
DUAL CHANNEL 16-BIT 1 MHz SIMULTANEOUS ANALOG/DIGITAL INPUT BOARD HARDWARE MANUAL

MODEL USB-A16-2A



CHAPTER 1: QUICK START

It is recommended that you install the software package before connecting the USB module to your computer. You can install the software¹ using either a stand-alone installer downloaded from the website or an optional Software Master CD.

Run the installer you downloaded (or autorun.exe on the Software Master CD) and follow the prompts to install the software for your device.

Once the software has been installed: If your device is configured to use external power, connect the voltage source to the device, then turn on the power. Plug the USB cable into both the USB module and your system.

As soon as the green Power/Activity LED lights, your new analog input module is ready to use; you can run any of the provided sample programs to begin acquiring analog input data or controlling and monitoring the digital I/O lines.

If, for any reason, the Power/Activity LED does not light, launch Device Manager and look under the “Data Acquisition” section. If the USB device displays a warning triangle, right-click and select “Update Driver”.

Please note: during the installation you may be prompted regarding the installation of non-WHQL-certified drivers; please carefully confirm the digitally signed source of the drivers and accept the installation.

¹ In Linux or OSX please refer to the instructions in those directories.

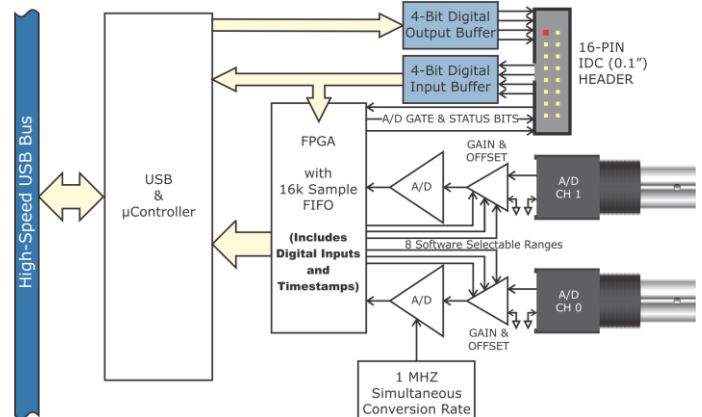
CHAPTER 2: INTRODUCTION

USB, the world’s most popular peripheral interconnect bus, provides an easy way to add capabilities of all kinds to your system. Although originally intended for Human Interface Devices like mice and keyboards, advances to the specification enabled reliable and high speed connectivity for everything from audio devices to frame grabbers.

FEATURES

- High-speed USB 2.0 device (USB 3.0+ compatible), w/High-retention USB connector
- Two 1MHz 16-bit A/D converters for 2MHz aggregate sampling rate
- Analog and digital inputs acquired simultaneously and time-stamped
- 4k sample FIFO (shared by all inputs)
- Per channel software selectable ranges of 0-1V, 0-2V, 0-5V, 0-10V, ±1V, ±2V, ±5V, ±10V
- Eight digital I/O’s (four inputs & four high-current outputs)

- All 8 DIO lines buffered with Sink 32mA / Source 32mA current capabilities
- Jumper selectable 10k ohm Pull-up/Pull-down resistors on DIO lines
- Standard 16-pin IDC connector for Digital I/O lines
- BNC connectors for Analog Inputs
- PC/104 module size and mounting compatibility
- Alternate USB micro-fit header can be used to reduce board footprint in embedded applications
- Small rugged steel industrial enclosure



The USB-AI16-2A is a high-speed USB 2.0 device designed for many applications including laboratory and semiconductor fab signal analysis. This product is a USB-based Analog to Digital (A/D) converter board that features two single-ended 16-bit analog inputs with software selectable input ranges, per channel. The board samples each A/D at 1MHz, simultaneously, for an aggregate speed of 2MHz.

Also provided are four general purpose digital inputs and four high-current digital outputs. The inputs and outputs are jumper configured for 10k ohm pull-up or pull-down resistors (inputs and outputs are separately configured).

The A/D conversion process is initialized by software control and can be started either by software command or digital input trigger via the right angle I/O header connector. Two status signals are provided at the I/O header; one indicates conversions are enabled; the other indicates the board's FIFO is almost full. Each sample acquired includes both of the analog input channels and the four digital inputs simultaneously. All data acquired by the board is time stamped with microsecond resolution.

All required power is normally supplied to the board via the USB cable, however for higher current sourcing capabilities, optional external power may be used. The I/O wiring connections for the digital I/O lines on the USB-AI16-2A are via a 16-position industry standard IDC connector.

The USB-AI16-2A is designed to be used in rugged industrial environments but is small enough to fit nicely onto any desk or testing station. The board itself is PC/104 sized (3.550 by 3.775 inches) and ships inside a steel powder-coated enclosure with an anti-skid bottom.

Control is possible either with custom application software, with off-the-shelf applications (such as LabVIEW), or with provided samples and utilities, including samples in Windows.

The analog inputs are connected using industry standard BNC connectors for assured signal integrity. The 8 digital I/O signals are connected via a right-angle IDC 16-pin (0.1" spacing) boxed and keyed header.

Refer to Chapter 4 for additional information regarding user-selectable option settings for this device including analog input range, polarity, and digital I/O bias selection.

CHAPTER 3: HARDWARE

This manual applies to the following model:

USB-AI16-2A Two 16-bit 1MHz Analog Inputs on USB

This unit is PC/104 sized and mounting-compatible (3.55" x 3.775") with a standard steel powder-coated enclosure (4" x 4.08" x 1.05"). This device is available RoHS compliant, and supports Industrial temperature environments (-40°C to 85°C operating, -65°C to 150°C storage) as an option. Additional options include 3.3V compatible digital I/O and screw-terminal connectivity for positive external power retention (replaces the DC input jack).

CHAPTER 4: CONFIGURATION SETTINGS

This product has several physical settings you should configure before connecting it to the computer. You can run the provided Windows Settings Program for a visual walk-through while configuring the settings, or refer to the image above and instructions below. You will need a Philips screw-driver to open the enclosure. Please follow ESD precautions while configuring settings.

- Digital I/O:
 - For each 4-bit port select between Pull-Up (to Vcc* via 10kΩ) or Pull-down (to GND via 10kΩ). You may also configure a DIO port for neither pull-up nor pull-down (unbiased) by removing the option selection jumper entirely.
 - * Vcc is 5VDC (or 3.3VDC if the -LV option was specified)
- Power Input:
 - Choose to use power as provided by the USB cable, or to use external power (as provided to the DC Jack or screw terminals (-ST option)).

Factory Options include:

-OEM	Board only, without enclosure, features PC/104 module size and mounting compatibility
-T	Extended Temperature (-40°C to 85°C)
-PR	+5VDC regulated AC/DC supply and onboard DC-power input jack
-ST	Screw terminals installed for DC-power input (no jack, no wall-wart)
-LV	Replaces +5VDC digital logic with +3.3V compatible I/O

A green LED provides Power and Activity status. A solid green light means the firmware has been successfully loaded and executed; a flickering light indicates activity.

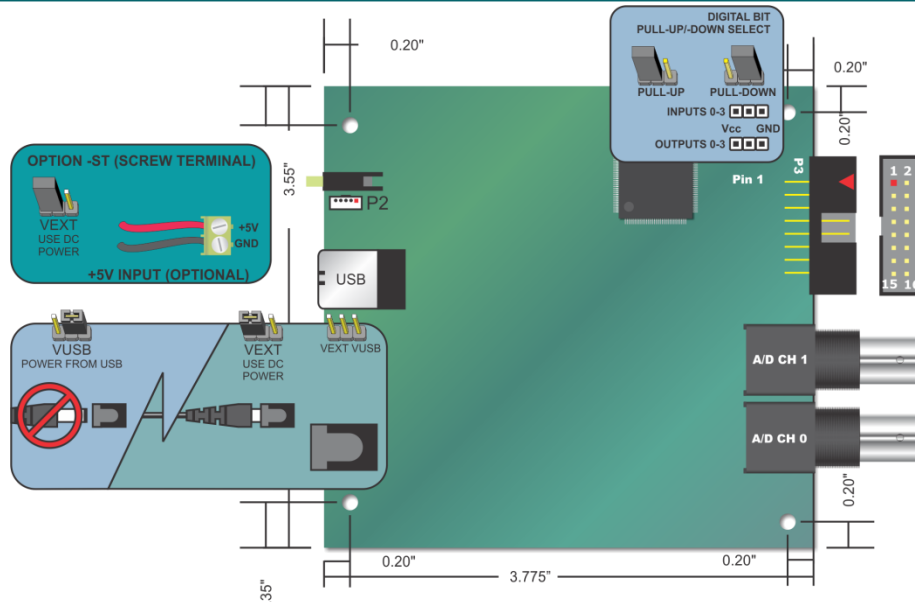
INCLUDED IN YOUR PACKAGE

USB module (installed in labeled enclosure)
6' USB cable

Optional available accessories include:

UTBK-16	Direct-connect 16-pin Screw Terminal board
CAB-BNC-6	Standard 6-foot co-axial cable, male BNC connectors
CAB-BNC-CLIP	3-foot co-axial BNC to mini-grabber test clip cable
MP104-DIN	DIN-rail mounting kit
Software CD	ACCES Master Software CD

Contact the factory for information regarding additional accessories, options, and specials that may be available to best fit your specific application requirements.



Option Selection Map & Dimension Drawing

CHAPTER 5: PC INTERFACE

The USB-AI16-2A is a USB 2.0 High-Speed device compatible with 2.0 and 3.0 USB ports.

The ubiquitous USB port provides a convenient and hot-pluggable interface for adding this high-speed analog input board to almost any system.

In addition to the industry standard type-B USB connector an alternate micro-fit embedded USB header connector is provided. This connector provides a very small footprint, latching signal interface that avoids the stiff and bulky USB cable.

The USB-AI16-2A can be powered via the USB cable (a powered USB port is required), or from external +5VDC power supplied via either a DC-jack (option -PR) or screw terminals (option -ST).

CHAPTER 6: I/O INTERFACE

A total of three I/O connectors are provided on this device. A 16-pin right-angle shrouded and keyed male 0.1" spacing IDC header contains the digital I/O bits. A pair of BNC connectors are used to connect analog inputs.

The pair of BNC connectors are industry standard "female" identical to those you would find on test equipment anywhere.

All DIO bits can be pulled up or down via jumper selection (in two groups of four bits each). Pull-ups are generally used with input mode (to make contact-closure monitoring easy), while outputs are best configured for pull-downs (so external devices don't activate while the computer is booting).

All pull-up/pull-down resistors for the Digital Inputs and Outputs are 10kΩ. The GATE signal input is pulled up, active high, and allows conversions to occur following software command. Grounding this input will disable A/D conversions. The /FIFO FULL signal is active low indicating the data FIFO is almost full. The /RUNNING signal is active low indicating conversions are software enabled.

Pin	Signal Names	Description	Pin	Signal Names	Description
1	DI 0	Digital Input0	2	DI 1	Digital Input1
3	DI 2	Digital Input2	4	DI 3	Digital Input3
5	GND	Ground	6	GND	Ground
7	DO 0	Digital Output0	8	DO 1	Digital Output1
9	DO 2	Digital Output2	10	DO 3	Digital Output3
11	GND	Ground	12	GND	Ground
13	GATE	ADC Gate	14	/RUNNING	ADC Status
15	/FIFO FULL	FIFO FULL	16	GND	Ground

CHAPTER 7: SOFTWARE INTERFACE

The USB-AI16-2A utilizes a high-speed custom function driver optimized for maximum continuous data throughput that is hundreds to thousands of times faster than the USB human interface device (HID) driver used by many competing products.

This approach maximizes the full functionality of the hardware along with capitalizing on the advantage of high-speed USB 2.0.

The boards are supported for use in most USB supported operating systems and includes a free Windows and Linux compatible software package. This package contains sample programs and source code in C# (.NET), Delphi, and Visual C++, for Windows.

Third party support includes a Windows standard DLL interface usable from the most popular application programs and includes example LabVIEW VIs. Embedded OS support includes the family of Windows Operating Systems including IoT. Full driver source code is provided to assist supporting any and all Operating Systems.

Numerous sample programs are provided to demonstrate using the API. Refer to the USB Software Reference Manual for details.

The onboard FIFO queues data, exclusively, in 8-byte "points". Each point is stored as a structure, shown below:

```
typedef struct _USB_AI16_2A_Point { // pragma packed,
intel byte order
    UInt16 ADCH0;
    UInt16 ADCH1;
    struct { // pragma packed, intel byte order
        UInt32 status: 1;
        UInt32 digital: 4;
        UInt32 Timestamp: 27;
    } dits;
} USB_AI16_2A_Point;
```

The structure could be used like the following:

```
USB_AI16_2A_Point data[]; // don't forget to allocate
memory!
```

```
// pass "data" as pointer to Acquire function(s), then
```

```
data[n].ADCH0 would refer to the nth conversion of CH0
data[n].ADCH1 refers to the nth conversion of CH1
data[n].dits.status is the status-indicator bit
```

```
data[n].dits.digital is the four digital input bits
data[n].dits.Timestamp holds the 27-bit usecond
timestamp
```

Our drivers and DLLs usually shield you from needing to know these details, but for advanced use the following information may be helpful:

Before the firmware has been loaded and initialized the device appears to your system as a VID/PID pair of 1605/0180.

Once the firmware has been successfully loaded and is running the device appears as a VID/PID of 1605/8180.

This information is primarily useful if you'll be using more than one board in the same computer, all using the same AIOUSB driver.

The latest information can always be found on the product page on the website. Here are some useful links:

Links to useful downloads

Main web site	http://aces.io
Product web page	aces.io/USB-AI16-2A
This manual	aces.io/MANUALS/USB-AI16-2A.pdf
Windows Software	aces.io/files/packages/USB-AI16-2A
Install Package	Install.exe

CHAPTER 8: SPECIFICATIONS

PC Interface

USB	USB 2.0 or 3.0+, High-Speed
Connector	High-retention type USB-B, complies with the class 1, Div II, minimum withdrawal requirement of over 3 pounds of force (15 Newtons)
Alternate, Embedded Connector	Latching small-form-factor "UP" connector Molex 53047-0510. The mating connector is Molex 51021-0500.
Data FIFO	Width: 16-bit Depth: 16k samples

Analog Input Interface

Input Connectors	BNC, female
Analog Inputs	2, Single-Ended
Resolution	16-bit
Unipolar Ranges	1V, 2V, 5V, 10V
Bipolar Ranges	±1V, ±2V, ±5V, ±10V
Impedance	1MΩ

Digital Input / Output Interface

I/O Connector	Right-angle IDC 16-pin (0.1") boxed and keyed header
Digital Outputs	5V Logic
High-output Voltage	≥ 3.8V
Low-output Voltage	≤ 0.55V
Sink Current	32mA
Source Current	32mA
	3.3V Logic
High-output Voltage	≥ 2.4V
Low-output Voltage	≤ 0.55V
Sink Current	24mA
Source Current	24mA

Digital Inputs	5V Logic
High-input Voltage	≥ 3.5V ≤ 2uA
Low-input Voltage	≤ 1.5V ≤ 2uA
	3.3V Logic
High-input Voltage	≥ 2V ≤ 2uA
Low-input Voltage	≤ 0.8V ≤ 2uA

Environmental

Operating temperature	Commercial (Standard) 0° to 70°C Industrial (-T) -40° to 85°C
Storage temperature	-50° to 125°C
Humidity	5% to 95%, non-condensing
Power required	~415 mA typical (no load) +5VDC, regulated

USB host controllers provide a max of 500mA in most desktop environments. This gives you 85mA available (500mA - 415mA = 85mA) to divide amongst the digital output buffered lines. Optional AC/DC adapter can be ordered ("-PR" option) if USB can't supply the full 500mA.

Physical

Size	3.550 x 3.775 inches <i>PC/104-size</i>
Enclosure Size	3.990 x 4.075 x 1.045 inches
Weight	72 grams

CHAPTER 9: CERTIFICATIONS

CE & FCC

These devices are designed to meet all applicable EM interference and emission standards.

ROHS / LEAD-FREE STATEMENT

All models are available in compliance with RoHS and various other lead-free initiatives. Make sure to specify “–RoHS” when placing your orders.

WARNING

A SINGLE STATIC DISCHARGE CAN DAMAGE YOUR CARD AND/OR CAUSE PREMATURE FAILURE! PLEASE FOLLOW ALL REASONABLE PRECAUTIONS TO PREVENT A STATIC DISCHARGE.

ALWAYS CONNECT AND DISCONNECT YOUR FIELD CABLING WITH THE POWER TO THE DEVICE OFF. CONNECTING CABLES TO A DEVICE WITH THE DEVICE 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

TERMS AND CONDITIONS

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 domestic 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.

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