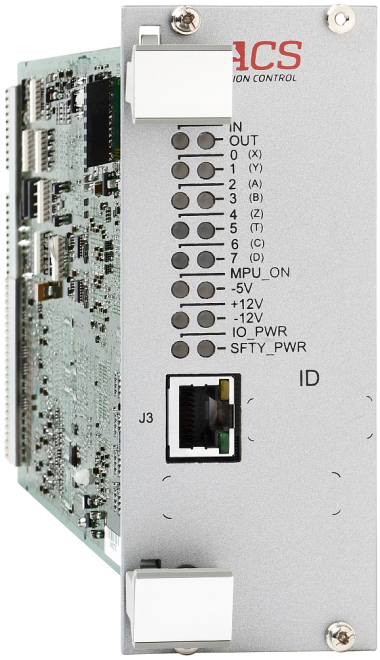

SPiiPlusNT-DC

Hardware Guide

March 2019

Document Revision: 2.60

ACS MOTION CONTROL


ENC
SAFETY & BRAKE
I/O
AXIS 3
AXIS 2
AXIS 1
AXIS 0
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SYSTEM
CONTROL SUPPLY
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MOTION CONTROL
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SPiiPlusNT-DC

Release Date: March 2019

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Revision History

Date	Revision	Description
September 2018	2.60.BD	Reorganized guide and combined MC4U Rev. B Hardware Guide and MC4U Rev. D Guide
August 2017	2.40.BD	Removed SPiiPlus ADK Suite software disc shipping with ordered product.
August 2016	2.30.BD	Updated references to SPiiPlusNT-DC-NP. Updated for SPiiPlus ADK Suite v2.30. Updated Related Documents list. Added minimum hardware revision and SPiiPlus Firmware version requirements.
August 2015	2.29.01.BD	Various documentation improvements and corrections. Updated for SPiiPlusNT-SC FW v2.29.01 Updated for Hardware Rev D.
May 2013	2.21	Updated for SPiiPlusNT FW v2.21.
Jan 2013	2.20	Updated for SPiiPlusNT FW v2.20.
June 2012	2.15	Updated for SPiiPlusNT FW v2.15.
Dec 2011	2.10	Updated for SPiiPlusNT FW v2.10.
August 2011	2.0	Updated for SPiiPlusNT FW v2.0.
Dec 2010	1.0	First release

Conventions Used in this Guide

Text Formats

Format	Description
Bold	Names of GUI objects or commands
BOLD+ UPPERCASE	ACSPL+ variables and commands
`Monospace + grey background`	Code example
Italic	Names of other documents
Blue	Hyperlink
[ ]	In commands indicates optional item(s)
|	In commands indicates either/or items

Flagged Text

	**Note** - includes additional information or programming tips.
	**Caution** - describes a condition that may result in damage to equipment.
	**Warning** - describes a condition that may result in serious bodily injury or death.
	**Model** - highlights a specification, procedure, condition, or statement that depends on the product model
	**Advanced** - indicates a topic for advanced users.

Related Documents

Documents listed in the following table provide additional information related to this document.

The most updated version of the documents can be downloaded by authorized users from www.acsmotioncontrol.com/downloads.

Document	Description
SPiiPlus Command & Variable Reference Guide	Complete description of all variables and commands in the ACSPL+ programming language.
SPiiPlus C Library Reference	C++ and Visual Basic® libraries for host PC applications. This guide is applicable for all the SPiiPlus motion control products.
SPiiPlus .NET Library Reference	.NET Methods, Properties, and Events for Communication with the Controller.
SPiiPlus COM Library Reference	COM Methods, Properties, and Events for Communication with the Controller.
SPiiPlus MMI Application Studio User Guide	A complete guide for using the SPiiPlus MMI Application Studio and associated monitoring tools.
SPiiPlus Utilities User Guide	A guide for using the SPiiPlus User Mode Driver (UMD) for setting up communication with the SPiiPlus motion controller.
MC4U Control Module Hardware Guide	Technical description of the MC4U Control Module integrated motion control product line.
MC4U-NP Control Module Hardware Guide	Technical description of the MC4U Control Module integrated motion control product line.
HSSI Expansion Modules Guide	High-Speed Synchronous Serial Interface (HSSI) for expanded I/O, distributed axes, and nonstandard devices.
PEG and MARK Operations Application Notes	Provides details on using the PEG commands in SPiiPlus systems.
Using Absolute Encoders with ACS Products AN 3.00	Addresses the physical connections, configuration and operation of absolute encoders with ACS Motion Control networking products.

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1. Introduction

1.1 Document Scope

This document describes the hardware details for the SPiiPlusNT/DC product line.

1.2 Product Overview

The ACS Motion Control SPiiPlusNT/DC product line is designed for insertion in the MC4U.

For details on using the SPiiPlusNT/DC-LT/HP/LD in the MC4U Control Module refer to the *MC4U Control Module Hardware Guide*.

1.2.1 SPiiPlusNT/DC Motion Controllers

This section provides technical details of the SPiiPlusNT/DC motion controllers.

1.2.1.1 SPiiPlusNT/DC Rev. B configurations

The MC4U is available in the following configurations:

- SPiiPlusNT-LT/HP/LD
- SPiiPlusDC-LT/HP/LD

The minimum SPiiPlusNT/DC-LT/HP/LD hardware revision is B3 and SPiiPlusNT-SC FW v2.25.

Figure 1-1. SPiiPlusNT Rev. B General View

The SPiiPlusNT and SPiiPlus DC controllers differ by their networking capabilities:

- The SPiiPlusNT serves as a network master: in addition to its regular control of the MC4U axes, it supports an EtherCAT port and the control software required to expand the network. Network expansion is provided by the addition of network elements such as other MC4Us (which contain a SPiiPlusDC controller), UDMnt, PDMnt, SDMnt and others.
- The SPiiPlusDC serves as a slave controller in a EtherCAT network, serving the local MC4U axes. In this slave role, the MC4U is a network element, being part of larger network whereby a master MC4U (containing a SPiiPlusNT controller) or an NTM controls the overall network. The SPiiPlusDC has an incoming port from a previous network element from which it receives the profiles and commands intended for its axes, and outgoing port to connect the next network element (if exists) and maintain the communication network. The SPiiPlusDC is physically similar to the SPiiPlusNT, except that it does not have an MPU board and does not include EtherCAT connector J3.

A network must contain one master and can have any number of slaves.

Both motion controller 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.
  - The SPiiPlusNT and SPiiPlusDC have 1/2 EtherCAT channels, operating at 100Mbs. The EtherCAT connectors are located on the controllers front panel.
- Discrete Interface Signals - the controllers come with digital and analog I/Os used for general purpose and for functional and dedicated purposes. These signals are accessible to the user from the MC4U's connector panel only. 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 delay accuracy.

Configuration of the digital I/Os are by jumpers, see SPiiPlusNT/DC Jumpers.

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

The SPiiPlusNT/DC controllers are available in the following models:

- High Performance Controllers:
  - SPiiPlusNT/DC-HP - a high performance drive controller with 16-bit A2D for motor current and analog SIN-COS encoder measurements.
  - SPiiPlusNT/DC-LD - a high performance drive controller based on the SPiiPlusNT/DC-HP with an additional module for 16-bit analog commands to linear drives.
- Light Controllers
  - SPiiPlusNT/DC- LT - an economical drive controller that uses 12-bit A2D for motor current and analog SIN-COS encoder measurements.

1.2.1.1.1 SPiiPlusNT/DC Motion Controllers Rev. B Features

The SPiiPlusNT/DC-LT/HP/LD features are described in the following tables:

The values are for a SPiiPlusNT system with additional slave drives, including MC4U slave drives with SPiiPlusDC controllers.

Table 1-1. CTIME Values for MC4UNT SPiiPlusNT-LT/HP/LD/NP (Rev. A, B, C) Controller

Controller (to be inserted into MC4UNT[1])	Number of Built-in Drives	Maximum Number of Axes	Default Number of Available ACSPL+ Buffers**	Maximum Number of Simultaneously Running		Controller Cycle Time					ServoBoost Supported
				Motors	ACSPL+Buffers	1 (msec) 2 (msec)	0.50 (msec)	0.25 (msec)	0.20 (msec)	Default Value (msec)	
SPiiPlus NT-LT-4	4	4	10	4	16	√ [3]	-	-	-	1	-
SPiiPlus NT-LT-4	4	8	10	8	16	√ [3]	-	-	-	1	-
SPiiPlus NT-LT-4	4	16	16	16	16	√	-	-	-	1	-
SPiiPlus NT-LT-4	4	32	32	16	16	√	-	-	-	1	-
SPiiPlus NT-LT-8	8	8	10	8	16	√ [3]	-	-	-	1	-
SPiiPlus NT-LT-8	8	16	16	16	16	√	-	-	-	1	-
SPiiPlus NT-LT-8	8	32	32	16	16	√	-	-	-	1	-
SPiiPlus NT-HP-4 / NT-LD-4 / NT-NP-2	4	4	10	4	10	√ [3]	√	-	-	0.5	√
SPiiPlus NT-HP-4 / NT-LD-4 / NT-NP-2	4	8	10	8	10	√ [3]	√	-	-	0.5	√
SPiiPlus NT-HP-4 / NT-LD-4 / NT-NP-2	4	16	16	16	16	√	-	-	-	1	√
SPiiPlus NT-HP-4 / NT-LD-4 / NT-NP-2	4	32	32	16	16	√	-	-	-	1	√
SPiiPlus NT-HP-8 / NT-LD-8 / NT-NP-4	8	8	10	8	10	√ [3]	√	-	-	0.5	√
SPiiPlus NT-HP-8 / NT-LD-8 / NT-NP-4	8	16	16	16	16	√	-	-	-	1	√
SPiiPlus NT-HP-8 / NT-LD-8 / NT-NP-4	8	32	32	16	16	√	-	-	-	1	√

[1] If the MPU processing power is not sufficient, then use the MC4Udc version with an external SPiiPlusNTM-yy-xx-xx-xx-xxx-H-x or SPiiPlusEC-yy-xx-xx-xx-xxx-x-x type controller.
[2] If the MPU processing power is not sufficient, then use the UDMpm / UDMba / UDMhp / UDMhv version with an external SPiiPlusNTM-yy-xx-xx-xx-xxx-H-x or SPiiPlusEC-yy-xx-xx-xx-xxx-x-x type controller.
[3] 2-axes Extended Segmented Motion (XSEG) with limitations: a. Segment length > 5 ms, b. IMM VEL = ... command shouldn't be used
[4] 6-axes Extended Segmented Motion (XSEG) with limitation: Segment length > 1 ms. The user's responsibility is to ensure that the USAGE doesn't exceed 80%.
[5] NetworkBoost (Ring Topology) with limitations: a. CTIME = 1 msec - up to 64 axes b. CTIME = 0.50 msec - up to 24 axes c. CTIME = 0.25 msec - up to 8 axes d. CTIME = 0.20 msec - up to 4 axes

**Up to 32 buffers supported with ordering option.

Table 1-2. SPiiPlusNT/DC-LT/HP/LD/NP Additional Features

HW Feature	SPiiPlusNT/DC-LT/HP/LD/NP	Remarks
Profile Generation		
Motion Profile generation rate	1 or 2kHz	
Feedback		
Incremental Digital Encoder	One per axis: A&B,I; UP/DN,I; CLK/DIR,I. Type: RS-422 Max. rate: 40 million encoder counts/sec.	
Sin-Cos Encoder (optional)	One per axis SPiiPlusNT/DC-HP/LD: Multiplication factor: From x4 to x65,536. Rate: HP/NP version: Up to $500*10^3$ sine periods/sec; LD version: $4*10^6$ sine periods/sec. Sin-Cos offset, gain, phase compensation: programmable with automatic calibration. Offset is hardware compensated, +/-50% of signal range. Maximum acceleration: 4×10^8 sine periods/sec^2. SPiiPlusNT/DC-LT: Multiplication factor: From x4 to x4,096 Sin-Cos offset gain, phase compensation: programmable with automatic calibration. Rate: $250*10^3$ sine periods/sec. Maximum acceleration: 4×10^8 sine periods/sec^2.	
Hall inputs	Set of three per axis. Single-ended, 5V, source, opto-isolated. Input circuit current: <7mA.	

HW Feature	SPiiPlusNT/DC-LT/HP/LD/NP	Remarks
Absolute encoder	Supports EnDat 2.1/2.2 (Digital only), Smart-ABS, Panasonic, Biss-C, SSI, Hiperface. Indices: X(0), Y(1), (Z(4) and T(5).	
Drive Interface		
Analog commands (SPiiPlusNT/DC-LD only):	Two phases per axis. Type: ±10V,differential, 16 bit resolution. Offset compensation: programmable, 0.3mV resolution.	Drive command analog outputs are supported only by the SPiiPlusNT/DC-LD product.
PWM drive commands	Three phases per axis. Control algorithm: digital PI filters with field oriented control and space vector modulation. PWM frequency: 40kHz on the motor.	
Drive Current Feedback	Two phases per axis. Current loop sampling rate: 20kHz. Current feedback resolution: SPiiPlusNT/DC-HP/LD/NP: 16 bit. SPiiPlusNT/DC-LT: 12 bit.	
External drives	SPiiPlusNT/DC-LD: two phases per axis	Supported only by following motherboards: MB5U-Z MB5U-YYYY MB5U-ZZZ MB5U-ZZW
Digital I/O		
Safety Inputs:		
Emergency stop input	One per controller. Type: two-terminal, sink or source, opto-isolated.	

HW Feature	SPiiPlusNT/DC-LT/HP/LD/NP	Remarks
Left and right limit inputs	One pair per axis. Type: single-ended, sink (default) or source, configurable by jumper, opto-isolated. Supply: 5V or 24V. Input current: <15mA.	
Digital Inputs:		
General Purpose Inputs	Eight. Type: single-ended, 5V or 24V, sink (default) or source, opto-isolated. Input current: <15mA.	
MARK (position capture) inputs	Up to four. Type: RS-422. Propagation delay: <0.1 µsec.	Four additional MARK inputs (MARK2), single-ended and opto-isolated, are available through general purpose digital inputs IN4, IN5, IN6 and IN7 Refer to *PEG and MARK Operations Application Notes* for detailed information.
Digital Outputs		
General purpose outputs	Eight. Type: single-ended, 5V or 24V, sink (default) or source, opto-isolated. Output current: 100mA per output.	Depends on controller configuration. Dual usage, can be used as Mechanical Brake.
Mechanical Brake Outputs:	One per axis. Type: single-ended, 5V, source only, opto-isolated Output current: 7mA per output.	Default configuration is dynamic brake.

General purpose digital outputs can be configured as Mechanical Brake Outputs.

Dynamic brake signal is available only for internal MC4U drivers and is not accessible as an external signal.

HW Feature	SPiiPlusNT/DC-LT/HP/LD/NP	Remarks
PEG pulse outputs:	Six. Type: RS-422. Propagation delay: <0.1µsec. PEG pulse width: 25nsec to 1.7msec. PEG position accuracy: ±1 count at speeds up to $18x10^6$ counts/sec.	Refer to *PEG and MARK Operations Application Notes* for detailed information.
PEG state outputs	Up to six. Type: RS-422. Propagation delay: <0.1µsec.	Refer to *PEG and MARK Operations Application Notes* for detailed information.
HSSI Expansion Channels	Up to three. Each channel provides 64 input bits and 64 output bits per channel, sampled and updated every 50µsec. Type: RS-422.	
Analog I/O		
Analog Inputs	Up to 16. Type: 1Vptp, differential. Resolution and SNR: SPiiPlusNT-HP/LD: 16 bit, SNR>72db. SPiiPlusNT-LT: 12 bit, SNR>52db.	Unused Sin-Cos encoder inputs can be used as general purpose analog inputs.
General Purpose Inputs	SPiiPlusNT-HP/LD/NP: Four dedicated general purpose inputs. Type: ±10V, differential. Resolution: 16 bits. SPiiPlusNT-LT: Up to four (when axes number 3 and/ or 7 Sin-Cos encoders are not used. Type: ±10V,differential. Resolution: 12 bits.	
General Purpose Outputs	2, 4. Type: ±10V, PWM filtered. Resolution: 10bit.	
Communication Channels		

HW Feature	SPiiPlusNT/DC-LT/HP/LD/NP	Remarks
Serial	SPiiPlusNT only: Two. RS-232. Up to 115,200bps	
Ethernet	SPiiPlusNT only: One. TCP/IP, 10/100 Mbits/sec.	SPiiPlusNT only: Simultaneous communication through all channels is fully supported. Modbus protocol as master or slave is supported via all channels
EtherCAT	SPiiPlusNT: One master port. SPiiPlusDC: One input, one output.	
MPU (SPiiPlusNT only)		
Powerup Time	25-100 sec. according to system and network configuration	
Environment & Standards		
Operating Temperature	0˚C to 55˚C	
Storage Temperature	40˚C to 70˚C	
Humidity	90%RH, non-condensing	
Standards	CE (EMC), UL certified and RoHS compliant	

1.2.1.2 SPiiPlusNT/DC Rev. C configurations

The SPiiPlusNT/DC Rev. C is available in the following configurations:

- SPiiPlusNT-NP
- SPiiPlusDC-NP

The minimum SPiiPlusNT/DC-NP hardware revision is C and SPiiPlusNT-SC FW v2.29.01.00.

Figure 1-2. SPiiPlusNT Rev. C General View

The SPiiPlusNT and SPiiPlus DC controllers differ by their networking capabilities:

- The SPiiPlusNT serves as a network master: in addition to its regular control of the MC4U-NP axes, it supports an EtherCAT port and the control software required to expand the network. Network expansion is provided by the addition of network elements such as other MC4Us (which contain a SPiiPlusDC controller), UDMnt, PDMnt, SDMnt and others.
- The SPiiPlusDC serves as a slave controller in a EtherCAT network, serving the local MC4U-NP axes. In this slave role, the MC4U-NP is a network element, being part of larger network whereby a master MC4U-NP (containing a SPiiPlusNT controller) or an NTM controls the overall network. The SPiiPlusDC has an incoming port from a previous network element from which it receives the profiles and commands intended for its axes, and outgoing port to connect the next network element (if exists) and maintain the communication network. The SPiiPlusDC is physically similar to the SPiiPlusNT, except that it does not have an MPU board and does not include EtherCAT connector J3.

A network must contain one master and can have any number of slaves.

Both motion controller versions have the following features:

- Supports *NanoPWM*™ technology drives and up four axes.
- 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.
  - The SPiiPlusNT and SPiiPlusDC have 1/2 EtherCAT channels, operating at 100Mbs. The EtherCAT connectors are located on the controllers front panel.
- Discrete Interface Signals - the controllers come with digital and analog I/Os used for general purpose and for functional and dedicated purposes. These signals are accessible to the user from the MC4U's connector panel only. 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 delay accuracy.

Configuration of the digital I/Os are by jumpers, see SPiiPlusNT/DC Jumpers.

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

1.2.1.2.1 SPiiPlusNT/DC Motion Controllers Rev. C Features

The SPiiPlusNT/DC-LT/HP/LD/NP features are described in the following tables:

The values are for a SPiiPlusNT system with additional slave drives, including MC4U slave drives with SPiiPlusDC controllers.

Table 1-3. CTIME Values for MC4UNT SPiiPlusNT-NP (Rev. C) Controller

Controller	Number of Built-in Drives	Maximum Number of Axes	Default Number of Available ACSPL+ Buffers**	Maximum Number of Simultaneously Running		Controller Cycle Time					ServoBoost Supported
				Motors	ACSPL+ Buffers	1 (msec)	0.50 (msec)	0.25 (msec)	0.20 (msec)	Default Value (msec)	
MC4Unt [1] (Rev. C)											
SPiiPlusNT-NP-2	4	4	10	4	10	√ [3]	√	-	-	0.5	√
SPiiPlusNT-NP-2	4	8	10	8	10	√ [3]	√	-	-	0.5	√
SPiiPlusNT-NP-2	4	16	16	16	16	√	-	-	-	1	√
SPiiPlusNT-NP-2	4	32	32	16	16	√	-	-	-	1	√
SPiiPlusNT-NP-4	8	8	10	8	10	√ [3]	√	-	-	0.5	√
SPiiPlusNT-NP-4	8	16	32	16	16	√	-	-	-	1	√
SPiiPlusNT-NP-4	8	32	32	16	16	√	-	-	-	1	√

[1] If the MPU processing power is not sufficient, then use the MC4Udc version with an external SPiiPlusNTM-yy-xx-xx-xx-xxx-H-x or SPiiPlusEC-yy-xx-xx-xx-xxx-x-x type controller.
[2] If the MPU processing power is not sufficient, then use the UDMpm / UDMba / UDMhp / UDMhv version with an external SPiiPlusNTM-yy-xx-xx-xx-xxx-H-x or SPiiPlusEC-yy-xx-xx-xx-xxx-x-x type controller.
[3] Extended Segmented Motion (XSEG) with limitations: a. Segment length > 5 ms, b. IMM VEL = ... command shouldn't be used
[4] Extended Segmented Motion (XSEG) with limitation: Segment length > 1 ms. The user's responsibility is to ensure that the USAGE doesn't exceed 80%.
[5] NetworkBoost (Ring Topology) with limitations: a. CTIME = 1 msec - up to 64 axes b. CTIME = 0.50 msec - up to 24 axes c. CTIME = 0.25 msec - up to 8 axes d. CTIME = 0.20 msec - up to 4 axes

**Up to 32 buffers supported with ordering option.

SPiiPlusNT/DC-NP Additional Features

HW Feature	SPiiPlusNT/DC-NP	Remarks
Profile Generation		
Motion Profile generation rate	1 or 2kHz	
Feedback		
Incremental Digital Encoder	One per axis: A&B,I; UP/DN,I; CLK/DIR,I. Type: RS-422 Max. rate: 40 million encoder counts/sec.	
Sin-Cos Encoder (optional)	One per axis SPiiPlusNT/DC-NP: Multiplication factor: From x4 to x65,536. Rate: NP version: Up to $500*10^3$ sine periods/sec; LD version: $4*10^6$ sine periods/sec. Sin-Cos offset, gain, phase compensation: programmable with automatic calibration. Offset is hardware compensated, +/-50% of signal range. Maximum acceleration: 4×10^8 sine periods/sec^2.	
Hall inputs	Set of three per axis. Single-ended, 5V, source, opto-isolated. Input circuit current: <7mA.	
Absolute encoder	Supports EnDat 2.1/2.2 (Digital only), Smart-ABS, Panasonic, Biss-C, SSI, Hiperface. Indices: X(0), Y(1), (Z(4) and T(5).	
Drive Interface		
PWM drive commands	Three phases per axis. Control algorithm: digital PI filters with field oriented control and space vector modulation. PWM frequency: 40kHz on the motor.	
Drive Current Feedback	Two phases per axis.	

HW Feature	SPiiPlusNT/DC-NP	Remarks
	Current loop sampling rate: 20kHz. Current feedback resolution: SPiiPlusNT/DC-NP: 16 bit.	
Digital I/O		
Safety Inputs:		
Emergency stop input	One per controller. Type: two-terminal, sink or source, opto-isolated.	
Left and right limit inputs	One pair per axis. Type: single-ended, sink (default) or source, configurable by jumper, opto-isolated. Supply: 5V or 24V. Input current: <15mA.	
Digital Inputs:		
General Purpose Inputs	Eight. Type: single-ended, 5V or 24V, sink (default) or source, opto-isolated. Input current: <15mA.	
MARK (position capture) inputs	Up to four. Type: RS-422. Propagation delay: <0.1 µsec.	Four additional MARK inputs (MARK2), single-ended and opto-isolated, are available through general purpose digital inputs IN4, IN5, IN6 and IN7

HW Feature	SPiiPlusNT/DC-NP	Remarks
		Refer to *PEG and MARK Operations Application Notes* for detailed information.
Digital Outputs		
General purpose outputs	Eight. Type: single-ended, 5V or 24V, sink (default) or source, opto-isolated. Output current: 100mA per output.	Depends on controller configuration. Dual usage, can be used as Mechanical Brake.
Mechanical Brake Outputs:	One per axis. Type: single-ended, 5V, source only, opto-isolated Output current: 7mA per output.	Default configuration is dynamic brake.
General purpose digital outputs can be configured as Mechanical Brake Outputs. Dynamic brake signal is available only for internal MC4U-NP drivers and is not accessible as an external signal.		
PEG pulse outputs:	Six. Type: RS-422. Propagation delay: <0.1µsec. PEG pulse width: 25nsec to 1.7msec. PEG position accuracy: ±1 count at speeds up to $18x10^6$ counts/sec.	Refer to *PEG and MARK Operations Application Notes* for detailed information.
PEG state outputs	Up to six. Type: RS-422. Propagation delay: <0.1µsec.	Refer to *PEG and MARK Operations Application Notes* for detailed information.

HW Feature	SPiiPlusNT/DC-NP	Remarks
HSSI Expansion Channels	Up to three. Each channel provides 64 input bits and 64 output bits per channel, sampled and updated every 50µsec. Type: RS-422.	
Analog I/O		
Analog Inputs	Up to 16. Type: 1Vptp, differential. Resolution and SNR: SPiiPlusNT-NP: 16 bit, SNR>72db	Unused Sin-Cos encoder inputs can be used as general purpose analog inputs.
General Purpose Inputs	SPiiPlusNT-NP: Four dedicated general purpose inputs. Type: ±10V, differential. Resolution: 16 bits.	
General Purpose Outputs	2, 4. Type: ±10V, PWM filtered. Resolution: 10bit.	
Communication Channels		
Serial	SPiiPlusNT only: Two. RS-232. Up to 115,200bps	
Ethernet	SPiiPlusNT only: One. TCP/IP, 10/100 Mbits/sec.	SPiiPlusNT only: Simultaneous communication through all channels is fully supported. Modbus protocol as master or slave is supported via all channels

HW Feature	SPiiPlusNT/DC-NP	Remarks
EtherCAT	SPiiPlusNT: One master port. SPiiPlusDC: One input, one output.	SPiiPlusNT only: Optional network failure detection and recovery with ring topology.
MPU (SPiiPlusNT only)		
Powerup Time	25-100 sec. according to system and network configuration	
Environment & Standards		
Operating Temperature	0˚C to 55˚C	
Storage Temperature	40˚C to 70˚C	
Humidity	90%RH, non-condensing	
Standards	CE (EMC), UL certified and RoHS compliant	

1.2.1.3 SPiiPlusNT/DC Rev. D configurations

The SPiiPlusNT/DC is available in the following configurations:

- SPiiPlusNT-LT/HP/LD
- SPiiPlusDC-LT/HP/LD

The minimum SPiiPlusNT/DC-LT/HP/LD hardware revision is D and SPiiPlusNT-SC FW v2.29.04.00.

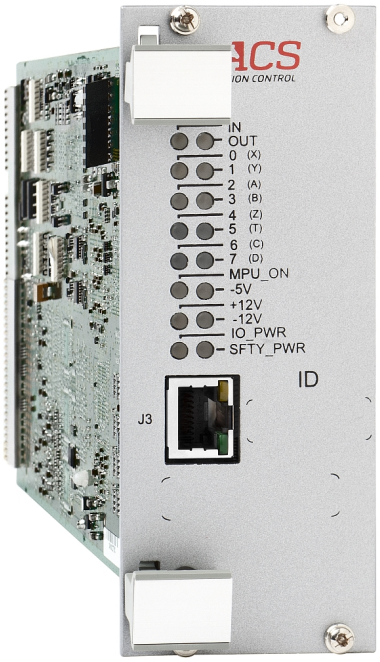


Figure 1-3. SPiiPlusNT Rev. D General View

The SPiiPlusNT and SPiiPlus DC controllers differ by their networking capabilities:

- The SPiiPlusNT serves as a network master: in addition to its regular control of the SPiiPlusNT/DC axes, it supports an EtherCAT port and the control software required to expand the network. Network expansion is provided by the addition of network elements such as other MC4Us (which contain a SPiiPlusDC controller), UDMnt, PDMnt, SDMnt and others.
- The SPiiPlusDC serves as a slave controller in a EtherCAT network, serving the local SPiiPlusNT/DC axes. In this slave role, the SPiiPlusNT/DC is a network element, being part of larger network whereby a master SPiiPlusNT/DC (containing a SPiiPlusNT controller) or an NTM controls the overall network. The SPiiPlusDC has an incoming port from a previous network element from which it receives the profiles and commands intended for its axes, and outgoing port to connect the next network element (if exists) and maintain the communication network.
  The SPiiPlusDC is physically similar to the SPiiPlusNT, except that it does not have an MPU board and does not include EtherCAT connector J3.

A network must contain one master and can have any number of slaves.

Both motion controller versions have the following features:

- Supports *NanoPWM*™ technology drives and up four axes.
- 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.
  - The SPiiPlusNT and SPiiPlusDC have 1/2 EtherCAT channels, operating at 100Mbs. The EtherCAT connectors are located on the controllers front panel.
- Discrete Interface Signals - the controllers come with digital and analog I/Os used for general purpose and for functional and dedicated purposes. These signals are accessible to the user from the MC4U's connector panel only. 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 delay accuracy.

Configuration of the digital I/Os are by jumpers, see SPiiPlusNT/DC Jumpers.

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

The SPiiPlusNT/DC controllers are available in the following models:

- High Performance Controllers:
  - SPiiPlusNT/DC-HP - a high performance drive controller with 16-bit A2D for motor current and analog SIN-COS encoder measurements.
  - SPiiPlusNT/DC-LD - a high performance drive controller based on the SPiiPlusNT/DC-HP with an additional module for 16-bit analog commands to linear drives.
  - SPiiPlusNT/DC-NP - a high performance *NanoPWM*™ drive controller
- Light Controllers
  - SPiiPlusNT/DC- LT - an economical drive controller that uses 12-bit A2D for motor current and analog SIN-COS encoder measurements.

1.2.1.3.1 SPiiPlusNT/DC Motion Controllers Rev. D Features

The SPiiPlusNT/DC-LT/HP/LD/NP features are described in the following tables:

The values are for a SPiiPlusNT system with additional slave drives, including MC4U slave drives with SPiiPlusDC controllers.

Table 1-4. CTIME Values for MC4UNT SPiiPlusNT-LT/HP/LD/NP (Rev. D) Controller

Controller (inserted into MC4UNT)	Built-in Drives	Maximum Axes	Default Number of ACSPL+ Buffers**	Max Running		Controller Cycle Time					ServoBoost Supported
				Motors	ACSPL+ Buffers	1 (msec) 2 (msec)	0.50 (msec)	0.25 (msec)*	0.20 (msec)*	Default (msec)	
SPiiPlus NT-LT-4	4	4	10	4	10	√ (4,5)	-	-	-	1	-
SPiiPlus NT-LT-4	4	8	10	8	10	√ (4,5)	-	-	-	1	-
SPiiPlus NT-LT-4	4	16	16	16	16	√ (4,5)	-	-	-	1	-
SPiiPlus NT-LT-4	4	32	32	32	32	√ (4,5)	-	-	-	1	-
SPiiPlus NT-LT-4	4	64	64	64	64	√ (4,5)	-	-	-	1	-
SPiiPlus NT-LT-8	8	8	10	8	10	√ (4,5)	-	-	-	1	-
SPiiPlus NT-LT-8	8	16	16	16	16	√ (4,5)	-	-	-	1	-
SPiiPlus NT-LT-8	8	32	32	32	32	√ (4,5)	-	-	-	1	-
SPiiPlus NT-LT-8	8	64	64	64	64	√ (4,5)	-	-	-	1	-
SPiiPlus NT-HP-4 / NT-LD-4 / NT-NP-2	4	4	10	4	10	√ (4,5)	√ (4,5)	√ (4,5)	√ (4,5)	0.5	√
SPiiPlus NT-HP-4 / NT-LD-4 / NT-NP-2	4	8	10	8	10	√ (4,5)	√ (4,5)	√ (4,5))	√ (3,5)	0.5	√
SPiiPlus NT-HP-4 / NT-LD-4 / NT-NP-2	4	16	16	16	16	√ (4,5)	√ (4,5)	√ (3,5)	-	0.5	√
SPiiPlus NT-HP-4 / NT-LD-4 / NT-NP-2	4	32	32	32	32	√ (4,5)	√ (4,5)	-	-	0.5	√
SPiiPlus NT-HP-4 / NT-LD-4 / NT-NP-2	4	64	64	64	64	√ (4,5)	-	-	-	1	√
SPiiPlus NT-HP-8 / NT-LD-8 / NT-NP-4	8	8	10	8	10	√ (4,5)	√ (4,5)	√ (4,5)	√ (3,5)	0.5	√
SPiiPlus NT-HP-8 / NT-LD-8 / NT-NP-4	8	16	16	16	16	√ (4,5)	√ (4,5)	√ (3,5)	-	0.5	√
SPiiPlus NT-HP-8 / NT-LD-8 / NT-NP-4	8	32	32	32	32	√ (4,5)	√ (4,5)	-	-	0.5	√
SPiiPlus NT-HP-8 / NT-LD-8 / NT-NP-4	8	64	64	64	64	√ (4,5)	-	-	-	1	√

(1) If the MPU processing power is not sufficient, then use the MC4Udc version with an external SPiiPlusNTM-yy-xx-xx-xx-xxx-H-x or SPiiPlusEC-yy-xx-xx-xx-xxx-x-x type controller.
(2) If the MPU processing power is not sufficient, then use the UDMpm / UDMba / UDMhp / UDMhv version with an external SPiiPlusNTM-yy-xx-xx-xx-xxx-H-x or SPiiPlusEC-yy-xx-xx-xx-xxx-x-x type controller.
(3) 2-axes Extended Segmented Motion (XSEG) with limitations: a. Segment length > 5 ms, b. IMM VEL = … command shouldn't be used
(4) 6-axes Extended Segmented Motion (XSEG) with limitation: Segment length > 1 ms. The user's responsibility is to ensure that the USAGE doesn't exceed 80%.
(5) NetworkBoost (Ring Topology) with limitations: a. CTIME = 1 msec - up to 64 axes b. CTIME = 0.50 msec - up to 24 axes c. CTIME = 0.25 msec - up to 8 axes d. CTIME = 0.20 msec - up to 4 axes
*Supported ordering option.
**Up to 64 buffers supported with ordering option.

Table 1-5. SPiiPlusNT/DC-LT/HP/LD/NP Additional Features

HW Feature	SPiiPlusNT/DC-LT/HP/LD/NP	Remarks
Profile Generation		
Motion Profile generation rate	1, 2, 4 or 5kHz	
Feedback		
Incremental Digital Encoder	One per axis: A&B,I; UP/DN,I; CLK/DIR,I. Type: RS-422 Max. rate: 40 million encoder counts/sec.	
Sin-Cos Encoder (optional)	One per axis SPiiPlusNT/DC-HP/LD/NP: Multiplication factor: From x4 to x65,536. Rate: HP/NP version: Up to $500*10^3$ sine periods/sec; LD version: $4*10^6$ sine periods/sec. Sin-Cos offset, gain, phase compensation: programmable with automatic calibration. Offset is hardware compensated, +/-50% of signal range. Maximum acceleration: 4×10^8 sine periods/sec^2. SPiiPlusNT/DC-LT: Multiplication factor: From x4 to x4,096 Sin-Cos offset gain, phase compensation: programmable with automatic calibration. Rate: $250*10^3$ sine periods/sec. Maximum acceleration: 4×10^8 sine periods/sec^2.	
Hall inputs	Set of three per axis. Single-ended, 5V, source, opto-isolated. Input circuit current: <7mA.	

HW Feature	SPiiPlusNT/DC-LT/HP/LD/NP	Remarks
Absolute encoder	Supports EnDat 2.1/2.2 (Digital only), Smart-ABS, Panasonic, Biss-C, SSI, Hiperface, Sanyo Danki. Indices: X(0), Y(1), (Z(4) and T(5).	
Drive Interface		
Analog commands (SPiiPlusNT/DC-LD only):	Two phases per axis. Type: ±10V,differential, 16 bit resolution. Offset compensation: programmable, 0.3mV resolution.	Drive command analog outputs are supported only by the SPiiPlusNT/DC-LD product.
PWM drive commands	Three phases per axis. Control algorithm: digital PI filters with field oriented control and space vector modulation. PWM frequency: 40kHz on the motor.	
Drive Current Feedback	Two phases per axis. Current loop sampling rate: 20kHz. Current feedback resolution: SPiiPlusNT/DC-HP/LD/NP: 16 bit. SPiiPlusNT/DC-LT: 12 bit.	
External drives	SPiiPlusNT/DC-LD: two phases per axis	Supported only by following motherboards: MB5U-Z MB5U-YYYY MB5U-ZZZ MB5U-ZZW
Digital I/O		
Safety Inputs:		
Emergency stop input	One per controller. Type: two-terminal, sink or source, opto-isolated.	

HW Feature	SPiiPlusNT/DC-LT/HP/LD/NP	Remarks
Left and right limit inputs	One pair per axis. Type: single-ended, sink (default) or source, configurable by jumper, opto-isolated. Supply: 5V or 24V. Input current: <15mA.	
Digital Inputs:		
General Purpose Inputs	Eight. Type: single-ended, 5V or 24V, sink (default) or source, opto-isolated. Input current: <15mA.	
MARK (position capture) inputs	Up to four. Type: RS-422. Propagation delay: <0.1 µsec.	Four additional MARK inputs (MARK2), single-ended and opto-isolated, are available through general purpose digital inputs IN4, IN5, IN6 and IN7 Refer to *PEG and MARK Operations Application Notes* for detailed information.
Digital Outputs		
General purpose outputs	Eight. Type: single-ended, 5V or 24V, sink (default) or source, opto-isolated. Output current: 100mA per output.	Depends on controller configuration. Dual usage, can be used as Mechanical Brake.
Mechanical Brake Outputs:	One per axis. Type: single-ended, 5V, source only, opto-isolated Output current: 7mA per output.	Default configuration is dynamic brake.

General purpose digital outputs can be configured as Mechanical Brake Outputs.

Dynamic brake signal is available only for internalSPiiPlusNT/DC drivers and is not accessible as an external signal.

HW Feature	SPiiPlusNT/DC-LT/HP/LD/NP	Remarks
PEG pulse outputs:	Six. Type: RS-422. Propagation delay: <0.1µsec. PEG pulse width: 25nsec to 1.7msec. PEG position accuracy: ±1 count at speeds up to $18x10^6$ counts/sec.	Refer to *PEG and MARK Operations Application Notes* for detailed information.
PEG state outputs	Up to six. Type: RS-422. Propagation delay: <0.1µsec.	Refer to *PEG and MARK Operations Application Notes* for detailed information.
HSSI Expansion Channels	Up to three. Each channel provides 64 input bits and 64 output bits per channel, sampled and updated every 50µsec. Type: RS-422.	
Analog I/O		
Analog Inputs	Up to 16. Type: 1Vptp, differential. Resolution and SNR: SPiiPlusNT-HP/LD/NP: 16 bit, SNR>72db. SPiiPlusNT-LT: 12 bit, SNR>52db.	Unused Sin-Cos encoder inputs can be used as general purpose analog inputs.
General Purpose Inputs	SPiiPlusNT-HP/LD/NP: Four dedicated general purpose inputs. Type: ±10V, differential. Resolution: 16 bits. SPiiPlusNT-LT: Up to four (when axes number 3 and/ or 7 Sin-Cos encoders are not used. Type: ±10V,differential. Resolution: 12 bits.	
General Purpose Outputs	2, 4. Type: ±10V, PWM filtered. Resolution: 10bit.	
Communication Channels		

HW Feature	SPiiPlusNT/DC-LT/HP/LD/NP	Remarks
Serial	SPiiPlusNT only: Two. RS-232. Up to 115,200bps	
Ethernet	SPiiPlusNT only: One. TCP/IP, 100/1000 Mbits/sec.	SPiiPlusNT only: Simultaneous communication through all channels is fully supported. Modbus protocol as master or slave is supported via all channels
EtherCAT	SPiiPlusNT: One or two master ports. SPiiPlusDC: One input, one output.	SPiiPlusNT only: Optional network failure detection and recovery with ring topology.
MPU (SPiiPlusNT only)		
Processor	Intel® Atom™ N2600 1.6 GHz	
Memory	RAM: 1GB Flash NV memory: 1GB	
Powerup Time	25-100 sec. according to system and network configuration	
Environment & Standards		
Operating Temperature	0˚C to 55˚C	
Storage Temperature	40˚C to 70˚C	
Humidity	90%RH, non-condensing	
Standards	CE (EMC), UL certified and RoHS compliant	

1.3 Order Options

The following sections detail the ordering options for the SPiiPlusNT-LT/HP/LD/NP and SPiiPlusDC-HP/LT/LD/NP.

Both versions are supported by the SPiiPlus ADK (Advanced Development Kit) which is intended for aiding programmers in developing ACSPL+ based applications and host based programs. The kit contains:

- **SPiiPlus MMI Application Studio** - user graphic interface for axis configuration, servo tuning, programming and monitoring operations
- **SPiiPlus Library** - for host programming in C/C++ or Visual Basic™
- **SPiiPlus Simulator** – controller simulator for fast application development
- Hardware, software, setup, and programming guides in PDF format
- ACSPL+ and C/C++ training files and programming examples

The latest versions of all software are downloadable (for registered customers) from https://www.acsmotioncontrol.com/downloads.

The ordering codes and their explanations are given in the sections that follow.

The ordering codes, as given, are for ordering stand-alone units; when they are incorporated in the MC4U, the configuration is designated by the MC4U ordering code (see *MC4U Hardware Guide*).

Figure 1-4 illustrates the SPiiPlusNT/DC-HP/LT/LD/NP ordering code elements. These elements and options are described in Table 1-6.

```
SPiiPlus[NetType]-[Performance Type]-[Axis#]
```

Figure 1-4. SPiiPlusNT Ordering Code Elements

Table 1-6. SPiiPlusNT Ordering Code Description

Element and Description	Options
NetType	Type can be: > NT > DC
Performance Type	Can be: > HP > LT > LD > NP
Axis# - the number of axes	2 - two axes controller 4 - four axes controller 8 - eight axes controller

2. Specifications

This chapter provides detailed specifications for the SPiiPlusNT-LT/HP/LD/NP and the SPiiPlusDC-HP/LT/LD/NP.

2.1 Controller and Power Supply

Table 1-7. Controller and Power Supply

Element	Description
Power Supply Voltage/Current	+5Vdc (±10%)/2.7A -5Vdc (±10%)/0.1A ±12Vdc (±5%)/0.6A
Configuration I/O Supply Voltage/Current	+5Vdc (±10%)/1A, or 24Vdc (±20%)/1A
Safety Supply Voltage Current	+5Vdc(±10%)/1A or 24Vdc(±10%)/1A
LEDs	Six LEDs located on the front panel indicate the status of all above power supplies.

2.2 Axis Definitions

In previous SPiiPlus products axes were designated by letters, such as X, Y, and Z, but SPiiPlusNT is based on a mapping routine that assigns an index number to the axis. Thus a signal name, for example, **X_ENA**, may be sent to any axes index. In particular in the case of EtherCAT-connected controllers the same signal name may be sent by each controller to an axis index specified for the controller.

Axes are assigned in the range of 0 to 63 by ACS, according to the customer's configuration and need not be consecutive. The axes of an MC4U, on the other hand, are consecutive.

In this document the axis indices for a single SPiiPlusNT/DC are given.

The on board SPiiPlusNT/DC-HP/LT/LD/NP supports 2, 4, 6 or 8 axes. 4 and 8 axes are configured by assembly (see Table 1-8 below); 2 and 6 axes are configured by software, based on 4 and 8 axes board assemblies.

The axes indices given in the table are for stand-alone units. When connected in a network, the indices are not necessarily those as given.

Table 1-8. On Board Axes Definition

Product	Description	Built-In Axes Indices
SPiiPlusDC-LT/HP-4	4-axes high performance Drive controller	0, 1, 2, and 3

Product	Description	Built-In Axes Indices
SPiiPlusDC-LT/HP-8	8-axes high performance Drive controller	0, 1, 2, 3, 4, 5, 6, and 7
SPiiPlusDC-LD-4	4-axes high performance Drive controller	0, 1, 2, and 3
SPiiPlusDC-LD-8	8-axes high performance Drive controller	0, 1, 2, 3, 4, 5, 6, and 7
SPiiPlusNT-LT/HP-4	4-axes Network controller	0, 1, 2, and 3
SPiiPlusNT-LT/HP-8	8-axes Network controller	0, 1, 2, 3, 4, 5, 6, and 7
SPiiPlusNT-LD-4	4-axes Network controller	0, 1, 2, and 3
SPiiPlusNT-LD-8	8-axes Network controller	0, 1, 2, 3, 4, 5, 6, and 7
SPiiPlusDC-NP-2	2-axes Network controller	0, 1
SPiiPlusDC-NP-4	4-axes Network controller	0, 1, 2, and 3
SPiiPlusNT-NP-2	2-axes Network controller	0, 1
SPiiPlusNT-NP-4	4-axes Network controller	0, 1, 2, and 3

2.3 External Interfaces Signal Definition

In the tables that follow the pound sign (#) stands for a letter designation, for example, X_ENA stands for 0_ENA, Y_ENA stands for 1_ENA, Z_ENA stands for 4_ENA, etc.

Table 1-9 provides a breakdown of the signal definitions to external electrical interfaces.

Table 1-9. External Interfaces

Signal Designation	Signal Description	Signal Source/ Destination
#_CHA± #_CHB± #_CHI±	AQB encode phase A AQB encode phase B AQB encode Index	Inputs RS422
#_HA #_HB #_HC	Hall feedback Channel A Hall feedback Channel B Hall feedback Channel C	Source input type

Signal Designation	Signal Description	Signal Source/ Destination
#_SIN± #_COS± #_SC_I±	Sin-Cos encoders Sine Sin-Cos encoders Cosine Sin-Cos encoders Index	Input differential
#_PWM0 #_PWM1 #_PWM2	PWM command bridge leg R PWM command bridge leg S PWM command bridge leg T	Output TTL
#_ENA	Drive enable output	Output source
#_FLT	Drive fault input	Input sink
#_BRK	Dynamic Brake	Output source
#_IS± #_IT±	Current feedback Phase S Current feedback Phase T	Input differential
#_IS_CMD± #_IT_CMD±	SPiiPlusNT/DC-LD only: Two phase analog command Phase S Phase T	±10V differential
DRV_SUP_ENA	Drive Supply enable	Sink output/Source input (optional)
DRV_RST	Drive Fault Reset	Sink output/Source input (optional)
#_RL #_LL	Right limit Left limit	Input source or sink
ES±	E-Stop	
#_OVER_T	Motor over temperature inputs	Input Single-ended

Signal Designation	Signal Description	Signal Source/ Destination
IN0, IN1, IN2, IN3, IN4, IN5, IN6, IN7	General purpose logic inputs	Inputs sink or source
#_MARK1± #_MARK2±	Registration Mark 1 Registration Mark 2	Input RS422
OUT0, OUT1, OUT2, OUT3, OUT4, OUT5, OUT6, OUT7	General purpose outputs	Output sink or source
#_PEG±	PEG pulse	Output RS422
#_STATE0± #_STATE1± #_STATE2±	PEG State	
AIN10,AIN11, AIN14,AIN15	General purpose analog inputs	Input differential
AOUT_CS±, AOUT_CC±, AOUT_DS±, AOUT_DC±	General purpose analog outputs	Output differential
H_CON_#± H_DI_#± H_DO_#±	HSSI Control signal HSSI Input signal: HSSI Output signal:	Output RS422 Input RS422 Output RS422
ETH#_TX± ETH#_RX±	Ethernet Transmit Ethernet Receive	Output differential Input differential
COM1_TX COM1_RX COM2_TX COM2_RX	Serial communication Transmit Serial communication Receive	Output RS232 Input RS232
I2C_CLK I2C_DATA	I^2C serial bus clock I^2C serial bus data	Output open drain Bidirectional open drain

2.4 EtherCAT Network Performance

All servo performance of the controller in the system is based on the EtherCAT synchronization standard. EtherCAT master synchronizes the system with MPU cycle and MAC of each node generates the servo interrupt for each servo processor.

Figure 1-5 illustrates the control synchronization cycles on the controller board.

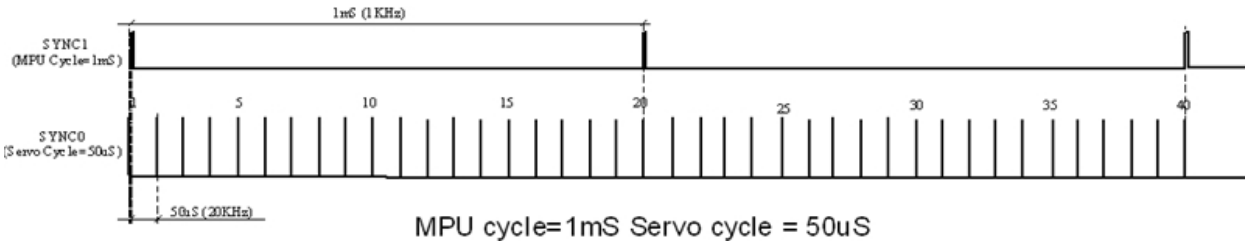


Figure 1-5. EtherCAT Control Synchronization

The EtherCAT Performance Specifications are in the following table, see CTIME Values for MC4Unt SPiiPlusNT-LT/HP/LD/NP (Rev. A, B, C) Controller, CTIME Values for MC4Unt SPiiPlusNT-NP (Rev. C) Controller, CTIME Values for MC4Unt SPiiPlusNT-LT/HP/LD/NP (Rev. D) Controller for CTIME Values for network features.

Table 1-10. EtherCAT Performance Specifications

Item	Parameter Value
Servo cycle	50µsec (20 kHz) for all axes
Control algorithm	Fixed algorithm
MPU cycle synchronization jitter and servo cycle synchronization jitter between EtherCAT nodes for all axes	Jitter not more than 100nsec

2.4.1 EtherCAT Connector J3

The optional *NetworkBoost*™ failure detection and recovery functionality using ring topology is enabled through J3, located on the SPiiPlusNT front panel.

For information on EtherCAT functionality and connections in the MC4U, refer to the *MC4U Control Module Hardware Guide* or MC4U-NP Control Module Hardware Guide.

2.5 PEG Engines

The SPiiPlusNT/DC has six PEG engines for all configurations.

PEG is not supported with ABS encoders.

The SPiiPlusNT/DC-HP/LT/NP controllers contain identical PEG engine units. Each PEG engine can operate in two modes:

- Incremental PEG mode
- Random PEG mode (maximum 1024 points).

In addition in this mode control is provided for four output vectors and the generation of states at a set of predefined array positions (maximum 1024 points).

Each PEG engine has next output signals:

- PEG#_PULSE

On each event (incremental or random), a pulse is generated.

> PEG#_OUT.y (state)

Refer to *PEG and Mark Operations" Application Notes* for detailed information.

2.6 Controller Interfaces

2.6.1 Encoder Feedback

2.6.1.1 Incremental Digital Encoder

Table 1-11 details the feedback signals for an incremental digital encoder.

Table 1-11. Incremental Digital Encoder Interface Signals

Item	Parameter Value	Remarks
Signal Designation	A: #_CHA± B: #_CHB± I: #_CHI±	
Quantity	One per axis.	
Format	A&B,I UP/DN,I CLK/DIR,I	
Maximum input frequency	≥ 10 MHz	≥10 MHz A & B input frequency appropriate to 40 million counts per second.
Interface type	RS422 compatible. Input impedance 120Ω±10%.	No single-ended.
Diagnostic	Encoder Error 1 (#ENC)	Encoder fault or encoder not-connected

2.6.1.2 Hall Feedback

Table 1-12 details the feedback signals for the Hall sensor.

Table 1-12. Hall Feedback Interface Signals

Item	Parameter Value	Remarks
Signal Designation	Channel A: #_HA Channel B: #_HB Channel C: #_HC	All Hall signals are routed and processed by the respective SPs (4 Hall sets per SP).
Quantity	Three per axis.	

Item	Parameter Value	Remarks
Format	A, B, C	
Interface type	Opto-isolated input. Source input type, (open cathode). Up to 7mA current. DGND referenced.	Power supply range: 5Vdc ±5%. 50mA max supply load current for A, B, C Hall sensors in one motor.
Maximum input frequency	2 kHz	

2.6.1.3 Sin-Cos Encoder Inputs

Table 1-13 details the feedback signals for the Sin-Cos encoder inputs.

Table 1-13. Sin-Cos Encoder Input Interface Signals

Item	Parameter Value	Remarks
Signal Designation	Sine, Cosine, Index#_SIN± #_COS± #_SC_I±	
Quantity	One per axis	
Band pass	Max frequency HP/NP: 500 kHz LT: 250 kHz LD: 4 MHz (optional)for axes indices 0, 1, 4, 5, 2, 3, 6 and 7	
Type	Differential input impedance 120Ω±10% Encoder voltage range 1Vptp±10% Input Voltage range: 1.25Vptp	
Offset compensation	Programmable Range: ±50% Resolution 12bit ±1LSB	HP/NP only
Gain compensation		Values set by SW

Item	Parameter Value	Remarks
Phase compensation		Values set by SW
ADC	Resolution: 12 bit for LT SNR > 53dB 16 bit for HP/NP SNR > 72dB	
Diagnostics	Encoder not connected detection in software level	Encoder error detection on the SW level

2.6.1.4 Squared Sin-Cos Outputs

Table 1-14 details the feedback signals for the Squared Sin-Cos encoder outputs.

Table 1-14. Squared Sin-Cos Encoder Output Interface Signals

Item	Parameter Value	Remarks
Signal Designation	A: #_CHA± B: #_CHB±	In SIN-COS mode used the same pins as digital encoder inputs.
Total quantity	One per axes 0, 1, 4,and 5	
Format	A, B	
Type	RS422	
Output impedance	120Ω ±10%	In parallel
Protection	Output short protected	

2.6.1.5 Absolute Encoders

The SPiiPlusNT/DC supports the following absolute encoders:

- EnDat 2.1/2.2 (Digital only)
- Smart-ABS
- Panasonic
- Biss-C
- Hiperface
- Sanyo Danki

For more information see *Using Absolute Encoders with ACS Products AN 3.00*.

2.6.2 Drive Interfaces

2.6.2.1 PWM Drive Command Output

Table 1-15 details the Drive interface signals for the PWM Drive Command outputs.

Table 1-15. PWM Drive Command Outputs Interface Signals

Item	Parameter Value
Signal Designation	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 ≤ 15mA
Base frequency	20 kHz
Synchronization	PWM update synchronization: 20 kHz
Pulse width	Min. Pulse width – 3µS Max. Pulse width – 47µS Command range ±1875
Resolution	Command time resolution 14nS. (11.8bit).
Default	Power-up output state "Z"

2.6.2.2 Analog Drive Command

This applies only to SPiiPlusNT/DC-LD units.

Table 1-16 details the analog drive command.

Table 1-16. Analog Drive Command

Item	Parameter Value	Remarks
Signal Designation	Phase S: #_IS_CMD± Phase T: #_IT_CMD±	Current commands for two phases
Quantity	Two per axis	
Type	Differential ±10V	

Item	Parameter Value	Remarks
Power-up state	0V	
Resolution	16 bit	
Synchronization	Synchronized with 20 kHz	
Maximum zero offset	±70mV at 0V	
Maximum load	5 mA	

2.6.2.3 Drive Enable Outputs

Table 1-17 details the Drive interface signals for the Drive Enable outputs.

Table 1-17. Drive Enable Outputs Interface Signals

Item	Parameter Value	Remarks
Signal 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	Reference defined by internal jumper. DGND default.
Voltage drop in active state	≤ 0.6 V	
Default	Upon power-up signal is high impedance (no current through the output transistor) Power-up state high impedance.	

2.6.2.4 Drive Fault Input

Table 1-18 details the Drive interface signals for the Drive Fault inputs.

Table 1-18. Drive Fault Inputs Interface Signals

Item	Parameter Value	Remarks
Signal Designation	Axis Fault: #_FLT	Fault status code readable via I^2C interface.
Quantity	One per axis	

Item	Parameter Value	Remarks
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. +5VCC default.
Default state	No current	
Default state	No current	
Propagation delay	½ from input to measured output delay < 3mS	Drive enable is target output

2.6.2.5 Dynamic/ Mechanical Brake

Table 1-19 details the Drive interface signals for the Dynamic/ Mechanical Brake.

Table 1-19. Dynamic/Mechanical Brake Interface Signals

Item	Parameter Value	Remarks
Signal Designation	Brake enable: #_BRK	The same pins of connectors can be used 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 ≤ 3mS	Reference defined by internal jumper. +5VCC default.
Default state	No current through the output transistor.	

2.6.2.6 Drive Current Feedback

Table 1-20 details the Drive interface signals for the Drive Current feedback.

Table 1-20. Drive Current Feedback Interface Signals

Item	Parameter Value
Signal Designation	Current in two phases (S, T) of the motor phase S: #_IS± Phase T: #_IT±
Quantity	Sixteen. - two per axis
Type	Differential analog input voltage range: ±2.5V, referenced to AGND.Input impedance ≥10kΩ ±10%
Bandwidth	4 kHz/3dB
ADC	Resolution: 12 bit for LT SNR > 53dB 16 bit for HP/NP SNR > 72dB

2.6.2.7 Drive Supply Fault Input

Table 1-21 details the Drive interface signals for the Drive Supply fault.

These signals can be used either as input or as output, as set by assembly option.

Table 1-21. Drive Supply Fault Interface Signals

Item	Parameter Value	Remarks
Signal Designation	Drive high voltage supply enable: DRV_SUP_ENA Drive Fault Reset: DRV_RST	
Quantity	One DRV_SUP_ENA common to all devices One DRV_RST common to all devices	PS fault
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),	Reference defined by internal jumper. DGND default.

Item	Parameter Value	Remarks
	Supplied by +5VCC.Max current < 7mA.	Default: input.
Default state	Input default state: no current Output default state: no current through the output transistor	
Output voltage drop in active state	≤ 0.3V	

2.6.3 Safety Inputs

Table 1-22 details the Safety Inputs signals.

Table 1-22. Safety Input Signals

Item	Parameter Value	Remarks
Limit Switches		
Signal Designation	Right limit: #_RL Left limit: #_LL	
Quantity	One Left Limit and one Right Limit per axis	
Type	**Limits**: Single-ended, opto-isolated. Configurable by the user as either source or sink (as a group). 5Vdc ±10% or 24Vdc±15% Automatic detection. Requires an external supply. Reference: V_SUP_SFTY	Configured by jumper JP1 (see Jumpers and Switches). The user has to set the value for V_SUP_SFTY (see Main Connectors J1 and J2).
Input current	2.8-14mA.	

Item	Parameter Value	Remarks
Default state	No limit, no current.	
Propagation delay	½ from input to measured output delay < 3mS	
E-Stop		
Signal 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 E-Stop.	
Type	E-Stop: opto-isolated, floating cathode and anode (two pins). 5Vdc±10% or 24Vdc ±15% Automatic detection.	
Input current.	2.8-14mA	
Default state	No emergency stop, no current.	
Propagation delay	½ from input to measured output delay < 3mS	
Motor Over Temperature Inputs		
Signal Designation	Motor over temperature: #_OVER_T	
Quantity	One per axis	
Type	Single-ended, opto-isolated, Reference: V_ RTN_IO Threshold resistance 3.6 kΩ.	When using PTC, if the motor is cold, the resistance should be below 1650 Ω and if hot – above 4000 Ω.

Item	Parameter Value	Remarks
Default state	Low impedance: < 3kΩ (No over temperature)	
Motor Not Connected		Implementation by SW

2.6.4 Logic/Digital Inputs

Table 1-23 details the Logic/Digital input signals.

Table 1-23. Logic/Digital Input Signals

Item	Parameter Value	Remarks
General Purpose Logic Inputs		
Signal Designation	IN0, IN1, IN2, IN3, IN4, IN5, IN6, IN7	IN6 shared with 0-axis MARK2 IN7 shared with 1-axis MARK2 IN4 shared with 4-axis MARK2 IN5 shared with 5-axis MARK2 See Registration Mark
Quantity	Eight.	
Type	Single-ended, opto-isolated. Can be configured as sink or source – by the user. 5Vdc ±10% or 24Vdc±15% Referenced to V_SUP_IO (Sink) or V_RET_IO (Source) Automatic voltage detection.	Configuration by jumper JP3 (see Jumpers and Switches). See Main Connectors J1 and J2.
Input current	2.8-14mA	
Default state	No input current	
Propagation delay	½ from input to measured output delay < 3mS	
Registration Mark		

Item	Parameter Value	Remarks
Signal Designation	Mark 1: #_MARK1± Mark 2: #_MARK2±	
Quantity	Two per X, Y, Z, T	
Type	#_MARK1 RS422 compatible. Input impedance 120Ω ±10%. #_MARK2 shared with GP inputs. See **General Purpose Logic Inputs**	IN6 shared with MARK2 IN7 shared with MARK2 IN4 shared with MARK2 IN5 shared with MARK2
Propagation delay	< 0.1µsec	
Default state	Vin < 0.2V Open state: No input current	

2.6.5 Logic/Digital Outputs

Table 1-24 details the Logic/Digital output signals.

Table 1-24. Logic/Digital Output Signals

Item	Parameter Value	Remarks
General Purpose Outputs		
Signal Designation	OUT0, OUT1, OUT2, OUT3, OUT4, OUT5, OUT6, OUT7	By FPGA configuration the same pins of connectors can be defined as opto-isolated PEG's. Functionality - see **PEG Outputs**. State outputs - see PEG State Outputs Default: Digital output.
Quantity	Eight.	
Type	Single-ended, opto-isolated. Can be configured as sink or source – by the user. 5 Vdc±10% to 24 Vdc ±15% Referenced to V_RET_IO (Sink) or V_SUP_IO (Source).	Configuration by jumper JP2 (see Jumpers and Switches). Short protected. See Main Connectors J1 and J2

Item	Parameter Value	Remarks
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)	
Maximum current per all output	800mA	
Protection	All outputs are protected against overload and short current	
Propagation delay	½ from input to measured output delay < 3mS	
PEG Outputs		
Signal Designation	PEG Pulse: #_PEG± PEG State: #_STATE0± #_STATE1± #_STATE2±	For details on PEG Pulse - see PEG Pulse Outputs For details on PEG State - see PEG State Outputs
Quantity	One PEG pulse per axis. Up to six can be assigned. Up to 10 PEG states can be assigned	Refer to *PEG and MARK Operations Application Notes*.
Type	RS422 compatible. Or shared with GP outputs.	Default: RS422 See **General Purpose Outputs** and PEG Engines.
Propagation delay	For differential outputs < 0.1µsec	

Item	Parameter Value	Remarks
	For opto-isolated outputs < 1msec	
PEG generated pulse width range	Minimal PEG input duration: 26.64 nSec. Maximal PEG input duration: 1.745 mSec.	
Number of PEG events in incremental mode	Up to 18MHz	In random mode up to 10MHz
Number of time-based pulses	From 0 to 65,535	

2.6.6 General Purpose Analog Inputs

Table 1-25 details the General Purpose Analog Input signals.

Table 1-25. General Purpose Analog Input Signals

Item	Parameter Value	Remarks
Signal Designation	AIN10, AIN11, AIN14, AIN15	SW logical names - included for backward compatibility
Total quantity	Two for 4 axes Four for 8 axes	SPiiPlusNT - LT: Up to four (when axes number 3 and/or 7 Sin-Cos encoders are not used).
Type:	±10V±3% differential	
Input impedance	≥ 20 kΩ	
Resolution	LT: 12 bits ±1LSB SNR > 53 dB HP/NP: 16 bits ±1LSB SNR > 72 dB	

2.6.7 General Purpose Analog Outputs

Table 1-26 details the General Purpose Analog Output signals.

Table 1-26. General Purpose Analog Output Signals

Item	Parameter Value	Remarks
Signal Designation	AOUT10, AOUT11, AOUT14, AOUT15	SW logical names - included for backward compatibility
Total quantity	Two for 4 axes Four for 8 axes	
Type:	±10 V±10% In maximum output voltage	Output short protected
Max differential current	≤ 5 mA	
Default state	0 V Upon power-up, outputs have full range spike for 1.6 ms	
Resolution	10 bits	
Offset	±50m V at 0 V	
Ripple	70 mVp-p	

2.6.8 Mechanical Brake Outputs

SPiiPlusNT/DC provides up to eight mechanical brakes outputs. See instructions in ***SPiiPlus Setup Guide***, Axis Configuration and Setup, Mechanical Brake.

The same pins in the controller's connector can be used as GP output or mechanical brake. The function can be defined by through the controller's software or using the SPiiPlus MMI Application Studio.

With the OUT1.x variable, use the mechanical brake outputs as additional general purpose outputs.

Table 1-27. Mechanical Brake Output Signals

Category	Description
Quantity	One per axis.
Type	

Category	Description
Maximum Output Current	7mA per output
Associated signals	OUT1.0 …OUT1.7 to use the mechanical brake outputs as general purpose outputs

Example

Figure 1-6 is an example of a digital brake output.

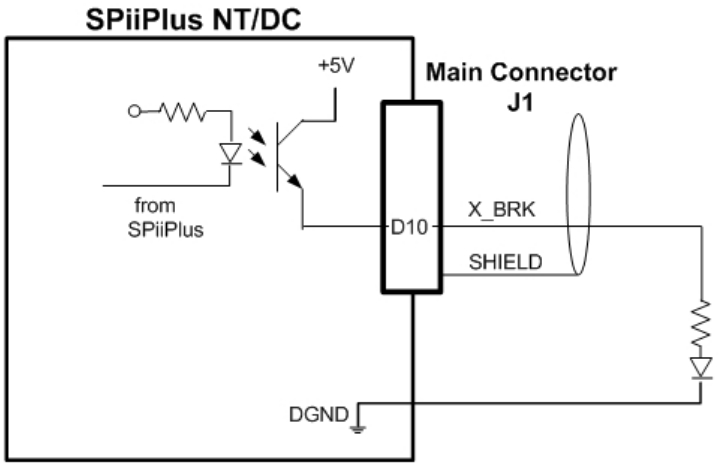


Figure 1-6. Digital Dynamic Brake Output

2.6.9 Communication Channels

Table 1-28 details the Communication Channel signals.

Table 1-28. Communication Channel Signals

Item	Parameter Value		Remarks
	SPiiPlusNT-LT/HP/LD/NP	SPiiPlusDC-LT/HP/LD/NP	
HSSI			
Signal Designation	Control signal: H_CON_#± Input signal: H_DI_#± Output signal: H_DO_#±	Control signal: H_CON_#± Input signal: H_DI_#± Output signal: H_DO_#±	
Quantity	Three	Three	HSSI channels

Item	Parameter Value		Remarks
	SPiiPlusNT-LT/HP/LD/NP	SPiiPlusDC-LT/HP/LD/NP	
			Can be allocated to all axes
Input word size	16x4 = 64 per HSSI channel.	16x4 = 64 per HSSI channel.	
Output word size	16x4 = 64 per HSSI channel.	16x4 = 64 per HSSI channel.	
TX / RX type	RS422 compatible.	RS422 compatible.	
Distance	≤ 10m	≤ 10m	
Input impedance	120Ω ±10%.	120Ω ±10%.	
Sampling rate	All the 64 input bits are sampled and all the 64 output bits are updated every 50 µS.	All the 64 input bits are sampled and all the 64 output bits are updated every 50 µS.	
Ethernet - Host Communication			
Signal Designation	Transmit: ETH1_TX± Receive: ETH1_RX±	N/A	
Line impedance	100Ω ±10%	N/A	
Quantity	One ETH1	N/A	Via back plane connectors
Protocol	ETH1 TPC IP	N/A	
Speed	10/100Mbps	N/A	
Protection	Galvanic Isolated ESD protected	N/A	
Distance	≤ 100 m		Factory tests have confirmed a minimum length of 30cm.

Item	Parameter Value		Remarks
	SPiiPlusNT-LT/HP/LD/NP	SPiiPlusDC-LT/HP/LD/NP	
EtherCAT - Real Time Network (Point-to-Point Connection)			
Signal Designation	Transmit: ETH#_TX± Receive: ETH#_RX±	Transmit: ETH#_TX± Receive: ETH#_RX±	
Line impedance	100Ω ±10%	100Ω ±10%	
Quantity	Two ETH2 - master J3 - optional *NetworkBoost*™ on front panel of controller	ETH1 - input ETH2 - output	Via backplane connectors. For DC configuration ETH1 used as EtherCAT IN, ETH2 as Ethercat_ OUT
Protocol	EtherCAT	EtherCAT	
Speed	100Mbps full duplex	100Mbps full duplex	
Protection	Galvanic Isolated ESD protected	Galvanic Isolated ESD protected	
Distance	≤ 50m		Factory tests have confirmed a minimum length of 30cm.
RS-232			
Signal Designation	COM1: Transmit: COM1_TX Receive: COM1_RX COM2: Transmit: COM2_TX Receive: COM2_RX	N/A	ESD protected

Item	Parameter Value		Remarks
	SPiiPlusNT-LT/HP/LD/NP	SPiiPlusDC-LT/HP/LD/NP	
Number of channels	Two	N/A	Both are available via the back motherboard connector. COM1 and COM2 translate communication interfaces from MPU.
Maximum Baud rate	Up to 115,200	N/A	
Distance	≤ 10 m		
I^2C Serial Bus			
Signal Designation	I2C_CLK I2C_DATA	I2C_CLK I2C_DATA	Bi-directional serial interface for configuration and status feedback. Inside the rack.
Bus numbers	Two	Two	
Frequency	400 kHz standard	400 kHz standard	
Type	Open drain. Isolated interface	Open drain. Isolated interface	

2.7 SPiiPlusNT/DC Layout and Dimensions

Figure 1-7 presents the layout and overall dimensions (in mm) of the SPiiPlusNT/DC.

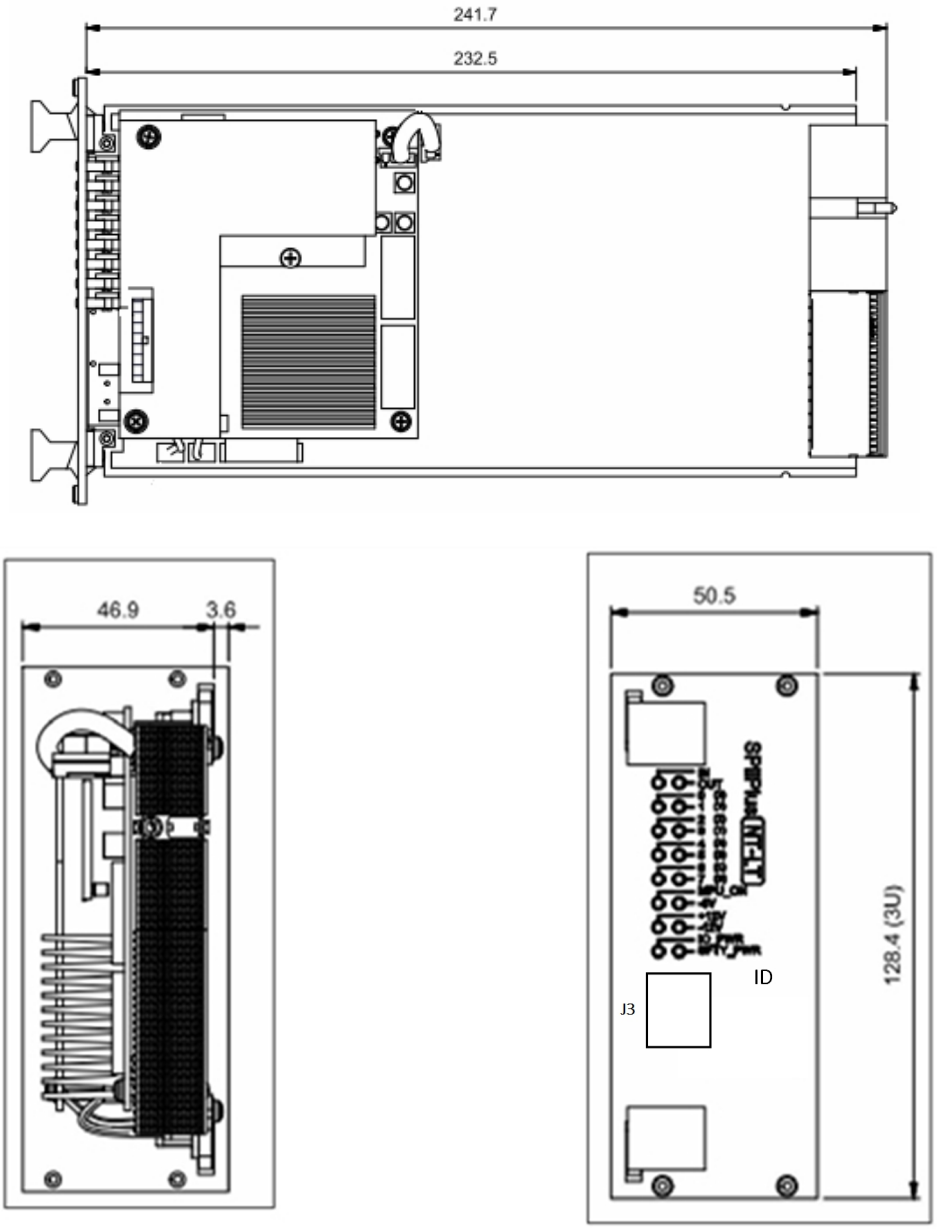


Figure 1-7. SPiiPlusNT/DC Dimensions

3. Installing SPiiPlusNT/DC-LT/HP/LD/NP in MC4U

Figure 1-8 shows the SPiiPlusNT/DC-LT/HP/LD/NP connected to the MC4U motherboard. The following components are important for a proper installation:

- One 176-pin female RA connector - to mate with the motherboard
- One 200-pin female RA connector - to mate with the motherboard
- Two extractors with locks - to secure the controller to the rack slot.

In addition, it is recommended to use Schroff guide rails (64560-057).

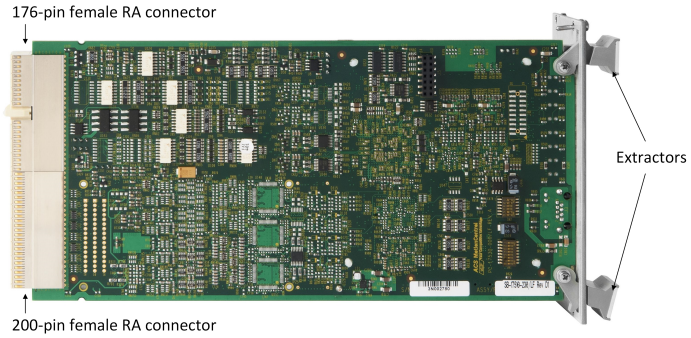


Figure 1-8. SPiiPlusNT/DC-LT/HP/LD/NP

To mount the SPiiPlusNT/DC-HP/LD/NP controller in the rack, do the following:

1. Before installing the SPiiPlusNT/DC-HP/LD/NP controller on the rack verify the settings of the jumpers according to the digital I/O configuration and as your application requires (refer to Jumpers and Switches for the settings).
2. Power off the rack.
3. Insert the SPiiPlusNT/DC-HP/LD/NP controller into the slot along the rack guidelines. (Rack guidelines are located around 8cm inside the slot).
4. Push gently until the 176-pin and 200-pin female RA connectors mate securely with the connector on the motherboard.
5. Hold both extractors and push them down until they snap and lock.
6. Power up the rack.
7. Run **SPiiPlus MMI Application Studio** and connect to the controller.

4. Safety and EMC Guidelines

4.1 General Safety Guidelines

Read and understand the following precautions before operating the SPiiPlusNT/DC!

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

4.2 Emergency Stop Device

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

4.3 Fail-Safe Logic Recommendation

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

4.4 Initial Logic State of Outputs

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

4.5 Electrical Separation

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

4.6 Protective Precautions

- Digital outputs are protected against short circuits with ground.
- Over-travel Protection – Provides over-travel limit protection where over-travel is hazardous. Design and install the over-travel limiting device to interrupt the power circuit.
- Over-current Protection – Use the software Current/Torque Limit parameters in the **SPiiPlus MMI Application Studio Adjuster Wizard** to provide over-current protection for the motors.

- Thermal Detection – Use suitable thermal detection devices to interrupt the power circuit where abnormal temperatures can cause a hazardous condition.
- Cooling Fans – Make sure the cooling fan remains unobstructed at all times.
- In order to insure good heat dissipation, make sure that the cooling vents remain clean at all times.

4.7 General Wiring and Electromagnetic Compatibility (EMC) Guidelines

4.7.1 Routing Signal and Power Cables

Power cables (to the motor, mains outlet, etc.) and signal cables (to I/O, encoder, RS-232, etc.) must be kept as far apart as possible. Keep at least an inch (~2.5 cm) for each 3 feet (~1 m) of parallel run as illustrated in Figure 1-9. For example, if the motor and encoder cables run parallel for 6 feet (~2 m), maintain a 2 inch (~5 cm) separation between them.

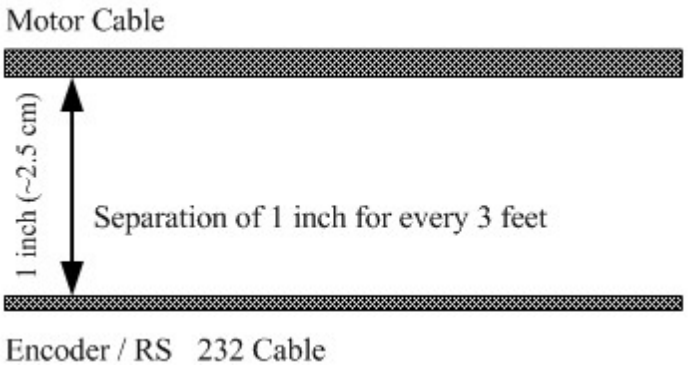


Figure 1-9. Cable Spacing

It is recommended to use completely shielded cables as illustrated in Figure 1-10.

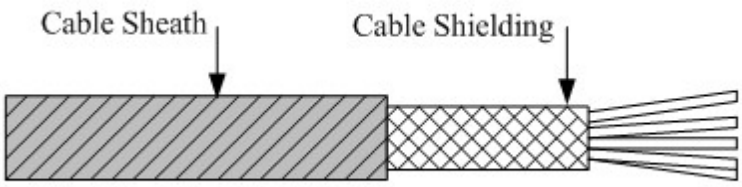


Figure 1-10. Shielded Cable

4.7.2 Cable Length

The recommended cable type for HSSI, Ethernet and EtherCAT is STP CAT5e.

The recommended cable type for COM ports is 24AWG twisted pair shielded cable with a shunt capacitance of 16 pF per foot and 100-120 Ω characteristic impedance.

Use short cable runs, and route cables as far from other EMI sources as possible. For the length of the communication cable see Table 1-28.

4.7.2.1 EtherCAT Network Cable Limitation

For proper operation of the unit installed in an EtherCAT network strict adherence to the cable length limitations given in this section is required.

The maximum cable length between units in an EtherCAT network is 100m. Factory tests have confirmed a minimum length of 30cm.

The following EtherCA5e cables are offered by ACS Motion Control.

Table 1-29. SPiiPlusNT/DC Ethernet Cables

Length [m]	Part Number
0.3	SP+ECAT-CA-30CM-00
0.5	SP+ECAT-CA50CM-00
1	SP+ECAT-CA-1M-00
2	SP+ECAT-CA-2M-00
2	SP+ECAT-CA-3M-00
5	SP+ECAT-CA-5M-00
10	SP+ECAT-CA-10M-00
15	SP+ECAT-CA-15-00
20	SP+ECAT-CA-20M-00

4.7.3 Shielding

To reduce EMI radiation, do the following:

> Use shielded cables

> Install a ferrite core around the cable as close to the SPiiPlusNT/DC as possible as illustrated in Figure 1-11.

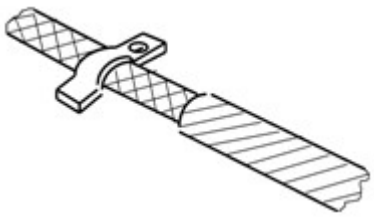


Figure 1-11. Improved Shielding

4.7.4 Grounding

Grounding system electrical components is crucial.

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

5. Connectivity

This chapter is relevant only to the stand-alone SPiiPlusNT-LT/HP/LD/NP motion controllers. When installed in an MC4U Control Module, with the exception of the Ethernet connections, all connections are made through the MC4U motherboard.

5.1 Main Connectors J1 and J2

Table 1-30 lists the designations used for the signals of J1 and J2 connectors.

In the tables that follow the pound sign (#) stands for a letter designation, for example, #_ENA stands for 0_ENA, 1_ENA, 4_ENA, etc.

Table 1-30. J1 and J2 Signal Designations

Signal Designation	Description
AGND	Analog ground
AIN	Analog input
AOUT	General Analog output AOUT 10, 11, 14 15.
#_BRK	Mechanical Brake output
#_CHA	Channel A of incremental digital encoder
#_CHB	Channel B of incremental digital encoder
#_CHI	Channel Index of incremental digital encoder
COM_Rx	COM port input data
COM_Tx	COM port output data
#_DIR	Direction signal for stepper motor
#_ENA	Drive Enable Output
ES	Emergency Stop input
ETH_Rx	Ethernet port input data
ETH_Tx	Ethernet port output data
#_FLT	Drive Fault Input
GND	Digital ground

Signal Designation	Description
H_CON	HSSI control signal
H_DI	HSSI input data
H_DO	HSSI output data
INx	Digital input
#_MARK	MARK input
OUTx	Digital output
#_OVER_T	Motor over temperature input
#_PEG	PEG output
#_PULSE	Pulse command (for step motor control)
#_RL and #_LL	Right and Left Limit (safety inputs)
#_COS	Cosine signal of the Sin-Cos analog encoder feedback (normal 0.25MHz or fast 2.5MHz)
#_SIN	Sine signal of the Sin-Cos analog encoder feedback (normal 0.25MHz or fast 2.5MHz)
#_SC_I	Index signal of the Sin-Cos analog encoder feedback (normal 0.25MHz or fast 2.5MHz)
V_SUP_SFTY, V_ RET_SFTY	Supply and return supply of safety inputs

5.1.1 J1 - Digital Connector

J1, located on the upper back of SPiiPlusNT/DC-HP/NP is an ERNI, PN 104415, 176-pin, female RA connector.

The back pane should have an ERNI, PN 104152, 176-pin, male straight mating connector.

Table 1-31 provides the detailed pinout for the J1 connector.

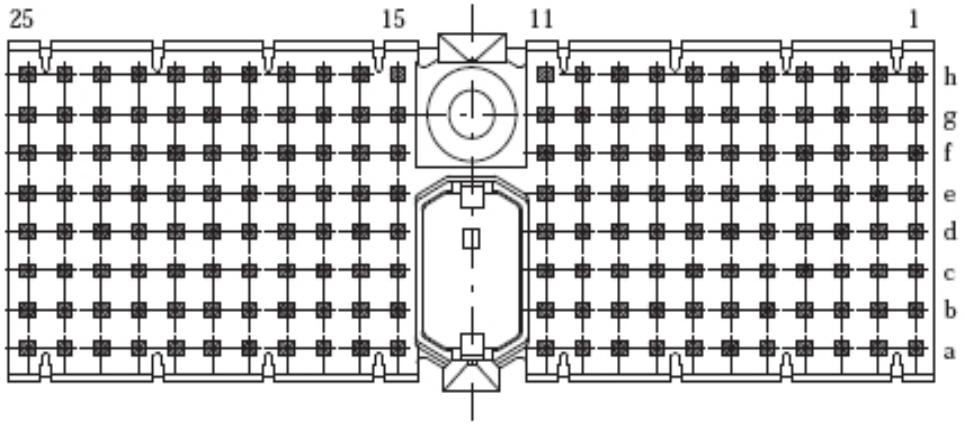


Figure 1-12. J1 Connector Layout

Table 1-31. J1 Connector - Pinout

Pin	A	B	C	D	E	F	G	H
1	D_CHA+	D_CHB+	D_CHI+	H_CON_2-/ H_CON_3-/ CANL	H_DI_2-/ H_DI_3-	H_DO_2-/ H_DO_3-	ETH2_TX+	ETH2_TX-

Pin	A	B	C	D	E	F	G	H
2	D_CHA-	D_CHB-	D_CHI-	H_CON_2-/ H_CON_3-/ CANH	H_DI_2-/ H_DI_3-	H_DO_2-/ H_DO_3-	Y_HC	ETH2_RX-
3	T_CHA+	T_CHB+	T_CHI+	H_CON_1-	H_DI_1-	H_DO_1-	ETH2_RX+	Y_HB
4	T_CHA-	T_CHB-	T_CHI-	H_CON_1+	H_DI_1+	H_DO_1+	COM2_TX	COM2_RX
5	Not in use	Not in use	GND	H_CON_0-	H_DI_0-	H_DO_0-	COM1_RX	ETH_RX-
6	V_SUP_SFTY	V_RET_SFTY	D_FLT	H_CON_0+	H_DI_0+	H_DO_0+	COM1_TX	ETH_RX+
7	A_OVER_T	D_ENA	D_BRK	II^2C_CLK	II^2C_DATA	Z_HA	Z_HB	ETH1_TX-
8	B_OVER_T	C_OVER_T	D_OVER_T	X_OVER_T	Y_OVER_T	Z_OVER_T	T_OVER_T	ETH1_TX+
9	A_ENA	B_ENA	C_ENA	X_ENA	Y_ENA	Z_ENA	T_ENA	DRV_RST
10	A_BRK	B_BRK	C_BRK	X_BRK	Y_BRK	Z_BRK	T_BRK	DRV_SUP_ ENB
11	A_FLT	B_FLT	C_FLT	X_FLT	Y_FLT	Z_FLT	T_FLT	-5V
12	Not in use	Not in use	Not in use	Not in use	Not in use	Not in use	Not in use	Not in use
13	Not in use	Not in use	Not in use	Not in use	Not in use	Not in use	Not in use	Not in use
14	Not in use	Not in use	Not in use	Not in use	Not in use	Not in use	Not in use	Not in use
15	A_LL	B_LL	C_LL	X_LL	Y_LL	Z_LL	T_LL	ES+

Pin	A	B	C	D	E	F	G	H
16	A_RL	B_RL	C_RL	X_RL	Y_RL	Z_RL	T_RL	ES-
17	B_PWM0	D_LL	D_RL	X_PWM0	A_PWM0	Y_PWM0	Z_PWM0	T_PWM0
18	B_PWM1	C_PWM0	D_PWM0	X_PWM1	A_PWM1	Y_PWM1	Z_PWM1	T_PWM1
19	B_PWM2	C_PWM1	D_PWM1	X_PWM2	A_PWM2	Y_PWM2	Z_PWM2	T_PWM2
20	GND	C_PWM2	D_PWM2	X_PEG+/ Y_DIR+	Y_PEG+/ Y_PULSE+	T_PEG+	Z_PEG+	-5V
21	X_HB	Y_HA	GND	X_PEG-/ Y_DIR-	Y_PEG-/ Y_PULSE-	T_PEG-	Z_PEG-	GND
22	C_CHA+	C_CHB+	C_CHI+	OUT0	OUT1	OUT2	OUT3	+5V
23	C_CHA-	C_CHB-	C_CHI-	OUT4	OUT5	OUT6	OUT7	GND
24	Z_CHA+	Z_CHB+	Z_CHI+	X_MARK1+	Y_MARK1+	Z_MARK1+	T_MARK1+	+5V
25	Z_CHA-	Z_CHB-	Z_CHI-	X_MARK1-	Y_MARK1-	Z_MARK1-	T_MARK1+	+5V

5.1.2 J2 - Digital/Analog Connector

J2, located on the lower back of SPiiPlusNT/DC-HP/NP, is an ERNI, PN 104416, 200-pin, female, digital and analog connector.

Table 1-32 provides the detailed pinout for the J2 connector.

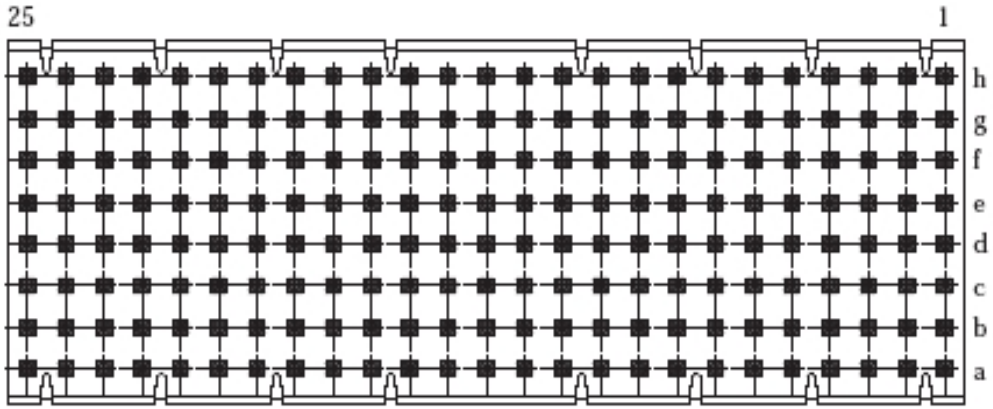


Figure 1-13. J2 Connector Layout

Table 1-32. J2 - Pinout

Pin	A	B	C	D	E	F	G	H
1	B_CHA+	B_CHB+	B_CHI+	IN4	IN5	IN6	IN7	+5V
2	B_CHA-	B_CHB-	B_CHI-	IN0	IN1	IN2	IN3	V_RET_ SFTY
3	Y_CHA+	Y_CHB+	Y_CHI+	D_SIN+	D_SIN-	D_COS+	D_COS-	V_SUP_ SFTY
4	Y_CHA-	Y_CHB-	Y_CHI-	T_SC_I+	T_SC_I-	D_SC_I+	D_SC_I-	V_RET_IO
5	A_CHA+	A_CHB+	A_CHI+	T_SIN+	T_SIN-	T_COS+	T_COS-	V_SUP_IO

Pin	A	B	C	D	E	F	G	H
6	A_CHA-	A_CHB-	A_CHI-	C_SIN+	C_SIN-	C_COS+	C_COS-	B_FSC_I-
7	X_CHA+	X_CHB+	X_CHI+	Z_SC_I+	Z_SC_I-	C_SC_I+	C_SC_I-	B_FSC_I+
8	X_CHA-	X_CHB-	X_CHI-	Z_SIN+	Z_SIN-	Z_COS+	Z_COS-	Y_FSC_I-
9	V_RET_IO	B_FSIN+	B_FSIN-	B_FCOS+	B_FCOS-	Y_FSC_I+		
10	V_SUP_IO	A_HA	D_HA	Y_FSIN+	Y_FSIN-	Y_FCOS+	Y_FCOS-	A_FSC_I-
11	Z_HC	A_HB	D_HB	A_FSIN+	A_FSIN-	A_FCOS+	A_FCOS-	A_FSC_I+
12.	T_HA	A_HC	D_HC	X_FSIN+	X_FSIN-	X_FCOS+	X_FCOS-	X_FSC_I-
13.	X_STATE0+/ X_DIR+	X_STATE0/-X_DIR-	C_HA	AIN10+	AIN10-	AIN11+	AIN11-	X_FSC_I+
14	X_STATE1+/ X_PULSE+	X_STATE1/-X_PULSE-	C_HB	T_IS+	T_IS-	T_IT+	T_IT-	AIN14+
15	X_STATE2+/ XY_STATE+	X_STATE2/-XY_STATE-	C_HC	Z_IS+	Z_IS-	Z_IT+	Z_IT-	AIN14-
16	T_HB	B_HA	B_HC	Y_IS+	Y_IS-	Y_IT+	Y_IT-	AIN15+
17	T_HC	B_HB	GND	A_IS+	A_IS-	A_IT+	A_IT-	AIN15-

Pin	A	B	C	D	E	F	G	H
18	B_IT-	C_IT-	D_IT-	X_IS+	X_IS-	X_IT+	X_IT-	+12V
19	B_IT+	C_IT+	D_IT+	AOUT_DS+	AOUT_DS-	AOUT_DC+	AOUT_DC-	+12V
20	B_IS-	C_IS-	D_IS-	AOUT_CS+	AOUT_CS-	AOUT_CC+	AOUT_CC-	AGND
21	B_IS+	C_IS+	D_IS+	T_ IS_CMD+	T_ IS_CMD-	T_ IT_CMD+	T_ IT_CMD-	AGND
22	B_IT_CMD-	C_IT_CMD-	D_IT_CMD-	Z_ IS_CMD+	Z_ IS_CMD-	Z_ IT_CMD+	Z_ IT_CMD-	AGND
23	B_IT_CMD+	C_IT_CMD+	D_IT_CMD+	Y_ IS_CMD+	Y_ IS_CMD-	Y_ IT_CMD+	Y_ IT_CMD-	AGND
24	B_IS_CMD-	C_IS_CMD-	D_IS_CMD-	A_ IS_CMD+	A_ IS_CMD-	A_ IT_CMD+	A_ IT_CMD-	-12V
25	B_IS_CMD+	C_IS_CMD+	D_IS_CMD+	X_ IS_CMD+	X_ IS_CMD-	X_ IT_CMD+	X_ IT_CMD-	-12V

The signals designated in blue indicate Analog and Digital signals.

The separation between Analog and Digital signals is indicated by the bold line. Digital signals are above the line, and Analog signals are below the line.

5.2 EtherCAT Connector J3

Table 1-33 lists the designations used for the signals of the J3 connector.

Table 1-33. J3 Ehternet Pinout

Pin #	Signal Designator	Description
1	ETH$_TX +	Positive transmit signal
2	ETH$_TX -	Negative transmit signal
3	ETH$_RX +	Positive receive signal
4	-	
5	-	
6	ETH$_RX -	Negative receive signal
7	-	
8	-	

5.3 Incremental Digital Encoder Interface

Power supply for encoders and safety switches must be provided separately by the user and directly to the encoder.

For information on connecting the controller to absolute encoders, see *Using Absolute Encoders with ACS Products AN 3.00*.

Table 1-34 describes the incremental digital encoders supported by the SPiiPlusNT/DC-LT/HP/NP series.

Table 1-34. Incremental Digital Encoder Support

Item	SPiiPlusNT/DC-HP /LD/NP
Quantity	SPiiPlusNT-LT-4: 4 SPiiPlusNT-LT-8: 8 SPiiPlusNT-HP-4: 4 SPiiPlusNT-HP-8: 8 SPiiPlusDC-LT-4: 4 SPiiPlusDC-LT-8: 8

Item	SPiiPlusNT/DC-HP /LD/NP
	SPiiPlusDC-HP-4: 4 SPiiPlusDC-HP-8: 8 SPiiPlusDC-NP-2-4:4 SPiiPlusDC-NP-4-8:8 SPiiPlusNT-NP-2-4:4 SPiiPlusNT-NP-4-8:8
Encoders per axis	1
Characteristics	See Controller Interfaces.
ACSPL+ standard variable	FPOS
Recommended Wires	AWG22 wires with shielding. Twisted pair cable for each differential signal (+ and -).
Supported Types of Digital Encoders	**A&B, I**: Quadrature encoder with index. **CLK-Dir, I:** Clock – direction encoder with index. **UP–DN, I:** Up-down encoder with index.

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

The digital encoder channel A, channel B and Index inputs are built around 26C32 line receivers with 120Ω termination resistor. The use of encoders with built-in line drivers, such as AM26C31 or similar, is recommended. Figure 1-14 is an example of an incremental encoder connection.

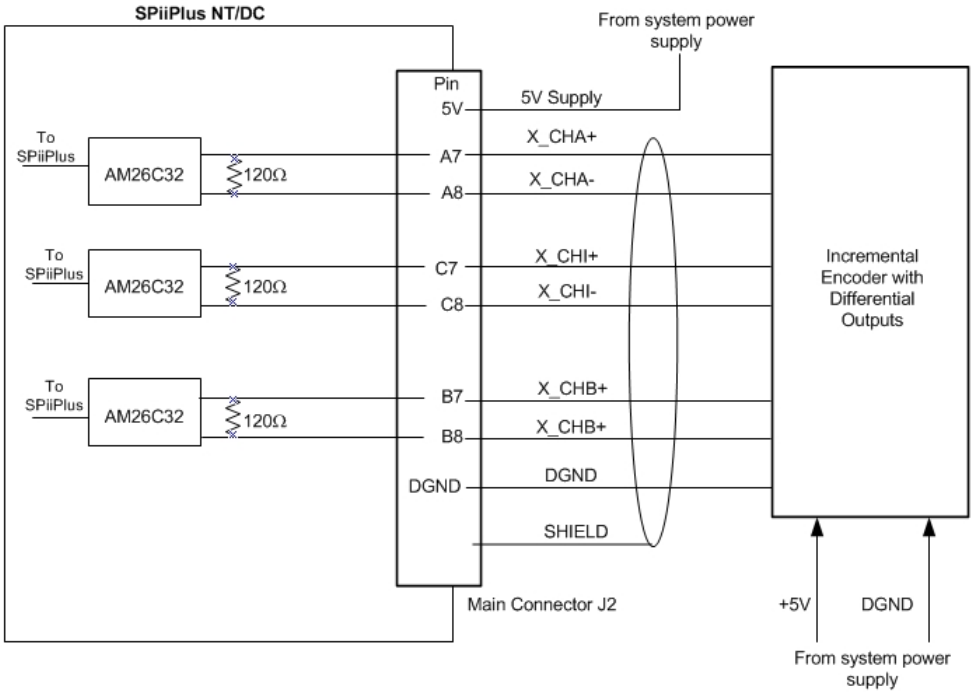


Figure 1-14. Incremental Digital Encoder Interface

5.4 Absolute Encoder Interface

There are multiple types of absolute encoders, see Absolute Encoders for a list of supported absolute encoders.

Absolute encoders are supported through HSSI-HES. Following a successful initialization, an absolute encoder is considered by the system as any incremental encoder.

For information on connecting the controller to absolute encoders, see the *Using Absolute Encoders with ACS Products AN 3.00*.

5.5 Drive Enable Interface

The SPiiPlusNT/DC-LT/HP/LD/NP provides one drive enable output per axis. The drive enable output is used with user-supplied voltages of up to 24V/7mA.

The drive enable output can be used in a source type configuration only.

5.5.1 Drive Enable Outputs

Table 1-35 provides details of the drive enable outputs.

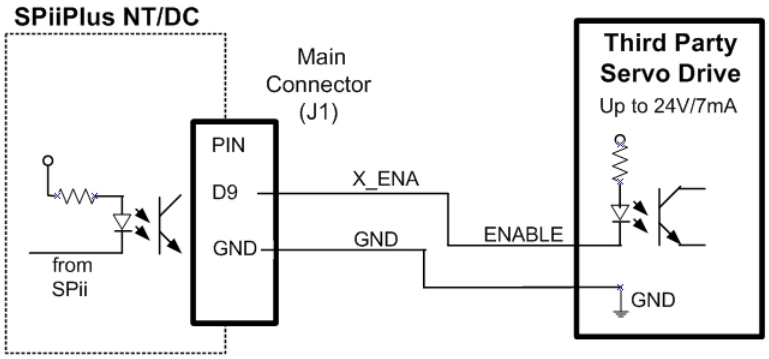
Table 1-35. Drive Enable Outputs

Category	Description
Quantity	One enable output per axis
Type	Single ended, opto-isolated, sink only
Output Voltage	Up to 24Vdc
Maximum Current	7mA, active low

Below is an example of an enable output connection to a **source-type** input on a servo drive, the drive having an **internal** pull-up resistor. When the drive receives external voltage (up to 24Vdc), it becomes enabled.

The same interface applies for direct-connected stepper drives.

The value of the pull-up or pull-down resistor must ensure that the enable output current does not exceed the controller's rated maximum current (7mA).



Example

Figure 1-15 is an example of an enable output connection to a **source-type** input on a servo drive, the drive having an **internal** pull-up resistor. When the drive receives external voltage (up to 24Vdc), it becomes enabled.

The same interface applies for direct-connected stepper drives.

The value of the pull-up or pull-down resistor must ensure that the enable output current does not exceed the controller's rated maximum current (7mA).

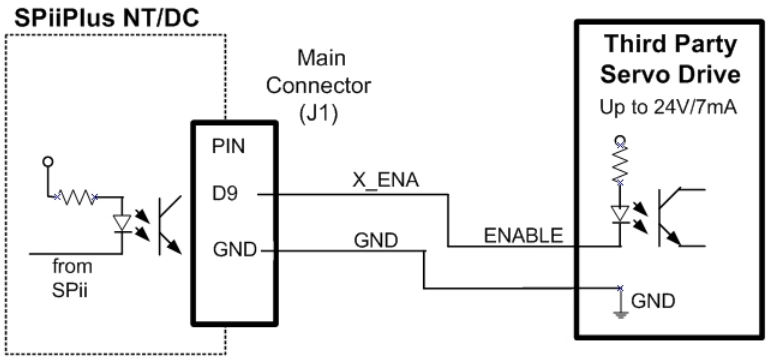


Figure 1-15. Source-Type Drive Enable Output

5.6 Drive Fault Interface

The SPiiPlusNT/DC-LD provides one drive fault input per axis with a sink type configuration only.

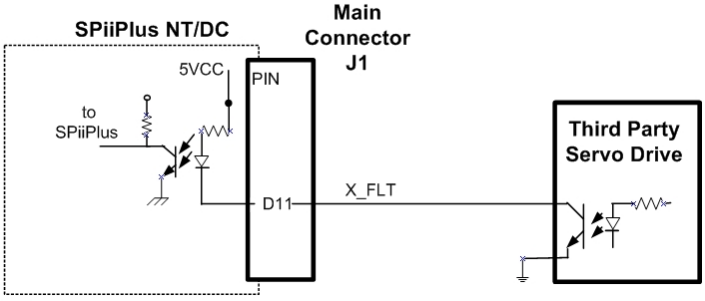
Table 1-36. Drive Fault Inputs

Category	Description
Quantity	One fault input per axis
Type	Single ended, opto-isolated, sink only.
Input Current	<7mA

Drive Fault Interface Example

The following example illustrates the drive fault interface for direct-connected servo drives. The same interface applies for direct-connected stepper drives.

The figure below is an example of a **sink-type** drive fault input connection from a servo drive.



Example

The following example illustrates the drive fault interface for direct-connected servo drives. The same interface applies for direct-connected stepper drives.

Figure 1-16 is an example of a **sink-type** drive fault input connection from a servo drive.

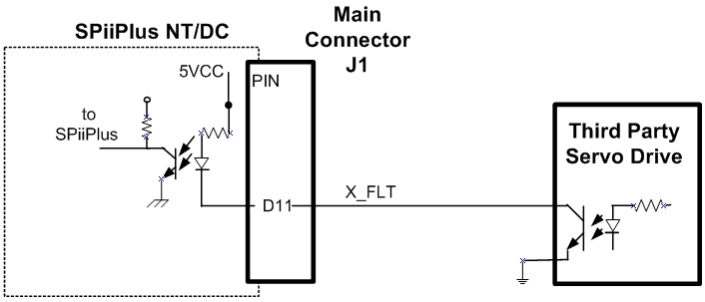


Figure 1-16. Connection To Drive With Sink Fault Input

5.7 Motor Temperature Input

Table 1-37 provides details of the motor temperature input

Table 1-37. Motor Temperature Input

Category	Description
Quantity	1 per axis
Type	Opto-isolated single ended
Logic	When the resistance between OVER_T and V_RTN_IO becomes greater than 3.6 kΩ, ±5% the Overheat fault of the SPiiPlusNT/DC is activated.
Overheat OFF	Resistance to ground that guarantees that OVERHEAT is off is < 3.42 kΩ
Overheat ON	Resistance to ground that guarantees that OVERHEAT is off is > 3.8 kΩ.

Figure 1-17 shows the motor temperature input for axis 5.

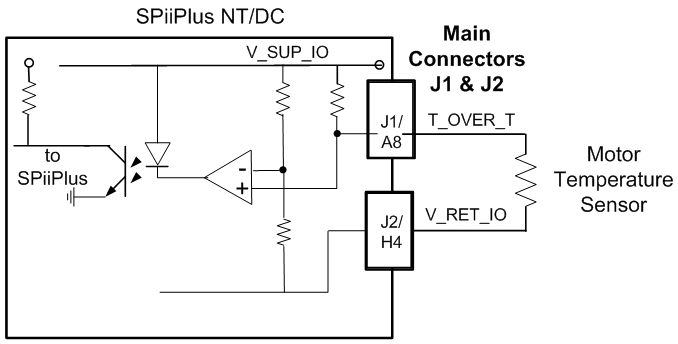


Figure 1-17. Connection to Motor Temperature Input

To guarantee Over Temperature circuit operation, pin J2/H5 (V_SUP_IO) has to receive 5V or 24V.

A relay with the same resistance may be connected between OVER_T and V_RET_IO.

5.8 Analog Outputs

Table 1-38 describes analog outputs.

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

Table 1-38. Analog Outputs

Category	Description
Quantity	Two or four as per number or axes
Type	±10V Differential
Voltage Range	Between the output's two differential lines: -10V to 10V. Between (GND) and the output's (+) line: -5V to 5V.
Resolution	10 bit
Associated ACSPL+ variables	General purpose only: AOUT# - see note below.

The user can obtain the exact mapping of the ACSPL+ **AOUT** variables to the connector pins for each device in the system through the SPiiPlus MMI Application Studio:

1. Select **Toolbox → Setup → System Configuration Wizard → View System Task**
2. Click **View Report**, the **System Configuration Report** is displayed, for example:

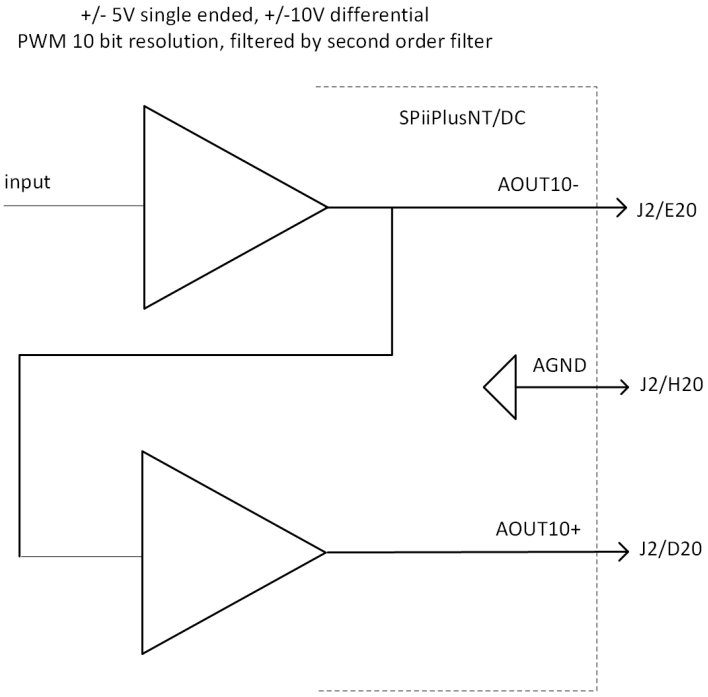
Input / Output information

ACSPL+ Name	Network ID #	Connector Name (Pin Name)
AOUT0	00000000 (DIP=0), (ID=0)	J8(AOUT10)
AOUT1	00000000 (DIP=0), (ID=0)	J8(AOUT11)
AOUT2	00000000 (DIP=0), (ID=0)	J8(AOUT14)
AOUT3	00000000 (DIP=0), (ID=0)	J8(AOUT15)
AOUT4	00000000 (DIP=0), (ID=2)	J8(AOUT10)

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

Analog Output Example

The figure below is an example of an analog output interface.



5.8.1 Analog Output Example

Figure 1-18 is an example of an analog output interface.

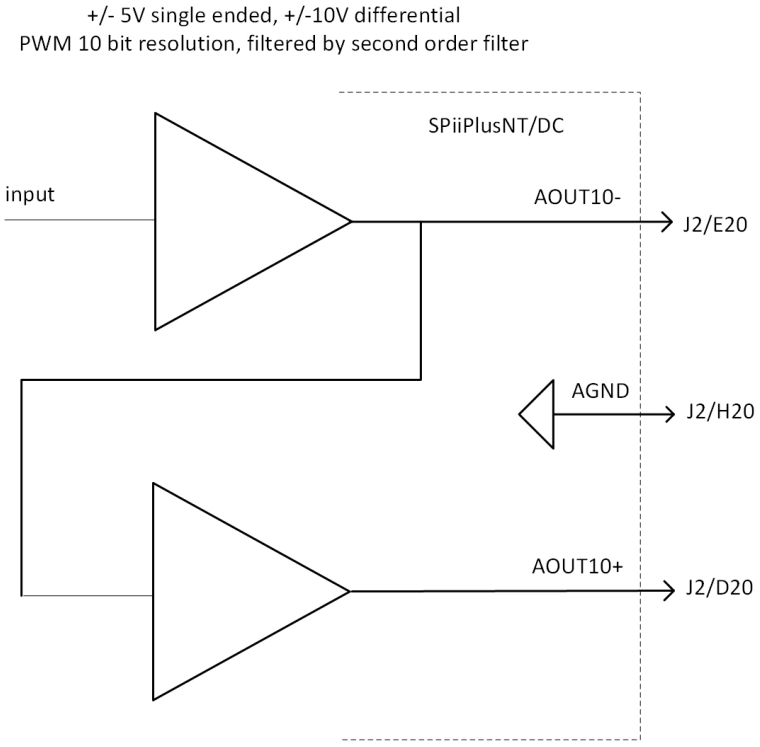


Figure 1-18. Analog Output Interface

5.9 Drive Command

5.9.1 Drive Command

Drive commands are supported with the SPiiPlusNT/DC-LD. Table 1-39 describes drive commands and analog outputs.

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

Table 1-39. Drive Commands and Analog Outputs

Category	Description
Quantity	Two per axis
Type	±10V Differential
Voltage Range	Between the output's two differential lines: -10V to 10V. Between (GND) and the output's (+) line: -5V to 5V.
Resolution	16 bit
Associated ACSPL+ variables	General purpose only: AOUT# - see note below.

The user can obtain the exact mapping of the ACSPL+ **AOUT** variables to the connector pins for each device in the system through the SPiiPlus MMI Application Studio:

1. Select **Toolbox → Setup → System Configuration Wizard → View System Task**
2. Click **View Report**, the **System Configuration Report** is displayed, for example:

Input / Output information

ACSPL+ Name	Network ID #	Connector Name (Pin Name)
AOUT0	00000000 (DIP=0), (ID=0)	J8(AOUT10)
AOUT1	00000000 (DIP=0), (ID=0)	J8(AOUT11)
AOUT2	00000000 (DIP=0), (ID=0)	J8(AOUT14)
AOUT3	00000000 (DIP=0), (ID=0)	J8(AOUT15)
AOUT4	00000000 (DIP=0), (ID=2)	J8(AOUT10)

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

5.9.2 Defining Drive Commands as General Purpose

To define the drive command as general purpose, do the following using ACSPL+:

1. MFLAGS(axis).#OPEN=1
2. ENABLE axis.
3. For this axis, mask the Encoder Not Connected bit - FMASK(axis).#ENCNC=1
4. For this axis, mask the drive alarm bit - FMASK(axis).#DRIVE=1
5. Set the value of the analog output using the DCOM command.

The scale of the DCOM command ranges from -100% to +100% which corresponds to -10V to +10V analog output voltage.

Axis Analog Outputs Used for General Purpose(s)

Axis	ACSPL+ Command	Signal Name	PIN Number	Axis
			+	-
0	DCOM0	X_IS_CMD±	J2/D25	J2/E25
1	DCOM1	Y_IS_CMD±	J2/D23	J2/E23
2	DCOM2	Z_IS_CMD±	J2/D22	J2/E22
3	DCOM3	T_IS_CMD±	J2/D21	J2/E21
4	DCOM4	A_IS_CMD±	J2/D24	J2/E24
5	DCOM5	B_IS_CMD±	J2/A25	J2/A24
6	DCOM6	C_IS_CMD±	J2/B25	J2/B24
7	DCOM7	D_IS_CMD±	J2/C25	J2/C24

5.9.3 Drive Output Examples

Figure 1-19 is an example of an output command connection for a DC brush motor.

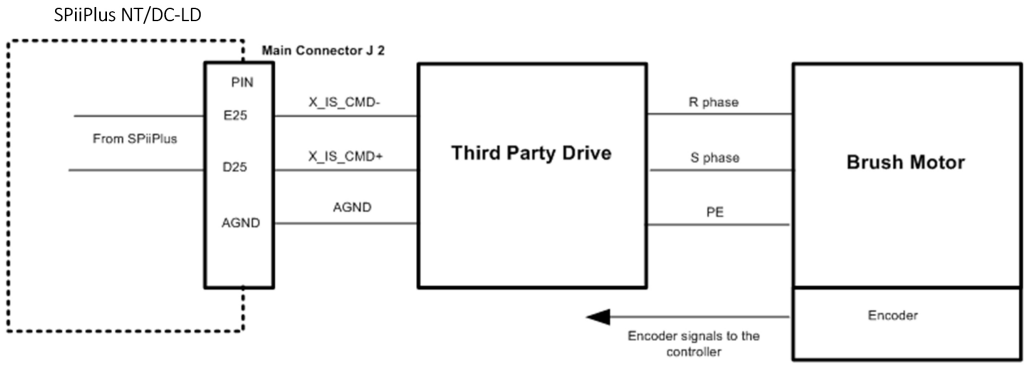


Figure 1-19. Output Command Connection to a DC Brush Motor Drive (Axis 0)

Figure 1-20 is an example of an output command connection for a DC brushless motor.

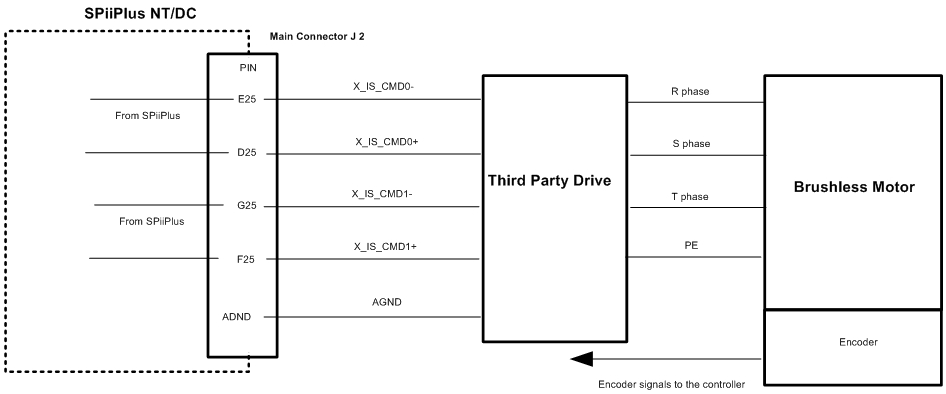


Figure 1-20. Output Command Connection to a DC Brushless Motor Drive

5.10 Digital Inputs

SPiiPlusNT/DC-LT/HP/LD/NP provides the following digital inputs:

- Safety inputs - includes emergency stop, left and right limit inputs, motor over temperature inputs
- General purpose inputs
- MARK registration inputs

5.10.1 Safety Inputs

The safety inputs of the SPiiPlusNT/DC include:

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

The safety inputs can be configured as source or sink. This configuration is jumper dependent as explained in Jumpers and Switches.

5.10.1.1 Emergency Stop Input

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

Table 1-40. Emergency Stop Input

Category	Description
Quantity	One
Type	Opto-isolated, two-terminal, source or sink
Associated ACSPL+ Variables	SFAULT.#ES
External Supply Voltage	5Vdc (±10%)/< 15mA, or 24Vdc (±20%)/< 15mA

Example

The following example illustrates the emergency stop input interface for axis 0.

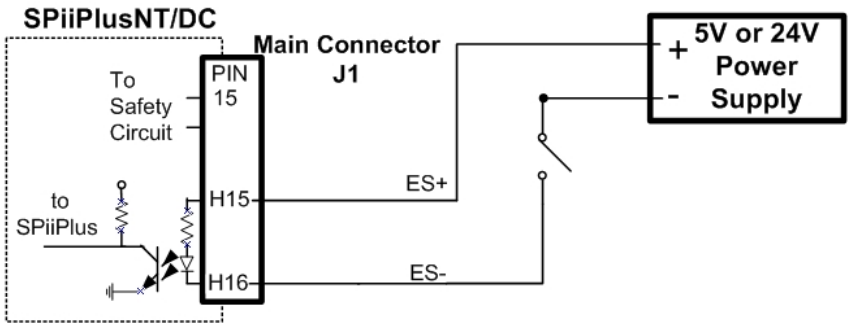
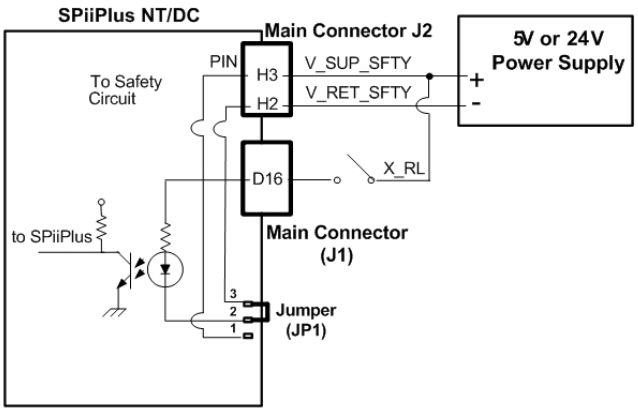


Figure 1-21. Connection for Emergency Stop Input

5.10.1.2 Limit Inputs

Table 1-41. Limit Inputs

Category	Description
Quantity	One left limit and one right limit per axis
Type	single-ended, source (open emitter) or sink (open collector), opto-isolated.
Associated ACSPL+ Variables	**<AXIS>_FAULT.#LL** and **<AXIS>_FAULT.#RL** (example: **0_ FAULT.#LL**)
External Supply Voltage	5Vdc (±10%) or 24Vdc (±20%), detected automatically. Must be connected between the V_SUP_SFTY and V_RET_SFTY pins
Input Current	<15mA



Source Connection for a Switched Right Limit Input

Examples

The following examples illustrate the limit input interfaces.

Sink-type is default. Source-type is configurable by jumper.

Figure 1-22 is an example of a **sink-type switched** limit input.

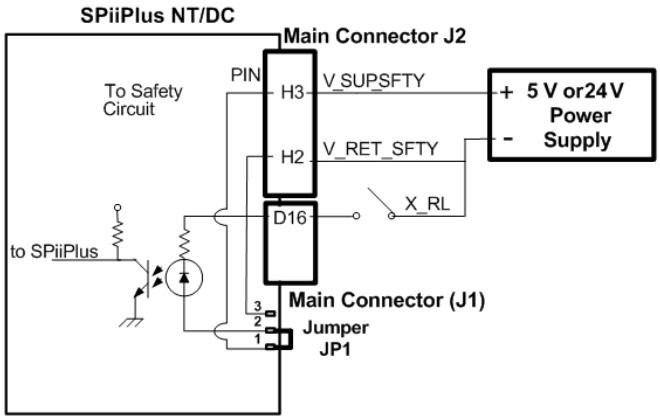


Figure 1-22. Sink Connection for a Switched Right Limit Input

Figure 1-23 is an example of a **source-type switched** limit input

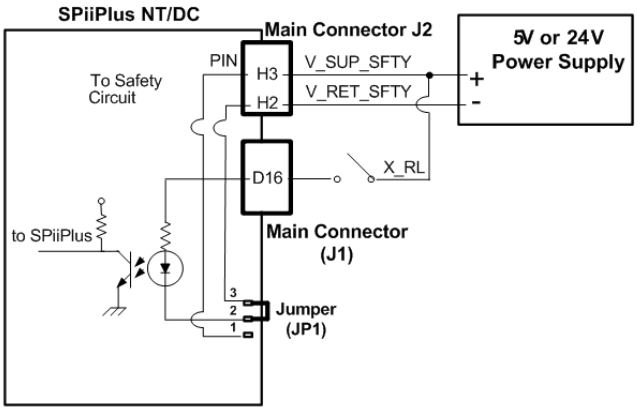


Figure 1-23. Source Connection for Switched Right Limit Input

5.10.2 General Purpose Digital Inputs

The SPiiPlusNT/DC provides up to eight digital inputs. The general purpose digital inputs can be configured as sink or source. This configuration is jumper dependent. For details, see Jumpers and Switches.

Table 1-42. General Purpose Digital Inputs

Category	Description
Quantity	Eight
Type	5V or 24V, single-ended, sink (default) or source, opto-isolated
Input Current	>3mA
Associated ACSPL+ Variables	IN0.# - see note below IN6 is shared with 0-axis MARK2 IN7 is shared with 1-axis MARK2 IN4 is shared with 2-axis MARK2 IN5 is shared with 3-axis MARK2 See Registration MARK Inputs.

The associated ACSPL+ variables given in the table reflect the default shared assignments. These can be changed through programming, see *PEG and MARK Operations Application Notes*.

The user can obtain the exact mapping of the ACSPL+ **IN** variables to the connector pins for each device in the system through the SPiiPlus MMI Application Studio:

1. Select **Toolbox → Setup → System Configuration Wizard → View System Task**
2. Click **View Report**, the **System Configuration Report** is displayed, for example:

Input / Output information

ACSPL+ Name	Network ID #	Connector Name (Pin Name)
IN0.0	00000000 (DIP=0), (ID=0)	J8(IN0)
IN0.1	00000000 (DIP=0), (ID=0)	J8(IN1)
IN0.2	00000000 (DIP=0), (ID=0)	J8(IN2)
IN0.3	00000000 (DIP=0), (ID=0)	J8(IN3)
IN0.4	00000000 (DIP=0), (ID=0)	J8(IN4)

Examples

The following examples illustrate the digital input interface.

Figure 1-24 is an example of a **single-ended** digital input source connection. A voltage divider is used as a source of reference voltage.

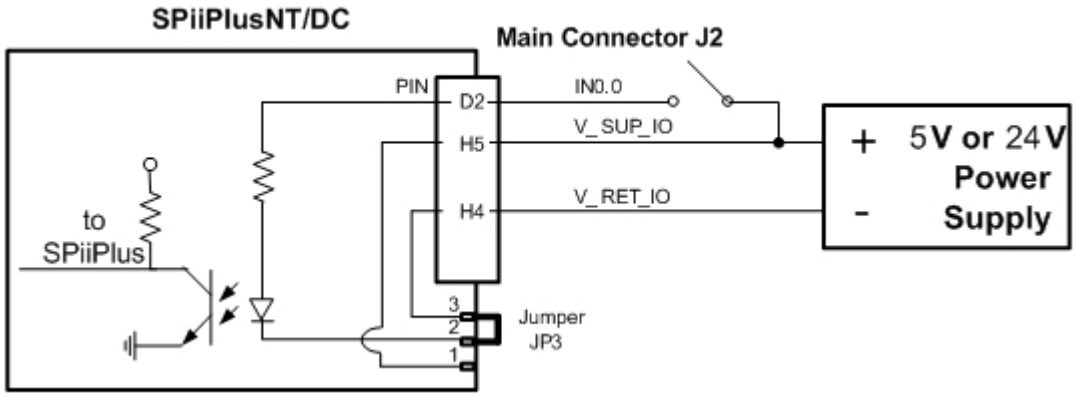


Figure 1-24. Single-Ended Source Connection for a Digital Input

Figure 1-25 is an example of a **single-ended** digital input sink connection.

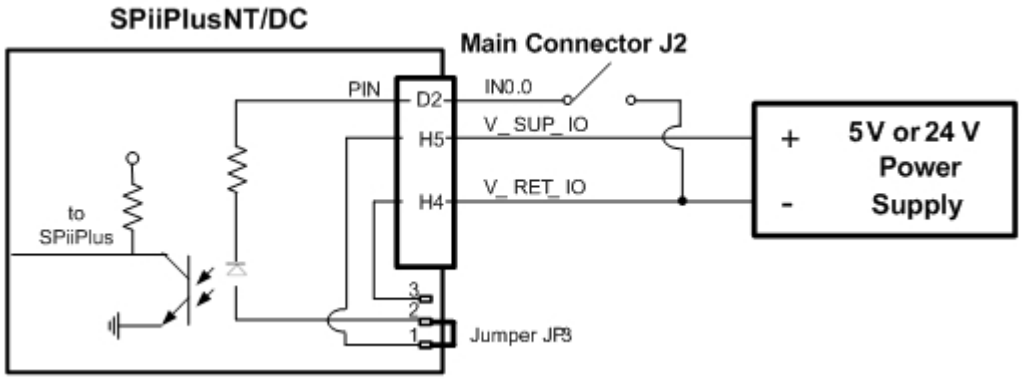


Figure 1-25. Single-Ended Sink Connection for a Digital Input

5.11 Registration MARK Inputs

SPiiPlusNT/DC-HP/NP provides two registration MARK input signals, MARK1 (primary) and MARK2 (secondary) per axes.

Encoder latching occurs on the falling edge of input signal (input changes state from **ON** to **OFF** state).

Table 1-43 lists characteristics for MARK fast digital input signals. See Logic/Digital Inputs for additional information.

#_MARK2 is shared with GP inputs, see General Purpose Logic Inputs.

Table 1-43. Fast Digital Inputs (MARK)

Category	Description
Type	RS-422 - An input state for MARK1 is:

Category	Description
	> Undefined - when there is no voltage on either the (+) or (-). > ON - when the (+) is 5V and the (-) is 0V. > OFF - when the (+) is 0V and the (-) is 5V.
Associated ACSPL+ Variables	MARK. The fast input signal latches the current encoder position to the associated variable with extremely small delay. See the *SPiiPlus ACSPL+ Programmer's Guide*.

Example

Figure 1-26 provides an example illustrating the Mark input interface.

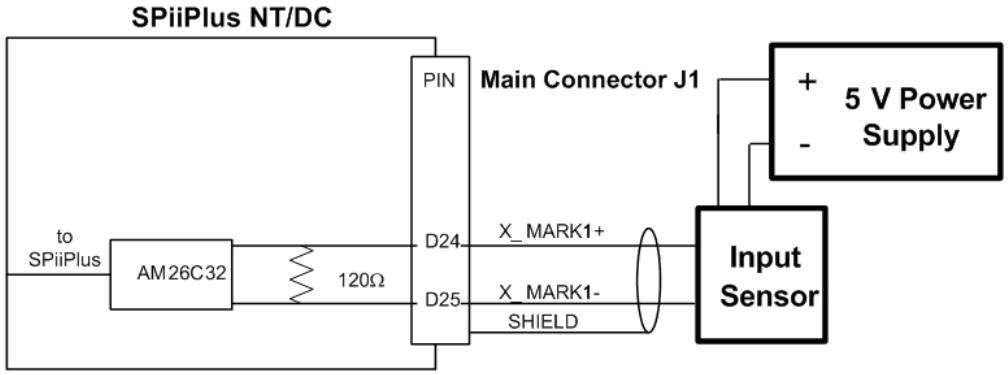


Figure 1-26. Differential Connection for MARK1 Input

5.12 Digital Outputs

The digital outputs of SPiiPlusNT/DC include the following:

> General purpose digital outputs
> PEG pulse outputs
> PEG state outputs

5.12.1 General Purpose Digital Outputs

SPiiPlusNT/DC provides up to eight digital outputs.

Table 1-44. General Purpose Digital Outputs

Category	Description
Quantity	Eight
Type	5V or 24V, single ended, sink (default) or source, opto-isolated
Maximum Current	100mA per output

Category	Description
Associated ACSPL+ Variables	OUT# - see note below.

The user can obtain the exact mapping of the ACSPL+ **OUT** variables to the connector pins for each device in the system through the SPiiPlus MMI Application Studio:

1. Select **Toolbox → Setup → System Configuration Wizard → View System Task**
2. Click **View Report**, the **System Configuration Report** is displayed, for example:

Input / Output information

ACSPL+ Name	Network ID #	Connector Name (Pin Name)
OUT0.0	00000000 (DIP=0), (ID=0)	J8(OUT0)
OUT0.1	00000000 (DIP=0), (ID=0)	J8(OUT1)
OUT0.2	00000000 (DIP=0), (ID=0)	J8(OUT2)
OUT0.3	00000000 (DIP=0), (ID=0)	J8(OUT3)
OUT0.4	00000000 (DIP=0), (ID=0)	J8(OUT4)
OUT0.5	00000000 (DIP=0), (ID=0)	J8(OUT5)
OUT0.6	00000000 (DIP=0), (ID=0)	J8(OUT6)
OUT0.7	00000000 (DIP=0), (ID=0)	J8(OUT7)

Examples

Figure 1-27 is an example of a single-ended **general purpose** digital output in source configuration.

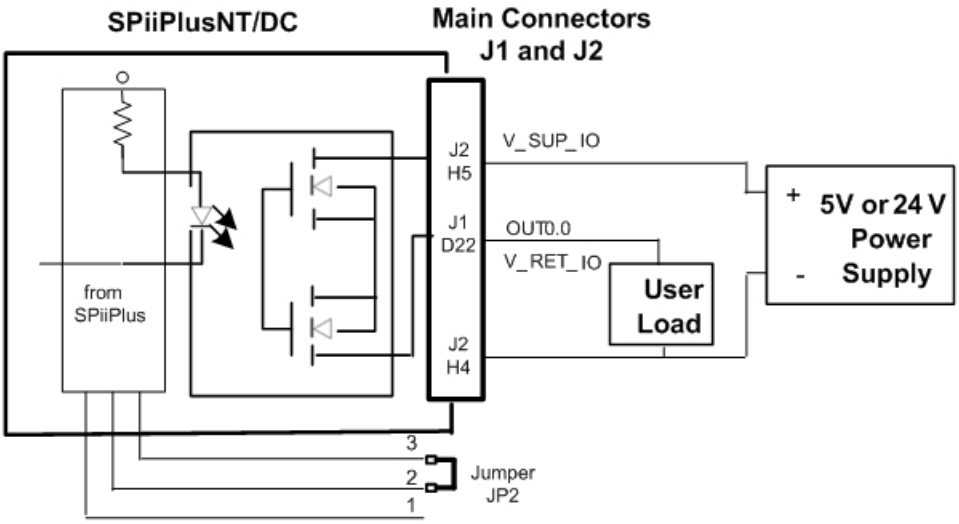


Figure 1-27. Single-Ended General Purpose Digital Output Source Connection

Figure 1-28 is an example of a single-ended **general purpose** digital output in sink configuration.

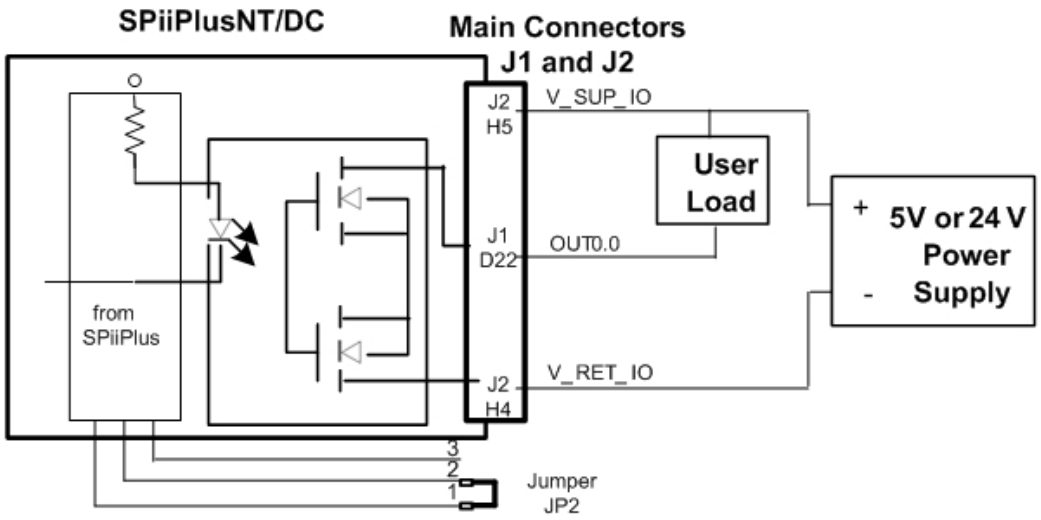


Figure 1-28. Single-Ended General Purpose Digital Output Sink Connection (OUT0.0)

5.12.2 PEG Pulse Outputs

SPiiPlusNT/DC-LT/HP/NP provides up to six PEG Pulse signals.

The PEG pulse can be triggered at a precise position by PEG_I or PEG_R commands. The fast output signal is generated with extremely small delay when the encoder position matches a predefined value. See PEG description in the *SPiiPlus ACSPL+ Programmer's Guide*.

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

Example

Figure 1-29 is an example of a PEG pulse output.

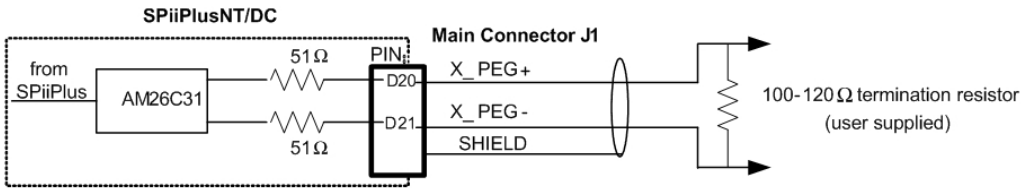


Figure 1-29. PEG Pulse Digital Output Connection

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

5.12.3 PEG State Outputs

SPiiPlusNT/DC-LT provides up to ten PEG State outputs. When a PEG pulse is activated, the output state changes. For complete details on the **PEG** commands see the *PEG and MARK Operations Application Notes* and *SPiiPlus ACSPL+ Command and Variable Reference Guide*.

With the **OUT8.x** variable, you can use the PEG outputs as additional general purpose outputs.

Table 1-45. PEG State Specifications

Category	Description
Quantity	Three 0
Type	
Propagation Delay	< 0.1µsec
Associated ACSPL+ Functions	OUT8.0 …OUT8.2

In Table 1-46, the ACSPL+ variable are relevant only when the PEG outputs are used as general purpose.

Table 1-46. PEG Pulse and PEG State

Pin	Signal Name	Description	ACSPL+ Variable
J1/D20	0_PEG+	Fast PEG PULSE output for axis: 0	OUT8.8
J1/D21	0_PEG-		
J2/A13	0_STATE0+	Fast PEG PULSE 0 output for axis: 0	OUT8.0
J2/B13	0_STATE0-		
J2/A14	0_STATE1+	Fast PEG PULSE 1 output for axis: 0	OUT8.1
J2/B14	0_STATE1-		
J2/A15	0_STATE2+	Fast PEG PULSE 2 output for axis: 0	OUT8.2
J2/B15	0_STATE2-		

5.12.4 Sin-Cos Encoder Inputs

TheSPiiPlusNT/DC is equipped with the following configuration of differential analog inputs:

- Up to 16 1Vptp differential inputs.
- In the SPiiPlusNT/DC-LT, when a Sin-Cos encoder is not being interfaced with, AIN10 (pin J2/F14), AIN11(pin J2/F13), AIN14 (pin J2/H14) and AIN15(pin J2/H16) inputs can be used as ±10V general purpose analog inputs.

Table 1-47 is a summary of analog sin-cos inputs. See Sin-Cos Encoder Inputs for detailed information.

Table 1-47. Analog Sin-Cos Inputs- Specification

Element	Description
Quantity	SPiiPlusNT/DC-4: 8 (4 encoders) SPiiPlusNT/DC-8: 16 inputs (8 encoders)

Element	Description
Inputs per Axis	Up to 2. Each comprising two encoder signals and one index signal
Element	Description
Input Assignment	General purpose or joystick or Sin-Cos encoder input. Joystick - Potentiometer output must be connected to **AIN#+** and return supply must be connected to **AIN#-.** Sin-Cos encoder - Optional feature that takes both of an axis' analog inputs.
Associated ACSPL+ Variables	**AIN**. Example: **AIN7** represents analog input 7.

Table 1-48 describes the general purpose analog inputs.

Table 1-48. General Purpose Analog Inputs

Category	Description
Quantity	Up to four
Type	±10V differential signals
A/D conversion resolution	LT: 12 bit HP/NP: 14 bit
Associated ACSPL+ Variables	AIN# - see note below

The user can obtain the exact mapping of the ACSPL+ **AIN** variables to the connector pins for each device in the system through the SPiiPlus MMI Application Studio:

1. Select **Toolbox → Setup → System Configuration Wizard → View System Task**
2. Click **View Report**, the **System Configuration Report** is displayed, for example:

Input / Output information

ACSPL+ Name	Network ID #	Connector Name (Pin Name)
AIN0	00000000 (DIP=0), (ID=0)	J8(AIN10)
AIN1	00000000 (DIP=0), (ID=0)	J8(AIN11)
AIN2	00000000 (DIP=0), (ID=0)	J8(AIN14)
AIN3	00000000 (DIP=0), (ID=0)	J8(AIN15)
AIN4	00000000 (DIP=0), (ID=2)	J8(AIN10)
AIN5	00000000 (DIP=0), (ID=2)	J8(AIN11)
AIN6	00000000 (DIP=0), (ID=2)	J8(AIN14)
AIN7	00000000 (DIP=0), (ID=2)	J8(AIN15)
AIN8	00000000 (DIP=0), (ID=5)	J5(AIN)
AIN9	00000000 (DIP=0), (ID=6)	J8(AIN10)
AIN10	00000000 (DIP=0), (ID=6)	J8(AIN11)
AIN11	00000000 (DIP=0), (ID=6)	J8(AIN14)
AIN12	00000000 (DIP=0), (ID=6)	J8(AIN15)

Example

Figure 1-30 illustrates the Sin-Cos encoder interface.

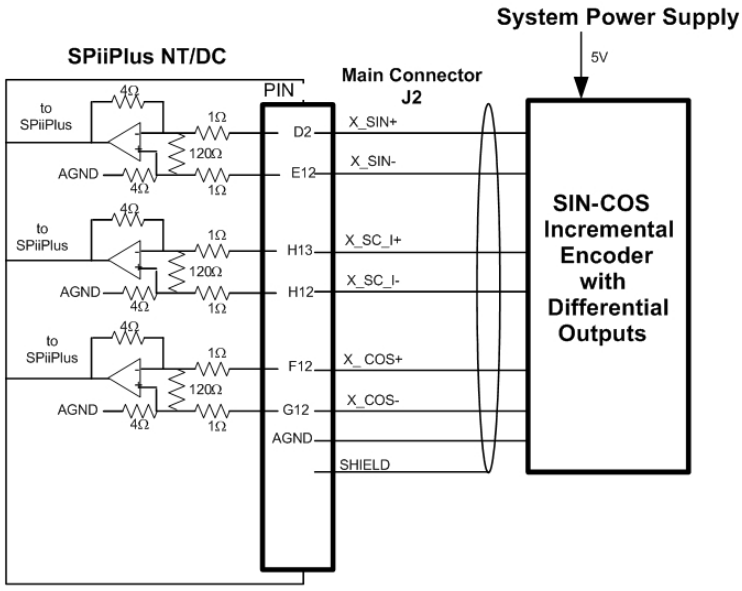


Figure 1-30. Sin-Cos Encoder Interface

5.12.5 Joystick Input Interface

Figure 1-31 illustrates how to configure the differential analog inputs to work with 10V to -10V.

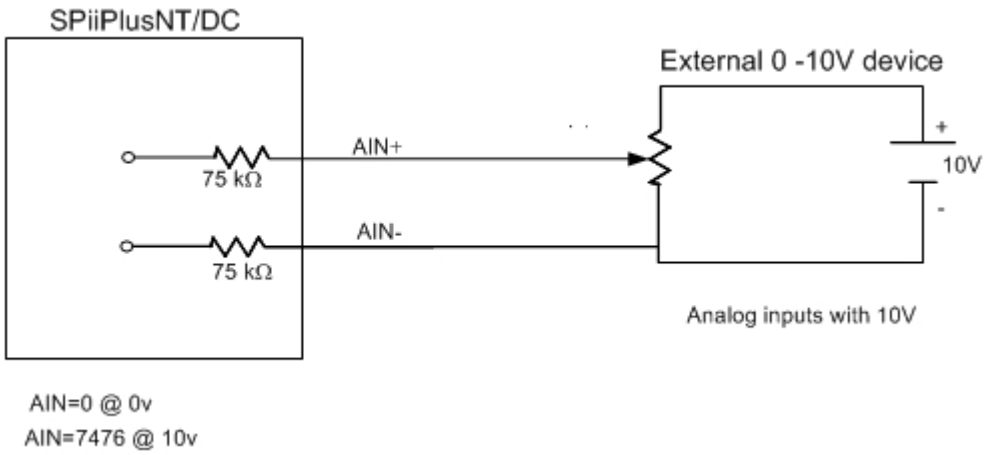


Figure 1-31. Analog Inputs with ±10V Configuration

Examples

The following examples illustrate the limit input interfaces.

Sink-type is default. Source-type is configurable by jumper.

Figure 1-32 is an example of a **sink-type switched** limit input.

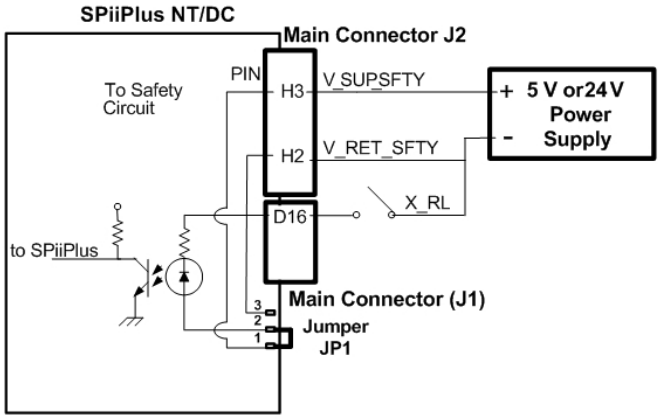


Figure 1-32. Sink Connection for a Switched Right Limit Input

Figure 1-33 is an example of a **source-type switched** limit input

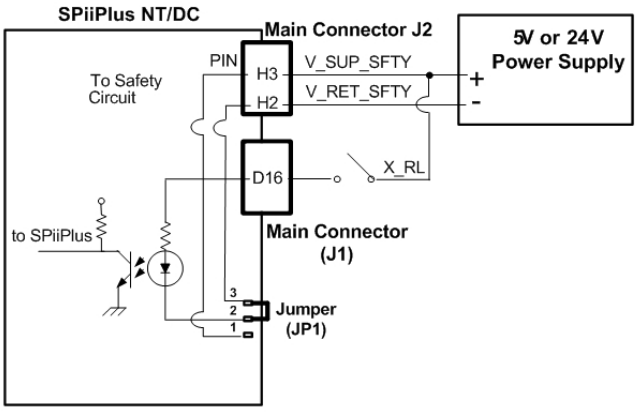


Figure 1-33. Source Connection for Switched Right Limit Input

5.13 HSSI Interface

SPiiPlusNT/DC provides up to three HSSI channels. These channels are used to communicate with remote HSSI modules (HSSI-IO16 and HSSI-ED2). Each HSSI channel is connected to a SPiiPlus processor.

The number of available HSSI channels depends on the number of SPiiPlusNT/HP/NP processors ordered. The number of available HSSI channels appears in the label on the side of the controller. For example if "HSSI Available: 0,1" appears on the label, it means that only HSSI0 and HSSI1 are available.

For more information about the HSSI, refer to the *SPiiPlus Setup Guide*.

Table 1-49 lists the HSSI signals, with the relevant pins, signal names and a short description:

Table 1-49. HSSI Signal Description

Pin	Signal	Description
J1/D6	H_CON_0+	Control signal for HSSI channel 0
J1/D5	H_CON_0-	
J1/D4	H_CON_1+	Control signal for HSSI channel 1
J1/D3	H_CON_1-	
J1/D2	H_CON_2+	Control signal for HSSI channel 2
J1/D1	H_CON_2-	
J1/G1	H_CON_3+	Control signal for HSSI channel 3
J1/H1	H_CON_3-	

Pin	Signal	Description
J1/E6	H_DI_0+	Input data for HSSI channel 0
J1/E5	H_DI_0-	
J1/E4	H_DI_1+	Input data for HSSI channel 1
J1/E3	H_DI_1-	
J1/E2	H_DI_2+	Input data for HSSI channel 2
J1/E1	H_DI_2-	
J1/G3	H_DI_3+	Input data for HSSI channel 3
J1/H3	H_DI_3-	
J1/F6	H_DO_0+	Output data for HSSI channel 0
J1/F5	H_DI_0-	
J1/F4	H_DO_1+	Output data for HSSI channel 1
J1/F3	H_DI_1-	
J1/F2	H_DO_2+	Output data for HSSI channel 2
J1/F1	H_DI_2-	
J1/G2	H_DO_3+	Output data for HSSI channel 3
J1/H2	H_DO_3-	

The ASCPL+ variables associated with HSSI are:

- **EXTIN#** - HSSI input
- **EXTOUT#** - HSSI output

The user can obtain the exact mapping of the **EXTIN/EXTOUT** variables to the connector pins for each device in the system through the SPiiPlus MMI Application Studio:

1. Select **Toolbox → Setup → System Configuration Wizard → View System Task**
2. Click **View Report**, the **System Configuration Report** is displayed, for example:

Input / Output information

ACSPL+ Name	Network ID #	Connector Name (Pin Name)
EXTOUT1	00000000 (DIP=0), (ID=0)	J4_HSSI0
EXTOUT2	00000000 (DIP=0), (ID=0)	J4_HSSI0
EXTOUT3	00000000 (DIP=0), (ID=0)	J4_HSSI0
EXTOUT4	00000000 (DIP=0), (ID=0)	J5_HSSI1
EXTOUT5	00000000 (DIP=0), (ID=0)	J5_HSSI1
EXTOUT6	00000000 (DIP=0), (ID=0)	J5_HSSI1
EXTOUT7	00000000 (DIP=0), (ID=0)	J5_HSSI1
EXTOUT8	00000000 (DIP=0), (ID=0)	J6_HSSI2
EXTOUT9	00000000 (DIP=0), (ID=0)	J6_HSSI2

6. Jumpers and Switches

This chapter provides details of the jumpers and switches located on the SPiiPlusNT/DC-LT/HP/LD/NP.

6.1 SPiiPlusNT/DC Jumpers

Different jumper settings affect the following:

- Safety inputs in sink and source configuration
- Digital outputs in sink and source configuration
- Digital inputs in sink and source configuration.

Table 1-50 lists the SPiiPlusNT/DC jumpers, their functions, and, where relevant, their settings:

Table 1-50. SPiiPlusNT/DC Jumpers and Setting

Jumper	Function	Jumper Settings
JP1	Safety inputs in sink and source	Position 1,2 - sink Position 2,3 - source Default: sink
JP2	Digital outputs in sink and source	Position 1,2 - sink Position 2,3 - source Default: sink
JP3	Digital inputs in sink and source	Position 1,2 - sink Position 2,3 - source Default: sink
JP7	I^2C slave device EEPROM data protection.	Installed - Data protected Uninstalled - Data not protected Default: Data protected

6.2 SPiiPlusNT/DC Switches

There are two switches located on theSPiiPlusNT/DC . Table 1-51 lists the switches found on the SPiiPlusNT-DC.

Table 1-51. SPiiPlusNT/DC Switches

Switch	Function
SW1 (optional)	Used for setting the network identification number (network ID). Available code from 0 to 256 decimal. SW1/1 is the least significant bit of the 8bit code, SW1/8 is the most significant bit.

Switch	Function
	The switch generates inverted code: the Off position is equivalent to '1' logic, the On position is equivalent to '0' logic.
SW2	Used only during the manufacturing process.

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