

# User Guide

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27-May-2020



## A-812.21xxx 2-AXIS MOTION CONTROLLER

FOR USE WITH **PI**GLIDE AIR BEARING PRODUCTS AND OTHER DIRECT-DRIVE STAGES.



This document describes the A-812.21xxx Series of Integrated Motion Controllers.

# User Guide

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## 1. About this Document

### 1.1. Objective and Target Audience of this User Guide

This User Guide contains information on the intended use of the A-812.21xxx series of motion controllers, hereinafter referred to as the “A-812”. It assumes that the reader has a fundamental understanding of basic servo systems as well as motion control concepts and applicable safety procedures.

### 1.2. Symbols and Typographic Conventions

The following symbols and markings are used in this User Guide:

Symbol	Meaning
 WARNING	If not avoided, the situation could result in damage to the equipment.
 DANGER DANGER DANGER	Failure to observe these precautions could result in serious injury to those performing the procedures and damage to the equipment.
1. 2.	Action consisting of several steps whose sequential order must be observed
➤	Action consisting of one or several steps whose sequential order is irrelevant

### 1.3. Other Applicable Documents

Name
Instructions for SpiiPlus ADK Suite Installation
ACSPL Plus Programmer's Guide
SpiiPlus MMI Application Studio User Guide
SpiiPlus Command and Variable Reference Guide
SpiiPlus C Library Reference Programmer Guide
SpiiPlus COM Library Programmers Guide
SpiiPlus NET Programmers Guide
App Note – PEG and MARK Operations

## 2. Safety

### 2.1. Intended Use

The A-812 is a laboratory device according to DIN EN 61010-1. It is intended to be used in interior spaces and in an environment which is free of dirt, oil and lubricants.

According to its design, the A-812 is intended for operating the PIglide line of direct-drive air bearing linear and rotary stages and other stages from PI with servo motors. Do not attempt to connect the A-812 to any other device unless specifically instructed to do so by a PI engineer.

The A-812 may only be used in compliance with the technical specifications and instructions in this User Guide. The user is responsible for process validation and application software development.

### 2.2. General Safety Instructions

The A-812 is built according to state-of-the-art technology and recognized safety standards. Improper use can result in personal injury and/or damage to the A-812.

- Only use the A-812 for its intended purpose, and only use it if it is in a good working order.
- Read the user documentation.
- Immediately eliminate any faults and malfunctions that are likely to affect safety.

The operator is responsible for the correct installation and operation of the A-812.

- Install the A-812 near the power source so that the power plug can be quickly and easily disconnected from the mains.
- Use the supplied components to connect the A-812 to the power source.

### 2.3. Organizational Measures

- Always keep this user guide available by the A-812.
- The latest versions of the user guide are available from PI.
- Add all information given by the manufacturer to the user documentation, for example supplements or Technical Notes.
- If you give the A-812 to other users, also turn over the user documentation as well as other relevant information provided by the manufacturer.
- Only use the device on the basis of the complete user documentation. Missing information due to incomplete user documentation can result in property damage.
- Only install and operate the A-812 after having read and understood this user guide.

### 2.4. Personnel Qualification

The A-812 may only be installed, started up, operated, maintained and cleaned by authorized and qualified staff.

## 2.5. Warnings and Safety Notices

The following statements apply throughout this user guide. Failure to observe these precautions could result in serious injury to those performing the procedures and damage to the equipment. This user guide and any additional instructions included with the stage should be retained for the lifetime of the stage.

 DANGER	To minimize the possibility of electrical shock and bodily injury or death, disconnect all electrical power prior to making any electrical connections.
 DANGER	To minimize the possibility of electrical shock and bodily injury or death when any electrical circuit is in use, ensure that no person comes in contact with the circuitry when the stage or controller is connected to a power source.
 DANGER	To minimize the possibility of bodily injury or death, disconnect all electrical power prior to making any mechanical adjustments.
 DANGER	To minimize the possibility of bodily injury or death from electric shock in the case of malfunction or failure of the system, make sure a protective earth conductor is properly connected.
 DANGER	Moving parts of the stage can cause crushing or shearing injuries. All personnel must remain clear of any moving parts.
 DANGER	Improper use of the equipment can cause damage, shock, injury, or death. Read and understand this user guide before operating the stage.
 DANGER	If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment can be impaired.
 DANGER	Interconnect cables can pose a tripping hazard. Securely mount and position all stage cables to avoid potential hazards.
 DANGER	Do not expose the equipment to environments or conditions outside the specified range of operating environments. Operation in conditions other than those specified can cause damage to the equipment.
 DANGER	The equipment must be mounted securely. Improper mounting can result in injury and damage to the equipment.
 DANGER	Use care when moving the equipment. Lifting or transporting stages can result in injury.
 WARNING	Use care when moving the equipment. Avoid any shocks, drops or bumps that can cause scratches, dings, dents, or distortion of the equipment.

## 3. Unpacking

Carefully unpack the controller, stages, and other components from the shipping packaging. Inspect the contents for signs of damage. If there is any sign of damage or missing parts, contact PI immediately. Keep all packaging materials in case the product needs to be returned.



## 4. Product Overview

### 4.1. Model Overview and Part Numbering

The A-812 series offers various models, defined by the encoder type, communications protocol, and IO options.

Model	Encoder	Options
A-812.21	A = Incremental Analog SIN/COS (1 V <sub>p-p</sub> )	00 = 5A cont. / 10A peak per axis
	B = Absolute BiSS-C or EnDat 2.1/2.2	02 = 2.5A cont. / 5A peak per axis
	C = Incremental Digital RS-422 (TTL) A-quad-B	

### 4.2. Product Description

The A-81x series of motion controllers from PI offers a completely integrated electronics solution, with controller, drives, and power supplies packaged together in a compact 2U, 19-inch rack-mount enclosure. These controllers are designed and optimized to work with the PIglide line of air bearing stages which feature direct drive linear and rotary servo motors and high resolution encoders. The A-81x.21xxx series features the UDMnt PWM servo drive from ACS, which offers the excellent performance at a reduced cost.

Standard options include inputs for incremental analog (SIN/COS 1V<sub>pp</sub>) and digital (RS-422) encoders, and absolute encoders using the BiSS-C or EnDat 2.1/2.2 protocols. Sine encoder support includes integrated encoder multiplication up to 4096x.

All controllers feature on-board flash memory for stored motion programs and parameters. The A-81x controllers can run in standalone mode running stored programs, or controlled via an external PC. A PC is required for programming and setup. All software is included with the controller.

### 4.3. Product Features

- [ACS SPiiPlus EC Motion Controller](#) and EtherCAT® master.
- [ACS UDMnt PWM servo drives](#)
- AC-to-DC power supplies to convert AC line voltage into the required DC voltages needed for the servo motors and controller logic. Universal AC Power Input. 100 - 265VAC (single phase) 50-60 Hz.
- Cooling Fan
- Replaceable AC fuses
- Cabling to bring all necessary electrical signals to the rear panel, using industry-standard D-sub connectors on the package exterior.
- 19" wide rack-mount chassis.
- MPU cycle rate of 5 kHz.
- Encoder-based sine commutation (no Hall Effect sensors needed) of 3-phase motors.
- 10 buffers for stored motion programs.
- 24VDC IO and limits.
- 24VDC interlock input.
- EtherCAT® output port for expansion to more axes, [expanded IO](#), [LCM2 laser control module](#), and more.
- Ethernet (TCP/IP) communications to host PC. Ethernet/IP also supported.

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- All required software drivers.
- [ACS SPiiPlus ADK Suite](#) of software tools. Includes SPiiPlus MMI Application Studio, SPiiPlus Utilities for software maintenance and application management, documentation of all ACS products and software tools, controller simulator tool.

## 4.4. Product Views

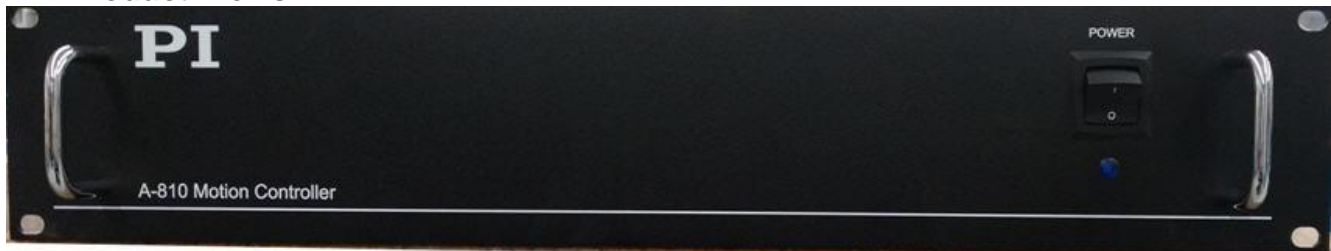


Figure 1 - Front panel of A-812.21xxx motion controller



Figure 2 - Rear panel of A-812.21xxx motion controller

Labeling	Type	Function
AC INPUT	IEC 60320 Type C14	Connection for the AC supply voltage
ETHERNET	RJ45 Socket	Connection to the host PC
ETHERCAT OUT	RJ45 Socket	Connection to ACS Controller EtherCAT Bus
INTERLOCK	DB9-F	E-Stop/Interlock Connection
24V BRAKE	Power-D 5W1-F	Stage Brake Connection
ANALOG IO	DB9-M	User Analog I/O Connection
DIGITAL IO	DB25-F	User Digital I/O Connection
ENCODER 1	DB15-F	Stage Encoder Connection Axis #1
MOTOR 1	Power-D 9W4-F	Stage Motor Connection Axis #1
ENCODER 2	DB15-F	Stage Encoder Connection Axis #2
MOTOR 2	Power-D 9W4-F	Stage Motor Connection Axis #2

See Section 21.4 for connector pin assignments.

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## 4.5. Product Labeling



Figure 3 - Product Labeling Example

#	Description
1.	A-812.21A00 (Product model number example)
2.	Serial number (example), individual for each A-812 Meaning of the places (counting from left): A = PIglide Air Bearing Product 16 = year of manufacture (i.e. 2016) 242401 = consecutive unique number, 6-digit
3.	Warning sign "Observe manual"
4.	Old equipment disposal warning sign
5.	CE mark
6.	Country of origin
7.	Manufacturer's address (website)
8.	Manufacturer's logo

## 5. Scope of Delivery

Item number	Description
A-812.21xxx	2-Axis Motion Controller, 19" rack mount enclosure ACS SPiiPlus Controller & UDMnt Drive 100-240 VAC Input Configuration per the sales order.
000060073 USA, Japan, Taiwan 000060572 Australia/NZ 000065580 UK, Singapore 000066613 Korea, EU 000066614 China	Power cord (1x), per order or country of delivery.
000056566	CAT5e Patch Cable, Shielded, 10 ft.
-	USB Memory Stick and/or CR-ROM and/or DVD with documentation and software, including controller parameter backup files
A812D001	User Guide for the A-812 (this document)

## 5.1. Upgrade Options

The [ACS SPiiPlus EC Motion Controller](#) contained inside the A-81x series controller can be upgraded at the factory or in the field to add the following features. Contact a PI sales engineer for details and pricing.

- Increase the number of axes that can be controlled; up to 64 (note this does not add drive axes).
- Add [ServoBoost™](#) (in blocks of 4 axes). ServoBoost™ provides:
  - Automatic adaptation to large changes in load and system parameters
  - Automatic compensation of disturbances, resonances, axes interaction, cogging and more)
  - ServoBoost™ is required for gantry applications.
- Add ServoBoost™ *PLUS* (requires at least 4 axes of ServoBoost™ already installed). ServoBoost™ *PLUS* provides:
  - Improved stability and jitter performance
  - Improved velocity stability
- G-Code programming
- [Input Shaping](#) for increased step-and settle performance and decreased reaction force motion.
- Add additional programming buffers for stored motion programs (up to 64 total).

## 6. Mounting

The A-812 is intended for either desktop use or to be mounted in a 19" wide electrical rack using the mounting holes on the front panel. Mounting holes for side-mounted slide rails are included; the rails themselves are not included.



Take care not to block the air inlet and exhaust ports on either side of the chassis, otherwise the controller could overheat.

## 7. Connecting the Cables

Stage interconnect cables are not in the scope of delivery of the A-812. However, PI offers several standard cable sets that can be used, depending on the motion controller options being used. See Section 21.4 for connector pin assignments.



WARNING

Only use the interconnect cables that have been designed for the combination of stage and controller being used. Connection using the wrong cable may result in damage to the stage and the controller.



DANGER

To minimize the possibility of electrical shock and bodily injury or death, disconnect all electrical power prior to making any electrical connections.



DANGER

To minimize the possibility of electrical shock and bodily injury or death when any electrical circuit is in use, ensure that no person comes in contact with the circuitry when the stage is connected to a power source.



DANGER

To minimize the possibility of bodily injury or death, disconnect all electrical power prior to making any mechanical adjustments.

Prior to electrically connecting the stage to the A-812 controller, follow the instructions in the stage's user guide for proper mounting of the stage and the stage payload.

1. Connect the #1 stage motor connector to the A-812 "Motor 1" connector with the proper interconnect cable.
2. Connect the #1 stage encoder connector to the A-812 "Encoder 1" connector with the proper interconnect cable.
3. Connect the #2 stage motor connector to the A-812 "Motor 2" connector with the proper interconnect cable.
4. Connect the #2 stage encoder connector to the A-812 "Encoder 2" connector with the proper interconnect cable.
5. Connect the air pressure switch on the Air Prep Kit (if purchased) to the A-812 "Interlock" connector with the proper interconnect cable.
6. Ensure that all cable connector screws are securely fastened, but do not overtighten.
7. Connect the A-812 to the host PC using an Ethernet patch cable.
8. Connect the A-812 power input connector to an AC outlet using the power cord provided with the controller.

When ready to use, switch on the controller power using the power switch located on the front of the A-812. A blue power-on indicator light on the front of the A-812 will turn on.

## 8. Hardware Interlock

The controller has an interlock input that needs to be connected to a +24 VDC source for the servo drives to run; otherwise the controller will be in the "Interlock fault" state; no motion can be commanded and the motors cannot be energized. See Section 21.4 for connector pin assignments.

The interlock is typically connected (in series to a +24VDC supply) to an air pressure switch on a PI-supplied A-80x series air prep kit. In the event of an air pressure loss, the switch will open and the interlock will disable the servo drives.

The Interlock cable which connects the air pressure switch on the air prep kit (if purchased) includes a 2-pin connector (Molex Part# 43640-0201) that can be used by the end user to connect additional interlock devices. The two pins can be connected in series to various 24 VDC devices, such as E-stop switches, door switches, light curtains, etc. Integrating these functions is the decision and the responsibility of the user.

The Interlock cable is shipped with a bypass jumper installed. If the jumper is installed, the user interlock is bypassed, and only the air pressure switch is used by the controller's interlock circuit.

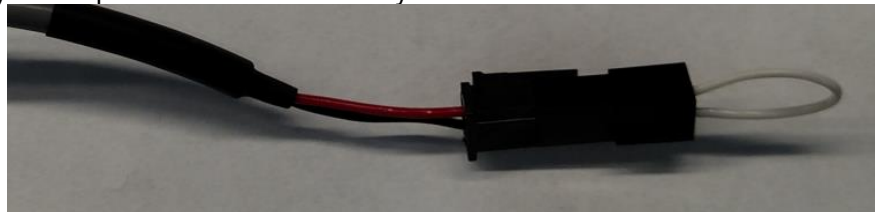


Figure 4 - STO Bypass Jumper

To completely bypass all interlock functionality of the A-812, connect +24VDC to the INTLOCK1 pin on the A-812's Interlock connector.

## 9. Connecting the Controller to Protective Earth



To minimize the possibility of bodily injury or death from electric shock in the case of malfunction or failure of the system, make sure a protective earth conductor is properly connected.

The A-812 has two (2) M4 threaded studs for connecting the controller chassis to a protective earth ground conductor. The studs are marked with the symbol for the protective earth ground and are located on the rear panel of the controller near the upper corners.



Figure 5 - Chassis Protective Earth Stud Location

- The fasteners needed to attach a protective earth conductor are included with the A-812, with a full set mounted to each ground stud.
- The protective earth conductor cable cross-section should be  $\geq 0.75 \text{ mm}^2$  (20 AWG or heavier).

**To connect the controller to a protective earth conductor:**

1. If necessary, fasten a suitable cable lug to the protective earth conductor. Note that the conductor and lug are not in the scope of delivery of the A-812.
2. Remove the fasteners (M4 nut, two safety “star” washers, and two flat washers) from the stud.
3. Attach the cable lug of the protective earth conductor to the protective earth stud using the fasteners as shown:

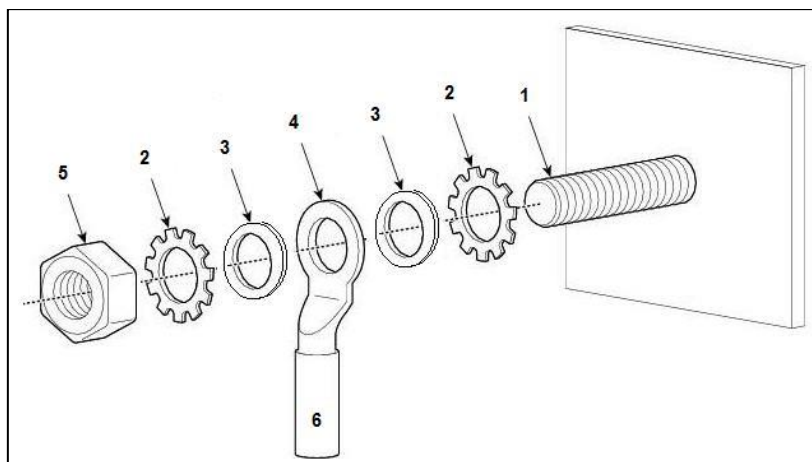


Figure 6 - Attaching the Protective Earth Conductor

#	Description
1.	Chassis stud (M4 male)
2.	Star washer (2x)
3.	Flat washer (2x)
4.	Cable lug
5.	M4 Nut
6.	Protective earth conductor

4. Tighten the M4 nut with a torque of 1.2 Nm to 1.5 Nm.
5. Make sure that the contact resistance at all connection points relevant for mounting the protective earth conductor is  $< 0.1 \Omega$  at 25 A.



## 10. Motor Outputs

The A-812 is default configured to drive 3-phase brushless motors. The controller can also drive single-phase DC brush and voice-coil motors.

The A-812 does not include motor Hall inputs; motor commutation is provided via encoder feedback only (sine commutation).

The A-812 can be factory-configured with drives that provide either 2.5A continuous / 5A peak current per axis, or 5A continuous / 10A peak current per axis.

## 11. Encoder Inputs

The A-812 can be factory-configured to support three different types of encoder inputs. The option must be selected at time of order. Custom configurations are required if encoder types are to be mixed across the various channels of the controller. The encoder inputs provide power to the connected device's encoder.

The A-812 does not support single-ended encoders

Option A: Incremental quadrature, differential, analog SIN/COS 1Vp-p. Interpolation rate from 4x to 4096x is selectable in software settings.

Option B: Absolute BiSS-C or EnDat 2.1/2.2. Protocol is selectable in software settings.

Option C: Incremental quadrature, differential, digital RS-422 (AqB).

## 12. Limit Switch Inputs (A & C Encoder Options)

The A-812 provides two (2) inputs used for travel limit switches for each axis of motion. These inputs are not provided for controllers using the "B" Absolute Encoder option. The limit switch signals connect to the A-812 controller via the Encoder connectors. See Section 21.4 for connector pin assignments.

All limit inputs are single ended and opto-isolated.

Limit Switches Supported

- 24VDC Current Sinking (NPN), < 5 mA
- Open Collector
- 5V TTL Current Sourcing, < 50 mA (**only available with "C" Encoder Option**)



The 5V TTL Sourcing Limit option must be specified in advance; this is a hardware selectable option set at the factory. Use of incompatible limit switches can cause damage to the switch and/or the controller.

### Mapping

A-812 Axis #	A-812 Limit Name	ACS Axis #	ACS Signal Name
1	Lim+	0	0LL (Left Limit)
1	Lim-	0	0RL (Right Limit)
2	Lim+	1	1LL (Left Limit)
2	Lim-	1	1RL (Right Limit)

## 13. User I/O

### 13.1. Analog Input

- 1x
- Variable: AIN 0
- Resolution: 12-bit
- Range: Differential,  $\pm 10$  VDC
- Input resistance:  $>160$  k $\Omega$
- Default Scaling: The programming range, in real numbers, is from -100 to +100. Measured across the AIN+ pin and AIN- pin, this corresponds to an input voltage of -10VDC to +10VDC.

### 13.2. Analog Output

- 1x
- Variable: AOUT 0
- Resolution: 10-bit
- Range: Differential,  $\pm 10$  VDC
- Max output current: 1 mA
- Default Scaling: The programming range, in real numbers, is from -100 to +100. Measured across the AOUT+ pin and AOUT- pin, this corresponds to an output voltage of -10VDC to +10VDC.

**Programming Note:** The Analog Input and Output objects can be accessed through the “Variables Manager and Watch” object in the ACS MMI. Select the desired IO object from the “Variables” list, then click “Create Watch”.

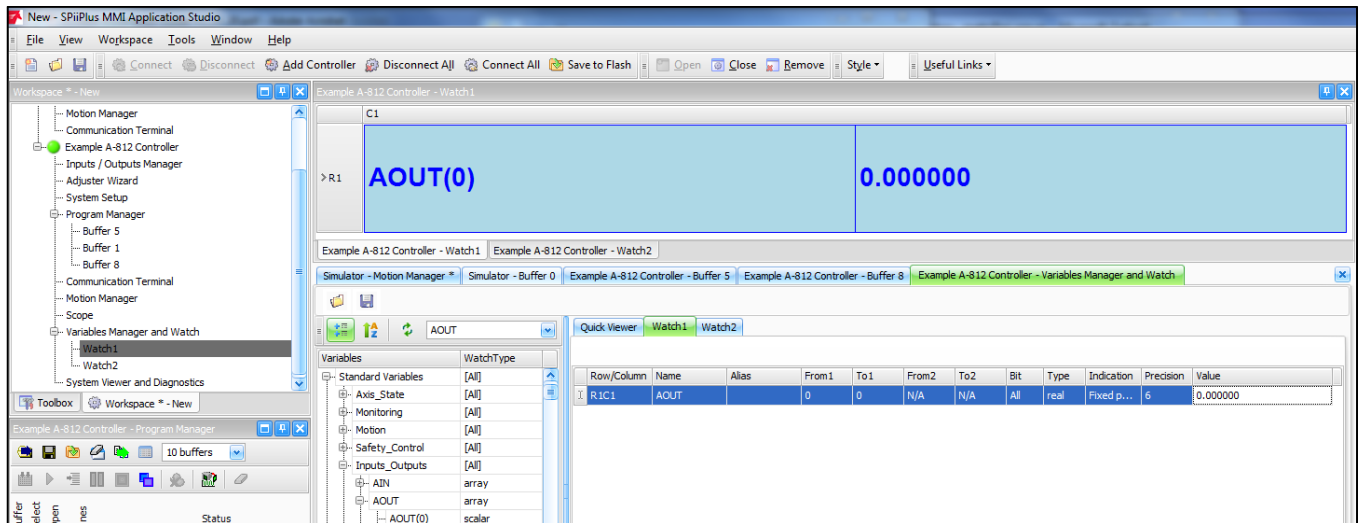


Figure 7 - Variables Manager and Watch Dialog



## 13.3. Digital I/O

The A-812 provides two (2) general purpose digital inputs and two (2) general purpose digital outputs. These are in addition to the inputs used for travel limit switches. All are single ended and opto-isolated. Inputs and outputs are tied to the single drive in the controller, which ACS refers to as ID 0 (or Dive 0).

*Programming Note:* The general purpose input and output objects can be accessed through the “Inputs / Outputs Manager” object in the ACS MMI. Outputs can be toggled by clicking on the green square of the desired output. Input status is indicated by the green circles.

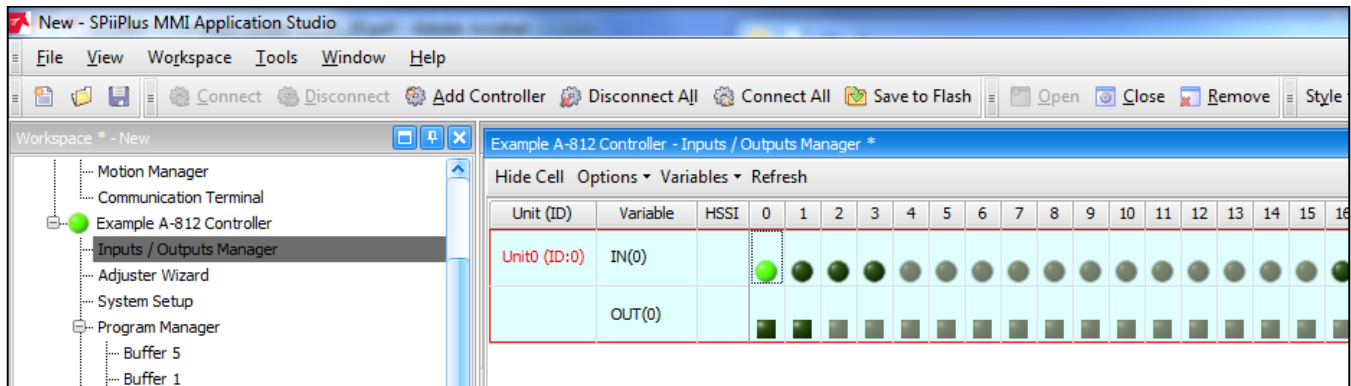
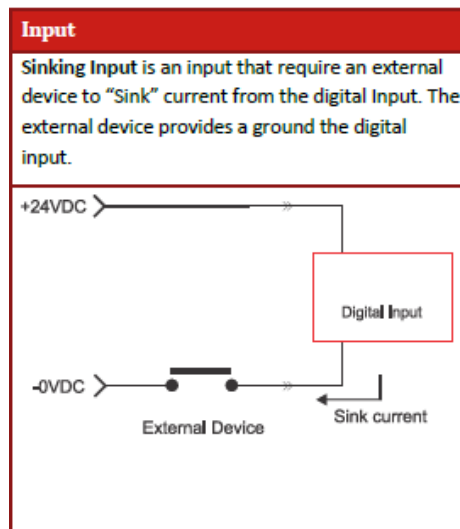


Figure 8 - Inputs / Outputs Manager

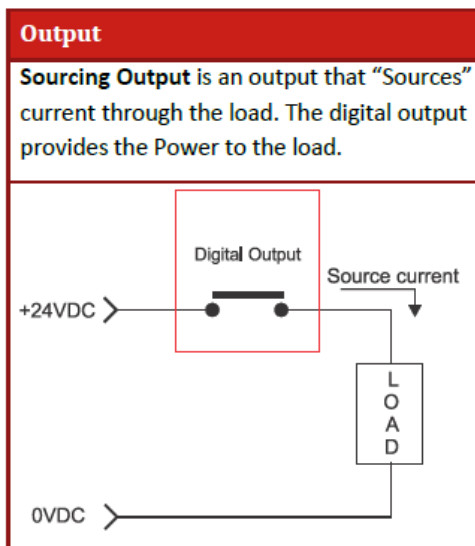
### 13.3.1. General Purpose Inputs

- 2x
- Variables: Drive0 IN 1, Drive0 IN 2
- Current Sinking (NPN)
- Voltage: 24 VDC
- Input current: < 5 mA



### 13.3.2. General Purpose Outputs

- 2x
- Variables: Drive0 OUT 0, Drive0 OUT 1
- Current Sourcing (PNP)
- Voltage: 24 VDC
- Output Current: 100 mA max



### 13.4. Brake Outputs

Any axis can be configured to work with a Z axis stage which includes a power-off brake.

The brake is controlled via digital IO; the variable used will depend on which axis uses the brake. Operation of the brake is automatic when the servo is enabled and disabled for the axis. If the brake function is used for a specific axis, that output is not available as a user IO.

- Current Sourcing
- Voltage: 24VDC
- Output Current: 1A max per channel (max 1A total from all 4 outputs combined)
- 2x

Example: If the Z axis with a brake uses axis 2, Drive 1 OUT 0 will not be available for general user IO, since this is the IO point used by the brake.

Note: The brake outputs on the A-812 are tied directly to the General Purpose Digital Outputs described in Section 13.3.2 General Purpose Outputs. These brake outputs are operated through a relay to supply a higher current than the GPO can supply. The user should be aware that when a Digital Output is triggered, the corresponding output on the brake connector will also be triggered.

### 13.5. High Speed IO (PEG)

In addition to the general purpose DIO, the A-812 includes two (2) additional high-speed TTL-level (RS-422) outputs used for the Position Event Generator (PEG) to trigger external events based on real-time position data. See the ACS document “App Note - PEG and MARK Operations” for more details.

- Signal Type: RS-422 (5 VDC)
- Pulse width: 26 nsec – 1.75 msec
- Max Rate: 10 MHz

## 14. AC Fusing and Input Voltage

The A-812 can accommodate a wide range of AC input voltages. For maximum safety, the input power fuses should be set to match the correct input voltage range. See Section 21.1 for details on fuse types and ratings.

See Section 19.3 for instructions on how to change the fuses.

## 15. Axis Numbering

The following mapping applies between the Axis Number used in the ACS controller software and the hardware ports on the A-812:

Axis #	Hardware Port
0	Motor 1, Encoder 1
1	Motor 2, Encoder 2

## 16. Software Installation on Host PC

1. Copy the file “SPiiPlus ADK Suite v.xxx.zip” from the provided USB Memory stick/CD-ROM/DVD to a local folder on the user’s host PC.
  - The software can also be downloaded from: <https://www.acsmotioncontrol.com/downloads>. You may need to create a user account to access these materials.
2. Unzip the file.
3. Follow the instructions in the “Instructions for SPiiPlus ADK Suite Installation”.
4. Run the file “setup.exe” located in the folder to which the .zip file was unpacked.

## 17. Establishing Host PC Communications with the Controller

Communication with a host PC is necessary to operate the controller in non-autonomous mode. Note that it is possible to operate the controller without a host PC; however motion programs must first be saved to the controller’s non-volatile memory.

To connect the host PC to the A-812 controller:

1. Make sure the A-812 and the host PC are connected by an Ethernet patch cable.
2. You may need to adjust your PC’s LAN adapter settings to talk locally to the A-812. The following figure shows suggested settings for your PC’s LAN adapter:

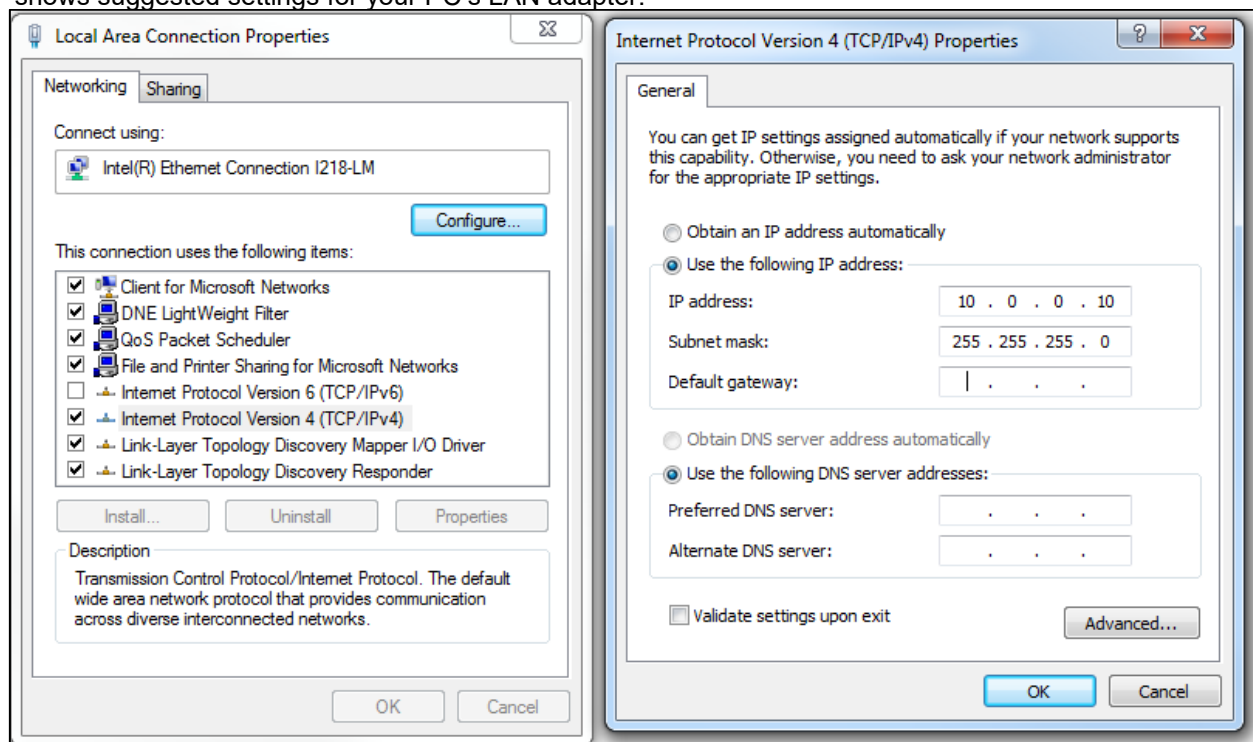


Figure 9 - Suggested PC LAN Adapter Settings

3. Turn on the power on the A-812 using the switch on the front panel.
4. Start the SPiiPlus MMI Application Studio software on the host PC.
5. Click “Add Controller” on the main menu toolbar.
6. In the “Connect to Controller” dialog, give your controller a name, select the “Ethernet” tab, and enter IP address **10.0.0.100**, **Port 701**. This is the default IP address of the A-812 controller set at the factory.

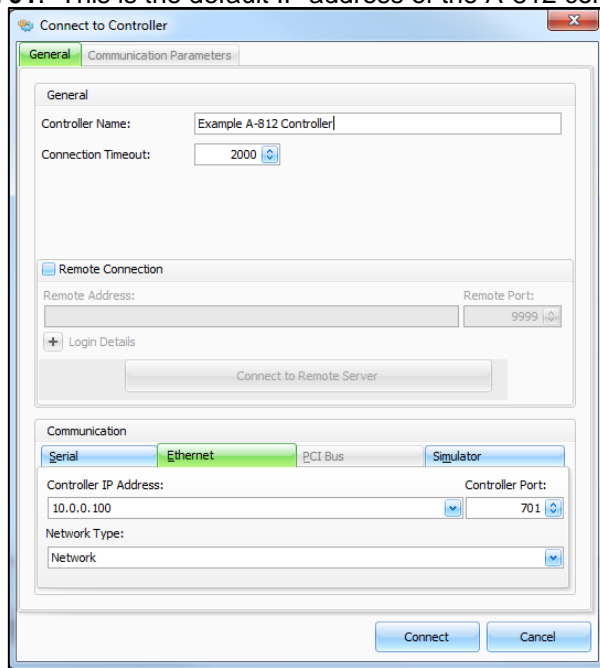


Figure 10 - Connect to Controller Dialog

See the ACS document “SPiiPlus MMI Application Studio User Guide” for details on connecting to the controller.

For additional tutorials on the use of the MMI software, see <https://www.acsmotioncontrol.com/downloads> and click under the “Training Materials” section. You may need to create a user account to access these materials.

## 18. Operation

The SPiiPlus MMI Application Studio software can be used to control the system, to develop user programs, and to alter the system configuration. For complete instructions, see the ACS documentation provided with this system.

**Note:** The SPiiPlus MMI Application Studio software also has extensive online help. To access it, press “F1” from any screen in the program.

## 18.1. Basic Setup

To access the most-used features of the MMI, you must add components to the controller object. The following figure shows a typical setup. Components can be added by right-clicking on the controller object in the Workspace area of the MMI, then selecting “Add Component”, then selecting the desired component(s) from the pop-out menu.

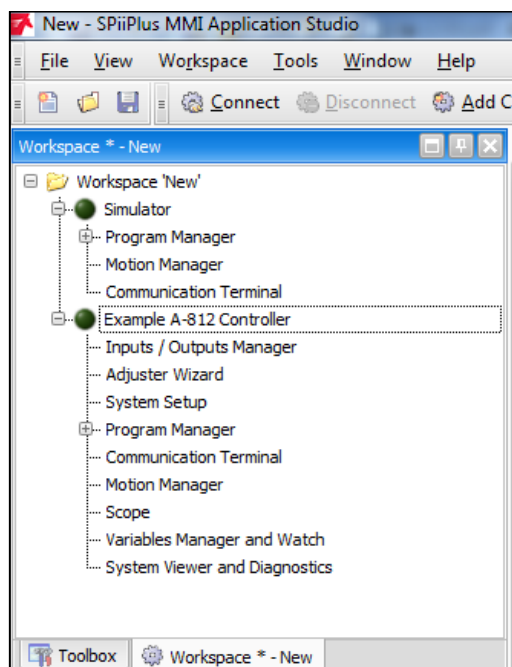


Figure 11 - Controller Object – List of Typical Components

Full details of the use and operation of the ACS SPii Plus controller, which is contained in the A-812, are beyond the scope of this guide. Consult the ACS manuals and training materials for details.

## 18.2. Homing and Initialization

A homing procedure couples a position to a specific axis. Homing is dependent on the encoder type (incremental vs. absolute) and motion type (linear vs. rotary). Absolute encoders do not need a movement during the homing procedure, since the exact positions can be directly transferred to the system. For incremental encoders, a movement is necessary, since there is no knowledge of the exact position within the system at power-on. This movement is made at slow speed in some direction until a certain measuring point is reached.

The A-812 has been configured at the factory to run a specific set of motion stages typically purchased along with the controller. The program Buffer #8 contains PI's standard homing program.



WARNING

Initialization must be done for all axes after the controller has been turned on or power-cycled **before any other motion can be commanded.**

To initialize and home any axis, enter the following commands in the Communications Terminal object of the MMI:

Command	Alternate Commands	Result
p900 = 0	START 8, home0	Will initialize and home Axis 0
p900 = 1	START 8, home1	Will initialize and home Axis 1
p900 = 9	START 8, homeA	Will initialize and home all axes.

## 18.3. Simple Motion

Simple point-to-point motions can be created using the Motion Manager. To access, make sure the Motion Manager component has been added to your controller object. Select the Motion Manager.

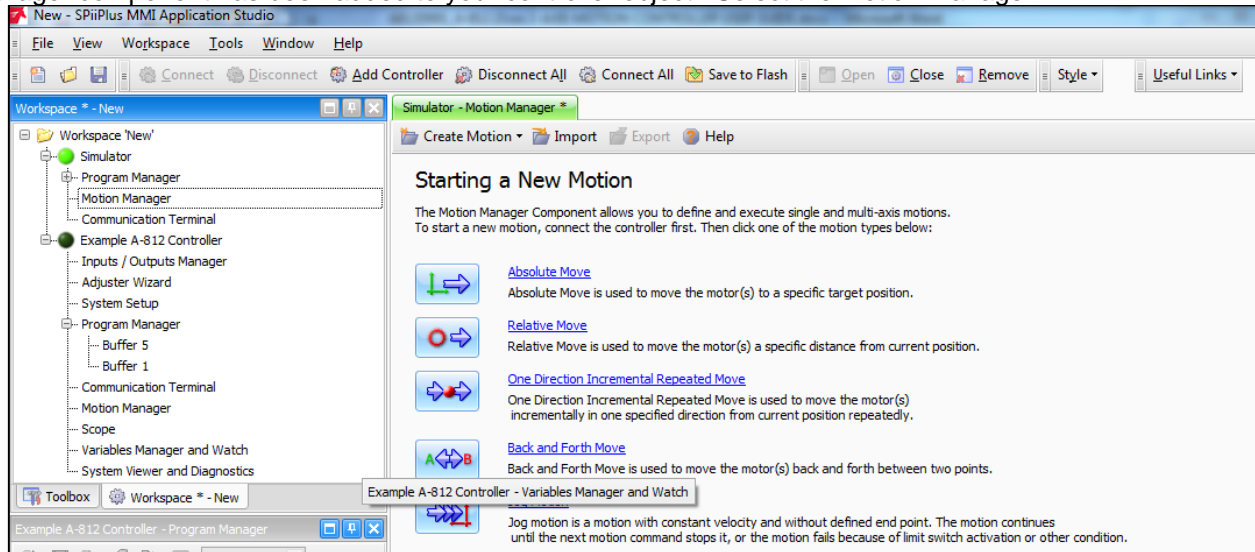


Figure 12 - Motion Manager

Simple motion types can be created by selecting one of the motion types and then setting some basic parameters. Below is an example of a simple back-and-forth motion commanded for two axes. Motion can be started by clicking on the “Start Motion” button.

Back and Forth Move			
Axis	<input checked="" type="checkbox"/> Axis 0	<input checked="" type="checkbox"/> Axis 1	
Point A	Read +/- 0	Read +/- 0	
Point B	Read +/- 250	Read +/- 100	
Dwell	1	1	
Feedback	0 10000.0050	0 10000.0000	
Position Error	0.0000	0.0000	
Moving	<input type="radio"/>	<input type="radio"/>	
Accelerating	<input type="radio"/>	<input type="radio"/>	
In Position	<input checked="" type="radio"/>	<input checked="" type="radio"/>	
Motor State	<input checked="" type="radio"/> Disable	<input checked="" type="radio"/> Disable	
Parameters			
Velocity	1000	10000	
Acceleration	100	100000	
Deceleration	100	100000	
Kill Deceleration	100000	100000	
Jerk	2E+007	2E+007	
<input type="checkbox"/> Trigger Scope on Motion			
Disable Motor(s)		Start Motion	
Select Axis(Axes)		Scope Autoset	

Figure 13 - Back and Forth Motion

Note: The axis will already be enabled if the Homing and Initialization program has been run, as described in Section 18.2.

## 18.4. Cycle Program

Your A-812 controller may have been setup at the factory with an automatic cycle program that will run your stages in a repeating cycle pattern. If this is the case, the program will have been saved in Buffer #5. To run the program, select “Buffer 5” in the Program Manager component. You can start, pause, and stop the program using the three buttons at the top of the window as indicated below.

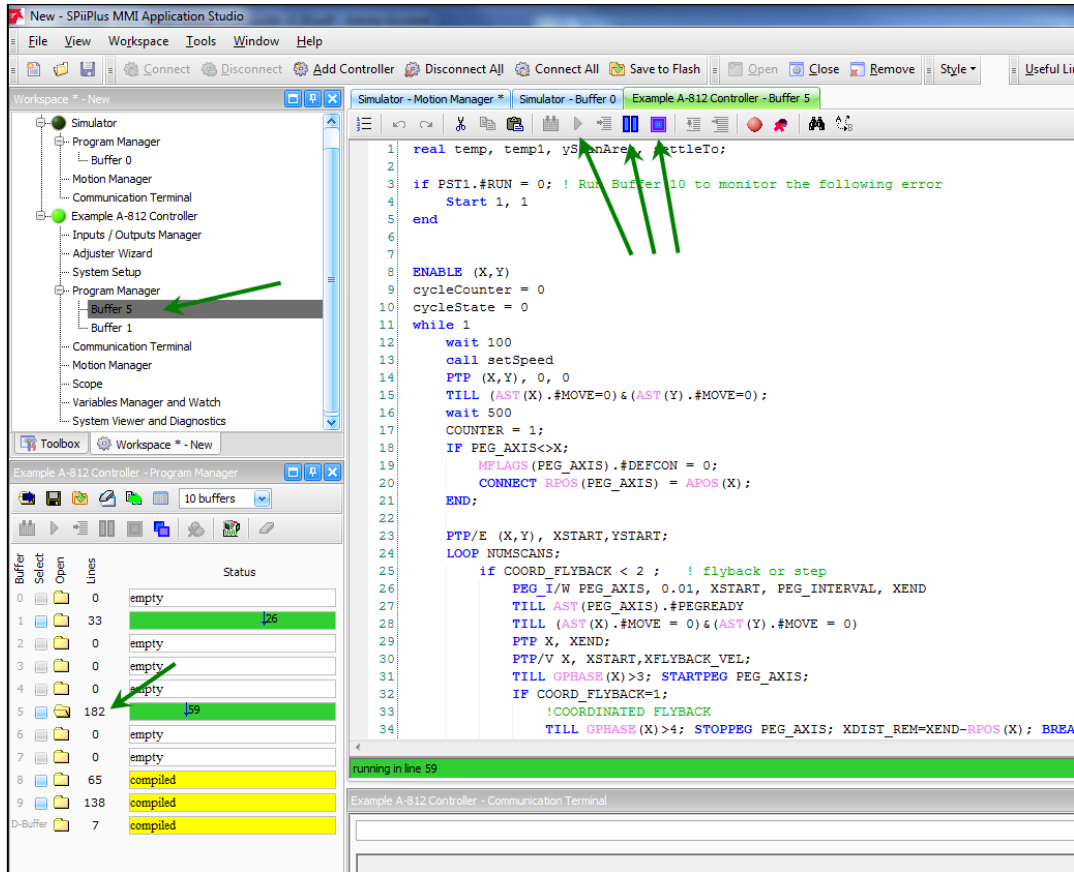


Figure 14 - Buffer Window

## 18.5. Servo Tuning

The A-812 controller has been setup and the servo loops tuned at the factory to operate a particular set of stages with a specified payload per the customer order. Should you need to change the payload or optimize performance, the servo loops may need to be re-tuned. Consult the ACS User Guides and training materials as needed. Servo tuning instructions are beyond the scope of this manual.

## 19. Maintenance

### 19.1. Updating Firmware

Should it become necessary to update the controller firmware, see the ACS user guide for instructions. Contact PI for assistance.

### 19.2. Cleaning

#### NOTICE



#### Short circuits or flashovers!

The A-812 contains electrostatic sensitive devices that can be damaged by short circuits or flashovers when cleaning fluids enter the case.

- Before cleaning, remove the A-812 from the power source by pulling the power plug.
- Prevent cleaning fluid from entering the case.
- DO NOT remove the cover of the enclosure for any reason. There are no user-serviceable parts inside the enclosure.

1. Disconnect the A-812 from the power supply.
2. Wait a minute to be sure that any residual voltage has dissipated.
3. Clean the case surface with a cloth lightly dampened with a mild cleanser or disinfectant.

### 19.3. Changing the Fuses

The A-812 is equipped with two (2) user-replaceable AC fuses. If the fuses need to be replaced or changed, use the following procedure.

- Be sure to only use the fuse type and rating specified in Section 21.1.
- Do not mix fuse types or fuses of different ratings. Use Qty. 2 of the exact same model fuse.



Figure 15 - Fuse Type

#### To install or replace the fuses:

1. Turn off the power switch and disconnect the A-812 from the power supply.
2. Wait a minute to be sure that any residual voltage has dissipated.



3. Using a small flat head screwdriver, pry open the fuse holder from the main AC input module.



Figure 16 - Remove the Fuse Holder

4. IF REPLACING FUSES: Remove both fuses from the fuse holder.
5. Insert two fuses into the fuse holder as shown.



Figure 17 - Fuse Holder with Fuses Installed

6. Insert the fuse holder into the main AC input module as shown. Press firmly until the fuse holder audibly snaps into place.



Figure 18 - Inserting the Fuse Holder

## 20. Customer Service

For inquiries and orders, contact your PI sales engineer or use the following contacts:

Email: [air@pi-usa.us](mailto:air@pi-usa.us)

Address: 16 Albert Street, Auburn, MA 01501, USA

Tel: 508-832-3456

Fax: 508-832-0506

If you have questions concerning your system, have the following information ready:

- Product codes and serial numbers of all products in the system
- Firmware version of the controller (if present)
- Version of the driver or the software (if present)
- Operating system on the PC (if present)
- If possible: Take photographs or make videos of your system that can be sent to our customer service department if requested.

## 21. Technical Data

### 21.1. Specifications

Model	A-812.21xxx
Function	Motion controller for 3-phase brushless motors, sine-commutated
Motor & Encoder # of channels	2
Controller # axes supported	8 (can be upgraded to max of 64)
Servo Drive Type	Digital PWM, 40 kHz switching frequency
EtherCAT & Profile Generation Update Rate	5 kHz (will be reduced if controller is upgraded to support more than 8 axes)
Number of Program Buffers	16 (can be upgraded to max of 64)
Position Loop Update Rate	10 kHz
Current Loop Update Rate	20 kHz
Servo characteristics	PID controller for position and velocity, parameter change on-the-fly
Encoder Inputs (determined by model ordered)	Incremental encoder: analog differential (SIN/COS; 1 Vp-p) 4x to 4096x interpolation (selected in software), 500 kHz max input frequency -or- Absolute encoder: BiSS-C or EnDat 2.1/2.2 interface -or- Incremental encoder: digital differential (RS-422 A-quadr-B), 12.5 million lines / 50 million quad-counts/sec max input frequency
Encoder Power Output	5VDC, 0.25A max per channel
Max. Output Voltage	60 VDC
Max. Output Current (determined by model ordered)	2.5 A continuous, 5 A peak per axis -or- 5 A continuous, 10 A peak per axis
Max. Output Power	600 W continuous
Communication Interface	Ethernet TCP/IP 10/100 Mbit/sec
Input Power Ratings	100-120 VAC, 1-phase, 50/60 Hz, 10A 200-240 VAC, 1-phase, 50/60 Hz, 5A
Fusing	Type: Cartridge, 5mm x 20mm, Slo-Blo (Qty. 2) Rating: 90-120 VAC: 10A, 250V -or- 200-240 VAC: 5A, 250V
Mass	8.5 kg

## 21.2. Dimensions

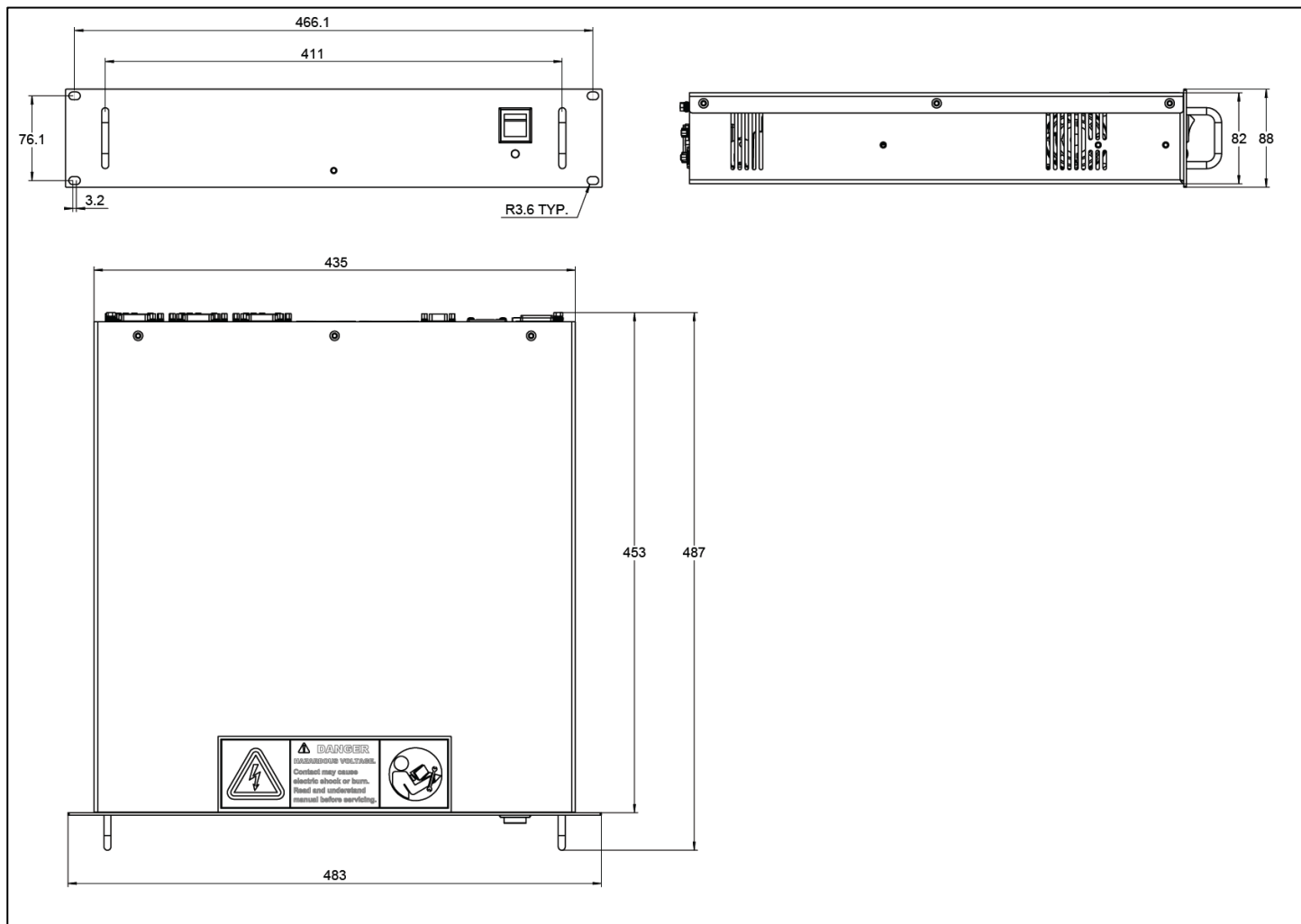


Figure 19 - A-812.21xxx Dimensions

## 21.3. Ambient Conditions

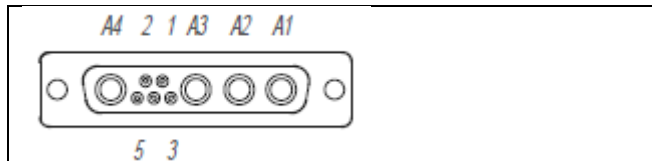
The following ambient conditions and classifications must be observed for the A-812:

Area of application	For indoor use only
Maximum Altitude	2000 m
Relative humidity	20% - 80% (non-condensing)
Operating temperature	0°C to +40°C
Storage temperature	-20°C to +60°C
Overvoltage Category	II
Protection Class	I
Degree of Pollution	2
Degree of protection according to IEC 60529	IP20

## 21.4. Connector Pin Assignments

Pins are assumed N/C if not listed or blank.

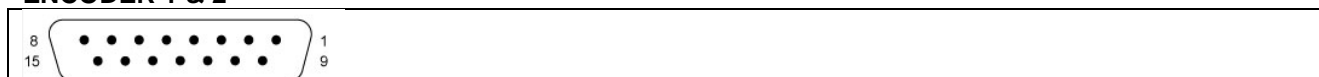
### MOTOR 1 & 2



DB9W4-F

Pin	Function	Description
A1	PHA	Motor phase A
A2	PHB	Motor phase B
A3	PHB	Motor phase C

### ENCODER 1 & 2



DB15-F

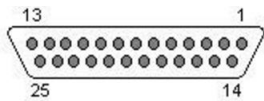
Pin	Option "A" Incremental Analog SIN/COS 1Vp-p		Option "B" Absolute BiSS-C or EnDat 2.1/2.2		Option "C" Incremental Digital RS-422 A-quad-B	
	Function	Description	Function	Description	Function	Description
1	COS-	Cosine -				
2	SIN-	Sine -	MA+	CLK+ (MA+)	GND	Encoder Ground
3	IND+	Index Mark +	MA-	CLK- (MA-)		
4	+5V	Encoder Power	+5V	Encoder Power	IND-	Index Mark -
5					B-	B -
6			SLO+	Data+ (SLO+)	A-	A -
7	LIM+	Positive Limit	SLO-	Data- (SLO-)	+5V	Encoder Power
8	LIM-	Negative Limit	GND	Encoder Ground		
9	COS+	Cosine +				
10	SIN+	Sine +			LIM-	Negative Limit
11	IND -	Index Mark -			LIM+	Positive Limit
12	GND	Encoder Ground			IND+	Index Mark +
13					B+	B +
14					A+	A +

# User Guide

Doc# A812D001 v2.1  
27-May-2020

# PI

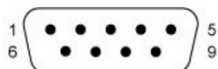
## DIGITAL IO



DB25-F

Pin	Function	Description	Pin	Function	Description
1	DOUT 0	Drive 0, Digital Output 0	14	DIN 0	Drive 0, Digital Input 1
2	DOUT 1	Drive 0, Digital Output 1	15	DIN 1	Drive 0, Digital Input 2
6	PEG 0 +	PEG 0 Output +	19	PEG 0 -	PEG 0 Output -
7	PEG 1 +	PEG 1 Output +	20	PEG 1 -	PEG 1 Output -
12	+24V	+24 VDC Logic Source	23	DGND	Digital Ground (reference for PEG signals)
13	+24V	+24 VDC Logic Source	24	GND	Logic Ground
			25	GND	Logic Ground

## ANALOG IO



DB9-M

Pin	Function	Description
1	AIN 0+	Analog Input 0+
3	AOUT 0+	Analog Output 0+
5	AGND	Analog Ground
6	AIN 0-	Analog Input 0-
8	AOUT 0-	Analog Output 0 -

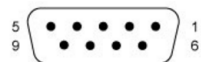
## 24V BRAKE OUTPUT



Power-D 5W1-F

Pin	Function	Description
1	BRK_OUT 0	Brake Output, Drv0, Out0
2	BRK_OUT 1	Brake Output, Drv0, Out1
A1	BRK_GND	Brake Ground

## INTERLOCK



DB9-F

Pin	Function	Description
1	+24VDC	Interlock +24VDC Source
2	INTLOCK1	Interlock +24VDC Input

## 22. EC Declaration of Conformity

For the A-812 (all options and configurations), an EC Declaration of Conformity has been issued in accordance with the following European directives:

- 2004/108/EC, EMC Directive
- 2014/35/EU, Safety/Low Voltage Directive
- 2011/65/EU, RoHS Directive

The applied standards certifying the conformity are listed below.

- EMC: EN 61326-1:2013
- Safety/LVD: EN 61010-1:2010
- RoHS: EN 50581:2012

If an electrical operating device is designed to be integrated in another electrical operating device: The operator is responsible for a standards compliant integration of the electrical device into the overall system.

## 23. Old Equipment Disposal

In accordance with EU law, electrical and electronic equipment may not be disposed of in EU member states via the municipal residual waste.

Dispose of your old equipment according to international, national, and local rules and regulations.

In order to fulfil its responsibility as the product manufacturer, Physik Instrumente (PI) GmbH & Co. KG undertakes environmentally correct disposal of all old PI equipment made available on the market after 13 August 2005 without charge.

Any old PI equipment can be sent free of charge to the following addresses:

Physik Instrumente (PI) GmbH & Co. KG  
Auf der Roemerstr. 1  
D-76228 Karlsruhe  
Germany

PI (Physik Instrumente) L.P.  
16 Albert Street  
Auburn, MA 01501  
USA

