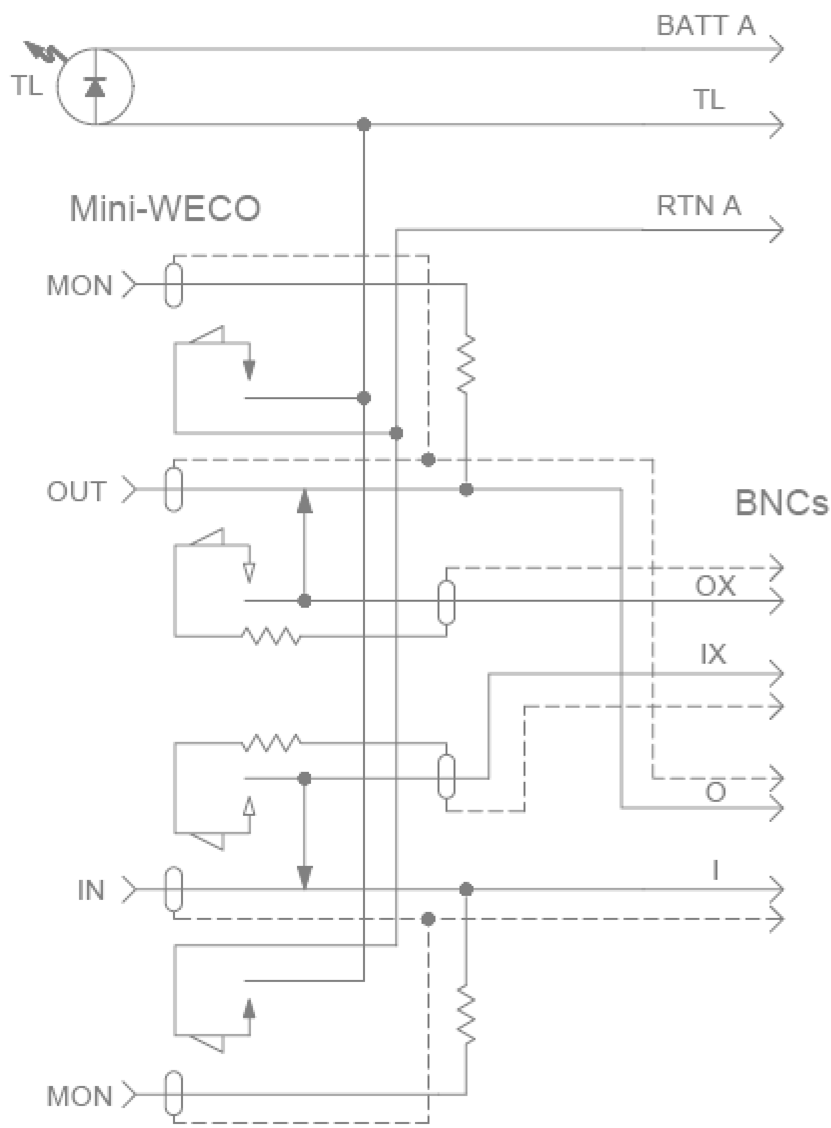
DSX-3

Technical Reference Guide



CONNECTING THE FUTURE®

DSX-3

Technical Reference Guide, part number 119178 A0.1

1730 N Madson St., Liberty Lake, Washington

About Telect

Telect offers complete solutions for physical layer connectivity, power, equipment housing and other network infrastructure equipment. From outside plant and central office to inside the home, Telect draws on more than 25 years of experience to deliver leading edge product and service solutions. Telect is committed to providing superior customer service and is capable of meeting the dynamic demands of customer and industry requirements. This commitment to customer and industry excellence has positioned Telect as a leading connectivity and power solution provider for the global communications industry.

Technical Support

E-mail: getinfo@telect.com

Phone: 888-821-4856 or 509-921-6161

DSX-3

Technical Reference Guide

Table of Contents

List of Figures

Chapter 1: About DSX-3 Systems — An Overview

1.1 Description

A digital signal cross-connect (DSX) is a central terminal for digital equipment at a particular digital signal bit rate, providing both permanent and temporary connections. DSX test ports provide bridged and series access for test or patching.

A DSX-3 is a high-density device for cross-connecting the DS3, STS-1, STS-3, and E3 signal types from broadband equipment, such as digital radio, fiber-optic multiplexers, and 3:3 or 3:1 DCS.

1.1.1 Hard Wire vs. DSX

"Hard wire" is direct cabling between network elements (NEs). Such an arrangement has the following disadvantages:

- Difficult cable management.
- Inadequate access for testing and monitoring.
- Hard to add on or rearrange, affecting circuit integrity.
- Circuit back-up in case of failure can be difficult; service down-time could be lengthy.

Terminating digital network equipment at a DSX has these advantages over hard-wired arrangements:

- The DSX can handle a large number of terminations in a nonblocking arrangement.
- Network equipment can be handled or coordinated efficiently, in spite of location at the site.
- Grooming—adding, removing, rearranging circuit connections—is easier.
- Fast service recovery and alternate routing are possible in case of NE failure.
- The DSX provides quick access to circuits for testing and monitoring (intrusive or nonintrusive).
- Circuits can be rolled with minimal interruption of circuit integrity.

- LEDs give visual indication of completed cross-connects.

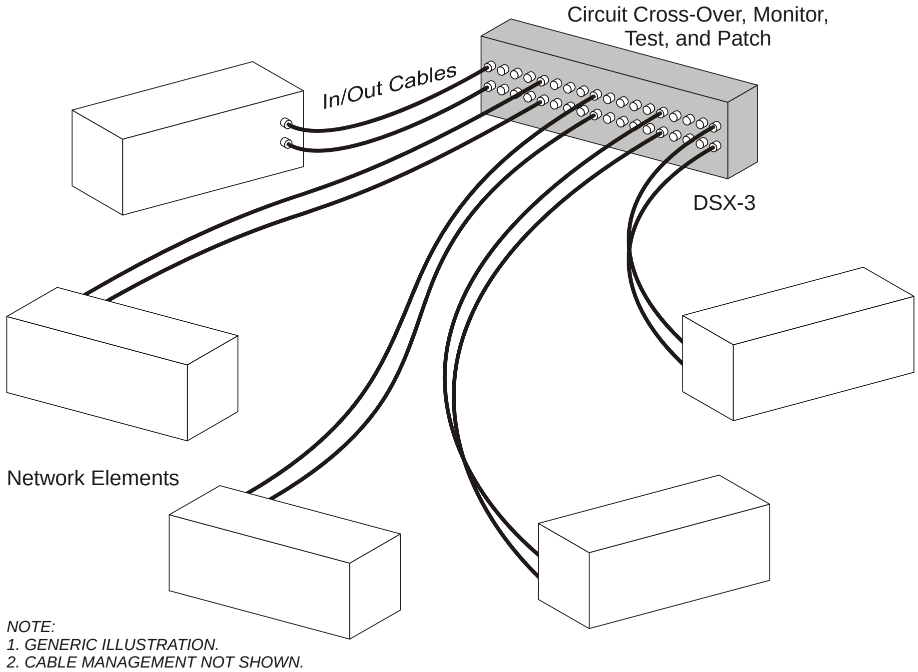


Figure 1 - Cross-connects

1.2 Terminology

Digital Signal (DS)—One of several transmission rates in the time-division multiplex hierarchy.

DS3 (T3)—The digital signal rate of 44.736 Mbps (45 MBps, generically), accommodating 672 voice channels (28 T1s). This is the signal rate handled by DSX-3 equipment.

DS Equipment—System/network elements, not including DSX-3 panels.

DSX-3 Panel—The individual cross-connect panel or shelf equipment, installed in a bay or mounted on a wall.

DSX-3 Bay—The individual rack structure that contains DSX-3 panels, associated communication panels, terminal strips, blocks, and test and maintenance equipment required for DSX-3 frame support. Cable and wire management are included with the bays.

DSX-3 Frame—A generic term for one or more DSX-3 bays equipped with all necessary equipment to perform all DSX-3 functions.

DSX-3 Network—Includes one or more interlinked DSX frames, at a single location, that perform all DSX-3 functions in common. *A single bay could comprise the entire network.*

DSX-3 System—A DSX-3 network that includes all operating equipment terminated at the DSX-3 frames, cabling, support services, planning, engineering records, assignment, and operations support.

Digital Multiplexers (MUX)—Equipment that interfaces different bit rates to a single transmit path in the digital network. Multiplexing combines individual channels into common bit streams. Demultiplexing separates the channels out again.

Tie Frames—Provide electrical access and connection points between physically separated DSX-3 frames within an office environment.

Span—A digital line between two offices or between an office and a remote site, run through repeater equipment.

Distributing Frame—Interconnection points that provide telecommunications services to customers. Distributing frames provide termination for facilities and equipment, cross-connection, support for electrical protection devices, and test access.

Decibel (dB)—A unit of measure that expresses the ratio of two voltages, currents, or powers. The dB specifies transmission loss, gain, or relative level of the digital signal.

Relay Rack—A generic term for the mounting structure that contains telecommunications operating equipment. The relay rack is the base structure for the physical DSX-3 frame.

Churn—A common term for connection, disconnection, and rearrangement activities at a DSX-3 frame.

Roll—Move an in-service circuit to another termination with minimal effect to signal transmission.

Tracer—An LED, usually called a “lamp,” that gives the user a visual indication of a successful cross-connect (completed circuit). The terms tracer, lamp, and LED, in connection with this function, are used interchangeably in this reference guide.

Line-up—A frame of bays, side-by-side, in a straight line.

Jumper—Cross-connect wire.

STS—Sonet transport signal.

STM—Synchronous transport mode.

1.3 DSX-3 System Elements

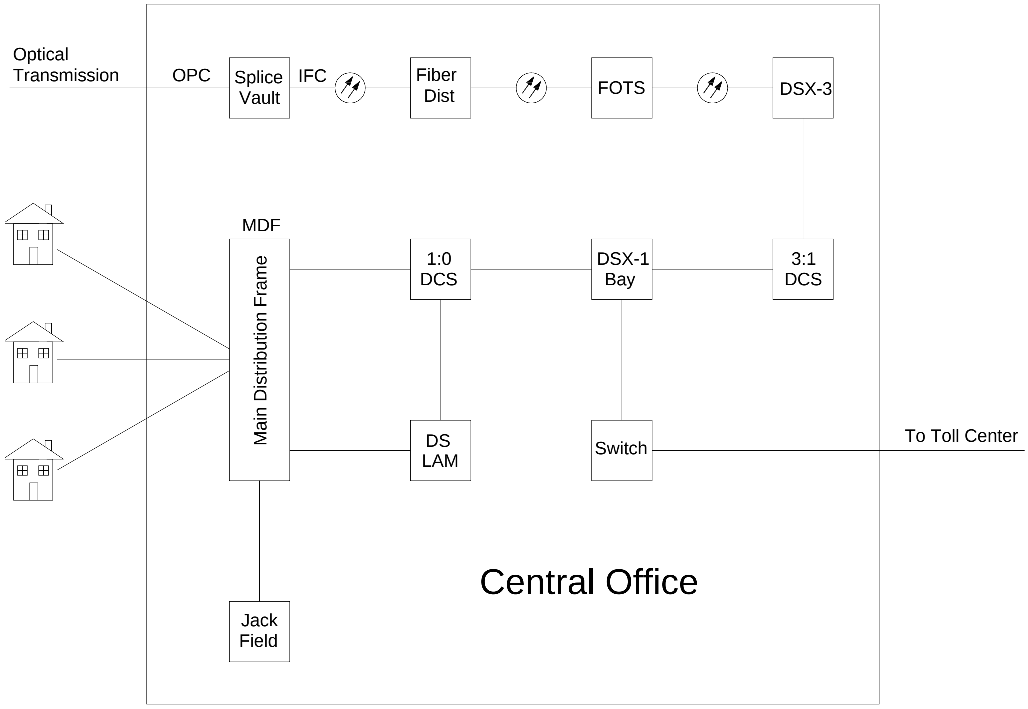


Figure 2 - Example of Network

DSX-3 networks are suitable for large and small central offices, remote sites, and customer premise locations. A large digital system (DS) environment can consist of several equipment frames located on several floors, separate areas, or in remote extended offices that serve a specific population center.

Network Elements (NE) terminate at DSX-3 panels mounted in bays in the DSX frame. Such elements include fiber-optic equipment, DCS, routers, digital radios, network office terminating equipment, and digital switches. The frame bays may also include patch, cross-aisle, and power-distribution panels and test equipment.

1.3.1 DSX-3 Panels

1.3.1.1 Size

The total number of DSX jacks determines the circuit size of the panel. Most panels are designed in increments of eight circuits. Standard configurations are 24- and 32-circuit terminations.

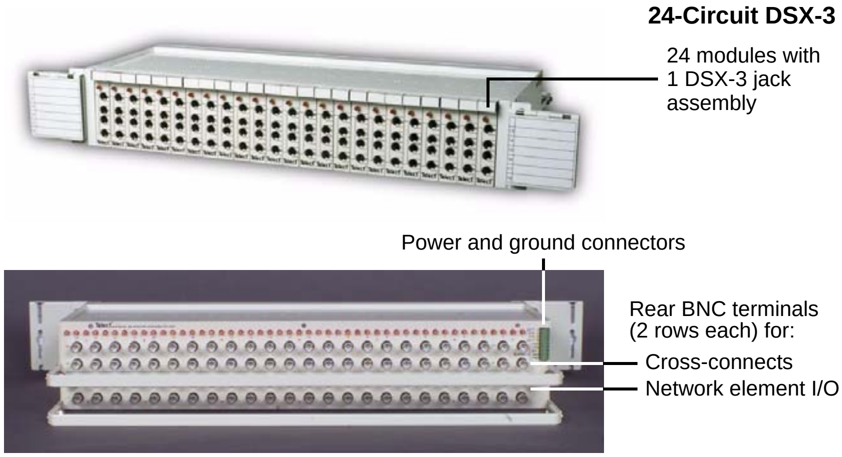


Figure 3 - 24-circuit DSX-3

1.3.1.2 Rear Access

A DSX-3 panel that provides cross-connects and NE terminations at the rear of the panel, with temporary port access at the front, is called a rear access cross-connect panel. The preceding illustration shows a 4-port panel with MiniWECO jack at the front and cross-connect BNC at the rear.

1.3.1.3 Front Access

If all cross-connects and temporary port access are on the front of a panel, then the panel is called a front-access panel. Normally, the NE terminations are on the rear.

The illustration on the right shows a 5-port module containing three MiniWECO jacks for temporary patching and two MiniWECO jacks for cross connections—all on the front. The NE terminations on the rear plug into the backplane of a configurable panel.

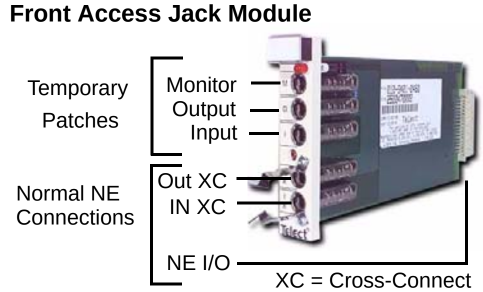


Figure 4 - 5-port module

If a panel provides all temporary cross-connect and port access *and* NE termination at the front, it is called a total front access (TFA) panel. A 6-port TFA jack module is shown on the right. All BNC connections and MiniWECO jacks are on the front.

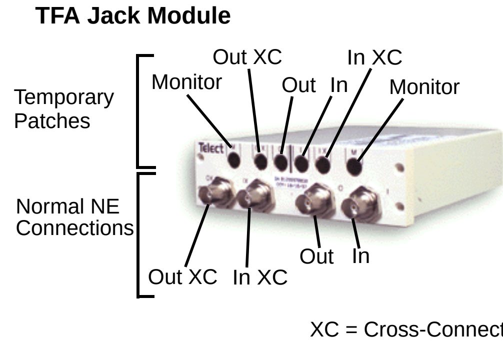


Figure 5 - 6-port TFA jack module

1.3.1.4 Jack Modules

The main component of a DSX-3 panel is the jack module. These modules allow for an expandable number of circuits within the panel chassis.

Each module has at least three ports—MON, OUT, and IN. Four and six ports are also possible, with a fourth port providing monitor capability of the “in” signal, and ports five and six providing access to the cross-connects. The monitor ports provide -20 dB of paralleled isolation between the output/input port and itself. The following figure shows a 4-port module

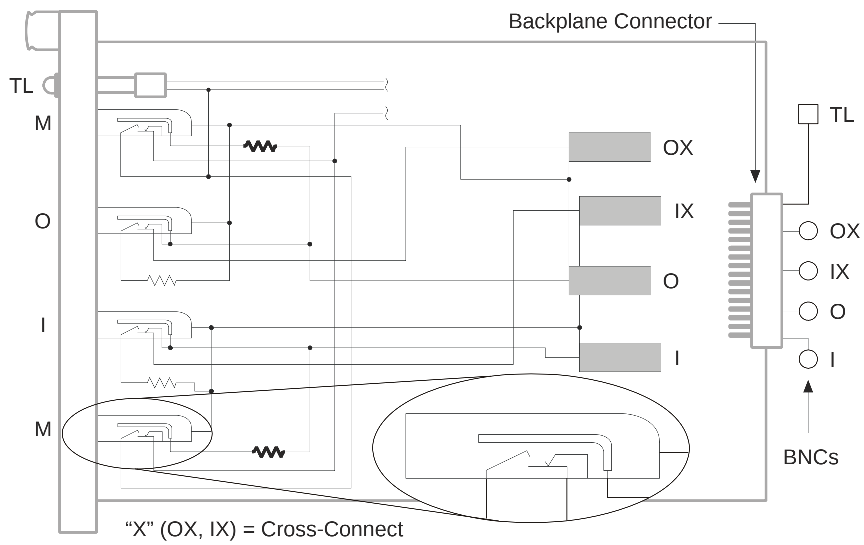


Figure 6 - 4-port module

The input (IN) jack provides serial access to the signals going into the connected NE. The output (OUT) jack provides serial access to signals coming out from the connected NE.

1.3.1.5 Backplane

The backplane connects the jack modules to the BNC and tracer lamp (TL) connectors and provides five cross-connect terminals. Four of these complete signal connections between NEs. The fifth is a tracer lamp terminal. Tracer lamps identify circuit routing when the tracer terminals of that circuit are connected.

1.3.1.6 Patch Cords

Patch cords temporarily route digital signals during turn-up, rollover, reconfiguration, modification, and testing of a DSX-3 frame.

1.3.2 DSX-3 Bay Configuration

A bay is a 7-foot relay rack loaded with equipment. Besides DSX-3 panels, a bay may include such equipment as cross-aisle panels and test equipment. DSX-3 panel height determines the number of panels contained within a bay. One DC power distribution panel, located at the top of the bay, is normally included in the configuration.

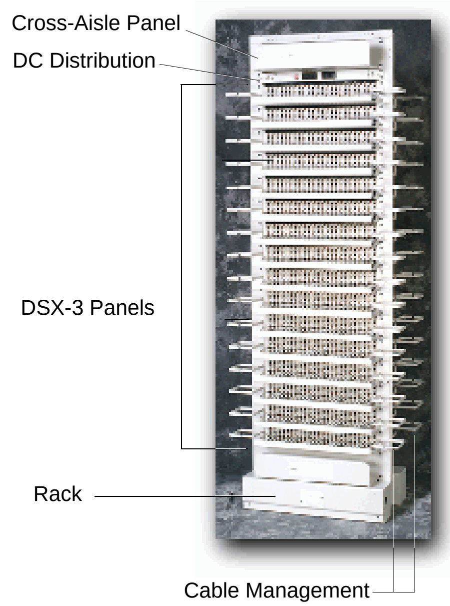


Figure 7 - Bay

1.3.2.1 DC Distribution Panel

The distribution panel must provide enough fuse or circuit breaker positions and load capability to support all the equipment in the DSX-3 bay. DSX-3 bay equipment is normally dc powered, but certain types of test equipment may require AC power. DSX-3 panels need DC power to operate the tracer lamps.

Figure 8 - Fuse Panel

Other types of equipment, such as amplifiers and regenerators, are usually service-affecting and should be powered by a dual-feed DC distribution panel.

1.3.2.2 Cross-Aisle Panels

These panels *cross-connect* between DSX-3 bays that are not in the same line-up. Cross-aisle panels eliminate the need to route jumpers outside of the DSX cross-connect pathways. At least two cross-aisle panels are needed in a DSX-3 frame to accommodate this feature. Tie cables provide the interconnection between the two panels. Cross-aisle panels are available in both straight feed-through connections and cross-over feed-through connections.

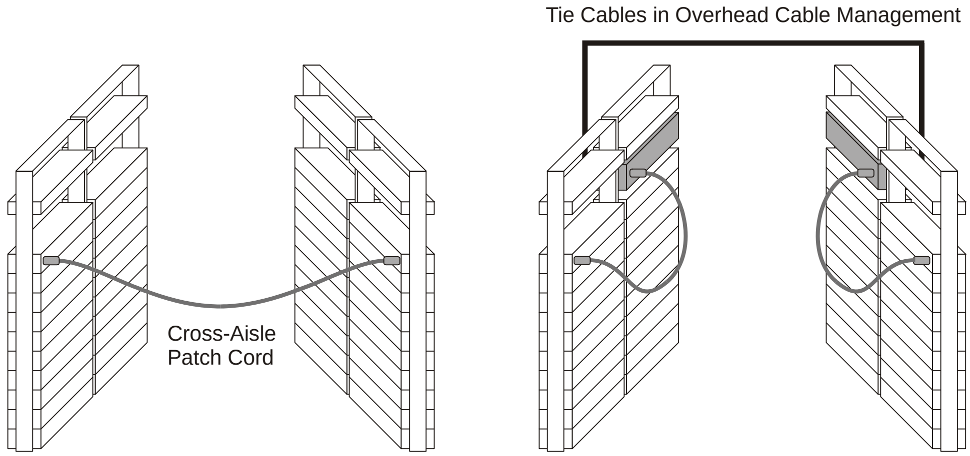


Figure 9 - Interbay Patch

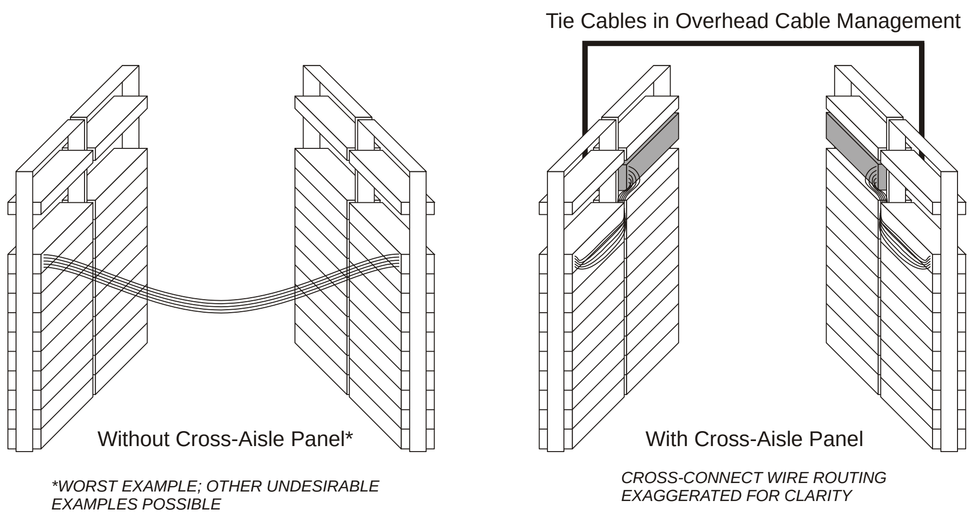


Figure 10 - Cross-aisle Patch

1.3.2.3 Test Equipment

Auxiliary DSX test equipment located in the frame should be capable of driving idle lines during system turn-up, and connecting unassigned and maintenance lines. The test equipment provides a controlled, error-free test signal for use during installation, troubleshooting, and stressing of span lines suspected of being marginal.

1.3.3 Cables

BNC cables connect the network equipment to the DSX-3. BNC cables also connect the in/out circuits of the equipment at the cross-connect ports of the DSX-3.

1.3.3.1 Cable Management

- Overhead cable ladders
- Retainer rings and troughs on racks
- Wire trays or tie-down bars

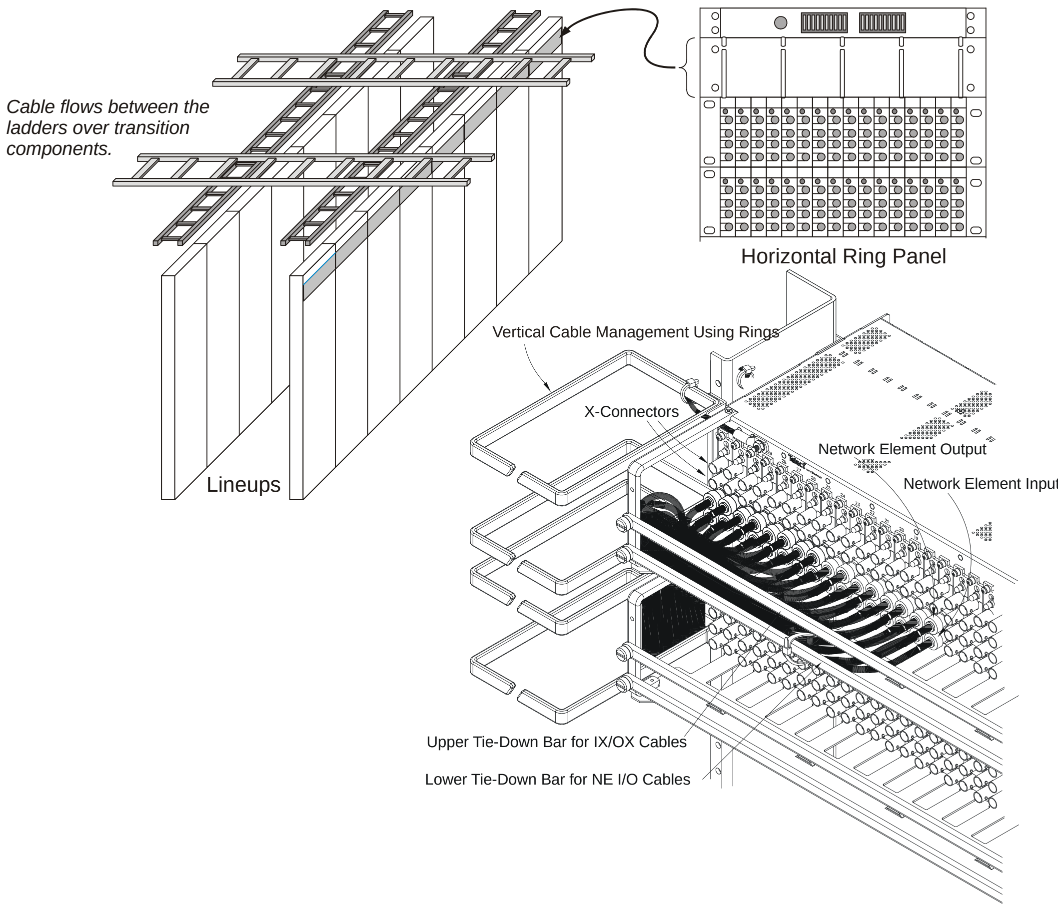


Figure 11 - Cable Management

1.4 System Issues

1.4.1 Unbalanced Line or Circuit

If the two sides of the line or circuit are not equal in series resistance, series inductance, shunt capacitance, or leakage to ground, the line or circuit is "unbalanced." DSX-3 coaxial cable is an example of unbalanced cable. European standards refer to unbalanced pair cable as "unsymmetrical."

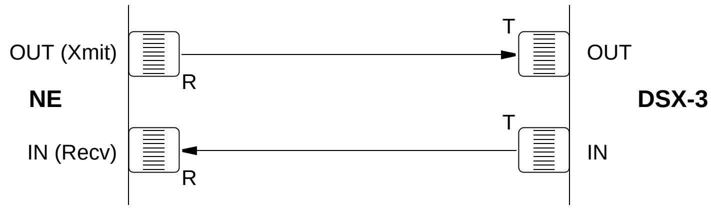


Figure 12 - DSX-3 Cable

1.4.2 Impedance

This is the total resistance and capacitive/inductive reactance that opposes the flow of alternating current. Equipment input load and the specified frequency determine the impedance for a given circuit. Cable design and materials determine a transmission line's characteristic impedance. Impedance matching between the source and load is critical for maximum transfer of the digital signal.

Standard line/circuit impedance is 75 ohms at 22.368 MHz (T3).

1.4.3 Line Build-Out

Line build-out (LBO) is intentionally attenuating the signal level at the last NE in a span to equalize the circuit (reduce distortion and improve frequency response). While normal cable attenuation might perform this function, varying cable lengths usually mean that a technician must measure output signal levels and then adjust LBO as necessary at the last NE (at an LBO "pad"). LBO can be manually or software controlled.

1.5 Signal Characteristics

1.5.1 Signal Problems

1.5.1.1 Crosstalk

Crosstalk is the unwanted coupling of a signal from one circuit to an adjacent signal on a separate circuit. The result is the faint speech or tone heard in one (disturbed) circuit, coming from the adjacent (disturbing) circuit.

Adjacent signal paths in a DSX-3 network are designed to have a crosstalk loss of -60 dB or greater loss.

1.5.1.2 Jitter

Jitter is a variation or oscillation of pulse spacing in an otherwise regular digital signal. A DSX-3 frame with proper signal levels and matched impedance will not contribute to this effect.

1.5.2 Signal Losses

1.5.2.1 Insertion Loss

This is the total loss created by the terminal connections at the DSX-3 panel and the DSX-3 jack assembly at half line rate (22.368 MHz, T3) through the DSX-3 equipment or frame. Insertion loss must be less than 1.15 dB.

1.5.2.2 Line Loss

The total signal loss between equipment terminations, including all components of the DSX-3 frame, in each direction of transmission, should not exceed 12.15 dB at half line rate (22.368 MHz, T3).

1.5.2.3 Return Loss

The sum of reflected losses at half line rate (22.368 MHz, T3) must be equal to -26 dB or greater loss.

1.6 Digital Signal Rate Standards

1.6.1 North America

1.6.1.1 DS0

An individual time slot of 64 kbps on a DS1 signal.

1.6.1.2 T1 or DS1 Signal

Digitally multiplexed channel consisting of 24 DS0s (numbered 1 through 24). Data transmission rate is 1.544 Mbps.

1.6.1.3 T3 or DS3 Signal

Digitally multiplexed channel consisting of 28 T1s. Data transmission rate is 44.736 Mbps.

1.6.2 Europe

1.6.2.1 E0

An individual time slot of 64 kbps on an E1 signal.

1.6.2.1 E1

Digitally multiplexed channel consisting of 32 E0s (numbered 0 through 31). Data transmission rate is 2.048 Mbps.

1.6.2.1 E3

Basic multiplexed channel consisting of 16 E1s. Data transmission rate is 34.368 Mbps.

1.6.3 Synchronous Digital Hierarchy (SDH)

SDH is a world standard developed in 1989 that addresses interworking between the North American and European transmission hierarchies.

1.6.4 Sonet Transport Signal

1.6.4.1 STS-1

Digitally multiplexed optical channel consisting of 1 T3. Data transmission rate is 51.84 Mbps.

1.6.4.2 STS-3

Digitally multiplexed optical channel consisting of 3 T3s. Data transmission rate is 155.52 Mbps.

1.6.4.3 STS-12

Digitally multiplexed optical channel consisting of 12 T3s. Data transmission rate is 622.08 Mbps.

1.6.4.4 STS-48

Digitally multiplexed optical channel consisting of 48 T3s. Data transmission rate is 2488.32 Mbps.

1.6.4.5 STS-192

Digitally multiplexed optical channel consisting of 192 T3s. Data transmission rate is 9953.28 Mbps.

1.6.5 Synchronous Transport Module

1.6.5.1 STM-1

Digitally multiplexed optical channel consisting of 3 E3s. Data transmission rate is 155.52 Mbps.

1.6.5.2 STM-4

Digitally multiplexed optical channel consisting of 12 E3s. Data transmission rate is 622.08 Mbps.

1.6.5.3 STM-16

Digitally multiplexed optical channel consisting of 48 E3s. Data transmission rate is 2488.32 Mbps.

1.6.5.4 STM-64

Digitally multiplexed optical channel consisting of 192 E3s. Data transmission rate is 9953.28 Mbps.

1.7 Signal Paths

This is an overview to give a sense of DSX-3 signal flow. The illustration on the next page gives a more specific example, as you might see at a telecom network site.

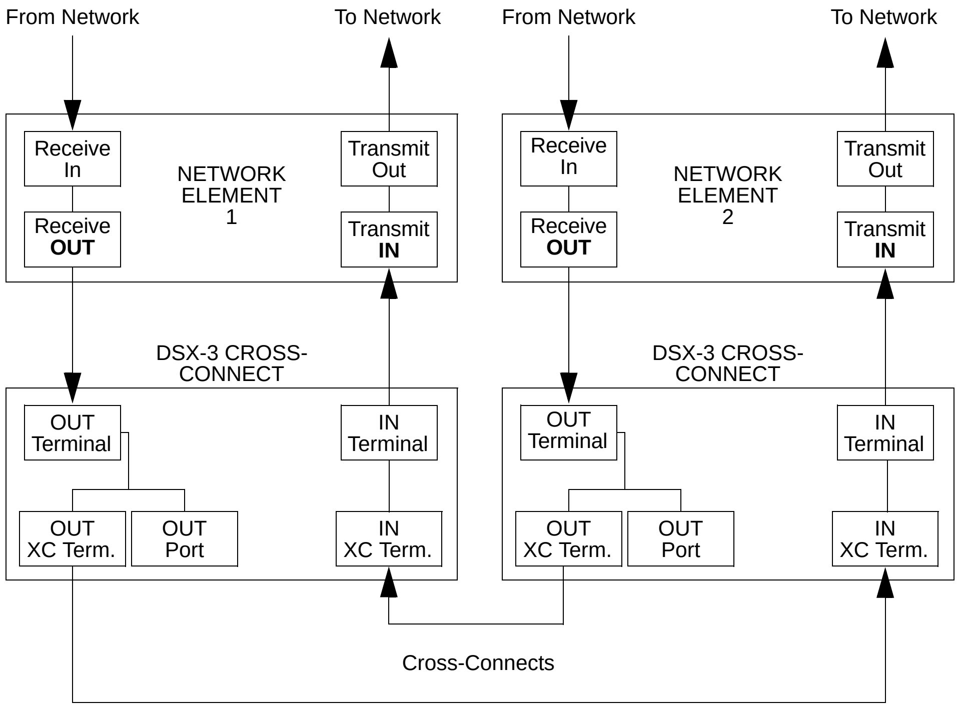
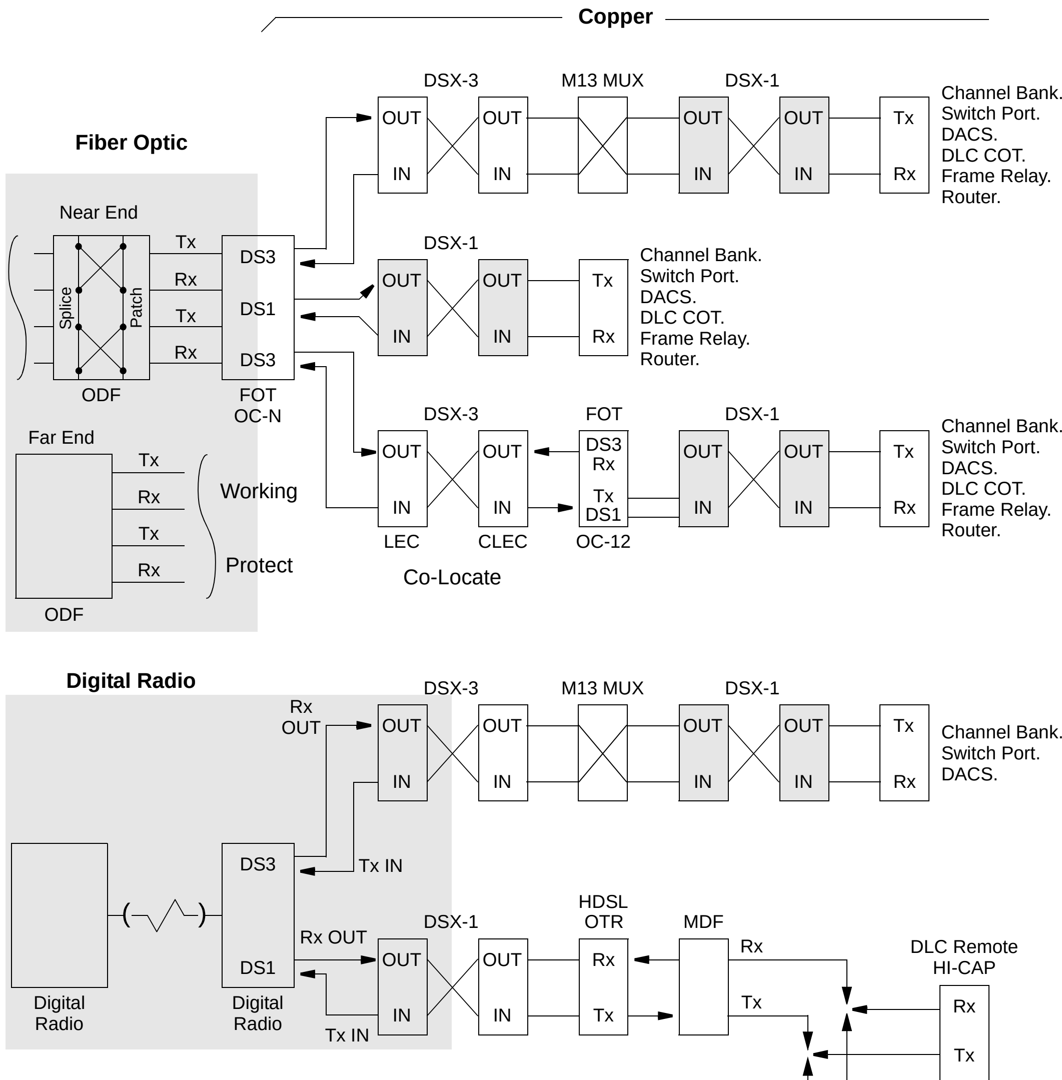


Figure 13 - Signal Flow



DLC COT	Digital loop carrier, central office terminal
ODF	Optical distribution frame
FOT	Fiber optic terminal
OC-N	Optical carrier-[number]
LEC	Local exchange carrier
CLEC	Competitive local exchange carrier
HI-CAP	High capacity
HDSL	High bit rate digital subscriber line
OTR	Office terminating repeater
MDF	Main distribution frame

Figure 14 - Example of Signal Flow

1.7.1 Transmit and Receive Terminals and Ports

These establish the path direction for the signals to be connected to the DSX-3 frame. The in and out terminals of the DSX-3 are extensions of the network element (NE)—"in" at the DSX-3 is the same as "in" at the NE; the same is true for "out." This illustration generically diagrams signal flow in a DSX-3 system:

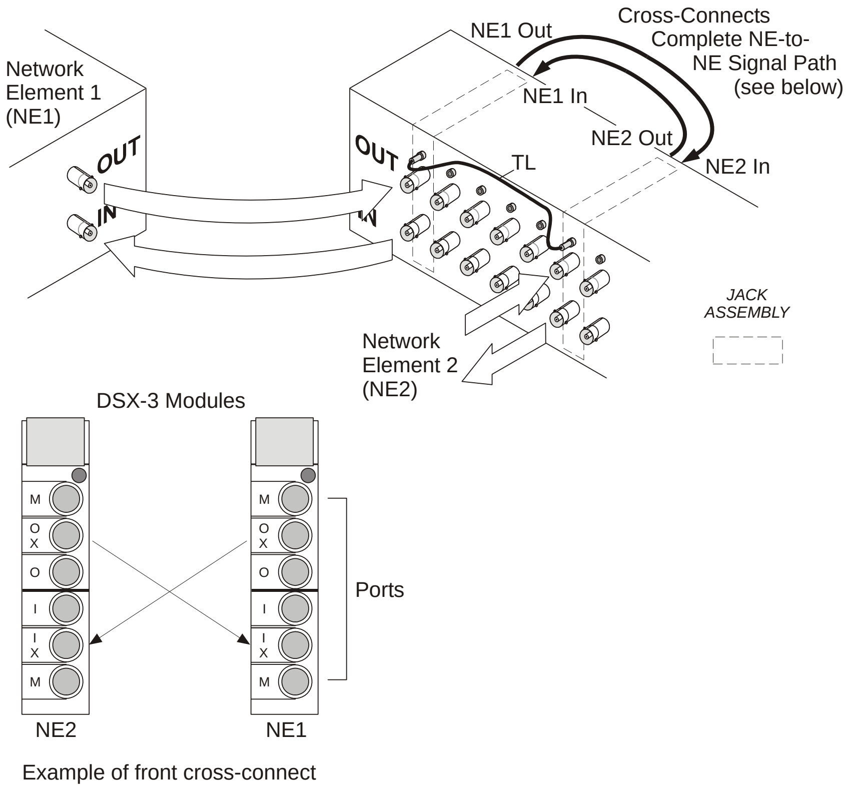


Figure 15 - Example of Signal Flow in a DSX-3 System

1.7.2 Cross-Connects

The input and output terminals must be "rolled" or electrically crossed over to complete a circuit path. The OX and IX cross-connect ports at the DSX-3 accomplish this. Connecting the output of a circuit to the respective input of another completes the transmit and receive loop.

1.7.2.1 Ports

An OX or IX cross-connect port, located on either the front or rear of the DSX-3, is an extension of the input or output terminal. If no jack plug is in the input or output ports, BNC cables connect the cross-connect ports directly to the NE's associated input/output terminals at the DSX-3.

1.7.2.2 Cross-Connect Cables

The maximum length of cross-connect cable is 27 feet (8.2m).

1.7.2.3 Cross-Connect Pathways

These are routing methods for cross-connection coax jumpers. The pathway is formed by DSX-3 cable trays, cable rings, cross-aisle panels, and cable routing devices that control the direction and location of the cable or wire.

1.7.2.4 Tracer Lamps

Tracer lamps or LEDs provide a visual identification of cross-connect circuit paths within a frame. The LEDs or lamps come in various colors to identify a particular network equipment's termination.

A single wire connecting the tracer terminals of two DSX-3 circuits makes a tracer lamp circuit. A plug is inserted into either MON jack completes the circuit, causing the lamps at both ends to light. Some units are equipped with LEDs that flash for 30 seconds and then light steadily.

1.8 DSX-3 Jack Circuit

This illustration shows simplified signal flow paths through a DSX-3 jack module.

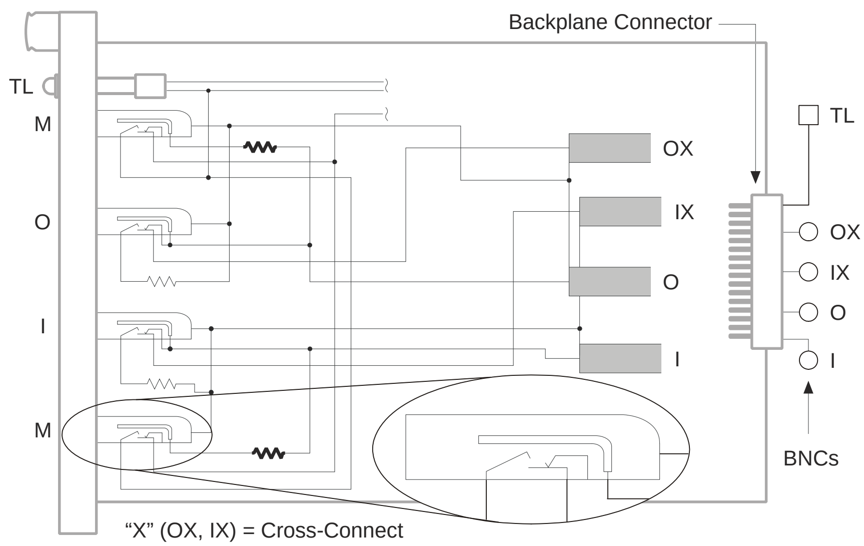


Figure 16 - Simplified Signal Flow Paths through a DSX-3 Jack Module

1.8.1 Output Port

This is an intrusive connection point that interrupts the DS3 signal from the NE upstream of the signal path. This port is used for establishing signal levels coming to the DSX-3 frame as well as for testing, patching, and rerouting the digital signal.

1.8.2 Input Port

This is an intrusive connection point that interrupts the DS3 signal to the NE downstream of the signal path. This port is used for testing, patching, and rerouting the digital signal.

1.8.3 Monitor Port

Inserting a jack into a test port accesses -20 dB of the signal present at the OUT port and sends it to the test port contacts. A jack insert also completes the tracer lamp circuit and lights the tracer LEDs.

1.9 Cross-Aisle Panels

These panels help maintain proper jumper-wire management by serving as an intermediate terminal point between line-ups. Each DSX-3 circuit cross-connect to the nearest cross-aisle panel. The two panels connect by straight-through tie cable arranged in cable management hardware.

This illustration shows the option for half of the signal path.

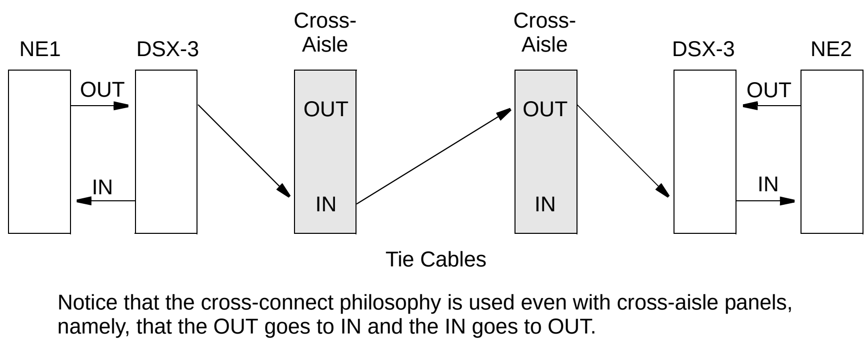


Figure 17 - Option for Half of the Signal Path

This page intentionally left blank.

Chapter 2: DSX-3 System Design

2.1 General Considerations

The DSX-3 network should be flexible, able to handle present and future needs. The DSX-3 system must interface with different DSX-3 frames and technologies. The DSX-3 frame must be able to interact with any other type of identical bit-rate DSX-3 frame regardless of operation (manual, partially automated, fully automated) or location. The DSX-3 network must address transmission levels between the DSX-3 frames, transmission pathways, total interconnection flexibility, as well as the location and installation of the DSX-3 frames that make up the DSX-3 network.

DSX-3 systems can be installed in a new office environment or into an existing DSX-3 network environment. For offices without a DSX-3 system, the main design criteria depends on the physical restrictions of the office environment.

2.1.1 Future Growth

The ability of the DSX-3 frames and support systems to integrate growth without major rearrangement determines the long-term success of the DSX-3 network. Designing the DSX-3 system for future needs is a must when considering modular or incremental growth. Growth can be greatly constrained by the existing office environment and current DSX-3 system installation.

2.2 DSX-3 Area

A DSX-3 area is an identifiable area within the site that is dedicated to DSX-3 line-ups and the network element line-ups that connect to them. How to locate and arrange line-ups depends on the equipment to be used and the cabling relationship between line-ups and DS3 transport equipment locations relative to the DSX-3 area.

2.2.1 Floor Plan

Use a floor plan to determine the best location for the DSX-3 frame in relation to the network elements. Locate the frame within the cable length limits of the network elements.

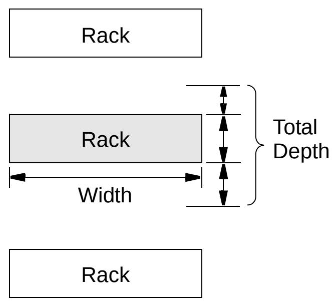
2.2.2 Vertical Space Allocation

The following guidelines are based on the assumption of a 10 ft. (304.8 cm) or higher ceiling:

- 7 ft. (213.4 cm) equipment racks
- 1 ft. (30.5 cm) clearance between top of racks and bay line-up cable management ladder
- 1 ft. (30.5 cm) clearance between the bay line-up cable management ladder and the cross-aisle cable management ladder
- 1 ft. (30.5 cm) clearance between the cross-aisle cable management ladder and the system/ power cable management ladder

2.2.3 Floor Loading

The site may already have a specification for site-floor loading. If it does not, follow this guideline: The floor should be able to support 150 lb/ft.^{2} (732 kg/m^2). This weight allocation comprises loaded bay (rack plus equipment), cables, and miscellaneous weight. Determine the square footage for weight distribution this way:



Rack Width X Total Depth
(Total depth = rack depth + half of aisle width in front of rack + half of aisle width behind rack)

The actual weight of a typical 7 ft. bay fully loaded comes to about 525 lb (238.1 kg).

2.2.4 Bay Footprint

2.2.4.1 19" Bay

“Channel” type racks: 20.3 in. x 15.0 in. (51.6 cm x 38.1 cm).

2.2.4.2 23" Bay

“Channel” type racks, all heights: 24.3 in. x 15.0 in. (61.7 cm x 38.1 cm).

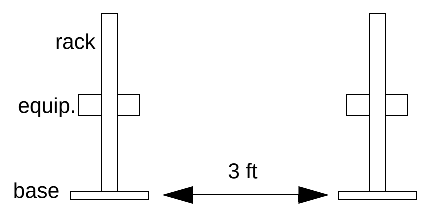
“Unequal flange” type racks: 24.3 in. x 15.0 in. (61.7 cm x 38.1 cm).

“Network” type racks: 25.9 in. x 12.0 in. (65.8 cm x 30.5 cm).

2.2.5 Aisle Spacing

The site may already have specifications for zone aisle widths. If it does not, consider these guidelines. For most DSX-3 panels (circuit connections at both the rear and the front), typical aisle widths are

- Front (“maintenance”)—2.5 to 3 ft. (76.2 to 91.4 cm) wide
- Rear (“wiring”)—2 to 2.5 ft. (61 to 76.2 cm) wide
- Main traffic aisles within the zone should be at least 3 ft. (91.4 cm).



The rear of parallel line-ups should face each other across wiring aisles and the fronts should face each other across maintenance aisles.

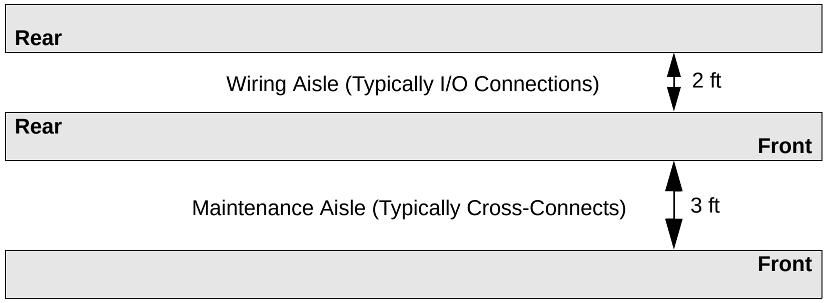


Figure 18 - Line-ups

2.2.6 Heat Dissipation

The site may already have specifications for heat dissipation. If it does not, follow this guideline: A single bay should not exceed 120W/ft.^{2} (1.72 kg-cal./min. per ft.^{2}). You may have to decrease the amount of equipment in a bay if anticipated heat dissipation exceeds the specification.

To determine heat dissipation for the planned equipment, divide the estimated heat release for the entire bay by the same square footage you determined for floor loading in the previous subsection.

2.2.7 Environment

Temperature: 0 to 50°C (32 to 122°F).

Relative humidity: 5–95%, noncondensing.

2.3 Planning Cable Traffic

Effective cable management is crucial to a well-organized zone. DSX-3 frames should consist of DSX bay equipment that meet the same physical cabling format.

- Cable distances should be as short as possible, yet cable traffic must be designed to avoid congestion, mixed cable types, and blocking of vents, lights, or fire safety devices.
- If possible, a cable should not route through zones in which it does not terminate.
- Equipment that must connect between floors may need to be located close to cable holes in ceiling and/or floor.
- High-density DSX-3 panels can require up to three times the cable capacity as standard DSX-3 panels.

Cable characteristics and specifications are discussed in the next major section.

2.3.1 Cable Ladders

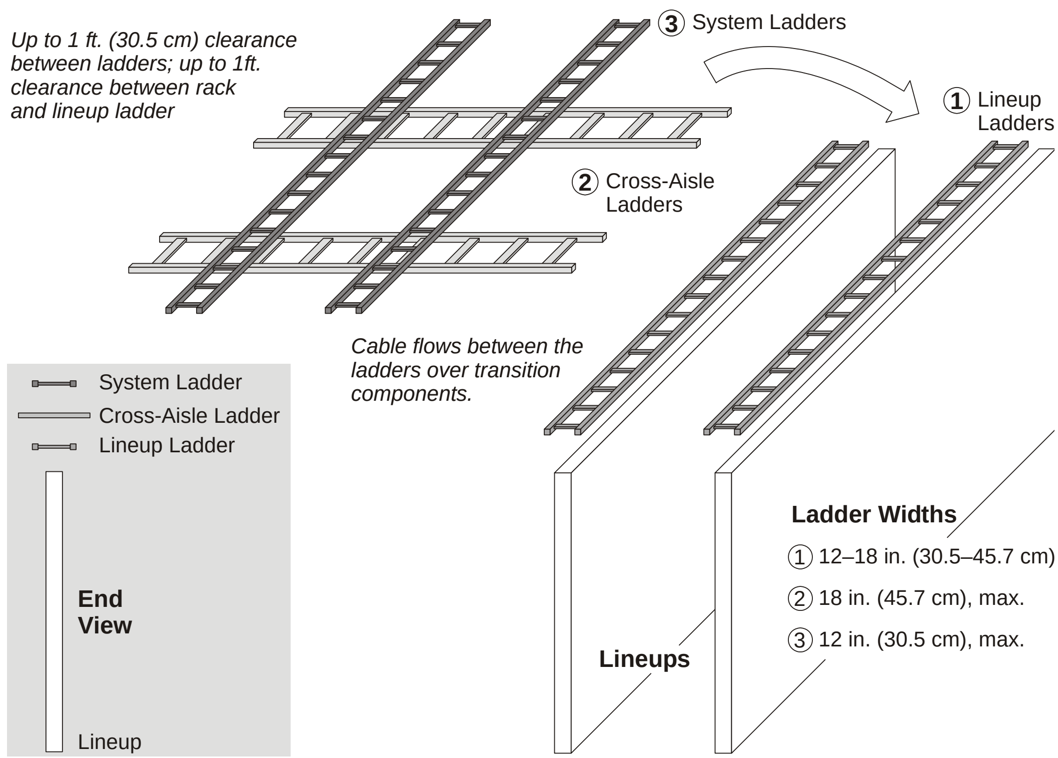


Figure 19 - Cable Ladders

2.3.1.1 System Ladder

This ladder, supported by threaded rods from overhead supports, carries power and plant cable to different zones within a facility.

Limit system ladders to three per zone. To make cable routing changes easier, plan to layer cables in the ladder no deeper than 6 inches (15.2 cm).

2.3.1.2 Cross-Aisle Ladder

This ladder directs cable to line-ups within the same zone and perhaps serves as an auxiliary for the system ladder. The rack supports the cross-aisle ladder with stand-off devices. Cable cascades down from the system ladder.

Space these ladders 5 ft. (152.4 cm) apart, measured from the center, and plan rack supports every 5 ft. These ladders should be reinforced where lengths exceed 5 ft. without support.

2.3.1.3 Line-up Ladder

This ladder manages the cable that terminates in the line-up. The rack supports the ladder with stand-off devices. Cable cascades down from the cross-aisle ladder.

Plan to offset ladder location in the direction of the maintenance aisle to allow the cabling to "flow" off the side of the parallel cable rack and down into the vertical cable wire ways of the bay below them.

2.3.2 Routing Cable at the DSX-3 Frame

NOTE: Cable groups should not mix digital transmission rates.

DSX-3 transmission cables should be split into two groups, one group consisting of the "out" cables and the other group consisting of the "in" cables. These groups should be divided along the entire cable path between the DS equipment and the DSX-3 frame, including the vertical paths alongside the DSX-3 bays.

Dividing the out and in cables reduces electromagnetic interference and promotes a simpler installation.

Cabling between bay line-ups within the same frame for use with inter-aisle panels should be separated and routed into out and in groups.

2.3.2.1 Cable Rings and Pathways

Provide cable pathways for all in/out cables, cross-connects, cross-aisle panels, and interbay patch panels. To calculate the needed size, choose a density from the following chart. Allow a 15% margin for excess cable.

Cable Type	IN/OUT Cables Per Sq. In.
735A	33
734A/RG59	12
X-Connect Jumpers	Two Single or One Dual Cord Per Sq. In.
735A w/messenger	10
734A/RG59 w/messenger	5

Horizontal ring panels typically hold jumpers that run on horizontal pathways; a bridge ring panel is used for horizontal travel across spacers in multiple rack line-ups. Cable rings on the rack column manage cable for jumpers running up or down the DSX-3 bay.

- Pathways cannot interfere or obstruct access to apparatus, terminations, or designation markings.
- The pathway must permit inspection and maintenance of the existing terminations and not interfere with the addition of new terminations.
- A pin, ring, or other wire-retaining device must be provided at each point where the jumper pathway bends or turns.
- At points where the jumpers come in contact with shelf or bay edges, the contact point must be covered with a durable insulation material of at least a 1000 megaohms.

2.3.3 Cable Terminations

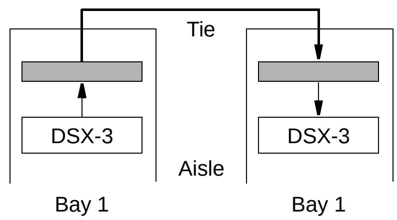
All of the digital equipment terminations should be grouped on one side of the physical frame. Likewise, all of the DSX-3 cross-connections and the associated pathways should be grouped together on one side of the frame. Digital equipment terminations should not be intermingled with DSX-3 cross-connections.

2.3.4 Tie Cabling

Tie cables are cables that route above the line-ups in the cable ladder system. They solve the problem of long patch cords across the face of the frame, long cross-connect jumpers, or cords/ jumpers that would otherwise have to stretch across aisles, blocking human traffic. They do *not* extend the 27 ft. length limit; rather, their use and length must be considered within the limit.

NOTE: Extending the 27 ft. limit requires the use of repeaters.

Cross-aisle tie cabling follows one of two schemes:



Direct Cabling—The DSX-3 patches to a cross-aisle panel in the same bay. The panel connects by tie cable to another panel that is also in the same bay as the DSX-3 to which it patches. These bays have the same number in their line-up.

Zoned Cabling—A single 22- or 23-bay line-up might occupy two or more zones, but the bays are still numbered in straight sequential order. Zone cabling not only patches same-numbered bays within different line-ups, but also same-positioned bays in different zones. For example, bay 12 may be the equivalent “bay 1” position in a different zone. Zone cabling could patch between this bay and the actual bay 1 of another zone.

2.4 Line-Up Structure

Constraints and requirements of cable traffic are a factor in determining line-up placement and structure. An industry standard is a maximum of nine bays in a single line-up. (Nine bays is the maximum number of DSX-3 bays that can be in a single lineup and still maintain the 27 ft cross-connect limit.) The number of possible terminations in any line-up depends on the density offered by the DSX-3 equipment. As you plan NE/DSX-3 configurations within the line-up, remember that the maximum length for cross-connect cables is 27 feet (8.2m).

2.4.1 Rack Spacing

Choose a spacer width that accommodates the entire amount of cable needed for present and future growth.

The amount of cable area is the vertical space alongside the vertical risers where cable can reside. End panels are used at the right and left ends of the DSX-3 bay line-ups for cable protection. They can also be used in the middle of a line-up to segregate different DSX frames.

2.4.2 Maintenance Bays

A maintenance bay holds a variety of miscellaneous equipment. Possible items could include a communication panel, patch panels, backup panels, and test equipment. Except as defined in local procedures, bay Positions 3 and 7 in each lineup are identified typically as maintenance bays (MTCEs).

2.5 Bay Configuration

A typical bay includes fuse panel and DSX-3 equipment. It could also include ring panels for horizontal wire management, interbay patch panel, and cross-aisle panel. The fuse panel and any cross-aisle panel go in the topmost rack unit (RU) spaces in the bay. The system designer can arrange all remaining equipment in the bay in a manner that makes the most sense for the site and system plan.

2.5.1 Interbay Patch Panels

These panels can be located in a DSX-3 bay or in a maintenance bay. Two panels are needed to complete a full patching circuit. Panels should have a minimum of 48 terminations. This provides the ability to patch the equivalent of 24 T3 circuits.

2.5.2 Cross-Aisle Panels

These panels can be located in a DSX-3 bay or in a maintenance bay. Two panels are needed to complete a full patching circuit. A typical site could have about 25% of the circuit cross-connects going to another line-up.

2.6 DSX-3 Panel Considerations

Jack Module

Characteristic	Specification
Insertion Loss	Insertion loss for DSX-3 jack contacts is ≤0.30 dB.
Resistance	**Contact** resistance is ≤10 milliohms for metal surface contacts. **Open** resistance is ≥10 megaohms.
Contact Wipe	The jacks are C-type contact configuration, which provides 0.005-to-0.008 in. of travel to the contact surfaces when closing.
Contact Current Ratings	200 mA continuous, 2A peak for 10 seconds.
Impedance	75 ohms of characteristic impedance, unbalanced circuits.
Insulation Resistance	Between any two terminals, ≥ 1000 megaohms at dc voltages up to 500V.
Crosstalk	–60 dB or greater loss.
Insert/Withdraw Force	10 lb max. insertion; 7 lb max, withdrawal.
Life Cycle	10,000 insertions and withdrawals (typical).
Humidity	Up to 95%, operating and nonoperating.
Thermal Limits	-55°C to +85°C (-67°F to +185°F) for operating or nonoperating.

2.6.1 DSX-3 Jack Shields

Normally, a single-ended shield connection is provided with the DSX-3 panel for shielding that can be extended through the jack field. Connecting the jack field shield to the frame ground of the bay extends the shielding through the jacks and does not violate the IBN scheme.

(See the next section, “DSX-3 Electrical Planning.”)

2.6.2 Coaxial Terminations

DSX-3 panel equipment terminations are available in BT43, Type 1.6, BNC (preferred), and TNC connections using 75-ohm unbalanced coaxial cable. One cable handles each direction of transmission. Coaxial cables are available from manufacturer’s in both connectorized and nonconnectorized versions. (Connectivity loss is discussed in section “2.8.7 Connectivity Losses and Loss Budget” on page 30.)

2.7 DSX-3 Electrical Planning

2.7.1 DC Power

The DC distribution panel, located at the top of each DSX-3 bay, should have enough fuse positions to accommodate every piece of equipment that requires power from the bay. Each position must have the proper fuse and wire rating for the equipment to be powered.

To determine the maximum input amperage needed to fully operate the equipment within a bay, add the maximum load amperage for each piece of equipment. Refer to Telect’s ***Secondary Dc Distribution Reference Guide***, Telect Publication 118101. (Contact Telect for a copy.)

When combining a DC electrical circuit with an IBN, take care to not violate the grounding design.

NOTE: Based on information from the National Electric Code and such agencies as Underwriters Laboratories, Telect recommends that panels or shelves be individually fused, not daisy-chained or paralleled to a single fuse distribution point. If the equipment is paralleled, the maximum fuse size that can be used is the smallest value determined by a single panel.

2.7.2 AC Power

Except as precluded by local operating procedures, supply power and grounding that conforms to the following guidelines:

- AC power feeds must consist of a three-wire conductor, with one of the conductors providing ground.
- Space for AC electrical receptacles and associated wiring must be provided at the base of each DSX-3 bay. One standard duplex AC receptacle must be provided every 4½ feet (137.2 cm) of frame length, or every third bay, for AC-powered equipment.
- AC receptacles must have the grounding terminal connected to mounting hardware. Do not use insulated terminal receptacles.
- AC receptacles should be properly installed and contained in an approved junction box.
- Plan to run all AC conductors in jacketed flexible conduit for a secure and safe installation.
- When combining an AC electrical circuit with an IBN, take care not to violate the grounding design.
- AC electrical circuits installed as part of the DSX-3 frame must conform to all local electrical codes and to the latest issue of the National Electric Code.

NOTE: Electrical devices such as AC drill motors that produce large amounts of electrical noise should not be used around the DSX-3 frame.

2.7.3 Bonding

Guidelines for bonding dead metal parts (racks, trays, panel sheet metal, etc.) may differ from operating company to operating company and from locale to locale. The guidelines set forth here follow general industry practices conforming to NEC code.

Bonding ensures that all dead metal parts are electrically connected with less than 0.1 Ohm resistance between the grounding lug and the dead metal. Use special bonding screws that ensure electrical conductivity between the dead metal parts.

All subsystems, such as panels and other DS equipment located within a bay, should be bonded to the relay racks through the mounting ears. This requires the use of paint-breaking devices, such as star washers, to ensure electrical fault current paths. In addition, all equipment located within a bay should be properly grounded with a bonding jumper between the chassis ground terminals and the relay rack.

2.7.4 Grounding

Ground systems in an office environment are a very critical part of the equipment installation. Proper grounding ensures personnel safety, equipment protection and proper operation, noise reduction, and reliability.

There are two types of grounding methods that are used separately or in conjunction with each other—Common Bonding Network (CBN) and Isolated Bonding Network (IBN).

The CBN is the basic ground system that exists between the AC primary earth ground and all associated conductive parts of the building. Refer to Common Bonding Network (CBN CCITT recommendation K.27): GR-1089-CORE issue 2, Dec. 1997, Section 9.2.1.

The IBN is a dedicated single-point ground system that is used in conjunction with isolated DS equipment frames. IBN provides a selective fault-current path within the ground system. Refer to Isolated Bonding Network (IBN CCITT recommendation K.27): GR-1089-CORE issue 2, Dec. 1997, Section 9.2.2.

The main difference between IBN and CBN is that no current flows in an IBN other than electrical noise currents and temporary short-circuit fault currents. During a frame-fault current, the IBN network allows a least-resistance path through the ground-conducting path, ensuring quick interruption of the fault current while keeping voltage potentials to a minimum. Current from a lightning strike is shunted through the CBN and around the IBN, reducing the high-voltage potentials that can cause insulation breakdown. With the single-point ground terminations disconnected from the ground window, the insulation resistance between the IBN and the CBN should be 100,000 ohms or greater.

For information on proper grounding methods see Bellcore TR-NWT-00295 Issue 2, July 1992, Isolated Ground Planes.

2.7.5 Ground Window

The ground window is the interface point between the building's CBN and the AC/dc grounding conductors included in the IBN. This transition zone is a sphere with a maximum radius of 3 feet (91.4 cm). IBN conductors, after passing through the window, must be insulated and isolated from the CBN.

2.7.5.1 IBN Requirements

All DSX-3 frames that are part of the IBN must be insulated from the common bonding network. Typical fastening points that require insulation include anchor bolts, bottom of bays, superstructure supports, lighting fixtures, and other hardware.

The insulating material must have a dielectric strength not less than that of nylon (400 volts/mil).

2.8 DSX-3 Cables

DSX-3 cables must meet the electrical, mechanical, and flammability ratings as described in the most recent issue of the National Electric Code, Article 800, Communications Circuits. Cables must also be listed with a Nationally Recognized Test Laboratory (NRTL) for other compliance ratings.

Choose DSX-3 cables that meet these minimum electrical characteristics
(at 22.368MHz [44.736 Mbps]):

Cable Type	Nominal Impedance	Insertion Loss	Far-End Crosstalk	Near-End Crosstalk
720	75 ohms ±5% at 22.368 MHz	2.16 dB/100 ft.	Better than 90 dB/1000 ft., all freq.	Better than 85 dB/1000 ft., all freq.
728		1.23 dB/100 ft.		
734		1.18 dB/100 ft.		
735		2.31 dB/100 ft.		

(!) ALERT

ALERT! Failure to use electrically compliant DSX-3 cables may cause transmission errors, bipolar violations, crosstalk, and loss of signal strength.

2.8.1 Unbalanced Cable

Coaxial cable must meet stringent transmission characteristics for impedance and loss. The cables contain annealed copper or copper-plated steel conductors covered with a dielectric of low-density polyethylene (LDPE). This dielectric core is then covered with an outer conductor of two tinned copper braids and a polyvinyl-chloride (PVC) jacket.

2.8.2 Shielding

Shielding is important to the digital transmission scheme. Proper shielding practices allow the inherent capacitance and inductive reactance of the cables to reduce electrical noise. Shield grounding at one end prevents incidental ground loops that can carry fault currents within a given frame.

2.8.3 Plenum Cable

This cable is made with slow-burning and low-smoke materials (specifically fluoropolymers). It is run in plenum air spaces such as cable troughs and racks or above ceiling tiles. Plenum cables are a common requirement in installations; refer to the local electrical codes.

2.8.4 Cross-Connects

Standard cross-connect cable is unbalanced coaxial with BNC connectors.

2.8.5 Patch Cords

WECO-style jacks are standard throughout the Telco industry.

2.8.6 Cable Lengths

Standard cable lengths have been determined to minimize crosstalk and help ensure adequate signal strength to the digital equipment.

- The cable between a DSX-3 and a network element must be 75 ohm coaxial. Maximum distance is 450 ft. (137.2m), with 734 coaxial.
- Cross-connects between DSX-3s—this includes cross-aisle circuits—must be 75 ohm coaxial. Maximum distance is 27 ft. (8.2m), based on a standard, generic cable. (A specific cable will exhibit its own specific characteristics.)
- The maximum distance from network element to DSX-3 cross-connected to another DSX-3 to another network element is 927 ft. (282.5 m). DSX-3 intra-office repeaters are commonly used when spanning greater distances between NEs.

2.8.7 Connectivity Losses and Loss Budget

As you plan your DSX-3 circuits, consider that the maximum allowable equipment-to-equipment signal loss is 12.15 dB. This is your "available loss budget," and it is depleted by the DSX-3 equipment and components, according to their dB loss rating. You must consider all of these loss sources:

- Cable type and length
- Cable connectors (out/in, cross-connects, cross-aisle panels)
- Jack insertion loss

Chapter 3: DSX-3 Installation Guidelines

3.1 Preliminaries

DSX-3 Installtion Guidelines are important. Most of the "instructions" are points to remember, rather than specific, step-by-step procedures. You must depend on all existing installation reference information.

3.1.1 Installation Reference Information

Information Source	Pertains To...
Job Site Specifications	All aspects of site preparation and installation.
Operating Company Rules, Regulations, Guidelines	All aspects of site preparation and installation.
Equipment User Documents	Proper install of specific bay equipment.
Telect's Secondary DC Distribution Technical Reference Guide	DC power distribution to bay equipment; electrical grounding rules and techniques.
National Electric Code	Rules, regulations, and procedures of site and equipment power supply and grounding. Also, cable labeling and coding.
Manufacturer's Specifications	Special instructions for installing, protecting, and servicing a specific product or its components going into the bay.
Bellcore GR-1275-CORE; Bellcore practices	Specific grounding and bonding information; cable securing methods.

Review all available information before installation. Verify you have all tools and all components necessary for each phase of the installation.

3.1.2 Safety

Observe OSHA regulations while preparing the site and installing the equipment.

3.1.3 Site Preparation

Points to remember:

- Verify that equipment spatial requirements and cable routing space has been determined for the installation.
- Verify all requirements for cable lengths, DC power, and AC power have been met.
- Establish the point-to-point termination connections within the site.

3.1.4 Product Inspection

Inspect equipment after unpacking for any shipping damage, defects, or missing parts. Keep all documentation shipped with the equipment. Inventory the equipment.

3.2 The DSX-3 Bay

Relay racks that make up the bays should be consistent in design, shape, and style. This provides a uniform and simple installation. Individual bays should be mounted as straight and level with the frame line-up as possible. Allow enough space between bays to provide adequate room for all cables.

3.2.1 Mounting

Follow the spatial requirements shown in the job specifications.

3.2.1.1 Floor

DSX-3 bays mount to the floor with anchor bolts. Verify that the anchor bolts meet size and depth requirements. When drilling anchor holes, use a three-conductor, grounded vacuum cleaner to pick up dust.

Shims are provided with most relay racks to level the bays within the line-up. Use these in conjunction with floor-mounting hardware. When installing within an IBN, insulate anchor bolts that might touch grounded structural metal in the floor.

3.2.1.2 Frame, Overhead Support

Secure the top of the relay rack to the supporting structure within the frame. The securing methods and types of superstructures vary, but should be consistent throughout the DSX-3 frame. When installing within an IBN, the bay may or may not be isolated from the superstructure. Guidelines for using insulating materials to meet the IBN requirements appear later in this chapter.

3.2.2 Cable Pathways

Retaining rings or cable routing devices control the direction and location of cables and jumper wires. Pathways cannot interfere with or obstruct access to apparatus, existing or new terminations, or designation markings. Pathways must permit inspection, repair and maintenance of terminations.

- Install cable ladders uniformly to allow even cable dispersal from the ladders to the equipment.
- Provide a pin, ring, or other wire-retaining device at each point where a jumper pathway bends or turns.
- At points where jumpers come in contact with shelf or bay edges, cover the contact point with a durable insulation material of at least 1000 megaohms.
- Provide pathways for both the intra and interbay jumpers.
- All cable pathways between the NEs and the DSX-3 frame should be clearly defined with adequate space for future cabling needs.

DSX-3 chassis typically have cable management assemblies built in for I/O and cross-connect cables.

3.3 Power, Grounding

3.3.1 Isolated Bonding Network

- All DSX-3 frames that are part of the isolated bonding network (shown in the site plan) must be insulated from the common bonding network. Typical fastening points that require insulation include anchor bolts, bottom of bays, superstructure supports, lighting fixtures, and other hardware.
- The insulating material must have a dielectric strength not less than that of nylon (400 volts/mil).
- Use reliable frame-to-frame grounding connections to ensure good bonding between the dead metal parts.
- Before making ground connections from the isolated frame to the ground window, measure insulation resistance. Verify it is 100,000 ohms or greater.

3.3.2 AC Power Installation

AC circuits that are part of the DSX-3 frame must conform to all local electrical codes and to the latest issue of the National Electric Code. Also consider these points:

- AC power feeds must consist of a three-wire conductor that provides a separate ground conductor.
- A standard duplex AC receptacle must be provided every 4½ feet of frame length (or every third bay) for test equipment, portable lamps, and other AC-powered equipment.
- AC receptacles should be contained in an approved junction box.
- Connect the grounding terminal of AC receptacles to mounting hardware. Do not use insulated-ground-type receptacles.
- When grounding an AC circuit, do not violate the rules of the IBN grounding system.
- Run all AC conductors in jacketed flexible conduit for a secure and safe installation.

NOTE: Electrical devices, such as drill motors, that produce large amounts of electrical noise should not be used around the DSX-3 frame.

3.3.3 Grounding and Bonding Guidelines

An isolated 1/0 cable is normal for an IBN ground network connected to DSX-3 frames. Other points to remember:

- When connecting to the IBN, it is critical that no incidental ground paths are created to the CBN.
- Nonconductive coatings, such as paint or enamel on the contact surfaces of equipment to be bonded or grounded should be removed to assure electrical continuity.
- Bonding and grounding conductors must be copper (tinned or nontinned); do not use aluminum conductors.

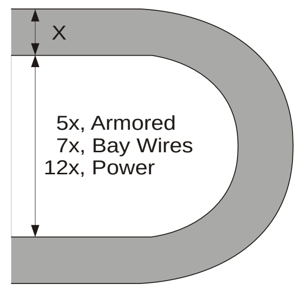
- Each ground cable must be the proper size.
  - Connect the relay racks to the grounding network with a minimum of 6 AWG wire.
  - When connecting to a CBN, verify the cable is equal or greater in size than the return input wire.
  - The IBN cable must be large enough to ensure interruption of a short-circuit fault current without thermal damage to the cable. (The output fuse/breaker of the distribution panel in the bay determines the maximum fault current.)
  - The National Electric Code recommends a minimum size of 14 AWG for the grounding wire from chassis to frame for a DSX-3 panel. Or, size the wire per the DSX-3 manufacturer's recommendations.
- Ground cables should be "run exposed"—routed and placed to allow visual inspection of the entire ground system and all connectors.
- Do not secure multiple ground connections to a single point.
- Refer to the manufacturer's specifications for recommended lug sizing and crimping methods.
- Connection mating surfaces should be flat and corrosion-free to ensure maximum surface contact.
  - Buff all nonplated connectors and bus bars to a bright finish.
  - Clean mating surfaces of plated connectors with a nonabrasive, nonconducting pad, such as scotch-bright, to remove oxidation without removing any plating material.
- Coat connectors or connector mating surfaces with an antioxidant compound before making connections.
- For single-hole terminals, place a star washer between the metal surface and the terminal lug connection to prevent cable rotation.

3.4 Cabling

3.4.1 General Practices

- Avoid stressing or damaging new and existing cables.
- Protect existing cables in the racks.
- Install cable guide rings for equipment racks to prevent cables from rubbing on the framework, threaded rods, and other cables.
- Cable amount is determined by the number of circuits to be terminated. Before installing cables, verify that adequate cable space is provided for the cable runs.
- Before running cables, tape the unterminated ends.

- Label the cables according to the accepted practice of the operating company. (See also the following subsection.)
- Divide and bundle the cables into "in" and "out" groups. Route these groups to the frame in different pathways if possible. The vertical risers on each side of the bay should contain only one of the groups.
- Avoid routing different digital signal rates on a particular DSX frame.
- Secure cables temporarily when laying them in the racks.
- This illustration shows the maximum bending radius for different types of cable, measured on the inner side of the bend. When forming power cable into turns or bends, avoid damaging the cable sheathing.
- Review the operating company's regulations on securing methods. Permanently secure cables in a way as to not allow opposing force to the terminals.



3.4.1.1 Cable Labeling

Refer to Article 800 in the latest edition of the National Electric Code for details on labeling the following:

- Type CM—General-purpose communications cables
- Type CMP—Plenum cable
- Type CMR—Cable that can be installed in vertical risers located in multi-story buildings

3.4.1.2 Cable Coding

Refer to the latest issue of the National Electric Code, Articles 400 and 800, for identification markings pertaining to cables used within the United States. Refer to the European Harmonized Cordage CENELEC publications, HD-21 and HD-22, for the harmonized wire-coding system related to European standards.

3.4.1.3 Cable Service Loops

Regardless of the type of cable or termination, provide a 6-inch service loop (15.2 cm), measured on the inside diameter of the cables, in case the cables require retermination from re-installation, maintenance, or service. Normally, the service loop is located at or nearby the DSX-3 chassis.

3.4.2 Fire Stops

Review the operating company regulations pertaining to fire stops before opening the stops and routing cables through them. All cable openings must be closed temporarily at the end of each shift and be permanently closed at the completion of the cable operation. The installer who opened the hole must ensure fire stop integrity when the stop is closed. When holes are opened in floors for cabling operations, the installer must provide adequate protection to prevent personnel and equipment from falling through the hole.

3.4.2.1 Fire Stop Opening and Closing

1. Remove the intumescent (fire-retardant) putty from around the cables.
2. Remove the retaining bolts from the opening plates on both sides of the fire stop.
3. Remove any nonflammable stuff bags within the hole.
4. After cable operations through the hole are complete, cut the cover plates to fit the new cables.
5. Reinstall the plates and stuff bags within the hole, securing the plates.
6. Using new intumescent putty, reseal the holes around the cables on both sides of the fire stop.
7. Relabel the fire stop inspection tag as specified by the operating company.

3.4.2.2 Coaxial Connectors

Attach coaxial connectors to the cable per connector manufacturer specifications, using the recommended tooling. Common tools include

- Cable strippers, such as the Paladin CST cable stripper, which is available in various cable sizes.
- Crimping tools, such as the Paladin CTX 1300, 1400, and 1600 series crimpers, also available in various cable sizes.

3.4.3 Vertical Direction Cabling

Route the “in” cable bundle to the vertical riser on one side of the bay; route the “out” bundle to the other side. The direction of cable entry to the DSX-3 bays determines the cabling structure. Terminate cables entering from the top of the bay at the bottom DSX-3 panel first; terminate cables that enter from the bottom of the bay to the top most DSX-3 panel first.

- Uniformly structure the cables in 1-inch square bundles, avoiding twists and rolls within the bundles.
- Layer the cables inside the entire width of the vertical riser of the bay and stack the cable bundles on top of each other in a neat uniform manner.
- Secure cables to the vertical risers using standard securing methods.

3.4.4 Cable Management at the DSX-3 Panel

Typically this is accomplished with troughs or tie-down bars.

3.4.5 Securing Methods

These methods vary throughout the industry.

NOTE: Avoid securing cables in a manner, or with excessive tension, that deforms the structure of the cable. This is critical to cable performance.

Wrap coaxial cables that have soft foam dielectric with fiber paper before securing them to the cable pathways. Use twine or nylon ties to secure wires that break out from the bundle. Give these wires a maximum spacing of 4 inches (10.2 cm).

3.4.5.1 Fiber Paper-Wrap Protection

If power cables are not clearly identifiable as textile-jacketed, use fiber paper wrap that is a minimum of 1/32 in. thick to buffer these cables from contact with cable brackets, cable ties, and twine. In general, sheet fiber or insulating materials should be used anywhere cables

- turn off the rack
- are close to the rack retaining brackets
- are routed next to exposed metal surfaces other than the rounded edges of the cable ladder cross members

Secure fiber protection independently to the metal surfaces with twine or nylon ties.

3.4.5.2 Securing With Twine

Use twine on power cables that leave or go to the horizontal cable racks and at the first uppermost vertical rack securing position. Refer to the operating company's guidelines or Bellcore practices for proper stitching or sewing procedures. Unless job specifications state otherwise, twine should be two strands of nine-ply, waxed polyester.

3.4.5.3 Nylon Cable Ties

NOTE: Use twine, not cable ties, on cables that leave or go to the horizontal cable racks and at the first uppermost vertical rack securing position.

Cable ties should be a flame-retardant nylon that meets the requirements of UL 94V-0 and be of adequate size, type, and strength for the application. Refer to the operating company's guidelines for proper use. Here are some general guidelines:

- Tension and cut cable ties with an approved tensioning and cutting tool.
- Do not let the cut end of the tie protrude past the locking head.
- The cut end cannot be sharp or jagged ("sharp" means sharp to the touch).
- Tension cable ties tight enough to hold the cables together, but not so tight as to damage them.
- The tie should be able to rotate when slight or moderate pressure is applied to the head.
- Locate the locking head in a position that does not interfere with other cables or equipment.

3.4.5.4 Tape

- Use gray electrical tape that meets UL 94V-0 flammability ratings.
- Do not use tape where it comes in contact with hot surfaces.

- During application, keep the tape clean and apply it in even half-lapped layers.
- Overlap the last two layers and apply it without any tension before cutting loose from the tape roll.

3.4.5.5 Shrink Tubing

Shrink tubing must be UL 94V-0, with an oxygen index of 28 or greater. Use rated size shrink tubing for recommended wire size and the correct color for polarity identification. When applying heat to shrink the tubing do not over-heat the insulation of the material being covered.

3.5 Equipment

3.5.1 DC Power Panel Installation

DC power installation must follow strict guidelines to meet safety requirements.
Points to remember:

- Verify all electrical components such as wire sizes, lugs, and fuses meet requirements.
- Adjust mounting brackets, if necessary, to fit bay size. Mount panel to the uppermost position available on the bay.
- Install a star washer at each mounting bracket to meet bonding requirements.
- Fuse and wire-size ratings are provided with the panel. You must follow these ratings, as well as voltage polarity, to comply with the safety requirements.
- Cable input power and ground connections from the battery distribution fuse bay (BDFB) or power distribution frame (PDF).
- Before cabling any equipment to the distribution panel's output terminals, test panel functionality according to the installation instructions.
- Install equipment power wires from bottom to top in a neat uniform manner and secure cables to the vertical rails following standard securing practices.
- Install the rated fuse in a circuit, then test that circuit's operation. Use only one fuse position per equipment input feed.

NOTE: Do not daisy chain power leads.

3.5.2 DSX-3 Panel Installation

The number of panels that can be located within a DSX-3 bay is determined by the height of the individual panels. Regardless of the number, ideal DSX-3 panel placement is no lower than 16 inches (40.6 cm) from the bottom and no higher than 76 inches (193 cm) at the top of a 7-foot (213.4 cm) relay rack. Panel alignment should be consistent with all other bays within the DSX-3 frame.

The number of DSX-3 circuits for the individual panels vary depending on the circuit configuration. The total number of circuits determines the amount of cable; high-density panels can require up to three times more cable per bay.

NOTE: Do not tighten equipment mounting screws until the rack has been leveled. This helps prevent the panels from being distorted.

1. If necessary, adjust the mounting bracket positions to the desired mounting position for the associated 19" or 23" rack configuration.
2. Mount the panels in the bay from bottom to top. Place a star washer under the mounting screws (one on each side) to meet bonding requirements.
3. Provide and terminate properly rated power wires from the DC distribution panel to the DSX panel.
4. Install a 14 AWG ground wire, terminated with a properly rated lug, between the chassis ground of the panel and the bay frame.
5. Test the individual panels by placing a jack plug in the monitor (MON) jack. Verify that the tracer lamp lights.

Terminating signal wires at the DSX-3 panel is discussed in the next major section, “Terminations.”

3.6 Terminations

3.6.1 Connecting the NE Ports

NE equipment can have different names for “in” and “out” signals. Therefore, you must establish or verify the signal path direction to and from the DSX-3 frame.

Terminate the DS3 signals coming from the NE and going to the DSX-3 frame at the DSX-3 “out” terminals. Terminate the DS3 signals going to the NE from the DSX-3 frame at the DSX-3 “in” terminals.

3.6.2 DSX-3 Cross-Connect Terminations

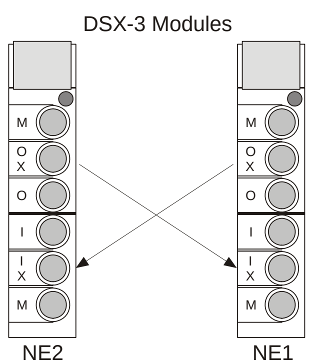


Figure 20 - Example of Front Cross-connect

Make cross-connect terminations at NE equipment turn-up. Three connector ports are provided for the cross-connections done within the frame, two for the crossover connections and a single connection for the tracer lead. “Out” crosses over to “in” and “in” crosses over to “out” between the DSX circuits for circuit loop operation. Cross-connect ports are located at the front or rear of the jack module; the single tracer wire typically is located at the rear of the DSX-3 panel.

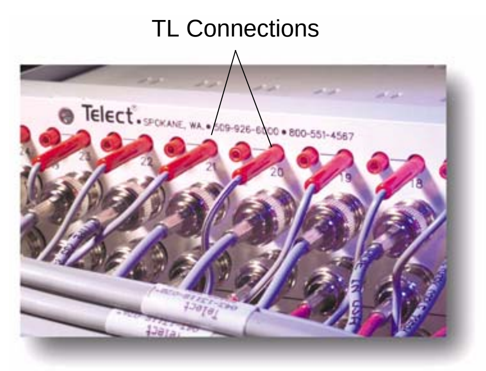


Figure 21 - TL Connections

This page intentionally left blank.

Chapter 4: DSX-3 User Functions

4.1 Identifying a Circuit

The number of panels and the mass of jumper wires in a line-up can make it difficult to identify a cross-connected circuit. To identify a circuit quickly, insert any jack plug into the MON port of that half of the circuit you already know. Watch the tracer lamps—both the circuit you know and the cross-connected one will light.

4.2 Patching

Patch cords temporarily reroute (“roll”) signals through the IN and OUT jack ports at the front of the DSX-3 module. Service moves from one line to another without removing the original cross-connection.

- Patch the OUT port of the circuit to be temporarily disabled to the IN port of the new connection.
- Then patch IN to OUT.
- Having two people patch both ports simultaneously lessens circuit downtime.
- When removing the patch, disconnect the new location first, if you cannot remove the patches simultaneously.

A patching schematic appears on the next page.

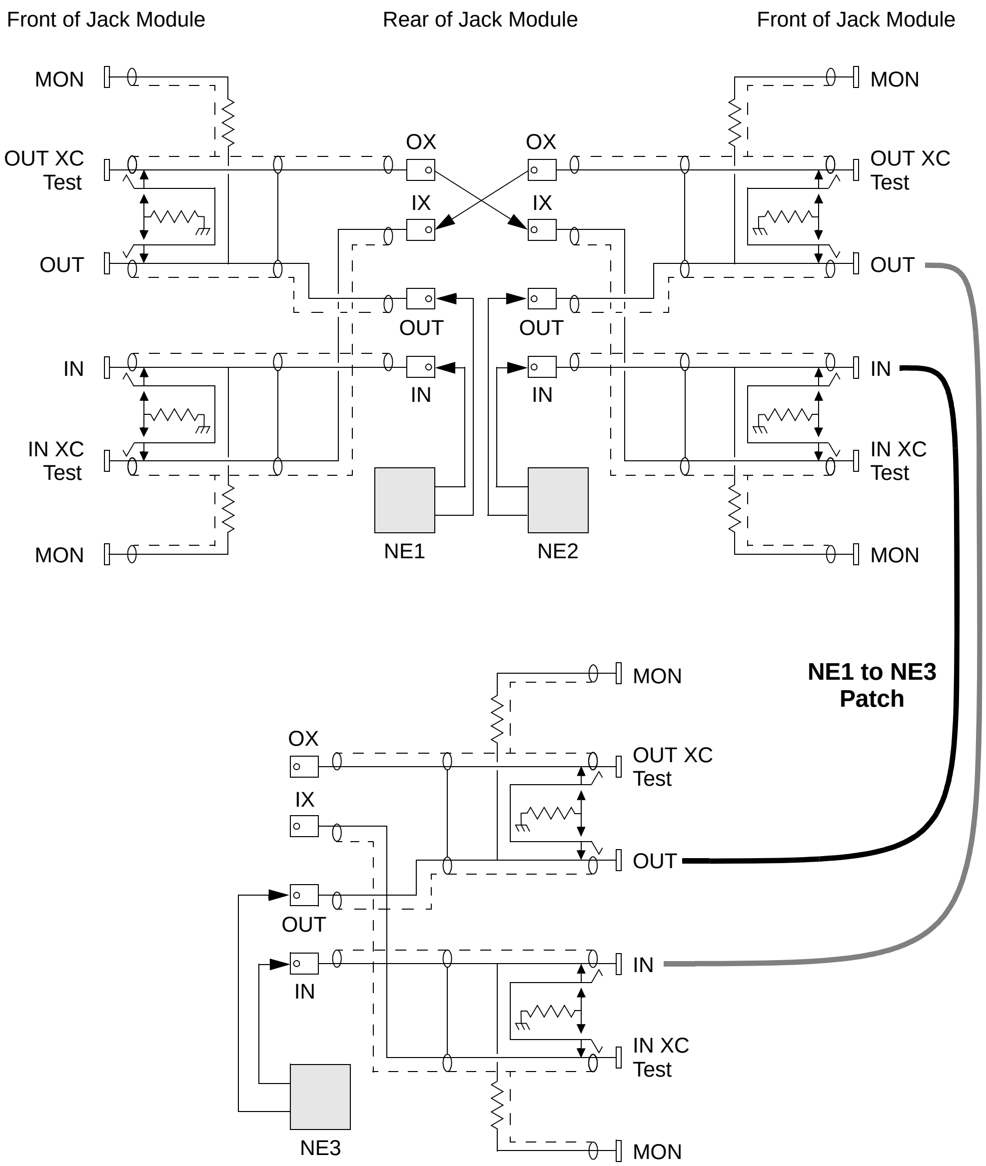


Figure 22 - Patching Schematic