

*phy***MOTION**[™]

Modular

Multi-axis Controller for Stepper Motors
with INTERNAL / EXTERNAL Power Supply

TRANSLATION OF THE GERMAN ORIGINAL MANUAL

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Phytron GmbH

Industriestraße 12

82194 Gröbenzell, Germany

Tel.: +49(0)8142/503-0

Fax: +49(0)8142/503-190

In this manual *phyMOTION™ Modular Multi-axis Controller for Stepper Motors* (<http://www.phytron.eu/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.

Email address: doku@phytron.de

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.eu/>) in your local agencies.

1 Legal 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:

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



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.



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 isolation 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.



CAUTION – Possible injury!

The phyMOTION™ may weigh up to 30 kg, depending on the expansion stage. Foot injuries can occur from dropping the unit.

- Make sure that the phyMOTION™ is securely held at all times.
- Wear safety shoes during transport and handling.

2 Available phyMOTION™ Manuals

The following manuals are available for phyMOTION™ controller, which are referred to in this manual by the following remark:



Further manual

Detailed information on this subject is in a supporting manual.

phyMOTION™ – Multi-axis Controller for Stepper Motors	MA 1259-A00x EN
POWM01/POW02/POWM03/POWM04 – Power Supply Modules	MA 1273-A00x EN
MCM01 – CPU and Bus Module	MA 1261-A00x EN
MCM02/MCM03 – CPU, Bus Module and Power Supply	MA 1294-A00x EN
I1AM01 – 1 Axis Stepper Motor Drive 3.5 A power supply	MA 1269-A00x EN
I1AM02 – 1 Axis Stepper Motor Drive 5 A power supply	MA 1269-A00x EN
DIOM01 – Digital I/O Module	MA 1271-A00x EN
AIOM01/AIM01/AOM01 – Analogue I/O Module	MA 1288-A00x EN
INAM01/INAM02 – Power Stage Carrier Module	MA 1275-A00x EN
INSM01 – Power Stage Carrier Module with safety shutdown	MA 1xxx-A00x EN
EXAM01 – Interface Module for an External Power Stage	MA 1277-A00x EN
I4XM01 – Indexer Module	MA 1279-A00x EN
phyLOGIC™ Command Reference for the phyMOTION™ Controller	MA 1265-A00x EN
phyLOGIC™ ToolBox – Communication Software for the Stepper Motor Controllers phyMOTION™, MCC and OMC/TMC	MA 1285-A00x EN
Principles of Positioning for Stepper Motor Controllers	MA 1267-A00x EN
ProfiNet/ProfiBus Interfaces	MA 1263-A00x EN
phyLOGIC™ Control – User Software for the operator panel/tablet operation of the stepper motor controller phyMOTION™	MA 1299-A00x EN
More manuals are in progress.	

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4 phyMOTION™ Overview

4.1 Housing

With our *phyMOTION™* you have chosen a high quality stepper motor controller concept “made in Germany”. Our *phyMOTION™* is designed to merge the worlds of PLC and CNC by combining high-performance components with cost efficient basic functionality – adjustable to your individual requirements. Contrary to PLC systems our *phyMOTION™* opens up the world of co-operative product and module development: as a mid-size family-owned company your feedback is the basis for our future – whenever off the shelf PLCs fall short the *phyMOTION™* grows with your requirements:

The *phyMOTION™* is a stepper motor controller with modular design and offers the option for later expansion. It controls, depending on the configuration, multi-axes synchronisation and interpolation and offers integrated power stages (up to 15 A_{PEAK} , 120 V_{DC}) and allows connection of more powerful external power stages.

Whatever its housing (bench, 19” sub rack, rail), with or without touch panel, motor temperature evaluation, limit switches, encoders or I/O - the *phyMOTION™* adapts to the requirements with up to 21 modules per device.

phyLOGIC™ programs are edited, transmitted to the controller and stored by the free development environment *phyLOGIC™* ToolBox.

Of course, the *phyMOTION™* can be controlled and programmed, if required, via host interface (ProfiBus, ProfiNet, Ethernet, CAN, RS 485, RS 232, Bluetooth...).

INT *phyMOTION™* with internal power supply (mains 230 / 115 V_{AC})

EXT *phyMOTION™* with external power supply (e.g. SPH mains adaptor)

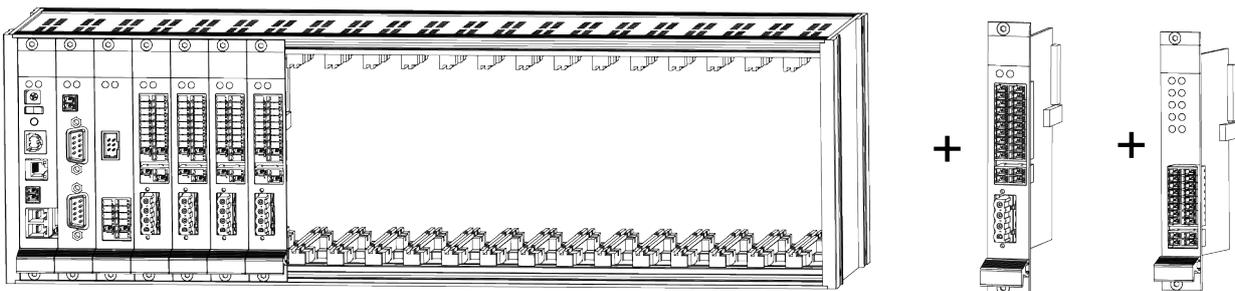


Fig.1 Example 19” sub rack with module equipment (**EXT**)

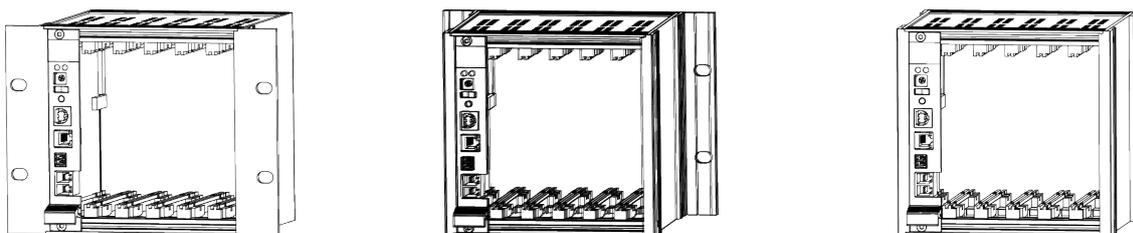


Fig.2 Housing types: sub rack, wall or rail mounting, bench

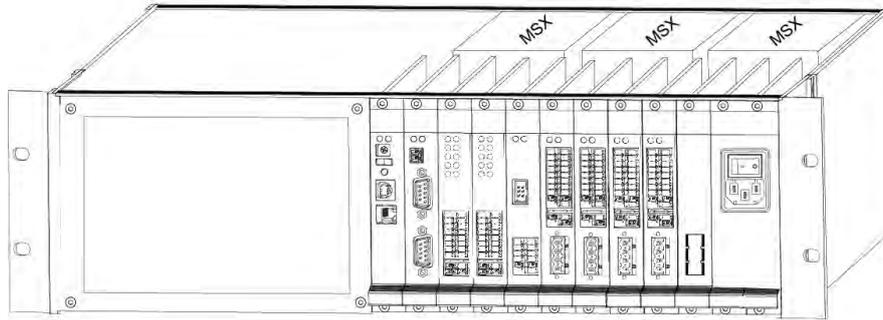
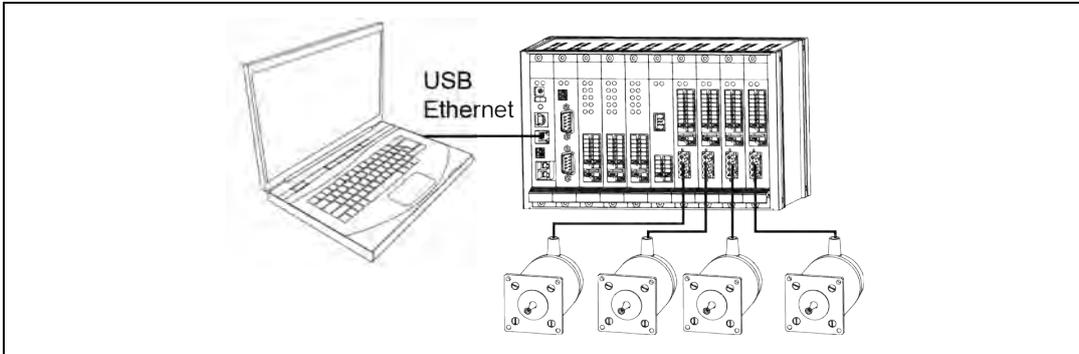


Fig.3 Example 19" sub rack with integrated power stages and touch panel (INT)

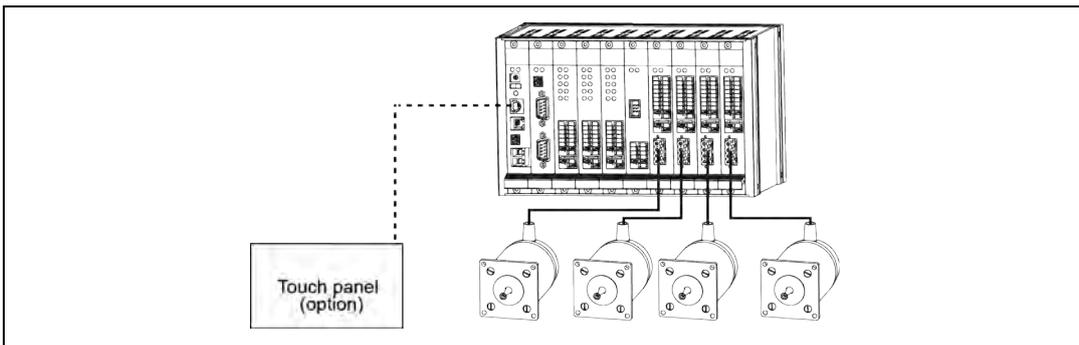
4.2 Application Scenarios and Embedding in Existing Systems

There can be many different ways to operate and integrate the *phyMOTION*TM into your system architecture:

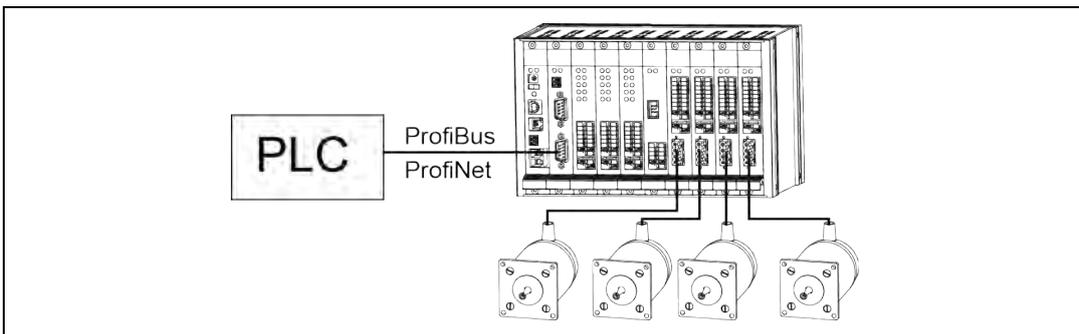
Via PC:



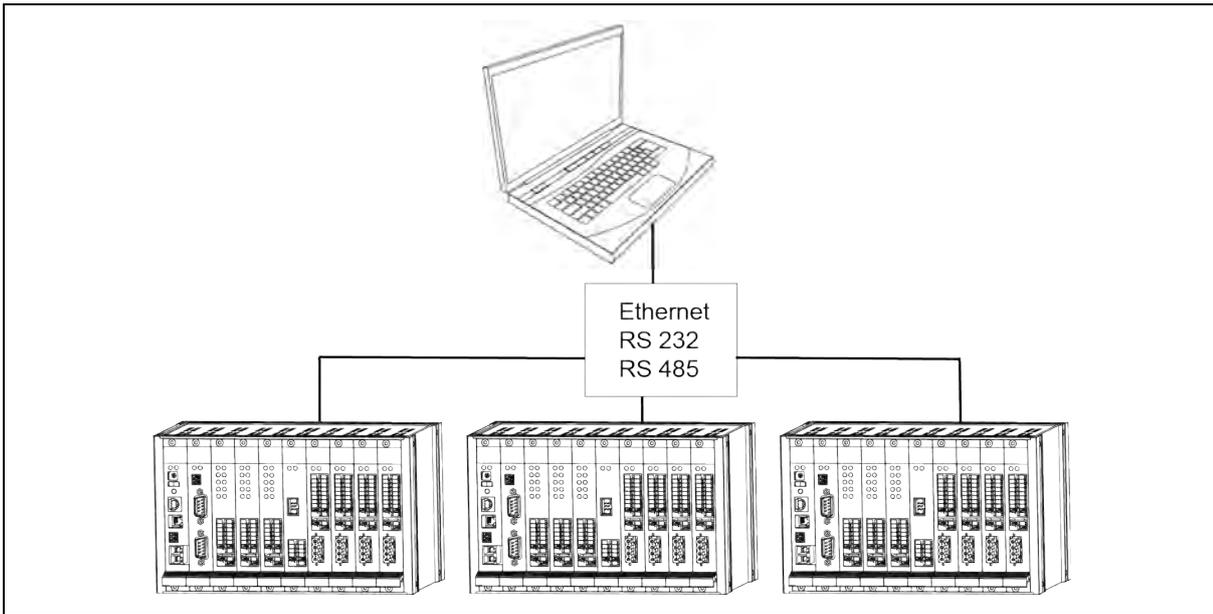
As stand-alone unit:



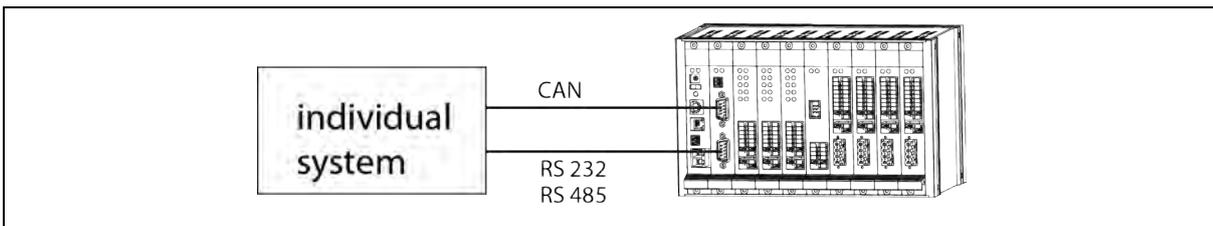
As distributed or intelligent I/O (PLC):



In a network:



Embedded in a customer's system:



In combination with higher-powered amplifiers:

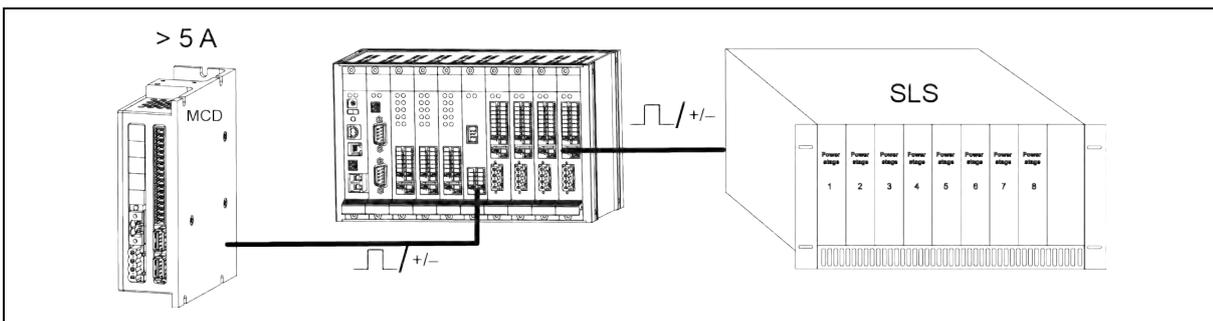


Fig.4 *phyMOTION*™ for power stages > 5 A/70 V as in this case, for example, with phytron's MCD⁺ or a phytron's SLS sub rack with 8 ZMX⁺ or 4 MSX power stages

Power adaptor and power stages are integrated: **INT**

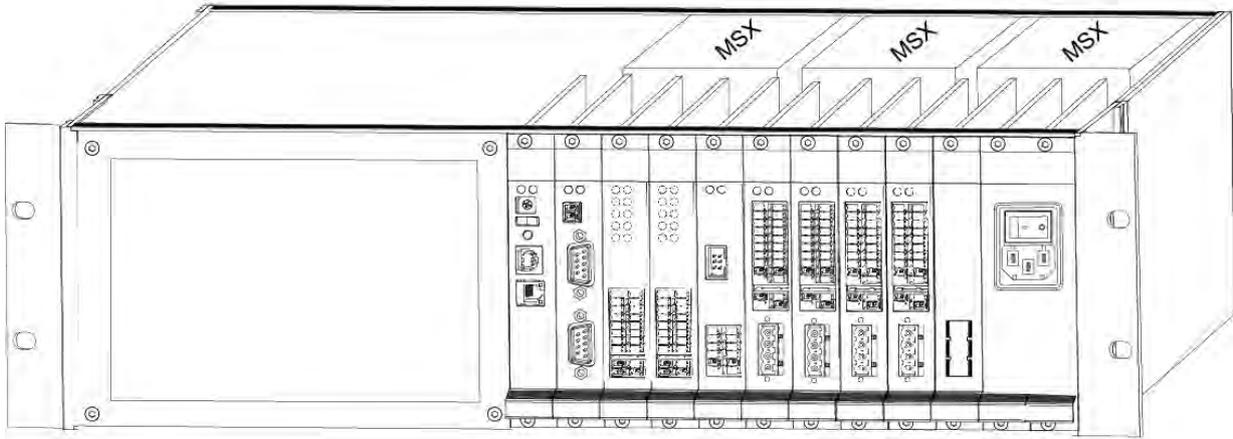


Fig.5 *phyMOTION*[™] with power adaptor, touch panel and MSX power stages

4.3 The Basic Functions and Modules at a Glance

The modules of the phyMOTION™ can be split up into the following functions:

Main functions	POWER SUPPLY	There is a power supply in the module (power supply unit).
	CPU	Modules with a CPU contain intelligent processors to execute all of the sequential programs and enable the phyMOTION™ to drive in stand-alone mode.
	INDEX	The INDEXER represents the functionality to generate signals from the commands of a programming language, which the power stage amplifies. Normally, the signals are control/direction pulses or SIN/COS inputs.
	POWER STAGE	The POWER STAGE represents a stepper motor amplifier. Incoming control/direction pulses or SIN/COS signals are amplified and output to the motor.

Auxiliary functions	ENC	Encoder evaluation
	TEMP	Motor temperature evaluation
	I/O D	Digital inputs and/or outputs
	I/O A	Analogue inputs and/or outputs
	POW IN	Power distribution
	COM	Host interface

With the following modules the *phyMOTION*TM is tailored to your requirements:

	Type	Description	Current consumption [mA]	Weight [g] (without/with front panel)
Power supply from the mains (230 V_{AC} / 115 V_{AC})	NETM01	230 V _{AC} / 115 V _{AC} supply, motor voltage and 24 V I/O or encoder supply are internally generated		–
Supply with external supply voltage	POWM01:	Mains supply and configuration		68 / 90
	POWM02:	Intermediate supply		53 / 86
with internal supply voltage	POWM03:	Mains supply and configuration		
	POWM04:	Intermediate supply		
CPU and Host interface	MCM01:	Intelligent CPU with selectable host interface	180 70 (RS interface) 120 (ProfiNet)	61 / 82
	MCM02:	Intelligent CPU with selectable host interface with external power supply	180 70 (RS interface) 120 (ProfiNet)	65 / 85
	MCM03:	Intelligent CPU with selectable host interface with internal power supply	180 70 (RS interface) 120 (ProfiNet)	65 / 85

	Type	Description	Current consumption [mA]	Weight [g] (without/with front panel)
Axes	I1AM01:	Indexer with integrated 3.5 A power stage; encoder and temperature evaluation optional	170 (5 V) 30 (EnDat encoder 5 V) 10 (24 V) 20 + encoder (24 V) 30 (temp-module) axis load (24-48 V)	102 / 116
	I1AM02:	Indexer with integrated 5 A power stage; encoder and temperature evaluation optional	170 (5 V) 30 (EnDat encoder 5 V) 10 (24 V) 20 + encoder (24 V) 30 (temp-module) Axis load (24-70V)	90 / 112
	I4XM01:	High end stepper motor indexer for 1 to 4 axes		52 / 73
	INAM01:	Carrier module for APS power stage; encoder and temperature evaluation optional	80 (power stage) 30 (EnDat encoder 5 V) 20 + encoder (24 V) 30 (temp-module) axis load (24-48 V)	71 / 93

	Type	Description	Current consumption [mA]	Weight [g] (without/with front panel)
	INAM02:	1-Axis module for MSX power stage with internal supply voltage; encoder and temperature evaluation optional	10 A (MSX power stage) 30 (EnDat encoder 5 V) 20 + encoder (24 V) 30 (temp-module) axis load (up to 120 V)	71 / 93
	PEM01:	Grounding module for motors with motor voltage >70 V		
	EXAM01:	Interface between indexer and an external power stage; encoder and temperature evaluation optional	30 (EnDat encoder 5 V) 20 + encoder (24 V) 30 (temp-module) axis load (24-48 V)	51 / 67
Expansions	DIOM01:	Digital input and output module	75 (5 V) load + 5 (24 V)	56 / 79
	AIOM01:	Analogue input and output module	75 (5 V) 5 (24 V)	66 / 87
	AIM01:	Analogue input module	75 (5 V) 5 (24 V)	66 / 87
	AOM01:	Analogue output module	75 (5 V) 5 (24 V)	66 / 87

	Type	Description	Current consumption [mA]	Weight [g] (without/with front panel)
	TPM01:	Android-based integrated touch panel; mountable on connection side or plain side		
	TPE	External touch panel		
		Control by Android-based tablets via Bluetooth interface		

4.4 Equipment Rules

The following equipment rules are useful for the configuration of your *phyMOTION*TM:

Our personnel will be pleased to advise you on your desired configuration:
phone: 0049-8142-503205

POWM01 / POWM02 / POWM03 / POWM04 supply modules

Every configuration starts

for **external** supply voltage (**EXT**):

- with a touch panel (optional)
- with the POWM01 power input and configuration module followed by the CPU module MCM01, which holds the selectable host interface sub module or
- with the MCM02 module, the combined supply, configuration module and CPU module

for **internal** supply voltage (**INT**):

- with a touch panel (optional)
- with the POWM03 power input and configuration module followed by the CPU module MCM01, which holds the selectable host interface sub module or
- with the MCM03 module, the combined supply, configuration module and CPU module

Each power input module:

- is designed to supply up to 10 more modules with an internal logic voltage (**5 V**)
- can draw 20 A maximum at **24-70 V** from the external power supply to the axis modules, which is the limitation on the number of cards per power input module.
- can draw a total of 5 A from the **24 V** I/O supply for outputs (analogue or digital) or to power limit switches.

If more current is needed an additional POWM02/POWM04 module should be considered.

An intermediate power input module can also be used to divide the backplane into different motor voltage sections. That way several different motor voltages can be used within one unit.

Indexer modules

The indexing functionality can be found integrated with the power stage functionality within one module or can be combined by including sub modules. Power stages that use external indexer functionality have to be placed directly after the indexing module.

Stepper motor modules

Several stepper motor modules already contain some power stage functionality; others need additional power stage modules. In both cases encoder and temperature evaluation are additional modular options (for INAM01, INAM02, I1AM01, I1AM02...).

In case the internal power stage supply of 5 A (per power stage) at 70 V is not sufficient, external power stages can be addressed with control/direction signals via the EXAM01 module.

Mains power module NETM01 for internal supply voltage (INT)

The NETM01 power module is always placed at the right end of the connection side.

If the motor voltage >70 VDC, it applies: the grounding module PEM01, which is placed right next to the last INAM02 module, is used for grounding of up to six motors.

Backplane, expandability

Expandability options (for additional power input modules) have to be specified during the ordering process. The backplane separation is permanent and has to be considered when your phyMOTION™ is configured.

For the internal supply voltage is applied (INT): The **first INAM02 module** terminates the backplane, all phyMOTION™ modules, which are not controlled by the corresponding 4-axis indexer must be placed left to the indexer module.

Empty slots

The slots must be filled from left to right without gaps in between. Empty slots at the housing's end must be covered with blanking plates.

Sub modularity

The following modules can be expanded with sub modules: MCM01, MCM02, MCM03, INAM01, INAM02, EXAM01, I1AM01, I1AM02, INSM01...

Android-based touch panel

The touch panel can be installed as the first or last module, or outside of the housing as an external touch panel.

The touch panel can be integrated either on the connection side or on the plain side or outside of the housing configuration as an external touch panel

Alternative configurations

By integrating independent backplanes, several autonomous main units with their own host interface each can be built into one housing. This way several phyMOTION™ controllers can be combined using a minimum of space.

Options for internal power supply (mains 230 V_{AC} / 115 V_{AC}) (INT)

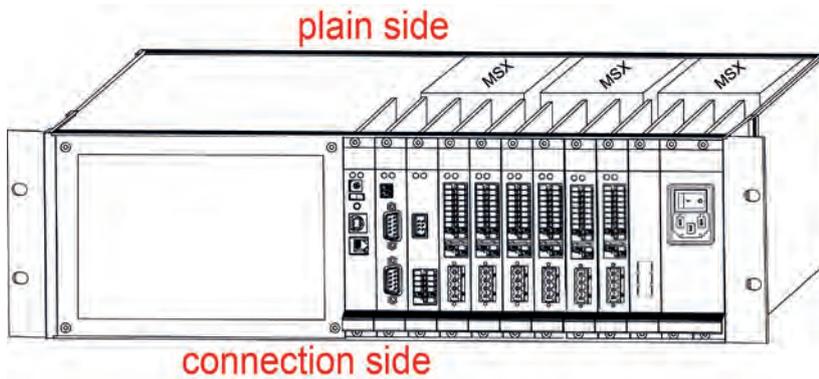


Fig.6 Connection side and plain side

<i>phy</i> MOTION™	Option	CONNECTION SIDE Number of <i>phy</i> MOTION™ modules	PLAINS SIDE Number of MSX power stages
with integrated touch panel (TPM01)	Option 1: TPM01 on the connection side	up to 10	1 to 3
	Option 2: TPM01 on the connection side	up to 19	1 to 2
with external touch panel	Option 3	up to 19	1 to 2
without operator panel	Option 4	up to 19	1 to 3
Combination with SLS for up to 4 MSX or 8 ZMX+ power stages	Option 5	up to 19	—

Max. power consumption: 1300 W (up to 100 % overload possible in a short time)

The **Mains power** 230 V_{AC} or 115 V_{AC} is supplied via NETM01 and

- supplies up to 19 *phy*MOTION™ modules.
- generates internally the motor voltage **48–120 V** and/or **48–70 V** and
- the **24 V** I/O-supply.

Power stage fans

For reducing the device's internal temperature and protect the components.

5 General Technical Data

5.1 Directives and Standards

CE Mark	With the declaration of conformity and the CE Mark on the product the manufacturer certifies that the product complies with the requirements of the relevant EC directives. The unit, described here, can be used anywhere in the world.
Machinery Directive	The drive system, described here, is not a machine in the sense of the Machinery Directive (2006/42/EC), but a component of a machine for installation. They have no functional moving parts, but they can be part of a machine or equipment. The conformity of the complete system in accordance with the machine guideline is to be certified by the manufacturer with the CE marking.
EC EMC Directive	<p>The EC Directives on electromagnetic compatibility (2004/108/EC) applies to products that can cause electromagnetic interference or whose operation can be impaired by such interference.</p> <p>The drive system's compliance with the EMC Directive cannot be assessed until it has been installed into a machine or installation. The instructions provided in "Installation" must be complied with to guarantee that the drive system is EMC compliant when fitted in the machine or installation and before use of the device is permitted.</p>
Standards for safe operation	<p>EN 60204-1:2006/AC:2010 Electrical equipment of machines, degree of pollution 2 must be observed</p> <p>EN 60529: IP Degree of protection</p>
Standards for observing the EMC limit values	<p>EN 61000-3-2:2006 / EN 61000-3-2:2006/A2:2009: EMC Limits for harmonic current emissions</p> <p>EN 61000-6-2:2005 / EN 61000-6-2:2005/AC:2005: Generic standards – Immunity for industrial environments</p> <p>EN 61000-6-4:2007: Generic standards – Emission standard for industrial environments</p>

We commit to transmit, in response to a reasoned request by the market surveillance authorities, relevant documents on the partly completed machinery.

Important note! The partly completed machinery must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of Directive 2006/42/EC on Machinery, where appropriate, and until the EC Declaration of Conformity according to Annex II A is issued.

This Declaration of Incorporation is only valid in combination with the Declaration of Incorporation 7029, phyMOTION® with external power supply.

Gröbenzell, 2015-06-25



Birgit Hartmann
Managing Director

Art. 033007/040
CE 7048 Rev. 1

Phytron GmbH
Industrieweg 12 - 82194 Gröbenzell
Postfach 1755 - 82180 Gröbenzell
T +49-8147-503-0 F +49-8147-503-199
E info@phytron.de W www.phytron.de

Geschäftsführung Birgit Hartmann
Reg. Gericht München - HRB 205987
USt-Identi-Nr. DE290476265
Steuernummer 117/135/11449

Genussbank AG Bank - Kto. 94610 - BLZ 7016948
IBAN-DE6790169264000094610 - BIC: GENB3333
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Volksbank Fürstentum Oberbayern - Kto. 712531 - BLZ 70163370
Postbank München - Kto. 0286001800 - BLZ 70010080

5.4 Transport and Storage Information

Acceptable transport and storage conditions:

Storage and transport temperatures	-40 to +70 °C
Relative humidity	95 % max. without condensation and ice
Package:	Module: only in ESD packaging Housing: only in the original packaging designed for transporting



CAUTION – Possible injury!

The phyMOTION™ may weigh up to 30 kg, depending on the expansion stage. Foot injuries can occur from dropping the unit.

- Make sure that the phyMOTION™ is securely held at all times.
- Wear safety shoes during transport and handling.



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 by collisions!

The phyMOTION™ partly consists of sensitive electronic and mechanical components.

- Avoid sudden shocks and excessive force during installation.

6 Project Planning

Please consider the following information for project planning, before the actual installation.

6.1 Information for a Suitable Installation Location

Permissible conditions for the right installation location:

Degree of protection:	IP20
Level of pollution:	2
Ambient temperature:	0 to +70 °C
Relative humidity:	95 % max., without condensation and ice
Installation altitude	2000 m max. above sea level



CAUTION – Possible injury!

The phyMOTION™ may weigh up to 30 kg, depending on the expansion stage. Foot injuries can occur from dropping the unit.

- Make sure that the phyMOTION™ is securely held at all times.
- Take extra care when wall mounting the phyMOTION™.
- Wear safety shoes during transport and handling.



Stray light

The phyMOTION™ initialises the installed modules by light transmission.

- To ensure proper module addressing, avoid intense light sources above or below the phyMOTION™ device.



Air ventilation

The phyMOTION™ includes power electronic components, which may become hot depending on the load.

- Place the phyMOTION™ horizontally and with sufficient distance to devices above or below to allow adequate air circulation.
- With active cooling, filtering measures are necessary.

6.2 Safety Concept

First, define the overall safety concept concerning the actual application.

- i** **Intended use:**
The phyMOTION™ is designed for operating in a drive system. An installation is allowed only if the requirement of the EC Machine Directive and EMC are conformed with.
- An installation is allowed only if the requirements of the EC Machinery and EMC Directives are conformed with.
- i** **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).

6.2.1 External Power Supply (EXT)

The phyMOTION™ is designed for operation in a SELV/PELV system up to 70 V_{DC} maximum power supply. The insulation of the phyMOTION™ fulfils the requirements of a basic isolation for non-mains circuits. Thus, power supplies must be used to separate the mains circuit safely from the phyMOTION™ supply.

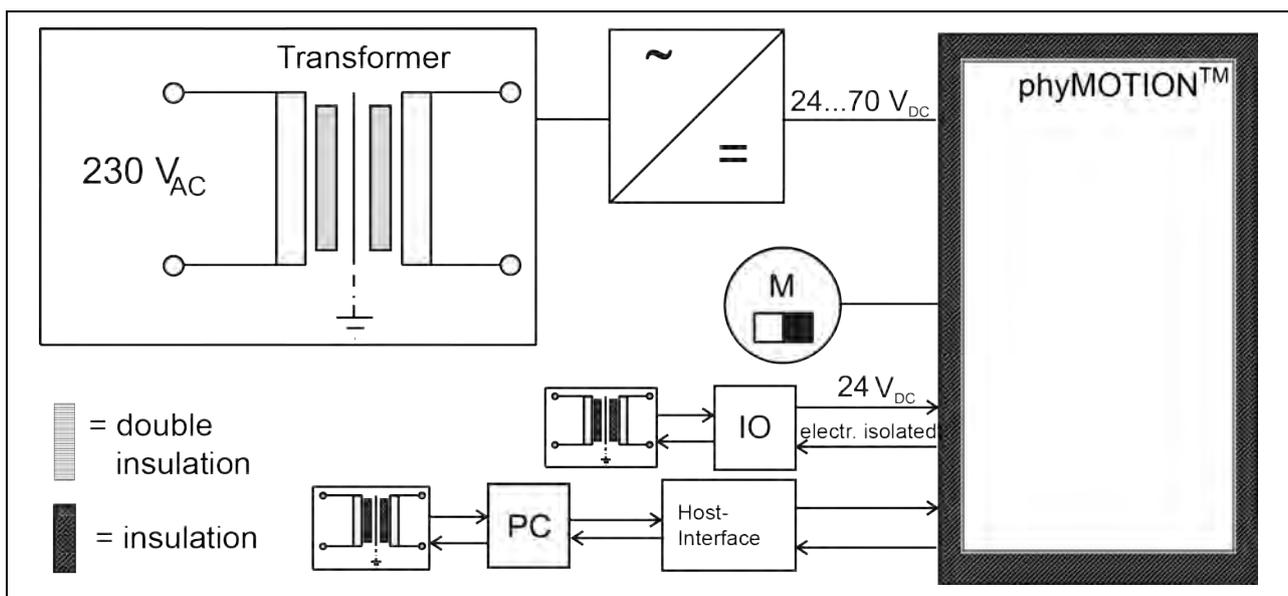


Fig.7 phyMOTION™ isolation overview with external power supply



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 isolation and separation of low voltage supplies from the mains.



WARNING – Serious injury from electric shock!

Also, devices which are connected to the phyMOTION™ for controlling or communication (e.g. PCs, etc.) must have a safe isolation from the mains:

- Make sure that the devices used to control the phyMOTION™ fulfil the safety concept SELV / PELV, and ensure safe separation from the mains.

6.2.2 Internal Power Supply (INT)



WARNING – Serious injury from electric shock!

The secondary motor circuits (motor current circuit, I/O and logic circuit) are not insulated by means of a protective separation as defined by the EN 60664:

- Therefore the connecting cables to all secondary circuits (I/O cables, logic control cables and motor cables) should have a basic insulation appropriate to the maximum voltage which might be met during normal operation.
Depending on the special requirements of the application and the insulation concept for the complete machine, it might be necessary to apply a reinforced or double insulation for this voltage. In some cases it could be necessary to mount a protective earth connection at adjoining metal parts which might be accessible for persons.

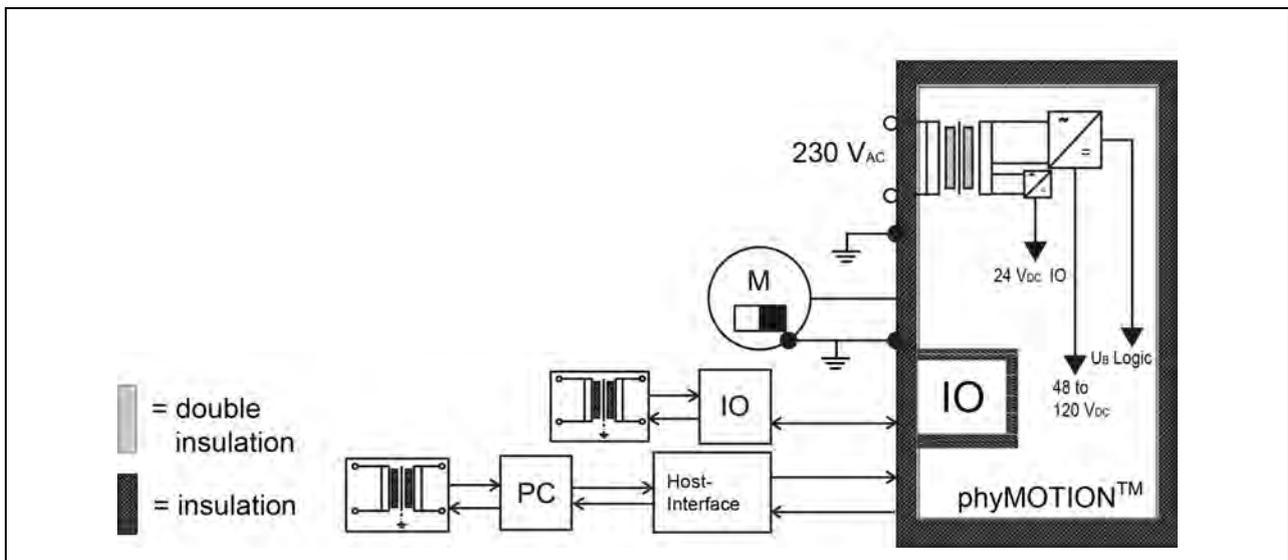


Fig.8 phyMOTION™ isolation overview with internal power supply

The I/O signals are safely electrically isolated by optocoupler.

All host interface signals are electrically isolated from the motor voltage (withstand voltage 800 V_{DC}).

In the following section you'll find more information for your safety concept:



WARNING – Serious injury possible!

To avoid personal injury please consider the following items in your safety concept:

- Ensure that no person has access to the area of the plant where there are moving parts.
- Install an emergency stop system in keeping with current technical standards (e.g. European standards EN 60204, EN 418, etc.).



WARNING – Serious injury possible!

The phyMOTION™ is not designed for safety operating modes. Thus, safety operating modes such as SafeTorqueOff (STO) from IEC61508-2 cannot be implemented directly!

- In case your risk analysis identifies possible risks for personnel generating the need for safety operating modes you have to implement these security functions at a superior system level.



CAUTION – Possible damage!

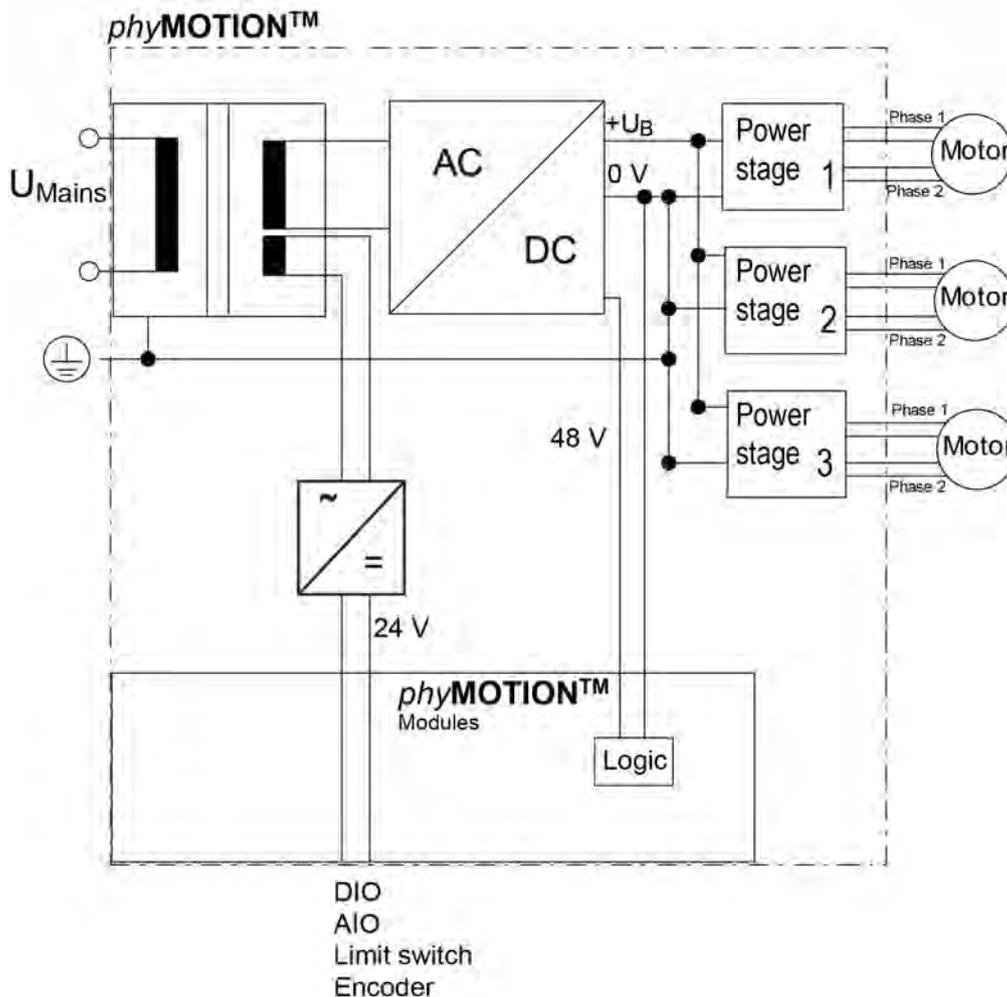
To avoid damage please consider the following items in your safety concept:

- Install, for example, hardware limit switches for the end positions of the axes that switch off the power control system directly.
- Install devices and take steps to protect motors and power electronics.

6.2.3 phyMOTION™ with Power Stages up to 70 V_{DC}

phyMOTION™ with power stages up to 70 V_{DC} must be operated by the protective measure PELV acc. to VDE 0100. The phyMOTION™ has to be grounded and the '0 V' in the phyMOTION™ is grounded.

The protective measure PELV is fulfilled, as follows:



CAUTION – Possible damage!

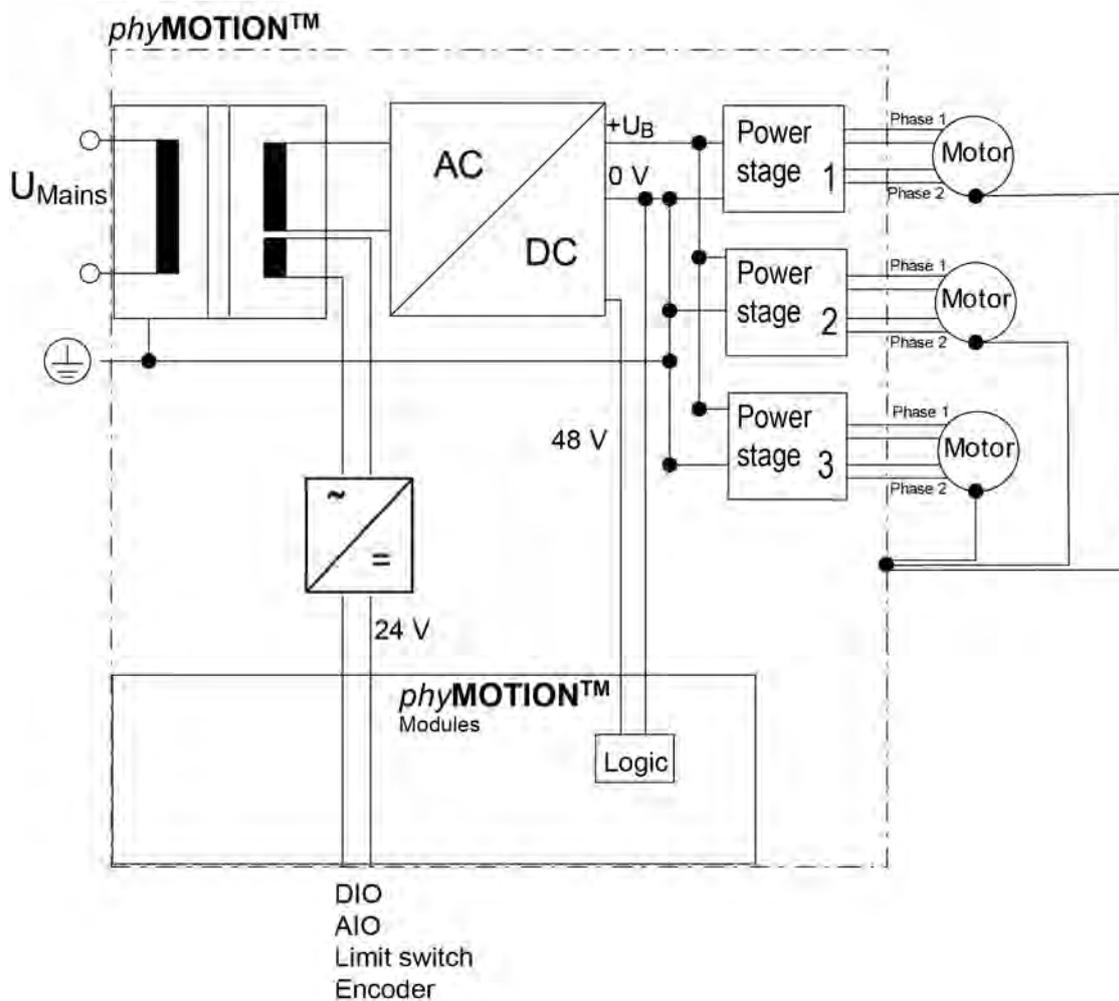


To avoid damage please consider the following items in your safety concept:

- Protective measure PELV for application of the $+U_B$ should not exceed 70 V_{DC} or 50 V_{AC} at dry environment (environmental conditions 3 acc. to IEC 61201).
- The supply transformer must be constructed with reinforced or double insulation between supply and secondary winding (acc. to EN 61558).
- Only use motors which are checked acc. to EN 60034-1 (500 V_{AC}/1 minute).

6.2.4 phyMOTION™ with Power Stages up to 120 V_{DC}

phyMOTION™ with power stages over 70 V_{DC} must be operated according to VDE 0100 part 200 with protection by automatic disconnection. Therefore, the motor, power stage, 0 V and each equipment have to be grounded:



CAUTION – Possible damage!

i

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).

6.3 Basic Wiring of the phyMOTION™

6.3.1 with External Supply (EXT)

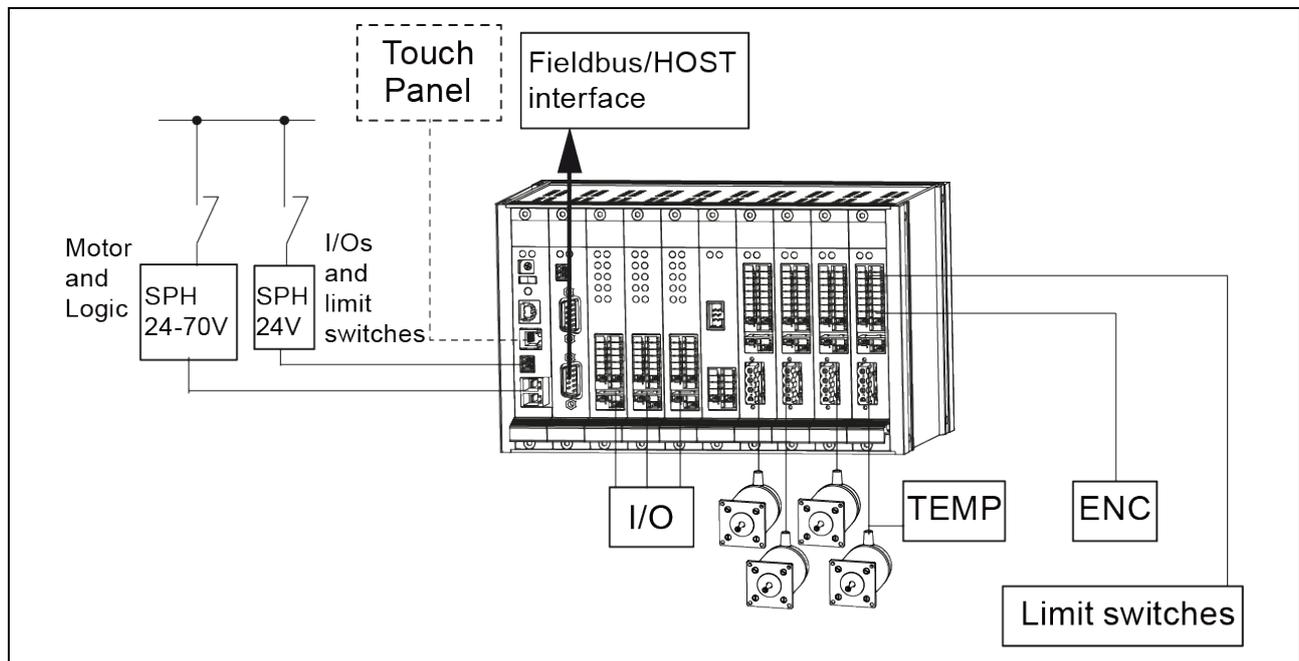


Fig.9 Example of wiring the phyMOTION™ – schematically

Power supply of the phyMOTION™:

Power input modules like the POWM01 and the POWM02 offer two different inputs for power supply:

24–70 V_{DC} Supply input for motor supply:

The 24 – 70V_{DC} supply input does not only supply the motors. This supply is also used to generate the internal logic voltage (5 V). The power input is designed for 20 A maximum. If the integrated power stages need more than 20 A totals, there is need for an additional power feed (POWM02 and POWM04).

After 10 modules an additional power input module is needed in any case.

Intermediate power input modules cut up the supply voltage on the backplane. This offers the option to drive motors with different voltages separated by an additional power input module (POWM02 and POWM04). The backplane separation is permanent and has to be considered when your phyMOTION™ is configured.

24 V I/O Supply input:

In case you want to connect limit switches, inputs or outputs (digital / analogue) to the phyMOTION™, you need the additional supply input at 24 V_{DC}. The 24 V can supply 5 A per power input module.



Further manual

Detailed information on this subject is in a supporting manual:

“**phyMOTION™** Power Modules POWM01 and POWM02“

6.3.2 with Internal Supply (INT)

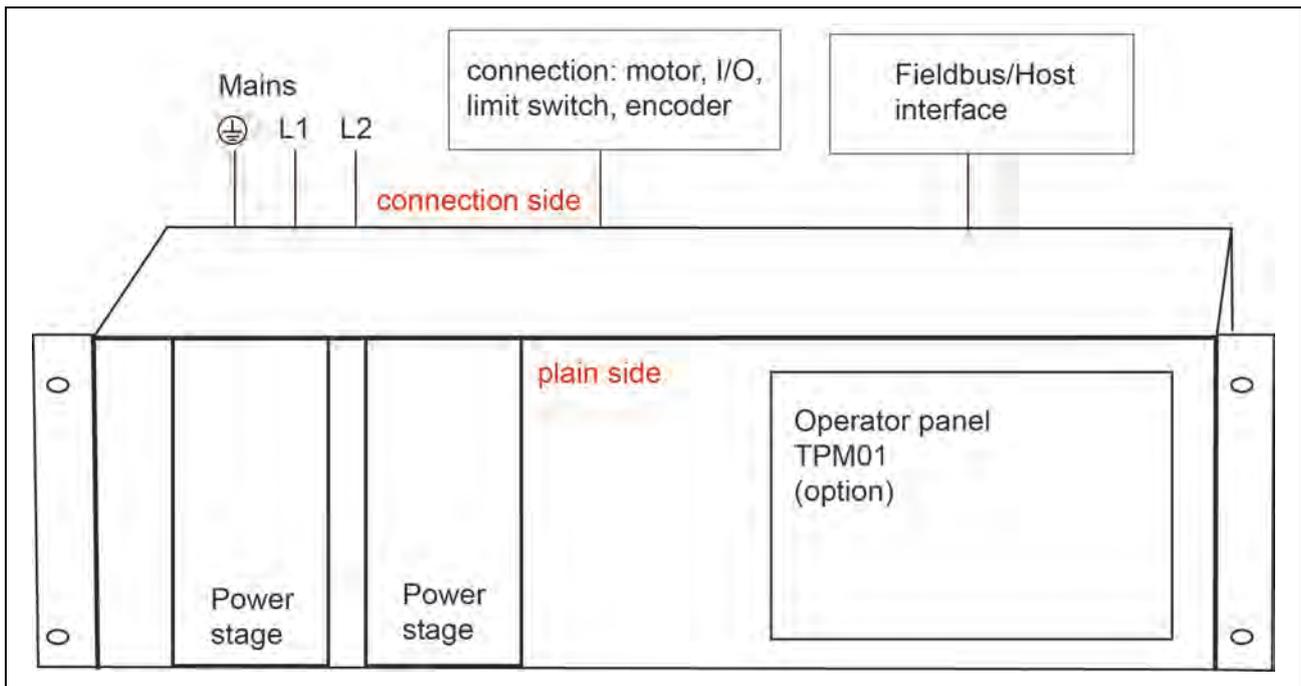


Fig.10 *phyMOTION™* wiring with internal power supply (example)

Power supply of the *phyMOTION™*:

From the 230 V_{AC} or 115 V_{AC} mains voltage:

- the ten *phyMOTION™* modules are supplied.
- the motor voltage **48 V and/or 70 V and/or 120 V** and
- the **24 V** I/O supply are internally generated.

The supply modules like POWM03 and POWM04 have no power connection for the supply. They conduct the power supply internally.

The PEM01 module is used for motor voltage >70 V to ground the motors.

24 V I/O Supply input:

In case you want to connect limit switches, inputs or outputs (digital / analogue) to the *phyMOTION™*, you need the additional supply input at 24 V_{DC}. The 24 V can supply 5 A per power input module.

6.3.3 Further Modules

HOST interface:

Within each system there is at least the POWM01 main feeding module and the MCM01 CPU and host interface module or the MCM02 or the MCM03 module. If you plan to communicate with the system via USB only you have no need for an additional sub module for the MCM. Your PC can be connected directly via the USB interface of the POWM01 (or POWM03).

If you need an additional host interface select the corresponding sub module for the MCM01/MCM02/MCM03.



Further manual

Detailed information on this subject is in a supporting manual:

„phyMOTION™ CPU and Bus Module MCM01“

„phyMOTION™ CPU and Bus Module and Power Supply MCM02/MCM03“

Axis modules:

The stepper motors themselves are connected directly to the axis modules. These modules can be expanded by additional sub modules for different encoder and motor temperature evaluation. Evaluations and up to 3 limit or reference switches are directly connected to the axis module.



Further manuals

Detailed information on this subject are in the supporting manuals:

“phyMOTION™ 1 Axis Stepper Motor Drive I1AM01“

„phyMOTION™ 1 Axis Stepper Motor Drive I1AM02“

“phyMOTION™ 4 Axis High End Indexer I4XM01“

“phyMOTION™ Carrier Module for APS Power Stages INAM01/INAM02“

“phyMOTION™ Indexer Interface EXAM01“

Inputs and outputs:

Inputs and outputs have to be connected to the corresponding I/O modules supplied by the separated 24 V_{DC} supply. There are 5 A available per power feeding module. Then an additional power feeding module has to be integrated.



Further Manual

Detailed information on this subject is in a supporting manual:

“*phy***MOTION**TM Digital I/O Module DIOM01“

„*phy***MOTION**[®] Analogue I/O Modules AIOM01/ AIM01/ AOM01 “

HMI – Human-Machine-Interface:

There is a Human-Machine-Interface like the phytron touch panel that can be connected to your *phy***MOTION**TM.

6.4 Power Supply Sizing for phyMOTION™ with external Supply (EXT)

6.4.1 For the Motor Supply

The voltage of the supply unit (24 V_{DC} to 70 V_{DC}) depends on the motor speed during operation. For low velocity (about < 300 rev/min) but high torque or if only low torque is necessary at higher velocity (> 300 rev/min), a 24 V_{DC} supply voltage is often sufficient. Refer to the technical data of the stepper motor manufacturer for information about the required performance with 24 V. These usually indicate torque characteristics dependent on the supply voltage.

If higher numbers of revolutions must be achieved, we recommend supplying the POWM01 or POWM02 module with 70 V_{DC} if your selected motors can be driven with these voltages.

i **Number of modules to be supplied:**

The inputs for the motor supply of the power input modules are designed for max. 20 A. If the input is higher it may cause damage to the device.

- Make sure that the total power consumption of all modules that delivers one power supply module is less than 20 A with maximum load.

Generally the required power of the supply voltage is calculated by rules of thumb:

$$P_{\text{SUPPLY}} = 2 \times \Sigma P_{\text{MECHANICAL}} \text{ (for speeds } < 300 \text{ rev/min)}$$

$$P_{\text{SUPPLY}} = 3 \times \Sigma P_{\text{MECHANICAL}} \text{ (for speeds } > 300 \text{ rev/min)}$$

„ ΣP “ is the sum of all power of all connected motors to be supplied by one power supply.

i **Remote power supply units:**

If the power supply unit is situated far away from the phyMOTION™ because of installation reasons, ferrites may be needed to suppress line interference.

6.4.2 For Input/Output Supply

Limit and reference switches on the axis modules, also analogue or digital inputs and outputs on the corresponding I/O modules are fed by a separate supply voltage.

i **Number of I/Os to be supplied:**

The inputs for the 24 V I/O supply of the power input modules are designed for 5 A maximum. If the input is higher it may cause damage to the device.

- Make sure that the total power consumption of all I/Os that use one power supply module is less than 5 A.

i **Separate power supply:**

The power supply for motor and for the limit/reference switches and I/Os are electrically isolated from one another to reduce interferences.

- To reduce interference always use two separate power supplies for the 24 V supply and the motor supply. Even if the motor is only driven with 24 V.

6.6 EMC Measures

For EMC compliant installation, consider the following measures:

	EMC Measures	Effect
Wall/rack/rail mounting, bench	Closed metal housing – bolted and securely seated front and rear panels.	Good conductivity due to planar contacts.
	Fit switching devices such as contactors, relays or solenoids with interference or spark suppressors (e. g. diodes, varistors and RC elements).	Reduction of mutual interference.
	Mount power and control components separately.	Reduction of mutual interference.
Cabling	Keep cables as short as possible. No “safety loops“.	Avoidance of capacitive and inductive interference
	Connect the shielding of all shielded cables to the <i>phyMOTION</i> TM housing by the shield contact element (option) to a large area on the front panels.	Reduction of EMC emissions.
	Lay the fieldbus and signal cables spatially separated from each other.	Avoidance of mutual interference.
Power supply	Protective circuit to mitigate over voltage or lightning strikes.	Protection of damage by over voltage.

6.7 Shielding

To avoid interference affecting the wires and instruments installed close to the drive system, we recommend the use of shielded cables.

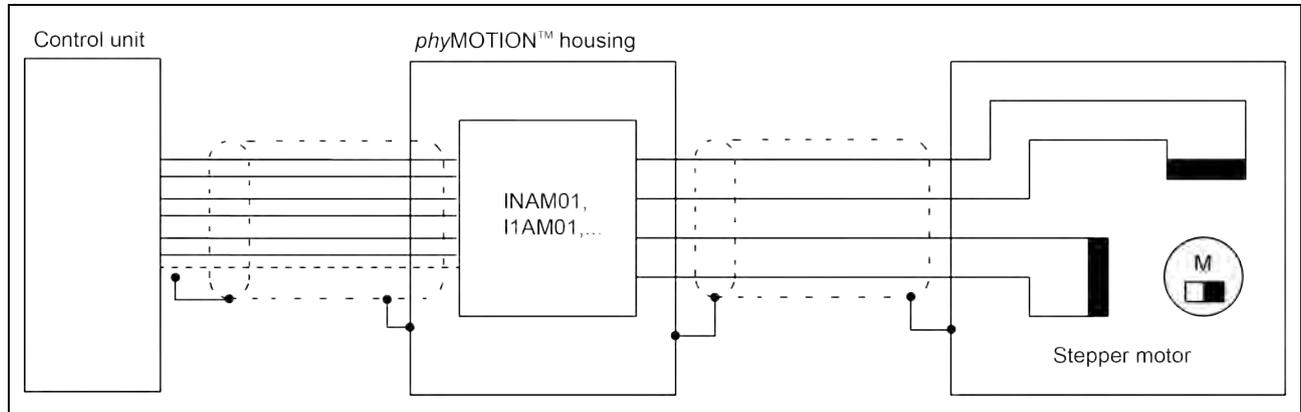


Fig.12

Motor cable shielding

Motor cables

The motor cable is a source of interference and must be positioned with care.

Use the cables recommended by phytron. They are tested for EMC safety and are suitable for movement.

The motor cable must be connected by a shield contact element at the housing front of the *phyMOTION™* and directly to the motor either with a low resistance or to a large surface area.

- Connect the motor cables without interruption (do not use switches) from the motor to the device. If a cable must be interrupted, use shielded connections and metal housings to reduce interference.
- Lay the motor cable at a distance of at least 20 cm from the signal cables. If they are laid closer together, motor cable and signal wiring must be shielded and grounded.



Easy mountable plug-in connection for the motor shielding of the modules INAM or I1AM.

Fig.13 Shield clamp for motor connection

6.8 Grounding for Motor Voltage > 70V (INT)

The grounding module PEM01 is used for motor voltage >70 V to ground the PE wire (up to 6 motors).

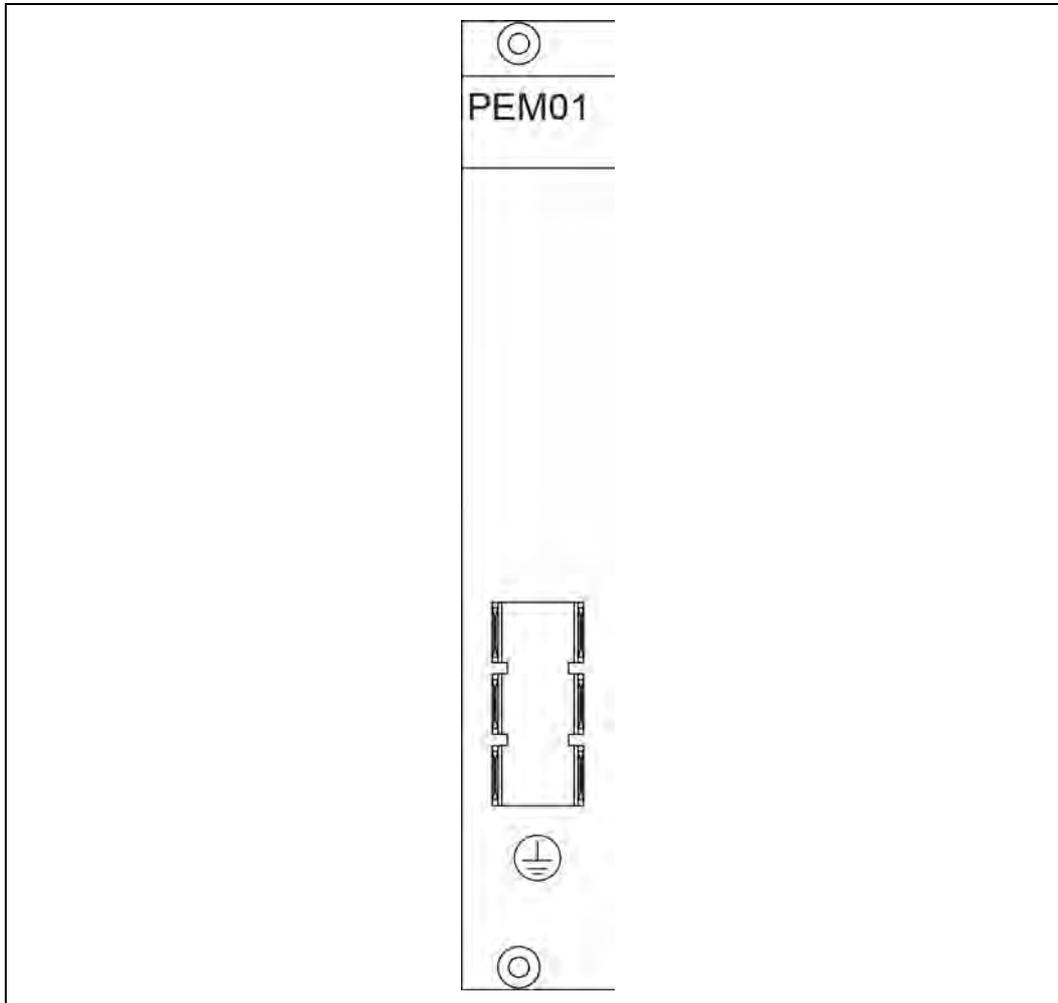


Fig.14 Grounding module for motors with motor voltage >70 V

7 Installation

7.1 Mechanical Installation

Phytron always delivers the phyMOTION™ devices fully configured and assembled.

The following modules/components are necessary for the mechanical installation:

- phyMOTION™ device
- Power supply unit(s) for 24-70 V_{DC} motor voltage supply (one per supply module)
e.g. SPH 240-4805 for 48 V_{DC}
- Power supply unit(s) for 24 V_{DC} I/O supply (one per supply module)
e.g. SPH 240-2410
- Mating connectors (included in delivery)
- The necessary wiring materials
- Option: Shield contact element(s) per motor connector



CAUTION – Possible injury!

The phyMOTION™ may weigh up to 30 kg, depending on the expansion stage. Foot injuries can occur from dropping the unit.

- Make sure that the phyMOTION™ is securely held at all times.
- Wear safety shoes during transport and handling.



CAUTION – Possible damage from collisions!

The phyMOTION™ partly consists of sensitive electronic and mechanical components.

- Avoid sudden shocks and excessive force during installation.

If you have ordered individual modules, or received them as replacements or expansions, we will send these modules in ESD compliant packaging. Keep the modules in their packaging until you start installing, subject to compliance with the ESD safety measures.

Before the replacement or installation of the module, read the corresponding manual.



Further Manual

Read the corresponding module manual for installation of a single module into your phyMOTION™.



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 the single modules in ESD protective packaging
- Always handle the components in compliance with the ESD protection measures.
- For any consequences resulting from improper handling or non-ESD-friendly packaging, no responsibility can be accepted.

7.2 Housing Types and Dimensions

Dimensions	Width: dependent on the number of slots Height: 3 HU Depth: s / external: 121 mm p / internal: 360 mm
Material/Surface	Aluminium, transparently chromated

	Number of slots		A	B	C	D	E	F
EXT	6	[mm]	121 / 135 (with handle)	160	132.5	177.0	137.0	137.0
	8			200.6		217.7	177.6	177.6
	10			241.3		258.3	218.3	218.3
INT	21			465.6		482.6	442.4	442.4
			Dimensions: ±5% tolerance					

Number of free configured slots		A	B	C	D	E	F
10 (with TPM01 connection side)	[mm]	360 / 374 (with handle)	465.6	132.5	482.6	442.4	442.4
21 (with TPM01 plain side)							
21 (touch panel external)							

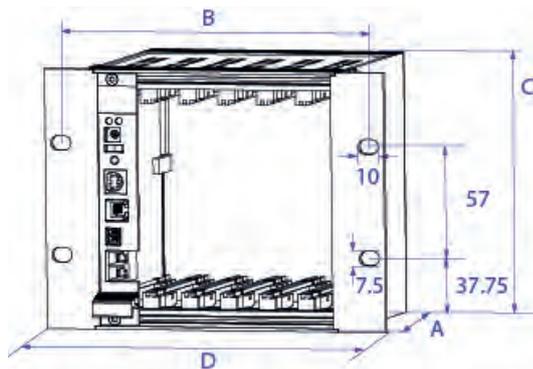


Fig.15 Sub rack dimensions

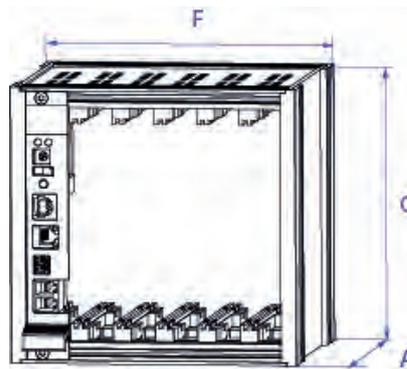


Fig.16 Bench dimensions

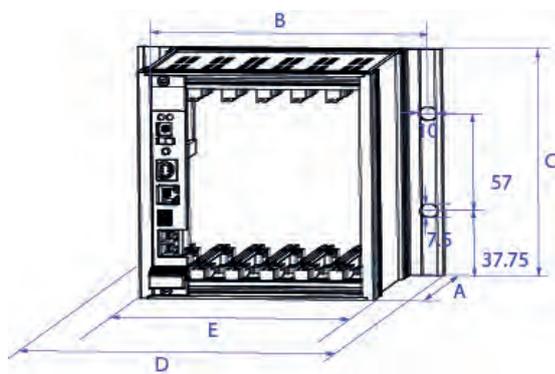


Fig.17 Wall dimensions/rack inverse

7.2.1 Bench

- Make sure that the set-up location is level and that the device has at least 30 mm distance to neighbouring devices
- Don't cover the air vents on the device's top to make sure that emerging heat can escape the housing at any time.

7.2.2 Wall/Rail Mounting for *phyMOTION*TM with External Supply **EXT**

- The device needs at least 30mm distance to neighbouring devices. The *phyMOTION*TM's interfaces are placed at the bottom on the front side. Therefore we recommend leaving at least 100mm of free space below the device in order to ensure the cables can be installed without any kinks.
- Make sure that the device is installed level, so that heated air can escape the housing.
- The installation on a mounting rail has to be designed to hold the weights of the *phyMOTION*TM unit.

7.2.3 Sub Rack Mounting

- When the *phyMOTION*TM is installed within a rack you have to take into account the rack manufacturer's guidelines.
- Rails must be installed for the 19" subrack.
- Push the *phyMOTION*TM carefully into the rack's sub rack slot from the front. Secure the unit by connecting it with bolts through the unit's oblong holes into the rack. Fasten the bolts securely.
- The rack's air circulation system has to make sure that the heat produced by the integrated units can escape the rack.
- The *phyMOTION*TM with internal supply can be mounted as follows:

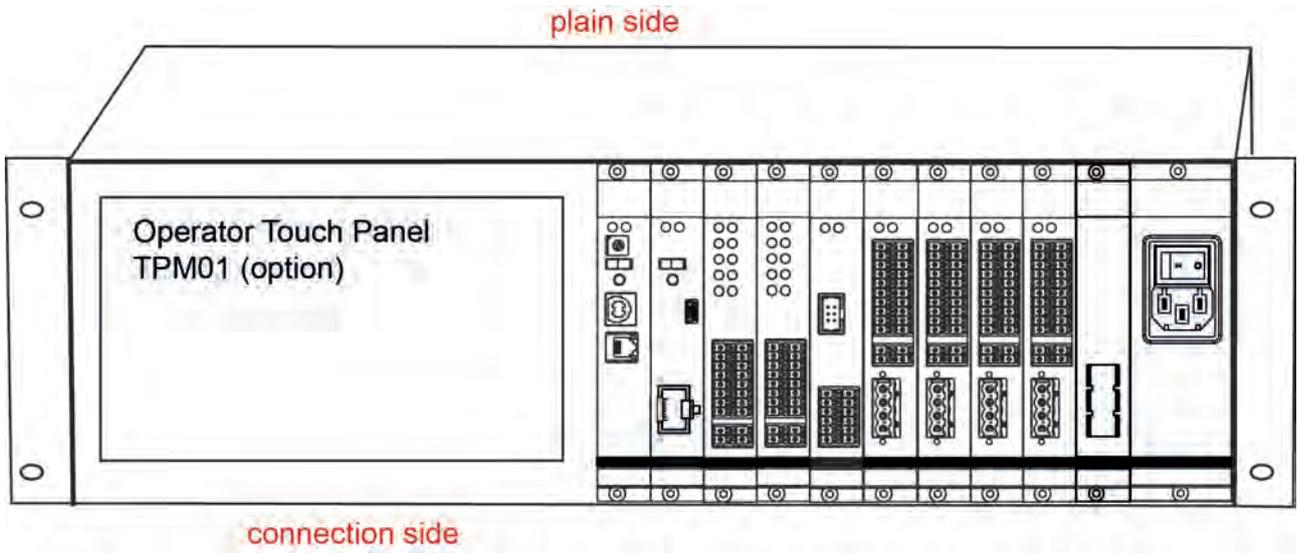


Fig.18 Connection side front

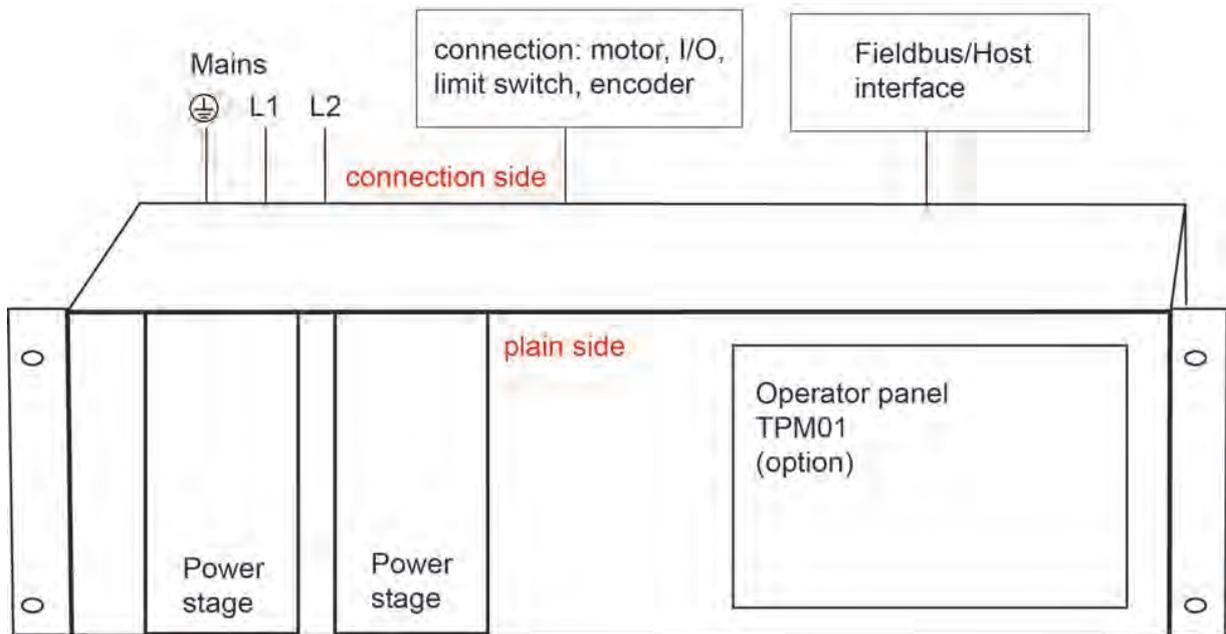


Fig.19 Plain side front

7.3 Electrical Installation



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*TM 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.



Further Manual

Read the corresponding module manual for installation of the single modules.

Ensure sufficient bending radius of the cables during installation. Do not lay the cables in tension or distort them. The cable shields are not for strain-relief – for this purpose use the optional shield contact element(s).

We recommend labelling the mating connectors to prevent interchanging them.

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

8 Commissioning

8.1 Condition

The condition is a fully mechanically and electrically installed phyMOTION™ and a full installation of the delivered programming software phyLOGIC™ ToolBox.

i 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.

8.2 Testing of the Communication MCM Module – PC

i CAUTION – Possible damage!

For the MCM01 module with thePOWM01 module and for the MCM02/MCM03 module the communication test is possible with the following interfaces: USB, Ethernet or RS232 / RS485.

- Please check the interfaces of the MCM module before starting.
- You'll find the description of the communication test with Ethernet or RS232 or RS485 interface in the manual phyLOGIC™ ToolBox – Communication software for the stepper motor controller phyMOTION™.

Description of the communication with the USB interface		
	MCM01 module	MCM02/MCM03 module
1.	Connect the PC to the POWM01 module via USB cable (A-B).	Connect the PC to the MCM02/MCM03 module via USB cable (A-B).
2.	Switch the Remote/Local switch on the POWM01 module to REMOTE.	Switch the Remote/Local switch on the MCM02/MCM03 module to REMOTE.
3.	Power on the supply voltages ('+24...70 V') and ('+24 V') on the POWM01 module.	Power on the supply voltages ('+24...70 V') and ('+24 V') on the MCM02 module.

4. First, the LEDs of the modules blink „red“ while addressing and are a steady red, when the *phyMOTION*TM is ready.

Note: If you cannot go through addressing fully, check that no intense light sources are placed near the *phyMOTION*TM – too bright light can affect the addressing

5. Start *phyLOGIC*TM ToolBox.
6. Select the controller type and the interface. Save the interface parameters.



Further Manual

Parameterising and programming of the phyMOTIONTM is described in the programming manual phyLOGICTM.

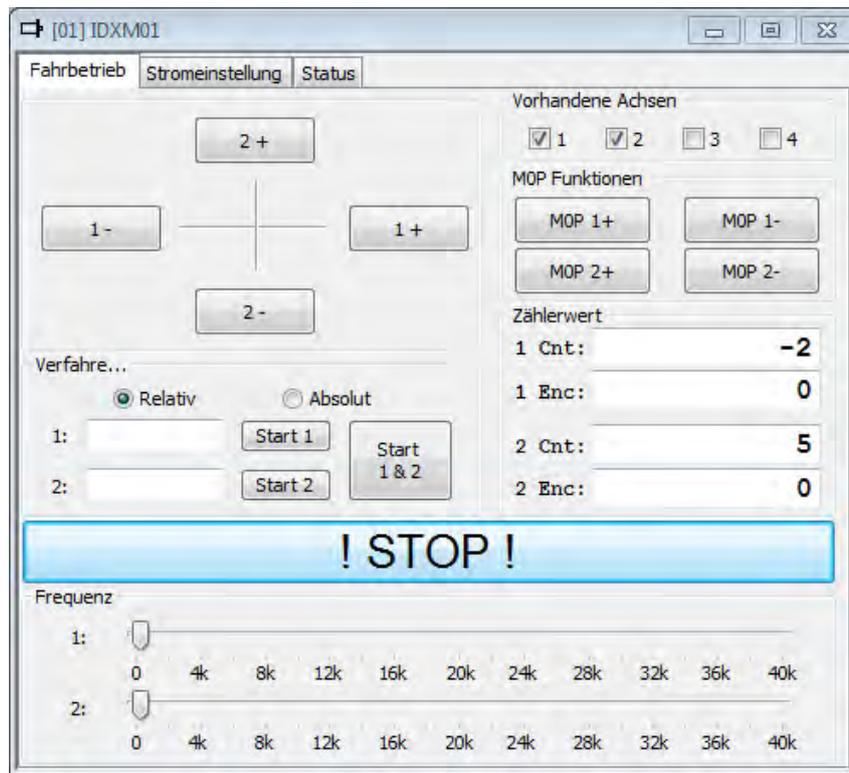
7. After the motor currents have been set to suitable values you can test the modules by selecting the menu items *Transmission/Direct Mode* or *Transmission /Operation*.
8. Menu item *Transmission/Direct Mode*
Many customers are already familiar with *phyLOGIC*TM program instructions. They can enter all types of *phyLOGIC*TM instructions into a dialog box. The instruction is executed at once.

Example: Enter *1.1+200*

The motor axis 1 drives 200 steps in direction +.

The corresponding instruction for a second a motor would be: *1.2+200*.

9. An icon in the menu bar *Transmission/Operation* opens the following dialog box which enables you to drive the motor per mouse click.



10. Simply click on one of the buttons e.g. . Direction + means clockwise, as seen looking on the motor shaft.
If the motor should move in the wrong direction, exchange the connecting leads of one motor phase, e.g. A and B.
11. You can enter drive instructions for two axes into the window "Drive relative ...
The symbol + or – before the entered number of steps defines the direction.
When you click on the button  the instruction will be executed. Now the button has the marking  in order to cancel the movement if required.
12. You can change the drive frequencies of two motors with two slider controls at the bottom of the window 'Frequency'.
13. You can initialise each axis by clicking on one of the buttons . After starting the button has the marking  to cancel initialising if required.
14. In the module window (e.g. DIOM01) you can test the inputs and outputs.

i CAUTION – Possible damage!
Malfunctions are possible while programming the instruction codes – e.g. sudden running of a connected motor, braking etc.

- Please test the program flow step by step.

i **CAUTION – Possible damage!**

For each application, the functional reliability of software products by external factors such as voltage differences or hardware failure, etc. is affected.

- To prevent damage due to system error, the user should take appropriate safety measures. These include back-up and shut-down mechanisms.

i **CAUTION – Possible damage!**

Each end user system is customised and differs from the testing platform. Therefore the user or application designer is responsible for verifying and validating the suitability of the application.

- The suitability of the device's use must be tested and validated.

i **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 before starting, if the parameters are correct.

9 Service and Modular Expansion

In case of a service contract, 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).



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.



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.

9.1 Service for *phyMOTION*TM with External Supply **EXT**

Removal of a module:

- Switch off the *phyMOTION*TM'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.
- Loosen the screw on top and the screw on the bottom of the module's front plate
- Pull the card carefully by the handle.
- If you want to use the *phyMOTION*TM after removing a module, the gap has to be covered with a blanking plate before power supply is reconnected and switched on.
- To send a module to phytron use ESD packaging only.

9.2 Service for *phyMOTION*TM with Internal Supply **INT**

Please note that only the following modules are interchangeable due to the complex design:

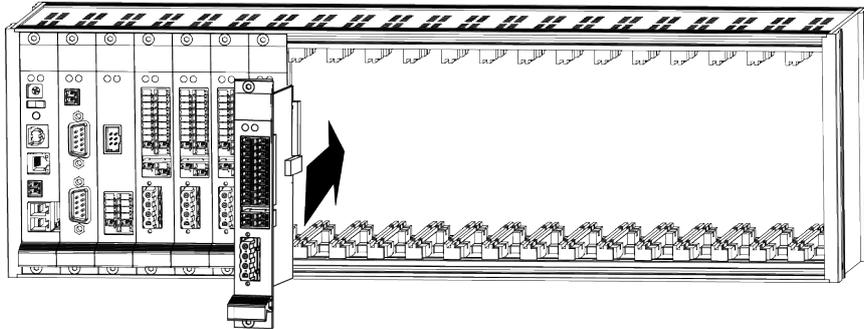
- the power stages MSX
- all *phyMOTION*TM modules on the connection side – except NETM01 and TPM01

When removing the module please observe chap. 9.1.

9.3 Expansion for phyMOTION™ with External Supply **EXT**

For modular expansion the housing has to be opened. These steps may be taken by qualified personnel only.

Before integrating additional modules read chapter 4.5 *Equipment rules* first.



- Switch off the phyMOTION™'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.
- Loosen the screws of the first blanking plate (directly to the right of the last built installed module). Do not leave a gap between existing integrated modules and the expansion.
- If the module you want to add is a power feeding module (POWM01 / POWM02), make sure the backplane slot is prepared for power feeding.
- Push the module carefully into the guide rail until the rear contacts the housing's frame. In case there is a problem pushing the module in the last half centimetre, move the modules front plate slightly to the left and to the right while gently pushing in the module, so that the plug's pins slide into the backplane's socket.
- Connect all necessary plugs to the corresponding modules (read the corresponding manual for each module)
- Connect the supply voltage to your phyMOTION™'s power feeding modules ('+24 – 70V') and ('+24 V')
- Power up the phyMOTION™

10 Warranty, Disclaimer and Registered Trademarks

10.1 Disclaimer

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.

10.2 Warranty

The *phyMOTION*[™] 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, unauthorised modifications, incorrect handling or wiring.

10.3 Registered Trademarks

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 of rights of third parties. Some product names used herein are for instance.

- *phyMOTION*[™] is a trademark of the Phytron GmbH.
- *phyLOGIC*[™] is a trademark of the Phytron GmbH.
- Microsoft is a registered trade mark and WINDOWS is a trade mark of the Microsoft Corporation in the USA and other countries.

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