

# 16 ANALOG INPUT, 4 ANALOG OUTPUT, 16 DIGITAL I/O INTELLIGENT ETHERNET MODULE HARDWARE MANUAL

## MODELS

## eNET-AIO16-16F FAMILY

### 16-BIT BOARDS

eNET-AIO16-16F	eNET-AIO16-16A	eNET-AIO16-16E	eNET-AI16-16F	eNET-AI16-16A	eNET-AI16-16E
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### 16-BIT DAQ-PACK

eNET-AIO16-64MA	eNET-AIO16-64MA	eNET-AI16-64MA	eNET-AI16-64MA
eNET-AIO16-64ME	eNET-AIO16-64ME	eNET-AI16-64ME	eNET-AI16-64ME
eNET-AIO16-32A	eNET-AIO16-32A	eNET-AI16-32A	eNET-AI16-32A
eNET-AIO16-32	eNET-AIO16-32	eNET-AI16-32	eNET-AI16-32
eNET-AIO16-32E	eNET-AIO16-32E	eNET-AI16-32E	eNET-AI16-32E
eNET-AIO16-64A	eNET-AIO16-64A	eNET-AI16-64A	eNET-AI16-64A
eNET-AIO16-64	eNET-AIO16-64	eNET-AI16-64	eNET-AI16-64
eNET-AIO16-64E	eNET-AIO16-64E	eNET-AI16-64E	eNET-AI16-64E
eNET-AIO16-96A	eNET-AIO16-96A	eNET-AI16-96A	eNET-AI16-96A
eNET-AIO16-96	eNET-AIO16-96	eNET-AI16-96	eNET-AI16-96
eNET-AIO16-96E	eNET-AIO16-96E	eNET-AI16-96E	eNET-AI16-96E
eNET-AIO16-128A	eNET-AIO16-128A	eNET-AI16-128A	eNET-AI16-128A
eNET-AIO16-128	eNET-AIO16-128	eNET-AI16-128	eNET-AI16-128
eNET-AIO16-128E	eNET-AIO16-128E	eNET-AI16-128E	eNET-AI16-128E

### 12-BIT BOARDS

eNET-AIO12-16A	eNET-AIO12-16	eNET-AIO12-16E	eNET-AI12-16A	eNET-AI12-16	eNET-AI12-16E
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### 12-BIT DAQ-PACK

eNET-AIO12-64MA	eNET-AIO12-64MA	eNET-AI12-64MA	eNET-AI12-64MA
eNET-AIO12-64M	eNET-AIO12-64M	eNET-AI12-64M	eNET-AI12-64M
eNET-AIO12-64E	eNET-AIO12-64E	eNET-AI12-64E	eNET-AI12-64E
eNET-AIO12-32A	eNET-AIO12-32A	eNET-AI12-32A	eNET-AI12-32A
eNET-AIO12-32	eNET-AIO12-32	eNET-AI12-32	eNET-AI12-32
eNET-AIO12-32E	eNET-AIO12-32E	eNET-AI12-32E	eNET-AI12-32E
eNET-AIO12-64A	eNET-AIO12-64A	eNET-AI12-64A	eNET-AI12-64A
eNET-AIO12-64	eNET-AIO12-64	eNET-AI12-64	eNET-AI12-64
eNET-AIO12-64E	eNET-AIO12-64E	eNET-AI12-64E	eNET-AI12-64E
eNET-AIO12-96A	eNET-AIO12-96A	eNET-AI12-96A	eNET-AI12-96A
eNET-AIO12-96	eNET-AIO12-96	eNET-AI12-96	eNET-AI12-96
eNET-AIO12-96E	eNET-AIO12-96E	eNET-AI12-96E	eNET-AI12-96E
eNET-AIO12-128A	eNET-AIO12-128A	eNET-AI12-128A	eNET-AI12-128A
eNET-AIO12-128	eNET-AIO12-128	eNET-AI12-128	eNET-AI12-128
eNET-AIO12-128E	eNET-AIO12-128E	eNET-AI12-128E	eNET-AI12-128E

## CHAPTER 1: QUICK START

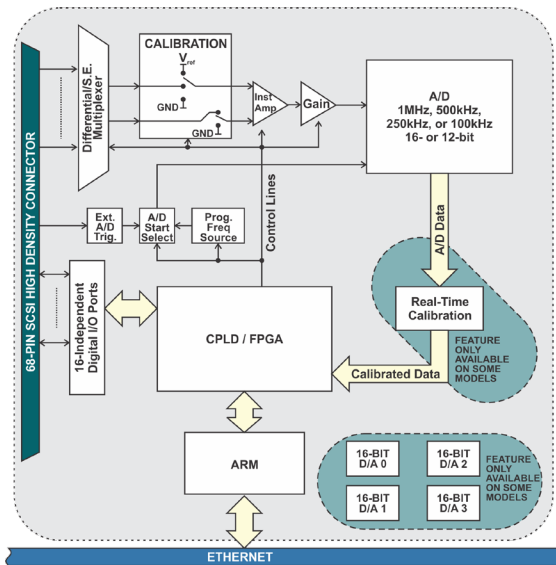
It is recommended that you install the software package before installing the board in your Ethernet environment. Install the software<sup>1</sup> using our stand-alone installer downloaded from the website.

Run the installer you downloaded and follow the prompts to install the software for your device.

Once the software has been installed run the Settings program and follow the onscreen instructions to get the eNET- device configured and usable.

<sup>1</sup> In Linux or OSX please refer to the [AIOeNET Software Reference Manual.html](http://www.acces-i-o.com/AIOeNET_Software_Reference_Manual.html)

## CHAPTER 2: INTRODUCTION



- Ethernet 10/100/1000 Multifunction DAQ (Optional PoE)
- Sustained sampling speeds up to 1MHz
- 16-bit or 12-bit resolution A/D converter
- Flexible, software configured functionality
- 16 single-ended or 8 differential analog inputs
- 8 input ranges, 4 unipolar and 4 bipolar, per channel
- Autocalibration and filtering onboard for accurate data
- Four 16-bit analog outputs with 4 factory ranges
- 16 high-current digital I/O lines
- TCP packet interface with Windows DLL API wrapper
- Small, (4"x4"x1.7") rugged, steel industrial enclosure
- Designed, made, supported, and manufactured in the USA

## CHAPTER 3: HARDWARE

This manual applies to the following models:

eNET-AIO16-16F	A/D 16-bit, 1 Msps, 4 D/A
eNET-AIO16-16A	A/D 16-bit, 500 Ksps, 4 D/A
eNET-AIO16-16E	A/D 16-bit, 250 Ksps, 4 D/A
eNET-AI16-16F	A/D 16-bit, 1 Msps
eNET-AI16-16A	A/D 16-bit, 500 Ksps
eNET-AI16-16E	A/D 16-bit, 250 Ksps

eNET-AIO12-16A	A/D 12-bit, 500Ksps, 4 D/A
eNET-AIO12-16	A/D 12-bit, 250Ksps, 4 D/A
eNET-AIO12-16E	A/D 12-bit, 100Ksps, 4 D/A
eNET-AI12-16A	A/D 12-bit, 500Ksps
eNET-AI12-16	A/D 12-bit, 250Ksps
eNET-AI12-16E	A/D 12-bit, 100Ksps

The boards are designed as PC/104 sized, with PC/104 mounting hole locations.

All units are RoHS compliant.

### INCLUDED IN YOUR PACKAGE

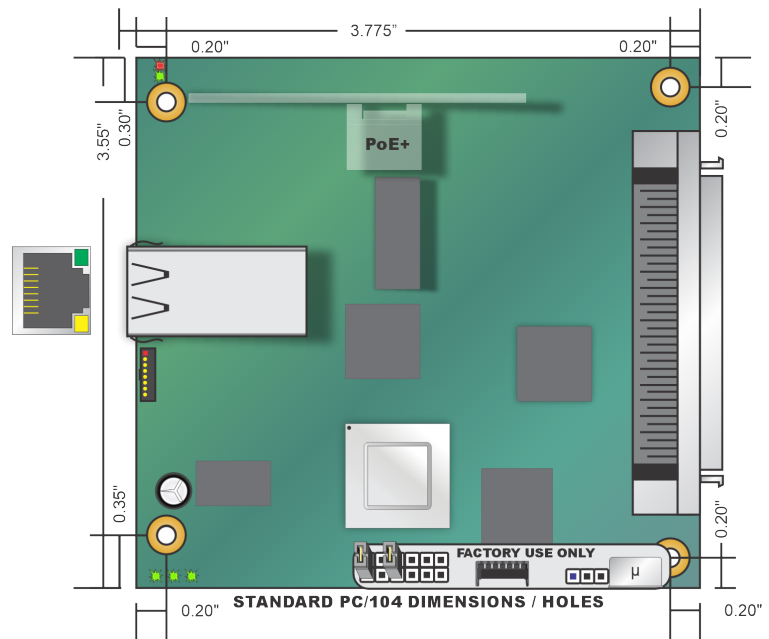
1x eNET-AIO16-16F Family board

### Available accessories include:

TBD	+12VDC @ 5A Power Supply
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Contact the factory for information regarding additional accessories, options, and specials that may be available to best fit your specific application requirements, such as Industrial Temperature (-40°C to 85°C).

## CHAPTER 4: CONFIGURATION SETTINGS



All configuration of this device is performed through software; Any jumpers or switches are for factory use only.

## CHAPTER 5: PC INTERFACE

This product interfaces with one (or more) computers via a 10/100/1000Base-T Ethernet connection, typically by RJ45 CAT5 cable to an existing LAN switch.

The PoE option uses the Ag5400 series Power-over-Ethernet (PoE+) module to extract power from the RJ45, conforming to the IEEE802.3 PoE standard, compatible with the IEEE802.3bt, IEEE802.3at, and IEEE802.3af amendments. This is a Type 2 Class 4 device.

The primary control and monitoring connection is at port 18767 (0x494F, "IO" in ASCII), and the streaming ADC data connection is at port 18768. An additional diagnostic status / logging port can be

enabled, if desired. An arbitrary number of connections can be opened, but only one at a time can operate the Analog Input features of the board.

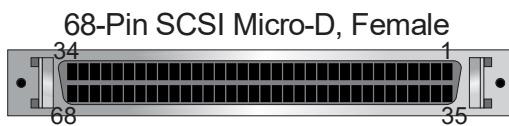
Complete details for the Windows AIOeNET.dll API and the eNET-Protocol TCP Packets is provided in the AIOeNET Software Reference.html.

## CHAPTER 6: I/O INTERFACE

I/O connections are made at the 68-pin SCSI connector.

A Note About Unused Analog Inputs:

Any unused analog input should be connected to ground with a short jumper wire; either in the mating connector cable, or on the breakout terminal board. This will reduce / eliminate crosstalk which, if left unchecked, can influence measurements of adjacent *connected* input channels.



68-Pin SCSI I/O Connector Pin Assignments

Pin	Signal Name	Pin	Signal Name
1	Ch0 (SE) / Ch0+ (DIFF)	35	Ch8 (SE) / Ch0- (DIFF)
2	AGND	36	AGND
3	Ch1 (SE) / Ch1+ (DIFF)	37	Ch9 (SE) / Ch1- (DIFF)
4	AGND	38	AGND
5	Ch2 (SE) / Ch2+ (DIFF)	39	Ch10 (SE) / Ch2- (DIFF)
6	AGND	40	AGND
7	Ch3 (SE) / Ch3+ (DIFF)	41	Ch11 (SE) / Ch3- (DIFF)
8	AGND	42	AGND
9	Ch4 (SE) / Ch4+ (DIFF)	43	Ch12 (SE) / Ch4- (DIFF)
10	AGND	44	AGND
11	Ch5 (SE) / Ch5+ (DIFF)	45	Ch13 (SE) / Ch5- (DIFF)
12	AGND	46	AGND
13	Ch6 (SE) / Ch6+ (DIFF)	47	Ch14 (SE) / Ch6- (DIFF)
14	DAC0 (AIO) / AGND (AI)	48	AGND
15	Ch7 (SE) / Ch7+ (DIFF)	49	Ch15 (SE) / Ch7- (DIFF)
16	DAC1 (AIO) / AGND (AI)	50	AGND / PDGND (for -PD)
17	DAC2 (AIO-16F) / AGND (AI)	51	-15V (Factory Use)
18	Factory Use	52	n/c
19	DAC3 (AIO-16F) / AGND (AI)	53	+15V (Factory Use)
20	Factory Use	54	n/c
21	Factory Use	55	n/c
22	GND	56	GND
23	DIO14	57	DIO15
24	DIO12	58	DIO13
25	DIO10	59	DIO11
26	DIO8	60	DIO9
27	DIO6	61	DIO7
28	DIO4	62	DIO5
29	DIO2	63	DIO3
30	DIO0	64	DIO1
31	GND	65	GND
32	PWM I/O	66	GND
33	X_USER_IO_0	67	A/D Conversion Start Enable
34	X_USER_IO_1	68	External Trigger

### Signal Descriptions

Signal Name	I/O	Description
Ch0 thru Ch7(SE) Ch0+ thru Ch7+ (DIFF)	I	Channel 0 thru Channel 7 Single-ended or Channel 0 thru Channel 7 Differential non-inverting input
Ch8 thru Ch15(SE) Ch0- thru Ch7- (DIFF)	I	Channel 8 thru Channel 15 Single-ended or Channel 0 thru Channel 7 Differential inverting input
AGND	X	Analog Ground
PDGND	I	Pseudo Differential Ground Connection (used for all -PD analog inputs)
-15V	O	AIMUX-64M Power. Factory use only. Do not connect.
+15V	O	AIMUX-64M Power. Factory use only. Do not connect.
MUX CTL	O	Multiplexer control when AIMUX board(s) present
DAC0 & DAC1	O	D/A outputs for AIO models
DAC2 & DAC3	O	D/A outputs for AIO models
GND	X	Digital Ground
DIO0 thru DIO15	I/O	Digital I/O Bits 0 through 15, individually configured as either inputs or outputs (pulled-up to 3.3V through 10k ohms; factory option for +5V, pull-down, or no bias)
A/D Conversion Start Enable	I	Enable Analog to Digital Conversion Starts (pulled-up; active-high)
External Trigger	I	External Analog to Digital Conversion Start Trigger (pulled-up; software selectable rising/falling edge )



## CHAPTER 7: SOFTWARE INTERFACE

### How to use

**Tip:** Taking data from every channel can be as simple as calling “ADC\_GetImmediateScanV(0, rangeCode, &data);”, which converts all channels at the specified range and stuffs the data (as double-precision floating point Voltages) into the data array. This function can be called many thousands of times per second. Please refer to the samples and the software reference manual (.html) for details on this and other available API functions, including how to acquire 1MHz data via callback or polling.

### Advanced Topics

#### ADC START MODES

ADC Start Events can be generated by software command, the ticks of an onboard timing circuit, or via an external signal’s edges (rising or falling selectable).

The onboard timing circuit is programmed as the divisor of a 25 MHz source, with  $\div 25$  being the minimum possible divisor, resulting in a 1 MHz ADC Start Event Rate. Setting a divisor greater than zero, but less than *your* eNET- model supports, will result in the fastest available rate (which the eNET-AIO rate-divisor register will show).

Take care to calculate your desired ADC Start Event rate correctly, including a careful understanding of the ADC Scan vs Channel Start Modes, and the impact of Oversamples (see below).

#### SINGLE AND SCAN START MODES

Each ADC Start Event can be configured to start either a Scan of channels or a single channel conversion.

**Single Start Mode:** Each ADC Start Event will acquire a single channel of data, then increment the internal channel pointer to the next channel in the configured sequence. (see Oversamples)

**Scan Start Mode:** Each ADC Start Event will acquire the entire configured sequence of channels then no further data will be acquired until a subsequent ADC Start Event. The data within this “scan” of channels are acquired at the fastest possible rate.

#### OVERSAMPLES

Each “channel acquired” is either one ADC conversion, or up to 256 consecutive conversions performed at the fastest speed possible, based on the Oversample configuration (0-255; each Start takes  $1 + \text{Oversample number}$  of conversions).

#### MAXIMUM START RATE

If you configure the device for “Channel” ADC Start Modes, and set Oversamples to zero, each ADC Start Event will perform exactly one conversion.

Ex: If you configure the device for “Scan” ADC Start Mode, with the Scan Start Channel set to zero and the Scan End Channel set to 15, with Oversamples set to zero, each ADC Start Event will perform exactly 16 conversions, as fast as your model allows.

Ex: If you configure the device for “Channel” with 255 Oversamples, each ADC Start will perform exactly 256 conversions, as fast as your model allows.

Ex: If you configure the device for “Scan” ADC Start Mode, Channels 0-15, with 255 Oversamples, each ADC Start Event will perform exactly 4096 conversions, as fast as your model allows.

The Maximum Rate (Hz) you can perform ADC Start Events, whether via the onboard Timer or External edges, is:

#### CHANNEL START MODE

$$\text{Hz} = \text{MaxAdcRate} \div (1 + \text{Oversamples})$$

#### SCAN START MODE:

$$\text{Hz} = \text{MaxAdcRate} \div (\text{EndChannel} - \text{StartChannel} + 1) \times (1 + \text{Oversamples})$$

Note: MaxAdcRate is based on your device model; refer to Chapter 3 for specifics.

#### CALIBRATION

Unipolar and Bipolar reference and analog ground can be measured and compared against a factory-measured value to compensate for thermal or other sources of calibration drift. Onboard logic can apply software-configured scale/offset factors to the data in real-time to perform even system-level calibration. All ADC's suffer from offset and gain errors. The circuit is intentionally designed to have some minimum amount of scale error so the full analog input ranges will always be measurable, even after years of service, and in any supported thermal environment: e.g., the 0-10V input range, uncalibrated, will *actually* measure from a few millivolts below zero to a few mV above 10V.

#### Software Pro Tips:

- Use our API. Avoid accessing the card at the TCP packet-level unless you really know you need to. Contact us for any questions — we’re here to help.
- Always prefer Scan Start Mode unless you have unusual intra-channel timing needs.

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

#### Links to useful downloads

ACCES web site	<a href="https://accessio.com">https://accessio.com</a>
Product web page	<a href="https://accessio.com/eNET-AIO16-16F">accessio.com/eNET-AIO16-16F</a>
This manual	<a href="https://accessio.com/MANUALS/eNET-AIO16-16F-Family.pdf">accessio.com/MANUALS/eNET-AIO16-16F-Family.pdf</a>
Install Package	<a href="https://accessio.com/files/packages/eNET-AIO16-16F-Install.exe">accessio.com/files/packages/eNET-AIO16-16F-Install.exe</a>
Software Reference	<a href="https://accessio.com/AIOeNET-Software-Reference.html">accessio.com/AIOeNET-Software-Reference.html</a>

## CHAPTER 8: SPECIFICATIONS

### PC Interface

Ethernet	10/100/1000 Base-T RJ45 with optional PoE
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### Analog Inputs

ADC Type	Successive approximation
Resolution	16-bit
Sampling rate	1 Msps max aggregate
Number of channels	8 Differential, each software configurable as 2 Single Ended, for up to 16 Single Ended channels. 16 pseudo-differential channels Factory Option available
4-20mA or 10-50mA	Factory option
Int Nonlinearity Error	0.0011% FS
No Missing Codes	16 bits
Input Impedance	1 MΩ
A/D Start Sources	Software, Timer, and External Start (rising or falling edge software selectable)
A/D Start Types	Channel or Scan
Overvoltage Protection	±40 V
Crosstalk	-53dB @ 1 MHz; -84dB @ 500 kHz

### Analog Outputs

Number	4, 2, or 0
Type:	Single-ended
Resolution:	16-bit
Ranges:	0-5V, 0-10V, ±5V, or ±10V <i>factory options</i> <b>The Output Range must be specified at the time of order</b>
Settling Time	4 μs typical, 7μs max; ¼ to ¾ scale to ±2 LSBs
Output Current	±10 mA per channel

### Digital Input / Output Interface

Digital Bits	16, individually direction controllable	
Digital Inputs	Logic High	2.31V to 5.5V (3.3VDC, 5VDC tolerant)
	Logic Low	-0.5V to 0.99V
Digital Outputs	Logic High	2.5V (min) 10mA source
	Logic Low	0.7V (max) 14mA sink
There are 3 additional DIO bits available; contact us for more information		

### Environmental

Temperature	Operating	0°C to +70°C -40°C to +85°C (-T option)
	Storage	-40°C to +105°C
Humidity	5% to 95% RH, non-condensing	
Dimensions	PC/104 format, 3.550" by 3.775" and mounting holes	

### Power

Power required	+12VDC @ 475mA (idle)
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### I/O Interface Connectors

ADC/DAC/DIO	68-pin Type 2 SCSI female with quick-release "one-touch" locking latches; TE Connectivity PN 1761028-4
Ethernet	RJ45 MagJack

### Model Options

-T	Extended Temperature Operation (-40° to +85°C)
-I	4-20mA inputs (Singled-ended)
-PD	Pull downs on digital bits
-Sxx	Special configurations (10-50mA inputs, input voltage dividers, conformal coating, etc.)
-xxx	16 Pseudo-differential ADC inputs
-TTL	CMOS signaling (+5 VDC) on DIO pullups
-PoE	Power Over Ethernet (PoE+, IEEE802.3 PoE)

## CHAPTER 9: CERTIFICATIONS

### UL & TUV

Neither DC voltages above 15V, nor AC voltages of any kind, are consumed or produced during normal operation of this device. This product is therefore exempt from any related safety standards. Use it with confidence!

### ROHS / LEAD-FREE STATEMENT

All models are produced in compliance with RoHS and various other lead-free initiatives.

### WARNING

**A SINGLE STATIC DISCHARGE CAN DAMAGE YOUR CARD AND CAUSE PREMATURE FAILURE! PLEASE FOLLOW ALL REASONABLE PRECAUTIONS TO PREVENT A STATIC DISCHARGE SUCH AS GROUNDING YOURSELF BY TOUCHING ANY GROUNDED SURFACE PRIOR TO TOUCHING THE CARD.**

### 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:

### 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.

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## 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 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.

## DISCLAIMER

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