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NOVEMBER 1993

MX035A MX035A-ST
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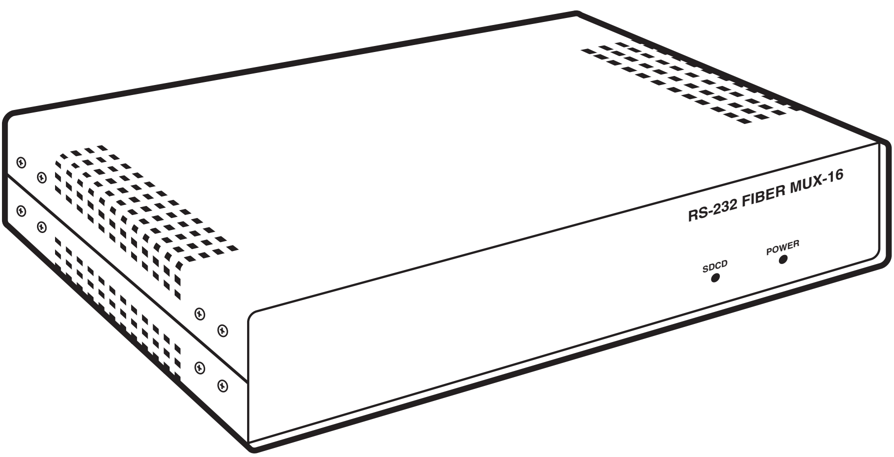
RS-232 to Fiber Optic Multiplexor



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Contents

1. Specifications

Approvals —	FCC Class A, IC Class/classe A
Multiplexing Technique —	Time-division
User Channels —	MX035 units: (8); (24) in Triple Asynchronous Mode with 3-to-1 adapter cable (EYN355) MX036 units: (16); (48) in Triple Asynchronous Mode with 3-to-1 adapter cable (EYN355)
Interface —	Channel: Serial EIA RS-232C/CCITT V.24, DCE Composite: Dual fiberoptic
Protocols —	Asynchronous or synchronous (user-selectable)
Clock —	Internal or external from local DTE (user-selectable)
Operating Mode —	Full duplex over dual fiberoptic cable
Speeds —	Channel: Asynchronous: Transparent to all speeds up to 19,200 bps; Synchronous: 1200, 2400, 4800, 9600, or 19,200 bps (user-selectable) Composite: 11 Mbps
Maximum Distance —	7200 ft. (1.36 mi., 2.2 km) over cable with a 50-µm fiber core
Wavelength —	830 ±15 nm
Optical Output —	-22 dBm typical into 50-µm core
Receiver Sensitivity —	-33 dBm minimum at 10^{-9} bit error rate
Dynamic Range —	11 dBm for 50-µm core
Bit Error Rate —	Better than 10^{-9} over the full receiver range

User Controls — Rear-mounted 6-position DIP switches:
MX035 units: (8); MX036 units: (16)

Indicators — (2) Front-panel LEDS: Power, SDCD (carrier detect)

Connectors — (10) or (18) Rear-mounted:
Channel: MX035 units: (8) DB25 female;
MX036 units: (16) DB25 female;
Composite: Units without "-ST" suffix:
(1 TX, 1 RX) SMA 905 female;
Units with "-ST" suffix: (1 TX, 1 RX) ST female

Leads/Signals Supported — RS-232: 1 (PGD), 2 (TXD), 3 (RXD), 5 (CTS), 6 (DSR), 7 (SGD), 8 (DCD), 14 (STXD), 15 (TXC), 17 (RXC or SRXD), and 20 (DTR)

Power — MX035A, MX036A units: Directly from outlet:
Input range: 95 to 130 VAC, 50 to 60 Hz, 1 A;
MX035AE, MX036AE units: Directly from outlet:
Input range: 230 VAC, 50 to 60 Hz, 0.5 A

Fuse — MX035A, MX036A units: 1 A, 120-VAC Slo-Blo;
MX035AE, MX036AE units: 0.5 A, 220-VAC Slo-Blo

Temperature — 32 to 113° F (0 to 45° C) ambient

Humidity — 0 to 95%, noncondensing

Enclosure — Metal, with rubber feet

Size — 3.4"H x 16.6"W x 12.2"D (8.6 x 42.2 x 31 cm)

Weight — 8.4 lb. (3.8 kg)

2. Introduction

2.1 General

The RS-232 to Fiber Optic Multiplexor is available in two major model types: one with 8 channels (product codes beginning with "MX035"), and one with 16 channels (product codes beginning with "MX036"). Both models are built from the same circuit board and are identical in every way except for the number of channels. An 8-channel unit can communicate with channels 1 through 8 of the 16-channel unit if the two units are connected together.

There are two other points of difference in this product line. First, product codes in which the letter "A" follows "MX035" or "MX036" use 120 VAC; codes with the letters "AE" in this position use 240 VAC. Second, codes that end with the "A" or "AE" have SMA 905 fiberoptic connectors; codes in which "-ST" follows the "A" or "AE" have ST® connectors.

Using rear-panel switches, you can independently configure each full-duplex RS-232 channel of either multiplexor in a pair of these muxes for one of five modes of operation, three asynchronous and two synchronous. The multiplexor is transparent to data rates up to 19,200 bps in the asynchronous modes, and is transparent to sub-protocols and data formats in both the asynchronous and synchronous modes.

1. The first mode of operation is single-channel asynchronous: The multiplexor transmits one data signal, one DTR/CTS-handshaking control, and no other signals.

2. The second mode is only slightly different: In addition to the DTR/CTS handshaking, a second, auxiliary (control or data) signal is present.

3. The third mode is triple-channel asynchronous: The multiplexor sends three separate data signals on each channel, across a 3-to-1 adapter cable (our product code EYN355), without any handshaking or control signals. This allows you to connect three asynchronous RS-232 "dumb terminals" to each of the mux's ports; in this mode, 8-channel units can handle 24 async data-only channels and 16-channel units can handle 48 async data-only channels.

4. The fourth mode is synchronous with internal clocking (the multiplexor supplies the clock to the terminal device). This mode supports transmission of one handshaking signal, which allows the Data Terminal Ready (DTR) input at one end of the system to control the Clear to Send (CTS) output at the other end. Data rates of 1200, 2400, 4800, 9600, and 19,200 bps are available.

5. The fifth mode is synchronous with external clocking (the terminal device supplies the clock to the multiplexor). Like all other modes but the third, this mode supports DTR/CTS handshaking. The mux will accept and adapt to any externally-clocked data rate up to 14,400 bps. This is identical to Mode 2, with the exception that the auxiliary signal is clock timing from the DTE (terminal device).

The multiplexor is housed in a metal enclosure. The case has rubber feet for stand-alone use on a table top or shelf, but can also be rack-mounted in a standard 19-inch rack by attaching the optional rackmounting brackets (product code RM901).

2.2 Physical Description

This section describes the physical characteristics of the multiplexor.

The front panel (see Figure 2-1, below) of the mux has no controls, but has two LED indicators in the lower right-hand corner. The red LED at the extreme right is the POWER ON indicator. The green LED to its left, labeled "SDCD" (System Data Carrier Detect), indicates that an optical signal is being received. It does not indicate that the signal is error-free or that the multiplexor is in synchronization with the incoming signal. If the optical-receiver connector (RX) is disconnected and open, it is possible that external light sources could trigger the optical receiver and cause this LED to light.

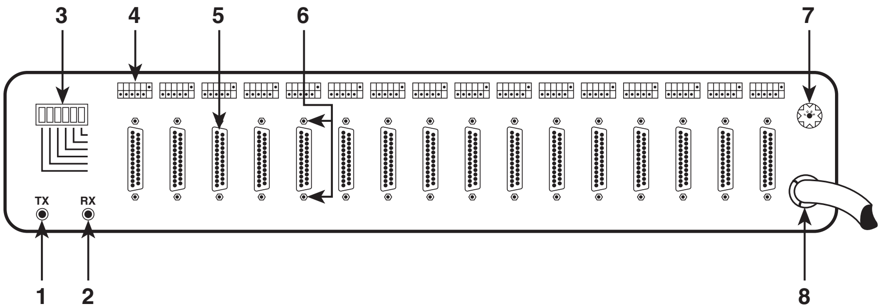
The components on the rear panel of the multiplexor are shown in Figure 2-2 on the next page, which illustrates a 16-channel unit. The rear

Figure 2-1. The front panel.

panel of the 8-channel mux is the same, except that a plate covers the holes for the connectors and switches of channels 9 through 16.

1. Optical-Transmitter Connector: SMA or ST compatible connector for the optical transmitter.

Figure 2-2. The rear panel.



2. Optical-Receiver Connector: SMA or ST compatible connector for the optical receiver.

3. Switch-Setting Chart: Identifies the channel-configuration-switch settings.

4. Channel-Configuration Switches: A 6-position DIP switch for each channel, which you can use to select the internal transmit clock/data rate, or secondary transmit data in place of the transmit clock. (See **Section 4.1**.)

5. Channel-I/O Connector: A DB25 female connector for each channel. The 16-channel unit has 16 connectors and switches; the 8-channel unit has 8 connectors and switches with a cover plate over the unused slots.

6. Locking-Screw Sockets (2 per connector): 4-40 threaded female standoffs to accept locking screws on the cable connector.

7. Fuse Holder: Holds a Slo-Blo AC-line fuse (1 A for 120-VAC units, 0.5 A for 240-VAC units).

8. AC-Power Cord: Has a U.S. standard 3-prong plug for 120-VAC units or a standard plug for the country in which the unit is sold for 240-VAC units. AC-line voltage is printed directly above the point at which the power cord enters the rear panel.

3. Installation

This section describes the installation procedures for the multiplexor in a standard 19-inch rack and explains how to connect the optical cable and the terminal devices.

If possible, test the pair of multiplexors and the optical cable with each other before installation. Testing before installation will reveal any damage that might have occurred to either mux or cable during shipping, so you'll know that the items weren't damaged during installation. This initial testing and troubleshooting are much easier when both muxes are placed close to each other and both ends of the cable are easily accessible.

Standard units of this multiplexor are supplied with four rubber feet for placement on a table top or shelf. If it is necessary to remove the feet for another type of mounting, first remove only one foot and check the type of mounting screw used.

If a 4-40 machine screw is used to mount the feet, the unit is an early one that uses the foot-mounting screws to hold the internal printed circuit board in place. DO NOT REMOVE ALL THE SCREWS AT THE SAME TIME. Remove only one foot at a time and replace its mounting screw with a 4-40 x 3/16-inch flathead screw. (Holes in the chassis bottom are countersunk.)

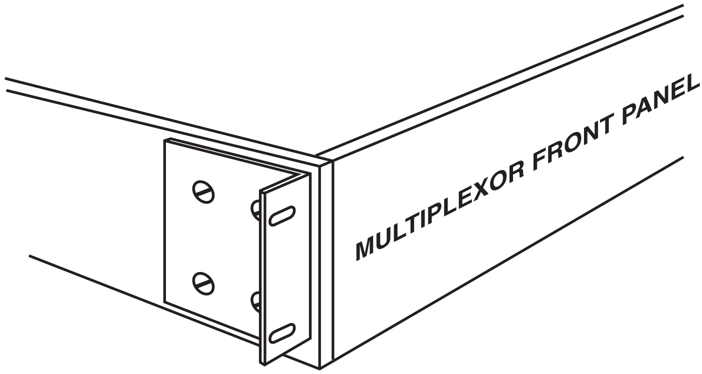
If the foot-mounting screws are self-tapping sheet-metal screws, the unit is a newer one with separate mounting holes for the feet. The feet can be removed without replacing the screws.

3.1 Rackmounting

For rackmounting, a pair of brackets are available for the necessary mounting flanges (product code RM901). To attach the rackmount brackets, first remove the four screws closest to the front of the chassis from one side of the multiplexor chassis. See Figure 3-1 on the next page.

Do not remove the screws from both sides at the same time, because the front panel may fall out. If this happens, the front panel can be replaced by inserting it back into the multiplexor chassis and pressing against the top and bottom of the front panel at the same time, holding it against the edge of the internal printed circuit board, while positioning the panel to line up its threaded inserts with the holes in the multiplexor chassis.

Figure 3-1. Attaching a rackmount bracket.



After removing the screws, place one of the rackmount brackets against the side of the multiplexor, lining up the four round holes in the long side of the bracket with the holes from which the screws were just removed. Then use the same screws that were previously removed to attach the rackmount bracket.

The holes in the brackets are spaced 1.75 inches (4.45 cm) apart, located at equal distances from the top and bottom of the multiplexor.

The multiplexor is 3.4 inches (8.7 cm) high and requires 3.5 inches (8.9 cm) of vertical rack space. Additional vertical space above and below the multiplexor may be required to provide clearance for cooling air flow in and out of the chassis.

For air cooling, the multiplexor must be mounted to allow unobstructed air flow into and out of the perforations in the sides and top of the mux chassis. If the mux is mounted in a rack cabinet, minimum air flow of 120 cubic feet (3.4 cubic meters) per minute through the cabinet must be provided. If other equipment is mounted above the mux in the same rack, it must not block air flow through the perforations in the top of the mux chassis. Also, the sides of the rack cabinet must be far enough from the sides of the mux chassis to allow air flow into the perforations on the sides of the mux chassis. (Virtually all rackmount cabinets have adequate clearance in this area, but this should be checked.) If mounting another piece of equipment directly above the mux blocks air flow out of the perforations on the top of the mux, a spacer panel should be placed between the two units to provide clearance.

3.2 AC Power Connection

The 120-VAC version of the multiplexor requires 95 to 130 VAC, 50 to 60 Hz power, at a maximum current of 1 ampere. It is equipped with a U.S.-standard three-prong power plug that should be connected to a properly grounded AC outlet. Do not operate the mux with the chassis ungrounded.

Units of 240-VAC versions require 50 to 60 Hz power at a maximum current of 0.5 amp. The power cord is provided with a plug that matches the standard for the country for which the unit is sold.

3.3 Optical-Cable Connection

The multiplexor operates in full-duplex mode, requiring a two-fiber cable or two fibers of a multifiber cable.

Multifiber cables usually have number labels on each connector with both ends of the same fiber having the same number. This type of cable should have the same-numbered fiber connected to the transmitter of the first mux at one end of the cable and the receiver of the second mux at the other end of the cable.

Before connecting optical cables to the mux's optical transmitter and receiver, verify that both the cable terminations and the optical transmitter and receiver receptacles are clean. It is good practice to cover the connectors with the provided plastic caps when the connectors are not in use.

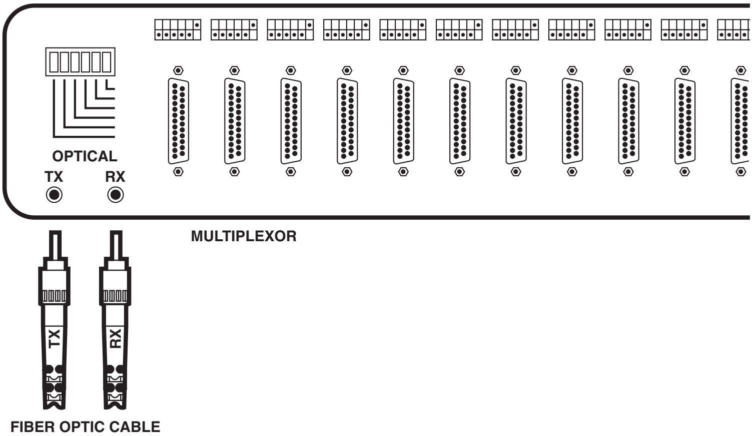
To connect fiberoptic cables to your mux, insert each cable's male connector into the matching female connector of the optical transmitter or receiver, as shown in Figure 3-2 on the next page. If the connectors are SMA type, finger-tighten the coupling nut. If the connectors are ST type, gently twist the male connector to lock it into place.

For SMA connectors, failure to tighten the coupling nut can cause inadequate optical coupling between the cable and the mux, especially at the transmitter.

CAUTION!

Do not use any tools to tighten the connectors under any circumstances. Excessive tightening of a connector can result in damage to the connector and possibly to the optical transmitter or receiver as well.

Figure 3-2. Connecting fiberoptic cables.



Take care in the placement of the optical cables to ensure that the cables are not subjected to stress at or near the optical connectors. Take special caution to ensure that there are no sharp bends in the cable near the connectors. We recommend that some form of strain relief be provided to ensure that no stress is placed on the cable connectors by either tension on the cable or movement of the multiplexor chassis.

3.4 Channel-Cable Connection

The channel connectors of the multiplexor are RS-232 standard DB25 females, requiring a matching male connector on the interface cable.

A 4-40 female threaded standoff is located at each end of the connector to accept locking screws from the male cable connector. Unless the connection to an individual channel is expected to be temporary, we recommend that connectors with locking screws be used and that these screws be secured in the threaded standoffs provided, to ensure that the cables will not be accidentally pulled out of the connectors.

If a three-channel adapter cable (product code EYN355) is being connected to a channel of the mux, the male connector of the adapter cable should be secured to the mux's channel connector using the provided locking screws. The RS-232 cables connecting to the adapter should be secured to the female connectors of the adapter cable in the same way.

4. Configuration and Operation

This chapter describes how to configure each channel for the desired mode of operation and how to operate the multiplexor.

4.1 Modes of Operation

On each channel of the multiplexor, one of five modes of operation can be independently selected:

1. Single asynchronous data line with one control signal.
2. Single asynchronous data line with one control and one auxilary signal.
3. Three async data lines on the same port without control signals (using 3-to-1 adapter cable).
4. Single synchronous data line using internal clock.
5. Single synchronous data line using external clock.

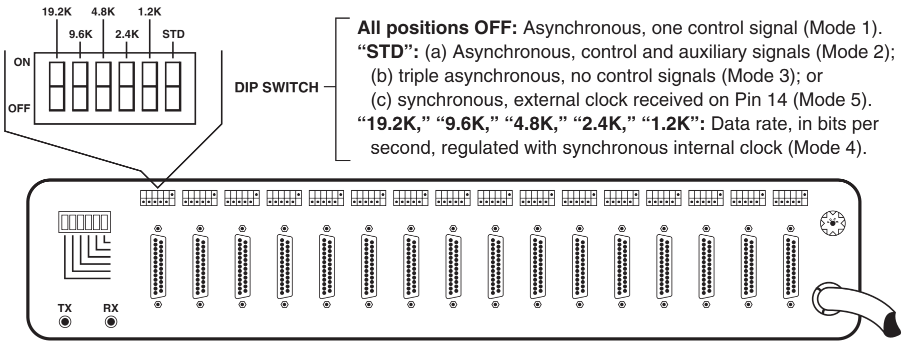
See **Section 4.3** for more detailed information on the supported control signals and their functions.

Select the operating mode of each channel with the DIP switch located directly above that channel's connector. The function of each position in the switch is indicated by the chart in the upper left-hand corner of the rear panel (see Figure 4-1 on the next page).

4.1.1 Single Asynchronous Data Line With One Control Signal (Mode 1)

In this mode of operation, the asynchronous Transmit Data signal fed into one multiplexor is transmitted to the Receive Data output of the other multiplexor, the Data Terminal Ready input (Pin 20) at one end controls the Clear to Send signal (Pin 5) at the other end, and no other signals are passed. This minimal communication will suffice for many types of "dumb terminals." The mux is transparent to asynchronous data rates on a channel in this mode up to 19,200 bps. To set a given channel for this mode, set all of that channel's DIP-switch positions to OFF.

Figure 4-1. DIP-Switch settings.



4.1.2 Single Asynchronous Data Line With Control and Auxiliary Signals (Mode 2)

There is only one difference between this mode and Mode 1: A second signal can be fed into RS-232 Pin 14 (Secondary Transmit Data) and passed to Pin 17 of the other multiplexor. This "auxiliary" signal can be a data or control signal. To set a given channel for this mode, set that channel's "STD" switch position (position 6, the one at the extreme right-hand end of the switch block) to ON and set all other switch positions for that channel OFF. (If any other switch positions are left ON, other channels might malfunction.)

NOTE

The auxiliary signal fed into the mux on Pin 14 will be "reflected" back out Pin 15 of the same connector. See Section 4.1.5 **for the reason why.**

4.1.3 Triple Asynchronous Data Lines Without Controls (Mode 3)

In this mode, data is carried on not only the normal data line but across the DTR/CTS control line and the auxiliary line as well, allowing you to attach three standard RS-232 devices to one multiplexor channel with a 3-to-1 adapter cable (our product code EYN355). This cable has one male connector that plugs into the mux channel's input connector and three female connectors labeled A (2-3), B (14-17), and C (20-5). The only signals supported by this cable are Transmit Data, Receive Data, Protective Ground, and Signal Ground.

Signals fed into the A connector at one end of the system (attached to a terminal device connected to one mux) will be received at the A connector at the other end of the system (attached to a terminal device connected to the other mux), and vice versa. The B and C connectors work the same way. The numbers on each connector are the pin numbers on the mux channel's connector through which the signals actually pass. For more detailed information, see **Section 4.3.3**.

To set a given channel for this mode, set that channel's STD switch position ON, all others OFF.

NOTE

Data coming into the mux from the B device on Pin 14 will be present on Pin 15 of the mux's input connector. See Section 4.1.5 **for the reason why.**

4.1.4 Synchronous Data Line with Internal Clock (Mode 4)

For a channel in this mode of operation, the local multiplexor supplies the transmit clock to its attached terminal device on Pin 15 and transmits the same clock, with the terminal device's synchronous transmit data, to the remote multiplexor. The remote mux (which can be set for either internal or external clocking) will output the clock signal from the local mux on Pin 17 of the corresponding channel's connector.

Data Terminal Ready controls Clear to Send the same way it does in Modes 1 and 2. Available internal-clock data rates are 1200, 2400, 4800, 9600, and 19,200 bps.

To set a given channel for this mode, set the position of that channel's DIP switch that corresponds to the desired data rate (see Figure 4-1 on the next page) ON, and all other positions OFF. A channel will not operate properly with two data rates selected, and any other channel that has either of those data rates selected will also malfunction.

4.1.5 Synchronous Data Line with External Clock (Mode 5)

For a channel in this mode, the local multiplexor receives the transmit clock from its attached terminal device on Pin 14 and passes it on to the remote multiplexor. The remote mux (which can be set for either internal or external clocking) will output the clock signal from the local mux on Pin 17 of the corresponding channel's connector. (This mode is essentially the same as Mode 2: clocking is carried by the auxiliary signal instead of data or another type of control.)

The mux can accept and adapt to any data rate up to 14,400 bps on a channel in this mode. To set a given channel for this mode, set that channel's STD switch position ON, all others OFF.

NOTE

Any time the mux's STD switch position is ON (Mode 2, 3, or 5), the signal input to the mux on Pin 14 will be retransmitted back out Pin 15. This feature is not particularly useful for Mode 2 or 3, but for Mode 5 it allows the mux to get the external clock on Pin 14 (Secondary Transmit Data) and echo it on Pin 15 (Transmit Clock). This feature will also come in handy if you ever need to do end-to-end testing (see Section 5.3.1**).**

4.2 Operating the Multiplexors

After connecting the multiplexors with the optical cable, connecting the terminal devices to the individual channels (either directly or through the adapter cables), and setting the channel configuration switches, connect both multiplexors to their AC power sources. Note that the muxes have no AC power switch. Each multiplexor is turned ON and OFF by plugging and unplugging its power cord. Verify that the red POWER LED of each multiplexor comes on when AC power is connected, and that the green SDCD LEDs of both multiplexors come on when power is applied to the second multiplexor.

Try transmitting through the multiplexors. If data does not seem to be passing through, or if there seem to be errors in the data being transmitted, see **Chapter 5**.

4.3 Interface Desription

This section describes the basic operating principles of the multiplexor and the functions and characteristics of the channels' electrical interface signals. Instructions are also given on how to connect three asynchronous terminal devices to a single channel of the multiplexor.

4.3.1 Method of Multiplexing and Demultiplexing

Each channel of the multiplexor transmits three signals in each direction. All signals in all channels are sampled simultaneously at a rate of 76.8 KHz. The samples are then transmitted serially on the fiberoptic link and reconstructed at the receiving end, where they are all simultaneously transferred in parallel to the interface outputs.

This sampling and reconstruction induces variable propagation delays on each signal, since signals coming into the mux from external sources will not necessarily be synchronized to the internal sampling clock.

Maximum timing distortion is 13.2 µs, which is 1/4 of one bit time at the maximum input data rate of 19.2 Kbps.

Total propagation delay of signals from the input of one multiplexor to the corresponding output of the other multiplexor is 14 to 27 µs, plus 5 ns per meter of fiberoptic cable. All of these time delays are the same for both the 8-channel unit and the 16-channel unit.

4.3.2 Signal Functions

Functions of the multiplexor channel interface signals are described below. All outputs except Data Set Ready and Data Carrier Detect go to the negative (MARK or OFF) state if the optical signal is not being received from the other multiplexor. Also, all inputs will appear to be a negative level if they are left open.

Table 4-1 on page 16 shows all of the signals, their pins, directions, and originating and receiving devices.

Data Set Ready (DSR, Pin 6)
All DSR outputs of all channels are connected in parallel to a common pull-up resistor, and will be at the true level whenever the multiplexor is powered ON.

Data Carrier Detect (DCD, Pin 8)
All DCD outputs of all channels are connected in parallel to a separate pull-up resistor in the same fashion as the Data Set Ready output, and will also always be true whenever the multiplexor is powered ON.

Transmit Data (TXD, Pin 2) and Receive Data (RXD, Pin 3)
The signal fed into the Transmit Data input (Pin 2) of the channel is transmitted through the optical link and appears at the other multiplexor channel as the Received Data output (Pin 3).

Data Terminal Ready (DTR, Pin 20) and Clear to Send (CTS, Pin 5)
The signal fed into the Data Terminal Ready input (Pin 20) of a multiplexor channel is transmitted to the other multiplexor, where it appears at the Clear to Send output (Pin 5). The Clear to Send output is true whenever Data Terminal Ready is true at the other multiplexor, even if Request To Send (RTS, Pin 4) is false. (The multiplexor has no Request To Send input.) It is possible that some terminal devices connected to the multiplexor may be confused by this condition and not work properly.

Transmit Clock (TXC, Pin 15), Receive Clock (RXC, Pin 17), and Secondary Transmit Data (STXD, Pin 14)
The received signal that appears as an output at Pin 17 (Receive Clock) of one of the local multiplexor's channels has two possible sources at the remote mux:

If the corresponding channel of the remote multiplexor is configured for internal-clock synchronous operation (Mode 4), that multiplexor's Transmit Clock output (Pin 15) also appears at the Receive Clock (Pin 17) output of the local mux.

If the corresponding channel of the remote multiplexor has its channel-configuration switch set with STD ON and all other positions OFF (Mode 2, 3, or 5), any signal fed into the remote multiplexor on that channel on Pin 14 (Secondary Transmit Data) appears on that channel at Pin 15 (Transmit Clock) and is transmitted to the local multiplexor, where it appears at the Receive Clock (Pin 17) output.

Table 4-1. Signal Paths (Per Channel)

Each signal’s originating device(s) are shown by the letter “O.” Each signal’s destination device(s) are shown by the letter “D.” Positive voltage is shown by “+V.” Signal directions are shown by arrows.

Channel is in Mode 1 (Async, 1 Control):

Signal	Local Device	Local-Mux Pin	Local Mux	Remote Mux	Remote-Mux Pin	Remote Device	Signal
TXD	O →	2 →	→	→	→ 3 →	D	RXD
RXD	D ←	← 3 ←	←	←	2 ←	O	TXD
CTS	D ←	← 5 ←	←	←	20 ←	O	DTR
DSR	D ←	← 6 ←	(+V) O	O (+V) →	→ 6 →	D	DSR
Sig. Gnd.		7			7		Sig. Gnd.
DCD	D ←	← 8 ←	(+V) O	O (+V) →	→ 8 →	D	DCD
DTR	O →	→ 20 →	→	→	→ 5 →	D	CTS

Channel is in Mode 4 (Internal Sync):
All of the signals shown above, plus these:

Signal	Local Device	Local-Mux Pin	Local Mux	Remote Mux	Remote-Mux Pin	Remote Device	Signal
TXC	D ←	← 15 ←	O →	→	→ 17 →	D	RXC
RXC	D ←	← 17 ←	←	O →	→ 15 →	D	TXC

Channel is in Mode 2 (Async, 2 Controls), 3 (Triple Async), or 5 (Ext. Sync):
All of the signals shown for Mode 1, plus these:

Signal	Local Device	Local-Mux Pin	Local Mux	Remote Mux	Remote-Mux Pin	Remote Device	Signal
STXD	O →	→ 14 →	→	→	→ 17 →	D	RXC
TXC	D ←	← 15 ←			→ 15 →	D	TXC
RXC	D ←	← 17 ←	←	←	14 ←	O	STXD

4.3.3 Connecting Three Asynchronous Lines to One Multiplexor Channel

As described in **Section 4.1.3**, three separate asynchronous data-only channels (no control signals) can be transmitted through one channel of the multiplexor. To connect three standard RS-232 cables to one multiplexor channel requires an adapter cable (product code EYN355). This cable has female connectors labeled A, B, and C, and is wired according to Table 4-2 below.

If any of the three terminal devices on a given channel require the Data Set Ready, Clear to Send, or Data Carrier Detect signals, these can be provided in the following ways:

- Data Set Ready: Pin 6 of the 3-to-1 adapter cable's female connector(s) must be wired to Pin 6 of the cable's male connector.

- Data Carrier Detect: Pin 8 of the adapter cable's female connector(s) must be wired to Pin 8 of the cable's male connector.

(Neither of the above arrangements is standard with the normal adapter cable EYN355, but we will be happy to customize the cable for you. Call us for a quote.)

- Clear to Send: On the adapter cable, jumper together Pins 4 and 5 of the female connector corresponding to the desired device.

Table 4-2. Adapter-Cable Pinning

Male Connector Pin Number:	Female Connector(s) Pin Number(s):
1	A-1, B-1, C-1
2	A-2
3	A-3
5	C-3
7	A-7, B-7, C-7
14	B-2
17	B-3
20	C-2

5. Troubleshooting

5.1 General

All circuitry of the multiplexor is on a single printed circuit board. Troubleshooting by the user is limited to isolating a failure to either one of the multiplexors or the fiberoptic cable.

5.2 Troubleshooting Procedure

1. If any failure occurs, first check for simple problems such as loose connectors (especially the optical connectors), incorrect switch settings (such as two internal-clock data rates selected on the same channel), or blown fuses. The multiplexor has no logic that can "hang up" and therefore no power-on-reset circuit is needed. All logic is self-clearing; therefore, the common troubleshooting procedure of turning power OFF and ON does not clear problems.

2. If a 3-to-1 adapter cable is used on a channel, check continuity of all connections through that cable (see the pinning in **Section 4.3.3**).

3. Check for the possibility of interface incompatibilities between the multiplexor and the particular terminal devices being used.

4. Verify that the proper protocol (synchronous or asynchronous) is selected on the multiplexor and on each terminal device. If a problem mux channel is operating in Mode 4 (sync, internal clock), verify that the terminal device is set to receive the transmit clock from the mux rather than to supply the transmit clock to the mux. If a problem mux channel is operating in Mode 5 (sync, external clock), verify that the terminal device is set to supply the transmit clock to the mux on the mux's Pin 14.

5. If three asynchronous data-only channels are being fed into one channel of the multiplexor, check for the possibility that the terminal device may need the Data Set Ready, Data Carrier Detect, or Clear to Send signals, none of which are normally provided in this mode. If the terminal device does need one or more of these signals, the adapter cable may have to be rewired (see **Section 4.3.3**).

6. There is a possibility of other problems with the Clear to Send signal. Clear to Send at one end of the system is true only if Data Terminal Ready is true at the other end of the system; therefore, problems might occur if a terminal device that requires Clear to Send attempts to communicate through the multiplexor with a terminal device that does not provide the Data Terminal Ready signal. If this is the case, the Data Terminal Ready signal can be provided by jumpering Data Set Ready (Pin 6) to Data Terminal Ready (Pin 20) either at the terminal device or at the multiplexor I/O connector.

   It is also possible that a terminal device might become "confused" if the Clear to Send output from the multiplexor to the terminal device is true when the Request To Send output from the terminal device to the multiplexor is false. (See **Section 4.3.3** for more information.) If this problem occurs, although it is very rare, it can be solved with an adapter. This adapter should consist of male and female RS-232 connectors with all pins connected straight through except Pins 4 and 5 (Request To Send and Clear to Send, respectively.) Between these pins is a gating circuit that holds Clear to Send false when Request To Send is false. Consult us for information on obtaining this type of adapter, if required. The best source of information for determining if a terminal device is affected is the terminal device's manufacturer.

7. If all of the above possible problems have been eliminated or corrected, and the multiplexors still do not pass data or seem to have data errors, use the procedures in the following sections to isolate the source of the problem.

5.3 Testing

Data transmission through the multiplexor can be tested by using the same bit-error-rate testers (BERTs) used for testing standard RS-232 modems and multiplexors. End-to-end tests using two testers are exactly the same as tests with standard modems and multiplexors.

Since these multiplexors, like all fiberoptic modems and multiplexors, are basically all-digital devices, a crude functional test can be performed with only one or two RS-232 breakout boxes, and a fairly good test can be done with breakout boxes and an oscilloscope.

In addition to end-to-end tests with either BERTs or breakout boxes, local or remote loopback tests can be performed using the procedures in **Sections 5.3.2 and 5.3.3**.

Other than the method of performing the actual loopback, the only difference between loopback testing and end-to-end testing is that with loopback tests, input fed into one multiplexor causes an output change at the same multiplexor, rather than at the other end of the system (as in end-to-end tests).

5.3.1 END-TO-END TESTING

To run an end-to-end test with standard BERTs, connect the testers to the same-numbered channels at each end of the system. Configure the testers and the channels for either internally clocked synchronous mode or asynchronous mode and proceed as follows:

1. Verify that data can be transmitted from one tester to the other without errors.
2. Verify that when Data Terminal Ready is turned ON and OFF at one end of the system, Clear to Send at the other end of the system goes ON and OFF. Note that Clear to Send is not affected by Request To Send unless a gating adapter (refer to **Section 5.2**, Step 6) is used. If a gating adapter is used, Clear to Send should be true at one end only if Request To Send is true at that end and Data Terminal Ready is true at the other end.
3. If a channel of the multiplexor is operated in the triple asynchronous mode with an adapter cable, set the testers for asynchronous data transmission and connect them to the “A” female connector of the adapter cable at both ends of the system and verify data transmission in each direction. (Note that control signals are not provided to the tester or accepted by the multiplexor.) After testing the “A” subchannel, repeat the test for the “B” and “C” subchannels.

To test a channel of the multiplexor using RS-232 breakout boxes, set the channel for internally clocked synchronous mode and verify, using either the indicator LEDs on the breakout box or an oscilloscope, that the transmit clock appearing at Pin 15 of the channel connector at one multiplexor also appears at Pin 17 of the same channel of the other multiplexor. If possible, verify the waveform with an oscilloscope at both the transmitting and receiving ends. (At the receiving end, there will be varying timing distortion—that is, jitter—of up to 13 μs, caused by the sampling rate of the multiplexing circuits.) Connect the internal transmit clock from Pin 15 at one multiplexer to the Transmit Data input (Pin 2) and verify that the same signal appears at the Receive Data output (Pin 3) of the other multiplexor. Repeat this test, connecting the transmit clock to the Data Terminal Ready input (Pin 20) and verify that the same signal appears at the Clear to Send output (Pin 5) of the other multiplexor.

5.3.2 Remote Loopback Testing

The only way to perform a complete and totally reliable test of an multiplexor channel or channels is an end-to-end test using two bit-error-rate testers. If only one tester is available, a remote loop test is almost as reliable as an end-to-end test.

A remote loop test sends data from one multiplexor to the other, where it is externally jumpered back into the second multiplexor and returned to the first multiplexor, where the tester is located. Since data passes through the multiplexing/demultiplexing circuits twice in a remote loop test, the maximum data rate is only half the maximum that can be transmitted in an end-to-end test. For internally clocked synchronous tests, the maximum data rate would be 9600 bps. For asynchronous tests, the maximum data rate is dependent on the amount of timing distortion the tester can tolerate.

The remote loop test is run in the same manner as described previously for the end-to-end test, except that what happens at the other end of the system in the end-to-end test happens at the same end in the remote loopback test. For example, data fed into one multiplexor's transmit data input is received at the same multiplexor's receive data output.

To put a channel in remote loop, proceed as follows:

1. Connect the tester (or breakout box) to one multiplexor's channel's connector, and at the other multiplexor set the corresponding channel's STD switch position ON and all other positions OFF.

2. Insert jumper wires into the connector, or make up a jumper plug, to connect Pin 2 to 3, 14 to 17, and 5 to 20. A test run in this way tests all functions of the multiplexor except the Data Carrier Detect, Data Set Ready, and Internal Transmit Clock outputs at the remote multiplexor (the one that has the jumpers). For a total system test using only a single tester and a remote loop mode, the test must be run from each end of the system.

5.3.3 Local Loopback Testing

If the remote loop test shows one or more channels of the multiplexor system not operating or generating data errors, the problem can be isolated to one multiplexor by a local loop test.

A local loop test is performed by connecting the optical transmitter of the multiplexor back to its own optical receiver, which causes all signals fed into any channel of the multiplexor to be looped back to the corresponding outputs of the same channel. Proceed as follows:

1. Connect the optical transmitter's output to the receiver's input with a short fiberoptic cable.

2. Verify that the SDCD indicator comes ON; test the individual channels in the same way described in the previous sections.

3. If your data becomes swamped with continuous errors, the cable may be too short to avoid overloading the optical receiver. If you have a longer cable, replace the short cable and try again. If you don't have a longer cable, unscrew or untwist the cable connector at the end attached to the mux's transmitter, and withdraw the cable partway out of the transmitter's socket. Now try again; the light coming through the cable should be much weaker.

5.4 No Data Transfer on All Channels

If data cannot be transmitted on any channel and the multiplexor pair doesn't pass a remote loop test (see **Section 5.3.2**), perform a local loop test (see **Section 5.3.3**). If neither mux passes the local loop test, this would tend to indicate that the data is being garbled before it gets to the muxes. Check your software, your terminal hardware, and your RS-232 cables carefully.

If at least one multiplexor passed the local loop test, or if your data is good when it comes out of each RS-232 cable, the problem must be in either the fiberoptic cable or one of the multiplexors. First, check the muxes' switch settings and their RS-232 connectors. If these are OK, check the fiberoptic cable's connectors and the muxes' optical transmitters and receivers for fingerprints and other things that could impede or distort optical signals. If you find anything, clean the affected surface with an alcohol-saturated cotton swab. If you can't remove the offending substance, call us for technical support. After cleaning, try your data communication again. If data still can't get through, proceed with the fiberoptic testing that the rest of this section is concerned with.

If you have an optical power meter, you can pinpoint the problem quickly. Disconnect the cables from the muxes' transmitters and test the data signals as they emerge directly from the transmitters. If a signal is weak or dead when it is output, the transmitter is faulty. If both signals are strong at that point, reconnect the the cables and test the signals as they emerge from the other ends of the cables. If a signal that is output strongly is weak or dead at the receiver end of the cable, the cable is faulty. If both signals are strong at the receiver ends of the cables, one of the receivers is probably faulty. Replace faulty cables; send muxes with faulty transmitters or receivers back to us for repair (see **Section 5.7**).

If an optical power meter isn't available, these steps will at least help you to narrow the possibilities:

1. If both muxes pass the local loop test (see **Section 5.3.3**), go to Step 3. If both muxes fail the local loop test, proceed to Step 2 and check both transmitters. If only one of the muxes fails, proceed to Step 2 and check its transmitter. If you can't do the local loop test, check the SDCD LEDs on both multiplexors. If this LED is OFF on one of the muxes, proceed to Step 2 and check the transmitter on the opposite mux; if the SDCD LED is OFF on both muxes, go to Step 4.

2. To check an optical transmitter's LED, unscrew or untwist the cable connector attached to the mux's TX connector, turn off or dim the lights in the room, and hold a thin sheet of white paper in front of the optical transmitter. A faint red glow should be visible on the paper, since the transmitter LED puts out a small amount of visible red light in addition to its primarily infrared output. If no glow can be seen, even with the room in total darkness, the transmitter isn't working; see **Section 5.7** for instructions on shipping the mux for repair.

CAUTION!

Do not look into the transmitter. Prolonged exposure to high-intensity infrared light will cause eye damage.

3. If both optical transmitters appear to be operating and only one SDCD LED is OFF, reverse the fiberoptic cable connections at both ends of the cable. That is, connect the fiber that was attached to each mux's transmitter to its receiver, and vice versa. If the SDCD LED that was OFF comes ON and the other one goes OFF when the connections are reversed, this definitely isolates the problem to one fiber of the cable. The cable will have to be replaced. If there is no change in the state of the SDCD LEDs—the one that was OFF stays OFF and the one that was ON stays ON—go to Step 5.

4. If both SDCD LEDs are OFF, try testing the two multiplexors with another fiberoptic cable, if one is available. If the problem goes away when you use the replacement cable, the old cable is faulty. If the problem remains, or if no replacement cable is available, proceed to Step 5.

5. Test the muxes' ability to communicate without cable. The multiplexors can transmit to each other optically through the air over very short distances (not more than 2 to 3 inches [5 to 7.6 cm]). Place the two multiplexors on a flat surface with the rear corners facing each other and the optical transmitter and receiver connectors pointing toward each other, at a distance of approximately one inch (2.5 cm). If the muxes' SDCD LEDs don't come on immediately, slowly slide one mux toward the other, keeping the optical connectors aligned, until the LEDs of both muxes come ON. If this happens, it should be possible to transmit error-free between the multiplexors using any of the tests described in **Section 5.3** after you move the muxes a little closer yet. If you achieve error-free transmission through the air, proceed to Step 6. If both LEDs don't light or it remains impossible to transmit data without errors no matter how close together you push the multiplexors, there is probably a problem with a transmitter or receiver. See **Section 5.7** for instructions on shipping the muxes for repair.

6. If the multiplexors can communicate error-free through the air, but not through your original fiberoptic cable or any replacement cable you try, the problem is probably in a transmitter or receiver, but will require an optical power meter to pin down. If you can obtain one, try the procedure described in the third paragraph of this section. If you can't, call us for technical support.

5.5 Data Transfer Is Badly Corrupted

If data transfer in one or both directions has high error rates, the problem is most likely inadequate optical signal strength, caused by either (a) foreign matter in a fiberoptic interface, (b) low optical power output of one or both optical transmitters, (c) inadequate sensitivity of one or both optical receivers, or (d) damage to the fiberoptic cable resulting in excessive optical-signal attenuation.

Before doing anything else, check (and clean if necessary) the cable's connectors and the muxes' transmitter and receiver, as described in the second paragraph of the previous section. If the high error rate remains after cleaning:

If the high error rate hits data transmitted in one direction but not data transmitted in the other direction, the cause of the problem can be isolated by reversing the fiberoptic cable connections at both multiplexors as described in Step 3 of the previous section. If, when you do this, the direction of the high error rate reverses, the problem is in the cable. If the direction of the high error rate does not reverse, the problem is in one of the multiplexors.

If the high error rate hits both directions of data transmission, try swapping in another fiberoptic cable as directed in Step 4 of the previous section. If the problem goes away when you use the replacement cable, the old cable is faulty.

If the problem remains and you have an optical power meter, test the fiberoptic components as described in the third paragraph of the previous section. If an optical power power is not available, call us for technical support.

5.6 Calling Us

If you determine that your multiplexor itself is malfunctioning, *do not attempt to alter or repair the unit.* Contact us; the problem may be solvable over the phone.

Before you do, make a record of the history of the problem. We will be able to provide more efficient and accurate assistance if you have a complete description, including:

- the nature and duration of the problem.
- when the problem occurs.
- the components involved in the problem.
- any particular application that, when used, appears to create the problem or make it worse.

5.7 Shipping and Packaging

If you need to transport or ship your multiplexor:

- Package it carefully. We recommend that you use the original container.
- If you are returning the multiplexor, make sure you include this manual. Before you ship the multiplexor back to us for return or repair, contact us to get a Return Materials Authorization (RMA) number.

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