SPiiPlus PCI 4/8 Motion Controller

SPiiPlus PCI
SPiiPlus PCI-LT
SPiiPlus PCI-ST

Hardware Guide

Version 6.50

Version 6.50, 30 January 2009
123-456-789

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Changes in Version 6.50

Page	Change
	Updated according to new products.
Page 10	Corrected the SPiPlus PCI bracket dimensions.
Page 71	Updated Figure 37 with correct dimensions for SPiPlus PCI bracket.
Page 31	Corrected signal designators for pins 70 and 170 in Table 43.

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1 About this Guide

This guide provides detailed hardware information concerning the SPiiPlus PCI, SPiiPlus PCI-LT, SPiiPlus PCI-STline of motion control modules - SPiiPlus PCI, SPiiPlus PCI-LT and SPiiPlus-ST. This guide includes the following information:

- How to install the SPiiPlus PCI, SPiiPlus PCI-LT, SPiiPlus PCI-ST, SPiiPlus PCI-LT and SPiiPlus-ST
- How to connect the electrical interface with the system (motors, feedback, I/O, etc.)

For a setup procedure of the SPiiPlus PCI, SPiiPlus PCI-LT, SPiiPlus PCI-STproducts, refer to the SPiiPlus Setup Guide. It includes:

- How to establish communication
- How to configure the drive, motor, feedback for an axis
- How to adjust (tune) the parameters of an axis

The remaining tasks involved in operating the SPiiPlus PCI, SPiiPlus PCI-LT, SPiiPlus PCI-STproducts, are described in the SPiiPlus ACSPL+ Programmers Guide, including:

- How to program motion,
- How to program I/O events
- Additional product features

1.1 The SPiiPlus Documentation

Table 1 Collateral Documentation (page 1 of 2)

Document	Description
SPiiPlus PCI Series Hardware Guide	Installation and hardware connection with the SPiiPlus PCI series of products
SPiiPlus CM Hardware Guide	Installation and hardware connection with the SPiiPlus Control Module
SPiiPlus Setup Guide	Communication, configuration and adjustment procedures for SPiiPlus motion control products.
SPiiPlus ACSPL+ Programmer's Guide	Command set and high level language for programming SPiiPlus controllers.
SPiiPlus Command & Variable Reference Guide	Commands and variables of high level language for programming SPiiPlus controllers.
SPiiPlus MMI User's Guide	Software tools reference guide.
HSSI Expansion Modules Guide	High-Speed Synchronous Serial Interface (HSSI) for expanded I/O, distributed axes, and nonstandard devices.
SPiiPlus C Library Reference	C++ and Visual Basic® libraries for host PC applications. This guide is applicable for all the SPiiPlus motion control products
SPiiPlus Utilities User's Guide	Firmware upgrade and recovery procedures.

Table 1 Collateral Documentation (page 2 of 2)

Document	Description
SPiiPlus COM Library Reference Guide	COM Methods, Properties, and Events for Communication with the Controller
SPiiPlus FRF Analyzer User's Guide	The SPiiPlus FRF (Frequency Response Function) Analyzer? is a powerful servo analysis GUI for ACS Control Motion SPiiPlus motion controllers.
SPiiPlus SA and SA-LT Hardware Guide	Installation and hardware connection with the SPiiPlus SA and SPiiPlus SA-LT Controllers.
SPiiPlus 3U Hardware Guide	Installation and hardware connection with the SPiiPlus 3U Controller.

1.2 Conventions Used in this Guide

Several text formats and fonts, illustrated in **Table 2**, are used in the text to convey information about the text.

Table 2 Text Conventions

Text	Description
BOLD CAPS	ACSPL+ elements (commands, functions, operators, standard variables, etc.) when mentioned in the text. Software tool menus, menu items, dialog box names and dialog box elements.
bold	Emphasis or an introduction to a key concept.
`Monospace`	Code examples.
`Italic monospace`	Information in code examples that the user provides.
ALL CAPS	(Keyboard) key names [example: SHIFT key].
Bold Blue Text	Links within this document, to web pages, and to e-mail addresses.
|	Used in command syntax to indicate input of one alternative *or* another.
→	Used in GUI descriptions to indicate nested menu items and dialog box options leading to a final action. For example, the sequence: **Debug → New Watch → Real-time** directs the user to open the Debug menu, choose the New Watch command, and select the Real-time option.

1.3 Statement Text and Icons Used in this Guide

Note 	*Notes include helpful information or tips.*

Caution 	***A Caution describes a condition that may result in damage to equipment.***

Warning 	***A Warning describes a condition that may result in serious bodily injury or death.***

Advanced 	*Indicates a topic for advanced users.*

Model 	*Highlights a specification, procedure, condition, or statement that depends on the product model.*

2 Introduction

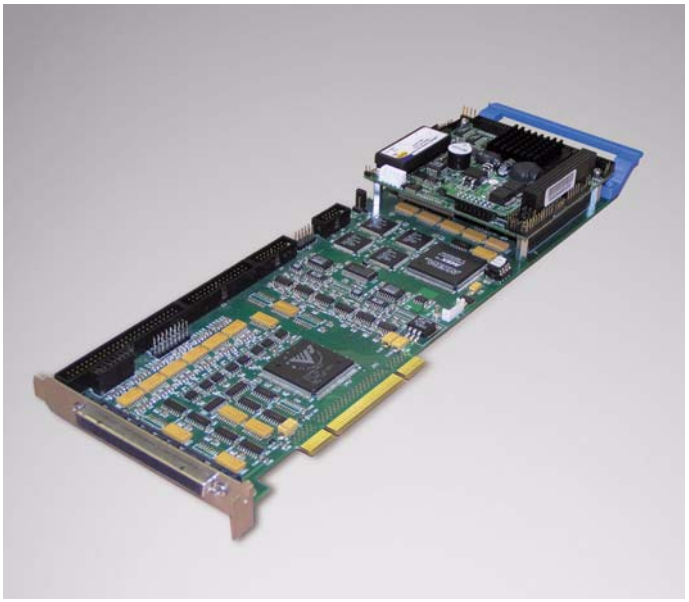


Figure 1 SPiiPlus PCI, Motion Controller

2.1 About the SPiiPlus PCI

The SPiiPlus PCI motion control line handles complex demands without compromising accuracy or throughput. The SPiiPlus PCI can operate inside a PC or as a standalone motion controller. Each product of the SPiiPlus PCI line is tailored to a specific application as explained henceforth:

- SPiiPlus PCI - The SPiiPlus PCI meets the motion control requirements of the utmost demanding applications such as semiconductors manufacturing, wafers inspection and Flat Panel Display assembly and testing.
- SPiiPlus PCI-LT - The SPiiPlus PCI-LT is designed for enhancing the performance of OEM machinery that requires multi-axis synchronization and low price.
- SPiiPlus PCI-ST - The SPiiPlus PCI-ST is designed for enhancing the performance of OEM systems operating with step motors and servo motor drives with Pulse-Direction interface.

The following table lists the main features unique to each SPiiPlus PCI product:

Table 3 SPiiPlus PCI Main Features

Product	Drive Interface	Feedback	HSSI Channels
SPiiPlus PCI	One command for torque or two for torque and software commutation	Digital encoder Sin-cos encoder	Up to four
SPiiPlus-LT	One torque command	Digital encoder only	One
SPiiPlus-ST	Pulse direction commands	Digital encoder only	One

SPiiPlus PCI line of products is furnished with the following features:

Controller - The servo control algorithm executes at an uncompromising rate of 20kHz for each axis regardless of the number of axis, providing very large bandwidth, exceptional dynamic tracking, fast settling, and excellent smoothness at low velocities.

The controller is manufactured under ISO 9001 certified quality management system, meeting stringent safety and EMC standards and is CE marked.

Communication Channels - The Communication with the controller through all channels can be done simultaneously:

In the PC, the SPiiPlus PCI communicates with the PC host via a bi-directional FIFO and user programmable dual port RAM.

In addition it can communicate with other computers via an RS-232 and an RS-232/422 serial channel (115,200 baud) or Ethernet 10/100 BaseT channel.

Digital I/O - The SPiiPlus PCI comes with digital and analog I/O that can be used for general purpose. In addition, digital inputs can be used for hardware-based position registration and outputs can be used to trigger position-based events with sub-microsecond delays.

ACSPL+ - Complex applications are easy to develop with ACSPL+, a powerful, compiled, true multitasking, high-level language that is optimized for motion control applications. Ten programs can run simultaneously, enabling multiple interacting and synchronized processes.

ACSPL+ enables implementation of highly complex motion-time-event sequences with accurate positioning and timing. The program can run directly on the controller or can be implemented in a host PC application using libraries provided for C, C++, and COM.

Suite of Tools - Powerful software tools are also provided for setup, tuning, and programming. Application development is particularly easy with the integrated four-channel soft scope and multi-axis motion simulator.

2.2 Axis Configuration Options

The SPiiPlus PCI line of products can control up to eight axes, which can comprise:

- One to eight direct-connected servo drives for DC brush, DC brushless/AC servo motors.
- One to four direct-connected drives for stepper motors.
- One to four HSSI-Networked Drives for remote servo motors (DC brush, DC brushless/AC servo).

For Example:

- The SPiiPlus PCI-4 can be connected to two stepper drives and two DC brush motor drives.
- The SPiiPlus PCI-LT-8 can be connected to one stepper drive, three directly connected DC brushless motor drives and four remotely connected DC brush motors via two units of HSSI-ED2.
- The SPiiPlus PCI-ST-2 can be connected to two stepper drives.

See the *SPiiPlus Setup Guide* for how to assign an axis to a direct-connected servo/stepper drive or HSSI-networked servo drive.

Table 4 lists the SPiiPlus PCI axis assignment configuration.

Table 5 lists the SPiiPlus PCI-LT axis assignment configuration

Table 6 list the SPiiPlus PCI-ST axis assignment configuration.

Table 4 SPiiPlus PCI Axis Assignment Configuration

Product	Motors	Direct-Connected Servo Drives	Direct-Connected Stepper Drives	SW Commu-tation	Dual Loop	HSSI	MPU Cycle (msec)
PCI-2	DC brush, DC brushless, Nano motion, Stepper	2 (X,A)	1(X)	Yes (by two ±10V drive commands per axis)	1(X)	1	0.5,1*,2
PCI-4		4 (X,Y,A,B)	2(X,Y)		2(X,Y)	2	
PCI-6		6 (X,A,Y,B,Z,C)	3(X,Y,Z)		3 (X,Y,Z)	3	
PCI-8		8 (X,Y,Z,T,A,B,C, D)	4(X,Y,Z,T)		4 (X,Y,Z, T)	4	

1* - 1 is the defalut MPU Cycle (msec)

Table 5 SPiiPlus PCI-LT Axis Assignment Configuration

Product	Motors	Direct-Connected Servo Drives	Direct-Connected Stepper Drives	SW Commu-tation	Dual Loop	HSSI	MPU Cycle (msec)
PCI-LT-2	DC brush, DC brushless, Nano motion, Stepper	2 (X,A)	1(X)	No	1(X)	1	1
PCI-LT-4		4 (X,Y,A,B)	2(X,Y)		2(X,Y)		
PCI-LT-6		6 (X,A,Y,B,Z,C)	3(X,Y,Z)		3 (X,Y,Z)		
PCI-LT-8		8 (X,Y,Z,T,A,B, C,D)	4(X,Y,Z,T)		4 (X,Y,Z, T)		

Table 6 SPiiPlus PCI-ST Axis Assignment Configuration

Product	Motors	Direct-Connected Servo Drives	Direct-Connected Stepper Drives	SW Commu-tation	Dual Loop	HSSI	MPU Cycle (msec)
PCI-ST-2	Stepper	N.A	2(X,Y)	No	No	1	1
PCI-ST-4		N.A	4(X,Y,Z,T)				

2.3 I/O Configuration Options

The SPiiPlus PCI line of products comes with digital and analog I/O that can be used for general purpose. Digital inputs can be used for hardware-based position registration (MARK) and digital outputs to trigger position-based events (PEG pulse and PEG State).

The following tables list the digital and analog I/O configuration options for each product:

Table 7 lists the SPiiPlus PCI I/O configuration options

Table 8 lists the SPiiPlus PCI-LT I/O configuration options

Table 9 lists the SPiiPlus PCI-ST I/O configuration options

Table 7 SPiiPlus PCI I/O Configuration Options

		Digital I/O			Analog I/O			
Product	**Digital Encoders**	**Digital I/O**	**PEG Pulse Output**	**PEG State Output (per axis)**	**MARK Input (per axis)**	**Analog Inputs**	**Analog Output**	**Sin-Cos Encoder**
PCI-2	1 per axis	6/5	1(X)	4 (X)	2(X)	4	4	1 per axis
PCI-4		8/10	2(X,Y)	4 (X,Y)	2(X,Y)	8	8	
PCI-6		8/11	3(X,Y,Z)	4 (X,Y)	2 (X,Y,Z)	12	12	
PCI-8		8/12	4(X,Y,Z,T)	4 (X,Y)	2 (X,Y,Z,T)	16	16	

Table 8 SPiiPlus PCI-LT I/O Configuration Options

		Digital I/O				Analog I/O (for general purpose)		
Product	**Digital Encoders**	**Digital I/O**	**PEG Pulse Output**	**PEG State Output (per axis)**	**MARK Input (per axis)**	**Analog Inputs**	**Analog Output**	**Sin-Cos Encoder**
PCI-LT-2	1 per axis	6/5	1(X)	N.A	2(X)	4[1)]	2[2)]	N.A
PCI-LT-4		8/10	2(X,Y)		2(X,Y)			
PCI-LT-6		8/11	3(X,Y,Z)		2 (X,Y,Z)			
PCI-LT-8		8/12	4(X,Y,Z,T)		2 (X,Y,Z,T)			

1) - General purpose analog inputs are AIN0...AIN3

2) - General purpose analog outputs are AOUT1 and AOUT3

Table 9 SPiiPlus PCI-ST I/O Configuration Options

		Digital I/O				Analog I/O (for general purpose)		
Product	**Digital Encoders**	**Digital I/O**	**PEG Pulse Output**	**PEG State Output (per axis)**	**MARK Input (per axis)**	**Analog Inputs**	**Analog Output**	**Sin-Cos Encoder**
PCI-ST-2	1 per axis	8/10	2(X,Y)	N.A	2(X,Y)	N.A	N.A	N.A
PCI-ST-4		8/12	4(X,Y,Z,T)		4(X,Y,Z,T)			

2.4 Ordering Options

Figure 2 illustrates the SPiiPlus PCI ordering code elements. These elements and options are described in **Table 10**.

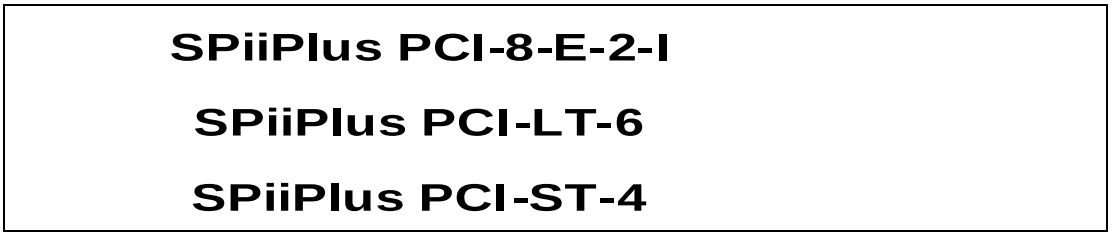


Figure 2 SPiiPlus PCI Ordering Code Elements

Table 10 SPiiPlus Ordering Code Options

Element and Description	Options
SPiiPlus PCI - Product name	PCI or PCI-LT or PCI-ST
8 - Represents the number of axes 6 - Represents the number of axes 4 - Represents the number of axes	PCI - [2] or [4] or [6] or [8] PCI-LT [2] or [4] or [6] or [8] PCI-ST [2] or [4]
E - Represents the communications options Applies to SPiiPlus PCI only	[E] = one RS-232, one RS-232/422 and one Ethernet 10/100BaseT channel
2 - Represents the number of optional encoder sine/cosine multipliers Applies to SPiiPlus PCI only	[0], [1], [2].....[8]
I - Optional field Applies to SPiiPlus PCI only	Convolve Input Shaping? algorithm to reduce vibration and settling time

Table 11 lists the items that are supplied with the SPiiPlus PCI family of products.

Table 11 Standard items supplied with the SPiiPlus PCI Line

Item	Explanation
Serial communication cable	(37cm/14.1inc P.N FC-50920-226) for one RS-232 channel and one RS-232/422 channel
SPiiPlus ADK (Advanced Development Kit) CD intended for programmers who develop ACSPL+ based applications and host based programs.	CD includes: • **SPiiPlus MMI** - for axis configuration, servo tuning, programming and viewing parameters • **SPiiPlus Library** - for host programming in C/C++ or Visual Basic • **SPiiPlus Utilities** -for upgrading or reinstalling firmware • **SPiiPlus Simulator** – controller simulator for fast application development • Hardware, software, setup, and programming guides in PDF format • ACSPL+ and C/C++ training files and programming examples • SPiiPlus FRF (Frequency Response Function) Analyzer ™

2.5 Additional Products

2.5.1 SPiiPlus PCI-INT

Interface kit for easy connection of controller to system using standard D-type connectors and provided cables. Kit includes:

- One SPiiPlus breakout box. Dimensions: 35mm (1.37”)x 425mm (16.73”)x 145mm (5.70”)[H x W x D] (P.N SB-12527-700)
- One flat cable (95cm/36”)- 200-pin header to four 50 pin headers (P.N FC-52050-493)

Note	
	*This cable can be ordered in various lengths separately. See* ***Section 2.5.2 - Interface Cables****.*

- One flat cable (95cm/37.4”)- 50-pin headers (P.N FC-35050-100)
- One flat cable (95cm/37.4”)- 30-pin headers (P.N FC-03030-100)
- One power male connector and cable (150cm/59”). for standalone operation (P.N SB-11338-700)
- One Breakout Box power mating connector, **Phoenix Contact** MC 1.5/5-STF-3.81 (P.N CO-21205-STF)

2.5.2 Interface Cables

The SPiiPlus PCI is always supplied only with a RS-232 flat communication cable (37cm/14.1") for COM1 and COM2 (P.N FC-50920-226).

In addition, you can order each of the following Interface cables:

- One flat cable (20cm/7.8")- 200-pin header to four 50 pin headers (P.N FC-52050-420)
- One flat cable (40cm/15.7")- 200-pin header to four 50 pin headers (P.N FC-52050-440)
- One flat cable (95cm/37.4")- 200-pin header to four 50 pin headers (P.N FC-52050-493). This cable is included in the SPiiPlus PCI-INT.
- One flat cable (141cm/55.5")- 200-pin header to four 50 pin headers (P.N FC-52050-4150)
- One RS-422 communication flat cable (36cm/14.1") with D-connector, 9-pin, male (P.N CB-RS422-040). See description in **Section 6.2 - COM2 RS-422 Serial Communication**.

2.5.3 SPiiPlus PCI-Bracket

Mounting bracket for standalone controller operation. Dimensions [H x W x D]: 172mm (6.77") x 344mm (13.54") x 44mm (1.73").

2.5.4 HSSI-IO16

I/O expansion module providing 16 additional opto-isolated digital inputs and 16 opto-isolated digital outputs per module. Up to four HSSI-IO16 units can be daisy chained to an HSSI channel, providing a total of 64 inputs and 63 outputs per channel. For more information, refer to the HSSI-IO16 data sheet.

2.5.5 HSSI-ED2

The HSSI-ED2 is applicable to the SPiiPlus PCI and SPiiPlus PCI-LT only. The HSSI-ED2 is an I/O expansion module providing encoder and drive interface up to 20m from the controller, 8 additional opto-isolated digital inputs and 8 opto-isolated digital outputs per module. For more information, refer to the HSSI-ED2 data sheet.

2.5.6 HSSI-Hub

The HSSI-Hub is a PC-based distribution board for up to four HSSI channels. The HSSI Hub may be used with a SPiiPlus PCI as a unit between the controller and the HSSI module.

3 Specifications

3.1 SPiiPlus PCI Specifications

For axes specifications, see **Section 2.2 - Axis Configuration Options**.

Table 12 Profile Generation

Element	Description
Trajectory Calculation Rate	Programmable 0.5, 1 (default), 2kHz
Position Range	$\pm 4 \times 10^{15}$ counts
Velocity	160×10^{9} counts/second
Acceleration	Up to $\pm 4 \times 10^{15}$ counts/second^2

Table 13 Control

Element	Description
Position+Velocity Loop	PI type, second order low pass and notch filters
Sampling Rate	20kHz
Accuracy	±1 encoder count
Dual Loop	SPiiPlus PCI-2: 1(X) SPiiPlus PCI-4: 2(X,Y) SPiiPlus PCI-6: 3(X,Y,Z) SPiiPlus PCI-8: 4(X,Y,Z,T)

Note	
	*Each dual loop consumes another axis which should be defined as a dummy.*

Table 14 Feedback

Element	Description
Type	• Incremental digital encoders - one per axis, A&B,I; UP/DN,I; CLK/DIR,I Type RS-485 Max. rate: 20 million encoder counts/sec • Sin-cos encoders (optional) - one per axis, three channel, 1Vptp, differential. Programmable multiplication factor x4-x65,536, rate: up to 250,000 sine periods/second. Max. acceleration with Sin-cos encoder: 10^8 sine periods/second^2. • Analog inputs or user defined devices via HSSI channels

Table 15 Drive Interface

Element	Description	
Analog Command	Quantity	Two for torque and commutation
	Type	±10V, differential
	Resolution	16bit DAC
	Offset Compensation	Programmable, 0.3mV res.
Pulse Direction Commands	Quantity	Half of the axes
	Type	RS-485. Up to 4 million pulse/sec
Drive Enable Output	Quantity	One per axis
	Type	Two terminal, source or sink
	Collector Emitter Voltage	5Vdc to 30Vdc
	Output Current	50mA
Drive Fault Input	Quantity	One per axis
	Type	Two terminal, source or sink
	Input Voltage	5Vdc(±10%), or 24Vdc(±20%) requires an external supply

Table 16 Digital I/O (page 1 of 2)

Element	Description	
Safety Inputs	Quantity	One E-stop. Left and Right limit per axis
	Type	Two terminal, source or sink, opto-isolated
	Voltage	5Vdc(±10%) or 24Vdc(±20%), requires external supply

Table 16 Digital I/O (page 2 of 2)

Element	Description	
MARK and Digital Inputs	Quantity	See **Section 2.3 - I/O Configuration Options**. Can be general purpose or registration mark inputs. **Note**: When working in open loop, the registration mark is based on the internal pulse counter. When working in closed loop, the registration mark is based on the encoder counter.
	Type	RS-485.
	Propagation Delay	<0.1µsec
PEG and Digital Outputs	Quantity	See **Section 2.3 - I/O Configuration Options**. Can be general purpose or PEG outputs or mechanical brake control
	Type	RS-485
	Maximum Current	20 mA per output or 80mA for four outputs (OUT0...OUT3 or OUT4...OUT7)
	Propagation Delay	<0.1µsec
	PEG Pulse Width	25nsec to 1.6 msec
	PEG Position Accuracy	±1 count at up to 5,000,000 count/sec
	PEG Random Events	Up to 30,000

Table 17 HSSI Expansion Channels

Element	Description
Quantity	See **Section 2.3 - I/O Configuration Options**.
Input Bits	64 per channel
Output Bits	64 per channel
Sampling and Updating Rate	20kHz
Type	RS-485
Comment	Up to additional 64/63 I/Os via each HSSI channel

Table 18 Analog I/O

Element	Description	
Analog Inputs	Quantity	See **Section 2.3 - I/O Configuration Options**.
	Type	1V ptp, differential
	Resolution	14bit
	Comment	Analog inputs may be used as Sin-cos encoder inputs. Each Sin-cos encoder uses two analog inputs.
Analog Outputs	Quantity	See **Section 2.3 - I/O Configuration Options**.
	Type	±10V, differential
	Resolution	16bit
	Comment	Analog outputs may be used as drive command outputs. Each servo axis uses one toque command or two commutation command analog outputs.

Table 19 Communication Channels

Element	Description
PCI Bus	33MHz, 32bit, bi -directional
FIFO	512x8 in each direction
RS232/422	Two ports (one port can be RS422), up to 115,200bps
Ethernet	TCP/IP, 10/100 Mbt per sec

Note	
	*Simultaneous communication through all channels is fully supported.*

Table 20 Controller

Element	Description
User Memory	RAM: 128 MB, Flash: 128 MB
Powerup Time	25sec
Power Supply Voltage/Current	5Vdc(-2%/+5%) /3.5A, ±12Vdc(±5%)/0.25A

Note	
	*When the controller is outside of the PC, the 5V and ±12V should be supplied through a dedicated power connector.*

Table 21 Environment

Element	Description
Operating Temperature	0^0C to 60^0C
Storage Temperature	-40^0C to 85^0C
Humidity	90%RH, non condensing

3.2 SPiiPlus PCI-LT Specifications

For axes specifications, see **Section 2.2 - Axis Configuration Options**.

Table 22 Profile Generation

Element	Description
Trajectory Calculation Rate	1kHz
Position Range	$\pm 4x10^{15}$ counts
Velocity	$160x10^9$ counts/second
Acceleration	no practical limitation

Table 23 Control

Element	Description
Position+Velocity Loop	PI type, second order low pass and notch filters
Sampling Rate	20kHz
Accuracy	±1 encoder count
Dual Loop	SPiiPlus PCI-LT-2: 1(X) SPiiPlus PCI-LT-4: 2(X,Y) SPiiPlus PCI-LT-6: 3(X,Y,Z) SPiiPlus PCI-LT-8: 4(X,Y,Z,T)

Note	*Each dual loop consumes another axis which should be defined as a dummy.*

Table 24 Feedback

Element	Description
Type	Incremental digital encoders - one per axis, A&B,I; UP/DN,I; CLK/DIR,I Type RS-485 Max. rate: 20 million encoder counts/sec Note: *Encoders require external supply.*

Table 25 Drive Interface

Element	Description	
Analog Command	Quantity	One torque command
	Type	±10V, differential
	Resolution	16bit DAC
	Offset Compensation	Programmable, 0.3mV res.
Pulse Direction Commands	Quantity	Half of the axes
	Type	RS-485. Up to 4 million pulse/sec
Drive Enable Output	Quantity	One per axis
	Type	Two terminal, source or sink
	Collector Emitter Voltage	5Vdc to 30Vdc
	Output Current	50mA
Drive Fault Input	Quantity	One per axis
	Type	Two terminal, source or sink
	Input Voltage	5Vdc(±10%), or 24Vdc(±20%), requires an external supply

Table 26 Digital I/O

Element	Description	
Safety Inputs	Quantity	One E-stop. Left and Right limit per axis
	Type	Two terminal, source or sink, opto-isolated
	Voltage	5Vdc(±10%) or 24Vdc(±20%), requires external supply

Table 26 Digital I/O

Element	Description	
MARK and Digital Inputs	Quantity	See **Section 2.3 - I/O Configuration Options**. Can be general purpose or registration mark inputs. **Note**: When working in open loop, the registration mark is based on the internal pulse counter. When working in closed loop, the registration mark is based on the encoder counter.
	Type	RS-485.
	Propagation Delay	<0.1µsec
PEG and Digital Outputs	Quantity	See **Section 2.3 - I/O Configuration Options**. Can be general purpose or PEG outputs or mechanical brake control
	Type	RS-485
	Propagation Delay	<0.1µsec
	PEG Pulse Width	25nsec to 1.6 msec
	PEG Position Accuracy	±1 count at up to 5,000,000 count/sec
	PEG Random Events	Up to 30,000

Table 27 HSSI Expansion Channels

Element	Description
Quantity	See **Section 2.3 - I/O Configuration Options**.
Input Bits	64 per channel
Output Bits	64 per channel
Sampling and Updating Rate	20kHz
Type	RS-485
Comment	Up to additional 64/63 I/Os via each HSSI channel

Table 28 Analog I/O

Element	Description	
Analog Inputs	Quantity	Four for general purpose
	Type	1V ptp, differential
	Resolution	14bit
Analog Outputs	Quantity	Two for general purpose.
	Type	±10V, differential
	Resolution	16bit

Table 29 Communication Channels

Element	Description
PCI Bus	33MHz, 32bit, bi -directional
FIFO	512x8 in each direction
RS232/422	two ports (one port can be RS422), up to 115,200bps
Ethernet	TCP/IP, 10/100 Mbt per sec

Note	
	*Simultaneous communication through all channels is fully supported.*

Table 30 Controller

Element	Description
User Memory	RAM: 128 MB, Flash: 128 MB
Powerup Time	25sec
Power Supply Voltage/Current	5Vdc(-2%/+5%) /3.5A, ±12Vdc(±5%)/0.25A

Note	
	*When the controller is outside of the PC, the 5V and ±12V should be supplied through dedicates power connector.*

Table 31 Environment

Element	Description
Operating Temperature	0^0C to 60^0C
Storage Temperature	-40^0C to 85^0C
Humidity	90%RH, non condensing

3.3 SPiiPlus PCI-ST Specifications

For axes specifications, see **Section 2.2 - Axis Configuration Options**.

Table 32 Profile Generation

Element	Description
Trajectory Calculation Rate	1kHz
Position Range	$\pm 4x10^{15}$ counts
Velocity	up to four million pulse/sec
Acceleration	up to $4x10^{15}$ counts/sec^2

Table 33 Feedback

Element	Description
Type	Incremental digital encoders - one per axis, A&B,I; UP/DN,I; CLK/DIR,I Type RS-485 Max. rate: 20 million encoder counts/sec Note: *Encoders require external supply.*

Table 34 Drive Interface

Element	Description	
Pulse Direction Commands	Quantity	Two or four
	Type	RS-485. Up to 4 million pulse/sec
Drive Enable Output	Quantity	One per axis
	Type	Two terminal, source or sink
	Collector Emitter Voltage	5Vdc to 30Vdc
	Output Current	50mA

Table 34 Drive Interface

Element	Description	
Drive Fault Input	Quantity	One per axis
	Type	Two terminal, source or sink
	Input Voltage	5Vdc(±10%), or 24Vdc(±20%), requires an external supply

Table 35 Digital I/O

Element	Description	
Safety Inputs	Quantity	One E-stop. Left and Right limit per axis
	Type	Two terminal, source or sink, opto-isolated
	Voltage	5Vdc(±10%) or 24Vdc(±20%), requires external supply
MARK and Digital Inputs	Quantity	See **Section 2.3 - I/O Configuration Options**. Can be general purpose or registration mark inputs. **Note**: When working in open loop, the registration mark is based on the internal pulse counter. When working in closed loop, the registration mark is based on the encoder counter.
	Type	RS-485.
	Propagation Delay	<0.1µsec
PEG and Digital Outputs	Quantity	See **Section 2.3 - I/O Configuration Options**. Can be general purpose or PEG outputs or mechanical brake control
	Type	RS-485
	Propagation Delay	<0.1µsec
	PEG Pulse Width	25nsec to 1.6 msec
	PEG Position Accuracy	±1 count at up to 5,000,000 count/sec
	PEG Random Events	Up to 30,000
	Num. of PEG Events in Incremental Mode	unlimited

Table 36 HSSI Expansion Channels

Element	Description
Quantity	See **Section 2.3 - I/O Configuration Options**.
Input Bits	64 per channel
Output Bits	64 per channel
Sampling and Updating Rate	20kHz
Type	RS-485
Comment	Up to additional 64/63 I/Os via each HSSI channel

Table 37 Communication Channels

Element	Description
PCI Bus	33MHz, 32bit, bi -directional
FIFO	512x8 in each direction
RS232/422	two ports (one port can be RS422), up to 115,200bps
Ethernet	TCP/IP, 10/100 Mbt per sec

Note	*Simultaneous communication through all channels is fully supported.*

Table 38 Controller

Element	Description
User Memory	RAM: 128 MB, Flash: 128 MB
Powerup Time	25sec
Power Supply Voltage/Current	5Vdc(-2%/+5%) /3.5A, ±12Vdc(±5%)/0.25A

Note	*When the controller is outside of the PC, the 5V and ±12V should be supplied through dedicates power connector.*

Table 39 Environment

Element	Description
Operating Temperature	0^0C to 60^0C
Storage Temperature	-40^0C to 85^0C
Humidity	90%RH, non condensing

3.4 Layout and Dimensions of SPiiPlus PCI Line

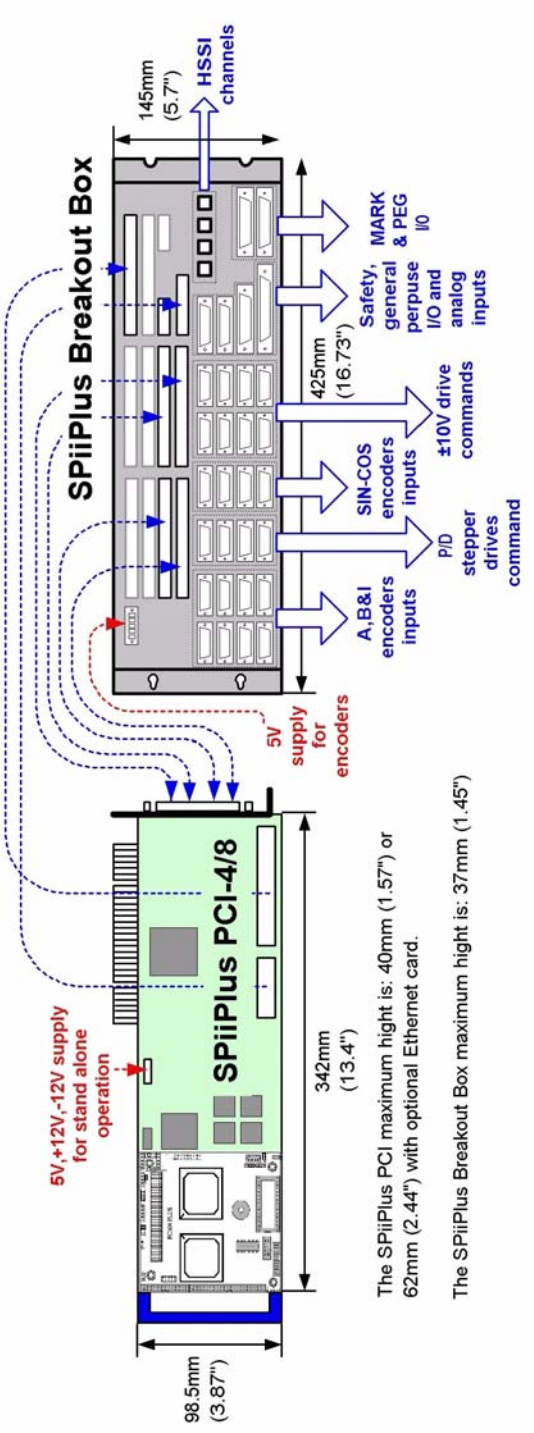


Figure 3 SPiiPlus PCI Line and Breakout Box - Layout and Dimensions

4 Safety and EMC Guidelines

4.1 Installation

Install the controller of the SPiiPlus PCI, or the SPiiPlus PCI-LT, or the SPiiPlus PCI-ST in a standard full-length PCI slot in the host PC. The thickness of the controller takes up an adjacent slot as well. As many controllers can be installed as there are slot pairs. For example, if there are six long slots, three controllers can be installed. When communicating with the controller via the PCI bus, it is necessary to specify the slot. This is done in the Communication dialog box of SPiiPlus software tools.

Alternatively, the controller can operate standalone when installed in the optional SPiiPlus PCI-BRACKET.

For easy connection of controller to system using standard D-type connectors, the optional **SPiiPlus PCI-INT** interface kit with breakout box is available.

4.2 General Safety Guidelines

Under emergency situations the unit should be completely disconnected from any power supply. The E-Stop Inputs and Left/Right Limits on ACS Motion Control products are designed for use in conjunction with customer-installed devices to protect driver load. The end user is responsible for complying with all Electrical Codes.

4.2.1 Emergency Stop Device

Warning 	***An emergency stop device should be located at each operator control station and other operating stations where an emergency stop may be required. The emergency stop device has to disconnect any electrical equipment connected to the unit from the power supply. It will not be possible to restore the circuit until the operator manually resets the emergency stop. In situations with multiple emergency stop devices the circuit shall not be restored until all emergency stops devices are manually reset.***

4.2.2 Fail Safe Logic Recommendation

ACS Motion Control recommends connecting all safety inputs (limit inputs and emergency stop input) with a fail safe logic. Meaning during normal operation the inputs is active. When a safety event happens (or the input wire is cut) the input becomes zero and the controller identifies that as a fault.

4.2.3 Initial Logic State of Outputs

The relevance of analog and digital output pins is product and model dependent. The initial logic state of the inactive analog and digital pins is undefined. They might carry a potential of 5V relatively to ground.

4.2.4 Electrical Separation

Electrical separation is required between the control and power supply cables to prevent electrical shock or damage to the equipment.

4.2.5 Over-Travel Protection

Warning	
	***Over-travel limit protection must be provided where over-travel is hazardous. Design and install the over-travel limiting device to interrupt the power circuit.***

4.2.6 Thermal Detection

Warning	
	***Suitable thermal detection devices to interrupt the power circuit where abnormal temperatures can cause a hazardous condition must be provided.***

4.2.7 Power Supply and Motor Cable Ground

The power supply cable and the motor cable must have a ground wire that is connected to the protective earth terminal located on the motor and power connectors. A connection must also be made between the protective earth screw (located on the top of the unit) and the equi-potential bar inside electrical enclosure.

4.3 General Wiring and Electromagnetic Compatibility (EMC) Guidelines

4.3.1 Routing Signal and Power Cables

Power cables (to the motor, mains outlet, etc.) and signal cables (to I/O, encoder, RS-232, etc.) must be kept as far apart as possible. Keep at least an inch (~2.5 cm) for each 3 feet (~1 m) of parallel run as illustrated in **Figure 4**. For example, if the motor and encoder cables run parallel for 6 feet (~2 m), maintain a 2 inch (~5 cm) separation between them.

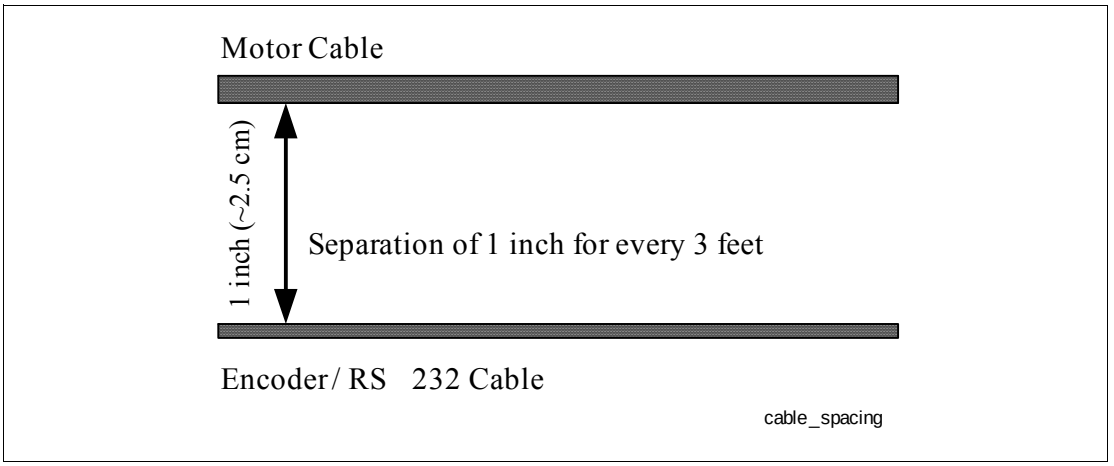


Figure 4 Cable Spacing

It is recommended to use completely shielded cables as illustrated in **Figure 5**.

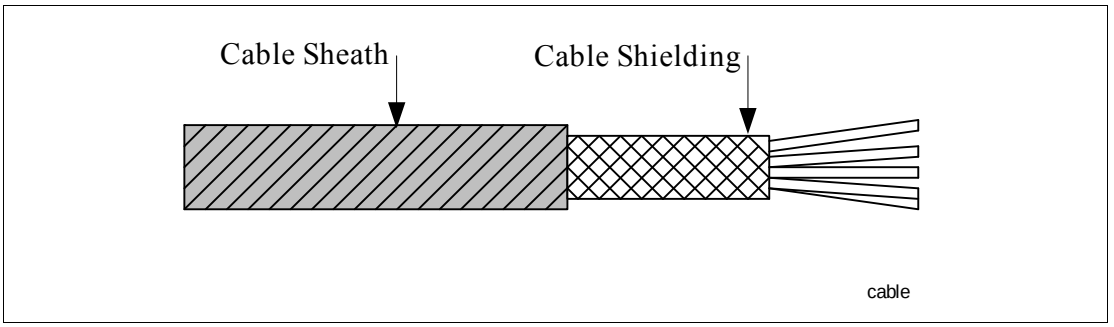


Figure 5 Shielded Cable

4.3.2 Cable Length

Use short cables runs, and route cables as far from other EMI sources as possible.

4.3.3 Shielding

To reduce EMI radiation, do the following:

- Use shielded cables
- Install a ferrite core around the cable as close to the unit as possible as illustrated in **Figure 6**.

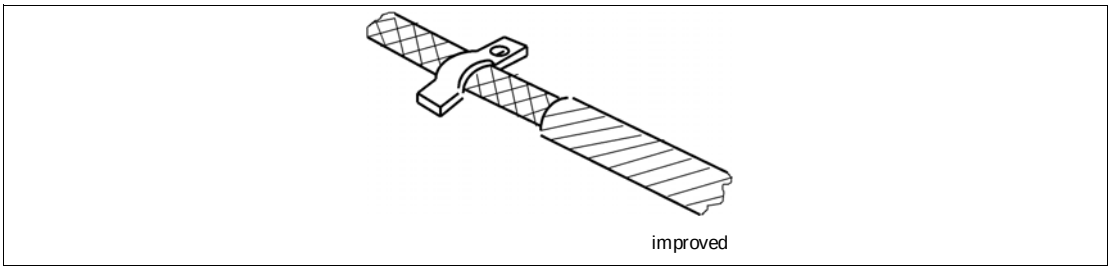


Figure 6 Improved Shielding

4.3.4 Grounding

Grounding of the system electrical components is crucial in two aspects:

- Safety grounding

Warning	
	***Verify that all electric circuits and electrical components, including motion controllers, power drives, motors, etc., have a grounding system. Grounding of AC and DC equipment shall be in accordance with 29 CFR 1910.304(f).***

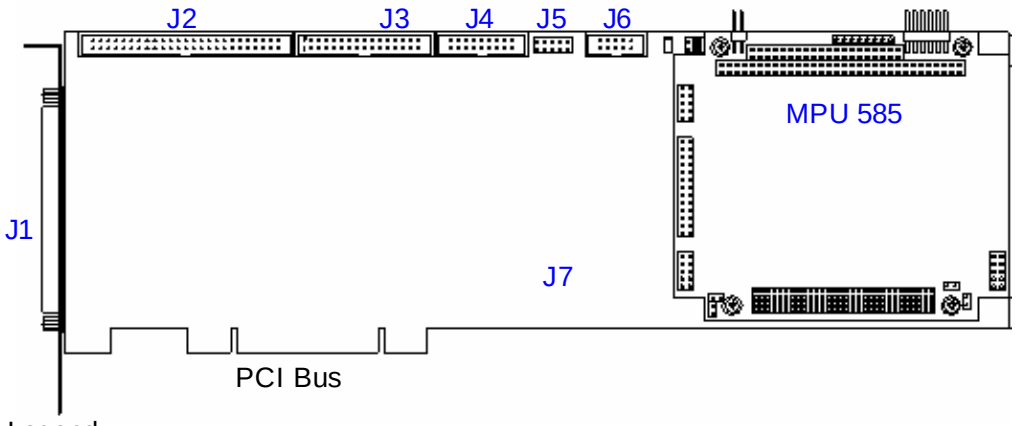
- High frequency grounding:

The primary objective of a high-frequency ground system is to provide a well defined path for HF currents and to minimize the loop area of the HF current paths. It is also important to separate HF grounds from sensitive circuit grounds. A single-point, parallel connected ground system is recommended.

The power supply cable and the motor cable must have a ground wire that is connected to the protective earth terminal located on the motors. A connection must also be made between the protective earth screw (located on the side of the unit) and the equi-potential bar inside electrical cabinet.

5 Electrical Interface

5.1 Electrical Interface Locations and Designation



Legend:

J1 - Incremental Encoders Drives/ Amplifiers, Safety Inputs , Digital Outputs/ PEG Analog Outputs, Digital Inputs/ MARK

J2 - Analog Inputs, SIN-COS Encoder Joystick Inputs

J3 - HSSI, Additional Outputs

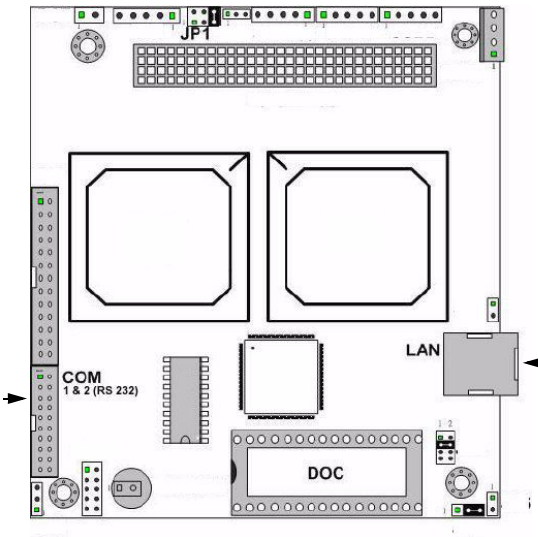
J4 – J6 Manufacturing and Testing

J7 – External Power Supply

MPU 585 – For connectivity, see picture below

SPiiPlus PCI card

Figure 7 Electrical Interface Locations



COM 1&2 for RS-232/422 communication ports

Ethernet communication

Figure 8 MPU 585 Connectivity

5.2 Main Connector J1

Caution	
	***The relevance of analog and digital output pins is product and model dependent. The initial logic state of the analog and digital pins that are inactive is undefined. They may carry an electrical potential.***

Table 40 Main Connector J1 - Components

Component	Description
Jack on SPiiPlus PCI Jack on SPiiPlus PCI-LT Jack on SPiiPlus PCI-ST	Molex® 200-pin, 71718-2000
Plug from System	Molex 200-pin, 71719-3000
Recommended Wires	200pin connector with the four flat cables to 50pin headers (ACS Motion Control P.N FC-52050-493)

There are two ways to connect the system to the main connector J1of the SPiiPlus PCI products:

- **Breakout Box**: The optional SPiiPlus PCI-INT, see **Chapter 8 - SPiiPlus PCI Breakout Box Connections**, includes a breakout box, plugs and cables. The breakout box receives two/four 50-pin plugs from main connector J1 and distributes the signals via convenient D-type connectors arranged according to axis and functional. This option is particularly recommended for prototyping.
- **Direct**: Instead of purchasing the full SPiiPlus PCI-INT the user can purchase only the flat cable with a 200-pin header at the J1 end and two/four flat cables at the system end (P.N. FC-52050-493) for connecting to the user's own distribution box. This option is recommended for serial production (saves the cost of the breakout box).

The flat cable's 200-pin J1 header connects to the controller's J1 jack on the back of the computer. The cable divides into four 50-pin connectors, each of which is labeled with its lowest pin number (pin 1, pin 51, pin 101, or pin 151). A red line in the connector flat cable indicates the wire connecting to the lowest pin number.

Table 41 Cable from Main Connector J1 – 50-Pin Plugs

Product	Axes	50-Pin Plug	Pin Number
SPiiPlus PCI-2/4/6/8 SPiiPlus PCI-LT-2/4/6/8 SPiiPlus PCI-ST-2/4	X and A X and A X only	J36	1-50
SPiiPlus PCI-4/6/8 SPiiPlus PCI-LT-2/4/6/8 SPiiPlus PCI-ST-2/4	Y and B Y and B Y only	J37	51-100

Table 41 Cable from Main Connector J1 – 50-Pin Plugs

SPiiPlus PCI-6/8 SPiiPlus PCI-LT-6/8 SPiiPlus PCI-ST-2	Z and C Z and C Z only	J40	101-150
SPiiPlus PCI-8 only SPiiPlus PCI-LT-8 only SPiiPlus PCI-ST-2/4	T and D T and D T only	J41	151-200

Table 42 lists the abbreviations used for the J1 plug signals listed in Table 43. The symbol # is a place holder for the axis designation, which can be X, Y, Z, T, A, B, C, or D. The letter x is a place holder for a number.

Table 42 Main Connector J1 - Signal Abbreviations

Symbol	Description
#FLT	Drive Fault Input
#ENA	Drive Enable Output
#RL and #LL	Right and Left Limit (safety inputs)
VIN+, VIN-, REF	Pins used for connecting external power supply for safety inputs
ES	Emergency Stop
#DIR, #PULSE	Pulse direction commands (for step motor control)
OUTx	PEG or digital output
#MARKx, INx	MARK or digital inputs
#CHA	Channel A of incremental encoder
#CHB	Channel B of incremental encoder
#CHI	Channel Index of incremental encoder
#DACx, AOUTx *	Analog drive command or analog output
NC	Not Connected

Model

The symbols #DACx, AOUTx apply only to SPiiPlus PCI and SPiiPlus PCI-LT. SPiiPlus PCI-ST does not support analog I/Os.

Pins in connector J1 apply according to the axes and I/Os supported by the product. For example, pin 198 applies to SPiiPlus PCI-8 only.

Table 43 Main Connector J1- Pinout (page 1 of 3)

Pin	J36 Cable	Pin	J37 Cable	Pin	J40 Cable	Pin	J41 Cable	Description
1	AFLT-	51	BFLT-	101	CFLT-	151	DFLT-	Drive Fault Interface
2	AFLT+	52	BFLT+	102	CFLT+	152	DFLT+	
3	XFLT-	53	YFLT-	103	ZFLT-	153	TFLT-	
4	XFLT+	54	YFLT+	104	ZFLT+	154	TFLT+	
5	AENA-	55	BENA-	105	CENA-	155	DENA-	Drive Enable Interface
6	AENA+	56	BENA+	106	CENA+	156	DENA+	
7	XENA-	57	YENA-	107	ZENA-	157	TENA-	
8	XENA+	58	YENA+	108	ZENA+	158	TENA+	
9	ARL	59	BRL	109	CRL	159	DRL	Limit Inputs
10	ALL	60	BLL	110	CLL	160	DLL	
11	XRL	61	YRL	111	ZRL	161	TRL	
12	XLL	62	YLL	112	ZLL	162	TLL	
13	REF	63	NC	113	NC	163	NC	Safety Inputs
14	VIN-	64	ES-	114	NC	164	NC	
15	VIN+	65	ES+	115	NC	165	NC	
16	XDIR-	66	YDIR-	116	ZDIR-	166	TDIR-	Pulse - Direction (Stepper) Outputs
17	XDIR+	67	YDIR+	117	ZDIR+	167	TDIR+	
18	XPULSE-	68	YPULSE-	118	ZPULSE-	168	TPULSE-	
19	XPULSE+	69	YPULSE+	119	ZPULSE+	169	TPULSE+	
20	XPEG_ STATE1- / OUT0.1-	70	X_PEG / OUT0.3-	120	YPEG_ STATE1- / OUT0.5-	170	Y_PEG / OUT0.7-	Digital Outputs/PEG Outputs
21	XPEG_ STATE1+ / OUT0.1+	71	XPEG_ STATE3+ / OUT0.3+	121	YPEG_ STATE1+ / OUT0.5+	171	YPEG_ STATE3+/ OUT0.7+	
22	XPEG_ STATE0- / OUT0.0-	72	XPEG_ STATE2- / OUT0.2-	122	YPEG_ STATE0- / OUT0.4-	172	YPEG_ STATE2- / OUT0.6-	
23	XPEG_ STATE0+ / OUT0.0+	73	XPEG_ STATE2+ / OUT0.2+	123	YPEG_ STATE0+ / OUT0.4+	173	YPEG_ STATE2+ / OUT0.6+	

Table 43 Main Connector J1- Pinout (page 2 of 3)

Pin	J36 Cable	Pin	J37 Cable	Pin	J40 Cable	Pin	J41 Cable	Description
24	XM2ARK -/IN0.1-	**74**	YM2ARK -/IN0.3-	**124**	ZM2ARK -/IN0.5-	**174**	TM2ARK- /IN0.7-	**Digital Inputs/Registration MARK Inputs**
25	XM2ARK +/IN0.1+	**75**	YM2ARK +/IN0.3+	**125**	ZM2ARK +/IN0.5+	**175**	TM2ARK+ /IN0.7+	
26	XMARK1 -/IN0.0-	**76**	YMARK1 -/IN0.2-	**126**	ZMARK1 -/IN0.4-	**176**	TMARK1- /IN0.6-	
27	XMARK1 +/IN0.0+	**77**	YMARK1 +/IN0.2+	**127**	ZMARK1 +/IN0.4+	**177**	TMARK1+ /IN0.6+	
28	ACHI-	**78**	BCHI-	**128**	CCHI-	**178**	DCHI-	**Incremental Digital Encoder Interface**
29	ACHI+	**79**	BCHI+	**129**	CCHI+	**179**	DCHI+	
30	ACHB-	**80**	BCHB-	**130**	CCHB-	**180**	DCHB-	
31	ACHB+	**81**	BCHB+	**131**	CCHB+	**181**	DCHB+	
32	ACHA-	**82**	BCHA-	**132**	CCHA-	**182**	DCHA-	
33	ACHA+	**83**	BCHA+	**133**	CCHA+	**183**	DCHA+	
34	XCHI-	**84**	YCHI-	**134**	ZCHI-	**184**	TCHI-	
35	XCHI+	**85**	YCHI+	**135**	ZCHI+	**185**	TCHI+	
36	XCHB-	**86**	YCHB-	**136**	ZCHB-	**186**	TCHB-	
37	XCHB+	**87**	YCHB+	**137**	ZCHB+	**187**	TCHB+	
38	XCHA-	**88**	YCHA-	**138**	ZCHA-	**188**	TCHA-	
39	XCHA+	**89**	YCHA+	**139**	ZCHA+	**189**	TCHA+	
40	GND	**90**	GND	**140**	GND	**190**	GND	Digital ground
41	+5VUF	**91**	+5VUF	**141**	+5VUF	**191**	+5VUF	User 5V
42	AGND	**92**	AGND	**142**	AGND	**192**	AGND	Analog ground

Table 43 Main Connector J1- Pinout (page 3 of 3)

Pin	J36 Cable	Pin	J37 Cable	Pin	J40 Cable	Pin	J41 Cable	Description
43	ADAC1-/AOUT3	**93**	BDAC1-/AOUT7	**143**	CDAC1-/AOUT11	**193**	DDAC1-/AOUT15	Analog (or Drive Command) Outputs
44	ADAC1+/AOUT3	**94**	BDAC1+/AOUT7	**144**	CDAC1+/AOUT11	**194**	DDAC1+/AOUT15	
45	ADAC0-/AOUT2	**95**	BDAC0-/AOUT6	**145**	CDAC0-/AOUT10	**195**	DDAC0-/AOUT14	
46	ADAC0+/AOUT2	**96**	BDAC0+/AOUT6	**146**	CDAC0+/AOUT10	**196**	DDAC0+/AOUT14	
47	XDAC1-/AOUT1	**97**	YDAC1-/AOUT5	**147**	ZDAC1-/AOUT9	**197**	TDAC1-/AOUT13	
48	XDAC1+/AOUT1	**98**	YDAC1+/AOUT5	**148**	ZDAC1+/AOUT9	**198**	TDAC1+/AOUT13	
49	XDAC0-/AOUT0	**99**	YDAC0-/AOUT4	**149**	ZDAC0-/AOUT8	**199**	TDAC0-/AOUT12	
50	XDAC0+/AOUT0	**100**	YDAC0+/AOUT4	**150**	ZDAC0+/AOUT8	**200**	TDAC0+/AOUT12	

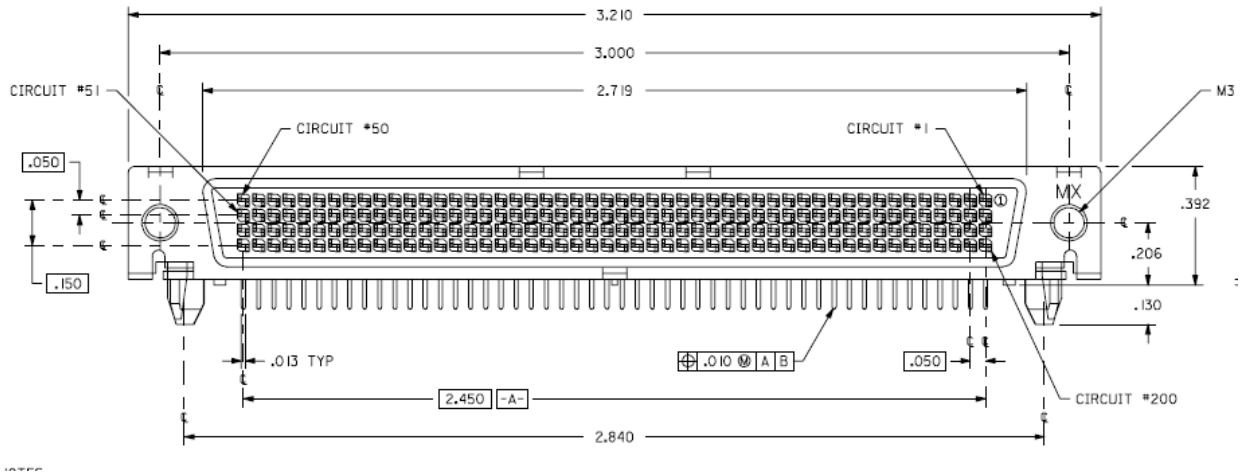


Figure 9 Main Connector

5.2.1 Incremental Digital Encoder Interface

Caution	
	***Power supply for encoders and safety switches must be provided separately by the user via the J35 connector of the breakout box or directly to the encoder.***

Table 44 describes the incremental digital encoders supported by the SPiiPlus PCI products.

Table 44 Incremental Digital Encoder Support

	SPiiPlus PCI	SPiiPlus PCI-LT	SPiiPlus PCI-ST
Quantity	SPiiPlus PCI-2: 2 SPiiPlus PCI-4:4 SPiiPlus PCI-6:6 SPiiPlus PCI-8:8	SPiiPlus PCI-LT-2: 2 SPiiPlus PCI-LT-4:4 SPiiPlus PCI-LT-6:6 SPiiPlus PCI-LT-8:8	SPiiPlus PCI-LT-2: 2 SPiiPlus PCI-LT-4:4
Encoders per axis	1	1	1
Characteristics	See **Chapter 3 - Specifications**	See **Chapter 3 - Specifications**	See **Chapter 3 - Specifications**
ACSPL+ standard variable	FPOS	FPOS	FPOS
Recommended Wires	AWG22 wires **with shielding**. Twisted pair cable for each differential signal (+ and -).	As in SPiiPlus PCI	As in SPiiPlus PCI
Supported Types	• **A&B, I**: Quadrature encoder with index. • **CLK-Dir, I:** Clock – direction encoder with index. • **UP–DN, I:** Up-down encoder with index.	As in SPiiPlus PCI	As in SPiiPlus PCI
Breakout Box Connectors (option)	**Section 8.3.1 - Encoder Connectors J1 to J8**	As in SPiiPlus PCI	As in SPiiPlus PCI

Note	
	*For more information about using incremental encoders refer to the SPiiPlus Setup Guide.*

The input buffer is built around a 26C32 line receiver with 220 termination resistor. The use of encoders with built-in line drivers, such as AM26C31 or similar, is recommended. **Figure 10** is an example (for the X axis) of an incremental encoder connection.

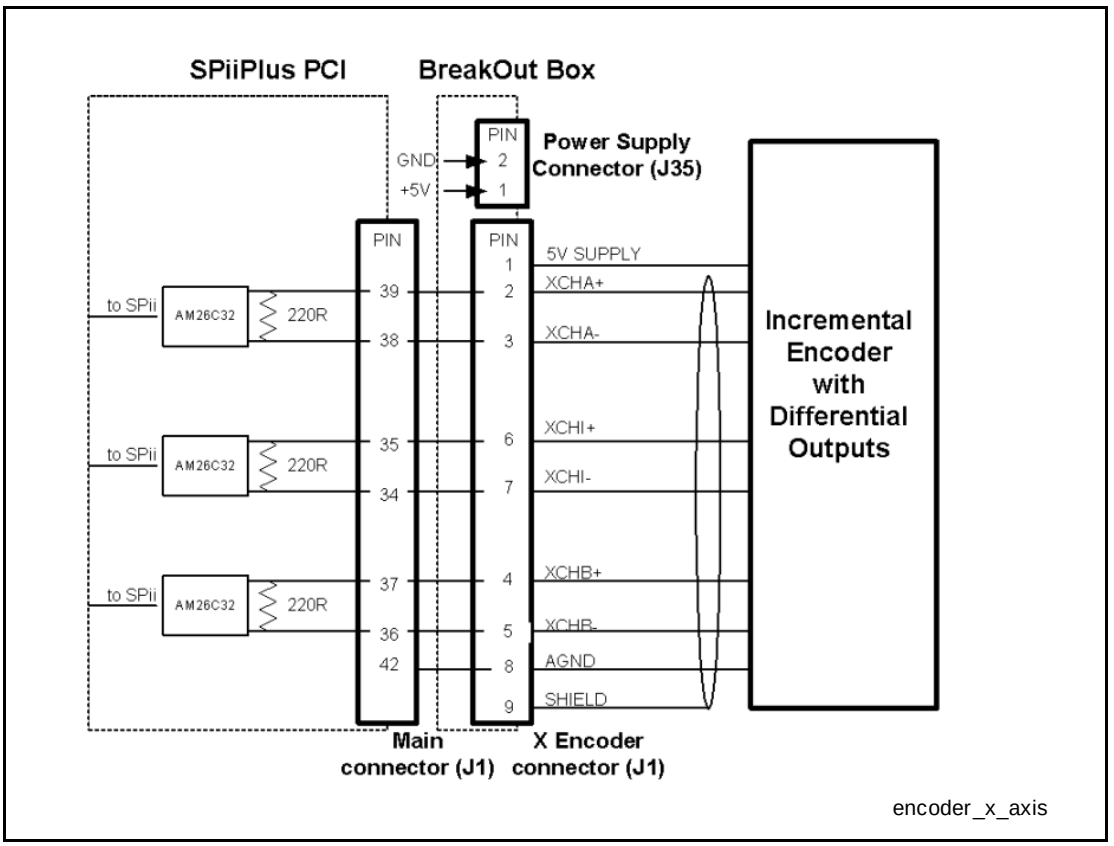


Figure 10 Incremental Digital Encoder Interface (X Axis)

5.2.2 Drive Enable Interface

All of the SPiiPlus PCI products provide one drive enable output per axis. The drive enable output is used with user-supplied 5V or 24V. The drive enable output can be used in a sink or source type configuration.

Table 45 Drive Enable Outputs

Category	Value
Quantity	One enable output per axis
Type	Opto-isolated, two-terminal. May be used as source (open emitter) or sink (open collector).
Propagation Delay	<1ms
Output Voltage	5Vdc (±10%) or 24Vdc (±20%) – user supplied
Maximum Current	50mA per enable output
Breakout Box Connectors (option)	For Stepper drive: **Section 8.3.2 - Pulse/Dir Connectors J9 to J12** For Servo drive: **Section 8.3.4 - Drive Connectors J17 to J24**

5.2.2.1 Drive Enable Examples

The following examples illustrate the drive enable interface for an X-axis direct-connected servo drive. The same interface applies for direct-connected stepper drives.

Caution	
	***The value of the pull-up or pull-down resistor must ensure that the enable output current does not exceed the controller's rated maximum current (50mA).***

Figure 11 is an example (for the X axis) of an enable output connection to a **source-type** input on a servo drive, the drive having **internal** pull-down resistor. When the drive receives external 5V/24V, it becomes enabled.

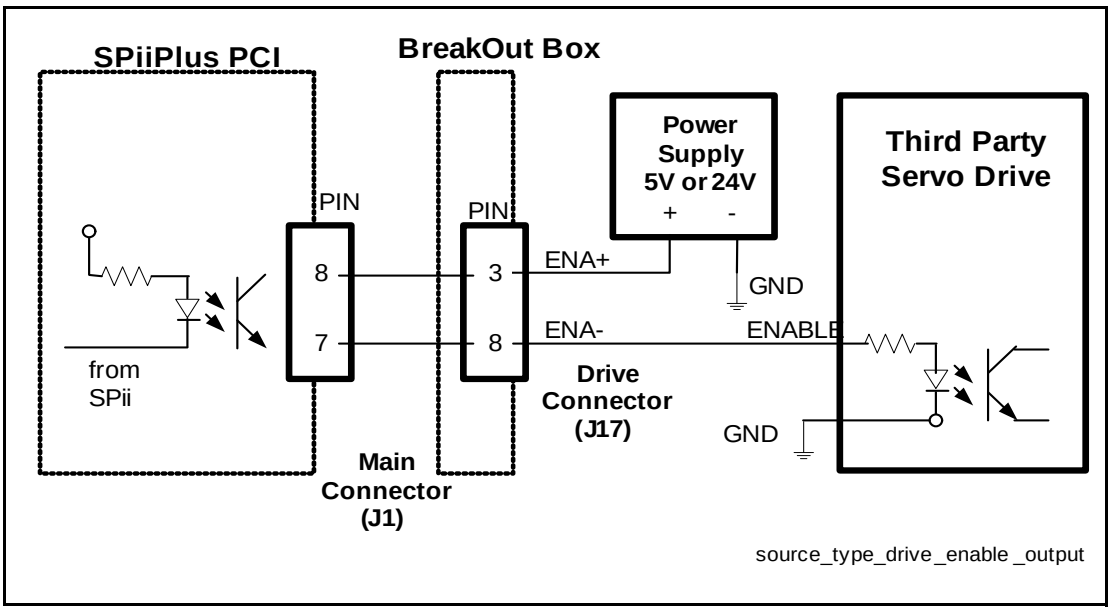


Figure 11 Source-Type Drive Enable Output (X Axis)

Figure 12 is an example (for the X axis) of an enable output connection to a **two terminal** input drive, the drive having an **internal** pull-up resistor and **internal** power supply. When the drive receives GND, it becomes enabled.

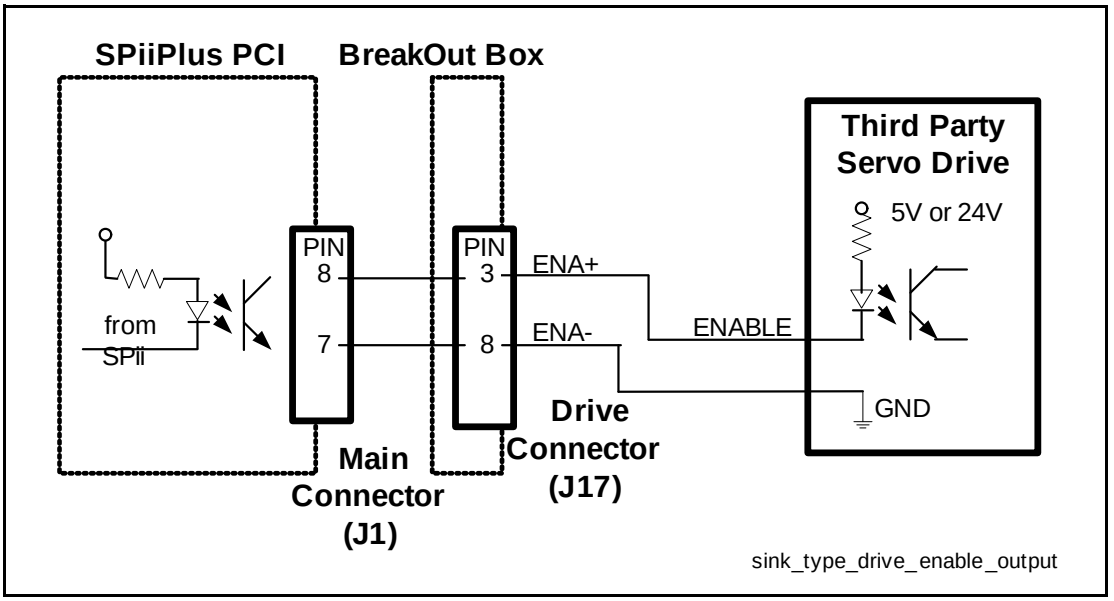


Figure 12 Two Terminal Drive Enable Output (X Axis)

Figure 13is an example (for the X axis) of a source enable connection to a servo drive, the drive having an **external** pull-up resistor and an **external** power supply. When the drive receives GND and source (5V/24V), it becomes enabled.

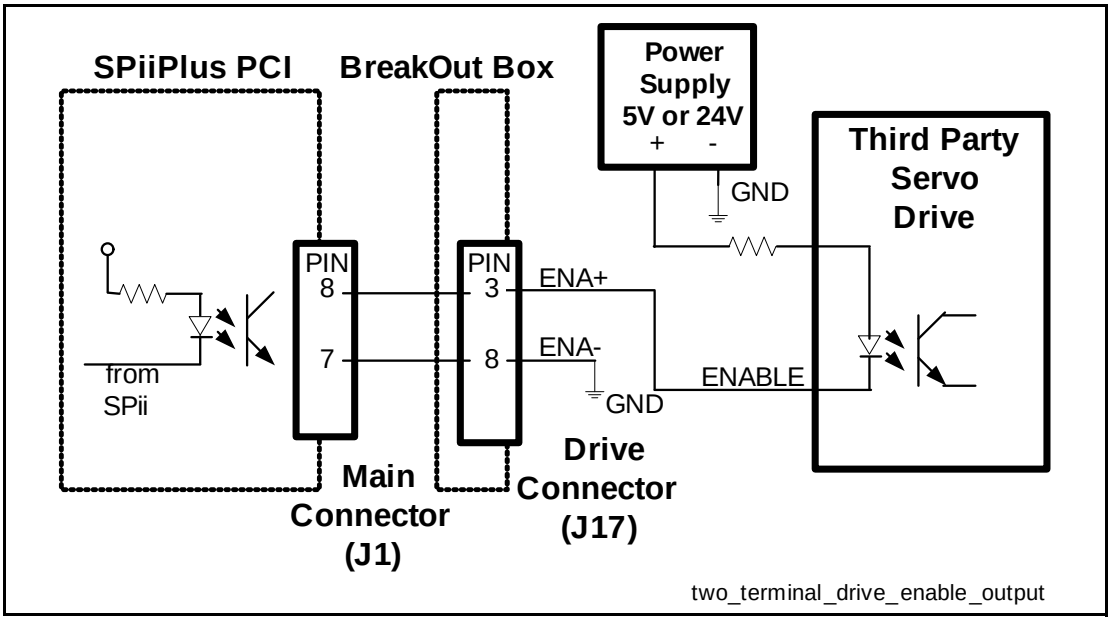


Figure 13 Source Drive Enable Output (X Axis)

5.2.3 Drive Fault Interface

All of the SPiiPlus PCI products provide one drive fault input per axis with user-supplied 5Vor 24V. The drive fault input can be used in a sink or source type configuration.

Table 46 Drive Fault Inputs

Category	Value
Quantity	One fault input per axis
Type	Opto-isolated, two-terminal. Can be used as source (open emitter) or sink (open collector).
Propagation Delay	<1ms
Input Voltage	5Vdc (±10%) or 24Vdc (±20%), detected automatically
Maximum Current	Up to 10mA per input
Protection	Protected against reverse polarity
Breakout Box Connectors (option)	For Stepper drive: **Section 8.3.2 - Pulse/Dir Connectors J9 to J12** For Servo drive: **Section 8.3.4 - Drive Connectors J17 to J24**

5.2.3.1 Drive Fault Examples

The following examples illustrate an X-axis drive fault interface for direct-connected servo drives. The same interface applies for direct-connected stepper drives.

Figure 14 is an example (for the X axis) of a **source-type** drive fault input from a servo drive.

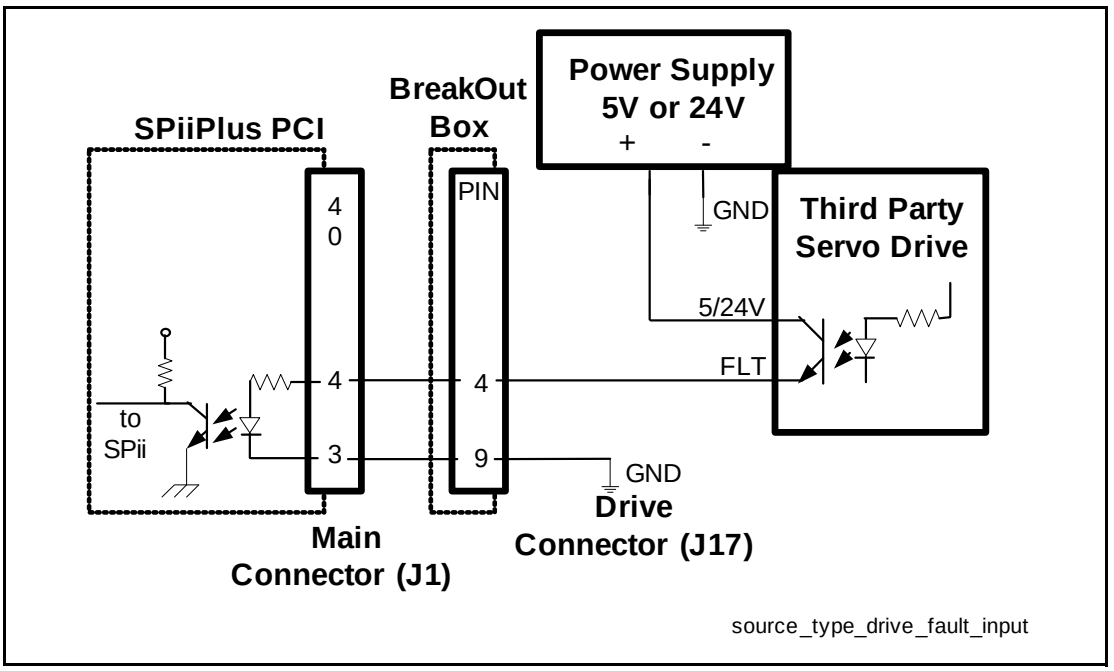


Figure 14 Source-Type Drive Fault Input (X Axis)

Figure 15 is an example (for the X axis) of a **sink-type** drive fault input connection (with external power supply) from a servo drive.

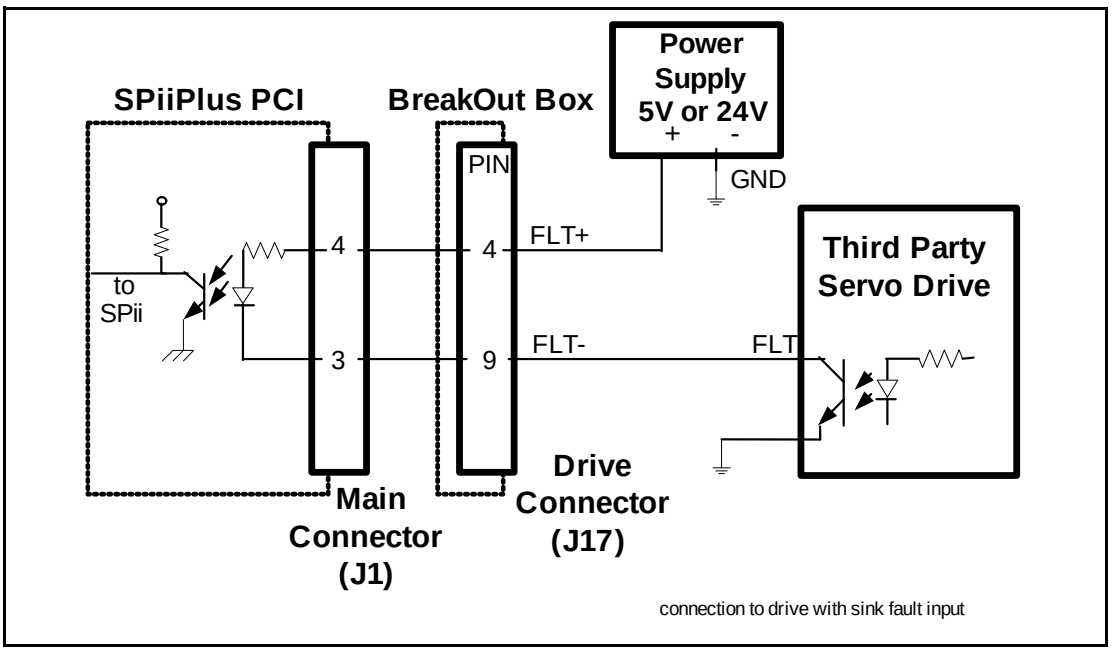


Figure 15 Connection To Drive With Sink Fault Input (X Axis)

5.2.4 Analog (or Drive Command) Outputs

The number of analog outputs varies from product to product as explained below:

- SPiiPlus PCI - provides up to 16 differential analog outputs.
- SPiiPlus PCI-LT - provides up to 10 differential analog outputs.
- SPiiPlus PCI-ST - does not support analog outputs.

(For details, see **Section 2.3 - I/O Configuration Options**). The analog outputs can be used to send drive commands to a third party drive for the following types of motors. For details, see **Section 2.2 - Axis Configuration Options**.

- **DC brush motor** - consumes one analog output per axis.
- **Three-phase DC brushless/AC servo motor** - consumes one analog output per axis when the drive is doing the motor commutation. Consumes two analog outputs per axis when the controller is doing the motor commutation ("software commutation").
- **Nanomotion motor** - consumes one analog output per axis.

In SPiiPlus PCI only, analog outputs that are not used for drive commands are available for general-purpose use. If an axis is not in use, the drive command output(s) can be freed up for general use by defining the axis as a dummy axis as follows: **MFLAGS(axis).#DUMMY= 1**. This feature is supported by the SPiiPlus PCI only and not by the SPiiPlus PCI-LT.

Caution	
	***The relevance of analog and digital output pins is product and model dependent. The initial logic state of the analog and digital pins that are inactive is undefined. They may carry an electrical potential.***

Table 47 Analog Outputs and Drive Commands

Category	SPiiPlus PCI	SPiiPlus PCI-LT
Quantity	SPiiPlus PCI-2:4	SPiiPlus PCI-LT-2: Two drive command, Two general purpose
	SPiiPlus PCI-4:8	SPiiPlus PCI-LT-4: Four drive command, Two general purpose
	SPiiPlus PCI-6:12	SPiiPlus PCI-LT-6:Six drive command, Two general purpose
	SPiiPlus PCI-8:16	SPiiPlus PCI-LT-8: Eight drive command, Two general purpose
Type	Differential, not isolated	
Voltage Range	Between the output's two differential lines: -10V to 10V. Between (GND) and the output's (+) line: -5V to 5V.	
D/A Resolution	16 bit	
D/A Conversion Circuit Accuracy	±2%	

Table 47 Analog Outputs and Drive Commands

Category	SPiiPlus PCI	SPiiPlus PCI-LT
Voltage Representation	-32768 to 32768	
Maximum Current	10mA per output	
Protection	short circuit	
Corresponding ACSPL+ Variables	OUT0… AOUT15	AOUT0, AOUT2, AOUT4, AOUT6, AOUT8, AOUT10, AOUT12, AOUT14 AOUT1 and AOUT3
Breakout Box Connectors (option)	See **Section 8.3.4 - Drive Connectors J17 to J24**	

Note

When using non-differential drivers, the single ended command from the controller is ±5V.

Table 48 Axis Analog Outputs Used for Drive Command(s)

Axis	One axis output is used when commutation is by drive (brushless motor) or by motor (brush motor) Default	Both axis outputs are used when commutation is by controller (brushless motor)
X	AOUT0	AOUT0 and AOUT1
Y	AOUT4	AOUT4 and AOUT5
Z	AOUT8	AOUT8 and AOUT9
T	AOUT12	AOUT12 and AOUT13
A	AOUT2	AOUT2 and AOUT3
B	AOUT6	AOUT6 and AOUT7
C	AOUT10	AOUT10 and AOUT11
D	AOUT14	AOUT14 and AOUT15

Note

Controller commutation is supported only by SPiiPlus PCI.

5.2.4.1 Drive Output Examples

The following examples illustrate the drive output interface for an X axis.

Figure 16 is an example (for the X axis) of an output command connection for a DC **brush** motor.

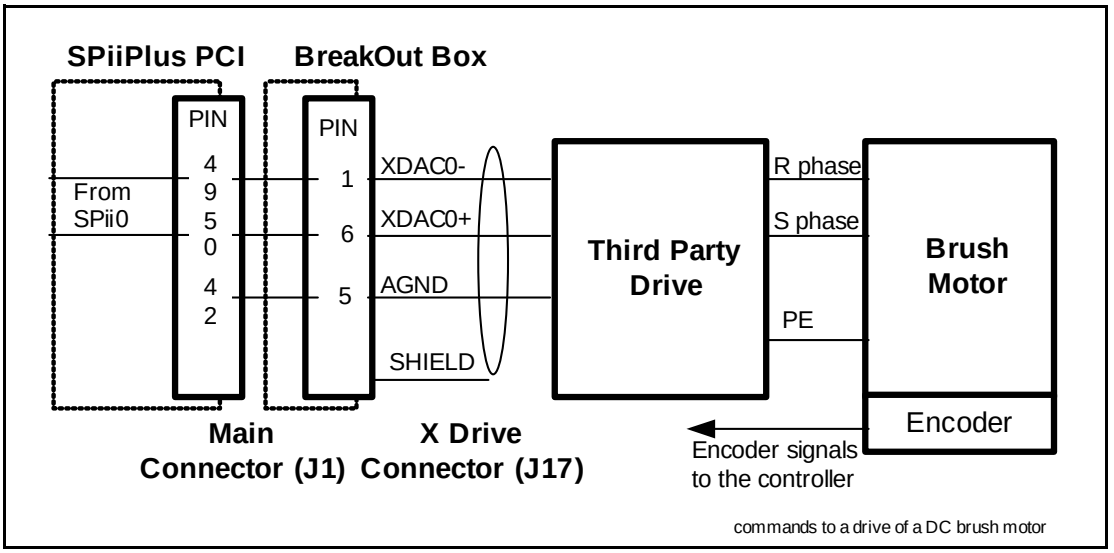


Figure 16 Connection of Output Commands to a Drive of a DC Brush Motor (X Axis)

Figure 17 is an example (for the X axis) of an output command connection for a DC brushless motor.

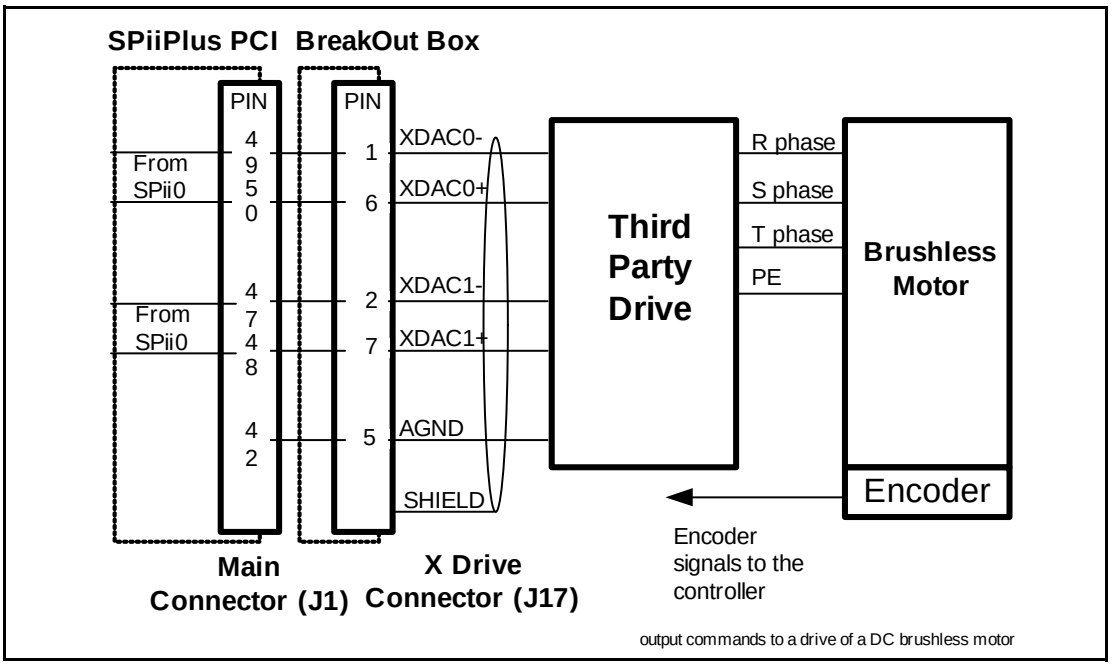


Figure 17 Output Command Connection to a DC Brushless Motor Drive (X Axis)

5.2.5 Pulse - Direction (Stepper) Outputs

The SPiiPlus PCI line of products provides up to four pulse direction digital differential outputs to control a stepper motor. For details, see the following table.

The SPiiPlus PCI line of products provides up to four sets of pulse and direction digital differential outputs to control a stepper motor.

Table 49 Stepper Drive Pulse and Direction Outputs

Category	SPiiPlus PCI	SPiiPlus PCI-LT	SPiiPlus PCI-ST
Quantity	PCI-2: 1(X) PCI-4: 2(X,Y) PCI-6: 3(X,Y,Z) PCI-8: 4(X,Y,Z,T)	PCI-LT-2: 1(X) PCI-LT-4: 2(X,Y) PCI-LT-6: 3(X,Y,Z) PCI-LT-8: 4(X,Y,Z,T)	PCI-ST-2: 2(X,Y) PCI-ST-4: 4(X,Y,Z,T)
Type	RS-485		
Maximum Current	10mA per output		
Breakout Box Connectors (option)	See **Section 8.3.2 - Pulse/Dir Connectors J9 to J12**		

5.2.5.1 Pulse - Direction Output

The following example illustrates the pulse – direction output interface for an X axis. **Figure 18** is an example (for the X axis) of a pulse – direction output to a stepper drive.

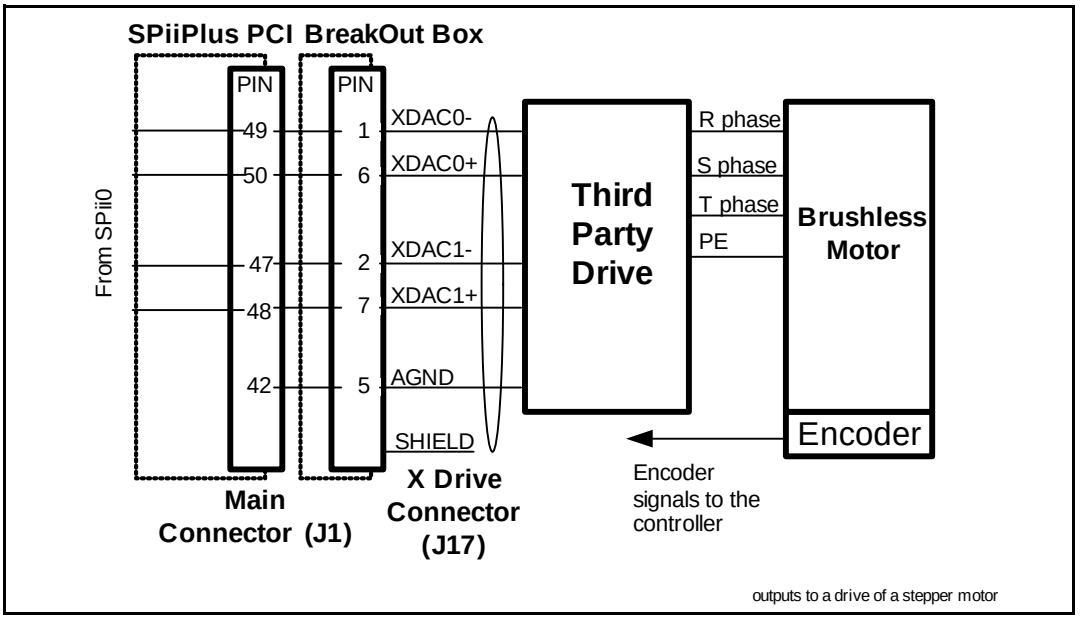


Figure 18 Differential Pulse-Direction Output Connection to a Stepper Motor Drive (X Axis)

5.2.6 Safety Inputs

The safety inputs of the SPiiPlus PCI line of products includes:

- One emergency stop (**ES**) input per controller
- Two limit inputs: left limit (LL) and right limit (RL), per axis.

5.2.6.1 Emergency Stop Input

Warning 	***The motion controller SHOULD NOT be used as the Emergency Stop handler of the entire system. The ES input only indicates to the controller that an emergency situation exists.***

Table 50 Emergency Stop Input

Category	Value
Quantity	One
Type	Opto-isolated, two-terminal. May be used as source (open emitter) or sink (open collector)
Corresponding ACSPL+ Variables	SFAULT.#ES
Maximum Propagation Delay	1msec
External Supply Voltage	5Vdc (±10%) or 24Vdc (±20%), detected automatically – as defined for the limit switches.
Input Current	2mA to 7mA
Breakout Box Connector (option)	See **Section 8.3.6 - Safety Connector J27 and J28**

Emergency Stop Input Example

The following examples illustrate the emergency stop input interface for an X axis. **Figure 19** is an example of a **source** emergency stop input.

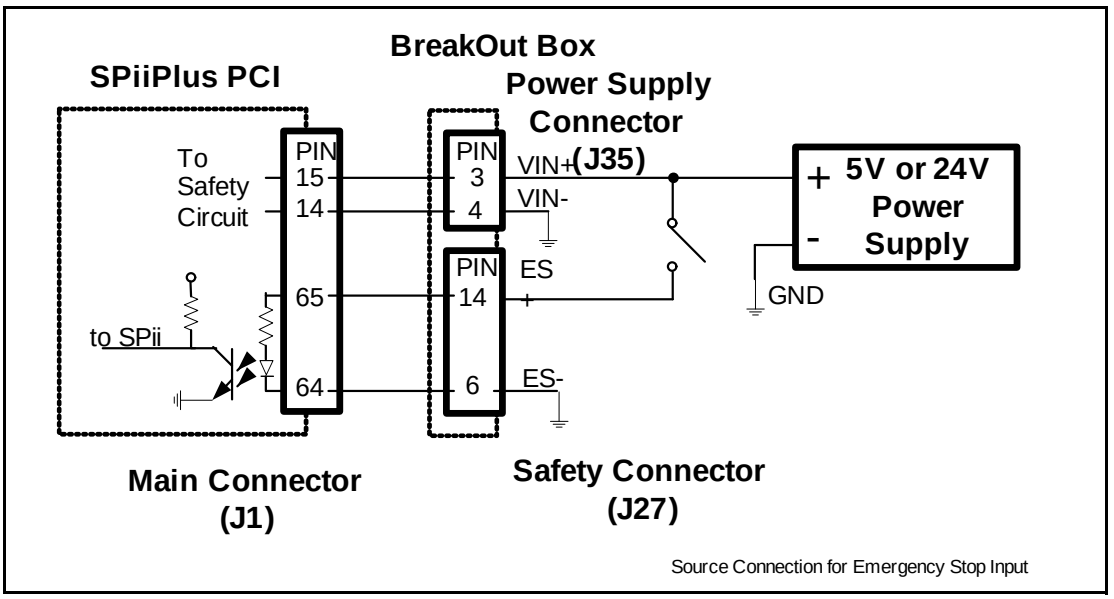


Figure 19 Source Connection for Emergency Stop Input

Figure 20 is an example of a **sink** emergency stop input

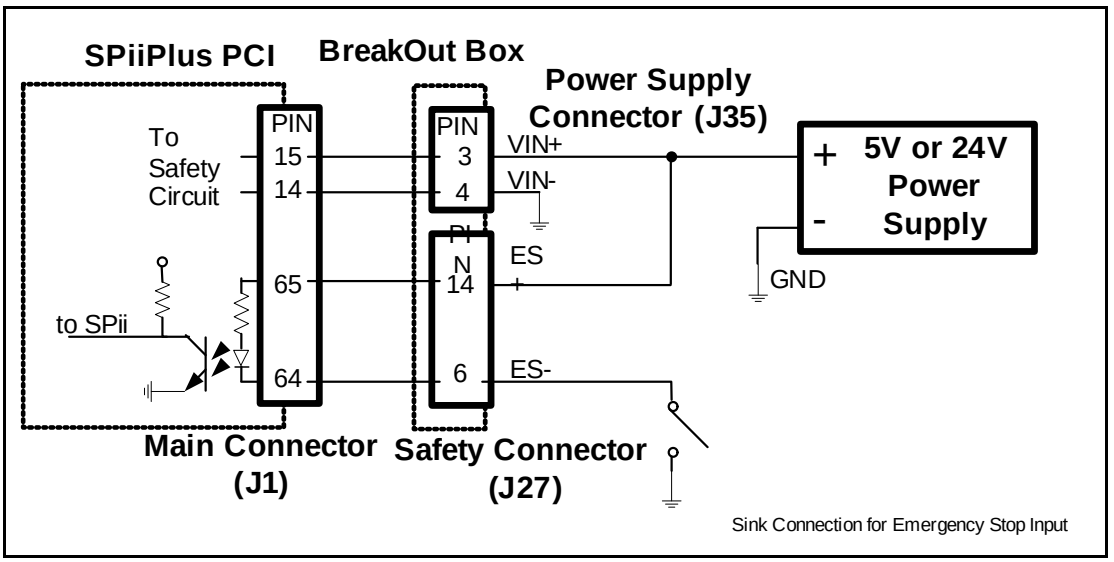


Figure 20 Sink Connection for Emergency Stop Input

5.2.6.2 Limit Inputs

Table 51 Limit Inputs

Category	Value
Quantity	One left limit and one right limit per axis
Type	Two terminal, source (open emitter) or sink (open collector), opto-isolated.
Corresponding ACSPL+ Variables	**<AXIS>_FAULT.#LL** and **<AXIS>_FAULT.#RL** (example: **X_FAULT.#LL**)
Maximum Propagation Delay	1msec
External Supply Voltage	5Vdc (±10%) or 24Vdc (±20%), detected automatically. Must be connected between the V_SUP_SFTY and V_RET_SFTY pins
Input Current	From 2mA to 7mA per input
Breakout Box Connectors (option)	See **Section 8.3.6 - Safety Connector J27 and J28**

Limit Input Examples

The following examples illustrate the limit input interface for an X axis. **Figure 21** is an example (for the X axis) of a **source-type switched** limit input

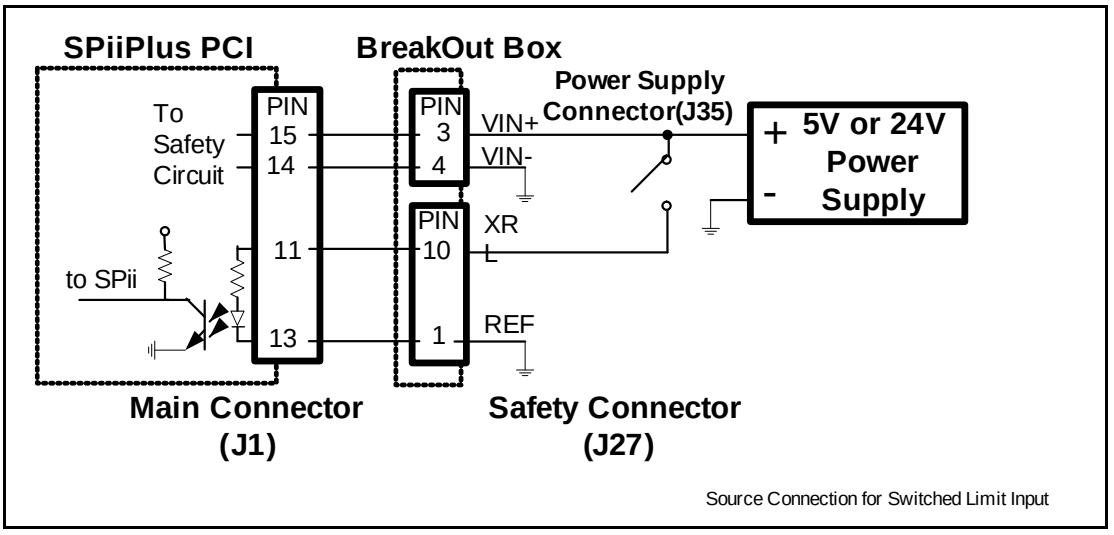


Figure 21 Source Connection for Switched Limit Input (X Axis Right Limit)

Figure 22 is an example (for the X axis) of a **source-type PNP** limit input.

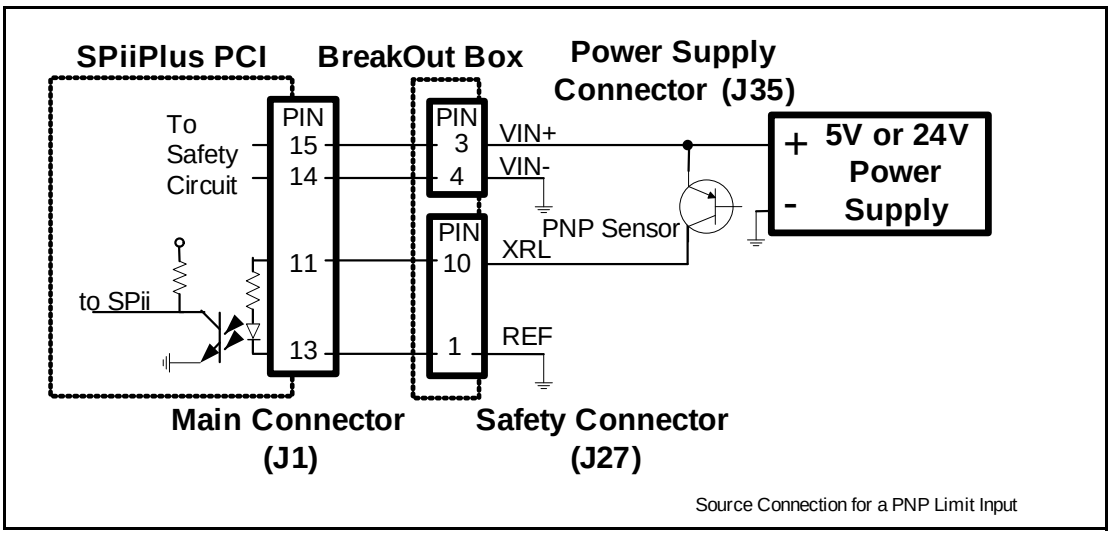


Figure 22 Source Connection for a PNP Limit Input (X Axis Right Limit)

Figure 23 is an example (for the X axis) of a **sink-type switched** limit input.

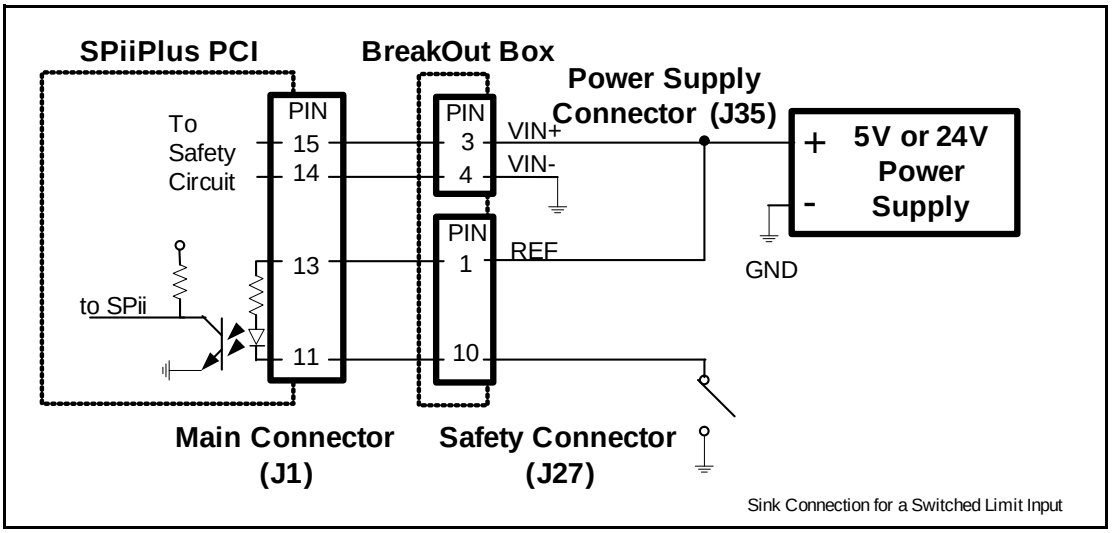


Figure 23 Sink Connection for a Switched Limit Input (X Axis Right Limit)

Figure 24 is an example (for the X axis) of a **sink-type NPN** limit input.

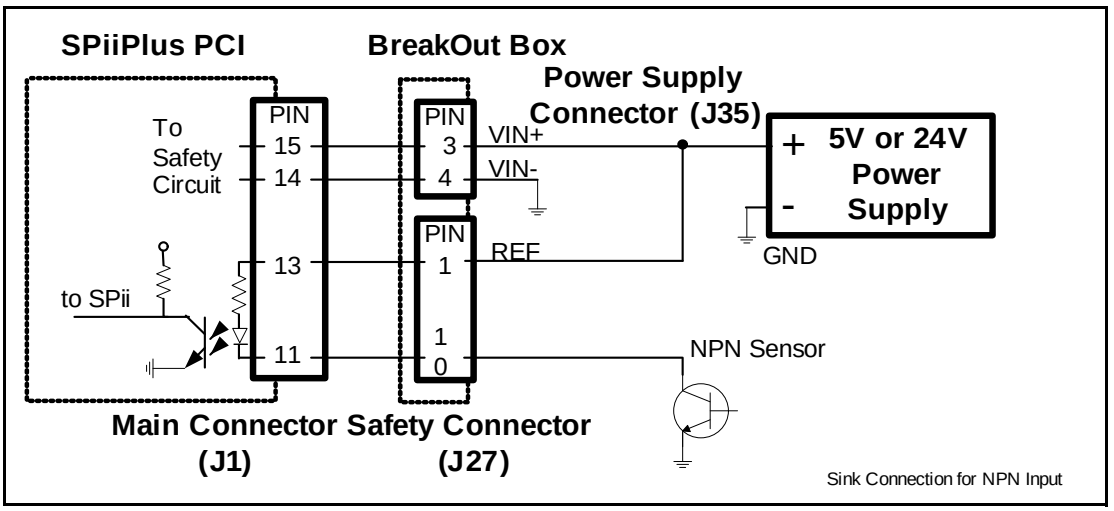


Figure 24 Sink Connection for NPN Input (X Axis Right Limit)

5.2.7 Digital Outputs/PEG Outputs

SPiiPlus PCI provides up to twelve fast digital outputs:

- Eight (OUT0.0 to OUT0.7) on the **Main Connector J1**.
- Four (OUT0.8 to OUT0.11) on the **HSSI & Additional Dedicated Outputs Connector J3**.

For details, see **Section 2.3 - I/O Configuration Options**. The digital outputs can be assigned for the following:

- General purpose digital output: total of twelve outputs.
- Mechanical brake logical digital outputs: for up to eight axes. See instructions in *SPiiPlus Setup Guide*, Axis Configuration and Setup, Mechanical Brake.
- PEG (Pulse Event Generation) for up to four outputs (SPiiPlus PCI-8, SPiiPlus PCI-LT-8 and SPiiPlus PCI-ST-4). The PEG pulse can be triggered at a precise position by Incremental or Random PEG commands – See PEG description in the *SPiiPlus ACSPL+ Programmer's Guide*.
- OUT0.8 to OUT0.11 PEG State – In SPiiPlus PCI only, four states for each of X and Y axes: total of up to eight outputs. When an output is configured as PEG State, the output state is set to on. When a PEG pulse is activated, the output state changes to off.– See PEG description in the *SPiiPlus ACSPL+ Programmer's Guide*.

Note	*The ASSIGNPEG command is used to assign the digital outputs for either PEG or general purpose (default) use. PEG affects the physical outputs but has no effect on the OUT variable. Refer to the SPiiPlus ACSPL+ Programmer's Guide.*

Table 52 Fast Digital Outputs/PEG

Category	Value
Quantity	Up to twelve, for details see, **Section 2.3 - I/O Configuration Options**. The fast digital outputs can be configured by software as PEG outputs or as general purpose outputs.
Type	Differential, RS-485, not isolated. (Requires 220ohm termination resistor.) The differential output state is: – **Off**: when the (+) is 0V and the (-) is inverted (5V) – **On**: when the (+) is 5V and (-) is inverted (0V). (The outputs may also be configured as single ended, see **Figure 26** In this case, they are TTL compatible.) When the controller firmware is not operational (for example, during powerup), the output states are not defined (tristate).
Associated ACSPL+ Functions	**peg_i** and **peg_r**. The fast output signal is generated with extremely small delay when the encoder position matches a predefined value. See PEG description in the *SPiiPlus ACSPL+ Programmer's Guide*.
Maximum Propagation Delay	< 0.1µsec
Breakout Box Connector (option)	**Section 8.3.8 - PEG & Digital Outputs Connector J30**

Table 53 Outputs Used for PEG Pulse and PEG State*

Axis	PEG Pulse	PEG state 0	PEG state 1	PEG state 2	PEG state 3
X	OUT3	OUT0	OUT1	OUT2	OUT8
Y	OUT7	OUT4	OUT5	OUT6	OUT9
Z	OUT10	-	-	-	-
T	OUT11	-	-	-	-

Note	
	*PEG state outputs are supported only by SPiiPlus PCI.*

5.2.7.1 PEG Output

Figure 25 is an example (for the X axis) of a differential PEG digital output.

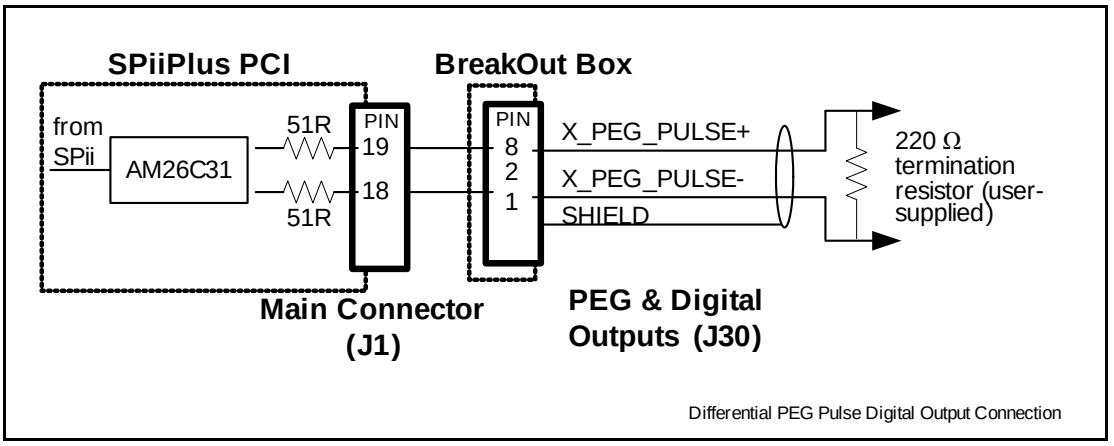


Figure 25 Differential PEG Pulse Digital Output Connection (X Axis)

Caution	
	***A user-supplied 220Ω resistor must be installed between the differential signals of the PEG outputs.***

Figure 26 is an example (for the X axis) of a single-ended **general purpose** digital output. The output is TTL compatible.

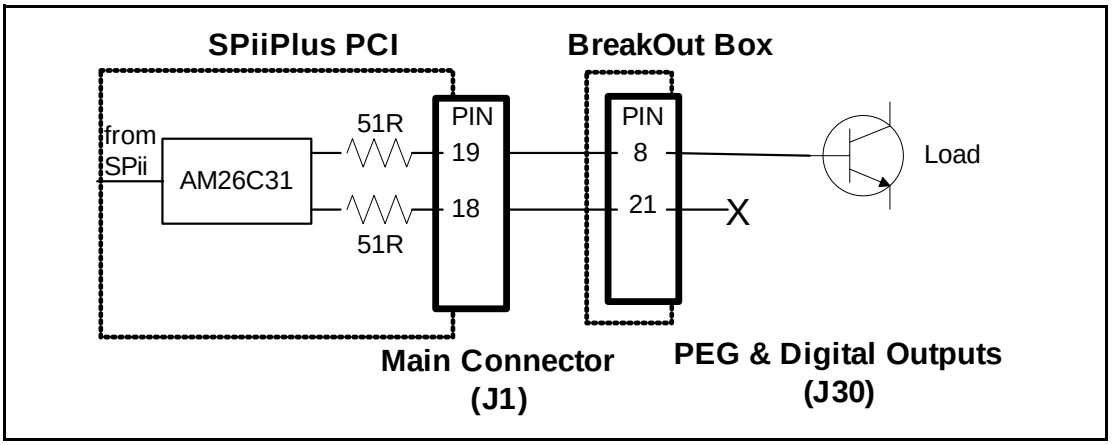


Figure 26 Single-Ended General Purpose Digital Output Connection (X Axis)

Caution	
	***If the output is configured as single-ended, the unused complementary pin MUST NOT be connected to ground.***

5.2.8 Digital Inputs/Registration MARK Inputs

The SPiiPlus PCI line of products provide up to eight fast digital inputs. For details, see **"I/O Configuration Options" on Page 7**. The digital inputs can be used for:

- General purpose digital inputs.
- Fast registration inputs (**MARK**), two per **X**, **Y**, **Z**, and **T**-axis

Encoder Registration (**MARK**) inputs shares the same pins as the general-purpose inputs. Encoder latching occurs on the falling edge of input signal (input changes state from **ON** to **OFF** state).

Table 54 Fast Digital Inputs (MARK)

Category	Value
Quantity	See, **Section 2.3 - I/O Configuration Options**.
Type	Differential, RS-485, not isolated. An input's state is: undefined: when there is no voltage on either the (+) or (-). **on**: when the (+) is 5V and the (-) is 0V. **off**: when the (+) is 0V and the (-) is 5V. (The inputs may also be configured as single ended see: **Figure 28**)
Interface	TI AM26C31 line receiver
MARK Input Voltage	5Vdc (±10%) only
Associated ACSPL+ Variables	**MARK and M2ARK**. The fast input signal latches the current encoder position to the associated variable with extremely small delay. See the *SPiiPlus ACSPL+ Programmer's Guide*.
Maximum Propagation Delay	< 0.1µsec
Breakout Box Connector (option)	See: **Section 8.3.7 - MARK/Digital Inputs Connector J29**

The inputs can be used for general purposes or for MARK with no software reconfiguration required.

Warning	
	***When an input is not connected, the state is undefined!***

5.2.8.1 Digital Input

The following examples illustrate the digital input interface for an X axis. **Figure 27** is an example (for the X axis) of a **differential** digital input connection

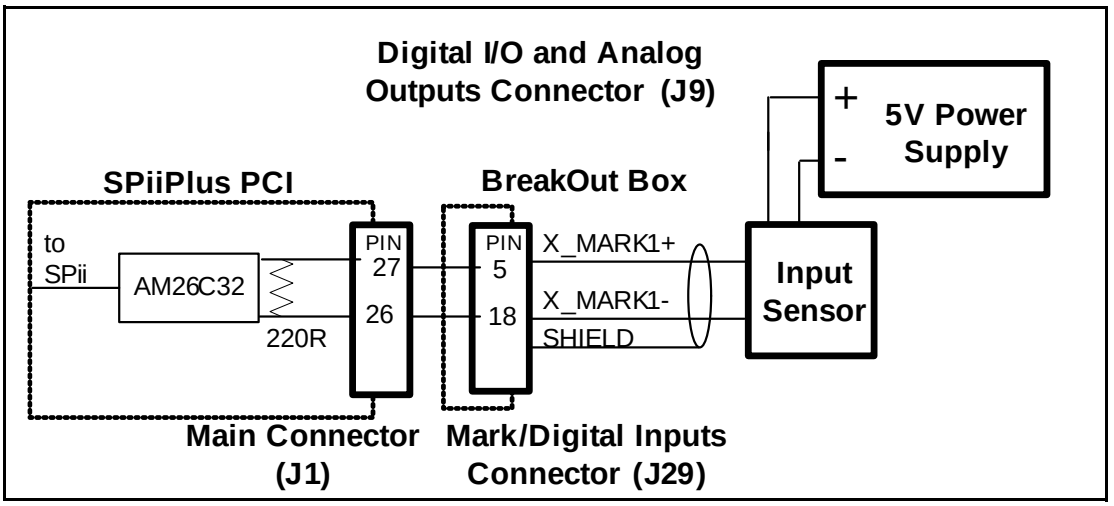


Figure 27 Differential Connection for MARK1 Input (X Axis)

Figure 28 is an example (for the X axis) of a **single-ended** digital input connection. A voltage divider is used as a source of reference voltage.

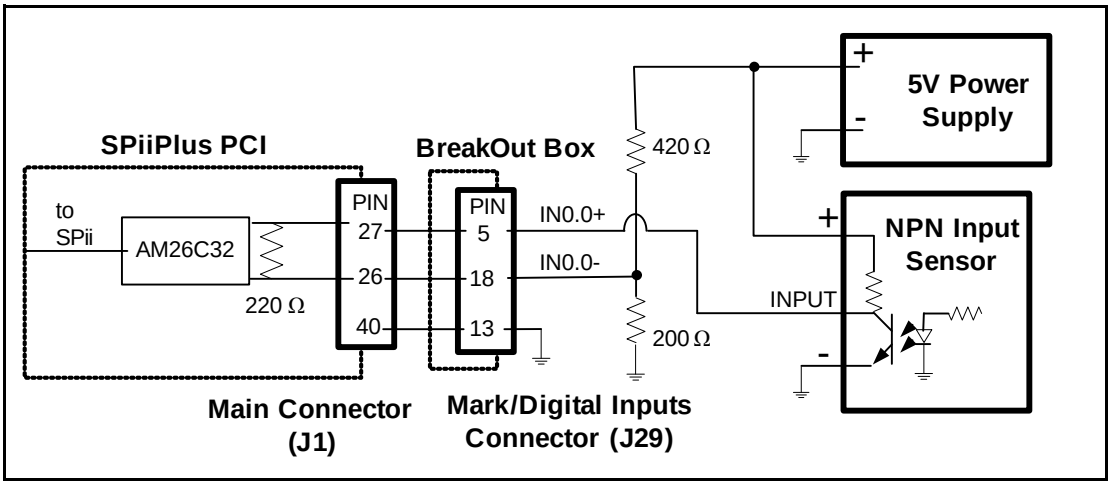


Figure 28 Single-Ended Connection for a Digital Input (Input 0)

Figure 29 is an example of a **switched** digital input connection.

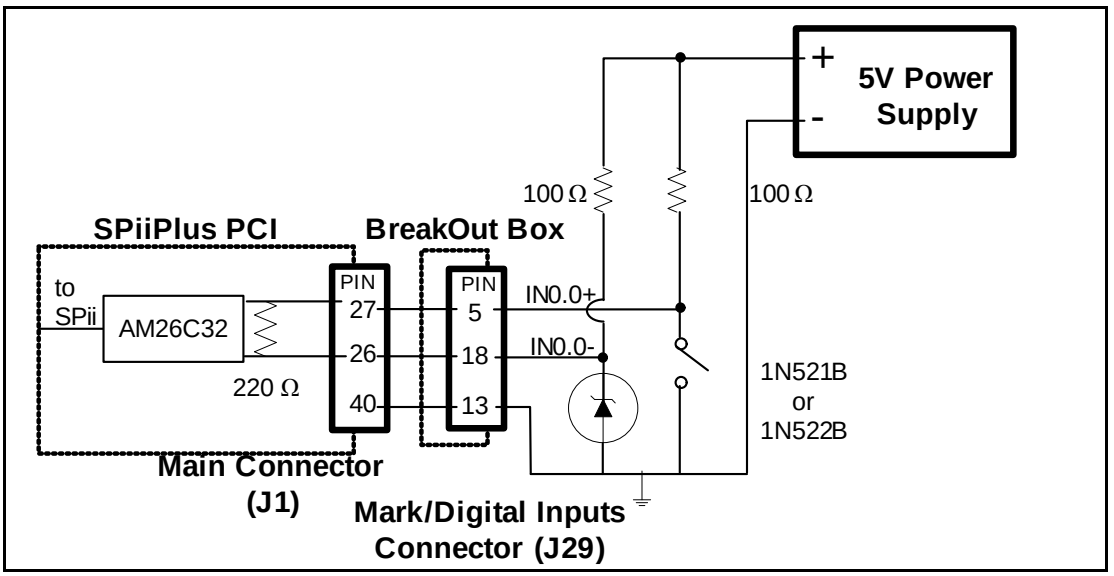


Figure 29 Switched Connection for MARK1 Input (X Axis)

5.3 Analog/SIN-COS Encoder Inputs Connector J2

Note	
	*Only SPiiPlus PCI supports Sin-Cos encoder inputs.*

Table 55 Analog/SIN-COS Encoder Inputs Connector J2 - Components

Component	Description
Jack on SPiiPlus PCI **Jack on SPiiPlus PCI-LT**	Type: dual row pin header, 50 pin, male
Plug from System	Type: dual row pin header, 50 pin, female
Recommended Wires	AWG22 wires **with shielding**. Twisted pair cable for each differential signal (+ and -).

Table 56 Analog/SIN-COS Inputs- Specification

Element	Description
Quantity	SPiiPlus PCI-2: 4 inputs (2 encoders) SPiiPlus PCI-4: 8 inputs (4 encoders) SPiiPlus PCI-6: 12 inputs (6 encoders) SPiiPlus PCI-8: 16 inputs (8 encoders) SPiiPlus PCI-LT-2: 4 inputs (general purpose only) SPiiPlus PCI-LT-4: 4 inputs (general purpose only) SPiiPlus PCI-LT-6: 4 inputs (general purpose only) SPiiPlus PCI-LT-8: 4 inputs (general purpose only) SPiiPlus PCI-ST: N.A
Inputs per Axis	2. See **Table 57.**
Input Assignment	SPiiPlus PCI: General purpose or joystick or SIN-COS encoder input. SPiiPlus PCI-LT: General purpose or joystick only
– Joystick	Potentiometer output must be connected to **AIN#+** and return supply must be connected to **AIN#-.** See **Section 5.3.2 - Joystick Input Interface**
– SIN-COS encoder	Optional feature that takes both of an axis's analog inputs and requires that the appropriate jumpers be installed.
Jumper Pairs	When installed, the inputs accept the SIN-COS encoder signal and terminate the input at 120 ohms. When removed, inputs carry general purpose signal or joystick signal. See **Table 58**.
– Across analog input (Ain#+ to Ain#- where # indicates an input number)	>1MΩ
– Between analog input and ground	Approximately 50KΩ
– SIN-COS input	120 ohm (termination resistor)
Input type	1V ptp, differential
ADC resolution	14bit
ACSPL+ standard variable	**AIN**. Example: **AIN7** represents analog input 7.
– Variable range	-8192 to 8191
Breakout Box Connectors (option)	Analog inputs: J26 Sin-cos encoders: J13 to J16

Model	
	*Pins in connector J2 apply according to the axes and I/Os supported by the product. For example, pin 7 applies to SPiiPlus PCI-2/4/6/8 only.*

Table 57 Analog/SIN-COS Encoder Inputs Connector J2 - Pinout

Pin	Signal	Pin	Signal
1	X-SIN+ / AIN0+	**2**	X-SIN- / AIN0-
3	X-COS+ / AIN1+	**4**	X-COS- / AIN1-
5	X-INDEX+	**6**	X-INDEX-
7	A-SIN+ / AIN2+	**8**	A-SIN- / AIN2-
9	A-COS+ / AIN3+	**10**	A-COS- / AIN3-
11	A-INDEX+	**12**	A-INDEX-
13	AGND	**14**	Y-SIN- / AIN4-
15	Y-SIN+ / AIN4+	**16**	Y-COS- / AIN5-
17	Y-COS+ / AIN5+	**18**	Y-INDEX-
19	Y-INDEX+	**20**	B-SIN- / AIN6-
21	B-SIN+ / AIN6+	**22**	B-COS- / AIN7-
23	B-COS+ / AIN7+	**24**	B-INDEX-
25	B-INDEX+	**26**	Z-SIN- / AIN8-
27	Z-SIN+ / AIN8+	**28**	Z-COS- / AIN9-
29	Z-COS+ / AIN9+	**30**	Z-INDEX-
31	Z-INDEX+	**32**	C-SIN- /AIN10-
33	C-SIN+ / AIN10+	**34**	C-COS- / AIN11-
35	C-COS+ / AIN11+	**36**	C-INDEX-
37	C-INDEX+	**38**	AGND
39	T-SIN+ / AIN12+	**40**	T-SIN- / AIN12-
41	T-COS+ / AIN13+	**42**	T-COS- / AIN13-
43	T-INDEX+	**44**	T-INDEX-
45	D-SIN+ / AIN14+	**46**	D-SIN- / AIN14-
47	D-COS+ / AIN15+	**48**	D-COS- / AIN15-
49	D-INDEX+	**50**	D-INDEX-

5.3.1 Sin-Cos Encoder/Analog Inputs

Model	
	*This section applies only to SPiiPlus PCI-2-4-6-8.*

The SPiiPlus PCI is equipped with up to 16 differential analog inputs. These 0.5 to (-0.5V) differential inputs can be used to interface with a Sin-Cos encoder (with 1Vp-p analog output amplitude) or for general purpose usage.

Note	
	*Sin-Cos encoder support is NOT provided as a standard feature. Up to four/eight sin-cos encoder interfaces can be specified in the product purchase order. The number of enabled sin-cos multipliers is written on a PAL located at the back side of the SPiiPlus PCI where"M1" means one multiplier, "M2" means two multipliers, etc.*

Caution	
	***When working with a Sin-Cos encoder, two jumpers on the SPiiPlus PCI board must be configured.***

Table 58 describes the jumper settings and the associated input which carries the Sin-Cos encoder input signal. When the jumper is removed, the input carries the analog input signal.

Table 58 Analog and Sin-Cos Encoder Inputs and Their Jumpers

Axis	Analog Input	Sin-Cos Encoder Input	Select Sin-Cos Input by Installing Jumper
X	AIN0, AIN1	X-SIN, X-COS	JP4, JP5
Y	AIN4, AIN5	Y-SIN, Y-COS	JP8, JP9
Z	AIN8, AIN9	Z-SIN, Z-COS	JP12, JP13
T	AIN12, AIN13	T-SIN, T-COS	JP16, JP17
A	AIN2, AIN3	A-SIN, A-COS	JP6, JP7

Table 58 Analog and Sin-Cos Encoder Inputs and Their Jumpers

Axis	Analog Input	Sin-Cos Encoder Input	Select Sin-Cos Input by Installing Jumper
B	AIN6, AIN7	B-SIN, B-COS	JP10, JP11
C	AIN10, AIN11	C-SIN, C-COS	JP14, JP15
D	AIN14, AIN15	D-SIN, D-COS	JP18, JP19

Table 59 Sin-Cos Encoder Input

Category	Value
Quantity	Up to eight interfaces, each comprising two encoder signals and one index signal
Type	1V ptp differential signals
Input frequency	Up to 250K sine or cosine periods per second
Digital representation of input voltage (AIN variable)	–8192…+8191
A/D conversion resolution	14 bit
Corresponding ACSPL+ Variables	AIN0... AIN5

5.3.1.1 Sin-Cos Encoder Input

Figure 30 illustrates the Sin-Cos encoder interface for an X axis.

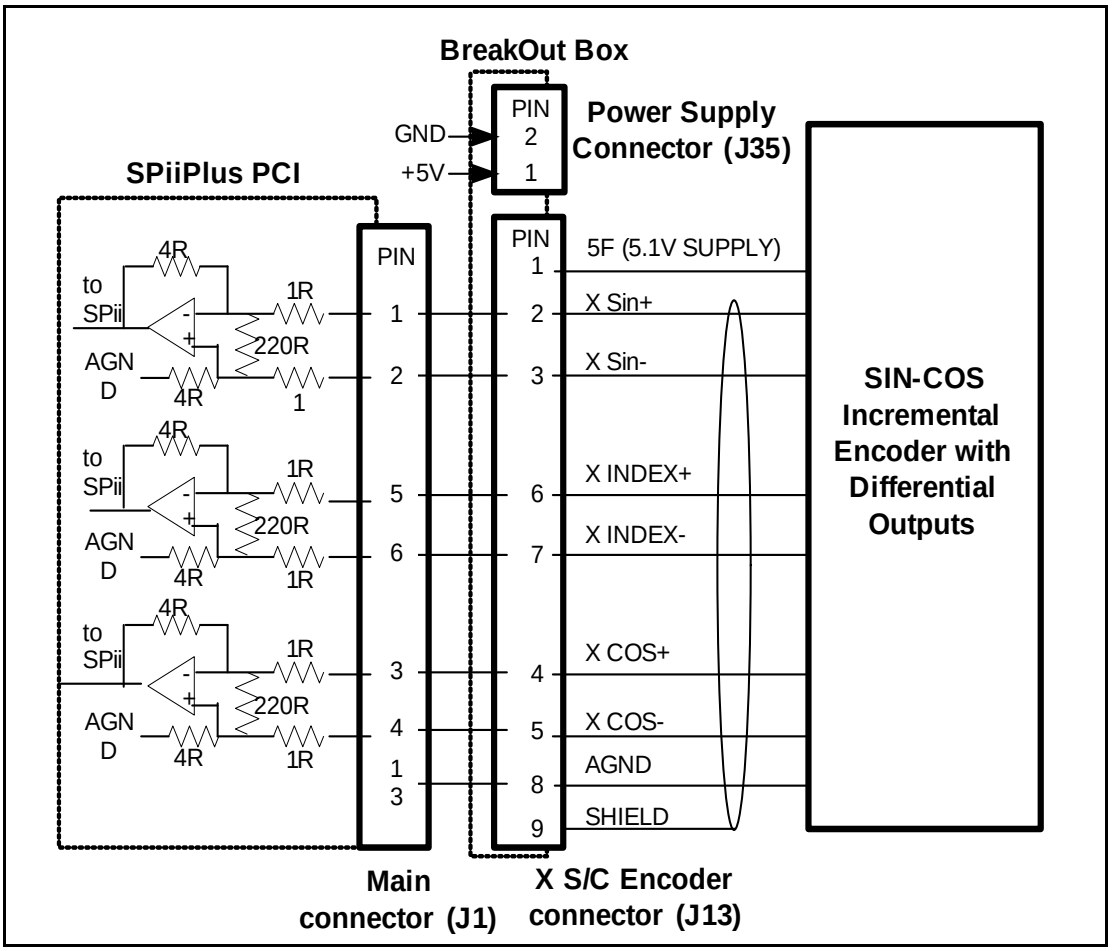


Figure 30 Sin-Cos Encoder Interface

5.3.2 Joystick Input Interface

Model	
	*This section applies to SPiiPlus PCI and SPiiPlus PCI-LT only.*

To configure the differential analog inputs to work with 10V to -10V, 75kΩ resistors are connected in series to the analog inputs pins as **Figure 31** illustrates.

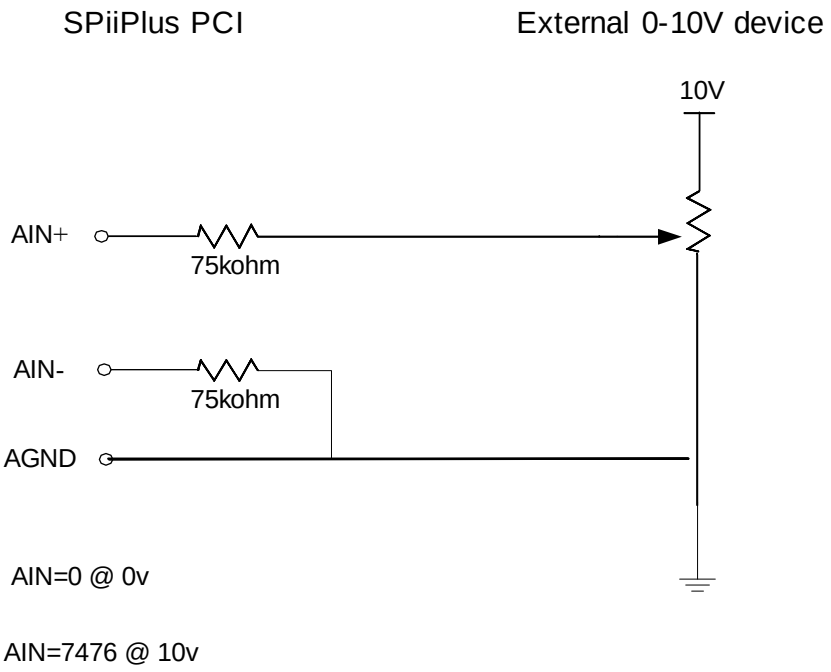


Figure 31 Analog Inputs with 10V ptp Configuration

Figure 32 illustrates the joystick interface.

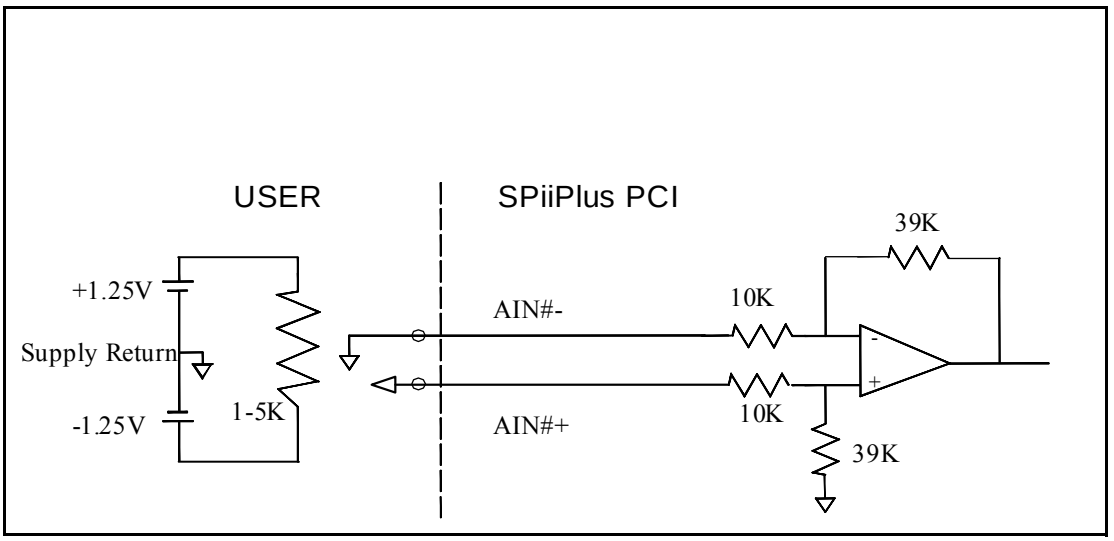


Figure 32 Joystick Connection

5.4 HSSI & Additional Dedicated Outputs Connector J3

The **J3** connector pins 1 through 22 are for the HSSI interface and pins 22 through 30 are dedicated digital outputs.

Caution	
	***The relevance of analog and digital output pins is product and model dependent. The initial logic state of the analog and digital pins that are inactive is undefined. They may carry an electrical potential.***

Table 60 HSSI & Additional Dedicated Outputs Connector J3- Components

Component	Description
Connector on SPiiPlus PCI products	30-pin, male, dual row header (Pin 1 is marked on the PCB)
Plug from System	30-pin, female, dual row header
Recommended Wires	Standard flat cable

HSSI and Additional Digital Outputs

Category	Value
Quantity: HSSI	SPiiPlus PCI-2: 1 channel SPiiPlus PCI-4: 2 channels SPiiPlus PCI-6: 3 channels SPiiPlus PCI-8: 4 channels SPiiPlus PCI-LT-2-4-6-8: 1 channel SPiiPlus PCI-ST-2-4: 1 channel
Quantity	• Up to eight (OUT0.0 to OUT0.7) on J1, see **Section 5.2 - Main Connector J1**. • Up to four (OUT0.8 to OUT0.11) on J3, see **Section 5.4 - HSSI & Additional Dedicated Outputs Connector J3**.
Breakout Box Connectors (option)	HSSI: J9 to 12 Digital outputs: J30

Model	*Pins in connector J3 apply according to the axes and I/Os supported by the product. For example, pin 16 applies to SPiiPlus PCI-8 only.*

HSSI & Additional Dedicated Outputs Connector J3 – Pinout

Pin	Signal / SW Comm.	Pin	Signal / SW Comm.	Description
1	XSER_DI+	**2**	XSER_DI-	Ground (pin 22) is common to both HSSI and the dedicated digital outputs
3	YSER_DI+	**4**	YSER_DI-	
5	ZSER_DI+	**6**	ZSER_DI-	
7	TSER_DI+	**8**	TSER_DI-	
9	GND	**10**	XSER_DO-	
11	XSER_DO+	**12**	YSER_DO-	
13	YSER_DO+	**14**	ZSER_DO-	
15	ZSER_DO+	**16**	TSER_DO-	
17	TSER_DO+	**18**	CONTROL1-	
19	CONTROL1+	**20**	CONTROL2-	
21	CONTROL2+	**22**	GND	

HSSI & Additional Dedicated Outputs Connector J3 – Pinout

Pin	Signal / SW Comm.	Pin	Signal / SW Comm.	Description
23	XPEG_STATE3+ / OUT0.8+	**24**	XPEG_STATE3- / OUT0.8-	PEG or general purpose outputs
25	YPEG_STATE3+ / OUT0.9+	**26**	YPEG_STATE3- / OUT0.9-	
27	ZPEG_PULSE+ / OUT0.10+	**28**	ZPEG_PULSE- / OUT0.10-	
29	TPEG_PULSE+ / OUT0.11+	**30**	TPEG_PULSE- / OUT0.11-	

5.4.1 HSSI Signals

Table 61 HSSI Signal Description

Symbol	Description
SER_DI	HSSI serial data input
SER_DO	HSSI serial data output
CONTROL	Composite signal that includes START and SER_CLK (data clock signal)
START	Synchronization signal for data transfer
SER_CLK	Data clock signal

5.4.2 Dual Purpose Digital Output Signals

The dual purpose digital outputs, see **Section 5.2.7 - Digital Outputs/PEG Outputs**, operate via pins 22 through 30 on the **J3** connector.

- Quantity: 4 (can be assigned for either PEG or general purpose use)
- Output type: Differential, RS-422

5.5 Manufacturing and Testing Connector J4

Warning	
	***The J4 connector is used for manufacturing and testing purposes only. Do not connect anything to this connector.***

5.6 JTAG Connector J5

Warning	
	**The J5 JTAG connector is used for manufacturing and testing purposes only. Do not connect anything to this connector.**

5.7 Servo Interrupt Connector J6

Warning	
	**The J6 Servo Interrupt connector is reserved for future enhancements. Do not connect anything to this connector.**

5.8 External Power Supply Connector J7

The **J7** connector is used for standalone operation only when connecting the controller outside a PC.

Table 62 External Power Supply Connector J7- Components

Component	Description
Jack on SPiiPlus PCI Jack on SPiiPlus PCI-LT Jack on SpiiPlus PCI-ST	JST™ B4B-EH-A
Plug from System	JST EHR-4 with contacts SEH-001T-P0.6
Recommended Wires	Use 22-AWG# wire

Note	
	*When installed into a PC host, the controller is powered via the PCI Bus. In this case the J7 connector is NOT in use.*

Table 63 External Power Supply Connector J7 - Pinout

J7 Pin	Cable Color	Signal (consumption)
1	Red	+5V (3.5A)
2	Green	+12V (250mA)

Table 63 External Power Supply Connector J7 - Pinout

J7 Pin	Cable Color	Signal (consumption)
3	White	-12V (250mA)
4	Black	GND

Caution	
	***The J7 connector should supply the power for the SPiiPlus controller only. Power supply for encoders and safety switches must be provided separately by the user via the J35 connector of the breakout box or directly to the encoder.***

5.9 Manufacturing and Testing Jumpers JP1 and JP3

Warning	
	***Jumpers JP1 and JP3 are used for manufacturing and testing purposes only. Do not change these jumper setting.***

5.10 Recovery Mode Jumper JP2

Warning	
	***JP2 is by default not installed. Do not set JP2 unless instructed to do so by the SPiiPlus Emergency Wizard during a firmware recovery. The controller firmware is disabled when JP2 is set.***

Figure 33 illustrates the location of JP2.

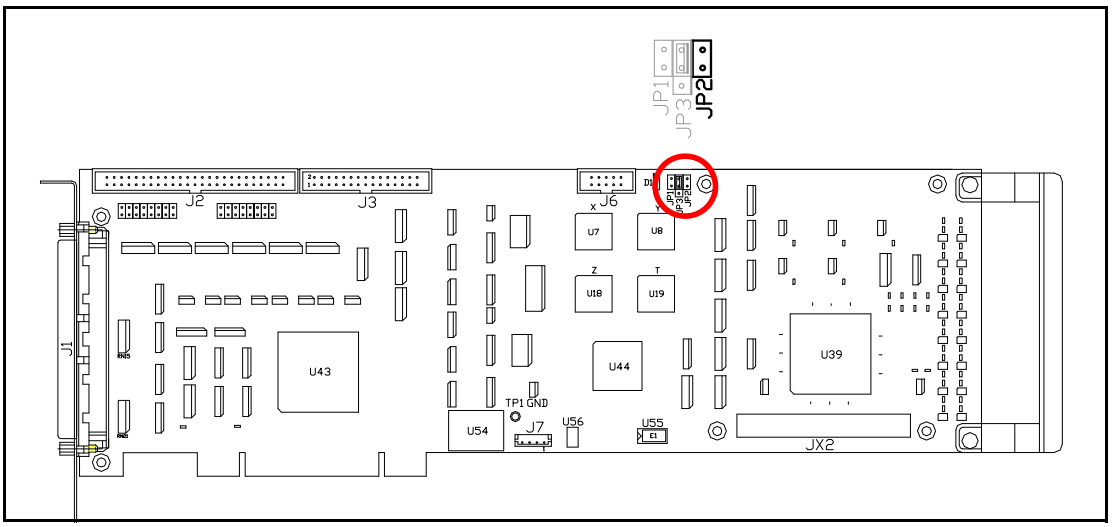


Figure 33 J2 – Recovery Mode Jumper

5.11 LED Indicator

Table 64 LED Indicators

LED Indicator	Description
MP_ON	Green LED. After power is turned on (about 30sec), the MPU_ON LED flickers and then remains green, indicating that the controller is functioning properly. During normal operation the LED may flicker or remain green.

6 Communication Interfaces

The SPiiPlus PCI, SPiiPlus PCI-LT and the SPiiPlus-ST provide the communication options described in **Table 65**:

Table 65 Communication Options

Connection Type	Required Cable	SPiiPlus PCI
Simulator	None	N.A
PCI Bus	None	N.A
Serial RS-232	Null-Modem cable	Supplied with SPiiPlus PCI products, see **Section 2.5.2 - Interface Cables**.
Serial RS-422	Null-Modem cable	Supplied with SPiiPlus PCI products, see **Section 2.5.2 - Interface Cables**.
Ethernet Network	10/100BASE-T Path-Through cable	Not supplied. Use a standard LAN Path Through cable
Ethernet Point-to-Point	10/100BASE-T Crossover cable	Not supplied. Use a standard LAN Crossover cable

6.1 Serial RS-232 Communication

The SPiiPlus PCI products include two COM ports combined on one dual-row 20-pin header where COM1 is pins 1 to 10 and COM2 is pins 11 to 20. **Figure 34** illustrates the location of the COM ports header on the MPU. COM1 is for RS-232 only and COM2 is for RS-232 or RS-422.

ACS Motion Control supplies a 37 cm (14.1 inch) communication cable. One side of this cable plugs into the 20-pin dual row MPU COM port header where COM1 is pins 1 to 10 and COM2 is pins 11 to 20. The other side has two 9-pin D-sub connectors for COM1 and COM2.**Table 66** describes the pin out of the 20-pin COM port header on the MPU. **Table 67** and **Figure 35** describe the pin out the two 9-pin D-sub connectors.

To use the RS-232 communication cable, set jumper JP1 as follows:

- Pins 5 & 6 are connected.

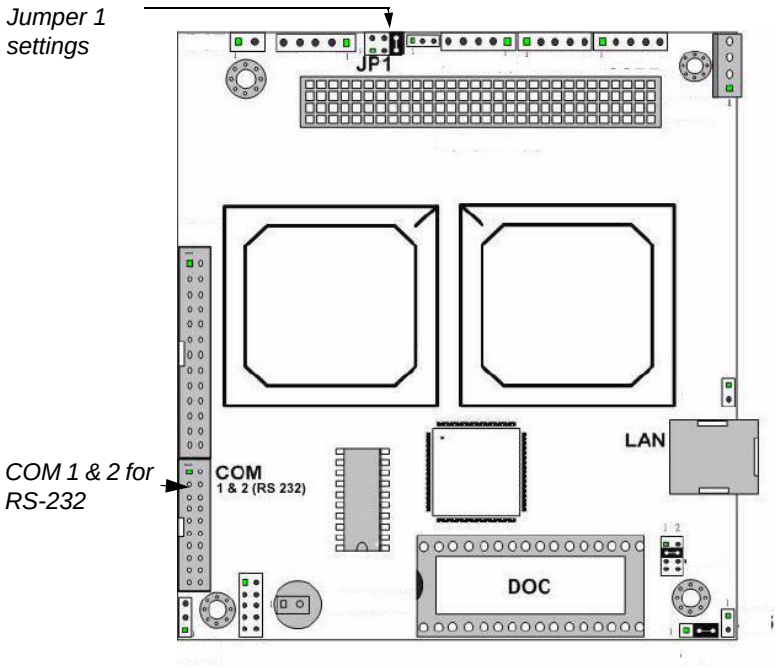


Figure 34 COM ports header and Jumper 1 settings

Note	
	*For a detailed description of serial communication setup see the SPiiPlus Setup Guide.*

Table 66 20-pin COM Port Header Pin Out- MPU

Pin	Name	Description
1 (or 11)	DCD	Data Carrier Detect
2 (or 12)	DSR	Data Set Ready
3 (or 13)	RX232	RS-232 receive signal
4 (or 14)	RTS	Request To Send
5 (or 15)	TX232	RS-232 transmit signal
6 (or 16)	CTS	Clear To Send
7 (or 17)	DTR	Data Terminal Ready
8 (or 18)	RI	Ring Indicator
9 (or 19)	GND	RS-232 ground
10 (or 20)	NC	Not Connected

Table 67 9-pin D-sub COM Port Cable Pin Out

Pin	Name	Description
2	TX232	RS-232 transmit signal
3	RX232	RS-232 receive signal
5	GND	Ground

Implement a serial communication connection illustrated in **Figure 35** as follows:

1. The PC transmit (**Tx**) pin 3 is wired to the controller's receive (**Rx**) pin 2
2. The PC receive (**Rx**) pin 2 is wired to the controller's transmit (**Tx**) pin 3
3. The ground (**GND**) is properly connected by pin 5 in both sides.

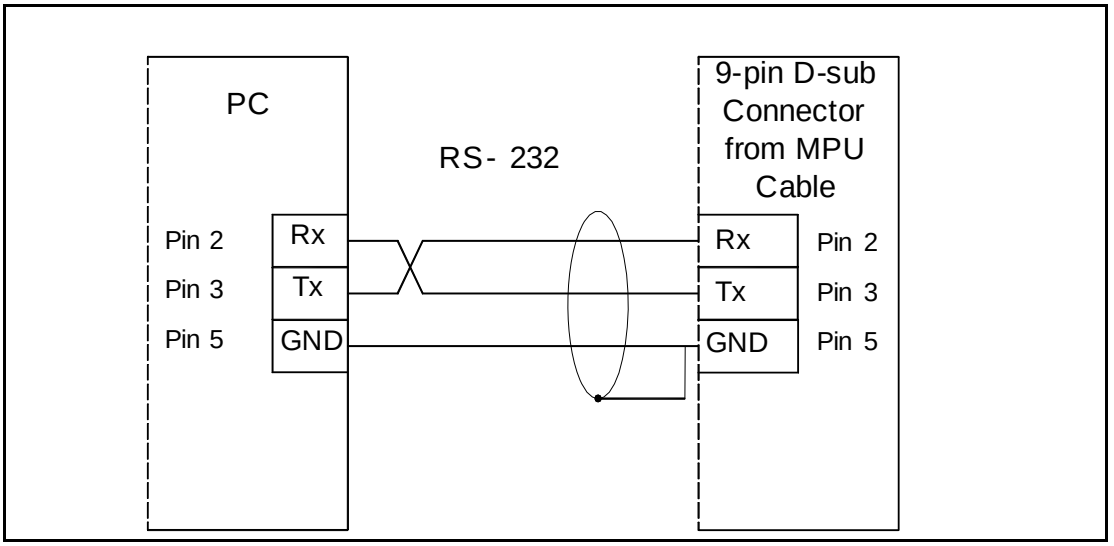


Figure 35 RS-232 Rx/Tx Connection

6.2 COM2 RS-422 Serial Communication

By default COM2 is configured for RS-232.

COM2 may be configured for RS-422. **Figure 36** illustrates the location of COM2 port header on the MPU and the settings of the jumpers. The RS-422 cable is not supplied with the controller.

You can purchase separately a 36cm (14.1 inch) RS-422 communication cable - see **Section 2.5.2 - Interface Cables**. One side of this cable plugs into the COM2 port on the MPU. The other side has a D-sub connector, 9-pin, male for COM2. **Table 68** describe the pin out of the 9-pin D-connector.

To use the RS-422 communication cable, set Jumper JP1 & JP2 as follows:

- JP1 - Pins 1 & 2 are connected.
- JP2 - Pins 2 & 3 are connected.

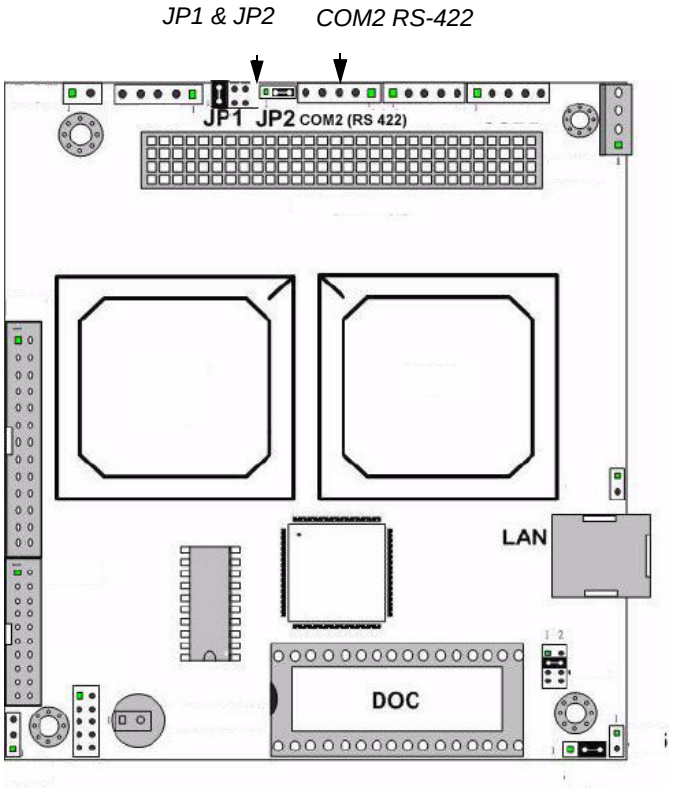


Figure 36 COM2 Port and Jumpers

Note	*For a detailed description of serial communication setup see the SPiiPlus Setup Guide.*

Table 68 COM2 Port RS-422 Pin Out

Pin	Name	Description
1	TX+	RS-422 transmit signal
3	TX-	RS-422 inverted transmit signal
2	RX-	RS-422 inverted receive signal
4	RX+	RS-422 receive signal
5	5 Volt (referenced to GND)	

6.3 Ethernet Network Communication

The SPiiPlus PCI products are equipped with a 10/100Mbit/sec Ethernet/LAN (10/100BASE-T) network interface. The Ethernet interface includes one RJ-45 type connector.

If your PC host is already connected to a local Ethernet network, you only need to configure the controller and to connect it to the same network.

6.3.1 Ethernet Physical Connection

The Ethernet connection is made through a standard RJ-45 connector.

- For Network connection: use a FTP, category 5, Ethernet **Path-Through** cable.
- For Network connection: use a FTP, category 5, Ethernet **Crossover** cable.

Note	*For a detailed procedure to establish Ethernet communication see the SPiiPlus Setup Guide.*

7 SPiiPlus PCI Bracket

The SPiiPlus PCI Bracket is an accessory that provides the option to install the SPiiPlus PCI on a metal bracket while using it as a standalone controller (out of a PC) during the integration and development phases of the user's application.

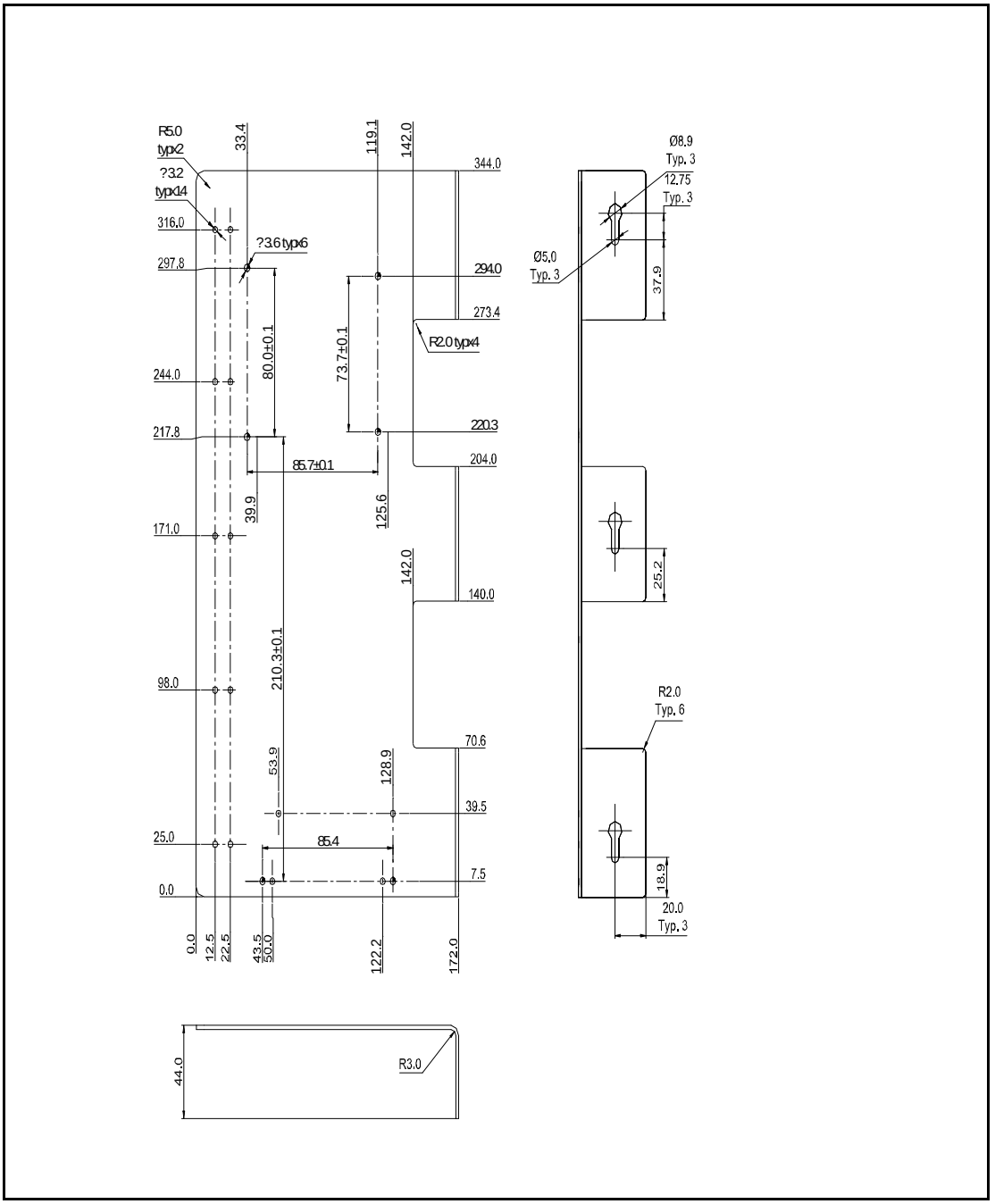


Figure 37 SPiiPlus PCI Bracket

7.1 SPiiPlus PCI-Bracket Installation

1. Remove nuts (connected with stand-off spacers that holds the MPU) the from the back side of the controller card.
2. Screw supplied stand-off spacers with washers where previous nuts were removed.
3. Insert screws with washers through the pre drilled, reinforced holes on the BRACKET.
4. Screw stand-off spacers with washers to the inserted screws on the back side of the BRACKET.
5. Attach nuts with washers to the bottom side of the mounting bracket.
6. Connect the open ends of the Power Supply Cable (part of the SPiiPlus PCI-INT) to the external power supply connector (J7) –see **Section 5.8 - External Power Supply Connector J7**.

8 SPiiPlus PCI Breakout Box Connections

The SPiiPlus Breakout box is a part of the optional SPiiPlus PCI-INT interface kit.

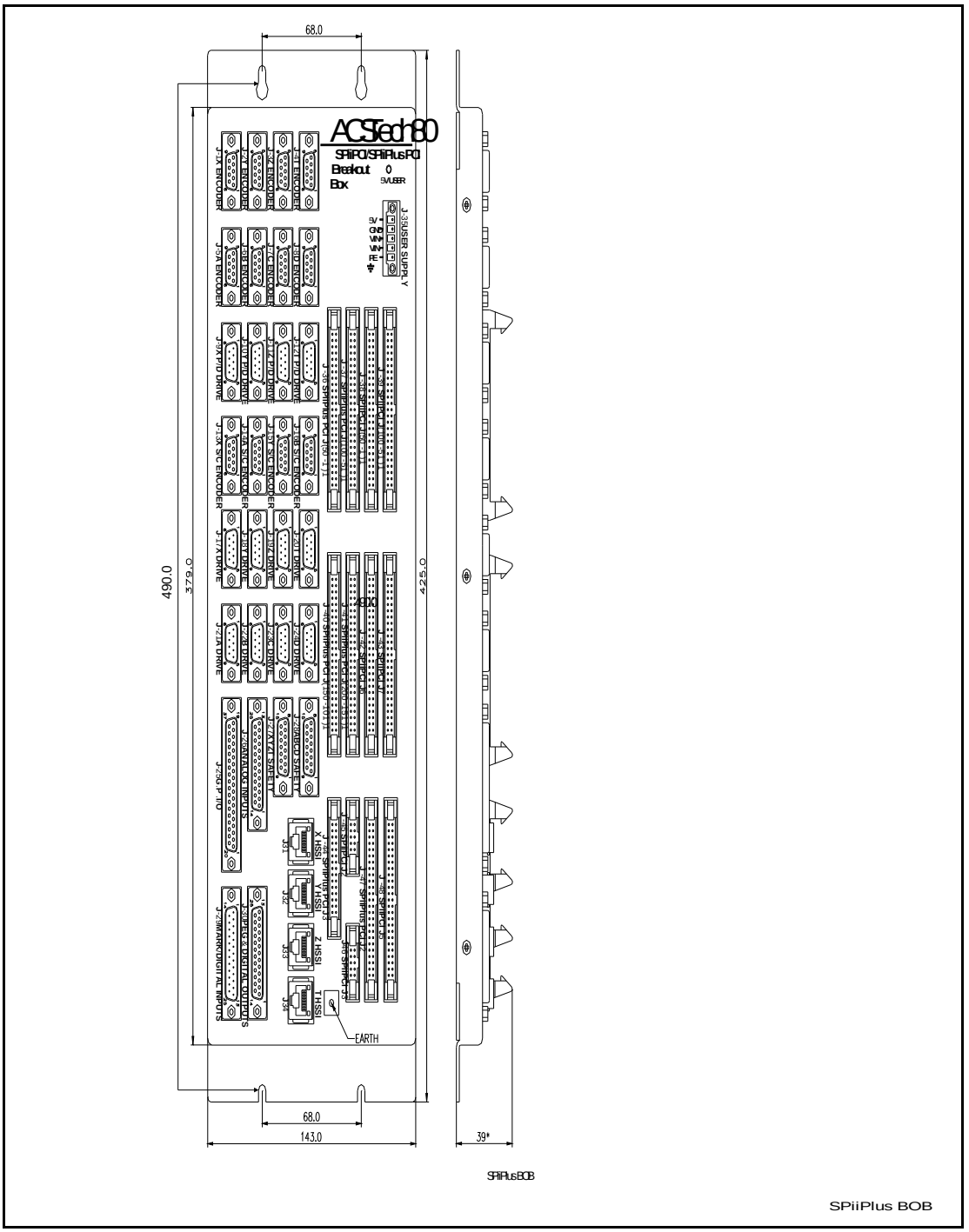


Figure 38 Breakout Box Connection Diagram

8.1 Breakout Box Specifications

Table 69 SPiiPlus PCI Breakout Box Specifications

Specification	Description
Operating Temperature	0 to 55°C (32 to 131°F)
Storage Temperature	-40 to 85°C (32 to 185°F)
Dimension (L x W x D)	42.5cm x 14.3cm x 3.75cm (16.75” x 5.63” x 1.48”)

8.2 Breakout Box Indicator

A green LED is connected to +5V encoder user power supply.

8.3 Breakout Box Connectors

Model 	*The usage of the connectors is product and model dependant. For example, connector J8 applies to SPiiPlus PCI-8 and SPiiPlus PCI-LT-8 only.*

8.3.1 Encoder Connectors J1 to J8

Table 70 Encoder Connectors J1 to J8

Component	Description
Jack on SPiiPlus BOB	D-connector, 9-pin, female
Plug from System	D-connector, 9-pin, male
Recommended Wires	AWG22 wires with shielding. Twisted pair cable for each differential signal (+ and -)

Table 71 Encoder Connectors J1 to J8 - Axis Relation (page 1 of 2)

Connector	Axis
J1	X
J2	Y
J3	Z
J4	T
J5	A
J6	B

Table 71 Encoder Connectors J1 to J8 - Axis Relation (page 2 of 2)

Connector	Axis
J7	C
J8	D

Table 72 Encoder Connectors J1 to J8 - Pinout

Pin	Signal	Description
1	+5V	Encoder supply +5V, 100mA max
2	#CHA+	Channel A non-inverted input
3	#CHA-	Channel A inverted input
4	#CHB+	Channel B non-inverted input
5	#CHB-	Channel B inverted input
6	#CHI+	Index non-inverted input
7	#CHI-	Index inverted input
8	GND	Ground
9	PE	Protected Earth

8.3.2 Pulse/Dir Connectors J9 to J12

Table 73 Pulse/Dir Connectors J9 to J12

Component	Description
Jack on SPiiPlus BOB	D-connector, 9-pin, male
Plug from System	D-connector, 9-pin, female
Recommended Wires	AWG22 wires with shielding. Twisted pair cable for each differential signal (+ and -)

Table 74 Pulse/Dir Connectors J9 to J12 - Axis Relation

Connector #	Axis
J9	X
J10	Y
J11	Z
J12	T

Table 75 Pulse/Dir Connectors J9 to J12 -Pinout

Pin	Signal	Description
1	#PULSE-	Pulse inverted
2	#DIR-	Direction inverted
3	GND	Ground
4	#ENA+	Drive Enable output, open collector
5	#FLT+	Drive Fault input +
6	#PULSE+	Pulse non-inverted
7	#DIR+	Direction non-inverted
8	#ENA-	Drive Enable output, open emitter
9	#FLT-	Drive Fault input -

8.3.3 Sin-Cos Encoder Connectors J13 to J16

Table 76 Sin-Cos Encoder Connectors J13 to J16

Component	Description
Jack on SPiiPlus BOB	D-connector, 9-pin, female
Plug from System	D-connector, 9-pin, male
Recommended Wires	AWG22 wires with shielding. Twisted pair cable for each differential signal (+ and -)

Table 77 SIN-COS Encoder Connectors J13 to J16 - Pinout (page 1 of 2)

Pin	X-Axis Signal / SW Comm.	A-Axis Signal / SW Comm.	Y-Axis Signal / SW Comm.	B-Axis Signal / SW Comm.	Description
	J13	J14	J15	J16	Connector location on the Breakout Box
1	+5V	+5V	+5V	+5V	Encoder supply +5V, 100mA max
2	XSIN+/AIN0+	ASIN+/AIN2+	YSIN+/AIN4+	BSIN+/AIN6+	SIN/AIN non-inverted input
3	XSIN-/AIN0-	ASIN-/AIN2-	YSIN-/AIN4-	BSIN-/AIN6-	SIN/AIN inverted input
4	XCOS+/AIN1+	ACOS+/AIN3+	YCOS+/AIN5+	BCOS+/AIN7+	COS/AIN non-inverted input
5	XCOS-/AIN1-	ACOS-/AIN3-	YCOS-/AIN5-	BCOS-/AIN7-	COS/AIN inverted input

Table 77 SIN-COS Encoder Connectors J13 to J16 - Pinout (page 2 of 2)

Pin	X-Axis Signal / SW Comm.	A-Axis Signal / SW Comm.	Y-Axis Signal / SW Comm.	B-Axis Signal / SW Comm.	Description
6	XINDEX+	AINDEX+	YINDEX+	BINDEX+	Index non-inverted input
7	XINDEX-	AINDEX-	YINDEX-	BINDEX-	Index inverted input
8	AGND	AGND	AGND	AGND	Analog ground
9	PE	PE	PE	PE	Protected Earth

Caution	
	***When connecting a SIN-COS encoder, it is necessary to connect the shields at each end of the cable (one shield at the controller connector and one shield at the SPiiPlus BOB or generic breakout box connector).***

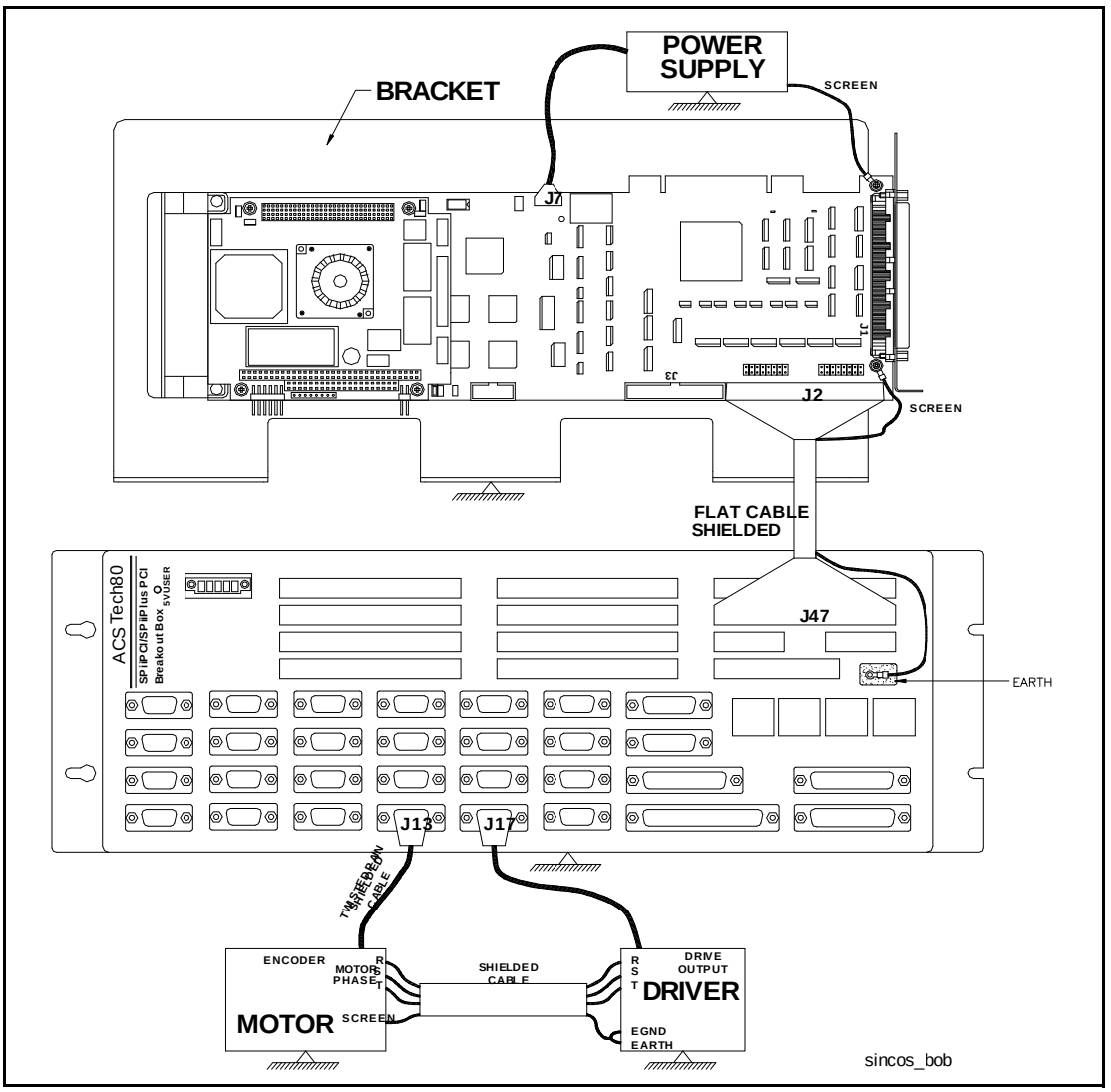


Figure 39 Sin-Cos Encoder Connection for Standalone Controller to SPiiPlus Breakout Box

8.3.4 Drive Connectors J17 to J24

Table 78 Drive Connectors J17 to J24

Component	Description
Jack on SPiiPlus BOB	D-connector, 9-pin, male
Plug from System	D-connector, 9-pin, female
Recommended Wires	AWG22 wires with shielding. Twisted pair cable for each differential signal (+ and -)

Table 79 Drive Connectors J17 to J24 - Axis Relation

Connector #	Axis
J17	X
J18	Y
J19	Z
J20	T
J21	A
J22	B
J23	C
J24	D

Table 80 Drive Connectors J17 to J24 Pinout

Pin	Signal	Description
1	#DAC0-	Drive analog Command 0 inverted
2	#DAC1-	Drive analog Command 1 inverted
3	#ENA+	Drive Enable output. Open collector
4	#FLT+	Drive Fault input +
5	AGND	Analog ground
6	#DAC0+	Drive analog Command 0 non-inverted
7	#DAC1+	Drive analog Command 1 non-inverted
8	#ENA-	Drive Enable output. Open emitter
9	#FLT-	Drive Fault input -

8.3.5 Analog Input Connector J26

Table 81 Analog Input Connector J26

Component	Description
Jack on SPiiPlus BOB	D-connector, 25-pin, female
Plug from System	D-connector, 25-pin, male
Recommended Wires	AWG22 wires with shielding. Twisted pair cable for each differential signal (+ and -)

Table 82 Analog Inputs Connector J26 - Pinout

Pin	Signals / SW Comm.	Description
	J26	Connector location on the Breakout Box
1	ZSIN+ / AIN8+	Analog input 8+/Z SIN non-inverted encoder input
2	ZCOS+ / AIN9+	Analog input 9+/Z COS non-inverted encoder input
3	CSIN+ / AIN10+	Analog input 10+/C SIN non-inverted encoder input
4	CCOS+ / AIN11+	Analog input 11+/C COS non-inverted encoder input
5	TSIN+ / AIN12+	Analog input 12+/T SIN non-inverted encoder input
6	TCOS+ / AIN13+	Analog input 13+/T COS non-inverted encoder input
7	DSIN+ / AIN14+	Analog input 14+/D SIN non-inverted encoder input
8	DCOS+ / AIN15+	Analog input 15+/D COS non-inverted encoder input
9	ZINDEX+	Z Index non-inverted input
10	CINDEX+	C Index non-inverted input
11	AGND	Analog ground
12	TINDEX+	T Index non-inverted input
13	DINDEX+	D Index non-inverted input
14	ZSIN- / AIN8-	Analog input 8-/Z SIN inverted encoder input
15	ZCOS- / AIN9-	Analog input 9-/Z COS inverted encoder input
16	CSIN- / AIN10-	Analog input 10-/C SIN inverted encoder input
17	CCOS- / AIN11-	Analog input 11-/C COS inverted encoder input
18	TSIN- / AIN12-	Analog input 12-/T SIN inverted encoder input
19	TCOS- / AIN13-	Analog input 1-/T COS inverted encoder input
20	DSIN- / AIN14-	Analog input 14-/D SIN inverted encoder input
21	DCOS- / AIN15-	Analog input 15-/D COS inverted encoder input
22	ZINDEX-	Z Index inverted input
23	CINDEX-	C Index inverted input
24	TINDEX-	T Index inverted input
25	DINDEX-	D Index inverted input

8.3.6 Safety Connector J27 and J28

Table 83 Safety Connectors J27 and J28

Component	Description
Jack on SPiiPlus BOB	D-connector, 15-pin, female
Plug from System	D-connector, 15-pin, male
Recommended Wires	AWG22 wires with shielding. Twisted pair cable for each differential signal (+ and -)

Table 84 Safety Connector J27 and J28 - Pinout

Pin	Signals XYZT-Axes (J27)	Signal ABCD-Axes (J28)	Description - Connector Location on the Breakout Box
1	REF	REF	Sink/Source
2	XLL	ALL	X or A Left limit
3	YLL	BLL	Y or B Left limit
4	ZLL	CLL	Z or C Left limit
5	TLL	DLL	T or D Left limit
6	ES-	NC	Emergency stop inverted input or NC
7	VIN-	VIN-	Safety inputs supply ref
8	PE	PE	Protected Earth
9	NC	NC	
10	XRL	ARL	X or A Right limit
11	YRL	BRL	Y or B Right limit
12	ZRL	CRL	Z or C Right limit
13	TRL	DRL	T or D Right limit
14	ES+	NC	Emergency stop non-inverted input or NC
15	VIN+	VIN+	Safety inputs supply

8.3.7 MARK/Digital Inputs Connector J29

Table 85 MARK/Digital Input Connector J29

Component	Description
Jack on SPiiPlus BOB	D-connector, 25-pin, male
Plug from System	D-connector, 25-pin, female
Recommended Wires	AWG22 wires with shielding. Twisted pair cable for each differential signal (+ and -)

Table 86 MARK/Digital Inputs Connector J29 - Pinout (page 1 of 2)

Pin	Signals/SW Comm.	Description - Connector Location on the Breakout Box
1	NC	
2	NC	
3	NC	
4	NC	
5	XMARK1+ / IN0.0+	X MARK1 non-inverted input/Digital 0 non-inverted input
6	XM2ARK+ / IN0.1+	X M2ARK non-inverted input/Digital 1 non-inverted input
7	YMARK1+ / IN0.2+	Y MARK1 non-inverted input/Digital 2 non-inverted input
8	YM2ARK+ / IN0.3+	Y M2ARK non-inverted input/Digital 3 non-inverted input
9	ZMARK1+ / IN0.4+	Z MARK1 non-inverted input/Digital 4 non-inverted input
10	ZM2ARK+ / IN0.5+	Z M2ARK non-inverted input/Digital 5 non-inverted input
11	TMARK1+ / IN0.6+	T MARK1 non-inverted input/Digital 6 non-inverted input
12	TM2ARK+ / IN0.7+	T M2ARK non-inverted input/Digital 7 non-inverted input
13	GND	Ground
14	NC	
15	NC	
16	NC	
17	NC	
18	XMARK1-/IN0.0-	X MARK1 inverted input/Digital 0 inverted input
19	XM2ARK-/IN0.1-	X M2ARK inverted input/Digital 1 inverted input
20	YMARK1-/IN0.2-	Y MARK1 inverted input/Digital 2 inverted input
21	YM2ARK-/IN0.3-	Y M2ARK inverted input/Digital 3 inverted input
22	ZMARK1-/IN0.4-	Z MARK1 inverted input/Digital 4 inverted input
23	ZM2ARK-/IN0.5-	Z M2ARK inverted input/Digital 5 inverted input

Table 86 MARK/Digital Inputs Connector J29 - Pinout (page 2 of 2)

Pin	Signals/SW Comm.	Description - Connector Location on the Breakout Box
24	TMARK1-/IN0.6-	T MARK1 inverted input/Digital 6 inverted input
25	TM2ARK-/IN0.7-	T M2ARK inverted input/Digital 7 inverted input

8.3.8 PEG & Digital Outputs Connector J30

Table 87 PEG & Digital Outputs Connector J30

Component	Description
Jack on SPiiPlus BOB	D-connector, 25-pin, female
Plug from System	D-connector, 25-pin, male
Recommended Wires	AWG22 wires with shielding. Twisted pair cable for each differential signal (+ and -)

Table 88 PEG & Digital Outputs Connector J30- Pinout (page 1 of 2)

Pin	Signals / SW Comm.	Description - Connector Location on the Breakout Box
	J30	Connector location on the Breakout Box
1	XPEG_STATE3+ / OUT0.8+	X PEG STATE 3 non-inverted output / Digital output 8 non-inverted
2	YPEG_STATE3 / OUT0.9+	Y PEG STATE 3 inverted output / Digital output inverted
3	ZPEG_PULSE+ / OUT0.10+	Z PEG PULSE non-inverted output / Digital output 10 non-inverted
4	TPEG_PULSE / OUT0.11+	PEG PULSE non-inverted output / Digital output 11 non-inverted
5	XPEG_STATE0+ / OUT0.0+	
6	XPEG_STATE1+ / OUT0.1+	
7	XPEG_STATE2+ / OUT0.2+	
8	XPEG_PULSE+ / OUT0.3+	
9	YPEG_STATE0+/ OUT0.4+	
10	YPEG_STATE1+ / OUT0.5+	
11	YPEG_STATE2+ / OUT0.6+	
12	YPEG_PULSE+ / OUT0.7+	
13	GND	Ground
14	XPEG_STATE3- / OUT0.8-	X PEG STATE 3 inverted output / Digital output 8 inverted

Table 88 PEG & Digital Outputs Connector J30- Pinout (page 2 of 2)

Pin	Signals / SW Comm.	Description - Connector Location on the Breakout Box
15	YPEG_STATE3 / OUT0.9-	Y PEG STATE 3 inverted output / Digital output inverted
16	ZPEG_PULSE- / OUT0.10-	Z PEG PULSE inverted output / Digital output 10 inverted
17	TPEG_PULSE / OUT0.11-	PEG PULSE inverted output / Digital output 11 inverted
18	XPEG_STATE0- / OUT0.0-	
19	XPEG_STATE1- / OUT0.1-	
20	XPEG_STATE2- / OUT0.2-	
21	XPEG_PULSE- / OUT0.3-	
22	YPEG_STATE0- / OUT0.4-	
23	YPEG_STATE1- / OUT0.5-	
24	YPEG_STATE2- / OUT0.6-	
25	YPEG_PULSE- / OUT0.7-	

8.3.9 HSSI Connectors J31 to J34

Table 89 HSSI Connectors J31 to J34

Component	Description
Jack on SPiiPlus BOB	RJ-45
Plug from System	RJ-45
Recommended Wires	AWG22 wires with shielding. Twisted pair cable for each differential signal (+ and -)

Table 90 HSSI Connectors J31 to J34 Pinout (page 1 of 2)

Pin	J31 Signals X-Axis	J32 Signals Y-Axis	J33 Signals Z-Axis	J34 Signals T-Axis	Description
1	CONTROL 1+	CONTROL 2+	CONTROL 1+	CONTROL 2+	Control 1 & 2 inverted output
2	CONTROL 1-	CONTROL 2-	CONTROL 1-	CONTROL 2-	Control 1 & 2 non-inverted output
3	XSER_DI+	YSER_DI+	ZSER_DI+	TSER_DI+	Serial data in non-inverted input
4	XSER_DI-	YSER_DI-	ZSER_DI-	TSER_DI-	Serial data in inverted input

Table 90 HSSI Connectors J31 to J34 Pinout (page 2 of 2)

Pin	J31 Signals X-Axis	J32 Signals Y-Axis	J33 Signals Z-Axis	J34 Signals T-Axis	Description
5	XSER_DO+	YSER_DO+	ZSER_DO+	TSER_DO+	Serial data out non-inverted input
6	XSER_DO-	YSER_DO-	ZSER_DO-	TSER_DO-	Serial data out inverted input
7	GND	GND	GND	GND	Ground
8	GND	GND	GND	GND	

8.3.10 Power Supply Connector J35

Table 91 Power Supply Connector J35

Component	Description
Jack on SPiiPlus BOB	5-pin, MC1.5/5 **Phoenix Contact** Jacket
Plug from System	
Recommended Wires	AWG22 wires with shielding. Twisted pair cable for each differential signal (+ and -)

Table 92 Power Supply Connector J35 Pinout

Pin	Signal	Description	Notes
1	+5V	5Vdc supply, 2A max	Used for LED indicator and external encoder supply
2	GND	Ground	
3	VIN+	VIN+ supply input	5Vdc or 24Vdc external power supply for safety inputs
4	VIN-	VIN- supply return	
5	PE	Protected Earth	

8.3.10.1 Non-Isolated Power Supply

For non-isolated 5V, connect VIN+ and VIN- to 5V and GND by using isolated wires on the plug (VIN+ to 5V and VIN- to GND) as illustrated in **Figure 40**.

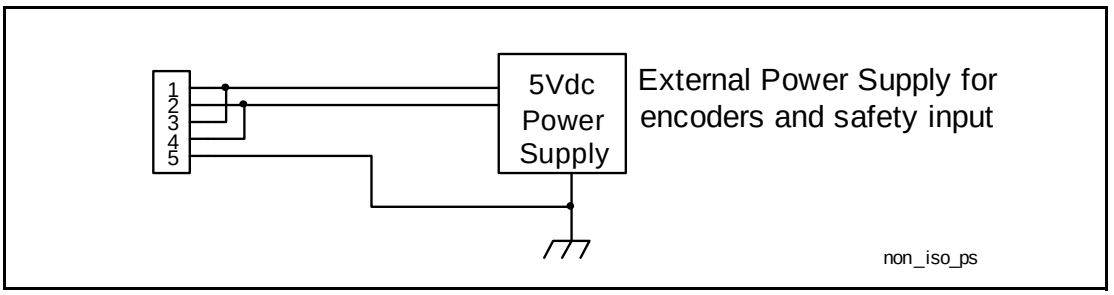


Figure 40 Breakout Box 5V Non-Isolated Power Supply Wiring Diagram

Table 93 Breakout Box 5V Non-Isolated Power Supply Pinout

J35 Pin	J35 Signal	Needed Power Supply Signal
1	+5V	+5V
2	GND	GND
3	VIN+	+5V
4	VIN-	GND
5	PE	PE on power supply

8.3.10.2 Isolated Power Supplies

For isolated 5V or 24V, connect VIN+ and VIN- to a separate 5V/24V power supply as illustrated in **Figure 41**.

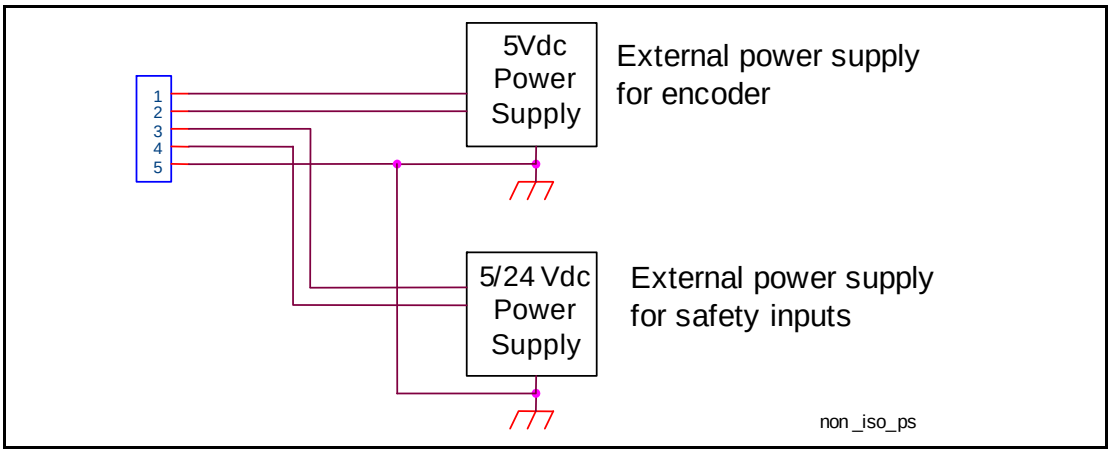


Figure 41 Breakout Box 5/24V Isolated Power Supply Wiring Diagram

Table 94 Breakout Box 5V Isolated Power Supply Pinout

J35 Pin	J35 Signal	Power Supply Signal Connection
1	+5V	+5V on power supply 1
2	GND	GND on power supply 1
3	VIN+	+5V on power supply 2
4	VIN-	GND on power supply 2
5	PE	PE on power supply 1 & 2

8.3.11 SPiiPlus PCI J1 Connector to BOB Connectors J36, J37, J40, J41

Table 95 Breakout Box J36, J37, J40, and J41 Connectors

Breakout Box Connector	Label on Cable	Axis	SPiiPlus PCI J1 Connector Pins
J36	P36 (1-50)	X and A	1-50
J37	P37 (51-100)	Y and B	51-100
J40	P40 (101-150)	Z and C	101-150
J41	P41 (151-200)	T and D	151-200

9 Warranty

ACS Motion Control warrants that its products are free from defects in materials and workmanship under normal use during the warranty period. The warranty period is one (1) year from receipt by the end user. This warranty does not apply to any product from which the serial number has been removed or destroyed, or damage as a result of accident, fire, misuse, abuse, negligence, operation outside the usage parameters, unauthorized modifications, or acts of G-d. If the product is provided in an enclosed case, this warranty does not apply if the case has been opened.

ACS Motion Control is not liable for any damages (material, financial, or physical) caused by the products or the failure of the products to perform. These limits of liability shall including, but not limited to: any lost profits, lost savings, lost earnings, loss of programs or other data, business interruption, incidental damages, consequential damages or personal injury.

These limitations apply whether damages are sought, or a claim made, under this warranty or as a tort claim (including negligence and strict product liability), or any other claim. These limitations of liability will be effective even if you have advised ACS Motion Control of the possibility of any such damages.

ACS Motion Control makes no other warranties, expressed or implied, including any implied warranties of merchantability or fitness of any product for a particular purpose. ACS Motion Control expressly disclaims all warranties not stated in this warranty. ACS Motion Control reserves the right to make change to this warranty without notice.

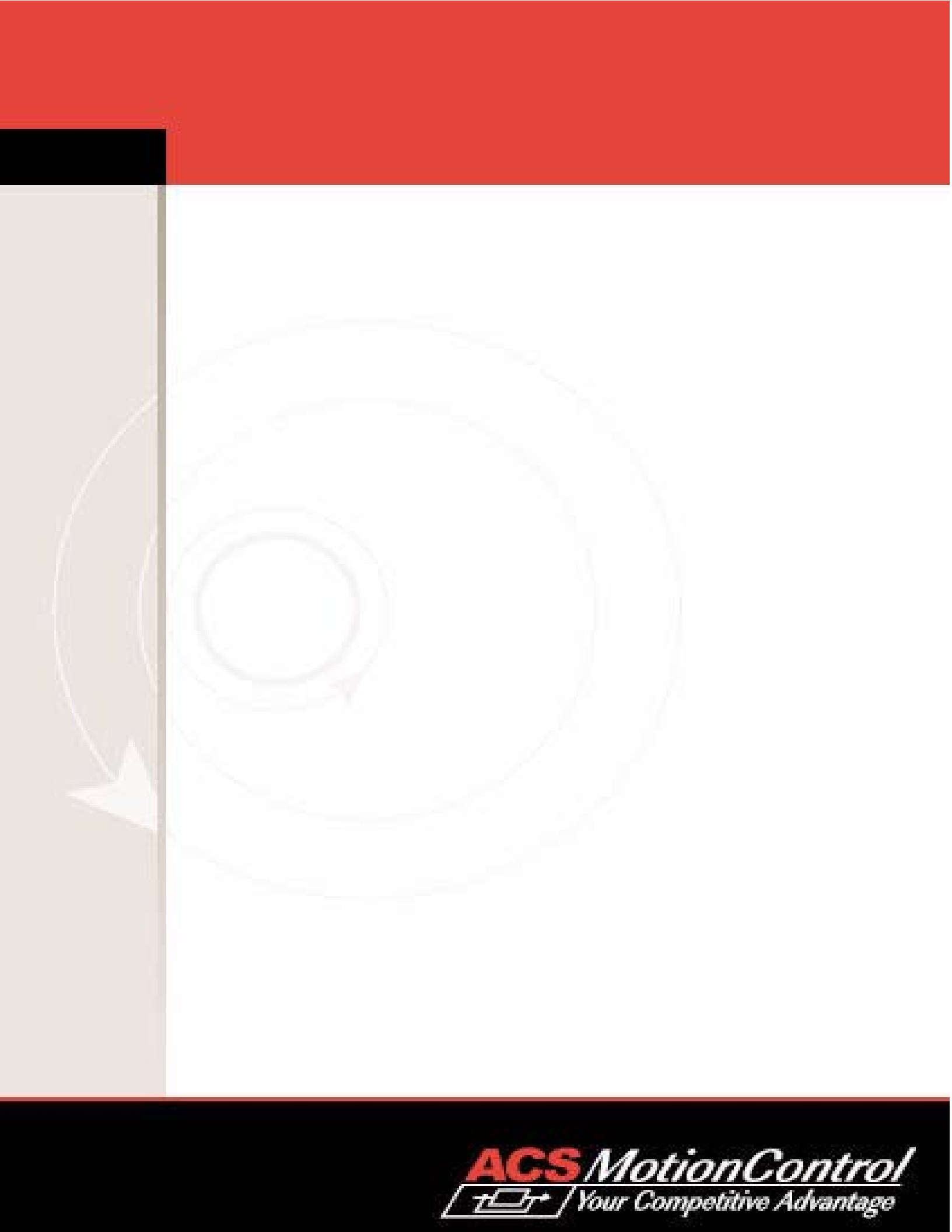
10 Appendix A: RS-485/422 Voltage

Table 96 RS-485 Compatible Input Signal Definitions

Item	Description	Comments
Vth	Differential input voltage	200mv< | Vth | < 14v
Vcm	Common mode input voltage	-14v < Vcm < 14v

Table 97 RS-485 Compatible Output Signal Definitions

Item	Description	Comment
Voh	Output voltage high	2.5v < Voh < 5v
Vol	Output voltage low	Vol < 0.5v
Vt	Differential output voltage at R1=100Ω	>2.0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