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MODEL USB-AO16-16A
16-Bit, 16-Channel Analog Output
USB Module
USER MANUAL

FILE: MUSB-AO16-16A.C1c

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WARNING!!

ALWAYS CONNECT AND DISCONNECT YOUR FIELD CABLING WITH THE COMPUTER POWER OFF. ALWAYS TURN COMPUTER POWER OFF BEFORE INSTALLING A CARD. CONNECTING AND DISCONNECTING CABLES, OR INSTALLING CARDS INTO A SYSTEM WITH THE COMPUTER OR FIELD POWER ON MAY CAUSE DAMAGE TO THE I/O CARD AND WILL VOID ALL WARRANTIES, IMPLIED OR EXPRESSED.

Warranty

Prior to shipment, ACCES equipment is thoroughly inspected and tested to applicable specifications. However, should equipment failure occur, ACCES assures its customers that prompt service and support will be available. All equipment originally manufactured by ACCES which is found to be defective will be repaired or replaced subject to the following considerations.

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If a unit is suspected of failure, contact ACCES' Customer Service department. Be prepared to give the unit model number, serial number, and a description of the failure symptom(s). We may suggest some simple tests to confirm the failure. We will assign a Return Material Authorization (RMA) number which must appear on the outer label of the return package. All units/components should be properly packed for handling and returned with freight prepaid to the ACCES designated Service Center, and will be returned to the customer's/user's site freight prepaid and invoiced.

Coverage

First Three Years: Returned unit/part will be repaired and/or replaced at ACCES option with no charge for labor or parts not excluded by warranty. Warranty commences with equipment shipment.

Following Years: Throughout your equipment's lifetime, ACCES stands ready to provide on-site or in-plant service at reasonable rates similar to those of other manufacturers in the industry.

Equipment Not Manufactured by ACCES

Equipment provided but not manufactured by ACCES is warranted and will be repaired according to the terms and conditions of the respective equipment manufacturer's warranty.

General

Under this Warranty, liability of ACCES is limited to replacing, repairing or issuing credit (at ACCES discretion) for any products which are proved to be defective during the warranty period. In no case is ACCES liable for consequential or special damage arriving from use or misuse of our product. The customer is responsible for all charges caused by modifications or additions to ACCES equipment not approved in writing by ACCES or, if in ACCES opinion the equipment has been subjected to abnormal use. "Abnormal use" for purposes of this warranty is defined as any use to which the equipment is exposed other than that use specified or intended as evidenced by purchase or sales representation. Other than the above, no other warranty, expressed or implied, shall apply to any and all such equipment furnished or sold by ACCES.

Table of Contents

Chapter 1: Introduction

This multi-function USB module is an ideal solution for adding portable, easy-to-install analog outputs to any computer with a USB port. The unit is a high speed USB 2.0 device, offering the highest speed available with the USB bus. The board is plug-and-play allowing quick connection whenever you need additional I/O on a USB port.

Features

- High-speed USB 2.0 device, USB 1.1 compatible
- 16-channel, 16-bit resolution digital to analog converter (DAC) outputs
- Jumper selectable analog output ranges of 0-10V and ±5V (contact factory for additional available ranges)
- Zero and span software calibration for each DAC
- Computer generated analog outputs up to 4 kHz simultaneously
- Analog outputs on female 37-pin D type connector
- 2 Analog inputs, 16-bit resolution, 0-5V range up to 4 kHz simultaneously
- 16 digital I/O lines (DIO) on male 37-pin D connector
- Digital I/O buffers tri-stated under program control
- Digital I/O buffers jumper selectable for TTL or LVTTL
- All 16 I/O lines pulled up for dry contact monitoring, buffered for 10mA source or 24mA sink capabilities
- Resettable 0.5A fused +5V available to the user
- Rugged steel powder coated enclosure
    - (except –OEM versions)
- Includes 115VAC to +12V regulated external power supply adapter
    - (except –OEM versions)

Applications

- Portable / Laptop
- Education / Laboratory
- Industrial Automation
- Embedded OEM

Functional Description

This product features 16 digital-to-analog converters (DACs) with single-ended outputs on a female 37-pin D type connector. The board features jumper selectable unipolar and bipolar ranges for the DACs. The DACs can be updated individually or simultaneously. Each channel can be factory calibrated or to the user's requirements through software. To ensure that there will not be excessive outputs to external circuits when the board is plugged in, automatic circuits limit analog outputs to zero volts.

16 digital I/O lines are provided on a male 37-pin D type connector in two groups of 8 bits. Both digital bytes are individually configured as input or output.

A two-channel 16-bit analog-to-digital converter (ADC) version of this board is also available with an input range of 0-5V per channel.

The board is designed to be used in rugged industrial environments but is small enough to fit nicely onto any desk or testing station. The module is PC/104 sized (3.550 by 3.775").

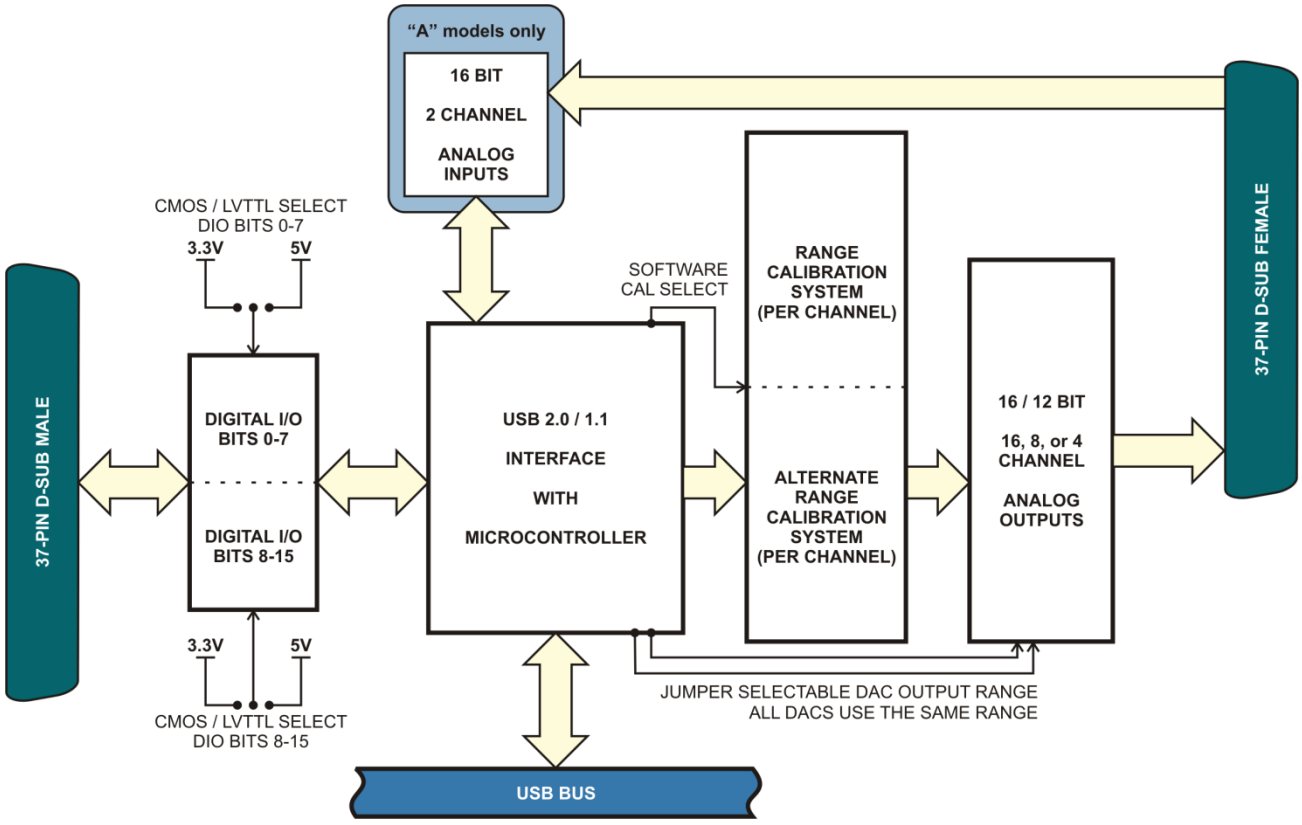


Figure 1-1: Block Diagram

Ordering Guide

- USB-AO16-16A 16-Bit, 16-Channel Analog Output Board with 2 Analog Inputs
- USB-AO16-16E 16-Bit, 16-Channel Analog Output Board
- USB-AO16-8A 16-Bit, 8-Channel Analog Output Board with 2 Analog Inputs
- USB-AO16-8E 16-Bit, 8-Channel Analog Output Board
- USB-AO16-4A 16-Bit, 4-Channel Analog Output Board with 2 Analog Inputs
- USB-AO16-4E 16-Bit, 4-Channel Analog Output Board
- USB-AO12-16A 12-Bit, 16-Channel Analog Output Board with 2 Analog Inputs
- USB-AO12-16E 12-Bit, 16-Channel Analog Output Board
- USB-AO12-8A 12-Bit, 8-Channel Analog Output Board with 2 Analog Inputs
- USB-AO12-8E 12-Bit, 16-Channel Analog Output Board

Model Options

- -OEM Board only version (no enclosure or 12V external power supply)
- -T Extended Temperature Operation (-40°to +85°C)
- -10B Output range of Bipolar ±10V
- -5V Output range of Unipolar 0-5V
- -ST Screw terminals for +12VDC power input instead of DC jack
- DIO Pull-Downs Pull-down resistors on DIO lines

Special Order

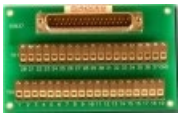
Contact factory at **800-326-1649** for customizations to your specific requirement. Examples of special orders would be conformal coating, vertical DB37 connectors vs. right-angle etc.

Included with your board

The following components are included with your shipment, depending on options ordered. Please take the time now to ensure that no items are damaged or missing.

- USB Module installed in Enclosure (not included with –OEM versions)
- 6' USB 2.0 cable
- Software Master CD
- USB I/O Quick-Start Guide
- 115VAC to 12VDC Regulated Power Supply (not included with –OEM versions)

Optional Accessories

• STB-74 Kit	Compact, complete breakout accessory. 74 Position Screw Terminal Board that mounts on top of the AO Module enclosure, includes short ribbon cables	
• STB-37	37-Pin Male D connector screw terminal board. DIN-rail mountable (need 2 for complete solution)	
• DIN-SNAP	1 foot length of snap-track with clips for mounting to DIN-rail, accepts two STB-37's	
• CAB37MF-36	36 inch flat ribbon cable Male to Female	
• CAB37-36	36 inch flat ribbon cable Female to Female	
• MP104-DIN	DIN-rail mounting adapter plate for affixing any USB/104 module to a DIN-rail	
• CUSB-EMB-6	6 foot USB Type A to micro-fit OEM header	

Chapter 2: Installation

Software CD Installation

The software provided with this board is contained on one CD 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: in the examples below.

WIN NT/2000/XP/2003

a. Place the CD into your CD-ROM drive.
b. The install program should automatically run. If it does not click START | RUN and type D:INSTALL, click OK or press Enter.
c. Follow the on-screen prompts to install the software for this board.

Hardware Installation

The board can be installed in any USB 2.0 or USB 1.1 port. Please refer to the USB I/O Quick Start Guide which can be found on the CD, for specific, quick steps to complete the hardware and software installation.

Plug in the provided AC/DC 12V regulated power supply adapter first, then plug in the USB cable.

Chapter 3: Hardware Details

Option Selections

Refer to the setup programs on the CD provided with the board. Also, refer to the Block Diagram and the Option Selection Map when reading this section of the manual.

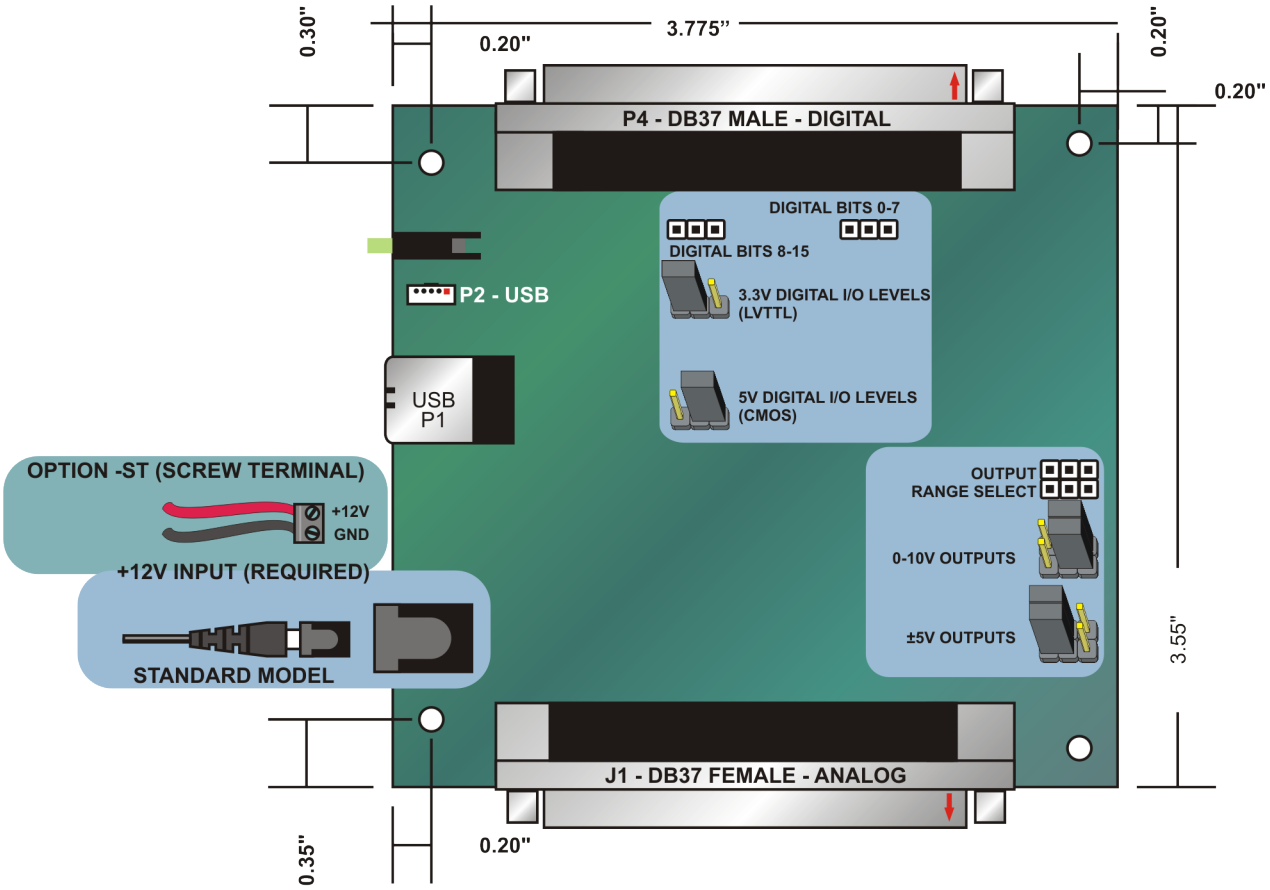


Figure 3-1: Option Selection Map

USB Connector

The USB connector is a Type B high-retention type connector and mates with the cable provided. The USB port provides communication signals along with +5VDC power. The board is powered externally through the **DC Input Jack**. The +5VDC power from the USB port is tied directly to the **5V Resettable Fused Output** providing access to the user.

Embedded USB Connector

Micro 5-pin header in parallel with type B connector to provide a compact interface within embedded systems. (OEM version allows access to this connector)

DB37 Connectors

Two DB37 connectors provide access to the I/O signals. Both J1 (Female, Analog signals) and P4 (Male, Digital signals) have female 4-40 UNC jack-screws. See Chapter 6 for connector pin assignments. In the option selection map the red arrows are pointing to the location of Pin 1.

LED

The LED on the front of the enclosure is used to indicate power and data transmissions. When the LED is in an illuminated steady green state, this signifies that the board is successfully connected to the computer and has been detected and configured by the operating system. When the LED flashes continuously, this signifies that there is data being transmitted over the USB bus.

DC Power Jack

This is the +12 VDC input required to provide power to the board. The DC jack has a 2.00mm post on board and is designed to be used with the +12 VDC AC/DC external power supply that ships with the (non-OEM versions) board. A 2-position screw terminal block can be installed as a factory option (-ST) if the DC jack isn't preferred.

Output Voltage Range Jumpers

This is used to select the range desired. See Figure 3-1 for proper position of jumpers to select either ±5V range or 0-10V range. These jumpers configure the range for all channels.

5V Resettable Fused Output

A 0.5A resettable fuse feeds the digital I/O connector for general purposes. If an over-current persists on a circuit protected by a resettable fuse, it will open interrupting power to the circuit. The amount of time it takes the fuse to act depends on the amount of over-current and other conditions such as ambient temperature, humidity, etc. The fuse will remain open until the bi-metal elements cool sufficiently, at which time the circuit will be restored.

+5V CMOS I/O / +3.3V LVTTL I/O Configuration Jumpers

Each 8-bit digital I/O group can be configured for either 5V CMOS or 3.3V LVTTL signaling via jumper selection.

Chapter 4: USB Address Information

Use the provided driver to access the USB board. This driver will allow you to determine how many supported USB devices are currently installed, and each device's type. This information is returned as a Vendor ID (VID), Product ID (PID) and Device Index.

The VID is "0x1605" and the PID is listed in the following table.

Model Number	Product ID
USB-AO16-16A	"0x8070"
USB-AO16-16E	"0x8071"
USB-AO16-8A	"0x8074"
USB-AO16-8E	"0x8075"
USB-AO16-4A	"0x8076"
USB-AO16-4E	"0x8077"
USB-AO12-16A	"0x8078"
USB-AO12-16E	"0x8079"
USB-AO12-8A	"0x807C"
USB-AO12-8E	"0x807D"

Table 4-1: Product ID to Model Number

The Device Index is determined by how many of the devices you have in your system, and provides a unique identifier allowing you to access a specific board.

Chapter 5: Programming

The driver software provided with the board uses a 32-bit .dll front end compatible with any Windows programming language. Samples provided in Borland C++Builder, Borland Delphi, Microsoft Visual Basic, and Microsoft Visual C++ demonstrate the use of the driver.

The following is a list of the most common function calls provided by the driver in Windows.

For a complete list of available functions and details on how to use them refer to the USB Software Reference Manual located in the installation path for this board.

unsigned long DACSetBoardRange(DeviceIndex,RangeCode)

unsigned long DeviceIndex - number from 0-31 indicating on which device you wish to set the DAC range
unsigned long RangeCode - the range code to set for the board; see the manual for your device's range codes
)

Range	Range Code
0-5V	0
+/-5V	1
0-10V	2
+/-10V	3

Table 5-1: Analog Output Range Codes

unsigned long DACMultiDirect(DeviceIndex,pDACData,DACDataCount)

unsigned long DeviceIndex - number from 0-31 indicating on which device you wish to set a DAC value
unsigned short *pDACData - a pointer to the first of an array of WORDs, consisting of channel/value pairs; channels are from 0-7, values are from 000h-FFFh, as for DACDirect()
unsigned long DACDataCount - number indicating how many channel/value pairs are in the array referenced by pDACData
)

Sample Programs

Sample programs are useful to check out initial operation of the board as well as aiding in the understanding of the programming techniques used (sample source code provided).

Calibration

Each of the DACs is capable of being individually calibrated through the onboard calibration circuitry. The board is shipped from the factory already calibrated, but the user is able to calibrate each DAC to any desired preference. For example, the factory calibration is performed under benign temperature conditions, with negligible load on the DACs; the user may want to calibrate the unit at its operating temperature to improve accuracy, and / or may want to calibrate the unit and the system. The onboard calibration circuit allows both offset and scale errors to be corrected, and can provide non-linearity and other correction types, all in real-time, purely in hardware.

To calibrate the board you will need to create a “calibration table” per channel. Each channel needs a file containing the corrected count values. A provided utility is then used to upload these calibration tables into the on-card circuitry, and all future readings are automatically calibrated in real-time by this circuit.

These calibration tables can be created programmatically (using Y=mX+b, or more complex formulae) or even in a spreadsheet program; the most common file type is simply a single column CSV (although the API we provide will also accept raw binary files).

For a more automated calibration experience refer to the Calibration Utility in the sample directory.

Chapter 6: Connector Pin Assignments

A DB37F connector is provided for analog outputs and a DB37M is provided for the digital I/O lines. Connector pin assignments are listed below.

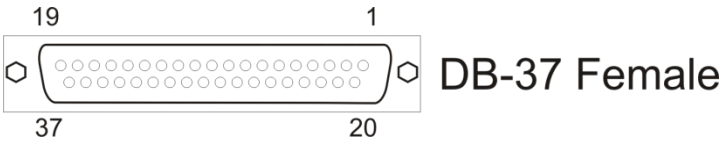


Figure 6-1: J1 DB37F Connector Pin Arrangement

Pin	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Pin
Signal Name	AGND	AGND	AGND	AGND	AGND	AGND	AGND	AGND	AGND	AGND	AGND	AGND	AGND	AGND	AGND	AGND	AGND	AGND	AGND	Signal Name
Pin	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20		Pin
Signal Name	A_IN 1	A_IN 0	DAC15	DAC14	DAC13	DAC12	DAC11	DAC10	DAC9	DAC8	DAC7	DAC6	DAC5	DAC4	DAC3	DAC2	DAC1	DAC0		Signal Name

Table 6-1: J1 DB37F Analog Outputs Connector Pin Assignments

J1 Signal Names and Descriptions	
AGND	Analog Ground
DAC0 to DAC15	Single-ended DAC output
A_IN 0 to A_IN 1	0-5V Analog Input

Table 6-2: J1 Signal Names and Descriptions

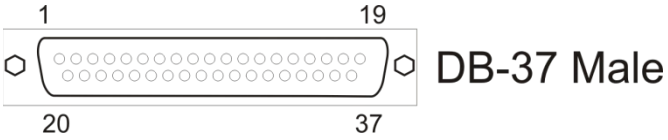


Figure 6-2: P4 DB37M Connector Pin Arrangement

Pin	Signal Name	Pin	Signal Name
1	I/O_0	20	GND
2	GND	21	I/O_10
3	I/O_1	22	GND
4	GND	23	I/O_11
5	I/O_2	24	GND
6	GND	25	I/O_12
7	I/O_3	26	GND
8	GND	27	I/O_13
9	I/O_4	28	GND
10	GND	29	I/O_14
11	I/O_5	30	GND
12	GND	31	I/O_15
13	I/O_6	32	GND
14	GND	33	GND
15	I/O_7	34	GND
16	GND	35	GND
17	I/O_8	36	GND
18	GND	37	FUSED
19	I/O_9		

Table 6-3: P4 DB37M Digital I/O Connector Pin Assignments

P4 Signal Names and Descriptions	
GND	Ground
I/O_0 to I/O_15	Digital I/O
FUSED +5VDC	0.5A FUSED +5VDC Output

Table 6-4: P4 Signal Names and Descriptions

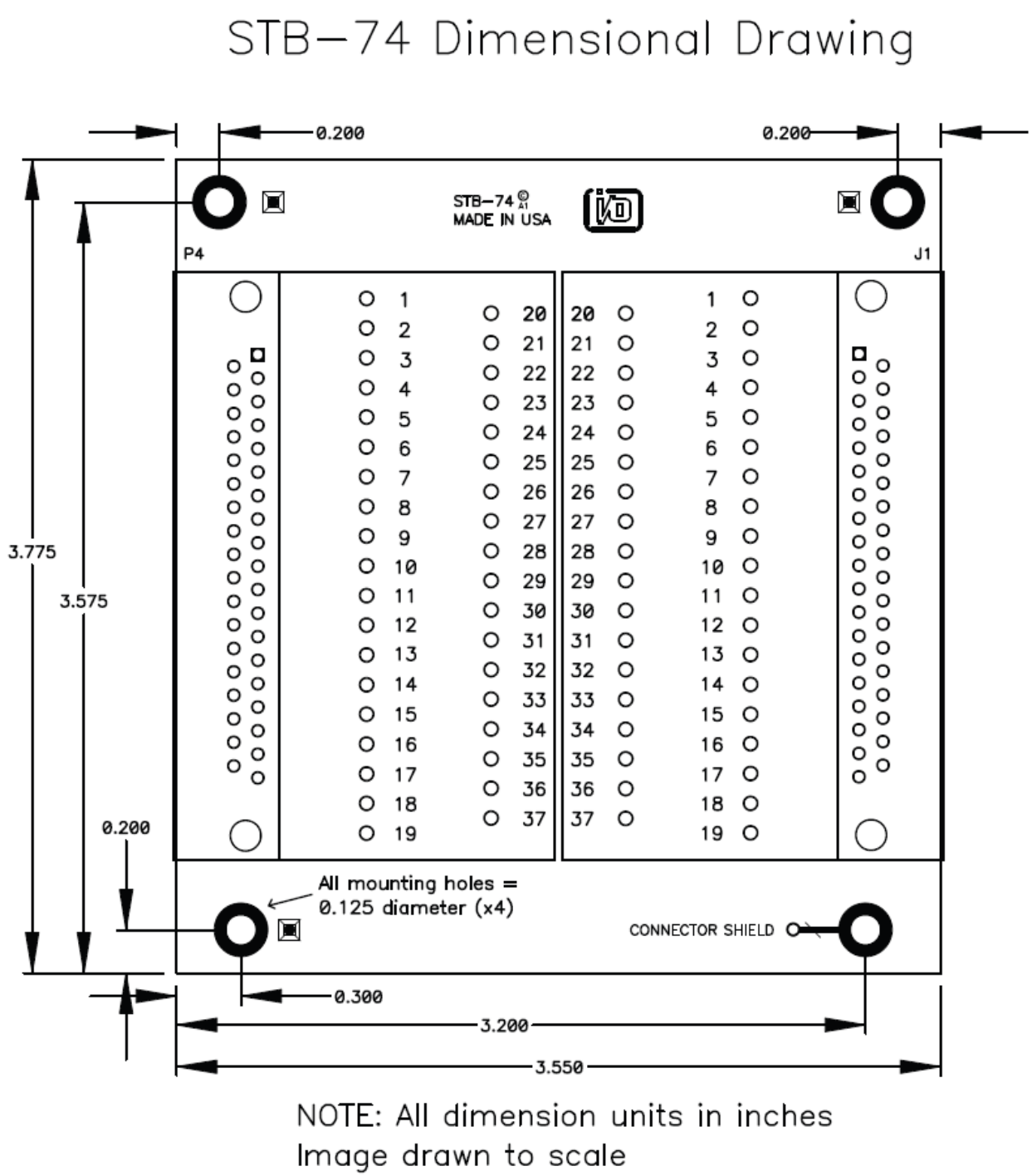


Figure 6-3: STB-74 Breakout Board Dimensional Drawing

Chapter 7: Specifications

Analog Outputs

Number of Outputs:	16 channels
Type of Outputs:	Single-ended
Resolution:	16-bit resolution
Unipolar Ranges:	0-10V standard (0-5V factory option)
Bipolar Ranges:	±5V standard (±10V factory option)
Conversion Rate:	4kHz, all channels simultaneous
Relative Accuracy:	±4 LSB typical
Differential Non-linearity:	±0.25 LSB typical
Settling Time:	8us typical, 10us max
Output Current:	±12 mA per channel

Digital Inputs

3.3V configuration	
Logic High:	2VDC min, 5.5VDC max
Logic Low:	0.8VDC max, -0.5VDC min
5V configuration	
Logic High:	3.5VDC min, 5.5VDC max
Logic Low:	1.5VDC max, -0.5VDC min

Digital Outputs

3.3V configuration	
Logic High:	2.4VDC min, source 10 mA
Logic Low:	0.55VDC max, sink 24 mA
5V configuration	
Logic High:	3.8VDC min, source 10 mA
Logic Low:	0.55VDC max, sink 24 mA

Analog Inputs

Number of channels:	Two, Single-Ended
ADC Type:	Successive Approximation
Sampling Rate:	4k samples per second, all channels simultaneous
Resolution:	16-bit
Range:	0-5V

Environmental

Operating Temperature:	0◦ to 70◦C
Storage Temperature:	-40◦ to +85◦C
Humidity:	5% to 95% non-condensing
Board Dimension:	3.550 x 3.775 inches

Power

+12VDC regulated:	@ ~100 mA typical, no-load on DIO buffer sourced outputs and DAC outputs @ ~520 mA typical, full-load on DIO buffer sourced outputs and DAC outputs

Customer Comments

If you experience any problems with this manual or just want to give us some feedback, please email us at: ***manuals@accesio.com***. Please detail any errors you find, we will reply with manual updates.

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