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# GPIB-130
## User Manual

**November 1993 Edition**

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A Return Material Authorization (RMA) number must be obtained from the factory and clearly marked on the outside of the package before any equipment will be accepted for warranty work. National Instruments will pay the shipping costs of returning to the owner parts which are covered by warranty.

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# FCC/DOC Radio Frequency Interference Compliance

This equipment generates and uses radio frequency energy and, if not installed and used in strict accordance with the instructions in this manual, may cause interference to radio and television reception. This equipment has been tested and found to comply with the following two regulatory agencies:

## Federal Communications Commission

This device complies with Part 15 of the Federal Communications Commission (FCC) Rules for a Class A digital device. Operation is subject to the following two conditions:

1. This device may not cause harmful interference in commercial environments.

2. This device must accept any interference received, including interference that may cause undesired operation.

## Canadian Department of Communications

This device complies with the limits for radio noise emissions from digital apparatus set out in the Radio Interference Regulations of the Canadian Department of Communications (DOC).

Le présent appareil numérique n'émiet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de classe A prescrites dans le réglement sur le brouillage radioélectrique édicté par le ministére des communications du Canada.

## Instructions to Users

These regulations are designed to provide reasonable protection against harmful interference from the equipment to radio reception in commercial areas. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

There is no guarantee that interference will not occur in a particular installation. However, the chances of interference are much less if the equipment is installed and used according to this instruction manual.

If the equipment does cause interference to radio or television reception, which can be determined by turning the equipment on and off, one or more of the following suggestions may reduce or eliminate the problem.

- Operate the equipment and the receiver on different branches of your AC electrical system.
- Move the equipment away from the receiver with which it is interfering.
- Reorient or relocate the receiver's antenna.
- Be sure that the equipment is plugged into a grounded outlet and that the grounding has not been defeated with a cheater plug.

**Notice to user:** Changes or modifications not expressly approved by National Instruments could void the user's authority to operate the equipment under the FCC Rules.

If necessary, consult National Instruments or an experienced radio/television technician for additional suggestions. The following booklet prepared by the FCC may also be helpful: *How to Identify and Resolve Radio-TV Interference Problems.* This booklet is available from the U.S. Government Printing Office, Washington, DC 20402, Stock Number 004-000-00345-4.

# Contents

**About This Manual** ..... ix
Organization of This Manual ..... ix
Conventions Used in This Manual ..... ix
Related Documentation ..... x
Customer Communication ..... x

**Chapter 1**
**Introduction** ..... 1-1
Description of the GPIB-130 ..... 1-1
What Your Kit Should Contain ..... 1-3
Optional Equipment ..... 1-4
Unpacking Your GPIB-130 ..... 1-4

**Chapter 2**
**Connection** ..... 2-1
Connecting the GPIB-130 ..... 2-1
Connecting an External Power Supply ..... 2-2
Connecting to a Specially Configured GPIB Interface Board ..... 2-2
Connecting to Hewlett-Packard Controllers ..... 2-3

**Chapter 3**
**Configuration and Operation** ..... 3-1
Operating Modes ..... 3-1
Unbuffered Mode ..... 3-1
Buffered Mode ..... 3-1
Setting the Operating Mode ..... 3-2
Parallel Poll Response (PPR) Modes ..... 3-2
Stored PPR Mode (Approach 1) ..... 3-3
Immediate PPR Mode (Approach 2) ..... 3-3
Choosing the PPR Mode ..... 3-3
Setting the PPR Mode ..... 3-4
Operating the GPIB-130 System ..... 3-4
Power LED ..... 3-4
Link LED ..... 3-5
Talk LED ..... 3-5
Listen LED ..... 3-5

**Chapter 4**
**Theory of Operation** ..... 4-1
Power-On (PON) State ..... 4-1
System Controller Detection ..... 4-2
Controller-In-Charge Detection ..... 4-2
Source Handshake Detection ..... 4-2
Parallel Poll Detection ..... 4-2
FIFO Controller ..... 4-2

**Appendix A**
**Operation of the GPIB** ..... A-1
Types of Messages ..... A-1
Talkers, Listeners, and Controllers ..... A-1
The Controller-In-Charge and System Controller ..... A-2
GPIB Signals and Lines ..... A-2
Data Lines ..... A-2
Handshake Lines ..... A-2
Not Ready For Data (NRFD) ..... A-2
Not Data Accepted (NDAC) ..... A-3
Data Valid (DAV) ..... A-3
Interface Management Lines ..... A-3
Attention (ATN) ..... A-3
Interface Clear (IFC) ..... A-3
Remote Enable (REN) ..... A-3
Service Request (SRQ) ..... A-3
End Or Identify (EOI) ..... A-3
Physical and Electrical Characteristics ..... A-4
Configuration Requirements ..... A-7
Related Document ..... A-7

**Appendix B**
**Specifications** ..... B-1
System Configuration ..... B-1
Performance Characteristics ..... B-1
Operating Characteristics ..... B-2
Electrical Characteristics ..... B-2
Environmental Characteristics ..... B-2
Physical Characteristics ..... B-2

**Appendix C**
**Cable Assembly Wire List** ..... C-1

**Appendix D**
**Multiline Interface Messages** ..... D-1

**Appendix E**
**Customer Communication** ..... E-1

**Glossary** ..... Glossary-1

## Figures

Figure 1-1. The Model GPIB-130 Bus Extender....1-1
Figure 1-2. Typical GPIB-130 Extension System (Physical Configuration) ....1-2
Figure 1-3. Typical GPIB-130 Extension System (Logical Configuration)....1-2

Figure 2-1. GPIB-130 Side View ....2-1

Figure 3-1. Switch Setting for Operating Mode....3-2
Figure 3-2. Switch Setting for Parallel Poll Response (PPR) Mode ....3-4

Figure 4-1. GPIB-130 Block Diagram ....4-1

Figure A-1. GPIB Connector and the Signal Assignment....A-4
Figure A-2. Linear Configuration ....A-5
Figure A-3. Star Configuration ....A-6

## Table

Table C-1. Cable Assembly Wire List....C-1

# About This Manual

This manual describes how to use the National Instruments GPIB-130 bus extender.

## Organization of This Manual

This manual is organized as follows:

- Chapter 1, *Introduction*, contains a description of the GPIB-130, lists the contents of your GPIB-130 kit, lists optional equipment, and explains how to unpack the GPIB-130.
- Chapter 2, *Connection*, contains information for connecting your GPIB-130.
- Chapter 3, *Configuration and Operation*, describes how to configure and operate a GPIB-130 system.
- Chapter 4, *Theory of Operation*, describes how the GPIB-130 circuitry operates.
- Appendix A, *Operation of the GPIB*, describes GPIB terminology and protocol for users unfamiliar with the GPIB.
- Appendix B, *Specifications*, lists the specifications of the GPIB-130.
- Appendix C, *Cable Assembly Wire List*, contains the listing of wire connections for the GPIB-130 transmission cable.
- Appendix D, *Multiline Interface Messages*, contains an ASCII chart with a list of the corresponding GPIB messages and hex values.
- Appendix E, *Customer Communication*, contains forms for you to complete to facilitate communication with National Instruments concerning our products.
- The *Glossary* contains an alphabetical list and description of terms used in this manual, including abbreviations, acronyms, metric prefixes, mnemonics, and symbols.

## Conventions Used in This Manual

Throughout this manual, the following convention is used to distinguish elements of text:

| | |
|---|---|
| *italic* | Italic text denotes emphasis, a cross reference, or an introduction to a key concept. |

# Related Documentation

The following document contains information that you may find helpful as you read this manual:

- ANSI/IEEE Standard 488.1-1987, *IEEE Standard Digital Interface for Programmable Instrumentation*

# Customer Communication

National Instruments wants to receive your comments on our products and manuals. We are interested in the applications you develop with our products and we want to help if you have problems with them. To make it easy for you to contact us, this manual contains comment and configuration forms for to you complete. These forms are located in Appendix E, *Customer Communication*, at the end of this manual.

# Chapter 1
# Introduction

This chapter contains a description of the GPIB-130, lists the contents of your GPIB-130 kit, lists optional equipment, and explains how to unpack the GPIB-130.

The GPIB-130 is a high-speed bus extender with the following features:

- It extends the maximum GPIB cable length to 300 m.
- It expands the GPIB to interface up to 28 devices.
- It performs high-speed parallel transmissions, with rates up to 900 kbytes/sec.
- It has a switch to select buffered transfers for high performance or normal GPIB transfers with interlocked handshaking.
- It has a switch to select immediate parallel poll mode, for cable lengths of 60 m or less, or stored parallel poll mode, for longer distances.

## Description of the GPIB-130

The high-speed GPIB-130 bus extender (shown in Figure 1-1) is used in pairs with a special parallel data transmission cable to connect two separate GPIB (IEEE 488) bus systems in a functionally transparent manner.

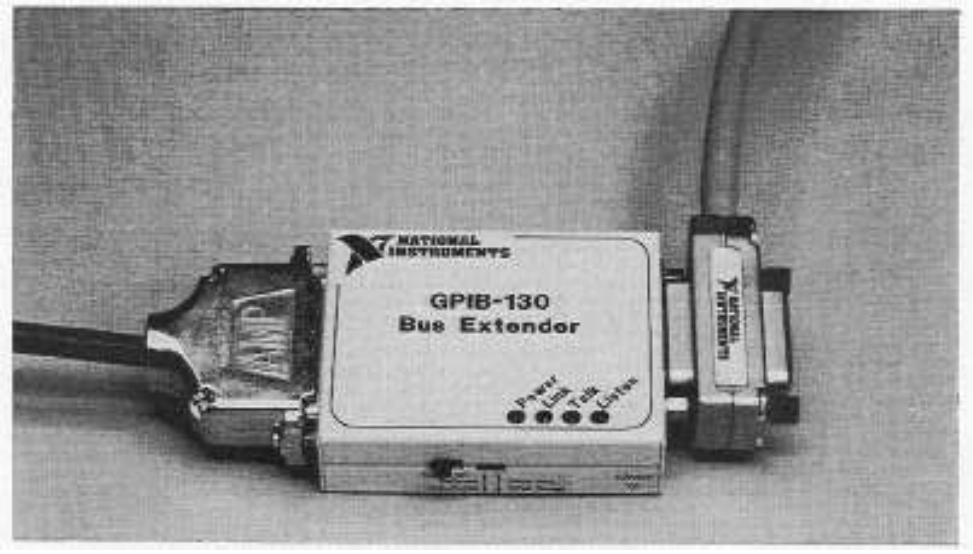



Figure 1-1. The Model GPIB-130 Bus Extender

While the two bus systems are physically separate, as shown in Figure 1-2, devices logically appear to be located on the same bus as shown in Figure 1-3.

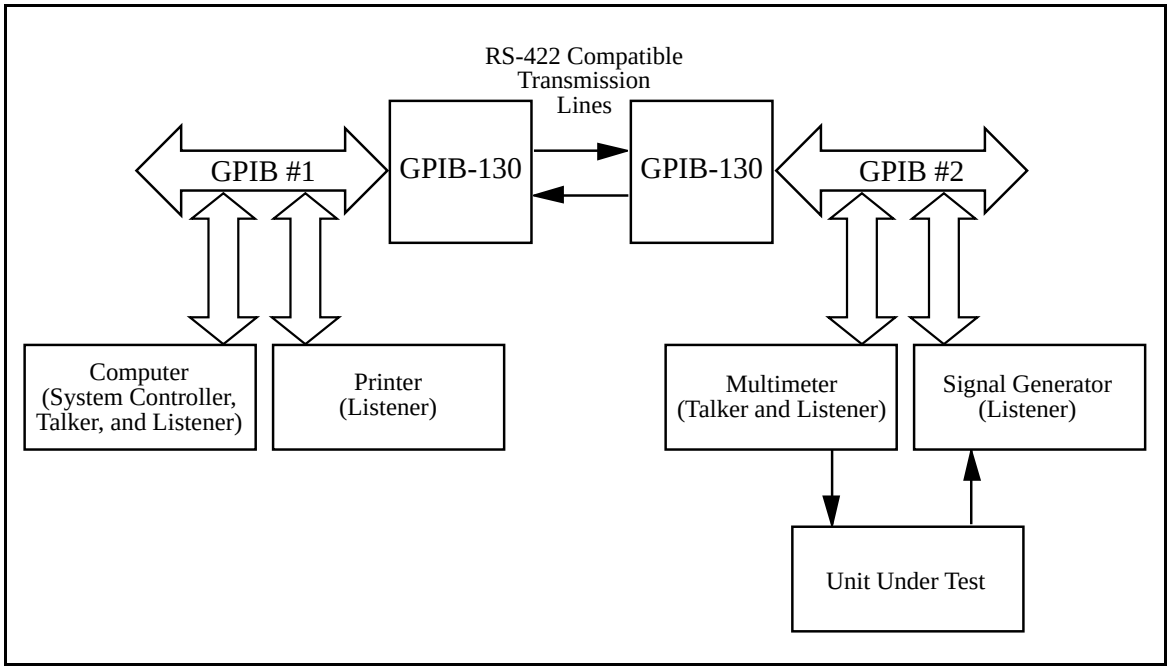



Figure 1-2. Typical GPIB-130 Extension System (Physical Configuration)

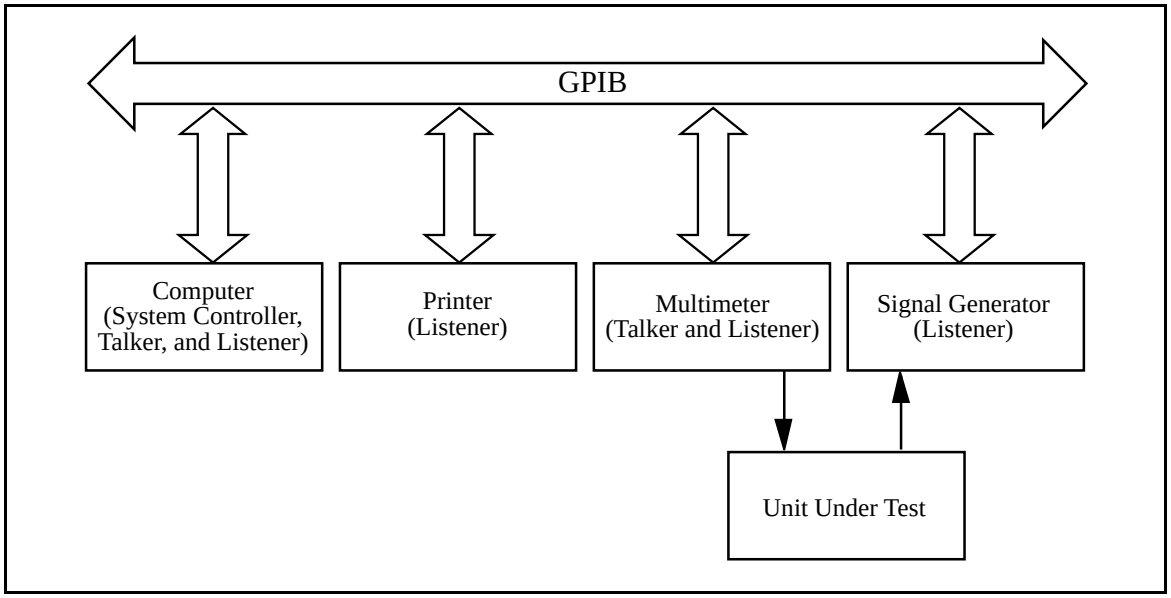



Figure 1-3. Typical GPIB-130 Extension System (Logical Configuration)

With the GPIB-130, it is possible to overcome the following two configuration restrictions imposed by ANSI/IEEE Standard 488.1-1987:

- A cable length limit of 20 m total per contiguous bus or 2 m times the number of devices on the bus, whichever is smaller

- An electrical loading limit of 15 devices per contiguous bus

Each GPIB-130 system extends the distance limit by 300 m and the loading limit to 30 devices (including the extenders), without sacrificing speed or performance. These point-to-point extender systems can be connected in series for longer distances or in star patterns for additional loading.

The maximum data transfer rate over the extension is 900 kbytes/sec. Furthermore, there is no speed degradation at all for transfers between devices on the same side of the extension. Because the GPIB-130 is a functionally transparent extender, the same GPIB communications and control programs that work with an unextended system can work unmodified with an extended system. There is one minor exception to this transparency in conducting parallel polls, as explained in Chapter 3 in the section *Parallel Poll Response (PPR) Modes.*

# What Your Kit Should Contain

Your GPIB-130 kit should contain the following components:

| Kit Component | Part Number |
|---|---|
| GPIB-130 Bus Extender | 181460-01 |
| One of the following power supplies:<br>• 100-120 VAC (5V-regulated, 700mA)<br>or<br>• 220-240 VAC (5V-regulated, 1A) | <br>181626-01<br><br>181626-31 |
| *GPIB-130 User Manual* | 320391-01 |

# Optional Equipment

| Equipment | Part Number |
|---|---|
| Transmission Cables:<br>• Type T5 (NEC CL2 rated) – up to 50 m<br>• Type T2 (NEC CL2 rated) – 0 m to 300 m<br>• Type T6 (NEC CL2P-Plenum rated) – 0 m to 300 m | (xxx = length in meters)<br>181563-xxx<br>178056-xxx<br>181564-xxx |
| Type X1 GPIB Cable (Single-Shielded)*:<br>• 1 m<br>• 2 m<br>• 4 m | <br>763001-01<br>763001-02<br>763001-03 |
| Type X2 GPIB Cable (Double-Shielded)*:<br>• 1 m<br>• 2 m<br>• 4 m | <br>763061-01<br>763061-02<br>763061-03 |
| * To meet FCC emission limits for this Class A device, you must use a shielded (Type X1 or X2) GPIB cable. Operating this equipment with a non-shielded cable may cause interference to radio and television reception in commercial areas. | |

# Unpacking Your GPIB-130

Follow these steps when unpacking your GPIB-130.

1. Verify that the pieces contained in the package you received match the kit parts list given earlier in this section.

2. Inspect the shipping container and contents for damage. If the container is damaged and the damage appears to have been caused in shipment, file a claim with the carrier. If the equipment is damaged, do not attempt to operate it. Contact National Instruments for instructions. Retain the shipping material for possible inspection by carrier or reshipment of the equipment.

# Chapter 2
# Connection

This chapter contains information for connecting your GPIB-130.

## Connecting the GPIB-130

Figure 2-1 shows a side view of the GPIB-130.




Figure 2-1. GPIB-130 Side View

The GPIB-130 may be powered on from either an external 5V regulated power supply or from a specially configured National Instruments GPIB interface board.

## Connecting an External Power Supply

**Caution**: Not for installation in air ducts or plenums. For installation in other environmental air handling spaces, use only with cable classified by U.L. Inc. as to fire and smoke characteristics in accordance with section 725.2(B) of the National Electrical Code.

To connect an external power supply to the GPIB-130, complete the following steps.

**Caution:** Failure to follow these steps for installation may result in damage to your GPIB-130 and your system.

1. Make sure that the power switch on the side panel is in the *off* position.
2. Inspect the power supply to confirm that it is compatible with the line voltage available from the wall outlet.
3. Push the phono-jack connector of the external power supply into the 5VDC jack of the GPIB-130.
4. Turn the phono-jack connector so that it screws into the threading on the 5VDC jack.
5. Plug the power supply into the wall outlet.
6. Connect the transmission cable to both GPIB-130s.
7. Slide the power switch of both extenders to the *on* position.

The GPIB-130 extension is now operational.

## Connecting to a Specially Configured GPIB Interface Board

To connect the GPIB-130 to a specially equipped National Instruments GPIB interface board, complete the following steps.

**Caution:** Failure to follow these steps for installation may result in damage to your GPIB-130 and your system.

1. Make sure that the power switch on the side panel is in the *off* position.
2. Turn off the computer containing the interface board.
3. Unplug the power cord of the computer.
4. Push either phono-jack connector of the special power cord into the 5VDC jack of the GPIB-130.
5. Turn the phono-jack connector so that it screws into the threading on the 5VDC jack on the GPIB-130.

6. Push the other phono-jack connector of the special power cord into the 5VDC jack of the National Instruments interface board.

7. Turn the phono-jack connector so that it screws into the threading on the 5VDC jack on the interface board.

8. Plug in the power cord of the computer and turn on the computer.

9. Connect the transmission cable to both GPIB-130s.

10. Slide the power switch of both extenders to the *on* position.

The GPIB-130 extension is now operational.

## Connecting to Hewlett-Packard Controllers

To achieve very high data transfer rates and long cable spans between devices, many HP Controllers and computers, such as the 64000 series, use a *preload* technique on the unit designated Master Controller. When preloaded, the GPIB lines of the Master Controller are terminated to represent six device loads. HP has two types of preloading: Class A, in which all 16 GPIB lines are loaded, and Class B, in which all lines, except NRFD and NDAC lines, are loaded.

Preloading increases ringing on signal transitions and can cause improper operation of the GPIB-130s. If this happens, set all signals on the Master Controller to normal (1 unit) load. This is done using a back panel switch on your HP Controller. In addition, you must also strictly conform to the cabling rule of no more than two meters per device.

# Chapter 3
# Configuration and Operation

This chapter describes how to configure and operate a GPIB-130 system.

## Operating Modes

The GPIB-130 has two operating modes: *Unbuffered* mode and *Buffered* mode. The operating mode determines how data is transmitted across the extension. Both units in the extension system must be set to the same mode.

### Unbuffered Mode

In Unbuffered mode, each data byte is transmitted using the GPIB double interlocked handshaking protocol. For long data streams, transfers using Unbuffered mode are slower than transfers using Buffered mode. However, the GPIB extension is transparent in Unbuffered mode.

### Buffered Mode

In Buffered mode, the GPIB-130 uses FIFOs to buffer data between the remote and local units. For long data streams, you can obtain a much higher data throughput with Buffered mode than with Unbuffered mode.

Consider the following situation: a GPIB device on the local side of the extension is addressed to talk; another device on the remote side is addressed to listen. When the talking device sources data bytes, the GPIB-130s accept the data bytes and store them in a FIFO. At the same time, the GPIB-130s read data from the FIFO and source data bytes to the Listener. Whenever the FIFO contains data, the number of bytes sourced by the Talker differs from the number of bytes accepted by the Listener. A few applications may not operate properly in Buffered mode.

GPIB command bytes are not stored in the FIFOs; they are transmitted using the GPIB double interlocked handshaking protocol.

In most applications, the GPIB-130s should be configured in Buffered mode.

## Setting the Operating Mode

Both GPIB-130s in the extension system must be set to the same operating mode. Use switch position 1 on the side of each GPIB-130 to set the operating mode. Slide the switch to the up position to set Buffered mode; slide the switch down to set Unbuffered mode. See Figure 3-1.

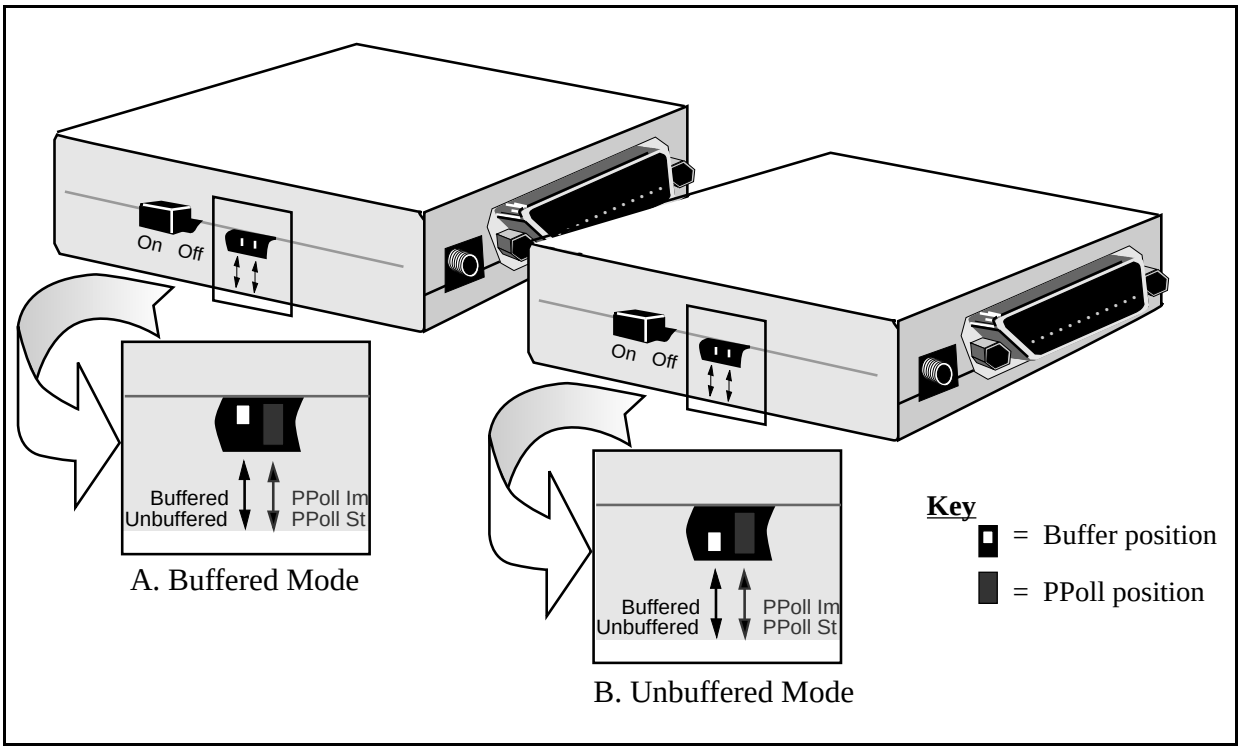



Figure 3-1. Switch Setting for Operating Mode

# Parallel Poll Response (PPR) Modes

According to ANSI/IEEE Standard 488.1-1987, devices must respond to a parallel poll within 200 nsec after the Identify (IDY) message (Attention (ATN) and End Or Identify (EOI)) is asserted by the Controller-In-Charge (CIC). The Controller then waits at least 2 µsec before reading the Parallel Poll Response (PPR). In many cases, a remote device on an extended system cannot respond to Parallel Polls this quickly because of cable propagation delays. The GPIB-130s can solve this problem using one of the following two approaches:

Approach 1: Respond to IDY within 200 nsec with the results of the previous poll of the remote bus.

Approach 2: Ignore the 200 nsec rule and assume that the Controller will wait long enough to capture the response.

## Stored PPR Mode (Approach 1)

In the stored PPR mode, the GPIB-130s use an internal PPR data register. When a Controller on the local GPIB system asserts IDY, the local GPIB-130 extender responds by outputting the contents of the PPR data register to the local GPIB data lines. At the same time, a parallel poll message is sent to the remote bus. When the local IDY signal is unasserted, the PPR from the remote system is loaded into the internal PPR data register. Consequently, the register always contains the response of the previous complete poll. To obtain the response of both local and remote GPIB systems, the control program executes two parallel polls back-to-back and uses the second response.

The software driver library of most Controllers contains an easy-to-use parallel poll function. If, for example, the function is called `ibrpp` and the control program is written in BASIC, the sequence to conduct a poll in Stored PPR mode might be similar to the following sequence:

```
.
.
.
CALL ibrpp (brd0%, ppr%)
CALL ibrpp (brd0%, ppr%)
IF ppr > 0 GOTO 300
.
.
.
```

## Immediate PPR Mode (Approach 2)

In this mode, the GPIB-130s do not use the internal PPR data register. When a Controller on the local GPIB system asserts IDY, the local GPIB-130 extender sends the IDY message to the remote bus and the response is returned as fast as propagation delays permit. The Controller must allow time to receive the response.

## Choosing the PPR Mode

Choosing the right PPR depends on the type of Controllers present in the GPIB system and the length of cable between the GPIB-130s. Of course, if the control program does not use parallel polls, the PPR mode does not matter.

Many Hewlett-Packard GPIB Controllers remain in a parallel poll state with IDY asserted whenever they are not performing another function. A change in the response causes an interrupt of the control program. In other Controllers, the IDY signal is toggled on and off and the duration of the signal can be varied to accommodate delayed responses over extenders. When used with these types of Controllers, the GPIB-130 should be set to Immediate PPR mode.

Most other Controllers pulse the IDY signal for about 2 µsec and expect a response within that time. When used with this type of Controller, the GPIB-130 should use the Stored PPR mode if the cable between the extenders is longer than about 60 m. For shorter cable distances, using the Immediate PPR mode is recommended.

Both GPIB-130s in the extension system do not need to be set to the same PPR mode. The PPR mode of the local GPIB-130 should be chosen to accommodate the Controllers on the local GPIB system. Likewise, the PPR mode of the remote GPIB-130 should be chosen to accommodate the Controllers on the remote GPIB system. If no Controllers are physically connected to one of the GPIB-130s, the PPR mode of that GPIB-130 has no effect on the system.

### Setting the PPR Mode

Use switch position 2 on the side of each GPIB-130 to set the PPR mode. Slide the switch to the up position to set Immediate PPR mode; slide the switch down to set Stored PPR mode. See Figure 3-2.

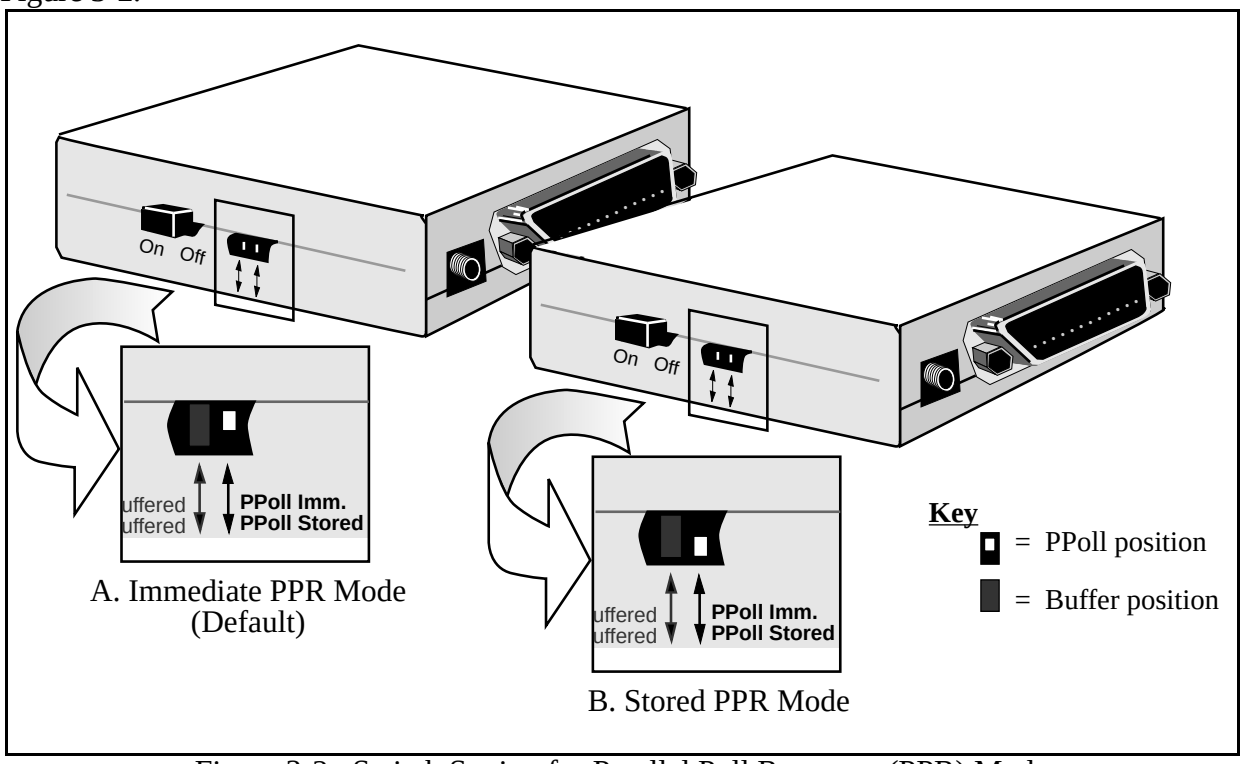



Figure 3-2. Switch Setting for Parallel Poll Response (PPR) Mode

# Operating the GPIB-130 System

The GPIB-130 extension system is fully operational when power is applied to both units. In some systems, it is necessary to power on the System Controller device last, after the extenders and all other devices are operating. This power-on sequence is necessary if the System Controller executes only one IFC shortly after power-on.

The GPIB-130 has four indicator LEDs on the top of the box labeled *Power*, *Link*, *Talk*, and *Listen.*

### Power LED

The Power LED is lit whenever power is applied to the GPIB-130 and the power switch on the side of the box is in the *on* position.

## Link LED

The Link LED is lit whenever both GPIB-130s are powered on and the transmission cable is properly connected to both extenders. During operation, the Link LED turns off if the cable is disconnected from either end of the extension, or if either GPIB-130 is powered off.

## Talk LED

The Talk LED is lit whenever a device on the local GPIB system is identified as a Talker, or if a Controller on the local GPIB system is actively asserting the ATN message. Whenever the Talk LED of the *local* GPIB-130 is lit, the Listen LED of the *remote* GPIB-130 is lit.

## Listen LED

The Listen LED is lit whenever a device on the remote GPIB system is identified as a Talker, or if a Controller on the remote GPIB system is actively asserting the ATN message. Whenever the Listen LED of the *local* GPIB-130 is lit, the Talk LED of the *remote* GPIB-130 is lit.

# Chapter 4
# Theory of Operation

This chapter describes how the GPIB-130 circuitry operates. This chapter assumes that you have a basic knowledge of the GPIB. If you are a first-time user or you would like to review the basics, refer to Appendix A, *Operation of the GPIB*, for a history and the basic operation of the GPIB.

Figure 4-1 shows a block diagram of the GPIB-130.

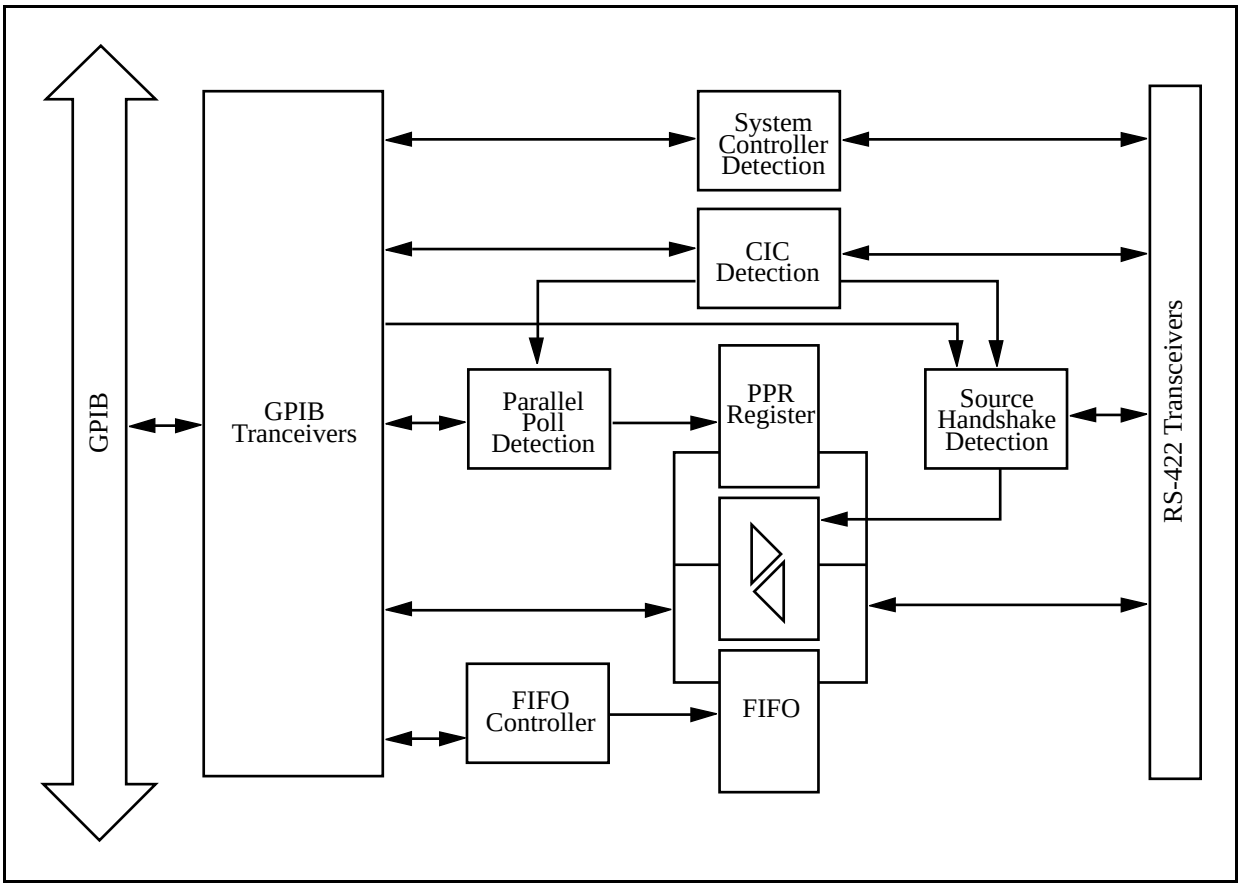



Figure 4-1. GPIB-130 Block Diagram

## Power-On (PON) State

The GPIB-130s enter the Power-On (PON) state when you first turn them on. The GPIB-130s remain in the PON state until the transmission cable is properly connected to both GPIB-130s. In the PON state, all state machines and FIFOs are cleared. No GPIB lines are asserted by the GPIB-130 in the PON state.

When the GPIB-130s leave the PON state, the Link LED turns on and the extension system becomes operational.

# System Controller Detection

The System Controller Detection circuitry locates the GPIB System Controller if one is present in the system. The System Controller may be on either the local side or the remote side of the GPIB-130 extension.

The ANSI/IEEE Standard 488.1-1987 restricts a GPIB system to having only one System Controller. However, the GPIB-130s work in systems that have more than one System Controller. A GPIB device should assert the Interface Clear (IFC) message to become the System Controller.

# Controller-In-Charge Detection

The Controller-In-Charge (CIC) Detection circuitry locates the GPIB Controller-In-Charge if one is present in the system. The GPIB Controllers may be on the local side, the remote side, or both sides of the GPIB-130 extension. Devices on one side of the extension system may pass control or take control from devices on the remote side of the extension.

# Source Handshake Detection

The Source Handshake Detection circuitry locates the device sourcing GPIB command or data bytes. Command bytes may be sourced by the CIC; data bytes may be sourced by the addressed GPIB Talker.

One or more devices in the system may be addressed as GPIB Listeners. Listeners may be on the same side, the opposite side, or both sides of the GPIB-130 extension.

# Parallel Poll Detection

The Parallel Poll Detection circuitry determines when the CIC is conducting a parallel poll. The GPIB-130 responds to parallel polls according to the Parallel Poll Response (PPR) mode chosen by the position of switch 2 (see the *Parallel Poll Response (PPR) Modes* section in Chapter 3).

Devices on both sides of the extension may respond to parallel polls.

# FIFO Controller

The FIFO Controller manages data flow into and out of the GPIB-130's FIFO. For long data streams, you can obtain a much higher data throughput with Buffered mode than with Unbuffered mode. The FIFO Controller remains inactive unless a device is sourcing data bytes *and* the GPIB-130 is configured to be in Buffered mode. See the *Operating Modes* section in Chapter 3.

Each GPIB-130 contains a FIFO and the FIFO Controller circuitry, so GPIB Talkers on both sides of the extension can use Buffered mode.

# Appendix A
# Operation of the GPIB

Communication among interconnected GPIB devices is achieved by passing messages through the interface system.

## Types of Messages

The GPIB carries device-dependent messages and interface messages.

- Device-dependent messages, often called *data* or *data messages*, contain device-specific information such as programming instructions, measurement results, machine status, and data files.

- Interface messages manage the bus itself. They are usually called *commands* or *command messages*. Interface messages perform such tasks as initializing the bus, addressing and unaddressing devices, and setting device modes for remote or local programming.

The term *command* as used here should not be confused with some device instructions which can also be called commands. Such device-specific instructions are actually data messages.

## Talkers, Listeners, and Controllers

A Talker sends data messages to one or more Listeners. The Controller manages the flow of information on the GPIB by sending commands to all devices.

Devices can be Listeners, Talkers, and/or Controllers. A digital voltmeter, for example, is a Talker and may be a Listener as well.

The GPIB is a bus like an ordinary computer bus, except that the computer has its circuit cards interconnected via a backplane bus, whereas the GPIB has standalone devices interconnected via a cable bus.

The role of the GPIB Controller can also be compared to the role of the CPU of a computer, but a better analogy is to the switching center of a city telephone system. The switching center (Controller) monitors the communications network (GPIB). When the center (Controller) notices that a party (device) wants to make a call (send a data message), it connects the caller (Talker) to the receiver (Listener).

The Controller addresses a Talker and a Listener before the Talker can send its message to the Listener. After the message is transmitted, the Controller may unaddress both devices.

Some bus configurations do not require a Controller. For example, one device may always be a Talker (called a Talk-only device) and there may be one or more Listen-only devices.

A Controller is necessary when the active or addressed Talker or Listener must be changed. The Controller function is usually handled by a computer.

With the GPIB interface board and its software your personal computer plays all three roles.

- Controller - to manage the GPIB
- Talker - to send data
- Listener - to receive data

# The Controller-In-Charge and System Controller

Although there can be multiple Controllers on the GPIB, only one Controller at a time is active or Controller-In-Charge (CIC). Active control can be passed from the current CIC to an idle Controller. Only one device on the bus, the System Controller, can make itself the CIC. The GPIB interface board is usually the System Controller.

# GPIB Signals and Lines

The interface system consists of 16 signal lines and 8 ground return or shield drain lines.

The 16 signal lines are divided into the following three groups.

- Eight data lines
- Three handshake lines
- Five interface management lines

## Data Lines

The eight data lines, DIO1 through DIO8, carry both data and command messages. All commands and most data use the 7-bit ASCII or ISO code set, in which case the eighth bit, DIO8, is unused or used for parity.

## Handshake Lines

Three lines asynchronously control the transfer of message bytes among devices. The process is called a three-wire interlocked handshake, and it guarantees that message bytes on the data lines are sent and received without transmission error.

### Not Ready For Data (NRFD)

NRFD indicates when a device is ready or not ready to receive a message byte. The line is driven by all devices when receiving commands and by Listeners when receiving data messages.

### Not Data Accepted (NDAC)

NDAC indicates when a device has or has not accepted a message byte. The line is driven by all devices when receiving commands and by Listeners when receiving data messages.

### Data Valid (DAV)

DAV tells when the signals on the data lines are stable (valid) and can be accepted safely by devices. The Controller drives DAV when sending commands and the Talker drives it when sending data messages.

## Interface Management Lines

Five lines are used to manage the flow of information across the interface.

### Attention (ATN)

The Controller drives ATN true when it uses the data lines to send commands and false when it allows a Talker to send data messages.

### Interface Clear (IFC)

The System Controller drives the IFC line to initialize the bus and become CIC.

### Remote Enable (REN)

The System Controller drives the REN line, which is used to place devices in remote or local program mode.

### Service Request (SRQ)

Any device can drive the SRQ line to asynchronously request service from the Controller with the SRQ line.

### End Or Identify (EOI)

The EOI line has two purposes. The Talker uses the EOI line to mark the end of a message string. The Controller uses the EOI line to tell devices to identify their response in a parallel poll.

# Physical and Electrical Characteristics

Devices are usually connected with a cable assembly consisting of a shielded 24 conductor cable with both a plug and receptacle connector at each end. This design allows devices to be linked in either a linear or a star configuration, or a combination of the two. See Figures A-1, A-2, and A-3.

The standard connector is the Amphenol or Cinch Series 57 *Microribbon* or *Amp Champ* type. An adapter cable using a non-standard cable and/or connector is used for special interconnection applications.

The GPIB uses negative logic with standard TTL logic level. When DAV is true, for example, it is a TTL low level ( ≤ 0.8V), and when DAV is false, it is a TTL high level ( ≥ 2.0V).

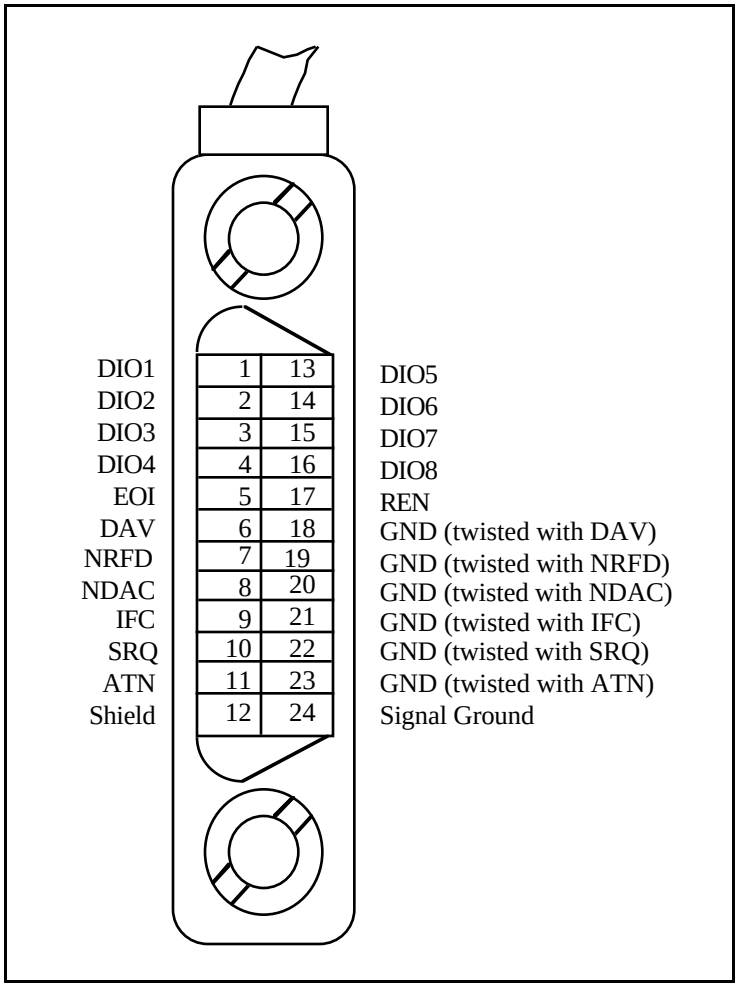



Figure A-1. GPIB Connector and the Signal Assignment

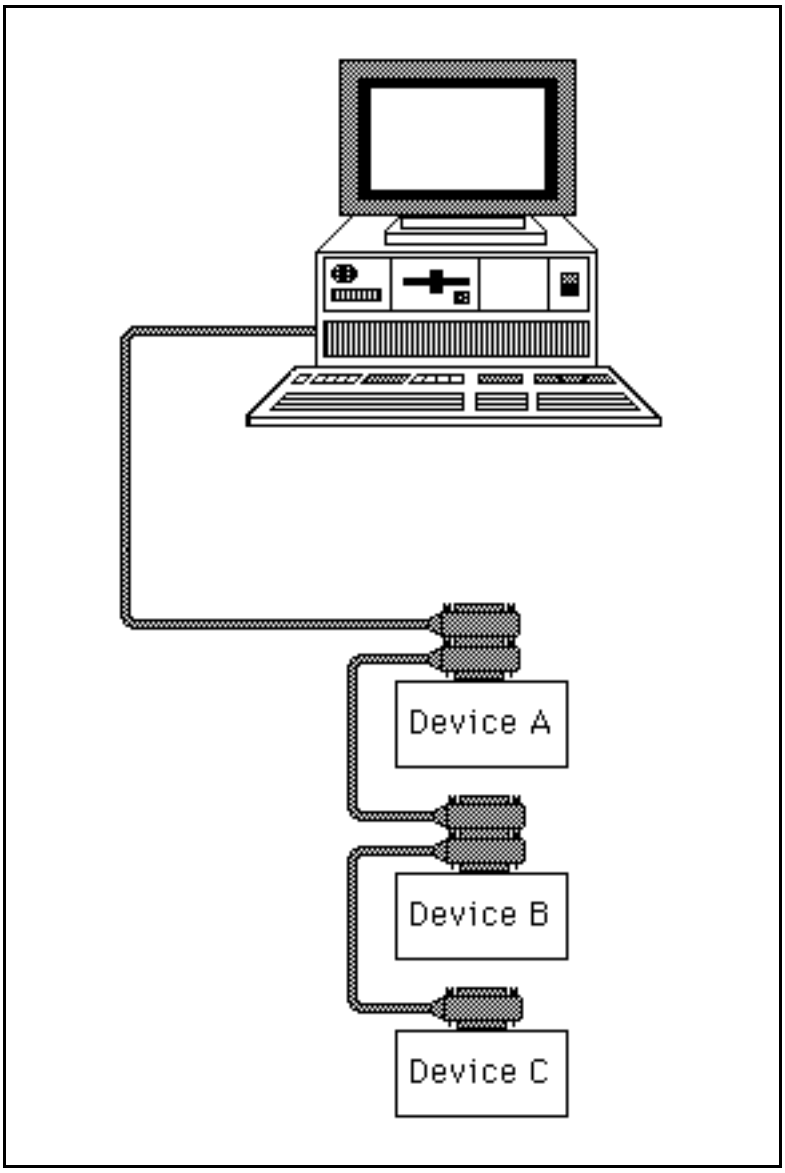



Figure A-2. Linear Configuration

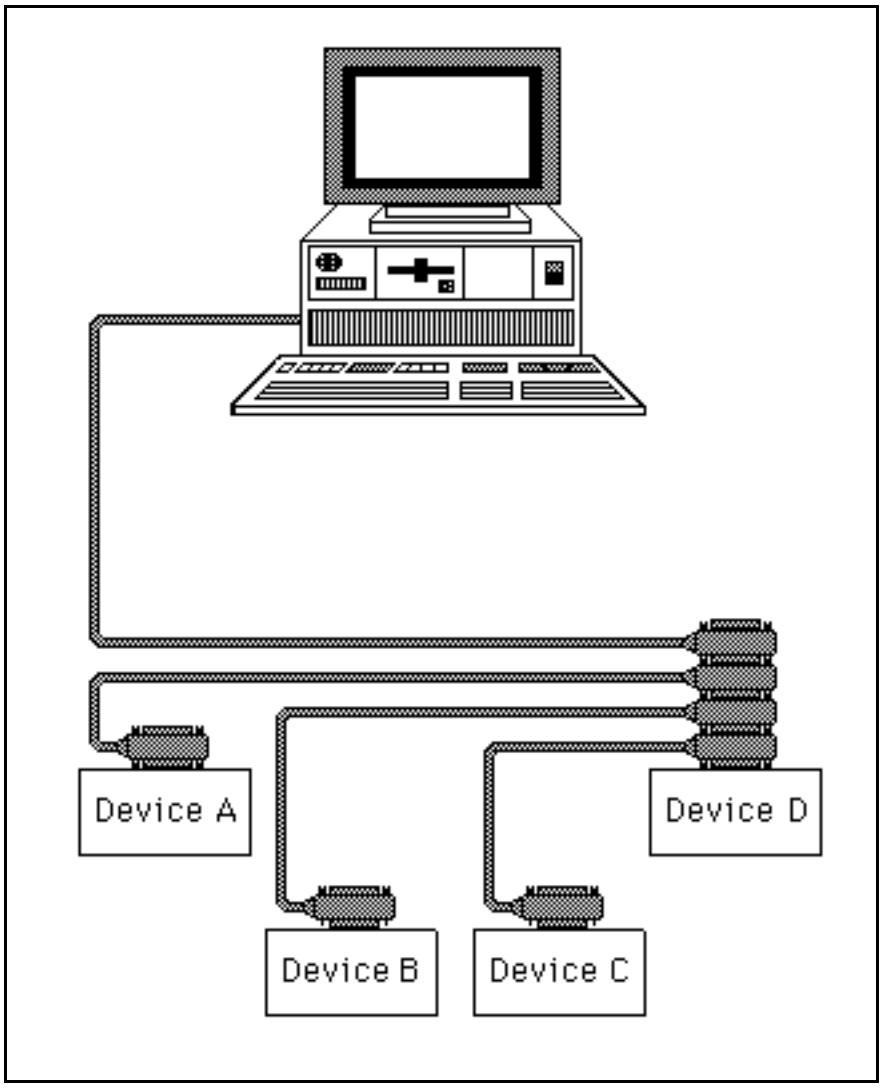



Figure A-3. Star Configuration

# Configuration Requirements

To achieve the high data transfer rate that the GPIB was designed for, the physical distance between devices and the number of devices on the bus are limited.

The following restrictions are typical.

- A maximum separation of four meters between any two devices and an average separation of two meters over the entire bus.
- A maximum total cable length of 20 m.
- No more than 15 devices connected to each bus, with at least two-thirds powered on.

Bus extenders are available from National Instruments for use when these limits must be exceeded.

# Related Document

For more information on topics covered in this section, consult ANSI/IEEE Standard 488.1-1987, *IEEE Standard Digital Interface for Programmable Instrumentation.*

# Appendix B
# Specifications

This appendix lists the specifications of the GPIB-130.

## System Configuration

| | |
|---|---|
| Distance per extension | up to 300 m |
| Loading per extension | up to 14 additional devices |
| Multiple extensions | permitted in any combination of star or linear pattern |
| GPIB driver output circuit and T1 timing of source device | no restrictions |

**Note**: T1 is the settling time (DIO valid to DAV) and varies according to the type of drivers and the system configuration used.

## Performance Characteristics

| | |
|---|---|
| Speed (buffered mode)* | 900 kbytes/sec maximum |
| Speed (unbuffered mode)* | |
| 5 m | 790 kbytes/sec maximum |
| 20 m | 640 kbytes/sec maximum |
| 50 m | 460 kbytes/sec maximum |
| 100 m | 315 kbytes/sec maximum |
| 300 m | 140 kbytes/sec maximum |
| Functionality | transparent GPIB operation except for stored parallel polls |
| Interlocked IEEE 488 handshake | maintained across the extension in Unbuffered mode |

| | | |
|---|---|---|
| IEEE 488 capability identification codes | SH1 | complete Source Handshake |
| | AH1 | complete Acceptor handshake |
| | T5, TE5 | complete Talker |
| | L3, LE3 | complete Listener |
| | SR1 | complete Service Request |
| | RL1 | complete Remote Local |
| | PP1,2 | complete Parallel Poll |
| | DC1 | complete Device Clear |
| | DT1 | complete Device Trigger |
| | C1-5 | complete Controller |
| | E2 | tri-state GPIB drivers |

* Maximum sustained transfer rates assuming 1 Mbytes/sec transfer rate without extenders.

# Operating Characteristics

| | |
|---|---|
| Architecture | point-to-point (not multi-drop) transmission |
| Operating modes | Buffered mode or Unbuffered (interlocked) mode |
| Parallel Poll Response modes | Immediate Parallel Poll Response mode or Stored Parallel Poll Response mode |

# Electrical Characteristics

| | |
|---|---|
| GPIB interface circuit | tri-state drivers (SN75ALS160, SN75ALS162) |
| Transmission interface circuit | RS-422 drivers and receivers connected with parallel data transmission cable |
| GPIB interface load | one standard load, AC and DC |
| Power | 2.2 W typical |

# Environmental Characteristics

| | |
|---|---|
| Operating temperature | $0^{o}$ to $55^{o}$ C |
| Humidity | 5% to 95% non-condensing conditions |
| FCC | Class A verified |

# Physical Characteristics

| | |
|---|---|
| Case dimensions | 3.75 x 3.0 x 0.95 in. (95 x 76 x 24 mm) |
| Case material | 0.050 in THK 5052-H32 Aluminum |
| Rack mounting | Contact factory for information |
| GPIB cable | IEEE 488 standard 24-pin |
| Transmission cables | NEC CL2 and CL2P (Plenum) rated cables available with AMP Amplimite connectors AMP HDP-20 50 pin connector with RFI/EMI shield |

# Appendix C
# Cable Assembly Wire List

This appendix contains the wire list for the GPIB-130 Transmission Cable.

Table C-1. Cable Assembly Wire List

| Connector P2A | | Cable | Connector P2B | |
|---|---|---|---|---|
| **Signature** | **Pin Number** | **Pair Number** | **Signature** | **Pin Number** |
| DIO1+<br>DIO1- | 44<br>43 | 1 | DIO1+<br>DIO1- | 44<br>43 |
| DIO2+<br>DIO2- | 34<br>41 | 2 | DIO2+<br>DIO2- | 34<br>41 |
| DIO3+<br>DIO3- | 48<br>47 | 3 | DIO3+<br>DIO3- | 48<br>47 |
| DIO4+<br>DIO4- | 36<br>39 | 4 | DIO4+<br>DIO4- | 36<br>39 |
| DIO5+<br>DIO5- | 42<br>18 | 5 | DIO5+<br>DIO5- | 42<br>18 |
| DIO6+<br>DIO6- | 45<br>46 | 6 | DIO6+<br>DIO6- | 45<br>46 |
| DIO7+<br>DIO7- | 40<br>35 | 7 | DIO7+<br>DIO7- | 40<br>35 |
| DIO8+<br>DIO8- | 37<br>38 | 8 | DIO8+<br>DIO8- | 37<br>38 |
| BUS SRQ+<br>BUS SRQ- | 30<br>32 | 9 | BUS SRQ+<br>BUS SRQ- | 30<br>32 |
| BUS REN+<br>BUS REN- | 14<br>15 | 10 | BUS REN+<br>BUS REN- | 14<br>15 |
| BUSPP+<br>BUSPP- | 16<br>17 | 11 | BUSPP+<br>BUSPP- | 16<br>17 |
| XIFC+<br>XIFC- | 29<br>12 | 12 | RIFC+<br>RIFC- | 31<br>33 |
| RIFC+<br>RIFC- | 31<br>33 | 13 | XIFC+<br>XIFC- | 29<br>12 |

(continues)

Table C-1. Cable Assembly Wire List (continued)

| Connector P2A | | Cable | Connector P2B | |
|---|---|---|---|---|
| **Signature** | **Pin Number** | **Pair Number** | **Signature** | **Pin Number** |
| XATN+<br>XATN- | 27<br>11 | 14 | RATN+<br>RATN- | 8<br>1 |
| XRFD+<br>XRFD- | 21<br>22 | 15 | RRFD+<br>RRFD- | 3<br>6 |
| RRFD+<br>RRFD- | 3<br>6 | 16 | XRFD+<br>XRFD- | 21<br>22 |
| BUSDAC+<br>BUSDAC- | 5<br>28 | 17 | BUSDAC+<br>BUSDAC- | 5<br>28 |
| XEOI+<br>XEOI- | 25<br>9 | 18 | REOI+<br>REOI- | 2<br>7 |
| REOI+<br>REOI- | 2<br>7 | 19 | XEOI+<br>XEOI- | 25<br>9 |
| XDAV+<br>XDAV- | 10<br>26 | 20 | RDAV+<br>RDAV- | 4<br>13 |
| RDAV+<br>RDAV- | 4<br>13 | 21 | XDAV+<br>XDAV- | 10<br>26 |
| XPON+<br>XPON- | 24<br>23 | 22 | RPON+<br>RPON- | 20<br>19 |
| RATN+<br>RATN- | 8<br>1 | 23 | XATN+<br>XATN- | 27<br>11 |
| RPON+<br>RPON- | 20<br>19 | 24 | XPON+<br>XPON- | 24<br>23 |
| SHIELD | 49<br>50 | | SHIELD | 49<br>50 |

# Appendix D
# Multiline Interface Messages

This section contains an interface message reference list, which describes the mnemonics and messages that correspond to the interface functions. These multiline interface messages are sent and received with ATN TRUE.

For more information on these messages, refer to the ANSI/IEEE Standard 488.1-1987, *IEEE Standard Digital Interface for Programmable Instrumentation.*

# Multiline Interface Messages

| Hex | Oct | Dec | ASCII | Msg | Hex | Oct | Dec | ASCII | Msg |
|---|---|---|---|---|---|---|---|---|---|
| 00 | 000 | 0 | NUL | | 20 | 040 | 32 | SP | MLA0 |
| 01 | 001 | 1 | SOH | GTL | 21 | 041 | 33 | ! | MLA1 |
| 02 | 002 | 2 | STX | | 22 | 042 | 34 | " | MLA2 |
| 03 | 003 | 3 | ETX | | 23 | 043 | 35 | # | MLA3 |
| 04 | 004 | 4 | EOT | SDC | 24 | 044 | 36 | $ | MLA4 |
| 05 | 005 | 5 | ENQ | PPC | 25 | 045 | 37 | % | MLA5 |
| 06 | 006 | 6 | ACK | | 26 | 046 | 38 | & | MLA6 |
| 07 | 007 | 7 | BEL | | 27 | 047 | 39 | ' | MLA7 |
| 08 | 010 | 8 | BS | GET | 28 | 050 | 40 | ( | MLA8 |
| 09 | 011 | 9 | HT | TCT | 29 | 051 | 41 | ) | MLA9 |
| 0A | 012 | 10 | LF | | 2A | 052 | 42 | * | MLA10 |
| 0B | 013 | 11 | VT | | 2B | 053 | 43 | + | MLA11 |
| 0C | 014 | 12 | FF | | 2C | 054 | 44 | , | MLA12 |
| 0D | 015 | 13 | CR | | 2D | 055 | 45 | - | MLA13 |
| 0E | 016 | 14 | SO | | 2E | 056 | 46 | . | MLA14 |
| 0F | 017 | 15 | SI | | 2F | 057 | 47 | / | MLA15 |
| 10 | 020 | 16 | DLE | | 30 | 060 | 48 | 0 | MLA16 |
| 11 | 021 | 17 | DC1 | LLO | 31 | 061 | 49 | 1 | MLA17 |
| 12 | 022 | 18 | DC2 | | 32 | 062 | 50 | 2 | MLA18 |
| 13 | 023 | 19 | DC3 | | 33 | 063 | 51 | 3 | MLA19 |
| 14 | 024 | 20 | DC4 | DCL | 34 | 064 | 52 | 4 | MLA20 |
| 15 | 025 | 21 | NAK | PPU | 35 | 065 | 53 | 5 | MLA21 |
| 16 | 026 | 22 | SYN | | 36 | 066 | 54 | 6 | MLA22 |
| 17 | 027 | 23 | ETB | | 37 | 067 | 55 | 7 | MLA23 |
| 18 | 030 | 24 | CAN | SPE | 38 | 070 | 56 | 8 | MLA24 |
| 19 | 031 | 25 | EM | SPD | 39 | 071 | 57 | 9 | MLA25 |
| 1A | 032 | 26 | SUB | | 3A | 072 | 58 | : | MLA26 |
| 1B | 033 | 27 | ESC | | 3B | 073 | 59 | ; | MLA27 |
| 1C | 034 | 28 | FS | | 3C | 074 | 60 | < | MLA28 |
| 1D | 035 | 29 | GS | | 3D | 075 | 61 | = | MLA29 |
| 1E | 036 | 30 | RS | | 3E | 076 | 62 | > | MLA30 |
| 1F | 037 | 31 | US | | 3F | 077 | 63 | ? | UNL |

## Message Definitions

| | |
|---|---|
| DCL | Device Clear |
| GET | Group Execute Trigger |
| GTL | Go To Local |
| LLO | Local Lockout |
| MLA | My Listen Address |
| MSA | My Secondary Address |
| MTA | My Talk Address |
| PPC | Parallel Poll Configure |
| PPD | Parallel Poll Disable |

# Multiline Interface Messages

| Hex | Oct | Dec | ASCII | Msg | Hex | Oct | Dec | ASCII | Msg |
|---|---|---|---|---|---|---|---|---|---|
| 40 | 100 | 64 | @ | MTA0 | 60 | 140 | 96 | ` | MSA0,PPE |
| 41 | 101 | 65 | A | MTA1 | 61 | 141 | 97 | a | MSA1,PPE |
| 42 | 102 | 66 | B | MTA2 | 62 | 142 | 98 | b | MSA2,PPE |
| 43 | 103 | 67 | C | MTA3 | 63 | 143 | 99 | c | MSA3,PPE |
| 44 | 104 | 68 | D | MTA4 | 64 | 144 | 100 | d | MSA4,PPE |
| 45 | 105 | 69 | E | MTA5 | 65 | 145 | 101 | e | MSA5,PPE |
| 46 | 106 | 70 | F | MTA6 | 66 | 146 | 102 | f | MSA6,PPE |
| 47 | 107 | 71 | G | MTA7 | 67 | 147 | 103 | g | MSA7,PPE |
| 48 | 110 | 72 | H | MTA8 | 68 | 150 | 104 | h | MSA8,PPE |
| 49 | 111 | 73 | I | MTA9 | 69 | 151 | 105 | i | MSA9,PPE |
| 4A | 112 | 74 | J | MTA10 | 6A | 152 | 106 | j | MSA10,PPE |
| 4B | 113 | 75 | K | MTA11 | 6B | 153 | 107 | k | MSA11,PPE |
| 4C | 114 | 76 | L | MTA12 | 6C | 154 | 108 | l | MSA12,PPE |
| 4D | 115 | 77 | M | MTA13 | 6D | 155 | 109 | m | MSA13,PPE |
| 4E | 116 | 78 | N | MTA14 | 6E | 156 | 110 | n | MSA14,PPE |
| 4F | 117 | 79 | O | MTA15 | 6F | 157 | 111 | o | MSA15,PPE |
| 50 | 120 | 80 | P | MTA16 | 70 | 160 | 112 | p | MSA16,PPD |
| 51 | 121 | 81 | Q | MTA17 | 71 | 161 | 113 | q | MSA17,PPD |
| 52 | 122 | 82 | R | MTA18 | 72 | 162 | 114 | r | MSA18,PPD |
| 53 | 123 | 83 | S | MTA19 | 73 | 163 | 115 | s | MSA19,PPD |
| 54 | 124 | 84 | T | MTA20 | 74 | 164 | 116 | t | MSA20,PPD |
| 55 | 125 | 85 | U | MTA21 | 75 | 165 | 117 | u | MSA21,PPD |
| 56 | 126 | 86 | V | MTA22 | 76 | 166 | 118 | v | MSA22,PPD |
| 57 | 127 | 87 | W | MTA23 | 77 | 167 | 119 | w | MSA23,PPD |
| 58 | 130 | 88 | X | MTA24 | 78 | 170 | 120 | x | MSA24,PPD |
| 59 | 131 | 89 | Y | MTA25 | 79 | 171 | 121 | y | MSA25,PPD |
| 5A | 132 | 90 | Z | MTA26 | 7A | 172 | 122 | z | MSA26,PPD |
| 5B | 133 | 91 | [ | MTA27 | 7B | 173 | 123 | { | MSA27,PPD |
| 5C | 134 | 92 | \ | MTA28 | 7C | 174 | 124 | \| | MSA28,PPD |
| 5D | 135 | 93 | ] | MTA29 | 7D | 175 | 125 | } | MSA29,PPD |
| 5E | 136 | 94 | ^ | MTA30 | 7E | 176 | 126 | ~ | MSA30,PPD |
| 5F | 137 | 95 | _ | UNT | 7F | 177 | 127 | DEL | |

| | | | |
|---|---|---|---|
| PPE | Parallel Poll Enable | SPE | Serial Poll Enable |
| PPU | Parallel Poll Unconfigure | TCT | Take Control |
| SDC | Selected Device Clear | UNL | Unlisten |
| SPD | Serial Poll Disable | UNT | Untalk |

# Appendix E
# Customer Communication

---

For your convenience, this appendix contains forms to help you gather the information necessary to help us solve technical problems you might have as well as a form you can use to comment on the product documentation. Filling out a copy of the *Technical Support Form* before contacting National Instruments helps us help you better and faster.

National Instruments provides comprehensive technical assistance around the world. In the U.S. and Canada, applications engineers are available Monday through Friday from 8:00 a.m. to 6:00 p.m. (central time). In other countries, contact the nearest branch office. You may fax questions to us at any time.

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Technical support fax: (800) 328-2203
(512) 794-5678

| **Branch Offices** | **Phone Number** | **Fax Number** |
|---|---|---|
| Australia | (03) 879 9422 | (03) 879 9179 |
| Austria | (0662) 435986 | (0662) 437010-19 |
| Belgium | 02/757.00.20 | 02/757.03.11 |
| Denmark | 45 76 26 00 | 45 76 71 11 |
| Finland | (90) 527 2321 | (90) 502 2930 |
| France | (1) 48 14 24 00 | (1) 48 14 24 14 |
| Germany | 089/741 31 30 | 089/714 60 35 |
| Italy | 02/48301892 | 02/48301915 |
| Japan | (03) 3788-1921 | (03) 3788-1923 |
| Netherlands | 03480-33466 | 03480-30673 |
| Norway | 32-848400 | 32-848600 |
| Spain | (91) 640 0085 | (91) 640 0533 |
| Sweden | 08-730 49 70 | 08-730 43 70 |
| Switzerland | 056/20 51 51 | 056/27 00 25 |
| U.K. | 0635 523545 | 0635 523154 |

# Technical Support Form

Photocopy this form and update it each time you make changes to your software or hardware, and use the completed copy of this form as a reference for your current configuration. Completing this form accurately before contacting National Instruments for technical support helps our applications engineers answer your questions more efficiently.

If you are using any National Instruments hardware or software products related to this problem, include the configuration forms from their user manuals. Include additional pages if necessary.

Name _____

Company _____

Address _____

_____

Fax ( ___ ) _____ Phone ( ___ ) _____

Computer brand _____ Model _____ Processor _____

Operating system _____

Speed _____MHz RAM _____M Display adapter _____

Mouse _____yes _____no Other adapters installed _____

Hard disk capacity _____M Brand _____

Instruments used _____

National Instruments hardware product model _____ Revision _____

Configuration _____

National Instruments software product _____ Version _____

Configuration _____

The problem is _____

_____

_____

_____

_____

List any error messages _____

_____

_____

_____

The following steps will reproduce the problem _____

_____

_____

# GPIB-130 Hardware and Software Configuration Form

Record the settings and revisions of your hardware and software on the line to the right of each item. Complete a new copy of this form each time you revise your software or hardware configuration, and use this form as a reference for your current configuration. Completing this form accurately before contacting National Instruments for technical support helps our applications engineers answer your questions more efficiently.

## National Instruments Products

- GPIB-130 Revision _____
- Remote GPIB-130 Revision _____
- National Instruments GPIB Interface _____
- National Instruments Software _____

## Other Products

- Computer Make and Model _____
- Operating System Version _____
- Number of GPIB Devices on Bus _____
- Other Boards in System _____
- GPIB Devices in System _____

# Documentation Comment Form

National Instruments encourages you to comment on the documentation supplied with our products. This information helps us provide quality products to meet your needs.

Title: **GPIB-130 User Manual**

Edition Date: **November 1993**

Part Number: **370897A-01**

Please comment on the completeness, clarity, and organization of the manual.

If you find errors in the manual, please record the page numbers and describe the errors.

Thank you for your help.

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# Glossary

| Prefix | Meaning | Value |
|---|---|---|
| m-<br>μ-<br>n- | milli-<br>micro-<br>nano- | $10^{-3}$<br>$10^{-6}$<br>$10^{-9}$ |

| | |
|---|---|
| % | percent |
| ° | degrees |
| > | greater than |
| ≥ | greater than or equal to |
| < | less than |
| ≤ | less than or equal to |
| A | amperes |
| AC | alternating current |
| ANSI | American National Standards Institute |
| ASCII | American Standard Code for Information Interchange |
| ATN | Attention |
| C | Celsius |
| CIC | Controller-In-Charge |
| CPU | central processing unit |
| DAV | Data Valid |
| DC | direct current |
| DIO | Data Input/Output |
| EOI | End Or Identify |
| FCC | Federal Communications Commission |
| FIFO | first-in-first-out |
| GND | Ground |
| GPIB | General Purpose Interface Bus |
| IDY | Identify |
| IEEE | Institute of Electrical and Electronic Engineers |
| IFC | Interface Clear |
| ISO | International Standards Organization |
| kbytes | 1,000 bytes |
| LED | light-emitting diode |
| m | meters |
| M | megabytes of memory |
| NDAC | Not Data Accepted |
| NEC | National Electrical Code |
| NRFD | Not Ready For Data |
| oz. | ounces |
| PON | Power On |

| | |
|---|---|
| PP | Parallel Poll |
| PPR | Parallel Poll Response |
| REN | Remote Enable |
| sec | seconds |
| SRQ | Service Request |
| TTL | transistor-transistor logic |
| V | volts |
| VAC | volts alternating current |
| VDC | volts direct currect |
| W | watts |

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