NPMpm

Installation Guide

December 2020

Document Revision: 3.10

ACS MOTION CONTROL

NPMpm

Release Date: December 2020

www.acsmotioncontrol.com

support@acsmotioncontrol.com

sales@acsmotioncontrol.com

Revision History

Date	Revision	Description
December 2020	3.10	Dynamic braking with relays
September 2020	3.02	Changed recommended max drive input
March 2020	1.91	Reformatting to support single source
April 2018	1.90	Added caution for short circuit of motor phase
November 2017	1.80	Updated connector bottom view image Removed DIP0 Switches and Jumper information
October 2017	1.70	Updated for STO, UL EMC certifications Updated list of supported motors Document reformatted
August 2016	1.60	Added note to install external capacitor of 4400uF as close as possible to the drive in order to help the power supply handle peak current and reduce bus current ripple. Updated the maximum programmable multiplication factor for Sin-Cos encoders to x65536
May 2016	1.50	Added note concerning STO
March 2016	1.40	Changed Control Supply fuse specification to 3A
January 2016	1.30	Updated Table 4.8 and 4.9 Reformatted Section 5 Updated Section 5.4.1 Added new NanoPWM icon
November 2015	1.20 Draft	Replaced NPDpm product name with NPApm
October 2015	1.10 Draft	Numerous minor improvements. Resolved differences between Installation Guide and Data Sheet Added UDMmc&NPXpm-ACC2 accessory cable for drive supply connector
March 2015	1.00	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 below 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 Setup Guide	Provides guidance on how to configure and adjust the SPiiPlusNT systems to work with supported types of motors and feedback devices.
SPiiPlus MMI Application Studio User Guide	Explains how to use the SPiiPlus MMI Application Studio and associated monitoring tools.
NT PEG and MARK Operations Application Note	Provides detailed description, specification and operation instructions for PEG capabilities.
EtherCAT Network Diagnostics	An application note describing how to perform diagnostics of the EtherCAT network.
Dual Axis PEG	An application note describing dual axis PEG usage.
Using Absolute Encoders with ACS Products	An application note that addresses the physical connections, configurations and operation of absolute encoders with ACS networking products.
Safe Torque Off Function	An application note providing the technical details for implementing the STO function for drives installed in ACS Motion Control systems.
NPMpm Functional Safety Manual	Describes the use of the STO function in the NPMpm.

Table of Contents

List Of Figures

List of Tables

1. Introduction

1.1 Document Scope

This document describes the installation information for the NPMPM.

This document is intended for the use of hardware engineers.

1.2 Product Overview

The NPMPM is a dual-axis, NanoPWM™ drive, suitable for applications that require nanometer and sub-nanometer position jitter levels.

The NPMPM operates from 12V to 100Vdc (drive supply) and provides continuous/peak current options of 3.3/10A, 6.6/20A, 10/30A, and 13.3/40A. The unit works with an ACS Motion Controller and EtherCAT master. Figure 1-1 shows the interface block diagram.

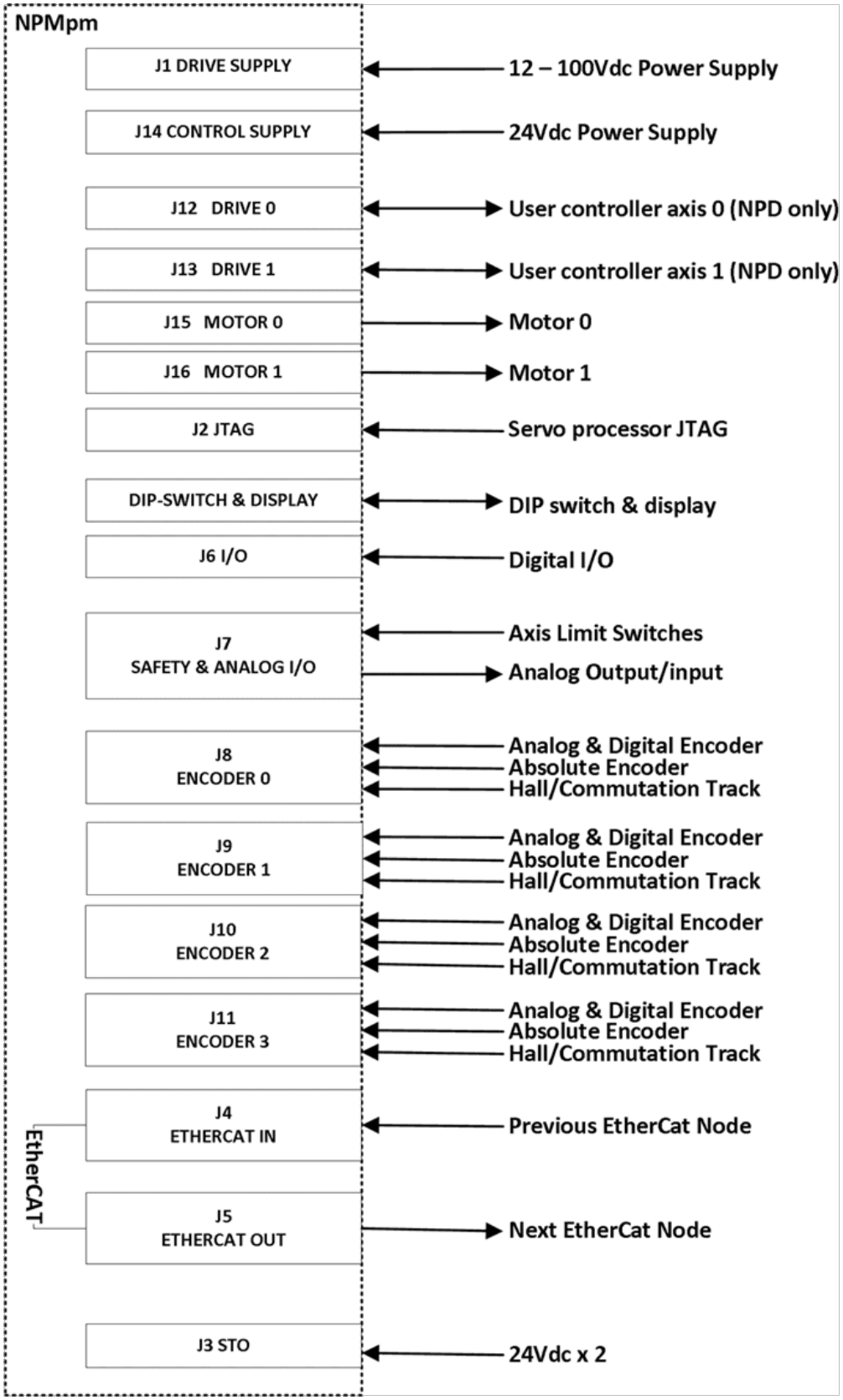


Figure 1-1. Interface Block Diagram

2. Detailed Description

2.1 Connectors and Jumper

The following figures and table shows and describes the NPMPM connectors.

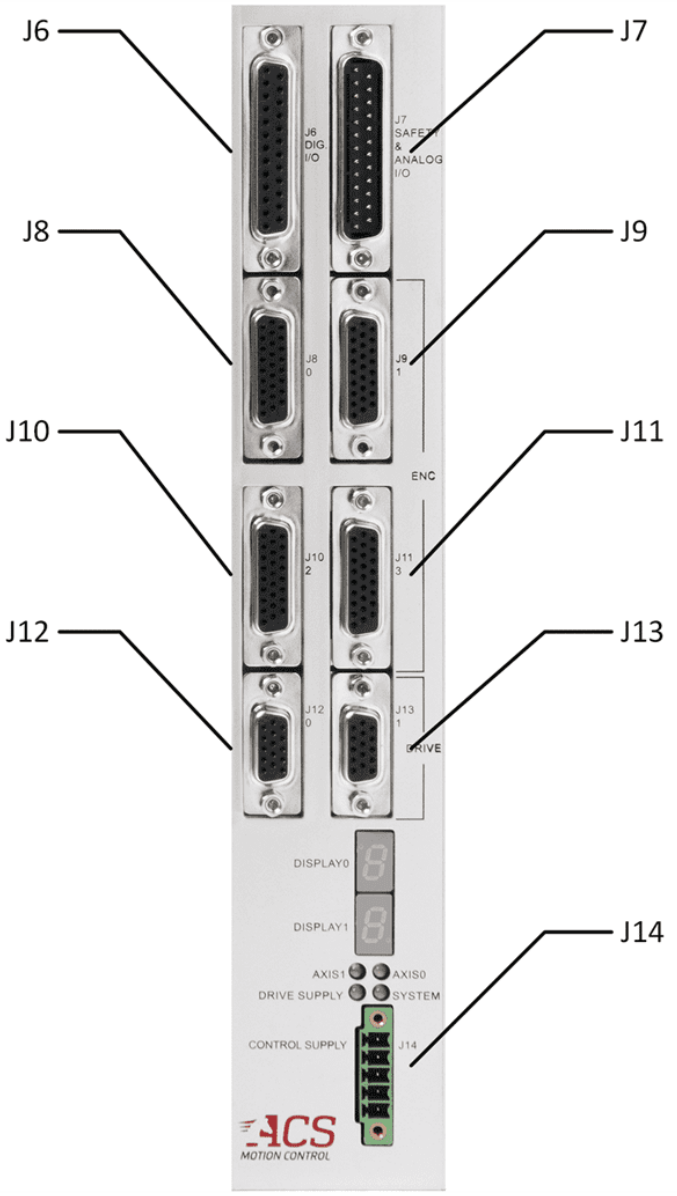


Figure 2-1. Connectors - Front View

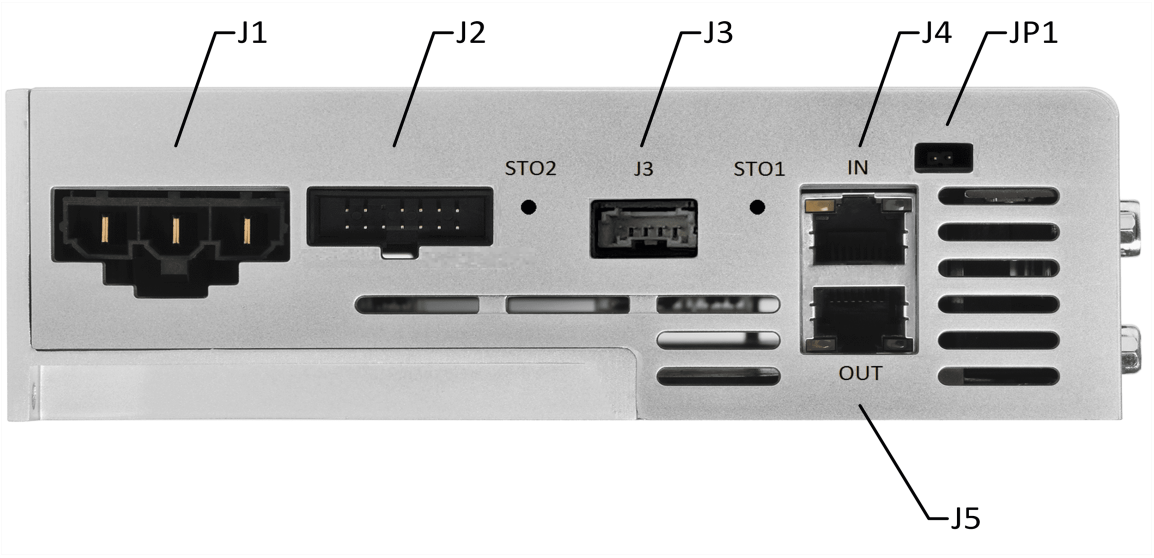


Figure 2-2. Connectors and Jumper - Top View

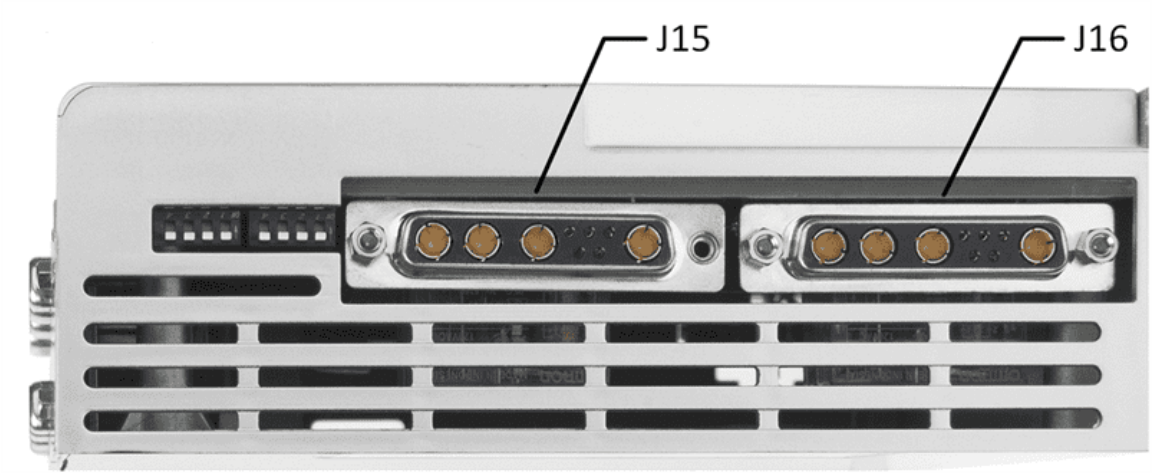


Figure 2-3. Connectors and DIP Switches - Bottom View

Table 2-1. Connections

Connector Assignment	Connector Name	Description
J1	Drive supply	12 - 100Vdc, maximum recommended 96Vdc
J2	JTAG	Used by ACS to modify or upgrade the firmware.
J3	STO	Optional
J4	EtherCAT in	

Connector Assignment	Connector Name	Description
J5	EtherCAT out	
J6	Digital I/O	
J7	Analog & safety I/O	
J8	Encoder axis 0	
J9	Encoder axis 1	
J10	Encoder axis 2	
J11	Encoder axis 3	
J12	(Not used)	
J13	(Not used)	
J14	Control supply	
J15	Motor 0	
J16	Motor 1	

2.2 Indicators

2.2.1 LED Indicators

The following figures and tables show and describe the NPMPM LED indicators.

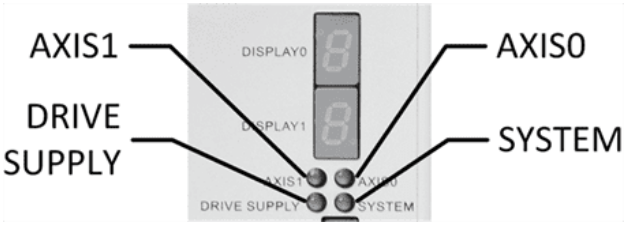


Figure 2-4. LED Indicators

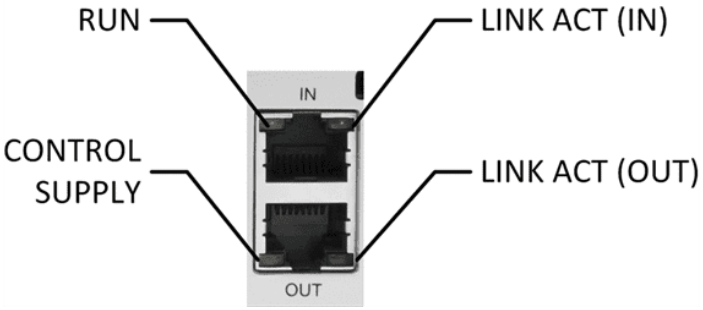


Figure 2-5. EtherCAT Indicators

Figure 2-6. STO Indicators

Table 2-2. LED Indicators Description

Indicator	Description	Remarks
Axis 0 Axis 1	One bicolor LED for each axis: > Green - Drive is enabled > Red - Drive fault > Off - Drive is disabled	AIXS0 (DRIVE0, MOTOR0) AIXS1 (DRIVE1, MOTOR1)
System	One bicolor LED: > Red - System Fault > Green - System OK > Blinking - Software command	

Indicator	Description	Remarks
Drive supply	One green LED: > On - drive supply is OK. > Off - no drive supply is connected	
Control supply	One yellow LED: > On - Control supply is OK > Off - Control supply is not functioning	
Link Act	Two green LEDs (one per port) > On - Link without activity > Off - No cable is connected > Blinking - Link and active	
Run	Yellow LED: > On - network communication is OK > Blinking/Off - network communication error	
STO 1 STO 2	One green LED: > On - STO is deactivated.	

2.2.2 Axis/Drive Status Display

The following figure and table show and describe the NPMPM Axis/Drive Status Displays. There is one display for each axis.

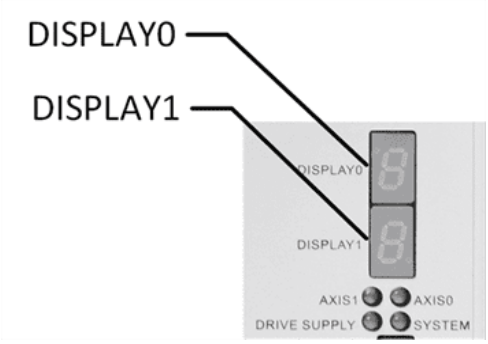


Figure 2-7. Axis/Drive Status Displays

Table 2-3. Axis/Drive Status Display Description

Code	Status	Description
C	Power up	Drive power up executed.

Code	Status	Description
0	No fault, enabled.	Drive enabled and no faults detected.
1	Over voltage	Drive over-voltage protection is activated. The drive is disabled. The drive supply must be reduced or a regeneration circuit must be used.
5	Short circuit	Drive short- circuit protection is activated. The drive is disabled.
H	Over temperature	Drive over-temperature protection is activated. The drive is disabled. Forced-air cooling may be required.
h	Motor over temperature	Motor over-temperature protection is activated (indicating the motor temperature sensor (PTC) impedance is above 10kΩ or not connected) and the drive is disabled.  When this protection is not used, connect the X_OVER pin to GND.
U	Under voltage	Drive under-voltage protection is activated (indicating the drive supply is under 9Vdc or not connected) and the drive is disabled.
2	Drive over current	Drive over-current protection is activated (indicating the drive exceeded the specified motor continuous RMS current) and the drive is disabled.
L	Drive saturation	Drive saturation (due to low drive supply amplitude for the required motor velocity or at least one motor phase is disconnected). The drive is disabled.
E	EtherCAT communication error	EtherCAT communication error. Check the EtherCAT cable.
F	Invalid EEPROM data	Invalid EEPROM data. Contact your ACS representative for repair options.

Error 5076:drive stauration - may occur if the drive exceeds the voltage saturation for a relatively long period of 0.5 sec. This fault may indicate a hardware problem like a missing motor phase or short circuit. It may also occur if the motion parameters (velocity, acceleration) are too high and the bus voltage is insufficient

2.3 Package Content

The NPMPM package contains the following items:

- NPMPM module
- STO Connector Kit P/N: STO-ACC1 (supplied only for units ordered with STO)
- Control supply mating connector (for J14), Phoenix MC 1,5/ 5-STF-3,81

2.4 Optional Accessories

2.4.1 Ethernet Cables

ACS offers the following Ethernet CAT5 cables:

Table 2-4. Ethernet Cables

Length [m]	Part Number
0.3	SP+ECAT-CA-30CM-00
0.5	SP+ECAT-CA-50CM-00
1	SP+ECAT-CA-1M-00
2	SP+ECAT-CA-2M-00
3	SP+ECAT-CA-3M-00
5	SP+ECAT-CA-5M-00
10	SP+ECAT-CA-10M-00
15	SP+ECAT-CA-15M-00
20	SP+ECAT-CA-20M-00

2.4.2 Mating Connectors Kit

P/N: NPXpm-ACC1

Description: Mating Connector Kit

This kit serves both the NPMPM and the NPAPM. Not all connectors are used by the NPAPM.

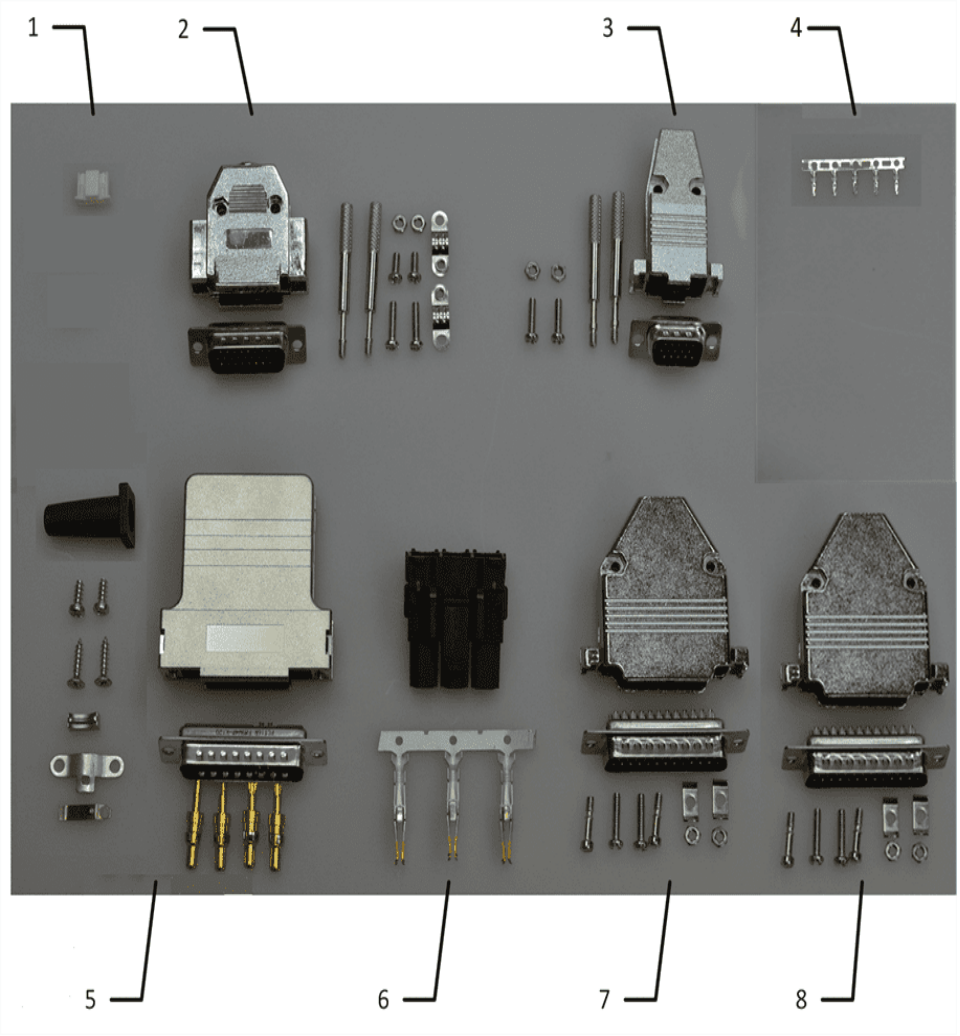


Figure 2-8. Mating Connectors Kit

Table 2-5. Mating Connector Kit

Reference	Quantity	Part Description	Connector	Manufacturer	PN
1	1	5-pin housing 2mm pitch NPB female	J3	JST	PAP-05V-S
2	4	D-type 26 pin high density male	J8,J9,J10,J11	Many	

Reference	Quantity	Part Description	Connector	Manufacturer	PN
3	2	D-type 15 pin high density male	Not used		
4	5	Crimp Contact for 26-22AWG wire	J3 pins	JST	SPHD-001T-P0.5
5	2	Sub D 9W4 male	J15,J16	FCT	FM9W4P-K120
6	1	Molex 3 pin up to 50A per contact housing	J1	Molex	42816-0312
7	1	D-type 25 pin male	J6	Many	
8	1	D-type 25 pin female	J7	Many	

2.4.3 STO Breakout Cable

P/N: STO-ACC1

Description: 2 meter cable with the STO mating connector on one end and flying leads on the other.

Figure 2-9. STO-ACC1 Breakout Cable

Table 2-6. STO-ACC1 Pinout

Pin	Wire Color	Signal
1	Black	STO1-
2	Red	STO1+
3	Yellow	EGND
4	White	STO2+
5	Black	STO2-

2.4.4 UDMmc&NPXpm-ACC2 Accessory Cable

P/N:UDMmc&NPXpm-ACC2

Description: NPM (J1) mating 2m flying lead cable.

This kit serves both the NPMPM and the NPAPM.

Figure 2-10. UDMmc&NPXpm-ACC2 Accessory Cable

2.5 Order Part Number

The ordering part number (P/N) contains several characters (see example in Figure 2-11) that each specify a configuration characteristic ordered for the NPMPM module, as described in Table 2-7.

Figure 2-11. Label with Ordered P/N - Example

Table 2-7. Configuration as Indicated by P/N

Ordering Options	Field	Example User Selection	Available Ordering Option Values
Number of axes/drives	1	2	1,2
Current	2	A	A - 3.3/10A B - 6.6/20A C - 10/30A D - 13.3/40A
500kHz SIN-COS encoder interface	3	0	0,1,2,3,4
10MHz SIN-COS encoder interface	4	4	0,1,2,3,4
Absolute encoders type	5	N	U - All N - None E - EnDAT 2.2 & 2.1 digital only S - Smart Abs P - Panasonic B - BiSS-A/B/C I - SSI A - Sanyo ABS
Number of Absolute encoders interface	6	0	0,1,2

Ordering Options	Field	Example User Selection	Available Ordering Option Values
STO	7	Y	Y - Yes N - No
Limit switch inputs	8	C	A - 5V, Source/PNP B - 5V, Sink/NPN C - 24V, Source/PNP D - 24V, Sink/NPN
Digital Inputs	9	B	A - 5V, two-terminal B - 24V, two-terminal
Digital Outputs	10	A	A - Source/PNP, 5V & 24V B - Sink/NPN, 5V & 24V
Motor relays	11	N	Y - Yes N - No
Special options	12	N	N - No A - Customized for Constant Velocity following error of sta.ges with dual-feedback, one Laser encoder / interferometer & one optical encoder
Total number of feedback channels	13	C	A - 2 (utilize 1 axis) B - 2 (utilize 2 axes) C - 4 (utilize 4 axes) D - 4 (utilize 2 axes)

As an example, P/N NPMpm2A04N0YCBANNC would represent the configuration described in Table 2-8 below.

Table 2-8. P/N Example

Field		1	2	3	4	5	6	7	8	9	10	11	12	13
P/N	NPMpm	2	A	0	4	N	0	Y	C	B	A	N	N	C

The NPMPM is shipped with the configuration set as ordered. Modifications can be done by ACS only.

3. Mounting and Cooling

- Unit should be mounted vertically, using M4 type Philips screws. The dimensions (in millimeters) are shown below.
- Leave sufficient clearance of 50 millimeters on all open sides for cable routing and free airflow.
- Unit operates in the temperature range of 0 to 40°C.
- See Environment for more information on environmental conditions and airflow.

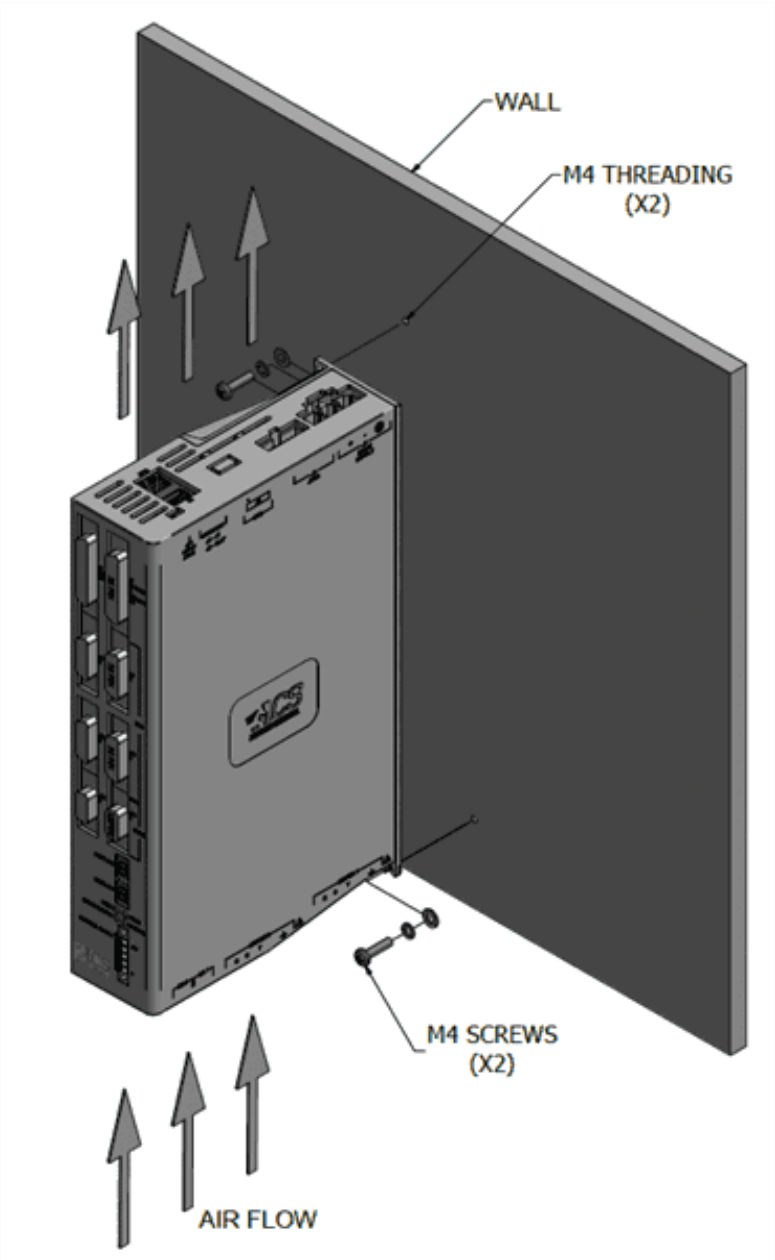


Figure 3-1. Airflow and Mounting

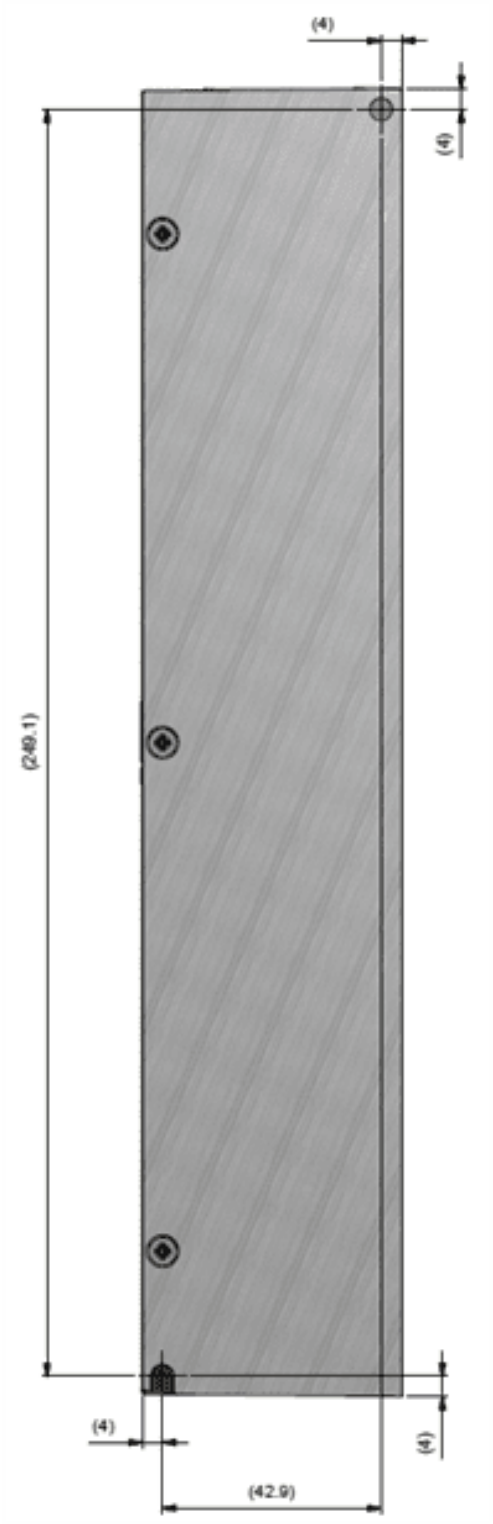


Figure 3-2. Dimensions - Rear (mounting side) View

Figure 3-3. Dimensions - Right Side View

4. Connections

This section describes how to interface with the NPMpm using proper safety, EMC and wiring guidelines.

The following diagram is a standard representation of connections and grounding. Specific settings and configurations are described in the subsections below.

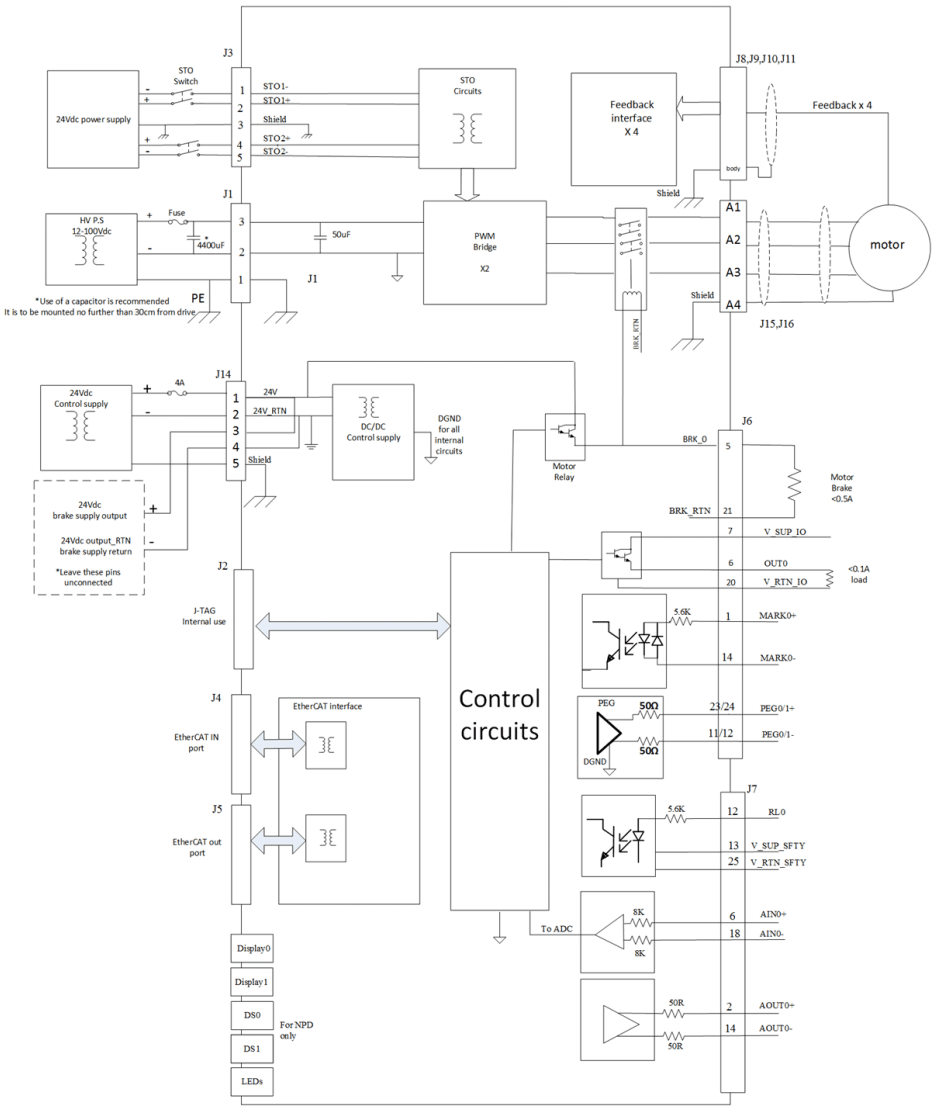


Figure 4-1. Connections and Grounding

Connector Assignment	Connector Name	Description
J1	Drive supply	12 - 100Vdc, maximum recommended 96Vdc

Connector Assignment	Connector Name	Description
J2	JTAG	Used by ACS to modify or upgrade the firmware.
J3	STO	Optional
J4	EtherCAT in	
J5	EtherCAT out	
J6	Digital I/O	
J7	Analog & safety I/O	
J8	Encoder axis 0	
J9	Encoder axis 1	
J10	Encoder axis 2	
J11	Encoder axis 3	
J12	(Not used)	
J13	(Not used)	
J14	Control supply	
J15	Motor 0	
J16	Motor 1	

4.1 Safety, EMC and Wiring Guidelines

Read this section carefully before beginning the installation process.

Make sure that the following guidelines and procedures are addressed and observed prior to powering up and while handling any of the EtherCAT network elements.

An STO module (Safe Torque Off) is an optional feature of the unit. Additional information can be found in STO (J3) .

Installation and maintenance must be performed only by qualified personnel who have been trained and certified to install and maintain high power electrical and electro-mechanical equipment, servo systems, power conversion equipment and distributed networks.

Prior to powering up the system, ensure that all EtherCAT network devices are properly installed and grounded. Further ensure that all of the attached power and signal cables are in good operating condition. Maintenance should be performed only after the relevant network devices

have been powered down, and all associated and surrounding moving parts have settled in their safe mode of operation. Certain drives require a longer time to fully discharge.

To avoid electric arcing and hazards to personnel and electrical contacts, avoid connecting and disconnecting the NPMpm while the power source is on.

When connecting the NPMpm to an approved isolated control and drive supply, connect it through a line that is separated from hazardous live voltages using reinforced or double insulation, in accordance with approved safety standards.

The NPMpm is not intended for use in safety-critical applications (such as life support devices) where a failure of the NPMpm can reasonably be expected to cause severe personal injury or death.

J1, J15 and J16 contain hazardous voltages of 100V PWM modulated.

J9 and J18 contain hazardous voltages (TBD).

Perform the following instructions to ensure safe and proper wiring:

- Whenever possible, use shielded cables with braided shield of at least 80%-95% coverage.
- Follow the guidance of below, based on the current rating of your NPMpm.
- Proper wiring, grounding and shielding are essential for ensuring safe, dependable, and optimal servo performance. After completing the wiring, carefully inspect all wires to ensure tightness, good solder joints, and general safety.

Table 4-1. Wiring Guidelines

Item	Gauge	Twisted pair
Control power supply	18AWG	No
Drive power supply	12-16AWG	No
Motor	14-16AWG	No
Motor Brake	18AWG	No
Encoders	28AWG (up to 0.6A), 26AWG (up to 1A)	Yes

Connecting or disconnecting the motor without disabling the drive first can potentially damage the drive.

4.2 Connecting the NPMPM

To connect the NPMPM:

1. Ensure that all supplies are off when preparing the unit.
2. Connect the 24Vdc control supply to J14.
3. Connect the drive supply to J1.
4. Connect motor 0 to J15.
5. Connect motor 1 to J16.
6. Connect I/O to J6 and J7.
7. Connect EtherCAT-in J4 from the previous device and EtherCAT-out J5 to next slave.
8. Turn on the control supply and verify communication with the unit.
9. Turn on the drive supply.

The supplies can be turned on and off in any order.

4.3 Power Supplies

The unit is fed by two power supplies:

> Drive Supply: 12 to 100Vdc (96Vdc recommended) (J1)

> Control Supply: 24Vdc (J14)

The power supplies must be provided by the customer and has to be UL certified. Each power supply has a LED indicator on the unit.
The supplies can be switched on and off in any order. During emergency situations, the drive supply can be disconnected while the control supply should remain connected.

4.3.1 Drive Supply (J1)

An external isolated 12Vdc to 100Vdc power supply (not included with the unit) feeds the drives and the motors.

The drive supply must be connected to the unit via fuse. The fuse rating should be calculated according to the total input current of the unit and should not exceed the ratings below.

Table 4-2. Fuse Ratings

Unit	Maximum Fuse Rating
40A peak unit	30A
30A peak unit	20A
20A peak unit	15A

Unit	Maximum Fuse Rating
10A peak unit	10A

4.3.1.1 Drive Supply Guidelines

When selecting the drive power supply, use the following guidelines:

The NPMpm does not include a regeneration circuit. You must ensure that the DC drive supply voltage does not exceed 100V under any conditions. It is recommended to use a power supply with voltage not exceeding 96Vdc. For more details contact your ACS representative.

- The power supply must be isolated.
- The power supply must be CE and UL approved.
- The power supply must be short circuit protected.
- Make sure the power supply can absorb the regeneration energy from the motor when it decelerates. Otherwise an external regeneration circuit is needed.
- The power supply must be able to provide the peak current required by the motor (inductance load). Adding an external capacitor of 4400µF, installed as close as possible to the drives, can help the power supply to handle the peak current and reduce the bus current ripple.
- The power supply must be selected based on the power consumed by the drives.

4.3.1.2 Drive Supply Description

Label: J1 DRIVE SUPPLY

Connector: 3 pin header by Molex PN 42820-3228

Mating connector: 3 pin socket by Molex PN 42816-0312; Pin: Molex PN 42815-0042; Tool: Molex PN 63811-3800

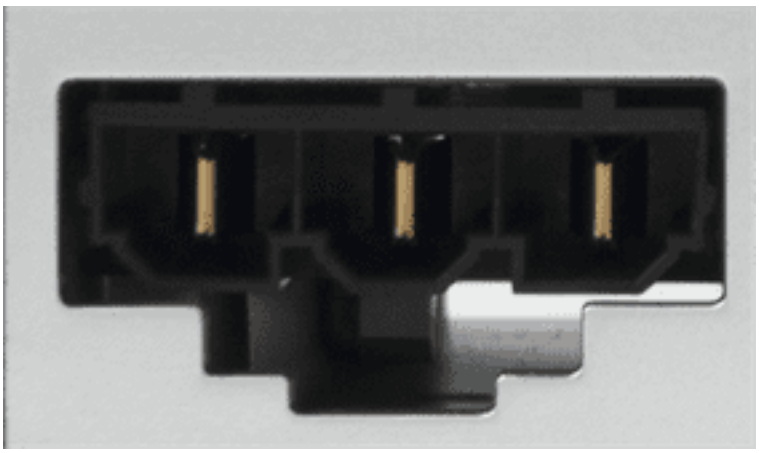


Figure 4-2. J1 - Drive Supply Connector

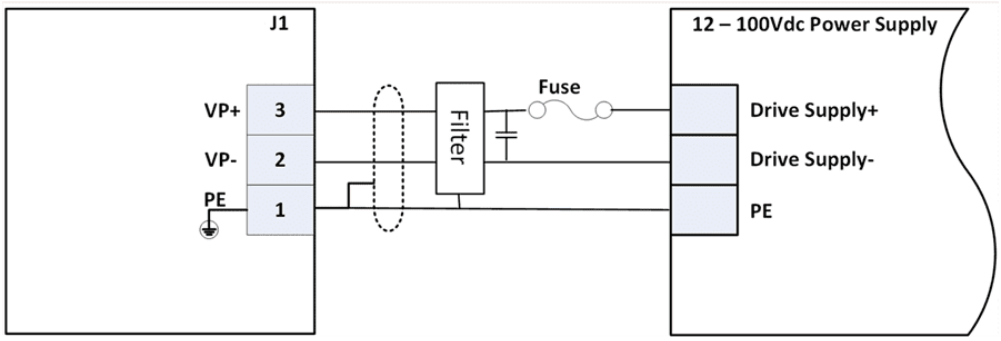
Table 4-3. J1 - Drive Supply Connector Pinout

Pin	Signal	Description
1	PE	Protected earth
2	VP-	Drive supply return
3	VP+	Drive supply positive edge

For better noise immunity, make a short between VP- and PE.

4.3.1.3 Drive Supply Connection Instructions

1. Use a low inductance cable with a minimum gauge of 14-18 AWG.
2. Route the drive supply and motor cables as far as possible from all other noise sensitive cables (such as encoders and I/O).
3. Connect a fast active fuse between the unit and the external power supply.
4. If required, connect the External Regeneration Resistor.
5. Connect the unit PE (Protective Earth) to the power supply PE point.



4.3.2 Control Supply (J14)

An external 24Vdc isolated power supply (not included with the unit) feeds all logic and control low voltage circuitry.

This power supply should remain active (on) even during emergency stop situations, thus ensuring the continuing operation of the network, the controller, the feedback sensors and I/Os.

The 24V control supply must be connected to the unit via a 3A fuse.

4.3.2.1 Control Supply Guidelines

When selecting the control power supply, use the following guidelines:

> The power supply must be isolated.

> The power supply must be CE and UL approved.

- The power supply must be short circuit protected.
- The maximum input current should not exceed 1A @ 21.6V when no external motor relays are used or 2A @ 21.6V when two external motor relays are used.
- An example of a suitable 24V/70W power supply is the XP Power P/N VCS70US24 supply.

4.3.2.2 Control Supply Description

Label: J14 24V CONTROL SUPPLY

Connector: MC 1,5/ 5-GF-3,81, by PHOENIX, PN 1827897

Mating connector: MC 1,5/ 5-STF-3,81, by PHOENIX, PN 1827732

Figure 4-3. J14 - Control Supply Connector

Pin 1 is left most pin.

Table 4-4. J14 - Control Supply Pinout

Pin	Signal	Description
1	24V_CON_SUP	24V control supply
2	24V_RTN	24V control supply return
3	BRK_SUP	Brake supply output (leave this pin unconnected)
4	BRK_RTN	Brake supply output return (leave this pin unconnected)
5	EGND	Shield

4.3.2.3 Control Supply Connection Instructions

- Use a shielded cable with a minimum gauge of 18 AWG.
- Connect a 3A fuse between the NPMpm and the control supply.

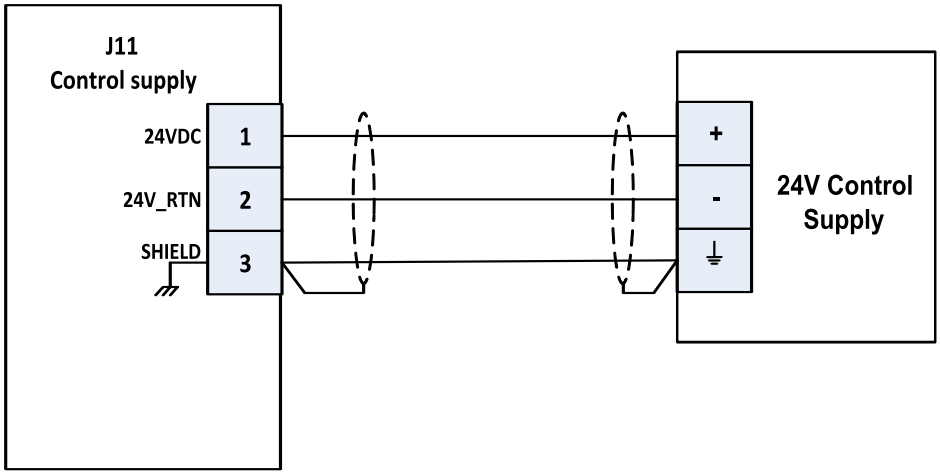


Figure 4-4. Control Supply Connections

4.4 JTAG (J2)

For ACS use only.

4.5 STO (J3)

The Safe Torque Off module is intended for use in safety applications up to and including SIL-3 according to:

- EN/IEC 61800-5-2 Ed. 2 (second environment)
- EN/ IEC 61800-5-1
- IEC 61508
- IEC 62061

Performance Level PLe and Category 3 according to:

- EN ISO 13849-1/-2

STO is an ordering option.

The STO (Safe Torque Off) inputs should be connected to a 24V (18Vdc to 33Vdc) source to enable the drives to generate current and feed the motors. When the 24V is removed from one or both STO inputs, the PWM signals to the power stages are blocked within 200 msec. In addition, the controller is informed about this event within a few milliseconds. This delay (between informing the controller and blocking of the PWM signals of the drive) provides the controller the ability to bring all axes to a complete stop or slow velocity movement in an orderly manner. The implementation of the STO guarantees that under any foreseen circumstances, failure or damage, any of following types of motors will not move:

- AC synchronous (DC brushless)

- Step motor
- AC asynchronous (AC induction)

4.5.1 STO Description

Label: J3 STO

Connector: 5 pin 2mm male by JST P/N SM05B-PASS-1

Mating connector: 5 pin 2mm female by JST P/N PAP-05V-S; Pin: SPHD-001T-P0.5

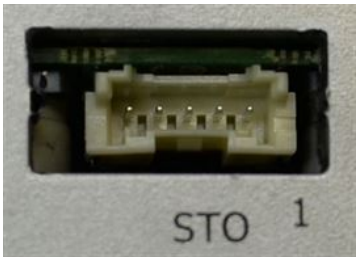


Figure 4-5. J3 - STO Connector

Table 4-5. J3 - STO Connectors Pinout

Pin	Signal	Description
1	STO1-	STO input 1 inverted input
2	STO1+	STO input 1 non inverted input
3	NC	Not connected
4	STO2+	STO input 2 non inverted input
5	STO2-	STO input 2 inverted input

4.5.2 STO Connection Instructions

The STO1 and STO2 are typically connected to a 24V source via an industry standard safety switch. This device disconnects the 24V upon opening a door, a light current tripping, or other safety related event. Details for handling STO are provided in the *Safe Torque Off Function Application Note*.

The STO circuit draws up to 50mA per STO input, with an inrush current of less than 70mA.

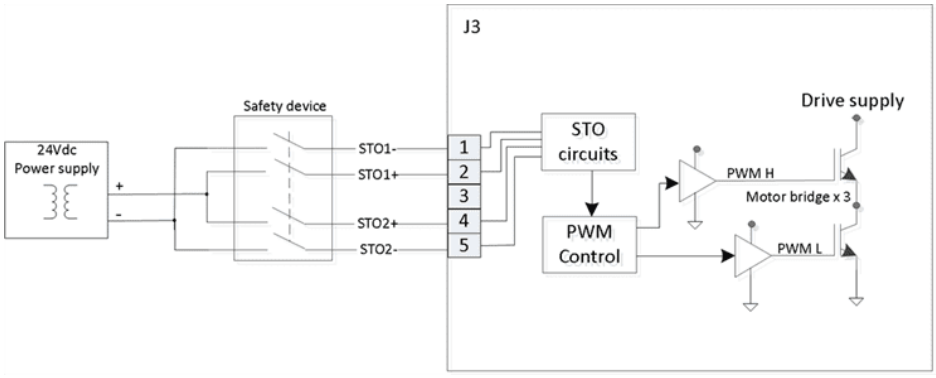


Figure 4-6. STO Connections

4.6 EtherCAT (J4, J5)

4.6.1 EtherCAT Description

Labels: J4 EtherCAT IN, J5 EtherCAT OUT

Connectors: standard RJ45

Mating connector: Ethernet plug, Standard Ethernet CAT5e cable

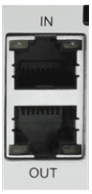


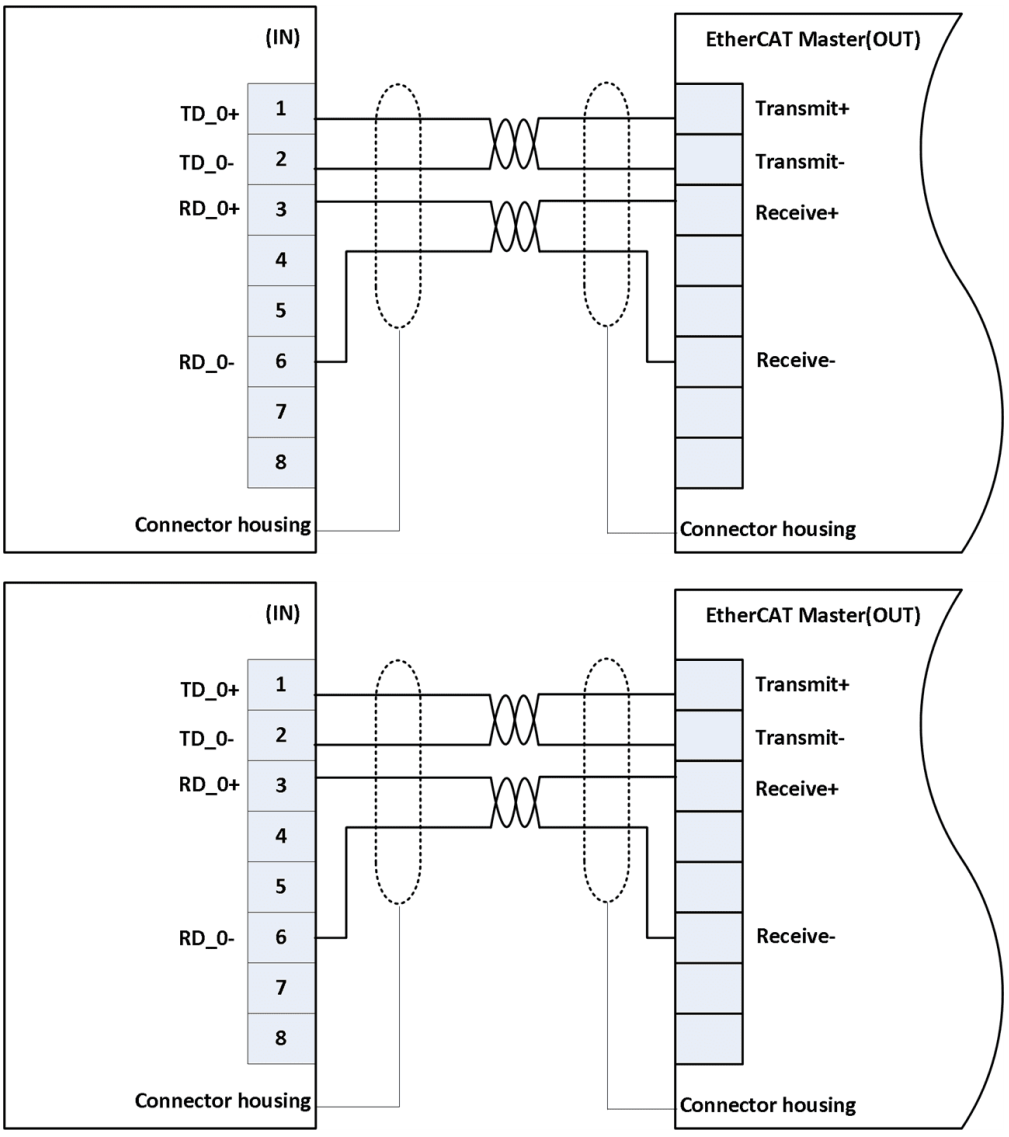
Figure 4-7. J4, J5 - EtherCAT Connectors

Table 4-6. J4, J5 - EtherCAT Connectors

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

4.6.2 EtherCAT Connection Instructions

1. Use Ethernet cables CAT 5e or better. ACS offers standard cables in different lengths (see Ethernet Cables).
2. Connect EtherCAT cable between the EtherCAT master unit or preceding slave to J4 (ETHERCAT IN).
3. When the unit is not the last network node, connect EtherCAT cable between J5 and EtherCAT IN of the next EtherCAT slave.
4. When the unit is the last network node and a ring topology is used, connect J5 to the EtherCAT Master secondary port.
5. When the unit is the last network node and a line topology is used, leave J5 not connected.



The following diagram illustrates the wiring of the IN connection of the NPMpm to an EtherCAT Slave.

Figure 4-8. EtherCAT IN connection to external EtherCAT Slave device

The following diagram illustrates the connection of the NPMpm EtherCAT OUT port to an EtherCAT slave.

Figure 4-9. EtherCAT In (J4) Connection

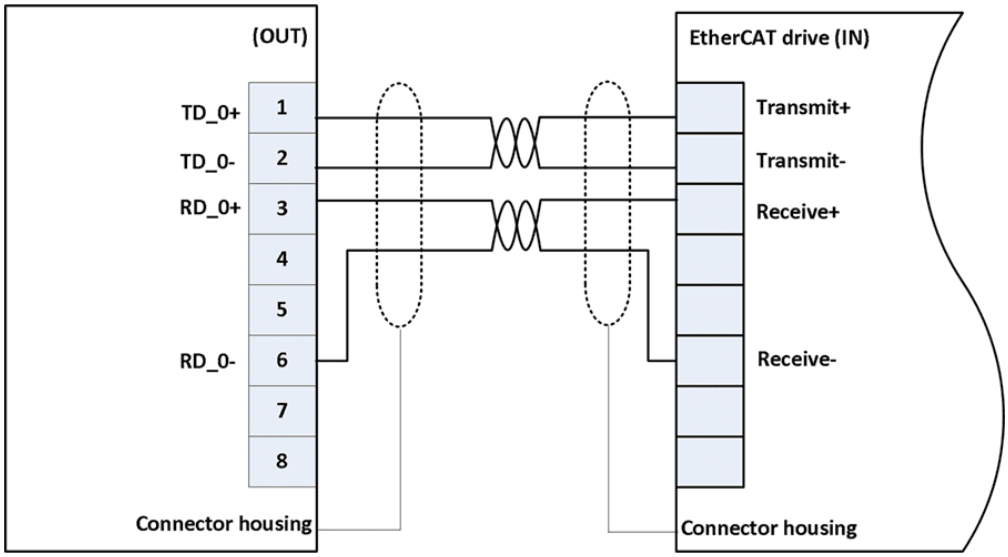


Figure 4-10. EtherCAT Out (J5) Connection

4.7 I/O

4.7.1 Digital I/O (J6)

4.7.1.1 Digital I/O Description

Label: J6 Digital I/O

Connector: D-type 25 pin female

Mating connector: D-type 25 pin male

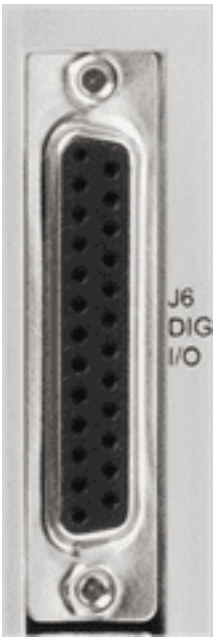


Figure 4-11. J6 - Digital I/O Connector

Table 4-7. J6 - Digital I/O Connector Pinout J6 -

Pin	Signal	Description
1	MARK0+	Axis 0 , Mark input 0 non inverted (may be used as general purpose input)
2	MARK1+	Axis 0, Mark input 1 non inverted (may be used as general purpose input)
3	MARK2+	Axis 1, Mark input 2 non inverted (may be used as general purpose input)
4	MARK3+	Axis 1, Mark input 3 non inverted (may be used as general purpose input)
5	Motor relay_0	Motor relay 0
6	M.BRK0/OUT0	Mechanical brake 0 (may be used as general purpose output0)
7	V_SUP_IO	Supply for the IO
8	Relay_V_SUP	Motor relay supply output (leave this pin unconnected)
9	NC	Not connected
10	DGND	Digital ground

Pin	Signal	Description
11	PEG0-	PEG 0 output inverted (may be used as general purpose output) (SW programmable, default assignment encoder 0, see *PEG and MARK Operations Application Note*)
12	PEG1-	PEG 1 output inverted (may be used as general purpose output) (SW programmable, default assignment encoder 1, see *PEG and MARK Operations Application Note*)
13	DRV_1_ON	Drive 1 on status
14	MARK0-	Axis 0, Mark input 0 inverted (may be used as general purpose input)
15	MARK1-	Axis 0, Mark input 1 inverted (may be used as general purpose input)
16	MARK2-	Axis 1, Mark input 2 inverted (may be used as general purpose input)
17	MARK3-	Axis 1, Mark input 3 inverted (may be used as general purpose input)
18	Motor relay_1	Motor relay 1
19	M.BRK1/OUT1	Mechanical brake 1 (may be used as general purpose output1)
20	V_RTN_IO	Supply return for the IO
21	Relay_SUP_RTN	Motor relay supply return
22	DGND	Digital ground
23	PEG0+	PEG 0 output non inverted (may be used as general purpose output) (SW programmable, default assignment encoder 0, see *PEG and MARK Operations Application Note*)
24	PEG1+	PEG 1 output non inverted (may be used as general purpose output) (SW programmable, default assignment encoder 1, see *PEG and MARK Operations Application Note*)

Pin	Signal	Description
25	DRV_0_ON	Drive 0 on status
	Connector shell and front screw	SHIELD

4.7.1.2 Digital I/O Connection Instructions

1. Use shielded cables with twisted pairs, a minimum gauge of 24 AWG and up to 10 meters in length.
2. The diagrams below show connections options for different Digital I/O functions.

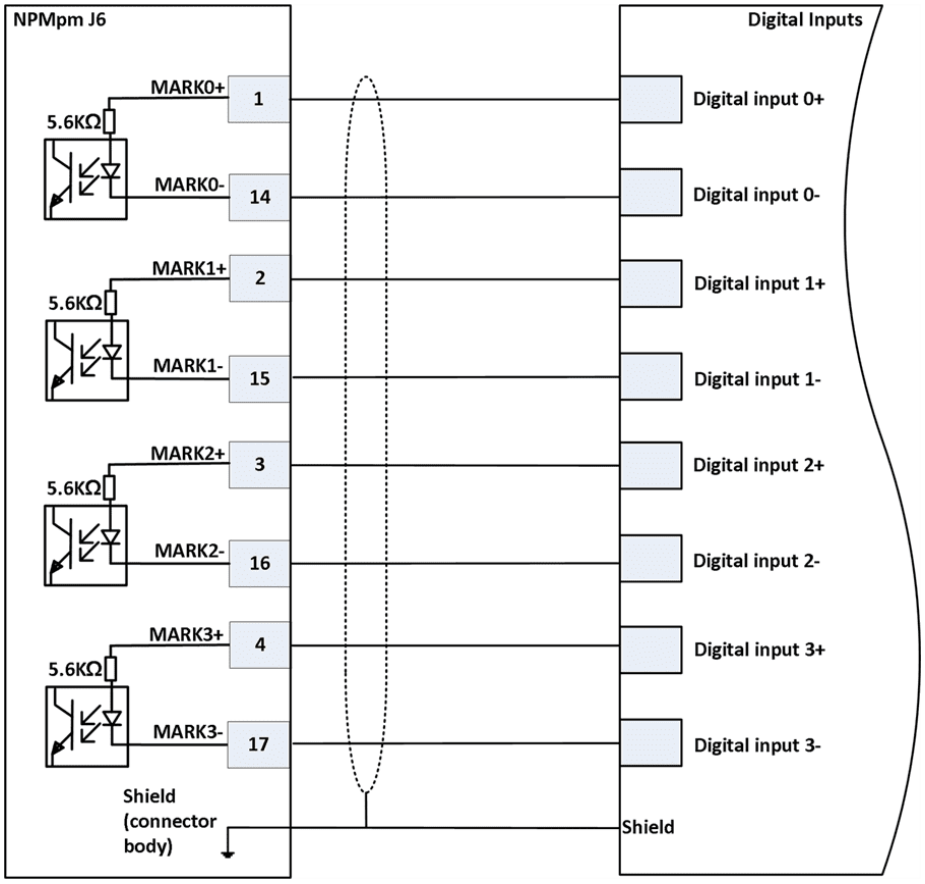


Figure 4-12. Mark Input Connection

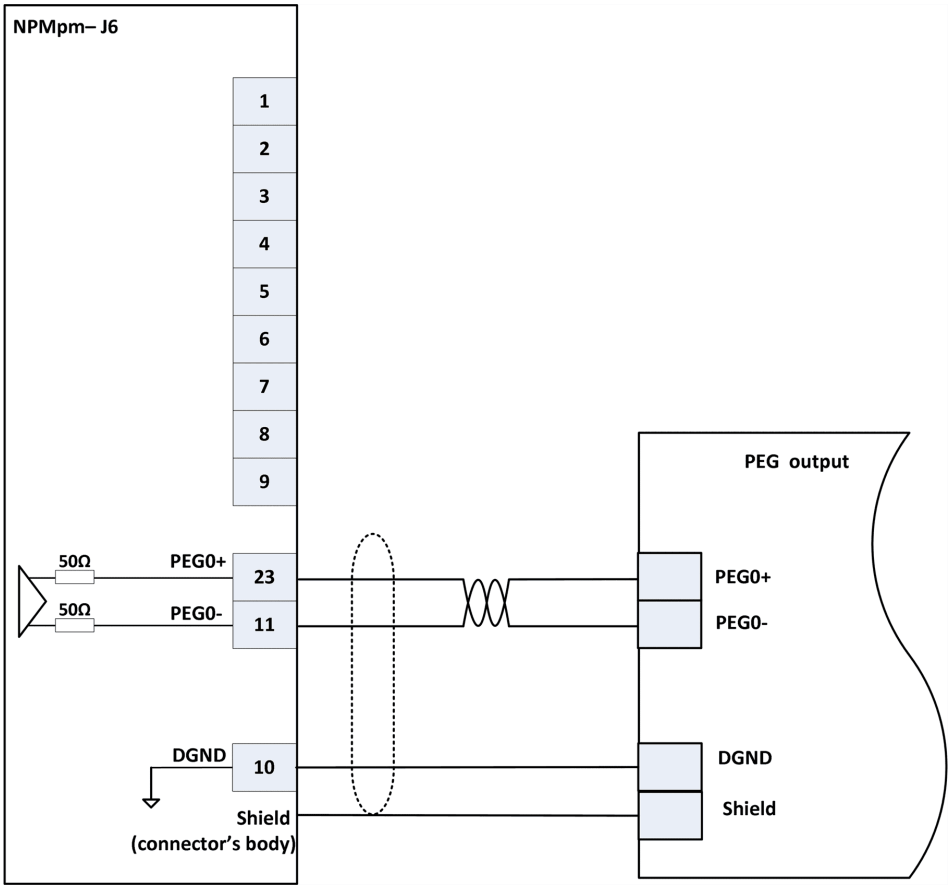


Figure 4-13. PEG Output Connection

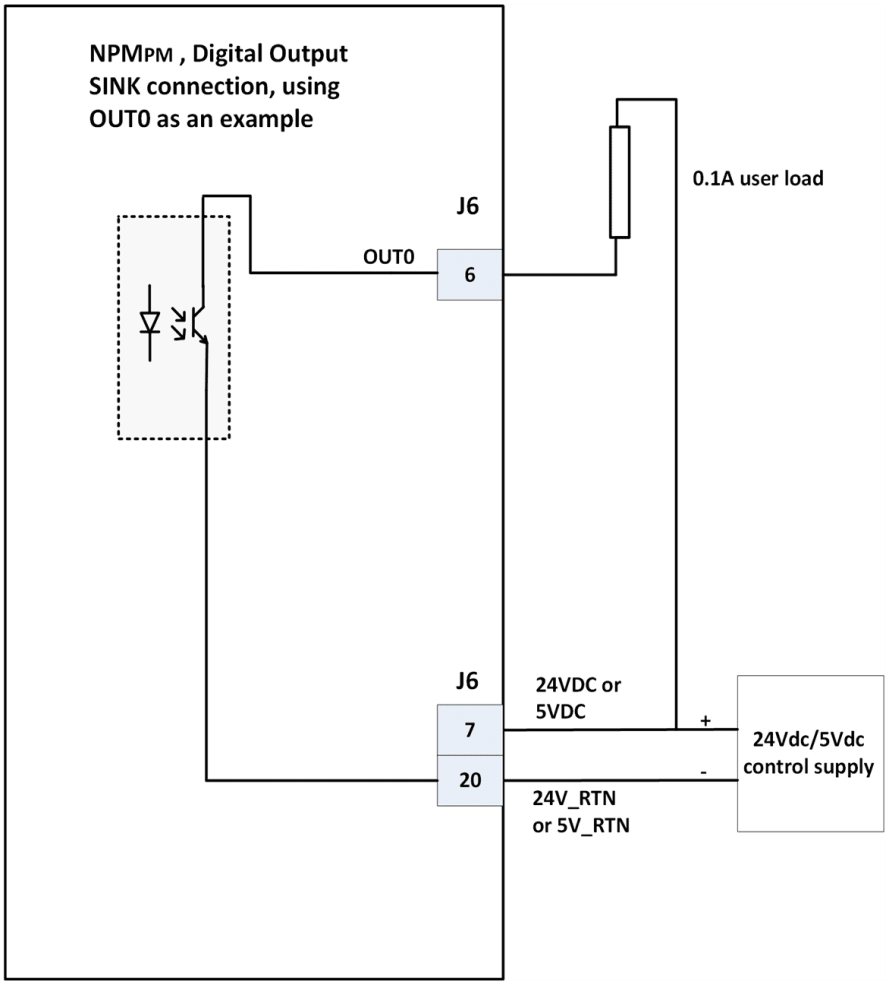


Figure 4-14. 24V/5V Sink Output

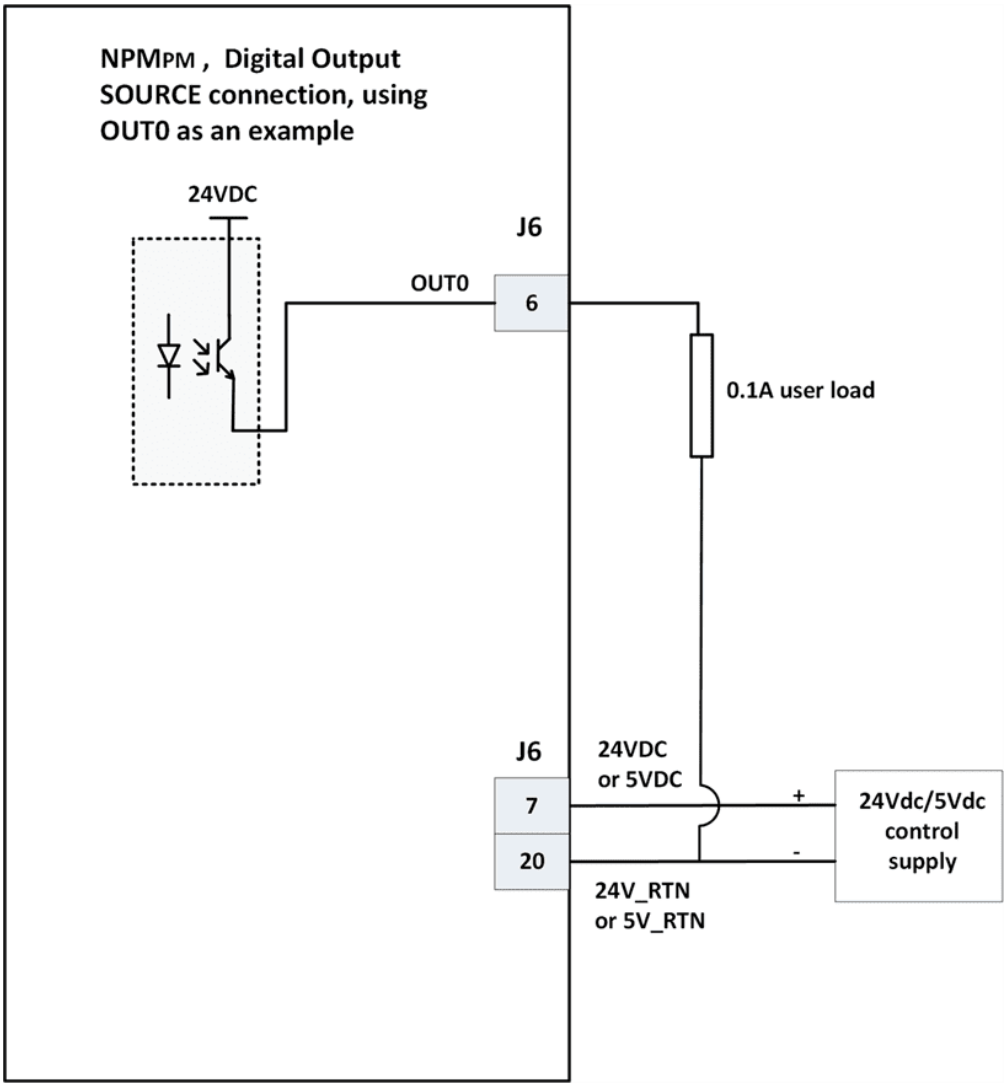


Figure 4-15. 24V/5V Source Output

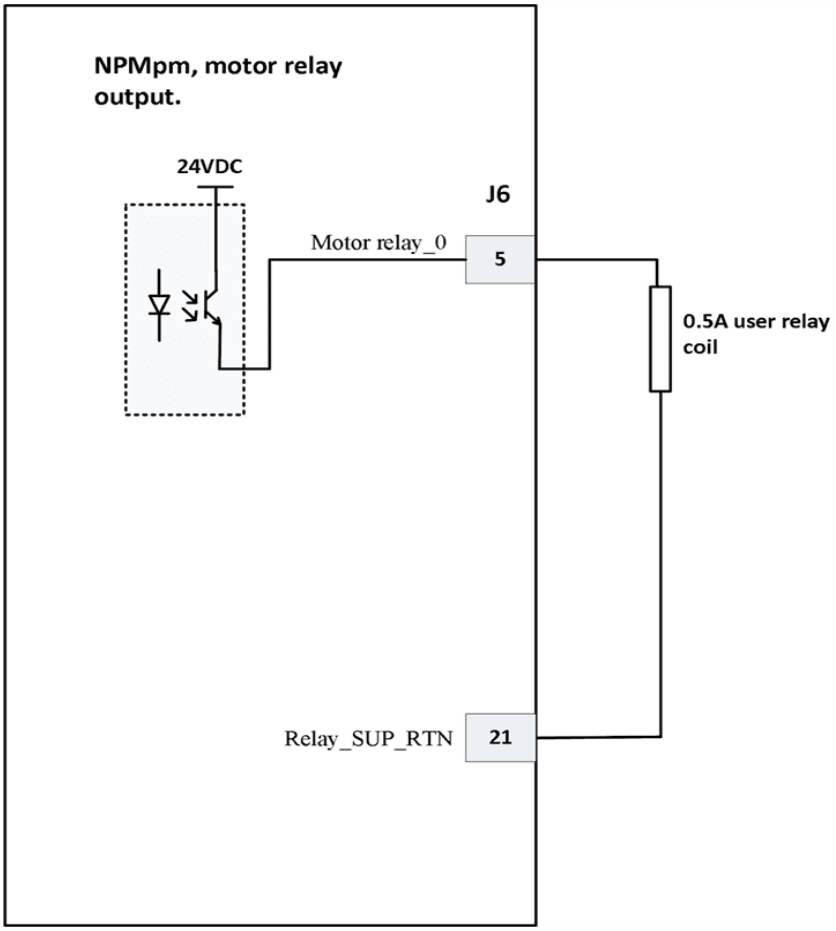


Figure 4-16. Motor Relay Output

4.7.2 Analog & Safety I/O (J7)

4.7.2.1 Analog & Safety I/O Description

Label: J7 Analog & Safety I/O

Connector: D-type 25 pin male

Mating connector: D-type 25 pin female

Figure 4-17. J7 - Analog & Safety I/O Connector

Table 4-8. J7 - Analog & Safety I/O Pinout

Pin	Name	Description
1	AGND	Analog ground for AIN and AOUT circuits.
2	AOUT0+	Analog output 0 non inverted
3	AOUT1+	Analog output 1 non inverted
4	AOUT2+	Analog output 2 non inverted
5	AOUT3+	Ae analog output 3 non inverted
6	AIN0+	Analog input 0 non inverted
7	AIN1+	Analog input 1 non inverted
8	AIN2+	Analog input 2 non inverted
9	AIN3+	Analog input 3 non inverted
10	NC	Not connected
11	1_RL	Axis 1 right limit
12	0_RL	Axis 0 right limit
13	V_SUP_SFTY	Safety supply

Pin	Name	Description
14	AOUT0-	Analog output 0 inverted
15	AOUT1-	Analog output 1 inverted
16	AOUT2-	Analog output 2 inverted
17	AOUT3-	Analog output 3 inverted
18	AIN0-	Analog input 0 inverted
19	AIN1-	Analog input 1 inverted
20	AIN2-	Analog input 2 inverted
21	AIN3-	Analog input 3 inverted
22	NC	Not connected
23	1_LL	Axis 1 left limit
24	0_LL	Axis 0 left limit
25	V_RTN_SFTY	Safety supply return
	Connector shell and front screw	SHIELD

4.7.2.2 Analog & Safety I/O Connection Instructions

1. Use shielded cables with twisted pairs, a minimum gauge of 24 AWG and up to 10 meters in length.
2. The diagrams below show connections options for different Analog I/O functions

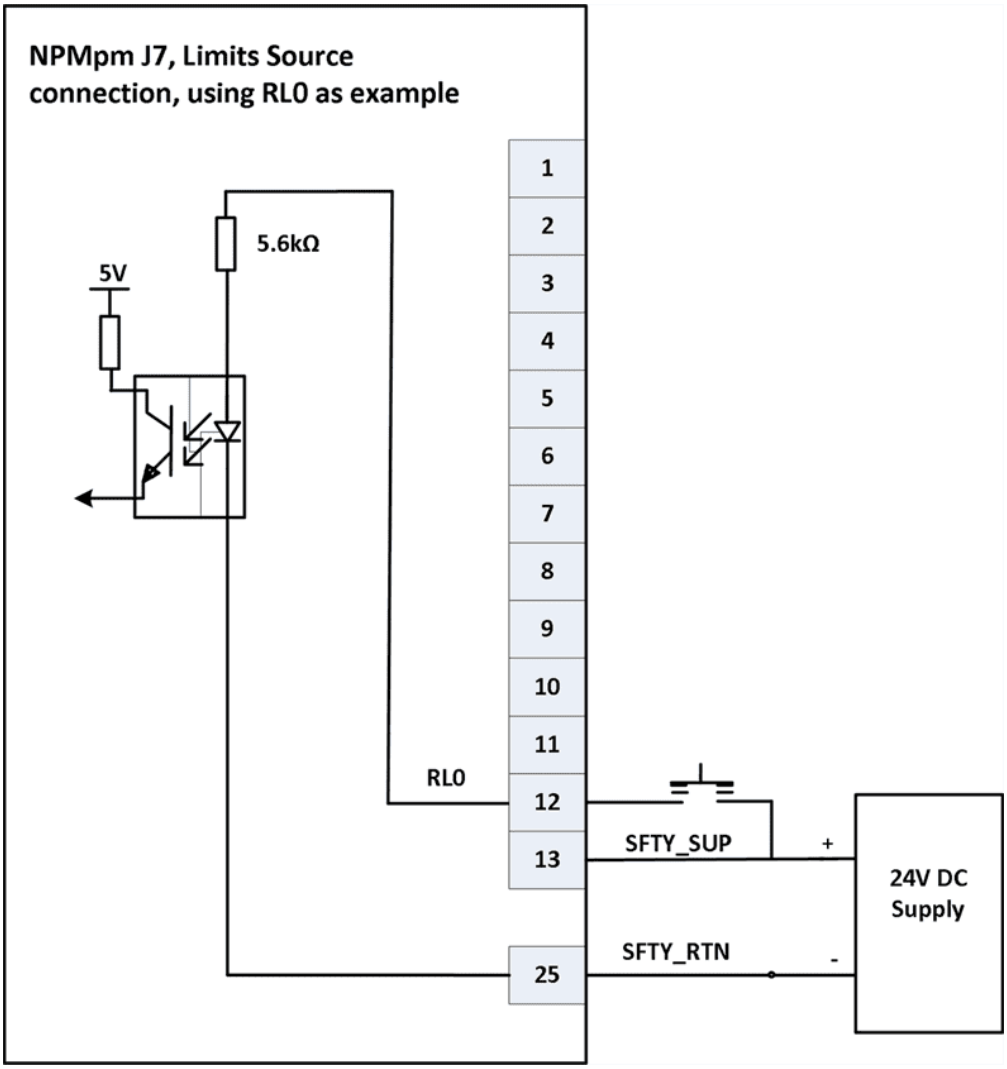


Figure 4-18. Limit Source Connection

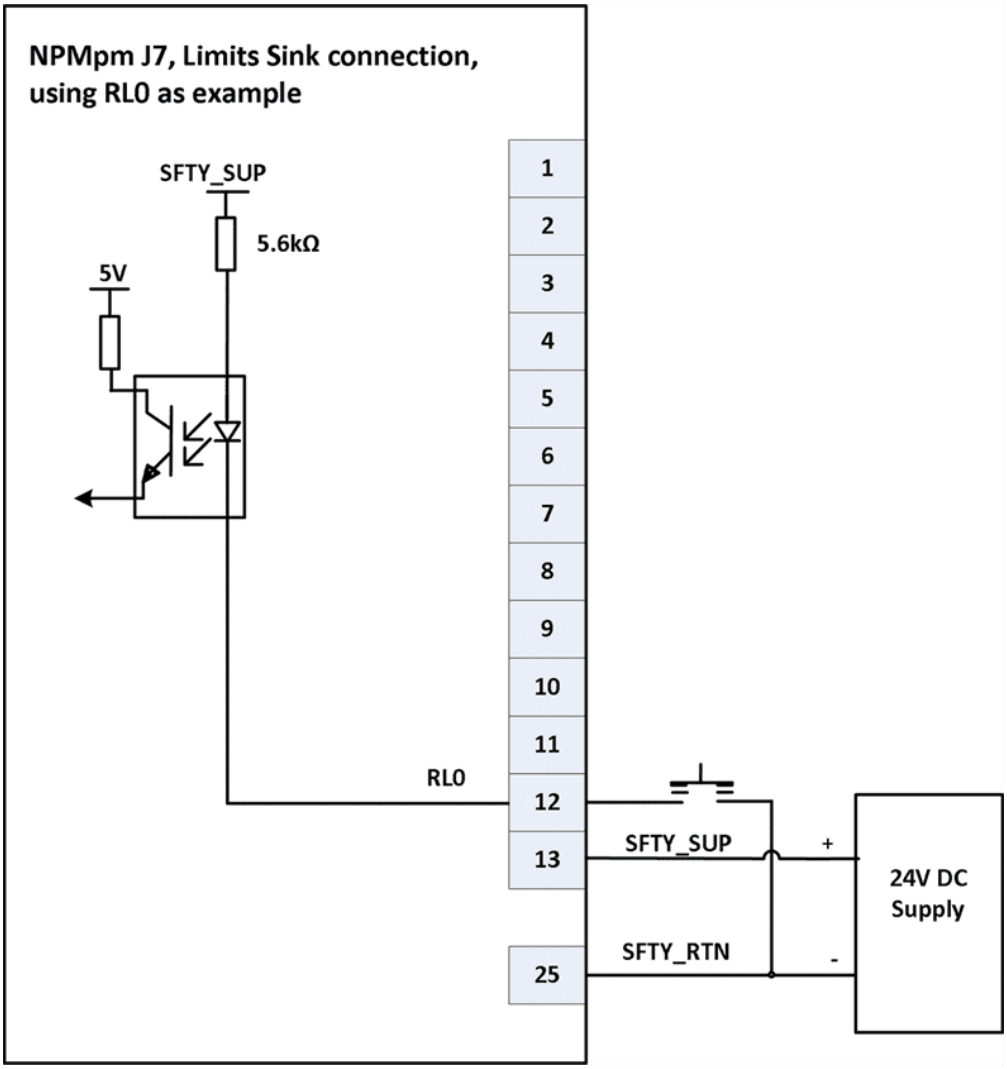


Figure 4-19. Limit Sink Connection

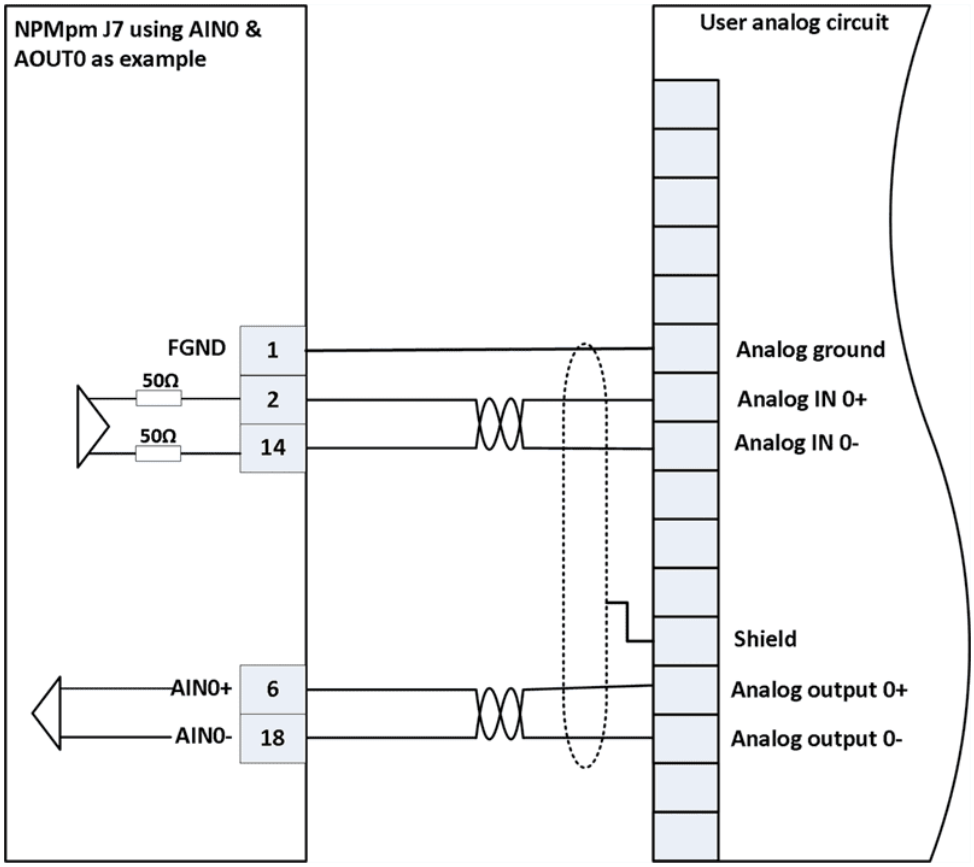


Figure 4-20. Analog I/O Connection

4.8 Encoder Feedback (J8-J11)

The following feedback types are supported:

1. Incremental Digital Encoder. Maximum frequency: 12.5MHz.
2. Incremental Analog SIN-COS Encoder (includes squared SIN-COS output). Maximum frequencies: 500kHz or 10MHz (depending on ordering options).
3. Absolute Digital Encoder. Maximum frequency: 2MHz - 10MHz depending on encoder type.

4.8.1 Encoder Feedback Description

Label: J8 Encoder Channel 0, J9 Encoder Channel 1, J10 Encoder Channel 2, J11 Encoder Channel 3

Connector: D-type 26 pin high density female

Mating connector: D-type 26 pin high density male

Figure 4-21. Encoder Connectors

Figure 4-22. J8, J9, J10, J11 - Encoder Connectors Pinout

Pin	Signal	Description
1	$_CHA-/ SQR_ SIN$-	$ digital encoder, channel A inverted input, for differential encoder only. Absolute encoder Data-. Squared SIN inverted output.
2	$_CHB-/ SQR_ COS$-	$ digital encoder, channel B inverted input for differential encoder only. Absolute encoder CLK- (for EnDat2, BiSS-C and SSI), Squared inverted output.
3	$_CHI-	$ digital encoder, channel I (index) inverted input for differential encoder only.
4	$_HB	$ Motor Hall B (for axis 0 and 1 only.)

Pin	Signal	Description
5	V_SUP_SFTY	Supply for limit switch input.
6	$_RL	Right limit (for axis 0 and 1 only.)
7	$_SIN-	$ Encoder SIN inverted input
8	$_COS-	$ Encoder COS inverted input
9	$_SC_I-	$ Encoder SIN-COS Index inverted input
10	$_CHA+/ SQR_ SIN$+	$ digital encoder, channel A non-inverted input, used for both single-ended and differential encoders. Absolute encoder Data+. Squared SIN non inverted output.
11	$_CHB+/ SQR_ COS$+	$ digital encoder, channel B non-inverted input, used for both single-ended and differential encoders Absolute encoder CLK+ (for EnDat2, BiSS-C and SSI), Squared COS non inverted output.
12	$_CHI+	$ digital encoder, channel I (index) non inverted input, used for both single-ended and differential encoders
13	X_HA	$ Motor Hall A (for axis 0 and 1 only.)
14	X_HC	$ Motor Hall C (for axis 0 and 1 only.)
15	$_LL	Left limit (for axis 0 and 1 only.)
16	$_SIN+	$ SIN non inverted input
17	$_COS+	$ Encoder COS non inverted input
18	$_SC_I+	$ Encoder SIN-COS Index non inverted input
19	5U	5V user supply for digital encoder and Hall
20	5U_RTN	5V return user supply for digital encoder, A return for $ motor temperature sensor and Hall
21	NC	not connected
22	MTMP_#	MTMP motor temperature sensor (for axis 0 and 1 only.)
23	MTMP_#_RTN	Return supply for MTMP (for axis 0 and 1 only.)

Pin	Signal	Description
24	V_RTN_SFTY	A return for limit switch input.
25	5F	5V user supply for analog encoder and Hall
26	5F_RTN	5V return user supply for analog encoder and Hall
	Connector shell and front screw	SHIELD

$ represents the encoder channel number 0,1,2 or 3.

4.8.2 Encoder Feedback Connection Instructions

1. Use shielded cables with twisted pairs, a minimum gauge of 24 AWG and up to 10 meters in length.
2. The diagrams below show feedback connections options

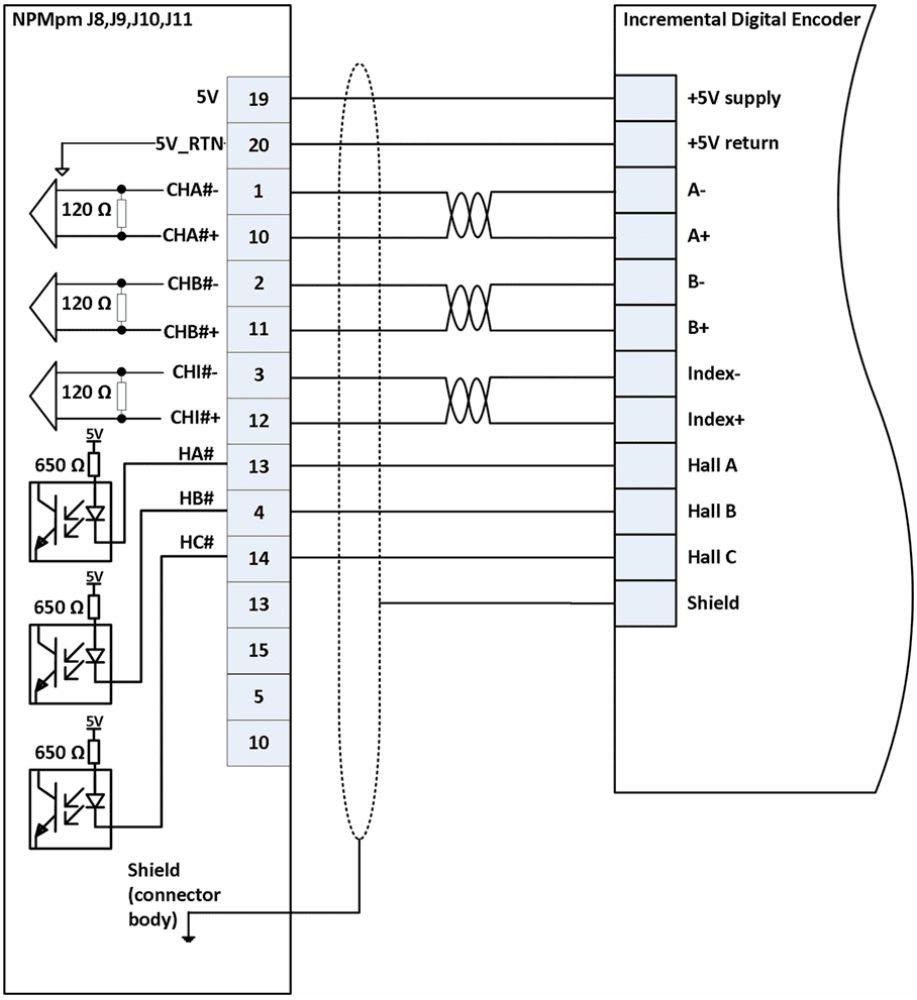


Figure 4-23. Incremental Digital Encoder - AqB Connection

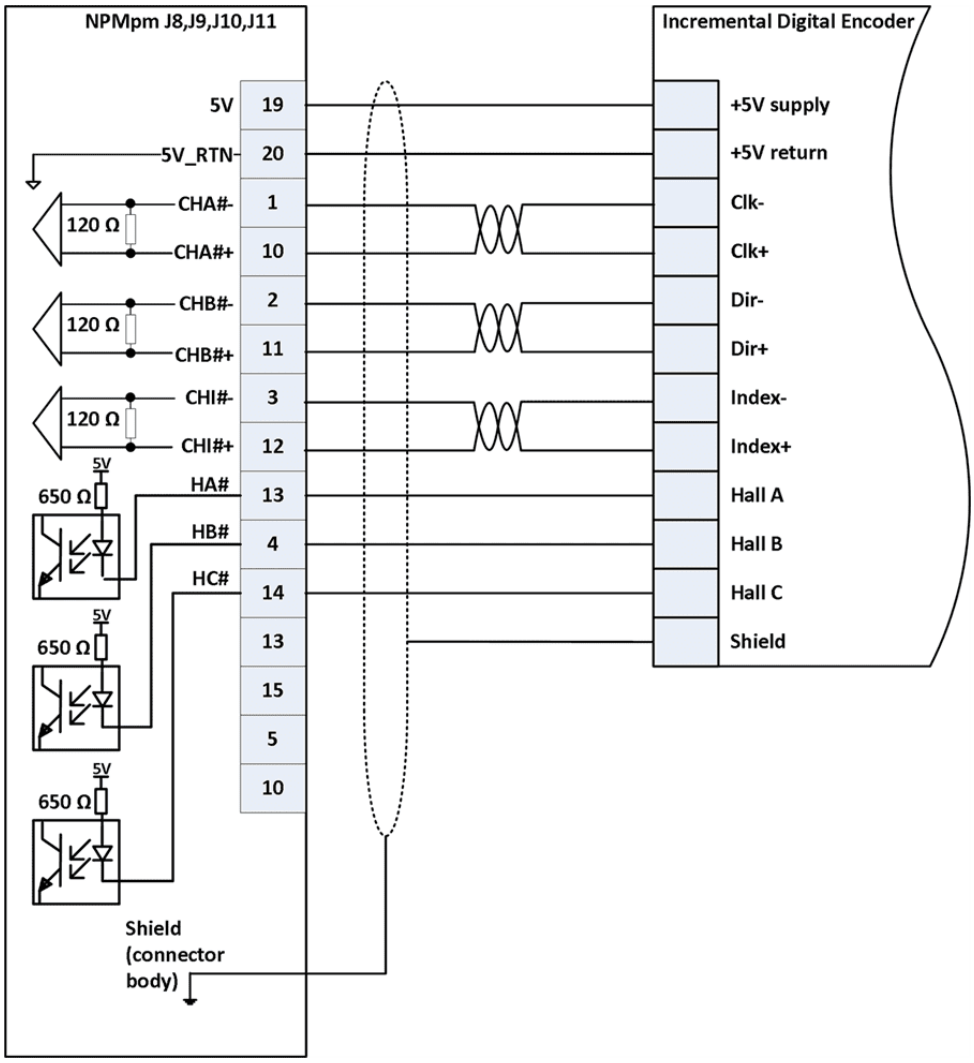


Figure 4-24. Incremental Digital Encoder -Clk-Dir Connection

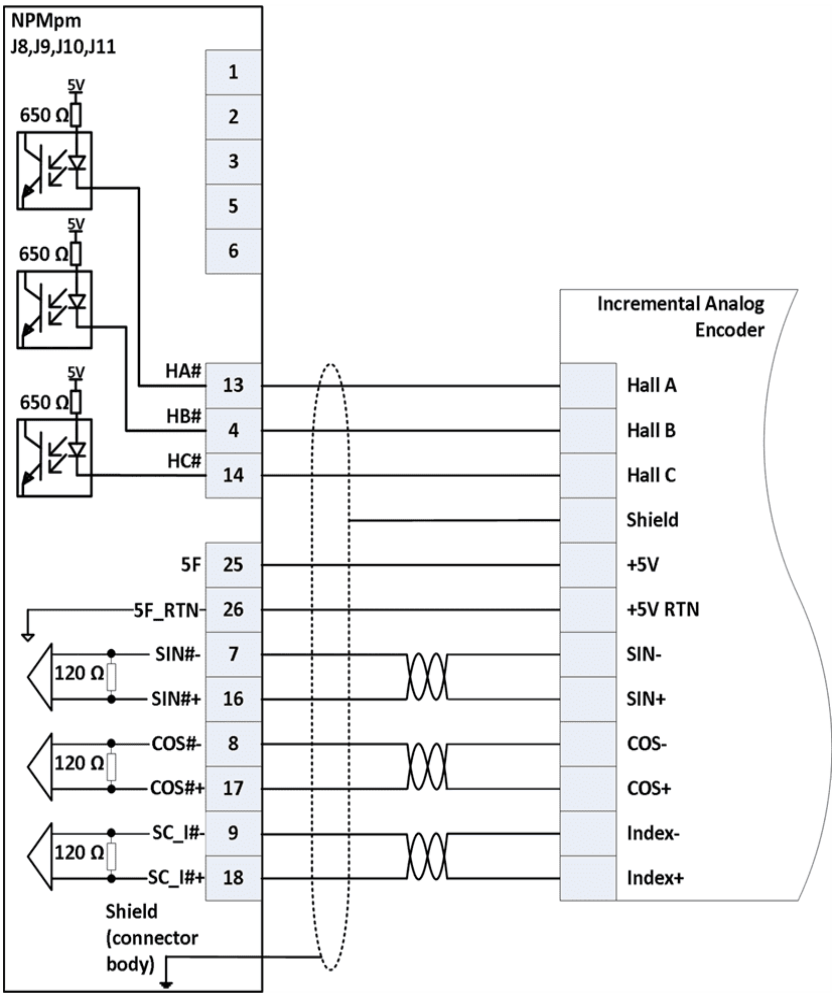


Figure 4-25. Incremental Analog SIN-COS Encoder

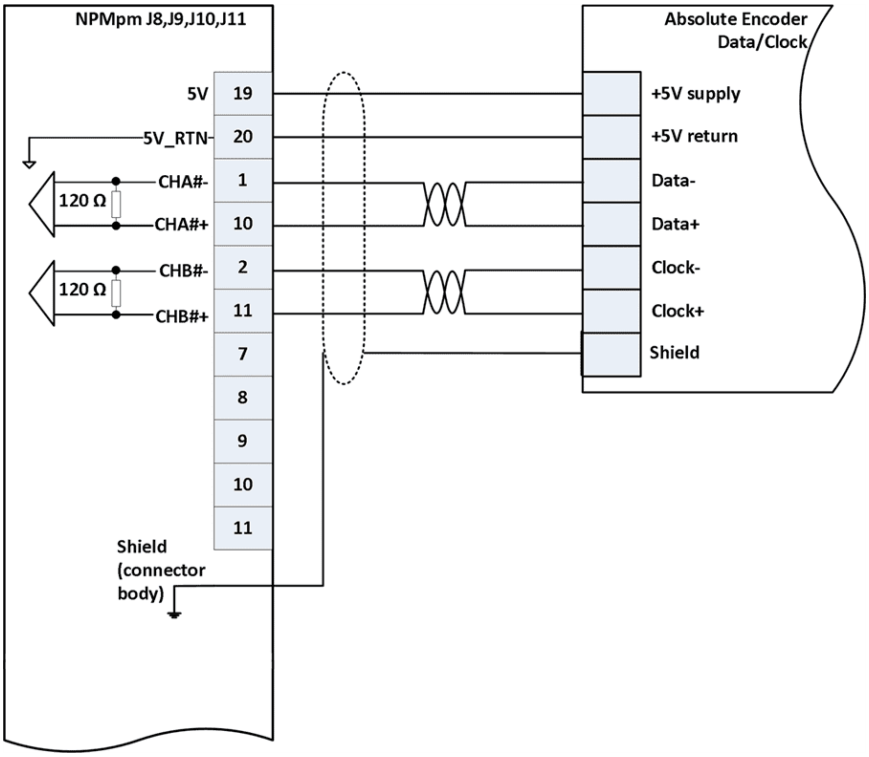


Figure 4-26. Absolute Encoder - Clk-Data Connection

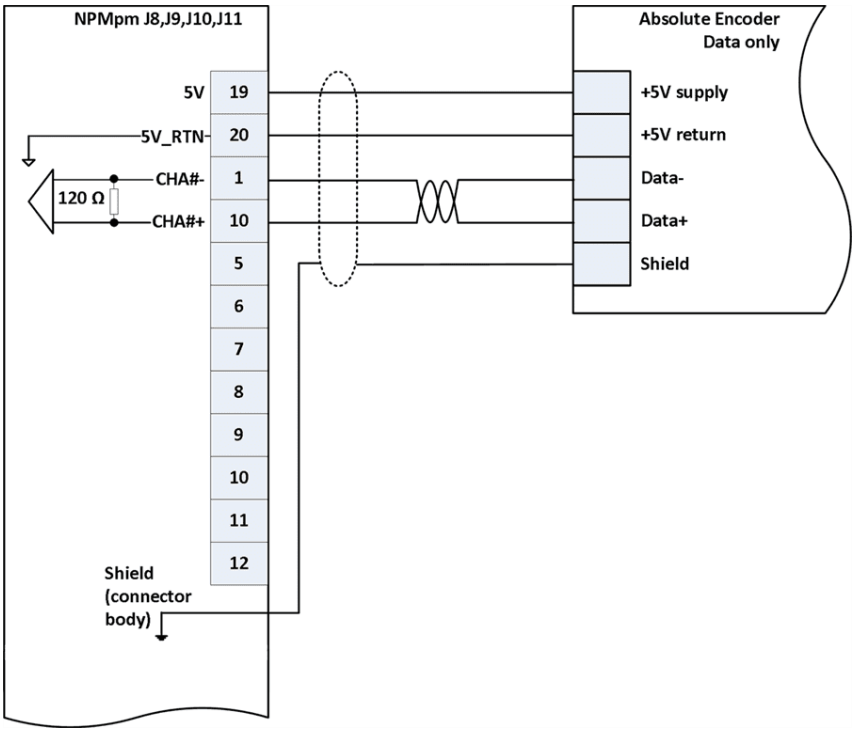


Figure 4-27. Absolute Encoder - Data Only Connection

4.9 Motors (J15, J16)

4.9.1 Motor Description

Label: J15 (Motor 0), J16 (Motor 1)

Connector: Sub D 9W4 female

Mating connector: Sub D 9W4 male. FTC PN FM9W4P-K120; Pin: FTC FMP005P103 (four required)

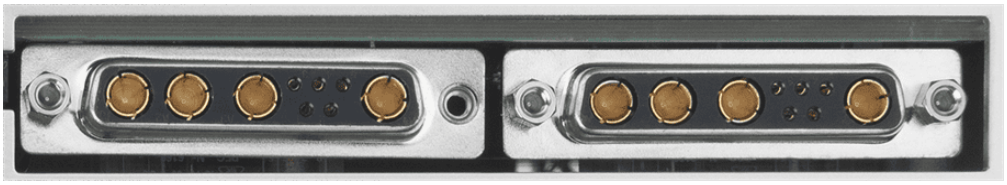


Figure 4-28. Motor Connectors

Table 4-9. J15, J16 - Motor Connectors Pinout

Pin	Signal	Description
A1	R_#	Motor R phase for DC brush, three-phase brushless motor
A2	S_#	Motor S phase for DC brush, three-phase brushless motor
A3	T_#	Motor T phase for DC brush, three-phase brushless motor
A4	SHIELD/PE	Motor shield
1	MTMP_#	MTMP Motor temperature sensor
2	NC	Not connected
3	MTMP_#_RTN	Return supply for MTMP
4	NC	Not connected
5	SHIELD	SHIELD
	Connector shell and front screw	SHIELD

# Denotes motor number (0,1)

Figure 4-29. Motor Connector Pin Locations

4.9.2 Motor Connection Instructions

1. Use a shielded cable with a minimum gauge of 16 AWG. It should be less than 20 meters long.
2. Route the motors' cable (and the drive supply cable) as far as possible from all other noise sensitive cables (such as encoders and I/O).
3. Connect the motors according to the figures below.

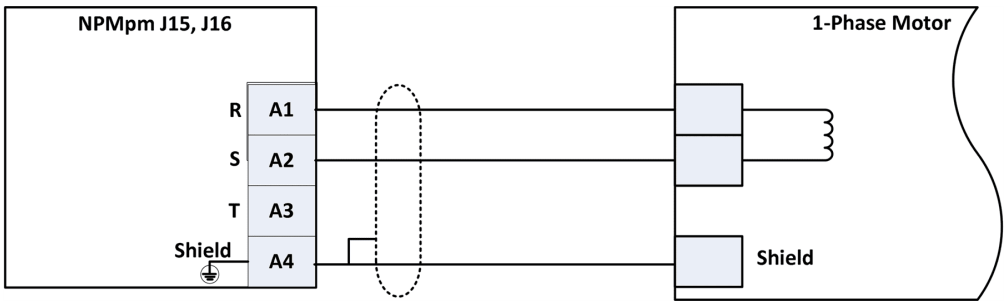


Figure 4-30. 1-Phase Motor Connection

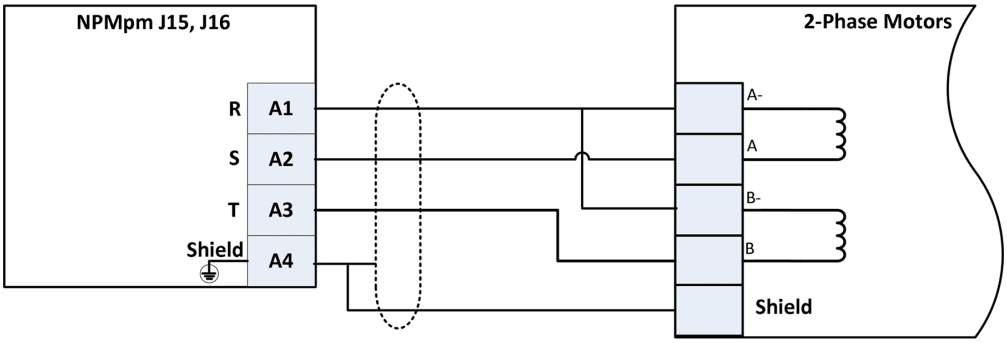


Figure 4-31. 2-Phase Motor Connection

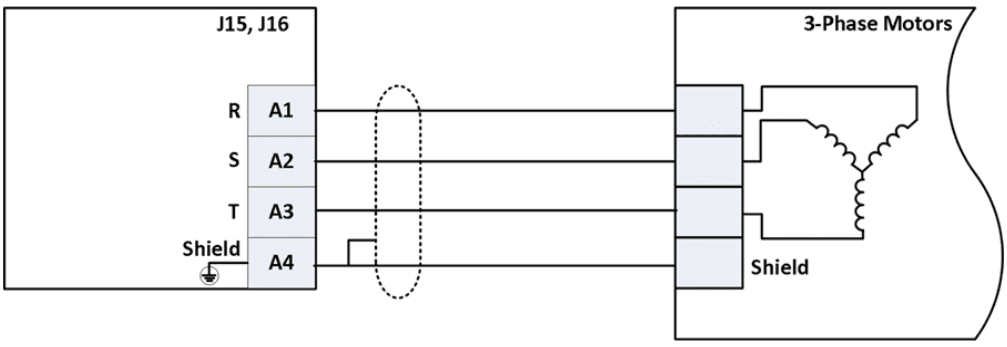


Figure 4-32. Three-Phase Motor

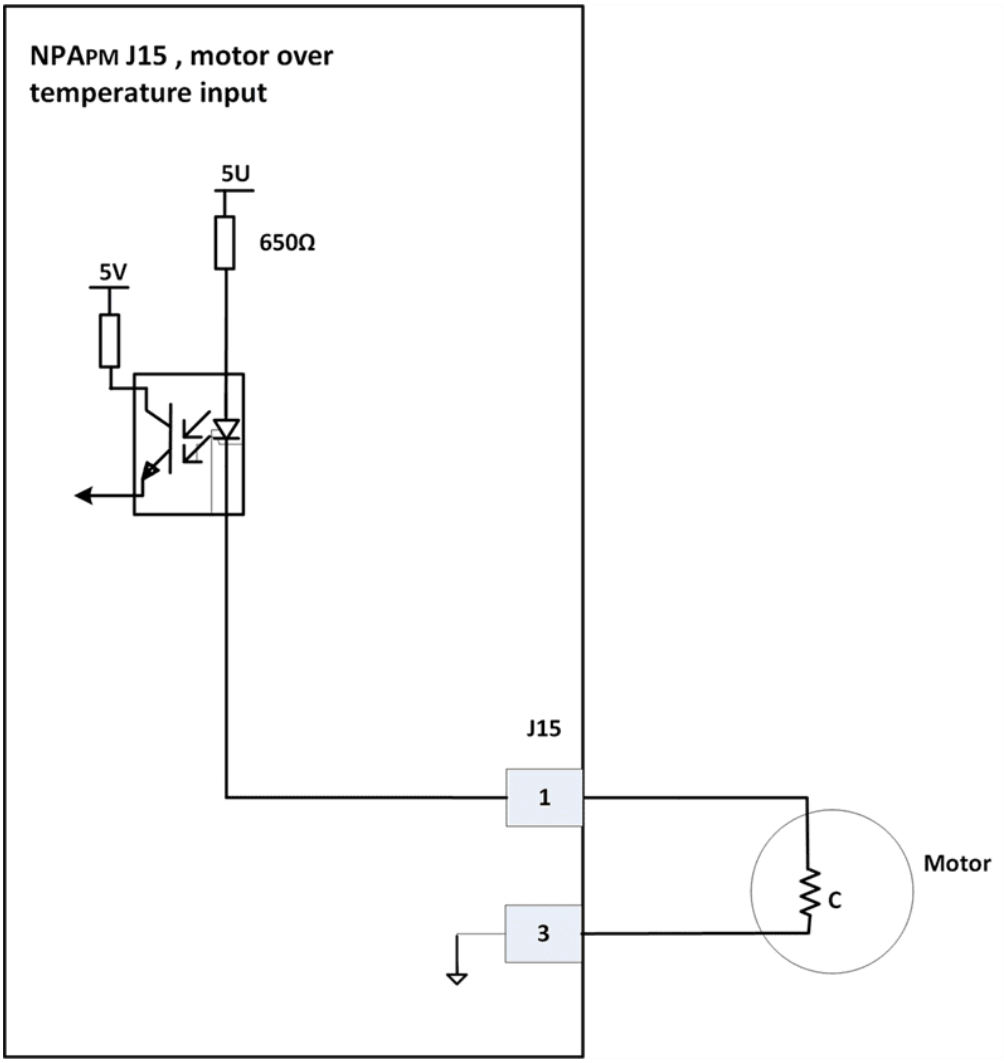


Figure 4-33. Motor Over Temperature Input

Connector J16 services Motor 0, J17 services Motor 2, J18 services Motor 3, and J18 services Motor 4.

If the motor over temperature protection is not used, then connect input pin 1 to input pin 3.

5. Product Specifications

Feature	Specifications
Drives	> Type: Digital current control with field oriented control and space vector modulation > Current ripple frequency: 40 kHz > Current loop sampling rate: 20 kHz > Programmable current loop bandwidth: up to 4 kHz. Will vary with tuning and load parameters. > Commutation type: Sinusoidal. Initiation with and without hall sensors > Switching method: Advanced unipolar PWM > Protection: > Over & under voltage > Phase to phase > Phase to ground short  Short circuit on one of the motor phases might damage the drive. > Over current > Over-temperature
Supply	The module is fed by two power sources: > Motor supply > 24Vdc control supply. During emergency conditions there is no need to remove the 24Vdc control supply.
Motor Drive Supply	> Range: 12Vdc to 100Vdc, recommended 96Vdc. > Current rating of the power supply should be calculated based on actual load. > External shunt power resistor, activated at 102V, should be added in parallel to motor drive supply in the event external regeneration is required. The drive supply voltage- bus voltage must not exceed 105V under any operating conditions. > Maximum In-rush current: 100A for 40uS @100Vdc > Designation: VP, VP_RTN
Control Supply	> Range: 24Vdc ± 10% > Maximum input current / power: 0.9A @21.6V/ 20W without motor brakes > With 2 motor brakes: 1.9A @ 21.6Vdc) / 42W > Protection: Reverse polarity (3A external fuse

Feature	Specifications
	must be used) > Designation: 24V_CON_SUP, CON_RTN.
Motor Type	> Two- and three- phase permanent magnet synchronous (DC brushless / AC servo) > DC brush and voice coil > Two- and three-phase stepper (micro-stepping open or closed loop)
Feedback	Standard > Incremental digital encoders (AqB) > Hall inputs Optional: > Absolute encoders > Analog sin-cos
Incremental Digital Encoder	> Two or four, two per axis > AqB,I and Clk/Dir, Type: Differential RS-422 > Maximum rate: 50 million quad counts/sec (12.5MHz A & B input frequency) > Protection: Encoder error, not connected > Input termination: 120Ω (on each signal pair) > Encoder supply: 5.1-5.15V, 0.5A total for all encoders. > Designation: A: #_CHA±, B: #_CHB±, I: #_CHI±
Sin-Cos Analog Encoder (optional)	> Two or four, max. two per axis > Type: 1Vptp, differential > Programmable multiplication factor: x4 to x65536 > Maximum frequency: 500kHz or 10MHz > Maximum acceleration with sin-cos encoder: 10^8 sin periods/second^2 > Format: SIN, COS and Index > Type: > Differential input > Input impedance: 120Ω±10% > Encoder voltage range: 1V-PTP±10% > Input voltage range: 1.25V-PTP > Encoder analog output supply: 5.1-5.15V, 1.5A total for all encoders. > ADC resolution: 16-bit > Protection: Encoder error, not connected > Designation: SIN±, COS±, SC_I± (share the same inputs with current command)

Feature	Specifications
Squared SIN-COS Output	> Format: Squared of SIN, COS > Quantity: 2 > Type: Differential RS422 > Designation: SQR_SIN$, SQR_COS$ (share same pins with AqB)
Absolute Encoder (optional)	> Up to two: > Smart- Abs > Panasonic > BiSS-A/B/C > SSI > Sanyo ABS > Type: > Smart-Abs: Tamagawa, based on: SA35-17/33bit-LSP-5V > EnDat2.2, Heidenhain, based on ROQ 437 SERIES > BiSS-C > Panasonic: based on AC Servo Motor MINAS A4 Series > SSI > Maximum input frequency: > EnDat: 2MHz > Smart-Abs: 2.5MHz > Biss-C: 10MHz > Panasonic: 2.5MHz > Interface : Differential RS485 > Encoder supply : 5.1V-5.15V, 0.5A total for all encoders. > Designation: #_CHA, #_CHB
Hall inputs	> Two sets of three per axis > Type: single-ended, 5V, source, open cathode > Input current: <7mA > Interfaces: 5V, Source input type, (open cathode), Reference DGND > Designation: $_HA, $_HB, $_HC
Limit Switch Inputs	> Left and right limit switch inputs per axis > Interfaces: Configured by ordering option: 5 or 24V, Sink (NPN) or Source (PNP), single ended, opto-isolated > Behavioral : No current ->limit off > Input current: 4-14mA > Designation: #_RL, #_LL (for axis 0 and 1 only)

Feature	Specifications
Registration MARK Inputs	> Four, 24V±20%, opto-isolated, two terminals (High Speed Position Capture) > Input current 4-14mA > Maximum encoder frequency: 2MHz > Position latch: Rising or falling edge (SW programmable) > Max Capture Frequency: 500 Hz > Can be used as general purpose inputs > Designation: MARK0±, MARK1±, MARK2±, MARK3±
Digital Outputs	> Interface: Configured by ordering option: Sink (NPN) or Source (PNP). 5 & 24V, single ended, opto-isolatedReference: V_RTN_IO > 100mA per output > output drop 2.5V at 0.1A > Protection: short current > Designation: OUT0, OUT1
Motor relays (Optional)	> One per motor, 24V ±20% > Source, 0.5A Max > Reference: BRK_RTN > These output signals are used for external relays control (in addition to the internal ones).
PEG (Position Event Generator)	> (Position Event Generator): Two Pulse or State > Differential, RS422 > Pulse width: 26nSec to 1.75mSec > Maximum rate: 10MHz > Can be used as general purpose output > Allocation: By default, the PEG output pins are mapped to ACSPL+ variables. Other optional selections are SW programmable (see the *PEG and MARK Operations & Application Notes*). > Designation: PEG0±, PEG1±  PEG does not operate with absolute encoders.
Analog Inputs	> Four, ±10V, differential, 12 bit resolution > Max. input frequency: 1KHz > Offset: < 30mV > SNR: >665db (using SW algorithm) > Designation: AIN_#± (# = analog output number 0-3)

Feature	Specifications
Analog Outputs	> Four, ±10V, differential, two terminal, 16 bit resolution > Offset: ±50mV, Bandwidth: 5KHz > Max. output load: 10kΩ > Noise & Ripple: <40mV > Designation: AOUT_#± (# = analog output number 0-3)
EtherCAT Communication	> Two EtherCAT ports: In and Out > Interface: EtherCAT protocol > Speed: 100Mbps > Designation: Transmit: ETH#_TX±, Receive: ETH#_ RX±
Environment	> Operating range: 0 to + 40°C > Storage and transportation range: -25 to +60°C > Humidity (operating range): 5% to 90% non-condensing
Accessories	> NPXpm-ACC1: Mating connectors kit > UDMmc&NPXpm-ACC2: NPM (J1) mating 2m flying lead cable > STO-ACC1: STO cable > STO-ACC2: STO connector kit > Ethernet cables

Table 5-1. Drive Power Specifications

Feature	Specifications			
Per Drive	A	B	C	D
Continuous/peak current sin amplitude [A]	3.3/10	6.6/20	10/30	13.3/40
Continuous/peak current RMS per axis [A]	2.3/7	4.6/14.1	7/21.2	9.4/28.2
Maximum cont. Input current [A] @ continuous current	2.6	5.3	8	10.6

Feature	Specifications			
Maximum cont. Input current [A] @ peak current	8	15	24	32
Heat dissipation [W] (power loss in standby is 7[W])	7+0.9x (no. of drives)	7+2.1x (no. of drives)	7+3.7x (no of drives)	7+5.6x (no of drives)
Maximum cont./peak output power @ 100Vdc [W] (±5%)	260/780	520/1560	790/2340	1050/3120
Peak current time [sec]	1			
Minimum load inductance @100Vdc [mH] Can be derated linearly for lower voltages	0.05			
Type	3-phase NanoPWM bridge			
Phase Designation per axis	$_R, $_S, $_T			
Quantity	1 or 2			
Drive current loop measurement	16-bit			
Protections	> Short & over current: 60A±5% > Over temperature: 100°C (on PCB) > Over voltage:106V±1% > Under voltage: 9V±3%			
Per Module				
Control voltage input [Vdc]	24 ±10%			
Drive voltage input range [Vdc]	12 – 100 (90V maximum recommended)			

Feature	Specifications			
Maximum drive voltage [Vdc]	(Vin motor) x 88%			
Maximum cont. input current per module [A]	5.2	10.6	16	21.2

Table 5-2. Motor Relay Control

Item	Description	Remarks
Designation	#_BRK	Per axis. There are two built-in relays that internally short the motor phases upon disable or drive fault. These two outputs provide up to 0.5A and work in parallel to the internal relay.
Type	24V±20%, opto-isolated, source Reference: BRK_RTN	The supply for the Brake is internal.
Output current	0.5A per output	
Protection	Short current @4A	

Table 5-3. Motor Over Temperature Specifications

Motor Over Temperature Specifications

Item	Description	Remarks
Designation	Motor over temperature: #_OVER_T	
Quantity	Two, one per motor	
Type	> Single-ended, opto-isolated > Reference: DGND	
Threshold	> Over temperature protection is on, when the impedance	When this protection is not used, the Motor_OVER pin should be shorted to ground.

Item	Description	Remarks
	between $_ Motor_OVER pin to ground is above 10kΩ > Over temperature protection is off, when the impedance between $_ Motor_OVER pin to ground is below 1kΩ	
Default state	Over temperature off = Low impedance <1kΩ	

5.1 Dynamic Braking

Ordering the NPMpm with the motor relays option enables dynamic braking. Dynamic braking cannot be disabled in this configuration

Dynamic braking will not work if the product is not ordered with motor relays.

5.2 STO

Table 5-4. STO Specifications

Item	Description	Remarks
Designation	STO1±, STO2±	
Quantity	2 inputs. One input shuts off the upper part of the motor bridge and second input shuts off the lower part of the bridge.	Both drives shut off simultaneously. All drives are disabled within 200ms.
Interface	24V, two terminals for each input	
Input current (per input pin)	<50mA.	
Operation	No current -> drive off.	

5.3 Dimensions

- Length: 257 mm
- Depth: 154.9> mm
- Height: 50.9 mm

5.4 Weight

- 1.6kg

5.5 Compliance with Standards

5.5.1 Environment

The operational temperature range is from 0 to + 50°C. Forced air might be required above 40°C.

5.5.2 CE

- IEC 61800-3:2012(2.1nd Edition) follwing the provisions of 2014/30/EU directive
- EN61800-5-2 follwing the provisions of 2014/30/EU directive

5.5.3 Safety

- Functional safety
  - EN 60204-1 : 2006 (+A1`:2009, + AC :2010 Stop Category 0)
  - EN ISO 13849-1 : (+ AC :2009 Category 3; PL e)
  - EN 62061 : 2005 (+ AC :2010, + A1 :2013 SIL CL 3)
  - IEC61800-5-2:2016 Safe Totque Off (STO)
  - EN 61800-5-1:2007
  - IEC 61800-3 :2017
  - EN 61800-5-1 (pending)
  - IEC 61800-5-2 (pending)
- Electrical safety

5.5.4 RoHS

- Design complies with ROHS directives

5 HaTnufa St.
Yokneam Illit 2066717
Israel
Tel: (+972) (4) 654 6440 Fax: (+972) (4) 654 6443