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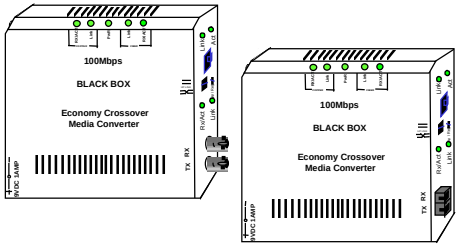
100 Mbps Economy Crossover Media Converters

February 2002

LH1503A, LH1504A
LH1506A, LH1507A
LH1508A
LH1505P-RACK



CUSTOMER SUPPORT INFORMATION

Order **toll-free** in the U.S. 24 hours, 7 A.M. Monday to midnight Friday: **877-877-BBOX**
FREE technical support, 24 hours a day, 7 days a week: Call **724-746-5500** or fax **724-746-0746**
Mail order: **Black Box Corporation**, 1000 Park Drive, Lawrence, PA 15055-1018
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BLACK BOX®

100Mbps Economy Crossover Media Converters Installation and User Guide

Trademarks

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Important: Black Box 100 Mbps Economy Crossover Media Converters contain no user serviceable parts. Attempted service by unauthorized personnel shall render any and all warranties null and void. If problems are experienced with a 100 Mbps Crossover Media Converter, consult Section 5, Troubleshooting, of this User Guide.

 Printed in the United States of America.

Contacting Black Box Corporation

Please use these mailing address and phone and fax numbers:

Black Box Corporation

1000 Park Drive

Lawrence, PA 15055

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email: info@blackbox.com

FEDERAL COMMUNICATIONS COMMISSION
AND
CANADIAN DEPARTMENT OF COMMUNICATIONS
RADIO FREQUENCY INTERFERENCE STATEMENTS

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 B 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 the Canadian Department of Communications.

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 le ministère des Communications du 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 deberan 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 reconnendados por el fabricante.
7. El aparato eléctrico debe ser montado a la pared o al techo sólo como sea recommendado por el fabricante.
8. Servicio—El usuario no debe intentar dar sercicio al equipo eléctrico más allá a lo descrito en las instrucciones de operatión. Todo otro servicio deberá ser referido a personal de servicio calificado.
9. El aparato eléctrico debe ser situado de tal mannera 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 du fuentes de calor como radiadores, registros de calor, estufas u otros aparatos (incluyendo amplificadores) que producen calor.
11. El aparato eléctrico deberá ser connectado una fuente de poder sólo del tipo descrito en el instrucivo de operación, o como se indique en el aparato.
12. Precaución debe ser tomada de mal 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 recommendaciones 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.

Certification Notice for Equipment Used in Canada

The Canadian Department of Communications label identifies certified equipment. This certification means that the equipment meets certain telecommunications-network protective, operation, and safety requirements. The Department does not guarantee the equipment will operate to the user's satisfaction.

Before installing this equipment, users should ensure that it is permissible to be connected to the facilities of the local telecommunications company. The equipment must also be installed using an acceptable method of connection. In some cases, the company's

inside wiring associated with a single-line individual service may be extended by means of a certified connector assembly (extension cord). The customer should be aware that compliance with the above conditions may not prevent degradation of service in some situations.

Repairs to certified equipment should be made by an authorized Canadian maintenance facility—in this case, your supplier. Any repairs or alterations made by the user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment.

Users should ensure for their own protection that the electrical ground connections of the power utility, telephone lines, and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

CAUTION:

Users should not attempt to make such connections themselves, but should contact the appropriate electric inspection authority, or electrician, as appropriate.

The LOAD NUMBER (LN) assigned to each terminal device denotes the percentage of the total load to be connected to a telephone loop which is used by the device, to prevent overloading. The termination on a loop may consist of any combination of devices, subject only to the requirement that the total of the load numbers of all the devices does not exceed 100.

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1.0 SPECIFICATIONS

1.1. Technical Specifications

Performance: Data Rate: 100 Mb/s

Half- or Full-Duplex transparent

F/H auto-negotiation supported on the RJ-45 port

200ns (20 bit-times) Path Delay Value (PDV) for HDX conversion delay

Network Standards:

Fast Ethernet IEEE 802.3u: 100BASE-TX, 100BASE-FX

Operating Environment:

Ambient Temperature: 32°F to 120°F (0°C to 50°C)
Storage Temperature: -20°C to 60°C
Ambient Relative Humidity: 10% to 95% (non-condensing)

Maximum Standard Fast Ethernet Segment Lengths:

100BASE-TX (twisted pair):	100 m (328 ft)
100BASE-FX Fiber optic, half-duplex: (multi-mode)	412 m (1350 ft)
100BASE-FX Fiber optic, full duplex: (multi-mode)	2.0 km (6,562 ft)
100BASE-FX Fiber optic, half-duplex: (single-mode)	412 m (1350 ft)
100BASE-FX Fiber optic, full duplex: (single-mode)	25 km (66k ft)
100BASE-FX Long Haul: Fiber optic, full duplex: (single -mode)	40 km (132k ft)

Note: Black Box Crossover Media Converters DO NOT *support full length shared Fast Ethernet segments. See Section 3.2 of this manual for media lengths and shared segment distance calculations.*

Number of Media Converters in series: ***Experience shows that up to three units can be used in series between repeaters. For 4 or more in series, noise build-up will typically preclude proper operation.***

Power Supply (External):

Power Input: 95 - 125 vac at 60 Hz for "A" Models,
100 - 240 vac at 50 Hz for "AE" Models which have
IEC power cable connector.

Power Consumption: 4 watts typical

Power Adapter: 9VDC, 1.0 Amps; center positive

Note: Optional –48vdc and 24vdc external power units are available as Special items, RFQ

Connectors:

RJ-45 Port: 8-Pin female, with “cross-over” up-link switch

Note: The AN/reg manual switch is for user-selected auto-negotiation support, or for regular operation. See Section 4.4

Fiber, multi-mode (up to 2Km) :

SC-type (snap-in): Fiber optic multi-mode, 100BASE-FX

ST-type (twist-lock): Fiber optic multi-mode, 100BASE-FX

MT-RJ, Small Form Factor (plug in): Multi-mode,100BASE-FX

Fiber, single-mode (25-Km and up):

SC-type (snap-in): Fiber optic single-mode, 100BASE-FX, 25Km

SC-type (snap-in): "Long-Haul" single-mode, 100BASE-FX, 40Km

Packaging:

Enclosure: High strength sheet metal.

Dimensions: 3.5 in H x 3.0 in W x 1.0 in D (8.9 cm x 7.6 cm x 2.5 cm)

**Power Supply: 2.0 in x 2.0 in x 1.5 in (5.1 cm x 5.1 cm x 3.8 cm)

Weight: 4.6 oz. (130 gr); Power Supply 1.0 lb (455 gr)

LED Indicators for the 100Mbps Crossover Series (Dual, on front and on end) :

PWR	Indicates unit is receiving DC power.

Note: 100Mbps Crossover models has Link Pass-through feature, see Section 4.5

LINK, Fiber port	Steady ON when both attached cable segments are operational at their respective other ends, blinking when receiving remote fault from the other end.
LINK, Copper port	Steady ON when the attached cable segments are operational at their respective other ends
RX/ACT	Activity, blinking indicates port is receiving

Agency Approvals:

UL Listed (UL 1950), cUL , CE Certified

Emissions: Meets FCC Part 15 Class B, cUL, CE

Made in USA

1.1 Summary of models and descriptions:

LH1503A = Twisted pair to MM(Multi-Mode) fiber SC, ext. 115 vac, 60Hz AC Power Supply
LH1503AE = Twisted pair to MM(Multi-Mode) fiber SC, ext. 230 vac, 50Hz AC Power Supply
LH1504A = Twisted pair to MM(Multi-Mode) fiber ST, ext. 115 vac, 60Hz AC Power Supply
LH1504AE = Twisted pair to MM(Multi-Mode) fiber ST, ext. 230 vac, 50Hz AC Power Supply
LH1506A = Twisted pair to MM(Multi-Mode) fiber MTRJ, ext. 115vac, 60Hz AC Power Supply
LH1506AE = Twisted pair to MM(Multi-Mode) fiber MTRJ, ext. 230vac, 50Hz AC Power Supply
LH1507A = Twisted pair to SM(Single-Mode) fiber SC ext. 115vac, 60Hz AC Power Supply
LH1507AE = Twisted pair to SM(Single-Mode) fiber SC ext. 230vac, 50Hz AC Power Supply
LH1508A = Twisted pair to SM(LH) Single-Mode (Long Haul) 40Km fiber SC ext. 115vac, 60Hz
LH1508AE =Twisted pair to SM(LH) Single-Mode (Long Haul)40Km fiber SC ext. 230vac, 50Hz

LH1505-RACK = 19" Rack-mount tray for 100Mbps Economy Crossover Media Converters, up to 16 units. Uses 2U rack space, has space for a few external PS units (which are part of the MC's)

LH1505P-RACK = Powered 19" Rack-mount tray for 100Mbps (and 10Mbps, mix and match) Economy Crossover Media Converters, up to 12 units. Uses 2U rack space. Includes common multi-unit Power Supply for universal AC input, 55 watts at 9vdc, and power cabling for the MC's.

2. INTRODUCTION

This section describes the LH503A, LH1503AE, LH1504A, LH1504AE, LH1506A, LH1506AE, LH1507A,LH1507AE, LH1508A and LH 1508AE 100Mbps media converter models, including appearance, features and typical applications.

2.1 Inspecting the Package and the Product

Examine the shipping container for obvious damage prior to installing this product; notify the carrier of any damage which you believe occurred during shipment or delivery. Inspect the contents of this package for any signs of damage and ensure that the items listed below are included.

This package should contain:

1	100 Mbps Economy Crossover Media Converter Unit
1	External Power Supply, either 115 vac 60 Hz or 230 vac 50 Hz
1 set	Metal mounting clips and screws, 2 each unit
1	Velcro® Tape section, approximately 3 inches in length
1	User Guide, i.e., this manual

Remove the Black Box Media Converter from the shipping container. Be sure to keep the shipping container should you need to ship the unit at a later date.

In the event there are items missing or damaged contact your supplier. If you need to return the unit use the original shipping container. Refer to Section 5, Troubleshooting, for specific return procedures.

2.2 Product Description

Black Box 100Mbps Crossover Media Converters offer a convenient, cost-effective and graceful way to incorporate fiber media into a 100BASE-TX Ethernet network. Each Crossover media converter supports both full- and half-duplex mode transparently so that an attached RJ-45 switch or hub operates at its highest performance level. For support of "N-way" auto-negotiating switches, a manual AN/reg switch on the 100Mbps Crossover Media Converter allows the user to manually enable either (a) "AN" for auto-negotiation, where the media converter transmits applicable auto-negotiation Fast Link Pulses (FLPs)

from the RJ-45 port to the connected 10/100 switch port at Link-enable, or (b) “reg” regular media converter mode, no auto-negotiation.

Black Box 100Mbps Economy Crossover Media Converters are designed for quick and easy installation even in very tight spaces. Media cables are easily attached. The Crossover Media Converters feature an up-link switch on the TX port to eliminate the need for a special cross-over cable when connecting the TX port to a switch or hub. Because of their compact size, 100Mbps Crossover Media Converters can be Velcro®-mounted on an office wall or the side of a desk or cabinet. The external power supply, 115vac 60Hz or 230vac 50Hz, plugs into a nearby AC wall socket or power strip. Each 100Mbps Crossover Media-Converter features a two full sets (front and side) of LEDs that convey essential status information in any mounting arrangement. See Section 4.1, LED Indicators, for LED function information.

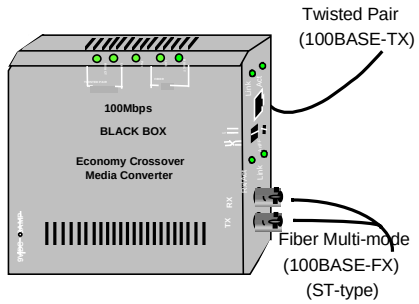
Black Box 100Mbps Crossover Media Converters are designed to operate at high ambient temperatures over an extended period, making them some of the most reliable in the industry. Their high-strength fabricated metal packaging shields against Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI), avoiding interference with other nearby electronic devices.

The Black Box 100Mbps Crossover Media Converter units comply with the IEEE 802.3u (100BASE-TX and 100BASE-FX) specification for 100 Mbps traffic via shielded (STP) or unshielded twisted pair (UTP) segments.

The Link Pass-Through feature is especially desirable for use in managed networks, and is standard in all Black Box 100Mb Economy Crossover Media Converters.

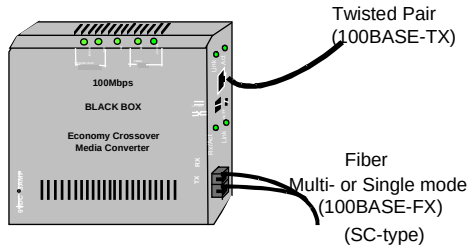
The Black Box 100Mbps Crossover media converter LH504A models are equipped with one multi-mode fiber-ST and one RJ-45 connector for connection into 100BASE-FX segments.

LH1504A with ST integrates 100BASE-TX and FX networks, with fiber ST connector



The Black Box LH1503A Model comes in three models, with three different fiber transceivers. Models are LH503A(multi-mode SC, 2Km), LH1507A (single-mode, 25Km) or LH1508A (single-mode Long Reach, 40Km) are

equipped with one fiber SC-type port and one RJ-45 port for connection into 100BASE-FX and 100BASE-TX compliant Fast Ethernet network segments.

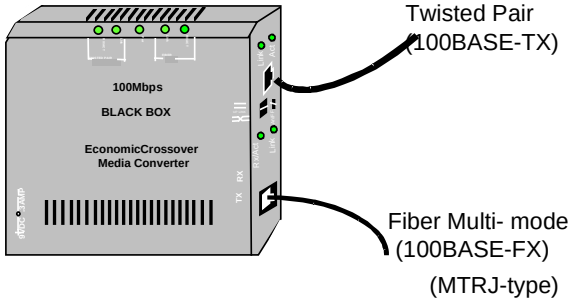


LH1503As with SC integrate 100BASE-TX and FX networks, with fiber SC connectors.

The Black Box (SFF, small form factor) comes with multi-mode fiber transceivers. The Model LH1506A (multi-mode, 2Km), equipped with one fiber MTRJ-type port and one RJ-45 port, connects into 100BASE-FX and 100BASE-TX compliant Fast Ethernet network segments. The SFF MT-RJ connector is keyed so that it

can only be connected when the two fiber strands are correctly positioned for transmit and receive. See Section 3.4.3.

LH1506As with SC integrate 100BASE-TX and FX networks, with fiber MT-RJ connectors.



2.3 Features and Benefits

- **Reduces Network Costs**
  Black Box 100Mbps Media Converters offer an ideal solution to quickly and inexpensively connect Twisted-Pair TX with Fiber FX cabling.
- **Full-duplex or Half-duplex transparent, auto-negotiation support**
  Black Box 100Mbps Crossover media converter's support both full-duplex and half-duplex mode transparently, and are suitable for use with 100Mb Ethernet switches supporting (or not supporting) auto-negotiation.
- **Low PDV for Maximum Cable Lengths in Shared 100Mb Segments**
  Black Box 100Mbps Crossover Media Converters add signal timing delays of only 20 Bit Times in a shared half-duplex segment, much less than a Class II hub (90 to 95 BT), and can be used to attach fiber cables to TX ports with low distance loss in an overall HDX collision domain.

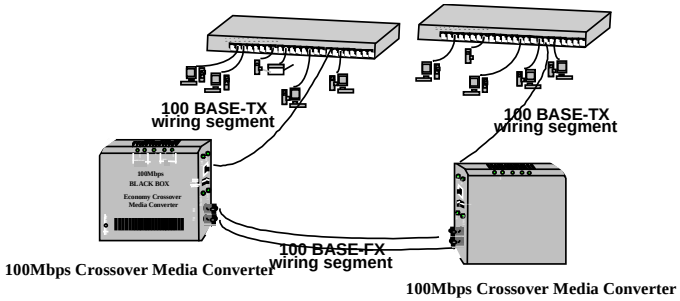
- **Small, Compact, Lightweight Design, Rack mountable**
  Featuring a compact and lightweight metal case with an external power supply, multiple 100Mbps Crossover Media Converters can be conveniently combined with 10Mbps in a rack mount using LH1505P-RACK.
- **Two sets of LEDs for viewing status from any angle.**
  Each 100Mbps Crossover Media Converter is equipped with a two sets (front & side) of LEDs to provide status information when viewed at any angle or mounting arrangement, even powered rack-tray or wall-mount.
- **Choice of 100Mb Ethernet Fiber port connector types**
  Models of the 100Mbps Crossover Media Converters are available with all of the popular fiber connectors: ST, SC mm and sgl-mode, and MT-RJ SFF (small form-factor).
- **Link Pass-through is standard** This feature, desired mainly in managed networks, is standard in all 100Mbps Crossover models.

2.4 Applications

The primary function of a Black Box 100Mbps Crossover Media Converter is to permit two different media types to coexist within the same network by allowing data to be transmitted / received between different media types. The 100Mbps Crossover media converters provides an effective solution for a network environment where auto-negotiation is a primary concern for the attached devices. They also support 100Mb half duplex or full duplex mode, transparent. Because of its auto-negotiation feature, the Black Box 100Mbps Crossover Media converter supports an attached "N-way" auto-negotiating RJ-45 switch or hub port, allowing it to operate at its highest performance level, i.e., full-duplex 100Mb/s.

Black Box 100Mbps Economy Crossover Media Converters are typically used where new 10/100Mb switches or switching hubs with auto-negotiating RJ-45 ports are being installed, and where full-duplex fiber segments (of up to 2Km for multi-mode or

25Km to 40Km for single mode) are needed to interconnect them with other 100Mb switches or switching hubs in distant wiring closets. Alternatively, a server with a full-duplex NIC may need to be connected via fiber to a 100Mb switches or switching hubs with RJ-45 ports.

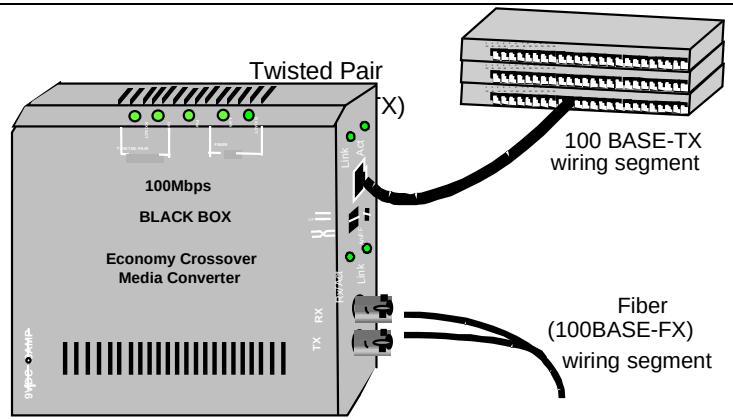


Two Crossover's M.C provide connectivity for 100Mbps switches or hubs via fiber

In these and similar situations, the Black Box 100Mbps Economy Crossover Media Converter conveniently converts the twisted pair cable to fiber, allowing use of any available RJ-45 Fast Ethernet switched port with a new or existing fiber cable. See Section 3.2.1 for cable distance calculation information.

Where shared Fast Ethernet segments are used, such as with Fast Ethernet switches or switching hubs with RJ-45 ports, it may be desirable to connect one or more servers or users via fiber cable. Because of its manual AN/reg switch feature, the Black Box 100Mbps Economy Crossover media converter supports both “Auto-negotiation” and “reg” regular mode at the attached RJ-45 port, allowing flexibility with the unit attached. See Section 3.4.3 for details on auto-negotiation support.

It is necessary to calculate the PDV of the overall collision domain (see Section 3.2.2) for proper operation of the 100Mbps Economy model in HDX applications.



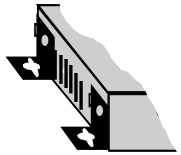
A typical 100Mb Crossover Media Converter application converts copper media to fiber, with auto-negotiation support for the attached device on the copper port.

3.0 INSTALLATION

This section describes the installation of the Black Box 100Mbps Crossover Media Converters, including location, segment distance calculation and media connection.

3.1 Locating the 100Mbps Economy Crossover Media Converter unit

The compact and lightweight design of the Black Box 100Mbps Crossover Media Converter allows it to be easily installed in almost any location. A Velcro strip and a set of two metal clips and screws are included (either may be used) for mounting the unit on a vertical surface such as a wall or cabinet, or for securing the unit on a table-top or shelf. The installation location is dependent upon the physical layout of the Ethernet network and associated cabling. Make sure the unit is installed in a location that is easily accessible to an AC power outlet or power strip, and where convection cooling is not inhibited.



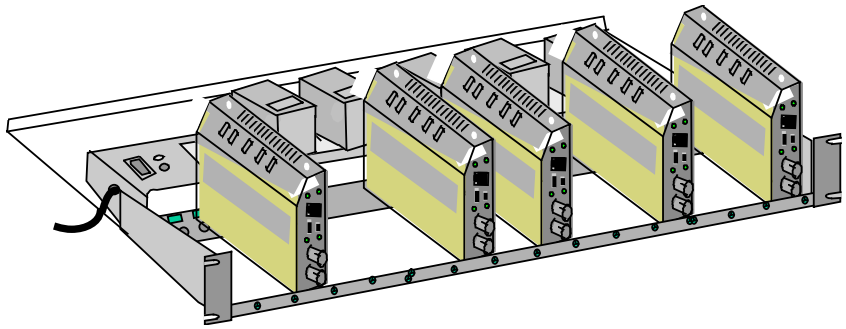
Proper attachment of metal mounting clips for secure mounting

3.2 LH1505-RACK for Rack Mounting 100Mbps Crossover Media Converters

For 19” rack-mounting of Black Box 100Mbps Economy Crossover Media Converters, a rack-mount tray is available, LH1505-RACK. The Media Converter units are mounted with their DC power jack in the back, and with the RJ-45 and the fiber ports in front. Any mix of the Black Box 10Mb Economy Media Converters and 100Mbps Crossover

media-converters be placed on a tray, up to a maximum of 16 units.

(The mounting spaces of the LH1505-RACK are specific to the 10Mb “Economy”- series and the 100Mbps “Crossover” series, and do not permit other models or other sizes to be put in the tray).



A typical installation of the model LH1505-RACK, 19” rack-mount tray will hold a few (often three to eight) 100Mbps Crossover Media Converters, each with their

power supply plugged into power strips (not included) in the rear area of the tray. Metal mounting screws in the bottom-front hold the media converters secure in the tray.

3.3 LH1505P-RACK for Rack Mounting 100Mbps Crossover Media Converters

The LH1505P -RACK is another option available for Rack Mounting the mix-match of 10Mbps and 100Mbps Economy Crossover Media Converters together in 19" rack-mount tray. The LH1505P-RACK model comes with built-in common universal AC power supply rated at 40 watts at 50C ambient, 9VDC output, and supporting up to 10 MC units. (Six tray positions for MC's are not wired for power). Typically, 3 to 8 MC units are in use with a LH1505P-RACK, with expansion space left available.

The LH1505P-RACK holds up to 10 mix-match of 10Mbps and 100Mbps Black Box Economy Media Converters. (The MC mounting spaces of the LH1505P-RACK are specific to the 10Mb "Economy"- series and the 100Mbps "Crossover" series, and do not permit other models or other sizes to be put in the tray).

The side-view picture shown here is an example of an installation of the model LH1505P-RACK, 19” rack-mount tray, holding a few 100Mbps Crossover Media Converters, each with their power input plugged into the built-in common AC power supply in the rear area of the tray. (PS units that come with the MC’s are not used)..

Metal mounting screws in the bottom-front hold each of the media converters secure in the tray, separately removable for service. The dual LEDs permit viewing operating status of the Media Converters from any angle.

3.4 Calculating Segment Distances

The media distance considerations are quite different for full-duplex and for half-duplex (standard Fast Ethernet) installations. Each is covered below in a section.

3.4.1 Power Budget Calculations for Fiber Media

Receiver Sensitivity and Transmitter Power are the parameters necessary to compute the power budget. To calculate the power budget of different fiber media installations, the following equations should be used:

OPB (Optical Power Budget) = P_T(min) - P_R(min)

where P_T = Transmitter Output Power, and P_R = Receiver Sensitivity

Worst case OPB = OPB - 1dB(for LED aging) - 1dB(for insertion loss)

Worst case distance = {Worst case OPB, in dB} / [Cable Loss, in dB/Km]

where the “Cable Loss” for 62.5/125 and 50/125μm (m.m.) is 2.8 dB/km,
and the “Cable Loss” for 100/140 (multi-mode) is 3.3 dB/km,
and the “Cable Loss” for 9/125 (single-mode) is 0.5 dB/km

The following data has been collected from component manufacturer's (HP's and Siemens') web sites and catalogs to provide guidance to network designers and installers.

Fiber Port Module	Speed, Std.	Mode	Std. km fdx (hdx)	Wave-length nm	Cable Size µm	X'mitr Output P_T, dB	R'cvr Sens. P_R,dB	Worst OPB, dB	Worst* distance Km, fdx		typical OPB, dB	typical* distance Km, fdx
LH1503A	**100Mb FX**	Multi-mode	2 (0.4)	1300	62.5/125	-20	-31	9.0	2.5		14	5
LH1504A MST, MSC					50/125	-23.5	-31	5.5	2.0		12	4
LH1507A	**100Mb FX**	Single-mode	25 (0.4)	1300	9/125	-15	-31	14	28		17.5	35
LH1506A MT-RJ	**100Mb FX**	Multi-mode	2 (0.4)	1300	62.5/125	-20	-31	9.0	2.5		14	5
					50/125	-23.5	-31	5.5	2.0		12	4
LH1508A Long Haul	**100Mb FX**	Single-mode	40 (0.4)	1300	9/125	-5	-34	27	54		32.5	65

See Note, next page

**** Note:*** *The use of either multi-mode or single-mode fiber to operate at 100Mbps speed over long distances (i.e., over approx. 400 meters) can be achieved* **only** *if the following factors are both applied:*

- *The 100Mb fiber segment must operate in full-duplex (FDX) mode, i.e. a switch (or equal external unit such as a FDX NIC) must be used, and*
- *The worst-case OPB of the fiber link must be greater than the fiber cable's passive Attenuation.*

(Attenuation = Cable loss + LED aging loss + Insertion loss + safety factor)

3.4.2 Segment Distances, Full-duplex for copper media (RJ-45) and fiber

Full-duplex ports, such as are found in switching hubs and some NICs, can receive and transmit signals simultaneously and do not experience collisions accordingly. There may be only two nodes present on a full-duplex segment. Media distance rules are not the same as for standard (half-duplex) Fast Ethernet because collision distance

limitations are not a factor. Specifically, fiber segments can be up to 2Km for multi-mode and up to 25Km for single mode (or 40Km for “Long Haul” single mode).

The Black Box 100Mbps Crossover media converter, with full-duplex operation as a standard feature, can be used in these applications. When installing the 100Mbps Economy Crossover model in a full-duplex segment, it is important to consider the combined overall segment length of both of the attached media types. The overall segment length is calculated by adding together the segment lengths on both sides of the 100Mbps Crossover Media Converters. The figure below illustrates how a 100Mbps Crossover Media Converter is used to connect a multi-mode fiber (100BASE-FX) with a twisted pair (100BASE-T) segment.

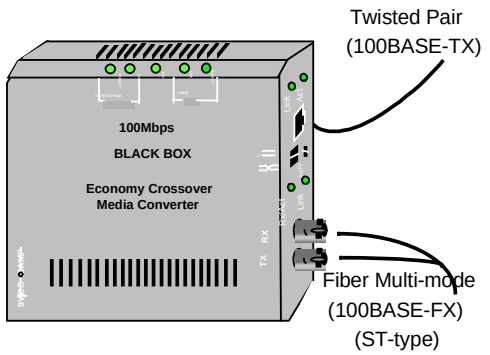
Segment length on each side of the 100Mbps Crossover Media Converter is measured as a percentage of the maximum allowable standard media distance for the given media type. The percentages, when added together, must not exceed 100%.

Media Distance Formula for 100Mbps Crossover Model, full-duplex:
X% + Y% ≤ 100%

Where **X** = The segment distance on one side of the 100Mbps Crossover Media Converter divided by the Standard Maximum Media Distance for that media type, x 100%

Where **Y** = The segment length on the other side of the 100Mbps Crossover Media Converter divided by the Standard Maximum Media Distance for that media cabling type, x 100%

Connectivity between 100BASE-TX and 100BASE-FX Ethernet Media.



In the example shown above, the length of fiber Segment X is 1500m (4920 ft). This is 75% of the maximum allowable distance for multi-mode 100BASE-FX fiber full-duplex media (2000 m) [75/2000 x 100% = 75%]. The length of twisted pair Segment Y is 10m (33 ft). This is 10% of the maximum allowable distance for 100BASE-TX full-

duplex twisted-pair media (100 m) [10/100 x 100% = 10%]. The total of the two percentages (75% + 10%) is 85%, which is allowable.

> ***Note 1***: Where more than one media converter is used in one segment run, the percentages for all of the cabling lengths in the run must be added together and must not exceed 100%.

In another instance, a 100Mbps Crossover Media Converter is used to connect a ***single*** mode fiber (100BASE-FX) with a twisted pair (100BASE-T) segment. In this example, the length of fiber Segment X is 8,500m (27,880 ft). This is 43 % of the maximum distance for single mode 100BASE-FX fiber full-duplex media (20,000 m) [8,500/20,000 x 100% = 43%]. The length of twisted pair Segment Y is 12m (40 ft). This is 12% of the maximum allowable distance for 100BASE-TX full-duplex twisted-pair media (100 m) [12/100 x 100% = 12%]. The total of the two percentages (43% + 12%) is 55%, which is allowable for the media but beyond collision domain limits.

3.4.3 Segment Distances, Half-duplex mode

Fast Ethernet shared bandwidth devices operate with multiple nodes in a traffic domain. When a node attempts to send a packet, it may hit another packet passing by, i.e., a collision may occur. This is normal and does not cause a problem because the Ethernet protocol provides for this situation and requires that the sender wait and try again. When installing the Black Box Crossover media converter in a half-duplex segment, it is important to consider the collision domain of the segment, including the 100Mbps Crossover Media Converter itself, repeaters and hubs present, and the lengths of both of the attached media types.

3.4.4 Collision Domain (PDV Calculations)

A collision domain is defined in the IEEE 802.3u standard as a cluster of network devices that, regardless of topology, must be less than 512 BT (Bit Times) of signal delay (PDV or Path Delay Value) in diameter between any two nodes. Nodes in a collision domain are connected by means of a repeater or repeaters such that no bridging or switching devices are present between any two nodes in the cluster. A Black Box Economy Crossover media converter has a PDV of about twenty Bit Times (20 BT), and this value must be included in the overall collision domain diameter PDV calculations as applicable for the placement of the 100Mbps Economy Crossover model in the topology of the collision domain.

Collision Domain Diameter

The Collision Domain Diameter is the length of the longest path between any two devices in a single collision domain. Regardless of the actual network topology, the Collision Domain Diameter must be less than 512 BT (Bit Times). Bit Times are related to media type as shown in Table 3.2.2a.

Table 3.2.2a: Worst case round-trip delay for Fast Ethernet media*

Media Type	Round-trip delay in Bit Time per Meter (BT/m)
Fiber Optic	1.000
Shielded TP cable	1.112
Category 5 Cable	1.112
Category 4 Cable	1.140

*Worst case delays taken from IEEE Std 802.3u-1995, actual delays may be less for a particular cable. Contact your cable supplier for exact cable specifications.

Each shared Fast Ethernet network device also has an associated BT delay. Table 3.4b shows typical Fast Ethernet device components and the associated BT delay. Note that there is only one DTE pair associated with any device-to-device path.

Table 3.4b: Worst case round-trip delay for Fast Ethernet device components*

Component	Round-trip delay in Bit Times (BT)
2 TX DTEs	100
2 FX DTEs	100
1 FX and 1 TX DTE	100
1 T4 and 1 TX or FX DTE	127
Class I Repeater	140
Class II Repeater with any combination of TX and FX ports	92

*Worst case delays taken from IEEE Std 802.3u-1995.

To determine whether a prospective network topology adheres to the collision domain diameter specification, the following formula should be applied to the worst case path through the network. The worst case path is the path between the two Fast Ethernet devices (DTEs) which have the longest round trip delay time.

PDV = (sum of cabling delays) + (sum of repeater & media converter delays) + (DTE pair delays) + (safety margin)

PDV is the Path Delay Value of the worst case path. For the network to adhere to IEEE 802.3u standard, this value must be less than 512 BT. The safety margin is specified in BT and may be a value between 0 and 5. This margin can be used to accommodate unexpected delays, such as an extra long patch cable. A safety margin of at least 2 to 4 BT is recommended.

"Rules-of-thumb" Collision Domain Calculations

Rules-of-thumb, while inexact, may be helpful in planning network topology. As a rule-of-thumb, a Class II Repeater has a PDV of about 90 to 95 BTs, and twisted-pair or fiber media has a PDV of about 1 BT per meter of length. The Black Box Crossover media converter has a PDV of 30 BT. Therefore, in shared Fast Ethernet applications, the 100Mbps Economy Crossover model uses about 20 meters of equivalent cable distance to convert from TX media to fiber FX media, i.e., it consumes almost ¼ as much of the available PDV as a Class II repeater. Since a 512BT collision domain will almost always include at least one repeater and two media segments, the remaining amount of Bit Times left after allowing for a 100Mbps Economy Crossover Model and a length of fiber media indicates that the available fiber length will be much less than the 412 meters that is the known maximum for fiber. Therefore, in shared environments, the

100Mbps Crossover Media Converters will be of benefit when they allow the use of fiber media, but not to gain distance by facilitating use of fiber media instead of twisted pair.

As a sample calculation, consider the question of what fiber cable distance (connected by a pair of 100Mbps Economy Crossover models on each end) can be obtained that will interconnect two 100Mb hubs where the twisted pair cables to the user nodes are 10 meters in length. The solution is :

512 = total available Bit Times in a collision domain diameter,

minus 100 BT for two DTEs on each end leaves 412 BTs,

minus 180 BT for two Class II repeaters leaves 232 BTs,

minus 20 BT for two 10-meter TP cables for hubs to users leaves 212 BTs,

minus 10 BT for two short TP cables from the hubs to 100Mbps Economy Crossover model's leaves 2022 BTs,

minus 60 BT for two 100Mbps Economy Crossover models leaves 142 BTs for fiber cable, which indicates a fiber cable length of about 140 meters.

It is obvious that using twisted pair wiring to connect the hubs would enable the interconnect length to be the 100 meters maximum for twisted pair media, and this would still leave about a hundred BTs as a safety margin. In other words, use of 100Mbps Economy Crossover models and fiber in this case gained 60m allowable maximum cable distance vs. TP cable without the 100Mbps Economy Crossover models.

Consider a more typical use of 100Mbps Crossover media converters in a shared Fast Ethernet segment. A stack of Fast Ethernet hubs comprises the only repeater in the collision domain, and the users and servers in the local workgroup are each

connected via Category 5 twisted pair cable, a maximum of 30 meters (100 ft.) in length. It is desired to connect one remote user with a fiber NIC via fiber cable, using a 100Mbps economy Crossover models in the circuit. How long can the fiber cable be?

The solution is :

512 = total available Bit Times in a collision domain diameter,

minus 100 BT for two DTEs on each end leaves 412 BTs,

minus 90 BT for one Class II stackable repeater leaves 322 BTs,

minus 30 BT for one 30-meter TP cable from hub to user node leaves 292 BTs,

minus 5 BT for a short TP cable from the hub to 100Mbps Economy Crossover model leaves 287 BTs,

minus 30 BT for one 100Mbps Economy Crossover model leaves 257 BTs for fiber cable, which indicates a fiber cable length of about 250 meters.

3.5 Connecting Fast Ethernet Media

Connecting Ethernet media to the Black Box 100Mbps Crossover Media Converter is very simple and straightforward. Using a properly terminated media segment, simply attach the cable end to the appropriate connector. See Sections 4.2 and 4.3 for a description of the LEDs.

3.5.1 Connecting Twisted Pair (RJ-45 standard)

The following procedure describes how to connect a 100BASE-TX twisted pair segment to the RJ-45 port on the 100Mbps Economy Crossover Media Converters. The procedure is the same for both unshielded and shielded twisted pair segments.

1. Using standard 100BASE-TX media, insert either end of the cable with an RJ-45 plug into the RJ-45 connector of the 100Mbps Crossover Media Converter.
2. Connect the other end of the cable to the corresponding device.

3. Use the LINK LED ensure proper connectivity by noting that the LED will be illuminated when the units are powered and proper connections established. If the LINK LED is not illuminated, change the setting of the up-link switch (See Section 4.4 for up-link switch information.) If this does not help, ensure that the cable is connected properly at both ends and is not defective.
4. For all 100Mbps Crossover models, the Link-Pass-through feature is standard, the two LINK LEDs operate together, and either both LEDs are lit or neither is lit. Both of the attached cables must be operable for LINK to be indicated.Absence of LINK does not point to the problem cable segment, and the fault may be in either.

3.5.2 Connecting Fiber Optic 100BASE-FX, Type ST and SC, MM and Sgl.M

The following procedure applies to 100BASE-FX applications using the 100Mbps Crossover Media Converter with ST-type (twist-lock) and SC-type (snap-in) fiber connectors.

1. Before connecting the fiber optic cable, remove the protective dust caps from the tips of the connectors on the 100Mbps Economy Crossover media converter. Save these dust caps for future use.

2. Wipe clean the ends of the dual connectors with a soft cloth or lint-free lens tissue dampened in alcohol. Make certain the connectors are clean before connecting.
   Note: One strand of the duplex fiber optic cable is coded using color bands at regular intervals; you must use the color-coded strand on the associated ports at each end of the fiber optic segment.
3. Connect the Transmit (TX) port (light colored post) on the 100Mbps Crossover model to the Receive (RX) port of the remote device. Begin with the color-coded strand of the cable for this first "Transmit-to-Receive" connection.
4. Connect the Receive (RX) port (dark colored post) on the 100Mbps Crossover model to the Transmit (TX) port of the remote device. Use the non-color coded fiber strand for this.
5. The LINK LED corresponding to the fiber port, on the front of the product, will illuminate when a proper connection has been established at both ends (and when power is ON in the units at each end). If LINK is not lit after cable connection, the normal cause is improper cable polarity. Swap the fiber cables on the product connector to remedy this situation.
6. Because of standard Link Pass Through feature the LINK indication will not be present unless LINK is made for the cables on both sides.

3.5.3 Connecting Fiber Optic 100BASE-FX, Type MT-RJ Small Form Factor

The following procedure applies to 100BASE-FX applications using the 100Mbps Crossover model with MT-RJ (snap-in, two-fibers-in-one-piece) fiber connectors.

1. Before connecting the fiber optic cable, remove the protective dust cap from the tip of the connector on the 100Mbps Economy Crossover model.
2. Wipe clean the ends of the connector with a soft cloth or lint-free lens tissue dampened in alcohol. Make certain the connector is clean before connecting.
   Note: The MT-RJ connector is keyed so that it will only plug in when both TX and RX fiber elements are correctly positioned.
3. Insert the male MT-RJ part into the female MT-RJ port. This connection is keyed so that it only goes in one way, aligning the fiber pair for transmit and receive.
4. The LINK LED corresponding to the fiber port, on the front of the product, will illuminate when a proper connection has been established at both ends (and when power is ON in the units at each end). If LINK is not lit after cable connection, the normal cause is improper cable seating. Re-insert the fiber cables on the product connector to possibly remedy this situation.
5. Because of standard Link Pass-through feature, the LINK indication will not be present unless LINK is made for the cables on both sides.

4.0 OPERATION

This section describes the operation of the Black Box 100Mbps Economy Crossover Media Converters including power supply, up-link switch and AN/reg functionality, and LEDs.

4.1 Power Requirements, Power Supply Types

Black Box 100Mbps Economy Crossover Media converter require 4 watts of power and are designed to be used with an external power supply. The external power supply unit supplied is one of two types; one version ("A" models) for AC input power of 115 vac 60 Hz, and one version for 230 vac 50 Hz. The 115 vac version has a small transformer integral with a convenience power outlet plug. The 230 vac version ("AE" models) has a small transformer integral with an IEC-type power plug for a user-supplied AC power cord with a convenience power outlet plug. Both types include a lightweight DC power cord to the applicable power jack on the Media Converter unit.

4.2 Dual LED Indicators (front and side-panel LEDs)

LED	Description
PWR	Illuminates GREEN to indicate the unit is receiving DC power.

Note: 100Mbps Economy Crossover Media Converters have the Link Pass-through feature, see Section 4.5

LINK, Fiber port	Steady ON when both attached cable segments are operational at their respective other ends, blinking when receiving remote fault from the other end.
LINK, Copper port	Steady ON when the attached cable segments are operational at their respective other ends
RX/ACT	Activity, blinking indicates port is receiving

4.3 Up-Link or "Crossover" Switch (On the RJ-45 port)

Black Box 100Mbps Economy Crossover Media Converters are equipped with an up-link slide switch to accommodate switch- or repeater-to-converter connections without a special cross-over cable. When set to the straight position (=), the 100Mbps Economy Crossover Media Converter is wired for normal twisted pair connection to a user node device. When set to the cross-over position (X), the Media Converter is wired with cross-over functionality for direct up-link to a network hub or switch.

See Figure 4.4 below for the location of the switch on the 100Mbps Economy Crossover Media -Converter unit.

4.4 Manual AN / reg Switch (Auto-negotiate or Full-duplex Fixed 100Mb)

Black Box 100Mbps Economy Crossover Media Converters are equipped with a manual switch on the RJ-45 copper port. It is located just underneath the up-link switch, and is very tiny. See Figure 4.4 below.

The AN / reg switch provides the flexibility to the user to manually select either (a) **A**uto-**N**egotiation support to send Fast Link Pulses (FLP's) to the attached device, or (b) **reg** mode for regular or normal operation. In all cases, the unit functions at both FDX and HDX transparently, but always at 100Mbps speed. The factory default setting is **AN** (Auto-Negotiation).

The difference in the two settings is for the attached port, i.e., the port in the switch or hub or NIC at the other end of the twisted pair cable. If the attached port is of the increasingly popular auto-negotiate-only variety, it needs to get FLPs from

the 100Mbps Crossover Media Converter in order to decide what to do. Not receiving FLPs would indicate (incorrectly) that the 100Mbps Economy Crossover model is only capable of half-duplex operation. Setting the switch in the AN position causes FLPs to be sent, advertising full-duplex capability. **BUT NOTE** . . . it is up to the user who chooses the AN position to determine that the device on the other end of the fiber cable is, in fact, capable of full-duplex operation. If it is not, choose the **reg** position and do not advertise full-duplex.

The **reg** position is also suitable for use when non-auto-negotiating devices are attached. In this case, the attached RJ-45 port (such as in a traditional managed switch) is set to half-or full-duplex by the operator, and does not depend upon auto-negotiating FLPs. The 100Mbps Economy Crossover model itself is transparent half- or full-duplex, and will always operate correctly in this situation.

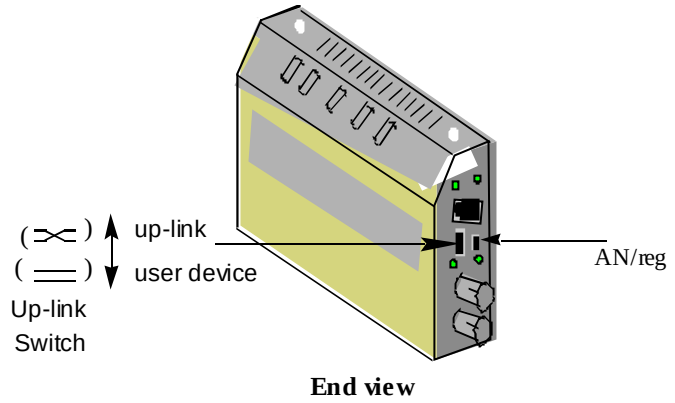


Figure 4.4 End View of the 100Mb Economy Crossover Media Converter

4.5 LINK Pass-Through feature in 100Mbps Economy Crossover Model:

The LINK Pass-through feature is standard in all 100Mbps Economy Crossover model's and works one way only, i.e., RJ-45 with pass-through to fiber. It allows network devices attached from the RJ-45 port to sense the LINK status of the attached copper cable, and also the Link status of the fiber cable on the adjacent port.

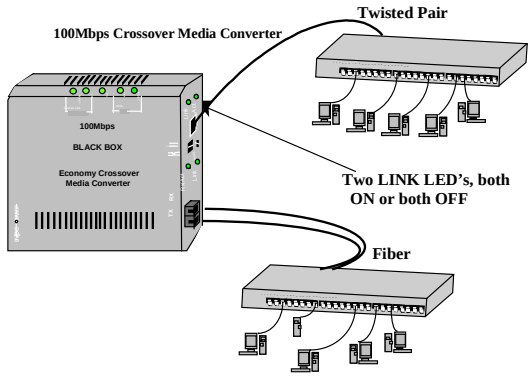
Without the LINK Pass-through option, the two cable segments attached to the Black Box 100Mbps Economy Crossover model shown in the figure below would be treated as two separate segments, each with its own separate LINK status.

With LINK Pass-through, as shown in the figure below, the two attached cables (one TP and one fiber) are treated as one "link" segment. The 100Mbps Economy Crossover model is transparent, and devices at both ends of the cables see through the 100Mbps Media-Converter for LINK status. The 100Mbps Economy Crossover model passes the same LINK status from one side to the other. Two LINK LED's represent end-to-end connection and are both ON (LINK ready) or both OFF.

.

LINK Pass-through :

With LINK Pass-through, the Black Box 100Mbps Crossover Media Converter unit treats both LINK indicators for the two cable segments as one, with common LINK LED status. The Media Converter becomes "Link-transparent."



5.0 TROUBLESHOOTING

All Black Box Ethernet products are designed to provide reliability and consistently high performance in all network environments. The installation of 100 Mbps Crossover Media Converters is a simple procedure (see Section 3.0, INSTALLATION); their operation is described in Section 4.0, OPERATION.

Should problems develop during installation or operation, this section should help to locate, identify and correct such problems. Please follow the suggestions listed below prior to contacting your supplier. However, if you are unsure of any procedure described in this section, or if the 100Mbps Crossover Media Converter is not operating as expected, do not attempt to repair or alter the unit. Contact Black Box for assistance.

5.1 Before Calling for Assistance

1. If difficulty is encountered when installing or operating the 100Mbps Crossover Media Converter, refer back to Section 3.0, Installation and Section 4.0, Operation. Check to make sure that the various other components of the network are operable.

2. Check the cables and connectors to ensure that they have been properly connected, and the cables/wires have not been crimped or in some way impaired during

installation. (About 90% of network downtime can be attributed to wiring and connector problems.)

3. Make sure that the external DC power supply is properly attached to the unit, that it is of the proper type, and that it is plugged into a functioning electrical outlet. Use the PWR LEDs to verify the unit is receiving proper power.

4. If the problem is isolated to a network device other than the 100Mbps Crossover Media Converter, it is recommended that the problem device be replaced with a known good device. Verify whether or not the problem is corrected. If not, go to Step 5 below. If the problem is corrected, the Media Converter and its associated cables are functioning properly.

5. If the problem continues after completing Step 4 above, contact Black Box.

5.2 When Calling for Assistance

Please be prepared to provide the following information.

1. A complete description of the problem, including the following points:
   a. The nature and duration of the problem;
   b. Situations when the problem occurs;
   c. The components involved in the problem;
   d. Any particular application that, when used, appears to create the problem;
2. An accurate list of Black Box product model(s) involved, with serial number(s). Include the date(s) that you purchased the products from your supplier.
3. It is useful to include other network equipment models and related hardware, including personal computers, workstations, terminals and printers; plus, the various network media types being used.
4. A record of changes that have been made to your network configuration prior to the occurrence of the problem. Any changes to system administration procedures should all be noted in this record.

5.3 Shipping and Packaging Information

Should you need to ship the unit back to Black Box Corporation, please follow these instructions:

1. Package the unit carefully. It is recommended that you use the original container if available. Units should be wrapped in a "bubble-wrap" plastic sheet or bag for shipping protection. (You may retain all connectors and this Installation Guide.)

CAUTION : Do not pack the unit in Styrofoam "popcorn" type packing material. This material may cause electro-static shock damage to the unit.

2. Clearly mark the Return Material Authorization (RMA) number on the outside of the shipping container.
3. Black Box Corporation is not responsible for your return shipping charges.
4. Ship the package to:

Black Box Corporation
1000 Park Drive
Lawrence, PA 15055
Phone: (724) 746-5500
Fax: (724) 746-0746