



SPIPLUS CM
Revision B
Control Module



Hardware Guide

Version 6.60

SPiiPlus CM Motion Controller Revision B

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ACS Motion Control, Ltd.

Ramat Gabriel Industrial Park

POB 5668

Migdal HaEmek, 10500

ISRAEL

Tel: (972) (4) 6546440

Fax: (972) (4) 6546443

ACS Motion Control, Inc.

6575 City West Parkway

Eden Prairie, MN 55344

USA

Tel: 763-559-7669, 800-545-2980

Fax: 763-559-0110

ACS Motion Control (Korea)

Digital Empire Building D-191

980-3, Youngtong-dong, Youngtong-gu,

Suwon, Geonggi-do, 443-813, Korea

Tel: +82-31-202-3541

Fax: +82-31-202-3542

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1 About this Guide

This guide provides detailed hardware information concerning the SPiiPlus CM motion control module, including:

- How to install the SPiiPlus CM
 - How to connect the electrical interface with the system (motors, feedback, I/O, etc.)
- For a setup procedure of the SPiiPlus CM, 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

1.1 Related SPiiPlus Tools

Table 1 Related SPiiPlus Tools

Tool	Description
SPiiPlus MMI	A multipurpose user interface with the controller including: Program management, Motion management, Communication terminal, Four channel digital oscilloscope, Safety and I/O signals monitor, Signal tuning and adjustment, and a fully interactive simulator. Program and SPii debugging tools and FRF are also included.
SPiiPlus Utilities	A program used for upgrading or downgrading the controller firmware.
SPiiPlus C Library	A DLL (Dynamic Link Library) that supports host application programming in a variety of languages including C/C++. The library introduces a new level of application support with a built-in controller simulator and it also provides outstanding debugging capabilities. All tools are provided with a full simulator of the controller.
SPiiPlus COM Library	A DLL (Dynamic Link Library) that supports host application programming in a variety of languages including Visual Basic, LabView, and more. The library introduces a new level of application support with a built-in controller simulator and it also provides outstanding debugging capabilities. All tools are provided with a full simulator of the controller.

1.2 The SPiiPlus Documentation

Table 2 Collateral Documentation

Document	Description
<i>SPiiPlus PCI Series Hardware Guide</i>	Installation and hardware connection with the SPiiPlus PCI 4 or 8 axes
<i>HSSI Expansion Modules Guide</i>	High-Speed Synchronous Serial Interface (HSSI) for expanded I/O, distributed axes, and nonstandard devices.
<i>SPiiPlus Setup Guide</i>	Communication, configuration and adjustment procedures for SPiiPlus motion control products.
<i>SPiiPlus ACSPL+ Programmer's Guide</i>	Guide for using the ACSPL+ high level programming language.
<i>SPiiPlus ACSPL+ Command and Variable Reference Guide</i>	ACSPL+ programming language command and variable set for programming SPiiPlus controllers.
<i>SPiiPlus C Library Reference</i>	C++ and Visual Basic® libraries for host PC applications. This guide is applicable for all the SPiiPlus motion control products
<i>SPiiPlus COM Library Reference Guide</i>	COM Methods, Properties, and Events for Communication with the Controller
<i>SPiiPlus FRF Analyzer User's Guide</i>	The SPiiPlus FRF (Frequency Response Function) Analyzer™ is a powerful servo analysis GUI for ACS MotionControl SPiiPlus motion controllers.
<i>SPiiPlus Modbus User's Guide</i>	Describes Modbus setup and register address.
<i>SPiiPlus SA Hardware Guide</i>	Installation and hardware connection with the SA and SA-LT controller.
<i>SPiiPlus 3U-HP/LT Hardware Guide</i>	Installation and hardware connection with the 3U-HP/LT controllers.
<i>SPiiPlus Utilities User Guide</i>	Guide for using the Upgrader utility for upgrading or downgrading the controller firmware.

1.3 Conventions Used in this Guide

1.3.1 Text Conventions


Several text formats and fonts, illustrated in [Table 3](#), are used in the text to convey information about the text.


Table 3 Document Conventions


Document	Description
Bold	ACSPL+ command names. Software tool menus, menu items, dialog box names, and dialog box elements.
<i>Italic</i>	Emphasis or an introduction to a key concept. In a command syntax, specifies a variable name or other information that the user provides.
Monospace	Code examples.
<i>Italic monospace</i>	Information in code examples that the user provides.
ALL CAPS	Names of keys on the keyboard. For example, SHIFT.
<i>blue italic</i>	Names of other documents.
blue bold	Cross references, web pages, and e-mail addresses.
→	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.


1.3.2 Flagged Text


The following symbols are used to flag text in this document:

Note 	<i>Notes include helpful information or tips.</i>
--	---

Caution 	<i>A Caution describes a condition that may result in damage to equipment.</i>
---	--

Warning 	<i>A Warning describes a condition that may result in serious bodily injury or death.</i>
---	---

Advanced 	<i>Indicates a topic for advanced users.</i>
--	--

Model 	<i>Highlights a specification, procedure, condition, or statement that depends on the product model.</i>
---	--

2 Introduction and Specifications

This chapter provides an overview of the SPiiPlus CM Revision B and its technical specifications.

2.1 SPiiPlus CM Revision B vs. Revision A

SPiiPlus CM Revision B incorporates changes based on customer feedback, and fall into two categories:

- Changes in existing functionality over Revision A, and outward appearance
- New features and enhancements, while leaving existing Revision A functionality intact. The SPiiPlus CM Revision B is CE certified for single phase power supply, with additional certifications pending, and CSA certified for single-phase and three phase power supplies.

This guide includes the latest technical data and details about using the SPiiPlus CM Revision B. Click here to download the guide from our web site: www.AcsMotionControl.com.

Table 4 and **Table 5** summarize the differences between Revision A and B, and describe the reasons for the changes.

Table 4 Changes in Existing Functionality and Outward Appearance
(page 1 of 2)

Status in Revision A	Change in Revision B
The user could plug the drive supply input (J18) by mistake into the Motor Output connectors, thereby damaging the product.	The Drive Supply Input connector was modified to eliminate the possibility of such a mistake, as follows: <ul style="list-style-type: none"> <input type="checkbox"/> Connector Type: Weidmuller SV 7.62/4/90F P/N1822410000 <input type="checkbox"/> Mating Connector Type: Weidmuller BVZB 7.62/4F P/N 1821650000 Since the type of connector was changed, each SPiiPlus CM will be equipped with the new drive supply input user mating connector of as part of the standard package.
The CM could not be horizontally mounted - as originally planned.	The SPiiPlus CM provides two mounting L brackets mounts that can be used for vertical (factory default) or horizontal mounting.
The motor shielding could not be easily connected to the ground (PE).	The SPiiPlus CM-ACC optional accessories kit includes three dedicated, spring-loaded clamping yokes for improved shielding and better performance. See Section 2.8.1 - SPiiPlus CM-ACC for complete details.
The analog inputs range was 1V ptp.	Analog inputs range is modified to 1V ptp to provide better dynamic range and performance while working with sin-cos encoders.
External regeneration fuse house was provided.	External regeneration fuse house was removed. If external regeneration is required, apply an external fuse as a part of the shunt resistor apparatus.

Table 4 Changes in Existing Functionality and Outward Appearance
(page 2 of 2)

Status in Revision A	Change in Revision B
The signal to noise ratio on analog inputs was too low.	The signal to noise ratio was significantly improved to 62dB (3 sigma) equivalent to ± 6 AIN counts.
The COM1 serial port was characterized by a greater sensitivity to electrical noise than COM2.	Sensitivity to noise was improved on COM1 to provide same performance as COM2.
CAN option label on front panel in anticipation of future CAN implementation.	CAN label removed from front panel.

Table 5 New Features or Enhanced Capabilities

Reason for the Change	The Change in Revision B
Single-end analog inputs for joystick were required by customers.	In the Version B, two single-end analog inputs for joystick implementation were added. These signals exist in the PEG and Analog Inputs (J26) connector.
Hall sensor commutation support for brushless motors was required by customers.	Hall sensor commutation support for brushless motors was implemented and will be available in SPiiPlus software version 5.00 and higher.
Customers request	While using a Sin-Cos encoder, the squared (quadrature) signals of channels A and B are routed to the incremental digital encoder (connector J11, J13, J15). Based on these squared signals, the user can get the axis' non-interpolated position reading for his needs.

Figure 1 illustrates the SPiiPlus CM Motion Control Module.



Figure 1 SPiiPlus CM Control Module

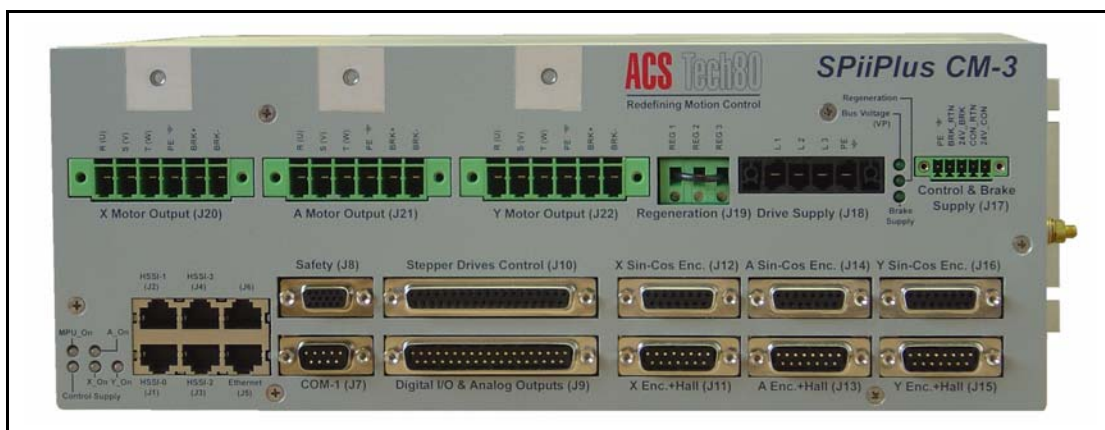


Figure 2 SPiiPlus CM Control Module - Front Panel



Figure 3 SPiiPlus CM Control Module - Right Panel



Figure 4 SPiiPlus CM Control Module - Left Panel

2.2 SPiiPlus CM Revision B Overview

SPiiPlus motion controllers and control modules are designed to meet the requirements of the most demanding applications including semiconductor manufacturing and inspection, electronic assembly and testing, medical imaging and digital printing equipment. SPiiPlus products handle complex demands without compromising accuracy or throughput.

The SPiiPlus Control Module (CM) combines an advanced programmable motion controller, up to three digital drives, and a power supply in a single standalone package. The integrated drives are software configured for AC servo/DC brushless or DC brush motors. Two external stepper indexers can be added to bring the total number of controlled axes to five.

The following digital drive supply voltages are available:

- 90-125Vdc or 100-240Vac, single phase
- 230Vac phase-to-phase
- Low-voltage option 24Vdc-60Vdc

The drive output current can be 5A continuous/10A peak, 10A continuous/20A peak (sine wave amplitude), or 15A continuous/30A peak (sine wave amplitude).

SPiiPlus CM supports both Sin-Cos and high-speed incremental encoders. An internal programmable multiplier (4x to 65,536x) can be ordered for any axis with Sin-Cos feedback. SPiiPlus CM can operate standalone module, or can be connected to a host computer via an RS-232 serial port, an RS-232/422 serial port, or an Ethernet 10/100 BaseT port. All ports can be used simultaneously.

The SPiiPlus CM features a versatile implementation of general purpose I/Os. Digital inputs can be used for hardware-based position registration and digital outputs can be used to trigger position-based events with sub-microsecond delays. Special high power outputs are provided for activating mechanical brakes.

Complex applications are easy to develop with ACSPL+, a powerful, compiled, true multitasking, high-level language that is optimized for motion control applications. ACSPL+ enables implementation of highly complex motion-time-event sequences with accurate positioning and timing. Up to ten ACSPL+ programs can run simultaneously on the controller. Programs can also be implemented by a host PC application running under Windows 90/2000/ME/NT/XP using the DLL or the COM libraries provided for C, C++, Visual Basic and LabView and more. In addition, extensive C/C++ DLL libraries are available for On-time and Venturecom RTX real-time operating systems.

A powerful suite of software tools are provided for easy setup, tuning, and programming. Application development is particularly easy with the integrated four-channel soft scope and multi-axis motion controller simulator.

The servo control algorithm executes at a steady rate of 20kHz per axis, regardless of the number of axes in use, providing very large bandwidth, exceptional dynamic tracking, fast settling, and excellent smoothness at low velocities.

The controller is manufactured under an ISO 9001:2000 certified quality management system, meeting stringent safety and EMC standards.

2.3 Axis Configurations and Options

The SPiiPlus CM can control up to eight axes, depending on the model, the number of SPii processors, and the motor types. For example:

- One to three direct-connected motors for servo motors (DC Brush, DC Brushless/AC Servo).
- One to three direct-connected drives for stepper motors in open loop (without position feedback)
- One to six HSSI-networked drives for remote servo motors (DC Brush, DC Brushless/AC Servo).

The specific number and type of motors supported depends on the number of internal drives (one to three) and the number of SPii processors (one to four) specified in the product order.

Table 6 describes the available axis assignments and configurations.

In general, each SPii processor supports up to two servo axes or one stepper axis.

Axis assignment as a Direct-Connected Motor is preset at the factory and can not be changed by the user.

Axis assignment as a Direct-Connected Drive is done by the user as a part of the Setup process, (see Chapter 5 - Axis Configuration and Setup of the *SPiiPlus Setup Guide*).

Axis assignment as a HSSI-Networked Axes is done by the user as a part of the Setup process (see see Chapter 5 - Axis Configuration and Setup of the *SPiiPlus Setup Guide*).

Table 6 Axis Assignment Configurations (page 1 of 2)

# of Internal Drives	# of SPii Processors	Axis Type			Total Number of Axes (2 x # of SPiis)
		Motors	Drives	HSSI Axes	
		DC Brush DC Brushless	Stepper (open loop)	DC Brush DC Brushless	
One drive - SPiiPlus CM-1	Two SPii processors (default)	X	Y	A, Y, B	4
	Four SPii processors (SpiiPlus CM-1- x-x-xx-H4)	X	Y, Z, T	A, Y, B, Z, C, T, D	8
Two Drives- SPiiPlus CM-2	Two SPii processors (default)	X, A	Y	Y, B	4
	Four SPii processors (SpiiPlus CM-2- x-x-xx-H4)	X, A	Y, Z, T	Y, B, Z, C, T, D	8

Table 6 Axis Assignment Configurations (page 2 of 2)

# of Internal Drives	# of SPii Processors	Axis Type			Total Number of Axes (2 x # of SPiis)
		Motors	Drives	HSSI Axes	
		DC Brush DC Brushless	Stepper (open loop)	DC Brush DC Brushless	
Three Drives - SPiiPlus CM-3	Two SPii processors (default)	X, Y, A		B	4
	Four SPii processors (SpiiPlus CM-3- x-x-xx-H4)	X, Y, A	Z, T	B, Z, C, T, D	8

For example:

The product order code **SPiiPlus CM-3-x-x-xx-H4** delivers three internal digital drives and four SPii motion control processors. Since each SPii processor controls up to two motors, the following axis assignments are possible:

- Axes X, A, Y will be taken by the internal drive and can be DC brush or DC brushless motors.
- Axes B,C,D can be assigned to an external digital drive for DC brush or DC brushless motor, networked to the control module from a HSSI-ED2 distribution module or a HSSI-SA-1 drive.
- Axes Z and T can be:
 - Assigned to an external digital drive for DC brush or DC brushless motors, networked to the control module from a HSSI-ED2 distribution module or a HSSI-SA-1 drive (like B,C axes), or
 - Connected directly to a stepper motor drive.

2.4 Specifications

This section provides the following specifications:

- Position Control**
- Velocity Control**
- Position and Velocity Feedback**
- Integrated Digital Drives**
- Signals to Direct-Connected P/D Stepper Drives**

2.4.1 Position Control

- ❑ **Sampling Rate:** 20kHz.
- ❑ **Control Algorithms:** P type, automatic velocity feed-forward, acceleration feed-forward, integrator anti-reset windup
- ❑ **Trajectory Calculation Rate:** Programmable 0.5, 1, 2kHz.
- ❑ **Position Range:** $\pm 4 \times 10^{15}$ counts
- ❑ **Accuracy:** ± 1 encoder count

2.4.2 Velocity Control

- ❑ **Sampling Rate:** 20kHz.
- ❑ **Control Algorithm:** PI type, second order low pass and notch filters
- ❑ **Velocity Programming Range:** Up to 160×10^9 counts/second.
- ❑ **Velocity Accuracy:**
 - Long term: 0.005%.
 - Short term: 0.01%-0.5% (system-dependent).
- ❑ **Acceleration Programming Range:** Up to $\pm 4 \times 10^{15}$ counts/second².

2.4.3 Position and Velocity Feedback

- ❑ **Feedback Types:** Any combination of incremental digital encoders, sin-cos encoders (optional), analog inputs or custom HSSI feedback modules.
- ❑ **Incremental Digital Encoder:**
 - **Quantity:** One per direct-connected or HSSI-networked motor.
 - **Type:** Three-channel, differential, incremental, RS-485. A&B,I; UP-DN,I; CLK-DIR,I.
 - **Maximum rate:** 20 million encoder counts/second.
 - **Index pulse duration:** >200 nsec.
 - **A&B type requirements:** A, B line cycle >200 nsec; A, B low and high states >100 nsec; A to B edge separation >25 nsec.
 - **UP-DN, CLK-DIR types requirements:** Pulse width >100 nsec.
- ❑ **Sin-Cos Analog Encoder (optional):**
 - **Quantity:** One per direct connected motor. Each sin-cos encoder uses two analog inputs
 - **Type:** Three channel, differential, incremental, 1Vptp.
 - **Programmable multiplication factor:** 4x to 65,536x.
 - **Maximum rate:** Up to 250,000 sine periods/second. Higher rates are available on request.
 - **Maximum acceleration with Sin-Cos encoder:** 10^8 sine periods/second².

2.4.4 Integrated Digital Drives


- ❑ **Quantity:** One, two or three.
- ❑ **Type:** PWM, digital current control with space vector modulation
- ❑ **PWM Frequency:** 20kHz.
- ❑ **Current Loop Sampling rate:** 20kHz.
- ❑ **Control Algorithm:** PI
- ❑ **Current Resolution:** 14 bit
- ❑ **Drive short circuit capability:** 5kA
- ❑ **Phase Current (sine wave amplitude):**
 - SPiiPlus CM-1/2/3-A: 5A continuous; 10A peak (1 second). Maximum power per axis is 1370W continuous, 2740W peak.
 - SPiiPlus CM-1/2/3-B: 10A continuous; 20A peak (1 second). Maximum power per axis is 2740W continuous, 5480W peak.
 - SPiiPlus CM-1/2/3-C: 15A continuous; 30A peak (1 second). Maximum power per axis is 4110W continuous, 8220W peak.
- ❑ **Total Power Consumption for all Axes:**
 - SPiiPlus CM-1/2/3-A: 4800W continuous, 7200W peak. (1 second)
 - SPiiPlus CM-1/2/3-B: 4800W continuous, 7200W peak. (1 second)
 - SPiiPlus CM-1/2/3-C: 4800W continuous, 7200W peak. (1 second)

2.4.5 Signals to Direct-Connected P/D Stepper Drives


- ❑ **P/D Stepper Drive Commands:**
 - **Quantity:** Two or three, depending on the model.
 - **Type:** Pulse/Direction commands, differential, RS-485.
 - **Maximum Rate:** Four million pulses/second.
- ❑ **Drive Enable Output:**
 - **Quantity:** One per stepper drive.
 - **Type:** Two terminal, may be used as source (open emitter) or sink (open collector).
 - **Output Voltage Range:** 5Vdc to 24Vdc.
 - **Output Current:** 50mA.
 - **Propagation Delay:** <1msec.
- ❑ **Drive Fault Input:**
 - **Quantity:** One per stepper drive.
 - **Type:** Two terminal, may be used as source (open emitter) or sink (open collector).
 - **Input Voltage:** 5Vdc ($\pm 10\%$) or 24Vdc ($\pm 20\%$), automatic detection.
 - **Propagation Delay:** <1msec.

2.4.6 I/O

- ❑ **Safety Inputs:**
 - **Quantity:** One dedicated E-stop. Left limit and right limit per axis.
 - **Type:** Single-ended, Opto-isolated, can be configured as sink or source.
 - **Input safety voltage range:** 5Vdc ($\pm 10\%$) or 24Vdc ($\pm 20\%$), automatic detection.
 - **Propagation delay:** <1msec.
- ❑ **General Purpose Digital Inputs:**
 - **Quantity:** Eight.
 - **Type:** Single-ended, opto-isolated, can be configured as sink or source.
 - **Input Voltage:** 5Vdc ($\pm 10\%$) or 24Vdc ($\pm 20\%$), automatic detection
 - **Propagation Delay:** <1msec.
- ❑ **Registration Mark (Position Capture) Digital Inputs:**
 - **Quantity:** Two per X axis and two per Y axis.
 - **Type:** Differential, RS-485.
 - **Propagation Delay:** <0.1 μ sec.


 <p>Note</p>	<p><i>These inputs can be configured for general purpose use.</i></p>
---	---

- ❑ **General Purpose Digital Outputs:**
 - **Quantity:** Eight
 - **Type:** Single-ended, opto-isolated. Can be configured as sink or source.
 - **Outputs Voltage:** 5Vdc ($\pm 10\%$) or 24Vdc ($\pm 20\%$).
 - **Propagation Delay:** <1msec.
 - **Maximum Current per Single Output:** <350mA
 - **Maximum current per all Outputs:** <350mA

 <p>Note</p>	<p><i>All outputs are protected against overload and short circuit.</i></p>
--	---

- ❑ **Position Event Generator (PEG) Digital Outputs:**
 - **Quantity:** One PEG pulse per each X and Y axis. Four PEG states per each X and Y axis.
 - **Type:** Differential, RS-485.
 - **Propagation Delay:** <0.1 μ sec.

- **PEG Position Compare Accuracy:** ± 1 quadrature count up to 5,000,000 counts/second.
 - **PEG Generated Pulse Width Range:** 25nsec to 1.6msec.
 - **Edge Separation Between Two Peg Events:** Minimum 200nsec.
 - **Number of PEG Pulses in Random (table based) Mode:** Up to 30,000.
 - **Number of PEG Events in Incremental Mode:** Unlimited.
- Mechanical Brake Outputs:**
- **Quantity:** Three.
 - **Type:** Single-ended, opto-isolated, source type
 - **Outputs Voltage:** 5-30Vdc ($\pm 10\%$)
 - **Maximum current per Output:** 1A

 <p>Note</p>	<p><i>Mechanical break outputs can be used for general purposes.</i></p>
--	--

- Analog Inputs:**
- Analog inputs also serve as sin-cos encoder inputs. Each sin-cos encoder uses two analog inputs.
- Type and Quantity:**
- In SPiiPlus CM-1/2/3 – two/four/six analog inputs, respectively; differential ± 10 Vdc, 14-bit resolution, signal to noise ration equal to 62dB (3 sigma) equivalent to ± 6 AIN counts.
 - The SPiiPlus CM-3 includes two single-ended ± 10 Vptp, 14-bit resolution analog inputs for joystick implementation
- Analog Outputs:**
- **Quantity:** One (with one HSSI channel) or two (with more than one HSSI channel).
 - **Signal-to-Noise Ratio:** 46dB (3 sigma) equivalent to ± 50 mV or ± 3 AOUT counts.
 - **Type:** Single ended, 10V ptp, 10-bit resolution.
- Expanded Digital I/O:**
- **Quantity:** Up to 256 inputs and 252 outputs using 16 optional HSSI-IO16 modules
 - **Type:** Opto-isolated, 5Vdc or 24Vdc
- HSSI Expansion Bus:**
- **Quantity:** Up to four HSSI channels (optional).
 - **Type:** Differential, RS-485. Each channel provides 64 input bits and 64 output bits, sampled and updated at 20kHz.

2.4.7 Multi-processor Architecture

- ❑ **Motion Processor Unit (MPU):** PC104+.
- ❑ **Real-time Controllers:** 120MHz SPii Servo
- ❑ **Processors:** one per two axes.
- ❑ **Controller Power-up Time:** 25sec.

2.4.8 Memory

- ❑ **RAM:** 128MB.
- ❑ **Flash Memory:** 128MB.

2.4.9 Communication Channels

- ❑ **RS-232:** One channel, up to 115,200 bps
- ❑ **RS-232/422:** One channel, up to 115,200 bps
- ❑ **Ethernet Channel:** TCP/IP 10/100 Mbits/sec (10/100 BaseT)

Note



Simultaneous communications through all channels is supported.

2.4.10 Power Supplies

- ❑ **Control Section:**
 - **Voltage:** 24Vdc ($\pm 20\%$).
 - **Current:** Up to 4A.
- ❑ **Mechanical Brake:**
 - **Voltage:** 5-30Vdc ($\pm 10\%$).
 - **Current:** Up to 3A.
- ❑ **I/O Section:**
 - **Voltage:** 5Vdc ($\pm 10\%$) or 24Vdc ($\pm 20\%$).
 - **Current:** Up to 0.8A.
- ❑ **Safety Inputs Section:**
 - **Voltage:** 5Vdc ($\pm 10\%$) or 24Vdc ($\pm 20\%$).
 - **Current:** Up to 0.2A.

❑ **Drive Power Section:**

- **Single phase supply:** Voltage 90Vdc to 125Vdc, 100Vac to 240Vac, or Low Voltage option 17Vdc-85Vdc, current up to 18A RMS-up to 4800W continuous, 7200W peak (1 second).
- **Three phase supply:** Voltage 230Vac phase-to-phase. Current per phase up to 18A RMS for a total of 8200W continuous, 12,300W peak. (1 second).for all phases.

Note



If the input power is above 4000W, user-supplied external air flow cooling is required on the heat sink.

- **Regeneration:** Module provides an internal regeneration shunt resistor rated at 100Ω/100W (continuous). If required, an external shunt resistor (rated >13Ω) can be connected.

2.4.11 Environment

- ❑ **Operating Temperature:** 0 C° to 40 C°.
- ❑ **Storage Temperature:** -40 C° to 85 C°.
- ❑ **Humidity:** 90% RH, non-condensing.

2.5 Dimensions

Figure 2 illustrates the SPiiPlus CM front panel dimensions.

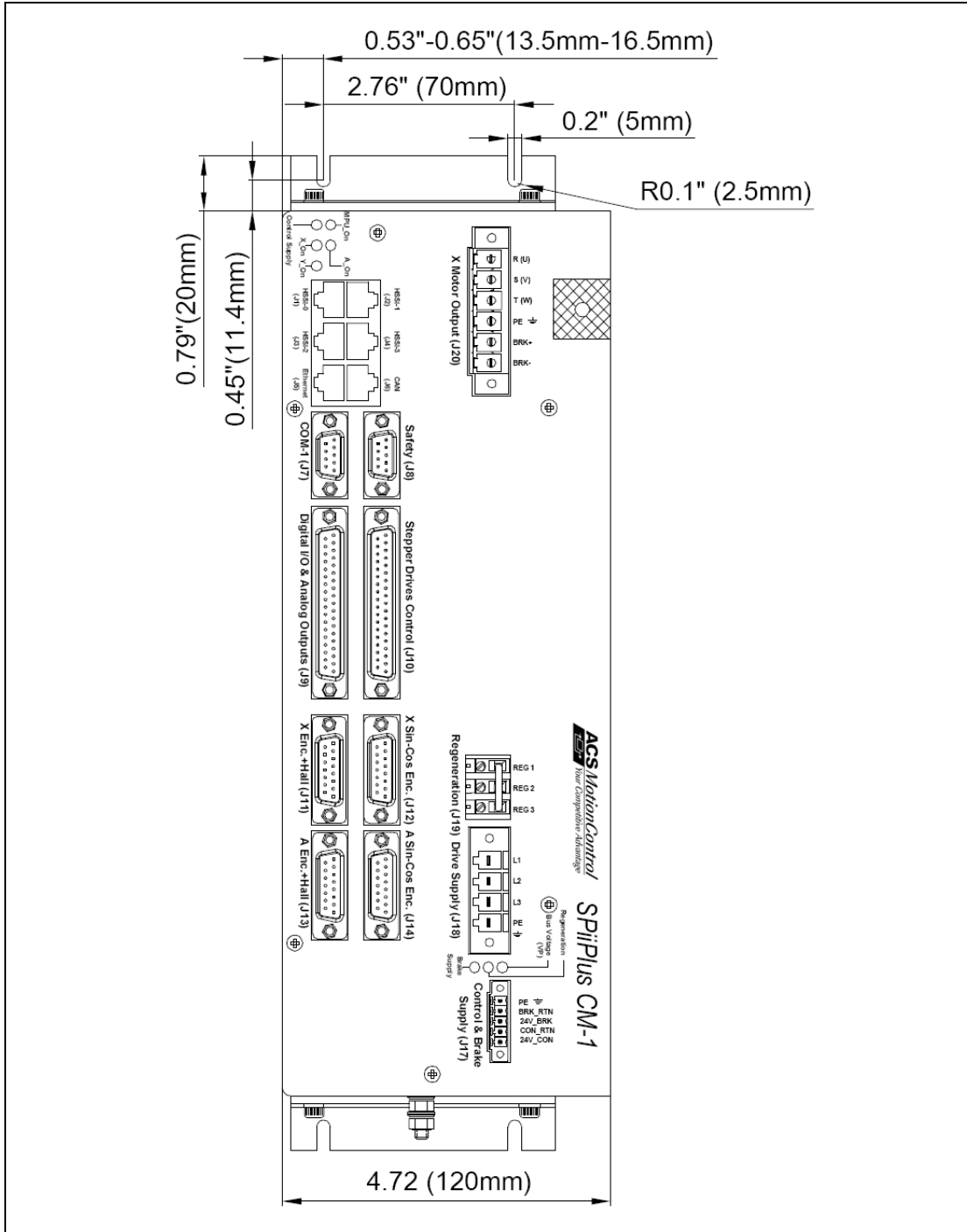


Figure 5 SPiiPlus CM-1 Revision B Front Panel Dimensions

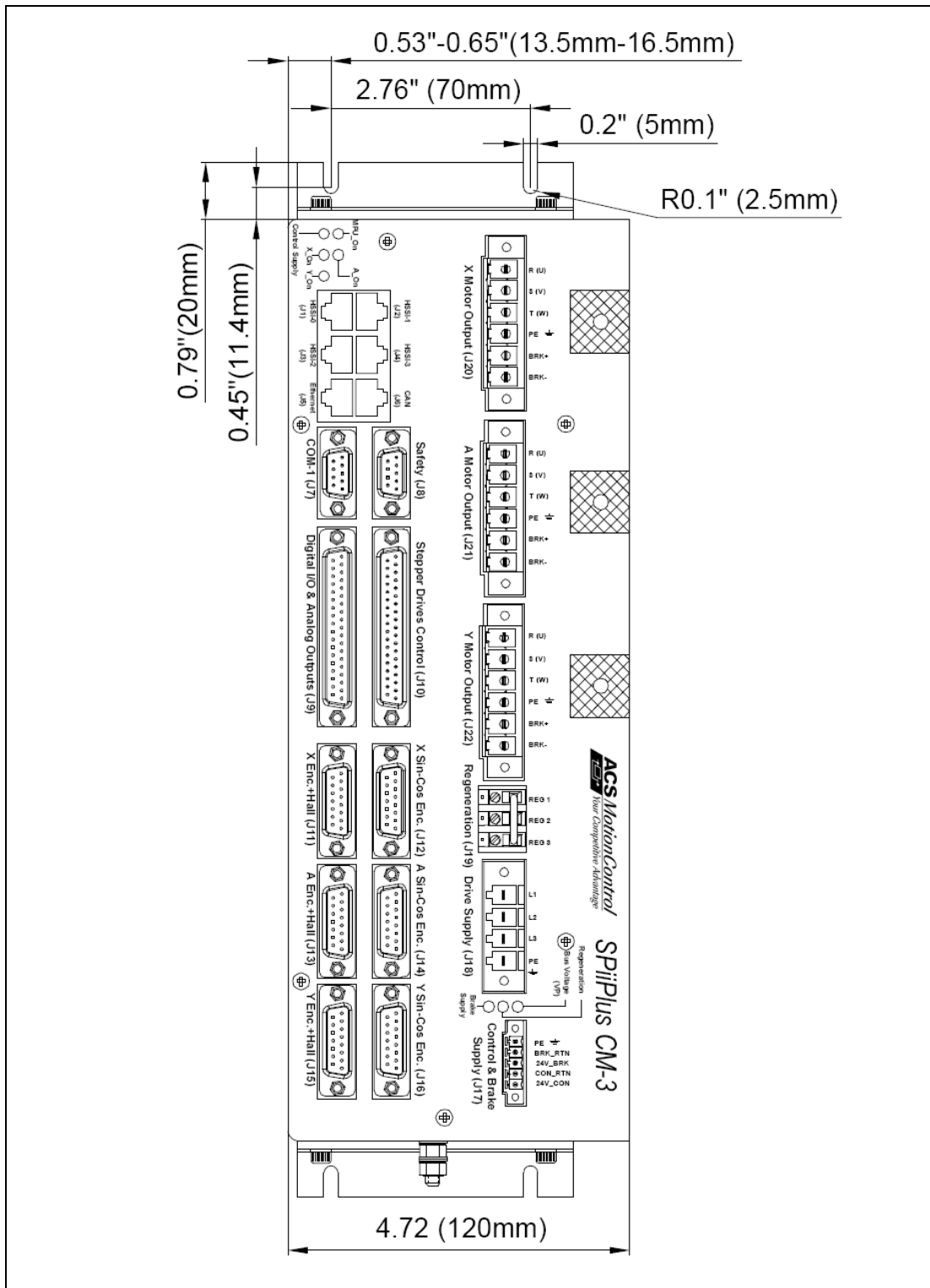


Figure 7 SPiiPlus CM-3 Revision B Front Panel Dimensions

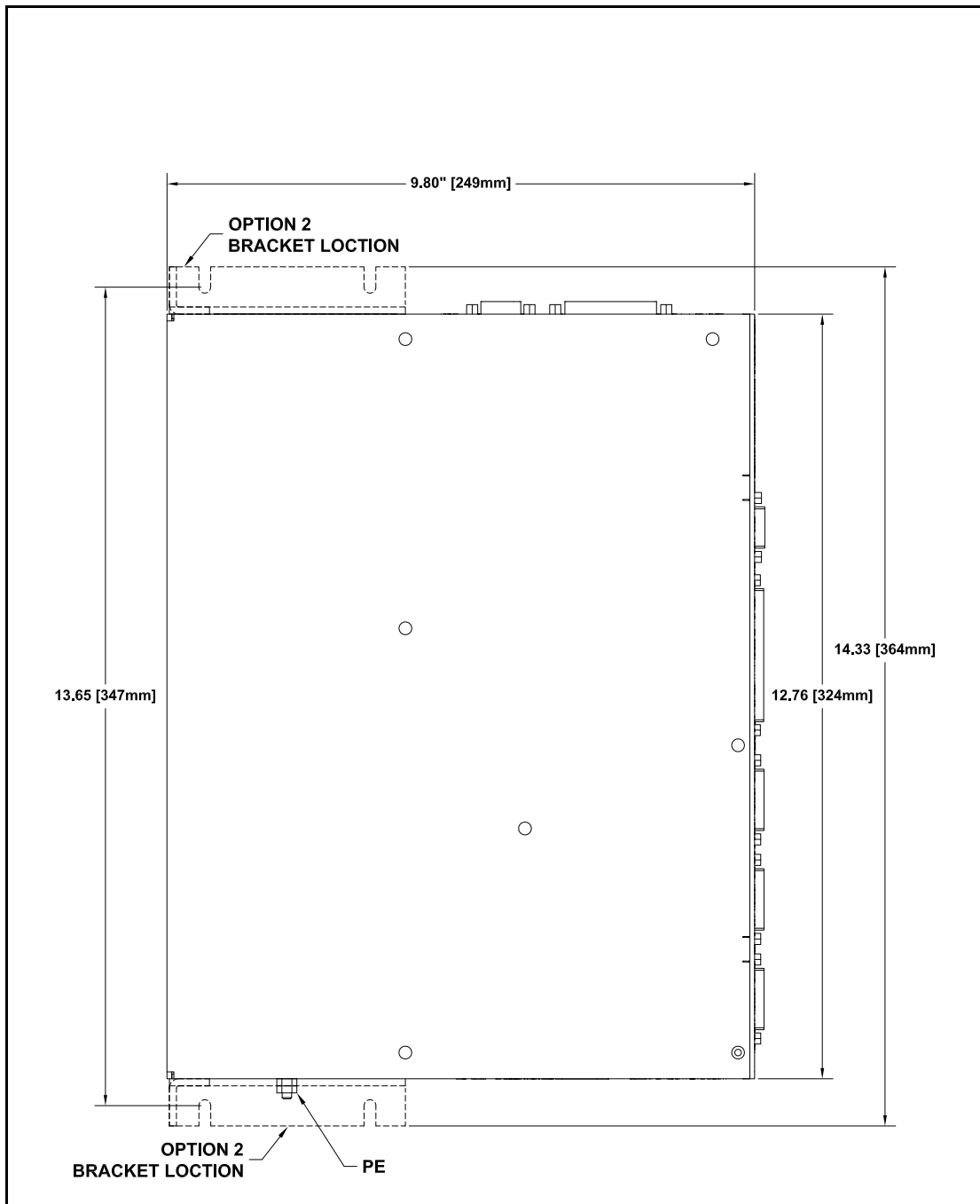


Figure 8 Bottom Dimensions

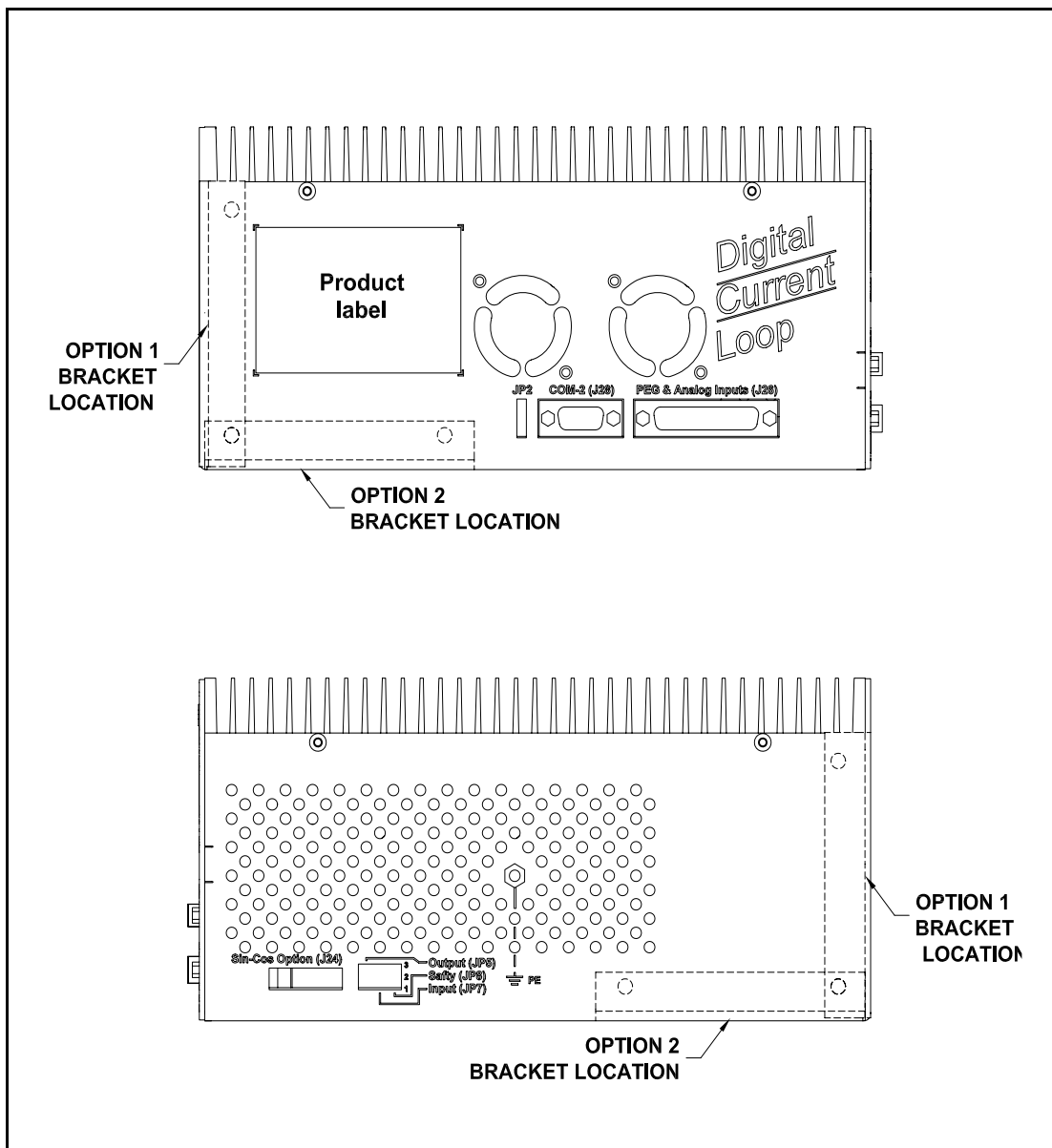



Figure 9 SPiiPlus CM Side Views and Bracket Locations

2.6 SPiiPlus CM Mounting Options

 <p>Note</p>	<p><i>The fans of the controller exhaust air into the controller. To allow proper air flow into the controller, mount the controller at least 5cm away from any object that may obstruct air flow.</i></p>
--	--

The SPiiPlus CM can be mounted vertically or horizontally as follows:

- ❑ The SPiiPlus CM is equipped with holes for vertical mounting
- ❑ Two metal brackets are provided for horizontal mounting

Figure 10 illustrates these mounting options.

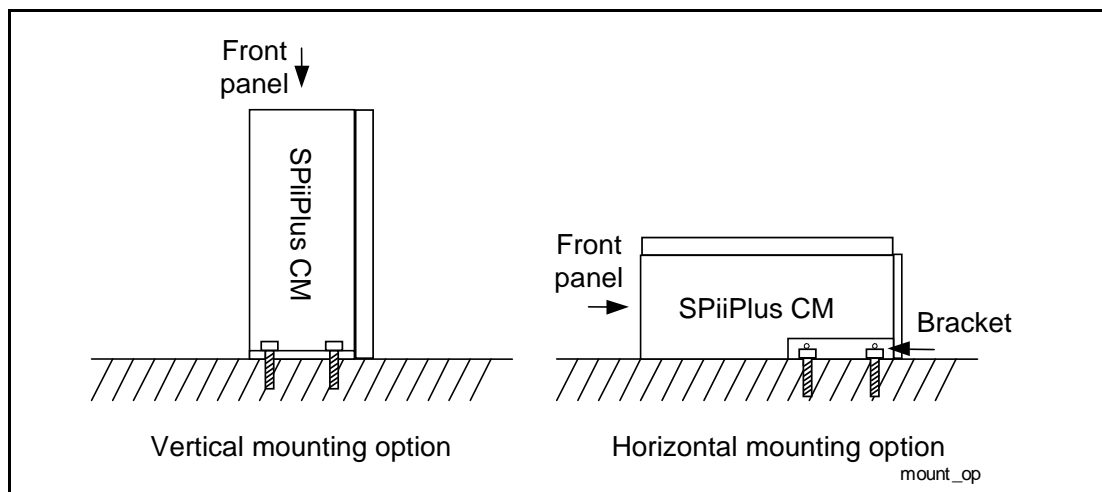


Figure 10 SPiiPlus CM Mounting Options

2.7 Ordering Options and Content of Products

Figure 11 illustrates the SPiiPlus CM ordering code elements. These elements and options are described in **Table 7**.

SPiiPlus CM - X - Y - E - M# - [H#] - [LV]

Figure 11 SPiiPlus CM Ordering Code Elements

Table 7 SPiiPlus Ordering Code Options

Element	Description
X	This is the number of integrated drives, the value of X can be: 1 - One integrated drive 2 - Two integrated drives 3 - Three integrated drives
Y	This is the integrated drives' current level (sine amplitude) and the value of Y can be: A - 5A continuous/10A peak B - 10A continuous/20A peak C -15Acontinuous//30A peak
E	The communications options, which are: RS-232, RS-422 and Ethernet 10/100BaseT channels
M#	The number of optional encoder sine/cosine multipliers and can be: M0 - No sine/cosine multiplier M1 - One sine/cosine multiplier M2 - Two sine/cosine multipliers M3 - Three sine/cosine multipliers
H#	Optional field, representing the number of optional HSSI channels and SPii processors and can be: No code - One or two channels (default) H1 - One channel H2 - Two channels H3 - Three channels H4 - Four channels (maximum)
LV	Optional field, represents Low Voltage option and can be: No code - Standard high-voltage drive supply LV - 17-85Vdc single phase drive supply

The SPiiPlus CM Revision B is designed to work with the current release of the SPiiPlus SW tools and with firmware Version 6.0 or higher.


The SPiiPlus CM Revision B will be shipped with:

- Firmware Version - current version
- SPiiPlus ADK CD-ROM including the SPiiPlus Software tools

The SPiiPlus ADK (Advanced Development Kit) CD is intended for programmers who develop ACSPL+ based applications and host-based programs. The 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 firmware and recovering from errors

<p>Caution</p> 	<p><i>If you decide to upgrade or downgrade the firmware be sure and use Upgrader version 6.0 or above.</i></p> <p><i>Never downgrade the firmware to versions below 6.0. Doing this may cause the controller to become inoperable.</i></p>
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- ❑ **SPiiPlus Simulator** - for fast application development and debugging
- ❑ SPiiPlus FRF - for analyzing motion frequency response
- ❑ Hardware, software, setup, and programming guides in PDF format
- ❑ ACSPL+ and C/C++ training files and programming examples
- ❑ MATLAB/Simulink servo algorithm models

2.8 Additional Products

2.8.1 SPiiPlus CM-ACC

<p>Note</p> 	<p><i>The SPiiPlus CM does <u>NOT</u> come with user-side connectors, with the exception of the J18 drive supply mating connector.</i></p>
--	--

The SPiiPlus CM-ACC includes the following items:

- ❑ All mating (user-side) connectors, except for J18 drive supply, which supplied with each unit. The manufacturer and part number for each mating connector is described under each connector in the manual.
- ❑ Three spring-loaded clamping yokes, illustrated in [Figure 12](#). The clamp yoke manufacturer designation and part number are: Weidmuller Clamping Yoke F, P/N CC-KLBU4-135.



Figure 12 SPiiPlus CM Clamping Yoke F

The screw terminal includes a pressnut (PEM P/N CLS-M4-2) that allows the use of M4 screws.

2.8.2 HSSI-IO16

The HSSI-IO16 is an I/O expansion module that provides 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.

2.8.3 HSSI-ED2

The HSSI-ED2 module provides a convenient and cost-effective way to interface the SPiiPlus controller with two distributed axes. The module includes two motor drive interfaces with the following characteristics:

- $\pm 10V$ ptp torque command
- two three-channel quadrature (A & B, I) encoder inputs
- Four limit switches
- Eight/eight general purpose digital I/Os

For more information, refer to the HSSI-ED2 data sheet.

2.9 How to Determine the Product Features from the Product Label

Support features are listed on the product label, which appears on the side of the SPiiPlus CM CM.

Figure 13 illustrates an example of a SPiiPlus CM CM label:




SPiiPlus CM-3-B-E-M3-H4  	
AC Single Phase Drive Supply	100-240Vac; 16A; 50/60Hz
AC Three Phase Drive Supply	See H/W Manual
DC single Phase Drive Supply	90-125Vdc; 16A ---
DC Control & Brake Supply	19-29Vdc; 3A ---
Number of Digital Drives	Three (X, Y, A axes)
Digital Drives Cont./Peak Current	10/20A (sine amplitude)
RS-232 / RS232/422 / Ethernet	Yes / Yes / Yes
Number of Sin-Cos Multipliers	Three
HSSI Channels Available	Four (#0, #1, #2, #3)
Serial Number / HW Revision	CM000005 / B1
Production Date	June 14, 2005
 <i>ACS MotionControl</i> <small>Your Competitive Advantage</small>	

Figure 13 SPiiPlus CM Label

3 Safety and EMC Guidelines

This chapter provides general safety and EMC guidelines as they apply to the SPiiPlus CM Revision B.

3.1 Certifications

The SPiiPlus CM is CE certified as follows:

- CE certified for single phase power supplies, with additional certifications pending
- CSA certified for single phase and three phase power supplies


The following certificates have been issued to ACS MotionControl for the SPiiPlus CM:

- CE, Safety of Machinery report: Directive 98/37/EC according to IEC 60204: 1997. Download the full report from our web site: www.AcsMotionControl.com.
- CE, EMC report: Directive 89/336/EEC, Article 7(1) according to EN 61326:1997 + A1(98) + A2(01), equipment intended for use in industrial locations. Download the full CE report from our web site: www.AcsMotionControl.com.
- CSA Standard C22.2 No. 0: General Requirements – Canadian Electrical Code, Part II.
- CSA Standard C22.2 No. 14: Industrial Control Equipment
- ANSI/UL 508C: Power Conversion Equipment

Figure 14 shows the standards organization marks that appear on the SPiiPlus CM.




Figure 14 Standards Organization Marks

<p>Warning</p> 	<p><i>SPiiPlus CM is for use in restricted access locations and by qualified personnel only.</i></p>
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3.2 General Safety Guidelines

<p>Warning</p> 	<p><i>Read and understand the following precautions before operating the SPiiPlus CM!</i></p>
---	--

Before connecting the SPiiPlus CM to the power line, make sure that the protective ground terminal is connected to the safety ground conductor of the mains power cord. See [Section 3.3.1 - External AC Line Filters and Circuit Breakers](#).

<p>Caution</p> 	<p><i>ACS MotionControl recommends using a 16A branch circuit overturned protection fuse for each phase—to protect AC and DC power sources. Use one fuse for each phase and place the fuses as close to the controller as possible.</i></p> <p><i>This precaution is designed to protect the internal 20A fuses.</i></p>
---	--


- This SPiiPlus CM comes with a connection between the grounded conductor of the DC supply circuit and the grounding conductor. The protective ground conductor shall be connected before the supply conductors and disconnect only after disconnect the supply conductors.
- The SPiiPlus CM shall be connected directly to the DC supply system, there shall be no switching or disconnecting devices in the grounded circuit conductor between the DC source and the point of connection of grounding electrode conductor.
- Under emergency situations the SPiiPlus CM should be completely disconnected from any power supply. The E-Stop Inputs and Left/Right Limits on ACS MotionControl 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.

<p>Warning</p> 	<p><i>Read and understand the following precautions before operating the SPiiPlus CM!</i></p>
---	--

- To avoid electric arcing and hazards to personnel and electrical contacts, never connect or disconnect the control module while the power source is on.
- The control module contains hot surfaces and electrically-charged components during operation.
After power down and removal of the power source from the SPiiPlus CM, wait five minutes before touching the unit or disconnecting parts from the SPiiPlus CM and other equipment, that are normally loaded with electrical charges, including capacitors and

contacts. Measure and check the electrical contact points for electrical load to ascertain a safe condition before touching the unit or disconnecting parts from the SPiiPlus CM.

3.2.1 Emergency Stop Device

Warning 	<p><i>Reread and understand the following precautions before operating the SPiiPlus CM!</i></p>
---	--

1. Locate an emergency stop device at each operator control station and other operating stations where an emergency stop may be required.
2. The emergency stop device shall disconnect all electrical equipment connected to the SPiiPlus CM from their respective power supplies.
3. It will not be possible to restore the circuit until the operator manually resets the emergency stop.
4. In situations with multiple emergency stop devices the circuit shall not be restored until all emergency stops devices are manually reset.


3.2.2 Fail-Safe Logic Recommendation

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

3.2.3 Electrical Separation

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

3.2.4 Protective Precautions

Warning 	<p><i>Read and understand the following precautions before operating the SPiiPlus CM!</i></p>
---	--

- Digital outputs are protected against short circuit with ground. A short circuit on any digital output will disable ALL digital outputs without any indication by the software. The digital outputs will become enabled again only after controller power-up.
- Over-travel Protection—Provide over-travel limit protection where over-travel is hazardous. Design and install the over-travel limiting device to interrupt the power circuit.

- Over-current Protection–Use the software Current/Torque Limit parameters in the MMI Adjuster to provide over-current protection for the motors.
- Thermal Detection–Suitable thermal detection devices to interrupt the power circuit where abnormal temperatures can cause a hazardous condition.
- Cooling Fans–Make sure the cooling fan remains unobstructed at all times
- In order to insure good heat dissipation, make sure that the cooling vanes remain clean at all times.

3.2.5 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 side of the SPiiPlus CM) and the equi-potential bar inside electrical enclosure.

3.3 General Wiring and Electromagnetic Compatibility (EMC) Guidelines

3.3.1 External AC Line Filters and Circuit Breakers

An external AC line filter is required to prevent noise from returning to the line and to insure the SPiiPlus CM meets strict RFI European regulations for CE certification. ACS MotionControl has tested and certified the following Corcom (www.corcom.com) AC line filters:

- For a single phase AC supply - 16FC10 model
- For 3 x 220Vac (phase - phase) - 16FCD10 model.

Note



The above Corxom filters meet the requirements for CE certification. Similar products may also meet CE requirements, however these products have not been tested and certified by ACS MotionControl.

These filters perform best when installed on the line side of the motor drive.

ACS MotionControl recommends using a 16A branch circuit overturned protection fuse for each phase—to protect AC and DC power sources. Use one fuse for each phase and place the fuses as close to the controller as possible.

This precaution is designed to protect the internal 20A fuses.

3.3.2 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 15](#). For example, if the motor and encoder cables run parallel for 6 feet (~2 m), maintain a 2 inch (~5 cm) separation between them.

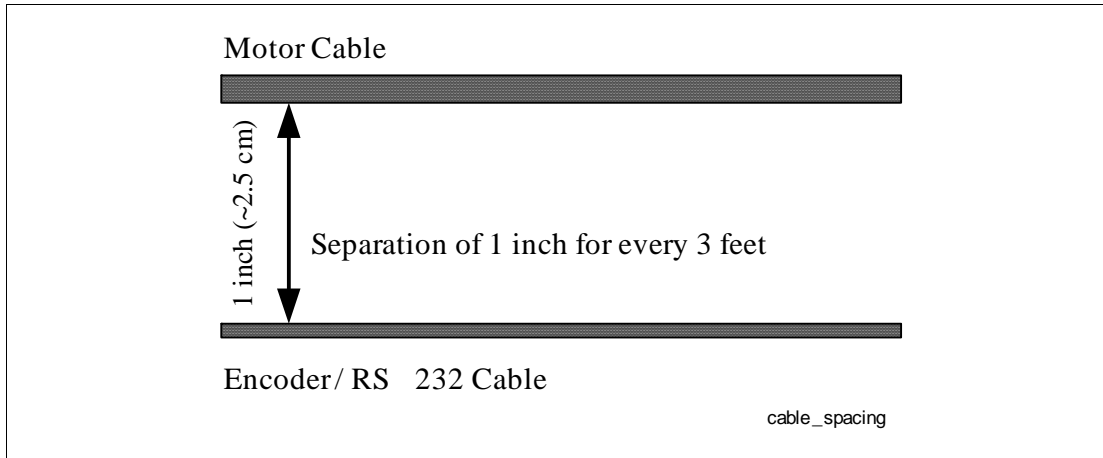


Figure 15 Cable Spacing

It is recommended to use completely shielded cables as illustrated in [Figure 16](#).

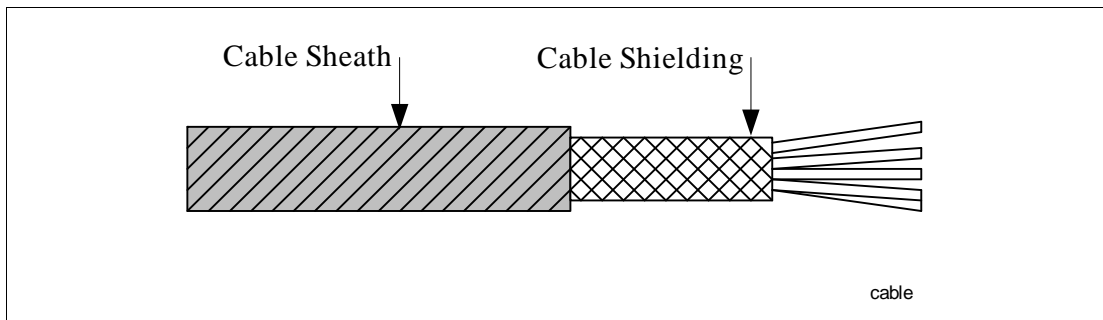


Figure 16 Shielded Cable

3.3.3 Cable Length

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

3.3.4 Shielding

To reduce EMI radiation, do the following:

- Use shielded cables
- Install a ferrite core around the cable as close to the SPiiPlus CM as possible as illustrated in [Figure 17](#).

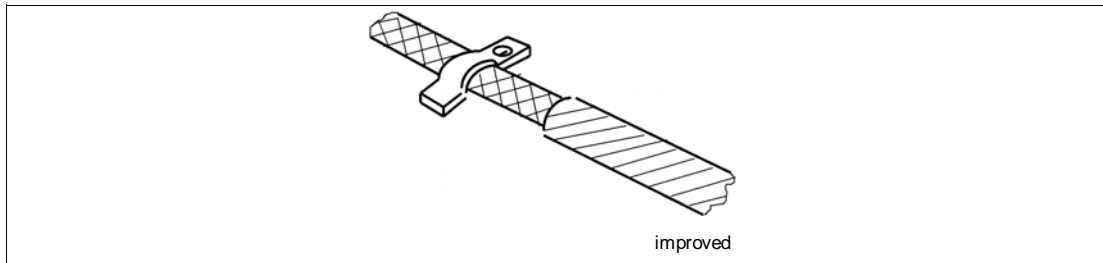



Figure 17 Improved Shielding

The SPiiPlus CM comes ready for the installation of three spring-loaded clamps to facilitate connecting the motor shielding to the ground.

3.3.5 Grounding

Grounding system electrical components is crucial in two aspects:

- Safety grounding

<p>Warning</p> 	<p><i>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).</i></p>
--	---

- 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 SPiiPlus CM) and the equipotential bar inside the electrical cabinet.

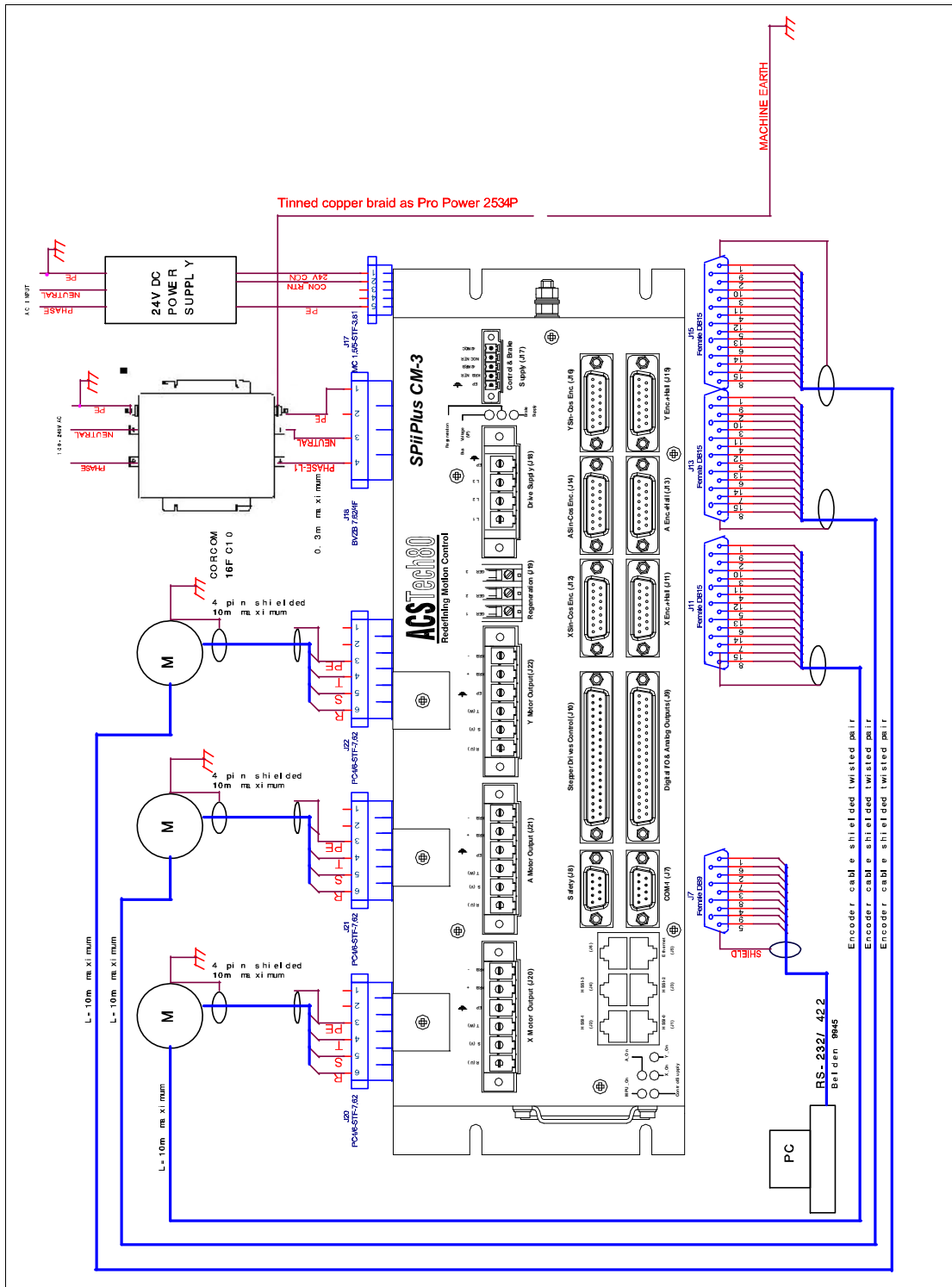


Figure 18 System Grounding

4 Electrical Interface


<p>Model</p> 	<p><i>This chapter describes the interface of the SPiiPlus CM-3 Revision B. The interfaces of the SPiiPlus CM-1 and the SPiiPlus CM-2 are identical to those of SPiiPlus CM-3 with the following exceptions:</i></p> <p><i>In the SPiiPlus CM-2 the following connectors are not present:</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> Y Motor Output (J20) <input type="checkbox"/> Y Sin-Cos Encoder (J16) <input type="checkbox"/> Y Encoder + Hall (J14) <p><i>In the SPiiPlus CM-1 the following connectors are not present:</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> Y Motor Output (J20), <input type="checkbox"/> Y Sin-Cos Encoder (J16) <input type="checkbox"/> Y Encoder + Hall (J15) <input type="checkbox"/> A Motor Output (J21) <input type="checkbox"/> A Sin-Cos Encoder (J14) <input type="checkbox"/> Y Encoder + Hall (J13)
---	---

Table 8 lists the SPiiPlus CM electrical interfaces by group.

Table 8 Electrical Interfaces by Group (page 1 of 2)

Group	Functionality	Connector	Reference
Supply	Control And Brake Supply (24vdc)	J17	Section 4.3
	Drive Supply	J18	Section 4.2
Regeneration	Internal Or External Regeneration	J19	Section 4.4
I/O	General Purpose Digital Inputs	J9	Section 4.9
	General Purpose Digital Outputs	J9	Section 4.9
	Mark Fast Digital Inputs	J9	Section 4.9
	PEG Pulse Fast Outputs	J9, J26	Section 4.9 , Section 4.10
	PEG States Fast Output	J26	Section 4.10
	Mechanical Brake High Current Outputs	J20, J21, J22	Section 4.5
	General Purpose Differential Analog Inputs $\pm 10V$ ptp	J11, J13, J15	Section 4.7
Joystick Single-ended Analog Inputs $\pm 10V$	J26	Section 4.10	

Table 8 Electrical Interfaces by Group (page 2 of 2)

Group	Functionality	Connector	Reference
I/O	General Purpose Single-ended Analog Outputs 10V ptp	J9	Section 4.9
	Digital Encoder Differential Inputs	J12, J14, J16	Section 4.8
	Analog Encoder Differential Inputs or 1Vptp	J11, J13, J15	Section 4.7
	Safety Inputs and E Stop	J8	Section 4.11
Motor	Motor Output	J20, J21, J22	Section 4.5
	RS232/RS422 for J7; RS232 for J7 and J23	J7, J23	Section 4.13
	Ethernet, 10/100BaseT	J5	Section 4.14
Communication	High Speed Synchronous Serial Interface (HSSI)	J1, J2, J3, J4	Section 4.12

4.1 Electrical Interface Component Locations

Figure 19 illustrates the SPiiPlus CM-3 Revision B front panel. (Double-click the image to open as a PDF.)

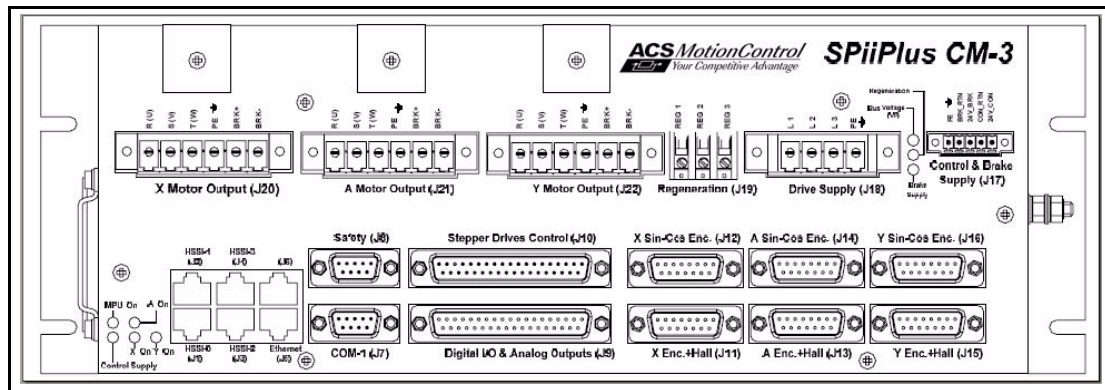


Figure 19 Front Panel Connectors - SPiiPlus CM

Refer to [Figure 9](#) for an illustration of the left end panel, and the right end panel.

4.2 J18 - Drive Supply

Connector J18 receives supply power for the integrated digital drives.

The drive power supply is same for all installed digital drives. The following power supplies are available:

- ❑ **Single-Phase:**
 - 90-125Vdc
 - 100-240Vac input supply (supply frequency 50/60Hz)
 - Low Voltage option 17-85Vdc.

- ❑ **Two-Phase 230Vac Phase-to-Phase:**
230Vac Phase-to-Phase (supply frequency 50/60Hz)
- ❑ **Three-Phase 230Vac:**
230Vac Phase-to-Phase (supply frequency 50/60Hz)

Table 9 details the J18 connector.

Table 9 J18 - Drive Supply Connector

Item	Description
Jack on SPiiPlus CM	Connector Type: Weidmuller™ SV 7.62/4/90F P/N1822410000
Plug from System	Mating Connector Type: Weidmuller™ BVZB 7.62/4F P/N 1821650000 This connector is supplied with each unit.
Recommended Wires	Safety Approved 18-14AWG


<p>Note</p> 	<p><i>After powering the drive supply, a soft-start mechanism is activated for five seconds to limit the inrush current that the SPiiPlus consumes from the electricity network. During these five seconds the user should not enable any of the axis (X,A or Y). If any of these axes are being enabled by the user, an error 5071 will be activated.</i></p>
--	--

Figure 20 illustrates the J18 pin layout.

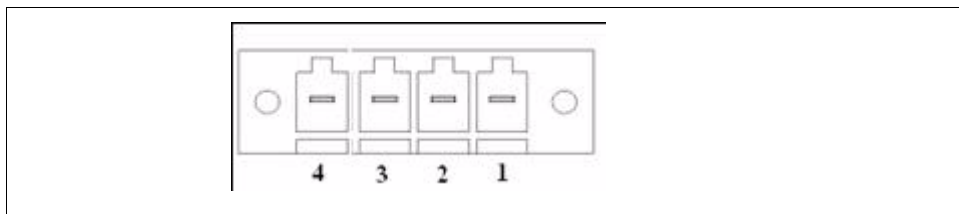


Figure 20 J18 - Drive Supply Connector Pin Layout

The following tables detail the J18 pinout for various current supplies:

- ❑ **Table 10 - J18 Single-Phase 17-85Vdc or 90-125Vdc Supply Pinout**
- ❑ **Table 11 - J18 Single-Phase 100-240Vac Supply Pinout**
- ❑ **Table 12 - J18 Two-Phase 230Vac (Phase-to-Phase) Pinout**
- ❑ **Table 13 - J18 Three-Phase 230Vac (Phase-to-Phase) Pinout**

Table 10 J18 Single-Phase 17-85Vdc or 90-125Vdc Supply Pinout

Pin	Name	Description
1	L1	Phase input for single phase supply
2	L2	Neutral input for single phase supply
3	L3	N/A
4	PE	Electrical ground

Table 11 J18 Single-Phase 100-240Vac Supply Pinout

Pin	Name	Description
1	L1	Phase input for single phase supply
2	L2	Neutral input for single phase supply
3	L3	N/A
4	PE	Electrical ground

Table 12 J18 Two-Phase 230Vac (Phase-to-Phase) Pinout

Pin	Name	Description
1	L1	Phase R input
2	L2	Phase S input
3	L3	N/A
4	PE	Electrical ground, connected to protective earth wire

Table 13 J18 Three-Phase 230Vac (Phase-to-Phase) Pinout

Pin	Name	Description
1	L1	Phase R input
2	L2	Phase S input
3	L3	Phase T input
4	PE	Electrical ground

4.3 J17 - Control and Brake Supply

The control and mechanical brake supply is a separate circuit from the internal drive supply. This ensures that control will continue to operate and mechanical brakes will continue to be supplied even in the event that power to the integrated drives is lost.

Table 14 details the J17connector.

Table 14 J17 - Control and Brake Supply Connector

Item	Description
Jack on SPiiPlus CM	Part number: MC 1,5/5-GF-3,81 Phoenix Contact TM Type: 5 pin plug connector
Plug from System	Part number: MC 1,5/5-STF-3,81 Phoenix Contact TM
Recommended Wires	Safety Approved 18-14AWG

Figure 21 illustrates the J17 pin layout.

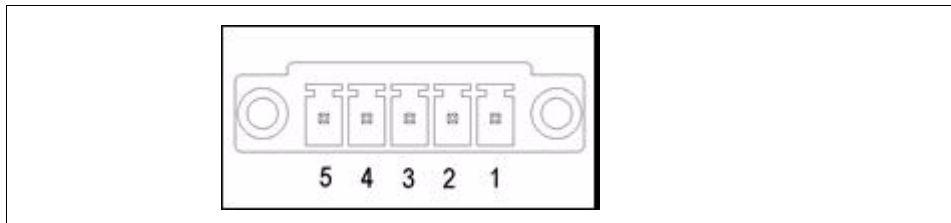



Figure 21 J17 - Control and Brake Supply Connector Pin Layout

Table 15 provides the J17 pinout.

Table 15 J17 - Control and Brake Supply Pinout

Pin	Name	Description
1	PE	Electrical ground
2	BRK_RTN	Brake supply return
3	BRK_SUP	Brake supply: 5-30Vdc ($\pm 10\%$) up to 3A
4	CON_RTN	24Vdc control supply return
5	24V_CON	Control supply: 24Vdc ($\pm 20\%$)/ up to 3A

Note	
	<i>24V control supply and brake supply are protected by two internal 4A fuses.</i>

4.4 J19 - Regeneration

This section covers the following topics:


- [Section 4.4.1 - Regeneration Overview](#)
- [Section 4.4.2 - Calculating External Regeneration Resistor Requirements](#)
- [Section 4.4.3 - Regeneration Interface](#)

4.4.1 Regeneration Overview


A regeneration circuit with an internal shunt or external shunt resistors can be used to absorb a motor's regeneration energy during axis deceleration. Braking the motor causes energy stored in the moving mechanical mass to be returned to the drive power supply. Since the power supply is not able to regenerate this energy back to the AC input supply, the power supply capacitor is charged up beyond its normal level. If the excess braking energy is low, then the capacitor may be able to absorb the excess energy and simply return it to the motor during the next motoring period. However, if the excess energy is high, then a clamp circuit is used to limit the bus voltage to a safe level (400V) and to dissipate the excess energy as heat in an internal or external power resistor.

The shunt regulator is specified to handle peak power and continuous power instances. If the peak power is exceeded, the clamp circuit will not be able to limit the voltage to a safe level, and the drive high voltage protection will be activated.

In practice, if peak shunt power is being exceeded, check to see if the current limit can be lowered or if the deceleration time can be lengthened.

<p>Caution</p> 	<p><i>Applications that frequently stop and start with high inertia and high speed should be studied closely to see if continuous shunt power is exceeded.</i></p>
---	---

If the internal shunt resistor value is too low, an over-voltage alarm will be generated during deceleration of the axis.

<p>Note</p> 	<p><i>In this case, use a higher rated external shunt resistor instead of the internal shunt resistor.</i></p>
--	--

4.4.2 Calculating External Regeneration Resistor Requirements


The purpose of the procedure described in this section is to:

- Calculate the regenerated power and energy values during deceleration.
- Identify if an external shunt resistor is required.
- If an external resistor is required, to calculate external shunt resistor and fuse ratings

Table 16 describes the external regeneration resistor parameters and total power.

Table 16 Regeneration Parameters

	Continuous Power [W]	Peak Power [W]	Regeneration Fuse [A]
With internal shunt resistor	100 W	1000 W	There is no internal regeneration fuse
With external shunt resistor	Add and calculate the value of the external fuse on a per case basis, 13Ω minimum.		

 <p>Note</p>	<p><i>If an external resistor is required, add an external fuse like KLKD series by Littlefuse</i></p>
--	--

1. Define the motion profile parameters, mass and cycle of the motion as follows:
 - Maximum linear velocity: v [m/sec] or angular velocity: ω [rad/sec]
 - Maximum linear deceleration: a [m/sec²] or angular deceleration: α [rad/sec²]
 - Deceleration time of the motion: T_d [sec]
 - Total mass: M [Kg] (for linear axis) or inertia: J [Kg x m²] (for rotary axis)
 - Motor phase current during deceleration: I_d [A]
 - Motor phase resistance: R_{ph} [Ω]
 - Number of motor phases: n ($n=1$ for DC brush motor)
 - Motor Force constant: K_f (for linear axis) or torque constant: K_T (for rotary axis)
 - Line to line supply voltage amplitude: U_{L-L} [V]
 - Shunt resistor clamping voltage: $U_{clamp} = 400$ [V]
 - Total capacitance of the SPiiPlus CM: $C=4000\mu F$
2. Define the motion profile parameters and cycle of the motion as illustrated in **Figure 22**:

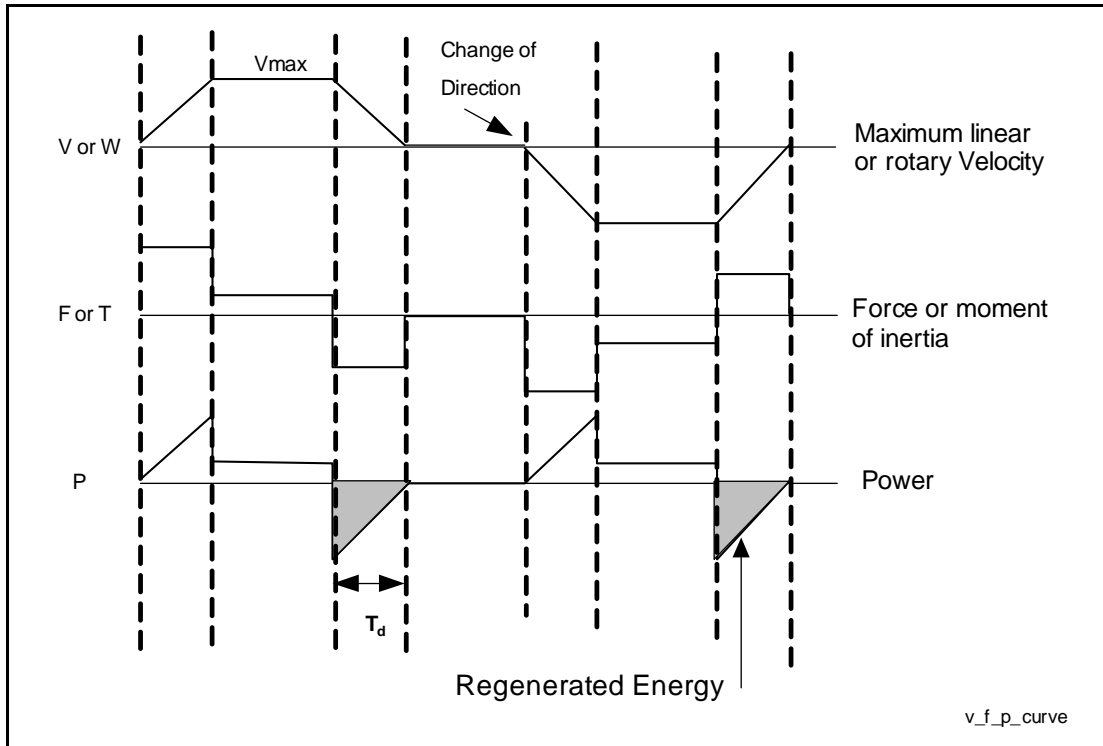


Figure 22 Example of Velocity, Force and Power Curves

(1)

3. Calculate the peak break power for a linear axis:

$$\text{Peak Power [W]} = v_{\max} [\text{m/sec}] \times M[\text{kg}] \times a[\text{m/sec}^2]$$

(2)

4. Calculate the peak break power for a rotary axis:

$$\text{Peak Power [W]} = \omega_{\max} [\text{m/sec}] \times J[\text{kg}] \times \alpha[\text{m/sec}^2]$$

(3)

5. Calculate the total break energy (triangular area):

$$\text{BreakEnergy[J]} = \frac{\text{PeakPower} \times T_d}{2}$$

(4)

6. Calculate the motor conductive energy loss during deceleration.

$$\text{Motor Loss [J]} \approx n \times I_d^2 R_{\text{phase}} \times T_d$$

where $I_d = \frac{Ma}{K_F}$ is for a linear axis, and $I_d = \frac{J\alpha}{K_T}$ is for a rotary axis calculations

(5)

7. Calculate the capacitor charging energy during deceleration (depends of the drive supply voltage)

$$\text{CapacitorEnergy[J]} \approx \frac{1}{2} C [U_{\text{clamp}}^2 - (\sqrt{2} U_{L-L})^2]$$

Note


For example, if the AV mains = 220Vac:

$$\text{CapacitorEnergy[J]} \approx \frac{1}{2} (4000 \times 10^{-6}) [400^2 - (\sqrt{2} \times 220)^2] = 126.4\text{J}$$

(6)

8. Calculate the regeneration shunt resistor energy:


$$\text{Shunt Energy [J]} = \text{Break Energy} - \text{Capacitor Energy} - \text{Motor Loss}$$

<p>Note</p> 	<p><i>Motor losses may be neglected, giving additional regeneration margins to the chosen shunt resistor.</i></p> <p><i>In case of a negative result, no energy should be absorbed by the shunt internal resistor.</i></p>
--	--

(7)

9. Calculate the regeneration shunt resistor power rating:

$$\text{Shunt power}[W] \approx \frac{\text{Shunt Energy}}{T_d}$$

<p>Note</p> 	<p><i>An external shunt resistor is required in the following cases:</i></p> <ol style="list-style-type: none"> <i>1. If the result is larger than the internal shunt continuous rating (100W).</i> <i>2. If the peak power is larger than the peak internal shunt rating (1000W).</i>
---	--

10. If an external shunt resistor is required, calculate the required fuse rating according to the following formula:

$$\text{Fuse}[A] \approx \sqrt{\frac{\text{Shunt power}[W]}{\text{External shunt}[\Omega]}}$$

Table 17 details the J19 connector.

Table 17 J19 - Regeneration

Item	Description
Jack on SPiiPlus CM	Part number: FRONT 2.5-H/SA5 Phoenix Contact TM 3-pin terminal block
Plug from System	No plug – accepts wires directly
Recommended Wires	Safety Approved 18-16AWG

Figure 21 illustrates the J19 pin layout.

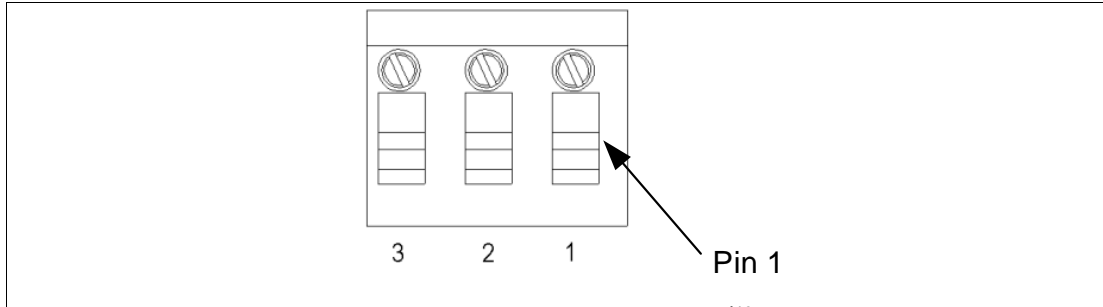


Figure 23 J19 - Regeneration Connector Pin Layout

Table 18 provides the pinout for J19.

Table 18 J19 - Regeneration Pinout

Pin	Name	Description
1	REG1	Used for <u>internal</u> regeneration only. Connect via external jumper to pin#3.
2	REG2	Used for <u>external</u> regeneration only. Connect to an external regeneration resistor lead.
3	REG3	For internal regeneration, connect via external jumper to Pin 1. For external regeneration, connect to the other lead of the external regeneration resistor.

Note



*The default configuration of the SPiiPlus CM is with the internal shunt resistor connected. This means that **REG1** and **REG3** are connected.*

4.4.3 Regeneration Interface

The SPiiPlus CM regeneration circuit begins to operate when the bus voltage exceeds 400V. The regeneration circuit can absorb 100W of regeneration energy. Since the nominal bus voltage is 160Vdc, part of the regeneration energy charges the bus capacitors to 400V before the regeneration circuit is activated.

If the regeneration energy is lower than 115 J, then all of this energy is absorbed by the bus capacitors and the regeneration circuit does not activate.

Since the voltage on the bus capacitors may reach 240V ($400V - 160V = 240V$) during regeneration, calculations based on the maximum ripple current via used bus capacitors indicate that the time between regeneration cycles must NOT be $<300mS$.

Figure 24 illustrates the use of an internal shunt resistor.

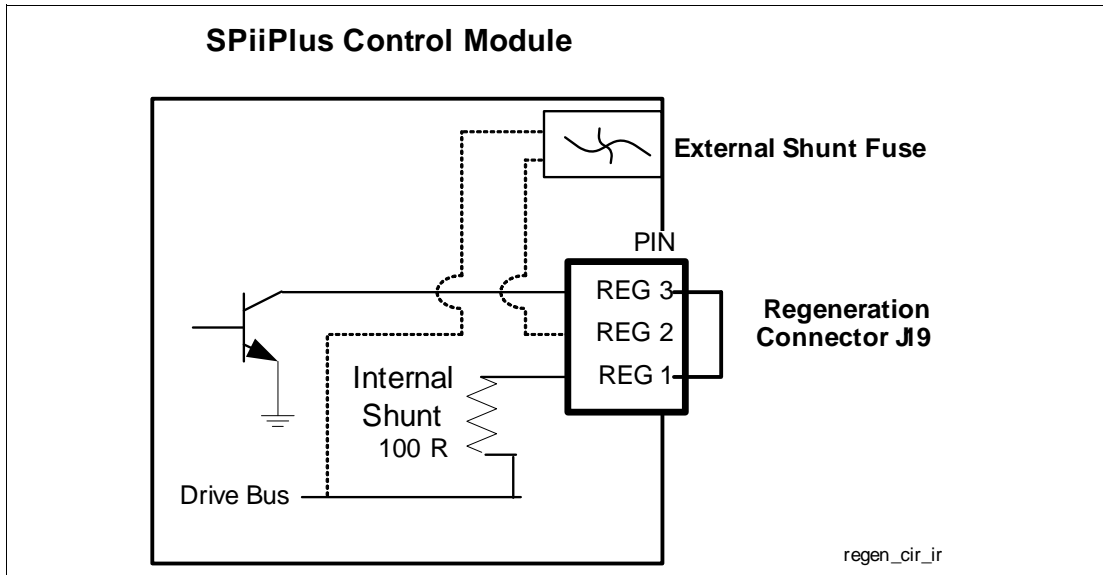


Figure 24 Regeneration Circuit with the Internal Resistor

4.5 J20, J21, J22 - Servo Motor and Brake Output

The motor output connector supplies power from the SPiiPlus CM internal drive to a DC brush or three phase DC Brushless (AC servo) motor.

The connectors also include an output command for a mechanical brake device. This high current output is active when bit 23 in the **MFLAGS** register of the axis is set and the drive is enabled.

Table 19 details the J20, J21 and J22 connector.

Table 19 J20, J21 and J22 - Sevor Motor and Brake Output Connectors

Item	Description
Jack on SPiiPlus CM	Part Number: PC 4/6-G-7.62, Phoenix Contact TM Type: 5 pin plug connector
Plug from System	Part Number: PC 4/6-STF-7,62 Phoenix Contact TM
Recommended Wires	Safety Approved 18-14AWG


Model	
	<p>Connector J20 (all product versions) - supplies X axis motor</p> <p>Connector J21 (in SPiiPlus CM-2/3 only) - supplies A axis motor</p> <p>Connector J22 (in SPiiPlus CM-3 only) - supplies Y axis motor</p>

Figure 25 illustrates the J19 pin layout.

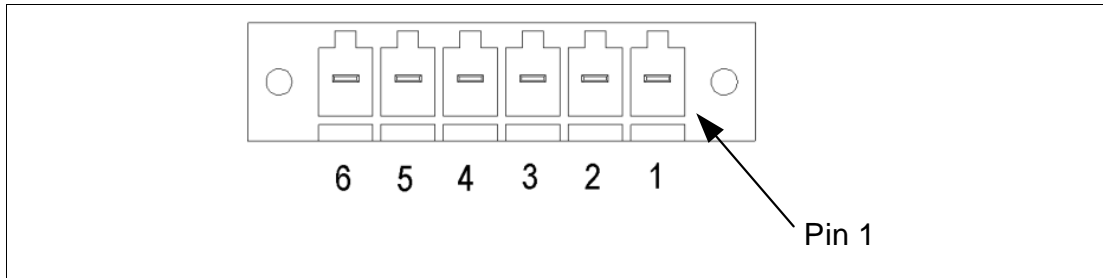


Figure 25 J20, J21 and J22 - Motor Output Connector Pin Layout

Table 20 details the J20, J21, J22 pinout.

Table 20 J20, J21, J22 - Motor Output Pinout

Pin	Name	Description
1	R (U)	For DC brush motor phase For DC brushless motor: phase “R” Note: current of this phase isn’t measured by the controller.
2	S (S)	For DC brush motor phase For DC brushless motor: phase “S”
3	T (V)	For DC brushless motor: motor phase “T”
4	PE	Electrical ground
5	BRK +	5-30Vdc brake output.
6	BRK -	Brake return

4.5.1 Mechanical Brake Interface

There is a single ended opto-isolated mechanical brake output on each Motor Output Connector.

Each mechanical brake output is protected against short circuit, over-current, over-voltage and reverse polarity.

In event of protection initialization the mechanical brake output will be deactivated.


<p>Note</p> 	<ol style="list-style-type: none"> Whenever the mechanical brake output (high current) of an axis is enabled, the output will be automatically activated when the axis is disabled. In addition, delays can be defined between the drive enable command and the mechanical brake output activation/deactivation. For more information, refer to the SPiiPlus Setup Guide, Mechanical Brake section. When the axis is not equipped with a mechanical brake, the mechanical brake outputs can be used as general purpose outputs. When the brake outputs should be used as general purpose outputs with <u>high</u> current, they are used via the Motor Output Connectors (J20, J21, J22). When the brake outputs are used as general purpose outputs with <u>low</u> current, they are used via the Digital I/O and Analog Output Connector (J9)
--	--

Table 21 details the Mechanical Brake output.

Table 21 Mechanical Brake Output

Specification	Description
Quantity	One in SPiiPlus CM-1, two in SPiiPlus CM-2, three in SPiiPlus CM-3
Type	Opto-isolated, Source type only
Output voltage	5-30Vdc ($\pm 10\%$)
Maximum Current per mechanical brake output	1A
Remark	For testing the brake output (in sink configuration) while the brake is not connected, a pull-up resistor should be connected.

Figure 26 illustrates the mechanical brake circuit.

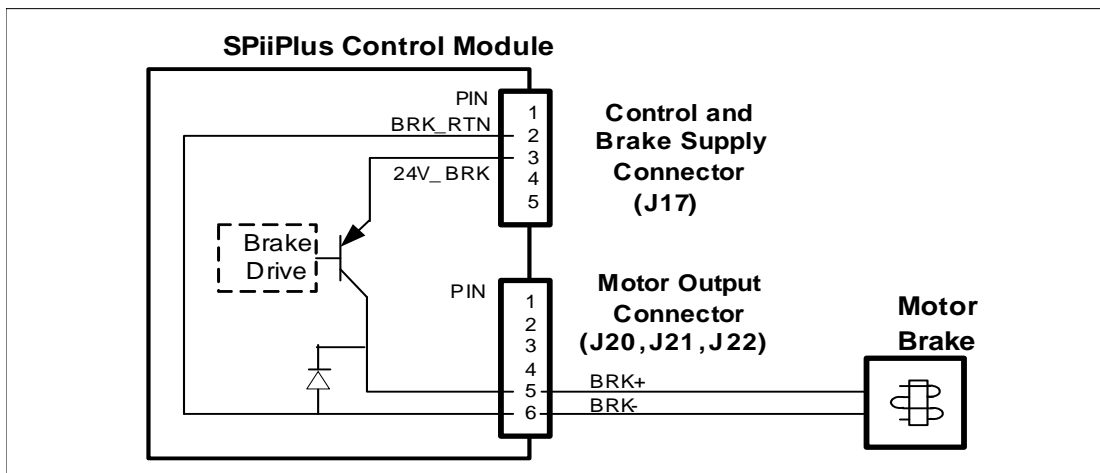



Figure 26 Mechanical Brake Circuit

4.6 J10 - Stepper Drive Commands

The SPiiPlus CM can control up to three step motors powered by third party drives with Pulse-Direction line commands in open loop control. For information about stepper axis configuration options refer to [Section 2.3 - Axis Configurations and Options](#).

For information about the configuration of a stepper axis, refer to the *SPiiPlus Setup Guide Stepper Drives*.

<p>Note</p> 	<p><i>In general, a stepper axis can be used only with Y, Z, T axes. The Y axis can be available for stepper only with SPiiPlus CM-1/2 (where integrated servo drive is NOT installed for Y axis). The Z and T axes are available for stepper axes only in the SPiiPlus CM-x-x-x-Mx-H4 (where four SPii DSPs where ordered) – see Section 2.7 - Ordering Options and Content of Products.</i></p>
--	---

[Table 22](#) details the J10 connector.

Table 22 J10 - Drive Commands Connector

Item	Description
Jack on SPiiPlus CM	Type: D-type, 37 pin, female
Plug from System	Type: D-type, 37 pin, male
Recommended Wires	AWG22 wires with shielding. Twisted pair cable for each differential signal (+ and -).

[Figure 27](#) illustrates the J10 pin layout.

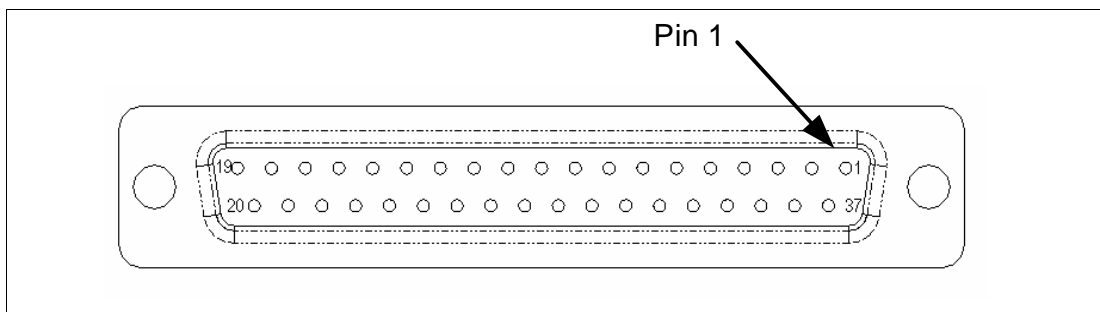


Figure 27 J10 - Drives Command Connector Pin Layout

[Table 23](#) details the J10 pinout.

Table 23 J10 - Drives Command Pinout

Pin	Designation	Description
1	PULSE_X+	Pulse non-inverted command for X axis step motor driver
2	PULSE_Y+	Pulse non-inverted command for Y axis step motor driver
3	PULSE_Z+	Pulse non-inverted command for Z axis step motor driver
4	PULSE_T+	Pulse non-inverted command for T axis step motor driver
5	DIR_X+	Direction non-inverted command for X axis step motor driver
6	DIR_Y+	Direction non-inverted command for Y axis step motor driver
7	DIR_Z+	Direction non-inverted command for Z axis step motor driver
8	DIR_T+	Direction non-inverted command for T axis step motor driver
9	DGND	Digital ground
10	ENA_X+	Drive enable sink output for X axis step motor driver
11	ENA_Y+	Drive enable sink output for Y axis step motor driver
12	ENA_Z+	Drive enable sink output for Z axis step motor driver
13	ENA_T+	Drive fault source input for T axis step motor driver
14	FLT_X+	Drive fault source input for X axis step motor driver
15	FLT_Y+	Drive fault source input for Y axis step motor driver
16	FLT_Z+	Drive fault source input for Z axis step motor driver
17	FLT_T+	Drive fault source input for T axis step motor driver
18	V_SUP_IO	Digital I/O supply 5/24Vdc
19	SHIELD	Cable shield connection
20	PULSE_X-	Pulse inverted command for X axis step motor driver
21	PULSE_Y-	Pulse inverted command for Y axis step motor driver
22	PULSE_Z-	Pulse inverted command for Z axis step motor driver
23	PULSE_T-	Pulse inverted command for T axis step motor driver
24	DIR_X-	Direction inverted command for X axis step motor driver
25	DIR_Y-	Direction inverted command for Y axis step motor driver
26	DIR_Z-	Direction inverted command for Z axis step motor driver
27	DIR_T-	Direction inverted command for T axis step motor driver
28	DGND	Digital ground
29	ENA_X-	Drive enable source output for X axis step motor driver
30	ENA_Y-	Drive enable source output for Y axis step motor driver
31	ENA_Z-	Drive enable source output for Z axis step motor driver
32	ENA_T-	Drive enable source output for T axis step motor driver
33	FLT_X-	Drive fault sink input for X axis step motor driver
34	FLT_Y-	Drive fault sink input for Y axis step motor driver
35	FLT_Z-	Drive fault sink input for Z axis step motor driver
36	FLT_T-	Drive fault sink input for T axis step motor driver
37	V_RTN_IO	Digital I/O supply return

4.6.1 Stepper Drive Pulse and Direction Outputs

The Stepper drive commands are differential and can be used with a Pulse – Direction stepper drive with two inputs per command. However, a Pulse – Direction stepper drive with a single-ended (one input per command) command input can also be used.

Table 24 describes the Stepper Drive Pulse and Direction Outputs.

Table 24 Stepper Drive Pulse and Direction Outputs

Item	Description
Quantity	One pulse output and one direction output per axis Y, Z, T.
Type	Differential, RS-422/485, not isolated

Figure 28 illustrates a Y axis implementation of a differential stepper drive connection.

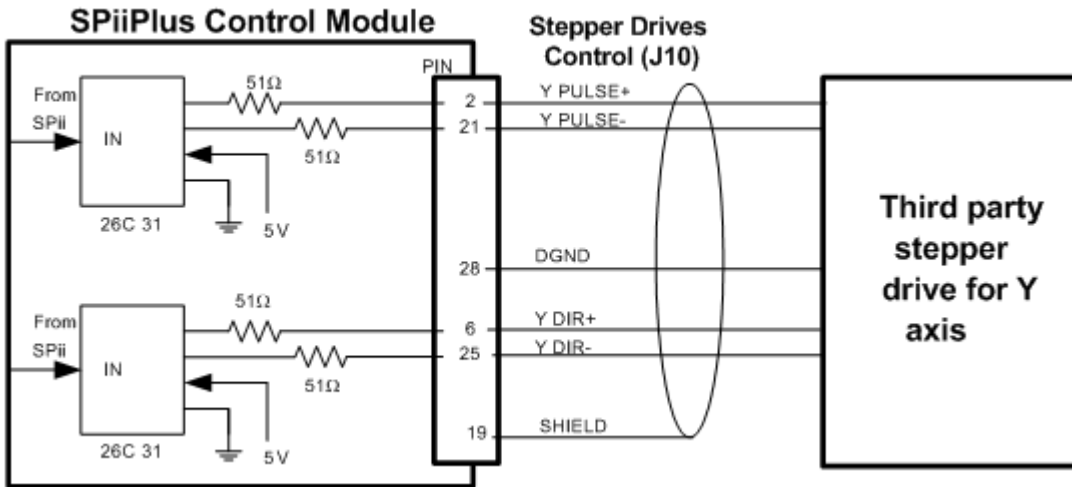



Figure 28 Pin J10 - Stepper Drive Pulse and Direction Interface (Y axis)

<p>Note</p> 	<p><i>If the stepper drive has a single-ended input commands interface (not differential), use only the DIR+ and the PULSE+ commands.</i></p>
--	---

4.6.2 Stepper Drive Enable Outputs

Table 25 describes the Stepper Drive Enable Outputs.

Table 25 Stepper Drive Enable Outputs

Item	Description
Quantity	One enable output per axis (Y, Z, T)
Type	Source (open emitter) or sink (open collector), opto-isolated
Propagation Delay	<1ms
Output Voltage	5Vdc ($\pm 10\%$) or 24Vdc ($\pm 20\%$) – pending on V_SUP_IO or V_RET_IO voltage
Maximum Current	50mA per enable output.
Output Protection	Short circuit, over-voltage and over-current

The following examples illustrate the stepper drive enable interface for a Y axis.

- ❑ **Figure 29** is an example of a **source** type enable connection to a stepper drive. When the drive receives external 5V or 24V, it is enabled.
- ❑ **Figure 30** is an example of a sink-type enable connection to a stepper drive with an external power supply. When the drive receives GND, it is enabled.

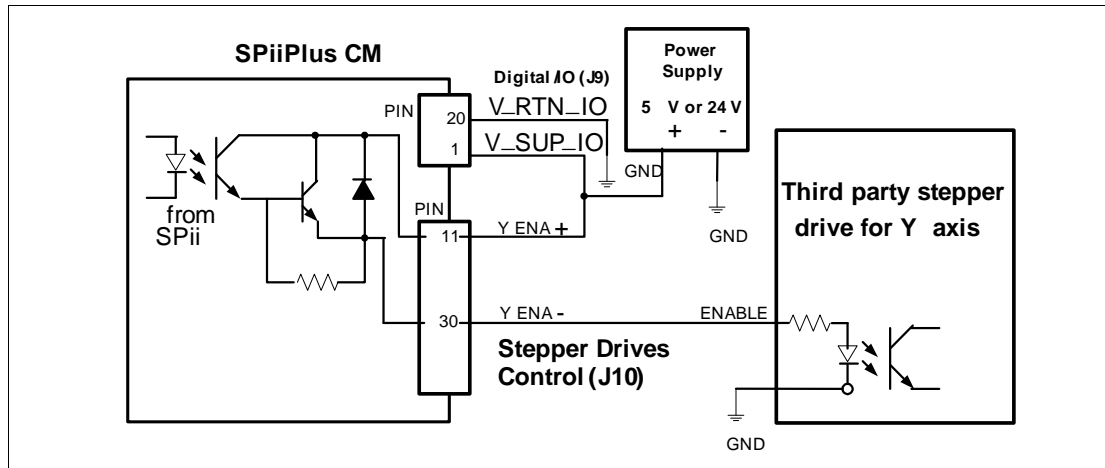


Figure 29 Connection To Stepper Drive With Enabled Source Output (Y axis)

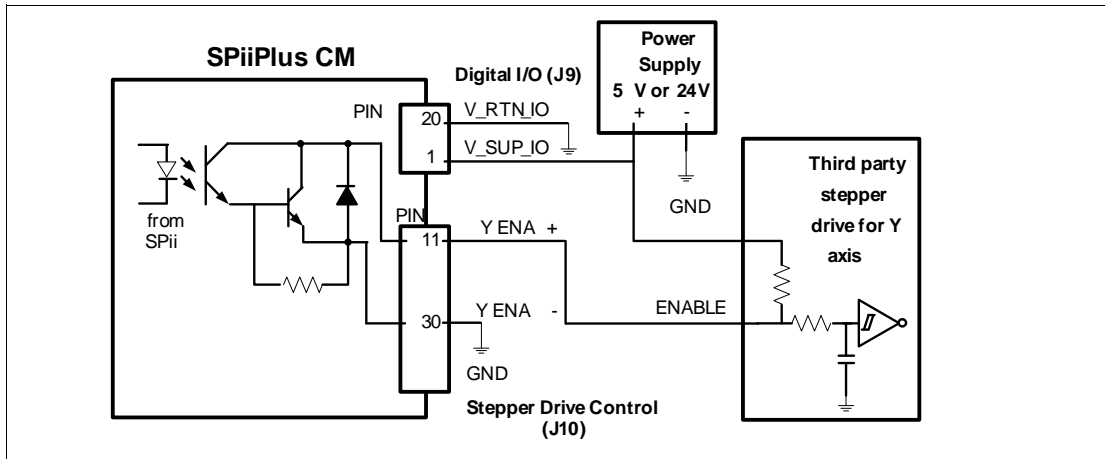


Figure 30 Connection To Stepper Drive With Enable Sink Output (Y axis)

4.6.3 Stepper Drive Fault (Alarm) Inputs

Table 26 describes the Stepper Drive Fault Inputs.

Table 26 Stepper Drive Fault Inputs

Item	Description
Quantity	One fault input per axis (X, Y, Z, T)
Type	Differential, opto- isolated
Propagation Delay	<1ms
Input Voltage	5Vdc (±10%) or 24Vdc (±20%), detected automatically
Maximum Current	10mA per output.

The following examples illustrate the stepper drive fault interface for a Y axis.

- ❑ **Figure 31** is an example of an **source**-type fault input. When the drive sends 5V/24V, the controller detects that a drive fault has occurred.
- ❑ **Figure 32** is an example of a **sink** fault input. When the drive sends fault signal V_SUP_IO (5/24V), the controller detects a drive fault has occurred.

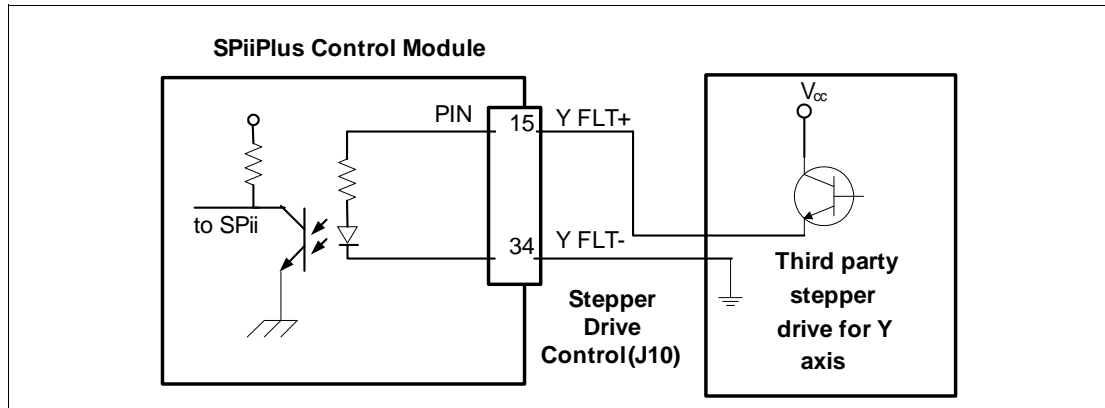


Figure 31 Connection To Drive With Source Fault Input (Y axis)

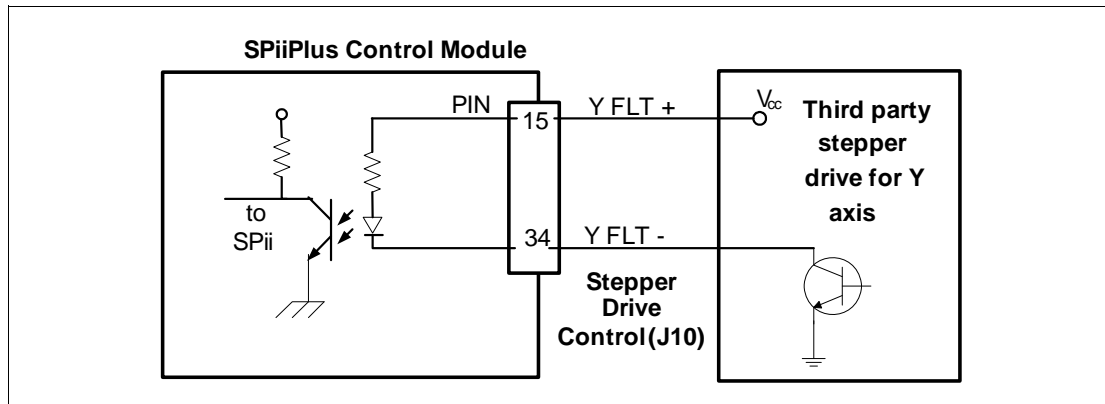



Figure 32 Connection To Drive With Sink Fault Output (Y axis)

4.7 J11, J13 and J15 - Incremental Digital Encoder + Hall

Axes connected to one of the integrated drives are supported by the following types of digital incremental encoders:

- A&B, I:** Quadrature encoder with index.
- CLK-Dir, I:** Clock – direction encoder with index.
- UP-DN, I:** Up - down encoder with index.

<p>Note</p> 	<p><i>A DC brushless motor powered by an integrated drive can be commutated by the control module based on the encoder feedback (preferred) or based on the motor Hall signals.</i></p> <p><i>Hall commutation support is available from SPiiPlus Firmware Version 5.0 and up.</i></p> <p><i>For more information, refer to Chapter 7 - Commutation for DC Brushless (AC Servo) Motors of the SPiiPlus Setup Guide.</i></p>
--	---


<p>Note</p> 	<p><i>For more information about limitations while using incremental encoders refer to Section 2.4 - Specifications.</i></p>
--	--

Table 27 details the J11, J13, and J15 connectors.

Table 27 J11, J13 and J15 -Incremental Digital Encoder + Hall Connectors

Item	Description
Connector J11	X axis incremental encoder + Hall
Connector J13	A axis incremental encoder + Hall
Connector J15	Y axis incremental encoder + Hall
Jack on SPiiPlus CM	Type: D-type, 15 pin, male
Plug from System	Type: D-type, 15 pin, female
Recommended Wires	AWG22 wires with shielding. Twisted pair cable for each differential signal (+ and -).

Figure 33 illustrates the J11, J13 and J14 pin layout.

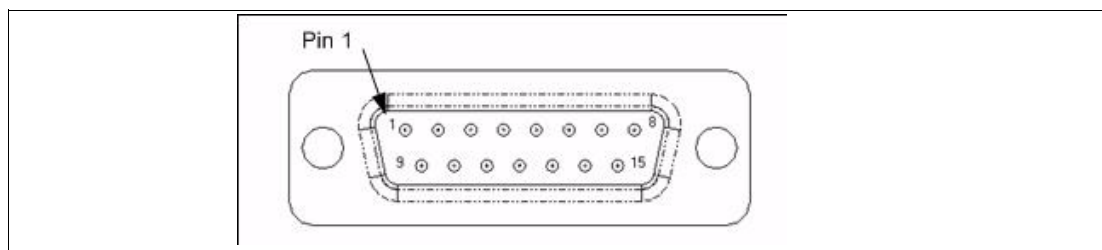


Figure 33 J11, J13, and J15 Connector Pin Layout

Table 28 provides the pinout for J11, J13 and J15.

Table 28 J11, J13 and J15 - Incremental Digital Encoder + Hall Pinout

Pin	Designator	Description
1	5D	5.1V user digital supply to the Encoder and Hall, 200mA maximum
2	CHA+	Encoder A non-inverted input
3	CHA-	Encoder A inverted input
4	CHB+	Encoder B non-inverted input
5	CHB-	Encoder B inverted input
6	DGND	Digital ground
7	HA	Motor Hall A
8	HB	Motor Hall B
9	CHI+	Encoder index non-inverted input
10	CHI-	Encoder index inverted input
11	MTMP_RTN	A return for motor temperature sensor. (Internally connected to DGND)
12	SHIELD	Cable shield connection
13	5U	5.1V user supply to encoder and Hall, 200mA maximum
14	HC	Motor Hall C
15	MTMP	Motor temperature sensor input. If a temperature sensor is being used, a normally closed sensor contact should be connected between pin 15 and pin 11. If temperature sensor is NOT used, pin 15 must be shorted to pin 11 for proper operation.
	SHIELD	Cable shield connection

4.7.1 Incremental Digital Encoder + Hall Interface

Figure 34 illustrates the incremental digital encoder interface.

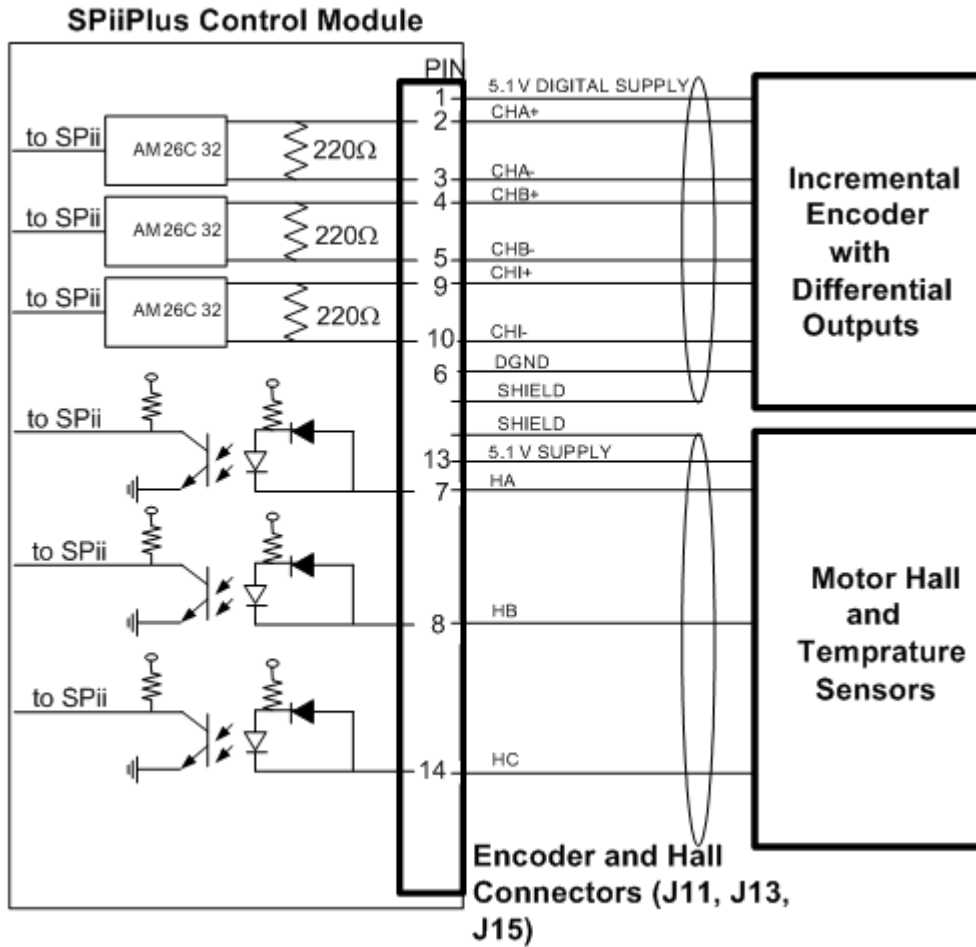


Figure 34 Incremental Digital Encoder and Hall Interface

Table 29 Hall Sensor Input

Item	Description
Input Quantities	A, B, C
Type	Single ended

Table 30 Power Supply for Encoder and Hall Sensor

Item	Description
Range of 5U supply	5.1Vdc \pm 2% (5.0-5.2Vdc)
Max. allowed total current consumption per axis (Encoder + Hall)	200mA

4.7.2 Motor Temperature Input

The SPiiPlus CM includes up to three motor temperature inputs, one per axis. These inputs are single end opto-isolated. A normally closed motor temperature sensor must be connected between pin J11/15 and pin J11/11 for the X axis.

If no sensor is used, short pin J11/15 (X_MTMP) to pin J11/11 (X_MTMP_RTN) for proper operation.


 <p>Note</p>	<p><i>Motor temperature is masked in the Firmware by default.</i></p>
--	---

Table 31 Motor Temperature Inputs

Item	Description
Quantity	One motor temperature input per integrated axis (X, A,Y)
Type	Single end, opto-isolated
Input Voltage	None
Logic	Whenever the resistance between MTMP (pin 15) and MTMP-RTN (pin 11) exceeds 2kΩ, the Overheat fault of the SPiiPlus CM will become active.
Overheat OFF	Resistance to ground that will guarantee that OVERHEAT will be OFF is <2.4kΩ.
Overheat ON	Resistance to ground that will guarantee that OVERHEAT will be ON is >46kΩ

The following example illustrates the motor temperature input for Y axis.

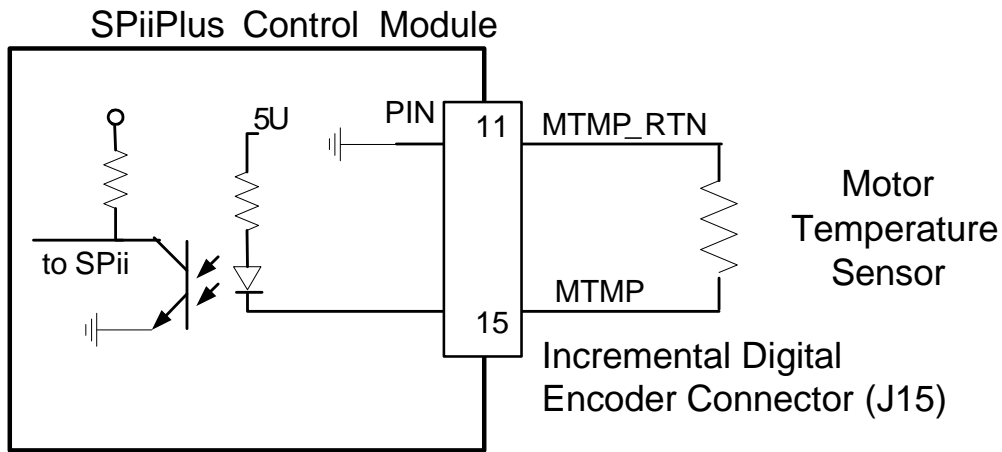


Figure 35 Connection to Motor Temperature Input (Y axis)

4.8 J12, J14 and J16 - Sin-Cos Encoder and Analog Input

The SPiiPlus CM is equipped with six differential and two single-ended analog inputs. The latter are located in connector J26. All of the six differential analog inputs are connected in parallel and can be used in either of the following methods:

- Sin-Cos encoder inputs - input voltage of 1V_{ptp} (-0.5V to 0.5V)
 - General purpose inputs - input voltage of ± 10 V_{dc} (peak-to-peak, differential).
- In addition, the connector provides an interface with a motor temperature sensor.

Table 32 describes the available analog inputs.

Table 32 J12, J14 and J16 - Analog Inputs

Axis/Connector	General Purpose (± 10 V _{dc}) Analog Input Name	Sin-Cos (1V _{ptp}) Analog Input Name
X axis (J12)	AIN0+ (pin5)	XSIN+ (pin2)
	AIN0- (pin13)	XSIN- (pin10)
	AIN1+ (pin 6)	XCOS+ (pin 3)
	AIN1- (pin 14)	XCOS- (pin 11)
A axis (J14)	AIN2+ (pin5)	ASIN+ (pin2)
	AIN2- (pin13)	ASIN- (pin10)
	AIN3+ (pin 6)	ACOS+ (pin 3)
	AIN3- (pin 14)	ACOS- (pin 11)
Y axis (J16)	AIN4+ (pin5)	YSIN+ (pin2)
	AIN4- (pin13)	YSIN- (pin10)
	AIN5+ (pin 6)	YCOS+ (pin 3)
	AIN5- (pin 14)	YCOS- (pin 11)

Note



1. Sin-Cos encoder support is not provided as a standard feature. Up to three Sin-Cos encoder interfaces can be specified in the product purchase order.
2. While using a Sin-Cos encoder, the squared (quadrature) signals of channels A and B are routed to the incremental digital encoder (connector J11, J13, J15). Based on these squared signals, the user can get the axis' non-interpolated position reading for his needs.

Table 33 details the J12, J14, and J16 connectors.

Table 33 J12, J14, and J16 - Sin-Cos Encoder Connectors

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

Figure 36 illustrates the J12, J14 and J16 pin layout.

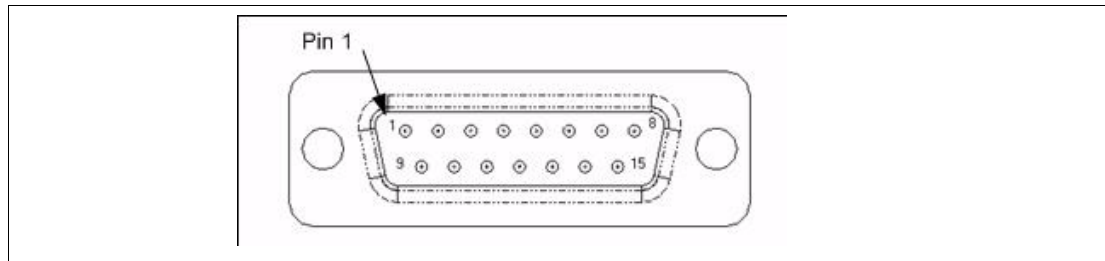
**Figure 36 J12, J14 and J16 - Sin-Cos Encoder Connector Pin Layout**

Table 34 provides the pinout for J12. The pinouts for J14 and J16 are similar.

Table 34 J12 - Sin-COS Encoder X Axis Pinout

Pin	Designator	Description
1	5F	5.1V field supply (to analog circuit) to the X Sin-Cos encoder 200mA max
2	XSIN+	X encoder Sin non-inverted input
3	XCOS+	X encoder Cos non-inverted input
4	INDEX+	X encoder index non-inverted input
5	AIN0+	Analog non-inverted input 0 (AIN0)
6	AIN1+	Analog non-inverted input 1 (AIN1)
7	MTMP	Motor temperature sensor input. A normally closed sensor contact must be connected between pin 15 and pin 7. If no sensor is used, pin 15 must be shorted to pin 7 for proper operation.
8	SHIELD	Cable shield connection
9	AGND	Analog ground for 5F field supply
10	XSIN-	X Encoder Sin inverted input
11	XCOS-	X Encoder Cos inverted input
12	INDEX-	X Sin-Cos encoder index inverted input
13	AIN0-	Analog inverted input 0 (AIN0)
14	AIN1-	Analog inverted input 1 (AIN1)
15	DGND	Digital ground (and return for X motor temperature sensor)

4.8.1 Sin-Cos Encoder Interface

Table 35 Sin-Cos Encoder Input

Item	Description
Quantity	Up to three interfaces, each comprising two encoder signals and one index signal
Type	1V ptp differential signals
Restriction	Sin-Cos inputs (1V ptp) are connected in parallel with general purpose analog inputs ($\pm 10Vdc$); hence, it is impossible to use both voltage range of an inputs simultaneously.
Input frequency	Up to 250k sine or cosine periods per second
Signal-to-Noise Ratio	62dB (3 sigma) equivalent to ± 6 AIN counts
Input Impedance	120 Ω
Digital representation of input voltage (AIN variable)	-8192...+8192
A/D conversion resolution	14 bit
Corresponding ACSPL+ Variables	AIN0... AIN5

Figure 37 illustrates the Sin-Cos encoder interface for an X axis.

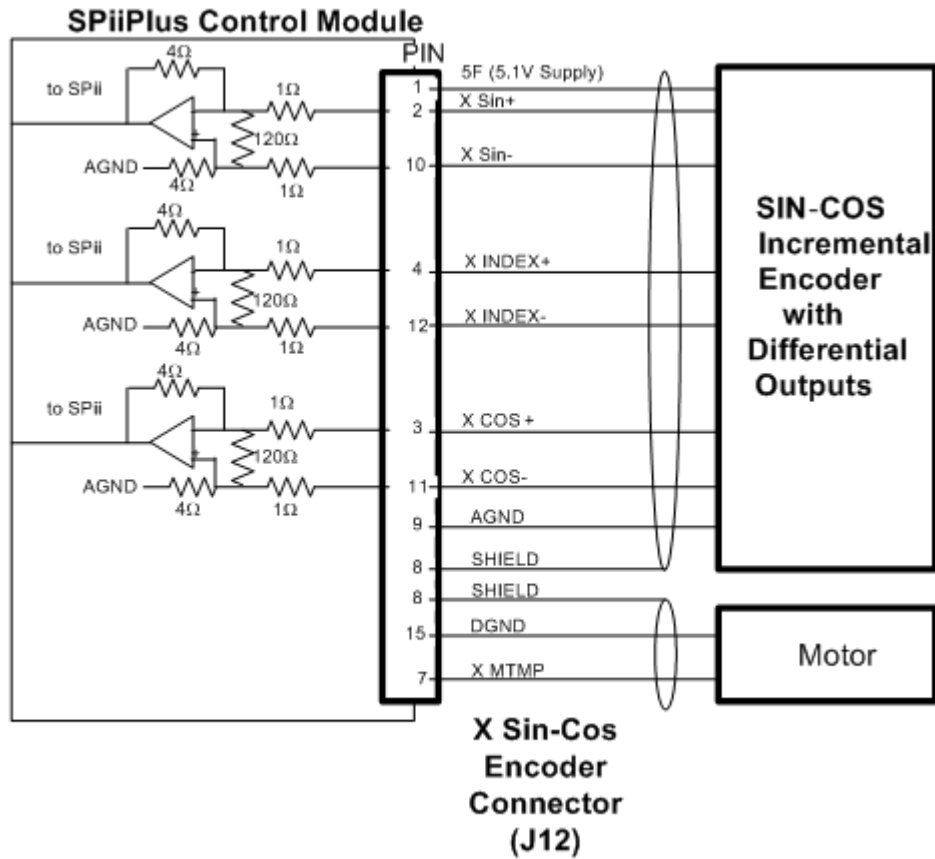


Figure 37 Sin-Cos Encoder Interface (X Axis)

Table 36 Power Supply for Sin-Cos Encoders

Item	Description
Source	Onboard
Range	5.1Vdc \pm 2% (5.0-5.2Vdc)
Max. supply load current per encoder	200mA

Table 37 Analog Inputs

Item	Description
Voltage Representation in Controller	+10Vdc is equivalent to +8192. -10Vdc is equivalent to -8192.
Input Impedance	120Ω
Corresponding ACSPL+ Variables	AIN0... AIN5


<p>Note</p> 	<p><i>Additional single-ended analog inputs for joystick implementation are provided via J26.</i></p>
--	---

Figure 38 illustrates the analog input interface for analog input 1 (AIN0).

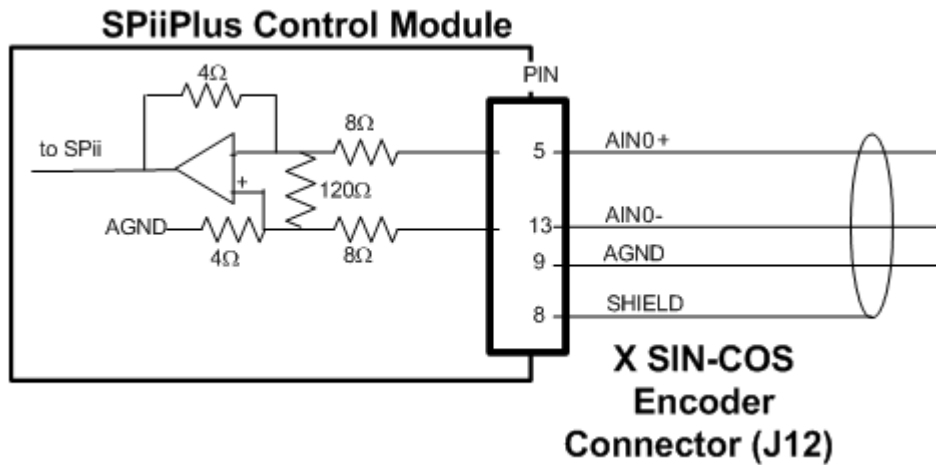


Figure 38 Connection of AIN0 Differential Input

4.8.2 Motor Temperature Input

Table 38 Motor Temperature Input

Item	Description
Quantity	One motor temperature input per each integrated axis (X, A, Y)
Type	Opto-isolated
Input Voltage	None
Logic	Whenever the resistance between MTMP (pin7) and DGND (pin 15) becomes greater than 2kΩ, the Overheat fault of the SPiiPlus CM will become active.
Overheat OFF	Resistance to ground that will guarantee that OVERHEAT will be OFF is <2.4kW.
Overheat ON	Resistance to ground that will guarantee that OVERHEAT will be ON is >46kW

The following examples illustrate the motor temperature input for Y axis.

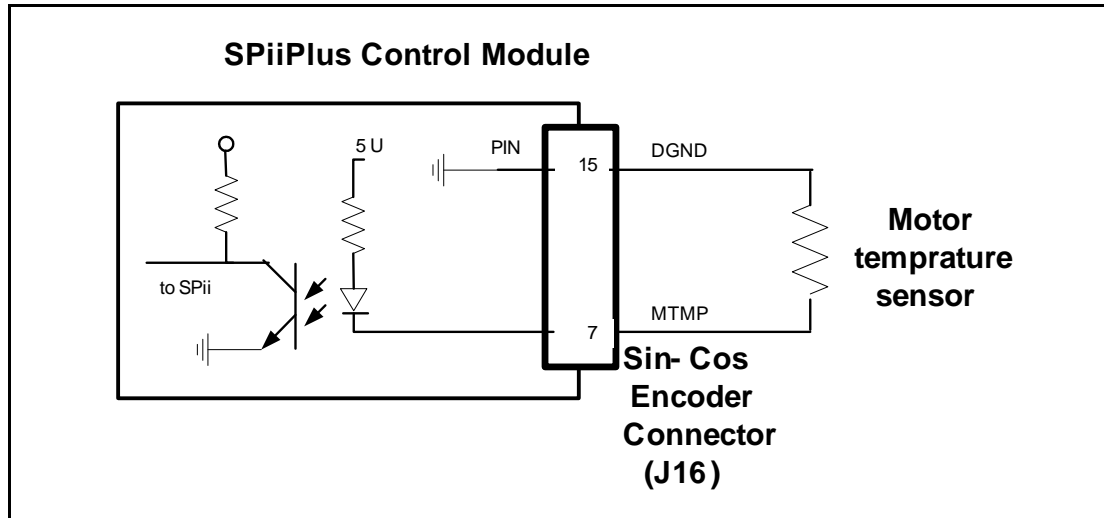


Figure 39 Connection to Motor Temperature Input (Y axis)

4.9 J9 - Digital I/O and Analog Outputs

This section covers:

- Digital Inputs**
- Fast Digital Inputs (MARK)**
- Digital Outputs**
- Fast Digital Outputs (PEG)**
- Digital Brake Outputs**
- Analog Outputs**


SPiiPlus CM is supports the following digital inputs:

- Eight Single-ended opto-isolated (Sink or source) digital inputs for general purpose.
- Four fast ($<0.1\mu\text{sec}$ delay), differential, non opto-isolated inputs that can be used for position capture (MARK) as general purpose inputs.

The SPiiPlus CM is equipped with the following digital outputs:

- Eight single-ended opto-isolated (Sink or source) digital outputs for general purpose.
- Two fast ($<0.1\mu\text{sec}$ delay), differential, non opto-isolated outputs that can be used for Position Event Generator pulses (PEG) **pulses** for X and Y axes or as general purpose outputs.
The PEG states are also provided via the PEG (J26) connector (see [Section 4.10 - J26 - PEG](#)).

- ❑ Eight fast (<0.1µsec delay), differential, non opto-isolated outputs that can be used for Position Event Generator (PEG) **states** for X and Y axes (four states per axis) or as general purpose outputs. The PEG states are provided only via the PEG (J26) connector.
- ❑ Three high current (up to 1A), opto-isolated outputs that can be used for mechanical brake control for X,Y and A axes (see [Section 4.5 - J20, J21, J22 - Servo Motor and Brake Output](#)) or as general purpose outputs (sink only!).

 <p>Note</p>	<p><i>The PEG pulses are also provided in parallel in the PEG (J26) connector (with PEG states signals).</i></p>
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The SPiiPlus CM is equipped with the following analog outputs:

- ❑ One/two single-ended outputs with a range of 10V ptp, 10-bit resolution. Whenever the controller has one SPii (one HSSI channel), only one analog output will be available.
- ❑ Whenever the controller has more than one SPii (one HSSI channel), two analog outputs will be available.

[Table 39](#) details the J9 connector.

Table 39 J9 - Digital I/O and Analog Outputs

Component	Description
Jack on SPiiPlus CM	D-type, 37 pin, male
Plug from System	D-type, 37 pin, female
Recommended Wires	AWG22 wires with shielding. Twisted pair cable for each differential signal (+ and -).

[Figure 40](#) illustrates the J9 pin layout.

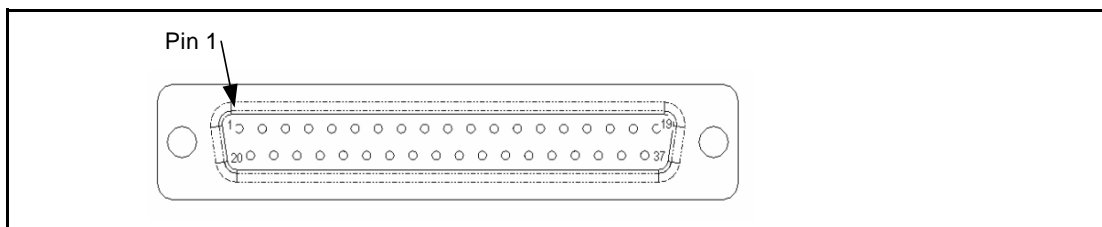


Figure 40 J9 - Digital I/O and Analog Output Connector Pin Layout

[Table 40](#) details the J9 pinout.


 <p>Note</p>	<p><i>In the description column, for each PEG output and brake output the variable name that commands the output when it is used as general purpose output is mentioned.</i></p>
--	--

Table 40 Digital I/O and Analog Output Connector J9 – Pinout (page 1 of 2)

Pin	Designator	Description	ACSPL+ Variable
1	V_SUP_IO	Digital I/O supply 5/24Vdc (use same voltage for digital brake output - see Section 4.9.5 - Digital Brake Outputs).	
2	IN0.0	Digital input 0	IN0.0
3	IN0.2	Digital input 2	IN0.2
4	IN0.4	Digital input 4	IN0.4
5	IN0.6	Digital input 6	IN0.6
6	OUT0.0	Digital output 0	OUT0.0
7	OUT0.2	Digital output 2	OUT0.2
8	OUT0.4	Digital output 4	OUT0.4
9	OUT0.6	Digital output 6	OUT0.6
10	BRAKE_X	Digital motor brake output for X axis	OUT1.0
11	BRAKE_A	Digital motor brake output for A axis	OUT1.4
12	X_MARK1+	Fast non-inverted X MARK1 input for X axis	IN8.10
13	X_MARK2+	Fast non-inverted X MARK2 input for X axis	IN8.8
14	Y_MARK1+	Fast non-inverted Y MARK1 input for Y axis	IN9.10
15	Y_MARK2+	Fast non-inverted Y MARK2 input for Y axis	IN9.8
16	X_PEG_PULSE+	Fast non-inverted PEG output for X axis	OUT8.8
17	Y_PEG_PULSE+	Fast non-inverted PEG output for Y axis	OUT9.8
18	GND	Ground	
19	AOUT1	Analog output 1 (available only with two or more SPii processors)	
20	V_RTN_IO	Digital I/O supply return	

Table 40 Digital I/O and Analog Output Connector J9 – Pinout (page 2 of 2)

Pin	Designator	Description	ACSPL+ Variable
21	IN0.1	Digital input 1	IN0.1
22	IN0.3	Digital input 3	IN0.3
23	IN0.5	Digital input 5	IN0.5
24	IN0.7	Digital input 7	IN0.7
25	OUT0.1	Digital output 1	OUT0.1
26	OUT0.3	Digital output 3	OUT0.3
27	OUT0.5	Digital output 5	OUT0.5
28	OUT0.7	Digital output 7	OUT0.7
29	BRAKE_Y	Digital motor brake output for Y axis	OUT1.1
30	BRAKE_B	Digital motor brake output for B axis	OUT1.5
31	X_MARK1-	Fast inverted X MARK1 input for X axis	IN8.10
32	X_MARK2-	Fast inverted X MARK2 input for X axis	IN8.8
33	Y_MARK1-	Fast inverted Y MARK1 input for Y axis	IN9.10
34	Y_MARK2-	Fast inverted Y MARK2 input for Y axis	IN9.8
35	X_PEG_PULSE-	Fast inverted PEG output for X axis	OUT8.8
36	Y_PEG_PULSE-	Fast inverted PEG output for Y axis	OUT9.8
37	AOUT0	Analog output 0	AOUT0
	Connector metal case (SHIELD)	Cable shield connection	

4.9.1 Digital Inputs

Table 41 Digital Inputs (page 1 of 2)

Item	Description
Quantity	Eight
Type	Single-ended, opto-isolated
Type	Single-end
Corresponding ACSPL+ Variables	IN0.0... IN0.7
Maximum Propagation Delay	< 1msec

Table 41 Digital Inputs (page 2 of 2)

Item	Description
External Supply Voltage	5Vdc ($\pm 10\%$) or 24Vdc ($\pm 20\%$), detected automatically. Must be connected between the V_SUP_IO and V_RET_IO pins of connector J9 or J10.
Input Voltage	5Vdc ($\pm 10\%$) or 24Vdc ($\pm 20\%$)
Input Current	From 2mA to 14mA per input, depending on external supply voltage.
Connection	Sink/source – jumper configured.
Sink/source jumper configuration	See Section 6.4 - Configuration of Sink or Source by Jumpers – JP5, JP7, JP8

Figure 41 illustrates the source-type switched general purpose digital input interface for IN0.0.

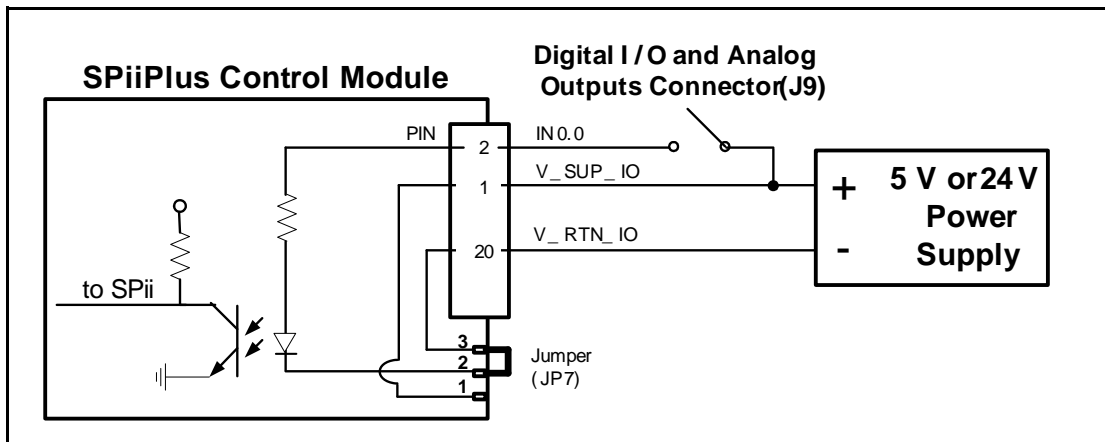


Figure 41 Source (Switched) Connection for Digital Input 0

Figure 42 illustrates the source-type PNP general purpose digital input interface for IN0.0.

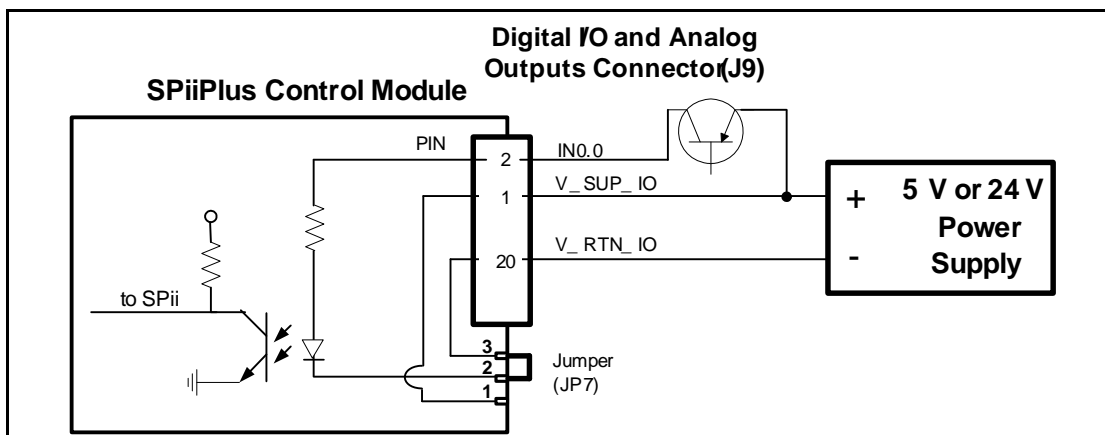


Figure 42 Source (PNP) Connection for Digital Input 0

Figure 43 illustrates the sink-type switched general purpose digital input interface for IN0.0.

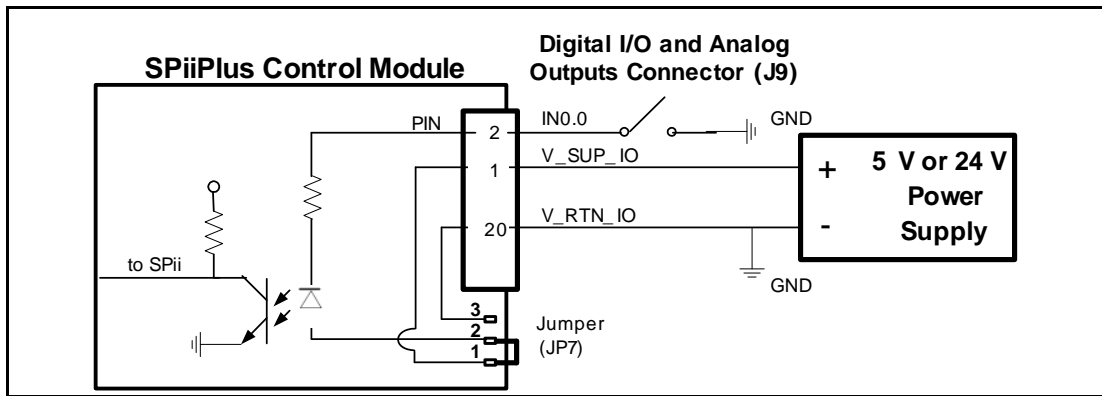


Figure 43 Sink (Switched) Connection for Digital Input 0

Figure 44 illustrates the sink-type NPN general purpose digital input interface for IN0.0.

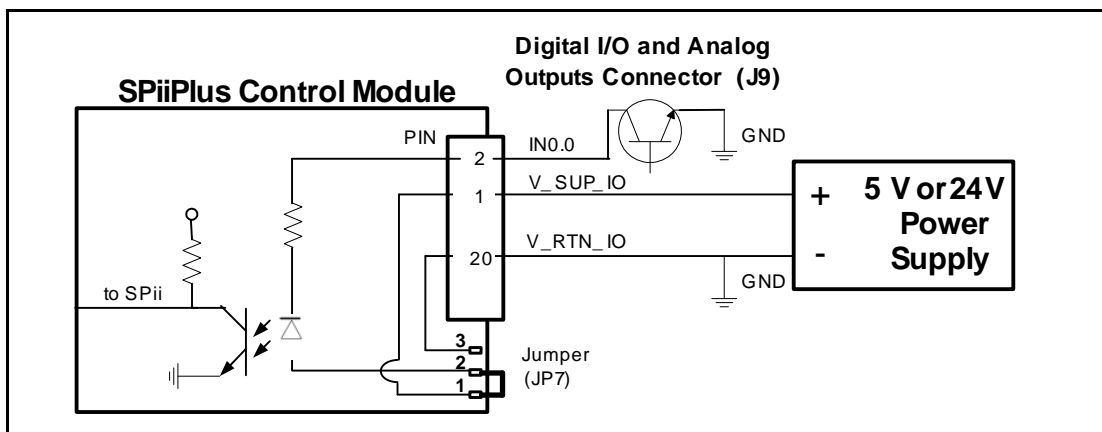


Figure 44 Sink (NPN) Connection for Digital Input 0

4.9.2 Fast Digital Inputs (MARK)

Table 42 Fast Digital Inputs (MARK)

Item	Description
Quantity	Four. Can be configured as MARK inputs or as general purpose inputs.
Type	Differential, not isolated
Interface	TI AM26C31 line receiver
MARK Input Voltage	5Vdc ($\pm 10\%$) only
Associated ACSPL+ Variables	MARK and M2ARK . The fast input signal latches, with extremely small delay, the current encoder position to the associated variable. See the <i>SPiiPlus ACSPL+ Programmer's Guide</i> .
Maximum Propagation Delay	$< 0.1\mu\text{sec}$
Protection	ESD Protection

Figure 45 illustrates the MARK/general purpose **differential** input interface for axis X.

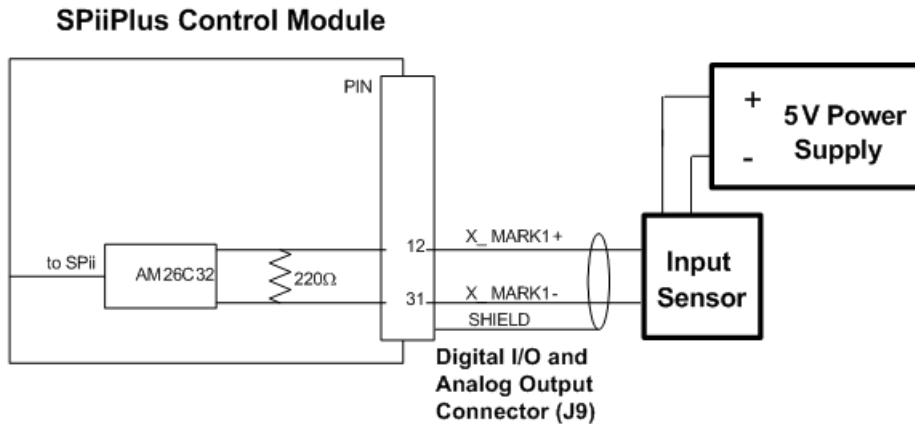


Figure 45 Differential Connection for MARK1 Input (X Axis)

Figure 46 illustrates the MARK/general purpose **single-end** input interface for axis X.

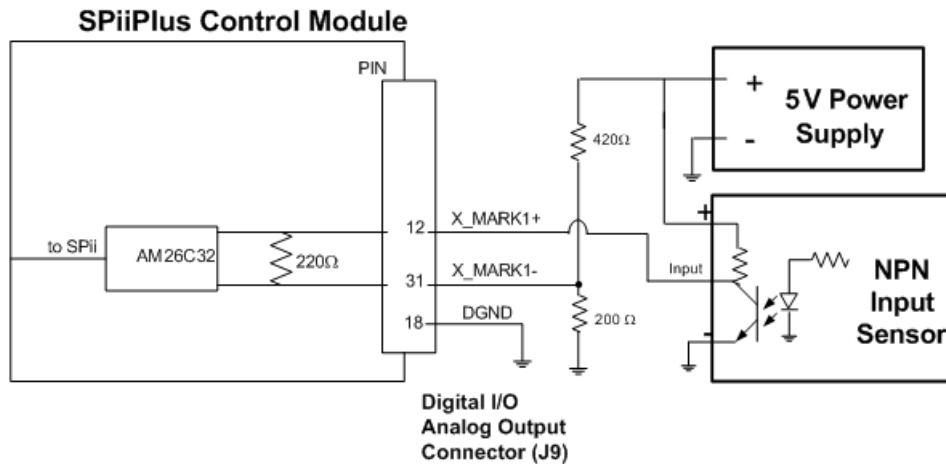


Figure 46 Single-End (NPN) Connection for MARK1 Input (X Axis)

4.9.3 Digital Outputs

Table 43 Digital Outputs (page 1 of 2)

Item	Description
Quantity	Eight
Type	Single-end, opto-isolated
Corresponding ACSPL+ Variables	OUT0... OUT7

Table 43 Digital Outputs (page 2 of 2)

Item	Description
External Supply Voltage	5Vdc ($\pm 10\%$) or 24Vdc ($\pm 20\%$), detected automatically. Must be connected between the V_SUP_IO and V_RET_IO pins
Maximum Current per Output	350mA
Maximum Current for all Outputs	400mA
Protection	Overload (total current > 400mA) or short circuit with ground. A short circuit on any digital output will disable ALL digital outputs without any indication by the software. The digital outputs will become enabled again only after controller power-up.
Connection	Sink/source – jumper configured.


Note
 To test an output in source/sink configuration without a load, connect a pull-down/pull-up resistor.

Figure 47 illustrates the **source-type** general purpose digital output interface for **OUT0.0**.

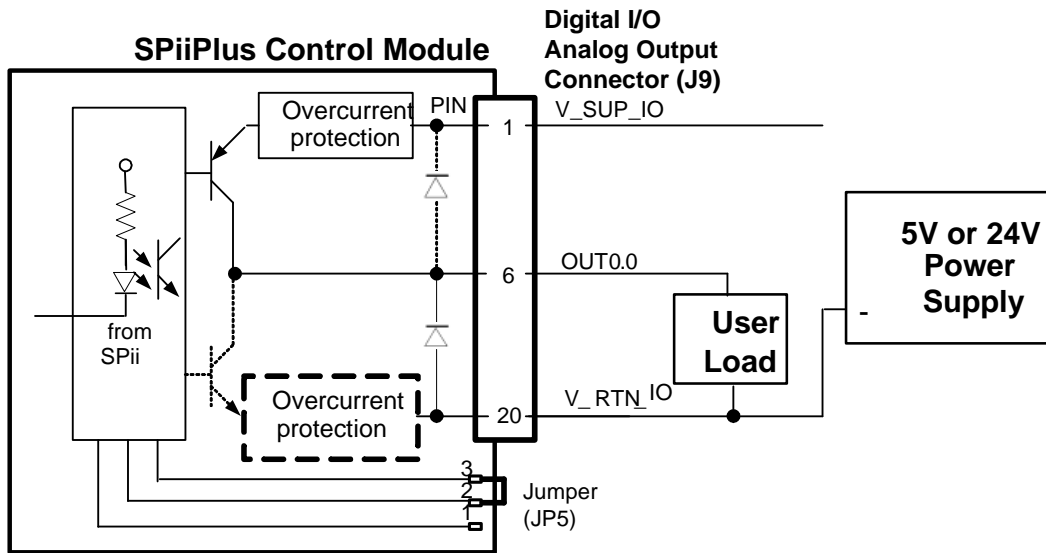


Figure 47 Source Connection for Digital Output 0


Note
 When jumper JP5 is set to pins 2 and 3, the circuit shown in a dashed line is inactive.

Figure 48 illustrates the **sink-type** general purpose digital output interface for **OUT0.0**.

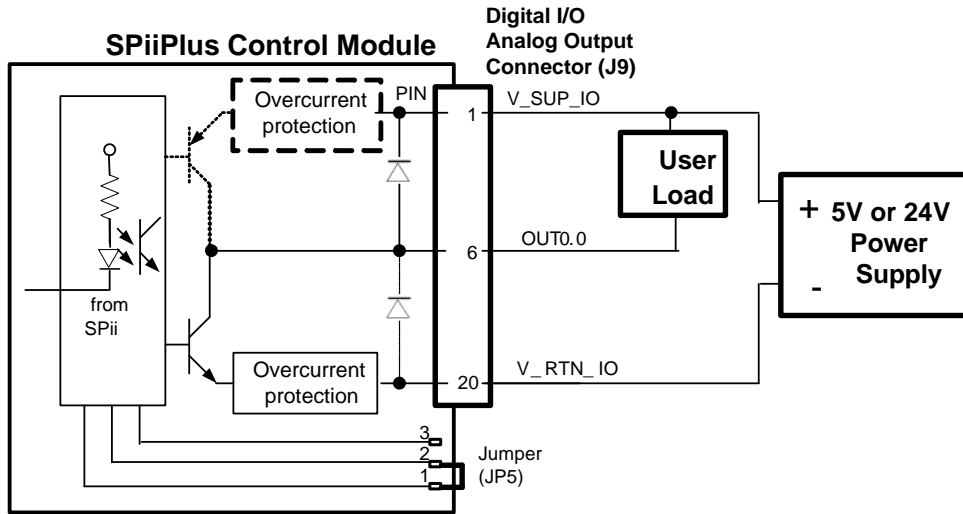



Figure 48 Sink Connection for Digital Output 0

Note
 When jumper JP5 is set to pins 1 and 2, the circuit shown in a dashed line is inactive.

4.9.4 Fast Digital Outputs (PEG)

Configuration of PEG pulses as PEG outputs (default) or as general purpose outputs is done by the software `assignpeg` command. Refer to the *SPiiPlus ACSPL+ Programmer's Guide*.

Table 44 Fast Digital Outputs (PEG)

Item	Description
Quantity	Four. Can be configured as PEG outputs or as general purpose outputs.
Type	Differential, not isolated. (Requires 220Ω termination resistor.)
Associated ACSPL+ Functions	<code>peg_i</code> and <code>peg_r</code> . The fast output signal is generated with extremely small delay when the encoder position matches a predefined value. See PEG description in the <i>SPiiPlus ACSPL+ Programmer's Guide</i> .
Maximum Propagation Delay	< 0.1μsec
See Also	Section 4.10 - J26 - PEG

Figure 49 illustrates the PEG pulse output interface for axis X.

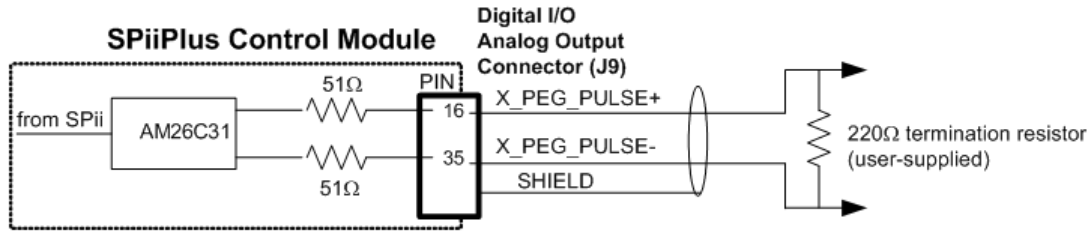


Figure 49 Example of X PEG Pulse Output Connection

Note
A user-supplied 220Ω resistor must be installed between the two differential signals of the PEG outputs

4.9.5 Digital Brake Outputs

Note
When the axis is not equipped with a mechanical brake, the mechanical brake outputs can be used as general purpose outputs. When the brake outputs should be used as general purpose outputs with high current, they are used via the Motor Output Connectors (J20, J21, J22). When the brake outputs are used as general purpose outputs with low current, they are used via the Digital I/O and Analog Output Connector (J9).

Table 45 Digital Brake Outputs

Item	Description
Quantity	Four. Can be configured as motor brake outputs or as general purpose outputs.
Type	Single-end, opto-isolated, sink only!
External Supply Voltage	5-30Vdc (±10%). Must be connected between the V_SUP_IO and V_RET_IO pins
Maximum Current per Output	The maximum current for each output is 50mA, for all outputs, 4x50mA.
Maximum Current per All Output	350mA
Protection	Overload (current of any output > 100mA) or short circuit

Note

See [Section 4.5.1 - Mechanical Brake Interface](#) for an illustration of the brake output interface for axis X.

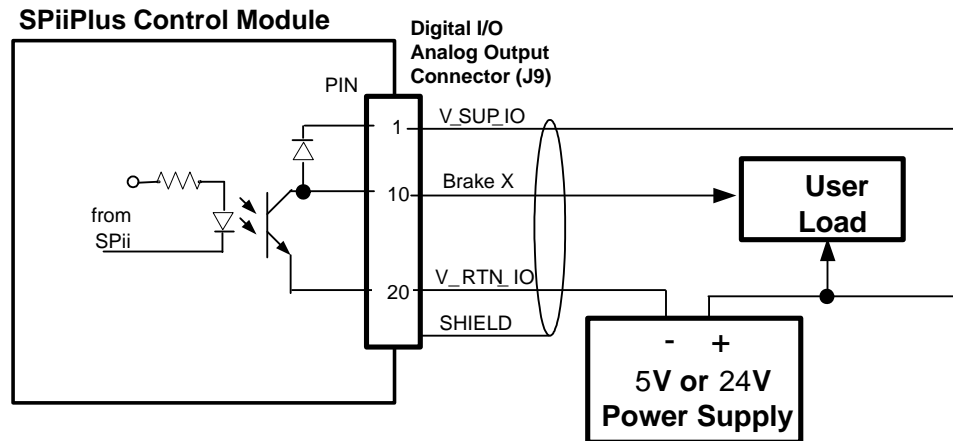


Figure 50 Sink Connection for Using Brake_X as a General Purpose Output

4.9.6 Analog Outputs

Table 46 Analog Outputs

Item	Description
Quantity	One/ two (Analog output 1 is available only if two or more SPii processors are present)
Type	Single-end
Signal-to-Noise Ratio	46dB (3 sigma) equivalent to $\pm 50\text{mV}$ or ± 3 AOUT counts
Voltage Range	10V ptp
D/A Resolution	10 bit
D/A Conversion Circuit Accuracy	$\pm 5\%$
Voltage Representation in Controller	-511 to 511
Maximum Current	1mA per output
Protection	short circuit
Corresponding ACSPL+ Variables	AOUT0, AOUT1

Figure 51 illustrates the analog output interface for **AOUT0**.

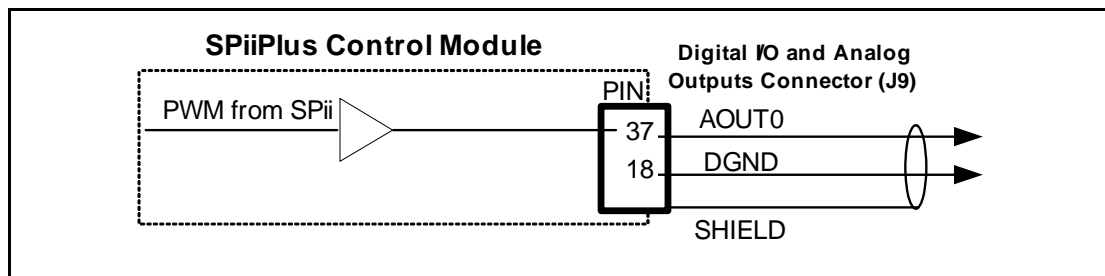


Figure 51 Connection for AOUT0 Output

4.10 J26 - PEG

The SPiiPlus CM also provides PEG outputs as described in [Section 4.9 - J9 - Digital I/O and Analog Outputs](#).

J26 provides eight fast ($< 0.1\mu\text{sec}$ delay), differential, non opto-isolated outputs that can be used for PEG states for X and Y axes (four states per axis) or as general purpose outputs. PEG states are provided only through J26.

In the SPiiPlus CM, two additional single-ended analog inputs are provided through J26 for joystick implementation. See [Section 4.10.2 - Analog Inputs for Joystick Implementation](#).


<p>Note</p> 	<p><i>Configuration of PEG pulses and states as PEG outputs (default) or as general purpose outputs is done by software assignpeg command.</i></p>
--	---

Table 47 details the J26 connector.

Table 47 J26 - PEG States Connector

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

Figure 52 illustrates the J26 pin layout.

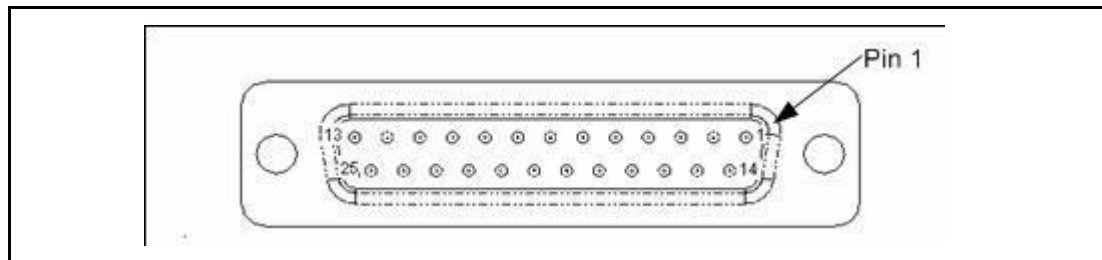


Figure 52 J26 - PEG States Connector Pin Layout


<p>Note</p> 	<p><i>In the description column, for each PEG output the variable name that commands the output when it is used as general purpose output is mentioned.</i></p>
--	---

Table 48 details the J26 pinout.

Table 48 J26 - PEG States Pinout (page 1 of 2)

Pin	Designator	Description	ACSPL+ Variable
1	X_PEG_PULSE+	Fast non-inverted PEG PULSE output for X axis	OUT8.8
2	X_STATE0+	Fast non-inverted PEG STATE 0 output for X axis	OUT8.0
3	X_STATE1+	Fast non-inverted PEG STATE 1 output for X axis	OUT8.1


Table 48 J26 - PEG States Pinout (page 2 of 2)

Pin	Designator	Description	ACSPL+ Variable
4	X_STATE2+	Fast non-inverted PEG STATE 2 output for X axis	OUT8.2
5	X_STATE3+	Fast non-inverted PEG STATE 3 output for X axis	OUT8.3
6	Y_PEG_PULSE+	Fast non-inverted PEG PULSE output for Y axis	OUT9.8
7	Y_STATE0+	Fast non-inverted PEG STATE 0 output for Y axis	OUT9.0
8	Y_STATE1+	Fast non-inverted PEG STATE 1 output for Y axis	OUT9.1
9	Y_STATE2+	Fast non-inverted PEG STATE 2 output for Y axis	OUT9.2
10	X_STATE3+	Fast non-inverted PEG STATE 3 output for Y axis	OUT9.3
11	GND	Digital ground	
12	AGND	Analog Ground	
13	AGND	Analog Ground	
14	X_PEG_PULSE-	Fast inverted PEG PULSE output for X axis	OUT8.8
15	X_STATE0-	Fast inverted PEG STATE 0 output for X axis	OUT8.0
16	X_STATE1-	Fast inverted PEG STATE 1 output for X axis	OUT8.1
17	X_STATE2-	Fast inverted PEG STATE 2 output for X axis	OUT8.2
18	X_STATE3-	Fast inverted PEG STATE 3 output for X axis	OUT8.3
19	Y_PEG_PULSE-	Fast inverted PEG PULSE output for Y axis	OUT9.8
20	Y_STATE0-	Fast inverted PEG STATE 0 output for Y axis	OUT9.0
21	Y_STATE1-	Fast inverted PEG STATE 1 output for Y axis	OUT9.1
22	Y_STATE2-	Fast inverted PEG STATE 2 output for Y axis	OUT9.2
23	X_STATE3-	Fast inverted PEG STATE 3 output for Y axis	OUT9.3
24	AIN6	Analog input 6 (single ended)	AIN6
25	AIN7	Analog input 7 (single ended)	AIN7

4.10.1 PEG States Interface

Refer to [Section 4.9.4 - Fast Digital Outputs \(PEG\)](#).

4.10.2 Analog Inputs for Joystick Implementation

Model	 <p>In SPiiPlus CM models CM-3 and CM-2...XY two additional analog inputs are available to implement joystick operation.</p>
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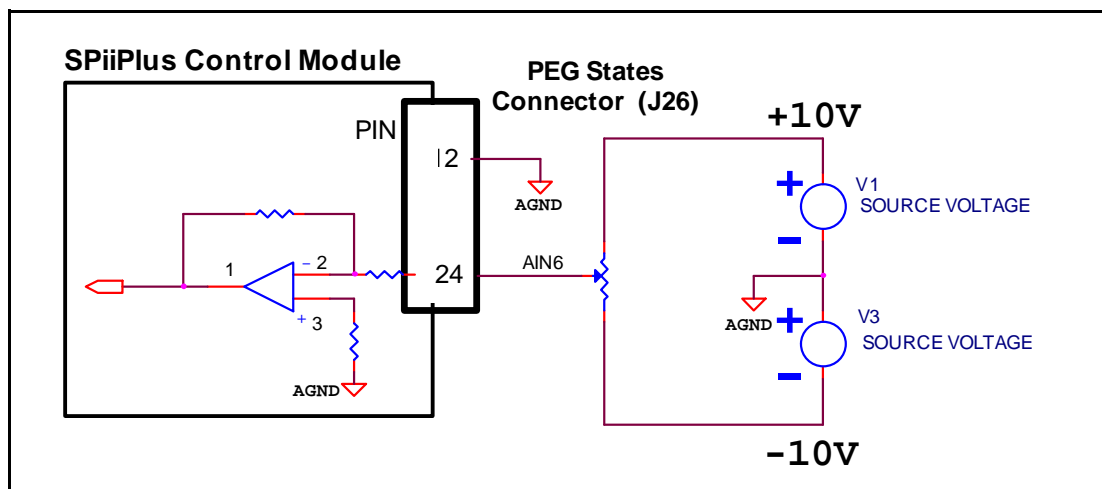


Figure 53 Single-axis Joystick Through AIN6

Table 49 Single-ended Joystick Analog Inputs

Item	Description
Quantity	Two
Type	Single-ended
Voltage Range	±10V
Input Impedance	165 kΩ
A/D Resolution	14 bit
Voltage Representation in Controller	+10V is equivalent to AIN6 or AIN7 = -8192. -10V is equivalent to AIN6 or AIN7 = +8192.
Corresponding ACSPL+ Variables	AIN6, AIN7

4.11 J8 - Safety

Table 50 details the J8 connector.

Table 50 J8 - Safety Connector

Item	Description
Jack on SPiiPlus CM	High density D-type, 15 pin, female
Plug from System	High density D-type, 15 pin, male (CHANT SINCERE CO.Ltd p.n. 101A-15MGTA*)
Recommended Wires	AWG22 wires with shielding.

Figure 54 illustrates the J8 pin layout.

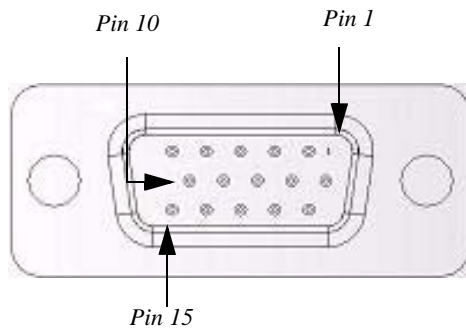


Figure 54 J8 - Safety Connector Pin Layout

Table 51 details the J26 pinout.

Table 51 J8 - Safety Pinout (page 1 of 2)

Pin	Designator	Description
1	XRL	X axis right limit
2	XLL	X axis left limit
3	YRL	Y axis right limit
4	YLL	Y axis left limit
5	ARL	A axis right limit
6	ALL	A axis left limit
7	BRL	Not relevant in SPiiPlus CM
8	BLL	Not relevant in SPiiPlus CM
9	ZRL	Z axis right limit. Relevant for stepper axis controlled via the J10 connector.
10	ZLL	Z axis left limit. Relevant for stepper axis controlled via the J10 connector.

Table 51 J8 - Safety Pinout (page 2 of 2)

Pin	Designator	Description
11	TRL	T axis right limit. Relevant for stepper axis controlled via the J10 connector.
12	TLL	T axis left limit. Relevant for stepper axis controlled via the J10 connector.
13	ES	Emergency stop
14	V_RTN_SFTY	Safety supply return
15	V_SUP_SFTY	Safety supply 5/24Vdc
	Connector metal case (SHIELD)	Cable shield connection

The SPiiPlus CM provides the following safety inputs:

- [Left and Right Limit Inputs](#)
- [Emergency Stop Input](#)

4.11.1 Left and Right Limit Inputs

Table 52 Limit Inputs

Item	Description
Quantity	One left limit and one right limit per axis: X, Y, Z, T and A
Type	Single end, opto-isolated
Corresponding ACSPL+ Variables	<AXIS>_FAULT.#LL and <AXIS>_FAULT.#RL (example: X_FAULT.#LL)
Maximum Propagation Delay	1msec
External Supply Voltage	5Vdc ($\pm 10\%$) or 24Vdc ($\pm 20\%$), detected automatically. Must be connected between the V_SUP_SFTY and V_RET_SFTY pins
Input Current	Maximum input current is 14mA
Connection	See Section 6.4 - Configuration of Sink or Source by Jumpers – JP5, JP7, JP8

Figure 55 illustrates a **source-type switched** limit input interface for axis X.

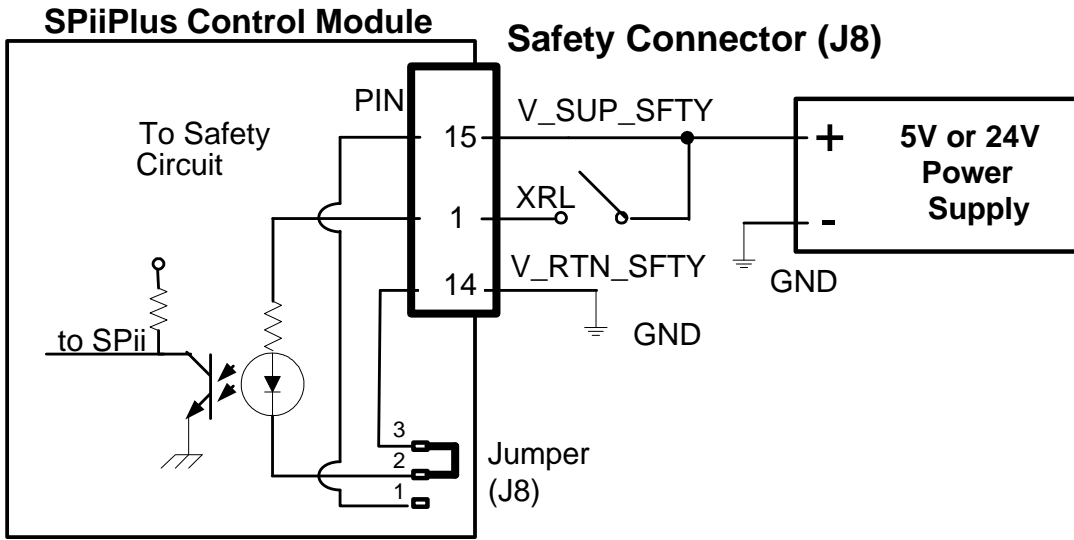


Figure 55 Source (Switched) Limit Input Connection (X Axis)

Figure 56 illustrates a **source type PNP** limit input interface for axis X.

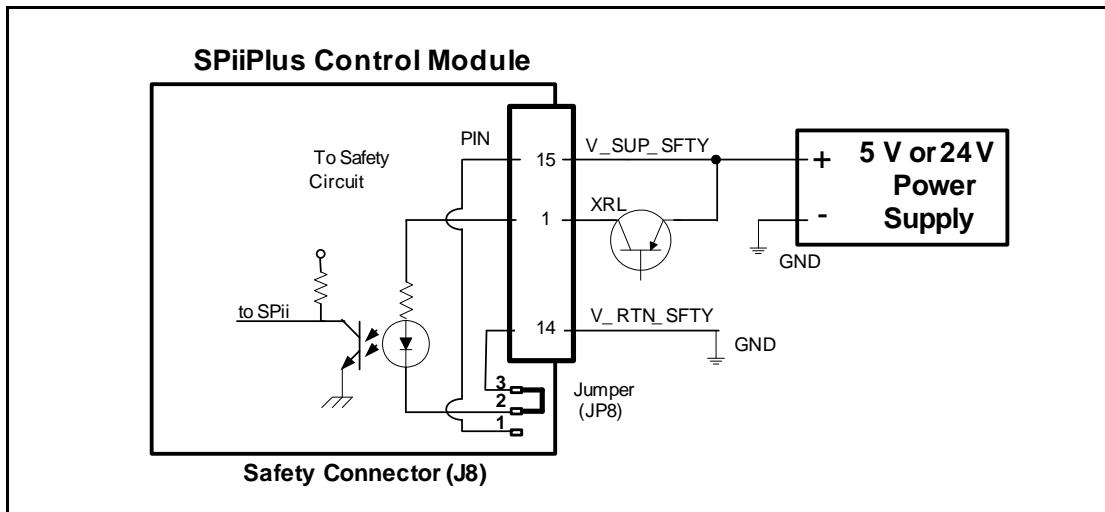


Figure 56 Source (PNP) Limit Input Connection (X Axis)

Figure 57 illustrates a **sink-type switched** limit input interface for axis X.

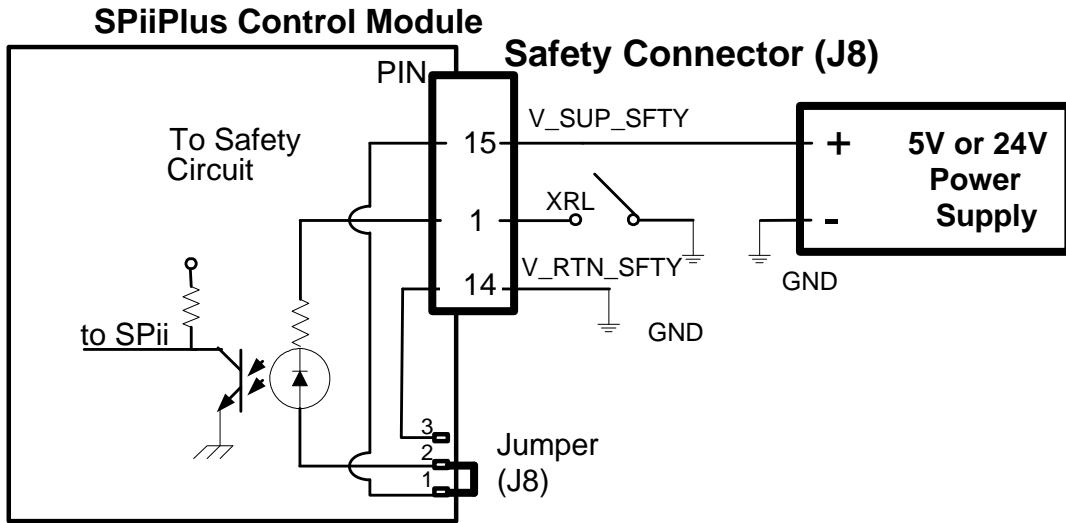


Figure 57 Sink (Switched) Limit Input Connection (X Axis)

Figure 58 illustrates a sink-type NPN limit input interface for axis X.

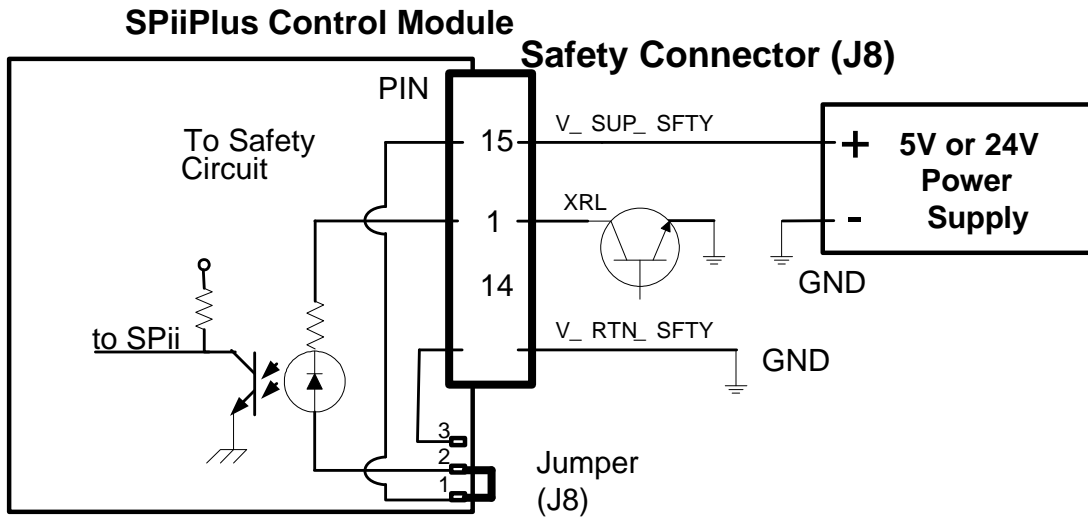


Figure 58 Sink (NPN) Limit Input Connection (X Axis)

4.11.2 Emergency Stop Input

Table 53 Emergency Stop Inputs (page 1 of 2)

Item	Description
Quantity	One
Type	Single-end, opto-isolated

Table 53 Emergency Stop Inputs (page 2 of 2)

Item	Description
Corresponding ACSPL+ Variables	SFAULT.#ES
Maximum Propagation Delay	1msec
External Supply Voltage	5Vdc ($\pm 10\%$) or 24Vdc ($\pm 20\%$), detected automatically. Must be connected between the V_SUP_SFTY and V_RET_SFTY pins
Input Current	2mA to 14mA
Connection	See Section 6.4 - Configuration of Sink or Source by Jumpers – JP5, JP7, JP8 .

Figure 59 illustrates a **source** emergency stop input interface.

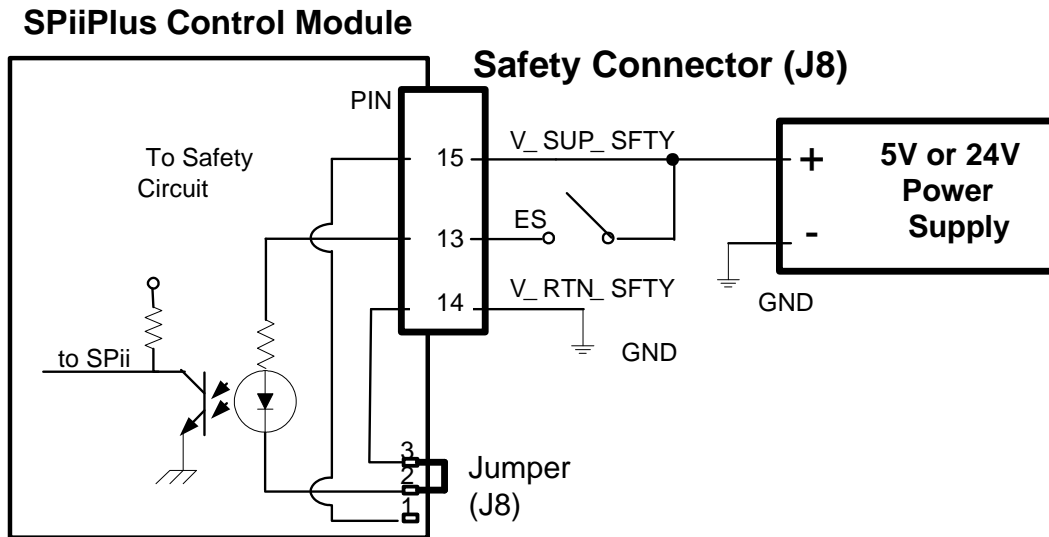


Figure 59 Source Connection for Emergency Stop Input

Figure 60 illustrates a sink emergency stop input interface.

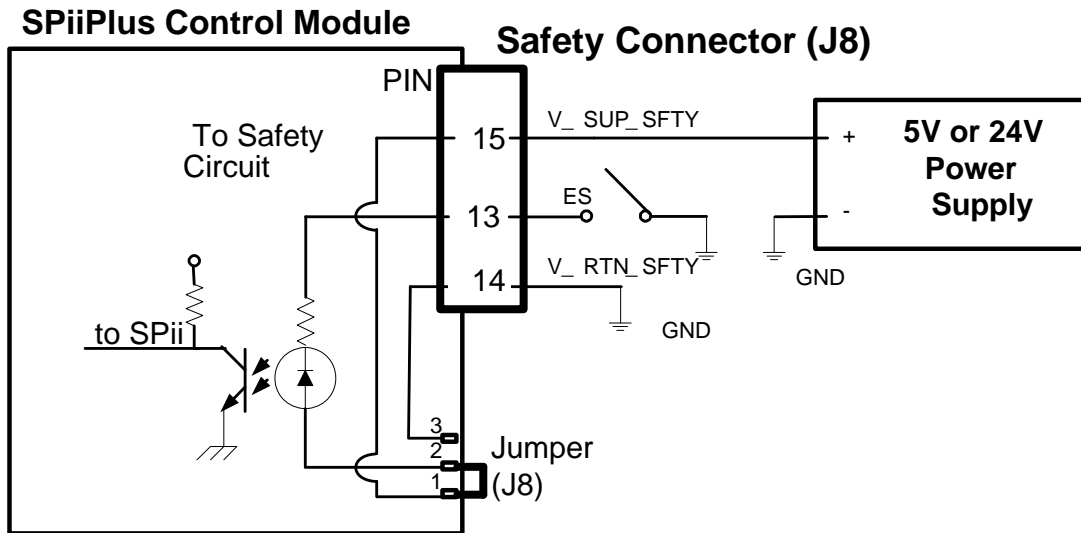



Figure 60 Sink Connection for Emergency Stop Input

4.12 J1-J4 - HSSI Network

SPiiPlus CM provides up to four HSSI channels. These channels are used to communicate with remote HSSI modules (HSSI-IO16, HSSI-ED2, HSSI-SA-1, etc.). Each HSSI channel is connected with a SPii processor.

<p>Note</p> 	<p><i>SPiiPlus CM includes HSSI connectors J1-J4. The number of available HSSI channels depends on the number of SPii processors ordered. The number of available HSSI channels appears in the label on the side of the controller. For example if “HSSI Channels Available: 0,1” appears on the label, it means that only HSSI0 (connected to J1) and HSSI1 (connected to J2) are available.</i></p>
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The HSSI connectors provide interface with HSSI modules like HSSI-IO16 (IO expansion), HSSI-ED2 (two remote axes interface module) and HSSI-SA-1 (one remote axis drive). For more information refer to the HSSI HW and Setup Guide.

Table 54 details the J1-J4 connectors.

Table 54 J1-J4 HSSI Connectors

Item	Description
Jack on SPiiPlus CM	RJ-45, 8-pin, socket
Plug from System	RJ-45, 8-pin, plug
Recommended Wires	Standard “Ethernet” cable FTP type, category 5, 20m maximum

Figure 61 illustrates the J1-J4 pin layouts.

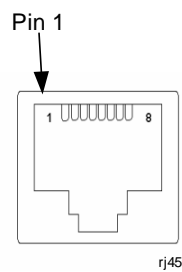


Figure 61 J1-J4 HSSI Connectors Pin Layout

Table 55 details the J1-J4 pinouts.

Table 55 J1-J4 - HSSI Pinout

Pin	Designator	Description
1	CONTROL+	Control signal non-inverted output. The signal includes START (synchronization for data transfer) and SER_CLK (data clock) information.
2	CONTROL-	Control signal inverted output
3	SER_DI+	Serial data non-inverted input
4	SER_DI-	Serial data inverted input
5	SER_DO+	Serial data non-inverted output
6	SER_DO-	Serial data inverted output
7	DGND	Digital ground for 5L
8	DGND	Digital ground for 5L

4.12.1 HSSI Interface

Table 56 HSSI

Item	Description
Quantity	4 connectors: HSSI channel 0 is connected to SPii0 (exists always) HSSI channel 1 is connected to SPii1 (if available) HSSI channel 2 is connected to SPii2 (if available) HSSI channel 3 is connected to SPii3 (if available)

4.13 J7 and J28 - COM

The following communication protocols are supported:

- One RS-232/422 serial communication port (COM1) - J7 only
- One RS-232 serial communication port (COM2) - J7 and J28
- One Ethernet 10/100 Base -T communication port (optional)

Note



1. Check the SPiiPlus CM controller product label for supported protocols.
2. Refer to the [SPiiPlus Setup Guide](#) for how to establish serial (RS-232/422) and Ethernet communication.

Table 57 details the J7 and J28 connectors.

Table 57 J7 and J28 - COM Connectors

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

Figure 62 illustrates the J7 and J28 pin layouts.

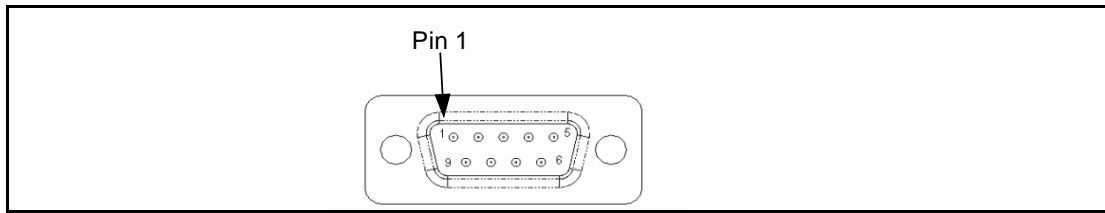


Figure 62 J7 and J28 - COM Connectors Pin Layout

Table 58 details the J7 pinout, and **Table 59** details the J28 pinout.

Table 58 J7 - COM1 Pinout

Pin	Designator	Description
1	SHIELD	Cable shield connection
2	RX232	RS-232 receive signal
3	TX232	RS-232 transmit signal
4	NC	Not connected
5	DGND	Digital ground.
6	TX+	RS-422 positive transmit signal
7	TX-	RS-422 negative transmit signal
8	RX+	RS-422 positive receive signal
9	RX-	RS-422 negative receive signal
	Connector metal case (SHIELD)	Cable shield connection

Note



Make sure that the RS-232 and RS422 serial communications are by the same type of 9-pin connector. This implementation may not comply with some of the standard null-modem communication cables that can be found.

Table 59 J28 - COM2 Pinout

Pin	Designator	Description
1	SHIELD	Cable shield connection
2	RX232	RS-232 receive signal
3	TX232	RS-232 transmit signal
4	NC	Not connected
5	DGND	Digital ground
6	NC	Not connected
7	NC	Not connected
8	NC	Not connected
9	NC	Not connected
	Connector metal case (SHIELD)	Cable shield connection

4.14 J5 - Ethernet (Optional)

Table 60 details the J5 connector.

Table 60 J5 - Ethernet Connector

Item	Description
Jack on SPiiPlus CM	RJ-45, 8-pin, socket
Plug from System	RJ-45, 8-pin, plug
Recommended Wires	Standard “Ethernet” cable FTP type, category 5

Figure 63 illustrates the J5 pin layout.

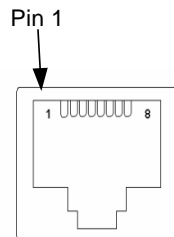
**Figure 63 J5 - Ethernet Connector Pin Layout**

Table 61 details the J5 pinout.

Table 61 J5 - Ethernet Pinout

Pin	Designator	Description
1	TD+	Positive transmit signal
2	TD-	Negative transmit signal
3	RD+	Positive receive signal
4	NC	Not connected
5	NC	Not connected
6	RD-	Negative receive signal
7	NC	Not connected
8	NC	Not connected

5 LED Indicators

Table 62 LED Indicators

LED Designator	Color	Description
Control Supply	Green	24Vdc (user-supplied) for the control circuits is present.
MPU_ON	Green	Potion Processor Unit (MPU) works. This LED can blink or light steady about 30sec after connection of control supply.
X_ON	Green	X motor is enabled
	Red	X motor is failed
	Off	X motor is disabled
Y_ON (Does not exist in SPiiPlus CM-1)	Green	Y motor is enabled
	Red	Y motor is failed
	Off	Y motor is disabled
A_ON (Does not exist in SPiiPlus CM-1/2)	Green	A motor is enabled
	Red	A motor is failed
	Off	A motor is disabled
VP	Green	AC/DC drive supply (user-supplied) for the drives bus circuits is present.
REGEN	Green	Regeneration circuit in standby mode
	Flashing	Regeneration circuit is active
	Off	If VP LED is on, the regeneration circuit is faulty
Brake Supply	Green	24Vdc (user-supplied) for the brake circuits is present.

6 Protection Circuits

The SPiiPlus CM provides the following protection circuits:

- Drive Input Supply Protection**
- Internal Integrated Drive Protection Circuits**
- Control and Brake Supply Protection**

6.1 Drive Input Supply Protection

The Integrated digital drives provide four input supply protection circuits:

- Phase-Loss (for Three-Phase AC input supply only)
- Power Down
- Power Supply Too High (Over Voltage)
- Power Supply Too Low (Under Voltage)
- Drive enable while soft-start mechanism is active.


 <p>Note</p>	<p><i>After powering up the drive supply, a soft-start mechanism is activated for 5 seconds to limit the inrush current that the SPiiPlus consumes from the electric network. During these 5 seconds the user should not enable any of the axis (X,A or Y). If any of these axes are being enabled by the user, an error 5071 will be activated.</i></p>
---	--

Table 63 Drive Input Supply Protection (page 1 of 2)

Protection	Specification	Value
Phase-Loss (for Three-Phase AC Input Supply Only)	Action	Drive Alarm fault: disables all integrated digital drives
	Drive Alarm	“Phase loss” - MERR variable code 5070
Power Down	Action	Drive Alarm fault: disables all integrated digital drives
	Drive Alarm	“Power Down” - MERR variable code 5069
High (Over Voltage)	Triggered by	DC bus voltage > 420Vdc
	Action	Drive Alarm fault: disables all drives
	Drive Alarm	“Power supply too high” - MERR variable code 5064
Low (Under Voltage)	Triggered by	DC bus voltage < 70Vdc
	Action	Drive Alarm fault: disables all drives
	Drive Alarm	Power supply too low – MERR variable code 5063

Table 63 Drive Input Supply Protection (page 2 of 2)

Protection	Specification	Value
Drive not Ready	Triggered by	If drive enable command is sent within five seconds of drive power on
	Action	Sends error message
	Drive Alarm	Drive not ready– MERR variable code error 5171

6.2 Internal Integrated Drive Protection Circuits

The SPiiPlus integrated digital drives provide four internal protection circuits:

- Short Between Phases or Short between Phase to Ground
- Over Current
- Over Temperature
- Drive not Ready

Table 64 Internal Drive Protection

Protection	Specification	Value
Short circuit Between Phases or Phase to Ground	Triggered By	Current in one of the integrated digital drive output phases exceed the maximum value.
	Trigger Level	SPiiPlus CM-X-A: 25A SPiiPlus CM-X-B: 50A
	Action	Disables drive
	Propagation Delay	<1μsec
	Drive Alarm	Short circuit - MERR variable code 5061
Over Current	Triggered By	Current in one of the integrated digital drive outputs exceeds the over current protection level
	Trigger Level	SPiiPlus CM-X-A: 15A SPiiPlus CM-X-B: 30A
	Action	Disables drive
	Propagation Delay	<5ms
	Drive Alarm	“Over current” - MERR variable code 5026
Over Temperature	Triggered by	Temperature on drive's power bridge >100±5°C
	Action	Disables drive
	Drive Alarm	“Over temperature” - MERR variable code 5065
Drive not Ready	Triggered by	At AC ON for a duration of six seconds
	Action	User cannot enable drive
	Drive Alarm	

6.3 Control and Brake Supply Protection

The SPiiPlus CM provides 4A fuse protection for Control and Brake Supply:

6.4 Configuration of Sink or Source by Jumpers – JP5, JP7, JP8

The factory default configuration of jumpers JP5, JP7 and JP8 is Sink (pin number 1 and pin number 2 are connected). SPiiPlus CM provides configuration of digital inputs, digital outputs and safety inputs.

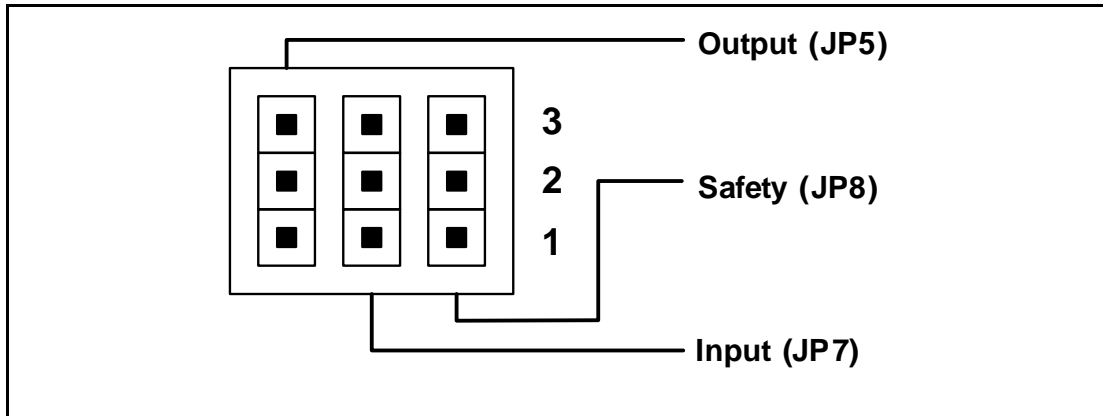


Figure 64 Configuration of Sink or Source by Jumpers

- To set Sink configurations, install jumper between 1 and 2.
- To set Source configurations, install jumper between 2 and 3.

6.5 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 65 illustrates the location of the Recovery Mode Jumper JP2.

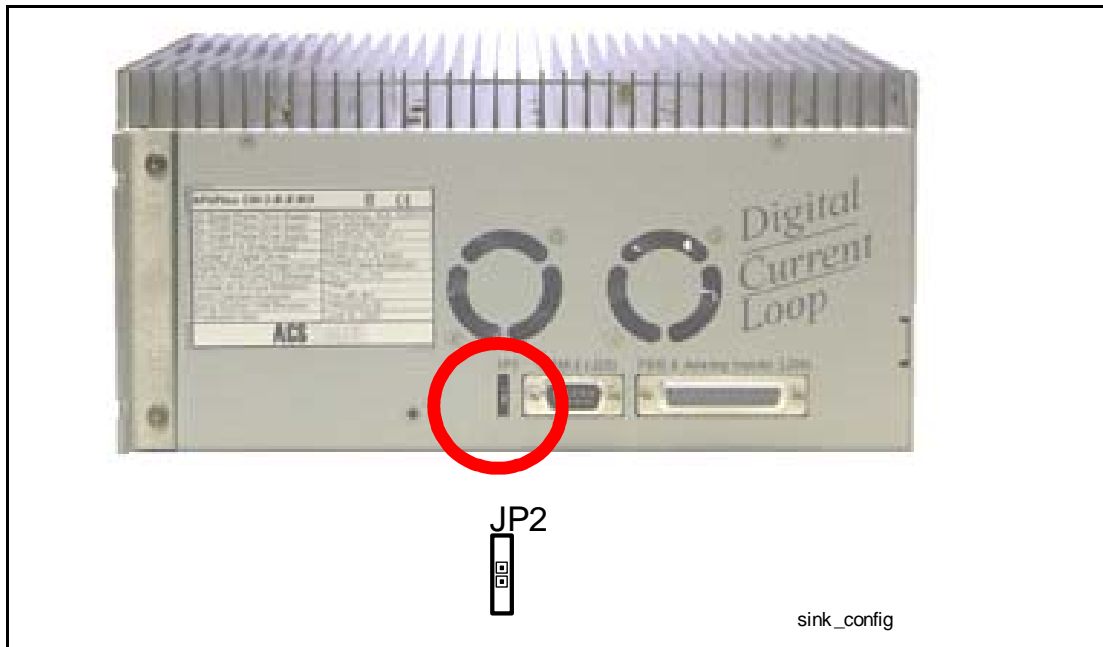


Figure 65 SPiiPlus CM-2/3 Revision B: Recovery Mode Jumper – JP2

7 External Fuses

To connect to the drive power supply connector (J18), you should use external fuses that comply with the following specifications. The specifications are for SPiiPlus CM for single, two and three phase drive supply, for 1, 2 and 3 axis and A, B, C power range.

Table 65 One and Two Phase SPiiPlus CM - 1 Axis, 2 Axis, 3 Axis

SPiiPlus CM	1 Axis	2 Axis	3 Axis
A: 5A cont./10A peak	12A, 250Vac, Slo-Blo	15A, 250Vac, Slo-Blo	15A, 250Vac, Slo-Blo
B: 10A cont./15A peak	15A, 250Vac, Slo-Blo	15A, 250Vac, Slo-Blo	15A, 250Vac, Slo-Blo
C: 15A cont./30A peak	15A, 250Vac, Slo-Blo	15A, 250Vac, Slo-Blo	15A, 250Vac, Slo-Blo

Table 66 Three Phase SPiiPlus CM - 1 Axis, 2 Axis, 3 Axis

SPiiPlus CM	1 Axis	2 Axis	3 Axis
A: 5A cont./10A peak	8A, 250Vac, Slo-Blo	15A, 250Vac, Slo-Blo	15A, 250Vac, Slo-Blo
B: 10A cont./15A peak	15A, 250Vac, Slo-Blo	15A, 250Vac, Slo-Blo	15A, 250Vac, Slo-Blo
C: 15A cont./30A peak	15A, 250Vac, Slo-Blo	15A, 250Vac, Slo-Blo	15A, 250Vac, Slo-Blo

8 Sin-Cos Module Installation

If you have ordered a Sin-Cos encoder with your SPiiPlus CM, you can always add this device at your discretion. This chapter describes how to install the Sin-Cos module.

8.1 Physical Description

Refer to [Figure 66](#) for an illustration of **Side A** and **Side B** of the Sin-Cos encoder module.

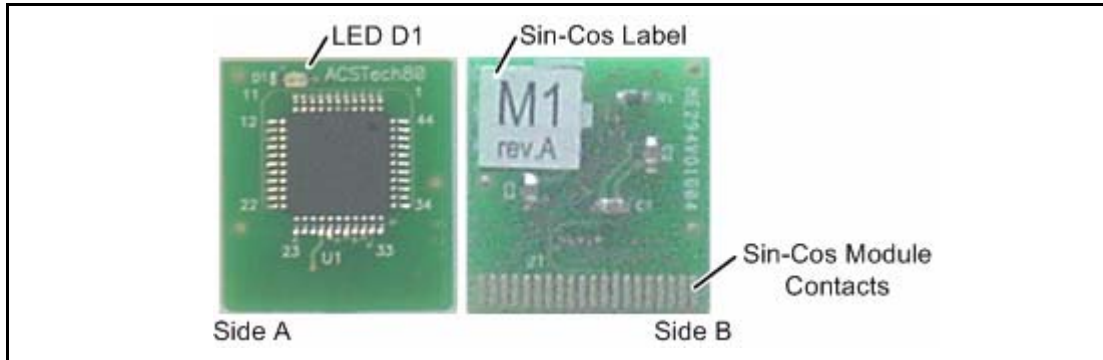



Figure 66 Sin-Cos Module Sides

<p>Caution</p> 	<p><i>The Sin-Cos module is a static sensitive device. Handle the Sin-Cos module only at a static safe work station.</i></p>
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8.2 Installation

Proper installation of the Sin-Cos module includes two procedures: Hardware Installation and Software Settings Update. The following sections describe these procedures.

8.2.1 Hardware Installation

Install the Sin-Cos module as follows:

1. Disconnect the SPiiPlus CM unit from the power source.
2. Locate the J24 Sin-Cos slot on the side of the CM unit. [Figure 67](#) illustrates the location of J24.
3. Place the Sin-Cos module in the Sin-Cos module slots with **Side A** facing up and with the module contacts on **Side B** facing towards the CM unit.

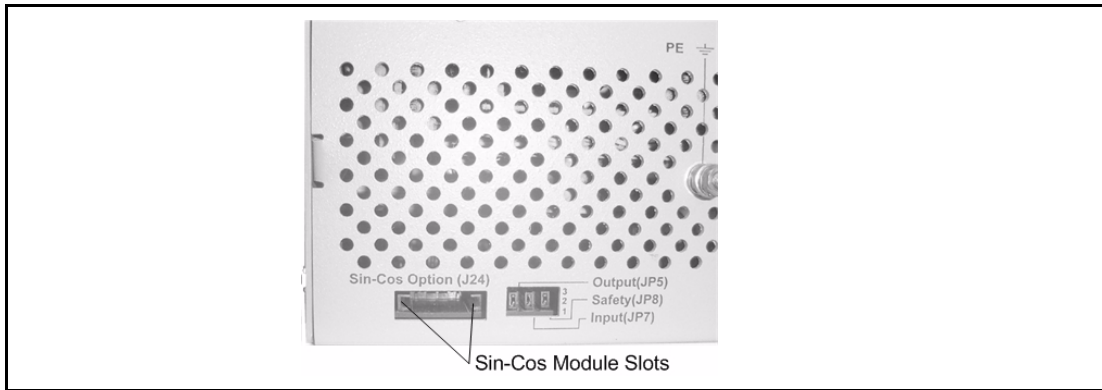


Figure 67 Location of J24 and Sin-Cos Module Slots

4. With a needle nose pliers or similar tool, use hand force and push in the module as illustrated in [Figure 68](#).

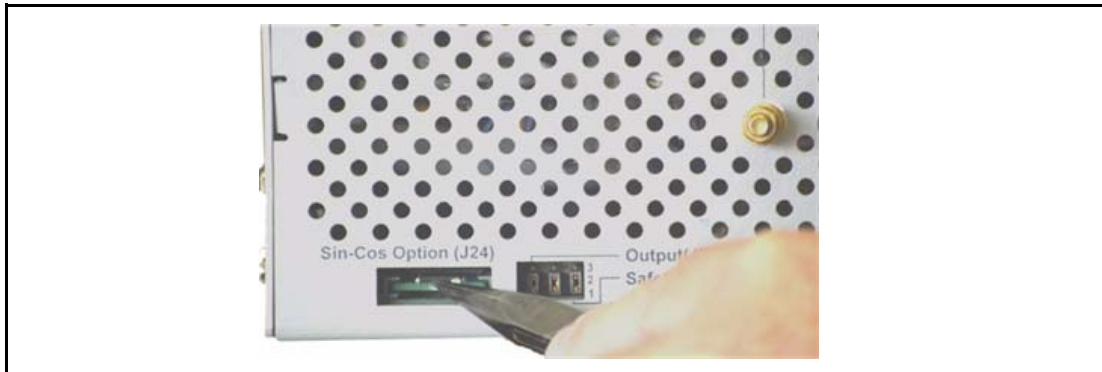


Figure 68 Sin-Cos Module in Place

5. Power on the SPiiPlus CM unit and check that LED D1 is on.
6. Proceed to [Section 8.2.2 - Software Settings Update](#).

Note



To remove a Sin-Cos module, use the needle nose pliers to grab the module.

Caution



Note the location of LED D1, see [Figure 66](#), to avoid damage with the needle-nose pliers.

8.2.2 Software Settings Update

After installing the Sin-Cos module, update the software settings as follows:

1. Open the **SPiiPlus MMI** and from the tool bar click **Setup**→ **Adjuster**.
2. From the **Adjuster** menu, click **Axis Setup**. The **Axis Setup** dialog comes up.
3. From the **Type** list, select **SIN-COS**.
4. From the **Internal Multiplier Factor** list, select the multiplier value as described below.

Note



1. The label on side B of the Sin-Cos module, see [Figure 66](#), indicates the number of available multipliers as follows:
 - *M1 = One multiplier*
 - *M2 = Two multipliers*
 - *M3 = Three multipliers*
2. *If you have made any motor or drive changes, be sure to update these parameters as well.*

5. Click **Calculate Parameters and Close**.
6. Click **OK** on the Calculated Parameters summary.

9 Warranty

ACS MotionControl 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 God. If the product is provided in an enclosed case, this warranty does not apply if the case has been opened.

ACS MotionControl 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 include, but not be 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 MotionControl of the possibility of any such damages.

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