BLACK BOX
NETWORK SERVICES

Star Mux Express
Star Mux Express Fiber
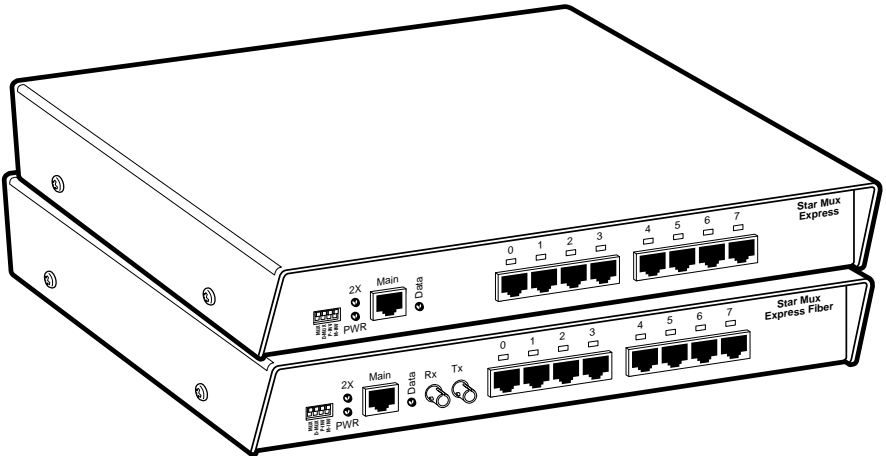
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This equipment generates, uses, and can radiate radio frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio communication. It has been tested and found to comply with the limits for a Class A computing device in accordance with the specifications in Subpart J of Part 15 of FCC rules, which are designed to provide reasonable protection against such interference when the equipment is operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case the user at his own expense will be required to take whatever measures may be necessary to correct the interference.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This digital apparatus does not exceed the Class A limits for radio noise emission from digital apparatus set out in the Radio Interference Regulation of Industry Canada.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de la classe A prescrites dans le Règlement sur le brouillage radioélectrique publié par Industrie Canada.

NORMAS OFICIALES MEXICANAS (NOM)
ELECTRICAL SAFETY STATEMENT

INSTRUCCIONES DE SEGURIDAD

1. Todas las instrucciones de seguridad y operación deberán ser leídas antes de que el aparato eléctrico sea operado.

2. Las instrucciones de seguridad y operación deberán ser guardadas para referencia futura.

3. Todas las advertencias en el aparato eléctrico y en sus instrucciones de operación deben ser respetadas.

4. Todas las instrucciones de operación y uso deben ser seguidas.

5. El aparato eléctrico no deberá ser usado cerca del agua—por ejemplo, cerca de la tina de baño, lavabo, sótano mojado o cerca de una alberca, etc..

6. El aparato eléctrico debe ser usado únicamente con carritos o pedestales que sean recomendados por el fabricante.

7. El aparato eléctrico debe ser montado a la pared o al techo sólo como sea recomendado por el fabricante.

8. Servicio—El usuario no debe intentar dar servicio al equipo eléctrico más allá a lo descrito en las instrucciones de operación. Todo otro servicio deberá ser referido a personal de servicio calificado.

9. El aparato eléctrico debe ser situado de tal manera que su posición no interfiera su uso. La colocación del aparato eléctrico sobre una cama, sofá, alfombra o superficie similar puede bloquea la ventilación, no se debe colocar en libreros o gabinetes que impidan el flujo de aire por los orificios de ventilación.

10. El equipo eléctrico deber ser situado fuera del alcance de fuentes de calor como radiadores, registros de calor, estufas u otros aparatos (incluyendo amplificadores) que producen calor.

11. El aparato eléctrico deberá ser connectado a una fuente de poder sólo del tipo descrito en el instructivo de operación, o como se indique en el aparato.

12. Precaución debe ser tomada de tal manera que la tierra fisica y la polarización del equipo no sea eliminada.

13. Los cables de la fuente de poder deben ser guiados de tal manera que no sean pisados ni pellizcados por objetos colocados sobre o contra ellos, poniendo particular atención a los contactos y receptáculos donde salen del aparato.

14. El equipo eléctrico debe ser limpiado únicamente de acuerdo a las recomendaciones del fabricante.

15. En caso de existir, una antena externa deberá ser localizada lejos de las lineas de energia.

16. El cable de corriente deberá ser desconectado del cuando el equipo no sea usado por un largo periodo de tiempo.

17. Cuidado debe ser tomado de tal manera que objectos liquidos no sean derramados sobre la cubierta u orificios de ventilación.

18. Servicio por personal calificado deberá ser provisto cuando:

    A: El cable de poder o el contacto ha sido dañado; u

    B: Objectos han caído o líquido ha sido derramado dentro del aparato; o

    C: El aparato ha sido expuesto a la lluvia; o

    D: El aparato parece no operar normalmente o muestra un cambio en su desempeño; o

    E: El aparato ha sido tirado o su cubierta ha sido dañada.

Contents

1. Specifications

Data Rate —	1 to 2 Mbps
Heat Dissipation —	21 BTUs per hour
Fuse —	0.5 amp, 250V Slo-Blo
Connectors —	IC205A: Female twinax or RJ-45 for host, RJ-45 for devices; Female RJ-45 for device connections: Female RJ-45 and female twinax for host or controller connection; IC206A: 2 female fiber ST® connectors
Indicators —	Power, 2X (indicates Star Mux Express is in 2-Mbps mode), (1) LED for each controller and device port
Devices Supported —	IBM® Processors: AS/400® (all models), 534X (all models), 536X, 538X; Remote Controllers: IBM 5294 and compatibles, IBM 5394 and compatibles, IBM 5494 and compatibles
Operating Temperature —	32 to 131°F (0 to 55°C)
Humidity —	Up to 95% noncondensing
Power —	Autosensing 100 to 220 VAC; 6 watts power consumption
Size —	1.7"H x 11.3"W x 9"D (4.3 x 28.7 x 22.9 cm)

Balun Specifications

Data Rate —	Up to 5 Mbps
System Data Rate —	1 to 2 Mbps
Transformer —	Proprietary ferromagnetic core with 26-gauge winding
Frequency —	100 kHz low to 5 MHz high cutoff
Out-of-Band —	Electrical noise filtration and RF rejection

Impedance for Twinax —   100 ohms (unbalanced), 110 ohms (terminated)

Impedance for Twisted Pair — 100 to 110 ohms, balanced

Insertion Loss —   Less than 0.2 dB

DC Isolation —   0 volts (DC continuity provided)

Operating Temperature —   14 to 140°F (-10 to +60°C)

Storage Temperature —   -4 to +158°F (-20 to +70°C)

MTBF —   240,000 hours

Construction —   Exterior: Fire-rated ABS plastic;
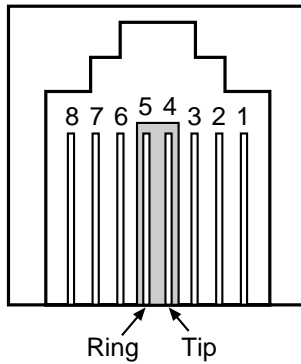   Interior: Printed circuit board

Figure 1-1. RJ-45 (Pin 4 - Tip, Pin 5 - Ring).

2. Introduction

2.1 Description

The Star Mux Express is an advanced active star/mux repeater that converts your twinax daisychain cabling configuration into a cost-saving, flexible star-wired configuration. It supports multiple applications by operating in three different modes: star, mux, and demux. Change modes by setting the DIP switches on the front of the multiplexor.

The Star Mux Express is available in copper or fiber configurations.

After receiving a twinax signal from the host or controller, the Star Mux Express regenerates, amplifies, retimes, reshapes, and then splits it into seven device channels. Each of the Star Mux Express's device ports has its own transmit and receive drivers, enabling all connected devices to operate concurrently, yet independently.

You can attach up to seven twinax devices to the Star Mux Express.

The Star Mux Express also offers the following features:

Express Mode Compatibility. The Star Mux Express automatically selects between 1- and 2-Mbps operation.

Flexibility. You can easily switch the Star Mux Express from a star configuration to a twinax multiplexor configuration using UTP cabling. The Star Mux Express supports fiber and backup twisted-pair or twinax cables between units.

Switch-Selectable Polarity. Host-port and device-port polarity wiring are controlled by DIP switch. This makes it easy to correct for reversed polarity.

2.2 What's Included

When you order the Star Mux Express, check the package to make sure you received everything that should have come with it. The complete package includes:

(1) Star Mux Express

This user's guide

Power cord

Rubber feet for shelf mounting

A 19" rack mounting kit

3. Planning Your Network

3.1 Drawing a Map

For proper planning, draw a map of your cable layout based on your floor plan. Note the location and number of wiring closets of terminal devices and their distances from controllers. Include a projection of future needs.

Depending on your application, your mapped plan might also include wiring closet equipment racks, patch panels, patch cables, punch-down blocks, and other related equipment.

To determine extended cabling distances, consult **Section 3.2**.

Because telephone twisted-pair cable is unshielded, avoid placing it near sources of electrical disturbance, such as fluorescent lights, power cables, electric motors, and radio transmitters.

3.2 Choosing and Using Cables

Choosing cables includes considering existing wiring, the types of cables you need, and the distances the cables will cover.

3.2.1 USING EXISTING WIRING

You might be able to use existing twisted-pair telephone wiring to connect terminals to the Star Mux Express. You should consider factors such as matching impedances and resistance to interference. Consult an expert in the use of telephone wiring for data transmission.

3.2.2 UNSHIELDED TWISTED PAIR (UTP)

Unshielded twisted-pair cable should be stranded or solid twisted-pair telephone building wire. Do not use consumer telephone cable, sometimes called flat cable or silver satin. This type of cable is not twisted pair and can drastically reduce the cable lengths possible in your network.

Usually, with UTP cabling, the larger the diameter of the wire, the farther the signal can reach. For example, 19 gauge is larger than 24 gauge, and four twists per foot is better than two twists per foot. Balance this against your budget; larger diameter wire and more twists per foot are more expensive.

The UTP cable should meet the following requirements:

- Straight-through polarity. Pre-assembled modular cables for telephone equipment often reverse polarity between the ends of the cable. You can configure the Star Mux Express to set polarity per port. The cables should maintain straight-through polarity for future networking needs.

- Type 3, Level 4, or CAT 5

- Gauge of 24 or 22 (AWG) 9562 Belden

- Stranded or solid copper twisted pairs with at least two twists per foot

- A maximum DC resistance of 28.6 ohms per 1000 feet

- Characteristic impedance:

    90 to 120 ohms at 256 kHz
    87 to 117.5 ohms at 512 kHz
    85 to 114 ohms at 772 kHz
    84 to 113 ohms at 1000 kHz

- Maximum attenuation per 1000 feet:

    4.00 dB at 256 kHz
    5.66 dB at 512 kHz
    6.73 dB at 772 kHz
    8.20 dB at 1000 kHz

3.2.3 TWINAX

Use twinax cable to connect the host or controller port to the Star Mux Express if you are not using UTP cable.

3.2.4 FIBER

Use multimode duplex fiber 50/120, 62.5/125 (preferred), or 100/140.

3.3 Cable Distance

Distances between the host and the Star Mux Express will vary depending on the gauge or level of the UTP cables, the quality of baluns or Ts, twinax and UTP, or the building environment. Each mechanical connection (break) usually reduces the overall distance by fifty feet (about fifteen meters).

3.3.1 MAXIMUM DISTANCES BETWEEN HOST, STAR MUX EXPRESS, AND DEVICES

Consult the following chart for maximum distances between the host, Star Mux Express, and devices.

Type of Connection	Meters	Feet
TWX to Host	1,524	5,000
UTP to Host	762	2,500
UTP to Devices	914	3,000
Fiber Cascade	2,012	6,600
TWX Multiplexing	1,219	4,000
UTP Multiplexing	610	2,000

3.3.2 MAXIMUM DISTANCES USING MULTI-MODE FIBER CABLING

Consult the following chart for maximum distances with different kinds of multi-mode fiber cable. You can expect up to 1-dB loss for each break and connector in the fiber cable.

Fiber Cable Type	Maximum Distance
50.0 Micron	3500 feet
62.5/125 (typical)	6600 feet
HCP-M0200T	10,000 feet
100.0 Micron	7500 feet

3.4 RJ-45 and RJ-11 Pinouts

RJ-11: 3 Tip, 4 Ring
RJ-45: 4 Tip, 5 Ring

If the wiring or balun you use has reversed polarity, see the DIP-switch settings in **Appendix A** for instructions on changing polarity.

NOTE

Pinouts on the Star Mux Express should only be changed by authorized service personnel.

3.5 Using Baluns

Each twinax terminal device must have a balun attached to its twinax port. Baluns balance the interface so you can use UTP wire. The controller does not need a balun if it attaches to the Star Mux Express with twinax cable.

Black Box Mini Twinax↔Twisted Pair baluns (part number IC067A) are strongly recommended for proper impedance matching.

For balun specifications, refer to **Chapter 1**.

3.6 Using Terminators

If using twinax T-connectors, make sure that they self-terminate (Smart T). If they are not self-terminating, then a termination plug will be needed on an unused port.

Make sure the Y cables or T-connectors are attached to the device for proper termination. Do not remove the Y cables or T-connectors from the 5250 devices when connecting a balun directly to the device.

4. Installation and Configurations

4.1 Installing the Star Mux Express

To install the Star Mux Express configuration:

1. Connect the three-prong power cord to the back of the Star Mux Express.

2. Plug the power cord into a wall outlet. Make sure the power LED is green and the other LEDs are off.
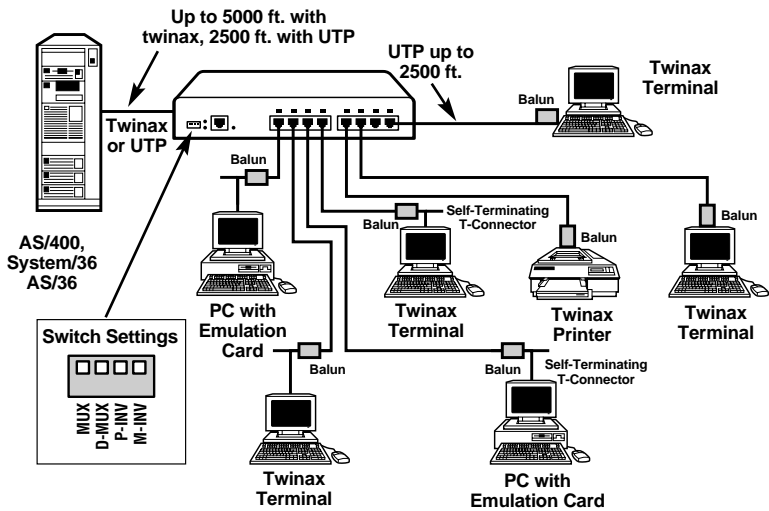
4.2 Star Mux Express in Star Mode

Figure 4-1. Typical Star Configuration.

The Star Mux Express hubs convert the daisychain configuration into a star-wired configuration, replacing twinax cabling between host or controller and devices with more flexible, efficient, and economical unshielded twisted-pair (UTP) cabling.

For converting twinax lines to twisted pair, Black Box Mini Twinax↔Twisted Pair baluns (part number IC067A) are recommended.

The Star Mux Express can receive the host or controller signal via either twinax or UTP cabling. Each device channel uses an RJ-45 modular connector.

Connect a twinax cable 10 to 5000 feet long from the host or controller port to the female twinax port on the back of the Star Mux Express. Or connect a twinax balun to the host or controller port, then connect a UTP cable 10 to 2500 feet long to the "main" port on the Star Mux Express.

The UTP cable should be at least one pair (2-wire), with either the RJ-11 or RJ-45 connectors, depending on the host/controller balun. It should have straight-through polarity. Connect the UTP cable to the Star Mux Express RJ-45 controller port on the front panel. If the polarity is reversed, use the front-panel DIP switch to invert the polarity of the host port. See **Appendix A** for setting the switches.

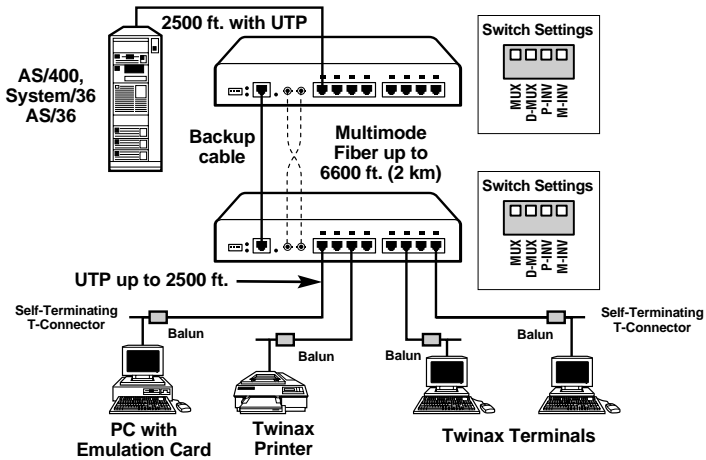## 4.3 Star Mux Express Fiber Star Mode

Figure 4-2. Star Mux Express Fiber Star to Star Mode.

Extend a host/controller port to a remote location to a Star Mux Express in star mode.

The Star Mux Express's dual fiberoptic ports allow you to maximize distances between the host/controller and devices. Establish the fiber link by connecting two Star Mux Expresses through their fiber ports using a dual fiber cable.

To connect the two units using fiber, connect the Transmit (T) fiber cable to the Receive (R) connector on the second Star Mux Express. Connect the Receive (R) fiber connector to the Transmit (T) connector on the second Star Mux Express.

If only one host/controller port is needed over fiber, configure the host-end Star Mux Express in star mode. Connect the host port with a Black Box Mini Twinax↔Twisted Pair balun (part number IC067A) and 10 to 2500 feet of UTP. Connect the duplex fiber ends to each Star Mux Express. You may connect up to seven 5250s to ports 0 through 7 on the second Star Mux Express while in star mode.

NOTE

Insert the UTP from the host into any device (ports 0 through 7) but NOT into the main twinax port in the back of the unit. (The main or twinax port can be used for back up cable between Star Mux Expresses).

A link LED will flash when the AS/400 is polling for devices and there is no active devices on the hub.

A device port will be green if a device is varied off on the host but still connected to the hub. When using the Star Mux Express in Fiber Star Mode or Mux/Demux mode, no LED will be lit on the near unit until there is an active connection at the remote Star Mux Express.

4.4 Star Mux Express Mux to Mux to Star

You can link up to eight Star Mux Expresses together in mux-to-demux-to-star mode, supporting up to fifty six 5250 devices over a single pair of fiberoptic cables. (See **Appendix B** for important information about multiplexing and "split controller" modes on the AS/400.)
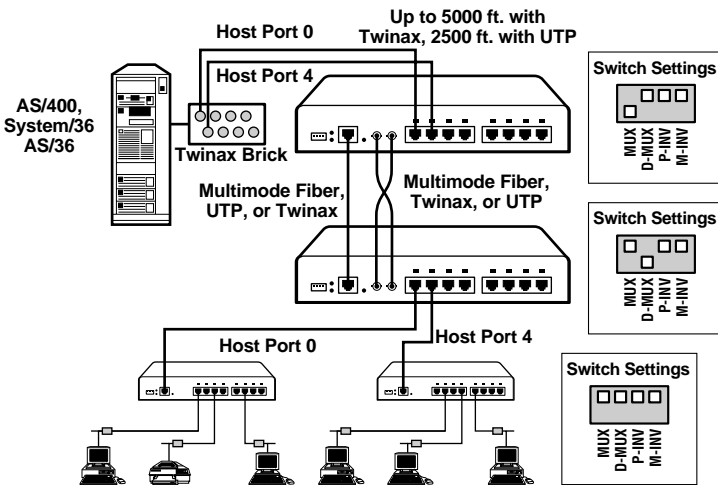

Figure 4-3. Star Mux Express, Mux-to-Mux-to-Star Mode.

Each twinax brick equipped with four or eight twinax host ports corresponds to one common host workstation controller card.

In the fiberoptic repeater mode, the host-end Star Mux Express operates as a multiplexor, where you can connect up to eight host/controller ports to ports 0 through 7. Depending on the quality of the fiber being used, place the second Star Mux Express up to 6600 feet (2 km) away from the first unit and configure it to operate in demux mode when more than one host port is needed. Configure the mode of operation by using the DIP switch on the front of the Star Mux Express.
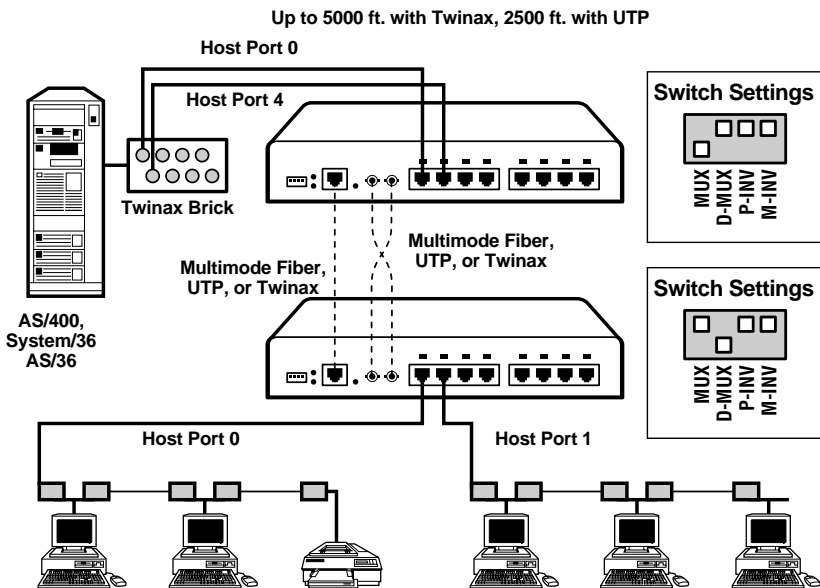
4.5 Mux to Mux to Daisy

Figure 4-4. Mux Mode to Daisychain.

Rather than breaking into a star configuration at the remote location, the Star Mux Express also allows you to go into a daisychain.

You can link up to 6600 feet with fiber, 2500 feet with twinax or UTP.

5. Hardware

5.1 Pin Assignments

The Star Mux Express is shipped from the factory with active RJ-45 pins set to the USOC standard (Pin 4 = Tip, Pin 5 = Ring). (See Figure 1-1 in **Chapter 1** for more information.)

We recommend using Black Box Mini Twinax↔Twisted Pair baluns (part number IC067A) for proper impedance matching between Star Mux Express and twinax peripherals and host/controllers link connections.

TWINAX CABLE PIN ASSIGNMENTS

The phase A pin on standard twinax cable corresponds to pin 4 of an R-J45 connector; the phase B pin corresponds to pin 5.

5.2 Configuring Polarity

Not all balun manufacturers use the same polarity pinouts. One manufacturer might wire the balun RJ-11 pin 3 to phase A and pin 4 to phase B of the twinax connector. Another might use the same RJ pins, but wire phase A and B opposite (reverse polarity).

The Star Mux Express allows you to invert the polarity independently on the host port or the device ports.

Switch 3 inverts the polarity of the eight device ports. Polarity switch 4 inverts the host/controller port.
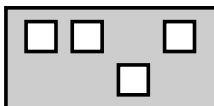
5.3 Changing Fuses

To change the fuse on the back of the Star Mux Express:

1. Unplug the power.

2. Locate the fuse holder built into the three-prong outlet on the back of the Star Mux Express.

3. With a flat screwdriver, push out on the center lip of the fuse holder and pull it out.

½ Amp Slo-Blo Fuse

**110-240 VAC
Autosensing
Power Supply**

**Twinax
Connector**
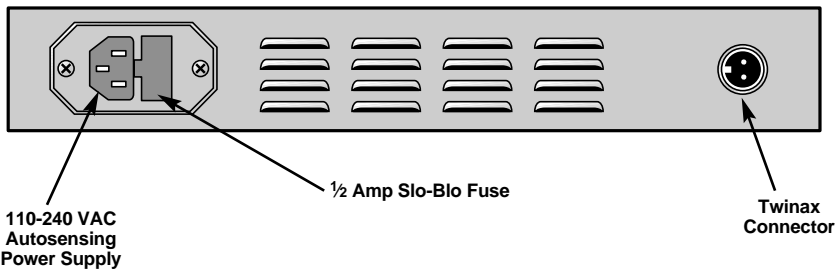
4. Remove and discard the burned-out fuse from the fuse holder. Replace it with a new 0.5-amp, 250-volt Slo-Blo fuse.

5. Push the fuse holder back in place.

5.4 Reading LEDs

The LEDs on the Star Mux Express's front panel allow you to diagnose the status of data traffic at a glance.
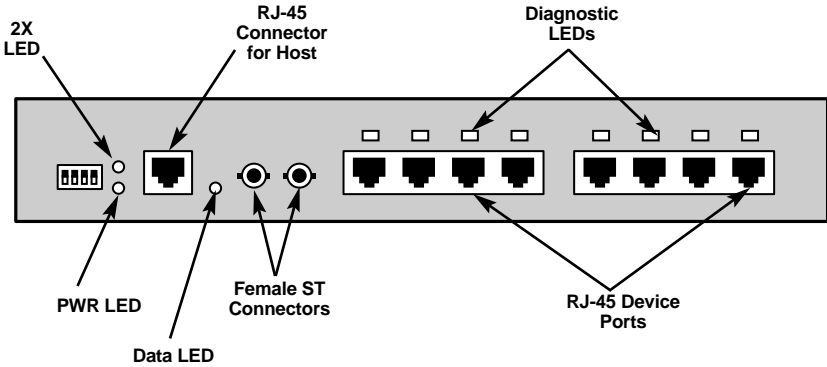

Table 5-1. Star Mux Express LEDs

	Green	Off
PWR	Unit is on-line.	If no light, unit is off-line.
2X	Unit is operating at 2 Mbps.*	Unit is operating at 1 Mbps.
Data (from controller port)	Data traffic is OK.	No data traffic. Cabling errors.
Device ports	Data traffic is OK.	No data traffic. Cabling errors.

Table 5-2. Star Mux Express Fiber LEDs

	Green	Off
Data (from controller port)	Data traffic is OK.	No data traffic. Cabling errors.
Device ports	Data traffic is OK.	No data traffic. Cabling errors.
2X	Unit is operating at 2 Mbps.*	Unit is operating at 1 Mbps.
PWR	Unit is on.	Unit is off.

*In 2-Mbps mode, the AS/400 intermittently polls at 1 Mbps to see if any devices not connected to the Star Mux Express have come onto the line. You may see the 2X light flicker occasionally.

NOTES

The Data LED will flash when the AS/400 is polling for devices and there is no active devices on the hub.

A device port's LED will also be green if a device is varied off at the host but still connected to the hub.

When using Star Mux Express in Fiber Star Mode or Mux/Demux mode, no LED will be lit on the near unit until there is an active connection at the remote Star Mux Express.

6. Troubleshooting

This appendix lists troubleshooting steps you can follow if a terminal attached to a Star Mux Express device does not come on-line.

Follow the steps in order until the terminal comes on-line. If you try all the steps and the terminal still does not come on-line, contact Technical Support.

1. **Check the Status of the Device on the AS/400 or System/3X Host.** The AS/400 command is WRKCFGSTS *DEV device name.

    If the device status is VARY ON PENDING but the device does not sign on, power the device off, then back on again. Check the polarity of your cabling and baluns and Star Mux Express switch settings. Your switch settings must match the polarity of the Star Mux Express port.

    If the status is VARY OFF, power off the device and execute the host command to VARY ON the device. If the host menu indicates errors on the host port to which your device is attached, clear the errors and power off and on the device (see your host documentation).

    If the status remains VARY OFF (the host still does not recognize the device), check the polarity of the cabling and pinouts of the Star Mux Express and baluns.

2. **Move the Device to Another Port.** If one device is failing, move that device to a known good port on the Star Mux Express. If the device fails on that port, the device may be at fault.

3. **Power the Star Mux Express Off and On.** If multiple device ports are failing on the Star Mux Express, power it off and on by unplugging the power cord and plugging it back in.

4. **Check for Duplicate Device Addresses.** Check to make sure there are no duplicated device addresses. Devices contending for the same address will drop off-line.

5. **Change to Black Box Baluns.** Use Black Box Mini Twinax↔Twisted Pair baluns (part number IC067A).

6. **Reassign IBM Terminal Address.** If you are using an IBM 3196 terminal, assign it the first address on that twinax line.

7. **Check T-Connectors.** Make sure any twinaxial T-connectors you are using are self-terminating. Do not remove the twinax Ts or Y cables or try connecting a balun directly to the device. Use the twinax Ts or Y cables for proper termination.

8. **Check Polarity of UTP Wiring.** Most twinax products use the following pin assignments:

   • On RJ-11: Pin 3 = Tip, Pin 4 = Ring

   • On RJ-45: Pin 4 = Tip, Pin 5 = Ring.

   For data transmission, *do not* use flat silver satin cables anywhere in the network. *Do not* use shielded twisted pair wire, unless it is data-grade Type 3 or better.

   UTP wiring should have straight-through polarity. You can invert the popularity using switches 3 and 4 on the Star Mux Express, but it is always best to have straight-through polarity for future cabling needs.

9. **Check Multi-Conductor Cable.** Make sure that multi-conductor cable is not using more than two thirds of its lines for data. Ground one end of any unused pairs.

10. **Check PA System Wiring.** Do not run PA system wiring with data UTP wiring. PA systems have a constant voltage on-line.

11. **Check Location of UTP Wiring.** Avoid running UTP wiring near power lines, fluorescent lighting, transformers, electric motors, or other sources of electrical disturbance.

12. **Check Length of Patch Cables.** Make sure there is a minimum of 10 feet of patch cable connecting the host and all devices to the Star Mux Express in star or muxing configurations.

Appendix A. DIP-Switch Settings

There is a single four-position DIP switch on the front of the Star Mux Express.

Switch	OFF (Default)	ON
MUX	Star Mode	Only for host side, when the Star Mux Express is being used as a multiplexor (over fiber or copper).
Demux	Star Mode	On is used at the remote end of a pair of units being used in Mux.
P-INV	Device Port (0 through 7) Polarity Normal	Invert the polarity on the Device Ports (Ports 0 through 7).
H-INV	Host Polarity Normal	Invert polarity of host/controller port.

Appendix B.
Special Application Note

Star Mux Express in Mux Mode and the New IBM AS/400 Workstation Controllers

You may have been reading about the recent changes in twinax technology that IBM has been introducing on their newest systems. One of the changes is the way that the workstation controller polls twinax devices. This change in the way that the AS/400 controller polls devices may impact the way that you configure twinax-to-fiber multiplexors, such as in the Star Mux Express.

BACKGROUND

The connection to the workstation controller is accomplished through the twinax Block (also commonly referred to as a brick). The brick typically has eight twinax ports, each one supporting 7 twinax addresses. The way this has historically worked, the AS/400 workstation controller would poll all 7 addresses on all 8 of the ports in a round-robin fashion. The new workstation controller (266C or 2661) can divide its attention across the twinax ports and work as if it were two independent controllers. One half of the controller services ports 0 through 3, while the other half services ports 4 through 7. A divided controller results in two ports being serviced at the same time. Each portion of the workstation controller still uses time slices to communicate with a single port at a time; but it has fewer ports to service. Individual devices have the potential of receiving attention from the workstation controller twice as often. That theoretically results in better performance.

The Star Mux Express combines the signals of multiple ports into a single fiber pair for a long transmission run. At the far end, the signals are again converted into separate ports. Because the legacy controllers gave each port a separate time slice, a multiplexor's job was relatively straightforward.

With new workstation controllers driving two ports at the same time, this form of eight-port multiplexing may not work. The signals from two ports might be garbled together, making twinax communications impossible.

WHAT TO DO

There are two options.

1. Multiplex ports 0 through 3 together, and separately multiplex ports 4 through 7 (see the illustration below).

2. IBM has created PTF # SF43465 for the workstation controller to allow customers to switch the workstation controller back into the sequential method of polling. Apply this PTF to allow multiplexing of all eight twinax ports together over a single pair of fibers on the Star Mux Express.
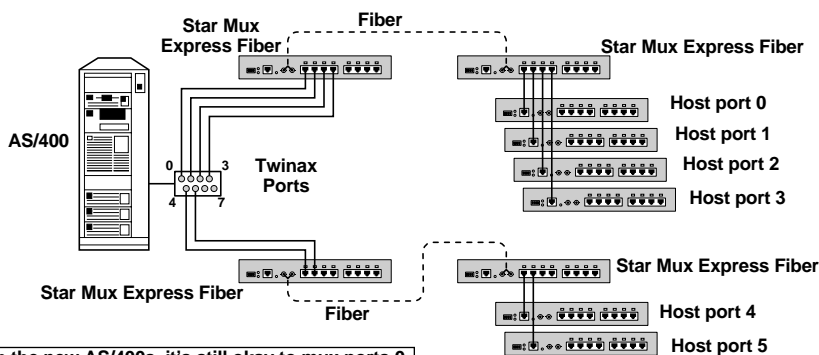
With the new AS/400s, it's still okay to mux ports 0 through 3 or ports 4 through 7 together. However, avoid mixing ports from separate sides.

NOTE

Only the newest AS/400 systems are affected by this. Any CISC-based AS/400 will continue to operate the same as before, no matter what version of OS you are running. Remember, the star-mode operation remains unchanged. The only area where there might be a configuration issue is with the mux-mode operation of the Star Mux Express.