ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Find the *Colby Instruments PDL-30A* at our website: *Click HERE*

Colby Instruments, Inc.

Precision Programmable Delay Lines

and Phase Shifters

Model PDL-30A

OPERATING AND PROGRAMMING MANUAL

VERSION 2.0
JULY 1997



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

CERTIFICATION

COLBY INSTRUMENTS, INC. guarantees that the PDL series of programmable delay lines meets all published specifications at the time the instruments are shipped from the manufacturer.
SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTIFICATION.

WARRANTY

The product is warranted against defects in material and workmanship for a period of one year from the date of shipment. During the warranty period, COLBY INSTRUMENTS, INC. (CII) will, at its option, either repair or replace products which prove to be defective.

EXCESSIVE WEAR OF CONNECTORS, THE TROMBONE UNIT, AND THE COAXIAL RELAYS, AND OTHER RELAYS CARRYING THE SIGNAL, ARE NOT COVERED BY THE WARRANTY.

THE FOREGOING WARRANTY SHALL NOT APPLY TO DEFECTS RESULTING FROM IMPROPER CARE OR USE OF THE INSTRUMENT BY THE BUYER. THIS SHALL APPLY TO ALL COMPONENTS DELIVERED TO THE BUYER.

For warranty service or repair, this product must be returned to CII. The Buyer shall prepay all shipping charges for the shipment to CII. CII shall pay the shipping charges to return the product to the Buyer. However, the Buyer shall be responsible for **ALL** shipping charges, duties and taxes for product returned to CII from outside the continental United States of America. **THE BUYER MUST OBTAIN A RETURN AUTHORIZATION NUMBER (RMA #) FROM CII BEFORE ANY PRODUCT CAN BE SENT BACK TO CII.**

No other warranty is expressed or implied. COLBY INSTRUMENTS, INC. specifically disclaims the implied warranties or merchantability and fitness for a particular purpose. The remedies provided herein are the Buyer's sole and exclusive remedies. CII shall not be liable for any direct or special, incidental or consequential damages, whether based on contract, tort, or any other legal theory.

General Shipping Information

Should you ever need to ship the complete instrument back to the manufacturer please make sure that all equipment is packaged properly. Use the original shipping container if possible and use cushioning material to prevent transportation damage. Such damage is **NOT** covered by CII. We suggest that you always insure shipments. Attach a tag to the unit identifying the owner and indicate the service or repair needed. Please provide us with a phone number to contact the person requesting the repair. Please obtain a RMA # from CII before sending any merchandise for service (in warranty or not).

Colby Instruments, Inc.
1810 14th Street
Santa Monica, CA 90404 USA
Ph: (310) 450-0261, FAX: (310) 452-0027

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

TABLE OF CONTENTS

GETTING STARTED QUICKLY

General Description 1-1

Fist-time Use of the Instrument 1-1
Power and Fuse Requirements 1-1
Front-Panel Connections 1-2

Manual Operation of the Delay Line with the Microterminal 1-3A

Picture of Microterminal and Layout of Keyboard Keys 1-3B

Operation through the GPIB Interface 1-4

Power up with a Microterminal 1-4
Setting the Delay with Microterminal 1-4
Monitoring the Instrument's Activity 1-4

Available Functions on the Microterminal 1-5

Function "1" (GPIB) 1-5
Function "2" (GPIB) 1-5

Technical Information 1-6

Delay Line Structure 1-6
Self Test 1-6

SPECIFICATIONS

ELECTRICAL: PDL-10A MODE TO 625 ps 2-1A
ELECTRICAL: PDL-30A MODE TO 10 ns 2-1B

IEEE 488.1,2 (GPIB) 2-2
Addressing 2-2
Interface Messages 2-2
Buffers and Queues 2-2
Overlapped Commands 2-2
Polling 2-2
Remote/Local Operation 2-2

Exceptions to the IEEE 488.2 Standard 2-2

Decimal Numeric Program Data (NRf) ANSI X3.42-1975 2-2

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

GPIB INTERFACE FUNCTIONS

Introduction 3-1

Interface capabilities 3-1

Addressing 3-1

Remote, Local and Local Lockout 3-2

LOCAL 3-2
REMOTE 3-2
LOCAL LOCKOUT 3-2
RETURNING TO LOCAL mode 3-2

Bus Commands 3-3

Single Line Commands 3-3
Multiline commands 3-3
Addressed (multiline) commands 3-3
Secondary commands 3-4

COMMUNICATION LANGUAGE

Introduction 4-1

System components 4-1

Protocol Overview 4-2

The dialogue 4-2

Protocol exceptions 4-2

Missing Listener(s) 4-2
Unterminated 4-2
Nothing to say 4-2
Interrupted 4-3
Deadlocked 4-3

SYNTAX 4-3

Basic Definitions and Elements 4-3

Device listening syntax 4-4

{program message} 4-4
{program message unit} 4-4
{program message unit separator} 4-5
{command program header} 4-5
{query program header} 4-7
{program data} 4-7
Suffix Multiplier 4-9
Suffix Units 4-10
Non-Decimal numeric data 4-10

Device talking syntax 4-11

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

{response message} 4-11
{response message unit} 4-12
{response data} 4-12

STATUS REPORTING **4-15**

Bit Definitions 4-16
Serial Poll 4-17
Parallel Poll 4-17
Programming the Parallel Poll Response 4-17

Common Commands

Introduction 5-1
Common Command Summary 5-1

*CAL?	(Calibration)	Query	5-2
*CLS	(Clear Status)	Command	5-2
*ESE	(Event Status Enable)	Command	5-2
*ESE?	(Event Status Enable)	Query	5-3
*ESR?	(Event Status Register)	Query	5-4
*IDN?	(Identification)	Query	5-4
*IST?	(Individual Status)	Query	5-5
*OPC	(Operation Complete)	Command	5-6
*OPC?	(Operation Complete)	Query	5-6
*PRE	(Parrallel Poll Enable Register)	Command	5-6
*PRE?	(Parrallel Poll Enable Register)	Query	5-7
*RST	(Reset)	Command	5-7
*SRE	(Service Request Enable)	Command	5-8
*SRE?	(Event Status Enable)	Query	5-8
*STB?	(Status Byte)	Query	5-9
*TST?	(Self Test)	Query	5-9
*WAI	(Wait)	Command	5-10

System Commands

Introduction 6-1
System Command Summary 6-1

DEL	(Delay)	Command	6-1
DEL?	(Delay)	Query	6-2
ERR?	(Error)	Query	6-2
MON	(Monitor)	Command	6-3
MON?	(Monitor)	Query	6-3

Programming Examples

For the Newcomer **7-1**

PDL 10A : Setting the mode 7-3

Appendix A - System and Error Messages

Hardware related **A-1**

IEEE488.1 related **A-1**

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

IEEE488.2 related **A-2**

Messages from ERR? Query **A-2**

Command errors: A-3
Execution errors: A-3
Device dependent errors: A-4
Summary of Error Codes A-4

Microterminal Specific **A-5**

Appendix B - Trouble Shooting

No power, Power Indicator Off B-1
No response on the GPIB B-1
Microterminal doesn't respond B-1
SELF TEST errors B-1
Can't change the mode B-1
Calibration Test B-1

Appendix C - Connectors and Addressing

Appendix D - Grounding

Appendix E - References and Reading List

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

1. GETTING STARTED QUICKLY

1.1. General Description

The PDL20A delay line features a variable delay of 10 ns with a resolution of 1 ps, or 0.5 ps if the special high-resolution stepper motor option is installed. The instrument is powered on via the round, orange push-button switch on the front panel. Instruments delivered to customers in North America include a power cord that must be plugged into the power entry module on the rear panel. Customers outside of North America must supply their own power cords. The power entry module uses a standard IEC connector.

1.1.1. First-time use of the instrument

After unpacking the instrument carefully inspect it for any shipping damage. Remove all standard accessories from the shipping carton.

WARNING
IMPORTANT

Check the line voltage selection for the instrument before plugging in the power cord to an AC line voltage in excess of 200 V rms. All instruments are internally wired for the proper AC line voltage at the time of shipment. To check for proper AC line voltage, remove the blue top cover from the instrument. This can be completed by removing two # 6-32 screws from the top rear panel of the instrument and by sliding the blue, top cover out toward the rear of the instrument. The proper AC line voltage for the instrument is listed on top of the main transformer. After verifying the proper line voltage replace the blue, top cover.

1.1.2 Power and Fuse Requirements

If you are operating the unit outside the U.S. you should check the line voltage selection as described above. The instrument can be wired for operation at 100, 120, 220, and 240 VAC 50/60 Hz. If it is necessary for you to re-wire the instrument for operation at another AC line voltage please contact the factory via FAX and we will send you detailed wiring diagrams and the necessary instructions. This process takes approximately 5 minutes.

The in-line fuse holder is located on the left side of the instrument, toward the rear. The fuse holder is white. It may be necessary to cut the plastic tie-wrap in order to gain access to the fuse holder and the fuse. The fuse ratings for various line voltages are shown below:

Line Voltage	Fuse
100, 110 V	1.6 Amp
220, 240 V	1 Amp

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

FRONT-PANEL CONNECTIONS

1. FULL 10 ns DELAY RANGE:

When the instrument is shipped, it is connected as shown in the sketch below to provide full 0 to 10 ns delay range between **connector 1** and **connector 2**, see below. The 625 ps Trombone Unit to the right has 4 connectors. The short semi-rigid cable labeled **CABLE 1** connects the two identical 312.5 ps delay sections in series for the full delay range up to 625 ps.

The longer semi-rigid cable labeled **CABLE 2** connects the Trombone Unit to the delay extensions up to 10 ns. The delay extension is made from semi-rigid cable with very tight delay match, and with microwave coaxial cables. Each binary delay extension requires two microwave coaxial relays. The standard PDL-30A has 4 binary extensions: 625 ps, 1.25 ns, 2.5 ns, and 5ns, to provide a total range of 10 ns when all delay sections, plus the trombone unit are added.

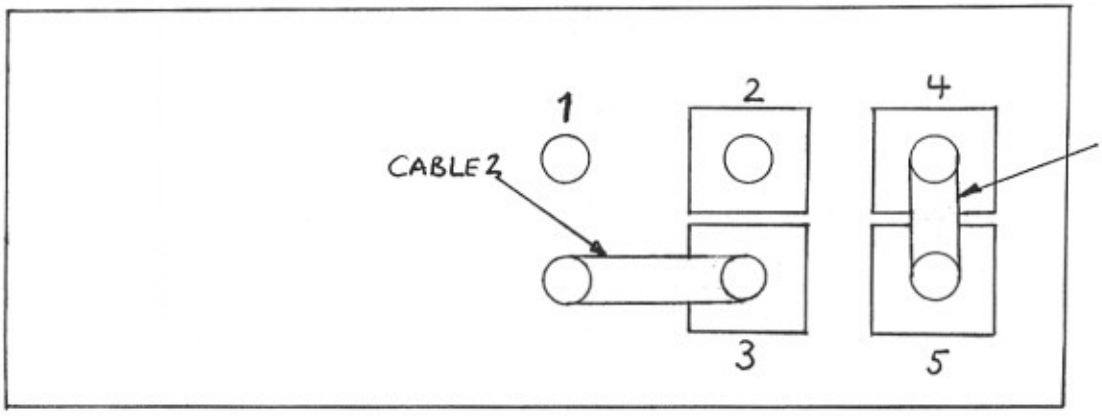
The customer may order the standard PDL-30A series with different total total ranges of either less or more than 10 ns. The step size in all cases is either 1 ps (standard), or, if the High-Resolution Option is included, you will have Factor 2 higher resolution of 0.5 ps.

2. DELAY RANGE TO 625 ps FOR HIGHER BANDWIDTH:

To achieve much higher bandwidth up to 18 GHz, the PDL-30A can be easily changed to provide identical performance of our **Model PDL-10A**. For this reason, we also have included the electrical specifications of the PDL-10A Delay Line later in this manual. The conversion requires to remove the semi-rigid cable labeled **CABLE 2** and use **connectors 2 and 3** to directly access the Trombone Unit.

3. TWO MATCHED DELAY LINES WITH DELAY RANGE OF 312.5 ps:

If the short semi-rigid cable labeled **CABLE 1** is removed, you will have two identical, well matched delay lines available with a total delay range of 312.5 ps each. One half line is accessed through **connectors 2&4**, the other half line through **connectors 3&5.** Please notice that your step size also is one half, i.e., 0.5 ps for the standard resolution. If you have purchased the High-Resolution Option, the resolution for the two half lines is reduced to 0.25 ps. At this time, you cannot enter this number directly, only in 0.5 ps steps. If you do so, please remember that the actual step size is only 0.25 ps. We are working on fixing this situation. **NOTE: ALL INPUT AND OUTPUT CONNECTORS ARE INTERCHANGEABLE.**



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

1.2. Operation with the Microterminal

After pushing the power switch, you will hear a short beep, indicating that the unit has successfully powered up. The red power LED on the Microterminal will illuminate and the display should show "SELF TEST". After successfully completing the test, the unit will display:
"Delay = 0 ps". General operation: Entering digits lets the instrument know you are intending to input [ps] values. Using the decimal point indicates to the instrument that the entry is in [ns]. If the 0.5 ps stepper motor option has been installed the unit only accepts [ns] entries.

1.2.1 Keyboard Keys

The 19 keyboard keys have the following functions :

- **".","0","1","2","3","4","5","6","7","8","9"**
  The standard numeric input keys. Pressing any of these keys will clear the display and echo the input. The unit automatically assumes that you would like to change to a new value.
- **"ENTER"**
  After having entered the desired delay value using the standard numeric keys, pressing "ENTER" will execute the new setting. A question mark at the end indicates an invalid entry.
- **"<-"**
  The backspace key allows in line editing. It moves the "underline" style cursor to the left, effectively erasing the previous character.
- **"+/="**
  The Plus/Equal key allows incrementing the current delay by a constant amount. If a value was entered previous to pushing this key, the current delay setting will be incremented by that value. After power up, this value is 1 ps. An appearing question mark indicates that the unit cannot reach the next value because it would be out of bounds.
- **"-/="**
  The Minus/Equal key operates in the same manner as the Plus/Equal key, except that it decrements the delay by the preset value instead of incrementing it.
- **"CLEAR"**
  Clears the display of all previous input. The unit then awaits a new input. Pushing either "ENTER" or "DELAY" will recall the current delay setting.
- **"DELAY"**
  Whenever pushed the current delay setting is displayed.
- **"REMOTE"**
  This key is used with the GPIB interface option to indicate a "user request" when in remote mode.
- **"FUNCT."**
  This key allows special functions to be executed. After pressing this key, the display will show the available functions. Please refer to section 1.4. to find out which ones are available for your model and options.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

MICROTERMINAL



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

1.3. Operation through the GPIB interface

The unit is shipped with the IEEE address set to 5 . The setting can be modified with the microswitches on the back panel (see Appendix C). The switches are coded in a 5 bit binary fashion where the right most switch represents bit 0 (the LSB). A bit is ON when the switch is UP. To reset the address setting, power the instrument down and back up again. Make sure you are addressing the unit to LISTEN (to the correct address) before sending any commands. You may also change the address by using the "FUNCT" followed by the "1" key. For details please refer to the end of this chapter.

1.3.1 Power up with a Microterminal (GPIB option installed)

While running internal test programs the unit will display "HOST SELF TEST". After completing the tests successfully the Microterminal displays **"Delay = 0 ps".**

1.3.2 Setting the Delay without Microterminal

- **DEL** To set the delay to 123 picoseconds, for example, send "del 123 ps".
- **DEL?** Delay query command. The unit returns the current delay setting, i.e. 1.230e-10. The IEEE488-2 standard requires that all queries end with a "?". By first sending the query command "mode?", the instrument will check its mode and prepare a response to be read as soon as the unit is addressed to talk. It is a good practice to read the complete response message, which is terminated by a line feed (10) and EOI asserted, before a new command (program message) is sent. If a new < program message > is sent before reading an answer the response will be lost.

1.3.3 Monitoring the Instrument's Activity

- **MON** If the Microterminal is available and connected to the unit, this "toggle" command allows continuous monitoring of commands sent to the unit and possible errors. Bus traffic is slowed down to allow updating the display of the Microterminal.
- **MON?** Monitor query command. The unit will return the state of the monitor "toggle", either "ON" or "OFF".

This concludes the instrument specific commands. In further chapters the interface capabilities, the set of common commands, the polling features and other specific information will be discussed.

In Appendix A one can find a few sample session listings that can help setup the instrument quickly without having to understand every detail of the interface language.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

1.4. Available Functions on the Microterminal

1.4.1 Function "1"

Function "1" allows the user to perform a quick calibration test. If it fails, the unit will display **"Calibration error"**. Otherwise it displays **"Cal. test O.K."**.

1.5. Functions available with the GPIB & Microterminal

The following FUNCTIONS after pressing the "FUNCT." key are only available if you have the IEEE 488.2 Interface Option installed and a Microterminal is available.

1.5.1 Function "1"

Function "1" allows you to check the IEEE address setting of the instrument and to change it if so desired. The Microterminal will display : **Address XX OK=1?**
If the displayed address is correct, press the number "1" key. Otherwise modify the address switch setting on the backpanel (Appendix C) and type any other key. The display should now show the new setting. You can continue this cycle until you see the correct address appear on the display, then press the "1" key to acknowledge your choice.
Note: The address change will update the controller regardless of its STATE. It is advisable to have previously sent an IFC message over the GPIB bus to make sure there is no activity.

1.5.2 Function "2"

Function "2" allows you to quickly perform a Calibration Test. When the test completes, the message : **Cal. Test. O.K.** should appear and the unit will shortly resume its delay setting before the test.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

1.6. Technical Information

1.6.1 Delay Line Structure

The PDL series of delay lines is based on a "trombone" programmable delay line. The flexible delay line consists of four flexible lines connected in series to achieve a total of 625 ps or 312.5 ps if used individually as a set of two. A high torque aerospace grade miniature stepper motor with a custom precision lead screw is used to position a sled on which one part of the tubing is attached. Precision interfaces have been designed to minimize impedance mismatches. A proprietary contact design achieves reliable and long lasting contacts. This design is patented under U.S. Patent number 4,843,355 (June 27,1989).

1.6.2 Self Test

Both the Microterminal and the IEEE 488.2 Interface card use a microprocessor to perform all necessary tasks. After power up, both will initiate a selftest.

The Microterminal will test the display memory, the program in ROM, the RAM in the CPU and the stepper motor supply voltage. After a successful completion of these tests, it will check the calibration of the unit by slowly moving the delay line towards its maximum setting until it reaches an infrared light barrier set at a precise position. A full speed test is performed by moving the delay to 0 (relative) and then back to 625 ps and checking the factory setting again. Finally, the delay is reset to its 0 ps delay position and the unit is ready to accept commands. The IEEE 488.2 interface electronics will perform the same tests on its side in addition to initializing the Microterminal as a serial terminal instead of a complete system controller. For PDL models that offer larger ranges of delay (i.e PDL 20A) the IEEE488.2 microcontroller will also test the power supply under full loading conditions after having turned on all relays.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2. SPECIFICATIONS PDL-10A (TO 625 ps RANGE)

2.1 ELECTRICAL

Delay Range/Resolution:
Series Connected Lines:.....625 ps/0.5 ps
Dual Channel Lines:.....312.5 ps/0.25 ps

Equivalent Phase Shift at 1 GHz/Resolution:
Series Connected Lines:.....0 to 225 deg./0.18 deg.
Dual Channel Lines:.....0 to 112.5 deg./0.09 deg.

Frequency Range [1]:
Series Connected Line:.....DC to 18 GHz (-3 dB)
Dual Channel Lines:.....DC to 18 GHz (-2 dB)

Insertion Loss [1]:
Series Connected Lines:.....0.4 dB + 0.2 dB x f(GHz) to 13 GHz
.....3 dB from 13 to 18 GHz
Dual Channel Lines:.....0.2 dB + 0.1 dB x f(GHz)

Return Loss [1]:
Series Connected Lines:.....14 dB to 2 GHz
.....8 dB to 8 GHz
.....4 dB to 18 GHz
Dual Channel Lines:.....18 dB to 2 GHz
.....10 dB to 8 GHz
.....6 dB to 18 GHz

DC Resistance:.....0.5 ohm
Tuning Time (Full Travel):.....1000 ms

Absolute Accuracy (Er=1.00), max.:.....0.5 %, + 2 ps
Absolute Accuracy (Er=1.00), typ.:.....0.1%, + 0.2ps

Rated Lifetime:.....500,000 operations
Power Handling Capability:..... 10W CW, 50W peak
AC Supply & Power:.....100V, 110V, 220V, 240V, 50-60 Hz, 80 VA max.

Operating Temperature:.....10 to 30 deg.C
Physical Dimensions (WxHxD):.....32.75 cm (12 7/8")x13.4 cm (5 ¼")x34 cm(13 3/8")
Weight:.....6.5 kg (14.3 lbs)

[1] The unit is tested for Insertion Loss and Return Loss for *all* delay increments from 0 to 625 ps. The customer receives a printout at 300 ps (*series* connected lines) and 150 ps (D*ual Channel Lines*
We should point out that the *Insertion Loss* at a given frequency is fairly *independent* over the entire 0 to 625 ps range.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2. SPECIFICATIONS PDL-30A (FULL 10 ns RANGE)

2.1 ELECTRICAL

Delay Range/Resolution:.....10 ns/0.5 ps

Phase Shift at 1 GHz/Resolution:.....3600 deg/0.18 deg

Frequency Range [1]:.....DC to 2 GHz (-3 dB)

Insertion Loss [1]:.....1.0 dB + 1.0 dB x f[GHz] to 2 GHz
.....3.0 dB + 0.8 dB x f[GHz] from 2 to 4.5 GHz

Return Loss [1]]:.....15 dB to 1 GHz
.....10 dB to 3 GHz
.....8 dB to 4.5 GHz

DC Resistance (max):.....1 ohm

Tuning Time (worst case):.....1000 ms

Absolute Accuracy (typ.).....0.1%, + 5 ps to 10 ns

Power Handling Capability:.....10W CW, 50W peak

Rated Lifetime:.....400,000 Operations

AC Supply:.....100V, 110V, 220V, 240V, 50-60 Hz

AC Power:.....80 VA

Operating Temperature:.....10 to 30 deg. C

Physical Dimensions (WxHxD):.....32.75 cm (12 7/8") x 13.4 cm (5 ¼") x 34 cm (13 3/8")

Weight:.....7.3 kg (16 lbs)

[1] The unit is tested for Insertion and Return Loss for *all* delay increments from 0 to 10 ns. The customer receives a printout at 0 ns, 2.5 ns, and 10 ns. Please notice that the Insertion Loss and Return Loss will depend on the length of the coaxial line.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2.2. IEEE 488.1,2 (GPIB)

2.2.1 IEEE 488.1

SH1,AH1,T6,L4,SR1,RL1,PP1,DC1,DT0,C0,E1

2.2.2 Addressing

Valid address : .....0 - 30

2.2.3 Interface Messages

All IEEE488.1 Interface messages as stated in ANSI Std 488.1-1987

2.2.4 Buffers and Queues

Input Buffer :.....300 bytes
Output queue : .....300 bytes
Error Queue :.....128 bytes

2.2.5 Overlapped Commands

The PDL series does not implement any overlapped commands. All commands are processed sequentially.

2.2.6 Polling

Serial and remotely programmable parallel poll exist.

2.2.7 Remote/Local Operation

The IEEE interface controller is active at all times. The instrument can be queried or programmed at any time briefly suspending access through the Microterminal. In the local mode the GPIB retains full control of the unit effectively allowing simultaneous operation through the Microterminal and the IEEE 488 bus.

2.3. Exceptions to the IEEE 488.2 standard

2.3.1 Decimal Numeric Program Data (NRf) ANSI X3.42-1975

The mantissa of a NRf including leading zeroes cannot exceed 50 characters.
The exponent must be in the range -150 to +150.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3. GPIB INTERFACE FUNCTIONS

3.1. Introduction

This chapter describes the capabilities of the GPIB interface and the available "low level" (IEEE-488.1) commands. The instrument has been designed to both comply with the IEEE 488.1 and IEEE 488.2 standards. The complete command set will be described in the following chapters.

3.2. Interface capabilities

The PDL series of delay lines equipped with the GPIB option posess the following capabilities as defined by the IEEE 488.1 :

SH1	*source handshake*
AH1	*acceptor handshake*
T6	*basic talker, serial poll, unaddress on* MLA (My Listen Address)
L4	*basic listener, unaddress on* MTA (My Talk Address)
SR1	*service request function*
RL1	*complete remote-local programming functions*
PP1	*remote parallel poll configuration*
DC1	*full device clear capabilities*
DT0	*no device trigger*
C0	*no controller capabitiy*
E1	*open collector driver*

3.3. Addressing

Above the GPIB connector, on the back panel of the instrument, resides a 5 position micro-switch bank. Each switch represents one bit of the binary encoded address. The least significant bit (bit 0 or the LSB) is represented by the right most switch. A bit is high (or on) when the switch is in the UP position (Appendix C).

If the address setting is modified while the instrument is powered on, the unit needs to be powered off and powered on again to recognize the new setting. (No Microterminal available; otherwise use Function "1")

- Each device (15 max. including the controller) on the GPIB bus must reside at one address between 0 and 30 inclusively. The talking and listening address is the same.
- The active controller on the bus determines which instrument is to be addressed as a listener or talker.

Once the controller has addressed the instrument to talk, it will remain in that state until it receives either an *Interface Clear Message* (IFC), an *Other* instrument's *Talk Address* (OTA), *My Listen Address* (MLA) or the *Universal UnTalk* (UNT) command.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

If the instrument has been addressed to listen, it will remain in that state until it receives IFC, *My Talk Address* (MTA) or the *Universal UnListen* (UNL) command.

3.4. Remote, Local and Local Lockout

The GBIB (delay line) controller program may be in one of three modes:

3.4.1 LOCAL

Specifically refers to an instrument that is used in conjunction with the MT1A microterminal. The Microterminal, in this mode, is completely active and can be used to adjust the delay setting. The GPIB interface is active simultaneously and can be used to monitor or also send commands to the unit.

3.4.2 REMOTE

All of the Microterminal keys are disabled except the "**REMOTE**" key, which will set the *User ReQuest* (URQ) bit in the standard *Event Status Register* (ESR). It is the controller's responsibility to flag this event and to take appropriate action so that the instrument is able to accept local commands again. This mode is indicated on the Microterminal by an "*" (asterick) instead of the " = " sign between the word "Delay" and the digits, i.e. **Delay*222 ps**.

3.4.3 LOCAL LOCKOUT

It is equivalent to the REMOTE mode, but deactivates all keys. The Microterminal will replace the " = " or "*" with an "#" sign, i.e Delay#122.5 ps, to inform the user that he cannot control the instrument through the Microterminal.

3.4.4 RETURNING TO LOCAL mode

To return to the local mode, either
a) the power must be switched off and on again. This will reset other states of the unit as well.
or b) the *Go To Local* (GTL) command must be sent by the controller
or c) the *Remote ENable* (REN) single line message must be false when (re-)addressing the instrument
or d) the IFC message is sent.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

3.5. Bus Commands

3.5.1 Single Line Commands

Single line commands refer to 4 dedicated lines (wires) of the GPIB bus which are toggled to perform specific functions.

- **IFC:** This commands halts all bus activity and returns command to the system controller. It also unaddresses all listeners, the talker and disables a serial poll.
- **REN:** When this "line" is active while the instrument is addressed to listen, the unit will switch to the REMOTE mode.
- **ATN:** *ATteNtion*. The state of this line indicates whether information sent on the bus is a "command" or "data".
- **EOI:** *End Or Identify*. It is used to indicate the end of a "program message" and is asserted with the last byte sent. The IEEE 488.2 allows its presence or absence. The PDL's will recognize an ASCII "line feed" (decimal 10) as the end of a message regardless of the state of the EOI line. The PDL's response messages will be terminated with a "line feed" character and EOI asserted. Upon being polled serially, the instrument will NOT assert EOI. During a parallel poll sequence response, both ATN and EOI will be true.

3.5.2 Multiline commands

These commands are issued over the (8) GPIB data lines with ATN asserted. They are also commonly referred to as universal commands, since they are supposed to reach all instruments on the bus regardless of their addressing status.

- **DCL** *Device CLear*. Upon receipt of this command, the instrument will be initialized to its power on state. It clears the input buffer, the ouput queues and buffers, resets the parser and execution unit and clear all pending commands. The status registers will also be reset to reflect the current state of the instrument.
- **GTL** *Go To Local*. Switches the unit back to local mode.
- **LLO** *Local LockOut* . For this command to have any effect, the unit must be in remote mode. Issuing this command will then put the instrument into the LOCAL LOCKOUT mode, disabling any key entry from the microterminal.
- **PPU** *Parallel Poll Unconfigure*. This command resets all parallel poll devices to their idle state. After having received this command, the unit will no longer respond to a parallel poll.
- **SPE** *Serial Poll Enable.* After receiving this command, the unit will assert the *Service ReQuest* (SRQ) line if an UNMASKED bit in the standard event status register or *STatus Byte* register is set due to an error condition or to a specific state the unit has reached.
- **SPD** *Serial Poll Disable*. The serial poll disable command terminates the serial poll mode for all responding devices.

3.5.3 Addressed (multiline) commands

These commands are similar to the multiline commands described previously except that only addressed devices will respond to them.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- **SDC** *Select Device Clear*. Performs the same actions as DCL device clear.
- **PPC** *Parallel Poll Configure.* This command allows the controller to remotely program the parallel poll response of the unit.

3.5.4 Secondary commands

- **PPE** *Parallel Poll Enable*. The unit must be first configured for parallel polling before this command is sent. It is used to selectively enable the reponse.
- **PPD** *Parallel Poll Disable*. It is targeted at specific devices by first addressing the device and then issuing this command.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4. COMMUNICATION LANGUAGE

4.1. Introduction

This instrument follows the conventions stated in the ANSI/IEEE Standard 488.2-1987. Instruments that are IEEE 488.2 compatible must also be compatible with the IEEE 488.1. The reverse is not true in most cases. The IEEE 488.2 standard goes far beyond the definitions and conventions in the IEEE 488.1. The message exchange protocols have been clearly defined, i.e. "forgiving listening" and "precise talking". A set of "common" commands has been devised to eliminate ambiguities in the basic "house keeping" functions among IEEE 488.2 instruments. The precise interaction between the different system functions and the handling of protocol exceptions have also been defined. The IEEE 488.2 also encourages more transparent and less instrument specific programming, a good idea if you have 15 or more instruments from various manufacturers in your test rack.

4.2. System components

A general IEEE 488.2 system (including this instrument) is made up of the following elements :

Input Buffer - The input buffer is a storage area in the instrument that collects the incoming messages that the addressed instrument receives from the controller. It serves two main purposes : it allows the controller to send a complete message at maximum speed before the instrument starts parsing or executing elements of this message and it also allows very long messages to be sent without losing data. The PDL series input buffer can store 300 characters (or bytes) before starting to analyze them. It is advisable to keep messages under that length of 300 characters to prevent slowing down bus traffic.

Output Queue - The output queue is also a storage area which is used by the system to store response data while it is processing "query commands". This response data is then read by the controller until the queue is empty. The output queue of the PDL series can up to 300 bytes (characters), depending on the query command(s) sent. This means that one could send all available query commands implemented in this instrument in one single program message before the queue fills.

Parser - The parser reads, interprets the incoming messages and decides which functions to execute. The parsing and execution of commands starts after either a <program message terminator> (line feed: 10 decimal) or another data byte with EOI asserted has been received or the input buffer has filled. In the latter case the GPIB bus activity will be suspended until there is more space to accept data.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4.3. Protocol Overview

4.3.1 The dialogue

The controller, usually a computer equipped with an IEEE interface, sends so called < program messages >. These are strings of characters that make up the commands to set and/or query the instrument. The instrument will answer to one or more queries by sending a < response message > when addressed to talk. One must make sure to send a valid < query message > before trying to read data from the unit, otherwise the dialogue stops since the instrument has "nothing to say" and a timeout will occur.

The basic "dialogue" philosophy of the IEEE 488.2 can be stated as follows:
The instrument will only talk if you asked a COMPLETE question, after the question you should listen to the COMPLETE answer before sending anything else, otherwise you might lose the answer.

The word COMPLETE is important and leads to a series of protocol exceptions if it is not observed. A complete < program message > is terminated with a < program message terminator >. A complete < response message > has been read when the message terminator has been read. If a query message was sent, one should thereafter read the response.

Compound queries, multiple query commands in one program message, are allowed and generate multiple answers (separated by semicolons) in the sequence that they were received.

4.4. Protocol exceptions

The IEEE 488.2 lists the possible protocol exceptions. These are error conditions that occur when the protocol is not observed. They can be classified into the following categories.

4.4.1 Missing Listener(s)

The controller has selected the instrument as a talker but did not address a listener. In this case the instrument will wait until a listener exists or until the controller resumes control.

4.4.2 Unterminated

The controller has sent a program message but has not sent a message terminator. It then proceeds to try to read from the unit. The result is an Unterminated action by the unit. The query error will be flagged, the queue will be flushed and the parser will reset itself.

4.4.3 Nothing to say

When the instrument has been addressed to talk before it received a query, it will flag the query error bit in the ESR and continue as if nothing happened. If a query was sent but for some error condition no answer could be formulated, no query error will be indicated and the instrument will await further instructions. This condition also falls into the Unterminated category.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4.4.4 Interrupted

This condition exists when the controller does not read the complete response message. The remaining response data will be lost and a query error will be flagged. The interrupting program message will not be affected.

4.4.5 Deadlocked

If both the input buffer and the output queue are full the instrument will enter the deadlock state. Very long program messages that generate many responses can lead to this rare situation. The unit cannot accept more data and the controller can't read the responses before finishing its message would be a typical case. Under these conditions the instrument will break out of this state by clearing the output queue and discarding response messages until it receives a message terminator. Of course, the query error bit in the ESR will be set.

Further exceptions and error conditions are discussed in this chapter under **Status reporting.**

4.5. SYNTAX

The IEEE 488.2 describes in great detail (approx. 36 pages) with many illustrations the syntax of program and response messages. This chapter will contain only the major blocks necessary to operate this instrument successfully.

4.5.1 Basic Definitions and Elements

- The **semicolon** is used to separate *message units*. A message unit is simply a command mnemonic possibly followed by some numeric or other data.
- The **comma** is used to separate data elements within a message unit. It is not used in this instrument.
- The **program message terminator** <PMT> is the last data byte sent to a listener, an ASCII 10 (decimal, "line feed") in a program message.
- **White space**, ASCII 0 through 32 except 10 is used to separate a command from its parameters. It can also be used freely before and after commands to improve readability.

Examples of valid program messages :

del 12.333567ps ; *ESE 201 ; del?;mon?; *stb? ; *pRE 62314 ; del 345 e -12;;;;<PMT>

Examples of invalid program messages :

del444ps; A "white space" is missing between del and 444ps.
del -450ps; There are no negative values of delay.
*pre 345 del 12ps; a semicolon is missing between the two commands.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4.6. Device listening syntax

The IEEE 488.2 standard emphasizes a "forgiving" listening syntax. White space, any ASCII character between 0 and 32 except 10, can be freely used to improve readability of <program messages>.

Upper and Lower Case Equivalence: The parser is insensitive to the case of the letters which means that lower and upper case characters (a-z, A-Z) are equivalent.

4.6.1 {program message}

The <program message> is the complete message sent by the controller to the instrument. It may contain any ASCII 7 or 8 bit characters and must end with a "line feed" (10) character. Several commands, separated by semicolons form a program message, for example.

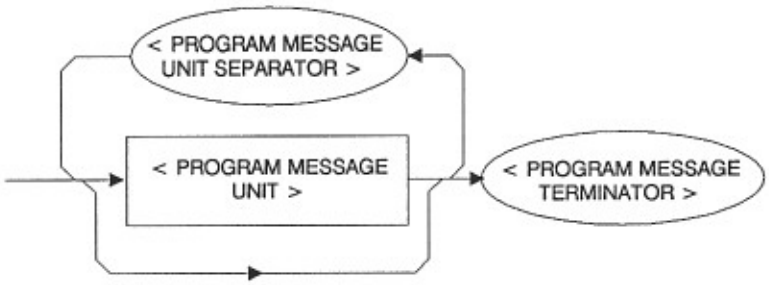


Figure 4-1
<program message >

4.6.2 {program message unit}

The <program message unit> is a single command with or without data. One or several <program message units> make up a program message.

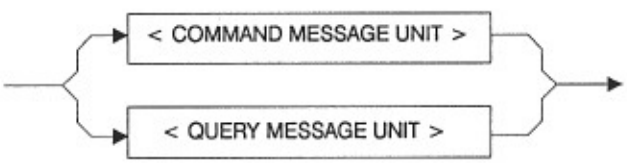


Figure 4-2
<program message unit>

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

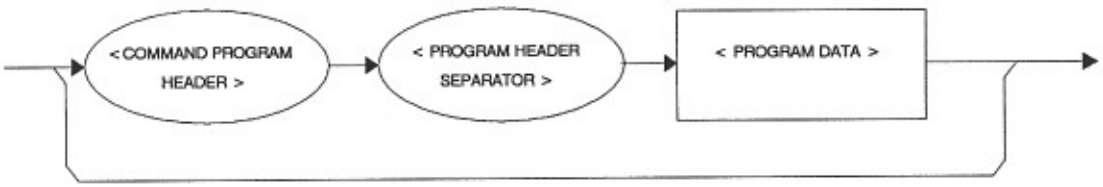


Figure 4-3
< command message unit >

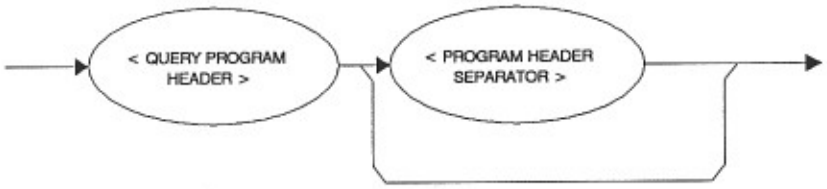


Figure 4-4
< query message unit >

4.6.3 {program message unit separator}

The < program message unit separator >, a semicolon, separates the individual message units.

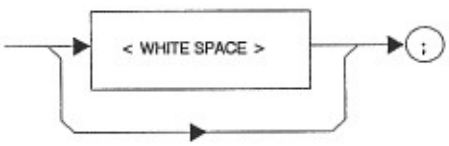


Figure 4-5
< program message unit separator >

4.6.4 {command program header}

These elements form the command name such as "del" (delay) or "mon" (monitor).

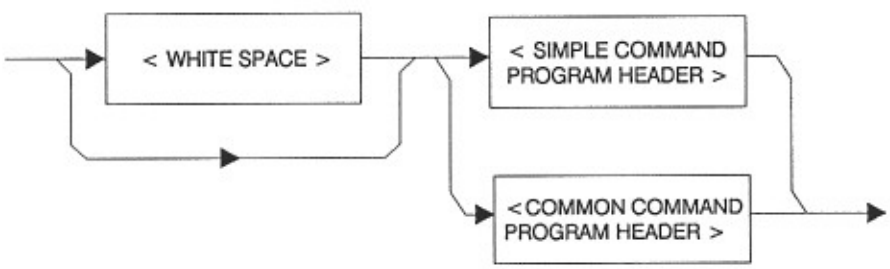


Figure 4-6
< command program header >

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

where <simple command program header> is defined as



Figure 4-7
<program mnemonic>

where <common command program header> is defined as

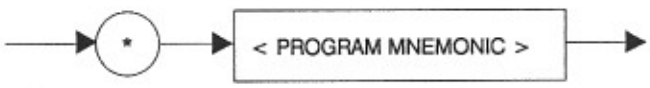


Figure 4-8
<query program mnemonic>

where <program mnemonic> is defined as

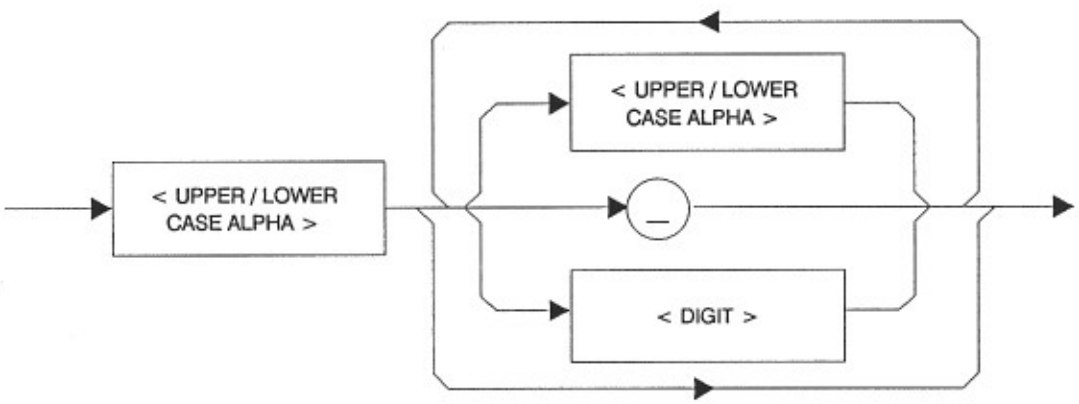


Figure 4-9
character data

Where < upper/lower case alpha> is defined as a single ASCII encoded data byte in the range 65-90, 97-122 decimal.

Where < digit > is defined as a single ASCII encoded byte in the range 48-57 decimal.

Where (_) represents an "underscore, a single ASCII encoded byte of value 95 decimal.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4.6.5 {query program header}

< Query program headers > form the query commands such as "del?" (delay query) or "mon?" (monitor status query).

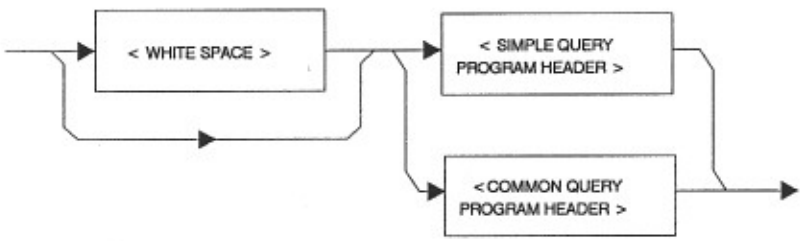


Figure 4-10
< query program header >

Where < simple query program header > is defined as



Figure 4-11
< query program mnemonic >

Where < common query program header > is defined as

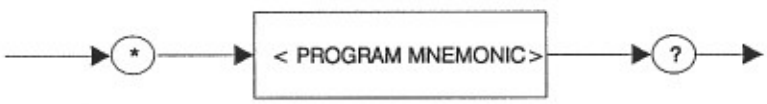


Figure 4-12
< common query program mnemonic >

4.6.6 {program data}

The < program data > element represents the possible types of data that may follow the command program/query header. The PDL series will accept the following types :

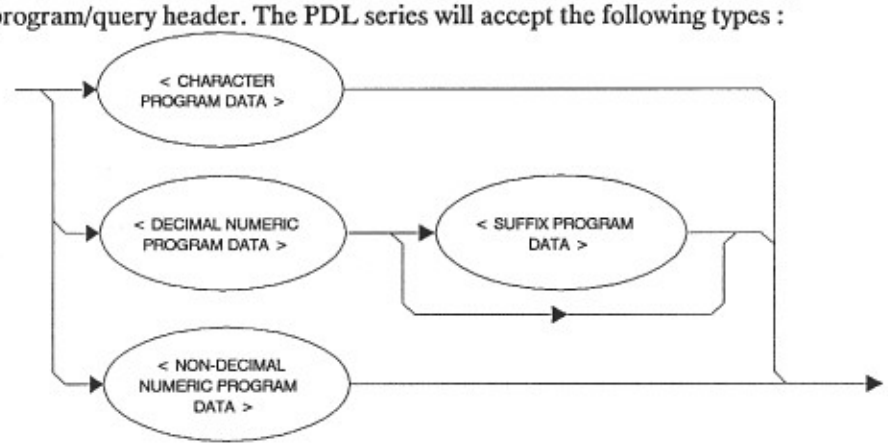


Figure 4-13
< program data >

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

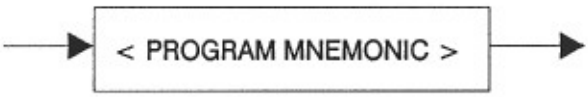


Figure 4-14
< character program data >

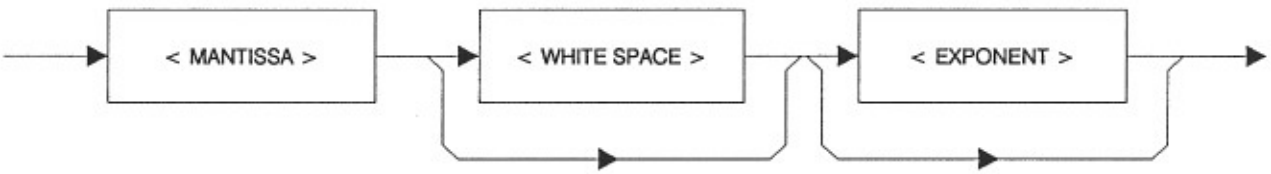


Figure 4-15
< character program data >

Where < mantissa > is defined as

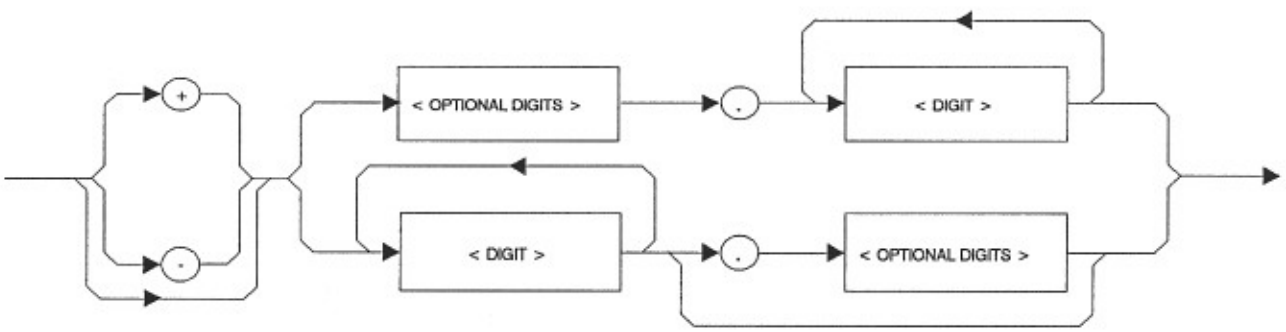


Figure 4-16
< mantissa >

Where < optional digits > is defined as

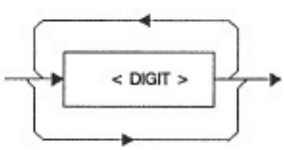


Figure 4-17
< optional digits >

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Where < exponent > is defined as

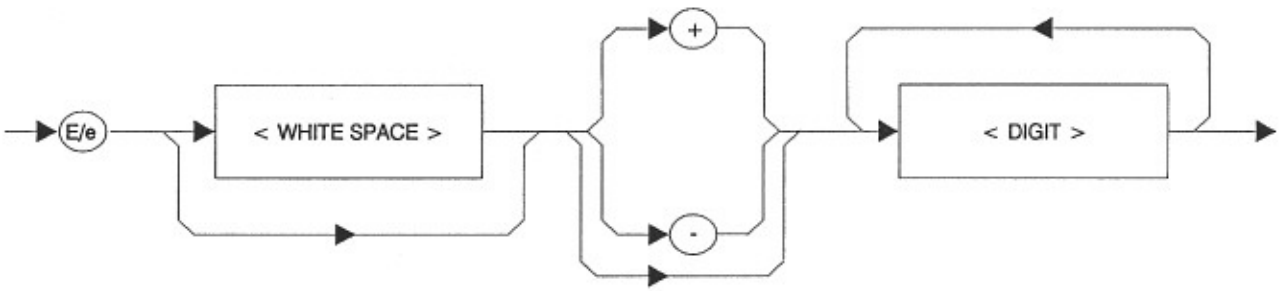


Figure 4-18
<decimal numeric program data>

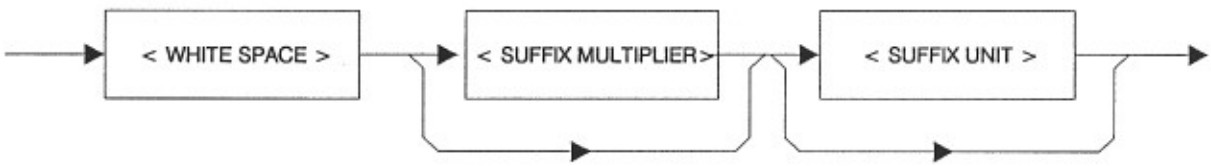


Figure 4-19
<suffix program data>

4.6.7 Suffix Multiplier

The suffix multiplier that the PDL series will recognize are listed in the following table (4.1):

Table 4-1

VALUE	Mnemonic
1E18	EX
1E15	PE
1E12	T
1E9	G
1E6	MA
1E3	K
1E-3	M
1E-6	U
1E-9	N
1E-12	P
1E-15	F
1E-18	A

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4.6.8 Suffix Units

The suffix units that the PDL series will recognize are listed in the following table (4.2):

Table 4-2

Suffix	Reference Units
S	Second

4.6.9 Non-Decimal numeric data

The instrument will also accept hexadecimal, octal or binary numeric data which follows the following convention:

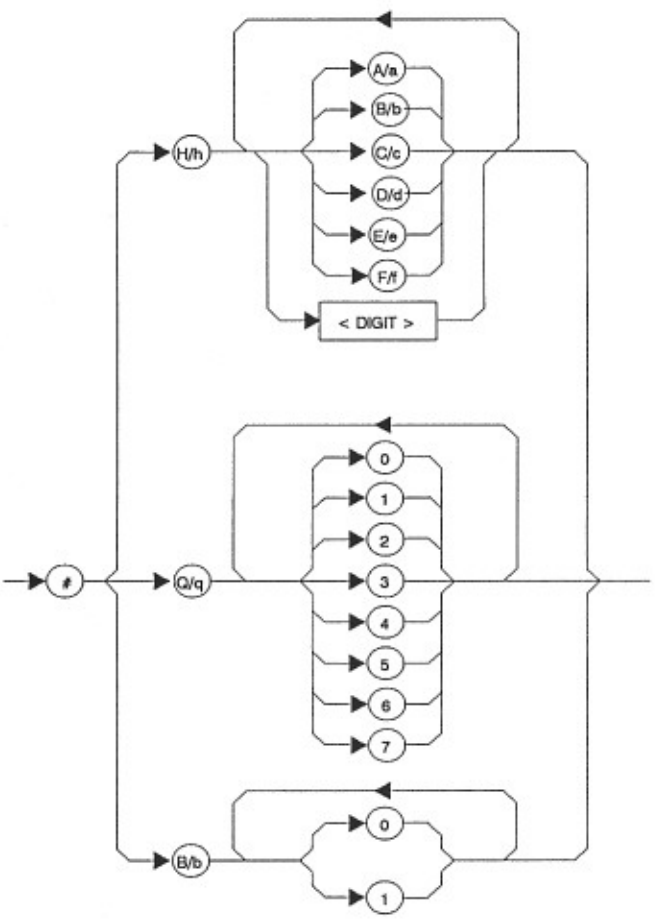


Figure 4-20
< non-decimal numeric program data >

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4.7. Device talking syntax

According to the IEEE 488.2 standard, the talking syntax is more precise than the listening syntax. This facilitates the reading, converting and storing of data sent by the unit. The talking syntax is kept brief, no white space is used to pad messages or data.

4.7.1 {response message}

The response message is the complete message sent by the unit including the < response message terminator >, a "line feed" (10) character. This message has been previously prepared upon receipt of a valid query command and was stored in the output queue, awaiting reading. The queue, being of "first in, first out" (FIFO) type, is gradually emptied as the device sends its data back to the controller.

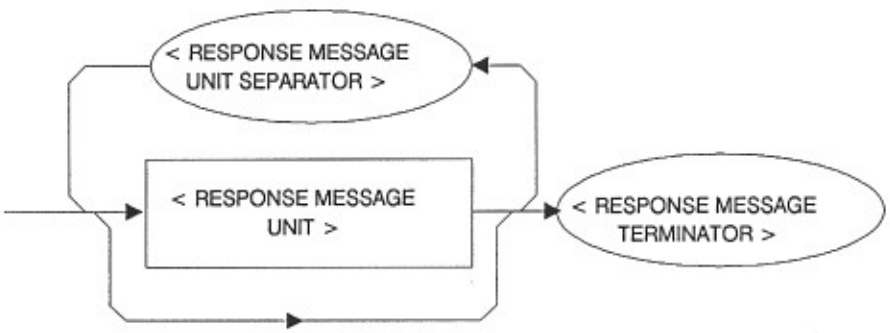


Figure 4-21
< terminated response message >

Where < response message unit separator > is defined as



Figure 4-22
< response message unit separator >

and < response message terminator > is defined as



Figure 4-23
< response message terminator >

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4.7.2 {response message unit}

A complete <response message> may contain the replies to several queries. These will be separated by semicolon(s), the <response message terminator>. An individual response is called a <response message unit>.



Figure 4-24
< response message unit >

4.7.3 {response data}

The <response data> element represents the various types of data, which the instrument may return.

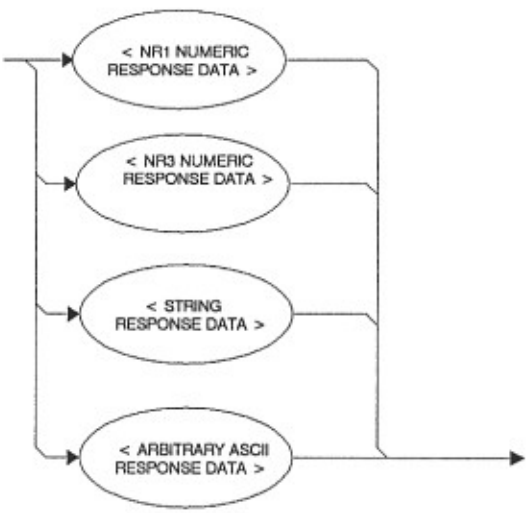


Figure 4-25
< response data >

Where <NR1 numeric response data> is defined as

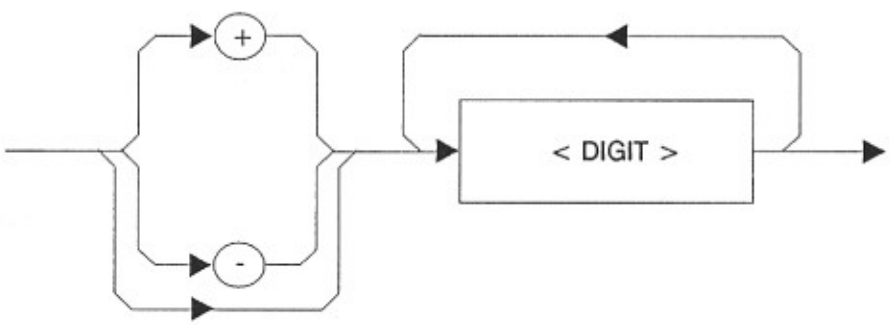


Figure 4-26
< NR1 numeric response data >

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Where < NR3 numeric response data > is defined as

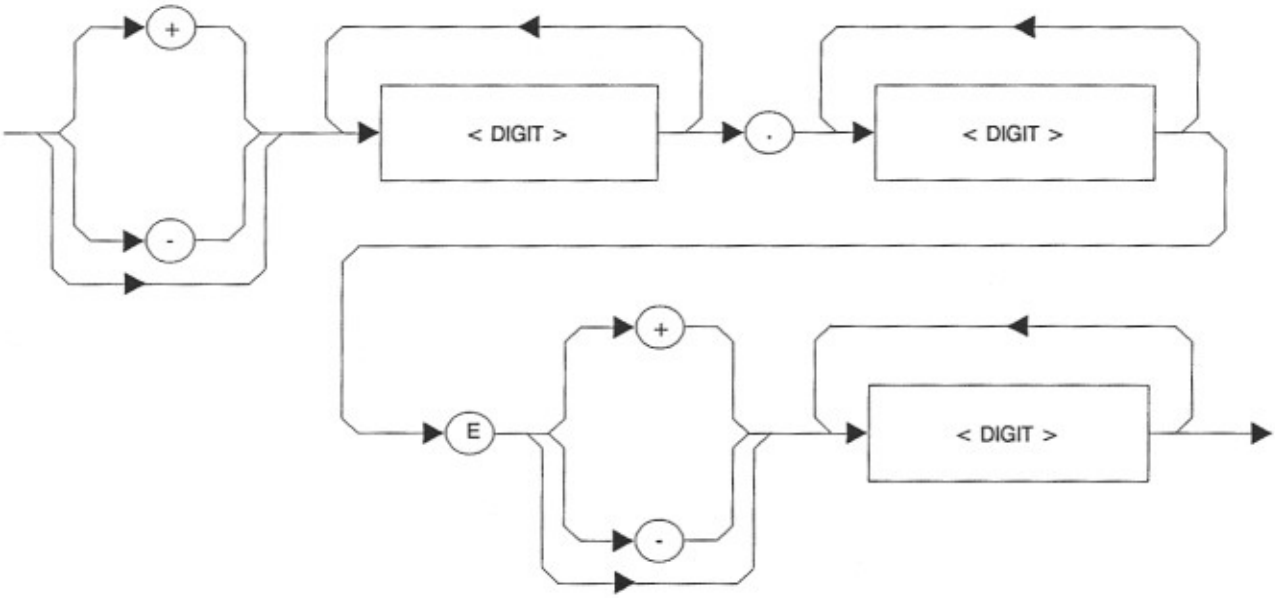


Figure 4-27
< NR3 numeric response data >

Where < string response data > is defined as

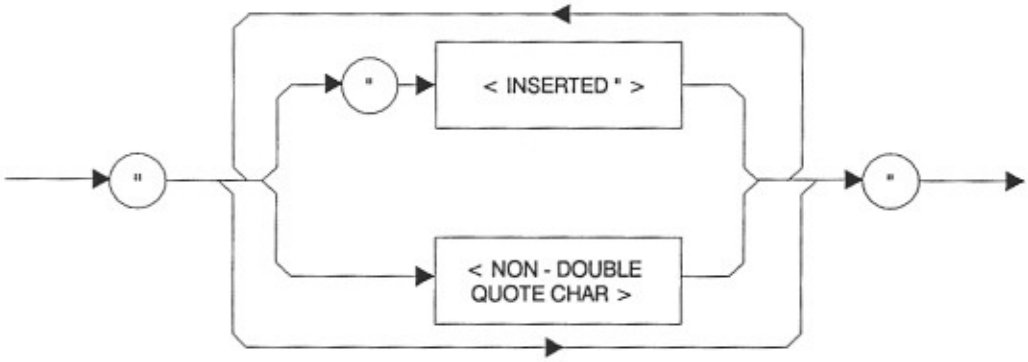


Figure 4-28
< string response data >

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

And where < arbitrary ASCII response data > is defined as

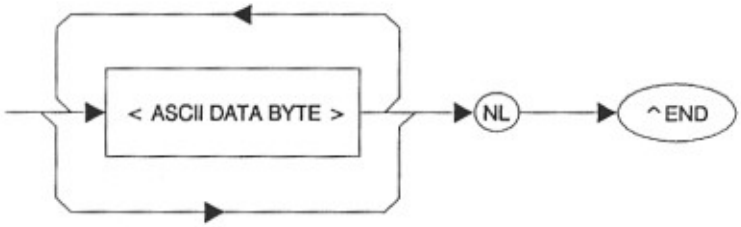


Figure 4-29
< arbitrary ASCII response data >

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

4.8. STATUS REPORTING

The PDL series features two major ways to report its status, the serial poll and the parallel poll. The IEEE 488.2 defines a set of standard registers as part of the "status structure" which can also be read with command query commands.

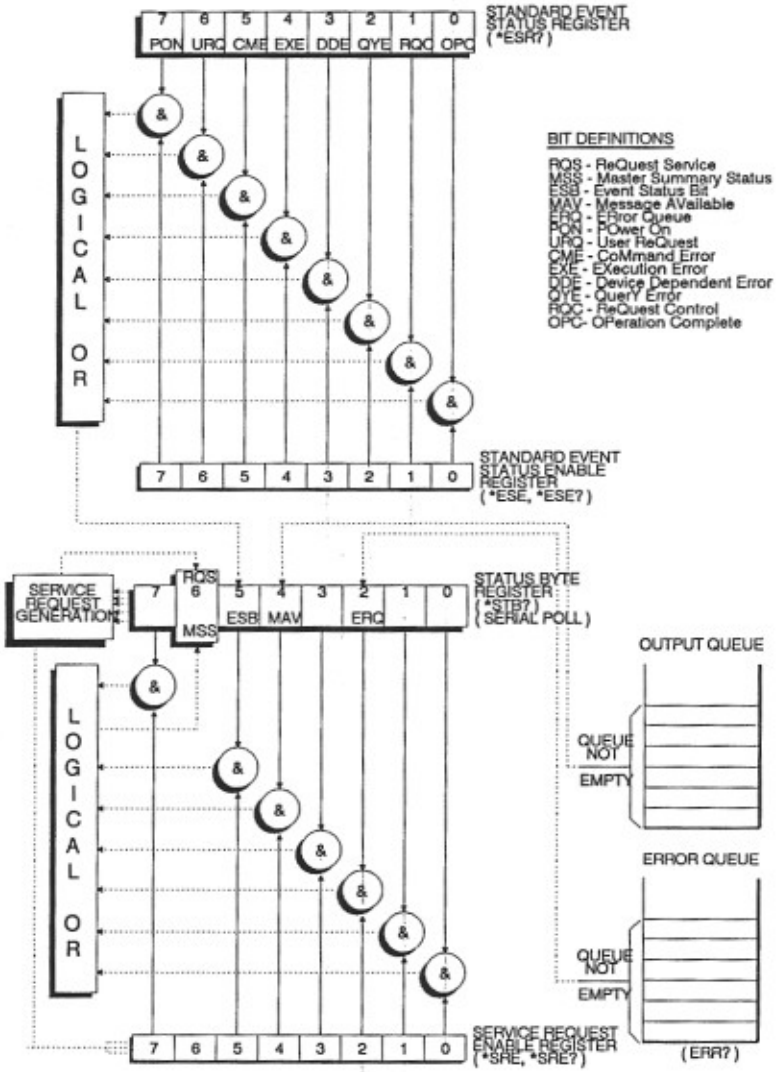


Figure 4-30
Overview of status and queue structure

The bits in the status byte register act as summary bits for the status structures residing behind them. For example the ESB bit in the status byte registers will be on (=1) if any of the unmasked bits in the standard event status register are set. The queue status is directly reported to the status byte register. If messages are present the MAV and/or the ERQ bits will be set. The events captured in the registers will remain flagged until either the register is read through a common query or cleared by the *CLS command. They are also referred to as "sticky" bits. The *CLS will also clear the error queue. The output queue can only be cleared by the first command in a new

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

program message that is not a query. Therefore, *CLS immediately following a < program message terminator > will effectively clear the output queue.

4.8.1 Bit Definitions

PON	Power ON	After power up this bit will be set. It tells the controller to take appropriate actions. In the PDL 10A the controller would have to issue the MODE command, so that the instrument can accept a DEL (delay) command.
URQ	User ReQuest	This bit can indicate to the controller that the REMOTE key on the Microterminal has been pressed. If the device controller is in the remote mode, this would be the only key active and visible to an IEEE controller.
CME	ComMand Error	When the parser can't identify the data sent to the unit, it will set this bit.
EXE	EXecution Error	Arguments, data sent with a command that are out of range or inconsistent with the current settings of the instrument will be flagged in this bit.
DDE	Device Dependent Error	The device could not perform an operation for specific reasons. In the PDL 10A, forgetting to issue a MODE command after power up and trying to set the delay will result in a DDE.
QYE	QuerY Error	The protocol for query processing has been violated. The beginning of this chapter discusses the various protocol exceptions that can lead to a query error.
RQC	ReQuest Control	Not used in the PDL series.
OPC	OPeration Complete	This bit when set indicates that all pending operations in the unit have been completed. It is mainly used to synchronize events among different instruments.
RQS	ReQuest Service	This bit is returned during a serial poll. It indicates that the device is requesting service. After a serial poll this bit will be reset, but not the other bits in the status byte register.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

MSS	Master Summary Status	Informs the user if the instrument has a reason to request service. A *STB? query will return this bit and not the RQS bit. It is not cleared by the query.
ESB	Event Status Bit	If any enabled bit in the standard event status register is set, this bit will also be set.
MAV	Message AVailable	This bit reflects the status of the output queue. As long as information is present in the output queue this bit will be set.
ERQ	ERror Queue	This bit indicates if error messages are present in the error queue.

4.8.2 Serial Poll

The PDL series implements the IEEE 488.1 serial poll feature. Assuming that a service request has been enabled and is activated, the instrument will return the contents of the status byte register with bit 6 (RQS) set upon answering to a serial poll. This action then resets the RQS bit. The remaining bits will be left unaltered and can be read at any time. Please refer to chapter 7 for a detailed application example of the serial poll feature.

4.8.3 Parallel Poll

The PDL series also offers the parallel poll feature. The parallel poll contrary to the serial poll does not involve an active service request from the unit. It is the responsibility of the IEEE bus controller to perform a parallel poll. The IEEE controller must initially configure all devices on the bus that are supposed to respond to a parallel poll. The <ist> local message will then appear at a specific bit location on the data bus during a parallel poll. The parallel poll is used to allow simultaneous status inquiry of 8 or more instruments and can be used to quickly assess status. In the PDL series the lower byte of the parallel poll register is the status byte register.

4.8.4 Programming the Parallel Poll Response

Since the PDL series implements the PP1 (remote) configuration it is the controller's responsibility to configure the device to respond in the desired fashion. The following sequence must be followed:

1) Unlisten and Untalk all devices on the bus
2) Address the devices to be configured to listen
3) Send the Parallel Poll Configure command followed by decimal

104 - to respond on I/O line 1
105 - to respond on I/O line 2
106 - to respond on I/O line 3

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

107 - to respond on I/O line 4
108 - to respond on I/O line 5
109 - to respond on I/O line 6
110 - to respond on I/O line 7
111 - to respond on I/O line 8

For the CEC controller one would send i.e.:

UNL UNT LISTEN 5 PPC CMD 104

Sending PPU will disable all parallel poll responses. If PPC follows the configuration syntax described above, that particular instrument's parallel poll response will be disabled.

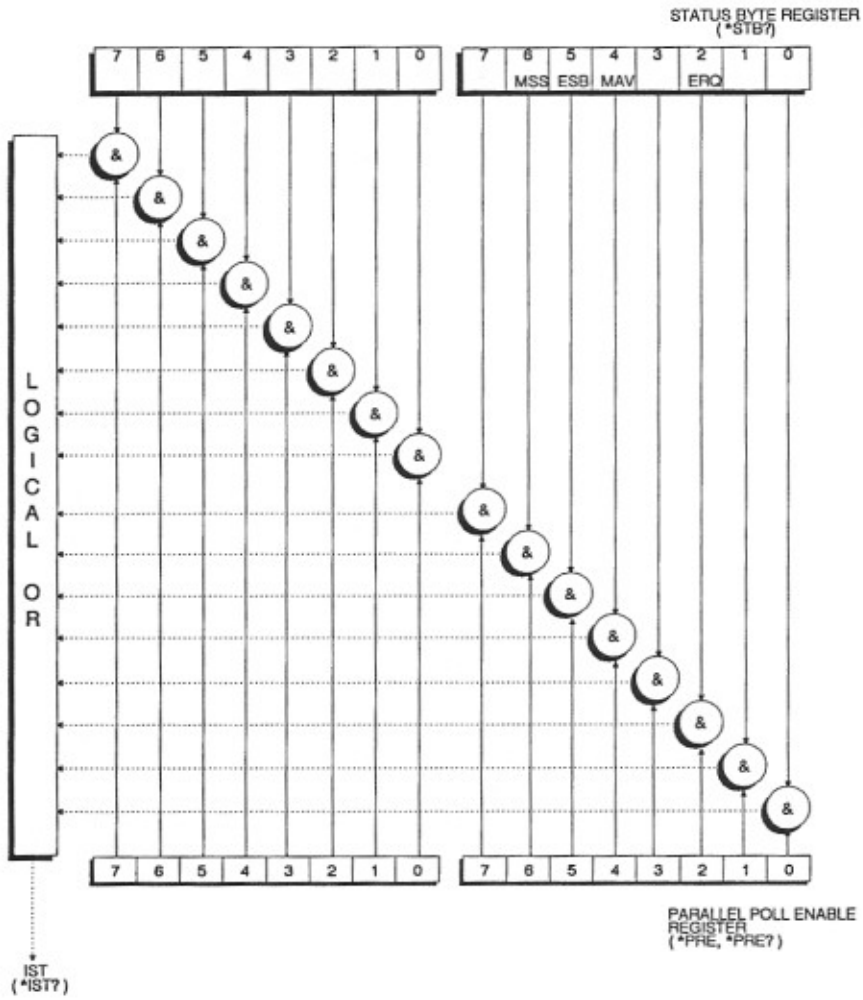


Figure 4-31
The Parallel Poll Status Structure, Registers

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

5. Common Commands

5.1 Introduction

A set of so called "common commands" is defined by the IEEE 488.2 standard. Instruments that adhere to this standard will all responde to these commands in the same manner. The "common commands" are used mainly to set and query the status and the status enable registers. They also include commands to reset the instrument, to inquire about the manufacturer, to manage serial and parallel poll capabilities and to synchronize events. The figures and status structure descriptions in chapter 4 are useful when examining the commands described hereafter. The examples listed with each command refer to three systems HP = Hewlett Packard, NIC = National Instruments Corporation, CEC = Capital Equipment Corporation. **NOTE:** for simplicity the string information was placed directly into the function call. Some BASICS will not accept this format.

5.2 Common Command Summary

Figure 5-1 gives an overview of the common commands implemented in the PDL series.

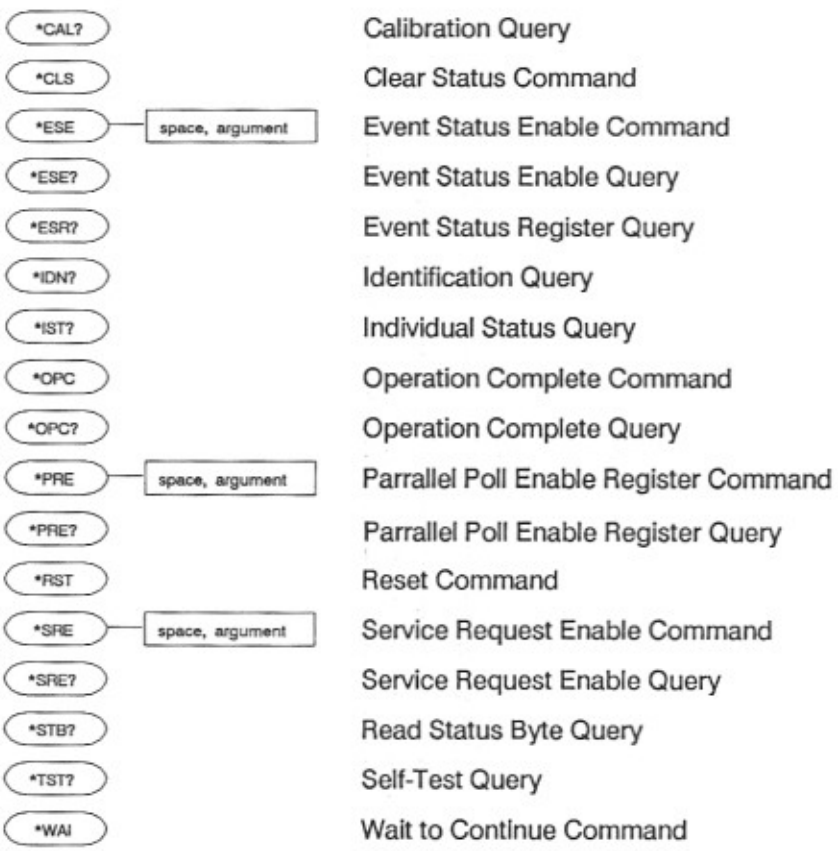


Figure 5-1

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

*CAL? (Calibration) Query

The *CAL? command/query performs a calibration check and returns the result as either 0 = eveyting o.k. or 1 = we could not calibrate. This comand can be useful to make sure the delay is accurate over long time periods before a set of important measurements.

Syntax *CAL?

Return Format <value><NL> ; <value> = 1 if no calibration possible, 0 otherwise

Example
```
HP  : OUTPUT 705;"*CAL?"<NL>
CEC: CALL SEND(5,"*CAL?",status%)
NIC : CALL IBWRT(5,"*CAL?" +CHR$(&H0A))
```

*CLS (Clear Status) Command

The *CLS command clears the Event Status Register, the Status Byte Register and the error queue. It does not clear the output queue unless it immediately follows a <program message terminator> since any new <program message> clears the output queue and the related MAV bit in the status byte register. It is a good idea to start a program message with this command to make sure you are cleaning out previous error reports and possibly remaining service requests or parallel poll states.

Syntax *CLS

Example
```
HP  : OUTPUT 705;"*CLS"<NL>
CEC: CALL SEND(5,"*CLS",status%)
NIC : CALL IBWRT(5,"*CLS" +CHR$(&H0A))
```

*ESE (Event Status Enable) Command

The *ESE command is used to set specific bits in the event status enable register. (Refer to figure 4-30) These bits act as masks for events occurring in the instrument to be relayed to the ESB bit in the status byte register and eventually generating a service request and/or a preprogrammed response to a parallel poll. The data is defined as <Decimal Numeric Program Data>. The instrument will round this number to an integer following the IEEE conventions. Expressing this number in base 2 (binary) represents the values of the individual bits in the Standard Event Status Enable Register.

Syntax *ESE <mask value> ; <mask value> = 0 to 255

Example To set bit 5 (Command Error) and bit 2 (Query Error) one would issue the command:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

```
HP  : OUTPUT 705;"*ESE 36"
CEC: CALL SEND(5,"*ESE 36",status%)
NIC : CALL IBWRT(5,"*ESE 36")
```

36 = 32 (for bit 5) + 4 (for bit 2).

Table 5-1
Standard Event Status Enable Register

(A "high" bit enables the ESB bit)		
Bit	Value	Enable
0	1	OPC - Operation Complete
1	2	RQC - Request Control (not implemented)
2	4	QYE - Query Error
3	8	DDE - Device Dependent Error
4	16	EXE - Execution Error
5	32	CME - Command Error
6	64	URQ - User Request
7	128	PON - Power On

*ESE? (Event Status Enable) Query

The *ESE? query returns the value stored in the Standard Event Status Enable Register. This value will and can only be modified by the user. No direct command exists to clear it. To reset it to zero one must issue a *ESE 0 command. After power up all enable registers will be reset to zero. The *ESE command will force all unused bits to remain at zero, so if you try to enable an unused bit you will see no changes in its setting.

Syntax *ESE?

Return Format <mask value><NL> ; <mask value> = 0 to 255

Example We want to enable the user request bit (64) and check if it was set in the instrument

```
HP  : OUTPUT 705;"*ESE 64;*ESE?"<NL>
      ENTER 705;Event
CEC: R$=SPACE(10)
      CALL SEND(5,"*ESE 64;*ESE?",status%)
      CALL ENTER(R$,length%,5,status%)
NIC : CALL IBWRT(5,"*ESE 64;*ESE?" + CHR$(&H0A))
      CALL IBRDA(5,R$)
```


Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

*ESR? (Event Status Register) Query

This command reads the contents of the Standard Event Status Register. Reading this register clears it. It returns an integer, which when converted to a binary number represents the setting of the individual bits.

Syntax *ESR?

Return Format <register value><NL> ; <register value> = 0 to 255

Example The delay line received a value that was out of range and flagged an execution error. Note that since we are reading the standard event register the mask value of the standard event mask register is irrelevant.

```
HP  : OUTPUT 705;"*ESR?"<NL>
      ENTER 705;Event
```

Event1 will have the value 16, for the execution error.

```
CEC: R$=SPACE(10)
     CALL SEND(5,"*ESR?;",status%)
     CALL ENTER(R$,length%,5,status%)
     PRINT(R$);
```

The result is: 16.

```
NIC : CALL IBWRT(5,"*ESR?"+ CHR$(&H0A))
      CALL IBRDA(5,R$)
      PRINT(R$);
```

*IDN? (Identification) Query

This command allows the user to inquire about the origins of the instrument addressed. The instrument will return an <Arbitrary ASCII Response Data> element. The response consists of four fields separated by commas: Colby Instruments Inc, XXXX, YYYYY,VZZZZZ, where XXXX denotes the model number, YYYYY the serial number and VZZZZZZ the software revision version. The *IDN? query must be the last command in a <program message>. Any queries after *IDN? will be ignored.

Syntax *IDN?

Return Format <string><NL> ;

Example

```
HP  : DIM ID$(50)
      OUTPUT 705;"*IDN?"<NL>
```


Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

```
        ENTER 705;ID$
        PRINT(ID$)
```

The result : Colby Instruments Inc,PDL 10A,00123,V1.02

```
CEC: ID$ = SPACE(50)
        CALL SEND(5,"*IDN?",status%)
        CALL ENTER(ID$,length%,5,status%)
        PRINT(ID$)
```

The result : Colby Instruments Inc,PDL 10A,00123,V1.02

```
NIC : CALL IBWRT(5,"*IDN?" + CHR$(&H0A))
        CALL IBRDA(5,ID$)
        PRINT(ID$)
```

The result : Colby Instruments Inc,PDL 10A,00123,V1.02

*IST? (Individual Status) Query

The Individual Status Query allows the user to read the current state of the <ist> local message. The instrument's <ist> is the individual status that an instrument sends in response to a parallel poll. The state of this bit is determined by the Parallel Poll Enable Register and the corresponding status information. The device will return either "0" if FALSE or "1" if TRUE. The command allows the user to read the <ist> without performing a parallel poll.(Figure 4-xx).

Syntax *IST?

Return Format <ASCII byte><NL> ; <ASCII byte> = "0" or "1"

Example

```
HP  : OUTPUT 705;"*IST?"<NL>
        ENTER 705;ist
CEC: IST$ = SPACE(10)
        CALL SEND(5,"*IST?",status%)
        CALL ENTER(IST$,length%,5,status%)
NIC : CALL IBWRT(5,"*IST?" + CHR$(&H0A))
        CALL IBRDA(5,IST$)
```


Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

*OPC (Operation Complete) Command

The *OPC command enables synchronization of instruments. It tells the instrument to set bit 0 in the Standard Event Status Register when it completes all pending operations. Please refer to chapter 7 (programming examples) for a detailed discussion.

Syntax *OPC

Return Format 1<NL>;

Example
```
HP  : OUTPUT 705;"*OPC"<NL>
CEC: CALL SEND(5,"*OPC",status%)
NIC : CALL IBWRT(5,"*OPC" + CHR$(&H0A))
```

*OPC? (Operation Complete) Query

The *OPC? query command enables the user in synchronizing instruments. It places an ASCII character "1" into the output queue when all pending selected device operations have been completed. Please refer to chapter 7 for a detailed discussion.

Syntax *OPC?

Example
```
HP  : OUTPUT 705;"*OPC?"<NL>
      ENTER 705;Opc
CEC: PC$=SPACE(10)
      CALL SEND(5,"*OPC?",status%)
      CALL ENTER(OPC$,length%,5,status%)
NIC  CALL IBWRT(5,"*OPC?" + CHR$(&H0A))
      CALL IBRDA(5,OPC$)
```

*PRE (Parrallel Poll Enable Register) Command

The *PRE command is used to set specific bits in the parallel poll enable register. (Refer to figure 4-31) These bits act as masks for events occuring in the instrument to control the state of the <ist> local message and to generate a preprogammed response to a parallel poll. The data is defined as <Decimal Numeric Program Data>. The instrument will round this number to an integer following the IEEE conventions. Expressing this number in base 2 (binary) represents the values of the individual bits in the Parrallel Poll Enable Register.

Syntax *PRE <mask value> ; <mask value> = 0 to 65535

Example To set bit 4 (Message available) and bit 2 (Error Queue) one would issue the command:

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

```
HP  : OUTPUT 705;"*PRE 20"
CEC: CALL SEND(5,"*PRE 20',status%)
NIC : CALL IBWRT(5,"*PRE 20")
```

20 = 16 (for bit 4) + 4 (for bit 2).

*PRE? (Parrallel Poll Enable Register) Query

The *PRE? query returns the value stored in the Parrallel Poll Enable Register. This value will and can only be modified by the user. No operation or command exists to clear it directly. To reset it to zero one must issue a *PRE 0 command. After power up all enable registers will be reset to zero. The *PRE command will force all unused bits to remain at zero, so if you try to enable an used bit you will see no changes in its setting.

Syntax *PRE?

Return Format <mask value><NL> ; <mask value> = 0 to 65535

Example We want to enable the parallel poll enable status bit (32) and check if it was set in the instrument

```
HP  : OUTPUT 705;"*PRE 32;*PRE?"<NL>
      ENTER 705;Event
CEC: R$=SPACE(10)
      CALL SEND(5,"*PRE 32;*PRE?",status%)
      CALL ENTER(R$,length%,5,status%)
NIC : CALL IBWRT(5,"*PRE 32;*PRE?"+ CHR$(&H0A))
      CALL IBRDA(5,R$)
```

*RST (Reset) Command

The reset command performs a device reset. The unit will return to a predefined state as listed hereafter:

1) Initial a Microterminal if it is connected. 2) Ask to edit an out of range IEEE address if a MT is present 3) reset the delay line to its power up setting = 0 ps

Note: The reset command specifically will NOT affect:

1) The state of the IEEE488.1 interface
2) The selected address of the instrument
3) The output queue
4) The setting of status enable registers

Syntax *RST

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

```
HP  : OUTPUT 705;"*RST"
CEC: CALL SEND(5,"*RST",status%)
NIC : CALL IBWRT(5,"*RST")
```

*SRE (Service Request Enable) Command

The *ESE command is used to set specific bits in the service request enable register. (Refer to figure 4-30) These bits act as masks for bits to be set in the Status Byte Register and to eventually generate a service request. The data is defined as <Decimal Numeric Program Data>. The instrument will round this number to an integer following the IEEE conventions. Expressing this number in base 2 (binary) represents the values of the individual bits in the Service Request Enable Register.

Syntax *SRE <mask value> ; <mask value> = 0 to 255

Example To set bit 4 (Message available) one would issue the command:

```
HP  : OUTPUT 705;"*SRE 16"
CEC: CALL SEND(5,"*SRE 16",status%)
NIC : CALL IBWRT(5,"*SRE 16")
```

*SRE? (Event Status Enable) Query

The *SRE? query returns the value stored in the Servcice Request Enable Register. This value will and can only be modified by the user. No operation exists to clear it. To reset it to zero one must issue a *SRE 0 command. After power up all enable registers will be reset to zero. The *SRE command will force all unused bits to remain at zero, so if you try to enable an used bit you will see no changes in its setting.

Syntax *SRE?

Return Format <mask value><NL> ; <mask value> = 0 to 255

Example We want to enable the message available bit (16) and check if it was set in the instrument

```
HP  : OUTPUT 705;"*SRE 16;*SRE?"<NL>
      ENTER 705;Event
CEC: R$=SPACE(10)
      CALL SEND(5,"*SRE 16;*SRE?",status%)
      CALL ENTER(R$,length%,5,status%)
NIC : CALL IBWRT(5,"*SRE 16;*SRE?" + CHR$(&H0A))
      CALL IBRDA(5,R$)
```


Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

*STB? (Status Byte) Query

The *STB? query returns the value stored in the Status Register. The MSS (Master Summary Status) is reported in bit 6, not the RQS bit. The MSS bit indicates that there exist at least one reason for the instrument to request service.

Syntax *STB?

Return Format <mask value><NL> ; <mask value> = 0 to 255

Example
```
HP  : OUTPUT 705;"*STB?"<NL>
      ENTER 705;Event
CEC: R$=SPACE(10)
      CALL SEND(5,"*STB?",status%)
      CALL ENTER(R$,length%,5,status%)
NIC: CALL IBWRT(5,"*STB?" + CHR$(&H0A))
      CALL IBRDA(5,R$)
```

*TST? (Self Test) Query

The *TST? query command initiates an instrument self-test and reports of the outcome. The returned value is "bit weighted" where the individual bits have the following meaning:

Bit 0 :1 -Power supply failure
Bit 1 :2 -Rom error
Bit 2 :4 -Ram error
Bit 3 :8 -No Calibration

A returned value of zero indicates a successful test.

Syntax *TST?

Return Format <error value><NL> ; <error value> = 0 to 15

Example
```
HP  : OUTPUT 705;"*TST?"<NL>
      ENTER 705;Test
CEC: R$=SPACE(10)
      CALL SEND(5,"*TST?",status%)
      CALL ENTER(R$,length%,5,status%)
NIC : CALL IBWRT(5,"*TST?" + CHR$(&H0A))
      CALL IBRDA(5,R$)
```


Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

*WAI (Wait) Command

The *WAI command is designed for instruments that can execute multiple tasks simultaneously. The instrument will finish all tasks in execution and wait to continue executing commands or queries after the *WAI command. Since the PDL series does not implement overlapped commands, all previous commands or queries will have completed when encountering the *WAI command.

Syntax *WAI

Example
```
HP  : OUTPUT 705;"WAI"<NL>
CEC: CALL SEND(5,"*WAI",status%)
NIC : CALL IBWRT(5,"*WAI" + CHR$(&H0A))
```


Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

6. System Commands

6.1 Introduction

Contrary to the set of "common commands" described in the previous chapter the system commands are specific to the PDL series instruments.

6.2 System Command Summary

Figure 6-1 gives an overview of the system commands implemented in the PDL series

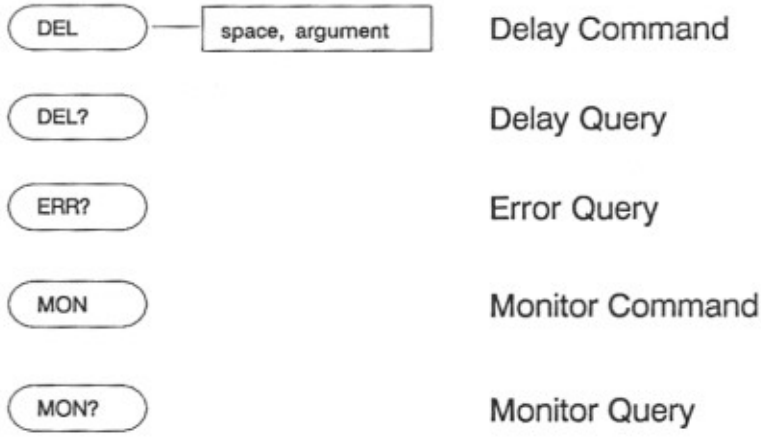


Figure 6-1

DEL (Delay) Command

The DEL command sets the delay of the unit. It accepts <NR1,2,3> data. The data must correspond to the resolution that the instrument is capable of achieving. For example : A unit with a maximum delay of 625ps with the 0.5ps stepper motor option will flag an error with a value of 450.6ps, because it can only be set in 0.5 ps increments. If this same unit is in the 312.5ps mode the fractions can only be 0, .25, 0.5, 0.75, all others will generate an error.

Syntax DEL <delay value> ; <delay value> = <NR1,2,3>

Example We would like to set the delay to 123 ps.

```
HP  : OUTPUT 705;"DEL 123 ps"<NL>
CEC: CALL SEND(5,"DEL 0.123 ns",status%)
NIC : CALL IBWRT(5,"DEL 123E-12" +CHR$(&H0A))
```


Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

DEL? (Delay) Query

The DEL? query command is used to return the current delay setting of the unit. The value returned is an <NR3>.

Syntax DEL?

Return Format <delay value><NL>;<delay value> = <NR3> = x.xxxxxE+yy

where (x..x) is a 4 digit mantissa and (yy) a two digit exponent.

Example

```
HP  : OUTPUT 705;"DEL?"<NL>
      ENTER 705;Delay
CEC: R$=SPACE(20)
      CALL SEND(5,"DEL?",status%)
      CALL ENTER(R$,length%,5,status%)
NIC : CALL IBWRT(5,"DEL?"+ CHR$(&H0A))
      CALL IBRDA(5,R$)
```

ERR? (Error) Query

The PDL series of instruments manages an error queue that collects explicit error messages. The ERQ bit in the status byte register indicates if error messages are present. Upon receiving the ERR? query command the unit will transfer the data to the output queue to be read by the controller in charge. Since the return format is an <arbitrary ASCII response data> the ERR? query should be the last query command in the <program message>.

Syntax ERR?

Return Format <arbitrary ASCII response data>

Example

```
HP  : DIM Error$(100) OUTPUT 705;"ERR?"<NL>
      ENTER 705;Error$
CEC: R$=SPACE(100)
      CALL SEND(5,"ERR?",status%)
      CALL ENTER(R$,length%,5,status%)
NIC : CALL IBWRT(5,"ERR?"+ CHR$(&H0A))
      CALL IBRDA(5,R$)
```


Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

MON (Monitor) Command

The PDL series includes a useful feature for debugging the sequencing of operations. The MON (monitor) command toggle will instruct the device controller to send all received commands and queries, data and errors to the Microterminal. A Microterminal is required in this case. The user can follow the data sent to the unit and the response to queries. It will also display status messages when queues fill or protocol exceptions occur. After power up the monitor feature is disabled or "off".

Syntax MON

Example Assume the monitor feature is turned off. To turn it on:

```
HP  : OUTPUT 705;"MON"<NL>
CEC: CALL SEND(5,"MON",status%)
NIC : CALL IBWRT(5,"MON" +CHR$(&H0A))
```

MON? (Monitor) Query

The MON? query allows the user to find out if the monitor feature is enabled or disabled. A string is returned.

Syntax MON?

Return Format <string data> ; <string data> = "ON" or "OFF"

Example

```
HP  : DIM Monitor$(10)
      OUTPUT 705;"MON?"<NL>
      ENTER 705;Monitor$
CEC: R$=SPACE(10)
      CALL SEND(5,"MON?",status%)
      CALL ENTER(R$,length%,5,status%)
NIC : CALL IBWRT(5,"MON?"+ CHR$(&H0A))
      CALL IBRDA(5,R$)
```


Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

7. Programming Examples

Chapter 5 and 6 have already given very simple programming examples with the description of the common and system commands. This chapter will describe in more detail a series of examples to help the user with the implementation of the new IEEE488.2 command structure and the various ways of synchronizing events in a test set up. The following listings have been written for a CEC (Capital Equipment Corporation) IEEE interface board installed in an IBM AT compatible personal computer. CEC offers a handy Co-Operator (tm) program that allows quick setups and testing of a GPIB setup. The examples are written in GWBASIC 3.2. The delay line address is assumed to be set to 5, the factory setting.

7.1. For the Newcomer

The following program listing can be very useful in getting acquainted with the basic commands and instrument responses. Being barely a little over half a page long it should take little time to enter it into your system. It will make you feel more comfortable when you later use these commands in a large application program.

```
10   DEF SEG = &HC400                          'SET IEEE PROGRAM ADDRESS
20   INITIALIZE = 0                            'SUBROUTINE OFFSET
30   MY.ADDRESS% = 0                           'CONTROLLER'S ADDRESS
40   CONTROLLER% = 0                           'BE A CONTROLLER
50 '
60   CALL INITIALIZE(MY.ADDRESS%,CONTROLLER%)'INITIALIZE BOARD
70   TRANSMIT = 3
80   T$ = "UNL LISTEN 5 PPC CMD 104"           'DO A PP1 PARALLEL POLL
90   CALL TRANSMIT(T$,STATUS%)                 'CONFIGURE TO RESPOND ON
100   SEND = 9                                 'DATA LINE D0
110 '
120   INPUT "COMMAND";S$                       'USER INTERFACE PROGRAM
130   IF S$ = "QUIT" OR S$ = "quit" THEN 340   'IF QUIT GO BACK TO DOS
140   IF S$ = "SPOLL" OR S$ = "spoll" THEN 360 'DO A SERIAL POLL
150   IF S$ = "PPOLL" OR S$ = "ppoll" THEN 420 'DO A PARALLEL POLL
160 '
170   ADDRESS% = 5                             'SIMPLE SEND MESSAGE ROUTINE
180   CALL SEND(ADDRESS%,S$,STATUS%)
190   B$ = "?"                                 'LOOK FOR A QUESTION MARK
200   FOR J = 1 TO LEN(S$)
210   IF B$ = MID$(S$,J,1) THEN 250            'IF WE FOUND ONE, RETRIEVE DATA
220   NEXT J
230   GOTO 100                                 'NO ?, GET NEXT COMMAND
240 '
250   ENTER = 21                               'SIMPLE ENTER DATA ROUTINE
260   R$ = SPACE$(100)                         'RESERVE SPACE
270   ADDRESS% = 5
280   CALL ENTER(R$,LENGTH%,ADDRESS%,STATUS%)
290   R$ = LEFT$(R$,LENGTH%)                   'TRIM RECEIVED STRING
300   PRINT "QUERY RESULT:";R$                 'PRINT OUT RESULTS
```


Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

```
310   PRINT "STATUS:";STATUS%
320   GOTO 100                              'GET NEXT COMMAND
330 '
340   SYSTEM                                'GO BACK TO DOS
350 '
360   SPOLL=12                              'SERIAL POLL ROUTINE
370   ADDRESS%=5
380   CALL SPOLL(ADDRESS%,POLL%,STATUS%)
390   PRINT "POLL:";POLL%;"STATUS:";STATUS%
400   GOTO 100
410 '
420   PPOLL=15                              'PARALLEL POLL ROUTINE
430   CALL PPOLL(POLL%)
440   PRINT "PPOLL:";POLL%
450   GOTO 100
```

This program will start by prompting: COMMAND ? and waiting for a command you would like to send to the instrument. If you send a query the instrument will be asked to send its response data after it received the query. This simple little program allows you also to perform a serial and parallel poll by entering "spoll" or "ppoll", respectively. To exit just type "quit". The same program with minor modifications can also be made to run on other computers with different interface cards. The following miniature tutorial assumes that you are using above or similar program. We assume you have turned on the delay line, that the display (if available) shows "Delay=0ps" or similar and that the IEEE address setting switches correspond to an address of 5.

Since we are taking this step by step, we want the instrument to monitor the messages or errors that it is receiving or encountering:

COMMAND ? mon

The command "mon" enables this feature. We assume you have a Microterminal hooked up, otherwise this command has no effect. The display will show MON, and after a while redisplay the delay value. This delay was introduced to allow maximum IEEE488 bus transfer speed. The controller inside your instrument monitors this activity and times out a few seconds until it updates the display. Maximum data transfer can only be achieved if the monitor mode has been turned off. To do that you would again send the command "mon".

Here is a useful feature if you are not sure if the instrument responded according to your command :

COMMAND ? err?

The error query will take all previously accumulated error messages and send them back to your computer when the instrument is addressed to talk. If you have a Microterminal attached, you will notice an "*" instead of a "=" sign between delay and 0ps. This means the unit has switched to remote mode disabling all terminal keys except the REMOTE key which when pressed will set the URQ bit in the standard event register.

QUERY RESULT:0 STATUS:0

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

indicates that everything went well so far. If status should be 8, it means that a time out occurred, the instrument did not send anything back because it was turned off or wrongly addressed. Check the setting and turn the unit off. Wait a few seconds to turn it back on. If you still don't get a response look in appendix B (trouble shooting).

But we didn't have any problems and will now try the following:

COMMAND ? del 232 ps

will set the delay line to 232 ps. Let's check if we actually have that delay:

COMMAND ? del?

QUERY RESULT:2.3200E-10 STATUS:0

Yes, it worked out fine. If this unit was the only one to be controlled our discussion could end here, but we need more features to allow proper interaction with other equipment such as data aquisition systems. There are various means to find out if the delay setting has been reached and is ready to be used. The first one described might be the simplest:

COMMAND ? del 624ps ; del?

The unit will start setting the delay while your computer is waiting to receive a message containing the new delay setting. This method is actually quite useful since it checks if your setting was valid and has been accepted. When the unit finishes you will receive the response:

QUERY RESULT:6.2400E-10 STATUS:0

You know that the delay line is ready and that it is set at the desired value. What is the problem with this approach? It is slow. While your computer is waiting to receive the messgae all bus traffic is held up. Your controller can use the relatively slow process of physically adjusting the delay line to setup other instruments or to do other internal program tasks. There are two main approaches: The most economic and efficient one is to use the serial poll feature to generate an interrupt in your system. The interrupt capabilities of each system vary so we will not present any results but show you how to set it up:

COMMAND ? *ESE 1;*SRE 32

The first command enables the Operation Complete Bit in the standard event register to set the ESB bit in the status byte register. The second command enables the ESB bit to create a Service Request. It could be helpful to also look at the status structures described at the end of chapter 4. We are now ready to generate a Service Request once the delay line has reached its position:

COMMAND ? del 0;*opc

The new command is *opc. It tells the unit to set the Operation Complete Bit in the standard event register when it completed all its tasks. If you installed an interrupt routine in your program, it would now branch to this part and it is up to you to find out who is requesting service on the bus.

COMMAND ? spoll

POLL:96 STATUS:0

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Should be the answer if you did not add anything to above program. Decimal 96 is equivalent to 0110000 binary, a little computer math calculator can come in handy for these conversions. We see that the RQS bit (6) has been set. The unit is actually requesting service. Bit 5, the ESB bit is also set, telling us that something happened and is being indicated in the ESR. Let's take a look:

COMMAND ? *esr?

QUERY RESULT:1 STATUS:0

Indeed, the unit has completed its operation and has set the OPC bit. By the way, by reading this register we have also cleared it. Also, when the computer performs a serial poll, the unit will clear the RQS bit in the status byte, unless another reason for a service request exists. Setting up interrupts can be a rather streneous enterprise. Some IEEE488 controller manufacturers will also sell specific "interrupt" software, if you try on your own, make sure you have plenty of documentation and a quick finger on the system reboot button. An alternative to the sometimes temperemental use of interrupts is polling. Experience shows that most programs are circular and also spend lots of time just waiting for a keyboard entry. By regularly checking the instruments one can find out if a desired setup has been reached. One could just perform serial polls over all instruments, a rather slow process. The parallel poll feature can speed up things quite a bit. The PDL series is fully remotely configurable and this little program we are using has already installed the feature after initialization.

COMMAND ? *PRE 32; *SRE 0

We have now enabled the parallel poll response to set bit 0 on the IEEE data lines. We also disabled any possible service request, this is not necessary, you can work both at the same time.

COMMAND ? DEL 2.01223022033e-10;*OPC

You should hear the unit humming to its new position. Try to quickly:

COMMAND ? ppoll

PPOLL:0

If you get above result you were faster than the unit, but since the unit only had to move less than half way, you probably got:

PPOLL:1

Which means the unit was faster.

This pretty much covers the most useful features. Plenty of written material exists to help setting up systems and efficiently using them. A list of publications appears in appendix E.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Appendix A - System and Error Messages

A.1 Hardware related

Mechanical Error	The unit reached the end position sensor or currently resides in it, but can't move. Possibly a mechanical malfunction.
Supply Failure	The stepper motor is not receiving the appropriate power from the power supply.
Calibration Test	A calibration test is under way. Normally the calibration is checked after power up. If you feel more confident to use it before a measurement this test can be performed.
Cal. went o.k...	The calibration test completed successfully.
ROM failure	The Eprom containing the program has been found to be defective.
RAM failure	The RAM has been found to be defective
No Calibration	The unit could not calibrate itself. This may not be a fatal error. The unit can still be operated but its absolute position at "0 ps" may not correspond to the original factory setting.

A.2 IEEE488.1 related

CONTROLLER ???	The IEEE488 interface has received the command to take control. The PDL series is not designed to be a BUS controller. To avoid any ambiguous system and bus states the IEEE interface is reset.
Remote Mode	The system has switched to remote mode. See also Chapter 3. The "*" also indicates this state. The only active key remaining is the REMOTE key which sets the URQ bit in the standard event register.
Local Mode	The system has returned to local mode. Full control is restored to the Microterminal.
Terminal Lockout	All Microterminal keys are disabled.
No listener	The unit has been told to talk without a listener on the bus. The unit will wait until a listener has been established and then send its data.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

A.3 IEEE488.2 related

Clearing System	An SDC or DCL message has been received. All event registers are cleared, and queues flushed.
INTERRUPTED	The unit still had data to send but was interrupted from doing so by a new program message. The unsent data is lost. QYE is set. The output queue is flushed.
DEADLOCK	Both input buffer and output queue are full and the controller must continue sending data before reading the queue. Further message generation is stopped. QYE is set. Output queue is flushed.
UNTERMINATED-1	An incomplete message was received. The parser is reset. QYE is set Output queue is flushed.
UNTERMINATED-2	The unit has been asked to talk but no query command has been send previously. QYE is set.
UNTERMINATED-3	Nothing to say. No flags. No queue changes.
In-buffer full !	The Input Buffer has filled and parsing, executing has begun. The controller will have to wait until the unit can accept more data.
O-queue full !	The output queue has filled. The instrument will now try to send as much data to the controller as possible. It then will continue parsing and executing. If a <PMT> has not been encountered the unit will continue to accept data from the controller unitl the input queue has filled. If it can't do so it will enter the DEADLOCK condition
E-queue full !	The output error queue has filled. Further error messages are ignored.

A.4 Messages from ERR? Query

The format of the returned message follows the following convention:

error number;"command";"argument";reason for error;error type

where

error number :	each bit in error number when displayed in binary format contains the reason for error and the error type
"command" :	this field lists the command that caused the error
"argument" :	this field lists the argument that caused an error
reason for error :	it gives an english explanation
error type :	the error definitions as stated in the IEEE488.2 standard

Note: If multiple errors occur, the "error number" will contain the "OR"ed result of all the errors. The "error number" is only generated once when sending the "err?" query and placed at

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

the beginning of the response message, so that your application program can make use of it easily.

A.4.1 Command errors:

1;	Parsed command unknown;	Command error

The command sent to the instrument could not be interpreted.

2;	Command length exceeded;	Command error

The command sent was longer than 12 characters.

4;	Semicolon expected;	Command error

The parser expected the beginning of a new command.

A.4.2 Execution errors:

8;	Numeric argument expected;	Execution error

The command sent expects a numeric argument. None was found.

16;	Numeric argument too long;	Execution error

The numeric argument sent with the command exceeded the maximum length of 274 digits and characters.

32;	Value out of bounds;	Execution error

The numeric argument lies outside the range that the instrument can accomodate.

64;	Invalid numeric argument;	Execution error

When using the "#" modifier, an error was discovered in the format of the binary, octal or hexadecimal number representation.

128;	Unknown suffix data;	Execution error

An unknown or illegal suffix multiplier or unit has been found.

256;	Integer Value not 0-255;	Execution error

The instrument expected a value in this range, a NR1 data type.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

A.4.3 Device dependent errors:

512; Illegal Stepsize value;

In some models of the PDL series only discrete values in increments of 0.5 or 0.25 ps are allowed. The value received violates the possible minimum delay step size.

1024; Fatal supply failure;

The unit regularly checks on the motor supply power. An error was detected.

2048; Fatal positioning error;

The unit has moved mechanically past its allowed range. A mechanical problem exists.

4096; No Microterminal present;

A command was encountered that logically requires the presence of a Microterminal. If you powered up the unit without a Microterminal attached you will receive this error message after having sent the "MON" command. To reenable operations through the Microterminal you must power the unit off, connect the Microterminal and power the unit back on.

A.4.4 Summary of Error Codes

Table A-1
Summary of Error messages and their weighting

Weight	Description
1	Parsed command unknown
2	Command length exceeded
4	Semicolon expected
8	Numeric Argument Expected
16	Numeric argument too long
32	Value out of bounds
64	Invalid numeric argument
128	Unknown suffix data
256	Integer value not 0-255
512	Illegal stepsize value
1024	Fatal supply failure
2048	Fatal positioning error
4096	No Microterminal present

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

A.5 Microterminal Specific

Funct:1,2,3,4,5	The function key was pressed and the MT is waiting for your choice of available functions. Press a key from 1 to 5.
Not available..	This particular function is not available in this PDL model.
Address x OK=1?	The unit is waiting for you to confirm the IEEE address setting. If the address is correct, type a 1. If you want to change the setting perform the necessary switch settings on the back panel and push the 0 key (see also appendix C).
Error => T	Transmission Error. The Microterminal could not switch into its serial terminal mode due to an unreconized character sequence after power up. Turn the unit off and on again.

The following errors may occur when unstable power line conditions exist. Before contacting the manufacturer, attempt to restart the instrument by repeatedly turning the power on and off again. The errors listed below are fatal. The manufacturer should be contacted for an authorized RMA number for repair.

Error => R	The microcontroller RAM has found to be defective.
Error => C	The unit could not calibrate.
Error => V	The voltage levels are incorrect.
Error => P	The power delivered to the motor is inadequate.
Error => M	The program memory has been found to be defective.
Error => D	The display memory is defective.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Appendix B - Trouble Shooting

This appendix should help the user narrow down problem areas in case the unit does not perform as predicted.

B0.1 No power, Power Indicator Off

Check if the AC supply chord is attached properly to the power entry module. If there is still no power remove the AC cable and use a little screw driver to flip open the fuse and voltage selector from the top. Make sure the fuse is in the right compartment and the the two white arrows line up. Also check the fuse.

B0.2 No response on the GPIB

After power up with a Microterminal attached the system might ask you to select the mode of operation. Before pressing the appropriate key, all system functions will be blocked. Also check if the address setting corresponds to the listen address you are sending. Make sure all interface cables are attached and locked properly.

B0.3 Microterminal doesn't respond

In General: If errors appear on the display, the unit will "beep" for approx. 5 seconds and restart a SELF TEST. It will continue to do so until the power is cut.

Make sure the connections are in place and locked. If you started the unit (GPIB) without a microterminal it will not recognize it if you make the connection. You should power the unit down, attach the Microterminal and power the unit back on.

B0.4 SELF TEST errors

The Microterminal senses for a low and high supply voltage under load. If your line voltage exceeds the input range specified in the specifications (chapter 2), the terminal will display a "V" or "P" error.

Remedy: Measure your line voltage. Turn the unit off and back on.
If your line voltage is correct, the unit might be defective.

B0.5 Can't change the mode

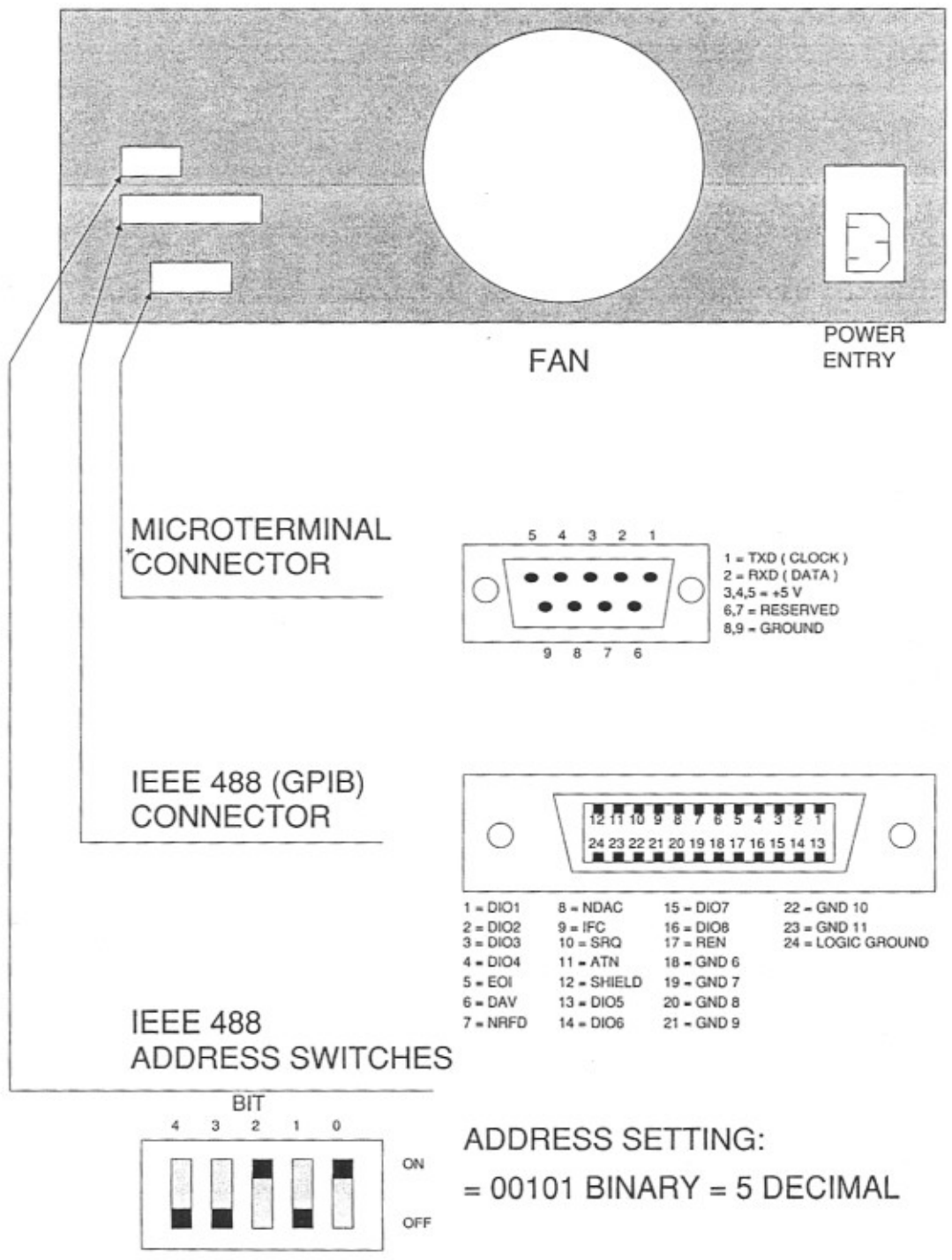
Once the mode has been set after power up, only a power down and up cycle will allow you to initialize to a different mode.

B0.6 Calibration Test

The unit uses a slotted optical switch to realign itself after power up. This assures that with each use the unit will produce repeatable results. Even if the unit cannot complete the calibration, it might still perform flawlessly. If this test fails repeatedly, the unit has started to wear out mechanically or some other defect might exist.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

BACKPANEL



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Appendix D - Grounding

Following established safety codes, the instrument case and therefore also the input connectors are connected to the ground wire of the AC supply wire. No part of the electronics that controls the instrument is connected with this ground. The IEEE488 signal return lines and the shield connection have been left floating to allow central grounding and prevent RF grounding problems. If you decide to float the chassis ground there will be no electrical connection between the RF and any other ground in the system.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Appendix E - References and Reading List

1) IEEE Standard Digital Interface for Programmable Instrumentation
ANSI/IEEE Std 488.1-1987
The Institute of Electrical and Electronics Engineers, Inc. 345 East 47th Street, New York, NY 10017, USA

2) IEEE Standard Codes, Formats, Protocols, and Common Commands
ANSI/IEEE Std 488.2-1987 The Institute of Electrical and Electronics Engineers, Inc. 345 East 47th Street, New York, NY 10017, USA

3) Tutorial Description of the Hewlett-Packard Interface Bus
1980
Hewlett-Packard Company, 4 Choke Cherry Road, Rockville, MD 20850, USA

4) PC< >488 Programming and Reference Manual
1987
Capital Equipment Corporation, 99 South Bedford Street #107, Burlington Massachussets 01803

5) GPIB < > PC IEEE 488 Instrumentation Interface Manual
April 1988 Edition P# 320014-01
National Instruments Corporation, 12109 Technology Blvd
Austin, Texas 78727

6) Microwave and RF
Programmable Delay tunes 1 ps steps with 30ps rise time
Vol. 27, No. 8, August 1988, p145 ff

5) IEEE-488 General Purpose Instrumentation Bus Manual
Anthony Carisiti, Amerite Corporation, ISBN:0-12-159820-9, March 1989
Academic Press, 1250 Sixth Avenue, San Diego, CA 92101-9665

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP