SINCOS

phytron

Linear
Stepper Motor Power Stage

Manual 2066-A006 GB

customized solutions
in motion

SINCOS

Linear Stepper Motor Power Stage

for Bipolar Control Mode

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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. Please send your comments to the following
E-mail address: info@phytron.de

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1 SINCOS Stepper Motor Power Stage

SINCOS is a linear stepper motor power stage particularly developed for applications which require very high step resolution, such as: measuring tables, machine tools, graphic instruments, etc.

SINCOS is specially recommended for applications where chopping is not acceptable.

- Designed to drive 2-phase, 8, 6 or 4 lead stepper motors
- Resolution up to 10,000 steps/rev. (for a 500-step motor)
- Front panel or external setting of step resolution and current shape
- Drive and stop currents are continuously adjustable independently of one another
- Overheat monitoring with safety cut-out and LED display
- Voltage monitoring with LED display
- No stabilized power supply required
- Compact Europe size plug-in board (100 * 160 mm)

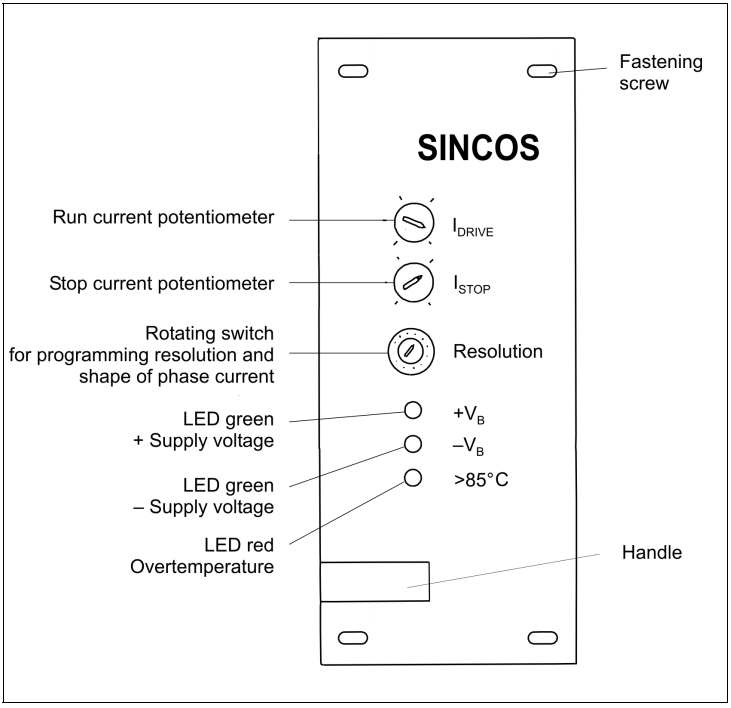

Fig. 1: Front view

1.1 Step Resolution/Current Shapes

SINCOS enables 15 different operating modes: Six step resolutions from full step up to 1/20 step and four different current shapes. So you can always select an adapted operating mode for each motor type and application.

The operating mode can be set with the selector switch at the front panel.
For external programming the SELECT inputs can be used.

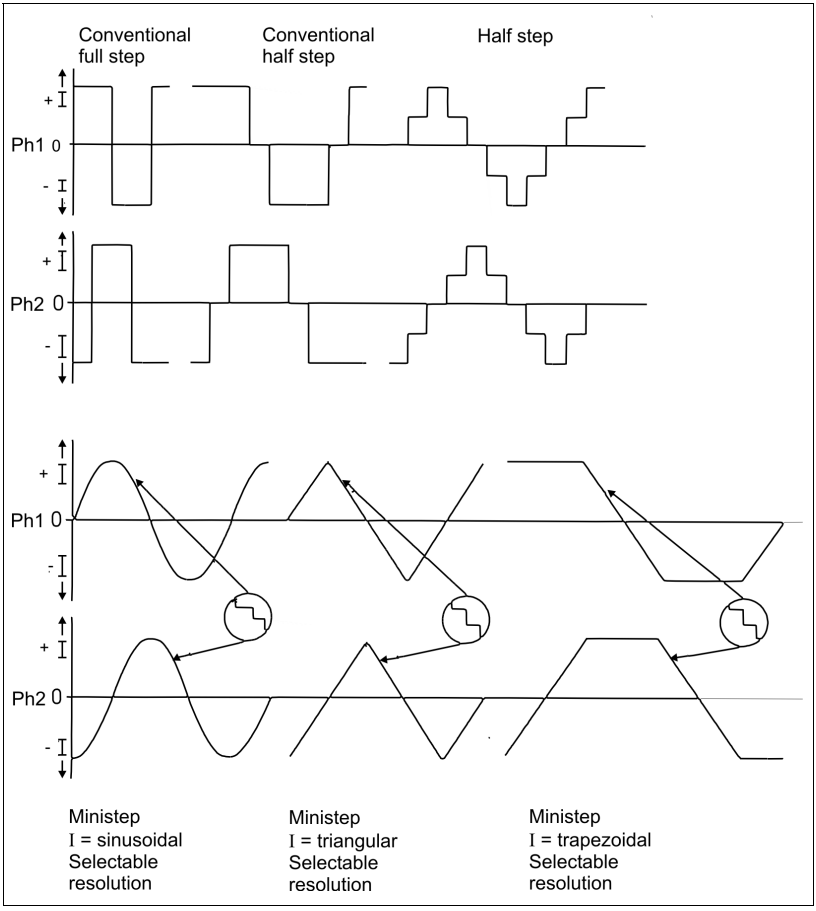

Fig. 2: Current shapes

1.2 Motor Currents

Drive current and stop current are adjustable in a range from 0 to 100 % of the maximum current.

The maximum current for each phase is 2.5 A (cooled), or 1.5 A (without cooling).

1.3 LED Display

Green LED $+V_B$ / $-V_B$

SINCOS requires a dual power supply of maximum 21V / 5A. The green LEDs show that both supply voltages are OK.

Red LED > 85 °C

The power stage is short-circuit proof. A temperature monitoring circuit cuts off the current if the heat sink temperature is above 85 °C. This will be displayed by the red front panel LED. An error output will also be set.

When the temperature falls below 75 °C the unit can be reactivated by RESET. Alternatively the supply voltage can be switched OFF and ON again. This automatically generates a RESET signal.

2 Technical Data

Stepper motor	for 2-phase stepper motors, wired as 8-, 6- or 4-lead motor
Steps/revolution	selectable by front panel switch RESOLUTION or external binary setting by the SELECT inputs
	for a 200-steps motor: 200, 400, 800, 1000, 2000, 4000 steps/rev. for a 500-steps motor: 500, 1000, 2000, 2500, 5000, 10.000 steps/rev.
Current shapes	Selectable by front panel switch RESOLUTION or external binary setting by the SELECT inputs
	Conventional full step and half step mode, triangular, sine-shaped or trapezoidal current shapes
Drive current Stop current	Front panel setting switches I_{DRIVE} and I_{STOP} Separate adjustment (continuously) from 0 to 100% of each current
Admissible supply voltage ranges	–8 to –21 V +8 to +21 V
Maximum current/phase	1.5 A without cooling 2.5 A cooled
Maximum heat sink temperature	+85 °C
Maximum control pulse frequency	200 kHz
Inputs	TTL and open collector Control pulses Direction +/– Stop / Run Motor current OFF Step resolution, current shape
Overtemperature output	Open collector 45 V / 100 mA
Front panel LED displays	$+V_B$ + supply monitoring $-V_B$ – supply monitoring > 85 °C overtemperature monitoring
Front panel width	50,5 mm (10 TE)

Dimensions	Europe size 100*160 mm
Connector	32-pole acc. to DIN 41612, model D
Accessories	Front panel (10 TE) with handle NTS 10 power supply unit NBS SINCOS power supply kit Mating connector

2.1 Dimensions

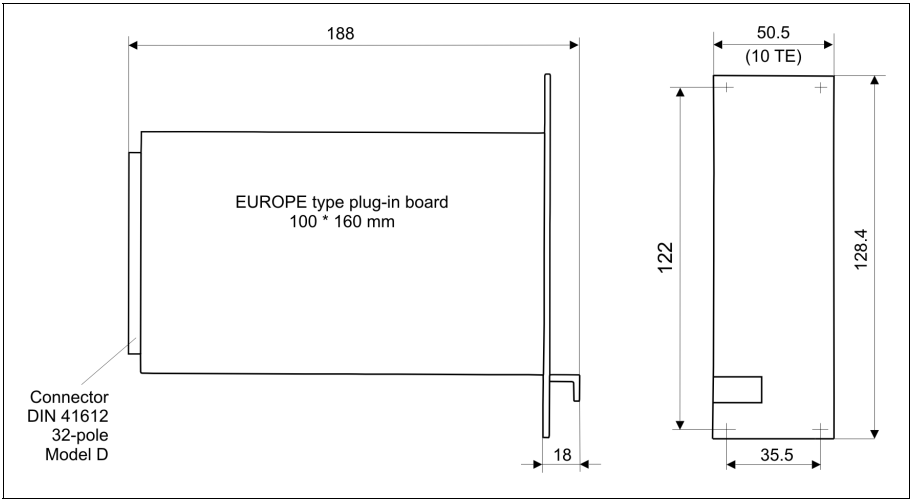

Fig. 3: Dimensions

2.2 Pin Assignment

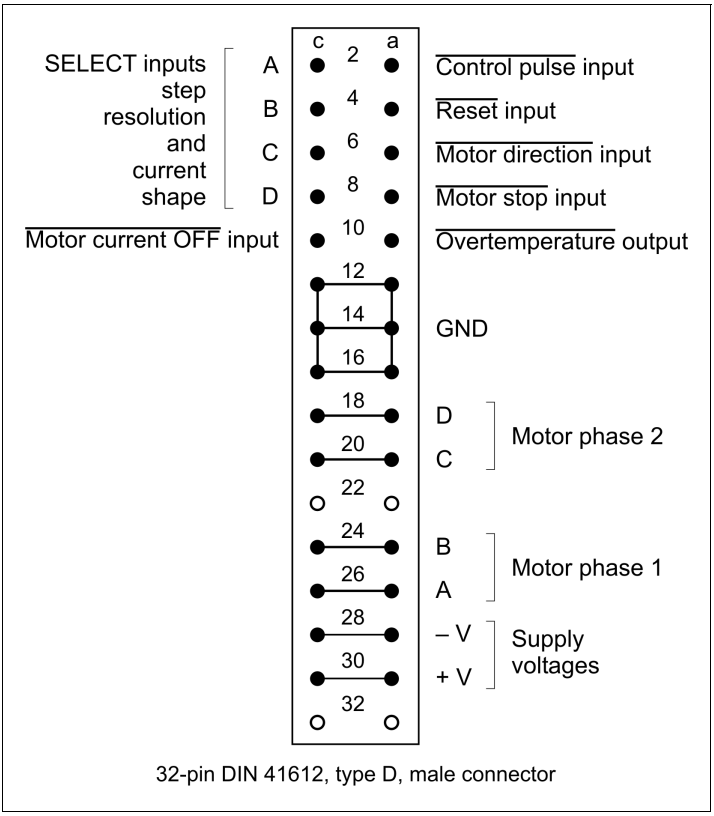

Fig. 4: Pin assigment of the 32-pole connector

3 Principle of Operation

To reach all intermediate positions between two full steps, both phase currents of a 2-phase stepper motor have to be controlled and phase-shifted by 90 degrees. This control is effected by an EPLD: By each control pulse a counter will be incremented or decremented in function of the direction of rotation. The counter value will be decoded equivalent to the step resolution.

The actual transient current value is transmitted to two bipolar output stages. By applicating the constant current principle, the phase currents are in a wide range independent of the supply voltage.

Microsteps can be programmed by dividing each full step into 1, 2, 4, 5, 10 or 20 microsteps. For step divisions of 2, a conventional half step or triangular phase current shape can be selected. For step divisions of 4, 5, 10 or 20 triangular, sine-shaped or trapezoidal phase current shapes can be selected.

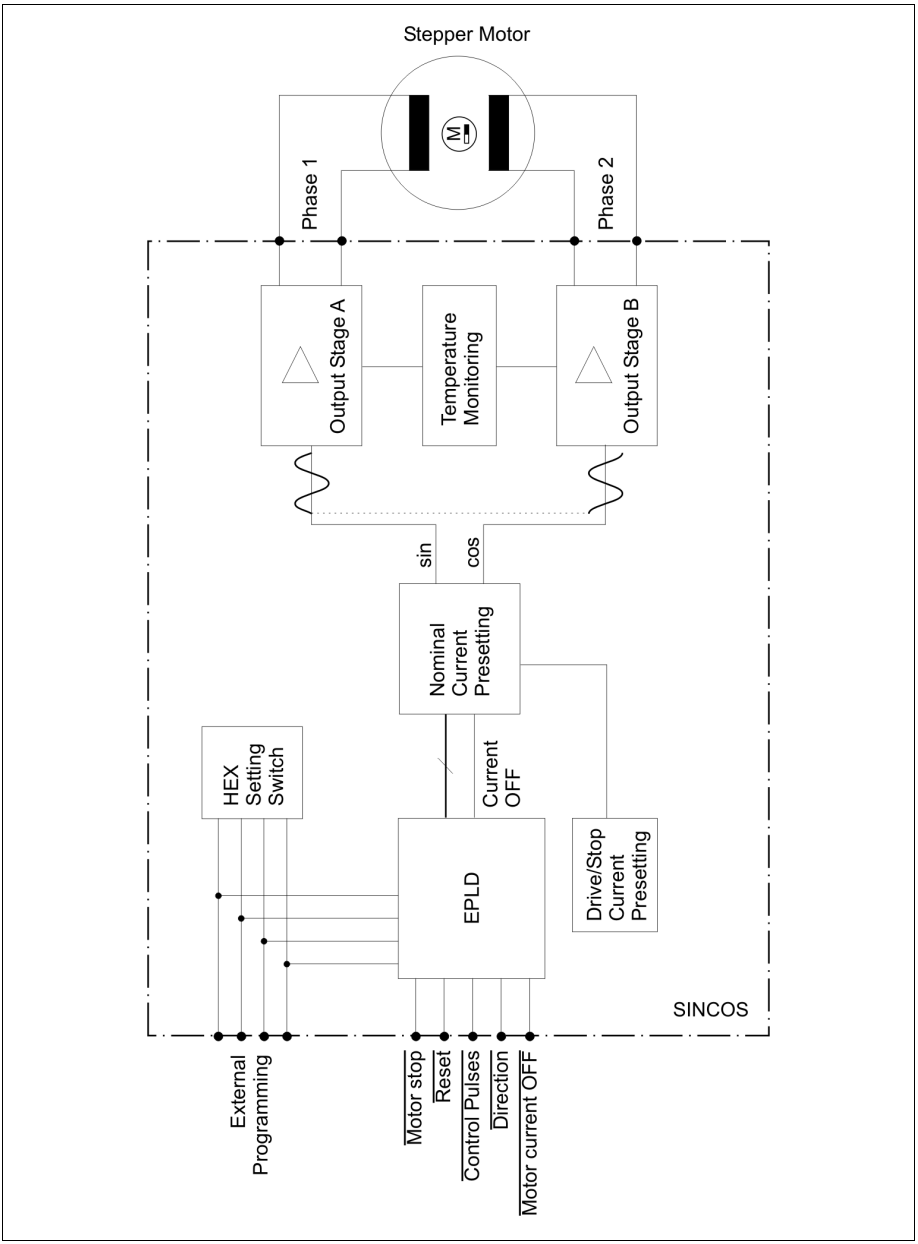

Fig. 5: Schematic diagram

4 Inputs

The inputs include internal 4.7 kΩ pull-up resistors and are designed for open collector control signals.

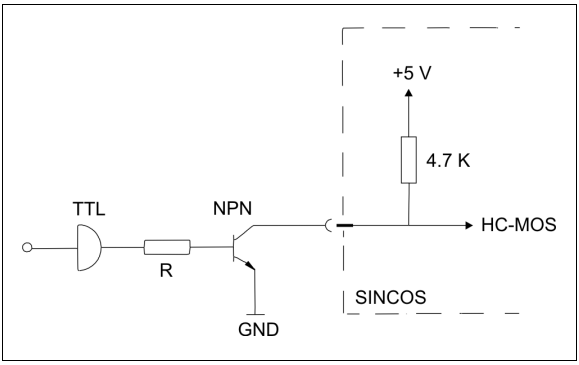

Fig. 6: Input wiring

4.1 Control Pulses

One control pulse provokes one motor step. With the falling signal edge the direction input signal is stored and the drive current switched ON. The effective motor step is executed with the rising edge of the control pulse signal.

An internal logic circuit will detect failing control pulses and switch back to the stop current after 100 ms delay time. If the control pulse signal remains on the low-level, the drive current remains ON.

4.2 Direction +/–

This determines the rotational direction of the motor. The corresponding signal level must only be changed when the motor stands still or is driven within the start/stop frequency range.

Switching at higher speeds provokes "loosing" of steps or will stop the motor.

If the motor rotates – in function of the logic level – in the undesired direction, the motor connecting wires of one phase should be inverted (e.g. 24ac and 26ac).

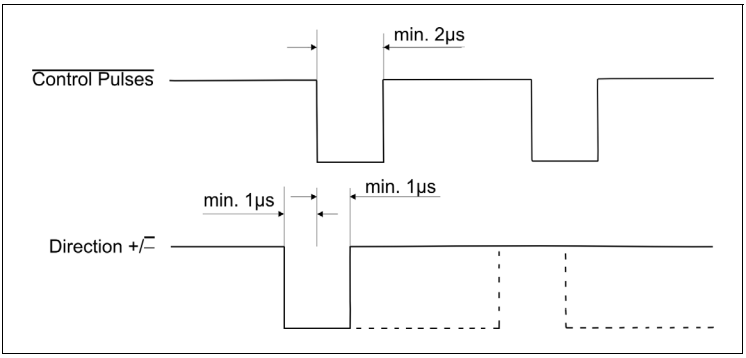

Fig. 7: Time diagram: control pulses and motor direction

The control pulse signal width should be at least 2 µs (maximum frequency 200 kHz).

The direction input must not be changed within 1 µs before and 1 µs after the falling edge of the control pulse signal (see time diagram).

4.3 Motor Stop

This signal stops the motor independently of the control pulse signal.

Warning:
Using this input is not a safe interruption in case of emergency.
For safe cut-off the unit, the supply voltage has to be interrupted.

4.4 Reset

This signal resets the internal counter (asynchronous to the control pulse signal). With the rising edge of the clock signal, an overtemperature error message will be reset, too. Both functions are automatically initiated when the supply voltages are switched ON.

Warning:
Using this input is not a safe interruption in case of emergency.
For safe cut-off the unit, the supply voltage has to be interrupted.

4.5 Motor Current OFF

This signal switches the motor current off independently of other input signals.

Warning:
Using this input is not a safe interruption in case of emergency.
For safe cut-off the unit, the supply voltage has to be interrupted.

4.6 Select A, B, C, D

Via four external data lines, step resolution and current shapes can be set instead of using the selection switch.

For enabling setting by the inputs, the upper front panel selection switch has to be set to position **F**.

Programming is indicated in the following table.

4.6.1 Table Step Resolution and Current Shape

How to set step resolution and current shape					
External programming: SELECT inputs				RESOLUTION selection switch	Step resolution and current shape
D	**C**	**B**	**A**		
L	L	L	L	0	Conventional full step
L	L	L	H	1	Conventional half step
L	L	H	L	2	Half step triangular
L	L	H	H	3	1/4 step sine-shaped
L	H	L	L	4	1/5 step sine-shaped
L	H	L	H	5	1/10 step sine-shaped
L	H	H	L	6	1/20 step sine-shaped
L	H	H	H	7	1/4 step triangular
H	L	L	L	8	1/5 step triangular
H	L	L	H	9	1/10 step triangular
H	L	H	L	A	1/20 step triangular
H	L	H	H	B	1/4 step trapezoidal
H	H	L	L	C	1/5 step trapezoidal
H	H	L	H	D	1/10 step trapezoidal
H	H	H	L	E	1/20 step trapezoidal
H	H	H	H	F	External programming

4.7 Overtemperature Output

This output is switched to GND when the temperature monitoring circuit is activated (open collector).

Max. admissible load: 45 V; 0.1 A; max. 0.3 W (BC 547B).

Remark:
The losses can be reduced as well as the heat sink temperature, by applying a lower supply voltage.

5 Supply Voltage

The SINCOS unit requires a dual supply voltage in the ranges of –8 to –21 V and +8 to +21 V.

The voltage value depends on the desired run frequency.

A low supply voltage will reduce the losses as well as the heat sink temperature.

5.1 Power Supply Unit

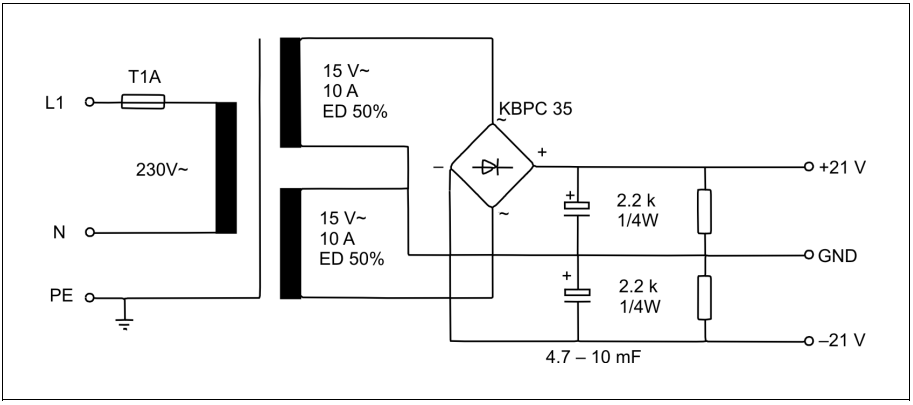

Fig. 8: Power supply unit for SINCOS (ED = duty cycle)

The mains transformer and bridge rectifier size depend on the adjusted maximum current. Within each half part of the power supply the maximum current is twice the value of the adjusted motor current.

The SINCOS unit includes internal fuses in the supply leads: 2 * 5 A fast-blow.

The supply leads from power supply unit to SINCOS should have a cross section of at least
1 mm².

5.2 Phase Current Setting

With the I_{DRIVE} and I_{STOP} potentiometers, drive current and stop current can be adjusted indepently from another to values from 0 to 100% of the maximum value.

As the following figure shows, the true values can be measured with instruments.

The SINCOS has to be set to the full step mode!

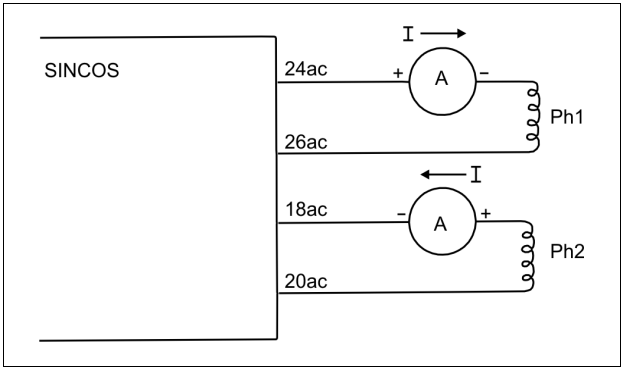

Fig. 9: Phase current measuring

5.2.1 Stop Current

In general, the stop current should be adjusted to approx. 50 % of the drive current, in order to avoid excessive heating of motor and power stage. With the potentiometer I_{STOP} the motor current during motor standstill can be adjusted.

5.2.2 Drive Current

The drive current (run current or operating current) I_{DRIVE} should be adjusted as low as possible (empirical determination). To measure the current please proceed as follows:

1. Wire measuring instruments as shown in the figure above.
2. Set full step mode.
3. Activate a $\overline{\text{STOP}}$ input signal.
4. Apply a control pulse signal (approx. 20 to 50 Hz).
5. Adjust the required drive current by means of potentiometer I_{DRIVE}.

Warning:

If the $\overline{\text{STOP}}$ input signal would not be activated during current adjustment, the current flow direction would change after each control pulse and the instruments might be damaged.

6 Motor Wiring Schemes

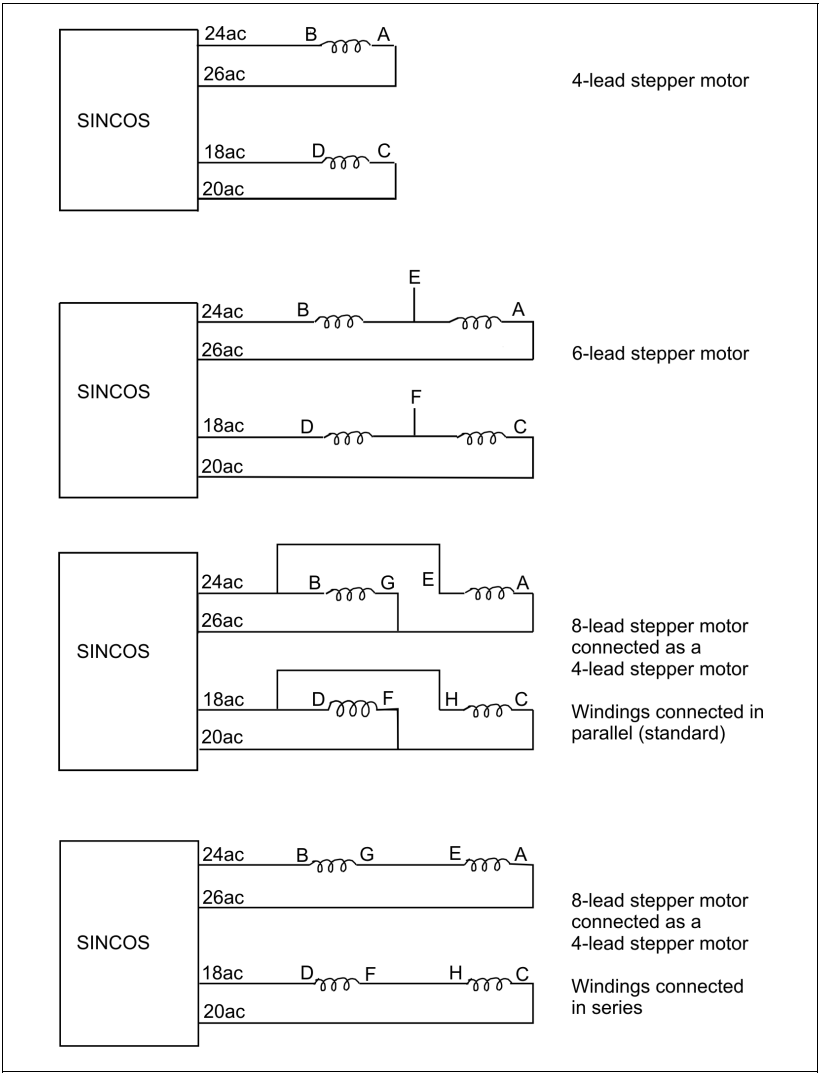

Fig. 10: Motor Connection

The letters correspond to the connector pin assignment and refer to Phytron stepper motors (see motor connection leaflet).

7 To Consider before Installation

Read this manual very carefully before installing and operating this unit.
Observe the safety instructions in the following chapter.

7.1 Qualified Personnel

Design, installation and service may only be performed by qualified and trained personnel.

This personnel should be able to recognize and handle risks emerging from electrical, mechanical or electronic system parts.

WARNING !

By persons without proper training and qualification serious damages to devices and persons might result!

7.2 Safety Instructions

1. Check the output voltages of the supply unit before connecting the SINCOS rear connector.
   Inverted supply voltage leads would immediately cause damage of the power stage.

2. **Do not unplug the SINCOS when powered !**

3. Check correct wiring of the motor leads.

4. Always switch off the supply voltage if you connect or disconnect any wires or connector.
   Most important:
   Do not unplug the motor connector while powered !
   Danger of electric arcing.

5. Voltages connected to the signal inputs and outputs should be safely separated from mains.
   The maximum voltage against protective ground must not exceed 60 V_{DC} or 25 V_{AC}.
6. The inputs STOP and MOTOR CURRENT OFF must only be switched during motor standstill.

7. Setting the inputs MOTOR CURRENT OFF, MOTOR STOP or RESET is no sure separation in the emergency case.

   The voltage supply has to be interrupted for safely switching off the drive.

8. For high stepping frequencies, the control pulse frequency should not be interrupted suddenly. Also avoid maintaining the control pulse input at the low-level (L).
9. If the stepper motor misses steps, decrease the acceleration or the maximum frequency values.
10. The motor should not be driven externally, because it would operate as a generator and deliver energy to the SINCOS.
11. If the SINCOS power stage switches to overtemperature, make sure that sufficient cooling measures are installed.
    Perhaps the supply voltage could be reduced in order to get lower losses. The stop current should not be set to more than 50% of the drive current (check potentiometer I_{STOP} setting).

12. The SINCOS surface may reach temperatures of 70 °C.
    Danger of injury if touching the surface !

8 Warranty

The SINCOS stepper motor power stages are subject to Phytron's legal warranty. Phytron will repair or exchange units which show a failure due to defects in material or caused by the production process. This warranty does not include damages which are caused by the customer, as there are, for example, not intended use, unauthorized modifications, wrong treatment or wrong wiring.

9 ESD Protective Measures

All the products which we deliver have been carefully checked and submitted to a longterm test. To avoid the failure of components sensitive to electrostatic discharge (ESD), we apply a great number of protective measures during manufacturing, from the component input check until the delivery of the finished products.

Warning:

Manipulation of ESD sensitive devices must be effected by respecting special protective measures (EN 61340 – 5). Only return the devices in adapted packaging.

Phytron's warranty is cancelled in case of damages arising from improper manipulation or transportation of ESD sensitive modules and components.

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