

# **DAP 1216a & DAP 2416a Manual**

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*Installation Guide and  
Connector Reference*

*Version 1.10*

**Microstar Laboratories, Inc.**

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# Contents

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<b>Contents</b> .....	<b>iii</b>
<b>1. Introduction</b> .....	<b>1</b>
<b>2. Installation, Testing, &amp; Troubleshooting</b> .....	<b>3</b>
Data Acquisition Processor Handling Precautions.....	3
System Requirements.....	3
Standard Configurations .....	4
Installing the Data Acquisition Processor .....	4
To Install the Data Acquisition Processor: .....	4
Installing DAP Software .....	5
To Install Data Acquisition Processor Software: .....	5
Testing Installation.....	6
Troubleshooting.....	7
<b>3. Advanced Installation Options</b> .....	<b>11</b>
Nonstandard Configurations .....	11
The INSTALL Program .....	13
Device Driver Configuration.....	15
The ACOMINIT Program.....	16
Com Pipe Configuration .....	16
P Parameter Size .....	19
DAP-to-DAP Communication .....	20
The DAPLINIT Program .....	22
Installing Several Data Acquisition Processors.....	23
Installation on a Network.....	24
DAPL Licensing .....	24
Removing Data Acquisition Processor Software .....	25
<b>4. DAP 1216a &amp; DAP 2416a Connectors</b> .....	<b>27</b>
Analog Input/Output Connector.....	30
Digital Input/Output Connector .....	33
Output Clock Connector .....	36
Shunts .....	36
Analog Signal Path Selection.....	37
Analog Signal Path Configuration .....	37
Channel List Selection .....	39
Analog Output Voltage Range Selection .....	40
Digital Output Reset Polarity Jumper .....	40
Input/Output Synchronization Header .....	40
Synchronization Connector.....	41
<b>5. Analog Input Circuits</b> .....	<b>43</b>
Analog Input Circuits.....	43
Programmable Gain Amplifier .....	44

<b>6. Clocks and Triggers .....</b>	<b>45</b>
Software Triggers vs. Hardware Triggers for Input .....	45
External Input Clock.....	46
Early External Input Clock Edges.....	48
Input Pipeline Timing.....	49
External Output Clock.....	50
Hardware Input Trigger .....	50
Hardware Output Trigger.....	52
Timing Considerations.....	53
Input Clocking Startup Considerations.....	53
Using the Input Trigger with External Input Clocking .....	54
Using the Output Trigger with External Output Clocking .....	54
Timing tables .....	55
<b>7. Recalibration.....</b>	<b>57</b>
CALDAP .....	57
Equipment Requirements.....	58
Connector Numbering .....	58
Preparing the Data Acquisition Processor .....	59
Starting CALDAP.....	59
Calibrating the Data Acquisition Processor .....	61
<b>Appendix A: Declaration of Conformity .....</b>	<b>63</b>
<b>Index.....</b>	<b>65</b>

## 1. Introduction

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The Data Acquisition Processor from Microstar Laboratories is a complete data acquisition system that occupies one expansion slot in a PC. Data Acquisition Processors are suitable for a wide range of applications in laboratory and industrial data acquisition and control.

Both the DAP 1216a and DAP 2416a:

- have an onboard Intel 80C188XL processor
- have 16-bit analog-to-digital converters.
- are completely compatible with other a-Series Data Acquisition Processors.

In addition, the DAP 2416a has a Motorola DSP 56001 coprocessor.

The DAP 1216a and DAP 2416a use DAPL as the onboard operating system, which is optimized for the 16-bit processors used by these boards.



## 2. Installation, Testing, & Troubleshooting

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Installing the DAP 1216a or DAP 2416a involves the following steps:

1. If necessary, change jumper settings on the Data Acquisition Processor (see Chapter 4).
2. Install the Data Acquisition Processor.
3. Install the DAP Software.
4. Test the Installation.

Installation instructions are provided in this chapter. Advanced installation information is provided in Chapter 3. If there are any problems with installation, please read the troubleshooting guide at the end of this chapter.

### Data Acquisition Processor Handling Precautions

Static control is required for handling all electronic equipment. The Data Acquisition Processor is especially sensitive to static discharge because it contains many high-speed analog and digital components. To protect the Data Acquisition Processor, observe the following precautions:

- Wear a grounding strap when handling the Data Acquisition Processor. If it is not possible to use a grounding strap, continuously touching a metal screw on a grounded PC offers protection.
- If it is necessary to transport the Data Acquisition Processor outside of the PC, be sure to shield the Data Acquisition Processor in a conductive plastic bag. If a conductive bag is not available, shield the Data Acquisition Processor by wrapping it completely in aluminum foil. Do not ship or store a Data Acquisition Processor in plastic peanuts without suitable shielding.

Static damage to analog components can cause subtle problems, including oscillation, increased settling time, and reduced slew rate. If you suspect that a Data Acquisition Processor has been affected by static discharge, return it to Microstar Laboratories for testing, repair, and quality control.

### System Requirements

The Data Acquisition Processor is compatible with 16-bit ISA or 32-bit EISA slots in AT/386/486/Pentium computers and requires version 3.0 or higher of DOS.

## Standard Configurations

The Data Acquisition Processor is factory-configured to use interrupt 2 and I/O addresses in the range 220-22F (hexadecimal). This configuration does not conflict with most standard PC hardware. If you have nonstandard PC hardware or if any installed cards that use the same interrupt vector or I/O address as the Data Acquisition Processor, please read [Chapter 3](#) before proceeding with installation.

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Note: Some sound cards are known to use I/O addresses in the 220-22F range. If your system has a sound card, check the configurations.

---

Interrupt and I/O address conflicts may cause subtle or obvious problems in your PC. After installing the Data Acquisition Processor, if your PC does not operate properly, check that there are no configuration conflicts.

## Installing the Data Acquisition Processor

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Caution: Do not install the Data Acquisition Processor while the PC is on.

---

### To Install the Data Acquisition Processor:

1. Make any necessary changes to the hardware settings. Interrupt vector and I/O address information is provided in [Chapter 3](#). [Chapter 4](#) provides information about setting other hardware options. The default hardware settings are correct for msot systems.
2. Turn off the PC and remove the PC's cover.
3. Insert the Data Acquisition Processor into any free slot.

The Data Acquisition Processor requires approximately 15 Watts from the PC's power supply. If your system behaves erratically with the Data Acquisition Processor installed, the PC may need a larger power supply.

## Installing DAP Software

Before installing the DAP Software, make backup copies of the diskette(s). Put the originals in a safe place, and use the backup disks for installation.

### To Install Data Acquisition Processor Software:

1. Install the Data Acquisition Processor, as previously described.
2. Insert the DAP software disk into the PC's diskette drive.
3. At the DOS prompt, type A: /I NSTALL.
4. Follow the on-screen instructions.

INSTALL prompts for configuration information including Data Acquisition Processor type and software destination directories. INSTALL provides information about each step to guide you through the installation process and provides options for copying DAPview and other software and Data Acquisition Processor support software to your PC.

INSTALL copies several files to your boot disk and adds information to your system configuration files CONFIG.SYS and AUTOEXEC.BAT. Backup copies of these files are created with the .BAK extension so that the original versions can be recovered.

## Testing Installation

After running the INSTALL program, verify that software installation was successful by rebooting your PC. Before you see the DOS prompt, the following lines should appear on your screen:

```
ACCEL device driver 4.3
ACCEL driver initialization completed
DAPL initialization completed
```

The exact lines may vary slightly, depending upon configuration options. If a line is missing or if an error message appears, see the Troubleshooting section in this chapter.

When the DOS prompt is displayed, set the current directory to your DAPview directory and run DAPview by entering the following command:

```
DV
```

DAPview allows you to communicate interactively with the Data Acquisition Processor. Now everything you type at the PC keyboard is sent to the Data Acquisition Processor and all Data Acquisition Processor messages are printed on your screen. When the DAPview program begins, the following lines should be displayed on your screen:

```
*** DAPview [1.2] ***
*** DAPL Interpreter [4.XX XX/X] Serial # XXXXX ***
#
```

The appearance of the # prompt indicates that the Data Acquisition Processor is installed correctly. If the # prompt does not appear or if DAPview issues an error message and terminates, you have not established communication with the Data Acquisition Processor. Turn to the end of this chapter for [troubleshooting hints](#).

---

Note: To exit from DAPview, press the Ctrl and Z keys simultaneously.

---

The number sign (#) indicates that the Data Acquisition Processor is waiting for a command. At this time you can enter DAPL commands from the keyboard or load DAPL command files. Sample applications are provided in the Applications Manual. The Systems Manual contains more information about DAPview.

## Troubleshooting

The Systems Manual contains a list of the error messages which may be printed during software installation and system boot. The following errors commonly result from installation problems:

INSTALL prints an error message.

Find the error message in the "System Messages" chapter of the Systems Manual.

At system startup, the "ACCEL device driver 4.3" message is not printed. OR

DAPview prints the error message "Host communication port is uninitialized"

Check that the file CONFIG.SYS is present on your boot volume. If this file was not present before installation, it should have been placed on your boot volume by INSTALL. If the file CONFIG.SYS is present, check that it includes the line

```
DEVICE=x:\yyy\ACOM.SYS . . .
```

The "x" character should be the letter of your boot disk. "yyy" should be the correct directory where the file ACOM.SYS is located. If CONFIG.SYS is not on your boot volume, or if the ACOM.SYS line of the file CONFIG.SYS is incorrect, use INSTALL again, being careful to install the software on the correct volume.

The message "Bad or missing ACOM.SYS" is printed.

The file ACOM.SYS probably was not copied by INSTALL from the Data Acquisition Processor diskette to your boot volume. Use INSTALL again, being careful to install the software on the correct volume.

When your system is booted, one of the following messages is printed:

```
DAP hardware not found or improperly configured
DAP interrupt conflict
DAP interrupt selection error
```

These messages suggest a hardware conflict with another card in the PC; one or more of the Data Acquisition Processor configuration jumpers may need to be changed to resolve the conflict. See [Chapter 3](#).

At system startup, the message "ACCEL driver initialization completed" is not printed.

If an error message is printed by the ACOMINIT program, find the error message in the Systems Manual. If no error message is printed, check that the AUTOEXEC. BAT file on your boot volume contains a line beginning with the command ACOMINIT. If no ACOMINIT line is found, use INSTALL again, being careful to install the software on the correct volume.

At system startup, the message "DAPL initialization completed" is not printed.

If an error message is printed by the DAPLINIT program, find the error message in the Systems Manual. If no error message is printed, check that the AUTOEXEC. BAT file on your boot volume contains a line beginning with the command DAPLINIT. If no DAPLINIT line is found, use the INSTALL program again, being careful to install the software on the correct volume.

DAPview issues the error message "Could not establish communications" OR DAPview does not display a DAPL # prompt.

The Data Acquisition Processor is not communicating with your PC. This may indicate that an error occurred at boot time. Check that no error messages are printed when you boot your system.

If your PC has cards other than those listed at the beginning of the chapter, a card may be interfering with communications. Remove optional cards, boot the PC, and try using DAPview again.

Check that the configuration jumpers on the Data Acquisition Processor are correct. See [Chapter 3](#) for the correct jumper selections. Check also for consistency between the jumper settings and the settings on the ACOM. SYS line in the file CONFIG. SYS.

A final possibility is that the Data Acquisition Processor may be faulty. If you suspect that this is the case, call Microstar Laboratories. When calling for installation support, please open your PC case so that the Data Acquisition Processor jumpers are visible, and be ready to provide the following information:

- the serial and model numbers of your Data Acquisition Processor.
- the contents of your AUTOEXEC.BAT and CONFIG.SYS files.
- a list of all hardware boards installed in your computer.

Your PC keyboard locks up when DAPview is started and does not accept the Ctrl-Z key.

Your PC may have an old style keyboard. Try starting DAPview with one of the following command line options:

```
DV /K1  
DV /K2
```

DAPview issues the error "Help file DV.HLP not found."

Check that the file DV.HLP has been copied to the directory containing the DAPview files. Check also to make sure the file AUTOEXEC.BAT has the line:

```
SET DV=C:\DV
```

Replace C:\DV with the drive and directory containing the DV.HLP file.



### 3. Advanced Installation Options

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Installation for standard hardware configurations is described in [Chapter 2](#). This chapter covers installation in more detail.

#### Nonstandard Configurations

The Data Acquisition Processor uses two resources from the host PC:

- an interrupt vector
- a range of I/O addresses

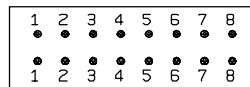
The Data Acquisition Processor allows several interrupt vector and I/O address selections. The interrupt vector may be 2, 3, 4, or 5. When selecting an interrupt vector, note the following interrupt vectors used by standard cards:

EGA/VGA	2
serial port COM2	3
serial port COM1	4
parallel port #2	5
hard disk controller on IBM XT	5
parallel port #1	7

The Data Acquisition Processor is shipped configured to use interrupt 2. EGA and VGA video adapters potentially can use interrupt 2, but most applications do not use this capability. Since interrupt 2 does not conflict with any other standard hardware, this is the default Data Acquisition Processor interrupt vector.

If any other cards are installed, determine the interrupts used and select a Data Acquisition Processor interrupt number distinct from these. Depending on the selection, the host computer may lose access to one of the serial COM ports or one of the parallel ports.

To change interrupt vectors, locate the 16-pin HOST CONFIGURE connector:



J10 HOST CONFIGURE

This connector is directly above the gold fingers on the Data Acquisition Processor printed circuit board.

The following table gives the four possible interrupt selections:

<b>Interrupt Vector</b>	<b>Jumper</b>
2	pin pair 7
3	pin pair 4
4	pin pair 5
5	pin pair 6

To change the interrupt, remove the jumper and replace it according to this table. Note that exactly one of the pin pairs 4, 5, 6, and 7 should be connected.

When the interrupt is changed, the INSTALL program must be informed of the new interrupt selection. When running INSTALL, select the DAP 0 button and select the interrupt number that matches the interrupt of the Data Acquisition Processor.

In addition to an interrupt vector, the Data Acquisition Processor uses a range of I/O addresses. If a sound card or any nonstandard cards are used in the host PC, check that the Data Acquisition Processor I/O addresses do not conflict with those cards.

The Data Acquisition Processor is shipped configured to use I/O addresses in the range 220-22F (hexadecimal). This range may be changed by changing the jumpers on the HOST CONFIGURE connector. Pin pairs 1, 2, and 3 select the I/O address of the Data Acquisition Processor according to the following table:

<b>I/O Address Range</b>	<b>Jumpers</b>
220 - 22F	1, 2, 3
230 - 23F	2, 3
240 - 24F	1, 3
250 - 25F	3
320 - 32F	1, 2
330 - 33F	2
340 - 34F	1

When the I/O address is changed, the INSTALL program must be informed of the new address selection. When running INSTALL, select the DAP 0 button and select the address that matches the address of the Data Acquisition Processor.

---

Note: The only effect of changing the interrupt number or address in the INSTALL program is to change the value of the /I or /A parameter of the line ACOM. SYS that is inserted in the file CONFIG. SYS.

---

## The INSTALL Program

This section provides additional details about the INSTALL program. This information is of interest only to advanced Data Acquisition Processor users.

The INSTALL program installs Data Acquisition Processor software on a PC and configures the PC to initialize the ACCEL driver when the PC boots. INSTALL uses the following syntax:

```
A: INSTALL <options>
```

If installing from a drive other than A: , type the letter for that drive instead. INSTALL allows several command line options for special installation features. The following options are legal:

```
/Mxx      Default ACCEL driver mode (See the Systems Manual)
/Dx       Install more than one DAP
/?        Help
```

When running INSTALL, several prompts are provided for configuring Data Acquisition Processor software on a PC. Select a DAP button to choose the DAP model, address, and interrupt for the Data Acquisition Processor. Choose the “Select Software Options” button to select the specific software options to install. For help on the options press F1.

After all options have been verified, INSTALL copies Data Acquisition Processor software to the PC and modifies the system files. INSTALL copies the files ACOM.SYS, ACOMINIT.EXE, DAPLIMIT, and Dx-x.STD to the PC boot drive. INSTALL creates the file ACOM.DAT and places it on the boot drive. These files are all placed on the boot drive so they are available when the PC first boots.

After copying the boot files, INSTALL copies the software that was specified in the Select Software Options dialog box to the Main directory.

INSTALL adds a line to the file CONFIG.SYS that loads the ACCEL device driver. If this line already exists from a previous installation, INSTALL replaces it. The following line is a typical line that INSTALL adds to CONFIG.SYS:

```
device=c:\dap\acom.sys i 2 dap: a220 m20 p1A4
```

More information about the ACCEL driver configuration line is provided later in this chapter. If CONFIG.SYS does not exist, INSTALL creates it. Before modifying CONFIG.SYS, INSTALL saves an original copy in the file CONFIG.BAK.

INSTALL also modifies the file AUTOEXEC.BAT by adding several lines that configure the ACCEL driver with specific communication information. If these lines already exist from a previous installation, INSTALL replaces them. The following lines are typical lines that INSTALL adds to AUTOEXEC.BAT:

```
c: \dap\acominit c: \dap\acom.dat
@if errorlevel 1 pause
c: \dap\daplinit /reset c: \dap\d*.std
@if errorlevel 1 pause
```

The ACOMINIT program configures the ACCEL driver with specific communication pipe information provided by the file ACOM.DAT. For some Data Acquisition Processor models, the DAPLINIT program is required to initialize the DAPL operating system. More information about the [ACOMINIT](#) and [DAPLINIT](#) programs is provided later in this chapter.

If AUTOEXEC.BAT does not exist, INSTALL creates it. Before modifying AUTOEXEC.BAT, INSTALL saves an original copy in the file AUTOEXEC.BAK.

## Device Driver Configuration

This section explains the format of the device driver command that is placed in the CONFIG.SYS file by the INSTALL program. This information is of interest only to advanced programmers.

The format of the device driver command is:

```
DEVICE=ACOM.SYS [ix] [DAP[yyy]:Azzz] [Muu] [Pwww]
```

---

Note: Several parameters are optional. The letters u through z in each parameter represent hexadecimal digits.

---

x specifies the interrupt vector that is used for PC communication. This number should match the configuration of jumper J10 on the Data Acquisition Processor.

The ACCEL driver automatically detects the type of Data Acquisition Processor that is installed. yyy is optional and manually specifies the board type. For the DAP 1216a, yyy is 1216a. For the DAP 2416a, yyy is 2416a.

zzz specifies the hexadecimal starting I/O address of the Data Acquisition Processor. This number must match the configuration of jumper J10 on the Data Acquisition Processor.

uu is a hexadecimal number that specifies the default mode of the ACCEL driver. See the Systems Manual for more information about ACCEL driver modes.

www is a hexadecimal number that specifies the number of paragraphs of memory to reserve for PC communications pipes. See “Com Pipe Configuration” later in this chapter.

The following is a typical ACCEL driver command line:

```
device=c:\dap\acom.sys i 2 dap: a220 m20 p1A4
```

The ACCEL driver can be loaded into high memory with the DOS devicehigh statement. See your DOS manual for details on loading device drivers into high memory.

## The ACOMINIT Program

ACOMINIT configures the ACCEL driver communication pipes. ACOMINIT is placed in the file AUTOEXEC. BAT to configure the ACCEL driver when the PC first boots. The syntax for ACOMINIT is:

```
ACOMINIT <cfg_file>
```

<cfg\_file> provides communication pipe configuration information. <cfg\_file> normally is named ACOM.DAT. The following section describes the contents of ACOM.DAT.

## Com Pipe Configuration

This section describes the format of communication pipe configuration in the file ACOM.DAT. This information is not required for most applications. During initialization, the Microstar Laboratories program ACOMINIT reads the contents of a configuration file which specifies a com pipe configuration. The configuration file determines the connection between com pipes on the Data Acquisition Processor and com pipes on the PC. Lines in the configuration file have the following syntax:

```
<source> -> <destination> [<options>]
```

<source> and <destination> are specifications of communication pipe locations. A com pipe location is either a Data Acquisition Processor com pipe, a PC com pipe, or a PC serial port:

```
(DAP[n] CPI PE v)  
(PC CPI PE w)
```

n is the Data Acquisition Processor number when several boards are installed in one PC. v is a DAPL com pipe number, w is a PC com pipe number. The space before v and w can be omitted.

For example, the following lines connect the default text input and text output com pipes of the Data Acquisition Processor to the PC:

```
(dap cpi pe 0) -> (pc cpi pe 0)  
(pc cpi pe 0) -> (dap cpi pe 0)
```

The first line connects DAPL output com pipe 0 to PC input com pipe 0. The second line connects PC output com pipe 0 to DAPL input com pipe 0. By default, DAPL

defines two input com pipes and two output com pipes. Output com pipe 0, named \$SYSOUT, is for text output to the PC. Output com pipe 1, named \$BINOUT, is for binary output to the PC. Input com pipe 0, named \$SYSIN, is for text input from the PC. Input com pipe 1, named \$BININ, is for binary input from the PC.

Each line in the com pipe configuration file may contain one or more options, enclosed in square brackets. The following options are available:

```
BI NARY|TEXT  
MAXSI ZE=xx  
WI DTH BYTE | WORD | LONG
```

BI NARY and TEXT specify the type of the data in the com pipe. The default is TEXT.

MAXSI ZE specifies the size of the PC buffer of the com pipe, in bytes. The default is 1024 bytes. The INSTALL program sets the maximum size of the com pipes to be relatively small to conserve PC memory yet provide good performance. The Data Acquisition Processor automatically provides additional pipe buffering when needed. In some applications, increasing the maximum com pipe size can improve performance by allowing larger block operations. Performance can increase with com pipe sizes up to 4096 or 8192. Larger com pipe sizes typically do not provide further performance benefits.

WI DTH specifies the width of data items that are transferred through the com pipe. The WI DTH option must match the width of the corresponding Data Acquisition Processor com pipe. BYTE is the default for text com pipes and also is the only width allowed. WORD is the default for binary com pipes. Any width is allowed for binary com pipes.

The default com pipe configuration file generated by the INSTALL program is stored in the file ACOM. DAT. If the Data Acquisition Processor is operated inside a PC, the following configuration is placed in the file ACOM. DAT:

```
(dap0 cpi pe0) -> (pc cpi pe0) [text maxsi ze=1024]  
(pc cpi pe0) -> (dap0 cpi pe0) [text maxsi ze=1024]  
(dap0 cpi pe1) -> (pc cpi pe1) [bi nary maxsi ze=2048]  
(pc cpi pe1) -> (dap0 cpi pe1) [bi nary maxsi ze=1024]
```

In some applications, additional com pipes need to be defined. More com pipes are needed when extra com pipes are defined in DAPL on a Data Acquisition Processor or when several Data Acquisition Processors are installed.

For special applications, extra com pipes can be defined in DAPL. See the CPI PE command in the DAPL Manual.

Note that in many cases, the commands MERGE, MERGEF, and NMERGE can be used instead of defining extra com pipes. It is best to use standard com pipes when possible to maintain a standard communication setup.

When more than one Data Acquisition Processor is installed in a system, additional com pipes need to be defined. For several Data Acquisition Processors, the following com pipe numbering is recommended:

```
DAPO
  system text pipe i s PC com pipe #0
  system binary pipe i s PC com pipe #1
DAP1
  system text pipe i s PC com pipe #2
  system binary pipe i s PC com pipe #3
.
.
DAP6
  system text pipe i s PC com pipe #12
  system binary pipe i s PC com pipe #13
```

## P Parameter Size

In a system with additional com pipes, the memory available to the ACCEL driver must be increased. The P parameter in the ACOM.SYS line of the file CONFIG.SYS specifies the number of paragraphs of PC memory reserved for the ACCEL driver and com pipes. The storage requirement of the ACCEL driver and PC com pipes, in bytes, is:

$$\text{storage} = 830 + (\text{maxsize in bytes}) + (\text{number of com pipes}) * 190$$

MaxSize in bytes is the sum of all com pipe sizes defined in the file ACOM.DAT. Number of com pipes is the number of com pipes defined.

---

Note: This storage requirement applies for version 4.34 of the ACCEL driver. Subsequent driver versions may require additional storage.

---

The P parameter is a hexadecimal number, specified in paragraphs. A paragraph of PC memory is 16 bytes. To determine the P parameter, divide the storage requirements by 16 and convert to hexadecimal.

The following example calculates the P parameter for the default ACOM.DAT file created by INSTALL. The result, in bytes, is divided by 16 to get the P parameter in paragraphs.

$$\begin{aligned} \text{storage} &= 830 + 5120 + 4 * 190 = 6710 \text{ bytes} \\ p &= 6710 / 16 = 420 \text{ paragraphs (decimal)} = 1A4 \text{ (hex)} \end{aligned}$$

When defining additional com pipes, remember to define pipes for both the DAP-to-PC and PC-to-DAP direction. Some programs such as DAPview for Windows expect additional com pipes defined for both directions.

## DAP-to-DAP Communication

Communication pipes can be configured to allow communication between two Data Acquisition Processors. DAP-to-DAP communication occurs over the PC bus in the background with no PC program intervention required. The following syntax is used in the file ACOM.DAT to configure DAP-to-DAP communication:

```
(DAPw CPI PEx) -> (DAPy CPI PEz)  
(DAPy CPI PEz) -> (DAPw CPI PEx)
```

w is the number of the DAP that sends data. x is the DAP communication pipe used to send data. y is the number of the DAP that receives data. z is the DAP communication pipe to receive data. The DAPL command CPI PE is needed to define the DAP communication pipes on each DAP.

The following example shows how to configure a system for DAP-to-DAP communication. This example configures two DAPs. DAP 0 samples one channel of data and sends the data to DAP 1 for analog output.

In the file ACOM.DAT, add:

```
(dap0 cpi pe15) -> (dap1 cpi pe15) [binary maxsize=1024]  
(dap1 cpi pe15) -> (dap0 cpi pe15) [binary maxsize=1024]
```

DAP-to-DAP com pipes require twice the storage space as DAP-to-PC or PC-to-DAP com pipes. For the above DAP-to-DAP com pipe definition, the P parameter in CONFIG.SYS must be increased by 130 (hex). The following example calculates the P-parameter increase:

```
storage increase= 2 * (2048 + 2 * 190) = 4856 (decimal)  
p increase=4856/16 = 304 paragraphs (decimal) = 130 (hex)
```

The following DAPL commands provide an example of how to implement DAP-to-DAP communication.

```
; DAPL commands for DAP 0:
CPI PE TODAP1 PC NUM=15 OUTPUT BINARY WORD
RESET
I DEF A 1
    SET I PIPE0 S0
    TIME 10000
    END
PDEF B
    COPY(I PIPE0, TODAP1)
    END
START A, B
```

```
; DAPL commands for DAP 1:
CPI PE FROMDAPO PC NUM=15 INPUT BINARY WORD
RESET
PDEF A
    COPY(FROMDAPO, $BI NOUT)
    END
START A
```

## The DAPLINIT Program

DAPLINIT initializes the DAPL operating system on the Data Acquisition Processor by downloading a binary image of DAPL to the Data Acquisition Processor. ACCEL driver communication pipes must be configured using [ACOMINIT](#) before DAPLINIT is run. The syntax for DAPLINIT is as follows:

```
DAPLINIT [/RESET] [<dapl_file>] [<dapl_file>]*
```

<dapl\_file> specifies a binary file containing DAPL. DAPLINIT allows several DAPL binary files to initialize several Data Acquisition Processors in a PC.

The optional parameter /RESET requests a hardware reset of the Data Acquisition Processor before downloading DAPL. If /RESET is not specified, all Data Acquisition Processors retain their state during a warm PC boot.

DAPLINIT detects the Data Acquisition Processor model types on the ACOM. SYS line of the file CONFIG. SYS. DAPLINIT downloads the DAPL files, in order, to the Data Acquisition Processors that require DAPL initialization.

DAPLINIT can accept a wildcard file specification to allow flexibility for when DAP installations change. With a wildcard file name, DAPLINIT searches the current directory and the DOS PATH to find a DAPL binary file that matches the DAP type that is installed. The following example shows how DAPLINIT can be configured to search for the correct DAPL/STANDARD binary file.

```
DAPLINIT /RESET D*.STD
```

The INSTALL program automatically configures new installations to use a wildcard file name for DAPLINIT.

## Installing Several Data Acquisition Processors

Up to seven Data Acquisition Processor boards can operate simultaneously in one PC. Running several boards in parallel increases the maximum sampling rate and the real-time processing power of a system. For special options to install up to 14 Data Acquisition Processor boards in one PC, contact Microstar Laboratories.

Each Data Acquisition Processor requires one PC slot. All the Data Acquisition Processors in a PC share just one interrupt line; no DMA lines are required. The Data Acquisition Processors are distinguished by their I/O addresses in the PC. Before installing Data Acquisition Processors in the PC, select a distinct I/O address for each board.

There are seven possible I/O addresses; this limits the number of Data Acquisition Processors in a PC to seven. Set the I/O addresses with the jumpers on the HOST CONFIGURE connector. Information about the HOST CONFIGURE connector is provided at the beginning of this chapter.

---

Note: Pin pair 8 of the HOST CONFIGURE connector sets the level of the PC's interrupt line. Pin pair 8 must be connected for one Data Acquisition Processor in a PC, and must not be connected for all other Data Acquisition Processors.

---

INSTALL can perform installation for several Data Acquisition Processors. When typing the INSTALL command, add the option /Dx to the end of the command, where x is the number of boards. For example, the following line defines installation for three Data Acquisition Processors.

```
A: I NSTALL /D3
```

INSTALL provides on-screen options for configuring each Data Acquisition Processor individually. Select a DAP button to display a dialog box for choosing the Data Acquisition Processor model, address, and interrupt.

---

Note: The order in which the boards appear in the ACOM.SYS line in the file CONFIG.SYS determines the numbering of the Data Acquisition Processors. The first Data Acquisition Processor is DAP 0, the second is DAP 1, etc. The addresses do not matter when determining the numbering. When synchronous operation is used with DLOG, the last board in the list is the master unit.

---

## Installation on a Network

Data Acquisition Processor software can be installed on a network consisting of PC workstations connected to one or more servers. The INSTALL program can copy Data Acquisition Processor software to a PC workstation from a network that has a copy of the DAP Software disk image.

---

Note: When using Data Acquisition Processor software on a network, each simultaneous user must have a licensed copy of the software.

---

When installing Data Acquisition Processor software from a network, INSTALL copies several files to the PC workstation boot drive. The files are ACOM.SYS, ACOMINIT.EXE, ACOM.DAT, and, if necessary, DAPLINIT.EXE and Dx-x.STD. These files must be on the PC boot drive so that they are available immediately at boot time. INSTALL copies the remaining Data Acquisition Processor software to a network drive for use once the network is connected. INSTALL modifies AUTOEXEC.BAT and CONFIG.SYS on the workstation boot drive as in regular installations.

## DAPL Licensing

When a Data Acquisition Processor is shipped from the factory, a copy of DAPL is provided that is licensed to run on the Data Acquisition Processor. When a DAP Software Upgrade is shipped, the DAPL file on the upgrade is licensed to be used with the Data Acquisition Processor that was specified when the upgrade was ordered.

## Removing Data Acquisition Processor Software

When a Data Acquisition Processor is removed from a PC, the software can be removed as well. This section describes how to remove a Data Acquisition Processor software installation.

1. Delete the directory where Data Acquisition Processor software was in-stalled. Usually this directory is `c:\dap`. Delete all the subdirectories under the DAP directory. Make sure that there are no important data files in these directories before deleting them.

2. Edit the file `AUTOEXEC.BAT`. Delete the following four lines:

```
c:\dap\acomini t c:\dap\acom.dat
@if errorlevel 1 pause
c:\dap\dapl i ni t /reset c:\dap\d*.std
@if errorlevel 1 pause
```

3. Edit the file `CONFIG.SYS`. Delete the following line:

```
device=c:\dap\acom.sys i 2 dap: a220 m20 p1A4
```



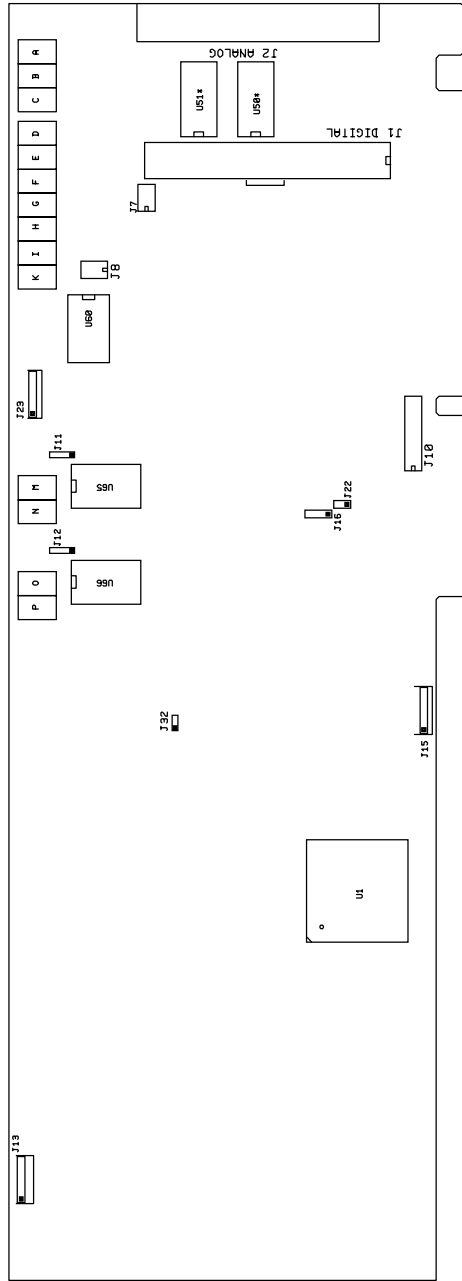
## 4. DAP 1216a & DAP 2416a Connectors

---

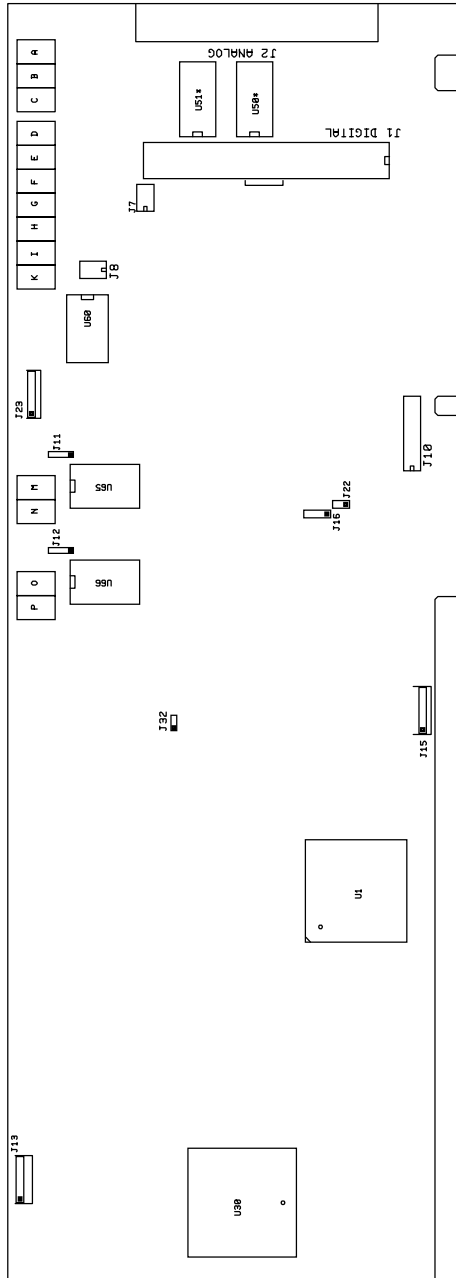
This chapter discusses the interface connectors on the DAP 1216a and DAP 2416a series. Diagrams and documentation for all jumpers, the [analog input/output connector](#), the [digital input/output connector](#), and the [output clock connector](#) are provided in this chapter, along with detailed instructions for setting the following options:

- the analog input voltage range (J7 & J8)
- channel list selection (J16)
- the output voltage ranges of DAC0 and DAC1 (J11 and J12)
- the digital output polarity at power-on (J32)
- input/output synchronization (J22)

Figure 1 and Figure 2 show component placement outlines of the DAP 1216a and the DAP 2416a. The only components shown are connectors, whose labels begin with the letter J, some integrated circuits, whose labels begin with the letter U, and trim potentiometers, whose labels are single letters.



**Figure 1.**  
**DAP 1216a**



**Figure 2.**  
**DAP 2416a**

## Analog Input/Output Connector

Analog voltages are connected to the Data Acquisition Processor through a 68-pin connector on the back panel of the PC. This connector is located on the right side of the Data Acquisition Processor and is labeled J2 ANALOG I N/OUT. It has a double row of pins on 0.050 inch centers. The connector is 3M part number 10268-52E2VC or AMP part number 2-178238-8. It mates with discrete wire connector 3M part number 10168-6000EC or AMP 2-175677-8. Both connectors are shielded and are compatible with round cable. The analog I/O connector also mates with insulation displacement ribbon cable connector 3M part number 10168-8100EE. The insulation displacement connector is compatible with 0.025" pitch ribbon cable.

Looking at the analog connector from the back of a PC, the pin numbering is:

DAP -18V	35 □ □ 34	DAP +18V
DAC 0 OUT	36 □ □ 33	DAC 0 GROUND
DAC 1 OUT	37 □ □ 32	DAC 1 GROUND
S15 (D7+)	38 □ □ 31	G15 (G7+)
S14 (D7-)	39 □ □ 30	G14 (G7-)
S13 (D6+)	40 □ □ 29	G13 (G6+)
S12 (D6-)	41 □ □ 28	G12 (G6-)
S11 (D5+)	42 □ □ 27	G11 (G5+)
S10 (D5-)	43 □ □ 26	G10 (G5-)
S9 (D4+)	44 □ □ 25	G9 (G4+)
S8 (D4-)	45 □ □ 24	G8 (G4-)
S7 (D3+)	46 □ □ 23	G7 (G3+)
S6 (D3-)	47 □ □ 22	G6 (G3-)
S5 (D2+)	48 □ □ 21	G5 (G2+)
S4 (D2-)	49 □ □ 20	G4 (G2-)
S3 (D1+)	50 □ □ 19	G3 (G1+)
S2 (D1-)	51 □ □ 18	G2 (G1-)
S1 (D0+)	52 □ □ 17	G1 (G0+)
S0 (D0-)	53 □ □ 16	G0 (G0-)
ANALOG GROUND	54 □ □ 15	ANALOG GROUND
RESERVED	55 □ □ 14	DIGITAL GROUND
RESERVED	56 □ □ 13	DIGITAL GROUND
RESERVED	57 □ □ 12	+5 VOLTS
ANALOG EXPANSION BIT 4	58 □ □ 11	DIGITAL GROUND
ANALOG EXPANSION BIT 3	59 □ □ 10	DIGITAL GROUND
ANALOG EXPANSION BIT 2	60 □ □ 9	+5 VOLTS
ANALOG EXPANSION BIT 1	61 □ □ 8	DIGITAL GROUND
ANALOG EXPANSION BIT 0	62 □ □ 7	DIGITAL GROUND
INTERNAL OUTPUT CLOCK - OUTPUT (OUTCLK)	63 □ □ 6	+5 VOLTS
EXTERNAL OUTPUT TRIGGER (OXTIN)	64 □ □ 5	DIGITAL GROUND
EXTERNAL OUTPUT CLOCK - INPUT (OXCIN)	65 □ □ 4	DIGITAL GROUND
INTERNAL INPUT CLOCK - OUTPUT (INCLK)	66 □ □ 3	+5 VOLTS
EXTERNAL INPUT TRIGGER (IXTIN)	67 □ □ 2	DIGITAL GROUND
EXTERNAL INPUT CLOCK - INPUT (IXCIN)	68 □ □ 1	DIGITAL GROUND

---

Note: Use the pin numbering on this chart, rather than numbers which may be found on your connector. Connectors from different manufacturers are not numbered consistently.

---

Single-ended inputs are indicated by S0 through S15; their corresponding ground inputs are G0 through G15. Differential inputs are indicated by D0- and D0+ through D7- and D7+; their corresponding ground inputs are G0- and G0+ through G7- and G7+. Every differential signal must be referenced to the corresponding ground. Data Acquisition Processors have a limited common mode voltage range and a ground connection must be used to assure that this range is not exceeded.

A single-ended analog signal should be connected to an analog ground pin and to an analog input pin, for example to pins 16 and 53. A differential analog signal should be connected to two adjacent analog input pins and either of their corresponding grounds, for example to input pins 52, 53, and ground pin 16 or 17.

Termination boards to connect all lines of the analog connector to discrete wires are available from Microstar Laboratories.

The DAP 1216a and DAP 2416a feature fault-protected input multiplexers. Fault protected input multiplexers allow signals to be connected to the Data Acquisition Processor with power off and allow a higher input voltage without damaging the inputs. Spare fault-protected input multiplexers are available.

Analog input signals should be within the range from -25 volts to +25 volts, relative to the ground of the Data Acquisition Processor. Input signals may be applied to the Data Acquisition Processor when the PC's power is off. See [Chapter 5](#) for electrical characteristics of the analog input pins.

The analog I/O connector of the Data Acquisition Processor includes digital-to-analog converter output pins and analog power supply voltages. Pins 36 and 37 are the outputs of DAC0 and DAC1, respectively. Pins 33 and 32 are the grounds for DAC0 and DAC1, respectively. The digital-to-analog converters have voltage outputs with low output impedance. The digital-to-analog converters normally should drive high impedance inputs. The output current from each digital-to-analog converter output is rated at  $\pm 5$  milliamps, but it is recommended that this current not exceed  $\pm 1$  milliamp.

Analog outputs are set to zero when the system is first powered on. When J32 is moved, the analog outputs at power-on may vary by up to 5 millivolts.

Pin 15 is analog power ground. Pins 34 and 35 are connected to +18 volt and -18 volt analog supplies. The maximum allowable current drain from these supplies is 20 milliamps per side. These supplies can be used for low current, low noise devices such as external multiplexers. To supply power to other devices, either use an external supply or use the 5-volt digital power supply found on the analog control connector with an external DC-to-DC converter.

The analog I/O connector also provides analog input expansion control lines, an external trigger input, an external input clock input, an internal input clock output, and connections to the 5-volt digital supply and its ground.

Pins 62-58 provide TTL-compatible analog input expansion control signals that select the expansion port. The five highest order bits of the input pin number appear in descending order on pins 58, 59, 60, 61, and 62 for a period starting one sample time before the analog input is sampled.

External analog input expansion boards are available from Microstar Laboratories. Each input expansion board allows up to 32 differential inputs, or up to 64 single-ended inputs, or any combination requiring up to 64 input lines. A Data Acquisition Processor can control up to 8 external analog input expansion boards, for a total of 512 single-ended input lines.

The analog I/O connector has an input pin for an active high external trigger. Sampling is inhibited if the external trigger is inactive when an input procedure is started. Sampling then commences on the inactive to active transition.

The external trigger is either one-shot or gated, depending on the HTRIGGER command in the active input procedure. The external trigger is ignored if there is no HTRIGGER command in the active input procedure. See [Chapter 6](#) for more information.

An external trigger signal must be within the standard TTL logic range of 0 to +5 volts. The Data Acquisition Processor provides a pull-up resistor on the external trigger input. This forces the trigger input active if it is left unconnected.

Clock and trigger inputs may have signals applied when the Data Acquisition Processor is off.

The analog I/O connector has input and output pins for an external input clock. The input pin should be used to connect an external input clock. The output pin is the buffered output of the internal clock circuit. See [Chapter 6](#) for more information.

Pins 3, 6, 9, and 12 provide +5 volt power. Maximum current available from the +5 volt supply is 1 Amp.

### **Digital Input/Output Connector**

The digital input/output connector is a vertical 100-pin connector labeled J1 DIGITAL IN/OUT. This connector is near the right edge the Data Acquisition Processor, to the left of the analog input/output connector. The digital I/O connector has two rows of 50 pins on 0.050 inch centers. This connector is manufactured by AMP, part number 1-104549-0. The digital I/O connector mates with insulation displacement connector AMP 1-111196-6.

The digital I/O connector is not accessible from the back of the PC. A cable, part number MSCBL 042, that makes the digital connector accessible at the adjacent slot in the PC is available from Microstar Laboratories. For systems that comply with the European EMC Directive, MSCBL 046 provides the same functionality as MSCBL 042 but with a shielded connector.

The pin numbering of the digital input/output connector is shown in the following diagram:

RESERVED	51	• •	50	RESERVED
DIGITAL GROUND	52	• •	49	+5 VOLTS
DOUT 15	53	• •	48	DIGITAL GROUND
DOUT 14	54	• •	47	DIGITAL GROUND
DOUT 13	55	• •	46	DIGITAL GROUND
DOUT 12	56	• •	45	+5 VOLTS
DOUT 11	57	• •	44	DIGITAL GROUND
DOUT 10	58	• •	43	DIGITAL GROUND
DOUT 9	59	• •	42	DIGITAL GROUND
DOUT 8	60	• •	41	+5 VOLTS
DOUT 7	61	• •	40	DIGITAL GROUND
DOUT 6	62	• •	39	DIGITAL GROUND
DOUT 5	63	• •	38	DIGITAL GROUND
DOUT 4	64	• •	37	+5 VOLTS
DOUT 3	65	• •	36	DIGITAL GROUND
DOUT 2	66	• •	35	DIGITAL GROUND
DOUT 1	67	• •	34	DIGITAL GROUND
DOUT 0	68	• •	33	+5 VOLTS
INTERNAL OUTPUT CLK - OUTPUT	69	• •	32	DIGITAL GROUND
RESERVED	70	• •	31	DIGITAL GROUND
RESERVED	71	• •	30	DIGITAL GROUND
RESERVED	72	• •	29	+5 VOLTS
RESERVED	73	• •	28	DIGITAL GROUND
RESERVED	74	• •	27	DIGITAL GROUND
RESERVED	75	• •	26	DIGITAL GROUND
RESERVED	76	• •	25	+5 VOLTS
RESERVED	77	• •	24	DIGITAL GROUND
RESERVED	78	• •	23	DIGITAL GROUND
RESERVED	79	• •	22	DIGITAL GROUND
DX2	80	• •	21	+5 VOLTS
DX1	81	• •	20	DIGITAL GROUND
DX0	82	• •	19	DIGITAL GROUND
INTERNAL INPUT CLK - OUTPUT	83	• •	18	DIGITAL GROUND
DIN 15	84	• •	17	+5 VOLTS
DIN 14	85	• •	16	DIGITAL GROUND
DIN 13	86	• •	15	DIGITAL GROUND
DIN 12	87	• •	14	DIGITAL GROUND
DIN 11	88	• •	13	+5 VOLTS
DIN 10	89	• •	12	DIGITAL GROUND
DIN 9	90	• •	11	DIGITAL GROUND
DIN 8	91	• •	10	DIGITAL GROUND
DIN 7	92	• •	9	+5 VOLTS
DIN 6	93	• •	8	DIGITAL GROUND
DIN 5	94	• •	7	DIGITAL GROUND
DIN 4	95	• •	6	DIGITAL GROUND
DIN 3	96	• •	5	+5 VOLTS
DIN 2	97	• •	4	DIGITAL GROUND
DIN 1	98	• •	3	DIGITAL GROUND
DIN 0	99	• •	2	DIGITAL GROUND
+5 VOLTS	100	• •	1	DIGITAL GROUND

Pins 1 and 100 are closest to the gold edge fingers.

Digital inputs are indicated by DIN 0-15 and digital outputs are indicated by DOUT 0-15. Bit 0 is the least significant bit.

A termination board from Microstar Laboratories, part number MSTB 008, connects all lines of the digital connector to discrete wire connectors.

The digital inputs are FCT TTL with 10K pull-up resistors. The digital inputs sink no more than 5 microamps for a “1” input and source no more than 0.5 milliamps for a “0” input. An input voltage greater than 2V is interpreted as a “1” and an input voltage less than 0.8V is interpreted as a “0”. When no signal is connected, a digital input is read as a “1” due to the pull-up resistors.

Digital inputs may have TTL signals applied when the Data Acquisition Processor is off.

Digital output polarity at power-on is selected by J32, the [Digital Output Reset Polarity Jumper](#), described later in this chapter.

The digital outputs are FCT TTL; they can sink no more than 12 milliamps for a “0” output and can source no more than 15 milliamps for a “1” output. The output voltage for a “1” is greater than 2.4 V and the output voltage for a “0” is less than 0.50 V.

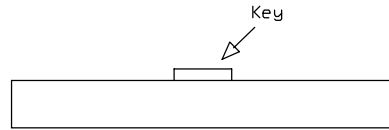
The [digital input/output connector](#) has multiple connections for the Data Acquisition Processor +5 V power supply. The supply current is rated at 500 milliamps per connection with a total current limit of 2 Amps. The 2 Amp current limit is due to the limited current available from the host computer.

Pins 80, 81, and 82 provide TTL-compatible digital input expansion control signals. The low-order bit of the port number appears on pin 82, the middle bit appears on pin 81, and the high-order bit appears on pin 80.

An optional digital input port may be specified in a DAPL SET command. The digital input port numbers range from 0 to 7. The specified port number appears on the control pins for a period starting one sample time before the time at which the digital inputs are sampled. The port number can be used to control external multiplexers.

An external digital expansion board is available from Microstar Laboratories. Each external expansion board allows up to 64 digital inputs and 64 digital outputs. Each Data Acquisition Processor may be expanded to have a maximum of 128 digital inputs and 1024 digital outputs.

The Microstar Laboratories cable MSCBL 036-01 is compatible with the digital input/output port. The diagram below shows the key on the cable MSCBL 036-01. This key must be towards the left side of the Data Acquisition Processor.




---

Note: Cables not made by Microstar Laboratories may have different keys.

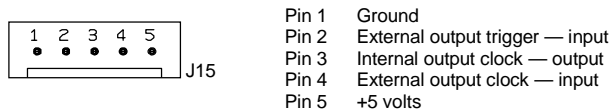
---

## Output Clock Connector

Connector J15 is a five-pin connector, Molex part number 22-23-2051; the mating connector is Molex part number 22-01-3057. J15 is located on the lower edge of the Data Acquisition Processor, between the 80186 CPU and the gold edge fingers.

The output clock signals and the output trigger signal are available on connector J15, along with power and ground. These signal pins can be used to control when outputs are updated. See [Chapter 6](#) for more details.

The pin numbering for J15 is given in the following table:



## Shunts

Several of the Data Acquisition Processor options are set by shunts. These are jumper wires enclosed in plastic, designed for connecting pins on 0.100" centers.

Each shunt has a top and a bottom. When a shunt is placed correctly, a probe point is visible in the shunt. Shunts must not be placed upside down on the pins, as incorrectly placed shunts do not provide reliable contacts.

## Analog Signal Path Selection

In addition to the DAPL configuration options, the Data Acquisition Processor has several hardware configuration options. These determine the path taken by analog signals from the input pins to the analog-to-digital converter.

The analog signal path between the input pins and the analog-to-digital converter consists of the following functional units:

1. input multiplexers
2. instrumentation amplifier
3. programmable gain amplifier
4. range amplification circuit
5. analog-to-digital converter

Analog signals must pass through the input multiplexers, the instrumentation amplifier, and the analog-to-digital converter. Jumpers determine whether the analog signal path includes the programmable gain amplifier and the range amplification circuit, and also determine the input voltage range.

A signal range is called bipolar if it includes both positive and negative voltages; a signal range is called unipolar if it includes voltages of only one sign. The DAP DAP 1216a and DAP 2416a have only bipolar ranges. Jumpers select from two bipolar voltage ranges. If the programmable gain amplifier is enabled, gains of 1, 10, 100, and 500 are software selectable.

## Analog Signal Path Configuration

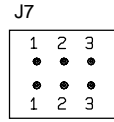
Two connectors control the analog signal path of the DAP 1216a and DAP 2416a . Note that changing voltage ranges may require recalibration.

The following table summarizes the DAP 1216a and DAP 2416a jumper connections:

ADC Range	J7	J8
$\pm 5\text{v}$ *	2 *	1 *
$\pm 10\text{v}$	1	2

\*Factory Configuration

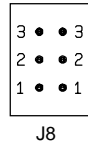
The input signal to the range amplifier circuit is selected by J7, a header of two rows on 0.100 inch centers.



Exactly one jumper should be placed on J7, as follows:

Jumper	Signal range
1	+/- 10 Volt range
2	+/- 5 Volt range, gain enabled
3	+/- 5 Volt range, gain disabled

The input signal to the analog-to-digital converter is selected by J8, a header of two rows on 0.100 inch centers. J8, along with J7, selects the input voltage range as well as enabling or disabling gain. It is often desirable to leave gain enabled, even if only a gain of 1 is used.



Exactly one jumper should be placed on J8, as follows:

Jumper	Signal range
1	bipolar, +/- 5 Volts
2	bipolar, +/- 10 Volts, gain enabled
3	bipolar, +/- 10 Volts, gain disabled

---

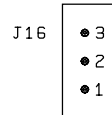
Note: Regardless of the input voltage range, positive and negative differential signals may range from -10 volts to +10 volts.

---

## Channel List Selection

The Data Acquisition Processor has two possible external input clocking modes. When Channel List Clocking is enabled, all input pins are sampled on each low to high transition of the external clock. When Channel List Clocking is disabled, a single pin is sampled on each low to high transition of the external clock.

Connector J16, located above the left-most gold edge connector, determines the clocking mode for external clocking. J16 is a three pin vertical header of one column on 0.100 inch centers. The factory configuration is “enabled.”

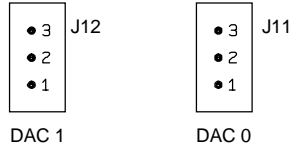


Exactly one jumper should be placed on J16, as follows:

<u>Pins</u>	<u>Channel List Clocking</u>
2,3	disabled
1,2	enabled

## Analog Output Voltage Range Selection

The voltage ranges of DAC0 and DAC1 are selected by headers J11 and J12, respectively. The factory configuration is +/- 5 Volts.



Exactly one jumper should be placed on each of J11 and J12 as follows:

<b>Jumpers</b>	<b>Range</b>
1 to 2	+/- 10 Volts
2 to 3	+/- 5 Volts

## Digital Output Reset Polarity Jumper

The digital output reset polarity jumper J32 has two pins spaced at 0.100". J32 is located near the center of the Data Acquisition Processor, approximately 2.5" above J15. The digital output reset polarity jumper allows selection of the digital output polarity at power-on. If J32 is installed, all digital outputs will be reset to 0 at power-on. If J32 is removed, all digital outputs will be preset to 1 at power-on. All Data Acquisition Processors are shipped from the factory with J32 installed. The voltage of the analog outputs at reset may vary by up to 600 microvolts when J32 is removed.

## Input/Output Synchronization Header

The input/output synchronization header J22 has two pins spaced at 0.100". J22 is located approximately one inch above the left set of gold fingers on the Data Acquisition Processor. If a shunt is placed on J22, the input trigger is connected to the output update clock. This causes a hardware input trigger to occur when an output procedure initiates its first update. This is used to synchronize input sampling to output updates.

## Synchronization Connector

The synchronization connector J13 has a single row of five pins on 0.100 inch centers. J13 is located at the upper left of the Data Acquisition Processor printed circuit board. The synchronization connector allows several Data Acquisition Processors to share the same sampling clock. See the Systems Manual for more information about using synchronous Data Acquisition Processors.

For synchronization, the shared sampling clock requires special cabling between Data Acquisition Processors. The analog sampling clock of the master unit is supplied to the slave units by means of the cable MSCBL 015-01. Contact Microstar Laboratories for more information about cabling for synchronous Data Acquisition Processors.



## 5. Analog Input Circuits

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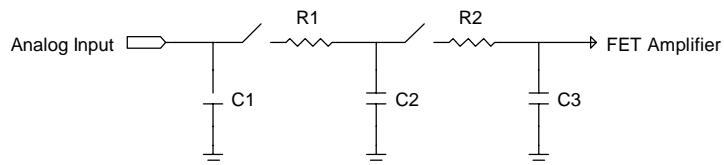
The analog input hardware of the Data Acquisition Processor is discussed in some detail in this chapter. The following summary gives sufficient information for most Data Acquisition Processor applications:

- the DC input impedance is very high.
- at high sampling rates, the signal source impedance should be low.
- minimum sampling times are specified for unity gain.
- at gain 10, the fastest sampling rate is slower than the fastest sampling rate at gain 1.
- at gain 100 and 500, the fastest sampling rate is substantially slower than the fastest sampling rate at gain 1.

### Analog Input Circuits

Data Acquisition Processor analog input signals pass through two analog multiplexers and then to an op amp with an FET input. The DC input impedance is very high, typically far in excess of 10M Ohms. The AC input impedance is dominated by the capacitance of the multiplexers.

Figure 3 shows a useful equivalent circuit for each Data Acquisition Processor input. As the Data Acquisition Processor scans through the input pins defined by an input procedure, the switches in the multiplexers open and close, connecting the specified inputs to multiplexer outputs. When an input signal is connected to the FET amplifier, the signal source must supply sufficient current to charge the equivalent capacitance of the multiplexers before the analog-to-digital conversion starts.



**Figure 3.**

The DAP 1216a and DAP 2416a have fault-protected multiplexers. The following table shows typical resistance and capacitance values, in Ohms and picofarads, for fault-protected multiplexers.

<b>Typical Value</b>	
R1	100Ω
R2	100Ω
C1	5 pF
C2	35 pF
C3	30 pF

## Programmable Gain Amplifier

At gains other than unity, the programmable gain amplifier requires extra time to switch from pin to pin and then settle to full accuracy. The following table shows typical minimum sampling times for each Data Acquisition Processor at each gain.

<b>Model</b>	<b>Minimum Sample Times in μS at Gain:</b>			
	<b>1</b>	<b>10</b>	<b>100</b>	<b>500</b>
<b>All models</b>	10	11	50	500

## 6. Clocks and Triggers

---

The Data Acquisition Processor is designed to operate using either internal clocks or external clocks. The Data Acquisition Processor has onboard crystal controlled timers to provide an internal input sampling rate and output update rate, and also has provisions for external clocks for both input and output.

The Data Acquisition Processor has hardware control lines for an input clock, an output clock, an input trigger, and an output trigger. These lines all are TTL compatible. The input clock and the output clock both are positive edge triggered.

The input clock on all models has two modes. In the first mode, called Channel List Clocking, the Data Acquisition Processor starts conversion of an entire channel list on the positive edge of the clock. In the second mode, the Data Acquisition Processor converts a single channel on the positive edge of the clock.

The input trigger and output trigger on all models also have two modes, a one-shot mode and a level-triggered gate mode.

### Software Triggers vs. Hardware Triggers for Input

DAPL provides a powerful software triggering mechanism which is suitable for most applications. For those applications that require precise synchronization to external hardware or that are too fast to take advantage of software triggering, hardware triggering is provided. Software triggering is more versatile than hardware triggering. In applications with sampling rates of less than 10 KHz, software triggering almost always provides a better solution than hardware triggering.

Software triggers rely on DAPL tasks to scan input data to detect events within the data. When an event is detected, a task asserts a software trigger. After the trigger is asserted, another task may act, based on the assertion. The most common action is to pass a number of values around the trigger event either to another task or to the PC. The trigger mechanism is much like the trigger on an oscilloscope. Since all of the processing functions of DAPL may be used to define events, however, much more complex events may be detected.

Hardware input triggers are implemented using a digital control line which is separate from the sampling stream. This control line starts and stops input sampling. Since the trigger line is not dependent on the input data, external hardware must be provided to detect events of interest.

Software triggers have several advantages over hardware triggers. First, a software trigger may be changed by changing a few lines in a DAPL command list. In contrast, a hardware trigger event must be detected by external hardware which may be inflexible and costly to modify. Second, software triggers scan input data to detect events, so pretrigger data are available. Because a hardware trigger starts the Data Acquisition Processor input section, no samples are taken before a trigger event. Finally, with software triggers DAPL provides precise timing information. With hardware triggers DAPL is not able to provide accurate timing information because hardware triggers start and stop input sampling at undefined times.

Hardware triggering does provide precise synchronization of acquisition to external events. Hardware triggering also allows detection of events which are too fast to process with software triggers.

Software and hardware triggering are implemented separately and may be used together.

## External Input Clock

The external input clock is a positive-edge triggered TTL signal. The external input clock is activated by the command `CLOCK EXTERNAL` in an input procedure. The `TIME` command of an input procedure with input clocking enabled must be at least `tSYNCH` less than the period of the external clock. `tSYNCH` is defined at the end of this chapter.

External input clocking has two modes. The first mode, called Channel List Clocking, starts conversion of an entire channel list on the positive edge of the external clock. The second mode converts a single channel on the positive edge of the external clock. On the DAP 1216a and DAP 2416a, the selection between the modes is made by the position of a shunt on connector J16. As the Data Acquisition Processor is shipped from Microstar Laboratories, Channel List Clocking is selected. See [Chapter 4](#) for a diagram of J16.

DAPL application example:

```
 I DEF A 5
CLOCK EXTERNAL
SET I PIPE0 S0
SET I PIPE1 S1
SET I PIPE2 S2
SET I PIPE3 S3
SET I PIPE4 S4
TIME 1000
. . . . .
END
```

In this application, external input clocking is enabled for the input procedure A. With Channel List Clocking selected, each positive edge of the external clock causes conversion of the entire channel list consisting of channel 0 (S0) to channel 4 (S4). The channels are converted in sequence with channel 0 synchronized to the positive edge of the external clock and each of the subsequent channels converted according to the TIME command. Channel 1 (S1) is converted 1000  $\mu$ s following the edge of the external clock, channel 2 (S2) is converted 2000  $\mu$ s following the edge of the external clock, up to channel 4 (S4) which is converted 4000  $\mu$ s following the edge of the external clock. When using Channel List Clocking, the period of the external clock (rising edge to rising edge) must be greater than the TIME command times the number of channels plus tSYNCH. The external clock may be as slow as required; there is no maximum period.

In the previous application, the external clock must have a minimum period of 5000  $\mu$ s plus tSYNCH. For example, on a DAP 2416a/4, the time for tSYNCH is 0.25  $\mu$ s, so the minimum period of the external clock is 5000.25  $\mu$ s. The value of tSYNCH is calculated as 4/n, where n is the CPU clock speed in MHz.

If single channel clocking is selected rather than Channel List Clocking, each positive edge of the external clock causes conversion of only one channel. The channels are converted in sequence. Each channel is synchronized to a positive edge of the external clock. In the previous application, channel 0 (S0) is converted on the first edge of the external clock, channel 1 (S1) is converted on the second edge of the external clock, and so on up to channel 4 (S4), which is converted on the fifth edge of the external clock. The channel list then is repeated with channel 0 converted again on the sixth positive edge of the external clock. When using single channel clocking, the period of the external clock (rising edge to rising edge) must be greater than the TIME command plus tSYNCH. The external clock may be as slow as required; there is no maximum period.

In the previous application, the external clock must have a period of  $1000\ \mu\text{s}$  plus  $t_{\text{SYNCH}}$ . For example, on a DAP 2416a/4, the time for  $t_{\text{SYNCH}}$  is  $0.25\ \mu\text{s}$ , so the minimum period of the external clock is  $1000.25\ \mu\text{s}$ .

## Early External Input Clock Edges

To guarantee that the DAP 1216a and DAP 2416a acquires only on external clock edges requires that there are no extra external input clock edges between  $200\ \text{ns}$  and  $t_{\text{SYNCH}}$  plus the TIME command after the last acquisition. If this is not prevented, the Data Acquisition Processor will continue to operate, but the next acquisition will start according to the TIME command, not the external clock. Clocks earlier than  $200\ \text{ns}$  from the last acquisition are ignored.

In the previous example with channel list clocking, the external clock must not rise between  $4000\ \mu\text{s}$  plus  $200\ \text{ns}$  ( $4000.2\ \mu\text{s}$ ) and  $5000\ \mu\text{s}$  plus  $t_{\text{SYNCH}}$  after the external clock that channel 0 converted upon. Extra clock edges less than  $4000.2\ \mu\text{s}$  after the clock for channel 0 are guaranteed to be ignored. Edges after that time and before  $5000\ \mu\text{s}$  plus  $t_{\text{SYNCH}}$  can cause the next channel list to start  $1000\ \mu\text{s}$  after channel 4 (S4), instead of at the time of an external clock.

In the previous example with single channel clocking, the external clock should not rise between  $200\ \text{ns}$  and  $1000\ \mu\text{s}$  plus  $t_{\text{SYNCH}}$  after any external clock that causes an acquisition. Any clock edge that does not meet this requirement will cause the next channel to be converted  $1000\ \mu\text{s}$  after the previous channel, instead of being converted upon an external clock edge.

## Input Pipeline Timing

This section is of interest only when using external clocking or low latency with internal clocking.

Input sampling hardware has one pipeline stage for digital inputs and two pipeline stages for analog inputs. The number of pipeline stages and the type of the first input channel determines the number of clock pulses that are needed for the CPU to read a given value.

If the first channel is analog, analog conversion occurs on the first clock pulse and the value is read by the CPU on the second clock pulse. For channel list clocking, the last value in the channel list is read on the next external clock edge. The following timing diagram shows the relation of analog and digital samples when the first channel is analog. Note that for external clocking, one additional clock pulse is required before the first clock pulse shown in this diagram. See "Input Clocking Startup Considerations" later in this chapter for more details.

	clock edge	1 channel list			1 channel list			
		1	2	3	4	5	6	
input								
S0	setup	convrt	read		setup	convrt	read	setup
B0	-	-	setup	read	-	setup	read	
S1	-	-	setup	convrt	read	setup	convrt	

Note that setup indicates the setting up of analog or digital input circuits before the value is sampled, convrt indicates when the value is held and converted to digital, and read indicates when the value is read by the CPU. Each action occurs at or soon after the previous clock edge in the diagram.

If the first channel is a binary input and channel list clocking is used, the next clock pulse is not required to read the value from the last channel in the list. If one or more binary channels are used in a channel list with external clocking, it is best to make the first channel binary to simplify the timing. The following timing diagram shows relative timing when the first channel is binary.

	clock edge	1 channel list			1 channel list		
input		1	2	3	4	5	6
B0	setup	read	-	setup	read	-	setup
S0	setup	convrt	read	setup	convrt	read	setup
S1	-	setup	convrt	read	setup	convrt	read

The pipeline is important to consider in low latency applications. The time between the beginning of conversion and when the value is read by the CPU adds to the total response latency of the Data Acquisition Processor. For analog inputs one sample period is added to the latency. No significant latency is added for digital inputs.

## External Output Clock

For most applications, there is no need to provide an output clock source to the Data Acquisition Processor; the on-board timer provides a wide range of update frequencies with fine time resolution. The main use of an output clock is to precisely match the output update rate to a standard frequency.

The external output clock on the Data Acquisition Processor is a positive-edge triggered TTL signal. Similar to the external input clock, the output clock is activated by the command `CLOCK EXTERNAL` in an output procedure. The `TIME` command of an output procedure with output clocking enabled must be at least `tSYNCH` shorter than the external clock period. `tSYNCH` and other times are defined at the end of this chapter. Unlike the external input clock, the first external output clock pulse is recognized.

On the DAP 1216a and DAP 2416a, all channels are updated simultaneously on the external clock.

## Hardware Input Trigger

There are two modes for the input trigger. The first is a one-shot mode and the second is a level controlled gated mode. The mode of the hardware trigger is selected by a parameter to the `HTRIGGER` command in an input procedure. The three options for `HTRIGGER` are `ONESHOT`, `GATED`, and `OFF`. The default is `OFF`.

In the one-shot mode, the trigger line is held in a low state when an input procedure is started. Input sampling does not start until the trigger line is high. Sampling continues until a STOP command is issued or the number of samples specified by the COUNT command of the input procedure is reached. The first sampled value is precisely synchronized to the trigger edge and all subsequent values are within  $\pm t_{\text{SYNCH}}$  of the TIME command of the input procedure.  $t_{\text{SYNCH}}$  and other times are defined at the end of this chapter. The active period of the external input trigger must be greater than  $t_{\text{TRIG\_MIN}}$  to guarantee proper operation.

In the level-triggered gated mode, input sampling may start and stop repeatedly, depending on the level of the trigger signal. The input is sampled continuously when the trigger signal is high. Input sampling stops when the trigger signal is low. The active period of the output trigger must be less than  $t_{\text{TRIG\_MAX}}$  to guarantee that only one update occurs.

When input clocking is configured in Channel List Clocking mode, the input is stopped only at channel list boundaries. When input clocking is configured to clock single channels, the input is stopped on channel boundaries. The effect of this is that the start of sampling is precisely synchronized to the positive edge of the trigger signal, assuming that sampling has stopped. Sampling stops when the Data Acquisition Processor has completed sampling of either a channel list or a channel. When input sampling has been stopped with the gated trigger, synchronization of sampling to the positive edge of the trigger signal is the same as for the one-shot mode.

## Hardware Output Trigger

There are two modes for the output trigger of a-Series Data Acquisition Processors. The first mode is a one-shot mode and the second mode is a level-controlled gated mode. The mode of the hardware trigger is selected by a parameter to the HTRIGGER command in an output procedure. The three options for HTRIGGER are ONESHOT, GATED, and OFF. The default is OFF.

In the one-shot mode, the trigger line is held in a low state when an output procedure is started. Output updating does not start until the trigger line is high. Updating continues until a STOP command is issued or the number of updates specified by the COUNT command of the output procedure is reached. The first updated value is precisely synchronized to the trigger edge and all subsequent values are within  $\pm t_{\text{SYNCH}}$  of the TIME command of the output procedure.  $t_{\text{SYNCH}}$  and other times are defined at the end of this chapter. The active period of the external output trigger must be greater than  $t_{\text{TRIG\_MIN}}$  to guarantee proper operation.

In the level-triggered gated mode, output updating may start and stop repeatedly, depending on the level of the trigger signal. The output is updated continuously when the trigger signal is high. Output updating stops when the trigger signal is low. The active period of the output trigger must be less than  $t_{\text{TRIG\_MAX}}$  to guarantee that only one update occurs.

When using the level-triggered gated mode without external output clocking, the hardware output trigger needs to be well-defined. Specifically, the high pulse width of the trigger cannot be in the range of  $n * \text{TIME} \pm t_{\text{SYNCH}}$ , where  $n$  is any integer. A high pulse with such a width can cause data corruption and/or data being swapped between DACs.

When using the level-triggered gated mode with external output clocking, the hardware output trigger does not have to be well-defined.

On the DAP 1216a and DAP 2416a, all channels are updated simultaneously on the external clock.

## Timing Considerations

When an external clock is used, the time of an event with respect to the start of sampling may only be determined if the period of the external clock is known. DAPL establishes event times as sample times. If the external clock period is variable or the period is unknown, the time of an event cannot be determined. The event's sample number may still be useful in other contexts. Note that the results of all frequency domain processing such as FREQUENCY, FFT, and RFI LTER depend on the period of the external clock and may not be defined if the external clock period varies.

When hardware triggering is used, DAPL provides timing information relative to the start of each external trigger. In a case of a one-shot trigger, sampling or output updating starts on a single event so all timing information is relative to the trigger event. In the case of a gated trigger, sampling or output updating may start or stop at arbitrary times. Timing information may still be obtained if means are provided to distinguish one external trigger event from the next.

## Input Clocking Startup Considerations

For the DAP 1216a and DAP 2416a, following the start of an input procedure with external input clocking enabled, there is a delay of one external clock edge before the first input sample is taken. This delay is required to allow clean synchronization of the internal clock to the external input clock. This means that the first positive edge of the external input clock, following the START command to the input procedure, is ignored. The second positive edge of the external input clock may be as close as 50 ns to the first positive edge.

If loss of the first external clock edge is unacceptable, the input trigger, configured in the level triggered gated mode, may be used as an input clock. This requires the input trigger to have a short active period. The active period of the input trigger should be more than  $t_{TRIG\_MIN}$ ; this allows for any speed of acquisition. The active period of the input trigger must be less than  $t_{TRIG\_MAX}$  to guarantee that only one acquisition occurs.

If the input trigger is held inactive until the input procedure is started, the first positive edge of the input trigger will cause a conversion. Note that this approach to clocking seldom makes sense when the external clock source is free running; in most cases, using external hardware to provide a clean trigger signal will lose one clock edge.

## Using the Input Trigger with External Input Clocking

Input triggering may be used with external input clocking. When these functions are used together, however, precise synchronization of acquisition to a trigger edge is not available. The reason for the loss of synchronization is that the Data Acquisition Processor has no control over the external clock.

For the DAP 1216a and DAP 2416a, the time from a trigger edge until the first conversion will be from 1 to 2 external clock cycles, assuming input sampling has stopped. To guarantee recognition of an external trigger after 1 external clock cycle, the external trigger must meet a setup time of  $t_{TCSETUP}$  to the positive edge of the external clock. Each time a trigger is reasserted, there is a 1 to 2 clock delay before acquisition starts. When a hardware trigger is used with the internal clock, the Data Acquisition Processor synchronizes its clock to the edge of the external trigger so there is no synchronization condition.

## Using the Output Trigger with External Output Clocking

Output triggering may be used with external output clocking. Unlike input clocking, updates can occur on the first external clock after the trigger is asserted. To guarantee recognition of an external clock, the external trigger must meet a setup time of  $t_{TCSETUP}$  to the positive edge of the external clock.

## Timing tables

tSYNCH	four CPU clock cycles	Time needed to synchronize an internal clock to an external clock
tTRIG_MIN	60 ns	Minimum high period for the input and output trigger
tEXTCLK_PW	25 ns	Minimum high or low period of an external clock
tTCSETUP	50 ns	External trigger to external clock setup time
tTRIG_MAX	200 ns	Maximum high period of the input trigger to guarantee a single conversion
tINSKEW	200 ns	Time from input clock or trigger to conversion value held
tOUTSKEW	30 ns	Time from output clock until start of DAC slewing



## 7. Recalibration

---

Each Data Acquisition Processor is burned in and then calibrated by Microstar Laboratories. The accuracy of this calibration is sufficient for most applications. Accuracy is affected by three factors:

- the operating temperature of the Data Acquisition Processor
- drift in the Data Acquisition Processor circuitry
- analog voltage range selection.

The operating temperature is determined by a number of factors. If the Data Acquisition Processor is operated inside a personal computer, the operating temperature is affected by the number of expansion boards, power supply loading, fan efficiency, etc.

Component drift depends on total operating time of the unit as well as the number of times the unit has been powered up and down.

Changes to analog voltage ranges generally require that the Data Acquisition Processor be recalibrated.

For applications requiring high accuracy, occasional recalibration may be necessary. For high absolute accuracy, the Microstar Laboratories calibration sequence requires that measurements be made using a 4.5 digit digital voltmeter with a DC accuracy of .024% (244 ppm) or better. In most applications, only relative accuracy is important, so recalibration with a less accurate digital voltmeter may be acceptable. Calibration also requires a variable voltage source with high stability.

Because calibration requires significant setup time, it generally is best to send Data Acquisition Processors to Microstar Laboratories for recalibration. Calibration is available from Microstar Laboratories for a nominal fee.

### CALDAP

CALDAP is a program which uses a PC to recalibrate Data Acquisition Processor analog input circuitry. Recalibration may be necessary if analog voltage range jumpers are changed, or if the Data Acquisition Processor factory calibration has drifted.

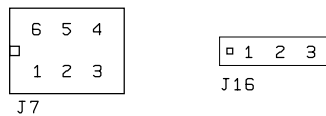
## Equipment Requirements

Data Acquisition Processor calibration requires the following equipment:

- A 4 1/2 digit digital voltmeter (DVM).
- A -10 volt to +10 volt adjustable voltage source. The voltage source must be very stable and must have an output impedance of less than 500 ohms.

## Connector Numbering

CALDAP prompts refer to particular pins of Data Acquisition Processor connectors. A diagram with connector locations for the Data Acquisition Processor is included at the beginning of [Chapter 4](#). Pin 1 of a connector with a single row of pins is identified by a dot, and pin 1 of a connector with two rows of pins is identified by a notch—pins are numbered in a counter-clockwise direction in the same manner as an integrated circuit, as in the following examples:



A PC-bus extender card can be used to permit easier access to the connectors on the Data Acquisition Processor.

## Preparing the Data Acquisition Processor

The Data Acquisition Processor must have power applied for at least two hours before calibration.

Configure the DAP 1216a or DAP 2416a hardware as follows:

1. Connect the S1 pin to the G1 pin.
2. Apply the adjustable voltage source across S0 and G0.
3. Connect the DVM to sense S0 relative to G0.
4. Connect the S15 pin to the S14 pin. Also connect these two pins to DAC1 OUT.

## Starting CALDAP

CALDAP is included on the Data Acquisition Processor diskettes in the subdirectory \DAP\CALDAP. The active drive and the active directory should be set so that the CALDAP program is in the current directory. For example:

```
C:  
CD \DAP\CALDAP
```

CALDAP should be started by typing CALDAP at the DOS prompt. CALDAP accepts five optional switches:

```
CALDAP [/CF: DAP2416E\aaaa] [/Rxyz] [/FORCECAL] [/Scccc] [/M]
```

The parameter aaaa selects the type of calibration. The calibration types are:

RANGE	Range amplifier calibration.
PGA	PGA gain calibration.
DACS	DAC calibration.
CAL	Complete calibration procedure.

The entire calibration sequence is required when the input voltage range is changed. The PGA gain calibration trims the 10, 100, and 500 gains of the programmable gain amplifier. The DAC calibration calibrates the offsets and gains of the digital-to-analog converters. The complete calibration performs each of the above operations, as well as calibration of the instrumentation amplifier. Microstar Laboratories recommends that a complete calibration *not* be performed unless specifically required. Calibration is available from Microstar Laboratories for a nominal fee.

The second CALDAP parameter determines calibration voltage ranges. The parameters x, y, and z are numbers selecting voltage ranges. They select the analog input voltage range, DAC0 analog output voltage range, and DAC1 analog output voltage range, respectively:

- 2        -5 to +5 volts
- 3        -10 to +10 volts

For example, the following CALDAP command performs complete Data Acquisition Processor calibration with a -10 to +10 volt analog input range and a -10 to +10 volt analog output range on both DACs:

```
CALDAP /CF: DAP2416E\CAL /R333
```

If no range parameter is specified on the command line, /R222 is assumed.

The /FORCECAL parameter causes calibration to start immediately upon entry into CALDAP.

The /SCCCC parameter is for custom Data Acquisition Processors. This parameter should not be specified on the CALDAP command line for standard Data Acquisition Processors. Contact Microstar Laboratories for information on calibrating Data Acquisition Processors with custom analog input sections.

The /M parameter is used internally by Microstar Laboratories and should not be specified on the CALDAP command line.

## Calibrating the Data Acquisition Processor

Once the PC is executing CALDAP, a <Ctrl -E> command from the keyboard is used to begin calibration. This is not necessary if the /FORCECAL parameter is used, in which case calibration begins automatically.

CALDAP performs a series of calibration steps. Each calibration step has a unique step number. There are several different types of calibration steps:

1. Configuration step. This step sends configuration information to the Data Acquisition Processor. No user interaction is required.
2. Prompt step. This step waits for you to perform a specific action. The action may be changing a jumper or may be changing the voltage of the variable voltage source. When CALDAP prompts to change the variable voltage, the jumper pin numbers to use for the signal and the ground sense of a DVM are provided within parentheses. For example, a prompt of Inst Out (J7: 3, J7: 1) specifies that J7: 3 is the signal connection for the DVM and J7: 1 is the ground sense connection for the DVM.
3. Potentiometer adjustment step. This step allows interactive adjustment of a potentiometer. CALDAP displays the letter of a particular potentiometer and a sequence of arrows which indicate the direction in which to turn the potentiometer. Turn the potentiometer until the arrow display is centered and the arrows are replaced by a vertical line.

During calibration, the following keys perform control functions:

<enter>	goes to next step
<backspace>	goes to previous step
<esc>	aborts calibration

After aborting or finishing calibration, a <Ctrl -Z> command from the keyboard will end the CALDAP program. Optionally, the user may enter a <Ctrl -E> command from the keyboard to restart calibration. Several calibration sequences are iterative—a series of calibration steps is repeated until potentiometer adjustments are sufficiently accurate. In most cases, no iteration is required during recalibration; if a particular potentiometer is adjusted more than three times, CALDAP probably has detected instability in the calibration sequence. This usually is caused by excessive noise in the adjustable external voltage supply, or possibly by damaged analog circuitry on the Data Acquisition Processor.



## Appendix A: Declaration of Conformity

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### *Declaration of Conformity*

**Microstar Laboratories  
2265 116th Avenue NE  
Bellevue, WA 98004**

Microstar Laboratories declares that the DAP 1216a and DAP 2416a conform to the following Directive and Standards:

**Electromagnetic Compatibility (EMC):**

EMC Directive	89/336/EEC
EN 55022	Emission Standard
EN 50082-1	Immunity Standard

Data Acquisition Processors carrying the CE mark have been tested for compliance in a typical host system. It is the responsibility of the system integrator to ensure that any system using a Data Acquisition Processor is compliant to all relevant standards.



## Index

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\$BININ .....	17
\$BINOUT .....	17
\$\$SYSIN .....	17
\$\$YSOUT .....	17
Accuracy .....	44
ACOM.SYS .....	15
ACOMINIT .....	16
Advanced Installation Options .....	11
Analog	
connector .....	30
control connector .....	32
expansion .....	32
input circuits .....	43
input expansion control lines .....	32
input range .....	37
input signals .....	31
output range .....	40
outputs at power on .....	31
path selection .....	37
signal range .....	31
supply voltages .....	31
ANALOG IN/OUT, J2 .....	30
Analog Input Circuits .....	43
Analog Output Voltage Range Selection .....	40
Analog Signal Path Configuration .....	37
Analog Signal Path Selection .....	37
Auto-detection .....	15
AUTOEXEC.BAT .....	5
Automatic DAPL file search .....	22
Binary connector .....	33
CALDAP .....	57
Calibrating the Data Acquisition Processor .....	61
Channel list clocking .....	39, 45
Channel List Selection .....	39
CLOCK	
input procedure .....	46
output procedure .....	50
Clocks .....	45
Clocks and Triggers .....	45
Com Pipe Configuration .....	16
CONFIG.SYS .....	5, 15, 19
Configuration	
DAP .....	<i>See Connectors</i>

nonstandard PC.....	11
Connector Numbering.....	58
Connectors.....	27
Control connector.....	32
DAC0.....	31
DAC1.....	31
DAP 1200a Connectors.....	27
DAP 2400a Connectors.....	27
DAPL Licensing.....	24
DAPLINIT.....	22
DAP-to-DAP Communication.....	20
DAPview.....	6
Data Acquisition Processor Handling Precautions.....	3
Declaration of Conformity.....	63
Deinstalling.....	25
Device driver.....	15
Device Driver Configuration.....	15
Differential inputs.....	31
Digital	
connector.....	33
ground.....	32
output reset polarity jumper.....	40
supply.....	32
Digital Input/Output.....	33
Digital Output Reset Polarity Jumper.....	40
Digital-to-analog converter output pins.....	31
DOS.....	3
Early External Input Clock Edges.....	48
Equipment Requirements.....	58
Error messages.....	7
Expansion.....	32
port selection.....	32
External	
input clock.....	32, 46
input clock, early edges.....	48
input trigger.....	50
output trigger.....	52
trigger.....	32, 45
External Input Clock.....	46
External Output Clock.....	50
Fault-protected input multiplexers.....	31, 44
Gain.....	44
Hardware	
triggering.....	45
Hardware Input Trigger.....	50
Hardware installation.....	4
Hardware Output Trigger.....	52

Host configuration connector .....	11
HTRIGGER .....	32
HTRIGGER, input procedure .....	50
HTRIGGER, output procedure .....	52
I/O address .....	4
Impedance .....	31
Input	
clock .....	46
impedance .....	31
multiplexers .....	44
voltage selection .....	37
Input Clocking Startup Considerations .....	53
Input Pipeline Timing .....	49
Input/output	
synchronization header .....	40
Input/output address .....	11
Input/Output Connector .....	30
Input/Output Synchronization Header .....	40
INSTALL .....	5, 12, 13
Installation .....	4
advanced .....	11
multiple Data Acquisition Processors .....	23
network .....	24
options .....	13
Installation on a Network .....	24
Installation, Testing, & Troubleshooting .....	3
Installing DAP Software .....	5
Installing Several Data Acquisition Processors .....	23
Installing the Data Acquisition Processor .....	4
Internal input clock .....	32
Interrupt vector .....	4
Introduction .....	1
J10 .....	11
J11 .....	40
J12 .....	40
J13 .....	41
J15 .....	36
J16 .....	39
J2 .....	30
J22 .....	40
J32 .....	40
J7 .....	38
J8 .....	38
Jumpers .....	<i>See specific connectors</i>
Licensing .....	24
Low latency .....	50
Maximum rate for each gain .....	44

MSCBL 036-01.....	36
MSCBL 015.....	41
MSCBL 042.....	33
MSCBL 046.....	33
Multiple Data Acquisition Processors.....	23
Multiplexers.....	31, 44
Network installation.....	24
Nonstandard Configurations.....	11
Options	
installation.....	13
Output	
clock.....	36, 50
current.....	31
impedance.....	31
reset polarity jumper.....	40
trigger.....	36
voltage selection.....	40
Output Clock Connector.....	36
P parameter.....	15, 19
P Parameter Size.....	19
Parallel port.....	11
Port	
COM.....	11
expansion.....	32
parallel.....	11
Power supply.....	4
Preparing the Data Acquisition Processor.....	59
Processor.....	1
Programmable Gain Amplifier.....	44
Pull-up resistors.....	32, 35
Range selection.....	37, 40
Recalibration.....	57
Removing DAP software.....	25
Removing Data Acquisition Processor Software.....	25
Requirements.....	3
Reset polarity jumper.....	40
Sample rate.....	44
Serial	
COM port.....	11
Settling time.....	44
Several Data Acquisition Processors.....	23
Shunts.....	36
Signal path selection.....	37
Sink.....	35
Slew rate.....	55
Software triggers.....	45
Software Triggers vs. Hardware Triggers for Input.....	45

Source.....	35
Standard Configurations.....	4
Starting CALDAP.....	59
Static sensitivity.....	3
Synchronization Connector.....	41
System Requirements.....	3
Testing.....	6
Testing Installation.....	6
The ACOMINIT Program.....	16
The DAPLINIT Program.....	22
The INSTALL Program.....	13
Timing.....	53
Timing Considerations.....	53
Timing tables.....	55
Trigger.....	40
Triggers.....	45
Troubleshooting.....	7
Uninstalling.....	25
Using the Input Trigger with External Input Clocking.....	54
Using the Output Trigger with External Output Clocking.....	54
Wildcard file name.....	22