



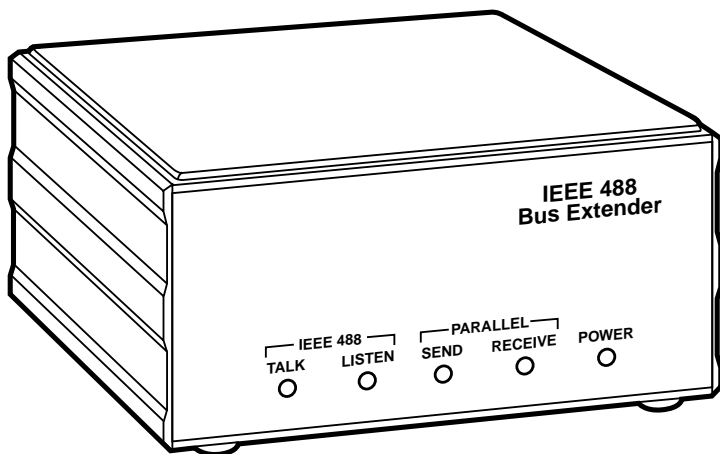
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IEEE Bus Extender

IEEE Fiber Bus Extender



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**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 conectado 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 líneas de energía.
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 objetos líquidos 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.

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1. Specifications

1.1 IEEE 488 Bus Extender (IC095A)

IEEE 488-1978 —	<i>Implementation:</i>	Proprietary transparent control and data transfers
	<i>Connector:</i>	Standard IEEE 488 connector with metric studs
Serial Interface —	<i>EIA RS-422A:</i>	Balanced voltage on TxD and RxD
	<i>Connector:</i>	DB9 female
	<i>Character Set:</i>	Proprietary asynchronous bit serial
	<i>Baud Rate:</i>	Selectable 300, 600, 1200, 2400, 4800, 9600, 19,200, and 115,200
	<i>Data Format:</i>	Selectable 7 or 8 data bits; 1 stop bit; odd parity
	<i>Max. Cable Length:</i>	3280 feet (1000 meters)
Data Rates —	Specifications apply to data transfers after addressing has been established	
	<u>Baud Rate</u>	<u>Data Rate (bytes per second, average)</u>
	300	13
	600	26
	1200	53
	2400	105
	4800	204
	9600	385
	19,200	691
	115,200	3400
Indicators —	LEDs for IEEE Talk, Listen, SRQ, Error, and Power	
Controls —	Power switch (external), serial parameter switches (internal)	

IEEE 488 BUS EXTENDER AND IEEE 488 FIBER BUS EXTENDER

Temperature —	32 to 122°F (0 to 50°C)
Humidity —	Up to 70% relative humidity
Power —	105- to 125-VAC or 210- to 250-VAC; 50-60 Hz, 10 VA max.
Size —	2.7"H x 5.5"W x 7.4"D (6.9 x 14 x 18.8 cm)
Weight —	3.1 lb. (1.4 kg)

1.2 IEEE 488 Fiber Bus Extender (IC096A)

IEEE 488-1978 —	<i>Implementation:</i>	Proprietary transparent control and data transfers
	<i>Connector:</i>	Standard IEEE 488 connector with metric studs
Fiber optic Interface —	<i>Wavelength:</i>	820 nanometers typical
	<i>Connectors:</i>	SMA-905 series female
	<i>Required Cable:</i>	Duplex 100- μ m, 140- μ m clad fiber optic; 200-MHz-km bandwidth; 6 dB/km max. attenuation
	<i>Max. Cable Length:</i>	3280 feet (1000 meters)
Data Rates —		3400 bytes per second typical
Indicators —		LEDs for IEEE Talk, Listen, SRQ, Error, and Power
Temperature —		32 to 122°F (0 to 50°C)
Humidity —		Up to 70% relative humidity
Controls —		Power switch (external)
Power —		105- to 125-VAC or 210- to 250-VAC; 50-60 Hz, 10 VA max.
Size —		2.7"H x 5.5"W x 7.4"D (6.9 x 14 x 18.8 cm)
Weight —		3.6 lb. (1.6 kg)

2. Introduction

2.1 Description

The IEEE 488 Bus Extenders and IEEE 488 Fiber Bus Extenders help you control IEEE 488 devices up to 4000 feet (1219.2 m) from the host computer. This overcomes the IEEE 488's specified limit of 6 feet (1.8 m) between any two devices, with a maximum of 60 feet (18.3 m) total chained length. In addition, the Extenders allow up to 30 devices to be on the bus—double the 15-device limit imposed by the IEEE standard.

You'll need two Extenders for bus extension. The bus connecting the host computer, or controller, is the "local" bus. The bus to which control is extended is the "remote" bus. An Extender is required on each bus for IEEE bus extension.

The **IEEE 488 Bus Extender** (IC095A) transmits RS-422 data between Extenders. RS-422, a differential serial data format, provides high noise immunity and long distances using low-cost twisted-pair wire.

The **IEEE 488 Fiber Bus Extender** (IC096A) communicates serially over duplex fiberoptic cables. Fiberoptic transmission provides even better noise immunity, low RFI emissions, and long distances.

Extender operation is completely transparent to the system. The controller can access both local and remote devices just as it could without the Extender, with the exception of Parallel Poll (see "Parallel Poll Response Times" in **Chapter 4**).

2.2 Abbreviations

The following IEEE 488 abbreviations are used throughout this manual.

addr n	IEEE bus address “n”
ATN	Attention line
CA	Controller Active
CO	Controller
CR	Carriage Return
data	Data String
DCL	Device Clear
GET	Group Execute Trigger
GTL	Go To Local
LA	Listener Active
LAG	Listen Address Group
LF	Line Feed
LLO	Local Lock Out
MLA	My Listen Address
MTA	My Talk Address
PE	Peripheral
PPC	Parallel Poll Configure
PPU	Parallel Poll Unconfigure
SC	System Controller
SDC	Selected Device Clear
SPD	Serial Poll Disable
SPE	Serial Poll Enable
SRQ	Service Request
TA	Talker Active
TAD	Talker Address
TCT	Take Control
term	Terminator
UNL	Unlisten
UNT	Untalk
*	Unasserted

2.3 What's Included

The Extenders are carefully inspected prior to shipment. Before you start using your Extender, however, carefully inspect it for any obvious signs of physical damage which may have occurred during shipping. Immediately report any damage found. Remember to retain all shipping materials in case shipping the Extender back to the factory becomes necessary.

Every Extender is shipped with a power supply and this user guide.

WARNING!

The Extender requires a regulated external power supply with a maximum output of 5.25 volts. Using voltages above this level will result in damage to the interface. Only use power supplies provided by Black Box.

3. Configuration and Installation

3.1 Configuring and Installing the IEEE 488 Bus Extender (IC095A)

This section describes the configuration necessary for the RS-422 IEEE 488 Bus Extenders. If you are using the fiberoptic extenders (IC096A), refer to **Section 3.2**.

Two IEEE 488 Bus Extenders are required for bus extension, with one connected directly to the local IEEE bus, and the other connected to the remote IEEE bus.

Both local and remote Extenders are identical. At power-up, each Extender monitors the Attention (ATN) and Remote Enable (REN) lines. The Error LED on each Extender will blink, indicating that ATN or REN has not yet been detected and that communication with the other Extender has not yet been established. The first Extender to detect either of these lines asserted declares itself the local Extender and commands the other Extender to declare itself the remote Extender. The Error LEDs will now stop blinking. From this moment on, the local Extender will monitor all local bus activity and transmit this activity to the remote Extender. All activity detected by the remote Extender is also communicated back to the local Extender.

3.1.1 SETTING THE SERIAL BAUD RATE

The Extender is shipped with the serial baud rate set to 115.2 Kbps. For most applications, this is the most efficient operating rate. However, if the Extenders will be located at extreme distances from each other, baud rates other than 115.2 Kbps can be selected. Selectable baud rates include 115.2 Kbps, 19.2 Kbps, 9600 bps, 4800 bps, 2400 bps, 1200 bps, 600 bps, and 300 bps. Both Extenders must be set to the same baud rate for proper operation.

To modify the baud rate, disconnect the power supply from the AC line and from the interface. Disconnect any IEEE or serial cables prior to disassembly.

WARNING!

Never open the Extender's case while it is connected to the AC line. Doing so may result in equipment failure, personal injury, or death.

Remove the screws located in each corner of the rear panel. Hold the case firmly and pull the rear panel outward, noting the slot location of the main circuit board. Set the DIP switches for the baud rate you want (use **Figure 3-1** as a guide) and reassemble the unit. Slide the main circuit board into the previously noted slot and finish reassembly by re-tightening the screws.

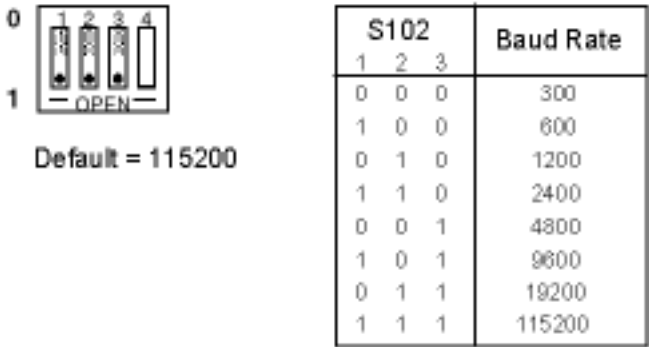


Figure 3-1. Baud Rate Selection.

3.1.2 SERIAL DATA FORMAT SELECTION

The Extender is configurable for two data formats. The first format, the factory default, is 8 data bits, 1 stop bit with odd parity. The number of data bits transmitted can be set to 7 by setting S102 switch 4 to the closed position. Even though the seven-bit format is chosen, binary data can still be transferred over the Extenders. There will, however, be a slight degradation in data-transfer speeds with this format.



Figure 3-2. Data Format Selection.

3.1.3 INSTALLING SERIAL PORT CABLING

The Extender is designed to use an RS-422 transmission medium, which prescribes differential receivers for high noise immunity. To ensure signal integrity, only use shielded cable for the serial-port connections. If you are not using a cable provided by Black Box, listed below are the appropriate connections for proper operation.

Local Extender		Remote Extender	
Signal	Pin #	Pin #	Signal
Receive Data -	1	← 6	Transmit Data -
Receive Data +	2	← 7	Transmit Data +
Ground (shield)	5	← 5	Ground (shield)
Transmit Data -	6	→ 1	Receive Data -
Transmit Data +	7	→ 2	Receive Data +

3.2 Configuring and Installing the IEEE 488 Fiber Bus Extender (IC096A)

3.2.1 OVERVIEW

This section describes the configuration necessary for the fiberoptic IEEE 488 Fiber Bus Extenders. If you are using the RS-422 extenders (IC095A), refer to **Section 3.1**.

Two Extenders are required for bus extension, with one connected directly to the local IEEE bus, and the other connected to the remote IEEE bus.

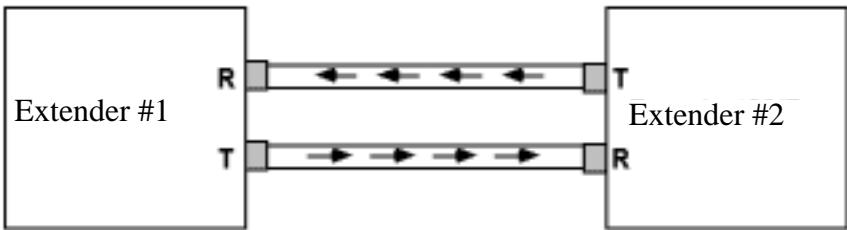
Both local and remote Extenders are identical. At power-up, each Extender monitors the Attention (ATN) and Remote Enable (REN) lines. The Error LED on each Extender will blink, indicating that ATN or REN has not yet been detected and that communication with the other Extender has not yet been established. The first Extender to detect either of these lines asserted declares itself the local Extender and commands the other Extender to declare itself the remote Extender. The Error LEDs will now stop blinking. From this moment on, the local Extender will monitor all local bus activity and transmit this activity to the remote Extender. All activity detected by the remote Extender is also communicated back to the local Extender.

WARNING!

There are no user-serviceable parts or user-selectable parameters inside the Extender's case. Refer all servicing to qualified repair personnel. Refer to Section 6.4 for additional information on malfunctioning equipment.

3.2.2 INSTALLING AND MAINTAINING FIBEROPTIC CONNECTIONS

The Extender requires duplex fiberoptic cabling. Most cable manufacturers mark the two connectors at each end of the duplex cable with a “T” and an “R” to distinguish which to connect to the transmitter (T) and which to connect to the receiver (R). Connect the fiberoptic cables as shown below. The Transmitter of #1 is connected to the receiver of #2 and vice versa.



Follow these guidelines for taking care of your Extender.

1. Treat the fiberoptic transmitter, receiver, and cabling ends gently. Good system performance requires clean port optics and cable ferrules to avoid obstructing the optical path.
2. Compressed air is often all that's needed to remove dirt particles from the optic transmitters and receivers. Standard lens-cleaning tissues or cotton swabs soaked with methanol or freon also work well for cleaning cable ferrules. Be careful not to splash methanol or freon on case parts.
3. When the Extender is not in use, replace the Extender's optical transmitter and receiver protection caps. Make sure cable ferrule protection caps are also replaced.
4. When pulling optical cable through conduits of walls, *never* use the connectors as a link to the pulling lead. Make sure that the cable is loose in the conduit after installation. If the cable is pulled tight on a corner, transmission loss may be increased significantly.
5. When seating connectors in the transmitter and receiver, you might have to turn the connector a little to achieve satisfactory transmission.

4. Operation

4.1 Powering the System

After configuring the Extenders and attaching the serial port or fiberoptic cabling, plug the power-supply connector into the rear jack on the interface.

CAUTION

Always connect the power supply to the Extender first, then to the AC line power. Connecting it to the power first may result in damage to the Extender. Only a supply with regulated +5-volt output should be used.

WARNING

The power supply provided with the interface is intended for indoor use only. Using it outdoors could result in equipment failure, personal injury, or death.

After connecting the power supply to the Extender, plug the power supply into the AC line power. Place the rear-panel power switch in the ON [1] position. All front-panel indicators should light for approximately one second while the Extender performs an internal ROM and RAM self-check. At the end of the power-on sequence, the ERROR LED should continue to blink, indicating that communication with another Extender has not been established. Now repeat the above procedure with the second Extender. All LEDs should function the same as with the first Extender. If any of the following LED conditions exist after power-on, a failure has occurred.

SYMPTOM

- All lights remain on.
- All lights blink continually.
- No LEDs blink.

FAILURE

- ROM test has failed.
- RAM test has failed.
- Power supply has failed.

If any of the symptoms shown occur, cycle the power switch on the Extender to be sure of the problem. If the problem is unresolved, refer to **Chapter 6**.

WARNING

The Extender makes its earth-ground connection through the IEEE interface cable. Each Extender must be connected to at least one IEEE device which is earth-ground referred. Failure to do so may allow dangerous voltages to build up. This could result in damage to the interface, personal injury, or death.

If the Extender seems to be operating properly, turn off the Extender's power switch and connect the other IEEE devices to each of the Extender's IEEE ports. Connect the local Extender to the remote Extender via the serial or fiberoptic cable. Apply power to all devices in the system. If the Extender's ERROR LED continues to blink after the power-on sequence, this indicates one of two possible conditions: either the system controller has not yet asserted the Attention line, or communication with the mating Extender has not yet been established. Be sure both Extenders are powered on, the cabling has been installed, and the controller has asserted Attention before assuming there is a problem.

Once all IEEE devices have been connected and powered on, the Extender will allow the system controller to command up to 13 IEEE devices on its local bus (in addition to the controller itself and the local Extender), and up to 14 IEEE devices on the remote bus (in addition to the remote Extender). The Extenders have no address of their own, and therefore will operate completely transparent to the system (with the exception of parallel poll—see below). Be careful not to have two IEEE devices with the same address connected to either remote or local buses. If you do, the bus will “lock up” when one of the devices is accessed.

4.2 Parallel Poll Response Times

The Parallel Poll function is the only extended bus transaction which is not completely transparent to your system. This is because the speed at which data is transferred serially is slower than the IEEE specification for Parallel Poll response. Consequently, it is necessary for the controller to perform two Parallel Polls.

When the local Extender detects the parallel poll, it outputs the most recent Parallel Poll information to the controller on the local bus. This data should be discarded by the controller because it is not current. After receiving a Parallel Poll, the local Extender commands the remote Extender to perform a Parallel Poll, and returns the remote Parallel Poll data byte to the local Extender. The bus controller should now perform another Parallel Poll and use this data as the valid Parallel Poll byte. The table on the next page describes the minimum times the controller should wait between consecutive Parallel Polls in order to assure valid data on the second poll.

Table 4-1. Extender Parallel Poll Response Times

Baud Rate	Delay (typ)
115200	1 msec
19200	3 msec
9600	8 msec
4800	13 msec
2400	24 msec
1200	48 msec
600	92 msec
300	200 msec

The minimum time the controller should wait with the IEEE 488 Fiber Bus Extender between consecutive Parallel Polls is 1 millisecond.

5. IEEE 488 Primer

5.1 History

The IEEE 488 bus is an instrumentation communication bus adopted by the Institute of Electrical and Electronic Engineers in 1975 and revised in 1978. The IEEE 488 Bus Extender and the IEEE 488 Fiber Bus Extender conform to this most recent revision designated IEEE 488-1978.

Prior to the adoption of this standard, most instrumentation manufacturers offered their own versions of computer interfaces. This placed the burden of system hardware design on the end user. If his application required the products of several different manufacturers, then he might need to design several different hardware and software interfaces. The popularity of the IEEE 488 interface (sometimes called the General Purpose Interface Bus or GPIB) is due to the total specification of the electrical and mechanical interface as well as the data transfer and control protocols. The use of the IEEE 488 standard has moved the responsibility of the user from design of the interface to design of the high-level software that is specific to the measurement application.

5.2 General Structure

The main purpose of the GPIB is to transfer information between two or more devices. A device can either be an instrument or a computer. Before any information transfer can take place, it's first necessary to specify which will do the talking (send data) and which devices will be allowed to listen (receive data). The decision of who will talk and who will listen usually falls on the System Controller, which is, at power-on, the Active Controller.

The System Controller is similar to a committee chairman. On a well-run committee, only one person may speak at a time and the chairman is responsible for recognizing members and allowing them to have their say. On the bus, the device which is recognized to speak is the Active Talker. There can only be one Talker at a time if the information transferred is to be clearly understood by all. The act of "giving the floor" to that device is called Addressing to Talk. If the committee chairman cannot attend the meeting, or if other matters require his attention, he can appoint an acting chairman to take control of the proceedings. For the GPIB, this device becomes the Active Controller.

At a committee meeting, everyone present usually listens. This is not the case with the GPIB. The Active Controller selects which devices will listen and commands all other devices to ignore what is being transmitted. A device is instructed to listen by

being Addressed to Listen. This device is then referred to as an Active Listener. Devices which are to ignore the data message are instructed to Unlisten.

The reason some devices are instructed to Unlisten is quite simple. Suppose a college instructor is presenting the day's lesson. Each student is told to raise their hand if the instructor has exceeded their ability to keep up while taking notes. If a hand is raised, the instructor stops his discussion to allow the slower students time to catch up. In this way, the instructor is certain that each and every student receives all the information he is trying to present. Since there are a lot of students in the classroom, this exchange of information can be very slow. In fact, the rate of information transfer is no faster than the rate at which the slowest note-taker can keep up. The instructor, though, may have a message for one particular student. The instructor tells the rest of the class to ignore this message (Unlisten) and tells it to that one student at a rate which he can understand. This information transfer can then happen much quicker, because it need not wait for the slowest student.

The GPIB transfers information in a similar way. This method of data transfer is called handshaking. Handshaking is discussed in more detail in **Section 5.5**.

For data transfer on the IEEE 488, the Active Controller must...

- a) Unlisten all devices to protect against eavesdroppers.
- b) Designate who will talk by addressing a device to talk.
- c) Designate all the devices who are to listen by addressing those devices to listen.
- d) Indicate to all devices that the data transfer can take place.

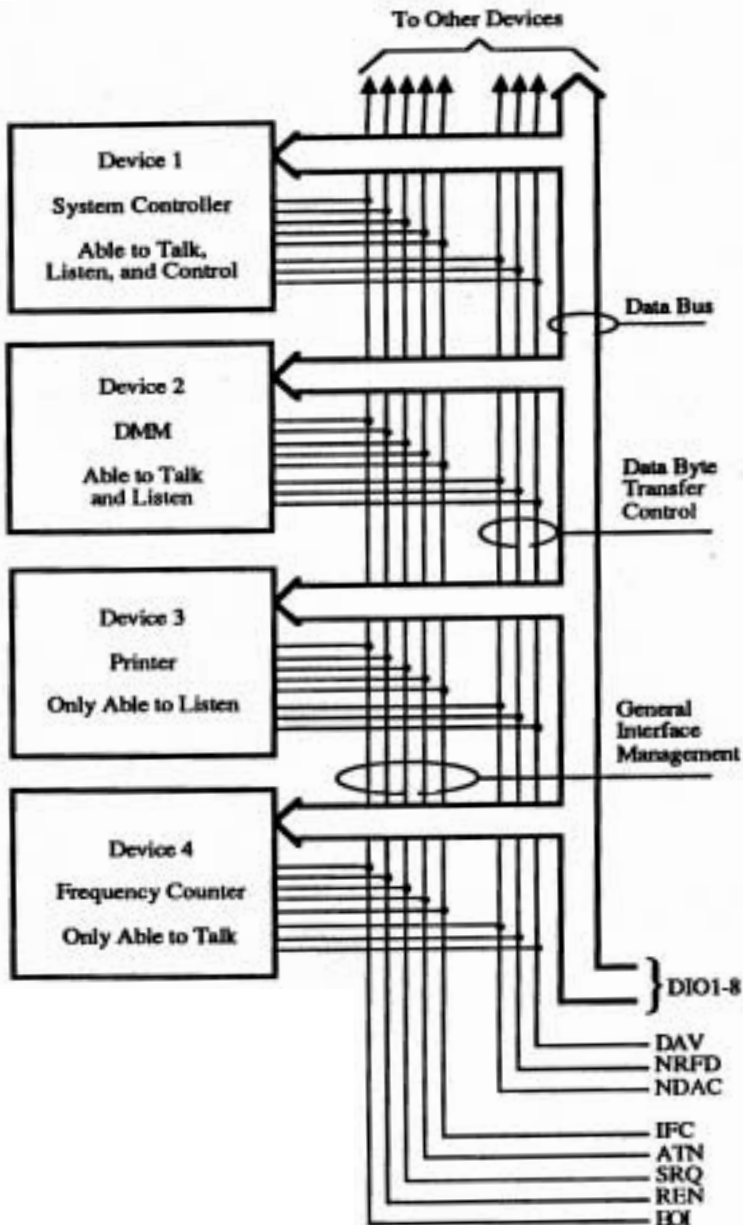


Figure 5-1. IEEE 488 Bus Structure.

5.3 Send It to My Address

In the previous discussion, the terms Addressed to Talk and Addressed to Listen were used. These terms require some clarification.

The IEEE 488 standard permits up to 15 devices to be configured within one system. Each of these devices must have a unique address to avoid confusion. In a similar fashion, every building in town has a unique address to prevent one home from receiving another home's mail. Exactly how each device's address is set is specific to the product's manufacturer. Some are set by DIP switches in hardware, others by software. Consult the manufacturer's instructions to determine how to set the address.

Addresses are sent with universal (multiline) commands from the Active Controller. These commands include My Listen Address (MLA), My Talk Address (MTA), Talk Address Group (TAG), and Listen Address Group (LAG).

5.4 Bus Management Lines

Five hardware lines on the GPIB are used for bus management. Signals on these lines are often referred to as uniline (single-line) commands. The signals are active low—that is, a low voltage represents a logic “1” (asserted), and a high voltage represents a logic “0” (unasserted).

5.4.1 ATTENTION (ATN)

ATN is one of the most important lines for bus management. If Attention is asserted, then the information contained on the data lines is to be interpreted as a multiline command. If it isn't, then that information is to be interpreted as data for the Active Listeners. The Active Controller is the only bus device that has control of this line.

5.4.2 INTERFACE CLEAR (IFC)

The IFC line is used only by the System Controller. It is used to place all bus devices in a known state. Although device configurations vary, the IFC command usually places the devices in the Talk and Listen Idle states (neither Active Talker nor Active Listener).

5.4.3 REMOTE ENABLE (REN)

When the System Controller sends the REN command, bus devices will respond to remote operation. Generally, the REN command should be issued before any bus programming is attempted. Only the System Controller has control of the Remote Enable line.

5.4.4 END OR IDENTIFY (EOI)

The EOI line is used to signal the last byte of a multibyte data transfer. The device that is sending the data asserts EOI during the transfer of the last data byte. The EOI signal is not always necessary, as the end of the data may be indicated by some special character such as carriage return.

The Active Controller also uses EOI to perform a Parallel Poll by simultaneously asserting EOI and ATN.

5.4.5 SERVICE REQUEST (SRQ)

When a device desires the immediate attention of the Active Controller it asserts SRQ. It is then the Controller's responsibility to determine which device requested service. This is accomplished with a Serial Poll or a Parallel Poll.

5.5 Handshake Lines

The GPIB uses three handshake lines in an "I'm ready—Here's the data—I've got it" sequence. This handshake protocol assures reliable data transfer, at the rate determined by the slowest Listener. One line is controlled by the Talker, while the other two are shared by all Active Listeners. The handshake lines, like the other IEEE 488 lines, are active low.

5.5.1 DATA VALID (DAV)

The DAV line is controlled by the Talker. The Talker verifies that NDAC is asserted (active low), which indicates that all Listeners have accepted the previous data byte transferred. The Talker then outputs data on the bus and waits until NRFD is unasserted (high), which indicates that all Addressed Listeners are ready to accept the information. When NRFD and NDAC are in the proper state, the Talker asserts DAV (active low) to indicate that the data on the bus is valid.

5.5.2 NOT READY FOR DATA (NRFD)

This line is used by the Listeners to inform the Talker when they are ready to accept new data. The Talker must wait for each Listener to unassert this line (high), which they will do at their own rate when they are ready for more data. This assures that all devices that are to accept the information are ready to receive it.

5.5.3 NOT DATA ACCEPTED (NDAC)

The NDAC line is also controlled by the Listeners. This line indicates to the Talker that each device addressed to listen has accepted the information. Each device releases NDAC (high) at its own rate, but the NDAC will not go high until the slowest Listener has accepted the data byte.

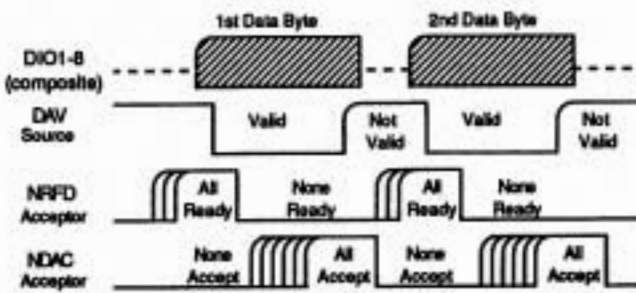


Figure 5-2. IEEE Bus Handshaking.

5.6 Data Lines

The GPIB provides eight data lines for a bit parallel/byte serial data transfer. These eight data lines use the convention of DIO1 through DIO8 instead of the binary designation of D0 to D7. The data lines are bidirectional and are active low.

5.7 Multiline Commands

Multiline (bus) commands are sent by the Active Controller over the data bus with ATN asserted. These commands include addressing commands for talk, listen, Untalk, and Unlisten.

5.7.1 Go To LOCAL (GTL)

This command allows the selected devices to be manually controlled. (IEEE 488 command code: \$01.)

5.7.2 LISTEN ADDRESS GROUP (LAG)

There are 31 (0 to 30) listen addresses associated with this group. The 3 most significant bits of the data bus are set to 001 while the 5 least significant bits are the address of the device being told to listen.

5.7.3 UNLISTEN (UNL)

This command tells all bus devices to Unlisten. This is the same as Unaddressed to Listen. (IEEE 488 command code: \$3F.)

5.7.4 TALK ADDRESS GROUP (TAG)

There are 31 (0 to 30) talk addresses associated with this group. The 3 most significant bits of the data bus are set to 010 while the 5 least significant bits are the address of the device being told to talk.

5.7.5 UNTALK (UNT)

This command tells bus devices to Untalk. This is the same as Unaddressed to Talk. (IEEE 488 command code: \$5F.)

5.7.6 LOCAL LOCKOUT (LLO)

Issuing the LLO command prevents manual control of the instrument's functions. (IEEE 488 command code: \$11.)

5.7.7 DEVICE CLEAR (DCL)

This command causes all bus devices to be initialized to a pre-defined or power-up state. (IEEE 488 command code: \$14.)

5.7.8 SELECTED DEVICE CLEAR (SDC)

This causes a single device to be initialized to a pre-defined or power-up state. (IEEE 488 command code: \$04.)

5.7.9 SERIAL POLL DISABLE (SPD)

The SPD command disables all devices from sending their Serial Poll status byte. (IEEE 488 command code: \$19.)

5.7.10 SERIAL POLL ENABLE (SPE)

A device which is Addressed to Talk will output its Serial Poll status byte after SPE is sent and ATN is unasserted. (IEEE 488 command code: \$18.)

5.7.11 GROUP EXECUTE TRIGGER (GET)

This command usually signals a group of devices to begin executing a triggered action. This allows actions of different devices to begin simultaneously. (IEEE 488 command code: \$08.)

5.7.12 TAKE CONTROL (TCT)

This command passes bus-control responsibilities from the current Controller to another device which has the ability to control. (IEEE 488 command code: \$09.)

5.7.13 SECONDARY COMMAND GROUP (SCG)

These are any one of the 32 possible commands (0 to 31) in this group. They must immediately follow a talk or listen address. (IEEE 488 command codes: \$60 to \$7F.)

5.7.14 PARALLEL POLL CONFIGURE (PPC)

This tells devices capable of performing a Parallel Poll which data bit they are to assert in response to a Parallel Poll. (IEEE 488 command code: \$05.)

5.7.15 PARALLEL POLL UNCONFIGURE (PPU)

This disables all devices from responding to a Parallel Poll. (IEEE 488 command code: \$15.)

5.8 More On Service Requests

Most of the commands covered, both uniline and multiline, are the responsibility of the Active Controller to send and the bus devices to recognize. Most of these are taken care of routinely by the interface and are totally transparent to the system programmer. Other commands are used directly by the user to provide optimum system control.

Of the uniline commands, SRQ (Service Request) is very important to the test system, so the software designer has easy access to this line from most devices. Service Request is the method by which a bus device can signal to the Controller that an event has occurred. It is similar to an interrupt in a microprocessor-based system.

Most intelligent bus peripherals have the ability to assert SRQ. A DMM might assert it when its measurement is complete, if its input is overloaded, or for any of an assortment of reasons. A power supply might assert SRQ if its output has current limited. This is a powerful bus feature that removes the burden from the System

Controller to periodically inquire, “Are you done yet?” Instead, the Controller says, “Do what I told you to do and let me know when you’re done,” or “Tell me when something is wrong.”

Since SRQ is a single-line command, there is no way for the Controller to determine which device requested the service without additional information. This information is provided by the multiline commands for Serial Poll and Parallel Poll.

5.8.1 SERIAL POLL

Suppose the Controller receives a service request. For this example, let’s assume there are several devices which could assert SRQ. The Controller issues an SPE (Serial Poll enable) command to each device sequentially. If any device responds with DIO7 asserted, it indicates to the Controller that it was the device that asserted SRQ. Often the other bits will indicate why the device wanted service. This Serial Polling sequence, and any resulting action, is under control of the software designer.

5.8.2 PARALLEL POLL

The Parallel Poll is another way the Controller can determine which device requested service. It provides the who but not necessarily the why. When bus devices are configured for Parallel Poll, they are assigned one bit on the data bus for their response. By using the Status bit, the logic level of the response can be programmed to allow logical OR/AND conditions on one data line by more than one device. When SRQ is asserted, the Controller (under user’s software) conducts a Parallel Poll. The Controller must then analyze the eight bits of data received to determine the source of the request. Once the source is determined, a Serial Poll might be used to determine the why.

Of the two polling types, the Serial Poll is the most popular due to its ability to determine the who and why. In addition, most devices support Serial Poll only.

6. Service Information

6.1 Theory of Operation

At the heart of the IEEE 488 Bus Extender is a 6809 microprocessor (U101) supported by 8 KB of firmware EPROM (U102 [2764]) and 8 KB of static RAM (U103 [6264]). A counter (U105 [65C22]) contained in the VIA generates real-time interrupts for the firmware operating system. The front-panel annunciators are driven by the VIA through an inverter/driver (U113 [74LS04]).

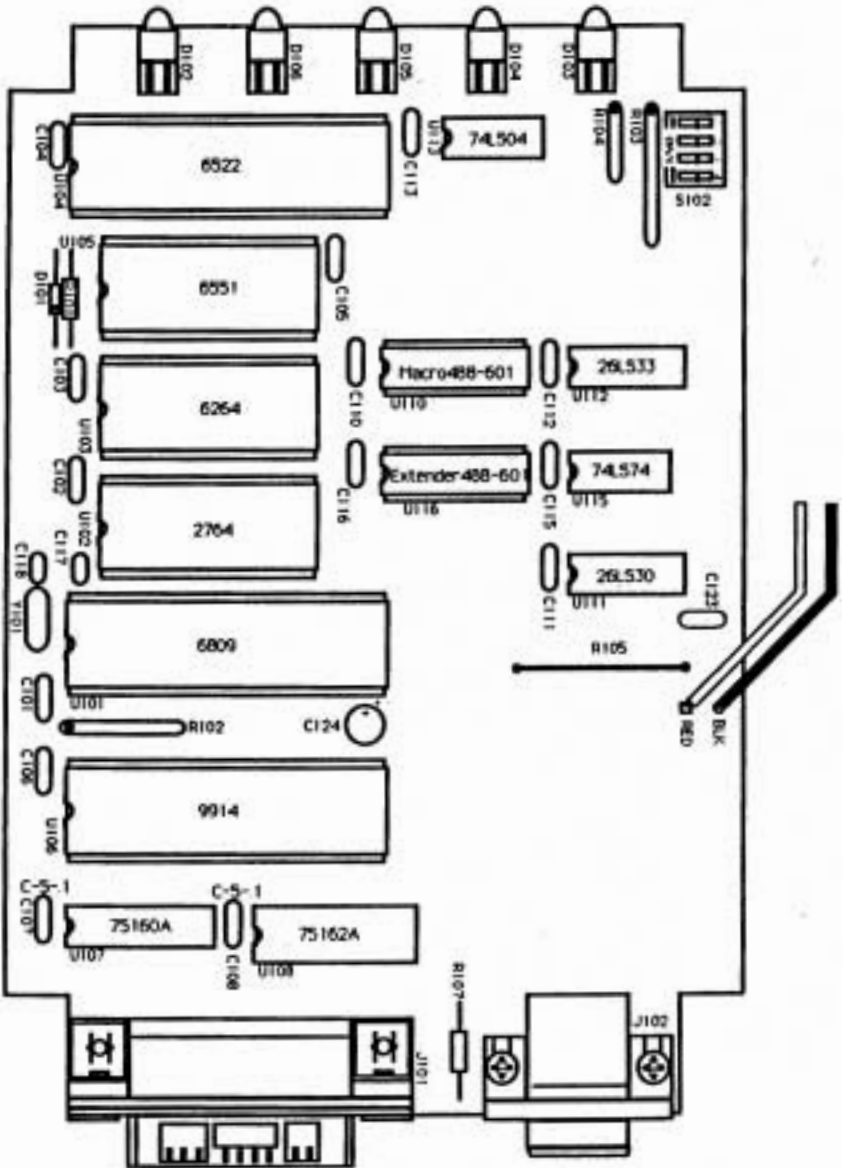
To achieve serial communication to the mating IEEE 488 Bus Extender, use a UART (U105) through the RS-422 receiver (U112) and driver (U111). For the IEEE 488 Bus Fiber Extender, use the UART and a fiberoptic transmitter (U202) and receiver (U203).

The IEEE 488 bus is monitored by a 9914A IEEE bus device (U106). Circuitry surrounding the 9914A (U115 and U116) enables the device to monitor all bus activity and to initiate bus activity when required.

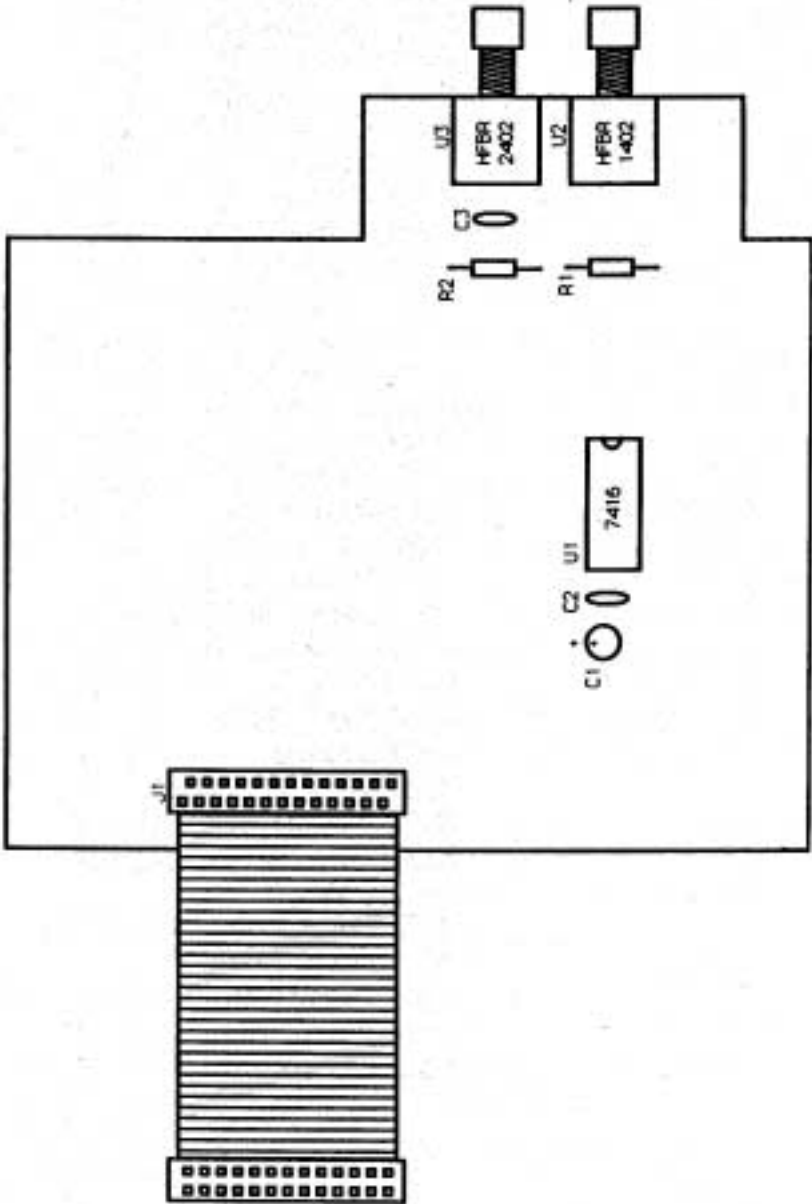
To decode the microprocessor address space, use a programmed PAL (U110 [16L8]). The memory-space allocation is shown below.

<u>Address</u>	<u>Device</u>	<u>Function</u>
\$6000-\$7FFF	U103	Static RAM
\$A000-\$A007	U106	IEEE Controller
\$A800-\$A803	U105	UART
\$B000-\$B00F	U104	VIA
\$E000-\$FFFF	U102	Programmed EPROM

6.2 IEEE 488 Bus Extender Board (IC095A)



6.3 IEEE 488 Fiber Bus Extender Board (IC096A)



6.4 Calling Black Box

If you determine that your Extender is malfunctioning, *do not attempt to alter* or repair the unit. It contains no user-serviceable parts. Contact Black Box Technical Support at 724-746-5500.

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

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

6.5 Shipping and Packaging

If you need to transport or ship your Extender:

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

Appendix: Character Codes and IEEE Multiline Messages

When reading this table, note that the codes listed in the upper-left corners are IEEE 488 command codes, the codes in the upper right corners are the ASCII representations, and the actual message is shown in the center of each block.

000	0	010	10	020	32	030	48	040	64	050	80	060	96	070	112
NUL	DLE		SP	0	@	P			P						
			00	04	08	0C	10	14	18	1C	20	24	28	2C	30
001	1	011	17	021	33	031	49	041	65	051	81	061	97	071	113
SOH	DC1	I	1	A	Q	a	q								
002	2	012	18	022	34	032	50	042	66	052	82	062	98	072	114
STX	DC2	*	2	B	R	b	r								
003	3	013	19	023	35	033	51	043	67	053	83	063	99	073	115
ETX	DC3	#	3	C	S	c	s								
004	4	014	20	024	36	034	52	044	68	054	84	064	100	074	116
EOT	DC4	\$	4	D	T	d	t								
005	5	015	21	025	37	035	53	045	69	055	85	065	101	075	117
ENQ	NAK	%	5	E	U	e	u								
006	6	016	22	026	38	036	54	046	70	056	86	066	102	076	118
ACK	SYN	&	6	F	V	f	v								
007	7	017	23	027	39	037	55	047	71	057	87	067	103	077	119
BEL	ETB	'	7	G	W	g	w								
008	8	018	24	028	40	038	56	048	72	058	88	068	104	078	120
BS	CAN	(	8	H	X	h	x								
009	9	019	25	029	41	039	57	049	73	059	89	069	105	079	121
HT	EM	)	9	I	Y	i	y								
010	10	01A	26	02A	42	03A	58	04A	74	05A	90	06A	106	07A	122
LF	SUB	*	:	J	Z	j	z								
011	11	01B	27	02B	43	03B	59	04B	75	05B	91	06B	107	07B	123
VT	ESC	+	;	K	[	k	[
012	12	01C	28	02C	44	03C	60	04C	76	05C	92	06C	108	07C	124
FF	FS	,	<	L	\	l	\								
013	13	01D	29	02D	45	03D	61	04D	77	05D	93	06D	109	07D	125
CR	GS	-	=	M	]	m]								
014	14	01E	30	02E	46	03E	62	04E	78	05E	94	06E	110	07E	126
SO	RS	.	>	N	^	n	^								
015	15	01F	31	02F	47	03F	63	04F	79	05F	95	06F	111	07F	127
SI	US	/	?	O	_	o	_								

ACG = Addressed Command Group
 UCG = Universal Command Group
 LAG = Local Address Group

TAG = Talk Address Group
 SCG = Secondary Command Group

NOTES

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