FOX-2R DS-2 FIBER OPTIC EXTENSION UNIT
GENERAL DESCRIPTION

1. GENERAL

1.01 This section is a cover sheet for the Telco Systems Fiber Optics Corporation FOX-2R DS-2 Fiber Optic Extension Unit General Description. This section is reproduced with permission of Telco Systems Fiber Optics Corporation and is the equivalent of Telco practice 831-100-001, Issue 1.

1.02 Whenever this section is reissued the reason(s) for reissue will be listed in this paragraph.

1.03 This section describes the basic functions and features of the Rack-Mounted FOX-2R DS-1/DS-2 Fiber Optic Extension Unit.

1.04 If corrections are required in the attached document, use Form-3973 as described in Section 000-010-015.

1.05 If equipment design and/or manufacturing problems should occur, refer to Section SW 010-522-906 for procedures on filing an Engineering complaint.

2. ORDERING PROCEDURE

2.01 For information concerning equipment and parts availability contact Telco Systems, Order Administration Department, in Norwood, Massachusetts, at:

1-800-44-SALES
1-617-551-0300

2.02 To order additional copies of this practice, use TELC 365-407-857SW as the section number.

3. REPAIR/RETURN

3.01 For defective modules and assemblies contact the Repair and Return Department at the following number:

8:00 a.m. - 5:00 p.m. (617) 551-0300 - Ext. 2778

Attachment: Telco Systems Fiber Optics Corporation
FOX-2R DS-2 Fiber Optic Extension Unit
General Description

FOX-2R DS-2 FIBER OPTIC EXTENSION UNIT
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CONTENTS PAGE

1. SCOPE

A. General

1.01 This section describes the basic functions and features of the Rack-Mounted FOX-2R DS-1/DS-2 Fiber Optic Extension. Figure 1-1 shows the FOX-2R unit with its front cover installed. Figure 1-2 illustrates the unit with front cover removed to display the circuit card layout and unit-level design of the FOX-2R.

1.02 Whenever this section is reissued, the reason for reissue will be listed in this paragraph.

2. MANUAL ORGANIZATION

2.01 This manual contains the following sections:

SECTION I: GENERAL DESCRIPTION provides an overview of FOX-2R operation with emphasis on features and functions incorporated into equipment design.

SECTION II: THEORY OF OPERATION presents a detailed discussion of equipment subsystems and circuit card operation to block diagram level.

SECTION III: ORDERING INFORMATION provides guidelines for subassembly and circuit card ordering.

SECTION IV: SPECIFICATIONS details unit-level physical and electrical specifications.

SECTION V: INSTALLATION provides instruction on unit installation, cabling, and equipment configuration.

SECTION VI: INITIAL OPERATION TESTING details all procedures required for circuit card optioning, unit turn-up, and equipment testing and alignment.

SECTION VII: MAINTENANCE details all procedures required for unit-level maintenance including fault isolation, card and module replacement, and the procedures necessary for the return and repair of equipment.

SECTION VIII: DRAWINGS provides equipment reference drawings, motherboard wiring schematics, and assembly prints to be used as an aid for detailed troubleshooting or installation as required.

1-1

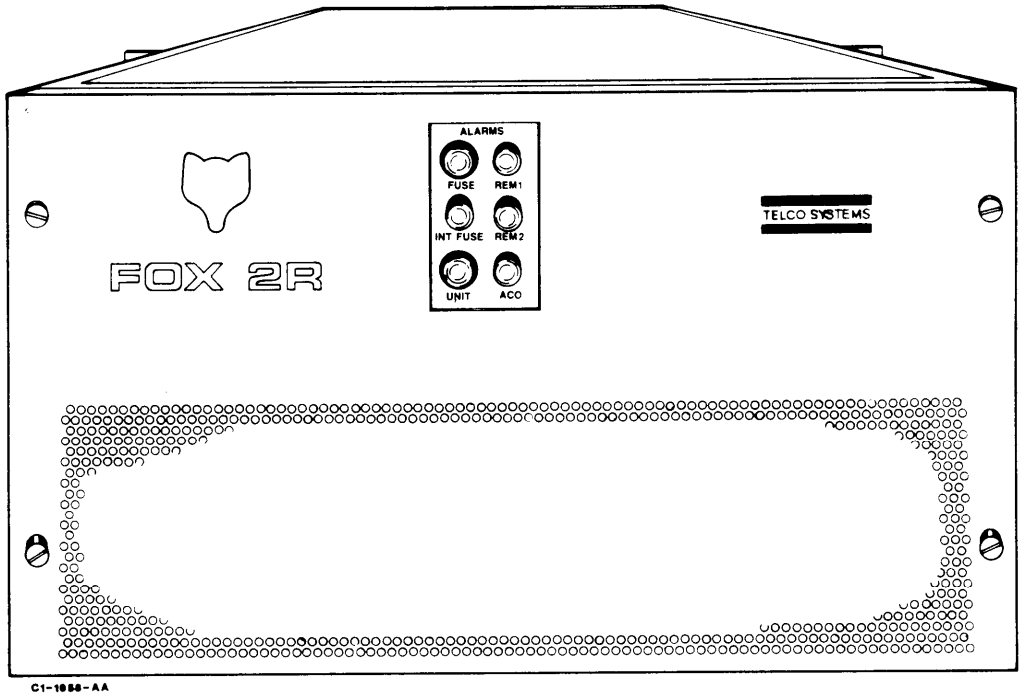

Figure 1-1. FOX-2R Fiber Optic Extension Unit (Cover Installed)

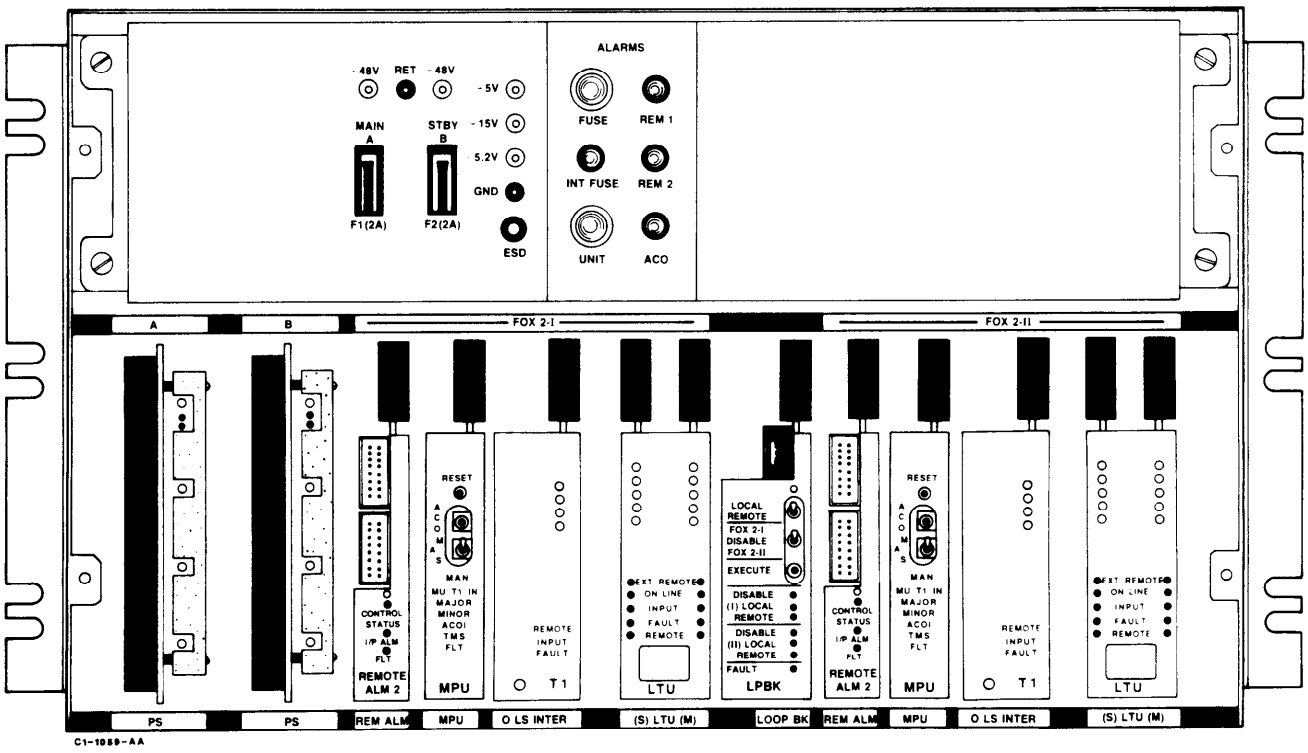

Figure 1-2. FOX-2R Fiber Optic Extension Unit (Cover Removed)

3. GENERAL INFORMATION

A. Safety Precautions

3.01 As with any product, care must be exercised when working near the -48 Vdc office power. Since the FOX-2R contains a Fuse and Alarm panel integrated into the basic equipment cage design, direct power connections from the office voltage source are possible without an external Fuse and Alarm Panel. Consequently, potentially high electrical currents might flow if the -48 Vdc terminals of TB-1 are inadvertently shorted to ground. Terminal TB-3 should be connected to the office ground system to reduce T1 line noise and provide electrical protection.

3.02 All cards and modules contained in the FOX-2R unit, with the exception of the Power Supply modules and the Fuse and Alarm Panel assembly, are designed to be able to be removed or installed without defusing the equipment.

WARNING: To prevent possible equipment damage from electrical arcing at the end of the -48 Vdc office power line, always defuse primary power before disconnecting the primary power to the unit. If the Fuse and Alarm Panel Assembly requires replacement, disconnect primary office power at the source.

3.03 Circuit cards can be damaged by static electrical discharge. Before handling any circuit cards, connect your wrist to an equipment frame ground using an approved anti-static wrist strap (EMX031-1). Ensure that all circuit cards removed from the equipment are properly stored in anti-static packing material (PKG033-1). When working with circuit cards, always place the card on an electrically grounded approved anti-static mat.

B. References

3.04 Since the FOX-2R may interface to an 828M/F, 828A/F, Channel Bank, or another FOX-2R or FOX-2 wall-mount unit, other reference material may be required for system-level installation and test. The following is a list of Operation and Maintenance manuals and practices that may be useful in the planning or installation phases of the FOX-2R Unit in conjunction with other Telco Systems transmission products.

TELCO SYSTEMS FIBER OPTICS CORPORATION:

828M Digital Multiplexer
Operation and Maintenance Manual

828A Digital Multiplexer
Operation and Maintenance Manual

828AF Digital Multiplexer
Operation and Maintenance Manual

TELTRAC Users Manual

TELTRAC Configuration Manual

TELCO SYSTEMS NETWORK ACCESS CORP:

DCB-24 Channel Bank:
Description/Installation/
Maintenance Practice
Section 2424-00-101
Installation/Maintenance Practice
Section DCB-24-200

DDI-24 Digital Drop/Insert System:
Description Practice
Section 2400-00-101
Installation Practice
Section 2400-00-200

TPS-4002 Digital Timeslot
Processing System
System Practice
Section 4002-100

NDI-2000 Network Digital Interface
Sections 2010-00-100, 2020-00-100,
and 2030-00-101

4. PRODUCT OVERVIEW

A. Unit Description

4.01 The FOX-2R is a dual 1:1 protected DS-2 fiber optic extension unit. It can be employed as a point-to-point DS-2 optical transmission system or as part of a DS-2 optical extension from an 828M/F or 828A/F MX-3 type multiplexer, depending upon the specific system application.

4.02 Each of the FOX-2R units, designated FOX-2R I and II, within the equipment cage contains the circuitry required to multiplex up to four T1 (1.544 Mb/s) or two T1C (3.152 Mb/s) channels into a DS-2 single-mode optical data channel. This composite optical data channel can therefore represent the combined transmission capacity of up to 96 voice or data channels (64 kb/s PCM) along with imbedded overhead supervisory information. To ensure sufficient data transitions to extract receive clock timing regardless of data stream content, the DS-2 data stream is 3B6B encoded into a 12.624 Mb/s data stream (2 x 6.312 Mb/s), which also accommodates an overhead channel for MPU-to-MPU communications. A fully loaded FOX-2R can handle a total of eight T1 or four T1C signals for a total of 192 (64 kb/s PCM) voice channels.

4.03 The unit is constructed as a single 19" rack-mountable cage which can be installed in standard equipment racks or within custom cabinetized systems (CET-1). The cabinet can be equipped for 117 Vac operation with integrated battery power reserve. The FOX-2R can be installed in equipment bays or cabinets in conjunction with other FOX-2Rs, 828M, 828A, or 828AF multiplexers, channel banks, and/or digital cross-connect systems, comprising a versatile fiber optic system suitable for central office, fiber hub, and/or customer premises system applications.

4.04 Four different circuit cards comprise a single unprotected unit within the FOX-2R equipment cage. These circuit cards perform line coding/decoding, multiplexing/demultiplexing, channel synchronization, fiber optic transmission and circuit control functions. Part numbers for these circuit cards are listed below:

Power Supply: PSX016-1
Main Light Transmission Unit (LTU):
CCA148G
Control MPU: CCA137G21
T1 Low-Speed Interface Card:
CCA050G1, CCA124G1 or CCA161G2
OR
T1C Low-Speed Interface:
CCA006G1

4.05 To equip the second unit for unprotected operation, requires a second Low Speed Interface, LTU, and MPU circuit cards. Another power supply (PSX016-1) and standby LTU(s) (CCA149G1) for each main LTU card can be installed for optional 1:1 power supply and optical interface equipment protection. The muldem circuits of each Low Speed Interface card, which are responsible for M12 multiplexing and demultiplexing of the DS-2 data channel are internally 1:1 protected with redundant circuitry and provision for circuit card replacement without service interruption.

4.06 Each Control Microprocessor Unit (MPU) card is responsible for monitoring equipment operation, illuminating fault and status LEDs in response to equipment performance failure or degradation, and initiating automatic switching to redundant circuitry, to maintain uninterrupted service operation. The FOX-2R equipment cage contains two MPUs, each dedicated to its respective FOX-2R unit, to provide independent fault monitoring, alarm reporting, data channel switching, and loopback.

4.07 In the transmit direction, incoming T1 or T1C signals from channel banks or related T1 transmission equipment are time-division multiplexed into a single DS-2 (6.312 Mb/s) data channel and converted into a 1300 nm single-mode optical signal, for transmission to another FOX-2R, 828A, or 828AF multiplexer. Optical transmission is accomplished via the Light Transmission Unit (LTU) card, which amplitude modulates a single-mode Light-Emitting-Diode (LED) to generate a 12.624 Mb/s optical transmission carrier employing 3B6B data encoding.

4.08 The incoming 12.624 Mb/s optical transmission from the remote system end is coupled into the receive circuits of the LTU, where an avalanche photodiode detector converts optical data stream into an electrical signal. Associated clock timing is extracted from data transitions by LTU phase-locked loop clock recovery circuits. Special 3B6B data encoding by the transmit circuitry of the far-end LTU ensures the presence of regular data transitions, to facilitate clock recovery regardless of data content. Synchronizing on imbedded framing information, the receive circuits of the LS Interface card multiplex the DS-2 (6.312 Mb/s) data and timing streams into industry-standard T1 or T1C channels for electrical interface via shielded twisted-pair cable to downline T1 or T1C equipment.

4.09 In the presence of an alarm condition, the far-end FOX-2R unit transmits remote fault information to the local unit, illuminating remote LEDs on corresponding circuit cards which aids in system-level fault diagnosis.

4.10 During an alarm condition, the MPU activates UNIT and MAJOR or MINOR (NO/NC) fault reporting relays to provide contact closures for use by auxiliary customer premises audible or visual alarm reporting equipment. Primary power fuse failures within the Fuse and Alarm Panel assembly are also reported via FUSE alarm relay contact closure. A customer selectable alarm cutoff (ACO) function disables relay contact closure to audible or both audible and visual alarm reporting equipment.

4.11 If the network is equipped for TELTRAC (Telco Systems Telecommunications Remote Alarm and Control), the control MPU transmits alarm and telemetry information and responds to remote commands and interrogation from a central TELTRAC master terminal station via an 828A/AF multiplexer.

4.12 When used as DS-2 optical extensions from an 828A or 828AF multiplexer, each FOX-2R communicates with TELTRAC via the multiplexer. Alarm telemetry and control information is transmitted to/from the multiplexer via an overhead channel, imbedded in the optical span line coding. An optional Control MPU (CCA135G1) installed in the 828A or 828AF is responsible for TELTRAC network interface to all remote FOX-2 units.

4.13 Through the use of an optional Remote Alarm Card, the presence of up to eight equipment fault conditions from an external device(s) can initiate local major or minor fault conditions and be reported to the far-end, using the Remote 1 or 2 fault indicators. When equipped for TELTRAC, each external alarm point can be uniquely labeled and identified.

4.14 The Remote Alarm card also provides up to eight addressable relay contact closures, which can be remotely activated on command to control external equipment operation. Up to two Remote Alarm cards (one per FOX-2R unit) can be installed in the FOX-2R cage.

B. Features

Equipment Size

4.15 A fully loaded FOX-2R unit, equipped for 1:1 protection, is configured as a single shelf unit which occupies 10.4 inches of rack space (equivalent to 6 rack mount spaces of 1.75" each) in a standard 19-inch equipment rack. Mounting ear extensions allow for 23-inch rack mounting if required. Full dimensions are: 19" wide x 10.4" high x 12" deep. Up to seven FOX-2Rs can be mounted into a standard 7-foot bay. Figure 1-3 illustrates various bay configurations for the FOX-2R used in conjunction with other Telco Systems Fiber Optics Corp. and Telco Systems Network Access Corp. Products.

State-of-the-Art Technology

4.16 Circuit cards used in the FOX-2R employ the latest VLSI technology, including the use of programmable gate arrays, thin-film, and surface-mount technology for superior reliability and lower power consumption.

Transmission Capacity

4.17 Each fully loaded FOX-2R unit can multiplex up to four T1 signals or two T1C signals (per FOX 2-I or FOX 2-II unit) into a single 12.624 Mb/s single-mode optical data stream. A fully loaded equipment cage can accommodate up to eight T1 or four T1C channels.

Channel Expansion

4.18 Channel capacity is expandable from one to four T1 or up to two T1C channels, (for a single FOX-2R I or II unit) or up to eight T1 or four T1C channels or their T1 equivalent for the entire FOX-2R equipment cage. As T1/T1C channels are added to the system, no hardware reconfiguration is required. Additional channels are automatically acknowledged by the MPUs at the time that valid data is initially applied to each channel.

Selectable Low Speed Interface

4.19 Each FOX-2R unit can be equipped for T1 or T1C channel interface by installing the appropriate Low-Speed Interface card.

4.20 User selectable AMI (Alternate Mark Inversion) or B8ZS (Bipolar with 8 Zero Substitution) can be optioned on a per T1 channel basis via a four-pole front-mounted DIP switch on the T1 Low Speed Interface card (CCA161G1).

Equipment Protection

4.21 Fully redundant 1:1 equipment protection of all transmission multiplexing, optical transmission circuit cards, and power supplies is integrated into the unit-level architecture of the FOX-2R. Main and standby LTU circuit cards provide redundant fiber optic transmission protection. T1 and T1C Low Speed Interface cards contain on-board integrated 1:1 protection of all M12 multiplexing circuitry.

4.22 All circuitry is monitored for equipment failure by the Control MPU, which initiates automatic switching to protection circuitry in the presence of a hardware failure or when the predetermined BER switching threshold (10^{-6}) is exceeded. For maintenance purposes, the FOX-2R can be switched manually to standby circuitry via the Control MPU card, the Manual Interface card, or via an external network monitoring system, such as TELTRAC .

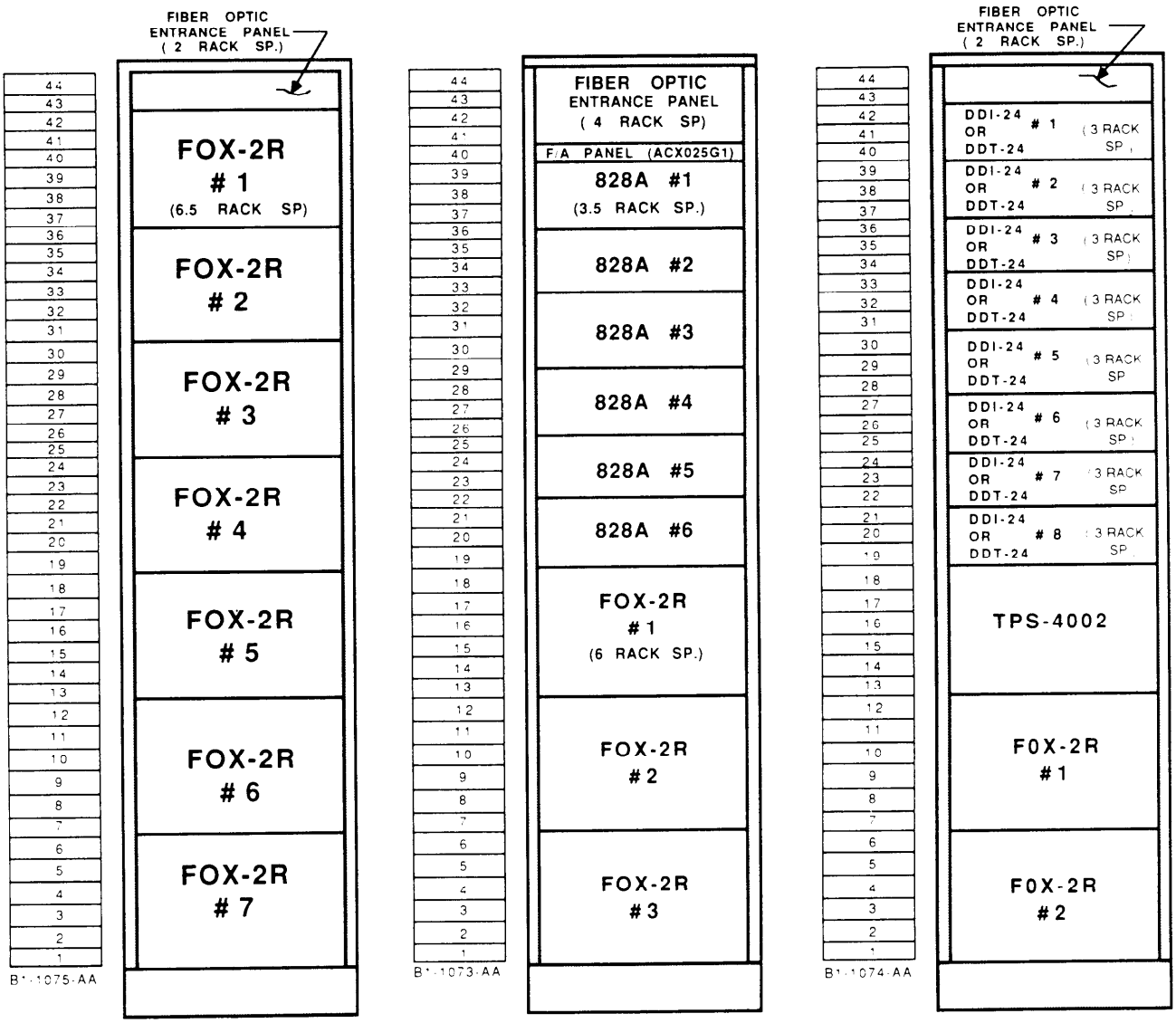

Figure 1-3. FOX-2R Rack Configurations

Integrated FOX-2R Fuse and Alarm Panel

4.23 The FOX-2R equipment cage contains an integrated Fuse and Alarm Panel to provide a direct fused, filtered, and regulated primary power interface without requiring the use of an external Fuse and Alarm Panel.

4.24 Convenient front-mounted test jacks allow for the measurement of -48 Vdc primary office voltage and +5, +15 and -5.2 secondary power supply voltages, without accessing the rear panel of the equipment cage.

Comprehensive Fault Monitoring

4.25 The FOX-2R is under the control of an internal microprocessor. The microprocessor monitors various alarm functions in the FOX-2R and illuminates fault and status LEDs to identify a defective card. The microprocessor also:

- o Monitors transmission quality,
- o Calculates the Bit Error Rate (BER),
- o Illuminates a FAULT LED on the MPU card when the BER exceeds a predetermined threshold,
- o Performs automatic protection switching to redundant circuitry.

The Control MPU also:

- o Communicates with TELTRAC,
- o Exchanges remote fault information with the far-end MPU,
- o Initiates DS-1 or DS-2 loopbacks on request,
- o Provides external alarm hardware notification via relay contact closure,
- o Configures and controls all unit-level operation.

Alarm Lockout

4.26 Through the use of lockout software, down-line sympathetic alarm conditions are suppressed or "locked out" so that only the suspected card is indicated. This prevents multiple alarms and assists in fault isolation.

Remote Fault Display

4.27 In the presence of a far-end equipment fault, remote fault indicators are illuminated for each FOX-2R unit individually on the Fuse and Alarm Panel assembly. Circuit card remote fault LEDs likewise illuminate to indicate specific far-end fault conditions.

External Alarm Reporting

4.28 Each FOX-2R is equipped with Major, Minor, Fuse, and ACO relays which are activated during fault conditions, to provide both N/O and N/C relay contact closures for remote alarm reporting to external alarm equipment. Fuse fault relay contact indicates the loss of a PS-1 or PS-2 primary power fuse. Major or minor relay contact closure, acknowledging the presence of traffic-affecting or potentially traffic-affecting faults, can be remoted to visual and audible customer supplied alarm reporting equipment. If the alarm cutoff (ACO) mode is activated, alarm reporting via Major or Minor Audible contacts are silenced while the corresponding Visual contact closures are unaffected. Remote alarm relay contacts (Remote 1 or 2) are energized in response to the receipt of a remote fault condition from the corresponding far-end unit, indicating remote unit trouble.

4.29 A single 38-pin jack provides a single connectorized alarm interface to remote its Unit, Fuse, Major, Minor, and Remote I and II alarms to external alarm reporting equipment without the use of an external Fuse and Alarm Panel. However, in applications where the FOX-2R is installed in bays containing 828A or 828AF multiplexers, two ribbon cable connectors (J16 and J17) allow the FOX-2R to interconnect its Major, Minor, and Unit alarms to an external Fuse and Alarm Panel (ACX025G1), to provide a common alarm interface for all units.

4.30 Unit, Fuse, ACO, Int Fuse and Remote (1 & 2) alarm indicator lamps are provided on the front of the FOX-2R Fuse and Alarm Panel, for visual unit-level fault indication.

Maintenance Interface Card

4.31 The Maintenance Interface card allows the testing of replacement T1 and T1C low-speed interface cards prior to in-service application, without traffic interruption. Test data is inserted into the replacement cards through built-in test jacks on the Maintenance Interface card.

T1 Monitor Card

4.32 An optional T1 Monitor Card (CCA176G1) is available to provide isolated bridging monitor jacks for each T1 channel, to measure on-line T1 line performance using external T1 test equipment. This circuit card also allows direct channel interconnection, for T1 signal injection to facilitate unit-level installation and test without requiring a DSX-1 cross-connect, or patch panel facility for T1 channel access.

Remote Monitoring System

4.33 The Control MPU card can interface with a TELTRAC network. TELTRAC provides comprehensive network remote alarm and status reporting and control. In addition, diagnostic fault isolation and remote controlled switching is provided.

Custom Cabinetized Configurations

4.34 Since the FOX-2R is designed for standard 19-inch rack mounting, custom cabinetized configurations of the FOX-2R with other Telco Systems' products or accessories are also available. This self-contained CET-1 equipment enclosure can be equipped for 117 Vac operation with backup battery protection for up to eight hours of power reserve. It is ideally suited for permanent customer premises installation and can be readily used for temporary service restoration, rerouting projects, or emergency service.

5. SYSTEM APPLICATIONS

5.01 The following section explores the system application possibilities of the FOX-2R to address specific network requirements.

A. Terminal Application

5.02 A point-to-point optical DS-2 transmission can be constructed by interconnecting two FOX-2R units at the terminal ends of a single-mode fiber optic span. T1 transmission equipment which could utilize the FOX-2R includes channel banks, network terminal interfaces, digital switches, and/or digital cross-connect systems (DCSs). Figure 1-4 illustrates a point-to-point terminal system application, employing terminal channel bank to transmit voice and data information between terminal system ends via DS-2 optical transmission.

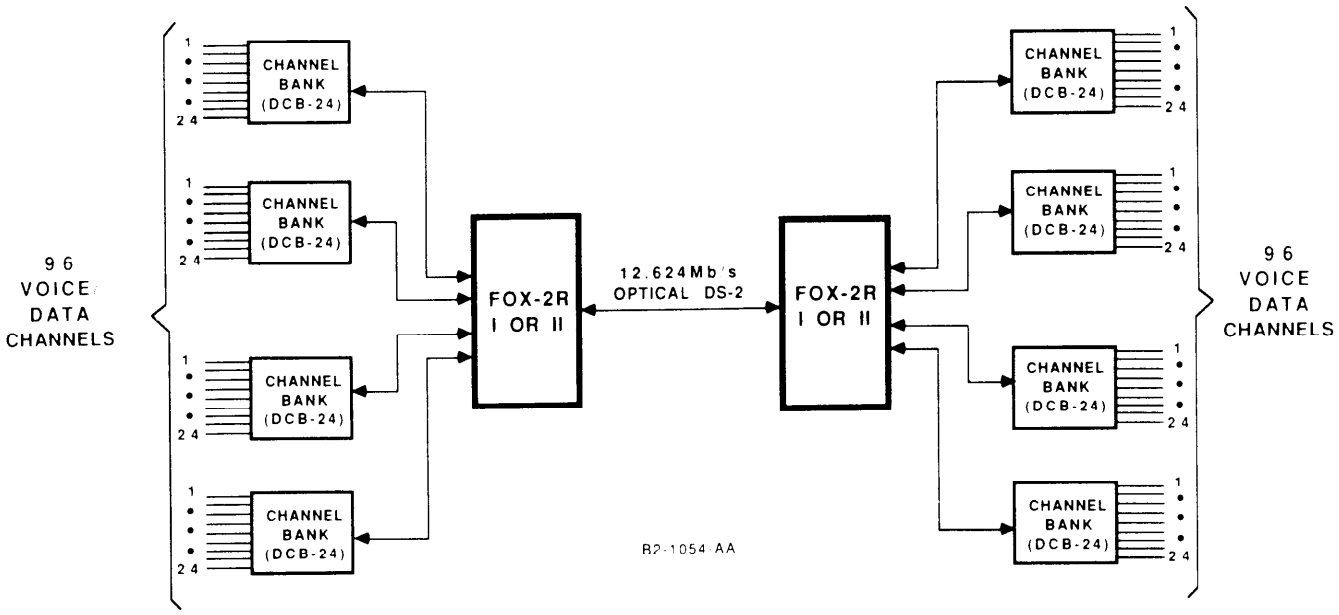

Figure 1-4. FOX-2R Point-to-Point Terminal Application

B. Drop/Insert Application

5.03 An intermediate location along a DS-2 interoffice fiber optic trunk requires T1 access to support local voice and/or data service (see Figure 1-5). Since the FOX-2R is designed as a dual DS-2 optical unit, each unit (FOX-2R I and II) of the dual FOX-2R equipment cage can be interconnected back-to-back at the T1 unit interface. One or more T1 channels can be dropped and inserted to/from channel banks or T1 multiplexers. The remaining T1 channels are multiplexed back into the DS-2 optical trunk and continue downline to the next site location.

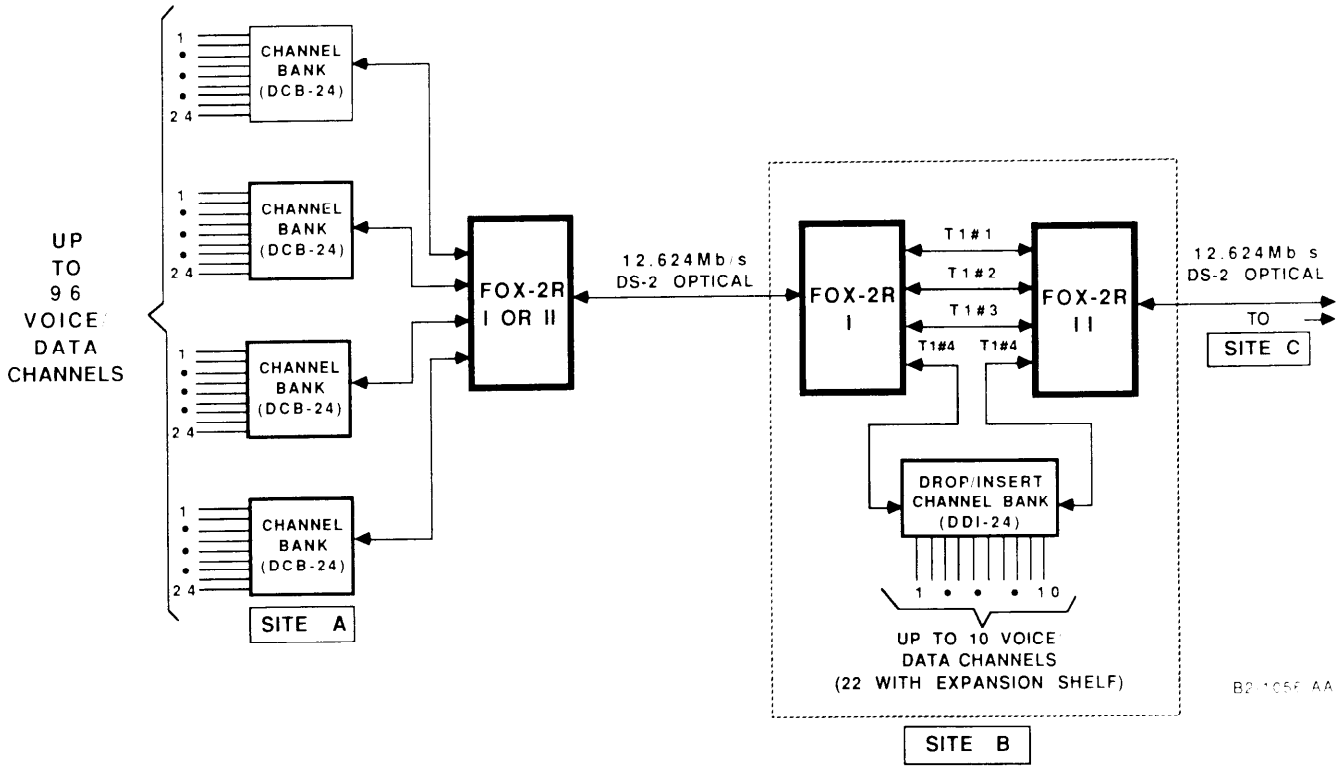

Figure 1-5. FOX-2R (I and II) Drop and Insert Application

C. DS-2 Fiber Optic Extension Application

5.04 An 828A or 828AF multiplexer provides T1 service at a central office or hub location which must route up to four T1 channels to a distant customer premises site or another telephone office (see Figure 1-6). Instead of constructing multiple repeatered T1 metallic spans, an optical Low-Speed Interface card (LTU) provides a DS-2 optical extension directly from the multiplexer to a remote FOX-2 wall-mount or rack-mount unit at the customer location.

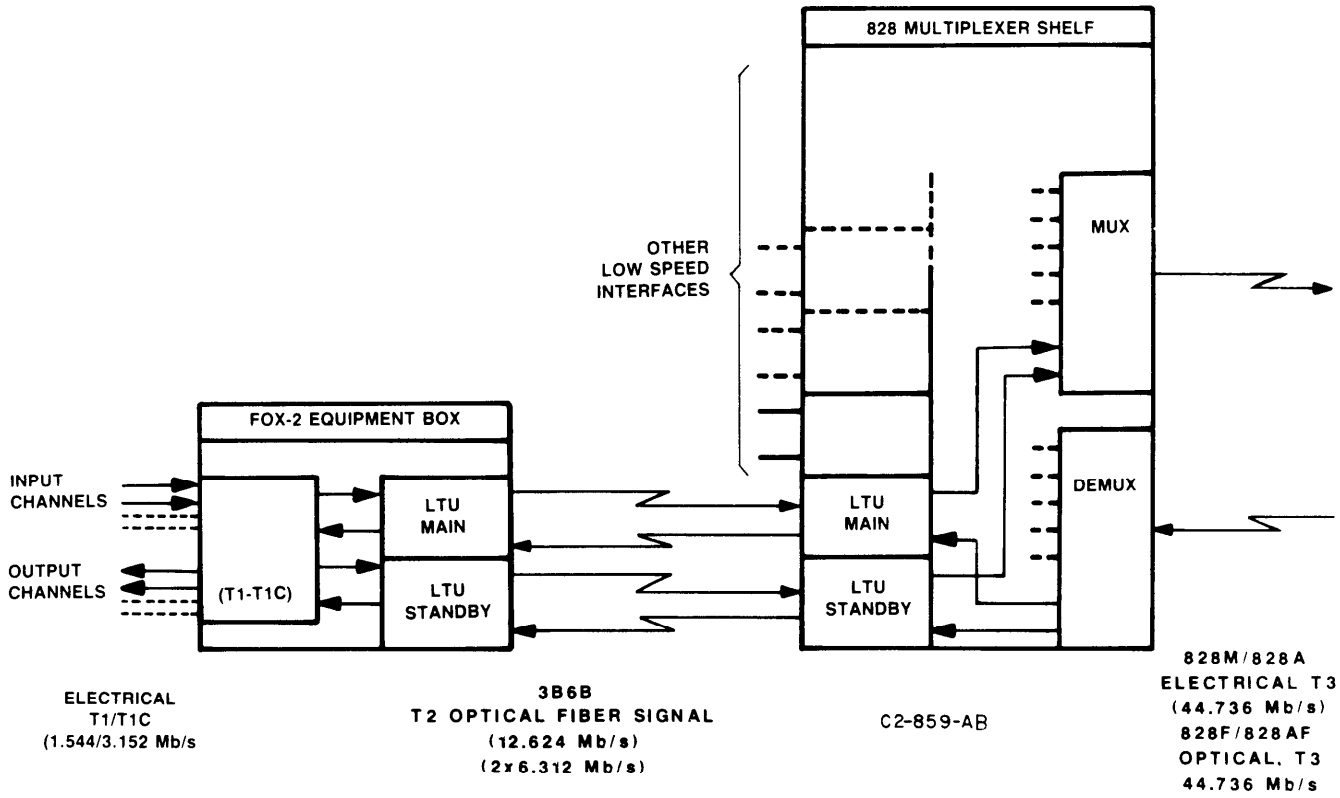

Figure 1-6. FOX-2R DS-2 Fiber Optic Optical Extension Application

D. DS-2 Fiber Optic Hub Distribution

5.05 An optical DS-3 (44.736 Mb/s) transmission trunk interconnecting a central office and hub distribution center can be subdivided into six DS-2 optical extensions, to provide high-capacity transmission to individual terminal end users (see Figure 1-7). LTU cards installed in the low-speed section of the 828AF multiplexer as required, provide independent DS-2 optical spur links from the central hubbing location.

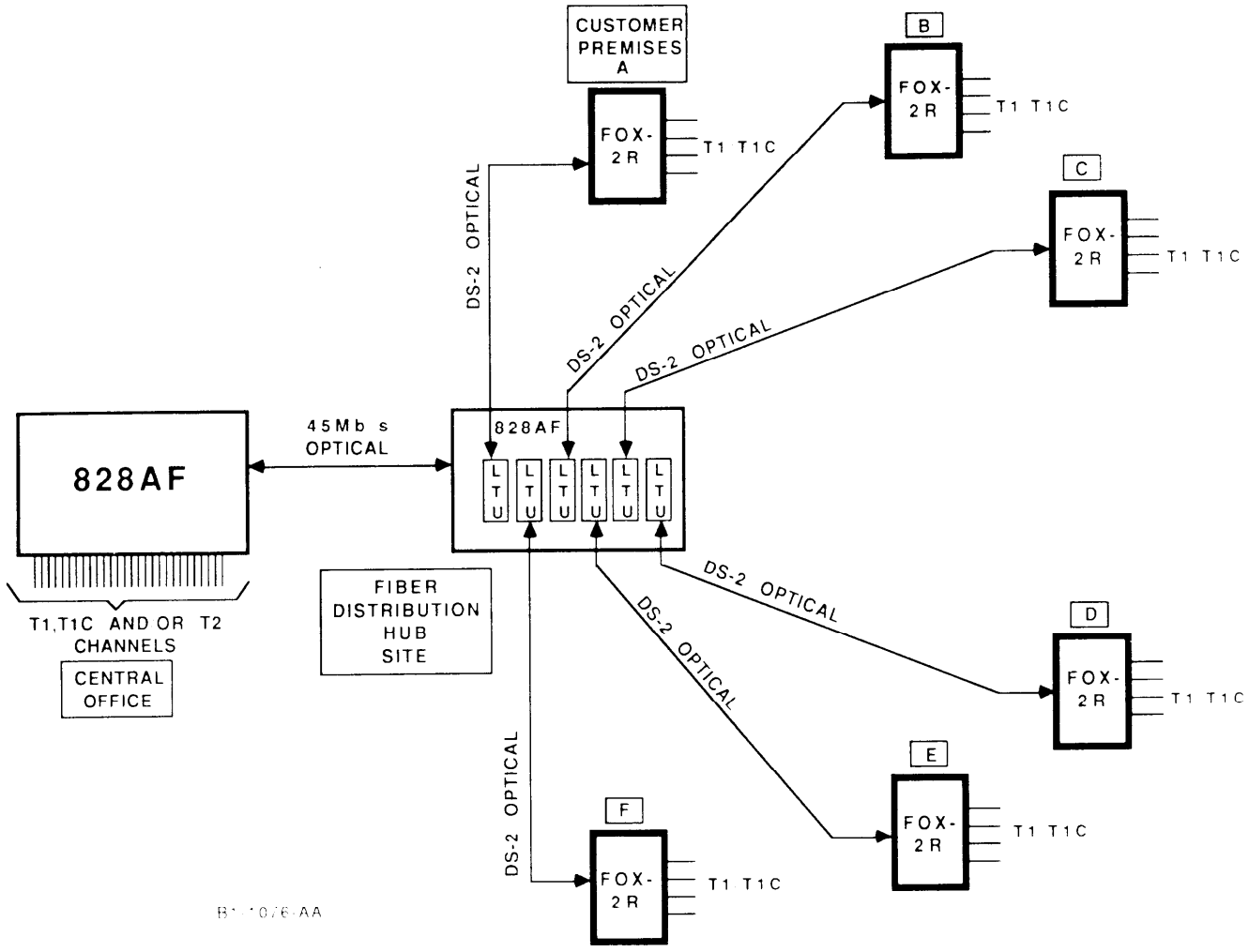

Figure 1-7. 828AF/FOX-2R Fiber Optic Hub Distribution Application

E. Switched Network Application

5.06 A digital cross-connect system (DCS) could be included in FOX-2R terminal or drop/insert site locations, to provide DS-0 channel routing capabilities between customer premises locations as part of a DS-2 optical local area network (see Figure 1-8). Such network flexibility allows the routing and density of data traffic between network nodes, to be dynamically adjusted according to changing customer requirements.

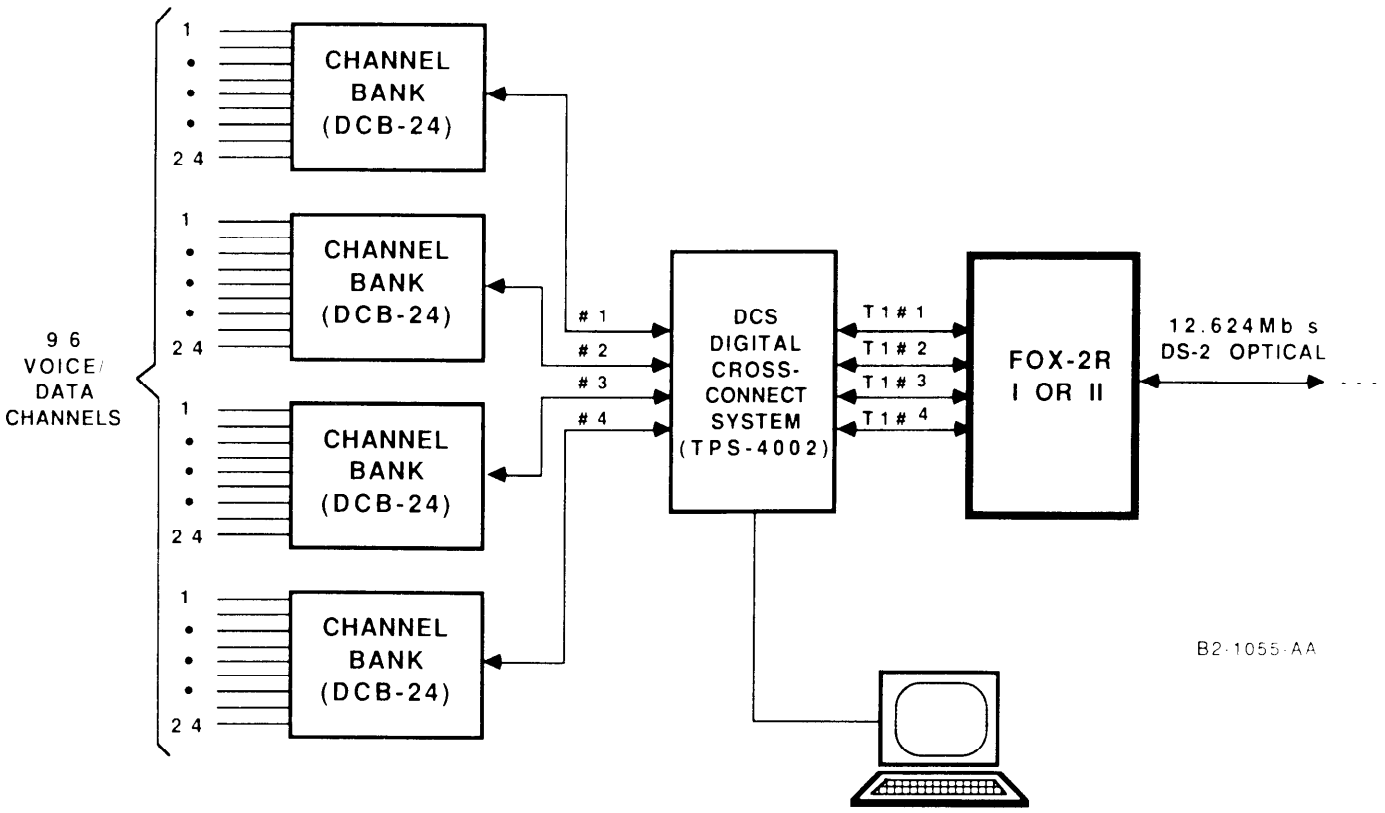

Figure 1-8. FOX-2R/DCS Switched Network Application