rexroth
A Bosch Company

NYCe 4000

Multi-axis motion control system
Hardware System Manual

Project Planning Manual
R911337671

Edition 10

Title

NYCe 4000
Multi-axis motion control system
Hardware System Manual

Type of Documentation

Project Planning Manual

Document Typecode

DOK-NY4000-HW***SYSTEM-PR10-EN-E

Internal File Reference

RS-eb2ca56b361ca3f60a6846a501caac28-10-en-US-10

Record of Revision

Edition	Release Date	Notes
DOK-NY4000-HW***SYSTEM-PR01-EN-E	09/2012	First edition
DOK-NY4000-HW***SYSTEM-PR02-EN-E	01/2013	2nd edition
DOK-NY4000-HW***SYSTEM-PR03-EN-E	09/2013	3rd edition
DOK-NY4000-HW***SYSTEM-PR04-EN-E	06/2014	4th edition
DOK-NY4000-HW***SYSTEM-PR05-EN-E	03/2015	5th edition
DOK-NY4000-HW***SYSTEM-PR06-EN-E	04/2016	6th edition
DOK-NY4000-HW***SYSTEM-PR07-EN-E	11/2016	7th edition
DOK-NY4000-HW***SYSTEM-PR08-EN-E	12/2017	8th edition
DOK-NY4000-HW***SYSTEM-PR09-EN-E	03/2018	9th edition
DOK-NY4000-HW***SYSTEM-PR10-EN-E	07/2018	10th edition

List of trademarks

FireWire is a registered trademark of Apple® Computer Inc.

Products in this publication are referred to by their general trade names. In most, if not all cases, these designations are claimed as trademarks or registered trademarks of their respective companies.

Liability

The specified data is intended for product description purposes only and shall not be deemed to be a guaranteed characteristic unless expressly stipulated in the contract. All rights are reserved with respect to the content of this documentation and the availability of the product.

Published by

Bosch Rexroth AG

P.O. Box 7170 ■ 5605 JD Eindhoven ■ The Netherlands

http://www.boschrexroth.com

Table of Contents

Table of Contents

Table of Contents

Page

Table of Contents

Table of Contents

Page

Table of Contents

1 Introduction

1.1 Purpose of Documentation

This NYCe 4000 Hardware System Manual provides information about the modules of the NYCe 4000 system. You can find on the internet (http://www.boschrexroth.com/various/utilities/mediadirectory/index.jsp?oid=326148&language=en-GB) the latest version of this manual. Click the links "Electric Drives and Controls" → "Control Units" → "Controls" → NYCe 4000" on the mentioned webpage.

This Hardware System Manual is intended for electrical engineers, system engineers and users of the NYCe 4000 system. They can use this document as a reference for connecting and installing a specific NYCe 4000 system.

⚠ WARNING **Personal injury and property damage can be caused by incorrect usage of the modules, machines and installations!**

Take the content of this Hardware System Manual into account.

This Hardware System Manual, among other things, contains:

- specifications for the components of the drive system
- configuration of the drive system components
- arrangement of the components in the control cabinet
- electromagnetic compatibility (EMC)
- connections of the components in the drive system

1.2 General Information

Damage can be caused to the NYCe 4000 module or circuit boards if electrostatic charge present in people and/or tools is discharged across them. Therefore, please note the following information:

⚠ WARNING **Electrostatic charges can cause damage to electronic components and interfere with their operational safety!**

Objects that come into contact with components and circuit boards must be discharged by means of grounding. Otherwise errors may occur when triggering motors and moving elements.

Such objects include:

- the copper bit when soldering
- the human body (discharge through touching a conductive, grounded item)
- parts and tools (placing on a conductive support)

Components sensitive to electrostatic discharge may only be stored or dispatched in conductive packaging.

☞ Rexroth connection diagrams are only to be used for producing installation connection diagrams. The machine manufacturer's installation connection diagrams must be used for wiring the installation!

- Route signal wires separately from the load resistance wires because of the occurrence of interference.
- Feed analog signals (for example, command values, actual values) via shielded lines.
- Do not connect mains, DC bus or power leads to low voltages or allow them to come into contact.
- When carrying out a high voltage test or insulation withstand test on the machine's electrical equipment, disconnect all connections to the units. This protects the electronic components (permitted in accordance with EN 60204-1).

⚠ WARNING **Plugging and unclamping live connections can damage the controller.**

Do not plug in or unclamp live connections.

1.3 Cross reference component name, order number, short name

1.3.1 Introduction

This chapter identifies the components of the NYCe 4000 system, the official component name with its order number and the short name as used in the user documentation. The short name is used in the user documentation to improve readability.

1.3.2 NYCe 4000 system housings

Component name	Order number	Short name
NYS04.2-ST-01-ULNN-NY4013	R911172904	NY4013
NYS04.2-ST-02-ULNN-NY4023	R911172905	NY4023
NYS04.2-ST-03-ULNN-NY4033	R911172966	NY4033
NYS04.2-ST-04-ULNN-NY4043	R911172906	NY4043
NYS04.2-ST-05-ULNN-NY4053	R911172907	NY4053
NYS04.1-ST-03-4125-NY4063	R911172218	NY4063
NYS04.2-ST-02-LMSN-NY4074	R911378504	NY4074
NYS04.1-ST-01-LMS-SERCOS-NY4079	R911378505	NY4079

Tab. 1-1: Component name - order number and short name overview of NYCe 4000 system housings

1.3.3 NYCe 4000 MCUs, drive, digital I/O and SERCOS III Master modules

Component name	Order number	Short name
NYM04.1-MCU-NNNN-NY4110	R911318960	NY4110
NYM04.1-MCU-ETHER-NY4112	R911173007	NY4112
NYM04.1-MCU-ETHER-NY4114	R911173598	NY4114
NYM04.1-2PW-NNNN-NY4120	R911318961	NY4120
NYM04.1-2PW-LMSN-NY4120/10	R911320447	NY4120/10
NYM04.1-5PW-NNNN-NY4125	R911172221	NY4125
NYM04.1-2LD-NNNN-NY4130	R911318962	NY4130
NYM04.1-1HV-NNNN-NY4140	R911318963	NY4140
NYM04.1-SE3-MAST-NY4150	R911325072	NY4150
NYM04.1-SE3-MAST-NY4150/10	R911172782	NY4150/10

Tab. 1-2: Component name - order number and short name overview of NYCe 4000 system modules

1.3.4 NYCe 4000 accessories

Component name	Order number	Short name
NYM04.1-ESC-NNNN-NY4199	R911320450	NY4199
NYA04.1-COVRPL-NO-USED-NY4900	R911318964	NY4900
NYA04.1-STRAIN-RELIEF-5PCS-4110-NY4901	R911322873	NY4901
NYA04.1-STRAIN-RELIEF-41XX-NY4901/10	R911172941	NY4901/10
NYA04.1-SHIELD-SUP-MOT-5PCS-NY4910	R911172999	NY4910
NYA04.1-1394B-INT-MOD1-NY4915/10	R911328808	NY4915/10
NYA04.1-1394B-INT-CAT-NY4916/10	R911325070	NY4916/10
NYA04.1-1394B-INT-PCIE-NY4917	R911345705	NY4917
HAWA MCS KONVERTER FWB-UTPS400	R911329980	-
NYA04.1-CONSET-SYSPW-NY4920/10	R911325078	NY4920/10
NYA04.1-CAP-100V-NY4921	R911325079	NY4921
NYA04.1-CAP-200V-NY4921/10	R911325082	NY4921/10
NYA04.1-FAN-1DRV-NY4922/00	R911328062	NY4922/00
NYA04.1-FAN-2DRV-NY4922/10	R911325083	NY4922/10
NYA04.1-FAN-3DRV-NY4922/20	R911172220	NY4922/20
NYA04.1-FAN-4DRV-NY4922/30	R911328063	NY4922/30
NYA04.1-FAN-5DRV-NY4922/50	R911325084	NY4922/50
NYA04.1-1394B-CABLE-B-B-00.5M-NY4950	R911318966	NY4950
NYA04.1-1394B-CABLE-B-B-01.0M-NY4950/10	R911318967	NY4950/10
NYA04.1-1394B-CABLE-B-B-02.0M-NY4950/20	R911318968	NY4950/20
NYA04.1-1394B-CABLE-B-B-04.5M-NY4950/30	R911318969	NY4950/30

Introduction

Component name	Order number	Short name
NYA04.1-1394B-CABLE-ANGLED-01.2M-NY4950/40	R911334596	NY4950/40
NYA04.1-CHOKES-10PCS-1394B-NY4950/99	R911322874	NY4950/99
NYA04.1-LMS-MUX2-10Vtt-5V-NY4960/10	R911320451	NY4960/10
NYA04.1-LMS-MUX2-10Vtt-15V-NY4960/20	R911320453	NY4960/20
NYA04.1-LMS-COIL-UNIT-TM3S-3685075	R911343771	-
NYA04.1-LMS-COIL-UNIT-TM6S-3685076	R911343770	-
NYA04.1-LMS-COIL-UNIT-TM12S-3685078	R911343769	-
NYA04.1-LMS-COIL-UNIT-TM18N-3685500	R911384027	-
NYA04.1-LMS-COIL-UNIT-TM18S-3685519	R911384029	-
NYA04.1-LMS-MAGNETTM-96MM-3685225	R911343774	-
NYA04.1-LMS-MAGNETTM-144MM-3685226	R911343775	-
NYA04.1-LMS-MAGNETTM-384MM-3685227	R911343773	-
NYA04.1-LMS-MAGNETTMV-144MM-120C-3685419	R911343772	-
NYA04.1-LMS-MAGNETTMV-384MM-120C-3685511	R911369668	-
NYA04.1-LMS-COIL-UNIT-TL6N-3697458	R911343602	-
NYA04.1-LMS-COIL-UNIT-TL6S-3685032	R911343601	-
NYA04.1-LMS-COIL-UNIT-TL9N-3685311	R911343558	-
NYA04.1-LMS-COIL-UNIT-TL9S-3675312	R911343559	-
NYA04.1-LMS-COIL-UNIT-TL12N-3697459	R911343597	-
NYA04.1-LMS-COIL-UNIT-TL12S-3685033	R911343435	-
NYA04.1-LMS-COIL-UNIT-TL15N-3687460	R911343560	-
NYA04.1-LMS-COIL-UNIT-TL15S-3685034	R911343561	-
NYA04.1-LMS-COIL-UNIT-TL18N-3685223	R911343562	-
NYA04.1-LMS-COIL-UNIT-TL18S-3685224	R911343603	-
NYA04.1-LMS-COIL-UNIT-TL24N-3685014	R911343604	-
NYA04.1-LMS-COIL-UNIT-TL24S-3685035	R911343605	-
NYA04.1-LMS-MAGNETTL-192MM-3685193	R911343580	-
NYA04.1-LMS-MAGNETTL-288MM-3685194	R911343563	-
NYA04.1-LMS-MAGNETTLV-192MM-120C-3685457	R911343565	-
NYA04.1-LMS-MAGNETTLV-288MM-120C-3685472	R911343573	-
NYA04.1-LMS-MAGNETTLV-192MM-150C-3685473	R911343576	-
NYA04.1-LMS-MAGNETTLV-288MM-150C-3685420	R911343579	-
NYA04.1-LMS-COIL-UNIT-TB12N-3685155	R911343767	-
NYA04.1-LMS-COIL-UNIT-TB12S-3685157	R911347637	-
NYA04.1-LMS-COIL-UNIT-TB15N-3685122	R911347642	-
NYA04.1-LMS-COIL-UNIT-TB15S-3685120	R911347643	-

Component name	Order number	Short name
NYA04.1-LMS-COIL-UNIT-TB30N-3685123	R911347644	-
NYA04.1-LMS-COIL-UNIT-TB30S-3685121	R911347645	-
NYA04.1-LMS-COIL-UNIT-TBW18N-3685263	R911347646	-
NYA04.1-LMS-COIL-UNIT-TBW18S-3685264	R911347647	-
NYA04.1-LMS-COIL-UNIT-TBW30N-3685242	R911347648	-
NYA04.1-LMS-COIL-UNIT-TBW30S-3685243	R911347649	-
NYA04.1-LMS-COIL-UNIT-TBW45N-3685244	R911347650	-
NYA04.1-LMS-COIL-UNIT-TBW45S-3685245	R911347651	-
NYA04.1-LMS-MAGNETTB-192MM-3685221	R911343765	-
NYA04.1-LMS-MAGNETTB-288MM-3685222	R911343763	-
NYA04.1-LMS-MAGNETTBV-192MM-120C-3685474	R911343764	-
NYA04.1-LMS-MAGNETTBV-288MM-120C-3685475	R911343768	-
NYA04.1-LMS-HALLSENSOR-24-180-NY4980/00	R911173569	NY4980/00
NYA04.1-LMS-HALLSENSOR-24-90-NY4980/10	R911173570	NY4980/10
NYA04.1-LMS-MRSENSOR-180-NY4981/00	R911174592	NY4981/00
NYA04.1-LMS-MAGNETSCALE-5-XXXX-NY4985	R91117yyyy	NY4985
NYA04.1-SHARED-CABLE-M-M-01.0M-NY4951/70	R911174516	NY4951/70
NYA04.1-SENSORCABLE-M-F-00.6M-NY4951/00	R911174517	NY4951/00
NYA04.1-SENSORCABLE-M-F-01.5M-NY4951/10	R911174518	NY4951/10
NYA04.1-SENSORCABLE-M-F-03.0M-NY4951/20	R911174519	NY4951/20
NYA04.1-SENSORCABLE-M-F-05.0M-NY4951/30	R911174520	NY4951/30
NYA04.1-SENSORCABLE-M-F-09.0M-NY4951/40	R911174521	NY4951/40

Tab. 1-3: Component name - order number and short name overview of NYCe 4000 accessories

2 Safety Instructions for Electric Drives and Controls

2.1 Definitions of Terms

Application Documentation The entire documentation used to inform the user of the product about the use and safety-relevant features for configuring, integrating, installing, mounting, commissioning, operating, maintaining, repairing and decommissioning the product. The following terms are also used for this kind of documentation: User Guide, Operation Manual, Commissioning Manual, Instruction Manual, Project Planning Manual, Application Manual, etc.

Component Combination of elements with a specified function, which are part of a piece of equipment, device or system. Components of a drive and control system are, for example, supply units, drive controllers, mains choke, mains filter, motors, cables, etc.

Control System Several interconnected control components placed on the market as a single functional unit.

Device Finished product with a defined function, intended for users and placed on the market as an individual piece of merchandise.

Drive System A group of components consisting of electric motor(s), motor encoder(s) and cable(s), supply units and drive controllers, as well as possible auxiliary and additional components, such as mains filter, mains choke, etc.

Electrical Equipment Objects used to generate, convert, transmit, distribute or apply electrical energy, such as machines, transformers, switching devices, cables, lines, power-consuming devices, circuit board assemblies, plug-in units, control cabinets, etc.

Installation Several devices or systems interconnected for a defined purpose and on a defined site which, however, are not intended to be placed on the market as a single functional unit.

Machine Entirety of interconnected parts or units at least one of which is movable. Thus, a machine consists of the appropriate machine drive elements, as well as control and power circuits, which have been assembled for a specific application. A machine is, for example, intended for processing, treatment, movement or packaging of a material. The term "machine"" also covers a combination of machines which are arranged and controlled in such a way that they function as a unified whole.

Manufacturer Individual or legal entity bearing responsibility for the design and manufacture of a product which is placed on the market in the individual's or legal entity's name. The manufacturer can use finished products, finished parts or finished elements, or contract out work to subcontractors. However, the manufacturer must always have overall control and possess the required authority to take responsibility for the product.

Product Produced device, component, part, system, software, firmware, among other things.

Project Planning Manual Part of the application documentation used to support the dimensioning and planning of systems, machines or installations.

Qualified Persons In terms of this application documentation, qualified persons are those persons who are familiar with the installation, mounting, commissioning and operation of the components of the drive and control system, as well as with the hazards this implies, and who possess the qualifications their work requires. To comply with these qualifications, it is necessary, among other things,

- to be trained, instructed or authorized to switch electric circuits and devices safely on and off, to ground them and to mark them,
- to be trained or instructed to maintain and use adequate safety equipment,
- to attend a course of instruction in first aid.

User A person installing, commissioning or using a product which has been placed on the market.

2.2 Explanation of Signal Words and the Safety Alert Symbol

The Safety Instructions in the available application documentation contain specific signal words (DANGER, WARNING, CAUTION or NOTICE) and, where required, a safety alert symbol (in accordance with ANSI Z535.6-2006).

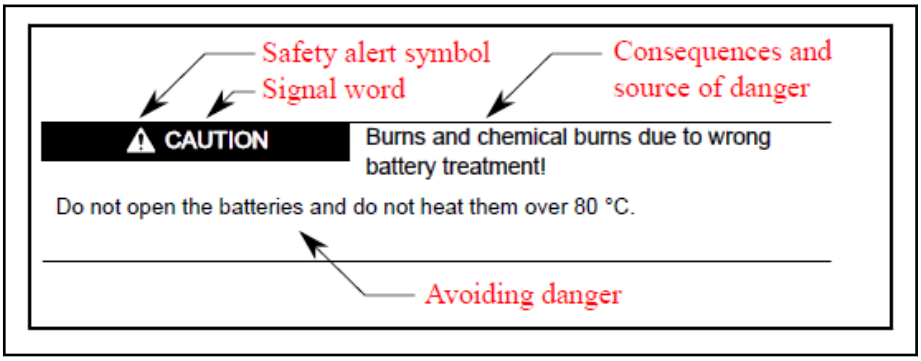

Fig. 2-1: Example of a Safety Instruction

The signal word is meant to draw the reader's attention to the safety instruction and identifies the hazard severity.

The safety alert symbol (a triangle with an exclamation point), which precedes the signal words DANGER, WARNING and CAUTION, is used to alert the reader to personal injury hazards.

⚠ DANGER

In case of non-compliance with this safety instruction, death or serious injury **will** occur.

⚠ WARNING

In case of non-compliance with this safety instruction, death or serious injury **can** occur.

⚠ CAUTION

In case of non-compliance with this safety instruction, minor or moderate injury can occur.

NOTICE

In case of non-compliance with this safety instruction, property damage can occur.

2.3 General Information

2.3.1 Using the Safety Instructions and Passing Them on to Others

Do not attempt to install and operate the electric components of the drive and control system without first reading all documentation provided with the product. Read and understand these safety instructions and all user documentation prior to working with these components. If you do not have the user documentation for the components, contact your responsible Bosch Rexroth sales partner. Ask for these documents to be sent immediately to the person or persons responsible for the safe operation of the components.

If the component is resold, rented and/or passed on to others in any other form, these safety instructions must be delivered with the component in the official language of the user´s country.

⚠ WARNING

Improper use of these components, failure to follow the safety instructions in this document or tampering with the product, including disabling of safety devices, can result in property damage, injury, electric shock or even death.

Observe the safety instructions!

2.3.2 Requirements for Safe Use

Read the following instructions before initial commissioning of the electric components of the drive and control system in order to eliminate the risk of injury and/or property damage. You must follow these safety instructions.

- Bosch Rexroth is not liable for damages resulting from failure to observe the safety instructions.
- Read the operating, maintenance and safety instructions in your language before commissioning. If you find that you cannot completely understand the application documentation in the available language, please ask your supplier to clarify.
- Proper and correct transport, storage, mounting and installation, as well as care in operation and maintenance, are prerequisites for optimal and safe operation of the component.
- Only qualified persons may work with components of the drive and control system or within its proximity.

Safety Instructions for Electric Drives and Controls

- Only use accessories and spare parts approved by Bosch Rexroth.
- Follow the safety regulations and requirements of the country in which the electric components of the drive and control system are operated.
- Only use the components of the drive and control system in the manner that is defined as appropriate. See chapter 3.1 "Appropriate Use" on page 25.
- The ambient and operating conditions given in the application documentation at hand must be observed.
- The equipment is designed for installation in industrial machinery.
- Safety-relevant applications are only allowed if clearly and explicitly specified in the application documentation "Integrated Safety Technology". If this is not the case, they are excluded. Safety-relevant are all such applications which can cause danger to persons and property damage.

  For example, the following areas of use are not permitted: construction cranes, elevators used for people or freight, devices and vehicles to transport people, medical applications, refinery plants, transport of hazardous goods, nuclear applications, applications sensitive to high frequency, mining, food processing, control of protection equipment (also in a machine).
- The information given in the application documentation with regard to the use of the delivered components contains only examples of applications and suggestions.

  The machine and installation manufacturer must
  - make sure that the delivered components are suited for his individual application and check the information given in this application documentation with regard to the use of the components,
  - make sure that his individual application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.
- Commissioning of the delivered components is only allowed once it is sure that the machine or installation in which the components are installed complies with the national regulations, safety specifications and standards of the application.
- Operation is only allowed if the national EMC regulations for the application are met.
- The instructions for installation in accordance with EMC requirements can be found in the section on EMC in the documentation.

  The machine or installation manufacturer is responsible for compliance with the limit values as prescribed in the national regulations.
- The technical data, connection and installation conditions of the components are specified in the respective application documentations and must be followed at all times.

National regulations which the user must take into account

- European countries: According to European EN standards
- United States of America (USA):
  - National Electrical Code (NEC)
  - National Electrical Manufacturers Association (NEMA), as well as local engineering regulations

  - Regulations of the National Fire Protection Association (NFPA)
- Other countries:
  - International Organization for Standardization (ISO)
  - International Electrotechnical Commission (IEC)

2.3.3 Hazards by Improper Use

- High electrical voltage and high working current! Danger to life or serious injury by electric shock!
- High electrical voltage by incorrect connection! Danger to life or injury by electric shock!
- Dangerous movements! Danger to life, serious injury or property damage by unintended motor movements!
- Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electric drive systems!
- Risk of burns by hot housing surfaces!
- Risk of injury by improper handling! Injury by crushing, shearing, cutting, hitting!

2.4 Instructions with Regard to Specific Dangers

2.4.1 Protection against Contact with Electrical Parts and Housings

☞ This section concerns components of the drive and control system with voltages of **more than 50 volts**.

Contact with parts conducting voltages above 50 volts can cause personal danger and electric shock. When operating components of the drive and control system, it is unavoidable that some parts of these components conduct dangerous voltage.

Safety Instructions for Electric Drives and Controls

⚠ WARNING **High electrical voltage! Danger to life, risk of injury by electric shock or serious injury!**

- Only qualified persons are allowed to operate, maintain and/or repair the electric components of the drive and control system.
- Follow the general installation and safety regulations when working on power installations.
- Before switching on, the equipment grounding conductor must have been permanently connected to all electric components in accordance with the connection diagram.
- Even for brief measurements or tests, operation is only allowed if the equipment grounding conductor has been permanently connected to the points of the components provided for this purpose.
- Before accessing electrical parts with voltage potentials higher than 50 V, you must disconnect electric components from the mains or from the power supply unit. Secure the electric component from reconnection.
- With electric components, observe the following aspects:

  Always wait **30 minutes** after switching off power to allow live capacitors to discharge before accessing an electric component. Measure the electrical voltage of live parts before beginning to work to make sure that the equipment is safe to touch.
- Install the covers and guards provided for this purpose before switching on.
- Never touch electrical connection points of the components while power is turned on.
- Do not remove or plug in connectors when the component has been powered.
- As a basic principle, residual-current-operated circuit-breakers cannot be used for electric drives to prevent direct contact.
- Secure built-in devices from penetrating foreign objects and water, as well as from direct contact, by providing an external housing, for example a control cabinet.
- The System Housing may only be used as build-in equipment for indoor use only, which means that the end-user must provide a suitable fire and electrical safe enclosure.
- The System Housing has no certified functional safety on board. This means that all precautions for a safe operation must be ensured by external components.
- The System Housing may only be used in combination with external approved power supplies. The supply voltages 24V System, DP NY4130, 24V Dig, and 24V Fdig for the system must be separated at least by reinforced insulation from all hazardous voltages according to the standard EN61010-1 third edition.

To be observed with electrical drive and filter components:

⚠ WARNING **High housing voltage and high leakage current! Danger to life, risk of injury by electric shock!**

- Before switching on and before commissioning, ground or connect the components of the drive and control system to the equipment grounding conductor at the grounding points.
- Connect the equipment grounding conductor of the components of the drive and control system permanently to the main power supply at all times. The leakage current is greater than 3.5 mA.
- Establish an equipment grounding connection with a copper wire of a cross section of at least 10 mm^2 (AWG 8) or additionally run a second equipment grounding conductor of the same cross section as the original equipment grounding conductor.

2.4.2 Safety Extra-Low Voltage as Protection Against Electric Shock

Safety extra-low voltage (SELV) is used to allow connecting devices with basic insulation to extra-low voltage circuits.

All connections and terminals with voltages between 5 and 50 volts at the components of the Bosch Rexroth drive and control system are SELV systems. It is allowed to connect devices equipped with basic insulation (such as programming devices, PCs, notebooks, display units) to these connections.

⚠ WARNING **Danger to life, risk of injury by electric shock! High electrical voltage by incorrect connection!**

If extra-low voltage circuits of devices containing voltages and circuits of more than 50 volts (for example, the mains connection) are connected to Bosch Rexroth products, the connected extra-low voltage circuits must comply with the requirements for SELV ("Safety Extra-Low Voltage").

- Only connect equipment, electrical components and cables of the protective low voltage type to all terminals and clamps with voltages of 0 to 50 Volts.
- Only electrical circuits may be connected which have double or reinforced isolation against high voltage circuits. Double or reinforced isolation is achieved, for example, with an isolating transformer or when battery-operated.

2.4.3 Protection against Dangerous Movements

Dangerous movements can be caused by faulty control of connected motors. Some common examples are:

- Improper or wrong wiring or cable connection
- Operator errors
- Wrong input of parameters before commissioning
- Malfunction of sensors, encoders and monitoring devices
- Defective components

- Software or firmware errors

These errors can occur immediately after equipment is switched on or even after an unspecified time of trouble-free operation.

The monitoring functions in the components of the drive and control system will normally be sufficient to avoid malfunction in the connected drives. Regarding personal safety, especially the danger of injury and/or property damage, this alone cannot be relied upon to ensure complete safety. Until the integrated monitoring functions become effective, it must be assumed in any case that faulty drive movements will occur. The extent of faulty drive movements depends upon the type of control and the state of operation.

⚠ WARNING **Dangerous movements! Danger to life, risk of injury, serious injury or property damage!**

- A **risk assessment** must be prepared for the installation or machine, with its specific conditions, in which the components of the drive and control system are installed. As a result of the risk assessment, the user must provide for monitoring functions and higher-level measures on the installation side for personal safety. The safety regulations applicable to the installation or machine must be taken into consideration. Unintended machine movements or other malfunctions are possible if safety devices are disabled, bypassed or not activated.

To avoid accidents, injury and/or property damage:

- Keep free and clear of the machine's range of motion and moving machine parts. Prevent personnel from accidentally entering the machine's range of motion by using, for example:
  - Safety fences
  - Safety guards
  - Protective coverings
  - Light barriers
- Make sure the safety fences and protective coverings are strong enough to resist maximum possible kinetic energy.
- Mount emergency stop switches in the immediate reach of the operator. Before commissioning, verify that the emergency stop equipment works. Do not operate the machine if the emergency stop switch is not working.
- Prevent unintended start-up. Isolate the drive power connection by means of an emergency stop circuit or use a safe starting lockout.
- Make sure that the drives are brought to a safe standstill before accessing or entering the danger zone.
- Additionally secure vertical axes against falling or dropping after switching off the motor power by, for example,
  - mechanically securing the vertical axes,
  - adding an external braking/arrester/clamping mechanism or
  - ensuring sufficient equilibration of the vertical axes.
- The standard equipment **motor holding brake** or an external holding brake controlled by the drive controller is **not sufficient to guarantee personal safety**!
- Disconnect electrical power to the components of the drive and control system using the master switch and secure them from reconnection for:
  - Maintenance and repair work
  - Cleaning of equipment
  - Long periods of discontinued equipment use
- Prevent the operation of high-frequency, remote control and radio equipment near electric/electronic components of the drive and control system and their supply leads. If the use of these devices cannot be avoided, check the machine or installation, before initial commissioning of the drive and control system, for possible malfunctions when operating such high-frequency, remote control and radio equipment in its possible positions of normal use. It might possibly be necessary to perform a special electromagnetic compatibility (EMC) test.

2.4.4 Protection against Magnetic and Electromagnetic Fields during Operation and Mounting

Magnetic and electromagnetic fields generated by current-carrying conductors or permanent magnets of electric motors represent a serious danger to persons with heart pacemakers, metal implants and hearing aids.

⚠ WARNING **Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electric components!**

- Persons with heart pacemakers and metal implants are not allowed to enter the following areas:
  - Areas in which components of the drive and control systems are mounted, commissioned and operated.
  - Areas in which parts of motors with permanent magnets are stored, repaired or mounted.
- If it is necessary for somebody with a heart pacemaker to enter such an area, a doctor must be consulted prior to doing so. The noise immunity of implanted heart pacemakers differs greatly so that no general rules can be given.
- Those with metal implants or metal pieces, as well as with hearing aids, must consult a doctor before they enter the areas described above.

2.4.5 Protection against Contact with Hot Parts

⚠ CAUTION **Hot surfaces of components of the drive and control system. Risk of burns!**

- Do not touch hot surfaces of, for example, braking resistors, heat sinks, supply units and drive controllers, motors, windings and laminated cores!
- According to the operating conditions, temperatures of the surfaces can be **higher than 60 °C** (140 °F) during or after operation.
- Before touching motors after having switched them off, let them cool down for a sufficiently long time. Cooling down can require **up to 140 minutes**! The time required for cooling down is approximately five times the thermal time constant specified in the technical data.
- After switching chokes, supply units and drive controllers off, wait **15 minutes** to allow them to cool down before touching them.
- Wear safety gloves or do not work at hot surfaces.
- For certain applications and according to the respective safety regulations, the manufacturer of the machine or installation has to take measures to avoid injuries caused by burns in the end application. These measures can be, for example: Warnings at the machine or installation, guards (shieldings or barriers) or safety instructions in the application documentation.

2.4.6 Protection during Handling and Mounting

⚠ CAUTION **Risk of injury by improper handling! Injury by crushing, shearing, cutting, hitting, and mechanical shock!**

- Observe the relevant statutory regulations of accident prevention.
- Use suitable equipment for mounting and transport.
- Avoid jamming and crushing by appropriate measures.
- Always use suitable tools. Use special tools if specified.
- Use lifting equipment and tools in the correct manner.
- Use suitable protective equipment (hard hat, safety goggles, safety shoes, safety gloves, for example).
- Do not stand under hanging loads.
- Immediately clean up any spilled liquids from the floor due to the risk of slipping.

3 Important Directions for Use

3.1 Appropriate Use

Introduction

Rexroth products represent state-of-the-art developments and manufacturing. They are tested prior to delivery to ensure operating safety and reliability.

⚠ WARNING **Personal injury and property damage caused by incorrect use of the products!**

The products have been designed for use in the industrial environment and may only be used in the appropriate way. If they are not used in the appropriate way, situations resulting in property damage and personal injury can occur.

☞ Rexroth, as manufacturer, is not liable for any damages resulting from inappropriate use. In such cases, the guarantee and the right to payment of damages resulting from inappropriate use are forfeited. The user alone carries all responsibility of the risks.

Before using Rexroth products, make sure that all the pre-requisites for an appropriate use of the products are satisfied:

- Personnel that in any way, shape or form uses our products must first read and understand the relevant safety instructions and be familiar with appropriate use.
- If the product takes the form of hardware, then they must remain in their original state, in other words, no structural changes are permitted. It is not permitted to decompile software products or alter source codes.
- Do not install damaged or faulty products or use them in operation.
- Make sure that the products have been installed in the manner described in the relevant documentation.

3.2 Areas of use and Application

NYCe 4000 modules made by Rexroth are designed to control electrical motors and monitor their operation.

Control and monitoring of the motors may require additional sensors and actuators.

☞ The NYCe 4000 modules may only be used with the accessories and parts specified in this documentation. If a component has not been specifically named, then it may neither be installed nor connected.

Operation is only permitted in the specified configurations and combinations of components using the software and firmware as specified in the relevant function descriptions.

Every NYCe 4000 module must be programmed before starting it up, making it possible for the motor to execute the specific functions of an application. The NYCe 4000 modules are designed for use in single or multiple-axis drive and control applications.

To ensure an application-specific use, the NYCe 4000 modules are available with differing drive power and different interfaces.

Typical application of NYCe 4000 modules is in machines requiring high-precision motion control.

The NYCe 4000 modules may only be operated under the assembly, installation and ambient conditions as described in this documentation (temperature, system of protection, humidity, EMC requirements, etc.) and in the position specified.

3.3 Inappropriate Use

Using the NYCe 4000 modules outside of the above-referenced areas of application or under operating conditions other than described in the documentation, technical data and specifications is defined as "inappropriate use".

NYCe 4000 modules may not be used

- if they are subject to operating conditions that do not meet the specified ambient conditions. This includes, for example, operation under water, in case of extreme temperature fluctuations or extremely high maximum temperatures,

  or
- if Rexroth has not specifically released them for that intended purpose.

☞ Make sure you carefully follow the specifications outlined in chapter 2.3 "General Information" on page 15.

3.4 Acceptance tests and approvals

3.4.1 Introduction

Declarations of conformity confirm that the components comply with valid EN standards and EC directives. If required, our sales representative can provide you with the declarations of conformity for our components.

3.4.2 Low voltage directive

These components correspond to the following standard.

- EN61010-1:2010 (IEC61010-1:2010)

(Safety requirements for electrical equipment for measurement, control and laboratory use - Part 1: General requirements)

- NYM04.1-2PW-NNNN-NY4120
- NYM04.1-2PW-LMSN-NY4120/10
- NYM04.1-1HV-NNNN-NY4140

3.4.3 EMC directive

These components correspond to the following standard

- EN61000-6-2:2005 (IEC61000-6-2:2005)

  (Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments)
- EN61000-6-4:2007 + A1:2011 (IEC61000-6-4:2006 + A1:2010)

  (Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments)
  - NYM04.1-MCU-NNNN-NY4110
  - NYM04.1-MCU-ETHER-NY4112
  - NYM04.1-MCU-ETHER-NY4114
  - NYM04.1-2PW-NNNN-NY4120
  - NYM04.1-2PW-LMSN-NY4120/10
  - NYM04.1-5PW-NNNN-NY4125
  - NYM04.1-2LD-NNNN-NY4130
  - NYM04,1-1HV-NNNN-NY4140
  - NYM04.1-SE3-MAST-NY4150/10

3.4.4 CE

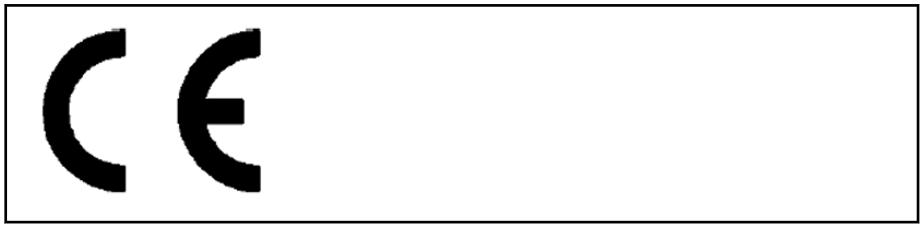

Fig. 3-1: CE conformity

The above mentioned components comply with the requirements and the target of the following EU directive and with the following harmonized European standards.

- Low Voltage Directive 2006/95/EG (valid until 19 April 2016)
- Low Voltage Directive 2014/35/EU (valid from 20 April 2016)
- EMC Directive 2014/30/EU

These components are built-in units which, owing to their installation characteristics, are not able to comply with the regulations for complete apparatus, machines or installations from the outset. For this reason, they may only be used for built-in purposes. The components may only be assessed with regard to their electrical and mechanical safety as well as to environmental effects (foreign bodies, moisture) after they have been installed in the product intended for the final user. After the component has been installed, its EMC properties may change. Hence the product intended for the final user (complete apparatus, machines or installations) should be

inspected with regard to its EMC properties by the manufacturer of the product intended for the final user.

3.4.5 UL

The above mentioned components, except the NYM04.1-5PW-NNNN-NY4125, are UL recognized (Underwriters Laboraties Inc. ®). You can find the evidence of certification on the internet address http://www.ul.com under "Certifications" by entering the file number of the "Company Name ": Rexroth".

Fig. 3-2: UL recognized

The above mentioned modules are certified according to:

- UL 61010-1:2012

  UL file no. E353498

However, there can exist combinations with modules or accessories with limited or missing certification. Therefore, verify the registration according to the UL marking on the device.

☞ **Loss of UL conformity due to changes to the component.**

The UL marking is only valid for the component in its delivery status. After any modification by the customer to the component the UL compliance is to be verified.

☞ **Loss of UL conformity due to assembly with not UL compliant components.**

The UL marking is only valid for an assembly if all components used in the assembly are UL compliant.

3.4.6 RoHS

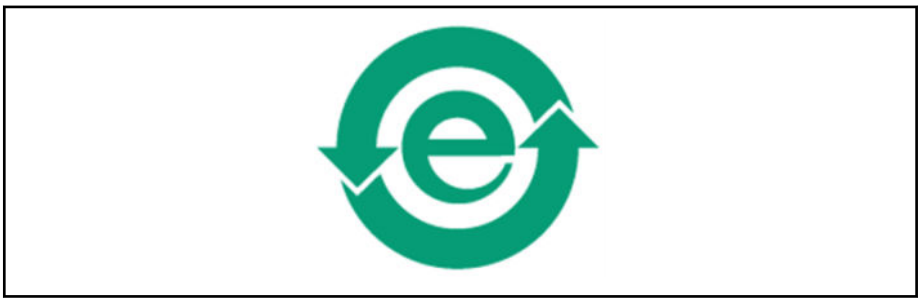

Fig. 3-3: China RoHS 2 marking

The above mentioned components, comply with the requirements of the Administrative Measures for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products, known as China RoHS 2.

4 System Overview

4.1 Hardware Architecture

The NYCe 4000 system is intended for the high-end motion control market.

The hardware of the NYCe 4000 system consists of:

- a node, containing slide-in modules that perform the functions needed in the system
- an industrial PC that controls the functions present within the motion node, using a IEEE 1394b or IEEE 802.3 electrical connection

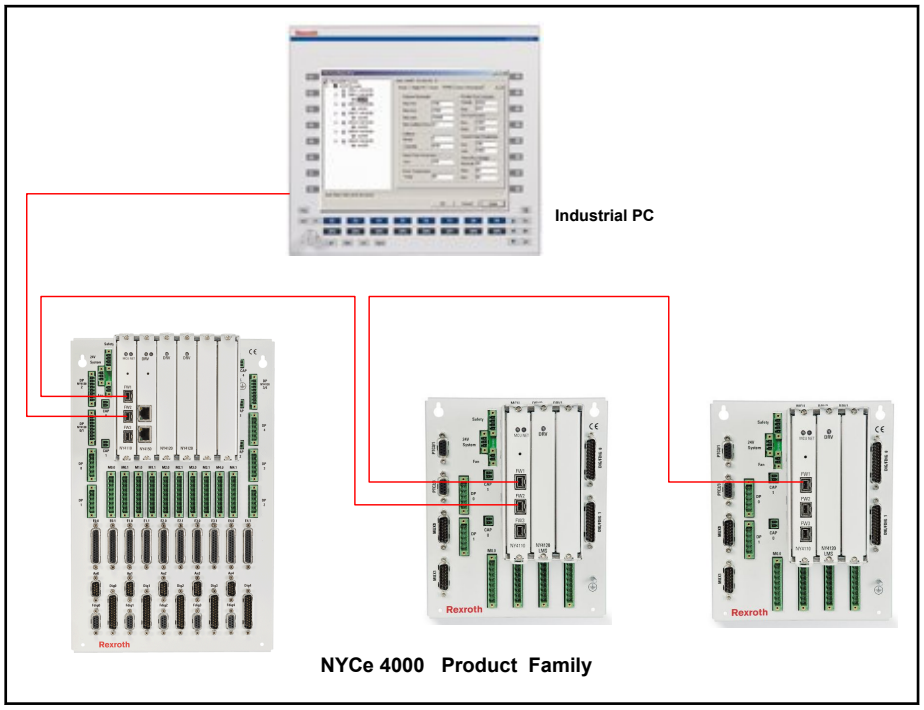

Fig. 4-1: NYCe 4000 Motion system

The motion node is a multiple axis controller with servo amplifiers included. It is a modular and flexible concept for 1 to 10 axes. For different axes, there are many variations for the interface electronics to the physical world, regarding

- power requirements of the servo motors,
- types of motors,
- types of position sensor interfaces,
- and amount of axis related I/O.

A motion node has one central processor module (motion control unit or MCU) with an IEEE 1394b or IEEE 802.3 interface, and executes the general node software. The axis drive modules are connected to this MCU. The drive modules contain all axis I/O and servo amplifier(s), see chapter 4.2 "Motion Node Modules" on page 30.

The modules are mounted in a system housing with a backplane that arranges the connections to system power, servo power, motors, encoders and I/O, see chapter 4.3 "System housing with backplane" on page 32.

The main features of the NYCe 4000 motion node hardware are the following.

- Use of IEEE 1394b or IEEE 802.3 for communication with the industrial PC and between the nodes.
- User-developed application support.
- Drive technology fully integrated in drive modules for stepper motor, DC motor and brushless motor support up to 150 Volts / 20 Ampere peak.
- Digital I/O and analog I/O integrated in the drive modules.
- Position sensor connectivity (for example incremental quadrature encoders, SinCos, etc.)
- Maximum 10 axes per node.

4.2 Motion Node Modules

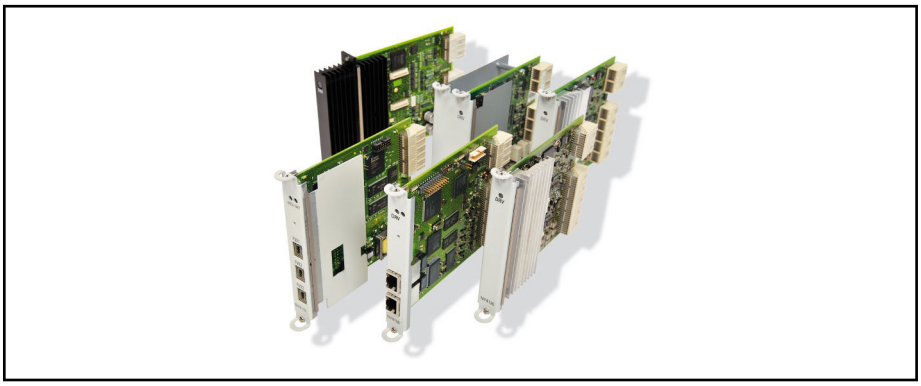

Fig. 4-2: NYCe 4000 motion modules

A NYCe 4000 system contains one motion control unit and one or more drive modules.

Motion control unit (MCU)

The NY4110 MCU uses IEEE 1394b to communicate with the host PC and other nodes. The NY4112 and NY4114 MCU use IEEE 802.3 to communicate with the host PC and other nodes. The MCU communicates via the system backplane with the drive modules. The MCU also generates all power supply voltages required by the logic of the drive modules in the node. One MCU is required for every NYCe 4000 motion node. The NY4110 MCU module is described in detail in chapter 5 "NY4110: MCU Module" on page 35. The NY4112 MCU module is described in detail in chapter 6 "NY4112: Ethernet MCU Module" on page 43. The NY4114 MCU module is described in detail in chapter 7 "NY4114: Ethernet MCU Module" on page 51.

Drive modules

A drive module contains the technology for driving different types of motors and provides analog and digital I/O. The following types of drive modules are available for the NYCe 4000 system:

- NY4120, which can drive two axes of the following motor types:
  - brushless DC
  - brushless AC
  - brushed DC

  - stepper

  The NY4120 is described in chapter 8 "NY4120 and NY4120/10: PWM Drive Module" on page 63.

- NY4125, which can drive five axes of the following motor types:
  - brushless AC
  - brushed DC

  The NY4125 is described in chapter 9 "NY4125: 5-axis low power PWM Drive Module" on page 87.
- NY4130, which can drive two brushed DC motors.

  The NY4130 is described in chapter 10 "NY4130: DC Drive Module" on page 105.
- NY4140, which can drive one axis of the following motor types:
  - brushless DC
  - brushless AC
  - brushed DC

  The NY4140 is described in chapter 11 "NY4140: High Voltage Drive Module" on page 127.
- NY4150, module with a Drivelink connection based on the SERCOS III standard hardware to connect IndraDrive amplifiers of Bosch Rexroth.

  The NY4150 is described in chapter 12 "NY4150 and NY4150/10: SERCOS III Master Module" on page 151.

fig. 4-3 "Basic structure (example) of NYCe 4000 motion node" on page 31 gives an overview of the NYCe 4000 node structure, with the MCU and some of the drive modules.

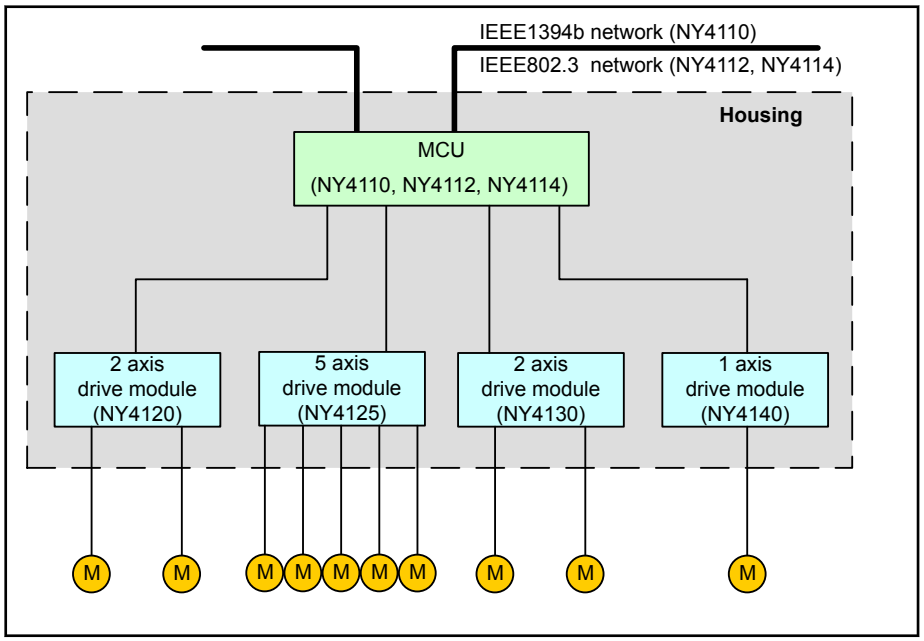

Fig. 4-3: Basic structure (example) of NYCe 4000 motion node

4.3 System housing with backplane

The NYCe 4000 motion node has a slot principle. The MCU and drive modules are placed next to each other in the mechanical system housing, resulting in a specific type and placement of the corresponding connectors. The number of slots is customer's application specific. The first (left) slot is always for the MCU, the following slot or slots are for the drive module(s).

The MCU and drive modules are connected to the system backplane which contains the module slots and connectors.

Several types of standard system housings (with corresponding backplanes) are available, see "NYCe 4000 Standard Housings & Accessories" for more information.

- NY4013: 1 drive slot system housing
- NY4023: 2 drive slots system housing
- NY4033: 3 drive slots system housing
- NY4043: 4 drive slots system housing
- NY4053: 5 drive slots system housing
- NY4063: 3 drive slots system housing, specific for NY4125
- NY4074: LMS 2 drive slots system housing
- NY4079: LMS 1 drive slot system housing for IndraDrive

A NYCe 4000 backplane consists of a system backplane and an I/O backplane.

System backplane

The system backplane is an interconnection between the MCU and the drive modules. It is used for internal node communication between the modules and the distribution of the necessary supply voltages, generated on the MCU, to all the drive modules. On this backplane the interconnection is made between the following parts.

- The motion control MCU module (NY4110, NY4112, NY4114)
- The drive module (NY4120, NY4120/10, NY4125, NY4130, NY4140, NY4150, NY4150/10)
- 24V system power supply
- Service inputs

I/O backplane

The I/O backplane is a connection panel between drive modules, and motor and I/O connectors. It is used for interconnecting the field I/O from the customer specific connectors with the drive connectors and for distributing the drive power supply. The position of the customer specific connectors for a drive, are mostly below the corresponding drive module. On this backplane the interconnection is made between the following parts.

- The drive module (NY4120, NY4120/10, NY4125, NY4130, NY4140, NY4150, NY4150/10)
- Customer specific connections
- 24V I/O power supply (part of customer specific connections)
- Drive power supply (part of customer specific connections)

fig. 4-4 "Backplanes in the node structure" on page 33 shows the place of the backplanes in the NYCe 4000 node structure.

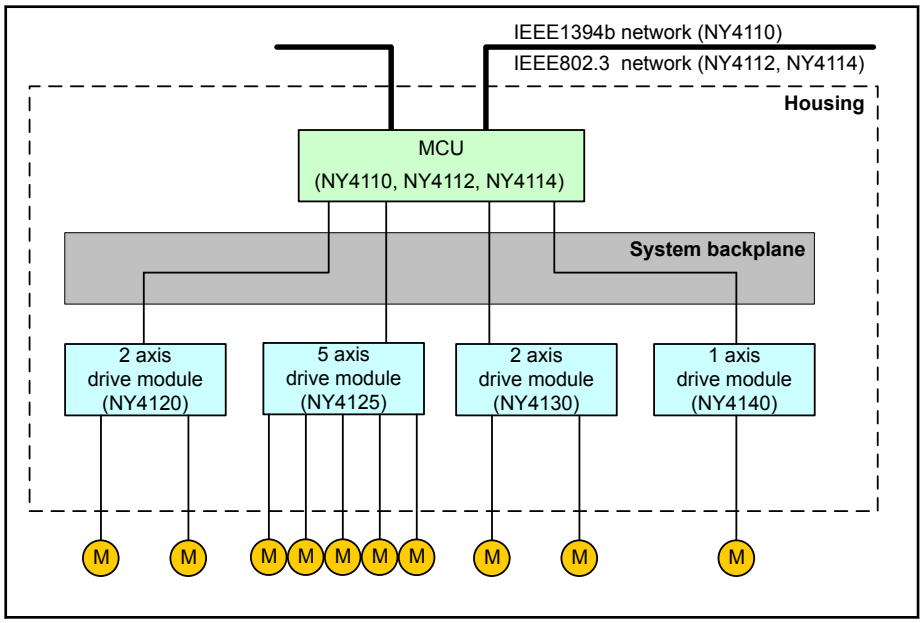

Fig. 4-4: Backplanes in the node structure

5 NY4110: MCU Module

5.1 Overview

The NY4110 is the motion control unit (MCU) in a NYCe 4000 motion node. The MCU can control up to 10 axes and support a maximum of 5 drive modules. The MCU connects the motion node to a network with an IEEE 1394b interface. Additionally it supports two central inputs for entering service mode and axes stop within the node. Part number is R911318960, ordering code is NYM04.1-MCU-NNNN-NY4110.

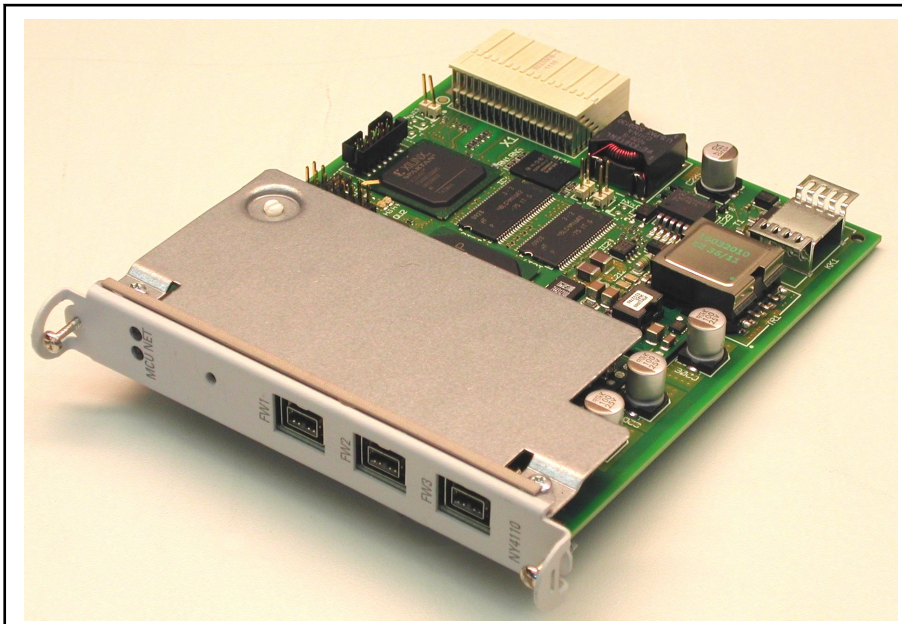

Fig. 5-1: MCU module NY4110

NY4110 main features:

- 3x IEEE 1394b interface connectors (IEEE 1394b cable length ≤ 4.5 m)
  - The IEEE 1394b connections provide galvanic insulation between nodes and the network.
  - The MCU does not supply power to the IEEE 1394b connections, nor does it consume power from the IEEE 1394b connections. The MCU has no provision to enable power supply to the IEEE 1394b connections. If power from an external source is supplied to a IEEE 1394b connector, this power is not passed on to the other IEEE 1394b connectors.
- Interconnect up to 5 drive modules
- Control lines (service mode and axes stop)
- Program and debug features
- Insulated power supply for on-board logic and drive modules logic

☞ Only NYCe 4000 Software Releases **before** 50VRS are supported.

5.2 Module identification

An identification label is attached on the NY4110 module.

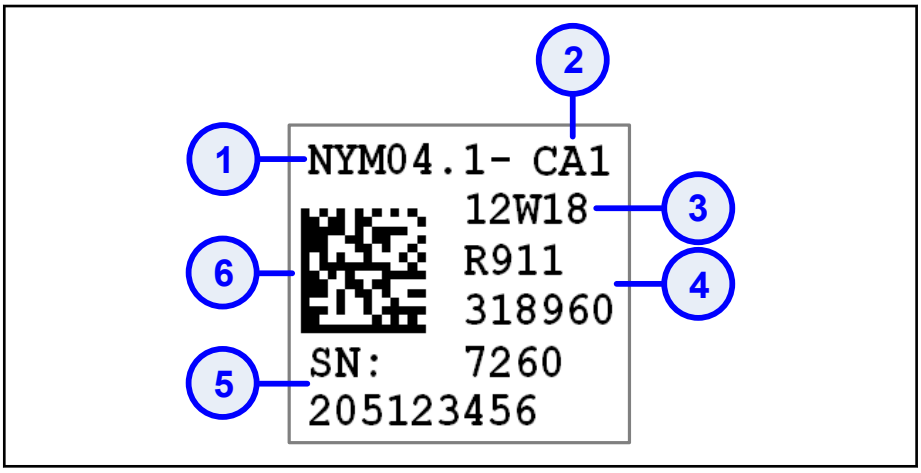

Fig. 5-2: Identification label of the NY4110

Identification number	Field explanation
1	Type code
2	Version level and status
3	Date of manufacture (yyWww)
4	Material number
5	Serial number
6	2D bar code

Tab. 5-1: Explanation of the fields of the NY4110 identification label

5.3 Module dimensions

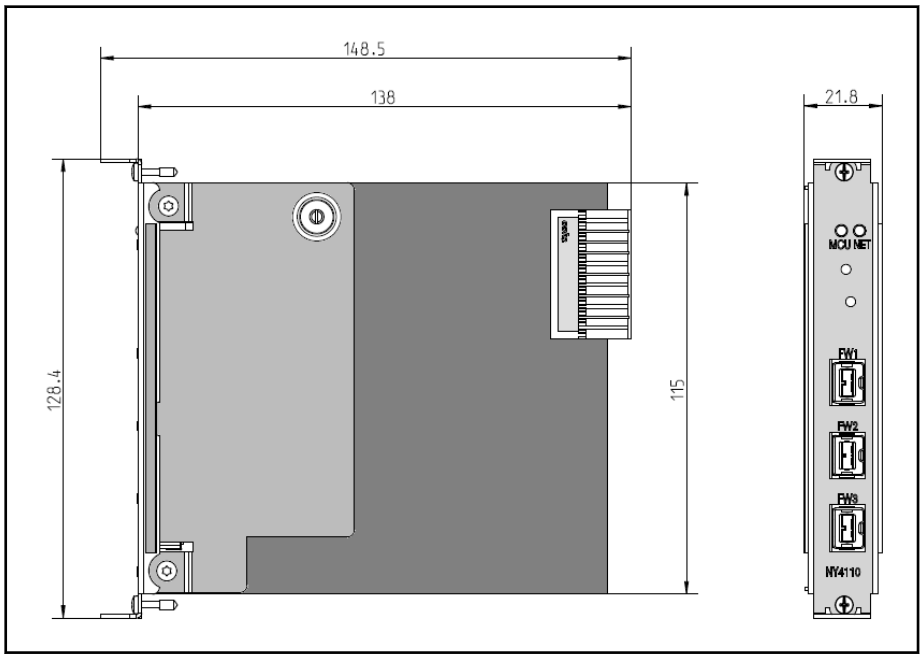

Fig. 5-3: NY4110 module dimensions

Module type code	Width	Height	Depth	Weight
NYM04.1-MCU-NNNN-NY4110	21.8 mm	128.4 mm	148.5 mm	350 gr

Tab. 5-2: NY4110 physical data

5.4 Field Diagnostics

The module does not contain any replaceable or wear parts. In case of failure, the entire module must be replaced.

The NY4110 module has 2 bi-color module status indicator LEDs on the front panel labeled "MCU" at the left side and "NET" at the right side.

- "MCU" – Module status indicator
- "NET" – IEEE 1394b network status indicator

The indications of the status indicator LEDs are described in tab. 5-3 ""MCU" status LED indications" on page 37 and tab. 5-4 ""NET" status LED indications" on page 38.

LED indication (visible color)	Description
Green flashing	POST (Power On Self Test) in progress.
Green continuously	Result of POST is OK. Node initialization successfully completed.
Orange continuously	Initializing node.
Red flashing	Start-up failure.
Red continuously	Result of POST is ERROR.

Tab. 5-3: "MCU" status LED indications

LED indication (visible color)	Description
Green continuously	Normal operation.
Red continuously	Network initialization failed. Network communication error. Power off/on needed.
Orange continuously	Firmware initialization. Approximately 0.5 s depends on the node configuration (drives, axes, I/O). Normal operation after a network error.
Green flashing approximately 1 Hz (duty cycle 50%)	Normal operation and node selected in NYCeConfigurator.
Green continuously, alternated with orange flashing at varying duty cycle	Normal operation. Network communication active. Duty cycle of orange flashes depends on amount of communication. More communication messages indicated by higher orange intensity.
Green flashing, alternated with red flashing at varying duty cycle	Normal operation and node selected in NYCeConfigurator. Network communication active. Duty cycle of red flashes depends on amount of communication. More communication messages indicated by higher red intensity.
Orange flashing, alternated with red flashing at approximately 1 Hz	Network communication error and node selected in NYCeConfigurator.

Tab. 5-4: "NET" status LED indications

5.5 24V System power supply

The 24 V power supply generates all the supply voltages for the following components.

- MCU module installed in the system housing
- All drive modules installed in the system housing
- All encoders connected to the system housing

Characteristic	Description
Input voltage	+24 V ± 5%
Current	Typical 6.5W (0.27A), power supply required for connected drive modules and encoders not included. Support inrush currents of 3A (6A for 10 ms), to prevent startup problems.

Tab. 5-5: NY4110 24V System power supply

When you determine the system power supply requirements of the 24V power supply, you must take into account that the external power supply must be able to deliver this power at a voltage lower than the nominal voltage of 24V. The MCU module incorporates a converter for all other voltages required by the logic in the node. At the moment that this converter switches on, the external power supply must be able to supply the full power required for the entire node, including the connected encoders. The minimum level at which the converter switches on is 16.2V. This means that the external power supply should be able to deliver at least 1.5 times the nominal current at 24V required for the node. The chosen external system power supply must be able to fulfil this current requirement, and must support inrush currents of 3A (6A for 10 ms) to prevent startup problems.

5.6 Service Mode and Stop Axes Inputs

Characteristic	Description
Number of digital inputs	2: INP_Service_Mode, INP_Stop_Axes
Functions	Enter service mode Stop all axes in node
High and low side switching	Possible (for both inputs)
Galvanic insulated	Yes
Switch time (Filter delay)	Typical 100 µs
Permitted input voltage	–30 V ... +30 V
Input high level	15 V ... +30 V –15 V ... –30 V
Input low level	–5 V ... +5 V
Input current @ 24V	Nominal 3,5 mA
Jitter on switching times	Typical 20 µs

Tab. 5-6: Characteristics of the digital inputs

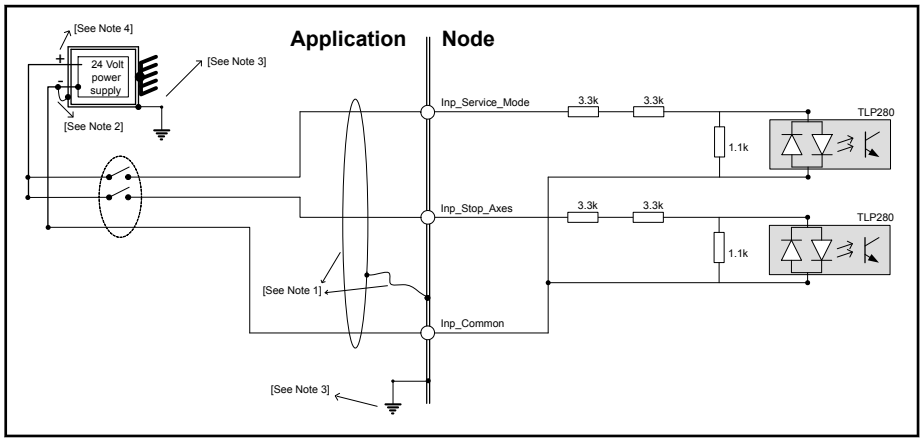

Fig. 5-4: Service_Mode and Stop_Axes inputs

Use the following cabling instructions.

1. • Shielded cable is recommended, but not mandatory. If shielded cable is used, the shielding on the NYCe 4000 side of the cable must be connected to Shield (housing connector).

   Connect the other side to a convenient metal part or leave it open,

   • Both inputs may be associated with more than one power supply, and/or the cable may contain more than one minus for power supply. If this is the case and if the cable is unshielded, connect at least one of the minus wires of each power supply to Shield (housing connector).
2. Connect the minus of the I/O power supply to the housing and/or safety earth (if this is not already the case).
3. Connect the NYCe 4000, power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. Both inputs can be used either as high side switching (HSS) - or as low side switching LSS).

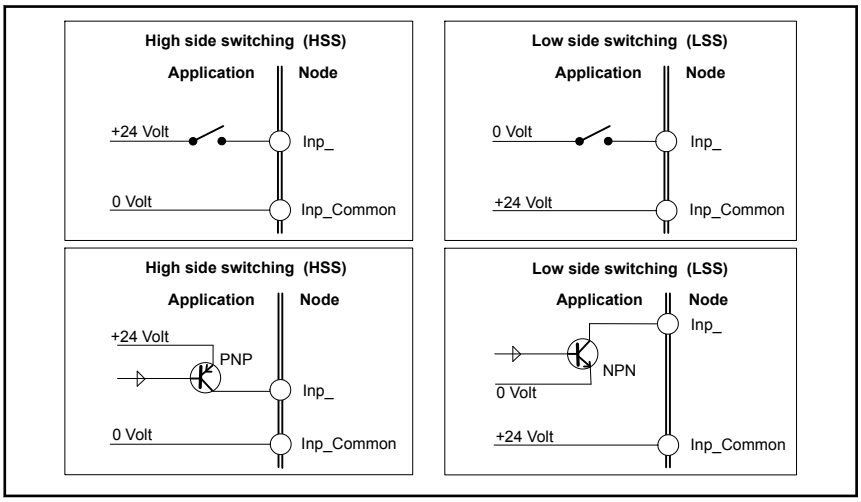

Fig. 5-5: HSS and LSS

5.7 FW1, FW2, FW3 connection information

Characteristic	Description
Cable length	max 4.5 m.
Type of cable	IEEE 1394b

Tab. 5-7: Connection cable characteristics

See also NYCe 4000 Standard Housings & Accessories, chapter "NY4950: IEEE 1394b Cables and Chokes".

5.8 Installation requirements

5.8.1 Before you begin

⚠ WARNING **Damage to components may occur if power is applied during installation or removal.**

- Make sure power supplies are switched off before installation or removal of the system housing.
- Do not apply power until the MCU module is installed.

⚠ WARNING **Damage to components may occur due to electrostatic discharges.**

- Comply with all ESD protective measures while working with modules and components. Avoid electrostatic discharges.

5.8.2 Cable connections

The NY4110 uses IEEE 1394b connection cables to connect to other nodes and the host. See chapter 14 "Network" on page 207 for more information about the network connection. The connections to the IEEE 1394b network are located on the front of the NY4110. Some form of network cable strain relief is required for this connection type. The cable with a IEEE 1394b connector needs a strain relief, because the connector does not support a locking mechanism. The NY4901 strain relief bracket is developed for this purpose. See the NYCe 4000 Standard Housings and Accessories manual for detailed information about the NY4901.

Make sure that your machine design has sufficient free clearance space in front of the NY4110 for a cable strain relief (for example the NY4901 bracket) and the maximum allowed bending of the IEEE 1394b cable. As rule of thumb, 100 mm should suffice.

☞ You must use some form of strain relief for the connection cables to the NY4110 to ensure reliable connections.

6 NY4112: Ethernet MCU Module

6.1 Overview

The NY4112 is the motion control unit (MCU) in a NYCe 4000 motion node. The MCU can control up to 10 axes and support a maximum of 5 drive modules. The MCU connects the motion node to a network with an IEEE 802.3 (Ethernet) interface. Additionally it supports two central inputs for entering service mode and axes stop within the node. Part number is R911173007, ordering code is NYM04.1-MCU-ETHER-NY4112.

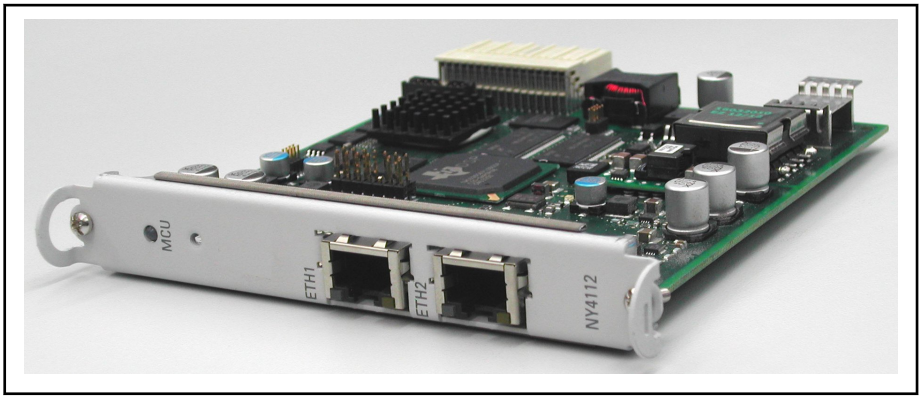

Fig. 6-1: MCU module NY4112

NY4112 main features:

- 2x IEEE 802.3 Ethernet interface connectors (1000BASE-T / 100BASE-TX)
  - Both interfaces support auto-MDIX (automatic cable cross-over detection).
  - Standard IEEE 802.3 network cable, Cat-5e UTP (or better) for 1000BASE-T, Cat-5 UTP (or better) for 100BASE-TX. Cable length ≤ 100 m)
  - The IEEE 802.3 connections provide galvanic insulation between nodes and the network.
  - The MCU does not supply power to the IEEE 802.3 connections, nor does it consume power from the IEEE 802.3 connections. The MCU has no provision to enable power supply to the IEEE 802.3 connections. If power from an external source is supplied to a IEEE 802.3 connector, this power is not passed on to the other IEEE 802.3 connectors.
- Interconnect up to 5 drive modules
- Control lines (service mode and axes stop)
- Program and debug features
- Insulated power supply for on-board logic and drive modules logic

☞ Only NYCe 4000 Software Releases **before** 50VRS are supported.

6.2 Module identification

An identification label is attached on the NY4112 module.

NY4112: Ethernet MCU Module

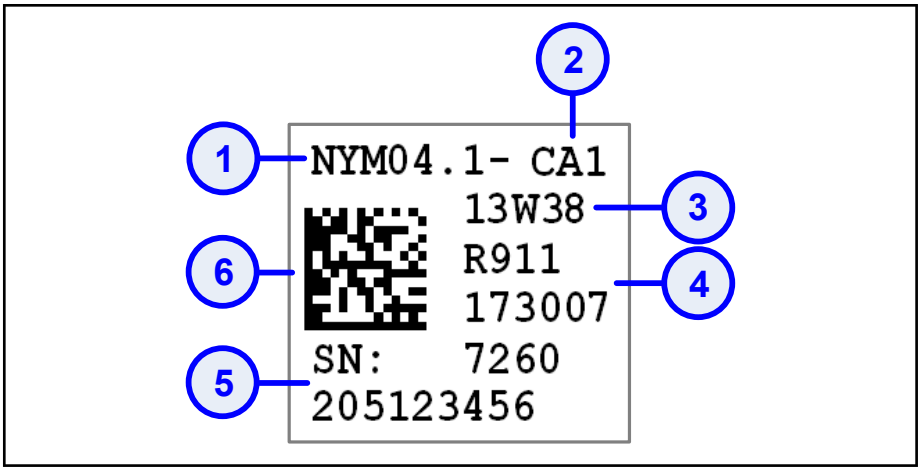

Fig. 6-2: Identification label of the NY4112

Identification number	Field explanation
1	Type code
2	Version level and status
3	Date of manufacture (yyWww)
4	Material number
5	Serial number
6	2D bar code

Tab. 6-1: Explanation of the fields of the NY4112 identification label

6.3 Module dimensions

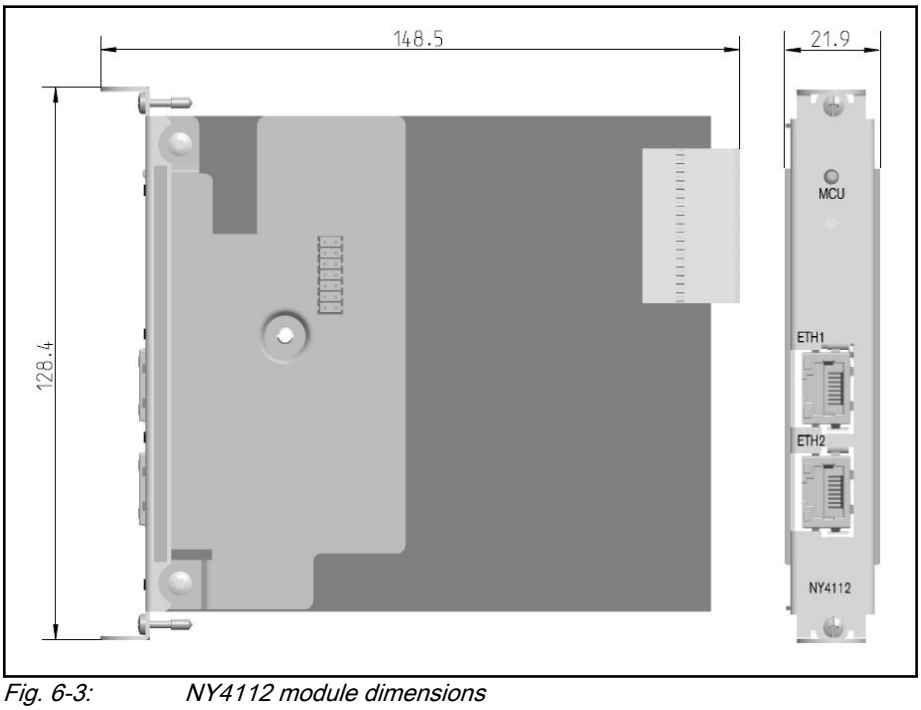

Fig. 6-3: NY4112 module dimensions

Module type code	Width	Height	Depth	Weight
NYM04.1-MCU-ETHER-NY4112	21.9 mm	128.4 mm	148.5 mm	400 gr

Tab. 6-2: NY4112 physical data

6.4 Field Diagnostics

The module does not contain any replaceable or wear parts. In case of failure, the entire module must be replaced.

The NY4112 module has one bi-color module status indicator LED on the front panel labeled "MCU".

LED indication (visible color)	Description
Green flashing	POST (Power On Self Test) in progress.
Green continuously	Result of POST is OK. Node initialization successfully completed.
Orange continuously	Initializing node.
Red flashing	Start-up failure.
Red continuously	Result of POST is ERROR.

Tab. 6-3: "MCU" status LED indications

Ethernet network connections

The NY4112 module has two RJ45 ("Ethernet") headers on the front panel. Each RJ45 header has 2 LEDs incorporated at the left side of the header.

- The upper LED (green or orange) is the speed indicator. Factory default, the LED is green to indicate a network speed of 100 Mbps and orange to indicate a network speed of 1 Gbps. This behavior can change depending on the installed NYCe 4000 firmware.
- The lower LED (yellow) is the link/activity indicator. The LED is illuminated when the Ethernet cable is correctly connected, and flashes to indicate that data is transported over the Ethernet connection.

The default (static) IP address of the NY4112 MCU is 192.168.41.12. The network mask is 255.255.255.0 and no default gateway IP address is set (0.0.0.0).

6.5 24V System power supply

The 24 V power supply generates all the supply voltages for the following components.

- MCU module installed in the system housing
- All drive modules installed in the system housing
- All encoders connected to the system housing

NY4112: Ethernet MCU Module

Characteristic	Description
Input voltage	+24 V ± 5%
Current	Typical 10.3W (0.43A), power supply required for connected drive modules and encoders not included. Support inrush currents of 3A (6A for 10 ms), to prevent startup problems.

Tab. 6-4: NY4112 24V System power supply

When you determine the system power supply requirements of the 24V power supply, you must take into account that the external power supply must be able to deliver this power at a voltage lower than the nominal voltage of 24V. The MCU module incorporates a converter for all other voltages required by the logic in the node. At the moment that this converter switches on, the external power supply must be able to supply the full power required for the entire node, including the connected encoders. The minimum level at which the converter switches on is 16.2V. This means that the external power supply should be able to deliver at least 1.5 times the nominal current at 24V required for the node. The chosen external system power supply must be able to fulfil this current requirement, and must support inrush currents of 3A (6A for 10 ms) to prevent startup problems.

6.6 Service Mode and Stop Axes Inputs

Characteristic	Description
Number of digital inputs	2: INP_Service_Mode, INP_Stop_Axes
Functions	Enter service mode Stop all axes in node
High and low side switching	Possible (for both inputs)
Galvanic insulated	Yes
Switch time (Filter delay)	Typical 100 µs
Permitted input voltage	–30 V ... +30 V
Input high level	15 V ... +30 V –15 V ... –30 V
Input low level	–5 V ... +5 V
Input current @ 24V	Nominal 3,5 mA
Jitter on switching times	Typical 20 µs

Tab. 6-5: Characteristics of the digital inputs

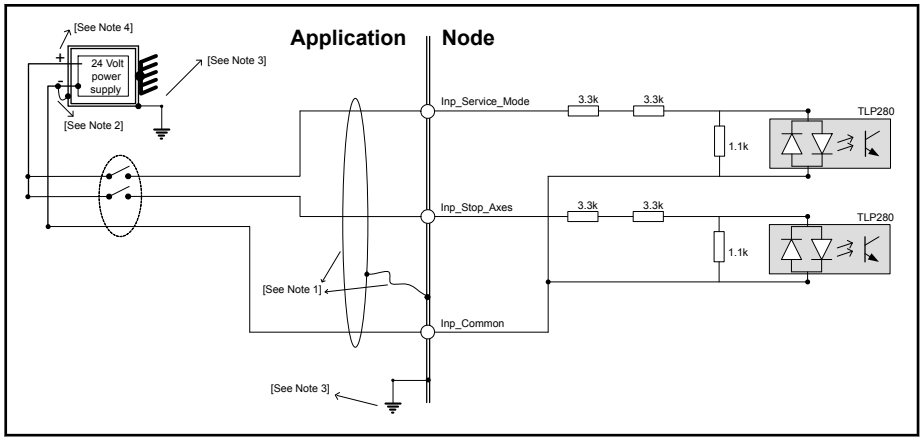

Fig. 6-4: Service_Mode and Stop_Axes inputs

Use the following cabling instructions.

1. - Shielded cable is recommended, but not mandatory. If shielded cable is used, the shielding on the NYCe 4000 side of the cable must be connected to Shield (housing connector).

     Connect the other side to a convenient metal part or leave it open,

   - Both inputs may be associated with more than one power supply, and/or the cable may contain more than one minus for power supply. If this is the case and if the cable is unshielded, connect at least one of the minus wires of each power supply to Shield (housing connector).
2. Connect the minus of the I/O power supply to the housing and/or safety earth (if this is not already the case).
3. Connect the NYCe 4000, power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. Both inputs can be used either as high side switching (HSS) - or as low side switching LSS).

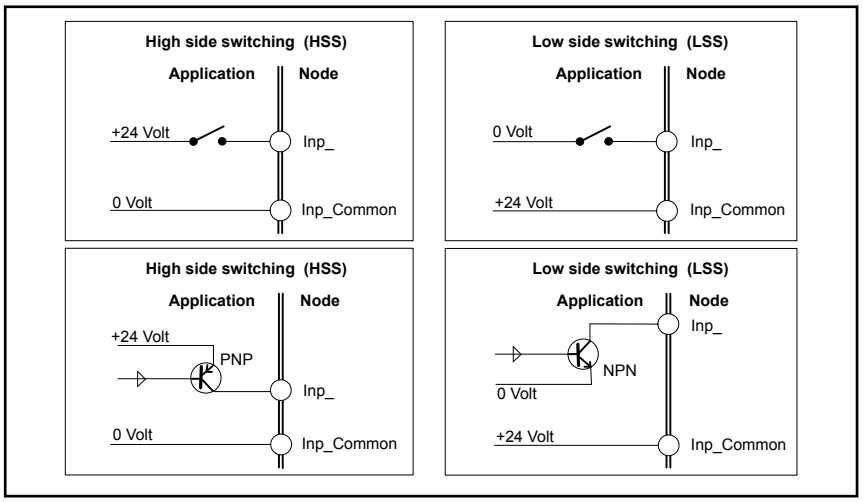

Fig. 6-5: HSS and LSS

6.7 ETH1, ETH2 connection information

Characteristic	Description
Cable length	max 100 m.
Type of cable	Crossed or straight
transmission speed 100 Mbps (100BASE-TX)	IEEE 802.3 Cat-5 UTP or better
transmission speed 1 Gbps (1000BASE-T)	IEEE 802.3 Cat-5e UTP or better
Default IP address (IPv4)	192.168.41.12
Default subnet mask	255.255.255.0
Default gateway	0.0.0.0

Tab. 6-6: Connection cable characteristics

6.8 Installation requirements

6.8.1 Before you begin

⚠ WARNING **Damage to components may occur if power is applied during installation or removal.**

- Make sure power supplies are switched off before installation or removal of the system housing.
- Do not apply power until the MCU module is installed.

⚠ WARNING **Damage to components may occur due to electrostatic discharges.**

- Comply with all ESD protective measures while working with modules and components. Avoid electrostatic discharges.

6.8.2 Cable connections

The NY4112 uses Ethernet connection cables to connect to an other node and the host. See chapter 14 "Network" on page 207 for more information about the network connection. The connections to the Ethernet network are located on the front of the NY4112. Some form of network cable strain relief is advised. You can use the NY4901/10 strain relief bracket which is developed for the NY4112. See the NYCe 4000 Standard Housings and Accessories manual for detailed information.

Make sure that your machine design has sufficient free clearance space in front of the NY4112 for an optional cable strain relief (for example the NY4901/10 bracket) and the maximum allowed bending of the Ethernet cable. Consult the specifications of the cable manufacturer for details.

6.8.3 Environmental conditions

Free clearance is required below and above the system housing in which the NY4112 is installed to guarantee sufficient free air flow. See the NYCe 4000 Standard Housings and Accessories manual for detailed information.

Forced cooling is required, if the NY4112 is used in an environment temperature of 40 °C or higher. See NYCe 4000 Standard Housings and Accessories manual for fan units that mount on the system housing.

7 NY4114: Ethernet MCU Module

7.1 Overview

The NY4114 is the motion control unit (MCU) in a NYCe 4000 motion node. The NY4114 MCU supports a higher level of motion control performance and functionality compared to the NY4110 and NY4112 MCUs. The NY4114 is an expansion of the NYCe 4000 MCU family. The NY4114 MCU enables higher sample performance and supports customer applications running on the node. These customer applications are called Embedded Applications. The NY4114 MCU can control up to 10 axes and support a maximum of 5 drive modules. The NY4114 MCU connects the node to a NYCe 4000 network with an IEEE 802.3 (ethernet) interface. Additionally, it supports two central inputs for entering service mode and axes stop within the node. Part number is R911173598, ordering code is NYM04.1-MCU-ETHER-NY4114.

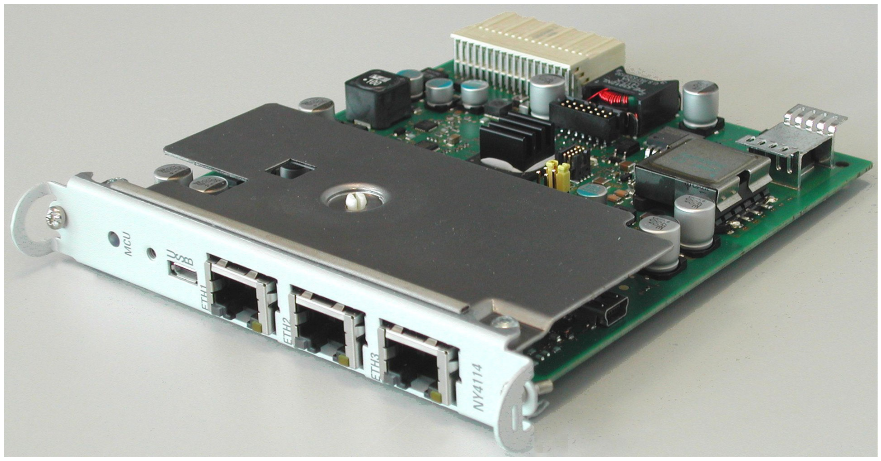

Fig. 7-1: MCU module NY4114

NY4114 main features

- 3 ethernet interface connections to build a NYCe 4000 network
  - The ethernet interfaces support 1000BASE-T and 100BASE-TX and auto-MDIX (automatic cable cross-over detection)
  - Standard ethernet network cable, Cat-5e UTP (or better) for 1000BASE-T, Cat-5 UTP for 100BASE-TX. Cable length ≤ 100 m.
  - The ethernet connections provide galvanic insulation between the node and the network.
  - The MCU does not supply power to the ethernet connections, nor does it consume power from the ethernet connections. The MCU has no provision to enable power supply to the ethernet connections. If power from an external source is supplied to an ethernet connection, this power is not passed on to the other ethernet connections.
- Interconnect up to 5 drive modules
- Control lines (service mode and axes stop)
- Program and debug features
- Linux operating system for on-board program environment for application software (Embedded Applications)

- System software recovery restart option
- 1 GB flash memory for firmware, gateware, Linux OS and Embedded Applications
- 1 GB SDRAM for Linux OS, Embedded Applications, RAM file system etc.
- One microUSB "On-The-Go" USB 2.0 port. Support for a memory stick to read and write flash memory on the NY4114 module.
- One microSD slot accessible when the NY4114 module is not installed in a system housing. The microSD slot is located on the rear side of the MCU module at the top side. The SDHC card can be used to upload Embedded Applications, logging, machine parameters and XML configuration files.
- Insulated power supply for on-board logic, drive modules and encoders

NYCe 4000 Software Release 50VRS or higher is required.

7.2 Module identification

An identification label is attached on the NY4114 module.

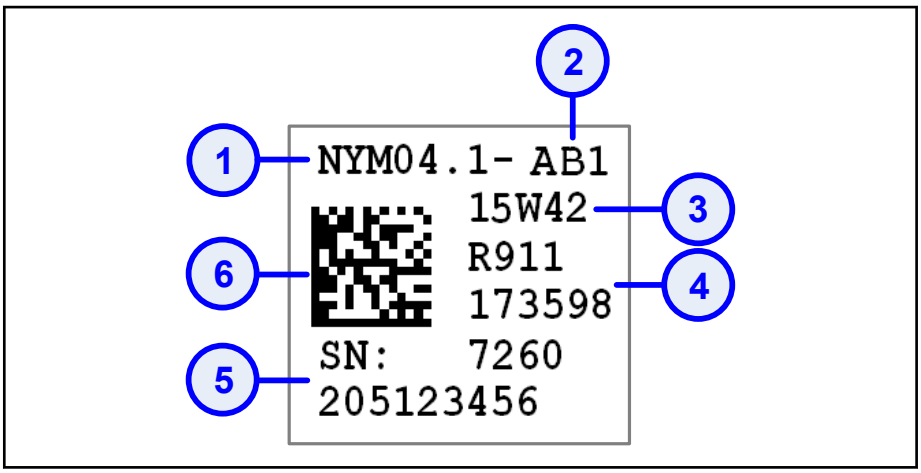

Fig. 7-2: Identification label of the NY4114

Identification number	Field explanation
1	Type code
2	Version level and status
3	Date of manufacture (yyWww)
4	Material number
5	Serial number
6	2D bar code

Tab. 7-1: Explanation of the fields of the NY4114 identification label

7.3 Module dimensions

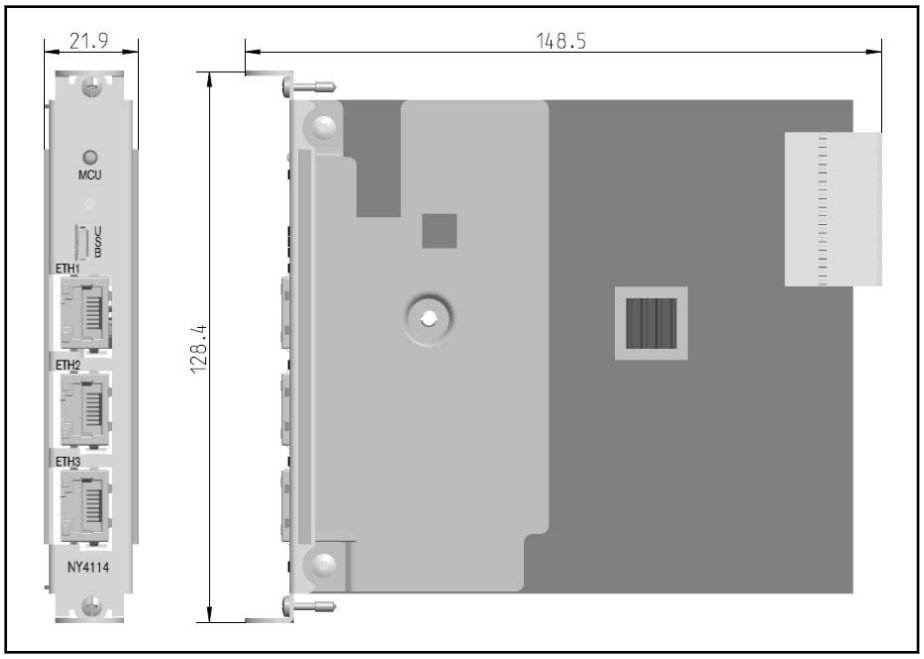

Fig. 7-3: NY4114 module dimensions

Module type code	Width	Height	Depth	Weight
NYM04.1-MCU-ETHER-NY4114	21.9 mm	128.4 mm	148.5 mm	230 gr

Tab. 7-2: NY4114 physical data

7.4 Field Diagnostics

The module does not contain any replaceable or wear parts. In case of failure, the entire module must be replaced.

The NY4114 module has one module status indicator LED on the front panel labeled "MCU". The status indicator LED is set to a specific continuous color, or flashes in one specific color or two specific colors and the flash frequency can be slow (0.5 Hz) and fast (2 Hz). You can see from the status indicator LED when the problem occurred. The status indicator LED also indicates normal operation mode states.

MCU LED state "continuous off or on"

Off	Red	Orange	Green
No 24V System power On-board power supply failure → replace board	Hardware start-up failure Hardware boot failure Hardware POST failure → replace board	2nd level boot problem - Linux problem - 2nd level boot error → restart board	Normal operation mode

Tab. 7-3: MCU LED continuous states

NY4114: Ethernet MCU Module

MCU LED state "slow flashing" (0.5 Hz)

first color	second color			
	Off	**Red**	**Orange**	**Green**
Red	Bootloader running Check EEPROM, flash memory failure EEPROM not OK and no write jumper	-	Recovery bootloader start-up Recovery bootloader failure	-
Orange	2nd level boot problem - Motion daemon failure - 2nd level boot error	-	-	Recovery boot active ① → switch 24V System off/on Flash memory failure
Green	Normal operation mode and node selected by NYCeConfigurator	-	-	-

① While the MCU is in recovery mode, the node is not visible in the tree view of the NYCe 4000 tools.

Tab. 7-4: MCU LED slow flashing states

MCU LED state "fast flashing" (2 Hz)

first color	second color			
	Off	**Red**	**Orange**	**Green**
Red	Bootloader start-up Bootloader failure	-	Bootloader running Flash memory programming failure Restart failure	-
Orange	2nd level boot problem - 2nd level boot error	-	-	Recovery boot active (forced by jumper) ①
Green	Normal operation mode and multi-node system: network stable, nodes synchronizing	-	-	-

① While the MCU is in recovery mode, the node is not visible in the tree view of the NYCe 4000 tools.

Tab. 7-5: MCU LED fast flashing states

Ethernet network connections

The NY4114 module has 3 RJ45 ("ethernet") sockets on the front panel. Each RJ45 socket has 2 LEDs incorporated at the left side of the socket.

- The upper LED (green or orange) is the speed and link status indicator. The LED is green to indicate a network speed of 1000 Mbps and orange to indicate a network speed of 100 Mbps. The LED is off when the link is not active.
- The lower LED (yellow) is the activity indicator. The LED is illuminated when data is transported over the ethernet connection.

The default (static) IP address of the NY4114 MCU is 192.168.41.14. The network mask is 255.255.255.0 and no default gateway IP address is set (0.0.0.0).

7.5 24V System power supply

The 24 V power supply generates all the supply voltages for the following components.

- MCU module installed in the system housing
- All drive modules installed in the system housing
- All encoders connected to the drive modules
- USB port

Characteristic	Description
Input voltage	+24 V ± 5%
Current	Typical 7.2W (0.3A), power supply required for connected drive modules, encoders, microUSB and microSD card not included. Support inrush currents of 3A (6A for 10 ms), to prevent startup problems.

Tab. 7-6: NY4114 24V System power supply

When you determine the system power supply requirements of the 24V power supply, you must take into account that the external power supply must be able to deliver this power at a voltage lower than the nominal voltage of 24V. The MCU module incorporates a converter for all other voltages required by the logic in the node. At the moment that this converter switches on, the external power supply must be able to supply the full power required for the entire node, including the connected encoders. The minimum level at which the converter switches on is 16.2V. This means that the external power supply should be able to deliver at least 1.5 times the nominal current at 24V required for the node. The chosen external system power supply must be able to fulfil this current requirement, and must support inrush currents of 3A (6A for 10 ms) to prevent startup problems.

USB port and encoders

The USB port and the encoders (connected to the drive modules) share the same power supply on the NY4114 module. The output of this power supply is 5.25V and the maximum current is 4A. The USB 2.0 specification specifies a maximum current of 500 mA for a connected USB device. However, if the connected encoders require more than 3.5A, the current available for the USB device decreases. The USB port on the NY4114 module is designed for memory sticks. These devices require typically less than 100 mA.

7.6 Service Mode and Stop Axes Inputs

Characteristic	Description
Number of digital inputs	2: INP_Service_Mode, INP_Stop_Axes
Functions	Enter service mode Stop all axes in node

NY4114: Ethernet MCU Module

Characteristic	Description
High and low side switching	Possible (for both inputs)
Galvanic insulated	Yes
Switch time (Filter delay)	Typical 100 µs
Permitted input voltage	–30 V ... +30 V
Input high level	15 V ... +30 V –15 V ... –30 V
Input low level	–5 V ... +5 V
Input current @ 24V	Nominal 3,5 mA
Jitter on switching times	Typical 20 µs

Tab. 7-7: Characteristics of the digital inputs

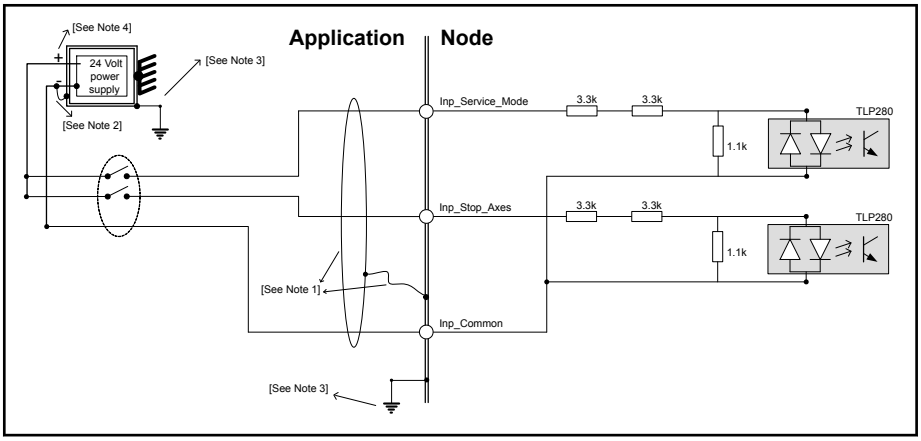

Fig. 7-4: Service_Mode and Stop_Axes inputs

Use the following cabling instructions.

1. • Shielded cable is recommended, but not mandatory. If shielded cable is used, the shielding on the NYCe 4000 side of the cable must be connected to Shield (housing connector).

   Connect the other side to a convenient metal part or leave it open,

   • Both inputs may be associated with more than one power supply, and/or the cable may contain more than one minus for power supply. If this is the case and if the cable is unshielded, connect at least one of the minus wires of each power supply to Shield (housing connector).
2. Connect the minus of the I/O power supply to the housing and/or safety earth (if this is not already the case).
3. Connect the NYCe 4000, power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. Both inputs can be used either as high side switching (HSS) - or as low side switching LSS).

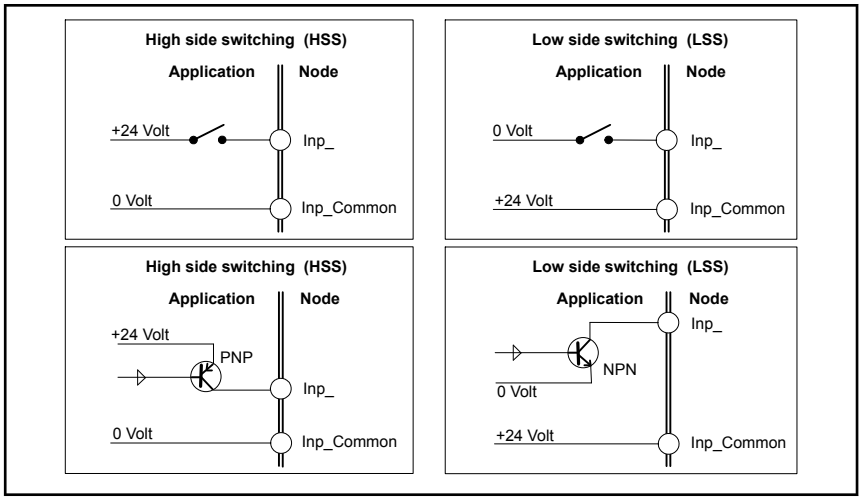

Fig. 7-5: HSS and LSS

7.7 ETH1, ETH2, ETH3 connection information

Characteristic	Description
Cable length	max 100 m.
Type of cable	Crossed or straight
transmission speed 100 Mbps (100BASE-TX)	Cat-5 UTP
transmission speed 1 Gbps (1000BASE-T)	Cat-5e UTP or better
Default IP address (IPv4)	192.168.41.14
Default subnet mask	255.255.255.0
Default gateway	0.0.0.0

Tab. 7-8: NY4114 connection characteristics

7.8 USB connection information

On the front of the MCU module is one microUSB "On-The-Go" USB 2.0 port. This USB port can be used to connect a memory stick to the MCU. You can copy data from the memory stick and write the data to the flash memory of the MCU, or read data from the flash memory of the MCU and store the data on the memory stick.

⚠ WARNING **Damage to the MCU may occur if external power is connected to the USB connector.**

- Do not connect an external (USB) power supply to the USB port of the MCU module.

7.9 Installation requirements

7.9.1 Before you begin

⚠ WARNING **Damage to components may occur if power is applied during installation or removal.**

- Make sure power supplies are switched off before installation or removal of the system housing.
- Do not apply power until the MCU module is installed.

⚠ WARNING **Damage to components may occur due to electrostatic discharges.**

- Comply with all ESD protective measures while working with modules and components. Avoid electrostatic discharges.

7.9.2 Cable connections

The NY4114 uses ethernet connection cables to connect to another node and the host. See chapter 14 "Network" on page 207 for more information about the network connection. The connections to the ethernet network are located on the front of the NY4114. Some form of network cable strain relief is advised. You can use the NY4901/10 strain relief bracket. See the NYCe 4000 Standard Housings and Accessories manual for detailed information.

Make sure that your machine design has sufficient free clearance space in front of the NY4114 for an optional cable strain relief (for example the NY4901/10 bracket) and the maximum allowed bending of the ethernet cable(s). Consult the specifications of the cable manufacturer for details.

7.9.3 Environmental conditions

The NY4114 module can be used in ambient temperatures up to 30 °C using convection cooling.

☞ Free clearance is required below and above the system housing in which the NY4114 is installed to guarantee sufficient free air flow. See the NYCe 4000 Standard Housings and Accessories manual for detailed information.

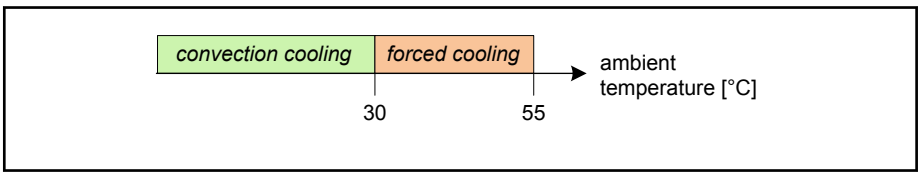

Fig. 7-6: Cooling requirements

Forced cooling is required if the ambient temperature is higher than 30 °C. See NYCe 4000 Standard Housings and Accessories manual for fan units that mount on the system housing.

7.10 System software recovery

The NY4114 MCU is a state-of-the-art hardware design and incorporates programmable logic and runs an on-board Operating System. Many checks are executed at start-up for module validation and operation. Some detected errors cannot be repaired and are reported by a red continuous lit "MCU" LED. Other errors may possibly be recovered and are reported by orange flashing "MCU" LED, see chapter 7.4 "Field Diagnostics" on page 53.

⚠ WARNING **Damage to components may occur if power is applied during installation or removal.**

- Make sure power supplies are switched off before installation or removal of the MCU.
- Do not apply power until the MCU module is installed.

⚠ WARNING **Damage to components may occur due to electrostatic discharges.**

- Comply with all ESD protective measures while working with modules and components. Avoid electrostatic discharges.

You always start the MCU in the so-called "recovery mode". Depending on the (unknown) cause of the problem, two methods are available to return the MCU to a operational state. The first method preserves the stored configuration tables and data in the flash memory. The second method erases all data in the flash memory.

☞ While the MCU is in recovery mode, the node is not visible in the tree view of the NYCe 4000 tools.

Before you begin

- Close all NYCe 4000 tools.
- Close all motion applications.

Do the following steps to force the MCU to start in "recovery mode".

1st recovery method

1. Power-down the MCU and remove the MCU from the node.
   - 1.1 Switch off all power supplies and wait until all module LEDs are off.
   - 1.2 Disconnect the network connection(s) to the NY4114 module.
   - 1.3 If the two screws that hold the NY4114 module in the slot of the system housing are tightened, loosen them.
   - 1.4 Gently pull the NY4114 module out of the slot of the system housing.
2. Locate the jumper block on the module and put a standard 0.1" jumper on the indicated pins.

NY4114: Ethernet MCU Module

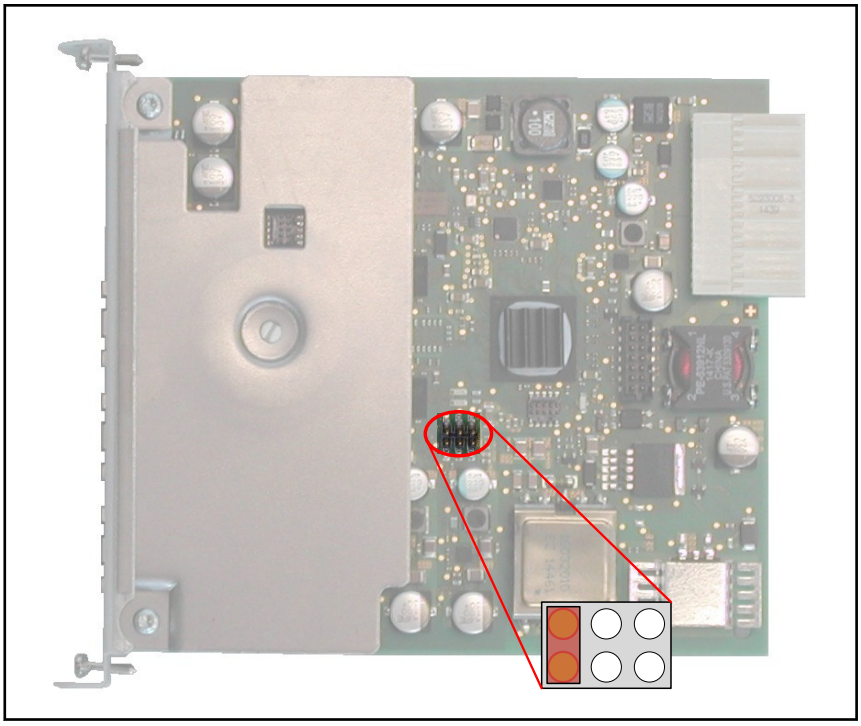

Fig. 7-7: Location of the "recovery mode" jumper

3. Install the MCU in the node and power-up the MCU.

   3.1 Position the MCU in the front slot guides and gently slide the module into the slot. Align the connectors of the module with the connectors on the system backplane. Push the module into the backplane connectors.

☞ Do **not** use excessive force to prevent damage to the connector pins of the module or the backplane connectors.

   3.2 Tighten the two screws on the cover plate of the NY4114 module.

   3.3 Connect the network connection(s) to the NY4114 module.

   3.4 Switch on the 24V System power supply.

   3.5 Wait until the "MCU" LED on the NY4114 is fast flashing green/ orange.

4. Connect to the web server of the MCU.

   Enter in the address field of the web browser on the PC the default IP address 192.168.41.14. The "Recovery Bootloader" page appears.

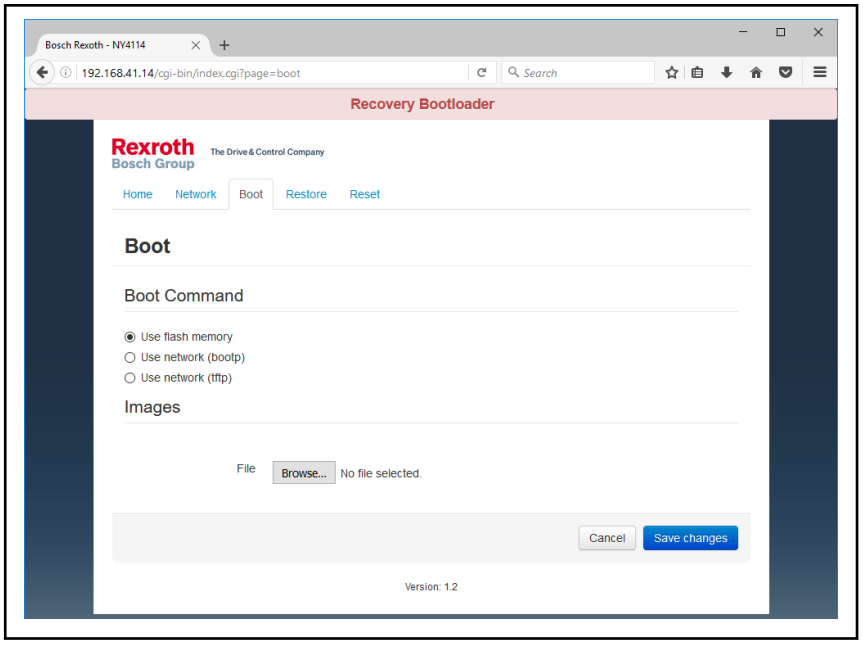

Fig. 7-8: Recovery Bootloader - Home tab

5. Click the "Boot" tab (you must use the mouse).
6. On the "Boot" tab, download the firmware to the MCU.

   Click the button "Execute Upgrade".

   Wait until the MCU restarts. The MCU restarts in the recovery mode, because the jumper is installed.
7. Power-down the MCU and remove the MCU from the node, see step ①.
8. Remove the installed jumper.
9. Install the MCU in the node and power-up the MCU, see step ③.
10. Wait until the "MCU" LED remains in a steady state, either continuously green or flashing orange.
    - If the "MCU" LED is continuously green, the recovery was successful and all stored data in the flash memory is preserved.
    - If the "MCU" LED remains flashing orange, the firmware recovery was not sufficient to solve the problem. You must use the 2nd recovery method to return the MCU to the operational status (and loose all data stored in the flash memory).

2nd recovery method

The 2nd method returns the MCU to the operational mode by reverting the MCU to the factory default settings.

All data, including configuration files, is erased from the flash memory.

1. Do steps ①, ②,③, and ④ of the 1st recovery method.
2. Click the "Restore" tab (you must use the mouse).

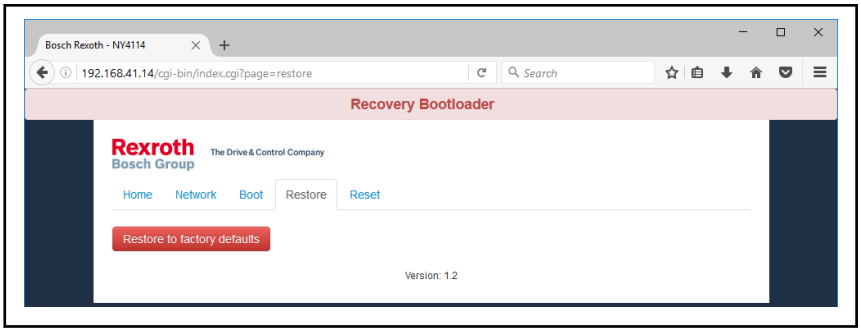

Fig. 7-9: Recovery Bootloader - Restore tab

3. Click the "Restore to factory defaults" button using the mouse.

   A pop-up message appears asking for confirmation. You must click the "Yes" button using the mouse.

   The MCU starts again and erases the flash memory.

   Wait until the erase operation has finished.
4. Power-down the MCU and remove the MCU from the node, see step ① of the 1st recovery method.
5. Remove the installed jumper.
6. Install the MCU in the node and power-up the MCU.

   6.1 Position the MCU in the front slot guides and gently slide the module into the slot. Align the connectors of the module with the connectors on the system backplane. Push the module into the backplane connectors.

☞ Do **not** use excessive force to prevent damage to the connector pins of the module or the backplane connectors.

   6.2 Tighten the two screws on the cover plate of the NY4114 module.

   6.3 Connect the network connection(s) to the NY4114 module.

   6.4 Switch on the 24V System power supply.

   The "MCU" LED on the NY4114 starts slow flashing green/ orange.

   6.5 Connect to the web server of the MCU.

   Enter in the address field of the web browser on the PC the default IP address 192.168.41.14. The "Recovery Bootloader" page appears.

   6.6 Click the "Boot" tab (you must use the mouse).

   6.7 On the "Boot" tab, download the firmware to the MCU.

   Click the button "Execute Upgrade".
7. Wait until the MCU restarts and the "MCU" LED is lit continuously green.

8 NY4120 and NY4120/10: PWM Drive Module

8.1 Overview

The NY4120 is a PWM (Pulse Width Modulation) drive module, which can drive two axes of the BLDC/BLAC (Brushless DC/AC) motors, DC motors or stepper motors. The NY4120/10 is designed for linear motors in combination with the NY4960 Linear Motion System (LMS) MUX module and the NY4073 or NY4078 system housing, or the NY4074 or NY4079 system housing. Part number for the NY4120 is R911318961, ordering code is NYM04.1-2PW-NNNN-NY4120. Part number for the NY4120/10 is R911320447, ordering code is NYM04.1-2PW-LMSN-NY4120/10.

Support for quadrature encoders with and without index pulse is available on-board, as well as other encoders, and there is a possibility to add one NY4199 SinCos Option module to connect another position sensor (for example EnDat or SinCos). The quadrature encoder is also known as A/B encoder, S0S90 encoder and 3-channel digital incremental encoder. See chapter 13 "Encoders" on page 161 for the supported encoder types.

NY4120 and NY4120/10: PWM Drive Module

Fig. 8-1: PWM drive module NY4120

The main features of the NY4120 are the following.

- Current control loop
- PWM frequency: 16 … 96 kHz.
- I nominal : 10 A
- I peak : 20 A per axis, 30 A per drive
- Bus voltage is minimal 15 V, maximal 75 V
- Over current and over temperature protection
- Quadrature encoder cable break detection
- Power consumption approximately 1.7 W at 24 V system power supply voltage

Per module the following I/O are available:

- 6 x RS422 encoder inputs (2 x QuadA, QuadB and Index).
- 2 analog outputs (16 bit).
- 2 analog inputs (12 bit).
- 8 digital inputs, 2 inputs can be configured as 2 disable drive inputs.
- 4 digital outputs.
- 2 fast digital inputs.
- 2 fast digital outputs.
- 6 x 5 Volt digital inputs, to be used as Hall input, quadrature counter input, general purpose digital Input or Rexroth MSM encoder input.

☞ If a drive slot was configured for an NY4140 drive module and now used for an NY4120 drive module, make sure that the DP drive voltage is changed (lowered) before you install the NY4120 drive module.

8.2 Module identification

An identification label is attached on the NY4120 module.

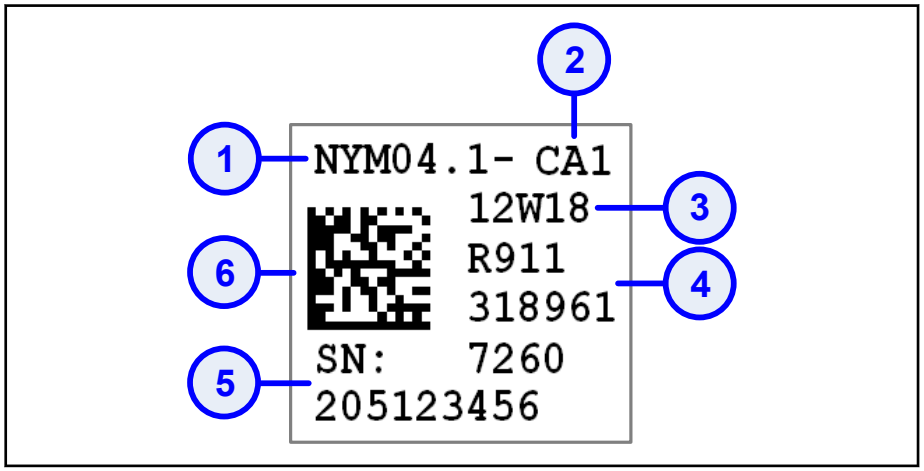

Fig. 8-2: Identification label of the NY4120

Identification number	Field explanation
1	Type code
2	Version level and status
3	Date of manufacture (yyWww)
4	Material number
5	Serial number
6	2D bar code

Tab. 8-1: Explanation of the fields of the NY4120 identification label

NY4120 and NY4120/10: PWM Drive Module

8.3 Module dimensions

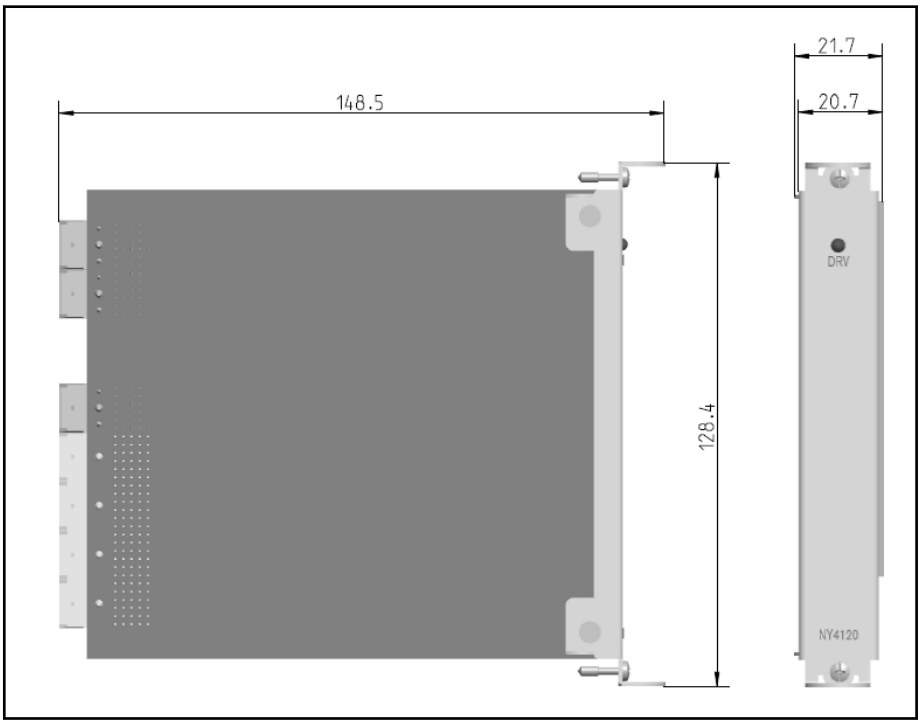

Fig. 8-3: NY4120 module dimensions

Module type code	Width	Height	Depth	Weight
NYM04.1-2PW-NNNN-NY4120 NYM04.1-2PW-LMSN-NY4120/10	21.7 mm	128.4 mm	148.5 mm	380 gr

Tab. 8-2: NY4120 physical data

8.4 Field Diagnostics

The module does not contain any replaceable or wear parts. In case of failure, the entire module must be replaced.

The NY4120 module has 1 bi-color module status indicator LED labeled "DRV" on the front panel. The various indications are described in tab. 8-3 ""DRV" status LED indications" on page 66.

LED indication	Description
Red steady	Default setting when the drive module starts (power-up). Fatal error on the drive module, or gateware is not correct or not loaded, or module not operational because a communication problem is detected (call service).
Orange steady	Gateware loaded, but node not yet operational, because other drive modules in the node are initializing.

LED indication	Description
Green steady	Drive module OK.
Red flashing	Drive module is OK, but an overvoltage condition or over temperature condition is detected, or a configured motor cannot run due to undervoltage or overcurrent. • Overvoltage condition occurs at 80 V. • Over temperature condition occurs at 105 °C. • Undervoltage condition occurs at 12 V. • Overcurrent condition occurs at 22 A.

Tab. 8-3: "DRV" status LED indications

8.5 Power switch on/off precautions

Follow these instructions to prevent damage to the drive module. See also chapter 16 "Drive power precautions for NY412x/NY4140" on page 213.

- Do not plug the drive module into the backplane while the 24V System power supply is applied.
- Do not remove the drive module from the backplane while the 24V System power supply is applied.
- Make sure that the 24V System power supply is applied before the drive power supply is applied.

The preferred method to switch on and off the drive power is by means of the mains switch as indicated by ① in fig. 8-4 "Schematic of drive power supply to a node" on page 67 to prevent destructive inrush currents.

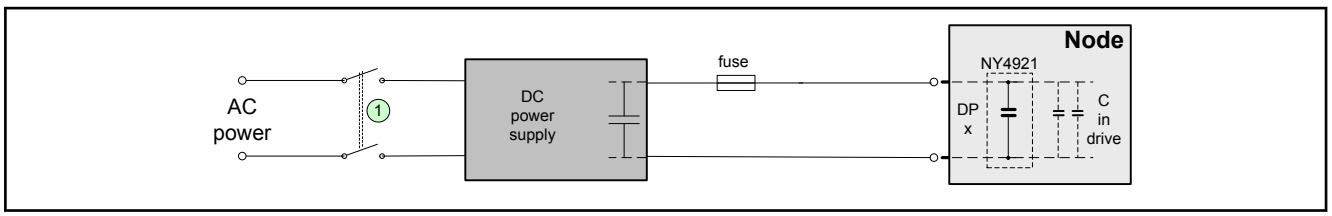

Fig. 8-4: Schematic of drive power supply to a node

If you want to remove the drive module from the backplane, follow this sequence.

1. Switch off the drive power supply to the system.
2. If an axis is configured on the drive module, wait until the "DRV" LED on the drive module flashes red on and off.

   If no axis is configured on the drive module, the "DRV" LED is continuous green and you can proceed to the next action.
3. Switch off the 24V System power supply to the system.
4. Wait until the "DRV" LED on the drive module is off.
5. Remove the drive module.

- Do not connect the drive power supply to the "DP x" connectors of the system while the drive power supply is switched on.
- Switching on/off the drive power supply by connecting/ disconnecting the "DP x" connectors is forbidden.

8.6 I/O Connector

The PWM drive module I/O connector uses a 150 pin, 2mm Modular Interconnect System. The pinout is sorted on insulated areas.

Pin	Row A	Row B	Row C	Row D	Row E
1	AnOut0	AnGND	AnIn1C	AnIn1–	AnIn1+
2	AnOut1	AnGND	AnIn0C	AnIn0–	AnIn0+
3	DGND	DGND	DGND	DGND	DGND
4	Enc1Index–	Enc1Index+	Dig5VIn1a–	Dig5VIn1a+	Opt_2+
5	Enc1QuadB–	Enc1QuadB+	Dig5VIn1b–	Dig5VIn1b+	Opt_2–
6	Enc1QuadA–	Enc1QuadA+	Dig5VIn1c–	Dig5VIn1c+	Opt_1+
7	Enc0Index–	Enc0Index+	Dig5VIn0a–	Dig5VIn0a+	Opt_1–
8	Enc0QuadB–	Enc0QuadB+	Dig5VIn0b–	Dig5VIn0b+	Opt_0+
9	Enc0QuadA–	Enc0QuadA+	Dig5VIn0c–	Dig5VIn0c+	Opt_0–
10	EncGND	EncVref	EncGND	Enc5V0	Enc5V1
11	DigIn0	DigIn1	DigIn2	DigIn3	DigComm0
12	DigIn4	DigIn5	DigIn6	DigIn7	DigComm1
13	FastIn0	FastIn1	FastOut0	FastOut1	GND_DIO
14	DigOut0	DigOut1	DigOut2	DigOut3	24V_DIO
15	24V_DIO	24V_DIO	24V_DIO	24V_DIO	GND_DIO
16					
17					
18					
19	HB4–	HB4–	HB4–	HB4–	HB4–
20	HB4+	HB4+	HB4+	HB4+	HB4+
21	HB3–	HB3–	HB3–	HB3–	HB3–
22	HB3+	HB3+	HB3+	HB3+	HB3+
23	DR_PWR	DR_PWR	DR_PWR	DR_PWR	DR_PWR
24	DR_PWR	DR_PWR	DR_PWR	DR_PWR	DR_PWR
25	HB2–	HB2–	HB2–	HB2–	HB2–
26	HB2+	HB2+	HB2+	HB2+	HB2+
27	HB1–	HB1–	HB1–	HB1–	HB1–
28	HB1+	HB1+	HB1+	HB1+	HB1+

Pin	Row A	Row B	Row C	Row D	Row E
29	DR_GND	DR_GND	DR_GND	DR_GND	DR_GND
30	DR_GND	DR_GND	DR_GND	DR_GND	DR_GND

Tab. 8-4: PWM drive module I/O connector

- DGND on row 3 is intended as shielding between Analog I/O and 5 Volt digital Inputs. No connections should be made to these pins.
- Not allocated pins must be not connected.

8.7 Analog Inputs

Characteristic	Description
Number of analog inputs	2: AnIn0– / AnIn0+ and AnIn1– / AnIn1+
Type	Differential; no galvanic insulation
Range (user selectable)	4 - 20 mA + / – 10 V differential + / – 10 V single ended
Input impedance	• NY4120 : 10 kΩ // 1 nF • NY4120/10 : 10 kΩ // 10 pF
Common mode rejection	80 dB at 200 Hz (from 200 Hz: –20 dB/decade)
Max. common mode voltage	12 V
Resolution	12 bit monotonic
Linearity	1 LSB
Accuracy	Absolute: 3% of full scale Relative: 0.1% of full scale
Sample frequency	Synchronously 32 kHz
Bandwidth	• NY4120 : 4 kHz ±10% • NY4120/10 : 125 kHz ±10%

Tab. 8-5: Characteristics of the analog inputs

NY4120 and NY4120/10: PWM Drive Module

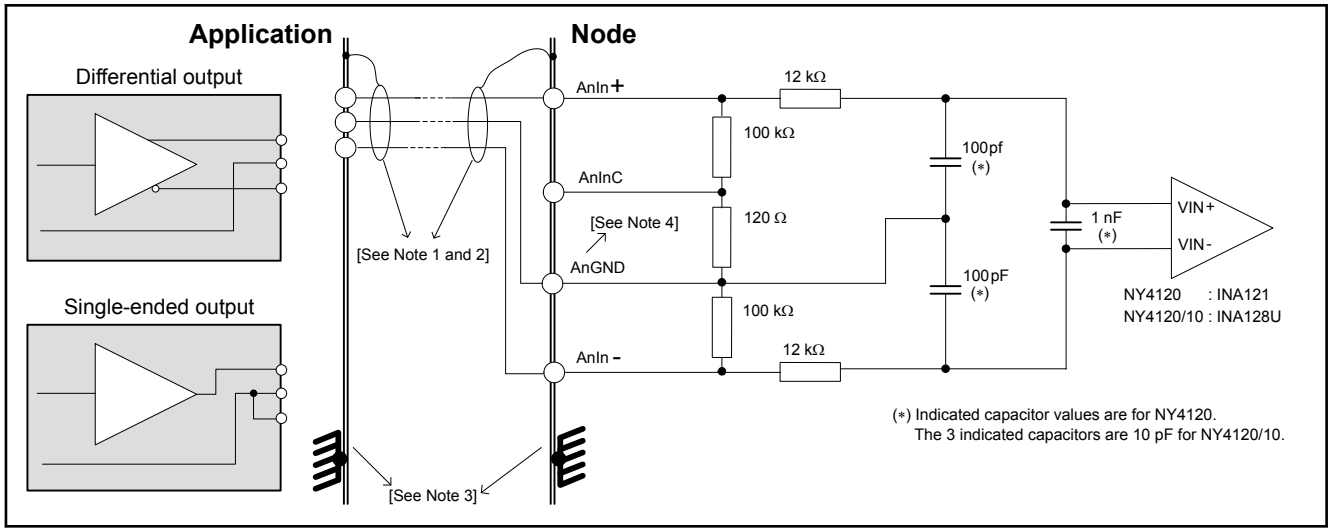

Fig. 8-5: Analog input circuit for AnIn0 and AnIn1

Notes

1. The shielding does not have to be separate for each input as the drawing suggests but may be common for all analog signals in the cable.
2. Follow the following cabling instructions:
   - Always use a shielded cable.
   - The shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).
   - If the equipment on the application side is metal, connect the shield to the equipment housing.
3. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. AnGND is connected to the internal system ground: ground MCU, drive logic, encoder ground, and host PC if the MCU is NY4110 and an IEEE 1394b cable is used.
5. For proper use, this ground may not be connected to motor or digital I/O ground.

The choice between the voltage or current measurement of the analog inputs is user selectable by a software parameter, see the file "nhiparameters.h", parameter NHI_PAR_ANINx_ADC_DIMENSION_SLOTy (x=0,1 y=0…4) and the NYCe 4000 Software Reference Manual, enumeration nhi_adc_dimension.

- + / – 10 Volt differential

  If the analog input source provides a balanced differential signal, connect the signal wires to the corresponding input pins on the NYCe 4000 side.

- + / – 10 Volt single ended

  If the analog input source provides a single ended signal, connect the signal wire to the positive print on the NYCe 4000 side, and connect the application ground to the negative input pin on the NYCe 4000 side.

- 4 – 20 mA.

– Connect pin AnIn– to AnGND in the connector
– Connect pin AnIn+ to AnInC in the connector

The diagrams in fig. 8-6 "How to select the range of the analog inputs" on page 71 show how to select the range of the analog inputs.

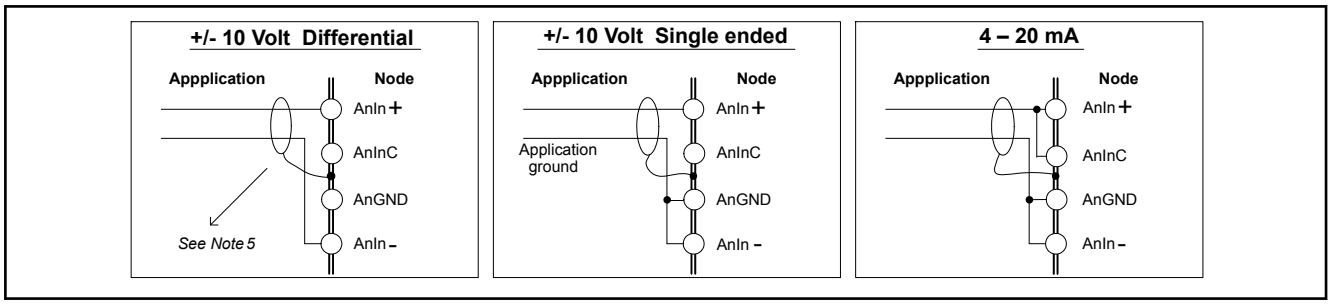

Fig. 8-6: How to select the range of the analog inputs

If the analog input source provides a balanced differential signal, it may be desirable to connect a termination resistor between the signal wires at the NYCe 4000 side. Consult for this the supplier's installation instructions.

8.8 Analog Outputs

Characteristic	Description
Number of analog outputs	2: AnOut0 and AnOut1 with common AnGND
Type	Single ended; no galvanic insulation
Functions	External power amplifier control General Purpose analog output
Grounding	Both analog output signals refer to AnGND, see note 1
Range	–10 V …+10V
Resolution	16 bit, monotonic (DAC8532)
Accuracy	Absolute: 3% of full scale Relative: 0.1% of full scale
Offset	Typical 30 mV, max. 120 mV
Noise	0.55 mV rms
Maximum output current	10 mA
Range load resistor (R2 in figure below)	≥ 1 kΩ
Capacitive load (C2 in figure below)	≤ 10 nF
Output short circuit proof	Yes, Ishort ≤ 35mA

NY4120 and NY4120/10: PWM Drive Module

Characteristic	Description
Bandwidth DAC	4 kHz
Update frequency	Maximum 32 kHz

Tab. 8-6: Characteristics of the analog outputs

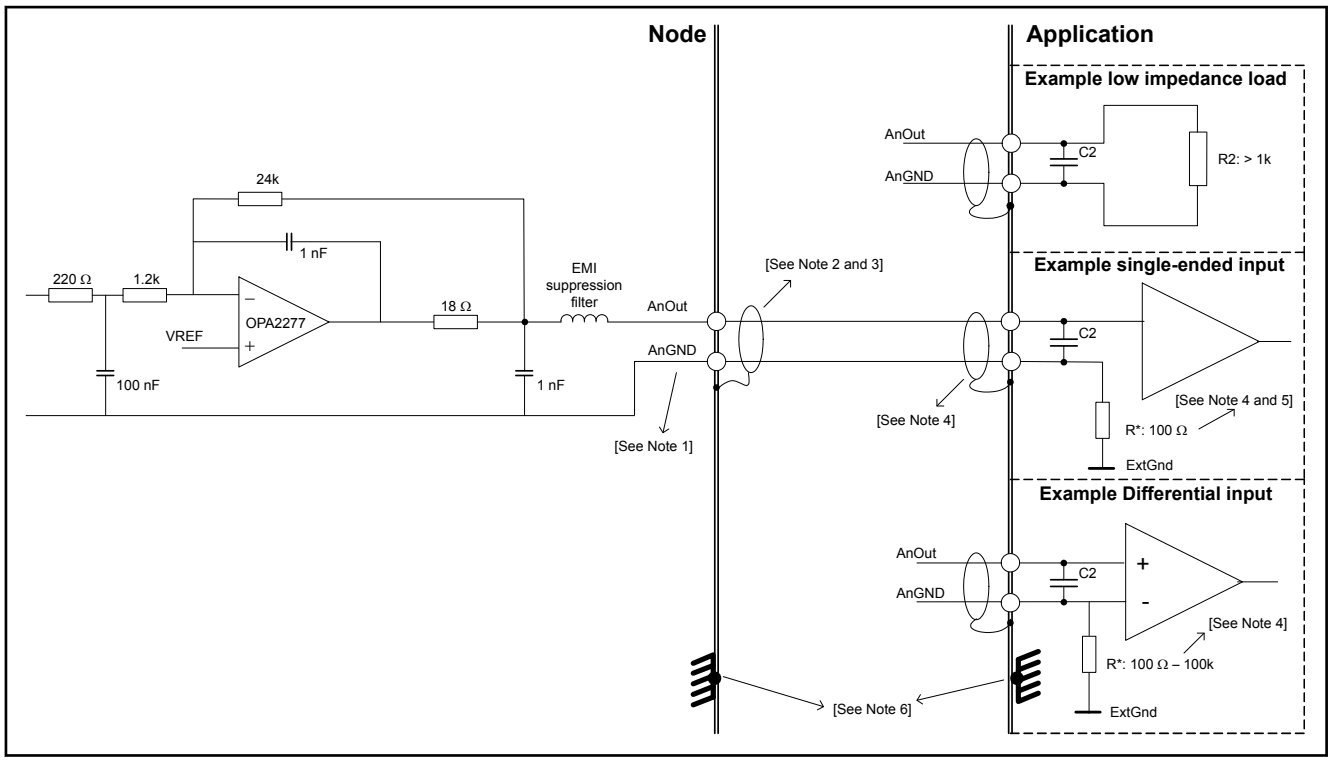

Fig. 8-7: Analog output circuit for AnOut0 and AnOut1

Notes

1. AnGND is connected to the internal system ground: ground MCU, drive logic, encoder ground, and host PC if the MCU is NY4110 and an IEEE 1394b cable is used.
2. The shielding does not have to be separate for each output as the drawing suggests but may be common for all analog signals in the cable.
3. Follow the following cabling instructions:
   - Always use a shielded cable.
   - The shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).
   - If the equipment on the application side is metal, connect the shield to the equipment housing.
4. If the analog equipment on the application side accepts a differential (preferred) or single-ended signal, the AnGND signal must be connected to the application ground with a resistor R*. If this resistor is not included in the equipment itself, install it for example in the connector at the equipment side of the cable. (For single ended input: 100 Ω, for differential 100 Ω – 100 kΩ).

5. If the analog equipment on the application side only accepts a single-ended signal (not recommended), the accuracy of the analog signal may be influenced by the resistor R* mentioned in Note 4. For this reason a low value is chosen.
6. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
7. For proper use, this ground may not be connected to motor or digital I/O ground

8.9 Digital Inputs

Characteristic	Description
Number of digital inputs	8, divided in 2 groups: • DigIn0 ... DigIn3 with DigComm0 • DigIn4 ... DigIn7 with DigComm1
Functions	General Purpose Digital input • 24V Hall sensors can be connected to the digital inputs – DigIn0, DigIn1, Digin2 for axis0 – DigIn4, DigIn5, DigIn6 for axis1 • Position latching • Change of state events (1 per MCU's time sample) • Count transitions interval (1 per MCU's time sample) • DigIn6 can be defined as disable drive input for axis0 • DIgin7 can be defined as disable drive input for axis1 Disable drive functionality is defined through the function SacWriteParameter, see NYCe 4000 Software User Manual. The power amplifier is disabled after the disable drive input is detected active for approximately 500 µs. **Note.** The 24V Hall sensor of axis1 conflicts with the disable drive function of axis0. Only one function can be supported.
High and low side switching	Possible (in groups of 4 digital inputs)
Galvanic insulated	Yes
Switch time (Filter delay)	Typical 100 µs
Permitted input voltage	–30 V ... +30 V
Input high level	15 V ... +30 V and –15 V ... –30 V
Input low level	–5 V ... +5 V
Input current @ 24V	Nominal 3,5 mA
Jitter on switching times	Typical 20 µs

Tab. 8-7: Characteristics of the digital inputs

NY4120 and NY4120/10: PWM Drive Module

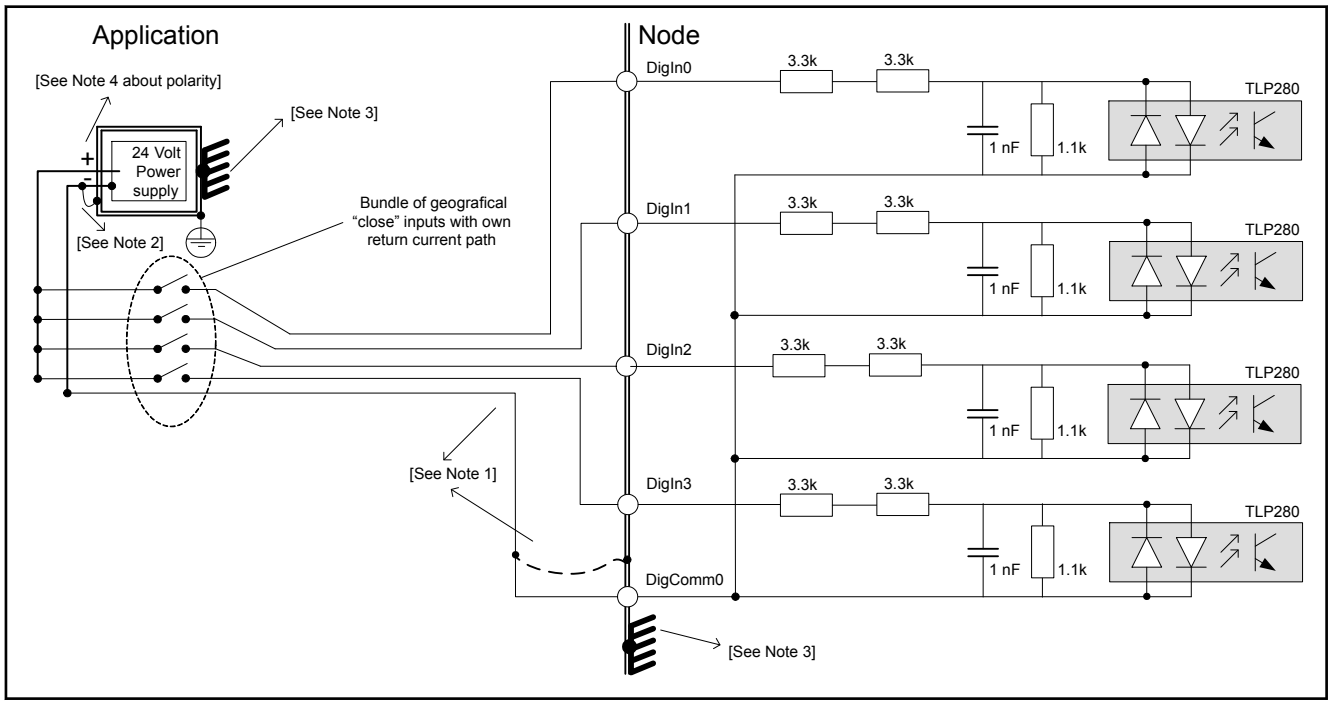

Fig. 8-8: First group of digital inputs

The second group (DigIn4 ... DigIn7 with DigComm1) is schematically identical to the first group.

Notes

1. Follow the following cabling instructions:
   - Shielded cable is recommended, but not mandatory.

     If shielded cable is used, the shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).

     Connect the other side to a convenient metal part or leave it unconnected.
   - The digital I/O may be associated with more than one power supply, and/or the cable may contain more than one minus for power supply. If this is the case and if the cable is unshielded, connect at least one of the minus wires of each power supply to Shield (house connector).
2. Connect the minus of the I/O power to the housing and/or safety earth (if this is not already the case).
3. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. Each group of 4 inputs can be used either as high side switching (HSS), or as low side switching (LSS).

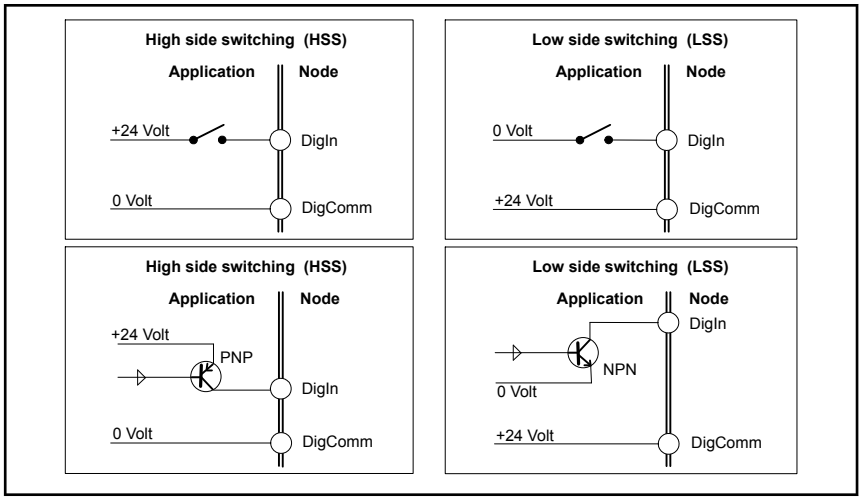

Fig. 8-9: HSS and LSS

5. Keep in mind that these digital inputs do not have a high impedance. If the application uses an open collector output to connect to these digital inputs, use an NPN transistor for low side switching and use a PNP transistor for high side switching, see fig. 8-9 "HSS and LSS" on page 75. It is not recommended to use an NPN transistor output in combination with high side switching, as shown in fig. 8-10 "HSS with an NPN output transistor" on page 75.

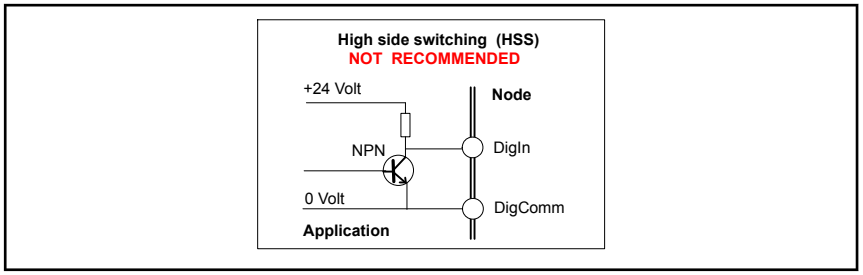

Fig. 8-10: HSS with an NPN output transistor

6. 24 Volt Hall sensors can be connected to the digital inputs, use the digital inputs DigIn0, DigIn1 and DigIn2 for the first axis, and use DigIn4, DigIn5 and DigIn6 for the second axis. See fig. 8-11 "24 Volt Hall sensor connection" on page 75 for the connection of a Hall sensor with either high side switched or low side switched outputs.

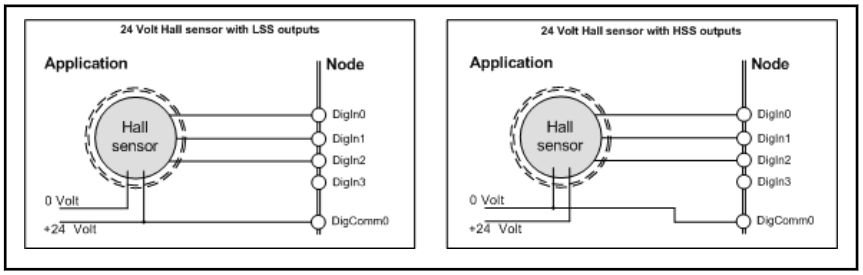

Fig. 8-11: 24 Volt Hall sensor connection

8.10 Digital Outputs

Characteristic	Description
Number of digital outputs	4: DigOut0 … DigOut3 with GND_DIO
Functions	State output Pulsed output PWM output with on delay
Type of load	• Resistive • Capacitive • Inductive If the stored energy is ≥ 2 mJ, to be calculated with the formula 0.5 * L * I^2, external protection (for example a diode) is required to prevent damage to the output component.
Voltage supply	24 V ±6 V
Output current	0,02 A ... 1 A, 2 A peak (max. 50 ms)
Output turn on time ([1])	Typical 50 µs
Output turn off time ([1])	Typical 50 µs (with a load current = 1 A) Note: turn off time increases if load current < 1 A.
Galvanic insulation	Yes
Short circuit protected	Yes
Fail / no load detection	No
Grounded load	Yes (high side switching)
IEC61131-2 compliant	Yes
PWM (Pulse Width Modulation)	Yes

1 Indicated times only apply with a resistive load.

Tab. 8-8: Characteristics of the digital outputs

Pulse time specification	Unit	Minimum	Typical	Maximum
Digital output pulse duration	µs	10		10 000 000
Pulse accuracy t_{PULSE_on} ≤ 160 ms	µs		10	
Pulse accuracy for t_{PULSE} > 160 ms	µs		node sample time (125, 250, 500, 1000)	

Tab. 8-9: Pulse time specifications of the digital outputs

PWM signal specifications	Unit	Minimum	Typical	Maximum
Digital output PWM frequency	Hz	0.1		10 000
PWM duty cycle	%	0		100
Pulse accuracy for f_{PWM} > 6.25 Hz	µs		node sample time (125, 250, 500, 1000)	
Pulse accuracy for f_{PWM} ≤ 6.25 Hz	µs		10	
Digital output on-delay, before PWM	µs	0		10 000 000
On-delay accuracy for t_{DELAY} ≤ 160 ms	µs		10	
On-delay accuracy for t_{DELAY} > 160 ms	µs		node sample time (125, 250, 500, 1000)	

Tab. 8-10: PWM signal specifications of the digital outputs

The PWM signal is defined by the NYCe 4000 software through the PWM frequency parameter specified in Hz, and the duty cycle parameter specified in %. These two parameters are internally converted to pulse duration "a" and pulse pause duration "b" (see fig. 8-12 "PWM signal specification parameters" on page 77) which can only have a discrete increment step size. The increment step size is equal to the pulse accuracy and depends on the specified PWM frequency. These discrete values for the pulse duration and pulse pause duration imply that the actual PWM frequency and duty cycle may differ from the specified PWM frequency and duty cycle.

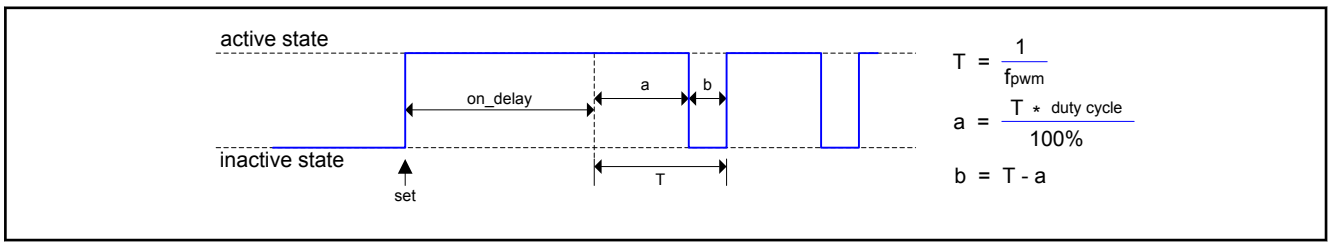

Fig. 8-12: PWM signal specification parameters

The schematic of the digital output is given in fig. 8-13 "DigOut0 and DigOut1" on page 78.

NY4120 and NY4120/10: PWM Drive Module

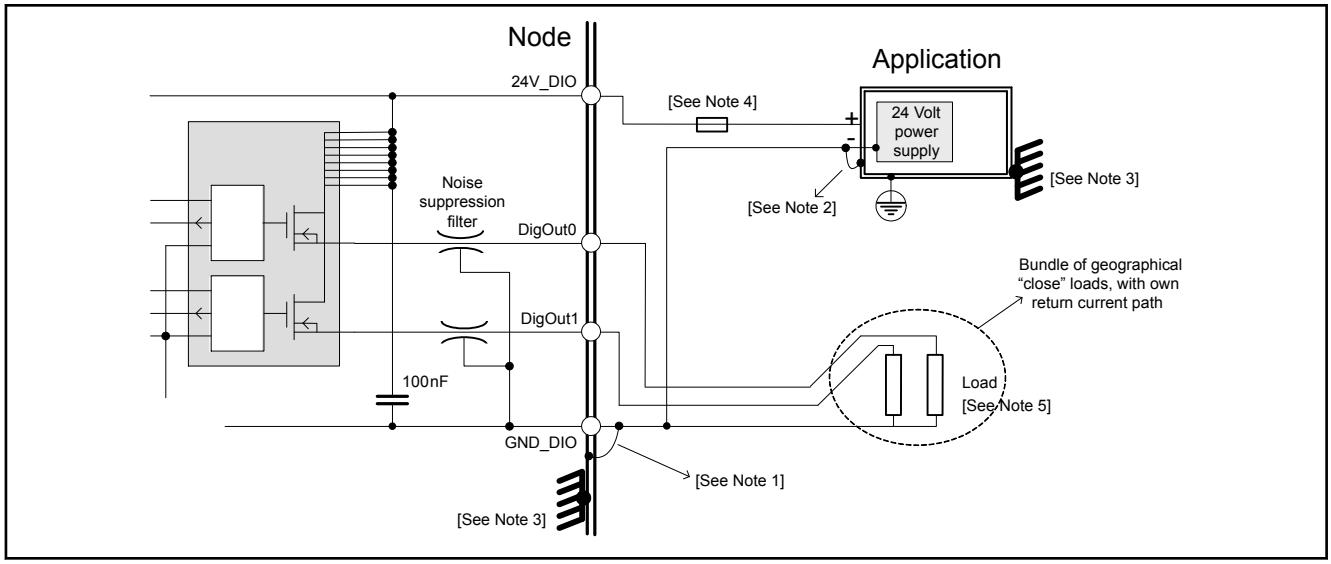

Fig. 8-13: DigOut0 and DigOut1

The second group (DigOut2 and DigOut3) is schematically the same.

Notes

1. Follow the following cabling instructions:
   - Shielded cable is recommended, but not mandatory.

     If shielded cable is used, the shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).

     Connect the other side to a convenient metal part or leave it open,
   - The digital I/O may be associated with more than one power supply, and/or the cable may contain more than one minus for power supply. If this is the case and if the cable is unshielded, connect at least one of the minus wires of each power supply to Shield (house connector).
2. Connect the minus of the I/O power to the housing and/or safety earth (if this is not already the case).
3. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. A fuse must be installed between the +24 V power supply and 24V_DIO on the node. The fuse is mandatory by safety regulations and must be UL recognized. See NYCe 4000 Standard Housings and Accessories manual for detailed information about fuses.
5. If the load represents a high impedance input, you must use an external pull down resistor to meet the minimum specified output current through the switch.

8.11 Digital High Speed Inputs and Outputs

Characteristic	Description
Number of digital inputs	2: FastIn0 and FastIn1
Function	High speed general purpose digital input High speed position latching Change of state event (1 per MCU sample time) Count transitions (max. frequency 250 kHz)
High and low side switching	No, always grounded load (high side switching)
Galvanic insulated	Yes
Switch time (Filter delay)	< 2 µs
Permitted input voltage	–30 V ... +30 V
Input high level	15 V ... +30 V
Input low level	–30 V ... +5 V
Input current @ 24V	Nominal 15 mA

Tab. 8-11: Characteristics of digital high speed input

Characteristic	Description
Number of digital outputs	2: FastOut0 and FastOut1
Function	External stepper drive control ([1]) High speed state output High speed pulsed output High speed PWM output with on delay
Type of load	Only resistive or capacitive loads are supported. The fast digital output cannot be used for inductive loads.
Grounded load	Yes, (high side switching outputs)
Galvanic insulated	Yes
Switch time ([2])	< 2 µs (with load current ≥ 50 mA)
Short circuit protected	Yes, single PTC fuse for both outputs
Fail / no load detection	No
Voltage supply	24 V ±6 V
Output current	0.4 mA ... 100 mA, typical is 50 mA

1 Active high control signals are recommended. Using active low control signals is only possible if the minimum input level specified by the external stepper drive is higher than 0.7 V.

2 Indicated time only apply with a resistive load. Indicated time changes if the load has a capacitive component.

Tab. 8-12: Characteristics of digital high speed output

See tab. 8-9 "Pulse time specifications of the digital outputs" on page 76 for the pulse time specification and tab. 8-10 "PWM signal specifications of the digital outputs" on page 77 for the PWM signal specification of the digital high speed output.

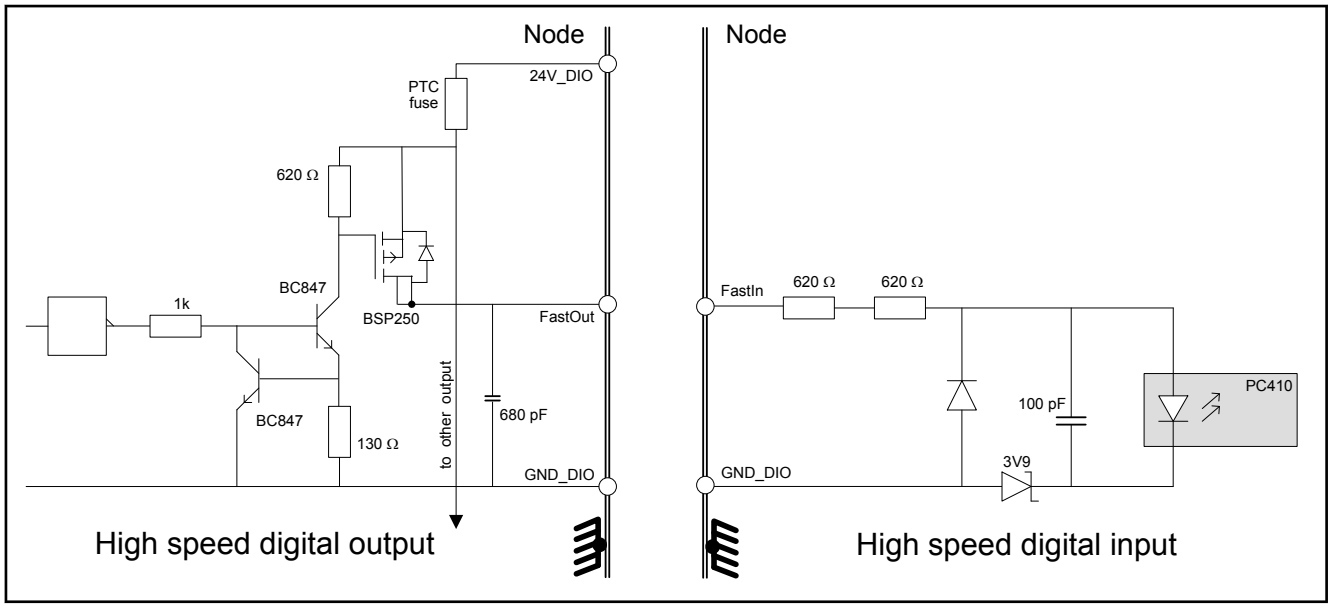

Fig. 8-14: Output circuit for FastOut0, FastOut1, and input circuit for FastIn0, FastIn1

For cabling and power supply connections of the fast digital inputs and fast digital outputs the same rules apply as for normal digital inputs and outputs, with one additional note. The cable with signal wire(s) of fast digital inputs and/or fast digital outputs must also include the return current path for every signal in the cable. For normal digital I/O this is recommended, but for fast digital I/O this is mandatory.

8.12 5 Volt Digital Inputs

Characteristic	Description
Number of Hall inputs	6, divided in two groups of 3 inputs: • Dig5VIn0a, Dig5VIn0b and Dig5VIn0c for axis0 • Dig5VIn1a, Dig5VIn1b and Dig5VIn1c for axis1
Function	Hall Input (see note in chapter 8.14.2 "Motor types" on page 84) Quadrature counter inputs Rexroth MSM encoder input General purpose digital Input Position latching Change of state event (1 per MCU sample time) Count transitions (1 per MCU sample time) (Functionality available on the Dig5VIn pins of the encoder headers of the system housing may be limited, because these pins are also used to connect encoders. See the encoder header pinout tables of the system housing in the NYCe 4000 Standard Housings & Accessories manual).
Signal interface	RS485 or 5 V (half RS485 referenced to 2.05 V)
Galvanic insulated	No
Line termination	On-board, 120 Ω in series with 680 pF
Interface type / input frequency	• 5 V open collector Depends on driver and pull-up resistor • TTL 1 MHz • RS485 10 MHz
Sink and source current	According to RS485 specification
Supply for signal source	Enc5V0 and Enc5V1 may be used (take care of current limit). Power supply for the encoders on both axes can only be switched on/off at the same time, not separately.
Pull-up resistor for open collector driver	Included (2,2 kΩ connected to non-switched Enc5V)

Tab. 8-13: Characteristics for Hall inputs, 5 Volt digital inputs and counter inputs

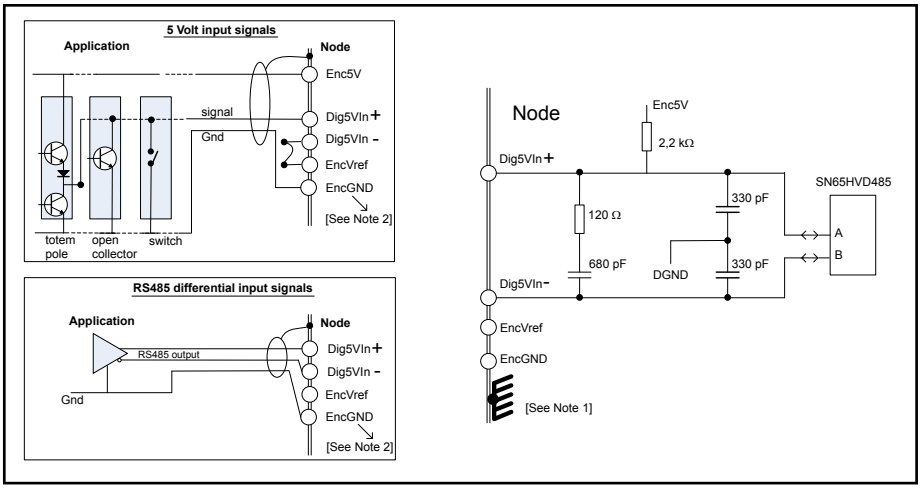

Fig. 8-15: Input circuit of the digital inputs and 2 connection examples

Notes

1. Connect the NYCe 4000, power supplies or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
2. EncVref and EncGND are allowed to be used.

Follow these cabling instructions:

- Always use a shielded cable.
- The shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).
- If the equipment on the application side is metal, connect the shield to the equipment housing.

☞ For proper use, this ground may not be connected to motor or digital I/O ground.

8.13 Encoder Inputs and Encoder Power Supply

The following encoder types can be used with the NY4120:

- Quadrature encoder
- Analog inputs
- Rexroth MSM incremental or absolute position encoder
- Sanyo Denki absolute position encoder
- EnDat2.2 encoder

For SinCos based encoders the NY4199 SinCos Option module is required. This module is connected to the drive module and contains hardware to process the SinCos signals. The SinCos based encoders supported by the NY4199 SinCos Option module are:

- SinCos
- EnDat2.1
- Hiperface

The +5 Volt Hall sensors of a BLDC motor are connected to the +5 Volt digital inputs (Dig5VIn0a, Dig5VIn0b, Dig5VIn0c for axis0 and Dig5VIn1a, Dig5VIn1b, Dig5VIn1c for axis1). The digital encoders (Rexroth MSM

incremental and absolute, EnDat2.1, EnDat2.2, Hiperface) and SinCos encoders also use these +5 Volt digital inputs. This means that a BLDC motor with +5 Volt Hall sensors and a digital encoder cannot be used on the same axis.

There is one exception. A SinCos encoder can be used together with a BLDC motor with +5 Volt Hall sensors on axis0.

If the Hall sensors of the BLDC motor are connected to the +24 Volt digital inputs, the digital encoders (Rexroth MSM incremental and absolute, SinCos, EnDat2.1, EnDat2.2 and Hiperface) can always be used on either axis.

☞ If a motor is connected on axis1 with an encoder that uses the digital input lines (Rexroth MSM incremental and absolute encoders, EnDat2.x or Hiperface), you cannot use a BLDC motor on axis0. This combination will cause an error on axis0 ("invalid Hall sensor").

The NYCe 4000 software includes functions to switch the encoder power supply on and off per axis. However, the encoder power supply pin Enc5V0 and Enc5V1 are connected in parallel on the NY4120 drive module. This means that whenever the encoder power supply for one of the axes is switched on, the encoder power supply for the other axis is also switched on. Only when the encoder power supply for both axes is switched off, pins Enc5V0 and Enc5V1 are switched off.

For detailed connection information, see chapter 13 "Encoders" on page 161.

☞ Do not connect or disconnect the encoders while the system power supply is switched on. This can destroy the encoder electronics.

8.14 Drive Output

8.14.1 Characteristics

Two PWM amplifiers with four half H-bridges are used as current amplifiers on the NY4120. During the active part of the PWM cycle, the drive power voltage is applied to the motor connections. During the passive part of the PWM cycle, the half H-bridges are in a freewheel mode and current measurements are done.

☞ When the logic power supply voltage drops below the required minimum voltage while a motor is running, the NYCe 4000 system is designed to stop the motor. Stopping the motor is achieved by creating a short circuit condition through the FETs of the H-bridge. This will not cause problems with small motors, but if the module drives a motor with a high amount of kinetic energy, the FETs can be destroyed by this energy.

Characteristic	Description
PWM frequency	16 kHz … 96 kHz
PWM duty cycle	Minimum OFF time: 1 µs
PWM resolution	12 bits

Characteristic	Description
Half bridges (2 axes per module)	Min: 2 (1 DC motor) Max: 8 (2 stepper motors)
Current control loop frequency	4 kHz … 32 kHz
Current measurement resolution	12 bits
I nominal	10 A
I peak	20 A (max. 100 ms)
Efficiency (at 48 V, % A, PWM 32 kHz)	92% … 95%
Motor power voltage	0 V … 73 V
Over current protection	Yes, at 22 A
Short circuit detection	Yes, at 64 A ±10%
Thermal protection	105 °C on PCB

Tab. 8-14: NY4120 drive output characteristics

8.14.2 Motor types

The following motor types can be connected to the NY4120.

PWM Brushless DC servo motor control (BLDC)

BLDC motors have a trapezoidal stator winding distribution which is designed for use on a square wave or block commutation inverter supply voltage, controlled by Hall sensors.

☞ If the Hall sensors are connected to the Dig5VIn inputs, you cannot use the digital encoders (EnDat2.x, Rexroth MSM or Hiperface) at the same time, because the Hall sensors use the same I/O lines as these digital encoders.

PWM Brushless AC servo motor control (BLAC)

BLAC motors have a sinusoidal stator winding distribution which is designed for use on a sinusoidal or PWM inverter supply voltage. In software, the alignment between motor coils and magnets is done using for example a wake-and-shake procedure.

PWM Brushed DC servo motor control (DC)

PWM Stepper motor control

Two phase stepper motors with a sinusoidal current of 7 A rms can be used.

8.14.3 Connection information

Characteristic	Description
Cable length	max 15 m.
Current capability	Conform application
Capacitance	max 100 pF/m.

Tab. 8-15: Motor cable characteristics

The motors are connected according to fig. 8-16 "NY4120 motor connection circuit" on page 85 and tab. 8-16 "Motor connections" on page 86.

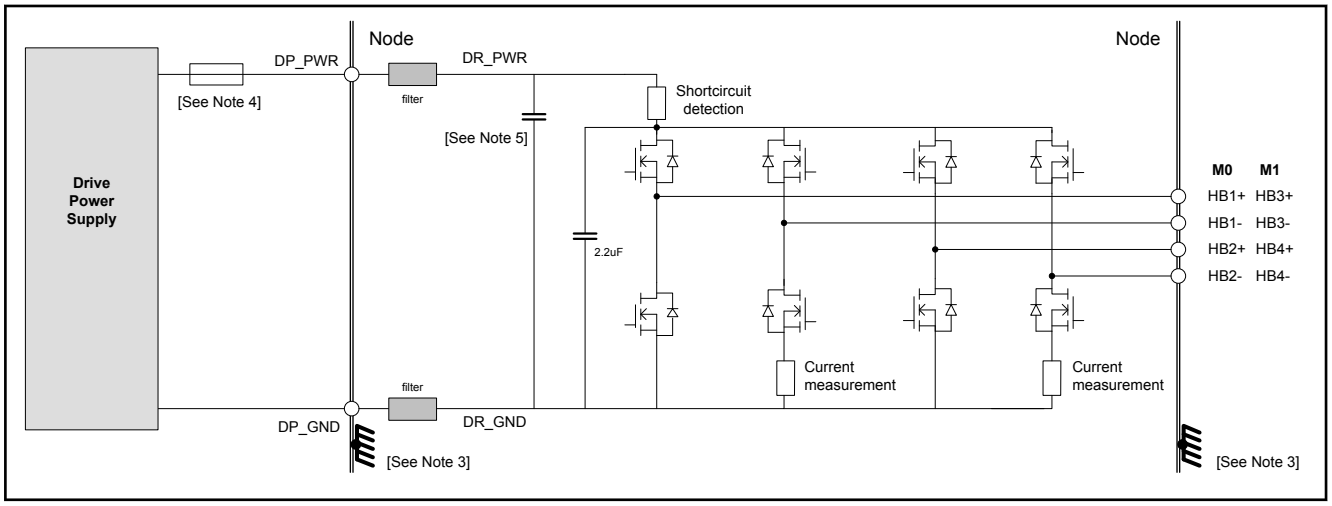

Fig. 8-16: NY4120 motor connection circuit

Notes

1. Follow this cabling instruction:

   Shielded cable is recommended, but not mandatory.

   If shielded cable is used, the shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).

   Connect the other side to a convenient metal part or leave it open.
2. Connect the DR_GND of the drive power to the housing and/or safety earth (if this is not already the case).
3. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. A fuse must be installed between the +V of the drive power supply and DP_PWR on the node. The fuse is mandatory by safety regulations and must be UL recognized. See NYCe 4000 Standard Housings and Accessories manual for detailed information about fuses.
5. Connect an external capacitor close to the drive module (see chapter 16.1 "Drive Power Filtering for NY412x/NY4140" on page 213), in order to avoid ripple currents.

M0	M1	BLDC/BLAC motor	DC motor	Stepper motor
HB1+	HB3+		+V	A+
HB1–	HB3–	U	–V	A–
HB2+	HB4+	V		B+
HB2–	HB4–	W		B–
DR_GND	DR_GND			
Shield	Shield			

Tab. 8-16: Motor connections

8.15 Drive Power

The NY4120 drive power is used to connect the drive power supply to PWM drive module. Both the drive power and drive ground are designed to conduct 14 A continuous.

Characteristic	Description
Number of inputs	2: DR_PWR, DR_GND
Drive power voltage	15 V … 75 V
Absolute maximum rating	90 V Note: The software disables the drive at 80 V. The maximum voltage at which the software disables the drive can only be set to a user defined value lower than 80 V. See Software User Manual, parameter SAC_PAR_POS_SERVO_OVER_VOLTAGE_LIMIT
Input current	12 A rms, 30 A peak
Overvoltage protection	No
Undervoltage protection	Yes The minimum voltage at which the software disables the drive is 12 V (default value) or a higher user defined voltage level. See Software User Manual, parameter SAC_PAR_POS_SERVO_UNDER_VOLTAGE_LIMIT

Tab. 8-17: NY4120 drive power inputs characteristics

9 NY4125: 5-axis low power PWM Drive Module

9.1 Overview

The NY4125 is a 5-axis PWM (Pulse Width Modulation) drive module, which can drive brushed DC motors and brushless AC (BLAC) motors. The NY4125 is a cost-effective solution for low demanding applications. Part number is R911172221, ordering code is NYM04.1-5PW-NNNN-NY4125.

One NY4125 5-axis low power PWM Drive module can be installed in the NY4063 system housing. The NY4125 drive module must always be installed in drive slot 0 of the NY4063 system housing, the drive slot right next to the MCU. Note that only the NY4063 system housing supports the NY4125.

Support for quadrature encoders with and without index pulse, digital Rexroth MSM encoders and EnDat2.2 encoders is available on-board. The quadrature encoder is also known as A/B encoder, S0S90 encoder and 3-channel digital incremental encoder. See chapter 13 "Encoders" on page 161 for the supported encoder types.

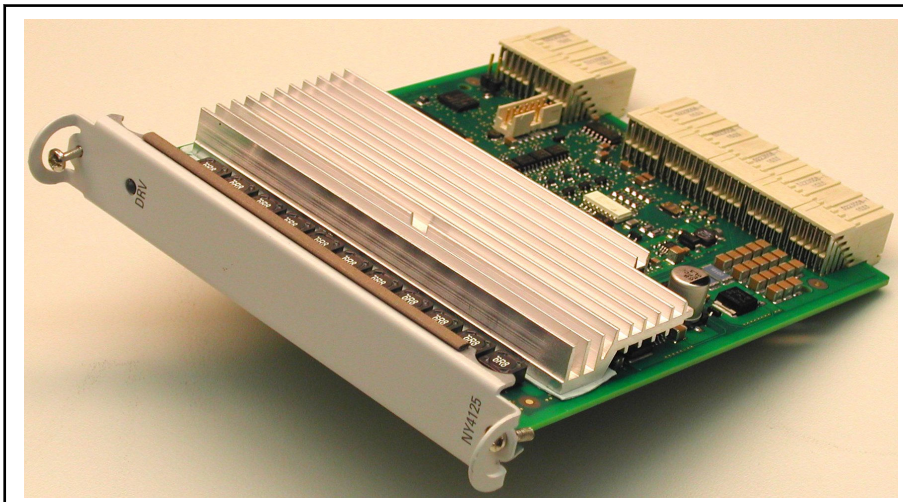

Fig. 9-1: 5-axis low power PWM drive module NY4125

The main features of the NY4125 are the following.

- PWM frequency: 16 … 96 kHz.
- I nominal : 2 A rms per axis, 10 A per drive module
- I peak : 3 A per axis, 15 A per drive module
- Bus voltage is minimal 15 V, maximal 36 V
- Small motors supported
- Short circuit, overvoltage and over temperature protection
- Quadrature encoder cable break detection
- Power consumption approximately 2.7 W at 24 V system power supply voltage

Per module the following I/O are available:

- 5 7.5 MHz ($30 * 10^6$ count/s) quadrature encoders, digital Rexroth MSM or EnDat2.2 encoder interfaces suitable for RS485 and TTL inputs.

NY4125: 5-axis low power PWM Drive Module

- 12 digital inputs. 5 inputs can be configured as disable drive input, 1 per axis.
- 4 digital outputs.
- 2 fast digital inputs. One general purpose, one stop alarm input for all axes.
- 2 fast digital outputs.
- 5 general purpose TTL digital inputs. Edge detection, counter functionality, etc. is not supported on these inputs.

☞ If a drive slot was configured for an NY4120 or NY4140 drive module and now used for an NY4125 drive module, make sure that the DP drive voltage is changed (lowered) before you install the NY4125 drive module.

9.2 Module identification

An identification label is attached on the NY4125 module.

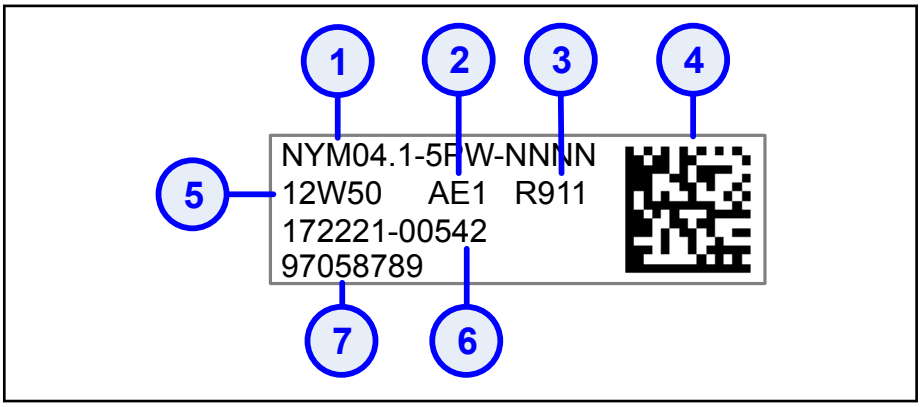

Fig. 9-2: Identification label of the NY4125

Identification number	Field explanation
1	Type code
2	Version level and status
3	Material number
4	2D bar code
5	Date of manufacture (yyWww)
6	Serial number
7	Manufacturer ID

Tab. 9-1: Explanation of the fields of the NY4125 identification label

9.3 Module dimensions

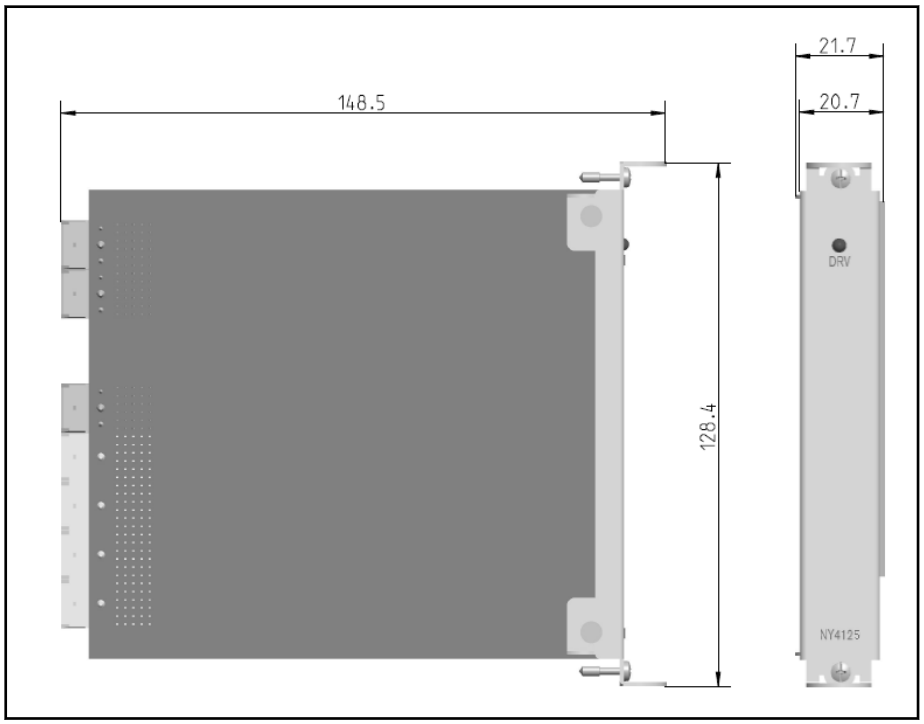

Fig. 9-3: NY4125 module dimensions

Module type code	Width	Height	Depth	Weight
NYM04.1-5PW-NNNN-NY4125	21.7 mm	128.4 mm	148.5 mm	277 gr

Tab. 9-2: NY4125 physical data

9.4 Field Diagnostics

The module does not contain any replaceable or wear parts. In case of failure, the entire module must be replaced.

The NY4125 module has 1 bi-color module status indicator LED labeled "DRV" on the front panel. The various indications are described in tab. 9-3 ""DRV" status LED indications" on page 89.

LED indication	Description
Red steady	Default setting when the drive module starts (power-up). Fatal error on the drive module, or gateware is not correct or not loaded, or module not operational because a communication problem is detected (call service).
Orange steady	Gateware loaded, but node not yet operational, because other drive modules in the node are initializing.

NY4125: 5-axis low power PWM Drive Module

LED indication	Description
Green steady	Drive module OK.
Red flashing	Drive module is OK, but an overvoltage condition or over temperature condition is detected, or a configured motor cannot run due to undervoltage. • Overvoltage condition occurs at 40 V. • Over temperature condition occurs at 105 °C. • Undervoltage condition occurs at 12 V.

Tab. 9-3: "DRV" status LED indications

9.5 Power switch on/off precautions

Follow these instructions to prevent damage to the drive module. See also chapter 16 "Drive power precautions for NY412x/NY4140" on page 213.

- Do not plug the drive module into the backplane while the 24V System power supply is applied.
- Do not remove the drive module from the backplane while the 24V System power supply is applied.
- Make sure that the 24V System power supply is applied before the drive power supply is applied.

The preferred method to switch on and off the drive power is by means of the mains switch as indicated by ① in fig. 9-4 "Schematic of drive power supply to a node" on page 90 to prevent destructive inrush currents.

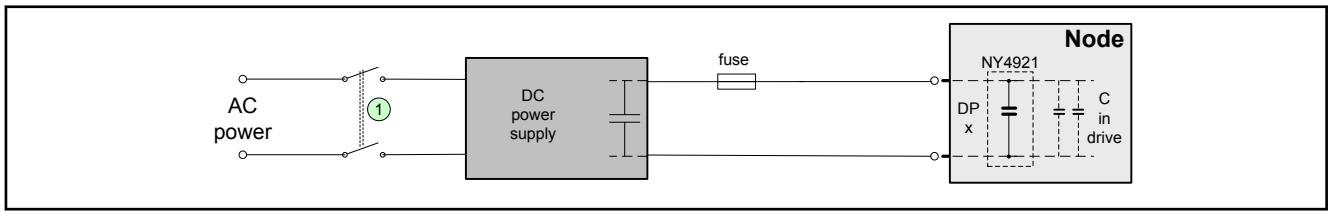

Fig. 9-4: Schematic of drive power supply to a node

If you want to remove the drive module from the backplane, follow this sequence.

1. Switch off the drive power supply to the system.
2. If an axis is configured on the drive module, wait until the "DRV" LED on the drive module flashes red on and off.

   If no axis is configured on the drive module, the "DRV" LED is continuous green and you can proceed to the next action.
3. Switch off the 24V System power supply to the system.
4. Wait until the "DRV" LED on the drive module is off.
5. Remove the drive module.

- Do not connect the drive power supply to the "DP x" connectors of the system while the drive power supply is switched on.
- Switching on/off the drive power supply by connecting/ disconnecting the "DP x" connectors is forbidden.

9.6 I/O Connector

The PWM drive module I/O connector uses a 150 pin, 2mm Modular Interconnect System. The pinout is sorted on insulated areas.

Pin	Row A	Row B	Row C	Row D	Row E
1	Enc5V3	TTLIn0	TTLIn2	TTLIn4	Enc5v4
2	Enc5V2	TTLIn1	TTLIn3		
3	DGND	DGND	DGND	DGND	DGND
4	Enc1Index–	Enc1Index+	Enc3Index–	Enc3Index+	Enc4QuadB–
5	Enc1QuadB–	Enc1QuadB+	Enc3QuadB–	Enc3QuadB+	Enc4QuadB+
6	Enc1QuadA–	Enc1QuadA+	Enc3QuadA–	Enc3QuadA+	Enc4Index–
7	Enc0Index–	Enc0Index+	Enc2Index–	Enc2Index+	Enc4Index+
8	Enc0QuadB–	Enc0QuadB+	Enc2QuadB–	Enc2QuadB+	Enc4QuadA–
9	Enc0QuadA–	Enc0QuadA+	Enc2QuadA–	Enc2QuadA+	Enc4QuadA+
10	EncGND	EncVref	EncGND	Enc5V0	Enc5V1
11	DigIn0	DigIn1	DigIn2	DigIn3	DigComm0
12	DigIn4	DigIn5	DigIn6	DigIn7	DigComm1
13	FastIn0	StopAlarm	FastOut0	FastOut1	GND_DIO
14	DigOut0	DigOut1	DigOut2	DigOut3	24V_DIO
15	24V_DIO	24V_DIO	24V_DIO	24V_DIO	GND_DIO
16	DigIn8	DigIn9	DigIn10	DigIn11	DigComm2
17					
18	Reserved	Reserved	Reserved	Reserved	Reserved
19	HB4_3	HB4_3			
20	HB4_1	HB4_1		HB4_2	HB4_2
21	HB3_1	HB3_1		HB3_2	HB3_2
22	HB2_3	HB2_3		HB3_3	HB3_3
23	DR_PWR	DR_PWR	DR_PWR	DR_PWR	DR_PWR
24	DR_PWR	DR_PWR	DR_PWR	DR_PWR	DR_PWR
25	HB2_1	HB2_1		HB2_2	HB2_2
26	HB1_1	HB1_1		HB1_2	HB1_2
27	HB0_3	HB0_3		HB1_3	HB1_3
28	HB0_1	HB0_1		HB0_2	HB0_2

NY4125: 5-axis low power PWM Drive Module

Pin	Row A	Row B	Row C	Row D	Row E
29	DR_GND	DR_GND	DR_GND	DR_GND	DR_GND
30	DR_GND	DR_GND	DR_GND	DR_GND	DR_GND

Tab. 9-4: 5-axis low power PWM drive module I/O connector

- DGND on row 3 is intended as shielding. No connections should be made to these pins.
- Not allocated pins must be not connected.

9.7 Digital Inputs

Characteristic	Description
Number of digital inputs	12, divided in 3 groups: • DigIn0 ... DigIn3 with DigComm0 • DigIn4 ... DigIn7 with DigComm1 • DigIn8 … DigIn11, with DigComm2
Functions of digital inputs	DigIn0 ... DigIn11: General Purpose Digital input • Position latching • Change of state events (1 per MCU's sample time) • Count transitions (1 per MCU's sample time) • DigIn7 ... DigIn11: can be configured as "disable drive" input for, respectively, axis0, axis1, axis2, axis3, axis4. All FETs of an axis are opened to create an open circuit of motor coils. The power amplifier is disabled after the disable drive input is detected active for approximately 500 µs.
High and low side switching	Possible for all 3 groups (in groups of 4 digital inputs)
Galvanic insulated	Yes
Switch time (Filter delay)	< 100 µs
Permitted input voltage	–30 V ... +30 V ±0.5 V
Input high level	+15 V ... +30 V or –15 V ... –30 V
Input low level	–5 V ... +5 V
Input current @ 24V	Nominal 3,5 mA
Jitter on switching times	Typical 20 µs

Tab. 9-5: Characteristics of the digital inputs

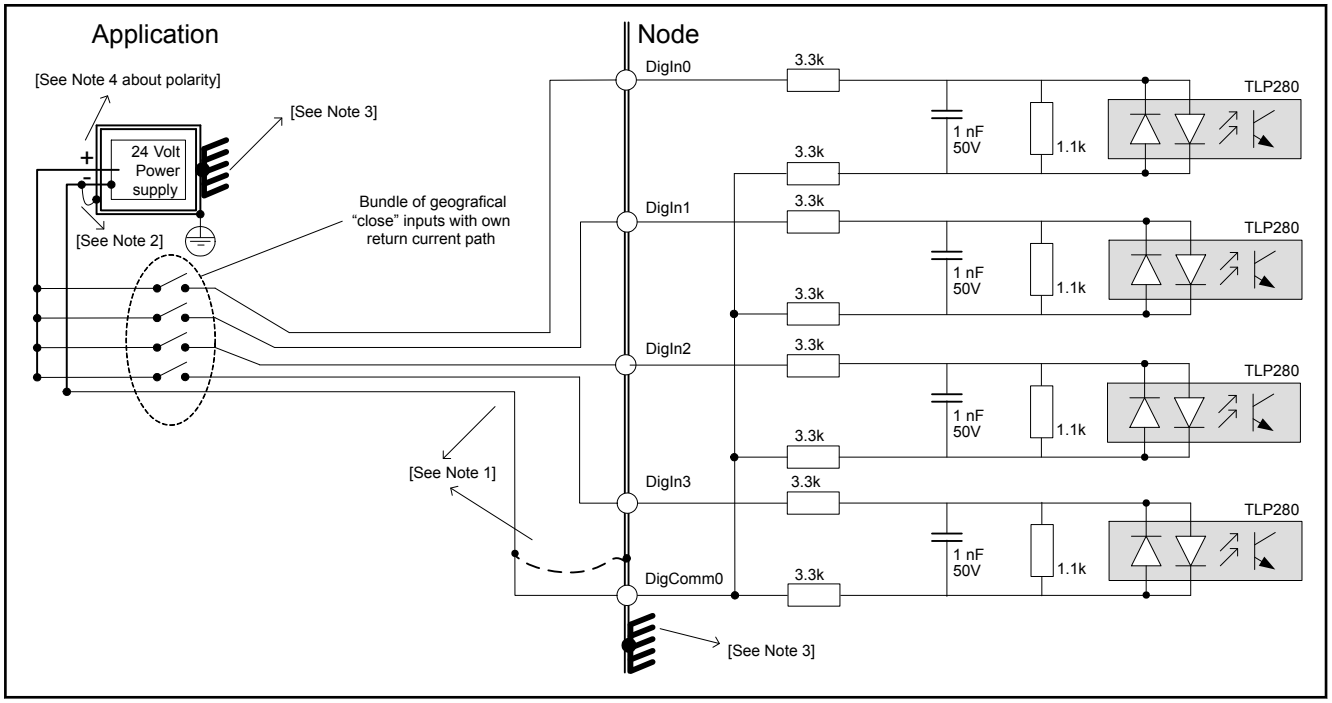

Fig. 9-5: First group of digital inputs

The second group (DigIn4 ... DigIn7 with DigComm1) and third group (DigIn8 ... DigIn11 with DigComm2) is schematically identical to the first group.

Notes

1. Follow the following cabling instructions:
   - Shielded cable is recommended, but not mandatory.

     If shielded cable is used, the shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).

     Connect the other side to a convenient metal part or leave it unconnected.
   - The digital I/O may be associated with more than one power supply, and/or the cable may contain more than one minus for power supply. If this is the case and if the cable is unshielded, connect at least one of the minus wires of each power supply to Shield (house connector).
   - For the "disable drive" inputs: The cable with signal wire(s) should also contain the return current path for every signal in the cable. (For normal digital I/O this is recommended).
2. Connect the minus of the I/O power to the housing and/or safety earth (if this is not already the case).
3. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. Each group of 4 inputs can be used either as high side switching (HSS), or as low side switching (LSS), but must be the same for the whole group.

NY4125: 5-axis low power PWM Drive Module

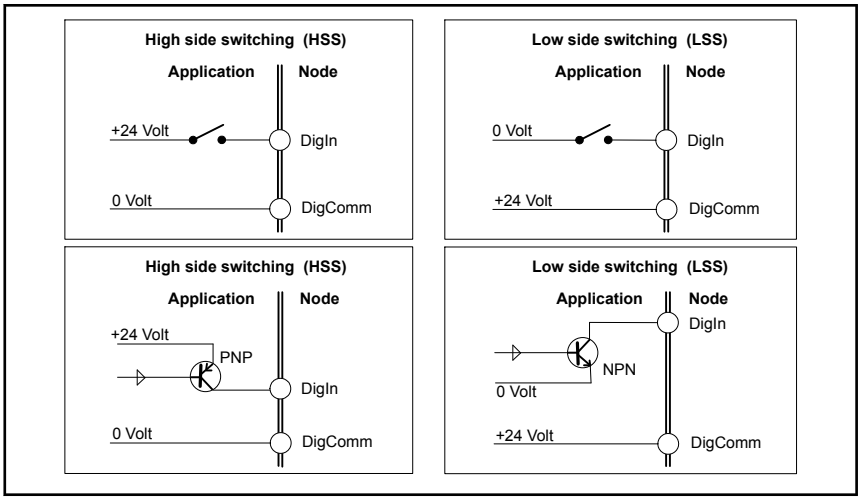

Fig. 9-6: HSS and LSS

5. Keep in mind that these digital inputs do not have a high impedance. If the application uses an open collector output to connect to these digital inputs, use an NPN transistor for low side switching and use a PNP transistor for high side switching, see fig. 9-6 "HSS and LSS" on page 94. It is not recommended to use an NPN transistor output in combination with high side switching, as shown in fig. 9-7 "HSS with an NPN output transistor" on page 94.

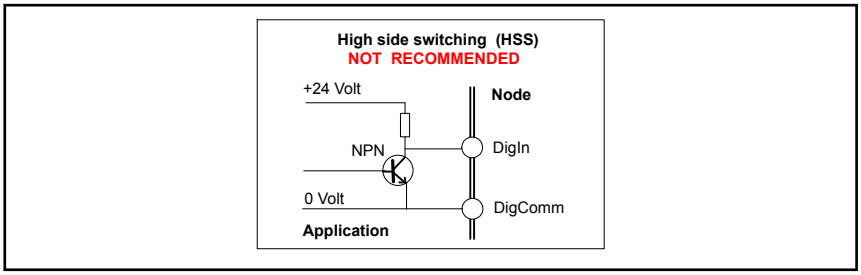

Fig. 9-7: HSS with an NPN output transistor

9.8 Digital Outputs

Characteristic	Description
Number of digital outputs	4: DigOut0 … DigOut3 with GND_DIO
Functions	State output Pulsed output PWM output with on delay
Type of load	Only resistive or capacitive loads are supported. The digital outputs cannot be used for inductive loads.
Voltage supply	24 V ±6 V
Output current	0,02 A ... 1 A, 2 A peak (max. 50 ms)
Output turn on time ([1])	Typical 50 µs

Characteristic	Description
Output turn off time ([1])	Typical 50 µs (with a load current = 1 A) Note: turn off time increases if load current < 1 A.
Galvanic insulation	Yes
Short circuit protected	Yes, maximum short circuit current 3 A.
Fail / no load detection	No
Grounded load	Yes (high side switching)
IEC61131-2 compliant	Yes
PWM (Pulse Width Modulation)	Yes

1 Indicated times only apply with a resistive load. Indicated times change if the load has a capacitive component.

Tab. 9-6: Characteristics of the digital outputs

Pulse time specification	Unit	Minimum	Typical	Maximum
Digital output pulse duration	µs	50		10 000 000
Pulse accuracy t_{PULSE_on} ≤ 160 ms	µs		50	
Pulse accuracy for t_{PULSE} > 160 ms	ms		1	

Tab. 9-7: Pulse time specifications of the digital outputs

PWM signal specifications	Unit	Minimum	Typical	Maximum
Digital output PWM frequency	Hz	0.1		10 000
PWM duty cycle	%	0		100
Pulse accuracy for f_{PWM} ≥ 6.25 Hz	µs		50	
Pulse accuracy for f_{PWM} < 6.25 Hz	ms		1	
Digital output on-delay, before PWM	µs	0		10 000 000
On-delay accuracy for t_{DELAY} ≤ 160 ms	µs		50	
On-delay accuracy for t_{DELAY} > 160 ms	ms		1	

Tab. 9-8: PWM signal specifications of the digital outputs

The PWM signal is defined by the NYCe 4000 software through the PWM frequency parameter specified in Hz, and the duty cycle parameter specified in %. These two parameters are internally converted to pulse duration "a" and pulse pause duration "b" (see fig. 9-8 "PWM signal specification parameters" on page 96) which can only have a discrete increment step size. The

NY4125: 5-axis low power PWM Drive Module

increment step size is equal to the pulse accuracy and depends on the specified PWM frequency. These discrete values for the pulse duration and pulse pause duration imply that the actual PWM frequency and duty cycle may differ from the specified PWM frequency and duty cycle.

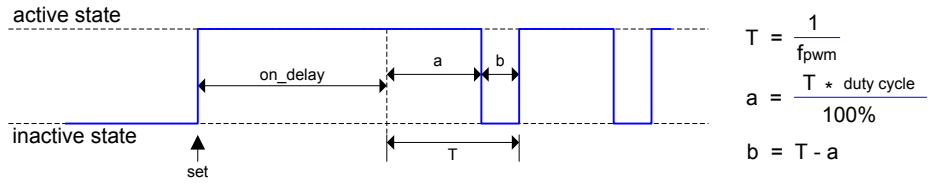

Fig. 9-8: PWM signal specification parameters

The schematic of the digital output is given in fig. 9-9 "DigOut0" on page 96.

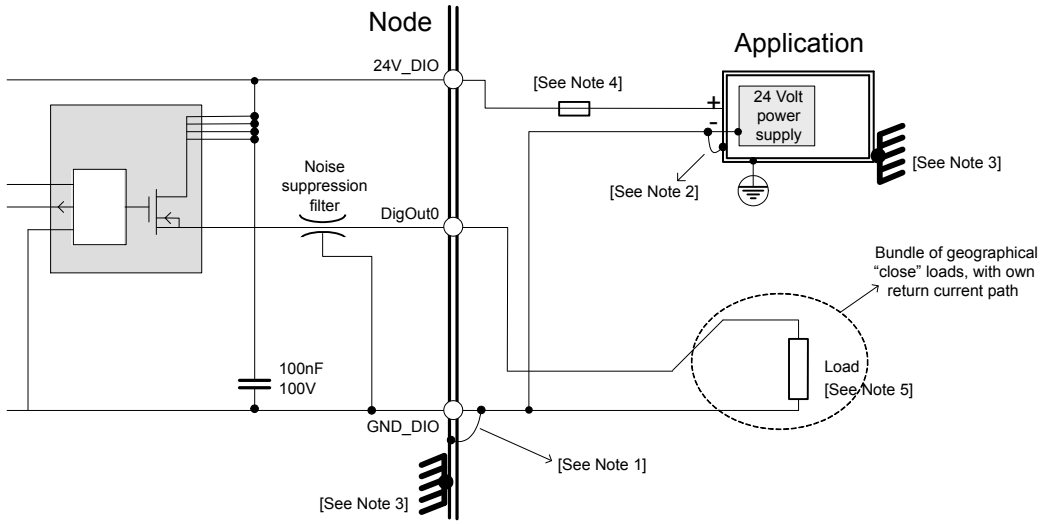

Fig. 9-9: DigOut0

DigOut1, DigOut2 and DigOut3 are schematically identical.

Notes

1. Follow the following cabling instructions:
   - Shielded cable is recommended, but not mandatory.

     If shielded cable is used, the shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).

     Connect the other side to a convenient metal part or leave it open,
   - The digital I/O may be associated with more than one power supply, and/or the cable may contain more than one minus for power supply. If this is the case and if the cable is unshielded, connect at least one of the minus wires of each power supply to Shield (house connector).
2. Connect the minus of the I/O power to the housing and/or safety earth (if this is not already the case).

3. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. A fuse must be installed between the +24 V power supply and 24V_DIO on the node. The fuse is mandatory by safety regulations and must be UL recognized. See NYCe 4000 Standard Housings and Accessories manual for detailed information about fuses.
5. If the load represents a high impedance input, you must use an external pull down resistor to meet the minimum specified output current through the switch.

9.9 Digital High Speed Inputs and Outputs

Characteristic	Description
Number of digital inputs	2: FastIn0 and StopAlarm
Function	• FastIn0 – High speed general purpose digital input – High speed position latching – Change of state event (1 per MCU's sample time) – Count transitions (max. frequency 250 kHz) • StopAlarm for the drive module (all axes) In less than 10 µs the upper FETs are open and the lower FETs of the bridges are closed to create a short circuit of the motor coils (fastest stop of the motor). The StopAlarm input is default configured high active.
High and low side switching	No, always grounded load (high side switching)
Galvanic insulated	Yes
Switch time (Filter delay)	< 2 µs
Permitted input voltage	–30 V ... +30 V
Input high level	+15 V ... +30 V
Input low level	–30 V ... +5 V
Input current @ 24V	Nominal 15 mA

Tab. 9-9: Characteristics of high speed digital input

Characteristic	Description
Number of digital outputs	2: FastOut0 and FastOut1
Function	External stepper drive control ([1]) High speed state output High speed pulsed output High speed PWM output with on delay

NY4125: 5-axis low power PWM Drive Module

Characteristic	Description
Type of load	Only resistive or capacitive loads are supported. The fast digital output cannot be used for inductive loads.
Grounded load	Yes, (high side switching outputs)
Galvanic insulated	Yes
Switch time (2)	< 2 µs (with load current ≥ 50 mA)
Short circuit protected	Yes, maximum short circuit current 300 mA
Fail / no load detection	No
Voltage supply	24 V ±6 V
Output current	0.4 mA ... 50 mA, 100 mA peak (max 50 ms)

1 Active high control signals are recommended. Using active low control signals is only possible if the minimum input level specified by the external stepper drive is higher than 0.7 V.

2 Indicated time only apply with a resistive load. Indicated time changes if the load has a capacitive component.

Tab. 9-10: Characteristics of high speed digital output

See tab. 9-7 "Pulse time specifications of the digital outputs" on page 95 for the pulse time specification and tab. 9-8 "PWM signal specifications of the digital outputs" on page 95 for the PWM signal specification of the digital high speed output.

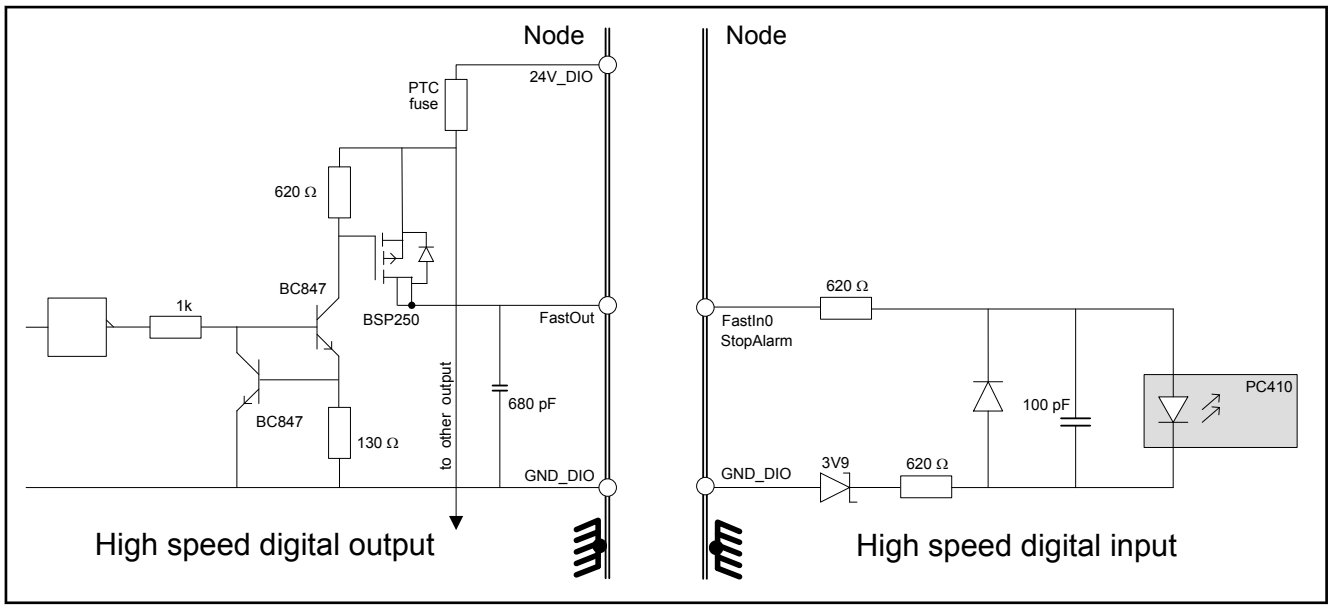

Fig. 9-10: Output circuit for FastOut0, FastOut1, and input circuit for FastIn0, StopAlarm

For cabling and power supply connections of the fast digital inputs and fast digital outputs the same rules apply as for normal digital inputs and outputs, with one additional note. The cable with signal wire(s) of fast digital inputs and/or fast digital outputs must also include the return current path for every

signal in the cable. For normal digital I/O this is recommended, but for fast digital I/O this is mandatory.

9.10 TTL Digital Inputs

Characteristic	Description
Number of inputs	5, TTLIn0 … TTLIn4
Function	General purpose digital Input (for example for encoder error signal). Other general purpose digital input functionality, such as edge detection, counter functionality, etc., is not supported. In NYCe 4000 Software these inputs are referenced with the following definitions: • Input TTLIn0 – referenced by identifier NYCE_DIG5VIN0A • Input TTLIn1 – referenced by identifier NYCE_DIG5VIN0B • Input TTLIn2 – referenced by identifier NYCE_DIG5VIN0C • Input TTLIn3 – referenced by identifier NYCE_DIG5VIN1A • Input TTLIn4 – referenced by identifier NYCE_DIG5VIN1B
Signal interface	TTL logic
Galvanic insulated	No
Input thresholds	Input "low" voltage range: 0 … 0.8 V Input "high" voltage range: 2.0 … 5.5 V
Input current	Typical 40 µA (input "low"), 1.4 mA (input "high")
Maximum input voltage	–5 … +10 V ±0.5 V
Interface type	TTL
Input frequency	1 MHz
Pull-up resistor for open collector driver	No

Tab. 9-11: Characteristics for TTL digital inputs

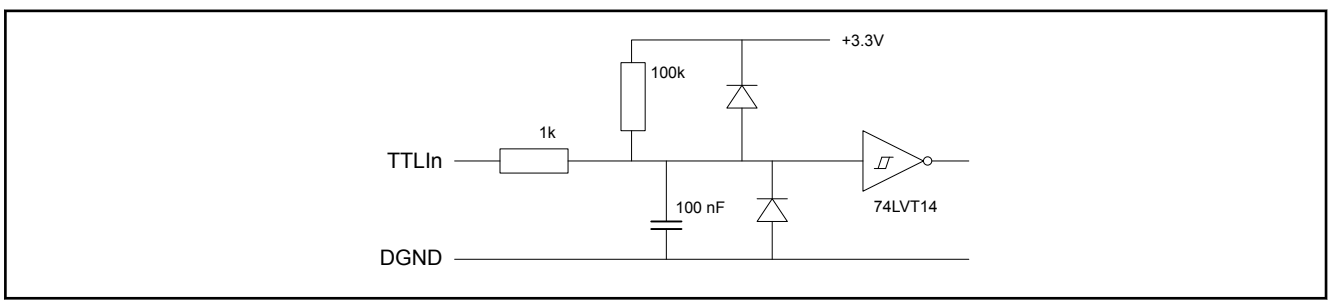

Fig. 9-11: Input circuit of the digital inputs TTLIn0…4

Notes

- Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
- Follow these cabling instructions:
  - Always use a shielded cable.
  - The shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).
  - If the equipment on the application side is metal, connect the shield to the equipment housing.

9.11 Encoder Inputs and Encoder Power Supply

The following encoder types can be used with the NY4125:

- Quadrature encoder
- Rexroth MSM incremental or absolute position encoder
- Sanyo Denki absolute position encoder
- EnDat2.2 encoder

The channel for QuadA input or clock output includes cable break detection, the channel for QuadB input or data input/output includes cable break detection. The index input does not have cable break detection.

The NYCe 4000 software includes functions to switch the encoder power supply on and off per axis. This means that the encoder power supply voltage on the pins Enc5V0, Enc5V1, Enc5V2, Enc5V3, and Enc5V4 can be switched on and off independently for each axis.

For detailed connection information, see chapter 13 "Encoders" on page 161.

☞ Do not connect or disconnect the encoders while the system power supply is switched on. This can destroy the encoder electronics.

☞ At stand-still of an axis with a high-resolution encoder, a certain steady state error may occur due to the limited resolution of the controller-out signal of the NY4125. In this condition, the other drive modules have a better (lower) steady state error.

9.12 Drive Output

9.12.1 Characteristics

Five PWM amplifiers with three half H-bridges each are used as voltage amplifiers on the NY4125. During the active part of the PWM cycle, the drive power voltage is applied to the motor connections. During the passive part of the PWM cycle, the half H-bridges are for a short moment in a short circuit mode and current measurements are done.

☞ When the 24V System power supply voltage drops below the required minimum voltage while a motor is running, the NYCe 4000 system is designed to stop the motor. Stopping the motor is achieved by creating a short circuit condition through the FETs of the H-bridge. This will not cause problems with small motors, but if the module drives a motor with a high amount of kinetic energy, the FETs can be destroyed by this energy.

Characteristic	Description
PWM frequency	16, 32, 64, 96 kHz
PWM duty cycle	Maximum PWM duty cycle • at 16 kHz: 98% • at 32 kHz: 96% • at 64 kHz: 93% • at 96 kHz: 90%
PWM pulse time	Minimum ON time: 200 ns Maximum OFF time: 1 µs Step resolution: 16 ns
PWM resolution	12 bits
Half bridges (5 axes per module)	Min: 2 (1 DC motor) Max: 15 (5 BLAC motors)
I nominal	2 A rms per axis
I peak	3 A (max. 100 ms) per axis
Motor power voltage	0 V … 35 V
Overcurrent protection	No
Short circuit detection	Yes, at 6 A peak ±0.5 A of the PWM top current • half bridge (HBx_1) to half bridge (HBx_2) • half bridge (HBx_y) to DR_GND
Thermal protection	105 °C on PCB

Tab. 9-12: NY4125 drive output characteristics

9.12.2 Motor types

The following motor types can be connected to the NY4125:

PWM Brushless AC servo motor control (BLAC)

BLAC motors have a sinusoidal stator winding distribution which is designed for use on a sinusoidal or PWM inverter supply voltage. In software, the alignment between motor coils and magnets is done using for example a wake-and-shake procedure.

PWM Brushed DC servo motor control (DC)

NY4125: 5-axis low power PWM Drive Module

9.12.3 Connection information

Characteristic	Description
Cable length	max 15 m.
Current capability	Conform application
Capacitance	max 100 pF/m.

Tab. 9-13: Motor cable characteristics

The motors are connected according to fig. 9-12 "NY4125 motor connection circuit (3 half bridges, HB0_1/2/3)" on page 102 and tab. 9-14 "Motor connections" on page 103.

The half bridges HB1_0/1/2, HB2_0/1/2, HB3_0/1/2, and HB4_0/1/2 are identical to HB0_0/1/2.

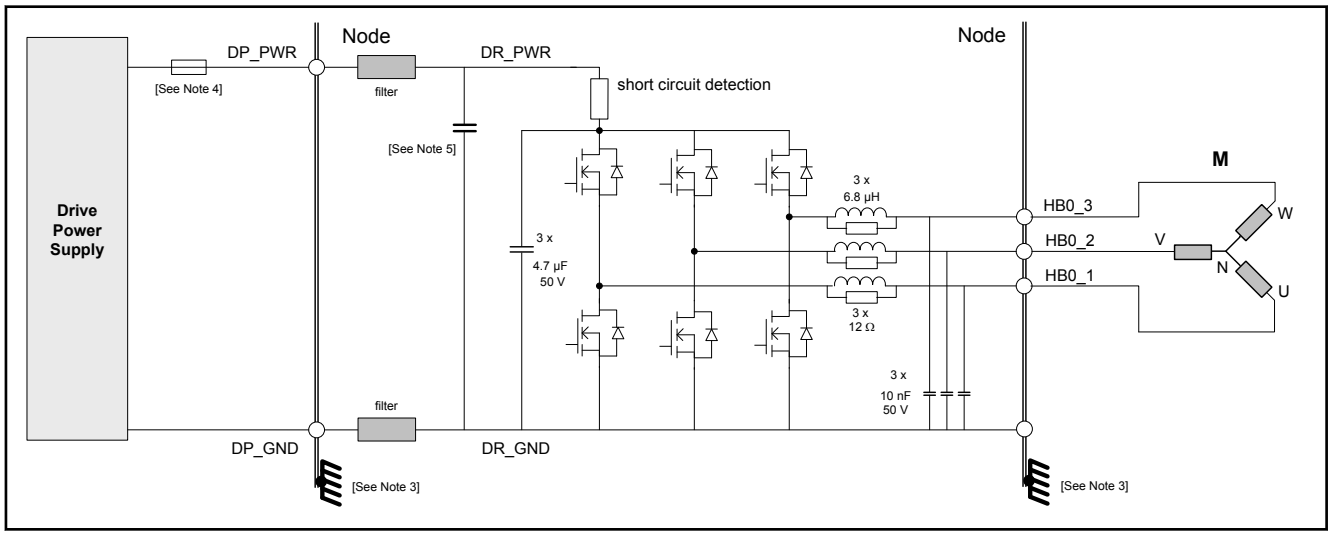

Fig. 9-12: NY4125 motor connection circuit (3 half bridges, HB0_1/2/3)

Notes

1. Follow this cabling instruction:

   Shielded cable is recommended, but not mandatory.

   If shielded cable is used, the shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).

   Connect the other side to a convenient metal part or leave it open.
2. Connect the DR_GND of the drive power to the housing and/or safety earth (if this is not already the case).
3. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. A fuse must be installed between the +V of the drive power supply and DP_PWR on the node. The fuse is mandatory by safety regulations and must be UL recognized. See NYCe 4000 Standard Housings and Accessories manual for detailed information about fuses.
5. Connect an external capacitor close to the drive module (see chapter 16.1 "Drive Power Filtering for NY412x/NY4140" on page 213), in order to avoid ripple currents.

M0	M1	M2	M3	M4	BLAC motor	DC motor
HB0_1	HB1_1	HB2_1	HB3_1	HB4_1	U	
HB0_2	HB1_2	HB2_2	HB3_2	HB4_2	V	V+
HB0_3	HB1_3	HB2_3	HB3_3	HB4_3	W	V−
DR_GND	DR_GND	DR_GND	DR_GND	DR_GND		
Shield	Shield	Shield	Shield	Shield		

Tab. 9-14: Motor connections

9.13 Drive Power

The NY4125 drive power is used to connect the drive power supply to the PWM drive module.

Characteristic	Description
Number of inputs	2: DR_PWR, DR_GND
Drive power voltage	15 V … 36 V, ±0.5 V.
Absolute maximum rating	42.4 V Note: The software disables the drive at 40 V. The maximum voltage at which the software disables the drive can only be set to a user defined value lower than 40 V. See Software User Manual, parameter SAC_PAR_POS_SERVO_OVER_VOLTAGE_LIMIT
Input current	10 A, 15 A peak
Overcurrent protection	Yes, at 20 A.
Overvoltage protection	No
Undervoltage protection	Yes The minimum voltage at which the software disables the drive is 12 V (default value) or a higher user defined voltage level. See Software User Manual, parameter SAC_PAR_POS_SERVO_UNDER_VOLTAGE_LIMIT

Tab. 9-15: NY4125 drive power inputs characteristics

10 NY4130: DC Drive Module

10.1 Overview

The NY4130 is a low power DC drive module, which can control two servo brushed DC motors. Part number is R911318962, ordering code is NYM04.1-2LD-NNNN-NY4130.

Support for quadrature encoders with and without index pulse is available on-board, as well as other encoders, and there is a possibility to add one NY4199 SinCos Option module to connect another position sensor (for example EnDat or SinCos). The quadrature encoder is also known as A/B encoder, S0S90 encoder and 3-channel digital incremental encoder. See chapter 13 "Encoders" on page 161 for the supported encoder types.

Fig. 10-1: DC drive module NY4130

The main features of the NY4130 are the following.

- Bus voltage is minimal ± 15 V, maximal ± 26 V
- Nominal current is 1 A for ± 26 V, 2 A for ± 15 V per drive
- I peak : 4 A per drive
- Over temperature protection
- Quadrature encoder cable break detection

- Power consumption approximately 1.7 W at 24 V system power supply voltage

Per module the following I/O are available:

- 6 x RS422 encoder inputs for each axis (2 x QuadA, QuadB and Index).
- 2 analog outputs (16 bit).
- 2 analog inputs (16 bit).
- 10 digital inputs.
- 4 digital outputs.
- 2 stop alarm inputs.
- 2 fast digital inputs.
- 2 fast digital outputs.
- 6 x 5 V digital inputs.

10.2 Module identification

An identification label is attached on the NY4130 module.

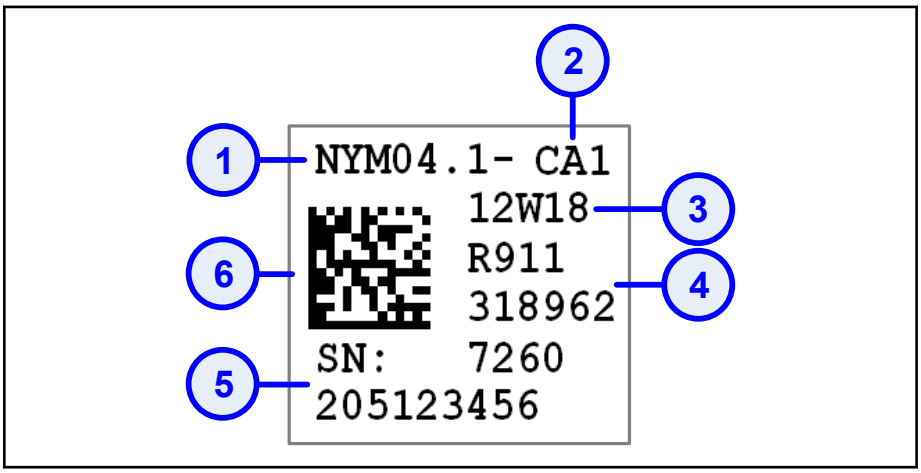

Fig. 10-2: Identification label of the NY4130

Identification number	Field explanation
1	Type code
2	Version level and status
3	Date of manufacture (yyWww)
4	Material number
5	Serial number
6	2D bar code

Tab. 10-1: Explanation of the fields of the NY4130 identification label

10.3 Module dimensions

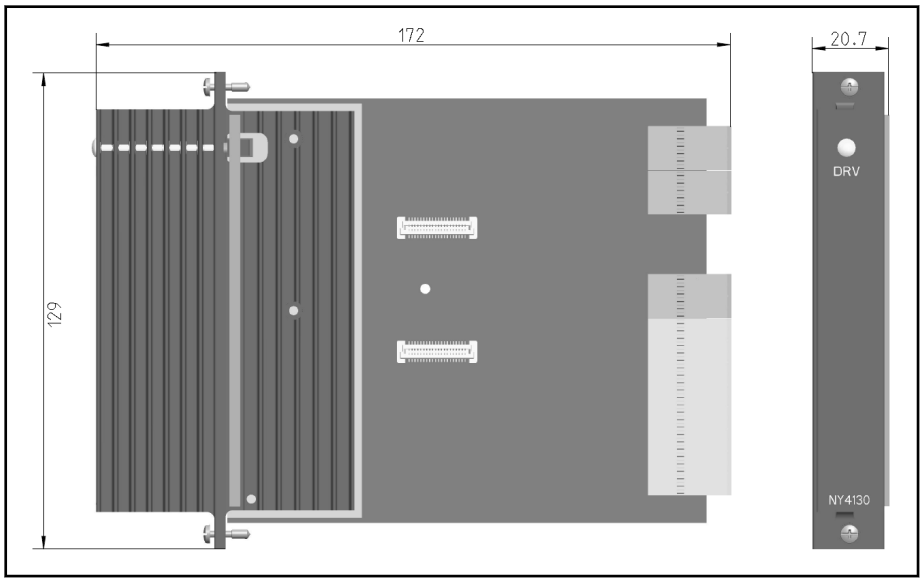

Fig. 10-3: NY4130 module dimensions

Module type code	Width	Height	Depth	Weight
NYM04.1-2LD-NNNN-NY4130	20.7 mm	129.0 mm	172.0 mm	440 gr

Tab. 10-2: NY4130 physical data

10.4 Field Diagnostics

The module does not contain any replaceable or wear parts. In case of failure, the entire module must be replaced.

The NY4130 module has 1 bi-color module status indicator LED labeled "DRV" on the front panel. The various indications are described in tab. 10-3 ""DRV" status LED indications" on page 107.

LED indication	Description
Red steady	Default setting when the drive module starts (power-up). Fatal error on the drive module, or gateware is not correct or not loaded, or module not operational because a communication problem is detected (call service).
Orange steady	Gateware loaded, but node not yet operational, because other drive modules in the node are initializing.

LED indication	Description
Green steady	Drive module OK.
Red flashing	Drive module is OK, but an overvoltage condition or over temperature condition is detected, or a configured motor cannot run due to undervoltage. • Overvoltage condition occurs at +/- 29 V. • Over temperature condition occurs at 105 °C. • Undervoltage condition occurs at +/- 12 V.

Tab. 10-3: "DRV" status LED indications

10.5 Power switch on/off precautions

Follow these instructions to prevent damage to the drive module.

- Do not plug the drive module into the backplane while the 24V System power supply is applied.
- Do not remove the drive module from the backplane while the 24V System power supply is applied.
- Make sure that the 24V System power supply is applied before the drive power supply is applied.

The preferred method to switch on and off the drive power is by means of the mains switch as indicated by ① in fig. 10-4 "Schematic of drive power supply to a node" on page 108 to prevent destructive inrush currents.

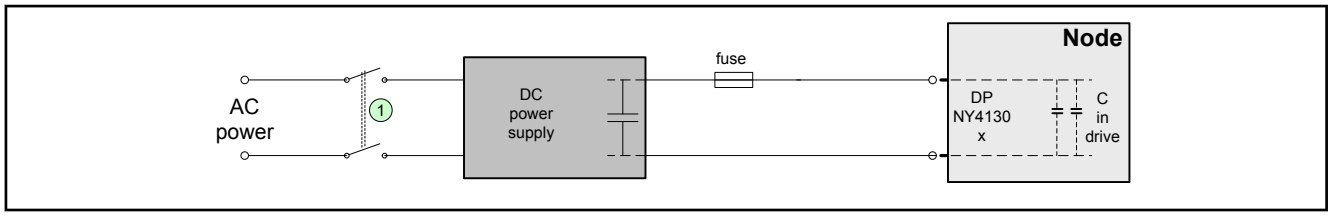

Fig. 10-4: Schematic of drive power supply to a node

If you want to remove the drive module from the backplane, follow this sequence.

1. Switch off the drive power supply to the system.
2. If an axis is configured on the drive module, wait until the "DRV" LED on the drive module flashes red on and off.

   If no axis is configured on the drive module, the "DRV" LED is continuous green and you can proceed to the next action.
3. Switch off the 24V System power supply to the system.
4. Wait until the "DRV" LED on the drive module is off.
5. Remove the drive module.

- Do not connect the drive power supply to the "DP NY4130 x" connectors of the system while the drive power supply is switched on.
- Switching on/off the drive power supply by connecting/ disconnecting the "DP NY4130 x" connectors is forbidden.

10.6 I/O Connector

The low power DC module I/O connector uses a 150 pin, 2mm Modular Interconnect System. The pinout is sorted on insulated areas.

Pin	Row A	Row B	Row C	Row D	Row E
1	AnOut0	AnGND	AnVref	AnIn1–	AnIn1+
2	AnOut1	AnGND	AnVref	AnIn0–	AnIn0+
3	DGND	DGND	DGND	DGND	DGND
4	Enc1Index–	Enc1Index+	Dig5VIn1a–	Dig5VIn1a+	Opt_2+
5	Enc1QuadB–	Enc1QuadB+	Dig5VIn1b–	Dig5VIn1b+	Opt_2–
6	Enc1QuadA–	Enc1QuadA+	Dig5VIn1c–	Dig5VIn1c+	Opt_1+
7	Enc0Index–	Enc0Index+	Dig5VIn0a–	Dig5VIn0a+	Opt_1–
8	Enc0QuadB–	Enc0QuadB+	Dig5VIn0b–	Dig5VIn0b+	Opt_0+
9	Enc0QuadA–	Enc0QuadA+	Dig5VIn0c–	Dig5VIn0c+	Opt_0–
10	EncGND	EncVref	EncGND	Enc5V0	Enc5V1
11	DigIn0	DigIn1	DigIn2	DigIn3	DigComm0
12	DigIn4	DigIn5	DigIn6	DigIn7	DigComm1
13	FastIn0	FastIn1	FastOut0	FastOut1	GND_DIO
14	DigOut0	DigOut1	DigOut2	DigOut3	24V_DIO
15	24V_DIO	24V_DIO	24V_DIO	24V_DIO	GND_DIO
16	DigIn8	DigIn9	StopAlarm0	StopAlarm1	DigComm2
17					
18	DRVPW–L	DRVPW–L		DRVPW+L	DRVPW+L
19					
20					
21	M2–	M2–	M2–	M2–	M2–
22	M2+	M2+	M2+	M2+	M2+
23					
24					
25					
26					
27	M1–	M1–	M1–	M1–	M1–
28	M1+	M1+	M1+	M1+	M1+

NY4130: DC Drive Module

Pin	Row A	Row B	Row C	Row D	Row E
29	DR_GND	DR_GND	DR_GND	DR_GND	DR_GND
30	DR_GND	DR_GND	DR_GND	DR_GND	DR_GND

Tab. 10-4: Low power DC module I/O connector

- DGND on row 3 is intended as shielding between Analog I/O and 5 Volt digital Inputs. No connections should be made to these pins.
- Not allocated pins must be not connected.

10.7 Analog Inputs

Characteristic	Description
Number of analog inputs	2: AnIn0– / AnIn0+ and AnIn1– / AnIn1+
Type	Differential; no galvanic insulation
Range (user selectable)	+ / – 10 V differential + / – 10 V single ended
Input impedance	200 kΩ // 1 nF (differential)
Common mode rejection	80 dB at 200 Hz (from 200 Hz: –20 dB/decade)
Max. common mode voltage	12 V
Resolution	16 bit monotonic
Linearity	3 LSB
Accuracy	Absolute: 3% of full scale Relative: 0.1% of full scale
Sample frequency	Synchronously 32 kHz
Bandwidth	4 kHz ±10%
Reference Voltage output	AnVref = 2.50 V
Reference Voltage current	Max. 10 mA

Tab. 10-5: Characteristics for analog inputs

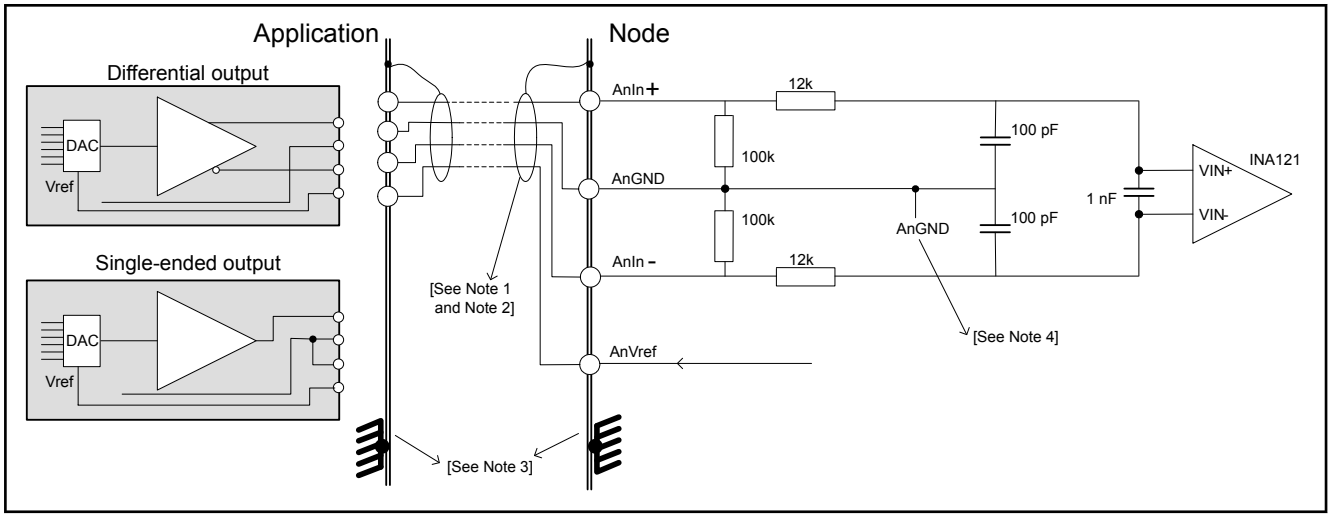

Fig. 10-5: Analog input circuit for AnIn0 and AnIn1

Notes

1. The shielding does not have to be separate for each input as the drawing suggests but may be common for all analog signals in the cable.
2. Follow the following cabling instructions:
   - Always use a shielded cable.
   - The shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).
   - If the equipment on the application side is metal, connect the shield to the equipment housing.
3. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. AnGND is connected to the internal system ground: ground MCU, drive logic, encoder ground, and host PC if the MCU is NY4110 and an IEEE 1394b cable is used.
5. You can use AnVref as a reference voltage for improved accuracy, for example for a DAC (if used, in your design).
6. If the analog input source provides a balanced differential signal, connect the signal wires to the corresponding input pins on the NYCe 4000 side.
7. If the analog input source provides a balanced differential signal, it may be desirable to connect a termination resistor between the signal wires at the NYCe 4000 side. Consult for this the supplier's installation instructions.
8. If the analog input source provides a single ended signal, connect the signal wire to the positive input pin on the NYCe 4000 side, and connect the application ground to the negative input pin and analog ground pin on the NYCe 4000 side.

NY4130: DC Drive Module

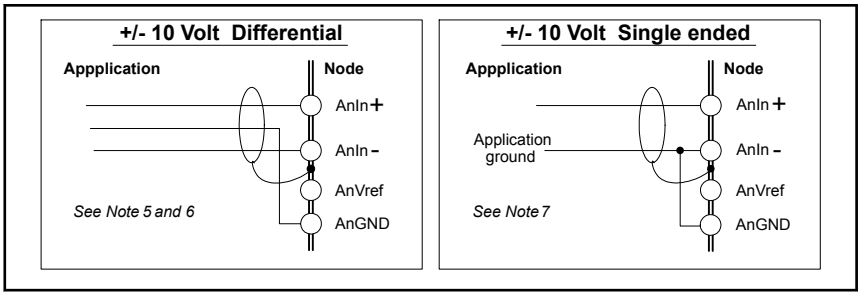

Fig. 10-6: Connection methods

10.8 Analog Outputs

Characteristic	Description
Number of analog outputs	2: AnOut0 and AnOut1 with common AnGND
Type	Single ended; no galvanic insulation
Functions	External power amplifier control General Purpose analog output
Grounding	Both analog output signals refer to AnGND, see note 1
Range	–10 V …+10V
Resolution	16 bit, monotonic (DAC8532)
Accuracy	Absolute: 3% of full scale Relative: 0.1% of full scale
Offset	Typical 30 mV, max. 120 mV
Noise	0.55 mV rms
Maximum output current	10 mA
Range load resistor (R2 in figure below)	≥ 1 kΩ
Capacitive load (C2 in figure below)	≤ 10 nF
Output short circuit proof	Yes, Ishort ≤ 35mA
Bandwidth DAC	4 kHz
Update frequency	Maximum 32 kHz

Tab. 10-6: Characteristics of the analog outputs

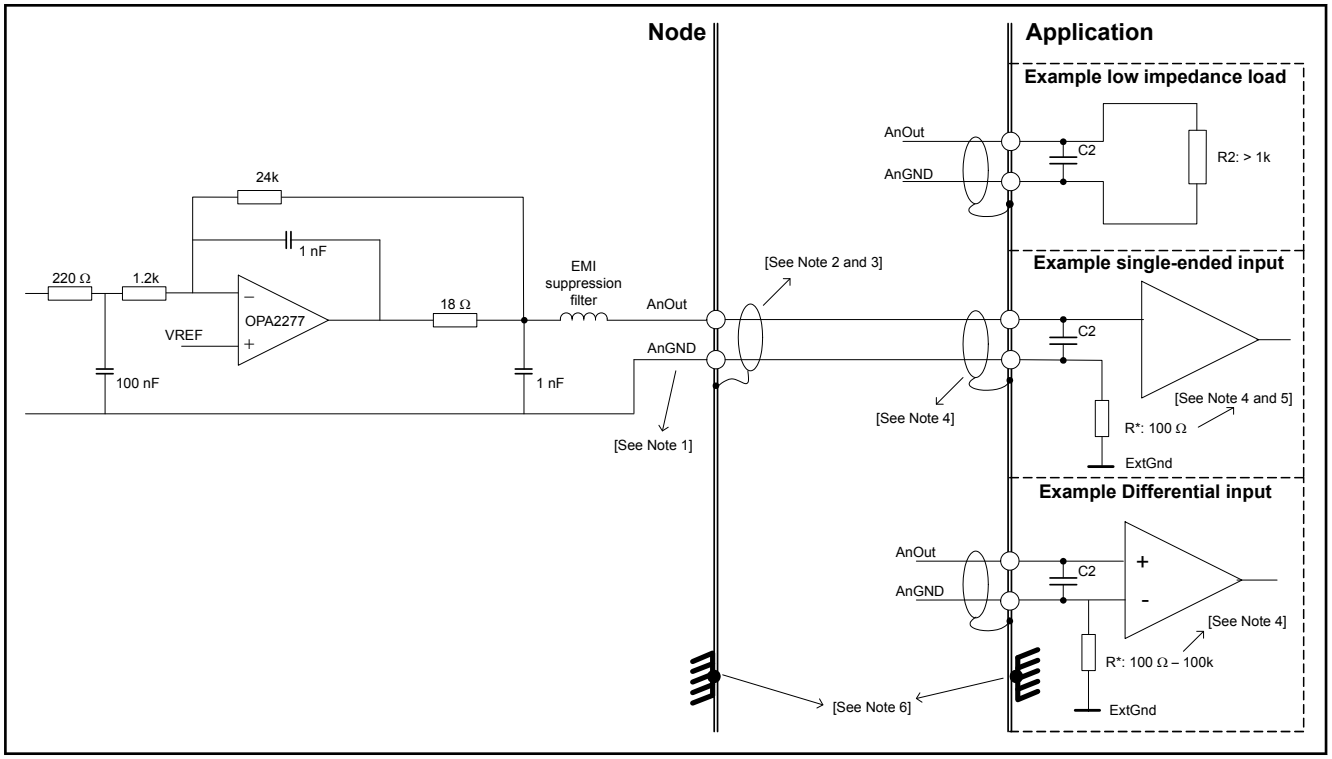

Fig. 10-7: Analog output circuit for AnOut0 and AnOut1

Notes

1. AnGND is connected to the internal system ground: ground MCU, drive logic, encoder ground, and host PC if the MCU is NY4110 and an IEEE 1394b cable is used.
2. The shielding does not have to be separate for each output as the drawing suggests but may be common for all analog signals in the cable.
3. Follow the following cabling instructions:
   - Always use a shielded cable.
   - The shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).
   - If the equipment on the application side is metal, connect the shield to the equipment housing.
4. If the analog equipment on the application side accepts a differential (preferred) or single-ended signal, the AnGND signal must be connected to the application ground with a resistor R*. If this resistor is not included in the equipment itself, install it for example in the connector at the equipment side of the cable. (For single ended input: 100 Ω, for differential 100 Ω – 100 kΩ).
5. If the analog equipment on the application side only accepts a single-ended signal (not recommended), the accuracy of the analog signal may be influenced by the resistor R* mentioned in Note 4. For this reason a low value is chosen.
6. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
7. For proper use, this ground may not be connected to motor or digital I/O ground

NY4130: DC Drive Module

10.9 Digital Inputs

Characteristic	Description
Number of digital inputs	10, divided in 3 groups: • DigIn0 ... DigIn3 with DigComm0 • DigIn4 ... DigIn7 with DigComm1 • DigIn8, DigIn9, with DigComm2 (Note: stop alarm inputs are also with DigComm2)
Functions of digital inputs	DigIn0 ... DigIn9: General Purpose Digital input • Position latching on DigIn0 ... DigIn9 • Change of state events on DigIn0 ... DigIn9 (1 per MCU sample time) • Count transitions on DigIn0 ... DigIn9 (1 per MCU sample time)
Number of stop alarm inputs	2
Functions of stop alarm inputs	StopAlarm0 and StopAlarm1: Stop alarm inputs: In less than 20 µs the Drive output is switched to 0 V. StopAlarm0 is connected to axis0. StopAlarm1 is connected to axis1.
High and low side switching	Possible for DigIn0 … DigIn7 (in groups of 4 digital inputs), and with restrictions for DigIn8 and DigIn9
Galvanic insulated	Yes
DigIn0 ... DigIn9	
• Switch time (Filter delay)	Typical 100 µs
• Permitted input voltage	–30 V ... +30 V
• Input high level	15 V ... +30 V or –15 V ... –30 V
• Input low level	–5 V ... +5 V
• Input current @ 24V	Nominal 3,5 mA
• Jitter on switching times	Typical 20 µs
StopAlarm0 and StopAlarm1	
• Switch time (Filter delay)	Max 2 µs
• Permitted input voltage	–30 V ... +30 V
• Input high level	15 V ... +30 V
• Input low level	–30 V ... +5 V
• Input current @ 24V	Nominal 15 mA

Tab. 10-7: Characteristics of the digital inputs

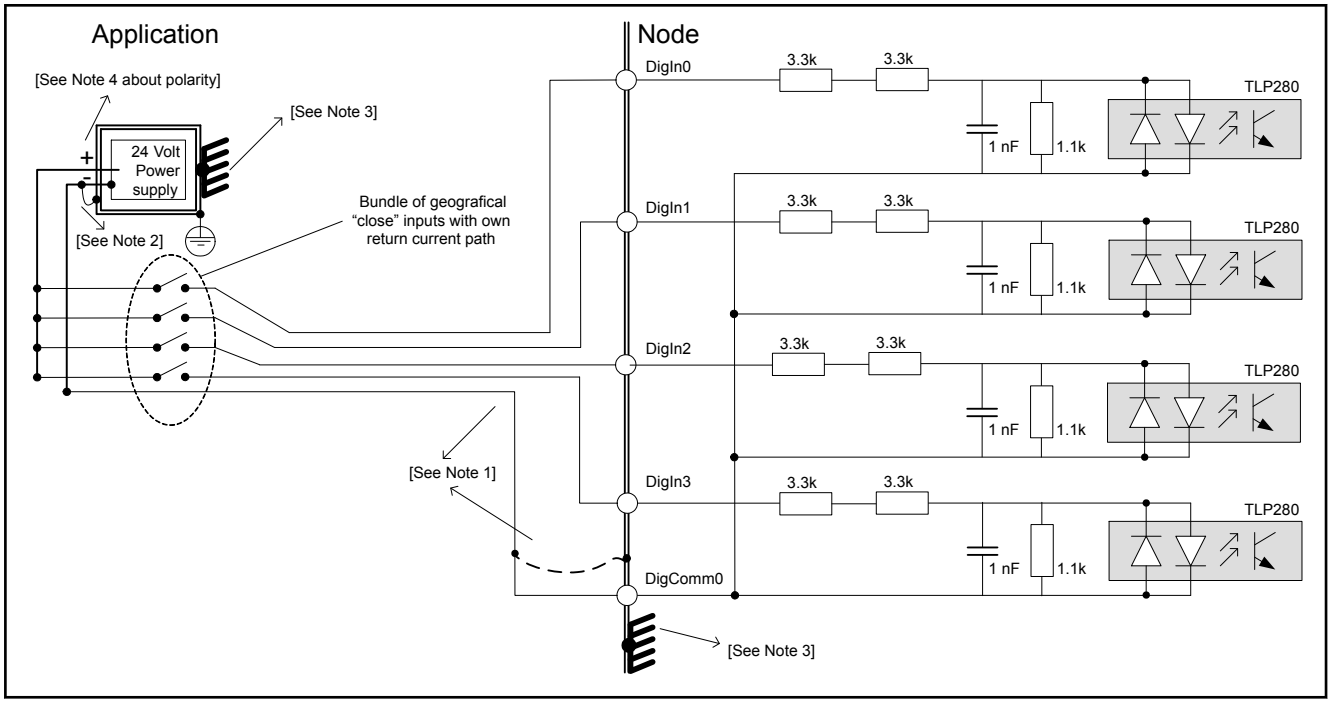

Fig. 10-8: First group of digital inputs

The second group (DigIn4 ... DigIn7 with DigComm1) is schematically identical to the first group.

The third group (DigIn8, DigIn9, StopAlarm0 and StopAlarm1 with DigComm2) has two kind of digital inputs:

- DigIn8 and DigIn9: As all other inputs
- StopAlarm0 and StopAlarm1: Fast inputs, only to be used as stop alarm.

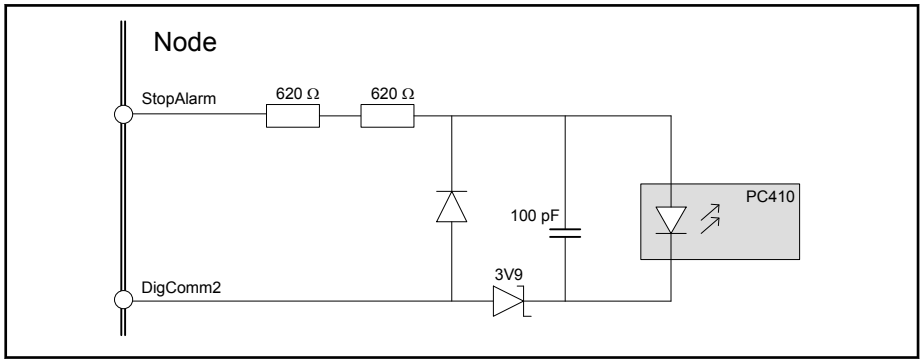

Fig. 10-9: Schematics of StopAlarm0 and StopAlarm1

Notes

1. Follow the following cabling instructions:
   - Shielded cable is recommended, but not mandatory.

     If shielded cable is used, the shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).

     Connect the other side to a convenient metal part or leave it unconnected.
   - The digital I/O may be associated with more than one power supply, and/or the cable may contain more than one minus for

power supply. If this is the case and if the cable is unshielded, connect at least one of the minus wires of each power supply to Shield (house connector).

- For the two stop alarm inputs: The cable with signal wire(s) should also contain the return current path for every signal in the cable. (For normal digital I/O this is recommended).

2. Connect the minus of the I/O power to the housing and/or safety earth (if this is not already the case).
3. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. Each group of 4 inputs can be used either as high side switching (HSS), or as low side switching (LSS).

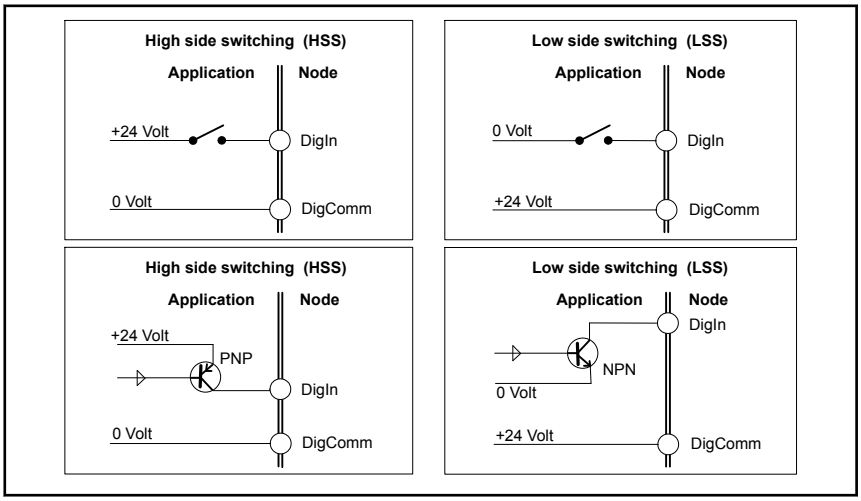

Fig. 10-10: HSS and LSS

5. Keep in mind that these digital inputs do not have a high impedance. If the application uses an open collector output to connect to these digital inputs, use an NPN transistor for low side switching and use a PNP transistor for high side switching, see fig. 10-10 "HSS and LSS" on page 116It is not recommended to use an NPN transistor output in combination with high side switching, as shown in fig. 10-11 "HSS with an NPN output transistor" on page 116.

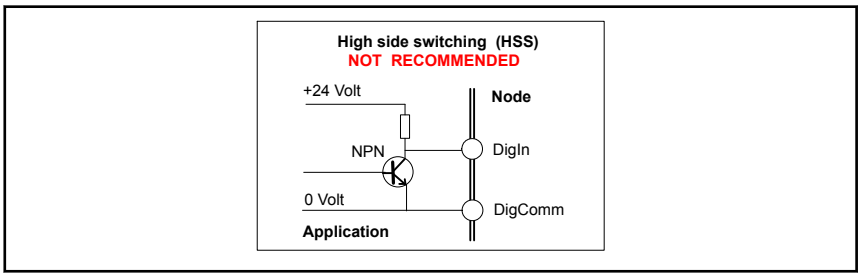

Fig. 10-11: HSS with an NPN output transistor

High side switching and low side switching is possible when you follow these rules:

- Both HSS and LSS is possible for the first two groups of four digital inputs, but must be the same for the whole group.
- HSS and LSS is limited supported for the last group.

When using the stop-inputs StopAlarm0 for axis0 and/or StopAlarm1 for axis1, the group always has a grounded load (HSS).

When not using the stop-inputs, HSS and LSS is both possible for the two other inputs (DigIn8 and DigIn9).

10.10 Digital Outputs

Characteristic	Description
Number of digital outputs	4: DigOut0 … DigOut3 with GND_DIO
Functions	State output Pulsed output PWM output with on delay
Type of load	• Resistive • Capacitive • Inductive If the stored energy is ≥ 2 mJ, to be calculated with the formula 0.5 * L * I^2, external protection (for example a diode) is required to prevent damage to the output component.
Voltage supply	24 V ±6 V
Output current	0,02 A ... 1 A, 2 A peak (max. 50 ms)
Output turn on time ([1])	Typical 50 µs
Output turn off time ([1])	Typical 50 µs (with a load current = 1 A) Note: turn off time increases if load current < 1 A.
Galvanic insulation	Yes
Short circuit protected	Yes
Fail / no load detection	No
Grounded load	Yes (high side switching)
IEC61131-2 compliant	Yes
PWM (Pulse Width Modulation)	Yes

1 Indicated times only apply with a resistive load.

Tab. 10-8: Characteristics of the digital outputs

NY4130: DC Drive Module

Pulse time specification	Unit	Minimum	Typical	Maximum
Digital output pulse duration	µs	10		10 000 000
Pulse accuracy t_{PULSE_on} ≤ 160 ms	µs		10	
Pulse accuracy for t_{PULSE} > 160 ms	µs		node sample time (125, 250, 500, 1000)	

Tab. 10-9: Pulse time specifications of the digital outputs

PWM signal specifications	Unit	Minimum	Typical	Maximum
Digital output PWM frequency	Hz	0.1		10 000
PWM duty cycle	%	0		100
Pulse accuracy for f_{PWM} > 6.25 Hz	µs		node sample time (125, 250, 500, 1000)	
Pulse accuracy for f_{PWM} ≤ 6.25 Hz	µs		10	
Digital output on-delay, before PWM	µs	0		10 000 000
On-delay accuracy for t_{DELAY} ≤ 160 ms	µs		10	
On-delay accuracy for t_{DELAY} > 160 ms	µs		node sample time (125, 250, 500, 1000)	

Tab. 10-10: PWM signal specifications of the digital outputs

The PWM signal is defined by the NYCe 4000 software through the PWM frequency parameter specified in Hz, and the duty cycle parameter specified in %. These two parameters are internally converted to pulse duration "a" and pulse pause duration "b" (see fig. 10-12 "PWM signal specification parameters" on page 118) which can only have a discrete increment step size. The increment step size is equal to the pulse accuracy and depends on the specified PWM frequency. These discrete values for the pulse duration and pulse pause duration imply that the actual PWM frequency and duty cycle may differ from the specified PWM frequency and duty cycle.

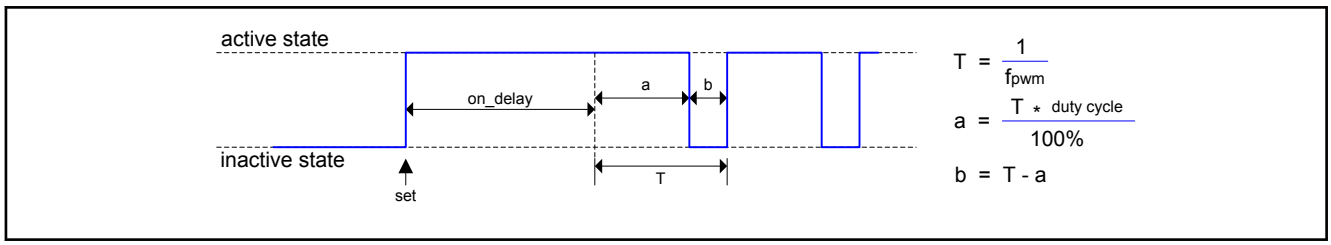

Fig. 10-12: PWM signal specification parameters

The schematic of the digital output is given in fig. 10-13 "DigOut0 and DigOut1" on page 119.

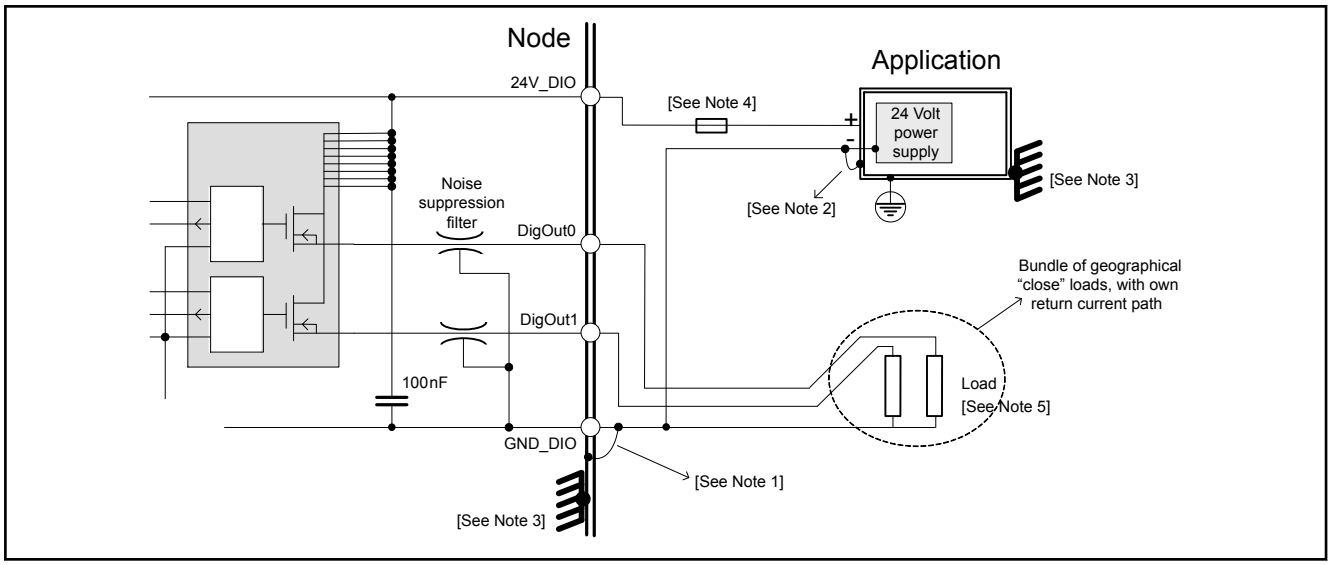

Fig. 10-13: DigOut0 and DigOut1

The second group (DigOut2 and DigOut3) is schematically the same.

Notes

1. Follow the following cabling instructions:
   - Shielded cable is recommended, but not mandatory.

     If shielded cable is used, the shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).

     Connect the other side to a convenient metal part or leave it open,
   - The digital I/O may be associated with more than one power supply, and/or the cable may contain more than one minus for power supply. If this is the case and if the cable is unshielded, connect at least one of the minus wires of each power supply to Shield (house connector).
2. Connect the minus of the I/O power to the housing and/or safety earth (if this is not already the case).
3. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. A fuse must be installed between the +24 V power supply and 24V_DIO on the node. The fuse is mandatory by safety regulations and must be UL recognized. See NYCe 4000 Standard Housings and Accessories manual for detailed information about fuses.
5. If the load represents a high impedance input, you must use an external pull down resistor to meet the minimum specified output current through the switch.

NY4130: DC Drive Module

10.11 Digital High Speed Inputs and Outputs

Characteristic	Description
Number of digital inputs	2: FastIn0 and FastIn1
Function	High speed general purpose digital input High speed position latching Change of state event (1 per MCU sample time) Count transitions (max. frequency 250 kHz)
High and low side switching	No, always grounded load (high side switching)
Galvanic insulated	Yes
Switch time (Filter delay) ([1])	< 2 µs
Permitted input voltage	–30 V ... +30 V
Input high level	15 V ... +30 V
Input low level	–30 V ... +5 V
Input current @ 24V	Nominal 15 mA

1 Indicated time only apply with a resistive load. Indicated time changes if the load has a capacitive component.

Tab. 10-11: Characteristics of the digital high speed inputs

Characteristic	Description
Number of digital outputs	2: FastOut0 and FastOut1
Function	External stepper drive control ([1]) High speed state output High speed pulsed output High speed PWM output with on delay
Type of load	Only resistive or capacitive loads are supported. The fast digital output cannot be used for inductive loads.
Grounded load	Yes, (high side switching outputs)
Galvanic insulated	Yes
Switch time	< 2 µs (with load current ≥ 50 mA)
Short circuit protected	Yes, single PTC fuse for both outputs
Fail / no load detection	No
Voltage supply	24 V ±6 V
Output current	0.4 mA ... 100 mA, typical is 50 mA

1 Active high control signals are recommended. Using active low control signals is only possible if the minimum input level specified by the external stepper drive is higher than 0.7 V.

Tab. 10-12: Characteristics of the digital high speed outputs

See tab. 10-9 "Pulse time specifications of the digital outputs" on page 118 for the pulse time specification and tab. 10-10 "PWM signal specifications of the digital outputs" on page 118 for the PWM signal specification of the digital high speed output.

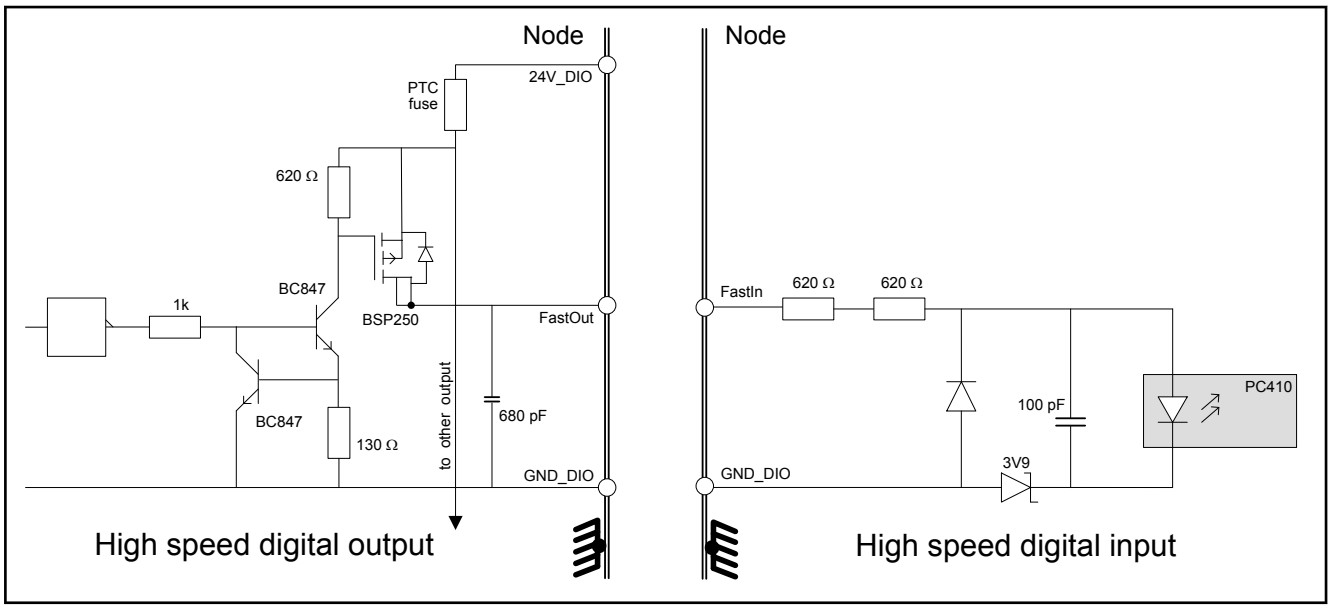

Fig. 10-14: Output circuit for FastOut0, FastOut1, and input circuit for FastIn0, FastIn1

For cabling and power supply connections of the fast digital inputs and fast digital outputs the same rules apply as for normal digital inputs and outputs, with one additional note. The cable with signal wire(s) of fast digital inputs and/or fast digital outputs must also include the return current path for every signal in the cable. For normal digital I/O this is recommended, but for fast digital I/O this is mandatory.

10.12 5 Volt Digital Inputs

Characteristic	Description
Number of inputs	6, divided in two groups of 3 inputs: • Dig5VIn0a, Dig5VIn0b and Dig5VIn0c for axis0 • Dig5VIn1a, Dig5VIn1b and Dig5VIn1c for axis1
Function	Quadrature counter inputs Rexroth MSM encoder inputs General purpose digital inputs Position latching Change of state event (1 per MCU sample time) Count transitions (1 per MCU sample time) (Functionality available on the Dig5VIn pins of the encoder headers of the system housing may be limited, because these pins are also used to connect encoders. See the encoder header pinout tables of the system housing in the NYCe 4000 Standard Housings & Accessories manual).

NY4130: DC Drive Module

Characteristic	Description
Signal interface	RS485 or 5 V (half RS485 referenced to 2.05 V)
Galvanic insulated	No
Line termination	On-board, 120 Ω in series with 680 pF
Interface type / input frequency	• 5 V open collector Depends on driver and pull-up resistor • TTL 1 MHz • RS485 10 MHz
Sink and source current	According to RS485 specification
Supply for signal source	Enc5V may be used (take care of current limit). Power supply for the encoders on both axes can be switched on/off separately for each axis.
Pull-up resistor for open collector driver	Not included.

Tab. 10-13: Characteristics of the 5 Volt digital inputs and counter inputs

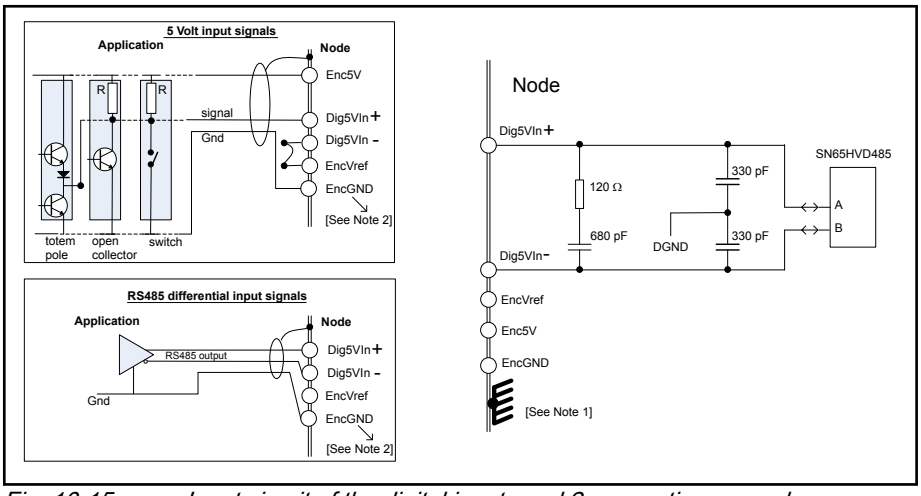

Fig. 10-15: Input circuit of the digital inputs and 2 connection examples

Notes

1. Connect the NYCe 4000, power supplies or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
2. EncVref and EncGND are allowed to be used.

Follow these cabling instructions:

- Always use a shielded cable.
- The shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).
- If the equipment on the application side is metal, connect the shield to the equipment housing.

10.13 Encoder Inputs and Encoder Power Supply

The following encoder types can be used with the NY4130:

- Quadrature encoder
- Analog inputs
- EnDat2.2 encoder

For SinCos based encoders the NY4199 SinCos Option module is required. This module is connected to the drive module and contains hardware to process the SinCos signals. The SinCos based encoders supported by the NY4199 SinCos Option module are:

- SinCos
- EnDat2.1
- Hiperface

The NYCe 4000 software includes functions to switch the encoder power supply on and off per axis. This means that the encoder power supply voltage on the pins Enc5V0 and Enc5V1 can be switched on and off independently for each axis.

For detailed connection information, see chapter 13 "Encoders" on page 161.

☞ Do not connect or disconnect the encoders while the system power supply is switched on. This can destroy the encoder electronics.

10.14 Drive Output

10.14.1 Characteristics

Two balanced 2 quadrant linear power devices are used as voltage amplifiers for the NY4130. These amplifiers can also be used in single-ended mode (unbalanced). The Drive Output can be switched to 0 Volt within 20 µs when the StopAlarm0 (axis0) and/or StopAlarm1 (axis1) are/is activated.

Characteristic	Description
Bandwidth voltage controller	4 kHz (phase loss 5° at 200 Hz, max 10 dB overshoot)
Output voltage (terminal-to-terminal), balanced	0 V … 48 V
Output voltage (terminal-to-ground), unbalanced	0 V … 24 V
Offset voltage	≤ 50 mV (no offset compensation)
OPA548 amplifier output gain	Fixed at 24
I nominal	1 A rms
I peak	2 A (max. 100 ms)
Over current protection	Yes

NY4130: DC Drive Module

Characteristic	Description
Short circuit detection	Yes
Thermal protection	105 °C on PCB
Leakage current (When disabled)	Max. 4 mA

Tab. 10-14: NY4130 drive output characteristics

10.14.2 Motor type

Only linear brushed DC servo motors can be connected to the NY4130.

10.14.3 Connection information

Characteristic	Description
Cable length	max 15 m.
Current capability	Conform application
Capacitance	max 100 pF/m.

Tab. 10-15: Motor cable characteristics

The motor is connected to the drive according to fig. 10-16 "Motor connection circuit NY4130" on page 124 and tab. 10-16 "Motor connections" on page 125.

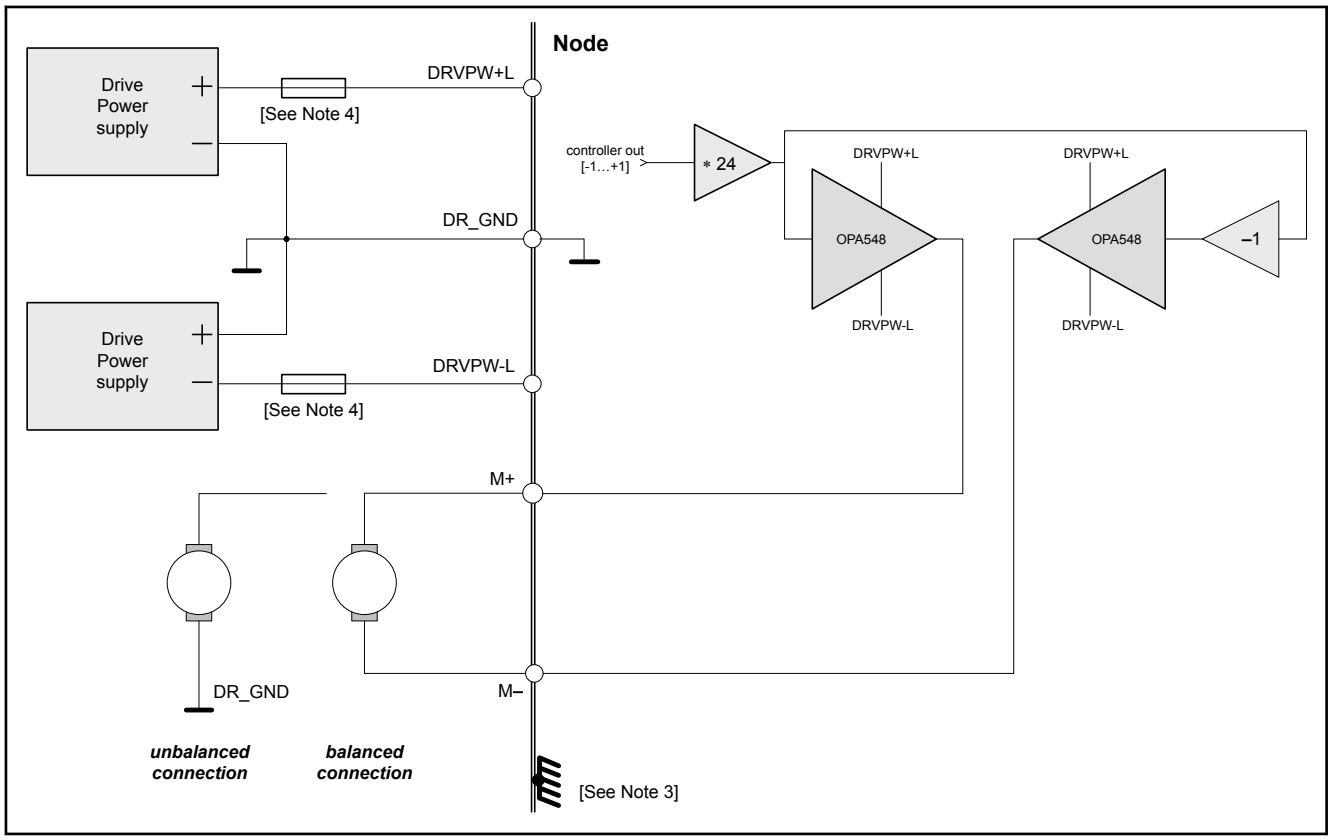

Fig. 10-16: Motor connection circuit NY4130

Notes

1. Follow this cabling instruction:

   Shielded cable is recommended, but not mandatory.

   If shielded cable is used, the shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).

   Connect the other side to a convenient metal part or leave it open.
2. Connect the DR_GND of the drive power to the housing and/or safety earth (if this is not already the case).
3. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. A fuse must be installed between the +V of the drive power supply and DRVPW+L on the node, and between the -V of the drive power supply and DRVPW-L on the node. The fuses are mandatory by safety regulations and must be UL recognized. See NYCe 4000 Standard Housings and Accessories manual for detailed information about fuses.

M0	M1	DC motor balanced	DC motor unbalanced
M1+	M2+	+V	+V
M1–	M2–	–V	
DR_GND	DR_GND		–V
Shield	Shield		

Tab. 10-16: Motor connections

If the power supply voltage is ±15 V, the motor must be rated for 12 V for an unbalanced connection, and must be rated 24 V for a balanced connection. Likewise, if the power supply voltage is ±26 V, the motor must be rated for 24 V for an unbalanced connection, and must be rated 48 V for a balanced connection.

To have the motor voltage reduced by 50%, the motor can be connected between +V and DR_GND (unbalanced).

10.15 Drive Power

The NY4130 drive power is used to connect the drive power supply to the low power DC drive module. The NY4130 has two drive power supplies (negative and positive). The drive power and the drive ground are designed to conduct 14 A continuous.

Characteristic	Description
Number of inputs	3: DRVPW–L, DRVPW+L, DR_GND
Positive drive power voltage	15 V … 26 V
Negative drive power voltage	–15 V … –26 V
	Note: Positive and negative drive power voltage must always be symmetrical.

NY4130: DC Drive Module

Characteristic	Description
Absolute maximum rating	+29 V (positive drive power) –29 V (negative driver power) Note: The software disables the drive at 29 V. The maximum voltage at which the software disables the drive can only be set to a user defined value lower than ±29 V. See Software User Manual, parameters SAC_PAR_POS_SERVO_OVER_VOLTAGE_LIMIT and SAC_PAR_NEG_SERVO_OVER_VOLTAGE_LIMIT respectively.
Input current	1.7 A rms, 4 A peak for +15 V / –15 V 1.0 A rms, 2 A peak for +26 V / –26 V
Overvoltage protection	No
Undervoltage protection	Yes The minimum voltage at which the software disables the drive is ±12 V (default value) or a higher user defined positive and negative voltage level. See Software User Manual, parameters SAC_PAR_POS_SERVO_UNDER_VOLTAGE_LIMITand SAC_PAR_NEG_SERVO_UNDER_VOLTAGE_LIMITrespectively.

Tab. 10-17: NY4130 drive power inputs characteristics

10.16 Installation requirements

Make sure that your machine design has at least 35 mm free clearance space in front of the protruding case of the modules for the heat sink of the NY4130.

11 NY4140: High Voltage Drive Module

11.1 Overview

The NY4140 is a PWM (Pulse Width Modulation) drive module, which can drive one axis with a BLDC/BLAC (Brushless DC/AC) motor or DC motor. Part number is R911318963, ordering code is NYM04.1-1HV-NNNN-NY4140.

Support for quadrature encoders with and without index pulse is available on-board, as well as other encoders, and there is a possibility to add one NY4199 SinCos Option module to connect another position sensor (for example EnDat or SinCos). The quadrature encoder is also known as A/B encoder, S0S90 encoder and 3-channel digital incremental encoder. See chapter 13 "Encoders" on page 161 for the supported encoder types.

NY4140: High Voltage Drive Module

Fig. 11-1: PWM drive module NY4140

The main features of the NY4140 are the following.

- Current control loop
- PWM frequency: 16 or 32 kHz.
- I nominal : 10 A
- I peak : 20 A
- Bus voltage is minimal 48 V, maximal 150 V
- Over current and over temperature protection
- Quadrature encoder cable break detection
- Power consumption approximately 4.4 W at 24 V system power supply voltage

Per module the following I/O is available:

- 3 x RS422 encoder inputs for each axis (QuadA, QuadB and Index).
- 2 analog outputs (16 bit).
- 1 analog input (12 bit).
- 8 digital inputs, 1 input can be configured as disable drive input.
- 2 digital outputs.
- 2 fast digital inputs.
- 2 fast digital outputs.
- 3 x 5 Volt digital inputs, to be used as Hall input, quadrature counter input, general purpose digital input or Rexroth MSM encoder input.

11.2 Module identification

An identification label is attached on the NY4140 module.

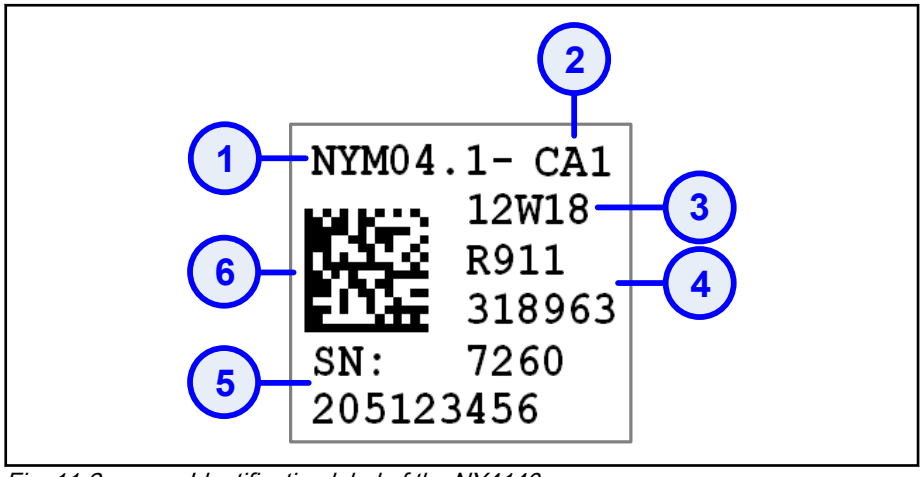

Fig. 11-2: Identification label of the NY4140

Identification number	Field explanation
1	Type code
2	Version level and status
3	Date of manufacture (yyWww)
4	Material number
5	Serial number
6	2D bar code

Tab. 11-1: Explanation of the fields of the NY4140 identification label

NY4140: High Voltage Drive Module

11.3 Module dimensions

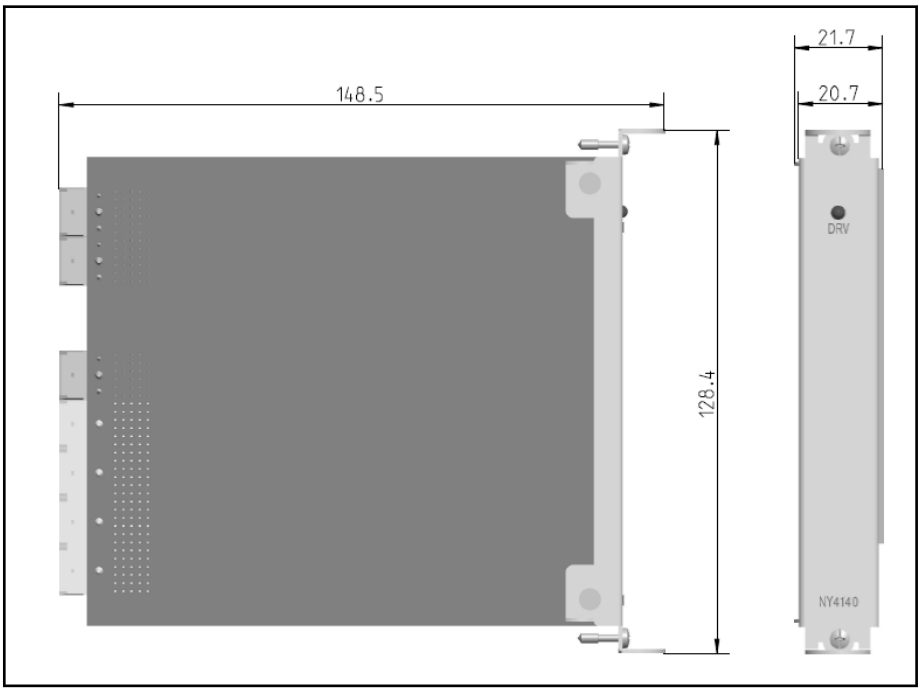

Fig. 11-3: NY4140 module dimensions

Module type code	Width	Height	Depth	Weight
NYM04.1-1HV-NNNN-NY4140	21.7 mm	128.4 mm	148.5 mm	295 gr

Tab. 11-2: NY4140 physical data

11.4 Field Diagnostics

The module does not contain any replaceable or wear parts. In case of failure, the entire module must be replaced.

The NY4140 module has 1 bi-color module status indicator LED labeled "DRV" on the front panel. The various indications are described in tab. 11-3 ""DRV" status LED indications" on page 130.

LED indication	Description
Red steady	Default setting when the drive module starts (power-up). Fatal error on the drive module, or gateware is not correct or not loaded, or module not operational because a communication problem is detected (call service).
Orange steady	Gateware loaded, but node not yet operational, because other drive modules in the node are initializing.

LED indication	Description
Green steady	Drive module OK.
Red flashing	Drive module is OK, but an overvoltage condition or over temperature condition is detected, or a configured motor cannot run due to undervoltage or overcurrent . • Overvoltage condition occurs at 160 V. • Over temperature condition occurs at 105 °C. • Undervoltage condition occurs at 35 V. • Overcurrent condition occurs at 22 A.

Tab. 11-3: "DRV" status LED indications

11.5 Power switch on/off precautions

Follow these instructions to prevent damage to the drive module. See also chapter 16 "Drive power precautions for NY412x/NY4140" on page 213.

- Do not plug the drive module into the backplane while the 24V System power supply is applied.
- Do not remove the drive module from the backplane while the 24V System power supply is applied.
- Make sure that the 24V System power supply is applied before the drive power supply is applied.

The preferred method to switch on and off the drive power is by means of the mains switch as indicated by ① in fig. 11-4 "Schematic of drive power supply to a node" on page 131 to prevent destructive inrush currents.

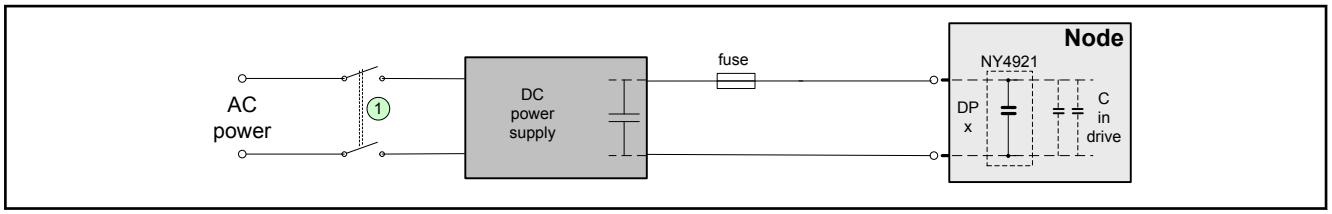

Fig. 11-4: Schematic of drive power supply to a node

If you want to remove the drive module from the backplane, follow this sequence.

1. Switch off the drive power supply to the system.
2. If an axis is configured on the drive module, wait until the "DRV" LED on the drive module flashes red on and off.

   If no axis is configured on the drive module, the "DRV" LED is continuous green and you can proceed to the next action.
3. Switch off the 24V System power supply to the system.
4. Wait until the "DRV" LED on the drive module is off.
5. Remove the drive module.

NY4140: High Voltage Drive Module

☞
- Do not connect the drive power supply to the "DP x" connectors of the system while the drive power supply is switched on.
- Switching on/off the drive power supply by connecting/ disconnecting the "DP x" connectors is forbidden.

11.6 I/O Connector

The PWM drive module I/O connector uses a 150 pin, 2mm Modular Interconnect System. The pinout is sorted on insulated areas.

Pin	Row A	Row B	Row C	Row D	Row E
1	AnOut0	AnGND			
2	AnOut1	AnGND	AnInC	AnIn0–	AnIn0+
3	DGND	DGND	DGND	DGND	DGND
4					Opt_2+
5					Opt_2–
6					Opt_1+
7	Enc0Index–	Enc0Index+	Dig5VIn0a–	Dig5VIn0a+	Opt_1–
8	Enc0QuadB–	Enc0QuadB+	Dig5VIn0b–	Dig5VIn0b+	Opt_0+
9	Enc0QuadA–	Enc0QuadA+	Dig5VIn0c–	Dig5VIn0c+	Opt_0–
10	EncGND	EncVref	EncGND	Enc5V0	
11	DigIn0	DigIn1	DigIn2	DigIn3	DigComm0
12	DigIn4	DigIn5	DigIn6	DigIn7	DigComm1
13	FastIn0	FastIn1	FastOut0	FastOut1	GND_DIO
14	DigOut0	DigOut1			24V_DIO
15	24V_DIO	24V_DIO	24V_DIO	24V_DIO	GND_DIO
16					
17					
18					
19					
20					
21	HB3	HB3	HB3	HB3	HB3
22					
23	DR_PWR	DR_PWR	DR_PWR	DR_PWR	DR_PWR
24					
25	HB2	HB2	HB2	HB2	HB2
26					
27	HB1	HB1	HB1	HB1	HB1
28					

Pin	Row A	Row B	Row C	Row D	Row E
29	DR_GND	DR_GND	DR_GND	DR_GND	DR_GND
30	DR_GND	DR_GND	DR_GND	DR_GND	DR_GND

Tab. 11-4: PWM drive module I/O connector

- DGND on row 3 is intended as shielding between Analog I/O and 5 Volt digital Inputs. No connections should be made to these pins.
- Not allocated pins must be not connected.

11.7 Analog Inputs

Characteristic	Description
Number of analog inputs	1: AnIn0– / AnIn0+
Type	Differential; no galvanic insulation
Range (user selectable)	4 - 20 mA + / – 10 V differential + / – 10 V single ended
Input impedance	10 kΩ // 1 nF
Common mode rejection	80 dB at 200 Hz (from 200 Hz: –20 dB/decade)
Max. common mode voltage	12 V
Resolution	12 bit monotonic
Linearity	1 LSB
Accuracy	Absolute: 3% of full scale Relative: 0.1% of full scale
Sample frequency	Synchronously 32 kHz
Bandwidth	4 kHz ±10%

Tab. 11-5: Characteristics of the analog inputs

NY4140: High Voltage Drive Module

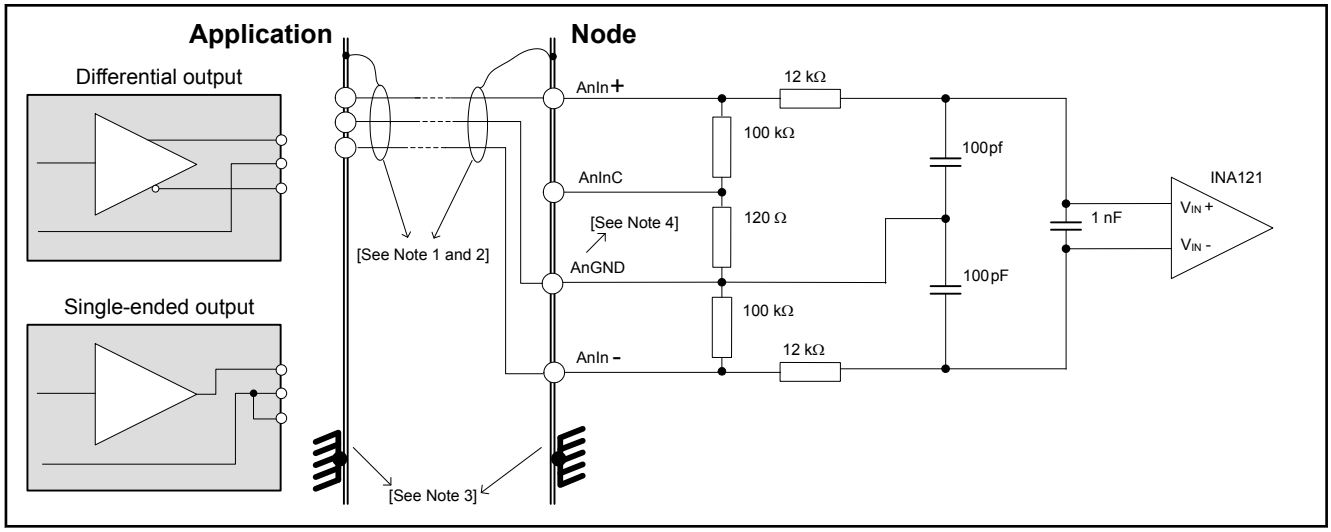

Fig. 11-5: Analog input circuit for AnIn0

Notes

1. The shielding does not have to be separate for each input as the drawing suggests but may be common for all analog signals in the cable.
2. Follow the following cabling instructions:
   - Always use a shielded cable.
   - The shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).
   - If the equipment on the application side is metal, connect the shield to the equipment housing.
3. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. AnGND is connected to the internal system ground: ground MCU, drive logic, encoder ground, and host PC if the MCU is NY4110 and an IEEE 1394b cable is used.
5. For proper use, this ground may not be connected to motor or digital I/O ground.

The choice between the voltage or current measurement of the analog inputs is user selectable by a software parameter, see the file "nhiparameters.h", parameter NHI_PAR_ANINx_ADC_DIMENSION_SLOTy (x=0,1 y=0…4) and the NYCe 4000 Software Reference Manual, enumeration nhi_adc_dimension.

- + / – 10 Volt differential

  If the analog input source provides a balanced differential signal, connect the signal wires to the corresponding input pins on the NYCe 4000 side.

- + / – 10 Volt single ended

  If the analog input source provides a single ended signal, connect the signal wire to the positive print on the NYCe 4000 side, and connect the application ground to the negative input pin on the NYCe 4000 side.

- 4 – 20 mA.

– Connect pin AnIn– to AnGND in the connector
– Connect pin AnIn+ to AnInC in the connector

The diagrams in fig. 11-6 "How to select the range of the analog inputs" on page 135 show how to select the range of the analog inputs.

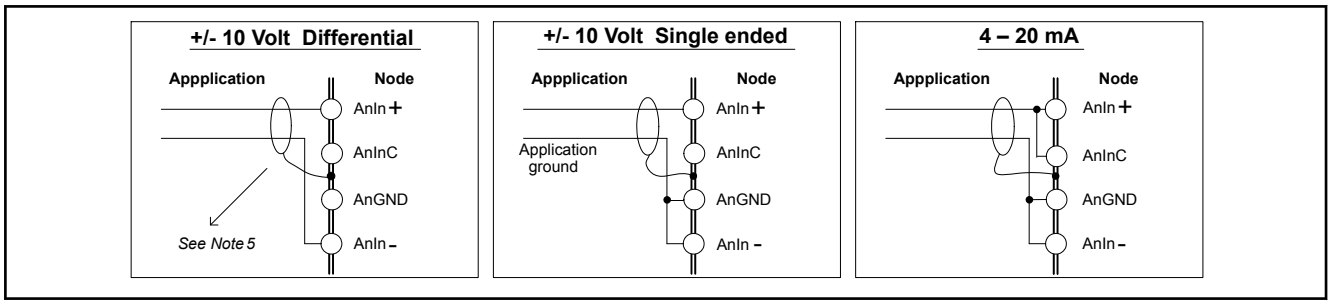

Fig. 11-6: How to select the range of the analog inputs

If the analog input source provides a balanced differential signal, it may be desirable to connect a termination resistor between the signal wires at the NYCe 4000 side. Consult for this the supplier's installation instructions.

11.8 Analog Outputs

Characteristic	Description
Number of analog outputs	2: AnOut0 and AnOut1 with common AnGND
Type	Single ended; no galvanic insulation
Functions	External power amplifier control General Purpose analog output
Grounding	Both analog output signals refer to AnGND, see note 1
Range	–10 V …+10V
Resolution	16 bit, monotonic (DAC8532)
Accuracy	Absolute: 3% of full scale Relative: 0.1% of full scale
Offset	Typical 30 mV, max. 120 mV
Noise	0.55 mV rms
Maximum output current	10 mA
Range load resistor (R2 in figure below)	≥ 1 kΩ
Capacitive load (C2 in figure below)	≤ 10 nF
Output short circuit proof	Yes, Ishort ≤ 35mA

NY4140: High Voltage Drive Module

Characteristic	Description
Bandwidth DAC	4 kHz
Update frequency	Maximum 32 kHz

Tab. 11-6: Characteristics of the analog outputs

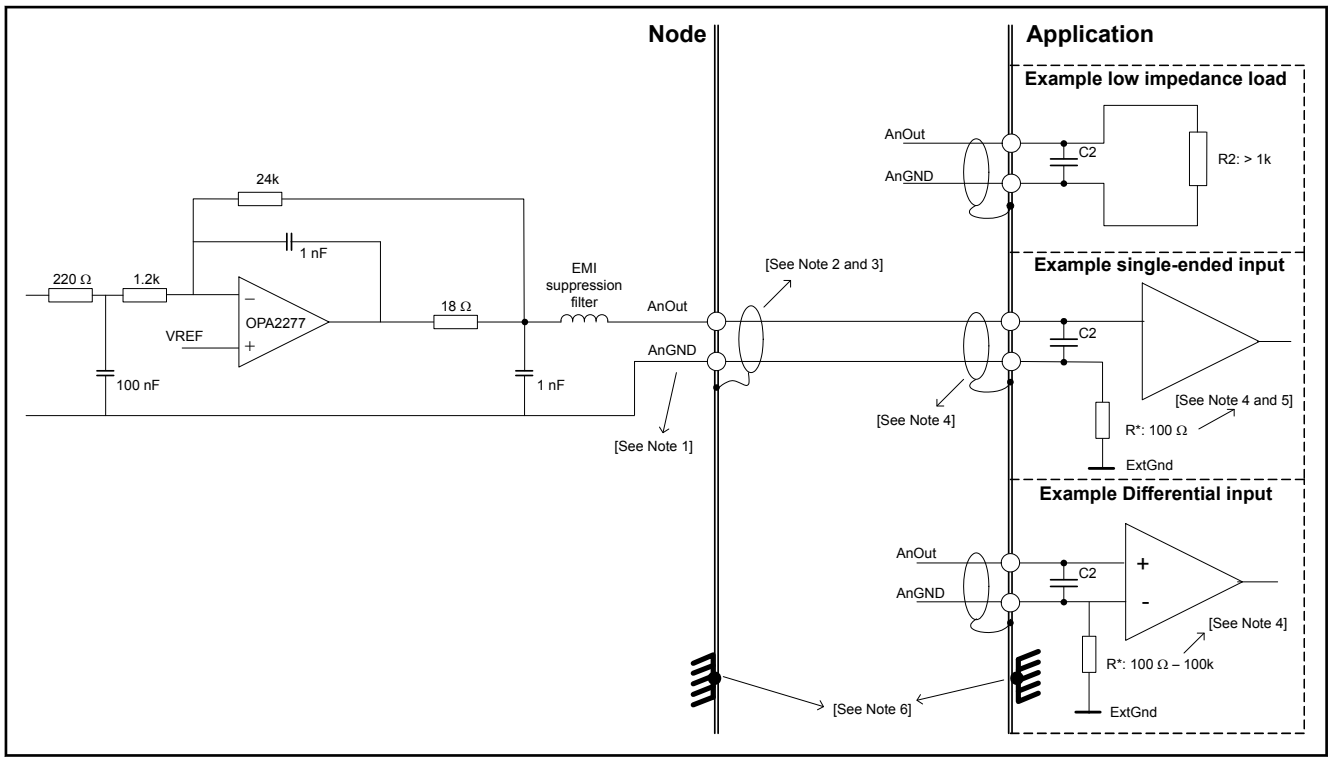

Fig. 11-7: Analog output circuit for AnOut0 and AnOut1

Notes

1. AnGND is connected to the internal system ground: ground MCU, drive logic, encoder ground, and host PC if the MCU is NY4110 and an IEEE 1394b cable is used.
2. The shielding does not have to be separate for each output as the drawing suggests but may be common for all analog signals in the cable.
3. Follow the following cabling instructions:
   - Always use a shielded cable.
   - The shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).
   - If the equipment on the application side is metal, connect the shield to the equipment housing.
4. If the analog equipment on the application side accepts a differential (preferred) or single-ended signal, the AnGND signal must be connected to the application ground with a resistor R*. If this resistor is not included in the equipment itself, install it for example in the connector at the equipment side of the cable. (For single ended input: 100 Ω, for differential 100 Ω – 100 kΩ).

5. If the analog equipment on the application side only accepts a single-ended signal (not recommended), the accuracy of the analog signal may be influenced by the resistor R* mentioned in Note 4. For this reason a low value is chosen.
6. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
7. For proper use, this ground may not be connected to motor or digital I/O ground

11.9 Digital Inputs

Characteristic	Description
Number of digital inputs	8, divided in 2 groups: • DigIn0 ... DigIn3 with DigComm0 • DigIn4 ... DigIn7 with DigComm1
Functions	General Purpose Digital input • 24V Hall sensors can be connected to the digital inputs – DigIn0, DigIn1, Digin2 for axis0 • Position latching • Change of state events (1 per MCU time sample) • Count transitions interval (1 per MCU time sample) • DigIn6 can be defined as disable drive input for axis0 Disable drive functionality is defined through the function SacWriteParameter, see NYCe 4000 Software User Manual. The power amplifier is disabled after the disable drive input is detected active for approximately 500 µs.
High and low side switching	Possible (in groups of 4 digital inputs)
Galvanic insulated	Yes
Switch time (Filter delay)	Typical 100 µs
Permitted input voltage	–30 V ... +30 V
Input high level	15 V ... +30 V and –15 V ... –30 V
Input low level	–5 V ... +5 V
Input current @ 24V	Nominal 3,5 mA
Jitter on switching times	Typical 20 µs

Tab. 11-7: Characteristics of the digital inputs

NY4140: High Voltage Drive Module

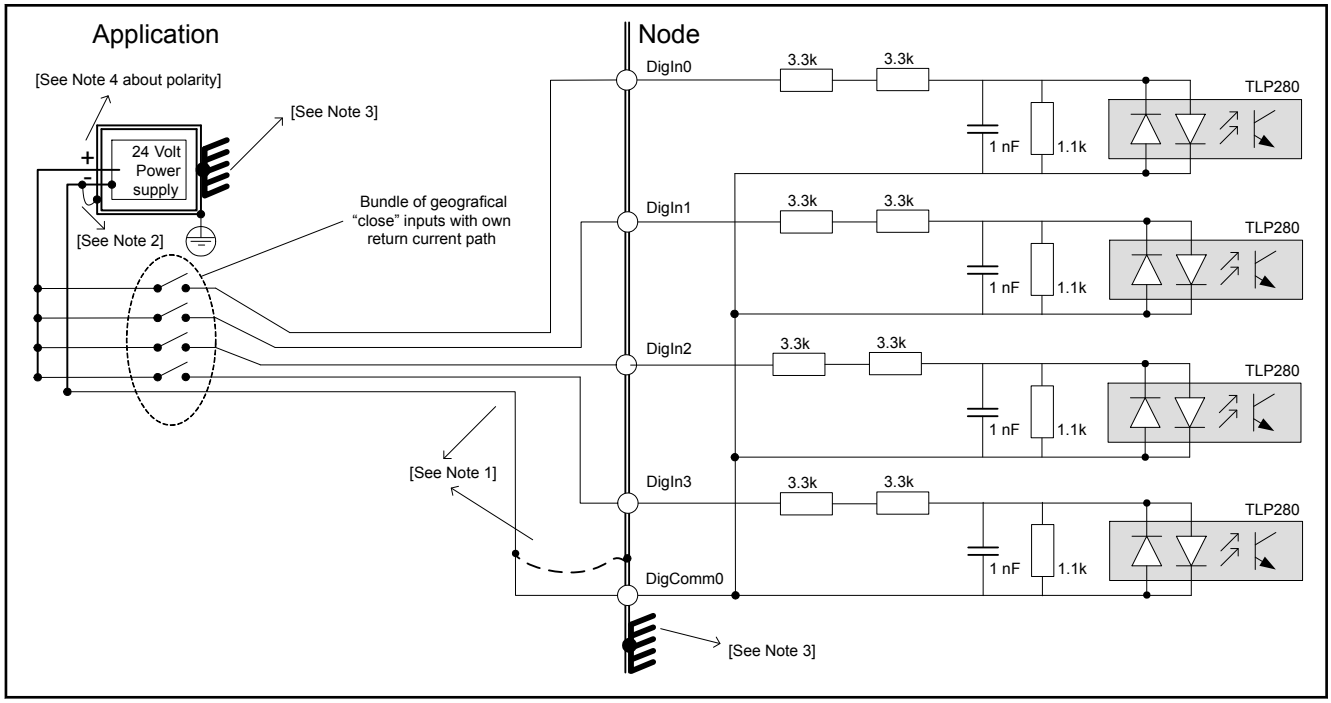

Fig. 11-8: The first group of digital inputs

The second group (DigIn4 ... DigIn7 with DigComm1) is schematically the same.

Notes

1. Follow the following cabling instructions:
   - Shielded cable is recommended, but not mandatory.

     If shielded cable is used, the shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).

     Connect the other side to a convenient metal part or leave it unconnected.
   - The digital I/O may be associated with more than one power supply, and/or the cable may contain more than one minus for power supply. If this is the case and if the cable is unshielded, connect at least one of the minus wires of each power supply to Shield (house connector).
2. Connect the minus of the I/O power to the housing and/or safety earth (if this is not already the case).
3. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. Each group of 4 inputs can be used either as high side switching (HSS), or as low side switching (LSS).

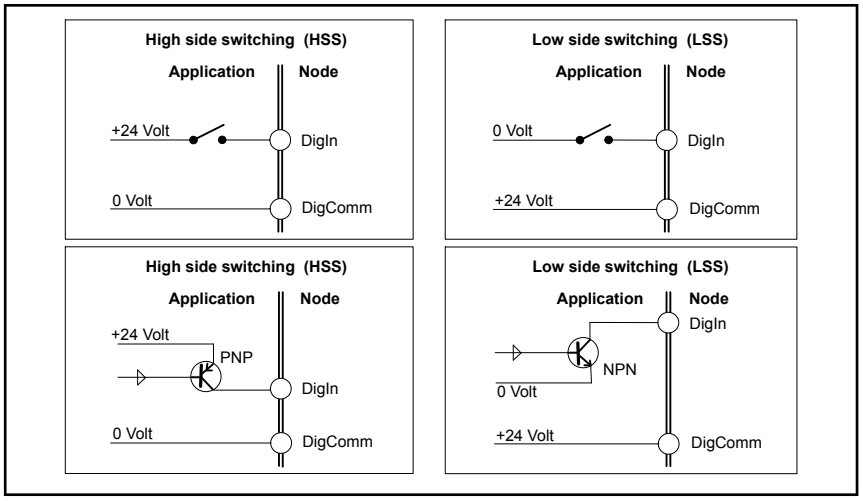

Fig. 11-9: HSS and LSS

5. Keep in mind that these digital inputs do not have a high impedance. If the application uses an open collector output to connect to these digital inputs, use an NPN transistor for low side switching and use a PNP transistor for high side switching, see fig. 11-9 "HSS and LSS" on page 139. It is not recommended to use an NPN transistor output in combination with high side switching, as shown in fig. 11-10 "HSS with an NPN output transistor" on page 139.

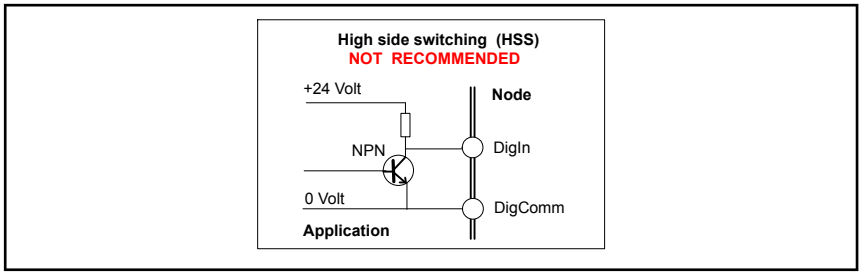

Fig. 11-10: HSS with an NPN output transistor

6. 24 Volt Hall sensors can be connected to the digital inputs, for the first axis DigIn0, DigIn1 and DigIn2 have to be used. See fig. 11-11 "24 Volt Hall sensor connection" on page 139 for the connection of a Hall sensor with either high side switched or low side switched outputs.

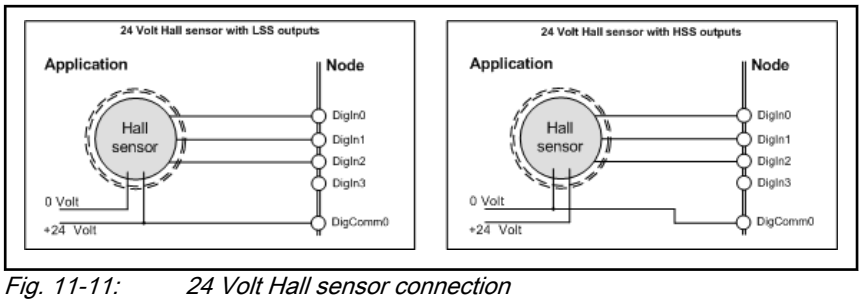

Fig. 11-11: 24 Volt Hall sensor connection

NY4140: High Voltage Drive Module

11.10 Digital Outputs

Characteristic	Description
Number of digital outputs	2: DigOut0, DigOut1 with GND_DIO
Functions	State output Pulsed output PWM output with on delay
Type of load	• Resistive • Capacitive • Inductive If the stored energy is ≥ 2 mJ, to be calculated with the formula 0.5 * L * I^2, external protection (for example a diode) is required to prevent damage to the output component.
Voltage supply	24 V ±6 V
Output current	0,02 A ... 1 A, 2 A peak (max. 50 ms)
Output turn on time ([1])	Typical 50 µs
Output turn off time ([1])	Typical 50 µs (with a load current = 1 A) Note: turn off time increases if load current < 1 A.
Galvanic insulation	Yes
Short circuit protected	Yes
Fail / no load detection	No
Grounded load	Yes (high side switching)
IEC61131-2 compliant	Yes
PWM (Pulse Width Modulation)	Yes

1 Indicated times only apply with a resistive load. Indicated times change if the load has a capacitive component.

Tab. 11-8: Characteristics of the digital outputs

Pulse time specification	Unit	Minimum	Typical	Maximum
Digital output pulse duration	µs	10		10 000 000
Pulse accuracy t_{PULSE_on} ≤ 160 ms	µs		10	
Pulse accuracy for t_{PULSE} > 160 ms	µs		node sample time (125, 250, 500, 1000)	

Tab. 11-9: Pulse time specifications of the digital outputs

PWM signal specifications	Unit	Minimum	Typical	Maximum
Digital output PWM frequency	Hz	0.1		10 000
PWM duty cycle	%	0		100
Pulse accuracy for f_{PWM} > 6.25 Hz	µs		node sample time (125, 250, 500, 1000)	
Pulse accuracy for f_{PWM} ≤ 6.25 Hz	µs		10	
Digital output on-delay, before PWM	µs	0		10 000 000
On-delay accuracy for t_{DELAY} ≤ 160 ms	µs		10	
On-delay accuracy for t_{DELAY} > 160 ms	µs		node sample time (125, 250, 500, 1000)	

Tab. 11-10: PWM signal specifications of the digital outputs

The PWM signal is defined by the NYCe 4000 software through the PWM frequency parameter specified in Hz, and the duty cycle parameter specified in %. These two parameters are internally converted to pulse duration "a" and pulse pause duration "b" (see fig. 11-12 "PWM signal specification parameters" on page 141) which can only have a discrete increment step size. The increment step size is equal to the pulse accuracy and depends on the specified PWM frequency. These discrete values for the pulse duration and pulse pause duration imply that the actual PWM frequency and duty cycle may differ from the specified PWM frequency and duty cycle.

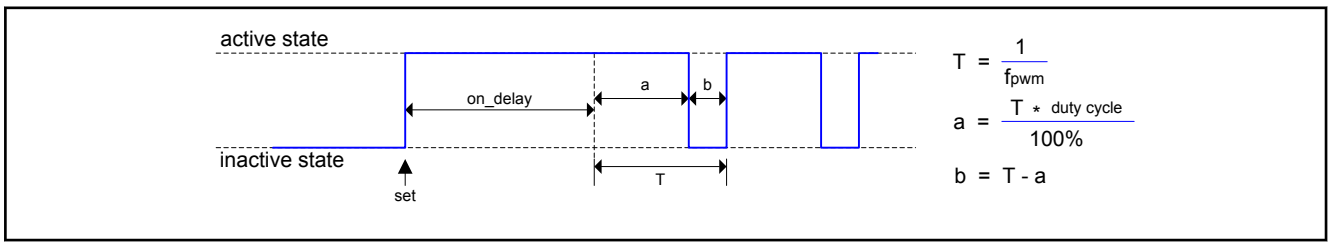

Fig. 11-12: PWM signal specification parameters

The schematic of the digital output is given in fig. 11-13 "DigOut0 and DigOut1" on page 142.

NY4140: High Voltage Drive Module

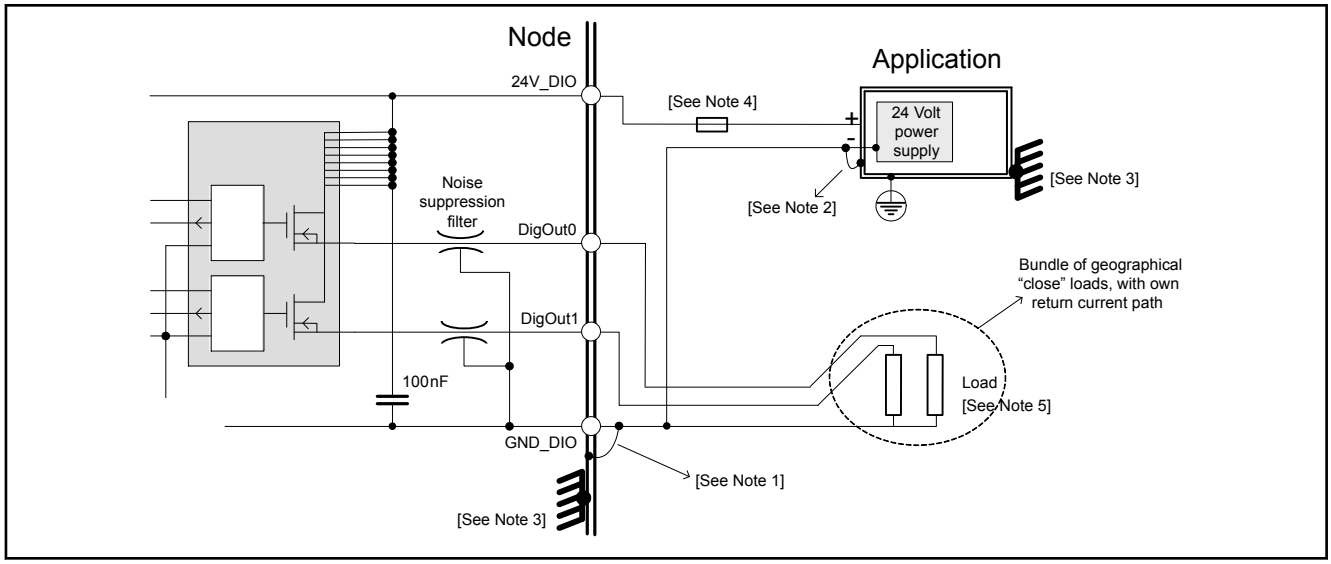

Fig. 11-13: DigOut0 and DigOut1

The second group (DigOut2 and DigOut3) is not available.

Notes

1. Follow the following cabling instructions:
   - Shielded cable is recommended, but not mandatory. If shielded cable is used, the shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).Connect the other side to a convenient metal part or leave it open,
   - The digital I/O may be associated with more than one power supply, and/or the cable may contain more than one minus for power supply. If this is the case and if the cable is unshielded, connect at least one of the minus wires of each power supply to Shield (house connector).
2. Connect the minus of the I/O power to the housing and/or safety earth (if this is not already the case).
3. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. A fuse must be installed between the +24 V power supply and 24V_DIO on the node. The fuse is mandatory by safety regulations and must be UL recognized. See NYCe 4000 Standard Housings and Accessories manual for detailed information about fuses.
5. If the load represents a high impedance input, you must use an external pull down resistor to meet the minimum specified output current through the switch.

11.11 Digital High Speed Inputs and Outputs

Characteristic	Description
Number of digital inputs	2: FastIn0 and FastIn1
Function	High speed general purpose digital input High speed position latching Change of state event (1 per MCU sample time) Count transitions (max. frequency 250 kHz)
High and low side switching	No, always grounded load (high side switching)
Galvanic insulated	Yes
Switch time (Filter delay)	< 2 µs
Permitted input voltage	–30 V ... +30 V
Input high level	15 V ... +30 V
Input low level	–30 V ... +5 V
Input current @ 24V	Nominal 15 mA

Tab. 11-11: Characteristics of digital high speed input

Characteristic	Description
Number of digital outputs	2: FastOut0 and FastOut1
Function	External stepper drive control ([1]) High speed state output High speed pulsed output High speed PWM output with on delay
Type of load	Only resistive or capacitive loads are supported. The fast digital output cannot be used for inductive loads.
Grounded load	Yes, (high side switching outputs)
Galvanic insulated	Yes
Switch time ([2])	< 2 µs (with load current ≥ 50 mA)
Short circuit protected	Yes, single PTC fuse for both outputs
Fail / no load detection	No
Voltage supply	24 V ±6 V
Output current	0.4 mA ... 100 mA, typical is 50 mA

1 Active high control signals are recommended. Using active low control signals is only possible if the minimum input level specified by the external stepper drive is higher than 0.7 V.

2 Indicated time only apply with a resistive load. Indicated time changes if the load has a capacitive component.

Tab. 11-12: Characteristics of digital high speed output

See tab. 11-9 "Pulse time specifications of the digital outputs" on page 140 for the pulse time specification and tab. 11-10 "PWM signal specifications of the digital outputs" on page 141 for the PWM signal specification of the digital high speed output.

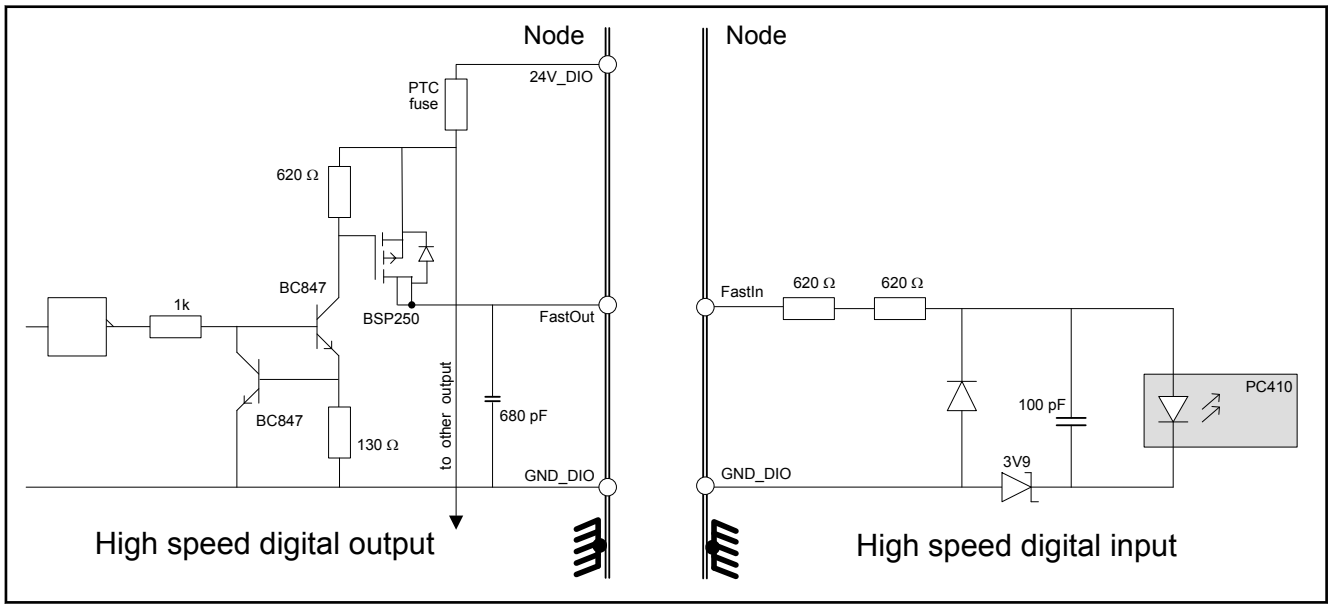

Fig. 11-14: Output circuit for FastOut0, FastOut1, and input circuit for FastIn0, FastIn1

For cabling and power supply connections of the fast digital inputs and fast digital outputs the same rules apply as for normal digital inputs and outputs, with one additional note. The cable with signal wire(s) of fast digital inputs and/or fast digital outputs must also include the return current path for every signal in the cable. For normal digital I/O this is recommended, but for fast digital I/O this is mandatory.

11.12 5 Volt Digital Inputs

Characteristic	Description
Number of Hall inputs	3, Dig5VIn0a, Dig5VIn0b and Dig5VIn0c for axis0
Function	Hall Input (see note in chapter 11.14.2 "Motor types" on page 147) Quadrature counter inputs Rexroth MSM encoder input General purpose digital Input Position latching Change of state event (1 per MCU sample time) Count transitions (1 per MCU sample time) (Functionality available on the Dig5VIn pins of the encoder headers of the system housing may be limited, because these pins are also used to connect encoders. See the encoder header pinout tables of the system housing in the NYCe 4000 Standard Housings & Accessories manual).
Signal interface	RS485 or 5 V (half RS485 referenced to 2.05 V)

Characteristic	Description
Galvanic insulated	No
Line termination	On-board, 120 Ω in series with 680 pF
Interface type / input frequency	• 5 V open collector Depends on driver and pull-up resistor • TTL 1 MHz • RS485 10 MHz
Sink and source current	According to RS485 specification
Supply for signal source	Enc5V may be used (take care of current limit).
Pull-up resistor for open collector driver	Included (2,2 kΩ connected to non-switched Enc5V)

Tab. 11-13: Characteristics for Hall inputs, 5 Volt digital inputs and counter inputs

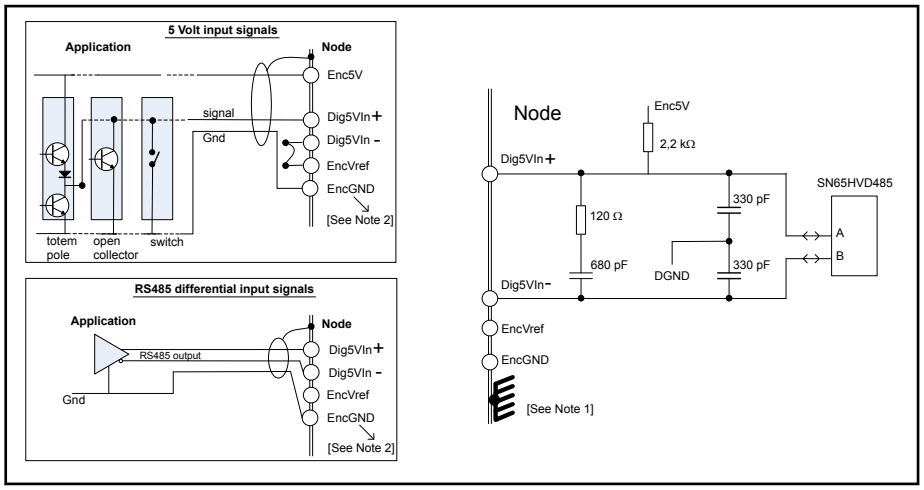

Fig. 11-15: Input circuit of the digital inputs and 2 connection examples

Notes

1. Connect the NYCe 4000, power supplies or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
2. EncVref and EncGND are allowed to be used.

Follow these cabling instructions:

- Always use a shielded cable.
- The shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).
- If the equipment on the application side is metal, connect the shield to the equipment housing.

For proper use, this ground may not be connected to motor or digital I/O ground.

11.13 Encoder Inputs and Encoder Power Supply

The following encoder types can be used with the NY4140:

- Quadrature encoder
- Analog inputs
- Rexroth MSM incremental or absolute position encoder
- Sanyo Denki absolute position encoder
- EnDat2.2 encoder

For SinCos based encoders the NY4199 SinCos Option module is required. This module is connected to the drive module and contains hardware to process the SinCos signals. The SinCos based encoders supported by the NY4199 SinCos Option module are:

- SinCos
- EnDat2.1
- Hiperface

The +5 Volt Hall sensors of a BLDC motor are connected to the +5 Volt digital inputs (Dig5VIn0a, Dig5VIn0b, Dig5VIn0c for axis0). The digital encoders (Rexroth MSM incremental and absolute, EnDat2.1, EnDat2.2, Hiperface) and SinCos encoders also use these +5 Volt digital inputs. This means that a BLDC motor with +5 Volt Hall sensors and a digital encoder cannot be used on the same axis.

There is one exception. A SinCos encoder can be used together with a BLDC motor with +5 Volt Hall sensors on axis0.

If the Hall sensors of the BLDC motor are connected to the +24 Volt digital inputs, the digital encoders (Rexroth MSM incremental and absolute, SinCos, EnDat2.1, EnDat2.2 and Hiperface) can always be used on either axis.

For detailed connection information, see chapter 13 "Encoders" on page 161.

☞ Do not connect or disconnect the encoders while the system power supply is switched on. This can destroy the encoder electronics.

Notes

- When using the NY4140 high voltage drive module, the encoder connections to the motor windings must be double insulated.
- The NY4140 high voltage drive module supports only one encoder. This still holds while applying an NY4199 SinCos Option module. The remaining I/O's are available for other functionality.

11.14 Drive Output

11.14.1 Characteristics

One PWM amplifier with three half H-bridges is used as current amplifier on the NY4140. During the active part of the PWM cycle, the drive power voltage is applied to the motor connections. During the passive part of the PWM cycle, the half H-bridges are in a freewheel mode and current measurements are done.

Characteristic	Description
PWM frequency	16 kHz or 32 kHz
PWM duty cycle	Minimum OFF time: 1 µs
PWM resolution	12 bits
Half bridges (2 axes per module)	Min: 2 (1 DC motor) Max: 3 (1 BLAC or BLDC motor)
Current control loop frequency	4 kHz … 32 kHz
Current measurement resolution	12 bits
I nominal	10 A
I peak	20 A (max. 100 ms)
Efficiency (at 48 V, 5 A, PWM 32 kHz)	92% … 95%
Motor power voltage	0 V … 147 V
Over current protection	Yes, at 22 A
Short circuit detection	Yes, at 32 A ±8%
Thermal protection	105 °C on PCB

Tab. 11-14: NY4140 drive output characteristics

11.14.2 Motor types

The following motor types can be connected to the NY4140:

PWM Brushless DC servo motor control (BLDC)

BLDC motors have a trapezoidal stator winding distribution which is designed for use on a square wave or block commutation inverter supply voltage, controlled by Hall sensors.

☞ If the Hall sensors are connected to the Dig5VIn inputs, you cannot use the digital encoders (EnDat2.x, Rexroth MSM or Hiperface) at the same time, because the Hall sensors use the same I/O lines as these digital encoders.

PWM Brushless AC servo motor control (BLAC)

BLAC motors have a sinusoidal stator winding distribution which is designed for use on a sinusoidal or PWM inverter supply voltage. In software, the alignment between motor coils and magnets is done using for example a wake-and-shake procedure.

PWM Brushed DC servo motor control (DC)

NY4140: High Voltage Drive Module

11.14.3 Connection information

Characteristic	Description
Cable length	max 15 m.
Current capability	Conform application
Capacitance	max 100 pF/m.

Tab. 11-15: Motor cable characteristics

The motor is connected to the drive according to fig. 11-16 "Motor connections NY4140" on page 148 and tab. 11-16 "Motor connections" on page 149.

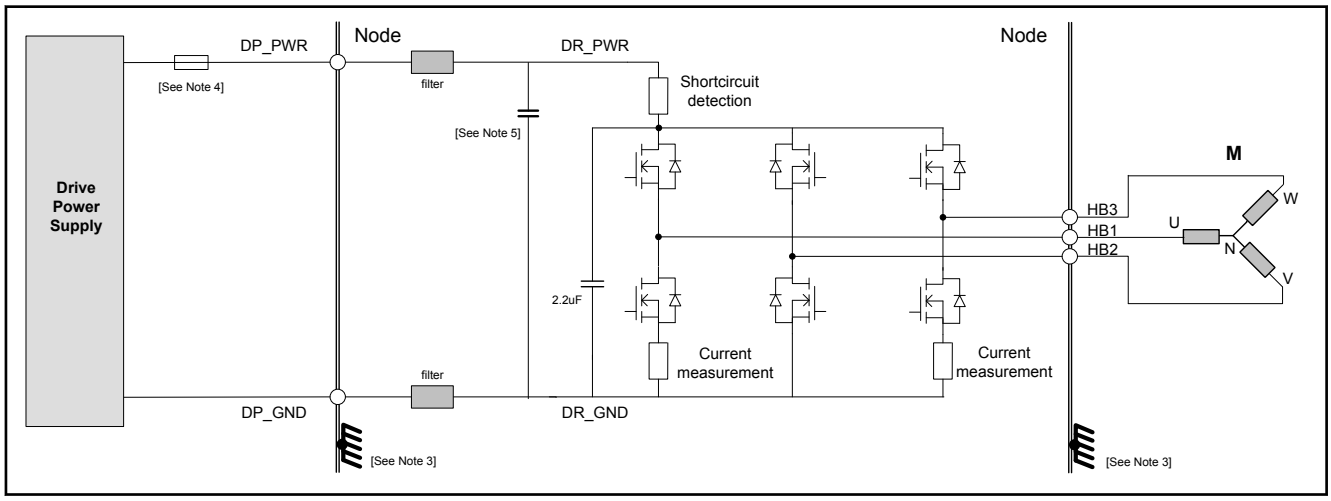

Fig. 11-16: Motor connections NY4140

Notes

1. Follow this cabling instruction:

   Shielded cable is recommended, but not mandatory.

   If shielded cable is used, the shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).

   Connect the other side to a convenient metal part or leave it open.
2. Connect the DR_GND of the drive power to the housing and/or safety earth (if this is not already the case).
3. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. A fuse must be installed between the +V of the drive power supply and DP_PWR on the node. The fuse is mandatory by safety regulations and must be UL recognized. See NYCe 4000 Standard Housings and Accessories manual for detailed information about fuses.
5. Connect an external capacitor close to the drive module (see chapter 16.1 "Drive Power Filtering for NY412x/NY4140" on page 213), in order to avoid ripple currents.

M0	BLAC/BLDC motor	DC motor
HB1	U	
HB2	V	+V
HB3	W	–V
DR_GND		
Shield		

Tab. 11-16: Motor connections

11.15 Drive Power

The NY4140 drive power is used to connect the drive power supply to PWM drive module. Both the drive power and drive ground are designed to conduct 14 A continuous.

Characteristic	Description
Number of inputs	2: DR_PWR, DR_GND
Drive power voltage	48 V … 150 V
Absolute maximum rating	170 V Note: The software disables the drive at 170 V. The maximum voltage at which the software disables the drive can only be set to a user defined value lower than 170 V. See Software User Manual, parameter SAC_PAR_POS_SERVO_OVER_VOLTAGE_LIMIT
Input current	6 A rms, 20 A peak
Overvoltage protection	No
Undervoltage protection	Yes The minimum voltage at which the software disables the drive is 35 V (default value) or a higher user defined voltage level. See Software User Manual, parameter SAC_PAR_POS_SERVO_UNDER_VOLTAGE_LIMIT

Tab. 11-17: NY4140 drive power inputs characteristics

12 NY4150 and NY4150/10: SERCOS III Master Module

12.1 Overview

The NY4150 and NY4150/10 are standard NYCe 4000 modules with a Drivelink connection based on the SERCOS III standard hardware to connect IndraDrive amplifiers of Bosch Rexroth to the NYCe 4000 system. SERCOS is the abbreviation of Serial Real time Communication System, and SERCOS III is the third generation SERCOS drive communication protocol based on the Ethernet physical hardware structure. The NY4150/10 is the successor of the NY4150. Both modules are referred as "NY4150" in this chapter, unless a difference must be explained. The NY4150 SERCOS III Master module must always be installed in drive slot 0 of the system housing, right next to the MCU. Part number for the NY4150 is R911325072, ordering code is NYM04.1-SE3-MAST-NY4150. Part number for the NY4150/10 is R911172782, ordering code is NYM04.1-SE3-MAST-NY4150/10.

Analog inputs and digital outputs are available to support LMS (Linear Motion System) applications.

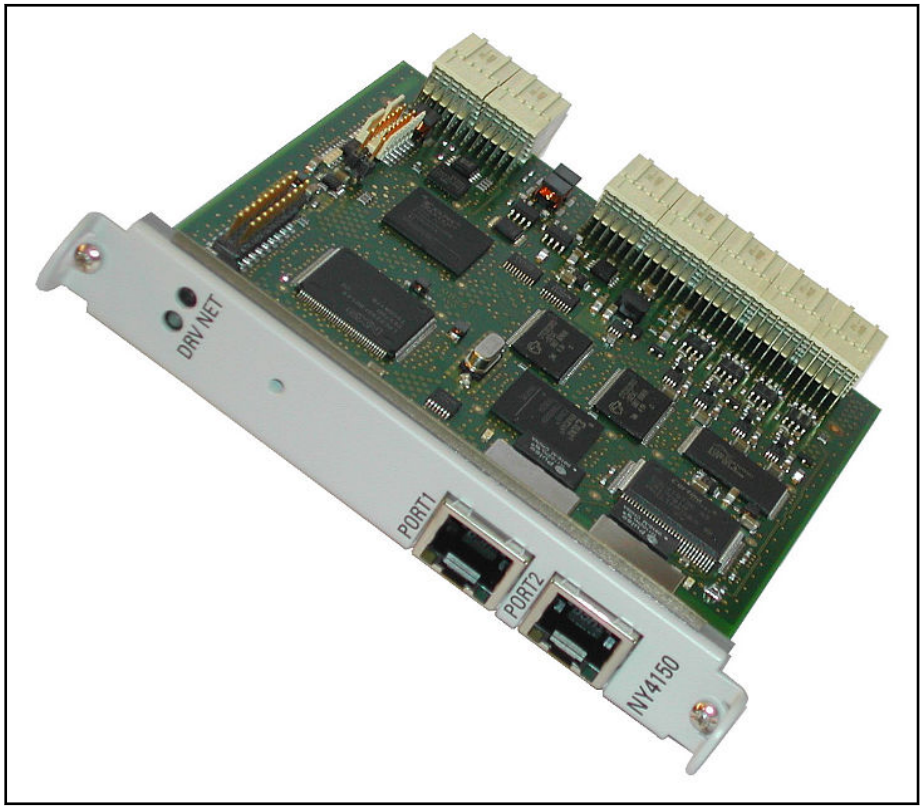

Fig. 12-1: SERCOS III Master module NY4150

NY4150 and NY4150/10: SERCOS III Master Module

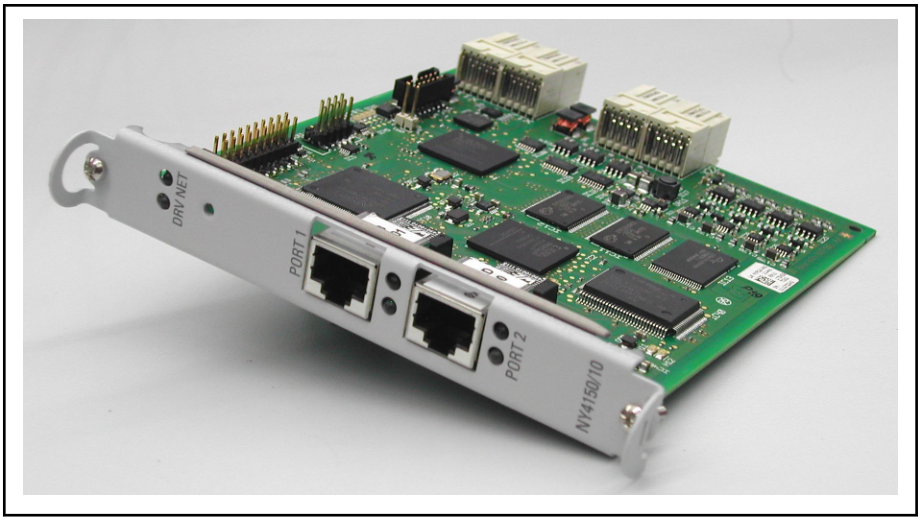

Fig. 12-2: SERCOS III Master module NY4150/10

The main features of the NY4150 are the following.

- Support for Bosch Rexroth IndraDrive C Advanced and IndraDrive Cs Basic Universal Servo Power Amplifiers. Up to 8 IndraDrives can be connected to the NY4150. Every power stage module can be used, but the CSH control section (for IndraDrive C Advanced) and the Basic Universal control section (for the IndraDrive Cs) must have the SERCOS III V1.1 protocol interface option. The firmware supported for the IndraDrive C Advanced is MPH. The firmware supported for the IndraDrive Cs is MPB. See the NYCe 4000 Software Release Bulletin for supported firmware versions of the IndraDrive.
- Microprocessor core for SERCOS III V1.1 protocol support
- 2 standard RJ45 ("Ethernet") headers on the front panel
- 2 LEDs on the front panel for status indication of the module
- Power consumption approximately 3 W at 24 V system power supply voltage (measurement conditions: IndraDrive communication active, no digital I/O connected)

Per module the following I/O are available:

- 8 analog inputs (for LMS-MUX NY4960 or NY4074/NY4079 internal multiplexer connection only)
- 3 digital RS485 outputs (for LMS-MUX NY4960 or NY4074/NY4079 internal multiplexer connection only)

12.2 Module identification

An identification label is attached on the NY4150 modules.

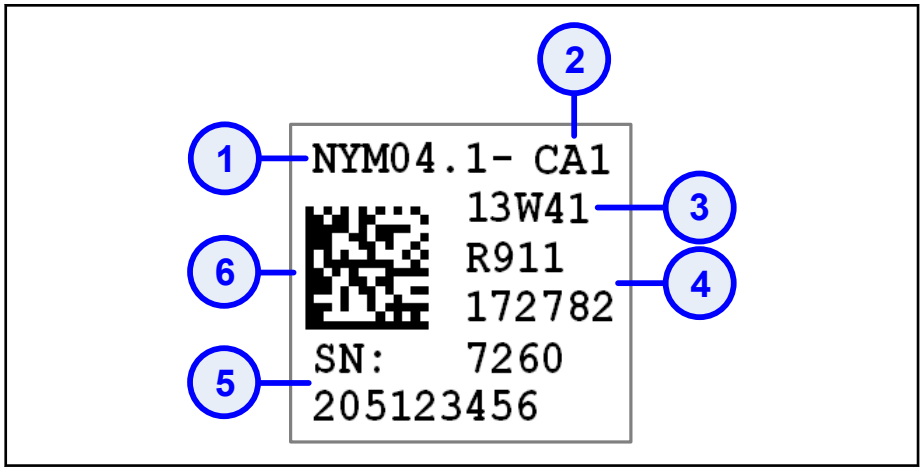

Fig. 12-3: Example: identification label of the NY4150/10

Identification number	Field explanation
1	Type code
2	Version level and status
3	Date of manufacture (yyWww)
4	Material number
5	Serial number
6	2D bar code

Tab. 12-1: Explanation of the fields of the NY4150 identification label

12.3 Module dimensions

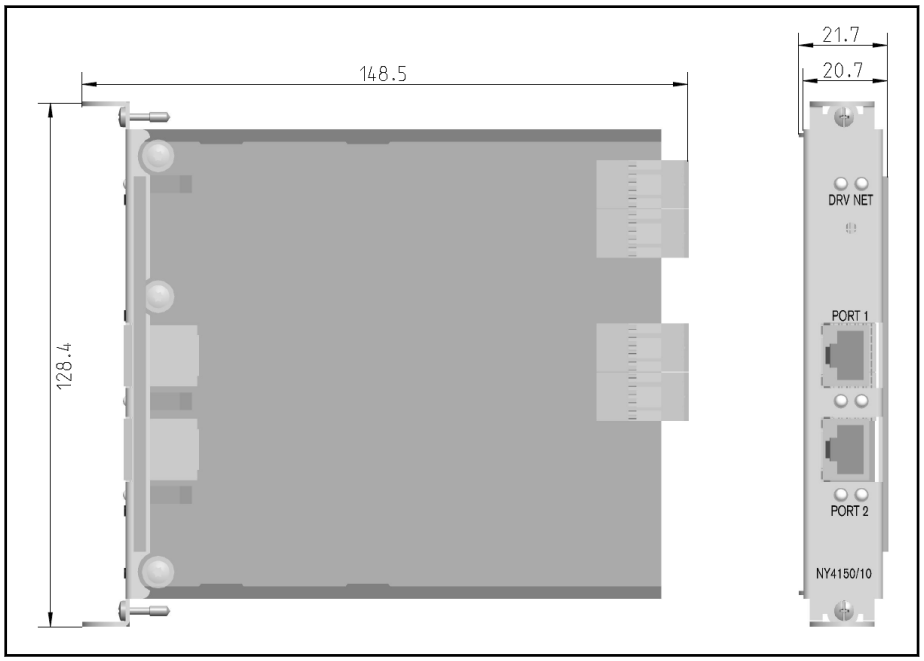

Fig. 12-4: NY4150 module dimensions

Module type code	Width	Height	Depth	Weight
NYM04.1-SE3-MAST-NY4150 NYM04.1-SE3-MAST-NY4150/10	21.7 mm	128.4 mm	148.5 mm	270 gr

Tab. 12-2: NY4150 physical data

12.4 Field Diagnostics

The module does not contain any replaceable or wear parts. In case of failure, the entire module must be replaced.

The NY4150 modules have 2 bi-color module status indicator LEDs on the front panel labeled "DRV" at the left side and "NET" at the right side.

- "DRV" – Module status indicator
- "NET" – Microprocessor and SERCOS network status indicator

The various indications of the status indicator LEDs are described in tab. 12-3 ""DRV" status LED indications" on page 154 and tab. 12-4 ""NET" status LED indications" on page 154.

LED indication	Description
Red steady	Default setting when module starts (power-up). Fatal error on the Master module, or gateware, microware or SERCON100M is not correct or not loaded, or communication problem detected on the backplane (call service). The NY4150/10 is only supported in NYCe 4000 Software Release 40V00 or higher.
Orange steady	Gateware, microware and SERCON100M loaded, but node not yet operational, because other drive modules in the node are initializing.
Green steady	Gateware, microware and SERCON100M is loaded, module is OK.

Tab. 12-3: "DRV" status LED indications

LED indication	Description
Off	Microprocessor not (yet) started. The MCU is starting, and has not yet started the microprocessor. After downloading new software to flash of the microprocessor (a reset is required).
Orange	During the power-up of the microprocessor, POST (Power On Self Test) or downloading software or SERCON100M bitfile.
Green steady	The SERCOS network is ready.
Red flashing (2Hz)	The SERCOS network is not ready. Cables not connected, loop not closed, IndraDrive not powered or network is being enumerated.

Tab. 12-4: "NET" status LED indications

SERCOS III network connections

The NY4150 and NY4150/10 module has two RJ45 ("Ethernet") headers on the front panel.

- The NY4150 has 2 LEDs incorporated in the RJ45 headers, These 2 LEDs are an information indication of the SERCOS ring. The upper LED (orange) indicates that data is transported over the Ethernet connection. The lower LED (green) indicates that the Ethernet cable is correctly connected.
- The NY4150/10 has 2 LEDs underneath the RJ45 headers. The orange LED at the left side indicates that data is transported over the Ethernet connection. The green LED at the right side indicates that the Ethernet cable is correctly connected.

12.5 Supported NYCe 4000 functionality with NY4150

See fig. 12-5 "NY4150 in NYCe 4000 architecture" on page 155 for the positioning of the NY4150 SERCOS III Master module in the NYCe 4000 architecture. The standard NYCe 4000 drive modules connect directly to motor and sensor connectors via the system housing, whereas the NY4150 SERCOS III Master module connects to the IndraDrive amplifiers via the SERCOS link directly on the front of the module.

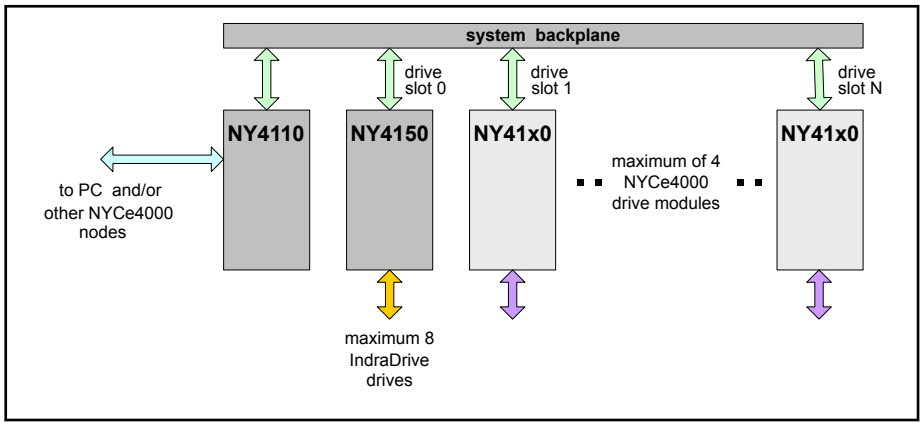

Fig. 12-5: NY4150 in NYCe 4000 architecture

The NY4150 SERCOS III Master module supports IndraDrive amplifiers in combination with the other standard drive modules. The following functional availability and limitations apply.

- The total amount of axes supported in one NYCe 4000 node is 10 axes, the maximum number of drive slots is 5. The axes are distributed over the number of connected IndraDrive amplifiers and NYCe 4000 drive modules.
- The SERCOS III update frequency is equal to the node sample time. Supported update frequency is 1 kHz. With Software Release 42VRS (or higher version) the update frequency of 2 kHz is also supported. All other update frequencies are not supported.
- Only one axis is supported per IndraDrive. The maximum supported number of IndraDrives for an NY4150 is limited to 8 if the update frequency is 1 kHz, and is limited to 5 if the update frequency is 2 kHz (if that update frequency can be set).
- Axis position sampling in the IndraDrive is synchronous with the axis position sampling of the other standard drive modules.

- If the PVL at the drive is chosen, the position and velocity controller of the IndraDrive is used. The controller parameters are mapped to the controller parameter structure and units of the NYCe 4000 controller. The corresponding sampling times depend on the used amplifier. The current controller is always in the IndraDrive and the sampling time of the current controller is predefined and fixed.
- The NY4150 SERCOS III Master module can only be installed in the first drive slot (slot 0). This implies that only one NY4150 is supported per node. The NYCe 4000 software will generate a configuration error if an NY4150 is installed in another drive slot.
- Two new motor types can be configured for the NY4150, IndraBLAC and IndraLMS. All axes defined on an NY4150 must be of the same motor type.

12.6 I/O Connector

The SERCOS III Master module I/O connector uses a 150 pin, 2mm Modular Interconnect System. The pinout is sorted on insulated areas.

Pin	Row A	Row B	Row C	Row D	Row E
1		AnGND	AnVref	AnIn1–	AnIn1+
2		AnGND	AnVref	AnIn0–	AnIn0+
3	DGND	DGND	DGND	DGND	DGND
4			AnIn2–	AnIn2+	AnIn7+
5			AnIn3–	AnIn3+	AnIn7–
6			AnIn4–	AnIn4+	AnIn6+
7			Dig5VIn0a–	Dig5VIn0a+	AnIn6–
8			Dig5VIn0b–	Dig5VIn0b+	AnIn5+
9			Dig5VIn0c–	Dig5VIn0c+	AnIn5–
10	EncGND	EncVref	EncGND	Enc5V0	Enc5V0
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					

Pin	Row A	Row B	Row C	Row D	Row E
24					
25					
26					
27					
28					
29					
30					

Tab. 12-5: SERCOS III Master module I/O connector

- DGND on pin 3 of all rows is intended as shielding between analog I/O and 5 Volt digital Inputs. No connections should be made to these pins.
- Not allocated pins must be not connected.

12.7 Analog Inputs

The analog inputs are only supported when the NY4150 is applied in a Linear Motion System (LMS) application. In the LMS application the analog inputs are connected to the LMS-MUX NY4960 or the NY4074/NY4079 internal multiplexer. See the NYCe 4000 Standard Housings and Accessories Manual for detailed information.

12.8 Digital Outputs

The digital outputs are only supported when the NY4150 is applied in a Linear Motion System (LMS) application. In the LMS application the digital outputs are connected to the LMS-MUX NY4960 or the NY4074/NY4079 internal multiplexer. See the NYCe 4000 Standard Housings and Accessories Manual for detailed information.

12.9 Connection NY4150 – IndraDrive

The connection between the NY4150 and the IndraDrive(s) forms a double ring topology. A shielded twisted pair (STP) cable from the "PORT1" header connects the NY4150 to the first IndraDrive, an STP cable connects the first IndraDrive to the next IndraDrive, etc. The last IndraDrive connects with an STP cable to the "PORT2" header on the NY4150, and closes the ring, see fig. 12-6 "Connection ring between NY4150 and IndraDrive(s)" on page 158.

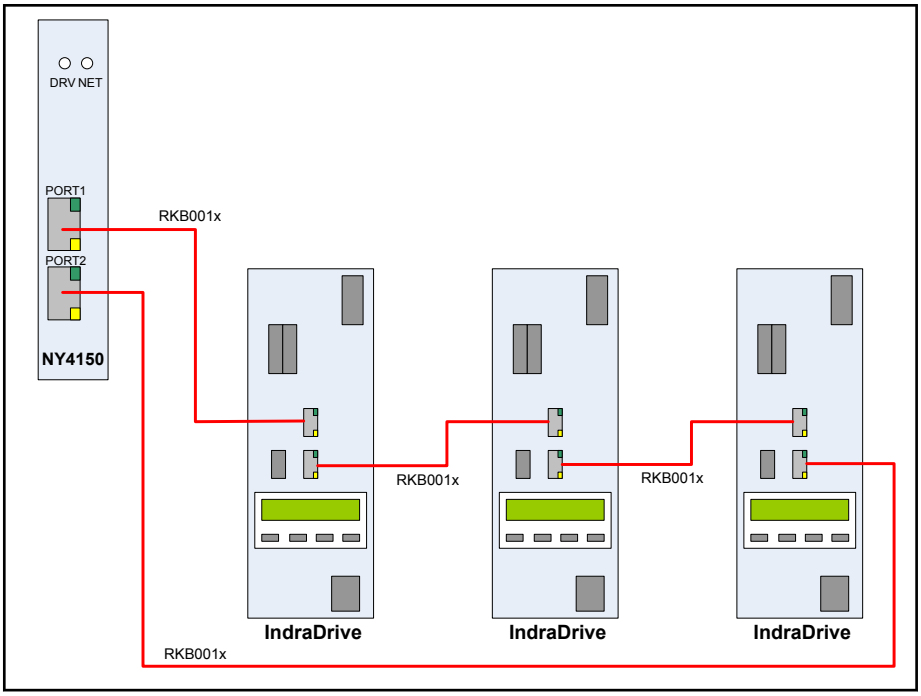

Fig. 12-6: Connection ring between NY4150 and IndraDrive(s)

The type numbers of the cables between the NY4150 and the IndraDrive(s) are the following.

- RKB0013, which have a length of 25, 35 or 55 cm.
- RKB0011, length is specified by the customer.

The RKB0013 is in principle meant for connection of IndraDrives that are installed next to each other. The RKB0011 is meant to span larger distances.

The RKB0011 and RKB0013 are electrically identical.

12.10 Installation requirements

The RJ45 connections to the SERCOS network are located on the front of the NY4150. Some form of network cable strain relief is required for this type of connection to ensure a reliable contact between the RJ45 plug and header. For SERCOS network cables connected to the NY4150 you can use the strain relief bracket installed on the MCU. The NY4901/10 strain relief bracket is developed for the NY4150/10. See the NYCe 4000 Standard Housings and Accessories manual for detailed information.

Make sure that your machine design has sufficient free clearance space in front of the NY4150 for a cable strain relief and the maximum allowed bending of the SERCOS cables. As rule of thumb, 100 mm should suffice.

You must use some form of strain relief for the connection cables to the NY4150 to ensure reliable connections.

☞ Follow these instructions to prevent damage to the NY4150 module.

- Do not plug the NY4150 module into the backplane while the 24V System power supply is applied.
- Do not remove the NY4150 module from the backplane while the 24V System power supply is applied.

IndraDrive I/O connection

See the NYCe 4000 Software User Manual, chapter Single Axis Control Drivelink (SACDL), for the mapping of IndraDrive I/O names to NYCe 4000 I/O names.

13 Encoders

13.1 Introduction

This chapter describes how to connect different types of encoders to the drive modules and gives timing information for the control loop of the various drive modules. You can connect the following encoder types.

- Quadrature encoder
- Analog position sensor (not supported on NY4125)
- Rexroth MSM incremental position encoder (not supported on NY4130)
- Rexroth MSM absolute position encoder (not supported on NY4130)
- Sanyo Denki absolute position encoder (not supported on NY4130)
- EnDat2.2 encoder
- SinCos based encoder types through an additional NY4199 SinCos Option module (not supported on NY4125), see also chapter 13.14 "NY4199 SinCos Option module for SinCos based encoders" on page 203.
  - SinCos encoder
  - EnDat2.1 encoder
  - Hiperface encoder

The power supply for all encoders connected to the drive modules in a system housing is integrated on the MCU.

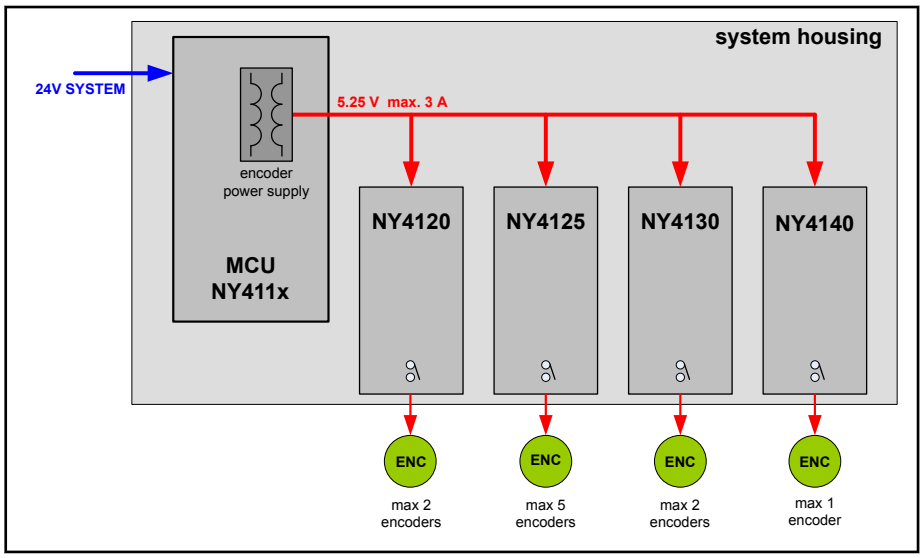

Fig. 13-1: Power supply diagram for encoders

The encoder power supply on the MCU delivers a voltage of 5.25V at a maximum of 3A. Thus, the total current of all encoders connected to a node must be lower than 3A. Another limitation is the maximum current that a drive module can deliver. The maximum current that a drive module can supply to its connected encoders depends on the drive module.

13.2 Encoder power supply switch

All drive modules have hardware to switch the encoder power supply on and off. The encoder power supply is available on the pin Enc5Vx where x is the axis number. The NYCe 4000 software includes functions to switch the encoder power supply on and off per axis. This functionality is available for all drive modules. However, on the NY4120 drive module the encoder power supply is combined for both axes. This implies that whenever the encoder power supply for one of the axes is switched on, the encoder power supply for the other axis is also switched on. Only when the encoder power supply for both axes is switched off software-wise, pins Enc5V0 and Enc5V1 are switched off.

See tab. 13-1 "Drive module encoder power supply characteristics" on page 163 for the properties of the encoder power supply, and tab. 13-2 "Encoder connection cable characteristics" on page 163 for the connection cable characteristics for the encoders.

- You must take care that the total current supplied by the encoder power supply for the connected encoders to a single drive module must stay below the maximum current specified in tab. 13-1 "Drive module encoder power supply characteristics" on page 163.
- The source for the encoder power supply on each drive module is on the MCU module. The total required current for all encoders connected to all installed drive modules in one node must stay below 3000 mA.

Characteristic	Description
Total supply current	• NY4120, NY4130, NY4140 700 mA maximum per drive module • NY4125 300 mA maximum per axis
Overload protection	Thermal protection • NY4120 up to 1.4 A for both encoders • NY4125 up to 0.59 A per encoder • NY4130, NY4140 up to 1.4 A per encoder
Short-circuit current	• NY4120 Limited at 1.7 A peak (0.4 A rms) typical for both encoders (pulsing until short-circuit condition is removed) • NY4125 Limited at 0.77 A peak (0.23 A rms) typical per encoder (pulsing until short-circuit condition is removed) • NY4130, NY4140 Limited at 1.7 A peak (0.4 A rms) typical per encoder (pulsing until short-circuit condition is removed)

Tab. 13-1: Drive module encoder power supply characteristics

Characteristic	Description
Cable length	max 15 m.
Characteristic impedance	80 … 120 Ω
Capacitance	max 100 pF/m.

Tab. 13-2: Encoder connection cable characteristics

13.3 Timing aspects of the control loop

This chapter explains the timing aspects of the control loop components. Components that act in the control loop are for example the position encoder, A/D conversion time needed for certain encoders, calculation time needed by the Position Velocity Loop (PVL), the Current Control Loop (CCL), and the time needed to transfer data from the drive modules to the MCU (via the so-called "sync" packet). Whether the PVL is executed on the MCU or on the drive module also has impact on the timing.

First, the different sample time definitions and their relationship are explained. With that information the moment of availability of encoder data and other timing aspects are explained, for example

- Data availability for sync packet transmission.

All data values in the sync packet must be available before they are fetched from the internal FPGA memory. The sync packet is transmitted over the backplane to the MCU. Every drive module has a dedicated communication channel with the MCU, so the sync packets of all drive modules in the node are transmitted at the same time in parallel to the MCU.

- Data availability for Current Control Loop (CCL) calculation.

  The CCL requires position data and current data for the current control algorithm. The data must be available before the CCL is triggered.

- Data availability for Position Velocity Loop (PVL) calculation.

  The PVL requires the actual position data available on the latch moment. The latch moment depends on the PVL frequency.

As all activities are derived from a network-synchronized clock, all activities in each NYCe 4000 node are executed synchronously.

Sample time definitions

All activities, such as start of the A/D conversion or latch moment of encoder data, start of the PVL calculation and transmission of the sync packet, are derived from a single clock source on the MCU. The sync packet is transmitted from the drive module to the MCU once every MCU sample.

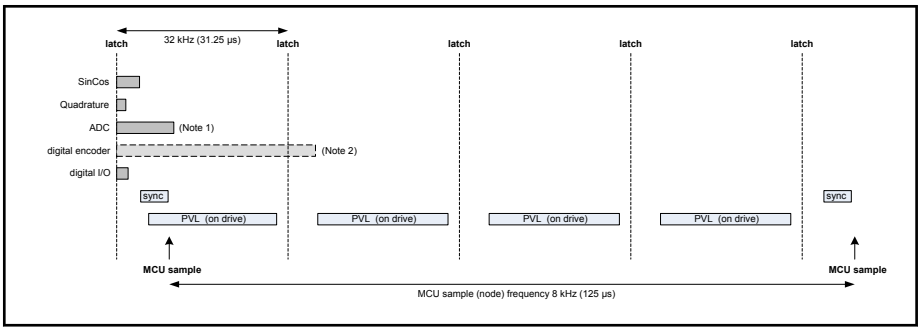

Fig. 13-2: Relation of MCU sample, PVL sample and encoder data (PVL on drive @ 32 kHz)

fig. 13-2 "Relation of MCU sample, PVL sample and encoder data (PVL on drive @ 32 kHz)" on page 164 shows that the information of the analog to digital conversion is not available in time to be included in the sync packet (Note 1). For this reason, the sync packet always contains the analog value of the previous PVL sample. fig. 13-2 "Relation of MCU sample, PVL sample and encoder data (PVL on drive @ 32 kHz)" on page 164 also shows that the information of a digital encoder will not be available in time for the PVL (on the drive module) when the PVL frequency is set at 32 kHz (Note 2). For this reason, the PVL frequency must be set lower if you use a digital encoder, see the following subchapter "Encoder position data". At the lower PVL frequency the PVL (on the drive module) can use the actual information of the digital encoder, see fig. 13-3 "Relation of MCU sample, PVL sample and encoder data (PVL on drive @ 16 kHz)" on page 165. However, the sync packet always contains the information of the digital encoder of the previous PVL sample.

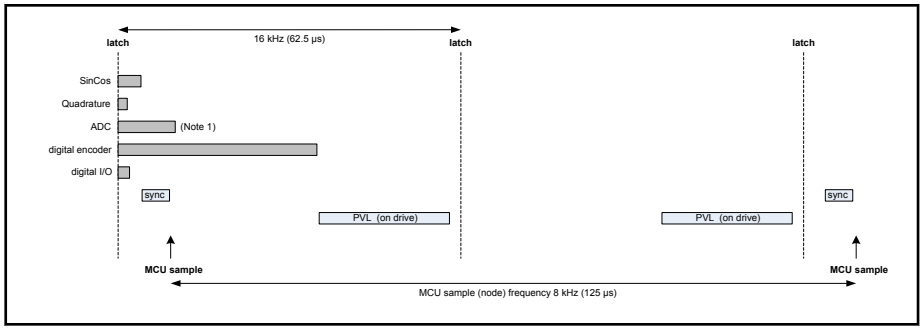

Fig. 13-3: Relation of MCU sample, PVL sample and encoder data (PVL on drive @ 16 kHz)

The moment that the PVL on the drive module starts depends on the configured position encoder. If a SinCos-based encoder is used, the PVL can start before the end of the sync packet. If a digital encoder is used the PVL starts as soon as the position data becomes available, see fig. 13-2 "Relation of MCU sample, PVL sample and encoder data (PVL on drive @ 32 kHz)" on page 164 and fig. 13-3 "Relation of MCU sample, PVL sample and encoder data (PVL on drive @ 16 kHz)" on page 165.

You can also use the PVL on the MCU. If you use the PVL on the MCU, keep the following in mind.

- The PVL on the drive module defines the latch frequency. Even when the PVL runs on the MCU, the latch frequency is the PVL frequency of the drive module.
- The PVL on the drive module adds dithering and the test signal to the controller out signal.
- The PVL on the drive module is the only component that communicates information to the CCL.

The PVL on the MCU always starts after the end of the sync packet, see fig. 13-4 "Timing relation of MCU sample, PVL sample, encoder information (PVL on MCU)" on page 165.

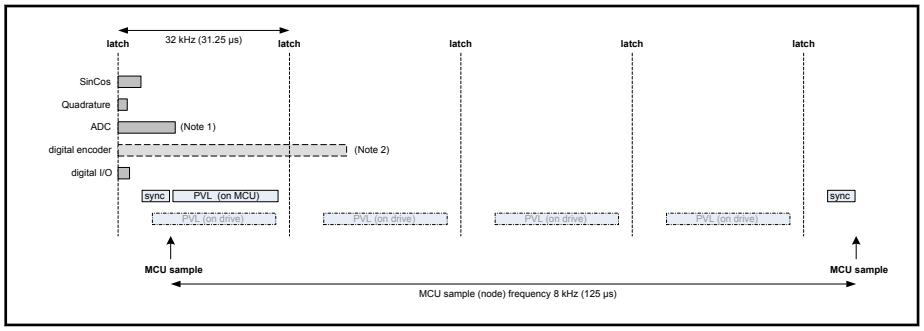

Fig. 13-4: Timing relation of MCU sample, PVL sample, encoder information (PVL on MCU)

The PVL (on the drive module) frequency can be set to 4, 8, 16, or 32 kHz. The sample frequency, also called the node frequency can be set to 1, 2, 4, or 8 kHz.

Note that, depending on the selected node (sample) frequency and the PVL (on the drive module) frequency, several PVL (on the drive module) sample cycles are executed in one MCU sample. For example, if the sample

frequency is 8 kHz and the PVL frequency is 32 kHz, 4 complete PVL cycles are executed in a single MCU sample. This aspect is important to remember when you examine trace data, as trace data is gathered once per MCU sample.

If a drive module includes a Current Control Loop (CCL), PVL results, for example Controller Out, are input data for the CCL. The CCL is executed concurrently with the PVL on the drive module. This implies that information for the CCL is one CCL sample delayed if the PVL runs on the drive module, see fig. 13-5 "Timing relation of PVL sample, CCL sample and PWM signal" on page 166 ①.

If the PVL runs on the MCU, the information for the CCL is two PVL samples delayed, because the PVL result (on the MCU) must be communicated to the PVL on the drive module and the PVL on the drive module subsequently must send the data to the CCL, see fig. 13-5 "Timing relation of PVL sample, CCL sample and PWM signal" on page 166 ②.

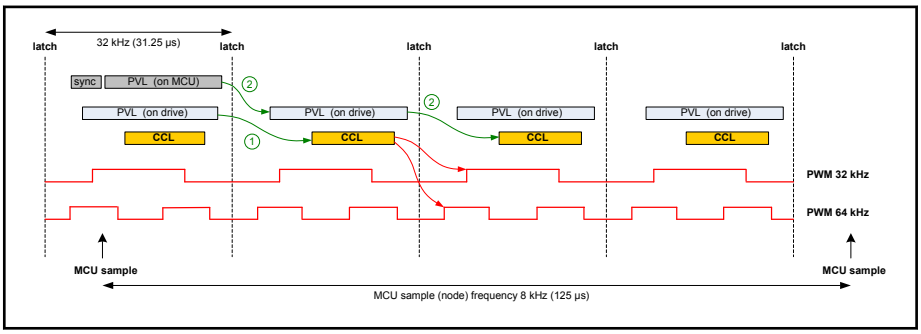

Fig. 13-5: Timing relation of PVL sample, CCL sample and PWM signal

Likewise, the update of the PWM output is concurrently executed with the CCL. The update of the PWM may be delayed one CCL sample depending on the PWM frequency, see fig. 13-5 "Timing relation of PVL sample, CCL sample and PWM signal" on page 166. The figure also shows that the CCL result on the PWM signal will be effective earlier if the PWM frequency is set higher.

The CCL frequency can be set at 4, 8, 16, or 32 kHz. The PWM frequency can be set to 16, 32, 64 or 96 kHz. Regarding the frequencies, the following rule must be met in a node

$$f_{node} \leq f_{PVL} \leq f_{CCL} \leq f_{PWM}$$

To minimize delay times it is beneficial to execute the PVL, CCL, and PWM processes at the highest possible frequency. However, the choice of frequencies depends on other factors as well.

Encoder position data

As can be seen in fig. 13-2 "Relation of MCU sample, PVL sample and encoder data (PVL on drive @ 32 kHz)" on page 164 and fig. 13-4 "Timing relation of MCU sample, PVL sample, encoder information (PVL on MCU)" on page 165, the position information of SinCos-based encoders (SinCos, EnDat2.1 and Hiperface) and quadrature encoders is available when the sync packet transmission is started. The position information that the PVL (on the drive module or on the MCU) uses is always the actual data of the SinCos, EnDat2.1, Hiperface encoder or quadrature encoder.

The analog to digital conversion for the analog input value needs a certain amount of time. The PVL calculation on the drive module is started before the conversion is finished. The transmission of the sync packet is also started before the conversion is finished. For these reasons, the PVL on the drive and the PVL on the MCU both use the analog input value of the previous PVL cycle.

As the acquisition and calculation of the position information of the digital encoders (MSM, Sanyo Denki, or EnDat2.2) requires more time than available when the PVL executes at 32 kHz, the use of a digital encoder puts a limit on the highest selectable PVL frequency. The PVL frequency must be set lower to meet the requirement that the position information used by the PVL is the actual position.

- For MSM incremental and absolute encoders the allowed maximum PVL frequency is 4 or 8 kHz.
- For Sanyo Denki absolute encoders the allowed maximum PVL frequency is 4 or 8 kHz.
- For EnDat2.2 encoders the allowed maximum PVL frequency depends on the EnDat clock, see tab. 13-3 "Maximum PVL frequency vs. EnDat2.2 encoder clock frequency" on page 167.

EnDat clock frequency	Maximum PVL frequency
1 MHz	4 kHz
2 MHz	8 kHz
4 MHz	16 kHz

Tab. 13-3: Maximum PVL frequency vs. EnDat2.2 encoder clock frequency

For more information see the NYCe 4000 Tools Manual, NYCeConfigurator chapter, "Configuration at the axis level".

Digital inputs and digital outputs

The hardware inputs (such as digital inputs and temperature sensor) are always up-to-date in the sync packet. The digital I/O operations are started on the latch pulse. Sampling the digital inputs or triggering the digital outputs requires a negligible amount of time, less than 2 µs.

The motor current is measured by the PVL. The sync packet contains the measured motor current of the previous PVL cycle.

Relation between PVL update and setpoint generator

The setpoint generator calculates every MCU sample a new setpoint. To minimize the disturbance in the closed loop the calculated displacement is "spread" over the PVL cycles executed during the MCU sample period. Thus, if the MCU sample frequency is 8 kHz and the PVL frequency is 32 kHz, the displacement is divided in 4 smaller displacements, see fig. 13-6 "Relation between MCU sample (setpoint generator) and PVL sample" on page 168.

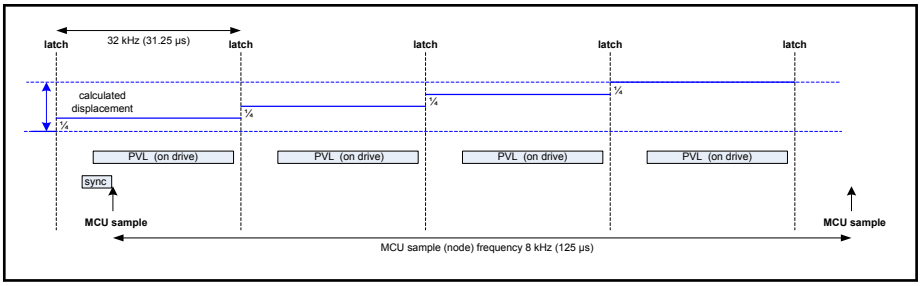

Fig. 13-6: Relation between MCU sample (setpoint generator) and PVL sample

Note that this division in smaller displacements is only done if the PVL on the drive module is used.

No interpolation is possible when the PVL on the MCU is used as the PVL frequency (on the MCU) equals the MCU sample frequency (node frequency).

13.4 Encoders and BLDC motor with +5 Volt Hall sensors

The NY4120 and NY4140 drive modules have +5 Volt digital inputs which can be used to connect the +5 Volt Hall sensors of a BLDC motor. For the first axis, axis0, these inputs are Dig5VIn0a, Dig5VIn0b, Dig5VIn0c, and for the second axis, if supported by the drive module, axis1, these inputs are Dig5Vin1a, Dig5Vin1b, Dig5Vin1c.

The digital encoders (Rexroth MSM incremental and absolute, Sanyo Denki absolute, EnDat2.1, EnDat2.2, Hiperface) and SinCos encoders also use these +5 Volt digital inputs. This means that a BLDC motor with +5 Volt Hall sensors and a digital encoder cannot be used on the same axis. There is one exception, see "SinCos encoder" below.

See NYCe 4000 Standard Housings & Accessories, chapter "Encoder connections" of the system housing for complete information of the pinout of the encoder header.

The following table gives a summary of the possible or not possible combinations of a BLDC motor with Hall sensors and a specific encoder on the axes of a drive module.

BLDC		Rexroth MSM	Sanyo Denki	SinCos	EnDat2.1	EnDat2.2	Hiperface
axis 0	5V Hall sensor	-	-	OK	-	-	-
	24V Hall sensor	OK	OK	OK	OK	OK	OK
axis 1	5V Hall sensor	-	-	-	-	-	-
	24V Hall sensor	OK	OK	OK	OK	OK	OK

Tab. 13-4: BLDC motor with Hall sensors on axis 0 or axis 1 possibilities

Rexroth MSM incremental and absolute encoder

The combination of a Rexroth MSM incremental or absolute encoder with a BLDC motor (with +5 Volt Hall sensors) is not possible. Note that if the Hall sensors are used on the +24 Volt digital inputs, the Rexroth MSM incremental or absolute encoder can be used with a BLDC motor.

Sanyo Denki absolute encoder

The combination of a Sanyo Denki absolute encoder with a BLDC motor (with +5 Volt Hall sensors) is not possible. Note that if the Hall sensors are used on the +24 Volt digital inputs, the Sanyo Denki absolute encoder can be used with a BLDC motor.

SinCos encoder

The SinCos encoder on axis1 uses the Dig5Vin1x connections for the SinCos signals. Thus, the SinCos encoder cannot be used in combination with a BLDC motor (with +5 Volt Hall sensors) on axis1. Note that if the Hall sensors are used on the +24 Volt digital inputs, the SinCos encoder can be used on axis1 with a BLDC motor.

The combination of a SinCos encoder with a BLDC (with +5 Volt or +24 Volt Hall sensors) is possible on axis0, because the SinCos encoder does not use the Dig5VIn0a, Dig5VIn0b, Dig5VIn0c inputs, but the Opt_0, Opt_1, Opt_2 inputs.

EnDat2.1 encoder

The EnDat2.1 encoder uses the Dig5Vin connections for clock, data and SinCos signals. Thus, the EnDat2.1 encoder cannot be used in combination with a BLDC motor (with +5 Volt Hall sensors) on either axis. As one Dig5Vin connection (Dig5VIn0b+ and Dig5VIn0b–) of axis0 is used on the encoder connector Ex.1 (for axis1), this also excludes the use of an EnDat2.1 encoder on axis1 if a BLDC motor (with +5 Volt Hall sensors) is connected to axis0. Note that if the Hall sensors are used on the +24 Volt digital inputs, the EnDat2.1 encoder can be used with a BLDC motor.

EnDat2.2 encoder

The EnDat2.2 encoder uses the Dig5Vinxa connection for clock, and the Dig5Vinxc connection for data. Thus, the EnDat2.2 encoder cannot be used in combination with a BLDC motor (with +5 Volt Hall sensors) on either axis. Note that if the Hall sensors are used on the +24 Volt digital inputs, the EnDat2.2 encoder can be used with a BLDC motor.

Hiperface encoder

The Hiperface encoder uses the Dig5Vin connections for data, SinCos signals and +8 Volt power supply. Thus, the Hiperface encoder cannot be used in combination with a BLDC motor (with +5 Volt Hall sensors) on either axis. As one Dig5Vin connection (Dig5VIn0b+ and Dig5VIn0b–) of axis0 is used on the encoder connector Ex.1 (for axis1), this also excludes the use of an Hiperface encoder on axis1 if a BLDC motor (with +5 Volt Hall sensors) is connected to axis0. Note that if the Hall sensors are used on the +24 Volt digital inputs, the Hiperface encoder can be used with a BLDC motor.

13.5 Quadrature encoder

The quadrature encoder is also named A/B encoder, S0S90 encoder and 3-channel digital incremental encoder.

Encoders

Power supply

Characteristic	Specification
Main power supply	5.25 V, ± 0.1 V
Switch on/off capability	Yes, switch on/off by software (see note 1) • NY4120 switch on/off per drive • NY4125, NY4130, NY4140 switch on/off per axis

Tab. 13-5: Power supply characteristics

Encoder inputs characteristics

Characteristic	Description
Number of encoder inputs	• 2 (NY4120, NY4130) • 1 (NY4140) • 5 (NY4125)
NY4199 SinCos Option module required	No
Galvanic insulated	No
Encoder signal interface	RS422 (differential) or 'half RS422 referenced to 2.05 Volt' (single ended)
Line termination	On-board, 390 Ω for NY4120, NY4130 On-board, 390 Ω for NY4140 On-board, 400 Ω for NY4125
Input frequency QuadA, QuadB and Index (not guaranteed with open collector output)	Max. 10 MHz. (incremental pulse count up to 40 MHz)
Pulse width Index pulse (not guaranteed with open collector output)	Tindex ≥ 25 ns
Phase alarm	Yes, if quadrature phase difference Tph < 16 ns within one sample
Cable break alarm	Yes, but only when differential signals are offered. Available on QuadA, QuadB and Index on all drive modules except NY4125. Available on QuadA and QuadB on NY4125 drive module. Enable/disable by software
Maximum allowed signal skew between balanced inputs for proper cable break detection	Tskew < 2500 ns

Characteristic	Description
Pull up resistor for open collector driver	Not included, if necessary add externally
Miscellaneous items	Markers can be set at every increment

Tab. 13-6: Encoder inputs characteristics per drive module

Software behavior on cable break and short-circuit detection

tab. 13-7 "Cable break and short-circuit detection conditions" on page 171 lists the cable break and short-circuit detection in the hardware on the QuadA, QuadB and Index connections and the behavior of the NYCe 4000 software (if the error is enabled).

Error condition	Software behavior
Both differential inputs not connected • QuadA+ and QuadA– • QuadB+ and QuadB– • Index+ and Index–	Cable break error
One of the differential inputs not connected • QuadA+ or QuadA– • QuadB+ or QuadB–	Position error
One or both differential inputs connected to GND • QuadA+ and / or QuadA– • QuadB+ and / or QuadB–	Position error
One or both differential inputs connected to Enc5V • QuadA+ and / or QuadA– • QuadB+ and / or QuadB–	Position error
Short circuit between differential inputs • QuadA+ and QuadA– • QuadB+ and QuadB– • Index+ and Index–	Cable break error

Tab. 13-7: Cable break and short-circuit detection conditions

Notes

- NYCe 4000 supports quadrature encoders with and without index. If you connect a "Quadrature without index" encoder, you must connect the Index+ and Index– inputs of that axis on the drive module to EncGND to prevent an incorrect cable break error. This does not apply to the NY4125, because the NY4125 does not support cable break detection on the index signal. Depending on the axis and the drive module, the index inputs are Enc0Index+ and Enc0Index– or Enc1Index+ and Enc1Index–.
- To connect the quadrature encoder hardware-wise single-ended, you must connect the differential negative inputs on the drive module to EncVref. If the quadrature encoder is connected hardware-wise single-ended, see fig. 13-9 "Examples of correct connections" on page 174, this can be indicated in the software with the parameter

SAC_PAR_QUADRATURE_SINGLE_ENDED. See the NYCe 4000 Tools Manual and the NYCe 4000 Software User Manual for more information. If single-ended is selected via the parameter, the cable break detection is disabled in software, and the cable alarm will never occur.

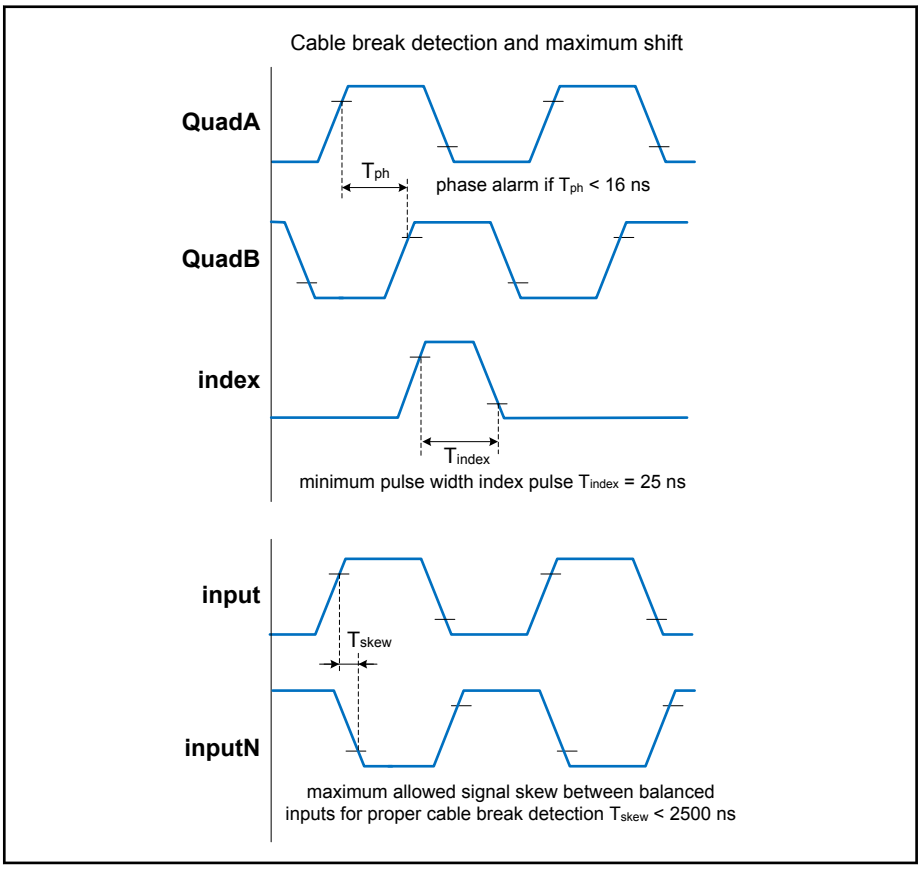

Fig. 13-7: Timing requirements of the encoder signals QuadA, QuadB and Index

Encoder inputs assignment

Backplane pin	Description	Remark
Enc#QuadA–, Enc#QuadA+	QuadA signal for axis#	1
Enc#QuadB–, Enc#QuadB+	QuadB signal for axis#	1
Enc#Index–, Enc#Index+	Index signal for axis#	2
Enc5V#	Power supply for axis#	1
EncVref	Common reference signal	-
EncGND	Common ground signals	-

1 # ■ 0, 1 for NY4120 and NY4130, 0 for NY4140, 0, 1, 2, 3, 4 for NY4125

2 # ■ 0, 1 for NY4120 and NY4130, 0 for NY4140

Tab. 13-8: Encoder inputs assignment

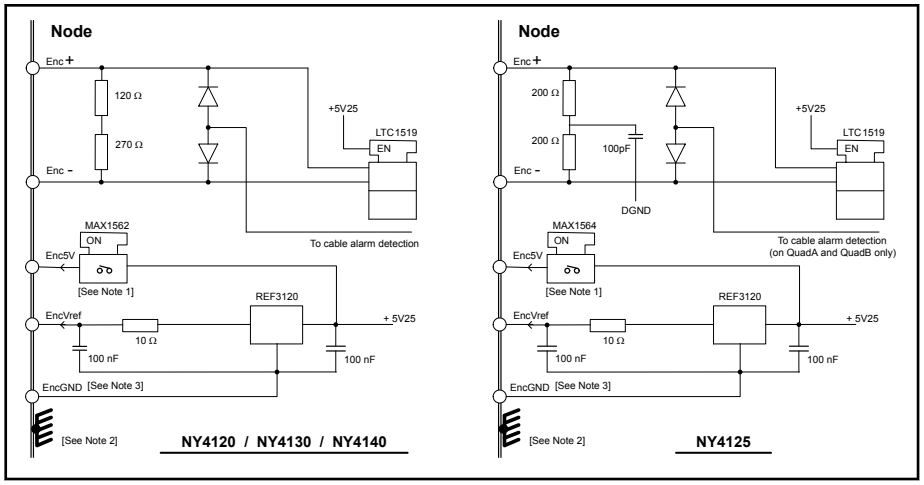

Fig. 13-8: Input circuit for the encoder signals QuadA, QuadB and Index

Notes

1. When switching off the power of the encoder the software behavior is as follows.
   - A power loss error may be generated on the axis.
   - The axis may go to the error state and set 'not homed'. If power to the encoder is switched off and both quadrature signals are "high", the axis goes to the error state and is set 'not homed'. If power to the encoder is switched off and both quadrature signals are "low", the axis remains in its current state.

   To recover from this situation, you must switch on the encoder power, reset and home the axis.
2. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
3. EncGND is connected to the internal system ground, which is ground MCU, drive logic, analog I/O, and host PC if the MCU is NY4110 and an IEEE 1394b cable is used.

   For proper use, this ground may not be connected to motor or digital I/O ground.
4. If necessary, depending on the type of encoder, add a pull up resistor, see fig. 13-9 "Examples of correct connections" on page 174 (see also the datasheet of the encoder).

Follow these cabling instructions.

- Always use a shielded cable.
- The shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).
- If the equipment on the application side is metal, connect the shield to the equipment housing.

Please study the datasheet of the encoder to find out the correct way to connect. fig. 13-9 "Examples of correct connections" on page 174 shows some examples.

Encoders

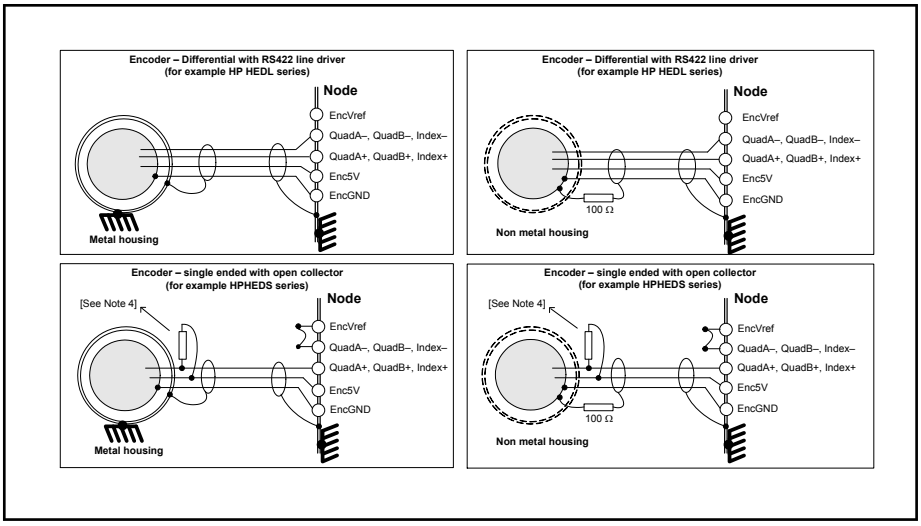

Fig. 13-9: Examples of correct connections

13.6 Analog position sensor

The analog inputs of the drive can be configured for connection of an analog position sensor.

Characteristic	Description
Number of analog inputs	• 2 (NY4120, NY4130) • 1 (NY4140)
Type	Differential; no galvanic insulation
Range (user selectable)	4 - 20 mA (not available on NY4130) + / – 10 V differential + / – 10 V single ended
Input impedance	10 kΩ // 1 nF
Resolution	12 bit monotonic (NY4120/NY4140) 16 bit monotonic (NY4130)
Linearity	1 LSB
Accuracy	Absolute: 3% of full scale Relative: 0.1% of full scale
Sample frequency	Synchronously 32 kHz
Bandwidth ADC	4 kHz

Tab. 13-9: Analog inputs characteristics per drive module

Encoder inputs assignment

Backplane pin	Description
AnIn0–, AnIn0+	Analog input 0 for axis0
AnIn1–, AnIn1+	Analog input 1 for axis1
AnVref	Analog reference voltage (only on NY4130)

Backplane pin	Description
AnInC	When used as current input (not on NY4130)
AnGND	GND

Tab. 13-10: Analog inputs assignment

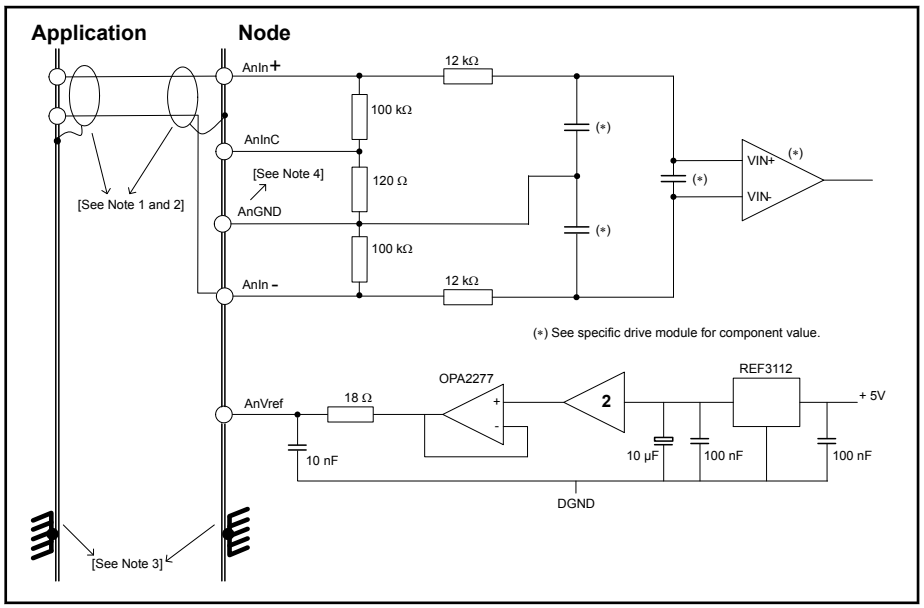

Fig. 13-10: Analog input circuit for AnIn0 and AnIn1

Notes

1. The shielding does not have to be separate for each input as the drawing suggests, but may be common for all analog signals in the cable.
2. Follow the following cabling instructions.
   - Always use a shielded cable.
   - The shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).
   - If the equipment on the application side is metal, connect the shield to the equipment housing.
3. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. AnGND is connected to the internal system ground, which is ground MCU, drive logic, encoder ground, and host PC if the MCU is NY4110 and an IEEE 1394b cable is used.

   For proper use, this ground may not be connected to motor or digital I/O ground.
5. AnVref can be used as a reference voltage for improved accuracy of analog conversion.
6. If the encoder input source provides a balanced differential signal, it may be desirable to connect a termination resistor between the signal wires at the NYCe 4000 side. Consult for this the installation instructions of the supplier.

Encoders

The choice between the voltage or current measurement of the analog inputs is user selectable by a software parameter, see the file "nhiparameters.h", parameter NHI_PAR_ANINx_ADC_DIMENSION_SLOTy (x=0,1 y=0…4) and the NYCe 4000 Software Reference Manual, enumeration nhi_adc_dimension.

- + / – 10 Volt differential

  If the analog input source provides a balanced differential signal, connect the signal wires to the corresponding input pins on the NYCe 4000 side.

- + / – 10 Volt single ended

  If the encoder input source provides a single ended signal, connect the signal wire to the positive print on the NYCe 4000 side, and connect the application ground to the negative input pin on the NYCe 4000 side.

- 4 – 20 mA (not on NY4130)
- Connect pin AnIn– to AnGND in the connector
- Connect pin AnIn+ to AnInC in the connector

fig. 13-11 "How to connect the analog inputs" on page 176 shows how to connect the analog inputs.

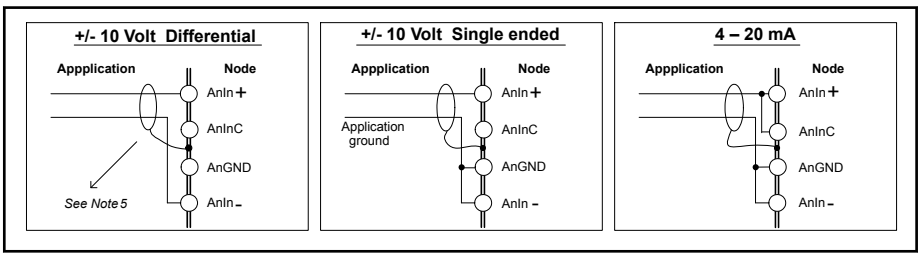

Fig. 13-11: How to connect the analog inputs

13.7 Rexroth MSM incremental encoder

Power supply

Characteristic	Specification
Main power supply	5.25 V ± 0.1 V
Switch on/off capability	Yes, switch on/off by software • NY4120 : switch on/off per drive • NY4125, NY4140 : switch on/off per axis
Battery	No battery

Tab. 13-11: Power supply characteristics

Encoder data

This encoder provides relative indirect position detection.

- After power-on or a power supply failure, the axis must always be moved to its home position before processing can begin.
- The Rexroth MSM encoder counts downward (position increases) when the shaft of the encoder rotates clockwise. This behavior is opposite to most other encoders.

	Value	Note
Signal	square-wave	Frequency: max. 250 kHz
Resolution	• 10000 (2500 pulses/rev) • 20 bit	1 zero pulse per revolution
Output format	Binary	
Increasing direction	Counter-clockwise	As viewed from the encoder shaft end
Operating temperature	70 °C	
Baud rate	2.5 MBaud	
Accumulative pitch error	+-0° 00' 80"	
Encoder interface (to drive controller)	Serial; baud rate 2.5 MBaud	

Tab. 13-12: Data of MSM incremental encoder (data based on a temperature of 25 °C)

Encoder inputs characteristics

Characteristic	Description
Number of encoder inputs	• 2 (NY4120, NY4130) • 1 (NY4140) • 5 (NY4125)
NY4199 SinCos Option module required	No
Galvanic insulated	No
Encoder signal interface	RS422 (differential)
Line termination	• On-board, 120 Ω in series with 680 pF on NY4120 and NY4140 • On-board, 400 Ω on NY4125
Input frequency	Max. 2.5 MHz (not guaranteed with open collector output)
Pull up resistors for open collector driver	• 2k2 on-board on NY4120, NY4140 • Not included on NY4125 If necessary add externally
Cable break alarm	By software protocol errors
Miscellaneous items	Markers can be set at every increment

Tab. 13-13: Encoder inputs characteristics per drive module

Encoder inputs assignment

Backplane pin	Description
Dig5VIn0c– , Dig5VIn0c+	Data– and Data+ to drive for axis0 (NY4120, NY4140)
Dig5VIn1c– , Dig5VIn1c+	Data– and Data+ to drive for axis1 (NY4120)

Encoders

Backplane pin	Description
Enc#QuadB– , Enc#QuadB+	Data– and Data+ to drive for axis# (NY4125) (# = 0, 1, 2, 3, 4)
EncGND	GND

Tab. 13-14: Encoder inputs assignment

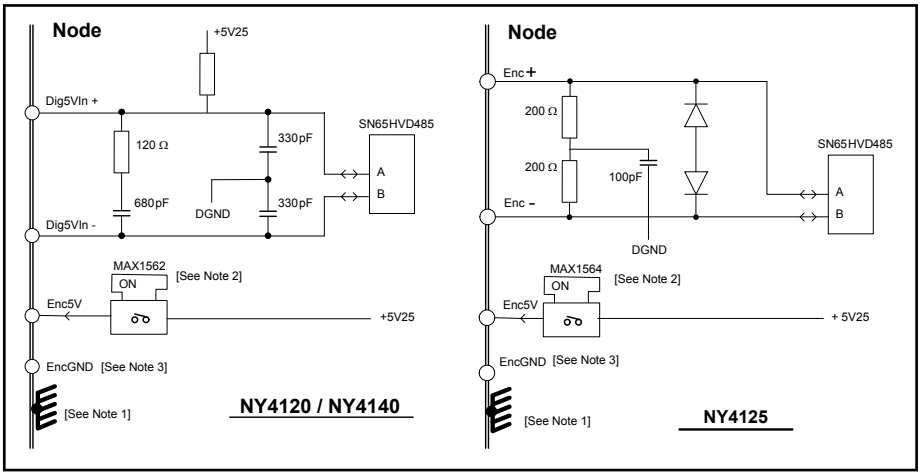

Fig. 13-12: Input circuit for the Rexroth MSM incremental encoder

Notes

1. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
2. When switching off the power of the encoder the software behavior is as follows.
   - A power loss error is generated on the axis.
   - The axis will go to the error state and be set 'not homed'.

   To recover from this situation, you must switch on the encoder power, reset and home the axis.
3. EncGND is connected to the internal system ground, which is ground MCU, drive logic, analog I/O, and host PC if the MCU is NY4110 and an IEEE 1394b cable is used.

   For proper use, this ground may not be connected to motor or digital I/O ground.

For connection of Rexroth MSM incremental encoders to the NYCe 4000, use encoder cable RKG0040, order number R911328668, see fig. 13-13 "MSM encoder cable layout" on page 179 and fig. 13-14 "MSM encoder cable pinout" on page 179. These cables are custom made to the length specified.

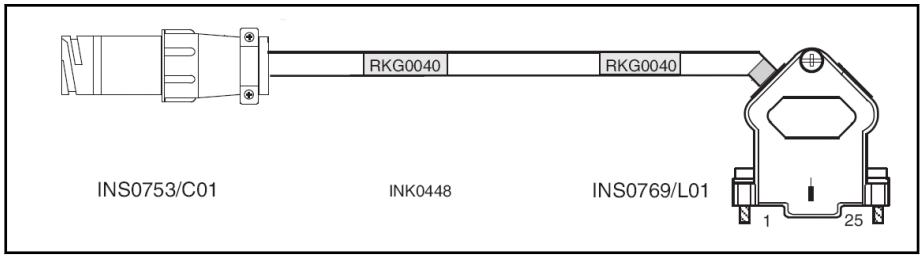

Fig. 13-13: MSM encoder cable layout

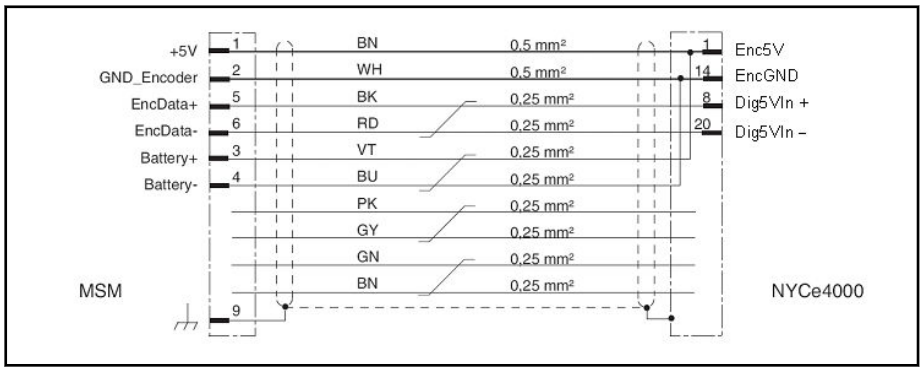

Fig. 13-14: MSM encoder cable pinout

Follow these cabling instructions.

- Always use a shielded cable.
- The shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).
- If the equipment on the application side is metal, connect the shield to the equipment housing.

13.8 Rexroth MSM absolute encoder

Power supply

Characteristic	Specification
Main power supply	5.25 V ± 0.1 V
Switch on/off capability	Yes, switch on/off by software • NY4120 : switch on/off per drive • NY4125, NY4140 : switch on/off per axis
Battery	3.6 V Battery enables • holding data (in multi-turn operation) • multi-turn operation when power supply fails

Tab. 13-15: Power supply characteristics

Encoder data

The absolute encoder type M0 and M5 can be used as single-turn encoder without further accessories. The absolute encoder type M0 and M5 can be used as multi-turn encoder when the battery box accessory is used.

Encoders

Single-turn absolute encoder

The single-turn absolute encoder is used for absolute indirect position detection within 1 motor revolution. With this operation mode the absolute axis position will get lost after power shut down.

Multi-turn absolute encoder

The multi-turn absolute encoder is used for absolute indirect position detection within -16384 to 16383 motor revolutions for encoder type M0 and within -2048 to 2047 motor revolutions for encoder type M5. The multi-turn absolute encoder replaces a separate absolute value encoder at the motor.

- The absolute axis position of this encoder type remains correct after power shut down, because of the battery back-up. When the encoder is fully powered by the battery the position is guaranteed only if the encoder did not exceed a velocity of 100 revolutions per minute. If you disconnect the battery box from the encoder, you will lose the absolute axis position.
- The Rexroth MSM encoder counts downward (position increases) when the shaft of the encoder is rotated clockwise. This behavior is opposite to most other encoders.
- If the Rexroth MSM absolute encoder is used without a battery, the NYCe 4000 software will report the error "Encoder Battery Warning" or "MSM system down" depending on the selected error handler. The encoder can be powered using an external battery or the NYCe 4000 encoder power supply. It depends on how long the external battery is disconnected and the severity level of the selected error handler whether the error message "Encoder Battery Warning" or "MSM System Down" is generated. Depending on the severity level of the error handler you can still reset the error and use this encoder.

Battery box for multi-turn

The use of the multi-turn option requires an external battery box. The external battery box can be connected to the battery power supply pins of the encoder.

The following accessories are available for the encoder type M0.

	Component name	Order number	cable length
Battery box	SUP-E01-MSM-BATTERYBOX	R911324240	-
Spare battery	SUP-E03-DKC*CS-BATTRY	R911295648	

Tab. 13-16: Accessories for encoder type M0

The following accessories are available for the encoder type M5.

	Component name	Order number	Cable length
Battery box	SUP-E02-MSM-BATTERYBOX-L010	R911346063	1000 mm
	SUP-E02-MSM-BATTERYBOX-L030	R911346065	3000 mm
	SUP-E02-MSM-BATTERYBOX-NNNN	R911346084	250 mm
Spare battery	SUP-E02-MSM-BATTERY	R911369925	

Tab. 13-17: Accessories for encoder type M5

Single-turn signals

	Value	Note
Absolute value	32 bit	
Resolution	Type M0: 17 bit (131072 pulses/ rev) Type M5: 20 bit (only supported in 47VRS and 48VRS)	
Maximum rotational speed (in normal operating mode)	6000 rpm	
Maximum angular acceleration (in normal operating mode)	80000 rad/s^2	
Output format	Binary	
Increasing direction	Counterclockwise	As viewed from the encoder shaft end
Accumulative pitch error	M0 : ±80" (±8LSB) M5 : ±80" (±64LSB)	
Adjacent pitch error	M0 : ±40" (±4LSB) M5 : ±5" (±4LSB)	
Accuracy in case the main power supply is switched on repeatedly (within a revolution of 3.5° after switching on power)	M0 : ±80" (±8LSB) M5 : ±40" (±32LSB)	After the shaft rotates by more than 3.5°, the tolerance increases to ±5LSB for M0, and ±20" (±16LSB) for M5 due to the increased correction precision
Encoder interface (to drive controller)	serial; baud rate 2,5 MBaud	

Tab. 13-18: Data for single-turn signals (data based on a temperature of 25 °C)

Multi-turn signals

	Value	Note
Resolution	1 C/T	C/T: counter value per turn
Counter for multi-turn	Type M0: 15 bit (-16384 to 16383) Type M5: 12 bit (-2048 to 2047) (only supported in 47VRS and 48VRS)	
Maximum rotational speed (in normal operating mode)	6000 rpm	
Maximum rotational speed (in power-off mode, timer)	6000 rpm	Time of the power-off timer: 5 seconds
Maximum rotational speed (in power-off mode, power-off operation)	6000 rpm	
Maximum angular acceleration (in normal operating mode)	80000 rad/s^2	
Maximum angular acceleration (in power-off mode, timer)	80000 rad/s^2	

Encoders

	Value	Note
Maximum angular acceleration (in power-off mode, power-off operation)	4000 rad/s^2	
Output format	binary	
Increasing direction	counterclockwise	As viewed from the encoder shaft end
Data rate time (by means of integrated capacitor, encoder type M0 only)	1 hour (at delivery) 15 minutes (after 10 years)	After 10 years, calculated time at 40° C and 12 hours per day powered (the service life of the capacitor basically depends on ambient temperature and operating voltage)

Tab. 13-19: Data for multi-turn signals (data based on a temperature of 25 °C)

Encoder inputs characteristics

Characteristic	Description
Number of encoder inputs	• 2 (NY4120) • 1 (NY4140) • 5 (NY4125)
NY4199 SinCos Option module required	No
Galvanic insulated	No
Encoder signal interface	RS422 (differential)
Line termination	• On-board, 120 Ω in series with 680 pF on NY4120 and NY4140 • On-board, 400 Ω on NY4125
Input frequency	Max. 2.5 MHz
Cable break alarm	By software protocol errors
Pull up resistors for open collector driver	• 2k2 on-board on NY4120 and NY4140 • Not included on NY4125 If necessary add externally
Miscellaneous items	Markers can be set at every increment

Tab. 13-20: Encoder inputs characteristics per drive module

Encoder inputs assignment

Backplane pin	Description
Dig5VIn0c– and Dig5VIn0c+	Data– and Data+ for axis0 (NY4120, NY4140)
Dig5Vin1c– and Dig5Vin1c+	Data– and Data+ for axis1 (NY4120)
Enc#QuadB– and Enc#QuadB+	Data– and Data+ for axis# (NY4125) # = 0, 1, 2, 3, 4)
EncGND	GND

Tab. 13-21: Encoder inputs assignment

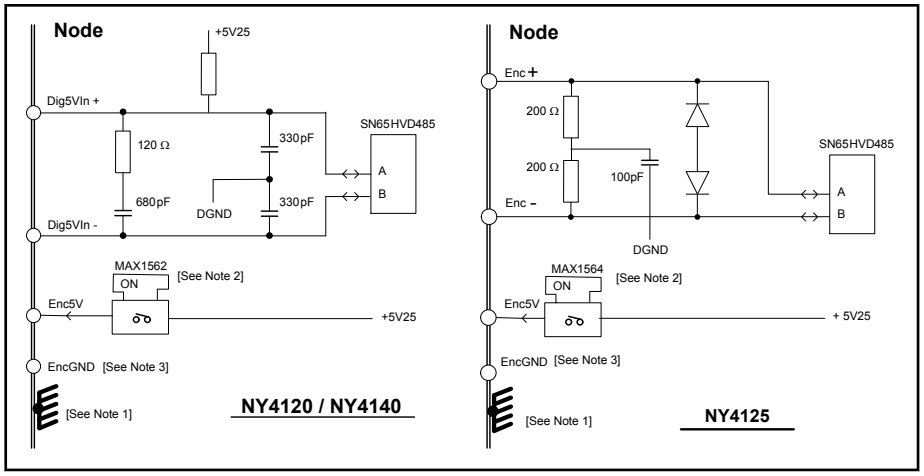

Fig. 13-15: Input circuit for the Rexroth MSM absolute encoder

Notes

1. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
2. When switching off the power of the encoder the software behavior is as follows.
   - A power loss error is generated on the axis.
   - The axis will go to the error state and be set 'not homed'.

   To recover from this situation, you must switch on the encoder power, reset and home the axis.
3. EncGND is connected to the internal system ground, which is ground MCU, drive logic, analog I/O, and host PC if the MCU is NY4110 and an IEEE 1394b cable is used.

   For proper use, this ground may not be connected to motor or digital I/O ground.

Encoder connection

Encoder type M0

For connection of Rexroth MSM encoder type M0 to the NYCe 4000, use encoder cable RKG0040, order number R911328668, see fig. 13-16 "MSM encoder type M0 cable layout" on page 183 and fig. 13-17 "MSM encoder type M0 cable pinout" on page 184. These cables are custom made to the length specified. The encoder cable RKG0040 connects the Battery+ and Battery– pins of the encoder to Enc5V and EncGND pins of the NYCe 4000 encoder power supply source.

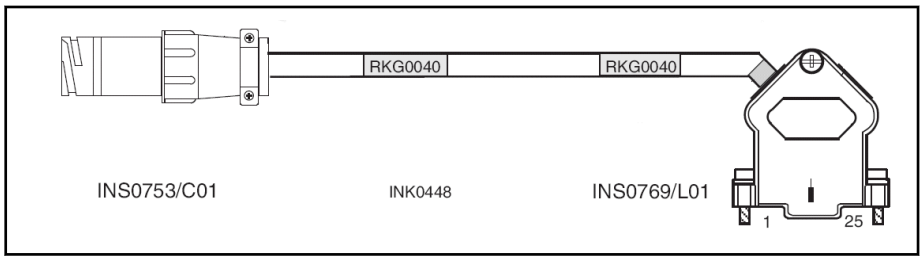

Fig. 13-16: MSM encoder type M0 cable layout

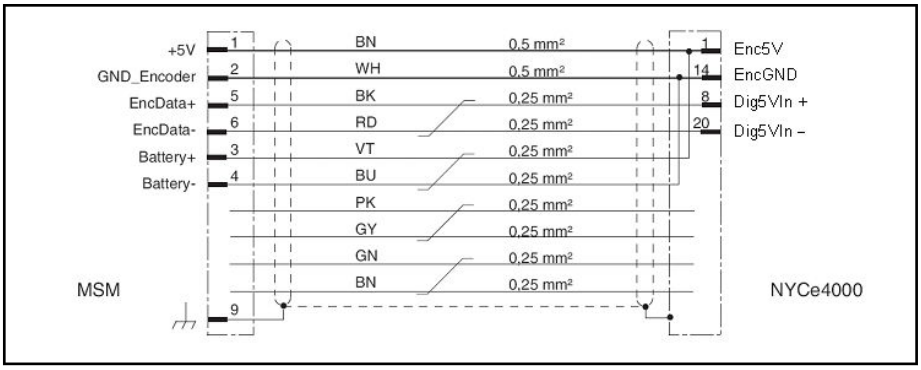

Fig. 13-17: MSM encoder type M0 cable pinout

Encoder type M5

For connection of Rexroth MSM encoder type M5 to the NYCe 4000, use encoder cable RKG0064, order number R911347438, see fig. 13-18 "MSM encoder type M5 cable layout" on page 184 and fig. 13-19 "MSM encoder type M5 cable pinout" on page 184. These cables are custom made to the length specified. The encoder cable RKG0064 connects the Battery+ and Battery– pins of the encoder to Enc5V and EncGND pins of the NYCe 4000 encoder power supply source.

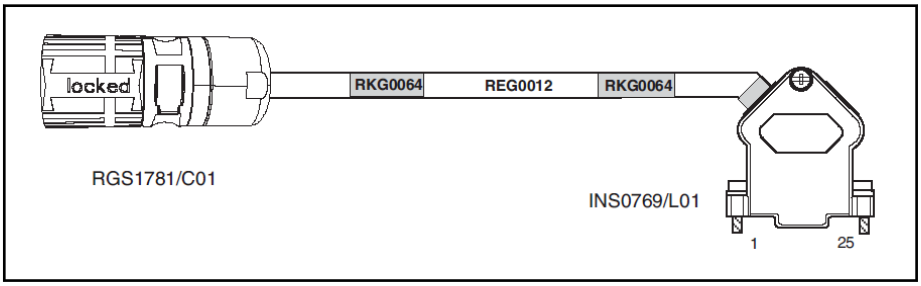

Fig. 13-18: MSM encoder type M5 cable layout

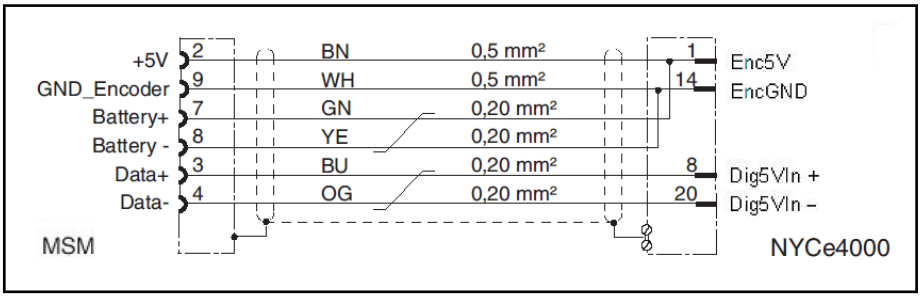

Fig. 13-19: MSM encoder type M5 cable pinout

NYCe 4000 powered

If the absolute encoder is powered with the NYCe 4000 encoder power supply source, the NYCe 4000 software may generate the error message "Encoder Battery Warning" or "MSM system down" every start-up after power-on of the 24V System power supply.

A power supply voltage must always be connected to Battery+ and Battery–. If no power supply voltage is connected, the encoder will return an error.

For proper use, you can choose between two power supply sources to connect to Battery+ and Battery–.

- External battery: the encoder always returns an absolute position, even when system power is switched off.
- Enc5V: the encoder works properly, but when system power is switched off, the absolute position is lost.

Follow these cabling instructions.

- Always use a shielded cable.
- The shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).
- If the equipment on the application side is metal, connect the shield to the equipment housing.

13.9 Sanyo Denki absolute encoder

Power supply

Characteristic	Specification
Main power supply	5.25 V, ± 0.1 V
Switch on/off capability	Yes, switch on/off by software (see note 2) • NY4120 switch on/off per drive • NY4125, NY4140 switch on/off per axis
Battery	3.6 V Battery enables • holding data (in multi-turn operation) • multi-turn operation when power supply fails

Tab. 13-22: Power supply characteristics

Encoder data

This encoder provides absolute indirect position detection within 65536 motor revolutions. Replaces separate absolute value encoders at the motor.

☞ If the Sanyo Denki absolute encoder is a single-turn encoder, an external battery is not needed. If the Sanyo Denki absolute encoder is a multi-turn encoder, an external voltage source must always be connected to Battery+/Battery–.

If the Sanyo Denki absolute multi-turn encoder is used and no external voltage source is connected, the encoder will return an error. After the error handling you can use the multi-turn encoder as a single-turn encoder.

Notes

- The absolute axis position of this encoder type remains correct after power shut down, because of the battery back-up.
- The Sanyo Denki encoder counts downward (position increases) when the shaft of the encoder is rotated clockwise. This behavior is opposite to most other encoders.

- If the Sanyo Denki absolute multi-turn encoder is used without a battery, the NYCe 4000 software will report the error "Encoder Battery Warning" or "MSM system down" depending on the selected error handler. The encoder can be powered using an external battery or the NYCe 4000 encoder power supply.
  - An external battery, SUP-E01-MSM-BATTERYBOX, order number R911324240, can be connected to the battery power supply pins of the encoder.
  - The encoder cable RKG0040 connects the Battery+ and Battery– pins of the encoder to Enc5V and EncGND pins of the NYCe 4000 encoder power supply source. If the absolute encoder is powered with the NYCe 4000 encoder power supply source, the NYCe 4000 software may generate the error every start-up after power-on of the 24V System power supply.

    It depends on how long the external battery is disconnected and the severity level of the selected error handler whether the error message "Encoder Battery Warning" or "General Encoder Error" is generated. Depending on the severity level of the error handler you can still use this encoder.

Single-turn signals

	Value	Note
Absolute value	32 bit	
Resolution	17 bit (131072 pulses per revolution)	Accuracy is 8 bit
Maximum rotational speed (in normal operating mode)	7200 rpm	
Maximum angular acceleration (in normal operating mode)	100000 rad/s^2	
Output format	Binary	
Increasing direction	Counterclockwise	As viewed from the encoder shaft end
Encoder interface (to drive controller)	serial; baud rate 2,5 MBaud	

Tab. 13-23: Data for single-turn signals

Multi-turn signals

	Value	Note
Resolution	1 C/T	C/T: counter value per turn
counter for multi turns	15 bit (-16384 to 16383)	
Maximum rotational speed (in normal operating mode)	7200 rpm	

	Value	Note
Maximum rotational speed (in power-off mode)	10000 rpm	
Maximum angular acceleration (in normal operating mode)	100000 rad/s^2	
Maximum angular acceleration (in power-off mode)	100000 rad/s^2	
Output format	binary	
Increasing direction	counterclockwise	As viewed from the encoder shaft end

Tab. 13-24: Data for multi-turn signals (data based on a temperature of 25 °C)

Encoder inputs characteristics

Characteristic	Description
Number of encoder inputs	• 2 (NY4120) • 1 (NY4140) • 5 (NY4125)
NY4199 SinCos Option module required	No
Galvanic insulated	No
Encoder signal interface	RS422 (differential)
Line termination	• On-board, 120 Ω in series with 680 pF on NY4120 and NY4140 • On-board, 400 Ω on NY4125
Input frequency	Max. 2.5 MHz
Cable break alarm	By software protocol errors
Pull up resistors for open collector driver	• 2k2 on-board on NY4120 and NY4140 • Not included on NY4125 If necessary add externally
Miscellaneous items	Markers can be set at every increment

Tab. 13-25: Encoder inputs characteristics per drive module

Encoder inputs assignment

Backplane pin	Description
Dig5VIn0c– and Dig5VIn0c+	ES– and ES+ for axis0 (NY4120, NY4140)
Dig5Vin1c– and Dig5Vin1c+	ES– and ES+ for axis1 (NY4120)
Enc#QuadB– and Enc#QuadB+	ES– and ES+ for axis# (NY4125 , # = 0, 1, 2, 3, 4)
EncGND	GND

Tab. 13-26: Encoder inputs assignment

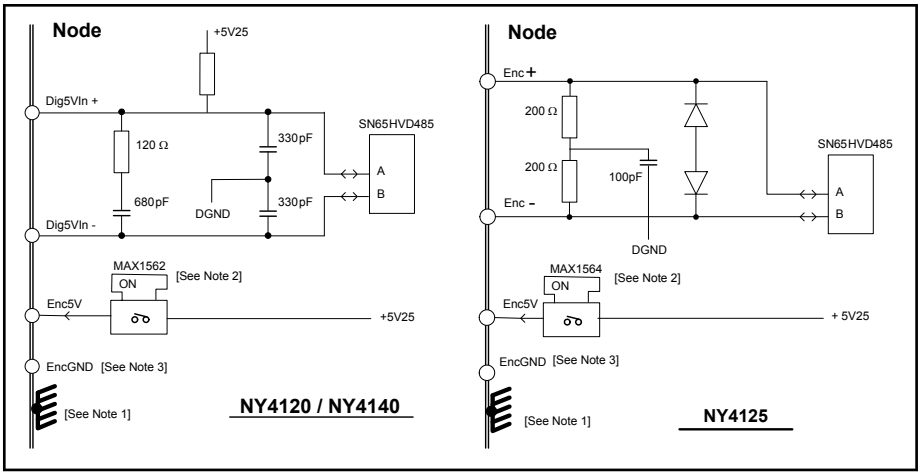

Fig. 13-20: Input circuit for the Sanyo Denki absolute encoder

Notes

1. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
2. When switching off the power of the encoder the software behavior is as follows.
   - A power loss error is generated on the axis.
   - The axis will go to the error state and be set 'not homed'.

   To recover from this situation, you must switch on the encoder power, reset and home the axis.
3. EncGND is connected to the internal system ground, which is ground MCU, drive logic, analog I/O, and host PC if the MCU is NY4110 and an IEEE 1394b cable is used.

   For proper use, this ground may not be connected to motor or digital I/O ground.

For connection of Sanyo Denki absolute encoders to the NYCe 4000, you can use encoder cable RKG0040, order number R911328668, see fig. 13-21 "Sanyo Denki absolute encoder cable layout" on page 188. This cable is custom made to the length specified. fig. 13-22 "Sanyo Denki absolute encoder cable pinout" on page 189 shows the cable pinout. The mentioned colors at the left side are the colors of the Sanyo Denki encoder wires.

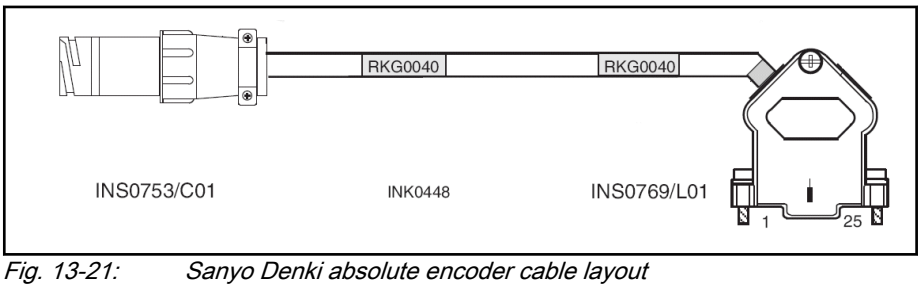

Fig. 13-21: Sanyo Denki absolute encoder cable layout

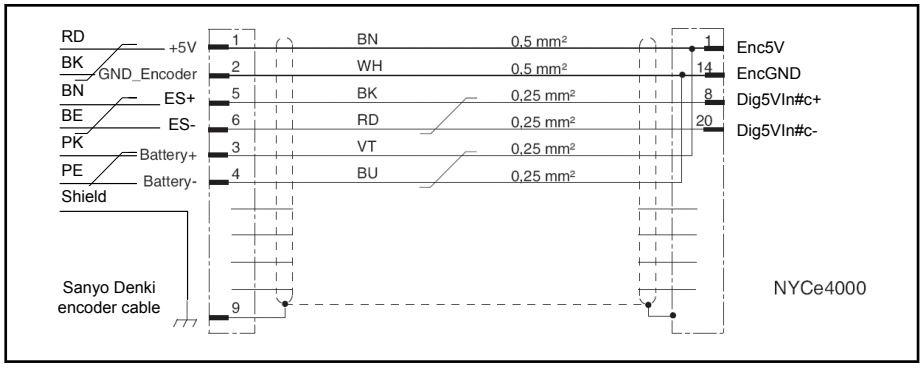

Fig. 13-22: Sanyo Denki absolute encoder cable pinout

For proper use, you can choose between two voltage sources to connect to Battery+/Battery–.

- 3.6 V battery: the encoder always returns an absolute position, even when system power is switched off.
- Enc5V: the encoder works properly, but when system power is switched off, the absolute position is lost.

Follow these cabling instructions.

- Always use a shielded cable.
- The shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).
- If the equipment on the application side is metal, connect the shield to the equipment housing.

13.10 EnDat2.2 encoder

Power supply

Characteristic	Specification
Main power supply	5.25 V, ± 0.1 V
Switch on/off capability	Yes, switch on/off by software (see note 2) • NY4120 switch on/off per drive • NY4125, NY4130, NY4140 switch on/off per axis

Tab. 13-27: Power supply characteristics

Encoder data

	Value	Note
Resolution	Max. 32 bits	Depending on the encoder used
Output format	EnDat2.2 protocol	Fully digital protocol
Baud rate	1 MHz, 2 MHz or 4 MHz	
Increasing direction	Clockwise	As viewed from the encoder shaft end

Tab. 13-28: Data of EnDat2.2 encoder

Encoders

Encoder inputs characteristics

Characteristic	Description
Number of encoder inputs	• 2 (NY4120, NY4130) • 1 (NY4140) • 5 (NY4125)
NY4199 SinCos Option module required	No
Galvanic insulated	No
Encoder signal interface	RS422 (differential)
Line termination	• On-board, 120 Ω in series with 680 pF on NY4120, NY4130, and NY4140 • On-board, 400 Ω on NY4125
Input frequency	Max. 4 MHz
Pull up resistors for open collector driver	• 2k2 on-board on NY4120, NY4140 • Not included on NY4125, NY4130 If necessary add externally
Cable break alarm	By software protocol errors

Tab. 13-29: Encoder inputs characteristics per drive module

Encoder inputs assignment

Backplane pin	Description
Dig5VIn0a– , Dig5VIn0a+	Clock– and Clock+ from drive for axis0 (NY4120, NY4130, NY4140)
Dig5VIn0c– , Dig5VIn0c+	Data– and Data+ to drive for axis0 (NY4120, NY4130, NY4140)
Enc5V0	Power supply for axis0 (NY4120, NY4130, NY4140)
Dig5VIn1a– , Dig5VIn1a+	Clock– and Clock+ from drive for axis1 (NY4120, NY4130)
Dig5VIn1c– , Dig5VIn1c+	Data– and Data+ to drive for axis1 (NY4120, NY4130)
Enc5V1	Power supply for axis1 (NY4120, NY4130)
Enc#QuadA– , Enc#QuadA+	Clock– and Clock+ from drive for axis# (# = 0, 1, 2, 3, 4) (NY4125)
Enc#QuadB– , Enc#QuadB+	Data– and Data+ to drive for axis# (# = 0, 1, 2, 3, 4) (NY4125)

Backplane pin	Description
Enc5V#	Power supply for axis# (# = 0, 1, 2, 3, 4) (NY4125)
EncGND	GND

Tab. 13-30: Encoder inputs assignment

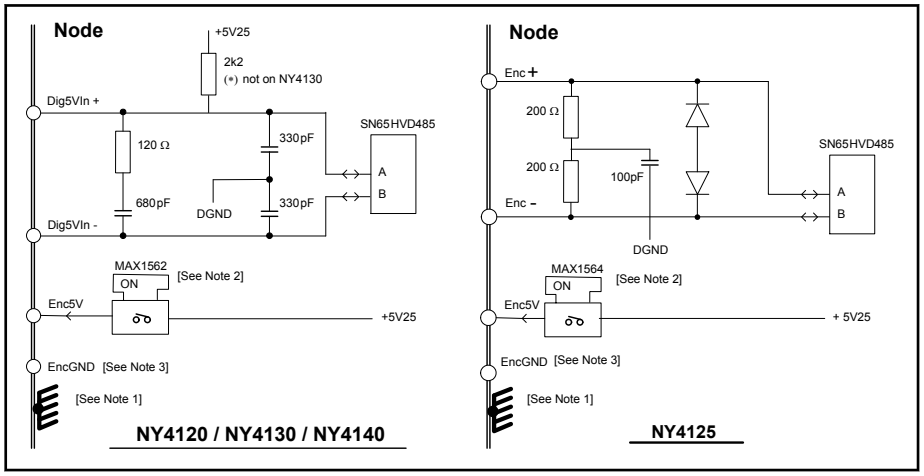

Fig. 13-23: Input circuit for the EnDat2.2 encoder

Notes

1. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
2. When switching off the power of the encoder the software behavior is as follows.
   - A power loss error is generated on the axis.
   - The axis will go to the error state and be set 'not homed'.

   To recover from this situation, you must switch on the encoder power, reset and home the axis.
3. EncGND is connected to the internal system ground, which is ground MCU, drive logic, analog I/O, and host PC if the MCU is NY4110 and an IEEE 1394b cable is used.

   For proper use, this ground may not be connected to motor or digital I/O ground.

Follow these cabling instructions.

- Always use a shielded cable.
- The shielding on the NYCe 4000 side of the cable must be connected to Shield (house connector).
- If the equipment on the application side is metal, connect the shield to the equipment housing.

13.11 SinCos encoder

To connect the SinCos encoder to a drive module you must install the NY4199 SinCos Option module on the drive module. See chapter 13.14

Encoders

"NY4199 SinCos Option module for SinCos based encoders" on page 203 for detailed information.

Power supply

Characteristic	Specification
Main power supply	5.25 V, ± 0.1 V
Switch off capability	Yes, switch on/off by software (see note 4) • NY4120 switch on/off per drive • NY4125, NY4130, NY4140 switch on/off per axis

Tab. 13-31: Power supply characteristics

Encoder inputs characteristics

Characteristic	Description
Number of encoder inputs	• 2 (NY4120, NY4130) • 1 (NY4140)
NY4199 SinCos Option module required	Yes
Galvanic insulated	No
Encoder signal interface	The differential signal levels on sine signal and differential signal levels on cosine signal are 1 Vtt. The absolute value is in the range of 0 V to 5 V. The index threshold value can be tuned by the software or by using the tools, refer to software and tools user manuals.
Increasing direction	Clockwise, as viewed form the encoder shaft end

Tab. 13-32: Encoder inputs characteristics

Encoder inputs assignment

Backplane pin	Description
Opt_0–, Opt_0+	Sine– and Sine+ for axis0
Opt_1–, Opt_1+	Cosine– and Cosine+ for axis0
Opt_2–, Opt_2+	Ref– and Ref+ for axis0
Enc5V0	Power supply for axis0
Dig5VIn1a–, Dig5VIn1a+	Sine– and Sine+ for axis1
Dig5VIn1b–, Dig5VIn1b+	Cosine– and Cosine+ for axis1
Dig5VIn1c–, Dig5VIn1c+	Ref– and Ref+ for axis1
Enc5V1	Power supply for axis1
EncGND	GND

Tab. 13-33: Encoder inputs assignment

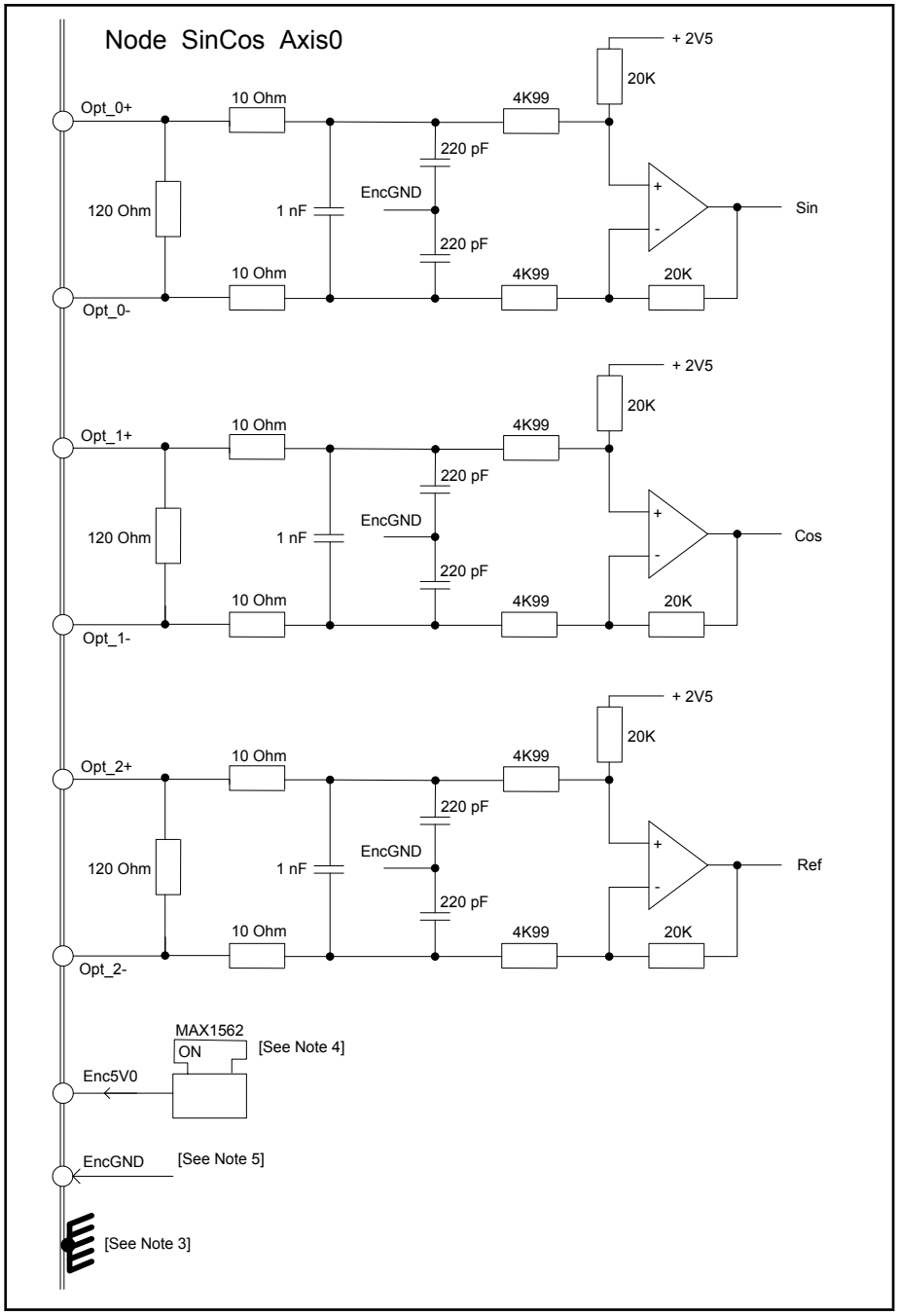

Fig. 13-24: SinCos encoder input circuit for axis0

Encoders

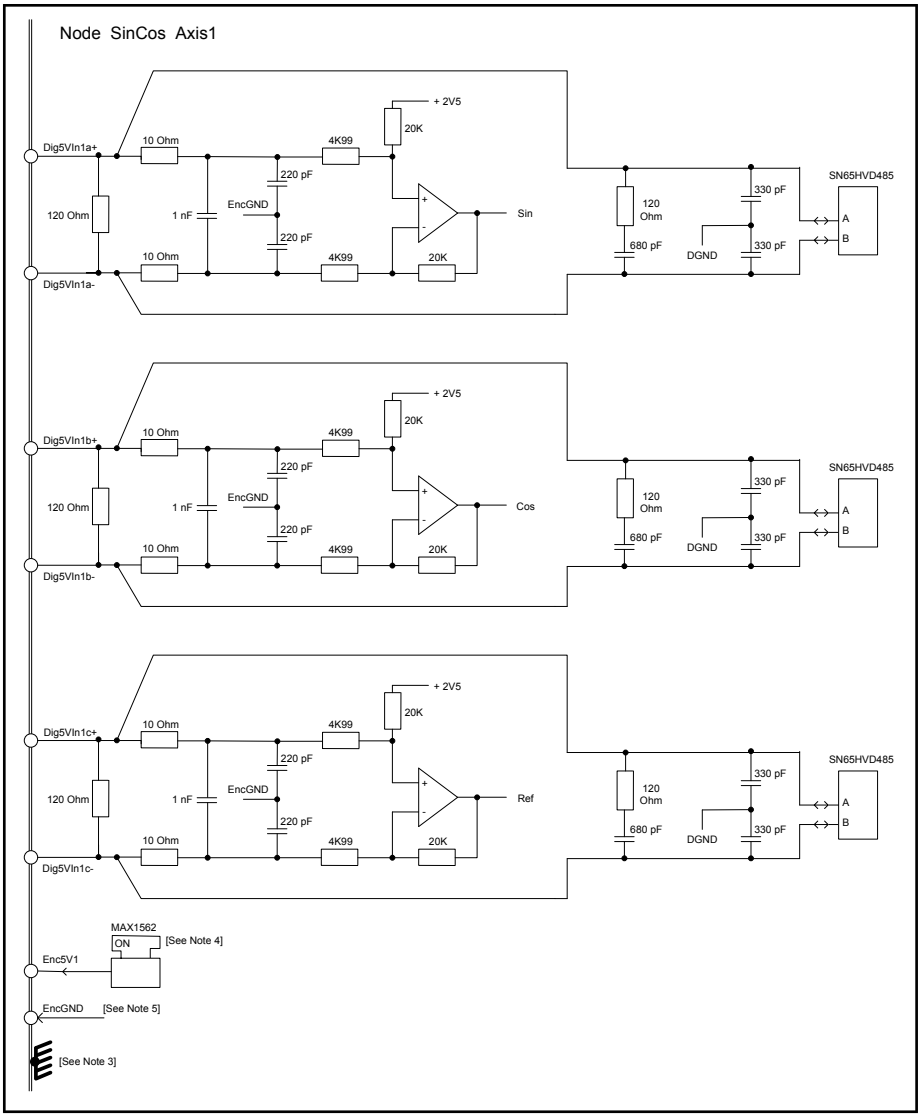

Fig. 13-25: SinCos encoder input circuit for axis1

Notes

1. The pins on the I/O connector at the back of the drive module have already a meaning, as shown in tab. 13-33 "Encoder inputs assignment" on page 192. These names are respected, also for the signals that are connected with the NY4199 SinCos Option module.
2. The drive module NY4140 supports only one encoder. This still holds while applying an NY4199 SinCos Option module. The remaining I/O are available for other functionality.
3. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
4. When switching off the power of the encoder the software behavior is as follows.
   - A power loss error is generated on the axis.
   - The axis will go to the error state and be set 'not homed'.

   To recover from this situation, you must switch on the encoder power, reset and home the axis.

5. EncGND is connected to the internal system ground, which is ground MCU, drive logic, analog I/O, and host PC if the MCU is NY4110 and an IEEE 1394b cable is used.

   For proper use, this ground may not be connected to motor or digital I/O ground.

13.12 EnDat2.1 encoder

To connect the EnDat2.1 encoder to a drive module you must install the NY4199 SinCos Option module on the drive module. See chapter 13.14 "NY4199 SinCos Option module for SinCos based encoders" on page 203 for detailed information.

Power supply

Characteristic	Specification
Main power supply	5.25 V, ± 0.1 V
Switch on/off capability	Yes, switch on/off per axis (see note 5) • NY4120 switch on/off per drive • NY4130, NY4140 switch on/off per axis

Tab. 13-34: Power supply characteristics

☞ Rexroth MSK motors with EnDat2.1 encoders require an external power supply in the range of 7 to 12V DC.

Encoder data

	Value	Note
Type	SinCos	
Output format	-	Analog signals
Increasing direction	Clockwise	As viewed from the encoder shaft end

Tab. 13-35: Data of incremental encoder

	Value	Note
Type	EnDat2.1	
Resolution	Max. 32 bits	Depending on the encoder used
Output format	EnDat2.1 protocol	Digital protocol
Baud rate	100, 200, 500, 1000 kHz	Supported baud rates

Tab. 13-36: Data of absolute encoder

Encoders

Encoder inputs characteristics

Characteristic	Description
Number of encoder inputs	• 2 (NY4120, NY4130) • 1 (NY4140)
NY4199 SinCos Option module required	Yes
Galvanic insulated	No
Cable breakage	By software on SinCos and motor level

Tab. 13-37: Encoder inputs characteristics

Encoder inputs assignment

Backplane pin	Description
Opt_0–, Opt_0+	Sine– and Sine+ for axis0
Opt_1–, Opt_1+	Cosine– and Cosine+ for axis0
Dig5VIn0a–, Dig5VIn0a+	Clock– and Clock+ for axis0
Dig5VIn0c–, Dig5VIn0c+	Data– and Data+ for axis0
Enc5V0	Power supply for axis0
Dig5VIn1a–, Dig5VIn1a+	Sine– and Sine+ for axis1
Dig5VIn1b–, Dig5VIn1b+	Cosine– and Cosine+ for axis1
Dig5VIn0b–, Dig5VIn0b+	Clock– and Clock+ for axis1
Dig5VIn1c–, Dig5VIn1c+	Data– and Data+ for axis1
Enc5V1	Power supply for axis1
EncGND	GND

Tab. 13-38: Encoder inputs assignment

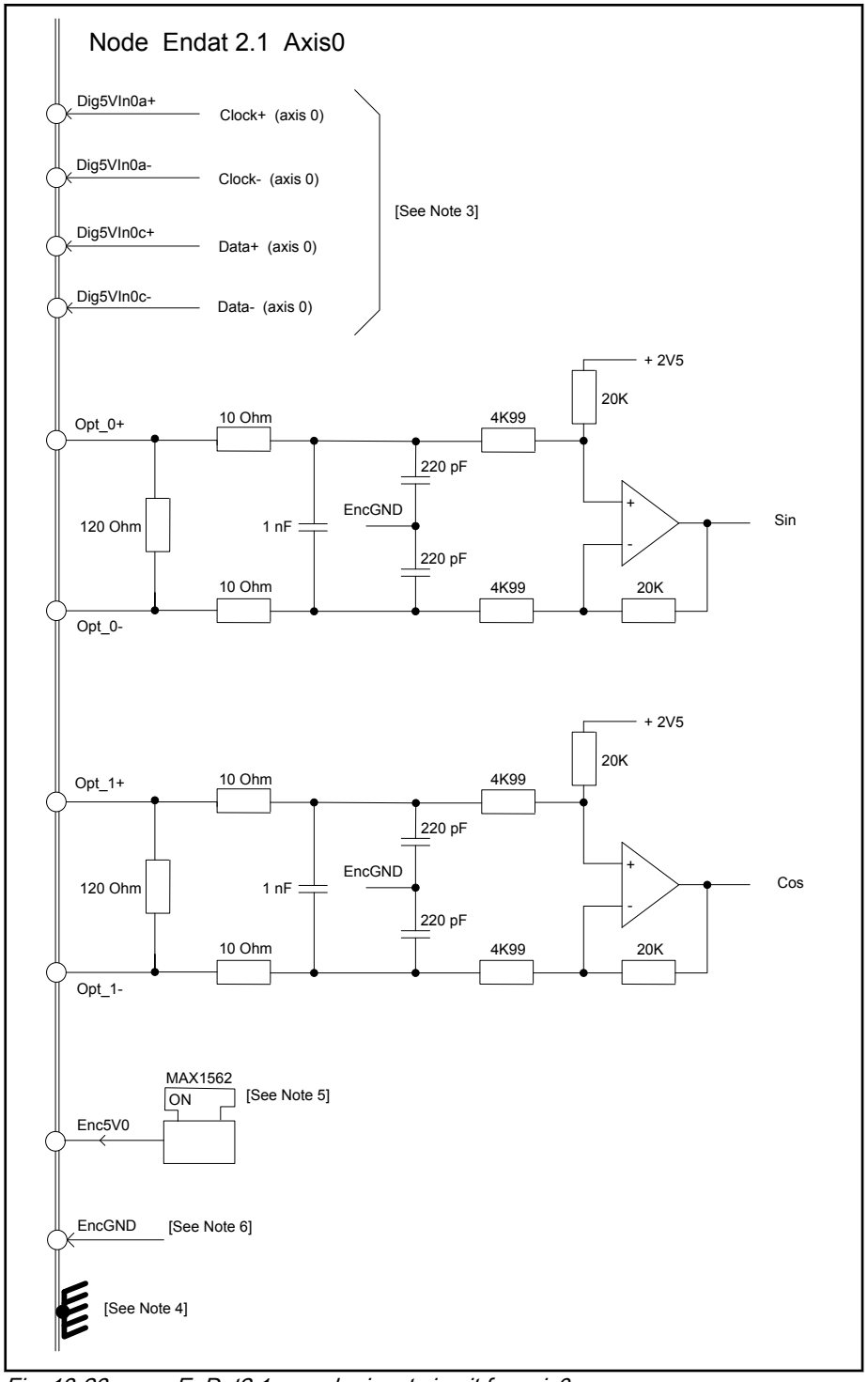

Fig. 13-26: EnDat2.1 encoder input circuit for axis0

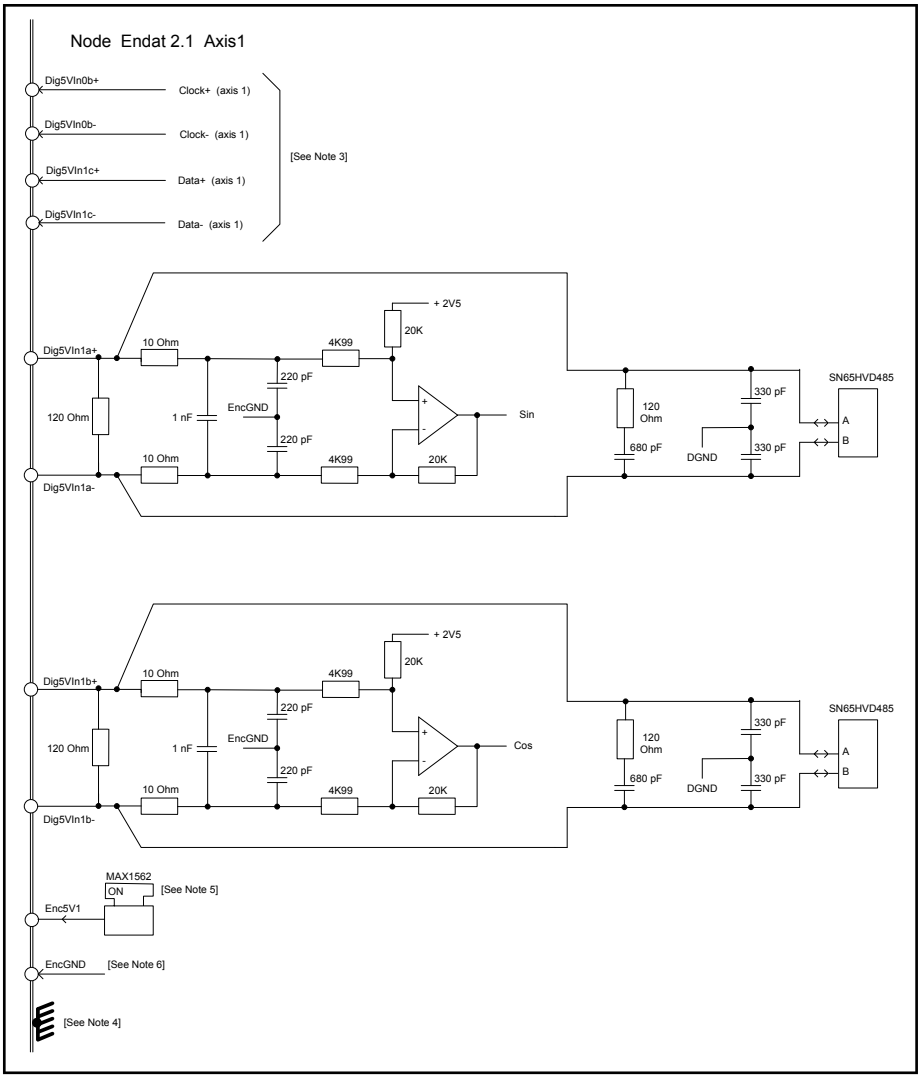

Fig. 13-27: EnDat2.1 encoder input circuit for axis1

Notes

1. The pins on the I/O connector at the back of the drive module have already a meaning, as shown in tab. 13-38 "Encoder inputs assignment" on page 196. These names are respected, also for the signals that are connected with the NY4199 SinCos Option module.
2. The drive module NY4140 supports only one encoder. This still holds while applying an NY4199 SinCos Option module. The remaining I/O are available for other functionality.
3. Since digital and analog signals are combined for the EnDat2.1 encoder special attention must be given to the risk of signal distortion.
4. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
5. When switching off the power of the encoder the software behavior is as follows.
   - A power loss error is generated on the axis.
   - The axis will go to the error state and be set 'not homed'.

To recover from this situation, you must switch on the encoder power, reset and home the axis.

6. EncGND is connected to the internal system ground, which is ground MCU, drive logic, analog I/O, and host PC if the MCU is NY4110 and an IEEE 1394b cable is used.

   For proper use, this ground may not be connected to motor or digital I/O ground.

13.13 Hiperface encoder

To connect the Hiperface encoder to a drive module you must install the NY4199 SinCos Option module on the drive module. See chapter 13.14 "NY4199 SinCos Option module for SinCos based encoders" on page 203 for detailed information.

Functionally Hiperface is very similar to EnDat2.1. Main difference is that Hiperface encoders do not produce a clock signal for the serial communication.

In addition Hiperface encoders require a 7...11V supply voltage, depending on the allowable cable length. For typical NYCe 4000 motion applications, a supply of 8V is sufficient. The 8V is created on the NY4199 SinCos Option module. The power supply can be turned on and off by the software.

☞ The 8 V power supply can be turned on and off by software. This functionality should be handled carefully, because the same pin of the appropriate output is used as input for other type of encoders. Inaccurate use can damage the encoder hardware.

Power supply

Characteristic	Specification
Main power supply	8 V ± 5% , provided by the drive module Maximum 400 mA for 2 axes per module
Switch on/ off capability	Yes, switch on/off by software (see note 6) • NY4120 switch on/off per drive • NY4130, NY4140 switch on/off per axis

Tab. 13-39: Power supply characteristics

Encoder data

	Value	Note
Type	Hiperface	
Resolution	128 lines per revolution	Bosch Rexroth standard for Hiperface encoders
Output format	-	Analog signals
Increasing direction	Clockwise	As viewed from the encoder shaft end

Tab. 13-40: Data of incremental encoder

Encoders

	Value	Note
Type	Hiperface	
Resolution	24 bits	12 bits single turn data and 12 bits multi turn data, depending on the encoder used
Output format	Hiperface protocol	Digital protocol
Baud rate	600 … 38400 Baud	Supported baud rates. Default baud rate is 9600 Baud
Parity bit	None, even or odd	Default parity bit is odd

Tab. 13-41: Data of absolute encoder

Encoder inputs characteristics

Characteristic	Description
Number of encoder inputs	• 2 (NY4120, NY4130) • 1 (NY4140)
NY4199 SinCos Option module required	Yes

Tab. 13-42: Encoder inputs characteristics

Encoder inputs assignment

Backplane pin	Description
Opt_0–, Opt_0+	Sine– and Sine+ for axis0
Opt_1–, Opt_1+	Cosine– and Cosine+ for axis0
Dig5VIn0c–, Dig5VIn0c+	Data– and Data+ for axis0
Opt_2+	8V power supply for axis0
Dig5VIn1a–, Dig5VIn1a+	Sine– and Sine+ for axis1
Dig5VIn1b–, Dig5VIn1b+	Cosine– and Cosine+ for axis1
Dig5VIn0b–, Dig5VIn0b+	Data– and Data+ for axis1
Dig5Vin1c+	8V power supply for axis1
EncGND	GND

Tab. 13-43: Encoder inputs assignment

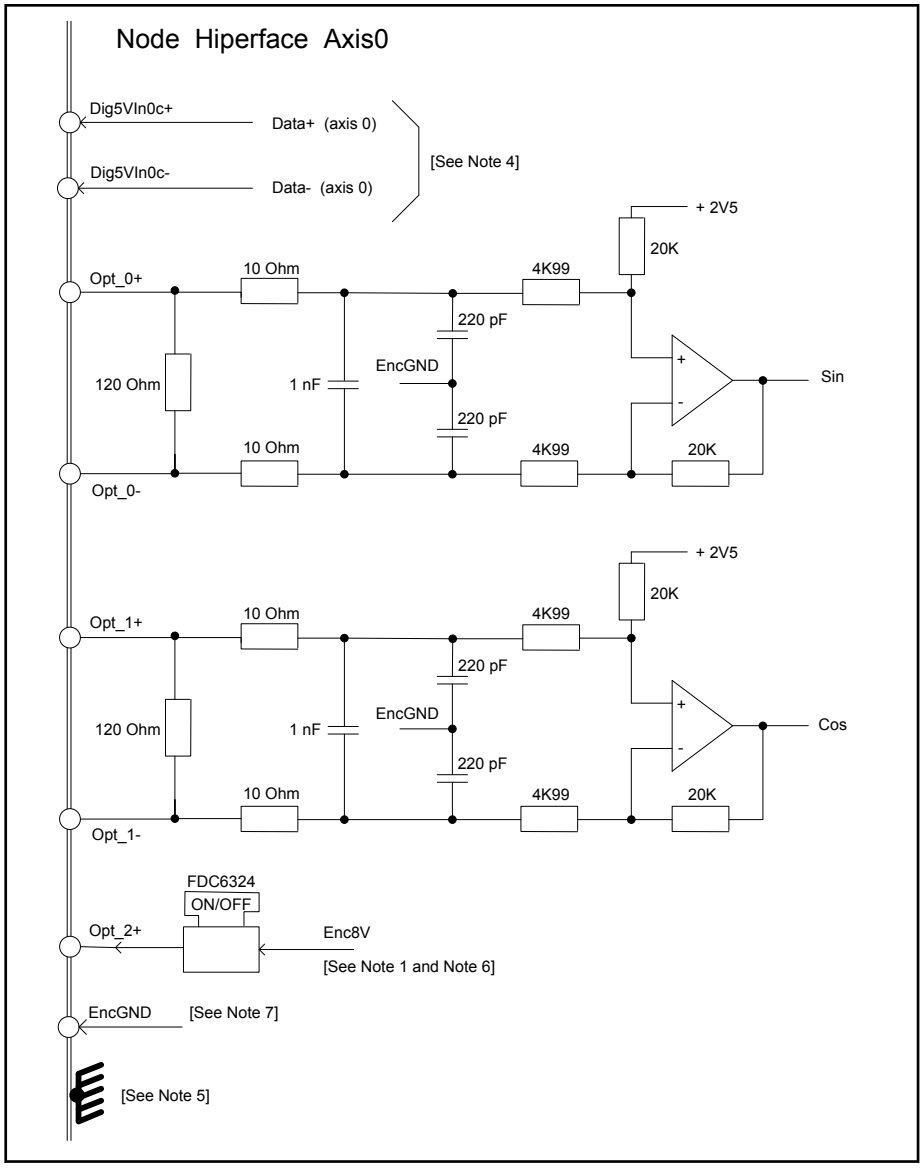

Fig. 13-28: Hiperface encoder input circuit for axis0

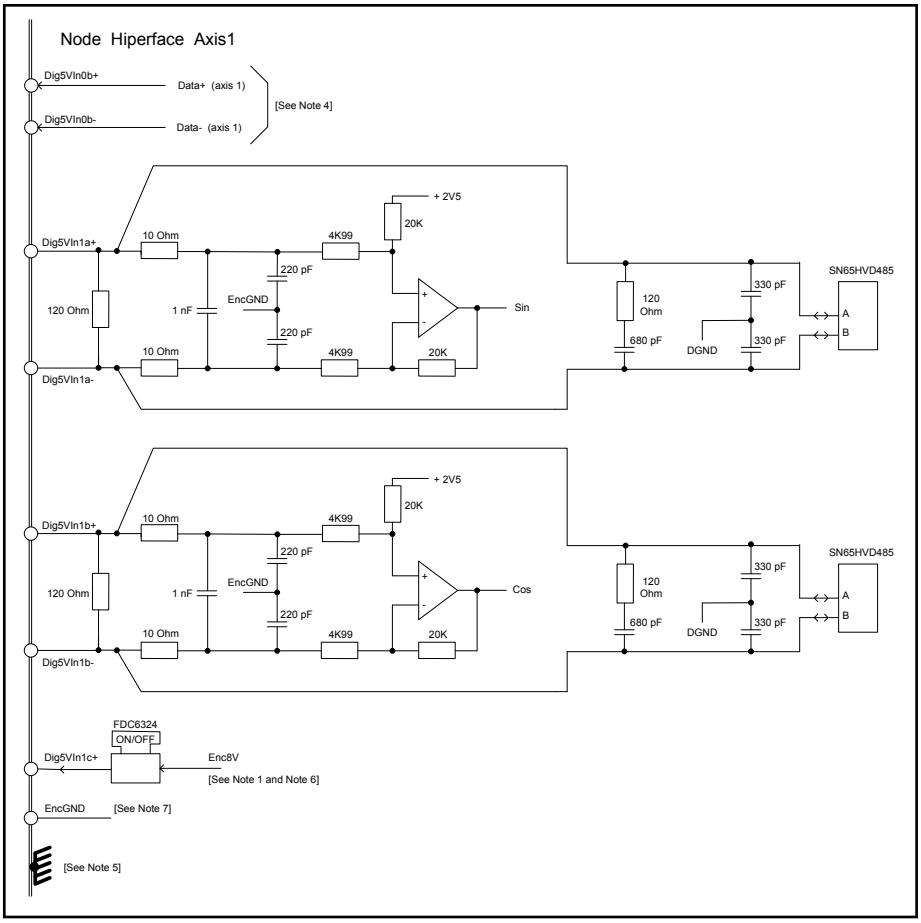

Fig. 13-29: Hiperface encoder input circuit for axis1

Notes

1. The 8V supply may only be applied for Hiperface. The same I/O pin has a different function for other encoder types. The 8V supply may damage such an encoder. The responsibility for appropriate usage of the 8V supply is with the user, although some protection is incorporated in the software.
2. The pins on the I/O connector at the back of the drive module have already a meaning, as shown in tab. 13-43 "Encoder inputs assignment" on page 200. These names are respected, also for the signals that are connected with the NY4199 SinCos Option module.
3. The drive module NY4140 supports only one encoder. This still holds while applying an NY4199 SinCos Option module. The remaining I/O's are available for other functionality.
4. Since digital and analog signals are combined for the EnDat2.1 encoder special attention must be given to the risk of signal distortion.
5. Connect the NYCe 4000, a power supply or other equipment on a metal frame or mounting base and make sure there is a galvanic contact.
6. When switching off the power of the encoder the software behavior is as follows.
   - A power loss error is generated on the axis.
   - The axis will go to the error state and be set 'not homed'.

To recover from this situation, you must switch on the encoder power, reset and home the axis.

7. EncGND is connected to the internal system ground, which is ground MCU, drive logic, analog I/O, and host PC if the MCU is NY4110 and an IEEE 1394b cable is used.

   For proper use, this ground may not be connected to motor or digital I/O ground.

13.14 NY4199 SinCos Option module for SinCos based encoders

13.14.1 Overview

All drive modules discussed in previous chapters, except the NY4125 and NY4150, have sockets for the NY4199 SinCos Option module. The NY4199 SinCos Option module is directly connected onto the drive module. Part number is R911320450, ordering code is NYM04.1-ESC-NNNN-NY4199.

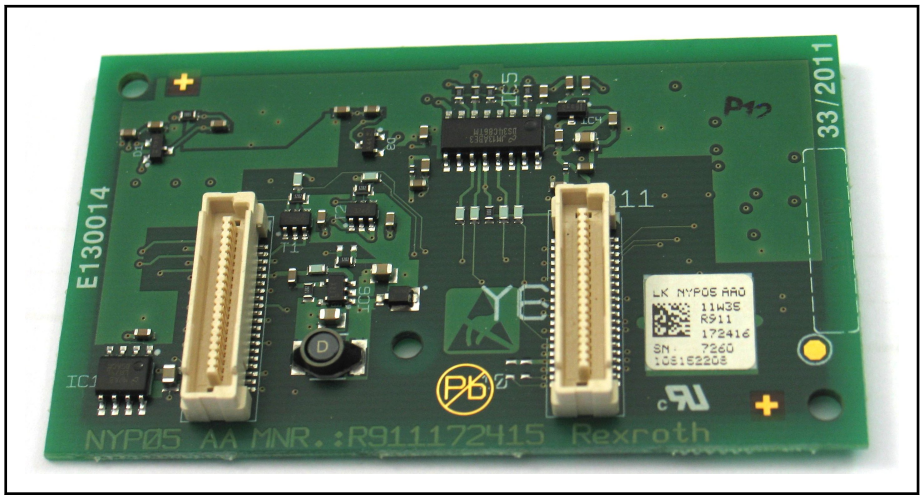

Fig. 13-30: SinCos Option module NY4199

Main features of the NY4199 SinCos Option module are the following.

- Installed directly on the drive module
- Power consumption approximately 1.25 W at 24 V system power supply voltage (power supply required for connected encoders not included)

Via the connectors the NY4199 SinCos Option module has three differential signal interfaces (Opt_0, Opt_1 and Opt_2) to the on-board logic. On the drive modules there are three additional differential signals (Dig5VIn1a, Dig5VIn1b and Dig5VIn1c) routed to the NY4199 SinCos Option module. This is shown schematically in fig. 13-31 "Drive module connections with NY4199 SinCos Option module" on page 204.

Encoders

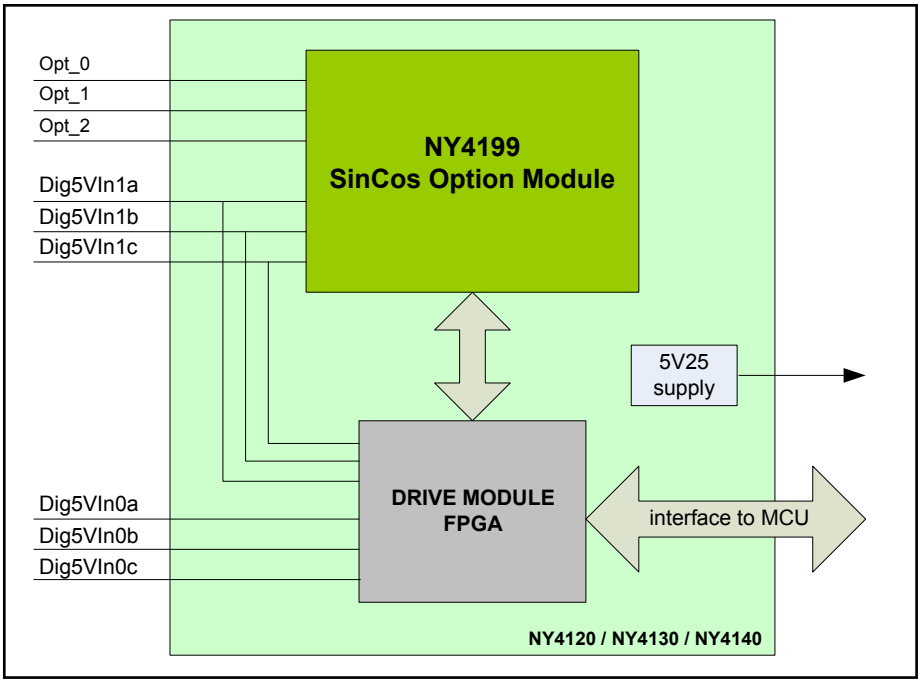

Fig. 13-31: Drive module connections with NY4199 SinCos Option module

☞ The digital input signals routed to the NY4199 SinCos Option module cannot be used as general purpose digital inputs when an encoder is connected to these digital inputs.

Characteristic	Description
Line termination	On-board, 120 Ω between differential lines
Input frequency	Max. 400 kHz
Low resolution Count frequency	Max. 1.6 MHz
Pulse width Index pulse	Tindex ≥ 250 ns
ADC resolution	Max. 12 bits

Tab. 13-44: General characteristics of the SinCos encoder inputs

SinCos encoders generate three signals, a sine, cosine and reference signal. Connections for SinCos encoders are fixed. The different SinCos based encoders and appropriate signals are discussed in the chapter 13.11 "SinCos encoder" on page 191, chapter 13.12 "EnDat2.1 encoder" on page 195 and chapter 13.13 "Hiperface encoder" on page 199.

13.14.2 Module identification

An identification label is attached on the NY4199 module.

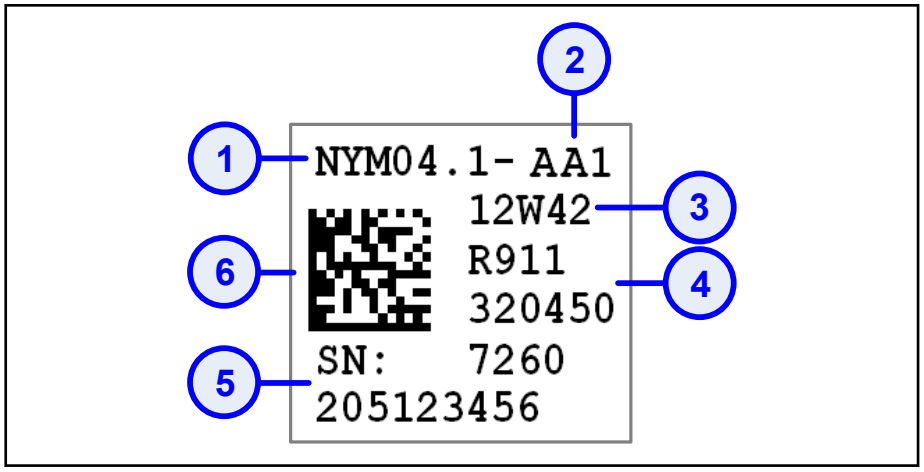

Fig. 13-32: Identification label of the NY4199

Identification number	Field explanation
1	Type code
2	Version level and status
3	Date of manufacture (yyWww)
4	Material number
5	Serial number
6	2D bar code

Tab. 13-45: Explanation of the fields of the NY4199 identification label

13.14.3 Module dimensions

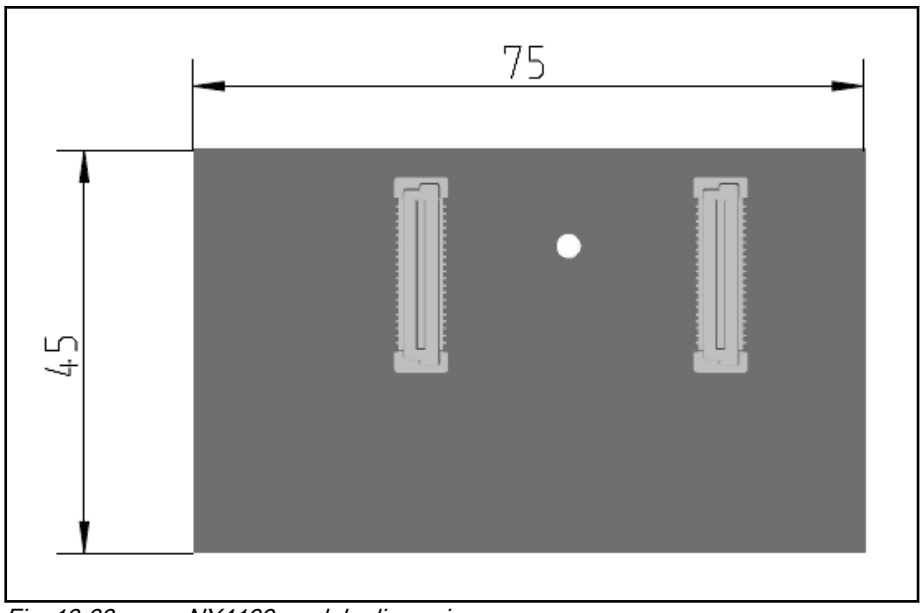

Fig. 13-33: NY4199 module dimensions

Module type code	Width	Height	Depth	Weight
NYM04.1-ESC-NNNN-NY4199	45.0 mm	75.0 mm	-	67 gr

Tab. 13-46: NY4199 physical data

13.14.4 Installation instructions for the NY4199 SinCos Option module

The NY4199 SinCos Option kit includes the following parts.

- NY4199 SinCos Option module
- One screw, one distance bushing, one curled washer and one nut

Do the following steps to install the NY4199 SinCos Option module on the drive module board.

NOTICE **Damage to components may occur due to electrostatic discharges.**

Comply with all ESD protective measures while working with modules and components. Avoid electrostatic discharges.

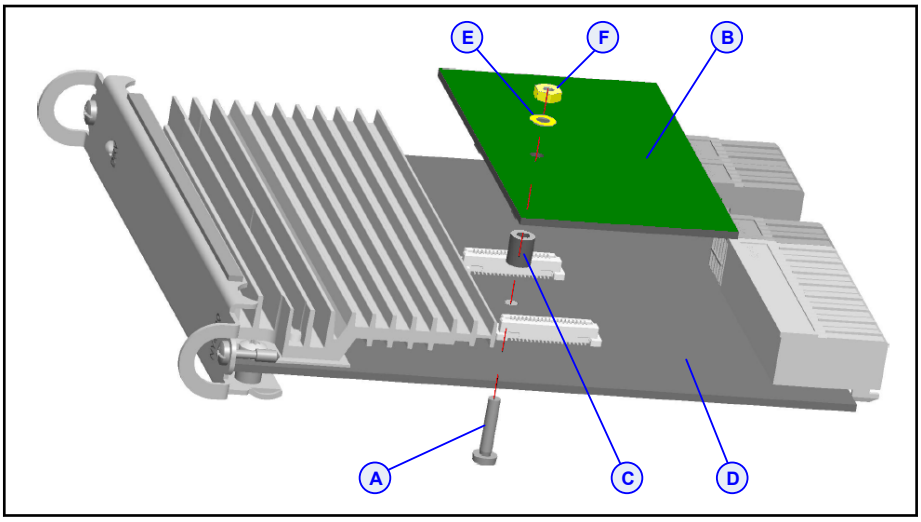

Fig. 13-34: NY4199 SinCos Option module installation

1. Wear a wrist strap to prevent damage to the boards, caused by ESD.
   Make sure that you observe all ESD safety precautions.
2. Put the screw Ⓐ through the hole of the drive module Ⓓ.
3. Put the distance bushing Ⓒ on the screw Ⓐ.
4. Install the NY4199 SinCos Option module Ⓑ with the screw and distance bushing on the drive module board. Make sure that the two headers are aligned with the two sockets on the drive module board before you push the NY4199 SinCos Option module into the sockets of the drive module.
5. Put the curled washer Ⓔ and the nut Ⓕ on the screw.
   Do not use excessive force to lock the nut.

14 Network

14.1 Introduction

The MCU in a node uses a cable to connect to the PC and optionally other nodes. The type of cable connection depends on the MCU model.

- The NY4110 MCU uses IEEE 1394b network cables.
- The NY4112 and NY4114 MCU use IEEE 802.3 network cables.

The IEEE 1394b network can be described as a communication channel with multiple masters (if more than one node is connected to the network). The network is a standard IEEE 1394b network and realizes the communication between the host and one or more nodes as well as between the nodes (without host intervention).

The IEEE 802.3 ethernet network is a serial bus network, as any other standard ethernet network.

14.2 IEEE 1394b multi-node configuration NY4110 MCU

In order to make this multi-master network operate independently from the host PC and guarantee synchronization and performance between the nodes, you must start the IEEE 1394b network tree at the host PC and connect the nodes using a "binary tree" topology, see fig. 14-1 "NYCe 4000 IEEE 1394b network, PC as single connection point" on page 208. Only one IEEE 1394b connection is connected to the host PC. This assures that the MCU modules in the nodes only operate as a repeater in the IEEE 1394b network, if applicable. "Node 1", "Node 2", "Node3", "Node5", and "Node7" operate as repeaters on the IEEE 1394b network.

The maximum number of devices connected to the IEEE 1394b network is limited to 63. This count includes the PC, so you can have a maximum of 62 nodes connected in the network. It is strongly discouraged to lay out the IEEE 1394b network as a daisy-chain (from one node to the following node to the following node etc). The "binary tree" topology minimizes the "depth" of the IEEE 1394b network and thus reduces latency times. The depth of the tree must be less than or equal to 16 hops, but additionally, the hop count from the "deepest" MCU in the left branch of the tree to the "deepest" MCU in the right branch of the tree must also be less than or equal to 16. Any device in the network introduces at least one hop.

For an LMS, due to the physical layout, a daisy-chain of MCUs is often the practical solution. The limitation of 16 hops also applies in this setup.

Network

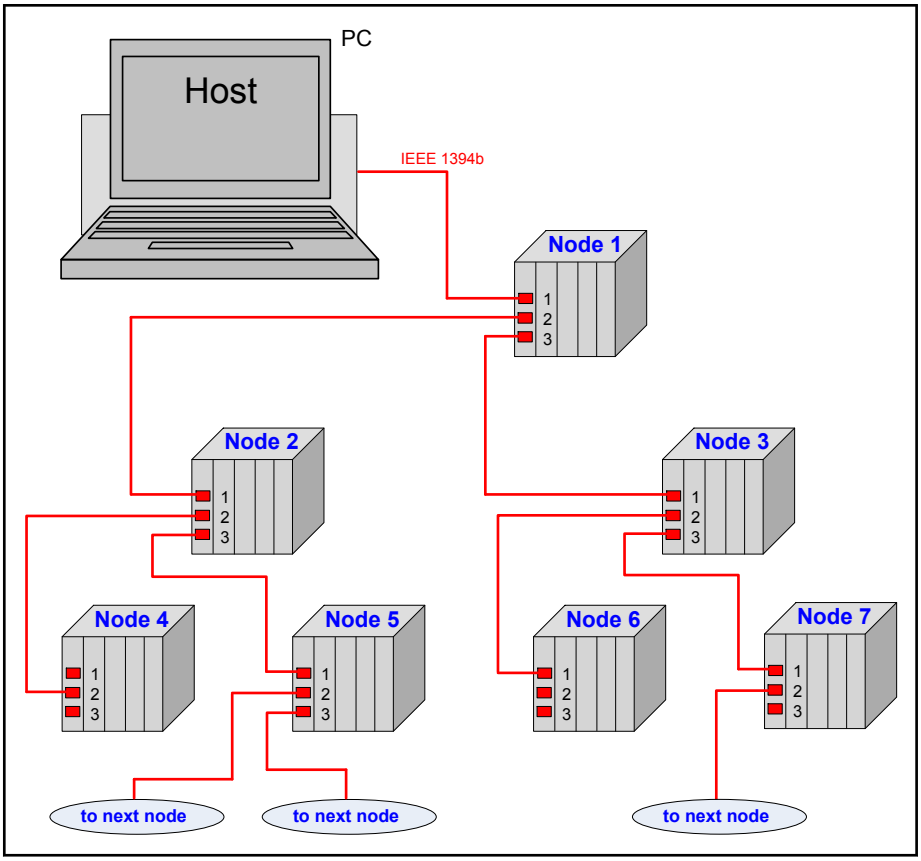

Fig. 14-1: NYCe 4000 IEEE 1394b network, PC as single connection point

With the NY4916/10 host adapter installed in the PC, you can put the PC at a larger distance from the first node than possible with IEEE 1394b cables. The cable connected to the PC (with the NY4916/10) is a shielded Cat-5e or Cat-6 cable. The other end of the shielded cable connects to the FireWire-b - 1394b Cat-5e/Cat-6 media converter. The media converter connects to the first node with a standard IEEE 1394b cable. Note that the media converter also counts as a hop in the network.

To guarantee multi-master operation and synchronization between the nodes, it is not allowed to connect other IEEE 1394b connection devices in the NYCe 4000 network. Further, it is not allowed to add repeaters in the NYCe 4000 network.

Use only certified IEEE 1394b cables. The length of the cables may differ from each other, but the maximum length of a cable is 4.5 meter.

14.3 IEEE 802.3 multi-node configuration NY4112 / NY4114 MCU

14.3.1 Introduction

If the motion control system consists of one node, you can use a direct cable connection between the PC and the node. If the motion control system consists of more nodes, the following methods of connection are available.

1. The nodes are daisy-chain connected. The PC connects to the first node, that node connects to the following node, etc.
2. The nodes are connected to a switch. The PC connects to the switch, all nodes connect to ports on the switch.

3. A combination of the previous two methods. You can use a switch to connect the PC to a node, and connect an other node (or nodes) to that node.

Ethernet-based multi-node configurations are only supported in NYCe 4000 LMS Software Release 45V06 / NYCe 4000 Software Release 46V06 or higher. The NY4114 MCU is only supported in NYCe 4000 Software Release 50V02 or higher.

The network adapter in the PC that connects to the NYCe 4000 machine network must be configured to be within the same subnet as the MCUs. Only one NYCe 4000 machine network is supported. Multiple NYCe 4000 machine networks (using physical multiple network interfaces or by defining multiple subnets on one network interface) are not supported.

14.3.2 Direct cable connection between PC and node(s)

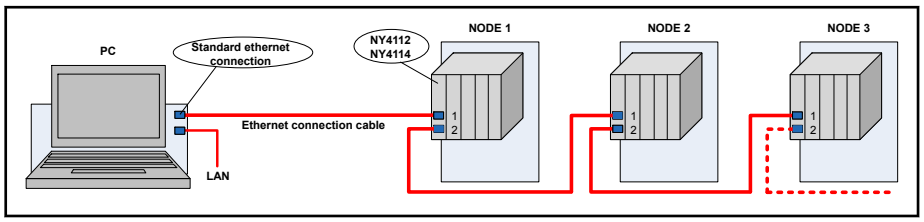

Fig. 14-2: Direct cable connection between PC and node(s)

If the system consists of more than one node, the nodes can be daisy-chain connected. The number of NYCe 4000 nodes you can connect in this topology for an LMS is limited to 16 nodes.

fig. 14-2 "Direct cable connection between PC and node(s)" on page 209 shows a daisy-chained network using NY4112 MCUs. Other configurations are not possible with the NY4112 MCU, because this MCU has only 2 ethernet ports. The NY4114 MCU has 3 ethernet ports, and therefore also supports a binairy tree topology.

14.3.3 Connection between PC and node using a switch

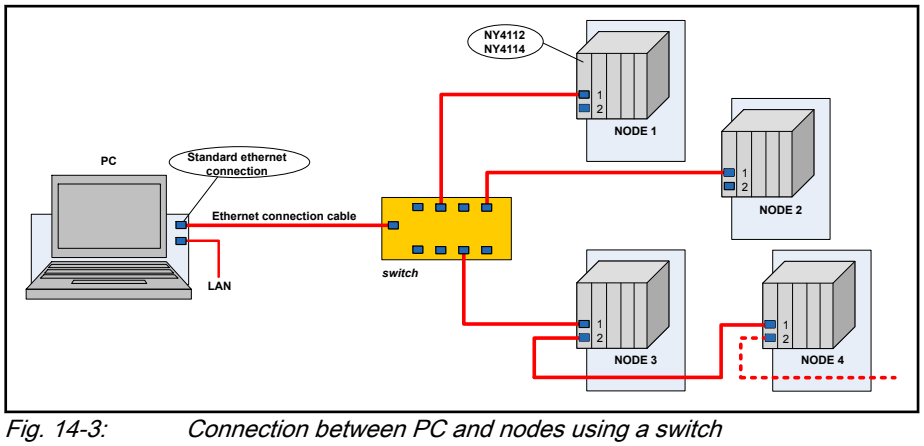

Fig. 14-3: Connection between PC and nodes using a switch

In this configuration the PC is connected to a switch. All NYCe 4000 nodes are connected to ports of the switch. Not shown in the figure is the possibility to build a binary tree toplogy if the MCU in the node is an NY4114. Further, not shown in the figure is the possibility to connect other ethernet devices to the switch. The number of NYCe 4000 nodes you can connect in this

topology is limited to 62. NYCe 4000 nodes can co-exist with other ethernet devices on the machine network.

☞ The switch must support IEEE 1588 (PTP - Precision Time Protocol). If the switch supports PTP Master it must be possible to disable PTP Master, because the first MCU must be PTP Master in the NYCe 4000 ethernet network.

☞ Other devices with ethernet connection can be connected to the NYCe 4000 ethernet network, but the following restrictions apply.

- These ethernet connected devices must be installed outside the IEEE 1588-aware NYCe 4000 segment, that is after the last node.
- These ethernet connected devices must not overload the NYCe 4000 network with extensive data communication.

14.3.4 DHCP support

The options that the DHCP client uses from the DHCP server offer are the following (see http://tools.ietf.org/html/rfc2132 for available options).

Name	Description	Example
default IP address	Decimal dotted IPv4 address	192.168.41.12 (NY4112) 192.168.41.14 (NY4114)
Subnet mask	Decimal dotted IPv4 subnet mask (option 1)	255.255.255.0
Default gateway	Optional decimal dotted IPv4 address of the default gateway (option 3)	0.0.0.0

Tab. 14-1: DHCP client options

15 NYCe 4000 Hardware Glossary

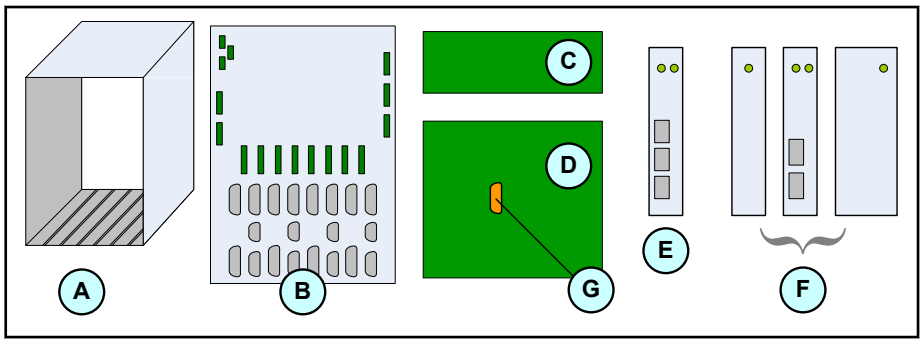

Fig. 15-1: NYCe 4000 components

Component	Name	Type number	Remarks
A	module holder	-	-
B	base plate	-	-
C	system backplane	-	Interconnect between MCU module and other NYCe 4000 motion node modules.
D	I/O backplane	-	Connection panel between NYCe 4000 drive modules and motor and I/O headers.
E	MCU	NY4110, NY4112, NY4114	Motion Control Unit. This is not a "drive" but actually a unit, because it can be used ‘stand-alone’. If an MCU is put in a system housing, you can communicate with it.
F	drive module	NY41xy, where xy = 20, 25, 30, 40, 50	These components are not "units" because they cannot be used ‘stand-alone’. If only a drive module is put in a system housing, you cannot do any useful work with it. Drive module can also be I/O module, power supply module, or SERCOS III Master module.
G	header	-	For clear identification the ‘connector’ at the end of a cable is called "plug" and the ‘connector’ on a [system, I/O] backplane is called "header".

Tab. 15-1: Identification names of the components

NYCe 4000 Hardware Glossary

Combination	Name	Type number	Remarks
A + B	metalwork	NY44xx NY46xx	This is a term only for internal use.
C + D	backplane	NY45xx	This is a combination of a system backplane and I/O backplane on a single board.
A + B + C + D	system housing	NY40x2 NY40x3 NY407x NY47xx	-
A + B + C + D + E + n*F	node	-	n ≥ 0 A node on the NYCe 4000 network is capable of controlling up to 10 axes.
m * node	NYCe 4000 system	-	m ≥ 1

Tab. 15-2: Identification names of combined components

Expression	Definition
MCU module	Motion Control Unit, a module containing the motion processor. A "Motion Controller" which takes care of the communication to the Industrial PC, and acts as a local motion controller.
Drive module	Module containing the drive technology for stepper motor, and/or brushless AC servo motor, and/or brushless DC servo motor, and/or DC servo motor and analog and digital I/O. A module can control one or more axes.
Drive power	Incoming supply voltage for the power stages on the drive modules.
System power	Incoming supply voltage for the logic of NYCe 4000 node.
I/O power	Digital I/O supply voltage.
Quadrature encoder	A digital position encoder that generates two block wave signals with 90° phase shift relative to each other and an optional index signal. Also known as A/B encoder, S0S90 encoder and 3-channel digital incremental encoder.

Tab. 15-3: Explanation of other expressions

16 Drive power precautions for NY412x/NY4140

16.1 Drive Power Filtering for NY412x/NY4140

16.1.1 Introduction

The PWM principle applied in the NY4120, NY4125 and NY4140 implies an unavoidable ripple current in the drive power connections of the bridge circuits. This ripple current has a peak-to-peak value equal to the average motor current and a frequency equal to the PWM frequency. Without adequate filter provisions, this ripple current will in many applications cause a severe ripple voltage at the drive power input to the NY4120, NY4125 and/or NY4140 and the node. This ripple voltage may in turn result in malfunctioning of the NY412x/NY4140 and may in extreme cases even cause permanent damage.

The capacitors required for the filtering of high-power applications are rather large, and for this reason they are not included in the on-board capacitance of the NY412x/NY4140. Bosch Rexroth has designed on-board capacitors in the NY412x/NY4140 for light applications only. For the heavier applications, the drive modules need a larger application dependent capacitor in parallel as close as possible to the I/O backplane.

In principle, the output capacitance normally included in the drive power supply can perform the necessary filter function, but if the drive power supply is not placed immediately next to the NYCe 4000 node, the wiring inductance dramatically reduces the effectiveness of this capacitance.

In EVERY heavy application, it is the customer’s responsibility to ensure that an adequate drive power filter capacitance is installed on or immediately next to the I/O backplane of a NYCe 4000 node. Neglecting to do so may result in unstable behavior of the NY412x/NY4140, and possibly even in permanent damage. See the NYCe 4000 Standard Housings and Accessories Manual, chapter "NY4921 Filter Capacitor kit" for installation details and more information.

The standard systems have a separate drive power input connector for every NY4120, NY4125 and NY4140. The following paragraphs give background information, selection criteria and describe solutions for the standard systems with NY4120, NY4125 and/or NY4140 drives. For less demanding applications and/or for customer-specific I/O backplanes, an optimal capacitor can be chosen with confidence.

There are three main criteria for selecting a capacitor:

1. Ripple current of power supply
2. Internal series resistor of the capacitor (ESR)
3. Required voltage

Ripple current

The rms ripple current must be calculated per NY4120/NY4125/NY4140 drive module. In the calculations the following assumptions must be made:

- The total ripple current is calculated by adding up the ripple current of all axes connected to the drive module.

- The drive power supply is so far away from the node that the cabling inductance keeps the supply current approximately constant (= worst case for the rms value of the ripple current).
- A combination of drive power and motor back EMF that gives a PWM duty cycle of 50% (= worst case for the rms value of the ripple current).
- The peak motor current (20 A) does not last long enough nor occurs often enough to significantly heat the capacitor.

Internal series resistor of capacitor (ESR)

The most important criterion for selecting a capacitor is its internal heating due to the strong ripple current and internal resistance. Only capacitors with a very low (< 0.07 Ω) ESR (Equivalent Series Resistance) may be used. For instance, the maximum ESR of a capacitor (at a representative frequency of 20 kHz) is 0,059 Ω. A ripple current of 7 A rms then gives a worst case dissipation of 3 W. The size of the capacitor should be such that it can withstand this power without heating up too much.

Required voltage

The maximum allowed voltage of the capacitor must be at least 33% higher than the allowed drive power supply voltage.

16.1.2 Filtering on NY40x3, NY4074 and NY40x2 system housings

For the NY40x2, NY40x3, and NY4074 standard system housings the capacitor, if needed, is installed on the housing with a clamp and connected to its filter capacitor connector (CAPx).

Ripple current all axes of a drive module	Capacitor for NY4120 / NY4125	Capacitor for NY4140
< 1 A rms	No external capacitor needed	No external capacitor needed
≥ 1 A rms	Capacitor kit 100 V NYA04.1-CAP-100V-NY4921 Order number R911325079	Capacitor kit 200 V NYA04.1-CAP-200V-NY4921/10 Order number R911325082

Tab. 16-1: Filter capacitors for NY412x / NY4140

16.1.3 Filtering on NY40x0 system housings

For the NY4010, NY4040, and the NY4050 standard system housings the capacitor, if needed, must be installed and connected as close as possible to each drive power input connector. See tab. 16-2 "Advised capacitors for NY412x (NY4010/4040/4050 housing)" on page 215 and tab. 16-3 "Advised capacitors for NY4140 (NY4010/4040/4050 housing)" on page 215 for the needed capacitor (per typical application) advised by Bosch Rexroth.

Ripple current both axes	External Capacitor type / value	Size: diameter x length	Voltage
< 1 A (rms)	No external capacitor needed		
1 - 4 A (rms)	Panasonic electrolytic capacitor of 1500 µF. Type number: ECOS2AA152CA (TS-HA series)	25 mm x 40 mm	100 VDC working, 125 VDC Surge
4 - 7 A (rms)	Panasonic electrolytic capacitor of 2200 µF. Type number: ECOS2AA222CA (TS-HA series)	25 mm x 50 mm	100 VDC working, 125 VDC Surge
7 A - full power	Panasonic electrolytic capacitor of 4700 µF. Type number: ECOS2AA472EA (TS-HA series)	35 mm x 50 mm	100 VDC working, 125 VDC Surge

Tab. 16-2: Advised capacitors for NY412x (NY4010/4040/4050 housing)

Ripple current both axes NY4140	External Capacitor type / value	Size: diameter x length	Voltage
< 1 A (rms)	No external capacitor needed		
1 - 3 A (rms)	Panasonic electrolytic capacitor of 1000 µF. Type number: ECOS2DA102EA (TS-HA series)	35 mm x 35 mm	200 VDC working, 250 VDC Surge
3 A - full power	Panasonic electrolytic capacitor of 1500 µF. Type number: ECOS2DA152EA (TS-HA series)	35 mm x 50 mm	200 VDC working, 250 VDC Surge

Tab. 16-3: Advised capacitors for NY4140 (NY4010/4040/4050 housing)

16.2 Motor Chokes

The measurement of the motor current in the NY4120, NY4125 and NY4140 modules is done in the middle of the passive cycle of the drive output PWM period. To get an accurate measurement of the motor current, the PWM frequency and the motor inductance must have minimum values. If the motor inductance is too low, additional chokes must be added in the motor wiring. See fig. 16-1 "PWM cycle and motor current measurement" on page 216.

Drive power precautions for NY412x/NY4140

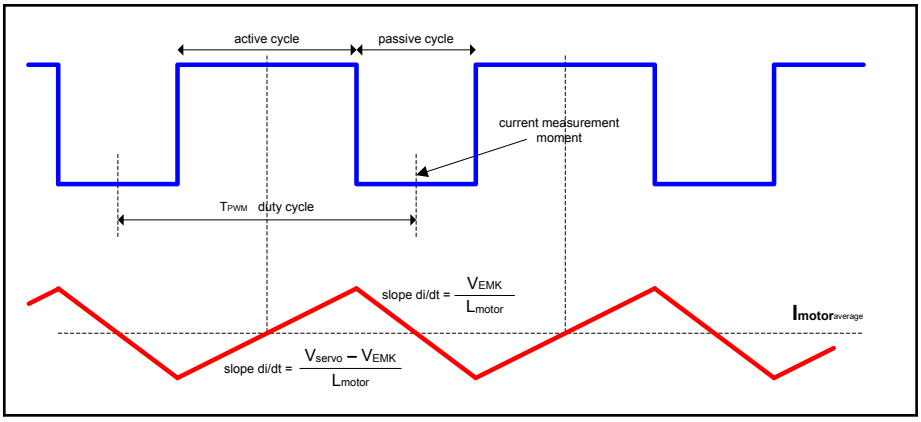

Fig. 16-1: PWM cycle and motor current measurement

For good operation of the modules the following rule should be met:

$L / R > 3 * T_{PWM}$

Where:

- L [H] is the inductance of the motor phase
- R [Ω] is the resistance of the motor phase
- Tpwm is the period time of the selected PWM frequency of the drive output

When selecting a choke, make sure that the maximum current and temperature requirements are met.

16.3 Regenerative Braking

When working with PWM controlled drives, energy will be regenerated when the motor is decelerated. When using a large enough electrical network, this energy can be reused. In other cases some of the energy must be absorbed by an external system.

Principle

A regenerative braking module converts excessive electrical energy into thermal energy (heat). This will prevent the energy from staying within the network. Energy staying within the network can cause a voltage increase which will (if large enough) lead to the destruction of the NYCe 4000 system. Some power supplies are not protected against current sinking, and in those cases the voltage increase will cause the power supply to break down.

17 Environmental Conditions

17.1 Thermal

Operating

- Temperature : +5 °C … +55 °C
- Relative Humidity : 10% … 90% (non condensing)

Storage

- Temperature : –40 °C … +85 °C (power derating applies, see chapter 17.5 "Derating Conditions" on page 218).
- Relative humidity : 5% … 95% (non condensing)

Thermal compatibility

- Cold: EN 60068-2-1:2007
- Dry heat: EN 60068-2-2:2007
- Change of temperature: EN 60068-2-14:2009
- Damp heat: EN 60068-2-30:2005

17.2 Shock and Vibration

Mechanical: Non-operating

- Shock: IEC 60068-2-27:2008

Mechanical: Operating

- Vibration: IEC 60068-2-6:2007
- Vibration, broad-band: IEC 60068-2-64:2008

17.3 Electromagnetic Compatibility

Emission

Standard EN 61000-6-4:2007/A1:2011 is met.

Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments.

Immunity

Standard EN 61000-6-2:2005 is met.

Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments.

- Electrostatic discharge: EN 61000-4-2:2009
- Radiated, RF electromagnetic field: EN 61000-4-3:2006 + A1:2008 + A2:2010
- Electrical fast transient (burst): EN 61000-4-4:2004 + A1:2010
- RF conducted disturbances: EN 61000-4-6:2009

17.4 Environment

Pollution degree (operating / storage and transport): 2.

Overvoltage category: II.

Maximum altitude: 4000 m.

17.5 Derating Conditions

17.5.1 Introduction

The NYCe 4000 system can be used as a convection cooled system. However, this will limit the maximum current to the motors because of the heat dissipation in the drive modules. In a practical situation not all motors need high power and do not need full power at the same moment. Since forced cooled systems are not always possible, the graphs give more insight in the possibilities of convection cooled systems at a given environmental temperature.

The NY4053 system housing is used during the measurements, except for the measurements of the NY4125 drive module. The NY4063 system housing is used during the measurements of the NY4125. Other drive modules and system housings will have similar characteristics.

17.5.2 Forced cooled systems, NY4120

The NYCe 4000 system can be installed with a standard fan unit with 3 fans each producing an airflow of 11.3 m^3/hr. The fan unit is strongly advised if motors are used with motor currents higher than 2 A rms and/or the environmental temperature is higher than 35 °C in a full system configuration.

When five NY4120 drive modules are used in the NY4053 system housing, you can build the maximum configuration with 10 axes. fig. 17-1 "Max. motor current for 10 axes (5 NY4120 drive modules) and all digital outputs at 1 A load with 3 fans (airflow 11.3 m^3/hr) installed vs. environmental temperature" on page 218 shows the situation when all 10 motors ask continuously the same motor current and all 20 digital outputs are driving a load of 1 A continuously. Under these conditions the maximum motor current is 7 A rms at an environmental temperature of up to 48 °C. Measurements indicate that 7 A rms is also possible up to the maximum supported environmental temperature of 55 °C, if fans are used producing an airflow of 20 m^3/hr.

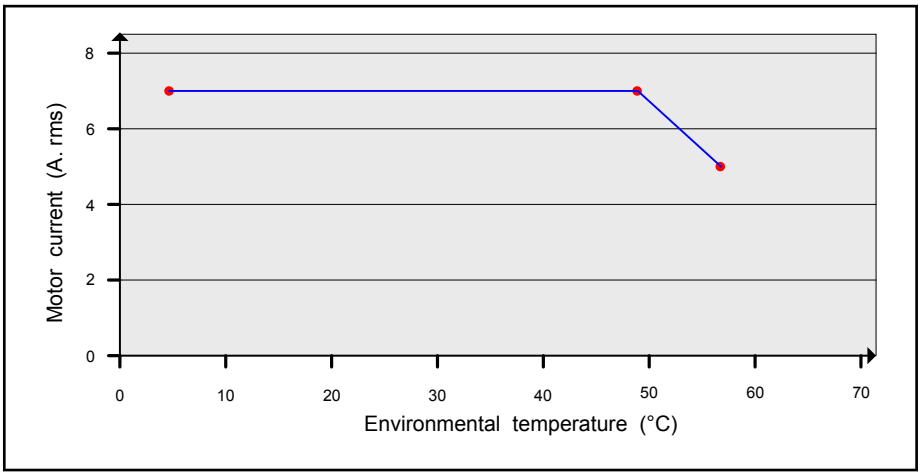

Fig. 17-1: Max. motor current for 10 axes (5 NY4120 drive modules) and all digital outputs at 1 A load with 3 fans (airflow 11.3 m^3/hr) installed vs. environmental temperature

17.5.3 Convection cooled systems, NY4120

When five NY4120 drive modules are used in the NY4053 system housing, you can build the maximum configuration with 10 axes. fig. 17-2 "Maximum motor current for 10 axes (5 NY4120 drive modules) and all digital outputs at 1A load vs. environmental temperature" on page 219 shows the situation when all 10 motors ask continuously the same maximum motor current and all 20 digital outputs are driving a load of 1 A continuously. Under these conditions the maximum motor current is 2 A rms at an environmental temperature of approximately 30 °C.

Note that the absolute maximum environmental temperature is 40 °C.

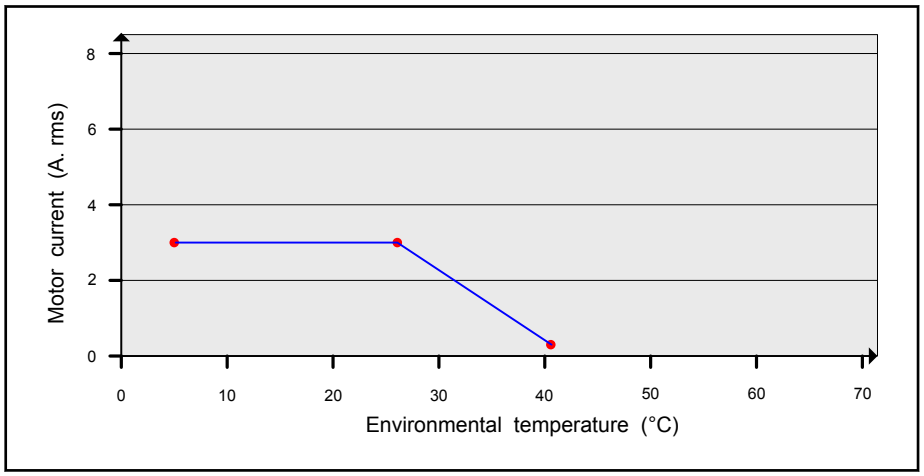

Fig. 17-2: Maximum motor current for 10 axes (5 NY4120 drive modules) and all digital outputs at 1A load vs. environmental temperature

As shown in fig. 17-3 "Maximum motor current for 10 axes (5 NY4120 drive modules) and digital outputs not used vs. environmental temperature" on page 219, when the digital outputs are not used, the absolute maximum environmental temperature increases to 45 °C.

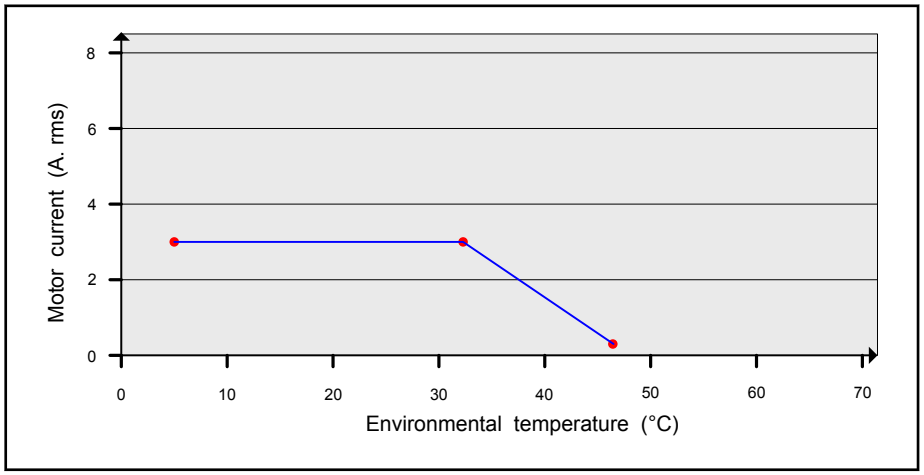

Fig. 17-3: Maximum motor current for 10 axes (5 NY4120 drive modules) and digital outputs not used vs. environmental temperature

For NYCe 4000 systems in which not all available slot positions are used, the thermal derating conditions improve because of better convection airflow in the system. fig. 17-4 "Maximum motor current for 2 axes (one NY4120 drive

module) and all digital outputs at 1 A load vs. environmental temperature" on page 220 shows an NY4053 system housing with 2 axes (one NY4120 drive module), where both motors ask continuously the same motor current, and the remaining 4 slot positions are not used.

The graph shows that under these conditions the maximum motor current is 5 A rms at an environmental temperature of approximately 30 °C.Note that the absolute maximum environmental temperature is 45 °C.

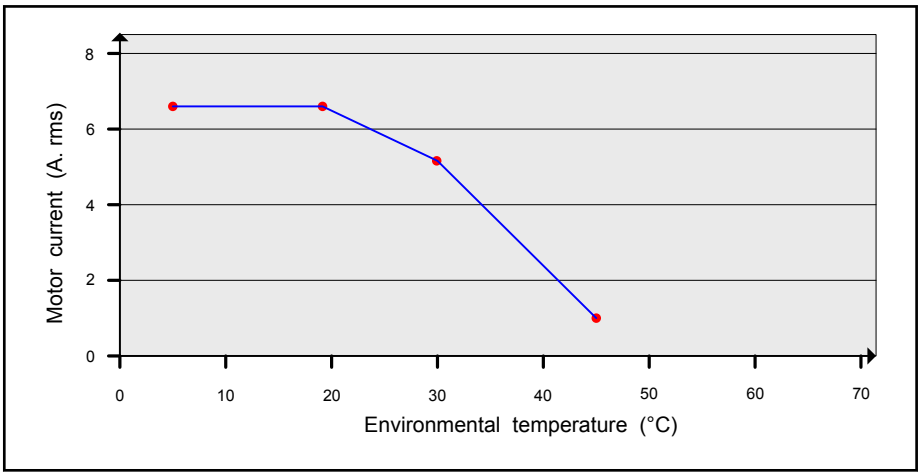

Fig. 17-4: Maximum motor current for 2 axes (one NY4120 drive module) and all digital outputs at 1 A load vs. environmental temperature

17.5.4 Forced cooled systems, NY4125

The NYCe 4000 system can be installed with a standard fan unit with 3 fans each producing an airflow of 11.3 m^3/hr. The fan unit is strongly advised if motors are used with motor currents higher than 2 A rms and/or the environmental temperature is higher than 25 °C in a full system configuration.

When an NY4125 drive module is used in the NY4063 system housing, you can connect 5 axes. fig. 17-5 "Max. motor current for 5 axes and all digital outputs at 1 A load with 3 fans (airflow 11.3 m^3/hr) installed vs. environmental temperature" on page 221 shows the situation when all 5 motors ask continuously the same motor current and all digital outputs are driving a load of 1 A continuously.

If the PWM frequency is 96 kHz, the following conditions apply. See line Ⓐ.

- The maximum motor current is 2.8 A rms for all axes at an environmental temperature up to 25 °C.
- The maximum motor current is 2.0 A rms for all axes at an environmental temperature up to 45 °C.

If the PWM frequency is 32 kHz, the following conditions apply. See line Ⓑ.

- The maximum motor current is 2.8 A rms for all axes at an environmental temperature up to 55 °C.

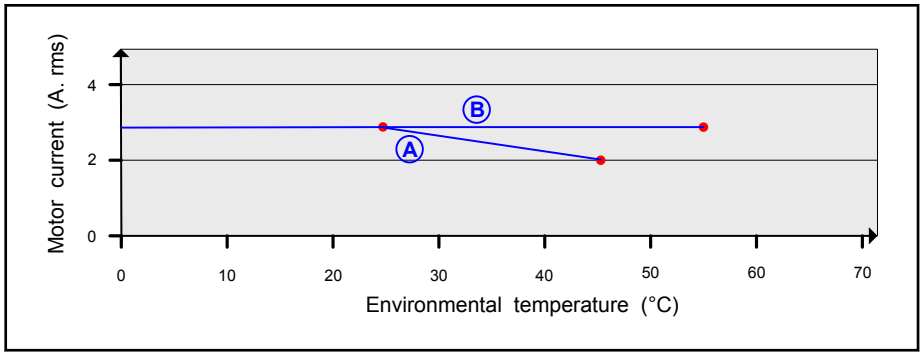

Fig. 17-5: Max. motor current for 5 axes and all digital outputs at 1 A load with 3 fans (airflow 11.3 m^3/hr) installed vs. environmental temperature

17.5.5 Convection cooled systems, NY4125

When the NY4125 drive module is used in the NY4063 system housing, you can connect 5 axes. fig. 17-6 "Max. motor current for 5 axes and all digital outputs at 1 A (line Ⓐ and Ⓑ) or all digital outputs at 0 A (line Ⓒ) vs. environmental temperature" on page 222 shows the situation where all 5 motors ask continuously the same maximum motor current, and all digital outputs drive a load of 1 A continuously, or are not used.

If the PWM frequency is 96 kHz and all digital outputs drive a load of 1 A continuously, the following conditions apply. See line Ⓐ.

- The maximum motor current is 2.0 A rms for all axes at an environmental temperature up to 20 °C.
- The absolute maximum environmental temperature is 43 °C (motor current is 0).

If the PWM frequency is 32 kHz and all digital outputs drive a load of 1 A continuously, the following conditions apply. See line Ⓑ.

- The maximum motor current is 2.0 A rms for all axes at an environmental temperature up to 28 °C.
- The absolute maximum environmental temperature is 45 °C (motor current is 0).

If the PWM frequency is 32 kHz and all digital outputs are not used, the following conditions apply. See line Ⓒ.

- The maximum motor current is 2.0 A rms for all axes at an environmental temperature up to 45 °C.
- The absolute maximum environmental temperature is 55 °C (motor current is .95 A rms).

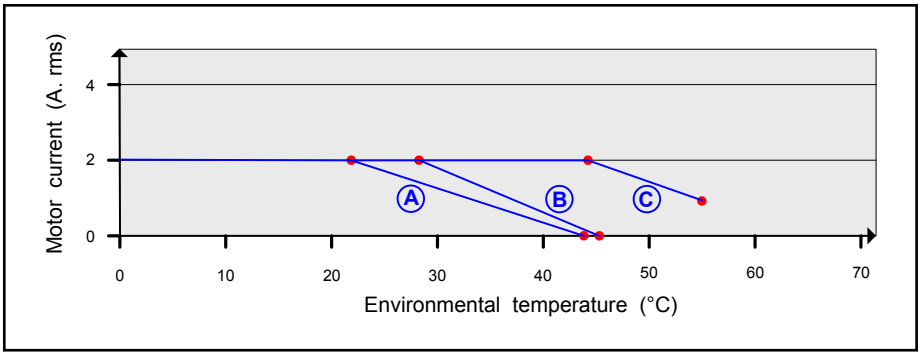

Fig. 17-6: Max. motor current for 5 axes and all digital outputs at 1 A (line Ⓐ and Ⓑ) or all digital outputs at 0 A (line Ⓒ) vs. environmental temperature

17.5.6 Forced cooled systems, NY4130

The NYCe 4000 system can be installed with a standard fan unit with 3 fans each producing an airflow of 11.3 m^3/hr. The fan unit is strongly advised. When five NY4130 drive modules are used in the NY4053 system housing, and each NY4130 is connected to 2 DC motors, control frequency is 32 kHz and all 20 digital outputs drive a load of 1 A continuously, fig. 17-7 "Max. load by 10 axes (5 NY4130 drive modules, control frequency = 32 kHz) and all digital outputs at 1 A load with 3 fans (airflow 11.3 m^3/hr) installed vs. environmental temperature" on page 222 shows the derating curve under these following conditions for the environmental temperature.

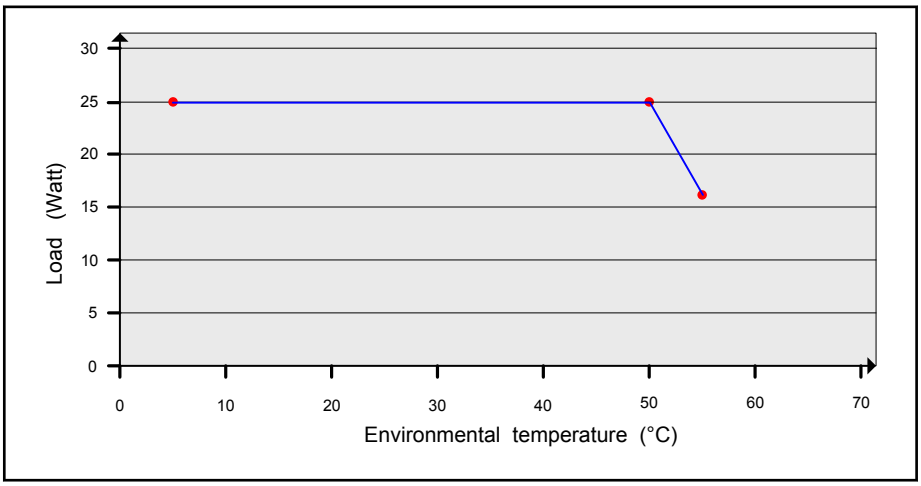

Fig. 17-7: Max. load by 10 axes (5 NY4130 drive modules, control frequency = 32 kHz) and all digital outputs at 1 A load with 3 fans (airflow 11.3 m^3/hr) installed vs. environmental temperature

17.5.7 Convection cooled systems, NY4130

When five NY4130 drive modules are used in the NY4053 system housing, you can build the maximum configuration with 10 axes. When five NY4130 drive modules are used in the NY4053 system housing, and each NY4130 is connected to 2 DC motors, control frequency is 32 kHz and the digital outputs are loaded with 1 A, fig. 17-8 "Max. load by 10 axes (5 NY4130 drive modules, control frequency = 32 kHz) and all digital outputs at 1 A load vs. environmental temperature" on page 223 shows the derating curve under these following conditions for the environmental temperature.

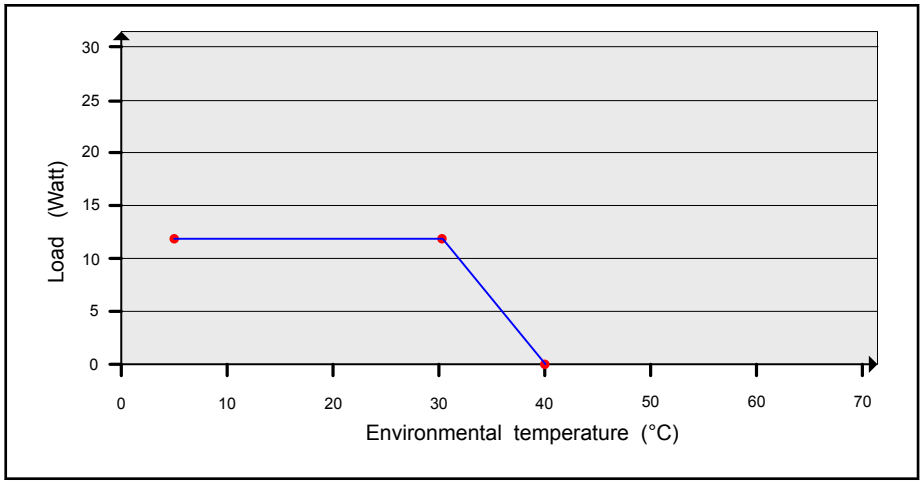

Fig. 17-8: Max. load by 10 axes (5 NY4130 drive modules, control frequency = 32 kHz) and all digital outputs at 1 A load vs. environmental temperature

17.5.8 Forced cooled systems, NY4140

The NYCe 4000 system can be installed with a standard fan unit with 3 fans each producing an airflow of 11.3 m^3/hr. When five NY4140 drive modules are used in the NY4053 system housing, you can build the maximum configuration with 5 axes. fig. 17-9 "Max. motor current for 5 axes (5 NY4140 drive modules, PWM frequency = 32 kHz) and all digital outputs at 1 A load with 3 fans (airflow 11.3 m^3/hr) installed vs. environmental temperature" on page 223 shows the situation where all 5 motors ask continuously the same motor current, PWM frequency is 32 kHz, and all 10 digital outputs drive a load of 1 A continuously. Under these conditions the maximum motor current is 7 A rms at an environmental temperature of up to 55 °C.

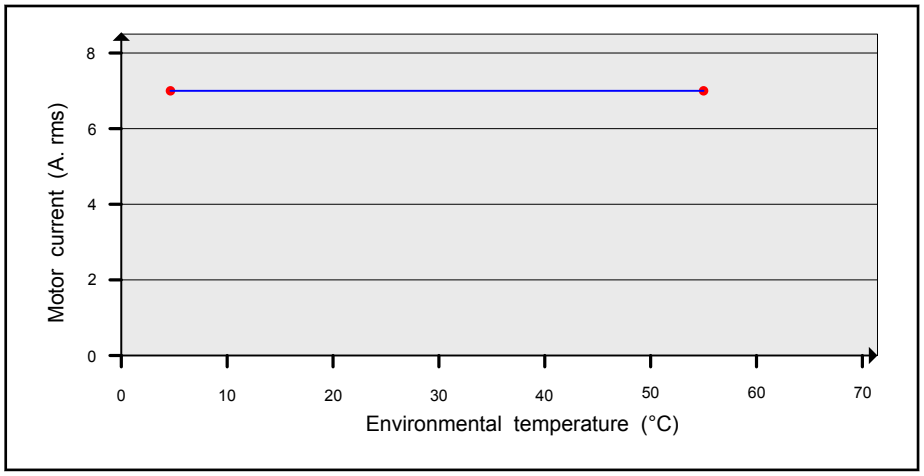

Fig. 17-9: Max. motor current for 5 axes (5 NY4140 drive modules, PWM frequency = 32 kHz) and all digital outputs at 1 A load with 3 fans (airflow 11.3 m^3/hr) installed vs. environmental temperature

17.5.9 Convection cooled systems, NY4140

When five NY4140 drive modules are used in the NY4053 system housing, you can build the maximum configuration with 5 axes. fig. 17-10 "Maximum motor current for 5 axes (5 NY4140 drive modules) and all digital outputs at 1A load vs. environmental temperature" on page 224 shows the situation

where all 5 motors ask continuously the same maximum motor current, all 10 digital outputs drive a load of 1 A continuously.

If the PWM frequency is 16 kHz, the following conditions apply.

- The maximum motor current is 4.0 A rms for all axes at an environmental temperature of 30 °C.
- The maximum motor current is 1.5 A rms for all axes at an environmental temperature of 40 °C.
- The absolute maximum environmental temperature is 45 °C.

If the PWM frequency is 32 kHz, the following conditions apply.

- The maximum motor current is 1.5 A rms for all axes at an environmental temperature of 30 °C.
- The absolute maximum environmental temperature is 37 °C.

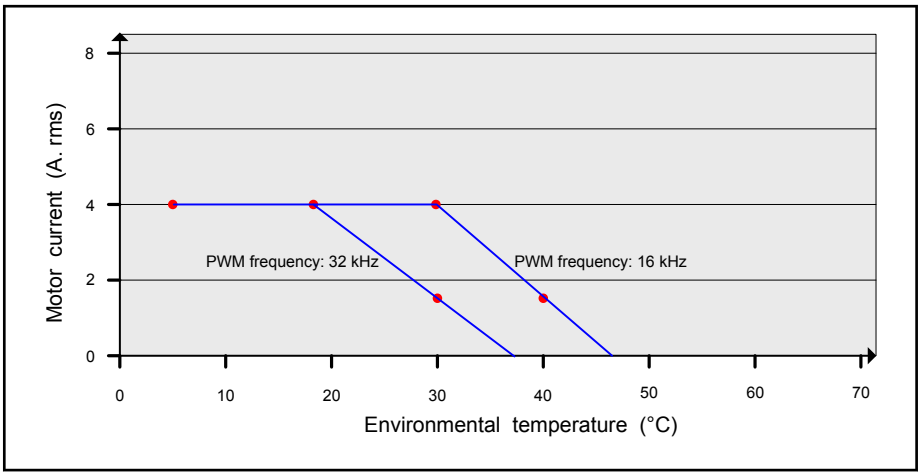

Fig. 17-10: Maximum motor current for 5 axes (5 NY4140 drive modules) and all digital outputs at 1A load vs. environmental temperature

As shown in fig. 17-11 "Max. motor current for 5 axes (5 NY4140 drive modules, PWM frequency = 16 kHz) and digital outputs not used vs. environmental temperature" on page 225, when the digital outputs are not used and the PWM frequency is 16 kHz, the following conditions apply.

- The maximum motor current is 5 A rms for all axes at an environmental temperature of 30 °C.
- The maximum motor current is 3 A rms for all axes at an environmental temperature of 40 °C.
- The absolute maximum environmental temperature is 50 °C.

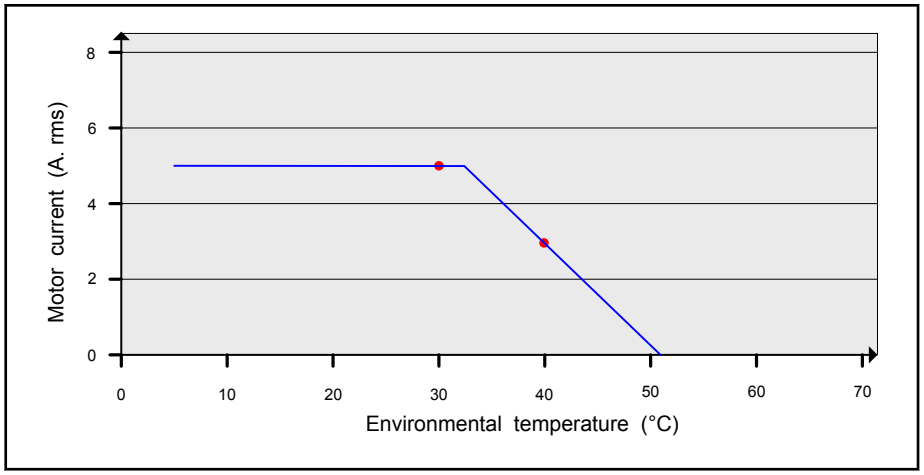

Fig. 17-11: Max. motor current for 5 axes (5 NY4140 drive modules, PWM frequency = 16 kHz) and digital outputs not used vs. environmental temperature

18 Cleaning, Disposal and Environmental Protection

18.1 Cleaning

Softly wipe the surface with a dampened cloth using a diluted neutral detergent or alcohol, and then wipe the surface again with a dry cloth. For systems without a fan, use a compressor or vacuum cleaner to blow off the accumulated dust in the ventilating channel of the housing and inside the housing.

☞ Do not use a compressor or vacuum cleaner on systems with a fan. Remove the fan before cleaning the system.

18.2 Disposal

Products

Our products can be returned to us free of charge for disposal. It is a precondition, however, that the products are free of oil, grease or other dirt. In addition, when returned the products must not contain any undue foreign matter or foreign component.

Please send the products free domicile to the following address:

Bosch Rexroth AG

Electric Drives and Controls

Bürgermeister-Dr.-Nebel-Straße 2

D-97816 Lohr am Main

Packaging Materials

The packaging materials consist of cardboard, wood and polystyrene. They can be easily recycled. For ecological reasons you should not return the empty packages to us.

18.3 Environmental Protection

No Release of Hazardous Substances

Our products do not contain any hazardous substances that they can release in the case of appropriate use. Normally there are not any negative effects on the environment to be expected.

Materials Contained in the Products

- Electronic Devices

  Electronic devices mainly contain:

  – steel
  – aluminum
  – copper
  – synthetic materials
  – electronic components and modules
- Motors

  Motors mainly contain:

  – steel

- aluminum
- copper
- brass
- magnetic materials
- electronic components and modules

Recycling

Due to their high content of metal most of the product components can be recycled. In order to recycle the metal in the best possible way it is necessary to disassemble the products into individual modules.

The metals contained in the electric and electronic modules can also be recycled by means of specific separation processes.

The synthetic materials remaining after these processes can be thermally recycled.

19 Service and Support

19.1 Helpdesk

Unser Kundendienst-Helpdesk im Hauptwerk Lohr am Main steht Ihnen mit Rat und Tat zur Seite. Sie erreichen uns	Our service helpdesk at our headquarters in Lohr am Main, Germany can assist you in all kinds of inquiries. Contact us

telefonisch - by phone: +49 9352 18 0

über Service Call Entry Center (Mo-Fr 07:00-18:00)

via Service Call Entry Center (Mo-Fr 7:00 am - 6:00 pm)

per Fax - by fax: +49 9352 18 8400

per e-Mail - by e-mail: **service**.svc@boschrexroth.de

19.2 Service-Hotline

Außerhalb der Helpdesk-Zeiten ist der Service direkt ansprechbar unter	After helpdesk hours, contact our service department directly at

+49 171 333 88 26

oder - or: +49 172 660 04 06

19.3 Internet

Unter **www.boschrexroth.com** finden Sie ergänzende Hinweise zu Service, Reparatur und Training sowie die aktuellen Adressen unserer Vertriebs- und Servicebüros.	At **www.boschrexroth.com** you may find additional notes about service, repairs and training in the Internet, as well as the actual addresses of our sales- and service facilities

19.4 Vor der Kontaktaufnahme... - Before contacting us...

Wir können Ihnen schnell und effizient helfen wenn Sie folgende Informationen bereithalten: 1. Detaillierte Beschreibung der Störung und der Umstände. 2. Angaben auf dem Typenschild der betreffenden Produkte, insbesondere Typenschlüssel und Seriennummern. 3. Tel.-/Faxnummern und e-Mail-Adresse, unter denen Sie für Rückfragen zu erreichen sind.	For quick and efficient help, please have the following information ready: 1. Detailed description of the failure and circumstances. 2. Information on the type plate of the affected products, especially type codes and serial numbers. 3. Your phone/fax numbers and e-mail address, so we can contact you in case of questions.

Notes

rexroth
A Bosch Company

Bosch Rexroth AG
Electric Drives and Controls
P.O. Box 13 57
97803 Lohr, Germany
Bgm.-Dr.-Nebel-Str. 2
97816 Lohr, Germany
Phone +49 9352 18 0
Fax +49 9352 18 8400
www.boschrexroth.com/electrics

R911337671

DOK-NY4000-HW***SYSTEM-PR10-EN-E