

*phy***MOTION**<sup>TM</sup>

**Power Stage Carrier Module INAM01.1 and  
1-Axis Module INAM02.1**

**TRANSLATION OF THE GERMAN ORIGINAL MANUAL**

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In this manual you will find the descriptions of the features and specifications of the **phyMOTION™** module: Carrier Module for APS or LPS Power Stage INAM01 or 1-Axis Module INAM02 for integrated MSX power stage

This manual is supplementary to the “**phyMOTION™** *Modular Multi-axis Controller for Stepper Motors*” manual.

In the manual **phyMOTION™** *Modular Multi-axis Controller for Stepper Motors* (<http://www.phytron.de/phyMOTION>) are the descriptions of the features and specifications for the **phyMOTION™** stepper motor controller.

Every possible care has been taken to ensure the accuracy of this technical manual. All information contained in this manual is correct to the best of our knowledge and belief but cannot be guaranteed. Furthermore we reserve the right to make improvements and enhancements to the manual and / or the devices described herein without prior notification.

We appreciate suggestions and criticisms for further improvement.

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Questions about the use of the product described in the manual that you cannot find answered here, please contact your representative of Phytron (<http://www.phytron.de/>) in your local agencies.

# 1 Information

**This manual:**



*Read this manual very carefully before mounting, installing and operating the device and if necessary further manuals related to this product.*

- Please pay special attention to instructions that are marked as follows:

	<b>DANGER – Serious injury!</b>	<i>Indicates a high risk of serious injury or death!</i>
	<b>DANGER – Serious injury from electric shock!</b>	<i>Indicates a high risk of serious injury or death from electric shock!</i>
	<b>WARNING – Serious injury possible!</b>	<i>Indicates a possible risk of serious injury or death!</i>
	<b>WARNING – Serious injury from electric shock!</b>	<i>Indicates a possible risk of serious injury or death from electric shock!</i>
	<b>CAUTION – Possible injury!</b>	<i>Indicates a possible risk of personal injury.</i>
	<b>CAUTION – Possible damage!</b>	<i>Indicates a possible risk of damage to equipment.</i>
	<b>CAUTION – Possible damage due to ESD!</b>	<i>Refers to a possible risk of equipment damage from electrostatic discharge.</i>
	<b>”Any heading“</b>	<i>Refers to an important paragraph in the manual.</i>

Observe the following safety instructions!

## Qualified personnel



### **WARNING – Serious injury possible!**

*Serious personal injury or serious damage to the machine and drives could be caused by insufficiently trained personnel!*

*Without proper training and qualifications damage to devices and injury might result!*

- Design, installation and operation of systems may only be performed by qualified and trained personnel.
- These persons should be able to recognize and handle risks emerging from electrical, mechanical or electronic system parts.
- The qualified personnel must know the content of this manual and be able to understand all documents belonging to the product. Safety instructions are to be provided.
- The trained personnel must know all valid standards, regulations and rules for the prevention of accidents, which are necessary for working with the product.

## Safety Instructions



### **Further Manual**

*This manual is in addition to the following main manual:*

*“phyMOTION™ Modular Multi-axis Controller for Stepper Motors”*

- First, read the main manual and then continue with this manual.

### **Intended use:**



**The phyMOTION™ is designed for operating in a drive system.**

- An installation is allowed only if the requirements of the EC Machinery and EMC Directives are conformed with.

### **Part of a machine:**



*This product is used as a part of a complete system, therefore risk evaluations concerning the specific application must be made before using the product.*

- Safety measures have to be taken according to the results and be verified.
- Personnel safety must be ensured by the concept of this overall system (e.g. machine concept).



**WARNING – Serious injury from electric shock!**

*If the phyMOTION™ is not operated with SELV/PELV voltages, the risk of dangerous voltages may be on the device. Touching these components carrying high voltages can cause serious injury or death from electric shock:*

- Always observe the safety concept SELV / PELV to ensure safe insulation and separation of low voltage supplies from the mains.



**WARNING – Serious injury from electric shock!**

*During electrical installation cables, connectors, etc. can be live.*

- Before starting wiring, make sure that none of the power supplies are connected to the primary side of the mains supply. Isolate the power supplies from the mains or remove the appropriate fuses.
- All modules must be inserted and screwed into the phyMOTION™ housing before powering up. If necessary, unoccupied module slots must be covered with the supplied blank front plates.  
Never operate the equipment when open.
- Do not plug or unplug the modules while powered.
- Do not plug or unplug the connectors while powered.
- If the equipment was energised, wait 3 minutes after power off to allow the capacitors to discharge and ensure that there are no residual charges on cables, connectors and boards.

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### 3 INAM (Internal Amplifier-Module) – Module Overview

INAM01 is a carrier board for stepper motor power stages up to 5 A<sub>PEAK</sub> max. with the APS01 power stage or up to 9 A<sub>PEAK</sub> max. with the LPS01 power stage (as a sub module).

INAM02 is a 1-axis module for the MSX power stage (up to 15 A<sub>PEAK</sub> max.) which is only available in *phyMOTION*<sup>™</sup> configurations with integrated power supply **INT**

Both INAM modules need an Indexer (e.g. I4XM01) in front.

Two limit switches and a third switch, which can be wired as a reference switch evaluation, are included as standard.

In addition, sub modules can be optionally selected for encoder evaluation (ECAS01, ECES01, ECMS01, ECBS01) as well as motor temperature evaluation (PTS01 and KTS01).

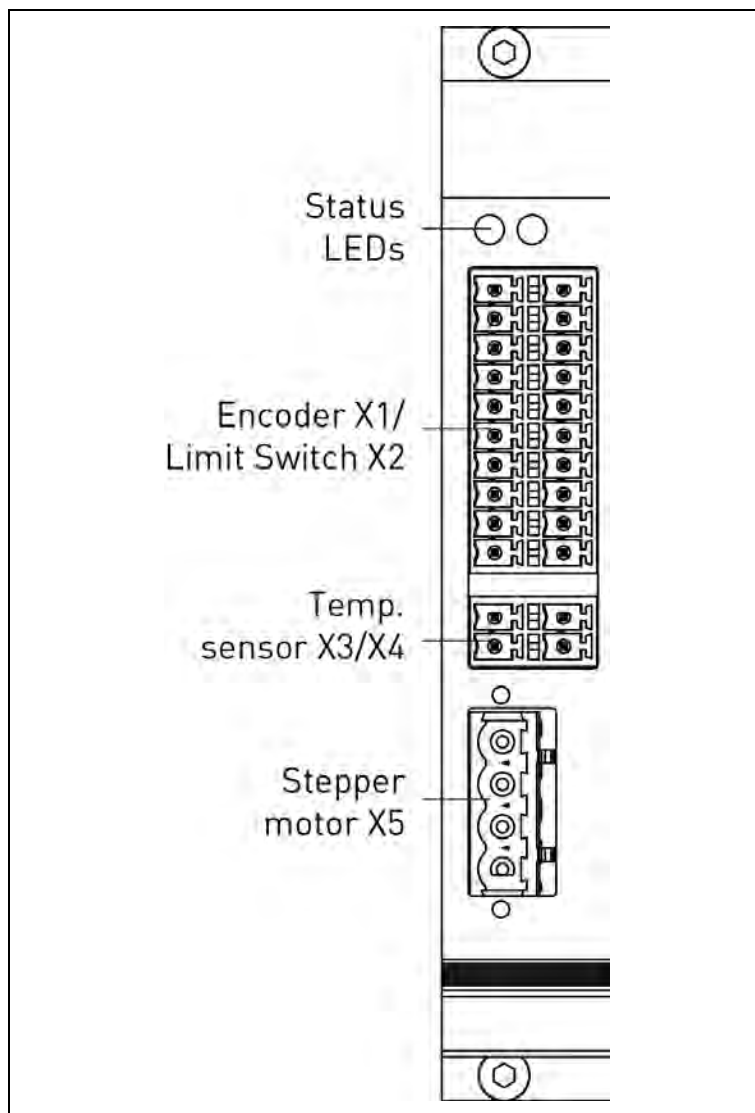


Fig. 1: INAM01 / INAM02 View of the front panel

## Ordering code of the power stage carrier module (INAM01) for the LPS power stage:

Ordering code (example): **INAM01-LPS01-ECAS01-PTS01:**

power stage carrier with LPS power stage, with integrated SSI encoder and Pt sensor

Ordering Code		
Type	Power stage	Encoder evaluation
INAM01	- LPS01 -	ECAS01 - PTS01
Options		
Power Stage	APS01 LPS01	Int. power stage 5A/70V Int. power stage 9A/70V
Encoder evaluation	ECES01 ECAS01 ECBS01 ECMS01	ENDAT encoder SSI/QUADR. encoder BiSS Resolver no encoder module
Temperature evaluation	PTS01 KTS01	Pt sensor K type no temperature module
Mating connectors are included in delivery.		

## Ordering code of the 1 axis stepper motor drive module (INAM02):

Ordering code (example): **INAM02-MSX-ECAS01-PTS01:**

Module with connected MSX power stage, integrated encoder SSI and Pt sensor

Ordering Code		
Type	Power stage	Encoder evaluation
INAM02	- MSX -	ECAS01 - PTS01
Options		
Power stage	MSX	Power stage up to 15 A/70 V
Encoder evaluation	ECES01 ECAS01 ECBS01 ECMS01	ENDAT encoder SSI/QUADR. encoder BiSS Resolver no encoder module
Temperature evaluation	PTS01 KTS01	Pt sensor K type no temperature module
Mating connectors are included in delivery.		



## 4 Technical Data

### 4.1 Declaration of Conformity: Modules gen. & External Supply **EXT**



#### Declaration of Conformity according to EC directive 2014/30/EU (EMC-Directive)

**Name and address of the manufacturer:**

Phytron GmbH,  
Industriestr. 12  
82194 Gröbenzell

We declare that the following product is in conformity with the EC Directives 2014/30/EU relating to EMC.

**Product denomination**

Part-Name	Description
AIM01.1	Analog Input-Module
AIOM01.1	Analog I/O Module
AOM01.1	Analog Output-Module
APS01.1	High-End Stepper Motor Power Stage
CANS01.1	CAN Communication Sub Module
DIOM01.1	Digital I/O Module
DIOM0a.1	Digital I/O Module (customer-specific version)
ECAS01.1	SSI/ Quadratic Encoder Sensing Sub Module
ECES01.1	EnDat Encoder Sensing Sub Module
ECMS01.1	Resolver Evaluation Submodule
EXAM01.1	Indexer Interface Module
I1AM01.1	1-Axis Stepper Motor Drive
I1AM0a.1	1-Axis Stepper Motor Drive (customer-specific version)
I1AM0b.1	Indexer & Power Stage Carrier (cust)
I4XM01.1	4 Axes HighEnd Indexer
INAM01.1	Carrier Module for APS Power Stage
MCM01.1	Main Controller Module
MCM02.1	Main Controller & ext. Power Input
PBS01.1	Profibus Communication Sub Module
PNS01.1	ProfiNet Communication Sub Module
POWM01.1	Main Power Input Module
POWM02.1	Intermediate Power Input Module
RSS01.1	RS485/RS232 Communication Sub Module

From serial number 1604xxxxx

AP QM10672.6  
CE 703a Rev 4

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Güterslocher Sparkasse: IBAN: AT 80 1500 0006 1111 1766 • BIC: OBKLA222XXX

## Applied harmonized standards

- EN 61000-6-1: 2007-01 Electromagnetic Compatibility (EMC) - Immunity for residential, commercial and light-industrial environmental
- EN 61000-6-2: 2005-08 Electromagnetic compatibility (EMC) - Immunity for industrial environments
- EN 61000-6-2: Corrigendum 1:2011
- EN 61000-6-3: 2007-01 Electromagnetic compatibility (EMC) - Emission standard for residential, commercial and light-industrial environments
- EN 61000-6-3: A1:2011
- EN 61000-6-3: AC:2012
- EN 61000-6-4: 2007-01 Electromagnetic compatibility (EMC) - Emission standard for industrial environments
- EN 61000-6-4: A1:2011

## Comment:

This declaration of conformity is valid only if the device is built in a suitable casing e.g. phyMOTION-6SL-MR-s.

Gröbenzell, 2016-04-20



Henning Brunke  
Technical Director

## 4.2 Declaration of Conformity: Modules with Internal Supply INT



### Declaration of Incorporation according to EC directive 2006/42/EC on machinery (Annex II B) for partly completed machinery

**Name and address of the manufacturer:**

Phytron GmbH,  
Industriestr. 12  
82194 Gröbenzell

**Representative in EU, authorized to compile the relevant technical documentation:**

Rainer Gareis  
Phytron GmbH,  
Industriestr. 12  
82194 Gröbenzell

**Description of the partly completed machinery:**

phyMOTION™, with internal power supply assembled with several of the following modules

Part-Name	Description
NETM01.1	Power Supply Input 230V
PEM01.1	Protective Earth Module
MSXS01.1	Power Stage; 15A
INAM02.1	High Performance Power Stage Carrier
POWM03.1	Main Power Input; int. Supply
MCM03.1	Main Controller & internal Supply
POWM04.1	Secondary Power Input; int. Supply

From serial number 1604xxxxx

**We declare that the product complies with the following essential requirements of the Machinery Directive 2006/42/EC:**

1.1.2.; 1.1.5.; 1.3.1.; 1.3.4.; 1.5.1.; 1.5.2.; 1.5.4.; 1.5.5.; 1.5.6.; 1.5.16.; 1.6.3.; 1.6.4.; 1.7.2.; 1.7.3.; 1.7.4.

**In addition the partly completed machinery is in conformity with the following EC Directives:**

EC Directives 2014/35/EU relating to electrical equipment  
EC Directives 2014/30/EU relating to electromagnetic compatibility.

**We declare that the relevant technical documentation is compiled in accordance with part B of Annex VII.**

Rev. 1.0  
CE 7048 Rev. 2

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**Comment:**

This declaration of conformity is valid only if the device is built in a suitable casing e.g. phyMOTION-6SL-MR-s.

Gröbenzell, 2016-04-20

Henning Brunke  
Technical Director

AP QM-0672-8  
CE 1049 Rev.2

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### 4.3 Mechanical Data

<b>Dimensions</b>	100 x 100 mm (without front panel)
<b>Weight</b>	INAM01: APS: 94 g / 71 g (without / with front panel) LPS: 95 g / 72 g (without / with front panel) INAM02: 75 g / 52 g (without / with front panel)
<b>Mounting</b>	Plug-in module into the modular stepper motor controller <i>phy</i> <b>MOTION</b> <sup>TM</sup>
<b>Mounting position</b>	Vertical

## 4.4 Features

Performance Characteristics	
<b>Stepper motor</b>	Suitable for bipolar control of 2 phase stepper motors with 4, (6) or 8 lead wiring
<b>Superior controller</b>	Modular <i>phyMOTION</i> <sup>TM</sup> controller
<b>Supply voltage</b>	with APS/LPS 24...70 V <sub>DC</sub> Nominal voltage: 70 V <sub>DC</sub> with MSX 70...120 V <sub>DC</sub> Nominal voltage: 120 V <sub>DC</sub>  I/O voltage 24 V <sub>DC</sub> APS: 5 V <sub>DC</sub> internal LPS: 3.3 V <sub>DC</sub> logic voltage
<b>Phase current</b>	with APS 0.1 to 5 A <sub>PEAK</sub> , (short-circuit-proof, overload-proof) with LPS 0.1 to 9 A <sub>PEAK</sub> with MSX 0.8 to 15.4 A <sub>PEAK</sub>
<b>Current adjustment</b>	with APS 10 mA steps with LPS 20 mA steps with MSX 10 / 20 / 30 mA steps (dep. on the MSX type)
<b>Step resolutions</b>	with APS Full step, half step, 1/2,5, 1/4, 1/5, 1/8, 1/10, 1/16, 1/20, 1/32, 1/64, 1/128, 1/256, 1/512 with LPS Full step, half step, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, 1/256 with MSX Full step, half step, 1/4, 1/5, 1/10, 1/20
<b>Maximum step frequency</b>	with APS 500,000 steps/sec. with LPS 250,000 steps/sec. with MSX 500,000 steps/sec.
<b>Physical resolution</b>	with APS Approx. 102,400 positions per revolution (0.00035° / step).  with LPS Approx. 51,200 positions per revolution (0.00070° / step).  The optional encoder modules should be considered for very fine positioning  with MSX about 4000 (0.09° / step)

<b>Current consumption (max.)</b>	<p>with APS      3.6 A<sub>DC</sub> at 5 A<sub>PEAK</sub> 250 mA (5 V<sub>DC</sub> internal)</p> <p>with LPS      6.6 A<sub>DC</sub> bei 9.2 A<sub>PEAK</sub> &gt;420 mA (3.3 V<sub>DC</sub> logic voltage)</p> <p>with MSX      3 / 6 / 10 A<sub>DC</sub> at 15 A<sub>PEAK</sub> (dep. on the MSX type)</p> <p>10 mA (24 V<sub>DC</sub> I/O)</p> <p>30 mA (EnDat Encoder 5 V<sub>DC</sub> internal)</p> <p>20 mA + Encoder (24 V<sub>DC</sub> I/O)</p> <p>30 mA (temperature module)</p>
<b>Mechanical output power</b>	<p>with APS      up to 70 V / 5 A</p> <p>with LPS      up to 70 V / 9 A</p> <p>with MSX      up to 120 V / 15 A</p>
<b>Nominal power of the motor voltage supply</b>	<p>with APS      100 W</p> <p>with LPS      460 W</p> <p>with MSX      300 / 600 / 1200 W (dep. on the MSX type)</p>
<b>Cable length – motor</b>	Shielded: 50 m max.
<b>Cable length – digital inputs</b>	30 m; if longer (100 m max.) use shielded cable and contact shield close to the controller.
<b>Diagnostics</b>	<p>Possibility for connection via 2 signal cables with 3.3 V logic level:</p> <p>LED1: power stage ready</p> <p>LED2: error</p>
<b>Support of linear and rotary axes</b>	Yes
<b>Hardware error detection</b>	<p>with APS      Over current, short circuit &gt; 10 A Over temperature T&gt;85 °C</p> <p>with LPS      None</p> <p>with MSX      Over current, short circuit &gt; 8.4 / 16.8 / 25.2 A (dep. on the MSX type)</p> <p>Over temperature T&gt;85 °C</p>

Interfaces	
<b>Analogue outputs</b>	A, B, C, D for a 2 phase stepper motor
<b>Analogue inputs</b>	Option: Motor temperature evaluation <ul style="list-style-type: none"> <li>- K thermal element (needs sub module: KTS01)</li> <li>- Pt100 sensor (needs sub module: PTS01)</li> </ul>
<b>Digital inputs</b>	3 Limit switches: PNP- NOC/NCC Option: Encoder evaluation <ul style="list-style-type: none"> <li>- with ECAS01 sub module: incremental or SSI</li> <li>- with ECES01 sub module: EnDat, incremental or SSI</li> <li>- with ECBS01 sub module: incremental, SSI or BiSS</li> <li>- with ECMS01 sub module: Resolver, LVDT or RVDT</li> </ul>
Communication and Programming	
<b>Programming</b>	Via phytron's programming environment <i>phyLOGIC</i> <sup>TM</sup> ToolBox
<b>Communication</b>	Master-slave communication. The INAM is slave and communicates with the MCM main controller module.



## 4.5 Functions

**INAM01: Integrated APS or LPS power stage with encoder and temperature module as option**

**INAM02: Connected MSX power stage with encoder and temperature module as option**


- Relative and absolute positioning
- Reference movements/ speed mode
- Step frequency: APS up to 500,000 steps/sec.  
LPS up to 250,000 steps/sec.  
MSX up to 500,000 steps/sec.

**INAM01: Integrated 5 A<sub>PEAK</sub> power stage APS01**

- Integrated 5 A<sub>PEAK</sub> / 24 to 70 V<sub>DC</sub> stepper motor power stage
- Selectable step resolution up to 1/512 micro step
- Online power stage parameterisation and diagnostics

**INAM01: Integrated 9 A<sub>PEAK</sub> power stage LPS01**

- Integrated 9 A<sub>PEAK</sub> / 24 to 70 V<sub>DC</sub> stepper motor power stage
- Selectable step resolution up to 1/256 micro step
- Online power stage parameterisation and diagnostics

**INAM02  Connected 15.4 A<sub>PEAK</sub> power stage MSX**

- 15.4 A<sub>PEAK</sub> / 70 or 120 V<sub>DC</sub> stepper motor power stage
- Selectable step resolution up to 1/20 micro step
- Online power stage parameterisation and diagnostics

### 3 Limit/reference switches

- Evaluation of up to three limit/reference switches (PNP NCC/NOC)

### **Option: Encoder evaluation**

- The evaluation of the following encoders depends on the selected sub module:
  - with ECAS01 sub module: incremental or SSI
  - with ECES01 sub module: EnDat, incremental or SSI
  - with ECBS01 sub module: BiSS, incremental or SSI
  - with ECMS01 sub module: Resolver, LVDT or RVDT

### **Option: Motor temperature evaluation**

- The evaluation of Pt100 temperature sensors (with PTS01 sub module) or K types (with KTS01 sub module) is possible depending on the selected sub module.

## 5 Installation

Phytron always delivers the **phyMOTION™** completely assembled in order to make sure you can start with the installation and the wiring right away.



### Further manual

*Detailed information on this subject is in a supporting manual:*

**“phyMOTION™ Modular Multi-axis Controller for Stepper Motors”**

## 5.1 Mechanical Installation

### 5.1.1 INAM01

In case you receive an individually packed INAM01 as an expansion module or after repair or service unpack the module in ESD protected area only.



#### CAUTION – Possible damage by ESD!

*The modules of the **phyMOTION™** consist of sensitive electronic components that can be destroyed by electrostatic discharge voltages.*

- Always store and transport single modules in ESD protective packaging.
- Always handle the components in compliance with the ESD protection measures.
- No liability is accepted for any consequences resulting from improper handling or non-ESD-friendly packaging.



#### CAUTION – Possible damage!

*The INAM01 module is designed for a maximum supply voltage of 48 V<sub>DC</sub>. If it is supplied with >48 V<sub>DC</sub> the card might be damaged.*

- Make sure that a power module (POWM01, POWM02) is supplied on the left with less than 48 V<sub>DC</sub> to avoid damage.

Before integrating or switching modules always make sure that the **phyMOTION™** is shut down and the power supplies are disconnected.



### **WARNING – Serious injury from electric shock!**

*During electrical installation cables, connectors, etc. can be live.*

- Before starting wiring, make sure that none of the power supplies are connected to the primary side of the mains supply. Isolate the power supplies from the mains or remove the appropriate fuses.
- All modules must be inserted and screwed into the *phyMOTION*<sup>TM</sup> housing before powering up. If necessary, unoccupied module slots must be covered with the supplied blank front plates.  
Never operate the equipment when open.
- Do not plug or unplug the modules while powered.
- Do not plug or unplug the connectors while powered.
- If the equipment was energised, wait 3 minutes after power off to allow the capacitors to discharge and ensure that there are no residual charges on cables, connectors and boards.

Make sure not to leave free slots in between modules so the module addressing sequence can work correctly.

Identify the correct slot position for your INAM01 referring to your order and documentation. The INAM01 needs at least a preceding power module (POWM01, POWM02), the main controller module (MCM01) and an additional indexer (EXAM01).

Push the module carefully into the guide rail until the rear contacts the housing frame of the *phyMOTION*<sup>TM</sup>.

In the last few millimetres the module's plug has to match with the backplane's socket. You should be able to push in the module with light pressure. In case you experience problems move the module's front plate slightly to the left and to the right while pushing in the module, so that the plug's pins can slide into the backplane's socket.

As soon as the module's front plate contacts the housing's frame the module is integrated properly and can be fixed with two electro-conductive bolts.

Now you can start with the electrical installation.

## 5.1.2 INAM02

The INAM02 module is only installed in phytron's plant.

## 5.2 Electrical Installation

Ensure sufficient bending radius of the cables during installation. Do not lay the cables in tension or bend them.

We recommend labeling the mating connectors to prevent interchanging the connectors.

If all the connections are made, the last step is to plug in the power supply to the mains.

### 5.2.1 Connectors - Overview

Connector	Number of pins	Connector on the module (Phoenix)	Mating connector (Phoenix)	Mating connector ID number
INAM01: Motor (X5)	1x4	IC 2,5/4-G-5,08	IC 2,5/4-ST-5,08	10005390
INAM02: Motor (X5)	1x4	IC 2,5 HC/ 4-G-5,08	FKIC 2,5 HC/4-ST-5,08	10015856
Limit switches (X2)	1x10	MCDN1,5/10-G1-3,5P26	FMC1,5/10-ST-3,5	10013217
Encoder (X1)	1x10	MCDN1,5/10-G1-3,5P26	FMC1,5/10-ST-3,5	10013217
Temperature evaluation (X3/X4)	2x2	MCDN1,5/2-G1-3,5P26	FMC1,5/2-ST-3,5	10007077

The mating connector is included in delivery of the module and is usually plugged into the module at the factory.



#### CAUTION – Possible damage!

*Damage of the module by wrong connection.*

- Do not exchange the 10-pin connector for limit switches with the 10-pin connector for the encoder evaluation. Module and encoder can be damaged.

## 5.2.2 Pin Assignment

In the following the pin assignment:

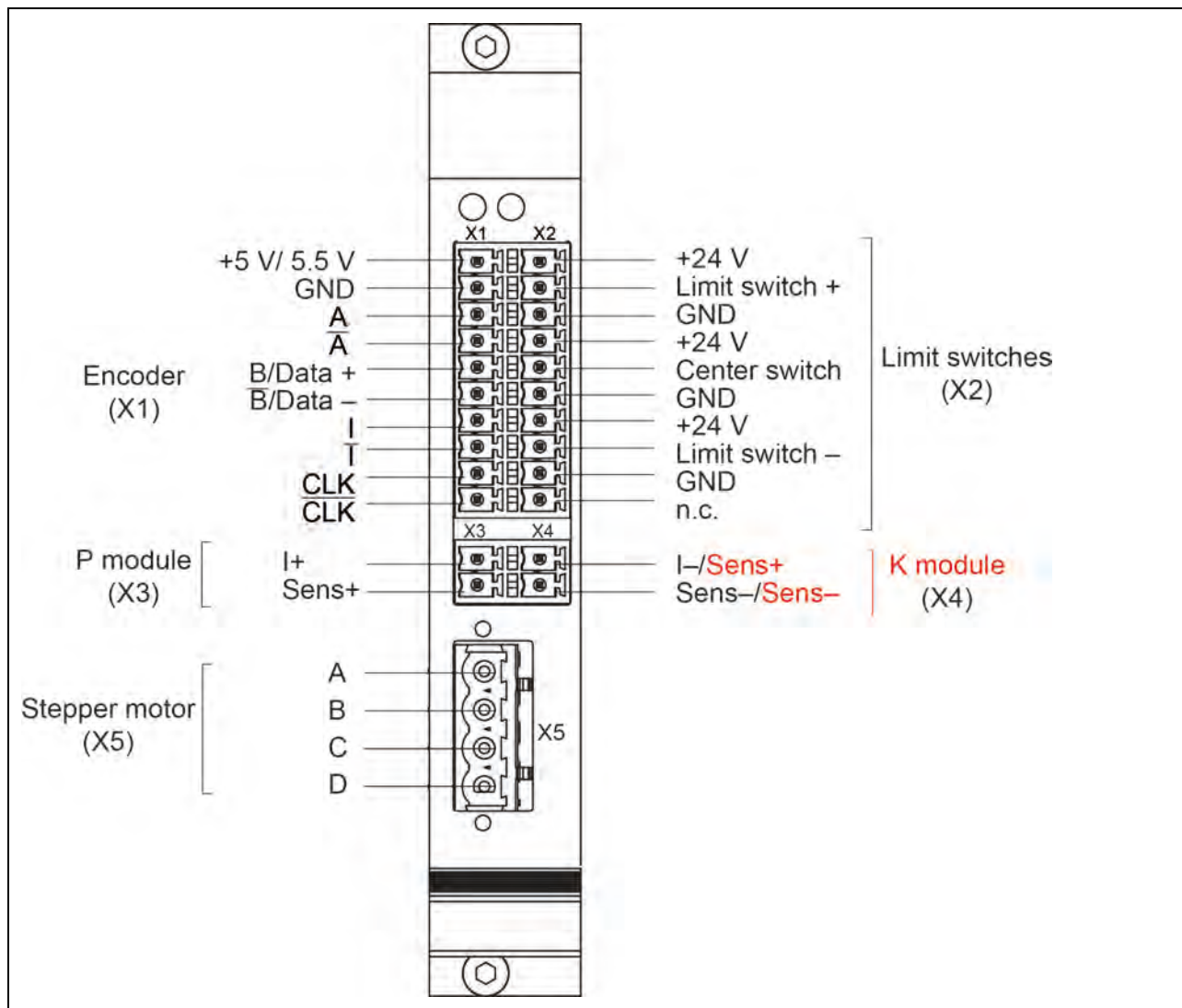


Fig. 2: Pin assignment INAM01 / INAM02

Use the specified mating connectors for wiring.



### CAUTION – Possible damage!

*Damage of the module by wrong connection.*

- Do not exchange the 10-pin connector for limit switches with the 10-pin connector for the encoder evaluation. Module and encoder can be damaged.

### 5.2.3 Stepper Motor Connection X5

Stepper motors with the INAM01 module can be driven with 0.1 to 5 A<sub>PEAK</sub> phase current at max. 70 V<sub>DC</sub>, with the INAM02 module motors up to 15.4 A<sub>PEAK</sub> phase current at max. 120 V<sub>DC</sub>.

In the next chapter the connection of a 2 phase stepper motor with 4, (6), or 8 lead wiring is described.

#### Wiring schemes

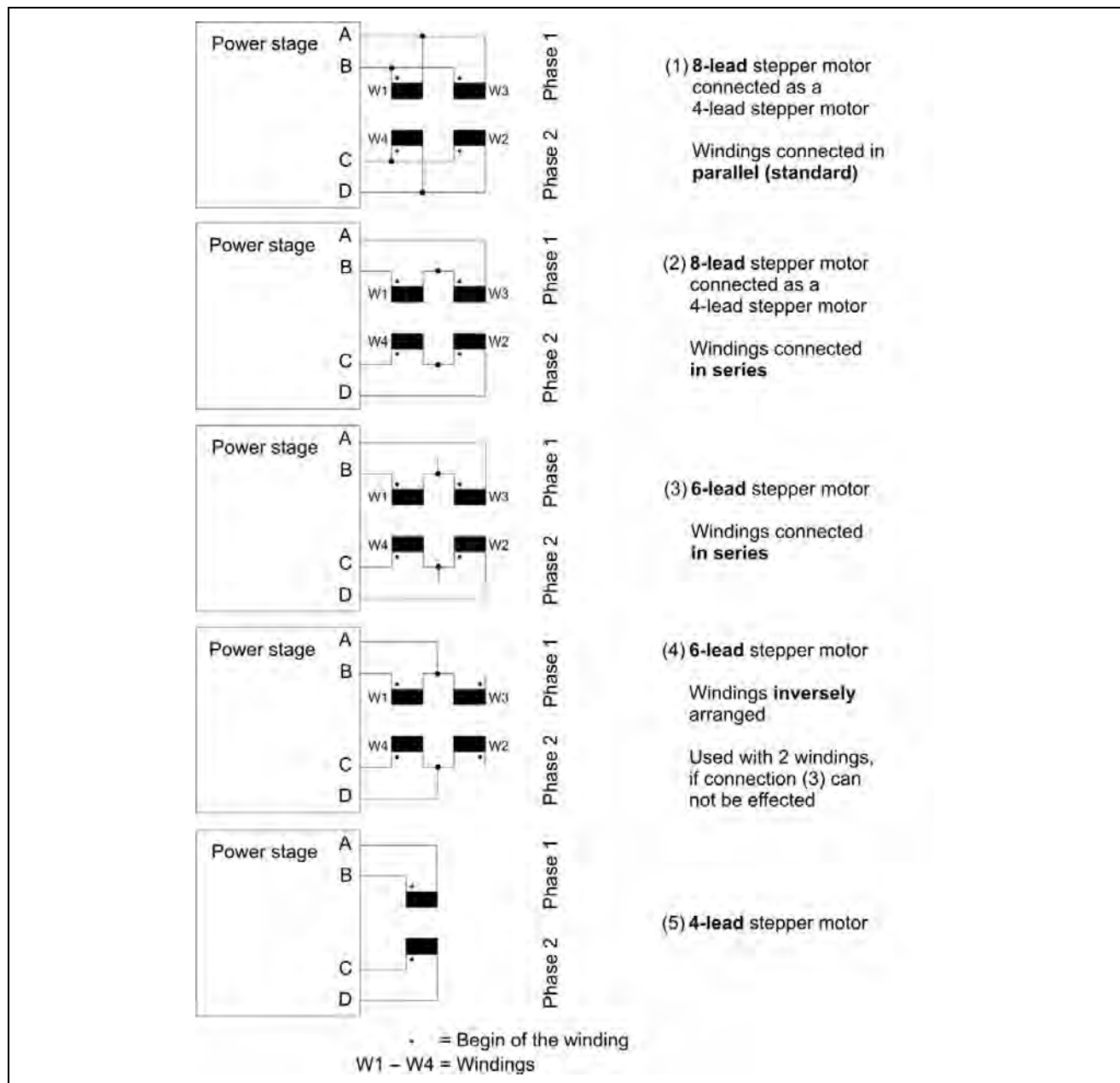


Fig. 3: Connection diagrams for 4,(6) and 8 lead stepper motors

Stepper motors with 8 leads can be connected with the windings wired in parallel (1) or series (2).

For 6 lead stepper motors, wiring scheme (3) with series windings is recommended.

If wiring scheme (3) cannot be used because of the motor construction, the motor may be operated with only two of the four windings energized according to wiring scheme (4).



## CAUTION – Possible damage!

*Destruction of the power stage by connecting a 5 phase stepper motor.*

- Do not connect any 5 phase stepper motors to avoid damage.

## Motor time constant $\tau$ :

$\tau = \frac{L}{R}$  applies to the electrical motor time constant  $\tau$ .

The total inductance  $L_{\text{total}}$  is equal to the winding inductance in a parallel circuit, because of interlinked inductances.

$L_{\text{total}} = 4 \times L$  applies to a series circuit.

The result is an equal motor time constant  $\tau$  for a serial and a parallel circuit:

Circuit	series	parallel
Resistance $R_{\text{total}}$	$2 \times R$	$\frac{R}{2}$
Inductance $L_{\text{total}}$	$4 \times L$	$L$
Motor time constant $\tau$	$\tau_{\text{series}} = \frac{4 \times L}{2 \times R} = \frac{2 \times L}{R}$	$\tau_{\text{parallel}} = \frac{L}{R/2} = \frac{2 \times L}{R}$



**If motor voltage >70 V: all equipment must be grounded!**



**WARNING – Serious injury from electric shock!**

*If the phyMOTION™ is not operated with SELV/PELV voltages, the risk of dangerous voltages may be on the device. Touching these components carrying high voltages can cause serious injury or death from electric shock:*

- Always observe the safety concept SELV / PELV to ensure safe insulation and separation of low voltage supplies from the mains.



**WARNING – Serious injury from electric shock!**

*Bei der elektrischen Installation können Kabel, Stecker o.ä. stromführend sein.*

- Before starting wiring, make sure that none of the power supplies are connected to the primary side of the mains supply. Isolate the power supplies from the mains or remove the appropriate fuses.
- All modules must be inserted and screwed into phyMOTION™ housing before powering up. If necessary, unoccupied module slots must be covered with the supplied blank front plates. Never operate the equipment when open.
- Do not plug or unplug the modules while powered.
- Do not plug or unplug the connectors while powered.
- If the equipment was energised, wait 3 minutes after power off to allow the capacitors to discharge and ensure that there are no residual charges on cables, connectors and boards.



**CAUTION – Possible damage!**

*To avoid damage please consider the following items in your safety concept:*

- When protection by automatic disconnection (EN 61140, VDE 0100, part 410) is used for power stages with definite voltage  $> 50 V_{AC}$  or  $+U_B > 70 V_{DC}$ :
- Only use motors, which are checked according to EN 60034-1 (500  $V_{AC}$  + twice determined voltage).
- The motors must have a protective conductor clamp (EN 60034).

For stepper motor grounding the PE wire is connected to the PE clamp of the PEM01 module or the NETM01 module.

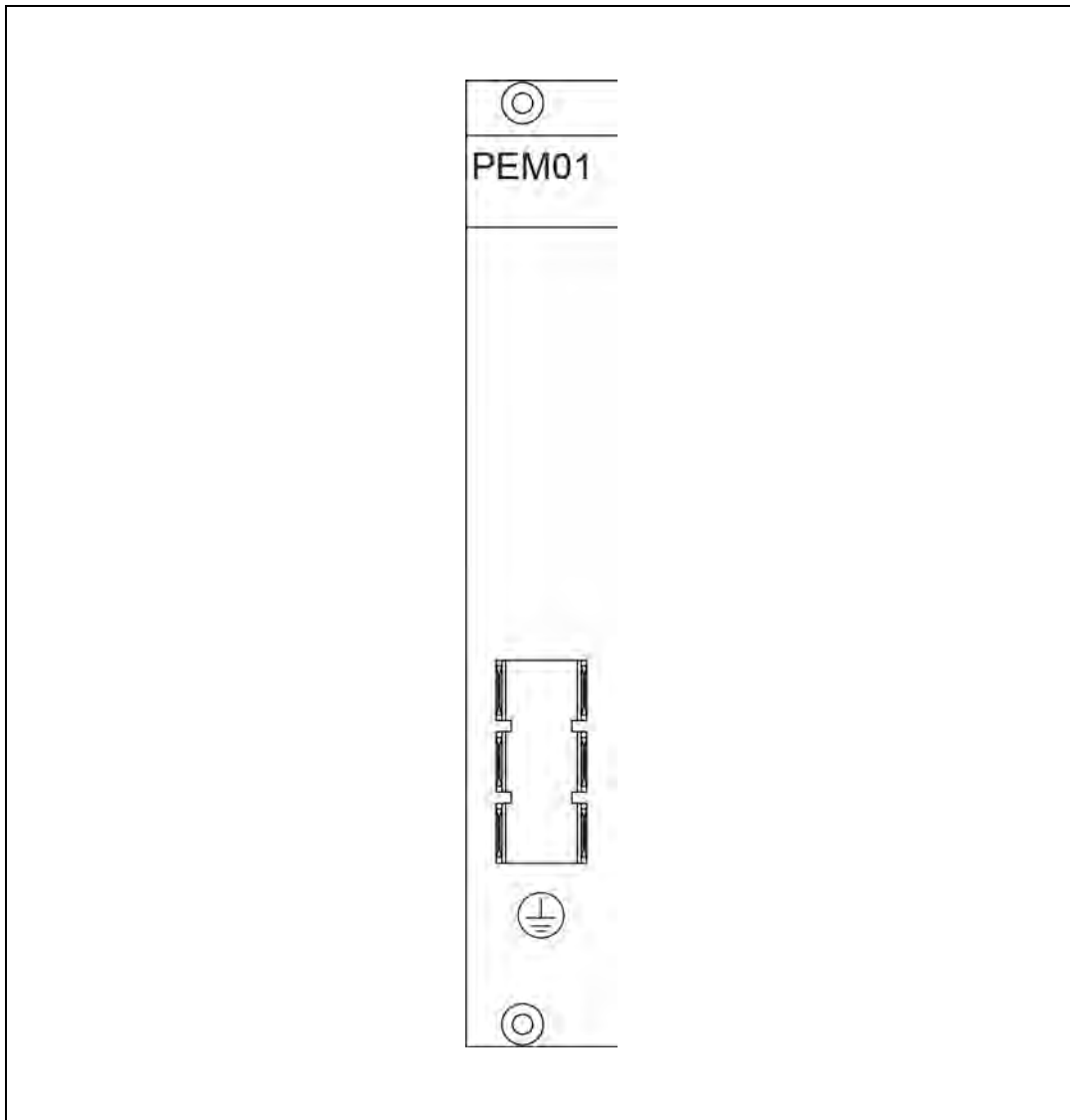


Fig. 4: PE connection for 5-wire motor cable by the PEM01 module

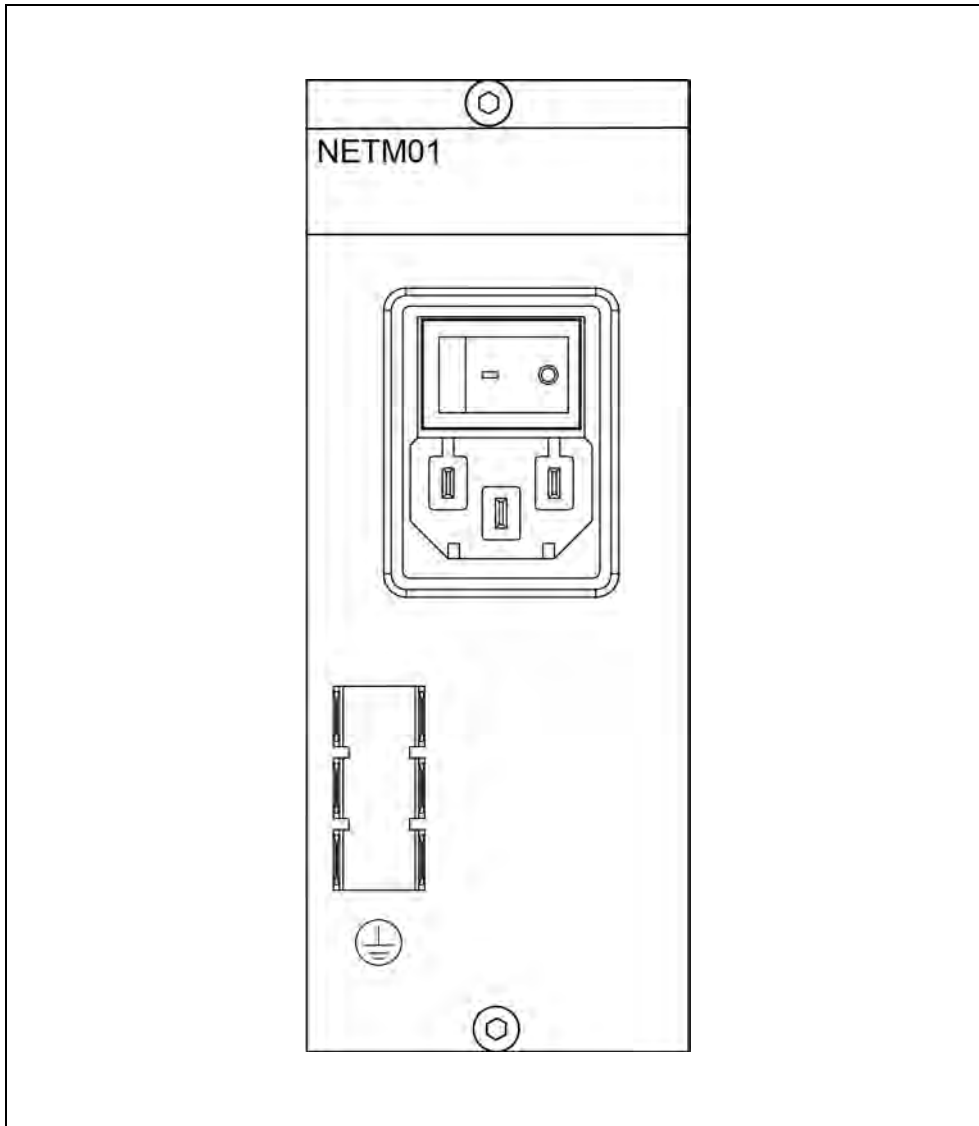


Fig. 5: PE connection for 5-wire motor cable by the NETM01 module

## 5.2.4 Limit Switch Connection X2

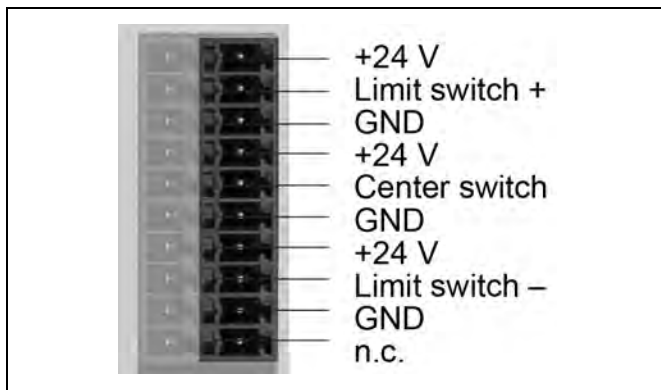


Fig. 6: Pin assignment of the limit switches

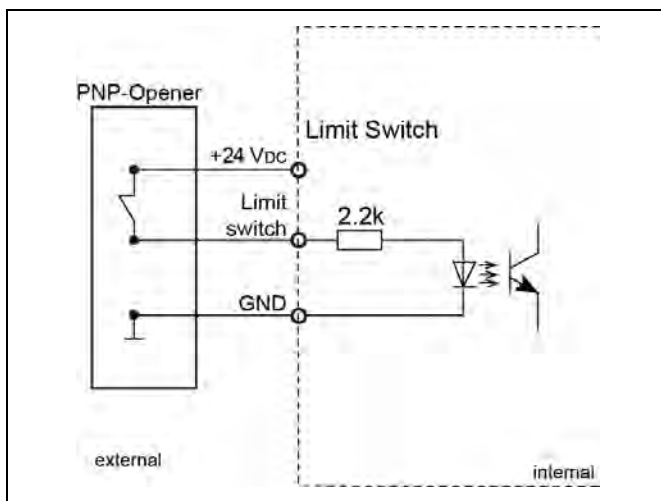


Fig. 7: Input wiring

The module is designed for connection of up to three limit switches type PNP-NOC/NCC. A limit switch is determined for monitoring the movement in the + direction (limit switch +), the second in the – direction (limit switch –). The third switch (centre switch) for example can be used as a reference switch. The switch type PNP NCC has the advantage that cable breaks can be detected.

Mechanical limit switches (NCC) can also be used.

- i CAUTION – Possible damage!**
- Damage of the module by wrong connection.*
- Do not exchange the 10 pin connector for limit switches with the 10 pin connector for the encoder evaluation. Module and encoder can be damaged.

## 5.2.5 Option: Encoder Connection X1

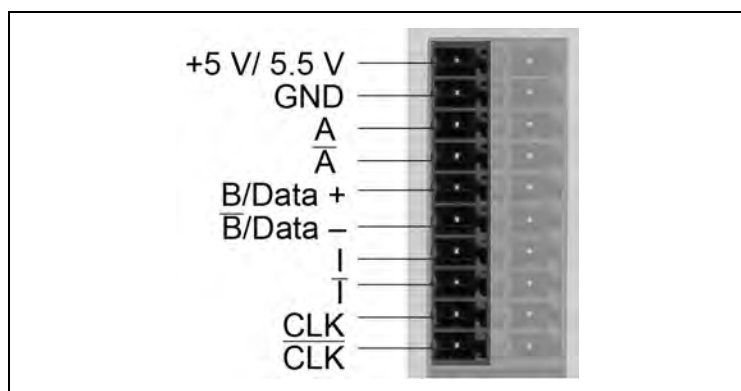


Fig. 8: Pin assignment of the encoder

- Suitable encoder types depend on the selected evaluation module:
  - with **ECAS01** sub module: **differential incremental encoder** with quadrature signals or absolute encoder according to the **SSI** standard
  - with **ECES01** sub module: **EnDat**, **differential incremental encoder** with quadrature signals or absolute encoder according to the **SSI** standard
  - with **ECBS01** sub module: **differential incremental encoder** with quadrature signals or absolute encoder according to the **SSI** standard or **BiSS** standard
  - with **ECMS01** sub module: **Resolver**, **LVDT** or **RVDT**
- The incremental encoder supply voltage is generated by the controller.
- Use shielded cables, twisted pair, for encoder connection. The transmission mode includes no protection against faulty transmission values.
- Wiring diagrams for the encoder types: see next pages.



### CAUTION – Possible damage!

*Damage of the module by wrong connection..*

- Do not exchange the 10 pin connector for limit switches with the 10 pin connector for the encoder evaluation. Module and encoder can be damaged.
- Please observe the supply voltage of the encoder: 5 V or 15 V
- Also ensure that the encoder is configured correctly in its programming. The connection of an incremental encoder and parameterising for SSI can cause damage.

## **Encoder - Technical Specification**

<b>Encoder type</b>	<b>Supply</b>	<b>Resolution</b>	<b>Supported types</b>
<b>Differential</b>	5 V / 5.5 V; 500 mA	$2^{32}$	Quadratur with zero track
<b>SSI</b>	5 V / 5.5 V; 500 mA	$2^{31}$	SSI
<b>BiSS</b>	5 V / 15 V; 500 mA	$2^{31}$	BiSS-C BiSS-B
<b>Endat</b>	5 V / 5.5 V; 500 mA	$2^{31}$	Endat 01 02 21 22 T
<b>Resolver</b>	5 to 10 V <sub>rms</sub> ; 1 to 10 kHz	$2^{12}$	Resolver 6-wire LVDT / RVDT 4-/5-/6-wire

## Wiring of the encoder

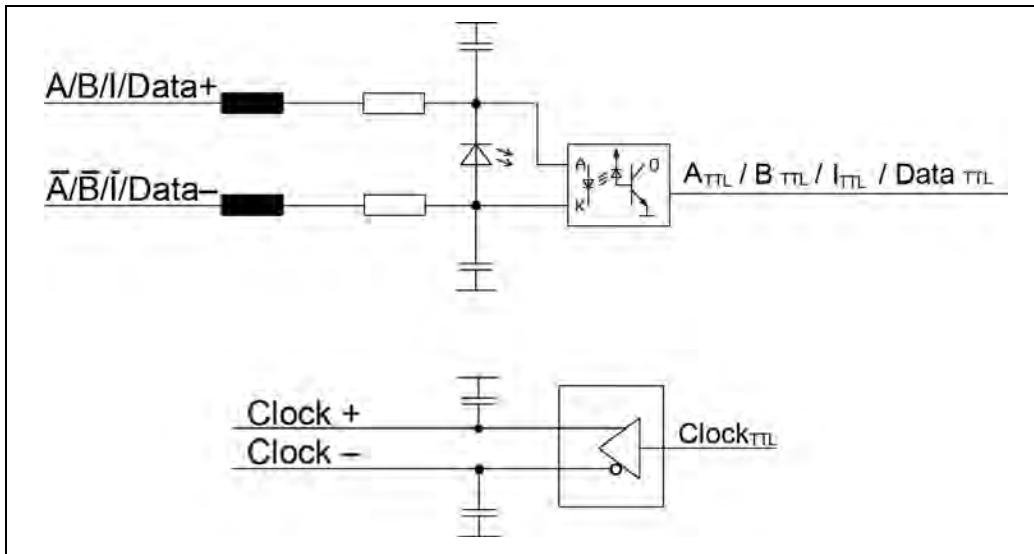


Fig. 9: Wiring: SSI/Quadrature

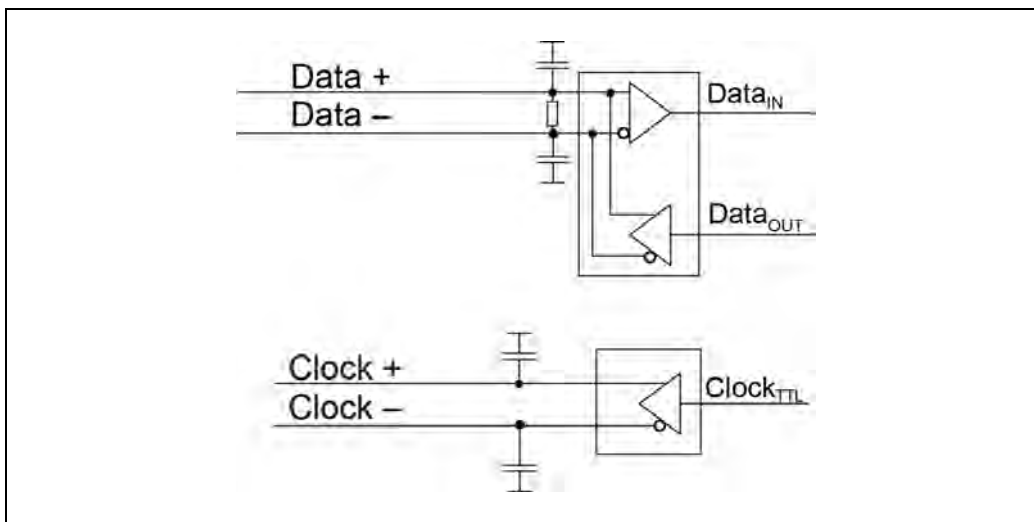


Fig. 10: Wiring: EnDat/BiSS encoder

Resolver wiring refer to chap. 5.2.6

**Optional accessories: adapter cable for EnDat encoder**

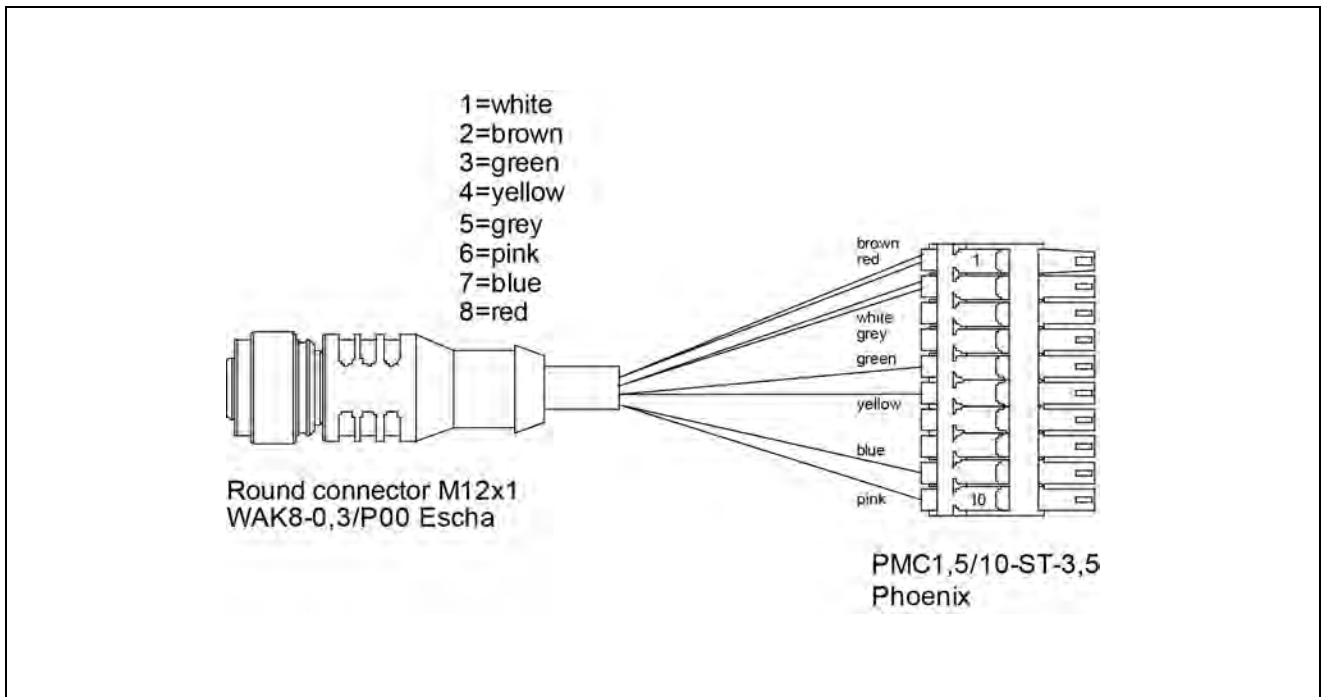


Fig. 11: Adapter cable (ID no 10014905)



## 5.2.6 Option: Resolver, LVDT or RVDT Connection X1

### Characteristics

- Excitation amplitude: 5 to 10 V<sub>r.m.s</sub>
- Excitation frequency: 10 kHz
- Excitation current: up to 150 mA
- Resolution: up to 8 arcmin (8/4096 increments/rev.)

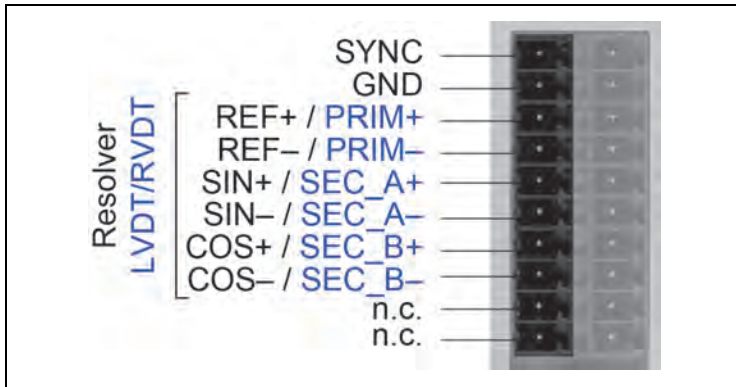


Fig. 12: Pin assignment of the encoder connector

### Setable parameters

- Primary sinusoidal voltage from 5 to 10 V<sub>r.m.s</sub>. in 1 V steps.
- Ratio from 1/8 to 2 (1/8, 1/4, 1/2, 1 and 2) only in the resolver or 5/6-wire-LVDT mode
- Operating modes: Resolver, 4-wire-LVDT and 5/6-wire-LVDT

The supply voltage for the ECSM module is provided by the controller.



Use shielded cables, twisted pair, for encoder connection. The transmission mode includes no protection against faulty transmission values

### Default values

Operating mode: Resolver

Excitation amplitude: 5 V<sub>r.m.s</sub>

Ratio: 1/2

SYNC-Slave: deactivated

## Operating modes of the encoders

### Resolver

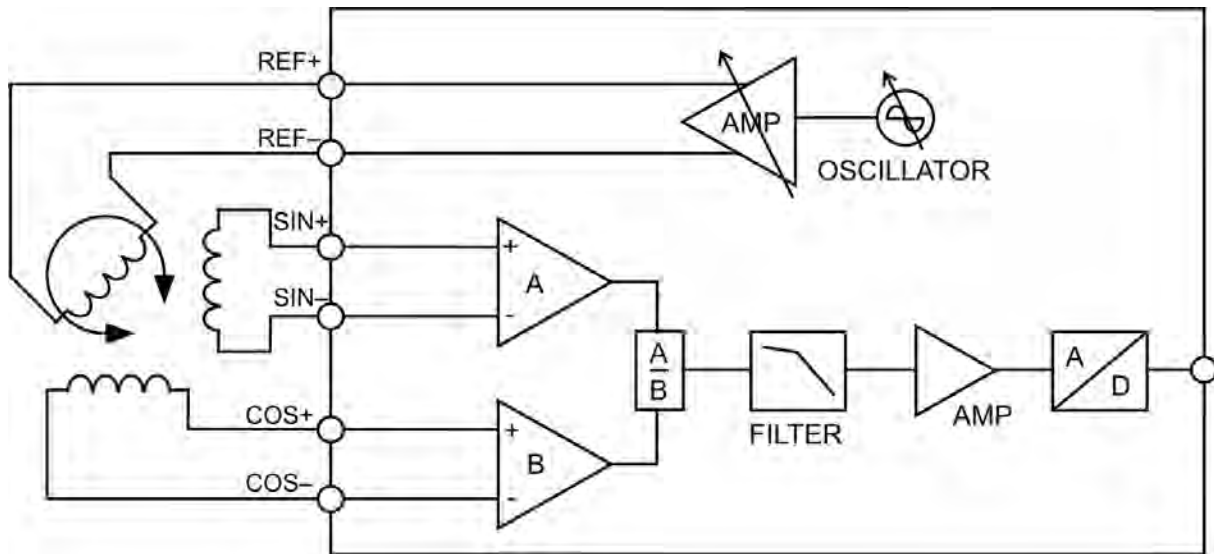


Fig. 13: Resolver wiring

### 4-wire-LVDT

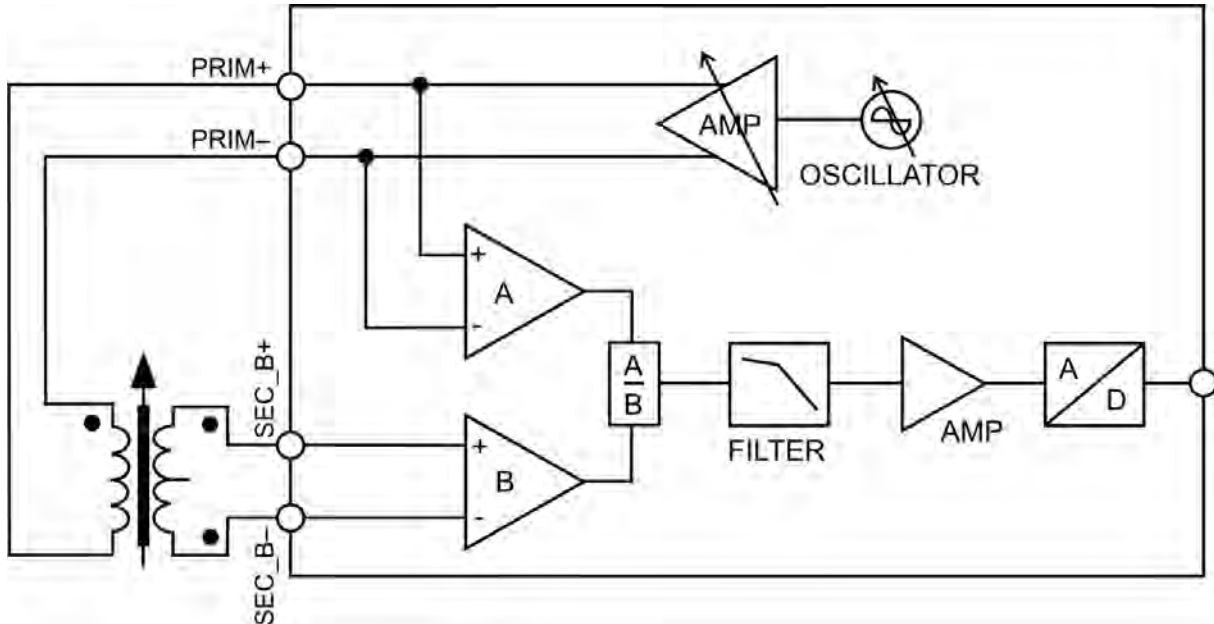


Fig. 14: 4-wire-LVDT/RVDT wiring (full bridge)

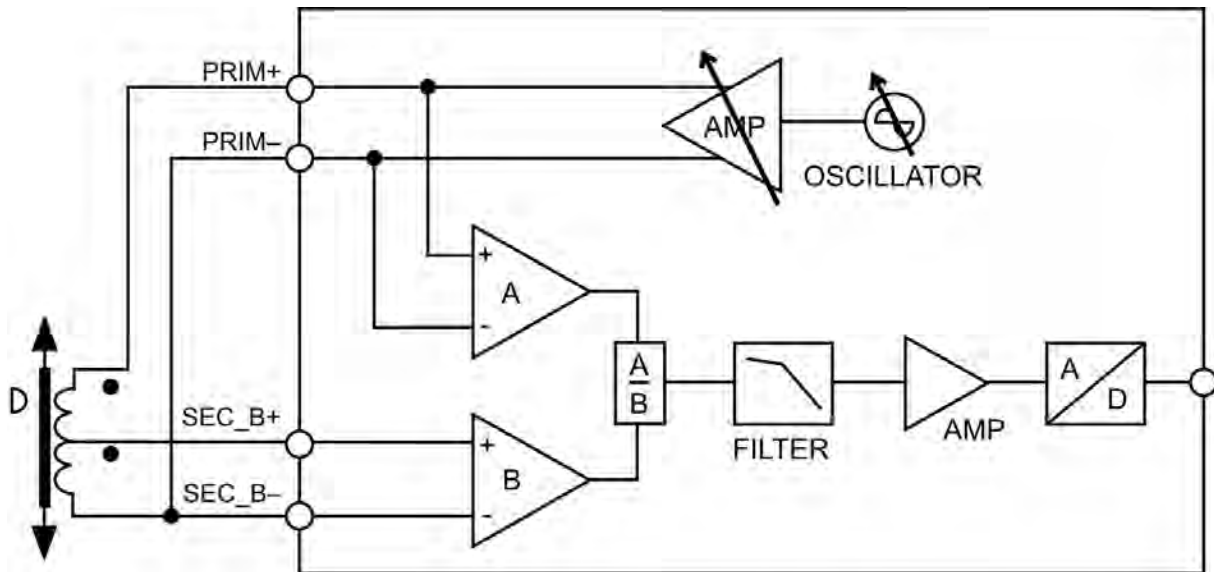


Fig. 15: 4-wire-LVDT/RVDT-wiring (half bridge)

#### 5/6-wire-LVDT

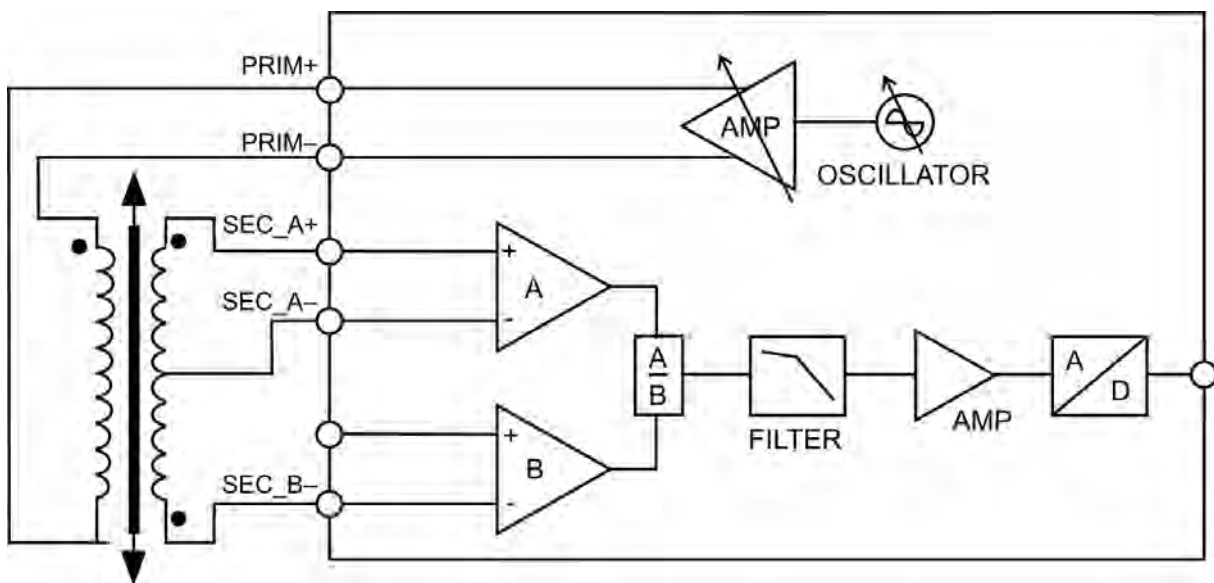


Fig. 16: 5-wire-LVDT/RVDT-wiring

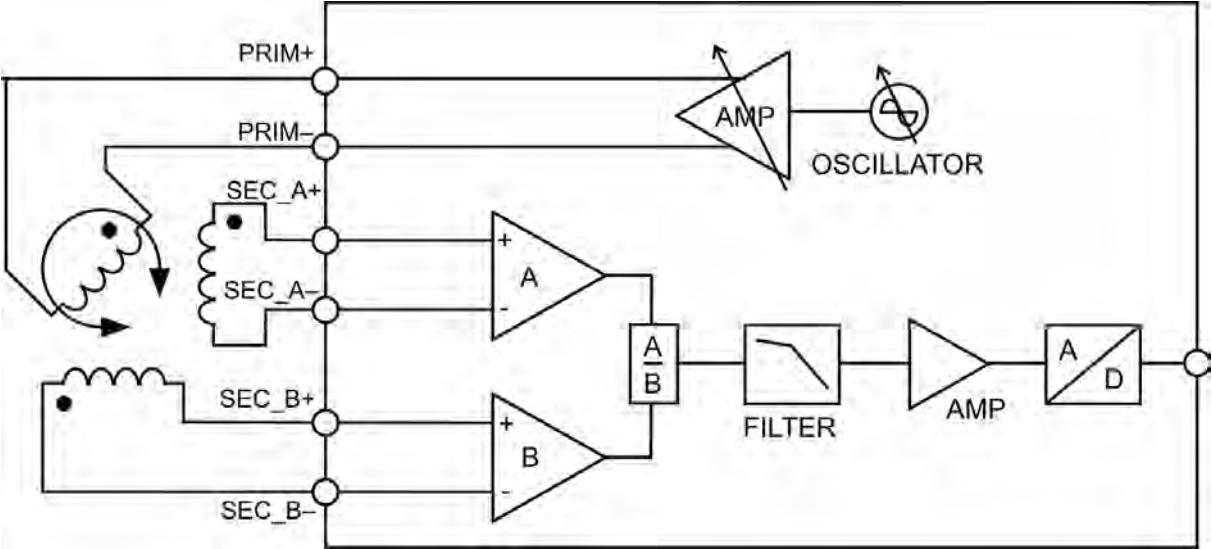


Fig. 17: 6-wire-LVDT/RVDT-wiring

## Synchronisation

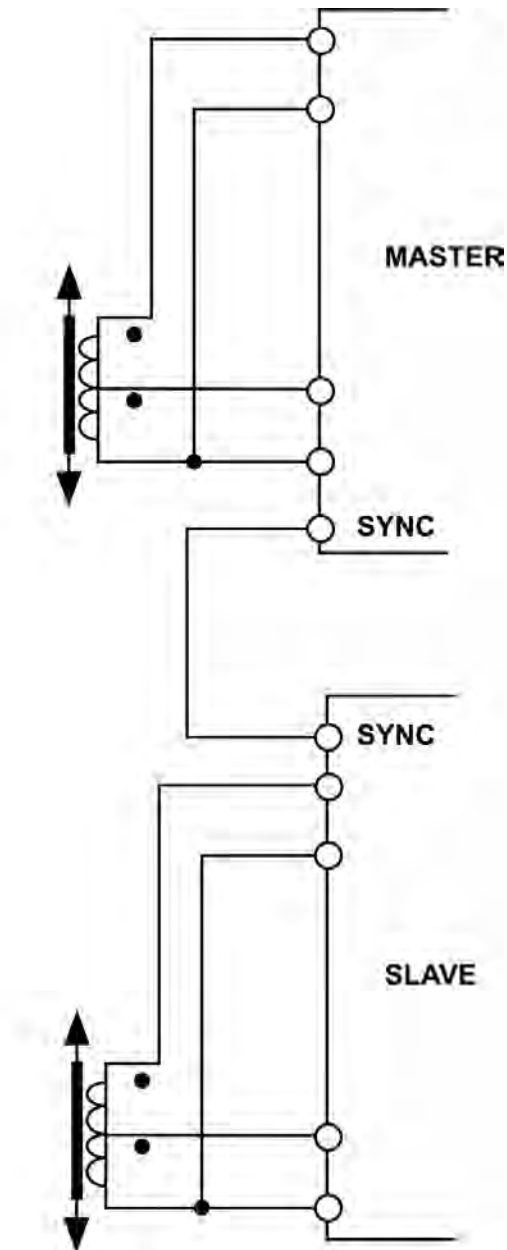


Fig. 18: Synchronisation wiring

## 5.2.7 Option: Motor Temperature Sensor Connection X3/X4

The temperature evaluation module is used for monitoring the stepper motor temperature.

Depending on the selected evaluation module (KTS01 or PTS01) thermal elements type K or platinum sensors PT100 can be used.

The insulated temperature sensor in phytron motors is integrated in the motor windings. The response time is very short, compared to temperature sensors mounted outside the motor housing. The temperature is measured all the time, even if only one motor phase is powered at any one time.

### Thermal element type K

With the Type K (NiCr-Ni) in-vacuum and cryo stepper motors, thermal elements in the temperature range from  $-270$  to  $+1370$  °C, accuracy class 1, are used.

The Type K is a metal thermal element with nickel-based alloy conductors. Temperature ranges, accuracy and characteristics of thermal elements for industrial use are defined in the IEC 584 standard (temperature measuring with thermal elements).

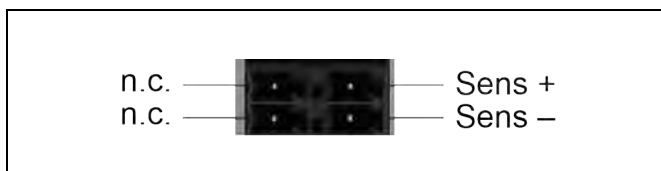


Fig. 1: K element connection

### Principle of the stepper motor temperature measurement by element type K:

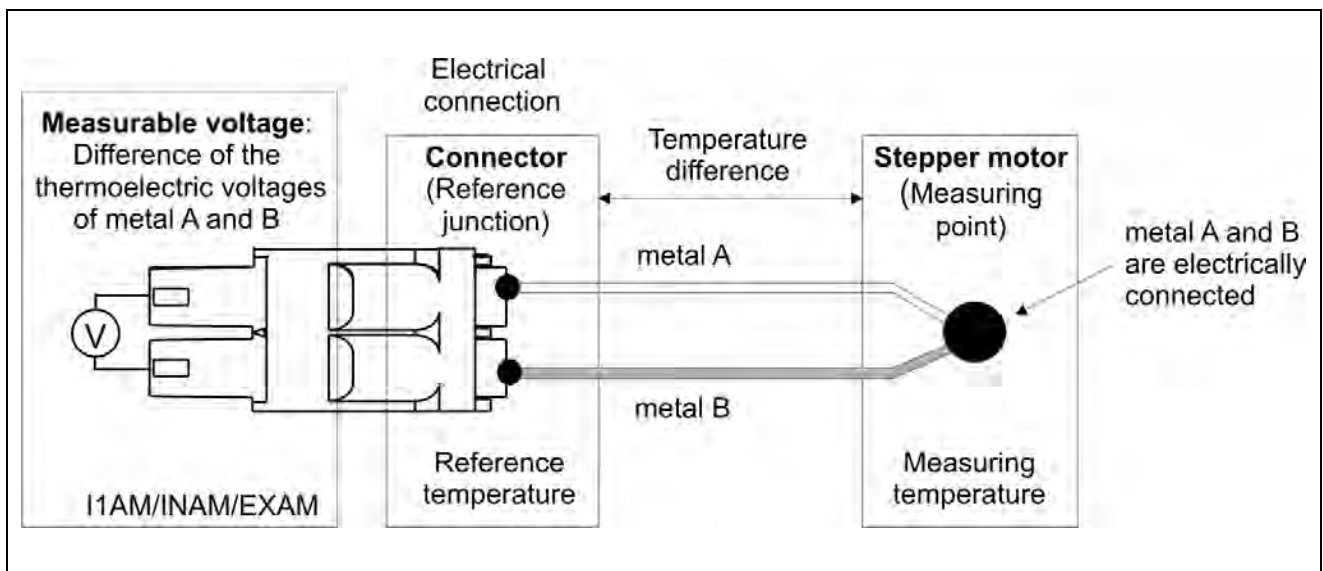


Fig. 2: Sample form

An accurate temperature can only be measured when the temperature at the reference junction (connector) is exactly known. This is not possible by the connection construction and und can cause indeterminate deviations of the temperature values.

Software evaluation of the measuring values from -180 °C to +260 °C.



**CAUTION – Possible damage!**

*Damage of the module by wrong connection or wire break.*

- Check the integrity of the element type K and the correct **phyMOTION™** connection before motor temperature measurement. An improperly connected or broken wire can result a wrong temperature evaluation and thus a damage of the motor or other system components by overheating.

## Pt100 Resistor Sensor

Pt100 resistor sensors are used with in-vacuum and cryo stepper motors in the temperature range -200 to +300 °C.

These precise sensors are used in extreme industrial and laboratory conditions. They consist of a wound resistance wire that is mounted and unsupported inside a cylindrical ceramic case.



Fig. 3: Pt100 connection

### Principle of the stepper motor temperature measurement by Pt100 resistor sensors:

The PTS generates a constant current between I+ and I-. This current generates a voltage drop at the Pt100 which is measured at Sens+ and Sens-. The Pt100 sensors are connected with 4 leads in order to enable measuring independent of the wire resistance.

Software evaluation of the measuring values from -220 °C to +390 °C.

### 6 Commissioning

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Please read the manual for basic commissioning information of the INAM01 or INAM02 module:



#### Further manual

*Detailed information on this subject is in a supporting manual:*

*“**phyMOTION™** Modular Multi-axis Controller for Stepper Motors”*

The programming environment **phyLOGIC™** ToolBox is explained in the following manual:



#### Further manual

*Detailed information on this subject is in a supporting manual:*

*“**phyLOGIC™** ToolBox – Communication Software for the **phyMOTION™** Stepper Motor Controller”*

For programming the sequential program please read:



#### Further manual

*Detailed information on this subject is in a supporting manual:*

*“**phyLOGIC™** Command Reference for the **phyMOTION™** Controller”*

Information about positioning you'll find in:



#### Further manual

*Detailed information on this subject is in a supporting manual:*

*“Principles of Positioning of the Stepper Motor Controllers”*



#### CAUTION – Possible damage!

*Some modules are set to a default value on delivery. So e.g., the motor current must be set to the corresponding value (see the motor data from the motor manufacturer). Connected components like motors can be damaged by incorrectly set values.*

- Please check if the parameters are correct before starting.



## 6.1 Diagnostics by the LEDs

The LEDs indicate the status and error of the INAM module by colours and blinking:

LEDs	left	right
<b>Off</b>	no logic power available	Power stage not ready
<b>green</b>	logic power ready	Power stage ready
<b>orange</b>	-	–
<b>red</b>	–	Error power stage

### 6.2 Parameterising the Module

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When using encoders, the corresponding *phyLOGIC*<sup>TM</sup> parameters **P34** to **P39** should be checked and set.

For the power stage settings use the parameters **P43** to **P45**.

For a general overview of the parameters:



#### Further manual

*Detailed information on this subject is in a supporting manual:*

*“*phyLOGIC*<sup>TM</sup> Command Reference for the *phyMOTION*<sup>TM</sup> Controller”*

Information about positioning you'll find in:



#### Further manual

*Detailed information on this subject is in a supporting manual:*

*“Principles of Positioning of the Stepper Motor Controllers”*

## 7 Principles of Positioning

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### Further manual

*Detailed information on this subject is in a supporting manual:*

“Principles of Positioning of the Stepper Motor Controllers”

### 8 Service

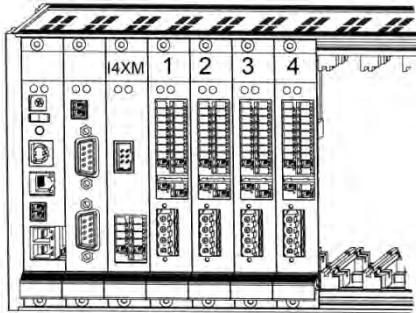
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In the case of a service order, please proceed as follows:

First try to identify the technical problem and document the fault. Feel free to ask our support team for help. We are pleased to assist you: tel. 0049-8142-503252 (local rate).

#### Removal of a INAM01 module or exchange of the APS or LPS power stage sub module:

- Switch off the *phyMOTION*<sup>TM</sup>'s supply voltage
- Disconnect the supply voltage
- Cut the red seal tape and the black label tape carefully on the left and right edge of the module/front panel which you want to remove. Don't slide the blade between the front panels by no means. When backfitting by our service the red seal tape is renewed.
- Please note the following before the removal, because up to four INAM modules are connected with the I4XM indexer module by a ribbon cable on the rear of the module:



- First, loosen the front screws of all five modules (I4XM and INAM).
- Then pull the I4XM module carefully out of the housing by the handle – proceed with the four INAM modules as well.
- Replace the corresponding APS assembly of the INAM module by loosening/removal.
- Then, starting with the I4XM module slide the five modules carefully back into the guide rail. If you have problems to push the module for the last half centimeter, move the module to the front panel slightly to the left and to the right during sliding, so that the connector pins contact the backplane socket.
- To send a module to phytron use ESD packaging only.

The **INAM02 module** can only be replaced in the phytron's plant. For this, the entire *phyMOTION*<sup>TM</sup> device must be sent.

## 9 Warranty, Disclaimer and Registered Trademarks

### 9.1 Disclaimer

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Phytron GmbH has verified the contents of the manual to match with the hardware and software. However, errors and omissions are exempt and Phytron GmbH assumes no responsibility for complete compliance. The information contained in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

### 9.2 Warranty

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The *phyMOTION*<sup>TM</sup> modules are subject to **legal warranty**. Phytron will repair or exchange devices which show a failure due to defects in material or caused by the production process. This warranty does not include damage caused by the customer, for example, not intended use, unauthorized modifications, incorrect handling or wiring.

### 9.3 Registered Trademarks

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In this manual several trademarks are used which are no longer explicitly marked as trademarks within the text. The lack of these signs may not be used to draw the conclusion that these products are free from third parties' rights. For example, some product names used herein are:

- *phyMOTION*<sup>TM</sup> is a trademark of Phytron GmbH.
- *phyLOGIC*<sup>TM</sup> is a trademark of Phytron GmbH.
- Microsoft is a registered trade mark and Windows<sup>TM</sup> is a trade mark of the Microsoft Corporation in the USA and other countries.
- DuPont<sup>TM</sup> is a registered trade mark and Kapton<sup>TM</sup> is a trade mark of E. I. du Pont de Nemours and Company or its affiliates.

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