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MC4U

Control Module

Hardware Guide

Version 6.50

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MC4U-CS Control Module Version 6.50, 15 February 2009

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Changes in Version 6.50

Page	Change
Page 52	Added specifications for the LDM3U Single Axis Linear Amplifier
Page 138	Added specifications for the MB5U-LDM3U motherboard
Page 44	Updated specifications for the DDM3U-X-60V-4A Low Power Motor Drive

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1 Introduction

The MC4U Control Module is a multi-axis machine and motion control module. The MC4U contains a motion controller, power supply, and motor drives all integrated in a single unit. All components are housed in “upright piano” enclosure that can be either panel- or rack-mounted.

The specific components, controller, drives, and power supplies can be specifically tailored to the needs of the application, thus optimizing the performance-to-cost ratio.

The controller is also a CANOpen master and up to an additional 64 nodes of I/Os and axes can be added using standard available CANOpen devices that the company qualifies.

1.1 MC4U Control Module Overview

There are three enclosures in the MC4U family:

1. 9” MC4U
2. 11” MC4U
3. 19” MC4U

1.1.1 9” MC4U Enclosure

The 9” MC4U can directly control two axes and contains the following plug-in components:

- A SPiiPlus controller
- A power supply
- One high-power dual axis DDM3U-2-320V-YY motor drive
- A specific motherboard that accommodates the plug-in components and external interface connectors

Note	
	*The unit can only be panel-mounted.*



Figure 1 9” MC4U

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1.1.2 11” MC4U Enclosure

The 11” MC4U can can directly control up to four axes and contains the following:

- A SPiiPlus controller
- A power supply
- Two high-power dual axis DDM3U-2-320V-YY motor drives
- A specific motherboard that accommodates the plug-in components and external interface connectors

Note	
	*The unit can only be panel-mounted.*



Figure 2 11” MC4U

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1.1.3 19” MC4U Enclosure

The 19” MC4U can control up to 8 axes. It provides the most flexibility with regards to type of drives (PWM, linear), matching power supplies and accessories. It can contain the following:

- A SPiiPlus controller
- A power supply with one or two motor voltages
- Up to four multi-axis motor drives
- One or more motherboards that accommodate the plug-in components and the external interface connectors.

Note	
	*The unit can either rack-mounted or panel-mounted.*



Figure 3 19” MC4U

1.2 About this Guide

The guide covers all three versions of the MC4U Control Module, and provides detailed hardware information. For each version this guide includes the following information:

- Detailed mechanical and electrical descriptions of the components making up the MC4U Control Module
- Installation instructions

For a setup procedure of the MC4U Control Module, 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

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The remaining tasks involved in operating the MC4U are described in the *SPiiPlus Programmer's Guide*, including:

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

1.3 Related MC4U Documentation

Table 1 Collateral Documentation

Document	Description
SPiiPlus Setup Guide	Provides communication, configuration and adjustment procedures for the MC4U Control Module motion controller.
SPiiPlus 3U-LT, SPiiPlus 3U-HP Hardware Guide	Provides details for the SPiiPlus 3U-LT and SPiiPlus 3U-HP motion controllers, one which is installed in the MC4U Control Module.
SPiiPlus Programmer's Guide	Provides the command set and high level language for programming the MC4U Control Module motion controller.
SPiiPlus C Library Reference	Provides C++ and Visual Basic® libraries for host PC applications. This reference is specifically applicable for the MC4U Control Module motion controller.
SPiiPlus COM Library Reference	Provides COM Methods, Properties, and Events for Communication with the MC4U Control Module motion controller.
SPiiPlus Command & Variable Reference Guide	Provides commands and variables of high level language for programming the MC4U Control Module motion controller.
SPiiPlus Utilities User's Guide	Provides MC4U Control Module firmware upgrade and recovery procedures for the motion controller.

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1.4 Conventions Used in this Guide

1.4.1 Documentation Conventions

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

Table 2 Text Conventions

Text	Description
BOLD CAPS	ACSPL+ elements (commands, functions, operators, standard variables, etc.) when mentioned in the text. Software tool menus, menu items, dialog box names and dialog box elements.
bold	Emphasis or an introduction to a key concept.
`Monospace`	Code examples.
`Italic monospace`	Information in code examples that the user provides.
ALL CAPS	(Keyboard) key names [example: SHIFT key].
Bold Blue Text	Links within this document, to web pages, and to e-mail addresses.
|	Used in command syntax to indicate alternate input from which the user uses one or the other.
→	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.

1.4.2 Statement Text and Icons Used in this Guide

Note	
	*Notes include helpful information or tips.*

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

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

Advanced	
	*Indicates a topic for advanced users.*

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

1.5 Terms and Definitions

The following terms specific to the MC4U and their definitions are given in the table below.

Table 3 Terms and Definitions

Term	Definition
EMC	Electromagnetic Compatibility
PEG	Position Event Generator
PWM	Pulse Width Modulation
TVS	Transient Voltage Suppressor

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2 MC4U Specifications

This chapter provides detailed specifications of the MC4U family and its components. The components consist of:

- SPiiPlus Motion Controller
- PSM3U Power Supply
- DDM3U Motor Drive (up to a maximum of 3 units)
- MC4U Interface Connectors

Model	*The functionality of any specific MC4U Control Module is determined by the motherboard that is installed. See* ***Section 2.5*** *for details of the various motherboards incorporated in the MC4U Control Module models.*

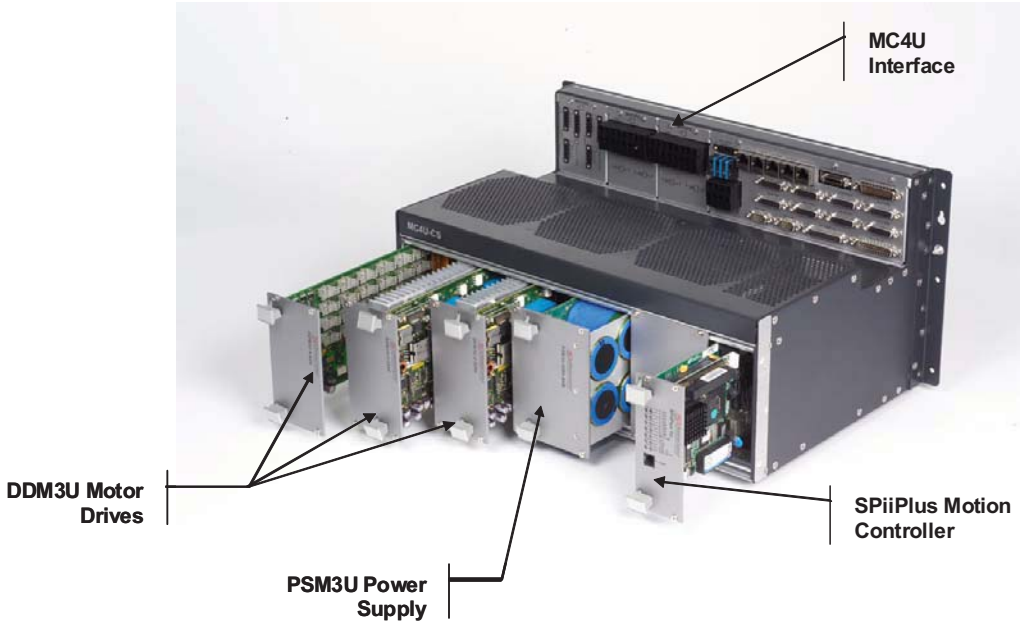


Figure 4 MC4U Components

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2.1 MC4U Physical Specifications

2.1.1 9” MC4U Dimensions

Table 4 provides the mechanical dimensions of the 9” MC4U unit.

Table 4 9” MC4U Dimensions

Height	221.5 ±1mm
Width	273.8 ±1mm (with extractors 287.3mm)
Length	211 ±1mm (with mounting-bracket 250.7±1mm)

Figure 5 displays the overall dimensions of the 9” MC4U unit.

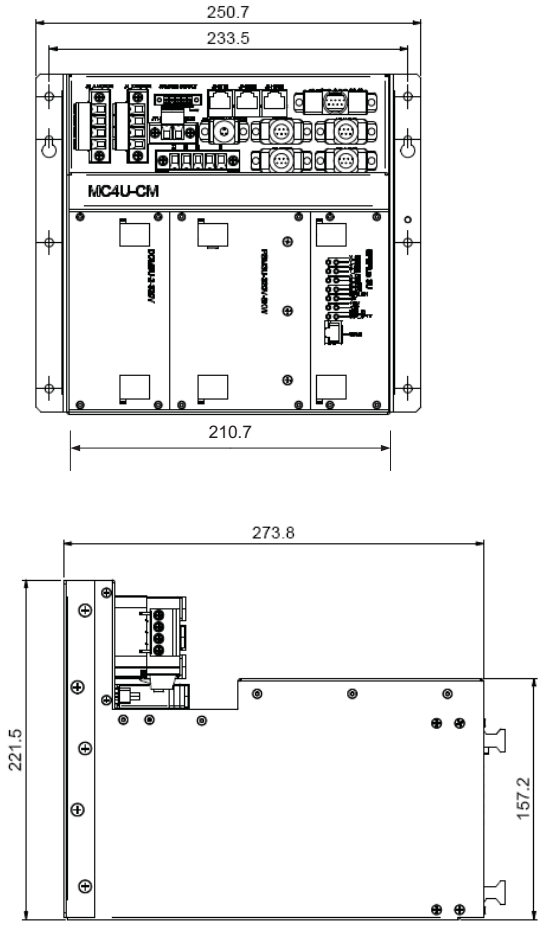


Figure 5 9” MC4U Dimensions

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2.1.2 11” MC4U Dimensions

Table 5 provides the mechanical dimensions of the 11” MC4U unit.

Table 5 11” MC4U Dimensions

Height	221.5 ±1mm
Width	273.8±1mm (with extractors 287.3mm)
Length	276.7±1mm (with mounting-bracket 316.7±1mm)

Figure 6 displays the overall dimensions of the 11” MC4U unit.

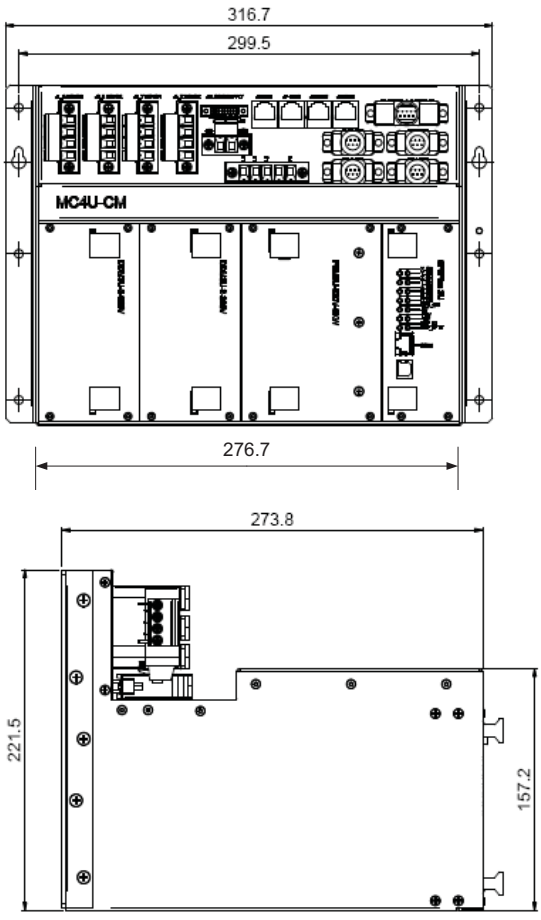


Figure 6 11” MC4U Dimensions

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2.1.3 19” MC4U Dimensions

Table 6 provides the mechanical dimensions of the 19” MC4U unit.

Table 6 19” MC4U Dimensions

Height	221.5 ±1mm
Width	• 483 ±1mm (with front bracket) • 476 ±1mm (with rear bracket) • 436 ±1mm (with no bracket)
Length	292 ±1mm

Figure 7 displays the overall dimensions of the 19” MC4U unit.

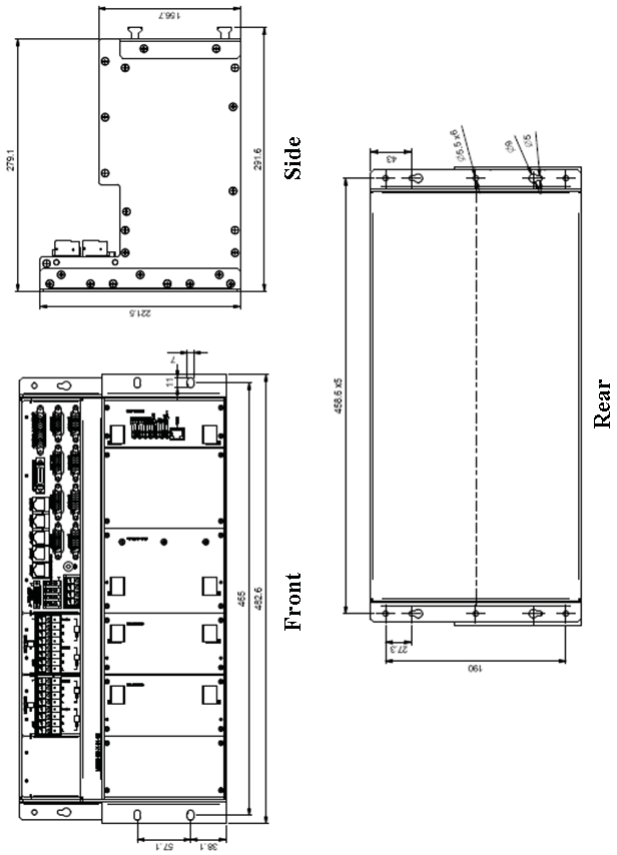


Figure 7 19” MC4U Dimensions

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2.1.4 Weight

The 9” MC4U has a maximum weight of 5.2 kg.

The 11” MC4U has a maximum weight of 6.5 kg.

The 19” MC4U has a maximum weight of 11.5 kg.

2.1.5 MC4U Power Dissipation

Table 7 provides the power dissipation of the modules for both the low and high power versions of the MC4U.

Table 7 MC4U Power Dissipation

Component	Power Loss
SPiiPlus-3U-8-E Motion Controller	25W
SPiiPlus 3U-LT Motion Controller	12W
PSM3U-48V-0.7kW Power Supply	85W
PSM3U-320V-8kW Power Supply	150W
DDM3U-4-06-02 Motor Drive	25W
DDM3U-2-30-20 Motor Drive	175W

2.1.6 MC4U Environmental Parameters

Table 8 provides the environmental parameters for MC4U operation.

Table 8 MC4U Environmental Specification

Parameter	Value
Ambient Temperature	Rated range of operation from 0 to + 40°C
Environmental conditions: Storage	IEC 60721-3-1 (class 1K3 and 1M3)
Environmental conditions: Transportation	IEC 60721-3-2 (class 2K4 and 2M3)
Environmental conditions: Operating	IEC 60721-3-3 (class 3K3 and 3M4)

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2.2 SPiiPlus Motion Controller

The SPiiPlus Motion Controller that is incorporated in the MC4U Control Module may be one of following:

- SPiiPlus 3U-LT Motion Controller
- SPiiPlus 3U-HP Motion Controller

Both versions have the following features:

- **Controller**

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

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

- **Communication Channels**

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

  - The controller communicates with a computer host via an RS-232 serial channel or Ethernet 10/100 BaseT channel.
  - In addition it can communicate with other computers via a second RS-232 serial channel (115,200 baud) or Ethernet 10/100 BaseT channel.

- **Digital I/O**

  The controller comes with digital and analog I/Os that can be used for general purposes. In addition, digital inputs can be used for hardware-based position registration and outputs can be used to trigger position-based events with sub-µSec delays.

- **ACSPL+**

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

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

- **Suite of Tools**

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

For complete details of the motion controllers, refer to the *SPiiPlus 3U-LT, SPiiPlus 3U-HP Hardware Guide*.

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2.2.1 SPiiPlus-3U Motion Controller

This section provides technical details of the SPiiPlus-3U Motion Controller.

Note	
	*In the ACSPL+ designations given in the specifications the dollar sign ($) stands in place of the actual axis designation, for example, $_RL can be X_RL, Y_RL, Z_RL, and so forth.*

2.2.2 SPiiPlus 3U-LT Motion Controller

2.2.2.1 SPiiPlus 3U-LT Features

The SPiiPlus 3U-LT Motion Controller features:

- High 20kHz update rate for all axes and position, velocity and current control loops, fast settling and outstanding smoothness at low velocities.
- Sub-nanometer in-position stability.
- Optional input shaping support
- Powerful software commutation of synchronous AC (DC brushless) motors.
  - 20 kHz update rate.
  - Automatic phase recognition.
- Powerful I/O handling.
- Position Event Generator (PEG) with sub-microsecond delay.
- Position registration.
- General purpose High Speed Synchronous Interface (HSSI) for IO expansion and interfacing with external user's devices.
- Multi-communication channels - one USB, one CAN bus, two Ethernet and two RS-232. All channels can be used simultaneously.

This section provides technical details of the SPiiPlus 3U-LT Motion Controller.

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2.2.2.2 SPiiPlus 3U-LT Specifications

Table 9 presents the SPiiPlus 3U-LT specifications.

Table 9 SPiiPlus 3U-LT Specifications (page 1 of 6)

	Description	Remarks
Supported Axes		
Number of axes	Four. 19" MC4U: Up to 8.	
ACSPL+ axis designations	Primary axes: • X, A for 9" MC4U (Optional additional two encoders: Y, B) • X, Y, A, B for 11" MC4U • X Y Z T for 19" MC4U (Optional secondary axes: A B C D)	
Supported motor types	Brush, Brushless, Two-Phase Brushless, and Two-Phase Step	With appropriate firmware support.
Digital Encoder Inputs/Outputs		
ACSPL+ Designations	A: $_CHA± B: $_CHB± I: $_CHI±	
Quantity	One per axis.	In dual loop, A, B, C, and D encoders can be used as secondary encoders for the X, Y, Z, and T axes.
Format	A, B, I	
Interface type	RS422 compatible. Input impedance: 120Ω.	
Maximum input frequency	7.5MHz	7.5MHz A & B input frequency appropriate to 30 million counts per second.
Diagnostic	Default Not Connected state: Diagnostic inputs logic "0", A, B, I inputs "1".	Supports Encoder Not Connected and Encoder Error faults
Hall Feedback		
ACSPL+ Designations	Channel A: $_HA Channel B: $_HB Channel C: $_HC	
Quantity	One per axis.	
Format	A, B, C	
Interface type	Opto-isolated input. Source input type, (open cathode). Up to 7mA current. DGND referenced. Default "Non active" (no current), inputs state ('1,1,1').	Power supply range: 5Vdc ±5% . 50mA max supply load current for A, B, C Hall sensors in one motor.

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Table 9 SPiiPlus 3U-LT Specifications (page 2 of 6)

	Description	Remarks
Diagnostics	Default state “1,1,1”. Inputs logic state 1,1,1	
Maximum input frequency	2kHz	
PWM Drive Command Output		(Applicable only for 19” MC4U)
ACSPL+ Designations	Three PWM signals, controlling a three-phase bridge Bridge leg R: $_PWM0 Bridge leg S: $_PWM1 Bridge leg T: $_PWM2	
Quantity	Three per axis.	
Type	TTL Load current < 6mA	
Base frequency	20kHz	
Pulse width	Min. Pulse width - 16.6 nSec Max. Pulse width - 49.84 µSec Command range 3000	
Resolution	Command time resolution 16.6nSec (12-bit)	
Default	Power-up output state “Z”	
Mechanical Brake		
ACSPL+ Designation	Same as Digital Output pins: BRAKE_X (OUT0) BRAKE_Y (OUT1) BRAKE_Z (OUT2) BRAKE_T (OUT3) BRAKE_A (OUT4) BRAKE_B (OUT5) BRAKE_C (OUT6) BRAKE_D (OUT7) Repeatable time ≤ 3mSec	The same pins of connectors can be defined as digital outputs or mechanical brake Default: Digital output.
Quanity	One per axis.	
Default state	No current through the output transistor.	Default FPGA output: "0"
Limit Switches		
ACSPL+ Designations	Right limit: $_RL Left limit: $_LL	
Quantity	One Left Limit and one Right Limit per axis	
Type	Single-ended, opto-isolated. Can be configured as either source or sink. 5Vdc ±10% or 24Vdc ±20%, external or internal supply, with automatic detection. Input current: 2.8 - 14mA. Reference: V_SUP_SFTY.	The user has to supply the V_SUP_SFTY value. On SpiiPlus 3U-LT controller board the JP1 jumper should be installed in position 1-2 for sink and 2-3 for source. The default is sink. See **Section 5.7**.
Default state	No limit, no current.	

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Table 9 SPiiPlus 3U-LT Specifications (page 3 of 6)

	Description	Remarks
E-Stop		
ACSPL+ Designation	E-Stop: ES±	E-Stop should be used to indicate to the controller that there is an emergency condition and should not be relied upon as the E-Stop safety mechanism.
Quantity	One	
Type	Opto-isolated, floating cathode and anode (two pins). 5Vdc ±10% or 24Vdc ±20%, automatically detected. Input current: 2.8-14mA	
Default state	No emergency stop, no current.	
Motor Over Temperature Inputs		
ACSPL+ Designation	Motor over temperature: $_OVER_T	
Quanity	One per axis	
Type	Single-ended, opto-isolated. Reference: V_RTN_IO Threshold resistance 3.6 kΩ ±5%	When using PTC, when the motor is cold, the resistance should be below 1650Ω, and when hot, above 4000Ω.
Default state	Low impedance < 3K (No Over Temperature)	
General Purpose Logic Inputs		
ACSPL+ Designations	IN0, IN1, IN2, IN3, IN4, IN5, IN6, IN7	IN6, IN7 can be shared with X-axis MARK1, MARK2; and Y-axis MARK2 can be shared with X-axis MARK2 by JP9 setup.
Quantity	Eight.	
Type	Single-ended, opto-isolated. Can be configured by the user as sink or source. 5Vdc ±10% or 24Vdc ±20%. Referenced to V_SUP_IO (Sink) or V_RET_IO (Source). Automatic voltage detection. Input current 2.8-14mA	Configuration by JP3.
Default state	No input current	
Registration Mark		
ACSPL+ Designations	$_MARK1± $_MARK2±	Can also be used for general purposes.
Quantity	Two	For 19” MC4U only: Two per X, and one per Y, Z, T
Type	RS422 compatible. Input impedance: 120Ω.	IN6, IN7 can be shared with X-axis MARK1,MARK2 and Y-axis MARK2 can be shared with X-axis MARK2 by JP9 setup
Default state	Vin < 0.2V Open state	

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Table 9 SPiiPlus 3U-LT Specifications (page 4 of 6)

	Description	Remarks
General Purpose Outputs		
ACSPL+ Designations	OUT0, OUT1, OUT2, OUT3, OUT4, OUT5, OUT6, OUT7	SPiiPlus 3U-LT does not have a dedicated mechanical brake connection. Rather, the same pins of connectors can be defined either as digital outputs or mechanical brake outputs (see **Section 2.5.3.3**). Default: Digital output. OUT6, OUT7 can be shared with X-axis PEG and Y-axis PEG by JP9 setup Default: Digital output.
Quantity	Eight	
Type	Single-ended, opto-isolated. Can be configured by the user as sink or source. 5Vdc ±10% to 24Vdc ±20%. Referenced to V_RET_IO (Sink) or V_SUP_IO (Source).	Configuration by JP2. Short protected
Maximum current per single output	100mA Drop voltage < 2.5V	
Default state	Upon power-up signal is high impedance (no current through the output transistor).	FPGA logic state: ‘0’
Maximum current per all outputs	800mA	
Protection	All outputs are protected against overloads and short currents.	
PEG Outputs		
ACSPL+ Designations	PEG pulse: $_PEG± 19” MC4U only: PEG State: X_STATE0± X_STATE1± X_STATE2±	Position compare with digital encoders. Resolution: Quadrature counts.
Quantity	9” MC4U: One PEG pulse per X axis 11” MC4U: Two, one PEG pluse per X, and one PEG pulse per Y axis 19” MC4U: One PEG pulse per X, Y, Z, T axes. Three PEG states per X axis.	
Type	RS422 compatible.	OUT6, OUT7 can be shared with X-axis PEG and Y-axis PEG by JP9 setup.

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Table 9 SPiiPlus 3U-LT Specifications (page 5 of 6)

	Description	Remarks
Propagation delay	<0.1µSec	Propagation delay - The delay from the moment that the encoder reaches the set position until the output PEG pulse is generated. It includes both the delay generated by the encoder processing logic and the delay of the PEG logic.
PEG generated pulse width range	25nSec to 1.6mSec, programmable	
Edge separation between two PEG events	>200nSec	
Number of random PEG events (table based mode)	Up to 30,000	
Default state	Logic '0' by pull down.	Upon power-up SpiiPlus output logic state: 'Z'
General Purpose Analog Inputs		
		SPiiPlus 3U-LT does not support general purpose analog inputs.
General Purpose Analog Outputs		
ACSPL+ Designations	SPiiPlus 3U-LT-4: AOUT_2 AOUT_6 SPiiPlus 3U-LT-8: AOUT_2 AOUT_6 AOUT_10 AOUT_14	No offset compensation.
Quantity	9” MC4U: One 11” MC4U: Two 19” MC4U: Four	
Type	Single ended ±10V	Output short protected
Maximum output inaccuracy	8% in maximum output voltage at 25 ºC and loading < 5mA	
Default state	Upon power-up output is 0V	
Resolution	10-bits	
Offset	±100mV at 0V at 25º C	
HSSI		
ACSPL+ Designations	Control signal: H_CON_$± Input signal: H_DI_$± Output signal: H_DO_$±	
Quantity	9” MC4U: One 11” MC4U: Two 19” MC4U: Three	
Input word size	16x4 = 64 per HSSI channel.	

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Table 9 SPiiPlus 3U-LT Specifications (page 6 of 6)

	Description	Remarks
Output word size	16x4 = 64 per HSSI channel.	
TX / RX type	RS422 compatible. Input impedance 120Ω Distance ≤10m.	
Sampling rate	All the 64 input bits are sampled and all the 64 output bits are updated every 50 µS.	
HSSI connection	HSSI channels can be commutated as external or internal.	
Ethernet		
ACSPL+ Designations	Transmit: ETH1_TX± Receive: ETH1_RX± Transmit: ETH2_TX± Receive: ETH2_RX±	
Quantity	Two: ETH1, ETH2	
Line impedance	100Ω	Galvanic Isolated
Protocol	TPC/IP 10/100Mbps	
RS-232		
ACSPL+ Designations	COM1: Transmit: COM1_TX Receive: COM1_RX COM2: Transmit: COM2_TX Receive: COM2_RX	ESD protected
Number of channels	9” MC4U and 11” MC4U: One 19” MC4U: Two	
Maximum Baud rate	115,200	
CAN Bus		
ACSPL+ Designations	CAN_H CAN_L	
Number of channels	1	The CAN bus connector, J3, is located on the front of the module.
Protocol	CANopen	
Frequency	Up to 1MHz	
Line impedance	120Ω	Galvanic isolated
CAN power supply	Internal	Galvanic isolated

2.2.3 SPiiPlus 3U-HP Motion Controller

2.2.3.1 SPiiPlus 3U-HP Features

The SPiiPlus 3U-HP (high performance) features:

- High 20kHz update rate for all axes and position, velocity and current control loops, fast settling and outstanding smoothness at low velocities.

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- Sub-nanometer in-position stability.
- Optional input shaping support.
- High-resolution encoder:
  - Sin-Cos encoders with up to 2.5 MHz frequencies and 65,536 multiplications.
  - Sub-nanometer resolution.
- Powerful software commutation of synchronous AC (DC brushless) motors:
  - 20 kHz update rate
  - Automatic phase recognition
- Powerful I/O handling.
- Position Event Generator (PEG) with sub-microsecond delay.
- Position registration.
- Supports CANopen bus operation.
- General purpose High Speed Synchronous Interface (HSSI) for I/O expansion and interfacing with external user's devices.

This section provides technical details of the SPiiPlus 3U-LT Motion Controller.

2.2.3.2 SPiiPlus 3U-HP Specifications

Table 10 presents the specifications for the SPiiPlus 3U-HP.

Table 10 SPiiPlus 3U-HP Specifications (page 1 of 12)

	Description	Remarks
Supported Axes		
Number of axes	Four. Optional: An additional four axes.	Restriction on more than four-axis move (coordinated or non-coordinated) should be applied by a factory installed protection PAL key.
ACSPL+ axis designations	Primary axes: X Y Z T Option: Secondary axes: A B C D	Secondary axes do not support Mark and PEG. 4 pairs of primary/secondary, XA, YB, ZC, TD can control step motors using the P/D command.
Supported motor types	Brush, Brushless, Two-Phase Brushless, Two-Phase Stepper, P/D Stepper (half of the axes), Piazo-ceramic (Nano-Motion)	With appropriate firmware support.
Digital Encoder Inputs/Outputs		
ACSPL+ Designations	A: #_CHA± B: #_CHB± I: #_CHI±	
Quantity	One per axis.	In dual loop, A, B, C, and D encoders can be used as secondary encoders for the X, Y, Z, and T axes.
Format	A, B, I	

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Table 10 SPiiPlus 3U-HP Specifications (page 2 of 12)

	Description	Remarks
Interface type	RS422 compatible. Input impedance: 120Ω.	
Maximum input frequency	7.5MHz	7.5MHz A & B input frequency appropriate to 30 million counts per second.
Diagnostic	Default Not Connected state: Diagnostic inputs logic “0”, A, B, I inputs “1”.	Supports Encoder Not Connected and Encoder Error faults
Hall Feedback		
ACSPL+ Designations	Channel A: #_HA Channel B: #_HB Channel C: #_HC	
Quantity	One per axis.	
Format	A, B, C	
Interface type	Opto-isolated input, source input type, (open cathode), up to 7mA current. DGND referenced. Default "Non active" (no current), inputs state (‘1,1,1’).	Power supply range: 5Vdc ±5% . 50mA max supply load current for A, B, C Hall sensors in one motor.
Diagnostics	Default state “1,1,1”.	Inputs logic state.
Maximum input frequency	2kHz	
Analog Drive Commands Output		
ACSPL+ Designations	Current commands for one phase: Phase S: #_IS_CMD±	
Quantity	One per axis.	
Type	±10V, differential. Upon power-up output is 0V.	Possible full range spike not more than a duration of 3mSec.
Maximum output inaccuracy	5% in max output voltage at 25° C	
Resolution	12-bit resolution	
Maximum zero offset	±50mV at 0V at 25°C	
Maximum load	5mA	
Fast 2.5MHz Sin-Cos Encoders Input		
ACSPL+ Designations	Sine, Cosine, Index: Sin: #_FSIN± Cos: #_FCOS± Index: #_FSC_I±	

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Table 10 SPiiPlus 3U-HP Specifications (page 3 of 12)

	Description	Remarks
Quantity	4 Fast 2.5MHz encoders for X, Y, A, B 4 normal 250kHz encoders for Z, T, C, D	Note: For the C and D axes, the Sin-Cos interface share the same A to D as AIN10, AIN11, AIN14, AIN15. There are separate input pins for each function. When AIN10, AIN11, AIN14, AIN15 are used as Sin-Cos, there is no offset compensation. See **General Purpose Analog Inputs** below.
Type	Differential input Input impedance 120Ω. Encoder voltage range 1Vptp ±10% Input Voltage range: 1.25Vptp	
Offset compensation	User programmable parameter will be saved in the Flash memory by the user application. Range: ±0.05V Resolution: 16 bit	
Maximum frequency	2.5MHz	
Internal multiplier	2^n, where n = 2 to 16	
ADC	Resolution: 14 bit SNR > 72dB	
Diagnostics	Encoder error	Detection of Encoder Not Connected is incorporated in the software.
Non-Fast 2.5MHz Sin-Cos Encoders Input		
ACSPL+ Designations	Sine, Cosine, Index: Sin: #_SIN± Cos: #_COS± Index: #_SC_I±	
Quantity	4 Fast 2.5MHz encoders for X, Y, A, B. 4 normal 250kHz encoders for Z, T, C, D 8 normal 250kHz encoders for X, Y, A, B, Z, T, C, D	Note: For the C and D axes, the Sin-Cos interface share the same A to D as AIN10, AIN11, AIN14, AIN15. There are separate input pins for each function. When AIN10, AIN11, AIN14, AIN15 are used as Sin-Cos, there is no offset compensation. See **General Purpose Analog Inputs** below.
Type	Differential input. Input impedance: 120Ω. Encoder voltage range: 1Vptp ±10% Input Voltage range: 1.25Vptp	
Offset compensation	User programmable parameter will be saved in the Flash memory by the user application. Range: 10% from Input range Resolution: 16-bit	
Maximum frequency	250kHz	

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Table 10 SPiiPlus 3U-HP Specifications (page 4 of 12)

	Description	Remarks
Internal multiplier	2^n, where n = 2 to 16	
ADC	Resolution: 14 bit SNR > 72dB	
Diagnostics	Encoder error	Detection of Encoder Not Connected is incorporated in the software.
Squared Sin-Cos Output		
ACSPL+ Designations	A: #_CHA± B: #_CHB± I: #_CHI±	In the SIN-COS mode the same pins are used as those of the digital encoder inputs.
Quantity	4 for axes X, Y, A and B	
Format	A, B, I	
Type	RS422	
Output impedance	100 - 120Ω	
Protection	Output short protected	
Analog Drive Commands Output		Optional: PWM filtered by third order filter
ACSPL+ Designations	Current commands for two phases: Phase S: #_IS_CMD± Phase T: #_IT_CMD±	
Quantity	Two per axis	
Type	Differential ±10V. Upon power-up output is 0V.	
Maximum output inaccuracy	5% in max output voltage at 25°C	
Resolution	16-bit resolution	
Maximum zero offset	±50mV at 0V at 25°C	Programmable
Maximum load	5mA	Output short protected.
PWM Drive Command Output		
ACSPL+ Designations	Three PWM signals, controlling a three-phase bridge Bridge leg R: #_PWM0 Bridge leg S: #_PWM1 Bridge leg T: #_PWM2	
Quantity	Three per axis	
Type	TTL Load current < 6mA	
Base frequency	20kHz	
Pulse width	Min. Pulse width: 16.6nS Max. Pulse width: 49.84µS Command range: 3000	
Resolution	Command time resolution: 16.6nSec (12-bit)	
Default	Power-up output state "Z"	
P/D Drive Command		
ACSPL+ Designations	Pulse: #_PWM0 Dir: #_PWM1	The P/D pair shares pins with PWM signals.

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Table 10 SPiiPlus 3U-HP Specifications (page 5 of 12)

	Description	Remarks
Quantity	Four pairs	For X, Y, Z and T axes
Type	TTL Load current < 6mA	
Maximum pulse rate	4,000,000 pulse/second	
Pulse width	Min. Pulse width: 25 nS Max. Pulse width: 57.175µS	
Resolution	Command time resolution: 25nS	
Default state	Power-up output state "Z"	
Drive Enable Output		
ACSPL+ Designation	Drive enable: #_ENA	
Quantity	One per axis	
Type	Opto-isolated, source output (open collector), up to 24V/7mA, active low. Reference: V_RET_IO or DGND Upon power-up the signal is high impedance (no current through the output transistor)	Reference defined by internal jumper. DGND default. Power-up output state "Z"
Voltage drop in active state	≤0.3V	
Drive Fault Input		
ACSPL+ Designation	Axis Fault: #_FLT	Note: Fault status code readable via the I²C interface.
Quantity	One per axis	
Type	Opto-isolated, sink input (open cathode). Supplied by V_SUP_IO or +5VCC. Fault: no current. Maximum current in active (no fault) state: ≤6mA.	Reference defined by Internal jumper. Default: +5VCC.
Default state	No current	Input logic state "0"
Propagation delay	½ from input to measured output delay < 3mS	Drive enable is target output
Dynamic Brake		
ACSPL+ Designation	Brake enable: #_BRK	The same pins of connectors can be defined by internal jumpers as Dynamic Brake or Mechanical Brake. Default: Dynamic Brake.
Quantity	One per axis	
Type	Opto-isolated (open emitter), up to 24V/7mA, active when current is sourcing. Reference: V_SUP_IO or +5VCC Upon power-up signal is high impedance (no current through the output transistor). Repeatable time ≤3mSec	Reference defined by internal jumper. Default: +5VCC.
Default state	No current through the output transistor.	Power-up output state "Z"

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Table 10 SPiiPlus 3U-HP Specifications (page 6 of 12)

	Description	Remarks
Voltage drop in active state	≤0.3V	
Mechanical Brake		
ACSPL+ Designation	Same as **Digital Output** - see **General Purpose Outputs** Repeatable time ≤ 3mSec	The same pins of connectors can be defined as digital outputs or Mechanical Brake. Default: Digital output.
Quanity	One per axis	
Default state	No current through the output transistor.	Default FPGA output: "0"
Drive Current Feedback		
ACSPL+ Designations	Current in two phases (S, T) of the motor: Phase S: #_IS± Phase T: #_IT±	
Quantity	16	
Type	Differential analog input. Voltage range: ±2.5V, referenced to AGND. Input impedance ≥5KΩ	
Maximum input Inaccuracy	3% in maximum input voltage and at 25ºC	
Bandwidth	3 - 4kHz	3dB cutoff
ADC	Resolution: 14-bit SNR > 72dB	
Drive Supply Enable Output/Input		
ACSPL+ Designation	Drive high voltage supply enable: DRV_SUP_ENA	Output used for backward compatibility. Input used as additional logic inputs (PS fault or general component fault).
Quantity	One common to all devices	
Type	**Output**: Opto-isolated (open collector), 24V/7mA, active low. Reference: V_RET_IO or DGND Upon power up signal is high impedance (no current through the output transistor). **Input**: Opto-isolated, sink input (open cathode). Supplied by +5VCC. Max current <7mA.	Reference defined by internal jumper. DGND default. Can configured by internal jumpers as input or output. Default: input.
Default state	Input default state: no current Output default state: no current through the output transistor	FPGA logic state "1" FPGA logic state "0"
Output voltage drop in active state	≤0.3V	

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Table 10 SPiiPlus 3U-HP Specifications (page 7 of 12)

	Description	Remarks
Drive Fault Reset Output/Input		
ACSPL+ Designation	Drive Fault Reset: DRV_RST	Output used for backward compatibility. Input used as additional logic inputs (Spare).
Quantity	One	
Type	**Output**: Opto-isolated (open collector), 24V/7mA, active low. Reference: V_RET_IO or DGND Upon power up signal is high impedance (no current through the output transistor). **Input**: Opto-isolated, sink input (open cathode). Supplied by +5VCC. Max current <7mA.	Reference defined by internal jumper. Default: DGND. Can be configured by internal jumpers as input or output. Default: input.
Default state	Input default state: no current Output default state: no current through the output transistor	FPGA logic state “1” FPGA logic state “0”
Output voltage drop in active state	≤0.3V	
Limit Switches		
ACSPL+ Designations	Right limit: #_RL Left limit: #_LL	
Quantity	One Left Limit and one Right Limit per axis	
Type	Single-ended, opto-isolated. Can be configured as either source or sink. 5Vdc ±10% or 24Vdc ±20%, with automatic detection. Requires an external supply. Input current: 2.8 - 14mA. Reference: V_SUP_SFTY.	Configured by JP1. The user has to supply the V_SUP_SFTY value.
Default state	No limit, no current.	FPGA logic state “1”
Propagation delay	½ from input to measured output delay <3mS	From Fault Input occurrence to response output.
E-Stop		
ACSPL+ Designation	E-Stop: ES±	E-Stop should be used to indicate to the controller that there is an emergency condition and should not be relied upon as the E-Stop safety mechanism.
Quantity	One	
Type	Opto-isolated, floating cathode and anode (two pins). 5Vdc ±10% or 24Vdc ±20%, automatically detected. Input current: 2.8-14mA	

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Table 10 SPiiPlus 3U-HP Specifications (page 8 of 12)

	Description	Remarks
Default state	No emergency stop, no current.	
Propagation delay	½ from input to measured output delay <3mS	From Fault Input occurrence to response output.
Motor Over Temperature Inputs		
ACSPL+ Designation	Motor over temperature: #_OVER_T	
Quanity	One per axis	
Type	Single-ended, opto-isolated. Reference: V_RTN_IO Threshold resistance: 3.6 kΩ ±5%	When using PTC, when the motor is cold, the resistance should be below 1650Ω, and when hot, above 4000Ω.
Default state	Low impedance < 3K (No Over Temperature)	
General Purpose Logic Inputs		
ACSPL+ Designations	IN0, IN1, IN2, IN3, IN4, IN5, IN6, IN7	IN6 shared with X-axis MARK2 IN7 shared with Y-axis MARK2 IN4 shared with Z-axis MARK2 IN5 shared with T-axis MARK2 See **Registration Mark**
Quantity	8	
Type	Single-ended, opto-isolated. Can be configured by the user as sink or source. 5Vdc ±10% or 24Vdc ±20%. Referenced to V_SUP_IO (Sink) or V_RET_IO (Source) Automatic voltage detection. Input current: 2.8-14mA	Configuration by JP3.
Default state	No input current	FPGA logic state ‘1’ Input logic ‘1’
Propagation delay	½ from input to measured output delay <3mS	From Fault Input occurrence to response/activity in CTIME=1
Registration Mark		
ACSPL+ Designations	Mark 1: #_MARK1± Mark 2: #_MARK2±	Can also be used for general purpose input.
Quantity	Two per X, Y, Z and T axes	
Type	#_MARK1 RS422 compatible. Input impedance: 120Ω #_MARK2 shared with GP inputs. (See **General Purpose Logic Inputs**)	IN6 shared with X-axis MARK2 IN7 shared with Y-axis MARK2 IN4 shared with Z-axis MARK2 IN5 shared with T-axis MARK2
Default state	Vin < 0.2V Open state, No Input Current	Input logic ‘0’ Input logic ‘1’
Propagation delay	For differential outputs <0.3µS For opto-isolated inputs not more 50µS	

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Table 10 SPiiPlus 3U-HP Specifications (page 9 of 12)

	Description	Remarks
General Purpose Outputs		
ACSPL+ Designations	OUT0, OUT1, OUT2, OUT3, OUT4, OUT5, OUT6, OUT7	The same pins of connectors can be defined by FPGA as digital outputs or mechanical brake. (See **Mechanical Brake**.) Through setting the JP9 jumper, the same pins of the connectors can be defined as opto-isolated PEGs. OUT6 shared with X-axis PEG OUT7 shared with Y-axis PEG OUT4 shared with Z-axis PEG OUT5 shared with T-axis PEG Default: Digital output.
Quantity	8	
Type	Single-ended, opto-isolated. Can be configured by the user as sink or source. 5Vdc ±10% to 24Vdc ±20%. Referenced to V_RET_IO (Sink) or V_SUP_IO (Source).	Configuration by JP2. Short protected
Maximum current per single output	100mA Drop voltage < 2.5V	
Default state	Upon power-up signal is high impedance (no current through the output transistor).	FPGA logic state: “0”
Maximum current per all outputs	800mA	
Protection	All outputs are protected against overloads and short currents.	
Propagation delay	½ from input to measured output delay <3mS	
PEG Outputs		
ACSPL+ Designations	PEG pulse: #_PEG± PEG State: #_STATE0± #_STATE1± #_STATE2±	Position compared with digital encoders. Resolution: Quadrature counts.
Quantity	One PEG pulse per X, Y, Z, T axes. Three PEG states per X axes.	
Type	RS422 compatible. Or shared with GP outputs (see **General Purpose Outputs**).	Through setting the JP9 jumper, the GP output pins of the connectors can be defined as opto-isolated PEGs. OUT6 shared with X-axis PEG OUT7 shared with Y-axis PEG OUT4 shared with Z-axis PEG OUT5 shared with T-axis PEG Default: RS422

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Table 10 SPiiPlus 3U-HP Specifications (page 10 of 12)

	Description	Remarks
Propagation delay	For differential outputs: <0.3µSec For opto-isolated outputs: <700µSec	The delay is from the moment that the encoder reaches the set position until the output PEG pulse is generated. It includes both the delay generated by the encoder processing logic and the delay of the PEG logic.
PEG generated pulse width range	25nSec to 1.6mSec, programmable for differential outputs. 0.7mSec to 1.6mSec, programmable for opto-isolated outputs.	
Edge separation between two PEG events	>200nSec for differential outputs	
Number of random PEG events (table based mode)	Up to 30,000	
Default state	Logic '0' by pull-down	Upon power-up SpiiPlus output logic state: 'Z'
XY State Output		
ACSPL+ Designation	XY_State_0±	The two pins of the X_State 2 can be shared with the XY_State 0 pins. Setup by JP10. Default state: X_State 2 Note: XY_State_0 output is a logical AND of the X_State 0 and Y_State 0 signals.
Quantity	One	
Type	RS422 compatible	
Propagation delay	<0.3µSec	From X_PEG and Y_PEG generation in defined positions to XY_State_0 output.
Default state	Logic '0' by pull-down	
General Purpose Analog Inputs		
ACSPL+ Designations	AIN10, (C sine) AIN11, (C cosine) AIN14, (D sine) AIN15, (D cosine)	Each of the analog inputs can be used as an encoder Sin-Cos input or can be used for general purposes. Analog inputs have a ±10V entry in parallel to the ±0.625V entry. For Sin-Cos inputs, see the **Sin-Cos Encoder** sections above.
Quantity	16	
Type	±10V differential Input impedance >20kΩ	
Maximum input Inaccuracy	3% in maximum input voltage and at 25°C	

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Table 10 SPiiPlus 3U-HP Specifications (page 11 of 12)

	Description	Remarks
Resolution	14-bits ±2LSB SNR>72	The effective resolution can be enhanced to 16-bits by the over sampling technique.
General Purpose Analog Outputs	Optional: PWM filtered by second order filter	
ACSPL+ Designations	AOUT_CS± (AOUT10) AOUT_CC± (AOUT11) AOUT_DS± (AOUT14) AOUT_DC± (AOUT15)	No offset compensation.
Quantity	16 + 4	Signals not used for drive commands can be used as analog outputs. Note: The four signals: AOUT_CS±, AOUT_CC±, AOUT_DS±, and AOUT_DC± are generated by the controller and controlled by the MPU and updated at during the MPU update cycle (1kHz).
Type	±10V Differential load: < 5mA	Output short protected
Maximum output inaccuracy	5% in maximum output voltage and at 25°C	
Default state	Upon power-up output is 0V	
Resolution	16-bits	
Offset	±50mV at 0V at 25° C	
HSSI		
ACSPL+ Designations	Control signal: H_CON_#± Input signal: H_DI_#± Output signal: H_DO_#±	
Quantity	3: HSSI0, HSSI1 and HSSI2	A fourth HSSI channel (HSSI3) can be effected through jumper settings on SPiiPlus 3U-HP.
Input word size	16x4 = 64 per HSSI channel.	
Output word size	16x4 = 64 per HSSI channel.	
TX / RX type	RS422 compatible. Input impedance: 120Ω Distance: ≤10m.	
Sampling rate	All the 64 input bits are sampled and all the 64 output bits are updated every 50 µSec.	
HSSI connection	HSSI channels can be commutated as external or internal.	
Ethernet		
ACSPL+ Designations	Transmit: ETH1_TX± Receive: ETH1_RX± Transmit: ETH2_TX± Receive: ETH2_RX±	
Quantity	Two: ETH1, ETH2	
Line impedance	100Ω	Galvanic Isolated

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Table 10 SPiiPlus 3U-HP Specifications (page 12 of 12)

	Description	Remarks
Protocol	TPC/IP 10/100Mbps	
RS-232		
ACSPL+ Designations	COM1: Transmit: COM1_TX Receive: COM1_RX COM2: Transmit: COM2_TX Receive: COM2_RX	ESD protected
Number of channels	2	
Maximum Baud rate	115,200	
USB 2		
Number of connectors	One	Connector located on the front of the module.
PCI Bus		
Quantity	One	
Summary bus timing	Not more than 100µSec	
I^2C Bus		
ACSPL+ Designations	I2C_CLK I2C_DATA	Bi-directional serial interface for configuration and status feedback.
Quantity	One	SPiiPlus 3U-HP contains master controller and slave components with EEPROM for saving card data, such as, serial number, revision, HW configuration, etc.
Frequency	400kHz	
Type	Open drain	Optional: Isolated interface
CAN Bus		
ACSPL+ Designations	CAN_H CAN_L	
Number of channels	One	Connector located on the front of the module. HSSI2 pins can be used as CAN bus in SA configuration.
Protocol	CANopen	
Frequency	Up to 1MHz	
Line impedance	120Ω	Galvanic isolated
CAN power supply	Internal	Galvanic isolated

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2.2.4 J3 - CAN Bus Connector

SPiiPlus 3U-LT and SPiiPlus 3U-HP come equipped with a connector (J3) that can be used for connecting the MC4U to the CAN bus (for details of the connectivity see **Section 5.12**).

J3 is an RJ-45 female connector.

The pinout for the CAN bus connector is given in **Table 11**.

Table 11 CAN Bus Pinout

Pin #	Signal Designator	Description	Remarks
1	CAN_H	CAN_H bus line	
2	CAN_L	CAN_L bus line	
3	CAN_GND	Ground, return CAN supply	Optional
4	-	Not connected	
5	-	Not connected	
6	CAN_SHLD	CAN shield	Optional
7	CAN_GND	Ground, return CAN supply	Optional
8	CAN_V+	CAN external positive supply	Optional
Shell	Shield	Shield	Drain Wire

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2.2.5 SPiiPlus 3U LED Indicators

The LED indicators are located on the front panel of the module and indicate the status of the power supplies and axes as shown in the example given in **Figure 8**.



Figure 8 SPiiPlus 3U LED Indicators - Example

The LED are detailed in **Table 12**.

Table 12 SPiiPlus 3U LED Indicators (page 1 of 2)

LED	Description
Axis_ON	Dual Color (Green/Red) LEDs Eight - One per each axis. Green On: Axis enabled and functional Red On: Axis enabled but non-functional Off: Axis disabled
MPU_ON	Green LED On: Control unit working properly. When the control unit detects an incoming message, this LED goes off for a fraction of a second. This indicates that the processor and communications are functioning properly.

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Table 12 SPiiPlus 3U LED Indicators (page 2 of 2)

LED	Description
-5V	Green LED On: -5V voltage is available Off: -5V voltage is not available
+12V	Green LED On: +12V available Off: +12V is not available
-12V	Green LED On: -12V available Off: -12V is not available
SUP_IO	Green LED On: Supply voltage is available Off: Supply voltage is not available
SUP_SFTY	Green LED On: The Emergency Stop voltage is available Off: The Emergency Stop voltage is not available

2.3 PSM3U Power Supplies

There are five types of PSM3U Power Supplies, only two of which may be installed in the 9" MC4U or the 11" MC4U. All power supplies need two input voltage supplies:

- 24Vdc input supply for internal logic circuit
- AC drive supply for motor operation

Caution	
	***The 24Vdc input power supply cannot be connected to a DC distribution network; rather an external AC/DC supply with a 24Vdc, 5A output must be used.***

The two power supplies that can be installed in any MC4U model are:

- PSM3U-48V-0.7kW

  The PSM3U-48V-0.7kW is a low power, regulated power supply and supplies:

  - One 51Vdc nominal BUS voltage, up to 700W (motor supply), for motor drivers such as DDM3U-4 drive or the like. (If 700W is not enough power, use the PSM3U-48V-1.4kW power supply.)
  - All voltages for the SpiiPlus Motion Controller.

  The PSM3U-48V-0.7kW is supplied from:

  - Single AC external power supply within the voltage fluctuation range: 85-265Vac
  - 24Vdc±10% for logic supply
- PSM3U-320V-8kW

  The PSM3U-320V-8kW is a high power, non-regulated power supply and supplies:

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- VACin x 1.4 nominal BUS voltage, up to 8.3kW (motor supply), for the motor drivers such as DDM3U-2 or the like. (If 8.3kW is not enough power, use the PSM3U-320V-11kW power supply.)
- All voltages for SpiiPlus Motion Controller.

The PSM3U-320V-8kW is supplied from:

- Single or three-phase AC external power supply within the voltage fluctuation range 85-265Vac
- 24Vdc±10% for logic supply

The three power supplies that can be installed only in the 19" MC4U model are:

- PSM3U-48V-1.4kW

  The PSM3U-48V-1.4kW is a low power regulated power supply, with dual DC bus voltage outputs (up to 1.4kW), and supplies:

  - Two 51Vdc nominal BUS voltage outputs, up to 700W (motor supply), for each output for the motor drivers such as DDM3U-4 or the like.
  - All voltages for the SpiiPlus Motion Controller.

  The PSM3U-48V-1.4kW is supplied from:

  - Single AC external power supply within the voltage fluctuation range 85-265Vac
  - 24Vdc±10% for logic supply
- PSM3U-320V-11kW

  The PSM3U-320V-11kW is a high power, non-regulated power supply, with dual DC bus voltage outputs (up to 11kW) and supplies:

  - Two outputs, VACin x 1.4 nominal BUS voltage up to 8.3kW for each output and up to 12kW for both outputs simultaneously, for the motor drivers such as DDM3U-2 or the like.
  - All voltages for SpiiPlus Motion Controller.

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The PSM3U-320V-11kW is supplied from:

- Single or three-phase AC external power supply within the voltage fluctuation range 85-265Vac
- 24Vdc±10% for logic supply

- PSM3U-320/48V-0.7/8kW

Model	*The PSM3U-320/48V-0.7/8kW is required if the DDM3U-2 and DDM3U-4 motor drivers are installed together in the 19" MC4U.*

The PSM3U-320/48V-0.7/8kW is a dual output, mixed voltages power supply, high (up to 8kW) and low power (up to 0.7kW) and supplies:

- VACin x 1.4 nominal BUS voltage, up to 8kW (motor supply), for the DDM3U-2 or the like
- 320Vdc nominal BUS voltage, up to 8kW (motor supply), for the DDM3U-2
- 48Vdc nominal BUS voltage, up to 700W (motor supply), for the DDM3U-4 drive or the like
- All voltages for SpiiPlus Motioin Controller

The PSM3U-320/48V-0.7/8kW is supplied from:

- Single or three-phase AC external power supply within the voltage fluctuation range 85-265Vac.
- 24Vdc±10% for logic supply.

Note	*When using both low and high power supplies in the same unit, the low voltage is connected to J30 (V2) on the motherboard, and the high voltage is connected to J29 (V1) on the motherboard.*

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2.3.1 PSM3U Specifications

2.3.1.1 PSM3U-48V-XXkW Low Power PS

Table 13 lists the PSM3U-48V-XXkW Low Power specifications.

Table 13 PSM3U-48V-XXkW Low Power PS Specifications (page 1 of 2)

	Description	Remarks
Power Input	AC Input voltage (drive supply): • Fluctuation Range: single phase 85-265Vac Input frequency: • Nominal frequency: 50Hz • Minimum frequency: 47Hz • Maximum frequency: 63Hz Inrush current: 50A peak Maximum input current: • 10.67A @85Vac (for 700W unit) • 21.3A @85Vac (for 1400W unit) Efficiency: 81%	
Power Output	Maximum output current: For 700W unit: • 14A (continuous and peak) @ Vin=265Vac • 10A continuous 14A peak @ Vin=85Vac Output voltage: • Nominal voltage: 51Vdc • Minimum voltage: 45Vdc • Maximum voltage: 57Vdc Output power: • Maximum output power: 700W (continuous and peak) for 700W unit @ Vin=265Vac and 500W continuous @ Vin=85Vac	

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Table 13 PSM3U-48V-XXkW Low Power PS Specifications (page 2 of 2)

	Description	Remarks

Logic Supply	The Logic Supply is used to generate all necessary low voltages for the SPiiPlus Motion Controller.
	The Logic Supply is powered from an external 24Vdc control supply, and has the following characteristics:
	• Input voltage:
	  • Nominal voltage: 24Vdc
	  • Minimum voltage: 21.6Vdc
	  • Maximum voltage: 26.4Vdc
	• Input power: 55W, max.
	• Input current: 2.9A, max., @ 21.6V control supply input voltage
	• Supply inrush current
	  • Maximum inrush current value is less than 4Arms measured within first 400ms after logic supply input voltage is applied.
	  • After the first 400ms, the inrush current value continuously decreases and drops below 2.9A within 1sec.
	• Supply input voltage ripple:
	  • Maximum input voltage ripple amplitude: 5V peak-to-peak at 100Hz frequency
	  • In any condition: the input voltage level including the voltage ripple amplitude must not be lower than 21.6V and not greater than 26.4V
	• Supply Output Voltages: see **Table 14**.	

I^2C Circuit	See **Section 4.1.3**.	
±12V supply for third party drive (DC/DC unit)	The PSM3U-48V-0.7kW Power Supply provides the option for supporting additional ±12V for third party drives.	
Power Supply Fault output signal	This signal goes to “0” logic level and remains in this level if one of the power supply protection circuits is activated.	For over voltage fault recovery, the AC input must be removed and reapplied.

Table 14 Logic Supply Output Voltages

Name	Voltage	Accuracy	Max Current	Reference	Ripple & Noise
+5L	5V	4.75-5.1V	3A	DGND	<100mVp-p
-5L	-5V	±5%	300mA	DGND	<100mVp-p
12VA	+12V	±5%	600mA	AGND	<70mVp-p
-12VA	-12V	±5%	600mA	AGND	<70mVp-p
For Encoder Supply					
+5F	5V	4.75-5.1V	0.75A	AGND	<100mVp-p
+5U	5V	4.75-5.1V	0.75A	DGND	<100mVp-p

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Note	
	*The voltages in **Table 14** exist only when the 24V Logic Supply is connected.*

2.3.1.2 PSM3U High Power Power Supply

Table 15 lists the PSM3U-320V-XXkW specifications.

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Table 15 PSM3U-320V-XXkW High Power PS Specifications (page 1 of 2)

	Description	Remarks
Power Input	Input voltage fluctuation range: • Single phase 85-265Vac input (phase-to-neutral) • Three phase 85-265Vac input (phase-to-phase) Input frequency: • Nominal frequency: 50Hz • Minimum frequency: 47Hz • Maximum frequency: 63Hz Inrush current: • Maximum inrush current value is 3.75A rms measured for the first 20ms after power supply input voltage is applied. • After the first 20ms, the inrush current value continuously decreases and drops below 1.3A rms within 5sec. Efficiency: • 80% - for 85 - 265Vac single phase supply • 85% - for 195 - 265Vac three phase supply Input Voltage: see **Table 16** and **Table 17**. Input Current: see **Table 18** and **Table 19**.	The maximum input current for the AC input (drive supply) must not be more than 30A due to the AC input in connector J14 of the MC4U Interface (see **"J14 - Drive Supply Voltage Connector" on Page 88**).
Power Output	Maximum output current: • 16A continuous, 32A peak for 85 - 130Vac single phase input supply • 15.5A continuous, 31A peak for 195 - 265Vac single phase input supply • 23A continuous, 62A peak for 195 - 265Vac three phase input supply Output Voltage: see **Table 20**, **Table 21** and **Table 22**. Output Power: see **Table 23** .	

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Table 15 PSM3U-320V-XXkW High Power PS Specifications (page 2 of 2)

	Description	Remarks

Logic Supply	The Logic Supply is used to generate all necessary low voltages for the SPiiPlus Motion Controller. The Logic Supply is powered from an external 24Vdc control supply, and has the following characteristics:
	• Input voltage:
	  • Nominal voltage: 24Vdc
	  • Minimum voltage: 21.6Vdc
	  • Maximum voltage: 26.4Vdc
	• Input power: 55W, max.
	• Input current: 2.9A, max., @ 21.6V control supply input voltage
	• Supply inrush current
	  • Maximum inrush current value is less than 4Arms measured within first 400ms after logic supply input voltage is applied.
	  • After the first 400ms, the inrush current value continuously decreases and drops below 2.9A within 1sec.
	• Supply input voltage ripple:
	  • Maximum input voltage ripple amplitude: 5V peak-to-peak at 100Hz frequency
	  • In any condition: the input voltage level including the voltage ripple amplitude must not be lower than 21.6V and not greater than 26.4V
	• Supply Output Voltages: see **Table 14**.	

I^2C Circuit	See **Section 4.1.3**.	
External Regeneration	Regeneration circuit activates when DC BUS output voltage exceeds 400V±3% (388 - 412V) External regeneration resistor >15Ω	The internal regeneration resistor must be disconnected from Power Supply J5 connector; otherwise it will work in parallel with the external resistor and heat the power supply heatsink for no reason.
Power Supply Fault output signal	This signal goes to “0” logic level and remains in this level if one of the power supply protection circuit is activated. A self-reset circuit generates a pulse every 130mSec to reset the signal to “1” logic level when the fault condition disappears.	This signal is sent to the SPiiPlus Motion Controller over the I^2C bus.

Table 16 Maximum Input Power @ Single Phase Input 85 - 265Vac

Parameter	85Vac	100Vac	115Vac	130Vac	195Vac	230Vac	265Vac
Input power nominal (Pin), [W]	1979.52	2304.79	2792.69	3280.59	4923.26	5868.57	6813.89
Input power peak (Pin peak), [W]	3159.04	3809.58	4785.38	5761.19	9095.74	10986.37	12876.99

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Table 17 Maximum Input Power @ Three Phase Input 195 - 265Vac

Parameter	195Vac	230Vac	265Vac
Input power nominal **(Pin), [W]**	7140.70	8460.91	9781.12
Input power peak **(Pin peak), [W]**	18063.55	21622.37	25181.20

Table 18 Maximum Input Current @ Single Phase Input 85 - 265Vac

Parameter	85Vac	100Vac	115Vac	130Vac	195Vac	230Vac	265Vac
Input current nominal **(Iin), [Arms]**	22.95	23.58	24.28	24.81	25.18	25.52	25.76
Input current peak **(Iin peak), [Arms]**	36.63	38.97	41.61	43.56	46.53	47.77	48.68

Table 19 Maximum Input Current @ Three Phase Input 195 - 265Vac

Parameter	195Vac	230Vac	265Vac
Input current nominal **(Iin), [A rms]**	21.09	21.24	21.35
Input current peak **(Iin peak), [Arms]**	53.35	54.28	54.97

Table 20 Output Voltage @ Single Phase Input 85 - 130Vac

Parameter	85Vac	100Vac	115Vac	130Vac
Maximum output voltage **(Vout_max), [Vdc]**	118.98	135.24	159.63	184.03
Nominal output voltage @ nominal output current 16A **(Vout_nom), [Vdc]**	98.98	115.24	139.63	164.03
Minimum output voltage @ peak output current 32A **(Vout_peak), [Vdc]**	38.98	55.24	79.63	104.03

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Table 21 Output Voltage @ Single Phase Input 195 - 265Vac

Parameter	195Vac	230Vac	265Vac
Maximum output voltage **(Vout_max), [Vdc]**	273.48	322.27	371.06
Nominal output voltage @ nominal output current 15.5A **(Vout_nom), [Vdc]**	254.10	302.89	351.68
Minimum output voltage @ peak output current 31A **(Vout_peak), [Vdc]**	195.98	244.77	293.56

Table 22 Output Voltage @ Three Phase Input 195 - 265Vac

Parameter	195Vac	230Vac	265Vac
Maximum output voltage **(Vout_max), [Vdc]**	273.48	322.27	371.06
Nominal output voltage @ nominal output current 23A **(Vout_nom), [Vdc]**	263.90	312.69	350
Minimum output voltage @ peak output current 62A **(Vout_peak), [Vdc]**	221.81	270.60	319.39

Table 23 Output Power @ Single Phase Input 85 - 130Vac

Parameter	85Vac	100Vac	115Vac	130Vac
Nominal output power @ nominal output current 16A **(Pout_nom), [W]**	1583.61	1843.83	2234.15	2624.48
Peak output power @ peak output current 32A **(Pout_peak), [W]**	2527.23	3047.66	3828.31	4608.95

Table 24 Output Power @ Single Phase Input 195 - 265Vac

Parameter	195Vac	230Vac	265Vac
Nominal output power @ nominal output current 15.5A **(Pout_nom), [W]**	3938.61	4694.86	5451.11
Peak output power @ peak output current 31A **(Pout_peak), [W]**	7276.59	8789.09	10301.59

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Table 25 Output Power @ Three Phase Input 195 - 265Vac

Parameter	195Vac	230Vac	265Vac
Nominal output power @ nominal output current 23A **(Pout_nom), [W]**	6069.59	7191.77	8313.95
Peak output power @ peak output current 62A **(Pout_peak), [W]**	15354.02	18379.02	21404.02

2.4 DDM3U Motor Drive

The DDM3U Motor Drive supplies the driving power for the motors connected to the MC4U. There are two types of motor drives:

- DDM3U-X-60V-4A (for low power motors)
  Where X can be 2 or 4

Model	*The DDM3U-X-60V-4A is applicable only to the 19" MC4U.*

- DDM3U-2-320V-YY (for high power motors)
  Where YY can be 5A, 10A, 15A or 20A.

This section provides details for both types.

2.4.1 DDM3U-X-60V-4A Low Power Motor Drive

The DDM3U-X-60V-4A has 2 or 4 Pulse Width Modulation (PWM) Power Bridges (amplifiers) for 2 or 4 Servo (DC Brushless, DC Brush) and/or 2 or 4 Step motors. There are two different assembly options available for DDM3U-X-60V-4A power block, as detailed in **Table 26**.

Table 26 DDM3U-X-60V-4A Power Block Assembly Options (page 1 of 2)

Power Block Name	Number of PWM Bridges	Number of Axes	PWM Bridge Continuous/ 3 Sec Peak Output Current [A]	Input Power Supply Nominal Voltage Range [Vdc]
DDM3U-2-60V-2A	2	2 DC Brushless	4/5	18 - 60
		2 DC Brush	2.8/5	
		2 Step	2.8/3.5	

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Table 26 DDM3U-X-60V-4A Power Block Assembly Options (page 2 of 2)

Power Block Name	Number of PWM Bridges	Number of Axes	PWM Bridge Continuous/ 3 Sec Peak Output Current [A]	Input Power Supply Nominal Voltage Range [Vdc]
DDM3U-4-60V-2A	4	4 DC Brushless	4/5	18 - 60
		4 DC Brush	2.8/5	
		4 Step	2.8/3.5	

2.4.1.1 DDM3U-X-60V-4A Specifications

Table 27 provides detailed DDM3U-X-60V-4A specifications.

Note	
	*All power for the DDM3U-X-60V-4A is supplied through the PSM3U-48V-0.7kW Power Supply.*

Table 27 DDM3U-X-60V-4A Specifications (page 1 of 2)

	Description	Remarks
Motor types supported	Brush, Brushless or Step	
Number of axes supported	Four for Brush/Brushless or two for Step motors	
Input Power	Nominal Input Supply Voltage: 18 - 60Vdc Input Current & Power - see **Table 28**. Inrush current: • Maximum inrush current value is less than 1A rms measured within first 10ms after drive supply input voltage is applied • After the first 10ms, the inrush current value will gradually decrease to below 0.2A rms within 1sec	The drive supply voltage may reach 66V during motor regeneration. If the voltage ripple during regeneration exceeds the specified value (72V), then the over voltage protection is activated.

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Table 27 DDM3U-X-60V-4A Specifications (page 2 of 2)

	Description	Remarks
Input Control Supply	Control supply input voltage: • Nominal voltage: 24Vdc • Minimum voltage: 19Vdc • Maximum voltage: 29Vdc Control supply input power: 15.8W max. Control supply input current: 0.83A max. @ 19V control supply input voltage Control supply inrush current: • Maximum inrush current value is less than 32A rms measured within first 500µSec after drive supply input voltage is applied. • After the first 500µSec, the inrush current gradually decreases to below 0.83A within 1sec. Control supply input voltage ripple: • Maximum input voltage ripple amplitude: 5V peak-to-peak at 100Hz frequency. • Under any condition, the instantaneous input voltage level (including voltage ripple amplitude) must be between 19V and 29V.	
Total Output Power	See **Table 29**	
Output Power to Motor	See **Table 30**	

Table 28 DDM3U-X-60V-4A Maximum Input Current and Input Power

	Number of Axes	Maximum Continuous Input Current [Arms]	Maximum Peak Input Current (3 Sec) [Arms]	Maximum Continuous Input Power [W]	Maximum Peak Input Power (3 Sec) [W]
DDM3U-2-60V-4A	2 DC Brushless	5.5	6.8	362	452
DDM3U-4-60V-4A	4 DC Brushless	10.9	13.7	723	904
DDM3U-2-60V-4A	2 DC Brush	5.2	9.2	341	608
	2 Step	3.4	4.2	222	276
DDM3U-4-60V-4A	4 DC Brush	10.3	18.4	682	1216
	4 Step	6.7	8.4	444	552

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Table 29 DDM3U-X-60V-4A Total Output Current and Output Power

	Number of Axes	Maximum Continuous Total Output Current [Arms/Sin Peak]	Maximum Peak Total Output Current (3 Sec) [Arms/Sin Peak]	Maximum Continuous Total Output Power [W]	Maximum Peak Total Output Power (3 Sec) [W]
DDM3U-2-60V-4A	2 DC Brushless	5.6/8	7.1/10	352	440
DDM3U-4-06V-4A	4 DC Brushless	11.2/16	14.1/20	704	880
DDM3U-2-60V-4A	2 DC Brush	5.6/NA	10/NA	336	600
	2 Step	4/5.6	7.1/10	212	264
DDM3U-4-60V-4A	4 DC Brush	11.2/NA	20/NA	672	1200
	4 Step	8/11.2	14.2/20	424	528

Table 30 DDM3U-X-60V-4A Power Motor Output Parameters

Type of Connected Motor	Maximum Continuous Phase Output Current [Arms/Sine Peak]	Maximum Peak Phase Output Current (3 Sec) [Arms/Sin Peak]	Maximum Phase-to-Phase Output Voltage [V]	Maximum Continuous Output Power [W]	Maximum Peak Output Power (3 Sec) [W]
DC Brushless	2.8/4	3.5/5	36	176	220
DC Brush	2.8/NA	5/NA	52	168	300
Step	2/2.8	2.8/3.5	52 (see note)	106	132

Note



The maximum output voltage for a Step motor Phase S to Phase T is 52V; but for Phase S or Phase T to Phase R it is 36V.

Note



The power output parameters are based on 40°C ambient temperature.

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2.4.1.2 DDM3U-X-60V-4A Controller - Drive Interface

The SPiiPlus Motion Controller, via the Controller - Drive interface, controls the output current for each of eight PWM Power Bridges. The DDM3U-X-60V-4A Controller - Drive interface provides the connection between control signals of the DDM3U-X-60V-4A power block and the controller.

The DDM3U-X-60V-4A Controller - Drive interface includes the following types of control signals (total for eight PWM Power Bridges):

- PWM signals (3x4) - Control of the power transistors in PWM Power Bridge
- Drive Enable signals (1x4) - Enables and disables the PWM Power Bridge:
  - Go to "0" logic level upon "Drive Enable" command
  - Go to "1" logic level upon "Drive Disable" command or in case of drive fault condition (one of the drive protection circuit is activated)
- Drive Brake signals (1x4) - Used for shorting the motor phases by the low side transistors of PWM Power Bridge
- Drive Fault signals (1x4) - Disable, by internal HW circuit PWM Power Bridge, in the event of a drive fault condition (one of the drive protection circuit is activated)
- Drive Current Feedback signals (4x4) - Converts the measured motor phase currents to a differential voltage signal. These signals are fed to the controller and used as current feedback in digital current loop.
- I^2C bus (x5) - Diagnostics, card and fault identification bus

2.4.2 DDM3U-2-320V-YY High Power Motor Drive

The DDM3U-2-320V-YY (where “YY” relates to Amperage) is a dual axis Pulse Width Modulation (PWM) digital universal driver for the following types of motors:

- DC Brushless
- AC Induction
- DC Brush Step Motor

The number of motors connected to the driver can be one or two. The SPiiPlus Motion Controller, via the Controller - Driver interface, controls the output current for each of two PWM digital drivers.

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There are four different options available for DDM3U-2-320V-YY dual axis digital driver:

- DDM3U-2-320V-5A
- DDM3U-2-320V-10A
- DDM3U-2-320V-15A
- DDM3U-2-320V-20A

2.4.2.1 DDM3U-2-320V-YY Specifications

Table 31 lists the DDM3U-2-320V-YY specifications.

Note	
	*All power for the DDM3U-2-320V-YY is supplied through the PSM3U Power Supply.*

Table 31 DDM3U-2-320V-YY Specifications (page 1 of 2)

	Description	Remarks
Supported motor types	Brush, Brushless or Step.	
Number of axes supported	Two	
Axis designations	9” MC4U: X, A 11” MC4U and 19” MC4U: X, Y (also A and B If two Motor Drives are installed)	
Input Power	Drive supply input voltage range: • Nominal: 24Vdc - 320Vdc • Minimal: 21Vdc (24Vdc -10%) • Maximum: 370Vdc (320Vdc +15%) Inrush current: • Maximum inrush current value is less than 1A rms measured within first 10ms after drive supply input voltage is applied. • After the first 10ms, the inrush current value will continuously decrease and drop below 0.2A rms within 1sec. Drive supply maximum input power (for 2 axes operated simultaneously): 2791W continuous and 5582W peak for DDM3U-2-320V-5A 5551W continuous and 11102W peak for DDM3U-2-320V-10A 8330W continuous and 11102W peak for DDM3U-2-320V-20A	During motor regeneration a rapid increase in the input voltage up to 420V is allowed. If the voltage ripple during regeneration exceeds this 420V, then the over voltage protection is activated. It should be noted that the maximum input power cannot be more than 11,102W due to the maximum input current that is limited by the maximum available PCB fuse size: 30A 600Vdc

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Table 31 DDM3U-2-320V-YY Specifications (page 2 of 2)

	Description	Remarks
Input Current	Drive supply maximum input current (for 2 axes operated simultaneously): • 7.5A continuous and 15A peak for DDM3U-2-320V-5A • 15A continuous and 30A peak for DDM3U-2-320V-10A • 22A continuous and 30A peak for DDM3U-2-320V-20A	
Input Control Supply	Control supply input voltage: • Nominal voltage: 24Vdc • Minimum voltage: 19Vdc • Maximum voltage: 29Vdc Control supply input power: 15W max. Control supply input current: 0.8A max. @ 19V control supply input voltage Control supply inrush current: • Maximum inrush current value is less than 2A rms measured within first 200ms after drive supply input voltage is applied. • After the first 200ms, the inrush current value will continuously decrease and drop below 1.25A within 1sec. Control supply input voltage ripple: • Maximum input voltage ripple amplitude: 5V peak-to-peak at 100Hz frequency. • In any condition: the input voltage level including the voltage ripple amplitude must not be lower than 19V and not greater than 29V	

Table 32 Minimum Output Voltage @ Single Phase Input 85 - 130Vac

DDM3U-2-320V-YY	Number of Motors	85Vac	100Vac	115Vac	130Vac
DDM3U-2-320V-5A **Vout_min [Vdc]** @ 10A sine peak motor phase current	1	99.55	115.94	140.46	164.95
	2	79.93	96.49	121.18	145.80
DDM3U-2-320V-10A **Vout_min [Vdc]** @ 20A sine peak motor phase current	1	80.15	96.69	121.36	145.95
	2	40.30	57.41	82.63	107.58
DDM3U-2-320V-20A **Vout_min [Vdc]** @ 30A sine peak motor phase current	1	60.18	76.96	101.91	126.68
	2	0.00	16.24	42.71	68.33
DDM3U-2-320V-20A **Vout_min [Vdc]** @ 40A sine peak motor phase current	1	40.05	57.21	82.48	107.43
	2	0.00	0.00	1.76	28.65

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Table 33 Minimum Output Voltage @ Single Phase Input 195 - 265Vac

DDM3U-2-320V-YY	Number of Motors	195Vac	230Vac	265Vac
DDM3U-2-320V-5A **Vout_min [Vdc]** @ 10A sine peak motor phase current	1	254.60	303.44	352.28
	2	235.68	284.62	333.48
DDM3U-2-320V-10A **Vout_min [Vdc]** @ 20A sine peak motor phase current	1	235.83	284.74	333.61
	2	198.03	247.12	296.11
DDM3U-2-320-20A **Vout_min [Vdc]** @ 30A sine peak motor phase current	1	216.85	265.84	314.78
	2	159.85	209.17	258.33
DDM3U-2-320-20A **Vout_min [Vdc]** @ 40A sine peak motor phase current	1	197.95	247.04	296.06
	2	121.70	171.34	220.68

Table 34 Minimum Output Voltage @ Three Phase Input 195 - 265Vac

DDM3U-2-320V-YY	Number of Motors	195Vac	230Vac	265Vac
DDM3U-2-320V-5A **Vout_min [Vdc]** @ 10A sine peak motor phase current	1	267.19	316.00	364.80
	2	260.90	309.73	358.54
DDM3U-2-320V-10A **Vout_min [Vdc]** @ 20A sine peak motor phase current	1	260.94	309.77	358.58
	2	248.39	297.26	346.10
DDM3U-2-320V-20A **Vout_min [Vdc]** @ 30A sine peak motor phase current	1	254.64	303.49	352.32
	2	235.76	284.68	333.57
DDM3U-2-320-20A **Vout_min [Vdc]** @ 40A sine peak motor phase current	1	248.37	297.24	346.09
	2	223.20	272.17	321.09

Caution	
	***Drive output peak current can be 80A at 1:7 duty (peak/idle) cycle, any current over this value causes the fuse to blow.***

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2.4.2.2 Pulse Width Modulation Power Bridge Specification

There are two identical PWM Power Bridges on the DDM3U-2-320V-YY board. Three types with different current levels (Cont/Peak) are available:

- 5/10A – DDM3U-2-320V-5A
- 10/20A – DDM3U-2-320V-10A
- 15/30A – DDM3U-2-320V-15A
- 20/40A – DDM3U-2-320V-20A

Table 35 provides the detailed PWM specifications.

Table 35 PWM Power Bridge Specifications

	Description	Remarks
Power Bridge architecture	Three phase PWM bridge	
Supported motor types	• DC Brush Step Motor • DC Brushless • AC Induction	
PWM Power Bridge Output	Maximum phase output current: • Type A 5/10A [continuous/peak] • Type B 10/20A [continuous/peak] • Type D 20/40A [continuous/peak] Maximum output voltage (phase-to-phase): 222Vrms ±5% @ 370Vdc ±5% power supply input voltage. For the bus voltages derived from PSM3U-320V 8KW supply, powered by 265Vac single phase: 212/200Vrms ± 5% For the bus voltages derived from PSM3U-320V 8KW supply, powered by 265Vac three phase: 219/216Vrms ± 5% Maximum output power for 370Vdc: • Type A: 1362/2724W±5% [continues/peak] • Type B: 2724/5448W±5% [continues/peak] • Type D: 5448/10896W±5% [continues/peak] For the bus voltages derived from PSM3U-320V 8KW supply, powered by 265Vac single phase (±5%): • Type A: 1348W continue and 2662W peak • Type B: 2662W continue and 5187W peak • Type D: 5187W continue and 9822W peak For the bus voltages derived from PSM3U-320V 8KW supply, powered by 265Vac three phase (±5%): • Type A: 1360W continue and 2708W peak • Type B: 2709W continue and 5371W peak • Type D: 5371W continue and 10558W peak	Drive output peak current can be 80A at 1:7 duty (peak/idle) cycle, any current over this value causes the fuse to blow.

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2.4.3 LDM3U Single Axis Linear Amplifier

The LDM3U is a single axis linear servo drive with digitally controlled current loop.



Figure 9 LDM3U Single Axis Linear Amplifer

The driver can be used with the following type of motors:

- DC Brushless
- DC Brush

Model	
	*The LDM3U Single Axis Linear Amplifier can only be installed in the 19" MC4U. When installed, the LDM3U requires the MB5U-LDM3U motherboard (**Section 2.5.9**).*

There are two different options available for the LDM3U Single Axis Linear Amplifier:

- LDM3U-55V-8A
- LDM3U-55V-16A

The main features of the LDM3U are as follows:

- Programmable Digital Current Loop bandwidth: Adjustable up to 5 kHz Commutation type: Sinusoidal. Initialization with and without Hall sensors.
- Fully protected against over and under voltage, over- current, under-current and over heating
- Built-in motor dynamic braking is automatically activated when the amplifier is disabled
- HW identification and fault diagnostic via I^2C interface

The following additional options are available upon request:

- Analog current loop control.
- Special digital control algorithm to increase maximum speed.

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2.4.3.1 LDM3U Amplifier Input Power Specifications

This section provides detailed input power specifications for the LDM3U Single Axis Linear Amplifier stage.

Model	
	*The LDM3U input power can only be supplied by the PSM3U-48V-0.7kW Power Supply (see **Section 2.3.1**) when the power supply is that coming with the MC4U; otherwise a user-supplied external power supply may be used.*

Table 36 LDM3U Input Power Specifications

	Description	Remarks
Drive Supply Input Voltage		
Vin min	45Vdc	With the *PSM3U-48V-0.7kW Power Supply*
Vin nom	51Vdc	
Vin max	57Vdc	
DC Brushless Motor Input Current		
Iin_cont (driver continuous input current)	4.24Arms	
Iin_peak (driver peak input current)	• LDM3U-55V-8A - 8.49Arms • LDM3U-55V-16A - 16.97Arms	
DC Brushless Motor Input Power		
Pin_cont (driver continuous input power)	256.68W	
Pin_peak (driver peak input power)	• LDM3U-55V-8A - 513.36W • LDM3U-55V-16A - 1026.72W	
DC Brush Motor Input Current		
Iin_cont (driver continuous input current)	4.00Adc	
Iin_peak (driver peak input current)	• LDM3U-55V-8A - 8.00Arms • LDM3U-55V-16A - 16.00Arms	
DC Brush Motor Input Power		
Pin_cont (driver continuous input power)	204.00W	
Pin_peak (driver peak input power)	• LDM3U-55V-8A - 408.00W • LDM3U-55V-16A - 816.00W	

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2.4.3.2 LDM3U Drive Amplifier Output Power Specifications

This section provides detailed output power specifications for the LDM3U Single Axis Linear Amplifier stage.

Table 37 LDM3U Output Power Specifications

	Description	Remarks
DC Brushless Motor Output Current		
Iout_cont (driver continuous output phase current, sine amplitude / r.m.s)	4A/2.83Arms	
Iout_peak (driver peak output phase current, sine amplitude / r.m.s)	• LDM3U-55V-8A - 8A/5.66Arms • LDM3U-55V-16A - 16A/11.31Arms	
DC Brushless Motor Output Voltage		
Vout_ph-ph_max (driver phase-to-phase maximum output voltage, r.m.s)	28.17Vrms	
DC Brushless Motor Output Power		
Pout_cont (driver continuous output power), [**W**]	166.50W	
Pout_peak (driver peak output power)	• LDM3U-55V-8A - 333W • LDM3U-55V-16A - 666W	
DC Brush Motor Ouput Current		
Iout_cont (driver continuous input current)	4.00Adc	
Iout_peak (driver peak input current)	• LDM3U-55V-8A - 8.00Arms • LDM3U-55V-16A - 16.00Arms	
DC Brush Motor Output Voltage		
Vout_ph-ph_max (driver phase-to-phase maximum output voltage, r.m.s)	46.00Vrms	
DC Brush Motor Ouput Power		
Pout_cont (driver continuous input power)	184W	
Pout_peak (driver peak input power)	• LDM3U-55V-8A - 368W • LDM3U-55V-16A - 736W	

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2.4.3.3 LDM3U DC/DC Control Supply Specifications

This chapter provides specifications of the LDM3U DC/DC control supply.

Table 38 provides the data of the control supply inputs.

Table 38 Control Supply Input

Input Voltage	LDM3U-55V-8A	LDM3U-55V-16A
Vin (input voltage range), [**Vdc**]	12 - 75	12 - 75
Iin (maximum input current), [**A**]	0.6	0.6
Pin (maximum input power), [**W**]	7.5	7.5
Efficiency	70%	70%

2.4.3.4 LDM3U Drive Protection

This section details the various protection elements incorporated in the LDM3U to provide both circuitry and drive protection. The elements include:

- Circuit Fuses
- Drive Protection Circuits
- Dynamic Braking

Table 39 lists the fuses that are incorporated in the LDM3U card.

Table 39 Drive Protection Fuses

Drive Circuit	LDM3U-55V-8A	LDM3U-55V-16A
Control supply	1A, 125Vdc, fast	1A, 125Vdc, fast
Drive supply	15A, 125Vdc, fast	15A, 125Vdc, fast
Drive output, phase S	15A, 125Vdc, fast	15A, 125Vdc, fast
Drive output, phase T	15A, 125Vdc, fast	15A, 125Vdc, fast

Warning	
	***Should a fuse blow, contact an ACS Motion Control technician for instructions.***

Table 40 provides details of the drive protection circuits.

Table 40 Drive Protection Circuits

Protection Type	LDM3U-55V-8A	LDM3U-55V-16A
Under voltage	Vbus < 32V±5%	Vbus < 32V±5%
Over voltage	Vbus > 67V±5%	Vbus > 67V±5%
Over current	Iin = 8A±5%, Td = 2Sec ±10%	Iin = 16A±5%, Td = 1.2Sec ±10%

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Table 40 Drive Protection Circuits

Protection Type	LDM3U-55V-8A	LDM3U-55V-16A
Short current (phase-to-phase and phase to ground)	Iin >10A±5%	Iin >20A±5%
Over temperature	T_heatsink > 95 - 100°C	T_heatsink > 95 - 100°C

Note



The software does not enable the display of an undervoltage warning message.

Table 41 provides the dynamic braking specifications for the LDM3U.

Table 41 LDM3U Dynamic Braking

	0.5Ω	1Ω	2Ω	4Ω
DC Brushless Motor				
Ibr_max (maximum allowed braking current)	16Arms	16Arms	16Arms	16Arms
Vmot ph-ph_max (maximum allowed phase-to-phase motor voltage before braking)	13.9Vrms	27.7Vrms	28.17Vrms (limited by drive supply)	28.17Vrms (limited by drive supply)
DC Brush Motor				
Ibr_max (maximum allowed braking current)	16Arms	16Arms	16Arms	16Arms
Vmot ph-ph_max (maximum allowed phase-to-phase motor voltage before braking)	8Vrms	16Vrms	32Vrms	46Vrms

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2.5 MC4U Motherboards

This section provides details of the motherboards installed in the various MC4U Control Module models. For each motherboard the supported functions are listed, details of each interface connector associated with the motherboard are provided, and jumper configuations are detailed.

2.5.1 MB5U-Z Motherboard

The MB5U-Z motherboard is installed in the 9” MC4U.

The connectors associated with the MB5U-Z motherboard are shown in **Figure 10**.



Figure 10 MB5U-Z Connectors

2.5.1.1 MB5U-Z Functionality

The MB5U-Z accomodates the SPiiPlus 3U-LT/HP motion controller, one DDM3U-X-320V-XX (up to 20A/40A) drive and one PSM3U-X-XKW power supply. It supports the following functionality:

- 4 x Digital encoders
- 4 x SIN-COS encoders (optional)
- 4 x Hall effect sensors
- 4 x Motor Temperature sensors
- 8 x Safety inputs
- 1 x E-stop
- 8 x Digital outputs/Mechanical brakes
- 8 x Digital inputs
- 2 x MARK signals
- 2 x PEG signals
- 2 x Motor output signals

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- 2 x Ethernet channels
- 1 x HSSI channel
- 1 x RS-232 channel
- 2 x External Drive Control (Y & B)

2.5.1.2 Encoder and Hall Connectors

Label: J14-Y ENC
J15-X ENC
J16-B ENC
J17-A ENC

Connector Type: D-type 26-pin HD female

Mating Type: D-type 26-pin HD male (for easy prototyping a Phoenix FLKM HDSUB-26/M Sub-D to Screw Terminal converter can be used)

The connectors are allocated as follows:

Connector	Axis	Connector	Axis
J15 - X ENC	X	J17 - A ENC	A
J14 - Y ENC	Y	J16 - B ENC	B

The pinout for the Encoder and Hall connectors is given in **Table 42**.

Note	
	*The dollar sign ($) stands for the given axis, for example, $_LL can be X_LL, or Y_LL, etc.*

Table 42 Encoder/Hall Connector Pinout (page 1 of 2)

Pin	Signal Designator	Description
1	$_CHA-	Encoder A inverted input
2	$_CHB-	Encoder B inverted input
3	$_CHI-	Encoder index inverted input
4	$_HB	Motor Hall B
5	V_SUP_SFTY	Supply for the limits input
6	$_RL	Right limit
7	$_SIN-	Encoder SIN inverted input
8	$_COS-	Encoder COS inverted input
9	$_SC_I-	Encoder SIN-COS Index inverted input
10	$_CHA+	Encoder A non-inverted input
11	$_CHB+	Encoder B non-inverted input
12	$_CHI+	Encoder Index non-inverted input
13	$_HA	Motor Hall A

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Table 42 Encoder/Hall Connector Pinout (page 2 of 2)

Pin	Signal Designator	Description
14	$_HC	Motor Hall C
15	$_LL	Left limit
16	$_SIN+	SIN non-inverted input
17	$_COS+	Encoder COS non-inverted input
18	$_SC_I+	Encoder SIN-COS Index non-inverted input
19	5U	5V user supply for the digital encoder and Hall sensor
20	5U_RTN	5V return user supply for the digital encoder and Hall sensor
21	Shield	Shield
22	$_MTMP	Motor temperature sensor input
23	V_RTN_IO	A return for the motor temperature sensor
24	V_RTN_SFTY	A return for the limits input
25	5F	5V user supply for the analog encoder and Hall sensor
26	5F_RTN	5V return user supply for the analog encoder and Hall sensor

2.5.1.3 J10 - Digital and Analog I/O Connector

Label: J10 - DIGITAL & ANALOG I/O

Connector Type: D-type 44-pin HD male

Mating Type: D-type 44-pin HD female (for easy prototyping a Phoenix FLKM HDSUB-44/M Sub-D to Screw Terminal converter can be used)

The connector serves for controlling Digital and Analog I/O signal formats. The pinout for J10 is given in **Table 43**.

Table 43 J10 - Digital and Analog I/O Pinout (page 1 of 2)

Pin #	Signal Designator	Description
1	OUT1	Digital Output 1
2	OUT3	Digital Output 3
3	OUT5	Digital Output 5
4	OUT7	Digital Output 7
5	IN1	Digital Input 1
6	IN3	Digital Input 3
7	AGND	Analog ground
8	AIN10-	Analog input inverted (Not Applicable)
9	AIN11-	Analog input inverted (Not Applicable)
10	AIN14-	Analog input inverted (Not Applicable)
11	AIN15-	Analog input inverted (Not Applicable)
12	AOUT_CS- (AOUT10)	Analog output CS inverted (Not Applicable)

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Table 43 J10 - Digital and Analog I/O Pinout (page 2 of 2)

Pin #	Signal Designator	Description
13	AOUT_CC- (AOUT11)	Analog output CC inverted (Not Applicable)
14	AOUT_DS- (AOUT14)	Analog output DC inverted (Not Applicable)
15	AOUT_DC- (AOUT15)	Analog output DS inverted (Not Applicable)
16	OUT0	Digital Output 0
17	OUT2	Digital Output 2
18	OUT4	Digital Output 4
19	OUT6	Digital Output 6
20	IN0	Digital Input 0
21	IN2	Digital Input 2
22	-	Not connected
23	AIN10+	Analog input non-inverted (Not Applicable)
24	AIN11+	Analog input non-inverted (Not Applicable)
25	AIN14+	Analog input non-inverted (Not Applicable)
26	AIN15+	Analog input non-inverted (Not Applicable)
27	AOUT_6	Analog output CS non-inverted (Not Applicable)
28	AOUT_CC+ (AOUT11)	Analog output CC non-inverted (Not Applicable)
29	AOUT_2	Analog output DC non-inverted
30	AOUT_DC+ (AOUT15)	Analog output DC non-inverted (Not Applicable)
31	V_SUP_IO	Input/Output Supply+
32	V_RTN_IO	Input/Output Supply Return
33	IN4	Digital Input 4
34	IN5	Digital Input 5
35	IN6	Digital Input 6
36	IN7	Digital Input 7
37	AGND	Analog ground
38	AGND	Analog ground
39	-	Not connected
40	-	Not connected
41	-	Not connected
42	-	Not connected
43	-	Not connected
44	-	Not connected

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2.5.1.4 J20 - Safety & Fast I/O Inputs Connector

Label: J20 - SAFETY & FAST I/O

Connector Type: D-type 25-pin male

Mating Type: D-type 25-pin female (for easy prototyping a Phoenix FLKM HDSUB-25/M Sub-D to Screw Terminal converter can be used)

The connectory serves for controlling Safety and Fast I/O input signals. The pinout for J20 is given in **Table 44**.

Table 44 J20 - Safety and Fast I/O Pinout

Pin	Signal Designator	Description
1	V_SUP_SFTY	Safety Supply +
2	-	Not Connected
3	X_LL	X Left Limit
4	A_LL	A Left Limit
5	Y_LL	Y Left Limit
6	B_LL	B Left Limit
7	DGND	Digital ground
8	Y_MARK1+	Non-inverted MARK1 for Y axis
9	X_MARK1+	Non-inverted MARK1 for X axis
10	Y_PEG+	Non-inverted PEG for Y axis
11	X_PEG+	Non-inverted PEG for X axis
12	-	Not Connected
13	-	Not Connected
14	V_RTN_SFTY	Safety Supply Return
15	-	Not Connected
16	X_RL	X Right Limit
17	A_RL	A Right Limit
18	Y_RL	Y Right Limit
19	B_RL	B Right Limit
20	Y_MARK1-	Inverted MARK1 for Y axis
21	X_MARK1-	Inverted MARK1 for X axis
22	Y_PEG-	Inverted PEG for Y axis
23	X_PEG-	Inverted PEG for X axis
24	ES+	Non-inverted Emergency Stop
25	ES-	Inverted Emergency Stop

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2.5.1.5 J3, J4 - Drive Motor Connectors

Label: J3_A MOTOR
J4_X MOTOR

Connector Type: Phoenix PCV 4/4-G-7,62-BK

Mating Type: Phoenix PC 4/ 4-STF-7,62

They serve for connecting the A axis drive motor and the X axis drive motor, respectively, to the controller. The pinout of the connectors is given in **Table 45**.

Note	
	*The dollar sign ($) stands for the given axis, for example, $_R can be A_R, or X_R, etc.*

Table 45 J3 and J4 - Drive Motor Pinout

Pin #	ACSPL+ Signal Designator	Description
1	EGND	Shield
2	$_R	Motor R phase
3	$_S	Motor S phase
4	$_T	Motor T phase

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The diagrams in **Figure 11**illustrate how motors are to be connected.

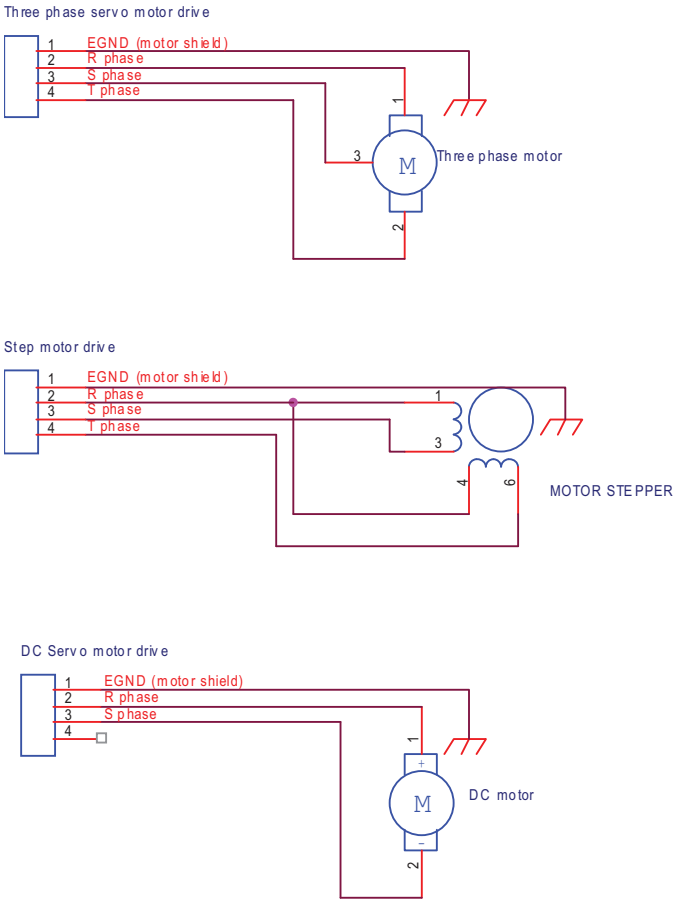


Figure 11 MB5U-Z Motor Drive Connections

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2.5.1.6 J6 and J7 - Ethernet Connectors

Label: J6 - ETH1
J7 - ETH2

Connector Type: RJ45 8-pin socet

Mating Type: RJ45 8-pin plug

The J6/J7 pinout is given in **Table 46**.

Table 46 J6 and J7 - Ethernet Pinout

Pin #	ACSPL+ Signal Designator	Description
1	ETH$_TX+	Positive transmit signal
2	ETH$_TX -	Negative transmit signal
3	ETH$_RX +	Positive receive signal
4	-	Not connected
5	-	Not connected
6	ETH$_RX -	Negative receive signal
7	-	Not connected
8	-	Not connected

2.5.1.7 J8 - HSSI Connector

Label: J8 - HSSI0

Connector Type: RJ45 8-pin socket.

Mating Type: RJ45 8-pin plug

The pinout of J8 is given in **Table 47**.

Table 47 J8 - HSSI Pinout

Pin #	Signal Designator	Description
1	CONTROL_$+	Control signal non-inverted output for channel 0
2	CONTROL_$-	Control signal inverted output for channel 0
3	SER_DI_$+	Serial data non-inverted input for channel 0
4	SER_DI_$-	Serial data inverted input for channel 0
5	SER_DO_$+	Serial data non-inverted output for channel 0
6	SER_DO_$-	Serial data inverted output for channel 0
7	DGND	Digital ground for 5L
8	DGND	Digital ground for 5L

2.5.1.8 J19 - RS-232 Communication Connector

Label: J19 - COM1

Connector Type: D-type 9-pin male

Mating type: D-type 9-pin female

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The pinout of J19 is given in **Table 48**.

Table 48 J19 - RS-232 Communicationi Pinout

Pin #	Signal Designator	Description
1	SHIELD	Cable shield connection
2	RX232	RS-232 receive signal for the communication port (COM1)
3	TX232	RS-232 transmit signal for communication port (COM1).
4	-	Not connected
5	DGND	Digital ground.
6	-	Not connected
7	-	Not connected
8	-	Not connected
9	-	Not connected

2.5.1.9 J13 - Y and B External Drive Control Signals Connector

Label: J13 EXTERNAL DRIVE

Connector Type: D-type HD 15-pin female

Mating Type: D-type HD 15-pin male

J13 serves for connecting an external drive.

Note	
	*It is possible to use external drives and control two additional axes, designated Y and B, through J13. In this case, the interface to both drives is through J13; however, for encoder feedback you have to use connectors J14 (for the Y axis) and J16 (for the B axis).*

The pinout of J13 is given in **Table 49**.

Table 49 J13 - External Drive Control Signals Pinout (page 1 of 2)

Pin #	Signal Designator	Description
1	Y_CMD0+	Y Drive Command 0+
2	Y_CMD0-	Y Drive Command 0-
3	Y_CMD1+	Y Drive Command 1+
4	Y_CMD1-	Y Drive Command 1-
5	Y_ENA	Y axis enable signal
6	B_CMD0+	B Drive Command 0+
7	B_CMD0-	B Drive Command 0-
8	B_CMD1+	B Drive Command 1+
9	B_CMD1-	B Drive Command 1-
10	Y_FLT	Y axis fault signal

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Table 49 J13 - External Drive Control Signals Pinout (page 2 of 2)

Pin #	Signal Designator	Description
11	AGND	Analog Ground
12	DGND	Digital Ground
13	5U	5V user supply for digital encoder and Hall sensor
14	B_ENA	B axis enable signal
15	B_FLT	B axis fault signal

2.5.1.10 J11 - External Regeneration

Label: J11 - EXTERNAL REGENERATION

Connector Type: Phoenix PCV 5/ 2-GF-7,62

Mating Type: Phoenix PC 5/ 2-STF-7,62

The pinout for J11 is given in **Table 50**.

Table 50 J11 - External Regeneration Pinout

Pin	Signal Designator	Description
1	REG1	External Regeneration resistor terminal 1
2	REG2	External Regeneration resistor terminal 2

2.5.1.11 J12 - Drive Supply Connector

Label: J12 - DRIVE SUPPLY

Connector Type: Phoenix PCV 5/ 5-GF-7,62

Mating Type: Phoenix PC 5/ 5-STF-7,62

AC power is provided through J12. The pinout is given in **Table 51**.

Table 51 J12 - Drive Supply Pinout

Pin #	Signal Designator	Description
1	L1	AC input phase L1
2	L2	AC input phase L2 (Neutral when using a single-phase motor)
3	L3	AC input phase L3
4	-	Not Connected
5	EGND	Earth Ground (shield)

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2.5.1.12 J5 - 24V Logic Supply Connector

Label: J5 - 24V LOGIC SUPPLY

Connector Type: Phoenix MCV-1.5/5 GF 3.81 connector

Mating Type: Phoenix MC-1.5/5 STF- 3.81

24Vdc is provided through J5. The pinout of J5 is given in **Table 52**.

Table 52 J5 - 24V Logic Supply Pinout

Pin #	Signal Designator	Description
1	24V_SUP	24V logic supply
2	24V_RTN	24V logic supply return
3	5V_ENC_EXT	External 5V supply for encoder
4	5V_ENC_EXT_RTN	External 5V supply return for encoder
5	EGND	Earth Ground (shield)

2.5.1.13 MB5U-Z Jumper Configuration

This section details the setup of the MB5U-Z motherboard jumper configuration.

Warning	
	***Only a qualified technician should make any changes to the factory settings of the jumpers. Remove the back cover of the unit to access the jumpers.***

Note	
	*In the tables that follow "X" means "don't care".*

Table 53 I/O Jumpers

Setup	JP1	JP3	JP5	JP7
I/O supply external	X	Remove	Remove	X
I/O supply internal 5V	X	1-2	1-2	X
I/O supply internal 24V	X	2-3	2-3	X
Safety supply external	Remove	X	X	Remove
Safety supply internal 5V	1-2	X	X	1-2
Safety supply internal 24V	2-3	X	X	2-3

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Note	
	*When using the 5V internal supply for digital I/O or Safety, these I/Os are not isolated.*

Table 54 Encoder Supply

Setup	JP9	JP10	JP11	JP12	JP21
Analog encoder external supply	1-2	X	1-2	X	1-2
Analog encoder internal supply	2-3	X	2-3	X	Open
Digital encoder external supply	X	1-2	X	1-2	2-3
Digital encoder internal supply	X	2-3	X	2-3	Open

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2.5.2 MB5U-ZZ Motherboard

The MB5U-ZZ motherboard is installed in the 11” MC4U.

The connectors associated with the MB5U-ZZ motherboard are shown in **Figure 12**.



Figure 12 MB5U-ZZ Connectors

2.5.2.1 MB5U-ZZ Functionality

The MB5U-ZZ accomodates the SPiiPlus 3U-LT/HP motion controller, two DDM3U-2-320V-XX drives and one PSM3U-XX-XX power supply. It supports the following functionality:

- 4 x Digital encoders
- 4 x SIN-COS encoders (optional)
- 4 x Hall effect sensors
- 4 x Motor Temperature sensors
- 8 x Safety inputs
- 1 x E-stop
- 8 x Digital outputs/Mechanical brakes
- 8 x Digital inputs
- 2 x MARK signals
- 2 x PEG signals
- 4 x Motor output signals
- 2 x Ethernet channels
- 2 x HSSI channel
- 1 x RS-232 channel

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2.5.2.2 Encoder and Hall Connectors

Label: J14-Y ENC
J15-X ENC
J16-B ENC
J17-A ENC

Connector Type: D-type 26-pin HD female

Mating Type: D-type 26-pin HD male (for easy prototyping a Phoenix FLKM HDSUB-26/M Sub-D to Screw Terminal converter can be used)

The connectors are allocated as follows:

Connector	Axis	Connector	Axis
J15 - X ENC	X	J17 - A ENC	A
J14 - Y ENC	Y	J16 - B ENC	B

The pinout for the Encoder/Hall Connectors is given in **Table 55**.

Note	
	*The dollar sign ($) stands for the given axis, for example, $_LL can be X_LL, or Y_LL, etc.*

Table 55 Encoder/Hall Pinout (page 1 of 2)

Pin	Signal Designator	Description
1	$_CHA-	Encoder A inverted input
2	$_CHB-	Encoder B inverted input
3	$_CHI-	Encoder index inverted input
4	$_HB	Motor Hall B
5	V_SUP_SFTY	Supply for the limits input
6	$_RL	Right limit
7	$_SIN-	Encoder SIN inverted input
8	$_COS-	Encoder COS inverted input
9	$_SC_I-	Encoder SIN-COS Index inverted input
10	$_CHA+	Encoder A non-inverted input
11	$_CHB+	Encoder B non-inverted input
12	$_CHI+	Encoder Index non-inverted input
13	$_HA	Motor Hall A
14	$_HC	Motor Hall C
15	$_LL	Left limit
16	$_SIN+	SIN non-inverted input
17	$_COS+	Encoder COS non-inverted input

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Table 55 Encoder/Hall Pinout (page 2 of 2)

Pin	Signal Designator	Description
18	$_SC_I+	Encoder SIN-COS Index non-inverted input
19	5U	5V user supply for the digital encoder and Hall
20	5U_RTN	5V return user supply for the digital encoder and Hall
21	Shield	Shield
22	$_MTMP	Motor temperature sensor input
23	V_RTN_IO	A return for the Motor temperature sensor
24	V_RTN_SFTY	A return for the limits input
25	5F	5V user supply for the analog encoder and Hall
26	5F_RTN	5V return user supply for the analog encoder and Hall

2.5.2.3 J10 - Digital and Analog I/O Connector

Label: J10 - DIGITAL & ANALOG I/O

Connector Type: D-type 44-pin HD male

Mating Type: D-type 44-pin HD female (for easy prototyping a Phoenix FLKM HDSUB-44/M Sub-D to Screw Terminal converter can be used)

J10 serves for controlling Digital and Analog I/O signal formats. The pinout for J10 is given in **Table 56**.

Table 56 J10 - Digital and Analog I/O Pinout (page 1 of 2)

Pin #	Signal Designator	Description
1	OUT1 (BRAKE_Y)	Digital Output 1 (Mechanical Brake for Y axis)
2	OUT3 (BRAKE_T)	Digital Output 3 (Mechanical Brake for T axis)
3	OUT5 (BRAKE_B)	Digital Output 5 (Mechanical Brake for B axis)
4	OUT7 (BRAKE_D)	Digital Output 7 (Mechanical Brake for D axis)
5	IN1	Digital Input 1
6	IN3	Digital Input 3
7	AGND	Analog ground
8	AIN10-	Analog input inverted (Not Applicable)
9	AIN11-	Analog input inverted (Not Applicable)
10	AIN14-	Analog input inverted (Not Applicable)
11	AIN15-	Analog input inverted (Not Applicable)
12	AOUT_CS- (AOUT10)	Analog output CS inverted (Not Applicable)

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Table 56 J10 - Digital and Analog I/O Pinout (page 2 of 2)

Pin #	Signal Designator	Description
13	AOUT_CC- (AOUT11)	Analog output CC inverted (Not Applicable)
14	AOUT_DS- (AOUT14)	Analog output DC inverted (Not Applicable)
15	AOUT_DC- (AOUT15)	Analog output DS inverted (Not Applicable)
16	OUT0 (BRAKE_X)	Digital Output 0 (Mechanical Brake for X axis)
17	OUT2 (BRAKE_Z)	Digital Output 2 (Mechanical Brake for Z axis)
18	OUT4 (BRAKE_A)	Digital Output 4 (Mechanical Brake for A axis)
19	OUT6 (BRAKE_C)	Digital Output 6 (Mechanical Brake for C axis)
20	IN0	Digital Input 0
21	IN2	Digital Input 2
22	-	Not connected
23	AIN10+	Analog input non-inverted (Not Applicable)
24	AIN11+	Analog input non-inverted (Not Applicable)
25	AIN14+	Analog input non-inverted (Not Applicable)
26	AIN15+	Analog input non-inverted (Not Applicable)
27	AOUT_6	Analog output CS non-inverted
28	AOUT_CC+ (AOUT11)	Analog output CC non-inverted (Not Applicable)
29	AOUT_2	Analog output DC non-inverted
30	AOUT_DC+ (AOUT15)	Analog output DC non-inverted (Not Applicable)
31	V_SUP_IO	Input/Output Supply+
32	V_RTN_IO	Input/Output Supply Return
33	IN4	Digital Input 4
34	IN5	Digital Input 5
35	IN6	Digital Input 6
36	IN7	Digital Input 7
37	AGND	Analog ground
38	AGND	Analog ground
39	-	Not connected
40	-	Not connected
41	-	Not connected
42	-	Not connected
43	-	Not connected
44	-	Not connected

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2.5.2.4 J20 - Safety & Fast I/O Inputs Connector

Label: J20 - SAFETY & FAST I/O

Connector Type: D-type 25-pin male

Mating Type: D-type 25-pin female (for easy prototyping a Phoenix FLKM HDSUB-25/M Sub-D to Screw Terminal converter can be used)

J20 serves for controlling Safety and Fast I/O input signals. The pinout for J20 is given in **Table 57**.

Table 57 J20 - Safety and Fast I/O Inputs Pinout

Pin	Signal Designator	Description
1	V_SUP_SFTY	Safety Supply +
2	-	Not Connected
3	X_LL	X Left Limit
4	A_LL	A Left Limit
5	Y_LL	Y Left Limit
6	B_LL	B Left Limit
7	DGND	Digital ground
8	Y_MARK1+	Non-inverted MARK1 for Y axis
9	X_MARK1+	Non-inverted MARK1 for X axis
10	Y_PEG+	Non-inverted PEG for Y axis
11	X_PEG+	Non-inverted PEG for X axis
12	-	Not Connected
13	-	Not Connected
14	V_RTN_SFTY	Safety Supply Return
15	-	Not Connected
16	X_RL	X Right Limit
17	A_RL	A Right Limit
18	Y_RL	Y Right Limit
19	B_RL	B Right Limit
20	Y_MARK1-	Inverted MARK1 for Y axis
21	X_MARK1-	Inverted MARK1 for X axis
22	Y_PEG-	Inverted PEG for Y axis
23	X_PEG-	Inverted PEG for X axis
24	ES+	Non-inverted Emergency Stop
25	ES-	Inverted Emergency Stop

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2.5.2.5 J1, J2, J3, J4 - Drive Motor Connectors

Label: J1_B MOTOR
J2_A MOTOR
J3_Y MOTOR
J4_X MOTOR

Connector Type: Phoenix PCV 4/4-G-7,62-BK

Mating Type: Phoenix PC 4/ 4-STF-7,62

They serve for connecting the B axis drive motor, A axis drive motor, Y axis drive motor, and the X axis drive motor, respectively, to the controller. The pinout of the connectors is given in **Table 58**.

Note	
	*The dollar sign ($) stands for the given axis, for example, $_R can be A_R, X_R, etc.*

Table 58 J1, J2, J3 and J4 - Drive Motor Pinout

Pin #	ACSPL+ Signal Designator	Description
1	EGND	Shield
2	$_R	Motor R phase
3	$_S	Motor S phase
4	$_T	Motor T phase

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The diagrams in **Figure 13**illustrate how motors are to be connected.

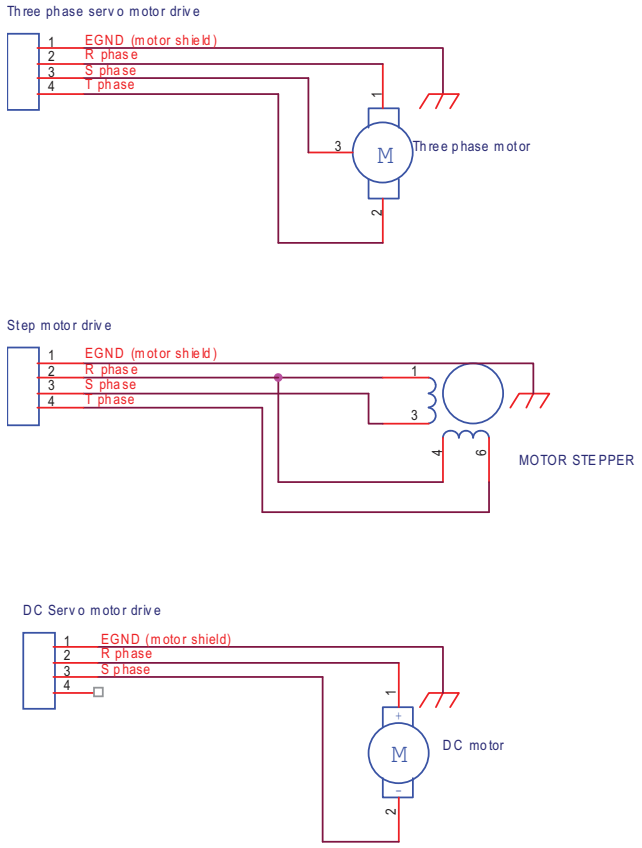


Figure 13 MB5U-ZZ Motor Drive Connections

2.5.2.6 J6 and J7 - Ethernet Connectors

Label: J6 - ETH1
J7 - ETH2

Connector Type: RJ45 8-pin socket

Mating Type: RJ45 8-pin plug

The pinout of the sockets is given in **Table 59**.

Table 59 J6 and J7 Pinout (page 1 of 2)

Pin #	ACSPL+ Signal Designator	Description
1	ETH$_TX+	Positive transmit signal
2	ETH$_TX -	Negative transmit signal
3	ETH$_RX +	Positive receive signal
4	-	Not connected
5	-	Not connected
6	ETH$_RX -	Negative receive signal

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Table 59 J6 and J7 Pinout (page 2 of 2)

Pin #	ACSPL+ Signal Designator	Description
7	-	Not connected
8	-	Not connected

2.5.2.7 J8 and J9 - HSSI Connectors

Label: J8 - HSSI0 (X & A axes)
J9 - HSSI1 (Y & Baxes)

Connector Type: RJ45 8-pin sockets

Mating Type: RJ45 8-pin plug

The pinout of the sockets is given in **Table 60**.

Table 60 J8 and J9 - HSSI Pinout

Pin #	Signal Designator	Description
1	CONTROL_$+	Control signal non-inverted output for channel 0
2	CONTROL_$-	Control signal inverted output for channel 0
3	SER_DI_$+	Serial data non-inverted input for channel 0
4	SER_DI_$-	Serial data inverted input for channel 0
5	SER_DO_$+	Serial data non-inverted output for channel 0
6	SER_DO_$-	Serial data inverted output for channel 0
7	DGND	Digital ground for 5L
8	DGND	Digital ground for 5L

2.5.2.8 J19 - RS-232 Communication Connector

Label: J19 - COM1

Connector Type: D-type 9-pin male

Mating type: D-type 9-pin female

The pinout for the J19 is given in **Table 61**.

Table 61 J19 - RS-232 Communication Pinout (page 1 of 2)

Pin #	Signal Designator	Description
1	SHIELD	Cable shield connection
2	RX232	RS-232 receive signal for the communication port (COM1)
3	TX232	RS-232 transmit signal for communication port (COM1).
4	-	Not connected
5	DGND	Digital ground.
6	-	Not connected
7	-	Not connected

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Table 61 J19 - RS-232 Communication Pinout (page 2 of 2)

Pin #	Signal Designator	Description
8	-	Not connected
9	-	Not connected

2.5.2.9 J11 - External Regeneration

Label: J11 - EXTERNAL REGENERATION

Connector Type: Phoenix PCV 5/ 2-GF-7,62

Mating type: Phoenix PC 5/ 2-STF-7,62

The pinout for J11 is given in **Table 62**.

Table 62 J11 - External Regeneration Pinout

Pin	Signal Designator	Description
1	REG1	External Regeneration resistor terminal 1
2	REG2	External Regeneration resistor terminal 2

2.5.2.10 J12 - Drive Supply Connector

Label: J12 - DRIVE SUPPLY

Connector Type: Phoenix PCV 5/ 5-GF-7,62

Mating Type: Phoenix PC 5/ 5-STF-7,62

AC power is provided through J12. The pinout is given in **Table 63**.

Table 63 J12 - Drive Supply Pinout

Pin #	Signal Designator	Description
1	L1	AC input phase L1
2	L2	AC input phase L2 (Neutral when using a single-phase motor)
3	L3	AC input phase L3
4	-	Not Connected
5	EGND	Earth Ground (shield)

2.5.2.11 J5 - 24V Logic Supply Connector

Label: J5 - LOGIC SUPPLY

Connector Type: Phoenix MCV-1.5/5 GF 3.81

Mating Type: Phoenix MC-1.5/5 STF- 3.81

24Vdc is supplied through J5. The pinout for J5 is given in **Table 64**

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Table 64 J5 - 24V Logic Supply Pinout

Pin #	Signal Designator	Description
1	24V_SUP	24V logic supply
2	24V_RTN	24V logic supply return
3	5V_ENC_EXT	External 5V supply for encoder
4	5V_ENC_EXT_RTN	External 5V supply return for encoder
5	EGND	Earth Ground (shield)

2.5.2.12 MB5U-ZZ Jumper Configuration

This section details the setup of the MB5U-ZZ motherboard jumper configuration.

Warning



Only a qualified technician should make any changes to the factory settings of the jumpers. Remove the back cover of the unit to access the jumpers.

Note



In the tables that follow "X" means "don't care".

Table 65 I/O Jumpers

Setup	JP1	JP3	JP5	JP7
I/O supply external	X	Remove	Remove	X
I/O supply internal 5V	X	1-2	1-2	X
I/O supply internal 24V	X	2-3	2-3	X
Safety supply external	Remove	X	X	Remove
Safety supply internal 5V	1-2	X	X	1-2
Safety supply internal 24V	2-3	X	X	2-3

Note



When using the 5V internal supply for digital I/O or Safety, these I/Os are not isolated.

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Table 66 Encoder Supply

Setup	JP9	JP10	JP11	JP12	JP21
Analog encoder external supply	1-2	X	1-2	X	1-2
Analog encoder internal supply	2-3	X	2-3	X	Open
Digital encoder external supply	X	1-2	X	1-2	2-3
Digital encoder internal supply	X	2-3	X	2-3	Open

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2.5.3 MB5U-CON-PS Motherboard

The MB5U-CON-PS is installed in the 19” MC4U.

The connectors associated with the MB5U-CON-PS motherboard are shown in **Figure 14**.

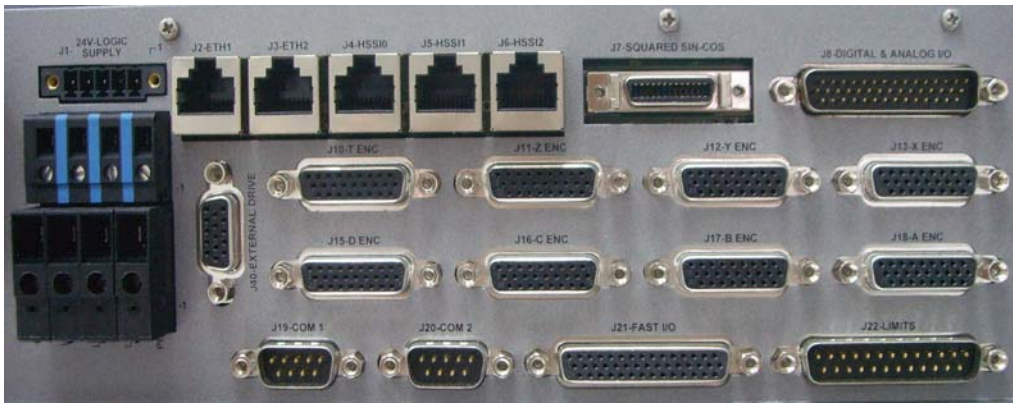


Figure 14 MB5U-CON-PS Connectors

2.5.3.1 MB5U-CON-PS Functionality

The MB5U-CON-PS accommodates the motion controller and the power supplies. It supports the following functionality:

- 8 x Digital encoders
- 8 x SIN-COS encoders (optional)
- 8 x Hall effect sensors
- 8 x Motor Temperature sensors
- 16 x Safety inputs
- 1 x E-stop
- 8 x Squared SIN-COS
- 8 x Digital outputs/Mechanical brakes
- 8 x Digital inputs
- 4 x Analog I/O
- 5 x MARK signals
- 4 x PEG signals, plus 3 x STATE signals
- 2 x Ethernet channels
- 3 x HSSI channel
- 2 x RS-232 channels

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2.5.3.2 Encoder and Hall Connectors

Label: J10-T ENC
J11-Z ENC
J12-Y ENC
J13-X ENC
J15-D ENC
J16-C ENC
J17-B ENC
J18-A ENC

Connector Type: D-type 26-pin HD female

Mating Type: D-type 26-pin HD male (for easy prototyping a Phoenix FLKM HDSUB-26/M Sub-D to Screw Terminal converter can be used)

The connectors are allocated as follows:

Connector	Axis	Connector	Axis
J10 - T ENC	T	J15 - D ENC	D
J11 - Z ENC	Z	J16 - C ENC	C
J12 - Y ENC	Y	J17 - B ENC	B
J13 - X ENC	X	J18 - A ENC	A

The pinout for the Encoder/Hall Connectors is given in **Table 67**.

Note	
	*The dollar sign ($) stands for the given axis, for example, $_LL can be X_LL, Y_LL, etc.*

Table 67 Encoder/Hall Pinout (page 1 of 2)

Pin	ACSPL+ Signal Designator	Description
1	$_CHA-	Encoder A inverted input
2	$_CHB-	Encoder B inverted input
3	$_CHI-	Encoder index inverted input
4	$_HB	Motor Hall B
5	V_SUP_SFTY	Supply for the limits input
6	$_RL	Right limit
7	$_SIN-	Encoder SIN inverted input
8	$_COS-	Encoder COS inverted input
9	$_SC_I-	Encoder SIN-COS Index inverted input
10	$_CHA+	Encoder A non-inverted input
11	$_CHB+	Encoder B non-inverted input

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Table 67 Encoder/Hall Pinout (page 2 of 2)

Pin	ACSPL+ Signal Designator	Description
12	$_CHI+	Encoder Index non-inverted input
13	$_HA	Motor Hall A
14	$_HC	Motor Hall C
15	$_LL	Left limit
16	$_SIN+	SIN non-inverted input
17	$_COS+	Encoder COS non-inverted input
18	$_SC_I+	Encoder SIN-COS Index non-inverted input
19	5U	5V user supply for the digital encoder and Hall
20	5U_RTN	5V return user supply for the digital encoder and Hall
21	Shield	Shield
22	$_MTMP	Motor temperature sensor input
23	V_RTN_IO	A return for the Motor temperature sensor
24	V_RTN_SFTY	A return for the limits input
25	5F	5V user supply for the analog encoder and Hall
26	5F_RTN	5V return user supply for the analog encoder and Hall

2.5.3.3 J8 - Digital and Analog I/O Connector

Label: J8 - DIGITAL & ANALOG I/O

Connector Type: D-type 44-pin HD male

Mating Type: D-type 44 pin HD female (for easy prototyping a Phoenix FLKM HDSUB-44/M Sub-D to Screw Terminal converter can be used)

J8 serves for controlling Digital and Analog I/O signal formats. The pinout for J8 is given in **Table 68**.

Table 68 J8 - Digital and Analog I/O Pinout (page 1 of 3)

Pin #	ACSPL+ Signal Designator	Description
1	OUT1	Digital Output 1
2	OUT3	Digital Output 3
3	OUT5	Digital Output 5
4	OUT7	Digital Output 7
5	IN1	Digital Input 1
6	IN3	Digital Input 3
7	AGND	Analog ground
8	AIN10-	Analog input inverted
9	AIN11-	Analog input inverted
10	AIN14-	Analog input inverted
11	AIN15-	Analog input inverted

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Table 68 J8 - Digital and Analog I/O Pinout (page 2 of 3)

Pin #	ACSPL+ Signal Designator	Description
12	AOUT_CS-	Analog output CS inverted (Not used when MC4U is with SPiiPlus 3U-LT controller)
13	AOUT_CC-	Analog output CC inverted (Not used when MC4U is with SPiiPlus 3U-LT controller)
14	AOUT_DS-	Analog output DC inverted (Not used when MC4U is with SPiiPlus 3U-LT controller)
15	AOUT_DC-	Analog output DS inverted (Not used when MC4U is with SPiiPlus 3U-LT controller)
16	OUT0	Digital Output 0
17	OUT2	Digital Output 2
18	OUT4	Digital Output 4
19	OUT6	Digital Output 6
20	IN0	Digital Input 0
21	IN2	Digital Input 2
22	-	Not connected
23	AIN10+	Analog input non-inverted
24	AIN11+	Analog input non-inverted
25	AIN14+	Analog input non-inverted
26	AIN15+	Analog input non-inverted
27	AOUT_CS+ (AOUT6)	Analog output CS non-inverted (Signal desigator when MC4U is with SPiiPlus 3U-LT controller)
28	AOUT_CC+ (AOUT14)	Analog output CC non-inverted (Signal desigator when MC4U is with SPiiPlus 3U-LT controller)
29	AOUT_DS+ (AOUT2)	Analog output DC non-inverted (Signal desigator when MC4U is with SPiiPlus 3U-LT controller)
30	AOUT_DC+ (AOUT10)	Analog output DC non-inverted (Signal desigator when MC4U is with SPiiPlus 3U-LT controller)
31	V_SUP_IO	Input/Output Supply+
32	V_RTN_IO	Input/Output Supply Return
33	IN4	Digital Input 4
34	IN5	Digital Input 5
35	IN6	Digital Input 6
36	IN7	Digital Input 7
37	AGND	Analog ground
38	AGND	Analog ground
39	-	Not connected
40	-	Not connected
41	-	Not connected
42	+12V1	12V for joystick (optional, need 0Ω resistor) (Not Applicable)

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Table 68 J8 - Digital and Analog I/O Pinout (page 3 of 3)

Pin #	ACSPL+ Signal Designator	Description
43	12V1_RTN	+-12V return for joystick (optional, need 0Ω resistor) (Not Applicable)
44	-12V1	-12V for joystick (optional, need 0Ω resistor) (Not Applicable)

2.5.3.4 J9 - Regeneration Connector

Model	
	*J9 is relevant only if the* PSM3U-320V-XXkW *(high power supply) is being used.*

Label: J9 - REGENERATION

Connector Type: Phoenix FRONT 2,5-V/SA 10

Mating Type: None (screw terminal)

The pinout for J9 is provided in **Table 69**.

Table 69 J9 - Regeneration Pinout

Pin #	ACSPL+ Signal Designator	Description
1	REG1_1	Regeneration resistor for PS 1 (V1 on the motherboard)
2	REG1_2	Regeneration resistor for PS 1
3	REG2_1	Regeneration resistor for PS 2 (V2 on the motherboard)
4	REG2_2	Regeneration resistor for PS 2

2.5.3.5 J21 - Fast I/O (PEG and Mark) Connector

Label: J21 - FAST I/O

Connector Type: Phoenix MCV-1.5/5 GF 3.81

Mating Type: Phoenix MC-1.5/5 STF- 3.81

The pinout for J21 is given in **Table 70**.

Table 70 J21 - PEG and Mark Fast I/O Pinout (page 1 of 2)

Pin #	ACSPL+ Signal Designator	Description
1	Y_STATE2+	Reserved for future use.
2	Y_STATE1+	Reserved for future use.
3	Y_STATE0+	Reserved for future use.
4	X_STATE2+	State Digital output non-inverted
5	X_STATE1+	State Digital output non-inverted

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Table 70 J21 - PEG and Mark Fast I/O Pinout (page 2 of 2)

Pin #	ACSPL+ Signal Designator	Description
6	X_STATE0+	State Digital output non-inverted
7	-	Not connected
8	-	Not connected
9	DGND	Internal digital supply return
10	DGND	Internal digital supply return
11	T_PEG+	PEG Digital output non-inverted
12	Z_PEG+	PEG Digital output non-inverted
13	Y_PEG+	PEG Digital output non-inverted
14	X_PEG+	PEG Digital output non-inverted
15	T_MARK2+	Reserved for future use.
16	Y_STATE2-	Reserved for future use.
17	Y_STATE1-	Reserved for future use.
18	Y_STATE0-	Reserved for future use.
19	X_STATE2-	State Digital output inverted
20	X_STATE1-	State Digital output inverted
21	X_STATE0-	State Digital output inverted
22	-	Not connected
23	-	Not connected
24	-	Not connected
25	-	Not connected
26	T_PEG-	PEG Digital output inverted
27	Z_PEG-	PEG Digital output inverted
28	Y_PEG-	PEG Digital output inverted
29	X_PEG-	PEG Digital output inverted
30	T_MARK2-	Reserved for future use.
31	X_MARK1+	Mark Digital input non-inverted
32	X_MARK1-	Mark Digital input inverted
33	X_MARK2+	Mark Digital input non-inverted
34	X_MARK2-	Mark Digital input inverted
35	Y_MARK1+	Mark Digital input non-inverted
36	Y_MARK1-	Mark Digital input inverted
37	Y_MARK2+	Reserved for future use.
38	Y_MARK2-	Reserved for future use.
39	Z_MARK1+	Mark Digital input non-inverted
40	Z_MARK1-	Mark Digital input inverted
41	Z_MARK2+	Reserved for future use.
42	Z_MARK2-	Reserved for future use.
43	T_MARK1+	Mark Digital input non-inverted
44	T_MARK1-	Mark Digital input inverted

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2.5.3.6 J22 - Motor Limits Connector

Label: J22 - LIMITS

Connector Type: D-type 25-pin male

Mating Type: D-type 25-pin female (for easy prototyping a Phoenix FLKM HDSUB-25/M Sub-D to Screw Terminal converter can be used)

The pinout for J22 is given in **Table 71**.

Table 71 J22 - Motor Limits Pinout

Pin #	ACSPL+ Signal Designator	Description
1	V_SUP_SFTY	Safety Supply +
2	-	Not connected
3	X_LL	X Left Limit
4	A_LL	A Left Limit
5	Y_LL	Y Left Limit
6	B_LL	B Left Limit
7	Z_LL	Z Left Limit
8	C_LL	C Left Limit
9	T_LL	T Left Limit
10	D_LL	D Left Limit
11	-	Not connected
12	-	Not connected
13	-	Not connected
14	V_RTN_SFTY	Safety Supply Return
15	-	Not connected
16	X_RL	X Right Limit
17	A_RL	A Right Limit
18	Y_RL	Y Right Limit
19	B_RL	B Right Limit
20	Z_RL	Z Right Limit
21	C_RL	C Right Limit
22	T_RL	T Right Limit
23	D_RL	D Right Limit
24	ES+	Emergency stop non-inverted
25	ES-	Emergency stop inverted

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2.5.3.7 J4, J5, and J6 - HSSI Connectors

Label: J4 - HSSI0 (X & A axes)
J5 - HSSI1 (Y & B axes)
J6 - HSSI2 (Z & C axes)

Connector Type: RJ45 8-pin sockets

Mating Type: RJ45 8-pin plug

The pinout of the sockets is given in **Table 72**.

Table 72 J4, J5, and J6 - HSSI Pinout

Pin #	ACSPL+ Signal Designator	Description
1	CONTROL_$+	Control signal non-inverted output for channel 0
2	CONTROL_$-	Control signal inverted output for channel 0
3	SER_DI_$+	Serial data non-inverted input for channel 0
4	SER_DI_$-	Serial data inverted input for channel 0
5	SER_DO_$+	Serial data non-inverted output for channel 0
6	SER_DO_$-	Serial data inverted output for channel 0
7	DGND	Digital ground for 5L
8	DGND	Digital ground for 5L

2.5.3.8 J2 and J3 - Ethernet Connectors

Label: J2 - ETH1
J3 - ETH2

Connector Type: RJ45 8-pin socket

Mating Type: RJ45 8-pin plug

The pinout of the sockets is given in **Table 73**.

Table 73 J2 and J3 - Ethernet Pinout

Pin #	ACSPL+ Signal Designator	Description
1	ETH$_TX+	Positive transmit signal
2	ETH$_TX -	Negative transmit signal
3	ETH$_RX +	Positive receive signal
4	-	Not connected
5	-	Not connected
6	ETH$_RX -	Negative receive signal
7	-	Not connected
8	-	Not connected

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2.5.3.9 J19 and J20 RS-232 Communication Connectors

Label: J19 - COM1
J20 - COM2

Connector Type: D-type 9-pin male sockets

Mating type: D-type 9-pin female

The pinout for the sockets is given in **Table 74**.

Table 74 J19 and J20 - RS-232 Communication Pinout

Pin #	ACSPL+ Signal Designator	Description
1	SHIELD	Cable shield connection
2	RX232	RS-232 receive signal for the communication port (J19 for COM1, and J20 for COM2)
3	TX232	RS-232 transmit signal for communication port (J19 for COM1, and J20 for COM2).
4	-	Not connected
5	DGND	Digital ground.
6	-	Not connected
7	-	Not connected
8	-	Not connected
9	-	Not connected

2.5.3.10 J14 - Drive Supply Voltage Connector

Label: J14 - DRIVE SUPPLY

Connector Type: Phoenix FRONT 4V-7,62

Mating Type: None (screw terminal)

AC power is provided through J14. The pinout for J14 is provided in **Table 75**.

Table 75 J14 - Drive Supply Voltage Pinout

Pin #	ACSPL+ Signal Designator	Description	Remarks
1	EGND	Earth Ground (shield)	
2	L3	AC input phase L3	
3	L2	AC input phase L2	When using AC single-phase, the voltage has to be connected between L1 and L2.
4	L1	AC input phase L1	

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2.5.3.11 J1 - 24V Logic Supply Connector

Label: J1 - 24V LOGIC SUPPLY

Connector Type: Phoenix MCV-1.5/5 GF 3.81

Mating Type: Phoenix MC-1.5/5 STF- 3.81

24Vdc is provided through J1. The J1 pinout is provided in **Table 76**.

Table 76 J1 - 24V Logic Supply Pinout

Pin #	ACSPL+ Signal Designator	Description
1	24V_SUP	24V logic supply
2	24V_RTN	24V logic supply return
3	5V_ENC_EXT	External 5V supply for encoder
4	5V_ENC_EXT_RTN	External 5V supply return for encoder
5	EGND	Electrical Ground

2.5.3.12 MB5U-CON-PS Jumper Configuration

This section details the setup of the MB5U-CON-PS jumper configuration.

Warning	
	***Only a qualified technician should make any changes to the factory settings of the jumpers. Remove the back cover of the unit to access the jumpers.***

Note	
	*In the tables that follow "X" means "don't care".*

Table 77 I/O Jumpers

Setup	JP1	JP3	JP5	JP7
I/O supply external	X	Remove	Remove	X
I/O supply internal 5V	X	1-2	1-2	X
I/O supply internal 24V	X	2-3	2-3	X
Safety supply external	Remove	X	X	Remove
Safety supply internal 5V	1-2	X	X	1-2
Safety supply internal 24V	2-3	X	X	2-3

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Note



When using the 5V internal supply for digital I/O or Safety, these I/Os are not isolated.

Table 78 Encoder Supply

Setup	JP9	JP10	JP11	JP12	JP21
Analog encoder external supply	1-2	X	1-2	X	1-2
Analog encoder internal supply	2-3	X	2-3	X	Open
Digital encoder external supply	X	1-2	X	1-2	2-3
Digital encoder internal supply	X	2-3	X	2-3	Open

Table 79 I^2C Address

Setup	JP15	JP16	JP18	JP19
Address 5, 6 for power supplies	Open	Install	Install	Open

Note



The general purpose analog inputs are shared with the IS current feedback; therefore the jumpers must be set as given in the table below.

Table 80 General Purpose Analog Input Jumpers

Setup	JP22, JP28	JP23, JP29	JP24, JP25	JP26, JP27
When Z axis integrated drive is used, there is no AIN10 support	Remove	X	X	X
When C axis integrated drive is used, there is no AIN11 support	X	Remove	X	X
When T axis integrated drive is used, there is no AIN14 support	X	X	Remove	X
When D axis integrated drive is used, there is no AIN15 support	X	X	X	Remove

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2.5.4 MB5U-2 Motherboard

The MB5U-2 is installed in the 19" MC4U. It accommodates a DDM3U-2-320V-YY dual axis drive and includes a connector for two motors.

The connectors associated with the MB5U-2 motherboard are shown in **Figure 15**.

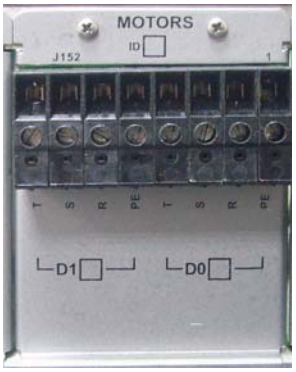


Figure 15 MB5U-2 Connectors

2.5.4.1 J152 - Servo Motor Drive

Label: J152

Connector Type: Phoenix FRONT 4V-7,62 connector.

Mating Type: None (terminal screw)

The pinout for J152 is given in **Table 81**.

Table 81 J152 - Servo Motor Drive Pinout

Pin #	ACSPL+ Signal Designator	Description
1	EGND	Electrical Ground
2	R_0	Motor 0 R phase
3	S_0	Motor 0 S phase
4	T_0	Motor 0 T phase
5	EGND	Electrical Ground
6	R_1	Motor 1 R phase
7	S_1	Motor 1 S phase
8	T_1	Motor 1 T phase

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The diagrams in **Figure 16**illustrate how motors are to be connected.

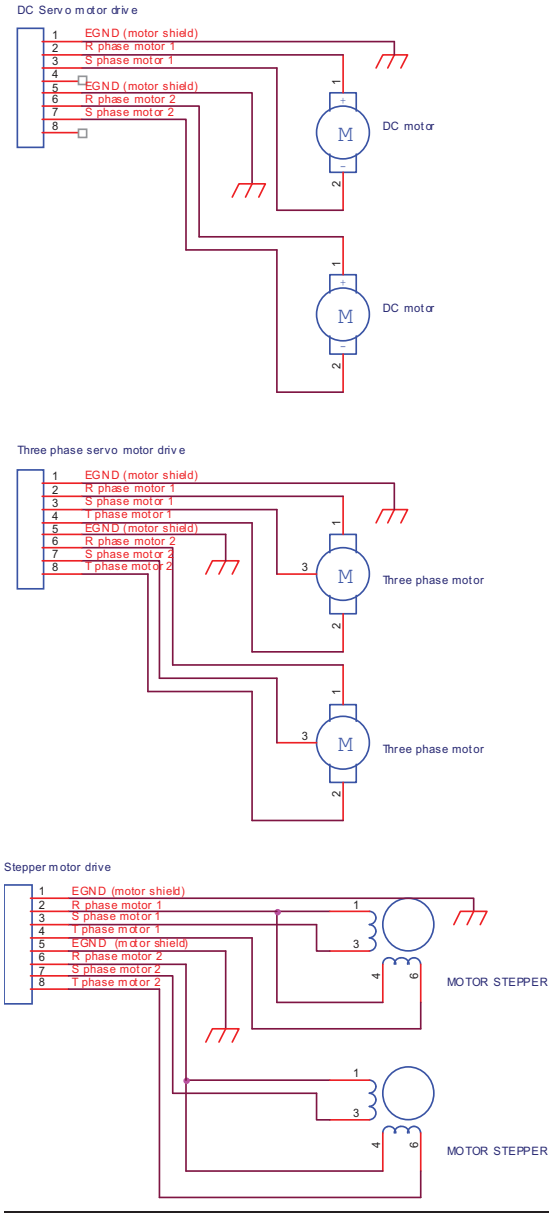


Figure 16 MB5U-2 Motor Drive Connections

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2.5.4.2 MB5U-2 Jumper Configuration

Warning	
	***Only a qualified technician should make any changes to the factory settings of the jumpers. Remove the back cover of the unit to access the jumpers.***

Table 82 provides details of the MB5U-2 jumper configuration.

Table 82 MB5U-2 Jumper Configuration

Name	Description	Functionality
JP2, JP3,	I2C A0, A1,	Used for setting the I^2C address: Set the JP2 & JP3 to: • "00" when the motherboard assembled is slot number 0. • "01" when the motherboard assembled is slot number 1. • "10" when the motherboard assembled is slot number 2. • "11" when the motherboard assembled is slot number 3. 0 - the jumper is installed. 1 - the jumper is removed.

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2.5.5 MB5U-4 Motherboard

The MB5U-4 motherboard is installed in the 19” MC4U.

The connectors associated with the MB5U-4 motherboard are shown in **Figure 17**.

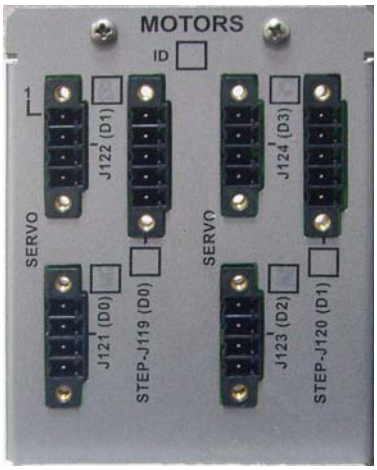


Figure 17 MB5U-4 Connectors

2.5.5.1 MB5U-4 Functionality

The MB5U-4 accomodates the SPiiPlus 3U-LT/HP Motion Controller, the DDM3U-X-60V-4A low power motor drives, and power supplies.

The motherboard includes a rear panel with four Servo Motor Drive connectors that are wired to the DDM3U-X-60V-4A motor drive, and, as such, the number of connectors depends on the number of Motor Drives installed in the MC4U.

2.5.5.2 Servo Motor Drive Connectors

Label: J121
J122
J123
J124

Connector Type: Phoenix MCV 1,5/4-GF-3,81

Mating Type: Phoenix MC 1,5/4-STF-3,81

The Servo Motor Drive connectors are for use with low power motor drives, such as the DDM3U-4-60V-2A Motor Drive, and, as such, the number of connectors depends on the number of Motor Drives (1 or 2) installed in the MC4U.

The Servo Motor Drive connectors are allocated as follows:

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Connector	Axis	Connector	Axis
J122 (D1)	Drive 1	J124 (D3)	Drive 3
J121 (D0)	Drive 0	J123 (D2)	Drive 2

The pinout for the Servo Motor Drive connectors is given in **Table 83**.

Table 83 J121-J124 - Low Power Motor Pinout

Pin #	ACSPL+ Signal Designator	Description
1	R_$	Motor $ R phase
2	S_$	Motor $ S phase
3	T_$	Motor $ T phase
4	EGND	Electrical Ground

The diagrams in **Figure 18**illustrate how motors are to be connected.

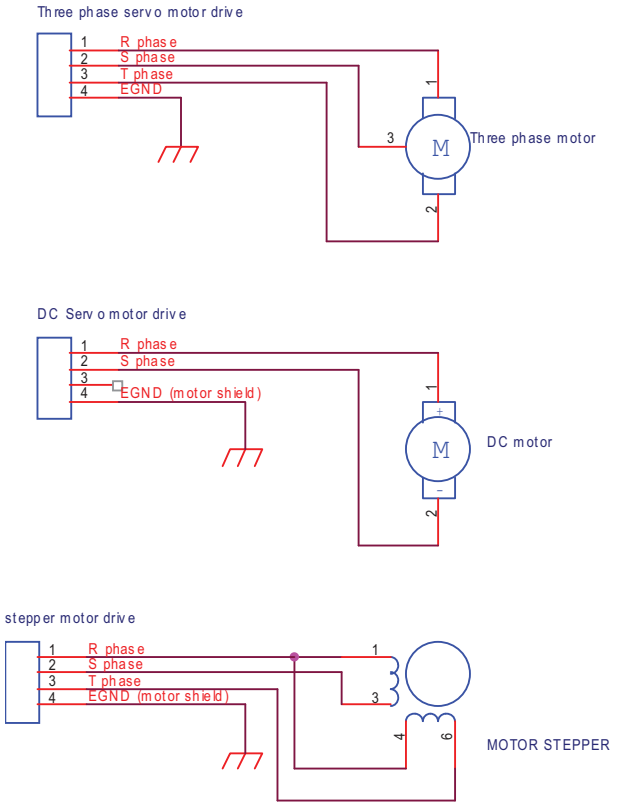


Figure 18 MB5U-4 Motor Drive Connections

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2.5.5.3 MB5U-4 Jumper Configuration

Table 84 provides details of the MB5U-4 jumper configuration.

Warning	
	***Only a qualified technician should make any changes to the factory settings of the jumpers. Remove the back cover of the unit to access the jumpers.***

Table 84 MB5U-4 Jumper Configuration

Jumper	Description	Functionality
J2, J3, J4	A0, A1, A2	For setting the I^2C address, set the J2, J3, J4 to: • "000" when the motherboard assembled is slot number 0. • "001" when the motherboard assembled is slot number 1. • "010" when the motherboard assembled is slot number 2. • "011" when the motherboard assembled is slot number 3.
		• "100" when the motherboard assembled is slot number 4. • "101" when the motherboard assembled is slot number 5. • "110" when the motherboard assembled is slot number 6. • "111" when the motherboard assembled is slot number 7. 0 - the jumper is installed. 1 - the jumper is removed.

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2.5.6 MB5U-YYYY Motherboard

The MB5U-YYYY is installed in the 19” MC4U.

The connectors associated with the MB5U-YYYY motherboard are shown in **Figure 19**.



Figure 19 MB5U-YYYY Connectors

2.5.6.1 MB5U-YYYY Functionality

The MB5U-YYYY accomodates the SPiiPlus 3U-LT/HP motion controller, four DDM3U-2-320V-XX (up to 10A/20A) drives and one PSM3U-320V-8KW power supply. It supports the following functionality:

- 8 x Digital encoders
- 8 x SIN-COS encoders (optional)
- 8 x Hall effect sensors
- 8 x Motor Temperature sensors
- 16 x Safety inputs
- 1 x E-stop
- 8 x Digital outputs/Mechanical brakes
- 8 x Digital inputs
- 4 x Analog I/O
- 5 x MARK signals
- 8 x Squared SIN-COS signals
- 4 x PEG signals, plus 3 x STATE signals
- 8 x Motor output signals
- 2 x Ethernet channels
- 2 x HSSI channel
- 2 x RS-232 channels

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2.5.6.2 Encoder and Hall Connectors

Label: J10-T ENC
J11-Z ENC
J12-Y ENC
J13-X ENC
J15-D ENC
J16-C ENC
J17-B ENC
J18-A ENC

Connector Type: D-type 26-pin HD female

Mating Type: D-type 26-pin HD male (for easy prototyping a Phoenix FLKM HDSUB-26/M Sub-D to Screw Terminal converter can be used)

The connectors are allocated as follows:

Connector	Axis	Connector	Axis
J10 - T ENC	T	J15 - D ENC	D
J11 - Z ENC	Z	J16 - C ENC	C
J12 - Y ENC	Y	J17 - B ENC	B
J13 - X ENC	X	J18 - A ENC	A

The pinout for the Encoder/Hall Connectors is given in **Table 85**.

Note



The dollar sign ($) stands for the given axis, for example, $_LL can be X_LL, or Y_LL, etc.

Table 85 Encoder/Hall Pinout (page 1 of 2)

Pin	ACSPL+ Signal Designator	Description
1	$_CHA-	Encoder A inverted input
2	$_CHB-	Encoder B inverted input
3	$_CHI-	Encoder index inverted input
4	$_HB	Motor Hall B
5	V_SUP_SFTY	Supply for the limits input
6	$_RL	Right limit
7	$_SIN-	Encoder SIN inverted input
8	$_COS-	Encoder COS inverted input
9	$_SC_I-	Encoder SIN-COS Index inverted input
10	$_CHA+	Encoder A non-inverted input
11	$_CHB+	Encoder B non-inverted input

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Table 85 Encoder/Hall Pinout (page 2 of 2)

Pin	ACSPL+ Signal Designator	Description
12	$_CHI+	Encoder Index non-inverted input
13	$_HA	Motor Hall A
14	$_HC	Motor Hall C
15	$_LL	Left limit
16	$_SIN+	SIN non-inverted input
17	$_COS+	Encoder COS non-inverted input
18	$_SC_I+	Encoder SIN-COS Index non-inverted input
19	5U	5V user supply for the digital encoder and Hall
20	5U_RTN	5V return user supply for the digital encoder and Hall
21	Shield	Shield
22	$_MTMP	Motor temperature sensor input
23	V_RTN_IO	A return for the Motor temperature sensor
24	V_RTN_SFTY	A return for the limits input
25	5F	5V user supply for the analog encoder and Hall
26	5F_RTN	5V return user supply for the analog encoder and Hall

2.5.6.3 J8 - Digital and Analog I/O Connector

Label: J8 - DIGITAL & ANALOG I/O

Connector Type: D-type 44-pin HD male

Mating Type: D-type 44-pin HD female (for easy prototyping a Phoenix FLKM HDSUB-44/M Sub-D to Screw Terminal converter can be used)

J8 serves for controlling Digital and Analog I/O signal formats. The pinout for J8 is given in **Table 86**.

Table 86 J8 - Digital and Analog I/O Pinout (page 1 of 2)

Pin #	ACSPL+ Signal Designator	Description
1	OUT1	Digital Output 1
2	OUT3	Digital Output 3
3	OUT5	Digital Output 5
4	OUT7	Digital Output 7
5	IN1	Digital Input 1
6	IN3	Digital Input 3
7	AGND	Analog ground
8	AIN10-	Analog input inverted
9	AIN11-	Analog input inverted
10	AIN14-	Analog input inverted
11	AIN15-	Analog input inverted
12	AOUT_CS-	Analog output CS inverted (Not used when MC4U is with SPiiPlus 3U-LT controller)

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Table 86 J8 - Digital and Analog I/O Pinout (page 2 of 2)

Pin #	ACSPL+ Signal Designator	Description
13	AOUT_CC-	Analog output CC inverted (Not used when MC4U is with SPiiPlus 3U-LT controller)
14	AOUT_DS-	Analog output DC inverted (Not used when MC4U is with SPiiPlus 3U-LT controller)
15	AOUT_DC-	Analog output DS inverted (Not used when MC4U is with SPiiPlus 3U-LT controller)
16	OUT0	Digital Output 0
17	OUT2	Digital Output 2
18	OUT4	Digital Output 4
19	OUT6	Digital Output 6
20	IN0	Digital Input 0
21	IN2	Digital Input 2
22	-	Not connected
23	AIN10+	Analog input non-inverted
24	AIN11+	Analog input non-inverted
25	AIN14+	Analog input non-inverted
26	AIN15+	Analog input non-inverted
27	AOUT_CS+ (AOUT6)	Analog output CS non-inverted (Signal desigator when MC4U is with SPiiPlus 3U-LT controller)
28	AOUT_CC+ (AOUT14)	Analog output CC non-inverted (Signal desigator when MC4U is with SPiiPlus 3U-LT controller)
29	AOUT_DS+ (AOUT2)	Analog output DC non-inverted (Signal desigator when MC4U is with SPiiPlus 3U-LT controller)
30	AOUT_DC+ (AOUT10)	Analog output DC non-inverted (Signal desigator when MC4U is with SPiiPlus 3U-LT controller)
31	V_SUP_IO	Input/Output Supply+
32	V_RTN_IO	Input/Output Supply Return
33	IN4	Digital Input 4
34	IN5	Digital Input 5
35	IN6	Digital Input 6
36	IN7	Digital Input 7
37	AGND	Analog ground
38	AGND	Analog ground
39	-	Not connected
40	-	Not connected
41	-	Not connected
42	+12V1	12V for joystick (optional, need 0Ω resistor) (Not Applicable)
43	12V1_RTN	+-12V return for joystick (optional, need 0Ω resistor) (Not Applicable)
44	-12V1	-12V for joystick (optional, need 0Ω resistor) (Not Applicable)

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2.5.6.4 J9 - Regeneration Connector

Model	
	*J9 is relevant only if the* PSM3U-320V-XXkW *(high power supply) is being used.*

Label: J9 - REGENERATION

Connector Type: external Phoenix FRONT 2,5-V/SA 10 connector.

Mating Type: None (screw terminal)

The pinout for J9 is provided in **Table 87**.

Table 87 J9 - Regeneration Pinout

Pin #	ACSPL+ Signal Designator	Description
1	REG1_1	Regeneration resistor for PS 1 (V1 on the motherboard)
2	REG1_2	Regeneration resistor for PS 1
3	REG2_1	Regeneration resistor for PS 2 (V2 on the motherboard)
4	REG2_2	Regeneration resistor for PS 2

2.5.6.5 J21 - Fast I/O (PEG & Mark) Connector

Label: J21 - FAST I/O

Connector Type: D-type 44-pin HD female connector.

Mating Type: D-type 44-pin HD male (for easy prototyping a Phoenix FLKM HDSUB-44/M Sub-D to Screw Terminal converter can be used)

The pinout for J21 is given in **Table 88**.

Table 88 J21 - Fast I/O Pinout (page 1 of 2)

Pin #	ACSPL+ Signal Designator	Description
1	Y_STATE2+	Reserved for future use.
2	Y_STATE1+	Reserved for future use.
3	Y_STATE0+	Reserved for future use.
4	X_STATE2+	State Digital output non-inverted
5	X_STATE1+	State Digital output non-inverted
6	X_STATE0+	State Digital output non-inverted
7	-	Not connected
8	-	Not connected
9	DGND	Internal digital supply return
10	DGND	Internal digital supply return
11	T_PEG+	PEG Digital output non-inverted

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Table 88 J21 - Fast I/O Pinout (page 2 of 2)

Pin #	ACSPL+ Signal Designator	Description
12	Z_PEG+	PEG Digital output non-inverted
13	Y_PEG+	PEG Digital output non-inverted
14	X_PEG+	PEG Digital output non-inverted
15	T_MARK2+	Reserved for future use.
16	Y_STATE2-	Reserved for future use.
17	Y_STATE1-	Reserved for future use.
18	Y_STATE0-	Reserved for future use.
19	X_STATE2-	State Digital output inverted
20	X_STATE1-	State Digital output inverted
21	X_STATE0-	State Digital output inverted
22	-	Not connected
23	-	Not connected
24	-	Not connected
25	-	Not connected
26	T_PEG-	PEG Digital output inverted
27	Z_PEG-	PEG Digital output inverted
28	Y_PEG-	PEG Digital output inverted
29	X_PEG-	PEG Digital output inverted
30	T_MARK2-	Reserved for future use.
31	X_MARK1+	Mark Digital input non-inverted
32	X_MARK1-	Mark Digital input inverted
33	X_MARK2+	Mark Digital input non-inverted
34	X_MARK2-	Mark Digital input inverted
35	Y_MARK1+	Mark Digital input non-inverted
36	Y_MARK1-	Mark Digital input inverted
37	Y_MARK2+	Reserved for future use.
38	Y_MARK2-	Reserved for future use.
39	Z_MARK1+	Mark Digital input non-inverted
40	Z_MARK1-	Mark Digital input inverted
41	Z_MARK2+	Reserved for future use.
42	Z_MARK2-	Reserved for future use.
43	T_MARK1+	Mark Digital input non-inverted
44	T_MARK1-	Mark Digital input inverted

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2.5.6.6 J22 - Motor Limits Connector

Label: J22 - LIMITS

Connector Type: D-type 25-pin male

Mating Type: D-type 25-pin female (for easy prototyping a Phoenix FLKM HDSUB-25/M Sub-D to Screw Terminal converter can be used)

The pinout for J22 is given in **Table 89**.

Table 89 J22 - Motor Limits Pinout

Pin #	ACSPL+ Signal Designator	Description
1	V_SUP_SFTY	Safety Supply +
2	-	Not connected
3	X_LL	X Left Limit
4	A_LL	A Left Limit
5	Y_LL	Y Left Limit
6	B_LL	B Left Limit
7	Z_LL	Z Left Limit
8	C_LL	C Left Limit
9	T_LL	T Left Limit
10	D_LL	D Left Limit
11	-	Not connected
12	-	Not connected
13	-	Not connected
14	V_RTN_SFTY	Safety Supply Return
15	-	Not connected
16	X_RL	X Right Limit
17	A_RL	A Right Limit
18	Y_RL	Y Right Limit
19	B_RL	B Right Limit
20	Z_RL	Z Right Limit
21	C_RL	C Right Limit
22	T_RL	T Right Limit
23	D_RL	D Right Limit
24	ES+	Emergency stop non-inverted
25	ES-	Emergency stop inverted

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2.5.6.7 J4, J5, and J6 - HSSI Connectors

Label: J4 - HSSI0 (X & A axes)
J5 - HSSI1 (Y & B axes)
J6 - HSSI2 (Z & C axes)

Connector Type: RJ45 8-pin sockets

Mating Type: RJ45 8-pin plug

The pinout of the sockets is given in **Table 90**.

Table 90 J4, J5, and J6 - HSSI Pinout

Pin #	ACSPL+ Signal Designator	Description
1	CONTROL_$+	Control signal non-inverted output for channel 0
2	CONTROL_$-	Control signal inverted output for channel 0
3	SER_DI_$+	Serial data non-inverted input for channel 0
4	SER_DI_$-	Serial data inverted input for channel 0
5	SER_DO_$+	Serial data non-inverted output for channel 0
6	SER_DO_$-	Serial data inverted output for channel 0
7	DGND	Digital ground for 5L
8	DGND	Digital ground for 5L

2.5.6.8 J2 and J3 - Ethernet Connectors

Label: J2 - ETH1
J3 - ETH2

Connector Type: RJ45 8-pin socket

Mating Type: RJ45 8-pin plug

The pinout of the sockets is given in **Table 91**.

Table 91 J2 and J3 - Ethernet Pinout

Pin #	ACSPL+ Signal Designator	Description
1	ETH$_TX+	Positive transmit signal
2	ETH$_TX -	Negative transmit signal
3	ETH$_RX +	Positive receive signal
4	-	Not connected
5	-	Not connected
6	ETH$_RX -	Negative receive signal
7	-	Not connected
8	-	Not connected

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2.5.6.9 J19 and J20 RS-232 Communication Connectors

Label: J19 - COM1
J20 - COM2

Connector Type: D-type 9-pin male sockets

Mating type: D-type 9-pin female

The pinout for the sockets is given in **Table 92**.

Table 92 J19 and J20 - RS-232 Communication Pinout

Pin #	ACSPL+ Signal Designator	Description
1	SHIELD	Cable shield connection
2	RX232	RS-232 receive signal for the communication port (J19 for COM1, and J20 for COM2)
3	TX232	RS-232 transmit signal for communication port (J19 for COM1, and J20 for COM2).
4	-	Not connected
5	DGND	Digital ground.
6	-	Not connected
7	-	Not connected
8	-	Not connected
9	-	Not connected

2.5.6.10 J14 - Drive Supply Voltage Connector

Label: J14 - DRIVE SUPPLY

Connector Type: Phoenix FRONT 4V-7,62

Mating Type: None (screw terminal)

AC power is provided through J14. The pinout for J14 is provided in **Table 93**.

Table 93 J14 - Drive Supply Voltage Pinout

Pin #	ACSPL+ Signal Designator	Description	Remarks
1	EGND	Earth Ground (shield)	
2	L3	AC input phase L3	
3	L2	AC input phase L2	When using AC single-phase, the voltage has to be connected between L1 and L2.
4	L1	AC input phase L1	

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2.5.6.11 J1 - 24V Logic Supply Connector

Label: J1 - 24V LOGIC SUPPLY

Connector Type: Phoenix MCV-1.5/5 GF 3.81

Mating Type: Phoenix MC-1.5/5 STF- 3.81

24Vdc is supplied through J1. The J1 pinout is provided in **Table 94**.

Table 94 J1 - 24V Logic Supply Pinout

Pin #	ACSPL+ Signal Designator	Description
1	24V_SUP	24V logic supply
2	24V_RTN	24V logic supply return
3	5V_ENC_EXT	External 5V supply for encoder
4	5V_ENC_EXT_RTN	External 5V supply return for encoder
5	EGND	Electrical Ground

2.5.6.12 J40 - T and D External Drive Control Signals

Label: J40 - ETERNAL DRIVE

Connector Type: D-type HD 15-pin female

Mating Type: D-type HD 15-pin male

J40 serves for supplying control signals to external drives.The J40 pinout is given in **Table 95**.

Model	
	*If SPiiPlus 3U-LT is installed, this connector is inactive.*

Table 95 J40 - External Drive Control Signals Pinout

Pin #	ACSPL+ Signal Designator	Description
1	T_CMD0+	T Drive Command 0+
2	T_CMD0-	T Drive Command 0-
3	T_CMD1+	T Drive Command 1+
4	T_CMD1-	T Drive Command 1-
5	T_ENA	T axis enable signal
6	D_CMD0+	D Drive Command 0+
7	D_CMD0-	D Drive Command 0-
8	D_CMD1+	D Drive Command 1+
9	D_CMD1-	D Drive Command 1-
10	T_FLT	T axis fault signal

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Table 95 J40 - External Drive Control Signals Pinout

Pin #	ACSPL+ Signal Designator	Description
11	AGND	Analog ground
12	DGND	Digital ground
13	5U	5V user supply for digital encoder and Hall sensor
14	D_ENA	D axis enable signal
15	D_FLT	D axis fault signal

2.5.6.13 J152_$ - Motor Drive Output Connectors

Label: J152_X
J152_Y
J152_Z
J152_T
J152_A
J152_B
J152_C
J152_D

Connector Type: Phoenix PCV 4/4-G-7,62-BK

Mating Type: Phoenix PC 4/ 4-STF-7,62

The connectors are allocated as follows:

Connector	Axis	Connector	Axis
J152_X	X	J152_A	A
J152_Y	Y	J152_B	B
J152_Z	Z	J152_C	C
J152_T	T	J152_D	D

The J152_$ pinout is given in **Table 96**.

Table 96 J152_$ - Motor Drive Output Pinout

Pin #	ACSPL+ Signal Designator	Description
1	EGND	Shield
2	$_R	Motor $ R phase
3	$_S	Motor $ S phase
4	$_T	Motor $ T phase

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The diagrams in **Figure 20**illustrate how motors are to be connected.

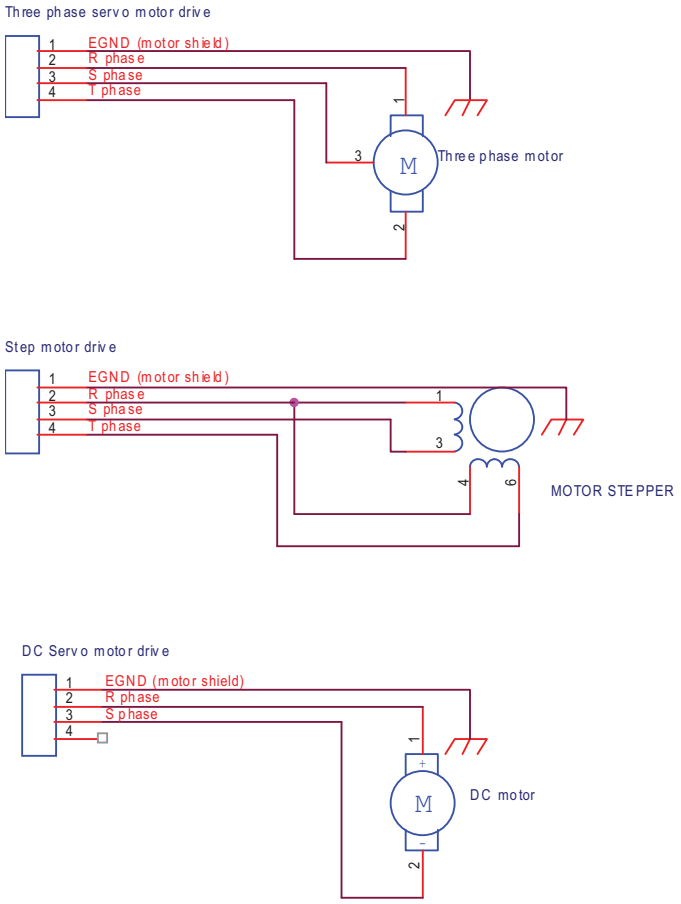


Figure 20 MB5U-YYYY Motor Drive Connections

2.5.6.14 MB5U-YYYY Jumper Configuration

Warning	
	***Only a qualified technician should make any changes to the factory settings of the jumpers. Remove the back cover of the unit to access the jumpers.***

Table 97 MB5U-YYYY Jumpers (page 1 of 2)

Name	Description	Functionality	Use for
JP1	5/24Vdc internal Safety supply	1-2 5Vdc internal 2-3 24Vdc internal	Safety supply configuration
JP2	Internal/external safety supply	1-2 external supply 2-3 internal supply	Safety supply configuration

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Table 97 MB5U-YYYY Jumpers (page 2 of 2)

JP3	5/24Vdc internal I/O supply	1-2 5Vdc internal 2-3 24Vdc internal	IO supply configuration
JP4	Internal/external IO supply	1-2 external supply 2-3 internal supply	IO supply configuration
JP5	24_RTN/ DGND IO supply return	1-2 DGND 2-3 24V_RTN	IO supply configuration
JP6	External/ Internal IO supply return	1-2 external supply return 2-3 internal supply return	IO supply configuration
JP7	24_RTN/ DGND safety supply return	1-2 DGND 2-3 24V_RTN	Safety supply configuration
JP8	External/ Internal safety supply return	1-2 external supply return 2-3 internal supply return	Safety supply configuration
JP9	Internal or external analog encoder supply	1-2 External 2-3 Internal	Encoder supply
JP10	Internal or external digital encoder supply	1-2 External 2-3 Internal	Encoder supply
JP11	Internal or external analog encoder supply return	1-2 External 2-3 Internal (AGND)	Encoder supply
JP21	Encoder external supply return common ground	1-2 encoder external supply connect to AGND 2-3 encoder external supply connect to DGND	Encoder supply
JP12	Internal or external digital encoder supply return	1-2 External 2-3 Internal (DGND)	Encoder supply
JP13	Digital ground to shield connection	Install – galvanic connection between digital ground to shield	Internal use only
JP14	Digital ground to analog ground connection	Install – galvanic connection between digital ground to analog ground	Internal use only

Note



In the tables that follow "X" means "don't care".

Table 98 I/O Jumper Setup

Setup	JP1	JP3	JP5	JP7
I/O supply external	X	Remove	Remove	X
I/O supply internal 5V	X	1-2	1-2	X
I/O supply internal 24V	X	2-3	2-3	X
Safety supply external	Remove	X	X	Remove
Safety supply internal 5V	1-2	X	X	1-2
Safety supply internal 24V	2-3	X	X	2-3

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Table 99 Encoder Supply

Setup	JP9	JP10	JP11	JP12	JP21
Analog encoder external supply	1-2	X	1-2	X	1-2
Analog encoder internal supply	2-3	X	2-3	X	Open
Digital encoder external supply	X	1-2	X	1-2	2-3
Digital encoder internal supply	X	2-3	X	2-3	Open

Note



When using 5V internal supply for digital I/O or Safety, these I/Os will not be isolated.

The general purpose analog inputs are shared with the IS current feedback, set the following jumpers as needed.

Table 100 General Purpose Analog Input

Setup	JP22, JP28	JP23, JP29	JP24, JP25	JP26, JP27
When Z axis is in use, (no AIN10 support)	Remove	X	X	X
When C axis is in use, (no AIN11 support)	X	Remove	X	X
When T axis is in use, (no AIN14 support)	X	X	Remove	X
When D axis is in use, (no AIN15 support)	X	X	X	Remove

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2.5.7 MB5U-ZZZ Motherboard

The MB5U-ZZZ is installed in the 19” MC4U.

The connectors associated with the MB5U-ZZZ motherboard are shown in **Figure 21**.



Figure 21 MB5U-ZZZ Connectors

2.5.7.1 MB5U-ZZZ Functionality

The MB5U-ZZZ accomodates the SPiiPlus 3U-LT/HP motion controller, four DDM3U-2-320V-XX (up to 10A/20A) drives and one PSM3U-320V-8KW power supply. It supports the following functionality:

- 8 x Digital encoders
- 8 x SIN-COS encoders (optional)
- 8 x Hall effect sensors
- 8 x Motor Temperature sensors
- 16 x Safety inputs
- 1 x E-stop
- 8 x Digital outputs/Mechanical brakes
- 8 x Digital inputs
- 4 x Analog I/O
- 5 x MARK signals
- 8 x Squared SIN-COS signals
- 4 x PEG signals, plus 3 x STATE signals
- 6 x Motor output signals
- 2 x Ethernet channels
- 2 x HSSI channel
- 2 x RS-232 channels
- 2 x External Drive controls (T, D)

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2.5.7.2 Encoder and Hall Connectors

Label: J10-T ENC
J11-Z ENC
J12-Y ENC
J13-X ENC
J15-D ENC
J16-C ENC
J17-B ENC
J18-A ENC

Connector Type: D-type 26-pin HD female

Mating Type: D-type 26-pin HD male (for easy prototyping a Phoenix FLKM HDSUB-26/M Sub-D to Screw Terminal converter can be used)

The connectors are allocated as follows:

Connector	Axis	Connector	Axis
J10 - T ENC	T	J15 - D ENC	D
J11 - Z ENC	Z	J16 - C ENC	C
J12 - Y ENC	Y	J17 - B ENC	B
J13 - X ENC	X	J18 - A ENC	A

The pinout for the Encoder/Hall Connectors is given in **Table 101**.

Note



The dollar sign ($) stands for the given axis, for example, $_LL can be X_LL, or Y_LL, etc.

Table 101 Encoder/Hall Pinout (page 1 of 2)

Pin	ACSPL+ Signal Designator	Description
1	$_CHA-	Encoder A inverted input
2	$_CHB-	Encoder B inverted input
3	$_CHI-	Encoder index inverted input
4	$_HB	Motor Hall B
5	V_SUP_SFTY	Supply for the limits input
6	$_RL	Right limit
7	$_SIN-	Encoder SIN inverted input
8	$_COS-	Encoder COS inverted input
9	$_SC_I-	Encoder SIN-COS Index inverted input
10	$_CHA+	Encoder A non-inverted input
11	$_CHB+	Encoder B non-inverted input

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Table 101 Encoder/Hall Pinout (page 2 of 2)

Pin	ACSPL+ Signal Designator	Description
12	$_CHI+	Encoder Index non-inverted input
13	$_HA	Motor Hall A
14	$_HC	Motor Hall C
15	$_LL	Left limit
16	$_SIN+	SIN non-inverted input
17	$_COS+	Encoder COS non-inverted input
18	$_SC_I+	Encoder SIN-COS Index non-inverted input
19	5U	5V user supply for the digital encoder and Hall
20	5U_RTN	5V return user supply for the digital encoder and Hall
21	Shield	Shield
22	$_MTMP	Motor temperature sensor input
23	V_RTN_IO	A return for the Motor temperature sensor
24	V_RTN_SFTY	A return for the limits input
25	5F	5V user supply for the analog encoder and Hall
26	5F_RTN	5V return user supply for the analog encoder and Hall

2.5.7.3 J8 - Digital and Analog I/O Connector

Label: J8 - DIGITAL & ANALOG I/O

Connector Type: D-type 44-pin HD male

Mating Type: D-type 44-pin HD female (for easy prototyping a Phoenix FLKM HDSUB-44/M Sub-D to Screw Terminal converter can be used)

J8 serves for controlling Digital and Analog I/O signal formats. The pinout for J8 is given in **Table 102**.

Table 102 J8 - Digital and Analog I/O Pinout (page 1 of 2)

Pin #	ACSPL+ Signal Designator	Description
1	OUT1	Digital Output 1
2	OUT3	Digital Output 3
3	OUT5	Digital Output 5
4	OUT7	Digital Output 7
5	IN1	Digital Input 1
6	IN3	Digital Input 3
7	AGND	Analog ground
8	AIN10-	Analog input inverted
9	AIN11-	Analog input inverted
10	AIN14-	Analog input inverted
11	AIN15-	Analog input inverted
12	AOUT_CS-	Analog output CS inverted (Not used when MC4U is with SPiiPlus 3U-LT controller)

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Table 102 J8 - Digital and Analog I/O Pinout (page 2 of 2)

Pin #	ACSPL+ Signal Designator	Description
13	AOUT_CC-	Analog output CC inverted (Not used when MC4U is with SPiiPlus 3U-LT controller)
14	AOUT_DS-	Analog output DC inverted (Not used when MC4U is with SPiiPlus 3U-LT controller)
15	AOUT_DC-	Analog output DS inverted (Not used when MC4U is with SPiiPlus 3U-LT controller)
16	OUT0	Digital Output 0
17	OUT2	Digital Output 2
18	OUT4	Digital Output 4
19	OUT6	Digital Output 6
20	IN0	Digital Input 0
21	IN2	Digital Input 2
22	-	Not connected
23	AIN10+	Analog input non-inverted
24	AIN11+	Analog input non-inverted
25	AIN14+	Analog input non-inverted
26	AIN15+	Analog input non-inverted
27	AOUT_CS+ (AOUT6)	Analog output CS non-inverted (Signal desigator when MC4U is with SPiiPlus 3U-LT controller)
28	AOUT_CC+ (AOUT14)	Analog output CC non-inverted (Signal desigator when MC4U is with SPiiPlus 3U-LT controller)
29	AOUT_DS+ (AOUT2)	Analog output DC non-inverted (Signal desigator when MC4U is with SPiiPlus 3U-LT controller)
30	AOUT_DC+ (AOUT10)	Analog output DC non-inverted (Signal desigator when MC4U is with SPiiPlus 3U-LT controller)
31	V_SUP_IO	Input/Output Supply+
32	V_RTN_IO	Input/Output Supply Return
33	IN4	Digital Input 4
34	IN5	Digital Input 5
35	IN6	Digital Input 6
36	IN7	Digital Input 7
37	AGND	Analog ground
38	AGND	Analog ground
39	-	Not connected
40	-	Not connected
41	-	Not connected
42	+12V1	12V for joystick (optional, need 0Ω resistor) (Not Applicable)
43	12V1_RTN	+-12V return for joystick (optional, need 0Ω resistor) (Not Applicable)
44	-12V1	-12V for joystick (optional, need 0Ω resistor) (Not Applicable)

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2.5.7.4 J9 - Regeneration Connector

Model	
	*J9 is relevant only if the* PSM3U-320V-XXkW *(high power supply) is being used.*

Label: J9 - REGENERATION

Connector Type: Phoenix FRONT 2,5-V/SA 10

Mating Type: None (screw terminal)

The pinout for J9 is provided in **Table 103**.

Table 103 J9 - Regeneration Pinout

Pin #	ACSPL+ Signal Designator	Description
1	REG1_1	Regeneration resistor for PS 1 (V1 on the motherboard)
2	REG1_2	Regeneration resistor for PS 1
3	REG2_1	Regeneration resistor for PS 2 (V2 on the motherboard)
4	REG2_2	Regeneration resistor for PS 2

2.5.7.5 J21 - Fast I/O (PEG & Mark) Connector

Label: J21 - FAST I/O

Connector Type: D-type 44-pin HD female

Mating Type: D-type 44-pin HD male (for easy prototyping a Phoenix FLKM HDSUB-44/M Sub-D to Screw Terminal converter can be used)

The pinout for J21 is provided in **Table 104**.

Table 104 J21 - Fast I/O Pinout (page 1 of 2)

Pin #	ACSPL+ Signal Designator	Description
1	Y_STATE2+	Reserved for future use.
2	Y_STATE1+	Reserved for future use.
3	Y_STATE0+	Reserved for future use.
4	X_STATE2+	State Digital output non-inverted
5	X_STATE1+	State Digital output non-inverted
6	X_STATE0+	State Digital output non-inverted
7	-	Not connected
8	-	Not connected
9	DGND	Internal digital supply return
10	DGND	Internal digital supply return
11	T_PEG+	PEG Digital output non-inverted
12	Z_PEG+	PEG Digital output non-inverted

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Table 104 J21 - Fast I/O Pinout (page 2 of 2)

Pin #	ACSPL+ Signal Designator	Description
13	Y_PEG+	PEG Digital output non-inverted
14	X_PEG+	PEG Digital output non-inverted
15	T_MARK2+	Reserved for future use.
16	Y_STATE2-	Reserved for future use.
17	Y_STATE1-	Reserved for future use.
18	Y_STATE0-	Reserved for future use.
19	X_STATE2-	State Digital output inverted
20	X_STATE1-	State Digital output inverted
21	X_STATE0-	State Digital output inverted
22	-	Not connected
23	-	Not connected
24	-	Not connected
25	-	Not connected
26	T_PEG-	PEG Digital output inverted
27	Z_PEG-	PEG Digital output inverted
28	Y_PEG-	PEG Digital output inverted
29	X_PEG-	PEG Digital output inverted
30	T_MARK2-	Reserved for future use.
31	X_MARK1+	Mark Digital input non-inverted
32	X_MARK1-	Mark Digital input inverted
33	X_MARK2+	Mark Digital input non-inverted
34	X_MARK2-	Mark Digital input inverted
35	Y_MARK1+	Mark Digital input non-inverted
36	Y_MARK1-	Mark Digital input inverted
37	Y_MARK2+	Reserved for future use.
38	Y_MARK2-	Reserved for future use.
39	Z_MARK1+	Mark Digital input non-inverted
40	Z_MARK1-	Mark Digital input inverted
41	Z_MARK2+	Reserved for future use.
42	Z_MARK2-	Reserved for future use.
43	T_MARK1+	Mark Digital input non-inverted
44	T_MARK1-	Mark Digital input inverted

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2.5.7.6 J22 - Motor Limits Connector

Label: J22 - LIMITS

Connector Type: D-type 25-pin male

Mating Type: D-type 25-pin female (for easy prototyping a Phoenix FLKM HDSUB-25/M Sub-D to Screw Terminal converter can be used)

The pinout for J22 is given in **Table 105**.

Table 105 J22 - Motor Limits Pinout

Pin #	ACSPL+ Signal Designator	Description
1	V_SUP_SFTY	Safety Supply +
2	-	Not connected
3	X_LL	X Left Limit
4	A_LL	A Left Limit
5	Y_LL	Y Left Limit
6	B_LL	B Left Limit
7	Z_LL	Z Left Limit
8	C_LL	C Left Limit
9	T_LL	T Left Limit
10	D_LL	D Left Limit
11	-	Not connected
12	-	Not connected
13	-	Not connected
14	V_RTN_SFTY	Safety Supply Return
15	-	Not connected
16	X_RL	X Right Limit
17	A_RL	A Right Limit
18	Y_RL	Y Right Limit
19	B_RL	B Right Limit
20	Z_RL	Z Right Limit
21	C_RL	C Right Limit
22	T_RL	T Right Limit
23	D_RL	D Right Limit
24	ES+	Emergency stop non-inverted
25	ES-	Emergency stop inverted

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2.5.7.7 J4, J5, and J6 - HSSI Connectors

Label: J4 - HSSI0 (X & A axes)
J5 - HSSI1 (Y & B axes)
J6 - HSSI2 (Z & C axes)

Connector Type: RJ45 8-pin sockets

Mating Type: RJ45 8-pin plug

The pinout of the sockets is given in **Table 106**

Table 106 J4, J5, and J6 - HSSI Pinout

Pin #	ACSPL+ Signal Designator	Description
1	CONTROL_$+	Control signal non-inverted output for channel 0
2	CONTROL_$-	Control signal inverted output for channel 0
3	SER_DI_$+	Serial data non-inverted input for channel 0
4	SER_DI_$-	Serial data inverted input for channel 0
5	SER_DO_$+	Serial data non-inverted output for channel 0
6	SER_DO_$-	Serial data inverted output for channel 0
7	DGND	Digital ground for 5L
8	DGND	Digital ground for 5L

2.5.7.8 J2 and J3 - Ethernet Connectors

Label: J2 - ETH1
J3 - ETH2

Connector Type: RJ45 8-pin socket

Mating Type: RJ45 8-pin plug

The pinout of the sockets is given in **Table 107**.

Table 107 J2 and J3 - Ethernet Pinout

Pin #	ACSPL+ Signal Designator	Description
1	ETH$_TX+	Positive transmit signal
2	ETH$_TX -	Negative transmit signal
3	ETH$_RX +	Positive receive signal
4	-	Not connected
5	-	Not connected
6	ETH$_RX -	Negative receive signal
7	-	Not connected
8	-	Not connected

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2.5.7.9 J19 and J20 RS-232 Communication Connectors

Label: J19 - COM1
J20 - COM2

Connector Type: D-type 9-pin male sockets

Mating type: D-type 9-pin female

The pinout for the connectors is given in **Table 108**.

Table 108 J19 and J20 - RS-232 Communication Pinout

Pin #	ACSPL+ Signal Designator	Description
1	SHIELD	Cable shield connection
2	RX232	RS-232 receive signal for the communication port (J19 for COM1, and J20 for COM2)
3	TX232	RS-232 transmit signal for communication port (J19 for COM1, and J20 for COM2).
4	-	Not connected
5	DGND	Digital ground.
6	-	Not connected
7	-	Not connected
8	-	Not connected
9	-	Not connected

2.5.7.10 J14 - Drive Supply Voltage Connector

Label: J14 - DRIVE SUPPLY

Connector Type: Phoenix FRONT 4V-7,62

Mating Type: None (screw terminal)

AC power is provided through J14. The pinout for the connector is provided in **Table 109**.

Table 109 J14 - Drive Supply Voltage Pinout

Pin #	ACSPL+ Signal Designator	Description	Remarks
1	EGND	Earth Ground (shield)	
2	L3	AC input phase L3	
3	L2	AC input phase L2	When using AC single-phase, the voltage has to be connected between L1 and L2.
4	L1	AC input phase L1	

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2.5.7.11 J1 - 24V Logic Supply Connector

Label: J1 - 24V LOGIC SUPPLY

Connector Type: Phoenix MCV-1.5/5 GF 3.81

Mating Type: Phoenix MC-1.5/5 STF- 3.81

24Vdc is provided through J1. The J1 pinout is provided in **Table 110**.

Table 110 J1 - 24V Logic Supply Pinout

Pin #	ACSPL+ Signal Designator	Description
1	24V_SUP	24V logic supply
2	24V_RTN	24V logic supply return
3	5V_ENC_EXT	External 5V supply for encoder
4	5V_ENC_EXT_RTN	External 5V supply return for encoder
5	EGND	Electrical Ground

2.5.7.12 J40 - T and D External Drive Control Signals

Label: J40 - EXTERNAL DRIVE

Connector Type: D-type HD 15-pin female

Mating Type: D-type HD 15-pin male

J40 serves for supplying control signals to external drives. The J40 pinout is given in **Table 111**.

Model	
	*If SPiiPlus 3U-LT is installed, this connector is inactive.*

Table 111 J40 - External Drive Control Signals Pinout (page 1 of 2)

Pin #	ACSPL+ Signal Designator	Description
1	T_CMD0+	T Drive Command 0+
2	T_CMD0-	T Drive Command 0-
3	T_CMD1+	T Drive Command 1+
4	T_CMD1-	T Drive Command 1-
5	T_ENA	T axis enable signal
6	D_CMD0+	D Drive Command 0+
7	D_CMD0-	D Drive Command 0-
8	D_CMD1+	D Drive Command 1+

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Table 111 J40 - External Drive Control Signals Pinout (page 2 of 2)

Pin #	ACSPL+ Signal Designator	Description
9	D_CMD1-	D Drive Command 1-
10	T_FLT	T axis fault signal
11	AGND	Analog ground
12	DGND	Digital ground
13	5U	5V user supply for digital encoder and Hall sensor
14	D_ENA	D axis enable signal
15	D_FLT	D axis fault signal

2.5.7.13 J152_$ - Motor Drive Output

Label: J152_X
J152_Y
J152_Z
J152_A
J152_B
J152_C

Connector Type: Phoenix PCV 4/4-G-7,62-BK

Mating Type: Phoenix PC 4/ 4-STF-7,62

The connectors are allocated as follows:

Connector	Axis	Connector	Axis
J152_X	X	J152_A	A
J152_Y	Y	J152_B	B
J152_Z	Z	J152_C	C

The J152_$ pinout is given in **Table 112**.

Table 112 J152_$ - Motor Drive Pinout

Pin #	ACSPL+ Signal Designator	Description
1	EGND	Shield
2	$_R	Motor $ R phase
3	$_S	Motor $ S phase
4	$_T	Motor $ T phase

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The diagrams in **Figure 22**illustrate how motors are to be connected.

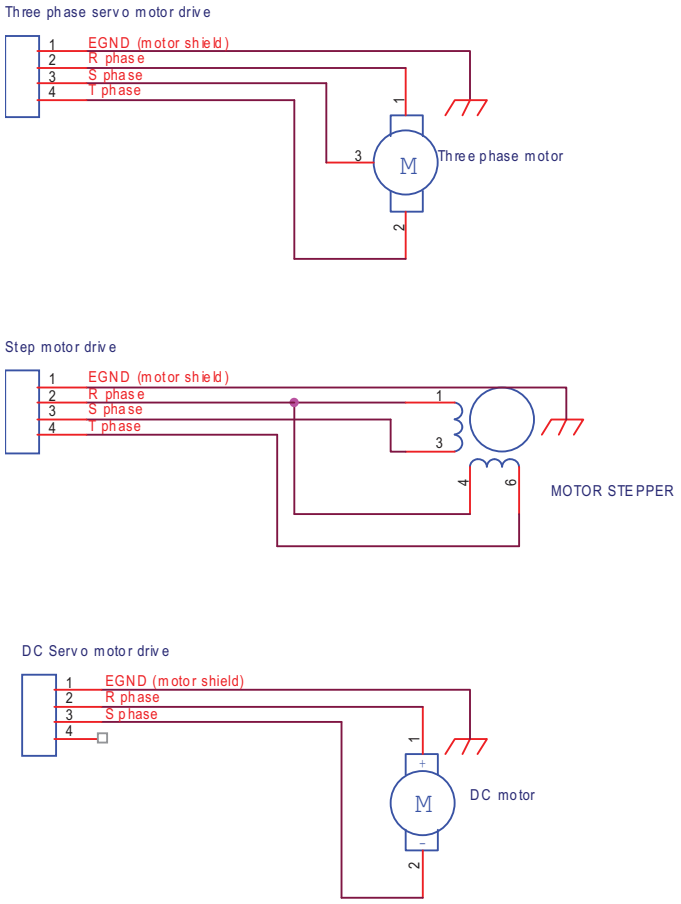


Figure 22 MB5U-ZZZ Motor Drive Connections

2.5.7.14 MB5U-ZZZ Jumper Configuration

Warning	***Only a qualified technician should make any changes to the factory settings of the jumpers. Remove the back cover of the unit to access the jumpers.***

Table 113 MB5U-ZZZ Jumpers (page 1 of 2)

Name	Description	Functionality	Use for
JP1	5/24Vdc internal Safety supply	1-2 5Vdc internal 2-3 24Vdc internal	Safety supply configuration
JP2	Internal/external safety supply	1-2 external supply 2-3 internal supply	Safety supply configuration

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Table 113 MB5U-ZZZ Jumpers (page 2 of 2)

JP3	5/24Vdc internal I/O supply	1-2 5Vdc internal 2-3 24Vdc internal	IO supply configuration
JP4	Internal/external IO supply	1-2 external supply 2-3 internal supply	IO supply configuration
JP5	24_RTN/ DGND IO supply return	1-2 DGND 2-3 24V_RTN	IO supply configuration
JP6	External/ Internal IO supply return	1-2 external supply return 2-3 internal supply return	IO supply configuration
JP7	24_RTN/ DGND safety supply return	1-2 DGND 2-3 24V_RTN	Safety supply configuration
JP8	External/ Internal safety supply return	1-2 external supply return 2-3 internal supply return	Safety supply configuration
JP9	Internal or external analog encoder supply	1-2 External 2-3 Internal	Encoder supply
JP10	Internal or external digital encoder supply	1-2 External 2-3 Internal	Encoder supply
JP11	Internal or external analog encoder supply return	1-2 External 2-3 Internal (AGND)	Encoder supply
JP21	Encoder external supply return common ground	1-2 encoder external supply connect to AGND 2-3 encoder external supply connect to DGND	Encoder supply
JP12	Internal or external digital encoder supply return	1-2 External 2-3 Internal (DGND)	Encoder supply
JP13	Digital ground to shield connection	Install – galvanic connection between digital ground to shield	Internal use only
JP14	Digital ground to analog ground connection	Install – galvanic connection between digital ground to analog ground	Internal use only

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2.5.8 MB5U-ZZW Motherboard

The MB5U-ZZW is installed in the 19” MC4U.

The connectors associated with the MB5U-ZZW motherboard are shown in **Figure 23**.

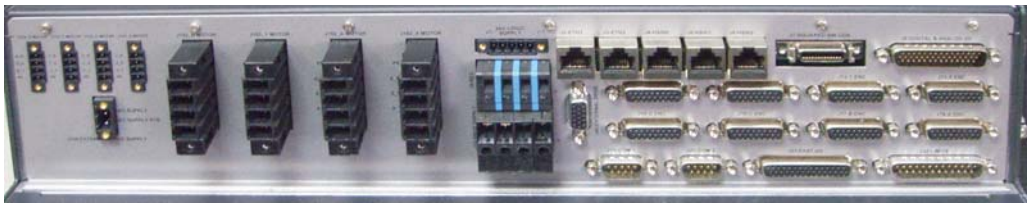


Figure 23 MB5U-ZZW Connectors

2.5.8.1 MB5U-ZZW Functionality

The MB5U-ZZW accomodates the SPiiPlus 3U-LT/HP motion controller, two DDM3U-2-320V-XX (up to 10A/20A) drives, one DDM3U-4-60V-XX dive, and PSM3U-320V-8KW and PSM3U-48V-0.7KW power supplies. It supports the following functionality:

- 8 x Digital encoders
- 8 x SIN-COS encoders (optional)
- 8 x Hall effect sensors
- 8 x Motor Temperature sensors
- 16 x Safety inputs
- 1 x E-stop
- 8 x Digital outputs/Mechanical brakes
- 8 x Digital inputs
- 4 x Analog I/O
- 5 x MARK signals
- 8 x Squared SIN-COS signals
- 4 x PEG signals, plus 3 x STATE signals
- 8 x Motor output signals
- 2 x Ethernet channels
- 2 x HSSI channel
- 2 x RS-232 channels

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2.5.8.2 Encoder and Hall Connectors

Label: J10-T ENC
J11-Z ENC
J12-Y ENC
J13-X ENC
J15-D ENC
J16-C ENC
J17-B ENC
J18-A ENC

Connector Type: D-type 26-pin HD female

Mating Type: D-type 26-pin HD male (for easy prototyping a Phoenix FLKM HDSUB-26/M Sub-D to Screw Terminal converter can be used)

The connectors are allocated as follows:

Connector	Axis	Connector	Axis
J10 - T ENC	T	J15 - D ENC	D
J11 - Z ENC	Z	J16 - C ENC	C
J12 - Y ENC	Y	J17 - B ENC	B
J13 - X ENC	X	J18 - A ENC	A

The pinout for the Encoder/Hall Connectors is given in **Table 114**.

Note



The dollar sign ($) stands for the given axis, for example, $_LL can be X_LL, Y_LL, etc.

Table 114 Encoder/Hall Pinout (page 1 of 2)

Pin	ACSPL+ Signal Designator	Description
1	$_CHA-	Encoder A inverted input
2	$_CHB-	Encoder B inverted input
3	$_CHI-	Encoder index inverted input
4	$_HB	Motor Hall B
5	V_SUP_SFTY	Supply for the limits input
6	$_RL	Right limit
7	$_SIN-	Encoder SIN inverted input
8	$_COS-	Encoder COS inverted input
9	$_SC_I-	Encoder SIN-COS Index inverted input
10	$_CHA+	Encoder A non-inverted input
11	$_CHB+	Encoder B non-inverted input

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Table 114 Encoder/Hall Pinout (page 2 of 2)

Pin	ACSPL+ Signal Designator	Description
12	$_CHI+	Encoder Index non-inverted input
13	$_HA	Motor Hall A
14	$_HC	Motor Hall C
15	$_LL	Left limit
16	$_SIN+	SIN non-inverted input
17	$_COS+	Encoder COS non-inverted input
18	$_SC_I+	Encoder SIN-COS Index non-inverted input
19	5U	5V user supply for the digital encoder and Hall
20	5U_RTN	5V return user supply for the digital encoder and Hall
21	Shield	Shield
22	$_MTMP	Motor temperature sensor input
23	V_RTN_IO	A return for the Motor temperature sensor
24	V_RTN_SFTY	A return for the limits input
25	5F	5V user supply for the analog encoder and Hall
26	5F_RTN	5V return user supply for the analog encoder and Hall

2.5.8.3 J8 - Digital and Analog I/O Connector

Label: J8 - DIGITAL & ANALOG I/O

Connector Type: D-type 44-pin HD male

Mating Type: D-type 44-pin HD female (for easy prototyping a Phoenix FLKM HDSUB-44/M Sub-D to Screw Terminal converter can be used)

J8 serves for controlling Digital and Analog I/O signal formats.The pinout for J8 is given in **Table 115**.

Table 115 J8 - Digital and Analog I/O Pinout (page 1 of 2)

Pin #	ACSPL+ Signal Designator	Description
1	OUT1	Digital Output 1
2	OUT3	Digital Output 3
3	OUT5	Digital Output 5
4	OUT7	Digital Output 7
5	IN1	Digital Input 1
6	IN3	Digital Input 3
7	AGND	Analog ground
8	AIN10-	Analog input inverted
9	AIN11-	Analog input inverted
10	AIN14-	Analog input inverted
11	AIN15-	Analog input inverted
12	AOUT_CS-	Analog output CS inverted (Not used when MC4U is with SPiiPlus 3U-LT controller)

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Table 115 J8 - Digital and Analog I/O Pinout (page 2 of 2)

Pin #	ACSPL+ Signal Designator	Description
13	AOUT_CC-	Analog output CC inverted (Not used when MC4U is with SPiiPlus 3U-LT controller)
14	AOUT_DS-	Analog output DC inverted (Not used when MC4U is with SPiiPlus 3U-LT controller)
15	AOUT_DC-	Analog output DS inverted (Not used when MC4U is with SPiiPlus 3U-LT controller)
16	OUT0	Digital Output 0
17	OUT2	Digital Output 2
18	OUT4	Digital Output 4
19	OUT6	Digital Output 6
20	IN0	Digital Input 0
21	IN2	Digital Input 2
22	-	Not connected
23	AIN10+	Analog input non-inverted
24	AIN11+	Analog input non-inverted
25	AIN14+	Analog input non-inverted
26	AIN15+	Analog input non-inverted
27	AOUT_CS+ (AOUT6)	Analog output CS non-inverted (Signal desigator when MC4U is with SPiiPlus 3U-LT controller)
28	AOUT_CC+ (AOUT14)	Analog output CC non-inverted (Signal desigator when MC4U is with SPiiPlus 3U-LT controller)
29	AOUT_DS+ (AOUT2)	Analog output DC non-inverted (Signal desigator when MC4U is with SPiiPlus 3U-LT controller)
30	AOUT_DC+ (AOUT10)	Analog output DC non-inverted (Signal desigator when MC4U is with SPiiPlus 3U-LT controller)
31	V_SUP_IO	Input/Output Supply+
32	V_RTN_IO	Input/Output Supply Return
33	IN4	Digital Input 4
34	IN5	Digital Input 5
35	IN6	Digital Input 6
36	IN7	Digital Input 7
37	AGND	Analog ground
38	AGND	Analog ground
39	-	Not connected
40	-	Not connected
41	-	Not connected
42	+12V1	12V for joystick (optional, need 0Ω resistor) (Not Applicable)
43	12V1_RTN	+-12V return for joystick (optional, need 0Ω resistor) (Not Applicable)
44	-12V1	-12V for joystick (optional, need 0Ω resistor) (Not Applicable)

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2.5.8.4 J9 - Regeneration Connector

Model	
	*J9 is relevant only if the* PSM3U-320V-XXkW *(high power supply) is being used.*

Label: J9 - REGENERATION

Connector Type: Phoenix FRONT 2,5-V/SA 10

Mating Type: None (screw terminal)

The pinout for J9 is provided in **Table 116**.

Table 116 J9 - Regeneration Pinout

Pin #	ACSPL+ Signal Designator	Description
1	REG1_1	Regeneration resistor for PS 1 (V1 on the motherboard)
2	REG1_2	Regeneration resistor for PS 1
3	REG2_1	Regeneration resistor for PS 2 (V2 on the motherboard)
4	REG2_2	Regeneration resistor for PS 2

2.5.8.5 J21 - Fast I/O (PEG & Mark) Connector

Label: J21 - FAST I/O

Connector Type: D-type 44-pin HD female

Mating Type: D-type 44-pin HD male (for easy prototyping a Phoenix FLKM HDSUB-44/M Sub-D to Screw Terminal converter can be used)

The pinout for J21 is given in **Table 117**.

Table 117 J21 - Fast I/O Pinout (page 1 of 2)

Pin #	ACSPL+ Signal Designator	Description
1	Y_STATE2+	Reserved for future use.
2	Y_STATE1+	Reserved for future use.
3	Y_STATE0+	Reserved for future use.
4	X_STATE2+	State Digital output non-inverted
5	X_STATE1+	State Digital output non-inverted
6	X_STATE0+	State Digital output non-inverted
7	-	Not connected
8	-	Not connected
9	DGND	Internal digital supply return
10	DGND	Internal digital supply return
11	T_PEG+	PEG Digital output non-inverted
12	Z_PEG+	PEG Digital output non-inverted

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Table 117 J21 - Fast I/O Pinout (page 2 of 2)

Pin #	ACSPL+ Signal Designator	Description
13	Y_PEG+	PEG Digital output non-inverted
14	X_PEG+	PEG Digital output non-inverted
15	T_MARK2+	Reserved for future use.
16	Y_STATE2-	Reserved for future use.
17	Y_STATE1-	Reserved for future use.
18	Y_STATE0-	Reserved for future use.
19	X_STATE2-	State Digital output inverted
20	X_STATE1-	State Digital output inverted
21	X_STATE0-	State Digital output inverted
22	-	Not connected
23	-	Not connected
24	-	Not connected
25	-	Not connected
26	T_PEG-	PEG Digital output inverted
27	Z_PEG-	PEG Digital output inverted
28	Y_PEG-	PEG Digital output inverted
29	X_PEG-	PEG Digital output inverted
30	T_MARK2-	Reserved for future use.
31	X_MARK1+	Mark Digital input non-inverted
32	X_MARK1-	Mark Digital input inverted
33	X_MARK2+	Mark Digital input non-inverted
34	X_MARK2-	Mark Digital input inverted
35	Y_MARK1+	Mark Digital input non-inverted
36	Y_MARK1-	Mark Digital input inverted
37	Y_MARK2+	Reserved for future use.
38	Y_MARK2-	Reserved for future use.
39	Z_MARK1+	Mark Digital input non-inverted
40	Z_MARK1-	Mark Digital input inverted
41	Z_MARK2+	Reserved for future use.
42	Z_MARK2-	Reserved for future use.
43	T_MARK1+	Mark Digital input non-inverted
44	T_MARK1-	Mark Digital input inverted

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2.5.8.6 J22 - Motor Limits Connector

Label: J22 - LIMITS

Connector Type: D-type 25-pin male

Mating Type: D-type 25-pin female (for easy prototyping a Phoenix FLKM HDSUB-25/M Sub-D to Screw Terminal converter can be used)

The pinout for J22 is given in **Table 118**.

Table 118 J22 - Motor Limits Pinout

Pin #	ACSPL+ Signal Designator	Description
1	V_SUP_SFTY	Safety Supply +
2	-	Not connected
3	X_LL	X Left Limit
4	A_LL	A Left Limit
5	Y_LL	Y Left Limit
6	B_LL	B Left Limit
7	Z_LL	Z Left Limit
8	C_LL	C Left Limit
9	T_LL	T Left Limit
10	D_LL	D Left Limit
11	-	Not connected
12	-	Not connected
13	-	Not connected
14	V_RTN_SFTY	Safety Supply Return
15	-	Not connected
16	X_RL	X Right Limit
17	A_RL	A Right Limit
18	Y_RL	Y Right Limit
19	B_RL	B Right Limit
20	Z_RL	Z Right Limit
21	C_RL	C Right Limit
22	T_RL	T Right Limit
23	D_RL	D Right Limit
24	ES+	Emergency stop non-inverted
25	ES-	Emergency stop inverted

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2.5.8.7 J4, J5, and J6 - HSSI Connectors

Label: J4 - HSSI0 (X & A axes)
J5 - HSSI1 (Y & B axes)
J6 - HSSI2 (Z & C axes)

Connector Type: RJ45 8-pin sockets

Mating Type: RJ45 8-pin plug

The pinout of the sockets is given in **Table 119**.

Table 119 J4, J5, and J6 - HSSI Pinout

Pin #	ACSPL+ Signal Designator	Description
1	CONTROL_$+	Control signal non-inverted output for channel 0
2	CONTROL_$-	Control signal inverted output for channel 0
3	SER_DI_$+	Serial data non-inverted input for channel 0
4	SER_DI_$-	Serial data inverted input for channel 0
5	SER_DO_$+	Serial data non-inverted output for channel 0
6	SER_DO_$-	Serial data inverted output for channel 0
7	DGND	Digital ground for 5L
8	DGND	Digital ground for 5L

2.5.8.8 J2 and J3 - Ethernet Connectors

Label: J2 - ETH1
J3 - ETH2

Connector Type: RJ45 8-pin socket

Mating Type: RJ45 8-pin plug

The pinout of the sockets is given in **Table 120**.

Table 120 J2 and J3 - Ethernet Pinout

Pin #	ACSPL+ Signal Designator	Description
1	ETH$_TX+	Positive transmit signal
2	ETH$_TX -	Negative transmit signal
3	ETH$_RX +	Positive receive signal
4	-	Not connected
5	-	Not connected
6	ETH$_RX -	Negative receive signal
7	-	Not connected
8	-	Not connected

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2.5.8.9 J19 and J20 RS-232 Communication Connectors

Label: J19 - COM1
J20 - COM2

Connector Type: D-type 9-pin male sockets

Mating type: D-type 9-pin female

The pinout for the sockets is given in **Table 121**.

Table 121 J19 and J20 - RS-232 Communication Pinout

Pin #	ACSPL+ Signal Designator	Description
1	SHIELD	Cable shield connection
2	RX232	RS-232 receive signal for the communication port (J19 for COM1, and J20 for COM2)
3	TX232	RS-232 transmit signal for communication port (J19 for COM1, and J20 for COM2).
4	-	Not connected
5	DGND	Digital ground.
6	-	Not connected
7	-	Not connected
8	-	Not connected
9	-	Not connected

2.5.8.10 J14 - Drive Supply Voltage Connector

Label: J14 - DRIVE SUPPLY

Connector Type: Phoenix FRONT 4V-7,62

Mating Type: None (screw terminal)

AC power is provided through J14. The pinout for the connector is provided in **Table 122**.

Table 122 J14 - Drive Supply Voltage Pinout

Pin #	ACSPL+ Signal Designator	Description	Remarks
1	EGND	Earth Ground (shield)	
2	L3	AC input phase L3	
3	L2	AC input phase L2	When using AC single-phase, the voltage has to be connected between L1 and L2.
4	L1	AC input phase L1	

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2.5.8.11 J1 - 24V Logic Supply Connector

Label: J1 - 24V LOGIC SUPPLY

Connector Type: Phoenix MCV-1.5/5 GF 3.81

Mating Type: Phoenix MC-1.5/5 STF- 3.81

24Vdc is provided through J1. The J1 pinout is provided in **Table 123**.

Table 123 J1 - 24V Logic Supply Pinout

Pin #	ACSPL+ Signal Designator	Description
1	24V_SUP	24V logic supply
2	24V_RTN	24V logic supply return
3	5V_ENC_EXT	External 5V supply for encoder
4	5V_ENC_EXT_RTN	External 5V supply return for encoder
5	EGND	Electrical Ground

2.5.8.12 J40 - T and D External Drive Control Signals

Label: J40-EXTERNAL

Connector Type: D-type HD 15-pin female

Mating Type: D-type HD 15-pin male

J40 serves for supplying control signals to external drives. The J40 pinout is given in **Table 124**.

Model	
	*If SPiiPlus 3U-LT is installed, this connector is inactive.*

Table 124 J40 - External Drive Control Signals Pinout (page 1 of 2)

Pin #	ACSPL+ Signal Designator	Description
1	T_CMD0+	T Drive Command 0+
2	T_CMD0-	T Drive Command 0-
3	T_CMD1+	T Drive Command 1+
4	T_CMD1-	T Drive Command 1-
5	T_ENA	T axis enable signal
6	D_CMD0+	D Drive Command 0+
7	D_CMD0-	D Drive Command 0-
8	D_CMD1+	D Drive Command 1+
9	D_CMD1-	D Drive Command 1-
10	T_FLT	T axis fault signal

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Table 124 J40 - External Drive Control Signals Pinout (page 2 of 2)

Pin #	ACSPL+ Signal Designator	Description
11	AGND	Analog ground
12	DGND	Digital ground
13	5U	5V user supply for digital encoder and Hall sensor
14	D_ENA	D axis enable signal
15	D_FLT	D axis fault signal

2.5.8.13 J152_$ - Motor Drive Output

Label: J152_X
J152_Y
J152_Z
J152_A
J152_B
J152_C

Connector Type: Phoenix PCV 4/4-G-7,62-BK

Mating Type: Phoenix PC 4/ 4-STF-7,62

The connectors are allocated as follows:

Connector	Axis	Connector	Axis
J152_X	X	J152_A	A
J152_Y	Y	J152_B	B
J152_Z	Z	J152_C	C

The J152_$ pinout is given in **Table 125**.

Table 125 J152_$ - Motor Drive Pinout

Pin #	ACSPL+ Signal Designator	Description
1	EGND	Shield
2	$_R	Motor $ R phase
3	$_S	Motor $ S phase
4	$_T	Motor $ T phase

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The diagrams in **Figure 24**illustrate how motors are to be connected.

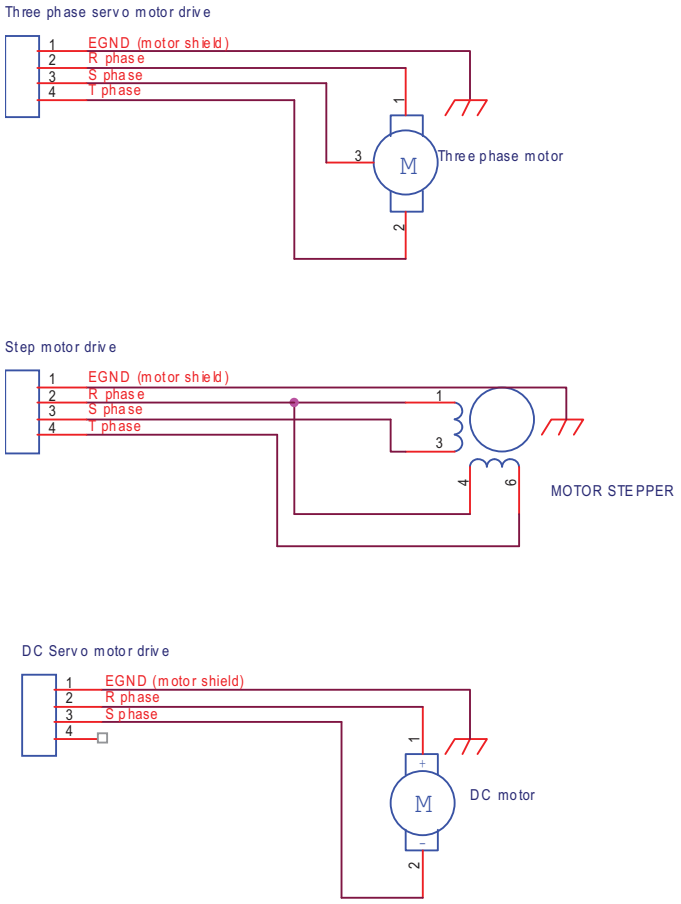


Figure 24 MB5U-ZZW J152 Motor Drive Connections

2.5.8.14 J125 - External DC Drive Supply Input

Label: J125 -EXTERNAL DC

Connector Type: Phoenix EMSTBV 2,5/2-GF-BK

Mating Type: Phoenix MSTB2,5/2-STF-BK

J125 serves for supplying input to an external DC drive.

Model	
	*This connector is valid only if the DDM3U-4-60 Motor Drive is installed.*

The J125 pinout is given in **Table 126**.

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Table 126 J125 - External DC Drive Support Pinout

Pin #	ACSPL+ Signal Designator	Description
1	VP_2	24-48V external supply for DDM3U-4-60
2	VP2_RTN	Drive supply return

2.5.8.15 J121 - J124 Low Power Motor Connectors

Label: J121(D0)
J122(D1)
J123(D2)
J124(D3)

Connector Type: Phoenix MCV-1.5/4 GF 3.

Mating Type: Phoenix MC-1.5/4 STF- 3.81

The connectors are allocated as follows:

Connector	Axis	Connector	Axis
J122 (D1)	Drive 1	J124 (D3)	Drive 3
J121 (D0)	Drive 0	J123 (D2)	Drive 2

The pinout for the Low Power Motor Drive connectors is given in **Table 127**.

Table 127 J121-J124 - Low Power Motor Pinout

Pin #	ACSPL+ Signal Designator	Description
1	R_$	Motor $ R phase
2	S_$	Motor $ S phase
3	T_$	Motor $ T phase
4	EGND	Electrical Ground

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The diagrams in **Figure 25**illustrate how motors are to be connected.

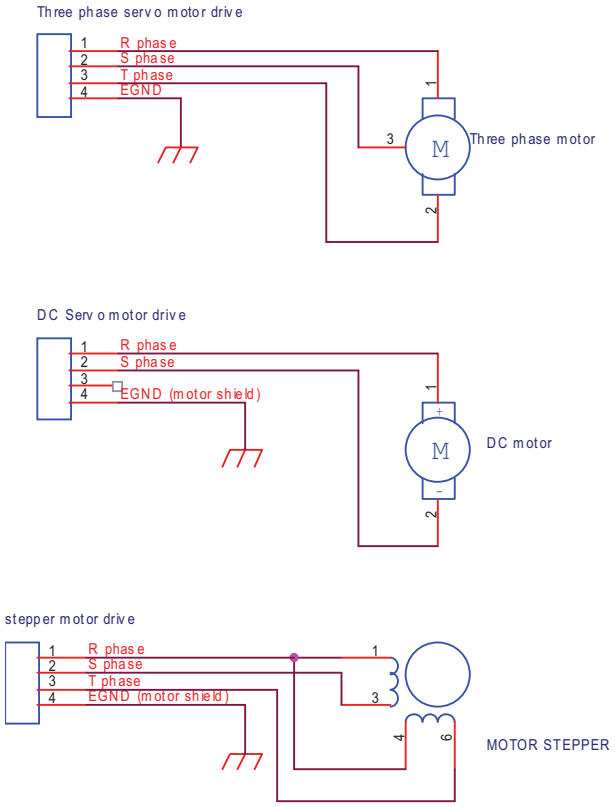


Figure 25 MB5U-ZZW J121-J124 Motor Drive Connections

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2.5.9 MB5U-LDM3U Motherboard

The MB5U-LDM3U is installed in the 19” MC4U.

The connectors associated with the MB5U-LDM3U motherboard are shown in **Figure 26**.



Figure 26 MB5U-LDM3U Connectors

2.5.9.1 MB5U-LDM3U Functionality

The MB5U-LDM3U accomodates the LDM3U Single Axis Linear Amplifier (see **Section 2.4.3**).

2.5.9.2 J2 - Drive Motor Connector

J2 - DRIVE MOTOR is a Phoenix MCV 1,5/4-GF-3,81 connector.

Mating type: Phoenix MC 1,5/4-STF-3,81

Table 128 provides the pinout for J2.

Table 128 J2 - Drive Motor Pinout

Pin	Name	Description
1	R	Motor R phase
2	S	Motor S phase
3	T	Motor T phase
4	Electrical Ground	Electrical Ground

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2.5.9.3 MB5U-LDM3U Jumper Configuration

Warning	
	***Only a qualified technician should make any changes to the factory settings of the jumpers. Remove the back cover of the unit to access the jumpers.***

Table 129 provides details of the MB5U-LDM3U jumper configuration.

Table 129 MB5U-LDM3U Jumper Configuration

Name	Description	Functionality
JP1	18AWG Wire	OFF: Power Sequence Control circuit is used ON: Power Sequence Control circuit is bypassed
JP2, JP3, JP4		ON: ±12Vdc from Power Sequence Control circuit is used OFF: Not Connected
JP5, JP6, JP7, JP8		ON: Is, It drive current feedback signals are used OFF: Not Connected
JP9		1-2: AGND is connected to 12_RTN 3-2: AGND is connected to DGND
JP10, JP11		ON: R_CMD analog command for phase "R" is used OFF: Not Connected
JP12, JP13, JP14	I2C A0, A1, A2	Used for setting the I^2C address: Set the JP12, JP13 & J14 to: "000" when the motherboard assembled is slot number 0. "001" when the motherboard assembled is slot number 1. "010" when the motherboard assembled is slot number 2. "011" when the motherboard assembled is slot number 3. "100" when the motherboard assembled is slot number 4. "101" when the motherboard assembled is slot number 5. "110" when the motherboard assembled is slot number 6. "111" when the motherboard assembled is slot number 7. 0 - the jumper is installed. 1 - the jumper is removed.

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2.6 MC4U Accessories

There are a number of optional accessories for the MC4U Control Module. These include:

- Motor Filter
- Regneration

This section provides a complete description of each accessory.

2.6.1 Motor Filter

The MC4U-MF-560V 3-phase Motor Filter (shown in **Figure 27**) is designed for applications that are especially sensitive to electrical noise. The Motor Filter is connected in series between the amplifier and the motor. The filter attenuates the noise induced by the drive's high current switching.



Figure 27 MC4U-MF-560V Motor Filter

The filter is housed in a 14cm by 12.7 cm metal enclosure, with power-in and power-out PHOENIX connectors. The filter's mechanical design provides for wall mounting.

2.6.1.1 Motor Filter Operational Specifications

Table 130 provides details of the MC4U-MF-560V Motor Filter operating parameters.

Table 130 MC4U-MF-560V Motor Filter Operational Specifications (page 1 of 2)

Item	Value
Maximum input continuous voltage (rms)	440Vac
Maximum input peak voltage	620V
Maximum continuous input current	20A

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Table 130 MC4U-MF-560V Motor Filter Operational Specifications (page 2 of 2)

Item	Value
Maximum input peak current up to 1 second from startup	40A
Maximum output continuous voltage (rms)	440Vac
Maximum output peak voltage	620V
Maximum output continuous current	20A
Maximum output peak current up to 1 second from startup	40A
Safety and EMC approval	UL508C
Ambient operating temperatures	0 to 40°C
Storage temperatures	-25° to +60°C

2.6.1.2 J1 - Drive Connector

J1 is a Phoenix PCV 4/5-G-7,62 high current power, 5-pin, header. It is designed for a 20Arms continuous contact current and a working voltage of 400Vrms. The connector can handle a minimum of 500 couplings. The pinout for J1 is provided in **Table 131**.

Table 131 J1 Pinout

Pin	Name	Description
1	T(L1_D)	Input- Driver phase
2	S(L2_D)	Input- Driver phase
3	R(L3_D)	Input- Driver phase
4	-	Not connected
5	PE(EGND)	Shield

2.6.1.3 J2 - Motor Connector

J2 is a Phoenix PC 4/4-G-7.62 high current power, 4-pin, header. It is designed for a 20Arms continuous contact current and a working voltage of 400Vrms. The connector can handle a minimum of 500 couplings. The pinout for J2 is provided in **Table 132**.

Table 132 J1 Pinout

Pin	Name	Description
1	T(L1_M)	Output-Motor phase
2	S(L2_M)	Output-Motor phase
3	R(L3_M)	Output-Motor phase
4	PE(EGND)	Shield

2.6.1.4 Motor Filter Physical Specifications

The MC4U-MF-560V Motor Filter is designed for rack mounting; although, as an option, it can be wall mounted.

Figure 28gives the external dimensions (in mm) of the MC4U-MF-560V Motor Filter.

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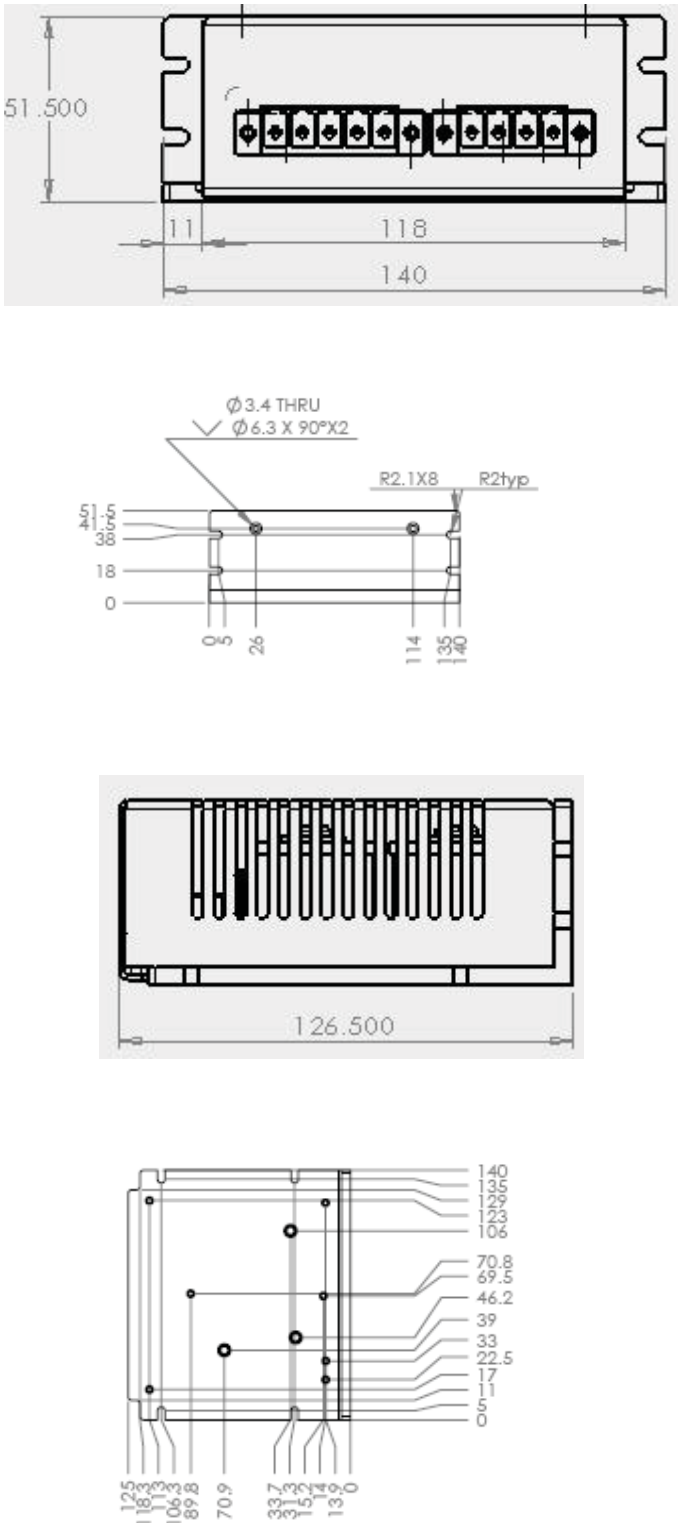


Figure 28 MC4U-MF-560V Motor Filter External Dimensions

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2.6.1.5 Connecting the MC4U-MF-560V

The filter is positioned between the drive and the motor and is designed for currents up to 20A continuous, and 40A peak.

Caution	
	***The Motor Filter should be cooled by an external fan when input current is more than 10Arms, otherwise the unit can be damaged.***

When connecting the MC4U-MF-560V, the filter has to be located as close as possible to the amplifier. The cable connecting the filter and amplifier should be shielded. It is recommended that continuity be maintained between the shields of the two cables.

2.6.2 Regeneration Module



Figure 29 MC4U Regeneration Module

The Regeneration Module enables the user to incorporate an external regeneration resistor into the system to absorb the motor regeneration energies of more than 100W rms.

The external regeneration resistor value depends on the application. The resistance value in this module is 26Ω/600W.

For complete details of Regeneration see **Section 4.1.2**.

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3 Safety and EMC Guidelines

3.1 Certification

The following standards and certificates apply to the MC4UControl Module:

Table 133 International Standards & Certificates Applicable to MC4U

Market	Category	Standard
Europe	Safety	EN 61010-1:01
Canada	Safety	C22.2 No.0
Canada	Safety	C22.2 No.14
USA	Safety	ANSI/UL 508C
Europe	EMC	EN 61326:2002
International	EMC	SEMI F47-0200

Figure 30 shows the standards organization marks that appear on the MC4U Control Module.



Figure 30 Standards Organization Marks

The CE marking indicates that the MC4U meets all the essential requirements of the relevant European Directive(s).

The ‘C’ and ‘US’ indicators adjacent to the Underwriters’ Laboratories Mark signify that the MC4U has been evaluated to the applicable CSA and ANSI/UL Standards for use in Canada and the U.S., respectively. The ‘US’ indicator includes products eligible to bear the ‘NRT’ indicator. NRT, i.e., National Recognized Testing Laboratory, is a designation granded by the U.S. Occupational Safety and Health Administration (OSHA) to laboratories which have been recognized to perform certification to U.S. Standards 163785, January 25, 200223301637853.

Model	
	*The DDM3U-4-60V-2A Motor Drive is not UL certified. It does, however, meet all relevant CE requirements.*

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3.2 General Safety Guidelines

Under emergency situations the MC4U must be completely disconnected from any power supply. The E-Stop Inputs and Left/Right Limits of the MC4U are designed for use in conjunction with customer-installed devices to protect driver load. The operator is responsible for complying with all Electrical Codes.

3.2.1 MC4U Handling & Maintenance

Warning	
	***It is absolutely forbidden to touch the MC4U unit or component whenever power is being applied for maintenance purposes.*** ***Whenever any MC4U maintenance has to be performed, all cables and input power to the unit have to been disconnected. A period of 30 minutes to allow complete voltage discharge must be strictly adhered to before removing the MC4U or disassembling any of its components.***

3.2.2 Emergency Stop Device

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

3.2.3 Fail Safe Logic Recommendation

ACS Motion Control recommends connecting all safety inputs (limit inputs and emergency stop input) with a fail safe logic whenever the normal operation the inputs are active.

Note	
	*When an unsafe event happens, the input becomes zero and the controller identifies this as a fault.*

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3.2.4 Initial Logic State of Outputs

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

3.2.5 Electrical Separation

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

3.2.6 Over-Travel Protection

Warning	
	***Over-travel limit protection must be provided where over-travel is hazardous. The over-travel limiting device must be capable of interrupting the power circuit.***

3.2.7 Thermal Detection

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

3.2.8 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 grounding post (located on the MC4U enclosure) and the equi-potential bar inside electrical enclosure.

3.3 General Wiring and Electromagnetic Compatibility (EMC) Guidelines

3.3.1 External AC Line Filters

In order to comply with the EN 61326:2002, line filters must be employed. The line filters for single phase input AC are given in **Table 134** and those for three phase input AC are given in **Table 135**.

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Table 134 Line Filters for Single Phase AC Input

Input Current [A rms]	Line Filter Type
8	B84142B0008R000 Epcos
12	B84142B0012R000 Epcos
16	B84142B0016R000 Epcos
25	B84142B0025R000 Epcos
36	B84143B0036R110 Epcos

Table 135 Line Filters for Three Phase AC Input

Input Current [A rms]	Line Filter Type
8	B84143B0008R000 Epcos
12	B84143B0012R000 Epcos
16	B84143B0016R000 Epcos
25	B84134B0025R110 Epcos
36	B84143B0036R110 Epcos

3.3.2 ACS Motor Filters

In order to comply with the EN 61326:2002, ACS motor filters must be employed.

3.3.3 Routing Signal and Power Cables

Power cables (to the motors, 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 between cables running in parallel as illustrated in **Figure 31**. 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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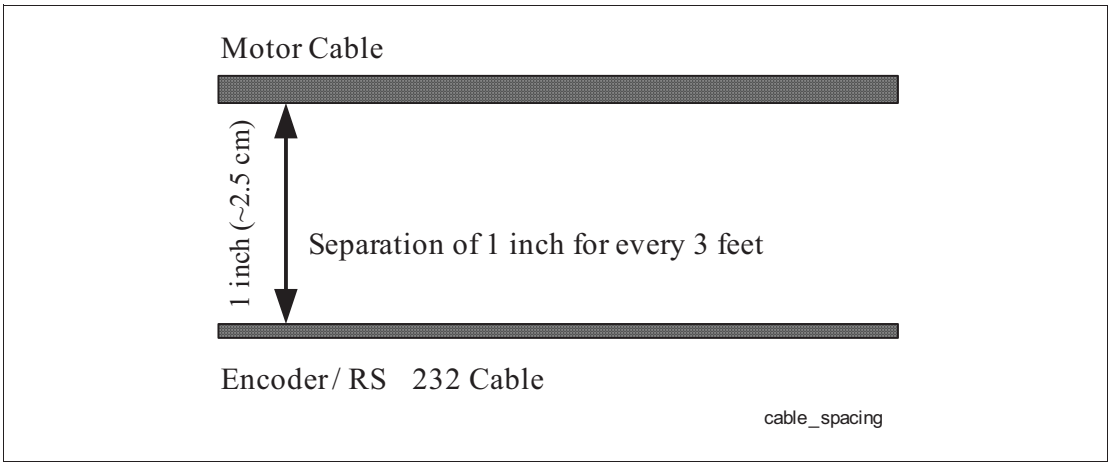


Figure 31 Cable Spacing

It is recommended to use completely shielded cables as illustrated in **Figure 32**.

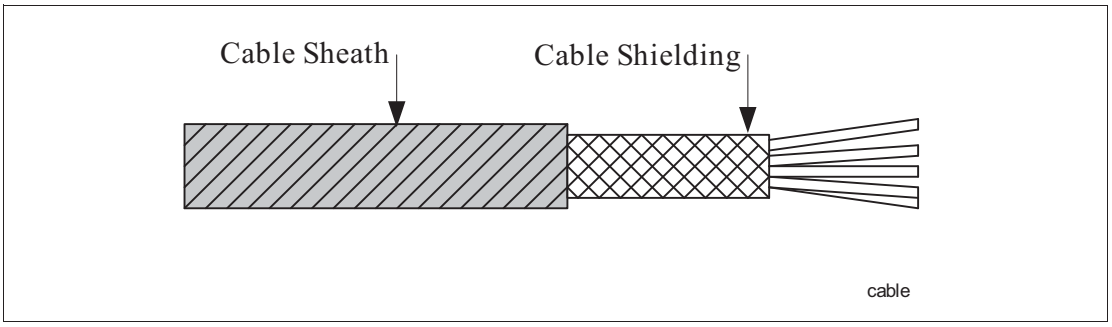


Figure 32 Shielded Cable

3.3.4 Cable Length

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

- The motor phase cable should not be more than 10 meters in length, shielded, and the shield wire should be connected to both the motor and the MC4U motor connector (PE terminal).
- The encoder cable should not be more than 10 meters in length, shielded, and the shield wire should be connected to both the motor and the MC4U encoder connector.

3.3.5 Grounding

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

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3.3.5.1 Safety Grounding

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

3.3.5.2 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 in the center of the MC4U Interface, shown in **Figure 33**) and the equi-potential bar inside the Mechanical Housing.

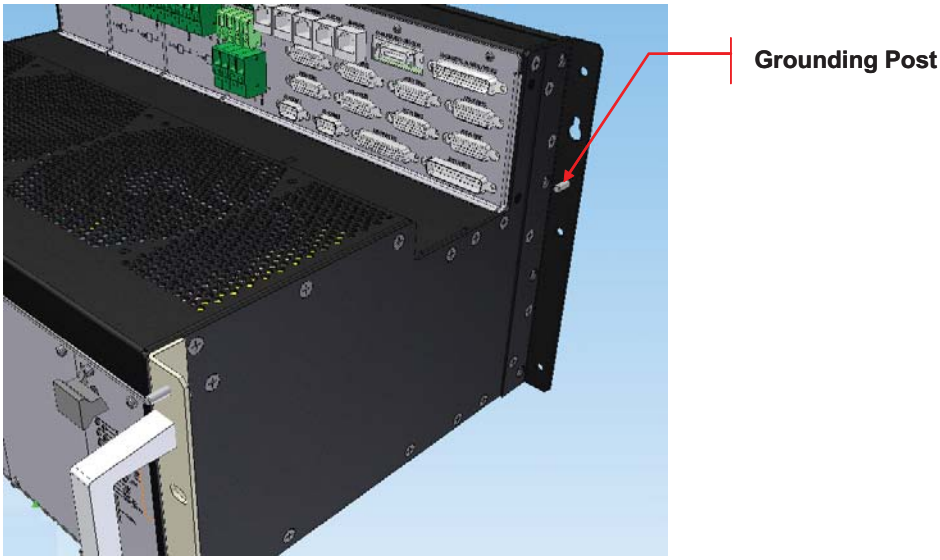


Figure 33 MC4U Grounding Post

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3.4 Cooling Vents

In order to improve the MC4U MTBF it is recommended that the cooling vents be replaced after 33,000 hours of operation.

Note	
	*The operating time of the unit can be monitored by incorporating the* **TIME** *command (see the SPiiPlus Command & Variable Reference Guide) in any program.*

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4 Circuit Protection

This chapter contains details of the various protection circuits and devices contained in the MC4U to ensure safe operation.

4.1 Internal Integrated Drive Protection Circuits

4.1.1 Soft Start Circuit

Caution	
	***When AC voltage is initially applied to the MC4U PSM3U Power Supply (through connector J14), a 10 second delay is required until the power supply is ready and can accept an ENABLE command for any axis. Otherwise the power supply may be damaged.***

The Soft Start circuit eliminates high inrush current when AC input voltage is applied to the power section of the PSM3U-320V-XXkW power supply. The Soft Start circuit also protects against damage the power transistors in power amplifiers during the power up in case of any of the amplifier outputs is shorted to the electrical ground (EGND).

The maximum inrush current value is 3.75A.

The Soft Start circuit consists of Soft Start resistor (100Ω resistance and 100W nominal power), NTC resistor (inrush current protection) and Soft Start Relay driven by the Soft Start control circuit.

When AC input voltage is applied to the power section of the PSM3U-320V-XXkW power supply, the electrolytic capacitors are charged via the Soft Start and NTC resistors. The Soft Start control circuit will switch ON the Soft Start Relay after a 4.8 - 7.2 Sec time delay, which will bypass the Soft Start and NTC resistors. If AC input voltage is disconnected for more than 36 mSec, the Soft Start control circuit will be reset within 5-10 mSec.

4.1.2 Motor Regeneration Circuit

An internal or an external (optional) Regeneration resistor can be used in the Regeneration circuit to absorb the motors' regeneration energy. The Regeneration circuit is activated when the DC BUS output voltage exceeds 400V±3% (388 - 412V) and protects the DC BUS electrolytic capacitors from the extra DC voltage stress (450V maximum voltage surge value for these capacitors).

Internal regeneration resistor is used to absorb the motors regeneration energy less then 100W rms. This resistor is connected to J5 connector on PSM3U-320V-XXkW board when the external regeneration resistor is not used. If the external regeneration resistor is used, the internal regeneration resistor must be disconnected from connector J5; otherwise it will work in parallel with the external resistor and just heat the power supply heatsink without any reason.

The internal regeneration resistor value is 100Ω, 100W (2kW peak).

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An external regeneration resistor can be used to absorb the motor regeneration energies of more than 100W rms. This resistor can be connected to REG1 user connector that is located on the power supply motherboard.

The external regeneration resistor value depends on the application. The minimum value is 15Ω.

4.1.3 I²C Circuit

The I²C circuit is card and fault identification bus that serves to identify faults that may occur in the MC4U components. There are two signals associated with the I²C circuit. **Table 136** provides the general characteristics of the I²C signals. Each component of MC4U has its own local address defined by jumpers on the motherboard according system configuration.

Table 136 I²C Signals

Signal	ACSPL+ Designation	Type	Default Value
CLOCK	I2C_CLK	Single ended TTL input	"1" logic level
DATA	I2C_DATA	Single ended TTL input/output	"1" logic level

The signals are handled by the SPiiPlus 3U controller. The sections that follow detail what can be reported via the I²C bus for each of the MC4U modules.

4.1.3.1 PSM3U Low Power PS

In PSM3U-48V-XXkW power supplies the I²C circuit is used for the following, non-real-time purposes

- **Power supply fault cause status reading**

  If a power supply fault signal goes to "0", due to one of the following conditions, "component fault: power down" will be read via I²C (the controller, however, is not able to differentiate between the four root causes):

  - Drive Supply Alarm: Power supply is missing (AC input is missing)
  - Drive Supply Alarm: Temperature too high
  - Drive Supply Alarm: Drive supply too high
  - Drive Supply Alarm: Over current
- **Power supply card identification reading**

  The power supply card identification information is located in I²C memory and can be read or written by the motion controller:

  - Power supply card serial number
  - Power supply card revision
  - Power supply card date of production
  - Power supply type

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4.1.3.2 PSM3U High Power PS

In PS3U-11a-23a-30N-XX power supplies the I^2C circuit is used for the following, non-real-time purposes:

- **Power supply fault cause status reading**

  If a power supply fault signal goes to “0” due to a power supply fault condition, the following fault cause status information can be read:

  - Drive Supply Alarm: “component fault: phase lost”
  - Drive Supply Alarm: “component fault: power down”
  - Drive Supply Alarm: “component fault: power supply not ready”
  - Drive Supply Alarm: “component fault: regeneration fault”
  - Drive Supply Alarm: “component fault: temperature too high”

- **Power supply fault cause status resetting**

  If a power supply fault signal goes to "0" due to a power supply fault condition, the controller can reset the fault cause status information.

- **Power supply card identification reading**

  The power supply card identification information is located in the I^2C I/O Port memory and can be read by the motion controller:

  - Power supply card serial number
  - Power supply card revision
  - Power supply card date of production
  - Power supply type

4.1.3.3 DDM3U Low Power Motor Drive

In DDM3U-4-06-XX-Y power block the I^2C bus is used for the following, non-real-time purposes:

- **Drive fault cause status reading**

  If a "$ Drive Fault signal" goes to "1" due to a drive fault condition, the following fault cause status information can be read:

  - Drive Alarm: Power supply too high
  - Drive Alarm: Power supply too low
  - Drive Alarm: Short circuit
  - Drive Alarm: Temperature too high
  - Drive fault cause status resetting:

  If a "$ Drive Fault" signal goes to "1" due to a drive fault condition, the controller can reset the fault cause status information.

  If a "$ Drive Enable" or "Brake" command is issued, the fault cause status information should be reset.

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- **Drive card identification reading**

  The drive card identification information is located in I^2C I/O Port memory and can be read by the motion controller:

  - Drive card serial number
  - Drive card revision
  - Drive card date of production
  - Drive type: Number and type of assembled power bridges, Drive supply voltage, Drive output current

4.1.3.4 DDM3U High Power Motor Drive

In DDM3U-2-320V-YY driver the I^2C bus is used for the following, non-real-time purposes:

- **Drive fault cause status reading**

  Once a "$ Drive Fault signal" goes to "1" in case of drive fault condition, the following fault cause status information can be read:

  - Drive Alarm: Power supply too high
  - Drive Alarm: Power supply too low
  - Drive Alarm: Short circuit
  - Drive Alarm: Over current
  - Drive Alarm: Temperature too high
  - Drive fault cause status resetting

  If a "$ Drive Fault" signal goes to "1" due to a drive fault condition, the controller can reset the fault cause status information. This switches the PWM Power Bridge (Power Amplifier) status LED "PA$" to "Off" as well.

  If a "$ Drive Enable" command is issued, the fault cause status information should be reset.

- **Drive card identification reading**

  The drive card identification information is located in I^2C I/O Port memory and can be read by the motion controller:

  - Drive card serial number
  - Drive card revision
  - Drive card date of production
  - Drive type: Number of assembled power bridges, Drive supply voltage, Drive output current

4.2 Cooling Vent

The 9” MC4U has one cooling vent, the 11” MC4U has two, and the 19” MC4U has three. Each vent provides a maximum of 120 CFM air flow for the internal cooling of the circuit boards within the Mechanical Housing. The cooling vents operate off the 24V Logic Supply. The current consumption of the cooling vents is 1A or less (depending on the number of vents).

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4.3 Fuses

The circuitry of the MC4U is protected by a number of fuses. The following sections provide details of fuses, by MC4U module.

4.3.1 PSM3U Power Supply

The number of fuses in the PSM3U Power Supply module depends on whether the Low Power PS or the High Power PS is installed.

4.3.1.1 PSM3U Low Power AC Input Power

The AC input power section is protected by a fuse, the parameters of which are:

- Type: Time Delay, ceramic tube
- Ampere rating: 15A
- Voltage rating: 250Vac
- Agency approvals: UL, CSA

If this fuse blows, all motor drivers supplied from the power supply are disabled.

4.3.1.2 PSM3U Low Power 24Vdc Logic Supply Input

The 24Vdc input circuit is protected against shorts or overloads as the result of the control supply internal circuits damage by a fuse, the parameters of which are:

- Type: Very fast acting, SMT
- Ampere rating: 5A
- Voltage rating: 125Vac/dc
- Agency approvals: UL, CSA

If this fuse blows, all motor drivers supplied from the power supply are disabled.

4.3.1.3 PSM3U High Power AC Input Power

The AC input power section is protected by three fuses (one fuse for each input phase), the parameters of which are:

- Type: Time Delay, ceramic tube
- Ampere rating: 30A fast
- Voltage rating: 250Vac
- Agency approvals: UL, CSA

If one or more of the fuses blows, all motor drivers supplied from the power supply are disabled.

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4.3.2 DDM3U Motor Drives

4.3.2.1 DDM3U-X-60V-4A Low Power Motor Drive

The DDM3U-X-60V-4A Low Power Motor Drive has the following fuses:

Control supply input fuse:

- Type: subminiature, very fast action
- Ampere rating: 2A
- Voltage rating: 125Vdc
- Agency approvals: UL

Drive supply input fuse:

- Type: very fast-acting,
- Ampere rating: 15A
- Voltage rating: 65Vdc
- Agency approvals: UL

In addition, there is protection against erroneous connection of the control supply with reverse polarity, in this case the control supply will not start to operate.

4.3.2.2 DDM3U-2-320V-YY High Power Motor Drive

The DDM3U-2-320V-YY High Power Motor Drive has the following fuses:

Control supply input fuse:

- Type: subminiature, very fast action
- Ampere rating: 2A
- Voltage rating: 125Vdc
- Agency approvals: UL

Drive supply input fuse:

- Type: fast-acting
- Ampere rating:
  - 15A for DDM3U-2-320V-5A
  - 30A for DDM3U-2-320V-10A and DDM3U-2-320V-20A
- Voltage rating: 600Vdc
- Agency approvals: UL

In addition, there is protection against erroneous connection of the control supply in reverse polarity, in this case the control supply will not start to operate.

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4.4 Fault Handling

The SPiiPlus 3U Motion Controller constantly monitors the drive input supply and if it detects a fault, it issues a warning message. **Table 137** lists the fault conditions and the actions that the MC4U takes, as well as the warning messages that SPiiPlus 3U generates.

Table 137 Fault Handling (page 1 of 2)

Condition	Action Taken	Remarks
Drive supply too high	• DDM3U-4-06-02 Disables all drivers when DC BUS voltage exceeds 72±5%. SPiiPlus 3U generates the message: "Drive Alarm: Power supply too high". • DDM3U-2-30-XX Disables all drivers when DC BUS voltage exceeds 445±5%. SPiiPlus 3U generates the message: "Drive Alarm: Power supply too high".	
Drive supply missing	Disables all drivers when the drive power supply is missing or the drive power supply voltage is less than 19.5V±5% (18.5 - 20.5V). SPiiPlus 3U generates the message: "Drive Alarm: Power down".	
24Vdc control supply missing	Disables the drives when the drive 24Vdc control supply is missing or 24Vdc control supply input fuse is blown. SPiiPlus 3U does not generate a message. The protection is activated only when the 24Vdc was working properly and then stopped.	
Phase lost (for three-phase AC input supply only)	In the event that one of the AC input supply phases is lost or one of the AC input fuses is blown all axis drivers which are supplied by this power supply are disabled. SPiiPlus 3U generates the message: "Drive Supply Alarm: Phase lost".	JP6 jumper should be installed in thePSM3U-320V-XXkW board if a three-phase input supply is used.
Drive phase-to-phase or phase-to-ground short circuit	Disables the corresponding drive when the current through one of the outputs of the PWM Power Bridge exceeds: • 25A ±5% for DDM3U-2-30-05 • 50A ±5% for DDM3U-2-30-10 • 40A-120A ±5% for DDM3U-2-30-20 • 7.5A ±5% for DDM3U-4-06-02 SPiiPlus 3U generates the message: "Drive Alarm: Short circuit".	
Drive over temperature	Disables the corresponding drive when the temperature in the PWM Power Bridge area is greater than 100±5°C. SPiiPlus 3U generates the message: "Drive Alarm: Temperature too high".	

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Table 137 Fault Handling (page 2 of 2)

Condition	Action Taken	Remarks
Power supply not ready	Disables all drivers during a Soft Start period. SPiiPlus 3U generates the message: “Drive Alarm: Power supply not ready”.	
Power supply missing	If the AC input supply is disconnected or one AC input fuse is blown (in the case of the single phase input supply), or more than one AC input fuse is blown (in the case of the three-phase input supply), all axis drivers which are supplied by this power supply are disabled. SPiiPlus 3U generates the message: “Drive Supply Alarm: Power supply is missing”.	
Power supply over voltage	When the power supply output voltage is more than the tolerance range: 60-70V, the power supply (only the 48V) is shut down.	For over voltage fault recovery, the AC input must be removed and reapplied.
Power supply over temperature	When the temperature in the power supply is more than: • 100-130°C for the PSM3U Low Power PS • 90±5°C for the PSM3U High Power PS The power supply is shut down. All axis drivers which are supplied by the power supply are disabled. SPiiPlus 3U generates the message: “Drive Supply Alarm: Temperature too high”.	To recover from the over temperature fault, the AC input must be removed and reapplied.
Power supply over current	When the current via the output voltage is more than 18.25A, the power supply (only the 48V) is shut down.	
Drive over current	Disables the corresponding drive when the current through one of the outputs of the PWM Power Bridge exceeds: • 15A ±5% for DDM3U-2-30-05 • 30A ±5% for DDM3U-2-30-10 • 60A ±5% for DDM3U-2-30-20 SPiiPlus 3U generates the message: “Drive Alarm: over current”.	
Regeneration fault	Disables all drivers when there is a short-circuit on the regeneration resistor (internal or external). SPiiPlus 3U generates the message: “Drive Alarm: Regeneration Fault”.	

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5 MC4U Connectivity

This chapter details the MC4U Control Module connectivity.

5.1 Incremental Digital Encoder Interface

The digital encoder channel A, Channel B and Index inputs are built around 26C32 line receivers with 120Ω termination resistors. The use of encoders with built-in line drivers, such as AM26C31 or similar, is recommended. **Figure 34** is an example (for the X-axis) of an incremental encoder connection.

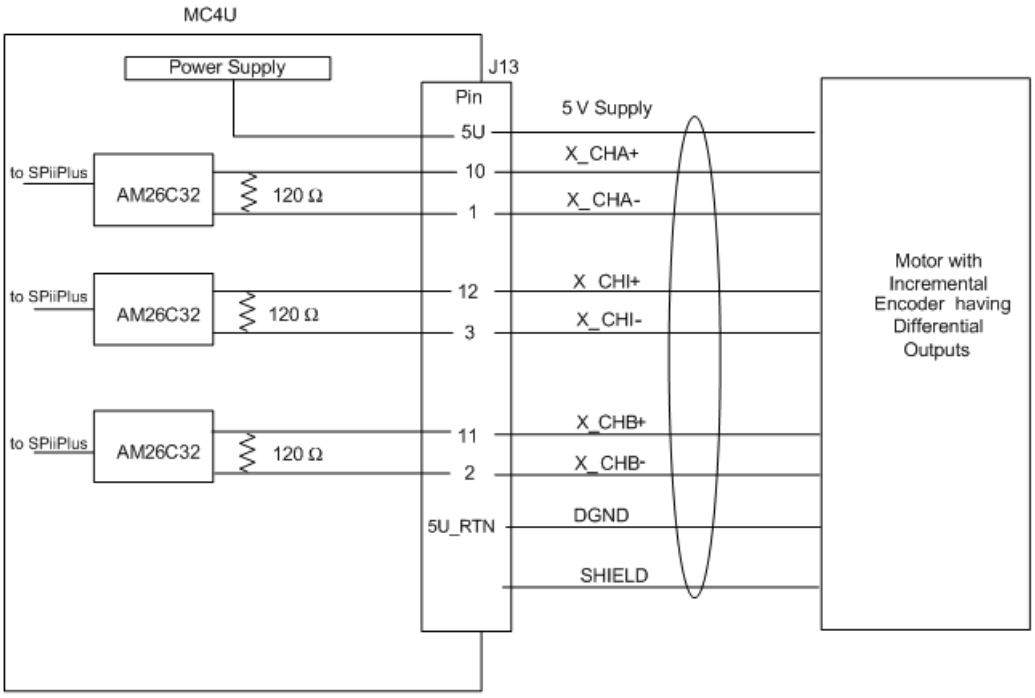


Figure 34 Incremental Digital Encoder Interface (X-axis)

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5.2 Motor Temperature Input

Figure 35 shows the motor temperature input for the X-axis.

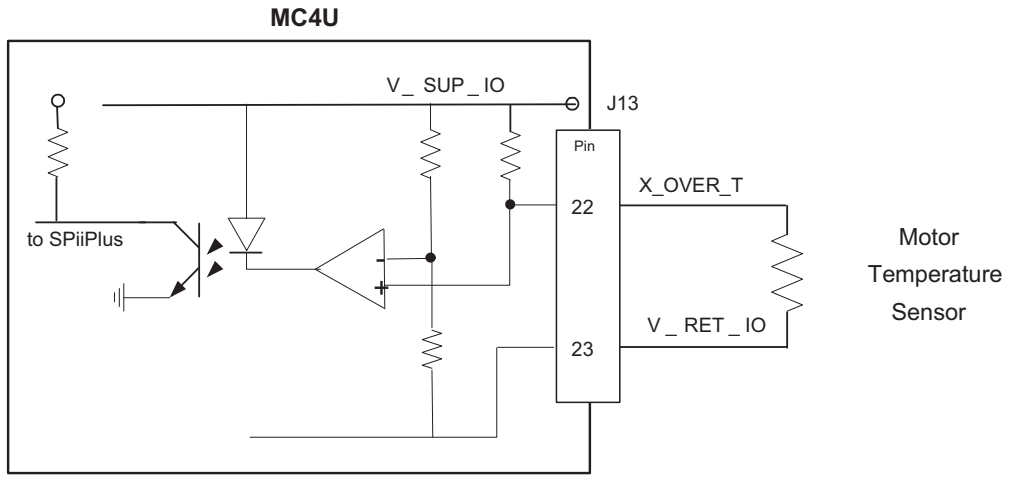


Figure 35 Connection to Motor Temperature Input (X-axis)

5.3 Emergency Stop Input

Figure 36 illustrates the emergency stop input interface for an X-axis.

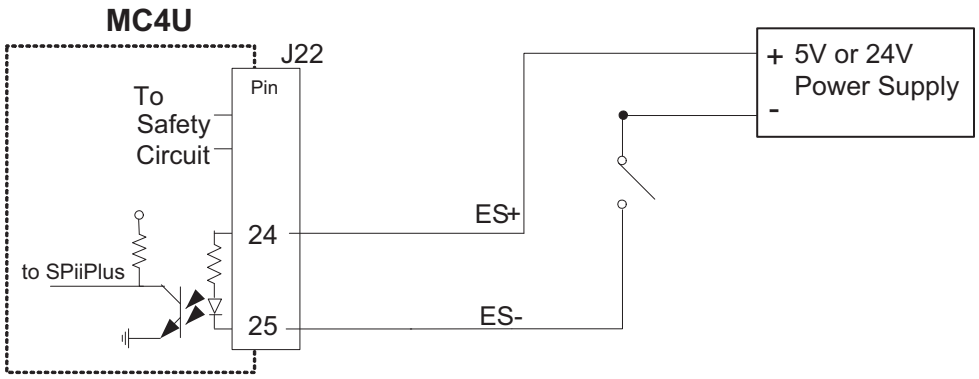


Figure 36 Connection for Emergency Stop Input

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5.4 Limit Inputs

Figure 37 is an example (for the X-axis) of a **source-type switched** limit input

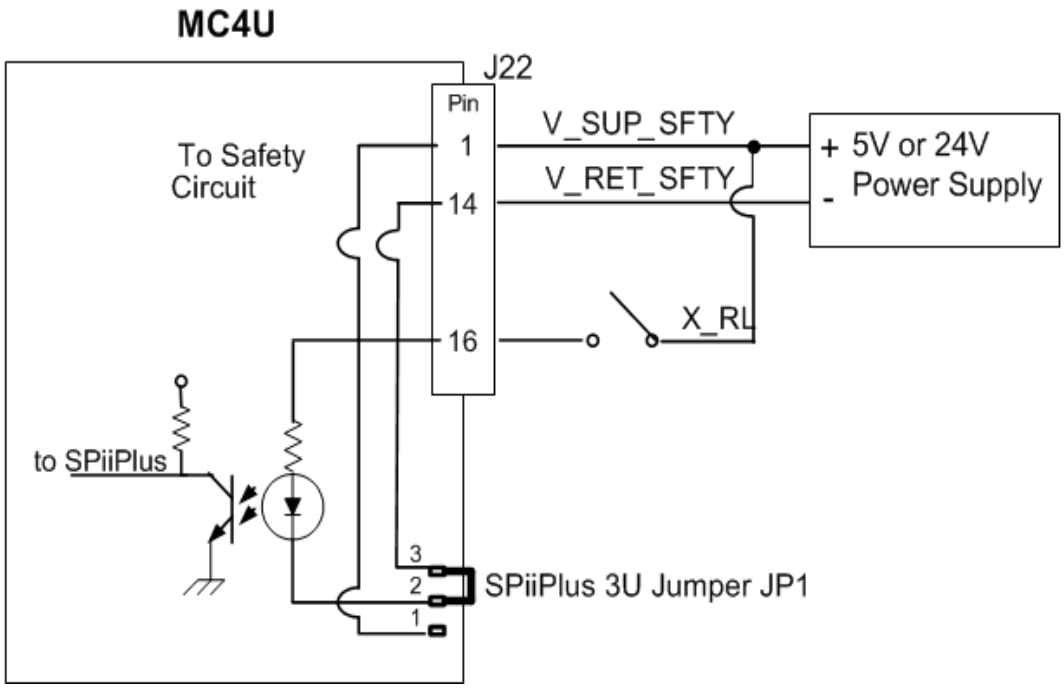


Figure 37 Source Connection for Switched Limit Input (X-axis Right Limits)

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Figure 38 is an example (for the X-axis) of a **sink-type switched** limit input.

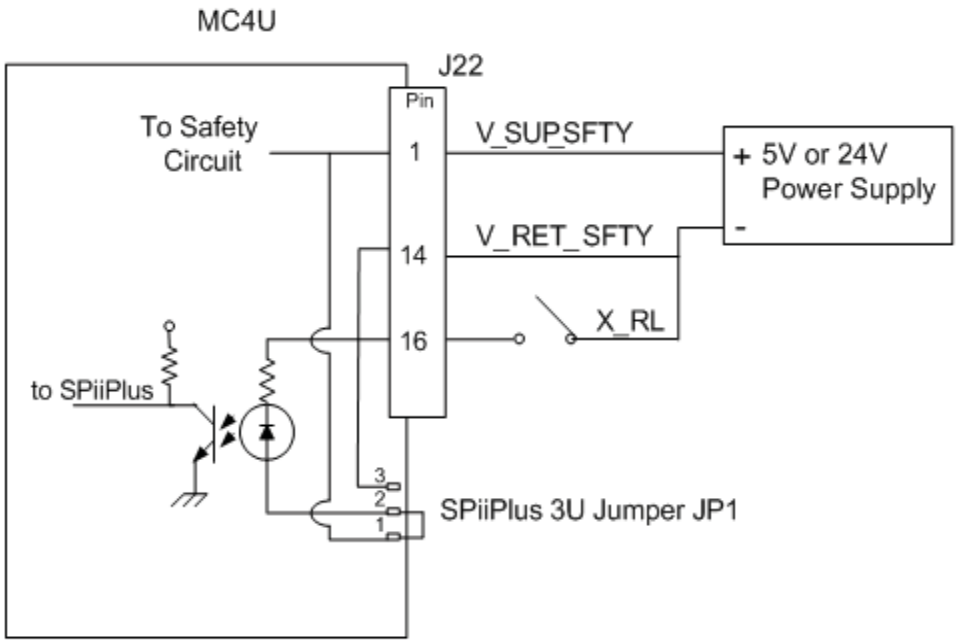


Figure 38 Sink Connection for a Switched Limit Input (X-axis Right Limit)

5.5 General Purpose Digital Input

The following examples illustrate the digital input interface.

Figure 39 is an example of a **single-ended** digital input source connection. A voltage divider is used as a source of reference voltage.

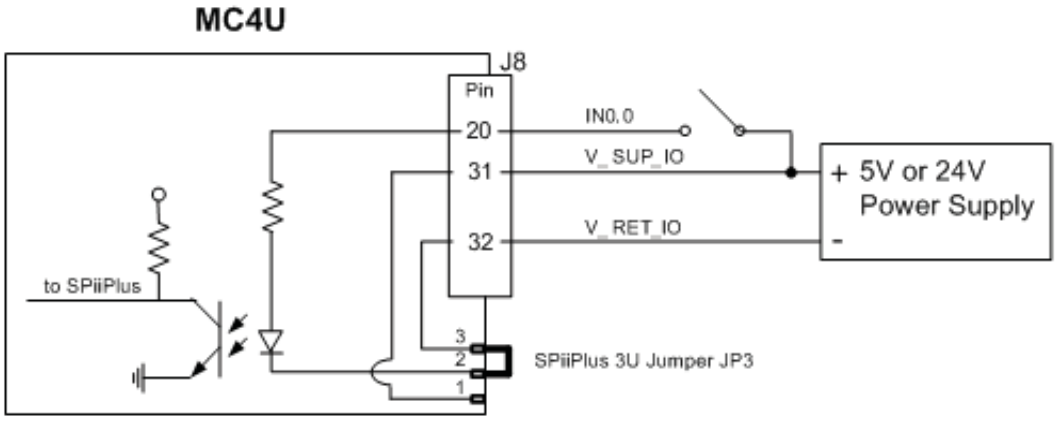


Figure 39 Single-Ended Source Connection for a Digital Input (Input 0.0)

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Figure 40 is an example of a **single-ended** digital input source connection. A voltage divider is used as a sosurce of reference voltage.

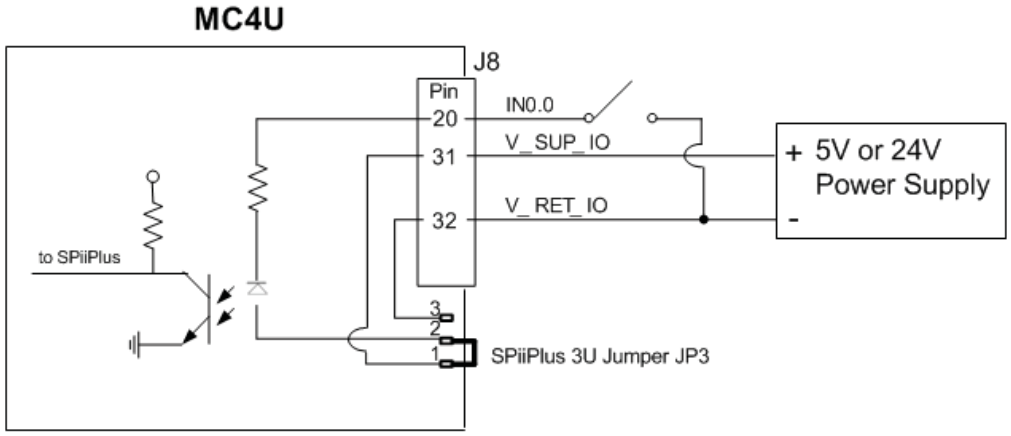


Figure 40 Single-Ended Sink Connection for a Digital Input (Input 0.0)

5.6 MARK Registration Digital Input

Figure 41 provides an example illustrating the MARK input interface for an X-axis.

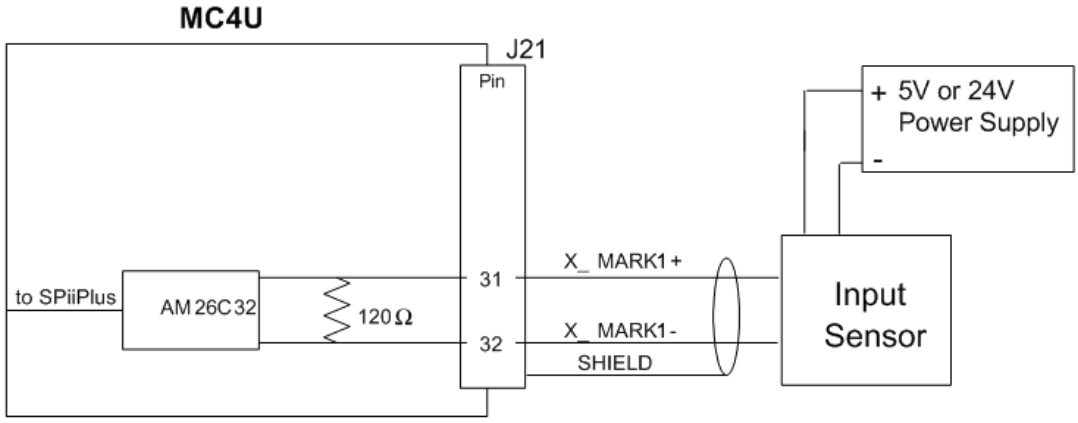


Figure 41 Diffential Connection for MARK1 Input (X-axis)

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5.7 General Purpose Digital Outputs

Figure 42 is an example of a **single-sided general purpose** digital output source configuration.

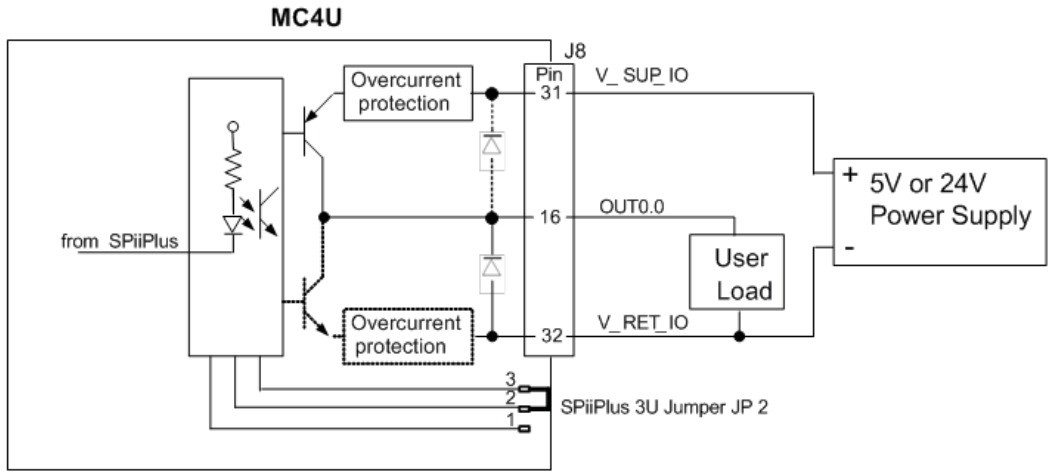


Figure 42 Single-Ended General Purpose Digital Output Source Connection (OUT0.0 Axis)

Figure 43 is an example of a **single-sided general purpose** digital output in sink configuration.

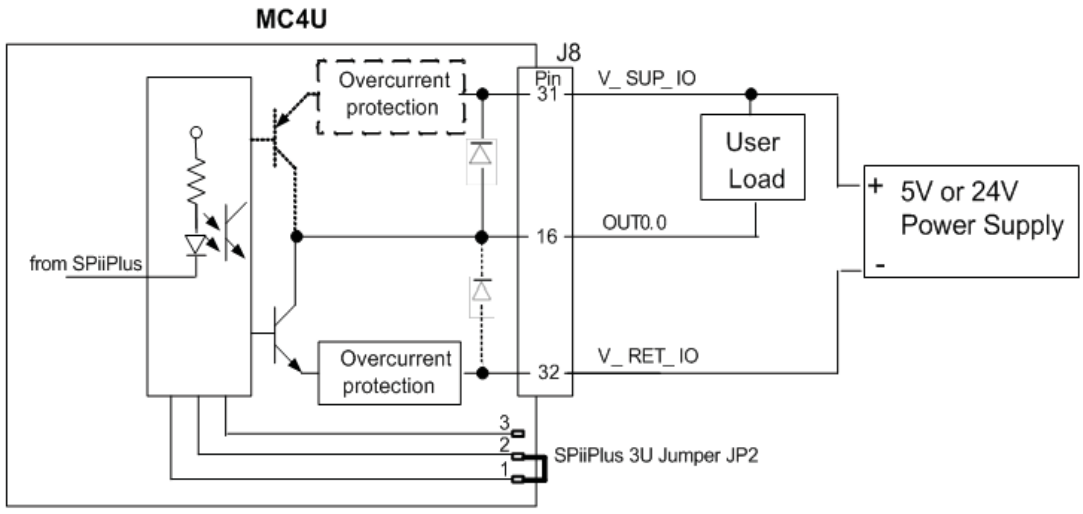


Figure 43 Single-Ended General Purpose Digital Output Sink Connection (OUT0.0)

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5.8 SPiiPlus 3U Jumpers

Many of the circuits depend on the settings of jumpers on the SPiiPlus 3U card. The SPiiPlus 3U card has three jumpers, JP1, JP2 and JP3, the locations of which are shown in **Figure 44**.

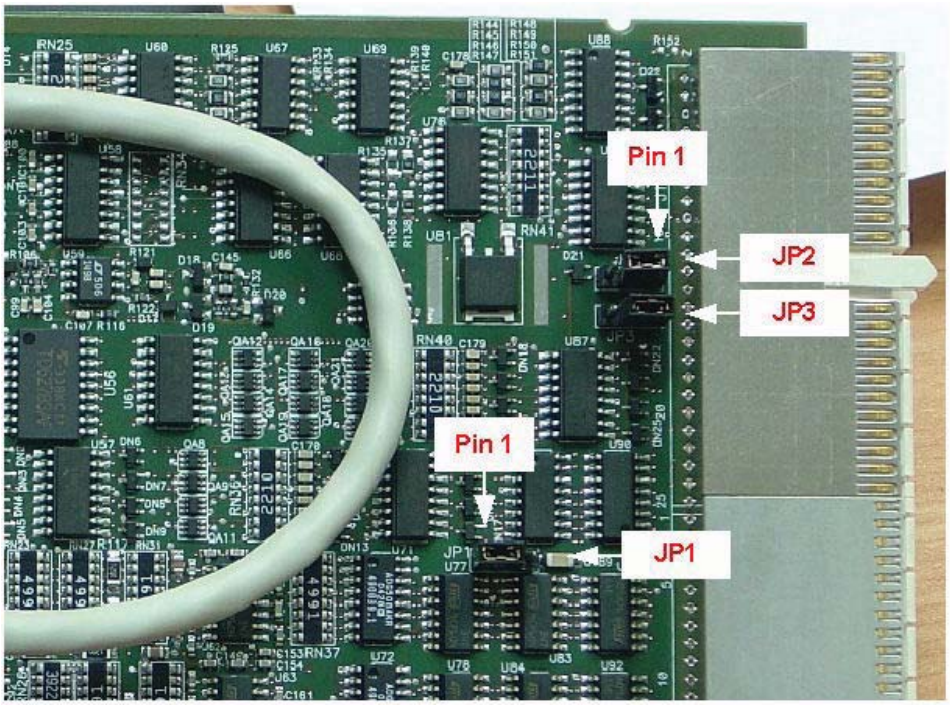


Figure 44 SPiiPlus 3U Jumper Locations

5.9 PEG Pulse Output

Figure 45 is an example (for the X-axis) of a PEG pulse output.

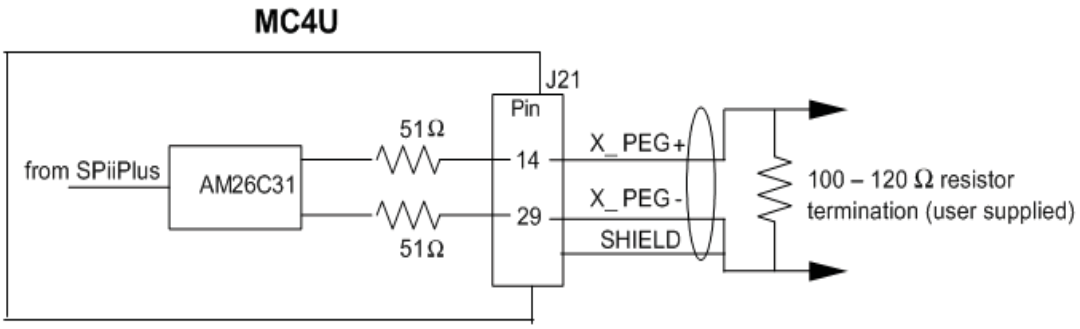


Figure 45 PEG Pulse Digital Output Connection (X-axis)

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Caution	
	**A user-supplied 100-120Ω resistor must be installed between the differential signals of the PEG outputs.**

5.10 Sin-Cos Encoder Input

Figure 46 illustrates the Sin-Cos encoder interface for an X-axis.

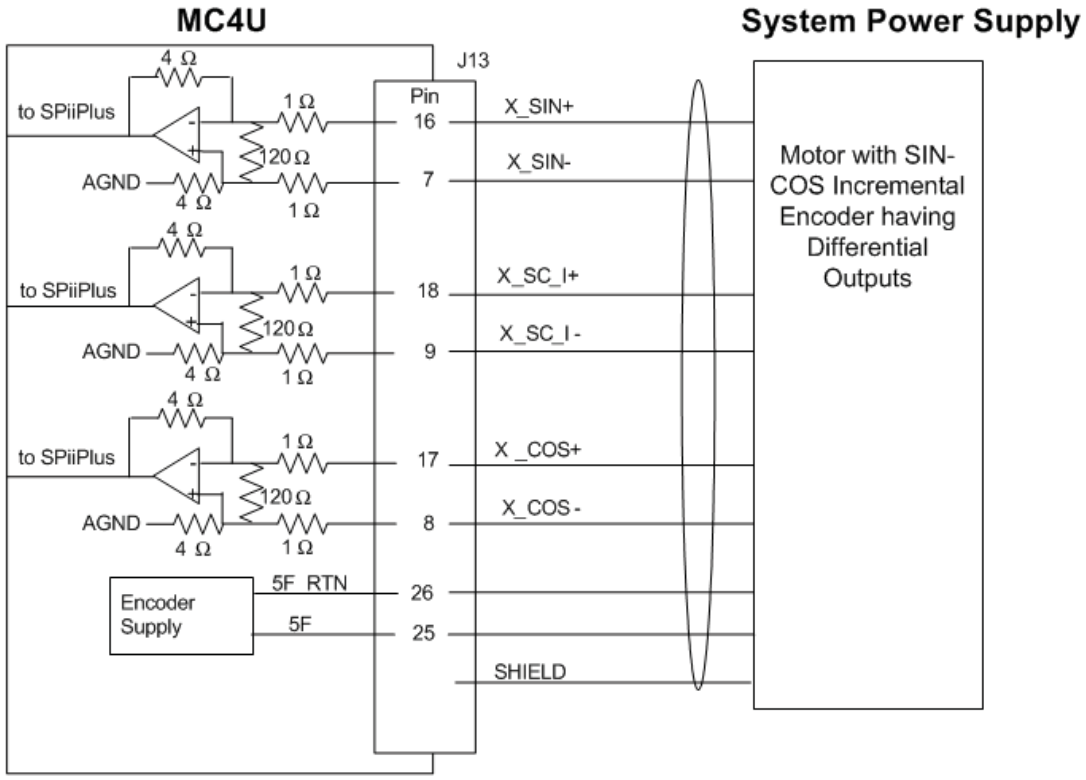


Figure 46 Sin-Cos Encoder Interface

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5.11 Joystick Input Interface

To configure the differential analog inputs (not Sin-Cos) to work with 0 to 10V, 39 kΩ resistors have to be connected in series to the analog input pins, as shown in **Figure 47**.

Note	
	*The user should be aware that in this configuration the resolution is reduced by a factor of 2.*

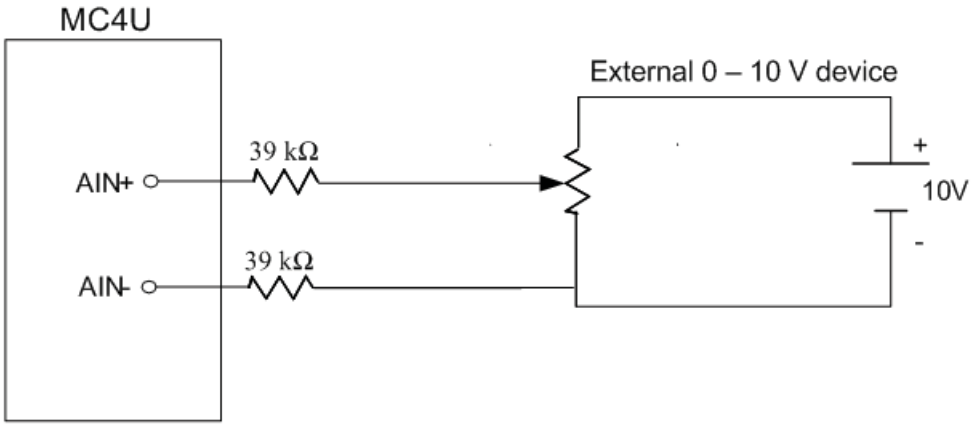


Figure 47 Analog Inputs with 0-10V Configuration

Figure 48 illustrates a typical joystick configuration.

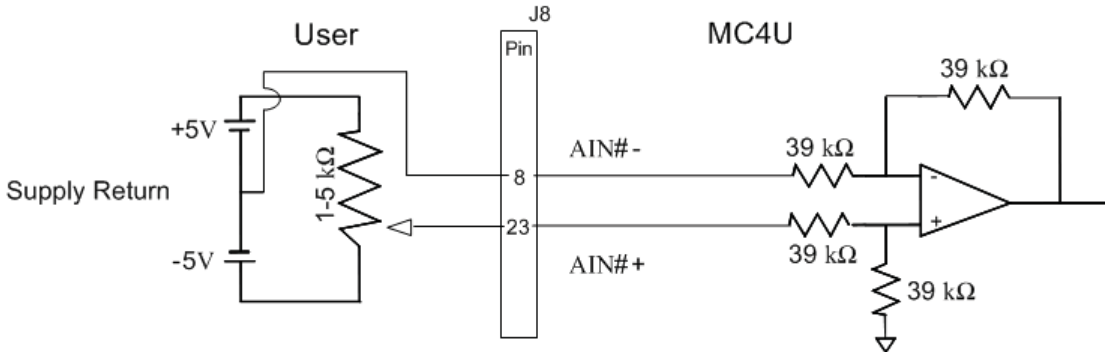


Figure 48 A ±5V Differential Joystick through AIN

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5.12 CAN Bus Connectivity

This section details connecting the MC4U Control Module to a CAN bus.

5.12.1 CAN Bus Topology

Figure 49 depicts the CAN bus topology when connected to the MC4U.

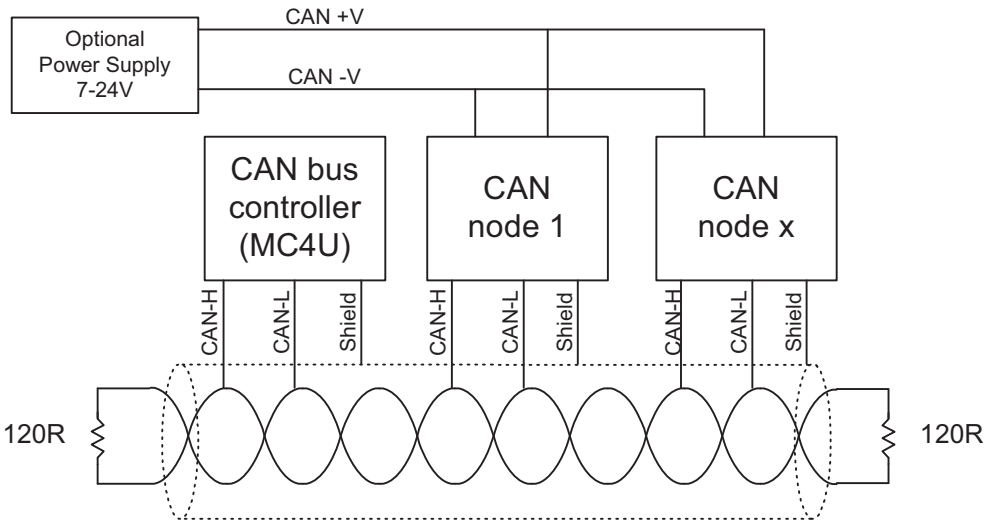


Figure 49 CAN Bus Network Topology with MC4U Control Module

The 120Ω termination resistor is required between CAN-H and CAN-L at both ends of the cabling. The termination resistor can be inserted on the MC4U side of the bus using JP8 on SPiiPlus 3U-LT.

5.12.2 CAN Bus Controller Interface

Figure 50 depicts the MC4U interface with the CAN bus.

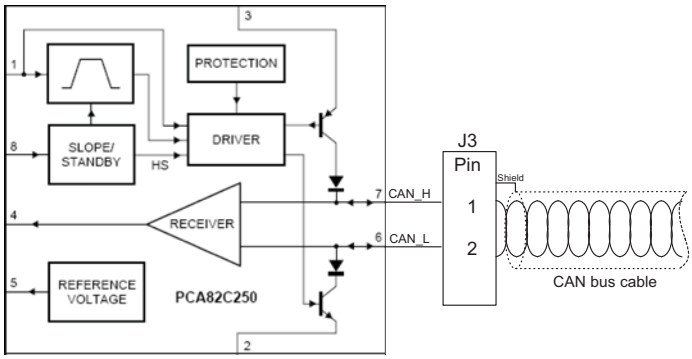


Figure 50 CAN Bus Interface

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It is recommend that a shielded twisted pair cable, for example, STP cable cat 5 with an RJ-45 plug connector, with a maximum length of up to 30m be used for connecting the CAN bus.

The MC4U does not require an external power supply for the CAN bus interface; however if another network component must be used, the external supply is as show in **Figure 49**, refer to HW guide of the component for further details.

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6 MC4U Installation and Maintenance

The MC4U has been designed for easy installation and is relatively maintenance free. This chapter covers MC4U installation and maintenance.

6.1 Installing the MC4U

The MC4U may be panel-mounted.

Model	
	*The 19" MC4U may also be rack-mounted.*

Note	
	*This section covers only the MC4U hardware installation. For software installation see Chapter 3 of the SPiiPlus Setup Guide.*

6.1.1 .Panel-Mounting the MC4U

The MC4U comes with brackets installed on each side of the rear of the unit for panel-mounting. **Figure 52** and **Figure 52** illustrate the panel mounting the 9" MC4U and 11" MC4U, and the 19" MC4U, respectively.

Caution	
	***When connecting the wiring, care must be taken to route the wiring from the top or sides so that there is no interference with the air flow of the vents in the top of the MC4U unit.***

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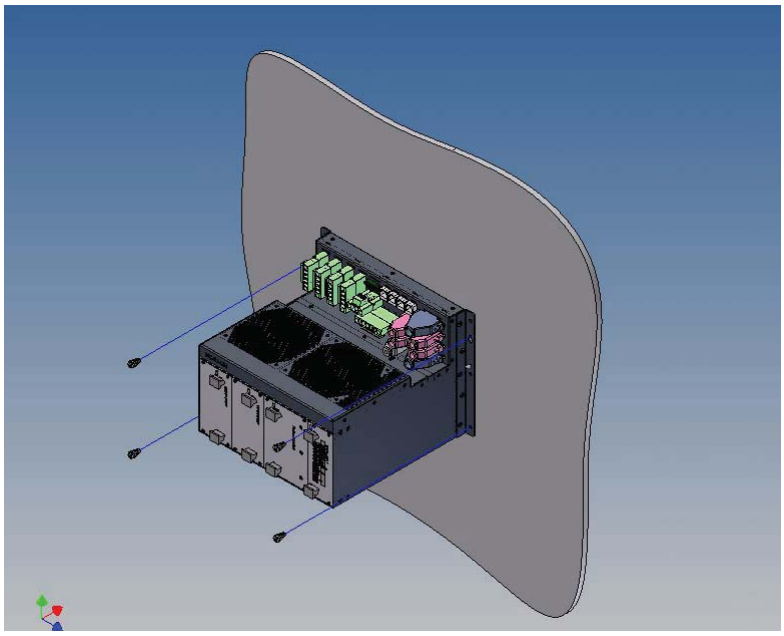


Figure 51 9” MC4U and 11” MC4U Panel-Mounting

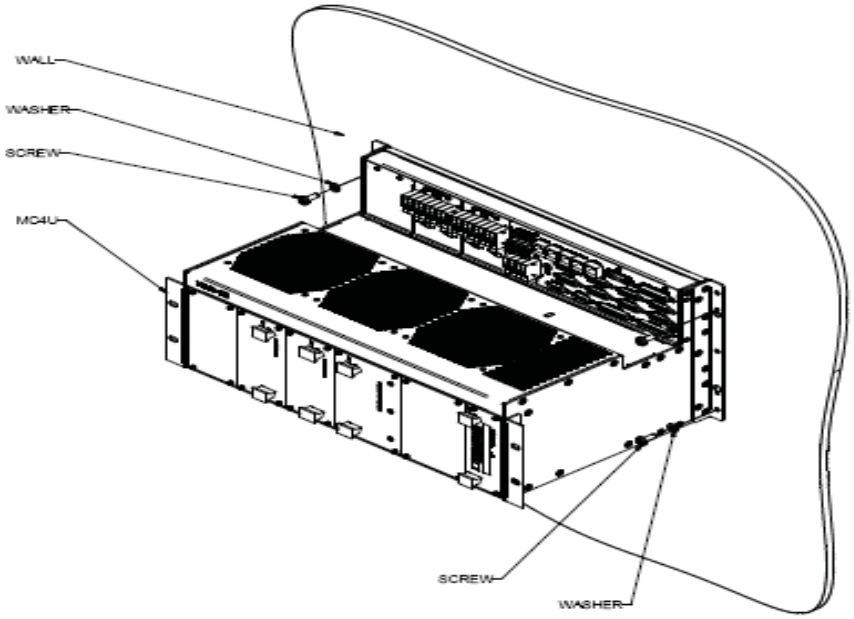


Figure 52 19” MC4U Panel-Mounting

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6.1.2 Rack-Mounting the 19” MC4U

The 19” MC4U may be mounted in a rack with a shelf width of 45 cm.**Figure 53** illustrates the hardware needed and how the unit is mounted.

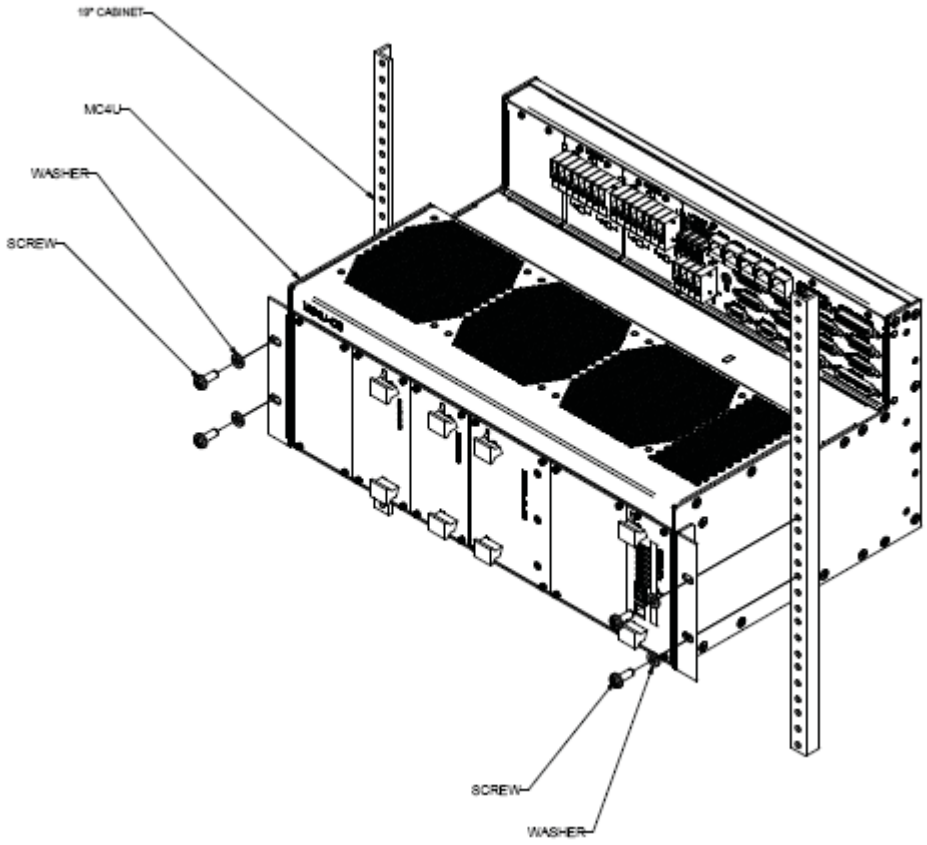


Figure 53 19” MC4U Rack Mount

Note	
	*There is an option for adding* Schroff P/N 10501-006 *handles to the front brackets to facilitate maneuvering the 19” MC4U.*

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6.2 Maintenance

6.2.1 Replacing MC4U Components

The MC4U is designed for the easy swapping out any of the component (SPiiPlus controller, PSM3U power supplies, DDM3U motor drives).

Warning	
	***Before replacing any MC4U module, disconnect all power and cables and wait for all voltages to discharge. A waiting period of 30 minutes must be strictly observed.***

To replace an MC4U module:

1. Make sure that no power is being applied to the unit and that all voltages have discharged.
2. Remove the MC4U unit from the machine.
3. Remove the four retaining screws located in the four corners of the module.
4. Push the upper extractor knob up while pushing the bottom extractor down and firmly pull the module out.
5. Insert the new module being careful to align the module card on the red guiderail and gently push the component straight in (using the two knobs) until the component is well seated in the motherboard.
6. Reinstall the four retaining screws.
7. Reinstall the MC4U into the machine.
8. Reconnect all cables.

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7 MC4U-CS Warranty

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

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