures

This chapter provides brief descriptions of the preinstallation project management tasks that must be done between the time that the design process starts and the installation is completed.

These general preinstallation and installation activities are usually organized and supervised by a network project manager. This manager can be the network designer or someone who the designer works with in coordinating the designer's responsibilities.

The network project manager's responsibilities include coordinating scheduling and installation activity. This includes:

- Creating the installation project plan
- Ordering the equipment
- Selecting the installation contractor
- Preparing the site for the installation activity and overseeing that activity

In addition, continuous supervision of the project by the network project manager can minimize delays by detecting problems and directing their correction as early as possible. Without this level of project management, undetected problems can result in an unreliable cable plant, customer dissatisfaction with the installation activity or the installed cable plant, or unexpected expenses over the functional life of the structured cable plant.

## 13.1 Create the Installation Project Plan

The installation project plan, which is used during the installation as a progress report, consists of:

- A list of required tasks showing the chronology and the person responsible for the inception and completion of each task defined.
- A complete set of the site and building floor plans as created or updated during the design process, as well as copies of all diagrams (logical, concept, network schematics, and footprints), connection maps (connection worksheets, connection cable maps, and crossconnect/interconnect maps), and identifier worksheets. A set of design documents is needed for the customer, as well as for all contractors and subcontractors involved in installing the cable plant.

## 13.2 Order the Cable Plant Components

During the design process, bills of materials (BOMs) were created for all of the components needed for the cable plant. These BOM components must be ordered, usually through the customer's purchasing organization, well in advance of the installation start date. In addition:

- Check with the purchasing organization to learn the date the cable plant components are scheduled to arrive. This information is critical to the installation schedule.
- Establish a receiving and stocking area for materials and installation tools as they arrive on site. For buildings that are under construction, a secure, adequately sized space within an existing building or a storage trailer or shed is required for the duration of the network installation.

## 13.3 Select a Network Installation Contractor

Whether selecting a sole source contractor or sending the installation out for competitive bidding, it is important to have sound contracts and good working relationships with the contractors. It is also important to make sure that the installation contractor has reviewed the *DECconnect System Fiber Optic Installation* guide (EK-DECSY-FI) and agrees to follow the installation techniques and guidelines presented in that guide.

Additional criteria for selecting a installation contractor include:

- Experience - ask for references to verify claims of expertise concerning actual or similar work.
- Cost - remember that the lowest bid is not always the wisest choice. Cost is only one component of the overall contractor selection. Extra money spent on a quality installation pays off in network performance over the life of the cable plant.
- Availability - make sure that the contractor starts the work on the required start date, and guarantees that the work will be completed by the scheduled end date.
- Warranty - find out for how long the contractor will warranty the installation. Use this as an indication of the contractor's confidence in the work.
- Testing - review the procedures and types of tools the contractor uses to test and certify the installed system.
- Documentation - make sure that the contractor provides as-built documentation at the end of the installation that reflects the actual installation in comparison with the design. A majority of the cabling will be hidden underground and behind walls. It is important for future maintenance and growth that the cable plant is well labeled and documented.

## 13.4 Prepare the Work Site and Oversee Installation

The following is a list of tasks that are involved in the overall preparation of the work site for installation and in supervising and coordinating the installation:

- Have a preinstallation meeting as close to the installation start date as possible. Include a walk-through of the site by the installation project manager, the network designer, a customer representative, the general contractor, the network installation contractor vendor, and any other people responsible for the success of the installation.
- For buildings under construction, inspect the site regularly and meet with the general contractor before the cabling installation begins. Changes to the original building design often occur as the structure is being constructed. These changes can affect such things as cable routing and equipment room construction.
- Establish trash removal responsibilities and methods prior to the start of the installation. This includes the disposal of toxic and nontoxic refuse materials.
- Establish the available installation working hours. Determine whether the work will be performed during regular day-shift hours or during off-shift hours and weekends.
- Establish access authorization to the site for the installation team. Make sure that the installers have access to all areas where work is to be performed, including the equipment storage area.
- Ensure that ac power and lighting will be available at the time equipment is to be installed and tested in the equipment rooms.

# APPENDIX A

# A

# Using 50/125 or 100/140 Micron Fiber

This appendix provides fiber specifications for 50/125 and 100/140 dual-window micron fibers. It also provides performance information for using the FDDI and ORnet product sets with these fiber sizes.

**NOTE**

For new installations, Digital recommends using 62.5/125 dual-window micron fiber. Digital also supports 50/125 for new installations.

Digital does not recommend or support 100/140 dual-window micron fiber for new installations. However, Digital will support installations in existing cable plants.

In addition, this appendix gives information about using FDDI products on a previously installed fiber optic cable plant that does not meet the requirements specified in Table A-1, Table A-2, or Table 5-2.

## A.1 Specifications for 50/125 and 100/140 Micron Fibers

Table A–1 and Table A–2 provide specifications for 50/125 and 100/140 micron dual-window fibers. The specifications are given for the 850 nm and 1300 nm fiber windows.

**NOTE**

Cable plants installed using 50/125 or 100/140 micron dual-window fibers must use patch cable assemblies with the same fiber size as used in the cable plant. These fibers must meet the specifications in Table A–1 or Table A–2.

Patch cables using 50/125 or 100/140 micron dual-window fibers are available only as custom cable assemblies. See the Auxiliary section of Chapter 11 for approved suppliers.

If the previously installed cable *fails to meet* any of the modal bandwidth or chromatic dispersion criteria listed in Table A–1 or Table A–2, see Section A.3.

If the previously installed cable *meets* the modal and chromatic dispersion criteria, but not the attenuation values in Table A–1 or Table A–2, see Section A.3.1.2.

**Table A–1: 50/125 Micron Fiber Specifications**

| Fiber Size | Specifications |
|---|---|
| 50/125 micron | Attenuation: 3.5 dB/km maximum at 850 nm; 1.5 dB/km maximum at 1300 nm<br><br>Numerical aperture: 0.200 ± 0.015 or 0.220 ± 0.015 microns (depending on the category of fiber)<br><br>Core diameter: 50.0 ± 3.0 microns<br><br>Minimum modal bandwidth: 160 MHz•km at 850 nm; 500 MHz•km at 1300 nm<br><br>Chromatic dispersion requirements<br>The zero dispersion wavelength and dispersion slope must fall below the following bounds when plotted as wavelength (*x* points) versus dispersion slope (*y* points) on a graph:<br><br>1295 nm, 0.105 ps/(nm$^2$•km)<br>1300 nm, 0.110 ps/(nm$^2$•km)<br>1348 nm, 0.110 ps/(nm$^2$•km)<br>1365 nm, 0.093 ps/(nm$^2$•km) |

**Table A–2: 100/140 Micron Fiber Specifications**

| Fiber Size | Specifications |
|---|---|
| 100/140 micron | Attenuation: 4.5 dB/km maximum at 850 nm; 2.5 dB/km maximum at 1300 nm<br><br>Numerical aperture: 0.290 ± 0.015 microns<br><br>Core diameter: 100.0 ± 4.0 microns<br><br>Minimum modal bandwidth: 160 MHz•km at 850 nm; 500 MHz•km at 1300 nm<br><br>Chromatic dispersion requirements<br>The zero dispersion wavelength and dispersion slope must fall below the following bounds when plotted as wavelength (*x* points) versus dispersion slope (*y* points) on a graph:<br><br>1295 nm, 0.105 ps/(nm$^2$•km)<br>1300 nm, 0.110 ps/(nm$^2$•km)<br>1348 nm, 0.110 ps/(nm$^2$•km)<br>1365 nm, 0.093 ps/(nm$^2$•km) |

## A.2 ORnet Product Applications

This section provides brief descriptions of ORnet operational parameters for 50/125 and 100/140 micron fiber operation. Each description includes:

- A table that indicates the maximum operational distances for the ORnet product set's fiber optic links for the specified fiber size, with the cable distances based on the number of connector pairs and splices used in the link. (This table is based on the fiber specifications in Table A–1 or Table A–2.) Remember to plan for two maintenance splices.
- Optical parameters that affect the ORnet product set's operation for the specified fiber size.

**NOTE**

> The link-loss tables in the 50/125 and 100/140 micron fiber operation descriptions provide look-up methods for determining a link's maximum distance, based on the number of splices and connector pairs designed for the link. Remember to add two splices for each link to budget for service splices. The table includes a 1.0 dB cable plant system loss margin and uses the indoor cable attenuation.
>
> Each table shows how the maximum link distance can be affected by splices and connector pairs used at interconnect and crossconnect administation points. It is not meant to imply that Digital recommends or supports links that consist of multiple small segments.

When the optical parameters are different than those in Table A–1 or Table A–2, use the Link-Loss Calculation Worksheet. (Procedures for using these worksheets are explained in Chapter 5.) Make a photocopy of the blank worksheet for each link to be analyzed. Filling in the worksheet allows you to analyze the link length that is possible, based on the ORnet and cable plant's optical parameters.

Consider the following when filling in the worksheet:

- Use the attenuation value defined by the cable's manufacturer.
- Use the correct maximum ORnet allowable system budget for the fiber size of the link's cable.

  — 5.55 dB for 50/125 micron

  — 14.35 dB for 100/140 micron

- If the link uses connectors other than 2.5 mm bayonet ST-type connectors, do not use the worksheets 0.7 dB value for connector pairs. Find out what the maximum loss value is for the connectors that are in use and use that loss value.
- If the link uses splices other than the recommended splices, do not use the worksheets 0.4 dB value for splices. Find out what the maximum loss value is for the splices that are in use and use that loss value.

### A.2.1 ORnet Product Set — 50/125 Micron Fiber Operation

- Fiber size — 50/125 micron
- Wavelength — 820 nm
- Maximum link length — 1000 m (3280 ft)
- Maximum allowable system loss — 5.55 dB
- Bandwidth derating — 0.25 dB/km

| Number of Splices | Number of Connector Pairs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 2 | 1000 | 813 | 626 | 440 | 253 | 66 | 0 | 0 | 0 |
| 3 | 893 | 706 | 520 | 333 | 146 | 0 | 0 | 0 | 0 |
| 4 | 786 | 600 | 413 | 226 | 40 | 0 | 0 | 0 | 0 |
| 5 | 680 | 493 | 306 | 120 | 0 | 0 | 0 | 0 | 0 |
| 6 | 573 | 386 | 200 | 13 | 0 | 0 | 0 | 0 | 0 |
| 7 | 466 | 280 | 93 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 359 | 173 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Distance in Meters | | | | | | | | |

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### A.2.2 ORnet Product Set — 100/140 Micron Fiber Operation

- Fiber size — 100/140 micron
- Wavelength — 820 nm
- Maximum link length — 2000 m (6560 ft)
- Maximum allowable system loss — 14.35 dB
- Bandwidth derating — 0.25 dB/km

| Number of Splices | Number of Connector Pairs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 2 | 2000 | 2000 | 2000 | 2000 | 2000 | 1905 | 1757 | 1610 | 1463 |
| 3 | 2000 | 2000 | 2000 | 2000 | 1968 | 1821 | 1673 | 1526 | 1378 |
| 4 | 2000 | 2000 | 2000 | 2000 | 1864 | 1736 | 1589 | 1442 | 1294 |
| 5 | 2000 | 2000 | 2000 | 1947 | 1800 | 1652 | 1505 | 1357 | 1210 |
| 6 | 2000 | 2000 | 2000 | 1863 | 1715 | 1568 | 1421 | 1273 | 1126 |
| 7 | 2000 | 2000 | 1926 | 1778 | 1631 | 1484 | 1336 | 1189 | 1042 |
| 8 | 2000 | 2000 | 1842 | 1694 | 1547 | 1400 | 1252 | 1105 | 957 |
| | Distance in Meters | | | | | | | | |

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## A.3 FDDI Product Descriptions

FDDI products operate at a 1300 nm wavelength and are designed to operate with 62.5/125 micron fiber that is fully characterized for 1300 nm wavelength operation. However, these products can be connected to other types of cable plants. These other cable plants are grouped in two general categories:

- A cable plant that uses dual-window fiber that meets the specifications defined in Table A–1 or Table A–2. Cable in this category provides transmission distance as long as cable attenuation and other loss factors (such as connector and splice loss) do not exceed the allowable system budget (see Section A.3.2).

- A cable plant that uses fiber (50/125, 62.5/125, 100/140 micron) that does not meet the requirements in Table A–1, Table A–2, or Table 5–2 for 1300 nm operation. Cable in this category has restrictions placed on the allowed lengths which depend on the characterization data available for the cable (see Section A.3.1).

### A.3.1 Guidelines for Using FDDI Products with Previously Installed Fiber

Previously installed cable plants may use fiber that does not meet the requirements in Table A–1 or Table A–2. The following data is required to determine if the cable is suitable for use with FDDI products:

- The exact length of the installed link, including any patch cables that will be used in the link.

- The attenuation of the cable at 1300 nm, and the maximum loss values for connectors and splices used in the link.

- The modal bandwidth (in MHz•km) of the cable's fiber for 1300 nm operation. This data is defined either by a direct measurement that was done by the installer when the cable was installed, or by the cable manufacturer's minimum-guaranteed modal bandwidth specification for the fiber at 1300 nm.

**NOTE**

To be supported, a specific fiber must have a minimum modal bandwidth of 100 MHz•km at 1300 nm.

Use the information in this section to perform a link modal bandwidth analysis and an optical link length/loss budget analysis to determine if the cable can be used by an FDDI application.

### A.3.1.1 Link Modal Bandwidth Analysis

If the fiber in the cable meets the requirement of 100 MHz•km modal bandwidth at 1300 nm operation, then only a link length of up to 400 meters (1312 feet) can be supported. If the link exceeds 400 meters (1312 feet), the cable cannot be used for 1300 nm operations. If the fiber in the cable has a modal bandwidth that is greater than 100 MHz•km, perform the following calculation to determine the maximum supportable length for the cable:

$$Maximum\ allowed\ length = \frac{Modal\ Bandwidth}{250\ MHz} \quad \text{(or } 1.6\ km\text{, whichever is less)}$$

**NOTE**

This calculation is also used to determine the length of cable that can be supported when the fiber characteristics either fail to meet the requirements in Table A–1 or have unknown chromatic dispersion characteristics.

The maximum supportable cable length is 1.6 km (5250 ft), even if the above calculation results in a greater value.

If the link's length does not exceed the maximum value allowed by the modal bandwidth of the cable, proceed to the next section to determine if the link length/loss budget characteristics of the cable are acceptable.

### A.3.1.2 Optical Link Length/Loss Budget Analysis

The optical link length/loss budget analysis is done using a Link-Loss Calculation Worksheet, but only after determining that the existing fiber optic link is within length parameters that meet the restrictions set by the fiber's minimum guaranteed modal bandwidth.

Procedures for using the Link-Loss Calculation Worksheets are explained in Chapter 5. Make a photocopy of the blank worksheet for each link to be analyzed. Filling in the worksheet allows you to analyze the link length that is possible, based on the FDDI and cable plant's optical parameters.

Consider the following when filling in the worksheet:

- Use the attenuation value defined by the cable's manufacturer.
- Use the correct maximum FDDI allowable system budget for the fiber size of the link's cable.

  — 6.0 dB for 50/125 micron

  — 11.0 dB for 62.5/125 or 100/140 micron

- If the link uses connectors other than 2.5 mm bayonet ST-type connectors, do not use the worksheets 0.7 dB value for connector pairs. Find out what the maximum loss value is for the connectors that are in use and use that loss value.
- If the link uses splices other than the recommended splices, do not use the worksheets 0.4 dB value for splices. Find out what the maximum loss value is for the splices that are in use and use that loss value.

If the maximum link length determined by the worksheet is less than the actual link length, the FDDI product cannot be used with the link. Only if the worksheet's link length is equal to or greater than the actual link can the FDDI product set be connected to that link.

### A.3.2 Guidelines for Using FDDI Products with Dual-Window Fiber

This section provides brief FDDI operational parameter descriptions for 50/125 and 100/140 micron dual-window fiber operation when using fiber that meets the specifications in Table A–1 or Table A–2. Each fiber size operational parameter description includes:

- A table that indicates the maximum operational distances for the FDDI product set's fiber optic links for the specified fiber size, with the link distances based on the number of connector pairs and splices used in the link. Remember to plan for two maintenance splices.
- Optical parameters that affect the FDDI product set's operation for the specified fiber size.

**NOTE**

The link-loss tables in the 50/125 and 100/140 micron fiber operation descriptions provide look-up methods for determining a link's maximum distance, based on the number of splices and connector pairs designed for the link. Remember to add two splices for each link to budget for service splices. The table includes a 1.0 dB cable plant system loss margin and uses the indoor cable attenuation.

Each table shows how the maximum link distance can be affected by splices and connector pairs used at interconnect and crossconnect administration points. It is not meant to imply that Digital recommends or supports links that consist of multiple small segments.

### A.3.2.1 FDDI Product Set — 50/125 Micron Dual-Window Fiber Operation

- Fiber size — 50/125 micron
- Wavelength — 1300 nm
- Maximum link length — 2000 m (6560 ft)
- Maximum allowable system loss — 6.00 dB
- Bandwidth derating — 0.00 dB/km

| Number of Splices | Number of Connector Pairs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 2 | 2000 | 2000 | 1866 | 1400 | 933 | 466 | 0 | 0 | 0 |
| 3 | 2000 | 2000 | 1599 | 1133 | 666 | 199 | 0 | 0 | 0 |
| 4 | 2000 | 1800 | 1333 | 866 | 399 | 0 | 0 | 0 | 0 |
| 5 | 2000 | 1533 | 1066 | 600 | 133 | 0 | 0 | 0 | 0 |
| 6 | 1733 | 1266 | 799 | 333 | 0 | 0 | 0 | 0 | 0 |
| 7 | 1466 | 1000 | 533 | 66 | 0 | 0 | 0 | 0 | 0 |
| 8 | 1199 | 733 | 266 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Distance in Meters | | | | | | | | |

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### A.3.2.2 FDDI Product Set — 100/140 Micron Dual-Window Fiber Operation

- Fiber size — 100/140 micron
- Wavelength — 1300 nm
- Maximum link length — 2000 m (6560 ft)
- Maximum allowable system loss — 11.00dB
- Minimum required system loss — 3.00 dB
- Bandwidth derating — 0.00 dB/km

| Number of Splices | Number of Connector Pairs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 2 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 1719 | 1439 |
| 3 | 2000 | 2000 | 2000 | 2000 | 2000 | 2000 | 1839 | 1559 | 1280 |
| 4 | 2000 | 2000 | 2000 | 2000 | 2000 | 1960 | 1680 | 1400 | 1120 |
| 5 | 2000 | 2000 | 2000 | 2000 | 2000 | 1800 | 1520 | 1240 | 959 |
| 6 | 2000 | 2000 | 2000 | 2000 | 1919 | 1640 | 1360 | 1079 | 800 |
| 7 | 2000 | 2000 | 2000 | 2000 | 1760 | 1479 | 1200 | 919 | 640 |
| 8 | 2000 | 2000 | 2000 | 1897 | 1600 | 1319 | 1039 | 759 | 479 |
| | Distance in Meters | | | | | | | | |

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# APPENDIX B

# B

# Using FDDI and ORnet Products with Existing Ethernet/802.3 Networks

This appendix provides information on how to use FDDI and ORnet products in interconnections with Ethernet/802.3 configurations. This information includes:

- Descriptions of the types of FDDI or ORnet fiber-to-Ethernet/802.3 network configurations, including application examples for using FDDI products in those configurations.
- Guidelines for using ORnet products in connections with Digital's Ethernet/802.3 products.

This appendix also addresses using FDDI and ORnet products for interconnections with an Ethernet/802.3 network that is using any of the following types of copper media:

- Standard Ethernet Coaxial Cable
- ThinWire Coaxial Cable
- Twisted-Pair Cable

**NOTE**

For more information on the guidelines that affect the copper subsystems within a DECconnect System structured system, see the *DECconnect System Planning and Configuration Guide* (EK–DECSY–CG).

## B.1 Integrating FDDI or ORnet Products with Ethernet/802.3 Hardware

Various types of network configurations can be created when integrating FDDI or ORnet fiber optic and Ethernet/802.3 networks together.

- Floor configurations — the fiber optic network interconnects with existing multiple Ethernet/802.3 offices or work groups on a floor of a building.
- Building configurations — the fiber optic network interconnects with existing Ethernet/802.3 floor configurations in a building.
- Campus configurations — the fiber optic network interconnects with standard Ethernet/802.3 cabling within the buildings in a campus site.

### B.1.1 Floor Configurations

Existing office clusters or work groups that are using an Ethernet/802.3 network can utilize FDDI or fiber optic Ethernet technologies.

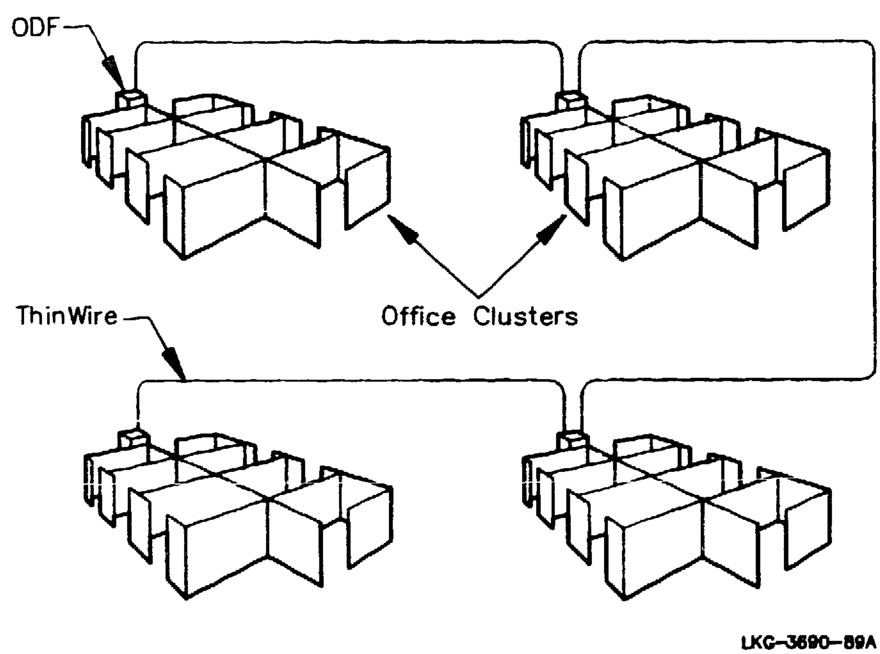
Figure B–1 illustrates simple office clusters that are integrated using a ThinWire Ethernet. Figure B–2 and Figure B–3 illustrate possible configuration examples of how FDDI technology can be integrated with existing Ethernet/802.3 networks within local offices or work groups using the following components:

- An FDDI wiring concentrator located in an HDF interconnects the various office and work group cluster's FDDI workstations and connects to an FDDI-to-Ethernet bridge (Figure B–2 and Figure B–3).
- The FDDI-to-Ethernet bridge within the HDF connects to a multiport repeater via ThinWire (Figure B–2 ) or connects to a DELNI within an ODF via a transceiver cable (Figure B–3).
- Workstations and VAX equipment connected to the multiport repeater via ThinWire (Figure B–2).
- FDDI workstation equipment connects to wiring concentrator via fiber optic cables (Figure B–2 and Figure B–3).
- Terminals connected through twisted–pair to a terminal server (Figure B–2 and Figure B–3).

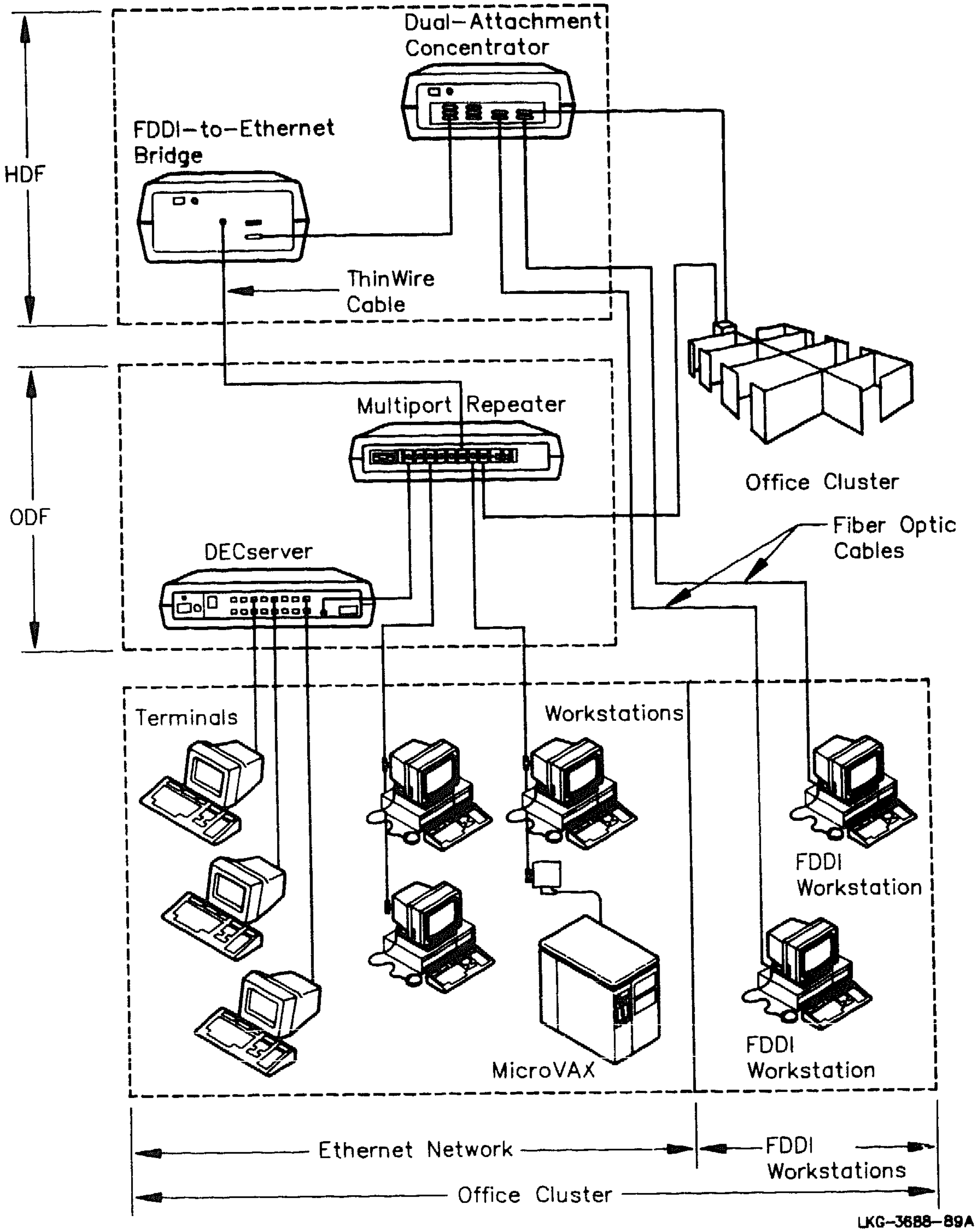
**NOTE**

For more information on FDDI product applications, see Chapter 5.

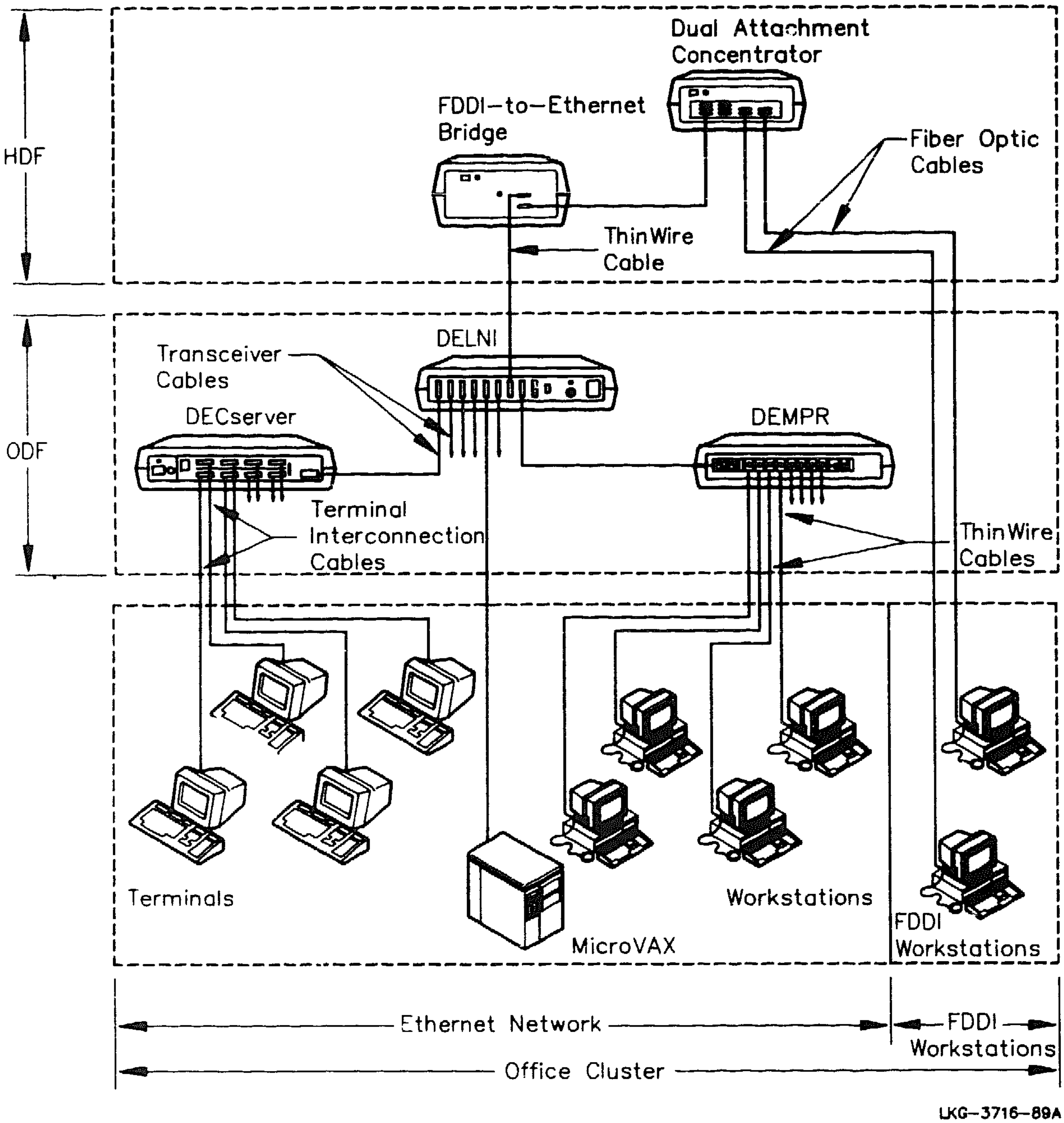
**Figure B–1: ThinWire Ethernet Office Cluster**



## Figure B–2: FDDI-to-Ethernet Bridge-to-DEMPR Floor Configuration Example



## Figure B–3: FDDI-to-Ethernet Bridge-to-DELNI Floor Configuration Example



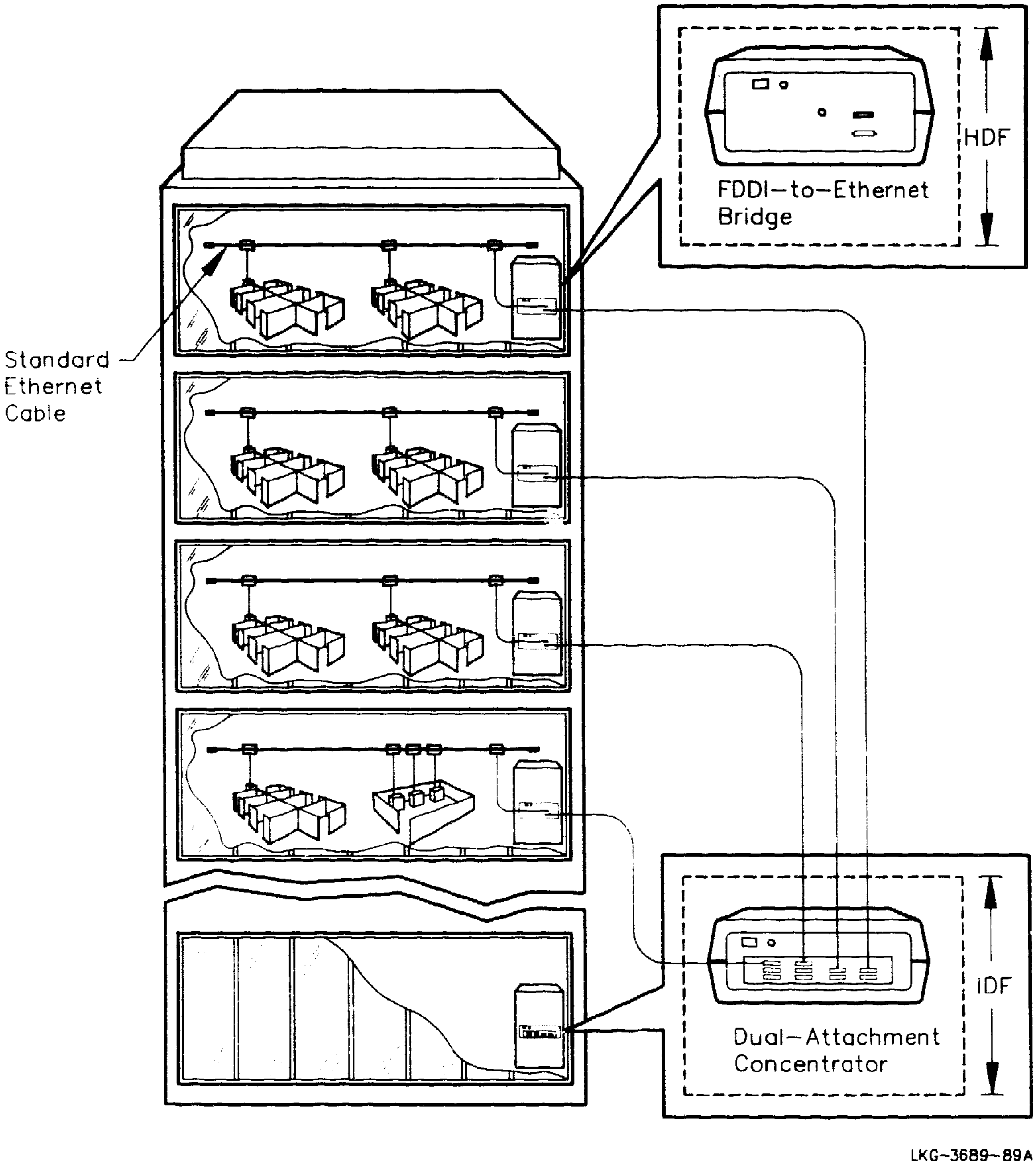
### B.1.2 Building Components

The building backbone riser allows for interconnecting various floors within a building. The use of fiber optic cabling in the backbone riser allows high-speed network technology, such as FDDI, to interconnect existing floors already configured for Ethernet/802.3.

Figure B–4 illustrates the connection of an FDDI building backbone riser to a standard Ethernet cable located on each floor of the building using the following components:

- An FDDI wiring concentrator (or concentrators) in the building's IDF interconnects with an FDDI-to-Ethernet bridge on each floor using Single Attachment Station (SAS) connections.
- Each FDDI-to-Ethernet bridge connects to the standard Ethernet cable using a transceiver and a transceiver cable.
- The standard Ethernet cable provides direct connections with communications equipment and computer facilities on each floor.

**Figure B–4: FDDI-to-Ethernet/802.3 Building Configuration Example**



### B.1.3 Campus Configurations

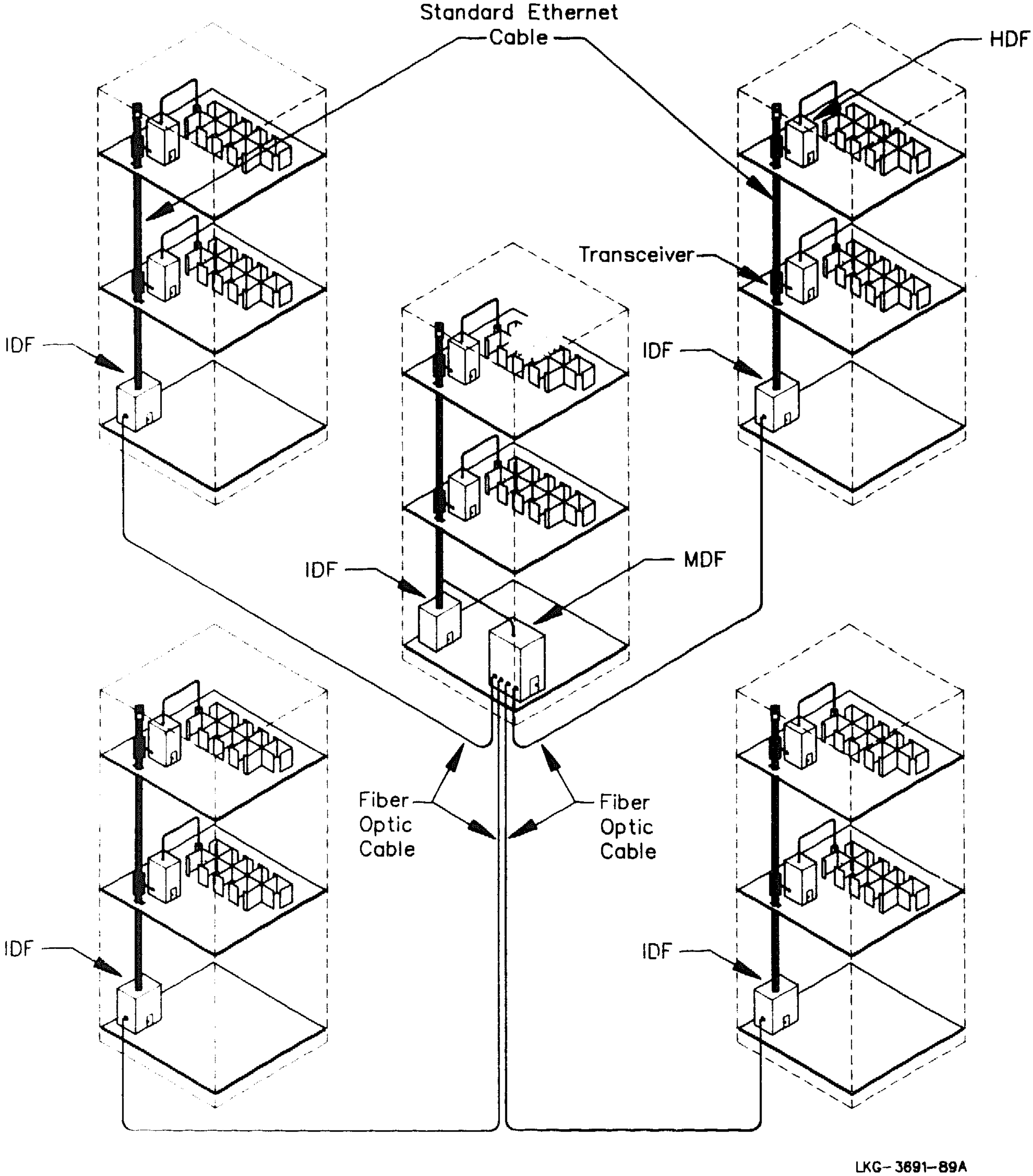
Multiple buildings within a campus site environment are interconnected using fiber optic links.

Figure B–5 shows buildings that have existing Ethernet/802.3 networks can be interconnected to a fiber optic campus backbone that is using FDDI fiber optic technology.

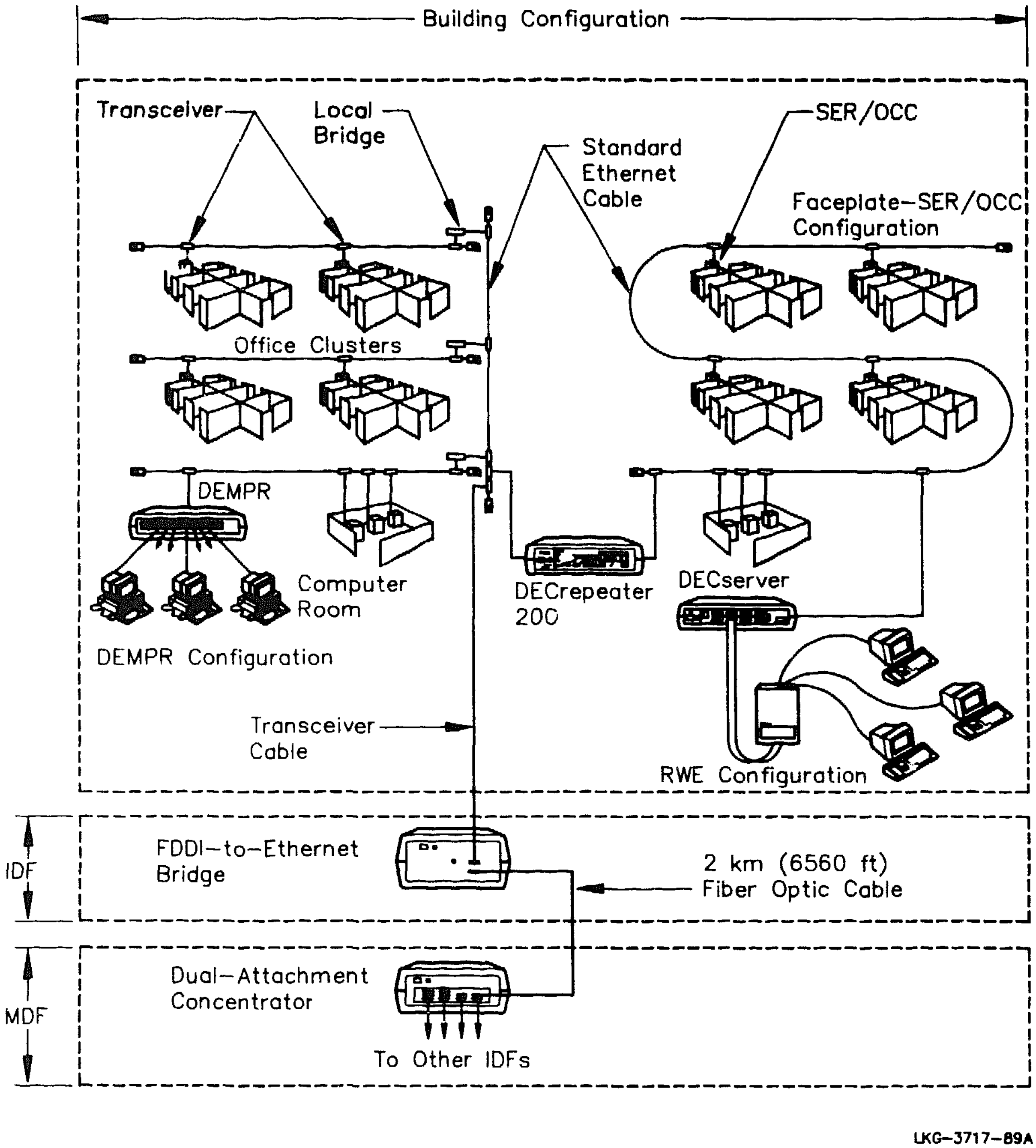
Figure B–6 illustrates a possible configuration for connecting an Ethernet/802.3 building network to the FDDI campus backbone using the following components:

- An FDDI wiring concentrator within the campus site's MDF interconnects to an FDDI-to-Ethernet bridge at the building using Single Attachment Station (SAS) connections.
- The FDDI-to-Ethernet bridge located at the building's IDF connects to the standard Ethernet building backbone using a transceiver and a transceiver cable.
- The standard Ethernet building backbone cable provides for the interconnections with each floor within the building.

## Figure B–5: Campus Configuration Example



## Figure B–6: FDDI-to-Ethernet Campus Configuration Example



## B.2 Using ORnet Products with Digital's Ethernet/802.3 Networking Products

ORnet is a fiber optic Ethernet product set that includes a multiport star and a transceiver (known as a fiber optic medium attachment unit (FOMAU)). The star provides for using Ethernet in a star configuration rather than the bus configuration used by the standard Ethernet/802.3 cabling.

As shown in Figure B–7, the star distributes the fiber optic Ethernet while the FOMAU interconnects the fiber optic Ethernet with Ethernet/802.3 networking hardware using a transceiver cable.

**Figure B–7: ORnet-to-Ethernet/802.3**

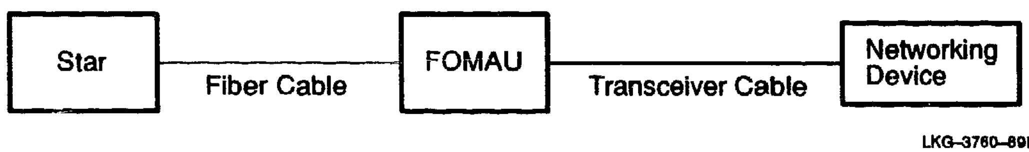



Table B–1 defines the interconnections between the ORnet product set and Digital's bridge and repeater products, including identification of the maximum fiber optic link lengths for each product when the specified bridge or repeater is connected to the FOMAU.

**NOTE**

The maximum fiber link distances given in Table B–1 are based on the physical timing limitations for the IEEE 802.3/Ethernet network. Optical budget limitations can reduce the maximum distances further.

Refer to Chapter 5 for the optical budget information concerning ORnet products to determine the maximum distance for a link based on the maximum allowable system loss. The smaller of the two types of distances (the timing or optical maximum distance) is used as the link's maximum distance.

**Table B–1: ORnet Interconnections with Digital's LAN Products**

| LAN Product | Maximum ORnet Fiber Link Distance | Maximum Transciever Cable Length |
|---|---|---|
| Remote Bridges | | |
| DEBET–*xx* | 2000 meters (6560 feet)* | 50 meters (164 feet) |
| DEBAM–*xx* | 2000 meters (6560 feet)* | 50 meters (164 feet) |
| Remote Repeaters | | |
| DEREN–*xx* | 770 meters (2525.6 feet) | 50 meters (164 feet) |
| DEREP–xx | No connection allowed | no connection allowed |
| Ethernet Repeaters | | |
| DEMPR–*xx* | 950 meters (3116 feet) | 50 meters (164 feet) |
| DESPR–*xx* | 950 meters (3116 feet) | 50 meters (164 feet) |
| Local Network Interconnect | | |
| DELNI–*xx* | 2000 meters (6560 feet)* | 50 meters (164 feet) |

*See the note on page B–11 concerning length restrictions.

## B.2.1 Guidelines for Connecting ORnet Products to Ethernet/802.3 Networking Hardware

The following guidelines affect the ORnet interconnections with the Ethernet/802.3 segments and active networking equipment:

- The FOMAU is compatible with both IEEE 802.3 and Ethernet transceiver cables.
- An IEEE 802.3 transceiver cable and an Ethernet transceiver cable cannot be interconnected.
- The maximum length for the transceiver cable is 50 meters (164 feet).
- The FOMAU can be connected to Digital's local network interconnect (DELNI) using the DELNI's global port.
- DEREN (DECrepeater 200) inteconnections with DELNIs are not supported by Digital or by the IEEE 802.3 standards.
- DEREP interconnections with FOMAU are not supported by Digital.
- The direct connection of an ORnet star's fiber ports to a LAN bridge or DECrepeater product's fiber ports are not supported due to incompatible optical signaling.

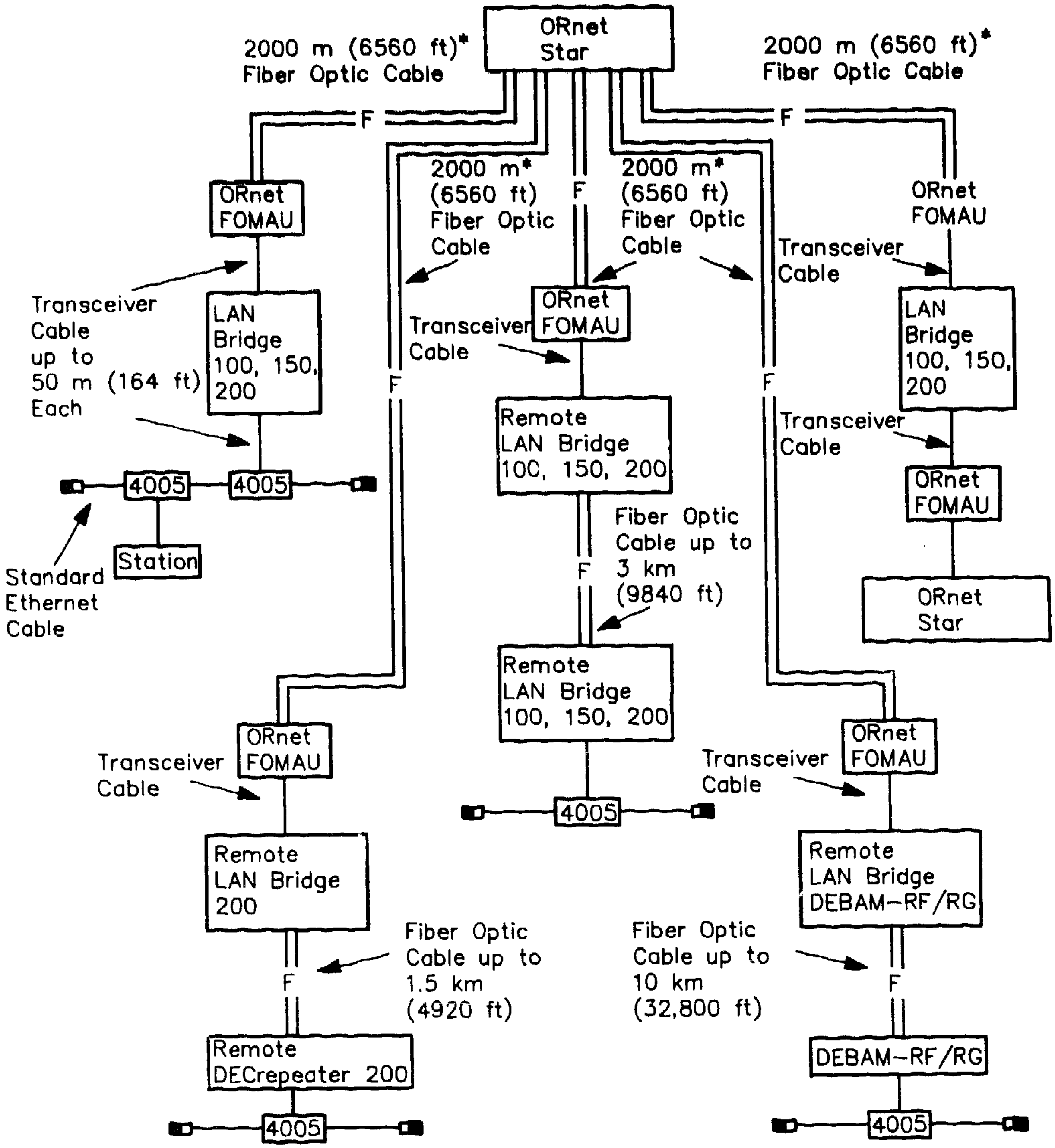
- Additional ORnet stars can be cascaded in a series path to allow for multiple star configurations. However, each additional star reduces the maximum fiber cable distances given in Table B–1 by 180 meters (590.4 feet).
- At the rear of the FOMAU there are three switches that must be set to specific settings as follows:
  - SQE TEST switch — Digital requires setting this switch to its disabled position when the FOMAU is connected to an 802.3 repeater.
  - ALTERNATE COLLISION MODE switch — Digital requires that this switch always be set to its disabled position.
  - FULL STEP switch — Digital requires that this switch always be set to its disabled position.

### B.2.2 ORnet-to-Ethernet/802.3 Interconnection Examples

Figure B–8 through Figure B–10 illustrate the types of ORnet fiber optic Ethernet interconnections as follows:

- Figure B–8 illustrates ORnet product interconnections with Digital's various LAN bridge products. As shown, these interconnections can be used to interconnect the ORnet campus backbone subsystem to a remote site or to standard Ethernet backbone cables.
- Figure B–9 illustrates ORnet product interconnections with Digital's various repeater products.
- Figure B–10 illustrates a two star serial path ORnet configuration with direct connection to a station device, LAN bridge, and repeater.

### Figure B–8: ORnet-to-LAN Bridge Connections




*See note on page B–11 concerning length restriction.

LKG–3711–89A

## Figure B–9: ORnet-to-Repeaters Interconnections

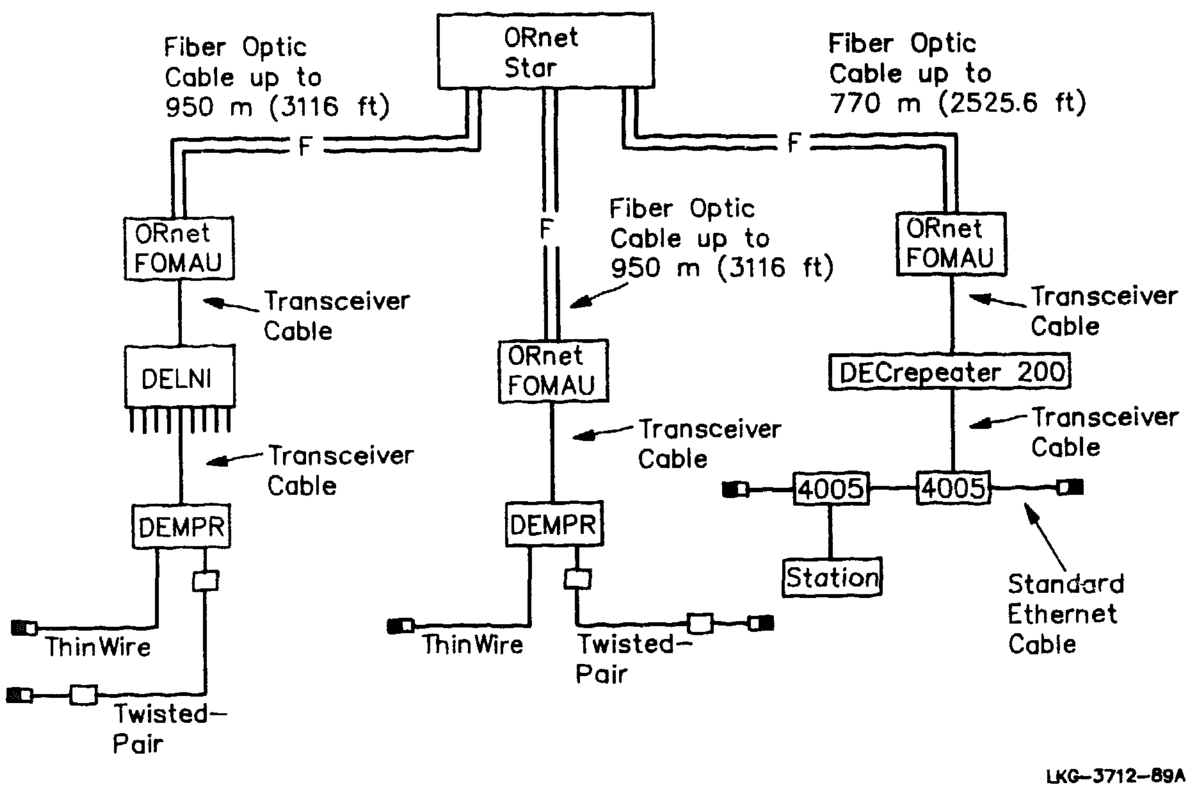
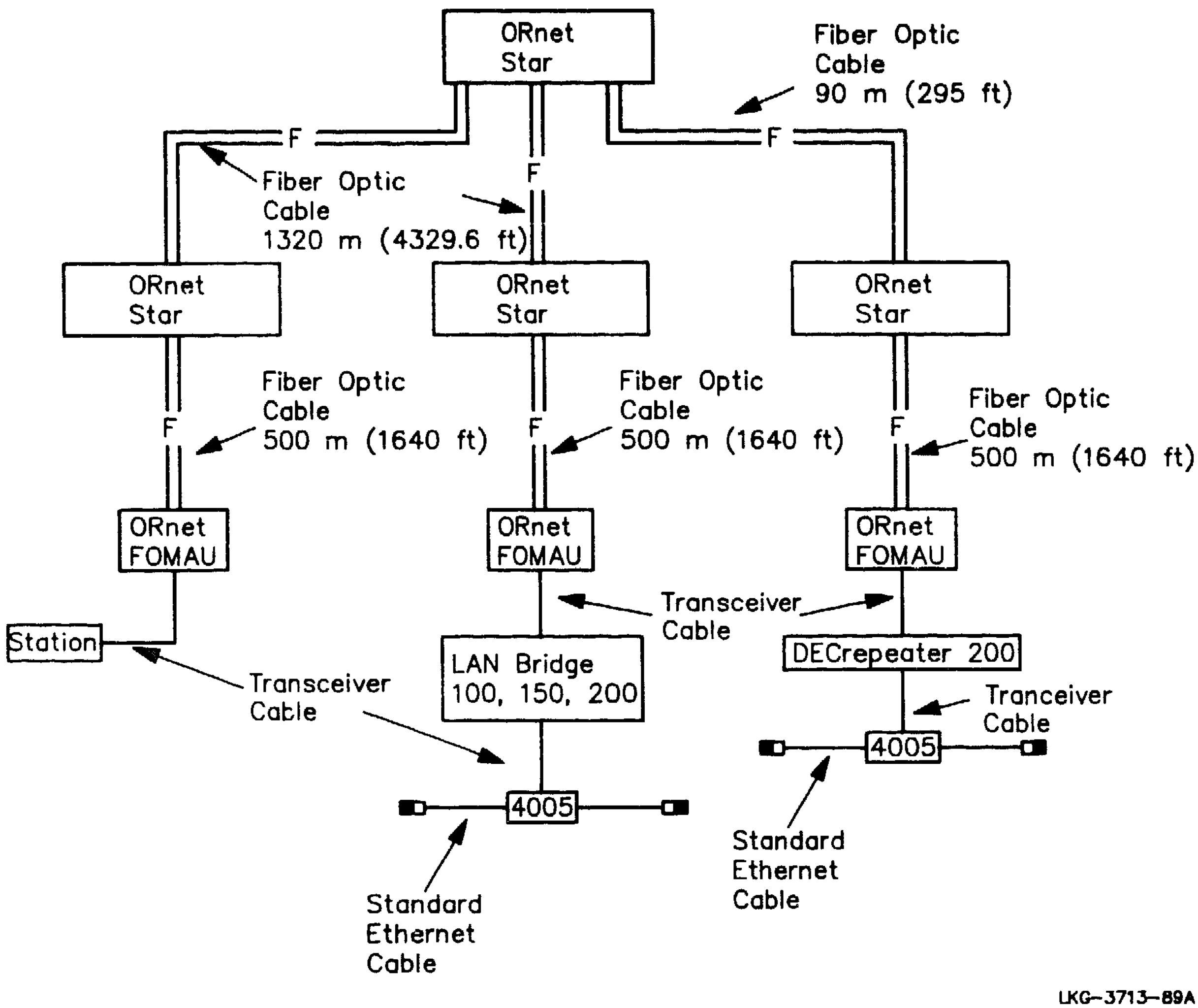


**Figure B–10: Multiple ORnet Star Connection Configuration**



# APPENDIX C

# C

# Remote Bridge and Repeater LAN Products

Digital Equipment Corporation offers a selection of bridges and repeaters for use in LAN (point-to-point) links. This appendix identifies:

- Digital's remote bridge and repeater products and the related documentation.
- The maximum link length for the product for 50/125, 62.5/125, and 100/140 micron fiber.
- The maximum allowable system loss for the remote bridge and repeater products.

## C.1 Remote Bridge Products

The following lists Digital's remote bridge products and their reference documents:

- DEBET-*xx* (LAN Bridge 100 or LAN Bridge 150) — *LAN Bridge 100 Installation Manual* (EK–DEBET–UG) or *LAN Bridge 150 Installation Manual* (EK–LB150–IN).
- DEBAM-*xx* (LAN Bridge 200) — *LAN Bridge 200 Installation Manual* (EK–DEBAM–IN).

## C.2 Remote Repeaters

The following lists Digital's remote repeater products and their reference documentation:

- DEREP–*xx* (DECrepeater 100) — *DECrepeater 100 Installation Manual* (EK–DEREP–IN).
- DEREN–*xx* (DECrepeater 200) — *DECrepeater 200 Installation Manual* (EK–DEREN–IN).

## C.3 Maximum Fiber Optic Link Distances for Ethernet LAN Products

Table C–1 lists the maximum link distances and maximum allowable system loss for Digital's fiber optic Ethernet LAN products. The products are listed by Digital part number, and described by wavelength, maximum distance, maximum power budget per fiber size (62.5/125, 50/125, 100/140 micron), minimum attenuation, and bandwidth derating. Table C–1 also includes descriptions of specific bridge-to-repeater links.

**NOTE**

The actual distances may be less depending on fiber attenuation, number of splices, and number of connectors within the link. Use the link-loss calculation procedure described in Chapter 5 to determine the actual link length.

Regardless of the link-loss calculation results, do not exceed the maximum distances given in Table C–1.

**Table C–1: Remote Fiber Optic LAN Product Maximum Link Lengths**

| Fiber Size | Wavelength | Maximum Distance | Loss Budget | Minimum Attenuation | Bandwidth Derating |
|---|---|---|---|---|---|
| **PRODUCT: DEREP-RC/RD-to-DEREP-RC/RD LINKS** | | | | | |
| 50/125 | 850 nm | 500 meters (1640 feet) | 3.10 dB | N/A | 0.25 dB/km |
| 62.5/125 | 850 nm | 1000 meters (3280 feet) | 8.30 dB | N/A | 0.25 dB/km |
| 100/140 | 850 nm | 1000 meters (3280 feet) | 12.50 dB | N/A | 0.25 dB/km |
| **PRODUCT: DEBET-RC/RD-to-DEBET-RC/RD LINKS** | | | | | |
| 50/125 | 850 nm | 500 meters (1640 feet) | 3.10 dB | N/A | 0.25 dB/km |
| 62.5/125 | 850 nm | 2000 meters (6560 feet) | 8.30 dB | N/A | 0.25 dB/km |
| 100/140 | 850 nm | 2000 meters (6560 feet) | 12.50 dB | N/A | 0.25 dB/km |
| **PRODUCT: DEBET-RC/RD-to-Remote Repeater (DEREP-RC/RD) LINKS** | | | | | |
| 50/125 | 850 nm | 500 meters (1640 feet) | 3.10 dB | N/A | 0.25 dB/km |
| 62.5/125 | 850 nm | 1500 meters (4920 feet) | 8.30 dB | N/A | 0.25 dB/km |
| 100/140 | 850 nm | 1500 meters (4920 feet) | 12.50 dB | N/A | 0.25 dB/km |
| **PRODUCT: DEREP-RH/RJ-to-DEREP-RH/RJ LINKS** | | | | | |
| 50/125 | 850 nm | 1000 meters (3280 feet) | 8.00 dB | N/A | 0.25 dB/km |
| 62.5/125 | 850 nm | 1000 meters (3280 feet) | 12.00 dB | N/A | 0.25 dB/km |
| 100/140 | 850 nm | 1000 meters (3280 feet) | 14.00 dB | 4.00 dB | 0.25 dB/km |
| **PRODUCT: DEBET-RH/RJ-to-DEBET-RH/RJ LINKS** | | | | | |
| 50/125 | 850 nm | 2000 meters (6560 feet) | 8.00 dB | N/A | 0.25 dB/km |
| 62.5/125 | 850 nm | 3000 meters (9840 feet) | 12.00 dB | N/A | 0.25 dB/km |
| 100/140 | 850 nm | 3000 meters (9840 feet) | 14.00 dB | 4.00 dB | 0.25 dB/km |

| Fiber Size | Wavelength | Maximum Distance | Loss Budget | Minimum Attenuation | Bandwidth Derating |
|---|---|---|---|---|---|
| **PRODUCT: DEBET-RH/RJ-to-Remote Repeater (DEREP-RH/RJ) LINKS** | | | | | |
| 50/125 | 850 nm | 1500 meters (4920 feet) | 8.00 dB | N/A | 0.25 dB/km |
| 62.5/125 | 850 nm | 1500 meters (4920 feet) | 12.00 dB | N/A | 0.25 dB/km |
| 100/140 | 850 nm | 1500 meters (4920 feet) | 14.00 dB | 4.00 dB | 0.25 dB/km |
| **PRODUCT: DEBET-RP/RQ-to-DEBET-RP/RQ LINKS** | | | | | |
| 50/125 | 850 nm | 2000 meters (6560 feet) | 8.00 dB | N/A | 0.25 dB/km |
| 62.5/125 | 850 nm | 3000 meters (9840 feet) | 12.00 dB | 1.0 dB | 0.25 dB/km |
| 100/140 | 850 nm | 2600 meters (8528 feet) | 14.00 dB | 4.00 dB | 0.25 dB/km |
| **PRODUCT: DEBET-RP/RQ-to-Remote Repeater (DEREP-RH/RJ) LINKS** | | | | | |
| 50/125 | 850 nm | 1500 meters (4920 feet) | 8.00 dB | N/A | 0.25 dB/km |
| 62.5/125 | 850 nm | 1500 meters (4920 feet) | 12.00 dB | 1.0 dB | 0.25 dB/km |
| 100/140 | 850 nm | 1500 meters (4920 feet) | 14.00 dB | 4.00 dB | 0.25 dB/km |
| **PRODUCT: DEBAM-RC/RD-to-DEBAM-RC/RD LINKS** | | | | | |
| 50/125 | 850 nm | 2000 meters (6560 feet) | 9.00 dB | N/A | 0.0 dB/km |
| 62.5/125 | 850 nm | 3000 meters (9840 feet) | 14.00 dB | N/A | 0.0 dB/km |
| 100/140 | 850 nm | 2800 meters (9184 feet) | 16.00 dB | 4.00 dB | 0.0 dB/km |
| **PRODUCT: DEBAM-RF/RG-to-DEBAM-RF/RG LINKS** | | | | | |
| 50/125 | 1300 nm | 10000 meters (32800 feet) | 12.00 dB | 3.00 dB | 0.0 dB/km |
| 62.5/125 | 1300 nm | 10000 meters (32800 feet) | 17.00 dB | 7.00 dB | 0.0 dB/km |
| 100/140 | 1300 nm | 4000 meters (13120 feet) | 17.00 dB | 9.00 dB | 0.0 dB/km |

| Fiber Size | Wavelength | Maximum Distance | Loss Budget | Minimum Attenuation | Bandwidth Derating |
|---|---|---|---|---|---|
| **PRODUCT: DEREN-RC/RD-to-DEREN-RC/RD LINKS** | | | | | |
| 50/125 | 850 nm | 1000 meters (3280 feet) | 9.00 dB | N/A | 0.0 dB/km |
| 62.5/125 | 850 nm | 1000 meters (3280 feet) | 14.00 dB | N/A | 0.0 dB/km |
| 100/140 | 850 nm | 1000 meters (3280 feet) | 16.00 dB | 4.00 dB | 0.0 dB/km |
| **PRODUCT: DEBAM-RC/RD-to-Remote Repeater (DEREN-RC/RD) LINKS** | | | | | |
| 50/125 | 850 nm | 1500 meters (4920 feet) | 9.00 dB | N/A | 0.0 dB/km |
| 62.5/125 | 850 nm | 1500 meters (4920 feet) | 14.00 dB | N/A | 0.0 dB/km |
| 100/140 | 850 nm | 1500 meters (4920 feet) | 16.00 dB | 4.00 dB | 0.0 dB/km |

# APPENDIX D

# D

# Connecting Sites

This appendix describes the structured wiring configuration connections to other sites for known applications only.

## D.1 Introduction

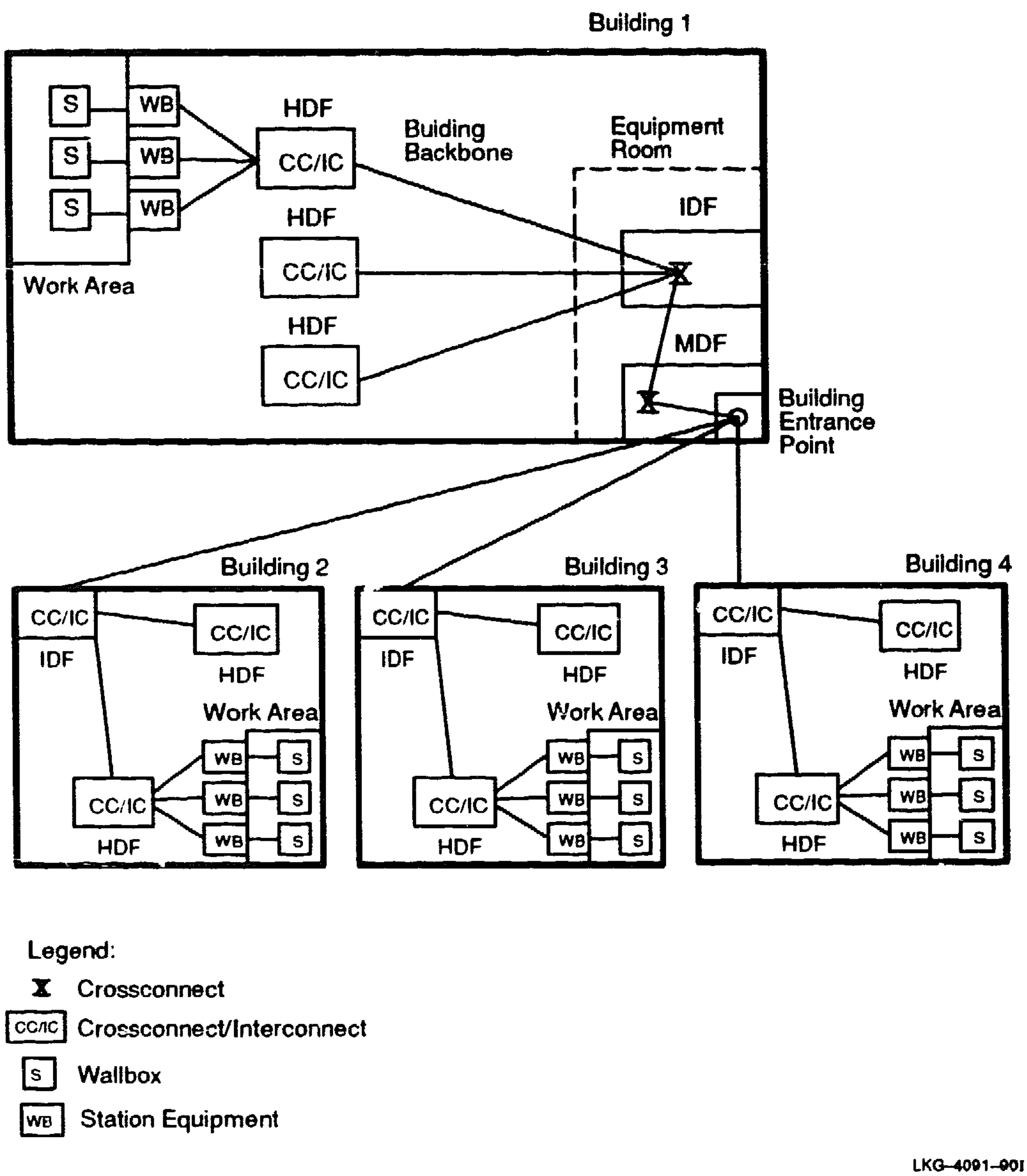
The DECconnect System structured wiring cable plant has specified a wiring infrastructure to be compliant with the EIA/TIA–568 building wiring standard (see Figure D–1). Within the cable plant infrastructure, a single site has only one main distribution frame (MDF). Connections to other sites can occur in the following type of configurations when designed for known applications.

- Campus Configuration
- Metropolitan Configuration
- Global Configuration

## D.2 Campus Configuration

Multiple sites can exist within the campus grounds. Connection of these sites is done through dedicated fiber optic links between each MDF. For most applications, Digital recommends using extended LAN to connect sites. For more information on extended LAN products, see the *Network and Communications Buyer's Guide* available from Digital Equipment Corporation.

## Figure D–1: Wiring Structure



## D.3 Metropolitan Configuration

When multiple sites in a metropolitan area must be connected and fiber optic links may not be practical, use a microwave link between METROWAVE bridges at each MDF to create an intersite extended LAN. Microwave links are "line–of–site," reaching distances of up to 7.2 kilometers (4.5 miles).

For more information on the METROWAVE bridge product, refer to the *Network and Communications Buyer's Guide* available from Digital Equipment Corporation.

## D.4 Global Configuration

When widely scattered sites must be connected, use a satellite or terrestrial link between TransLAN bridges located in each MDF. The TransLAN bridge supports network connections that can span the globe.

When widely scattered sites must be connected, or where connecting to multivendor networks, use wide area network (WAN) communications media between Routers and/or Gateways.

For more information on TransLAN bridges, Routers · Gateways, refer to the *Network and Communications Buyer's Guide* available from gital Equipment Corporation.

# APPENDIX E

# E

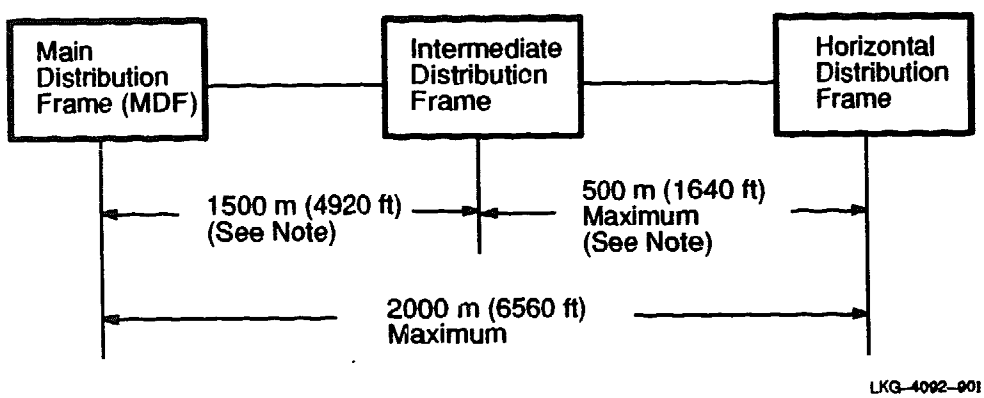
# Special Distance Situations

This appendix describes the special distance situations for known applications.

## E.1 Introduction

The DECconnect System structured wiring cable plant has specified campus and building backbone distances to be compliant with the EIA/TIA–568 building wiring standard (see Figure E–1).

**Figure E–1: Campus and Building Backbone Distances**




**NOTE**

When the HDF–to–IDF distance is less than maximum, the IDF–to–MDF distance can be increased to a maximum of 2000 meters (6560 feet).

These distances provide a site with a structured wiring system that supports a multiproduct environment. In special cases, distance requirements for the campus backbone require dedicated campus backbone fiber optic cables of 2000 meters (6560 feet) or greater with building backbone fiber optic cables up to 500 meters (1640 feet). These extended distances are only designed into the cable plant with known applications. Since dedicated active equipment is being designed with these links, it is important to verify the link-loss calculation for each link.

Review the procedures given in Chapter 5 (Fiber Optic Design), and complete the link-loss calculation worksheet to verify the extended distance numbers.

Figure E–2 and Figure E–3 illustrate special distance situation examples:

- Figure E–2 is a concept diagram of a site showing a fiber optic Ethernet backbone with an extended 10 kilometer (6.2 miles) connection to a remote building.

- Figure E–3 is a concept diagram of a dedicated FDDI backbone showing 2 kilometer (1.2 miles) connection between the MDF and building IDFs.

## Figure E–2: Fiber Optic Ethernet Backbone with an Extended Connection

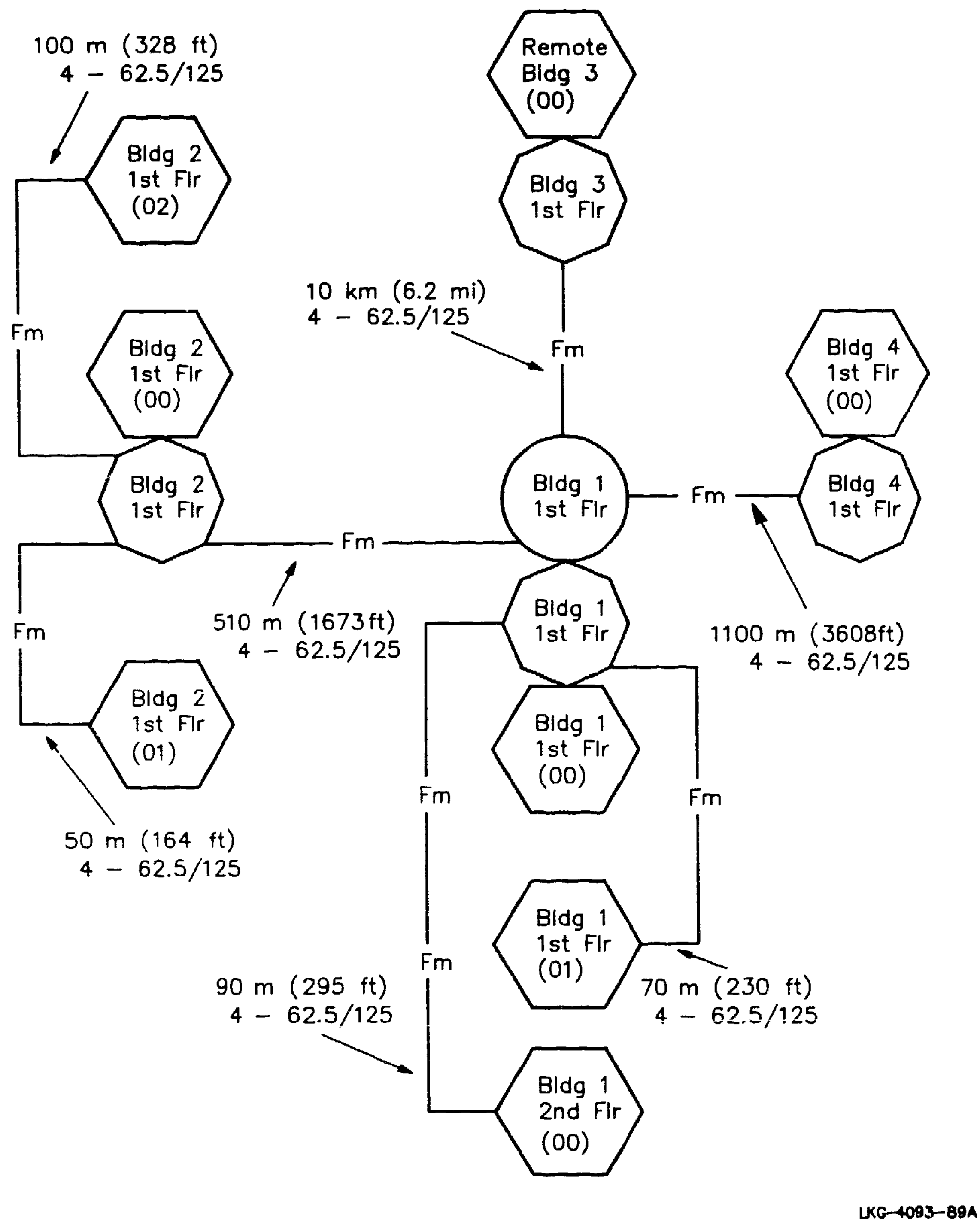
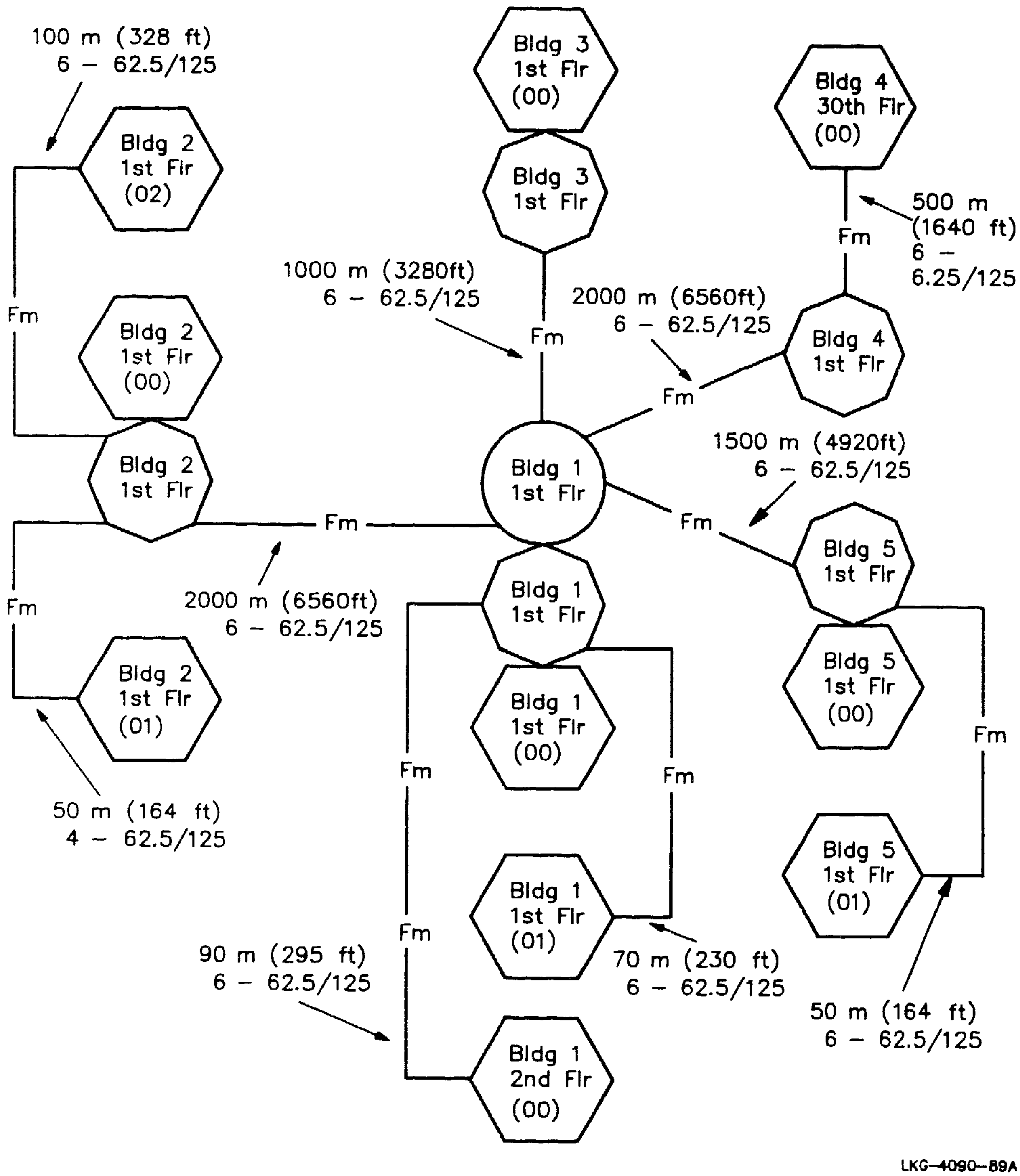


**Figure E–3: FDDI Backbone with 2 km (1.2 mi) Connection Between Buildings**



# APPENDIX F

F

# NEC Cabling Requirements

This appendix summarizes National Electrical Code (NEC) cabling requirements.

## F.1 Overview of the National Electrical Code

The NEC is issued by the National Fire Protection Association. The NEC's purpose is to safeguard people and property from hazards arising from the use of electricity and electrical equipment and conductors. The code is advisory and regulates the installation of electrical equipment and conductors within buildings. The code is updated every three years. (The latest version available is dated 1990.)

**NOTE**

For installations outside of the United States, use the appropriate local standards.

Although the code is advisory only, it is routinely adopted by jurisdictions across the United States as part of their local building codes. Some jurisdictions do not adopt the entire code and have local requirements that are different from the NEC. A local jurisdiction's rules always supersede the NEC.

### F.1.1 DECconnect System Copper Wiring Classifications

Generally, DECconnect System copper wiring is classed as either Class 2 (CL2) or Class CM wiring.

**NOTE**

This guide describes the installation of Class 2 (CL2) wiring. For international installations, refer to the appropriate national standards.

This guide does not describe installation of Class 1 wiring, which controls equipment whose failure to operate may cause a direct fire or life hazard (fire alarms, medical call systems, elevators, cranes, conveyers or other moving equipment.

#### F.1.1.1 Class 2 Wiring

Class 2 wiring (NEC article 725) is power-limited signaling circuitry whose failure to operate would not cause a direct fire or life hazard.

Class 2 wiring includes low-power heating and cooling control circuits, typical data and voice transfer circuits, and wiring used for interconnecting electronic data processing and computer equipment. Class 2 cables are marked CL2X, CL2, CL2R, and CL2P, depending on their flame resistance.

#### F.1.1.2 Class CM Wiring

Class CM wiring (NEC article 800) covers communications circuits used for telephones and telephone circuits used for data transmission. Class CM cables are marked CMX, CM, CMR, and CMP, depending on their flame resistance. CM cables can be used for CL2 applications, but not vice versa.

### F.1.2 Fiber Optic Cables Installed Along with Electrical Cables

The NEC also applies to the installation of fiber optic cables when they are installed along with electrical cables. Fiber optic cables (NEC article 770) are divided into three types:

- Nonconducting — contains no metallic members or other electrically conductive material. Nonconducting cables are labeled OFN, OFNR, or OFNP, depending on the NEC flammability rating.
- Conducting — contains electrically conductive material (such as metallic strength members or vapor barriers) that are not current carrying material. Conducting cables are labeled OFC, OFCR, or OFCP, depending on the NEC flammability rating.
- Hybrid — contains both fiber optic and current carrying electrical conductors. Hybrid cables are classified as electrical cables, depending on the type of electrical conductors they contain.

## F.2 Fire Resistance of Cabling

The 1990 NEC divides wiring into four classes. Each class is based on standard flame resistance and flame spread testing. The NEC specifies where each class of cable can be installed. The NEC class must be marked on the cable. In order of increasing strictness, the four NEC wiring classes are as follows:

1. Limited use cables — marked CMX or CL2X (the lowest flame resistance). Used only in single and multifamily dwellings. There are no fiber optic cables in this class.

2. General use cables — marked CM or CL2. Can be installed in offices and rooms, but not behind or through walls or ceilings and not in environmental air handling spaces. Fiber optic cables in this class are marked OFC or OFN.

3. Riser use cables — marked CMR or CL2R. Used between floors and in vertical shafts. Fiber optic cables in this class are marked OFCR or OFNR.

4. Plenum use cables — marked CMP or CL2P (the highest flame resistance). Used in plenums and air-handling spaces. Fiber optic cables in this class are marked OFCP or OFNR.

With flammability ratings, the NEC allows the use of a higher rated cable in a lower rated application. For example, in DECconnect System applications, CL2 is recommended for flammability classes CL2X and CL2, and CL2P for CL2R and CL2P. Cable marked CMP, CL2P, OFCP, or OFNP can be used for all four applications.

## F.3 Environmental Airspace

Often, cabling is installed in the space above a suspended ceiling or below a raised floor. These spaces can also act as the return for the building's heating, ventilation, and air-conditioning (HVAC) systems.

Figure F–1 shows an example of an above-ceiling environmental airspace. Note that there is no duct work for the air return; therefore, the entire area above the ceiling is considered environmental airspace.

Figure F–2 shows an example of an above-ceiling nonenvironmental airspace. Note that there is duct work for the air return above the ceiling; therefore, the area above the ceiling is considered nonenvironmental airspace.

**NOTE**

When designing cable links, make sure to adhere to all Underwriter Laboratories (UL) regulations by selecting air plenum certified cable for use in air plenums and ducts.

**Figure F–1: Typical Above-Ceiling Environmental Airspace**

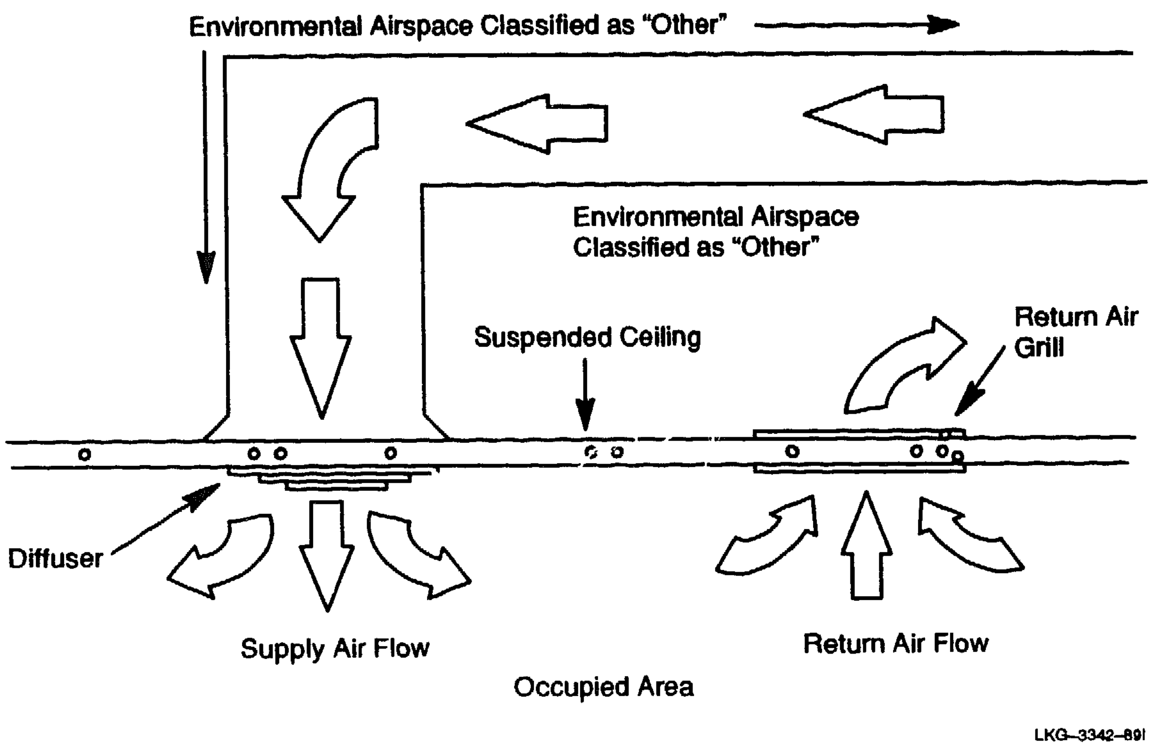
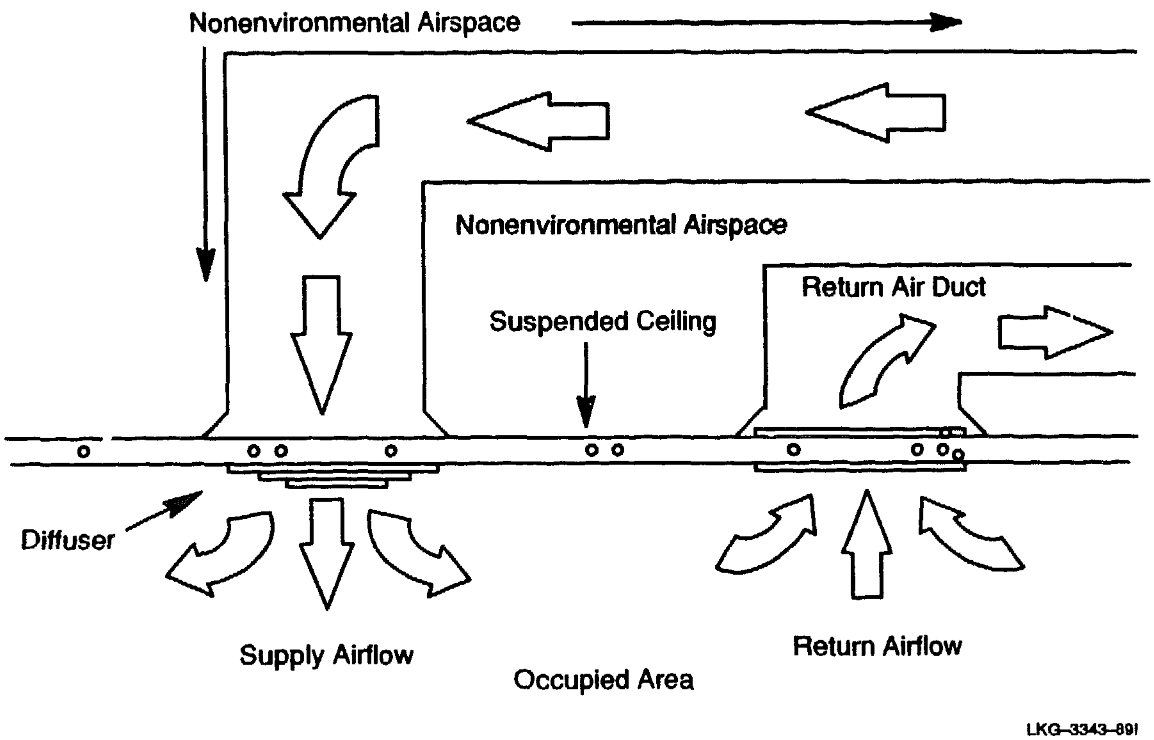


Figure F–2: Typical Above-Ceiling Nonenvironmental Airspace




## F.4 Fire Code Considerations

Any time cabling penetrates walls, partitions, floors, or ceilings that have a fire-resistance rating, the cabling penetration points must be fire-stopped using approved methods to maintain the fire-resistance rating. There are UL-listed prefabricated fire seals and caulking materials available. If there are any doubts about requirements, consult the local building inspection authorities or the building's architect.

**NOTE**

For installations outside of the United States, refer to the appropriate local standards.

On the network floor plans, note any locations where a cable path penetrates a fire wall.

# APPENDIX G

# G

# Reference Documents

This appendix provides ordering information for reference documents. Additional sources of standards and codes are listed at the end of this appendix.

## G.1 ANSI Documentation

Order the following documentation from:

American National Standards Institute (ANSI)
430 Broadway
New York, NY 10018
(212) 642–4900

- *Communications Wire and Cable for Wiring of Premises ANSI/ICEA 5–80–576–1988, Second Edition, September 1988*
- *ANSI/IPC–FC–213, Undercarpet Cable Specification*
- *Fiber Distributed Data Interface (FDDI) Physical Layer Medium Dependent (PMD)*
- *ANSI/EIA/TIA–492AAAA, Detail Specification for 62.5 µm Core Diameter/125 µm Cladding Diameter Class Ia Multimode, Graded–Index Optical Waveguide Fibers*
- *ANSI/IEEE Std 802.3b, c, d, and e (1989 Edition), an American National Standard.* IEEE Standards for Local Area Networks.

## G.2 ASTM Documentation

Order the following documentation from:

American Society for Testing and Materials (ASTM)
1916 Race Street
Philadelphia, PA 19103
(215) 299–5400

- *ASTM D 4566–86, Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable*

## G.3 AT&T Documentation

Order the following documentation from:

AT&T Customer Information Center
Commercial Sales Representative
P.O. Box 19901
Indianapolis, IN 46219
1–800–432–6600

- *AT&T Premises Distribution System Fiber Installation Manual* (Document No. 555–401–102)
- *LST1U–072/7 Lightguide Termination Shelf Installation AT&T 636–299–103–5*
- *LSC1U–024/5 Lightguide Combination Shelf Installation AT&T 636–299–103–6*
- *LSS1U–072/5 Lightguide Splice Shelf Installation AT&T 636–299–103–11*
- *LSJ1U–072/5 Lightguide Storage Shelf Installation AT&T 636–299–103–14*
- *LT1A Splice Organizer Installation AT&T 636–299–103–15*

## G.4 BICSI Documentation

Order the following documentation from TESTMARK Laboratories, but make check payable to GTE Supply Inc.

TESTMARK Laboratories
Publications Department
3050 Harrodsburg Road
Lexington, KY 40503
(606) 223–3061

- *BICSI Telecommunications Distribution Methods Manual*
  The Building Industry Consulting Service, International (BICSI)
  1989–1990 price: $72 (members), $179 (nonmembers)

## G.5 EIA/TIA Documentation

Order the following documentation from either of these sources:

The Electronic Industries Association (EIA)
1722 Eye Street, N.W., Suite 300
Washington, DC 20006
(202) 457–4900

Telecommunications Industries Association (TIA)
1722 Eye Street, N.W., Suite 4040
Washington, DC 20006
(202) 457–4934

- *EIA/TIA–568 Draft Standard, Commercial Building Wiring Standard*
- *EIA/TIA–570 Draft Standard, Residential and Light Commercial Building Wiring Standard*
- *EIA/TIA–569 Draft Standard, Building Standard for Telecommunications Media and System*
- *EIA–440A Fiber Optic Terminology*
- *EIA Interim Standard Omnibus Specification, Local Area Network Twisted Pair Data Communications Cable, NQ–EIA/IS–43, September 1987*
- *EIA–455 Fiber Optic Test Procedures*
- *EIA–472, Generic Specification for Fiber Optic Cables*
- *EIA–492 Specification Series for Optical Fibers*

- *EIA–472A, Sectional Specification for Fiber Optic Communication Cables for Outside Aerial Use*
- *EIA–472B, Sectional Specification for Fiber Optic Communication Cables for Underground and Buried Use*
- *EIA–479C, Sectional Specification for Fiber Optic Communication Cables for Indoor Use*
- *EIA–479D, Sectional Specification for Fiber Optic Communication Cables for Outdoor Telephone Plant Use*
- *Commercial Building Wiring Standard (EIA Part No. 1907)*

## G.6 GTE Documentation

Order the following documentation from:

GTE Communication Systems Corporation
Publications Manager
Department 431.1 – Tube Station C1
400 North Wolf Road
Northlake, IL 60164
(312) 681–7483 or (312) 681–7479

- *Line and Cable Placing* (CH No. 140)
  Approximate price: $32
- *Cable Splicing* (CH No. 150)
  Approximate price: $28
- *Cable Maintenance and Testing* (CH No. 170)
  Approximate price: $26

## G.7 IEEE Documentation

Order the following documentation from:

The Institute of Electrical and Electronic Engineers, Inc. (IEEE)
IEEE Service Center
445 Hoes Lane
P.O. Box 1331
Piscataway, NJ 08855–1331
(201) 981–0060

- *IEEE 802.3–1988 (also known as ANSI/IEEE Std 802.3–1988 or ISO 8802–3: 1989 (E)), Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*
- *IEEE 802.3 Supplements*
- *IEEE 802.5–1985 (also known as ANSI/IEEE Std 802.5–1985 or ISO Draft Proposal 8802/5), Token Ring Access Method and Physical Layer Specification*

## G.8 ISDN Documentation

Order the following documentation from:

International Standard Organization (ISO)
1, Tue de Varembe
Case Postale 56
CH–1211 Geneva 20
Switzerland
+41 22 34 12 40

- *ISDN BRI(ISO 8877)*

## G.9 NEC Documentation

Order the following documentation from:

The National Fire Protection Association (NFPA)
1 Batterymarch Park
Quincy, MA 02269
1–800–344–3555

- *National Electrical Code (NEC)*

## G.10 NEMA Documentation

Order the following documentation from:

National Electrical Manufacturers Association (NEMA)
2101 L Street
Washington, DC 20037
(202) 457–8400

- *NEMA–250–1985, Enclosures for Electrical Equipment (1000 Volts Maximum)*

## G.11 UL Documentation

Order the following documentation from:

Underwriters Laboratories, Inc. (UL)
333 Pfingsten Road
Northbrook, IL 60062
(312) 272–8800

- UL 1863

## G.12 Additional Sources

CSA: Canadian Standards Association (CSA)
178 Rexdale Boulevard
Rexdale (Toronto), Ontario
Canada M9W 1R3
(416) 747–4363

FCC: Federal Communications Commission (FCC)
Washington, DC 20554
(301) 725–1585

Federal and Military Specifications:

Naval Publications and Forms Center
Commanding Officer
NPFC 43, 5801 Tabor Avenue
Philadelphia, PA 19120–5099
(215) 697–3321

ICEA: Insulated Cable Engineers Association (ICEA)
P.O. Box 440
South Yarmouth, MA 02664
(508) 394–4424

IEC: International Electrotechnical Commission (IEC)
Sales Department
P.O. Box 131
3 rue de Varembe
1211 Geneva 20
Switzerland
+41 22 34 01 50

# GLOSSARY

# Glossary

**Active Equipment**
A device that provides for communication services and requires primary power; for example, repeaters, bridges, terminal servers, concentrators, and computers.

**Building**
A structure containing floor(s) and an entrance area where communications cables enter and leave the structure.

**Building Backbone cable**
The communications cable installed inside a building.

**Cable Plant**
The campus and building wiring infrastructure that supports voice, video, and data applications.

**Campus**
The buildings and grounds of a complex, such as a university, college, industrial park, or military establishment.

**Campus Backbone cable**
The communications cable installed between buildings.

**Central Voice**

The place where voice communications common carriers terminates customer lines and locates switching equipment that interconnects those lines.

**Crossconnect**

A patch cable and passive hardware that is used to administer the connection of cables at a distribution frame.

**Crossover**

Patch cable(s) within a link that connect in such a way to route the transmit port of one piece of active equipment to the receive port of another piece of active equipment.

**Electronic Industries Association (EIA)**

A standards organization that includes standards for the electrical and functional characteristics of interface equipment. These EIA standards are used to make sure there is compatibility between data communications equipment and data terminal equipment.

**Equipment Room (ER)**

A room in which active equipment, telecommunications equipment, MDF, IDF, HDF, and SDF is housed.

**Extended LAN**

The local area network (LAN) formed by the connection of two or more segments with bridges.

**Horizontal Crossconnect (HC)**

A crossconnect that is located within the horizontal wiring subsystem. Can occur at an horizontal, satellite, or office distribution frame.

**Horizontal Distribution Frame (HDF)**

Located in an equipment room on the floor of a building and consists of the active, passive, and support components that provide the connection between the building backbone cabling and the horizontal wiring.

**Intrabuilding cable**

See Building Backbone cable.

**Interbuilding cable**

See Campus Backbone cable.

**Intermediate Crossconnect (IC)**

A crossconnect that is located at the intermediate distribution frame (IDF).

**Intermediate Distribution Frame (IDF)**

Located in an equipment room and consists of the active, passive, and support components that provide the connection between interbuilding cabling and the intrabuilding cabling for a campus and the intrabuilding cabling for a building.

**Link**

A segment or a number of segments connected together through crossconnects that provide the communication path between active equipment at both ends.

**Main Crossconnect (MC)**

A crossconnect that is located at the main distribution frame (MDF).

**Main Distribution Frame (MDF)**

Located in a equipment room and consists of active, passive, and support components that provide the connection of the interbuilding backbone cables between IDFs.

**Not supported**

Does not meet the requirements for use and may or may not function properly. No support for service or troubleshooting problems.

**Office Distribution Frame (ODF)**

A enclosed rack usually located in an office area. It consists of the active, passive, and support components that provide the physical connection between the horizontal wiring and the wallbox.

**Recommended**

A recommended configuration is a supported configuration.

**Remote Wall Distribution Frame (RWDF)**

A small wall-mounted cabinet that consists of the passive and support components that provide the physical connection between the horizontal wiring and the wall box.

**Satellite Distribution Frame (SDF)**

Located in an equipment room on the floor of a building and consists of the active, passive, and support components that provide the connections between the horizontal wiring and the wallbox.

**Segment**

The fiber optic cable that is behind the wall or in ground with fiber connectors on each end.

**Site**

The campus and building wiring coverage with a geographical extent up to 3000 meters (9840 feet), up to 1,000,000 square meters (approximately 10,000,000 square feet) of office space, and a population of up to 50,000 individual users. A site shall have one MDF.

**Site plan**

A set of drawings that show the buildings on a campus, geological features of the campus, streets, parking lots, waterways, interbuilding tunnels, conduits, and utility hole covers.

**Subsystem**

A part of the structured wiring distribution system that is dedicated to a specific purpose; for example, the horizontal wiring subsystem.

**Supported**

Meets requirements for use. Has the backing of Customer Service and Engineering in troubleshooting and remedial efforts if needed.

**System Common Equipment**

The equipment on a campus that provides functions common to terminal devices such as telephones, data terminals, intergrated work stations, and personal computers. Typically, the system common equipment is the PBX switch, data packet switch, or a central host computer.

**Telecommunications Closet (TC)**

A space in a building that is set aside to provide a safe, secure, and environmentally suitable area for the installation of cables, wires, telecommunications equipment, termination, and administration cables.

**Wallbox**

Also called faceplate, information outlet, or telecommunications outlet. Connects workstation wiring to horizontal wiring.

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