BLACK BOX ▪
NETWORK SERVICES

Black Box
Hardened Ethernet Switch

BLACK BOX
NETWORK SERVICES

Installation and User Guide

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BLACK BOX®
Hardened Ethernet Switch

Installation and User Guide

Trademarks

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> **Important:** A Hardened Ethernet Switch contains no user serviceable parts. Attempted service by unauthorized personnel shall render any and all warranties null and void. If problems are experienced with a Hardened Ethernet Switch, consult Section 5, Troubleshooting, of this User Guide.

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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.

FEDERAL COMMUNICATIONS COMMISSION

AND
CANADIAN DEPARTMENT OF COMMUNICATIONS
RADIO FREQUENCY INTERFERENCE STATEMENT

Class B Digital Device. This equipment has been tested and found to comply with the limits for a Class B computing device pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. This equipment generates, uses, and can radiate radio frequency energy, and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. If this equipment does cause harmful interference to radio or telephone reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult an experienced radio/TV technician for help.

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

To meet FCC requirements, shielded cables and power cords are required to connect this device to a personal computer or other Class B certified device.

This digital apparatus does not exceed the Class B 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 B 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 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 física 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: Objetos 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.

TABLE OF CONTENTS   **PAGE**

1.0   SPECIFICATIONS

1.1   Technical Specifications

Ports Performance

Fiber, and when an auto-negotiating port is operating at 100Mbps:
Data Rate: 100Mbps
When an RJ-45 auto-negotiating port is operating at 10 Mbps:
Data Rate: 10 Mbps

Network Standards

100Mb: Ethernet IEEE 802.3u, 100BASE-TX, 100BASE-FX
10 Mb: Ethernet IEEE 802.3, 10BASE-T
Auto-sensing for speed: IEEE 802.3u

Packet-Processing Between Domains

Filtering and Forwarding Rate from 100Mbps ports: 148,800 pps max
Filtering and Forwarding Rate from 10 Mbps ports: 14,880 pps max.
Processing type: Store and Forward
Auto-learning: 16K address table, shared for all traffic domains
Packet buffers: 1.0Mb, dynamically shared on all domains
Latency (not incl. packet time): 100 to 10 Mbps and 10 to 100: $<15\mu s$

Path Delay Value: 50 BT on all ports

Maximum Ethernet Segment (or Domain) Lengths

10BASE-T (Unshielded twisted pair)   - 100 m (328 ft)
100BASE-TX (CAT 5 UTP)   - 100 m (328 ft)
100BASE-FX, full-duplex: (multi-mode)   - 2.0 km (6,562 ft)
100BASE-FX, full-duplex: (single-mode)   - 20.0 km (65,620 ft)
100BASE-FX, full-duplex: (single-mode, long) - 40.0 km (131,240 ft)

Operating Environment

Ambient Temperature: 40°F to 160°F (-40°C to 70°C)

Plenum rated, cold start down to 20°C

Storage Temperature: -40° to 185°F (-40°C to 85°C)
Ambient Relative Humidity: 10% to 95% (non-condensing)

Altitude: up to 15,000 ft. operating

Power Supply (Internal) 24VDC and -48VDC Power Supply

Power Input Voltage: 20 to 70 VDC (auto-ranging), "-, GND, +"
Power Consumption: 10watts typical.
DC-DC Converter Rating: 5VDC, 2Amps

Power Supply (External) AC Power Supply

AC Power Connector: IEC-type, male recessed at rear of Power Supply chassis
Input Voltage: 85 to 260 VAC (auto-ranging)
Input Frequency: 47 to 63 Hz (auto-ranging)
Power Consumption: 15 watts typical
Power Supply Rating: 3Amps at 5VDC

Network Cable Connectors -6 RJ-45 shielded female ports and 2 fiberport

100Mbps: Category 5 UTP/STP, fiber (50/125, 62.5/125 mm, or single-mode at 9/125 micron)

10 Mbps: Category 3, 4, 5 UTP (Note: auto-sensing does not sense cable type)

Full-duplex / Half -duplex on copper (RJ-45) switched Ports # 2 to 7

All the RJ-45 ports support Full / Half duplex and 10/100 speed, each independently auto-negotiating.

Fiber Ports # 1 and 8

The switched fiber ports # 1 & 8 are fixed at full-duplex only, 100Mb speed.

Mechanical

Enclosure: Rugged 18-gauge high-strength steel case. Metal mounting plate included. Suitable for stand-alone, shelf, pedestal or wall mounting. The case also serves as a heat sink. The metal mounting base is included, 13-guage steel. (Without the base, the box size is only 7" high). Mounting holes in the base plate are a rectangle that measures 3.35" x 8.25" (8.25 x 25 cm).

Dimensions (wall mounted): 1.70 in H x 5.75 in W x 9.0 in D
(4.3 cm x 14.6 cm x 22.9 cm)

Weight: 3.5 lb. (1.6 kg.)

Cooling method: Convection, with case operating as a heat sink.

Note: Internal steel plates conduct heat from the electronic elements inside to the Hardened Ethernet Switch steel case which acts as a heat sink. Internal chip temperatures are only about 10°C above case ambient during steady state operation

LED Indicators

PWR: Steady ON when power applied

SPEED (when LINK is ON): ON = 100Mbps; OFF = 10 Mbps

LINK/ACT: Steady ON for LINK with no traffic, blinking indicates port is transmitting / receiving.

F/H (RJ-45 ports only): ON = full-duplex, OFF = half-duplex

MTBF (Bellcore method)

DC Models: Over 15 years MTBF

AC Models: Over 10 years MTBF

Agency Approvals

UL Listed (UL 1950), cUL, CE

Emissions: meets FCC Part 15, Class A

Made in USA

1.2   Ordering Information

BLACK BOX®Hardened Ethernet Switch, six 10/100 RJ-45 ports with two 100Mb Fiber Ports

LB9901A: Hardened Ethernet Switch, six 10/100 switched RJ-45 auto-negotiating ports with two 100Mbps full-duplex switched fiber ports (multi-mode SC-type connector). The internal switch has 16K nodes address table and 1MB packet buffers. Includes unit for AC, 85-260VAC 47-63HZ, auto-ranging. Steel case acts as heat sink, designed for outdoor/rugged environment where ambient temperature is un-controlled.

LB9902A: Same as LB9901A, except one fiber connector is 20Km SM SC fiber connectors. Includes separate power-supply unit.

LB9903A: Same as LB9901A, except with two 20Km single-mode SC-type fiber connectors. Includes separate power supply unit for AC.

LB9908A: Ethernet Switch, six 10/100 RJ-45 and <u>no</u> fiber ports. Has 16KB address table and 1.0MB packet buffers. AC power input 85-260vac 47-63Hz worldwide auto-ranging, via Power Source Extended Temp (a separate unit). Steel case used as a heat sink, designed for use in environmentally auto-ranging. Steel case used as a heat sink, designed for use in environmentally challenged locations such as Ethernet outdoors.

LB9907PS: Spare power supply unit for AC versions (comes included with LB9901A, LB9902A, LB9903A).

LB9904A: Hardened Ethernet Switch, six 10/100 switched RJ-45 auto-negotiating ports with two 100Mbps full-duplex switched fiber ports (multi-mode SC-type connector). The internal switch has 16K nodes address table and 1MB packet buffers.Internal DC, 18-70VDC 47-63HZ, auto-ranging. Steel case acts as heat sink, designed for outdoor/rugged environment where ambient temperature is un-controlled.

LB9905A: Same as LB9904A, except one fiber port is 20km SM SC. Internal DC, 18-70VDC autoranging power supply.

LB9906A: Same as LB9904A, except both fiber ports are 20km SM SC, Internal DC, 18-70VDC Autoranging power supply.

LB9909A: Ethernet Switch, six 10/100 RJ-45 and <u>no</u> fiber ports. Has 16KB address table and 1.0MB packet buffers. DC power input, 18-70VDC auto-ranging. Steel case used as a heat sink, designed for use in environmentally challenged locations such as Ethernet outdoors.

Black Box Corp. reserves the right to change specifications, performance characteristics and / or model offerings without notice.

2.0   INTRODUCTION

2.1   Inspecting the Package and 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   Hardened Ethernet Switch, AC model

   (Consists of an Ethernet Switch unit, a Power Source unit, and an AC Power Cord suitable for U.S.A and other 115 vac locations only)

1   Installation and User Guide

OR

1   Hardened Ethernet Switch, DC model

   (Consists of an Ethernet Switch unit only. No Power Source unit, no Power Cord)

1   Installation and User Guide

Remove the Hardened Ethernet Switch unit 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 Black Box. If you need to return the unit use the original shipping container. Refer to Chapter 5, Troubleshooting, for specific return procedures.

2.2 Product Description

The Black Box Hardened Ethernet Switches are designed to operate in abnormal temperature applications, and are suitable for use in harsh environments with inhospitable high / low temperatures. Each Hardened Ethernet Switch provides two built-in 100Mb full-duplex switched fiber ports so that several units can be daisy-chained, coupled with the convenience of six switched 10/100Mb copper (RJ45) ports for easy connectivity to local nodes and devices, all in one compact rugged unit.

The two "future-proof" fiber ports have been designed with full-duplex 100Mbps switched fiber port, and six copper (RJ-45) with full / half-duplex-10/100-auto-negotiating ports. The Black Box Hardened Ethernet Switches provide the switching speed and the reliability to smoothly support multiple workgroups at 100Mbps or 10Mbps speed. The optional fiber ports are normally configured and tested with the Hardened Ethernet Switch unit in the factory, and available in multi-mode and single-mode SC-type fiber connectors.

Designed specifically to operate in temperature _un_controlled applications, the Hardened Ethernet Switch's high strength steel case functions as a heat sink to draw away the heat from the internal electronics and dissipate it. The efficient design of the Hardened Ethernet Switch case can easily handle the unusual heat of **70°C (160°F)** and the extreme cold of -**40°C (-40°F)** when properly installed (see Sec. 3.0). Applications for Black Box Hardened Ethernet Switches include roadside traffic data collection and control stations, unheated and or high temperatures industrial plant locations, plenums and ceiling locations in commercial buildings, data communications huts and pedestals, and military field operation sites.

A Black Box Hardened Ethernet Switch is easy to install and use. Addresses of attached nodes are automatically learned and maintained, adapting the switching services to network changes and expansions. Top-mounted LEDs provide extra advantage to the user to observe status information of each port. The Black Box Ethernet Switches generate high performance plug-and-play operation in a rugged package. The high-strength steel enclosure gives extra protection, and the fact that there is no cooling air flow prevents insects or smoke or other contaminants from getting inside to cause damage.

Each Hardened Ethernet Switch is non-blocking on all ports and has 1MB packet buffers and a 16K-node address table for advanced performance. A Black Box Ethernet Switch, armed with store-and-forward switching ability, filters all faulty packets to minimize traffic congestion.

2.2.1 Hardened Ethernet Switch chassis with fiber SC (m.m. or single-mode) connectors

BLACK BOX®LB9901A   BLACK BOX®LB9904A

The Black Box Ethernet Switch's chassis houses one main PC board. The front side of the chassis has a half dozen RJ-45 twisted-pair ports and two 100Mbps full-duplex fiber ports (one on each side of the RJ-45 ports) as shown in the adjacent picture. The fiber ports operate in full-duplex mode only to provide higher bandwidth and longer distances on fiber. All the LEDs are mounted on the top cover to conveniently indicate operating status of all ports.

There is a power on (PWR) indicator, and a SELF-TEST (self-test at power up is in progress or has failed) for the unit. For each RJ-45 (ports # 2 -7), there are Link and Activity (LK/ACT) LEDs indicating traffic, and 10/100 (ON for 100Mbps), and full/half (F/H) duplex indicators. The fiber ports (#1 and 8), have (LK/ACT) indicators.

The rugged design of the case using high-strength rugged 18-gauge steel enables this product to withstand harsh environments with inhospitable high / low temperatures, and makes it suitable for outdoors, road-side pedestals, industrial plants and field military use.

The DC power plug connector or "jack" is in the left front of the chassis. The Black Box Hardened Ethernet Switch Model is typically designed for power input of 24VDC or –48VDC only. The DC input power supports a wide range, from 20-70 VDC auto-ranging. DC power input is featured for high reliability and convenience in out-of-the-way locations.

The AC Power Source, LB9901A-LB9903A, is equipped with worldwide range of 85-264vac, 47-63Hz , auto-ranging, with 5VDC 3Amp Power output. For this model , the military style screw-lock plug provides a secure connection to the Hardened Ethernet Switch unit.

See Section 3.3 for detail description of the LB9907PS external power sources.

2.3 Fiber port, SC Connectors

The Fast Ethernet fiber switched ports on the Black Box Hardened Ethernet Switch operate at fixed 100Mb speed and full-duplex mode for the best performance. The Ethernet Switch's fiber ports are factory-built as either a multi-mode or single-mode SC connectors. A yellow label on the fiber port connector will indicate if it is single-mode . . . otherwise it is a multi-mode port. The 100Mbps fiber ports are each a switched port and perform as a domain, providing a high bandwidth backbone connection and supporting long (up to 20km single-mode, or 40km special "long-reach") fiber cable distances for installation versatility.
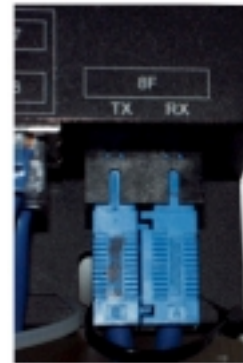
On Hardened Ethernet Switch units, there are three LED's for each of the RJ-45 switched ports. The F/H indicates full-duplex when ON; when it is OFF, operation is half-duplex. One (LK/ACT) is steady ON to indicate LINK, and blinking indicates the port is transmitting / receiving. The 10/100 LED is ON for 100Mbps and OFF for 10 Mbps (when LINK is made). For fiber ports, the LEDs are the same except no F/H (and 10Mb is not possible).

A device must be connected to the other end of a port's cable and a proper link (LK lit) must be made with the device at the other end of the cable in order for each LINK LED to provide a valid indication of operating conditions.

2.4 Frame Buffering and Latency

The Hardened Ethernet Switch is a store-and-forward switch. Each frame (or packet) is loaded into the Switch's memory and inspected before forwarding can occur. This technique ensures that all forwarded frames are of a valid length and have the correct CRC, i.e., are good packets. This eliminates the propagation of bad packets, enabling all of the available bandwidth to be used for valid information.

While other switching technologies such as "cut-through" or "express" impose minimal frame latency, they will also permit bad frames to propagate out to the Ethernet segments connected. The "cut-through" technique permits collision fragment frames, which are a result of late collisions, to be forwarded to add to the network traffic. Since there is no way to filter frames with a bad CRC (the entire frame must be present in order for CRC to be calculated), the result of indiscriminate cut-through forwarding is greater traffic congestion, especially at peak activity. Since collisions and bad packets are more likely when traffic is heavy, the result of

store-and-forward operation is that more bandwidth is available for good packets when the traffic load is greatest.

To minimize the possibility of dropping frames on congested ports, each Hardened Ethernet Switch dynamically allocates buffer space from an 1MB memory pool, ensuring that heavily used ports receive very large buffer space for packet storage. (Many other switches have their packet buffer storage space divided evenly across all ports, resulting in a small, fixed number of packets to be stored per port. When the port buffer fills up, dropped packets result.) This dynamic buffer allocation provides the capability for the maximum resources of the Hardened Ethernet Switch unit to be applied to all traffic loads, even when the traffic activity is unbalanced across the ports. Since the traffic on an operating network is constantly varying in packet density per port and in aggregate density, the Black Box Ethernet Switches are constantly adapting internally to provide maximum network performance with the least dropped packets.

When the Hardened Ethernet Switch detects that its free buffer queue space is low, the Switch sends industry standard (full-duplex only) PAUSE packets out to the devices sending packets to cause "flow control". This tells the sending devices to temporarily stop sending traffic, which allows a traffic catch-up to occur without dropping packets. Then, normal packet buffering and processing resumes. This flow-control sequence occurs in a small fraction of a second and is transparent to an observer. See Section 4.6 for additional details.

Another feature implemented in Black Box Hardened Ethernet Switch is a collision-based flow-control mechanism (when operating at half-duplex only). When the Switch detects that its free buffer queue space is low, the Switch prevents more frames from entering by forcing a collision signal on all receiving RJ-45 half-duplex ports in order to stop incoming traffic.

The latency (the time the frame spends in the Switch before it is sent along or forwarded to its destination) of the Hardened Ethernet Switch varies with the port-speed types, and the length of the frame is a variable here, as it is with all store-and-forward switches. For 10 Mb-to-10 Mb or 10 Mb-to-100Mb or 100Mb-to-10 Mb forwarding, the latency is 15 microseconds plus the packet time at 10Mb. For 100Mb-to-100Mb forwarding, the latency is 5 microseconds plus the packet time at 100Mb.

2.5 Features and Benefits

■ **100Mb switching services for high performance Ethernet LANs**

The Ethernet Switches provide Fast Ethernet switching on all ports. They perform high speed filter/forward operations on the traffic, giving each port's segment a full 100Mb (or possibly 10 Mb for RJ-45 ports) of bandwidth.

■ **Two "future-proof" fiber ports with SC connectors**

Built-in fiber ports may be ordered with 100Mb full-duplex multi-mode SC, single-mode SC, and (special order) SSCL-type connectors. The fiber ports are set to full-duplex mode. No Media Converters needed.

■ **All RJ-45 ports are auto-negotiating, support 10/100 full / half duplex**

RJ-45 ports support twisted pair "copper" segment connections, with 10 or 100Mb speed and full / half-duplex mode selected by Ethernet standard IEEE 802.3u auto-negotiation.

■ **Top-mounted LEDs for convenient viewing**

The LEDs that indicate operating status are on the top of the unit for easy viewing in any situation. As the units are normally vertical for wall- or pedestal-mounting, top-surface viewing is most convenient.

■ **Installation is "Plug and Play", operation is transparent to software**

The Black Box Hardened Ethernet Switch hardware only forwards those packets from each domain that are needed on the other domains. Internal address tables are self-learning, enabling users to change port connections or 10/100 domains without affecting operations.

■ **Thermal design enables Hardened Ethernet Switch to be used in temperature _un_controlled applications.**

The advanced thermal packaging with rugged 18-gauge high steel enclosures used as a heat sink is designed specifically for temperature in-sensitive applications such as roadside traffic data collection and control stations, underground vaults or mines, high temperature industrial plant locations, ceiling locations in warehouses, and military field operations sites.

■ **Wide-range 24VDC and -48VDC power input**

The Hardened Ethernet Switch is designed for 20-70 VDC auto-ranging power input. DC power is highly reliable and convenient in out-of-the-way locations.

■ **MTBF over 10 years, per Bellcore calculation method**

2.6   Applications

The Black Box Hardened Ethernet Switch is designed specifically for harsh temperature environments and brings future-proof fiber and widely-used copper connectivity to out-of-the-way sites and outdoors.

Example 1. Black Box Hardened Ethernet Switch   In this example, a Black Box Hardened Ethernet Switch serves roadside real time traffic data collection and transmits it to a remote control station over fiber. Since multiple traffic control sites are a long distance apart, they are all connected in series to each other and to the central station. Some local users (using RJ-45 ports) may operate at 100Mbps, and some users and utility devices may run at 10 Mbps. A Hardened Ethernet Switch serves this requirement economically and efficiently. The six full- and half-duplex switched ports make the required setup simple for collection of traffic data. The uncontrolled outdoor temperature feature and high reliability of the Hardened Ethernet Switch make it suited to the site.

The two 100Mbps full-duplex fiber ports easily fulfill the long distance connection and provide high bandwidth for fast movement of data. With no moving air for cooling needed, the Hardened Ethernet Switch is sealed against insects and fumes and smoke and other contaminants. The mechanical design of the Hardened Ethernet Switch also enables it to be easily placed in a NEMA 4 (water-proof) enclosure to provide an all- weather outdoor solution.
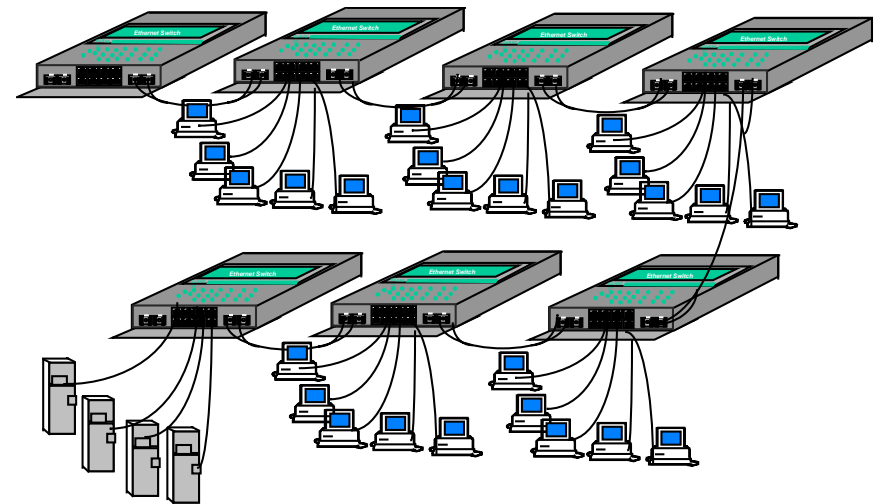
Figure 2.6.1: Hardened Ethernet Switch connects combinations of 10 Mbps and100Mbps network devices and provides a Fast Ethernet fiber backbone for access to the central control station.

Example 2.

The Black Box Hardened Ethernet Switch fits very well in high temperature industrial plant locations experiencing a need to scale its LAN quickly and cost effectively. With its half / full duplex switching capability, the Hardened Ethernet Switch provides a very economical high bandwidth solution at each copper-cable user-access point. The 10/100 dual-speed functions to support a mixed environment of 10 Mbps and 100Mbps users and devices, and the switching capability on all ports provides bandwidth for high performance. The ruggedness of the Ethernet Switch's steel case and the highly reliable design (over 10 years of MTBF) complements the temperature controlled packaging to provide an exceptional Industrial Ethernet product.
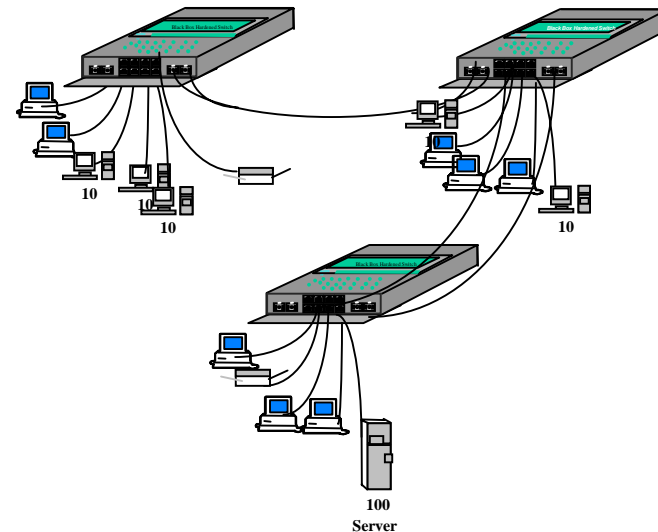
Figure 2.6.2: Three

Hardened Ethernet Switch connects together to provide 10 Mbps and100Mbps network with Fast Ethernet backbone.

In this example, the plenum-rated Hardened Ethernet Switch takes care of the LAN connectivity requirement in a harsh temperature environment, mounted above the ceiling in the building. The non-conductive fiber cabling inter-connects these switches through their fiber ports, providing a protected Ethernet network facility as part of the building infrastructure. The steel enclosure and 20-70VDC power input qualifies the Black Box Hardened Ethernet Switch to provide a dependable solution for any temperature un-controlled location in industrial environments. The rugged enclosure with cable strain feature gives extra protection and security to the LAN users.

3.0   INSTALLATION

This chapter provides instructions for installing Black Box Hardened Ethernet Switch units.

3.1   Locating Black Box 10/100Mb Ethernet Switch

The location of a Hardened Ethernet Switch is dependent on the physical layout of the network. The rugged 18-gauge high steel which acts as a heat sink will normally protect the Hardened Ethernet Switch from accidental damage in any workplace setting. Install the unit so that the metal case of the unit is in contact with a metal surface (such as a pedestal in the earth on an equipment enclosure box) which does not exceed the ambient rating of the unit.

Designed primarily for specific applications, such as road traffic data collection and control stations, high temperature industrial plants, pedestals and military field sites, the Hardened Ethernet Switch supports DC power input for high reliability and convenience in out-of-the way locations. Locate any 20-70VDC three-wire (+, GND, -) power source that is within the range of the intended Hardened Ethernet Switch site. Maintain an open view of the top surface to visually monitor the status LEDs.

3.1.1   Table-Top or Shelf Mounting

The Black Box Hardened Ethernet Switch can be easily mounted on a table-top, shelf or any suitable horizontal surface, but has to be securely mounted through appropriate screws. Rubber "feet" (if any) that would insulate the case from metal-to-metal contact with the mounting surface should be removed.   The full temperature rating of the unit cannot be achieved if it is not properly mounted on metal.

3.1.2   Wall (or vertical surface) mounting

The Hardened Ethernet Switch is quite heavy because of its 18-gauge high-strength steel case enclosure. Because of its weight, it is very important to select a sturdy place and carefully attach it to strong metal surface. Attaching it to a metal surface is necessary to allow the thermal heat transfer from the case, achieving rated ambient temperature specifications.

Each Black Box Hardened Ethernet Switch is normally mounted with screws in a vertical (cable connectors at the bottom) position. The base plate of the unit has screw holes cut out, two top and two bottom. The spacing for the mounting screws is a rectangle 3.35" x 8.25" (8.25cm x 21cm) center-to-center. Four user-supplied screws attach the Hardened Ethernet Switch base plate to the vertical mounting surface.

3.2   Connecting Ethernet Media, and Special Strain-relief feature

Note – see also "Cable Strain Relief Feature, Section 3.4.

The Black Box Ethernet Switches can be connected to the following three media types: 100BASE-TX, 10BASE-T and 100BASE-FX. CAT 5 cables should be used when making 100BASE-TX connections. When the ports are used as 10BASE-T ports, CAT 3 may be used. In either case, the maximum distance for unshielded twisted pair cabling is 100 meters (328 ft). For fiber port 100BASE-FX multi-mode, 50/125 or 62.5/125 microns cabling can be used, whereas for single-mode, 9/125 microns cabling should be used. Fiber cabling supports much longer cable distance and higher bandwidths as compared to copper wiring.

Media	IEEE Standard	Connector
Twisted Pair (CAT 3 or 5)	10BASE-T	RJ-45
Twisted Pair (CAT 5)	100BASE-TX	RJ-45
Fiber (Multi-mode)	100BASE-FX	SC
Fiber (Single-mode)	100BASE-FX	SC

NOTE : *It is recommended that high quality CAT. 5 cables (which work for both 10 Mbps and 100Mbps) be used whenever possible in order to provide flexibility in a mixed-speed network, since P80-series switch ports are auto-sensing for either 10 and 100Mbps. Note that the auto-sensing function does not sense the cable type.*

3.2.1   Connecting Twisted Pair (RJ-45, CAT 3 or CAT 5, Unshielded or Shielded)

The following procedure describes how to connect a 10BASE-T or 100BASE-TX

twisted pair segment to the RJ-45 port. The procedure is the same for both unshielded

and shielded twisted pair cables.

1. Using standard twisted pair media, insert either end of the cable with a RJ-45 plug into the RJ-45 connector of the port. Note that, even though the connector is shielded, either unshielded or shielded cables and wiring may be used.
2. Connect the other end of the cable to the corresponding device.
3. Use the LINK LED to ensure proper connectivity by noting that the LED will be illuminated when the unit is powered and proper connection is established. If this does not help, ensure that the cable is connected properly and that the device on the other end is powered and is not defective.
4.

3.2.2   Connecting Fiber Optic <u>SC-type</u>, "Snap-In"

The following procedure applies to installations using SC-type fiber connectors. This procedure applies to ports using multi-mode SC fiber connectors.

1. Before connecting the fiber optic cable, remove the protective dust cap / plug from the end of the fiber connectors, exposing the ports opening. Save the dust cover / plug for future use in case the fiber cable needs to be unplugged for service.
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. Then, insert the square male connector into the SC female jack of the Fiber port connector until it clicks and secures.
   > **Note:**   *<u>One strand of the duplex fiber optic cable may be coded using color bands at regular intervals; you should use the color-coded strand on the associated ports at each end of the fiber optic cable segment.</u>*
3. Connect the Transmit (TX) port on the Fiber port to the Receive (RX) port of the remote device. Begin with the color-coded strand of the cable for this first TX-to-RX connection. Note – the two male square-end SC cable strands may be fastened together to plug as a unit.
4. Connect the Receive (RX) port to the Transmit (TX) port of the remote device. Use the non-color coded fiber strand for this.
5. The LINK LED for the fiber connector will illuminate when a proper connection has been established at both ends (and when power is ON in the unit). If LINK is not lit after cable connection, the normal cause is improper cable polarity. Swap the fiber cables at the fiber connector to remedy this situation.

3.2.3   Connecting Fiber Optic <u>ST-type</u>, "Snap-In" (Optional)

The following procedure applies to installations using ST-type fiber connectors, i.e.,

using multi-mode ST.

When connecting fiber media to ST connectors, simply twist on the two round male connectors into the ST female jacks of the Fiber connector, until it clicks and secures.

3.2.4 Connecting <u>Single-Mode</u> Fiber Optic

When using single-mode fiber cable, be sure to use single-mode fiber port connectors. Single-mode fiber cable has a smaller diameter than multi-mode fiber cable (9/125 microns for single-mode, 50/125 or 62.5/125 microns for multi-mode where xx/xx are the diameters of the core and the core plus the cladding respectively). Single-mode fiber allows full bandwidth at longer distances, about 20Km with the single-mode SC.

The same procedures as for multi-mode fiber apply to single-mode fiber connectors. Follow the steps listed in Section 3.2.2 above.

3.2.5 Power Budget Calculations for Hardened Ethernet Switch 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 using Black Box products, 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
LB9901A, LB9904A-MSC	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
LB9902A, LB9903A-SSC	100Mb FX	Single-mode	20 (0.4)	1300	9/125	-15	-31	14	28	17.5	35

*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, 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)

3.2.6   Connections to NICs which support Auto-Negotiation, RJ-45 ports

The copper ports of Black Box Ethernet Switches will function properly with NICs (Network Interface Cards) which support Auto-Negotiation, and the Fast Link Pulse (FLP) coding for the 100BASE-TX signaling system. When connecting a NIC to a Hardened Ethernet Switch, it may be necessary to reload the NIC drivers on the user device if the NIC has been communicating with a protocol other than 100BASE-TX (such as 10BASE-T). When 100Mb speed is agreed and in use, the 10/100 LED is steady ON. It is OFF if there is no traffic or if 10 Mbps traffic.

3.3   Powering the Black Box Ethernet Switch

3.3.1   Powering the LB9904A, LB9905A & LB9906A models, for –48V and 24V DC power input

Each Black Box LB9904A Model Hardened Ethernet Switch requires a DC power source, from 20-70VDC. The wide range of power input qualifies this product for use both in 24VDC as well as -48VDC environments. The 24VDC or -48VDC power input provides an Ethernet networking product utilizing a special type of power supply with a proven high-reliability record.

DC Power Terminals: "+", "-",
internally floating

GND: Terminal for "earth" or ground wire connection to the Hardened Ethernet Switch chassis

Input Voltage: 20 to 70 VDC
Input current: 0.7 amp max.

Power Consumption: 10 watts typical

HARDENED ETHERNET SWITCH-

48V, 24VDC INSTALLATION

This section describes the proper connection of the -48VDC leads (or 24VDC leads) to the DC power terminal block on the Hardened Ethernet Switch (as shown in the Figure above) The DC terminal block on the Hardened Ethernet Switch is located on the left front of the unit and is equipped with three (3) screw-down lead posts. The power terminals are identified as

positive (+) and negative (-), and they are floating inside the unit so that either may be grounded by the user if desired. The chassis is "earth" or ground (GND).

The connection procedure is straightforward. Simply insert the DC leads to the Switch's power terminals, positive (+) and negative (-) screws. The use of Ground (GND) is optional; it connects to the Switch chassis. Ensure that each lead is securely tightened.

NOTE: Always use a voltmeter to measure the voltage of the incoming power supply and figure out the +ve potential lead or -ve potential lead. The more +ve potential lead will connect to the post labeled "+ve" and the rest to the "-ve".
The GND can be hooked up at the last.

When power is applied, the green PWR LED will illuminate.

3.3.2   Powering the Black Box's LB9901A - LB9903A Model with External AC Power Supply)

The rugged Black Box 's LB9901A-LB9903A model of Ethernet Switch, mainly used in Industrial and Outdoor Ethernet applications at extended temperatures, also supports universal AC power input from 85-275vac 50-60Hz through a separate Power Source unit. The wide range of AC power input qualifies this product with spare power supply to be used worldwide,

in almost any temperature environment. The AC power source form spare power supply enclosed in a rugged metal case that also acts as a heat sink, enabling extended application temperatures to be accommodated. The spare power supply also includes surge protection to withstand AC power input upsets, such as might result from nearby lightening strikes. Shock and vibration characteristics enable use in transportation applications such as ships, trains and road-side boxes. The DC power output cord comes with a military-style screw-lock female plug for secure attachment to the Ethernet Switch.

Input Voltage: 85-264 VAC, 47-63HZ, Auto-ranging

AC Power Connector: IEC-type, male recessed
Power Output : 5VDC, 3Amps max

Input Fuse for overload and short protection: 3AG type, 0.5 Amp; spare is included

Power Capacity: 15 watts output, 70% min efficiency

Surge Protection: over 150 joules, with clamping at 800V 50A min.

Operating Shock and Vibration: meets Bellcore GR-63-CORE Sections 4.4.1 and 4.4.3

NOTE: *For best results at high-temperature, fasten the metal case of the spare power supply unit to be in contact with a vertical surface (such as pedestal) that has good heat conducting properties. Remove rubber "feet", if present, to enhance metal-to-metal contact and provide the best heat transfer away from the spare power supply unit.*

3.4   Cable Strain Relief Feature on all Black Box Ethernet Switch's models

The Black Box Ethernet Switches are designed to use in harsh environments The extended temperature features qualify them to be used in roadside traffic data collection and control stations, high temperature industrial plants, plenums and ceiling locations in commercial buildings, etc. They are usually mounted vertically so that the cables hang out the bottom. There is a cable strain relief feature provided as part of the package design

The Black Box Ethernet Switches have a tie wrap holder as part of the base plate of the unit for use for cable strain relief. The strain-relief feature is applicable to power cables as well as to Ethernet cables, both twisted-pair copper and fiber. Cable tie-wraps can secure the cables and can be attached to the base plate HOOK provided at the bottom-front of the unit. In the event that the attached cable is pulled, the tie-wrap cable strain relief feature protects the cable connection from coming loose. This feature provides a more reliable and robust installation and operation.

The figure above illustrates the strain-relief feature, using tie-wraps.

4.0   OPERATION - the function and operation of the Hardened Ethernet Switches.

4.1   Dual-Speed Functionality, and Switching

The Black Box Hardened Ethernet Switch provide six 10/100 RJ-45 switched ports, and two 100Mb fiber ports. The architecture supports a dual speed switching environment, with two built-in full-duplex "future-proof" fiber ports. The six RJ-45 copper ports equipped with auto-negotiation capability.

The switched RJ-45 ports are full / half duplex and auto-sensing for speed. (See section 2.2). When the connected device is 10 Mbps, the Hardened Ethernet Switch obeys all the rules of 10 Mbps Ethernet configurations. The 10 Mbps users share a 10 Mbps traffic domain, and can "communicate with" 100Mbps users as well as 100Mbps domain. Similarly, the 100Mbps traffic obeys the rules of 100Mbps Ethernet, and can communicate with 10Mb domain too.

All Hardened Ethernet Switch units are plug-and-play devices. There is no software configuration to be done at installation or for maintenance. The Half / full duplex mode for the RJ-45 switched RJ-45 ports is user dependent and changes (by auto-negotiation) to full or half duplex as the unit attached with these ports. The internal functions of the Hardened Ethernet Switch are described below.

Switching, Filtering and Forwarding

Each time a packet arrives on one of the switched ports, the decision is taken to either filter or to forward the packet. Packets whose source and destination addresses on the same port segment will be filtered, constraining them to one port and relieving the rest of the network from processing them. A packet whose destination address is on another port segment will be forwarded to the appropriate port, and will not be sent to the other ports where it is not needed. Packets needed for maintaining the operation of the network (such as occasional multi-cast packets) are forwarded to all ports.

The Hardened Ethernet Switch operate in the store-and-forward switching mode, which eliminates bad packets and enables peak performance to be achieved when there is heavy traffic on the network.

Switching, Address Learning

The Ethernet units have address table capacity of 16K node addresses, and are suitable for use in large networks. They are self-learning, so that as nodes are added or removed or

moved from one segment to another, the Hardened Ethernet Switch automatically keeps up with node locations.

An address-aging algorithm causes least-used addresses to fall out in favor of new frequently-used addresses. To reset the address buffer, cycle power down-and-up.

4.2   **Auto-negotiation and Speed-sensing**

All six RJ-45 ports independently support auto-negotiation for speed in 10BASE-T and 100BASE-TX modes. Operation is according to the IEEE 802.3u standard.

When a RJ-45 cable connection is made, and each time a LINK is enabled, auto-negotiation takes place. The Black Box Hardened Ethernet Switch advertises its capability for 10 or 100 Mbps speed, and the device at the other end of the cable should similarly advertise / respond and both sides will agree to the speed being used. Depending upon the device connected, this will result in agreement to operate at either 10 Mbps or 100Mbps speed.

When the '**LK/ACT**' LED is ON, steady ON indicates LINK with no traffic, blinking ON indicates the port is transmitting / receiving. The port has auto-negotiated for operation. (If a Hardened Ethernet SwitchRJ-45port is connected to a non-negotiating device, it will default to 10 Mbps speed and half-duplex mode, per the IEEE 802.3u standard).

4.3   **LED's**

    POWER: Illuminates GREEN, steady on when power applied.

    SELF TEST: Indicates the self-test at power up was not successful.

    F/H: ON = Full-Duplex and Link, OFF = Half-Duplex and / or no Link.

    LK/ACT: Per port, steady ON for LINK with no traffic, blinking indicates port is transmitting and receiving.

    10/100:   Per port, ON = 100Mbps; OFF = 10 Mbps (when LINK is made).

5.0   TROUBLESHOOTING

All Black Box Ethernet products are designed to provide reliability and consistently high performance in all network environments. The installation of a Hardened Ethernet Switch is a simple procedure (see Section 3.0, INSTALLATION); operation is easy, as 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 Hardened Ethernet Switch is not operating as expected, do not attempt to repair or alter the unit. Contact Black Box Corporation for assistance.

5.1   Before Calling for Assistance

1. If you have difficulty installing or operating, refer to **Chapters 3** and **4.** Make sure that the various other components of the network are working.

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

3. Check that the AC power cord is plugged into a functioning electrical outlet. Make sure that the AC power cord is properly plugged into the Dual-Speed MiniHub. Use the PWR LED to verify that the unit is receiving proper power.

4. If the problem is isolated to a network device other than the Dual-Speed MiniHub, replace the problem device with a known good device. Verify whether or not the problem is corrected. If it is not, go to step 5. If the problem is corrected, the Dual-Speed Personal MiniHub and its associated cables will function properly.

5. If the problem still exists, contact Black Box.

5.2   When Calling for Assistance

If you determine that your Hardened Ethernet Switch is malfunctioning, do not attempt to alter or repair the unit. It contains no user-serviceable parts. Contact Black Box by phone at (724) 746-5500 or by other appropriate method .

Before you do, make a record of the history of the problem. Black Box 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.

5.3   Shipping and Packaging Information

If you need to transport or ship your Ethernet Switch:

- Package it carefully. We recommend that you use the original container.
- If you are shipping the Dual-Speed Personal Mini Hub for repair, make sure you include everything that was included in the original package. Before you ship, contact Black Box to get a Return Materials Authorization (RMA) number.

Ship the package to:

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