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ACCES I/O PRODUCTS INC
10623 Roselle Street, San Diego, CA 92121
TEL (858)550-9559 FAX (858)550-7322

MODEL D/A12-16(8)

USER MANUAL

FILE: MDA1216.Bb

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Chapter 1: Introduction

The D/A12-08 and D/A12-16 are full-size cards that can be installed in any long I/O slot of PC-AT class computers. They contain either 8 or 16 double-buffered digital-to-analog converters (DAC) and provide 8 or 16 independent analog output channels of 12-bit resolution. Each analog output channel can be configured for the following ranges:

0V to +2.5V
0V to +5V
0V to +10V
-2.5V to +2.5V
-5V to +5V
-10V to +10V

The analog output channels have a double-buffered input for single-step update and each is addressed at its own I/O location. Type AD7237 double-buffered, dual, DAC chips are used. Data are transferred into outer registers a byte at a time (eight LSBs then eight MSBs) and then transferred into inner registers a word at a time. The analog outputs can be updated either independently or simultaneously.

In order to prevent excessive outputs at power-up, D/A12-08 and D/A12-16 contain automatic circuits that set D/A outputs to less than 15 percent of span at system power-on. Upon power-up, the DAC reference voltage is set to a low voltage and the card is set in the Simultaneous Update mode. After all DACs have been loaded with the desired values, a software command can be used to switch the reference voltage ON at its nominal value. Similarly, a software command can be used at any time to set the reference voltage to zero causing all DAC outputs to be zero volts.

Software provided with the card includes a program called FINDBASE that will help you to select an I/O bus address for this card that will not conflict with other resources installed in your computer. Software provided also includes setup and calibration programs and sample programs. The setup and calibration program provides pictorial representation and menu selection on the computer monitor. For setup, of course, it is not necessary that the card be plugged into the computer. The Address Selection and Option Selection sections of this manual provide amplifying information about switch settings.

Specifications

Analog Outputs

- Resolution: 12 Binary bits (0 to 4095 decimal).
- Channels: 16 or 8 Voltage output channels.
- Voltage output ranges at 5mA max.:

  0 to +2.5 VDC.
  0 to +5.0 VDC.
  0 to +10.0 VDC.
  -2.5 to +2.5 VDC.
  -5.0 to +5.0 VDC.
  -10.0 to +10.0 VDC.

Digital-to-Analog Converter

- AD7237 D/A Converter, Double buffered / Simultaneous update.
- Relative Accuracy: ± ½ LSB.
- Monotonicity: 12 bits over operating temperature range.
- Settling Time: 8 usec to one LSB for full-scale step input.
- Linearity: ± ½ LSB integral non-linearity over rated temperature range.
- Gain Stability: 15 ppm/ °C.
- Output Drive Capability: 5mA maximum.
- Short-Circuit Current: 25 mA maximum.
- Output Resistance: Less than 0.1 Ω.
- Data Format: 12-bit binary, right justified, and offset binary for bipolar outputs.

Power Requirements

- +5 VDC at 250 mA.
- +12 VDC at 310 mA maximum (16 channels).
- -12 VDC at 150 mA maximum.

Environmental

- Operating Temperature Range: 0 °C. to +60 °C.
- Storage Temperature Range: -20 °C. to +85 °C.
- Humidity: 5% to 95% non-condensing.
- Size: Full size card, 13.130" long (334 mm) by 4.50" high (114 mm).

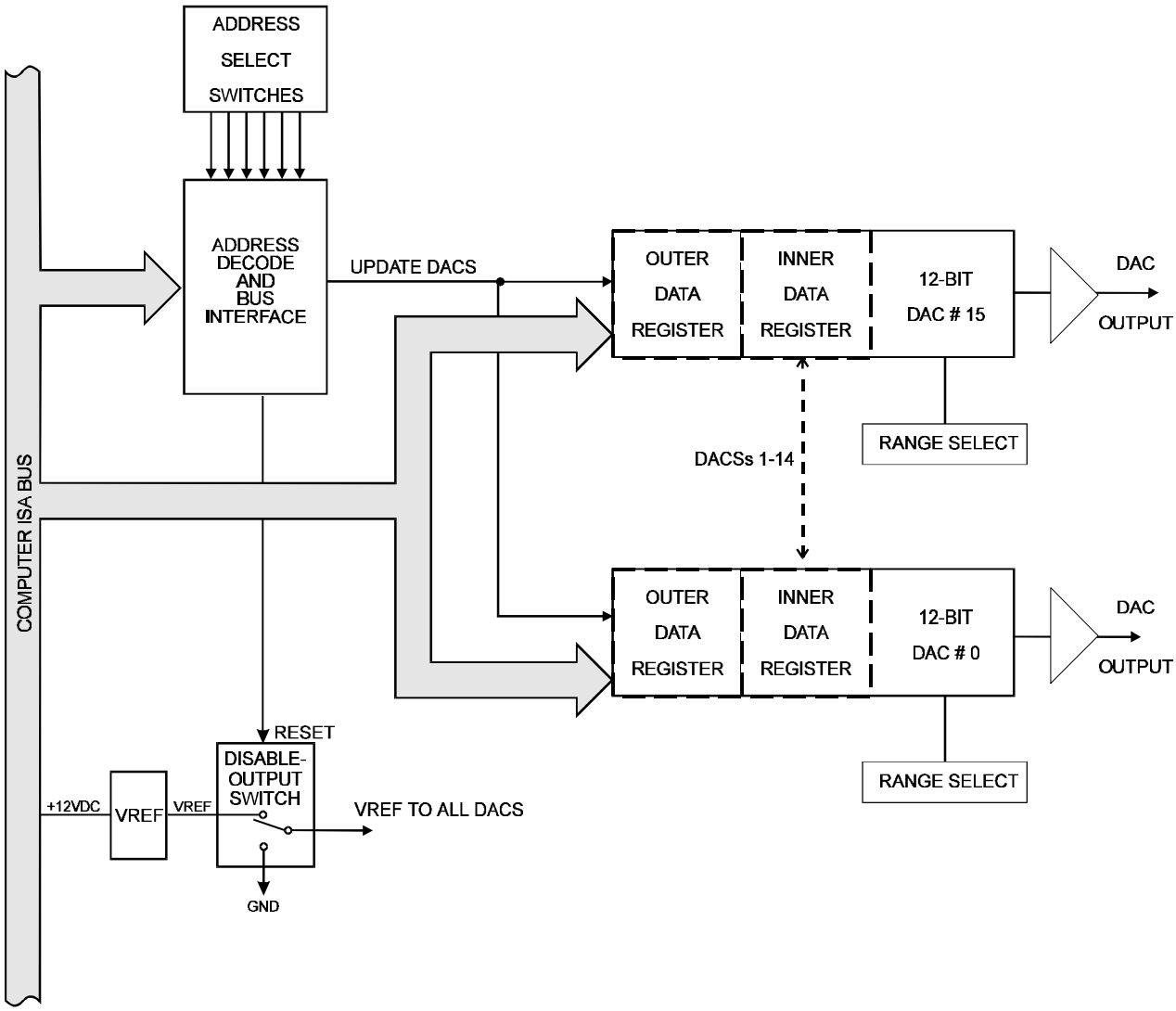


Figure 1-1: Block Diagram

Chapter 2: Installation

The software provided with this card is contained on either one CD or multiple diskettes and must be installed onto your hard disk prior to use. To do this, perform the following steps as appropriate for your software format and operating system. Substitute the appropriate drive letter for your CD-ROM or disk drive where you see d: or a: respectively in the examples below.

CD Installation

DOS/WIN3.x

1. Place the CD into your CD-ROM drive.
2. Type d:K to change the active drive to the CD-ROM drive.
3. Type installK to run the install program.
4. Follow the on-screen prompts to install the software for this card.

WIN95/98/NT

a. Place the CD into your CD-ROM drive.
b. The CD should automatically run the install program after 30 seconds. If the install program does not run, click START | RUN and type d:install, click OK or press K.
c. Follow the on-screen prompts to install the software for this card.

3.5-Inch Diskette Installation

As with any software package, you should make backup copies for everyday use and store your original master diskettes in a safe location. The easiest way to make a backup copy is to use the DOS DISKCOPY utility.

In a single-drive system, the command is:

diskcopy a: a:K

You will need to swap disks as requested by the system.
In a two-disk system, the command is:

diskcopy a: b:K

This will copy the contents of the master disk in drive A to the backup disk in drive B.

To copy the files on the master diskette to your hard disk, perform the following steps.

a. Place the master diskette into a floppy drive.
b. Change the active drive to the drive that has the diskette installed. For example, if the diskette is in drive A, type a:K.
c. Type installK and follow the on-screen prompts.

Directories Created on the Hard Disk

The installation process will create several directories on your hard disk. If you accept the installation defaults, the following structure will exist.

[CARDNAME]

Root or base directory containing the SETUP.EXE setup program used to help you configure jumpers and calibrate the card.

DOS\PSAMPLES: A subdirectory of [CARDNAME] that contains Pascal samples.
DOS\CSAMPLES: A subdirectory of [CARDNAME] that contains "C" samples.
Win32\language: Subdirectories containing samples for Win95/98 and NT.

WinRisc.exe

A Windows dumb-terminal type communication program designed for RS422/485 operation. Used primarily with Remote Data Acquisition Pods and our RS422/485 serial communication product line. Can be used to say hello to an installed modem.

ACCES32

This directory contains the Windows 95/98/NT driver used to provide access to the hardware registers when writing 32-bit Windows software. Several samples are provided in a variety of languages to demonstrate how to use this driver. The DLL provides four functions (InPortB, OutPortB, InPort, and OutPort) to access the hardware.

This directory also contains the device driver for Windows NT, ACCESNT.SYS. This device driver provides register-level hardware access in Windows NT. Two methods of using the driver are available, through ACCES32.DLL (recommended) and through the DeviceIOControl handles provided by ACCESNT.SYS (slightly faster).

SAMPLES

Samples for using ACCES32.DLL are provided in this directory. Using this DLL not only makes the hardware programming easier (MUCH easier), but also one source file can be used for both Windows 95/98 and WindowsNT. One executable can run under both operating systems and still have full access to the hardware registers. The DLL is used exactly like any other DLL, so it is compatible with any language capable of using 32-bit DLLs. Consult the manuals provided with your language's compiler for information on using DLLs in your specific environment.

VBACCES

This directory contains sixteen-bit DLL drivers for use with VisualBASIC 3.0 and Windows 3.1 only. These drivers provide four functions, similar to the ACCES32.DLL. However, this DLL is only compatible with 16-bit executables. Migration from 16-bit to 32-bit is simplified because of the similarity between VBACCES and ACCES32.

PCI

This directory contains PCI-bus specific programs and information. If you are not using a PCI card, this directory will not be installed.

SOURCE

A utility program is provided with source code you can use to determine allocated resources at run-time from your own programs in DOS.

PCIFind.exe

A utility for DOS and Windows to determine what base addresses and IRQs are allocated to installed PCI cards. This program runs two versions, depending on the operating system. Windows 95/98/NT displays a GUI interface, and modifies the registry. When run from DOS or Windows3.x, a text interface is used. For information about the format of the registry key, consult the card-specific samples provided with the hardware. In Windows NT, NTioPCI.SYS runs each time the computer is booted, thereby refreshing the registry as PCI hardware is added or removed. In Windows 95/98/NT PCIFind.EXE places itself in the boot-sequence of the OS to refresh the registry on each power-up.

This program also provides some COM configuration when used with PCI COM ports. Specifically, it will configure compatible COM cards for IRQ sharing and multiple port issues.

WIN32IRQ

This directory provides a generic interface for IRQ handling in Windows 95/98/NT. Source code is provided for the driver, greatly simplifying the creation of custom drivers for specific needs. Samples are provided to demonstrate the use of the generic driver. Note that the use of IRQs in near-real-time data acquisition programs requires multi-threaded application programming techniques and must be considered an intermediate to advanced programming topic. Delphi, C++ Builder, and Visual C++ samples are provided.

Findbase.exe

DOS utility to determine an available base address for ISA bus , non-Plug-n-Play cards. Run this program once, before the hardware is installed in the computer, to determine an available address to give the card. Once the address has been determined, run the setup program provided with the hardware to see instructions on setting the address switch and various option selections.

Poly.exe

A generic utility to convert a table of data into an nth order polynomial. Useful for calculating linearization polynomial coefficients for thermocouples and other non-linear sensors.

Risc.bat

A batch file demonstrating the command line parameters of RISCTerm.exe.

RISCTerm.exe

A dumb-terminal type communication program designed for RS422/485 operation. Used primarily with Remote Data Acquisition Pods and our RS422/485 serial communication product line. Can be used to say hello to an installed modem. RISCTerm stands for Really Incredibly Simple Communications TERMinal.

Installing the Card

Before installing the card, carefully read the Address Selection and Option Selection chapters of this manual and configure the card according to your requirements. Be especially careful with address selection. If the addresses of two installed functions overlap you will experience unpredictable computer behavior. If unsure what locations are available, you can use the FINDBASE program provided on CD to locate blocks of available addresses.

To Install the Card

1. Turn off computer power.
2. Remove the computer cover.
3. Remove the blank I/O backplate.
4. Set switches for selected options. See the option selection section of this manual.
5. Select the base address on the card. See the address selection section of this manual
6. Install the card in an I/O expansion slot. Important: Make sure that the card mounting bracket is properly screwed into place and that there is a positive chassis ground.
7. Install the I/O cable.
8. Inspect for proper fit of the card and cables, tighten screws.
9. Replace the computer cover and apply power.

To ensure that there is minimum susceptibility to EMI and minimum radiation, it is important that there be a positive chassis ground. Also, proper EMI cabling techniques (cable connect to chassis ground at the I/O connector, twisted-pair wiring, and, in extreme cases, ferrite level EMI protection) must be used for input/output wiring.

CE-marked versions of D/A12-08 and D/A12-16 meet the requirements of EN50081-1:1992 (Emissions), EN50082-1:1992 (Immunity), and EN60950:1992 (Safety).

Chapter 3: Option Selection

Voltage output ranges are determined by switch settings as described in the following paragraphs. Also, the method to update D/A outputs is programmable as described here and in the Programming section of this manual.

Output Ranges

There are three-position switches associated with each DAC channel to make voltage range selection: switches S17 (Channel 0) through S2 (Channel 15). A silk-screen illustration on the card defines switch positions to use for each range. The following table presents the same information:

Voltage Range	S1	S2	S3
0 to +2.5V	OFF	OFF	ON
0 to +5V	OFF	OFF	OFF
0 to +10V	OFF	ON	OFF
-2.5V to +2.5V	ON	OFF	ON
-5V to +5V	ON	OFF	OFF
-10V to +10V	ON	ON	OFF

Analog Outputs Update

Analog outputs are updated under program control in either one of two ways:

Automatic Update

Each channel is updated individually when new data are written to the related high-byte base address. Individual update mode may be set by a special read operation as defined in the programming section of this manual.

-OR-

Simultaneous Update

The outputs of all D/As may be updated simultaneously. This is done by first enabling simultaneous updating for all outputs and then preloading the low and high bytes of each DAC and then initiating a simultaneous update by software command.

Refer to the Programming section of this manual for more detail.

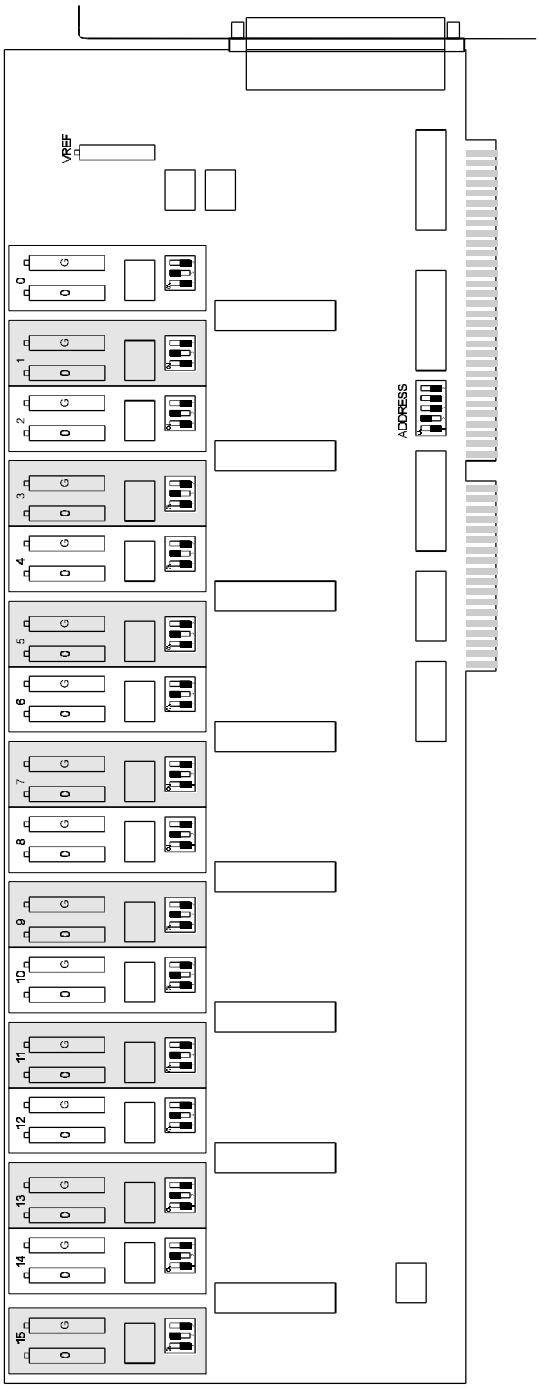


Figure 3-1: Option Selection Map

Chapter 4: Address Selection

The D/A12-08 and D/A12-16 require 16 or 32 consecutive address locations in I/O space, respectively. The starting, or base address, can be selected anywhere within an I/O address range 100-3FF hex (except 1F0 through 1F8) in AT-class computers and 200- 3FF in XT-class computers, providing that the address does not overlap with other functions. If in doubt refer to the table below for a list of standard address assignments. The Base Address Locator program FINDBASE provided on the CD will assist you in selecting a base address that will avoid this conflict.

Hex Range	Usage
000-01F	DMA Controller 1
020-03F	INT Controller 1, Master
040-05F	Timer
060-06F	8042 (Keyboard)
070-07F	Real Time Clock, NMI Mask
080-09F	DMA Page Register
0A0-0BF	INT Controller 2
0C0-0DF	DMA Controller 2
0F0	Clear Math Coprocessor Busy
0F1	Reset Coprocessor
0F8-0FF	Arithmetic Processor
1F0-1F8	Fixed Disk
200-207	Game I/O
278-27F	Parallel Printer Port 2
2F8-2FF	Asynchronous Comm'n (Secondary)
300-31F	Prototype Card
360-36F	Reserved
378-37F	Parallel Printer Port 1
380-38F	SDLC or Binary Synchronous Comm'n 2
3A0-3AF	Binary Synchronous Comm'n 1
3B0-3BF	Monochrome Display/Printer
3C0-3CE	Local Area Network
3D0-3DF	Color/Graphic Monitor
3F0-3F7	Floppy Diskette Controller
3F8-3FF	Asynchronous Comm'n (Primary)

Table 4-1: Standard Address Assignments for 286/386/486 Computers

The D/A12-16 and D/A12-08 base address bits A5 through A9 are set by DIP switch S1. The setup program provided on CD with your card includes an interactive base-address selection program. The computer monitor presents a pictorial display of the DIP switch and, when you enter your desired hex base address, the display changes to show proper switch settings for that address.

To understand how this works, consider the following. In order to select the base address, convert the desired address to binary form. Then *for each "1" of binary address set the corresponding DIP switch to OFF, and for each "0" of binary address set the corresponding switch to ON.*

Here's an example showing how to program the base address to hex 300:

1. Convert hex 300 to binary

   300 (hex) = 11 0000 0000 (binary)

2. Set the Address Selection DIP Switches

The D/A12-08 and D/A12-16 card occupy 16 and 32 bytes of I/O address space, respectively. Address lines A5 through A9 are used to select the base address via DIP switches marked with the same names. Address lines A0 - A4 are used to address registers at the digital-to-analog converters and there are no DIP switches for these five lines.

Address	1	1	0	0	0	0	0	0	0	0
Switch	A9	A8	A7	A6	A5	None				
Setting	OFF	OFF	ON	ON	ON	None				

Chapter 5: Programming

Programming the D/A12-16 and D/A12-08 is very straightforward as there are only two operating modes, three range-selection switches per channel, and one unique addition. The basic operation of a Digital-to-Analog card is to write a 12-bit value to a Digital to Analog Converter (DAC) preload (outer) register where it is buffered and loaded by an update command to a DAC (inner) register. Outputs of that register control a "ladder" network which produces the analog output. The output voltage range is defined by settings of the range-selection switches for that channel.

In C: outport(BASE+(CH*2), Volts*4096/5+2048);

would output "Volts" volts to channel "ch", assuming a bipolar 5V range. For other bipolar ranges, substitute the positive Full-Scale-Volts in place of "5" in the equation. For unipolar ranges, remove the "-2048" and use the appropriate FSV in place of the "5";

Upon power-up, or hardware reset, the DAC registers are restricted to a save value and the card is set in Simultaneous Update mode. Since the preload register is not cleared upon power-up, but left at an undefined value, a known value must be written to the preload registers before using a "Clear Restrict-Output-Voltage" command.

Simultaneous Update Mode is the power-up or default mode of operation for the DAC card. When a value is written to a DAC address the output does not change until an output update is commanded via a read to the BASE+8 address. (Alternatively, a read to BASE+10 will update the DAC registers and switch the board to Automatic Update Mode.) While in Simultaneous Update Mode, a single read will load all DAC registers with the value waiting in the preload registers causing all outputs to be updated and changed simultaneously.

Automatic Update Mode is the configuration which changes a DAC output immediately after the high-byte of the new value is written to the DAC address. If the card is in Simultaneous Update Mode a read to BASE+2 address will change the card back to Automatic Update Mode without updating the outputs. Or, a read to BASE+10 will update all outputs simultaneously and then release the card to the Automatic Update Mode.

Restrict-Output-Voltage is a unique addition to our DAC card which resets the DAC's in a manner similar to a hardware reset without changing the operating mode. This is done by sending a read to Base Address +14. Since the preload registers are not cleared the previous outputs will be restored from the preload register when a "Clear Restrict-Output-Voltage" command is issued by a write to Base Address +15.

The D/A12-08 and D/A12-16 cards use 16 and 32 consecutive I/O addresses, respectively. The I/O address map is as follows:

Address	Write *	Read
Base + 0	DAC 0 Low Byte	Place card in Simultaneous Mode without updating outputs.
Base + 1	DAC 0 High Byte	
Base + 2	DAC 1 Low Byte	Release card from Simultaneous Mode without updating outputs
Base + 3	DAC 1 High Byte	
Base + 4	DAC 2 Low Byte	
Base + 5	DAC 2 High Byte	
Base + 6	DAC 3 Low Byte	
Base + 7	DAC 3 High Byte	
Base + 8	DAC 4 Low Byte	Update all outputs and place card in Simultaneous Mode
Base + 9	DAC 4 High Byte	
Base + 10	DAC 5 Low Byte	Update all outputs and release card from Simultaneous Mode
Base + 11	DAC 5 High Byte	
Base + 12	DAC 6 Low Byte	
Base + 13	DAC 6 High Byte	
Base + 14	DAC 7 Low Byte	Restrict-Output-Voltage (Limits outputs to 15% of full scale range)
Base + 15	DAC 7 High Byte	Clear Restrict-Output-Voltage (Allows full operating output voltage)
Base + 16	DAC 8 Low Byte	
Base + 17	DAC 8 High Byte	
Base + 18	DAC 9 Low Byte	
Base + 19	DAC 9 High Byte	
Base + 20	DAC 10 Low Byte	
Base + 21	DAC 10 High Byte	
Base + 22	DAC 11 Low Byte	
Base + 23	DAC 11 High Byte	
Base + 24	DAC 12 Low Byte	
Base + 25	DAC 12 High Byte	
Base + 26	DAC 13 Low Byte	
Base + 27	DAC 13 High Byte	
Base + 28	DAC 14 Low Byte	
Base + 29	DAC 14 High Byte	
Base + 30	DAC 15 Low Byte	
Base + 31	DAC 15 High Byte	

* Although it is possible to write the low and high bytes separately as shown above, it is much easier to write both bytes with a single OUT DX, AX instruction. In that case, only even addresses are written.

Table 5-1: I/O Address Map

Data Format

BIT	D7	D6	D5	D4	D3	D2	D1	D0
Low Byte	B7	B6	B5	B4	B3	B2	B1	B0
High Byte	x	x	x	x	B11	B10	B9	B8

For UNIPOLAR ranges: For Unipolar ranges, data are in true binary form.

```
XXXX 0000 0000 0000  =   ZERO
XXXX 1000 0000 0000  =   1/2 SCALE
XXXX 1111 1111 1111  =   FULL SCALE
          |                |
MSB or B11 <----|          |----> B0 or LSB
```

For BIPOLAR ranges: For Bipolar ranges, data are in offset binary form.

```
XXXX 0000 0000 0000  = - FULL SCALE
XXXX 1000 0000 0000  =   ZERO
XXXX 1111 1111 1111  =  +FULL SCALE
          |                |
MSB or B11<----|           |----> B0 or LSB
```

Chapter 6: Software

The D/A12-08 and D/A12-16 cards are straightforward to program. The following example is in C.

To output an analog value with 12-bit resolution, a corresponding decimal number N between 0 and 4095 is calculated (2^12 = 4096).

N/4096 = V(out)/V(full scale)

Then the number is split between high and low bytes, as follows:

```
H = (int)(N / 256);
L = N - (H * 256);
```

Next the data are written to the selected analog output channel. (See the preceding I/O Address Map.) In this example, we will assume analog output on channel zero (AO 0).

```
OUTPORTB (BASE + 0, L);
OUTPORTB (BASE + 1, H);
```

For simplicity, it was assumed that the simultaneous-update capability was not used.

Chapter 7: Calibration

Periodic calibration of the D/A12-08 and D/A12-16 cards are recommended if it is used in extreme environmental conditions. The card uses very stable components but vibration, or high-low temperature cycles might result in slight analog output errors.

Factory calibration and periodic calibration of the card includes adjustment of the internal reference voltage unless you are using an external reference voltage.

The suggested sequence for calibration is:

a. Set base address for the card
b. Set range and polarity for each channel
c. Check the 5V Reference Voltage
d. Adjust Unipolar zero on each channel
e. Adjust Unipolar range of each channel
f. Adjust Bipolar negative full scale of each channel
g. Check Bipolar zero of each channel
h. Check Bipolar positive full scale of each channel

To calibrate the card, run the setup program and follow the screen prompts. No attempt at calibration should be made in noisy locations or with a noisy calibration setup.

Each DAC output is available between the AGND (analog ground) test point near the top right-hand edge of the card (component side) and the Channel Test Point Pins located near each DAC channel's set of calibration potentiometers.

Note

After changing a channel's voltage range or polarity, the channel may require recalibration for best accuracy.

Chapter 8: Connector Pin Assignments

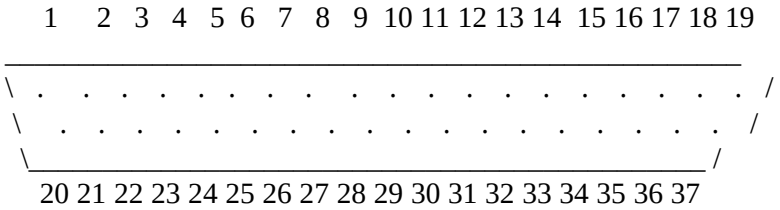
The analog outputs are accessible via a female 37-pin D type connector that extends through the back of the computer case and a DB37P solder cup plug may be used to make connections.

Pin	Name	Function
1	D/A 0 Out	Analog DAC 0 Output
2	D/A 1 Out	Analog DAC 1 Output
3	D/A 2 Out	Analog DAC 2 Output
4	D/A 3 Out	Analog DAC 3 Output
5	D/A 4 Out	Analog DAC 4 Output
6	D/A 5 Out	Analog DAC 5 Output
7	D/A 6 Out	Analog DAC 6 Output
8	D/A 7 Out	Analog DAC 7 Output
9	D/A 8 Out	Analog DAC 8 Output
10	D/A 9 Out	Analog DAC 9 Output
11	D/A 10 Out	Analog DAC 10 Output
12	D/A 11 Out	Analog DAC 11 Output
13	D/A 12 Out	Analog DAC 12 Output
14	D/A 13 Out	Analog DAC 13 Output
15	D/A 14 Out	Analog DAC 14 Output
16	D/A 15 Out	Analog DAC 15 Output
17	+ 12 Vout	+12 VDC from PC
18	Analog GND	Analog Ground
19	-12 Vout	-12 VDC from PC
20	Return GND	Return Analog Ground
21	Return GND	Return Analog Ground
22	Return GND	Return Analog Ground
23	Return GND	Return Analog Ground
24	Return GND	Return Analog Ground
26	Return GND	Return Analog Ground
27	Return GND	Return Analog Ground
28	Return GND	Return Analog Ground
29	Return GND	Return Analog Ground
30	Return GND	Return Analog Ground
31	Return GND	Return Analog Ground
32	Return GND	Return Analog Ground
33	Return GND	Return Analog Ground
34	Return GND	Return Analog Ground
35	Return GND	Return Analog Ground
36	+5 Vout	+5 VDC from PC
37	Power GND	Power Ground

Table 8-1: Connector Pin Assignments

Note

The figure below shows how pins are numbered on D type connectors.



Customer Comments

If you experience any problems with this manual or just want to give us some feedback, please email us at: ***manuals@accesioproducts.com.***. Please detail any errors you find and include your mailing address so that we can send you any manual updates.

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