NPMpc

Installation and Carrier Board Design Guide

September 2020

Document Revision: 3.02

ACS MOTION CONTROL

NPMpc

Release Date: September 2020

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Revision History

Date	Revision	Description
September 2020	3.02	Changed recommended max drive voltage voltage input
April 2018	1.70	Added note for drive short circuit
January 2018	1.60	Updated document template Updated input current specifications for Registration MARK inputs
October 2017	1.50	Updated for STO, UL, EMC certifications
August 2017	1.40	Updated list of supported motors. Document reformatted.
May 2016	1.30	Added note concerning STO
January 2016	1.10	Updated Title Page Image Added new *NanoPWM*™ icon
December 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 in the following table provide additional information related to this document.

Authorized users can download the latest versions of the documents from www.acsmotioncontrol.com/downloads.

Document	Description
SPiiPlus Setup Guide	Provides guidance on how to configure and adjust the SPiiPlus 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.
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.
AN STO - Safe Torque Off Function	Provides the technical details for implementing the STO function.
NPMPC / NPAPC / UDMCB Functional Safety Manual	Describes the use of the STO function in the NPMPC/NPAPC and UDMCB.

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1. Introduction

1.1 Document Scope

The NPMPC is a chip-like module mounted on a custom carrier circuit board. This document provides product installation instructions and design guidelines for the carrier board. The following are described:

- NPMPC mechanical dimensions
- Electrical interface connectivity
- Carrier board design guidelines
  - Mechanical structure requirements
  - Circuits implemented on the carrier board

1.2 Product Overview

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

The NPMPC is connected via an EtherCAT networrk, it 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.

1.2.1 Package Contents

The NPMPC package contains the following items:

- NPMPC module
- STO Connector Kit P/N: STO-ACC1 (supplied only for modules ordered with STO)

1.2.2 Optional Accessories

None.

1.2.3 Order Part Number

The ordered part number (P/N) contains several characters, each which specify a configuration characteristic ordered for the NPMPC module, as shown on the following label and described in the following table.

Figure 1-1. NPMPC Label with Ordered P/N - Example

Table 1-1. NPMPC 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
Limit switch inputs	7	C	A - 5V, Source/PNP B - 5V, Sink/NPN C - 24V, Source/PNP D - 24V, Sink/NPN
Digital Inputs	8	B	A - 5V, two-terminal B - 24V, two-terminal
Digital Outputs	9	A	A - Source/PNP, 5V & 24V B - Sink/NPN, 5V & 24V
Special options	10	N	N - No
Total number of feedback channels	11	C	A - 2 (utilize 2 axes) B - 2 (utilize 1 axis)* C - 4 (utilize 4 axes) D - 4 (utilize 2 axes)*

*Available after Ver. 2.30 release.

As an example, P/N NPMpc2A04N0CBANC would represent the configuration described in the following table.

Table 1-2. NPMPC P/N Example

Field		1	2	3	4	5	6	7	8	9	10	11
P/N	NPMpc	2	A	0	4	N	0	C	B	A	N	C

The NPMPC is shipped with the configuration ordered. Modifications can be done by ACS only.

2. Mechanical Description

The NPMPC is a chip-like module which is mounted on a carrier printed circuit board. The carrier printed circuit board is customer provided. The overall dimensions of the NPMPC and the location of the mounting holes are shown in the following figure. For details on mounting the NPMPC onto a carrier board see Mechanical considerations.

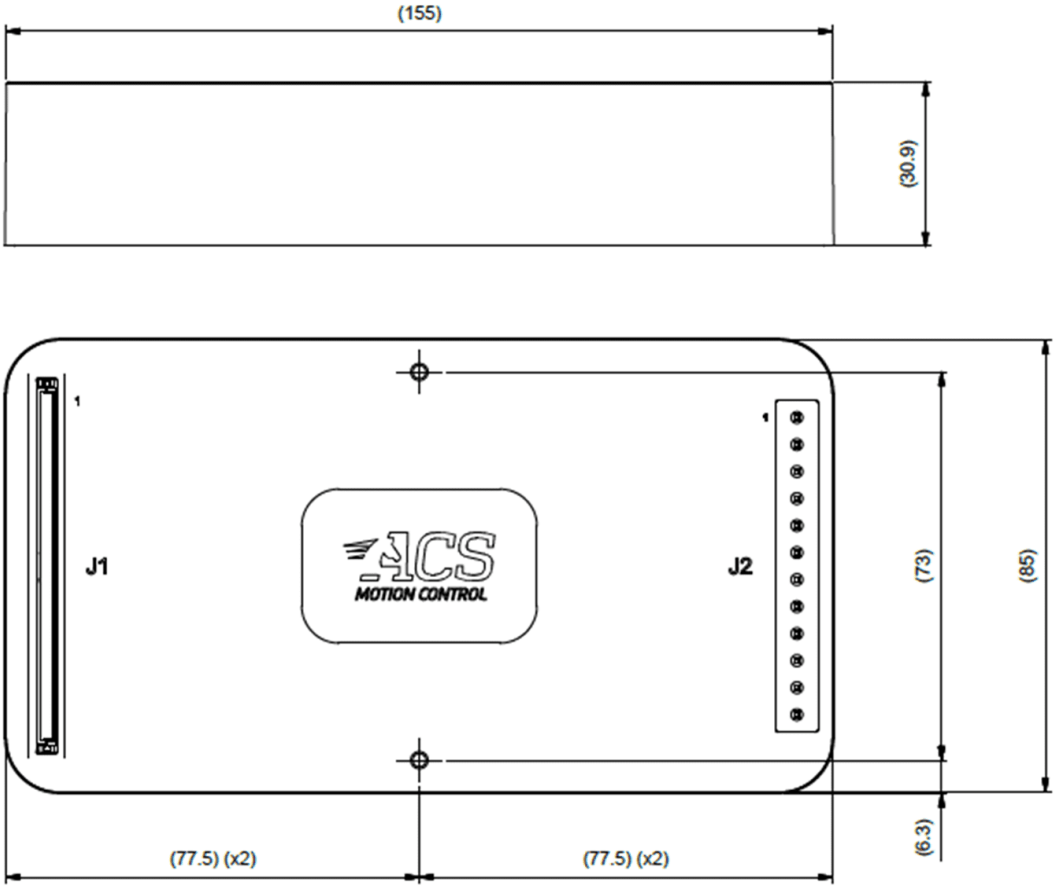

Figure 2-1. NPMPC Dimensions

3. Electrical Interface Description

This section describes how to interface with the NPMPC.

3.1 Connections

The following figure is a standard representation of connections and grounding. Specific settings and configurations are described in the following subsections. The connector assignments are in the following table.

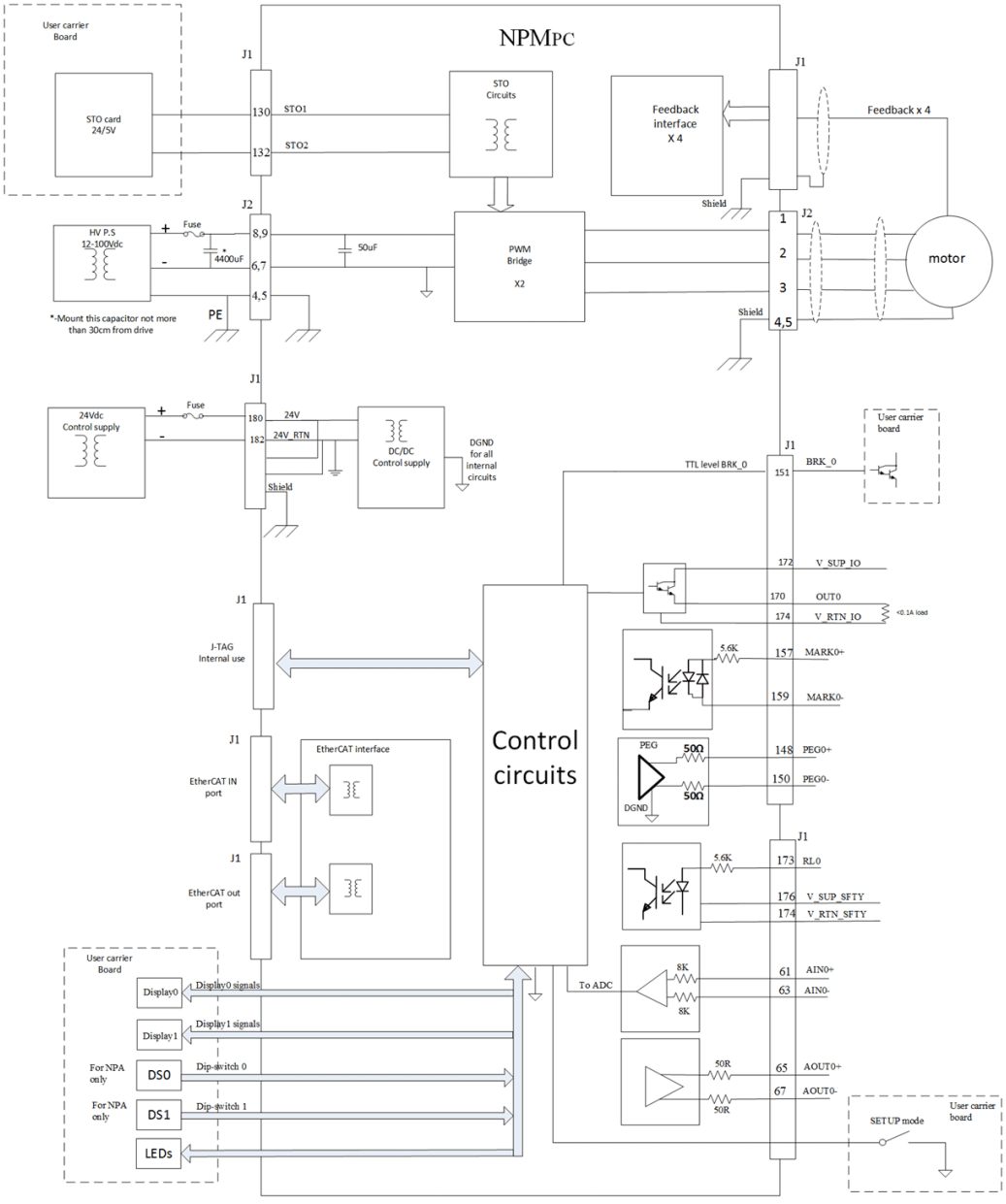

Figure 3-1. Connections and Grounding

Table 3-1. NPMPC Connections

Connector Assignment	Connector Name	Description
J1	Low power signals	Control power supply, encoders, I/Os, and all other low power signals
J2	High power signals	Drive power supply, motors

3.1.1 Position Feedback

The position feedback sensors supported by the NPMPC are the following:

- Incremental digital encoders
- Incremental analog Sin-Cos encoders
- Absolute digital encoders

Specific settings and configurations are described in the subsections below.

3.1.1.1 Incremental Digital encoder

The following incremental digital encoder types are supported:

- A,B,I
- A,B,I with Hall channels or commutation track
- Clk/Dir
- Clk/Dir with Hall channels or commutation track

The single-axis module supports up to two incremental digital encoders. The dual-axis module supports up to four incremental digital encoders.

The incremental digital encoders and the absolute encoders have identical pin assignments. The pin assignments for digital encoder input signals may also be assigned to analog SIN-COS encoder squared output signals, see J1 - Low Power Signals Connector for details.

The incremental digital encoder interface for A,B,I inputs and Hall signals is shown in Figure 3-2 and the interface for Clk/Dir inputs and Hall signals is show in Figure 3-3.

The internal NPMPC supply for digital encoders is limited to 0.5A. An encoders current consumption may exceed this value. A 5V power supply on the carrier board to supply the encoders is recommended.

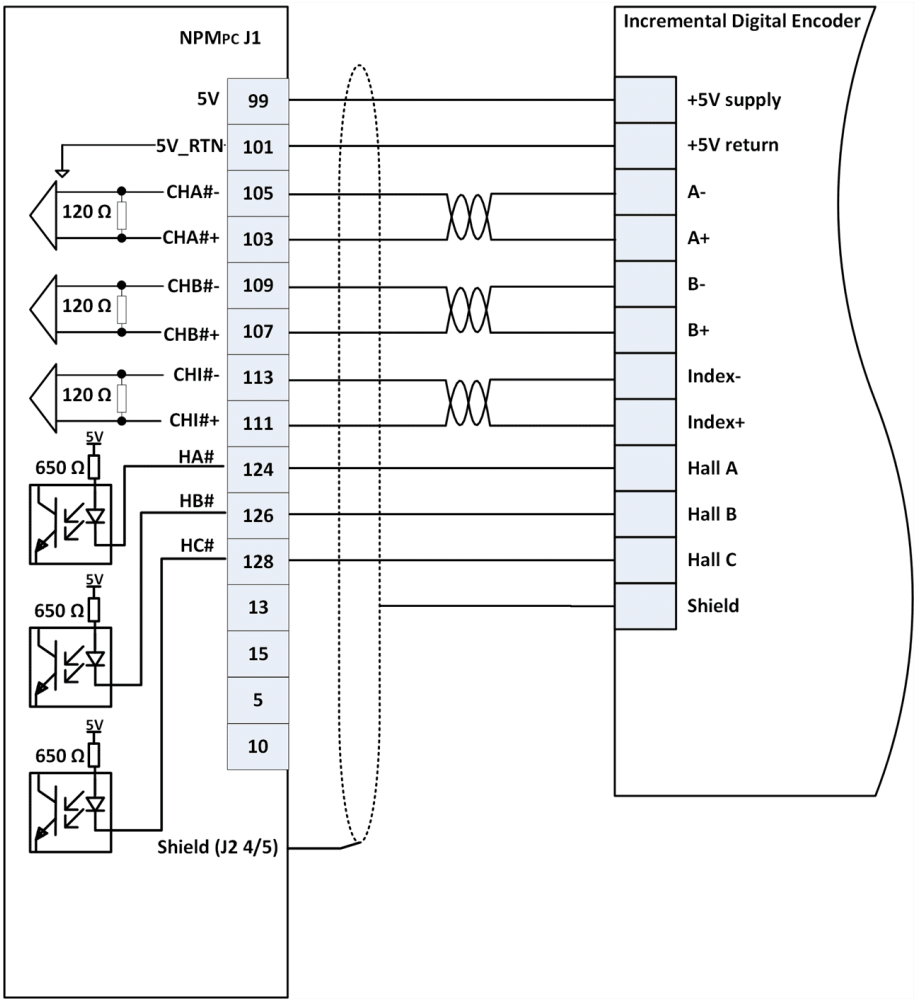

Figure 3-2. Incremental Digital Encoder - AqB Connection

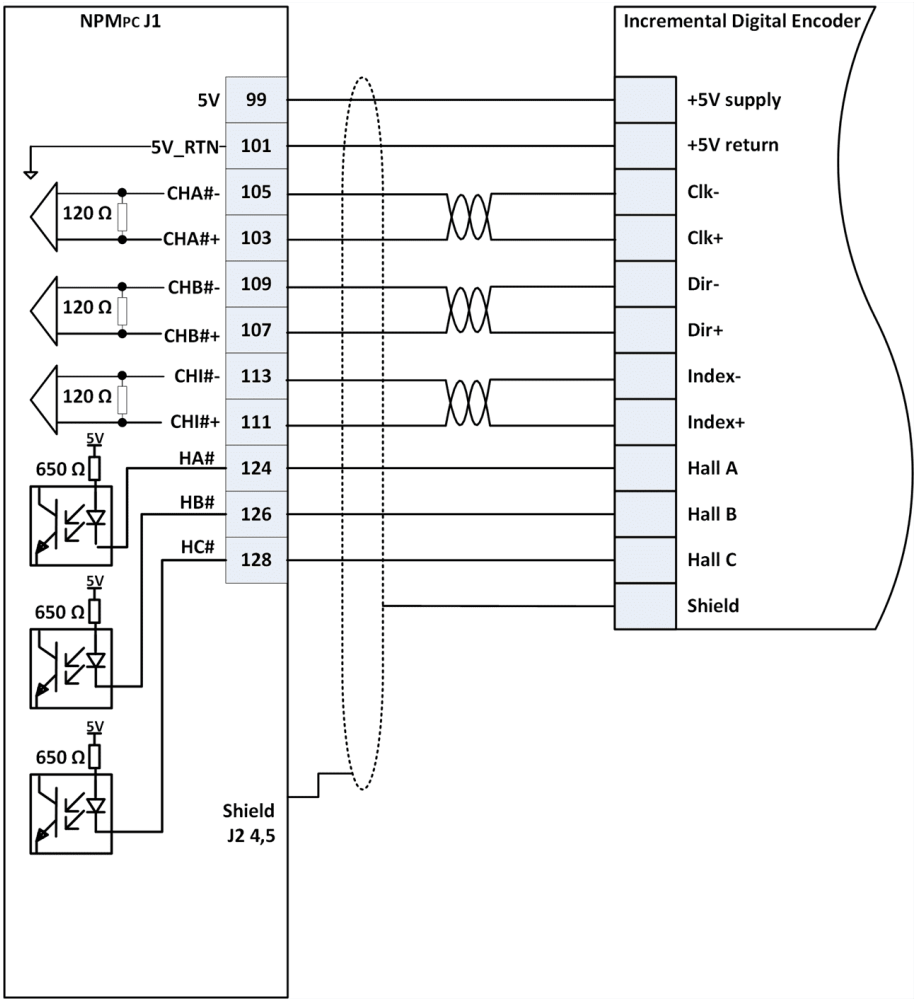

Figure 3-3. Incremental Digital Encoder - Clk/Dir Connection

3.1.1.2 Incremental Analog Sin-Cos Encoder

The single-axis module supports up to two analog Sin-Cos encoders. The dual-axis module supports up to four analog Sin-Cos encoders.

For encoder 0 and encoder 1 the squared signals of the analog Sin and Cos inputs are available as outputs. These outputs have pin assignments also assigned to digital encoder input signals, see J1 - Low Power Signals Connector for details.

The incremental analog Sin-cos encoder interface is shown in the following figure.

The internal NPMPC supply for analog Sin-Cos encoders is limited to 0.5A. An encoders current consumption may exceed this value. A 5V power supply on the carrier board to supply the encoders is recommended.

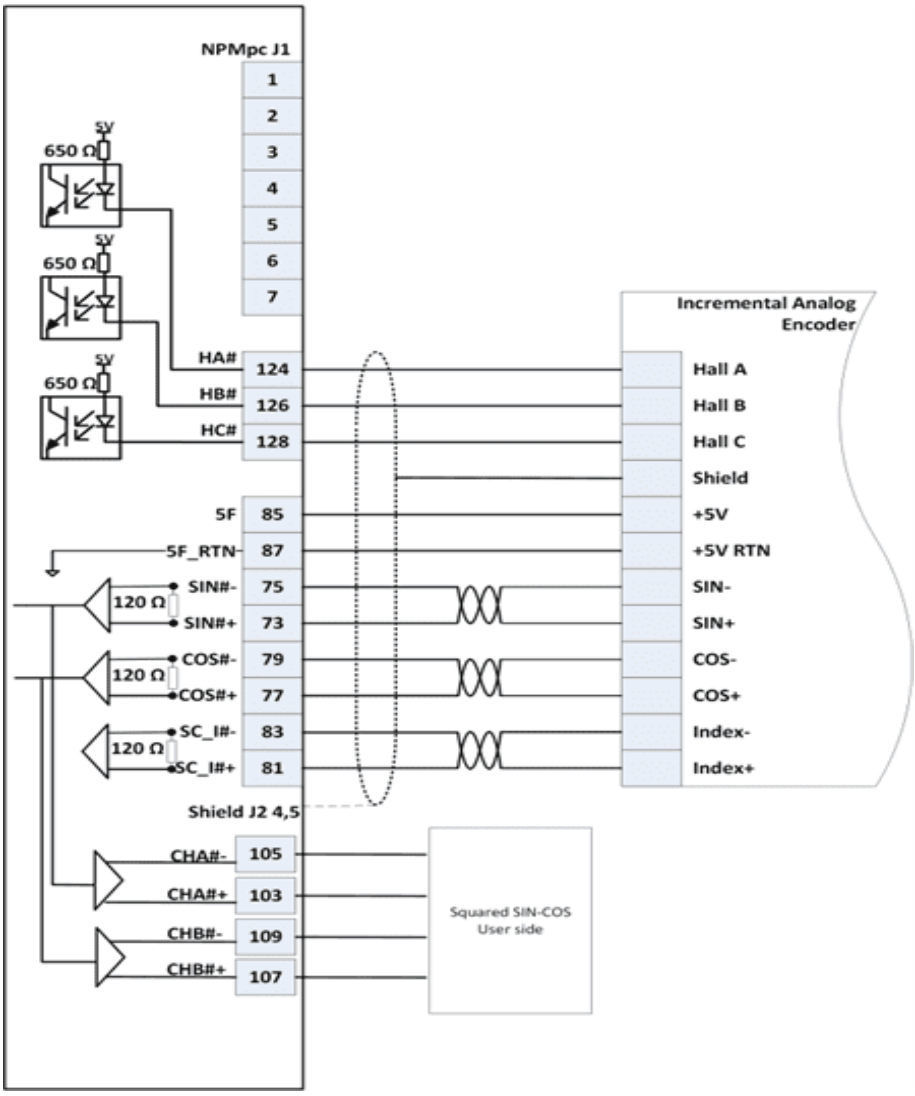

Figure 3-4. Incremental Analog SIN-COS Encoder

3.1.1.3 Absolute digital encoder

The single-axis module supports up to two absolute digital encoders. The dual-axis module also supports up to two absolute digital encoders.

Absolute encoders use a data/clock interface or a data intferace only.

The following encoders which use a data/clock interface are supported:

- EnDat 2.1 (digital) / 2.2
- BiSS - A/B/C
- SSI

The following encoders which use a data interface only are supported:

- Smart Abs
- Panasonic

> Sanyo ABS

The absolute digital encoders and the incremental digital encoders have identical pin assignments. The pin assignments for digital encoder input signals may also be assigned to analog Sin-Cos encoder squared output signals see J1 - Low Power Signals Connector for details.

The internal NPMPC supply for analog Sin-Cos encoders is limited to 0.5A. An encoders current consumption may exceed this value. A 5V power supply on the carrier board to supply the encoders is recommended.

The interface for a clock/data connection is shown in Figure 3-5 and the interface for a data only connection in Figure 3-6.

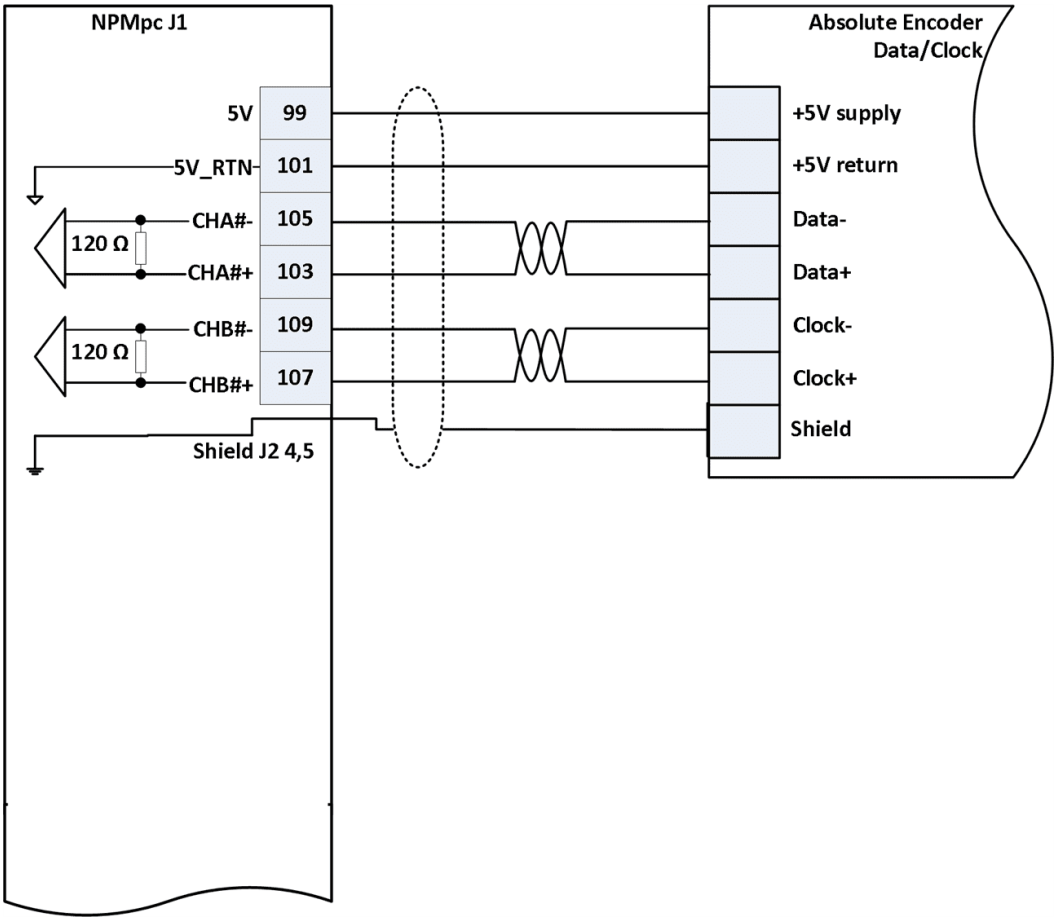

Figure 3-5. Absolute Encoder - Clk-Data Connection

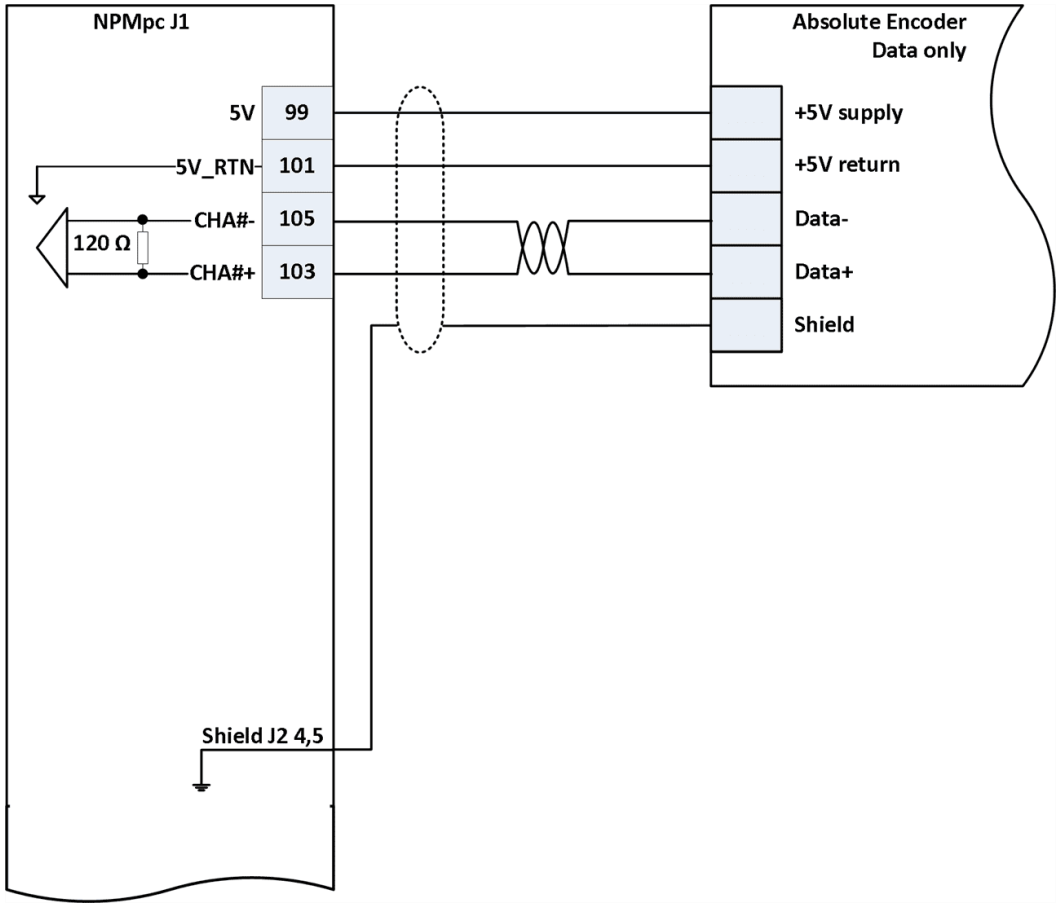

Figure 3-6. Absolute Encoder - Data Only Connection

3.1.1.4 Commutation feedback

Both digital Hall sensors or commutation tracks that are part of an incremental digital encoder are supported. Both utilize the same interface, see Incremental Digital encoder for pin assignments.

3.1.1.5 Limit Switch Inputs

The NPMpc provides two limit switch inputs per axis. One left and one right. The factory default configuration is for a 24V source connection. A 5V sink connection is available as an option, see Limit Switch Inputs for detailed specifications.

Unused safety inputs can be used as a general purpose inputs. Figure 3-7 shows a 24V source connection and Figure 3-8 shows a 24V sink connection.

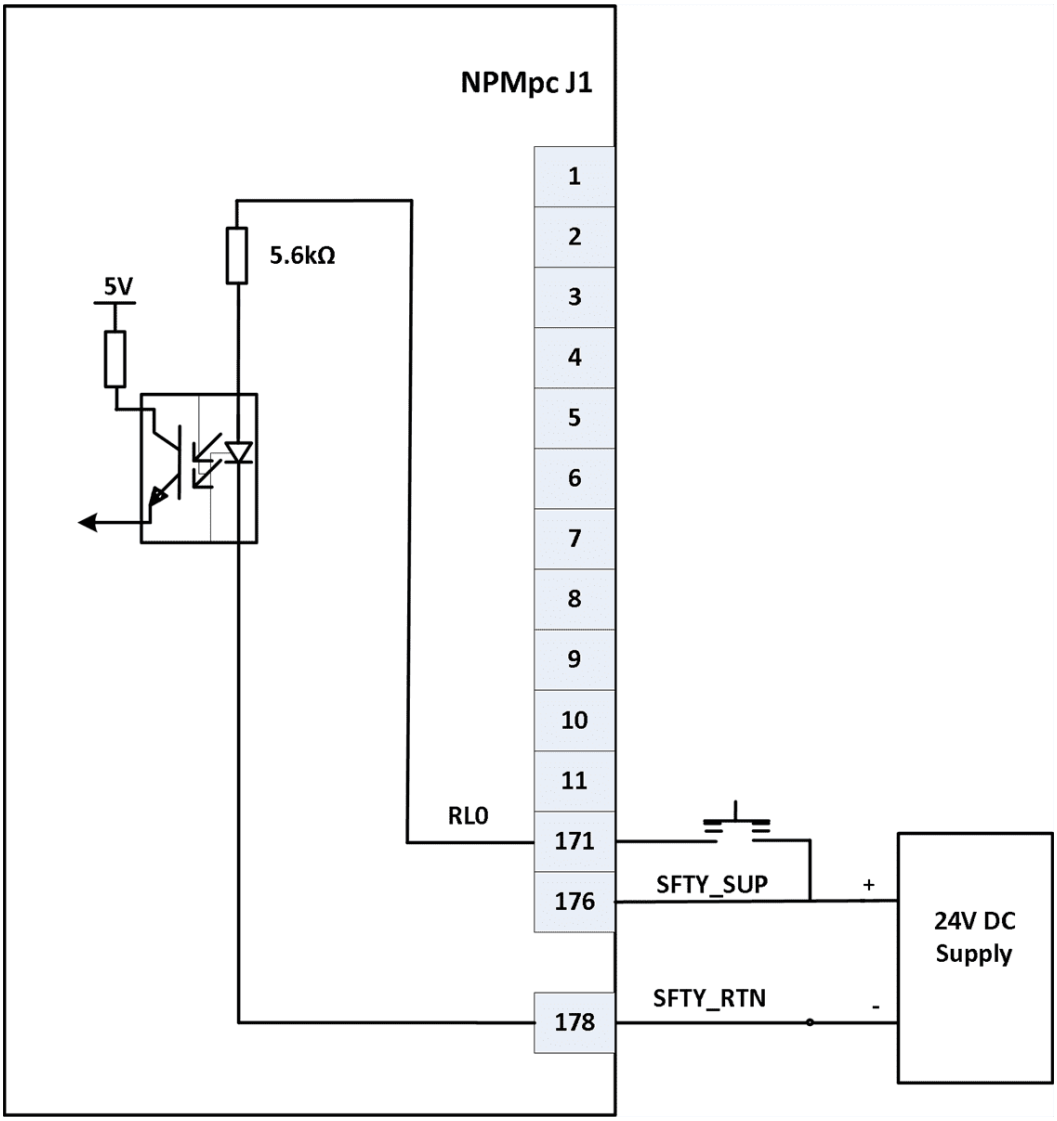

Figure 3-7. Limit Source Connection

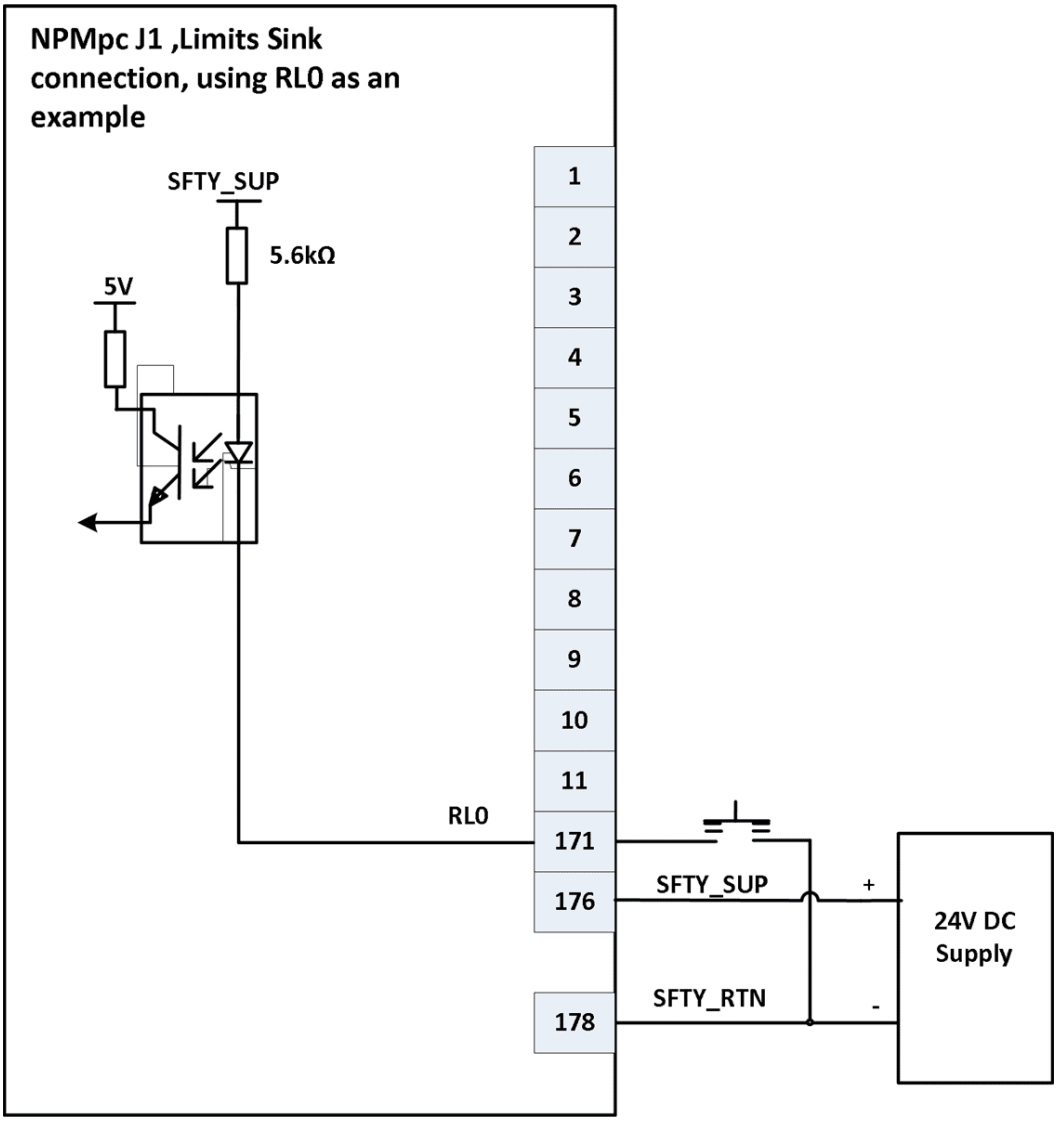

Figure 3-8. Limit Sink Connection

3.1.1.6 Analog I/O Connections

Four analog inputs and four analog outputs are provided, see Analog Inputs for detailed specifications. The following figure shows the analog I/O connection.

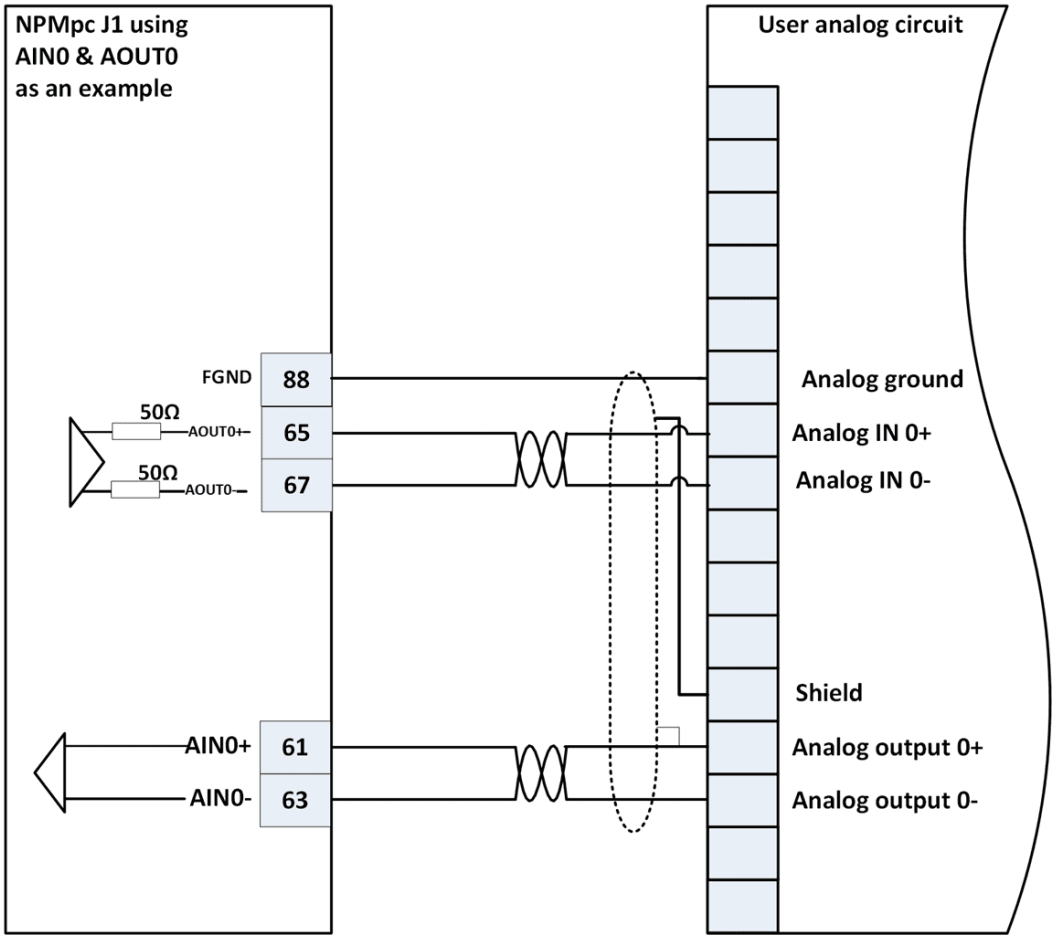

Figure 3-9. Analog I/O Connections

3.1.1.7 Digital Inputs

There are four digital MARK inputs. The factory default configuration is for a 24V source connection. A 5V option is also available, see Registration MARK Inputs for detailed specifications. Unused digital inputs can be used for general purpose inputs. The following figure shows the digital input connection.

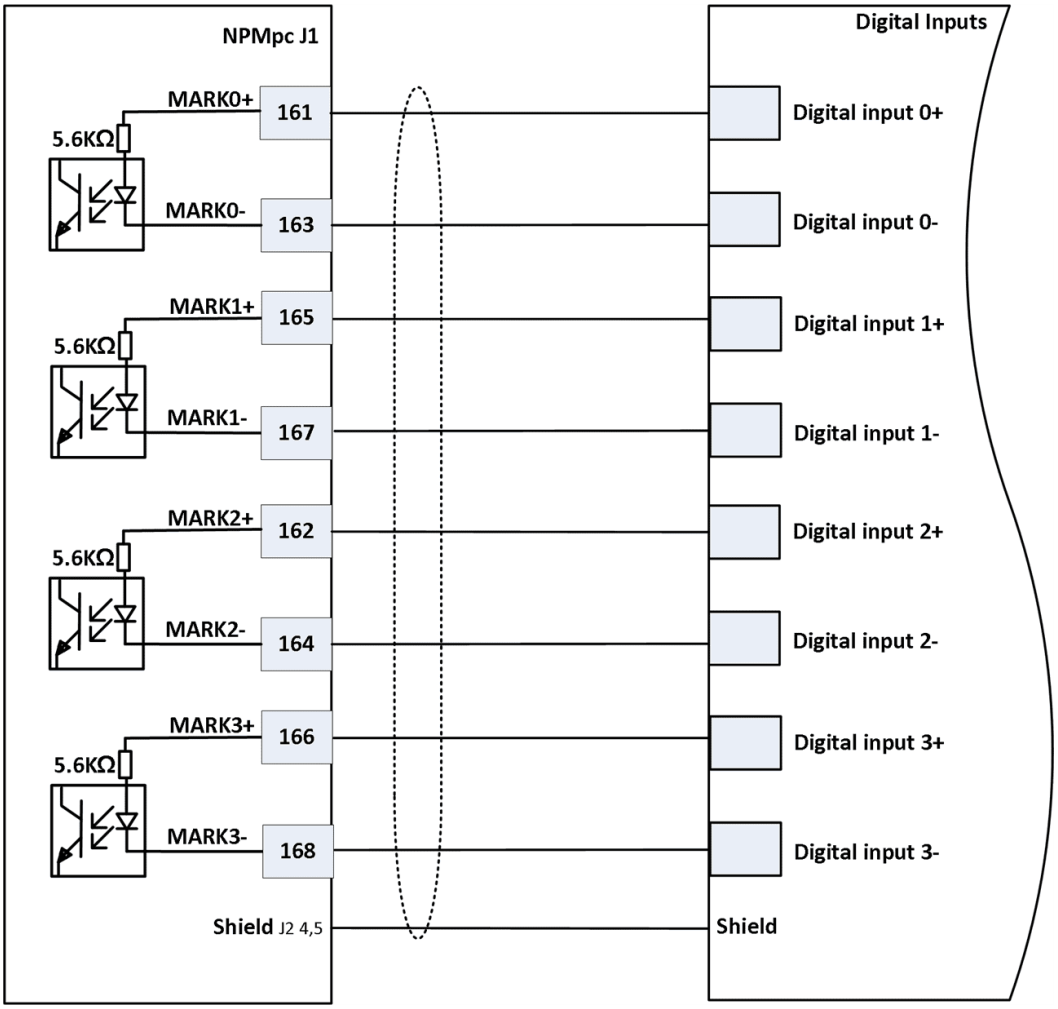

Figure 3-10. Digital Input Connections

3.1.1.8 Digital Outputs

There are two digital outputs available for motor brakes. Unused digital outputs can be used as general purpose outputs. The factory default configuration is for a 24V source connection. A 5V sink connection is available as an option, see Digital Outputs for detailed specifications. Figure 3-11 shows a 24V source connection and Figure 3-12 shows a 24V sink connection.

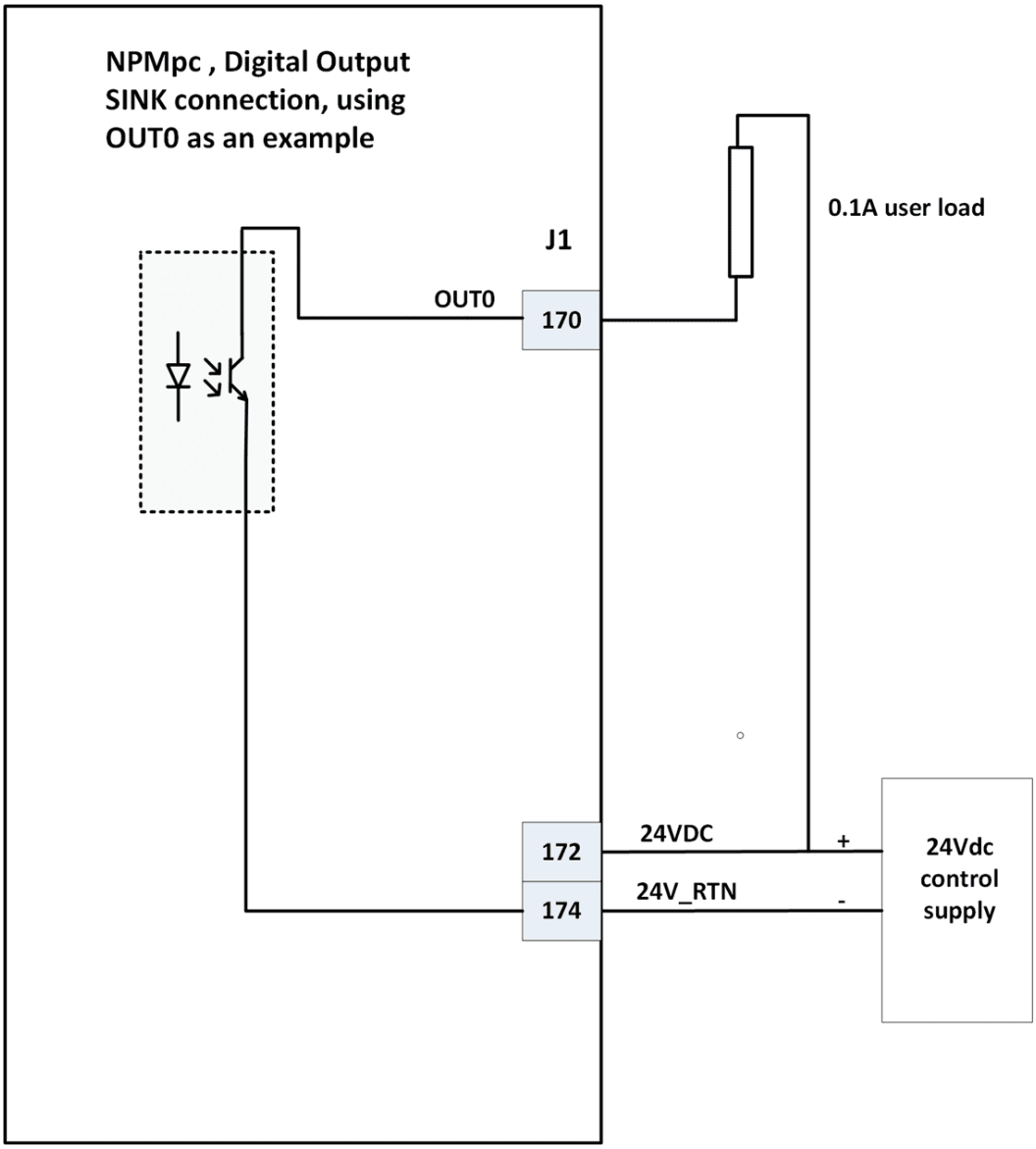

Figure 3-11. Digital Output 24V Source Connecton

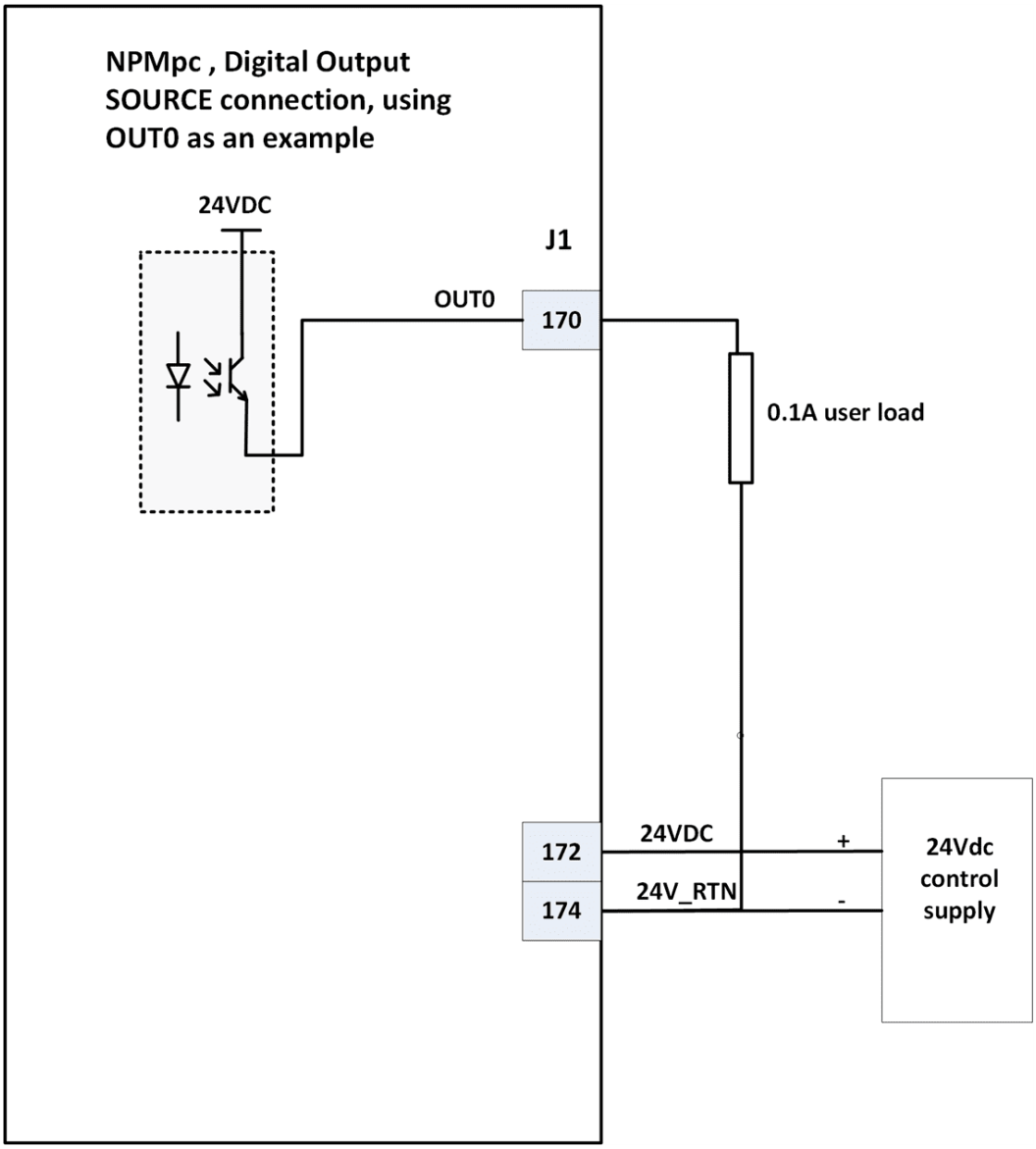

Figure 3-12. Digital Output 24V Sink Connection

3.1.1.9 Position Event Generator (PEG) Output

The NPMpc supports PEG output signals. Two PEG pulses or two PEG STATE signals are available. Unused PEG outputs can be used as general purpose outputs, see PEG (Position Event Generator) for detailed specifications. See *PEG and MARK Operations Application Note* for programming information. The following figure shows the digital PEG output connection.

The PEG operates either with an incremental digital encoder or with an analog encoder at an encoder zero crossing.

PEG does not work with absolute encoders.

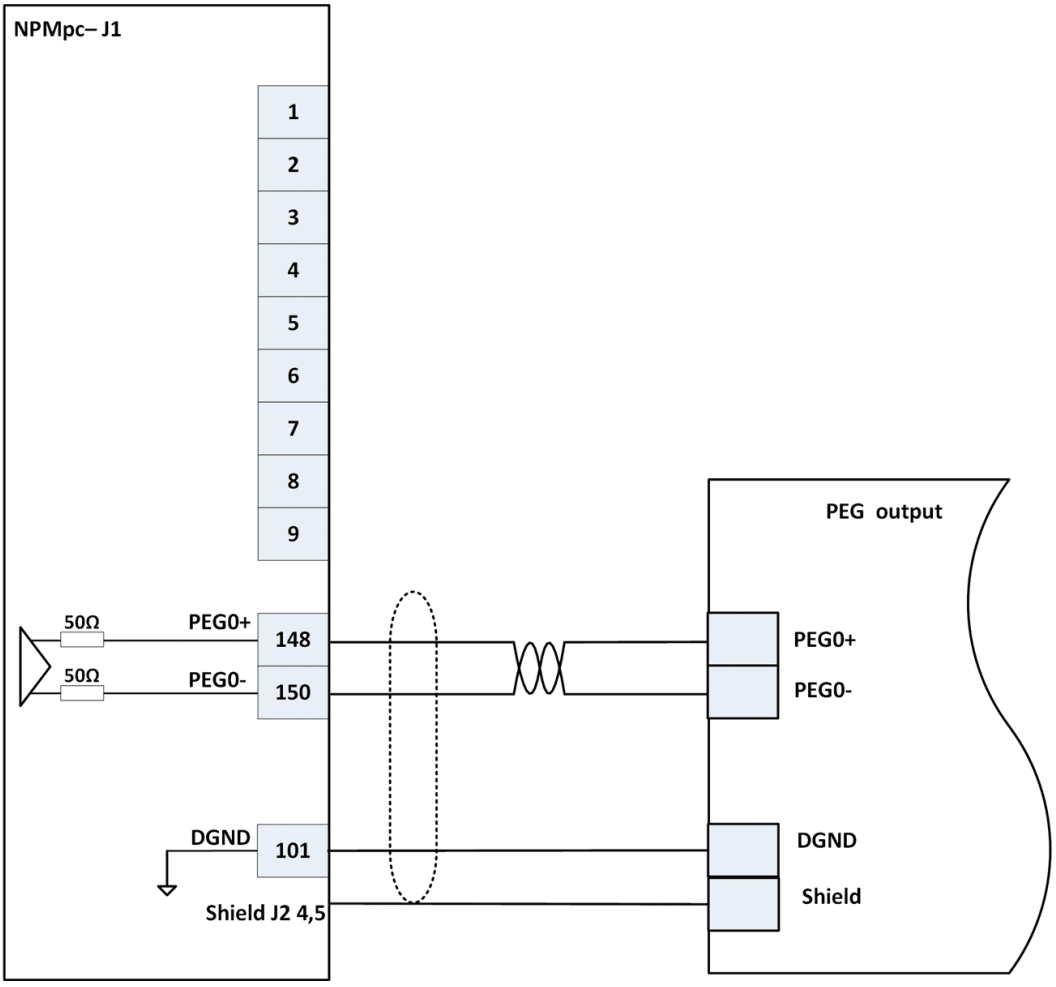

Figure 3-13. PEG Output Connection

3.1.2 Motors

The NPMpc supports the following motors:

- Two- and three-phase permanent magnet (DC brushless/AC servo)
- DC brush
- Voice coil
- Two- and three-phase stepper (micro-stepping open or closed loop)

For motor connections with relays see Motor connection with relays.

Figure 3-14 shows the connectivity diagram for a one-phase motor. Figure 3-15 shows the connectivity diagram for a two-phase motor. Figure 3-16 shows the connectivity diagram for a three-phase motor.

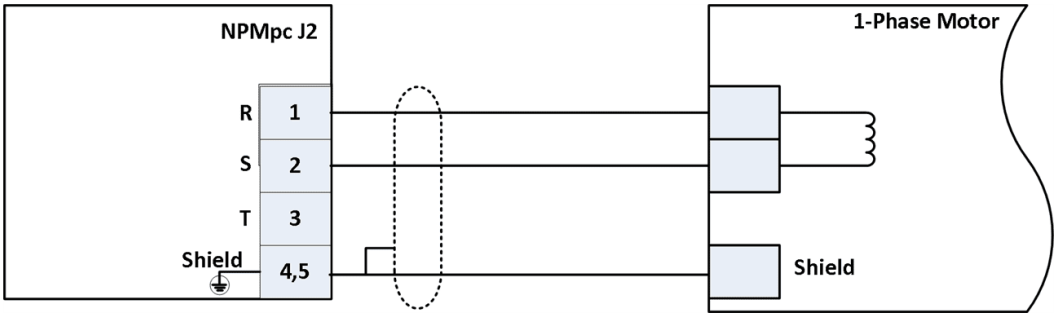

Figure 3-14. One-Phase Motor Connections

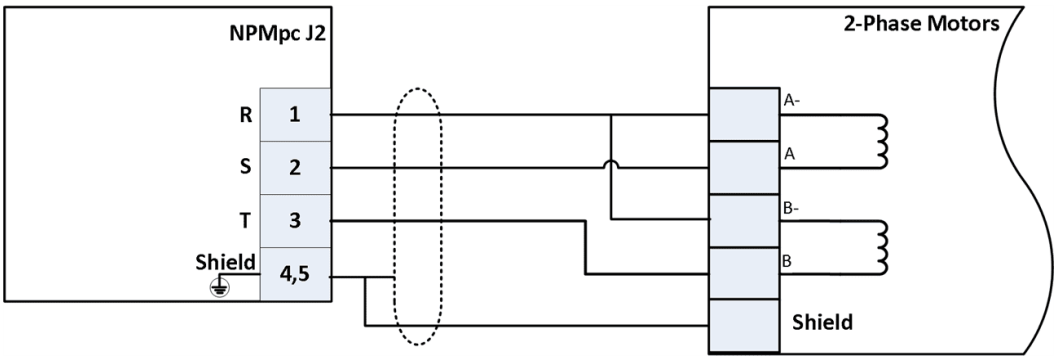

Figure 3-15. Two-Phase Motor Connections

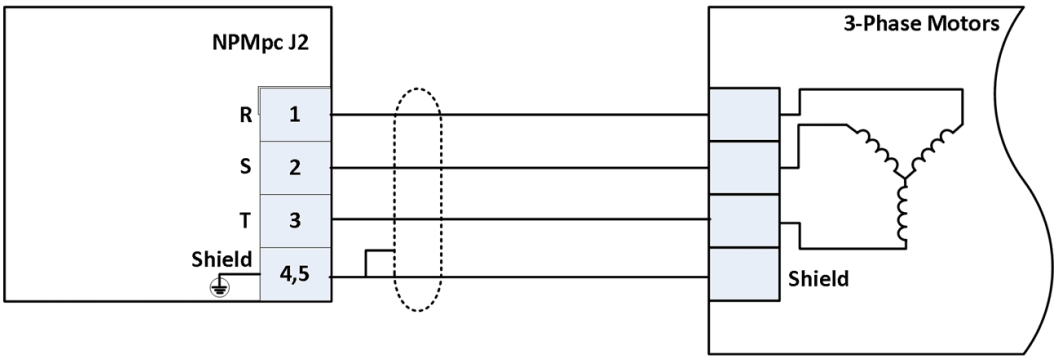

Figure 3-16. Three-Phase Motor Connections

3.1.3 Control and drive power supplies

The NPMPC is fed by two power supplies:

- 24Vdc control supply
- 12Vdc to 100Vdc drive supply

The supplies can be turned on and off in any order. During emergency situations, the drive supply can be disconnected while the control supply is to remain connected.

3.1.3.1 Control Supply Guidelines

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

- The control power supply must be isolated.

- The control power supply must be CE and UL approved.
- The control power supply must be short circuit protected.
- The control power supply must have very low noise and ripple.
- The control power supply must be connected to the unit via 3A fuse.
- An example of a suitable 24V/70W control power supply is the XP Power P/N VCS70US24 supply.
- To comply with European standards (CE), it is recommended to use an AC line filter.

For detailed specifications including current load with and without motor relays see Control Supply. The following figure shows the control supply connections.

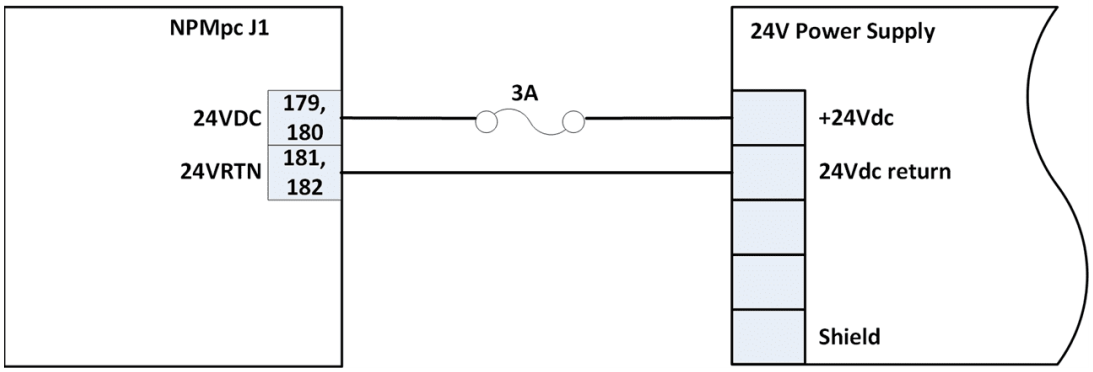

Figure 3-17. Control Supply Connections

3.1.3.2 Drive Supply Guidelines

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

- The drive power supply must be isolated.
- The drive power supply must be CE and UL approved.
- The drive power supply must be short circuit protected.
- The drive power supply must have very low noise and ripple.
- A drive power supply not exceeding 96Vdc is recommended.
- Do not use a drive power supply with voltage greater than 100V under any conditions.
- If the drive power supply cannot absorb the regeneration energy from the motor when decelerating, you must use an external regeneration circuit. Connect the regeneration circuit in parallel to the motor supply. The voltage activation level should not exceed 102V.
- The drive power supply must be able to provide the peak current required by the motor (inductance load). Adding an external capacitor of 4400uF, installed as close as possible to the drive (no further than 30cm from the drive), can help the power supply to handle the peak current and reduce the bus current ripple.
- The drive power supply must be selected based on the power consumed by drive 1 and drive 2 (if applicable).
- The drive power supply must be connected to the unit via fuse. The value of the filter depends on the power supply voltage and the current consumption.

> An example of a suitable drive power supply is from XP Power. The 48V/1500W power supply has the P/N HPU1K5PS48.

> To comply with European standards (CE), it is recommended to use an AC line filter. The value of the filter depends on the power supply voltage and the current consumption. The filter is to be as close as possible to the NPMPC.

For detailed specifications see Drive Power Specifications. The following figure shows the drive supply connection.

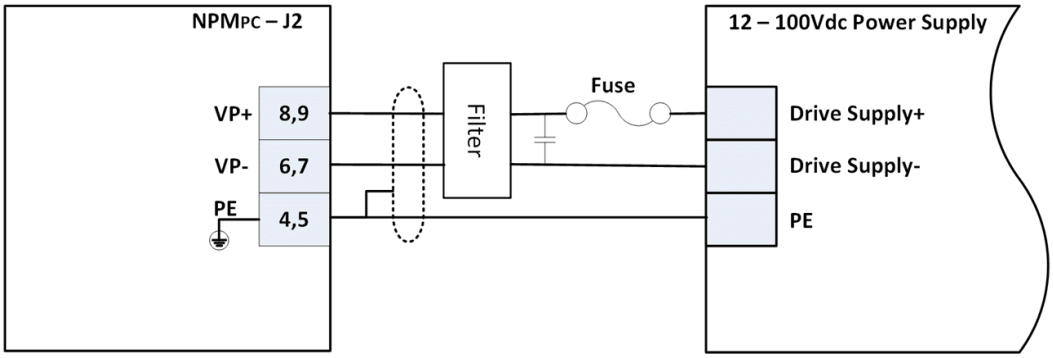

Figure 3-18. Drive Supply Connections

3.1.3.3 Regeneration

> A drive power supply with voltage not exceeding 96Vdc is recommended.

> Do not use a drive power supply with voltage greater than 100V under any conditions.

> If the drive power supply cannot absorb the regeneration energy from the motor when decelerating, you must use an external regeneration circuit. Connect the regeneration circuit in parallel to the motor supply. The voltage activation level should not exceed 102V.

3.1.4 EtherCAT Connection Instructions

The NPMPC communicates through EtherCAT lines only. It has two ports. One In and one Out. The following figure shows the EtherCAT connection.

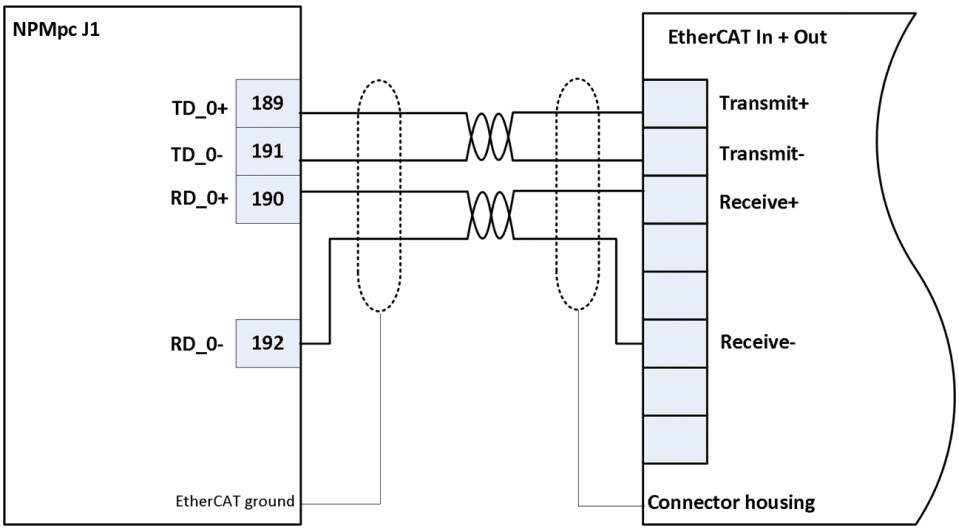

Figure 3-19. EtherCAT Connections

3.1.5 Low and High Power Signal Connectors

The following figure shows connector J1 and connector J2 for the NPMPC. Pin 1 for each connector is indicated with the red arrow.

Figure 3-20. NPMPC Connectors

3.1.5.1 J1 - Low Power Signals Connector

Label: J1

Figure 3-21 shows the connector on the NPMPC, Figure 3-22 shows the mating connector for the carrier board, and Table 3-2 lists the signal pinouts.

You must connect Pin 143 to DGND.

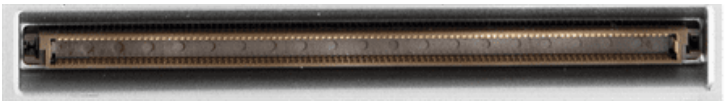

Figure 3-21. Connector: Molex P/N 536272074

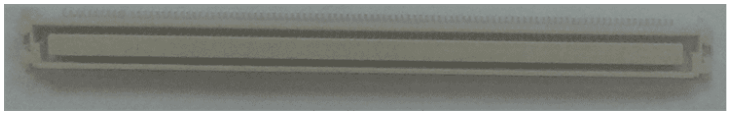

Figure 3-22. Mating connector: Molex P/N 528852074

Table 3-2. J1 - Low Level Signals Pinout

	Name	Description
1	AIN2+	Analog input 2 non-inverted signal
2	AIN3+	Analog input 3 non-inverted signal
3	AIN2-	Analog input 2 inverted signal
4	AIN3-	Analog input 3 inverted signal
5	AOUT2+	Analog output 2 non-inverted signal
6	AOUT3+	Analog output 3 non-inverted signal
7	AOUT2-	Analog output 2 inverted signal
8	AOUT3-	Analog output 3 inverted signal
9	CMD1_0+	Not used
10	CMD1_1+	Not used
11	CMD1_0-	Not used
12	CMD1_1-	Not used
13	SIN2+	Axis 2 (or secondary axis 0) Encoder SIN non-inverted input
14	SIN3+	Axis 3 (or secondary axis 1) Encoder SIN non-inverted input
15	SIN2-	Axis 2 (or secondary axis 0) Encoder SIN inverted input
16	SIN3-	Axis 3 (or secondary axis 1) Encoder SIN inverted input
17	COS2+	Axis 2 (or secondary axis 0) Encoder COS non-inverted input
18	COS3+	Axis 3 (or secondary axis 1) Encoder COS non-inverted input
19	COS2-	Axis 2 (or secondary axis 0) Encoder COS inverted input
20	COS3-	Axis 3 (or secondary axis 1) Encoder COS inverted input
21	SC_I_2+	Axis 2 analog Encoder INDEX non-inverted input
22	SC_I_3+	Axis 3 analog Encoder INDEX non-inverted input
23	SC_I_2-	Axis 2 analog Encoder INDEX inverted input

	Name	Description
24	SC_I_3-	Axis 3 analog Encoder INDEX inverted input
25	1_DSW1	Not used
26	FLT1	Not used
27	1_DSW2	Not used
28	ENA1	Not used
29	1_DSW3	Not used
30	AXIS1_ DIS_LED	Not used
31	1_DSW4	Not used
32	AXIS1_ ENA_LED	Not used
33	2_CHA+	Digital encoder 2 - A,B,I: channel A non-inverted, Clk/Dir: Clk+, Absolute encoder: Data+
34	3_CHA+	Digital encoder 3 - A,B,I: channel A non-inverted, Clk/Dir: Clk+, Absolute encoder: Data+
35	2_CHA-	Digital encoder 2 - A,B,I: channel A inverted, Clk/Dir: Clk-, Absolute encoder: Data-
36	3_CHA-	Digital encoder 3 - A,B,I: channel A inverted, Clk/Dir: Clk-, Absolute encoder: Data-
37	2_CHB+	Digital encoder 2 - A,B,I: channel B non-inverted, Clk/Dir: Clk+, Absolute encoder: Data+
38	3_CHB+	Digital encoder 3 - A,B,I: channel B non-inverted, Clk/Dir: Clk+, Absolute encoder: Data+
39	2_CHB-	Digital encoder 2 - A,B,I: channel B inverted, Clk/Dir: Clk-, Absolute encoder: Data-
40	3_CHB-	Digital encoder 3 - A,B,I: channel B inverted, Clk/Dir: Clk-, Absolute encoder: Data-
41	2_CHI+	Digital encoder 2 - A,B,I: channel Index non-inverted

	Name	Description
42	3_CHI+	Digital encoder 3 - A,B,I: channel Index non-inverted
43	2_CHI-	Digital encoder 2 - A,B,I: channel Index inverted
44	3_CHI-	Digital encoder 2 - A,B,I: channel Index inverted
45	PEG1+	PEG output 1 non-inverted (SW programmable, default assignment encoder 1, see *PEG and MARK Operations Applicsation Note*)
46	DR_IN1_0	Not used
47	PEG1-	PEG output 1 inverted assigned (SW programmable, default assignment encoder 1, see*PEG and MARK Operations Application Note*)
48	DRV_1_ON	Not used
49	1_HA	Motor 1 Hall A
50	1_HC	Motor 1 Hall C
51	1_HB	Motor 1 Hall B
52	1_OVER_T	Motor 1 over temperature input
53	7-SEG_1_A	7 segment 1 , A segment output
54	7-SEG_1_E	7 segment 1 , E segment output
55	7-SEG_1_B	7 segment 1 , B segment output
56	7-SEG_1_F	7 segment 1 , F segment output
57	7-SEG_1_C	7 segment 1 , C segment output
58	7-SEG_1_G	7 segment 1 , G segment output
59	7-SEG_1_D	7 segment 1 , D segment output
60	7-SEG_1_DO	7 segment 1 , DO segment output
61	AIN0+	Analog input 0 non-inverted
62	AIN1+	Analog input 1 non-inverted

	Name	Description
63	AIN0-	Analog input 0 inverted
64	AIN1-	Analog input 1 inverted
65	AOUT0+	Analog output 0 non-inverted
66	AOUT1+	Analog output 1 non-inverted
67	AOUT0-	Analog output 0 inverted
68	AOUT1-	Analog output 1 inverted
69	CMD0_0+	Not used
70	CMD0_1+	Not used
71	CMD0_0-	Not used
72	CMD0_1-	Not used
73	SIN0+	Sin-Cos encoder 0 - Sin non-inverted input
74	SIN1+	Sin-Cos encoder 1 - Sin non-inverted input
75	SIN0-	Sin-Cos encoder 0 - Sin inverted input
76	SIN1-	Sin-Cos encoder 1 - Sin inverted input
77	COS0+	Sin-Cos encoder 0 - Cos non-inverted input
78	COS1+	Sin-Cos encoder 1 - Cos non-inverted input
79	COS0-	Sin-Cos encoder 0 - Cos inverted input
80	COS1-	Sin-Cos encoder 1 - Cos inverted input
81	SC_I_0+	Sin-Cos encoder 0 - Index non-inverted input
82	SC_I_1+	Sin-Cos encoder 1 - Index non-inverted input
83	SC_I_0-	Sin-Cos encoder 0 - Index inverted input
84	SC_I_1-	sin-Cos encoder 1 - Index inverted input
85	5F	5.1V analog encoder supply output
86	5F	5.1V analog encoder supply output

	Name	Description
87	AGND	Analog ground for SIN-COS
88	FGND	Analog ground for AIN and AOUT signals
89	AGND	Analog ground for SIN-COS
90	AGND	Analog ground for SIN-COS
91	0_DSW1	Not used
92	FLT0	Not used
93	0_DSW2	Not used
94	DRV_0_ ON	Not used
95	0_DSW3	Not used
96	DR_IN0_0	Not used
97	0_DSW4	Not used
98	ENA0	Not used
99	5U	5.1V digital encoder supply output
100	5U	5.1V digital encoder supply output
101	DGND	Digital ground
102	DGND	Digital ground
103	0_CHA+	Digital encoder 0 - A,B,I: channel A non-inverted input, Clk/Dir:Clk+, Absolute encoder: Data+ Squared Sin non-inverted output
104	1_CHA+	Digital encoder 1 - A,B,I: channel A non-inverted input, Clk/Dir:Clk+, Absolute encoder: Data+ Squared Sin non-inverted output
105	0_CHA-	Digital encoder 0 - A,B,I: channel A inverted input, Clk/Dir:Clk-, Absolute encoder: Data- Squared Sin inverted output

	Name	Description
106	1_CHA-	Digital encoder 1 - A,B,I: channel A inverted input, Clk/Dir:Clk-, Absolute encoder: Data- Squared Sin inverted output
107	0_CHB+	Digital encoder 0 - A,B,I: channel B non-inverted input, Clk/Dir:Clk+, Absolute encoder: Data+ Squared Cos non-inverted output
108	1_CHB+	Digital encoder 1 - A,B,I: channel B non-inverted input, Clk/Dir:Clk+, Absolute encoder: Data+ Squared Cos non-inverted output
109	0_CHB-	Digital encoder 0 - A,B,I: channel B inverted input, Clk/Dir:Clk-, Absolute encoder: Data- Squared Cos inverted output
110	1_CHB-	Digital encoder 1 - A,B,I: channel B inverted input, Clk/Dir:Clk-, Absolute encoder: Data- Squared Cos inverted output
111	0_CHI+	Digital encoder 0 - A,B,I: channel Index non-inverted input
112	1_CHI+	Digital encoder 1 - A,B,I: channel Index non-inverted input
113	0_CHI-	Digital encoder 0 - A,B,I: channel Index inverted input
114	1_CHI-	Digital encoder 1 - A,B,I: channel Index inverted input
115	TCK	Servo processor JTAG TCK signal (for ACS use only)
116	VCC3	3.3V auxiliary voltage (for ACS use only)
117	EMU0	Servo processor JTAG EMU0 signal (for ACS use only)
118	TMS	Servo processor JTAG TMS signal (for ACS use only)
119	EMU1	Servo processor JTAG EMU1 signal (for ACS use only)
120	TDI	Servo processor JTAG TDI signal (for ACS use only)
121	TRST	Servo processor JTAG TRST signal (for ACS use only)
122	TDO	Servo processor JTAG TDO signal (for ACS use only)

	Name	Description
123	MPU_LED_ENA	Communication LED green
124	0_HA	Motor 0 Hall A
125	MPU_LED_DIS	Communication LED red
126	0_HB	Motor 0 Hall B
127	AXIS_0_DIS_LED	Not used
128	0_HC	Motor 0 Hall C
129	AXIS_0_ENA_LED	Not used
130	5V_STO_1	5V supply from STO card, input 1
131	STO1	STO1 input status (from STO card)
132	5V_STO_2	5V supply from STO card, input 2
133	STO2	STO2 input status (from STO card)
134	7-SEG_0_E	7 segment 0 , E segment output
135	7-SEG_0_A	7 segment 0 , A segment output
136	7-SEG_0_F	7 segment 0 , F segment output
137	7-SEG_0_B	7 segment 0 , B segment output
138	7-SEG_0_G	7 segment 0 , G segment output
139	7-SEG_0_C	7 segment 0 , C segment output
140	7-SEG_0_DO	7 segment 0 , DO segment output
141	7-SEG_0_D	7 segment 0 , D segment output

	Name	Description
142	RJ45_IN_D2P	Run LED for RJ45 input port anode (yellow LED)
143	SA_MODE	Setup mode input, connect to DGND
144	RJ45_IN_D2N	Run LED for RJ45 input port cathode (yellow LED)
145	RJ45_OUT_D2P	Control supply LED for RJ45 output port anode (yellow LED)
146	RJ45_IN_D1N	Link LED for RJ45 input port cathode (yellow LED) Note: the anode of this LED must be connected to 3.3V
147	RJ45_OUT_D2N	Control supply LED for RJ45 output port cathode (yellow LED)
148	PEG0+	PEG0 output non-inverted (SW programmable, default assignment encoder 0, see *PEG and MARK Operations Application Note*)
149	RJ45_OUT_D1N	Link LED for RJ45 output port cathode (yellow LED) Note: the anode of this LED must be connected to 3.3V
150	PEG0-	PEG0 output inverted (SW programmable, default assignment encoder 0, see *PEG and MARK Operations Application Note*)
151	BRK0	Control for dynamic brake relay of axis 0
152	0_OVER_T	Motor 0 over temperature input
153	BRK1	Control for dynamic brake relay of axis 1
154	NC	Not connected
155	NC	Not connected
156	NC	Not connected
157	NC	Not connected
158	NC	Not connected

	Name	Description
159	NC	Not connected
160	NC	Not connected
161	MARK0+	Axis 0, Mark input 0 non-inverted
162	MARK2+	Axis 1, Mark input 2 non-inverted
163	MARK0-	Axis 0, Mark input 0 inverted
164	MARK2-	Axis 1, Mark input 2 inverted
165	MARK1+	Axis 0, Mark input 1 non-inverted
166	MARK3+	Aixs 1, Mark input 3 non-inverted
167	MARK1-	Axis 0, Mark input 1 inverted
168	MARK3-	Axis 1, Mark input 3 inverted
169	OUT1	General purpose digital output 1 or mechanical brake
170	OUT0	General purpose digital output 0 or mechanical brake
171	0_RL	Axis 0 right limit input
172	V_SUP_IO	Supply for general purpose digital output
173	0_LL	Axis 0 left limit input
174	V_RTN_IO	Supply return for general purpose digital output
175	1_RL	Axis 1 right limit input
176	V_SUP_ SFTY	Supply for safety input
177	1_LL	Axis 1 left limit input
178	V_RTN_ SFTY	Supply return for safety input
179	24V	24V control supply
180	24V	24V control supply
181	24V_RTN	24V control supply return

	Name	Description
182	24V_RTN	24V control supply return
183	NC	Not connected
184	NC	Not connected
185	NC	Not connected
186	NC	Not connected
187	NC	Not connected
188	NC	Not connected
189	RJ45_IN_1	EtherCAT input RJ45 pin 1
190	RJ45_IN_3	EtherCAT input RJ45 pin 3
191	RJ45_IN_2	EtherCAT input RJ45 pin 2
192	RJ45_IN_6	EtherCAT input RJ45 pin 6
193	RJ45_IN_4	EtherCAT input RJ45 pin 4
194	RJ45_IN_7	EtherCAT input RJ45 pin 7
195	RJ45_ OUT_1	EtherCAT output RJ45 pin 1
196	RJ45_ OUT_3	EtherCAT output RJ45 pin 3
197	RJ45_ OUT_2	EtherCAT output RJ45 pin 2
198	RJ45_ OUT_6	EtherCAT output RJ45 pin 6
199	RJ45_ OUT_4	EtherCAT output RJ45 pin 4
200	RJ45_ OUT_7	EtherCAT output RJ45 pin 7

3.1.5.2 J2 - High Power Signal Connector

Label: J2

Figure 3-23 shows the connector on the NPMPC, Figure 3-24 shows the mating connector for the carrier board, and Table 3-3 lists the signal pinouts.

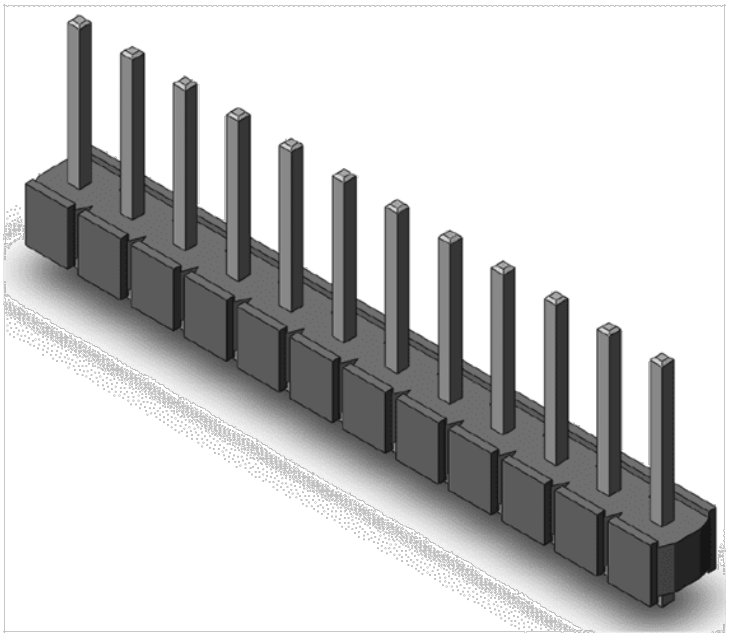

Figure 3-23. Connector: Samtec P/N HPW-12-04-T-S-200-511

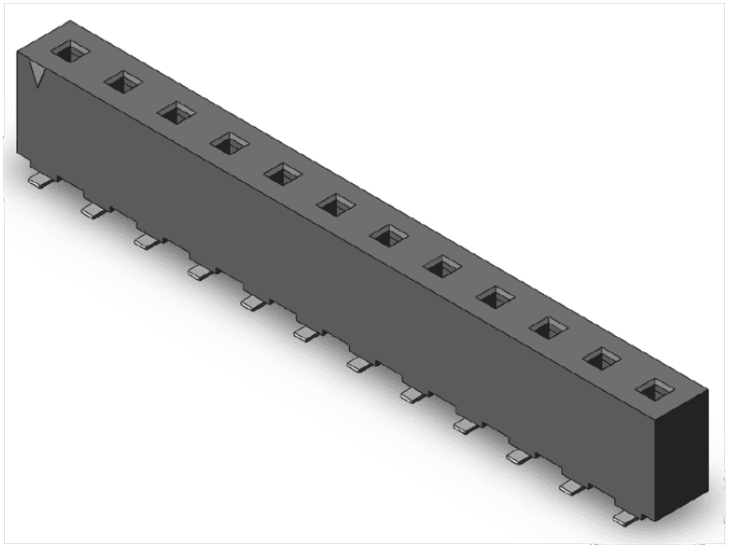

Figure 3-24. Mating connector: Samtec P/N HPF-12-02-T-S-LC

Table 3-3. J2 High Power Signals Pinout

Pin	Name	Description
1	R1	Motor 1 R phase for three-phase motor
2	S1	Motor 1 S phase for three-phase motor, single-phase motor
3	T1	Motor 1 T phase for three-phase motor, single-phase motor
4	PE	Protected earth
5	PE	Protected earth
6	VP-	Drive supply return
7	VP-	Drive supply return
8	VP+	Drive supply positive edge
9	VP+	Drive supply positive edge
10	R0	Motor 0 R phase for three-phase motor
11	S0	Motor 0 S phase for three-phase motor
12	T0	Motor 0 T phase for three-phase motor

4. Carrier Board Design

This section provides guidelines for the NPMPC carrier board design. The following guidelines are given:

- Mechanical structure requirements
- Circuits implemented on the carrier board

The NPMPM carrier board (internal ACS P/N SB-18027-100/LF) can be used as a design reference. The following design files are available for authorized users from https://www.acsmotioncontrol.com/NPMpc#downloads.

Table 4-1. NPMPC Carrier Design Reference Files

File Name	File Type
NPMPC printed circuit board	PCB
NPMPC mechanical design	DXF
NPMPC support bracket	PDF
UDMNP electrical design	OrCAD DSN

The NPMPM can be used as a prototype.

4.1 Mechanical considerations

When designing the carrier board, use the following guidelines:

- Traces between the NPMPC module and the end use connectors must be as short as possible.
- Use at least 2.5mm PCB thickness to insure mechanical stability and easy plug-in and out of the NPMPC connectors.

Figure 4-1 shows a potential carrier board layout with an NPMPC attached. The minimum size required for the NPMPC, the location of the mounting holes, and the connectors are shown. Figure 4-2 and Figure 4-3 are pictures for a top view and isometric view.

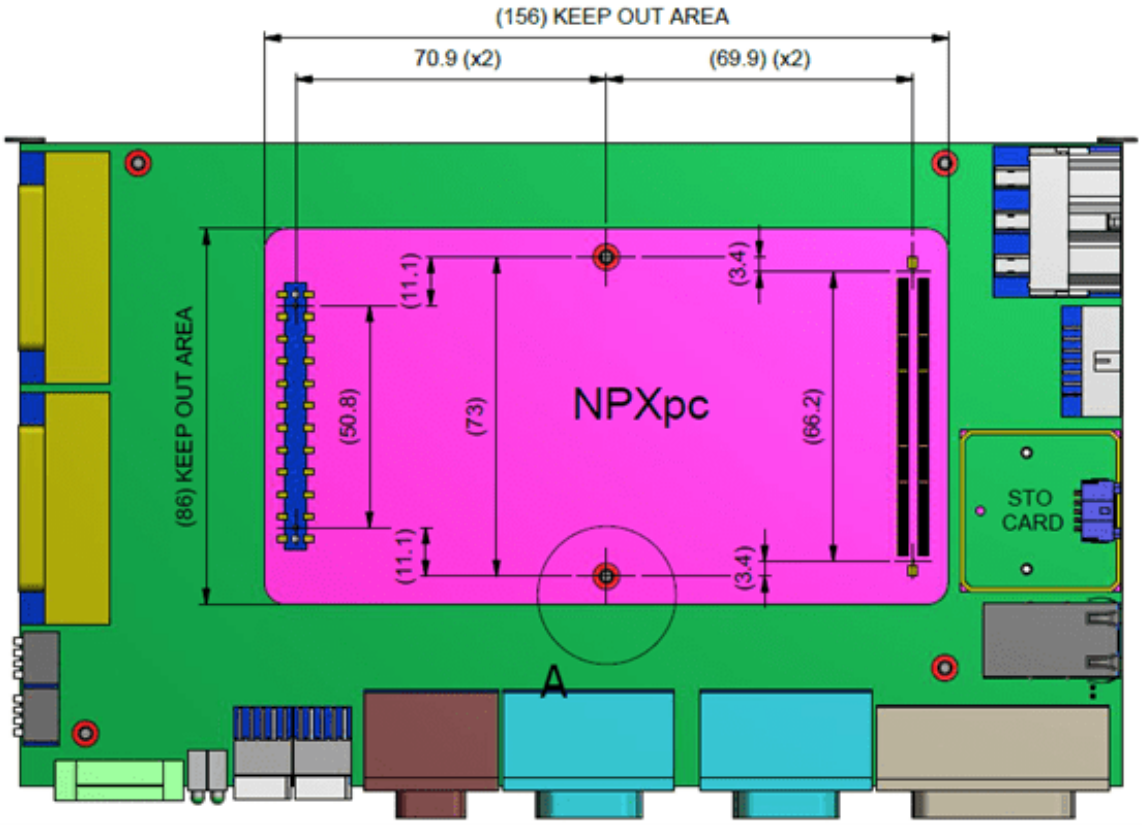

Figure 4-1. NPMPC Carrier Board Layout

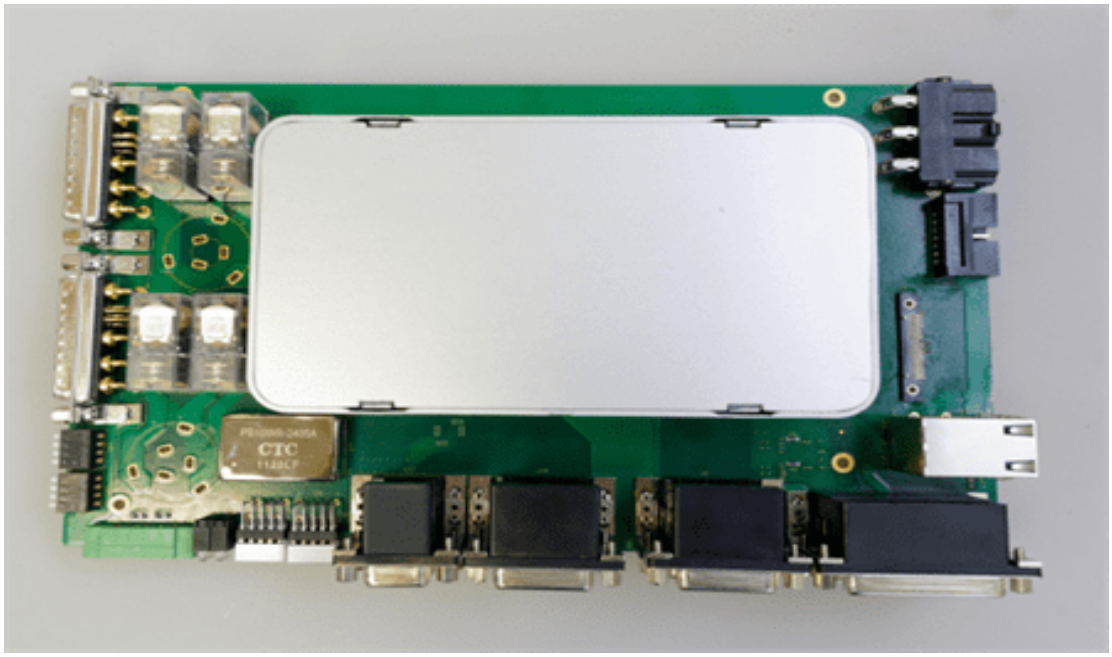

Figure 4-2. Top View

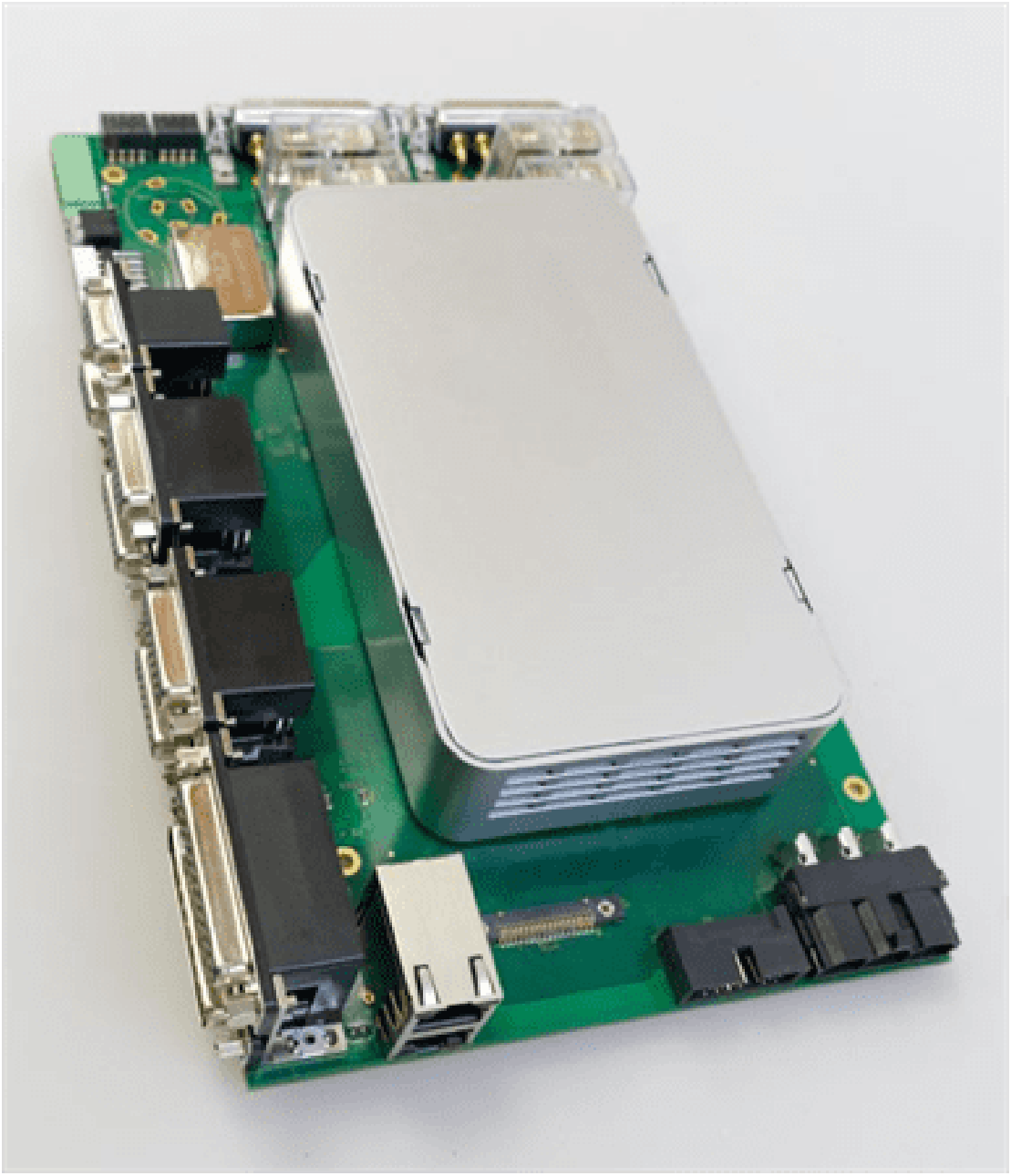

Figure 4-3. Isometric View

4.2 Electrical considerations

The carrier board should include interface circuits tailored to specific needs. This section provides guidelines including shielding, grounding, and a description of components such as resistors and capacitors.

The following are carrier board design guidelines:

- Observe industry standard practices for circuit layout.
- The traces must be as short as possible to minimize EMI.

- The width and thickness of the traces are to be calculated so that the temperature of the PCB will not exceed 100°C under any condition.
- Use ground planes wherever possible to minimize the inductance and the temperature of the traces.

4.2.1 Grounding

The NPMPC has groups of signals which utilize different grounds.

The following are carrier board design guidelines:

- Avoid cross conduction between the grounds to eliminate any cross talk and malfunction.
- Use a ground plane under the component-side and in last layer before print-side to protect the signals from EMI and to avoid radiated emission.

The following table shows the different signal groups.

Table 4-2. Grounding

Type of Signal or Circuit	Name	Description
Drive supply circuit	VP-	Drive supply return
PE/Shield	PE	Protected earth
Opto-isolated ground	24V_RTN V_RTN_SFTY V_RTN_IO	24V control supply return Supply return for safety input Supply return for general purpose digital output
Digital low level signals	DGND	
Analog encoder signals	AGND	Analog ground for SIN-COS signals
General purpose analog signal ground	FGND	Analog ground for AIN and AOUT signals
EtherCAT communication signals	All EtherCAT signals are to be fully isolated from all other circuits.	

4.2.2 Separation between high and low power signals

- The high and low power traces must be kept as far away as possible from the feedback, control, and communication traces.

- Clearance and creepage between the high voltage circuit and the low voltage circuits must be according to UL61800-5-1 and EN61800-5-1.
- The carrier design should comply with related safety and EMC standards.

4.2.3 EMC guidelines

- Use a ground plane under the component-side and in last layer before print-side to protect the signals from EMI and to avoid radiated emission.
- Use internal planes to avoid cross talk between signals inside a group .

4.2.4 Considerations for each function

This section provides guidelines for the Implementation of the interfacing circuits including motor phase inductors and termination resistors.

Guidelines for the following are provided:

- Encoders
- Motor connection with relays
- Motor over temperature
- STO
- Display LED
- Jumpers

4.2.4.1 Encoders

The NPMPC has an internal 5V supply available for all encoders. The internal NPMPC supply is limited to 0.5A. An encoders current consumption may exceed this value. A 5V power supply on the carrier board to supply the encoders is recommended. The module contains 120Ω termination for all Incremental digital encoder, incremental analog sin-cos encoder, and absolute digital encoder signals. Additional external termination is not required.

The incremental digital encoders and the absolute encoders have identical pin assignments. The pin assignments for digital encoder input signals may also be assigned to analog SIN-COS encoder squared output signals, see J1 - Low Power Signals Connector for details.

4.2.4.2 Motor connection with relays

The NPMPC provides control signals for two external motor relays, one per axis. The relays are not part of the product and should be implemented on the user side. The BRK0/1 signals will short circuit the motor phases if a drive is disabled or of a drive fault. When the drive is disabled, the relay closes. For detailed specifications see Motor Relay Control. The following figure shows the connections for motor relay.

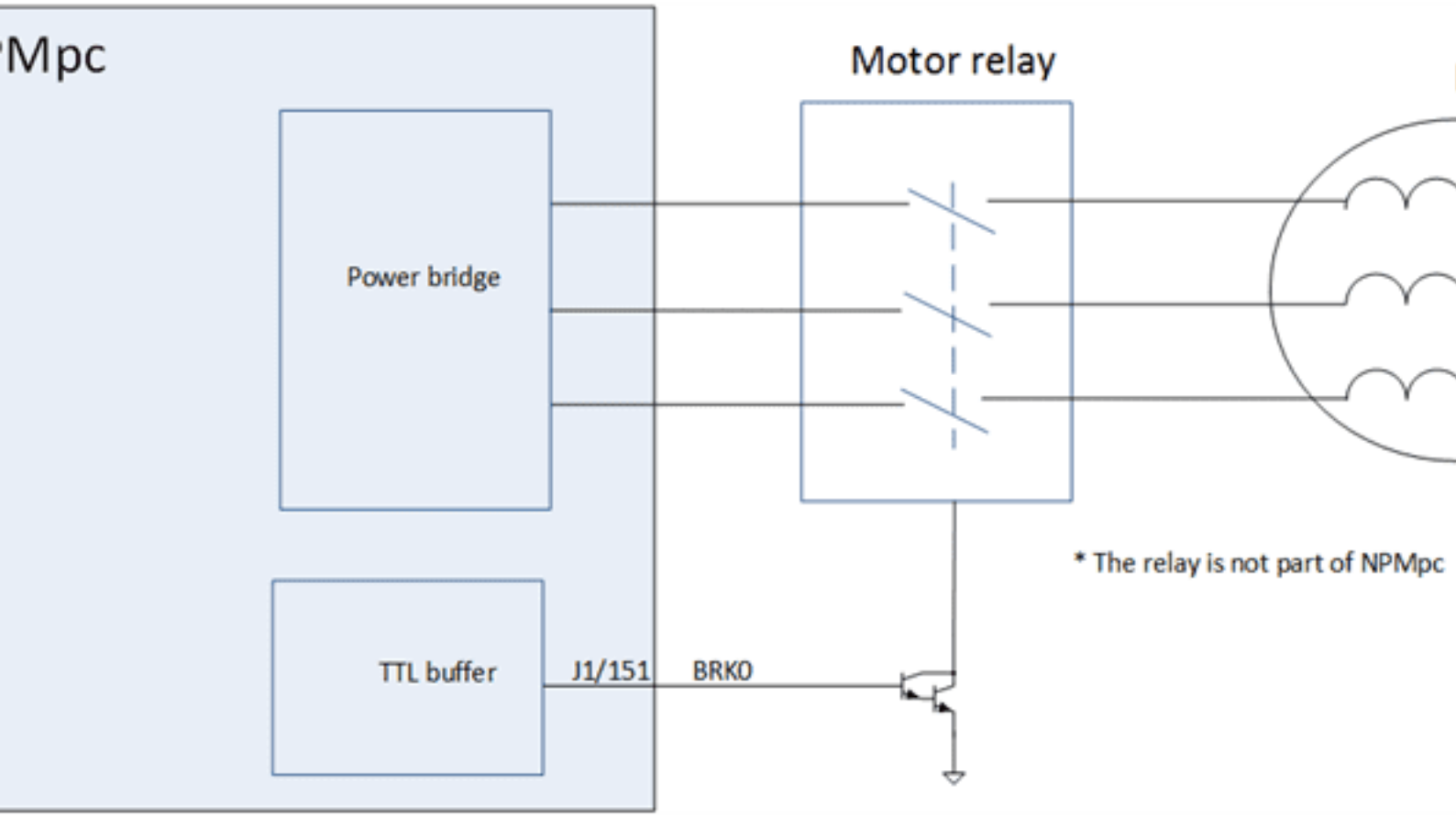

Figure 4-4. Motor Relay Connection

The motor connection without a relay is described in section Motors.

4.2.4.3 Motor Over Temperature

The NPMpc can be fed with a signal that the motor is overheated. One signal per axis is supported. The user can define the response of the controller. The default response is no action, see Motor Over Temperature Specifications for detailed specifications. The following figure shows the motor over temperature connection.

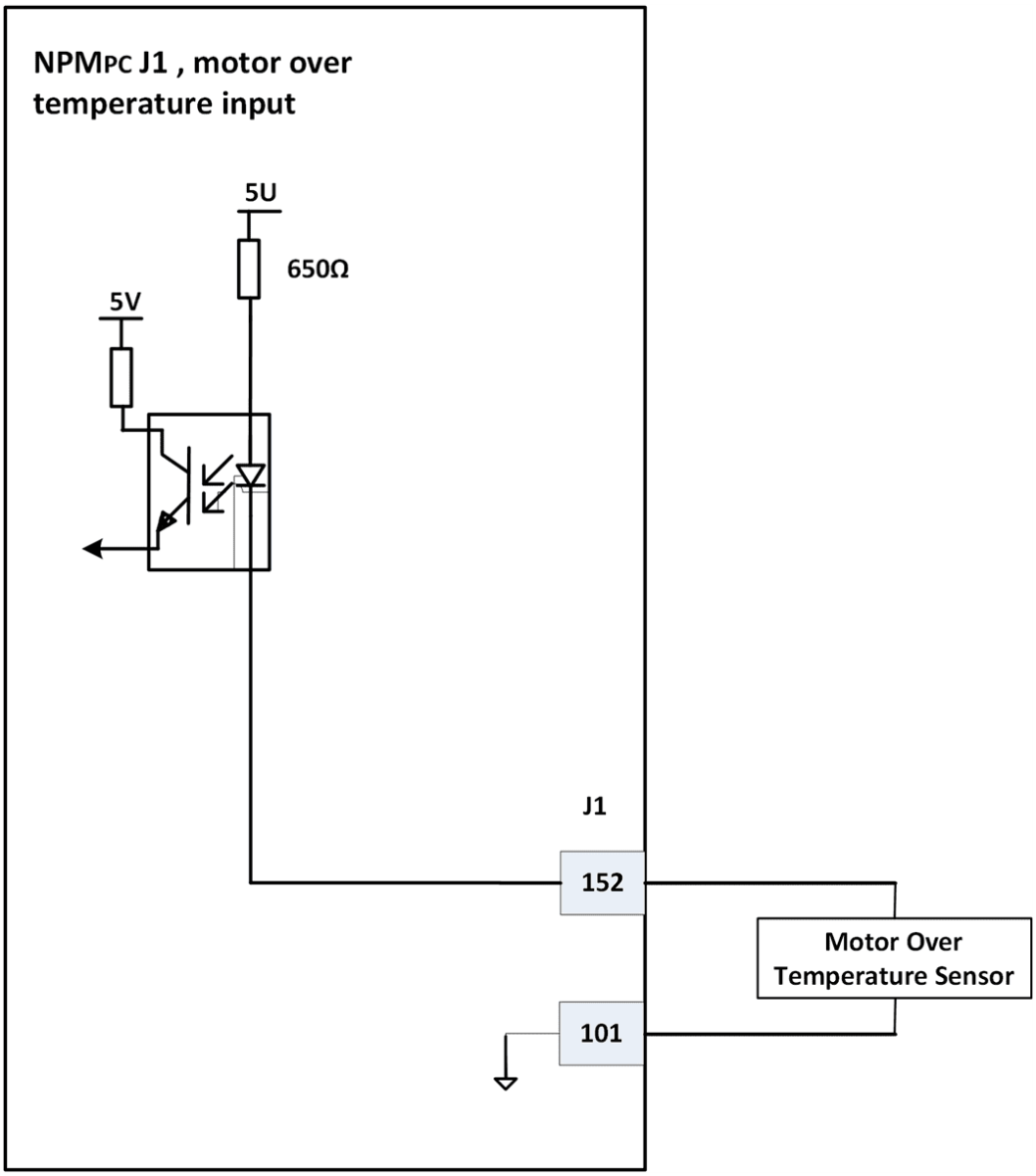

Figure 4-5. Motor Over-Temperature Connection

4.2.4.4 Connection Instructions

The NPMPC Safe Torque Off option module is certified 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

The ACS STO module P/N SB-16530-200/LF is not part of the NPMPC and should be ordered separately.

The following figure shows the STO connection. For detailed information on STO, see *AN Safe Torque Off Function and NPMPC NPAPC UDMCB Funtional Safety Manual*.

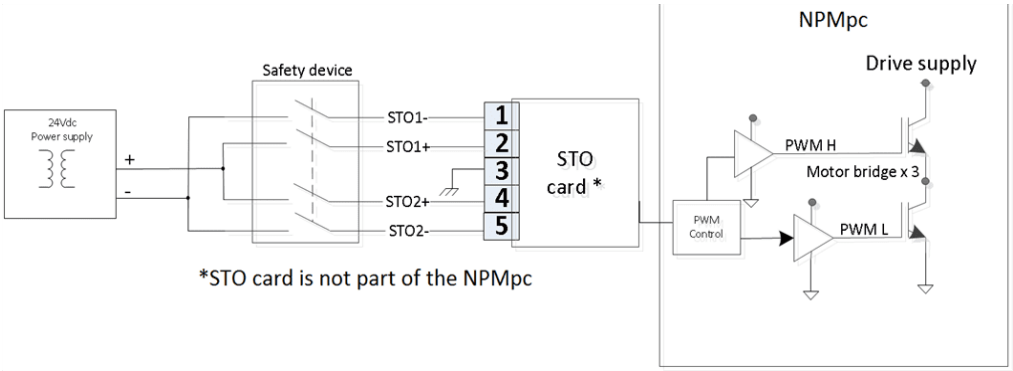

Figure 4-6. STO Connections

If the STO is not used:

1. Connect 5V to pin J1/130 (5V_STO_1) and pin J1/132 (5V_STO_2)
2. Connect pin J1/131 (STO1) and pin J1/133 (STO2) to DGND (pin 102) .

4.2.4.5 Display

The NPMPC supports two 7-segment displays and several LEDs. These show drive status and report fault conditions.

4.2.4.6 Jumpers

Pin 143 of connector J1 must be connected to ground.

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  Short circuit on one of the motor phases might damage the drive. > > Phase to ground short > > 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.

Feature	Specifications
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 must be used) > Designation: 24V_CON_SUP, CON_ RTN.
Motor Type	> Three- and two-phase permanent magnet synchronous, (DC brushless/ AC servo) > DC brush > 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

Feature	Specifications
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, 0.5A 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)

Squared SIN-COS Output	> Format: Squared of SIN, COS > Quantity: 2 > Type: Differential RS422 > Designation: SQR_SIN$, SQR_COS$ (share same pins with AqB)

Feature	Specifications
Absolute Encoder (optional)	> Up to two: > > EnDat 2.1 (digital) / 2.2 > > Smart Abs > > Panasonic > > BiSS - A/B/C > > SSI > > Sanyo ABS > Type: > > EnDat2.2, Heidenhain, based on ROQ 437 SERIES > > Smart-Abs: Tamagawa, based on: SA35-17/33bit-LSP-5V > > Panasonic: based on AC Servo Motor MINAS A4 Series > > BiSS-C > > SSI > Maximum input frequency: > > EnDat: 2MHz > > Smart-Abs: 2.5MHz > > Panasonic: 2.5MHz > > Biss-C: 10MHz > 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 <14mA > Maximum encoder frequency: 2MHz > Position latch: Rising or falling edge (SW programmable) > Can be used as general purpose inputs > Designation: MARK0±, MARK1±, MARK2±, MARK3±
Digital Outputs	> General purpose / Mechanical Brake: Two > Interface: Configured by ordering option: Sink (NPN) or Source (PNP). 5 & 24V, single ended, opto-isolated, Reference: V_RTN_IO > 100mA per output > output drop 2.5V at 0.1A > Protection: short current > Designation: OUT0, OUT1
Motor relays	> 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±

Feature	Specifications
Analog Inputs	> Four, ±10V, differential, 12 bit resolution > Max. input frequency: 1KHz > Offset: < 30mV > SNR: >65db (using SW algorithm) > Designation: AIN_#± (# = analog output number 0-3)
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)
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

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 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
Maximum cont. Input current [A] @ peak current	8	15	24	32

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

Motor Relay Control

Item	Description	Remarks
Designation	#_BRK	Per axis.
Type	TTL level Reference: DGND	
Output current	10mA per output	
Logic state	When enabled, this signal set to logic 1	

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 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	When this protection is not used, the Motor_OVER pin should be shorted to ground.
Default state	Over temperature off = Low impedance <1kΩ	

5.1 STO

The NPMPC supports STO. The STO is applicable only when using ACS STO module P/N SB-16530-200/LF which is not part of the NPMPC and should be ordered separately. For detailed information on STO, see *AN Safe Torque Off Function* and *NPMPC NPAPC UDMCB Functional Safety Manual*.

5.2 Dimensions

- Length: 155 mm
- Depth: 85 mm
- Height: 30 mm

5.3 Weight

- 360g

5.4 Compliance with Standards

5.4.1 Environment

Mount NPMPC the vertically or horizontally with the metal heatsink facing up. Leave enough clearance to enable free air convection around the module. Forced air flow may be required if the temperature of the module exceeds its threshold. Use the following graphs to calculate if forced air cooling is required.

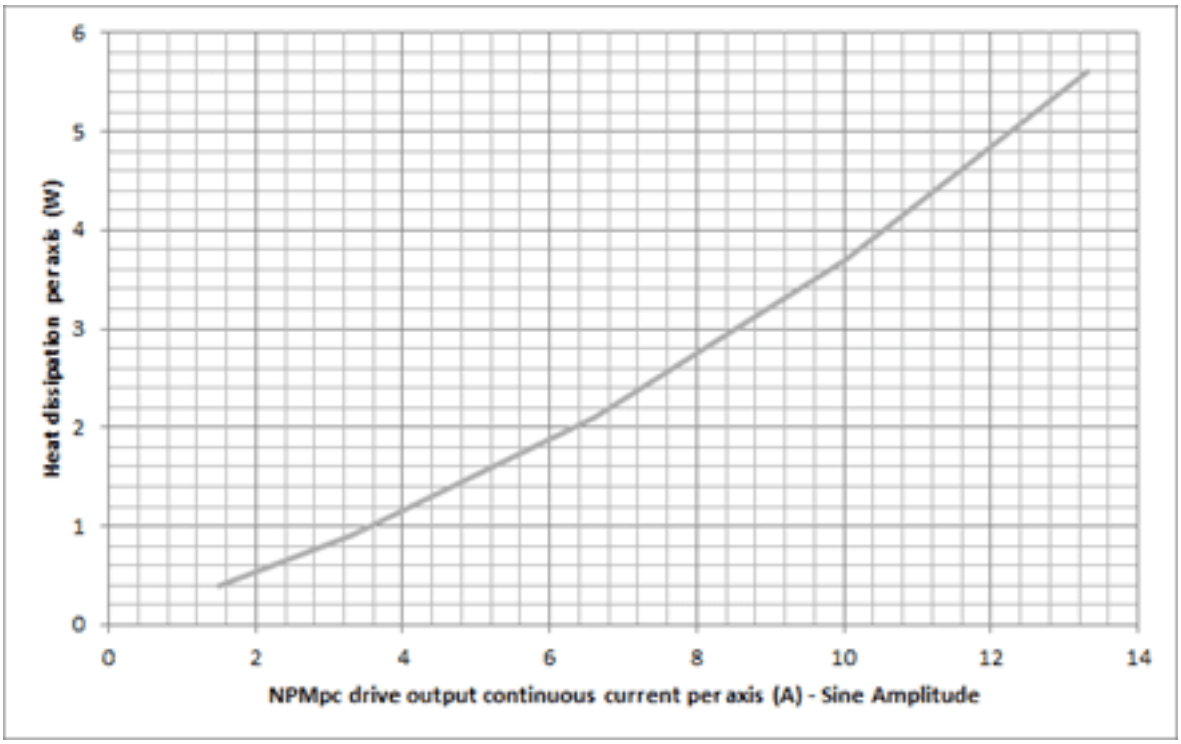

Figure 5-1. NPMPC Heat Dissipation per Axis

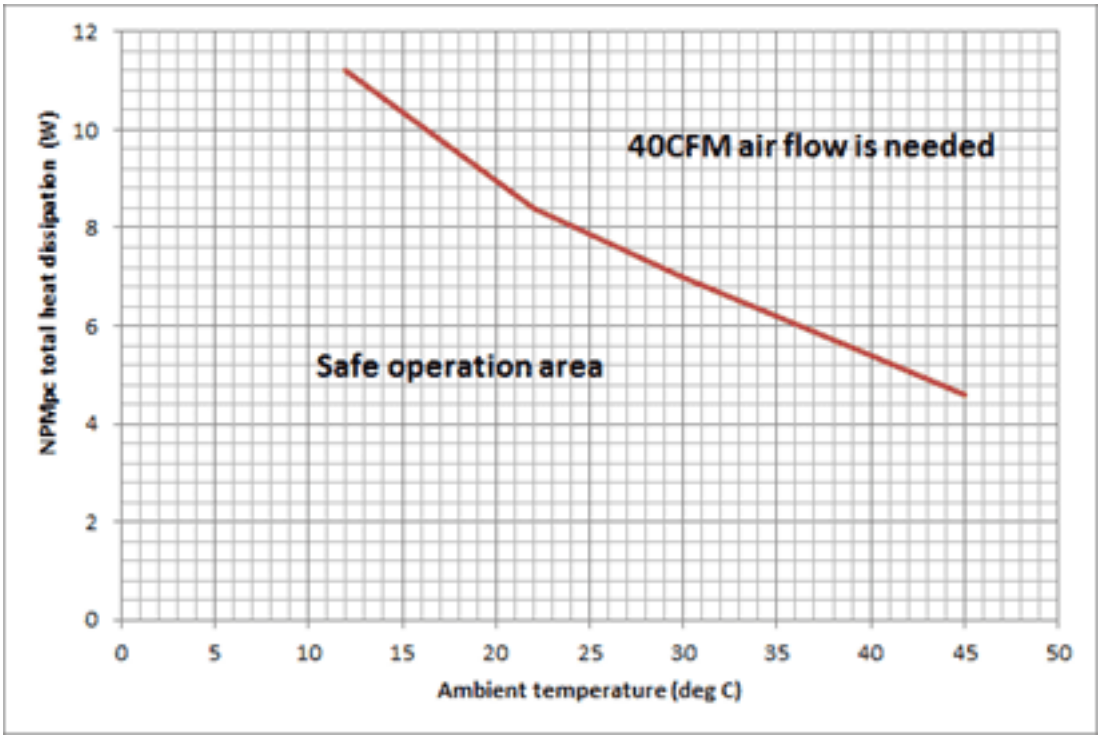

Figure 5-2. NPMPC Total Heat Dissipation

5.4.2 EMC

- 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

5.4.3 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 618000-5-1:2007
  - IEC 618000-3 :2017
- Electrical safety
  - UL61800-5-1
  - IEC 61800-5-1:2007 (2nd Edition) follwing the provisions of 2014/35/EU (Low Voltage Directive)

5.4.4 RoHS

- Design complies with ROHS requirements.

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