FT-2000 OC-48 Lightwave System

Applications, Planning, and Ordering Guide

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Document Number: **365-575-100**   Issue Number: **9**   Publication Date: **September, 1998**

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About This Document

Purpose

This applications, planning, and ordering guide (APOG) provides information about the features, applications, operation, engineering, support, specifications, and ordering of the latest release (9.1) of the FT-2000 OC-48 Lightwave System.

Intended Audiences

This applications, planning, and ordering guide is intended for network planners and engineers. However, it is also for anyone who needs specific information about the features, applications, operation, engineering, and ordering of the FT-2000 OC-48 Lightwave System.

How to Use This Document

Use the table below to guide you to the appropriate chapter for specific information.

If you need information about...	Refer to Chapter...
the general product and release	1, 2, 4, and 5.
applications planning	2, 3, 4, and 6.
engineering a system	4 and 6.
ordering equipment	4, 6, and 7.

The guide is organized as follows:

- "**About This Documen**t" describes the purpose, intended audience, reason for reissue, and organization of this document. This section references related documentation and explains how to order and make comments or recommend changes to this document.

- Chapter 1, "**Introduction,**" lists the members of the Lucent Technologies 2000 Product Family and briefly describes the FT-2000 OC-48 Lightwave System. This section lists the FT-2000 OC-48 Lightwave System Release and the features for that release.

- Chapter 2, "**Features,**" briefly describes the features listed in Chapter 1. These features are further described in Chapter 3, "Applications," Chapter 4, "Product Description," and Chapter 5, "Operations, Administration, Maintenance, and Provisioning."

- Chapter 3, "**Applications,**" describes how the FT-2000 OC-48 Lightwave System platforms serve such diverse needs as broadband service transport, hubbing, bidirectional line-switched rings, dual ring interworking, FT-Lightwave booster amplifier (FT-LBA) for extended distances, loop feeder network, dual-wire center architecture, path-in-line architecture, operations interworking through data communications channel (DCC), and point-to-point applications.

- Chapter 4, "**Product Description**," describes the FT-2000 OC-48 Light-wave System architecture. After introducing the FT-2000 OC-48 Lightwave System platforms, the chapter describes system control, physical design, transmission, synchronization, protection, and powering features down to the circuit pack level.

- Chapter 5, "**Operations, Administration, Maintenance, and Provisioning**," defines the "maintenance philosophy," outlining the various features available to monitor and maintain the FT-2000 OC-48 Lightwave System.

- Chapter 6, "**System Planning and Engineering**," summarizes applications information to help you plan procurement and deployment of the FT-2000 OC-48 Lightwave System.

- Chapter 7, "**Ordering**," provides equipment ordering information for the FT-2000 OC-48 Lightwave System.

- Chapter 8, "**Product Support**," describes how Lucent Technologies supports the FT-2000 OC-48 Lightwave System. This chapter includes information about engineering and installation services, technical support, documentation support, and training available from Lucent Technologies.

- Chapter 9, "**Reliability and Quality**," provides the Lucent Technologies quality policy and describes the reliability program.

- Chapter 10, "**Technical Specifications**," lists the technical specifications for the FT-2000 OC-48 Lightwave System.

- Appendix, "**A SONET Overview**," briefly describes the synchronous optical network and how it works.

- Glossary, provides definitions for telecommunication acronyms and terms.

- Index, supplies users with specific subjects and corresponding page numbers to find necessary information.

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Safety Labels

This document may contain safety labels in the form of **DANGERS**, **WARNINGS**, and **CAUTIONS**. These admonishments have the following definitions.

- **DANGER** shows the presence of a hazard that *will* cause death or severe personal injury if the hazard is not avoided.

- **WARNING** shows the presence of a hazard that *can* cause death or severe personal injury if the hazard is not avoided.

- **CAUTION** shows the presence of a hazard that *will* or *can* cause minor personal injury or property damage if the hazard is not avoided. Caution is also used for property-damage-only accidents. This includes equipment damage, loss of software, or service interruption.

These safety labels are noted by the alert symbol

Record of Changes

Significant changes included in Release 9.1 are:

- Operations Interworking Enhancement — Bidirectional Line Switched Ring Interworking with *WaveStar* Bandwidth Manager Release 2.0, *WaveStar* 2.5G Release 3.0, and *WaveStar* 10G Release 1.0

- DRI Enhancement — DRI switching on LOP-P

- Operations Interworking Enhancement — TL1-GNE for Wavestar 2.5G, 10G, and Tellabs *TITAN*

- CIT Enhancement — Support of *Windows 98*

- The FT-2000 Add/Drop-Rings Terminal has been DAed as of December, 1999, along with the corresponding E-Bay documentation set (J68974E1).

There are also 16 new OC-48 TRMTR (STS-1 OC-12c 1.5 STD) circuit packs (739H1-16) that are described in this manual but were not issued as part of Release 9.1. These circuit packs are for non-OLS compatible, passive DWDM systems. For more information on the 739H1-16 circuit packs, see Chapter 2 ("Features"), Chapter 3 ("Applications"), and Chapter 4 ("Product Description").

Significant changes included in Release 9.0 are:

- Software Release 9.0 provides the following:

    — DRI Enhancement — STS Path Payload Defect Indicator (PDI-P)

    — Performance Monitoring Enhancement — Pointer Justification Counts (PJC)

    — *TIRKS®*[1] (Trunk Integrated Record Keeping System) Compatible STS-1 Numbering

    — Equipage Dependent Reports

- New OC-3 Low Speed Interface Circuit Pack (LAA10B)

    — STS-1 Granularity Enhancement — Full E/W directionality

    — STS-1 Granularity Enhancement — Synchronization messaging on S1 Byte

Significant changes in Releases 8.0 and 8.1 include:

- CPro-2000 update modifications

- Year 2000 Impact Statement

- Change R8.0 to R8.1. Release 8.0 is discontinued availability (DA) as of April, 1998, and replaced with R8.1. Modifications for R8.1 are:

    — Red Line Services

    — Enhancements to Dual Ring Interworking (DRI):
    Switch on STS Path Unequipped (UNEQ-P) (Release 8.0)
    DRI on Protection (DRI-P) (Release 8.1)

- New technical support medium: Global Technical Support Information Platform (GTSIP) to replace COACH.

- DDM-2000 Ring to FT-2000 1+1 linear add/drop applications.

- Update software release data as needed (for example, Releases 7.1.0 is DAed)

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1. *TIRKS* is a Bellcore operations system and registered trademark.

Related Documentation

The following Lucent Technologies documents provide information about the
FT-2000 OC-48 Lightwave System:

- Number: 365-575-101

  Title: *FT-2000 OC-48 Lightwave System Quick Reference Guide*

  Audience: End user maintenance personnel

  Content: Abbreviated list of common report commands and a trouble clear-
  ing procedure that can be used to clear most trouble

- Number: 365-575-102 (For Releases 7.2 and earlier)

  Title: *FT-2000 OC-48 Lightwave System User/Service Manual*

  Audience: End user maintenance personnel

  Content: Detailed description, technical specifications, operation and main-
  tenance, and user interface descriptive/tutorial information; also includes
  Job Aids

- Number: 365-575-103 (For Releases 8.1 and later. Releases 8.1 and later
  provides multivendor operations interworking information.)

  Title: *FT-2000 OC-48 Lightwave System User/Service Manual*

  Audience: End user maintenance personnel

  Content: Detailed description, technical specifications, operation and main-
  tenance, and user interface descriptive/tutorial information; also includes
  Job Aids

- Number: Comcode 107184665REV

  Title: *FT-2000 OC-48 Lightwave System User/Service Manual*

  Audience: End user maintenance personnel

  Content: Issue 5B revision pages only. Covers Release 5.0.2.

- Number: 365-575-115 (Comcode C107373094)

  Title: *FT-2000 OC-48 Lightwave System Installation Manual*

  Audience: Customers planning to install and turn up the FT-2000 OC-48
  Add/Drop-Rings Terminal equipment (Releases 6.0.0 and later)

  Content: Customer installation instructions

- Number: 824-102-144

  Title: *Lucent Technologies 2000 Product Family MultiVendor Operations
  Interworking Guide*

Audience: Engineers responsible for system planning, using, or maintaining networks containing a mixture of 2000 Product Family products

Content: Information on using operations interworking capabilities of the 2000 Product Family in multivendor subnetworks

■ Number: 824-102-147

Title: *Lucent Technologies 2000 Product Family Operations Interworking Guide*

Audience: Engineers responsible for system planning, using, or maintaining networks containing a mixture of 2000 Product Family products

Content: Information on using operations interworking capabilities in the 2000 Product Family

■ Number: 824-102-148

Title: *2000 Family of Products Operations Systems Engineering Guide*

Audience: Engineers

Content: Operations systems engineering information for FT-2000 OC-48 Lightwave System.

■ Number: 824-102-151

Title: *2000 Family of Products Operations Systems Engineering Guide*

Audience: Engineers

Content: Operations systems engineering information for DDM-Multiplexers (OC-3/OC-12 Multiplexers).

■ Number: 824-102-175

Title: *2000 Family of Products Operations Systems Engineering Guide*

Audience: Engineers

Content: Operations systems engineering information for FT-2000 OC-48 Lightwave System Large Capacity Terminal (LCT).

■ Number: 824-102-176

Title: *2000 Family of Products Operations Systems Engineering Guide*

Audience: Engineers

Content: Operations systems engineering information for Optical Line System (OLS).

■ Number: 190-523-101 (User Manual only) Release 3.0
Order Comcode 107265944 for User Manual and Software for Release 3.0

Title: *CPro-2000 User Manual*

Audience: Maintenance personnel

Content: Using the tool to provision and maintain ring networks

■ Number: 365-576-100 (User Manual only) Release 4.0
Number: 365-576-101 (User Manual and Software) Release 4.0

Title: *CPro-2000 User Manual*

Audience: Maintenance personnel

Content: Using the tool to provision and maintain ring networks

■ Number: 365-576-110 (User Manual only) Release 5.0
Number: 365-576-111 (User Manual and Software) Release 5.0

Title: *CPro-2000 User Manual*

Audience: Maintenance personnel

Content: Using the tool to provision and maintain ring networks

■   Number: 365-576-120 (User Manual only) Release 6.0
    Number: 365-576-121 (User Manual and Software) Release 6.0

    Title: *CPro-2000 User Manual*

    Audience: Maintenance personnel

    Content: Using the tool to provision and maintain ring networks

Lucent Technologies Drawings

The following Lucent Technologies drawings provide information about the FT-2000 OC-48 Lightwave System.

A-Bay Drawing	Description
J68974A-1	FT-2000 OC-48 Lightwave Terminating Bay Upgrades
FPD 804-911-168-()	FT-2000 Lightwave Transmission System (Floor Plan Data Sheets)

E-Bay Drawing	Description
J68974E-1	FT-2000 OC-48 Enhanced Lightwave Terminating Bay (Equipment and Circuit Packs Ordered with Equipment)
J68974ES-1	FT-2000 OC-48 Enhanced Lightwave Terminating Bay (Software and Documentation)
J68974ES-2	FT-2000 OC-48 Enhanced Lightwave Terminating Bay (Software and Documentation for Releases 7.2 and later)
SD-5G250-02	FT-2000 OC-48 Enhanced Lightwave Terminating Bay Application Schematic (2-Fiber Ring applications)
T5G250-33	FT-2000 Lightwave Transmission System OC-48 Enhanced Lightwave Terminating Bay Interconnect Circuit
ED7G001-11	Method of Cabling for ED7G001-31 OC-48 Enhanced Lightwave Terminating Bay
ED7G001-21	FT-2000 OC-48 Coaxial Cable Assemblies for All EC-1/ DS3 Applications (Intraoffice Transmission Cables)
ED7G001-22	FT-2000 OC-48 Interbay Cable Assemblies (Intraoffice Non-Transmission Cables)
FPD 804-911-168-()	FT-2000 Lightwave Transmission System (Floor Plan Data Sheets)

D-Bay Drawing	Description
J68974D-1	FT-2000 OC-48 Dual Lightwave Terminating Bay (Equipment and Circuit Packs Ordered with Equipment)
J68974DS-1	FT-2000 OC-48 Dual Lightwave Terminating Bay (Software and Documentation)

SD-5G250-03	FT-2000 OC-48 Dual Lightwave Terminating Bay Application Schematic (2-Fiber Ring Applications)
T5G250-43	FT-2000 Lightwave Transmission System OC-48 Dual Lightwave Terminating Bay Interconnect Circuit
ED9C800-20	FT-2000 OC-48 Coaxial Cable Assemblies for all EC-1/ DS3 Applications (Intraoffice Transmission Cables)
ED7G001-22	FT-2000 OC-48 Interbay Cable Assemblies (Intraoffice Non-Transmission Cables)
ED7G001-33	FT-2000 Lightwave Transmission System OC-48 Dual Lightwave Terminating Bay Framework
FPD 804-911-168-()	FT-2000 Lightwave Transmission System (Floor Plan Data Sheets)

R-Bay Drawing	**Description**
J68974R-1	FT-2000 OC-48 Lightwave Repeater Bay (Equipment and Circuit Packs Ordered with Equipment)
J68974RS-1	FT-2000 OC-48 Lightwave Repeater Bay (Software and Documentation)
SD-5G252-01	FT-2000 OC-48 Lightwave Repeater Bay Application Schematic
T5G252-31	FT-2000 Lightwave Transmission System OC-48 Lightwave Repeater Bay Interconnect Circuit
FPD 804-911-168-()	FT-2000 Lightwave Transmission System (Floor Plan Data Sheets)

Documentation for Related Equipment and Software

The following Lucent Technologies documentation provides information about related equipment and software:

<u>Number</u>	<u>Title</u>
365-331-000	*DACS III-2000 Release 2.0 Applications, Planning, and Ordering Guide*
365-340-004	*DACS IV-2000 Release 2.1 Reference Manual*
363-206-200	*DDM-2000 Multiplexer Applications, Planning, and Ordering Guide*
365-301-130	*System III DSX-3/4, Planning, Engineering, Installation, and Operation System Reference Guide*
365-303-102	*DSX-3 Cross-Connect Bay, Description, Operation, and Maintenance Manual*
636-299-120	*LGX® Distribution System, Planning, Engineering, Installation, and Operation System Reference Guide*
365-565-200	*FT-Ring Diversity Switch, Engineering, Operation, and Maintenance Manual*
365-565-500	*Digital Transmission Systems FT-Lightwave Booster Amplifier Description, Engineering, Installation, and Maintenance*
190-523-101	*SNC-2000 CPro User Manual*
065-215-250	*Installation Guide, Seismic Network Bay Frame*
065-215-200	*Seismic Network Bay Frame Application, Planning, and Ordering Guide*

Electronic Documentation

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Introduction

1

Contents

Introduction

1

Overview

This chapter introduces the Lucent Technologies 2000 Product Family, briefly describes the FT-2000 OC-48 Lightwave System for the current release, and lists the features for previous releases.

Introduction to the Lucent Technologies 2000 Product Family

Lucent Technologies offers the widest range of high-quality transmission systems and related services in the industry designed to provide total network solutions. The Lucent Technologies 2000 Product Family is designed to offer telecommunications service providers advanced services and revenue generating capabilities for the new century. The 2000 Product Family complies with the synchronous optical network (SONET) standard and provides products needed to build an efficient and successful network. The 2000 Product Family provides broadband services, a high degree of reliability, and full compatibility with industry standards. In-service upgrade capabilities allow a graceful evolution from the asynchronous networks of today to the world class intelligent networks of the future.

The FT-2000 OC-48 Lightwave System is the high capacity optical carrier level 48 (OC-48) lightwave system in the 2000 Product Family. The 2000 Product Family also includes the DDM-2000 Multiplexers, the DACS III-2000 Cross-Connect System, the DACS IV-2000 Cross-Connect System, the ITM-XM, the *SLC*®-2000 Access System, the FT-2000 OC-48 Large Capacity Terminal, and the BRT-2000

Access System. The 2000 Product Family, along with the *5ESS*® Switch, provides the significant elements of the Lucent Technologies Service Net-2000 Architecture.

The Service Net-2000 Architecture furnishes increased network capabilities with standard interfaces, increased bandwidth, faster provisioning, and more robust operation.

What is the FT-2000 OC-48 Lightwave System?

The FT-2000 OC-48 Lightwave System is a flexible high capacity lightwave system that transmits digitally encoded information through single-mode optical fibers at the SONET OC-48[1] signal rate of 2.488 (2.5) Gb/s (up to 32,256 voice channels).

The FT-2000 OC-48 Lightwave System consists of several platforms. A platform is a family of equipment and software configurations designed to support a particular set of applications. These platforms include the following:

- FT-2000 OC-48 Add/Drop-Rings Terminal
- FT-2000 OC-48 Dual Lightwave Terminating Bay
- FT-2000 OC-48 Repeater Bay.

Figures 1-1, 1-2, and 1-3 show the three FT-2000 OC-48 platforms.

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1. OC-48 stands for optical carrier level 48.

Figure 1-1.   FT-2000 OC-48 Add/Drop-Rings Terminal
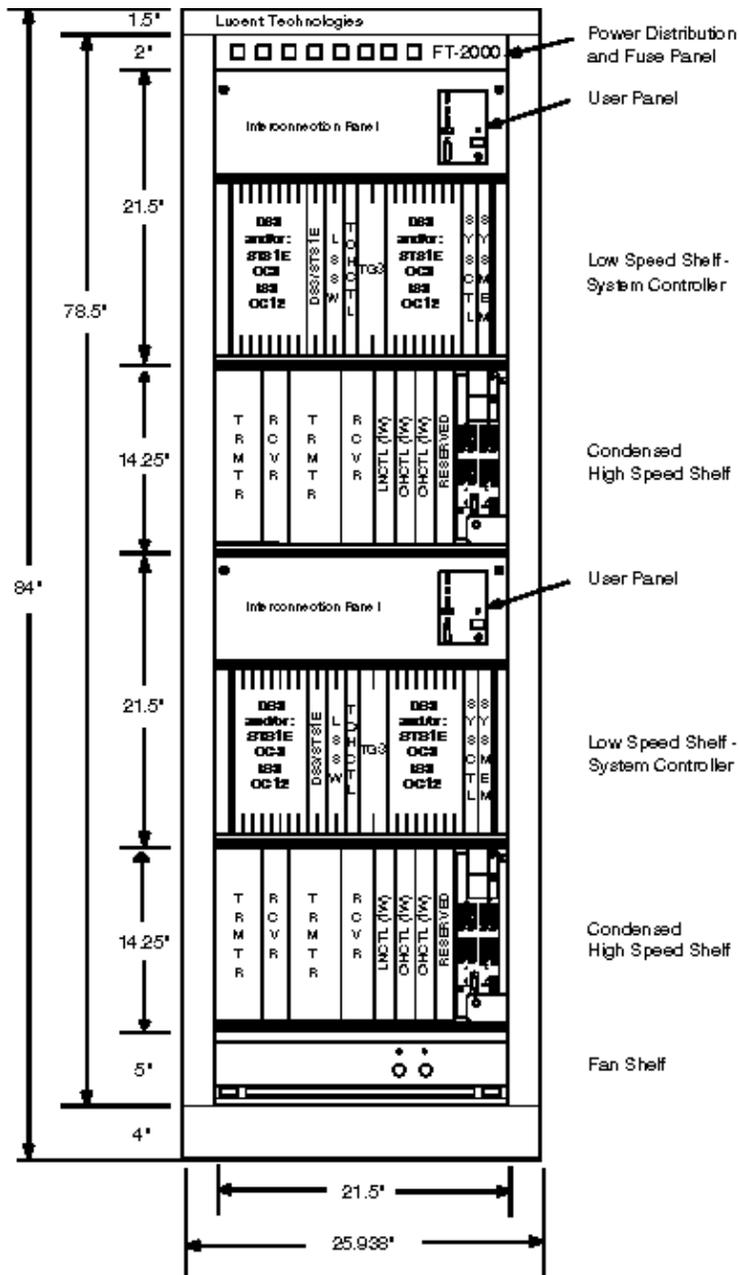
Figure 1-2.   FT-2000 OC-48 Dual Lightwave Terminating Bay
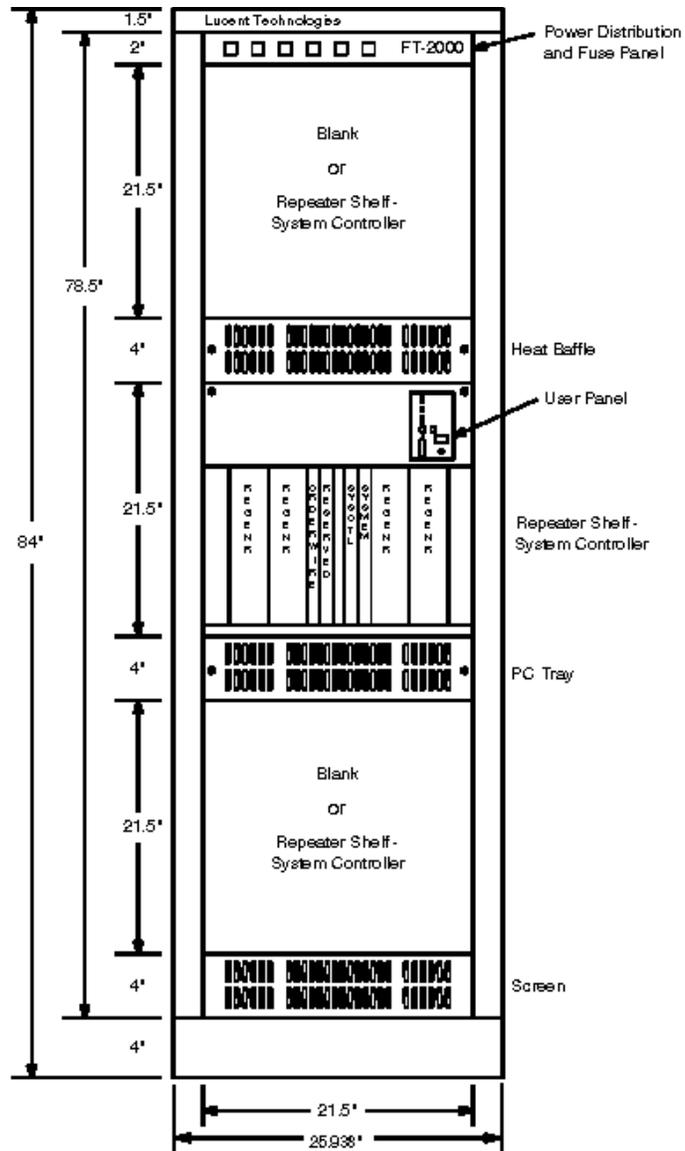
adr04021.01eJF0814967.1

Figure 1-3.   FT-2000 OC-48 Repeater Bay

The different platforms enable the FT-2000 OC-48 Lightwave System to offer flexible features for various applications in high capacity loops, interoffice, outstate, and long haul environments, and to provide different sets of features. The FT-2000 OC-48 Lightwave System software enables the platforms to be upgraded with new features when they become available. Figure 1-1 and Figure 1-2 show one bay of the FT-2000 OC-48 Add/Drop-Rings Terminal and the FT-2000 OC-48 Dual Lightwave Terminating Bay. The dual terminal packages two Add/Drop-Ring systems into a single seven-foot bay. For more information about equipment packages and platforms, refer to Chapter 4, "Product Description."

The FT-2000 OC-48 Add/Drop-Rings Terminal transports up to 48 DS3 equivalent signals over the OC-48 line. It supports a mix of asynchronous DS3, synchronous electrical carrier level 1 (EC-1)[2], synchronous OC-3, IS-3, and OC-12 low-speed interfaces. The electrical DS3 and EC-1 low-speed interfaces are 1xM (M$\leq$16) protected. The OC-3, IS-3, and OC-12 low-speed interfaces, which are 0x1 (unprotected) by default, can be provisioned to be 1+1 protected (one service and one protection).

The FT-2000 OC-48 Add/Drop-Rings Terminal also offers flexible high-speed interface options. See Chapter 10, "Technical Specifications," for the transmission distances that can be achieved. Operating certain FT-2000 OC-48 transmitters with the optional FT-Lightwave Booster Amplifier (FT-LBA) allows span lengths of up to 140 km on standard fiber and up to 160 km on dispersion-shifted fiber. For details see Chapter 3, "Applications."

The FT-2000 OC-48 Add/Drop-Rings Terminal is designed for easy installation and operation. Centralized operation is supported by a full set of single-ended control and maintenance features. Automatic turnup tests and default provisioning simplify installation and eliminate the need for external test equipment. The personal computer-based craft interface terminal (CIT) gives access to sophisticated maintenance and reporting features.

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2. EC-1 is the Bellcore standard term for electrical carrier level 1, formerly referred to as STS1-E (synchronous transport signal level-1 electrical). An STS-1 signal is referred to as EC-1 when it is shaped and encoded for transmission over copper media. When the shaping and encoding are removed, the signal is referred to as STS-1.

FT-2000 OC-48 Lightwave System
Features Release Plan

The FT-2000 OC-48 Lightwave System is made available in a series of phased releases. These phased releases provide new sets of features. Chapter 2, "Features," briefly describes features of the current release. The remainder of this guide discuss the features further, as applicable.

Release 3.0.1[3] (Add/Drop-Rings Terminal platform is available now and has the following features):[4]

- ■ Flexible network applications

    — OC-48 2-fiber bidirectional line-switched ring

    — Two-way time slot assignment (TSA) cross-connections

    — DS3 low-speed interface (formatted and clear channel)

    — External synchronization (DS1 timing inputs and outputs)

    — Extra traffic for restoration and revenue generation

    — Operation with an FT Series G ring diversity switch

- ■ Two-tiered and single-ended maintenance

    — Remote login

    — Remote alarming

    — CIT-PC

    — Craft interface terminal with security functions

- ■ Operations interface flexibility

    — Office alarms

    — Parallel telemetry interface (Releases 7.2 and earlier only)

    — Serial telemetry interface using telemetry byte-oriented serial (TBOS) protocol (Releases 7.2 and earlier only)

    — User-settable miscellaneous discrete interface and repeater sites

    — Basic message-based operations system interface, Transaction Language 1 (X.25/TL1) (local access only)

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3. Release 3.0.1 has been rated discontinued availability (DA) effective August 30, 1996.

4. To support low-speed interfaces in addition to DS3 interfaces, the FT-2000 OC-48 1x1 End Terminal system, which may no longer be ordered, must be upgraded to an Add/Drop-Rings Terminal system.

- Continuous performance monitoring

- Automatic protection switching

    — Bidirectional line-switched rings

    — 1xM (M ≤16) low-speed interface circuit pack protection

    — 1x1 timing circuit pack protection

    — Timing reference protection

- Original value provisioning and user-selectable thresholds

- Easy installation

    — Self-tests and diagnostics

    — Low-speed loopbacks

- Local and remote inventorying capabilities

- Flexible low-speed OC-48 interfaces

    — Standard performance (1.3 μm) add/drop low-speed interfaces

    — High performance (1.3 μm) add/drop low-speed interfaces

    — Standard performance 1.5 μm add/drop optic-compatible software

    — Universal optical connections (SC, FC, and ST)

- Front access

- Physical compactness

- On-board power modules

- Local and remote in-service software upgrades

- Standards compliance.

Release 4[5] (Add/Drop-Rings platform) was introduced in two stages: Release 4.0 and Release 4.1.

The first point release, Release 4.0, is available now and includes the following additional features for Add/Drop-Rings Terminals:

- Flexible network applications

    — EC-1 low-speed SONET interface (STS1E circuit pack)

    — Low-speed interface mixing (DS3/EC-1)

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5. Release 4 and 4.1 of the FT-2000 OC-48 Add-Drop Rings Terminal software have been rated discontinued availability August 30, 1996.

- Operations interface flexibility

  — Intermediate message-based operations system (OS) interface (X.25/TL1) (enhanced messages)

- Performance monitoring

  — Autonomous threshold-crossing alert reporting (TL1 and TBOS)

  — Threshold-crossing alert provisioning and reporting (CIT)

  — Far-end block error (FEBE) reporting

  — Performance monitoring for incoming electrical high-speed signals

  — DS3 path performance monitoring

- STS-1 path trace

- Flexible low-speed interface

  — Standard performance (1.5 μm) add/drop (A/D) low-speed interface

Release 4[6] (Repeater platform) is available now and includes the following features:

- Repeatered ring line facilities

  — 1.3 μm standard performance, 1.3 μm high performance, and 1.5 μm standard performance regenerators.

Release 4.1[7] (Add/Drop-Rings platform) is available now and includes the following additional features for Add/Drop-Rings Terminals:

- Flexible network applications

  — STS-3 dual ring interworking (DRI)

  — One way time slot assignment (TSA) cross-connections

  — Drop and continue TSA cross-connections

- Operations interface flexibility

  — Gateway network element capability (X.25/TL1) for a maintenance subnetwork

- Enhanced message-based OS interface (X.25/TL1) (larger command and message set)

- Security

  — Password aging.

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6. Release 4.0 (Repeater platform) has been rated discontinued availability August 30, 1996.

7. Release 4.1 (Add/Drop-Rings platform) has been rated discontinued availability August 30, 1996.

Release 5.0.1[8] (Add/Drop-Rings platform) is available now and includes the following additional features:

- Flexible network applications

    — STS-1 granularity time slot assignment (TSA)[9] (across an STS-3)

    — OC-3 low-speed interface (DCC[10] in Release 6)

    — Low-speed interface mixing (DS3/EC-1/OC-3)

    — Integrated operation with the FT-Lightwave Booster Amplifier

    — Multiple low-speed TSA cross-connection bridging

- Operations interface flexibility

    — Enhanced message-based OS interface (X.25/TL1) (larger command and message set)

    — TL1 commands through craft interface terminal (CIT)

    — CPro-2000 ready[11]

- Automatic protection switching

    — 1+1 or 0x1 optical low-speed OC-3 protection

- Provisioning

    — Enhanced cross-connect command line

    — Circuit provisioning audit

- Continuous performance monitoring

    — F and M bit, adjusted DS3 performance monitoring

    — Performance monitoring day bin start time provisioning

- Security

    — Login aging

- Local or remote software upgrades

    — Remote download (in-service software generic copy).

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8. Release 5.0.1 (Add/Drop-Rings platform has been rated discontinued availability February 28, 1997.

9. This feature requires external cabling and back-to-back interface circuit packs.

10. Data Communications Channel

11. The term "ready" means that all of the functionality necessary to work with CPro-2000 is in the FT-2000 OC-48 Add/Drop Rings Terminal. This functionality includes an expanded set of TL1 commands and autonomous messages.

Release 6[12] (Add/Drop-Rings platform) is available and includes the following additional features:

- Flexible network applications
    - OC-3 DCC support for
        - Loop feeder application
        - Intraoffice applications
- Single-ended operations
    - Gateway Network Element (through OC-3 DCC)
    - Directory Service Network Element (through OC-3 DCC)
    - Remote login (through OC-3 DCC)
    - Remote network element (NE) status (through OC-3 DCC)
    - Remote software copy (through OC-3 DCC)
- Automatic provisioning
    - Automatic node ID (NID) provisioning
- New 1.5 µm OC-48 transmitters compatible with
    - Wave division multiplexing (WDM)
    - Light booster amplifier (FT-LBA).

Release 6.0.1 (Repeater platform) is available now and includes the following additional features:

- New 1.5 µm OC-48 regenerators compatible with
    - WDM
    - LBA
- Orderwire capability on repeaters which provides
    - Voice communication
    - Remote CIT access.

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12. Release 6.0 and 6.0.1 (Add/Drop-Rings platform) has been rated discontinued availability February 28, 1997.

Release 7.0.1 (Add/Drop-Rings platform) is available now and includes the following features:

⟹ **NOTE:**

Release 7.0.1 has been rated discontinued availability as of June 30, 1999.

■ Flexible network applications

— STS-1 granularity TSA across an OC-48.

■ Operations interface flexibility

— Enhanced message-based OS interface (X.25/TL1) (larger command and message set)

■ New 1.3 μm and 1.5 μm OC-48 transmitters that are one or more of these:

— STS-1 granularity capable

— OC-12c ready

— Compatible with WDM and FT-LBA

■ New OC-48 receivers that are one or more of these:

— STS-1 granularity capable

— OC-12c compatible.

Release 7.0.3 (Add-Drop-Rings platform) is available now and includes the following features:

⟹ **NOTE:**

Release 7.0.3 has been rated discontinued availability as of June 30, 1999.

■ New format for CIT cross-connect report (similar to format in R6.0 and earlier)

■ Default logins have been changed from att01/att02 to luc01/luc02

■ All AT&T references have been changed to Lucent references.

Release 7.1.0 (Add-Drop-Rings platform) is available now and includes the following features:

⟹ **NOTE:**

Release 7.1.0 is discontinued availability (DA) as of May 5, 1998.

- OC12 optical low-speed interface

- IS3 optical low-speed interface for use in intraoffice networks

- OC-3/OC-12 port states

- Synchronization messaging

- Enhanced TL1 commands for:

    — Remote provisioning

    — Remote backup and restore

- STS-3 Non-Preemptible Protection Access (NPPA) (B5 optics only)

- DRI Enhancements

    — Revertive DRI

    — Switching on AIS-P

Release 7.2.3 (Add-Drop-Rings platform) is available in the following additional features:

- Dense wavelength division multiplexing (DWDM) with new transmitters

- OC12 1+1 transmission with DCC

- Synchronization messaging: line timing and auto reconfiguration

- Deny enhancements for Delete command

- STS-1 Non-Preemptible Protection Access (NPPA)

- DRI includes switch on signal degrade and adaptive alarming

- New low-speed shelf and user panel

- STS-3 Non-Preemptible Protection Access (NPPA) (all optics).

Release 8.0 (Add-Drop-Rings platform) is available and includes the following features:

➡ NOTE:
Release 8.0 is discontinued availability as of May 5, 1998 and was replaced by Release 8.1 which was released as part of Release 8.0.

MultiVendor Operations Interworking (OI):

- MultiVendor Operations Interworking (OI) compatibility

    — FT-2000 is compatible with any other-vendor NEs that support Target ID Address Resolution Protocol (TARP), operations system interworking (OSI), and TL1/X.25 as specified in Bellcore GR-253.

— Compatible with Tellabs *TITAN* 5500/S Release 5.0 Digital Cross-Connect System, including TL1/X.25 OS access with *TITAN* 5500/S Digital Cross-Connect System serving as the TL1/X.25 Gateway Network Element (GNE).

■ Lucent 2000 Product Family OI compatibility

— Compatible with DDM-2000 OC-3 R13.0, OC-12 R7.0, and Fiber-Reach R3.0 (but not with earlier releases due to multivendor OI support).

— FT-2000 TL1/X.25 GNE supports up to 105 (up from 64 previously) TL1 logins to remote NEs.

— DDM-2000 OC-3 R13.0 and OC-12 R 7.0 can serve as the TL1/X.25 GNE for FT-2000 R8.1 remote NEs.

■ Large subnetworks

— Supports large subnetworks of up to 256 NEs by partitioning into multiple areas connected via Level 2 Intermediate Systems (IS).

■ ITM SNC Release 5.0 enhancements for FT-2000 Release 8.0

— ITM SNC as the TL1/X.25 GNE for FT-2000

— ITM SNC supports enhanced database backup and restore of FT-2000

— ITM SNC software download to FT-2000[13]

Enhancements to Dual Ring Interworking (DRI):

■ Switch on path unequipped alarm (UNEQ-P)

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Release 8.1 (Add-Drop-Rings platform) includes the following features:

➡ **NOTE:**

Release 8.1 has been rated discontinued availability as of June 30, 1999.

■ Red-Line Services

■ DRI on Protection

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13. This feature will be useful when upgrading from FT-2000 R 8.0

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Release 9.0 (Add/Drop-Rings platform) includes the following features:

■   Software Release 9.0

    — DRI Enhancement — STS Path Payload Defect Indicator (PDI-P) on OC-3, OC-12, and EC-1 interfaces

    — Performance Monitoring Enhancement — Pointer Justification Counts (PJC) on OC-3, OC-12, and EC-1 interfaces

    — *TIRKS*® Compatible STS-1 Numbering

    — Equipage Dependent Reports

■   New OC-3 Low-Speed Interface Circuit Pack (LAA10B — backward compatible with LAA10)

    With Software Release 9.0 upgrade and LAA10B circuit pack installed, the following features are available:

    — STS-1 Granularity Enhancement — Full E/W directionality on OC-3 interface

    — Synchronization Messaging Enhancement — Synchronization messaging on S1 Byte on OC-3 interface

■   CIT Enhancement — Support of *Windows* 95 and *Windows* NT.

Release 9.1 (Add/Drop-Rings platform) includes the following features:

■   Operations Interworking Enhancement — Bidirectional Line Switched Ring Interworking with *Wavestar*™ Bandwidth Manager Release 2.0, WaveStar 2.5G Release 3.0, and WaveStar 10G Release 1.0.

■   DRI Enhancement — DRI switching on LOP-P.

■   Operations Interworking Enhancement — TL1-GNE for Wavestar 2.5G, 10G, and Tellabs *TITAN*

■   CIT Enhancement — Support of *Windows* 98.

There are also 16 new OC-48 TRMTR (STS-1 OC-12c 1.5 STD) circuit packs (739H1-16) that are described in this manual but were not issued as part of Release 9.1. These circuit packs are for non-OLS compatible, passive DWDM systems. For more information on the 739H1-16 circuit packs, see Chapter 2 ("Features"), Chapter 3 ("Applications"), and Chapter 4 ("Product Description").

Release 9.1 is a TARP release and is Operations Interworking (OI) compatible with Release 8.1 and Release 9.0, but is not OI compatible with Releases 7.2 and earlier.

Releases 7.2 and earlier:
For more detailed information on OI, refer to the *Lucent Technologies 2000 Product Family Operations Interworking Guide* (824-102-147).

Releases 8.1 and later:
For more detailed information on OI, refer to the *Lucent Technologies 2000 Product Family Operations Interworking Guide* (824-102-144).

Year-2000 Compliance for FT-2000 OC-48 Add/Drop Rings (ADR)

Testing indicates that the FT-2000 ADR is Year 2000 (Y2K) compliant with Software Releases 7.1 and later.

All software releases, including releases prior to R7.1, will continue to support transmission, at century rollover, with no problems being encountered. However, some of the security aspects will not function properly following century rollover in software releases prior to R7.1. Specifically, user passwords and visitor logins will not expire.

It is recommended that all customers upgrade to current software releases (R7.2.3 or later).

Upgrade Paths

- Release 5 or later: upgrade to Release 7.2.3

- Prior to Release 5: upgrade to Release 6.0.2 and then to Release 7.2.3 or later.

Features

2

Contents

Features

2

Overview

This chapter briefly describes the main features of the FT-2000 OC-48 Lightwave System.

Standards Compliance

Lucent Technologies offers products complying with the synchronous optical network (SONET) standard. The following important functions are defined in SONET Phase II and implemented in the Lucent Technologies 2000 Product Family:

- The data communications channel (DCC)

- The associated 7-layer protocol stack

- The operations, administration, maintenance, and provisioning (OAM&P) functions

As of Release 8.1, FT-2000 OC-48 multivendor OI compatibility is supported using Target ID Address Resolution Protocol (TARP) and the fully compliant operations system interworking (OSI) protocol stack on the DCC.

The Phase II type-A jitter standards are incorporated, guaranteeing a smooth interworking between asynchronous and SONET-based networks. The full benefits of the SONET standard are provided while preserving the integrity of the existing asynchronous network.

The FT-2000 OC-48 Lightwave System complies with the following:

- American National Standards Institute (ANSI) T1.105

- Bellcore standards on SONET

- Asynchronous interface standards

- Technical advisories (TAs) and technical requirements (TRs) on OAM&P functions

Environmental standards include the following:

- Bellcore Network Equipment-Building System (NEBS) requirements

- FCC electromagnetic compatibility (EMC) requirements

- International Electrotechnology Commission (IEC) requirements for electrostatic discharge (ESD).

The FT-2000 OC-48 Lightwave System is *UL*[1] listed and CSA[2] certified.

Flexible System for Network Applications

The FT-2000 OC-48 Lightwave System is a highly flexible system whose platforms are designed to support a variety of network applications. It supports a wide range of high capacity loop, interoffice, outstate, and long haul applications with maximum economy and efficiency.

This system provides multiplexing, demultiplexing, and transport for up to 48 DS3 equivalent signals over 2 OC-48 high-speed lines. It accepts a combination of asynchronous and synchronous low-speed signals. This capability enables the FT-2000 OC-48 Lightwave System to work in the existing asynchronous environment and the world class intelligent networks of the future.

The asynchronous low-speed signal is the DS3 signal (44.736 Mb/s).

The synchronous low-speed signals are the following:

- Electrical carrier level 1 (EC-1) (51.84 Mb/s)

- Optical OC-3 signal (155.52 Mb/s)

- Optical IS-3 signal (155.52 Mb/s)

- Optical OC-12 signal (622 Mb/s).

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1. Registered trademark of Underwriters Laboratories Inc.
2. Registered trademark of Canadian Standards Association.

The FT-2000 OC-48 Lightwave System provides STS-1 granularity time slot assignment (TSA) across an OC-48. For more information about this feature, see the "STS-1 Granularity TSA Across an OC-48" section later in this chapter.

Flexible Synchronization Modes

As the present asynchronous environment evolves to a SONET standard network, several synchronization configurations can be used to make this evolution as smooth as possible. The FT-2000 OC-48 Lightwave System can be provisioned for the following:

- Free-running asynchronous operation (FT-2000 OC-48 Add/Drop-Rings Terminal)

- Through timing from both East and West incoming high-speed signals (FT-2000 OC-48 Add/Drop-Rings Terminal and FT-2000 OC-48 Repeater Bay)

- External timing from the digital synchronous network by DS1 references (FT-2000 OC-48 Add/Drop-Rings Terminal).

FT-2000 also provides a DS1 timing output to the office building integrated timing supply (BITS) clock or other central office equipment.

Automatic Protection Switching

The automatic protection switching feature gives a network added reliability. It minimizes outages and service degradations by automatically switching traffic to an alternate path. All transmission and synchronization circuit packs are protected to guard against service-affecting failures.

The FT-2000 OC-48 Lightwave System provides the following types of automatic protection:

- Ring protection: The FT-2000 OC-48 Add/Drop-Rings Terminal for 2-Fiber Rings is a bidirectional line-switched ring platform. It uses revertive loop-back protection switching to protect service traffic, complies with standards, and supports up to 16 nodes (the maximum allowed by the standard). Traffic is restored in ≤60 ms, including detection time, for catastrophic failures in rings without existing protection switches and secondary traffic.

For more information about loopback switching, see "2-Fiber Bidirectional Line-Switched Ring" in Chapter 3.

- Electrical low-speed interface circuit pack protection: The DS3 Interface and EC-1 interface circuit packs use 1xM (M ≤16) revertive protection switching.

■ Optical low-speed interface circuit pack protection: The IS3, OC3, and
   OC12 optical interface circuit packs use 1+1 unidirectional, nonrevertive
   protection switching.

> ### ⇒ NOTE:
> The FT-2000 OC-48 Lightwave System does not support
> mixed LAA10/LAA10B operation on the OC-3 low-speed
> interface when configured for 1+1 protection. If 1+1 protection
> is desired, the OC-3 low-speed interface **MUST** be equipped
> with either LAA10 circuit packs or LAA10B circuit packs, but
> not a mix of the two.

■ Timing generator circuit pack protection: The timing generator circuit packs
   use 1x1 revertive protection switching.

■ Timing reference protection: The external timing references are 1x1 rever-
   tively protected.

The electrical low-speed interface circuit pack, the optical low-speed interface cir-
cuit pack, and external timing references can operate unprotected as well as pro-
tected.

Protection Access

Two types of protection access can be associated with the STS-1 protection tribu-
taries. They are as follows:

■ Preemptible - Extra Traffic

■ Non-preemptible.

Preemptible Protection Access - Extra Traffic

Of the 48 STS-1 tributaries in an OC-48 2-fiber ring, 24 STS-1 tributaries are nor-
mally used to carry protected service traffic and 24 STS-1 tributaries are reserved
for protection. When a protection switch occurs in the ring, the protection capacity
is used to protect the service traffic. Extra traffic can be provisioned using the 24
STS-1 tributaries of protection capacity. The extra traffic is unprotected, and it is
preempted (lost) when a protection switch is active in the ring because at that time
the protection capacity is needed for protection. The capability to carry extra traffic
is also called preemptible protection access.

Preemptible protection access is useful for any type of traffic that can be unpro-
tected and preemptible. Applications include transport of revenue-generating ser-
vices (example: video) and digital access and cross-connect (DACS) based
network restoration.

Extra traffic can be provisioned from a local or remote craft interface terminal (CIT), or an operations system. You can provision any low-speed slot to any STS-1 tributary, either service or extra traffic. STS-1 tributaries 1 through 24 in both east and west directions are for service. STS-1 tributaries 25 through 48 in both east and west directions are for protection access/extra traffic.

Non-Preemptible Protection Access (NPPA)

Non-preemptible protection access is a third type of capacity in an OC-48 2-fiber ring, in addition to the protected service capacity and the unprotected, preemptible protection access capacity. Each of the 24 STS-1 tributaries of protection capacity can independently be provisioned as non-preemptible. An STS-1 protection tributary which is provisioned as non-preemptible and the corresponding STS-1 service tributary (which it normally would protect) both become tributaries of unprotected non-preemptible capacity. The traffic carried by these tributaries (on all spans around the 2-fiber ring) is not protected, and it is not preempted (lost) when a protection switch is active in the ring. These tributaries do not participate in the ring protection switching.

Non-preemptible protection access increases the available span capacity for traffic which does not require protection by the OC-48 ring, but which cannot be preempted. A primary application is path-switched ring traffic in the path-in-line network architecture. Other applications include transport of revenue-generating services such as video, ATM, and bridge/router traffic, and DACS-based network restoration.

Traffic in these applications can be carried either by the protected service capacity (maximum of 24 STS-1 tributaries) or by the unprotected, non-preemptible protection access capacity (up to 48 STS-1 tributaries). By using non-preemptible protection access capacity, the span capacity can be used more efficiently for this traffic, and more protected service capacity remains available for other traffic.

Non-preemptible protection access is supported at the STS-1 level in rings that are equipped with STS-1 granularity transmitters and receivers at all nodes. Otherwise, it is supported at the STS-3 level, meaning that three STS-1 protection tributaries must be selected at a time. With selection at the STS-1 level, the total capacity usable in these applications (protected service plus non-preemptible protection access) can be provisioned in increments of one STS-1. Furthermore, in backbone networks carrying a mix of traffic, the customer has the flexibility to choose, for each STS-1 of traffic, whether to provide protection or to lower the cost by increasing bandwidth efficiency.

Flexible High-Speed Interfaces and Regenerators

The FT-2000 OC-48 Lightwave System offers flexible high-speed interfaces and regenerators for various network applications.

Practical span lengths vary depending on the types of high-speed interfaces and regenerators and on fiber characteristics. See Chapter 10, "Technical Specifications," for information on span lengths. Operating certain FT-2000 OC-48 transmitters with the optional FT-Lightwave Booster Amplifier (FT-LBA) allows span lengths up to 140 km on standard fiber and up to 160 km on dispersion-shifted fiber. For details see the "Integrated Operation with FT-LBA" section later in this chapter.

The 1.3 μm standard performance and 1.5 μm standard performance interfaces comply with the synchronous optical network (SONET) midspan meet specification. The following types of high-speed interfaces and regenerators are available:

- Transmitters
    - OC48 TRMTR (A/D OC-12c 1.3 STD)
    - OC48 TRMTR (A/D STS-1 OC-12c 1.3 STD)
    - OC48 TRMTR (A/D STS-1 OC-12c 1.3 HI PERF)
    - OC48 TRMTR (A/D 1.5 OC-12c STD)
    - OC48 TRMTR (A/D STS-1 OC-12c 1.5 STD)
    - OC48 TRMTR (A/D STS-1 OC-12c 1.5 LBA)
    - OC48 TRMTR (A/D STS-1 OC-12c 1.5 LBA, W1) and OC48 TRMTR (A/D STS-1 OC-12c 1.5 LBA, W2)[3]
    - OC48 TRMTR (A/D STS-1 1.5 W1 - W8)[4]
- Receivers
    - OC48 RCVR (A/D)
    - OC48 RCVR (A/D STS-1)
- Regenerators
    - OC48 Regenerator (REGENR) (1.3 STD)
    - OC48 REGENR (1.3 HI PERF)

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3. These transmitters are for use with wavelength division multiplexing (WDM) and/or FT-LBA. They are STS-1 granularity capable and OC-12c ready.

4. These transmitters are for use with dense wave division multiplexing (DWDM) and are OC-12c ready.

— OC48 REGENR (1.5 STD)

— OC48 REGENR (1.5 LBA, W1) and OC48 REGENR (1.5 LBA, W2) -
two wavelengths for use with WDM and/or FT-LBA.

Dense Wavelength Division Multiplexing (OLS Compatible)

To overcome fiber exhaust, dense wavelength division multiplexing (DWDM) enables the circuit-carrying capacity of lightguide cable to be increased by transmitting two or more signals at different wavelengths simultaneously over a single fiber. The Optical Line System (OLS) uses DWDM to provide transmission capacity for up to 8 FT-2000 OC 48 level signals, per single fiber. OLS is a stand-alone system, fully equipped with telemetry, fault location, and performance monitoring capability. The OLS interface depends upon the FT system providing an OC-48 signal of proper wavelength and tone. A new transmitter code is associated with each wavelength.

Dense Wavelength Division Multiplexing (Non-OLS Compatible)

For non-OLS interfaces, the FT-2000 provides 16 transmitter codes to ensure an OC-48 signal of proper wavelength and tone for passive 16-channel DWDM systems. A new transmitter code is associated with each wavelength.

Integrated Operation with FT-LBA

Operating the FT-2000 OC-48 transmitters and regenerators with the +9 dBm, +12 dBm, and +16 dBm FT-LBA (Lightwave Booster Amplifier) on standard, dispersion limited or dispersion shifted fiber allows span lengths up to

■ 140 km on standard fiber

■ 160 km on dispersion-shifted fiber.

See Chapter 10, "Technical Specifications," for information on span lengths.

The FT-2000 OC-48 Add/Drop-Rings Terminal requires additional cabling to transport status and alarm conditions from the FT-LBA into the FT-2000 miscellaneous discretes. FT-2000 reports these miscellaneous discretes to an operations system (OS) through serial telemetry (TBOS) or TL1.

⇒ **NOTE:**
Serial telemetry is supported in Releases 7.2 and earlier only.

The FT-LBA system:

■ Offers +12 dBm and +16 dBm versions that provide pump redundancy[5], allowing error free operation in the event of a pump failure[6]

■ Provides front access for all installation and maintenance activities

■ Provides local or remote reporting of circuit pack or shelf failure.

For more details about the loss budgets and span lengths associated with each version of the FT-LBA, refer to Chapter 10, "Technical Specifications". For information about the FT-LBA, refer to the *Digital Transmission Systems FT-Lightwave Booster Amplifier Description, Engineering, Installation, and Maintenance* (365-565-500).

Integrated Operation with WDM

The FT-2000 OC-48 terminals and repeaters are available with 1.5 μm transmitters in two wavelengths. This permits the use of wavelength division multiplexing (WDM). For more information on WDM, see Chapter 3, "Applications." Using WDM, two terminals or two repeaters can operate on the same fiber. This increases the fiber capacity from 2.5 Gb/s to 5.0 Gb/s.

The two transmitters or two regenerators must be of different wavelengths (W1, W2).

Electrical and Optical Low-Speed Interfaces

The FT-2000 OC-48 Lightwave System offers the following low-speed interfaces for your network applications:

■ Electrical

■ DS3 interface

■ EC-1 interface (STS1E circuit pack).

■ Optical

■ OC-3 interface

■ IS-3 interface

---

5. The +12 dBm and +16 dBm FT-LBA versions are dual pump versions (providing redundancy). The +9 dBm FT-LBA is a single pump version.

6. Subtract 3.5 dB from the loss budget to assure error free transmission in the event of a pump failure.

■   OC-12 interface.

Each DS3 and STS1E interface circuit pack terminates three DS3[7] equivalents.

Each OC3, IS3, and OC12 interface circuit pack:

■   Terminates one optical input signal

■   Generates one optical output signal

■   Supports the transport of STS-1, STS-3, STS-3c (concatenated payload), STS-12, STS-12c (concatenated payload) or STM-1 carrying AU-4 synchronous digital hierarchy (SDH) signals.

STM-1 operation is a provisionable option of the optical circuit packs.

The Low-Speed Shelf — System Controller provides 16 low-speed service slots. You can use one type of low-speed circuit pack or mix types. For example, you can have a shelf with a mixture of DS3 and STS1E circuit packs or of DS3, STS1E, OC3, IS3, and OC12 circuit packs.

Each low-speed slot of an FT-2000 OC-48 Add/Drop-Rings Terminal can be provisioned with fully flexible, STS-1 granularity, time slot assignment, including the choice of either the east or west line and the choice of any working or protection (extra traffic) channel. Several types of cross-connections are also included: two-way, one-way, bridge/broadcast, and dual ring interworking (drop-and-continue and add-or-continue).

Electrical Low-Speed Interfaces

Protected DS3 and STS1E circuit packs use 1xM (M ≤16) revertive protection switching. Therefore, the low-speed shelf also provides two low-speed protection slots: One slot is for a DS3 circuit pack to protect DS3 circuit packs that are in the service slots. The other slot is for an STS1E circuit pack to protect STS1E circuit packs that are in the service slots.

If a shelf contains only STS1E circuit packs or only DS3 circuit packs, you can use just one of these protection slots. If a service low-speed pack fails, an FT-2000 routes its input and output signals to and from the protection pack. Only one low-speed circuit pack can be protected at a time.

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7. Three DS3 signals are the equivalent of three STS-1 signals in terms of capacity. This guide uses these equivalents interchangeably when referring to capacity.

Optical Low-Speed Interfaces

There are three types of low-speed interfaces:

- OC-3

- IS-3

- OC-12.

The optical interfaces are ideal for one-way transport because both the input and output signals are supported independently.

OC-3 Low-Speed Interface

OC3 circuit packs are unprotected by default, and you can provision them for 1+1 unidirectional, nonrevertive protection switching. You must use one protection OC3 circuit pack to protect each service OC3 circuit pack that is provisioned for 1+1 protection. The two packs must be in adjacent service slots. Example: Slot A and Slot B.

➡ NOTE:

The FT-2000 OC-48 Lightwave System does not support mixed LAA10/LAA10B operation on the OC-3 low-speed interface in a 1+1 protected configuration. If 1+1 protection is desired, the OC-3 low-speed interface **MUST** be equipped with either LAA10 circuit packs or LAA10B circuit packs, but not a mix of the two.

If you fully equip a shelf with 1+1 protected OC-3 interfaces, the FT-2000 add/drop capacity at that node is 24 DS3 (STS-1) equivalent signals. If you do not want or need protection for the OC-3 interface or facility (as in a DRI-protected OC-3 facility) and the low-speed shelf is fully equipped with a mixture of DS3, EC-1, or unprotected (0x1) OC-3 low-speed interfaces, the FT-2000 add/drop capacity at that node is 48 DS3 (STS-1) equivalent signals.

IS-3 Low-Speed Interface

The IS-3 low-speed interface is to be used when optical connectivity is desired in intraoffice applications. It uses optical specifications and supports an interconnect distance up to 2000 feet using multimode fiber between the following Lucent products:

- FT-2000

- DDM-2000.

The IS-3 interface can be used

- In dual ring interworking when nodes are located in the same central office

- To connect an FT-2000 to a DDM-2000 when the two nodes are collocated

- To connect the collocated other-vendor NEs such as Tellabs *TITAN*[8] 5500/s DCS.

OC-12 Low-Speed Interface

The OC-12 low-speed circuit pack installs into one of four locations on the existing low-speed shelf. It is a "quad size" circuit pack and requires four adjacent low-speed slots in one quadrant of the low speed shelf.

The low-speed shelf supports up to four OC-12 circuit packs. These circuit packs can operate independently (1+1 protection).

For a shelf with 1+1 protected OC-12 packs, the remaining low-speed slots can be populated with the existing low-speed interfaces with full circuit pack mixing supported.

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8. *TITAN* is registered trademark of Tellabs Operations, Inc.

Dual Ring Interworking (DRI)

This feature enables an FT-2000/OC-48 ADR multiplexer to perform a Dual Ring Interworking (DRI) protection switching on a SONET STS path. A switch, from the Add Signal (STS Path) to the Through Signal (STS Path), is triggered on reception of loss of signal (LOS), loss of frame (LOF), line signal degrade (SD), signal failure (SF), or the Path Alarm Indication Signal (AIS-P).

For Release 8.1 and later:

■ STS Path Unequipped (UNEQ-P) — The STS Path Unequipped (UNEQ-P) condition also triggers a DRI switch.

⇒ **NOTE:**

Detection of a path unequipped requires a series 5 or later transmitter.

■ DRI on Protection (DRI-P) — The DRI-P allows for doubling the number of tributaries available for carrying DRI services by utilizing the protection bandwidth. The DRI-P cross-connect types are:

— 2-way-dri-pri: This type connects a 2-way-dri cross-connection between the specified source slot and specified service tributary at the DRI primary node. The through portion of the DRI cross-connection involves a Time Slot Interchange (TSI) from the service tributary to the corresponding protection tributary.

— 2-way-dri-sec: This type connects a 2-way cross-connection between the specified source slot and specified protection tributary at the DRI secondary node. If the DRI primary node is isolated, the 2-way-dri-sec cross-connection will be involved in a DRI switch at the secondary node.

The following is not a DRI-P cross-connect type. Rather, it was added to simplify provisioning standard DRI cross-connections:

— 2-way-dri: This type connects a 1-way-dri cross-connection between the specified source slot and specified destination tributary. A drop and continue cross-connection is established in the opposite direction using the specified source slot and specified destination tributary.

For Release 9.0 and later:

STS Path Payload Defect Indicator (PDI-P) — The STS path payload defect indicator (PDI-P) condition will trigger a DRI switch.

⇒ **NOTE:**

Detection of PDI-P requires a series 5 or later transmitter.

⇒ NOTE:
> The PDI is sent when the STS termination sources a good STS path level signal containing a defective payload, for example: one or more bad VTs or bad DS3 tributary in the STS. The detected PDI will cause the FT-2000 to switch to the alternate STS at the "Drop and Continue" interface.

For Release 9.1 and later:

STS Path Loss of Pointer (LOP-P) — The STS path loss of pointer condition will trigger a DRI switch.

⇒ NOTE:
> Detection of LOP-P requires a series 5 or later transmitter.

Once the Add signal is restored to health, the DRI switch automatically reverts back to the restored Add tributary after a 5-minute wait-to-restore interval.

DRI is used to protect circuits passing through more than one ring by interconnecting the circuit from one ring to another at two points. Each ring protects against failures within itself, and DRI provides protection against failures at the interconnections. It is especially useful when there is a Broadband Digital Cross-connect System (B-DCS) between two SONET rings.

Line Signal Degrade (SD)

Line SD is formally defined to be a "soft failure" condition detected on the SONET interface. This condition is detected when the line bit error rate exceeds a specified threshold which is normally user provisionable over the range from 10^{-5} to 10^{-9}.

Port States

Port states represent the state for each port in the system, at any given time. The three types of port states are automatic (AUTO), in-service (IS), and

non-monitored (NMON). Transitions between states occur due to events such as:

- Applying a good signal
- Loss of signal (LOS)
- CIT or TL1 command.

One-Way Cross-Connections

FT-2000 OC-48 Add/Drop-Rings Terminal enables you to make one-way cross-connections when provisioning the cross-connection of STS-1 or STS-3 signals within each ring node. One-way cross-connection allow independent use of the capacity in each direction of transmission. See the one-way video application in Chapter 3, "Applications," for an example of an application that uses this capability. You can make one-way cross-connections in either direction between:

- Any tributary and any low-speed interface slot (meaning the choice of the east or west line; and either service traffic or unprotected, extra traffic) or
- A tributary and the same-numbered tributary of the opposite line.

Drop and Continue Time Slot Assignment (TSA) Cross-Connections

You can bridge together two one-way cross-connections with the same tributary source: one in the drop direction (tributary-to-slot) and the other passing through (tributary-to-tributary, meaning continue). Drop and continue TSA cross-connections are used for economical transmission of video broadcasts from a head-end to multiple sites. Dual Ring Interworking also uses drop and continue for one direction of transmission.

In Dual Ring Interworking applications, the opposite direction of transmission uses a special type of one-way cross-connection. The one-way DRI cross-connection sets up an "add or continue" capability, which consists of two, switched, one-way cross-connections with the same tributary destination: one in the add direction (slot-to-tributary), and the other passing through (tributary-to-tributary, meaning continue). Only one of the two carries traffic at any particular time. The switching between them is provided by the dual ring interworking (DRI) feature.

The FT-2000 OC-48 Lightwave System rolling capability allows any 1-way cross-connection to be replaced within 60 milliseconds by another with the same destination slot or tributary. Rolling is used to switch the source of traffic at a cross-connection within a circuit, after the head-end has been bridged to two transmission paths.

Multiple Low-Speed TSA Cross-Connection Bridging

You can make more than one cross-connection with the same tributary source in the drop direction (tributary-to-slot). This capability is useful for video broadcasts where several local drops and/or optical extensions are at a ring node. As with the drop and continue capability, there can also be an additional bridged cross-connection passing through the node. Bridging from a tributary to multiple slots is also useful when rolling traffic to a different slot, such as when upgrading a low-speed interface to EC-1 or OC-3. The extended capability means that more than one cross-connection with the same slot source can be made in the add direction (slot-to-tributary). This is useful when rolling traffic to a different tributary within the ring, such as when rearranging traffic to accommodate growth in the ring.

STS-1 Granularity Time Slot Assignment Across an OC-48 (Increased Bandwidth Utilization)

The FT-2000 OC-48 Lightwave System provides STS-1 granularity time slot assignment (TSA) across an OC-48. This feature allows you to route service through your network at STS-1 rates, enabling you to use the capacity of a line more efficiently. It is beneficial in applications such as dual-wire center, path-in-line, and dual-ring interworking. STS-1 granularity TSA across an OC-48 enables you to use provisioning systems and schemes that are optimized to perform STS-1/DS3-based provisioning for Interoffice Facility (IOF) transport.

365-575-100
Features

With STS-1 granularity TSA across an OC-48, you can provision STS-1 add, drop, and through cross-connections associated with the electrical and optical low-speed interfaces. As shown in Figure 2-1, the STS-1 granularity TSA across an OC-48 feature requires that the three STS-1s (see STS-1 numbers 1, 2, and 3 at Node A) that are being demultiplexed on a given low-speed circuit pack <u>must come from the same direction</u>. In the figure, STS-1 number 1 is added at node C and dropped at node A. STS-1 numbers 2 and 3 are added at node E, passed through at node C, and are dropped at node A.
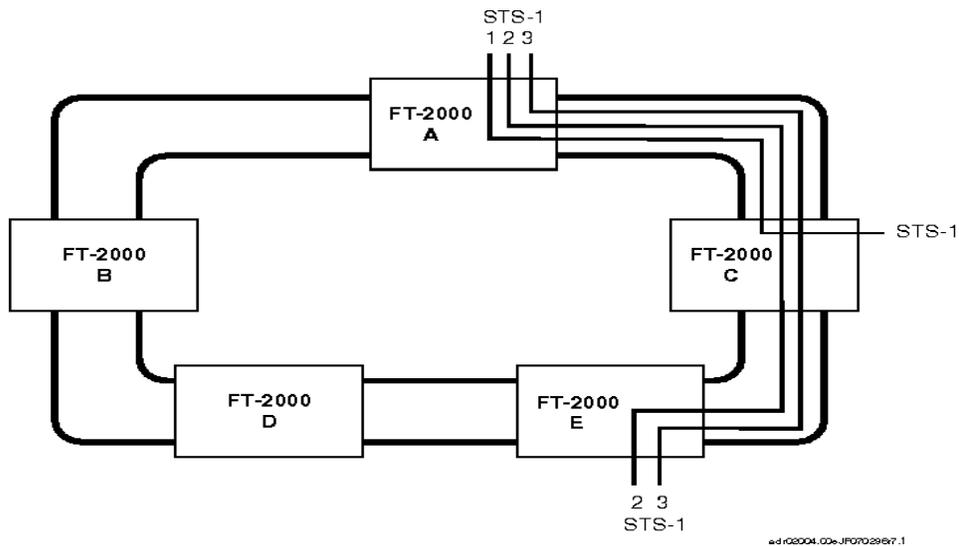
Figure 2-1.   STS-1 Granularity TSA Across an OC-48

For Releases 9.0 and Later:

As shown in Figure 2-2, full E/W directionality is supported with Release 9.0 or later upgrade and the OC-3 Interface circuit pack (LAA10B) installed. The STS-1 numbers 1, 2, and 3 are being demultiplexed through the LAA10B circuit pack coming from both the east and west directions. The STS-1 numbers 2 and 3 are added at node E, passed through node C, and dropped from the east side of node A. The STS-1 number 1 is added at node B and dropped from the west side of node A.

adr02004.01r81.eps
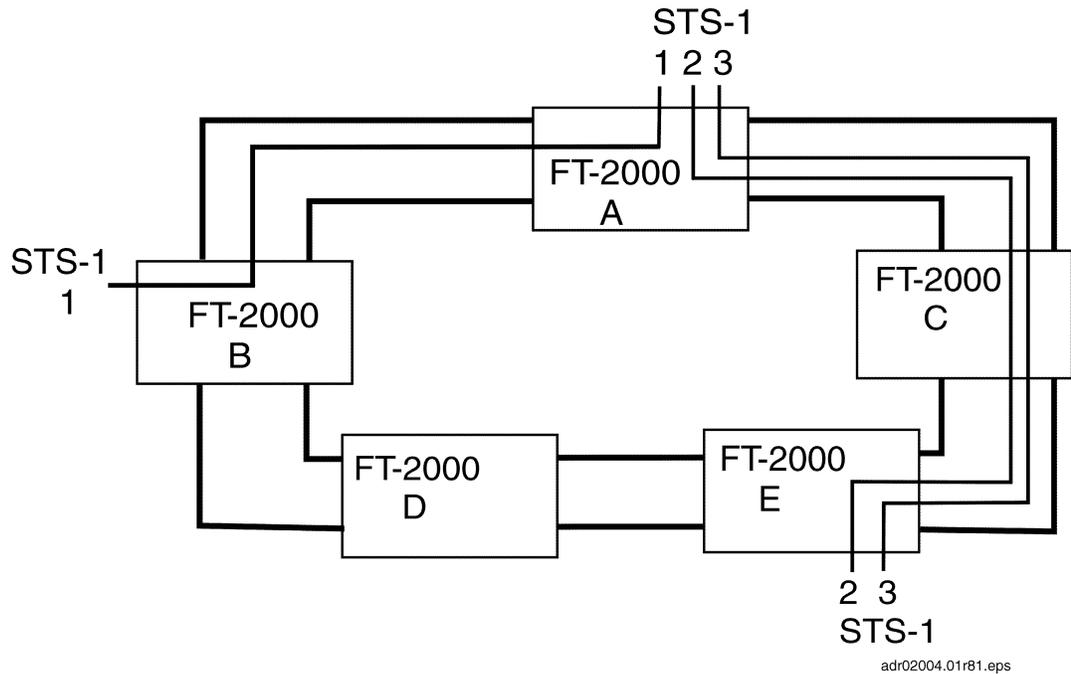
Figure 2-2.   Full East/West Directionality

Since you can manage bandwidth at the STS-1 level, you can use the capacity of a line more efficiently, generally with fewer low-speed circuit packs (Figure 2-3) and without having to reprovision in-service circuits.

Figure 2-3 illustrates how STS-1 granularity TSA across an OC-48 allows you to more efficiently manage the capacity of your line with fewer circuit packs.

Example 1 in Figure 2-3 shows a low-speed circuit pack and some tributaries in a node with STS-1 granularity TSA across an OC-48. As shown, only tributaries 1-3, 4-2, and 5-3 are available. Because this node is STS-1 granularity capable, you can add, drop, or pass through an STS-1 level signal to each of these nonadjacent STS-1 tributaries, using a single circuit pack. Nodes with STS-3 granularity are unable to drop a signal from these single STS-1 tributaries because they must drop signals at the STS-3 level.

Example 2 in Figure 2-3 depicts three low-speed circuit packs and some tributaries at a node with STS-3 granularity. To drop only one STS-1 signal each from tributaries 1-3, 4-2, and 5-3 at this node requires three low-speed circuit packs, three STS-3 signals. In a case such as this one, the remaining bandwidth at tributaries 1-2, 1-3, 4-1, 4-3, 5-1, and 5-2 could be stranded (unused).
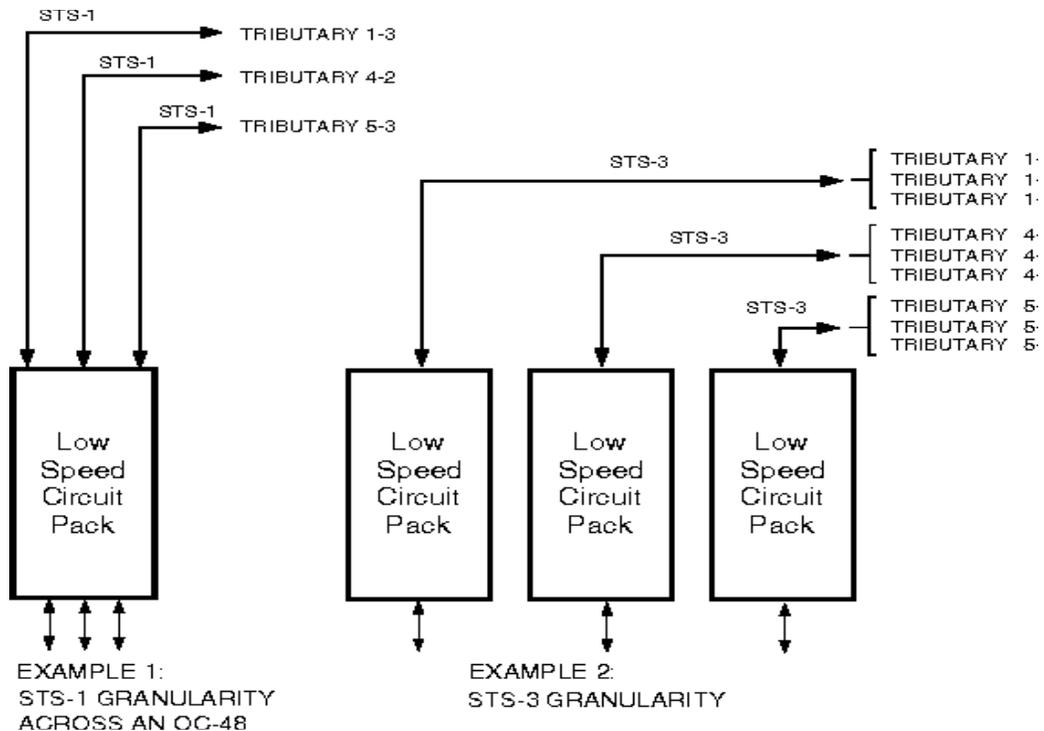
Figure 2-3.   STS-1 Granularity TSA Provides Increased Bandwidth

In a ring of more than eight nodes with STS-3 granularity, you could quickly reach the maximum fully protected capacity of eight STS-3s of service per span and still have bandwidth that is unused. To send more STS-3s of service, you would need to add another ring. However, if the ring had STS-1 granularity TSA across an OC-48, you could send up to 24 STS-1s of service, each going to a different destination. Having this capability would enable you to use or better manage the otherwise stranded bandwidth and often avoid adding another ring.

An FT-2000 ring can have a mixture of nodes that support STS-1 granularity and nodes that support only STS-3 granularity. All nodes must be running Release

7.0.1 or greater Add/Drop-Rings Terminal software[9]. All transmitters and receivers on STS-1 granularity nodes must support STS-1 granularity[10]. You can equip the STS-3 granularity nodes with any transmitters and receivers that are compatible with R7.0.1-ADR or greater software. (See the "FT-2000 OC-48 Add/Drop-Rings Terminal Slot/Circuit Pack/Software Compatibility" section in Chapter 7.)

When you install STS-1 granularity capable transmitters in a node, FT-2000 automatically translates STS-3 level cross-connections that are defined on your system into STS-1 level cross-connections.

FT-2000 Repeater software and associated hardware support STS-1 granularity.

For information about circuit pack/software compatibility and about ordering STS-1 granularity capable transmitters and receivers, see Chapter 7, "Ordering."

Circuit Provisioning Audit

As you provision circuits and perform maintenance functions at a node, the FT-2000 OC-48 Add/Drop-Rings Terminal

■ automatically detects and reports incomplete circuits and inconsistent squelch map/cross-connection provisioning.

■ provides, on request, a report on the continuity of a circuit, starting from a local low-speed slot. This report can help you pinpoint the location of a path interruption.

■ provides, on request, a report that displays all cross-connections involving a single timeslot throughout an entire ring (It is unnecessary to login to each node to obtain this information).

A squelch/cross-connection map contains information for each cross connection in the ring and indicates the source and destination nodes for the circuit path of which the cross connection is a part. The FT-2000 OC-48 Add/Drop-Rings Terminal uses this information to prevent traffic misconnection in rings with isolated nodes or segments. It also contains information about how signals are connected between the high-speed time slots and low-speed interface packs.

Using this up-to-date squelch map, each one-way cross-connection destination node can verify that there is a continuous path between it and the origin node. If this path is interrupted, the FT-2000 OC-48 Add/Drop-Rings Terminal generates

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9. As with previous releases, all nodes in a given FT-2000 ring must be running the same release of Add/Drop-Rings (ADR) software.

10. The STS-1 granularity capable transmitters include the 739B5, 739C5, 739J5, 739P5, 739R5, and 739S5. The STS-1 granularity capable receiver is the 839B5. See Chapter 7, "Ordering," for ordering information.

an autonomous alarm. It also generates an autonomous alarm if the source/destination node information is inconsistent for any of the cross connections that make up the path.

The FT-2000 OC-48 Add/Drop-Rings Terminal enables you to request a report that:

■ Assists in pinpointing the location of a path interruption

■ Lists all the cross-connections on a single time slot throughout the entire ring.

You can enable or disable the audit on a per cross-connection basis.

Three-Tiered Operations[11]

The FT-2000 OC-48 Lightwave System maintenance procedures are built on three levels of system information and control, spanning operations needs from summary-level status to detailed reporting.

User Panel and Faceplate LEDs
(Operations Tier 1)

The first maintenance tier consists of the user panel and alarm cutoff/line locator push button, the circuit pack faceplate light-emitting diodes (LEDs), and the filter panel LED.

The user panel line locator display and the circuit pack faceplate FAULT LEDs allow fast and easy troubleshooting to a particular circuit pack. The user panel provides system-level alarm and status information.

■ The office alarms interface provides a set of discrete relays that control office audible and visible alarms.

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11. The introduction of Target ID Address Resolution Protocol (TARP) for Operations Interworking (OI) in DDM-2000 OC-3 Release 13.0 and OC-12 Release 7.0 and FT-2000 Release 8.1 will affect the operations of some features in the three tiers. Refer to Chapter 5, "Operations, Administration, Maintenance, and Provisioning," for more information.

**Craft Interface Terminal
(Operations Tier 2)**

The second maintenance tier employs the Craft Interface Terminal (CIT) (CIT-PC
or the CIT-TL1). The CIT-PC (personal computer), enables you to get detailed
information and control the system. It supports these activities from one network
element (NE)

- provisioning

- maintenance

- configuration

- administration

- performance-monitoring.

The CIT-PC runs menu-driven CIT-PC software under an *MS-DOS* [12] operating
system and provides extensive on-line help and security against unauthorized
access.

The CIT-TL1 is an interface that enables you to maintain and control an NE using
industry-standard TL1 commands. You can use either the Lucent Technologies
user-friendly CPro-2000 or an ASCII terminal. For more information about CPro-
2000, refer to the "CPro-2000" section later in this chapter. For more information
about the CIT-PC or CIT-TL1, refer to Chapter 5, "Operations, Administration,
Maintenance, and Provisioning,".

Remote CIT Login

FT-2000 OC-48 Add/Drop-Rings Terminal can remotely login to other FT-2000
OC-48 Add/Drop-Rings Terminals or DDM-2000s when they are connected
through a path of DCC channels in the same SONET subnetwork. Each DCC
channel in the path can be carried over FT-2000 OC-48, DDM-2000 OC-12, or
FT-2000 and DDM-2000 OC-3 and OC-12 interfaces.

**Operations System (OS) Interfaces
(Operations Tier 3)**

The third maintenance tier provides access to NEs from remote OSs. FT-2000
offers parallel telemetry, serial telemetry, and TL1/X.25 OS interfaces. The TL1/
X.25 interface provides support for remote

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12. Registered trademark of Microsoft Corporation.

■   Automated services provisioning

■   Monitoring performance

■   Gathering alarm information (Alarm status)

■   Location/Isolating faults

■   Configuring system.

Operations Interface Flexibility

The FT-2000 OC-48 Lightwave System offers the following operations interfaces to meet the needs of an evolving operations system (OS) network:

■   The parallel telemetry interface provides a minimum set of alarm and status information to an operations center. (See Note.)

■   The serial telemetry interface uses the industry-standard telemetry byte-oriented serial (TBOS) protocol to provide alarm, status, and control to an operations system. (See Note.)

■   The user-settable miscellaneous discrete interface provides 16 miscellaneous discrete environmental inputs and 4 control outputs that you can set. These miscellaneous discrete inputs and outputs can be used to monitor and control equipment that is collocated with the FT-2000 OC-48 Lightwave System.

■   The X.25 interface uses an X.25 protocol to provide communications with a message-based operations system through TL1 operations messages. This interface is compatible with Bellcore's Network Monitoring and Analysis (NMA) system, as well as Lucent's ITM SNC[13]. A message-based OS can access the local FT-2000 OC-48 Add/Drop-Rings Terminals (local access capability) and remote FT-2000 OC-48 Add/Drop-Rings Terminals and DDM-2000 Multiplexers in a subnetwork using the TL1/X.25 Gateway Network Element (GNE) capability.

For more information on GNE, refer to Chapter 5 "TL1/X.25 Interface".

⇒ NOTE:

Parallel telemetry and serial telemetry are supported in Releases 7.2 and earlier only.

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13. ITM SNC forwards messages (commands) from an OS to the Network Elements in the SONET network and performs fault correlation. It then collects and forwards the responses and autonomous messages from the Network Elements to the OS. The OS uses the information it receives to perform fault correlation and diagnose problems in the SONET network.

Using the ITM SNC allows you to concentrate the data links to/from NEs onto a single X.25 link back to an OS such as NMA, providing a cost savings.

Lucent Product Family 2000 OI

⟹ **NOTE:**

The term single-ended operations (SEO) has traditionally been used to refer to such operations among DDM-2000 and FT-2000 systems. Now that SEO is supported among the 2000 Product Family NEs as well as multivendor operations, the term operations interworking (OI) is more commonly used.

The OI capability of the FT-2000 provides remote access to all FT-2000 systems in a subnetwork from a single location. This allows most maintenance, provisioning, and administration to be performed on a centralized basis, minimizing technician travel. CITs, user panel functions, and OS interfaces all give access to remote systems. Upgrades are simplified because OI is integrated into the FT-2000 through the SONET section DCC. If desired, the DCC can be disabled between any two FT-2000 shelves to create maintenance boundaries.

The FT-2000 OC-48 Lightwave System OI has been expanded to include DDM-2000 Multiplexers. This means that in subnetworks consisting of both DDM-2000 Multiplexers and FT-2000 OC-48 R6.0 and later Lightwave System shelves, DDM-2000 Multiplexer alarms appear in FT-2000 OC-48 Lightwave System alarm reports, and FT-2000 OC-48 Lightwave System alarms are included in DDM-2000 alarm reports. In addition, users at FT-2000 OC-48 Lightwave System shelves are able to log into any DDM-2000 shelf in the subnetwork using the FT-2000 OC-48 Lightwave System CIT. The FT-2000 OC-48 Lightwave System connectivity reports also list the DDM-2000 shelves in the subnetwork and vice-versa. This is in keeping with the Lucent Technologies 2000 Product Family philosophy of OI.

Lucent Technologies 2000 Product Family OI features include the following:

■ **Craft interface terminal (CIT) remote access:** The local NE provides a remote login capability from its CIT to a remote NE.

■ **User panel remote access:** The user panel provides a far-end activity (FE ACTY) LED to show that one or more remote NEs have a lighted near-end activity (NE ACTY) LED.

■ **OS remote access:**

— TL1/X.25: A TL1/X.25 OS can access local and remote:

■ FT-2000

■ DDM-2000 Multiplexers

— Parallel telemetry

— Serial telemetry.

➡ **NOTE:**
> Parallel telemetry and serial telemetry are supported in Releases 7.2 and earlier only.

- **Alarm report remote access:** The local terminal provides a summary alarm report that indicates the highest active alarm, if any, at all remote NEs in the same alarm group. These NEs can be FT-2000 OC-48 Add/ Drop-Rings Terminals or DDM-2000 Multiplexers.
- **Remote software copy:** This feature allows you to copy software from one FT-2000 OC-48 Add/Drop-Rings Terminal to another anywhere in the subnetwork.

Releases 7.2 and earlier:
For more detailed information on OI, refer to the *Lucent Technologies 2000 Product Family Operations Interworking Guide* (824-102-147).

Releases 8.1 and later:
For more information on OI, refer to the *Lucent Technologies 2000 Product Family multivendor Operations Interworking Guide* (824-102-144).

Multivendor Operations Interworking (OI)

To support multivendor OI, FT-2000 OC-48 R8.1 supports Target ID Address Resolution Protocol (TARP) instead of Lucent Directory Service (LDS). DDM-2000 (OC-3 R13.0, OC-12 R7.0) and FiberReach R3.0 also support TARP, thus Lucent 2000 Product Family OI compatibility is still supported, but not OI compatibility with previous releases of DDM-2000 and FT-2000. TARP is the established multivendor standard for SONET NEs that support TL1 OS interfaces.

FT-2000 OC-48 R8.1 is developed to be compatible with any other-vendor NEs that also support TARP, OSI, and TL1/X.25 as specified in Bellcore GR-253.

The Lucent 3000 Product Family (including *WaveStar* BandWidth Manager, 2.5G and 10G) also supports TARP, OSI, and TL1/X.25, enabling compatibility with the Lucent 2000 Product Family.

FT-2000 OC-48 R8.1 compatibility with Tellabs *TITAN* 5500 DCS R5.0, including TL1/X.25 OS access with *TITAN* 5500/s DCS serving as the TL1/X.25 GNE, has been confirmed through cooperative joint testing.

FT-2000 OC-48 R9.1 enables the FT-2000 to serve as the TL1/X.25 GNE for Tellabs *TITAN*, as well as *WaveStar* 2.5G and 10G.

Because FT-2000 OC-48 R8.1 is intended to facilitate OS-based centralized oper-
ations, and because TL1/X.25 OS access is the key standardized multivendor OI
application, the following Remote NE Status features are not (except for FE ACTY
LED - See Note.) supported in FT-2000 OC-48 R8.1:

- Remote office alarms

- Remote CIT alarm reports

- Remote user panel indications

- TBOS

- Parallel telemetry.

⮕ **NOTE:**
Parallel telemetry and serial telemetry (TBOS) are supported in Releases
7.2 and earlier only.

⮕ **NOTE:**
For Releases 8.1 and later, the FE ACTY LED is lighted only when an OC-
48 protection switch is active at the remote terminal.

All of the above features (except FT-2000 Release R8.1 FE ACTY LED) depend
on the proprietary exchange of information among Lucent NEs in a subnetwork,
specifically the communication of each remote NE's alarm status to other NEs.
Although the Remote NE Status features were supported in previous releases of
FT-2000, such Lucent-only operations features in multivendor subnetworks would
not include other-vendor NEs, due to the lack of applicable standards, and thus
would be incomplete.

FT-2000 OC-48 R8.1 still supports the following Lucent proprietary OI applications
between Lucent NEs in multivendor subnetworks:

- Remote Craft Interface Terminal (CIT) login

- Remote software copy

- Remote NE-to-NE automatic time/date synchronization at start-up.

⮕ **NOTE:**
Remote login and remote software copy are not possible from an FT-2000
CIT to a *WaveStar* NE. However, remote login and remote software copy
will pass through *WaveStar* NEs in mixed FT-2000/*WaveStar* rings.

Releases 7.2 and earlier:
For more detailed information on OI, refer to the *Lucent Technologies 2000 Product Family Operations Interworking Guide* (824-102-147).

Releases 8.1 and later:
For more information on OI, refer to the *Lucent Technologies 2000 Product Family Multivendor Operations Interworking Guide* (824-102-144).

Releases 9.1 and later:
For more information on FT-2000/*WaveStar* OI, refer to the *Lucent Technologies 2000 Product Family Multivendor Operations Interworking Guide* (824-102-144).

Local and Remote Software Copy/ Upgrades

The FT-2000 OC-48 Lightwave System provides the capability to upgrade the system software in service without requiring any control circuit pack changes. The system monitoring and control are fully functional during the software download. You can download software locally using the CIT-PC or remotely copy it from one FT-2000 OC-48 Add/Drop-Rings Terminal to another FT-2000 OC-48 NE over the DCC[14]. In addition, you can use a modem to download the software or issue a remote software copy CIT command.

An FT-2000 OC-48 Add/Drop-Rings Terminal can download (copy) software

- from a single site to local and remote FT-2000 Add/Drop-Rings Terminals in the same SONET subnetwork[14].

- through DDM-2000 Multiplexers to another FT-2000 in the same subnetwork[14].

- through *WaveStar* NEs to another FT-2000 in the same subnetwork.

⇒ **NOTE:**
Software can be installed via the ITM-SNC with an FT-2000 OC-48 Add/Drop-Rings Terminal, Release 9.0 or later, and an ITM-SNC Release 5.0 or later.

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14. To take advantage of this feature, you must have Release 5.0.1 or later software installed in all FT-2000 Add/Drop-Rings Terminals. In Release 5, you can copy software to FT-2000 OC-48 Add/Drop-Rings Terminals that are in the same ring. In Release 6 you can also copy software to FT-2000 OC-48 Add/Drop-Rings Terminals that are in the same subnetwork (DCC connected through OC-3 interfaces). In Release 7.1 you can copy software through OC-12 DCC.

In Figure 2-4, any FT-2000 node in ring A could remotely copy software to any other FT-2000 node in ring A and B and vice versa. The DDM-2000 Multiplexers must have OC-3 DCC connectivity to both FT-2000s. In the figure, the connection could be any type of connection, for example, a single 0x1 or dual 0x1 connection (recommended). This configuration can also occur using OC-12 DCC connectivity. For a brief description of these types of connections, refer to Chapter 5, "Operations Interworking".
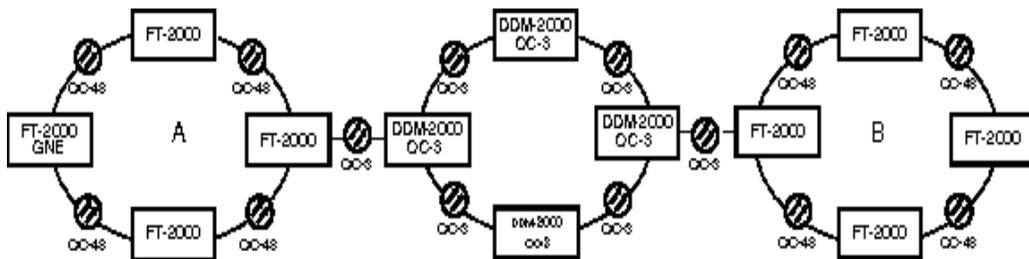
Figure 2-4.   FT-2000 to FT-2000 Remote Software Copy Across DDM-2000 Multiplexers

Local and Remote Inventorying Capabilities

The FT-2000 OC-48 Lightwave System provides automatic version recognition of all hardware and software installed in the system. Circuit pack types, circuit pack CLEI[15] codes, and serial numbers are accessible via the CIT. These capabilities greatly simplify troubleshooting, dispatch decisions, and inventory audits.

Orderwire for Remote CIT Access and Basic Party-Line Service to Repeaters and Terminals

The FT-2000 OC-48 Lightwave System configured with voice and remote CIT access DANTEL[16]Orderwire Shelf kits[17] provides the following capabilities over the SONET section orderwire:

- Basic party-line service (voice communication)

- Remote CIT access (to FT-2000 Repeaters and FT-2000 OC-48 Add/Drop-Rings Terminals that are in the same ring.)

NOTE:
An external modem (included in the DANTEL shelf kit) is required for CIT access at a terminal or repeater (node). Although you can use the DANTEL Orderwire Shelf for remote CIT access to terminals in the same ring, the primary use for this function is for remote CIT access to repeaters that are in the same ring. For FT-2000 OC-48 Add/Drop-Rings Terminals, the pre-ferred method of remote CIT access is through the OC-3 and OC-12 DCC. For more information about OC-3 DCC features see "Single-Ended Opera-tions" in Chapter 2.

Remote CIT access provides all of the operations, administration, maintenance, and provisioning capabilities that you have through local CIT access. (For more information about the commands that are available refer to the "FT-2000 OC-48 Lightwave System User/Service Manual" 365-575-103.) If a repeater fails, you can remote login to a node at one end of the repeater string to determine which

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15. COMMON LANGUAGE is a registered trademark and CLEI, CLLI, CLCI, and CLFI are trademarks of Bell Communications Research, Inc.

16. Registered trademark of DANTEL Incorporated.

17. The voice and remote CIT access DANTEL Orderwire Shelf kits require Release 6 or later of the FT-2000 OC-48 Add/Drop-Rings Terminal software and Release 6.0.1 or later of the Repeater Bay software. For ordering information about these shelves, see the **Related Products** tab in Chapter 7. This chapter also contains ordering information about voice only DANTEL Orderwire Shelves.

repeater has failed. If a circuit pack at a repeater fails[18], you can login to the repeater to determine the type and version of circuit pack that failed.

While you are using the remote CIT access feature of the *DANTEL* Orderwire Shelf, you are unable to use voice communications on the orderwire, and vice versa.

As in Figure 2-5, each repeater site and terminal site that you want to communicate with or from must be equipped with a *DANTEL* Orderwire Shelf that has an internal modem. The internal modem is wired to the data terminating equipment (DTE) port on the terminal or repeater. Additionally, each of the repeaters that you want remote CIT access to must be equipped with one Orderwire (OW) circuit pack. At least one site must have an external modem installed with the *DANTEL* shelf. It is recommended, that you install an external modem with the *DANTEL* shelf at each location to permit CIT access to the orderwire. See the **Related Products** tab in Chapter 7 for more information about the *DANTEL* shelf, external modem, PC (PC-CIT), and RS232 cable (required to connect the PC-CIT to the external modem).

The *DANTEL* shelf bridges the orderwire channels in the east (E) and west (W) directions at the repeaters and terminals to allow orderwire connectivity around the ring. However, one FT-2000 OC-48 Lightwave System Add/Drop-Rings Terminal in the ring should serve as a break point node to avoid oscillating audio in the system. The *DANTEL* shelf at this node is configured in terminal mode[19] so that:

- Channels 1 and 2 (east and west directions) of the *DANTEL* shelf are not bridged

- Channel 1 is the operational channel.

The SONET section orderwire is unprotected from fiber cuts or other transmission failures. Therefore, it is recommended that you locate the break point node in the Central Office (CO) where maintenance activity is most likely to be initiated. It may be necessary to interchange the east and west orderwire connectors of the break point node to reach nodes isolated by a failure.

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18. Although a repeater may be equipped with an Orderwire (OW) circuit pack, it is unrecognized by the system.

19. For information about the meaning of terminal and repeater modes, refer to the documentation that accompanies the *DANTEL* shelf.
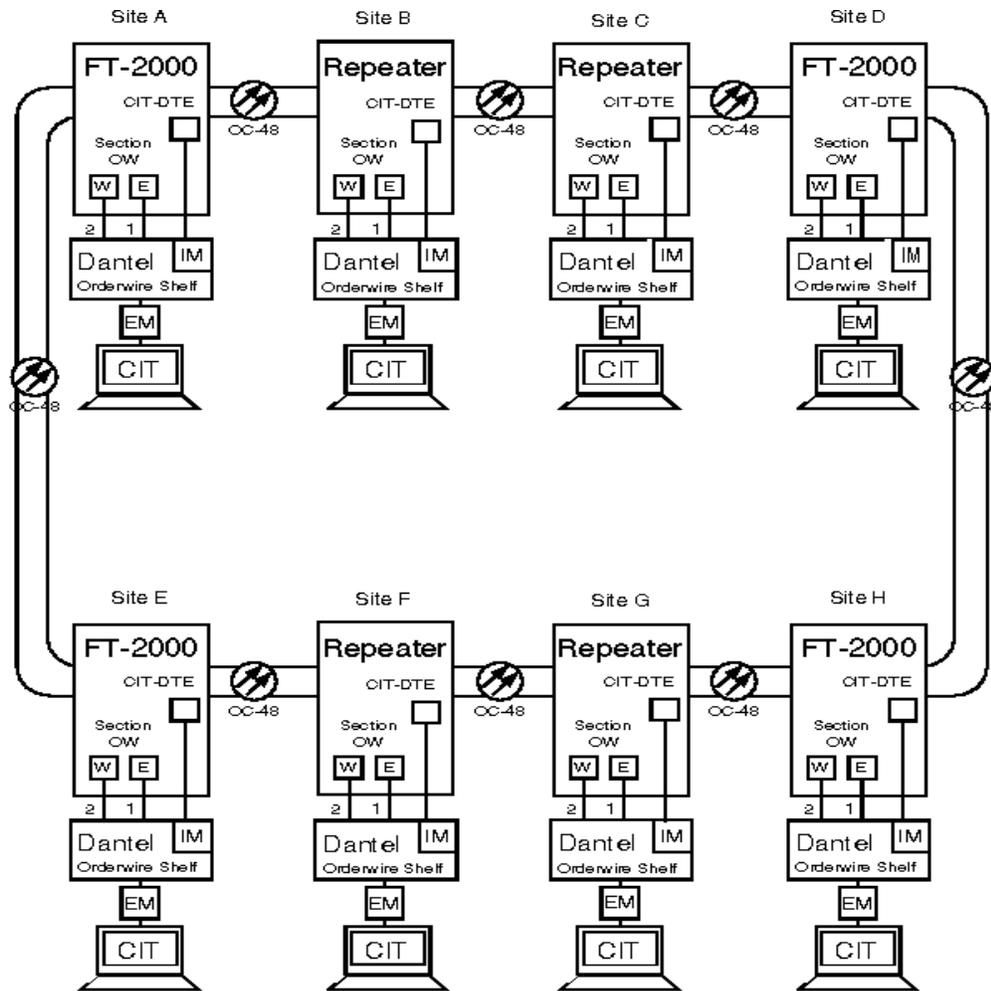
Figure 2-5. Orderwire for Remote CIT Access and Basic Party-Line Communication (2-Fiber Bidirectional Line Switched Ring)

TL1 Message Enhancements

The FT-2000 OC-48 Lightwave System Add/Drop-Rings Terminal communicates with OSs through a set of TL1 commands and autonomous messages through the X.25 message-based OS interface. These messages/commands allow remote OS surveillance and service provisioning, improved maintenance, basic remote OS security capabilities, and the ability to control and observe NEs.

Significant capabilities include:

- T1M1.3-compliant performance monitoring, which includes:
    — Autonomous threshold crossing alerts (TCAs)
    — Far-end STS-1 path performance monitoring
    — DS3 performance monitoring
- Remote operation of high-speed protection switching and synchronization reference switching
- Remote provisioning of:
    — DS3, EC-1, OC-3, IS-3, and OC-12 ports and low-speed slots
    — STS-3 and STS-1 cross-connection assignments
    — Path trace
    — Communication ports security
- Remote reports for:
    — Alarm status
    — Operational status
    — Current system provisioning
    — Neighbor connectivity over the DCC
- Remote assignment of DCC channels
- Remote system testing.

TL1 Commands Through the CIT

This feature allows FT-2000 to accept maintenance commands entered through one of the craft interface terminal (CIT) ports, using the CIT-TL1.

The CIT-TL1 is an interface that enables you to maintain and control the FT-2000 OC-48 Lightwave System locally and remotely by using Lucent Technologies CPro-2000 or an ASCII terminal with TL1 commands. You can use the entire set of available TL1 commands (excluding autonomous messages).

(For more information about CPro-2000, see the "CPro-2000" section.)

To enter the commands manually using an ASCII terminal, you must

- Know the TL1 commands

- Follow the standard TL1 format.

For information about TL1 commands through the CIT, refer to the *Lucent Technologies 2000 Family of Products Operations Systems Engineering Guide* (824-102-148).

CPro-2000

CPro-2000 is a graphical Microsoft[20] Windows[21] based alternative to entering TL1 commands manually to provision NEs. This intelligent graphical tool simplifies and mechanizes operations of transmission NEs. It also provides a common look and feel across the SONET subsystems of FT-2000 and DDM-2000. Using mouse clicks, instead of many manually typed TL1 commands, to enter information prompted by CPro-2000, you can

- Display, enter, and delete cross-connections at each NE and entire rings.

  Example: You can

  — provision normal, broadcast, and DRI cross-connections and end-to-end paths.

  — manually control which input tributary a DRI switch is to select.

  — CPro-2000 allows cross-connections at the STS-1 and STS-3 levels.

- Obtain inventory and display a graphical image of the subnetwork configuration, equipment, and cross connections from the NEs.

- Retrieve reports on cross-connections and alarms of the NE.

- Retrieve data about a selected NE and save it to an editable ASCII file.

- Backup and restore the NE database.

In response to your input and mouse clicks on the graphical elements of the screen, CPro-2000 automatically sends all of the TL1 commands necessary to perform the task.

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20. Microsoft is a registered trademark of Microsoft Corporation.
21. Windows is a registered trademark of Microsoft Corporation.

Example: If you are provisioning paths within a single ring, CPro-2000 automatically:

- Prevents provisioning errors by comparing the new provisioning information with the subnetwork inventory

- Determines the next node in the subnetwork to provision

- Ensures that the timeslots are available throughout the circuit path

- Logs in to each of the nodes

- Establishes all cross-connections (including pass-through connections).

For more information about CPro-2000, refer to the *CPro-2000 User Manual* (190-523-101).

Synchronization Messaging

Synchronization messages are a method by which nodes in an FT-2000 ring can communicate their synchronization status with other nodes in the ring.

On the OC-48 interface, synchronization messages are both transmitted and processed. On the IS-3, OC-3, and OC-12 interfaces, synchronization messages are supported in the drop direction to distribute timing to DDM-2000.

For Releases 9.0 and later:
The FT-2000 synchronization messaging has been enhanced to support OC-3 S1 byte synchronization messaging for synchronization interworking with other vendors equipment. This feature requires the OC-3 interface circuit pack (LAA10B).

Continuous Performance Monitoring

Continuous performance monitoring allows the FT-2000 OC-48 Lightwave System to detect network problems before they affect service. The FT-2000 OC-48 Lightwave System offers performance monitoring and reporting of SONET section, line, and path parameters. Thresholds for each parameter can be provisioned, depending on customer needs.

You can specify a single start time for measuring all 24-hour performance monitoring parameters. The start time can be the beginning of any hour. (The default is midnight.) The performance monitoring parameters begin daily at the specified time.

For Release 9.0 and later:
The FT-2000 performance monitoring has been enhanced to report STS pointer justification counts (PJC) for each SONET line interface (OC-3, OC-12, and EC-1).

PJC is a count of STS-n pointer adjustments created or absorbed by an NE, (for example: due to the differences in frame rates of the incoming and outgoing SONET signals).

Excessive PJCs indicate a frequency error in the network or other potential synchronization problems, (for example: shelf in holdover, frequency offset in external timing reference).

Original Value Provisioning and User-Selectable Thresholds

The FT-2000 OC-48 Lightwave System provides extensive provisioning capabilities such as:

- Protection switching thresholds
- Performance-monitoring thresholds
- Path trace
- Time slot assignment.

The alarm severity of failures can be customized to fit local maintenance practices.

To minimize pre-service provisioning, an original value is assigned to each parameter by the software. The values assigned by the software can be easily changed with the CIT.

Automatic Node ID (NID) Provisioning

The node ID is a number used by the software to uniquely identify Network Elements for loopback protection. In Releases 5.0 and earlier, this number was manually assigned. FT-2000 now generates this number automatically.

Security

The FT-2000 OC-48 Lightwave System provides three tiers of security to protect against unauthorized access to the CIT and OS functions (for example, Provisioning). The three tiers are Port Security, Network Element Login Security, and User Login Security.

Port Security

This feature controls access to the system through a per-port enable/disable mechanism and inactivity time-outs.

Network Element Login Security

This feature controls access to the system through a lockout mechanism to disable all but administrative logins (expert and privileged).

User Login Security

This feature controls access to the system on an individual user basis including

- **Login ID and password assignment —** Requires the user to enter a valid login ID and password to access the system. The FT-2000 OC-48 Lightwave System allows up to 100 login IDs and passwords. Two of these login IDs are expert/privileged and the others are reports only and general.

- **User authorization levels —** Provides four levels of access on a per login session basis:

    — Expert **—** Provides access to all commands and options. Only expert users have access to the security and access functions. These functions include assigning/changing logins/passwords for other users, setting login/password aging times, enabling/disabling ports, setting terminal ID (TID) names, and initializing the system.

    Expert users are privileged users who have gained this authorization level in one of two ways: They acquire it automatically by logging in through a TL1 interface (either X.25/TL1 or CIT-TL1 interface). They provide a special option as they login from a CIT-PC.

    — Privileged **—** Provides access to all commands and options except those that may affect all service at once, for example, TEST AUTO-TURNUP.

    — General **—** Provides access to all commands except those relating to security and system access.

— Reports Only — Provides access to all reports, for example OPR-ACO and TEST-LED. The reports only users are not allowed to change any of the system provisioning values.

■ **Login aging** — Enables you to set individual logins to be deleted if unused for a certain number of days or on a particular date (for example, for a visitor or for temporary access during installation).

■ **Password aging** — Enables you to require each user to change his or her password periodically.

■ **Autonomous indications and history log records** — Provides autonomous indications and history log records of successful and unsuccessful logins and intrusion attempts for security auditing.

Easy Installation and Self-Tests

The FT-2000 OC-48 Lightwave System minimizes installation time with connectorized cabling, commercially available connectors, simplified procedures, and a product delivery concept geared toward having all the product components arrive at the installation site at the same time in a few containers. In addition, original value provisioning and a set of automatic turnup tests is available. These include tests for the shelves and circuit packs, cabling to the local cross-connect system, and end-to-end continuity. Since test signal generators and detectors are integrated into the system, external test equipment is not needed.

Front Access

Front access is standard on the FT-2000 OC-48 Lightwave System. Front access provides greater flexibility, enabling the equipment to be placed in physically restricted locations. For certain equipment upgrades, access from the rear is necessary.

Physical Compactness

The FT-2000 OC-48 Lightwave System consists of the following compact bay arrangements.

■ The FT-2000 OC-48 Add/Drop-Rings Terminal can be mounted in a single 7-foot bay. It provides multiplexing and transport for up to 48 DS3 equivalents of signals. All the operations, administration, maintenance, and provisioning (OAM&P) functions are built in.

■ The FT-2000 OC-48 Dual Lightwave Terminating Bay can be used for applications where office floor space is limited. This bay allows for mounting two complete FT-2000 OC-48 Add/Drop-Ring Terminals in a single 7-foot bay.

■ The FT-2000 OC-48 Repeater Shelf can be miscellaneously mounted and provide regenerators for point-to-point and ring applications.

On-Board Power Modules

The FT-2000 OC-48 Lightwave System eliminates the need for individual power circuit packs by providing on-board power modules on each circuit pack to convert office source voltages. This distributed power configuration dissipates heat uniformly. The use of power modules on individual circuit packs eliminates a separate bulk power protection switching system and the cost associated with it.

Red-Line Services

The FT-2000 OC-48 Lightwave System provides for protection against accidental deletion of cross-connects for high priority services by tagging them as red-line. The cross-connects are established, then are red-lined tagged. After a cross-connect is red-lined it requires additional steps to delete.

Equipage Dependent Reports

Provides the flexibility of choosing whether the low speed circuit pack reports will include entries based on equipage or pre-provisioned values.

TIRKS®[22] Compatible STS-1 Numbering

Translation tables and cross-connect reports are provided in *TIRKS* format. This feature is to aid in trouble shooting end-to-end circuits that are provisioned from a work order record and details (WORD) document.

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22. *TIRKS* is a Bellcore operations system (OS) and registered trademark.

Applications

3

Contents

Applications

3

Overview

The FT-2000 OC-48 Bidirectional Line Switched Ring Lightwave System satisfies a wide range of applications with maximum economy and efficiency. These applications include point-to-point, hubbing, dual ring interworking, dual-wire center architecture, broadband service transport, and loop feeder network applications. This chapter describes how the FT-2000 OC-48 Lightwave System meets these diverse needs with the following platforms:

- FT-2000 OC-48 Add/Drop-Rings Terminal

- FT-2000 OC-48 Dual Lightwave Terminating Bay

- FT-2000 OC-48 Repeater Bay.

For more information about these platforms refer to Chapter 4, "Product Description." For a list of the features that are available with each platform, see Chapter 1, "Introduction."

The FT-2000 OC-48 Lightwave System provides cost-effective transport in interoffice, suburban, and outstate trunk routes. It can transport up to 48 DS3-equivalent signals over an OC-48 line at 2.5 Gb/s.

To accommodate different fiber losses in loop and interoffice routes, the system provides a variety of transmitters.[1] Refer to Chapter 10, "Technical Specifications," for loss budget information and a list of the spans (transmission distances) these transmitters support.

The standard performance OC-48 1.5 μm or Lightwave Booster Amplifier (LBA) performance OC-48 1.5 μm transmitter interface operating with the FT-LBA on dispersion-shifted fiber allows spans up to 160 km. The LBA performance OC-48 1.5 μm transmitter interface operating with the FT-LBA on standard fiber allows spans of up to 140 km. For details, refer to the "FT-2000 Lightwave Booster Amplifier (FT-LBA) for Extended Distances" section later in this chapter.

The FT-2000 OC-48 Lightwave System typically interfaces to digital multiplexers such as the DDM-2000 Multiplexers, to digital access and cross-connect systems such as DACS III-2000 or DACS IV-2000, to a digital switch, or to other facilities.

OC-48 Bidirectional Line-Switched Rings

The FT-2000 OC-48 Add/Drop-Rings Terminal supports 2-fiber bidirectional line-switched rings (BLSR). The rings are standards compliant and support up to 16 nodes (the maximum allowed by the standard). They perform automatic protection switching, restoring traffic in ≤60 ms (including detection time) for catastrophic failures in rings without existing switches and extra traffic. As required by the standard, protection switching is revertive.

Bidirectional line-switched rings provide redundant bandwidth and/or equipment to ensure system integrity in the event of any transmission failure, including a fiber cut or node power failure. A ring is a collection of nodes that form a closed loop, where each node is connected only to adjacent nodes. Ring nodes are made up of FT-2000 OC-48 Add/Drop-Rings Terminals.

In bidirectional line-switched rings under normal conditions, service traffic travels in both directions over a single span between two nodes. Each span of a ring consists of two sets of bidirectional channels: service channels and protection channels. In 2-fiber rings, each physical line is shared by service channels and protection channels.

The FT-2000 OC-48 Add/Drop-Rings Terminal offers full flexibility in assigning signals between low-speed slots and any high-speed tributary. This slot to tributary cross-connection is called time slot assignment (TSA). You can use the craft inter-

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1. The OC-48 Transmitter, Add/Drop 1.5 μm STD and OC-48 Transmitter, Add/Drop 1.5 μm LBA are features of the FT-2000 OC-48 Add/Drop-Rings Terminal platform. For more information about the FT-LBA, refer to *Digital Transmission Systems FT-Lightwave Booster Amplifier Description, Engineering, Installation, and Maintenance* (365-565-500).

face terminal (CIT) or the TL1 interface to an operations system to make channel assignments in a ring.

2-Fiber Bidirectional Line-Switched Ring

The FT-2000 OC-48 Add/Drop-Rings Terminal supports 2-fiber bidirectional line-switched rings. The 2-fiber bidirectional line-switched ring is shown in Figure 3-1. Each physical OC-48 line is shared between 24 service channels and 24 protection channels. Half the capacity of the high-speed line is assigned to service traffic and half the capacity is assigned to protection.

Service 1/Protection 2

Service 2/Protection 1

FT-2000*

FT-2000*

Service 2/Protection 1

Service 1/Protection 2
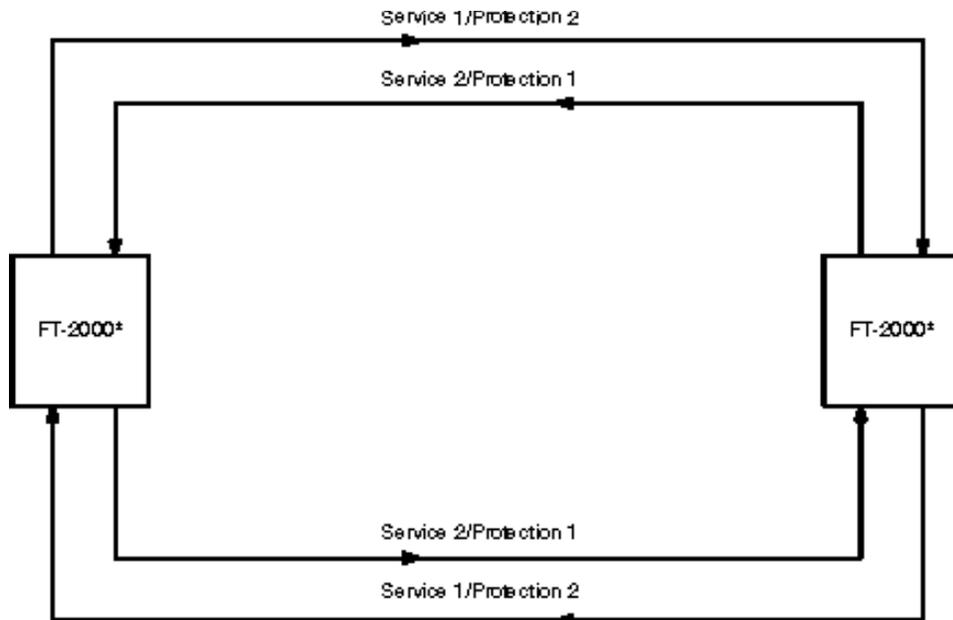
* FT-2000 OC-48 Add/Drop-Rings Terminal

Figure 3-1.   2-Fiber Bidirectional Line-Switched Ring Application

The 24 protection channels can be used to provide unprotected capacity either for preemptible protection access or for non-preemptible protection access. Refer to the sections later in this chapter about using protection access.

Loopback Protection Switch (2-Fiber Rings)

Protection switches in FT-2000 OC-48 Add/Drop-Rings Terminal 2-fiber bidirectional line-switched rings are called loopback switches. Each fiber provides

- 24 DS3 equivalent service capacity

- 24 DS3 equivalent protection capacity.

When a signal degrade or signal failure occurs, such as the fiber cut in the figure, protection switches at nodes D and E automatically loop the service traffic onto the protection capacity. The service traffic is reestablished on the protection capacity in ≤60 ms after detection of the failure (for catastrophic failures in rings without existing switches or extra traffic). For example, if the counterclockwise service fiber is cut (Figure 3-2), the counterclockwise protection capacity carries the signal from node D to node E.

The loopback protection capacity forms a "real-time" diverse route for the failed service span, protecting the failed span with the protection loop capacity around the opposite side of the ring. During loopback switches, the nodes that are adjacent to the failed link perform the loopback switches. The other nodes act like repeaters on the protection capacity.
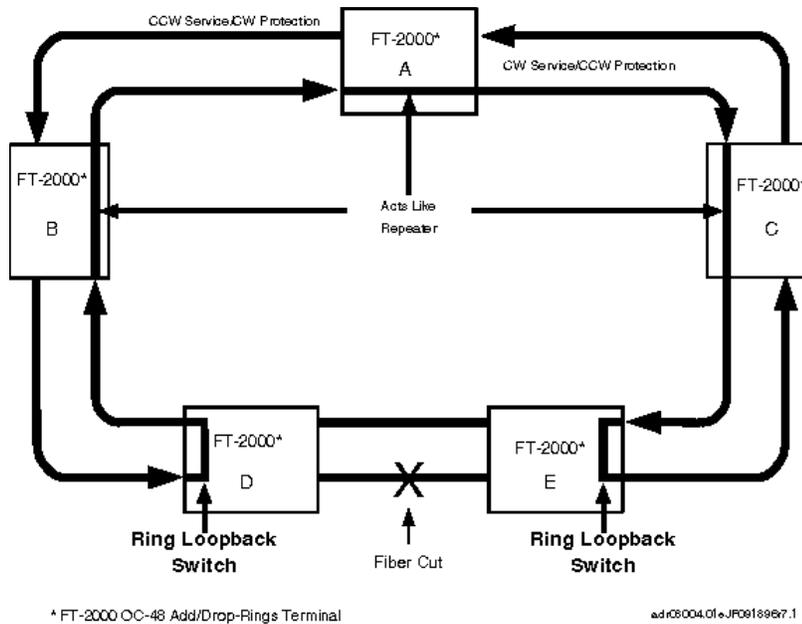
Figure 3-2. Loopback Protection Switch in a 2-Fiber Bidirectional Ring Application

BLSR Interworking with *WaveStar* BandWidth Manager and *WaveStar* 2.5G

The FT-2000 Add/Drop-Rings Terminal Release 9.1 now has the capability to interwork with *WaveStar* BandWidth Manager (BWM) Release 2.0 and *WaveStar* 2.5G Release 3.0 via the same OC-48 2-fiber bidirectional line-switched ring (BLSR). This capability provides the flexibility needed to expand existing FT-2000 rings by adding BWM or 2.5G nodes to those rings. Transmission with all FT-2000 ADR transmitter (TRMTR) and receiver (RCVR) circuit packs is supported.

The two primary advantages of utilizing these mixed ring applications are:

- the replacement of multiple, collocated (one central office) FT-2000 ring nodes supporting many different 2-fiber bidirectional line-switched rings with a single BWM system

- additional low-speed interface access to OC-48 bandwidth. *WaveStar* systems support 100% add/drop capacity. FT-2000 systems support only 50% add/drop capacity.

FT-2000/*WaveStar* BandWidth Manager Interworking

FT-2000 ADR interworking with *WaveStar* BandWidth Manager Release 2.0 provides the opportunity to replace multiple FT-2000 2-fiber bidirectional line-switched ring nodes located in one central office (CO) with a single BandWidth Manager system. This capability is especially beneficial in COs where space limitation is an issue. Rather than acquiring more space in a building, replacing the FT-2000 nodes with a single BWM provides additional access capacity at a lower cost per circuit. Also, once those FT-2000 nodes have been replaced, they can be redeployed in central offices where space is not a concern.

Currently, each FT-2000 ADR node located in a CO supports only one 2-fiber BLSR. The BWM has much greater capacity to support BLSRs. One BandWidth Manager can support as many as 192 2-fiber BLSRs, broken down as follows:

- 1 BWM shelf can support up to **4** 2-fiber BLSRs

- 1 BWM bay (2 shelves) can support up to **8** 2-fiber BLSRs

- 1 BWM (24 bays, 48 shelves) can support up to **192** 2-fiber BLSRs.

Figure 3-3 (A) shows a central office with multiple FT-2000 nodes supporting several different 2-fiber BLSRs.

Figure 3-3 (B) shows the multiple FT-2000 nodes in the central office being replaced by a single BandWidth Manager.
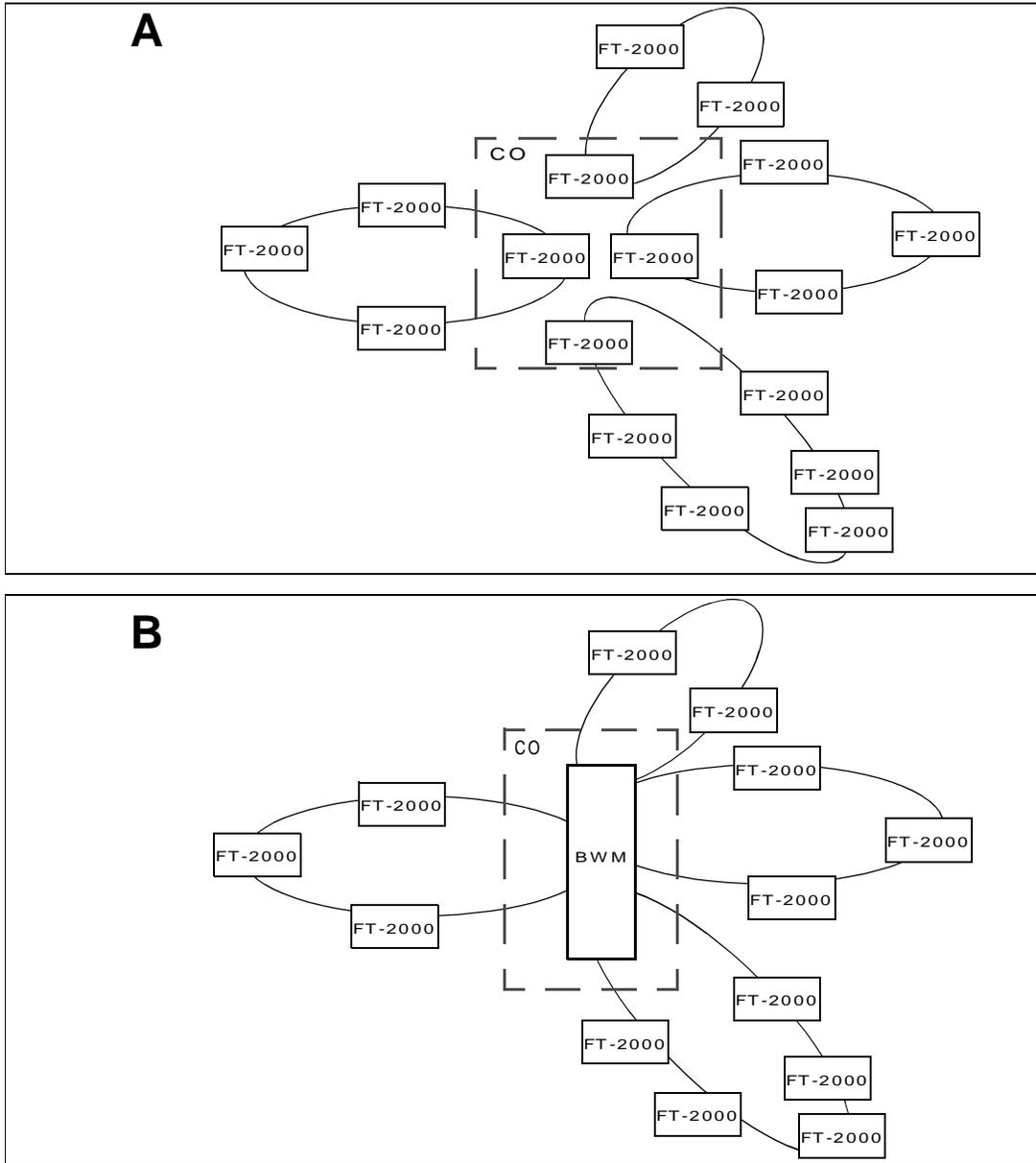
Figure 3-3. *WaveStar* **Bandwidth Manager and FT-2000 Interworking**

FT-2000/*WaveStar* 2.5G Interworking

FT-2000 ADR interworking with *WaveStar* 2.5G Release 3.0 provides additional access to OC-48 bandwidth. When an existing FT-2000 ring node has exhausted its low-speed interface capacity, a 2.5G node can be added to the ring at the capacity exhaust location (FT-2000 node).

There are two possible 2-fiber BLSR configuration options when the FT-2000 ADR interworks with 2.5G. After adding the 2.5G node into the existing ring, the FT-2000 node can either:

- remain collocated with the 2.5G node, or
- be redeployed elsewhere in the network.

The traffic on the FT-2000 node can be moved onto the 2.5G node if redeployment of the FT-2000 node is desired. This configuration is advantageous because the 2-fiber BLSR 2.5G node can add/drop up to 96 STS-1 tributaries, while the FT-2000 node can add/drop only up to 48 STS-1 tributaries. The greater bandwidth capacity of the 2.5G node can preserve a ring node in situations where a ring is at or near the BLSR 16 node limit.

Figure 3-4 (A) shows a normal FT-2000 ring, but node C has exhausted its low-speed interface capacity. Figure 3-4 (B) shows a 2.5G node added at the capacity exhaust location (node C). In Figure 3-4 (C), the FT-2000 node is removed and all traffic is moved onto the 2.5G node.

A

FT-2000 Node B

FT-2000 Node A

FT-2000 Node C

FT-2000 Node D

Large Capacity Drop Location

B

FT-2000 Node B

FT-2000 Node A

FT-2000 Node C

FT-2000 Node D

2.5G

Large Capacity Drop Location

C

FT-2000 Node B

FT-2000 Node A

FT-2000 Node D

2.5G

Large Capacity Drop Location

FT-2000 traffic   2.5G Traffic

Figure 3-4.   *WaveStar* **2.5G and FT-2000 Interworking**

Folded Rings (Point-to-Point)

Folded rings are rings without fiber diversity. The term is derived from the image of folding a ring into a linear segment.

FT-2000 Add/Drop-Rings Terminals enable you to use folded rings in a variety of "nonring" applications, such as linear add/drop topologies. Folded rings provide flexibility and can help evolve your network into a full ring configuration.

In the folded ring configuration shown in Figure 3-5, terminals are placed at adjacent nodes and the end nodes are connected together across the whole network.
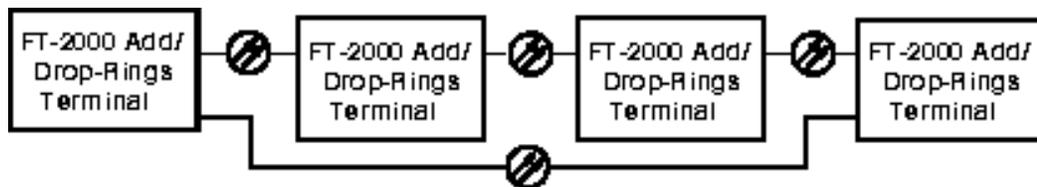
Figure 3-5.   Folded Rings

In a folded ring, all facilities are run in the same path, for example, a cable sheath between nodes. Therefore, in the case of a facility or node failure, nodes on each side of the failure are isolated, as in a linear add/drop chain. Because the length of the network will probably be long and the optical loss greater than the system gain of the transmitter/receiver pairs, you may need to use intermediate repeaters or ring nodes on the return path to connect the end nodes.

In a linear add/drop topology, folded rings provide flexibility in the amount of equipment you deploy. For example, see Figure 3-6. The need for a second terminal at Site B depends on the amount of low-speed traffic to be terminated at Site B and the distance between Sites A and C.

The distance spanned determines the type of optics used and whether or not the system is operating with optical amplifiers (FT-LBA). For details, see the "Overview" and "FT-Lightwave Booster Amplifier (FT-LBA) for Extended Distances" sections in this chapter.

For greater distances, in topologies that are without optical amplifiers, you may need one or more terminals or repeaters. The number you use depends on the distances spanned. If you plan to add/drop traffic now or in the future, use terminals; otherwise, use repeaters.

In many cases, a network starts out as a linear add/drop chain because of short-term service needs between some of the nodes. Later, it evolves into a ring when there is a need for service and fiber facilities to other nodes in the network. It is easier to evolve the linear add/drop network into a full ring configuration if a folded ring is used in the nodes that have this short-term service need (see the Future part of Figure 3-6, where Site D is added). Folded rings have upgrade, operational, and self-healing advantages over other topologies for this type of evolution.
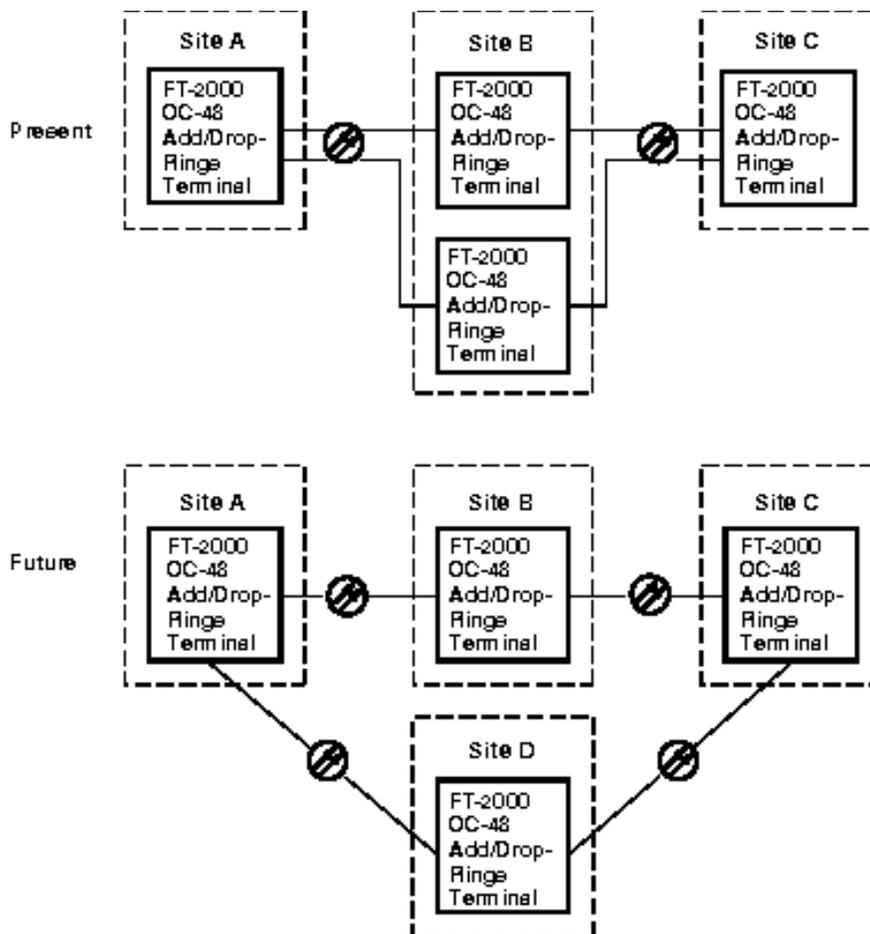
Figure 3-6.   Using Folded Rings to Evolve Linear Add/Drop Chain Networks into Full Ring Networks

Deploying folded ring technology to evolve a ring network from a linear add/drop chain configuration to a full ring network provides the following advantages:

- A folded ring can be more easily upgraded (that is, in-service) to include the new nodes in a full ring configuration than in back-to-back or linear add/drop configurations.

- A folded ring familiarizes a user with the operations, administration, maintenance, and planning (OAM&P) of a ring.

- In most cases, a folded ring is more cost-effective than deploying back-to-back or add/drop configurations.

- A folded ring can recover from some terminal failures better than a linear add/drop chain.

End-to-End Interface Mixing

The FT-2000 OC-48 Add/Drop-Rings Terminal supports a mix of DS3, EC-1 (STS1E), IS-3, OC-3, and OC-12 low-speed interface inputs and outputs.[2] You can mix DS3, EC-1, IS-3, OC-3, and OC-12 low-speed interfaces on the same low-speed shelf. Also, a circuit can enter an FT-2000 network through one type of interface and exit through another type (if the payload that is being carried is compatible with both types of interfaces). Mixing is supported not only within a terminal but also between the terminals.

These capabilities offer more efficient network evolution and let planners improve their equipment deployment based on the needs of the particular application. For example, network needs (sudden demand) may require SONET deployment in one area before others.

The asynchronous DS3 interfaces at one end of a circuit within an FT-2000 network can be upgraded in service to SONET interfaces (EC-1, OC-3, IS-3 or OC-12) without any changes at the other end (see Figure 3-7).

Time slot assignments (TSAs) with STS-1 granularity allow DS3 and EC-1 circuits from various nodes to be groomed within the ring to their destinations.

For example, FT-2000 OC-48 Add/Drop-Rings Terminal supports the following combinations concurrently with a mix of interface packs within and between the terminals in a ring:

- Three DS3s at one end (or from various nodes[3]) and one OC-3 at the other end

---

2. For end-to-end interface mixing, the signal level and type must be compatible. For example, an STS-1 that is carrying a DS3 is incompatible if the SONET NE expects an STS-1 that is carrying VT1.5 circuits. For more information, contact your Account Executive.

- Three EC-1s at one end (or from various nodes[3.]) and one OC-3 at the other end

- Three DS3s at one end (or from various nodes[3.]) and three EC-1s at the other end (or at various nodes[3.])

- Four OC-3s at one end and one OC-12 at the other end

- One OC-3 at one end and one IS-3 at the other end
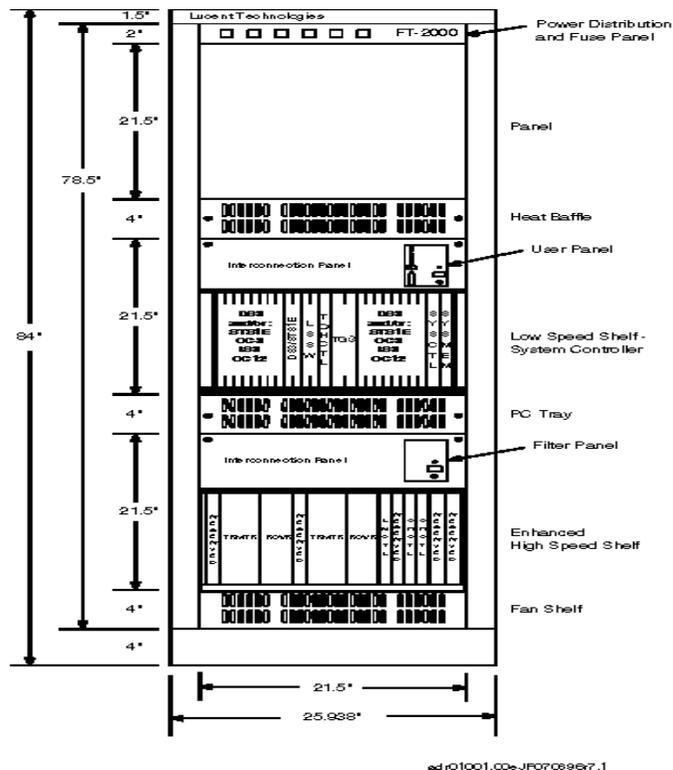
Figure 3-7. End-to-End Interface Mixing Application

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3. This case requires using the STS-1 granularity feature. For more information about this feature, refer to the "STS-1 Granularity TSA" section in Chapter 2 of this document and to the *FT-2000 OC-48 Lightwave System User/Service Manual* (365-575-102) for Release 7.0.1.

OC-48 Hubbing

The FT-2000 OC-48 Lightwave System can be configured to provide an OC-48 hubbing application. The FT-2000 OC-48 Lightwave System can serve a cluster of DDM-2000 Multiplexers located at remote sites in the loop environment (Figure 3-8). The FT-2000 OC-48 Add/Drop-Rings Terminal can be configured as an OC-48 hub. For example, the hub can supply a combination of OC-3 optical extensions and local DS3 and/or EC-1 interfaces. All the traffic for the DDM-2000 Multiplexers passes through the hub using these optical extensions.

In this figure, an FT-2000 is connected to the remote DDM-2000s through an OC-3 interface. Through the data communications channel (DCC), the FT-2000 OC-48 Add/Drop-Rings Terminal can perform single-ended operations for DDM-2000s.

For Releases 7.2 and earlier, the operations include:

- Remote login

- Gateway Networking Element (GNE)

- Remote network element (NE) status.

This application can also be accomplished through an OC-12 optical extension using OC-12 DCC.

For Releases 8.1 and later, refer to Chapter 5, "Operations, Administration, Maintenance, and Provisioning," for more detailed information on multivendor operations interworking.
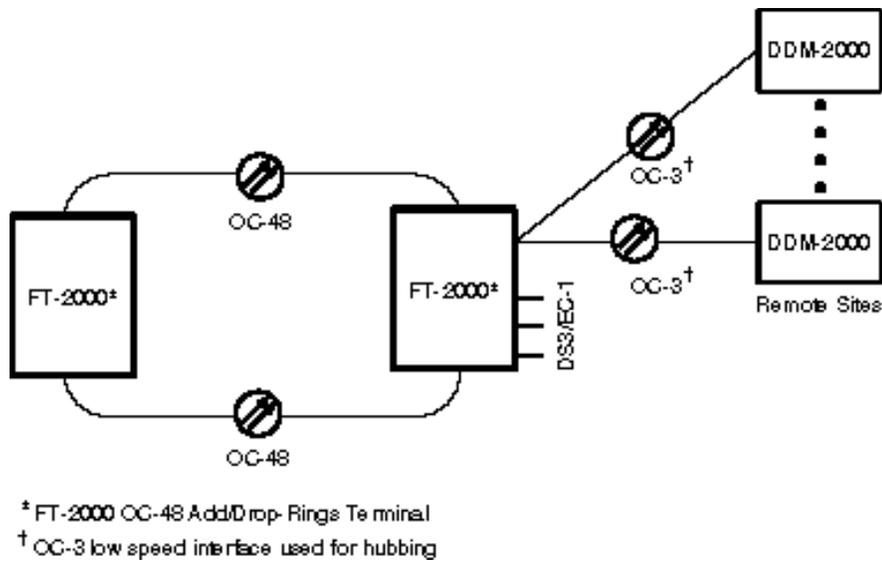
Figure 3-8.   OC-48 Hubbing Application

Dual Ring Interworking

All FT-2000 OC-48 Lightwave System low-speed interfaces (DS3, EC-1, IS-3, OC-3, and OC-12) can support dual ring interworking (DRI). DRI is a configuration of two ring networks that are interconnected by two nodes (terminals) in each ring. Figure 3-9 shows a sample DRI configuration.

You can connect an FT-2000 OC-48 ring to various kinds of rings, including:

- FT-2000 OC-48 ring

- DDM-2000 OC-3 ring

- DDM-2000 OC-12 ring

- SLC®-2000.

1. DRI Configuratiopns:
   Two Rings Interconnected
   by Two Nodes

2. Circuit Originating
   and Terminating in
   Nodes A and Z

3. Failure (Depicted by X) Triggers
   a DRI Switch at Top Ring's
   Priminary Node, Which Automatically
   Selects Traffic from Secondary Node

adr03047
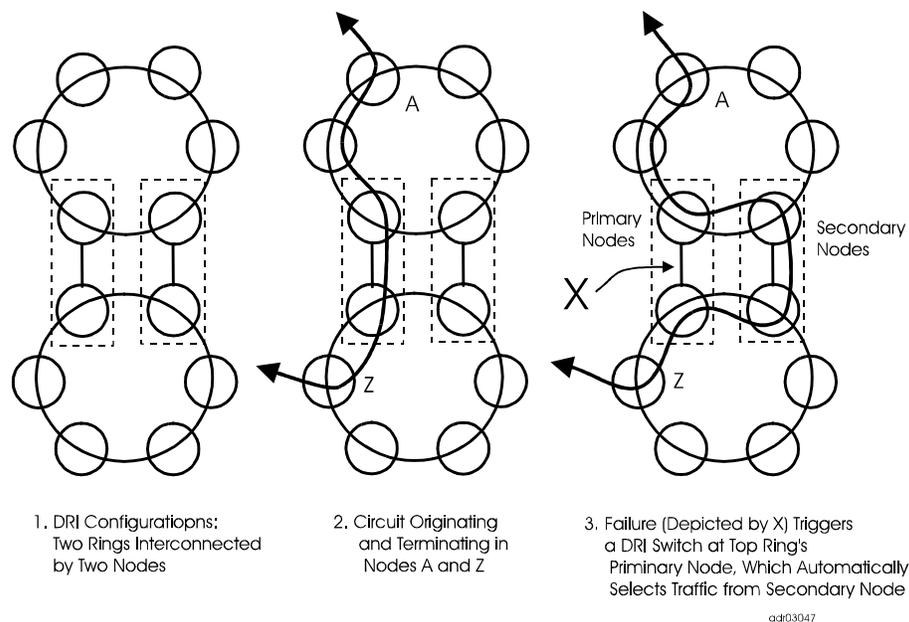
Figure 3-9.   Dual Ring Interworking Applications

For a given circuit in one of the rings, one of the interconnected nodes is desig-
nated as primary and the other as secondary. The primary node is closest to the
circuit termination and performs the DRI protection switching.

As Figure 3-9 illustrates, DRI allows a circuit (A-Z) with one termination in one ring
and one termination in another ring to survive a failure of the connection between
a pair of interconnected nodes or of either primary interconnecting node.

The failure is depicted by an "X" in the figure. In this case, the failure is of the inter-
connection to a primary interconnecting node and results in a DRI switch at the
primary node in the top ring. A DRI protection switch occurs in ≤ 100 milliseconds
(ms) for FT-2000 OC-3 interfaces and in ≤ 200 ms for all other FT-2000 interfaces.

NOTE:
> When there are two FT-2000 nodes located in the same central office, they
> may be interconnected using IS-3 circuit packs.

Figure 3-10 and Figure 3-11 show examples of DRI used to interconnect two dif-
ferent types of rings: an FT-2000 line-switched ring and a DDM-2000 path-
switched ring. The interconnected rings are protected from failure because they
can select from two identical traffic inputs/outputs.

For example, for the one-way circuit labeled A to Z Direction (see Figure 3-10), the
line-switched ring accepts two identical traffic inputs: one to the primary node
(node 2) and one to the secondary node (node 3). In this case, there is no failure,
so the primary node (node 2) selects the traffic received by its own low-speed
interface. However, if a failure were to occur on the incoming low-speed signal, the
primary node would automatically perform a DRI protection switch and select the
traffic received from the secondary node (node 3).
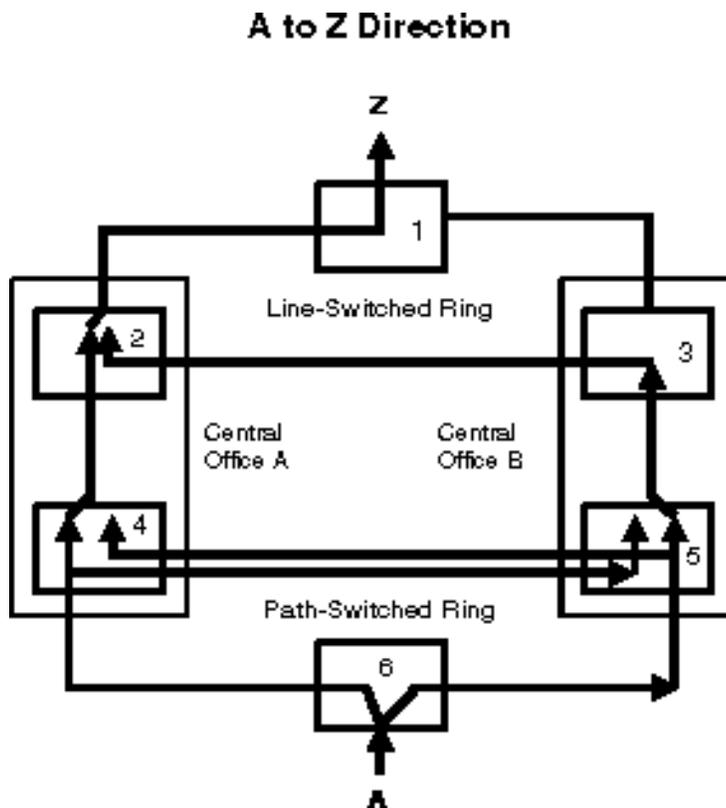
A to Z Direction

Figure 3-10.   One-Way Circuit in Dual Interworked Rings: A to Z Direction

For the one-way circuit labeled Z to A Direction (see Figure 3-11), the line-switched ring provides two identical traffic outputs: one from the primary node (node 2) and one from the secondary node (node 3). The primary node (node 2) bridges (duplicates) the traffic by using its "drop-and-continue"[4] capability. A failure at the connection between the primary nodes (node 2 and node 4) causes the path-switched ring to initiate a protection switch at node 6. Node 6 automatically selects the traffic received from the secondary node (node 5).
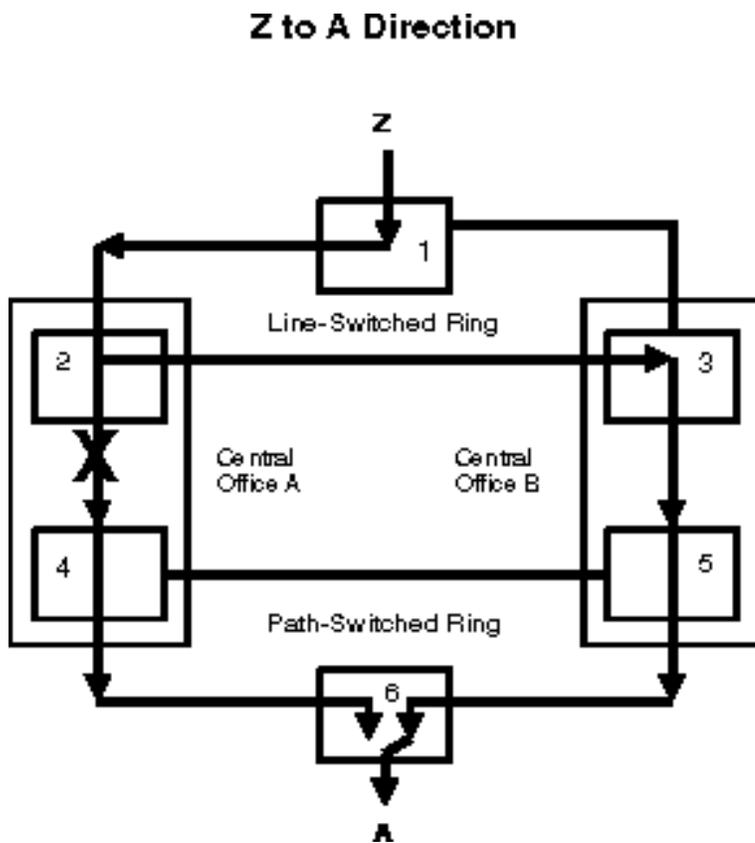
Z to A Direction

Figure 3-11.   One-Way Circuit in Dual Interworked Rings: Z to A Direction

---

4. Drop and continue is at the STS-1 level for nodes that are equipped with STS-1 granularity capable transmitters and receivers.

Figure 3-12 illustrates a DRI application using OC-3 interfaces between an FT-2000 OC-48 ring and a DDM-2000 OC-3 or OC-12 ring. The two types of connections are:

■ A direct intraoffice connection between the primary nodes, node 1 and node 2, at the first central office (CO 1)

■ An optically extended, direct secondary connection between the secondary nodes [node 3 at the second central office (CO 2) and node 4 of the DDM-2000 OC-3 ring]. This type of connection is achieved through the OC-3 low-speed interfaces at the interconnected nodes and can go through other equipment.
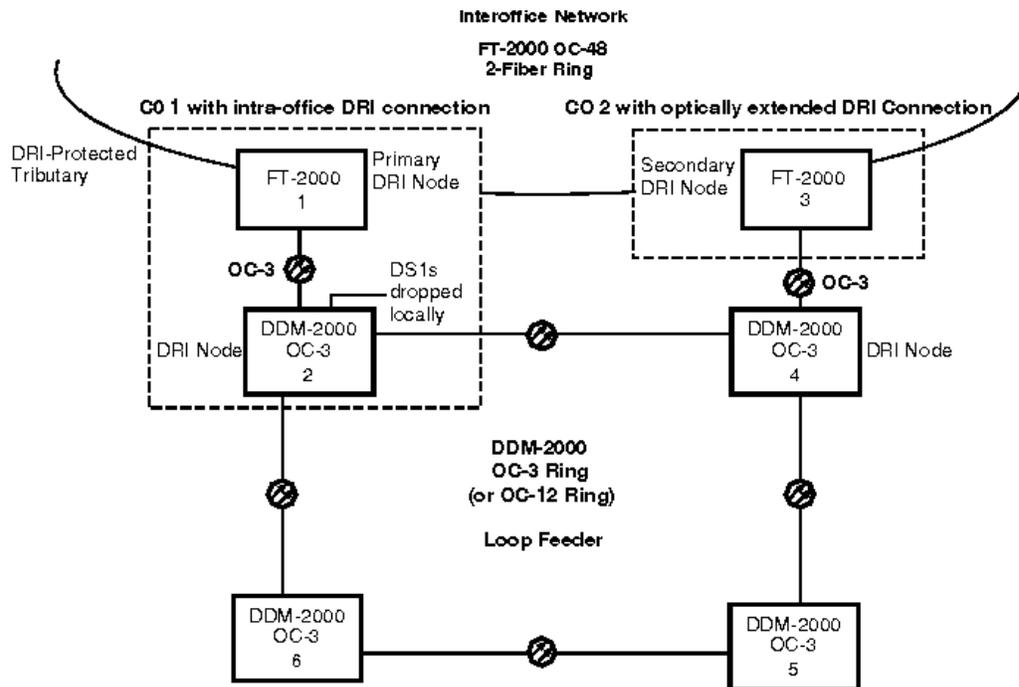
Figure 3-12. DRI Application: FT-2000 Interoffice Ring and DDM-2000 OC-3 (or OC-12) Ring

FT-2000 DRI protection switching results from the following failure conditions:

DS3 Interface	SONET Interface EC1, OC3, OC12, IS3
LOS (loss of signal)	LOS (loss of signal)
	LOF (loss of frame)
	SD (signal degrade)
	Path LOP (loss of pointer)
	Path AIS
	Path Unequipped
	Path PDI (Payload Defect Indicator)

DRI protection switching (manual and automatic) takes place at the STS-1 level at FT-2000 nodes that are equipped with transmitters and receivers that support STS-1 granularity. DRI protection switching occurs at the STS-1 level because one or two of the affected STS-1 signals in an STS-3 might be going to a non-DRI cross-connection.

DRI protection switching (manual and automatic) takes place at the STS-3 level at FT-2000 nodes that are equipped with transmitters and receivers that do not support STS-1 granularity.

FT-2000 reports active DRI switches (manual and automatic) at the STS-1 level for all FT-2000 nodes in the ring, whether or not their transmitters and receivers support STS-1 granularity.

It is recommended that the interconnection between the primary nodes in a DRI application should be direct (without any intervening transmission equipment). The secondary nodes can be in different locations and the interconnection between them can go through other transmission equipment.

Enhanced Dual Ring Interworking

For Releases 8.1 and later,
basic Dual Ring Interworking has been enhanced in two ways:

- by providing greater bandwidth management flexibility by allowing the secondary source of a Dual Ring Interworking circuit to be provisioned on an OC-48 protection tributary. This is called Dual Ring Interworking on Protection (DRI-P). Two new Cross-connection types are provided for this feature, 2-Way-DRI-Pri and 2-Way-DRI-Sec.

■ by providing a third new Cross-connection type: 2-way-dri which allows the
use of a single command to fully provision a 2-way-dri circuit at the primary
node (previously three commands were required to provision a
2-way-dri circuit: 1-way-dri, 1-Way through and 1-way drop).

Figure 3-13 illustrates the DRI and DRI-P cross-connection types.
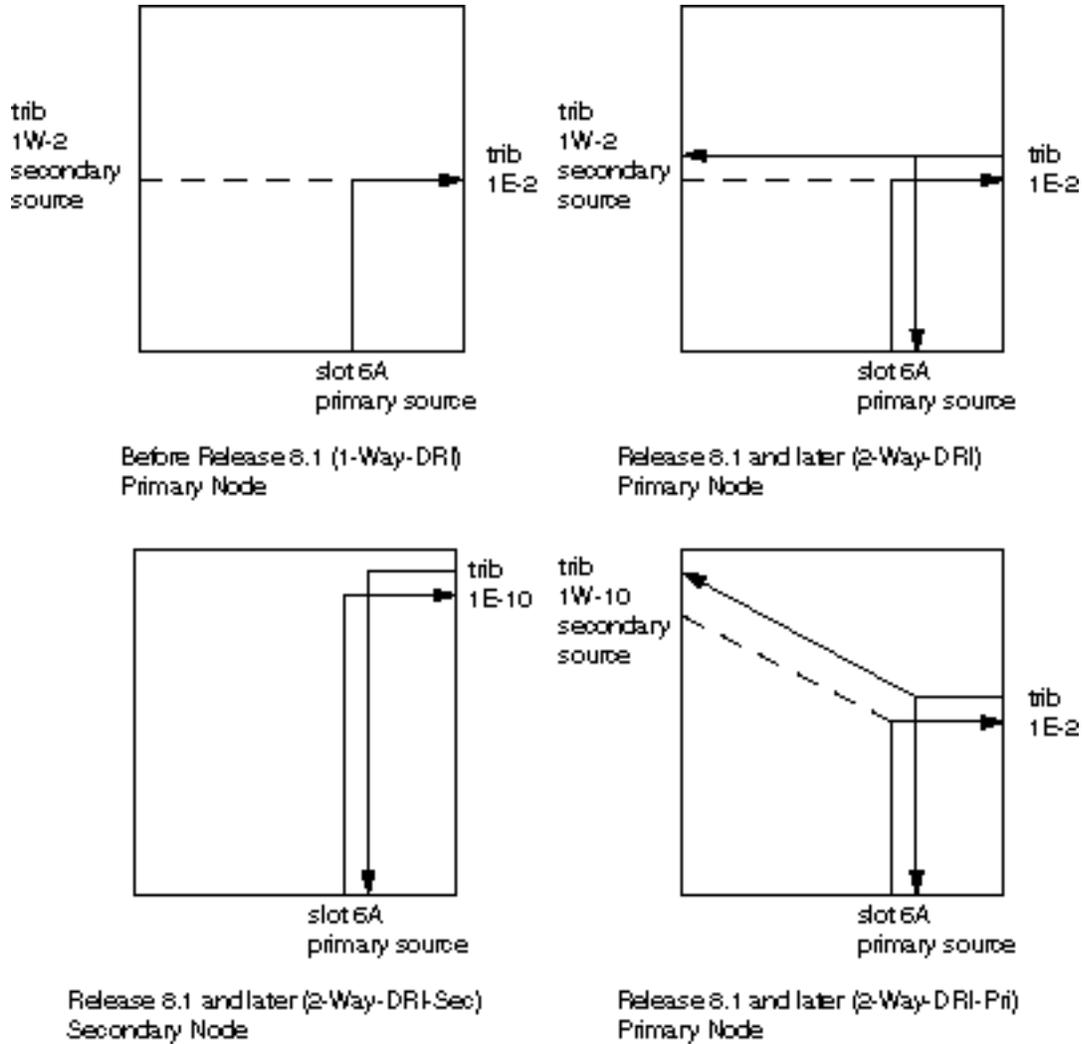
Figure 3-13. DRI and DRI-P Cross-Connection Types

DRI on Protection (DRI-P)

For Releases 8.1 and later:
Dual Ring Interworking on Protection (DRI-P) applications such as the one illustrated in Figure 3-14 are now possible. Provisioning both basic DRI and DRI-P cross-connects on the same service tributaries effectively doubles the bandwidth available for carrying DRI services. Prior to Release 8.1 basic Dual Ring Interworking restrictions would prevent full usage of available bandwidth.

NOTE:
Only one transmission direction is shown for clarity.
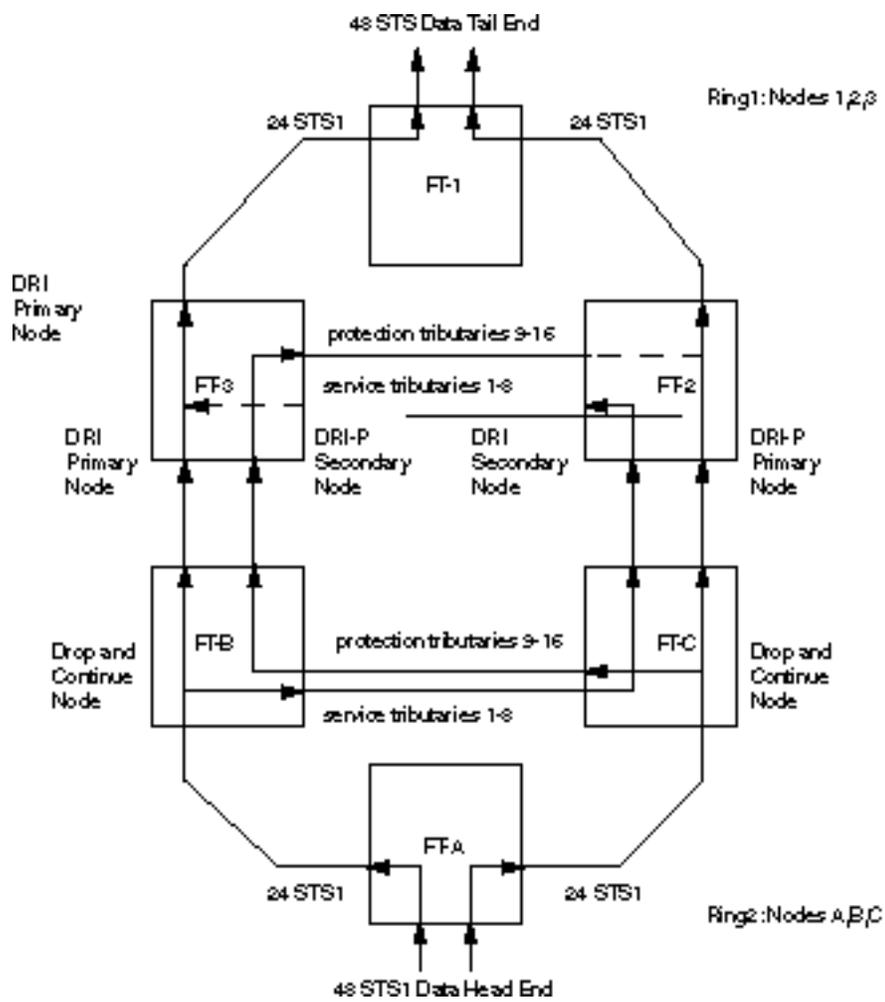
Figure 3-14.   Dual Ring Interworking on Protection (DRI-P)

DDM-2000 OC-3/OC-12 Ring Transport

FT-2000 Add/Drop-Rings Terminals, through their OC-3 or OC-12 low-speed interfaces, can provide transport within a DDM-2000 OC-3 or OC-12 ring (see Figure 3-15). A DDM-2000 OC-3 or OC-12 ring is an end-to-end self-healing network providing path-switched protection of DS1 services.

In the figure, the FT-2000 OC-48 ring is used to close (or complete) the DDM-2000 OC-3 ring by providing three STS-1s of bandwidth on the OC-48 ring between CO 1 and CO 2.

The grey shading indicates the extent of the OC-3 and OC-12 rings.
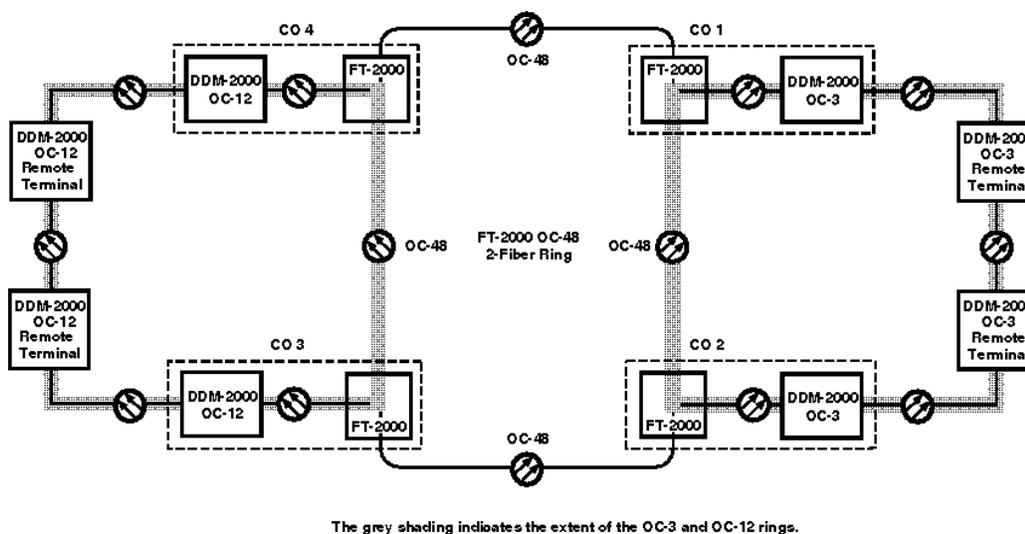
Figure 3-15.   DDM-2000 OC-3 and OC-12 Ring Transport Applications

The FT-2000 ring is used as a backbone network to transport the DDM-2000 ring traffic (along with other traffic) as an OC-3 or OC-12 tributary. As in the figure, you can use one or more FT-2000 ring segments or rings in various segments of the DDM-2000 ring (CO 1 ÷ CO 2).

CO 1 and CO 2 depict an FT-2000 OC-3 low-speed interface connecting to a high-speed interface (OC-3) of a DDM-2000 OC-3 ring terminal. Through this connection, the FT-2000 can perform single-ended operations for the DDM-2000s in the ring.

For Releases 7.2 and earlier, the operations include:

- Remote login
- GNE
- Remote NE status.

For Releases 8.1 and later, refer to Chapter 5, "Operations, Administration, Maintenance, and Provisioning," for more detailed information on multivendor operations interworking.

➡ **NOTE:**
> When an FT-2000 node and another network element are located in the same central office (shown as a dotted line), they may be interconnected using IS-3 circuit packs.

You can also use the FT-2000 OC-3 or OC-12 low-speed interface as an interoffice optical extension to a remote DDM-2000 OC-3 or OC-12 location.

DDM-2000 Ring Interface With FT-2000 1+1 Low-Speed Interface

Figure 3-16 illustrates the DDM-2000 Ring Shelf configured with FT-2000 1+1 OC-3 interface in a linear add/drop application. For example the DDM-2000 can be used to add/drop DS1 and other traffic through 1+1 configured low-speed OC-3 or OC-12 interfaces on the FT-2000 OC-48 system. Two-way ring add/drop cross-connects at DDM-2000 node A are used to route traffic from FT-2000 Node 3 to the low-speed ports of the DDM-2000. Similarly, two-way hairpin cross-connects can route traffic from FT-2000 node 16 to DDM-2000 low-speed ports. For FT-2000 provisioning information, refer to FT-2000 OC-48 Lightwave System User/Service Manual (365-575-103).

⊟▷ **NOTE:**
    For operations interworking the DDM-2000 and FT-2000 software releases must be OI compatible.
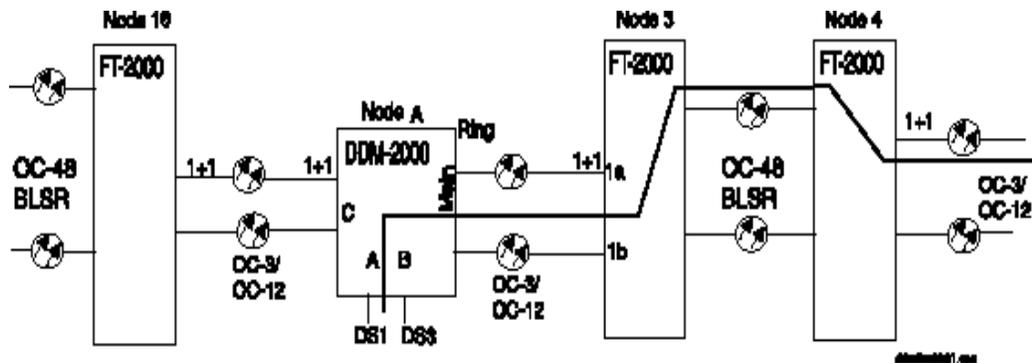
Figure 3-16.   DDM-2000 OC-3/OC-12 Ring to FT-2000 1+1 OC-3/OC-12 Interface

Dual-Wire Center Architecture

A dual-wire center architecture (see Figure 3-17 and Figure 3-18) is a self-healing network architecture that provides end-to-end survivable DS1 and DS3 business access services. This architecture protects against facility failures, node failures, and catastrophic central office failures. A failure in one ring or simultaneous failure in each ring is automatically healed and service is reestablished in $\leq 60^5$ ms (including detection time). This capability results in a highly reliable network.

With this architecture, you can use the same network for all services. You can mix DRI and non-DRI services on the same STS-1 from a DDM-2000 (node 3 and node 4) and send it to a DACS IV-2000 (node 6 and node 7) to be virtual tributary (VT) groomed or its destination. VT grooming between the access rings by a DACS IV-2000 can optimize interoffice bandwidth usage. VT1.5 channels coming in to the DACS IV-2000 are groomed (reassigned) so that the outgoing facilities have a more uniform and efficient fill.

---

5. For a catastrophic failure for a ring without extra traffic and existing switches.

The full SONET, self-healing network examples in Figure 3-17 and Figure 3-18 consist of the following:

■ A DDM-2000 OC-3 access ring with transmission interworking with a DACS IV-2000, which performs VT grooming.

■ An FT-2000 OC-48 bidirectional line-switched interoffice ring with transmission interworking with the DACS IV-2000, which performs the previously mentioned VT grooming. The connection between the DDM-2000 OC-3 ring and the DACS IV-2000 is through an EC-1 interface. The EC-1 connection can contain a mixture of VT1.5 channels for all types of services (for example, locally switched, dual-wire center, and single-wire center). The capability to mix services, instead of having application-specific assignments for STS-1 tributaries, conserves OC-3 Access Ring bandwidth. It also simplifies interconnections and cabling, allowing connections through EC-1, as opposed to individual DS1s.

The DACS IV-2000 grooms VT1.5 channels from multiple OC-3 access rings, providing outputs for locally switched traffic, as well as single-wire center and dual-wire center traffic.

■ A DDM-2000 OC-3 ring or node (at the top of the figures). The ring or node could be either an access ring or node for distribution from one customer premises equipment (CPE) to another or to an interexchange carrier (IEC) Point of Presence (POP).

Any FT-2000 node in Figure 3-17 and Figure 3-18 can perform single-ended operations for any DDM-2000 OC-3 node to which it has OC-3 DCC connectivity. In Figure 3-17, this includes nodes 12, 13, and 14. In Figure 3-18 this includes node 11.

For Releases 7.2 and earlier, the operations include:

■ Remote login

■ GNE

■ Remote NE status.

OC-12 applications using OC-12 DCC also support these operations.

For Releases 8.1 and later, refer to Chapter 5, "Operations, Administration, Maintenance, and Provisioning," for more detailed information on multivendor operations interworking.
.
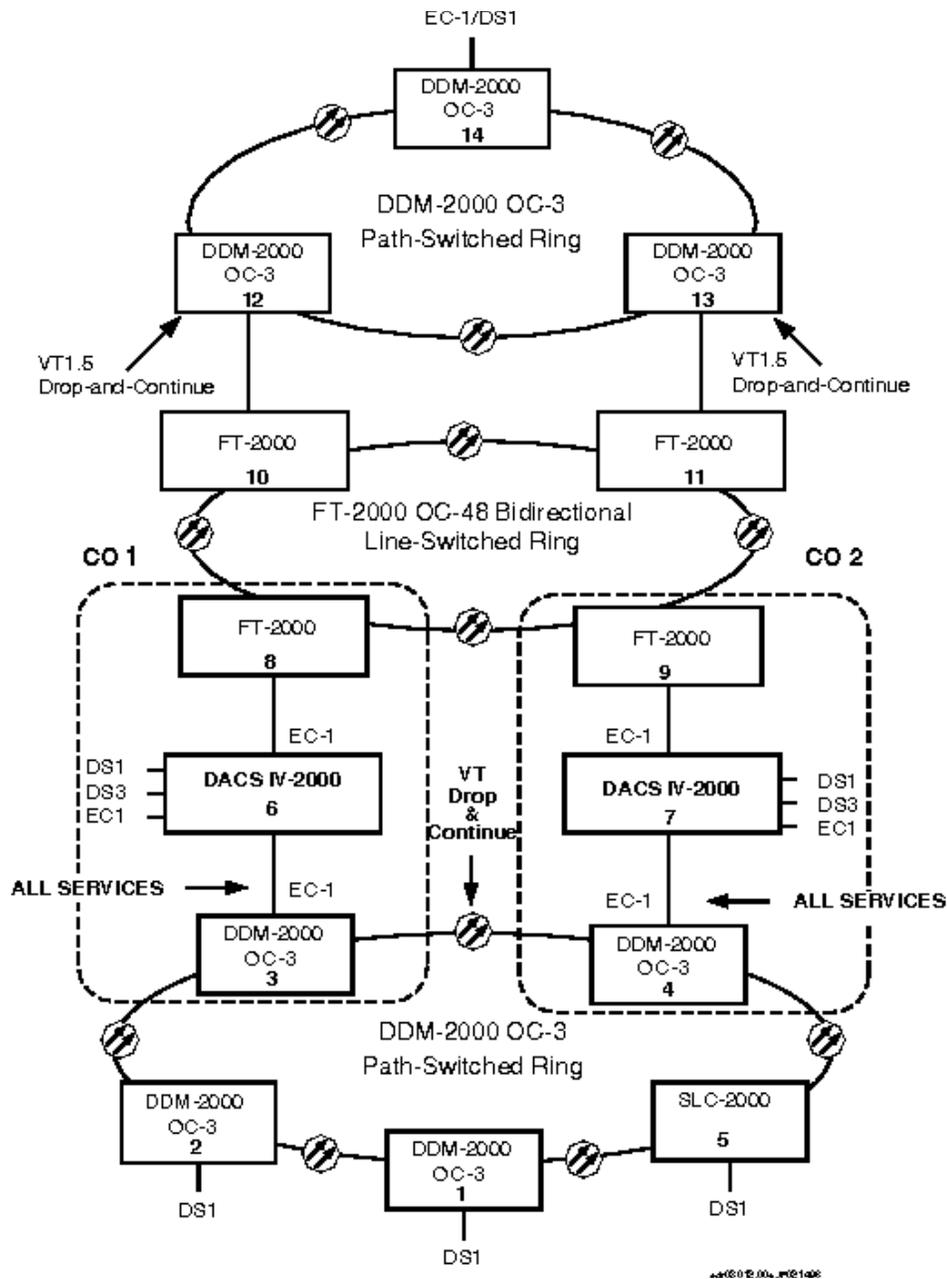
Figure 3-17.   Example 1: Self-Healing Network (Dual-Wire Center Architecture)
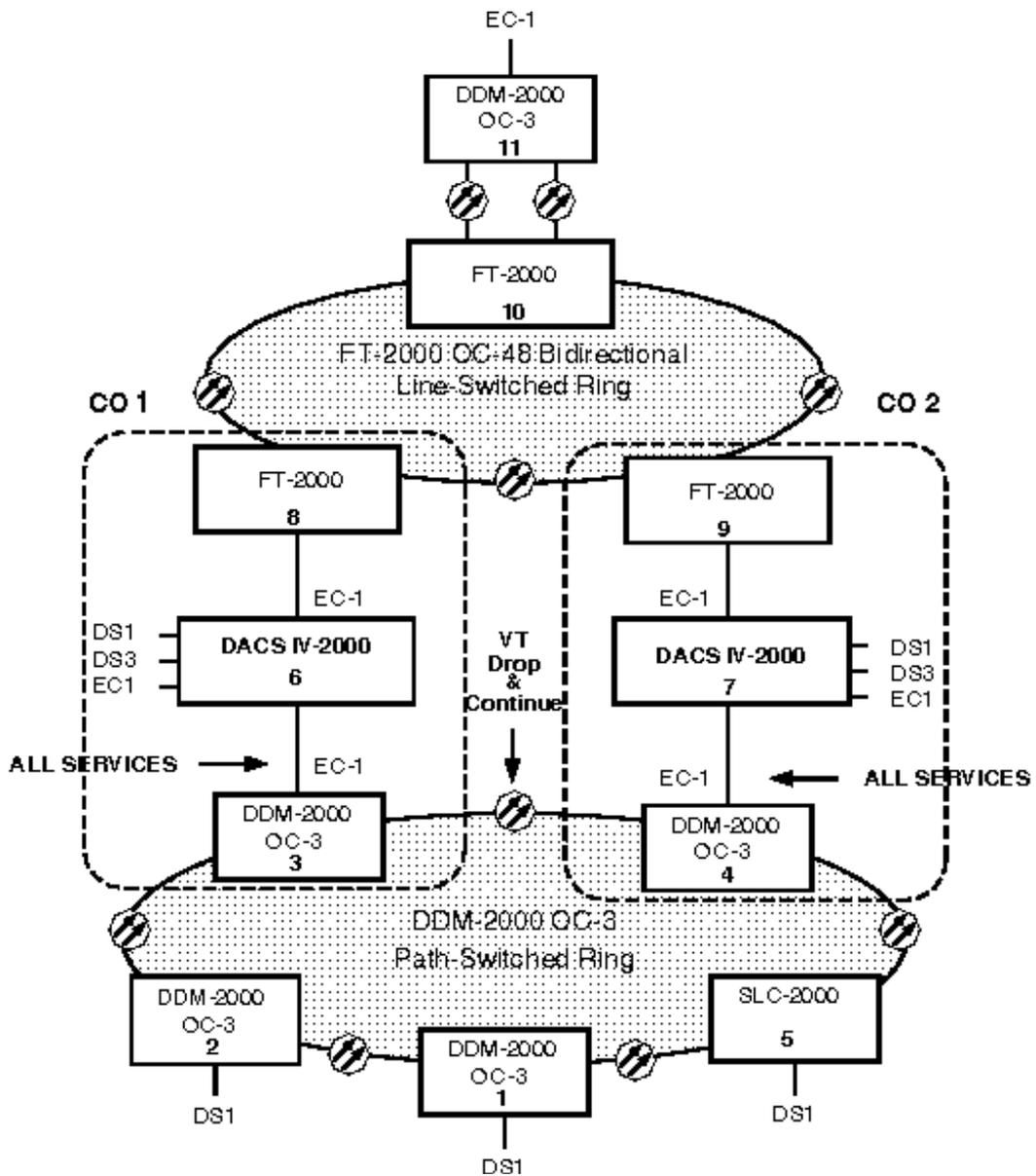
Figure 3-18.   Example 2: Self-Healing Network (Dual-Wire Center Architecture)

The self-healing network in Figure 3-19 shows a possible (default) routing for a cir-
cuit between DDM-2000 OC-3 (node 11) and DDM-2000 OC-3 (node 1). The
DDM-2000 OC-12 could be used in this scenario in place of DDM-2000 OC-3.
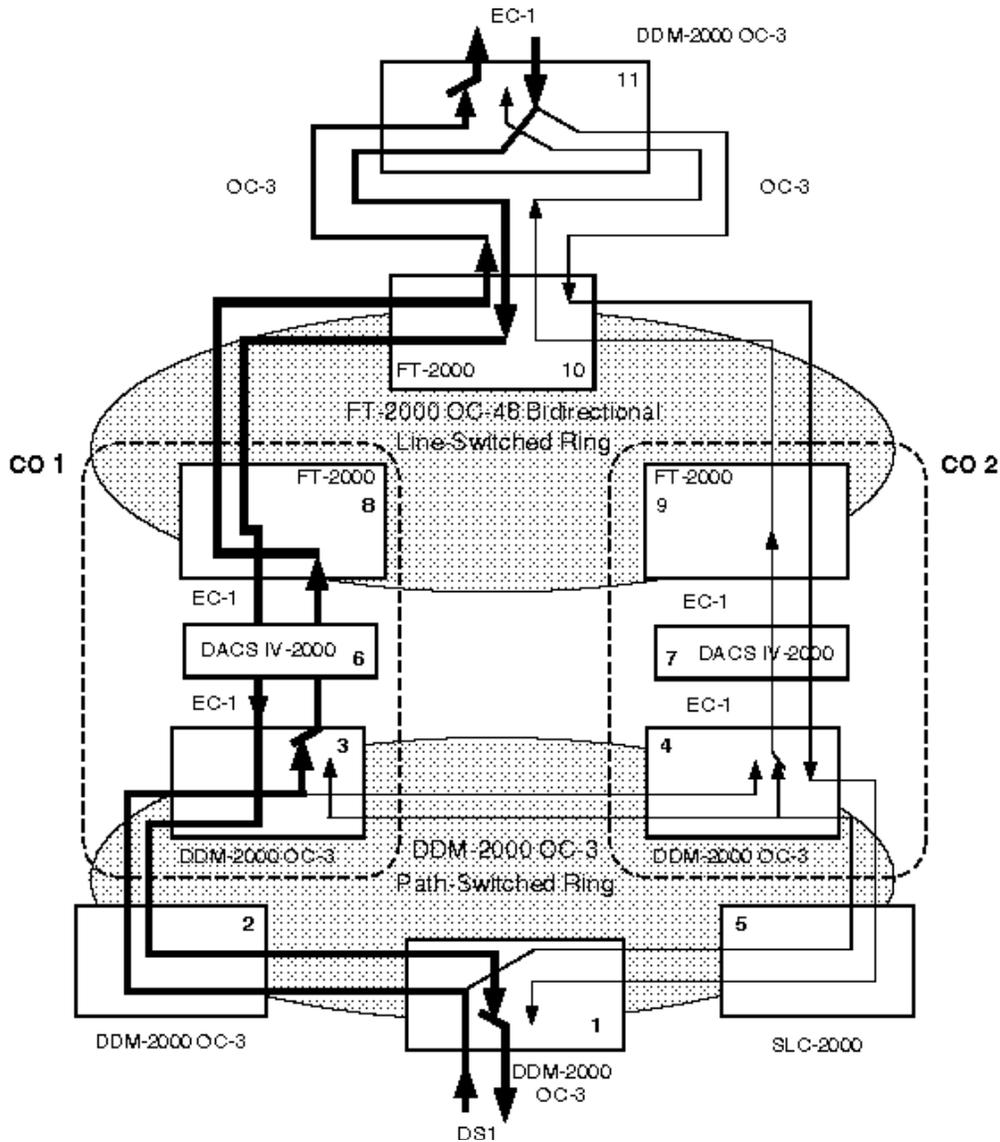
Figure 3-19.   Self-Healing Network: Circuit Routing Example

The DDM-2000 OC-3 (node 11 at the top of the figure) is a node provisioned with path-switched add/drop cross connections. (Node 11 could be a ring, instead of a node.) It receives two dual 0x1 protected OC-3 signals from the FT-2000 node 10. FT-2000 OC-48 bidirectional line-switched ring transports two separate STS-3 signals. The DACS IV-2000s provide VT grooming from multiple OC-3 inputs. The DDM-2000 OC-3 access ring that is at the bottom of the figure delivers traffic from DDM-2000 OC-3 node 1 to node 3 and node 4 through the path-switched drop-and-continue cross connections.

The next three figures show the protection switches that occur independently in each of the ring types in that network:

■ Interoffice ring (Figure 3-20)

■ Access ring (Figure 3-21)

■ EC-1 interconnect (Figure 3-22).

Interoffice Ring

In the interoffice ring example (Figure 3-20) a failure between the FT-2000 Add/Drop-Rings Terminals, nodes 8 and 10, activates a loopback switch[6] at each of these two nodes.[7] In this case, the failure is a fiber cut, but it could also be an equipment failure. The protection switch is the same as for any bidirectional line-switched ring and is independent of the type of service (DRI, dual-wire center, or non-DRI). The protection switch is revertive (as required by the standard) because the protection bandwidth is shared.

---

6. For more information on loopback protection switching in an OC-48 bidirectional line-switched ring, refer to the "Bidirectional Line-Switched Rings" section earlier in this chapter.

7. Because the protection switch occurs in ≤60 ms, including detection time, for a catastrophic failure for a ring without extra traffic and existing switches, a nonrevertive DDM-2000 OC-3 VT-path switch may also occur within 10 ms. The switch is reported according to the ANSI T1M1.3 standard.
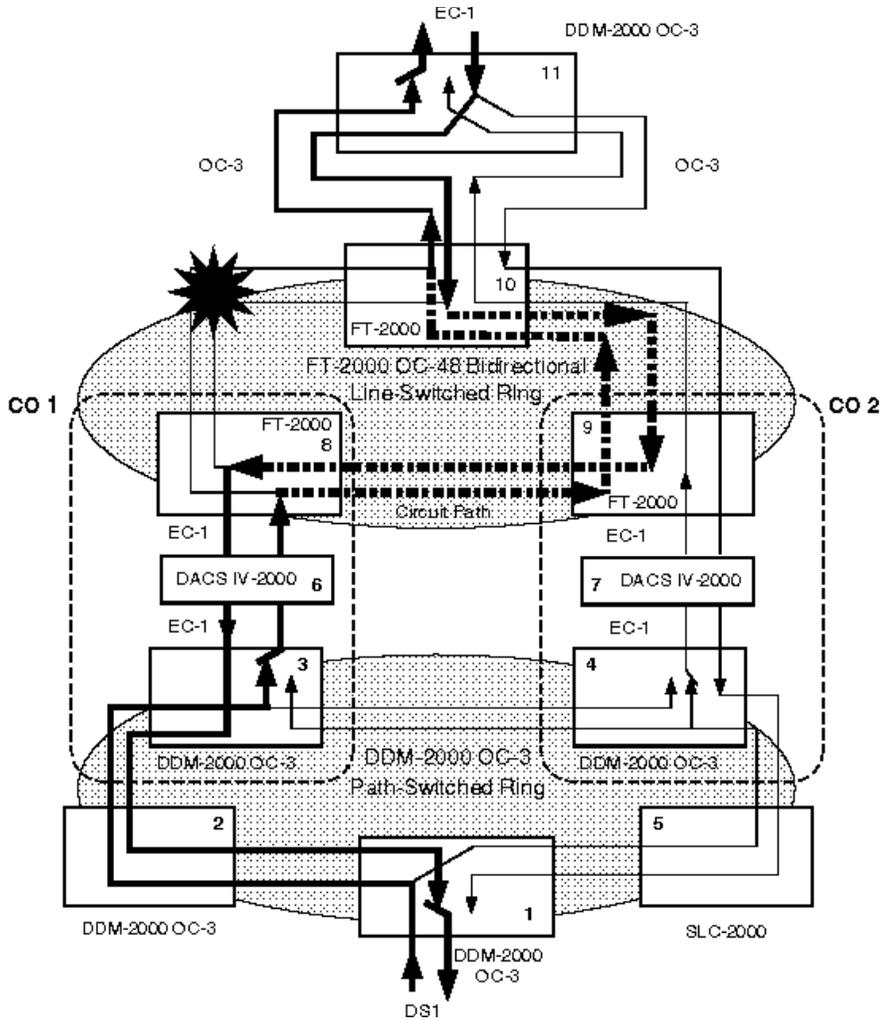
Figure 3-20.   Protection Switching: Interoffice Ring Failure Example

Access Ring

For dual-wire center applications, DDM-2000 OC-3 and DDM-2000 OC-12 drop and continue provide duplicate service in two central offices (CO 1 and CO 2) and throughout the network. If a fiber or equipment failure occurs in one CO, the service is routed through the other CO to the destination on both the line-switched

ring and the path-switched ring. Figure 3-21 provides an example. In this figure, a fiber failure between two DDM-2000 OC-3s, node 2 and node 3, activates a non-revertive path protection switch at node 3. This switch causes node 1 to automatically select the duplicate traffic routed through node 4 and node 5.

The path protection switch is nonrevertive because the protection bandwidth is dedicated in a path-switched ring. The protection switch and alarms are the same as those in any path-switched ring. They are also independent of the type of service.
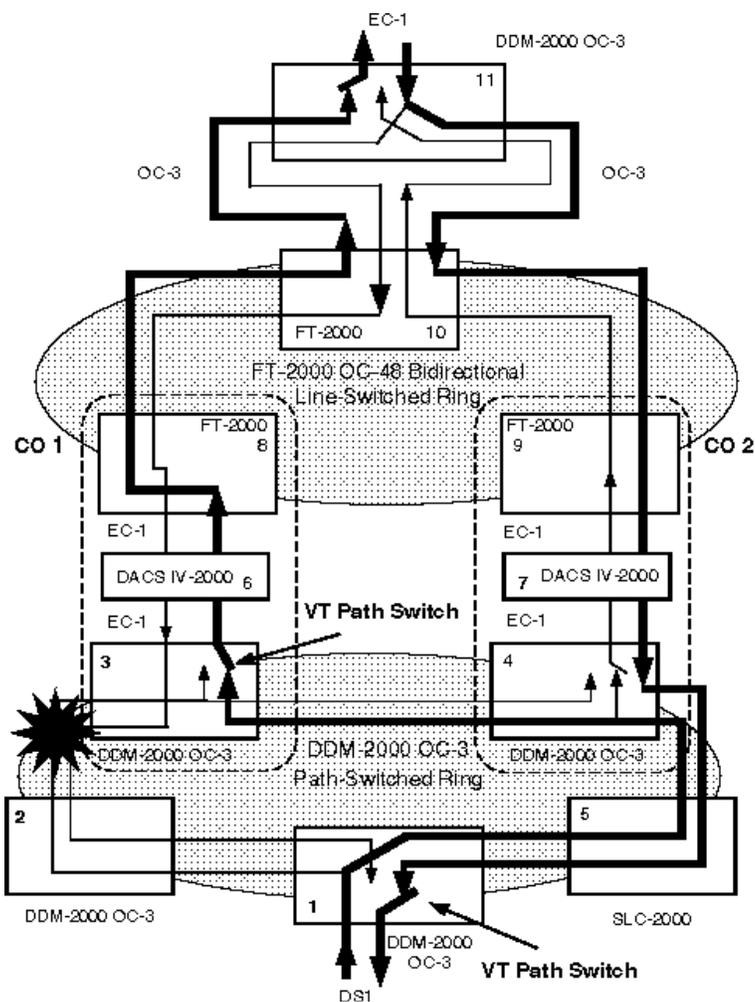
Figure 3-21.   Protection Switching: Access Ring Failure Example

Ring Interconnect or Central Office

An interconnect failure or a failure in a central office (see CO 1 in Figure 3-22) is also protected in a dual-wire center network architecture. When a central office failure such as this one occurs, VT-path protection switching takes place at the DDM-2000 OC-3s, node 1 and node 11 (exit nodes).
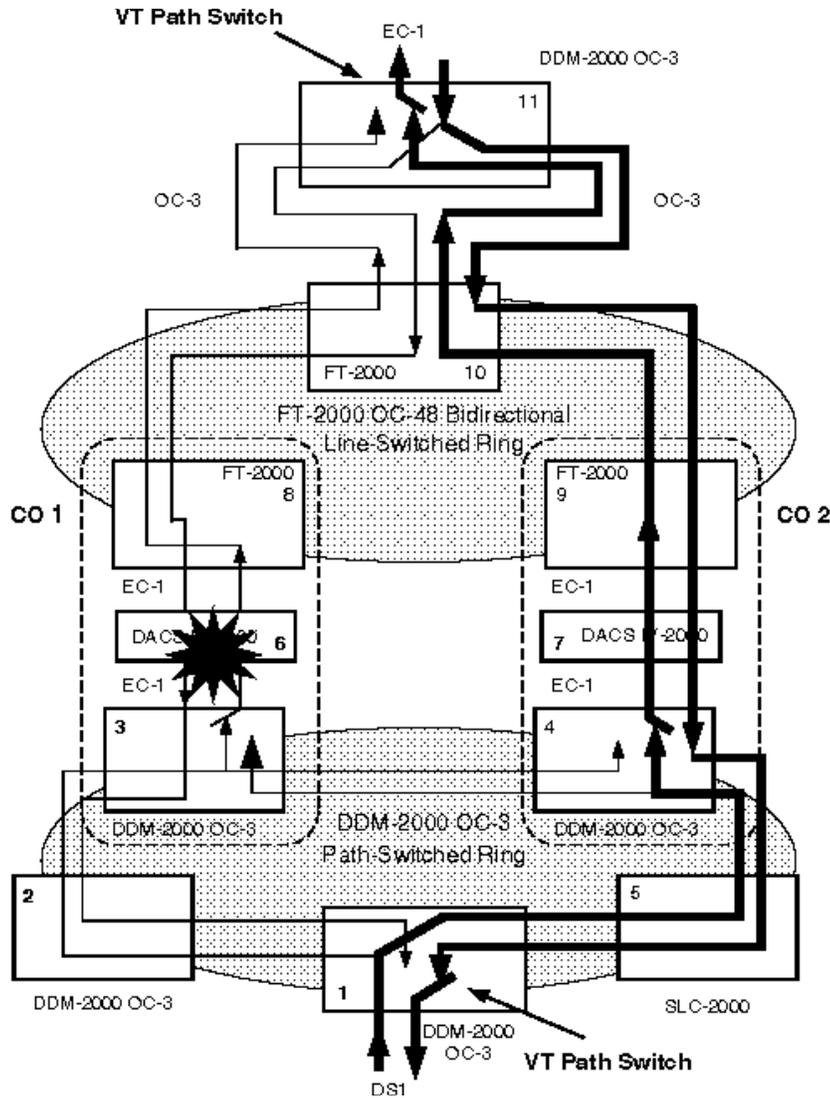
Figure 3-22. Protection Switching: Ring Interconnect or Central Office Failure Example

Dense Wave Division Multiplexing (OLS Compatible)

There are a number of strong industry and business drivers leading customers to search for solutions that can increase network capacity without the need for laying new fiber. By using FT-2000 OC-48 ADR with the Optical Line System (OLS), the circuit-carrying capacity of lightguide cable can be increased in both distance of span and capacity (up to 20 Gb/s) because multiple signals of different wavelengths can be transmitted simultaneously over a single fiber.

Dense wave division multiplexing (DWDM) is the optical combining of different optical wavelengths within the same transmission band onto a single fiber. The Optical Line System (OLS) is used to implement DWDM for FT-2000 OC-48 ADR. The OLS supports up to 16 wavelengths in the 1.5 µm band. The channels (wavelengths) can be equipped in any order. The OLS is used to multiplex the transmission of multiple FT-2000 OC-48 ADR systems onto the same OLS lines (fiber pairs). Figure 3-23 shows how the OLS allows multiple FT-2000 OC-48 ADR systems to use the same fiber or span that have already reached fiber exhaust.

When FT-2000 OC-48 ADR is used with OLS for dense wavelength division multiplexing, the 739E(1-8) and 739G(1-8)[8] TRMTR circuit packs are optimized for operation with the OLS. These 16 transmitters are designed to transmit in the first 8 wavelengths required by OLS. These transmitters have their dispersion performance optimized for the long distances that OLS makes possible (up to 360 km with E type transmitters and 640 km with G type transmitters). The 839E5 receiver must be used at the other end of the span, consistent with OLS requirements.

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8. These transmitters require Release 7.2 (Release 7.2.0-ADR) or later software on all nodes in the ring. For ordering information, see the **Dual Bay** tab in Chapter 7.

When FT-2000 OC-48 ADR is used with OLS in routes for dispersion of up to 6800 ps/nm, and up to 360 km, one of the following 739E transmitters must be used:

- 739E1 OC48 TRMTR (STS1 1.5 μm W1)
- 739E2 OC48 TRMTR (STS1 1.5 μm W2)
- 739E3 OC48 TRMTR (STS1 1.5 μm W3)
- 739E4 OC48 TRMTR (STS1 1.5 μm W4)
- 739E5 OC48 TRMTR (STS1 1.5 μm W5)
- 739E6 OC48 TRMTR (STS1 1.5 μm W6)
- 739E7 OC48 TRMTR (STS1 1.5 μm W7)
- 739E8 OC48 TRMTR (STS1 1.5 μm W8).

When FT-2000 OC-48 ADR is used with OLS in routes for dispersion from 6800 to 10,880 ps/nm, and up to 640 km, one of the following 739G transmitters must be used:

- 739G1 OC48 TRMTR (STS1 1.5 μm W1)
- 739G2 OC48 TRMTR (STS1 1.5 μm W2)
- 739G3 OC48 TRMTR (STS1 1.5 μm W3)
- 739G4 OC48 TRMTR (STS1 1.5 μm W4)
- 739G5 OC48 TRMTR (STS1 1.5 μm W5)
- 739G6 OC48 TRMTR (STS1 1.5 μm W6)
- 739G7 OC48 TRMTR (STS1 1.5 μm W7)
- 739G8 OC48 TRMTR (STS1 1.5 μm W8).

For more information about OLS, refer to the *Optical Line System Applications, Planning, and Ordering Guide* (365-575-300).

Dense Wave Division Multiplexing
(Non-OLS Compatible)

Passive DWDM systems are used in short span fiber exhaust applications. The 739H(1-16) TRMTR circuit packs are optimized for use with passive DWDM systems, and can be used with the FT-2000 Add/Drop-Rings Terminal. These 16 transmitters are designed to transmit in the 16 wavelengths required by passive 16-channel DWDM systems. The 839E5 receiver must be used at the other end of the span.

When the FT-2000 OC-48 Add/Drop-Rings Terminal is used with passive DWDM in routes for dispersion from 1525.80 to 1560.00 ps/nm, and up to 60 km, one of the following 739H transmitters must be used:

- 739H1 OC48 TRMTR (STS1 1.5 μm W1)
- 739H2 OC48 TRMTR (STS1 1.5 μm W2)
- 739H3 OC48 TRMTR (STS1 1.5 μm W3)
- 739H4 OC48 TRMTR (STS1 1.5 μm W4)
- 739H5 OC48 TRMTR (STS1 1.5 μm W5)
- 739H6 OC48 TRMTR (STS1 1.5 μm W6)
- 739H7 OC48 TRMTR (STS1 1.5 μm W7)
- 739H8 OC48 TRMTR (STS1 1.5 μm W8)
- 739H9 OC48 TRMTR (STS1 1.5 μm W9)
- 739H10 OC48 TRMTR (STS1 1.5 μm W10)
- 739H11 OC48 TRMTR (STS1 1.5 μm W11
- 739H12 OC48 TRMTR (STS1 1.5 μm W12)
- 739H13 OC48 TRMTR (STS1 1.5 μm W13)
- 739H14 OC48 TRMTR (STS1 1.5 μm W14)
- 739H15 OC48 TRMTR (STS1 1.5 μm W15)
- 739H16 OC48 TRMTR (STS1 1.5 μm W16)

Figure 3-23.   Integrated FT-2000 OC-48 ADR and DWDM/OLS System

Integration Impact

Since the OLS is a stand-alone system, and its interface to FT-2000 OC-48 ADR is at the physical level, there is minimal impact on the operation of the FT system. The primary impact is at the transmitter hardware level to ensure that it is compatible with the OLS. The transmitter(s) must:

- Meet the OLS requirements in terms of wavelength and power level.

- Be capable of providing the low frequency tone signal to the OLS.

- Be fully readable by the software as part of the circuit pack identification message in terms of the transmitter(s) identification/capabilities.

Broadband Service Transport — STS-3c/ STS-12c Payloads

Using the OC-3 or OC-12 low-speed interface, the FT-2000 OC-48 Add/Drop-Rings Terminal can transport STS-3c and STS-12c payloads. Current and evolving service requires this capability. Some examples of these services are medical imaging, LAN interconnect, or video distribution from a video server and asynchronous transport mode (ATM) switching. Figure 3-24 depicts an FT-2000 OC-48 ring with OC-3 or OC-12 interfaces connecting to ATM service multiplexers and switches.

⟹ **NOTE:**
When an FT-2000 node and another network element are located in the same central office (shown as a dotted line), they may be interconnected using IS-3 circuit packs.

a4/0802D.01JF1021987.1
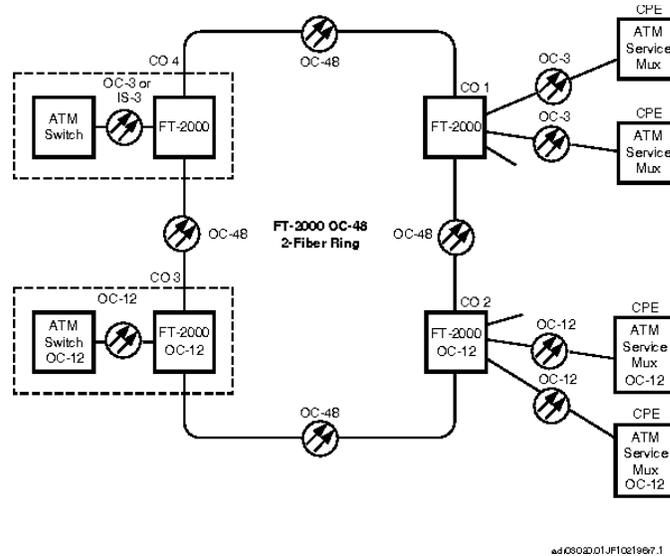
Figure 3-24. Broadband Service Transport Application

The nodes at the first and second central offices (CO 1 and CO 2) on the interoffice ring are optical hubs that provide point-to-point OC-3 and OC-12 extensions to ATM service multiplexers. Although the figure shows a point-to-point connection, the STS-3c and STS-12c payloads can pass through other equipment, such as DDM-2000.

The ring transports the ATM traffic from the optical hubs to the ATM switches in various central offices (CO 3 and CO 4). The ring also efficiently connects the ATM switches in different central offices together.

Synchronous Digital Hierarchy (SDH) Signal Transport

The OC-3 and OC-12 circuit packs can be provisioned for Synchronous Digital Hierarchy (SDH) signal transport. Using the SDH format, the FT-2000 OC-48 Add/Drop-Rings Terminal can transport SDH STM-1 payloads. An example of this service is international (service) connection to an overseas service provider. Figure 3-25 depicts an FT-2000 OC-48 ring with OC-3 or OC-12 interfaces connecting to SDH service multiplexers and switches.

> ⇒ **NOTE:**
> If an FT-2000 node and another network element are located in the same
> central office (shown as a dotted line), they may be interconnected using
> IS-3 circuit packs.
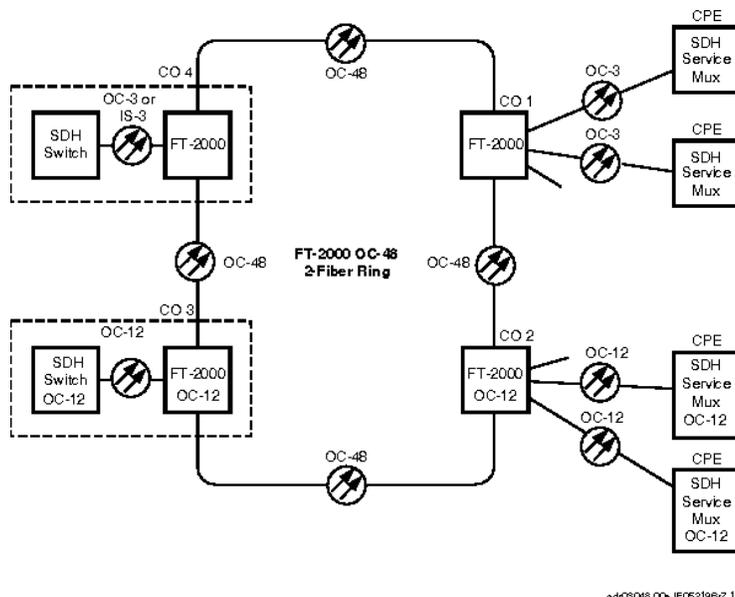
Figure 3-25.   Synchronous Digital Hierarchy Signal Transport Application

STM-1 AU-4 Signal Transport

Using the OC-3 or OC-12 low-speed interface, the FT-2000 ring can also transport
AU-4 payloads mapped into STM-1 [synchronous digital hierarchy (SDH)] signals.
You can provision the OC-3 or OC-12 interface to provide the appropriate values
in the pointer bytes so you can have a direct interface to SDH equipment over an
STM-1 optical interconnection. FT-2000 transports the payload within the OC-48
ring, using SONET requirements [for example, framing and loss of pointer (LOP)
detection].

For the OC-3c, you must provision each of the three STS-1s in an STS-3c signal
to adjacent tributaries within the same STS-3. For example, you could provision
ports 1, 2, and 3 to STS-1 tributaries 2-1, 2-2, and 2-3, respectively (see Figure 3-
26). Or you could provision these ports to any other three adjacent tributaries, for
example, tributary 8-1, 8-2, and 8-3.
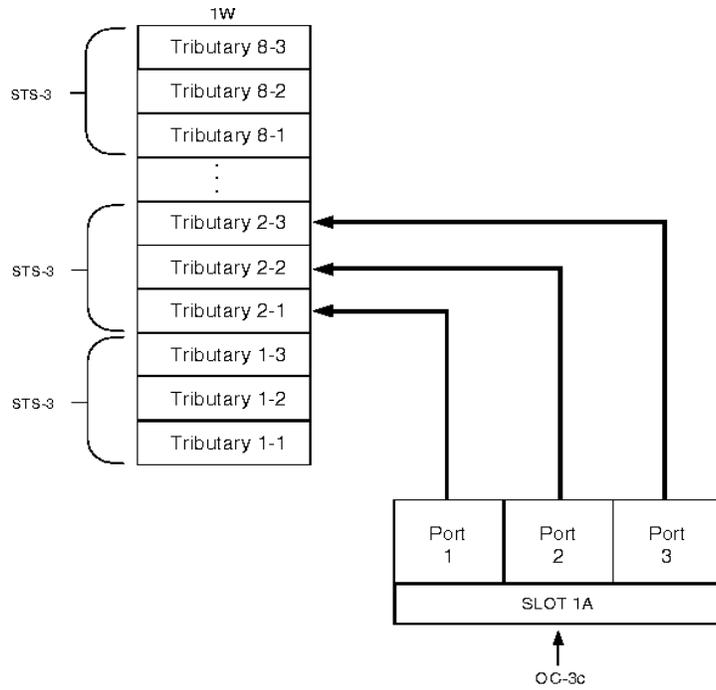
Figure 3-26.   Provisioning STS-1 Granular Systems to Carry OC-3c Signals

For the OC-12c, you must provision each of the 12 STS-1s in an STS-12c signal to adjacent tributaries within the same STS-12. For example, you could provision slots 1A, 1B, 2A, and 2B (Quad 1) to tributaries 5-1 through 8-3, respectively (see Figure 3-27). Or you could provision these ports to any other twelve adjacent tributaries, for example, tributary 13-1 through 16-3.
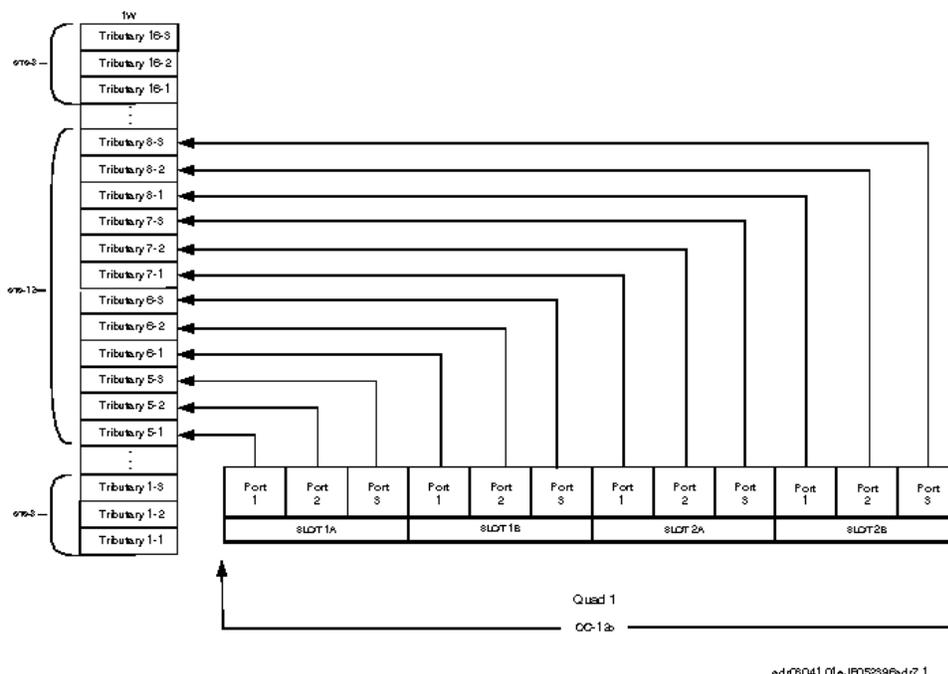
Figure 3-27.   Provisioning STS-1 Granular Systems to Carry OC-12c Signals

One-Way Video Distribution

One of the key features of the FT-2000 Bidirectional Line Switched Ring (BLSR) video application is its ability to distribute several copies of identical signals from a centralized headend (HE) or video server (VS) to a large number of nodes. These nodes serve tens of thousands of video customers.

Headend or video servers are usually collocated with one or more FT-2000 ring terminals. The headend or video server works with the FT-2000 ring terminal to provide a single or multiple feed to other nodes within the same ring (Figure 3-28). OC3c rates then transport video streams from the source through the ring where single or multiple signals are dropped.
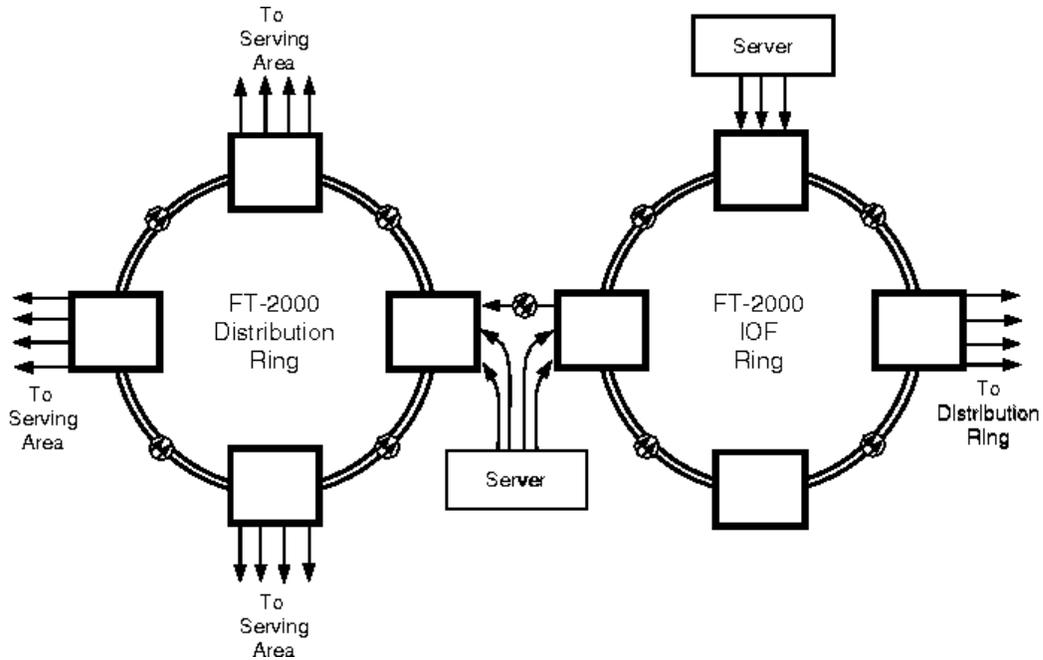
Figure 3-28.   One-Way Video Distribution From a Centralized Video Server

Capacity Planning

Analog and Digital Broadcast Services

FT-2000 BLSR video applications equipped with OC-3 circuit packs broadcast OC-3 signals at a number of hub offices as required. There can be up to 16 hub offices, consistent with the SONET standard.

For fully protected video services, the FT-2000 ring terminal must be configured in a line protection mode with bandwidth available as follows:

■   Bandwidth must be provisioned from the headend or video server in a clockwise direction (Figure 3-29). The maximum number of OC-3 signals is eight. Each signal originates from the HE/VS Office 2 with up to eight OC-3 signals dropped in each of the M hub offices (M < N-1 with N=the number of nodes).

■ Bandwidth must be provisioned from the headend or video server in a counterclockwise direction. The maximum number of OC-3 signals is eight. Each signal originates from the HE video information provider (VIP) Office 2 with up to eight OC-3 signals dropped in each of the M hub offices.

■ All OC-3 signals must be configured in 0X1 protection mode.

For the configurations listed above, each node contains up to 16 OC-3 signals for full video service capacity. The cross-section of the FT-2000 ring for each rotation includes 8 OC-3 signals (24 DS3 equivalent) that provide full line and high-speed circuit pack protection for all 16 OC-3 signals in all ring sections.
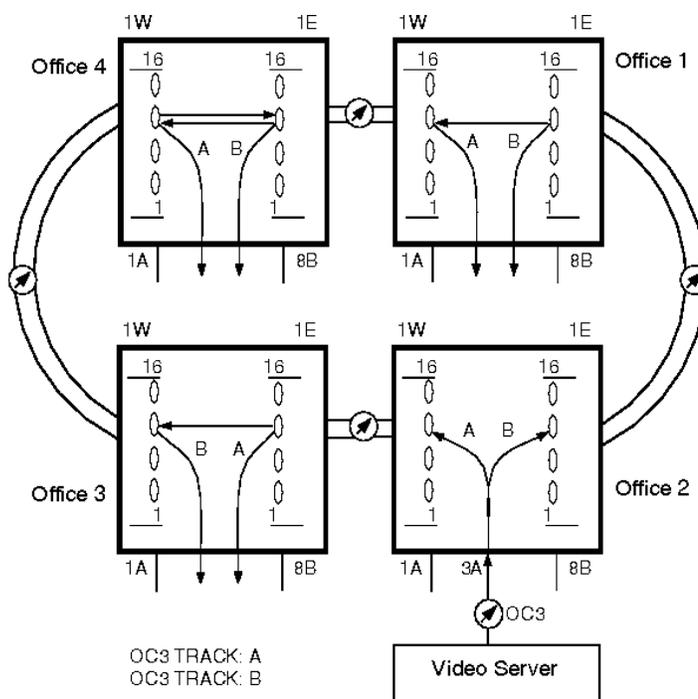
Figure 3-29.   One-Way Video Distribution Using FT-2000

FT-2000 Ring Terminal Configuration

Node 1 on the FT-2000 ring terminal connects to the video server via an OC-3 signal on the low-speed (LS) side. Four high-speed (HS) optical lines are required to connect to node 2 at the end office (Figure 3-30). The dedicated OC-3 point-to-point signals are then connected to the server.

A maximum of eight OC-3 signals can be assigned from the video server in a clockwise direction, that is, node 1 to node 2; and a maximum of eight OC-3 signals can be assigned in a counterclockwise direction, that is, node 2 to node 1. Thus, a total of 16 OC-3 signals can be transported point to point from the central office to distribution offices. For 100-percent service protection, all HS fiber lines must be physically diverse so that both HS circuit pack and line protection can be accomplished.

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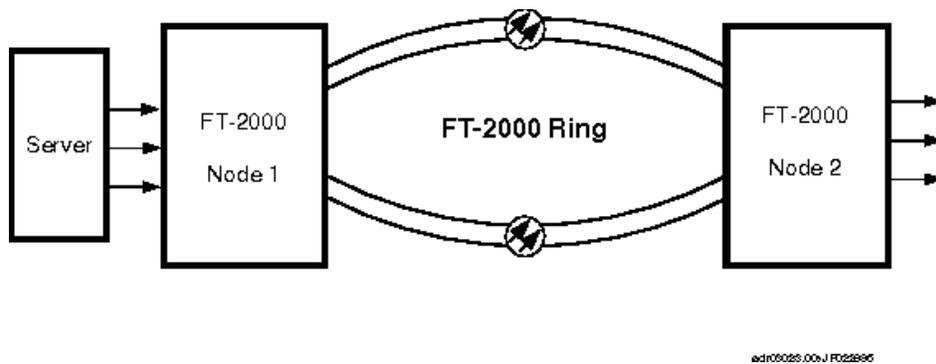
Figure 3-30. Point-to-Point Video

Synchronization

Figure 3-31 illustrates one example of a synchronization architecture for a video network. This configuration is suitable for both IntraLATA and InterLATA video distribution networks where collocated Building Integrated Timing Supply (BITS) clocks provide timing to each FT-2000 ring terminal.
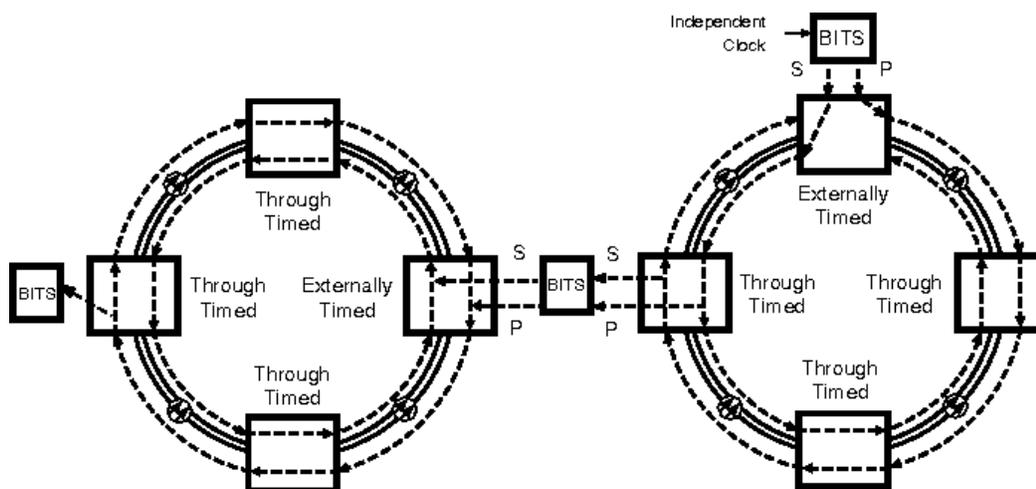
Figure 3-31.   Example Synchronization Architecture for a Video Network

Operation and Provisioning

The FT-2000 BLSR video application provisions broadcast video services using bridge cross-connection commands. All cross-connections are one-way from the video source through the ring to any node on the FT-2000 ring terminal. Because the corresponding return path has no input signal, the BLSR normally generates an alarm.

The video service alarm management function allows you to turn off performance monitoring. You can use the Set-OC3 CIT-PC command or the Set-ATTR-OC3 TL1 command to set the alarm level to NO, which disables reporting of this alarm. You can also disable OC-3 performance data.

Path-In-Line Architecture

Figure 3-32 illustrates a path-in-line architecture. In this architecture, a DDM-2000 OC-3 or OC-12 path-switched ring connects to an FT-2000 OC-48 Add/Drop-Rings Terminal 2-fiber bidirectional line-switched ring through the OC-3 or OC-12 interface. This type of architecture provides:

■   A combination of the self-healing advantages of both an FT-2000 Add/Drop-Rings Terminal 2-fiber bidirectional line-switched ring (loopback protection switching) and a DDM-2000 path-switched ring (path-switched protection).

■   STS-1 and VT1.5 TSI bandwidth management through the DDM-2000 path-switched ring. This capability enables you to designate one or more bandwidth rails (for example, one STS-1s or STS-3s worth of bandwidth) for different types of service in either the DDM-2000 OC-3/OC-12 ring or the FT-2000 OC-48 ring. Because bandwidth management is at the STS-1 and VT1.5 level, you can choose to completely fill a particular bandwidth rail (for example, one STS-3 rail can hold up to 3 STS-1 or 84 DS1 equivalent signals). You can also add, drop, or passthrough service at any node. This bandwidth management capability, in essence, allows you to build an OC-3 or OC-12 path-switched ring within the OC-48 bidirectional line-switched ring bandwidth. See the shaded line in Figure 3-32.

■   DS1 business service access into an FT-2000 OC-48 Add/Drop-Rings Terminal 2-fiber bidirectional line-switched ring through DDM-2000 STS-1 and VT1.5[9] TSI (bandwidth management capabilities).

For Releases 7.2 and earlier, any FT-2000 OC-48 Add/Drop-Rings terminal in this architecture can perform the single-ended operations for any of the DDM-2000 Multiplexers:

■   Remote login

■   GNE

■   Remote NE status.

For Releases 8.1 and later, refer to Chapter 5, "Operations, Administration, Maintenance, and Provisioning," for more detailed information on multivendor operations interworking.

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9. VT1.5 is a 1.728 Mb/s virtual tributary.

Figure 3-32 shows the following types of OC-3 interface connections between an FT-2000 OC-48 Add/Drop-Rings Terminal ring and a DDM-2000 OC-3 ring:

- Dual-homed ring (0x1) interface connection[10] to two FT-2000 OC-48 Add/ Drop-Rings Terminals (see node B and node C)

- Single-homed ring (0x1) interface (unprotected) connection[10.] to one FT-2000 OC-48 Add/Drop-Rings Terminal (see node A and node E).

Although the FT-2000 OC-3 interface is unprotected in each of these cases, if one of the interfaces fails, the DDM-2000 automatically performs a nonrevertive path protection switch. Similar connections can also exist for the OC-12 interface.
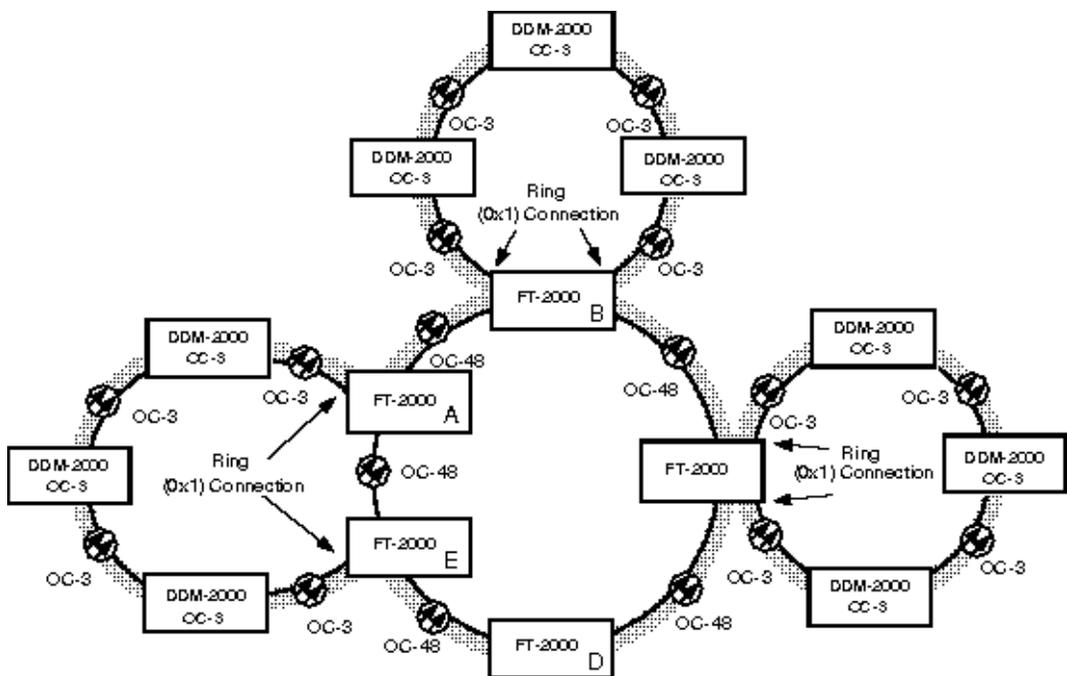
ad/03025.01+R R091996

Figure 3-32.   Path-In-Line Architecture: Dual and Single 0x1 Unprotected Connections

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10. In a dual-homed ring (0x1) interface configuration, there is a single 0x1 OC-3 or OC-12 interface connection at each of two FT-2000s. In a single-homed ring (0x1) interface (unprotected) configuration, there are two 0x1 OC-3 or OC-12 interface connections to one FT-2000 OC-48 Add/Drop-Rings Terminal.

Figure 3-33 illustrates a dual-homed (0x1) interface connection between an FT-2000 and an DDM-2000. It also shows two-way cross-connections on an FT-2000 OC-48 Add/Drop-Rings Terminal and an STS-1 or VT1.5 cross-connection on a DDM-2000 Multiplexer.
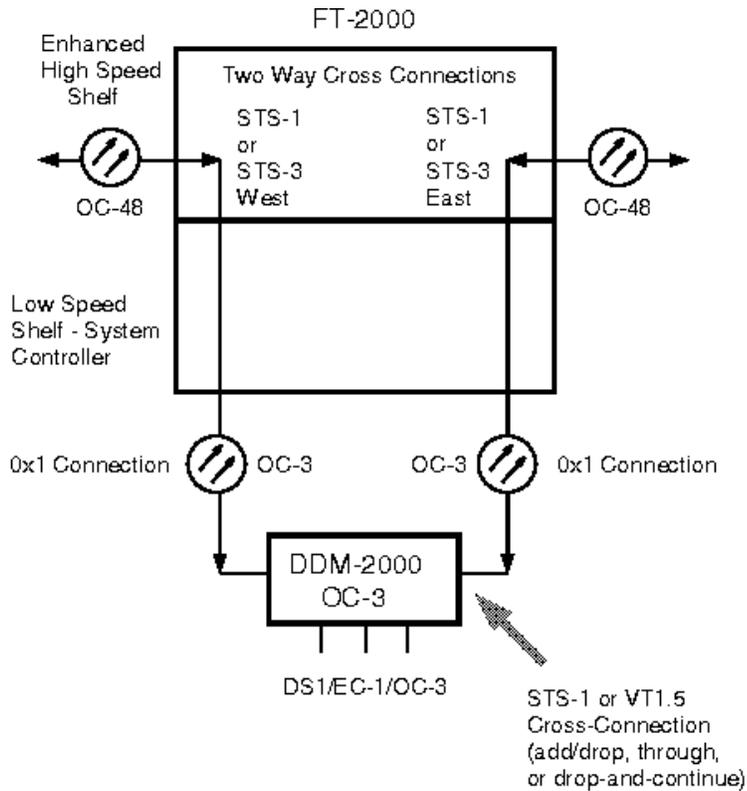
Figure 3-33. Path-In-Line Architecture: Cross-Connections

As the simplified view in Figure 3-34 illustrates, with STS-1 granularity TSA across an OC-48 on the FT-2000 ring, you can more efficiently manage the bandwidth in a path-in-line architecture. This figure shows an OC-48 ring (grey shaded ring) with STS-1s being dropped at various FT-2000 nodes to DDM-2000 nodes (black lines in the shaded ring). With STS-3 granularity, you would need to send an entire STS-3 to route one STS-1 from node B to node D, leaving two STS-1s unused. To drop one STS-1 from node C to node A, you would need to send an STS-3, leaving two STS-1s unused. Now only two STS-1s are used altogether.
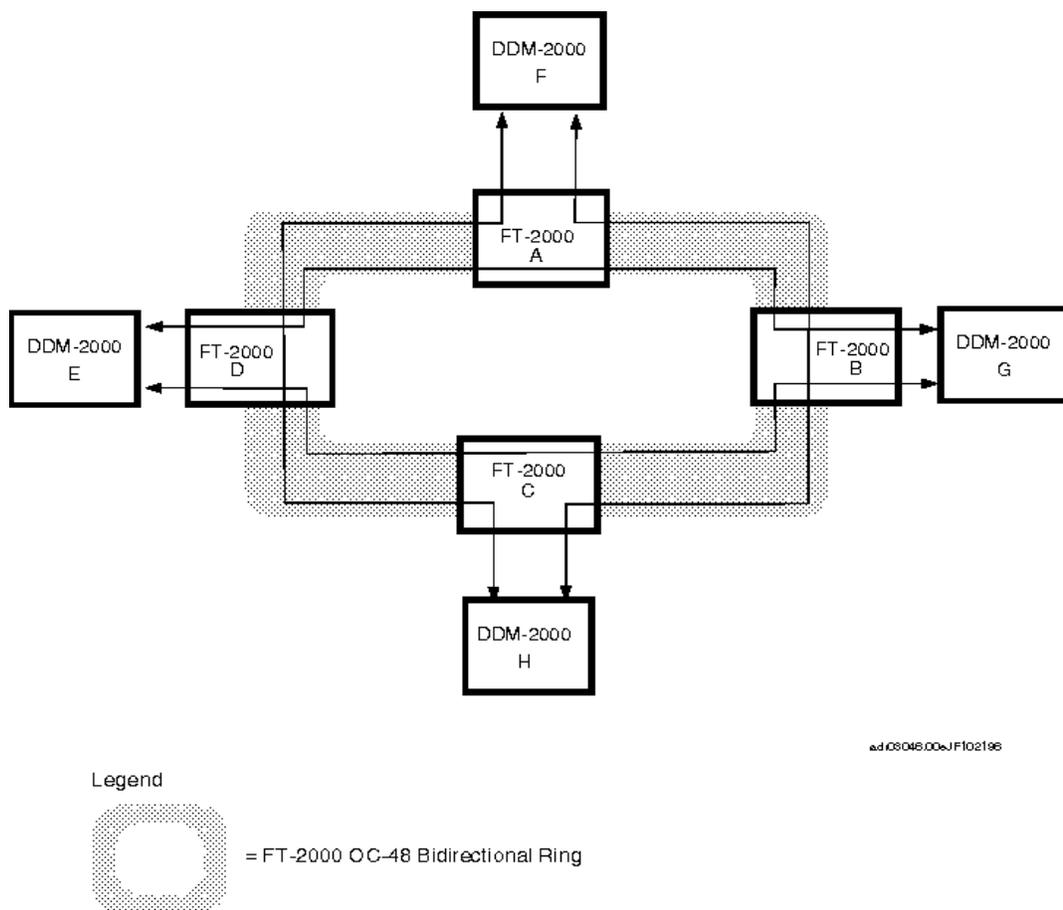
Figure 3-34.   FT-2000 STS-1 Granularity TSA Across an OC-48: For More Efficient Bandwidth Management

Network Restoration and Revenue Generation Using Protection Access

The protection channels of the FT-2000 OC-48 Add/Drop-Rings Terminal can be provisioned for extra traffic. Extra traffic allows the protection channels to be used as additional facilities to provide unprotected capacity for low priority traffic, temporary capacity relief, revenue-generating services (for example, video), or network restoration. In the 2-fiber ring, this is up to 24 DS3 equivalents of extra traffic capacity per span.[11]

By using protection access capacity, the span capacity can be used more efficiently for this traffic, and more protected service capacity remains available for other traffic. Protection access can be provisioned as either preemptible or non-preemptible.

Preemptible protection access is preempted (lost) when a protection switch is active in the ring because at that time the protection capacity is needed for protection.

When provisioned as non-preemptible, an STS-1 protection tributary and also its corresponding STS-1 service tributary (which it normally would protect) both become tributaries of unprotected, non-preemptible capacity. The traffic carried by these tributaries (on all spans around the 2-fiber ring) is not protected, and it is not preempted (lost) when a protection switch is active in the ring. These tributaries do not participate in the ring protection switching.

In path-in-line applications, path-switched ring traffic may be transported either by protected service capacity or by unprotected non-preemptible protection access capacity. Preemptible protection access capacity must not be used. The use of non-preemptible protection access in path-in-line applications is described in a separate subsection.

In network restoration applications, the FT-2000 OC-48 Add/Drop-Rings Terminals for 2-Fiber Rings can be used with a DACS III-2000 and/or DACS IV-2000 Cross-Connect System and the *DACScan*®-2000 Controller (Figure 3-35). If a failure occurs between central offices, the *DACScan*-2000 Controller receives alarms and sends cross-connect commands to the DACS III-2000 and/or DACS IV-2000 Cross-Connect Systems in the network to reroute traffic around the failure. The protection channels can be used to carry rerouted traffic until the failure is fixed

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11. The FT-2000 OC-48 Add/Drop-Rings Terminal provides multiplexing and transport for up to 48 DS3 equivalent signals over two OC-48 high-speed lines.

    The total interface capacity for any one node depends on the number of low-speed interfaces and the type of low-speed interface protection on the low-speed shelf. For example, an all electrical (DS3, EC-1) and/or unprotected optical (OC-3) low-speed shelf provides 48 DS3 or STS-1 equivalent (16 STS-3 or STS-3c payloads of) signals.

and the regular route is restored. The protection capacity used in restoration applications may be provisioned for preemptible (the normal state), or it may be provisioned temporarily as non-preemptible. Typically, a customer would use non-preemptible capacity when it is more important for the restored traffic to remain uninterrupted in case of a subsequent failure than it is for the service traffic on the corresponding tributary to remain protected during the restoration.

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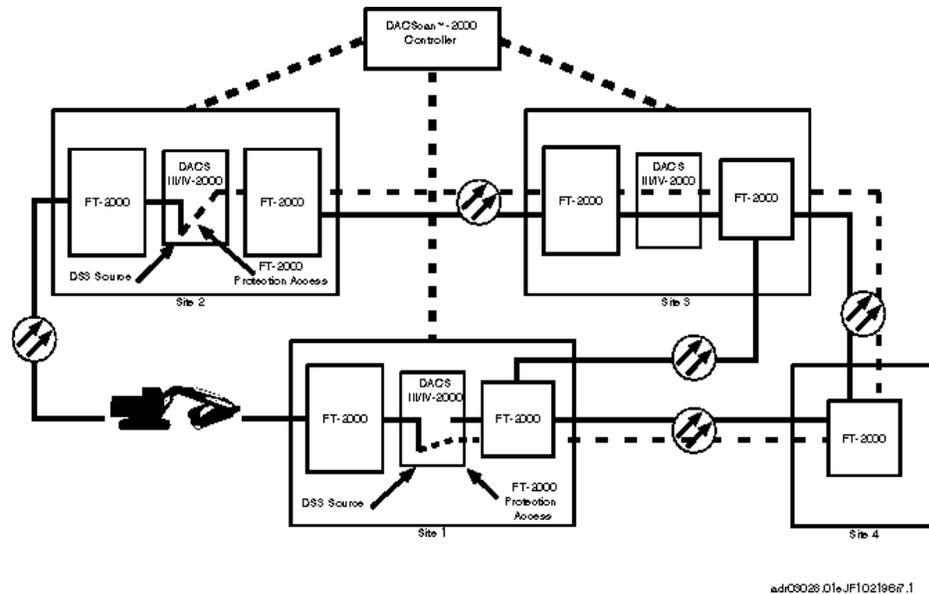
Figure 3-35.   DACS-Based Network Restoration Using Protection Access

Path-In-Line Applications Using Non-Preemptible Protection Access (NPPA)

Non-Preemptible Protection Access (NPPA) is a third type of capacity in an OC-48 2-fiber ring, in addition to the protected service capacity and the unprotected, preemptible protection access capacity. Each of the 24 STS-1 tributaries of protection capacity can independently be provisioned as non-preemptible. An STS-1 protection tributary which is provisioned as non-preemptible and also the corresponding STS-1 service tributary (which it normally would protect) then both become tributaries of unprotected, non-preemptible capacity. The traffic carried by these tributaries (on all spans around the 2-fiber ring) is not protected, and it is not preempted (lost) when a protection switch is active in the ring. These tributaries do not participate in the ring protection switching.

Non-preemptible protection access increases the available span capacity for traffic which does not require protection by the OC-48 ring, but which can not be preemptible. A primary application is path-switched ring traffic in the path-in-line network architecture. Other applications include transport of revenue-generating services such as video, ATM, and bridge/router traffic, and DACS-based network restoration.

The traffic in these applications can be carried either by the protected service capacity (maximum of 24 STS-1 tributaries) or by the unprotected, non-preemptible protection access capacity (up to 48 STS-1 tributaries). By using non-preemptible protection access capacity, the span capacity can be used more efficiently for this traffic, and more protected service capacity remains available for other traffic.

Non-preemptible protection access is supported at the STS-1 level in rings that are equipped with STS-1 granularity transmitters and receivers at all nodes. Otherwise, it is supported at the STS-3 level, meaning that three STS-1 protection tributaries must be selected at a time. With selection at the STS-1 level, the total capacity usable in these applications (protected service plus non-preemptible protection access) can be provisioned in increments of one STS-1. Furthermore, in backbone networks carrying a mix of traffic, the customer has the flexibility to choose, for each STS-1 of traffic, whether to provide protection or to lower the cost by increasing bandwidth efficiency.

The path-in-line application, also called "OC-3/OC-48 Ring-on-Ring" or "SONET-on-SONET," carries path-switched ring traffic within the FT-2000 line-switched ring. Tributaries of the FT-2000 ring provide transport between DDM-2000 OC-3 and/or SLC-2000 ring nodes which are located with (or remotely from) the FT-2000 nodes. Tributaries of the FT-2000 ring can also provide transport between DDM-2000 OC-12 ring nodes.

A primary purpose of the path-in-line application is service survivability. Path-switching provides end-to-end service survivability for DS1/VT services and STS services.

Figure 3-36 illustrates the use of one STS-1 tributary which has been provisioned for unprotected, non-preemptible operation to carry path-in-line traffic. Other STS-1 tributaries (even those in the same STS-3 tributary) may be used for any mix of traffic. Up to 3 STS-1 tributaries in all spans of an FT-2000 ring are provisioned to transport the traffic of one DDM-2000 OC-3 ring. Additional tributaries are provisioned to transport the traffic of additional DDM-2000 rings through the same FT-2000 ring. In this way, the path-in-line application saves the cost of additional fibers.

Each STS-1 tributary of path-switched ring traffic is independent and may be used by a different subset of nodes. An STS-1 tributary is dropped by the FT-2000 ring at each FT-2000 node where a DDM-2000 ring node needs access to any VT traf-

fic within that STS-1 tributary. Other VT traffic in that STS-1 is passed through by the DDM, and a new STS-1 is added by FT-2000 into the next span.

Each DDM-2000 ring node provides VT1.5 Time Slot Interchange and allows DS1/VT access at any FT-2000 node. This allows aggregation of services across an FT-2000 interoffice ring and efficient use of each STS-1 tributary on the FT-2000 ring for up to 28 VTs. In place of DDM-2000 ring nodes, SLC-2000 may be used to provide DS0 access, and DACS IV-2000 may be used for network interconnection.

The path-switched ring protects traffic with dual-fed signals, sending traffic in both directions from the node where the traffic enters the ring. The node where the traffic exits the ring selects one of the two received signals at the VT1.5 tributary level. Path-switching must be used to protect failures at immediate points where the traffic drops out of the FT-2000 ring to pass through a DDM-2000 ring node.

Since path-in-line traffic is already protected by a path-switched ring, it does not need to be protected by FT-2000. path-in-line traffic can be transported more efficiently by making use of unprotected, non-preemptible tributaries than by using only the protected service tributaries. Unprotected preemptible tributaries ("normal" protection access) must not be used for path-switched ring traffic.

Regarding time slot assignments, the expected practice is to choose the same FT-2000 tributary on every span, for traffic from the same path-switched ring. This would simplify operations, but it is not necessary. What is necessary is to route traffic around opposite sides of the FT-2000 ring whenever unprotected, non-preemptible capacity is used. Otherwise, both copies of dual-fed signals following the same route could be lost.

As an option for added survivability, DDM-2000 OC-3 path-switched ring nodes can interconnect remotely into two FT-2000 nodes, rather than one. (See FT-2000 nodes C and D in Figure 3-36.) This way, the path-switched ring can protect against a node failure (or double fiber-cut) of either interconnecting FT-2000 node.

Without using the NPPA feature, path-in-line traffic must be carried only on the service capacity (24 STS-1s). (It is possible to carry more of this traffic by locking out protection on the entire ring, but then no ordinary services can be mixed on the same ring.) With the NPPA feature, path-in-line traffic can be carried on non-preemptible unprotected capacity. This capacity includes both the selected STS-1 protection tributaries and the corresponding STS-1 service tributaries. Thus, the span capacity can be used more efficiently for path-in-line traffic, and more protected service capacity remains available for other traffic.

As an example, some path-in-line traffic could be carried on two service tributaries, or it could be carried on one service tributary and one protection tributary provisioned as non-preemptible. The second case saves the capacity on one service tributary for other traffic. With additional path-in-line traffic, the savings increases. Also, more than 24 STS-1s of such traffic can be carried in one FT-2000 ring.
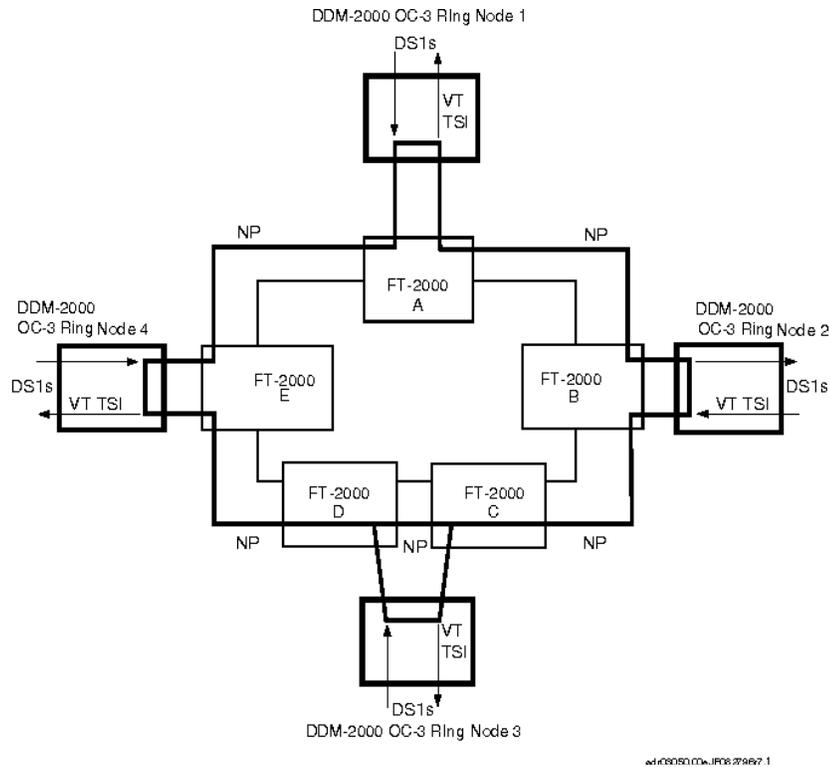
Figure 3-36.   Path-In-Line Application Using Non-Preemptible Protection Access (NPPA)

Loop Feeder Network

You can use an FT-2000 ring in a loop feeder network to connect one or more central offices (COs) to one or more DDM-2000 remote sites, as shown in Figure 3-37. The FT-2000 must be located in a controlled environment facility [such as a controlled environment vault (CEV), temperature controlled hut, or CO]. Through the FT-2000 OC-3 or OC-12 low-speed interface, the FT-2000 OC-48 Lightwave System can have an:

■ Intrasite connection to a local DDM-2000 OC-3 or OC-12 (Figure 3-37, CEV 1 and Office Building)

■ Intersite connection to a remote DDM-2000 OC-3 or OC-12 (Figure 3-37, CEV 2).

Although not explicitly shown in this figure, in many applications an STS-3 payload can enter the FT-2000 ring at one node via an OC-3 interface and leave the FT-2000 ring through a DS3 or EC-1 (STS1E) interface at another node. Note that the OC-3 or OC-12 signal must have an appropriate payload.

Using the DCC channels embedded in the OC-3 and OC-12 interfaces, FT-2000 OC-48 Add/Drop-Rings Terminals can perform local and remote operations for the DDM-2000 Multiplexers in any of the applications just listed.

For Releases 7.2 and earlier:
Through intrasite and intersite connections, the FT-2000 can perform single-ended operations for the local and remote DDM-2000s. These operations include:

■ Remote login

■ GNE

■ Remote NE status.

You can use either the OC-3, IS-3, or OC-12 signal or the available DS1 timing outputs (FT-2000) and inputs (DDM-2000) to distribute network timing from the FT-2000 terminals to the DDM-2000 and SLC-2000 systems.

For Releases 8.1 and later, refer to Chapter 5, "Operations, Administration, Maintenance, and Provisioning," for more detailed information on multivendor operations interworking.
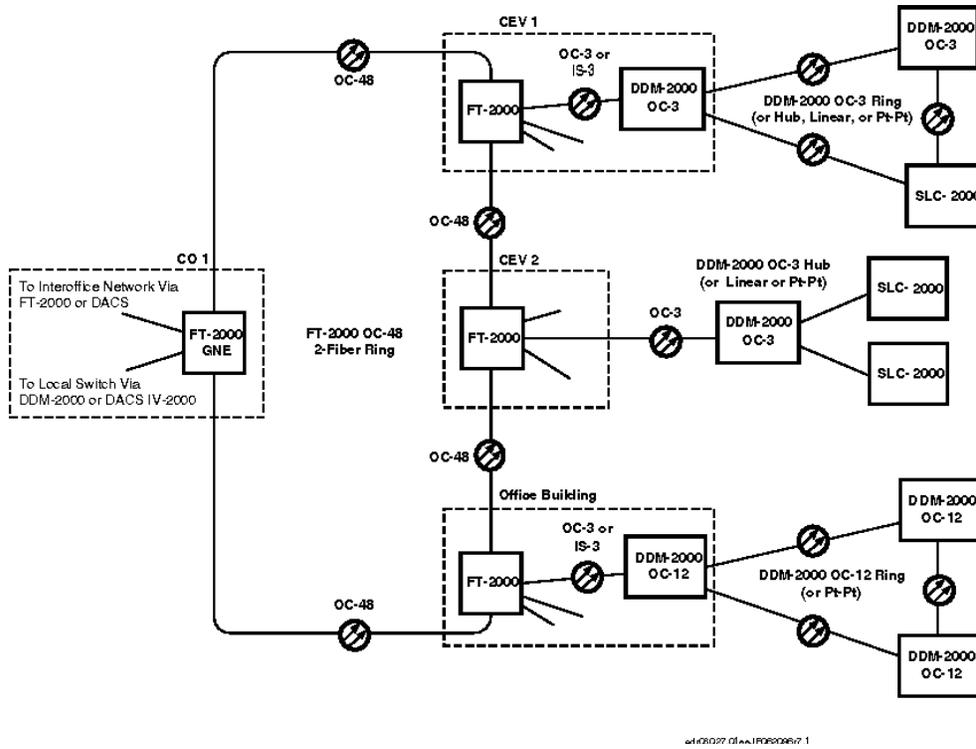
Figure 3-37.   Loop Feeder Application

Intrasite Connection to a Local DDM-2000 OC-3 and OC-12

Through the FT-2000 OC-3 or IS-3 low-speed interface, the FT-2000 OC-48 Add/Drop-Rings Terminal can have an intrasite connection to a local DDM-2000 OC-3 or OC-12, as shown in Figure 3-37.

In the CEV 1 section of Figure 3-37, the DDM-2000 OC-3 is a node in an IS-3 or OC-3 ring that supports VT and STS-1 path switching. An FT-2000 IS-3 or OC-3 interfaces with a DDM-2000 OC-3 ring path-switched ring. All VT-switching takes place in DDM-2000. As indicated in the figure, this DDM-2000 OC-3 can be an intermediate node in a hub network, linear subnetwork, or point-to-point system. The remote nodes in the DDM-2000 subnetwork beyond the local DDM-2000 OC-3 can be a combination of DDM-2000 OC-3 and SLC-2000 nodes. In this example, the FT-2000 IS-3 interface connects to the OC-3 interface of a DDM-2000 OC-3 ring terminal.

In the Office Building section of Figure 3-37, the local DDM-2000 OC-12 is a node in an OC-12 ring or a near-end node in a point-to-point subnetwork. In this example, the FT-2000 OC-3 or IS-3 low-speed interface connects to the OC-3 high-speed interface of a DDM-2000 OC-12 ring terminal.

Intersite Connection to a Remote DDM-2000 OC-3 and OC-12

Through the FT-2000 OC-3 or OC-12 low-speed interface, the FT-2000 OC-48 Add/Drop-Rings Terminal can have an intersite connection to a DDM-2000 OC-3 or OC-12 or SLC-2000, as shown in the CEV 2 in Figure 3-37.

As indicated in the figure, the remote DDM-2000 OC-3 or OC-12 can be:

■   An intermediate node in a hub or linear subnetwork. The nodes in the DDM-2000 subnetwork beyond this remote DDM-2000 OC-3 or OC-12 can be a combination of DDM-2000 OC-3 or OC-12 and SLC-2000 nodes.

■   A far-end node in a point-to-point subnetwork. Alternatively, the FT-2000 OC-48 Add/Drop-Rings Terminal can connect directly to a SLC-2000 as the far-end node in this type of subnetwork.

The FT-2000 OC-3 or OC-12 low-speed interface eliminates the need for a DDM-2000 OC-3 or OC-12 at the site of the FT-2000 OC-48 Add/Drop-Rings Terminal.

At a central office, direct OC-3 or OC-12 termination on the FT-2000 is desirable for DS3/EC-1 services and DS1 services (not terminated in this location) that require interoffice transport. At a CEV or hut, direct OC-3 or OC-12 termination on the FT-2000 is desirable for all services.

0% Add/Drop Application

A 0% add/drop application uses an FT-2000 OC-48 Add/Drop-Rings Terminal that has no low-speed circuit packs as a repeater (see Figure 3-38). In this application, the cross-connects are bridged (pass-through signals).

It can be very cost-effective to use the terminal in this way if this node will need to have an add/drop capability in the future. Using a terminal in place of a repeater, you can also access the OC-48 DCC to perform remote operations, administration, maintenance, and provisioning[12] for nodes in the same FT-2000 ring.
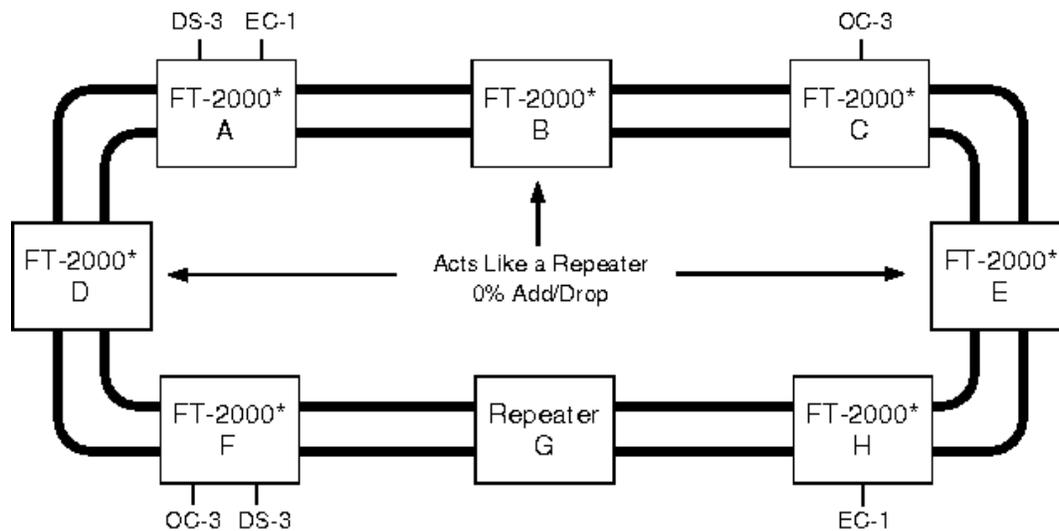
Figure 3-38. 0% Add/Drop Application

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12.   For information about using orderwire to perform remote operations, administration, maintenance, and provisioning for terminals and repeaters, see Chapter 2, "Features," for detail on Orderwire for Remote CIT Access and Basic Party-Line Service to Repeaters and Terminals.

FT-Lightwave Booster Amplifier (FT-LBA) for Extended Distances

The FT-Lightwave Booster Amplifier (FT-LBA) is a miscellaneously mounted shelf that you can use with the FT-2000 OC-48 Add/Drop-Rings Terminal to extend the distance between sites (Figure 3-39). This capability enables you to limit the number of intermediate sites on long routes (for example, a new route that would require you to build a new site).

You can use the FT-LBA with the following transmitters:

- Any OC48 TRMTR (A/D STD 1.5)

- Any OC48 TRMTR (A/D STS1 1.5 LBA)

- OC48 TRMTR (A/D STS1 1.5 LBA, W1)

- OC48 TRMTR (A/D STS1 1.5 LBA, W2).

See Chapter 10, "Technical Specifications," for a list of the transmission distances you can achieve when operating with these transmitters and the FT-LBA. See the "Wavelength Division Multiplexing (WDM)" section later in Chapter 3 for information about operating the two wavelength (W1 and W2) transmitters with wavelength division multiplexers and FT-LBA.

As previously mentioned, the FT-LBA is a miscellaneously-mounted shelf. If you install it in a bay adjacent to the FT-2000 bay, it is recommended that the FT-LBA bay be of the same type as the FT-2000 bay. This action will ensure proper bay alignment. Please note that the FT-LBA needs to be collocated with the transmitter.

For information, such as specifications, physical characteristics, operation and reliability, see the Lucent Technologies Practice, *Digital Transmission Systems FT-Lightwave Booster Amplifier Description, Engineering, Installation, and Maintenance* (365-565-500).
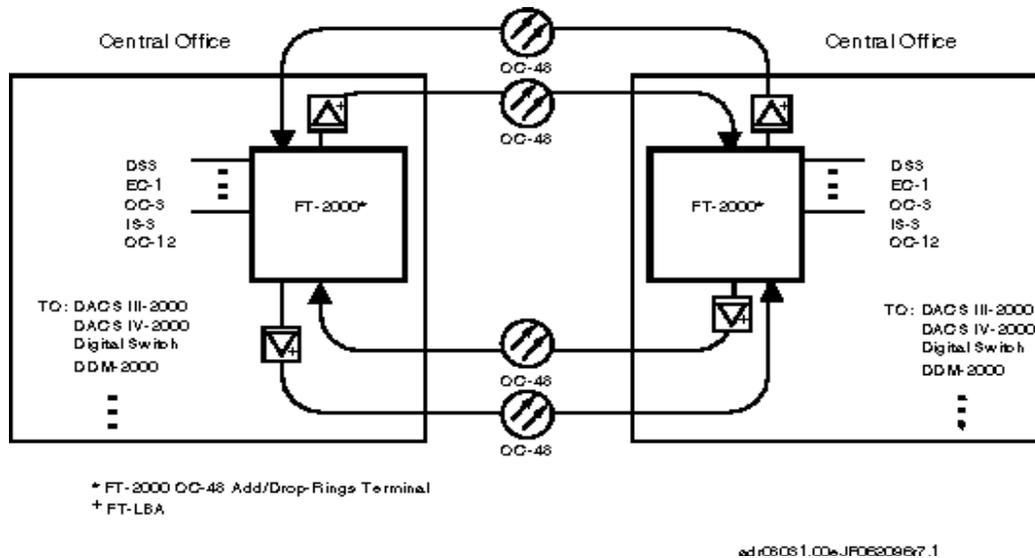
Figure 3-39.   FT-LBA Extends Distances Between Sites

Some examples of long reach applications that can benefit from the FT-LBA are:

- Applications in which you need to overcome the high loss associated with transmitting distances over poor fiber or fiber that has frequent, high loss splices (for example, in urban areas)

- Underwater/sea applications that use dispersion-shifted fiber and terrestrial electronics (for example, under lakes or between islands).

Wavelength Division Multiplexing (WDM) to Increase Fiber Capacity

The circuit-carrying capacity of lightguide cable can be increased by transmitting two signals of different wavelengths simultaneously over a single fiber. The combination of lightwave signals at different wavelengths is called wavelength division multiplexing (WDM).

The device used to implement WDM for the FT-2000 OC-48 Add/Drop-Rings Terminal is called a WDM filter.

When WDM is planned for a future addition to a span, the insertion loss of the WDM filters must be properly allocated in each outside plant repeater section cable loss design.

Refer to these sections for information about purchasing a WDM filter to multiplex the following wavelength combinations:

■ 1.3 µm and 1.5 µm — "Recommendations for Purchasing WDM Devices for Use with FT-2000" section in Chapter 6.

■ 1.5 µm and 1.5 µm — **Related Products** tab in Chapter 7 for information about ordering the 7A WDM Filter Assembly, the recommended filter.

Refer to Chapter 10, "Technical Specifications," for the loss budgets for FT-2000 OC-48 Lightwave System with and without a WDM.

1.5 µm and 1.3 µm Wavelength Signals on the Same Fiber Pair

Figure 3-40 shows how the WDM filters multiplex and demultiplex a single-mode 1.3 µm wavelength signal and a single-mode 1.5 µm wavelength signal, enabling the two signals to operate on the same fiber pair. Thus, two FT-2000 OC-48 Lightwave Systems or one FT-2000 OC-48 Lightwave System and one FT Series G 1.7 Gb/s system at the same location, each equipped for lightwave transmission at different wavelengths, can share the same fiber pair. Figure 3-41 shows wavelength division multiplexing used in repeater sections.
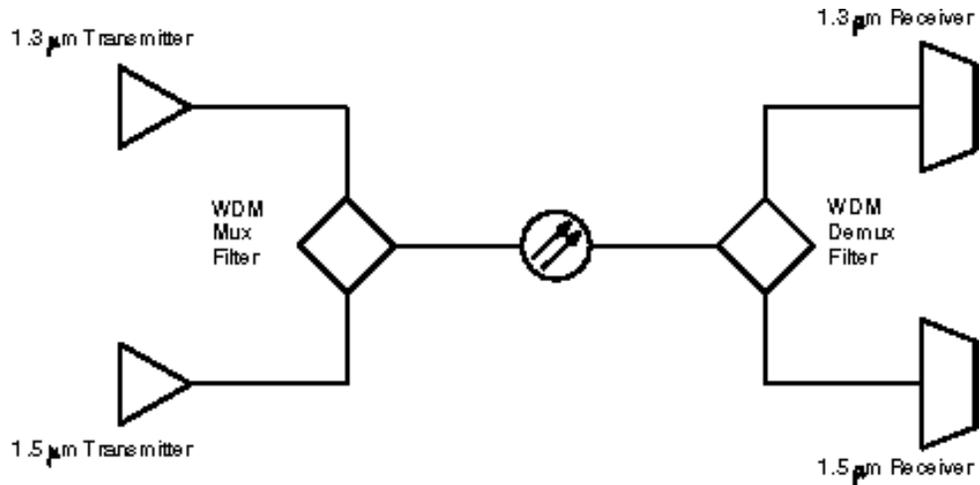
Figure 3-40.   Wavelength Division Multiplexing Application (1.3 μm/1.5 μm)
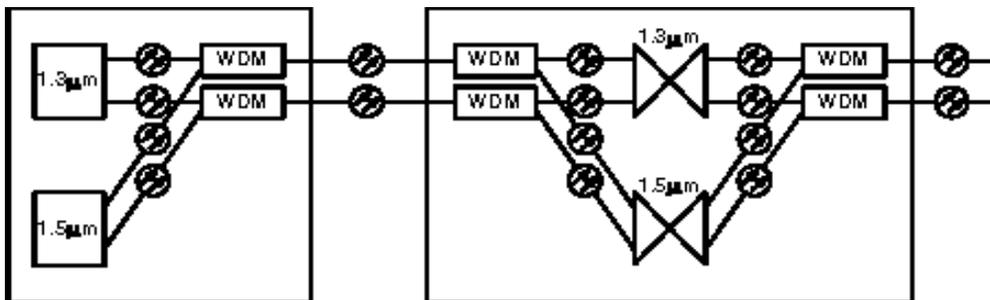
Figure 3-41.   Section by Section Wavelength Division Multiplexing (1.3 μm/1.5 μm)

Two Wavelength 1.5 μm WDM and LBA-Compatible Add/Drop Transmitters

You can use the FT-2000 OC48 TRMTR (A/D STS1 1.5 LBA, W1 and W2)[13] in ring applications together with:

- A wavelength division multiplexer (WDM) to increase the fiber capacity (for example, in situations where there are fewer fibers than are needed). The 7A WDM Filter Assembly is recommended for use with these transmitters.

- An FT-LBA to overcome attenuation loss (increase the distance spanned).

- Both a WDM and FT-LBA.

The WDM and FT-LBA must be collocated with the FT-2000 OC-48 Add/Drop-Rings Terminals. [For more information about FT-LBA, see the "FT-Lightwave Booster Amplifier (FT-LBA) for Extended Distances" section earlier in this chapter and the Lucent Technologies Practice, *Digital Transmission Systems FT-Lightwave Booster Amplifier Description, Engineering, Installation, and Maintenance* (365-565-500).]

These transmitters transmit at slightly different wavelengths from each other.[14] Thus signals from both transmitters can travel on the same fiber simultaneously, doubling the fiber capacity.

Refer to Chapter 10, "Technical Specifications," for information about the distances that the transmitters can span configured with either WDM alone or WDM and FT-LBA together.

Figure 3-42 shows a long-haul application in which two rings share a service and protection fiber span between CO 1 and CO 2. The nodes in ring A use wavelength 1 transmitters: Nodes 1 and 2 use the FT-2000 OC48 TRMTR [A/D STS1 1.5 LBA, Wavelength 1 (W1)] to provide STS-1 granularity TSA across an OC-48. Nodes 3 and 4 use the FT-2000 OC48 TRMTR (A/D 1.5 LBA, W1). STS-1 Granularity TSA across an OC-48 is undesired at these nodes. The nodes in ring B use FT-2000 OC48 TRMTR (A/D 1.5 LBA, W2) circuit packs.

In each of the central offices, a WDM and an FT-LBA are collocated with an FT-2000 Add/Drop-Rings Terminal (CO 1: node 1 and node 5; CO 2: node 2 and node 6) from each ring. The WDM multiplexes the signals from the transmitters at node 1 of one ring and node 5 of the other ring onto the same fiber. The multiplexed signal is then sent through the FT-LBA to span the 120 kilometer distance between the nodes and WDM that are in CO 1 and those that are in CO 2. The

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13. These transmitters require Release 7 (R7.0.1-ADR) or later software on all nodes in the ring. For ordering information, see the **E-Bay** tab in Chapter 7.

14. These transmitters transmit different and more narrow wavelengths than the other FT-2000 1.5 μm transmitters. For a description of the FT-2000 transmitters, see Chapter 4 or Chapter 7.

WDM in CO 2 demultiplexes the received signal into the two original 1.5 μm wavelengths. It sends the wavelength originally sent by node 1 to node 2 of the same ring (ring A) and the wavelength originally sent by node 5 to node 6 of the same ring (ring B).

If there is a failure in either ring (for example, a fiber cut), a loopback switch occurs. For more information about loopback switches, see the "Loopback Protection Switch (2-Fiber Rings)" section earlier in this chapter.
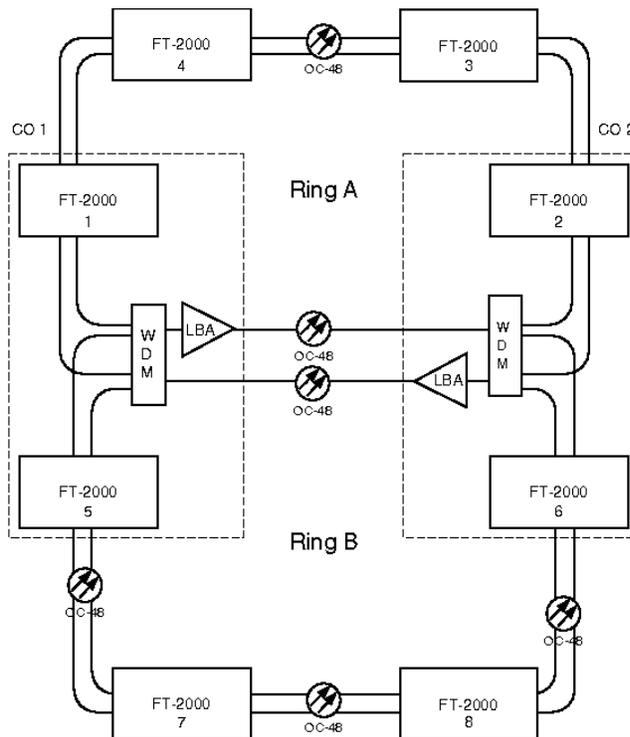
Figure 3-42. Example 1: Two-Ring WDM and FT-LBA Application Using Two Wavelength 1.5 μm Transmitters

Figure 3-43 shows an alternative configuration with a WDM. (As with the previous figure, FT-LBA could be part of the configuration.) In this figure, two nodes in different rings each have W1 and W2 transmitters: one ring B node in CO 1 and one ring A node in CO 2. This configuration is possible because the signals from the W1 transmitters are going different directions, as are the signals from the W2 transmitters.
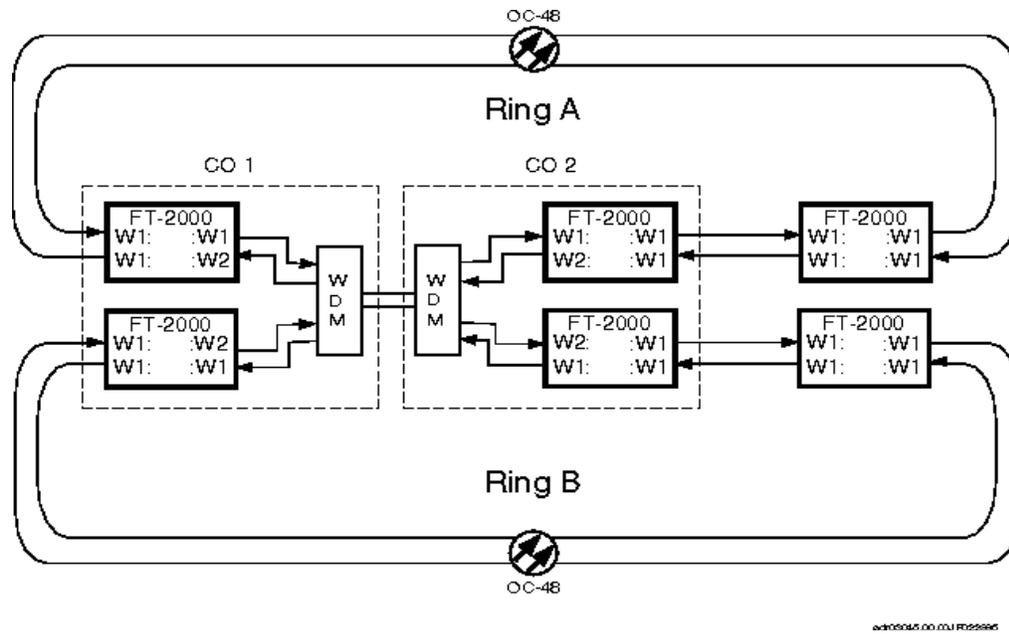
**Figure 3-43.   Example 2: Two-Ring WDM Application Using Two Wavelength 1.5 μm
              Transmitters**

Two Wavelength 1.5 μm WDM and LBA-Compatible Add/Drop Regenerators

You can use the FT-2000 OC48 REGENR (A/D 1.5 LBA, W1) and FT-2000 OC48 REGENR (A/D 1.5 LBA, W2)[15] circuit packs in ring applications together with:

■ A wavelength division multiplexer (WDM) to increase the fiber capacity (for example, in situations where there are fewer fibers than are needed). The 7A WDM filter is recommended for use with these regenerators.

■ An FT-LBA to overcome attenuation loss (increase the distance spanned).

■ Both a WDM and FT-LBA.

The previous section, "Two Wavelength 1.5 μm WDM and LBA-Compatible Add/Drop Transmitters," discusses an application using 1.5 μm W1 and W2 transmitters. When you use these transmitters for transmission, repeaters that are in the same ring must use regenerator circuit packs that operate at the same wavelength. The FT-2000 OC48 REGENR (A/D 1.5 LBA, W1) operates at the same wavelength as the FT-2000 OC48 TRMTR (A/D STS1 1.5 LBA, W1) and FT-2000 OC48 TRMTR (A/D 1.5 LBA, W1). The FT-2000 OC48 REGENR (A/D 1.5 LBA, W2) operates at the same wavelength as the FT-2000 OC48 TRMTR (A/D STS1 1.5 LBA, W2) and FT-2000 OC48 TRMTR (A/D 1.5 LBA, W2).

The WDM and FT-LBA must be collocated with the FT-2000 OC-48 Add/Drop-Rings Terminals and Repeaters. [For more information about FT-LBA, see the "FT-Lightwave Booster Amplifier (FT-LBA) for Extended Distances" section earlier in this chapter and the Lucent Technologies Practice, *Digital Transmission Systems FT-Lightwave Booster Amplifier Description, Engineering, Installation, and Maintenance* (365-565-500).]

Figure 3-44 shows an application in which ring A lacks the fiber to span the distance between the two central offices (CO 1 and CO 2) and the repeater site.

Using a different 1.5 μm WDM- and LBA-compatible wavelength transmitter in each ring and multiplexing the two signals through a WDM device at CO 1, allows both rings to share service and protection fiber between the sites. In this figure, assume that nodes in ring A use FT-2000 OC48 TRMTR (A/D STS1 1.5 LBA, W1). Ring B uses FT-2000 OC48 TRMTR (A/D 1.5 LBA, W2). In addition, an FT-LBA is collocated with the FT-2000 in the same central office (CO 1). The WDM multiplexes the two signals and sends them through the FT-LBA to span the 110 kilometer distance to the repeater site.

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15. These regenerator circuit packs require Release 6.0.1 or greater of the Repeater Bay software. For ordering information, see the **R-Bay** tab in Chapter 7.

The WDM at the repeater site demultiplexes the received signal into the two origi-nal 1.5 μm wavelengths. Because each regenerator can regenerate one signal, the WDM sends each signal to a different repeater at the site. After being regener-ated, both signals are multiplexed by another WDM and sent to CO 2. The WDM in CO 2 demultiplexes the signals. It sends the signal destined for ring A to the FT-2000 OC-48 Add/Drop-Rings Terminal (in CO 2) and the signal destined for ring B to the repeater for regeneration.
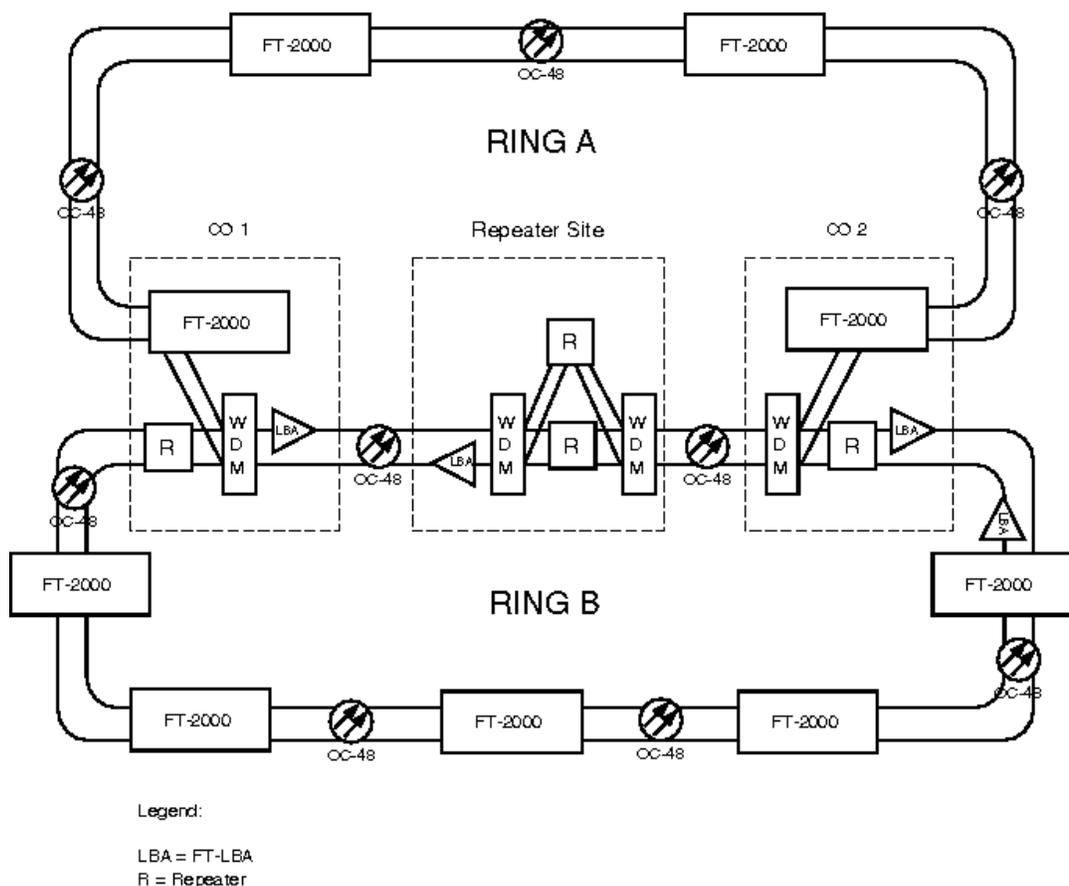
Figure 3-44.   Two-Ring WDM and FT-LBA Application Using OC48 REGENR (A/D 1.5 LBA, W1) and OC48 REGENR (A/D 1.5 LBA, W2)

Multivendor Operations Interworking (OI) Applications

Figure 3-45 shows a multivendor application partnering the Lucent DDM-2000 and FT-2000 with Tellabs *TITAN*[16]*5500* DCS. This OI, based on SONET standards, allows service providers to offer more flexible services to generate revenues and improve overall network maintenance efficiency.
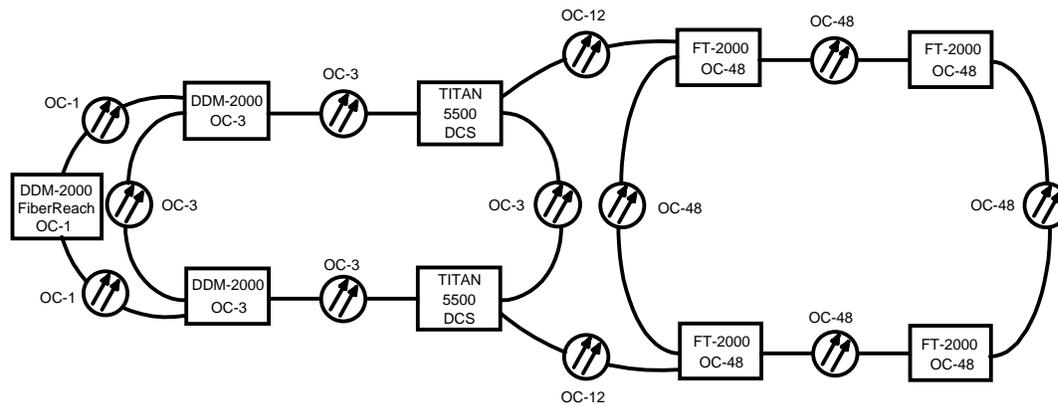
tpa 851613/01

Figure 3-45.   Interworking of OC-1/OC-3/OC-12/OC-48 with Tellabs *TITAN 5500* DCS

Red-Line Services Applications

The application for red-line services are for critical cross-connects such as airport facilities, defense, and hospital connections.

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16.   *TITAN* is a registered trademark of Tellabs, Inc.

Product Description

4

Contents

Product Description

4

Overview

This chapter provides a detailed view of the FT-2000 OC-48 Lightwave System architecture and features. After introducing the FT-2000 OC-48 Lightwave System platforms, this chapter describes the following systems down to the circuit-pack level: system control, physical design, transmission, synchronization, protection, and powering.

Introduction

The FT-2000 OC-48 Lightwave System consists of several platforms. A platform is a family of equipment and software configurations designed to support a particular application. These platforms include the:

■ FT-2000 OC-48 Add/Drop-Rings Terminal

■ FT-2000 OC-48 Dual Lightwave Terminating Bay

■ FT-2000 OC-48 Repeater Bay.

These platforms enable the FT-2000 OC-48 Lightwave System to offer flexible and upgradable features for different applications in high-capacity loop, interoffice, out-state, and long-haul environments. The FT-2000 OC-48 Lightwave System software permits the different platforms to provide different sets of features and to be upgraded with new features as they become available.

Physical Design

This section includes information about the physical design of the:

- FT-2000 OC-48 Add/Drop-Rings Terminal
- FT-2000 OC-48 Dual Lightwave Terminating Bay
- FT-2000 OC-48 Repeater Bay.

FT-2000 OC-48 Add/Drop-Rings Terminal Equipment Package

The FT-2000 OC-48 Add/Drop-Rings Terminal for 2-Fiber Rings (Figure 4-1) consists of the following equipment mounted in a single 7-foot seismic network bay:

- A power distribution and fuse panel
- One Low-Speed Shelf — System Controller
- A PC tray
- One Enhanced High-Speed Shelf.

This equipment package supports one east and one west OC-48 high-speed line. The high-speed line consists of two fibers. The maximum low-speed interface service capacity is 48 equivalent electrical or optical signals. These DS3 equivalent signals can be directed to the east or west OC-48 high-speed line.

FT-2000 OC-48 Dual Lightwave Terminating Bay Package

The FT-2000 OC-48 Dual Lightwave Terminating Bay for 2-Fiber Rings (Figure 4-2) consists of the following equipment mounted in a single 7-foot seismic network bay:

- A power distribution and fuse panel
- A fan cooling assembly
- Two Low-Speed Shelves — System Controllers
- Two Condensed High-Speed Shelves.

This equipment package supports two east and two west OC-48 high-speed lines. The maximum low-speed interface service capacity is 96 equivalent electrical or optical signals. These DS3 equivalent signals can be directed to the east or west OC-48 high-speed line.

FT-2000 Dual Lightwave Terminating Bay with
WaveStar **2.5G**

The FT-2000 Dual Lightwave Terminating Bay for 2-Fiber Rings can be combined with the *WaveStar* 2.5G (Figure 4-3) to provide greater bandwidth capacity. A 2.5G system can add/drop up to 96 STS-1 tributaries, while the FT-2000 node can add/drop only up to 48 STS-1 tributaries. Therefore, replacing a FT-2000 Shelf with a 2.5G system effectively doubles OC-48 bandwidth capacity.

The 2.5G system may be inserted into the Dual Lightwave Terminating Bay by removing the **UPPER** Low-Speed Shelf/Condensed High-Speed Shelf system. The 2.5G system combined with one FT-2000 Shelf consists of the following equipment:

■   2.5G Shelf assembly

■   Two DS3 Shelf assemblies

■   One heat baffle

■   One power dietribution and fuse panel

■   One fan cooling assembly

■   One Low-Speed Shelf — System Controller

■   One Condensed High-Speed Shelf.

If desired, the **LOWER** FT-2000 Shelf system can be replaced with a 2.5G system as well. However, the upper FT-2000 Shelf must be removed first. When removing the lower FT-2000 Shelf, remove the Condensed High-Speed Shelf/Low-Speed Shelf assembly, fan unit, and the power distribution and fuse panel. When replacing both FT-2000 Shelves with 2.5G systems, the Dual Lightwave Terminating Bay consists of the following equipment:

■   Two 2.5G Shelf assemblies

■   Four DS3 Shelf assemblies

■   Three heat baffles

■   One Spacer/Filler Plate (located at top of bay where the power distribution and fuse panel was positioned).

⇒ **NOTE:**
When **BOTH** FT-2000 Shelves are removed, a fan unit is not needed. Each 2.5G Shelf has a self-contained cooling system.

For more information on the *WaveStar* 2.5G system, including ordering, refer to the *WaveStar* TDM 2.5G *Applications, Planning, and Ordering Guide,* Release 2.0, 365-371-101.

Upgrades

An upgrade is the addition of new capabilities to the system (features). This addition requires new software and possibly new hardware. The FT-2000 OC-48 1x1 End Terminal with Basic Service[1] or with Protection Access can be upgraded in service to provide an FT-2000 OC-48 Add/Drop-Rings Terminal that supports Data communications channel (DCC) capability.

In-service upgrades mean there is a change from one platform to another without impacting service (however, transmission events of less than 60 ms in duration may occur). Some in-service upgrades may require rolling service to a second system before modifying the existing equipment.

The FT-2000 OC-48 can be upgraded in service to provide the following optical extensions as follows:

Low-Speed Interfaces	
From	**To**
DS3	OC-3 (OC-3c) or IS-3
STS1E	OC-3 (OC-3c) or IS-3
DS3	OC-12 (OC-12c)
STS1E	OC-12 (OC-12c)
OC3, OC3c, IS3	OC-12 (OC-12c)

For more information about upgrades, consult your local Account Executive.

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1. The FT-2000 OC-48 1x1 End Terminal with Basic Service (J68974A, L1) was rated Discontinued Availability (DA) effective May 1, 1994. The FT-2000 OC-48 1x1 End Terminal with Protection Access (J68974E, L2) and FT-2000 OC48 1x1 End Terminal with Basic Service (J68974E, L6) were rated Discontinued Availability (DA) effective December 31, 1995.
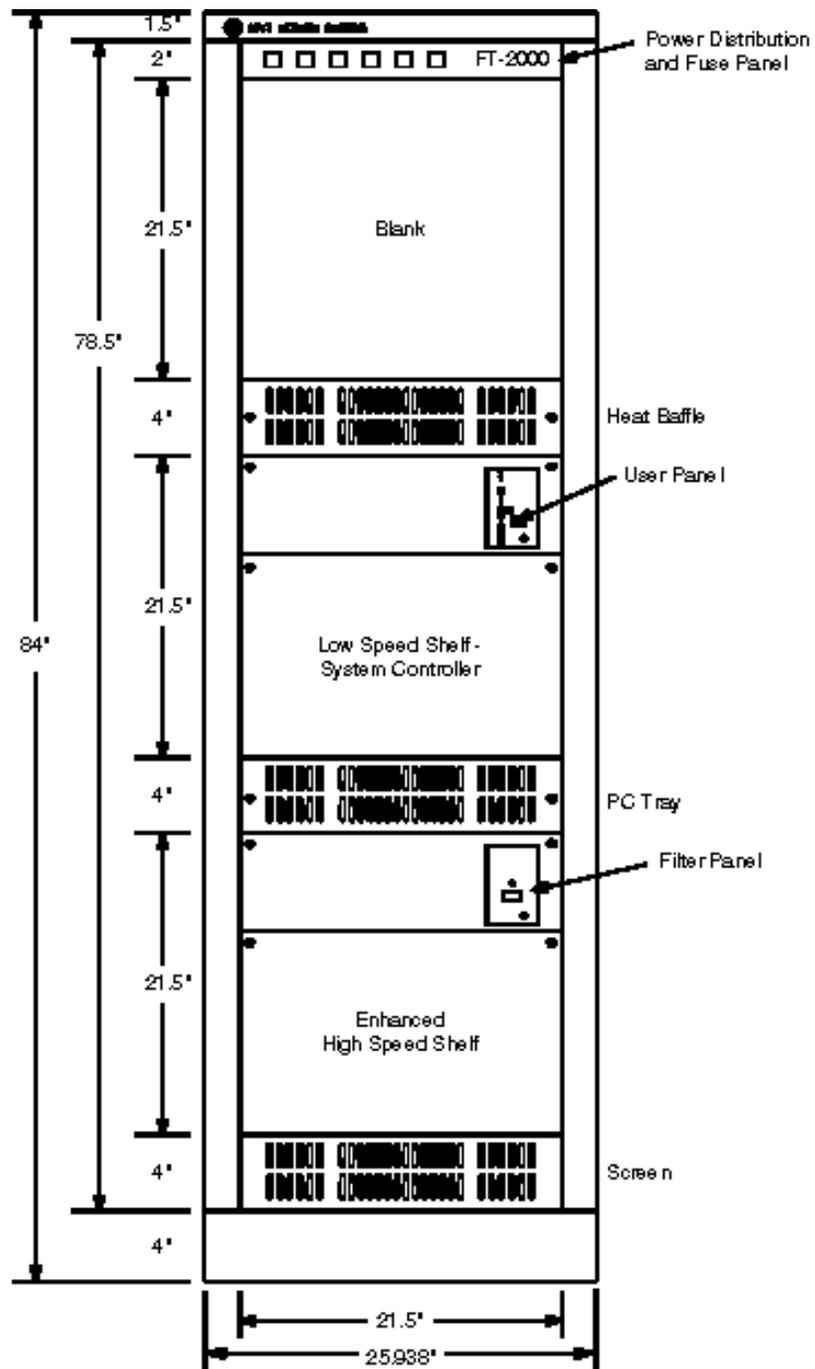
Figure 4-1.   FT-2000 OC-48 Add/Drop-Rings Terminal for 2-Fiber Rings
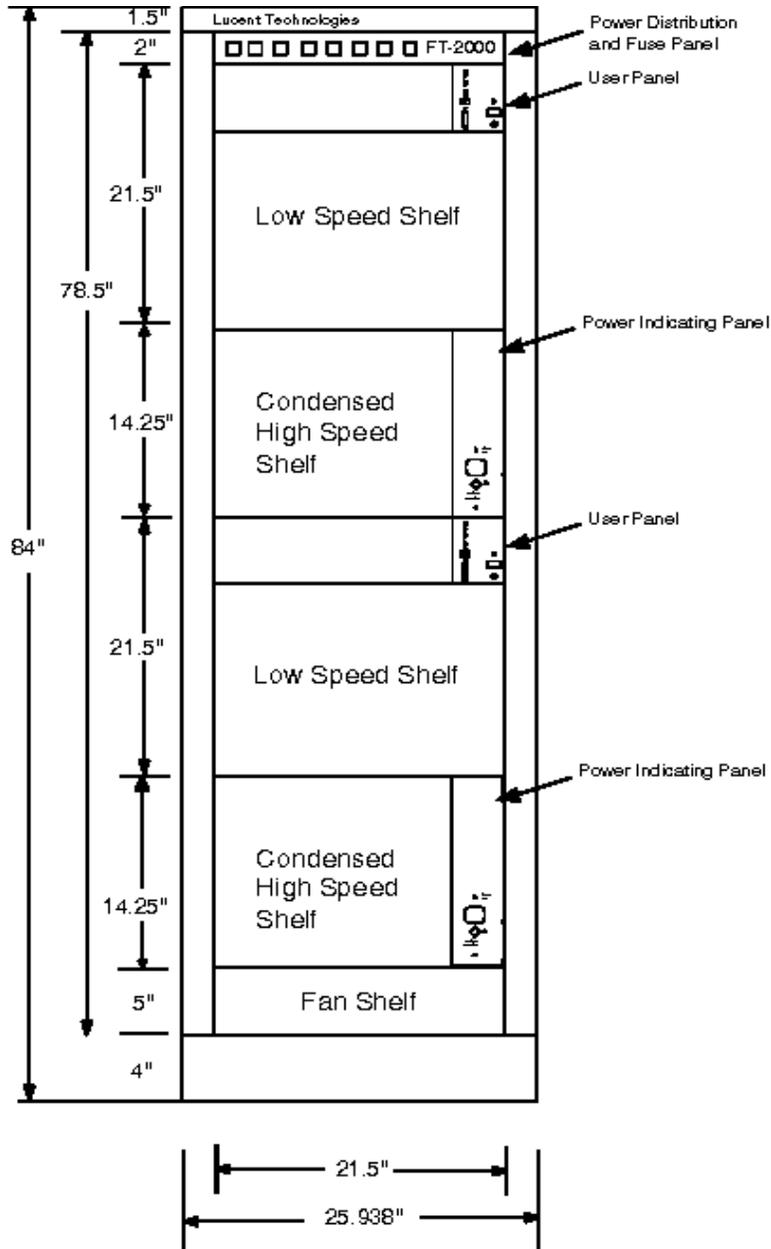
Figure 4-2.   FT-2000 OC-48 Dual Lightwave Terminating Bay

WAVESTAR 2.5 GF
BANDWIDTH
MANAGER

INTERCONNECTION
SHELF COVER
ASSEMBLY

(OC-48 LOW SPEED SHELF
SYSTEM CONTROLLER,
MOUNTED AT BOTTOM BAY
POSITION)

FT2000 OC-48
DUAL BAY
SYSTEM

(OC-48 CONDENSED
HIGH SPEED SHELF,
MOUNTED AT BOTTOM
BAY POSITION)

(FAN UNIT)

FRONT VIEW
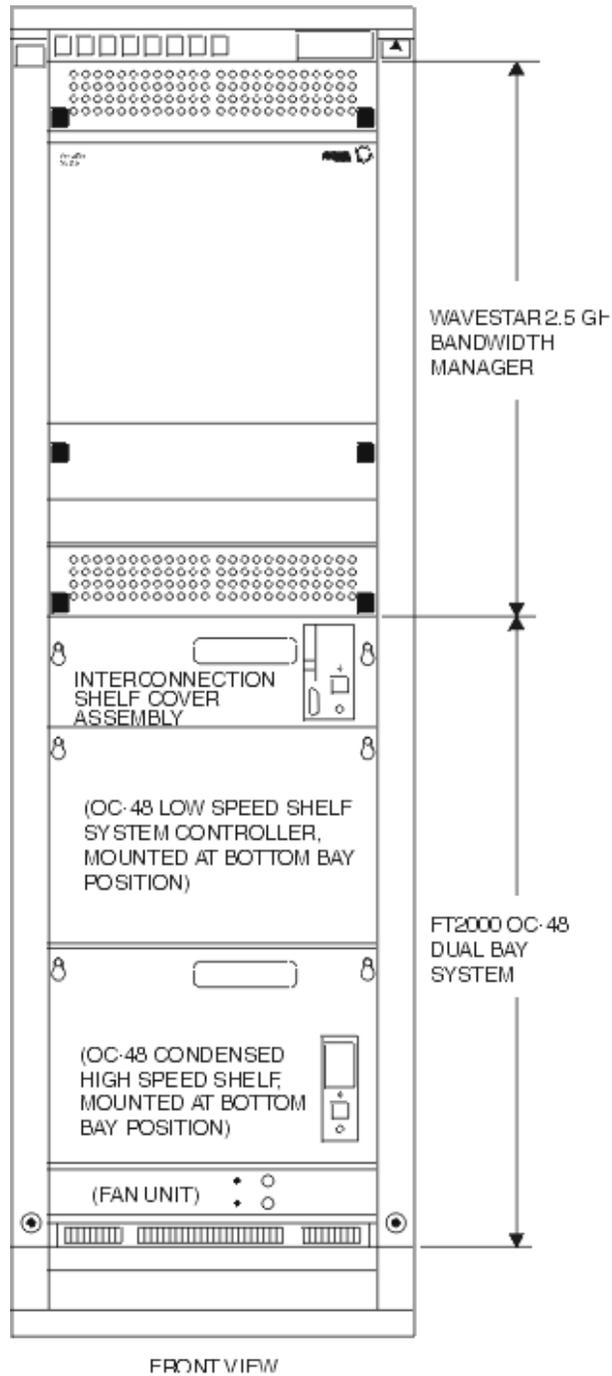
Figure 4-3.   FT-2000 Dual Lightwave Terminating Bay with *WaveStar* 2.5G

Shelf Descriptions

The FT-2000 OC-48 Add/Drop-Rings Terminal consists of the:

- Low-Speed Shelf -— System Controller
- Enhanced High-Speed Shelf

The FT-2000 OC-48 Dual Lightwave Terminating Bay consists of:

- Two Low-Speed Shelves — System Controllers
- Two Condensed High-Speed Shelves.

Power Distribution and Fuse Panel

The power distribution and fuse panel (Figure 4-4 and Figure 4-5) is located at the top of each FT-2000 OC-48 Lightwave System or Dual Lightwave System bay. It measures 2 inches high by 21.5 inches wide by 12 inches deep. The power distribution and fuse panel has a removable front cover that allows front access for shelf power connections. It accepts two 8-gauge power feeder stubs and distributes power to the shelves in the bay. The power distribution and fuse panel are equipped as follows:

- For the FT-2000 OC-48 Add/Drop-Rings System is equipped with six 10-amp fuses (two for each shelf in the bay). Three fuses are for power feeder A and three fuses are for power feeder B.

- For the FT-2000 OC-48 Dual Lightwave System is equipped with eight 10-amp fuses (two for each shelf in the bay). Four fuses are for power feeder A and four fuses are for power feeder B.
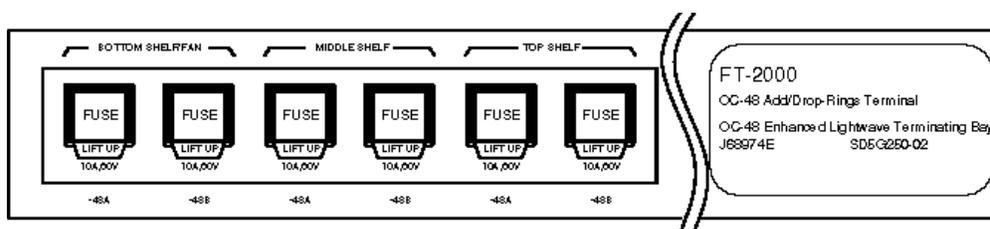
Figure 4-4.   Power Distribution and Fuse Panel for Add/Drop-Rings
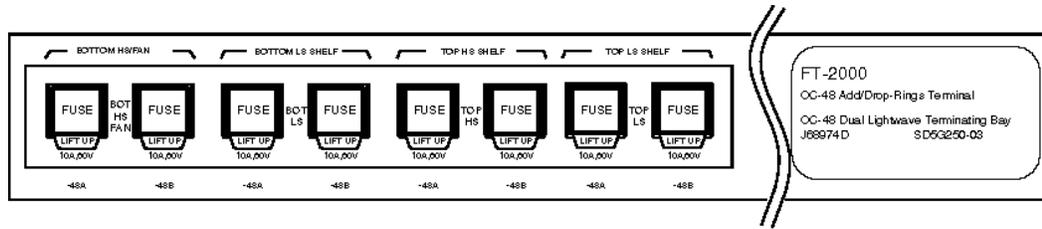
Figure 4-5.   Power Distribution and Fuse Panel for the Dual Bay

Low-Speed Shelf — System Controller

The Low-Speed Shelf — System Controller (Figure 4-6) consists of a fully connectorized interconnection panel, a user panel, and 25 circuit pack slots. It measures 21.5 inches high by 21.5 inches wide by 12 inches deep and fits in a standard 26-inch wide, seismic network bay frame.

The Low-Speed Shelf — System Controller provides the following circuit pack slots:

- Sixteen slots (LS INTFC 1A-8B) are reserved for the following low-speed interface circuit packs:

    — DS3 Interface (DS3) circuit pack (service)

    — EC-1 Interface (STS1E) circuit pack (service)

    — OC-3 Optical Interface (OC3) circuit pack

    — IS-3 Optical Interface (IS3) circuit pack

    — OC-12 Optical Interface (OC12) circuit pack.

- Two slots (LS INTFC P1 and P2) are reserved for protection of the electrical low-speed interface circuit packs (DS3 or STS1E). Only one DS3 and/or one STS1E circuit pack may be placed in the P1 and P2 slot. Two DS3 or two STS1E circuit packs cannot be used in these two slots.

- Two slots (LSSW) are reserved for two electrical Low-Speed Switch (LSSW) circuit packs. The LSSW circuit packs are optional but recommended for DS3 and STS1E applications.

■ One slot is reserved for the Tributary Overhead Controller (TOHCTL) circuit pack. A TOHCTL circuit pack is required only if you have OC3 or OC12 circuit packs and want to access the DCC capabilities.

■ Two slots (TG) are reserved for the Timing Generator, Stratum 3 - DS1 [TG3 (DS1)] circuit packs.

■ One slot (SYSCTL) is reserved for the System Controller (SYSCTL) circuit pack.

■ One slot (SYSMEM) is reserved for the System Memory (SYSMEM) circuit pack.

Circuit pack keying prevents circuit packs from being accidentally inserted into incorrect slots.
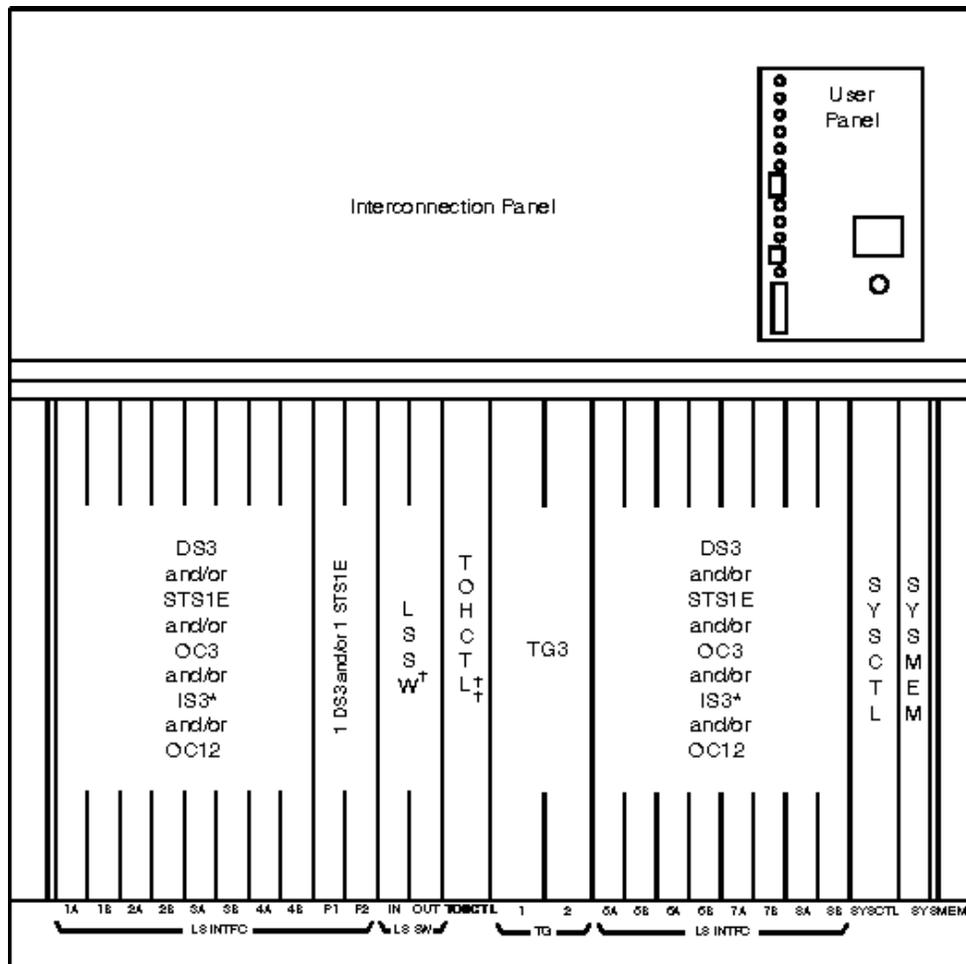
* IS3 circuit pack is for intraoffice applications only.
† LSSW is required only if you use DS3 and/or STS1E circuit packs with low speed protection
  (low speed protection is strongly recommended).
‡ TOHCTL is required only if you use OC3 or OC12 circuit packs and want DCC capabilities.

adr04008.01aJK040997

Figure 4-6.   Low-Speed Shelf — System Controller

Interconnection Panel

Front access connectors are provided through the interconnection panel
(Figure 4-7) for:

- Electrical low-speed interfaces

- Message-based operations systems access (X.25)

- Serial telemetry and parallel telemetry

- Office alarms

- Miscellaneous discretes

- Timing

- Remote craft interface terminal (CIT) modem

- Power.

Each column of low-speed interface connectors is cabled from left to right to the
electrical low-speed interface slots 1A through 8B. For example, a DS3 circuit
pack in slot 1A receives three DS3 signals through the three IN connectors (1, 2,
and 3) on the interconnection panel associated with slot 1A. The DS3 circuit pack
in slot 1A also transmits three DS3 signals through the three OUT connectors
(1, 2, and 3) associated with slot 1A. The 9A through 16B connector designations
are not used. The electrical low-speed interface cables for a given slot are not
required if an OC3 circuit pack is located in that corresponding slot. For more
information, refer to SD-5G250-02, *FT-2000 OC-48 Enhanced Lightwave Termi-
nating Bay Application Schematic*.
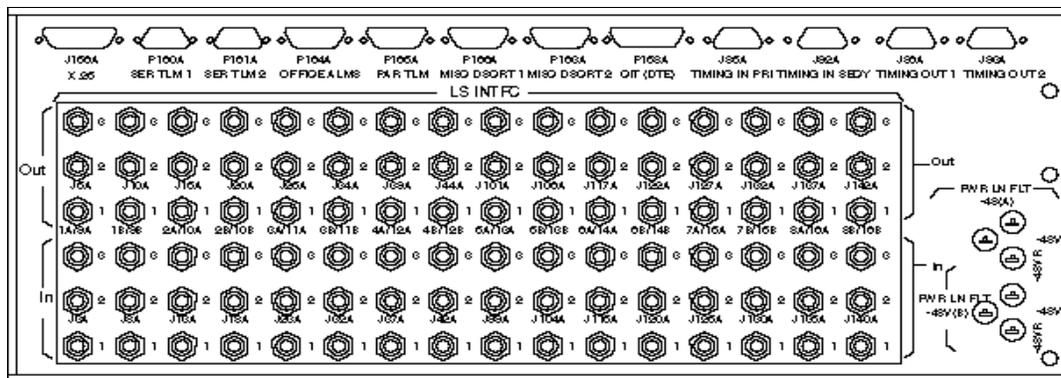
Figure 4-7. Interconnection Panel for the Low-Speed Shelf — System Controller

User Panel

The user panel provides system-level information. It is a factory-installed unit mounted next to the right-hand flange on the Low Speed Shelf - System Controller, the Repeater Shelf - System Controller, and the FT-2000 OC-48 Repeater Shelf. Figure 4-8 shows the user panel on the FT-2000 OC-48 Add/Drop-Rings Terminal Low Speed Shelf – System Controller. The user panel LEDs show the following local system information:

■ A red LED is shown for critical (CR) and major (MJ) alarms.

■ A yellow LED is shown for minor (MN) alarms.

■ A green alarm cutoff/line locator (ACO/LOCTR) push-button with a built-in LED activates the alarm cutoff function and lights the LED. The ACO/LOCTR push-button also controls the line locator (LINE LOCTR) LEDs, showing the shelf where a fault has occurred.

■ The yellow abnormal (ABN) LED is lighted when a temporary condition, potentially affecting transmission, exists; for example, a CIT-initiated protection switch or lockout, or loopback.

■ The yellow near-end activity (NE ACTY) LED is lighted when any alarm or status condition exists at the local terminal.

■ The yellow far-end activity (FE ACTY) LED is lighted when any alarm or status condition exists at any remote terminal.

> ⇒ **NOTE:**
> For Releases 8.1 and later, the FE ACTY LED is lighted only when an OC-48 protection switch is active at the remote terminal.

■ The LINE LOCTR consists of two 7-segment displays and two individual LEDs. (An earlier version had one 7-segment display and lacked the individual LEDs.)

The two 7-segment displays normally show the line number when a circuit pack fails. When the ACO/LOCTR push-button is pressed in and held, they show the shelf associated with the line containing the failed circuit pack.

The red east (E) and west (W) LEDs complete the number of the line containing the failed circuit pack. For example, if the failed circuit pack is associated with line 1E the right-hand 7-segment display will show the number "1" and the E LED will be lighted.

■ The yellow USE CIT LED is lighted when the CIT must be used to obtain more detailed information about system status.

■ The green power on (PWR ON) LED is lighted when the shelf is receiving -48 V power.
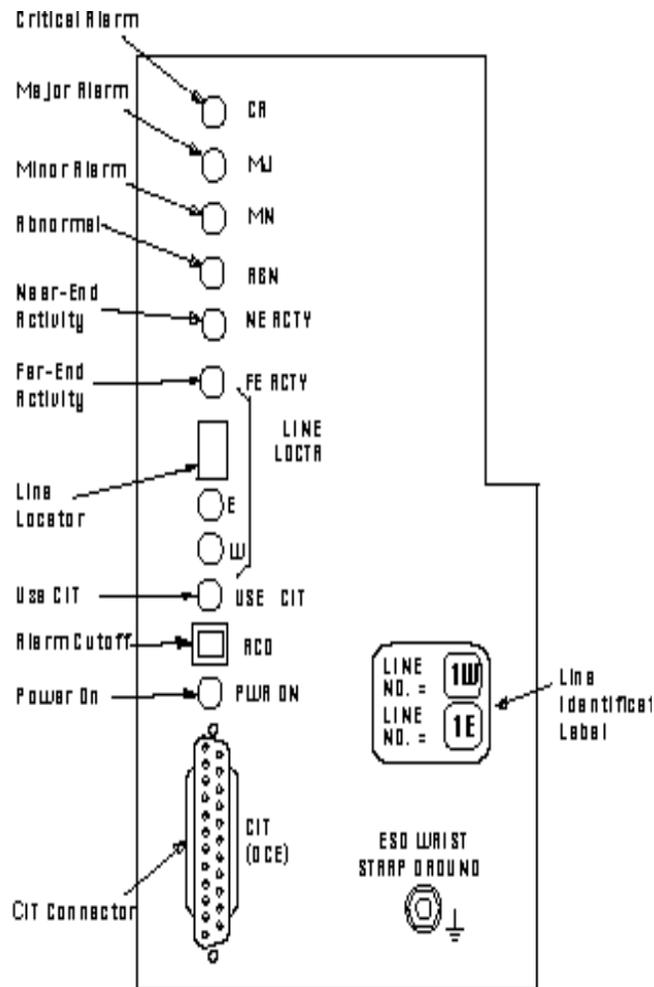
Figure 4-8. User Panel of the Low-Speed Shelf — System Controller for Add/Drop-Rings Terminal/Dual Bay

Figure 4-9 shows the user panel on the FT-2000 OC-48 Repeater Shelf - System Controller.
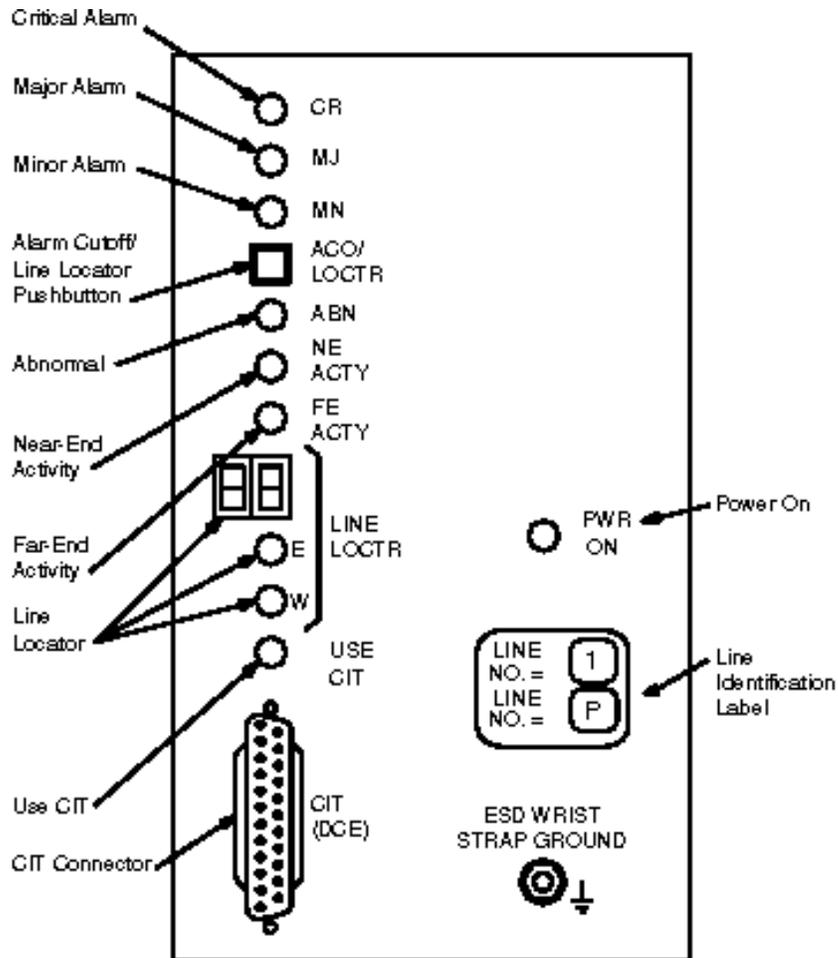
Figure 4-9.   User Panel (FT-2000 OC-48 Repeater Shelf – System Controller)

The user panel for the FT-2000 OC-48 Repeater Shelf (Figure 4-10) is also equipped with two fuses (-48A and -48B). One 10-amp fuse is provided for each -48 V DC power feeder (power feeder A and power feeder B).
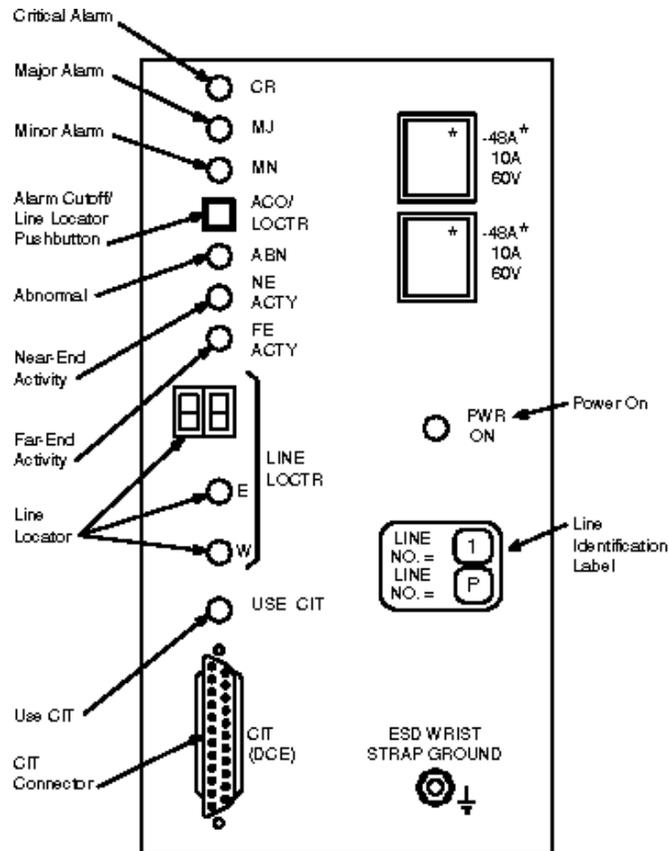
Figure 4-10. **User Panel (FT-2000 OC-48 Repeater Shelf)**

Front Covers

The Low-Speed Shelf — System Controller has two front covers. One covers the interconnection panel and the other covers the circuit packs. Openings in the top cover allow the user panel to show through and provide access to the craft inter-face terminal (CIT) port. The covers are hinged and can be easily removed for maintenance access.

The Enhanced and Condensed High-Speed Shelf

The Enhanced High-Speed Shelf (Figure 4-11) and Condensed High-Speed Shelf (Figure 4-12) consist of a fully connectorized interconnection and filter panel, as well as 12 circuit pack slots. Measurements for the high-speed shelves are:

- The Enhanced High-Speed Shelf measures 21.5 inches high by 21.5 inches wide by 12 inches deep and fits in a standard 26-inch wide seismic network bay frame.

- The Condensed High-Speed Shelf measures 14.25 inches high by 21.5 inches wide by 12 inches deep and fits in a standard 26-inch wide seismic network bay frame.

The Enhanced and Condensed High-Speed Shelves provide the following circuit pack slots:

- Two slots (TRMTR) for the OC48 Transmitter (OC48 TRMTR) circuit packs.

- Two slots (RCVR) for the OC48 Receiver (OC48 RCVR) circuit packs.

- One slot (LNCTL) for the Line Controller (LNCTL) circuit pack. One LNCTL is required for the FT-2000 OC-48 Add/Drop-Rings Terminal.

- Two slots for the Overhead Controller - Terminal [OHCTL (TERM)] circuit packs.

Circuit pack keying prevents circuit packs from being accidentally inserted into incorrect slots.
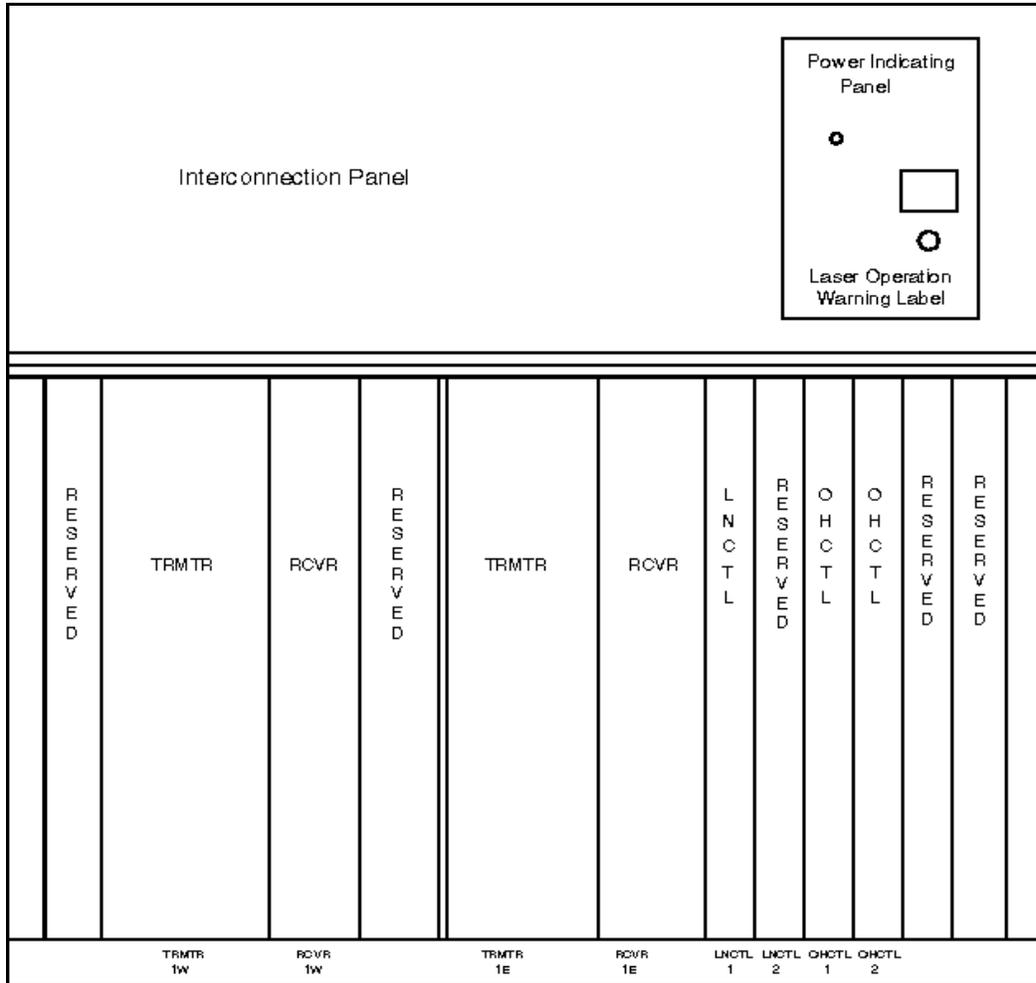
Figure 4-11.   Enhanced High-Speed Shelf
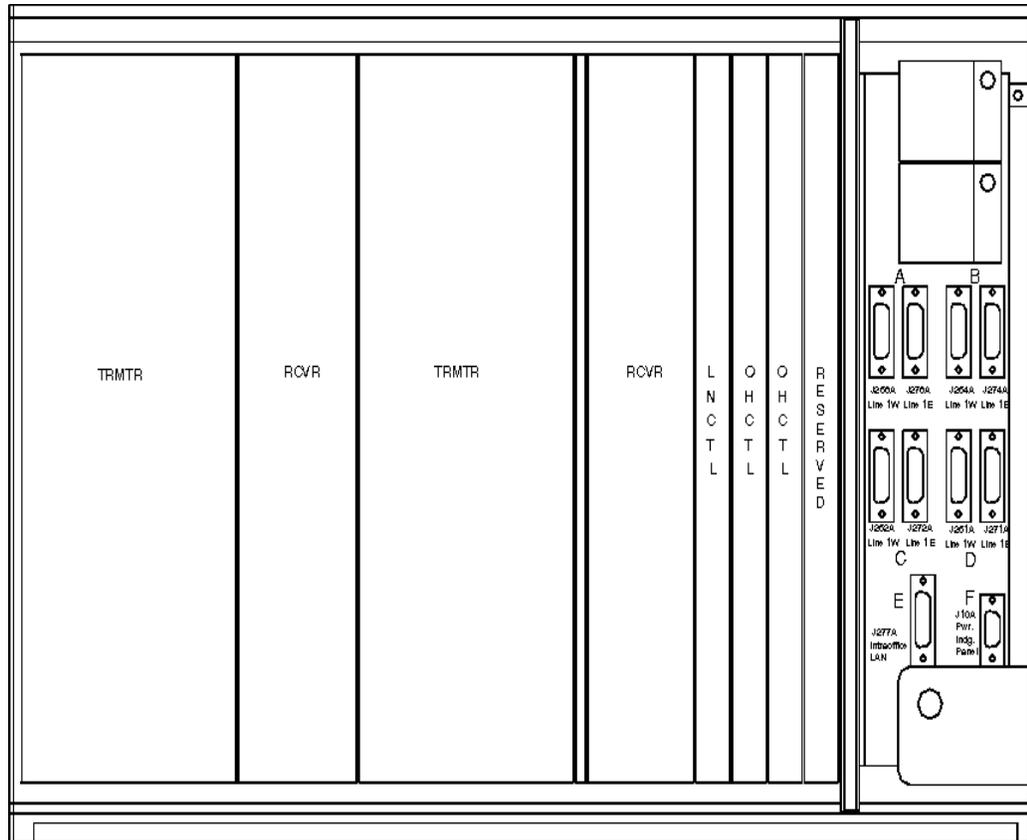
A: Section Order Wire (Local Order Wire)
B: Line Order Wire (EXP OW)
C: Line Growth Channel
D: Section User
E: Intraoffice LAN (Reserved for Future)
F: Power Indicating Panel [(PWR INDG PNL) (Cabled at Factory)]

Figure 4-12.   Condensed High-Speed Shelf (Dual Bay)

Add/Drop-Rings Terminal Interconnection Panel

Front access connectors are provided through the interconnection panel (Figure 4-13) for the following:

- Orderwire
- Power.
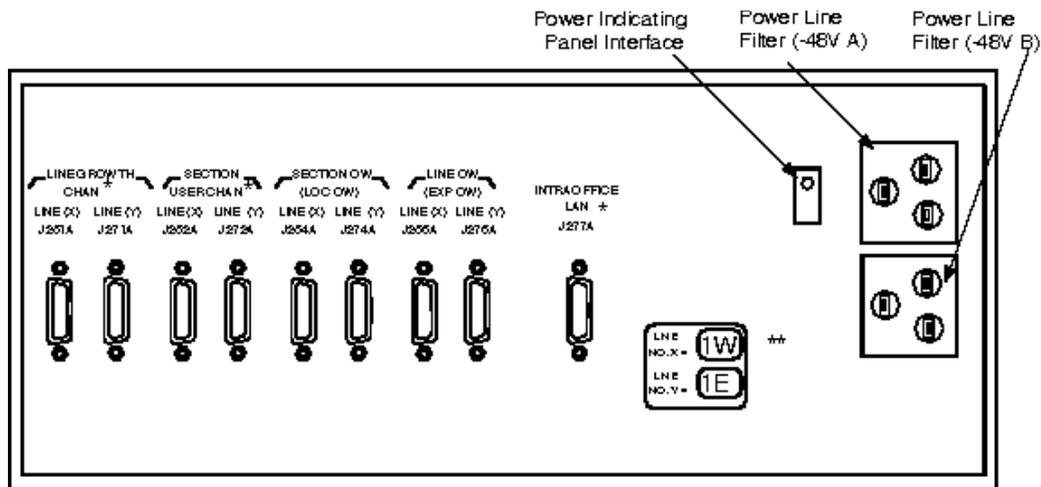
Figure 4-13. Interconnection Panel of the Enhanced High-Speed Shelf

Filter Panel

The filter panel (Figure 4-14) is a factory-installed unit mounted next to the right-hand flange on the Low Speed Shelf, Repeater Shelf, and Enhanced High Speed Shelf and provides -48 V power filters. The panel has a green power on (PWR ON) LED to show that the shelf is receiving -48 V power and an electro-static discharge jack.

adr04019.00eJF09189697.1
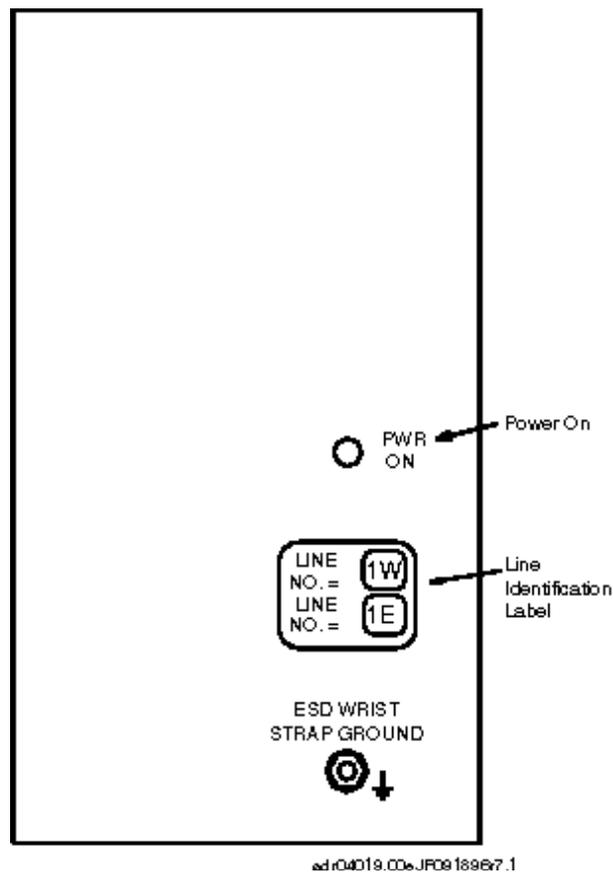
Figure 4-14.   Filter Panel of the Enhanced High-Speed Shelf

In the Dual Lightwave Terminating Bay, the interconnection and filter panel of the Condensed High Speed Shelf has a green power on (PWR ON) LED to indicate the shelf is receiving -48 V power. It is called the Power Indicating Panel (Figure 4-15).

adr05D04.00e JF10219617.1

Figure 4-15.   Power Indicating Panel (Condensed High Speed Shelf for FT-2000 OC-48 Dual Lightwave Terminating Bay)

Dual Lightwave Terminating Bay Interconnection and Filter Panel

Front access connectors (Figure 4-16) are provided through the interconnection and filter panel for orderwire and power.

The filter portion of the panel provides -48 V power filters, a power on (PWR ON) LED, and an electrostatic discharge jack.
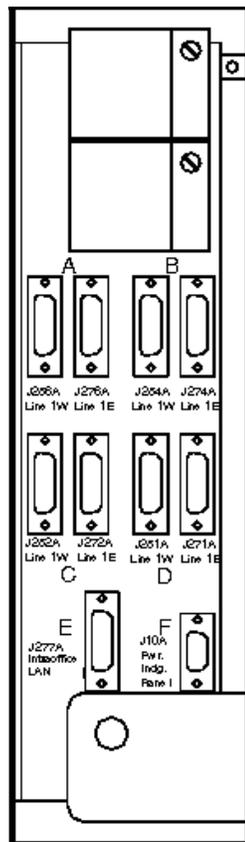
adr05005.00bJF102196r7.1

Figure 4-16.   Interconnection and Filter Panel of the Condensed High-Speed Shelf

Dual Lightwave Terminating Bay Fan Shelf

The fan shelf assembly (Figure 4-17) is required to keep the two systems in the single bay cool. It provides:

■   An alarm LED light and a power on LED light

■   A Feed and B Feed -48 V DC circuit breakers

■   An intake air filter.

⇒ NOTE:
> The filter for the fan units need to be changed every six months.

adr04037.01 aJF09189697.1
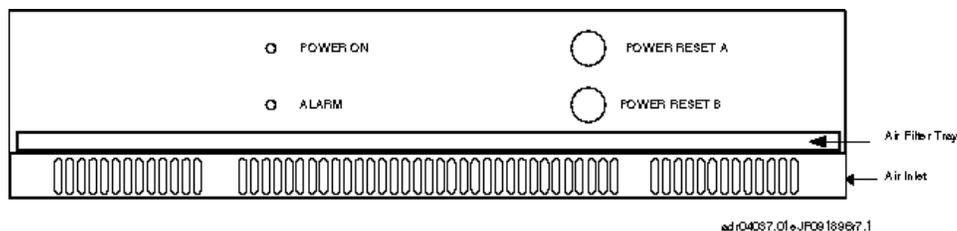
Figure 4-17.   Dual Bay Fan Shelf

⇒ NOTE:
> All circuit pack slots in the dual bay must be filled to allow the fan to cool the entire bay. Blank face plates (apparatus blanks) must be installed in slots where there are no circuit packs.

FT-2000 OC-48 Repeater Bay

Equipment Packages

> The FT-2000 OC-48 Repeater Bay is available as a bay arrangement for a single or multiple (up to three) 0x1 or 1x1 protected systems. The miscellaneously mounted FT-2000 OC-48 Repeater Shelf is also available.

> The FT-2000 OC-48 Repeater Bay (Figure 4-18) consists of a power distribution and fuse panel, one Repeater Shelf — System Controller, and a PC tray mounted in a single 7-foot seismic network bay. It is possible for one 7-foot seismic network bay to contain up to three independent 0x1 or 1x1 systems. This bay arrangement consists of one power distribution and fuse panel, a PC tray, and up to three Repeater Shelves — System Controllers.
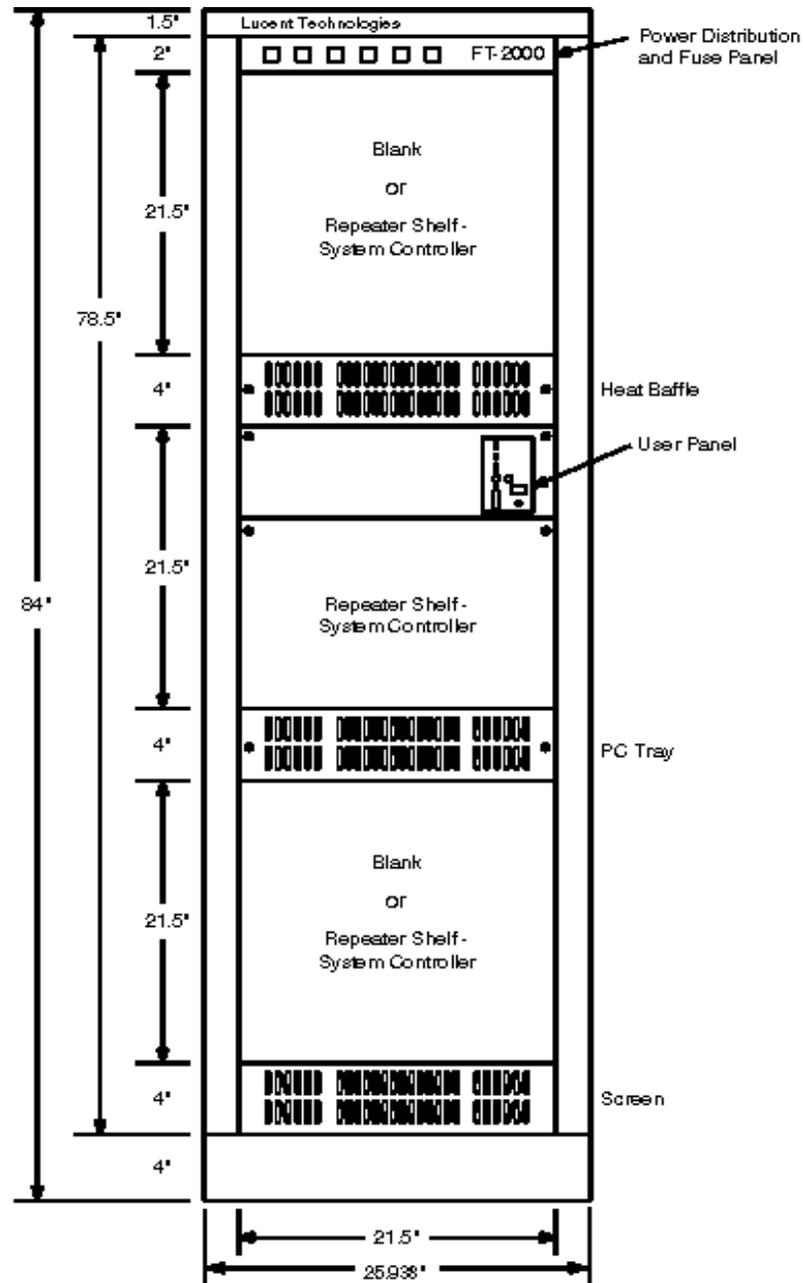
Figure 4-18.   FT-2000 OC-48 Repeater Bay

Shelf Descriptions

Repeater Shelf — System Controller

The Repeater Shelf — System Controller (within Figure 4-19) consists of the fully connectorized interconnection panel, a user panel, and eight circuit pack slots. It measures 21.5 inches high by 21.5 inches wide by 12 inches deep and fits in a standard 26-inch wide bay.

The Repeater Shelf — System Controller provides slots for the following circuit pack:

- Four slots (labeled REGENR) are for the OC48 Regenerator (OC48 REGENR) circuit packs. You can mix the 1.3 μm and 1.5μm regenerators in the same shelf.

- One slot (labeled ROHCTL 1) is for the optional Orderwire access (OW) cir- cuit pack.

- One slot (labeled ROHCTL P) is reserved.

- One slot (labeled SYSCTL) is for the System Controller (SYSCTL) circuit pack.

- One slot (labeled SYSMEM) is for the System Memory (SYSMEM) circuit pack.

Circuit pack keying prevents circuit packs from being accidentally inserted into incorrect slots.

Figure 4-19 shows the miscellaneously-mounted FT-2000 OC-48 Repeater Shelf. This shelf arrangement consists of one Repeater Shelf — System Controller, a PC tray, and a user panel equipped with two 10-amp fuses. (Power fusing is per- formed on the shelf level.) It is possible to mount the miscellaneously mounted FT-2000 OC-48 Repeater Shelf in several types of network bays or ESS bays. This shelf arrangement may be used in existing bays where space is limited or in cross route locations.
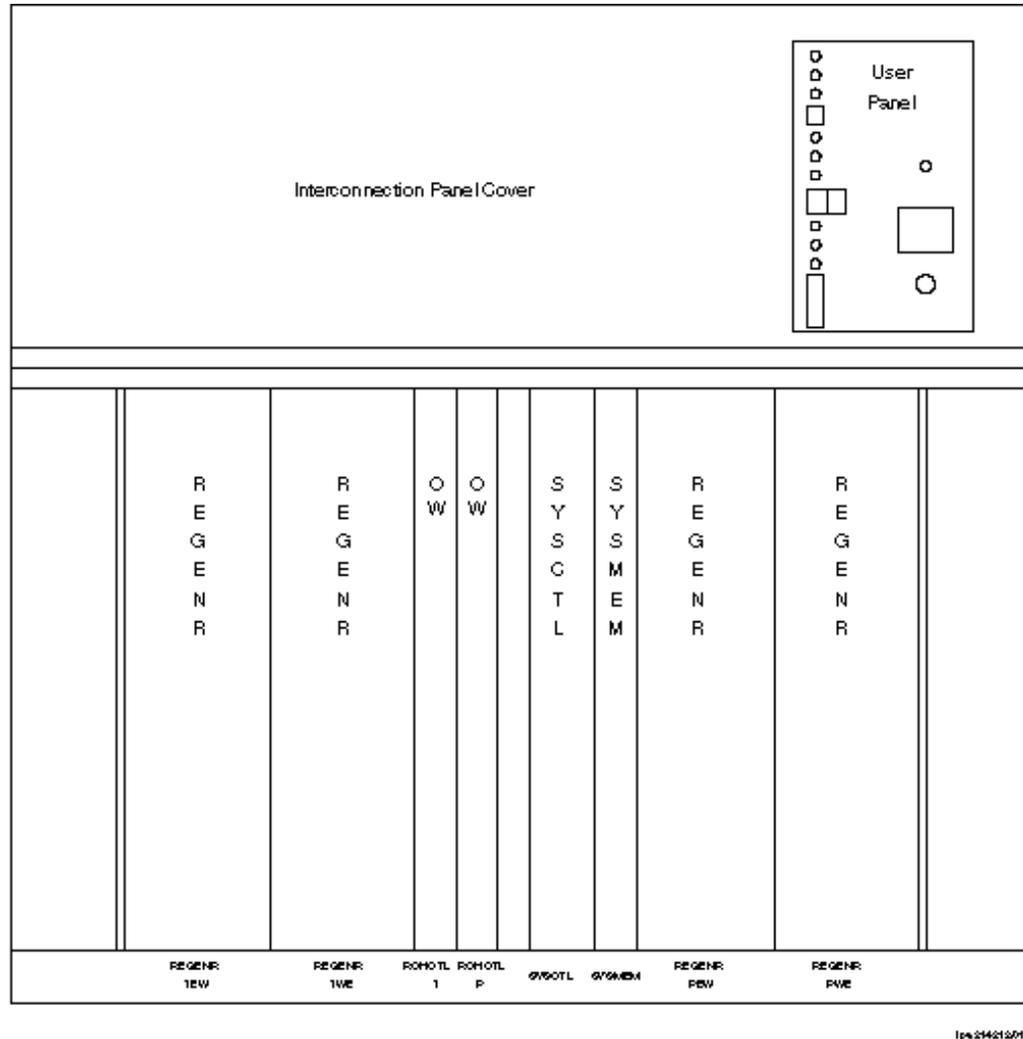
Figure 4-19. FT-2000 OC-48 Repeater Shelf ─ System Controller (Miscellaneously Mounted)

Interconnection Panel

Front access connectors are provided through the interconnection panel
(Figure 4-20) for:

- Shelf control

- Office alarms

- Miscellaneous discretes

- Remote CIT modem

- Control bus

- Local orderwire

- Power.
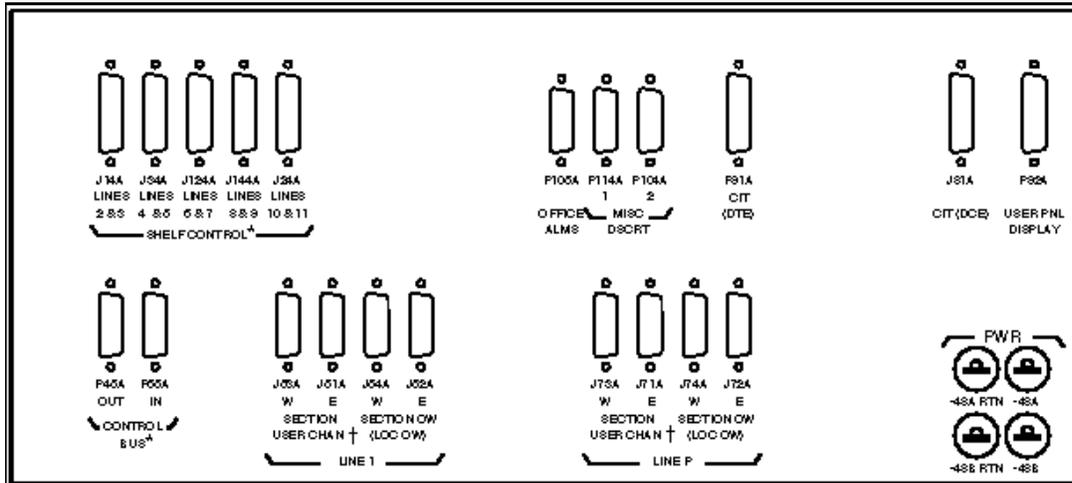
* Unavailable on the miscellaneously mounted shelf

† Reserved

Figure 4-20.   Interconnection Panel of the Repeater Shelf — System Controller

Transmission

This section includes information about transmissions for the:

- FT-2000 OC-48 Add/Drop-Rings Terminal

- FT-2000 OC-48 Dual Lightwave Terminating Bay

- FT-2000 OC-48 Repeater Bay.

FT-2000 OC-48 Add/Drop-Rings Terminal and Dual Lightwave Terminating Bay - 2-Fiber Ring

The FT-2000 OC-48 Add/Drop-Rings Terminal allows combinations of low-speed signals to be easily added or dropped. The through traffic is passed on without requiring low-speed interface circuit packs. The FT-2000 OC-48 Add/Drop-Rings Terminal provides a bidirectional line-switched ring capacity for use in 2-fiber ring applications.

Figure 4-21 shows a transmission block diagram of an FT-2000 OC-48 Add/Drop-Rings Terminal in a 2-fiber ring application. The FT-2000 OC-48 Add/Drop-Rings Terminal interfaces with up to 48 bidirectional DS3 equivalent signals and 2 OC-48 high-speed lines (1W and 1E). The Low-Speed Shelf — System Controller is cabled to one Enhanced High-Speed Shelf allowing low-speed signals to be routed to high-speed line 1W or 1E. The FT-2000 OC-48 Add/Drop-Rings Terminal accepts DS3, EC-1, and OC-3, IS-3, and OC-12 low-speed signals.
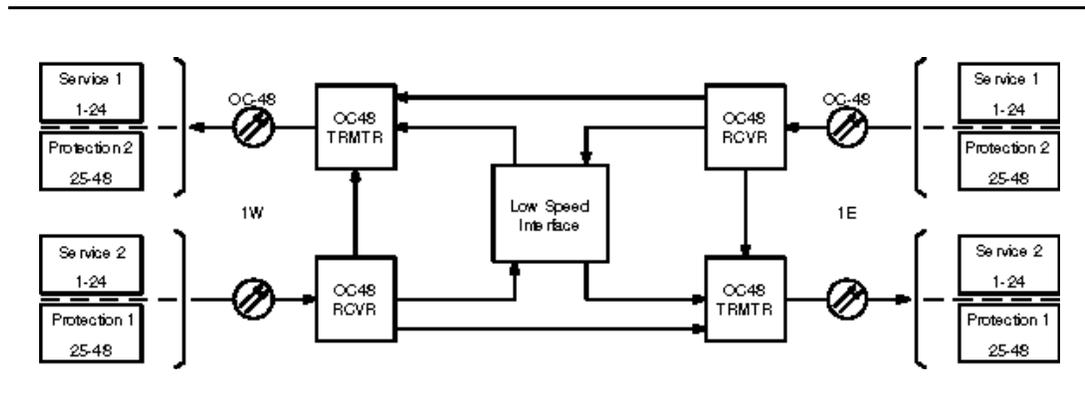
Figure 4-21. FT-2000 OC-48 Add/Drop-Rings Terminal Transmission Block Diagram (2-Fiber Ring)

Internally, the FT-2000 OC-48 Add/Drop-Rings Terminal employs SONET standard multiplexing for adding and dropping low-speed signals. (Refer to Appendix A.) To add low-speed signals, the low-speed interface accepts the low-speed signals and maps them into 155 Mb/s signals. The 155 Mb/s signals are combined with the through traffic, multiplexed to one STS-48 signal, and converted to an optical OC-48 signal for transmission over high-speed line 1W or 1E. There are 24 DS3 equivalent signal channels carrying service toward high-speed line 1W and 24 channels carrying service toward high-speed line 1E. The 24 channels not carrying service are the protection channels. The protection channels on high-speed line 1W are used to protect the service channels on high-speed line 1E, and the protection channels on high-speed line 1E are used to protect the service channels on high-speed line 1W.

To drop low-speed signals, the incoming optical OC-48 signal is converted back to an electrical STS-48 signal and is demultiplexed to sixteen 155 Mb/s signals. The 155 Mb/s signals that are designated to be dropped are then demultiplexed into low-speed signals. The 155 Mb/s signals not designated to be dropped are the through traffic. The through traffic is combined with the add traffic to make a complete STS-48 signal. The STS-48 signal is then converted to an optical OC-48 signal for transmission over high-speed line 1W or 1E.

The FT-2000 OC-48 Add/Drop-Rings Terminal offers full flexibility in assigning add, drop, and through cross-connections from the craft interface terminal. The add/drop 155 Mb/s signals may be assigned to any low-speed slot. This 155 Mb/s signal to slot cross-connection is called time slot assignment (TSA). Channel assignments are also made using the craft interface terminal[2]. The 48 DS3 equivalent signals can be assigned to service or extra traffic on high-speed line 1W or 1E. Extra traffic allows access to the protection channels on high-speed line 1W and 1E for low-priority traffic, temporary capacity relief, or revenue-generating services (for example, video).

FT-2000 OC-48 Repeater Bay

FT-2000 OC-48 Repeater Bay regenerates optical OC-48 signals for up to 12 high-speed lines (4 regenerators per Repeater Shelf). Two OC48 Regenerator (OC48 REGENR) circuit packs make a repeater. For example, one OC48 REGENR circuit pack receives an incoming OC-48 signal from high-speed line 1W and transmits it toward high-speed line 1E (Figure 4-22). The other OC48 REGENR circuit pack receives an incoming OC-48 signal from high-speed line 1E and transmits it toward high-speed line 1W.

Internally, the FT-2000 OC-48 Repeater Bay employs SONET standard multiplexing. (Refer to Appendix A.) For example, the incoming optical OC-48 signal from high-speed line 1W is converted to an electrical STS-48 signal and demultiplexed

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2. A craft interface terminal (CIT-PC) is a personal computer that is loaded with FT-2000 CIT software.

to sixteen 155 Mb/s signals. This allows the SONET section overhead bytes to be extracted, monitored, and controlled. The 155 Mb/s signals are then multiplexed to one STS-48 signal, and the SONET section overhead bytes are inserted. The STS-48 signal is then converted back to an optical OC-48 signal for transmission on high-speed line 1E.
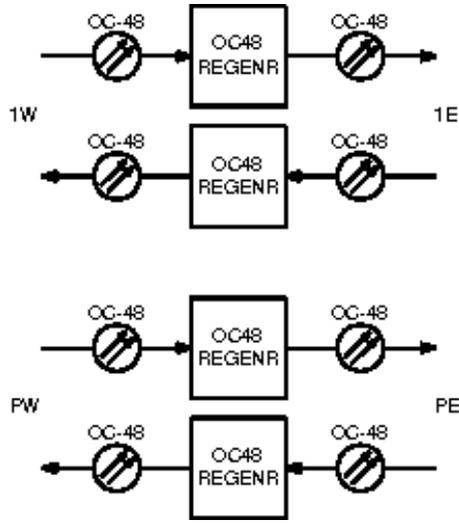
Figure 4-22.   FT-2000 OC-48 Repeater Bay Transmission Block Diagram

Transmission Circuit Packs

This section discusses how each FT-2000 circuit pack functions. For loss budget and transmission distance information, see Chapter 10, "Technical Specifications." For a complete listing of circuit pack/equipment/software compatibility, see Chapter 7, "Ordering".

OC48 Transmitter Add/Drop (OC48 TRMTR A/D)

This section discusses the OC48 Transmitter Add/Drop (OC48 TRMTR A/D).

The OC48 TRMTR A/D circuit pack is used for all FT-2000 OC-48 Add/Drop-Rings Terminal applications and provides complete nonblocking operation. This circuit pack is available in 1.3 μm (standard and high performance) and 1.5 μm (standard LBA and W1 and W2 performance) options. All OC48 TRMTR (A/D) circuit pack options meet the GR-253-CORE (Issue 1) long-reach requirement.

The OC48 TRMTR (A/D) circuit pack interfaces with the outgoing OC-48 high-speed line. The circuit pack accepts up to three different buses (add/drop, high-speed protection, and through) that carry up to eighteen 155 Mb/s signals each. Sixteen 155 Mb/s signals are for the service low-speed interface circuit packs and two are for protection low-speed interface circuit packs. The add/drop bus provides access to the 155 Mb/s signals from the low-speed interface circuit packs. The high-speed protection bus allows access to the 155 Mb/s signals during high-speed protection switching. The through bus provides access to the 155 Mb/s signals that are passed through in linear add/drop and bidirectional ring applications. Sixteen of the 155 Mb/s signals are frame synchronized and multiplexed into an STS-48 signal (2.488 Gb/s).

You must use either the 1.5 μm LBA or 1.5 μm STD performance circuit pack to operate with the FT-LBA. The 1.5 μm LBA performance circuit pack is screened for dispersion so that it can operate with the FT-LBA on standard, single-mode fiber. The 1.5 μm LBA, W1 and 1.5 μm LBA, W2 circuit packs are compatible with a WDM filter and/or the FT-LBA. The W1 and W2 transmitters operate on different wavelengths and double fiber capacity when their outputs are multiplexed through a WDM. The FT-LBA extends the span distance.

You must use only STS1 transmitters on those nodes where you require STS-1 granularity across an OC-48. These transmitters are:

- 737B5 OC48 TRMTR (A/D STS1 1.3 μm STD) (OC-12c ready)

- 739C5 OC48 TRMTR (A/D STS1 1.3 μm HI PERF) (OC-12c ready)

- 739J5 OC48 TRMTR (A/D STS1 1.5 μm STD) (OC-12c ready)

- 739P5 OC48 TRMTR (A/D STS1 1.5 μm LBA) (OC-12c ready)

- 739R5 OC48 TRMTR (A/D STS1 1.5 LBA, W1) and OC48 TRMTR (A/D STS1 1.5 LBA, W2).

When FT-2000 OC-48 ADR is used with OLS for dense wavelength division multiplexing, the 739E(1-8) and 739G(1-8) TRMTR circuit packs are optimized for operation with the OLS. These 16 transmitters are designed to transmit in the first 8 wavelengths required by OLS. These transmitters have their dispersion performance optimized for the long distances that OLS makes possible (up to 360 km with E type transmitters and 640 km with G type transmitters). The 839E5 receiver must be used at the other end of the span, consistent with OLS requirements.

For more information about OLS, refer to the *Optical Line System Applications, Planning, and Ordering Guide* (365-575-300).

When FT-2000 OC-48 ADR is used with OLS in routes for dispersion of up to 6800 ps/nm and distance up to 360 km, one of the following 739E transmitters must be used:

- 739E1 OC48 TRMTR (STS1 1.5 μm W1)
- 739E2 OC48 TRMTR (STS1 1.5 μm W2)
- 739E3 OC48 TRMTR (STS1 1.5 μm W3)
- 739E4 OC48 TRMTR (STS1 1.5 μm W4)
- 739E5 OC48 TRMTR (STS1 1.5 μm W5)
- 739E6 OC48 TRMTR (STS1 1.5 μm W6)
- 739E7 OC48 TRMTR (STS1 1.5 μm W7)
- 739E8 OC48 TRMTR (STS1 1.5 μm W8)

When FT-2000 OC-48 ADR is used with OLS in routes for dispersion from 6800 to 10,880 ps/nm and distance up to 640 km, one of the following 739G transmitters must be used:

- 739G1 OC48 TRMTR (STS1 1.5 μm W1)
- 739G2 OC48 TRMTR (STS1 1.5 μm W2)
- 739G3 OC48 TRMTR (STS1 1.5 μm W3)
- 739G4 OC48 TRMTR (STS1 1.5 μm W4)
- 739G5 OC48 TRMTR (STS1 1.5 μm W5)
- 739G6 OC48 TRMTR (STS1 1.5 μm W6)
- 739G7 OC48 TRMTR (STS1 1.5 μm W7)
- 739G8 OC48 TRMTR (STS1 1.5 μm W8).

When the FT-2000 OC-48 Add/Drop-Rings Terminal is used with passive DWDM in routes for dispersion from 1525.80 to 1560.00 ps/nm, and up to 60 km, one of the following 739H transmitters must be used:

- 739H1 OC48 TRMTR (STS1 1.5 μm W1)
- 739H2 OC48 TRMTR (STS1 1.5 μm W2)
- 739H3 OC48 TRMTR (STS1 1.5 μm W3)
- 739H4 OC48 TRMTR (STS1 1.5 μm W4)
- 739H5 OC48 TRMTR (STS1 1.5 μm W5)
- 739H6 OC48 TRMTR (STS1 1.5 μm W6)
- 739H7 OC48 TRMTR (STS1 1.5 μm W7)
- 739H8 OC48 TRMTR (STS1 1.5 μm W8)
- 739H9 OC48 TRMTR (STS1 1.5 μm W9)
- 739H10 OC48 TRMTR (STS1 1.5 μm W10)
- 739H11 OC48 TRMTR (STS1 1.5 μm W11)
- 739H12 OC48 TRMTR (STS1 1.5 μm W12)
- 739H13 OC48 TRMTR (STS1 1.5 μm W13)
- 739H14 OC48 TRMTR (STS1 1.5 μm W14)
- 739H15 OC48 TRMTR (STS1 1.5 μm W15)
- 739H16 OC48 TRMTR (STS1 1.5 μm W16)

OC48 Receiver Add/Drop (OC48 RCVR A/D)

This section discusses the OC48 Receiver Add/Drop (OC48 RCVR A/D) circuit packs.

The OC48 RCVR A/D circuit pack is used for all FT-2000 OC-48 Add/Drop-Rings Terminal applications and provides complete nonblocking operations.

The OC48 RCVR (A/D) circuit pack interfaces with the incoming OC-48 high-speed line. The circuit pack drives up to three different buses (add/drop, high-speed protection, and through) that carry up to eighteen 155 Mb/s signals each. The add/drop bus provides access to the low-speed interface circuit packs. Sixteen 155 Mb/s signals are for the service low-speed interface circuit packs and two are for protection low-speed interface circuit packs. The high-speed protection bus provides access to other circuit packs for high-speed protection switching. The through bus provides access to an OC48 TRMTR (A/D) circuit pack for the 155 Mb/s signals that are passed through in linear add/drop and bidirectional ring applications.

The OC48 RCVR (A/D) circuit pack interfaces with an incoming OC-48 high-speed line. The OC48 RCVR (A/D) circuit packs monitor the incoming OC-48 signal, convert it to an electrical STS-48 signal, and recover the timing. The STS-48 signal is then demultiplexed into sixteen 155 Mb/s signals. The OC48 RCVR A/D circuit pack also extracts SONET overhead bytes and provides the Timing Generator, Stratum 3 - DS1 [TG3 (DS1)] circuit pack with a recovered clock. Certain SONET overhead bytes are also sent to the Overhead Controller circuit pack.

The OC48 RCVR (A/D) circuit pack drives up to eighteen 155 Mb/s signals: sixteen 155 Mb/s signals are for the service low-speed interface circuit packs and two are for protection low-speed interface circuit packs. When the corresponding low-speed interface is unequipped, the signals are disabled.

When low-speed protection switching occurs, the 155 Mb/s receive signal is switched to one of the two protection low-speed interface circuit packs.

You must use only STS1 receivers on nodes where you require STS-1 granularity across an OC-48. For more information see the Chapter 2, "STS-1 Granularity TSA Across an OC-48" section.

DS3 Interface (DS3)

The DS3 Interface (DS3) circuit pack provides multiplexing and demultiplexing between three DS3 signals and an internal 155 Mb/s signal.

In the transmit direction, the incoming DS3 signals can be either framed or unframed (clear channel). The DS3 circuit pack accepts up to three 44.736 Mb/s bipolar 3-zero substitution (B3ZS) coded DS3 signals. Each DS3 signal is mapped into an STS-1 payload envelope using the standard asynchronous DS3

mapping. The STS-1 path overhead and pointer bytes are also added to the STS-1 payload.

In the receive direction, the 155 Mb/s signal from the OC48 Receiver (OC48 RCVR) circuit pack is demultiplexed into three STS-1 signals. Each STS-1 signal goes through STS-1 pointer processing, and the STS-1 path overhead is removed and processed. After each DS3 signal is recovered from the STS-1 payload enve-lope, it may be treated as either framed or unframed. If framed, the DS3 P-bits may be monitored and optionally corrected through a provisionable violation mon-itor and removal function. The DS3 signals are then sent to the cross-connect sys-tem.

Input and output protection is provided by relay circuits on the DS3 circuit pack. These relay circuits are controlled by the Low-Speed Switch (LSSW) circuit packs.

EC-1 Interface (STS1E)

The EC-1 Interface (STS1E) circuit pack provides multiplexing and demultiplexing between three EC-1 signals and an internal 155 Mb/s signal.

In the transmit direction, the STS1E circuit pack accepts up to three 51.84 Mb/s B3ZS-coded EC-1 signals. It removes line coding, recovers clock, removes line and section overhead, frequency synchronizes and frame synchronizes the three incoming EC-1 signals to the local timing generator, respectively. The three EC-1[3] signals are then multiplexed into a frame synchronously scrambled 155 Mb/s sig-nal and sent to the OC48 Transmitter (OC48 TRMTR) circuit pack.

In the receive direction, the 155 Mb/s signal from the OC48 RCVR circuit pack is demultiplexed into three STS-1 signals. Each STS-1 signal goes through STS-1 pointer processing. The three STS-1 signals are then synchronized to the local terminal clock, B3ZS-encoded, and sent to the cross-connect system as three EC-1 signals.

Input and output protection is provided by relay circuits on the STS1E circuit pack. These relay circuits are controlled by the Low-Speed Switch (LSSW) circuit packs.

OC3 Optical Interface (OC3)

The OC3 Optical Interface (OC3) circuit pack interfaces with a frame synchro-nously scrambled OC-3 or OC-3c signal (optical extension or intraoffice signal) and the internal 155 Mb/s signal.

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3. EC-1 is the Bellcore standard term for synchronous transport signal level one electrical (STS-1E). An STS-1 signal becomes an EC-1 signal when it is shaped and encoded for transmission over cop-per media. When the shaping and encoding are removed, the signal becomes an STS-1 signal.

In the transmit direction, the OC3 circuit pack accepts one 155 Mb/s OC-3 or OC-3c optical signal and converts it to an electrical 155 Mb/s STS-3 signal. It removes line coding, recovers clock, removes line and section overhead, synchronizes the signals to the local timing generator, and sends the 155 Mb/s STS-3 signal to the OC48 Transmitter (OC48 TRMTR) circuit pack.

In the receive direction, the OC3 circuit pack accepts one frame synchronously scrambled 155 Mb/s signal from the OC48 Receiver (OC48 RCVR) circuit pack. The 155 Mb/s signal is synchronized to the local terminal clock and converted to a frame synchronously scrambled OC-3 or OC-3c signal for transmission on the OC-3 optical extension line.

Optionally, you can route the DCC part of the SONET overhead to a Tributary Overhead Controller (TOHCTL) for processing.

IS3 Optical Interface (IS3)

The IS3 Optical Interface (IS3) circuit pack, designed for use in intraoffice networks only, supports the transport of both STS-3 and STS-3c formats, over distances of up to 2000 feet using multimode fiber. Both the one-way input and output signals are supported independently, making this interface ideal for one-way transport.

In the transmit direction, the IS3 circuit pack accepts one 155 Mb/s IS-3 optical signal and converts it to an electrical 155 Mb/s STS-3 or STS-3c signal. It removes line coding, recovers clock, removes line and section overhead, synchronizes the signals to the local timing generator, and sends the 155 Mb/s STS-3 signal to the OC48 Transmitter (OC48 TRMTR) circuit pack.

In the receive direction, the IS3 circuit pack accepts one frame synchronously scrambled 155 Mb/s signal from the OC48 Receiver (OC48 RCVR) circuit pack. The 155 Mb/s signal is synchronized to the local terminal clock and converted to a frame synchronously scrambled IS-3 signal for transmission on the IS-3 optical extension line. The IS-3 provides an intraoffice interface between two FT-2000s, or between FT-2000 and DDM-2000, DACSIII-2000, or DACSIV-2000.

Optionally, you can route the DCC part of the SONET overhead to a Tributary Overhead Controller (TOHCTL) for processing.

The IS-3 is only compatible with Releases 7.0 and later.

OC12 Optical Interface (OC12)

The OC12 Optical Interface (OC12) circuit pack terminates one OC-12 input signal, generates one OC-12 output signal, and supports the transport of STS-12 and STS-12c format signals. The STS-12 may consist of combinations of STS-1 and STS-3c tributaries having a total capacity equal to twelve STS-1 signals.

The OC-12 is a quad-size pack installed into four adjacent slots on the low-speed shelf. The low-speed shelf can hold up to four OC-12 circuit packs. OC-12 circuit packs can operate independently (one circuit pack providing 0x1 protection) or protected (two circuit packs providing 1+1 protection).

Optionally, you can route the DCC part of the SONET overhead to a Tributary Overhead Controller (TOHCTL) for processing.

The OC-12 is only compatible with Release 7.0 and later.

OC48 Regenerator (OC48 REGENR)

The OC48 Regenerator (OC48 REGENR) circuit pack regenerates one OC-48 signal.

The input side of the OC48 REGENR circuit pack accepts one incoming OC-48 signal from a repeater section in a high-speed line. The OC-48 signal is then converted to an electrical STS-48 signal and demultiplexed to sixteen 155 Mb/s signals. This allows the SONET section overhead bytes to be extracted, monitored, and controlled.

To produce its output, the OC48 REGENR multiplexes the 155 Mb/s signals to one STS-48 signal, and the SONET section overhead bytes are inserted. The STS-48 signal is then converted back to an optical OC-48 signal for transmission through the next repeater section in the high-speed line.

The OC48 REGENR is available in 1.3 μm (standard and high performance), 1.5μm (standard performance), and 1.5 LBA performance, W1 and W2 options.

You must use the W1 and W2 regenerator circuit packs in rings where you are using the W1 and W2 transmitters. For more information see the Chapter 3, "Two Wavelength 1.5 μm WDM and LBA-Compatible Add/Drop Regenerators" section.

Synchronization Functions

The FT-2000 OC-48 Lightwave System synchronization features are designed for high performance and reliability as the SONET network evolves. This section briefly describes these synchronization features showing how the FT-2000 OC-48 Lightwave System will fit into a network.

Internal timing functions—reference interfaces, the on-board clock elements, and timing distribution—are located on the Timing Generator, Stratum 3 - DS1 [TG3 (DS1)] circuit packs. The TG3 (DS1) circuit packs distribute clock signals derived from the selected reference source to the transmission circuit packs. Figure 4-23 shows an example of how synchronization signals are distributed to the transmission circuit packs in an FT-2000 OC-48 Add/Drop-Rings Terminal. The TG3 (DS1) circuit packs are 1x1 (revertive) protected, protecting against circuit pack failures. The external timing references are revertively protected independently of the TG3 (DS1) circuit packs.

The FT-2000 OC-48 Lightwave System has four synchronization modes:

- Free running (Add/Drop-Rings Terminals)
- External timing (Add/Drop-Rings Terminals)
- Line timing (Add/Drop-Rings Terminals)
- Through timing (1x1 Repeater Shelves and Add/Drop-Rings Terminals).

In typical central office applications, the system can operate 1) in free running mode (without DS1 synchronization reference inputs) or 2) in external timing mode (with DS1 synchronization reference inputs from a stratum 3 or better office clock).

In external timing mode, the system supports line-derived timing through the External Timing Emulation null-Bits cable. The FT-2000 Lightwave System may also provide DS1 reference signals to the office building integrated timing supply (BITS) clock or other SONET network elements in an office. In linear add/drop ring applications, the FT-2000 OC-48 Repeater Bay and FT-2000 OC-48 Add/Drop-Rings Terminal may operate in the through timing mode, in which the internal oscillator locks on the incoming OC-48 signal and derives timing for the transmitted signals. For more information about the synchronization modes, refer to Chapter 6, "System Planning and Engineering."
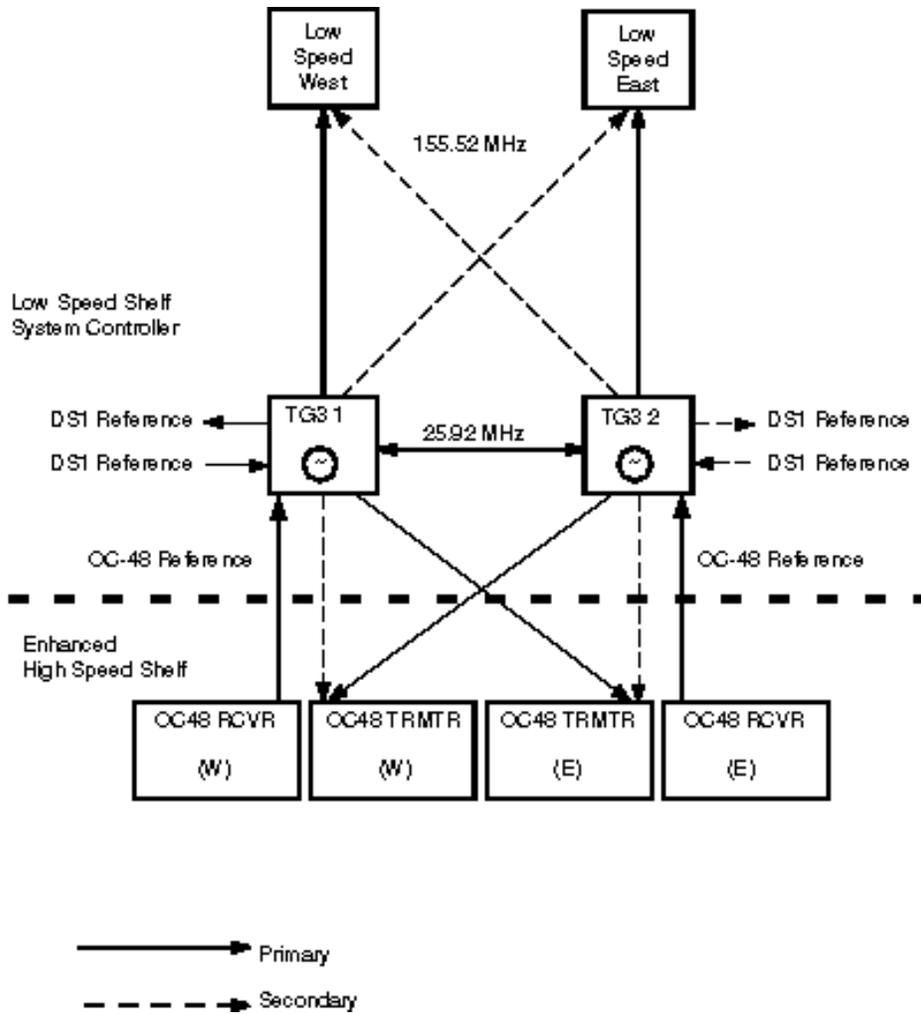
Figure 4-23.   Add/Drop-Rings Terminal Synchronization Architecture

Synchronization Circuit Packs

Timing Generator, Stratum 3 - DS1   [TG3 (DS1)]

Two Timing Generator, Stratum 3 - DS1 [TG3 (DS1)] circuit packs are located on the low-speed Shelves and support the synchronization needs of the FT-2000 OC-48 Lightwave System in the external timing, through timing, line timing, and free running modes.

In the external timing mode, each TG3 (DS1) circuit pack accepts a DS1 reference from an external Stratum 3 or better clock. These references synchronize the local system and any others timed to it, with other network equipment operating under the same primary clock source. Within the TG3 (DS1) circuit pack, a highly stable digital phase locked loop (DPLL) circuit removes any transient impairments on the DS1 reference for improved jitter performance.

The DS1 references are continuously monitored for error-free operation. If the primary reference becomes corrupted, the secondary reference will be selected without causing service degradations. If both DS1 inputs are corrupted, the DPLL circuit holds the on-board oscillator frequency at the last good reference sample (holdover mode) while the references are repaired. This approach to timing design makes the FT-2000 OC-48 Lightwave System more robust.

In the through timing mode, the TG3 (DS1) circuit pack derives timing from the incoming OC-48 optical signal on high-speed lines. The TG3 (DS1) circuit pack accepts a recovered clock from the OC48 Receiver circuit pack and derives the internal synchronization clock used by the transmission circuit packs. If all the OC-48 line references are lost, the DPLL circuit holds the on-board oscillator frequency at the last good reference sample. The TG3 (DS1) circuit pack may also provide an external DS1 reference interface to the office building integrated timing supply (BITS) clock or other SONET network elements in an office. The external DS1 timing reference is derived directly from the incoming optical line.

In the free running mode, the TG3 (DS1) circuit pack derives timing from a highly stable crystal oscillator. This oscillator has a long-term accuracy better than ± 4.6 ppm.

System Control Architecture

The FT-2000 OC-48 Lightwave System has a robust, flexible, 3-level system control architecture that supports all platforms. Figure 4-24 shows the system control architecture for the FT-2000 OC-48 Lightwave System. The system control architecture distributes the monitoring and control functions down to the lowest level where a particular function (for example, switching, timing) is performed. The board controller is at the lowest level of the control hierarchy and is located on each transmission, synchronization, and protection circuit pack. It consists of a microprocessor and its supporting circuitry. The board controller is responsible for:

■   The real-time intensive monitoring and control functions of the transmission, timing, and protection switch circuitry on a circuit pack

■   The control of the circuit pack FAULT LED and performs self-maintenance functions (for example, audit checks and routine diagnostics).

The middle level of the control hierarchy is the Line Controller (LNCTL) circuit pack. The FT-2000 OC-48 Add/Drop-Rings Terminal requires one LNCTL circuit pack. The LNCTL circuit pack is responsible for fault recovery and system integrity. The LNCTL circuit packs communicate with the board controllers to activate protection switching. The middle level of the control hierarchy is not needed in the FT-2000 OC-48 Repeater Bay. Therefore, the FT-2000 OC-48 Repeater Bay does not require a LNCTL circuit pack.

The system controller complex is the highest level of the control hierarchy. The system controller complex consists of the System Controller (SYSCTL) circuit pack and the System Memory (SYSMEM) circuit pack. The system controller complex performs the non-real-time intensive functions requiring overall system knowledge. The system controller complex also plays a major role in providing the extensive operations, administration, maintenance, and provisioning functions.

The Overhead Controller (OHCTL) circuit pack performs synchronous optical network (SONET) overhead access and processing functions. The OHCTL circuit pack processes section data communications channel (DCC) information and supports section and line orderwire (local and express orderwire, bytes E1 and E2). For more information about the overhead bytes, refer to Appendix A, "A SONET Overview."

The controllers within the control architecture communicate among the different hierarchical levels using internal local area networks (LANs). The board controllers and the LNCTL circuit pack of the same line communicate using the board controller local area network (BCLAN). The LNCTL circuit pack and the system controller complex communicate using the line controller local area network (LCLAN). The OHCTL circuit packs, TOHCTL circuit packs, and system controller complex communicate using the overhead access local area network (OALAN).

The FT-2000 OC-48 Lightwave System extensive control features are available through several craft and operations system (OS) interfaces. In addition to accessing the local terminal, the craft and OS interfaces can reach a remote terminal using the data communications channel (DCC) in the OC-48 signal. These functions are provided by the SYSCTL, SYSMEM, LNCTL, TOHCTL and OHCTL circuit packs.
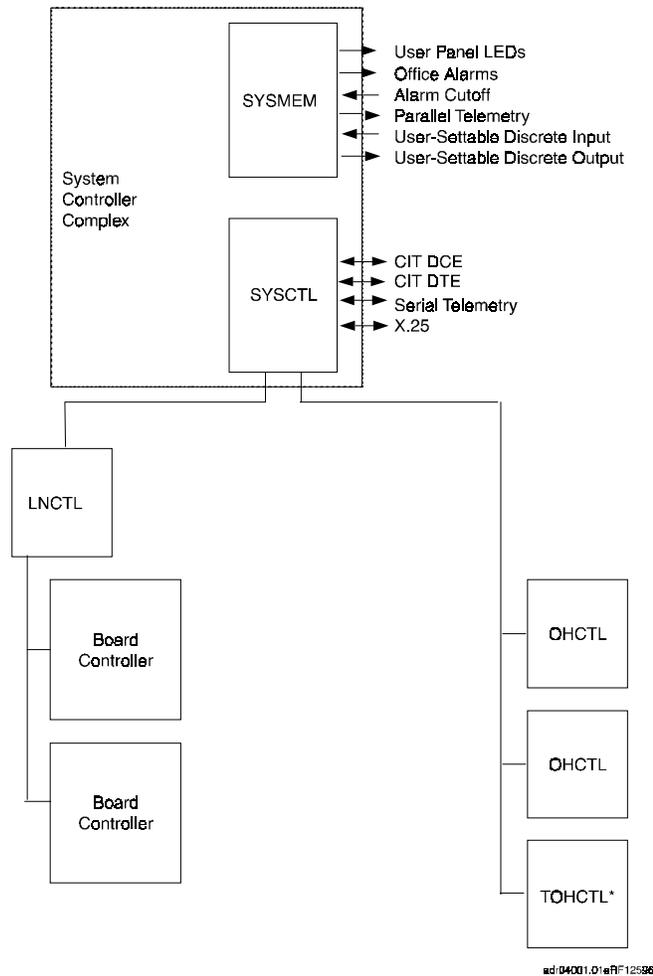
* The TOHCTL is used with the OC-3 and OC-12 low speed interface and
  is required for DCC network access.

Figure 4-24.   System Control Architecture for the FT-2000 OC-48 Lightwave System

Control Circuit Packs

This topic includes information about the types of control circuit packs used with an FT-2000 OC-48 system.

System Controller (SYSCTL)

The System Controller (SYSCTL) circuit pack and the System Memory (SYS-MEM) circuit pack provide the highest level of system control for the FT-2000 OC-48 Lightwave System. The SYSCTL circuit pack provides system-level user and operations systems interfaces and performs system-wide maintenance computations. It also includes system-wide performance monitoring. The SYSCTL circuit pack supports serial telemetry and X.25 interfaces.

The SYSCTL circuit pack is used on the Low-Speed Shelf — System Controller and the Repeater Shelf — System Controller.

System Memory (SYSMEM)

The System Memory (SYSMEM) circuit pack provides memory support for the System Controller (SYSCTL) circuit pack. The SYSMEM circuit pack contains erasable programmable read-only memory (EPROM) for nonvolatile storage of user-provisioned data and the system state and a flash EPROM for nonvolatile storage of the software for the entire system. The SYSMEM circuit pack also supports the user panel, parallel telemetry, miscellaneous discretes, and office alarms.

The SYSMEM circuit pack is used on the Low-Speed Shelf — System Controller and the Repeater Shelf — System Controller.

Line Controller (LNCTL)

A Line Controller (LNCTL) circuit pack interacts with the board controllers on each transmission, synchronization, and switching circuit pack associated with a particular high-speed line. A LNCTL circuit pack communicates with the board controller using the internal board controller local area network (BCLAN). A LNCTL circuit pack also communicates with the System Controller circuit pack using the line controller local area network (LCLAN).

The LNCTL circuit pack is used on the Enhanced High-Speed Shelf. It performs the following real-time intensive line-controlling functions:

- Executes low and high-speed protection switching computations

- Completes line specific computations

- Controls the circuit pack faceplate LED

- Fulfills self-maintenance functions (sanity checks, debugging, and trace).

Overhead Controller (OHCTL)

The Overhead Controller (OHCTL) circuit pack provides access to the SONET overhead channels. These overhead channels contain SONET line and section overhead bytes.

FT-2000 terminals use the Terminal [OHCTL (TERM)] circuit pack in the Enhanced High-Speed Shelf. The OHCTL (TERM) circuit pack processes line and section overhead bytes for OC-48 high-speed lines.

The OHCTL (TERM) circuit pack accepts the SONET overhead data from the OC48 Receiver circuit pack and demultiplexes it into the embedded information for the section and line data communication bytes, section and line orderwire bytes, and user bytes.

In the opposite direction, the OHCTL (TERM) circuit pack multiplexes the SONET overhead bytes and transmits them to the OC48 Transmitter circuit pack.

Tributary Overhead Controller (TOHCTL)

The Tributary Overhead Controller (TOHCTL) circuit pack processes the SONET Section DCC (D1 - D3) bytes present in OC-3 and OC-12 low-speed interfaces that terminate in the FT-2000 OC-48 Add/Drop-Rings Terminal Low-Speed Shelf — System Controller. The TOHCTL processes both the transmit and receive directions of the DCC. Each TOHCTL can terminate up to 8 DCC channels.

Protection

The Low-Speed Switch (LSSW) protection circuit pack is used with the FT-2000 OC-48 systems. It builds a low-speed protection bus in the transmit and receive directions for the electrical low-speed interface circuit packs (DS3 and STS1E). When the LSSW circuit pack is placed in the IN slot on the shelf, it provides a low-speed protection bus in the transmit direction. When the LSSW circuit pack is placed in the OUT slot, it provides a low-speed protection bus in the receive direction. Two low-speed circuit packs are required for bidirectional transmission.

Each LSSW circuit pack interfaces with up to 16 service electrical low-speed interface circuit packs (DS3 or STS1E) and two protection low-speed interface circuit packs. When a low-speed interface circuit pack fails, the low-speed switch circuit pack in the IN slot accepts the three low-speed signals from the failed circuit pack and switches them to a protection low-speed interface circuit pack. In the receive direction, the low-speed switch circuit pack in the OUT slot accepts the three low-speed signals from the protection low-speed interface circuit pack and switches them to the service circuit pack for transmission to the cross-connect system (or equivalent).

The LSSW circuit pack is used on the Low-Speed Shelf — System Controller.

Power

The FT-2000 OC-48 Lightwave System power distribution philosophy is based on individual rather than bulk power supplies. Each circuit pack contains DC-to-DC converters that change the office battery voltages to the voltages required. This leads to improved system reliability since heat is dissipated uniformly across the system avoiding "hot spots."

The FT-2000 OC-48 Lightwave System is powered by -48 V DC. The voltage range for all the components is -42.75 to -60 V DC.

The FT-2000 OC-48 Lightwave System accepts two -48 V DC office power feeders for feeder redundancy from the battery distribution and fuse bay (BDFB). Figure 4-25 is an example of how power is distributed in an FT-2000 OC-48 Lightwave System bay. The power feeders are 4.5-foot, 8-gauge power feeder stubs gutter-tapped to the feeder cables going to the BDFB. Power feeders are color coded for identification. Power feeder A is color coded red; feeder B is color coded blue.

There are also 8.5- and 15-foot, 8-gauge power feeders available. Power feeders can also be ordered to length.

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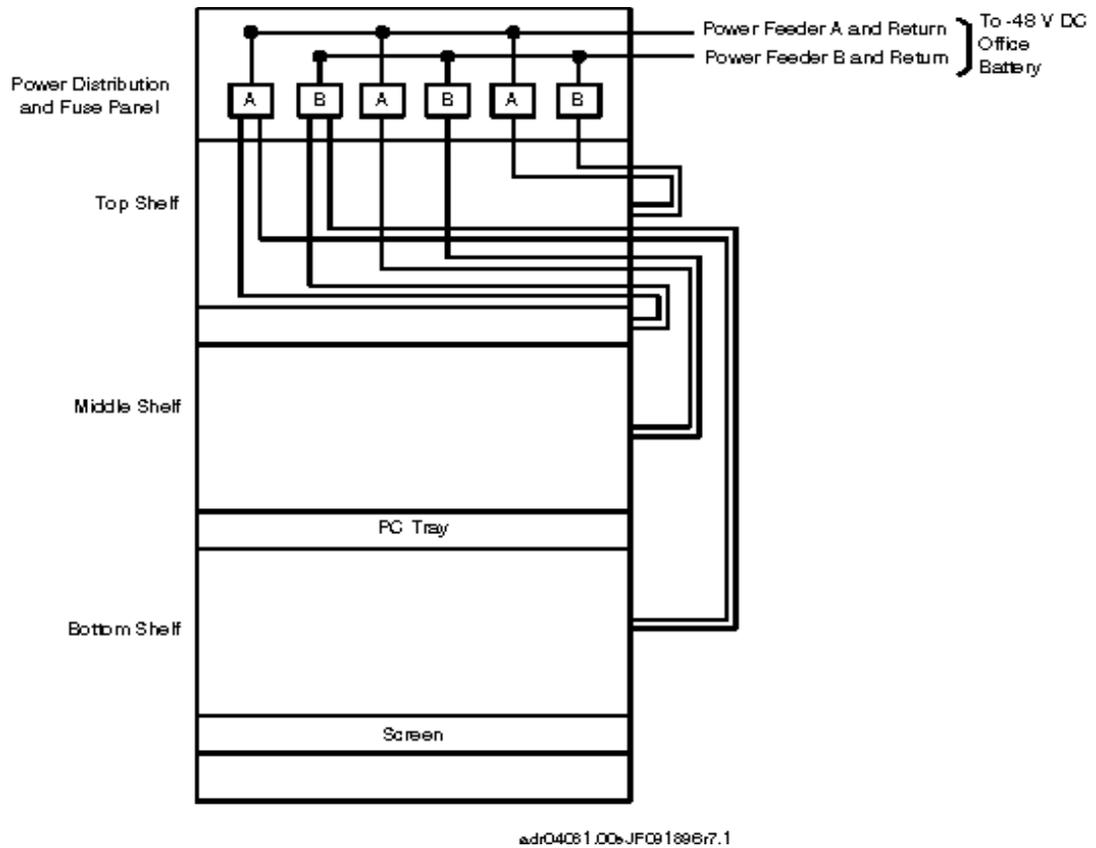
Figure 4-25.   Bay Power Distribution for the E-Bay

The 8-gauge power feeder stubs (power feeder A and power feeder B) are termi-
nated at the bay power distribution and fuse panel. Within the power distribution
and fuse panel, the power feeders are routed with 10-gauge wire to six 10-amp
fuses. Three fuses are for power feeder A and three fuses are for power feeder B.
The bottom shelf uses the first pair of fuses. The second pair of fuses is assigned
to the middle shelf. The third pair of fuses is assigned to the top shelf.

The 10-amp fuses protect the bay if a short-circuit occurs on a shelf. The current-
carrying capacity of an office battery feeder can be in the 100-amp range.

The power feeders are cabled, using 14-gauge wire, from the fuses down the right
side of the bay (when viewed from the front) to the shelves and the fan assembly
(if equipped).

Figure 4-26 shows an example of how power is distributed to a miscellaneously mounted FT-2000 OC-48 Repeater Shelf. The 8-gauge power feeder stubs are terminated at two 10-gauge power connectors that are connected to the user panel. The user panel is equipped with two 10-amp fuses: one fuse for power feeder A and one fuse for power feeder B.
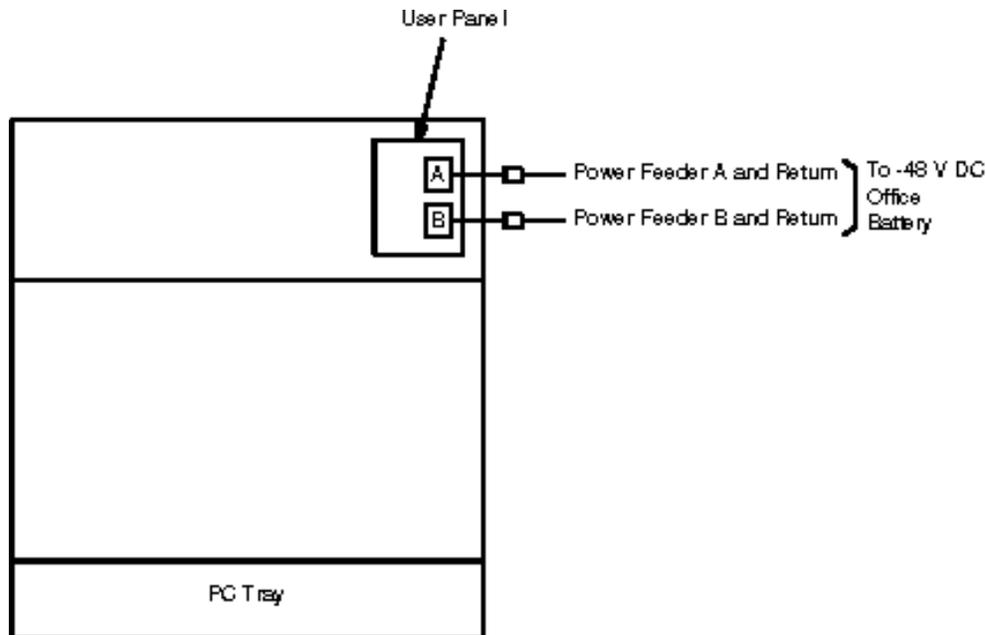
Figure 4-26.   Miscellaneously-Mounted FT-2000 OC-48 Repeater Shelf Power Distribution

The two independent -48 volt office power feeders, A (red) and B (blue) enter each shelf through a power interface circuit and are distributed to the circuit packs (Figure 4-27) through the printed backplane. The power interface circuit consists of a green PWR ON LED, two power filter assemblies, and two radio-frequency (RF) filter capacitors.

The green PWR ON LED (located on the user panel and filter panel) shows that the shelf is receiving fused -48 volt power. The green PWR ON LED will remain lighted as long as either -48 volt power feeder is supplying power to the shelf.

Each power filter assembly smooths the input current and reduces the converter switching noise to the allowed limit. Each power feeder also passes through an RF

filter network at the interconnection panel to remove any RF energy from the DC power before it is fed to the backplane.

From the RF filter network, the power feeders are connected to the backplane and distributed to the circuit packs on the shelf. Each power feeder connects to the circuit pack via four backplane pins. One pin is longer than the other three power pins and connects to the circuit pack first. This long pin feeds a surge resistor to eliminate arcing damage to the pins and prevent momentary voltage drops on the power feeders.
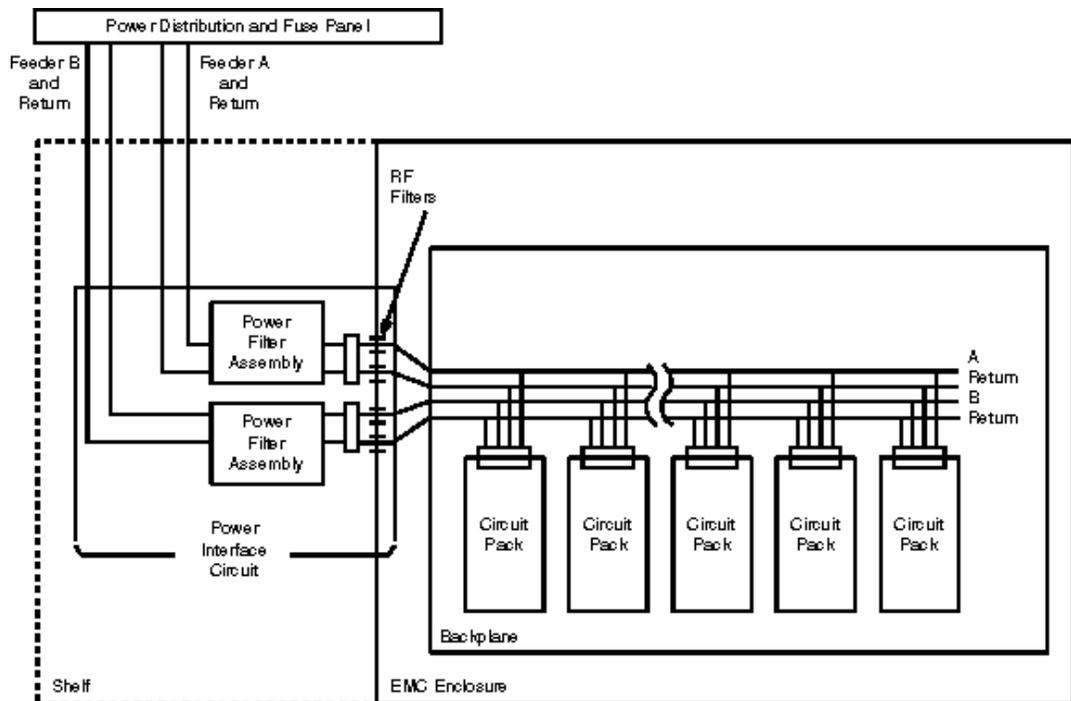
Figure 4-27.   Shelf Power Distribution

Each circuit pack is equipped with diodes and fuses that protect the power feeders (Figure 4-28). A filtering section follows the fused input. Modular DC-to-DC power converters on each circuit pack convert the -48 V to the voltages required on the circuit pack.

If the DC-to-DC converter fails on a transmission or synchronization circuit pack, the red FAULT LED is operated via a separate power path from a controller circuit pack.
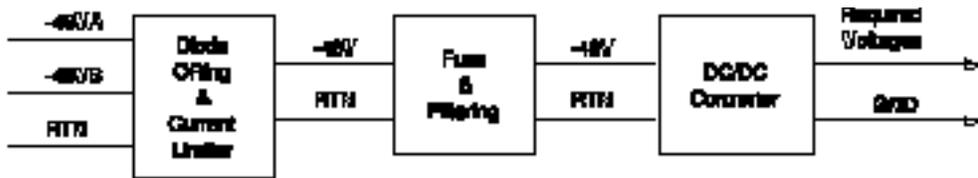
Figure 4-28.   Circuit Pack Power Distribution

Operations, Administration, Maintenance, and Provisioning

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Contents

Operations, Administration, Maintenance, and Provisioning

5

Overview

This chapter defines the operations, administration, maintenance and provisioning (OAM&P) functions available to monitor and maintain the FT-2000 OC-48 Lightwave System.

FT-2000 Release 8.1 introduced multivendor operations interworking (OI) compatibility using Target ID Address Resolution Protocol (TARP) instead of Lucent Directory Service (LDS) protocol.

Operations

Lucent Technologies 2000 Product Family OI

> **NOTE:**
> The term single-ended operations (SEO) has traditionally been used to refer to such operations among DDM-2000 and FT-2000 systems. Now that SEO is supported among the 2000 Product Family NEs as well as multivendor operations, the term operations interworking (OI) is more commonly used.

Operations interworking provides the capability to access, operate, administer, maintain, and provision remote Lucent network element (NEs) from any Lucent

NE in a subnetwork or from a centralized operation system (OS). Operations interworking among the Lucent 2000 Product Family uses Lucent Directory Services (LDS) and is applicable for FT-2000 OC-48 Release 6.0 through 7.2 only.

Lucent 2000 Product Family OI is available among Lucent NEs that are connected through the SONET DCC in Lucent-only subnetworks. With this feature, users can do OAM&P on a centralized basis, saving travel time and money.

Lucent 2000 Product Family OI features include the following:

- **Craft interface terminal (CIT) remote access:** The local NE provides a remote login capability from its CIT to a remote NE.

- **User panel remote access:** The user panel provides a far-end activity (FE ACTY) LED to show that one or more remote NEs have a lighted near-end activity (NE ACTY) LED.

- **OS remote access:**

    — TL1/X.25: A TL1/X.25 OS can access local and remote:

        - FT-2000

        - DDM-2000 Multiplexers (See Note.)

    — Parallel telemetry

    — Serial telemetry

- **Alarm report remote access:** The local terminal provides a summary alarm report that indicates the highest active alarm, if any, at all remote NEs in the same alarm group. These NEs can be FT-2000 OC-48 Add/Drop-Rings Terminals or DDM-2000 Multiplexers.

- **Remote software copy:** This feature allows you to copy software from one FT-2000 OC-48 Add/Drop-Rings Terminal to another anywhere in the sub-network.

⇒ **NOTE:**
The product name "DDM-2000" is used to mean DDM-2000 OC-3 and OC-12 Multiplexers, and *SLC®*-2000 Access Systems and DDM-2000 Fiber-Reach. The product name "FT-2000" is used to mean FT-2000 OC-48 Add/Drop-Rings Terminals. The product name PF-2000 is used to mean all of the 2000 Product Family products including FT-2000 and DDM-2000. The product name Tellabs TITAN[1] (or simply TITAN) is used to mean Tellabs TITAN 5500/S DCS.

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1. Registered trademark of Tellabs, Inc.

Releases 7.2 and earlier:
For more detailed information on OI, refer to the *Lucent Technologies 2000 Product Family Operations Interworking Guide* (824-102-147).

Releases 8.1 and later:
For more information on OI, refer to the *Lucent Technologies 2000 Product Family MultiVendor Operations Interworking Guide* (824-102-144).

Remote NE Status

The FT-2000 OC-48 Add/Drop-Rings Terminal (Release 6.0 through 7.2 only) can receive summary alarm and status information from DDM-2000 Multiplexers that are connected to it through a path of DCC channels in the same Lucent only subnetwork.

The remote NE status feature conveys remote summary alarm and status information through:

- Logical ORing of local and remote office alarms

- A set of far-end parallel telemetry relays (CR, MJ, MN)

- A far-end activity user panel LED

- A network alarm report (CIT and TL1) that indicates the highest severity alarm active at other NEs in the subnetwork.

The set of remote NEs that an FT-2000 Add/Drop-Rings Terminal can exchange status information with is determined by the value of the local alarm group parameter. You can provision this parameter to be a value from 0 to 255. A value of 0 means that the local NE does not exchange remote NE status with other NEs. All other values mean that the local NE exchanges remote NE status information with all other Lucent NEs having the same value and in the same subnetwork.

Members of an alarm group exchange remote NE status information through one or more Alarm Gateway Network Elements (AGNEs) that are defined in the same alarm group. The AGNEs and remote NEs use the DCC to receive and report alarm and status information from and to all NEs in the alarm group. When an AGNE receives the alarm and status information, it rebroadcasts the information to all other remote NEs in the group. The information allows each NE in the alarm group to provide far-end activity indications and a remote alarm report for all other NEs in the group.

Using AGNEs makes it unnecessary for each NE in an alarm group to communicate directly with every other NE in the group. Thus there is a more efficient use of DCC resources. You must provision at least one NE in each alarm group as an AGNE. You can provision additional AGNEs for redundancy, if needed.

For Releases 7.2 and earlier:
For more information on OI and network size, refer to the *Lucent Technologies 2000 Product Family Operations Interworking Guide* (824-102-147).

Directory Service Network Element (DS-NE)

For Releases 7.2 and earlier only:
One FT-2000 OC-48 Add/Drop-Rings Terminal can act as the Directory Service Network Element (DS-NE) for a subnetwork. The subnetwork can consist of multiple rings. The NEs can be FT-2000 OC-48 Add/Drop-Rings Terminals or DDM-2000 Multiplexers. The DS-NE receives its information from remote NEs through the DCC.

The DS-NE provides a centralized database that maps NE target identifiers (TIDs) to addresses [Network Service Access Points (NSAPs)]. The NSAPs are used for routing information within the subnetwork.

For more information on OI using Lucent Directory Service, refer to the *Lucent Technologies 2000 Product Family Operations Interworking Guide* (824-102-147).

For Releases 8.1 and later:
TARP is used to translate NE TIDs to addresses NSAPs. The NSAPs are used for routing information within the subnetwork.

For more information on OI using TARP, refer to the *Lucent Technologies 2000 Product Family Multivendor Operations Interworking Guide* (824-102-144).

Three-Tiered Operations

The FT-2000 is built on three levels of system information and control, spanning operations needs from summary-level status to detailed reporting.

User Panel and Faceplate LEDs
(Operations Tier 1)

The first maintenance tier is provided by the office alarms, user panel, and the circuit pack faceplate LEDs. These features enable maintenance tasks (such as circuit pack replacement) to be performed without a craft interface terminal (CIT) or external test equipment. For more information about the user panel, refer to Chapter 4 "User Panel".

The office alarms interface is a set of discrete relays that control office audible and visible alarms. Separate relays handle critical, major, and minor alarms, although the critical and major alarm outputs can be wire ORed to the office major alarm, if desired.

To supplement the system-level view of the user panel, most circuit packs have red FAULT LEDs on their faceplates. A continuously lighted FAULT LED means that the FT-2000 OC-48 Lightwave System has isolated a failure to that particular circuit pack.

The following information shows the significance of flashing FAULT LEDs.

A flashing FAULT LED on...	INDICATES that...
a transmission circuit pack	an incoming signal to that circuit pack has failed.
a synchronization circuit pack	an externally timed reference signal has failed.
the System Memory (SYSMEM) circuit pack	- the contents of the nonvolatile memory differs from the duplicate copy in the System Controller circuit pack or - there is corrupted data in the nonvolatile memory of the SYSMEM circuit pack

Craft Interface Terminal (CIT)
(Operations Tier 2)

The second maintenance tier uses the CIT to retrieve detailed reports about performance monitoring, alarms and status, and system configuration for local and remote terminals.

FT-2000 OC-48 Lightwave System enables you to provision one of three types of Craft Interface Terminal (CIT) access through the CIT data communication equipment (DCE), data terminal equipment (DTE) ports (CIT-PC or CIT-TL1), and CIT access through a *DANTEL*[2] shelf connected to the orderwire.

The FT-2000 OC-48 Lightwave System supports CIT local access, remote access using a modem, and remote access using the data communications channel (DCC).

The FT-2000 OC-48 Lightwave System also provides a security function to protect against unauthorized access to the CIT system functions (such as provisioning). Security is controlled through logins, passwords, CIT port disabling/enabling, and authorization levels for the system capabilities.

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2. Registered trademark of Dantel, Inc.

CIT-PC

The CIT-PC is a personal computer that is loaded with FT-2000 CIT software. The CIT-PC has a user-friendly interface with pull-down menus and extensive on-line help. The CIT-PC provides detailed information and system control for specialized local and remote maintenance and administrative activities.

Prior to Release 9.0, you must use the CIT-PC if you are installing or accepting a system. Software can be installed via the ITM-SNC with FT-2000 R9.0 or later software and an ITM-SNC R5 or later.

The CIT provides the following functions:

- Reports
- Loopbacks and testing
- Protection switching
- Initialization of performance-monitoring storage registers
- Cross-connect or time slot assignments (TSA)
- Provisioning.

For CIT-PC minimum system requirements, refer to Chapter 10, "Technical Specifications."

If you plan to use the CIT-PC with CPro-2000, refer to the *CPro-2000 User Manual* (190-523-101) for more information about software and hardware requirements.

When the CIT-PC is loaded with terminal emulation software (such as *ProComm Plus*[3] software), it can be used to access a DDM-2000 Multiplexer through the DDM-2000 local port. Such software is unnecessary for accessing a DDM-2000 remotely from FT-2000 OC-48 Add/Drop-Rings Terminals.

The CIT-PC software is enabled to run in a *Microsoft Windows* program environment. With FT-2000 R9.0 and later, the CIT-PC software can run as a *Windows 95* or *Windows NT* application. With FT-2000 R9.1 and later, the CIT-PC software can also run as a *Windows 98* application.

CIT-TL1

The CIT-TL1 is an interface that enables you to maintain and control the FT-2000 OC-48 Lightwave System locally and remotely using CPro-2000 or an ASCII terminal with Transaction Language 1 (TL1) commands.

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3. Registered trademark of Datastorm Technologies, Inc.

CPro is an intelligent, *Microsoft*[4] *Windows*[5]-based alternative to entering TL1 commands manually to provision network elements. FT-2000 OC-48 Add/Drop-Rings Terminal contains all of the functionality necessary to work with this craft provisioning tool. Chapter 2 of this guide contains a brief description of the functions you can perform using CPro-2000. For more information about this tool, including hardware requirements, software requirements, and ordering information, refer to the *CPro-2000 User Manual* (190-523-101).

To use an ASCII terminal with the CIT-TL1 interface to manually enter TL1 commands, you must:

- Know the TL1 commands

- Follow the standard TL1 format.

The TL1 messages *exclude* autonomous messages. For information about TL1 commands, refer to the *FT-2000 OC-48 Lightwave System Operations Systems Engineering Guide* (824-102-148).

To install or accept a system, you must use the CIT-PC.

For CIT-TL1 minimum requirements, refer to Chapter 10, "Technical Specifications.

CIT Access

The FT-2000 OC-48 Lightwave System provides two CIT ports compatible with the American Standard Code for Information Interchange (ASCII) EIA-232-D standard. The port on the user panel is configured as data communications equipment (DCE) for direct CIT access. The CIT (DCE) port provides automatic data rate selection from 1200 to 9600 baud. FT-2000 automatically adjusts to the baud rate of the CIT-PC.

The other port on the interconnection panel of the low-speed Shelf — System Controller and Repeater Shelf — System Controller is configured as data-terminating equipment (DTE) to allow a permanent connection to a modem or to an RS-232 switch. A pair of compatible modems allows remote dial-up access to the FT-2000 OC-48 Lightwave System from a CIT over the public switched telephone network. To establish remote dial-up access, connect a modem to the CIT (DTE) port at the FT-2000 OC-48 Lightwave System. At the CIT, connect a stand-alone modem via the serial port or use an internal modem card.

CIT access is also provided over the orderwire channel. See Chapter 3, "Orderwire for Remote CIT Access and Basic Party-Line Service to Repeaters and Terminals" and the "Orderwire" section in this chapter for more information.

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4. *Microsoft* is a registered trademark of Microsoft Corporation.
5. *Windows* is a registered trademark of Microsoft Corporation

A digital data network may be used in place of the modem pair to provide remote dial-up access to the FT-2000 OC-48 Lightwave System from the CIT.

A compatible modem or digital data network must support full duplex, asynchronous, and byte serial data transmission of eight bit bytes with one start bit and one stop bit. The data transmission speed should be from 1200 to 9600 baud. The CIT (DTE) port provides automatic data rate selection from 1200 to 9600 baud. The CIT-PC automatically selects the highest available baud rate. You must set the CIT-TL1 to a compatible baud rate.

For modem requirements and transmission standards, refer to Chapter 10, "Technical Specifications.

Remote CIT Login

FT-2000 OC-48 Add/Drop-Rings Terminal can remotely log into other FT-2000 OC-48 Add/Drop-Rings Terminals or DDM-2000 Multiplexers when they are connected through a path of DCC channels in the same SONET subnetwork. Each DCC channel in the path can be carried over FT-2000 OC-48, or FT-2000 and DDM-2000 OC-3 and OC-12 interfaces.

Operations System (OS) Interface
(Operations Tier 3)

The third maintenance tier consists of the remote OS interfaces. These OS interfaces include TL1/X.25, parallel telemetry, telemetry byte-oriented serial (TBOS), and miscellaneous discrete telemetry.

TL1/X.25 Interface

The FT-2000 OC-48 Lightwave System supports a message-based OS interface that uses the X.25 protocol to provide communication with a message-based OS. This interface supports Transaction Language 1 (TL1) operations messages. This interface is compatible with Bellcore's Network Monitoring and Analysis (NMA) and Lucent Technologies ITM SNC systems.[6] A message-based OI can access the local FT-2000 OC-48 Lightwave System (local access capability) and any remote terminals in a subnetwork using the DCC [gateway network element (GNE) capability].

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6. ITM SNC forwards messages (commands) from an OS to the Network Elements in the SONET network and performs fault correlation. It then collects and forwards the responses and autonomous messages from the Network Elements to the OS. The OS uses the information it receives to perform fault correlation and diagnose problems in the SONET network.

Using the ITM SNC allows you to concentrate the data links to/from NEs onto a single X.25 link back to an OS such as NMA, saving you money.

You can use one or more FT-2000 OC-48 Add/Drop Rings Terminals as a GNE. The GNE serves as an interface to the local X.25 message-based OS of the following NEs:

- FT-2000 OC-48 Add/Drop-Rings Terminals in the same ring or in the same subnetwork

- DDM-2000 OC-3 Multiplexers and FiberReach through the OC-3 interface

- DDM-2000 OC-12 Multiplexers and FiberReach through the OC-12 interface

- SLC-2000s Access Systems through the OC-3 interface.

The GNE receives operations information from these NEs through the DCC and reports that information and its own information to the OS. The operations information is in the form of TL1 messages. Through the GNE, the OS can send TL1 commands to any Lucent NE in the FT-2000 ring or SONET subnetwork.

You can use one or more FT-2000 OC-48 Add/Drop-Rings Terminals as GNEs. The number you use depends on your application and operations needs. For example, to reduce the number of operations data communication links between the network and the OS, you might choose to use one FT-2000 OC-48 Add/Drop-Rings Terminal as the GNE for the subnetwork. If you need redundancy, you might choose to use two as GNEs.

The FT-2000 OC-48 Lightwave System also provides a security function to protect against unauthorized access to OS functions, such as provisioning. Security is controlled through logins, passwords, and authorization levels for the system capabilities.

The FT-2000 OC-48 Lightwave System provides predefined sets of OS types. An OS type is a filter that determines the types of TL1 autonomous messages that are output to a TL1 login TL1 command/response messages supported for all OS types. The predefined sets are:

- **maintenance —** send reports on the status of the system (for example, alarm, switch, and event reports). This is the default for X.25 PVC 1.

- **memory administration —** send reports on changes in the provisioning status of equipment.

- **test —** send no autonomous messages (available Release 8.1 and later)

- **command response only —** send no autonomous messages. This is the default for X.25 PVC 2 and for all X.25 SVCs.

- **other —** send all autonomous messages.

Serial Telemetry

Serial telemetry is provided using the telemetry byte-oriented serial (TBOS) proto-col. The TBOS telemetry transfers alarm, status, and control and perfor-mance-monitoring information to and from a remote maintenance center via a 2400-baud EIA-422 port. Use of the TL1/X.25 protocol is recommended for cur-rent and future compatibility with operation systems instead of TBOS.

➡ **NOTE:**
Serial telemetry is supported by software Releases 7.2 and earlier only.

Parallel Telemetry Interface

Parallel telemetry brings a minimum set of alarm and status information to an operations center. Six alarm closures show critical, major, and minor alarms for local and remote terminals.

Remote terminals can be FT-2000 OC-48 Add/Drop-Rings Terminals, DDM-2000 Multiplexers, SLC-2000 Access Systems, or FiberReach Mutiplexers that are in the same alarm group.

➡ **NOTE:**
Parallel telemetry is supported by software Releases 7.2 and earlier only.

Miscellaneous Discrete Interface

The user-settable miscellaneous discrete interface allows an OS to control and monitor equipment collocated with the FT-2000 OC-48 Lightwave System through a set of input and output contact closures. There are 16 miscellaneous discrete environmental inputs that monitor conditions like open doors or high temperature, and 4 miscellaneous discrete control outputs control equipment like fans and gen-erators. The state of the miscellaneous discrete environmental inputs can be reported on demand using the CIT. FT-2000 collects miscellaneous discrete alarms from an FT-LBA and automatically sends them to the OS.

Data Communications Channel

The craft and operations interface features extend beyond the local FT-2000 OC-48 Add/Drop-Rings Terminals to cover repeater and remote terminal sites. For remote terminals, network operations capability uses the SONET section data communications channel (DCC) bytes. Craft interface dialogs and operations interface messages travel in these DCC bytes on each OC-48 interface and, optionally, on OC-3 and OC-12 interfaces.

Multivendor Operations Interworking (OI)

To support multivendor OI, FT-2000 OC-48 Release 8.1 and later supports Target ID Address Resolution Protocol (TARP) instead of Lucent Directory Service (LDS). DDM-2000 (OC-3 Release 13.0, OC-12 Release 7.0), and FiberReach Release 3.0 also supports TARP, thus Lucent 2000 Product Family OI compatibility is still supported, but not OI compatibility with previous releases of DDM-2000 and FT-2000. For a list of DDM-2000 (OC-3/OC-12) and FT-2000 software compatibility, refer to "Software Compatibility." For list of NE management CPro-2000 and ITM SNC software compatibility, refer to "Software Compatibility." Both LDS and TARP are directory services that provide NSAP-TID translations. LDS supports additional Lucent-only features, but TARP is the established multivendor standard for SONET NEs that support TL1 OS interfaces. FT-2000 supports the TARP Data Cache (TDC) function to reduce the frequency of TARP propagation throughout the subnetwork and to improve performance. No DSNE is required for TARP.

FT-2000 OC-48 Release 8.1 (and later) is developed to be compatible with any other-vendor NEs that also support TARP, OSI, and TL1/X.25 as specified in Bellcore GR-253. FT-2000 OC-48 Release 8.1 (and later) supports user provisioning of several OSI parameters to allow users to adjust their operations subnetwork, if necessary. For example, to support subnetwork partitioning of large subnetworks, FT-2000 supports user provisioning of NSAP area addresses and Level 2 Intermediate System (IS) functionality.

The Lucent 3000 Product Family (including *WaveStar* BandWidth Manager, 2.5G, and 10G) also supports TARP, OSI and TL1/X.25, enabling compatibility with the Lucent 2000 Product Family.

Because FT-2000 OC-48 Release 8.1 (and later) is intended to facilitate OS-based centralized operations, and because TL1/X.25 OS access is the key standardized multivendor OI application, the following Remote NE Status features are not (except for FE ACTY LED - See Note below) supported in FT-2000 OC-48 Release 8.1 or later releases:

- Remote office alarms
- Remote CIT alarm reports
- Remote user panel indications
- TBOS
- Parallel telemetry.

> ⟹ **NOTE:**
> For Releases 8.1 and later, the FE ACTY LED is lighted only when an OC-48 protection switch is active at the remote terminal.

All of the above features (except FT-2000 Release 8.1 FE ACTY LED) depend on the proprietary exchange of information among Lucent NEs in a subnetwork, specifically the communication of each remote NE alarm status to other NEs. Although the Remote NE Status features were supported in previous releases of FT-2000, such Lucent-only operations features in multivendor subnetworks would not include other-vendor NEs, due to the lack of applicable standards, and thus would be incomplete.

FT-2000 OC-48 Release 8.1 (and later) still supports the following Lucent proprietary OI applications between Lucent NEs in multivendor subnetworks:

- Remote Craft Interface Terminal (CIT) login

- Remote software copy

- Remote NE-to-NE automatic time/date synchronization at start-up.

> ⟹ **NOTE:**
> Remote login and remote software copy are not possible from an FT-2000 CIT to a *WaveStar* NE. However, remote login and remote software copy will pass through *WaveStar* NEs in mixed FT-2000/*WaveStar* rings.

Releases 7.2 and earlier:
For more detailed information on OI, refer to the *Lucent Technologies 2000 Product Family Operations Interworking Guide* (824-102-147).

Releases 8.1 and later:
For more information on OI, refer to the *Lucent Technologies 2000 Product Family Multivendor Operations Interworking Guide* (824-102-144).

Administration

This section includes information about the following:

- Version recognition
- Security.

Version Recognition

The FT-2000 OC-48 Lightwave System provides automatic version recognition of all the hardware and software installed. The FT-2000 OC-48 Lightwave System is able to report the type, version, and serial number of the circuit pack that is installed in each slot. Each circuit pack *CLEI*[7] code and serial number is stored on the circuit pack and is accessible by the System Controller circuit pack. The equipment catalog item (ECI) version identification and apparatus code for each circuit pack are also provided. The orderwire (OW) circuit pack is software transparent and thus has no interaction with the software.

Security

The FT-2000 OC-48 Lightwave System provides three tiers of security to protect against unauthorized access to the CIT and OS functions (for example, provisioning). The three tiers are Port Security, Network Element Login Security, and User Login Security.

Port Security

This feature controls access to the system through a per-port enable/disable mechanism and inactivity time outs.

Network Element Login Security

This feature controls access to the system through a lockout mechanism to disable all but administrative (expert and privileged) logins.

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7. COMMON LANGUAGE is a registered trademark and CLEI, CLLI, CLCI, and CLFI are trademarks of Bell Communications Research, Inc.

User Login Security

This feature controls access to the system on an individual user basis including

- **login ID and password assignment** — Requires the user to enter a valid login ID and password to access the system. FT-2000 OC-48 Lightwave system allows up to 100 login IDs and passwords. Two of these login IDs are expert/privileged and the balance are reports only and general.

- **user authorization levels** — Provides the following four levels of access on a per login session basis:

  — Expert — Provides access to all commands and options. Expert users have access to all commands and options. Only expert users have access to the security and access functions. These functions include assigning/changing logins/passwords for other users, setting login/password aging times, enabling/disabling ports, setting target ID (TID) names, and initializing the system.

  Expert users are privileged users who have gained this authorization level in one of two ways:

    - Acquiring it automatically by logging in through a TL1 interface (either TL1/X.25 or CIT-TL1 interface).

    - Providing a special option when logging from a CIT-PC.

  — Privileged — Provides access to all commands and options except those that may affect all service at once. Example: TEST-AUTO-TURNUP.

  — General — Provides access to all commands except those relating to security and system access.

  — Reports Only — Provides access to all reports, for example, OPR-ACO and TEST-LED. Reports Only users are not allowed to change any of the system provisioning values.

- **login aging** — Enables you to set individual logins to be deleted if unused for a certain number of days or on a particular date (for example, for a visitor or for temporary access during installation).

- **password aging** — Enables you to require each user to change his or her password periodically.

- **autonomous indications and history log records** — Provides autonomous indications and history log records of successful and unsuccessful logins and intrusion attempts for security audits.

Maintenance

This section includes information about:

- Local and Remote Software Copy/Upgrade
- Local and Remote Inventorying Capabilities
- Maintenance Signals
- Fault Detection, Isolation, and Reporting
- Provisioning Consistency Audits
- Loopbacks and Tests
- Protection Switching
- Performance Monitoring
- Reports
- Orderwire.

Local and Remote Software Copy/Upgrades

FT-2000 OC-48 Lightwave System enables you to upgrade the system software in service from a single site and without control circuit pack changes. You can use either the CIT or a modem. System monitoring and control are fully functional during the copy.

An FT-2000 OC-48 Add/Drop-Rings Terminal can copy software to another local or remote FT-2000 OC-48 Add/Drop-Rings Terminal that is in the same subnetwork. The copy can go through intervening DDM-2000 Multiplexers if there is OC-3 or OC-12 connectivity to both FT-2000 NEs.[8]

Because FT-2000 Release 8.1 (and later) is not OI-compatible with earlier releases of FT-2000 (and DDM-2000), Release 8.1 (and later) software should be downloaded and/or copied to all FT-2000 NEs in the subnetwork before activating the Release 8.1 (and later) software in any of the FT-2000 NEs. The sequence of software activation is critical. For the required procedure, refer to the *Lucent Technologies 2000 Product Family Multivendor Operations Interworking Guide* (824-102-144).

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8. To take advantage of this feature, you must have Release 5.0.1 or later software installed in all FT-2000 Add/Drop-Rings Terminals. In Release 5, you can copy software to FT-2000 OC-48 Add/Drop-Rings Terminals that are in the same ring. In Release 6, you can also copy software to FT-2000 OC-48 Add/Drop-Rings Terminals that are in the same subnetwork (DCC connected through OC-3 interfaces). In Release 7.1 you can copy software with OC-12 DCC.

➡ **NOTE:**

Software can be installed via the ITM-SNC with an FT-2000 OC-48 Add/
Drop-Rings Terminal, Release 9.0 or later, and an ITM-SNC Release 5.0 or
later.

Local and Remote Inventorying Capabilities

The FT-2000 OC-48 Lightwave System provides automatic version recognition of
all hardware and software installed in the system. Circuit pack types, circuit pack
CLEI codes, and serial numbers are accessible through the CIT. This capability
greatly simplifies troubleshooting, dispatch decisions, and inventory audits. It also
recognizes the current version of hardware and software being used.

Maintenance Signals

The FT-2000 OC-48 Lightwave System maintenance signals notify downstream
equipment that a failure has been detected and alarmed by some upstream equip-
ment [alarm indication signal (AIS)] and notify upstream equipment that a down-
stream failure has been detected (yellow signals).

The maintenance signals are SONET, ANSI[9], and Bellcore compliant. Alarm indi-
cation signals include SONET line AIS, STS-1 path AIS, and DS3 AIS. Also
included are path remote failure indications (RFI), previously called yellow signals,
and path and line remote defect indicator (RDI), previously called far-end-receive
failure (FERF).

Fault Detection, Isolation, and Reporting

The FT-2000 OC-48 Lightwave System continuously monitors its internal condi-
tion and incoming signals. Incoming SONET signals are monitored for loss of sig-
nal (LOS), loss of frame (LOF), loss of pointer (LOP), and bit error rate (BER).
Incoming DS3 low-speed signals are monitored for LOS and BER. Demultiplexed
SONET STS-1 signals that terminate on DS3 low-speed interfaces are monitored
for path unequipped. There is also an on-demand path trace diagnostic for such
signals.

When a fault is detected, the FT-2000 OC-48 Lightwave System employs auto-
matic diagnostics to isolate the failed circuit pack or signal. Failures are reported
to local craft and operations systems so that repair decisions can be made. If

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9. Registered trademark of American National Standards Institute.

desired, operations system personnel and local craft can use the CIT to gain more detailed information on the fault condition.

All fault conditions detected and isolated by the FT-2000 OC-48 Lightwave System are stored and made available to be reported, on demand, through the CIT. In addition, a history of the past 250 alarm and status conditions and CIT events is maintained and available for on-demand reporting. Each event is date and time stamped.

The FT-2000 OC-48 Lightwave System also automatically and autonomously reports all detected alarm and status conditions through the:

- Office alarm relays

- User panel

- Equipment LEDs

- Parallel telemetry

- Serial telemetry scan points

- Message-based operations systems.

⟹ **NOTE:**
Parallel and serial telemetry are supported by software Releases 7.2 and earlier only.

Provisioning Consistency Audits

The FT-2000 OC-48 Add/Drop Rings Terminal provides a function that monitors (audits) the consistency of the provisioning information related to ring administration and low-speed cross connections. This function alerts you to situations that may result in lost traffic or protection switching malfunctions.

In particular, FT-2000 audits the following information to ensure consistent operation of the ring subnetwork as a whole:

Target Identifier (TID) —
For Releases 7.2 and earlier:
The TID must be unique within a given subnetwork. FT-2000 uses a protocol called Lucent Directory Services to ensure the uniqueness of TIDs for all NEs in a subnetwork. You can make changes to a TID at any time. However, if a change would result in a duplication, FT-2000 sends an alarm and does not put the changes into effect until you make another change that removes the duplication.

For Releases 8.1 and later:

FT-2000 can only assure uniqueness of TIDs within each OC-48 ring. With TARP, the user needs to assure uniqueness of TIDs throughout the network to assure proper operations.

Ring Squelch Map — The ring squelch map consists of the provisioned source and destination TIDs for each cross connection at each node in the ring. Incorrect information in this map could result in misconnected traffic or traffic being dropped unnecessarily during failure conditions. This part of the audit function flags all instances of unknown TID values in the squelch map. It also propagates changes to the TID in any node in the ring and to all other nodes so that they can automatically update their squelch maps. Thus, you do not have to change the squelch maps manually.

■ **Low-Speed Circuit Add-to-Drop Continuity —** This part of the audit function checks that for each unidirectional drop cross connection to a low-speed slot, there is a continuous path of cross connections back to an add cross connection from a low-speed slot at some node in the ring subnetwork. FT-2000 alarms discontinuities, which may result from the accidental deletion of a cross connect or incomplete circuit provisioning, at the drop end. This part of the audit function also checks that the source and destination TIDs of each cross connection in the circuit match to help avoid misconnected and dropped traffic.

You can enable or disable the audit on a per cross-connection basis.

Loopbacks and Tests

The FT-2000 OC-48 Lightwave System allows loopbacks to be performed on all low-speed interfaces. low-speed DS3 or EC-1 loopbacks allow a single DS3 or EC-1 signal to be looped back toward the high-speed OC-48 line. low-speed OC-3 loopbacks allow a single OC-3 signal to be looped back towards the high-speed OC-48 line or the low-speed OC-3 line. The OC-12 signal can only loop back toward the high-speed OC-48 line.

FT-2000 makes the loopback electronically within the DS3 or EC-1 (STS1E) circuit pack in response to a command you enter at the CIT. Active electronic loopbacks are shown by the abnormal (ABN) LED on the user panel and in the alarm and status report.

Front access to the optical connectors on the circuit pack faceplates allows an easy manual OC-48 optical loopback. You can perform this loopback by connecting a single-mode fiber jumper and lightguide build-out from the optical transmitter to the receiver.

You can use the FT-2000 OC-48 Lightwave System internal testing capabilities to install and accept a system. Test signal generators and detectors are integrated in the system, eliminating the need for external test equipment.

You can control the following installation self-tests using the CIT.

- **Terminal Self-Test —** This test is for the FT-2000 OC-48 Add/Drop-Rings Terminal. The test verifies the transmission health of the local terminal. To test the local terminal, a test signal is generated in the low-speed interface circuit pack and automatically looped back toward the optical transmitter. The transmitted optical signal is manually looped back to the optical receiver. The signal is returned to the low-speed interface circuit pack where a signal detector measures the signal.

- **low-Speed Cabling Self-Test —** This test is for the FT-2000 OC-48 Add/Drop-Rings Terminal. The test verifies the transmission health of the electrical low-speed cabling. To test the low-speed cabling, a test signal is generated in the low-speed interface circuit pack and transmitted to the cross-connect panel. The test signal is manually looped back at the cross-connect panel and returned to the terminal. The signal is returned to the low-speed interface circuit pack where a signal detector measures the signal.

- **Repeater Self-Test —** This test is for the FT-2000 OC-48 Repeater. The test verifies the transmission health of the local OC48 Regenerator circuit packs and their optical connections.

Test results are displayed on the CIT.

The FT-2000 OC-48 Lightwave System also provides tests for LEDs, serial and parallel telemetry interfaces, and office alarms. For more information about these tests and the installation self-tests, refer to *FT-2000 OC-48 Lightwave System, User/Service Manual (*365-575-102*).*

Protection Switching

This topic contains information about high-speed, low-speed, and synchronization protection.

High-Speed Protection Switching

High-speed line protection switching occurs in response to automatically detected faults in the high-speed line, as well as external commands from craft at a local/

remote CIT or operations system. The FT-2000 OC-48 Lightwave System uses the following standard protection switching priorities:

- Reset

- Signal fail (protection)/automatic protection switch (APS) channel failure

- Lockout of protection

- Forced switch

- Signal fail

- Signal degrade

- Manual switch

- Wait to restore.

The FT-2000 OC-48 Add/Drop-Rings Terminal for 2-Fiber (bidirectional) Rings use loopback protection switching. Loopback switching is bidirectional and protects against all single span failures. In the case of a node failure, it protects all traffic that is destined for nodes other than the failed node.

Signal fail and signal degrade conditions on the incoming high-speed optical line initiate automatic line switches. FT-2000 calculates BER of the signal from violations in the SONET overhead B2 line parity byte. FT-2000 declares signal fail for incoming line AIS, loss of signal, loss of frame, a detectable hard defect, or a BER exceeding 10^{-3}. A BER exceeding a provisionable 10^{-5} to 10^{-9} threshold causes a signal degrade indication and a protection switch. Traffic is restored in $\leq$60 ms, including detection time, for catastrophic failures in rings without existing switches and secondary traffic. FT-2000 OC-48 Lightwave System protection switching is compliant with the applicable Bellcore technical advisories and technical requirements.

Low-Speed Protection

The FT-2000 OC-48 Lightwave System also provides protection for all the OC-48 low-speed interface circuit packs. Electrical low-speed interface circuit packs are 1xM (M$\leq$16) protected and use bidirectional revertive switching. Only one protection DS3 interface circuit pack and/or one protection EC-1 interface STS1E circuit pack can be used on a low-speed shelf. One of each is recommended. (Two protection DS3 interface circuit packs or two protection EC-1 interface STS1E circuit packs cannot be used.)

The optical low-speed interface circuit packs (OC-12, OC-3, and IS-3) are either 1+1 protected or 0x1 protected (the default, unprotected state) and use unidirectional nonrevertive switching. The 1+1 protection is independent of

- DS3 and STS1E protection

- OC-48 line protection

There are eight pairs of slots in the low-speed shelf for 1+1 protected optical inter-faces [OC3 (1.3 STD) circuit packs]. For 1+1 protection, you must equip a pair of slots that share the same integer identifier (for example, 1A and 1B) with OC3 (1.3 STD) circuit packs. (The slot state must be EQ/OC3 for both slots.) The cross-connections that you provision for the slots must not conflict with a 1+1 mode of operation (as would be the case if the slots are connected to different tributaries). If these conditions are violated, the mode of operation is 0x1 for that direction. If 0x1 protection is used, the other slot of the slot pair may be equipped with any other low-speed circuit pack.

OC-12 circuit pack is a "quad size" circuit pack assembly made of four circuit boards and a single extra wide faceplate. One quad consists of four consecutive low-speed slots. For 1+1 protection, a quad pair must occupy two consecutive quads. Example: 1A, 1B, 2A, 2B, 3A, 3B, 4A, and 4B.

You can assign each service 1xN low-speed interface (electrical) circuit pack a high or low protection priority. This allows a high priority circuit pack to preempt any automatic switch to protection by a lower priority circuit pack. Switch requests of equal priority are met in the order in which they are received. If two requests occur simultaneously, the one with the lower slot address takes priority.

Synchronization Protection

The FT-2000 OC-48 Lightwave System also provides protection for the Timing Generator, Stratum 3 - DS1 [TG3 (DS1)] circuit packs and the timing reference signals. The TG3 (DS1) circuit packs use 1x1 revertive protection switching. The timing reference signals are revertively protected independent of the TG3 (DS1) circuit packs. For details, see Chapter 6, "Synchronization."

Performance Monitoring

This topic contains information about

- SONET Performance Parameters
- Performance-Monitoring Processing
- Performance-Monitoring Data Storage
- Performance Monitoring During Failed Conditions
- Performance Parameter Thresholds
- Threshold-Crossing Alert Transmission to an Operations System.

SONET Performance Parameters

The FT-2000 OC-48 Lightwave System provides performance monitoring to support proactive maintenance of a network. It also provides fault-locating parame-

ters, such as the optic power receive (OPR). Proactive maintenance refers to the process of detecting degrading conditions not severe enough to initiate protection switching or alarming, but indicative of an impending hard or soft failure.

Proactive maintenance consists of monitoring performance parameters associated with the SONET sections, lines, and paths within the SONET network. (Refer to Appendix A, "A SONET Overview," for definitions of SONET sections, lines, and paths.)

Table 5-1 lists the SONET performance parameters monitored. These parameters are thresholded to show degraded performance. When a performance-monitoring threshold is crossed, it is reported to the operations system where all threshold crossings associated with a particular path can be correlated, and the likely source of the degradation can be identified.

Table 5-1 Performance-Monitoring Parameters

Facility	Measured Provisionable Parameter
OC-48/OC-12/ OC-3 Optics	Laser Bias Current (LBC) Optic Power Transmit (OPT) Optic Power Receive (OPR)
OC-48/OC-12/ OC-3/IS-3 Section	B1 Coding Violations (CV-S) Errored Seconds (ES-S) Severely Errored Seconds (SES-S) Severely Errored Frame Seconds (SEFS-S)
OC-48/OC-12/ OC-3/ IS-3 Line	Protection Switch Count (PSC) STS Pointer Justification Count (PJC) Composite B2 Coding Violations (CV-L) Errored Seconds (ES-L) Severely Errored Seconds (SES-L) Unavailable Seconds (UAS-L)
STS-1 Path	B3 Coding Violations (CV-P) Errored Seconds (ES-P) Severely Errored Seconds (SES-P) Unavailable Seconds (UAS-P)
STS-1 Path Far End	Far End Block Error (FEBE) (CV-PFE) coding violations Errored Seconds (ES-PFE) Severely Errored Seconds (SES-PFE) Unavailable Seconds (UAS-PFE)
EC-1 Section	Severely Errored Frame Seconds (SEFS-S)
EC-1 Line	STS Pointer Justification Count (PJC) B2 Coding Violations (CV-L) Errored Seconds (ES-L) Severely Errored Seconds (SES-L) Unavailable Seconds (UAS-L)
DS3 Line	Errored Seconds (ES-L)
DS3 Path	P-Bit (F-and-M-Bit) Coding Violations (CVP-P) P-Bit (F-and-M-Bit) Errored Seconds (ESP-P) P-Bit (F-and-M-Bit) Severely Errored Seconds (SESP-P)[*] P-Bit (F-and-M-Bit) Severely Errored Frame/AIS Seconds (SAS-P)[*] P-Bit (F-and-M-Bit) Unavailable Seconds (UASP-P)[*]

Performance-Monitoring Processing

The FT-2000 OC-48 Lightwave System processes the raw performance monitoring parameters into derived parameters. The derived parameters are based on the condition of the incoming OC-48 signal during a second. The following derived parameters are calculated for the parameters listed in Table 5-1 :

- OC-48 optical parameters

    — **Laser bias current (LBC):** A signal that indicates whether or not the system is operating within normal margins. The upper limit for the OC-48 parameter is 1.5 times the initial factory value.There is no lower limit.

    — **Optic power transmit (OPT):** The amount of signal (facet) power generated by the laser. The upper limit for this parameter is 0.8 dBm above the initial factory value. The lower limit is 1.0 dBm below the initial factory value.

    — **Optic power receive (OPR):** An indication of whether or not the received optical power is currently within the nominal sensitivity limits of the receiver. The OPR is a fault-locating tool to use in conjunction with the proactive maintenance performance monitoring parameters. Used in this way, it can help you to identify or exonerate the high-speed transmitter, high-speed receiver, and fiber as the source of an impending high-speed failure.

Table 5-2 lists the in and out-of-range limits.

Table 5-2 Optic Power Receive Parameters

Type	OC-48 OPR In Range	OC-48 OPR Out of Range
1.3 μm	-12 dBm to -26 dBm	>-9.0 dBm or <-31 dBm
1.5 μm	-12.7 dBm to -26.7 dBm	>-9.7 dBm or 31.7 dBm

Table 5-3 FT-2000 OC-48 Lightwave system can report the OPR parameter as in range or out of range, depending on many factors, including device variations, operating temperature, and circuit pack age. The receiver is operating within its nominal sensitivity limits at the optical powers listed in Table 5-3 :

Table 5-3 Nominal Optical Power Limits

Type	Optical Power
1.3 μm	-28.5 dBm; -10.5 dBm
1.5 μm	-29.2 dBm; -11.2 dBm

■ OC-48 section parameters

— **B1 coding violations (CV-S):** The B1 parity violations in the first STS-1 are an indicator of the performance of an STS-48 section. The system calculates, writes, and checks the section B1 parity for errors. For each error it detects, it increments the B1 parity violation counter.

— **Errored seconds (ES-S):** An ES-S is a second in which the system detects one or more B1 parity violations, out-of-frame events, or LOS defects.

— **Severely errored seconds (SES-S):** An SES-S is a second in which the system detects 249 or more OC-48 parity violations, one or more OC-48 LOS defects, or one or more OC-48 LOF defects.

— **Severely errored frame seconds (SEFS-S):** The number of seconds during which an out-of-frame event occurred.

■ OC-48 line parameters

— **Protection switch count (PSC-L):** The number of times that service switched to or from another line either automatically or by CIT or operations system request.

— **Composite B2 coding violations (CV-L):** The sum of B2 parity violations for each STS-1 signal on a given OC-48 line, an indicator of the performance of that line. The system calculates, writes, and checks the composite B2 parity for errors. For each line bit interleaved parity (BIP) error it detects, it increments the B2 parity violation counter. Each BIP-8 can detect up to 8 errors per STS-1 frame for a maximum of 8 times 48 parity errors per OC-48 frame.

— **Errored seconds (ES-L):** An ES-L is a second in which the system detects one or more B2 parity violations or an OC-48 line AIS.

— **Severely errored seconds (SES-L):** An SES-L is a second in which the system detects 494 or more OC-48 B2 parity violations or an OC-48 line AIS.

— **Unavailable seconds (UAS-L):** A UAS-L is a second in which the OC-48 line is "unavailable." A line is considered unavailable

  — during loss of signal, loss of frame, and line AIS conditions

  — from the beginning of 10 consecutive severely errored seconds until the beginning of 10 consecutive seconds, none of which are severely errored.

■ OC-12 and OC-3 optical parameters

— **Laser bias current (LBC):** A signal that indicates whether or not the system is operating within normal margins. The OC-3 and OC-12 laser bias current varies widely with temperature because the laser does not have a thermo-electric cooler to maintain a constant laser temperature. Typical normalized values are expected to range from 0.5 to 2 or even higher. The upper limit is set at 1.5 times the maximum (beginning of life) laser bias current limit.

— **Optic power transmit (OPT):** The amount of signal (facet power) power generated by the laser. The upper limit is 0.8 dBm above the initial factory value. The lower limit is 1.0 dBm below the initial factory value.

— **Optic power receive (OPR):** An indication of whether or not the received optical power is currently within the nominal sensitivity limits of the receiver. The upper limit is factory set at -6 dBm (nominal). The lower limit is factory set at -35 dBm (nominal).

■ OC-12, OC-3, and IS-3 section parameters

— **B1 coding violations (CV-S):** The B1 parity violations in the first STS-1, an indicator of the performance of an STS-3 section. The system calculates, writes, and checks the section B1 parity for errors. For each error it detects, it increments the B1 parity violation counter.

— **Errored seconds (ES-S):** An ES-S is a second in which the system detects one or more B1 parity violations, out-of-frame events, or LOS defects.

— **Severely errored seconds (SES-S):** An SES-S is a second in which the system detects 249 or more 16 OC-3 B1 parity violations, one or more OC-3 LOS defects, or one or more OC-3 LOF defects.

— **Severely errored frame seconds (SEFS-S):** The number of seconds during which an out-of-frame event occurred.

■ OC-12, OC-3, and IS-3 line parameters

— **Protection switch count (PSC-L):** The number of times that service switched to or from another line either automatically or by CIT or operations system request.

— **STS Pointer Justification Count (PJC):** A count of the STS-n pointer adjustments created or absorbed by an NE due to the differences in frame rates of the incoming and outgoing SONET signals.

— **Composite B2 coding violations (CV-L):** The sum of B2 parity violations for each STS-1 signal on a given OC-12, OC-3, or IS-3 line, an indicator of the performance of that line. The system calculates, writes, and checks the composite B2 parity for errors. For each line bit interleaved parity (BIP) error it detects, it increments the B2 parity violation counter. Each BIP-8 can detect up to 8 errors per STS-1 frame for a maximum of 8 times 3 parity errors per OC-12, OC-3, or IS-3 frame.

— **Errored seconds (ES-L):** An ES-L is a second in which the system detects one or more B2 parity violations or an OC-12, OC-3, or IS-3 line AIS.

— **Severely errored seconds (SES-L):** An SES-L is a second in which the system detects 32 or more OC-12, OC-3, or IS-3 B2 parity violations or an OC-3 line AIS.

— **Unavailable seconds (UAS-L):** A UAS-L is a second in which the OC-3 line is "unavailable." A line is considered unavailable during loss of signal, loss of frame, and line AIS conditions. A line is also considered unavailable from the beginning of 10 consecutive severely errored seconds until the beginning of 10 consecutive seconds, none of which are severely errored.

■ STS-1 path

— **B3 Coding Violations (CV-P):** The number of B3-byte errors found in the STS-1 path overhead when the STS-1 path is terminated. The system writes the B3 byte when the path is originated and checks it for errors when the path is terminated. The system increments the B3 coding violation counter each time it detects an error. Up to 8 errors can be detected in each STS-1 synchronous payload envelope.

— **Path errored seconds (ES-P):** An ES-P is a second in which the system detects one or more B3 parity violations, one or more STS-1 path AIS defects, or one or more STS-1 path LOP defects. The system counts errored seconds for each STS-1 path terminated by the system separately.

- — **Path severely errored seconds (SES-P):** An SES-P is a second in which the system detects 9 or more B3 parity violations, one or more STS-1 path AIS defects, or one or more STS-1 path LOP defects. Severely errored seconds are counted separately for each STS-1 path terminated by the system.

  — **Path unavailable seconds (UAS-P):** A UAS-P is a second in which the STS-1 path is "unavailable." An STS-1 path is considered "unavailable" from the beginning of 10 consecutive severely errored seconds until the beginning of 10 consecutive seconds, none of which are severely errored. Unavailable seconds are counted separately for each STS-1 path terminated by the system.

- ■ STS-1 path far-end parameters

  — **FEBE Coding Violations (CV-PFE):** The number of FEBEs parity violations found in the STS-1 path overhead when the STS-1 path is terminated. The system writes the FEBE when the path is originated and checks it for errors when the path is terminated. The system increments the B3 coding violation counter each time it detects an error. Up to 8 errors can be detected in each STS-1 synchronous payload envelope.

  — **FEBE errored seconds (ES-PFE):** An ES-PFE is a second in which one or more FEBE parity violations or one or more STS-1 path RDI (FERF) defects are detected. Errored seconds are counted separately for each STS-1 path terminated by the system.

  — **FEBE (SES-PFE):** An SES-PFE is a second in which 9 or more FEBE parity violations, one or more STS-1 path AIS defects, or one or more STS-1 path RDI (FERF) defects are detected. Severely errored seconds are counted separately for each STS-1 path terminated by the system.

  — **FEBE (UAS-PFE):** A UAS-PFE is a second in which the STS-1 path is "unavailable." An STS-1 path is considered "unavailable" from the beginning of 10 consecutive severely errored seconds until the beginning of 10 consecutive seconds, none of which are severely errored. Unavailable seconds are counted separately for each STS-1 path terminated by the system.

- ■ EC-1 section parameters

  — **Severely errored frame seconds (SEFS-S):** An SEFS-S is a second in which an out-of-frame event occurred.

- ■ EC-1 line parameters

  — **B2 coding violations (CV-L):** The B2 parity violations on an EC-1 line are an indicator of the performance of that line. The system calculates, writes, and checks the B2 parity for errors. For each line bit

interleaved parity (BIP) error detected, the system increments the B2 parity violation counter. Each BIP-8 can detect up to 8 errors per STS-1 frame.

— **STS Pointer Justification Count (PJC):** A count of the STS-n pointer adjustments created or absorbed by an NE due to the differences in frame rates of the incoming and outgoing SONET signals.

— **Line errored seconds (ES-L):** An ES-L is a second in which the system detects one or more B2 parity violations or an EC-1 line AIS defect.

— **Line severely errored seconds (SES-L):** An SES-L is a second in which the system detects 9 or more B2 parity violations or an EC-1 line AIS defect.

— **Line unavailable seconds (UAS-L):** A UAS-L is a second in which the EC-1 line is "unavailable." A line is considered unavailable during loss of signal, loss of frame, and line AIS conditions. A line is also considered unavailable from the beginning of 10 consecutive severely errored seconds until the beginning of 10 consecutive seconds, none of which are severely errored.

■ DS3 line parameters

— **Errored Seconds (ES-L):** An ES-L is a second in which the system detects one or more B3ZS coding violations or a DS3 LOS defect in the DS3 signal input from the cross-connect panel.

■ DS3 path parameters

Each FT-2000 OC-48 Lightwave System DS3 can be provisioned to monitor either P-bit or F-and-M-bit violations. The P-bit parameter is an absolute measure. The F-and-M-bit parameter is an estimate of the errors in the bit stream, based on a sampling of F and M bits.

— **coding violations (CVP-P):** The sum of DS3 signal P-bit (F-and-M-bit) parity violations on a given OC-48 line are an indicator of the performance of that line. The system calculates, writes, and checks the P-bit (F-and-M-bit) parity for errors.

— **errored seconds (ESP-P):** An ESP is a second in which the system detects one or more DS3 coding violations, one or more DS3 path AIS defects, or one or more DS3 path LOF defects in the signal received from the OC-48 line.

— **severely errored seconds (SESP-P):** An SES is a second in which the system detects 44 or more DS3 coding violations, one or more DS3 path AIS defects, or one or more DS3 path LOP defects in the DS3 signal received from the OC-48 line.

— **severely errored frame/AIS Seconds (SEFS-P)/(SAS-P):** An SES is a second in which the system detects an out of frame or AIS defect in the DS3 signal received from the OC-48 line.

— **unavailable seconds (UASP-P):** An UAS is a second during which the DS3 path is "unavailable." A path is considered unavailable during loss of signal, loss of frame, and line AIS conditions. A line is also considered unavailable from the beginning of 10 consecutive severely errored seconds until the beginning of 10 consecutive seconds, none of which are severely errored.

Performance-Monitoring Data Storage

The FT-2000 OC-48 Lightwave System provides current and 32 previous 15-minute registers; and current and 6 previous 24-hour registers for all accumulated performance parameters. It also enables you to provision the hour that the system is to begin measuring all daily performance monitoring periods. The performance monitoring parameters begin daily at the provisioned time.

The FT-2000 OC-48 Lightwave System can retrieve and report the contents of any parameter storage register at any time. It can initialize the current 15-minute and/or current 24-hour registers through the CIT locally or remotely at any time. This capability is helpful, for example, in verifying that a repair to a failed facility was successful.

Performance Monitoring During Failed Conditions

When a trouble condition is detected, the FT-2000 OC-48 Lightwave System stops accumulating affected performance parameters per Bellcore requirements. All unaffected performance parameters continue to be accumulated during the trouble condition.

Performance Parameter Thresholds

The current 15-minute and current 24-hour thresholds for each performance-monitoring parameter are provisionable using the CIT. Whenever the current 15-minute or the current 24-hour threshold for a given performance-monitoring parameter is reached or exceeded, the FT-2000 OC-48 Lightwave System generates a threshold-crossing alert (TCA). The TCA is then entered into the appropriate performance-monitoring report.

**Threshold-Crossing Alert Transmission to an
Operations System**

FT-2000 OC-48 Lightwave System supports the TL1 REPORT EVENT autonomous messages for TCA reporting. The TL1 messages and TBOS points provide information on the crossing of a raw count, ES, SES, or UAS threshold for the current 15-minute register. All threshold-crossing alerts (TCAs) are retrievable by the local and remote CIT interfaces. The message-based operations system interface may carry TCA reports to the operations centers if it is provisioned for autonomous TCA reporting.

Reports

This topic contains information about the following:

- Active Alarms and Status Report

- Performance Monitoring Report

- History Report

- Report on Circuit Pack, Slot, and Port States

- Version/Equipment List

- Synchronization Report.

Active Alarms and Status Report

The FT-2000 OC-48 Lightwave System provides an on-demand report that shows all the active alarm and status conditions. FT-2000 automatically displays the local alarm and status report on the local and remote CIT. The report shows the following alarm levels:

- Critical (CR)

- Major (MJ)

- Minor (MN)

- Abnormal (ABN)

- Near-end activity (NE ACTY).

The source address and description of the alarm condition (for example, controller failure and incoming high-speed signal failure) are included in the report along with the date and time detected. The report also shows if the alarm condition affects service. The option to display specified subsets of alarm conditions by severity is also provided.

Performance Monitoring Report

The FT-2000 OC-48 Lightwave System provides reports that contain the values of all performance monitoring registers requested at the time the report(s) is (are) requested. The start time of recording period of each register is also included. The reports provide SONET optics, section, line and path; as well as DS3 line and path, performance monitoring data that was recorded in a series of 15-minute and 24-hour storage registers. In addition, another report is provided that contains a summary of all SONET and DS3 performance parameters that have crossed their provisioned 15-minute or 24-hour thresholds within the history of the 15-minute and 24-hour registers[10]. For more information, refer to the topic "Performance-Monitoring Processing" in this chapter.

History Report

A history report displays the past 500 events. An event is any change in the FT-2000 OC-48 Lightwave System that may affect its performance (for example, a failure) or change its operation status (for example, loopback setup). This summary contains time stamps showing when each condition was detected and when it cleared. The CIT events contain a time stamp showing when the command was entered.

The day bin time stamp at the top of the report reflects the last time the 24-hour performance monitoring counts were initialized, even if the resulting "day" is longer or shorter than 24 hours. The report shows corrupted data as a question mark (?) for all non-24-hour day bin collection intervals, including those exceeding 24 hours.

Report on Circuit Pack, Slot, and Port States

This on-demand report displays the state of each addressed slot and the external DS1 references (if applicable) in the FT-2000 OC-48 Lightwave System. For each slot and external DS1 reference, the report includes the following:

- Address
- Circuit pack type
- Port states
- Switch state of the slot
- Switch priority.

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10. A series of 32 previous and one current 15-minute register is provided for each parameter, allowing for up to 8 hours and 15 minutes (495 minutes) of history in 15-minute registers. Also, 6 previous and one current 24-hour register is provided, allowing for up to 7 days (168 hours) of history in 24-hour registers.

Version/Equipment List

The version/equipment list report is an on-demand report that lists the circuit pack version and the software generic (if applicable). This report also lists all the circuit packs that are present.

Synchronization Report

The synchronization report is an on-demand report that lists the status of the system synchronization. This report lists all the clock parameters that can be interrogated from a CIT or from remote telemetry.

Orderwire

Orderwire provides voice and modem (CIT) communications for maintenance personnel to perform facility maintenance. The FT-2000 OC-48 Lightwave System provides two V.11/EIA-422, 64 kb/s orderwire interfaces, one for section orderwire and one for line orderwire. Line orderwire is terminated in terminals only. Section orderwire is terminated in terminal and repeater sites. For more information see Chapter 2, "Orderwire for Remote CIT Access and Basic Party-Line Service to Repeaters and Terminals."

To gain access to the orderwire interface at terminals, the Enhanced High-Speed Shelf or High-Speed Shelf must be equipped with the Overhead Controller - Terminal [OHCTL (TERM)] circuit pack.

To gain access to the orderwire interface at repeaters, the Repeater shelf must be equipped with the orderwire access circuit pack (OW).

Standard equipment can be connected to these interfaces. The orderwire shelf must be installed within a few feet of the bay. Refer to the **Related Products** tab in Chapter 7 for orderwire shelf ordering information.

Provisioning

This section contains information about the following:

- Original Value Provisioning
- Local or Remote Provisioning
- Preprovisioning Circuit Packs
- Provisioning on Circuit Pack Replacement
- Provisioning Port States.

Original Value Provisioning

Installation provisioning is minimized with original values. Each provisionable parameter is assigned an original value at the factory. A parameter is a characteristic of the system that affects its operation. A value is a number, text string, or other menu selection. The provisionable parameters and original values are copied from floppy disks in the CIT to the System Memory (SYSMEM) circuit pack.

There are three complete sets of data (parameters and their values) in the system under normal conditions:

- The first set contains the system parameters and their original values (value assigned to a parameter at the factory). This set is located in the nonvolatile memory of the SYSMEM circuit pack.

- The second set contains the system parameters and their current values (values currently being used by the system). This set is also located in the nonvolatile memory of the SYSMEM circuit pack.

- The third set contains the system parameters and their current values. This set is located in the volatile memory of the SYSCTL circuit pack.

The original values assigned at the factory cannot be changed. The current values can be overridden through local or remote provisioning.

Local or Remote Provisioning

The FT-2000 OC-48 Lightwave System software control allows local and remote provisioning of all CIT provisionable parameters using the CIT. Most parameters are provisionable through TL1 commands. The CIT can be used to override the current values assigned to CIT provisionable parameters. The provisionable parameters and values (current and original) are maintained in the nonvolatile memory of the SYSMEM circuit pack. For more information about provisioning parameters and original values using CIT-PC or TL1 commands, refer to 365-575-102, *FT-2000 OC-48 Lightwave System User/Service Manual*.

Preprovisioning Circuit Packs

To simplify circuit pack installation, parameters can be provisioned before install-ing the corresponding circuit pack. All system parameters and values (current and original) are preserved by the FT-2000 OC-48 Lightwave System in the nonvola-tile memory of the SYSMEM circuit pack. The parameters and values are pro-tected by the nonvolatile memory if a power failure occurs and are retrievable on demand regardless of the means used for provisioning. The parameters are auto-matically downloaded when the affected circuit pack is installed.

Provisioning on Circuit Pack Replacement

Replacement of a failed circuit pack is simplified by the FT-2000 OC-48 Lightwave System automatic provisioning of the original circuit pack values. The system con-troller (SYSCTL) and SYSMEM circuit packs maintain a provisioning map of the entire system, so when a transmission or timing circuit pack is replaced, the SYSCTL and SYSMEM circuit packs automatically download provisioning param-eters and values to the new circuit pack. Please note that cross connection provi-sioning is at the STS-1 level as of Release 7 and later. When you install STS-1 granularity capable transmitters in a node, FT-2000 automatically translates STS-3 level cross-connections that are defined on your system into STS-1 level cross-connections.

Provisioning Port States

Port states represent the state for each port in the system, at any given time. Each port state has its own characteristics for signal failure alarms and performance monitoring (PM) data collection. Transitions between states occur due to events such as:

- Applying a good signal

- Loss of signal (LOS)

- CIT or TL1 command.

Figure 5-1 shows how the ports transition from one state to another.
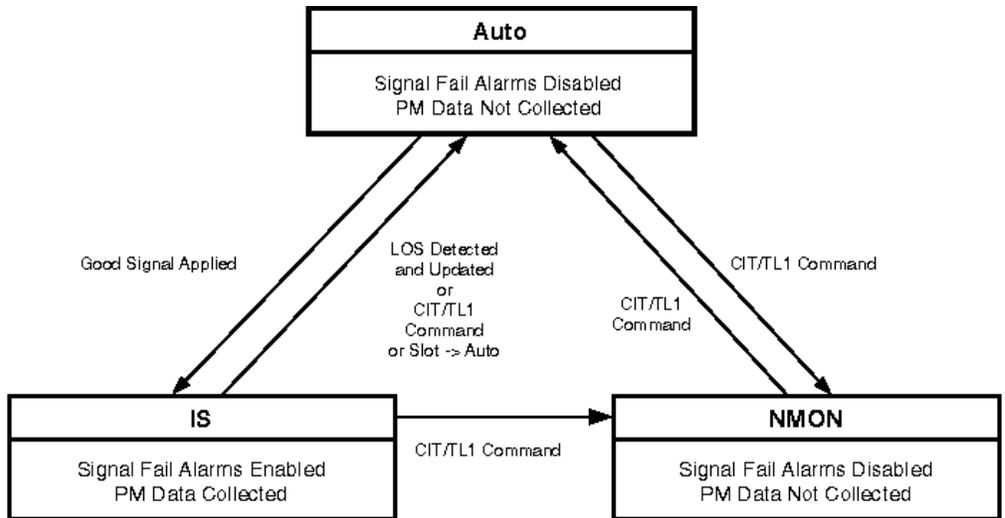
Figure 5-1.   Port State Transitions

The low-speed port states are:

- Auto (AUTO): AUTO refers to a low-speed port that is available for auto-matic provisioning. A low-speed port transitions from the AUTO state to the IS state if a good signal is detected. The original port state value is AUTO.

- In service (IS): IS refers to a low-speed port that is fully monitored and alarmed.

- Not monitored (NMON): NMON refers to a low-speed port that is not moni-tored and will not transition to the IS state if a good signal is detected. This port state is used to suppress unwanted alarms.

The FT-2000 supports port states for the following electrical and optical circuit packs:

- Electrical

    — DS3

    — EC-1.

- Optical

    — OC-3

    — IS-3

    — OC-12.

Electrical Port States

The electrical port states allow the DS3 and EC-1 circuit packs to be CIT provisioned to the NMON state at anytime, regardless of the auto-provisioned state of the terminating low-speed interface slot.

Optical Port States

The optical port states allow the IS-3, OC-3, and OC-12 circuit packs to be provisioned independently. When using the IS-3, OC-3, or OC-12 for transport in only one direction, the unused direction will have its own port state of "AUTO" instead of having the same port state of "IS" (in-service). Setting the alarm feature to "NO" will no longer be required for one-way IS-3, OC-3, or OC-12 transport.

Tagging and Untagging Red-Line Services

For high-priority services the cross-connects are established and then are red-line tagged using the CIT (ENTER-CROSSCONNECT-STS1) and TL1 (ENT-CRS-rr) commands. Use the CIT (SET-CROSSCONNECT-STS1) and TL1 (ED-CRS-rr) commands to untag a cross-connect prior to deleting.

FT-2000 Software Compatibility

Table 5-4 , Table 5-5 ,and Table 5-6 lists the FT-2000 SONET software compatibility for DDM-2000 OC-3/OC-12, CPro-2000, and ITM SNC within a subnetwork. All configurations listed support Operations Interworking (OI). The table lists all possible software combinations. Combinations not listed are not supported.

Software Compatibility With DDM-2000 OC-3/OC-12

Table 5-4 lists the FT-2000 SONET software compatibility with DDM-2000 OC-3 and OC-12 within a subnetwork.

Table 5-4 FT-2000 Software Compatibility With DDM-2000 OC-3 and OC-12

Release	OC-3												OC-12					
	3.2	6.2	7.1	7.2	8.0	8.1	9.0	9.1	11.0	11.1	13.0	15.0	2.3	3.1	5.0	5.1	5.2	7.0
FT-2000, R4.0 *		X	X	X	X		X						X	X	X			
FT-2000, R4.1 †			X	X	X		X						X	X	X			
FT-2000, R5.0 ‡	X	X	X	X	X		X						X	X†	X			
FT-2000, R6.0 §				X	X		X								X			
FT-2000, R7.0				X	X	X	X	X							X	X	X	
FT-2000, R7.1 **				X	X			X	X	X						X	X	
FT-2000, R7.2 ††				X	X			X	X	X						X	X	
FT-2000, R 8.1											X	X						X
FT-2000, R9.0											X	X						X
FT-2000, R9.1											X	X						X

†   Supports EC-1 transmission dual ring interworking (DRI).

‡   Supports OC-3 transmission interfaces without DCC.

§   Supports OI with OC-3 DCC.

¶   Supports EC-1 transmission interfaces.

**   Supports OI with OC-12 0x1 DCC and OC-12 1+1 transmission interface without DCC.

††   Supports OI with OC-12 1+1 DCC.

**CPro-2000 Network Element Management Software
Compatibility**

Table 5-5 lists the NE management CPro-2000 software compatibility with
FT-2000 within a subnetwork.

Table 5-5 CPro-2000 Network Element Management Software Compatibility

Product/Release	CPro-2000								
	3.0	4.0	5.0	6.0	6.1	7.0	8.1	9.0	10.0
FT-2000, R6.0	X	X	X	X	X				
FT-2000, R7.0		X	X	X	X				
FT-2000, R7.1				X	X				
FT-2000, R7.2				X	X				
FT-2000, R8.1							X	X	X
FT-2000, R9.0								X	X
FT-2000, R9.1									X

**ITM SNC Network Element Management Software
Compatibility**

Table 5-6 lists the NE management ITM SNC software compatibility with FT-2000
within a subnetwork.

Table 5-6 ITM SNC Network Element Management Software Compatibility

Product/Release	ITM SNC								
	2.1	2.2	3.0	4.0	5.0	6.0	8.0	9.0	10.0
FT-2000, R6.0	X	X	X	X	X	X	X	X	X
FT-2000, R7.0	X	X	X	X	X	X	X	X	X
FT-2000, R7.1			X	X	X	X	X	X	X
FT-2000, R7.2			X	X	X	X	X	X	X
FT-2000, R8.1						X	X	X	X
FT-2000, R9.0							X	X	X
FT-2000, R9.1									X

System Planning and Engineering

6

Contents

System Planning and Engineering

6

Overview

This chapter summarizes descriptive information that can be used in conjunction with applications information to plan procuring and deploying the FT-2000 OC-48 Lightwave System. It includes system planning and engineering considerations for the FT-2000 OC-48 Add/Drop-Rings and FT-2000 OC-48 Repeater Bay platforms.

Planning Considerations

There are several considerations to keep in mind when planning your network. The initial network configuration determines synchronization requirements. Projected customer requirements determine the initial capacity needed, as well as growth. Where you install the network and how you plan to use it determines the physical installation considerations.

Before ordering or installing the equipment, you need to develop an overall plan and select or construct the building that is to serve as a terminal office or repeater

site. This plan should take into consideration the eventual system size and include the following:

- Synchronization
- Protection
- Capacity
- Span length
- Optical line loss budgets
- Floor plan layout
- Equipment interconnection
- Cabling
- Environmental considerations
- Power planning.

Lucent Technologies offers engineering and installation services to plan and install the FT-2000 OC-48 Lightwave System. For more information about Lucent Technologies engineering and installation services, refer to Chapter 8, "Product Support."

Synchronization

This topic contains information about platform and network synchronization.

Platform Synchronization

The FT-2000 OC-48 Lightwave System platforms can be provisioned for the following synchronization modes:

- FT-2000 OC-48 Add/Drop-Rings Terminal

    — free running from an internal oscillator

    — line timed using synchronization messages that are derived from the incoming OC-48 signal

    — through timing from an incoming OC-48 signal

    — externally timed from the digital synchronization network using DS1 synchronization references

- FT-2000 OC-48 Repeater Bay

    — through timing from an incoming OC-48 signal.

As network needs evolve, the FT-2000 OC-48 Lightwave System can be reprovisioned easily in service to change synchronization modes as needed. If the synchronization mode is changed to the externally timed mode, external DS1 synchronization references need to be supplied.

The FT-2000 OC-48 Lightwave System also provides DS1 synchronization input and output signals to the office building integrated timing supply (BITS) clock or other central office equipment.

Internal timing functions — reference interfaces, on-board clock elements, and timing distribution — are located on the Timing Generator, Stratum 3 - DS1 [TG3 (DS1)] circuit packs. The TG3 (DS1) circuit packs distribute clock signals derived from the selected reference source to the transmission circuit packs.

Two TG3 (DS1) circuit packs are located on each low-speed shelf and support the synchronization needs of the FT-2000 OC-48 Lightwave System. The FT-2000 OC-48 Repeater Bay does not require TG3 (DS1) circuit packs. The TG3 (DS1) circuit packs are 1x1 (revertive) protected, protecting against circuit pack failures. The external timed references are revertively protected independently of the TG3 (DS1) circuit packs.

Synchronization Modes

Free Running Operation

The FT-2000 OC-48 Lightwave System is designed to operate without any external synchronization reference in the free running mode. In the free running mode (Figure 6-1), the TG3 (DS1) circuit packs derive timing from an internal stratum 3 oscillator. The internal stratum 3 oscillator has a long-term accuracy better than 4.6 ppm. The TG 3 (DS1) circuit packs generate and distribute the timing signals to the transmit circuits.
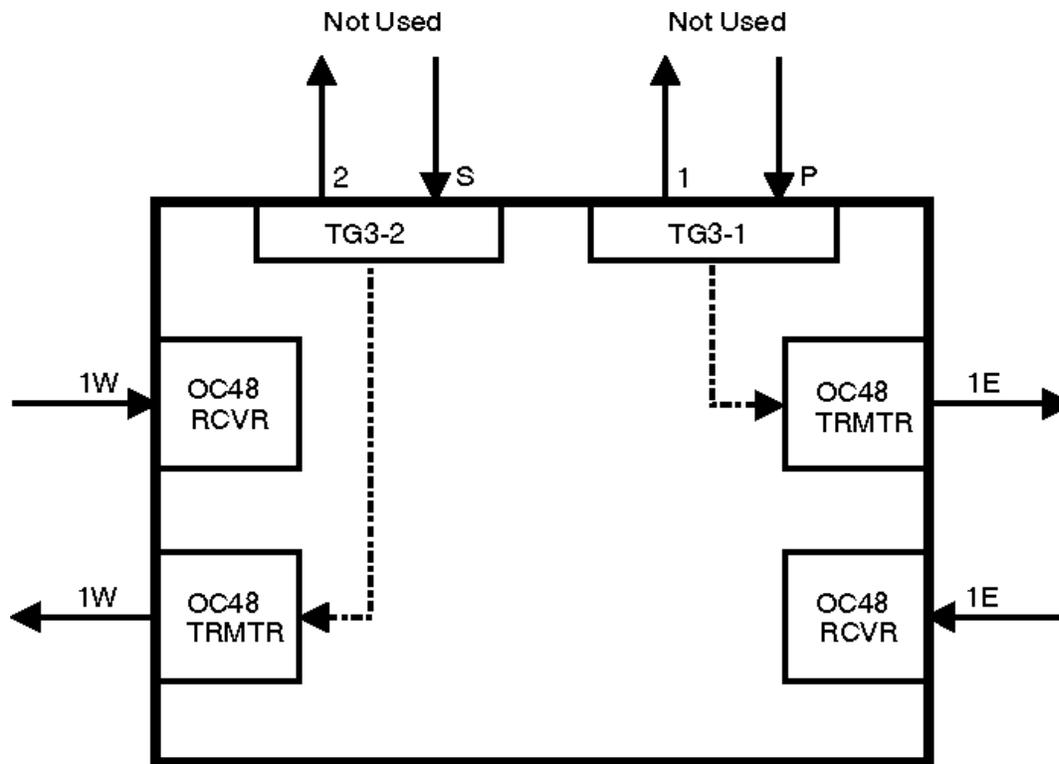
Figure 6-1.   Free Running Synchronization (FT-2000 OC-48 Add/Drop-Rings Terminal)

External Timing Operation

In the external timing mode (Figure 6-2), each TG3 (DS1) circuit pack accepts a DS1 synchronization reference signal from an external stratum 3 or better clock. These DS1 references synchronize the local terminal. Within the TG3 (DS1) cir-

cuit pack, a highly stable digital phase locked loop (DPLL) circuit removes any transient impairments on the DS1 reference for improved jitter performance.

The DS1 references are continuously monitored for error-free operation. If the primary DS1 reference becomes corrupted, the TG3 (DS1) circuit pack will select the secondary DS1 reference without causing service degradations. East (E) or West (W) backup may be chosen. If no backup is desired, choose None.

If both DS1 references are corrupted, the DPLL circuit holds the on-board oscillator frequency at the last good reference sample while the DS1 references are repaired (holdover mode).
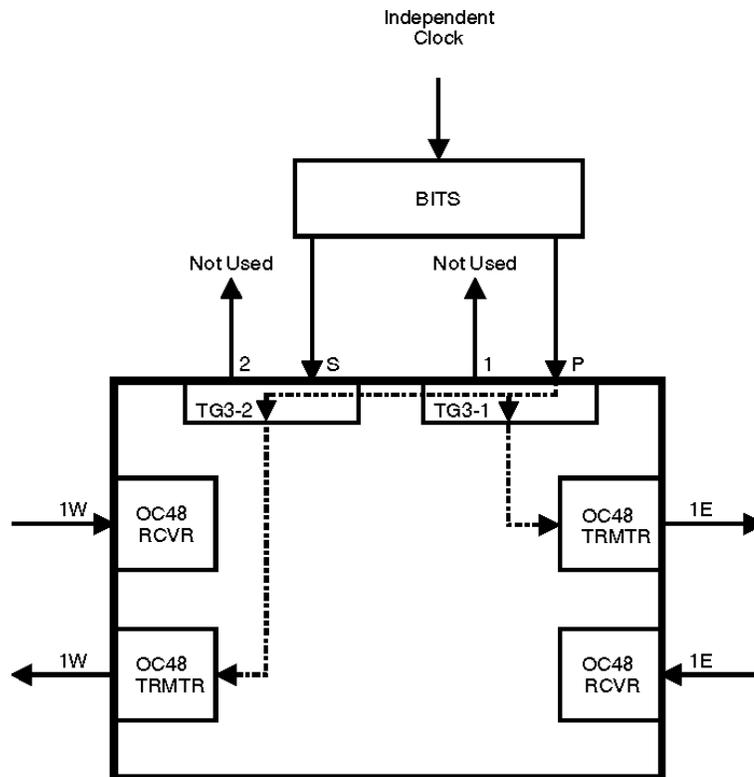
Figure 6-2.   External Timing Synchronization (FT-2000 OC-48 Add/Drop-Rings Terminal)

Through Timing Operation

In the through timing mode, an intermediate site derives timing from the incoming OC-48 signals. The intermediate site can be either an FT-2000 OC-48 Repeater Bay or FT-2000 OC-48 Add/Drop-Rings Terminal. This section discusses the FT-2000 OC-48 Add/Drop-Rings Terminal. For information about the FT-2000 OC-48 Repeater Bay, see the "OC-48 Repeater Bay Applications" section later in this chapter.

In the FT-2000 OC-48 Add/Drop-Rings Terminal, the TG3 (DS1) circuit packs derive timing from the incoming OC-48 signals (see Figure 6-3). The TG3 (DS1) circuit packs accept an OC-48 line reference signal (25.92 MHz) from the OC48 RCVR circuit packs and derive the internal synchronization used by the transmission circuit packs. For example, the TG3 (DS1) circuit pack that accepts the OC-48 line reference signal from high-speed line 1W derives timing for the OC-48 signal transmitted on high-speed line 1E. Also, the TG3 (DS1) circuit pack that accepts the OC-48 line reference signal from high-speed line 1E derives timing for the OC-48 signal transmitted on high-speed line 1W.
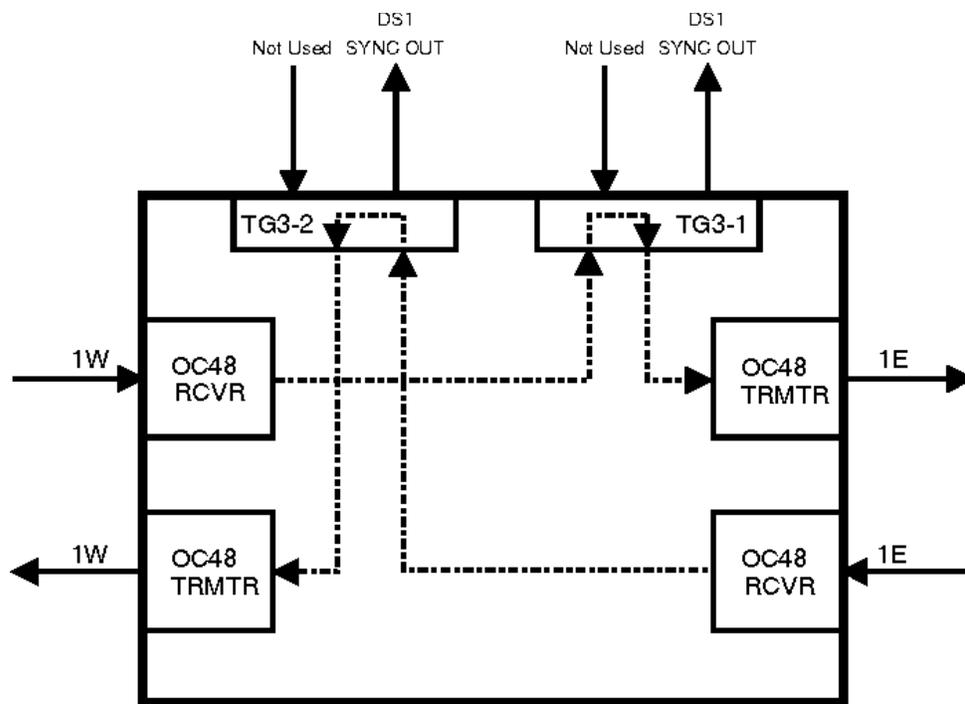
Figure 6-3.   Through Timing Synchronization

The OC-48 line references are continuously monitored for error-free operation. If the line reference becomes corrupted, the system takes the timing from the non-failed side.

In the through timing mode, the TG3 (DS1) circuit packs can also provide DS1 synchronization outputs to the office BITS clock or other central office equipment. The LAA18 TG3 (DS1) circuit pack derives the DS1 synchronization outputs directly from the OC-48 line reference signals recovered from the incoming OC-48 signals.

Network Synchronization

Careful consideration should be given to proper design of the synchronous optical network (SONET) synchronization. Proper synchronization engineering minimizes timing instabilities, maintains quality transmission network performance, and limits network degradation due to unwanted propagation of network synchronization faults. The synchronization features of the FT-2000 OC-48 Lightwave System are designed to complement existing and future network synchronization. These features allow the system not only to make use of network synchronization but also to take an active role in facilitating network synchronization.

Several published sources give generic recommendations on setting up a synchronization network. The FT-2000 OC-48 Lightwave System is designed to operate in a network that complies with recommendations stated in GR-436-CORE, *Digital Synchronization Network Plan*, Issue 1, June 1994; GR-378-CORE, *Generic Requirements for Timing Signal Generators*, Issue 1, June 1995; and *ANSI*[1] T1.101-1994, *American National Standard for Telecommunications - Synchronization Interface Standard*.

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1. Registered trademark of American National Standards Institute.

The following list contains some key recommendations from these documents. For a more detailed explanation, consult the sources directly.

■ A network element can receive the synchronization reference signal only from another network element that contains a clock of equivalent or superior quality (stratum level).

■ The facilities with the greatest availability (absence of outages) should be selected for synchronization facilities.

■ Where possible, all primary and secondary synchronization facilities should be diverse, and synchronization facilities within the same cable should be minimized.

■ The total number of network elements in series from the stratum 1 source should be minimized. For example, the primary synchronization network would ideally look like a star configuration with the stratum 1 source at the center. The network elements connected to the star would branch out in decreasing stratum level from the center.

■ No timing loops can be formed in any combination of primary and secondary facilities.

Synchronization Messaging

Synchronization messages are a method by which nodes in an FT-2000 ring can communicate their synchronization status with other nodes in the ring.

■ from FT-2000 nodes to DDM-2000 OC-3 or other vendor OC-3 equipment over LAA10B OC-3 interfaces via bits 5, 6, 7, and 8 of the S1 byte.

On the OC-48 interface, synchronization messages are both transmitted and processed. On the IS-3, OC-3, and OC-12 interfaces, synchronization messages are supported in the drop direction to distribute timing to DDM-2000.The table below shows two ring environments available:

■ interoffice

■ customer location.

Table 6-1 explains ring environments and the use of synchronization.

Table 6-1.   FT-2000 Ring Environments

IF the ring node environment is...	THEN the synchronization is located in...	AND...
interoffice	central offices with BITS clocks	synchronization messages are *not* needed.

Table 6-1.   FT-2000 Ring Environments

IF the ring node environment is...	THEN the synchronization is located in...	AND...
loop (customer location)	customer sites *without* BITS clocks	DS1 output will be used to provide timing to the equipment in the customer location. Note: If the timing is not traceable to the timing network, insert DS1 AIS.

Synchronization Applications

The FT-2000 OC-48 Lightwave System supports the following applications (with or without the FT-2000 OC-48 Repeater Bay) and network synchronization configurations:

■ OC-48 point-to-point applications with asynchronous (DS3) and synchronous (EC-1, OC-3, and OC-12) low-speed interfaces. The point-to-point applications with synchronous low-speed interfaces must be two-node folded rings in which the nodes are FT-2000 OC-48 Add/Drop-Rings Terminals.

■ bidirectional ring applications with

— asynchronous (DS3) low-speed interfaces only.

— asynchronous (DS3) and synchronous (EC-1, OC-3, and OC-12) low-speed interfaces.

— synchronous (EC-1, OC-3, and OC-12) low-speed interfaces only.

Bidirectional Line-Switched Ring Applications

A bidirectional line-switched ring consists of up to 16 nodes, and for each node there are several possible synchronization provisioning options. To ensure that each node is provisioned properly, you need to determine whether or not the ring is to be used to distribute timing from one location to another using the OC-48 signal. Proper provisioning is important, for example, to prevent closed timing loops during protection switching operations.

An FT-2000 ring provides high-quality, protected transmission. Using the FT-2000 OC-48 Lightwave System to distribute timing signals is becoming an increasingly important function because the direct T1 lines currently used to distribute timing over asynchronous transmission equipment are being replaced with SONET systems. (You cannot use SONET payloads carrying T1 facility traffic to distribute timing in rings.)

However, there are many good quality synchronization distribution networks in place that use T1 facilities that may not need to be converted.

The next sections discuss how to provision synchronization in various applications. The "Summary of Timing Rules for Bidirectional Line-Switched Rings" section summarizes the rules for determining how the synchronization mode should be provisioned for each node.

Bidirectional line switched rings may or may not be used to distribute timing, depending on the application.

Ring Applications Not Used to Distribute Timing

This section describes provisioning rules for the following applications in which the ring is not used to distribute timing signals:

- asynchronous applications (DS3 low-speed interfaces only)
- synchronous applications (mixture of asynchronous and synchronous low-speed interfaces)

Asynchronous Applications (Only for DS3 Low-Speed Interfaces)

Figure 6-4 illustrates an asynchronous synchronization configuration. This may only be used for applications in which every node in the ring has only asynchronous low-speed interfaces (DS3). In the figure

- exactly one node is provisioned free running and
- all other nodes are provisioned either through timed.

Provisioning only one node in the ring free running prevents cumulative pointer processing on transmission signals from passing through a node. In the future, if you add synchronous low-speed interfaces to nodes in the ring, follow the rules in the "Synchronous Applications (Mixture of Asynchronous and Synchronous low-speed Interfaces)" section.
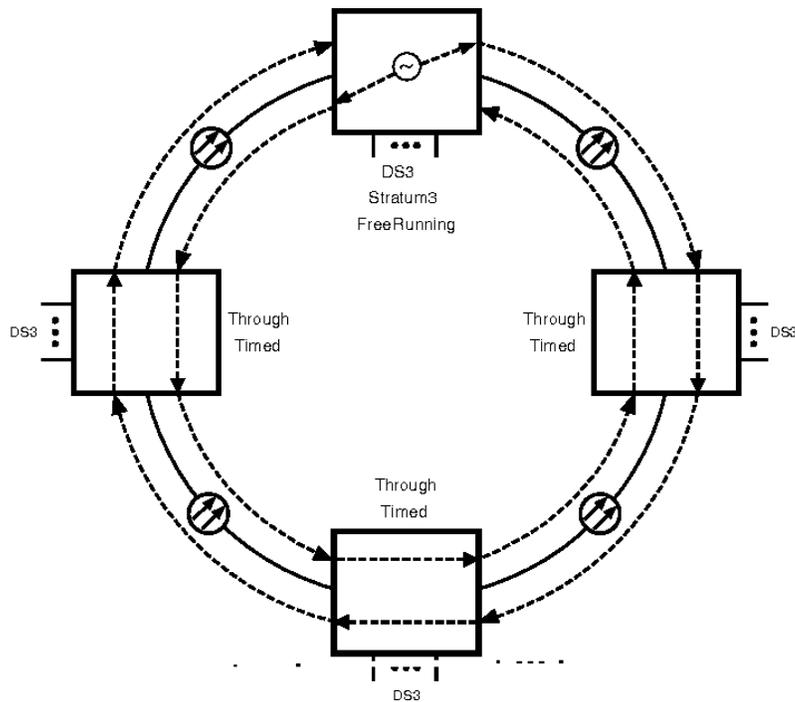
Figure 6-4. **Example 1: Bidirectional Ring Application Not Used to Distribute Timing (Free Running/Through Timed)**

Synchronous Applications (Mixture of Asynchronous and Synchronous Low-Speed Interfaces)

Figure 6-5 and Figure 6-6 show the synchronization configurations to use for synchronous applications. These applications may have either asynchronous or synchronous low-speed interfaces, or a mix of synchronous and asynchronous low-speed interfaces. In the figures

■ exactly one node is provisioned externally timed and

■ all other nodes are provisioned through timed or externally timed.

If you use this configuration, you do not need to reprovision a node when you add synchronous low-speed interfaces. The timing signals used to synchronize the externally timed nodes should be traceable to a stratum 1 timing source.

Legend:
  S = Secondary DS1 Reference Input to TG3-2 = (SECY Port)
  P = Primary DS1 Reference Input to TG3-1 = (PRI Port)
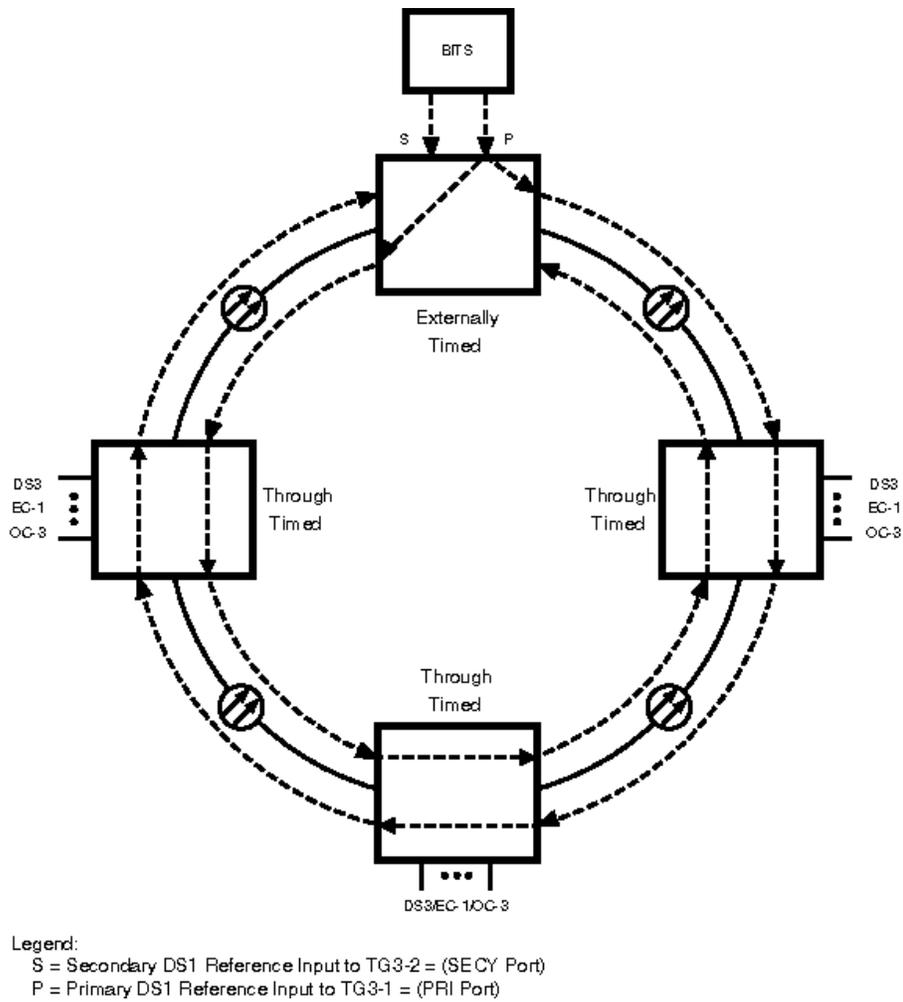
**Figure 6-5.   Example 2: Bidirectional Ring Application Not Used to Distribute Timing
        (Externally Timed/Through Timed)**
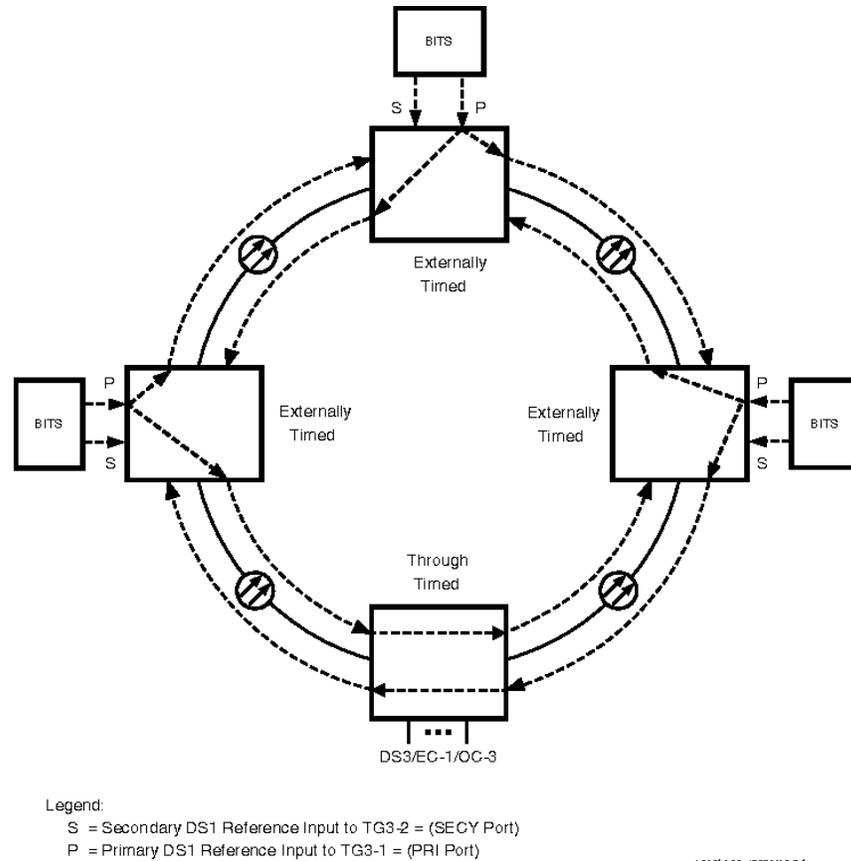
Figure 6-6. **Example 3: Bidirectional Ring Application Not Used to Distribute Timing (Externally Timed/Through Timed)**

Interoffice Network Synchronization Distribution

DS1 signals have long been used to pass timing information through the network synchronization hierarchy. In the past, these DS1 synchronization references were transmitted between master and BITS clock sources over the most reliable facilities available. In some cases, these DS1 signals also carried traffic.

The facility of choice has evolved from T-carrier through asynchronous lightwave systems to SONET lightwave systems. As you upgrade T-carrier and asynchronous lightwave systems to SONET lightwave systems, it is no longer possible to distribute timing over traffic carrying DS1s. Therefore, you should revisit synchro-

nization distribution plans to ensure the quality of the synchronization signals is not degraded.

The FT-2000 OC-48 Lightwave System supports the evolution to interoffice OC-N timing distribution by providing a DS1 timing output signal derived from the incoming OC-48 signal (see Figure 6-7). The DS1 timing output signal is traceable to the clock source that synchronizes the network and has extremely low jitter and wander. This is true regardless of the number of FT-2000 network elements connected in the network. This DS1 timing output signal can be fed to the local BITS clock that subsequently times all equipment in that office, including the local FT-2000 OC-48 Lightwave System. If a BITS clock is not available in the office, the DS1 timing output signal can be provided directly to other equipment (for example, a DDM-2000 Multiplexer or another FT-2000 OC-48 Lightwave System).

The DS1 timing input reference signals and the derived DS1 timing output signals do not/cannot carry DS1 traffic.

The FT-2000 OC-48 Lightwave System provides derived DS1 timing output signals in all supported applications with the LAA18 TG3 (DS1) circuit pack.

Figure 6-7.   OC-N Derived DS1 Timing Reference

Access Network Synchronization Distribution

OC-N timing distribution can be used in access networks or to small central offices. In this configuration, a DS1 reference signal from the central office BITS clock still times the OC-48 signal transmitted to the remote site. The DS1 timing output signal can be used to also extend synchronization to customer networks or

remote sites. In customer networks and at remote sites, the DS1 timing output can be used to time switch remotes, DDM-2000 multiplexers, or other local equipment directly.

When FT-2000 rings with synchronization messages are used to distribute timing, to prevent timing loops follow the rules in "Provisioning Rings with Two or More External Timing Sources", earlier in this chapter. To prevent timing loops in networks, the rules below must be followed.

Using Through Timing to Distribute Timing Signals to BITS Clocks

With synchronization messages, the DS1 output can be used to provide timing to office BITS or customer equipment for any configuration. In the through timing mode, an intermediate site (FT-2000 OC-48 Repeater Bay or FT-2000 OC-48 Add/Drop-Rings Terminal) derives timing from the incoming OC-48 signals. Ring applications used to distribute timing signals to BITS clocks provision at least one node externally timed and any nodes that drop timing signals through timed. All other nodes should be provisioned externally timed or through timed. The externally timed node provides the timing signal that is distributed to some or all the remaining nodes.

Figure 6-8 and Figure 6-9 each show an example of an externally timed/through timed topology in which more than one node has a stratum 1 traceable clock signal source. This type of topology supports either synchronous or asynchronous low-speed interfaces or any combination.

Legend:
   1 = DS1 Reference Output 1 from TG3-1
   2 = DS1 Reference Output 2 from TG3-2
   S = Secondary DS1 Reference Input to TG3-2 = (SECY Port)
   P = Primary DS1 Reference Input to TG3-1 = (PRI Port)
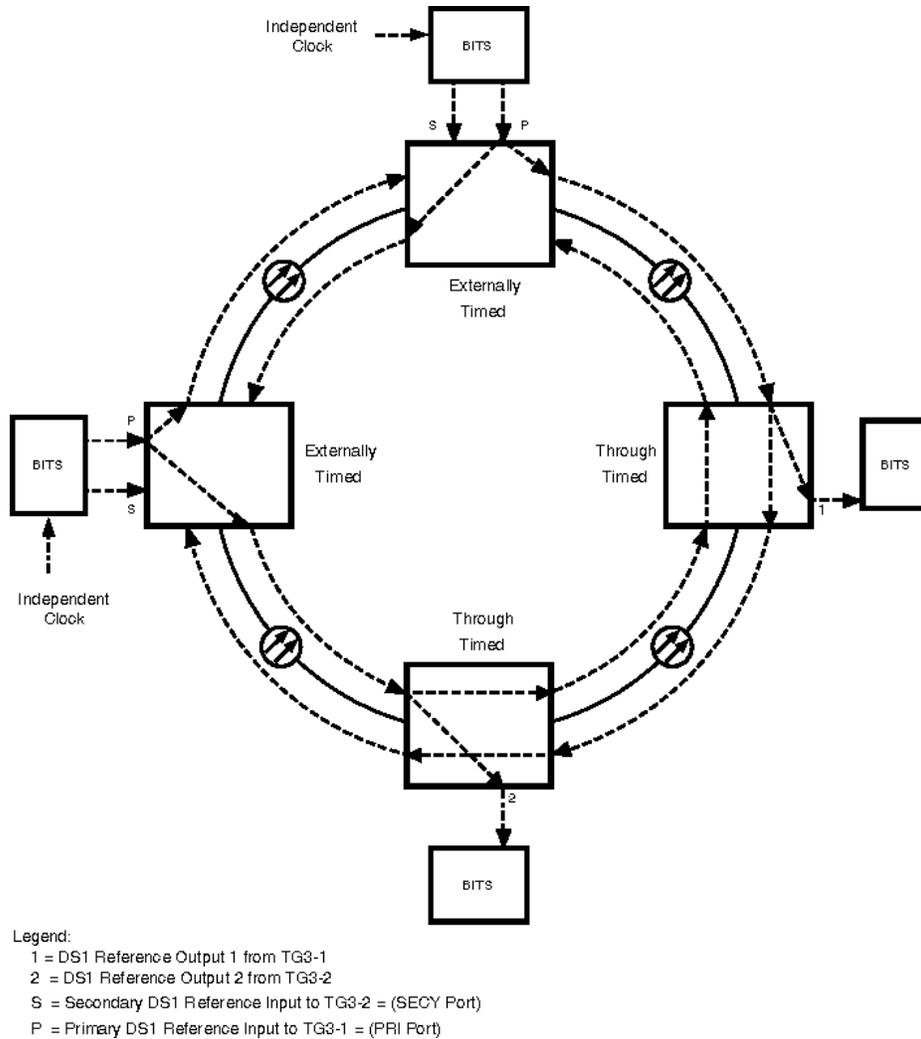
Figure 6-8.   Example 1: Bidirectional Ring Application Used to Distribute Timing (Externally Timed/Through Timed)
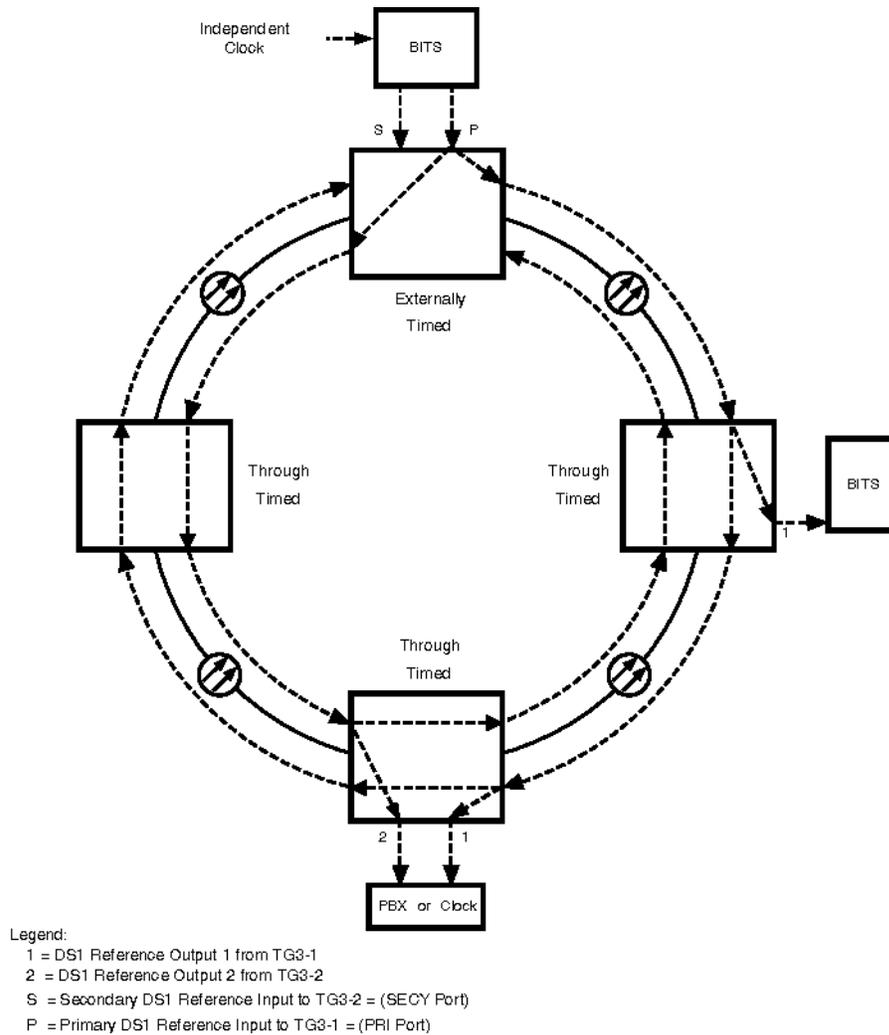
Figure 6-9. Example 2: Bidirectional Ring Application Used to Distribute Timing (Through Timed/Externally Timed)

All Nodes Equipped With Either Stratum 1 Traceable Signal or BITS

In certain central offices that contain a BITS clock, you might want to have all network elements in the office receive timing from the BITS clock. In this topology, you can use the FT-2000 to distribute timing to the offices and still have the FT-2000 externally timed from the office BITS. All nodes in this ring topology must be externally timed.

There are three possible situations:

- a BITS clock with a stratum 1 traceable source that is not distributed through this ring

- a BITS clock with a stratum 1 traceable source that is distributed through this ring

- no BITS clock

Figure 6-10 illustrates an example of this topology. Here, Node A is externally timed with a stratum 1 traceable clock while all other nodes (B, C, and D) are externally timed through their BITS. Nodes B, C, and D distribute the DS1 clock signal to and receive the DS1 clock signal from their collocated BITS, using the primary references only. As shown in the figure, Node B provides a DS1 timing output derived from the incoming OC-48 signal from the west. This timing output can be provided to the local BITS that is used to time the node. Node B drops DS1 timing signals to the BITS (to synchronize other networks) and receives the timing signal back from the BITS. Nodes C and D operate the same way.

Legend:
1 = DS1 Reference Output 1 from TG3-1
S = Secondary DS1 Reference Input to TG3-2 = (SECY Port)
P = Primary DS1 Reference Input to TG3-1 = (PRI Port)
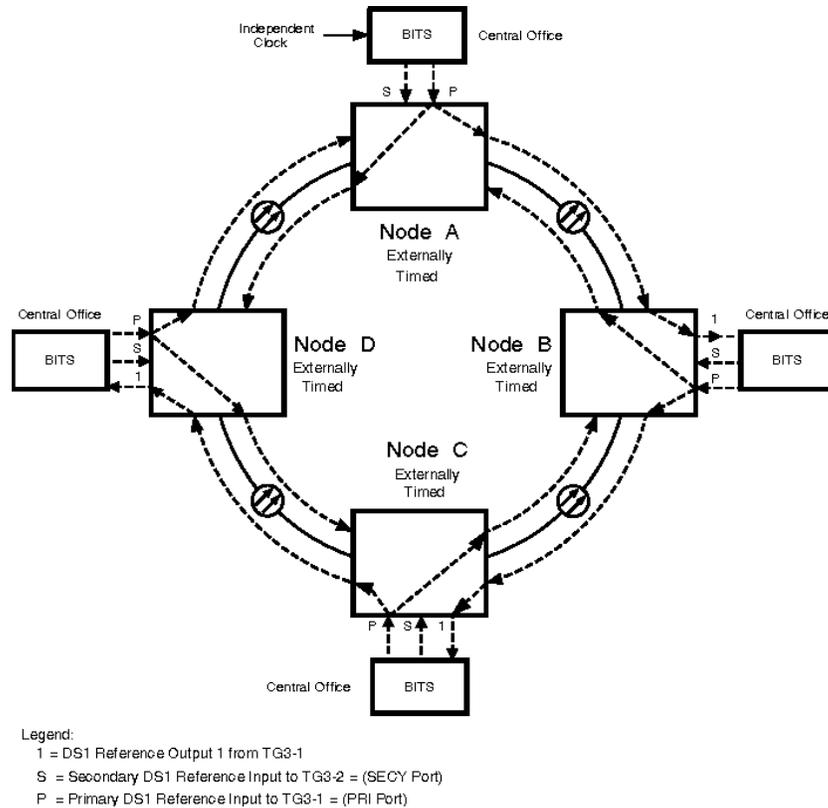
Figure 6-10. Bidirectional Ring Application Used to Distribute Timing in a BITS Environment (Externally Timed/Externally Timed)

This topology guarantees no timing loops as long as:

■   all nodes that have BITS clocks in the central office use only the primary DS1 timing reference output at all timing distribution nodes. Timing distribution nodes are nodes where timing is dropped to a BITS clock.

■   all nodes are provisioned externally timed.

■   at least one node is not used as a timing drop.

Violating any of these requirements can cause a timing loop. Figure 6-11 shows a timing loop (thick, solid line) caused by using a secondary interface at Node B and a primary interface at the remaining nodes. Figure 6-12 shows a timing loop caused by provisioning Node B and Node D externally timed and Node C through timed. A line failure between Node B and Node C results in a timing loop (thick, solid line) between Nodes C and D.

Avoid this topology.
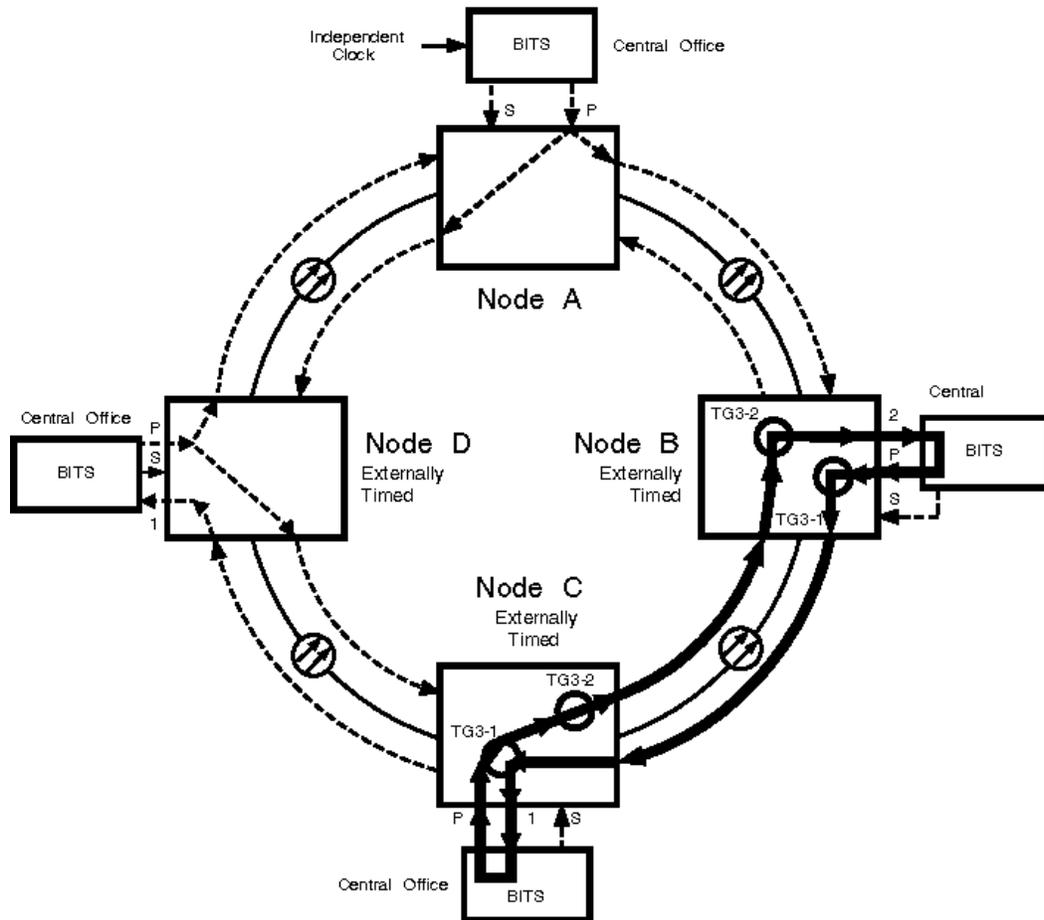
Legend:
1 = DS1 Reference Output from TG3-1
2 = DS1 Reference Output 2 from TG3-2
P = Primary DS1 Reference Input to TG3-1 (PRI Port)

Figure 6-11.   Timing Loop Caused by Mixing Primary and Secondary Interfaces

Avoid this topology.
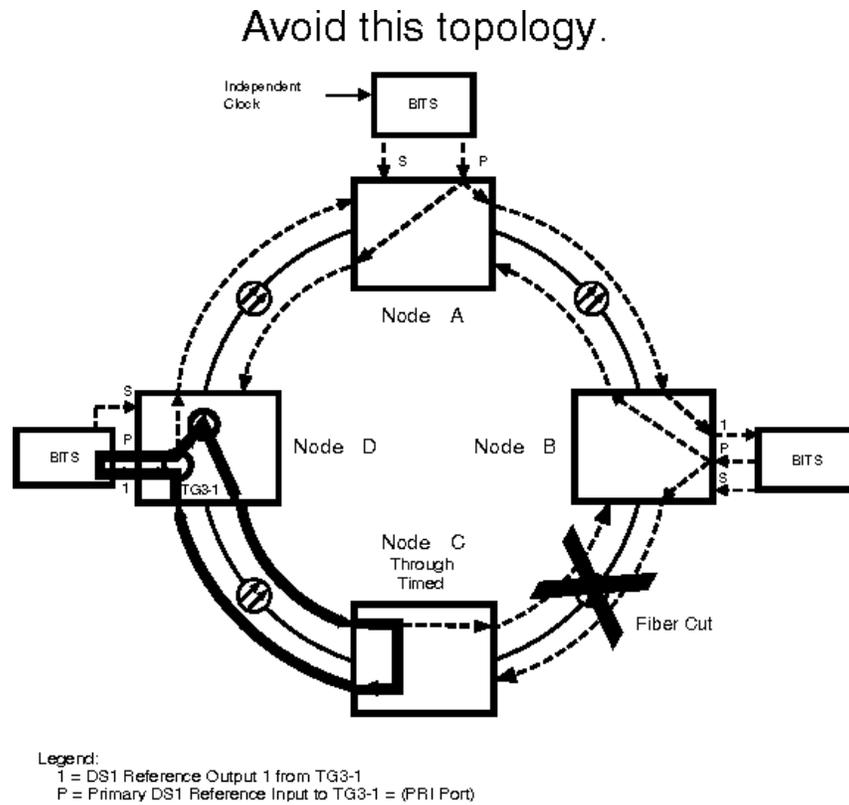
Figure 6-12.   Timing Loop Caused by Incorrect Provisioning

Most Nodes Equipped with Either Stratum 1 Traceable Signal or BITS

In applications where *most* nodes have a collocated BITS clock or an external timing source, you can use the external timing emulation (null-BITS) cable to emulate BITS operation at nodes without a collocated BITS clock. The external timing emulation cable emulates BITS operation when you use it to connect the primary DS1 output to the DS1 input of the node that is without a collocated BITS or other external timing source. All nodes must be provisioned externally timed.

Figure 6-13 illustrates this configuration (where the Node C uses the external timing emulation cable).
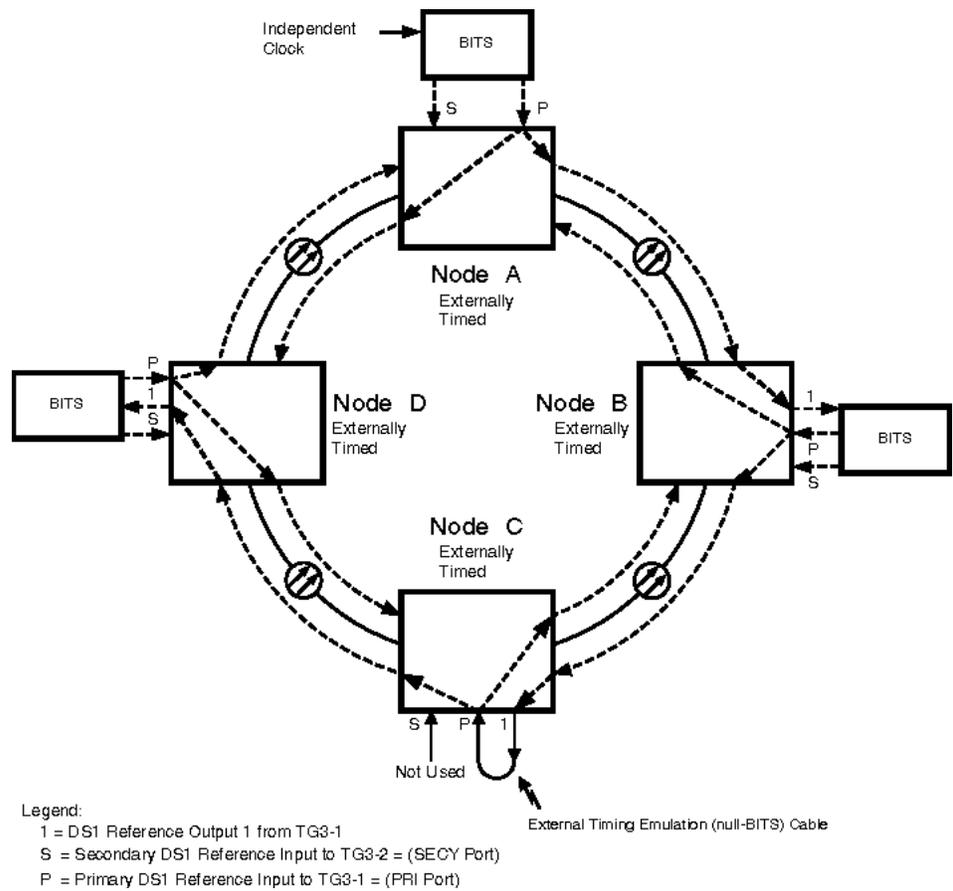
Figure 6-13.   External Timing Emulation Cable (null-BITS) Used to Emulate External Timing

Summary of Timing Rules for Bidirectional Line-Switched Rings

Strategy 1

Strategy 1 is applicable for all ring topologies.

■   At least one node must be externally timed from a stratum 1 traceable tim-
ing source that is not distributed by this ring.

■   Nodes used as a timing drop must be through timed.

■   Other nodes may be externally timed or through timed.

Strategy 2

Strategy 2 is applicable for rings that are used to distribute timing and where there is a BITS clock at every node. These are typically rings that connect central offices.

Externally timed nodes that are used to derive timing must obey the following rules to guarantee no timing loops:

- All nodes must be provisioned externally timed [2].

- At least one node must be timed from a stratum 1 traceable timing source that is not derived from this ring.

- Use only the Timing Out 1 signal[3].

- Do not use the Timing Out 2 signal[3.]

OC-48 Repeater Bay Applications

Through Timing Operation

In the through timing mode, an intermediate site (FT-2000 OC-48 Repeater Bay or FT-2000 OC-48 Add/Drop-Rings Terminal) derives timing from the incoming OC-48 signals. For information about the FT-2000 OC-48 Add/Drop-Rings Terminal, refer to the "Through Timing Operation" section earlier in this chapter.

In the FT-2000 OC-48 Repeater Bay, the OC48 Regenerator (OC48 REGENR) circuit packs derive timing from the incoming OC-48 signals. For example, the OC48 REGENR circuit pack that accepts the incoming OC-48 signal from high-speed line 1E derives timing for the OC-48 signal transmitted on high-speed line 1W (Figure 6-14). Also, the OC48 REGENR circuit pack that accepts the incoming OC-48 signal from high-speed line 1W derives timing for the OC-48 signal transmitted on high-speed line 1E. The FT-2000 OC-48 Repeater Bay does not require TG3 (DS1) circuit packs.

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2. You can use the external timing emulation (null-BITS) cable to emulate BITS operation at nodes without a collocated BITS clock.

3. Alternately, it is possible to use only the Timing Out 2 signal. In this case, do not use the Timing Out 1 signal.
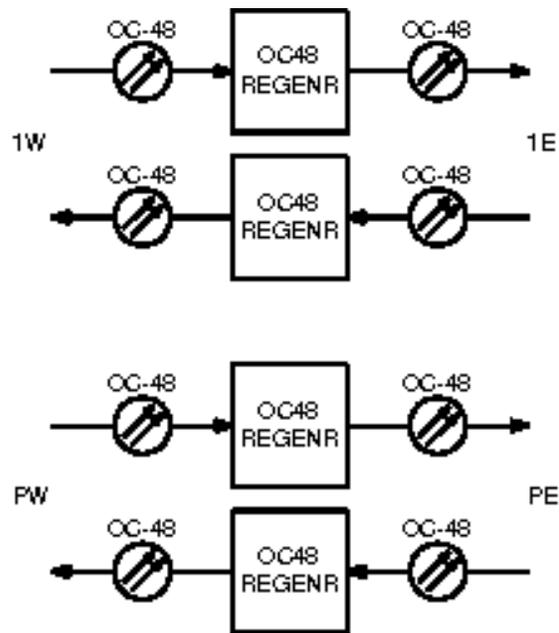
Figure 6-14.   Through Timing Synchronization (FT-2000 OC-48 Repeater Bay)

Protection

The FT-2000 OC-48 Lightwave System provides:

- Synchronization protection
- High-speed line protection
- Low-speed interface protection.

Synchronization Protection

The FT-2000 OC-48 Lightwave System also provides protection for the Timing Generator, Stratum 3 - DS1 [TG3 (DS1)] circuit packs and the timing reference signals. The TG3 (DS1) circuit packs use 1x1 revertive protection switching. The timing reference signals are revertively protected independent of the TG3 (DS1) circuit packs.

In the external timing mode, if the primary DS1 reference signal fails, the secondary DS1 reference signal will be selected. If both DS1 reference signals fail, the TG3 (DS1) circuit pack holds the on-board oscillator frequency at the last good reference sample (holdover mode) while the DS1 reference signals are repaired.

In the through timing mode (FT-2000 OC-48 Add/Drop-Rings Terminals only), if the OC-48 reference from one direction fails and this is the only OC-48 failure in the ring, the OC-48 reference from the other direction is used to provide timing to both directions. If either incoming OC-48 reference fails and there is more than one failure in the ring, the node enters holdover mode. In the through timing mode, if a single TG3 circuit pack fails, the node enters holdover mode.

In the line timing mode, if auto reconfiguration is enabled in the node, the node will choose the OC-48 line with the better synchronization quality level as the timing reference for that node, based on the incoming synchronization messages on each OC-48 line. If both incoming OC-48 reference signals fail or both synchronization messages are signaling an unacceptable quality level, the node enters holdover mode. If auto reconfiguration is disabled, the node will enter holdover mode if the provisioned OC-48 line timing reference fails or if the incoming synchronization message is signaling an unacceptable quality level.

Figure 6-15 depicts how synchronization of a through timed ring responds due to fiber cuts.
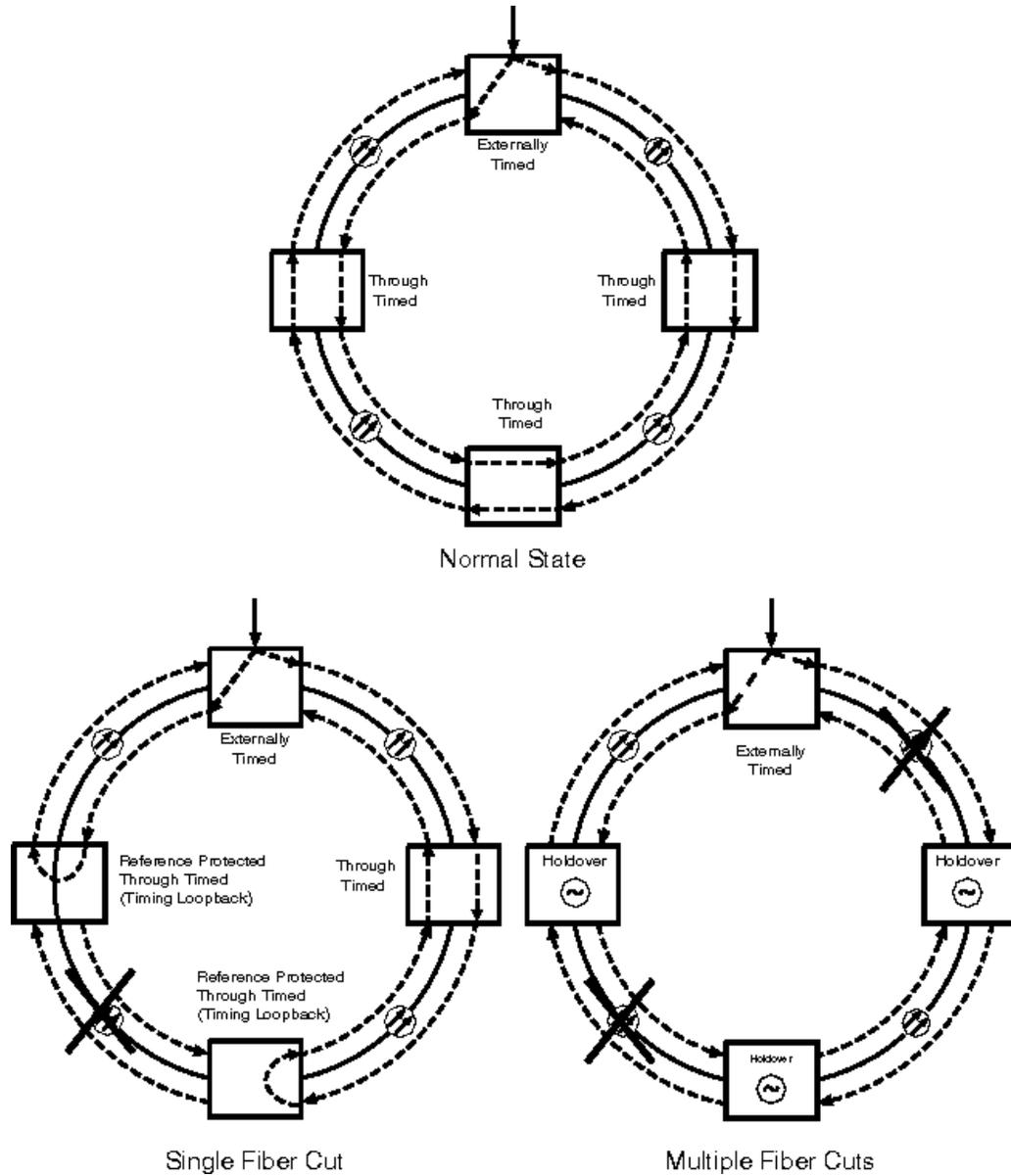
Figure 6-15. Timing Failure Due to Fiber Cuts)

Figure 6-16 depicts how synchronization of a through timed ring responds due to equipment failure.
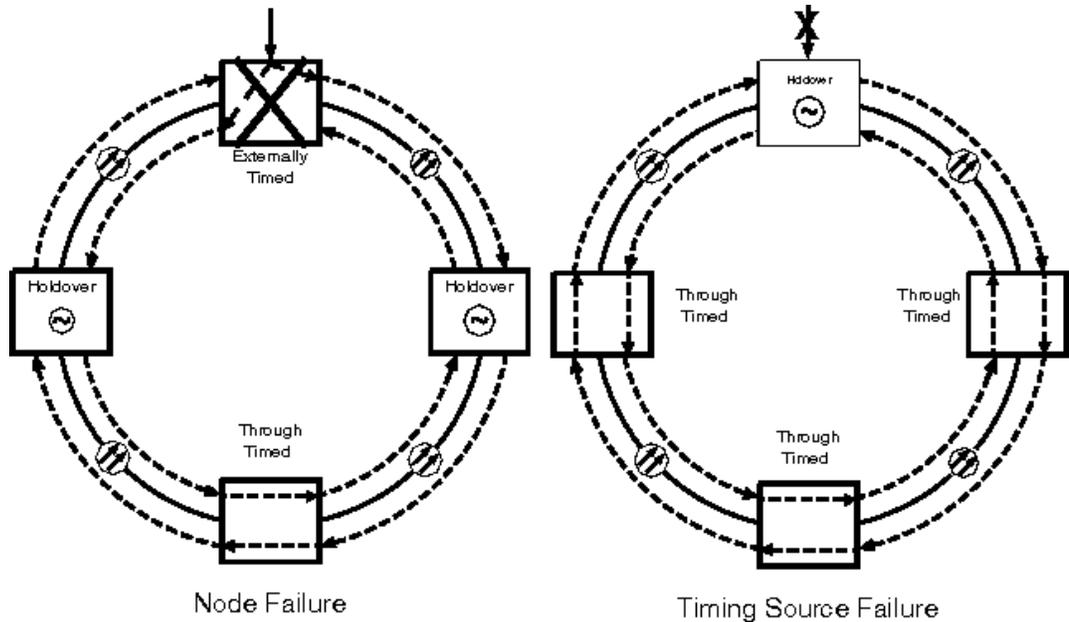
Figure 6-16.   Timing Failure Due to Equipment Failure)

High-Speed Line Protection

Each FT-2000 OC-48 Add/Drop-Rings Terminal for 2-Fiber Ring requires two OC48 Receiver and two OC48 Transmitter circuit packs for a 2-fiber bidirectional line-switched ring.

Low-Speed Interface Protection

The electrical low-speed interface circuit packs are 1xM (M≤16) revertively protected. Only one protection DS3 Interface circuit pack and/or one protection EC-1 interface circuit pack can be used on a low-speed shelf.

The OC-3 Optical Interface circuit packs are 0x1 protected (meaning unprotected) by default. You can equip and provision them to be 1+1 (unidirectional nonrevertive) protected. If 1+1 protection is desired, all OC-3 circuit packs must be of the same type (i.e., either all LAA10 or all LAA10B). The FT-2000 OC-48 ADR does not support mixed LAA10/LAA10B operation in a 1+1 protected configuration.

Capacity

The FT-2000 OC-48 Lightwave System provides the following capacity:

- The FT-2000 OC-48 Add/Drop-Rings Terminal provides multiplexing and transport for up to 48 DS3 equivalent signals over two OC-48 high-speed lines.

  The capacity for any one node depends on the configuration of the low-speed shelf. For example, an all electrical low-speed shelf provides 48 DS3 or STS-1 equivalent (16 STS-3 or STS-3c payloads) signals. A fully unprotected or protected optical low-speed shelf provides 24 STS-1 equivalent signals.

- The FT-2000 OC-48 Dual Lightwave Terminating Bay doubles the capacity of a single seven-foot Add/Drop-Rings Terminal.

- The FT-2000 OC-48 Repeater Bay regenerates OC-48 signals for up to two OC-48 high-speed lines per Repeater Shelf. A Repeater Bay can contain up to three Repeater Shelves.

Span Length

For information about transmission distances for FT-2000 with and without FT-LBA and/or WDM, see Chapter 10, "Technical Specifications."

Loss Budget for FT-2000 with and Without WDM and FT-LBA Systems

See Chapter 10, "Technical Specifications," for information about OC-48 optical line loss budgets for FT-2000 used with and without WDM and FT-LBA systems. See this Chapter also for information about FT-2000 OC-3 optical line loss budgets.

Recommendations for Purchasing WDM Devices for Use with FT-2000

This section contains information about the WDM devices and specifications for the WDM devices to use for wavelength division multiplexing these wavelengths:

- $1.5\ \mu m$ and $1.5\ \mu m$
- $1.5\ \mu m$ and $1.3\ \mu m$.

1.5 μm, W1 and 1.5 μm, W2 Wavelengths

Lucent Technologies 7A WDM Filter Assembly is the recommended filter for

- wavelength division multiplexing 1.5 μm signals from the OC48 TRMTR (A/D 1.5 LBA, W1) and OC48 TRMTR (A/D 1.5 LBA, W2) transmitter circuit packs.

- wavelength division multiplexing 1.5 μm signals from the OC48 REGENR (A/D 1.5 LBA, W1) and OC48 REGENR (A/D 1.5 LBA, W2) regenerator circuit packs.

- demultiplexing 1.5 μm signals from the optical line to the regenerator circuit packs and to the OC48 RCVR receiver circuit packs.

Specifications for the 7A WDM Filter are listed below.

- **Wavelength Range:** $\lambda 1$ = 1535 - 1541 nm
  $\lambda 2$ = 1555 - 1561 nm

- **Filter Loss** (including insertion + 2 faceplate connectors)**:**
  Multiplexer loss - 2.0 dB
  Demultiplexer loss - 2.5 dB

- **Crosstalk:** Less than -25 dB over operating wavelength ranges.

- **Reflections:** Less than -35 dB from the device, not including connectors. The Bellcore specification for discrete reflections is less than -27 dB for SONET systems. Certain 1.5 μm asynchronous systems may have tighter reflection requirements.

- **Connectors:** *ST*®[4]

- **Environment:**

  — Normal operating temperature: 40°F - 100°F (4.4°C - 37.8°C)
    Short term operating temperature: 35°F - 120°F (1°C - 44°C)

  — Normal operating humidity: 20 - 55 percent
    Short term operating humidity: 20 - 85 percent

A Lightguide Build-Out Set consisting of six 0 dB LBOs and one 10 dB LBO is supplied with each 7A WDM filter. For information about ordering the 7A WDM, see Chapter 7, "Ordering."

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4. ST is a registered trademark of Lucent Technologies Inc.

1.3 μm and 1.5 μm Wavelengths

The recommended specifications listed below assume that you are using FT-2000 on the 1.5 μm rail. The 1.3 μm equipment can be FT-2000, FT series G, or another vendor product. 1.3 μm and 1.5 μm WDM filters are commercially available from several vendors.

- **Wavelength Range:** 1290 - 1330 nm
  1535 - 1565 nm

- **Insertion Loss:** The insertion loss of the WDM mux and demux must be subtracted from the optical loss budget. For example, the total loss budget for FT-2000 at 1.5 μm is 23 dB, if the outside plant loss at 1.5 μm is 19 dB, then the combined total of the insertion loss of the WDM mux and the WDM demux must be no more than 4 dB. This calculation must be done separately at both 1.3 μm and 1.5 μm.

- **Crosstalk:** Less than -30 dB over operating wavelength ranges.

- **Reflections:** Less than -30 dB from the device, not including connectors (recommended). The Bellcore specification for discrete reflections is less than -27 dB for SONET systems. Certain 1.3 μm asynchronous systems may have tighter reflection requirements.

- **Connectors:** $ST^{®}$, FC, or SC.

- **Environment:** Temperature and humidity qualification should be discussed with the vendor.

Floor Plan Layout

Figure 6-17 shows a typical floor plan layout for the FT-2000 OC-48 Lightwave System bays in a central office. Front access is required for maintenance and operations activities. Upgrades and shelf additions can require cable rearrangements and shelf additions that require access to the rear. Refer to the floor plan data sheets [FPD 804-911-168-()] for explicit details.
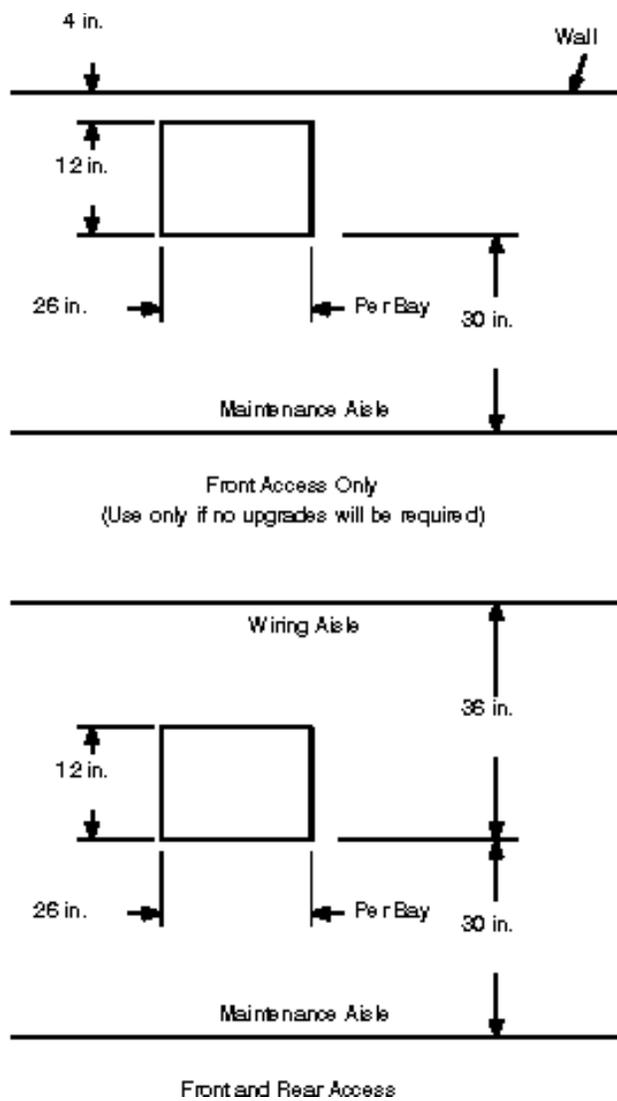
Figure 6-17.   FT-2000 OC-48 Lightwave System Floor Plan Layout

Figure 6-18 shows the three preferred shelf mounting arrangements for the miscellaneously mounted FT-2000 OC-48 Repeater Shelf.
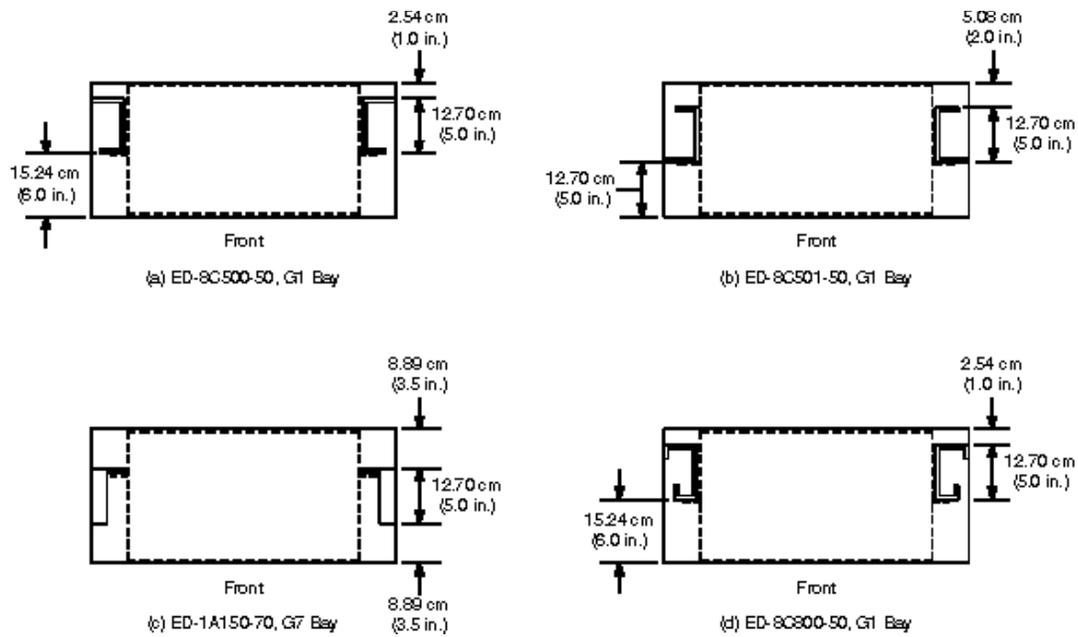
Figure 6-18.   Recommended Shelf Mounting Arrangements for FT-2000 OC-48 Repeater Shelf

⇒ **NOTE:**
Consult FPD 804-911-168 for complete engineering of the FT-2000 OC-48 Lightwave System.

Equipment Interconnection

The front access feature enables planners to design networks with the FT-2000 OC-48 Lightwave System in controlled environment vaults, concrete huts, or locations other than central offices where space is limited and equipment must be placed near or close to a wall. Any of these alternative locations must satisfy the environmental requirements for the equipment.

Rear access is typically selected in central office locations where a wiring aisle is ordinarily available at the rear of the equipment bays.

Access to the rear of the bay is also needed for upgrades that require cable rearrangement and shelf additions to the FT-2000 OC-48 Add/Drop-Rings Terminal. The FT-2000 OC-48 Repeater Bay requires only front access.

The cable interface to the FT-2000 OC-48 Lightwave System can be through a raised floor or overhead racking.

Cabling

The following are major classes of signals cabled to the FT-2000 OC-48 Lightwave System:

- Low-speed interface signals (DS3, EC-1, and OC-3)

- High-speed OC-48 signals (optical)

- Operations system and central office electrical signals.

The DS3 and EC-1 low-speed interfaces use coaxial interconnection. These low-speed interfaces use BNC connectors and connectorized electrical line build-outs (LBOs) on the interconnection panel. Figure 6-19 shows an electrical LBO. The electrical LBOs are considered part of the cabling and are installed only one time. No hardware switches are set. For more information about electrical LBO requirements, refer to Chapter 7, "Ordering."
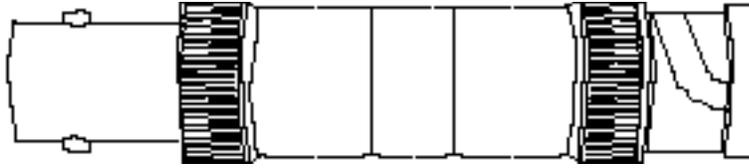
Figure 6-19. Electrical Line Build-Out

All low-speed interface signal outputs (for example, DS3) from the FT-2000 OC-48
Lightwave System must be properly terminated at all times. Therefore, these out-
puts must be connected to one of the following types of equipment:

■   Low-speed cross-connect panels that have internal 75-ohm terminations
    (for example, Lucent Technologies DSX-3/4 cross-connect panels) meet
    this requirement. These panels can be used with the FT-2000 OC-48 Light-
    wave System that is equipped with either DS3 low-speed interface circuit
    packs [LAA2B (DS3)] or EC-1 low-speed interface circuit packs [LAA4
    (STS1E)].

    For cross-connect panels that do not automatically terminate the OUT
    jacks, you must use 75-ohm termination plugs to terminate the OUT jacks.

■   Other working transmission equipment (for example, DACS III-2000
    Cross-Connect System or DDM-2000 Multiplexer) where the associated
    low-speed interfaces are equipped.

Care must be exercised during maintenance operations to assure that the low-
speed interface signal outputs are terminated.

The same manual DSX panel can be used for DS3 and EC-1 signals. In locations
where both types of electrical interface signals are used, care must be taken to
dedicate separate panels for each type of signal. The panels used for DS3 signals
should be labeled DSX-3. The panels used for EC-1 signals should be labeled
STSX-1. Cross-connections between the DSX-3 panel and the STSX-1 panel are
not allowed.

The optical interfaces (OC-3 and OC-48) are designed to provide connections through a faceplate-mounted connector system. The connector system supports the use of three different types of connectors:

■ *ST* type

■ FC type

■ SC type.

The connector system also provides optical attenuation (optical LBO) if required. All optical interfaces are factory-equipped with *ST* type connectors. All optical interfaces except the OC-3 output are provided with a 0-dB LBO. The OC-3 output is SONET Intermediate Reach (IR) compliant and has a 7.1-dB LBO. You can change the connector type or LBO value by replacing the factory-equipped connectors.

Figure 6-20 shows the build-out block and the *ST*-type LBOs. Figure 6-21 shows the build-out block and the FC-type LBOs. Figure 6-22 shows the build-out block and the SC-type LBOs.
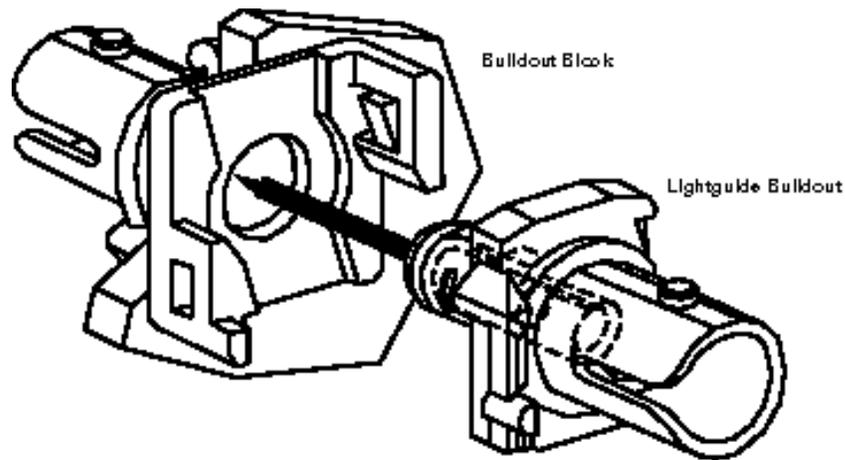
Figure 6-20. *ST*-**Type Build-Out Assembly**
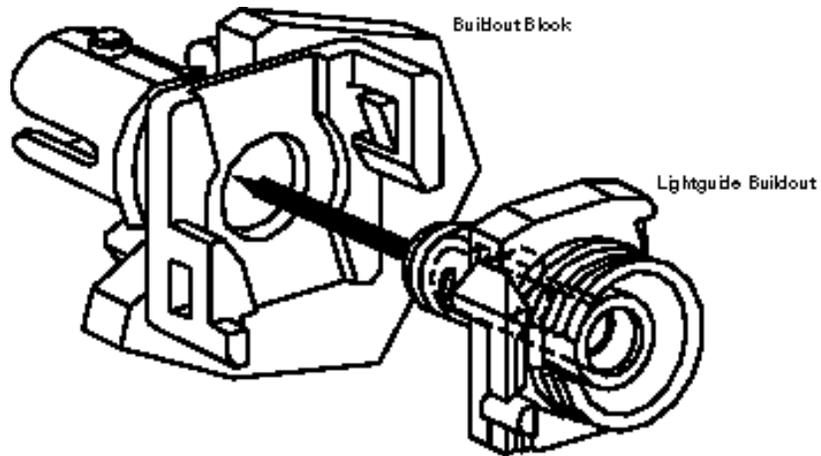
Figure 6-21. **FC-Type Build-Out Assembly**
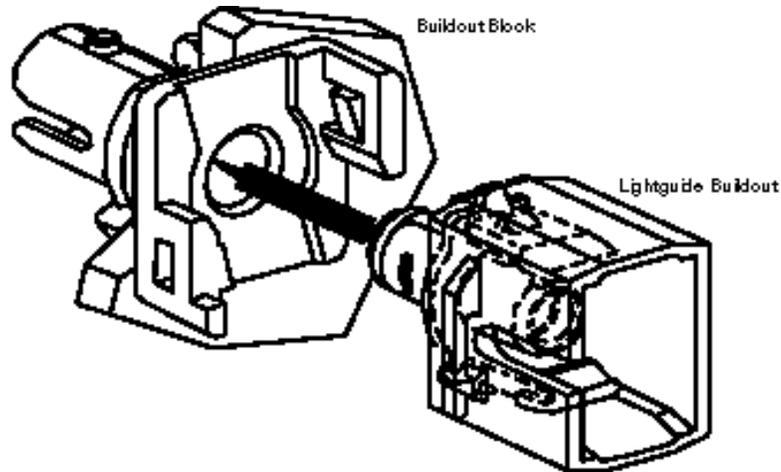
Figure 6-22.   SC-Type Build-Out Assembly

All fiber jumpers used between the lightguide cross-connect panel and the OC-48 rate circuit packs must use single-mode fiber. The fiber jumpers used for connecting to the OC3 circuit pack must use single-mode fiber unless the OC3 circuit pack is being connected to a multimode signal source, such as DDM-2000 IS3 circuit pack.[5] When connecting to a multimode signal source, you need to use multimode fiber jumpers.

> ⇒ **NOTE:**
> If the OC3 pack is being connected to a multimode signal source, avoid inappropriate multimode to single-mode fiber connections. Use only 0-dB optical LBOs at the single-mode to multimode fiber interface.

The OC3 circuit pack design allows you to use either single-mode or multimode jumpers, depending on the application. The OC3 input internally uses multimode fiber, and the OC3 output internally uses single-mode fiber. If attenuation must be provided at the input on the OC3 circuit pack, you must use a multimode LBO and multimode jumper. The LBOs are available in 5dB increments. If you use a multimode jumper for the OC-3 output, replace the factory-equipped 7.1-dB LBO with a 0-dB LBO.

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5. For detailed engineering and ordering information about this application, refer to the *DDM-2000 Applications, Planning, and Ordering Guide*.

When existing lightguide cross-connect panel connectors are not *ST*, FC, or SC connectors, hybrid jumpers must be used. A hybrid jumper has one type of connector at one end and another type of connector at the other end. The connector at the other end of the jumper must match the connector at the lightguide cross-connect panel. For example, if the lightguide cross-connect panel is equipped with keyed biconic connectors only, then jumpers with a keyed biconic connector at one end and an *ST* connector at the other end must be used to connect the OC-3 and OC-48 rate circuit packs to the lightguide cross-connect panel. The *ST* connectors are available for use at the lightguide cross-connect panel and can be installed when the FT-2000 OC-48 Lightwave System is installed.

The operations system and central office interfaces use cables with D-subminiature connectors that have crimp removable contacts (Figure 6-23).

Power feeds are individually engineered and sized for the maximum current drain the equipment can experience.

For more information about cabling, refer to Chapter 7, "Ordering."
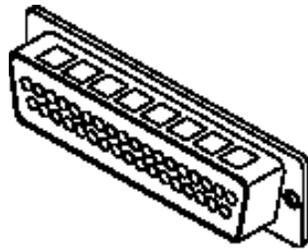
adr06008.01aJF070296

Figure 6-23.   D-Subminiature Connector

Environmental Considerations

The FT-2000 OC-48 Lightwave System is designed to meet Bellcore New Equipment Building Systems (NEBS) requirements (TR-63, NEBS Generic Equipment Requirements) for use in central office environments.

The unique front panel and shelf are designed to meet the electromagnetic compatibility (EMC) requirements of FCC Title 47, Part 15, Subpart J for Class A equipment. The top and bottom of each shelf are equipped with an EMC screen.

The FT-2000 OC-48 Lightwave System complies with the IEC 801-2 electrostatic discharge (ESD) recommendation for exchange carriers. The shelves are grounded to the uprights by the shelf-mounting hardware. An ESD jack is also provided at the front of each shelf and the rear of the bay for grounding straps.

The FT-2000 OC-48 Add/Drop-Rings Terminal for 2-Fiber Rings and FT-2000 OC-48 Repeater Bay each dissipate less than 563 watts and do not require a fan assembly.

The FT-2000 OC-48 Dual Lightwave Terminating Bay dissipates less than 1142 watts and requires a fan assembly for cooling.

Power Planning

Two -42.75 to -60.0 volt power feeders and returns (buses A and B) should be used to power each bay and miscellaneously mounted shelf with the FT-2000 OC-48 Lightwave System. Redundant power feeders are used to ensure maximum reliability of the system. Each power feeder should be sized to carry the maximum bay power consumption.

The office power feeders should be routed to the power distribution and fuse panel located at the top of each FT-2000 bay or the user panel of each miscellaneously mounted FT-2000 OC-48 1x1 Repeater Shelf. A maximum of eight power connections to the shelves may be obtained from this power distribution and fuse panel.

Refer to Table 10-9, "FT-2000 OC-48 Lightwave System Power Planning," in Chapter 10 for the power dissipation and currents drains of the FT-2000 OC-48 Lightwave System.

⇒ **NOTE:**
Consult FPD 804-911-168 for complete engineering of battery plant and feeders.

Orderwire Interface

The orderwire provides a facility for voice communications and remote access between terminals and repeaters, and between repeaters. The FT-2000 OC-48 Repeater Bay must be equipped with the Orderwire (OW) circuit pack to access the section orderwire. The FT-2000 OC-48 Add/Drop-Rings Terminal provides orderwire interfaces for section and line orderwire. The FT-2000 OC-48 Repeater Bay provides orderwire interfaces for section orderwire. Intervening FT-2000 OC-48 Repeater Bays must be equipped with the Orderwire (OW) circuit pack to support section orderwire communications between FT-2000 OC-48 Add/Drop-Ring Terminals.

The line (express) and section (local) orderwire interfaces [LINE OW (EXP OW) and SECTION OW (LOC OW)] are located on the interconnection panel of the FT-2000 OC-48 Add/Drop-Rings Terminal Enhanced and Condensed high-speed shelf. The section (local) orderwire interfaces [SECTION OW (LOC OW)] are located on the interconnection panel of the Repeater Shelf — System Controller.

To use the orderwire interface, the FT-2000 OC-48 Add/Drop-Rings Terminal must be equipped with two OHCTL (TERM) circuit packs. The FT-2000 OC-48 Repeater Bay must be equipped with an Orderwire (OW) circuit pack. The OHCTL (TERM) and OW circuit packs insert/extract the orderwire bytes to/from the synchronous optical network (SONET) overhead channel.

For more information about orderwire, refer to "Related Products" in Chapter 7, "Ordering."

Ordering

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Contents

Ordering

7

Overview

This chapter provides information about

- Ordering initial, upgrade, and spare FT-2000 OC-48 Lightwave System equipment and software for the

  — Dual Lightwave Terminating Bay

  — Repeater Bay

- Lucent Technologies software release ratings

- Ordering equipment that operates with the FT-2000 OC-48 Lightwave System

- Slot/circuit pack/equipment/software compatibility.

General Ordering Information

The ordering tables in this ordering guide are divided into sections by tabs which signify the following FT-2000 OC-48 platforms/packages:

■ FT-2000 OC-48 Dual Lightwave Terminating Bay (**Dual Bay** tab)

■ FT-2000 OC-48 Repeater Bay (**Repeater Bay** tab)

The FT-2000 OC-48 Dual Bay and Repeater Bay sections both contain tables for ordering

— bays

— circuit packs

— cables

— software and documentation

The platform-specific ordering tables are followed by sections covering

■ upgrades

■ spares

■ related framework

■ related products

■ slot/circuit pack/equipment/software compatibility

Retain this document as a permanent record of your FT-2000 order to substantially reduce the effort required to issue future FT-2000 orders for an office. Always use the current issue of the FT-2000 Applications, Planning, and Ordering Guide when generating an order.

⇒ NOTE:

The J68974A-1 documentation (drawing) is only used for upgrades. For software and spare parts, refer to J68974ES-2 and the "**Spares"** section in this chapter. For upgrade guidelines, see the "**Upgrades**" section in this chapter.

Ordering the FT-2000 OC-48 Lightwave System

The worksheets in this chapter cover the following FT-2000 OC-48 Lightwave System platforms:

- FT-2000 OC-48 Dual Lightwave Terminating Bay
- FT-2000 OC-48 Repeater Bay.

This chapter provides detailed worksheets at the end of each orderable section. They are usable by customers who want to engineer their own orders and customers who want Lucent Technologies to engineer their equipment order.

For customers who want Lucent Technologies to engineer their order, this service analyzes equipment needs and orders the FT-2000 OC-48 Lightwave System and any peripheral equipment required for integration into the central office network which includes

- connecting to the existing power plants and office alarms
- providing incremental additions to cable racking and aisle lighting, cable, terminal strips, fuses, etc.
- drafting necessary for creating and updating central office drawings.

Your answers on the worksheets provide Lucent Technologies with information to engineer and order a complete FT-2000 OC-48 Lightwave System for you. Each worksheet requires you to enter quantities or other information. The following tables contain these worksheets:

FT-2000 OC-48 Dual Lightwave Terminating Bay Worksheet   Table 7-5

FT-2000 OC-48 Repeater Bay Worksheet   Table 7-7

FT-2000 OC-48 Bay (Upgrade to 2-Fiber Ring) Worksheet   Table 7-33

To avoid mistakes in ordering or shipping, order each bay or equipment group on **its own set of worksheets:** one set of blanks for each order. You may photocopy as many copies of the worksheet(s) as you need.

Craft Interface Terminal-Personal Computer (CIT-PC) Minimum System Requirements

- 386SX *IBM*[1]-compatible desktop or laptop PC (25 MHz clock speed or greater)

- disk drive — one 1.44 megabyte (Mb) (3.5 inch)

- 80 Mb hard disk

- 4 Mb RAM

- 565 kilobytes available conventional memory[2]

- *MS-DOS*[3] operating system version 5.0 or later

- serial port (EIA-232-D) — configured as COM1, COM2, COM3, or COM4

- parallel port — configured as LPT1

- VGA color monitor.

Understanding Ordering Codes

The FT-2000 OC-48 Lightwave System orders are configured by selecting a package, then selecting orderable codes from the detailed equipment and code descriptions. Table 7-1 explains the codes used to order from the J68974 and ED-coded drawings.

Table 7-1.   Orderable Equipment

Number	Function
J68974x^*-1	Equipment and miscellaneous hardware shipped together.
J68974x **S-2**	Software and documentation. In S-2, S means Software.
ED8C900-20	Intraoffice electrical transmission cables (D-Bay).
ED7G001-22	Intraoffice electrical non-transmission cables.
Fiber Optic Products [†]	Intraoffice fiber transmission cables.

*x is a variable (D, A, or R).

†Check the latest issue of the Fiber Optic Products catalog, Select Code 2492C, for latest ordering information. Call 1-800-344-0223 for assistance.

1. Registered trademark of International Business Machines Company.

2. For systems without the required conventional memory, you need to use a memory manager such as the one supplied with MS-DOS version 5.0 or later.

3. Registered trademark of Microsoft Corporation.

Table 7-2 shows the platforms and the documentation sets that describe them.

Table 7-2.   Platforms, Software Generics, and Documentation Sets

Platform	Software Generic Supported	Documentation Set
FT-2000 OC-48 Dual Lightwave Terminating Bay	Release 7.2.5 Release 9.0 Release 9.1	J68974D-1 J68974ES-2
FT-2000 OC-48 Repeater Bay	Release 6.0.1	J68974RS-1

The FT-2000 OC-48 Dual Lightwave Terminating Bay platform must be ordered initially using the J68974D-1 documentation set.

The J68974A-1 documentation set is rated Discontinued Availability (DA) and is no longer used for initial equipment ordering. However, the J68974A-1 drawing can be used to order upgrades. For upgrade guidelines, see the "**Upgrades**" section in this chapter. If you need additional information about upgrading or ordering spare parts from these drawings, contact your Account Executive for details. The J68974A-1 documentation set included ordering information for the high-speed shelf.

The J68974E-1 documentation set (Add/Drop-Rings Terminal) has been rated Discontinued Availability (DA) as of December 31, 1999, and has been incorporated into the J68974D-1 documentation set.

FT-2000 Software Release Ratings

Each Lucent Technologies software release goes through the following product ratings in the order listed:

■ **STD (Standard)**: Lucent Technologies assigns this rating to the most current release of the software product.

■ **LA (Limited Availability)**: Existing customers can order an LA-rated software release. A product remains LA rated for a minimum of one year.

■ **DA (Discontinued Availability)**: A DA-rated software release is no longer orderable and is supported in accordance with DA policy of Lucent Technologies.

Table 7-3 lists the current ratings for FT-2000 OC-48 Lightwave System software releases.

Table 7-3.   FT-2000 OC-48 Lightwave System Software Release Ratings

Release	Drawing	List Number	Rating
3.0.1-ADR	J68974ES-1	L-7	DA August 30, 1996
4.0.0-ADR	J68974ES-1	L-4	DA August 30, 1996
4.0.0-RPTR	J68974RS-1	L-4	DA August 30, 1996
4.1.0-ADR	J68974ES-1	L-5	DA August 30, 1996
5.0.0-ADR	J68974ES-1	L-8	DA August 30, 1996
5.0.1-ADR	J68974ES-1	L-10	DA February 28, 1997
5.0.2-ADR	J68974ES-1	__	DA February 28, 1997
5.0.3-ADR	J68974ES-1	L-11	DA August 31, 1997
6.0.0-ADR	J68974ES-1	L-9	DA February 28, 1997
6.0.1-ADR	J68974ES-1	L-9	DA February 28, 1997
6.0.2-ADR	J68974ES-1	L-9	DA August 31, 1997
7.0.1-ADR	J68974ES-1	L-12	DA June 30, 1999
7.0.3 -ADR	J68974ES-1	L-14	DA June 30, 1999
7.1.0-ADR	J68974ES-1	L-13	DA May 5, 1998
7.2.5-ADR	J68974ES-2	L-1	STD
8.0.0-ADR	J68974ES-2	L-2	DA May 5, 1998
8.1.1-ADR	J68974ES-2	L-3	DA June 30, 1999
9.0.0-ADR	J68974ES-2	L-4	STD
9.1.0-ADR	J68974ES-2	L-5	STD
6.0.1-RPTR	J68974RS-1	L-5	STD

Completing Your Worksheet

Enter your FT-2000 OC-48 Lightwave System ordering selections on the worksheet at the end of each ordering section.

Each section contains tables and other information specific to the section. When you complete your FT-2000 OC-48 Lightwave System order, send to your Lucent Technologies Account Executive.

Ordering Considerations

When ordering transmitters and receivers for use with FT-2000 Dual Lightwave Terminating Bay Release 7 or higher software, choose from these:

- transmitters: 739B4, 739B5, 739C5, 739J4, 739J5, 735P5, 739R5, 739S5

- receivers: 839B4B or 839B5

When ordering transmitters and receivers for use with FT-2000 Dual Lightwave Terminating Bay for Release 7.2 and higher with DWDM capability, choose from these:

- transmitters: 739E1-8, 739G1-8, 739H1-16

- receivers: 839E5

Receivers 839B4B, 839B5, 839E5 are OC-12c compatible.

If you plan to use the FT-2000 as a timing source for DDM-2000s, you need to order ED8C724-22. Group 29 or Group 30 cables. For ordering information about these cables, refer to the *DDM-2000 Multiplexer Applications, Planning, and Ordering Guide (*363-206-200*)*.

When ordering a bay to be added to an existing ring running pre-Release 7 software, you have two choices:

1. Order B4 optics for the new bay and order sufficient Release 7.2 software to upgrade the entire ring, or,

2. Order the following B2 optics from the Lucent Reuse program and arrange with your local Account Executive for permission to use currently owned software compatible with the existing ring:

  - 839B2 107058208

  - 839B2 107058208

  - 739B2 107058190.

When ordering software it must be operations interworking (OI) compatible. Software Releases 8.1 and later are Target ID Address Resolution Protocol (TARP) releases. For Releases 8.1 and later the initial download of TARP release software to the first FT-2000 network element (NE) must be by diskettes through a PC.

After the initial FT-2000 NE is loaded with Release 8.1 or later by diskettes, copying software to other NEs and activating the software can be done through CIT or ITM SNC. For Releases 9.0 and later, software may be ordered on diskettes or digital audio tape (DAT) for download via ITM SNC. Subsequent downloads of TARP release software can be done through CIT or ITM SNC R5 and later.

Ordering from the Dual Bay (J68974D) Documentation Set

This section provides the following aids for ordering complete FT-2000 OC-48 Dual Lightwave Terminating Bay:

■ System package descriptions

■ Figures illustrating the equipment

■ Summary lists of system equipment, cables, and software

■ Ordering tables and reference information for systems, additional circuit packs, cables, software, documentation, and upgrades.

Package Descriptions (J68974D-1)

This topic lists package descriptions for the FT-2000 OC-48 Dual Lightwave Terminating Bay System.

OC-48 Dual Lightwave Terminating Bay (List 1): The OC-48 Dual Lightwave Terminating Bay List 1 supports two OC-48 Add/Drop-Ring Systems in a single seven-foot bay. The low-speed interface service capacity is 96 electrical DS3 (44.7 Mb/s) signals, 96 electrical EC-1 (51.8 Mb/s) signals, 16 optical OC-3 or IS-3 (155 Mb/s) signals, or 4 OC-12 signals. Combinations of these five types of signals are permissible in groups of 3 DS3, 3 EC-1, one OC-3, IS-3, or OC-12 signal(s). The two system bay consists of four shelves: two Condensed High-Speed Shelves and two Low-Speed Shelves — System Controllers.

OC-48 Dual Lightwave Terminating Bay (List 2): The OC-48 Dual Lightwave Terminating Bay List 2 contains one OC-48 Add/Drop-Ring System in a single seven-foot bay. There is space allocated in this bay to add a second OC-48 Add/Drop-Ring system.

OC-48 Dual Lightwave Terminating Bay (List 200): The OC-48 Dual Lightwave Terminating Bay List 200 is one OC-48 Add/Drop-Ring System to be mounted in an existing List 2 bay.
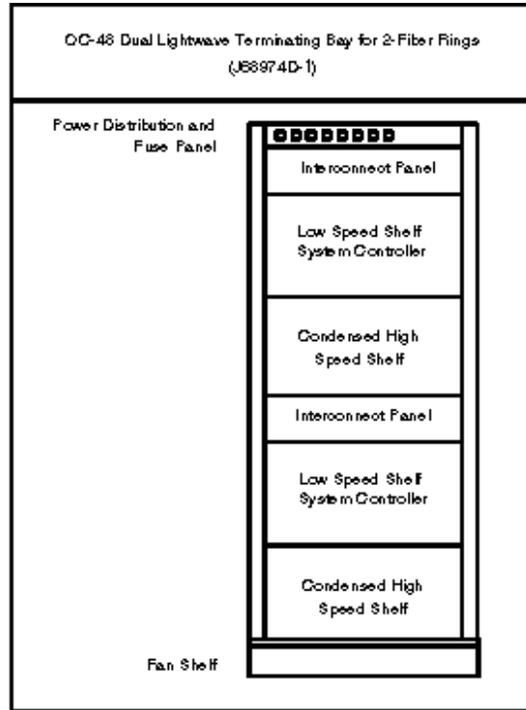
Figure 7-1.   FT-2000 OC-48 Dual Lightwave Terminating Bay Platform (J68974D)

Description of Equipment, Circuit Packs, and Miscellaneous Hardware Shipped Together

Table 7-4 describes equipment, circuit packs, and miscellaneous hardware that is shipped together when ordered at the same time.

⟹ **NOTE:**

Apparatus blanks are required in all unequipped circuit pack positions in any FT-2000 Dual Bay that contains powered circuit packs. The Dual Bay can contain one or two FT-2000 systems. Use Table 7-10 as a guide to order apparatus blanks. Below is an explanation of how to use the formula supplied in the table.

Table 7-4.   FT-2000 Dual Bay Equipment, Circuit Packs, and Miscellaneous Hardware Shipped Together

Ordering Code	Description
J68974D1 L-1	OC-48 Dual Lightwave Terminating Bay - Two Systems
J68974D1 L-2	OC-48 Dual Lightwave Terminating Bay - One System
J68974D1 L-200	OC-48 Dual Lightwave Terminating Shelf (to be mounted in List 2 System)
406682278	*DANTEL* Orderwire Shelf (voice only)
847593522	*DANTEL* Orderwire Shelf kit (voice; remote CIT access) (Release 6.0.0 and later)
106033269	OC3 Circuit Pack (LAA10)
108337478	OC3 Circuit Pack (LAA10B¶)
106033210	IS3 Circuit Pack (LAA5)
107508152	OC12 Circuit Pack (T939A)
106829559	DS3 Circuit Pack (LAA2)
106033202	STS1E Circuit Pack (LAA4)
107792988	LSSW Circuit Pack (LAA12B)
106281082	TOHCTL Circuit Pack (LAA26)
106053903	TG3 (DS1) Circuit Pack (LAA18)
106916687	SYSCTL Circuit Pack (LAA23B)
106053978	SYSMEM Circuit Pack (LAA25)
106281082	LNCTL (4 MEG) Circuit Pack (LAA28)
106690597	OHCTL (TERM) Circuit Pack (LAA21)
107781973	OC48 RCVR (A/D) Circuit Pack (839B4B)
107477457	OC48 RCVR (A/D STS-1) Circuit Pack (839B5)
107933434	OC48 RCVR (A/D STS-1) Circuit Pack (839E5)
107275828	OC48 TRMTR Circuit Pack (A/D 1.3 μm Standard) (739B4)
107428310	OC48 TRMTR (A/D STS1 1.3 μm Standard) (739B5)

(Sheet 1 of 3)

Table 7-4. FT-2000 Dual Bay Equipment, Circuit Packs, and Miscellaneous Hardware Shipped Together — *Continued*

Ordering Code	Description
107428336	OC48 TRMTR (A/D STS1 1.3 μm High Performance) (739C5)
107567646	OC48 TRMTR Circuit Pack (A/D STS-1 1.5 μm LBA, W1) (739R5)
107567653	OC48 TRMTR Circuit Pack (A/D STS-1 1.5 μm LBA, W2) (739S5)
107275844	OC48 TRMTR Circuit Pack (A/D 1.5 μm Standard Performance) (739J4)
107428344	OC48 TRMTR Circuit Pack (A/D STS-1 1.5 μm Standard Performance) (739J5)
107428351	OC48 TRMTR Circuit Pack (A/D STS-1 1.5 μm Standard Performance LBA) (739P5)
106079684	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W1) (739E1)
107430688	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W2) (739E2)
107430696	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W3) (739E3)
107430704	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W4) (739E4)
107430712	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W5) (739E5)
107430720	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W6) (739E6)
107430738	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W7) (739E7)
107430746	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W8) (739E8)
106079700	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W1) (739G1)
107974099	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W2) (739G2)
107974107	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W3) (739G3)
107974115	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W4) (739G4)
107974123	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W5) (739G5)
107974131	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W6) (739G6)
107974149	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W7) (739G7)
107974156	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W8) (739G8)
106079718	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W1) (739H1#)
108620584	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W2) (739H2)
108620618	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W3) (739H3)
108620634	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W4) (739H4)
108620667	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W5) (739H5)
108620691	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W6) (739H6)
108620709	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W7) (739H7)
108620717	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W8) (739H8)
108620733	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W9) (739H9)
108620758	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W10) (739H10)
108620774	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W11) (739H11)
108620790	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W12) (739H12)
108620816	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W13) (739H13)

(Sheet 2 of 3)

**Table 7-4.   FT-2000 Dual Bay Equipment, Circuit Packs, and Miscellaneous Hardware
Shipped Together — *Continued***

Ordering Code	Description
108620840	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W14) (739H14)
108620865	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W15) (739H15)
108620881	OC-48 TRMTR Circuit Pack (A/D STS-1 1.5 μm W16) (739H16)
105776579	Electrical Line Build-Out (for Out electrical transmission cables only)
J68974E1 L-116	Lightguide Build-Out Set, *ST* Connection, 5 dB, 10 dB, 15 dB, and 20 dB [Compatible with each 839-type receiver (List 77 and List 78) only]
J68974E1 L-117*	Lightguide Build-Out Set, *ST* Connection, 0 dB SM† (Compatible with List 21 only)
J68974E1 L-118	Lightguide Build-Out Set, ST Connection, 15 dB SM, 15 dB MM‡ (Compatible with List 23 and L33 only)
J68974E1 L-126**	Lightguide Build-Out Set, FC Connection, 0 dB (Qty. 2), 5 dB, 10 dB, 15 dB, 20 dB SM [Compatible with each pair of 839-type receivers (L77 and L78) and 739-type transmitters (List 81 through List 106) only]
J68974E1 L-127	Lightguide Build-Out Set, FC Connection, 0 dB (Qty. 2), 15 dB (Qty.2) SM (Compatible with List 21 only)
J68974E1 L-128	Lightguide Build-Out Set, FC Connection, 0 dB (Qty. 2), 7.1 dB (Compatible with List 23 and List 33 only)
J68974E1 L-136**	Lightguide Build-Out Set, SC Connection, 0 dB (Qty. 2), 5 dB, 10 dB, 15 dB, and 20 dB SM [Compatible with each pair of 839-type receivers (List 77 and List 78) and 739-type transmitters (List 81 through List 106) only]
J68974E1 L-137	Lightguide Build-Out Set, SC Connection, 0 dB (Qty. 2), 7.1 dB SM (Compatible with List 21 only)
J68974E1 L-138	Lightguide Build-Out Set, SC Connection, 0 dB SM (Qty. 2), 15 dB SM, 15 dB MM (Compatible with List 23 and List 33 only)
847012564	Apparatus Blank (3/4 inch)
847012556	Apparatus Blank (1 inch)
106566334	Apparatus Blank (2 1/4 inch)
106566367	Apparatus Blank (4 1/2 inch)

(Sheet 3 of 3)

* L117 is only necessary for long reach OC-3 applications or IS-3 interfaces.

† SM stands for Single Mode.

‡ MM stands for Multi Mode.

** L126 and L136 provide lightguide buildout sets for a pair of transmitters and receivers.

¶ LAA10B is backward compatible with LAA10, supporting mixed LAA10B/LAA10 operation. For more information, see the "Low-Speed Circuit Pack Descriptions" section in this chapter.

\#The OC-48 TRMTR (739H1-16) circuit pack fully supports compatible passive dense wavelength division multiplexing (DWDM) optics.

Dual Lightwave Terminating Bay Worksheet

Use Table 7-5 (form) below to select items to order for the Dual Lightwave Termi-nating Bay (D-Bay).

Table 7-5.   FT-2000 OC-48 DUAL LIGHTWAVE TERMINATING BAY Worksheet

Description/Action	Choice	Comcode	Reference
Engineered By Check One: Lucent Technologies _____ Customer _____			
2 Fiber Ring Terminal Bay (2 Systems) **OR**			Table 7-8
2 Fiber Ring Terminal Bay (1 System) **OR**			
2 Fiber Ring Terminal Shelves (1 System)			
Enter Relay Rack Number (Optional)	_____		
Software Required	(YES/NO) _____	List___	Table 7-24 (initial orders) Table 7-25 (additional copies) Table 7-27 (software and documentation)
Enter Release No. or "Latest"	_____		
DANTEL[*] Orderwire Shelf (voice only)	(YES/NO) _____	406682278	Order using Table 7-41
DANTEL Orderwire Shelf kit (voice and remote CIT access) (Release 6 and later)	(YES/NO) _____	847593522	Order using Table 7-43
Required Circuit Packs (shipped with bay)	(YES/NO) _____		Table 7-8

Order one each of:
    SYSCTL   (LAA23B)
    SYSMEM (LAA25)
    LNCTL   (LAA28)
	
	QTY Ordered _____
	QTY Ordered _____
	QTY Ordered _____
		
		106916687
		106053978
		106281082	

Order two of each:
    TG3   (LAA18)
    OHCTL (LAA21)
    LSSW   (LAA12B)
	
	QTY Ordered _____
	QTY Ordered _____
	QTY Ordered _____
		
		106053903
		106690597
		107792988	

Low-Speed Shelf Circuit Packs			Table 7-9
DS3 (LAA2) (3 DS3 signals)	QTY Ordered _____	106829559	
STS1E (LAA4) (3 EC-1 signals)[†]	QTY Ordered _____	106033202	
OC3 [LAA10 (1 OC-3 or IS-3 signal)	QTY Ordered _____	106033269	

(Sheet 1 of 5)

Table 7-5.   FT-2000 OC-48 DUAL LIGHTWAVE TERMINATING BAY Worksheet — *Continued*

Description/Action	Choice	Comcode	Reference
OC3 [LAA10B‡ (1 OC3 / IS-3 signal)]†	QTY Ordered _____	108337478	
IS3 (LAA5)	QTY Ordered _____	106033210	
OC12, OC12c (T939A)	QTY Ordered _____	107508152	
TOHCTL (LAA26)	(YES/NO) _____	106281066	Table 7-9
OC-48 Transmitters & Receivers			
RCVR A/D (839B4B)	QTY Ordered _____	107781973	
RCVR A/D STS-1 (839B5)	QTY Ordered _____	107477457	
RCVR A/D STS-1 (839E5)	QTY Ordered _____	107933434	
TRMTR (A/D OC-12c 1.3 STD) (739B4)	QTY Ordered _____	107275828	
TRMTR (A/D STS-1 OC-12c 1.3 STD) (739B5)	QTY Ordered _____	107428310	
TRMTR (A/D STS-1 OC-12c 1.3 HI PERF) (739C5)	QTY Ordered _____	107428336	
TRMTR (A/D STS-1 OC-12c 1.5 LBA, W1) (739R5)	QTY Ordered _____	107567646	
TRMTR (A/D STS-1 OC-12c 1.5 LBA, W2) (739S5)	QTY Ordered _____	107567653	Table 7-8 Pages 7-24 and 7-25
TRMTR (A/D OC12c 1.5 STD) (739J4)	QTY Ordered _____	107275844	
TRMTR (A/D STS-1 OC-12c 1.5 STD) (739J5)	QTY Ordered _____	107428344	
TRMTR (A/D STS-1 OC-12c 1.5 LBA) (739P5)	QTY Ordered _____	107428351	
TRMTR (A/D STS1 OC-12c 1.5 W1) (739E1)	QTY Ordered _____	106079684	
TRMTR (A/D STS1 OC-12c 1.5 W2) (739E2)	QTY Ordered _____	107430688	
TRMTR (A/D STS1 OC-12c 1.5 W3) (739E3)	QTY Ordered _____	107430696	
TRMTR (A/D STS1 OC-12c 1.5 W4) (739E4)	QTY Ordered _____	107430704	
TRMTR (A/D STS1 OC-12c 1.5 W5) (739E5)	QTY Ordered _____	107430712	
TRMTR (A/D STS1 OC-12c 1.5 W6) (739E6)	QTY Ordered _____	107430720	
TRMTR (A/D STS1 OC-12c 1.5 W7) (739E7)	QTY Ordered _____	107430738	
TRMTR (A/D STS1 OC-12c 1.5 W8) (739E8)	QTY Ordered _____	107430746	
TRMTR (A/D STS1 OC-12c 1.5 W1) (739G1)	QTY Ordered _____	106079700	
TRMTR (A/D STS1 OC-12c 1.5 W2) (739G2)	QTY Ordered _____	107974099	
TRMTR (A/D STS1 OC-12c 1.5 W3) (739G3)	QTY Ordered _____	107974107	
TRMTR (A/D STS1 OC-12c 1.5 W4) (739G4)	QTY Ordered _____	107974115	
TRMTR (A/D STS1 OC-12c 1.5 W5) (739G5)	QTY Ordered _____	107974123	
TRMTR (A/D STS1 OC-12c 1.5 W6) (739G6)	QTY Ordered _____	107974131	
TRMTR (A/D STS1 OC-12c 1.5 W7) (739G7)	QTY Ordered _____	107974149	
TRMTR (A/D STS1 OC-12c 1.5 W8) (739G8)	QTY Ordered _____	107974156	
TRMTR (A/D STS1 OC-12c 1.5 W1) (739H1¶)	QTY Ordered _____	106079718	
TRMTR (A/D STS1 OC-12c 1.5 W2) (739H2)	QTY Ordered _____	108620584	

(Sheet 2 of 5)

Table 7-5.   FT-2000 OC-48 DUAL LIGHTWAVE TERMINATING BAY Worksheet — *Continued*

Description/Action	Choice	Comcode	Reference
TRMTR (A/D STS1 OC-12c 1.5 W3) (739H3)	QTY Ordered _____	108620618	
TRMTR (A/D STS1 OC-12c 1.5 W4) (739H4)	QTY Ordered _____	108620634	
TRMTR (A/D STS1 OC-12c 1.5 W5) (739H5)	QTY Ordered _____	108620667	
TRMTR (A/D STS1 OC-12c 1.5 W6) (739H6)	QTY Ordered _____	108620691	
TRMTR (A/D STS1 OC-12c 1.5 W7) (739H7)	QTY Ordered _____	108620709	
TRMTR (A/D STS1 OC-12c 1.5 W8) (739H8)	QTY Ordered _____	108620717	
TRMTR (A/D STS1 OC-12c 1.5 W9) (739H9)	QTY Ordered _____	108620733	
TRMTR (A/D STS1 OC-12c 1.5 W10) (739H10)	QTY Ordered _____	108620758	
TRMTR (A/D STS1 OC-12c 1.5 W11) (739H11)	QTY Ordered _____	108620774	
TRMTR (A/D STS1 OC-12c 1.5 W12) (739H12)	QTY Ordered _____	108620790	
TRMTR (A/D STS1 OC-12c 1.5 W13) (739H13)	QTY Ordered _____	108620816	
TRMTR (A/D STS1 OC-12c 1.5 W14) (739H14)	QTY Ordered _____	108620840	
TRMTR (A/D STS1 OC-12c 1.5 W15) (739H15)	QTY Ordered _____	108620865	
TRMTR (A/D STS1 OC-12c 1.5 W16) (739H16)	QTY Ordered _____	108620881	
High-Speed Protection Required?	(YES/NO) _____		
Lightguide Jumpers			
Single Mode	(LENGTH) _____FT. QTY Ordered _____		
Multimode (for OC3 circuit pack with IS-3 interface)	(LENGTH) _____FT. QTY Ordered _____		Table 7-21
Type: ST-ST	(YES/NO) _____		
FC-FC	(YES/NO) _____		
SC-SC	(YES/NO) _____		
Other (Specify Type)	_____		
Lightguide Build-outs Required	QTY Ordered _____	List___	
Type: SC	(YES/NO) _____		Table 7-19
ST	(YES/NO) _____		
FC	(YES/NO) _____		

(Sheet 3 of 5)

Table 7-5.   FT-2000 OC-48 DUAL LIGHTWAVE TERMINATING BAY Worksheet — *Continued*

Description/Action	Choice	Comcode	Reference

Transmission Cable Assemblies Required
    DSX Cables
       Type A) 735 6-Conductor (Preferred)[**]
       B) 735 singles
       C) 734 splice in duct
       D) 734 splice on rack
           Enter Letter
    Connection is to
       E) DSX 3/4 e/w BNC
       F) DACS III w/o BNC
       G) DACS IV w/o BNC
       H) FT2000   e/w BNC
       J) DACS III e/w BNC
       K) DACS IV e/w BNC
          Enter Letter
Enter Cable Length   (100 ft) (250 ft) (as reqd)
	QTY Ordered _____
	
	_____
	
	_____
	_____FT.
			Table 7-13

Electrical Build-outs required (cables less than 125 ft.)	QTY Ordered _____	105776579	Table 7-22

(Sheet 4 of 5)

Table 7-5.   FT-2000 OC-48 DUAL LIGHTWAVE TERMINATING BAY Worksheet — *Continued*

Description/Action	Choice	Comcode	Reference
Non-transmission Cables and Length			
Timing In (150 ft) (250 ft) (as reqd)	(LENGTH) _____FT.		
Timing Out (150 ft) (250 ft) (as reqd)	(LENGTH) _____FT.		
Timing Out (Connectorized) (20 ft) (100 ft) (as reqd)	(LENGTH) _____FT.		Table 7-4 Table 7-15, Table 7-16
Ser Tlmtry (150 ft) (250 ft) (as reqd)	(LENGTH) _____FT.		
Misc Descrt (150 ft) (250 ft) (as reqd)	(LENGTH) _____FT.		
Par Tlmtry (150 ft) (250 ft) (as reqd)	(LENGTH) _____FT.		
Null-Bits Timing In/Out (9 inch cable)	(YES/NO) _____		
Office Alarms (150 ft) (250 ft) (as reqd)	(LENGTH) _____FT.		
Orderwire (150 ft) (250 ft) (as reqd)	(LENGTH) _____FT.		
X.25 (150 ft) (as reqd)	(LENGTH) _____FT.		
CIT (DTE) (150 ft) (as reqd)	(LENGTH) _____FT.		
Apparatus Blanks (Req'd.):			
3/4 inch	_____	847012564	
1 inch	_____	847012556	
2 1/4 inch	_____	106566334	
4 1/2 inch	_____	106566367	

(Sheet 5 of 5)

*Registered trademark of *DANTEL* Incorporated.

†You can add STS1E, OC3, IS3, and OC12 circuit packs only to the Add/Drop-Rings Terminal bay.

‡ LAA10B is backward compatible with LAA10, supporting mixed LAA10B/LAA10 operation. For more information, see the "Low-Speed Circuit Pack Descriptions" section in this chapter.

**Refers to 6 conductors comprising the cable assembly.

¶ The OC-48 TRMTR (739H1-16) circuit pack fully supports compatible passive dense wavelength division multiplexing (DWDM) optics.

Ordering from the Repeater Bay (J68974R) Documentation Set

This subsection provides the following ordering aids for ordering complete FT-2000 OC-48 Repeater Bays:

- Summary lists of system equipment, cables and software

- System Package Descriptions

- Figures illustrating the equipment

- Ordering tables and reference information for additional circuit packs, cables, software, documentation, and upgrades.

Package Descriptions (J68974R)

This topic lists package descriptions for the FT-2000 OC-48 Lightwave System.

OC-48 Repeater Bay (List 1): The OC-48 Repeater Bay supports one service and one protection OC-48 optical line rate signal. The bay consists of 1 Repeater Shelf — System Controller mounted in the middle shelf position. Up to 2 additional Repeater Shelves — System Controller [List 1 and List 15 (factory), List 1 and 2 List 15 (factory), or 1 or 2 List 200 (field upgrades)] can be mounted in the bay for Double and Triple Lines, respectively.

OC-48 Repeater Shelf (List 10): The OC-48 Repeater Shelf supports one service and one protection OC-48 optical line rate signal. This shelf is designed for miscellaneous flush mounting with three preferred arrangements using the following bays:

- ED8C500-50, G1 (top angle on closed duct side)

- ED8C501-50, G1 (top angle on open duct side)

- ED1A150-70, G7 (with terminal mounting strips, FT Series G bay arrangement)

The following seismic network bays are also supported:

- ED8C800-50, G1 (top angle on closed duct side)

- ED8C801-50, G1 (top angle on open duct side)

OC-48 Repeater Bay for Double Line (one List 1, one List 15): The OC-48 Repeater Bay for Double Line supports two service and two protection OC-48 optical line rate signals. The bay consists of one OC-48 Repeater Bay (List 1) with a Repeater Shelf — System Controller for an additional Single line (List 15) shop mounted in the bottom shelf position. One additional Repeater Shelf — System Controller (List 200) can be mounted in the bay for Triple Lines (field upgrade).

OC-48 Repeater Bay for Triple Line (one List 1, two List 15s): The OC-48 Repeater Bay for Triple Line supports three service and three protection OC-48 optical line rate signals. The bay consists of one OC-48 Repeater Bay (List 1) with two Repeater Shelves — System Controller for an additional Single line (List 15) shop mounted in the top and bottom shelf positions.

Repeater Shelf — System Controller Upgrade (List 200): The Repeater Shelf — System Controller Upgrade package provides the necessary equipment to add an additional Single line to an existing OC-48 Repeater Bay (List 1). This package consists of one Repeater Shelf — System Controller. Up to two List 200s can be added to an existing OC-48 Repeater Bay (List 1).
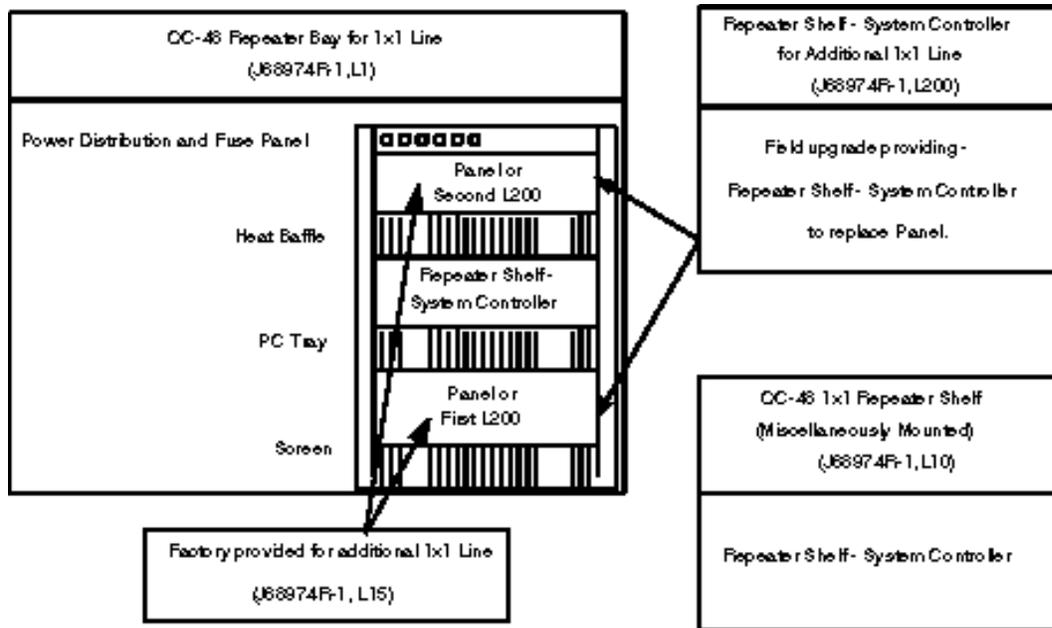
Figure 7-2.   FT-2000 OC-48 Repeater Bay Platform (J68974R)

Descriptions of Equipment, Circuit Packs, and Miscellaneous Hardware Shipped Together

Table 7-6 describes items to order for the repeater bay that will be shipped together.

Table 7-6. FT-2000 Repeater Bay Equipment, Circuit Packs, and Miscellaneous Hardware Shipped Together

Ordering Code	Description
J68974R-1 L-1	OC-48 Repeater Bay
J68974R-1 L-10	OC-48 Repeater Shelf — System Controller (Miscellaneously Mounted)
J68974R-1 L-200	Repeater Shelf — System Controller for Additional Single Line (service and protection) (Field Upgrade)
106916695	SYSCTL Circuit Pack (LAA23B)
106053978	SYSMEM Circuit Pack (LAA25)
106033319	OW Circuit Pack (LAA14)
847593522	*DANTEL* Orderwire Shelf kit (voice; remote CIT access, optional) (Release 6.0.0 and later)
106916695	OC48 REGENR Circuit Pack (1.3 μm Standard Performance) (39B2)
J68974E-1 L-116	Lightguide Build-Out Set, *ST*® Connection, 5 dB, 10 dB, 15 dB, and 20 dB (Compatible with Lists 98, 99, 101, and 102 Only)
J68974E-1 L-126	Lightguide Build-Out Set, FC Connection, 0 dB (Qty. 2), 5 dB, 10 dB, 15 dB and 20 dB (Compatible with Lists 98, 99, 101, and 102 Only)
J68974E-1 L-136	Lightguide Build-Out Set, SC Connection, 0 dB (Qty. 2), 5 dB, 10 dB, 15 dB and 20 dB (Compatible with Lists 98, 99, 101, and 102 Only)

Repeater Bay Worksheet

Use Table 7-7 (form) below to select items to order for the Repeater Bay (R-Bay).

.

Table 7-7.   FT-2000 OC-48 REPEATER BAY Worksheet

Description/Action	Choice	List/ Group	Reference
Engineered By: (Check One) Lucent Technologies _____ Customer _____	(YES/NO) _____		
FT-2000 Repeater Bay E/W, 1 Shelf			
Enter Relay Rack Number (Optional)	_____		
Enter quantity of Additional Shelves (Max 2)	(QTY Ordered) _____		
Software Required	(YES/NO) _____	List____	
Enter Release No. or "Latest"	_____		Table 7-32
DANTEL* Orderwire Shelf kit (voice; remote CIT access) (Release 6.0.0 and later)	(YES/NO) _____	847593522	Order using Table 7-43
Orderwire Circuit Pack† (required with remote CIT access Orderwire Shelf)	(YES/NO) _____	106033319	Table 7-12
Required Common Circuit Packs (SYSCTL,SYSMEM) (Shipped with Bay)	(YES/NO) _____	106916687 106053978	Table 7-12
Regenerator Packs 1.3 STD (39B2)	(QTY Ordered) _____	106916695	Table 7-12
7A WDM Filter Assembly(ies) or Filter Assembly Shelf(ves) Required	(YES/NO) _____ (QTY Ordered) _____		Table 7-41

Lightguide Jumpers
    Type: ST-ST
            Biconic-ST
            Other (Specify Type)
	(LENGTH) _____FT.
	(YES/NO)_____
	(YES/NO)_____
	_____
			Table 7-21

Lightguide Build-outs
    Type: ST
            FC
	(QTY Ordered) _____
	(YES/NO)_____
	(YES/NO)_____
		List____	Table 7-20

(Sheet 1 of 2)

Table 7-7.   FT-2000 OC-48 REPEATER BAY Worksheet — *Continued*

Description/Action	Choice	List/ Group	Reference
Other (Specify Type)	_____		
Non-Transmission Cables and Length			
Misc descrt (150 ft) (250 ft) (as reqd)	(LENGTH) _____FT.		
Office alarms (150 ft) (250 ft) (as reqd)	(LENGTH) _____FT.		Table 7-18
Orderwire (150 ft) (250 ft) (as reqd)	(LENGTH) _____FT.		
CIT (DTE) (150 ft) (as reqd)	(LENGTH) _____FT.		

(Sheet 2 of 2)

*Registered trademark of DANTEL Incorporated.

†Orderwire Circuit Pack required with remote CIT access Orderwire Shelf.

Dual Bay Circuit Packs

The information in this topic describes circuit packs for the Dual Bay as well as providing worksheets to assist in ordering cables for the terminal.

Enhanced and Condensed High-Speed Circuit Pack Descriptions

The information below describes enhanced high-speed circuit packs.

Circuit Pack/Term	Description
High-Speed Line Protection	The high-speed line protection option protects against an optical transmission failure by using a spare optical transmission line. This option is required when equipping the protection access feature.
LNCTL (4 MEG) (LAA28)	This controller provides overall administrative control of up to two optical lines (1E and 1W). It has 4 megabytes of memory and is required for 2-Fiber Ring applications. The LAA28 LNCTL (4 MEG) circuit pack may also be used in OC-48 point-to-point applications.

> ⇒ **NOTE:**
> The LAA28 LNCTL (4 MEG) circuit pack replaces the LAA27 LNCTL circuit pack and is required for the add/drop capabilities of Release 3.

Circuit Pack/Term	Description
OHCTL (TERM) (LAA21)	This controller provides the system with access to the SONET overhead channels. This circuit pack is required for orderwire access and single-ended operations (for example, remote login). 2-Fiber Ring applications require two of these circuit packs.
OC48 RCVR (A/D) (839B4B)	This receiver interfaces to the incoming high-speed optical line, provides to electrical conversion, clock recovery, demultiplexing, and extracts the line and section overhead. It supports bidirectional, line-switched rings. The OC48 RCVR (A/D) circuit pack is equipped with a build-out block that accepts *ST* (List 116), FC (List 126), or SC (List 136) lightguide connectors. It functions at both 1.31 and 1.55 µm wavelengths.
OC48 RCVR (A/D STS-1) (839B5)	This receiver is the same as the OC48 RCVR (A/D) circuit pack. It supports STS-1 granularity.
OC48 RCVR (A/D STS-1) (839E5)	This receiver is the same as the OC48 RCVR (A/D) circuit pack. It supports STS-1 granularity AND IS OLS compatible for Dense Wavelength Division Multiplexing.
OC48 TRMTR (A/D OC-12c 1.3 STD) (739B4)	This 1.3 µm transmitter interfaces to the outgoing high-speed optical line, provides frame synchronization of the incoming low-speed signals, inserts line and section overhead, multiplexes, and provides electrical to optical conversion. It supports bidirectional, line-switched rings. The OC48 TRMTR (A/D 1.3 STD) circuit pack is equipped with a build-out block that accepts *ST* (List 116), FC (List 126), or SC (List 136) lightguide connectors.

OC48 TRMTR
(A/D STS-1 OC-12c 1.3 STD)
(739B5)

This transmitter is the same as the OC48 TRMTR (A/D OC-12c 1.3 STD) circuit pack. It supports STS-1 granularity.

OC48 TRMTR (A/D STS-1 OC-12c 1.3 HI PERF) (739C5)

This transmitter is the same as the OC48 TRMTR circuit pack. It supports STS-1 granularity and is 1.3 HI PERF.

OC48 TRMTR (A/D OC-12c 1.5 STD) (739J4)

This 1.5 µm transmitter interfaces to the outgoing high-speed optical line, provides frame synchronization of the incoming low-speed signals, inserts line and section overhead, multiplexes, and provides electrical to optical conversion. It supports bidirectional, line-switched rings. The OC48 TRMTR (A/D 1.5 STD) circuit pack is equipped with a build-out block that accepts *ST* (List 116), FC (List 126), or SC (List 136) lightguide connectors.

OC48 TRMTR (A/D STS-1 OC-12c 1.5 STD)
(739J5)

This transmitter is the same as the OC48 TRMTR (1.5 STD) circuit pack. It supports STS-1 granularity.

OC48 TRMTR (A/D STS-1 OC-12c 1.5 LBA)
(739P5)

This transmitter is the same as the OC48 TRMTR (1.5 STD) circuit pack. It supports STS-1 granularity and is LBA compatible.

OC48 TRMTR (A/D STS-1 OC-12c 1.5 LBA W1)
(739R5)

This transmitter is the same as the OC48 TRMTR (1.5 STD) circuit pack. It supports STS-1 granularity and is LBA and WDM compatible.

OC48 TRMTR (A/D STS-1 OC-12c 1.5 LBA W2)
(739S5)

This transmitter is the same as the OC48 TRMTR (1.5 STD) circuit pack. It supports STS-1 granularity and is LBA and WDM compatible.

OC48 TRMTR (A/D STS-1 OC-12c 1.5 STD)
(739E1-8)

This transmitter is the same as the OC48 TRMTR (1.5 STD) circuit pack. It supports STS-1 granularity and is OLS compatible for Dense Wavelength Division Multiplexing.

OC48 TRMTR (A/D STS-1 OC-12c 1.5 STD)
(739G1-8)

This transmitter is the same as the OC48 TRMTR (1.5 STD) circuit pack. It supports STS-1 granularity, is OLS compatible for Dense Wavelength Division Multiplexing, and provides optimal dispersion performance for the long distances possible by the OLS.

OC48 TRMTR (A/D STS-1 OC-12c 1.5 STD)
(739H1-16)

This transmitter is the same as the OC48 TRMTR (1.5 STD) circuit pack. It supports STS-1 granularity, is used with passive Dense Wavelength Division Multiplexing systems, and provides optimal dispersion performance for short span fiber exhaust applications.
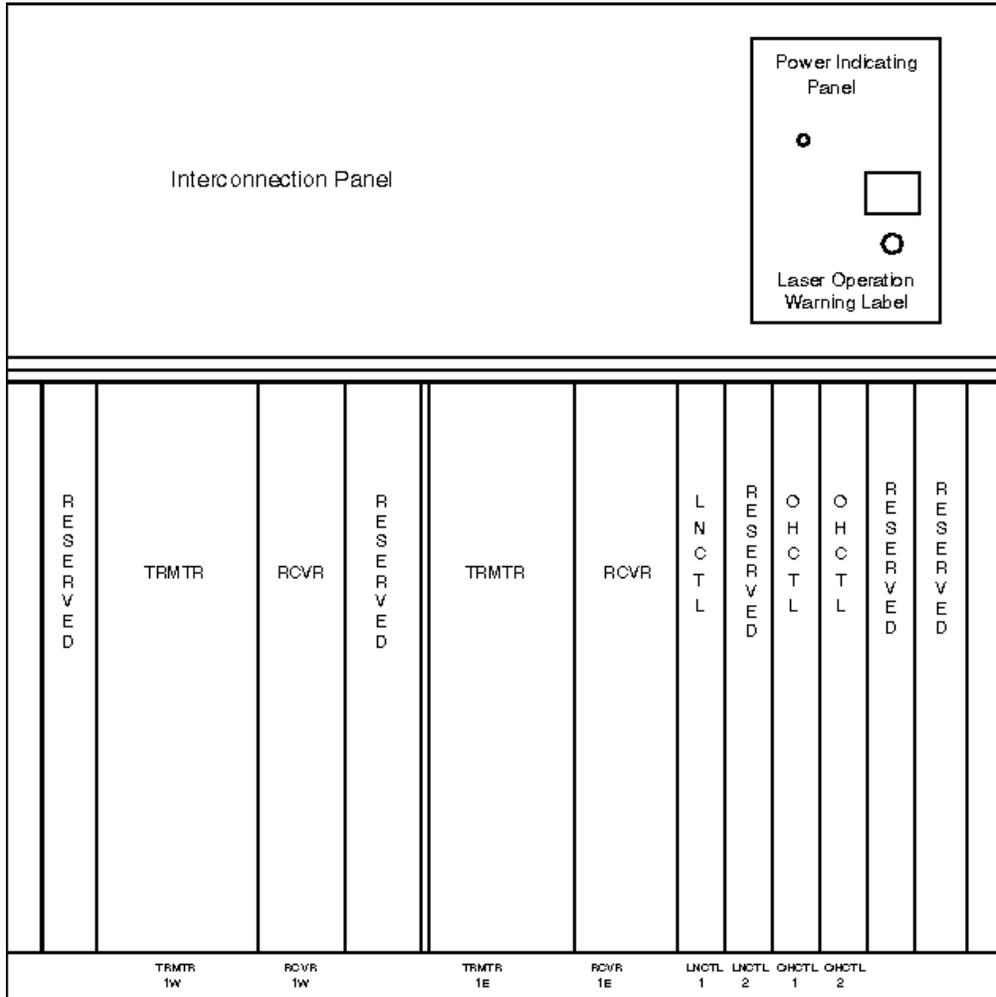
Figure 7-3.   Enhanced High-Speed Shelf Circuit Pack Locations
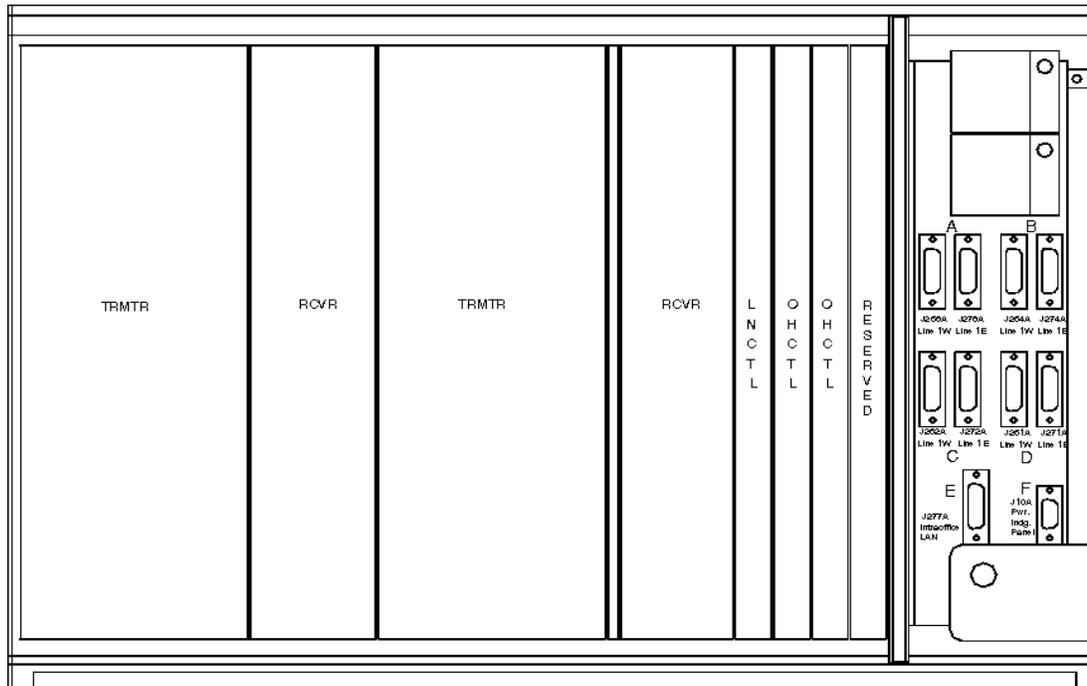
A: Section Order Wire (Local Order Wire)
B: Line Order Wire (EXP OW)
C: Line Growth Channel
D: Section User
E: Intraoffice LAN (Reserved for Future)
F: Power Indicating Panel [(PWR INDG PNL) (Cabled at Factory)]

adr04089.00eJF102196r7.1

Figure 7-4. Condensed High-Speed Shelf Circuit Pack Locations

High-Speed Circuit Pack Worksheet

Table 7-8 provides information for ordering the appropriate high-speed circuit packs. Select the correct circuit pack comcodes when filling the High-Speed Shelf or ordering List 7. Figure 7-3 shows the Enhanced High-Speed Shelf circuit pack locations for List 7, List 215, and List 216.

⇒ NOTE:
Before filling out the ordering worksheet, read the ordering considerations topic in the "General Ordering Information" section earlier in this chapter.

Table 7-8.   Ordering the FT-2000 OC-48 Add/Drop-Rings Dual Lightwave Terminating Bay (L1, L2, or L200)

Description	Circuit Pack Code	Comcode	Quantity Ordered
No Transmitters Desired			
Enhanced High-Speed Shelf Choices (OC-48 Transmitters and Receivers) **Note:** *Choose 1 transmitter and 1 receiver for Direction W and 1 transmitter and 1 receiver for Direction E.*			
TRMTR (A/D OC-12c)	739B4	107275828	
TRMTR (A/D STS-1 OC-12c 1.3 STD)	739B5	107428310	
TRMTR (A/D STS-1 OC-12c 1.3 HI PERF)	739C5	107428336	
TRMTR (A/D STS-1 OC-12c 1.5 LBA W1)	739R5	107567646	
TRMTR (A/D STS-1 OC-12c 1.5 LBA W2)	739S5	107567653	
TRMTR (A/D OC-12c 1.5 STD)	739J4	107275844	
TRMTR (A/D STS-1 OC-12c 1.5 STD)	739J5	107428344	
TRMTR (A/D STS-1 OC-12c 1.5 LBA)	739P5	107428351	
TRMTR (A/D STS-1 OC-12c 1.5 W1)	739E1	106079684	
TRMTR (A/D STS-1 OC-12c 1.5 W2)	739E2	107430688	
TRMTR (A/D STS-1 OC-12c 1.5 W3)	739E3	107430696	
TRMTR (A/D STS-1 OC-12c 1.5 W4)	739E4	107430704	
TRMTR (A/D STS-1 OC-12c 1.5 W5)	739E5	107430712	
TRMTR (A/D STS-1 OC-12c 1.5 W6)	739E6	107430720	
TRMTR (A/D STS-1 OC-12c 1.5 W7)	739E7	107430738	
TRMTR (A/D STS-1 OC-12c 1.5 W8)	739E8	107430746	
TRMTR (A/D STS-1 OC-12c 1.5 W1)	739G1	106079700	

(Sheet 1 of 3)

Table 7-8.   Ordering the FT-2000 OC-48 Add/Drop-Rings Dual Lightwave Terminating Bay (L1, L2, or L200) — *Continued*

Description	Circuit Pack Code	Comcode	Quantity Ordered
TRMTR (A/D STS-1 OC-12c 1.5 W2)	739G2	107974099	
TRMTR (A/D STS-1 OC-12c 1.5 W3)	739G3	107974107	
TRMTR (A/D STS-1 OC-12c 1.5 W4)	739G4	107974115	
TRMTR (A/D STS-1 OC-12c 1.5 W5)	739G5	107974123	
TRMTR (A/D STS-1 OC-12c 1.5 W6)	739G6	107974131	
TRMTR (A/D STS-1 OC-12c 1.5 W7)	739G7	107974149	
TRMTR (A/D STS-1 OC-12c 1.5 W8)	739G8	107974156	
TRMTR (A/D STS-1 OC-12c 1.5 W1)	739H1	106079718	
TRMTR (A/D STS-1 OC-12c 1.5 W2)	739H2	108620584	
TRMTR (A/D STS-1 OC-12c 1.5 W3)	739H3	108620618	
TRMTR (A/D STS-1 OC-12c 1.5 W4)	739H4	108620634	
TRMTR (A/D STS-1 OC-12c 1.5 W5)	739H5	108620667	
TRMTR (A/D STS-1 OC-12c 1.5 W6)	739H6	108620691	
TRMTR (A/D STS-1 OC-12c 1.5 W7)	739H7	108620709	
TRMTR (A/D STS-1 OC-12c 1.5 W8)	739H8	108620717	
TRMTR (A/D STS-1 OC-12c 1.5 W9)	739H9	108620733	
TRMTR (A/D STS-1 OC-12c 1.5 W10)	739H10	108620758	
TRMTR (A/D STS-1 OC-12c 1.5 W11)	739H11	108620774	
TRMTR (A/D STS-1 OC-12c 1.5 W12)	739H12	108620790	
TRMTR (A/D STS-1 OC-12c 1.5 W13)	739H13	108620816	
TRMTR (A/D STS-1 OC-12c 1.5 W14)	739H14	108620840	
TRMTR (A/D STS-1 OC-12c 1.5 W15)	739H15	108620865	
TRMTR (A/D STS-1 OC-12c 1.5 W16)	739H16	108620881	
RCVR (A/D)	839B4B	107781973	
RCVR (A/D STS-1)	839B5	107477457	
RCVR (A/D STS-1)	839E5	107933434	
Required Circuit Pack Choices		-	-
Choose 1 each of the following:			
SYSCTL	LAA23B	106916687	
SYSMEM	LAA25	106053978	
LNCTL (4 MEG)	LAA28	106281082	
Choose 2 each of the following:			
TG3 (DS1)	LAA18	106053903	
OHCTL (TERM)	LAA21	106690597	

(Sheet 2 of 3)

Table 7-8.   **Ordering the FT-2000 OC-48 Add/Drop-Rings Dual Lightwave Terminating Bay (L1, L2, or L200)** — *Continued*

Description	Circuit Pack Code	Comcode	Quantity Ordered
Low-Speed Shelf Choices (No Low-Speed Protection) **Note:** *Maximum 16 slots (OC-12 takes 4 slots)*			
DS3 (0xN)	LAA2	106829559	
STS1E (0xN)	LAA4	106033202	
OC-3 (0x1)	LAA10	106033269	
OC-3 (0x1)	LAA10B	108337478	
IS3	LAA5	106033210	
OC12	T939A	107508152	
Low-Speed Shelf Choices (With Low-Speed Protection **Note:** *Max. 16 any combination plus 1 additional DS3 and/or STS1E for protection*			
DS3 (1xN)	LAA2	106829559	
STS1E (1xN)	LAA4	106033202	
OC3 (1+1) (Order in Pairs)	LAA10 LAA10B	106033269 108337478	
IS3	LAA5	106033210	
OC12	T939A	107508152	
Choose the following if electrical low-speed protection is desired∗ **Note: *Maximum 2***			
LSSW	LAA12B	107792988	

(Sheet 3 of 3)

∗ Electrical low-speed protection is strongly recommended.

Low-Speed Circuit Pack Descriptions

The information below describes low-speed circuit packs.

Circuit Pack	Description
DS3 (LAA2)	Interfaces with three incoming and outgoing B3ZS-encoded DS3 (44.736 Mb/s) cross-connect signals.
STS1E (LAA4)	Interfaces with three incoming and outgoing EC-1 SONET signals (51.84 Mb/s).
OC3 (LAA10) (LAA10B)	Produces a low-speed OC-3 interface at the FT-2000. The LAA10B circuit pack is backward compatible with LAA10, supporting mixed LAA10/LAA10B operation. LAA10B and Release 9.0 and later software are required to support the "full E/W directionality" and "synchronization messaging on S1 byte" features. The FT-2000 ADR Terminal does not support mixed LAA10/LAA10B operation in a 1+1 protected configuration.
IS3 (LAA5)	Contains LED optics to produce an IS-3 interface for OC-3 signals in intraoffice applications. The IS3 circuit pack is only compatible with Release 7.0 and higher.
OC12 (T939A)	Interfaces with OC-12 optical signals. The OC12 circuit pack is only compatible with Release 7.0 and higher.
LSSW (LAA12B)	Directs failed electrical low-speed interface circuit pack signals to the electrical low-speed protection circuit pack. The LSSW circuit pack must be ordered with the protection DS3 or STS1E circuit pack to provide electrical low-speed protection. This is strongly recommended.
TG3 (DS1) (LAA18)	Generates clock for distribution to the transmission circuit packs. This circuit pack derives the DS1 outputs directly from the line reference signal recovered from the incoming OC-48 signal. The LAA18 TG3 (DS1) circuit pack replaced the LAA17 TG3 (DS1) circuit pack in January 1993. The LAA18 TG3 (DS1) circuit pack is compatible with Release 2.1 or later software only.
SYSCTL (LAA23B)	Provides overall administrative control of the FT-2000 OC-48 Lightwave System and is required for 2-Fiber Ring applications. Each LAA23B SYSCTL circuit pack has a unique network services access point (NSAP) code. The LAA23B SYSCTL circuit pack may also be used in OC-48 point-to-point applications. The LAA23B SYSCTL circuit pack replaced the LAA23 SYSCTL circuit pack in Release 2.1. The LAA23B SYSCTL circuit pack is compatible with Release 2.1 or later software only. The LAA23B SYSCTL circuit pack is required with List 205 and List 206.
SYSMEM (LAA25)	Provides memory support for the SYSCTL circuit pack.
TOHCTL (LAA26)	Used by the FT-2000 terminals in the Low-Speed Shelf. The TOHCTL circuit pack processes the SONET Section DCC (D1 - D3) bytes present in OC-3 low-speed interfaces that terminate in the low-speed shelf. The TOHCTL processes both the transmit and receive directions of the DCC, and each TOHCTL can terminate up to eight (8) DCCs.

Figure 7-5 shows the Low-Speed Shelf — System Controller.
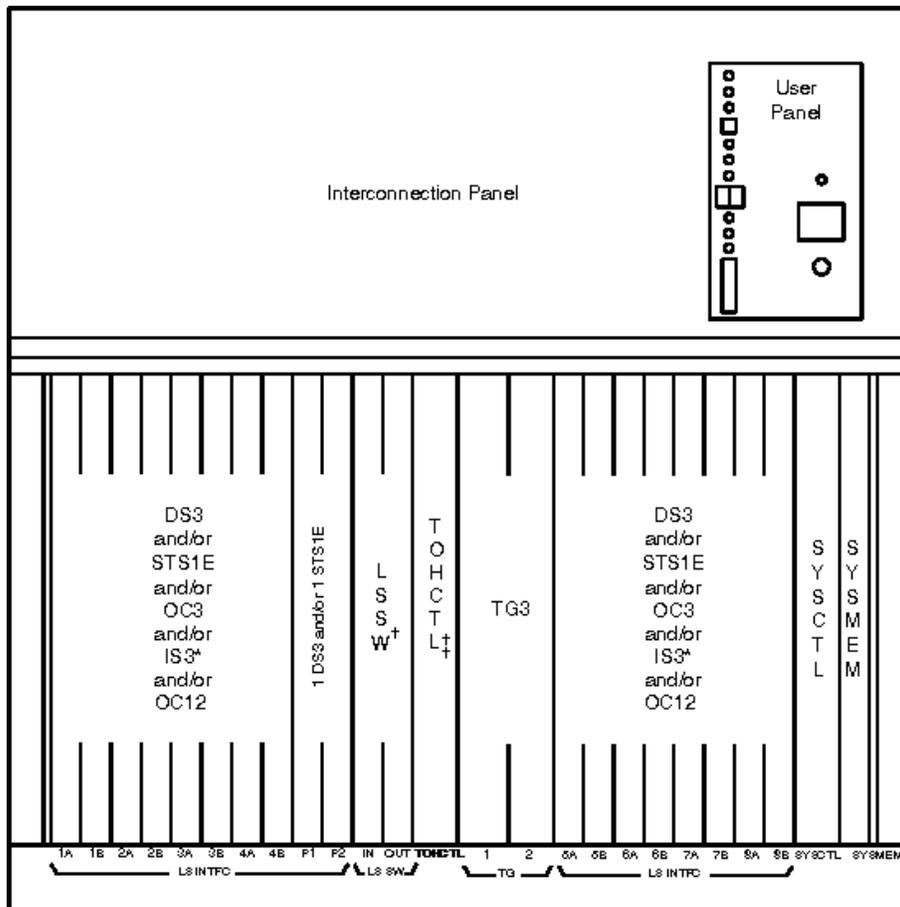
* IS3 circuit pack is for intraoffice applications only.
† LSSW is required only if you use DS3 and/or STS1E circuit packs with low speed protection (low speed protection is strongly recommended).
‡ TOHCTL is required only if you use OC3 or OC12 circuit packs and want DCC capabilities.

adr04008.00eJF081596

Figure 7-5.   Low-Speed Shelf — System Controller Circuit Pack Locations

Low-Speed Circuit Pack Worksheet

Use Table 7-9 and low-speed circuit pack descriptions to select the appropriate circuit pack comcodes to fill the Low-Speed Shelf — System Controller.

Table 7-9.   Ordering Low-Speed Shelf Circuit Packs

Description		Code	Comcode	2 Fiber Ring	Low-Speed Protection	Qty.
Required Circuit Pack Choices	LSSW *	LAA12B	107792988	2	-	
	TG3	LAA18	106053903	2	-	
	SYSCTL	LAA23B	106916687	1	-	
	SYSMEM	LAA25	106053978	1	-	
Optional Interface Circuit Pack Choices	DS3	LAA2	106829559	0/1 to 16	1 (max.)	
	STS1E	LAA4	106033202	0/1 to 16	1 (max.)	
	OC3 ¶	LAA10	106033268	0/1 to 16	-	
	OC3 ¶	LAA10B**	108337478	0/1 to 16		
	IS3¶	LAA5	106033210	0/1 to 16	-	
	OC12¶	T939A	107508152	0/1 to 4	-	
	TOHCTL†	LAA26	106281066	1‡	-	

*   LSSW is required only if you use DS3 and/or STS1E circuit packs with low-speed protection (low-speed protection is strongly recommended).

¶   For each service circuit pack that you provision for protected (1+1) operation, 1 protection pack is required.

†   Required to implement DCC Channel Option.

‡ Release 6 software or later must use the TOHCTL in the J68974D-1 terminal.

** The LAA10B circuit pack is backward compatible with LAA10, supporting mixed LAA10B/LAA10 operation. For more information, see "Low-Speed Circuit Pack Descriptions" in the Dual Bay section of this chapter.

Apparatus Blank Descriptions for the Dual Bay

Apparatus blanks are required in all unequipped circuit pack positions in any FT-2000 Dual Bay system that contains powered circuit packs. The Dual Bay can contain one or two FT-2000 systems.

Use Table 7-10 as a guide to order apparatus blanks. Below is an explanation of how to use the formula supplied in the table.

Formula: Maximum # of 1-inch apparatus blanks for List 1 (two systems) = 8 - (No. of LAA26) - (No. of LAA18) - (No. of LAA23B)

This means that the number of 1-inch apparatus blanks required for a two system Dual Bay equals 8 minus the number LAA16 minus the number of LAA18 minus the number of LAA23B. If you ordered one LAA26, four LAA18, and two LAA23B, then your equation would be 8-1-4-2=1. You would need to order one 1-inch apparatus blank for the List 1 (two system) Dual Bay.

Table 7-10.   Apparatus Blank Information

Comcode	Description	Formula
847012564	3/4-inch wide apparatus blank	Maximum # of 3/4-inch apparstus blanks for List 1 (two system) = 48 - (# of LAA10) - (# of LAA5) - (# of LAA2) - (# of LAA4) - (# of LAA28) - (# of LAA21) - (# of LAA12B) - (# of LAA25) -4 x (# of T939A)
		Maximum # of 3/4-inch apparatus blanks for List 1 (one system), List 2, and List 200 = 24 - (# of LAA10) - (# of LAA5) - (# of LAA2) - (# of LAA4) - (# of LAA28) - (# of LAA21) - (# of LAA12B) - (# of LAA25) -4 x (# of T939A)
847012556	1-inch wide apparatus blank	Maximum # of 1-inch apparatus blanks for List 1 (two systems) = 8 - (# of LAA26) - (# of LAA18) - (# of LAA23B)
		Maximum # of 1-inch apparatus blanks for List 1 (one system), List 2, and List 200 = 4 - (# of LAA26) - (# of LAA18) - (# of LAA23B)
106566334	2 1/4-inch wide apparatus blank	Maximum # of 2 1/4-inch apparatus blanks for List 1 (two systems) = 4 - (# of 839B4B) - (# of 839B5)
		Maximum # of 2 1/4-inch apparatus blanks for List 1 (one system), List 2, and List 200 = 2 - (# of 839B4B) - (# of 839B5)
106566367	4 1/2-inch wide apparatus blank	Maximum # of 4 1/2-inch apparatus blanks for List 1 (two systems) = 4 - (# of 739B4 through)
		Maximum # of 4 1/2-inch apparatus blanks for List 1 (one system), List 2, and List 200 = 2 - (# of 739B4 through List 106)

Apparatus Blank Worksheet for the Dual Bay

Use Table 7-11 to select the appropriate apparatus blank list numbers for the Dual Bay.

Table 7-11.   Ordering Apparatus Blanks for the Dual Bay (J68974D-1)

Description	Comcode	Quantity Ordered
3/4-inch wide apparatus blank	847012564	
1-inch wide apparatus blank	847012556	
2 1/4-inch wide apparatus blank	106566334	
4 1/2-inch wide apparatus blank	106566367	

Repeater Shelf Circuit Packs

Use the following table and circuit pack descriptions to select the appropriate circuit pack list numbers to fill the Repeater Shelf. Figure 7-6 shows the Repeater Shelf circuit pack locations. Two regenerators are required per line. These can be mixed in any combination.

Repeater Shelf — System Controller Circuit Pack Descriptions

The information below describes circuit packs for the repeater shelf.

Circuit Pack	Description
SYSCTL (LAA23B)	Provides overall administrative control of the FT-2000 OC-48 Lightwave System. Each LAA23B SYSCTL circuit pack has a unique network system access point (NSAP) code. The LAA23B SYSCTL circuit pack replaces the LAA23 SYSCTL circuit pack in Release 2.1. The LAA23B SYSCTL circuit pack is compatible with Release 2.1 or later software.
SYSMEM (LAA25)	Provides memory support for the SYSCTL circuit pack.
ORDERWIRE (LAA14)	Provides access to section orderwire (E1) byte to support voice communication or remote CIT access for site-to-site maintenance. Requires *DANTEL* Orderwire Shelf (A18-05547-01), an external modem (202T, 4-wire), and cable. A *DANTEL* Orderwire Shelf kit (drawing number 847593522) containing an orderwire shelf, external modem, cable, and modem mounting hardware is available.
OC48 REGENR (1.3 STD) (39B2)	1.31 μm standard performance regenerator regenerates the optical OC-48 signal. It is equipped with build-out blocks that accept *ST* (List 116), FC (List 126), or SC (List 136) lightguide connectors. The 39B2 OC48 REGENR circuit pack replaces the 39B1 OC48 REGENR circuit pack.

Figure 7-6 displays the repeater shelf — system controller circuit pack locations.
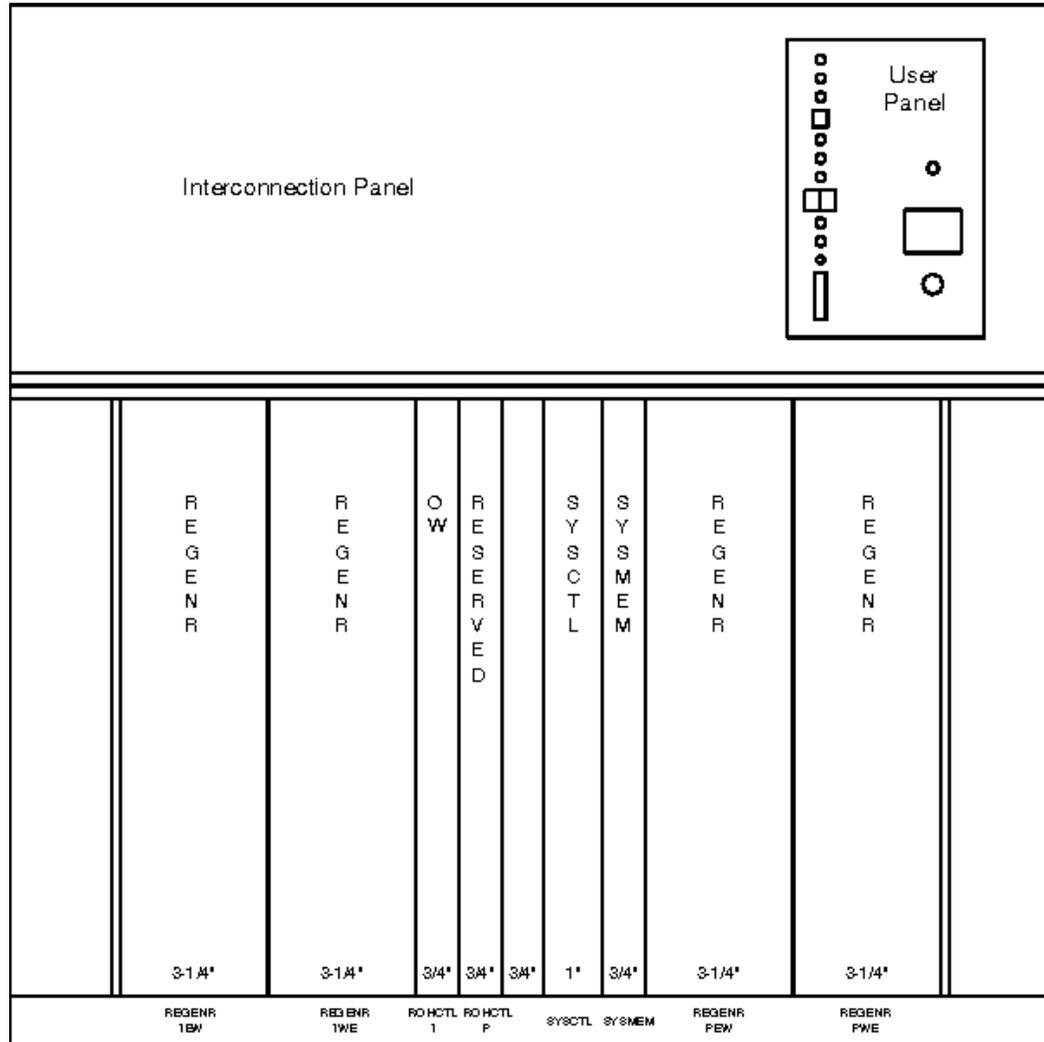
Figure 7-6.   Repeater Shelf — System Controller Circuit Pack Locations

High-Speed Circuit Pack Worksheet

Table 7-12 provides information to order repeater bay circuit packs.

Table 7-12.   Ordering Repeater Bay Circuit Packs

Description	Code	Comcode	Rptr. Bay L-1	Misc. Shelf L-10	Addl. Shelf L-200	Qty. Ordered
SYSCTL	LAA23B	106916687	1	1	1	
SYSMEM	LAA25	106053978	1	1	1	
OW	LAA14	106033319	1	1	1	
OC-48 REGENR (1.3 STD)	39B2	106916695	4 (max.)	4 (max.)	4 (max.)	

Cables

This topic includes information on ordering the following types of cables:

- intraoffice electrical low-speed transmission cables

- intraoffice electrical nontransmission cables

**Intraoffice Transmission Cable Worksheets for the
Dual Bay**

In selecting ED8C900-20 group numbers for intraoffice electrical low-speed (coaxial) transmission cables, always base your selection on the system that will be connected to the FT-2000 OC-48 Lightwave System Network Element.

ED8C900-20 intraoffice electrical low-speed transmission cables have replaced ED7G001-21 intraoffice electrical low-speed transmission cables. Both ED codes appear in Table 7-13 as a cross-reference during the transition period. Order ED8C900-20 cables for your applications when using software Release 7.1 or later.

ED8C900-20 cable orders must be entered as shown in the following examples:

- **Fixed Length** — An FT-2000 to DSX-3 100 foot fixed length cable connection (from the second entry in Table 7-13) is ordered as "ED8C900-20, G102 F/E 6BA, 6LA".

- **As Required Length** — An FT-2000 to DSX-3 180 foot (as req'd.) connection (from the first entry in Table 7-13) is ordered as "ED8C900-20, G105 180 ft. F/E 6BA, 6FA". The length entry is always required when G5, G105, or G305 is specified.

⚠️ **WARNING:**
When operating an FT-2000 OC-48 Lightwave System with non-Lucent Technologies electrical low-speed cross-connect equipment that does not automatically terminate the OUT jacks, you must use 75 ohm termination plugs to terminate the OUT jacks.

A Lucent Technologies DSX-3/4 cross-connect automatically terminates the OUT jacks with 75 ohms. This cross-connect can be used with the FT-2000 OC-48 Lightwave System equipped with either DS3 low-speed interface circuit packs [LAA2 (DS3)] or EC-1 low-speed interface circuit packs [LAA4 (STS1E)].

For 735A and 1735006A type cable, the following are the overall maximum length limitations:

- Network Element to DSX Type Distribution Frame — 250 feet maximum

- Network Element to Network Element — 500 feet maximum

For 734D type cable, the following are the overall maximum length limitations:

- ■ Network Element to DSX Type Distribution Frame — 450 feet maximum

- ■ Network Element to Network Element — 900 feet maximum

When 735A and 734D cable appear together in the cable type column, a 9-foot 735A cable is used at the end of the 734D cable to eliminate cable congestion in the FT-2000 bay.

Table 7-13.   Electrical Transmission Cables

FT-2000 Connected To	Cable Type	OLD (ED7G001-21) Group #	NEW (ED8C900-20) Group #	Length in Feet	LBO Req'd.
DSX-3 and To Other FT-2000	1735006A 6 conductor cable (BNC-BNC)	1	105, 6BA & 6FA	As Req'd.	Yes
		51	102, 6BA & 6LA	100	No
		61	104, 6BA & 6LA	250	No
		71	105, 6BA & 6LA[*]	500	No
	735A 1 conductor cable (BNC-BNC)	2	5, AA & FA	As Req'd.	Yes
		52	2, AA & LA	100	No
		62	4, AA & LA	250	No
		72	5, AA & LA[*]	500	No
	735A-734D-735A 1 conductor cable (BNC-BNC)	4	No Replacement		
		6	305, DAD & LAD[†]	As Req'd.	Yes for 0-225'
	734D 1 conductor cable (BNC-BNC)	8	305, DA & IFA[‡]	As Req'd. 450 Max	Yes for 0-225'

(Sheet 1 of 4)

Table 7-13.   Electrical Transmission Cables — *Continued*

FT-2000 Connected To	Cable Type	OLD (ED7G001-21) Group #	NEW (ED8C900-20) Group #	Length in Feet	LBO Req'd.
DACS III-2000 with BNC Interconnect	1735006A (BNC-BNC)	1	105, 6BA & 6FA	As Req'd.	Yes
		51	102, 6BA & 6LA	100	No
		61	104, 6BA & 6LA	250	No
		71	105, 6BA & 6LA*	500	No
	735A (BNC-BNC)	2	5, AA & FA	As Req'd.	Yes
		52	2, AA & LA	100	No
		62	4, AA & LA	250	No
		72	5, AA & LA*	500	No
	735A-734D-735A (BNC-BNC)	4	No Replacement		
		6	305, DAD & LAD†	As Req'd.	Yes for 0-225'
	734D (BNC-BNC)	8	305, DA & IFA‡	As Req'd. 450 Max	Yes for 0-225'
DACS III-2000 without BNC Interconnect	1735006A (BNC-9821AE)	201	105, 6BA & 6FC	As Req'd.	Yes
		251	102, 6BC & 6LA	100	Yes
		261	104, 6BC & 6LA	250	Yes for 0-125'
		271	105, 6BC & 6LA*	500	No
	735A (BNC-9821AE)	202	5, AA & FC	As Req'd.	Yes
		252	2, AC & LA	100	Yes
		262	4, AC & LA	250	Yes for 0-125'
		272	5, AC & LA*	500	No
	735A-734D-735A (BNC-9821AE)	204	No Replacement		
		206	305, DAD & LCD†	As Req'd.	Yes for 0-225'
	734D-735A (BNC-9821AE)	208	305, DA & LCD‡	As Req'd. 900 Max	Yes for 0-225'

(Sheet 2 of 4)

Table 7-13.   Electrical Transmission Cables — *Continued*

FT-2000 Connected To	Cable Type	OLD (ED7G001-21) Group #	NEW (ED8C900-20) Group #	Length in Feet	LBO Req'd.
DACS IV-2000 with BNC Interconnect	1735006A (BNC-BNC)	1	105, 6BA & 6FA	As Req'd.	Yes
		51	102, 6BA & 6LA	100	No
		61	104, 6BA & 6LA	250	No
		71	105, 6BA & 6LA[*]	500	No
	735A (BNC-BNC)	2	5, AA & FA	As Req'd.	Yes
		52	2, AA & LA	100	No
		62	4, AA & LA	250	No
		72	5, AA & LA[*]	500	No
	735A-734D-735A (BNC-BNC)	4	No Replacement		
		6	305, DAD & LAD[†]	As Req'd.	Yes for 0-225'
	734D (BNC-BNC)	8	305, DA & IFA[‡]	As Req'd. 450 Max	Yes for 0-225'

(Sheet 3 of 4)

Table 7-13. Electrical Transmission Cables — *Continued*

FT-2000 Connected To	Cable Type	OLD (ED7G001-21) Group #	NEW (ED8C900-20) Group #	Length in Feet	LBO Req'd.
	1735006A (BNC-9821EA/FA)	301	105, 6BJ & 6FA	As Req'd.	Yes
		351	102, 6BJ & 6LA	100	Yes
		361	104, 6BJ & 6LA	250	Yes for 0-125'
		371	105, 6BJ & 6LA*	500	No
	735A (BNC-9821EA)	302	5, AA & FE	As Req'd.	Yes
		352	2, AE & LA	100	Yes
		362	4, AE & LA	250	Yes for 0-125'
		372	5, AD & LA*	500	No
DACS IV-2000 without BNC Interconnect	735A (BNC-9821FA)	303	5, AA & FD	As Req'd.	Yes
		353	2, AD & LA	100	Yes
		363	4, AD & LA	250	Yes for 0-125'
		373	5, AD & LA*	500	No
	735A-734D-735A (BNC-9821EA)	304	No Replacement		
		306	305, DAD & LED†	As Req'd.	Yes for 0-225'
	735A-734D-735A (BNC-9821FA)	305	No Replacement		
		307	305, DAD & LDD†	As Req'd.	Yes for 0-225'
	734D-735A (BNC-9821EA)	308	305, DA & LED‡	As Req'd.	Yes for 0-225'
	734D-735A (BNC-9821FA)	309	305, DA & LDD‡	As Req'd.	Yes for 0-225'

(Sheet 4 of 4)

*This is an "As Req'd." cable that must be ordered in the specified length of 500 feet.

†For cable 735A to 734D, there is a splice in the cable rack.

‡Cable 734D is not recommended due to possible cable congestion in the FT-2000 bay.

Intraoffice Nontransmission Cable Descriptions for the Dual Bay

Table 7-14 describes the types of intraoffice electrical nontransmission cables to order for the Dual-Bay.

Cables will be shipped with the equipment ordered from the J68974D-1 drawing if the cables are placed on the same order. See SD-5G250-02, *FT-2000 OC-48 Enhanced Lightwave Terminating Bay Application Schematic*.

Table 7-14.   Intraoffice Electrical Nontransmission Cables (Associated with FT-2000 Dual Bays)

ED7G001-22 Group No.	Length (Feet)	Function	Description
3* 53 63	As Req'd.† 150 250	TIMING IN PRI	TIMING IN PRI cable connects FT-2000 equipment to a DS1 timing source for synchronous operation. TIMING IN SECY cable is required if this cable is ordered.
3* 53 63	As Req'd.† 150 250	TIMING IN SECY	TIMING IN SECY cable connects FT-2000 equipment to a DS1 timing source for synchronous operation. TIMING IN PRI cable is required if this cable is ordered.
3* 53 63	As Req'd.† 150 250	TIMING OUT 1	TIMING OUT 1 cable connects FT-2000 to other office equipment requiring a synchronous timing source. This cable may be ordered independently of TIMING OUT 2.
3* 53 63	As Req'd.† 150 250	TIMING OUT 2	TIMING OUT 2 cable is identical to TIMING OUT 1 cable. It provides timing out to other office equipment.
4‡ 54 64	As Req'd.† 20 100	TIMING OUT 1	This TIMING OUT 1 cable is the same as the one above, but is terminated on both ends.
4‡ 54 64	As Req'd.† 20 100	TIMING OUT 2	This TIMING OUT 2 cable is the same as the one above, but is terminated on both ends.
9	.75	NULL-BITS TIMING IN/OUT	Null-Bits Timing In/Out cable is used at nodes without BITS or an external clock to emulate externally timed provisioning. This cable connects TG3-1 primary DS1 output to the TG3-1 primary DS1 input of the node without BITS or external clock.

(Sheet 1 of 4)

**Table 7-14.   Intraoffice Electrical Nontransmission Cables (Associated with FT-2000 Dual Bays)
— *Continued***

ED7G001-22 Group No.	Length (Feet)	Function	Description
201	As Req'd. (4000 ft. max.)	SER TLM 1	Serial Telemetry cable connects FT-2000 with OS and is used to communicate FT-2000 terminal information.
251	150		
261	250		
201	As Req'd. (4000 ft. max.)	SER TLM 2	Serial Telemetry cable connects FT-2000 with OS and is used to communicate with repeater sites.
251	150		
261	250		
301	As Req'd.	OFFICE ALMS	Office Alarms cable connects FT-2000 to the local office alarms.
351	150		
361	250		
301	As Req'd.	PAR TLM	Parallel Telemetry cable connects FT-2000 to a parallel telemetry interface.
351	150		
361	250		
301	As Req'd.	MISC DSCRT 1	Miscellaneous Discrete 1 cable connects FT-2000 to a miscellaneously mounted terminal strip. The cable connection provides eight monitor points and two control points.
351	150		
361	250		
301	As Req'd.	MISC DSCRT 2	Miscellaneous Discrete 2 cable connects FT-2000 to a miscellaneously mounted terminal strip. The cable connection provides eight monitor points and two control points.
351	150		
361	250		
401	As Req'd. (11 ft. max.)	LINE GROWTH CHAN, LINE (X)	Line Growth Channel, Line(X) cable provides access to FT-2000 overhead line growth bits (Z1-Z2). The OHCTL(TERM) circuit pack is required to use this feature.
401	As Req'd. (2850 ft. max.)	LINE OW, LINE (X) (EXP OW)	Line Orderwire, Line(X) cable provides access to Orderwire set for terminal ⎯ terminal voice communication also known as Express Orderwire (EXP OW). The OHCTL(TERM) circuit pack is required to use this feature.
451	150		
452	250		
401	As Req'd. (2850 ft. max.)	SECTION OW, LINE (X) (LOC OW)	Section Orderwire, Line(X) cable provides access to Orderwire set for terminal ⎯ repeater voice communication and optionally, remote CIT access. Also known as Local Orderwire (LOC OW). The OHCTL (TERM) circuit pack is required to use this feature.
451	150		
461	250		

(Sheet 2 of 4)

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Table 7-14. **Intraoffice Electrical Nontransmission Cables (Associated with FT-2000 Dual Bays)**
— *Continued*

ED7G001-22 Group No.	Length (Feet)	Function	Description
401	As Req'd. (2850 ft. max.)	SECTION USER CHAN, LINE (X)	Section User Channel, Line(X) cable provides access to FT-2000 over-head Section User Channel bits (F1).
451	150		
461	250		
401	As Req'd. (11 ft. max.)	LINE GROWTH CHAN, LINE (Y)	Line Growth Channel, Line(X) cable provides access to FT-2000 over-head line growth bits (Z1-Z2). The OHCTL(TERM) circuit pack is required to use this feature.
401	As Req'd. (2850 ft. max.)	LINE OW, LINE (Y) (EXP OW)	Line Orderwire, Line(Y) cable pro-vides access to Orderwire set for terminal ── terminal voice commu-nication also known as Express Orderwire (EXP OW). The OHCTL(TERM) circuit pack is required to use this feature.
451	150		
461	250		
401	As Req'd. (2850 ft. max.)	SECTION OW, LINE (Y) (LOC OW)	Section Orderwire, Line(Y) cable pro-vides access to Orderwire set for ter-minal ── repeater voice communication and optionally, remote CIT access. Also known as Local Orderwire (LOC OW). The OHCTL (TERM) circuit pack is required to use this feature.
451	150		
461	250		
401	As Req'd. (2850 ft. max.)	SECTION USER CHAN, LINE (Y)	Section User Channel, Line(Y) cable provides access to FT-2000 over-head Section User Channel bits (F1).
451	150		
461	250		
501	As Req'd.	FAN ALARM	Fan alarm cable connects the fan assembly to a miscellaneously mounted terminal strip. This is required only for the E-Bay with an optional fan assembly. Fan alarm cabling is included in the D-Bay.
551	150		
561	250		

(Sheet 3 of 4)

Table 7-14. **Intraoffice Electrical Nontransmission Cables (Associated with FT-2000 Dual Bays)**
— *Continued*

ED7G001-22 Group No.	Length (Feet)	Function	Description
602¶	As Req'd. (150 ft. max.)		X.25 cable provides access to an OS interface also known as Q3.
603	As Req'd. (150 ft. max.)		
613	50	X.25	
623	75		
633	100		
643	125		
652¶	150		
702§	As Req'd. (150 ft. max.)		Craft Interface Terminal (Data Terminal Equipment) provides a remote interface to the FT-2000 equipment that is functionally similar to the user panel
752§	150	CIT (DTE)	CIT (DCE) port. The port may be used to load software, perform system diagnostics, and optionally, provide CIT access to repeaters. A modem can be used to send information to a distant location.

(Sheet 4 of 4)

*G3, G53, and G63 cables replace G1, G51, and G61 cables.

†YR28365 cable, 655 ft. max. to a DSX-1 cross-connect panel or 1310 ft. max. to another source or distribution.

‡G4, G54, and G64 cables replace G2, G52, and G62 cables.

¶G602 and G652 cables are replacements for G601 and G651 cables, which were rated Discontinued Availability in December 1993. G601 and G651 functioned with RS232 interfaces. G602 and G652 function with RS232 and datakit interfaces.

§G702 and G752 cables are equivalent replacements for G701 and G751 cables, which were rated Discontinued Availability effective December 1993.

**In this table, if the application is for FT-2000 OC-48 1x1 End Terminal Applications, (X) represents 1 and (Y) represents P. If the application is for FT-2000 OC-48 Add/Drop-Rings Terminal applications, (X) represents 1W and (Y) represents 1E.

**Intraoffice Nontransmission Cable Worksheet for the
Dual Bay**

Order nontransmission cables using Table 7-15 and Table 7-16.

⟹ **NOTE:**
All nontransmission cables may be ordered and preconfigured even
though software features to support the cable functions will be avail-
able in later releases.

Table 7-15.   Ordering Nontransmission Cables   (ED7G001-22 G-( ))

Description			Length (Feet)					Your Choice		
			20	100	150	250	As Req'd.	Max. Length	Grp.	Length	Qty.
TIMING	In	Primary *	-	-	53	63	3	1310 ft. to Stratum or 655 ft. to DSX-1			
		Secondary *	-	-	53	63	3				
	Out 1	Connector One End	-	-	53	63	3				
	Out 2	Connector One End	-	-	53	63	3				
	Out 1	Connector Both Ends	G-54	G-64	-	-	G4				
	Out 2	Connector Both Ends	G-54	G-64	-	-	G4				
	Null Bits Timing Cable		-	-	-	-	-	-	9	9 inches (fixed)	
SER TLM	1		-	-	251	261	201	4000 ft.			
	2		-	-	251	261	201				
MISC DSCRT	1		-	-	351	361	301	-			
	2		-	-	351	361	301				
PAR TLM			-	-	351	361	301	4000 ft.			
OFFICE ALARMS			-	-	351	361	301	-			
LINE GROWTH	CHAN X		-	-	451	461	401	11 ft.			
	CHAN Y		-	-	451	461	401				

(Sheet 1 of 2)

Table 7-15.   Ordering Nontransmission Cables   (ED7G001-22 G-( )) — *Continued*

Description			Length (Feet)						Your Choice		
		20	**100**	**150**	**250**	**As Req'd.**	**Max. Length**	**Grp.**	**Length**	**Qty.**
SECTION USER	CHAN X	-	-	451	461	401	2850 ft.			
	CHAN Y	-	-	451	461	401				
Orderwire	X	LINE OW (Exp)	-	-	451	461	401	2850 ft.			
		SEC OW (Loc)	-	-	451	461	401	2850 ft.			
	Y	LINE OW (Exp)	-	-	451	461	401				
		SEC OW (Loc)	-	-	451	461	401				

(Sheet 2 of 2)

FT-2000 needs a male connector below. The customer determines the far-end connector.

Table 7-16.   Ordering Other Nontransmission Cables (ED7G001-22G-( ))

Description				Length (Feet)					Your Choice		
		50	**75**	**100**	**125**	**150**	**As Req'd.**	**Max. Length**	**Grp.**	**Length**	**Qty.**
X.25 Connectorized Both Ends	Male-Male	613	623	633	643	-	603	150 ft.			
	Male-Female					652	602	150 ft.			
CIT (DTE) Connectorized Both Ends						752	702	150 ft.			

Repeater Bay Nontransmission Cable Descriptions

Table 7-17 provides information for ordering repeater bay nontransmission cables.

Cables will be shipped with the equipment ordered from the J68974R-1 drawing if the cables are placed on the same order. See also SD-5G252-01, *FT-2000 OC-48 Lightwave Repeater Bay Application Schematic.*

Table 7-17.   Intraoffice Electrical Nontransmission Cables (FT-2000 J68974R-1)

ED7G001-22 Group No.	Length (Feet)	Function	Description
301 351 361	As Req'd. 150 250	OFFICE ALMS	Office Alarms cable connects FT-1000 to the local office alarms.
301 351 361	As Req'd. 150 250	MISC DSCRT 1	Miscellaneous Discrete 1 cable connects FT-2000 to a miscellaneously mounted terminal strip. The cable connection provides eight monitor points and two control points.
301 351 361	As Req'd. 150 250	MISC DSCRT 2	Miscellaneous Discrete 2 cable connects FT-2000 to a miscellaneously mounted terminal strip. The cable connection provides eight monitor points and two control points.
401 451 461	As Req'd. (2850 ft. max.) 150 250	SECT OW, Line 1W	Section Orderwire, Line 1W cable provides access to Orderwire set for repeater - terminal or repeater - repeater voice communication or remote CIT access.
401 451 461	As Req'd. (2850 ft. max.) 150 250	SECT OW, Line 1E	Section Orderwire, Line 1E cable provides access to Orderwire set for repeater - terminal or repeater - repeater voice communication or remote CIT access.
401 451 461	As Req'd. (2850 ft. max.) 150 250	SECT OW, Line PW	Section Orderwire, Line PW cable for repeater - terminal or repeater - repeater. (Reserved for future release.)
401 451 461	As Req'd. (2850 ft. max.) 150 250	SECT OW, Line PE	Section Orderwire, Line PE cable for repeater - terminal or repeater - repeater. (Reserved for future release.)

(Sheet 1 of 2)

Table 7-17.   Intraoffice Electrical Nontransmission Cables (FT-2000 J68974R-1) —

ED7G001-22 Group No.	Length (Feet)	Function	Description
401	As Req'd. (2850 ft. max.)	SECT USER CHAN, Line 1W	Section User Channel, Line 1W cable provides access to FT-2000 overhead Section User Channel bits (F1). (Reserved for future release.)
451	150		
461	250		
401	As Req'd. (2850 ft. max.)	SECT USER CHAN, Line 1E	Section User Channel, Line1E cable provides access to FT-2000 overhead Section User Channel bits (F1). (Reserved for future release.)
451	150		
461	250		
401	As Req'd. (2850 ft. max.)	SECT USER CHAN, Line PW	Section User Channel, Line PW cable provides access to FT-2000 overhead Section User Channel bits (F1). (Reserved for future release.)
451	150		
461	250		
401	As Req'd. (2850 ft. max.)	SECT USER CHAN, Line PE	Section User Channel, Line (PE) cables provides access to FT-2000 overhead Section User Channel bits (F1). (Reserved for future release.)
451	150		
461	250		
702*	As Req'd. (150 ft. max.)	CIT (DTE)	Craft Interface Terminal (Data Terminal Equipment) provides a remote interface to the FT-2000 equipment that is functionally similar to the user panel CIT(DCE) port. The port may be used to load software and perform system diagnostics. A modem can be used to send information to a distant location.
752*	150		

(Sheet 2 of 2)

* Group 702, and Group 752 cables are equivalent replacements for Group 701, and
Group 751 cables, which were rated Discontinued Availability in December 1993.

Nontransmission Cable Worksheet for the
Repeater Bay

Select ED7G001-22 Group Numbers for intraoffice nontransmission cables from
Table 7-18 based on the following information.

⟹ **NOTE:**

All nontransmission cables may be ordered and pre-constructed even
though software features to support the cable functions will become avail-
able in subsequent releases.

Table 7-18.   Ordering Nontransmission Cables (J68974R-1)

Description			Length (Feet)						Your Choice	
			20	100	150	250	As Req'd.	Max. Length	ED Grp. #	Lgth.
MISC DSCRT Connectorized One End		1	-	-	351	361	301	-		
		2	-	-	351	361	301			
OFFICE ALARMS Connectorized One End			-	-	351	361	301	-		
SECT USER CHAN Connector- ized One End	X	East	-	-	451	461	401	2850 ft.		
		West	-	-	451	461	401			
	Y	East	-	-	451	461	401			
		West	-	-	451	461	401			
SECT OW Connector- ized One End	X	East	-	-	451	461	401	2850 ft.		
		West	-	-	451	461	401			
	Y	East	-	-	451	461	401			
		West	-	-	451	461	401			
CIT(DTE) Connectorized Both Ends			-	-	752	-	702	150 ft.		

1. Maximum quantity of each cable per bay is one.

2. Group 702 and Group 752 cables are equivalent replacements for Group 701
   and Group 751 cables, which were rated Discontinued Availability in December
   1993.

Lightguide Build-Out Set Descriptions for the Dual Bay

Lightguide build-outs are chosen based on the connector interface, the attenuation needed, and the type of circuit pack. There are three choices of connector interfaces: *ST*-type, FC-type, or SC-type. One lightguide build-out from the lightguide build-out sets is to be placed on **each** OC48 RCVR circuit pack.

It is recommended that one set per OC48 RCVR circuit pack be ordered. If FC- or SC-type connectors are used, an additional 0 dB lightguide build-out is provided in the set to be placed on the OC48 TRMTR circuit pack to provide the FC or SC connector interface. All factory-equipped OC48 TRMTR and OC48 RCVR circuit packs come with an *ST*-type 0 dB lightguide build-out.

Lightguide Build-Out Set Worksheet for the Dual Bay

Select lightguide build-out sets from Table 7-19.

Table 7-19.   Ordering FT-2000 OC-48 Add/Drop-Rings Terminal Lightguide Build-Out Sets (Dual Bay)

Used with Optical Packs	Values	Connector on jumper cable	List No.	Qty.
OC48 TRMTR 739B4 OC48 TRMTR 739B5 OC48 TRMTR 739C5	(1 each: 5db,10db, 15db,20db)	*ST* Conn.	J68974E1 L-116	
OC48 TRMTR 739J4 OC48 TRMTR 739J5 OC48 TRMTR 739P5 OC48 TRMTR 739R5 OC48 TRMTR 739S5	(1 each: 5db,10db, 15db,20db; 2 each: 0db)	FC Conn.	J68974E1 L-126	
OC48 TRMTR 739E1-8 OC48 TRMTR 739G1-8 OC48 TRMTR 739H1-16 RCVR (A/D) 839B4B RCVR (A/D STS-1) 839B5 RCVR (A/D STS-1) 839E5	(1 each: 5db,10db, 15db,20db; 2 each: 0db)	*SC Conn.*	J68974E1 L-136	
	(1 each: 0 dB)	*ST Conn.*	J68974E1 L-117 *†	
OC3 (1.3 STD) LAA10 or LAA10B**	(1 each: 7.1 dB; 2 each: 0 dB)	FC Conn.	J68974E1 L-127 *‡	
	(1 each: 7.1 dB; 2 each: 0 dB)	SC Conn.	J68974E1 L-137 *‡¶	
	___	*ST* Conn.	J68974E1 L-118	
IS3 LAA5	___	FC Conn.	J68974E1 L-128	
OC12 T939A	___	SC Conn.	J68974E1 L-138	

* Each LAA10 OC3 circuit pack is equipped with a 7.1-dB lightguide build-out (LBO) in its transmitter position and a 0-dB LBO in its receiver position. Both of these LBOs have *ST* connector terminations. These LBOs are for short-reach and intermediate-reach OC-3 applications (fiber routing lengths of up to 20 km).

† Order List 117 for long-reach OC-3 interface applications (fiber routing lengths of 20 km to 50 km) or IS-3 interface applications.

‡ If your OC-3/IS-3 interface applications require FC connector terminations, order List 127. If they require SC connector terminations, order L137.

¶ If the connection is to a DDM-2000 IS-3 interface, the DDM-2000 requires a 15dB LBO. For ordering information on the 15 dB multimode LBO, please see the *DDM-2000 Multiplexer Applications, Planning, and Ordering Guide* (363-206-200).

** LAA10B is backward compatible with LAA10, supporting mixed LAA10B/LAA10 operation. For more information, refer to "Low-Speed Circuit Pack Descriptions" in the Dual Bay section of this chapter.

Lightguide Build-Out Set (List 116, List 126, or List 136) Description for the Repeater Bay

Lightguide build-outs are chosen based on the connector interface, the attenuation needed, and the type of circuit pack. There are three choices of connector interfaces: *ST*-type, FC-type, or SC-type. Two lightguide build-outs from the lightguide build-out sets are to be placed on **each** OC48 REGENR circuit pack. Therefore, it is recommended that one set per OC48 REGENR circuit pack be ordered. If FC-type or SC-type connectors are used, an additional 0 dB lightguide build-out is provided in the set to be placed on the OUT position to provide the FC or SC connector interface. All factory- equipped OC48 REGENR circuit packs come with two *ST*-type 0 dB lightguide build-outs. The 39B2, 39C2, 39J2, 39R2, 39S2 OC48 REGENR circuit packs have a new build-out block on their faceplate and require List 116, List 126, or List 136 only.

Lightguide Build-Out Set Worksheet

Select lightguide build-out sets from the following table.

Table 7-20. Ordering Repeater Bay Lightguide Build-Outs

REGENR CIRCUIT PACK	List Number	Connector Types	Kit Values	Qty. Ordered
39B2 (1.3 STD)	J68974E1 L-116	*ST*	5 db, 10 db, 15 db, 20 db, 1 each	
	J68974E1 L-126	FC	5 db, 10 db, 15 db, 20 db, 1 each 0 db, 2 each	
	J68974E1 L-136	SC	5 db, 10 db, 15 db, 20 db, 1 each 0 db, 2 each	

Single-Mode Lightguide Jumper Cable Description for All Bays

A single-mode lightguide jumper is required for each TRMTR, RCVR, and REGENR ordered. A pair of single-mode or multimode lightguide jumpers is required for each OC3 circuit pack ordered with OC-3 or IS-3 applications, respectively. Single-mode lightguide jumpers may be ordered based on length and connector interface.

FC to FC and SC to SC lightguide jumpers or multimode jumpers can be ordered from the *Fiber Optic Products* catalog, Select Code 2492C. To order, call technical assistance 1-800-344-0223. ("PC" indicates the low-reflection polish that is needed for the FT-2000 OC-48 Lightwave System.)

⚠️ **CAUTION:**
In selecting the ST, FC, or SC lightguide jumpers, be certain that the strain relief boots associated with the jumpers are not of a length that will interfere with the closing of the shelf front cover. This length from the ferrule tip to the end of the boot on the connector should not exceed 2.3 inches; otherwise, an interference could occur. The Lucent Technologies lightguide jumpers are compatible with this dimension.

Lightguide Jumper Cables Worksheet

Order lightguide jumper cables for all bays using Table 7-21*.

.

Table 7-21.   Ordering Lightguide Jumper Cables Dual Bay and Repeater Bay

End 1 to End 2	Length (Feet)	Cable Code†	Comcode	Qty.
ST to ST	10	FS1EP-EP-10	107149536	
	25	FS1EP-EP-25	107149539	
	50	FS1EP-EP-50	107149601	
	100	FS1EP-EP-100	107149627	
	As Req'd.	FS1EP-EP-xxx	107149486	
ST to Keyed Biconic	10	FS1EP-K-10	107216020	
	25	FS1EP-K-25	107216053	
	50	FS1EP-K-50	107216111	
	100	FS1EP-K-100	107216202	
	As Req'd.	FS1EP-K-xxx	107310385	
SC to SC	As Req'd.	LS1SC-SC-xxx	106470495	
SC to D4	As Req'd.	LS1SC-D4-xxx	106470503	
SC to D4PC	As Req'd.	LS1SC-DP-xxx	106470586	
FC to FC	As Req'd.	LS1FP-FP-xxx	106470446	
FC to D4PC	As Req'd.	LS1FP-DP-xxx	106470453	
FC to SC	As Req'd.	LS1FP-SC-xxx	106470461	
ST to Biconic	As Req'd.	FS1E-A-xxx	106470834	
ST to D4	As Req'd.	FS1EP-D4-xxx	107310435	
ST to D4PC	As Req'd.	FS1E-DP-xxx	106470867	
ST to FC	As Req'd.	FS1EP-FC-xxx	107310401	
ST to FC	As Req'd.	FS1E-FP-xxx	106470883	
ST to SC	As Req'd.	FS1E-SC-xxx	106470891	

*   Check the latest issue of the *Fiber Optic Products* catalog, Select Code 2492C, for the latest ordering information. Call 1-800-344-0223 for assistance.

†   Replace the "xxx" at the end of the Cable Code with the desired cable length.

**Optional -48 V Input Power Cabling Description for
the Repeater Bay**

Use the information below to select the appropriate power cable.

■   For an overhead 9-foot high bay or 11.5-foot high bay cable racking installation, order List 107 power cables. List 107 consists of one ED9C103-20, Group 21 and one ED9C103-20, Group 22 cable. These cables are approximately 8.5 feet long.

■   For raised floor installations, order List 108 power cables. List 108 consists of one ED9C103-20, Group 2 and one ED9C103-20, Group 3 cable. These cables are approximately 15 feet long.

■   For other applications, instead of using the ED9C103-20, Group 5 and 6 cable assemblies provided, for the

— Repeater Bay, order two ED9C103-20, Group 1 power cable assemblies to their working length.

Electrical Line Build-Out Description for the Dual Bay

Electrical line build-outs may be required to be connected in series with the transmit LS INTFC cable connections depending on the application, cable type, and cable length associated with that particular LS INTFC cable. This relationship is summarized in the following table. The LBO must be installed as indicated based on the actual cable length (or equivalent measured signal level) for each transmit cable. Refer to Chapter 10, "Technical Specifications" for information about electrical line build-out specifications.

Electrical Line Build-Outs Worksheet

Table 7-22 shows the electrical line build-out based on length and type of coaxial cable. Each 9824AG-Type provides three electrical build-outs for use with short lengths of intra-office coaxial cables carrying DS3 signals.

Table 7-22.   Electrical LBO

Description	Comcode	Quantity Ordered
Electrical Line Build-Out, 9824AG-Type	105776579	

Software and Documentation

This topic describes software and documentation that can be ordered and provides worksheets to assist in ordering for the all bays.

Software and Documentation Description for the Dual Bay

Table 7-23 provides information necessary to order software and documentation for the Dual Bay.

Table 7-23.   FT-2000 J68974ES-2 Software and Documentation

J68974ES-2 List No. or Comcode		Description
main	L-1	Release 7.2.5-ADR Software
main	L-4	R9.0-ADR Software
main	L-5	R9.1-ADR Software
sub	L-M1R	Application Software Right-to-Use Fee (Release 7.2.5)
sub	L-P1R	Operating System Software Right-to-Use Fee (Release 7.2.5)
sub	L-M4R	Application Software Right-to-Use Fee (Release 9.0)
sub	L-P4R	Operating System Software Right-to-Use Fee (Release 9.0)
sub	L-M5R	Application Software Right-to-Use Fee (Release 9.1)
sub	L-P5R	Operating System Software Right-to-Use Fee (Release 9.1)
sub	L-A	*FT-2000 OC-48 Lightwave System User/Service Manual* (Release 7.2)
sub	L-D	*FT-2000 OC-48 Lightwave System User/Service Manual* (Releases 8.1 through 9.0)
sub	L-F	*FT-2000 OC-48 Lightwave System User/Service Manual* (Release 9.1)

Software and Documentation Worksheet (Dual Bay)

Use Table 7-24 to order FT-2000 OC-48 Add/Drop-Rings Terminal bay for initial software installation and initial documentation together.

Table 7-24. Ordering FT-2000 OC-48 Add/Drop-Rings Terminal Bay Software (J68974ES-2)

Release	List No. or Comcode	Application Right to Use Fee List	Operating Right to Use Fee List	User/Service Manual List	User/Service Manual CD Rom List
7.2.5	1	M1R	P1R	A	
9.0	4	M4R	P4R	C	D
9.1	5	M5R	P5R	F	D

Replacement or Backup Copies (Dual Bay)

Table 7-25 provides information to order replacement software on floppies for the Dual Bay. Only Release 7.0.1 and above apply to the Dual Bay.

Table 7-25. Ordering Replacement or Backup Copies of Terminal Bay Software On Floppies

Release	Programmed 3 1/2" Floppies	
	CIT-PC & Install	**Generic & Data**
7.2.5	108491971	
9.0	108361437	
9.1	108614363	

Table 7-26 provides information to order replacement software on digital audio tape (DAT) for the Dual Bay. Only Release 9.0 and above apply.

Table 7-26. Ordering Replacement or Backup Copies of Terminal Bay Software On Digital Audio Tape

Release	Programmed Digital Audio Tape (DAT)
9.0	108399973
9.1	108686692

The Software Release Description is shipped with the FT-2000 software. It is also available on CD-ROM. For ordering information, see the "Electronic Documents" section in "About This Document."

⇒ NOTE:

DAT tape is used to download software via the ITM-SNC.

Software and Documentation Description for the Repeater Bay

Floppy diskette sets include 3.5-inch floppies. Spare *User/Service Manual*s (365-575-102) may be ordered from the Lucent Technologies Customer Information Center using the nine-digit document number. Refer to the "About This Document" Section for more document ordering information.

Table 7-27 describes Repeater Bay orderable software and documentation.

Table 7-27.   FT-2000 J68974RS-1 Software and Documentation

J68974RS-1 List No.		Description
main	5	R6.0.1-RPTR Software (STD)
sub	M5R	Application Software Right-to-Use Fee
sub	P5R	Operating System Software Right-to-Use Fee
sub	C	*FT-2000 OC-48 Lightwave System User/Service Manual*

Software and Documentation Worksheet (Repeater Bay)

Use Table 7-28 and the J68974RS to order Repeater Bay software and Table 7-29 to order documentation.

Table 7-28.   Ordering Repeater Bay Software (J68974RS-1)

Release	Initial Software and Documentation Ordered Together			
	List No.	Application Software Right-to-Use Fee List	Operating System Right-to-Use Fee List	User/Service Manual List
6.0.1	5	M5R	P5R	C

Table 7-29 provides information to order replacement or backup copies of Repeater Bay software and documentation. These items must be ordered separately.

Table 7-29.   Ordering Replacement or Backup Copies of Repeater Bay Software and Documentation

Release	Software Release Description	User/Service Manual	Programmed 3 1/2" Floppies	
			CIT-PC & Install	Generic & Data
6.0.1	107889644	365-575-102	107889669	

Upgrades

This section provides the upgrade information for the FT-2000 OC-48 Lightwave System. The information is organized by platform, A-Bay and D-Bay. For more information about upgrades, please contact your Account Executive.

A-Bay (J68974A-1) Upgrades

This section provides guidelines for upgrading FT-2000 OC-48 Terminals to be Add/Drop-Rings Terminals with OC-3 DCC capability. Terminals to be upgraded can be either 1x1 End Terminals or Add/Drop-Rings Terminals.

Orderable Terminal Upgrades

Figure 7-7 identifies the possible upgrade paths for the J68974A-1 bay. Table 7-30 describes the contents of each upgrade kit.
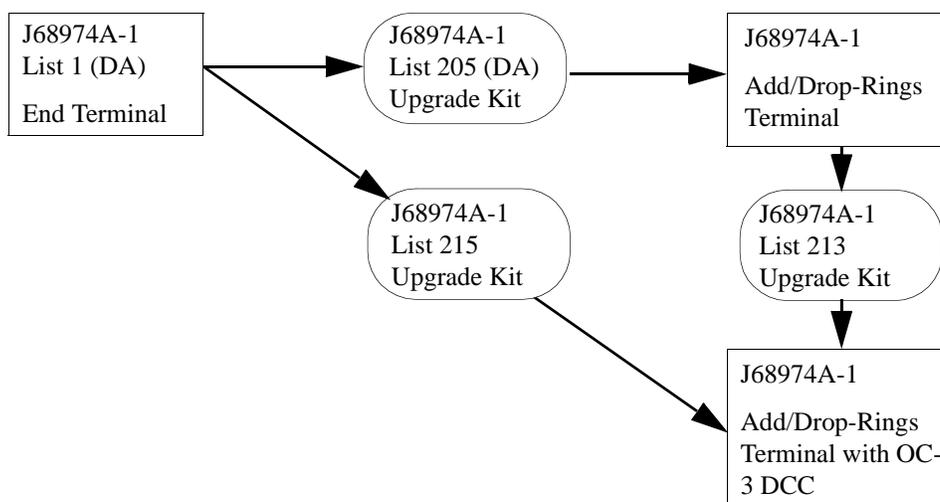
Figure 7-7.   Upgrade Paths for A-Bay (J68974A-1) Terminals

Table 7-30.   Description of A-Bay Upgrade Kit Contents

Type of Upgrade	Upgrade Kit	Material Included
Ring to Ring	J68974A-1, List 213	Provides cables, hardware, and labels to convert a J68974A-1 Add/Drop-Rings Terminal to be functionally equivalent to a J68974E-1, List 5 Add/Drop-Rings Terminal that supports the OC-3 DCC capability when OC-3 circuit packs and the TOHCTL are installed.
Point-to-Point to Ring	J68974A-1, List 215	Provides cables, hardware, and labels to convert a J68974A-1, L1 End Terminal to be functionally equivalent to a J68974E-1, List 5 Add/Drop-Rings Terminal that supports the OC-3 DCC capability when OC-3 circuit packs and the TOHCTL are installed.

Ordering Software Upgrades for the Dual Bay (D-Bay)

Use Table 7-31 below to order software upgrades and documentation together for the Dual Bay. The first column shows which product release you want to upgrade to (7.2.5 through 9.1). The second column shows which product release you want to upgrade from.

Table 7-31.   Ordering FT-2000 OC-48 Add/Drop-Rings Terminal Bay Software Upgrades (J68974ES-2)

Upgrading To (Release No.)	Upgrading From (Release No.)	List No. or Comcode	Application Right to Use Fee List	Operating Right to Use Fee List	User/Service Manual List	Qty.
7.2.5	3.0.1	1	M1S	P1S	A	
	4.0.0	1	M2S	P2S	A	
	4.1.0	1	M3S	P3S	A	
	5.0.1, 5.0.2, 5.0.3	1	M4S	P4S	A	
	6.0.0, 6.0.1, 6.0.2	1	M5S	P5S	A	
	7.0.1, 7.0.3	1	M6S	P6S	A	
	7.1.0	1	M7S	P7S	A	
9.0	3.0.1 through 6.0.2	4	N4S	Q4S	C	
	7.0.1 through 7.2.5	4	N5S	Q5S	C	
	8.1.1	4	N6S	Q6S	C	
9.1	3.0.1 through 6.0.2	5	N7S	Q7S	F	
	7.0.1 through 7.2.5	5	N8S	Q8S	F	
	8.0.0 through 9.0.0	5	N9S	Q9S	F	

▌ Ordering Software Upgrades for the Repeater Bay

Use Table 7-32 and the J68974RS to order Repeater bay upgrade software.

Table 7-32.   Ordering Repeater Bay Software (J68974RS-1)

Release Upgrade	Upgrade Software for the Repeater Bay				
	List No.	Application Software Right-to-Use Fee List	Operating System Right-to-Use Fee List	User/Service Manual List	Qty
4.0.0 TO 6.0.1	5	M5S	P5S	C	

Upgrades Worksheet

Use Table 7-33 (form) below to select items to order upgrades.

Table 7-33.   FT-2000 OC-48 BAY   (UPGRADE TO 2-FIBER RING) Worksheet

Description/Action	Choice	Comcode	Reference
Engineered by: (Check One) Lucent Technologies _____ Customer _____			
Upgrade 1X1 End Terminal (Ring Ready L3 to L5)			
Enter List No. from tables	_____		
Enter Relay Rack Number (optional)	_____		
Software Required	(YES/NO) _____		Table 7-31
Enter Release No. or "latest"	_____		
Low-Speed Circuit Packs	(YES/NO) _____		
SYSCTL LAA23B		106916687	
LNCTL LAA28		106281082	
OC-48 Transmitters & Receivers			
RCVR (A/D) (839B4B)	QTY Ordered _____	107781973	
RCVR (A/D STS-1) (839B5)	QTY Ordered _____	107477457	
RCVR (A/D STS-1) (839E5)	QTY Ordered _____	107933434	Table 7-34
TRMTR (A/D OC-12c 1.3 STD) (739B4)	QTY Ordered _____	107275828	
TRMTR (A/D STS-1 OC-12c 1.3 STD) (739B5)	QTY Ordered _____	107428310	
TRMTR (A/D STS-1 OC-12c 1.3 HI PERF) (739C5)	QTY Ordered _____	107428336	
TRMTR (A/D STS-1 OC-12c 1.5 LBA, W1) (739R5)	QTY Ordered _____	107567646	
TRMTR (A/D STS-1 OC-12c 1.5 LBA, W2) (739S5)	QTY Ordered _____	107567653	
TRMTR (A/D OC12c 1.5 STD) (739J4)	QTY Ordered _____	107275844	
TRMTR (A/D STS-1 OC-12c 1.5 STD) (739J5)	QTY Ordered _____	107428344	
TRMTR (A/D STS-1 OC-12c 1.5 LBA) (739P5)	QTY Ordered _____	107428351	
TRMTR (A/D STS-1 OC-12c 1.5 W1) (739E1)	QTY Ordered _____	106079684	
TRMTR (A/D STS-1 OC-12c 1.5 W2) (739E2)	QTY Ordered _____	107430688	
TRMTR (A/D STS-1 OC-12c 1.5 W3) (739E3)	QTY Ordered _____	107430696	
TRMTR (A/D STS-1 OC-12c 1.5 W4) (739E4)	QTY Ordered _____	107430704	
TRMTR (A/D STS-1 OC-12c 1.5 W5) (739E5)	QTY Ordered _____	107430712	
TRMTR (A/D STS-1 OC-12c 1.5 W6) (739E6)	QTY Ordered _____	107430720	
TRMTR (A/D STS-1 OC-12c 1.5 W7) (739E7)	QTY Ordered _____	107430738	

Table 7-33.   FT-2000 OC-48 BAY   (UPGRADE TO 2-FIBER RING) Worksheet — *Continued*

Description/Action	Choice	Comcode	Reference
TRMTR (A/D STS-1 OC-12c 1.5 W8) (739E8)	QTY Ordered _____	107430746	
TRMTR (A/D STS-1 OC-12c 1.5 W1) (739G1)	QTY Ordered _____	106079700	
TRMTR (A/D STS-1 OC-12c 1.5 W2) (739G2)	QTY Ordered _____	107974099	
TRMTR (A/D STS-1 OC-12c 1.5 W3) (739G3)	QTY Ordered _____	107974107	
TRMTR (A/D STS-1 OC-12c 1.5 W4) (739G4)	QTY Ordered _____	107974115	
TRMTR (A/D STS-1 OC-12c 1.5 W5) (739G5)	QTY Ordered _____	107974123	
TRMTR (A/D STS-1 OC-12c 1.5 W6) (739G6)	QTY Ordered _____	107974131	
TRMTR (A/D STS-1 OC-12c 1.5 W7) (739G7)	QTY Ordered _____	107974149	
TRMTR (A/D STS-1 OC-12c 1.5 W8) (739G8)	QTY Ordered _____	107974156	
TRMTR (A/D STS-1 OC-12c 1.5 W1) (739H1)	QTY Ordered _____	106079718	
TRMTR (A/D STS-1 OC-12c 1.5 W2) (739H2)	QTY Ordered _____	108620584	
TRMTR (A/D STS-1 OC-12c 1.5 W3) (739H3)	QTY Ordered _____	108620618	
TRMTR (A/D STS-1 OC-12c 1.5 W4) (739H4)	QTY Ordered _____	108620634	
TRMTR (A/D STS-1 OC-12c 1.5 W5) (739H5)	QTY Ordered _____	108620667	
TRMTR (A/D STS-1 OC-12c 1.5 W6) (739H6)	QTY Ordered _____	108620691	
TRMTR (A/D STS-1 OC-12c 1.5 W7) (739H7)	QTY Ordered _____	108620709	
TRMTR (A/D STS-1 OC-12c 1.5 W8) (739H8)	QTY Ordered _____	108620717	
TRMTR (A/D STS-1 OC-12c 1.5 W9) (739H9)	QTY Ordered _____	108620733	
TRMTR (A/D STS-1 OC-12c 1.5 W10) (739H10)	QTY Ordered _____	108620758	
TRMTR (A/D STS-1 OC-12c 1.5 W11) (739H11)	QTY Ordered _____	108620774	
TRMTR (A/D STS-1 OC-12c 1.5 W12) (739H12)	QTY Ordered _____	108620790	
TRMTR (A/D STS-1 OC-12c 1.5 W13) (739H13)	QTY Ordered _____	108620816	
TRMTR (A/D STS-1 OC-12c 1.5 W14) (739H14)	QTY Ordered _____	108620840	
TRMTR (A/D STS-1 OC-12c 1.5 W15) (739H15)	QTY Ordered _____	108620865	
TRMTR (A/D STS-1 OC-12c 1.5 W16) (739H16)	QTY Ordered _____	108620881	
7A WDM Filter Assembly(ies) or Filter Assembly Shelf(ves) Required	(YES/NO) _____ QTY Ordered _____		Table 7-41

Lightguide Jumpers
 	
    Single Mode
 	
    Multimode (for OC3 circuit
    pack with IS-3 interface)
 	
    Type: ST-ST
 	
           FC-FC
 	
           SC-SC
 	
           Other (Specify Type)
	
	(LENGTH) _____FT.
	QTY Ordered _____
	
	(LENGTH) _____FT.
	QTY Ordered _____
	
	(YES/NO) _____
	
	(YES/NO) _____
	
	(YES/NO) _____
	
	_____
			Table 7-21

Table 7-33.   FT-2000 OC-48 BAY   (UPGRADE TO 2-FIBER RING) Worksheet — *Continued*

Description/Action	Choice	Comcode	Reference
Lightguide Build-outs Required	QTY Ordered _____	L___	
Type: SC	(YES/NO) _____		Table 7-19
ST	(YES/NO) _____		
FC	(YES/NO) _____		

Spares

This section provides sparing information for the FT-2000 OC-48 Lightwave System. The information is organized in the following two formats:

- Tables — They provide sparing information in tables with the number of spares recommended for the number of bays in service.

- Graphs — They provide sparing information in the form of graphs. An example using the graphs is included.

To order spare parts (and/or upgrade equipment), use

- Table 7-34 and Table 7-35 (hardware)

- J68974ES-2, or J68974DS-1 (software)

Sparing Tables

The following tables provide sparing information with the number of spares recommended for the number of bays in service. Select spares using the codes (for example, Comcodes, *CLEI*[4]*codes*, or ED-type codes) from Table 7-34 and Table 7-35. These tables assume a 64-day lead time.

Items ordered as Main List 1 are shipped together as one order. Orders placed with Comcodes, ED, or *CLEI* codes generate separate orders.

When ordering transmitters and receivers for use with FT-2000 OC-48 Add/Drop-Rings Terminal Release 7 or higher software, choose from the following:

- transmitters: 739B4, 739B5, 739C5, 739J4, 739J5, 735P5, 739R5, 739S5

- receivers: 839B4B or 839B5

When ordering transmitters and receivers for use with FT-2000 OC-48 Add/Drop-Rings Terminal for Release 7.2 and higher with DWDM capability, choose from these:

- transmitters: 739E1-8, 739G1-8

- receivers: 839E5

Receivers 839B4B, 839B5, and 839E5 are OC-12c compatible.

If you plan to use the FT-2000 as a timing source for DDM-2000s, you need to order ED8C724-22. Group 29 or Group 30 cables. For ordering information about these cables, refer to the *DDM-2000 Multiplexer Applications, Planning, and Ordering Guide (*363-206-200*)*.

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4. COMMON LANGUAGE is a registered trademark and CLEI, CLLI, CLCI, and CLFI are trademarks of Bell Communications Research, Inc.

Table 7-34.   Ordering Spare Plug-Ins

Code	Description	CLEI (1)	Comcode	# of Spares Recommended					Qty
				1-5 Bays	6-10 Bays	11-15 Bays	16-20 Bays	21-25 Bays	
LAA2	DS3 Ckt. Pack	SNCLG0XA	106829559	3	4	5	6	6	
LAA4	STS1E	SNCLZJOA	106033202	3	4	5	6	6	
LA10	OC3 Ckt. Pack	SNLZDOA	106033269	4	5	6	8	9	
LAA10B‡	OC3 Ckt. Pack	SNCCACABAA	108337478	4	5	6	8	9	
LAA5	IS3 Ckt. Pack	SNC3ZU0AAA	106033210	4	5	6	8	9	
T939A	OC12 Ckt. Pack	SNI2N00BAA	107508152	3	3	4	4	4	
LAA12B	LSSW Ckt. Pack	SNCLFLOA	107792988	2	3	3	3	3	
LAA26	TOHCTL Ckt. Pack	SNCL300A	106281066	2	2	2	2	3	
LAA18	TG3 Ckt. Pack	SNPQARBA	106053903	2	3	3	3	3	
LAA21	OHCTL Ckt. Pack	SNPQAHFA	106690597	2	2	2	2	3	
LAA23B	SYSCTL Ckt. Pack	SNPQAVCA	106916687	2	2	2	3	3	
LAA25	SYSMEM Ckt. Pack	SNPQWA1A	106053978	2	2	2	3	3	
LAA28	LNCTL Ckt. Pack	SNPQARCA	106281082	2	2	3	3	3	
839B4B	OC48 RCVR (A/D)	SNTRZ80C	107781973	3	3	4	4	4	
839B5	OC48 RCVR (A/D STS-1)	SNC3BD0A	107477457	3	3	4	4	4	
839E5	OC48 RCVR (A/D STS-1)	SNR14Y0A	107933434	3	3	4	4	4	
739B4	OC48 TRMTR (A/D OC-12c 1.3 STD)	SNRTEE0A	107275828	3	3	4	4	5	

(Sheet 1 of 6)

Table 7-34.   Ordering Spare Plug-Ins — *Continued*

Code	Description	CLEI (1)	Comcode	# of Spares Recommended					Qty
				1-5 Bays	6-10 Bays	11-15 Bays	16-20 Bays	21-25 Bays	
739B5	OC48 TRMTR (A/D STS-1 OC-12c 1.3 STD)	SNRT7E0A	107428310	3	4	4	5	5	
739C5	OC48 TRMTR (A/D STS-1 OC-12c 1.3 HI PERF)	SNRT700A	107428336	3	4	4	5	5	
739J4	OC48 TRMTR (A/D OC12c 1.5 STD)	SNRTED0A	107275884	3	3	4	4	5	
739J5	OC48 TRMTR (A/D STS-1 OC-12c 1.5 STD)	SNTXXH0A	107428344	3	4	4	5	5	
739P5	OC48 TRMTR (A/D STS-1 OC-12c 1.5 LBA)	SNTXX0JA	107428351	3	4	4	5	5	
739R5	OC48 TRMTR (A/D STS-1 OC-12c 1.5 LBA, W1)	SNTXXZHA	107567646	3	4	4	5	5	
739S5	OC48 TRMTR (A/D STS-1 OC-12c 1.5 LBA, W2)	SNTXX60A	107567653	3	4	4	5	5	
739E1	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W1)	SNRT707A	106079684	3	4	4	5	5	
739E2	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W2)	SNRT708A	107430688	3	4	4	5	5	
739E3	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W3)	SNRT800A	107430696	3	4	4	5	5	

(Sheet 2 of 6)

Table 7-34.   Ordering Spare Plug-Ins — *Continued*

Code	Description	CLEI (1)	Comcode	# of Spares Recommended					Qty
				1-5 Bays	6-10 Bays	11-15 Bays	16-20 Bays	21-25 Bays	
739E4	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W4)	SNTXXOHA	107430704	3	4	4	5	5	
739E5	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W5)	SNTXX30A	107430712						
739E6	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W6)	SNTXXE0A	107430720	3	4	4	5	5	
739E7	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W7)	SNTXX40A	107430738	3	4	4	5	5	
739E8	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W8)	SNTXX50A	107430746	3	4	4	5	5	
739G1	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W1)	SNT4AAAA	106079700	3	4	4	5	5	
739G2	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W2)	SNT4AABA	107974099	3	4	4	5	5	
739G3	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W3)	SNT4AADA	107974107	3	4	4	5	5	
739G4	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W4)	SNT4AACA	107974115	3	4	4	5	5	

(Sheet 3 of 6)

Table 7-34.   Ordering Spare Plug-Ins — *Continued*

Code	Description	CLEI (1)	Comcode	1-5 Bays	6-10 Bays	11-15 Bays	16-20 Bays	21-25 Bays	Qty
						# of Spares Recommended			
739G5	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W5)	SNT4AAEA	107974123	3	4	4	5	5	
739G6	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W6)	SNT4AAFA	107974131	3	4	4	5	5	
739G7	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W7)	SNT4AAGA	107974149	3	4	4	5	5	
739G8	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W8)	SNT4AAHA	107974156	3	4	4	5	5	
739H1	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W1)	SN54BV0AAA	106079718	3	4	4	5	5	
739H2	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W2)	SN54BW0AAA	108620584	3	4	4	5	5	
739H3	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W3)	SN5BX0AAA	108620618	3	4	4	5	5	
739H4	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W4)	SN5BY0AAA	108620634	3	4	4	5	5	
739H5	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W5)	SN5BZ0AAA	108620667	3	4	4	5	5	

(Sheet 4 of 6)

Table 7-34.   Ordering Spare Plug-Ins — *Continued*

Code	Description	CLEI (1)	Comcode	# of Spares Recommended					Qty
				1-5 Bays	6-10 Bays	11-15 Bays	16-20 Bays	21-25 Bays	
739H6	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W6)	SN5B10AAA	108620691	3	4	4	5	5	
739H7	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W7)	SN54B20AAA	108620709	3	4	4	5	5	
739H8	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W8)	SN54B0AAAA	108620717	3	4	4	5	5	
739H9	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W9)	SN54B0BAAA	108620733	3	4	4	5	5	
739H10	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W10)	SN54B0CAAA	108620758	3	4	4	5	5	
739H11	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W11)	SN54BODAAA	108620774	3	4	4	5	5	
739H12	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W12)	SN54B0EAAA	108620790	3	4	4	5	5	
739H13	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W13)	SN54B0FAAA	108620816	3	4	4	5	5	
739H14	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W14)	SN54B0GAAA	108620840	3	4	4	5	5	
739H15	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W15)	SN54B0HAAA	108620865	3	4	4	5	5	

(Sheet 5 of 6)

Table 7-34. Ordering Spare Plug-Ins — *Continued*

Code	Description	CLEI (1)	Comcode	# of Spares Recommended					Qty
				1-5 Bays	6-10 Bays	11-15 Bays	16-20 Bays	21-25 Bays	
739H16	OC48 TRMTR (A/D STS-1 OC-12c 1.5 W16)	SN54B0JAAA	108620881	3	4	4	5	5	
LAA14	OW Ckt. Pack	SNC3IT0A	106033319	2	2	2	2	2	
39B2*	OC48 REGENR (1.3 STD)	SNPQAVEA	106916695	3	3	4	4	4	
39C2†	OC48 REGENR (1.3 HI PERF)	SNPQAVDA	106916703	3	3	4	4	4	
39J2	OC48 REGENR (1.5 STD)	SNTRFDEC	107003402	3	3	4	4	4	
39R2	OC48 REGENR (1.5 LBA, W1)	SNRXDF0A	107551244	3	3	4	4	4	
39S2	OC48 REGENR (1.5 LBA, W2)	SNRXDG0A	107551251	3	3	4	4	4	

(Sheet 6 of 6)

*The 39B2 OC48 REGENR circuit pack replaced the 39B1 OC48 REGENR circuit pack, which was rated Discontinued Availability.

†The 39C2 OC48 REGENR circuit pack replaced with the 39C1 OC48 REGENR circuit pack, which was rated Discontinued Availability.

‡The LAA10B circuit pack is backward compatible with LAA10, supporting mixed LAA10B/LAA10 operation. For more information, refer to the "Low-Speed Circuit Pack Descriptions" in the Dual Bay section of this chapter.

Spare Hardware Descriptions

The information in Table 7-35 describes the spare hardware that is available through either comcodes, CLEI codes, or ED-type codes.

Table 7-35.   Ordering Spare Equipment

Code	Description	Comcode	List No.	Qty
FS1EP-K-10	10 Ft. *ST*-Keyed Biconic Jumper	107216020		
FS1EP-K-25	25 Ft. *ST*-Keyed Biconic Jumper	107216053		
FS1EP-K-50	50 Ft. *ST*-Keyed Biconic Jumper	107216111		
982SB	PWR ON LED Ckt. Board	106197635	205	
1186A	Power FilterCkt. Board	106206543	207	
-	LBO Set (*ST* Conn.)	-	116	
-	LBO Set (FC Conn.)	-	126	
-	LBO Set (SC Conn.)	-	136	
-	LBO Set (*ST* Conn.)	-	117[*]	
-	LBO Set (FC Conn.)	-	127	
-	LBO Set (SC Conn.)	-	137	
9824AG	Electrical LBO	105776579	109	
	Apparatus Blank (3/4 in.) Req'd. for Dual Bay	847012564	-	
	Apparatus Blank (1 in.) Req'd. for Dual Bay	847012556	-	
179E	Apparatus Blank (2 1/4 in.) Req'd. for Dual Bay	106566334	-	
179H	Apparatus Blank (4 1/2 in.) Req'd. for Dual Bay	106566367	-	
FS1EP-EP-10	10 Ft. *ST-ST* Jumper	107149536		
FS1EP-EP-25	25 Ft. *ST-ST* Jumper	107149539		
FS1EP-EP-50	50 Ft. *ST-ST* Jumper	107149601		
FS1EP-EP-10	100 Ft. *ST-ST* Jumper	107149627		
FS1EP-EP-xxx	ST-ST Jumper, length as Req'd.	107149486		
FS1EP-K-10	10 Ft. *ST*-Keyed Biconic Jumper	107216020		
FS1EP-K-25	25 Ft. *ST*-Keyed Biconic Jumper	107216053		
FS1EP-K-50	50 Ft. *ST*-Keyed Biconic Jumper	107216111		
FS1EP-K-100	100 Ft. *ST*-Keyed Biconic Jumper	107216202		
FS1EP-K-xxx	ST-Keyed Biconic Jumper, length as req'd.	107310385		

(Sheet 1 of 2)

Code	Description	Comcode	List No.	Qty
LS1SC-SC-xxx	SC-SC Jumper, length as req'd.	106470495		
LS1SC-D4-xxx	SC-D4 Jumper, length as req'd.	106470503		
LS1SC-DP-xxx	SC-D4PC Jumper, length as req'd.	106470586		
LS1FP-FP-xxx	FC-FC Jumper, length as req'd.	10647446		
LS1FP-DP-xxx	FC-D4PC Jumper, length as req'd.	106470453		
LS1FP-SC-xxx	FC-SC Jumper, length as req'd.	10640461		
FS1EP-D4-xxx	*ST*-D4 Jumper, length as req'd.	107310435		
FS1E-DP-xxx	*ST*-D4PC Jumper, length as req'd.	106470867		
FS1EP-FC-xxx	*ST*-FC Jumper, length as req'd.	107310401		
FS1E-FP-xxx	*ST*-FC Jumper, length as req'd.	106470883		
FS1E-SC-xxx	*ST*-SC Jumper, length as req'd.	106470891		
ED6G994-30, G-11	Spare User Panel		203	
982SB	PWR ON LED Circuit Board.	106197635	202	
1186A	Power Filter Circuit Board	106206543	204	
	Spare Fan Assembly (Req'd. for D-Bay)	407612449		
	Air Filter Replacement (Req'd. for D-Bay)	407644640		
	Fan Fuse, 3 amps (Req'd. for D-Bay)	997942305		

(Sheet 2 of 2)

*List 117 is only necessary for long reach OC-3 applications and IS-3 interfaces.

The transmitters and receivers for Release 7 and higher are described in the "Enhanced High-Speed Shelf Circuit Pack Descriptions" section earlier in this chapter.

Equipment	Description
Circuit Packs	Use the "D-1" drawing section to help decide how many of each circuit pack will be required for a particular application.
Lightguide Build-Outs and Jumpers	Refer to the Cables tab for more information.
Fan, Fan Assembly, and Air Filter	The fan assembly air filter must be replaced every 6 months or whenever dirty. A fan assembly for spare/replacement.
Line Build-Out BNC Tool	A tool to make electrical line build-out BNC rearrangements on the interconnection panel of the low-speed Shelf may be obtained from: Trumpeter Electronics (818) 707-2020 Part Number:RT1L, BNC Tool
PWR ON LED Circuit Board	This circuit board is part of the ED6G994-30 User/Filter Panel Assembly and contains the power on LED.
User Panel	This is an equipment assembly (User/Filter Panel) that contains the alarm LEDs, designations, and the 7-segment displays.
Power Filter Circuit Board	This circuit board is part of the ED6G994-30 User/Filter Panel Assembly and provides power filtering. There is one circuit board for each power feeder (A and B).

Sparing Graphs

This section provides guidelines to help you determine how many spare circuit packs to order. Use Table 7-36, Figure 7-8 and Figure 7-9 to determine how many spare circuit packs to order to maintain 99.9% service-continuity, given 10-day and 64-day lead times. If you need ordering guidelines for 1-, 2-, 3-, and 5-day lead times or need more information on circuit pack spares, please contact your local Account Executive.

Lead time (also known as turn-around time) is defined as the elapsed time from when a circuit pack (CP) is known to fail at a given service location to when a repaired CP (or new CP) arrives at the location where spare CP are stocked (centralized or local) to maintain a CP spare level consistent with the CP population in service.

Lead time should not be confused with Mean Time To Repair (typically 2 to 4 hours) which is the time elapsed from when a CP is known to fail in service to when a spare CP is placed in service to replace the failed CP.

The procedure in the table below describes how to use the sparing graphs. FIT is failures in one billion hours (10^9 hours).

Step	Action	Example
1	Determine the circuit pack FIT rate using Table 7-36.	The CP FIT rate for SYSCTL (LAA23B) is 1373.
2	Select the chart corresponding to either 10- or 64-day lead times.	Figure 7-8 or Figure 7-9.
3	Select the curve that represents the nearest circuit pack FIT rate using the chart.	The nearest curve for a FIT rate of 1373 is 1000.
4	Follow the curve to the intersection with the vertical line that represents the number of circuit packs in service at a given location.	View the intersection where there are 30 circuit packs in service and the lead time is 64 days.
5	Notice that the horizontal line immediately above the intersection represents the minimum number of circuit pack spares recommended for that location.	If there are 30 circuit packs in service, the lead time is 64 days, and the FIT rate is 1373, order 3 replacement (spare) circuit packs.

 Table 7-36 indicates the CP FIT rates used to determine the amount of circuit packs needed. The information is based on the Reliability Information Notebook (RIN), 7th Edition, August 1995.

Table 7-36.   CP FIT Rates (RIN)

Description	Code	FIT
DS3	LAA2B	2633
STS1E	LAA4	2340
OC3	LAA10 or LAA10B[*]	2739
IS3	LAA5	2402
OC12	T939A	6312
LSSW	LAA12	5908
LSSW	LAA12B	5908
TG3	LAA18	2804
OHCTL (TERM)	LAA21	2028
OHCTL (TERM)	LAA22	2000
SYSCTL	LAA23B	3400
SYSMEM	LAA25	7200
TOHCTL	LAA26	2500
LNCTL	LAA28	2329
OC48 TRMTR (A/D OC-12c 1.3 STD)	739B4	7022
OC48 TRMTR (A/D STS-1 OC-12c 1.3 STD)	739B5	8014
OC48 TRMTR (A/D STS-1 OC-12c 1.3 HI PERF)	739C5	8014
OC48 TRMTR (A/D OC12c 1.5 STD)	739J4	7022
OC48 TRMTR (A/D STS-1 OC-12c 1.5 STD)	739J5	8014
OC48 TRMTR (A/D STS-1 OC-12c 1.5 LBA)	739P5	8014
OC48 TRMTR (A/D STS-1 OC-12c 1.5 LBA, W1)	739R5	8014
OC48 TRMTR (A/D STS-1 OC-12c 1.5 LBA, W2)	739S5	8014
OC48 TRMTR (A/D STS-1 OC-12c 1.5 W1-8)	739E1-8	8514
OC48 TRMTR (A/D STS-1 OC-12c 1.5 W1-8)	739G1-8	8514
OC48 TRMTR (A/D STS-1 OC-12c 1.5 W1-16)	739H1-16	8514
OC48 RCVR (A/D)	839B4B	3623
OC48 RCVR (A/D STS-1)	839B5	3460

(Sheet 1 of 2)

Table 7-36.   CP FIT Rates (RIN) — *Continued*

Description	Code	FIT
OC48 RCVR (A/D STS-1)	839E5	1180
OW	LAA14	1000
OC48 REGENR (1.3 STD)	39B2	8000
OC48 REGENR (1.3 HI PERF)	39C2	8000
OC48 REGENR (1.5 STD)	39J2	8000
OC48 REGENR (1.5 LBA, W1)	39R2	8000
OC48 REGENR (1.5 LBA, W2)	39S2	8000

(Sheet 2 of 2)

*LAA10B circuit pack is backward compatible with LAA10, supporting mixed
LAA10B/LAA10 operation. For more information, see "Low-Speed Circuit
Pack Descriptions" in the Dual Bay section of this chapter.
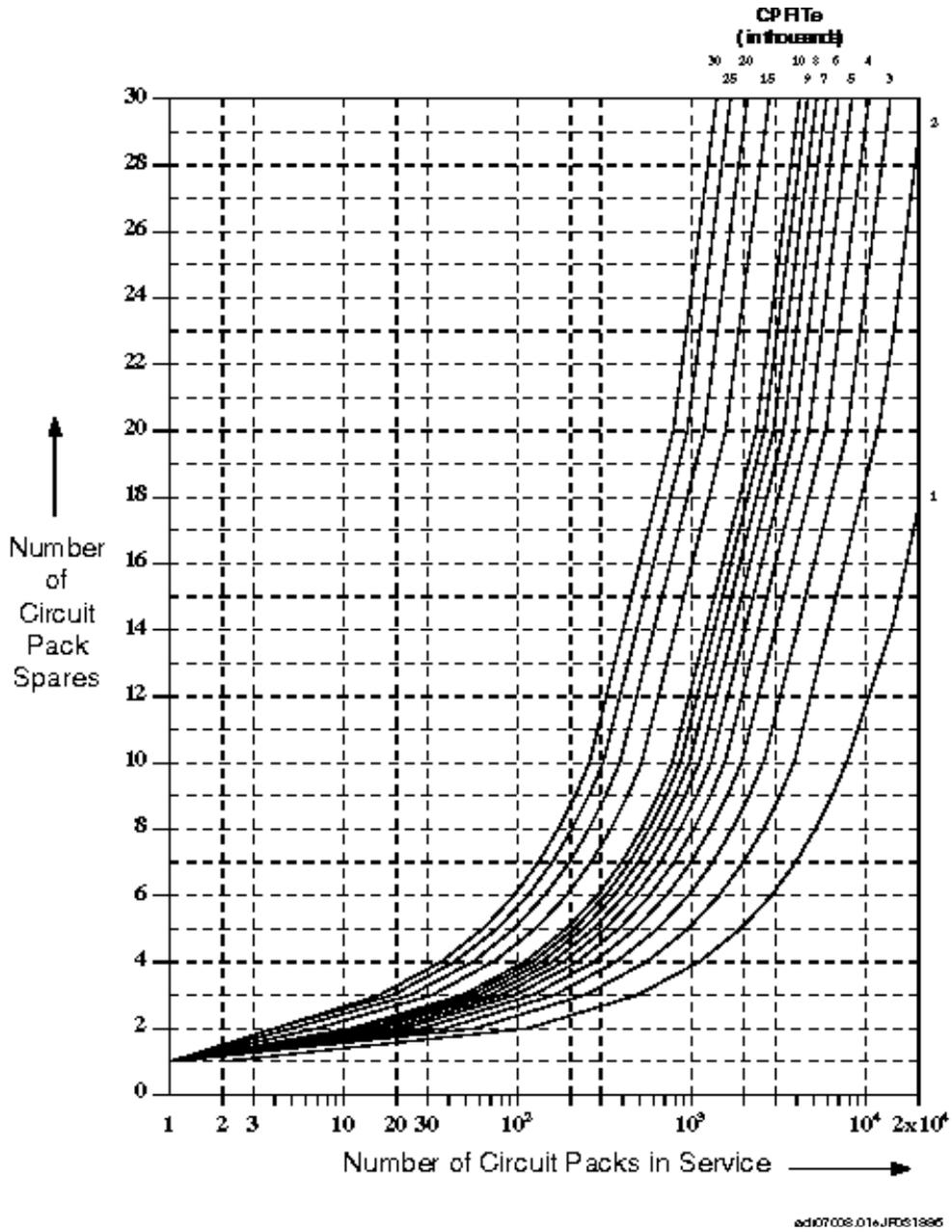
Figure 7-8.   Circuit Pack Sparing Chart — 10-Day Lead Time
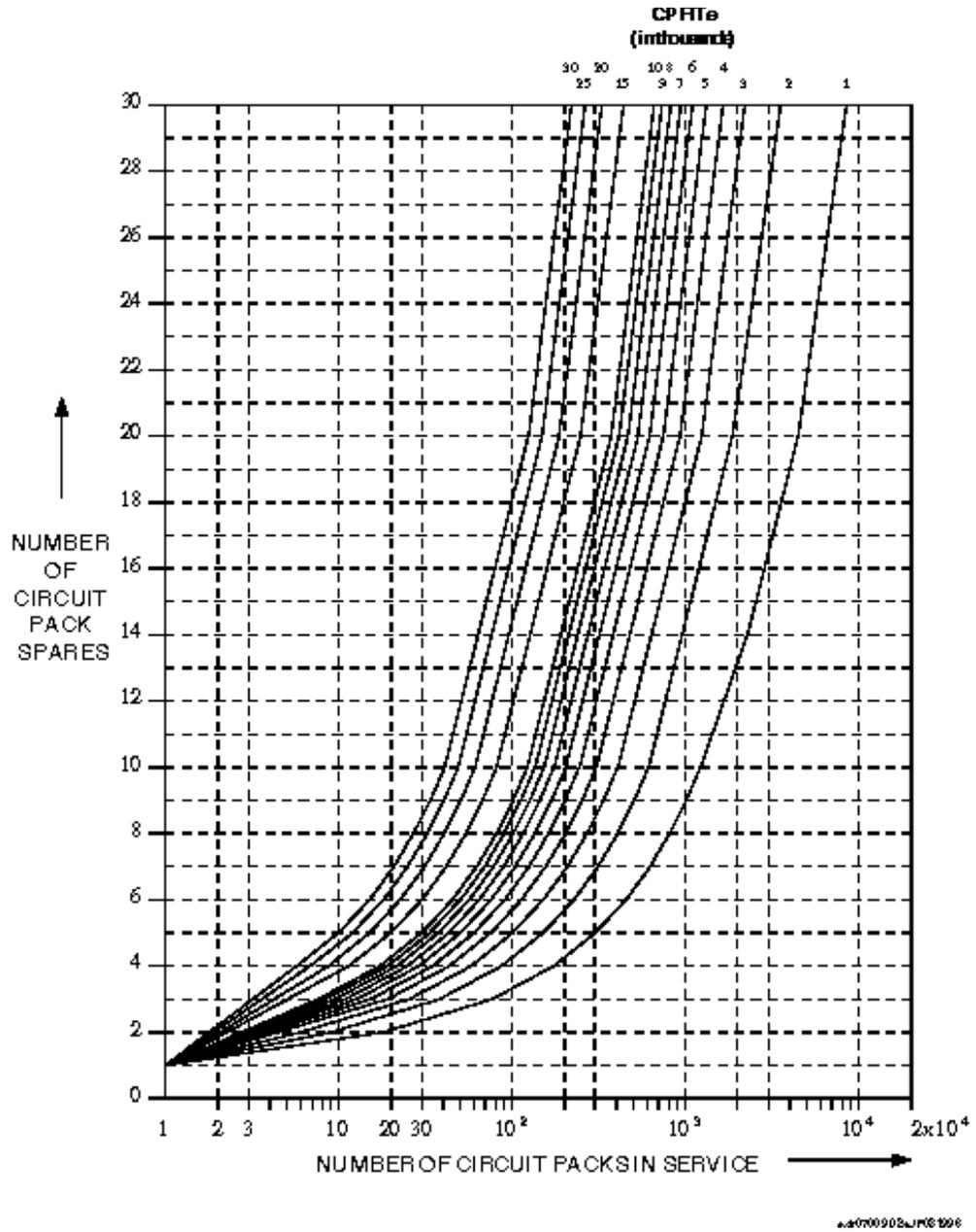
Figure 7-9.   Circuit Pack Sparing Chart — 64-Day Lead Time

365-575-100
Ordering

Related Framework

This section is provided for your convenience as an overview to FT-2000 framework. This document cannot be used, however, for ordering framework. To order framework for the FT-2000, please refer to *Seismic Network Bay Frame Application, Planning and Ordering Guide (065-215-200)*.

The FT-2000 OC-48 Lightwave System provides front access for all office and user interfaces. The FT-2000 OC-48 Add/Drop-Rings Terminal for 2-Fiber Rings requires access to the rear of the bay only during equipment upgrades. Upgrades to the FT-2000 OC-48 Repeater Bay do not require access to the rear of the bay.

120 V AC power is needed near the bay to be able to use a PC or charge a portable PC.

The following tables (Table 7-37, Table 7-38, Table 7-39, and Table 7-40) identify ordering information for recommended cable racking systems, rack covers, end guards, and rack interface baffles for 7-foot network bay frameworks.

Table 7-37.   Recommended Cable Racking System and Associated Line-Up Rack Covers

Cable Racking System	Recommended FT-2000 Applications	Line-Up Rack Cover (Soft Blue)	
		Length	Ordering Code
ED97868-50* Digital Cableway System	Overhead Cable Racking Installation or Line-Up Rack Only for Raised Floor Installation	2'2"	ED97868-50,G101
		4'4"	Not Available
		6'6"	ED97868-50,G103
ED8C610-50 Network Cable Management System	Overhead Cable Racking Installation Engineered to Comply with NEBS Cable Pathways Plan	9'8"	ED8C610-50,G18 ED8C610-50,G19
ED8C612-50,G18 Fiber Protection Systems	Overhead Power, Cable Racking and Fiber Protection	(variable)	ED8C612-70

*Digital Cableway Line-Up Rack is recommended for raised floor installations.

Table 7-38. 7-Foot EIS and Seismic Line-Up End Guards[*][†]

Order Code	Apparatus Cutouts				Application	
	AC Outlet	Light SW	Fuse HLDR	ALM LAMP	Adjacent to Cross Aisle	Adjacent to Wall
ED8C802-50, G1	N	N	N	N	Y	Y
G2	Y	Y	N	N	Y	Y
G3	Y	Y	Y	Y	Y	Y

*Refer to Seismic Network Bay Frame Application, Planning and Ordering Guide (065-215-200) for additional framework information.

†See the "Seismic End Guard Extenders" table below.

The following table provides framework extender ordering information.

Table 7-39. Bay Extender Ordering Information

ED8C800-51 Seismic Network Bay Framework	
Drawing	Description
ED8C804-51,G1	1'0" Extender
ED8C804-51,G2	1'8" Extender
ED8C804-51,G3	2'0" Extender
ED8C804-51,G4	3'6" Extender
ED8C804-51,G5	4'6" Extender
ED8C804-51,G6	4'8" Extender

The following table provides framework end guard extender ordering information.

Table 7-40. Seismic End Guard Extenders

Drawing	Description
ED8C802-50,G10	1'0"
ED8C802-50,G11	1'8"
ED8C802-50,G12	2'0"
ED8C802-50,G13	3'6"
ED8C802-50,G14	4'6"
ED8C802-50,G15	4'8"

Installation Guide, Seismic Network Bay Frame (065-215-250), provides installation instructions for the above-mentioned equipment, and Drawing ED8C800-70 provides additional information for Seismic bays. For additional framework information, refer to *Seismic Network Bay Frame Application, Planning and Ordering Guide* (065-215-200).

Related Products

This section provides information on ordering related products.

FT-LBA Equipment

For complete details about the FT-Lightwave Booster Amplifier (FT-LBA), including ordering information, please refer to the Lucent Technologies Practice *Digital Transmission Systems FT-Lightwave Booster Amplifier Description, Engineering, Installation, and Maintenance* (365-565-500).

7A WDM Filter Assemblies and WDM Filter Shelf Assembly

Use the information presented in Table 7-41 to order 7A WDM Filter Assemblies and the associated mounting shelf assembly. The shelf assembly has slots to accommodate up to 12 WDM Filter Assemblies and has mounting hole centers for installation in a Seismic Network Bay frame. The filter assemblies are equipped with captive screws for securing them in the shelf assembly frame.

Table 7-41.   7A WDM Filter Assembly and Filter Shelf Assembly

Comcode or Dwg. No.	Qty.	Description
106967409	1	7A WDM Filter Assembly. Includes six 0 dB LBOs, one 10 dB LBO
ED2C706-30, G50	1	WDM Filter Shelf Assembly

Equipment for Applications That Use the FT-2000 OC-3 Interface to Connect to the DDM-2000 IS-3 Interface

You can connect the FT-2000 OC-48 Lightwave System Add/Drop-Rings Terminals and DDM-2000 Multiplexers through their respective OC-3 and IS-3 interfaces. Ordering information for the FT-2000 OC-3 interface (LAA10) appears later in this chapter. For engineering and ordering information about the IS-3 interface application, refer to the *DDM-2000 Multiplexer Applications, Planning, and Ordering Guide* (363-206-200).

DANTEL Orderwire Equipment

Orderwire equipment for use in the FT-2000 OC-48 Lightwave System is available to furnish either voice or voice and remote CIT access capabilities.

The comcode 406682278 *DANTEL* Orderwire Shelf (Table 7-41) furnishes a voice-only orderwire capability.

Table 7-42.   Voice-Only Orderwire Shelf (406682278)

DANTEL Part No.	Qty.	Description
A18-04588-02	1	*DANTEL* Orderwire Shelf (voice only)

The *DANTEL* Orderwire Shelf for voice and remote CIT access (part of kit 847593522, listed in Table 7-43) provides voice communication and supports remote maintenance access to Add/Drop-Rings terminals and repeater terminals over the SONET section orderwire.   An external modem (202T, 4-wire) required for use with the remote CIT access orderwire shelf is provided in the kit. The cable required to interconnect the modem and the remote CIT access shelf is supplied with the modem. In order to connect the CIT-PC to the external modem, you must use an RS-232 cable. Orderwire shelves do not mount in an FT-2000 bay. They are miscellaneously mounted.

Equipment required to provide orderwire capability for one interface for voice and remote CIT access applications is available in a kit. The items in the kit are explained in Table 7-43 and provides everything necessary to replace an existing voice-only orderwire shelf with a voice/remote CIT access orderwire shelf and modem. If this is a new orderwire shelf installation, section orderwire cables and a CIT-DTE cable are also required and must be ordered separately. These cables are listed in the footnote to Table 7-43.

⇒ **NOTE:**

> Remote CIT access for repeater terminals is supported by Release 6.0 and later of FT-2000 OC-48 Add/Drop-Rings Terminal, Dual Bay, and Repeater Bay software.

Table 7-43.   Voice and Remote CIT Access Orderwire Shelf Kit (847593522)[*]

Comcode	Part No.	Description	Qty.
407386697	A18-05547-01	*DANTEL* Orderwire Shelf for voice; remote CIT access.	1
407423284	62025197-202T	Modem, 202T, 4-Wire Data (Motorola Inc.). Converts RS232 to 4-wire.	1
407403265	EL08M-4	Cable, RJ45/8-pin Modular, 4 ft. (Black Box Corp.). Provides 4-wire connection between the Orderwire Assembly and the 202T Modem.	1

Table 7-43.   Voice and Remote CIT Access Orderwire Shelf Kit (847593522)[*] — *Continued*

Comcode	Part No.	Description	Qty.
407426287	62005083	Rack Adaptor, 19-inch (Motorola Inc.). Rack adaptor for a single 202T Modem.	1
407430834	SPADAT	Bracket, Mounting (Internet, Inc.). Brackets for mounting 19-inch Rack Adaptor for 202T Modem to a 23-inch bay.	2
-	-	Mounting Hardware, 8 No. 12 screws, 4 No. 12 nuts. Hardware for attaching the Mounting Brackets to the Rack Adaptor and the Rack Adaptor to the bay frame.	-

*The following cables are also required if this is a new orderwire installation:

   — Cables, Section OW (X and Y). ED7G001-22, Group 401, Length — as required Qty. - 2. Connects from ADR Terminal or Repeater Interconnection Panel to *DANTEL* Orderwire Shelf.

   — Cable, CIT (DTE). ED7G001-22, Group 702, Length — as required, Qty. — 1. Connects from ADR Terminal or Repeater Interconnection Panel to *DANTEL* Orderwire Shelf.

CPro-2000 Description

The FT-2000 OC-48 Lightwave System Add/Drop-Rings Terminal also works with CPro-2000. CPro is a graphical *Microsoft*[5] *Windows*[6]-based tool that simplifies and mechanizes entering of TL1 commands to provision and manage the FT-2000 OC-48 Lightwave System and support DDM-2000 FiberReach, OC-3, and OC-12.

For more information about CPro, refer to the *SNC-2000 CPro User Manual* (190-523-101).

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5. *Microsoft* is a registered trademark of Microsoft Corporation.
6. *Windows* is a registered trademark of Microsoft Corporation.

CPro-2000 Worksheet

Table 7-44 provides information to order CPro-2000 equipment. The CPro-2000 User Manual is included with Group 1.

Table 7-44.   CPro-2000 Software Ordering Blank

Equipment Code	Release	Description	Qty.
ED-8C793-30, G1, M1R, P1R	R3.0	New System Software	
ED-8C793-30, G1, M1S, P1S	R3.0	Release 3.0 upgrade from 2.X	
ED-8C793-31, G1, M1R, P1R	R4.0	New System Software	
ED-8C793-31, G1, M1S, P1S	R4.0	Release 4.0 upgrade from 3.X	
ED-8C793-31, G1, M1X, P1X	R4.0	Release 4.0 upgrade from 2.X	
ED-8C793-32, G1, M1R, P1R	R5.0	New System Software	
ED-8C793-32, G1, M1S, P1S	R5.0	Release 5.0 upgrade from 4.X	
ED-8C793-32, G1, M1X, P1X	R5.0	Release 5.0 upgrade from 3.X	
ED-8C793-32, G1, M1Y, P1Y	R5.0	Release 5.0 upgrade from 2.X	
ED-8C793-33, G1, M1R, P1R	R6.0	New System Software	
ED-8C793-33, G1, M1S, P1S	R6.0	Release 6.0 upgrade from 5.X	
ED-8C793-33, G1, M1X, P1X	R6.0	Release 6.0 upgrade from 4.X	
ED-8C793-33, G1, M1Y, P1Y	R6.0	Release 6.0 upgrade from 3.X	
ED-8C793-33, G1, M1Z, P1Z	R6.0	Release 6.0 upgrade from 2.X	
ED-8C793-33, G1, M2R, P2R	R6.1	New System Software	
ED-8C793-33, G1, M2S, P2S	R6.1	Release 6.1 upgrade from 6.0	
ED-8C793-33, G1, M2X, P2X	R6.1	Release 6.1 upgrade from 5.X	
ED-8C793-33, G1, M2Y, P2Y	R6.1	Release 6.1 upgrade from 4.X	
ED-8C793-33, G1, M2Z, P2Z	R6.1	Release 6.1 upgrade from 3.X	
ED-8C793-33, G1, M2B, P2B	R6.1	Release 6.1 upgrade from 2.X	
ED-8C793-34, G1, M1R, P1R	R7.0	New System Software	
ED-8C793-34, G1, M1S, P1S	R7.0	Release 7.0 upgrade from 6.0	
ED-8C793-34, G1, M1X, P1X	R7.0	Release 7.0 upgrade from 5.X	
ED-8C793-34, G1, M1Y, P1Y	R7.0	Release 7.0 upgrade from 4.X	
ED-8C793-34, G1, M1Z, P1Z	R7.0	Release 7.0 upgrade from 3.X	
ED-8C793-34, G1, M1B, P1B	R7.0	Release 7.0 upgrade from 2.X	

Table 7-44. CPro-2000 Software Ordering Blank

Equipment Code	Release	Description	Qty.
ED-8C793-34, G1, M1C, P1C	R7.0	Release 7.0 upgrade from 6.1	
ED-8C793-35, G1, M1R, P1R	R8.0	New System Software	
ED-8C793-35, G1, M1S, P1S	R8.0	Release 8.0 upgrade from 7.x	
ED-8C793-35, G1, M1X, P1X	R8.0	Release 8.0 upgrade from 6.1	
ED-8C793-35, G1, M1Y, P1Y	R8.0	Release 8.0 upgrade from 6.0	
ED-8C793-35, G1, M1Z, P1Z	R8.0	Release 8.0 upgrade from 5.X	
ED-8C793-35, G1, M1B, P1B	R8.0	Release 8.0 upgrade from 4.X	
ED-8C793-35, G1, M1C, P1C	R8.0	Release 8.0 upgrade from 3.x	
ED-8C793-35, G1, M1D, P1D	R8.0	Release 8.0 upgrade from 2.x	
ED-8C793-36, G1, M1D, P1D	R9.0	New System Software	
ED-8C793-36, G1, M1S, P1S	R9.0	Release 9.0 upgrade from 8.x	
ED-8C793-36, G1, M1X, P1X	R9.0	Release 9.0 upgrade from 7.x	
ED-8C793-36, G1, M1Y, P1Y	R9.0	Release 9.0 upgrade from 6.1	
ED-8C793-36, G1, M1Z, P1Z	R9.0	Release 9.0 upgrade from 6.0	
ED-8C793-36, G1, M1B, P1B	R9.0	Release 9.0 upgrade from 5.x	
ED-8C793-36, G1, M1C, P1C	R9.0	Release 9.0 upgrade from 4.x	
ED-8C793-36, G1, M1D, P1D	R9.0	Release 9.0 upgrade from 3.x	
ED-8C793-36, G1, M1E, P1E	R9.0	Release 9.0 upgrade from 2.x	
ED-8C793-37, G1, M1R, P1R	R10.0	New System Software	
ED-8C793-37, G1, M1S, P1S	R10.0	Release 10.0 upgrade from 9.x	
ED-8C793-37, G1, M1X, P1X	R10.0	Release 10.0 upgrade from 8.x	
ED-8C793-37, G1, M1Y, P1Y	R10.0	Release 10.0 upgrade from 7.x	
ED-8C793-37, G1, M1Z, P1Z	R10.0	Release 10.0 upgrade from 6.2	
ED-8C793-37, G1, M1B, P1B	R10.0	Release 10.0 upgrade from 6.1	
ED-8C793-37, G1, M1C, P1C	R10.0	Release 10.0 upgrade from 6.0	
ED-8C793-37, G1, M1D, P1D	R10.0	Release 10.0 upgrade from 5.x	

Table 7-44.   CPro-2000 Software Ordering Blank

Equipment Code	Release	Description	Qty.
ED-8C793-37, G1, M1E, P1E	R10.0	Release 10.0 upgrade from 4.x	
ED-8C793-37, G1, M1F, P1F	R10.0	Release 10.0 upgrade from 3.x	
ED-8C793-37, G1, M1G, P1G	R10.0	Release 10.0 upgrade from 2.x	

Compatibility

The tables in this section list the slot/circuit pack/software compatibility as well as the equipment/software compatibility for the following FT-2000 platforms.

■ FT-2000 OC-48 Dual Lightwave Terminating Bay (D-Bay)

■ FT-2000 OC-48 Repeater Bay (R-Bay)

FT-2000 OC-48 Add/Drop-Rings Terminal Slot/Circuit Pack/Software Compatibility

Table 7-45, Table 7-46, and Table 7-47 respectively show the FT-2000 Add/Drop-Rings Terminal slot/circuit pack/software compatibility for the

■ Low-Speed Shelf – System Controller

■ Enhanced and Condensed High-Speed Shelf

■ High-Speed Shelf

> **NOTE:**
> Not all compatible circuit packs may be for sale when a specific software generic is introduced.

Table 7-45. FT-2000 OC-48 Add/Drop-Rings Terminal Low-Speed Shelf – System Controller Slot/Circuit Pack/Software Compatibility[*]

Slot	Supported Pack Codes	Software Generic						
		R3.0.1 - ADR	R4.0.0 - ADR	R4.1.0- ADR	R5.0.1- ADR	R5.0.3- ADR	R6.0.2- ADR	Release 7.0.1 - ADR through R9.1
LS INTFC 1A-4B[†]	LAA2, S1:1	0 - 8	0	0	0	0	0	0
	LAA2, S4:4	0 - 8	0 - 8	0 - 8	0 - 8	0 - 8	0 - 8	0 - 8
	LAA4	0	0 - 8	0 - 8	0 - 8	0 - 8	0 - 8	0 - 8
	LAA5	0	0	0	0	0	0	0 - 8
	LAA10 or LAA10B[¶]	0	0	0	0 - 8	0 - 8	0 - 8	0 - 8
	T939A	0	0	0	0	0	0	0 - 4
LS INTFC P1, P2[‡]	LAA2, S1:1	0 or 1	0	0	0	0	0	0
	LAA2, S4:4	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1
	LAA4	0	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1
	LAA5	0	0	0	0	0	0	0 - 8
	LAA10 or LAA10B	0	0	0	0	0	0	0
	T939A	0	0	0	0	0	0	0 - 4

Table 7-45.   FT-2000 OC-48 Add/Drop-Rings Terminal Low-Speed Shelf – System Controller Slot/Circuit Pack/Software Compatibility[*] — *Continued*

Slot	Supported Pack Codes	Software Generic						
		R3.0.1 - ADR	R4.0.0 - ADR	R4.1.0- ADR	R5.0.1- ADR	R5.0.3- ADR	R6.0.2- ADR	Release 7.0.1 - ADR through R9.1
LSSW IN, OUT[**]	LAA12	0 or 2	0 or 2	0 or 2	0 or 2	0 or 2	0 or 2	0 or 2
TOHCTL	LAA26	0	0	0	0	0	0 or 1	0 or 1
TG 1, 2[††]	LAA17	2	2	2	2	2	2	2
	LAA18	2	2	2	2	2	2	2
LS INTFC 5A-8B[†]	LAA2, S1:1	0 - 8	0	0	0	0	0	0
	LAA2, S4:4	0 - 8	0 - 8	0 - 8	0 - 8	0 - 8	0 - 8	0 - 8
	LAA4	0	0 - 8	0 - 8	0 - 8	0 - 8	0 - 8	0 - 8
	LAA5	0	0	0	0	0	0	0 - 8
	LAA10 or LAA10B[¶]	0	0	0	0 - 8	0 - 8	0 - 8	0 - 8
	T939A	0	0	0	0	0	0	0 - 4
SYSCTL	LAA23B	1	1	1	1	1	1	1
SYSMEM	LAA25	1	1	1	1	1	1	1

*This compatibility table is for the:

 J68974D-1: List 1, List 2, List 200 upgrade bay

 J68974A-1: List 1 with List 215 upgrade bay

†Any combination of circuit packs totaling between 0 and 8, inclusive, is allowed. LAA10 (OC3) circuit packs must be equipped in pairs in adjacent slots (for example, 1A and 1B) if OC-3 line protection is desired. If OC-3 line protection is not desired, either slot of a slot pair may be equipped with the LAA10 or LAA10B circuit pack; the other slot of the slot pair can be equipped with any other low-speed circuit pack.

‡Required only if protection of the electrical low-speed circuit packs (for example, LAA2 and LAA4) is desired. If an electrical low-speed circuit pack in LS INTFC slots 1A - 8B is to be protected, a circuit pack of the same code must be inserted in one of these slots.

**Required only if protection of either electrical LS circuit packs code is desired.

††Two of either of the listed codes is required.

¶ LAA10B circuit pack is backward compatible with LAA10, supporting mixed LAA10B/LAA10 operation. For more information, refer to "Low-Speed Circuit Pack Descriptions" in the Dual Bay section of this chapter.

Table 7-46. FT-2000 OC-48 Add/Drop-Rings Terminal Enhanced and Condensed High-Speed Shelf Slot/Circuit Pack/Software Compatibility*

Slot	Supported Pack Codes	Software Generic				
		R3.0.1 -ADR through R6.0.2 -ADR	Release 7.0.1 - ADR	Release 7.0.3 - ADR	Release 7.1.0- ADR	Release 7.2.3 - ADR through R9.1 - ADR
TRMTR 1W†	739B4	0	1	1	1	1
	739J4	0	1	1	1	1
	739B5	0	1	1	1	1
	739C5	0	1	1	1	1
	739J5	0	1	1	1	1
	739P5	0	1	1	1	1
	739R5‡	0	1	1	1	1
	739S5‡	0	1	1	1	1
	739E1-8	0	0	0	0	1
	739G1-8	0	0	0	0	1
	739H1-16	0	0	0	0	1
RCVR 1W	839B4B	0	1	1	1	1
	839B5	0	1	1	1	1
	839E5§	0	0	0	0	1
TRMTR 1E†	739B4	0	1	1	1	1
	739J4	0	1	1	1	1
	739B5	0	1	1	1	1
	739C5	0	1	1	1	1
	739J5	0	1	1	1	1
	739P5	0	1	1	1	1
	739R5‡	0	1	1	1	1
	739S5‡	0	1	1	1	1
	739E1-8	0	0	0	0	1
	739G1-8	0	0	0	0	1
	739H1-16	0	0	0	0	1
RCVR 1E	839B4B	0	1	1	1	1
	839B5	0	1	1	1	1
	839E5§	0	0	0	0	1
LNCTL 1W	LAA28	1	1	1	1	1
OHCTL 1W	LAA21	1	1	1	1	1
OHCTL 1E	LAA21	1	1	1	1	1
OECTL 1W	-	-	-	-	-	-
OECTL 1E	-	-	-	-	-	-

* This compatibility table is for the J68974D-1: use List 1, List 2, or List 200 up-grade bay.

† One of any of the listed codes is required

‡ The 739R5 and 739S5 circuit packs are used in WDM/LBA and FT-LBA applications.

§ The 839E5 receiver is optimized for operation in the 1.5 um band for WDM applications using E(1-8) and G(1-8) type transmitters. The 839E5 receiver will also work with all other FT-2000 transmitters.

The ()B2 transmitters and receivers have been rated discontinued availability (DA). However, by contacting your Account Executive, replacement for B2 optical packs may still be obtained.

Table 7-47. FT-2000 OC-48 Add/Drop-Rings Terminal High-Speed Shelf Slot/Circuit Pack/Software Compatibility[*]

Slot	Supported Pack Codes	Software Generic				
		R3.0.1 -ADR through R6.0.2 -ADR	Release 7.0.1 - ADR	Release 7.0.3 - ADR	Release 7.1.0 - ADR	Release 7.2.3 -ADR through R9.1- ADR
TRMTR 1W†	739B4	0	1	1	1	1
	739J4	0	1	1	1	1
	739B5	0	1	1	1	1
	739C5	0	1	1	1	1
	739J5	0	1	1	1	1
	739P5	0	1	1	1	1
	739R5‡	0	1	1	1	1
	739S5‡	0	1	1	1	1
	739E1-8	0	0	0	0	1
	739G1-8	0	0	0	0	1
	739H1-16	0	0	0	0	1
RCVR 1W	839B4B	0	1	1	1	1
	839B5	0	1	1	1	1
	839E5§	0	0	0	0	1
LNCTL 1W	LAA28	1	1	1	1	1
OHCTL 1W	LAA22	1	1	1	1	1
OHCTL 1E	LAA21	1	1	1	1	1
TRMTR 1E	739B4	0	1	1	1	1
	739J4	0	1	1	1	1
	739B5	0	1	1	1	1
	739C5	0	1	1	1	1
	739J5	0	1	1	1	1

Table 7-47. **FT-2000 OC-48 Add/Drop-Rings Terminal High-Speed Shelf Slot/Circuit Pack/Software Compatibility*** — *Continued*

Slot	Supported Pack Codes	Software Generic				
		R3.0.1 -ADR through R6.0.2 -ADR	Release 7.0.1 - ADR	Release 7.0.3 - ADR	Release 7.1.0 - ADR	Release 7.2.3 -ADR through R9.1- ADR
	739P5	0	1	1	1	1
	739R5‡	0	1	1	1	1
	739S5‡	0	1	1	1	1
	739E1-8	0	0	0	0	1
	739G1-8	0	0	0	0	1
	739H1-16	0	0	0	0	1
RCVR 1E	839B4B	0	1	1	1	1
	839B5	0	1	1	1	1
	839E5§	0	0	0	0	1

* This compatibility table is for the J68974A-1, List 1 with List 215 upgrade bays.

†One of any of the listed codes is required.

‡The 739R5 and 739S5 circuit packs are used in WDM/LBA and FT-LBA applications.

§ The 839E5 receiver is optimized for operation in the 1.5 um band for WDM applications using E(1-8) and G(1-8) type transmitters. The 839E5 receiver will also work with all other FT-2000 transmitters.

The ()B2 transmitters and receivers have been rated discontinued availability (DA). However, by contacting your Account Executive, replacement for B2 optical packs may still be obtained.

FT-2000 OC-48 Repeater Bay Slot/Circuit Pack/
Software Compatibility

Table 7-48 shows FT-2000 Repeater Bay slot/circuit pack/software compatibility.

Table 7-48. FT-2000 OC-48 Repeater Shelf – System Controller Slot/Circuit Pack/Software Compatibility*

Slot	Supported Pack Codes	Software Generic	
		R4.0.0-RPTR	R6.0.0-RPTR
REGENR 1EW, 1WE†	39B2	0 - 2	0 - 2
	39C2	0 - 2	0 - 2
	39J2	0 - 2	0 - 2
	39R2	-	0 - 2
	39S2	-	0 - 2
ROHCTL 1, P	-	0	0
SYSCTL‡	LAA14 (OW)	-	1
	LAA23	1	1
	LAA23B	1	1
SYSMEM	LAA25	1	1
REGENR PEW, PWE**	39B2	0 - 2	0 - 2
	39C2	0 - 2	0 - 2
	39J2	0 - 2	0 - 2
	39R2	-	0 - 2
	39S2	-	0 - 2

*This compatibility table is for the J68974R-1: List 1, List 10, List 15, List 200 combinations.

†If line 1 is to be equipped, one pack of any of the listed codes is required in each of these slots.

‡One of either type is required.

**If line P is to be equipped, one pack of any of the listed codes is required in each of these slots.

FT-2000 OC-48 Equipment/Software Compatibility

Table 7-49, Table 7-50, and Table 7-51 show the software compatibility of the listed equipment. An X means that the software generic recognizes, maintains, and operates with the piece of equipment.

Note that listed circuit packs may not be for sale when the software generic is introduced

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Table 7-49.   FT-2000 A BAY/Software Compatibility

Drawing (J68974A)		Software Release
List	**Description**	**R3.0.1-ADR through R9.1 -ADR**
L1+L205	L1+2-Fiber Ring Upgrade	X
L1+L205 +L213	L1+Protection Access Upgrade	X
L1+L215	L1+2-Fiber Ring Upgrade	X

Table 7-50.   FT-2000 D BAY/Software Compatibility

Drawing (J68974D)		
List	**Description**	**Release 7.0.1-ADR through R9.1 -ADR**
L1	Dual OC-48 Add/Drop Rings Terminal for 2-Fiber Rings	2X
L2	Single OC-48 Add/Drop Rings Terminal for 2-Fiber Rings (upgrades to dual)	X
L200	Single OC-48 Add/Drop Rings Terminal for 2-Fiber Rings (upgrade for the L2 bay)	X

Table 7-51.   FT-2000 R BAY/Software Compatibility

(J68974R)		Software Generic	
List	**Description**	**R4.0.0 -RPTR**	**R6.0.0 -RPTR**
L1	OC-48 Repeater Bay	X	X
L10	OC-48 Repeater shelf (miscellaneously mounted)	X	X
L1+one L200	L1 + Repeater Shelf-System Controller for One Additional Single Line	X	X

Product Support

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Product Support

8

Overview

This chapter describes how Lucent Technologies supports the FT-2000 OC-48 Lightwave System. This includes engineering and installation services, technical support, documentation support, and training.

Engineering and Installation Services

The Lucent Technologies Customer Technical Support (CTS) organization is committed to providing customers with quality product support services. Whether you need assistance in engineering, installation, normal system maintenance, or disaster recovery, the support staff provides you with the quality technical support you need to get your job done. Each segment of the CTS organization regards the customer as its highest priority and understands your obligation to maintain quality service for your customer.

Within the CTS organization, the Engineering and Installation Services group provides a highly skilled force of support personnel to provide customers with quality engineering and installation services. These engineering and installation specialists use state-of-the-art technology, equipment, and procedures to provide customers with highly competent, rapid response services. These services include analyzing your equipment request, preparing a detailed specification for manufacturing and installation, creating and maintaining job records, installing the equipment, and testing and turning over a working system.

When the CTS organization provides job records and installs the equipment, operationally effective changes to the system are automatically identified and applied at no additional cost.

The Engineering and Installation Services group provides the customer with an individually tailored, quality-tested job that meets our published high standards and operational requirements of the customer. The group ensures that the system order of the customer is integrated into a complete working system tailored to office conditions and preferences. This process provides for the complete needs of the customer. It includes provisions for cabling, lighting, power equipment, and ancillary connections to local and/or remote alarm systems. The group also responds to any customer changes that occur during installation.

All equipment engineered and installed by Lucent Technologies is thoroughly tested and then integrated into a reliable system. Once approved by the Quality Assurance Test group of Lucent Technologies' (the toughest in the industry), the system is turned over to the customer.

The group provides any specialized engineering and installation services required for unusual or highly individualized applications. These specialized services may include engineering consultations and database preparation. Your local Account Executive can provide more information about these services.

Technical Support

Assistance in maintaining your installed system is available through the Regional Technical Assistance Center (RTAC) and the Customer Technical Support (CTS). As shown in Figure 8-1, your single point of contact is the RTAC. RTAC personnel troubleshoot field problems 24 hours a day over the phone and, if necessary, on site. For technical assistance, simply call **1-800-225-RTAC (7822)**. One call guarantees support. You can also call this number to make comments on the FT-2000 OC-48 Lightwave System or to suggest enhancements.

RTAC organizations are supported by a centralized CTS for transmission products. CTS maintains a close relationship with Bell Laboratories and other Lucent Technologies organizations to expedite resolutions and maintain contact with the development community. This association provides continuous accessibility to every phase of a product life cycle and assures prompt resolution of all inquiries.

CTS has converted COACH to a new system — Global Technical Support Information Platform (GTSIP).   This system is used to support all Lucent products worldwide.   The customer interface is web based and requires a standard web browser such as *Netscape*™[1] or *Microsoft*®[2] Internet Explorer.

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1. *Netscape* is a trademark of Netscape Communications Corporation

GTSIP is a system of on-line support providing product news and bulletins, diagnostic services, compatibility information, and on-line documents. GTSIP tools reside on a dedicated time-share computer accessible over toll free lines and are available 24 hours a day, 7 days a week. For information about how to access GTSIP, contact your local Account Executive.

Many transmission products are currently supported by GTSIP, including the FT-2000 OC-48 Lightwave System.

Once connected to GTSIP, the user specifies which product to access and GTSIP grants the appropriate combination of tools and commands. The user reaches each one of these tools and commands through a centralized, menu-driven computer program. Every screen provides help in making appropriate menu selections. GTSIP users achieve proficiency quickly because of the consistency of menu selections among products.

2. *Microsoft* is a registered trademark of Microsoft Corporation

CUSTOMER

Technician
Customer Escalation Procedures
GTSIP Self-Help Tools

RTAC

First Lucent Technologies Contact
Supports Customer
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**LUCENT TECHNOLOGIES
TRANSMISSION CTS**

RTAC Assistance
Problem Diagnosis/Isolation
Provide Solutions/Work Arounds
Consultation

BELL LABORATORIES

Highest Level of Support
Design Modifications or Updates
Enhancements

Figure 8-1.   Levels of Product Support Available

The following GTSIP tools are available to the user:

Tool Name	The Tool's Function
Diagnostic dictionary	The diagnostic dictionary contains histories of previously encountered problems and the descriptions of the solutions or workarounds. Your support staff can use this tool when published documentation or standard diagnostic procedures fail to address a problem. Your support staff is allowed to enter problems and solutions into the customer input area of the diagnostic dictionary. CTS personnel evaluate the data daily and, when appropriate, the data is moved to the general area.
News and bulletins	Immediately after a user logs in to the GTSIP tools, the news and bulletins tool displays bulletins containing urgent information relating to all the user's products. All users are automatically notified about urgent matters such as problems with scheduled releases, recalls of hardware or software, or scheduled maintenance for computer support. Less urgent messages are distributed through news items that can be sent to individuals or categories of users. Notification of news appears on the screen immediately following current bulletins.
Compatibility data	Occasionally, hardware/software configuration problems arise when new software generics are issued. The compatibility data tools permit users to view the correct hardware configuration associated with a specific software generic. The user simply enters the appropriate software generic number and GTSIP responds with page-formatted lists of circuit packs compatible with the selected software generic.
Ordering guides	With the GTSIP ordering guide tool, users can obtain an electronic copy of the latest version of the ordering guide for selected products served by GTSIP tools. This eliminates the time-consuming delays experienced in distributing printed documentation.
GTSIP user guide	GTSIP supplies an on-line user guide that shows how to use the customer support tools and makes note of any changes to the previous version of the guide.

CTS strives to provide proactive, responsive technical support for all its products. Through the combined efforts of the individual customer support groups and through GTSIP tools, CTS provides you with the best possible customer support.

Documentation Support

The Lucent Technologies Bell Labs Innovations Technical Publications organization provides a postage-paid customer comment form in the front of this guide. Please use the form to report errors or make suggestions about the document. If the form is missing, please send or fax your comments to:

> Lucent Technologies Inc.
> Customer Training and Information Products
> Building 21, Room 3A-06
> 1600 Osgood Street
> North Andover, MA 01845
>
> Fax Number: (978) 960-6835

Training

No product offering is complete without a formal training package. The National Product Training Center at Hickory Ridge in Lisle, Illinois, provides management courses for system planning, engineering and ordering, as well as training telecommunications technicians in installation, operations, and maintenance. Suitcasing of these courses is also available. Contact the National Product Training Center at **1-800-TRA-INER** (**1-800-872-4637**) to enroll in training classes. To arrange suitcase sessions, call the Product Training Manager at **1-800 432-6317**.

The following courses are provided by the National Product Training Center:

■ Title: *FT-2000 OC-48 Lightwave System Applications and Architecture*

Number: LW2248

Audience: Fundamental planners, account executives, and private telecommunications network technical consultants

Content: Basic synchronous optical network (SONET) terms, applications (for example, point-to-point, add/drop, rings), architecture (that is, bays, shelves, circuit packs), and operation, administration, maintenance, and provisioning (OAM&P) features.

■ Title: *FT-2000 OC-48 Lightwave System Equipment Engineering and Planning*

Number: LW2348

Audience: Facility planners, outside plant engineers, central office equipment engineers, and private network design engineers

Content: Equipment and cabling specifications for engineering and ordering point-to-point terminals.

■ Title: *FT-2000 OC-48 Add/Drop-Rings Terminal Operations and Maintenance*

Number: LW2616

Audience: Technicians, installers, maintenance engineers, technical support personnel, product evaluators, and anyone desiring operations and maintenance information for the FT-2000 OC-48 Add/Drop-Rings Terminal

Content: Description of initial turnup and day-to-day operations and maintenance tasks. Emphasis on developing

— skills using the installation manual and the user/service manual

— competence performing turnup and day-to-day provisioning and maintenance tasks.

Reliability and Quality

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Contents

Reliability and Quality

9

Overview

Reliability is a key ingredient of the life cycle of the product. It begins at the earliest planning stage and continues into product architecture, design and simulation, documentation, prototypes, testing during development, design change control, manufacturing and product testing (which includes 100% screening), product quality assurance, product field performance, and product field return management.

Each stage of the life cycle of the product relies on people and processes that contribute to product reliability growth with customer satisfaction as the primary goal.

Product development involves the use of critical elements to ensure product reliability and requires the strict adherence to:

- design standards
- design and test practices
- comprehensive qualification programs
- system-level reliability integration
- reliability audits and predictions
- development of quality assurance standards for manufactured products.

Manufacturing and field deployment use the following critical elements to ensure product reliability:

- pre-manufacturing

- qualification

- accelerated product testing

- product screening

- production quality tracking

- failure mode analysis

- feedback and corrective actions.

Independent Quality Representatives are also present at manufacturing locations to ensure Shipped Product Quality.

Reliability Specifications

The following tables list the FT-2000 OC-48 Lightwave System reliability specifications.

Table 9-1lists the DS3/STS1E channel unavailability.

Table 9-1.   DS3/STS1E Channel Unavailability (Hardware Only)

Add/Drop-Rings Terminal for 2-Fiber Rings[*] (equipped with DS3 and/or STS1E interfaces)	0.20 minutes/year per DS3/ STS1E channel
566 mile, 16 node ring (circumference)[†] (DS3/STS1E traversing 9 OC-48 Add/Drop-Rings Terminals)	0.5 minutes/year per DS3/STS1E channel
Operations System Interface Unavailability[*] (FT-2000 OC-48 Add/Drop-Rings Terminal for 2-Fiber Rings)	11.0 minutes/year
Silent Failure Unavailability[*] [FT-2000 OC-48 Add/Drop-Rings Terminal for 2-Fiber Rings (equipped with DS3 and STS1E interfaces)]	0.10 minutes/year per DS3/ STS1E channel

* Based on Method I of the Bellcore Reliability Prediction Procedure for Electronic Equipment, Issue 5, December 1995.

† Assuming one fiber failure event every three years, and an average fiber repair time of three hours.

Table 9-2 lists the mean time between maintenance activities.

Table 9-2. Mean Time* Between Maintenance Activities

FT-2000 OC-48 Add/Drop-Rings Terminal for 2-Fiber Rings (equipped with protected and/or unprotected OC-3 and/or IS-3 interfaces)	43 months
FT-2000 OC-48 Add/Drop-Rings Terminal for 2-Fiber Rings (equipped with protected and/or unprotected OC-12 interfaces)	59 months
FT-2000 OC-48 Add/Drop-Rings Terminal for 2-Fiber Rings (equipped with DS3 and/or STS1E interfaces)	34 months
FT-2000 OC-48 Repeater Bay (one shelf)	109 months
FT-2000 OC-48 Repeater Bay (two shelves)	55 months
FT-2000 OC-48 Repeater Bay (three shelves)	36 months
FT-2000 OC-48 Repeater Shelf	109 months
Mean Time to Repair	≤ 2 hours (includes dispatch, diagnostics, and repair time)
Infant Mortality	≤ 1.5 times the steady state failures/10^9 hours (FIT) as defined in Bellcore TR-418, Issue 2
Product Design Life	25 years

* Based on the Lucent Technologies Reliability Information Notebook, 7th Edition, August 1995.

Table 9-3 shows the OC-3 and IS-3 channel unavailability.

Table 9-3.   OC-3/IS-3 Channel Unavailability[*] (Hardware Only)

Add/Drop-Rings Terminal for 2-Fiber Rings (equipped with protected OC-3/IS-3 interfaces)	0.0005 minutes/year per OC-3/IS-3 channel
Add/Drop-Rings Terminal for 2-Fiber Rings (equipped with unprotected OC-3/IS-3 interfaces)	2.9 minutes/year per OC-3/IS-3 channel
566 mile, 16 node ring (circumference)[†] (OC-3 channel traversing 9 OC-48 Add/Drop-Rings Terminals with protected OC-3/IS-3 interfaces)	.09 minutes/year per OC-3/IS-3 channel
566 mile, 16 node ring (circumference)[*] (OC-3 channel traversing 9 OC-48 Add/Drop-Rings Terminals with unprotected OC-3/IS-3 interfaces)	5.9 minutes/year per OC-3/IS-3 channel
Operations System Interface Unavailability (Add/Drop Rings Terminal for 2-Fiber Rings, equipped with protected and/or unprotected OC-3/IS-3 interfaces)	11.0 minutes/year per OC-3/IS-3 channel
Silent Failure Unavailability (Add/Drop Rings Terminal with 2-Fiber Rings, equipped with protected and/or unprotected OC-3/IS-3 interfaces)	0

  * Based on Method I of the Bellcore Reliability Prediction Procedure for Electronic Equipment, Issue 5, December 1995.

  † Assuming one fiber failure event every three years and an average fiber repair time of three hours.

Table 9-4 lists channel unavailability for the OC-12 interface.

Table 9-4.   OC12 Channel Unavailability * (Hardware Only)

Add/Drop-Rings Terminal for 2-Fiber Rings (equipped with protected OC-12 interfaces)	0.006 minutes/year per OC-12 channel
Add/Drop-Rings Terminal for 2-Fiber Rings (equipped with unprotected OC-12 interfaces)	6.6 minutes/year per OC-12 channel
566 mile, 16 node ring (circumference)* (OC-12 channel traversing 9 OC-48 Add/Drop-Rings Terminals with protected OC-12 interfaces)	.10 minutes/year per OC-12 channel
566 mile, 16 node ring (circumference)* (OC-12 channel traversing 9 OC-48 Add/Drop-Rings Terminals with unprotected OC-12 interfaces)	13.3 minutes/year per OC-12 channel
Operations System Interface Unavailability (Add-Drop Rings Terminal for 2-Fiber Rings equipped with protected and/or unprotected) OC-12 interfaces	11.0 minutes/year per OC-12 channel
Silent Failure Unavailability (Add/Drop-Rings Terminals for 2-Fiber Rings (equipped with protected and/or unprotected OC-12 interfaces)	0

* Assuming one fiber failure event every three years and an average fiber repair time of three hours.

* Based on method 1 of Bellcore Reliability Prediction Procedure for Electronic Equipment, Issue 5, December 1995.

Table 9-5 lists the circuit pack FIT rates for FT-2000 OC-48 Repeaters.

Table 9-5.   CP FIT Rates for Repeaters Per Bellcore RPP

Description	Code	Bellcore RPP* FIT
OW	LAA14	1500
SYSCTL	LAA23B	3400
SYSMEM	LAA25	7200
REGENR (1.3 STD)	39B2	8000

Table 9-5.   **CP FIT Rates for Repeaters Per Bellcore RPP** — *Continued*

Description	Code	Bellcore RPP* FIT
REGENR (1.3 HI PERF)	39C2	8000
REGENR (1.5 STD)	39J2	8000
REGENR (1.5 LBA, W1)	39R2	8000
REGENR (1.5 LBA, W2)	39S2	8000

* Based on Method l of the Bellcore Reliability Prediction Proce-
dure (RPP) for Electronic Equipment, Issue 5, December 1995.

Table 9-6 lists the circuit pack FIT rates for FT-2000 OC-48 Add/Drop-Rings Termi-
nals.

Table 9-6.   **CP FIT Rates for End and Add/Drop Terminals Per Bellcore RPP**

Description	Code	Bellcore RPP* FIT
DS3	LAA2	2633
STS1E	LAA4	2340
IS3	LAA5	2402
OC3	LAA10/ LAA10B†	2739
OC12	T939A	6312
LSSW	LAA12B	5908
TG3	LAA18	2804
OHCTL (TERM)	LAA21	2028
OHCTL (TERM)	LAA22	2000
SYSCTL	LAA23B	3400
SYSMEM	LAA25	7200
TOHCTL	LAA26	2500
LNCTL	LAA28	2329

Table 9-6.   CP FIT Rates for End and Add/Drop Terminals Per Bellcore RPP —

Description	Code	Bellcore RPP[*] FIT
TRMTR (A∕D 1.3 STD)	739B4	7022
TRMTR (A∕D STS1 1.3 STD)	739B5	7514
TRMTR (A∕D STS1 1.3 HI PERF)	739C5	7514
TRMTR (A∕D 1.5 STD)	739J4	7022
TRMTR (A∕D STS1 1.5 STD)	739J5	7514
TRMTR (A∕D STS1 1.5 LBA)	739P5	7514
TRMTR (A∕D STS1 1.5 LBA, W1)	739R5	7514
TRMTR (A∕D STS1 1.5 LBA, W2)	739S5	7514
TRMTR (A∕D STS1 1.5 W1)	739E1	7522
TRMTR (A∕D STS1 1.5 W2)	739E2	7522
TRMTR (A∕D STS1 1.5 W3)	739E3	7522
TRMTR (A∕D STS1 1.5 W4)	739E4	7522
TRMTR (A∕D STS1 1.5 W5)	739E5	7522
TRMTR (A∕D STS1 1.5 W6)	739E6	7522
TRMTR (A∕D STS1 1.5 W7)	739E7	7522
TRMTR (A∕D STS1 1.5 W8)	739E8	7522
TRMTR (A∕D STS1 1.5 W1)	739G1	7522
TRMTR (A∕D STS1 1.5 W2)	739G2	7522
TRMTR (A∕D STS1 1.5 W3)	739G3	7522
TRMTR (A∕D STS1 1.5 W4)	739G4	7522
TRMTR (A∕D STS1 1.5 W5)	739G5	7522
TRMTR (A∕D STS1 1.5 W6)	739G6	7522
TRMTR (A∕D STS1 1.5 W7)	739G7	7522
TRMTR (A∕D STS1 1.5 W8)	739G8	7522
TRMTR (A∕D STS1 1.5 W1)	739H1	7522
TRMTR (A∕D STS1 1.5 W2)	739H2	7522
TRMTR (A∕D STS1 1.5 W3)	739H3	7522

Table 9-6.   CP FIT Rates for End and Add/Drop Terminals Per Bellcore RPP —

Description	Code	Bellcore RPP* FIT
TRMTR (A∕D STS1 1.5 W4)	739H4	7522
TRMTR (A∕D STS1 1.5 W5)	739H5	7522
TRMTR (A∕D STS1 1.5 W6)	739H6	7522
TRMTR (A∕D STS1 1.5 W7)	739H7	7522
TRMTR (A∕D STS1 1.5 W8)	739H8	7522
TRMTR (A∕D STS1 1.5 W9)	739H9	7522
TRMTR (A∕D STS1 1.5 W10)	739H10	7522
TRMTR (A∕D STS1 1.5 W11)	739H11	7522
TRMTR (A∕D STS1 1.5 W12)	739H12	7522
TRMTR (A∕D STS1 1.5 W13)	739H13	7522
TRMTR (A∕D STS1 1.5 W14)	739H14	7522
TRMTR (A∕D STS1 1.5 W15)	739H15	7522
TRMTR (A∕D STS1 1.5 W16)	739H16	7522
RCVR (A/D)	839B4B	3623
RCVR (A/D STS1)	839B5	3460
RCVR (A/D STS1)	839E5	3460

* Based on Method I of the Bellcore Reliability Prediction Pro-
cedure for Electronic Equipment, Issue 5, December 1995.
† LAA10B is backward compatible with LAA10.

Maintainability Specifications

The FT-2000 OC-48 Lightwave System requires no periodic maintenance. Continuous performance monitoring allows the FT-2000 OC-48 Lightwave System to detect problems before they become service affecting.

In the Dual Bay platform, the fan filters must be replaced every six months.

Warranty

The terms and conditions of sale will include a five-year warranty on FT-2000 OC-48 Lightwave System hardware and a one-year warranty on software.

There is a two-year warranty on all FT-LBA equipment.

Technical Specifications

10

Contents

Technical Specifications

10

Overview

This chapter contains the technical specifications for the FT-2000 OC-48 Light-wave System as well as the OC-3, IS-3 and OC-12 low-speed interfaces. Bellcore Generic Requirements GR-253-CORE is the basis for this information.

For reliability specifications, refer to Chapter 9, "Reliability and Quality."

Optical Line Interface

Optical Output	2.488 Gb/s
Optical Line Code	Scrambled nonreturn to zero (NRZ)

Optical Connector Interfaces

The OC48 Transmitter, OC48 Receiver, and OC48 Regenerator circuit packs use *ST*® lightguide connectors, FC lightguide connectors, or SC lightguide connectors.

Transmission Medium

Single-Mode Fiber

Lightguide Jumpers

Single-mode lightguide jumpers are used on the OC48 Transmitter, OC48 Receiver, OC48 Regenerator circuit packs, and OC3 circuit packs that interface with an OC-3 interface.

Multimode lightguide jumpers are used with OC3 circuit packs that interface with IS-3 interfaces.

Optical Source

Distributed Feedback (DFB) Laser

Optical Detector

Avalanche Photodiode (APD)

Optical Safety (BRH Classification)

OC-48 standard performance (1.31 μm)	Class IIIB
OC-48 high performance (1.31 μm)	Class IIIB
OC-48 standard performance (1.55 μm)	Class I

Operating Wavelength

1310 nm $\pm$ 20 nm and 1550 nm $\pm$ 15 nm

Optical Dispersion

OC-48 standard performance (1.31 μm)	300 ps/nm
OC-48 high performance (1.31 μm)	300 ps/nm
OC-48 standard performance (1.55 μm)	1800 ps/nm

Optical Return Loss

Maximum system optical return loss	24.0 dB
Maximum receiver reflectance	-27.0 dB
Maximum discrete reflectance	-27.0 dB

Lucent Technologies has a computer tool that determines in-depth return loss characteristics. If you have concerns about return loss limitations and need assistance, contact your local Account Executive.

Outside Plant Loss

OC-48 standard performance (1.31 μm)	24.0 dB
OC-48 high performance (1.31 μm)	27.0 dB
OC-48 standard performance (1.55 μm)	23.0 dB

Transmission Delay Specifications

Add or Drop DS3 Circuit	8.2 μsec
Add or Drop EC-1/STS1E Circuit	4.0 μsec
Add or Drop OC3 Circuit	4.5 μsec
Add or Drop IS3 Circuit	4.5 μsec
Add or Drop OC12 Circuit	4.5 μsec
Through Circuit (OC-48 to OC-48)	5.2 μsec

Optical Line Loss Budgets

The FT-2000 OC-48 Lightwave System is designed to meet the loss budget specifications shown in Table 10-1.

Table 10-1.   OC-48 Loss Budget Specifications

Parameter	1.31 μm Standard Performance	1.31 μm High Performance	1.55 μm
Maximum Transmitter Power (P_{Tmax})[*]	2.5 dBm	5.5 dBm	4.0 dBm
Minimum Transmitter Power (P_{Tmin})[†]	-2.0 dBm	1.0 dBm	-2.0 dBm
Maximum Received Power (P_{Rmax})[‡]	-10.0 dBm	-10.0 dBm	-9.0 dBm
Receiver Sensitivity (P_{Rmin})[†‡]	-27.0 dBm	-27.0 dBm	-27.0 dBm
Minimum System Gain (S-R)	25.0 dB	28.0 dB	25.0 dB
Optical Path Penalty (P_O)	1.0 dB	1.0 dB	2.0 dB
Maximum Loss Budget	24.0 dB	27.0 dB	23.0[††] dB
Minimum Loss Budget[**]	10.0 dB	10.0 dB	10.0 dB

[*] Transmit and receive powers are referenced to points S and R as shown in Figure 10-1.

[†] These values include transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins.

[‡] The receiver sensitivity and maximum received power values are measured at a BER of 1×10^{-10}.

[**] These values assume that the maximum received power limitations are not exceeded.

[††] 1.5 μm Standard Performance Optics is dispersion limited to 92 km.

Figure 10-1 displays the optical system interfaces. Points S and R reference the transmit and receive powers.
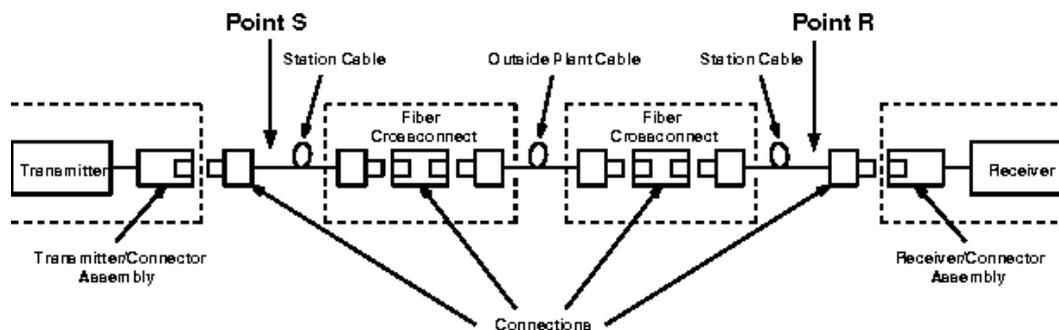
Figure 10-1.   Optical System Interfaces

Transmission Distances for FT-2000 Without
FT-LBA Optical Amplifiers

Table 10-2 lists the transmission distances for FT-2000 without optical amplifiers and wavelength division multiplexers (WDMs).

Table 10-2.   FT-2000 Transmission Distances Without Optical Amplifiers and WDMs

Option	Loss Budget	Standard Fiber* (SF)	Low-Loss Fiber† (LLF)	Dispersion-Shifted Fiber‡§ (DSF)
OC48 TRMTR (A/D 1.3 STD) and OC48 TRMTR (A/D STS1 1.3 STD)	24 dB	53 km 33 miles	64 km 40 miles	—
OC48 TRMTR A/D 1.3 HI PERF and OC48 TRMTR A/D STS1 1.3 HI PERF	27 dB	60 km 37 miles	72 km 45 miles	—
OC48 TRMTR A/D 1.5 STD and OC48 TRMTR A/D STS1 1.5 STD	23 dB (SF) 24 dB (DSF)	92 km 57 miles	105 km 65 miles	96 km 60 miles

*   Standard fiber assumes the following fiber loss (including splice loss) with a dispersion limit of 18 psec/nm per km:
n 1.3 μm — 0.45 dB/km
n 1.5 μm — 0.25 dB/km

†   Low-loss fiber assumes the following loss with a dispersion limit of 18 psec/nm per km:
n 1.3 μm — 0.375 dB/km
n 1.5 μm — 0.22 dB/km

‡   Dispersion-shifted fiber assumes a 0.25 dB/km loss at 1.5 μm.

§   Only 1.5 μm transmitters will work with dispersion-shifted fiber. On dispersion-shifted fiber, both versions of 1.5 μm transmitters support the same distances.

¶   The dispersion limit is applicable only to OC-48 1.5 μm STD Performance transmitters used on standard fiber. The limit is 1800 psec/nm or 100 km.

Loss Budget for FT-2000 with FT-LBA

Table 10-3 shows the loss budget information for FT-2000 Lightwave System used with the FT-LBA (lightwave booster amplifier).

Table 10-3.   FT-2000 OC-48 Lightwave System FT-LBA Loss Budgets

Type FT-LBA	+9 dBm FT-LBA		+12 dBm FT-LBA		+16 dBm FT-LBA	
	Standard Fiber	Dispersion-Shifted Fiber	Standard Fiber	Dispersion-Shifted Fiber	Standard Fiber	Dispersion-Shifted Fiber
Maximum Transmitter Power (P_{Tmax})	11.0 dBm	11.0 dBm	15.0dBm	15.0 dBm	17.0 dBm	17.0 dBm
Nominal Transmitter Power	9.0 dBm	9.0 dBm	12.0 dBm	12.0 dBm	16.0 dBm	16.0 dBm
Minimum Transmitter Power (P_{Tmin})*	7.0 dBm	7.0 dBm	10.0 dBm	10.0 dBm	14.0 dBm	14.0 dBm
Receiver Sensitivity*	-27.0 dBm	-27.0 dBm	-27.0 dBm	-27.0 dBm	-27.0 dBm	-27.0 dBm
Minimum System gain (S-R)	34 dB	34 dB	37 dB	37 dB	41 dB	41 dB
Optical Path Penalty (P_0)	2 dB	1 dB	2 dB	1 dB	2 dB	1 dB
Maximum Loss budget	32 dB	33 dB	35 dB[†]	36 dB[†]	39 dB[†]	40 dB[†]
Dispersion Limit	120 km[‡]	N/A	140 km[¶]	N/A	140 km[¶]	N/A

* These include transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins.

† Optional: Subtract 3.5 dB for pump redundancy.

‡ Based on a system performance of 2100 psec/nm which yields 120 km for a fiber dispersion of 18 psec/nm per km.

¶ Based on a system performance of 2520 psec/nm which yields 140 km for a fiber dispersion of 18 psec/nm per km.

Transmission Distances for FT-2000 With FT-LBA

Table 10-4 lists the transmission distances you can achieve when operating with the OC48 TRMTR (A/D 1.5 STD) or OC48 TRMTR (A/D 1.5 LBA) and the FT-LBA. Also see Table 10-6 for transmission distances for FT-2000 with wavelength division multiplexers and FT-LBA.

Table 10-4. FT-2000 Transmission Distances With the FT-LBA

FT-LBA Loss Budget		Dispersion Limit*		Maximum Distance		
		OC48 TRMTR A/D		Standard Fiber (SF)†		Dispersion-Shifted Fiber (DSF)¶
				OC48 TRMTR A/D		OC48 TRMTR A/D
		1.5 STD	1.5 LBA; LBA, W1; LBA, W2; STS1 LBA, W1; and STS1 LBA, W2§	1.5 STD	1.5 LBA; LBA, W1; LBA, W2; STS1 LBA, W1; and STS1 LBA, W2§	1.5 STD, LBA; LBA, W1; LBA, W2; STS1 LBA, W1; and STS1 LBA, W2
+9 dBm	32 dB (SF) 33 dB (DSF)	1800 psec/nm 100 km	2160 psec/nm 120 km	100 km 62 miles	120 km 75 miles	132 km 82 miles
+12 dBm	35 dB (SF) 36 dB (DSF)	1800 psec/nm 100 km	2520 psec/nm 140 km	100 km 62 miles	140 km 87 miles	144 km 89 miles
+16 dBm	39 dB (SF) 40 dB (DSF)	1800 psec/nm 100 km	2520 psec/nm 140 km	100 km 62 miles	140 km 87 miles	160 km 99 miles

*   The dispersion limit applies only to 1.5 μm STD and LBA Performance transmitters used with standard fiber.

†   Standard fiber assumes a dispersion limit of 18 psec/nm per km. It also assumes a fiber loss (including splice loss) of 0.25 dBm/ km at 1.5 μm.

¶   Dispersion-shifted fiber assumes a 0.25 dB/km loss for 1.5 μm. On dispersion-shifted fiber, both versions of 1.5 μm transmitters support the same distances.

§   The 1.5 μm LBA Performance transmitter is screened for dispersion.

Loss Budget for FT-2000 with WDM/LBA Systems

Table 10-5 shows the loss budget information for the FT-2000 OC-48 Lightwave System used with WDM systems.

Table 10-5.   FT-2000 OC-48 Lightwave System with WDM Systems

Parameter	TRMTR (A/D 1.5 LBA, W1 or W2)
Maximum Transmitter Power*	3.3 dBm
Minimum Transmitter Power[†]	0.0 dBm
Maximum Received Power[‡]	-11.0 dBm
Receiver Sensitivity[†, ‡]	-27.0 dBm
Minimum System Gain	27.0 dBm
MXR/DMXR Loss	4.5 dB
Optical Path Penalty	2.0 dB
Maximum Loss Budget[¶]	20.5 dB
Minimum Loss Budget[§]	10.0 dB
Optical Dispersion	2520 ps/nm

* Transmit and receive powers are referenced to points S and R as shown in Figure 10-1.

† The value for this parameter includes transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins.

‡ The receiver sensitivity and maximum received power values are measured at a BER of 1x10-10.

§ The value for this parameter assumes that the maximum received power limitation is not exceeded.

¶ 1.5 µm Standard Performance Optics is dispersion limited to 140 km.

Table 10-6 shows the loss budget information for the FT-2000 OC-48 Lightwave System used with both WDM and FT-LBA systems.

Table 10-6. FT-2000 OC-48 Lightwave System with WDM and +16 dBm FT-LBA Systems

Parameter	TRMTR (A/D 1.5 LBA, W1 or W2); TRMTR (A/D STS1 1.5 LBA, W1 or W2)
Maximum Transmitter Power*	17.0 dBm
Minimum Transmitter Power[†]	14.0 dBm
Minimum Transmitter Power Per Channel	11.0 dBm
Maximum Received Power[‡]	-11.0 dBm
Receiver Sensitivity[†, ‡]	-27.0 dBm
Minimum System Gain with LBA	38.0 dB
LBA Asymmetric Gain Penalty	2.5 dB
DMXR Loss	2.5 dB
Optical Path Penalty	2.0 dB
Maximum Loss Budget with LBA[¶]	31.0 dB
Minimum Loss Budget with LBA[§]	10.0 dB
Optical Dispersion	2520 ps/nm

* Transmit and receive powers are referenced to points S and R as shown in Figure 10-1.

[†] The value for this parameter includes transmitter/receiver connectors at 0.7 dB each (worst case) and the system margins.

[‡] The receiver sensitivity and maximum received power values are measured at a BER of 1×10^{-10}.

[§] The value for this parameter assumes that the maximum received power limitation is not exceeded.

[¶] 1.5 μm Standard Performance Optics is dispersion limited to 140 km.

Transmission Distances for FT-2000 With WDM and +16 dBm FT-LBA

Table 10-7 shows the distances for the transmitters used with either configuration: WDM alone or WDM and FT-LBA together.

Table 10-7. FT-2000 Transmission Distances With WDM and FT-LBA

OC48 TRMTR (A/D 1.5 LBA W1 and W2); OC48 TRMTR (A/D STS1 1.5 LBA, W1 and W2)¶	Loss Budget	Standard Fiber*	Low Loss Fiber†	Dispersion-Shifted Fiber‡§
used with WDM	20.5 dB (SF, LLF) 21.5 dB (DSF)	82 km 51 miles	93 km 58 miles	86 km 53 miles
used with WDM and FT-LBA	31.0 dB (SF, LLF)	124 km 77 miles	140 km 87 miles	-

* Standard fiber assumes the following fiber loss (including splice loss) with a dispersion limit of 18 psec/nm per km:
n 1.3 μm —0.45 dB/km
n 1.5 μm — 0.25 dB/km

† Low-loss fiber assumes the following loss with a dispersion limit of 18 psec/nm per km:
n 1.3 μm —0.375 dB/km
n 1.5 μm — 0.22 dB/km

‡ Dispersion-shifted fiber assumes a 0.25 dB/km loss at 1.5 μm.

§ Only 1.5 μm transmitters will work with dispersion-shifted fiber. On dispersion-shifted fiber, both versions of 1.5 μm transmitters support the same distances.

¶ The dispersion limit is applicable only to OC-48 1.5 μm STD Performance transmitters used on standard fiber. The limit is 2520 psec/nm or 140 km.

OC-48 Capacity

48 DS3 Equivalents (32,256 two-way voice circuits per fiber pair)

OC-48 Transmission Characteristics

The FT-2000 OC-48 Lightwave System meets single-mode interoffice digital fiber optic systems requirements and objectives as specified in GR-253-CORE and TR 499.

Error Rate	$<10^{-9}$ accumulated error rate for systems up to 400 kilometers (250 miles)
Maximum Repeater Spacing	60 kilometers at 1.3 μm on 0.46 dB/km fiber
Maximum Repeater Spacing	92 kilometers at 1.5 μm on 0.28 dB/km fiber (dispersion limited)

DS3 Access

Interface	Standard DS3 interface as specified in T1.102-1987, revised 1991
Growth Increment	Three DS3s per circuit pack; ports can be provisioned one at a time
Line Code	Bipolar 3-zero substitution (B3ZS)
Protection Ratio	1xM (M$\leq$16)

⚠ **WARNING:**

When operating an FT-2000 OC-48 Lightwave System with non-Lucent Technologies electrical low-speed cross-connect equipment that does not automatically terminate the OUT jacks, you must use 75-ohm termination plugs to terminate the OUT jacks.

A Lucent Technologies DSX-3/4 cross-connect automatically terminates the OUT jacks with 75 ohms. This cross-connect can be used with the FT-2000 OC-48 Lightwave System equipped with DS3 low-speed interface circuit packs [LAA2 (DS3)] or EC-1 low-speed interface circuit packs [LAA4 (STS1E)].

EC-1 Access

Interface	Standard EC-1 interface as specified by GR-253-CORE and T1X1.4
Growth Increment	Three EC-1s per (STS1E) circuit pack; ports can be provisioned one at a time
Line Code	Scrambled B3ZS
Protection Ratio	1xM (M≤16)

⚠ WARNING:

When operating an FT-2000 OC-48 Lightwave System with non-Lucent Technologies electrical low-speed cross-connect equipment that does not automatically terminate the OUT jacks, you must use 75-ohm termination plugs to terminate the OUT jacks.

A Lucent Technologies DSX-3/4 cross-connect automatically terminates the OUT jacks with 75 ohms. This cross-connect can be used with the FT-2000 OC-48 Lightwave System equipped with DS3 low-speed interface circuit packs [LAA2 (DS3)] or EC-1 low-speed interface circuit packs [LAA4 (STS1E)].

OC-3 Access

Interface	Standard OC-3 intermediate reach (IR) and short reach (SR) interface as specified by GR-253-CORE*
Growth Increment	One OC-3 per circuit pack
Line Code	Scrambled NRZ
Protection Ratio	1+1 (circuit pack plus line)

* The OC3 circuit pack is IR and SR compliant as shipped from the factory. The OC3 circuit pack can be configured for applications with spans up to 51 km.

IS-3 Access

Interface	Economical intraoffice optical interface over multimode fiber
Growth Increment	One IS-3 per circuit pack
Line Code	Scrambled NRZ
Protection Ratio	1+1 (circuit pack plus line)

OC-12 Access

Interface	Standard OC-12 long-reach (51 km) interface
Growth Increment	One OC-12 per circuit pack
Line Code	Scrambled NRZ
Protection Ratio	1+1 (circuit pack plus line)

Protection Switching (per High-Speed Line)

Switching Bit Error Rate (BER)	10^{-5} to 10^{-9} (user provisionable)
Restoral BER	One-tenth of the switching BER
Switching Time	60 msec (BER $\geq 10^{-3}$ line signal failure)

Cable Access

- Rear for certain equipment upgrades
- Front for all customer access
- Connectorized cabling with commercially available connectors

Electrical Line Build-Out Specifications

Electrical line build-outs may be required to be connected in series with the transmit LS INTFC cable connections depending on the application, cable type, and cable length associated with that particular LS INTFC cable. Table 10-8 shows when electrical line build-outs should be used based on the actual cable length (or equivalent measured signal level) for each transmit cable.

Table 10-8.   Electrical Line Build-Out Specifications

Application Connection to FT-2000	Length in Feet from FT-2000 Equipment to Connected Equipment for LS INTFC Signal In/Out Cables		LBO Required for LS INTFC Signal Out Cable
	735A Cable[*]	734D[†] [‡]or 735A/734D[**] or 735A/734D735A[††] Cable[‡‡]	
DS3 or EC-1 Cross-Connect Equipment	0-125	0-225[***]	Yes
	>125-250	>225-450	No
DACS III-2000,DACS IV-2000, DDM-2000, FT-2000,or Equiv. Non-Cross-Connect Equipment	0-125	0-225[***]	Yes
	>125-500	>225-900	No

*The exclusive use of 735A coaxial cables for connections between the FT-2000 and terminating equipment is strongly recommended. This an important consideration when deciding on office layout and equipment arrangement during site planning. Use the cable length figures in the table to aid in office layout.

†734D coaxial cable is electrically equivalent to 734A cable and has a silver coating on the center conductor to enhance crimping.

‡Direct connection of 734D cables to FT-2000 OC-48 Lightwave System equipment is not recommended due to space limitations in the interconnect panel. 735A cables should be used for these connections.

**If cable lengths required do not permit exclusive use of 735A cables, 735A/734D cable combinations may be used for DSX 3/4 applications or for DACS IV-2000s equipped with BNC connections.

††If cable lengths required do not permit exclusive use of 735A cables, 735A/734D/735A cable combinations may be used for all DACS III-2000 applications and/or DACS IV-2000s without BNC connectors.

‡‡If cable length requirements exceed the lengths specified for 735A cables, 735A/734D or 735A/734D/735A cable combinations may be used.

***The use of 735A coaxial cable it is strongly recommended over these cable types. 735A cable does not require an LBO (for lengths between 125 - 500 feet).

⚠ **WARNING:**

When operating an FT-2000 OC-48 Lightwave System with non-Lucent Technologies electrical low-speed cross-connect equipment that does not automatically terminate the OUT jacks, you must use 75-ohm termination

plugs to terminate the OUT jacks.

A Lucent Technologies DSX-3/4 cross-connect automatically terminates the OUT jacks with 75 ohms. This cross-connect can be used with the FT-2000 OC-48 Add/Drop-Rings Terminal equipped with either DS3 low-speed interface circuit packs [LAA2 (DS3)] or EC-1 low-speed interface circuit packs [LAA4 (STS1E)].

Power Specifications

Table 10-9 list the FT-2000 OC-48 Lightwave System Power Planning**.**

Table 10-9. FT-2000 OC-48 Lightwave System Power Planning

J68974E Equipment Package	Maximum Power Dissipated		Current Drain (Amps) Per Feeder (Two Feeders Required)[‡]	
	Watts	**Watts Per Square Foot**	**Nominal at -48 V (List 1)***	**Maximum (List 2)[†]**
FT-2000 OC-48 Add/Drop-Rings Terminal for 2-Fiber Rings	507	72	5.3	11.9
FT-2000 OC-48 Repeater Bay for 2 Fibers	175	25	1.8	4.1
FT-2000 OC-48 Repeater Bay for 4 Fibers	350	50	3.6	8.2
FT-2000 OC-48 Repeater Bay for 6 Fibers	525	75	5.5	12.3
FT-2000 OC-48 Fully Equipped Repeater Shelf	175	25	1.8	4.1
FT-2000 OC-48 Dual Lightwave Terminating Bay	1000	142	10.4	23.4

* To size batteries and rectifiers, use twice the Nominal (List 1) current drain per feeder. These current drains represent the average busy-hour current at normal operating voltages (-48 V DC).

[†] To size feeder cables and fuses, use the Maximum (List 2) current drain per feeder. (For example, for the FT-2000 OC-48 Add/Drop-Rings Terminal, use 11.9 amps.) These current drains represent the peak current under worst-case operating conditions. Maximum current drains occur at -42.75 V.

[‡] The two feeders, feeder A and feeder B, must be connected to opposite buses on the battery distribution fuse board. If the feeders are connected to opposite buses and one feeder fails, the remaining feeder carries the load of both feeders. For example, if the fuse or circuit breaker for feeder A trips at the battery distribution fuse board, feeder B carries its own current plus the current of feeder A.

⇒ NOTE:
Consult FPD 804-911-168 for complete engineering of battery plant and feeders.

Dimensions

Table 10-10 list system equipment dimensions.

Table 10-10.   FT-2000 OC-48 Lightwave System Equipment Dimensions

Equipment	Dimensions
FT-2000 OC-48 Lightwave System Bays*	7 feet (213 cm) high 25.938 inches (65.88 cm) wide 12 inches (30 cm) deep
Enhanced High-Speed Shelf	21.5 inches (54 cm) high 21.5 inches (54 cm) wide 12 inches (30 cm) deep
Condensed High-Speed Shelf	14.25 inches (36 cm) high 21.5 inches (54 cm) width 12 inches (30 cm) deep
Low-Speed Shelf — System Controller	21.5 inches (54 cm) high 21.5 inches (54 cm) wide 12 inches (30 cm) deep
Repeater Shelf — System Controller	21.5 inches (54 cm) high 21.5 inches (54 cm) wide 12 inches (30 cm) deep
Repeater Shelf — Complementary	21.5 inches (54 cm) high 21.5 inches (54 cm) wide 12 inches (30 cm) deep
FT-2000 OC-48 1x1 Repeater Shelf	25.5 inches (65 cm) high 21.5 inches (54 cm) wide 12 inches (30 cm) deep
PC Tray	4 inches (10 cm) high 21.5 inches (54 cm) wide 10 inches (25 cm) deep
Heat Baffle	4 inches (10 cm) high 21.5 inches (54 cm) wide 10 inches (25 cm) deep
Fan Assembly	5 inches (13 cm) high 21.5 inches (54 cm) wide 12 inches (30 cm) deep

* The shelves in an FT-2000 bay are central-office white, the framework is central-office soft-blue.

Table 10-11 list circuit pack dimensions

Table 10-11.   FT-2000 OC-48 Lightwave System Circuit Pack Dimensions

Description	Code	Height	Width	Depth
DS3	LAA2	13 inches (32 cm)	0.75 inches (1.9 cm)	7 inches (19 cm)

Table 10-11.   FT-2000 OC-48 Lightwave System Circuit Pack Dimensions — *Continued*

Description	Code	Height	Width	Depth
STS1E	LAA4	13 inches (32 cm)	0.75 inches (1.9 cm)	7 inches (19 cm)
IS3	LAA5	13 inches (32 cm)	0.75 inches (1.9 cm)	7 inches (1.9 cm)
OC3	LAA10/ LAA10B	13 inches (32 cm)	0.75 inches (1.9 cm)	7 inches (19 cm)
OC12	T939A	13 inches (32 cm)	3.00 inches (1.9 cm)	7 inches (19 cm)
LSSW	LAA12B	13 inches (32 cm)	0.75 inches (1.9 cm)	7 inches (19 cm)
OW	LAA14	13 inches (32 cm)	0.75 inches (1.9 cm)	7 inches (19 cm)
TG3	LAA18	13 inches (32 cm)	1.00 inches (2.5 cm)	7 inches (19 cm)
OHCTL (TERM)	LAA21	13 inches (32 cm)	0.75 inches (1.9 cm)	7 inches (19 cm)
OHCTL (TERM)	LAA22	13 inches (32 cm)	0.75 inches (1.9 cm)	7 inches (19 cm)
SYSCTL	LAA23B	13 inches (32 cm)	1.00 inches (2.5 cm)	7 inches (19 cm)
SYSMEM	LAA25	13 inches (32 cm)	0.75 inches (1.9 cm)	7 inches (19 cm)
TOHCTL	LAA26	13 inches (32 cm)	1.00 inches (2.5 cm)	7 inches (19 cm)
LNCTL	LAA28	13 inches (32 cm)	0.75 inches (1.9 cm)	7 inches (19 cm)
REGENR (1.3 STD)	39B2	13 inches (32 cm)	3.25 inches (8.3 cm)	7 inches (19 cm)
REGENR (1.3 HI PERF)	39C2	13 inches (32 cm)	3.25 inches (8.3 cm)	7 inches (19 cm)
REGENR (1.5 STD)	39J2	13 inches (32 cm)	3.25 inches (8.3 cm)	7 inches (19 cm)
REGENR (1.5 LBA, W1)	39R2	13 inches (32 cm)	3.25 inches (8.3 cm)	7 inches (19 cm)
REGENR (1.5 LBA, W2)	39S2	13 inches (32 cm)	3.25 inches (8.3 cm)	7 inches (19 cm)
TRMTR (A/D 1.3 STD)	739B4	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.3 STD)	739B5	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.3 HI PERF)	739C5	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W1)	739E1	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W2)	739E2	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W3)	739E3	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W4)	739E4	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W5)	739E5	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W6)	739E6	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W7)	739E7	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W8)	739E8	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W1)	739G1	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W2)	739G2	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)

Table 10-11.   FT-2000 OC-48 Lightwave System Circuit Pack Dimensions — *Continued*

Description	Code	Height	Width	Depth
TRMTR (A/D STS1 1.5, W3)	739G3	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W4)	739G4	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W5)	739G5	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W6)	739G6	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W7)	739G7	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W8)	739G8	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W1)	739H1	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W2)	739H2	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W3)	739H3	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W4)	739H4	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W5)	739H5	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W6)	739H6	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W7)	739H7	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W8)	739H8	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W9)	739H9	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W10)	739H10	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W11)	739H11	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W12)	739H12	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W13)	739H13	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W14)	739H14	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W15)	739H15	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5, W16)	739H16	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5 STD)	739J4	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5 STD)	739J5	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5 STD)	739P5	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5 LBA, W1)	739R5	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
TRMTR (A/D STS1 1.5 LBA, W2)	739S5	13 inches (32 cm)	4.50 inches (11.4 cm)	7 inches (19 cm)
RCVR (A/D STS1)	839B4B	13 inches (32 cm)	2.25 inches (5.7 cm)	7 inches (19 cm)
RCVR (A/D STS1)	839B5	13 inches (32 cm)	2.25 inches (5.7 cm)	7 inches (19 cm)
RCVR (A/D STS1)	839E5	13 inches (32 cm)	2.25 inches (5.7 cm)	7 inches (19 cm)

Floor Loading Specification

Table 10-12 displays the floor loading specifications for Terminal, Repeater, and Dual Bays.

Table 10-12. Floor Loading Specifications

Bay Configuration	Terminal Bay		Repeater Bay		Dual Bay	
	Weight	**Weight Per Square Foot**	**Weight**	**Weight Per Square Foot**	**Weight**	**Weight Per Square Foot**
1 Shelf Bay	NA	NA	220 lbs.	31 lbs.	NA	NA
2 Shelf Bay	375 lbs.	53 lbs.	270 lbs.	38 lbs.	375 lbs.	53 lbs.
3 Shelf Bay	420 lbs.	60 lbs.	320 lbs.	45 lbs.	NA	NA
4 Shelf Bay	NA	NA	NA	NA	465 lbs.	67 lbs.

Environmental Specifications

Table 10-13 provides environmental specifications for FT-2000 OC-48 Lightwave Systems.

Table 10-13. Environmental Specifications

Environmental Condition	Range
Normal Operating Temperature	5°C to 40°C (41°F to 104°F)
Short Term Operating Temperature*	-5°C to 50°C (23°F to 122°F)
Operating Temperature Change Rate	1°C/minute (1.8°F/minute)
Normal Operating Humidity[†]	5 to 85 percent
Short Term* Operating Humidity[†]	5 to 90 percent

* *Short term* refers to a period of up to 96 consecutive hours and a total of 15 days in one year.

[†] Noncondensing.

Earthquake and vibration, fire resistance, and airborne contaminant requirements meet GR-63-CORE Network Equipment Building Systems (NEBS) Generic Equipment Requirements. Electrostatic, electromagnetic, electrical grounding, and safety requirements meet GR-1089-CORE standards.

The FT-2000 OC-48 Lightwave System is also designed to meet the electromagnetic compatibility requirements of FCC Title 47, Part 15, Subpart J for Class A equipment.

The FT-2000 OC-48 Lightwave System is *UL*[1] listed and CSA[2] certified.

CIT Requirements

FT-2000 OC-48 Lightwave System enables you to provision either of two types of Craft Interface Terminal (CIT) access through the CIT data circuit equipment (DCE) and data terminating equipment (DTE) ports: CIT-TL1 or CIT-PC.

CIT-TL1

The CIT-TL1 is an interface that enables you to maintain and control the FT-2000 OC-48 Lightwave System locally and remotely using CPro-2000 or an ASCII terminal and TL1 commands.

CPro-2000 Interface

CPro-2000 is a graphical, Microsoft Windows-based alternative to entering TL1 commands manually. FT-2000 OC-48 Add/Drop-Rings Terminal contains all of the functionality necessary to work with this craft provisioning tool. Refer to Chapter 2 "CPro-2000" of this guide for a brief description of the functions you can perform using CPro-2000. For more information about this tool, including hardware requirements, software requirements, and ordering information, refer to the *SNC-2000 CPro User Manual* (190-523-101).

ASCII Terminal Interface

To use an ASCII terminal with the CIT-TL1 interface to manually enter TL1 commands, you must be an experienced TL1 command user. The TL1 commands that you enter must follow the standard TL1 format. The TL1 messages *exclude* autonomous messages. For information about TL1 commands through the CIT, refer to the *2000 Family of Products Operations Systems Engineering Guide* (824-102-148).

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1. Registered trademark of Underwriters Laboratories Inc.
2. Registered trademark of Canadian Standards Association.

To install or accept a system, you must use the CIT-PC.

CIT-TL1 Requirements

The following lists the minimum requirements for the CIT-TL1.

- ASCII-based data communications terminal with an 80-column display, scroll capability, and local echo

- serial port (EIA-232-D)

- selectable baud rate between 1200 to 9600 baud

- XON/XOFF flow control capability.

CIT-PC

The CIT-PC is a personal computer (PC) loaded with the CIT software. The "CIT-PC "Minimum System Requirements" section lists the minimum requirements for the PC. If you plan to use the CIT-PC with CPro-2000, refer to the *SNC-2000 CPro User Manual* (190-523-101) for more information about software and hardware requirements.

CIT-PC Minimum System Requirements

- 386SX *IBM*[3]-compatible desktop or laptop PC (25 MHz clock speed or greater)

- disk drive — one 1.44 megabyte (Mb) (3.5 inch)

- 80Mb hard disk

- 4 Mb Random Access Memory (RAM)

- 565 kilobytes available conventional memory[4]

- *MS-DOS*[5] operating system version 5.0 or later

- serial port (EIA-232-D) — configured as COM1, COM2, COM3, or COM4

- parallel port — configured as LPT1

- VGA color monitor.

3. IBM is registered trademark of International Business Machines Company

4. For systems without the required conventional memory, you need to use a memory manager such the one supplied with MS-DOS version 5.0 or later.

5. MS-DOS is registered trademark of Microsoft Corporation

**Using the CIT-PC with the *DANTEL*[6] Orderwire
Shelf Kit (847593522)**

If you use the CIT-PC with the *DANTEL* Orderwire Shelf that provides voice and
remote CIT access, an external modem and a standard RS232 cable are
required. Both of these items are supplied in *DANTEL* Orderwire Shelf kit
(847593522). Refer to the **Related Products** tab in Chapter 7.

Modem Requirements

A compatible modem or digital data network must meet the following minimum
requirements:

- Full duplex

- Asynchronous

- Byte serial data transmission of eight bit bytes

- One start bit

- One stop bit

- Data transmission speed should be from 1200 to 9600 baud.

The modem must comply with one of the transmission standards listed in Table
10-14. These standards apply to signaling used between modems.

Table 10-14.   Modem Transmission Standards

Standard	Baud Rate(s)
Bell 212A	1200
V.22	1200
V.22 bis	2400
V.32	4800, 9600
V.32 bis	9600 (fax), 14400 (data)

6. Registered trademark of *DANTEL* Incorporated.

Operations System Interfaces

■ Office alarms: The steady state current for office alarm connections should not exceed 0.9 A at 60 V or 1.8 A at 30 V. The maximum transient currents (20 ms duration) during initial contact closure should not exceed 9 A at 60 V or 18 A at 30 V.

■ Parallel Telemetry: The parallel telemetry interface is designed for a maximum open circuit voltage of 60 V and a maximum current of 35 mA.

■ Miscellaneous Discretes: Any external equipment to be monitored must provide the electrical equivalent of a contact closure across the corresponding pairs. The contact closure must be capable of passing at least 10 mA of drive current.

The power source that enables the outputs to control external equipment must be from 3 V to a maximum of 60 V. The load current should be limited by the external equipment and should not exceed 35 mA.

■ Telemetry Byte-Oriented Serial (TBOS) Protocol: The TBOS interface operates at 2400-baud through an EIA-422 port.

■ X.25 Protocol/Transaction Language 1 (TL1): The X.25/TL1 interface operates at 1200 to 19,200 baud through an EIA-232-D port.

➡ **NOTE:**
Parallel telemetry and serial telemetry are supported in Releases 7.2 and earlier only.

External Synchronization Capabilities

Table 10-15 lists FT-2000 DS1 timing inputs.

Table 10-15.   DS1 Timing Inputs

Source	Two references; must be derived from stratum 3 or better timing sources
Line Coding	AMI (default) or B8ZS
Frame Format	SF (default) or ESF
Connectors	DB9
Protection Switching Between References	Revertive Automatic on LOS, AIS, LOF, OOF, or BER

Table 10-16 lists FT-2000 DS1 timing outputs.

Table 10-16.   DS1 Timing Outputs

Source	Two references; derived directly from high-speed line.
Rings	Reference 1 derived from West direction Reference 2 derived from East direction
Frame Format	ESF or SF
DS1	AIS inserted if reference becomes unsuitable
Connectors	DB9
LBO	CIT provisionable

Table 10-17 lists the maximum lengths for the external synchronization timing cable.

Table 10-17.   External Sync Timing Cable

DS1 Cross-Connect (Max.)	655 ft.
Other Sources (Max.)	1310 ft.

OC-3, IS-3, and OC-12 Specifications

The OC3 (1.3 μm STD) circuit pack is both an intermediate-reach (IR) and short-reach (SR) compliant interface as shipped from the factory. It can also be configured to be long-reach compliant.

The IS-3 circuit pack is an optical interface providing intra-office signal transmission and supporting an interconnect distance up to 2000 feet. The IS-3 is based on proprietary AT&T optical specifications that are common across the SONET family.

The OC12 circuit pack is a bidirectional interface between an OC12/OC12c optical line and electrical STS-3 rate (155.52 Mb/s) backplane interface signals.

Transmission Mediums

Table 10-18 provides the transmission mediums for various circuit packs.

Table 10-18.   OC-3, IS-3, and OC-12 Transmission Medium Specifications

Circuit Pack	Input Fiber	Output Fiber
OC-3	Single-Mode or Multimode[*]	Single-Mode or Multimode[†]
IS-3	Multimode	Multimode
OC-12	Single-Mode or Multimode	Single-Mode

[*]A multimode LBO and multimode fiber jumper must be used if you need attenuation at the OC3 circuit pack input.

[†]If the connection to the OC-3 output is through a multimode fiber jumper, replace the factory-installed 7.1-dB single-mode lightguide build-out (LBO) with a 0-dB LBO.

Optical Connector Interfaces

The OC3 and IS3 (1.3 μm STD) circuit packs use *ST* lightguide connectors, FC lightguide connectors, or SC lightguide connectors.

The OC12 (1.3 μm STD) circuit pack uses *ST* lightguide connectors, FC/PC lightguide connectors, or SC lightguide connectors.

Optical Line Rate for the OC-12 Circuit Pack

Input: 622.08 Mb/s

Output: 622.08 Mb/s.

Operating Wavelengths

Table 10-19 provides the operating wavelengths of various circuit packs.

Table 10-19.   Circuit Pack Operating Wavelengths

Circuit Pack	Minimum	Maximum
OC-3	1272 nm	1350 nm
IS-3	1270 nm	1380 nm
OC-12	1298 nm	1325 nm

Spectral Widths

OC-3 - 3.0 nm (RMS)

IS-3 - 170 nm (RMS)

OC-12 - 2.0 nm (RMS).

Optical Sources

OC-3 - Multi-Longitudinal Mode (MLM) Laser

IS-3 - LED

OC-12 - InGaAsP Laser, MLM Structure.

Loss Budget Specifications

The OC-3, IS-3, and OC-12 low-speed interfaces are designed to meet the loss budget specifications in Table 10-20.

Table 10-20.   OC-3, IS-3, and OC-12 Loss Budget Specifications*

Parameter	1.31 μm Standard Performance		
	OC-3	IS-3	OC-12
Maximum Transmitter Power (P_{Tmax})[†] Minimum Transmitter Power (P_{Tmin}) Maximum Received Power (P_{Rmax}) Receiver Sensitivity (P_{Rmin})	0.0 dBm -7.0 dBm -7.0 dBm -34.0 dBm	-14.0 dBm -20.8 dBm -14.0 dBm -30.8 dBm	+2.0 dBm -2.5 dBm -8.0 dBm -30.5 dBm at 1310 nm
Minimum System Gain (S-R)[‡]	27.0 dB	10 dB	28.0 dBm
Optical Path Penalty (P_O)[§] Connector Loss[¶] Unallocated Margin**	1.0 dB 1.5 dB 1.5 dB	1.0 dB 1.5 dB 2.0 dB	2.0 dB 1.5 dB 1.5 dB
Minimum Loss Budget Maximum Loss Budget[††]	7.0 dB 23.0 dB	0.0 dB 5.5 dB	10.0 dB 23.0 dB
Expected Maximum Span Length	51 km	--	51 km

*   The OC-3 transmitter is shipped with a 7.1 dB LBO. For spans greater than 15 dB, replace this LBO with a 0-dB LBO. The 7.1-dB LBO (or equivalent optical attenuation) must be used for optical loopbacks.

[†]   Transmit and received powers are referenced to points S and R as shown in Figure 10-1.

[‡]   The minimum system gain allows for account aging, temperature, and manufacturing tolerances (these figures are built into the minimum transmitter power).

[§]   Optical path penalty includes the effects of dispersion, reflection, and jitter that occur on the optical path.

[¶]   One connector (0.75 dB) on each end is assumed to connect station cable to outside plant.

**   Unallocated margin, or safety margin, is usually used for fiber repairs. This can be used to increase the loss budget if needed.

[††]   The budget is available for both station and transmission cable and splices.

OC-3 and IS-3 Span Length

Table 10-21 presents data on the span length supported by the OC-3 and IS-3 interfaces.

Table 10-21.   OC-3 and IS-3 Span Length — Multimode Fiber

Fiber Bandwidth	OC-3 Span Length	IS-3 Span Length
1000 MHz-km	6.5 km	3.4 km
800 MHz-km	5.1 km	3.3 km
500 MHz-km	3.1 km	2.7 km
300 MHz-km	1.8 km	1.9 km

OC-3 to IS-3 Interface Interconnection

For interconnection with an IS-3 interface on a DDM-2000, the FT-2000 OC3 circuit pack requires a 0-dB output LBO, while the DDM-2000 IS-3 interface requires a 15-dB multimode LBO for the input.

For details and ordering information about connecting to a DDM-2000 IS-3 interface, refer to the *DDM-2000 Multiplexer Applications, Planning, and Ordering Guide* (363-208-200).

OC-3 and OC-12 Interface Transmission Distances

Table 10-22 lists the OC-3 and OC-12 interface transmission distances.

Table 10-22.   FT-2000 OC-3 and OC-12 Interface Transmission Distances

Interface	Loss Budget	Dispersion Limit	Maximum Distance	
			Standard Fiber (SF)*	Low-Loss Fiber (LLF)†
OC-3 1.3 μm	23 dB	NA	51 km 32 miles	61 km 38 miles
OC-12 1.3 μm	23 dB	NA	51 km 32 miles	61 km 38 miles

*   Standard fiber assumes the following fiber loss (including splice loss) with a dispersion limit of 18 psec/nm per km:
  n 1.3 μm — 0.45 dB/km
  n 1.5 μm — 0.25 dB/km

†   Low-loss fiber assumes the following loss with a dispersion limit of 18 psec/nm per km:
  n 1.3 μm — 0.375 dB/km
  n 1.5 μm — 0.22 dB/km

Appendix

A

A SONET Overview

A

Overview

This section briefly describes the Synchronous Optical Network (SONET).

History

In the early 1980s, the American National Standards Institute (ANSI) recognized the need for an optical signal standard for future broadband transmission. The ANSI T1X1 Technical Subcommittee began working on optical signal and interface standards in 1984. In 1985, Bellcore proposed a network approach to fiber system standardization to T1X1. In the proposal, Bellcore suggested a hierarchical family of signals whose rates would be **integer multiples** of a basic modular signal. The proposal further suggested a synchronous multiplexing technique, leading to the coining of the term *Synchronous Optical NETwork* (SONET).

The International Telegraph and Telephone Consultative Committee (CCITT) first showed interest in 1986. Conferences held through 1987 and 1988 resulted in coordinated specifications for both the American National Standard (SONET) and the CCITT-International Standard, Synchronous Digital Hierarchy (SDH). Approval of both sets of standards occurred in late 1988. The CCITT is now

named International Telecommunication Union, Telecommunication Standardization Sector (ITU-T)[1].

Basic Purpose

The basic purpose of SONET is to provide a standard synchronous optical hierarchy with sufficient flexibility to accommodate digital signals that currently exist in the network of today, as well as those planned for the future.

SONET currently defines standard rates and formats and optical interfaces. These and other related issues continue to evolve through the ANSI committees. SONET ultimately will permit an optical mid-span meet in a multivendor environment.

The set of American National Standards defines the following:

- optical parameters

- multiplexing schemes to map existing digital signals (that is, DS1 and DS3) into SONET payload signals

- overhead channels to support standard operation, administration, maintenance, and provisioning (OAM&P) functions

- criteria for optical line automatic protection switch (APS).

Technical Overview

This section includes information about SONET

- signal hierarchy

- layers

- frame structure

- digital multiplexing schemes

SONET Signal Hierarchy

The SONET signal hierarchy is based on a basic "building block" frame called the synchronous transport signal - level 1 (STS-1), as shown in Figure A-1. The STS-1 frame has a recurring rate of 8000 frames a second. Each frame is 125 microseconds.

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1. For more information refer to the "Standards: Their Global Impact" in the *IEEE Communications Magazine*, Vol. 32, No. 1, January 1994.

The STS-1 frame consists of:

- 90 columns (each column is an 8-bit byte)

- 9 rows.

The STS-1 frame is transmitted serially starting from the left with row 1 column 1 through column 90, then row 2 column 1 through 90, continuing on, row-by-row, until all 810 bytes (9 X 90) of the STS-1 frame have been transmitted.

Since each STS-1 frame consists of 810 bytes and each byte has 8 bits, the frame contains 6480 bits a frame. There are 8000 STS-1 frames a second, at the STS-1 signal rate of 51,840,000 (6480 X 8000) bits a second.

The first three columns in each of the nine rows carry the SECTION and LINE overhead bytes. Collectively, these 27 bytes are referred to as transport overhead.

The remainder of the frame, columns 4 through 90, is reserved for payload signals (for example, DS1 and DS3) and is referred to as the STS-1 synchronous payload envelope (STS-1 SPE). The optical counterpart of the STS-1 is the optical carrier level 1 signal (OC-1), which is the result of a direct optical conversion after scrambling.
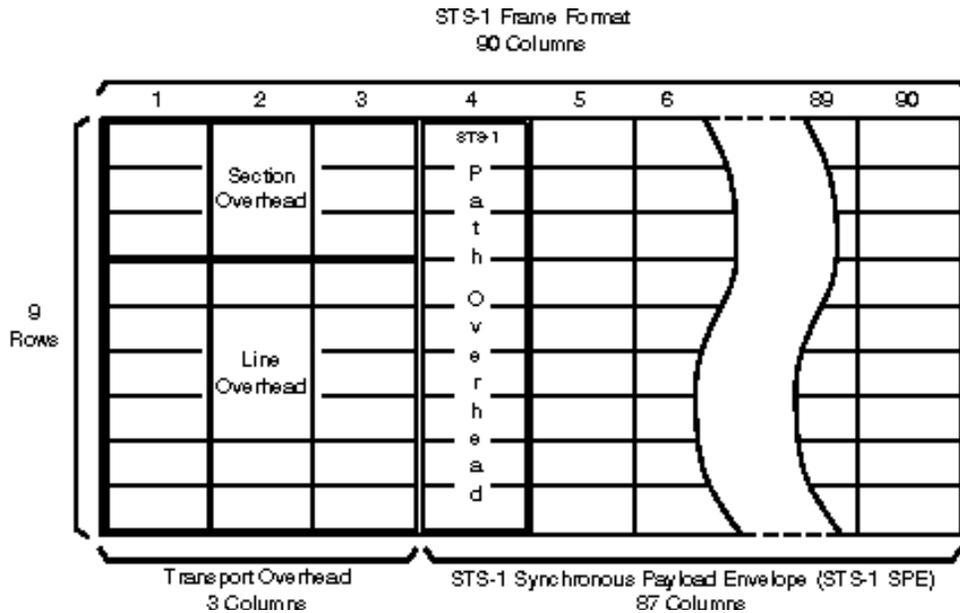
Figure A-1.   SONET STS-1 Frame Simplified Version

SONET Layers

SONET divides its processing functions into three layers. These three layers are associated with equipment that reflects the natural divisions in network spans. Figure A-2 shows these defined layers in a signal path. They include:

■ **SECTION** and **Section Terminating Equipment**—the transmission spans between lightwave terminating equipment and the regenerators. The spans between the regenerators are also considered sections. Section terminating equipment provides regenerator functions, terminates the section overhead to provide single-ended operations and section performance monitoring.

■ **LINE** and **Line Terminating Equipment**—the transmission span between terminating equipment (STS-1 cross-connects) that provides line performance monitoring.

■ **STS-1** and **VT Path Terminating Equipment**—the SONET portion of the transmission span for an end-to-end tributary (DS1 or DS3) signal that provides functions including signal labeling and path performance monitoring for signals as they are transported through a SONET network. STS-1 path terminating equipment can also provide cross-connections for lower-rate, (that is, DS1) signals. A virtual tributary (VT) is a sub-DS3 payload and is described later in more detail.
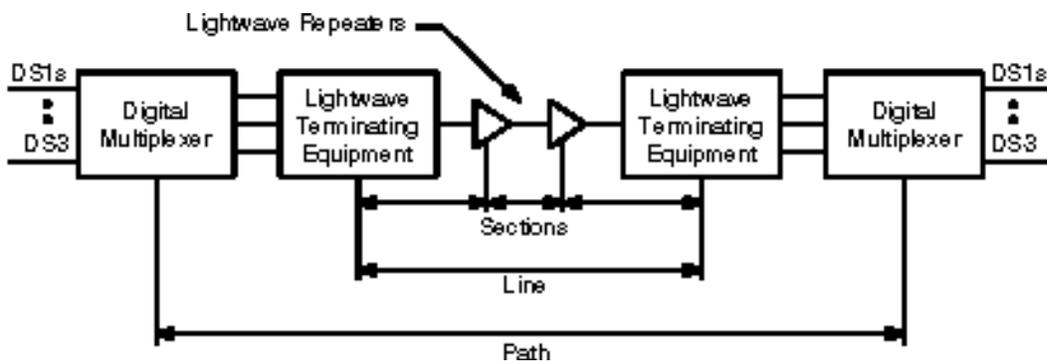
Figure A-2.   Section, Line, and Path Definitions

Each SONET layer has a set of overhead bytes as shown in Figure A-3. These bytes carry information used by various network elements.

- **SECTION** layer overhead contains information that is used by all SONET equipment including repeaters.

- **LINE** layer overhead is used by all SONET equipment except repeaters.

- **PATH** overhead is carried within the payload envelope across the end-to-end path.

  — **STS-1** remains with the STS-1 SPE until its payload is demultiplexed.

  — **VTN (N= 1.5, 2, 3, or 6)** remains with the VTN until it is demultiplexed to its asynchronous signal.
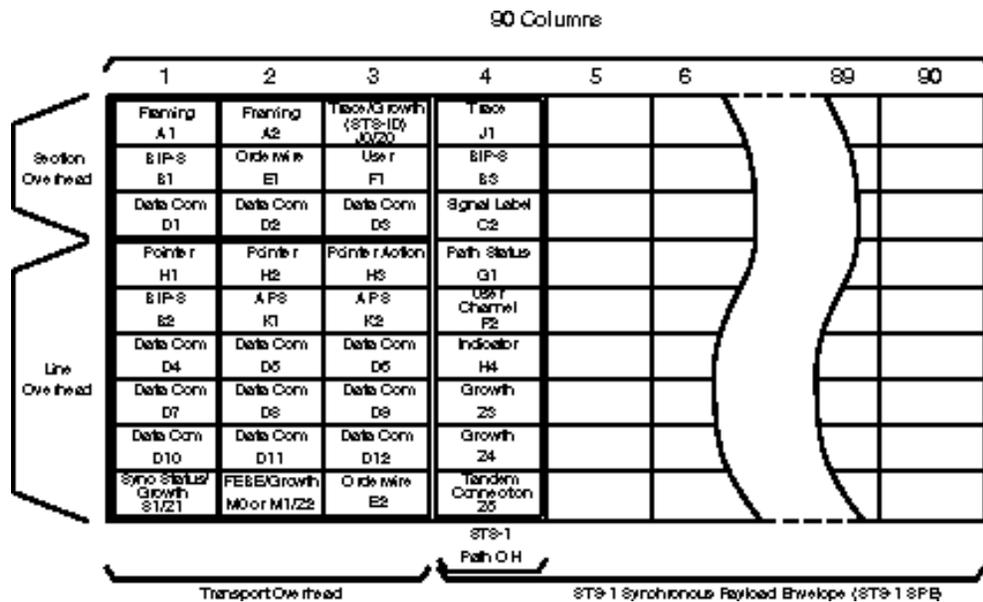
Figure A-3.   SONET Frame Format

SONET Frame Structure

The following pages provide more detailed information on the function of various overhead bytes for each SONET layer.

Section Overhead

- Framing (A1 and A2)

    — Provides framing for each STS-1.

- Trace/Growth (J0/Z0)

    — The Section Trace and Section Growth bytes replace STS-1 ID (C1).

    — J0/Z0 are for future use.

        — The J0 byte is located in the first STS-1 of an STS-N.

        — The Z0 byte is located in the second through Nth STS-1 of the STS-N.

- Section Bit Interleaved Parity (BIP-8) (B1)

    — Provides SECTION performance monitoring and is calculated over all bits of the previous STS-N frame. Defined only for STS-1 #1 of an STS-N signal.

- Section Orderwire (E1)

    — Provides a local orderwire for voice communication channel between regenerators. Defined only for STS-1 #1 of an STS-N signal.

- Section User Channel (F1)

    — Set aside for the user's purpose. Defined only for STS-1 #1 of an STS-N signal.

- Section Data Communications Channel (D1, D2, D3)

    — Is a 192 kb/s message-based channel. Used for alarms, maintenance, control, monitoring, and other communication needs between section terminating equipment. Defined only for STS-1 #1 of an STS-N signal.

Line Overhead

- Pointer (H1, H2)

    — Two bytes indicating the offset in bytes between the pointer action byte (H3) and the first byte (J1) of the STS-1 synchronous payload envelope (SPE).

- Pointer Action (H3)

    — This byte is allocated for frequency justification.

- Line Bit Interleaved Parity (BIP-8) (B2)

— This byte is for line performance monitoring and is provided in all STS-1 signals within an STS-N signal.

■ Automatic Protection Switch (APS) (K1, K2)

— Two bytes used for APS signaling between line level entities. In addition, bits 6, 7, and 8 of K2 are used for line alarm indication signal (AIS) and line far-end receive failure (FERF). Defined only for STS-1 #1 of an STS-N signal.

■ Line Data Communications Channel (D4 - D12)

— A 576 kb/s message-based channel.

■ Synchronization Status (S1)

— The byte is located in the first STS-1 of an STS-N.

— It conveys the synchronization status of the Network Element.

■ Growth (Z1).

— The byte is located in the second through Nth STS-1 of an STS-N.

— It is reserved for future growth.

■ Line Orderwire (E2). Defined only for STS-1 #1 of an STS-N signal.

— One byte is allocated to be used as an express orderwire between line entities.

Path Overhead

There are two types of path overheads:

— STS-1 path overhead

— VT path overhead

STS-1 Path Overhead

The STS-1 path overhead is assigned to and remains with the STS-1 SPE until the payload is demultiplexed and is used for functions that are necessary to transport all synchronous payload envelopes.

- STS-1 Path Trace (J1)

    — Repetitively transmits a 64-byte, fixed length string so that an STS-1 path receiving terminal can verify its continued connection to the intended transmitter.

- STS-1 Path Bit Interleaved Parity (BIP-8) (B3)

    — Provides each STS-1 path performance monitoring. This byte is calculated over all bits of the previous STS-1 SPE before scrambling.

- STS-1 Path Signal Label (C2)

    — Indicates the construction of the STS-1 synchronous payload envelope (SPE). Table A-1 and Table A-2 lists the values that FT-2000 identifies and their meanings. FT-2000 can generate 00, 01, or 04 and can carry any of the other values within the path layer overhead.

Table A-1 displays the STS-1 synchronous payload envelope values for Releases 8.1 and earlier.

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Table A-1.   STS-1 SPE Values for Releases 8.1 and Earlier

Hexidecimal Code	STS-1 SPE
00	Unequipped
01	Equipped-nonspecific payload
02	VT-Structured STS-1 SPE
03	Locked VT mode
04	Asynchronous mapping for DS3
05	Byte observable syntran
12	DS4NA Asynchronous mapping
13	Mapping for ATM
14	Mapping for DQDB
15	Asynchronous mapping FDDI

Table A-2 displays the STS-1 synchronous payload envelope values for Releases 9.0 and later.

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Table A-2.   STS-1 SPE Values for Releases 9 and Later

Hexidecimal Code	STS-1 SPE
00	Unequipped
01	Equipped-nonspecific payload
02	VT-Structured STS-1 SPE
03	Locked VT mode
04	Asynchronous mapping for DS3
05	Byte observable syntran
12	DS4NA Asynchronous mapping
13	Mapping for ATM
14	Mapping for DQDB
15	Asynchronous mapping FDDI
E1	VT-Structured STS-1 SPE with 1 VTx payload defect
E2	VT-Structured STS-1 SPE with 2 VTx payload defects
E3	VT-Structured STS-1 SPE with 3 VTx payload defects
E4	VT-Structured STS-1 SPE with 4 VTx payload defects
E5	VT-Structured STS-1 SPE with 5 VTx payload defects
E6	VT-Structured STS-1 SPE with 6 VTx payload defects
E7	VT-Structured STS-1 SPE with 7 VTx payload defects
E8	VT-Structured STS-1 SPE with 8 VTx payload defects
E9	VT-Structured STS-1 SPE with 9 VTx payload defects
EA	VT-Structured STS-1 SPE with 10 VTx payload defects
EB	VT-Structured STS-1 SPE with 11 VTx payload defects
EC	VT-Structured STS-1 SPE with 12 VTx payload defects
ED	VT-Structured STS-1 SPE with 13 VTx payload defects
EE	VT-Structured STS-1 SPE with 14 VTx payload defects

Table A-2.   STS-1 SPE Values for Releases 9 and Later

Hexidecimal Code	STS-1 SPE
EF	VT-Structured STS-1 SPE with 15 VTx payload defects
F0	VT-Structured STS-1 SPE with 16 VTx payload defects
F1	VT-Structured STS-1 SPE with 17 VTx payload defects
F2	VT-Structured STS-1 SPE with 18 VTx payload defects
F3	VT-Structured STS-1 SPE with 19 VTx payload defects
F4	VT-Structured STS-1 SPE with 20 VTx payload defects
F5	VT-Structured STS-1 SPE with 21 VTx payload defects
F6	VT-Structured STS-1 SPE with 22 VTx payload defects
F7	VT-Structured STS-1 SPE with 23 VTx payload defects
F8	VT-Structured STS-1 SPE with 24 VTx payload defects
F9	VT-Structured STS-1 SPE with 25 VTx payload defects
FA	VT-Structured STS-1 SPE with 26 VTx payload defects
FB	VT-Structured STS-1 SPE with 27 VTx payload defects
FC	VT-Structured STS-1 SPE with 28 VT1.5 payload defects, or a non-VT-Structured STS-1 or STS-Nc SPE with a payload defect.

- Path Status (G1)

   — Conveys the STS-1 path terminating status, performance, and remote defect indication (RDI) signal conditions back to an originating STS-1 path terminating equipment.

- Path User Channel (F2)

   — Reserved for user communication.

- Indicator

   — Provides a general multiframe indicator for VT-structured payloads.

- Path Growth (Z3 - Z4)

   — Reserved for future growth.

- Tandem Connection (Z5)

— Allocated for Tandem Connection Maintenance and the Path Data Channel.

— The tandem connection information is specified by ANSI T1.105.05.

VT Path Overhead

VT path overhead provides important functions for managing sub-STS1 payloads; for example, error checking, path status, and signal label. These functions are similar to those provided for STS1 paths.

SONET Digital Multiplexing Schemes

Asynchronous Multiplexing

Currently, fiber optic facilities are primarily used to carry DS3 signals. The DS3 signal consists of a combination of the following payload signals:

- 28 DS1s

- 14 DS1Cs

- 7 DS2s.

Typically, 28 DS1 signals are multiplexed into a DS3 signal, using an M13 format. Refer to Figure A-4. M13 format involves bit interleaving of four DS1 signals into a DS2 signal and then bit interleaving of seven DS2 signals into a DS3. In addition, the DS3 rate is not a direct multiple of the DS1 or the DS2 rates due to the bit-stuffing synchronization technique used in asynchronous multiplexing.

Identification of DS0s contained in any DS-N signal, except DS1, is complex and DS0s cannot be directly extracted. Thus, an asynchronous DS3 signal must be demultiplexed down to the DS1 level to access and cross-connect DS0 and DS1 signals.

Another disadvantage of the M13 format is there is no end-to-end overhead channel for use by OAM&P groups.

- Bit Interleaving above DS1

- DS1 Not Observable above DS1

- No End-To-End Overhead Channel

1 VF*Circuit = 1 DS0   24 DS0s = 1 DS1   4 DS1s = 1 DS2   7 DS2s = 1 DS3   DS3 X N = Line Signal

*Voice Frequency Circuit = 1 DS0
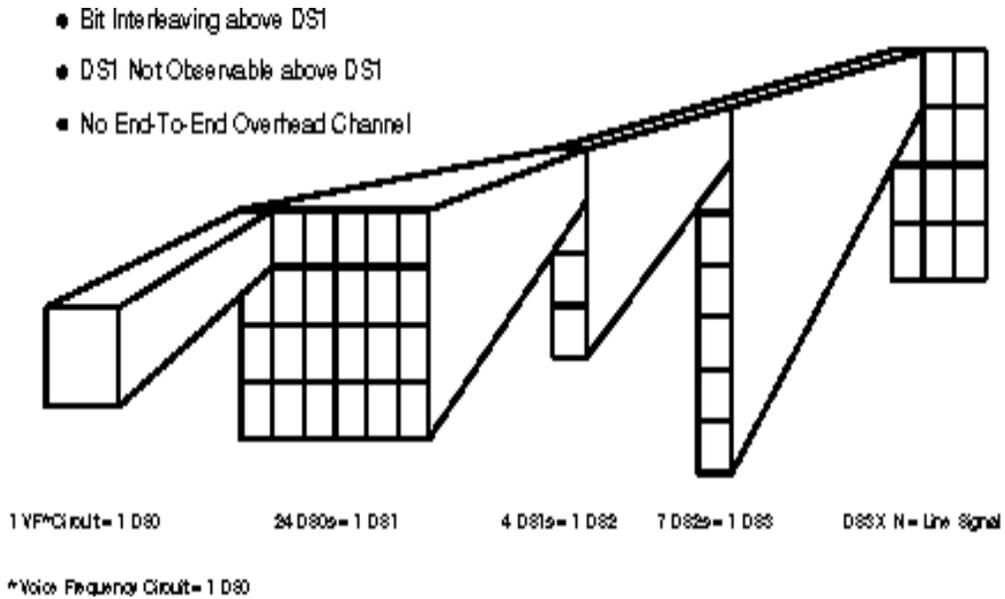
Figure A-4.   Asynchronous Multiplexing

Synchronous Multiplexing

SONET method of *byte interleaving* DS1s to a higher signal rate permits economical extraction of a single DS1 without the need to demultiplex the entire STS-1 SPE. In addition, SONET provides overhead channels for use by OAM&P groups.

In SONET, a single asynchronous DS3 signal is mapped into an STS-1 SPE (Figure A-5).

- Byte Interleaving above DS1
- DS1 Observable above DS1
- Standard End-To-End Overhead Channel

1 VF Circuit = 1 DS0   24 DS0s = 1 DS1   4 VT1.5s = VT-G   7 VT-Gs   STS-1 X N = OC-N

24 DS0s   + STS-1 Path OH
+ 1 DS0 (stuffing bit)   + STS-1 Line OH
+ 1 DS0 (VT Path OH)   + STS-1 Section OH
+ 1 DS0 (VT pointe ()   ─────────────
─────────────   1 STS-1
1 VT1.5
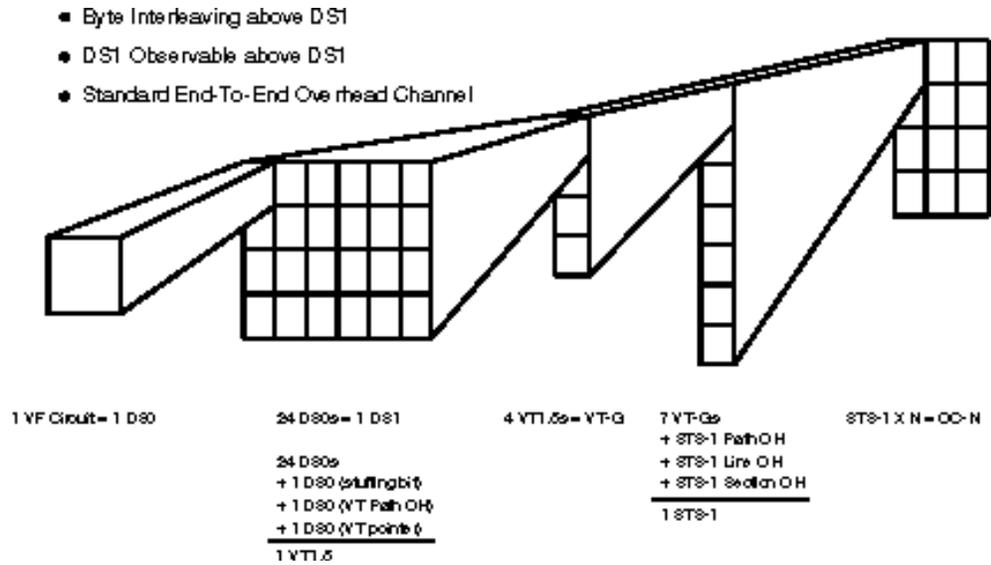
Figure A-5.   Synchronous Multiplexing

Sub-DS3 asynchronous signals (DS1, DS1C, DS2 and E1) are *byte interleaved* into a digital signal called a virtual tributary (VT). The VT is a structure designed for the transport and switching of sub-DS3 payloads. There are four sizes of virtual tributaries.

Table A-3 shows the digital signals that can be transported as SONET payloads.

Table A-3.   SONET Payloads

Input Tributary	Voice Channels (DS0s)	Rate	SONET Signal	Rate
DS1 E1 (CEPT) DS1C DS2 DS3	24 DS0s 32 DS0s 48 DS0s 96 DS0s 672 DS0s	1.544 Mb/s 2.048 Mb/s 3.152 Mb/s 6.312 Mb/s 44.736 Mb/s	VT1.5 VT2 VT3 VT6 STS-1	1.728 Mb/s 2.304 Mb/s 3.456 Mb/s 6.912 Mb/s 51.840Mb/s
DS4NA ATM FDDI	2016 DS0s	139.264 Mb/s 149.76 Mb/s 125.00 Mb/s	STS-3c STS-3c STS-3c	150.336 Mb/s 150.336 Mb/s 150.336 Mb/s
Future payloads Future broadband pay-loads		up to 150 Mb/s >150 Mb/s		

DS1 and DS3 digital signals are the most important asynchronous signals in the current network. Broadband payloads, such as ATM are of great importance also.

SONET Interface

The SONET interface (Figure A-6) provides the optical midspan meet between SONET network elements. A SONET network element is the hardware and software that affects the termination or repeating of a SONET standard signal.

Standard optical interconnect at SONET interface

Family of standard rates at N X 51.84 Mb/s
[Synchronous Transport Signal (STS-1)]

Overhead channels defined for interoffice operations
and maintenance functions
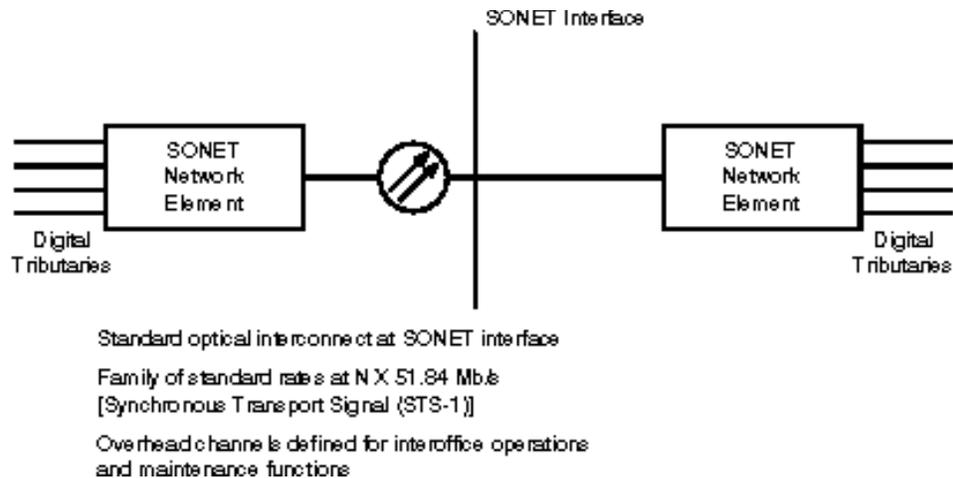
Figure A-6.   SONET Interface

The SONET standard is being revised to define optical interfaces at the SONET
transmitter and receiver.

SONET Multiplexing Procedure

SONET provides for multiplexing of asynchronous DS1s, synchronous DS1s, and
asynchronous DS3s. Refer to Figure A-7 and Figure A-8.

The first stage in multiplexing is mapping the input DS1 or DS3 tributary. In the
case of DS1 inputs, three time slots (DS0s) are added to the incoming signal thus
becoming a VT1.5. An asynchronous DS1 that fully meets the specified rate is
mapped into the VT1.5 SPE as clear channel input since no framing is needed.

- Each VT1.5 carries a single DS1 payload.
- Four VT1.5s are bundled into a VT group (VT-G).
- Seven VT-Gs are byte interleaved into an STS-1 frame.

The VT-G to-STS-1 multiplex is a simple byte interleaving process, so individual
VT signals are easily observable within the STS-1. Thus, cross-connections and
add/drop can be accomplished without the back-to-back mux/demux steps
required by asynchronous signal formats. The structured VTs are now multiplexed
into the STS-1 SPE, and the path, line, and section overhead is added. The final
multiplexing, as shown in Figure A-7, provides the scrambled STS-N signal to the
optical conversion stage.
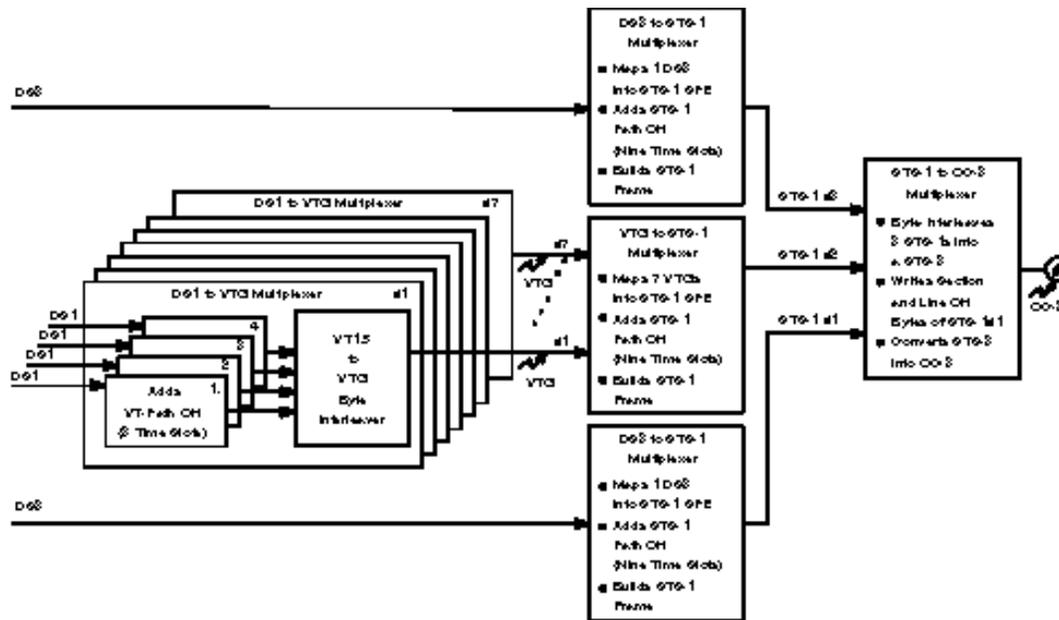
Figure A-7.   SONET Multiplexing Procedure

SONET Demultiplexing Procedure

As shown in Figure A-8, demultiplexing is the inverse of multiplexing. The unscrambled STS-1 signal from the optical conversion stages is processed to extract the section and line overhead and accurately locate the SPE. The next stage processes the path overhead and demultiplexes the VTs. The individual DS1 VTs are then processed to extract VT overhead and, via the VT pointer, accurately locate the DS1 SPE. Finally, desynchronization of the DS1 SPE provides a standard DS1 signal to the asynchronous network.
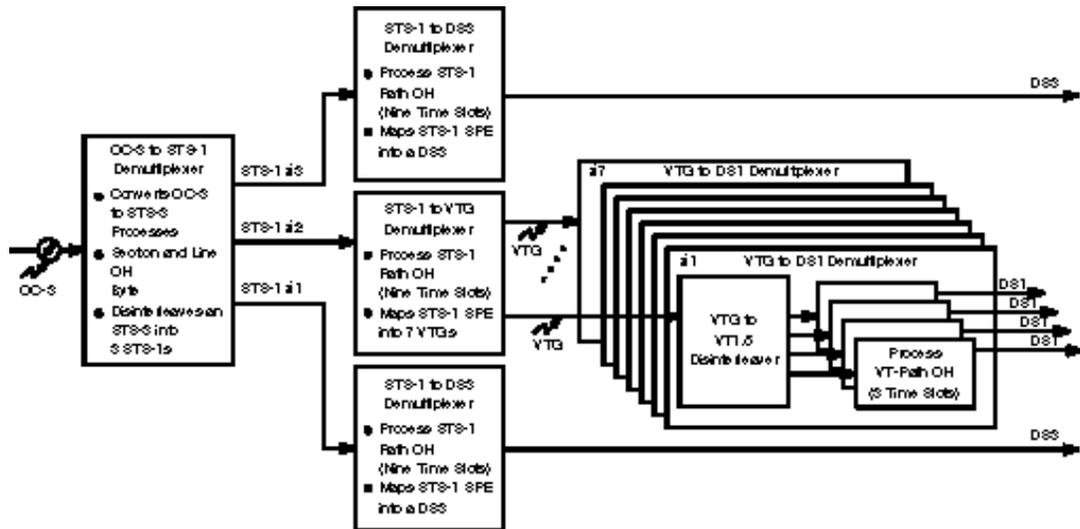
Figure A-8. SONET Demultiplexing Procedure

Note these two key points: First, the SONET frame is a fixed time (125 µs) and no bit-stuffing is used. Second, as shown in Figure A-9, the synchronous payload envelope can *float* within the frame. This is to permit compensation for small variations in frequency between the clocks of the two systems that may occur if the systems are independently timed (plesiochronous timing). The SPE can also drift across the 125-µs frame boundary.

SONET STS pointers are used to locate the SPE relative to the transport overhead.
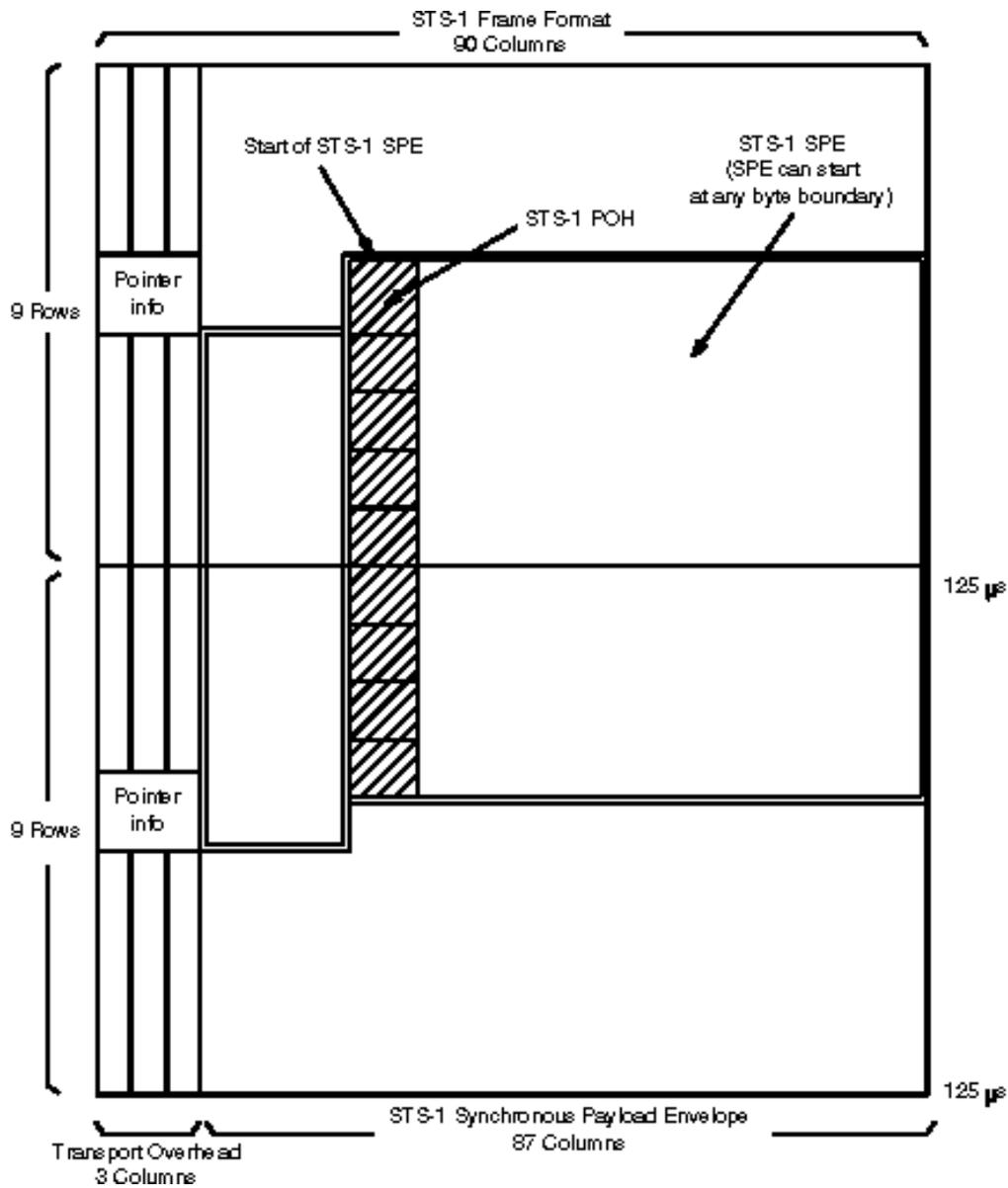
Figure A-9.   STS-1 Synchronous Payload Envelope in Interior of STS-1 Frame

Higher Rate Transport

Higher rate SONET signals are created by byte-interleaving STS-1 *N* to form an STS-*N* signal. The desired STS-*N* is created by adjusting all payload pointers and regenerating the section and line overhead bytes to be in phase with each other and the outgoing multiplexed signal. The STS-*N* is then scrambled and converted to an optical carrier - level *N* (OC-*N*) signal. The OC-*N* has a line rate of exactly *N* times the OC-1 signal (see Table A-4).

Table A-4.   SONET Transport Rates

OC Level	Line Rate (Mb/s)	Capacity
OC-1	51.84	28 DS1s or 1 DS3
OC-3	155.52	84 DS1s or 3 DS3s
OC-12	622.08	336 DS1s or 12 DS3s
OC-24	1244.16	672 DS1s or 24 DS3s
OC-48	2488.32	1344 DS1s or 48 DS3s
OC-192	9953.28	5376 or 192 DS3s

Conclusion

The intent of this section was to present a short overview of SONET. More detailed expositions can be found in the literature; an excellent description can be found in Reference 3, below.

REFERENCES

1. ANSI T1.105 - 1991 American National Standard for Telecommunications - Digital Hierarchy Optical Rates and Formats Specification and ANSI T1.106-1988 American National Standard for Telecommunications - Digital Hierarchy Optical Interface Specifications, Single Mode.

2. CCITT Recommendations G.707, G.708, G.709.

3. R. Ballert and Y. C. Ching, SONET: Now It's the Standard Optical Network, *IEEE Communications Magazine*, Vol. 27, No. 3 (March 1989): 8-15.

Glossary

0x1 Line Operation
A 0x1 protection system has one bidirectional service line and no protection line.

1+1 Line Protection
A 1+1 protection system has two bidirectional lines. The transmitting terminal sends the same payload on two lines. The receiving terminal monitors two lines independently and chooses one line as the working line and the other line as the standby line. When a protection switch occurs, the receiving terminal selects the signal from the standby line. This causes the standby line to be the new working line, and the original working line becomes the standby line. This status remains the same (nonrevertive) after the fault clears. See also Nonrevertive Switching.

1x1 Line Protection
A 1x1 protection system has two bidirectional lines. One line is designated as the service line, and the other is designated as the protection line. The service line normally carries traffic. When a protection switch occurs, the protection line is selected to carry traffic. When the fault clears, the traffic reverts to the original service line. See also Revertive Switching.

1xM Electrical Low-Speed Interface Protection
1xM electrical low-speed interface protection refers to a system with one protection electrical low-speed interface circuit pack (DS3 or STS1E) and up to 16 service electrical low-speed interface circuit packs (DS3 or STS1E). When a low-speed protection switch occurs, the electrical low-speed signals are routed from the service low-speed interface circuit pack to the protection low-speed interface circuit pack. When the fault clears, the low-speed signals revert to the service low-speed interface circuit pack. See also Revertive Switching.

A

ABN
Abnormal (condition)

ACO
Alarm Cutoff — A push-button switch on the user panel that can be used to retire an audible office alarm.

ADM
Add/Drop Multiplexer

Add/Drop-Rings Terminal Platform (A- Bay and E-Bay)
In the Add/Drop-Rings Terminal Platform one Low-Speed Shelf is interconnected to either one Enhanced High-Speed Shelf (2-fiber ring) or two Enhanced High-Speed Shelves (4-fiber ring and linear add/drop). Any low-speed slot on the Low-Speed Shelf may be provisioned to have its add/drop traffic coming from or going to the east or the west direction.

AGNE
Alarm Gateway Network Element

AID
Access Identifier — A unique identifier used to address equipment slots and ports, as well as facility tributaries, that are defined for the FT-2000 Network Element architecture.

AIS
Alarm Indication Signal — A code transmitted downstream in a digital network that shows that an upstream failure has been detected and alarmed if the upstream alarm has not been suppressed.

AMI
Alternate Mark Inversion — A line code that employs a ternary signal to convey binary digits, in which successive binary ones are represented by signal elements that are normally of alternating, positive, and negative polarity but equal in amplitude, and in which binary zeros are represented by signal elements that have zero amplitude.

ANSI
American National Standards Institute

APS
Automatic Protection Switch

AS&C
Alarm, Status, and Control

ASCII
American Standard Code for Information Interchange — A standard 8-bit code used for exchanging information among data processing systems and associated equipment.

ASN.1
Abstract syntax notation 1

Asynchronous
Refers to network elements that are not timed from references traceable to a single Stratum-1 source.

AUTO
Automatic — One possible state of a low-speed port or slot. When a port is in the AUTO state and the presence of a good signal is detected, the port is automatically placed in the IS (in-service) state. When a slot is in the AUTO state and the presence of a good circuit pack is detected, the slot is automatically placed in the EQ (equipped) state.

B

B3ZS
Bipolar 3-Zero Substitution — A line coding method that replaces a string of three zeros with a sequence of symbols having some special characteristic.

BCLAN

Board Controller Local Area Network — The internal local area network that provides communications between the Line Controller (LNCTL) circuit pack and board controllers on the circuit packs associated with a high-speed line.

B-DCS

Broadband Digital Crossconnect System

BDFB

Battery Distribution and Fuse Bay

BER

Bit Error Rate — The ratio of bits received in error to bits sent.

BIP

Bit Interleaved Parity — A method of error monitoring over a specified number of bits (BIP-3 or BIP-8).

BIP-N

Bit Interleaved Parity - N — A method of error monitoring. With even parity, an N-bit code is generated by the transmitting equipment over a specified portion of the signal in such a way that the first bit of the code provides even parity over the first bit of all N-bit sequences in the covered portion of the signal. The second bit provides even parity over the second bits of all the N-bit sequences within the specified portion, etc. Even parity is generated by setting the BIP-N bits so that there are an even number of ones in each of all the N-bit sequences including the BIP-N.

BITS

Building Integrated Timing Supply

BLSR

Bidirectional Line Switched Ring

BOC

Bell Operating Company

Broadband Communications

Voice, data, and/or video communications at greater than DS1 rates (1.544 Mb/s).

Broadband Service Transport

STS-3c transport over FT-2000 for ATM applications.

BRT

Business Remote Terminal

C

CC

Clear Channel — A provisionable mode for DS3 output that causes parity violations to not be monitored or corrected before the DS3 signal is B3ZS encoded.

CIT or CIT-PC

Craft Interface Terminal — A personal computer that meets FT-2000 minimum requirements loaded with Interface-2000 software.

CCITT
International Telephone and Telegraph Consultative Committee — An international advisory committee under United Nations sponsorship that has composed and recommended for adoption worldwide standards for international communications.

CMISE
Common Management Information Service Element

CO
Central Office

Collapsed Rings
See Folded Rings.

CR
Critical (alarm)

Cross-Connection Map
The cross-connection map for each FT-2000 ring node contains information about how signals are connected between the high-speed time slots and low-speed interface packs. (See also Squelch Map.)

CS&O
Lucent Technologies Customer Support and Operations

Current Value
The value currently assigned to a provisionable parameter.

CV
Coding Violation

D

DACS
Digital Access and Cross-Connect System

DACS III-2000
One of Lucent Technologies SONET-ready digital access and cross-connect systems.

DACS IV-2000
One of Lucent Technologies SONET-ready digital access and cross-connect systems.

Data
A collection of system parameters and their associated values.

DCC
Data Communications Channel — The embedded overhead communications channel in the SONET line, used for end-to-end communications and maintenance. It carries alarm, control, and status information between network elements in a SONET network.

DCE
Data Communications Equipment — The equipment that provides signal conversion and coding between the data terminating equipment and the line. The DCE may be separate or part of the data terminating equipment.

DDM-FiberReach

The DDM-2000 FiberReach multiplexer is an OC-1 low-density access product offering DS0 and DS1 services for business carrier access, fiber-in-the-loop or private network applications. DDM-2000 FiberReach is hosted by the DDM-2000 OC-3 or OC-12 multiplexer or the SLC-2000 Access System with a single-homed or dual-homed ring or star topology.

DDM-2000

Lucent Technologies SONET-ready network multiplexer that can function as a lightwave terminal. It is designed primarily for loop feeder and interoffice applications that work in existing asynchronous as well as the emerging SONET networks.

Demultiplexing

A process applied to a multiplexed signal for recovering signals combined within it and for restoring the distinct individual channels of these signals.

Dense Wave Division Multiplexing

Transmitting two or more signals of different wavelengths simultaneously over a single fiber.

DPLL

Digital Phase Locked Loop

DRAM

Dynamic Random Access Memory

DRI

Dual Ring Interworking

DRI-P

Dual Ring Interworking on Protection

DS3

Digital Signal Level 3 (44.736 M/bs)

DS3 Interface Circuit Pack

The FT-2000 OC-48 Lightwave System DS3 Interface circuit pack interfaces with up to three bidi-rectional DS3 signals.

DS-NE

Directory Service Network Element — A designated network element responsible for administering a database that maps network element names (TIDs) to addresses [NSAPs (network service access points). There can be one DS-NE per ring.

DSX

Digital Cross-Connect Panel — A panel designed to interconnect equipment that operates at a des-ignated rate. For example, a DSX-3 interconnects equipment operating at the DS3 rate.

DTE

Data Terminating Equipment — The equipment that originates data for transmission and accepts transmitted data.

Dual Lightwave Terminating Bay Platform (D-Bay)

The packaging of two Add/Drop-Rings systems in a single 7-foot bay.

Dual Ring Interworking

Dual Ring Interworking (DRI) is a configuration of two ring networks that share two common nodes. DRI allows a circuit with one termination in one ring and one termination in another ring to survive a loss-of-signal failure of the shared node that is currently carrying service for the circuit.

DWDM
Dense Wave Division Multiplexing — Transmitting two or more signals of different wavelengths simultaneously over a single fiber.

E

EC-1
Electrical Carrier level-1 signal — An STS-1 signal that has been shaped and encoded for transmission over electrical media.

ECI
Equipment Catalog Item

EEPROM
Electrically Erasable Programmable Read-Only Memory

EIA
Electronic Industries Association — A trade association of the electronic industry that establishes electrical and functional standards.

EMC
Electromagnetic Compatibility

EMS
See SNC-2000 Element Management System (EMS).

EMI
Electromagnetic Interference — High-energy, electrically induced magnetic fields that cause data corruption in cables passing through the fields.

EPROM
Erasable Programmable Read-Only Memory

EQ
Equipped — A memory administrative state for slots.

Equal Level Cross-Connect Equipment
Cross-connect equipment where the signal strength (power) is the same for all the inputs and outputs so that any output can be connected to any input. The DSX-3 is an example of equal level cross-connect equipment.

ES
Errored Seconds — A performance monitoring parameter.

ESD
Electrostatic Discharge

ESF
Extended Super Frame — A DS1 format option.

Executable Code
The "program" that controls the operation of the system.

Externally Timed

An operating condition of a clock in which it is locked to an external reference and is using time constants that are altered to quickly bring the local oscillator's frequency into approximate agreement with the synchronization reference frequency.

Extra traffic

Unprotected traffic that is carried over protection channels when their capacity is not used for the protection of working traffic.

F

FDDI

Fiber Distributed Data Interface — Fiber interface that connects computers and distributes data among them.

FE ACTY

Far-End Activity

FEBE

Far-End-Block Error — An indication returned to the transmitting terminal that an errored block has been detected at the receiving terminal. A block is a specified grouping of bits.

FERF

Far-end Receive Failure. See RDI.

FIT

Failures in Time — Circuit pack failure rates per 10^9 hours.

Flash EPROM

A new technology that combines the nonvolatility of EPROM with the in-circuit reprogrammability of EEPROM (electrically-erasable PROM).

FLS

Frame Loss Seconds

Folded Rings

Folded (collapsed) rings are rings without fiber diversity. The terminology derives from the image of folding a ring into a linear segment.

Free Running

An operating condition of a network element in which its local oscillator is not locked to any synchronization reference and is using no storage techniques to sustain its accuracy.

FT-LBA

FT-Lightwave Booster Amplifier

G

Gb/s

Gigabits per second

GNE

Gateway Network Element — A network element that passes information between other network elements and operations systems through a data communication network.

H

Headend

Refers to the transmitting end where a signal originates.

Holdover

An operating condition of a clock in which its local oscillator is not locked to an external reference but is using storage techniques to maintain its accuracy with respect to the last known frequency comparison with a synchronization reference.

I

IEC

International Electrotechnology Commission or Interexchange Carrier

InterLATA

Circuits that cross outside the LATA and to an interexchange carrier.

IntraLATA

Circuits with both end-points within the LATA.

I/O

Input/Output

IOF

Interoffice Facility

IR

Intermediate Reach

IS

In Service — A memory administrative state for ports. IS refers to a port that is fully monitored and alarmed.

IS-3

Low-speed intraoffice interface. Used within a central office when OC-3 connectivity is desired.

ITCO

Independent Telephone Company

IXC

Interexchange Carrier

J

Jitter

Jitter is defined as short-term variations of the significant instants of a digital signal from their ideal positions in time.

L

LAN

Local Area Network

LATA

Local Access and Transport Area

LBO

Line Build-Out — An equalizer network between the terminals and the DSX panel (or equivalent). It guarantees the proper signal level and shape at the DSX panel (or equivalent).

LCLAN

Line Controller Local Area Network — The internal local area network that provides communications between the System Controller (SYSCTL) circuit pack and the Line Controller (LNCTL) circuit pack.

LEC

Local Exchange Carrier

LED

Light-Emitting Diode

LGX

Lightguide cross-connect.

Line

An optical transmission line. In T1/Bellcore terminology, "line" refers to a transmission medium, together with the associated high-speed equipment, required to provide the means of transporting information between two consecutive Network Elements, one of which originates the line signal and the other terminates the line signal.

Line Timing

Refers to a network element that derives its timing from an incoming OC-48 signal.

LNCTL

The FT-2000 OC-48 Lightwave System Line Controller (SYSCTL) circuit pack performs line specific computations.

LOF

Loss of Frame

Loop Feeder Network

Remote FT-2000s deployed in controlled environment vaults (CEVs) or office buildings.

Loop Timing
A timing mode in which the terminal derives its transmit timing from the received line signal.

LOP
Loss of Pointer

LOS
Loss of Signal

LSSW
The FT-2000 OC-48 Lightwave System Low-Speed Protection Switch circuit pack performs low-speed interface protection switching.

LTA
Lightwave Terminating Assembly

M

μm
Micrometer

Menu
A set of possible values for a parameter.

Midspan Meet
The capability to interface between two lightwave terminals of different vendors. This applies to high-speed optical interfaces.

Miscellaneous Discrete Interface
Allows an operations system to control and monitor equipment collocated within the FT-2000 OC-48 Lightwave System through a set of input and output contact closures.

MJ
Major (alarm)

MML
Human-Machine Language

MN
Minor (alarm)

MTBF
Mean Time Between Failures

MTBMA
Mean Time Between Maintenance Activities

Multiplexing
The process of combining several distinct digital signals into a single composite digital signal.

N

NE
  Network Element

NE ACTY
  Near-End Activity

NEBS
  Network Equipment-Building System

NID
  Node ID — A number used by software to uniquely identify Network Elements for loopback protection. In Releases 5.0 and earlier, this number was manually assigned. In subsequent releases, this number is generated automatically. Valid values are 0 - 15.

nm
  Nanometer (10^{-9} meters)

NMA
  Network Monitoring and Analysis System

NMON
  Not Monitored — A memory administrative state for ports.

Non-Preemptible Protection Access
  Non-preemptible protection access increases the available span capacity for traffic which does not require protection by the OC-48 ring, but which cannot be preempted. Each of the 24 STS-1 tributaries of protection capacity can independently be provisioned as non-preemptible. An STS-1 protection tributary which is provisioned as non-preemptible and the corresponding STS-1 service tributary (which it normally would protect) both become tributaries of unprotected non-preemptible capacity.

Nonrevertive switching
  In nonrevertive switching, there is a working and standby high-speed line, circuit pack, etc. When a protection switch occurs, the standby line, circuit pack, etc., is selected causing the old standby line, circuit pack, etc., to be used for the new working line, circuit pack, etc. The original working line, circuit pack, etc., becomes the standby line, circuit pack, etc. This status remains in effect when the fault clears. Therefore, this protections scheme is "nonrevertive" in that there is no switch back to the original status in effect before the fault occurred. See also 1+1 Line Protection.

NPPA
  Non-Preemptible Protection Access

NRZ
  Nonreturn to Zero

NSA
  Nonservice Affecting

NSAP Address
  Network Service Access Point Address — An automatically assigned number that uniquely identifies a Network Element for the purposes of routing DCC messages.

O

O&M

Operation and Maintenance

OALAN

Overhead Access Local Area Network — The internal local area network that provides communications between the System Controller circuit pack and the Overhead Controller circuit pack.

OAM&P

Operations, Administration, Maintenance, and Provisioning

OC, OC-n

Optical Carrier — The optical signal that results from an optical conversion of an STS signal; that is, OC-1 from STS-1 and OC-n from STS-n.

OC3

Optical Interface Circuit Pack — The FT-2000 OC-48 Lightwave System OC3 Optical Interface circuit pack interfaces with one bidirectional OC-3 signal.

OC48 RCVR

The FT-2000 OC-48 Lightwave System OC48 Receiver circuit pack interfaces to the incoming OC-48 line (receive direction).

OC48 TRMTR

The FT-2000 OC-48 Lightwave System OC48 Transmitter circuit pack interfaces to the outgoing OC-48 line (transmit direction).

OCC

Other Common Carrier

OHCTL

The FT-2000 OC-48 Lightwave System Overhead Controller circuit pack provides user access to the SONET overhead channels.

OOF

Out-of-Frame

Operations Interface

Any interface providing you with information on the system behavior or control. These include the equipment LEDs, user panel, CIT, office alarms, and all telemetry interfaces.

Operations Interworking

The capability to access, operate, provision, and administer remote systems through craft interface access from any site in a SONET network or from a centralized operations system.

OPS/INE

Operations System/Intelligent Network Elements System

Original Value Provisioning

Preprogramming of a system's original values at the factory. These values can be overridden using local or remote provisioning.

Optical Line Build-out (LBO)
An attenuator placed between FT-2000 OC-48 Lightwave systems and the LGX (or equivalent). It guarantees the optical level will be below the receiving equipment's maximum received power requirements.

OW
Orderwire — a dedicated voice-grade line for communications between maintenance and repair personnel.

OS
Operations System — A central computer-based system used to provide operations, administration, and maintenance functions.

P

Parameter
A characteristic of the system that affects its operation.

Path
A path at a given rate is a logical connection between the point at which a standard frame format for a signal at the given rate is assembled and the point at which the standard frame format for the signal is disassembled.

Path AIS
Path Alarm Indication Signal — A path level code that is sent downstream in a digital network to indicate that an upstream failure has been detected and alarmed.

Path Terminating Equipment
Network elements in which the path overhead is terminated.

Payload Pointer
The offset in bytes from the Pointer Action Byte (H3) to the beginning of the synchronous payload envelope.

PC
Personal Computer

PDI-P
STS Path Payload Defect Indicator — A range of values in the C2 byte of the STS-1 path overhead that indicates the STS termination sources a good STS path level signal containing a defective payload.

PJC
Pointer Justification Counts — A count of the STS-n pointer adjustments created or absorbed by a network element due to the differences in frame rates of the incoming and outgoing SONET signals.

Platform
In the FT-2000 OC-48 Lightwave System, a platform is a family of equipment and software configurations designed to support a particular application.

Plesiochronous Network
A network that contains multiple subnetworks, each internally synchronous and all operating at the same nominal frequency, but whose timing may be slightly different at any particular instant.

PLL
Phase Lock Loop

PM

Performance Monitoring — Measures the quality of service and identifies degrading or marginally operating systems (before an alarm would be generated).

POH

Path Overhead — Overhead assigned to and transported with the payload until the payload is demultiplexed. It is used for functions that are necessary to transport the payload.

Preprovisioning
The capability to provision a slot before installing a circuit pack.

Proactive Maintenance
Refers to the process of detecting degrading conditions not severe enough to initiate protection switching or alarming, but indicative of an impending signal fail or signal degrade defect.

PROTN
Protection

Provisioning
Assigning a value to a system parameter.

PWR
Power

Q

Quad
A circuit pack assembly comprised of four individual circuit packs. The quad must be placed in four consecutive slots on the low-speed shelf.

R

RAM
Random Access Memory

RDI
Remote Defect Indicator — [Previously called far-end-receive failure (FERF)] An indication returned to a transmitting terminal that the receiving terminal has detected an incoming section failure.

RDS
Ring Diversity Switch

Reactive Maintenance
Refers to detecting defects/failures and clearing them.

Repeater Bay (R-Bay)
This bay arrangement contains up to three independent 0x1 or 1x1 protected systems. The system is known as the Repeater Shelf—System Controller.

Revertive Switching
In revertive switching, there is a service and protection high-speed line, circuit pack, etc. When a protection switch occurs, the protection line, circuit pack, etc. is selected. When the fault clears, service "reverts" back to the original service line. See also 1x1 Line Protection.

RF
Radio Frequency

RFI
Remote Failure Indication — (Previously called yellow signals.) A signal that alerts upstream STS-1 path terminating equipment that a downstream failure has been alarmed along the STS-1 path. This action prevents multiple alarms from being activated for the same failure and ensures that craft will be dispatched to the correct location of the failure.

RMS
Root Mean Square

RPP
Reliability Prediction Procedure

RT
Remote Terminal

RTAC
Regional Technical Assistance Center

S

SA
Service Affecting

SD
Signal Degrade

Secondary Service
See extra traffic.

SEFS
Severely Errored Frame Seconds — A performance-monitoring parameter.

SES
Severely Errored Seconds — A performance-monitoring parameter.

SESP
P-bit Severely Errored Seconds — A performance-monitoring parameter.

SF
Signal Fail

Single-ended Operations
Single-ended operations capability provides operations support from a single location to remote Lucent Technologies network elements (NEs) that are in the same SONET subnetwork. With this capability you can perform operations, administration, maintenance, and provisioning on a centralized basis. The remote NEs can be those that are specified for the current release.

Site Address

The unique address for each regenerator or terminal in a repeatered span.

SONET

Synchronous Optical Network

SPE

Synchronous Payload Envelope — A 125-microsecond frame structure composed of STS path overhead and bandwidth for the payload.

Squelch Map

This map contains information for each cross-connection in the ring and indicates the source and destination nodes for the low-speed circuit that the cross-connection is part of. This information is used to prevent traffic misconnection in rings with isolated nodes or segments. (See also Cross-Connection Map.)

SNC-2000 Element Management System (EMS)

SNC-2000 EMS forwards messages (commands) from an OS to the Network Elements in the SONET network. It then collects and forwards the responses and autonomous messages from the Network Elements to the OS. The OS uses the information it receives to perform fault correlation and diagnose problems in the SONET network.

Subnetwork

A group of interconnected/interrelated network elements (NEs). The most common connotation is a SONET network in which the NEs have data communications channel (DCC) connectivity.

STS, STS-n

Synchronous Transport Signal — The basic logical building block signal with a rate of 51.840 Mb/s for an STS-1 signal and a rate of n times 51.840 Mb/s for an STS-n signal.

STS-1E

Synchronous Transport Signal level 1- Now referred to as EC-1. This refers to the actual physical representation of an electrical signal with an STS-1 format at a manual or electronic cross-connect interface. This signal is typically carried by coaxial cables from one equipment location to another. The term EC-1 not only refers to the organization and data rate of a signal but also to the voltage template the signal must conform to and the impedances for which the voltage template is valid.

STS1E

Synchronous Transport Signal level 1 - Interface Circuit Pack — The FT-2000 OC-48 Lightwave System STS1E Interface circuit pack interfaces with up to three bidirectional STS-1 signals.

SW

The FT-2000 OC-48 Lightwave System Switch circuit pack performs high-speed line protection switching.

Synchronous

Refers to network elements that are timed from references traceable to a single Stratum-1 source.

Synchronization Messages

The provisioning of a ring to take advantage of reconfiguration and reliability capabilities.

Synchronous Network

The synchronization of synchronous transmission systems with synchronous payloads to a master (network clock that can be traced to a single reference clock).

SYSCTL

The System Controller circuit pack and the System Memory circuit pack provide the highest level of system control for the FT-2000 OC-48 Lightwave System. The System Controller circuit pack provides overall administrative control of the system.

SYSMEM

The System Memory circuit pack and the System Controller circuit pack provide the highest level of system control for the FT-2000 OC-48 Lightwave System. The System Memory circuit pack provides memory support for the System Controller circuit pack.

T

T1X1 and T1M1

The American National Standards Institute (ANSI) committees responsible for telecommunications standards.

TA

Technical Advisory

TABS

Telemetry Asynchronous Byte Serial (Protocol)

TARP

Target ID Address Resolution Protocol

TBOS

Telemetry Byte-Oriented Serial (Protocol) — The FT-2000 OC-48 Lightwave System provides a serial telemetry interface that uses TBOS protocol. The serial telemetry interface is used to connect the FT-2000 OC-48 Lightwave System to the telemetry remote. This interface provides the operations system with enough alarm and status information to localize a problem and determine the severity.

TCA

Threshold-Crossing Alert — A condition set when a counter exceeds a user-selected high or low threshold. A TCA does not generate an alarm but is available on demand through the Craft Interface Terminal (CIT).

TCVCXO

Temperature-Compensated, Voltage-Controlled Crystal Oscillator

TG3 (DS1)

The FT-2000 OC-48 Lightwave System Timing Generator, Stratum 3 - DS1 circuit pack generates clock signals for distribution to the transmit circuits. It operates in the free running, loop timed, phase-locked, and holdover modes.

Through Timing

Refers to a network element that derives its transmit timing in the east direction from a received line signal in the east direction and its transmit timing in the west direction from a received line signal in the west direction.

TID

Terminal Identifier — A provisionable parameter used to identify an FT-2000 OC-48 Lightwave System. Typically, the TID is the CLLI[1] code of the FT-2000 1x1 End Terminal, FT-2000 Add/Drop-Rings Terminal, and FT-2000 Repeater Bays.

TL1

Transaction Language 1 — A machine-to-machine communications language that is a subset of the CCITT human-machine language.

TOHCTL

Tributary Overhead Controller. This FT-2000 OC-48 Add/Drop-Rings Terminal circuit pack provides user access to the SONET Section DCC (D1 - D3) bytes present in OC-3 low-speed interfaces that terminate in the Low-Speed Shelf—System Controller. The TOHCTL processes both the transmit and receive directions of the DCC. The circuit pack can terminate up to 8 OC-3 DCCs.

The TOHCTL also provides unidirectional 1+1 switching of the DCC for 1+1 protected OC-3 interfaces.

TSA

Time Slot Assignment. This is a capability of the FT-2000 OC-48 Add/Drop-Rings Terminal that allows any service STS-3 tributary to be cross-connected to any service low-speed interface slot or to the same-numbered service STS-3 tributary in the opposite direction.

TR

Technical Requirement.

Tributary

A 155 Mb/s signal (STS-3 level) within the FT-2000 OC-48 Lightwave System. The maximum capacity of an OC-48 signal is 16 tributaries.

TSI

Time Slot Interchange

TSO

Technical Support Organization

U

UAS

Unavailable Seconds

Upgrade

An upgrade is the addition of new capabilities (features). This requires new software and may require new hardware.

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1.   COMMON LANGUAGE is a registered trademark and CLEI, CLLI, CLCI, and CLFI are trademarks of Bell Communications Research, Inc.

V

Value

A number, text string, or other menu selection associated with a parameter.

VF Circuit

Voice frequency circuit — A 64 kilobit per second digitized signal.

VM

Violation Monitor — A provisionable mode for DS3 output that causes parity violations to be monitored but not corrected before the DS3 signal is B3ZS encoded.

VMR

Violation, Monitor, and Removal — A provisionable mode for DS3 output that causes parity violations to be monitored and corrected before the DS3 signal is B3ZS encoded.

VT

Virtual Tributary — A structure designed for transport and switching of sub-STS-1 payloads. There are currently four sizes: VT1.5 (1.728 Mb/s), VT2 (2.304 Mb/s), VT3 (3.456 Mb/s), and VT6 (6.912 Mb/s).

VT-G

Virtual Tributary Group — A 9-row by 12-column structure (108 bytes) that carries one or more VTs of the same size. Seven VT groups (756 bytes) are byte interleaved with the VT-organized synchronous payload envelope.

W

Wavelength Division Multiplexing

A means of increasing the information-carrying capacity of an optical fiber by simultaneously transmitting signals at different wavelengths.

WDM

Wavelength Division Multiplexing

Wideband Communications

Voice, data, and/or video communications at digital rates from DS0 to DS1 rates (64Kb/s to 1544Kb/s)

X

X.25 Interface/Protocol

The CCITT packet-switched interface standard for terminal access that specifies three protocol layers: physical, link, and packet for connection to a packet-switched data network (PSDN).

Z

Zero Code Suppression
A technique used to reduce the number of consecutive zeros in a line-codes signal (B3ZS for DS3 signals).

B

C

E

O

U