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REDEFINING MOTION CONTROL

SPiiPlus CM

Control Module: Multi-Axis Controller & Digital Drives

Hardware Guide

Document revision no. 4.20

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Website: http://www.acs-tech80.com/
E-mail: info@acs-tech80.com
support@acs-tech80.com

ACS-Tech80 Inc.
7351 Kirkwood Lane North, Suite 130
Maple Grove, MN 55369
USA
Tel: (1) (763) 493-4080 (800-545-2980 in USA)
Fax: (1) (763) 493-4089

ACS-Tech80 BV
Antonie van Leeuwenhoekstraat 18
3261 LT Oud-Beijerland
THE NETHERLANDS
Tel: (31) (186) 623518
Fax: (31) (186) 624462

ACS-Tech80 Ltd.
Ramat Gabriel Industrial Park
POB 5668
Migdal Ha'Emek, 10500
ISRAEL
Tel: (972) (4) 6546440
Fax: (972) (4) 6546443

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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

The remaining tasks involved in operating the SPiiPlus CM, are described in the SPiiPlus ACSPL+ Programmers Guide. It includes:

- how to program motion,
- how to program I/O events
- and other features of the product

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1.1. The SPiiPlus Documentation

TABLE 1-1 SPiiPlus Documentation

Document	Description
SPiiPlus PCI-4-8 Hardware Guide	Installation and hardware connection with the SPiiPlus PCI 4 or 8 axes
SPiiPlus CM Hardware Guide	Installation and hardware connection with the SPiiPlus Control Module
SPiiPlus Setup Guide	Communication, configuration and adjustment procedures for SPiiPlus motion control products.
SPiiPlus ACSPL+ Programmer's Guide	Command set and high level language for programming SPiiPlus controllers.
SPiiPlus MMI User's Guide	Software tools reference guide.
SPiiPlus MultiDebugger User's Guide	Multiprogramming and debugging environment for ACSPL+ programs.
HSSI Expansion Modules Guide	High-Speed Synchronous Serial Interface (HSSI) for expanded I/O, distributed axes, and nonstandard devices.
SPiiPlus Library Reference	C++ and Visual Basic® libraries for host PC applications. This guide is applicable for all the SPiiPlus motion control products
SPiiPlus Utilities User's Guide	Firmware upgrade and recovery procedures.

1.2. Conventions Used in this Guide

Several text formats and fonts are used in the text to convey information about the text.

TABLE 1-2 Conventions Used in this Guide

Text	Description
Bold	ACSPL+ command names. Software tool menus, menu items, dialog box names, and dialog box elements.
Italic	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.
`Italic monospace`	Information in code examples that the user provides.

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Text	Description
ALL CAPS	Names of keys on the keyboard. For example, SHIFT.
blue italic	Names of other documents.
blue underlined	Cross references, web pages, and e-mail addresses.
|	Symbol used in 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.

1.2.1. Statement Text and Icons Used in this Guide

NOTE



Highlights an essential operating or maintenance procedure, condition, or statement.

WARNING



Highlights an essential operating or maintenance procedure, practice, or condition, which, if not strictly observed, could result in INJURY to, or DEATH of, personnel.

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2. INTRODUCTION AND SPECIFICATIONS

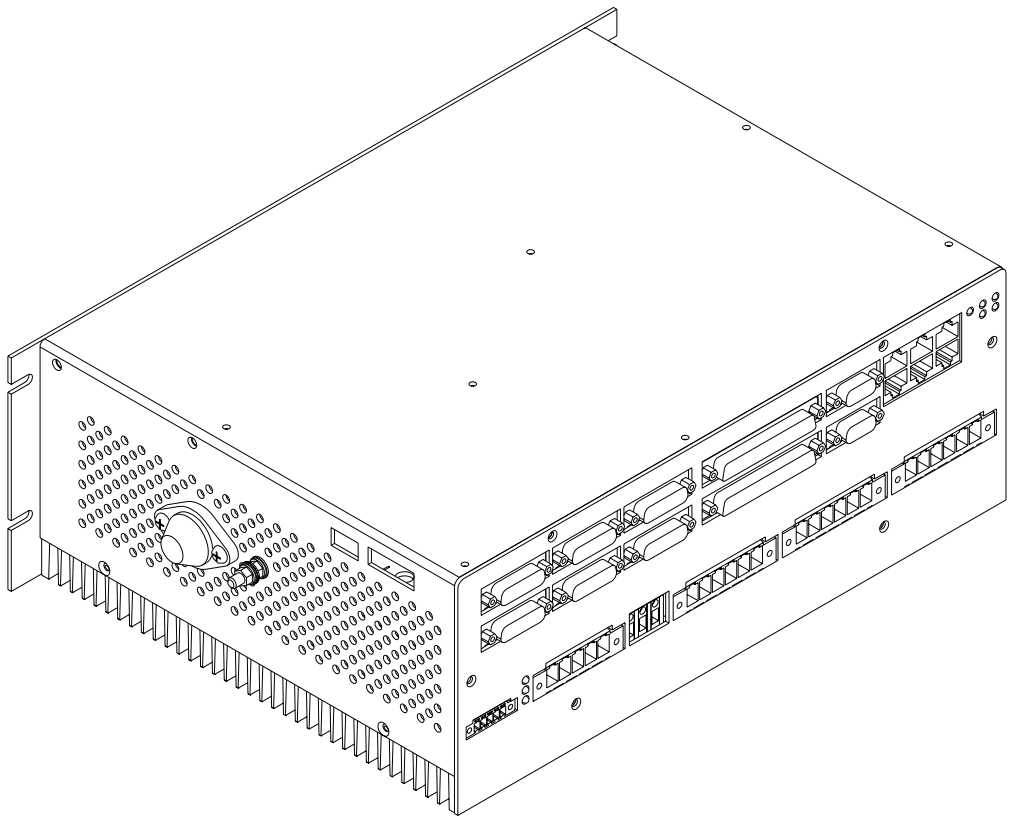


FIGURE 2-1 SPiiPlus CM Motion Control Module

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2.1. Overview

SPiiPlus motion controllers and control modules are designed to meet the requirements of the most demanding applications including semiconductors 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 configurable 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 supply voltage for the digital drives can be 24Vdc to 375Vdc or 17Vac to 265Vac,single- or three-phase. The drive output current can be 5A continous/10A peak or 10A continous/20A peak (sine wave amplitude).

SPiiPlus CM supports both high-speed incremental encoders and sin-cos encoders. An internal programmable multiplier (x4 to x65,536)can be ordered for any axis with sin-cos feedback. SPiiPlus CM can operate standalone or can be connected to a host computer via an RS-232 serial port, an RS-422/485 serial port, or an Ethernet 10/100 BaseT port. The ports can be used simultaneously.

The SPiiPlus CM comes with digital and analog I/O for general use. In addition, 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. DLL and COM libraries for C, C++, Visual Basic and LabView provide an interface between host PC applications and the controller.

Powerful software tools are provided for 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 an uncompromised 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 certified quality management system, meeting stringent safety and EMC standards.

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2.2. Axis Configurations Options

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

- 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 number of SPii processors (one to four) specified in the product order. In general, each SPii processor supports up to two servo axes or one stepper axis.

Axis assignment as a Direct-Connected Motor is predefined by the factory (no need for any configuration by the user).

Axis assignment as a Direct-Connected Drive is done by the user as a part of the Setup process. see – Setup Guide, Servo Drives (DC Brush, DC Brushless)

Axis assignment as a HSSI-Networked Axes is done by the user as a part of the Setup process. see – Setup Guide, Servo Drives (DC Brush, DC Brushless)

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TABLE 2-1 Axis Assignment Configurations

Specified in Product Order		Axis Type			
		Direct-connected motors	Direct-connected drives	HSSI-networked axes	Max. total axes (= 2 x total SPiis)
Internal Drives	SPii Processors	DC brush, DC brushless	Stepper (open loop)	DC brush, DC brushless	
1 (SPiiPlus CM-**1**)	One SPii (default)	X	-	A	2
	Four SPii (SPiiPlus CM-1-x-x-xx-H**4**)	X	Y,Z,T	A,Y,B,Z,C,T,D	8
2 (SPiiPlus CM-**2**)	One SPii (default)	X,A	-	-	2
	Four SPii (SPiiPlus CM-2-x-x-xx-H**4**)	X,A	Y,Z,T	Y,B,Z,C,T,D	8
3 (SPiiPlus CM-**3**)	Two SPii (default)	X,Y,A	-	B	4
	Four SPii (SPiiPlus CM-3-x-x-xx-H**4**)	X,Y,A	Z,T	B,Z,C,T,D	8

Example

Product Order	**SPiiPlus CM-3-x-x-xx-H4** with three internal digital drive and four SPii motion control processors.

Resulting Axis Assignments	Each SPii processor can control up to two motors, so the product will support a total of up to six motors:
	• The X, A, Y axes will be taken by the internal drive and can be DC brush or DC brushless motors.
	• The B,C,D axes can be assigned to 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.
	• The Z,T axes can be:
	  • Assigned to 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 (like B,C axes).
	Or
	  • The Z,T axes can be connected directly to a stepper motor drive.

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2.3. Specifications

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.

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 4×10^{15} counts/second^2.

Position and Velocity

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-422.
A&B,I; UP-DN,I; CLK-DIR,I.
*Maximum rate:*20 million encoder counts/second.
A&B type requirements:
-A,B line cycle >200nsec.
-A,B low &high states >100nsec.
-A to B edge separation >25nsec.
UP-DN, CLK-DIR types requirements:
-Pulse width >100nsec.
Sin-Cos Analog Encoder (optional):
Quantity: One per direct connected motor.
Type: Three channel, differential, incremental, 1Vptp.
Programmable multiplication factor: x4 to x65,536.
Maximum rate: Up to 250,000 sine periods/second. Higher rate is possible upon request.
Maximum acceleration with sin-cos encoder: 10^{8} sine periods/second^2.

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.
Bus voltage: Up to 400V.
Phase current (sine wave amplitude):
. SPiiPlus CM-1/2/3-A:
5A continuous.
10A peak (1 sec.).
. SPiiPlus CM-1/2/3-B:
10A continuous.
20A peak (1 sec.).
Maximum power (all drives): 3kW.
Minimal motor inductance: 0.5mH.
Current ripple: <5%of motor phase current.

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-422.
Maximum rate: Four million pulses per 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 or sink.
Input voltage: 5Vdc (±10%) or 24Vdc (±20%), automatic detection.
Propagation delay:<1msec.

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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 (±10%)or 24Vdc (±20%), automatic detection.
Propagation delay: <1msec.

General Purpose Digital Inputs:
Quantity: Eight.
Type: Single-ended, opto-isolated, can be configured as sink or source.
Inputs voltage: 5Vdc (±10%)or 24Vdc (±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-422.
Propagation delay: <0.1 ∝sec.
Note: These inputs can be configured for general purpose use.

General Purpose Digital Outputs:
Quantity: Eight.
Type: Single-ended, opto-isolated. Can be configured as sink or source.
Outputs voltage: 5Vdc (±10%)or 24Vdc (±20%).
Propagation delay: <1msec.
Maximum current per single output: <350mA
Maximum current per all outputs: <350mA
Note: All outputs are protected against overload and short circuit.

Position Event Generator (PEG) Digital Outputs:
Quantity: One PEG pulse per each of X,Y,Z and T axis. Four PEG states per each of X and Y axis.
Type: Differential, RS-422.
Propagation delay: <0.1 ∝sec.
PEG position compare accuracy: ±1 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 (±10%).
Maximum current per output: 1A.
Note: These outputs can be used for general purpose.

Analog Inputs:
General: Analog inputs also serve as sin-cos encoder inputs. Each sin-cos encoder consumes two analog inputs.
*Quantity: S*ix.
*Type:*Differential,±1.25V or ±10V,14-bit resolution.

Analog Outputs:
Quantity: One (in SPiiPlus CM-1/2)or two (in SPiiPlus CM-3).
Type: Single ended,±10V,10-bit resolution.

Expanded Digital I/O (Optional):
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.
Type: Differential, RS-422/485.
Each channel provides 64 input bits and 64 output bits, sampled and updated at 20kHz.

Multi-Processor Architecture

Motion Processor Unit (MPU): PC104+.
Real-time controllers: 120MHz SPii Servo Processors, one per two axes.
*Controller powerup time:*25sec.

Memory

RAM: >4Mb.
Nonvolatile memory: >4Mb.
User memory: >2Mb.

Communication Channels

*RS-232:*One channel, up to 115,200 bps.
*RS-232/422/485:*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.

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Power Supplies

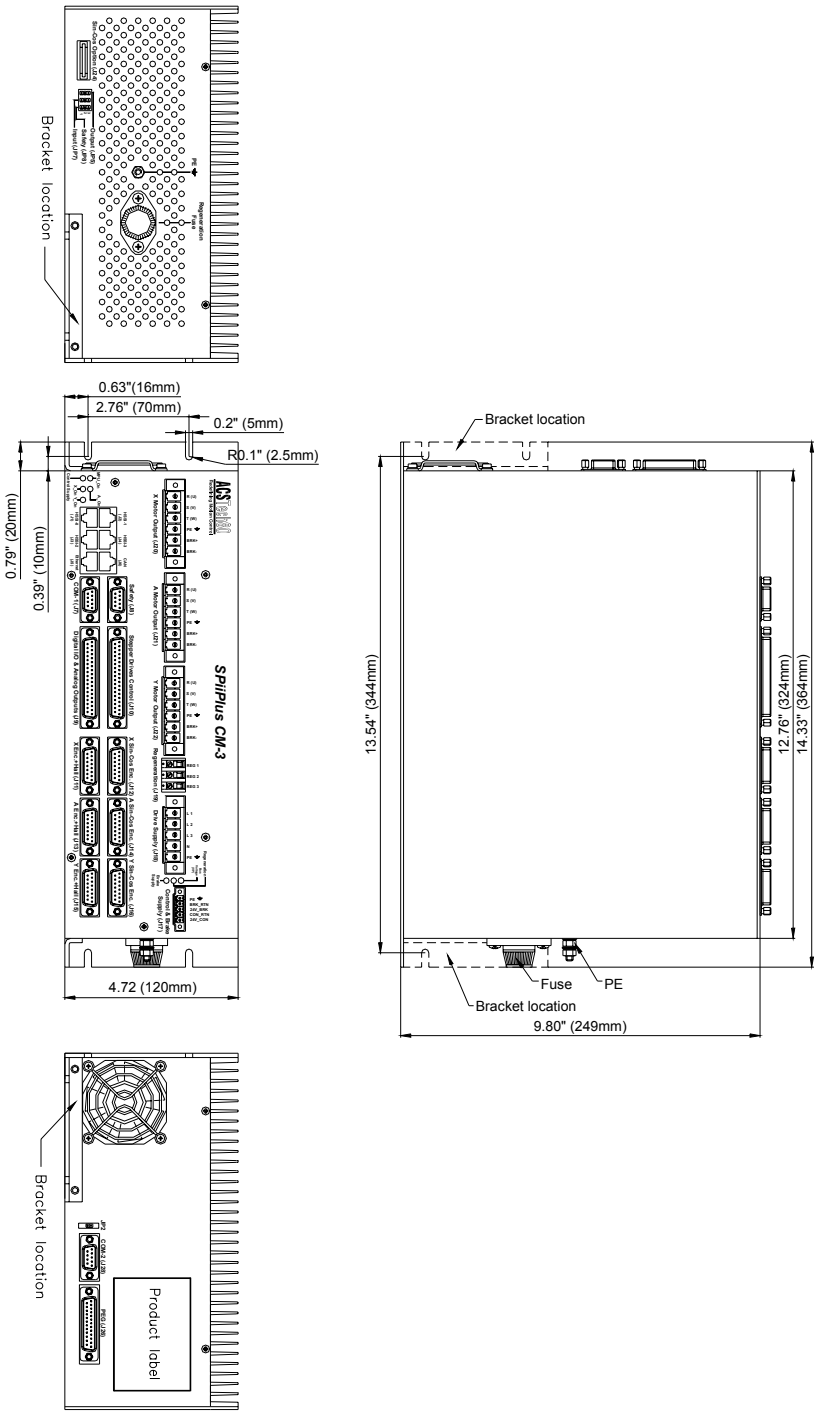
Control Section:
Voltage: 24Vdc (+/-20%).
Current: Up to 3A.
Mechanical Brake:
Voltage: 5-30Vdc (+/-10%).
Current: Up to 3A.
I/O Section:
Voltage: 5Vdc (±10%) or 24Vdc (±20%).
Current: Up to 0.8A.
Safety Inputs Section:
Voltage: 5Vdc (±10%) or 24Vdc (±20%).
Current: Up to 0.2A.
Drive Power Section:
Note: Current values are sine wave amplitude.
Single phase supply:
Voltage: 24Vdc to 375Vdc or 17Vac to 265Vac. 50/60Hz
Current: Up to 22A continuous, 45A peak.
Three phase 230Vac without neutral supply:
Voltage: 3 x 230Vac phase-to-phase.
Current: Up to 12A continuous, 24A peak.
Three phase 400Vac with neutral supply:
Voltage: 3 x 230Vac phase-to-neutral.
Current: Up to 7A continuous, 14A peak.
Regeneration: Module provides internal regeneration shunt resistor 100ohm/100W (continuous).If required, an external shunt resistor (>13ohm)can be connected.

Environment

Operating temperature: 0^0C to 40^0C.
Storage temperature: -40^0C to 85^0C.
Humidity: 90% RH, non-condensing.

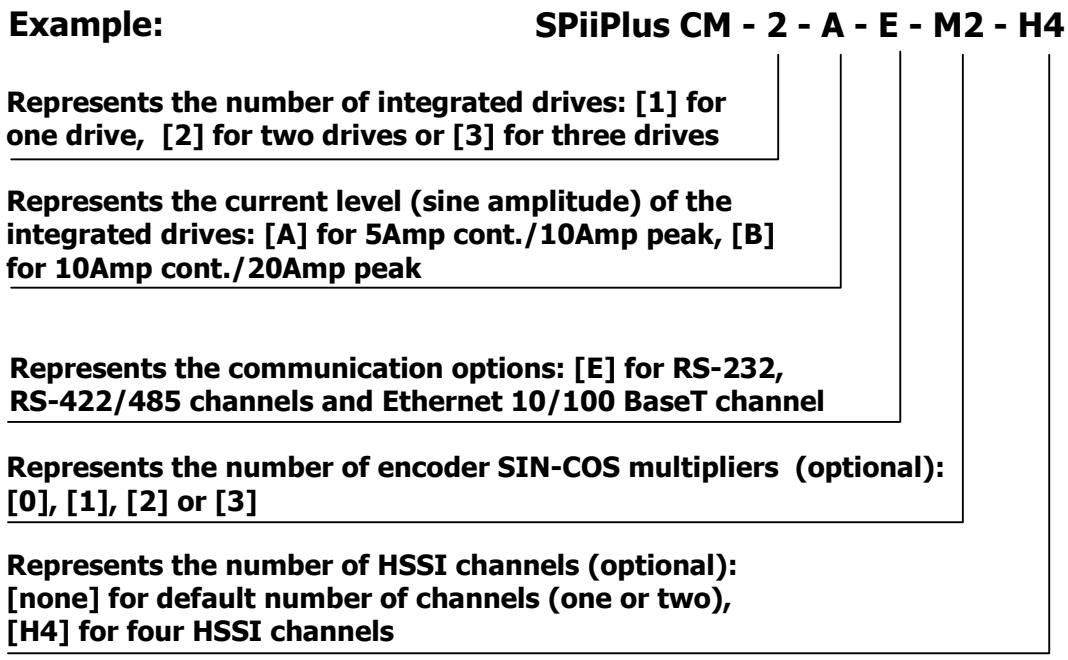
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2.4. Dimensions



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2.5. Ordering Options and Content of Products



See the ordering options per the following example:

The SPiiPlus CM comes as a standard with SPiiPlus ADK (Advanced Development Kit) CD 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 MultiDebugger** - for programming and debugging complex and multi -tasking applications
- **SPiiPlus Library** - for host programming in C/C++ or Visual Basic
- **SPiiPlus Utilities** -for upgrading firmware and recovering from errors
- **SPiiPlus Simulator** - for fast application development and debugging
- Hardware, software, setup, and programming guides in PDF format
- ACSPL+ and C/C++ training files and programming examples
- MATLAB/Simulink servo algorithms models

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2.6. Additional Products

2.6.1. SPiiPlus CM-ACC

NOTE

The SPiiPlus CM does NOT come with mating connectors (user side connectors) as standard. Mating connectors (for SPiiPlus CM-3) area available separately (product name: **SPIIPLUS CM-ACC**). For fast prototyping it is recommended to order the **SPIIPLUS CM-ACC** (part numbers of all mating connectors are listed in this guide).

2.6.2. HSSI-IO16

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

2.7. How to Determine the Product Features from the Product Label

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

Example of a label:

SPiiPlus CM-3-A-E-M2-H4
Drive Supply: 24-375VDC / 17-265VAC
Control & Brake Supply: 24VDC
Number of Digital Drives: 3
Digital Drives Cont./Peak Current: 5/10Amp. (sine amplitude)
RS-232 and RS-422/485 Comm.: Yes
Ethernet Communication: Yes
CAN Open Communication: No
Number of SIN-COS Multipliers: 2
HSSI Channels Available: 0,1,2,3
Serial Number / HW revision: 12345 / A1
Production Date: April 9 2003

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3. MOUNTING AND PHYSICAL INTERFACE

The SPiiPlus CM can be mounted vertically or horizontally.

The SPiiPlus CM is equipped with holes for vertical mounting.

Two metal brackets are provided for horizontal mounting.

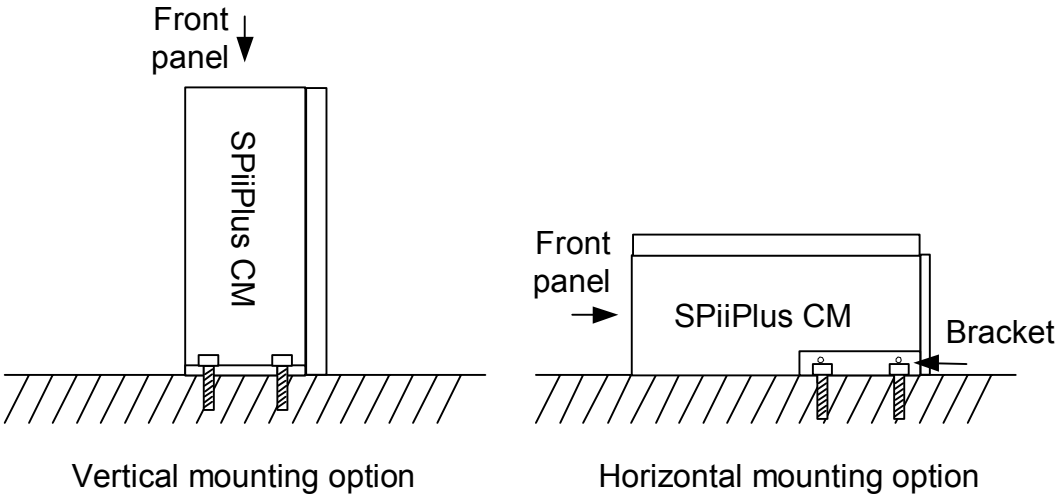


FIGURE 3-1 Mounting Options

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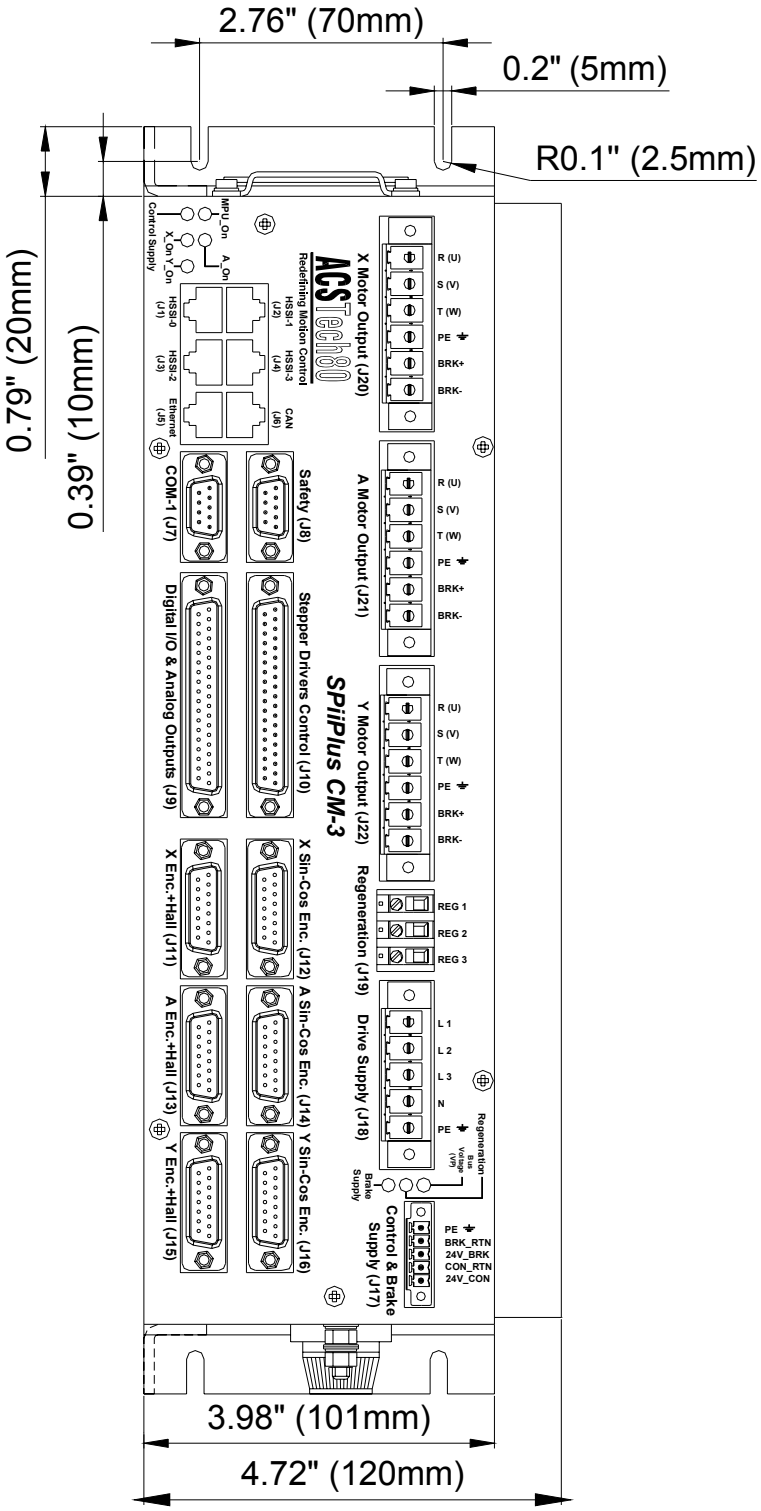


FIGURE 3-2 Front Panel

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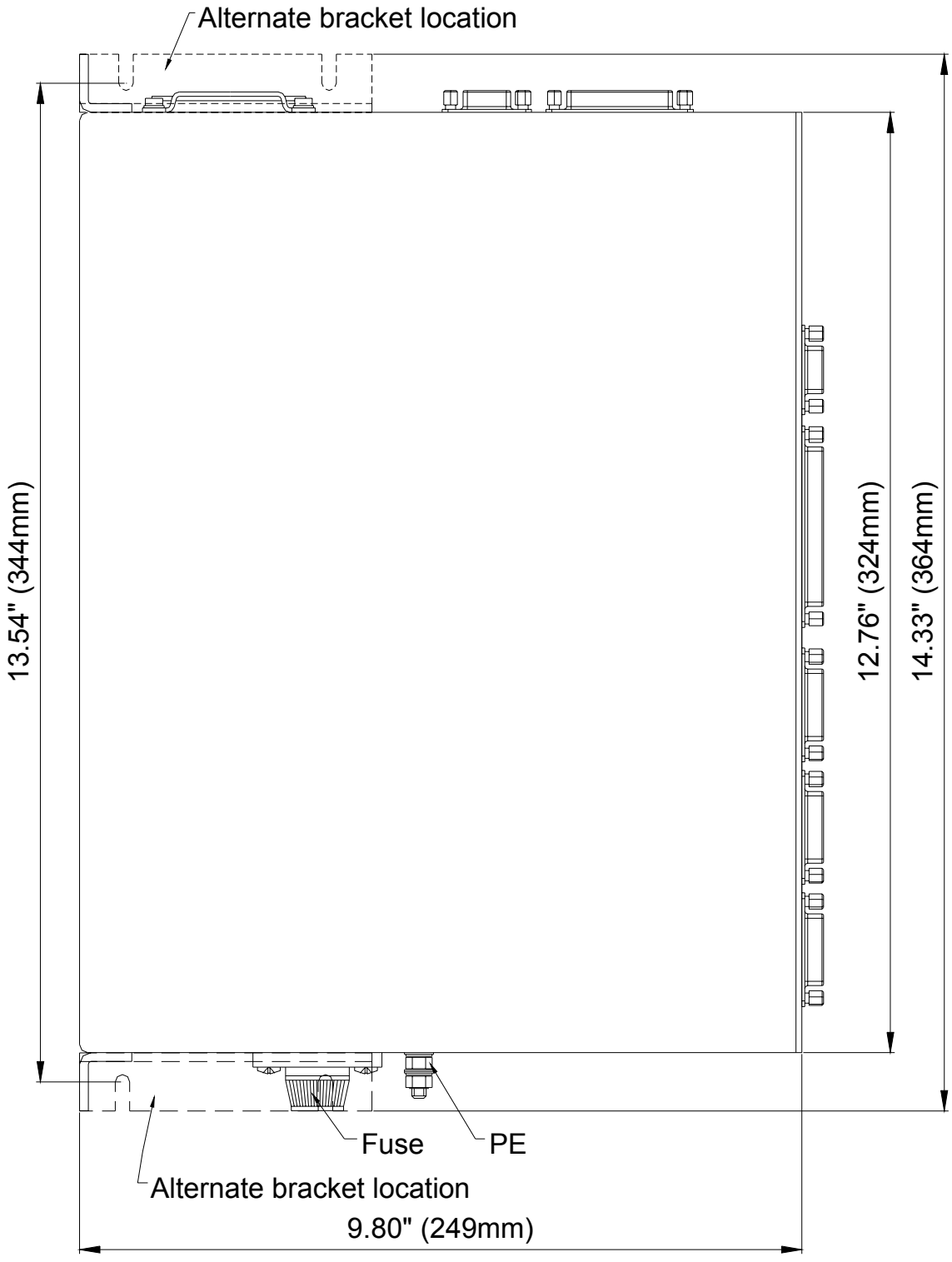


FIGURE 3-3 Side Panel

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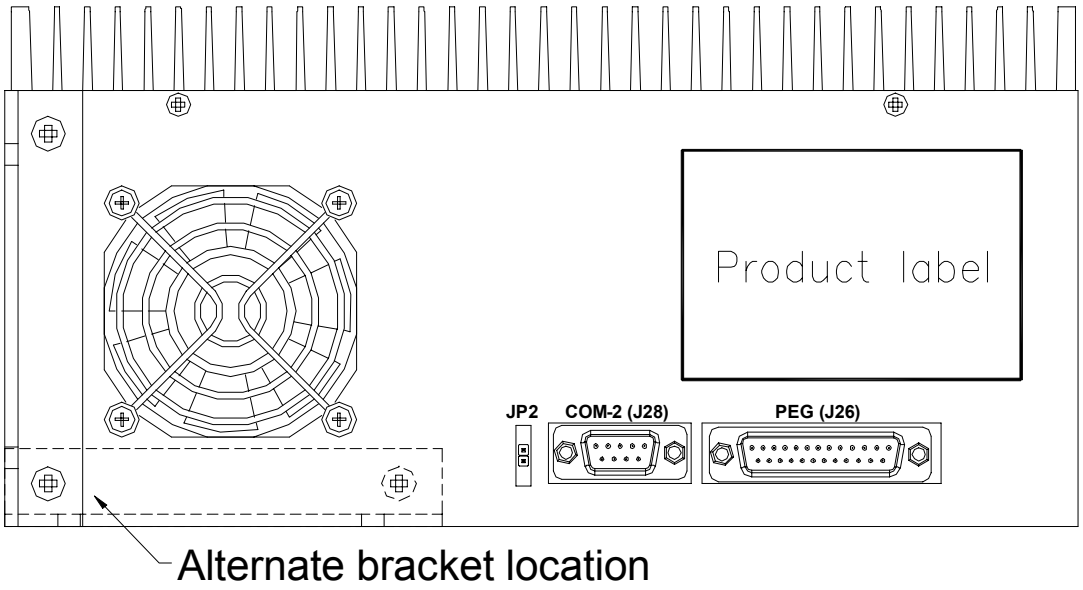


FIGURE 3-4 Left End Panel

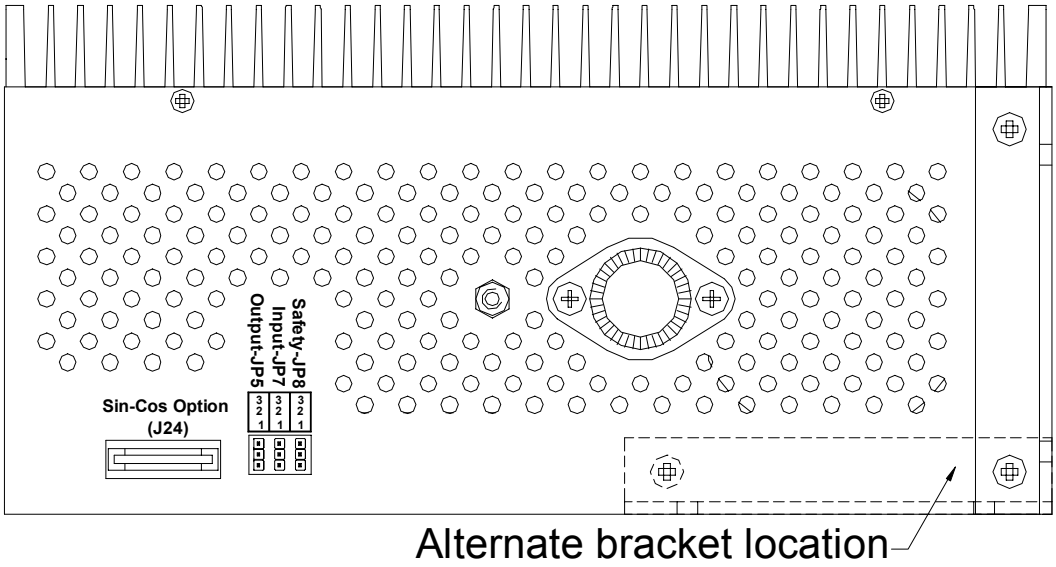


FIGURE 3-5 Right End Panel

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4. SAFETY AND EMC GUIDELINES

4.1. General Safety Guidelines

Under emergency situations the unit should be completely disconnected from any power supply. The E-Stop Inputs and Left/Right Limits on ACS-Tech80 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.

WARNING 	**To avoid electric arcing and hazards to personnel and electrical contacts, never connect/disconnect the control module while the power source is on.**

WARNING 	**After shutting off the power and removing the power source from your equipment, wait at least 5 minutes before touching or disconnecting parts of the equipment that are normally loaded with electrical charges (such as capacitors or contacts). Measuring the electrical contact points with a meter before touching the equipment is recommended.**

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CAUTION



The control module contains hot surfaces and electrically-charged components during operation. .

4.1.1. Emergency Stop Device

WARNING



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

4.1.2. Fail Safe Logic Recommendation

We recommend that all safety inputs (limit inputs and emergency stop input) will be connected in safe fail logic. Meaning during normal operation the inputs is active. When a safety event happens (or the input wire is cut) the input becomes zero and the controller identifies that as a fault.

4.1.3. Electrical Separation

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

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4.1.4. Over-Travel Protection



Over-travel limit protection shall be provided where over-travel is hazardous. The over-travel limiting device shall be installed to interrupt the power circuit.

4.1.5. Over-Current Protection



Properly sized circuit breakers shall be used for over-current protection on motor phases.

4.1.6. Thermal Detection



Suitable thermal detection shall be installed to interrupt the power circuit where abnormal temperatures can cause a hazardous condition.

4.1.7. Power Supply and Motor Cable Ground

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

4.2. General Wiring and Electromagnetic Compatibility (EMC) Guidelines

4.2.1. Routing Signal and Power Cables

Power cables (to the motor, mains outlet, etc.) and signal cables (to I/O, encoder, RS-232, etc.) must be kept as far apart as possible. Keep at least an inch (~2.5 cm) for each 3 feet (~1 m) of parallel run.

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

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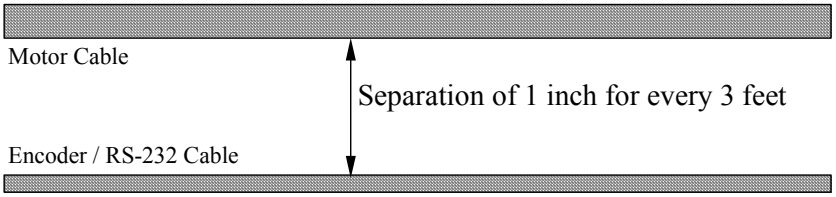


FIGURE 4-1 Cable Spacing

It is recommended to use cables that are completely shielded.

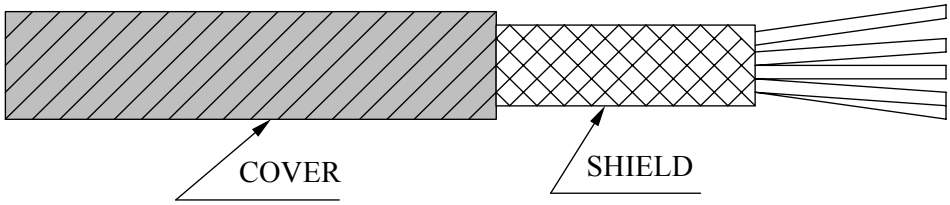


FIGURE 4-2 Shielded Cable

4.2.2. Cable Length

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

4.2.3. Shielding

To reduce EMI radiation, do the following:

- Use shielded cables
- Install a ferrite core around the cable as close to the unit as possible

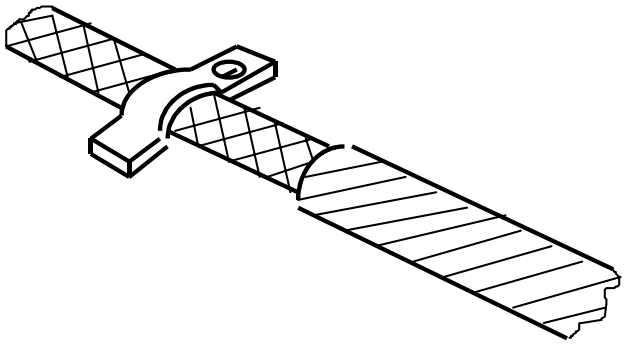


FIGURE 4-3 Improved Shielding

4.2.4. Grounding

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

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- **Safety grounding**

WARNING

The user must verify that all electric circuits and electrical components as motion controller, power drives, motors etc. shall have a grounding system. Grounding of ac and dc equipment shall be in accordance with 29 CFR 1910.304(f).

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

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

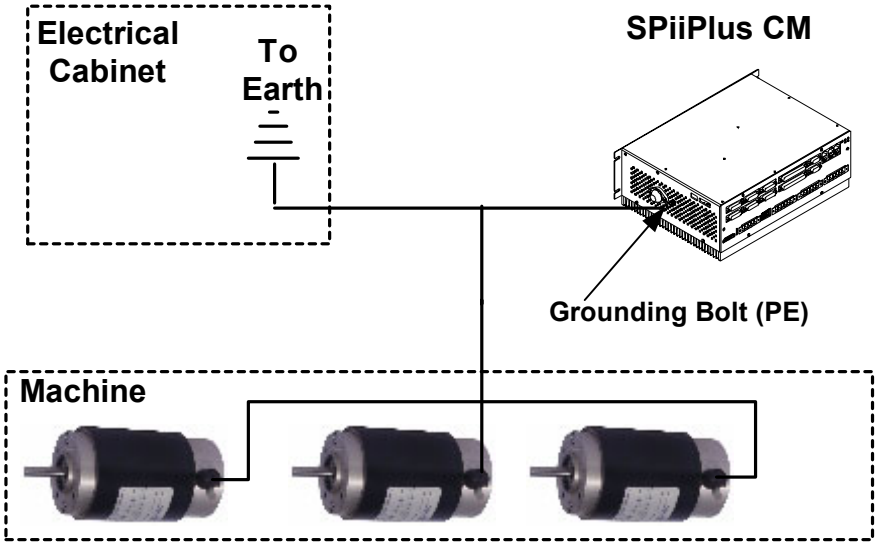


FIGURE 4-4 Grounding of the System

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5. ELECTRICAL INTERFACE

MODEL DEPENDENT



This chapter describes the interface of the SPiiPlus CM-3.
The interfaces of the SPiiPlus CM-1 and the SPiiPlus CM-2 are identical to those of SPiiPlus CM-3 with the following exceptions:

In SPiiPlus CM-2 the following connectors don't exist:
Y Motor Output (J20), Y Sin-Cos Enc. (J16), Y Enc+Hall (J14)

In SPiiPlus CM-1 the following connectors don't exist:
Y Motor Output (J20), Y Sin-Cos Enc. (J16), Y Enc+Hall (J15)
A Motor Output (J21), A Sin-Cos Enc. (J14), Y Enc+Hall (J13)

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5.1. Electrical Interface Component Locations

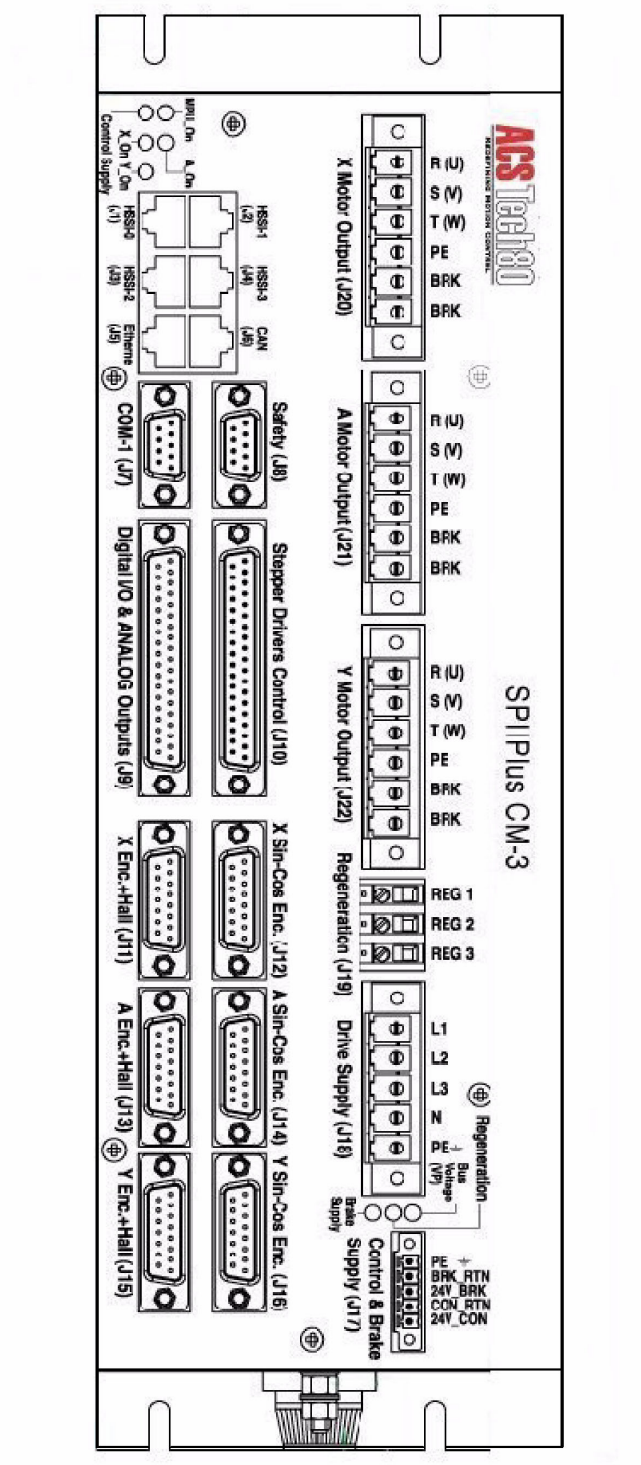


FIGURE 5-5 Front Panel Connectors - SPiiPlus CM-3

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See also the left end panel in FIGURE 3-4, and the right end panel in FIGURE 3-5.

5.2. Drive Supply Connector J18

Connector J18 receives supply power for the SPiiPlus CM's integrated digital drives.

The drive power supply is same for all installed digital drives of the Control Module.
The power supply can be:

- **Single-Phase**: 24-375Vdc or 17-265Vac input supply. Supply frequency 50/60Hz.
- **Three-Phase 230Vac**: without Neutral (3×230Vac Phase-To-Phase) input supply. Supply frequency 50/60Hz.
- **Three-Phase 400Vac**: with Neutral (3×230Vac Phase-To-Neutral) input supply. Supply frequency 50/60Hz.

TABLE 5-1 Drive Supply Connector J18 - Components

Component	Description
Jack on SPiiPlus CM	Part number: PC 4/5-G-7 Phoenix Contact™ (www.phoenixcontact.com/) Type: 5 pin plug connector
Plug from System	Part number: PC 4/5-STF-7,62 Phoenix Contact™
Recommended Wires	18-14AWG

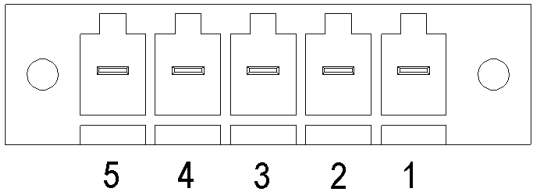


FIGURE 5-1 Drive Supply Connector J18

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TABLE 5-2 Connection of Single-Phase Supply

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

TABLE 5-3 Connection of Three-Phase 230Vac Supply

Pin	Name	Description
1	L1	Phase R
2	L2	Phase S
3	L3	Phase T
4	N	N/A
5	PE	Electrical ground

TABLE 5-4 Connection of Three-Phase 400Vac Supply

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

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5.3. Control & Brake Supply Connector J17

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 5-5 Control & Brake Supply Connector J17 - Components

Component	Description
Jack on SPiiPlus CM	Part Number: MC 1,5/5-GF-3,81 Phoenix Contact™ (www.phoenixcontact.com/) Type: 5 plug connector
Plug from System	Part Number: MC 1,5/5-STF-3,81 Phoenix Contact™
Recommended Wires	20-18AWG

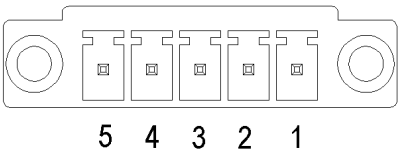


FIGURE 5-2 Control & Brake Supply Connector J17

TABLE 5-6 Control & Brake Supply Connector J17 - Pins

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

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NOTE

Control supply and brake supply 24V are protected by two internal 4A fuses.

5.4. Regeneration Connector J19

5.4.1. About Regeneration

A regeneration circuit with internal shunt or external shunt resistors can be used to absorb the motors regeneration energy (during deceleration of the axis). 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 a peak power and a continuous power.
If the peak power is exceeded then 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. Applications that frequently stop and start with high inertia and high speed should be studied closely to see if continuous shunt power is exceeded.
In case that the internal shunt resistor is too low, an over-voltage alarm will be generated during deceleration of the axis, indicating that a higher rated shunt resistor should be used externally **instead** of the internal one.

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5.4.2. Calculating External Regeneration Resistor

The following procedure explains how to:

- Calculate the regenerated power and energy values during deceleration.
- Identify if an external shunt resistor is required.
- Calculate external shunt resistor and fuse ratings (if required).

	Continuous Power [W]	Peak Power [W]	Regeneration Fuse [A]
With internal shunt resistor	100 watt.	1000 watt.	Internal protection by 1.5A fuse
With external shunt resistor	Calculate per case, 13ohm minimum.		

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/sec^2] or angular deceleration: **α** [rad/sec^2]
   - Deceleration time of the motion: $\mathbf{T_d}$ [sec]
   - Total mass: **M** [Kg] (for linear axis) or inertia: **J** [Kg x m^2] (for rotary axis)
   - Motor phase current during deceleration: $\mathbf{I_d}$ [A]
   - Motor phase resistance: $\mathbf{R_{ph}}[\Omega]$
   - Number of motor phases : **n** (n=1 for DC brush motor)
   - Motor Force constant: $\mathbf{K_F}$ (for linear axis) or torque constant: $\mathbf{K_T}$ (for rotary axis)
   - Line to line supply voltage amplitude: $\mathbf{U_L}$ [V]
   - Shunt resistor clamping voltage: $\mathbf{U_{clamp}}$= 400 [V]

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2. Define the motion profile parameters and cycle of the motion as follows:

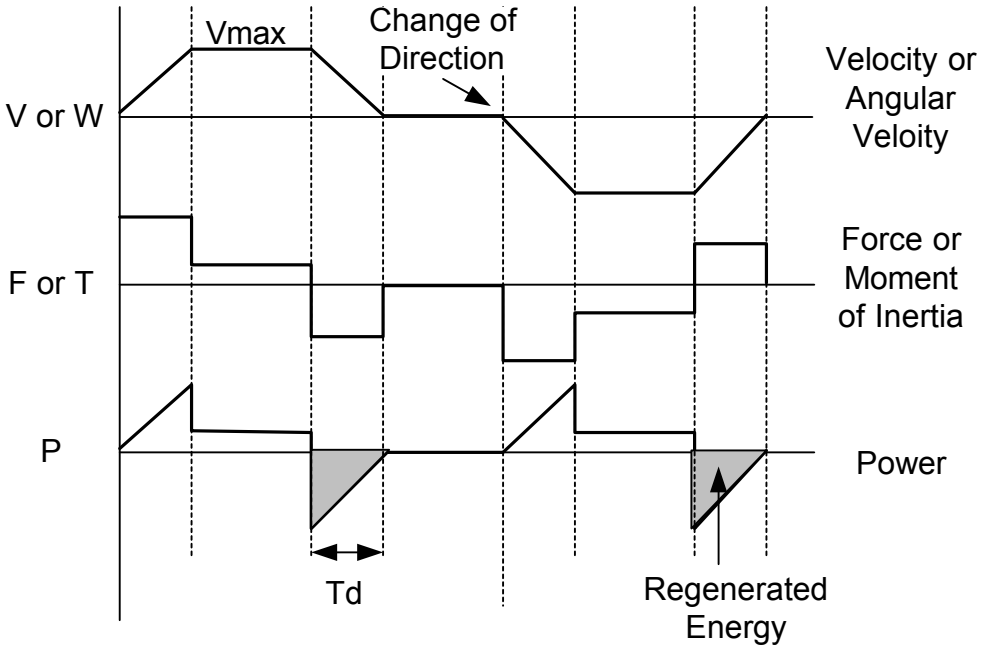


FIGURE 5-3 Example of Velocity ,Force and Power Curves

3 Calculate the peak break power for a linear axis:

$$\mathbf{Peak\ Power[W]} = \mathbf{v}_{max}\,[\mathbf{m}/\sec] \times \mathbf{M[Kg]} \times \mathbf{a}[\mathbf{m}/\sec^2]$$

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

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

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

$$\mathbf{Break\ Energy[J]} = \frac{\mathbf{Peak\ Power} \times \mathbf{T_d}}{2}$$

6. Calculate the motor conductive energy loss during deceleration.

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

where $\mathbf{I_d} = \frac{\mathbf{Ma}}{\mathbf{K_F}}$ for linear axis, $\mathbf{I_d} = \frac{\mathbf{J}\alpha}{\mathbf{K_T}}$ for rotary axis

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

$$\mathbf{Capacitor\ Energy\,[J]} \approx \frac{1}{2}\mathbf{C}\left(\frac{\mathbf{U_{clamp}} - \sqrt{2}\mathbf{U_{L-L}}}{2}\right)^2$$

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8. Calculate the regeneration shunt resistor energy:

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

Motor losses may be neglected, giving additional regeneration margins to the chosen shunt resistor.

In case of negative result no energy should be absorbed by the shunt internal resistor.

9. Calculate the regeneration shunt resistor power rating:

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

An external shunt resistor is required in the following cases:

- In case that the result is larger than the internal shunt continuous rating (100W) .
- In case that the peak power is larger than the peak internal shunt rating (1000W).

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

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

TABLE 5-7 Regeneration Connector J19 - Components

Component	Description
Jack on SPiiPlus CM	Part number: FRONT 2.5-H/SA5 Phoenix Contact™ (www.phoenixcontact.com/) 3-pin terminal block
Plug from System	No plug – accepts wires directly
Recommended Wires	18-16AWG

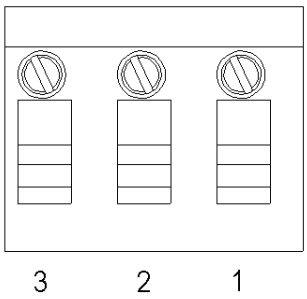


FIGURE 5-4 Regeneration Connector J19

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TABLE 5-8 Regeneration Connector J19 - Pins

Pin	Name	Description
1	REG1	Used for internal regeneration only. Connect via external jumper to pin#3.
2	REG2	Used for external regeneration only. Connect to a lead of the external regeneration resistor.
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

As a default, the SPiiPlus CM is provided with the internal shunt resistor connected (wire connected between REG1 and REG3).

5.4.3. Regeneration Interface

FIGURE 5-5 illustrates the use of an internal shunt resistor.

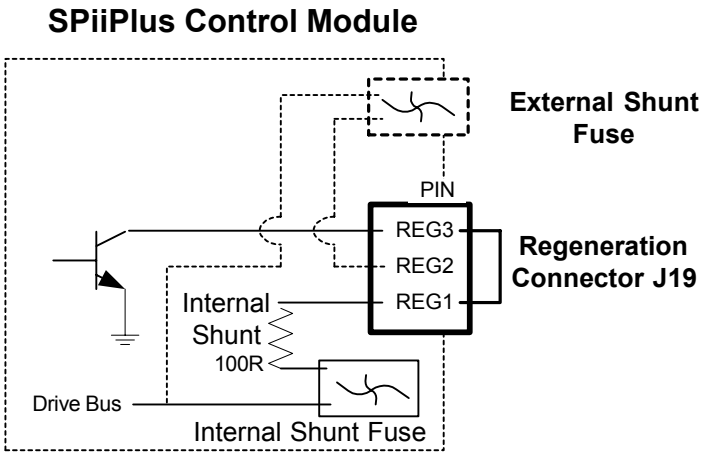


FIGURE 5-5 Regeneration Circuit with the Internal Resistor

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FIGURE 5-6 illustrates the use of an external shunt resistor.

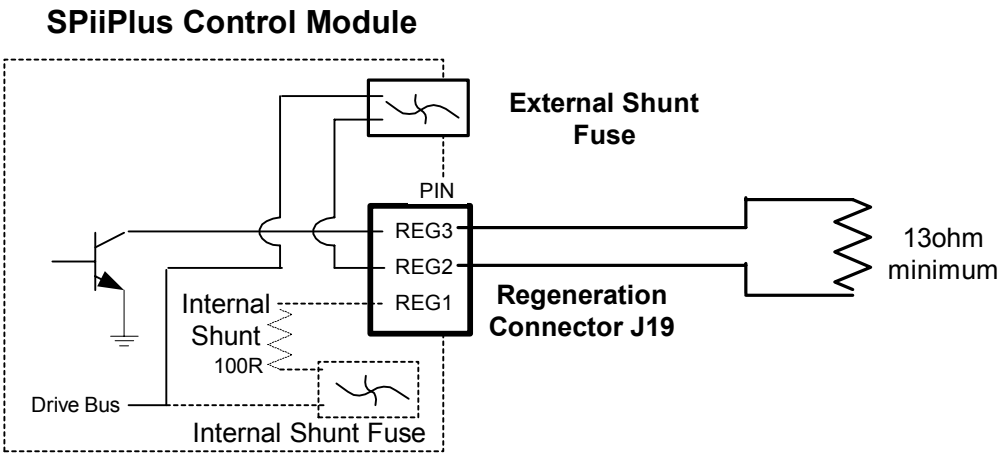


FIGURE 5-6 Regeneration Circuit with the External Resistor

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5.5. Servo Motor & Brake Output Connectors J20, J21, J22

The motor output connector supplies power from the SPiiPlus CM internal drive to a DC brush or three phases DC Brushless (AC servo) motor.
The connectors also include an output command for a mechanical brake device (if exists). This high current output is active if the **MFLAGS** bit 23 of the axis is set and the drive is enabled.

TABLE 5-9 Motor Output Connectors J20, J21, J22 - Components

Component	Description
Connector **J20** (exist in all product versions)	Supplies X axis motor
Connector **J21** (exist in SPiiPlus CM-2/3 only)	Supplies A axis motor
Connector **J22** (exist in SPiiPlus CM-3 only)	Supplies Y axis motor
Jack on SPiiPlus CM	Part Number: PC 4/6-G-7.62, Phoenix Contact™ (www.phoenixcontact.com/) Type: 5 pin plug connector
Plug from System	Part Number: PC 4/6-STF-7,62 Phoenix Contact™
Recommended Wires	18-14AWG

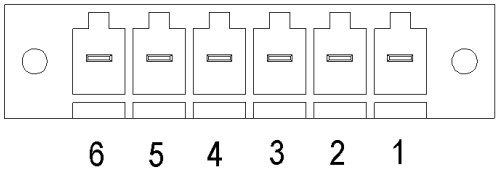


FIGURE 5-7 Motor Output Connectors J20, J21, J22

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TABLE 5-10 Motor Output Connectors J20, J21, J22 - Pins

Pin	Name	Description
1	R	For DC brush motor phase For DC brushless motor: phase "R" Remark: current of this phase isn't measured by the controller.
2	S	For DC brush motor phase For DC brushless motor: phase "S"
3	T	For DC brushless motor: motor phase "T"
4	PE	Electrical ground
5	BRK +	5-30Vdc brake output.
6	BRK -	Brake return

5.5.1. 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.

NOTE

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.

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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 5-11 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 (±10%)
Maximum Current per mechanical brake output	1A
Remark	For testing the brake out put in (sink configuration) while the brake is not connected, a pull-up resistor should be connected.

FIGURE 5-8 illustrates a for mechanical brake circuit.

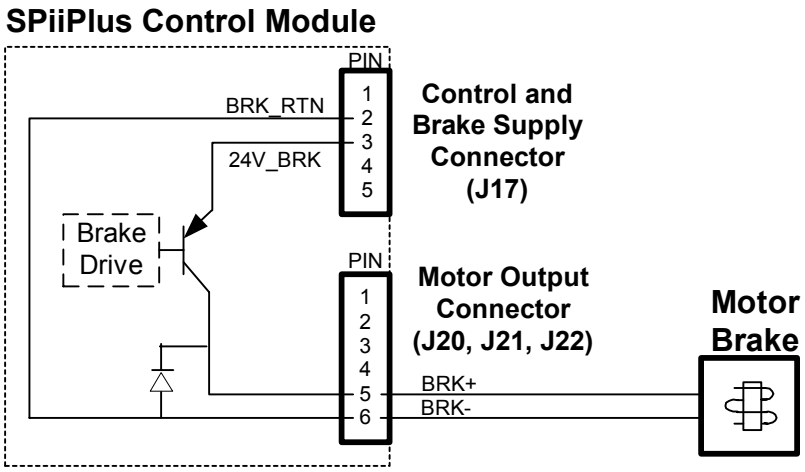


FIGURE 5-8 Mechanical Brake Circuit

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5.6. Stepper Drive Commands Connector J10

The SPiiPlus CM can control up to three step motors powered by third party drives with Pulse-Direction lines commands (in open loop control). For information about stepper axis configurations options refer to Axis Configurations Options (page 1-1). For information about configuration process of a stepper axis refer to SPiiPlus Setup Guide, Stepper Drives

NOTE

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 can be available for stepper only in SPiiPlus CM-x-x-x-Mx-**H4** (where four SPii DSP where ordered) – see Axis Configurations Options (page 2–3) and Ordering Options and Content of Products (page 2–2).

TABLE 5-12 Stepper Drive Commands Connector J10 - Components

Component	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 -).

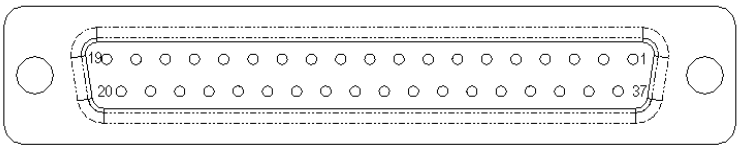


FIGURE 5-9 Stepper Drive Commands Connector J10

TABLE 5-13 Stepper Drive Commands J10 - Pins

Pin	Name	Description
1	PULSE_X+	Not applicable in SPiiPlus CM-1/2/3
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+	Not applicable in SPiiPlus CM-1/2/3

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Pin	Name	Description
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+	Not applicable in SPiiPlus CM-1/2/3
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+	Not applicable in SPiiPlus CM-1/2/3
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	NC	Not connected
19	SHIELD	Cable shield connection
20	PULSE_X-	Not applicable in SPiiPlus CM-1/2/3
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-	Not applicable in SPiiPlus CM-1/2/3
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-	Not applicable in SPiiPlus CM-1/2/3
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-	Not applicable in SPiiPlus CM-1/2/3
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

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Pin	Name	Description
36	FLT_T-	Drive fault sink input for T axis step motor driver
37	NC	Not connected

5.6.1. 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 be used. In this case only the + command (like "PULSE_Y+") should be connected to the drive.

TABLE 5-14 Stepper Drive Pulse and Direction Outputs

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

FIGURE 5-10 illustrates a Y axis implementation of a differential stepper drive connection.

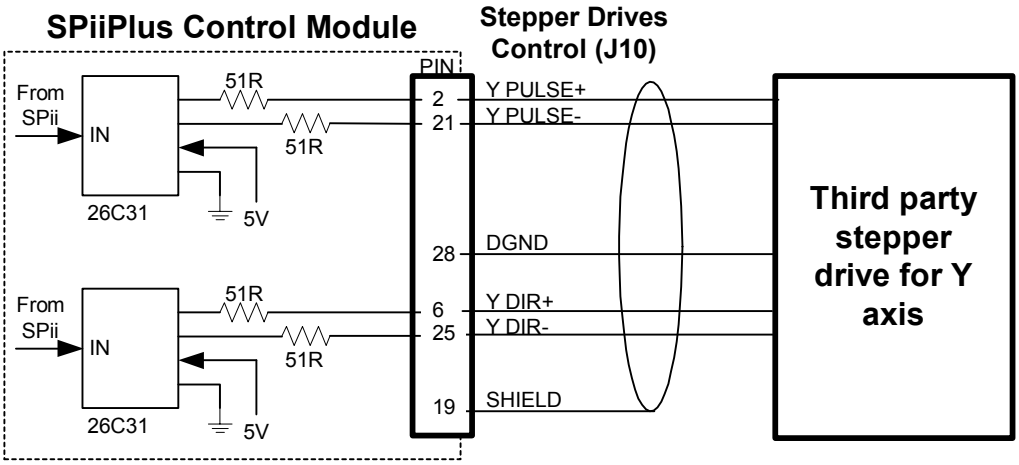


FIGURE 5-10 Stepper Drive Pulse and Direction Interface (Y axis)

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NOTE

In case that the stepper drive has a single-ended input commands (not differential), use only the DIR+ and the PULSE+ commands.

5.6.2. Stepper Drive Enable Outputs

TABLE 5-15 Stepper Drive Enable Outputs

Category	Value
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 (±10%) or 24Vdc (±20%) – pending on V_SUP_IO or V_RET_IO voltage
Maximum Current	50mA per enable output
Outputs Protection	Short circuit, over-voltage and over-current

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5.6.2.1. Stepper Drive Enable Examples

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

FIGURE 5-11 is an example of a source-type enable connection to a stepper drive. When the drive receives external 5V (or 24V), it is enabled.

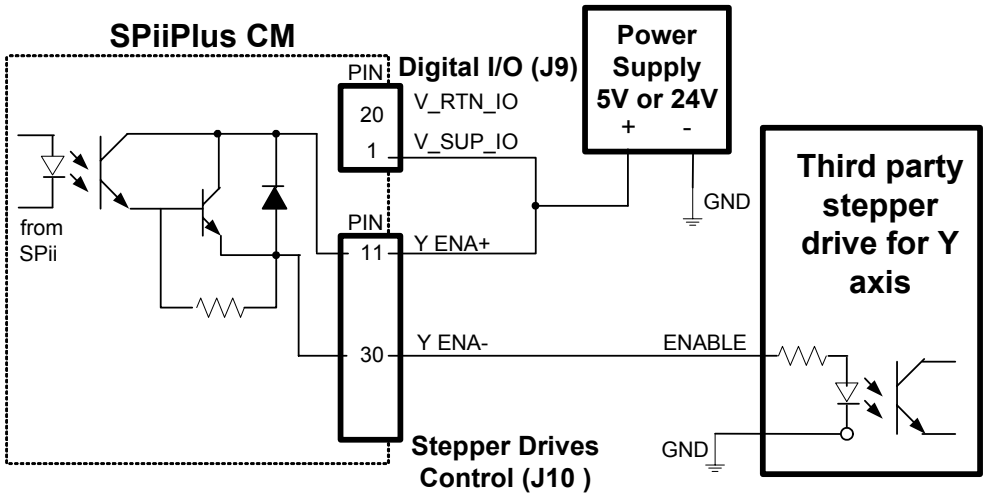


FIGURE 5-11 Connection To Drive With Enable Source Output (Y axis)

FIGURE 5-12 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.

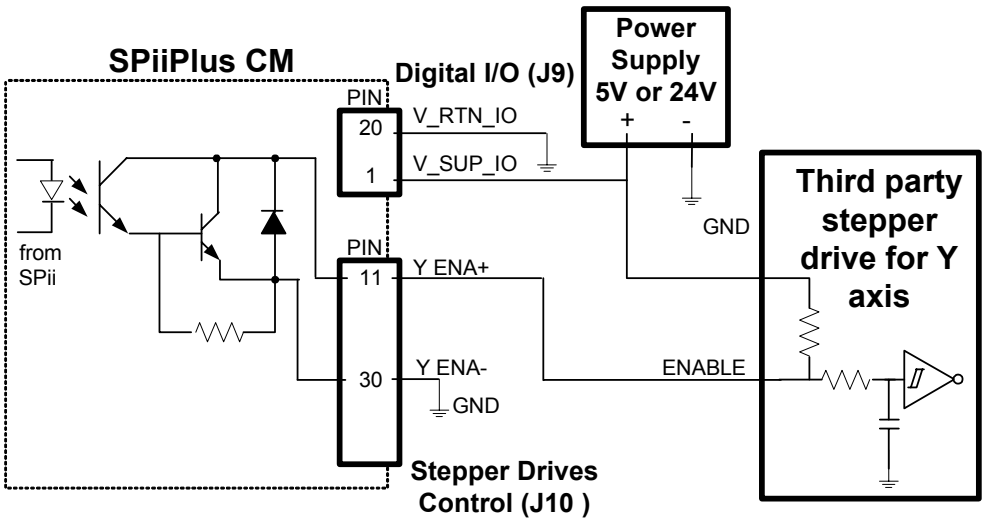


FIGURE 5-12 Connection To Drive With Enable Sink Output (Y axis)

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5.6.3. Stepper Drive Fault (Alarm) Inputs

TABLE 5-16 Stepper Drive Fault Inputs

Category	Value
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	Up to 10mA per input

5.6.3.1. Stepper Drive Fault Examples

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

FIGURE 5-13 is an example of an source-type fault input. When the drive sends 5V/24V, the controller detects a drive fault has occurred.

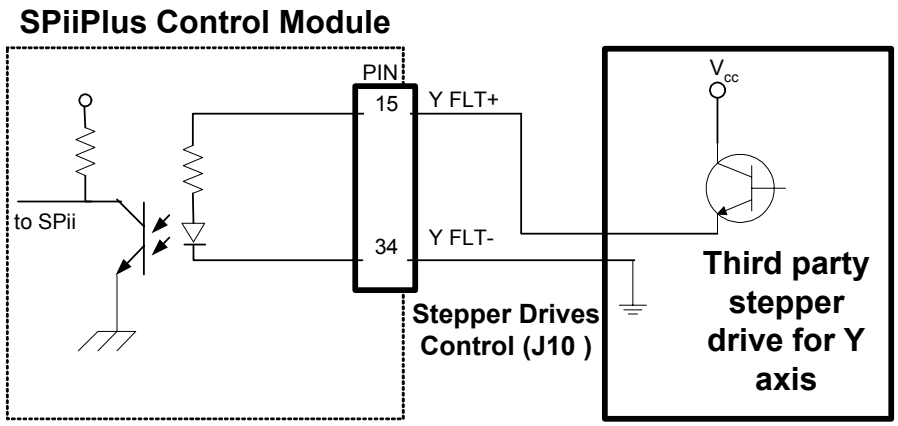


FIGURE 5-13 Connection To Drive With Source Fault Input (Y axis)

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FIGURE 5-14 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.

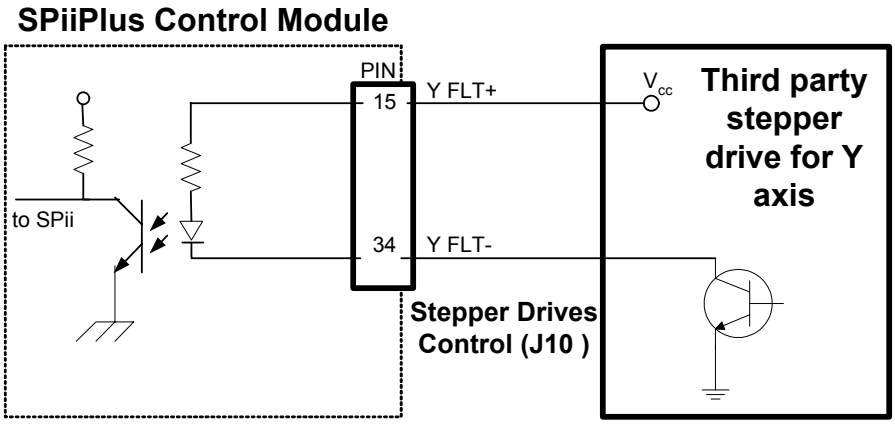


FIGURE 5-14 Connection To Drive With Sink Fault Output (Y axis)

5.7. Incremental Digital Encoder + Hall Connectors J11, J13, J15

For axes connected to one of the SPiiPlus CM's integrated drives the following types of digital incremental encoders are supported:

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

In addition, the encoder connector provides an interface with a motor temperature sensor.

MODEL DEPENDENT

Commutation based on Hall Sensors is not supported in SPiiPlus firmware version 4.20 or earlier.

NOTE

A DC brushless motor powered by an integrated drive can be commutated by the control module based on the encoder feedback. For more information, refer to the SPiiPlus Setup Guide, Commutation.

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NOTE

For more information about limitations while using incremental encoders refer to the Specifications (page 2–5).

TABLE 5-17 Incremental Digital Encoder + Hall Connectors J11, J13, J15 - Components

Component	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 -).

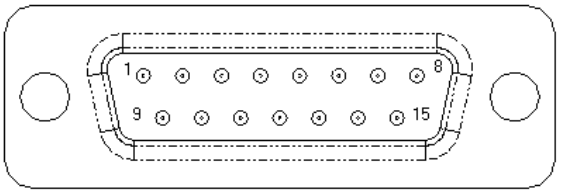


FIGURE 5-15 Encoder + Hall Connectors J11, J13, J15

TABLE 5-18 Incremental Digital Encoder + Hall Connectors J11, J13, J15 - Pins

Pin	Name	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

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Pin	Name	Description
6	DGND	Digital ground
7	HA	Motor Hall A **(not supported in SPiiPlus firmware version 4.20 or earlier)**
8	HB	Motor Hall B **(not supported in SPiiPlus firmware version 4.20 or earlier)**
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 **(not supported in SPiiPlus firmware version 4.20 or earlier)**
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

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5.7.1. Incremental Digital Encoder + Hall Interface

FIGURE 5-16 illustrates the incremental digital encoder interface.

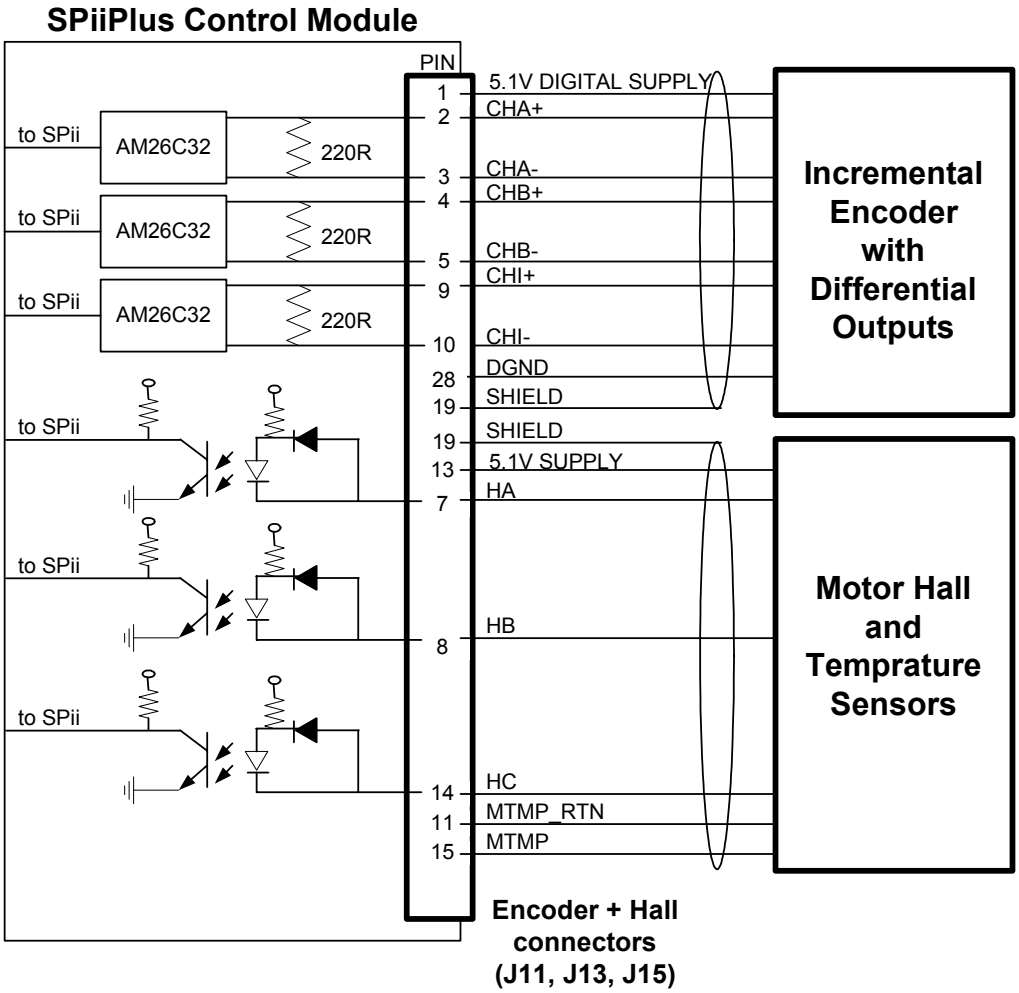


FIGURE 5-16 Incremental Digital Encoder and Hall Interface

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TABLE 5-19 Hall Sensor Input

Category	Subcategory	Value
Inputs	Quantity	Three: A, B, and C
	Type	Single ended

TABLE 5-20 Supply for Encoder + Hall

Category	Value
Range of 5U supply	5.1Vdc ±2% (5.0-5.2Vdc)
Max. allowed total current consumption per axis (Encoder + Hall)	150mA

5.8. Sin-Cos Encoder and Analog Input Connectors J12, J14, J16

The SPiiPlus CM is equipped with six differential analog inputs that can be used in two options 10V to (-10V) or 1.25 to (-1.25V). The 10V to (-10V) inputs are for general purpose usage. The 1.25V to (-1.25V) inputs are for Sin-Cos encoders (with 1Vp-p analog output amplitude) that are connected with the integrated axes of the SPiiPlus CM. Each analog input is connected in parallel to the ±1.25V or ±10V entry.
In addition, the connector provides an interface with motor temperature sensor.

The user can use the analog inputs per the following table:

Axis/Connector	General purpose (±10V) analog input name	Sin-Cos (±1.25V) 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)

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Axis/Connector	General purpose (±10V) analog input name	Sin-Cos (±1.25V) analog input name
Y axis (J16)	AIN4+ (pin5)	YSIN+ (pin2)
	AIN4- (pin13)	YSIN- (pin10)
	AIN5+ (pin 6)	YCOS+ (pin 3)
	AIN5- (pin 14)	YCOS- (pin 11)

NOTE

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.

TABLE 5-21 Sin-Cos Encoder Connectors J12, J14, J16 - Components

Component	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 -).

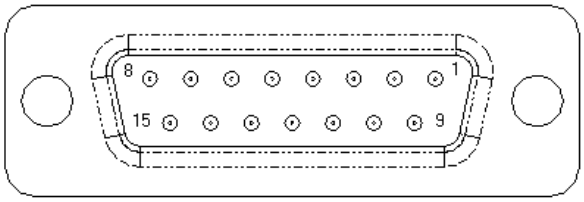


FIGURE 5-17 Sin-Cos Encoder Connectors J12, J14, J16

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TABLE 5-22 Sin-Cos Encoder Connector (J12) Pins (X axis)

Pin	Name	Description
1	5F	5.1V field supply (to analog circuit) to the X Sin-Cos encoder 150mA 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) 10V
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)

5.8.1. Sin-Cos Encoder Interface

TABLE 5-23 Sin-Cos Encoder Input

Category	Value
Quantity	Up to three interfaces, each comprising two encoder signals and one index signal
Type	±1.25V differential signals
Restriction	Sin-Cos inputs (±1.25V) are connected in parallel with general purpose analog inputs (±10V). Hence, it is impossible to use both voltage range of an inputs simultaneously.
Input frequency	Up to 250K sine or cosine periods per second

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Category	Value
Digital representation of input voltage (AIN variable)	–8192…+8191
A/D conversion resolution	14 bit
Corresponding ACSPL+ Variables	**AIN0 . . . AIN5**

FIGURE 5-18 illustrates the sin-cos encoder interface for an X axis.

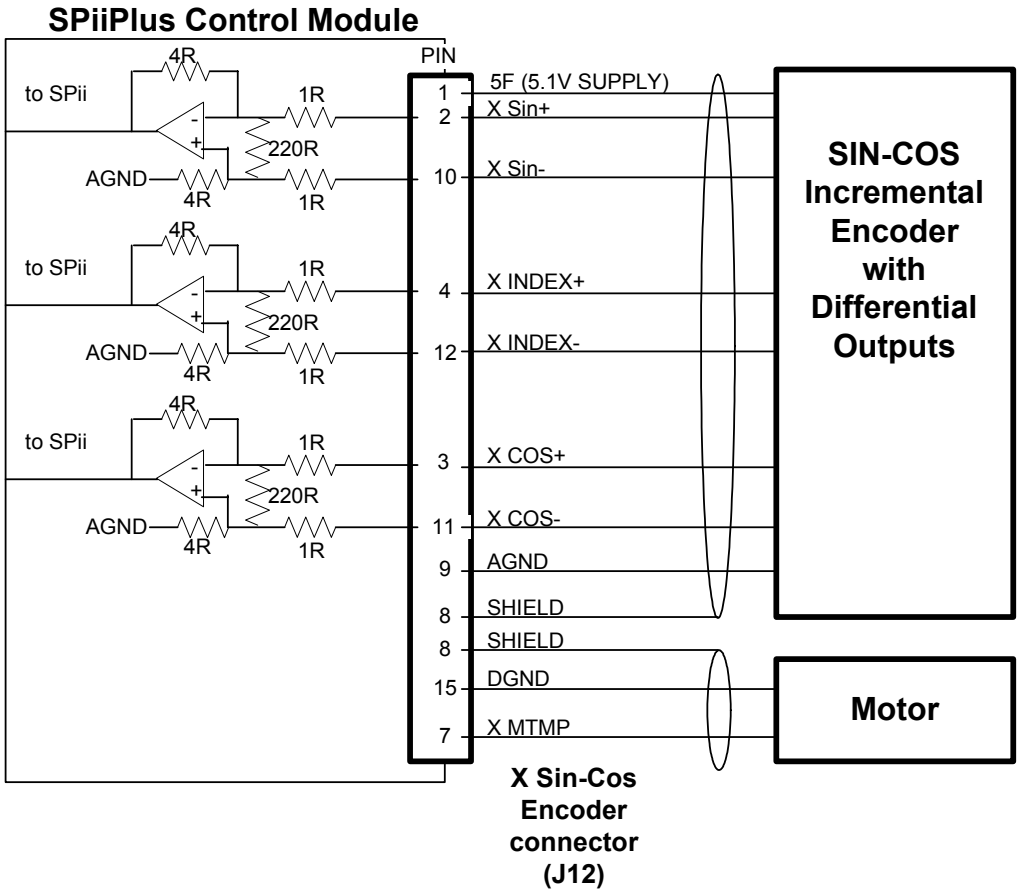


FIGURE 5-18 Sin-Cos Encoder Interface (X Axis)

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TABLE 5-24 Supply for Sin-Cos Encoders

Category	Value
Source	onboard
Range	5.1Vdc ±2% (5.0-5.2Vdc)
Max. supply load current per encoder	150mA

TABLE 5-25 Analog Inputs

Category	Value
Voltage Representation in Controller	-8192 to 8192
Corresponding ACSPL+ Variables	**AIN0** . . . **AIN5**

FIGURE 5-19 illustrates the analog input interface for analog input 1 (**AIN0**).

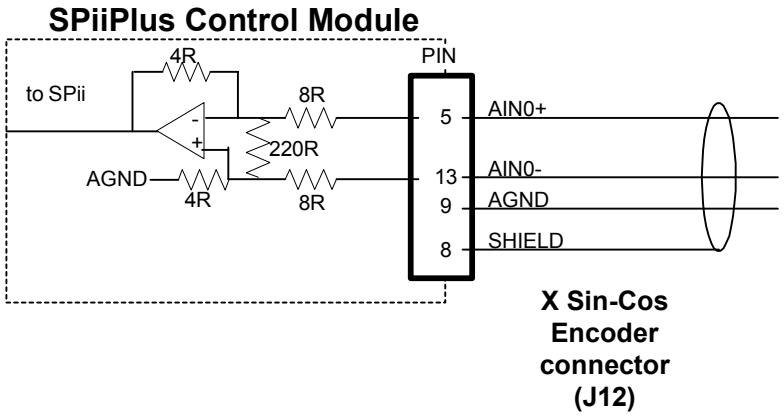


FIGURE 5-19 Connection of AIN0 Differential Input

5.9. Digital I/O and Analog Outputs

The SPiiPlus CM is equipped with the following digital inputs:

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

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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 (<0.1µsec 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.
- 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 to1A), opto-isolated outputs that can be used for mechanical brake control for X,Y and A axes (see Servo Motor & Brake Output Connectors J20, J21, J22 in page 5-12) or as general purpose outputs (sink only!).

NOTE

The Position Event Generator pulses (PEG) are provided in parallel also in the PEG (J26) connector (with PEG states signals).

The SPiiPlus CM is equipped with the following analog outputs:

- One/two Single-ended outputs with a range of ±10V, 10bit 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.

5.9.1. Digital I/O and Analog Outputs Connector J9

TABLE 5-26 Digital I/O and Analog Outputs Connector J9 - Components

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 -).

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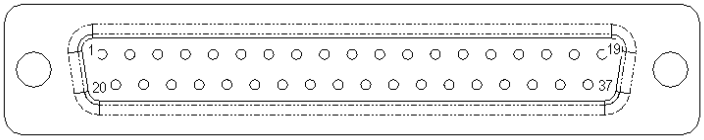


FIGURE 5-20 Digital I/O and Analog Output Connector J9

TABLE 5-27 Digital I/O and Analog Output Connector J9 – Pins

Remark: 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.

Pin	Name	Description	ACSPL+ Variable
1	V_SUP_IO	Digital I/O supply 5/24Vdc	
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	IN8.8
13	X_MARK2+	Fast non-inverted X MARK2 input for X axis	IN8.10
14	Y_MARK1+	Fast non-inverted Y MARK1 input for Y axis	IN9.8
15	Y_MARK2+	Fast non-inverted Y MARK2 input for Y axis	IN9.10
16	X_PEG_PULSE+	Fast non-inverted PEG output for X axis	OUT8.8

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Pin	Name	Description	ACSPL+ Variable
17	Y_PEG_PULSE+	Fast non-inverted PEG output for Y axis	OUT9.8
18	DGND	Digital ground	
19	AOUT1	Analog output 1 (available only if two or more SPii processors exists)	
20	V_RTN_IO	Digital I/O supply return	
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	IN8.8
32	X_MARK2-	Fast inverted X MARK2 input for X axis	IN8.10
33	Y_MARK1-	Fast inverted Y MARK1 input for Y axis	IN9.8
34	Y_MARK2-	Fast inverted Y MARK2 input for Y axis	IN9.10
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	

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5.9.1.1. Digital I/O and Analog Output Interfaces

5.9.1.1.1. Digital Inputs

TABLE 5-28 Digital Inputs

Category	Value
Quantity	Eight
Type	Single-ended, opto-isolated
Type	Single-end
Corresponding ACSPL+ Variables	**IN0.0 . . . IN0.7**
Maximum Propagation Delay	< 1msec
External Supply Voltage	5Vdc (±10%) or 24Vdc (±20%), detected automatically. Must be connected between the V_SUP_IO and V_RET_IO pins
Input Voltage	5Vdc (±10%) or 24Vdc (±20%)
Input Current	From 2mA to 7mA per input, depending on external supply voltage.
Connection	Sink/source – jumper configured.
Sink/source jumper configuration	See Configuration by Jumpers (page 5-58).

FIGURE 5-21 illustrates the source-type switched general purpose digital input interface for IN0.0.

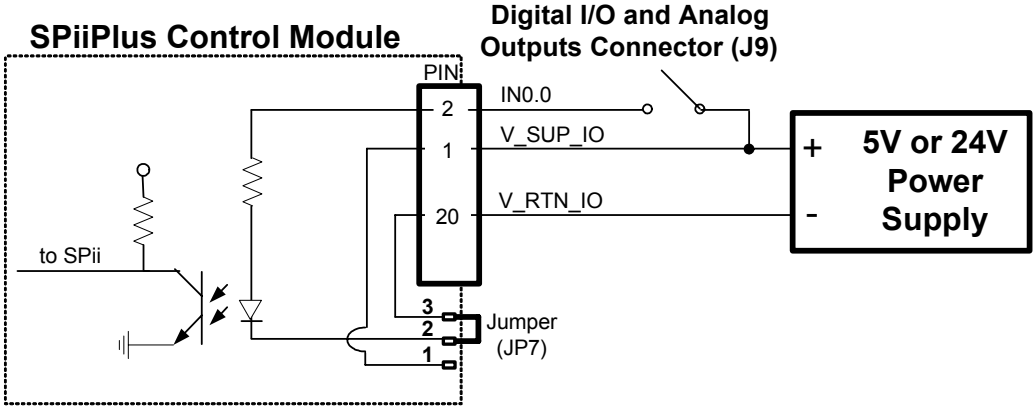


FIGURE 5-21 Source (Switched) Connection for Digital Input 0

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FIGURE 5-22 illustrates the source-type PNP general purpose digital input interface for **IN0.0**.

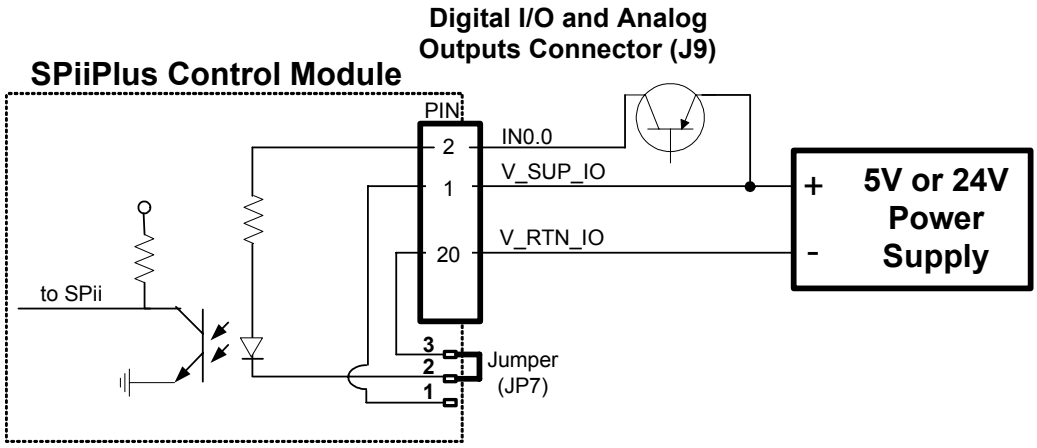


FIGURE 5-22 Source (PNP) Connection for Digital Input 0

FIGURE 5-23 illustrates the sink-type switched general purpose digital input interface for **IN0.0**.

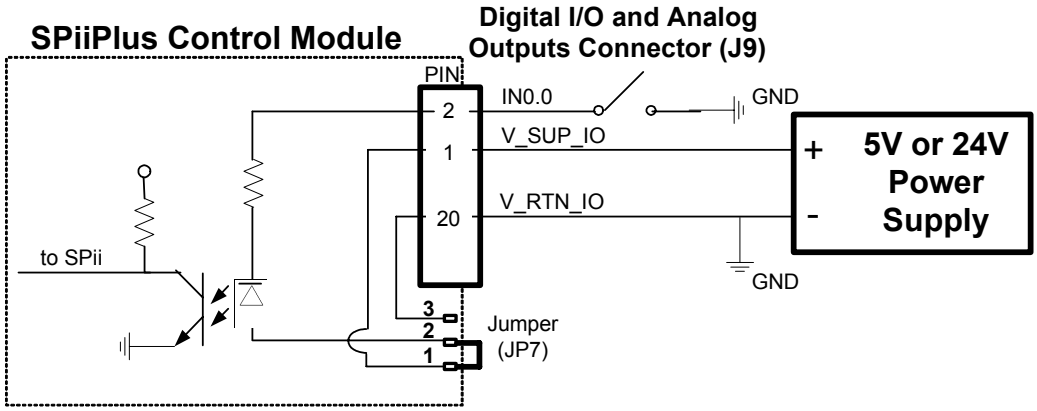


FIGURE 5-23 Sink (Switched) Connection for Digital Input 0

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FIGURE 5-24 illustrates the sink-type NPN general purpose digital input interface for **IN0.0**.

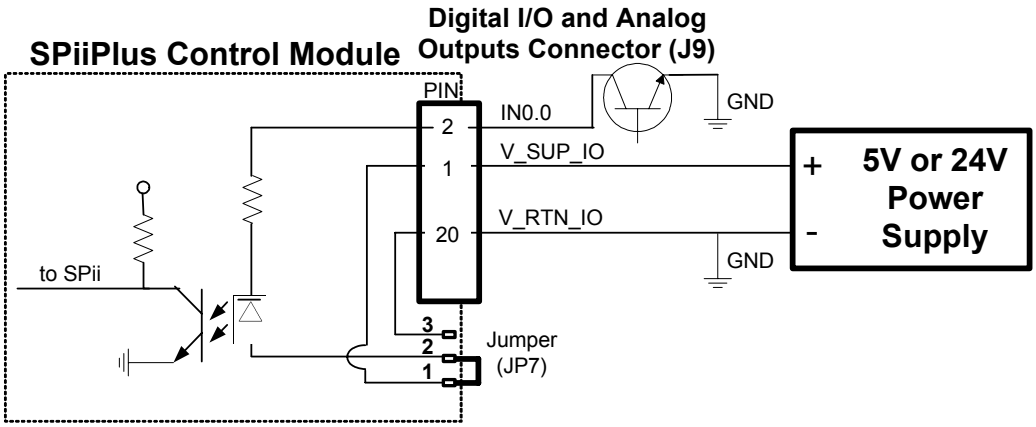


FIGURE 5-24 Sink (NPN) Connection for Digital Input 0

5.9.1.1.2. Fast Digital Inputs (MARK)

TABLE 5-29 Fast Digital Inputs (MARK)

Category	Value
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 (±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 *SPiiPlus ACSPL+ Programmer's Guide*.
Maximum Propagation Delay	< 0.1µsec
Protection	ESD protection.

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FIGURE 5-25 illustrates the MARK/general purpose differential input interface for axis X.

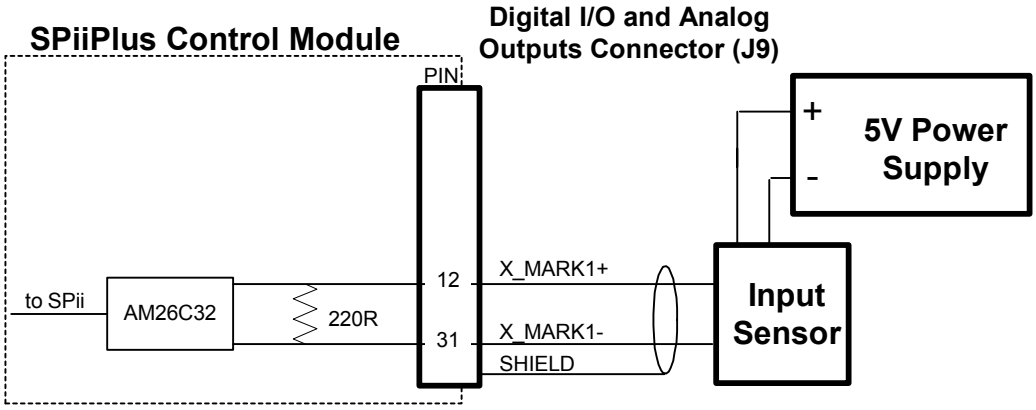


FIGURE 5-25 Differential Connection for MARK1 Input (X Axis)

FIGURE 5-26 illustrates the MARK/general purpose single-end input interface for axis X.

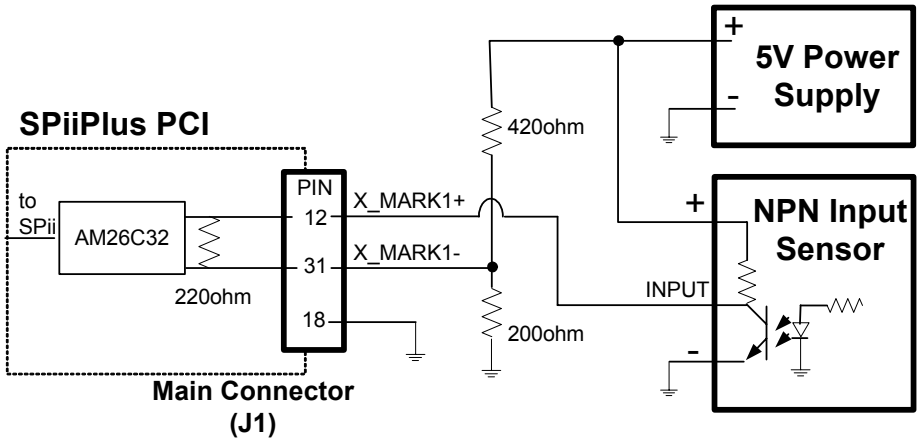


FIGURE 5-26 Single-End (NPN) Connection for MARK1 Input (X Axis)

5.9.1.1.3. Digital Outputs

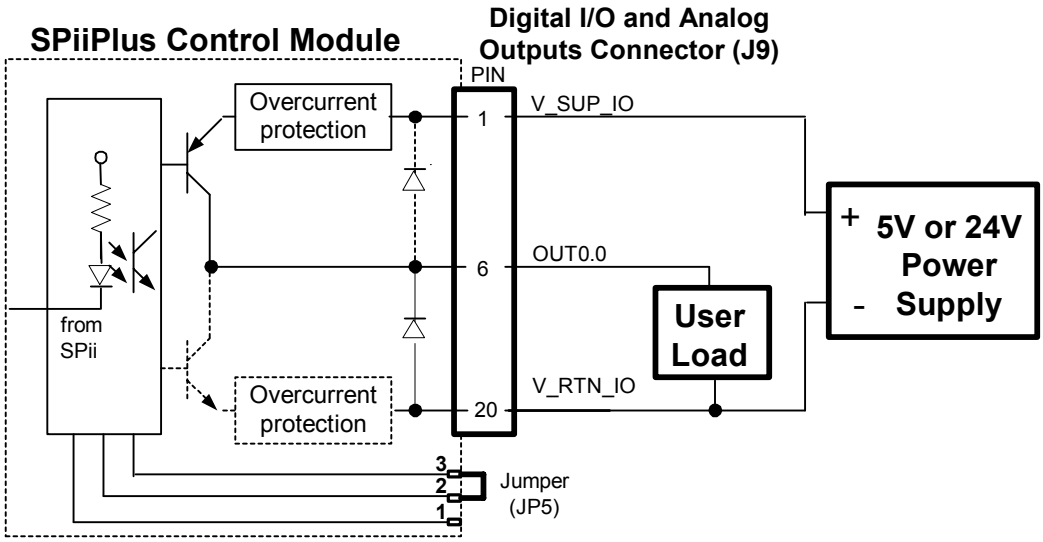
TABLE 5-30 Digital Outputs

Category	Value
Quantity	Eight
Type	Single-end, opto-isolated

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Category	Value
Corresponding ACSPL+ Variables	**OUT0** . . . **OUT7**
External Supply Voltage	5Vdc (±10%) or 24Vdc (±20%), detected automatically. Must be connected between the V_SUP_IO and V_RET_IO pins
Maximum Current per Output	350mA
Maximum Current per All Output	350mA
Protection	Overload (total current > 400mA) or short circuit
Connection	Sink/source – jumper configured.
Remark	For testing an out put in source/sink configuration without a load, a pull-down/pull-up resistor should be connected.

FIGURE 5-27 illustrates the source-type general purpose digital output interface for **OUT0.0**.

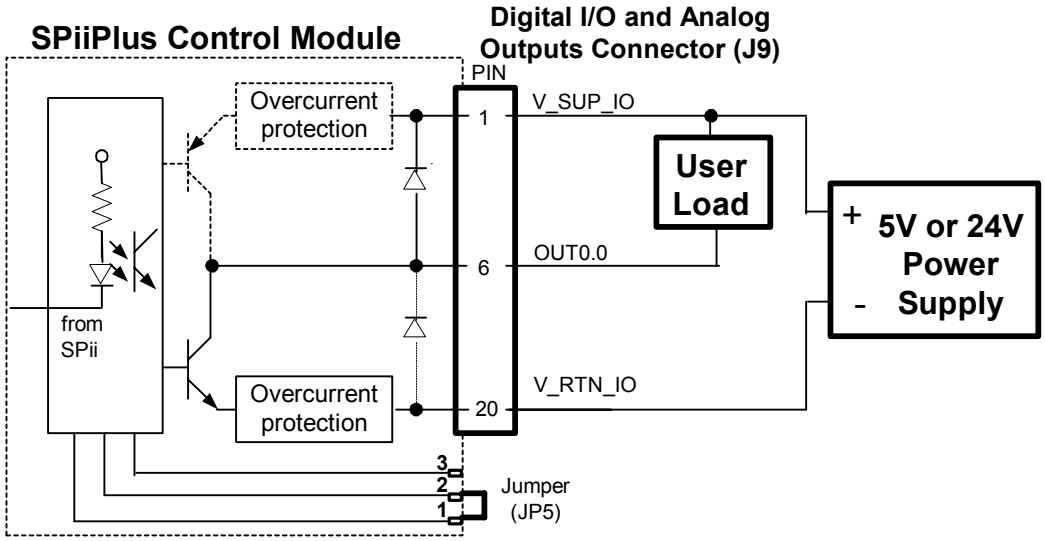


NOTE: When jumper JP5 is set to pins 2 and 3, the circuit shown in a dashed line is inactive.

FIGURE 5-27 Source Connection for Digital Output 0

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FIGURE 5-28 illustrates the sink-type general purpose digital output interface for **OUT0.0**.



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

FIGURE 5-28 Sink Connection for Digital Output 0

5.9.1.1.4. Fast Digital Outputs (PEG)

NOTE

Configuration of PEG pulses as PEG outputs (default) or as general purpose outputs is done by software **assignpeg** command.

TABLE 5-31 Fast Digital Outputs (PEG)

Category	Value
Quantity	Four. Can be configured as PEG outputs or as general purpose outputs.
Type	Differential, not isolated. (Requires 220ohm termination resistor.)
Associated ACSPL+ Functions	**peg_i** and **peg_r**. The fast output signal is generated with extremely small delay when the encoder position matches a predefined value. See PEG description in the *SPiiPlus ACSPL+ Programmer's Guide*.

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Category	Value
Maximum Propagation Delay	< 0.1µsec
See Also	PEG Connector J24 (page 5-41)

FIGURE 5-29 illustrates the PEG pulse output interface for axis X.

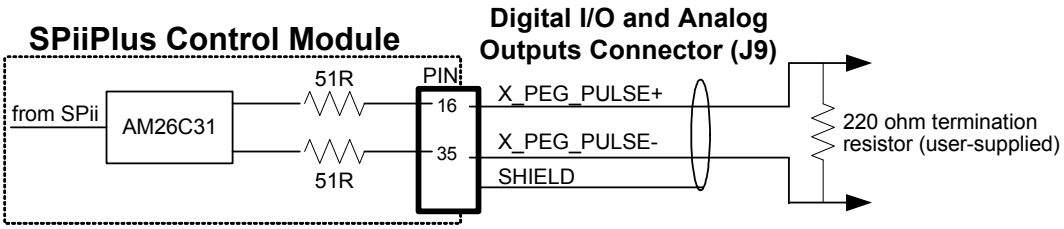


FIGURE 5-29 Example of X PEG Pulse Output Connection

NOTE

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

5.9.1.1.5. 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 5-32 Digital Brake Outputs

Category	Value
Quantity	Four. Can be configured as motor brake outputs or as general purpose outputs.
Type	Single-end , opto-isolated, **source only**!
External Supply Voltage	5-30Vdc (±10%). Must be connected between the V_SUP_IO and V_RET_IO pins

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Category	Value
Maximum Current per Output	1A (50mA per output)
Maximum Current per All Output	3A (50mA per output)
Protection	Overload (current of any output > 1mA) or short circuit

FIGURE 5-30 illustrates the brake output interface for axis X.

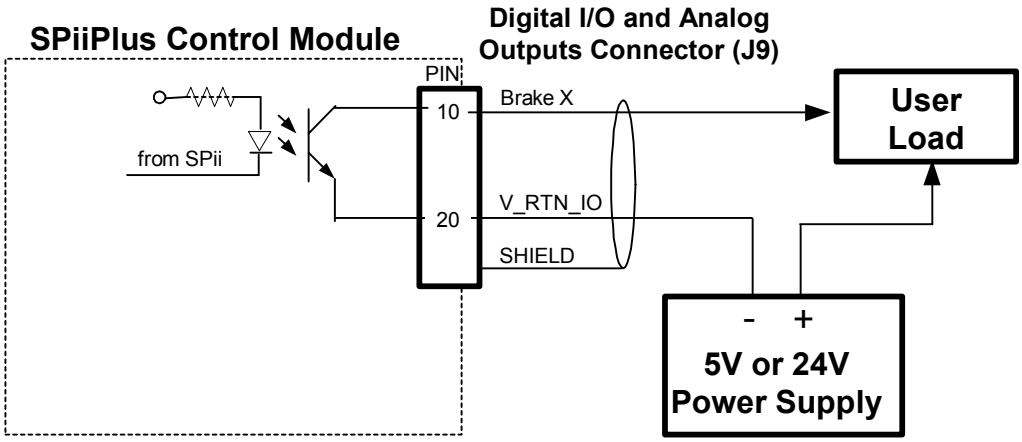


FIGURE 5-30 Sink Connection for Using Brake_X as a General Purpose Output

5.9.1.1.6. Analog Outputs

TABLE 5-33 Analog Outputs

Category	Value
Quantity	One/ two (Analog output 1 is available only if two or more SPii processors exists)
Type	Single-end
Voltage Range	±10V
D/A Resolution	10 bit
D/A Conversion Circuit Accuracy	±2%
Voltage Representation in Controller	-511 to 511

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Category	Value
Maximum Current	10mA per output
Protection	short circuit
Corresponding ACSPL+ Variables	**AOUT0, AOUT1**

FIGURE 5-31 illustrates the analog output interface for **AOUT0**.

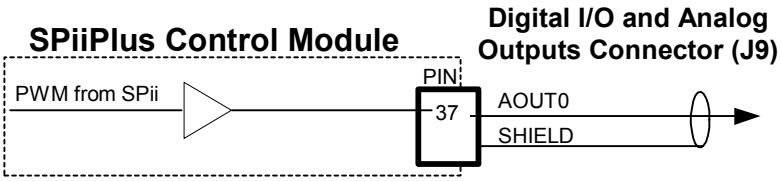


FIGURE 5-31 Connection for AOUT0 Output

5.9.2. PEG Connector J26

The SPiiPlus CM provides Position Event Generator (PEG) outputs as follows:

- Two fast (<0.1µsec 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 provided via the PEG (J26) connector and also via the Digital I/O and Analog Output Connector (J9).
- 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.

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NOTE

Configuration of PEG pulses and states as PEG outputs (default) or as general purpose outputs is done by software **assignpeg** command.

TABLE 5-34 PEG States Connector J26 - Components

Component	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 -).

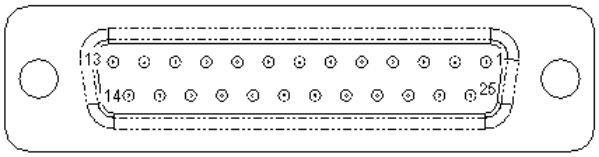


FIGURE 5-32 PEG States Connector J26

TABLE 5-35 PEG States Connector J26 – Pins

Remark: 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.

Pin	Name	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
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

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Pin	Name	Description	ACSPL+ Variable
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	NC	Not connected	
13	NC	Not connected	
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	NC	Not connected	
25	NC	Not connected	

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5.9.2.1. PEG States Interface

Refer to Fast Digital Outputs (PEG) (page 5-38)

5.10. Safety Connector J8

TABLE 5-36 Safety Connector J8 - Components

Component	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-15MGTAA*)
Recommended Wires	AWG22 wires with shielding.

TABLE 5-37 Safety Connector J8 - Pins

Pin	Name	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	Non relevant in SPiiPlus CM
8	BLL	Non relevant in SPiiPlus CM
9	ZRL	Z axis right limit
10	ZLL	Z axis left limit
11	TRL	T axis right limit
12	TLL	T axis left limit
13	ES	Emergency stop
14	V_RTN_SFTY	Safety supply return
15	V_SUP_SFTY	Safety supply 5/24Vdc

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Pin	Name	Description
	Connector metal case (SHIELD)	Cable shield connection

5.10.1. Safety Interface

The SPiiPlus CM provides the following safety inputs:

- Left and right limit inputs per axis
- Emergency Stop input

5.10.1.1. Limit Inputs

TABLE 5-38 Limit Inputs

Category	Value
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 (±10%) or 24Vdc (±20%), detected automatically. Must be connected between the V_SUP_SFTY and V_RET_SFTY pins
Input Current	From 2mA to 7mA per input.
Connection	See Configuration by Jumpers (page 5-58).

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FIGURE 5-33 illustrates a source-type switched limit input interface for axis X.

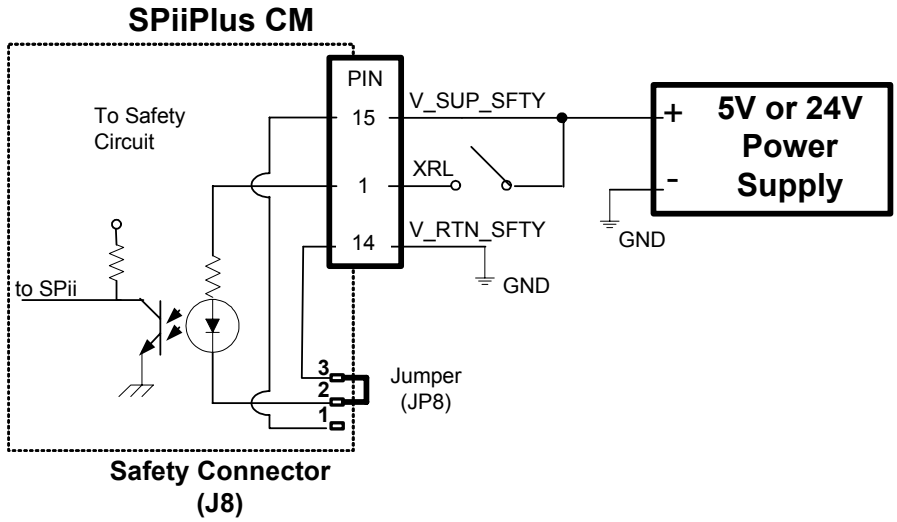


FIGURE 5-33 Source (Switched) Limit Input Connection (X Axis)

FIGURE 5-34 illustrates a source-type PNP limit input interface for axis X.

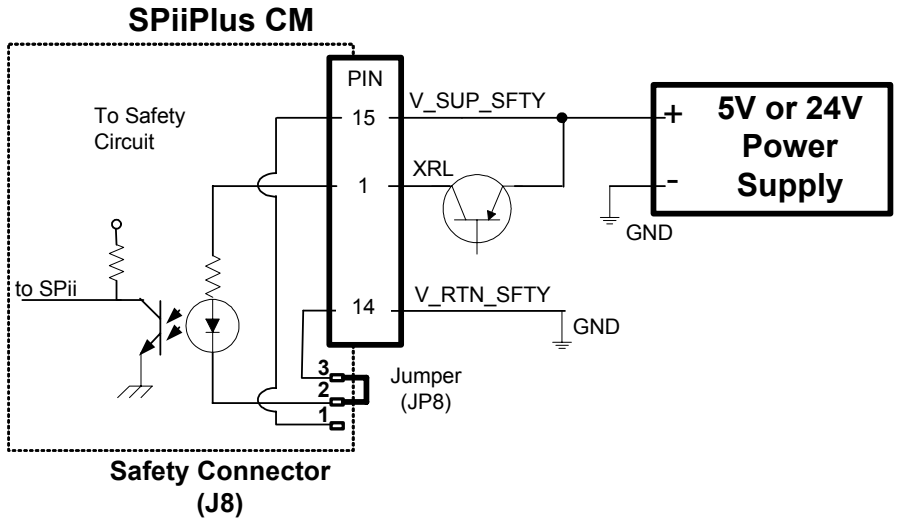


FIGURE 5-34 Source (PNP) Limit Input Connection (X Axis)

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FIGURE 5-35 illustrates a sink-type switched limit input interface for axis X.

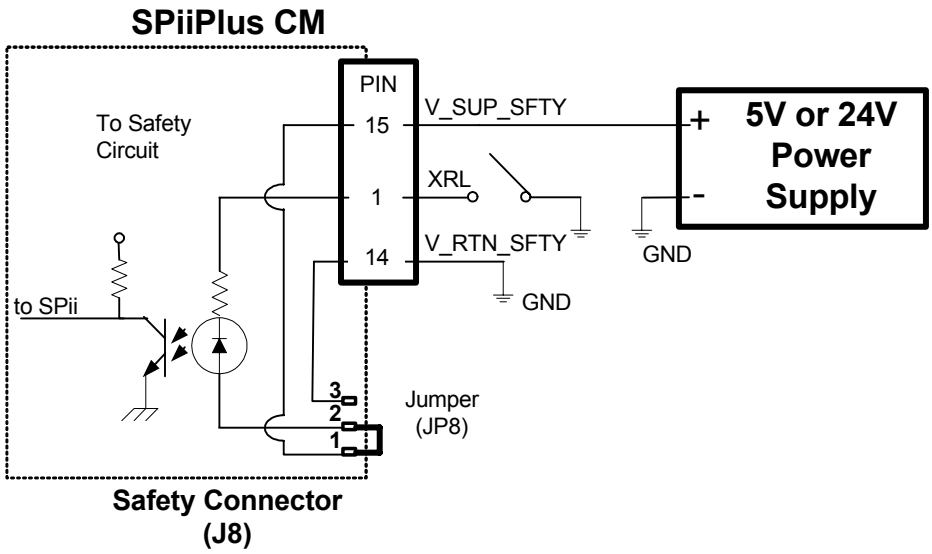


FIGURE 5-35 Sink (Switched) Limit Input Connection (X Axis)

FIGURE 5-36 illustrates a sink-type NPN limit input interface for axis X.

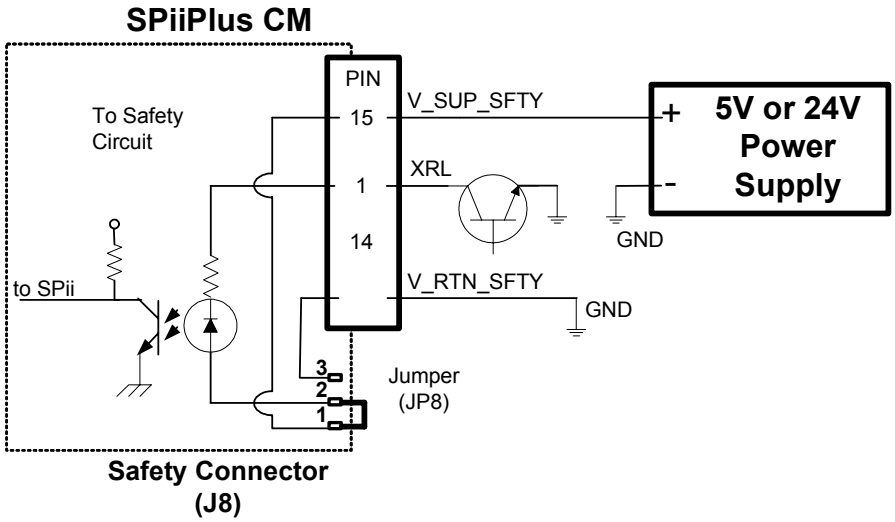


FIGURE 5-36 Sink (NPN) Limit Input Connection (X Axis)

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5.10.1.2. Emergency Stop Input

TABLE 5-39 Emergency Stop Input

Category	Value
Quantity	One
Type	Single-end, opto-isolated
Corresponding ACSPL+ Variables	**SFAULT.#ES**
Maximum Propagation Delay	1msec
External Supply Voltage	5Vdc (±10%) or 24Vdc (±20%), detected automatically. Must be connected between the V_SUP_SFTY and V_RET_SFTY pins
Input Current	2mA to 7mA
Connection	See Configuration by Jumpers (page 5-58).

FIGURE 5-37 illustrates a source emergency stop input interface.

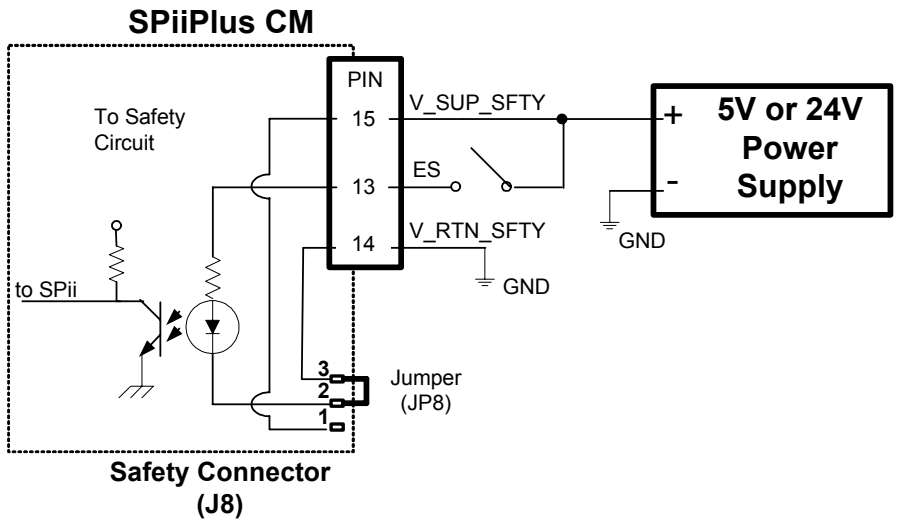


FIGURE 5-37 Source Connection for Emergency Stop Input

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FIGURE 5-38 illustrates a sink emergency stop input interface.

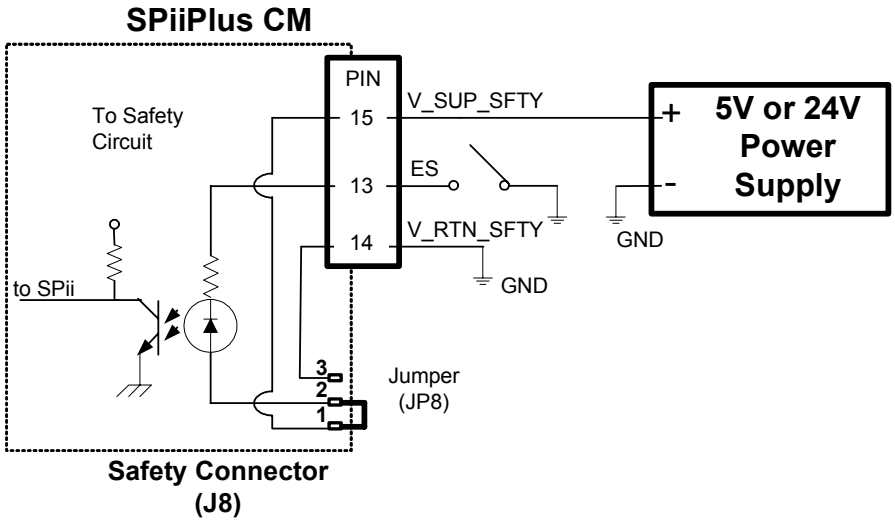


FIGURE 5-38 Sink Connection for Emergency Stop Input

5.11. High-Speed Synchronous Serial Interface (HSSI) Network

The 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.

NOTE

Every SPiiPlus CM has four HSSI connectors (J1-J4). However pending on the number of HSSI (SPii) that was ordered the HSSI channels will be available. See number of available HSSI channels in the label on the side of the product. For example if "HSSI Channels Available: 0,1" appears on the product's label, it means that only HSSI0 (connected to J1) and HSSI1 (connected to J2) will be available.

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5.11.1. HSSI Connectors J1, J2, J3, J4

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 Modules Setup Guide.

TABLE 5-40 HSSI Connectors J1, J2, J3, J4 - Components

Component	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

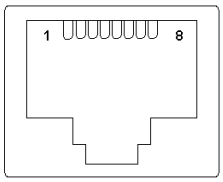


FIGURE 5-39 HSSI Connectors J1, J2, J3, J4

TABLE 5-41 HSSI Connectors J1, J2, J3, J4 - Pins

Pin	Name	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

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5.11.1.1. HSSI Interface

TABLE 5-42 HSSI

Category	Value
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)

5.12. Communication

The following communications are supported:

- One RS-232/422/485 serial communication port (COM1)
- One RS-232 serial communication port (COM2)
- One CAN communication port (optional) - **currently not supported**.
- One Ethernet 10/100 Base -T communication port (optional)

NOTE

Check the SPiiPlus CM controller's product label for supported communication options.

NOTE

Refer to the *SPiiPlus Setup Guide* for how to establish serial (RS-232/422/845) and Ethernet communication.

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5.12.1. COM Connectors J7, J23

TABLE 5-43 COM Connectors J7 J23 - Components

Component	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 -).

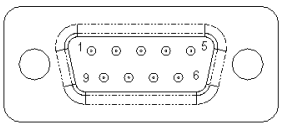


FIGURE 5-40 COM Connectors J7 J23

TABLE 5-44 COM-1 Connector J7 – Pins

NOTE

Pay attention that the RS-232 and RS-422/485 serial communications are both provided in same 9 pin connectors. This implementation may not comply with some of the standard null-modem communication cables that can be found.

Pin	Name	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-422/485 positive transmit signal

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Pin	Name	Description
7	TX-	RS-422/485 negative transmit signal
8	RX+	RS-422/485 positive receive signal
9	RX-	RS-422/485 negative receive signal
	Connector metal case (SHIELD)	Cable shield connection

TABLE 5-45 COM-2 Connector J23 - Pins

Pin	Name	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

5.12.2. CAN Connector J6 (Option)

CAN communication is currently not supported.

5.12.3. Ethernet Connector J5 (Option)

TABLE 5-46 Ethernet Connector J5 - Components

Component	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

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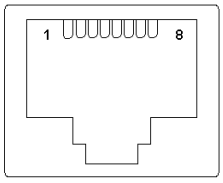


FIGURE 5-41 Ethernet Connector J5

TABLE 5-47 Ethernet Connector J5 - Pins

Pin	Name	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

5.13. LED Indicators

TABLE 5-48 LED Indicators

LED Indicator	Color	Meaning
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	Green	Y motor is enabled

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LED Indicator	Color	Meaning
(not exist in SPiiPlus CM-1)	Red	Y motor is failed
	Off	Y motor is disabled
A_ON **(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
	Flash	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.

5.14. Protection Circuits

The SPiiPlus CM provides the following protection circuits:

- Digital drive supply protection
- Digital drive protection
- Control and Brake supply protection

5.14.1. Drive Input Supply Protection

The Integrated digital drives provide four type of 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)

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TABLE 5-49 Drive Input Supply Protection

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 < 10V
	Action	**Drive Alarm** fault: disables all drives
	Drive Alarm	Power supply too low – **MERR** variable code 5063

5.14.2. Internal Integrated Drive Protection Circuits

The SPiiPlus integrated digital drives provide the following internal protection circuits:

- Short Between Phases
- Short between Phase to Ground
- Over Current
- Over Temperature

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TABLE 5-50 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	<1µs
	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±5ºC
	Action	Disable drive
	Drive Alarm	"Over temperature" - **MERR** variable code 5065

5.14.3. Control and Brake Supply Protection

The SPiiPlus provides protection for Control and Brake Supply:

- Control supply voltage disconnection
- Brake supply voltage disconnection

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TABLE 5-51 Control and Brake Supply Protection

Protection	Specification	Value
Control Supply Voltage Missing	Triggered by	Control supply not connected or internal fuse blown.
	Action	Disables all drives
	Drive Alarm	Power supply 24VF1 - **MERR** variable code 5069
Brake Supply Voltage Missing	Triggered by	Brake supply not connected or internal fuse activated (fuse has automatic reset)
	Action	Disables all drives
	Drive Alarm	Power supply 24VF2 - **MERR** variable code 5069

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

SPiiPlus CM provides configuration of digital inputs, digital outputs and safety inputs

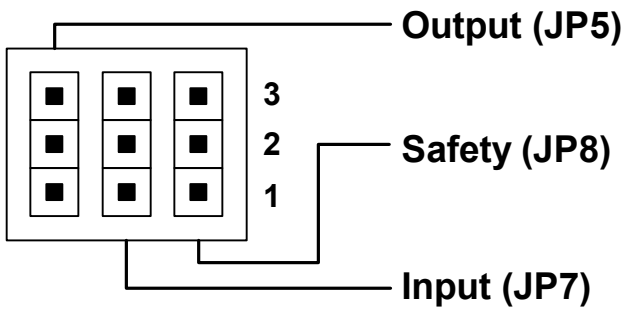


TABLE 5-52 Configuration of Sink or Source by Jumpers

Topic	Description
Sink configuration	Jumper should be installed between 1 to 2
Source configuration	Jumper should be installed between 2 to 3

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5.14.5. 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.

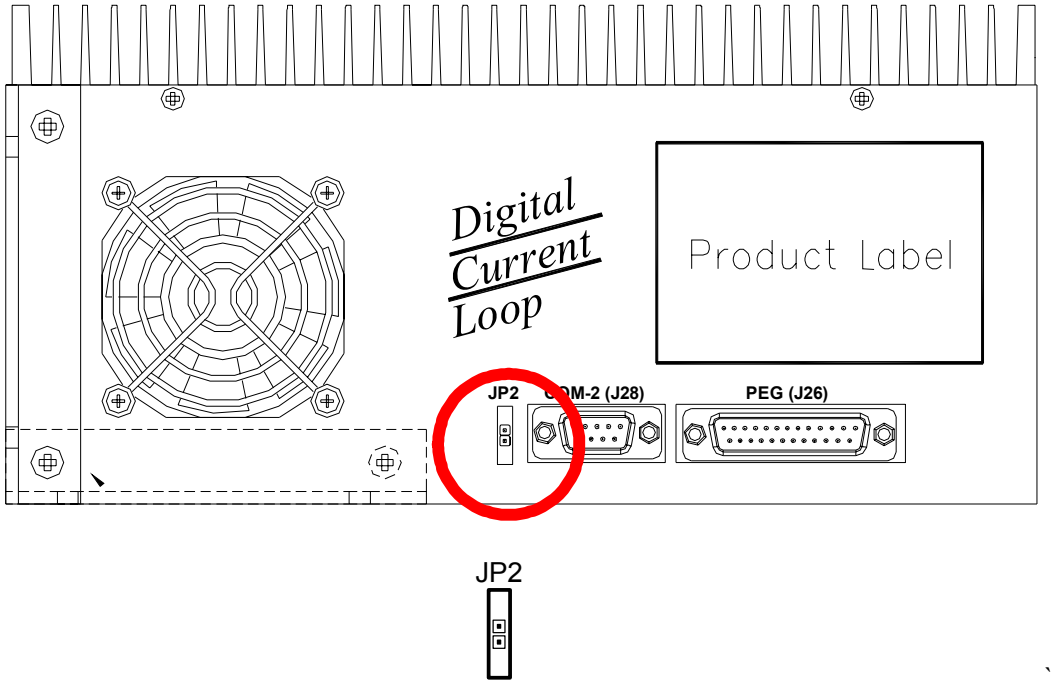


FIGURE 5-42 SPiiPlus CM-2/3: Recovery Mode Jumper – JP2

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6. WARRANTY

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