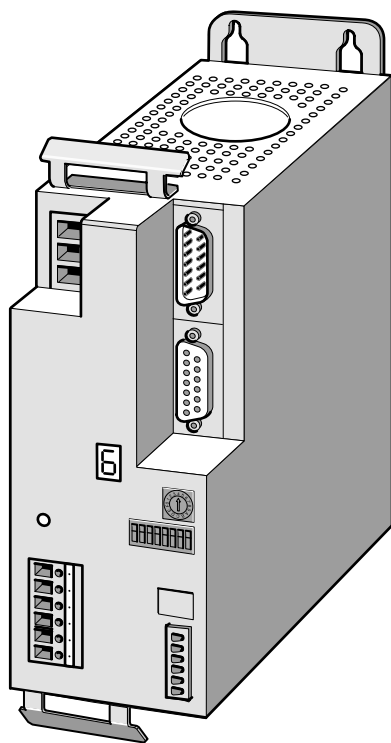


Technical documentation



Twin Line Drive 01x

Power electronic system for
stepper motors

TLD01x

Operating system: 1.0xx

Order no.: 9844 1113 102

Edition: d107, 09.02

Twin Line



CAUTION!

See the “Supplement” chapter at the end of the documentation for important information.

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Glossaries

Abbreviations

Abbreviation	Meaning
AC	Alternating current
DC	Direct current
DC link	DC link
EC	European Community
EMC	Electromagnetic compatibility
EU	European Union
I	Incremental encoder
I/O	Inputs/Outputs
Inc	Increment
IT system	I: isolation T: terre System without potential to ground, not grounded
LED	Light-Emitting Diode
M	Motor
PELV	Protective Extra Low Voltage, Functional Extra Low Voltage (FELV) with safe isolation
RC	Residual current

Product name

Abbreviation	Product designation	Term used
TL HBC	Twin Line Holding Brake Controller	Holding brake controller
TLD01x	Twin Line Drive 01x	Power electronic system

Technical Terms

<i>Actual position of the drive system</i>	The actual position of the drive system gives the absolute or relative positions of moving components in the system.
<i>Actual position of the motor</i>	See Angular position of the motor.
<i>Angular position of the motor</i>	The angular position of the motor corresponds to the angular position of the rotor in the motor housing, and refers to the zero point or index point of the position sensor.
<i>DC link</i>	The DC link generates the necessary direct current for operating the motor and provides the amplifier with the necessary energy. The DC link acts as a buffer for energy fed back by the motor.
<i>Direction of rotation</i>	Rotation of the motor shaft in a clockwise or anticlockwise direction. A clockwise direction of rotation is defined as the motor shaft rotating clockwise as the observer faces the end of the protruding shaft.
<i>Drive solution</i>	The drive solution comprises the drive system with the Twin Line Unit and motor with the system mechanics forming an integral part of the chain of motion.
<i>Drive system</i>	The drive system consists of the Twin Line Unit and the motor.
<i>Encoder</i>	Sensor for recording the angular position of a rotating element. The encoder is mounted on the motor and signals the angular position of the rotor.
<i>High/open</i>	Signal status of an input or output signal; when no signal is present, signal voltage is high (high level).
<i>Incremental encoder</i>	See encoder
<i>Incremental signals</i>	Angular steps of an encoder in the form of square-wave pulse sequences. The pulses signal changes in position.
<i>Index pulse</i>	Encoder signal for referencing the rotor position in the motor. The encoder sends one index pulse per revolution.
<i>IT system</i>	Power system with no ground potential reference, since it is not grounded. I: isolation T: terre
<i>Limit switch</i>	Switches that signal an overrun of the permissible travel range.
<i>Low/open</i>	Signal status of an input or output signal; when no signal is present, signal voltage is low (low level)
<i>Power amplifier</i>	This is the unit that controls the motor. The power amplifier generates currents for controlling the motor in accordance with the positioning signals from the control unit.
<i>Power controller</i>	See Power amplifier
<i>PULSE-C</i>	Pulse direction interface for recording external position presets via pulse direction signals or Pulse _{forward} /Pulse _{backward} signals for positioning the motor.
<i>Pulse direction signals</i>	Digital signals with variable pulse frequencies which signal changes in position and rotation direction via separate signal wires.
<i>RS422 level</i>	The signal status is calculated from the differential voltage of one positive and one inverted negative signal. Two signal wires must therefore be connected for one signal.

<i>Sense regulation</i>	The voltage drop on the supply lines is compensated in such a way that the output voltage at the sense terminals has the correct value. The output voltage is only activated once the sense lines have been connected.
<i>Speed monitoring</i>	Detects position deviations during motor movement. The actual position reported by the encoder is compared with the setpoint position. If the deviation exceeds a defined value, a following error is reported.
<i>Watchdog</i>	Device in the unit which detects internal faults. If a fault occurs, the Twin Line unit switches off the amplifier and outputs immediately.

Conventions and symbols

Action symbols "►" This action symbol is used for step-by-step instructions which can be carried out as they are described. If one of the instructions results in a noticeable response from the unit, this will be described after the description of the action to be carried out. This will give you direct confirmation that a particular step has been correctly carried out.

Enumeration symbol "•" The enumeration symbol is used for listing individual points in a given information group in summary form. If the result of steps or sequences is described, the step to be carried out is described first.



This symbol is used for general notes which give additional information about the unit.



Passages preceded by this symbol may have to be discussed in more detail with the local customer service.

1 The power electronic system

1.1 Scope of supply

- Check the parts supplied to make sure they are complete.

Keep the original packaging in case the unit has to be returned to the manufacturer for an update or repair.

*Scope of supply of
power electronic system*

The scope of supply of the TLD01x power electronic system includes:

Item	Qty.	Designation	Order no.
1	1	TLD011, TLD012	type code
2	1	Hood for front cover	-
3	1 or 2	SK 14 shielding terminal for motor connection (two shielding terminals in units without internal line filters)	6250 1101 400
4	1	Plug units for terminal strips	-
5	1	Documentation on the TLD01x on CD-ROM, multilingual	9844 1113 138

Optional equipment of the power electronic system:

Item	Qty.	Designation	Order no.
1	1	TLD01x...RM with speed monitoring	type code
1, 6	1	TLD01xNF... without internal line filter	type code

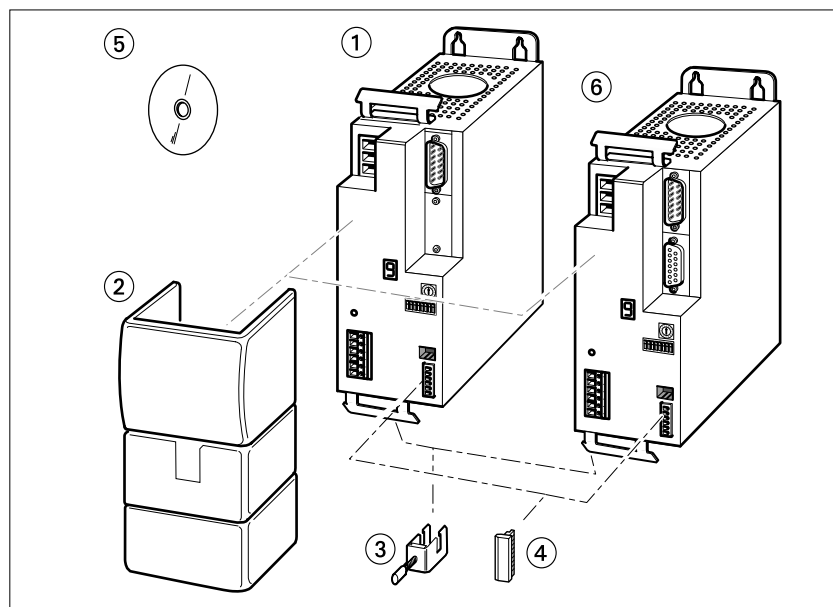


Fig. 1.1 TLD01x without and with speed monitoring

Accessories Accessories for the power electronic system are:

Item	Qty.	Designation	Order no.
1	1	Connector set for complete assembly	6250 1519 001
2	1	Motor cable 1.5 mm ² .	6250 1317 xxx ¹⁾
-	1	Pulse direction cable for PULSE-C interface 2 x socket, 15-pin 1 x socket, 15-pin, one end open	6250 1447 yyy ²⁾ 6250 1452 yyy ²⁾
3	1	Encoder cable for encoder interface	6250 1440 xxx ¹⁾
4	1	Holding brake controller TLHBC	6250 1101 606
5	1	External line filter for units without internal filters for TLD011 NF, 4 A for TLD012 NF, 10 A	5905 1100 200 6250 1101 900

1) Cable length xxx: 003, 005, 010, 020: 3 m, 5 m, 10 m, 20 m, greater lengths on request.

2) Cable length yyy: 005, 015, 030, 050: 0.5 m, 1.5 m, 3 m, 5 m;

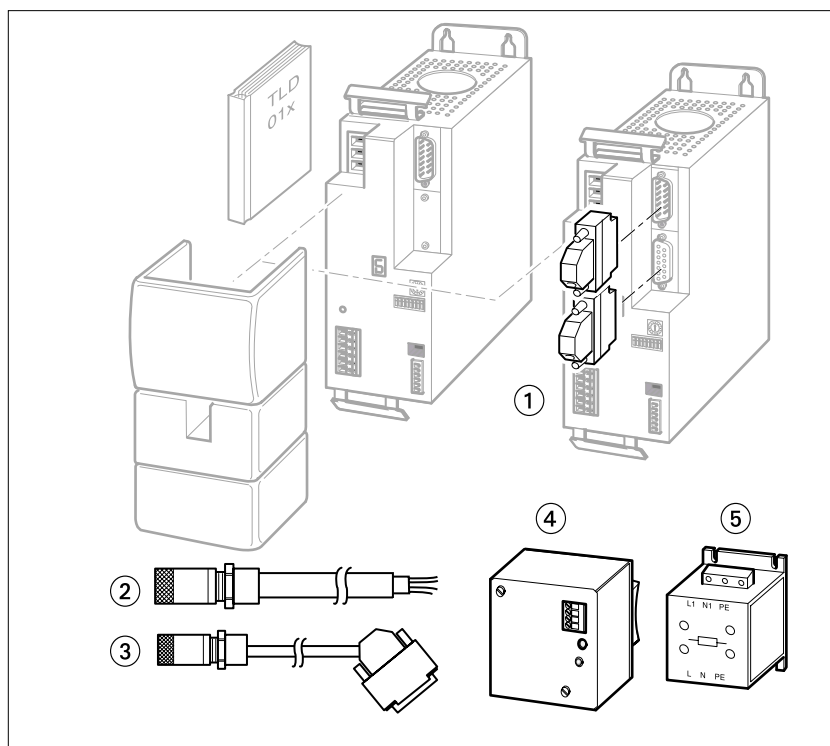


Fig. 1.2 Accessories for the TLD01x

1.2 Documentation and literature

Manuals for the power electronic system Twin Line HMI, manual for the Human-Machine Interface HMI, English
Order no.: 9844 1113 091

1.3 Unit series

The power electronic system TLD01x forms part of the Twin Line device series for controlling stepper motors and AC servomotors. The power electronic system operates as a stand-alone power amplifier with integrated controller and power circuitry.

The power electronic system is available with two power ratings in a similar housing design. Electrical connections and functional scope are identical for both units.

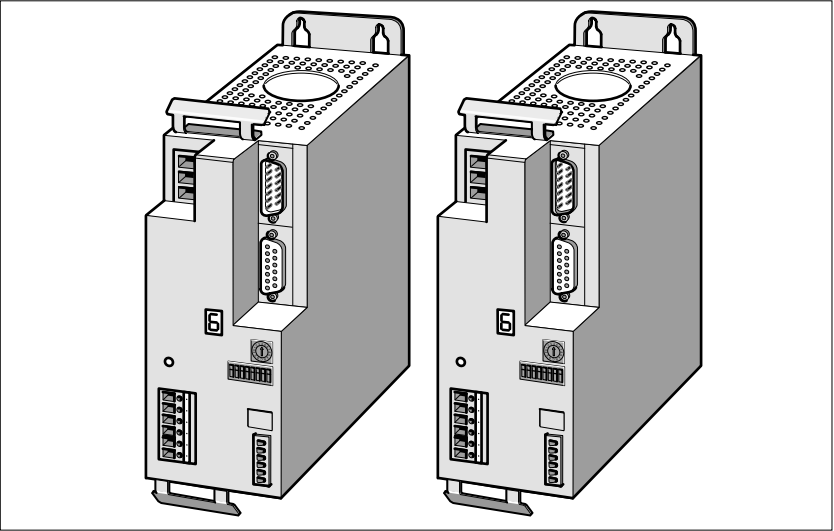


Fig. 1.3 Power electronic system TLD011 and TLD012,

Type code The power class of the power electronic system is indicated by the last digit in the device name "TLD01x" of the type code.

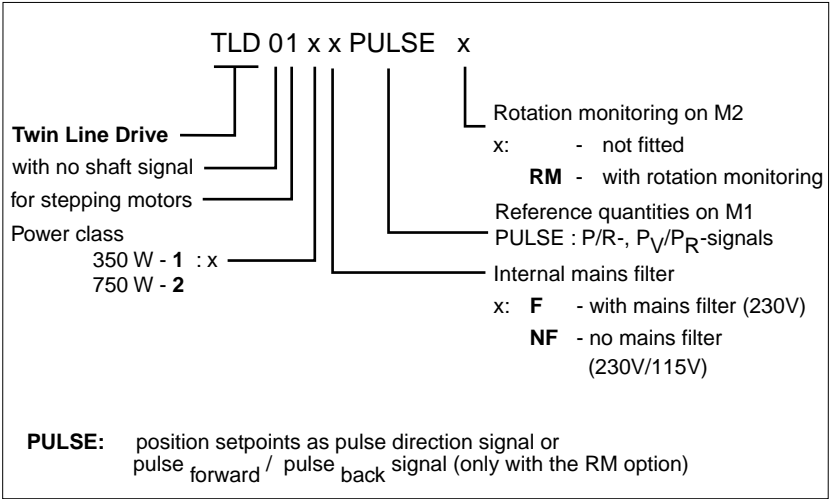


Fig. 1.4 Type code of the power electronic system TLD01x

1.4 Unit overview

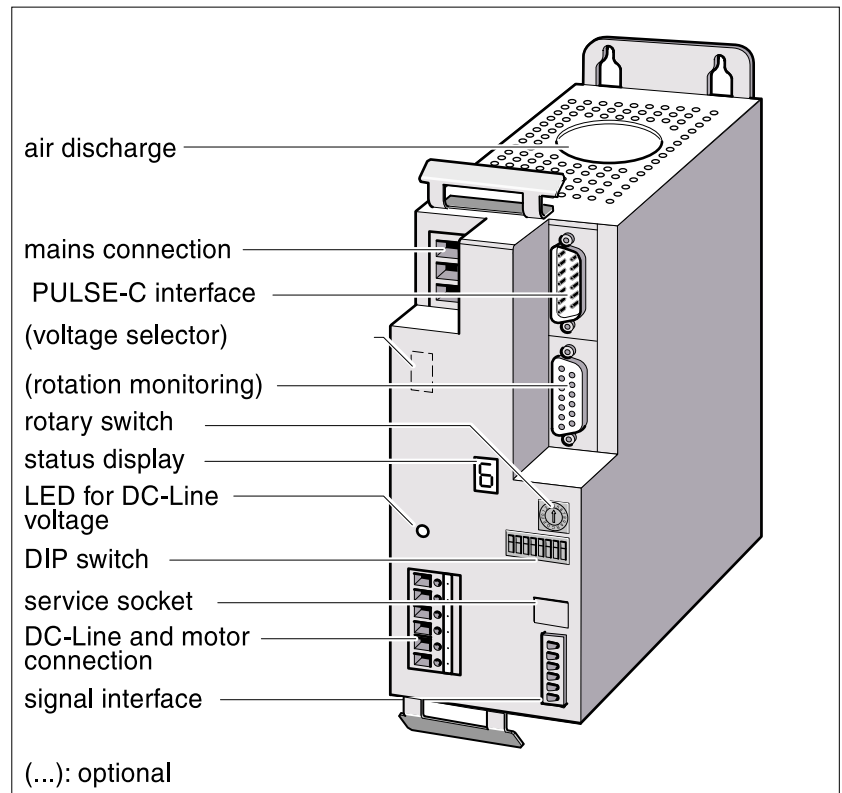


Fig. 1.5 Power electronic system TLD01x

<i>Power connection</i>	The power supply for the amplifier is connected to the line power output. A position controller with a built-in line power filter can be operated without any further noise suppression on the supply side.
<i>Motor connection</i>	The unit supplies the power for a stepper motor over the three-phase connection. The maximum power output is monitored by the unit. The motor connection is short-circuit protected and is checked for ground faults when the amplifier is enabled.
<i>DC link connection</i>	The DC link voltage for the unit is taken from the intermediate circuit terminal. The capacity of the built-in DC-link capacitors at the DC-link connection can be increased with external capacitors for short-term absorption of excess braking energy.
<i>PULSE-C interface</i>	<p>The setpoint position is set incrementally as a pulse signal over this interface. Control signals for enabling the power amplifier, changing the step resolution and the current setpoint value are also sent over the interface.</p> <p>Output signals at the PULSE-C interface report a fault and that the unit is ready for operation.</p>
<i>Speed monitoring</i>	<p>The power electronic system receives A/B signals for position monitoring of the stepper motor and a signal that checks the motor temperature. The encoder electronics in the motor receive the required operating power from the speed monitoring connection.</p> <p>Speed monitoring is built into the system as an option.</p>

<i>Voltage selector switch</i>	The unit can be connected to 115 V or 230 V power with the voltage selector switch. The voltage selector switch is only available with units without line filters (NF option).
<i>Signal interface</i>	The power for control loops and for controlling the fan must be supplied over the signal interface by an external 24 V _{DC} power supply. The lines for a holding brake or the control lines for the TL HBC holding brake controller are connected to the brake terminal.
<i>Status display</i>	A 7-segment display shows information about the operating status of the power electronic system. If there is an operating malfunction the display will flash and display the error code.
<i>DIP switch</i>	The step resolution and the controller signal functions are set by the eight DIP switches.
<i>Rotary switch</i>	The rotary switch limits the maximum motor r.m.s current. The value for the maximum motor current is shown in the motor type plate.
<i>LED for DC link voltage</i>	The LED comes on when there is voltage in the DC link.
<i>Air outlet and fan</i>	A built-in fan extracts cold air from the bottom of the unit and removes the unit operating heat through the upper air vents. Temperature sensors on the power amplifier's heat sink protect the unit from overheating.
<i>Circuit diagram</i>	

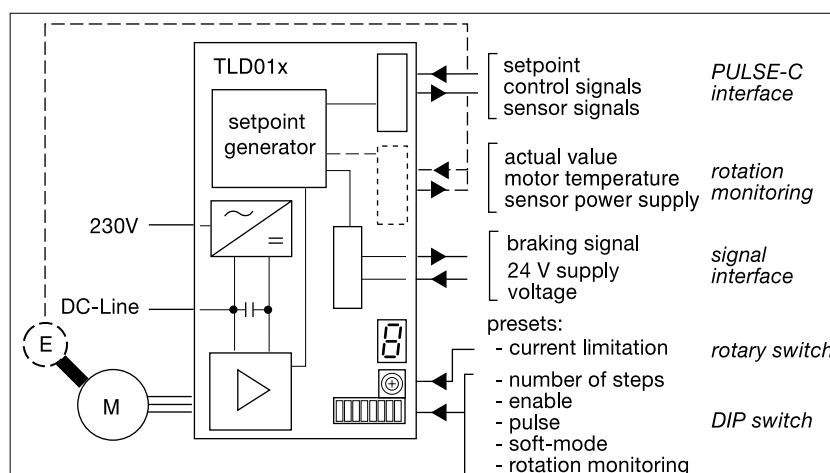


Fig. 1.6 Signals and function blocks of the power electronic system with speed monitoring

1.5 Operational function

The power electronic system moves a stepper motor in accordance with a setpoint. The setpoint signal is generated by a positioning or NC controller and fed to the PULSE-C interface as a pulse signal.

If speed monitoring is also installed, the power electronic system records the position of the motor and reports step losses, which may occur as a result of blocking or overload of the motor.

1.6 Directives and standards

1.6.1 Declaration of conformity and CE mark

The EC directives define the minimum requirements - particularly safety requirements - applicable to a product and must be complied with by all manufacturers and dealers marketing the product in the member states of the European Union (EU).

The EC directives describe the main requirements for a product. The technical details are laid down in the harmonized standards, which are published in Germany as the DIN EN standards. If there is not yet any EC standard applicable to a particular product area, existing technical standards and regulations will apply.

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 all relevant EC-directives. The unit can be used anywhere in the world.

Machine Directive The Twin Line unit is not a machine in the sense of the EC Machine Directive (89/392/EEC). It has no functional moving parts. The unit may however be a component part of a machine or installation.

Provided the rest of the machine complies with the machine directive and it has been set up in accordance with the EMC testing code of the manufacturer, conformity with the machine directive can be certified.

EMC Directive The EC directive on electromagnetic compatibility (89/336/EEC) applies to units which can cause electromagnetic interference or whose operation can be impaired by such interference.

The Twin Line unit'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 Twin Line unit is EMC-compliant when fitted in the machine or installation and before use of the unit is permitted.

Low Voltage Directive The EC Low-Voltage Directive (73/23/EEC) lays down safety requirements for "electrical apparatus" as protection against the risks that can originate in such devices and can be created in response to external influences.

As specified by the low voltage directive the Twin Line unit conforms to EN 50178 and to the following peripheral conditions:

- protection class 1
- pollution degree 2

Declaration of conformity The declaration of conformity certifies that the device satisfies the requirements of the EC directive cited. A declaration of conformity in accordance with the EC low-voltage directive has been issued for the Twin Line unit.


<u>EC Declaration of Conformity 2001</u>		BERGER LAHR	
		BERGER LAHR GmbH & Co.KG Breslauer Str. 7 D-77933 Lahr	
<input type="checkbox"/> Machine Directive 98/37/EEC, Appendix IIA <input checked="" type="checkbox"/> EMC Directive 89/336/EEC <input checked="" type="checkbox"/> Low Voltage Directive 73/23/EEC the above directives have been amended by the CE Marking Directive 93/68/EEC			
We hereby declare that the products designated below correspond, in their design and construction as well as in the version marketed by us, to the requirements of the listed EC directives. This declaration loses its validity if changes are made to the products which have not been agreed with us.			
Designation:		3-phase motor amplifiers with/without electronic control and accessories	
Type:		TLDx1x, TLCx1x, TLDx3x, TLCx3x, TLCx1xP, TLCx3xP, TLBRC, TLHBC	
Product number:		634xxxxxxx, 635xxxxxxx, 62501101706, 62501101606,	
Harmonised norms applied, especially:		EN 50178 Classification VDE 0160: 1998.04 EN 61800-3 Classification VDE 0160: 1997.08, category 2 according to BERGER LAHR test conditions	
national norms and technical specifications applied, especially:		UL 508C BERGER LAHR test conditions 200.47-01 EN	
Company stamp:		Berger Lahr GmbH & Co. KG Postfach 11 80 · D-77901 Lahr Breslauer Str. 7 · D-77933 Lahr	
Date/Signature:		27.04.2001 	
Name/Department:		W. Brandstätter / MOM-E	

Fig. 1.7 Conformity to the EC low-voltage directive

1.6.2 Regulations and standards

<i>Standards concerning safe operation of the Twin Line units</i>	EN 60204-1 (VDE 0113 Part 1: 1998): Electrical equipment of machines, General requirements
	DIN VDE 0100, Regulations regarding the installation of high-voltage systems with voltages up to 1000 V
	DIN VDE 0106-100, 1983, Protection against electrical shock; Location of actuation elements in the vicinity of operating resources liable to accidental contact
	DIN VDE 0470-1, 1992, IP protection types
	EN 954-1: Safety of machines, safety of components of control devices, Part 1: General design principles
<i>Standards regarding compliance with EMC limiting values</i>	EN 61000-4-1 (IEC 1000-4-1: 1992): Testing and measurement procedures, section 1: Overview of noise suppression test procedures
	EN 61800-3:1996 and prA11:1999: Variable-speed electric drives

2 Safety

2.1 Danger categories

Safety notes and general information are indicated by special symbols in the manual. In addition you will find symbols and instructions affixed to your Twin Line unit which warn you of possible dangers and help you to operate the unit safely.

Danger symbols are divided into three danger categories classified by how serious a danger is. The symbols shown emphasize the danger situation to which the warning applies.



DANGER!

This indicates direct personal danger.

Can lead to serious injuries with fatal consequences if not observed.



WARNING!

Indication of a recognizable danger.

If the warning is ignored, the danger can lead to serious injury with fatal consequences, and to the unit or system parts being permanently damaged.



CAUTION!

Indication of a danger.

If this is ignored, minor personal injury and light damage to the unit or system may be the result.

2.2 Safety notes



DANGER!

Electric shock from high voltage!

Follow safety rules when working on electrical systems:

- Switch off the power to the unit.
- Make sure the unit cannot be switched on again inadvertently.
- Confirm that no voltage is present.
- Cover or shield any neighboring system parts which are live.



DANGER!

Electric shock from high voltage!

Before starting work on the connections of the power unit or on the motor terminals, wait for the 4 minutes discharge time and then measure the residual voltage on the DC-link terminals DC+ and DC-. The residual voltage must not exceed 48 V_{DC} before you start work on the connections. If additional DC-link capacitors are connected, the discharge period is increased to 10 minutes. Wait for this period and then measure the residual voltage.

2.3 Use for the purpose intended

2.3.1 Ambient conditions

Ambient temperature	0 °C to +50 °C
Transport and storage temperature	-40 °C to +70 °C
Relative humidity	15% to 85% (no condensation permissible)
Installation height, operation with no reduction in performance	h<1000 m above m.s.l.
Vibration stress during operation to DIN IEC 68-2-6	
Number of cycles:	10
Frequency range:	10Hz to 500Hz
Acceleration:	20m/s ²
Continuous shocks to DIN IEC 68-2-29	
Number of shocks:	1000/direction (directions: X, Y, Z per pos. and neg. direction, total 6000)
Peak acceleration:	150m/s ²
Protection grade	IP20

2.3.2 Intended use

The power electronic system is an electrical device for controlling a variable-speed drive with stepper motor.

Only an AC stepper motor may be operated with the power electronic system. The motor must be approved by your local representative for operation with the unit.

The motor connections of multiple units may not be connected to each other.

Multiple units must not be connected in parallel over the DC-link output.

The power electronic system may be used for industrial applications in the system configuration described with a fixed connection only.

The power electronic system may only be set up and operated after correct EMC installation.

The power electronic system must be installed and properly mounted in a switch cabinet. It may only be used with the cables and accessories specified by your local representative.

The power electronic system may not be used in IT networks, as they have no ground potential. Interference suppression filters for correct EMC installation will only work properly with a ground potential connection.

2.4 Qualification of the personnel

Only personnel qualified as electrical technicians and controller technicians in accordance with IEC 826-09-01 (modified) and who are familiar with the contents of this manual are permitted to set parameters, commission and operate the TL unit. The technicians must be able to detect potential dangers that may be caused by setting parameters, changing parameter values and generally by the mechanical, electrical and electronic equipment.

Qualified personnel can use their technical training, knowledge and experience to assess the work to be done and to recognize and avoid possible dangers or non-qualified personnel can have the same knowledge as qualified personnel after several years of work in the same area.

Qualified personnel must be familiar with the current standards, regulations and accident prevention regulations which have to be observed when working on the unit.

2.5 Safety devices

The power electronic system unit monitors a range of signals from system and installation components.

Safety devices coupled with the unit protect the system and operating personnel. The following components and limit values are monitored internally:

Monitoring	Task and protective functions
Short-circuit	Monitor motor cable for short-circuits between phases, functional safety and device protection
Overvoltage and undervoltage	Monitor DC link for overvoltage and undervoltage, functional safety and device protection
Temperature	Monitor power amplifier and motor ¹⁾ with sensors for excess temperature, device protection
Speed error	Following error indicated in units with speed monitoring if position deviation is too great, functional safety

1) Motor monitoring only with devices with optional speed monitoring

3 Technical data

3.1 Mechanical data

3.1.1 Power electronic system TLD01x

Weight	TLD011 and TLD012 with speed monitoring	2.2 kg
Device protection	Protection grade to DIN EN 60529: 1991	IP 20
Dimensions		

TLD01x	
Width [mm]	81
Height [mm]	212.5
Depth [mm]	184.5

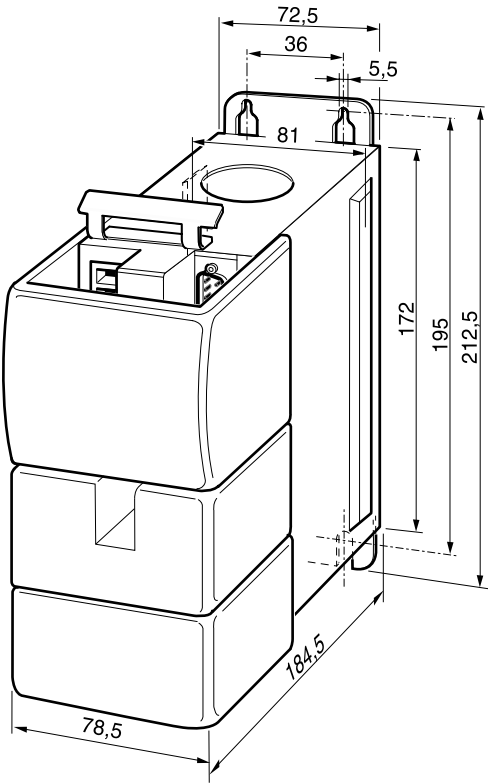


Fig. 3.1 Dimensions TLD011 and TLD012

3.1.2 Accessories

Holding brake controller
TL HBC

Dimensions (H x W x D)
Installation on top-hat rail

107 mm x 104 mm x 76 mm
55 mm

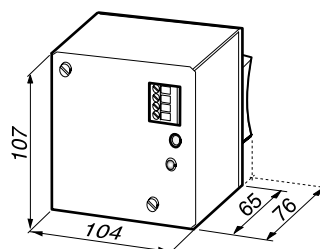


Fig. 3.2 Holding brake controller

3.2 Electronic data

3.2.1 Power electronic system

Line connection

	TLD011/TLD011P	TLD012/TLD012P
Line voltage [V_{AC}]	1 x 230 -20%/+15%	1 x 230 -20%/+15%
only with TLD01xNF:	1 x 115 -20%/+15%	1 x 115 -20%/+15%
Line frequency [Hz]	47 - 63	47 - 63
Current consumption [A]	2 (230 V) 4 (115 V)	5 (230 V) 10 (115 V)
Starting current [A]	< 60	< 60
Power factor $\cos\varphi$	> 0.6	> 0.6
Power loss [W]	≤ 40	≤ 60
Line buffering [ms]	< 5	< 5
Overvoltage strength (DIN EN 61800-3)	between phases: 1 kV, phases to ground: 1 kV	
Leakage current ¹⁾ [mA]	< 30	< 30
Fuse, external [A] / characteristics		
at 230 V	10 C, K or similar	10 C, K or similar
at 115 V	10 C, K or similar	10 C, K or similar

1) Leakage currents are measured with an RC circuit in accordance with IEC60990. The value can be higher if measured directly. Notes on using ground leakage circuit-breakers on request.

Motor connection

	TLD011/TLD011P	TLD012/TLD012P
Power class ¹⁾ [kW]	0.35	0.75
Switching frequency [kHz]	16	16
Rated current [A.r.m.s.], r.m.s.	3	7
Max. speed [rpm]	3000	3000
Cable length ²⁾ [m]	20	20
Cable cross-section [mm ²]	1.5	1.5

1) Max. electrical effective power of the unit at rated current and 115 V_{AC} or 230 V_{AC} line voltage

2) Longer cables on request

24 V _{DC} supply	PELV, DIN 19240, reverse-polarity-protected		
	Input		
	Voltage range		20 V to 30 V
	Ripple		< 2 V _{SS}
	Power consumption		≤ 1.5 A
	Stored energy time with power failure (at 24 V) without brake connection		≥ 20 ms
PULSE-C interface	Signal inputs		
	Symmetrical	compatible with RS422-voltage	
	Asymmetrical	4.5V to 30 V	
		connected electrically to 24VGND	
	Input resistance		5 kΩ
	Input frequencies:		
	Stepping frequency (PULSE/PV, DIR/PR)		≤ 200 kHz
	Motor current controller (PWM)		6 kHz to 25 kHz
	Step count		200, 400, 500, 1000, 2000, 4000, 5000, 10000
	Signal outputs ($\overline{\text{ACTIVE}}$, $\overline{\text{FUNCT_OUT}}$)	open collector outputs	
		short-circuit-proof,	
	Output voltage		≤ 30 V
Output current, maximum		50 mA	
Speed monitoring (optional)	Signal inputs (A, B)		RS422-level
			connected electrically to 24VGND
	Input frequency		≤ 400 kHz
			1 600 000 Inc/s
	Encoder pitch		1000 lines
	Output		
Encoder power supply (SENSE)		5 V ± 5%, ≤ 300 mA	
		sense-controlled	
		short-circuit and overload-proof	
Brake control	Signal output (ACTIVE_CON)		short-circuit-proof
	Output voltage		≤ 30 V
	Output current, maximum		1.7 mA
	Voltage drop at 0.5 A		≤ 1 V
	Reference potential (ACTIVE_GND)		GND of 24 V

3.2.2 UL 508C certification

The power electronic system TLD01x is certified to UL 508C with the following data.

Line connection

Unit	Line voltage [V]	Line frequency [Hz]	Current [A]	Phases
TLCX11	230 115	47-63	2 4	1
TLCX12	230 115	47-63	5 7.5	1

Motor data

Unit	Motor voltage [V]	Motor frequency [Hz]	Motor current [A]	Phases
TLCX11	0-230	0-2500	3	3
TLCX12	0-230	0-2500	7	3

Accessories

- holding brake controller, TL HBC power supply 24 V

3.2.3 Accessories

<i>TL HBC holding brake controller</i>	Supply voltage, input	20 V to 30 V
	Input current	Input current = 0.5 A + brake current
	Output, brake	
	DC voltage	20 V to 30 V
	Current at 24 V for 100 ms	0.5 A to 2.5 A
	Continuous current	0.5 A to 1.25 A
	DC voltage with voltage drop	9.5 V to 15 V
	Current at 12 V	0.5 A to 2 A
	Safe electrical isolation between 24 V input, control input and brake output	

4 Installation

4.1 Electromagnetic compatibility, EMC

Strong electromagnetic interference occurs in the power area of the power electronic system which can influence signals coming from control cables and system parts and endanger the operational reliability of the system if suitable protective measures are not taken.

The power electronic system meets the requirements of the EC directives on EMC noise resistance and on noise output as specified in EN 61800-3, as long as the following steps have been taken during installation.

Control cabinet setup

EMC measures	Effect
Use galvanized or chrome-plated mounting plates, make large contact surface connections for metal parts, remove paint from contact surfaces	Good conductivity due to two-dimensional contacts
Ground the control cabinet, door and mounting plate with metal tapes or cables with a cross section area greater than 10 mm ²	Reduction of EMC emissions
Mount power components and control components separately, minimum distance 25 cm, reduce interference injection from either component by using multiple-ground dividing plates	Reduction of mutual interference
Fit switching devices such as contactors, relays or solenoids with interference suppressors or spark suppressors (e.g. diodes, varistors, RC elements)	Reduction of mutual interference

Cabling

EMC measures	Effect
Keep cables as short as possible, no "safety loops", short cables from the star point in the control cabinet to outlying ground connection	Avoidance of capacitive and inductive interference injection
Use cable clamps to connect a large surface area of the shield of all shielded cables to the mounting plate at the control cabinet entry.	Reduction of EMC emissions
Lay the cables spatially separated from each other: - Signal cables and power cables - Power and motor cables - Line filter input and output cables	Reduction of mutual interference, reduction of emissions, increasing resistance to interference
Connect large surface areas of cable shields, use cable clamps and tapes	Low shielding effect if the connection is not made over large surface area, reduction of emissions
Ground a large surface area of the shields of digital signal cables at each end or via sub-D housing	Preventing interference on control cables, reduction of emissions
Shield analog signal lines at one end only at the power controller, at the other end via capacitor, e.g. 10 nF/100V MKT	Preventing ripple loops due to low-frequency interference
Use only shielded motor cables with copper braiding and at least 85% covering, ground a large surface area of the shield at each end. Use motor and encoder cables recommended by your local representative.	Controlled discharge of interference currents, reduction of emissions

EMC measures	Effect
If the motor and machine are not conductively connected, for example by an insulated flange or a non-flat connection, ground the motor with a grounding wire ($> 10 \text{ mm}^2$) or ground strap.	Reduction of emissions, increase in resistance to interference
Ground unused cable wires from control circuits at both ends of the cable (does not apply to motor cable)	Additional shielding effect

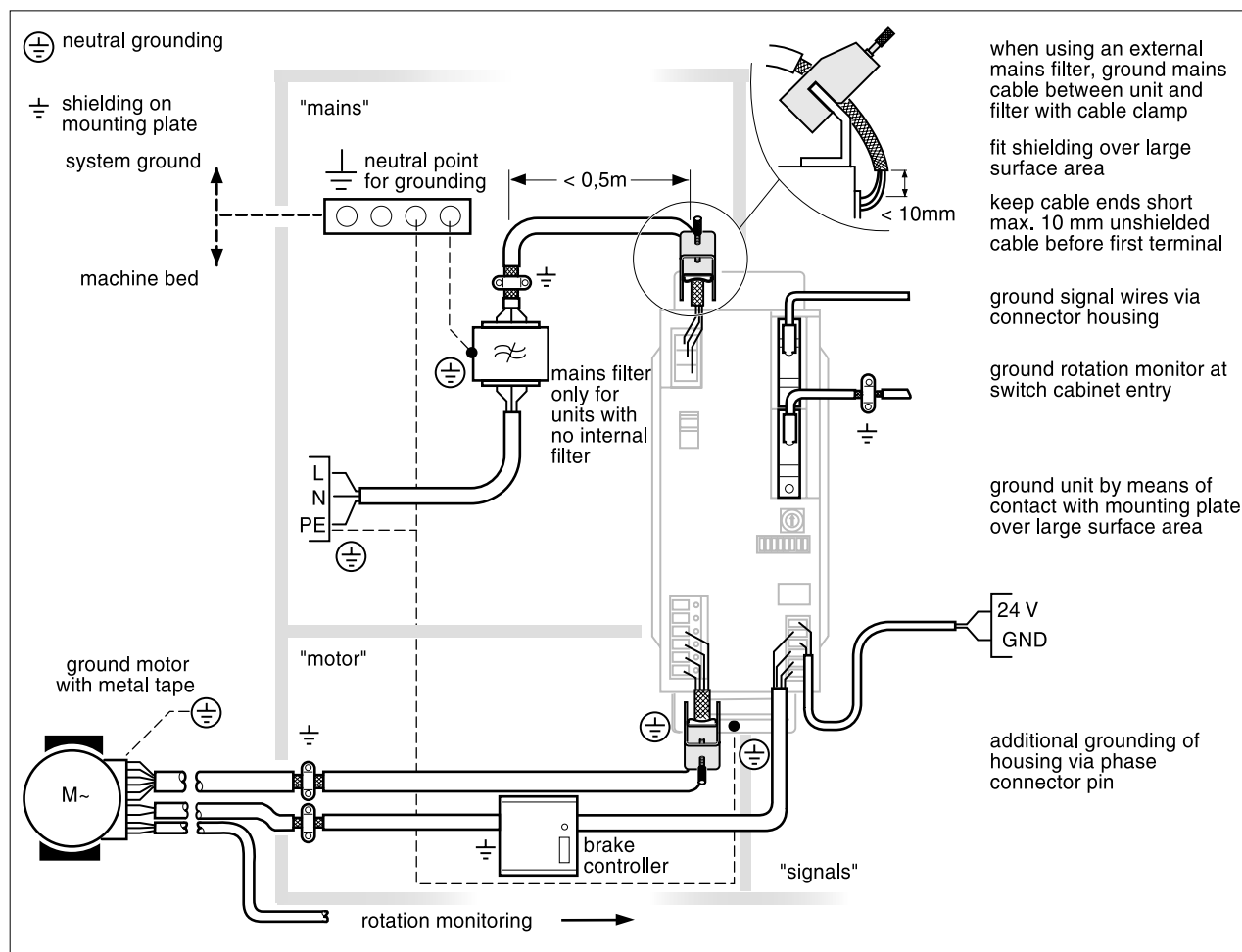


Fig. 4.1 EMC measures

**WARNING!**

Malfunctions and risk of injury!

The EMC of cables must be guaranteed if the unit is to function reliably and free of faults. The use of unsuitable, non-EMC-secure cables can damage the unit and lead to malfunctions.

Motor leads and encoder cables are especially critical signal circuits. Use the cables recommended by your local agent. They tested for EMC safety. They are also suitable for movement.

You can find information on the cables in section "Accessories and spare parts" on page 9-1.

4.2 System components

Besides the components included in the scope of delivery, other system components are required for connecting the power electronic system:

- three-phase stepper motor
- motor cable
- signal cable
- encoder cable when unit fitted with speed monitoring
- line cable and line fuses
- external power supply, 24 V_{DC} with safe separation - PELV
- external line filter for units with no built-in line filter
- control cabinet
- additional filters and chokes for line connection and motor connection, depending on system configuration
- NC control or PLC for automatic operation

4.3 Mechanical installation

4.3.1 Installing the power electronic system

Before installation... ► Check the unit for external damage such as dents in the housing or broken connection terminals. Do not install damaged units.



DANGER!

Danger from high voltages, possibility of permanent damage to the unit's electronic circuitry. During installation ensure that no loose parts such as pieces of wire or mounting parts fall into the unit. Loose conductive parts inside the unit can endanger life by forming parasitic voltages and permanently damage the unit through short-circuits.

Control cabinet

The control cabinet must be big enough to allow both unit and accessories such as ballast resistor controller and holding brake controller to be firmly mounted and connected in line with EMC requirements.

It must be possible to extract the heat generated by the unit and components during operation through the switch cabinet vents.

Installation clearances

The unit is fitted with a built-in fan. Ventilation slots on and under the unit must be kept at least 70 mm away from neighboring units or walls.

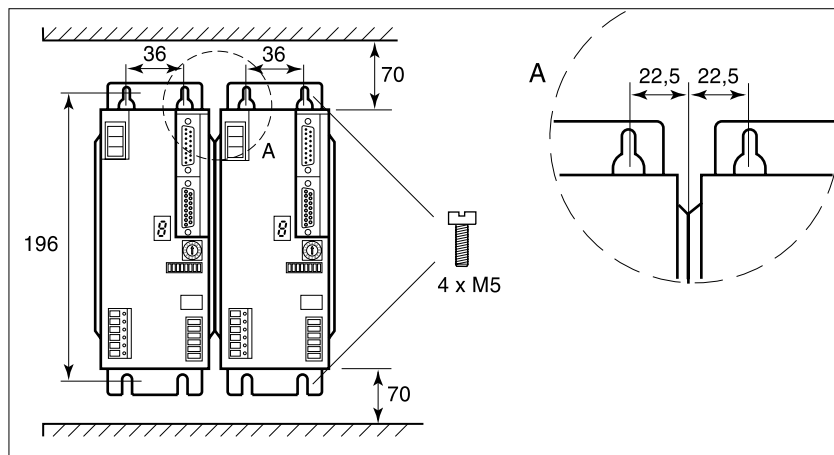


Fig. 4.2 Installation clearances, dimensions in mm

- Position the unit in the control cabinet such that the heated air flow from other units, for example from an external ballast resistor, does not result in undesired heating of the cooling air.
- Mount the unit vertically with the power connection at the top.
- Fasten the unit to a galvanized metal plate. The back wall of the unit must have good contact with the metal plate across its whole surface area.



Painted surfaces have an insulating effect. Before fixing the unit to a painted mounting plate, scratch off the paint over a wide surface area in the places where the unit is to be mounted, to ensure that it has a good connection with the grounded plate.

4.3.2 Fitting the unit label

The unit label provides information on the meaning of all operating states displayed on the 7-segment display, and on signal interface assignment. An example of the unit label for copying is provided in section "Unit label", page 10-1.

- Attach the unit label inside the hood of the Twin Line unit on the side where the signal plugs are connected.

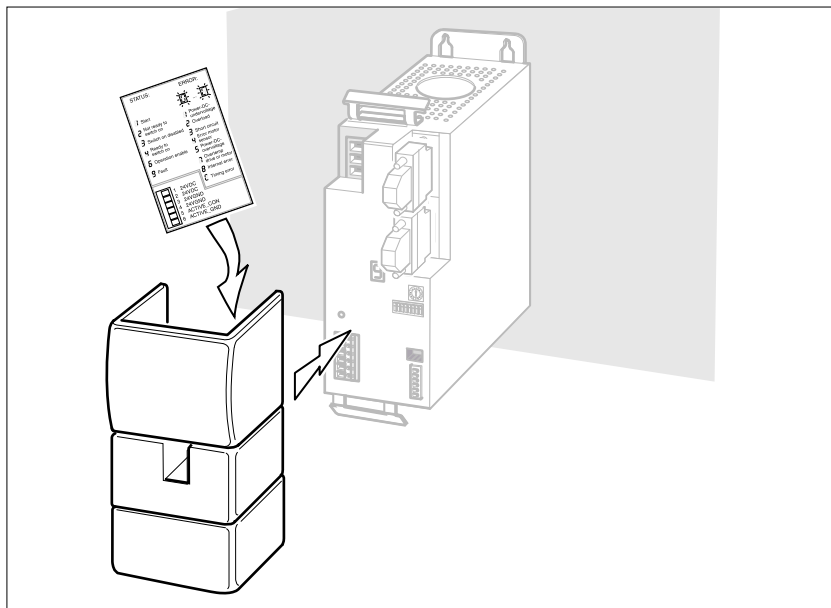


Fig. 4.3 Attach unit label to the side of the hood

After the electrical installation has been completed and the unit hood installed, the cables for connection to power and the cables for both upper signal connections are led out through the top of the hood, while the motor cable and other signal cables are taken out through the bottom.

4.3.3 Attach accessory components

Line filter The power electronics are supplied with a line filter built in in the standard design. A special version of the unit can also be ordered without a line filter.

Do not use the units with external line filters unless you can make test measurements at the unit of the functioning and the EMC of a selected line filter.



An external line filter is required for a standard unit without a built-in line filter. The user must ensure that the EMC directives are observed in this case.

The type plate on the front of the unit states whether a line filter is built in or not:

- "F": with line filter, e.g. TLD01x F
- "NF": without line filter, e.g. TLD01x NF

Select a two-stage line filter, e.g. for a frequency converter. The size and selection of a suitable filter is for the system designer to decide.

- Fit the line filter near the mains connection and on the same mounting plate. The length of the cable to the power electronic system must not exceed 50 cm. **The cable must be shielded and the shield must be grounded at both ends.**

4.4 Electrical installation

**WARNING!**

Malfunctions and danger of injury arising from interference with other units!

Connect the unit correctly to meet EMC requirements. Control signals suffering interference can generate unexpected signal states which can impair the functioning of the unit.

**DANGER!**

Electric shock from high voltage!

Follow safety rules when working on electrical systems:

- Switch off the power to the unit.
- Make sure the unit cannot be switched on again inadvertently.
- Confirm that no voltage is present.
- Cover or shield any neighboring system parts which are live.

**DANGER!**

Electric shock from high voltage!

Only work on the power system with the power supply switched off.

Lock the main switch and lock access to it.

Only qualified electrical technicians may install the power electronic system and other components and connect them to the power supply.

4.4.1 Line connection

Connect power cable ► Connect power lines to PE, N and L screw terminals

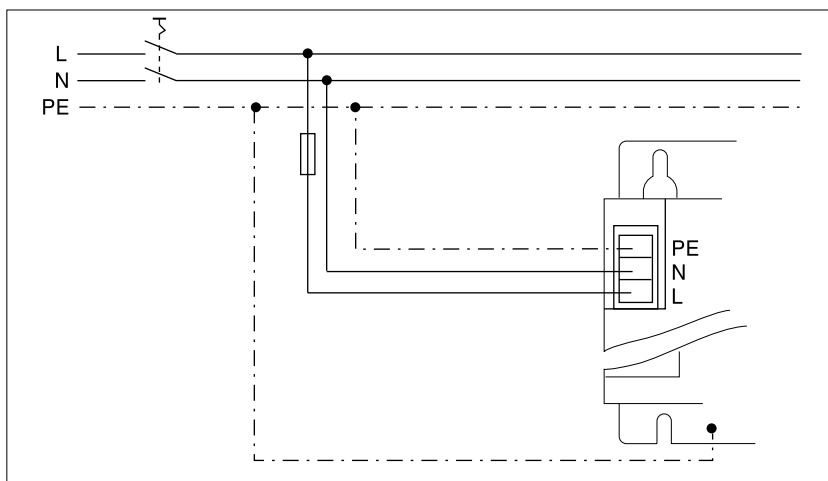


Fig. 4.4 Line connection

- The connection cross-section for power cables is 1.5 mm² to 2.5 mm².
- Fit a fuse in the power phase:
at 230 V terminal: 10 A (C, K characteristic or similar)
at 115 V terminal: 10 A (C, K characteristic or similar)
- In the case of units without integrated line filter, NF types, the power cable must be shielded and grounded at both ends between the filter and the unit terminal if it is longer than 20 cm.
- The correct torque for the terminal screws is 0.4 Nm - 0.5 Nm.
- The individual conductors of the cable can be connected to the unit without wire end ferrules.
- For units with a hood, the cable must be led upwards from the point of connection.

Wire end ferrules If you use wire end ferrules, pay attention to the following:

- Do not use end ferrules with a plastic collar on wires with a cable cross-section of 2.5 mm².
- Only use square end ferrules to ensure that they do not work loose.
- Strip the insulation from the cable to a length of 10 mm.

Ground leakage circuit-breaker If a fault occurs, fault currents with DC component may occur. For single-phase units, an e.l.c.b. for fault currents with a pulsating DC component can be fitted.

4.4.2 Motor connection


DANGER!

*Danger of high voltages from inductance!
Do not touch motor cable wires and contacts while the motor is moving. Even when they are not connected to the power electronic system, motors will build up dangerous induced voltages if the motor shaft is turned. During installation ensure that the motor cannot be driven by another device.*

Connecting motor wires

- Connect the motor wires and protective ground to terminals U, V, W and PE. Wiring assignment for motor and unit must match.

Terminal	Connection	Color
U	Motor cable	brown (bn)
V	Motor cable	blue (bl)
W	Motor cable	black (bk)
PE	Protective conductor (shield tracer wire)	-

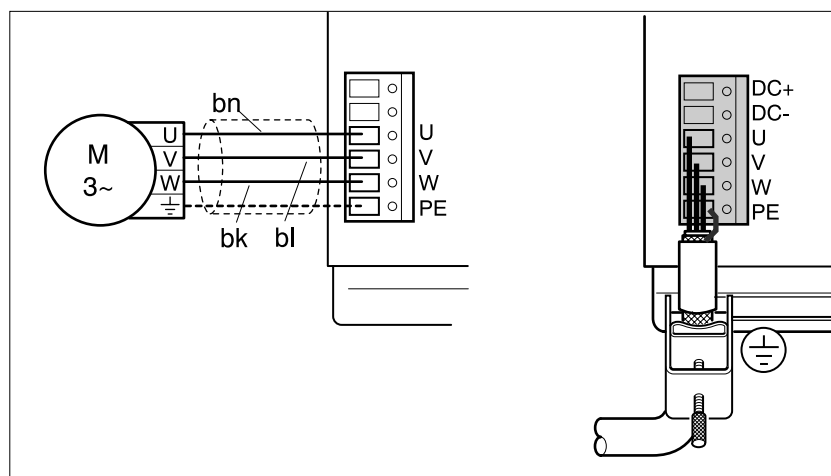


Fig. 4.5 Motor cable connection to unit

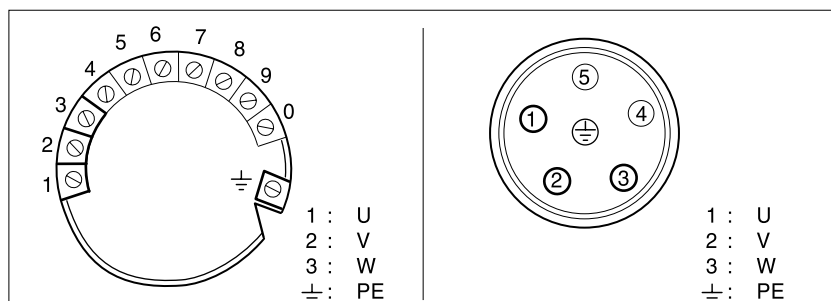


Fig. 4.6 Motor cable connected to motor with terminal box or plug

- cable cross-section: 1.5 mm²
- maximum cable length: 20 m
- The correct torque for the terminal screws is 0.4 Nm - 0.5 Nm.
- The individual conductors of the cable can be connected without wire end ferrules.
- For units with a hood, the cable must be led downwards from the point of connection.

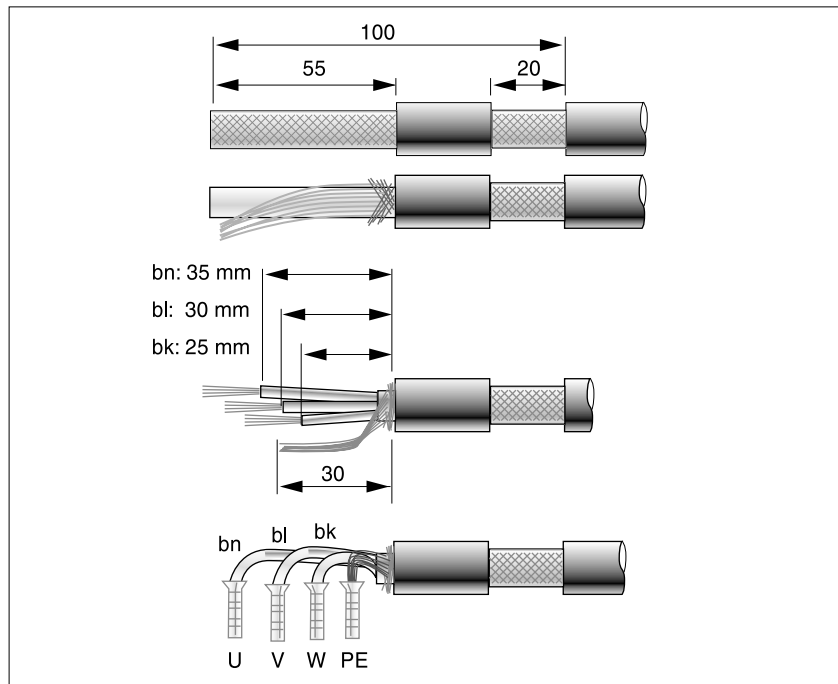


Fig. 4.7 Preparing the motor cable

Wire end ferrules

If you use wire end ferrules, pay attention to the following:

- Only use square end ferrules to ensure that they do not work loose.
- The wire must fill the wire end ferrule over its whole length. Only then has the connection been safely carried out, ensuring maximum current carrying capacity and vibration resistance.

EMC measures

The motor cable is a source of interference and must be carefully laid:

- The shield braiding of the motor cable must be connected to the motor housing and to the unit housing as well as to the switch cabinet entry with a large surface area connection. Use the supplied shielded terminal for the connection to the housing.
- Where possible motor cables and signal wiring must be laid at least 20 cm apart; if they are laid closer together, motor cables and signal wiring must be shielded with grounded plates.

4.4.3 Connecting the 24 V supply voltage

- Route the 24 V wires to the unit over a grounded 24 V_{DC} transformer (PELV).

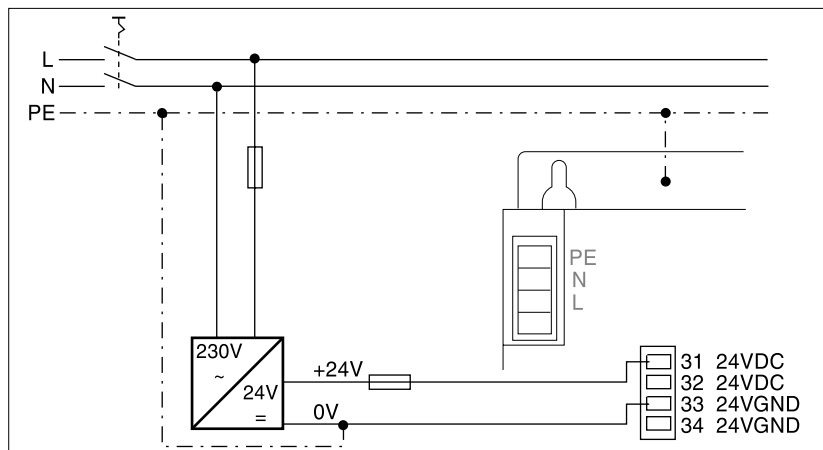


Fig. 4.8 24 V connection

Pin	Signal	Active	Meaning	I/O
1	24VDC	-	24 VDC supply voltage, internally connected to pin 2	-
2	24VDC	-	24 VDC power supply	-
3	24VGND	-	GND for 24 VDC voltage, internally connected with pin 4 and pin 6 (ACTIVE_GND)	-
4	24VGND	-	GND for 24 VDC voltage	-

- The second 24 VDC and GND connection can be used as a 24 V output for further consumers or for cascading several Twin Line units; the maximum terminal current is 7.5 A.
- In selecting your 24 V power supply unit make sure you take into account any additional consumers, such as the holding brake and the holding brake controller.
- To retain the position of the motor when the supply voltage to the power amplifier is switched off, the ENABLE input signal must be set to Low before the supply voltage is shut off. The external 24 V supply voltage must remain switched on, and the motor must not be subjected to external torque.
- Lay the 24 V supply line at a distance of at least 20 cm from other lines to ensure EMC protection. For wiring longer than 2 m, make a twisted pair of the 0 V and 24 V supply wires.
- The torque for terminal screws 1-34 is 0.22 Nm to 0.25 Nm.

4.4.4 Connecting a holding brake

In motors with holding brakes the brake can be connected directly or to the signal interface via the TL HBC holding brake controller. The holding brake controller connection is described in "Connecting accessories" on page 4-21.

Use the following circuit with direct control to protect the motor from overheating. The circuit reduces the exciter current shortly after the brake is opened.

The values for R1 and C1 are given for the manufacturer's VRDM 39... and VRDM311.. motors.

Motor	VRDM 36...	VRDM 39...	VRDM 311...
Resistance R1	72 Ω, min. 4 W	24 Ω, min. 6 W	18 Ω, min. 8 W
Capacitor C1	4700 μF / 25 V	4700 μF / 25 V	6800 μF / 25 V

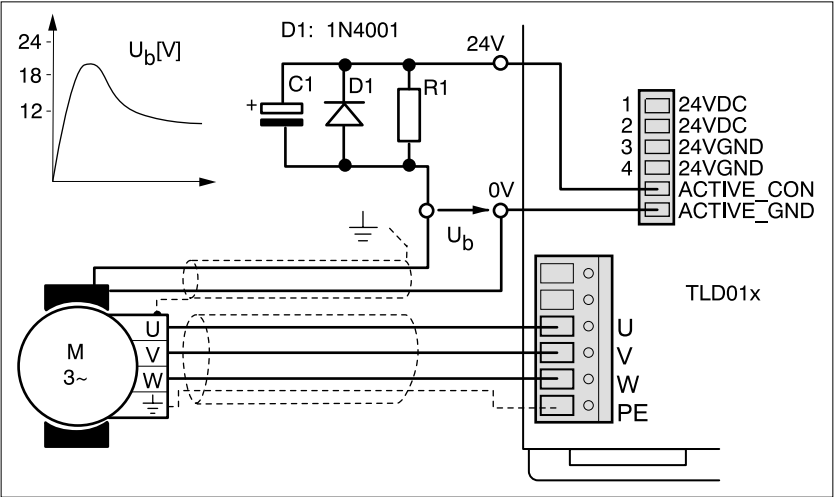


Fig. 4.9 Holding brake controller connection

For more information see section "Connecting accessories" at page 4-21.

The static load torque for vertical loads must not exceed 25% of the motor holding torque to ensure safe function of the holding brake.

Only use cables with the following specifications:

	TLD011	TLD012
Cable cross-section [mm ²]	1.5	1.5
Max. cable length ¹⁾ [m]	20	20

1) Longer cables on request

4.4.5 Connection to the PULSE-C interface

Connection The PULSE-C interface is equipped with a Sub-D plug, 15-pin with an M3 threaded connection.

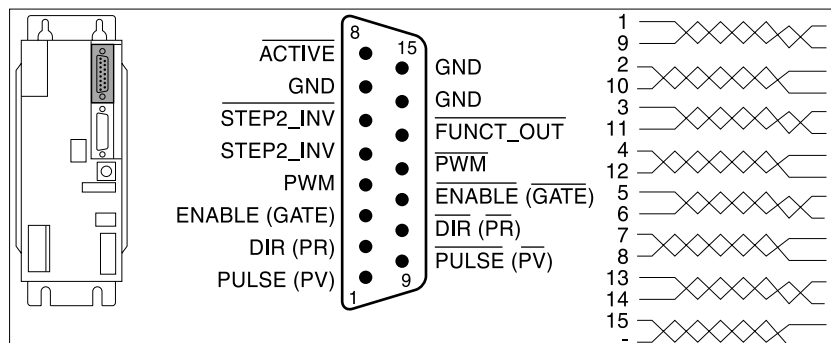


Fig. 4.10 PULSE-C interface

Pin	Signal	Color ¹⁾	Pair	Meaning	I/O
1	PULSE (PV)	white	1	Motor step "Pulse" or motor step forwards "PV"	I
9	$\overline{\text{PULSE}} (\overline{\text{PV}})$	brown	1	Motor step "Pulse" or motor step forwards "PV", inverted	I
2	DIR (PR)	green	2	Direction of rotation "Dir" or motor step backwards "PR"	I
10	$\overline{\text{DIR}} (\overline{\text{PR}})$	yellow	2	Direction of rotation "Dir" or motor step backwards "PR", inverted	I
3	ENABLE (GATE)	gray	3	Enable signal	I
11	$\overline{\text{ENABLE}} (\overline{\text{GATE}})$	pink	3	Enable signal, inverted	I
4	PWM	blue	4	Phase current value	I
12	$\overline{\text{PWM}}$	red	4	Phase current value, inverted	I
5	STEP2_INV	black	5	Angular resolution transfer	I
6	$\overline{\text{STEP2_INV}}$	purple	5	Angular resolution transfer, inverted	I
7	GND	pink/pink	6	Ground, signal applied internally via resistance at 24VGND	-
8	ACTIVE	red/blue	6	Drive ready	O
13	$\overline{\text{FUNCT_OUT}}$	white/green	7	Following error message	O
14	GND	brown/green	7	Ground, signal applied internally via resistance at 24VGND	-
15	GND	white/yellow	8	Ground, signal applied internally via resistance at 24VGND	-

1) Color details refer to the cable available as an accessory.

- Cable specification
- shielded cable
 - minimum cross-section of signal wires 0.14 mm²
 - twisted-pair wires
 - shield grounded at both ends
 - maximum length:
100 m with RS422 connection
up to 10 m with Open Collector connection

Function

Setpoint via externally fed pulse-direction signals

Reference signals for step-by-step positioning of the motor and control signals for motor current, angular resolution and power amplifier release are sent over the PULSE-C interface. The power electronic system simultaneously reports that it is ready for operation and possible operating fault over the interface.

- PULSE (PV), DIR (PR)
- The square-wave signals PULSE (PV) and DIR (PR) can be combined for two operating modes. The setting of DIP switch 6 sets the operating mode:
- PULSE/DIR: Pulse-direction signal with DIP 6 ON
 - PV/PR: Pulse_{forward} - Pulse_{backward} signal with DIP 6 OFF

PV/PR signals can only be used with units with speed monitoring.

You can find information on the DIP switches in section "Set DIP switch" on page 5-4.

Pulse direction mode

The motor executes an angular step with the leading edge of the PULSE signal. The direction of rotation is controlled by the DIR signal.

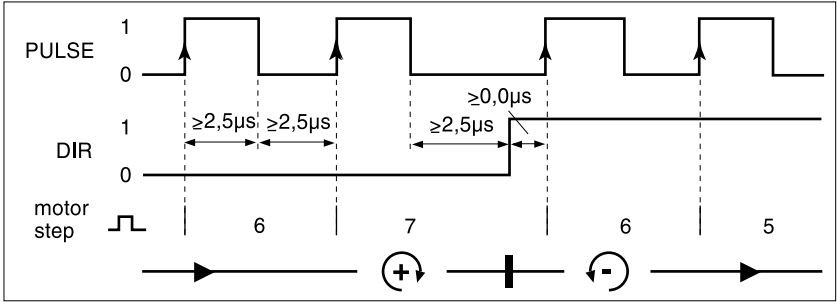


Fig. 4.11 Pulse direction signal

Pin	Signal	Function	Value
1, 9	PULSE	Motor step	low -> high
2, 10	DIR	Clockwise direction of rotation Anticlockwise direction of rotation	low/open high

Operating mode
Pulse_{forward} - pulse_{backward}

The PV (PULSE) signal is used to move the motor in a clockwise direction, and the PR (DIR) signal moves it in an anticlockwise direction.

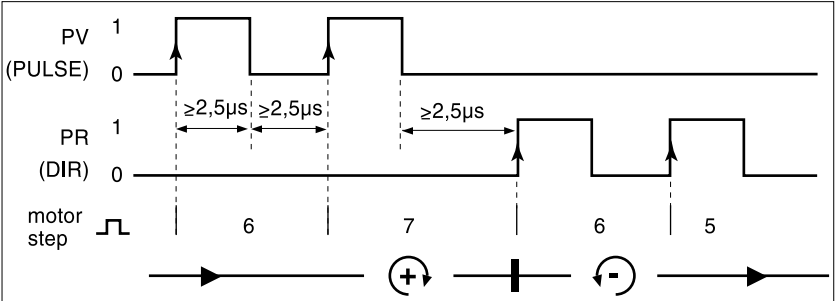


Fig. 4.12 Pulse_{forward} - Pulse_{backward} signal

Pin	Signal	Function	Value
1, 9	PULSE (PV)	PV: Step in clockwise direction of rotation	low -> high
2, 10	DIR (PR)	PR: Step in anticlockwise direction of rotation	low -> high

The maximum frequency of PULSE (PV) and DIR (PR) is 200 kHz.

ENABLE (GATE)

The ENABLE (GATE) input has two functions, which are set with DIP switch 5:

- ENABLE function: enable and disable power amplifier, DIP 5 = OFF
- GATE function: enable and disable pulse input, DIP 5 = ON

You can find information on the DIP switches in section "Set DIP switch" on page 5-4.

ENABLE function

The ENABLE (GATE) signal enables the power amplifier so the motor can be controlled. This requires DIP switch 5 to be set to OFF.

Pin	Signal	Function	Value
3, 11	ENABLE	Disable power amplifier Enable power amplifier	low/open high

An error message is also acknowledged with a negative slope at the ENABLE input.

If there is no operating fault, the $\overline{\text{ACTIVE}}$ output displays operational readiness for approx 100 ms after the power amplifier is enabled. Then pulses can be fed in for units without speed monitoring and brake.

Units with brake or speed monitoring require waiting periods before feeding in pulses to release a holding brake or to initialize the encoder.

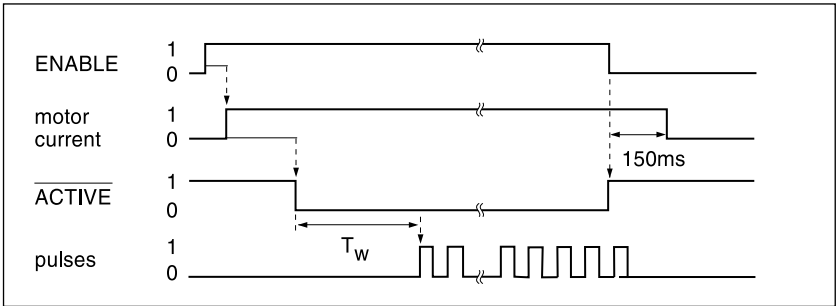


Fig. 4.13 Enabling and blocking the power amplifier with waiting time T_W

Twin Line unit...	without brake	with brake
without speed monitoring	$T_W = 0\text{ ms}$	$T_W = 100\text{ ms}$
with speed monitoring	$T_W = 300\text{ ms}$	$T_W = 300\text{ ms}$

If the ENABLE signal is removed, the power amplifier remains active for 150 ms to allow a holding brake to close. If an error that results in the power amplifier shutting down, the motor current is simultaneously shut off with $\overline{\text{ACTIVE}}$.

See page 5-7 for a view of the ENABLE function in motor operation.

GATE function

The GATE signal blocks the pulses at the setpoint value input with stopping it from being ready to operate. The GATE function can be used to select individual axes in a multi-axis system. DIP switch 5 must be set to ON for the GATE function.

Pin	Signal	Function	Value
3, 11	ENABLE (GATE)	Enable power amplifier Disable power amplifier	low/open high

The following graph shows the motor movement when the GATE function is enabled. There must be no pulse pending for 1.5 ms before and after switching the GATE signal.

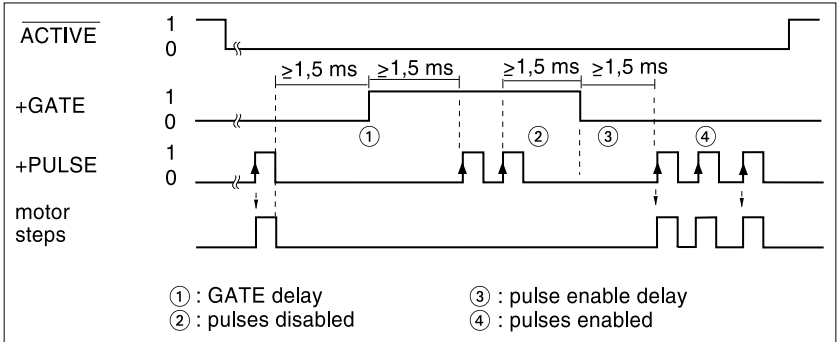


Fig. 4.14 Signal sequence when switching on the unit with GATE function

STEP2_INV The resolution of the motor step count can be increased by a factor of ten if this function is enabled by DIP switch 1 and has been activated with the signal STEP2_INV. STEP2_INV reverses the DIP switch setting.

Pin	Signal	Function	Value
5, 6	STEP2_INV	Angular resolution - as set with DIP 1 - DIP 1 setting inverted	low/open high

When operating the interface with a SIG Berger Lahr WPxxx positioning controller STEP2_INV is at low level.

The following graph shows the motor movement with the STEP2_INV signal enabled. There must be no pulse pending for 1.5 ms before and after switching the STEP2_INV signal.

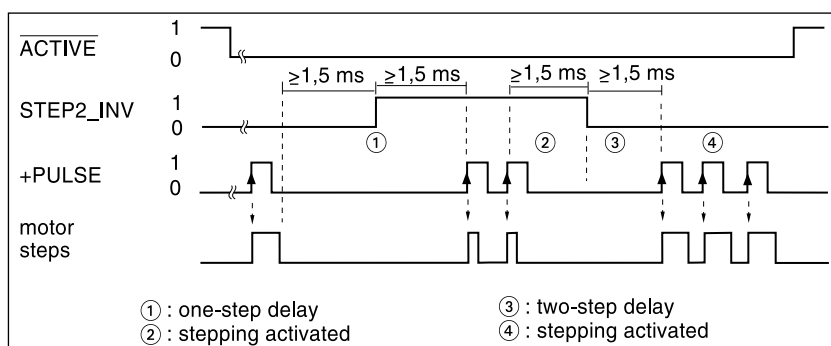


Fig. 4.15 Signal sequences when switching the step number

PWM The preset motor phase current and therefore the motor torque can be reduced to between 0% and 100% with the pulse-width-modulated signal.

Pin	Signal	Function	Value
4, 12	PWM	maximum motor phase current reduced motor phase current	low/open high

If there is constant high level at the PWM input, phase current does not flow and the motor has no current. If there is constant low level the motor operates at the set maximum phase current.



Only set the PWM controller together with the ENABLE function, not with the GATE function. The motor receives the full motor current with the GATE function if the PWM controller is switched off or fails.

ACTIVE

The output shows that the power electronic system is ready for operation.

Pin	Signal	Function	Value
8	ACTIVE	power amplifier is disabled power amplifier is enabled	high low

ACTIVE is an open collector output to GND.

FUNCT_OUT The output signals a following error if an encoder is connected and the encoder monitoring is enabled.

Pin	Signal	Function	Value
13	<u>FUNCT_OUT</u>	standard operating status following error message	low high

If FUNCT_OUT signals a following error, the signal must be reset before continuing to operate. You will find information in "Error display and troubleshooting" on page 7-2.

FUNCT_OUT is an open collector output to GND.

Circuit of the signal inputs It is recommended that signal inputs be switched via the RS422 interface.
The diagram shows the circuitry of the signal inputs PULSE (PV), DIR (PR) and ENABLE. Up to 10 inputs of the PULSE-C module can be connected to an RS422-C transmitter.

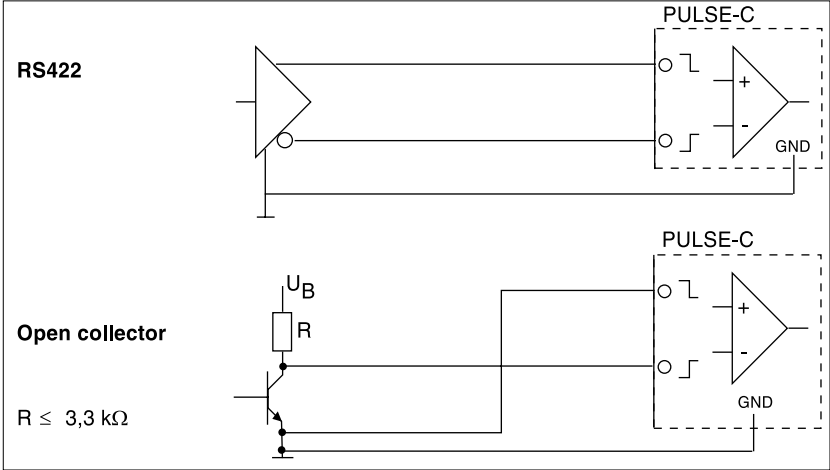


Fig. 4.16 Circuit of the signal inputs, L: Cable length

For cable lengths $\leq 10 \text{ m}$ and frequencies $\leq 50 \text{ kHz}$, Open Collector outputs can be used if interference resistance requirements are low.

4.4.6 Connection to the interface for speed monitoring

The optional encoder interface is only built-in in units with speed monitoring.

Connection The interface is equipped with a Sub-D socket, 15-pin with an M3 threaded connection.

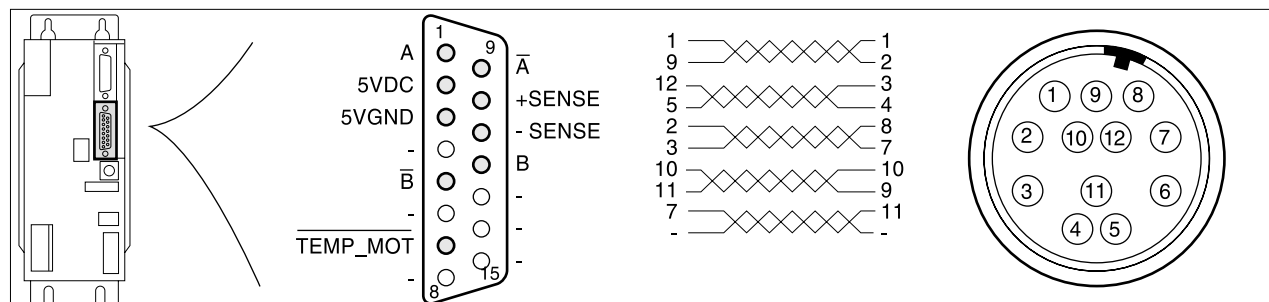


Fig. 4.17 Interface for speed monitoring, motor plug view: solder side

Pin	Signal	Color ¹⁾	Pair	Meaning	I/O
1	A	white	1	Encoder signal channel A	I
9	\bar{A}	brown	1	Channel A, negated	I
12	B	green	2	Channel B	I
5	\bar{B}	yellow	2	Channel B, negated	I
2	5VDC	red	3	Encoder supply, 5V, max. 300mA	O
3	5VGND	blue	3	Encoder supply, ground	O
10	+SENSE	purple	4	Sense line positive ²⁾	I
11	-SENSE	black	4	Sense line negative ²⁾	I
7	$\overline{\text{TEMP_MOT}}$	grey/pink	6	Temperature error, inverted	I
4	-	red/blue	6	not assigned	-
6	-	-	5	not assigned	-
8	-	-	5	not assigned	-
13	-	-	-	not assigned	-
14	-	-	-	not assigned	-
15	-	-	-	not assigned	-

1) Color details refer to the cable available as an accessory.

2) Sense line must be connected for activating the 5VDC.

- Cable specification**
- shielded cable
 - minimum cross-section of the signal conductors is 0.25 mm², 5VDC and 5VGND 0.5 mm²
 - twisted-pair wires
 - shield grounded at both ends
 - maximum length 100 m

Function The angular position of the motor is transferred incrementally over the connection with A/B rectangular signals. The unit detects stepper errors by comparison with the setpoint position and reports a following error if the limit value of 6.4° is exceeded.

The power electronic system does not evaluate index pulses.

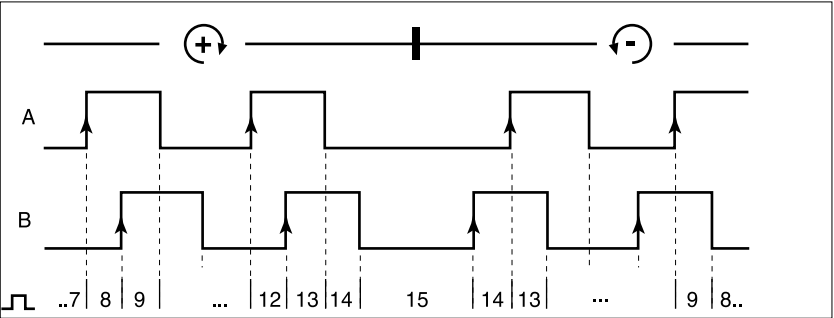


Fig. 4.18 Timing diagram with positive A and B signal, counting forwards and backwards

Temperature monitoring The motor winding temperature is monitored with the TEMP-MOT signal. The signal also indicates whether the encoder is connected.

Pin	Signal	Function	Value
7	TEMP_MOT	Temperature range OK	high
		Overheating of motor or break in cable	low

Encoder type An encoder with 1000 lines must be connected to use the speed monitoring.

4.4.7 Connecting accessories

Holding brake controller

In motors with holding brakes the brake can be connected directly or via the TL HBC holding brake controller.

The ACTIVE-CON control signal is amplified with the holding brake controller to ensure that the brake switches quickly and generates as little heat as possible.

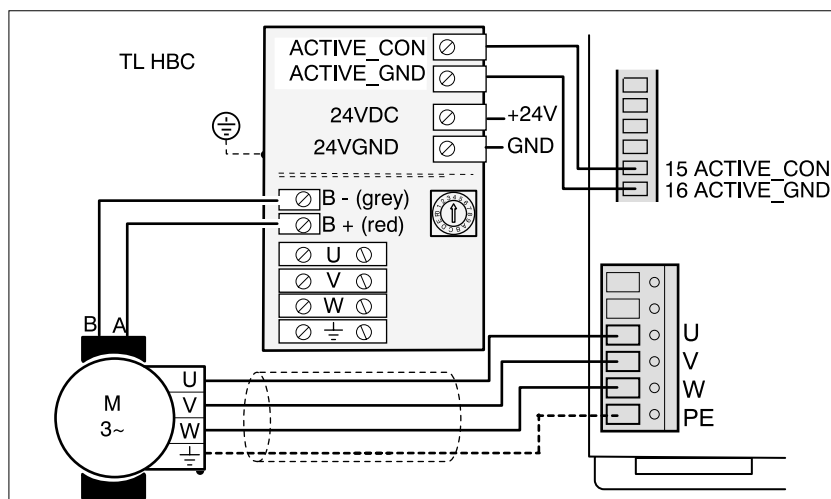


Fig. 4.19 Connection of the TL HBC holding brake controller

Connection

The connection of the motor cable is described on page 4-9.

- ▶ Connect the control connections to the holding brake terminals B+ and B-.
- ▶ Connect the control terminals ACTIVE_CON and ACTIVE_GND of the brake controller and the signal interface.
- ▶ Connect the 24 V_{DC} power supply to the holding brake controller.

The holding brake controller's power requirement depends on the switching current for the holding brake:

Brake controller input current [A] = 0.5 A + switching current [A]

- ▶ Set the switch for voltage reduction to 1.

The voltage reduction function is described in "Braking function with TL HBC", page 6-3.

External capacitors The power control can store superfluous braking energy on an external electrolytic capacitor viaq the DC link connection. This enables any increase in the DC link voltage to be reduced in the event of frequent braking.

Only use cables with the following specifications:

	TLD011	TLD012
dielectric strength	≥ 450 V	≥ 450 V
external capacity	< 500 µF	< 1000 µF

- Cable specification*
- shielded cable
 - shield grounded at both ends
 - maximum cable length 3 m
 - minimum cross-section: 1.5 mm²

Connection ► Connect the cable from the DC link connection to the capacitor connections. Observe correct polarity: DC+ to + and DC- to -. Otherwise the unit and capacitor can be destroyed.

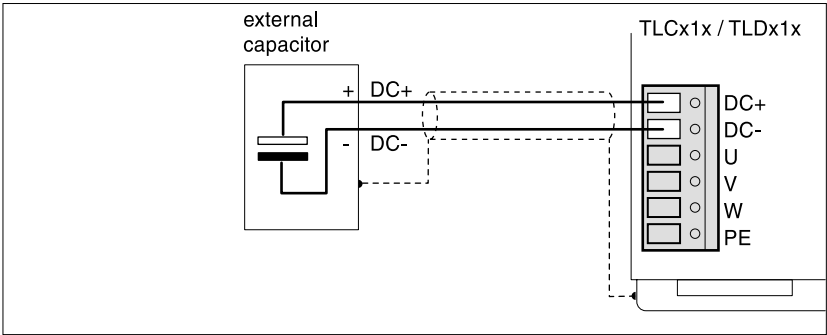


Fig. 4.20 Connection of an external capacitor

4.5 Wiring example

4.5.1 Stepper motor controller without speed monitoring

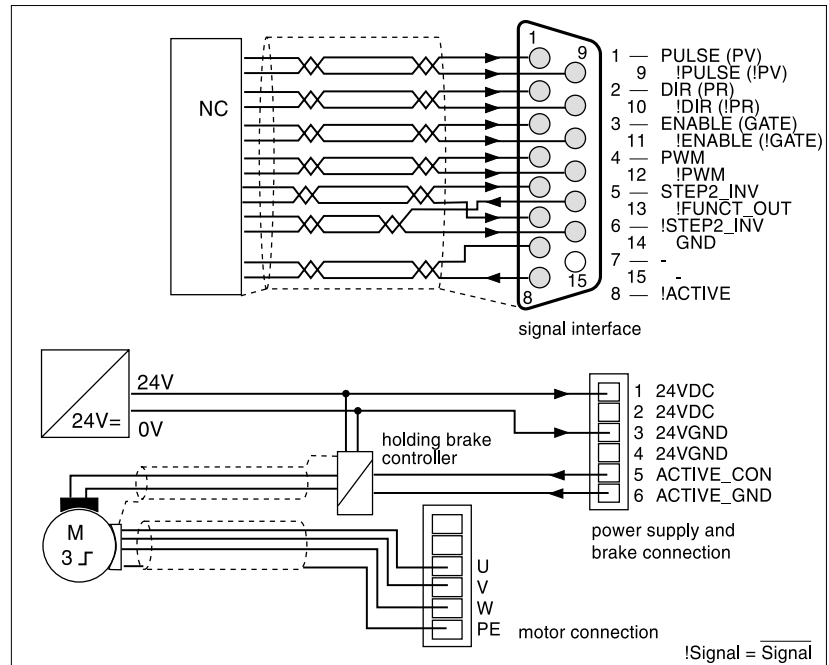


Fig. 4.21 Wiring example for stepper motor controller

Signal interface:

Pin	Signal	Active	Meaning	I/O
1/9	PULSE (PV) ¹⁾	high/low	Pulse signal or pulse forward signal	I
2/10	DIR (PR) ¹⁾	high/low	Direction signal or pulse backward signal	I
3/11	ENABLE (GATE) ¹⁾	high/low	Enable signal for power amplifier, DIP switch 5 to OFF	I
4/12	PWM	high/low	Phase current value	I
5/6	STEP2_INV	high/low	Angular resolution, inversion of DIP switch setting	I
7,14,15	GND ¹⁾	-	Ground	I
8	ACTIVE	low	Drive ready	O
13	FUNCT_OUT	low	Following error message	O

1) Minimum pin assignment of signal interface for commissioning

Power supply and brake connection:

Pin	Signal	Active	Meaning	I/O
1.2	24VDC ¹⁾	-	+ 24 V _{DC} power supply	I
3.4	24VGND ¹⁾	-	GND for 24 V _{DC} power supply	I
5	ACTIVE_CON	high	Drive ready, brake/relay control signal	O
6	ACTIVE_GND	-	GND for brake and relay control voltage	O

1) Minimum pin assignment of signal interface for commissioning

4.6 Check wiring

► Carry out these checks:

- Are all cables and connectors safely installed and connected?
- Are any live cable ends exposed?
- Are the control lines connected correctly?

System check and initialization

The motor must not be controlled for the wiring test.



WARNING

Destruction of motor!

The motor must only be operated with the correct phase current. Controlling the motor with excessively high phase current will destroy the motor immediately.

- Remove the plug for the PULSE-C interface to test the wiring.
- Select the ENABLE(GATE) function with DIP switch to OFF.

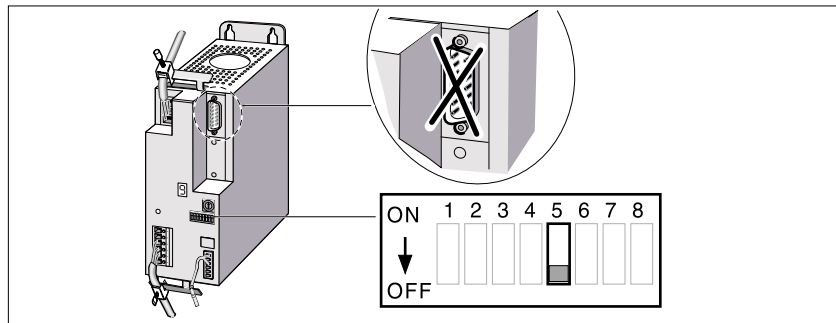


Fig. 4.22 Wiring test without PULSE-C plug; DIP 5 ENABLE to OFF

- Switch on the primary power supply.
- Switch on the 24 V power supply.

Unit OK

The status display first changes from "1" to "2", then to "3".

The unit carries out a self-test and checks the internal operating data, the internal monitoring devices and the connected sensing equipment.

The DC link is loaded. The DC link LED D2 lights.

- Switch off the power supply again.
- Connect the PULSE-C plug again for commissioning.

4.7 Installation troubleshooting

<i>Operational status indicator "2"</i>	If the power electronic system hangs in the switching-on state "2", this indicates an internal fault in the unit which can only be identified and corrected by your local representative.
<i>Operational status indicator "3"</i>	If the display does not change from "3" to "4", check whether the line voltage is switched on and the line voltage connections are correctly wired.
<i>Operational status indicator flashing</i>	The unit has detected a fault. In "Diagnosis and troubleshooting" from page 7-1 you will find a list of the causes of faults.

5 Commissioning

5.1 Commissioning procedure



The following commissioning steps are also required if you are using a configured unit under changed operating conditions. Incorrectly set values could cause permanent damage to the power electronic system, motor and system parts.

What you need to do...	Info
Make sure the Twin Line unit is correctly installed and wired up. When carrying out this check, use the wiring diagrams for the system layout or the sample circuits in "Wiring example", page 4-23.	Chapter "Installation" from page 4-1
Setting phase current	Page 5-3
Set DIP switch	Page 5-4
Check the functioning of the holding brake controller if it is wired for that	Page 5-6
Test run	Page 5-7
Optimizing the movement behavior of the motor	Page 5-8

5.2 Safety notes

Only qualified electrical technicians may commission the system.

**WARNING!**

Incorrectly set parameters can cause the motor to start unexpectedly with risk of crushing and damage to the system!

Close off the danger area and start up the motor when it is disconnected mechanically from the system and not under load.

**WARNING!**

Danger of injury and permanent damage to system parts by runaway motor!

In error class 3 or 4, or if the unit fails, the motor will no longer be actively braked and it will run at high speed against a mechanical stop.

**WARNING!**

Permanent damage to the power controller!

Only change the settings for the phase current and the DIP switch settings with the power supply switched off.

**WARNING!**

Danger of damage and destruction of system components by motor without braking if the device fails or error class 3 or 4!

**WARNING!**

Incorrectly set parameters can cause the motor to start unexpectedly with risk of crushing and damage to the system!

Close off the danger area and start up the motor when it is disconnected mechanically from the system and not under load.

5.3 Commissioning the power electronic system

5.3.1 Setting phase current

The power electronic system controls the motor torque with the phase current. A high phase current generates a high motor torque. To prevent damage to the motor, the maximum permissible phase current at the unit must be limited.



WARNING!

Phase current that is set too high can damage or destroy the motor!

The phase current at the unit must not be set higher than the rated phase current of the motor. If no value for the rated current is given, select the next lower phase current on the unit.

Rotary switch

Phase current

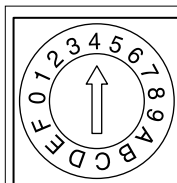


Fig. 5.1 Setting phase current

- Select the rotary switch position for the maximum phase current from the table.

Rotary switch	r.m.s. value of the max. phase current [A]	
	TLD011	TLD012
0	0.40	1.75
1	0.50	2.00
2	0.60	2.25
3	0.70	2.50
4	0.80	2.75
5	0.90	3.00
6	1.00	3.25
7	1.20	3.50
8	1.40	3.75
9	1.60	4.00
A	1.80	4.25
B	2.00	4.50
C	2.25	4.75
D	2.50	5.00
E	2.75	6.00
F	3.00	7.00

5.3.2 Set DIP switch

The DIP switch is used to set control signals for current reduction, enabling the power amplifier, pulses and speed monitoring.

DIP 1, 2 and 3 Increment count

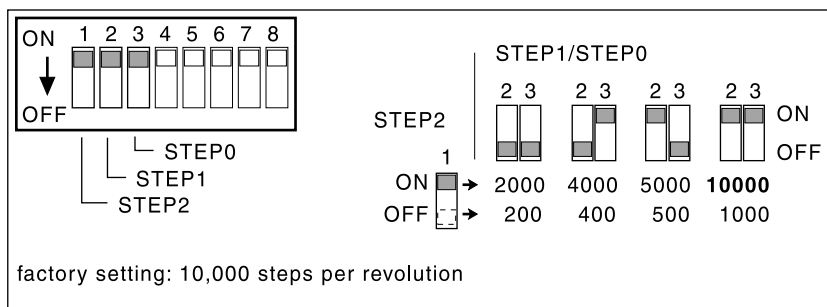


Fig. 5.2 Setting increment count

Setting increment count ► Set the increment count with DIP switches 3, 2 and 1. The increment count that you selected with STEP0 and STEP1 can be increased by 10 times with STEP2.

The STEP2 setting can be inverted with the PULSE-C interface STEP2_INV input signal. See page 4-17 for the signal settings.

DIP 4 and 5 Current reduction and ENABLE/GATE function

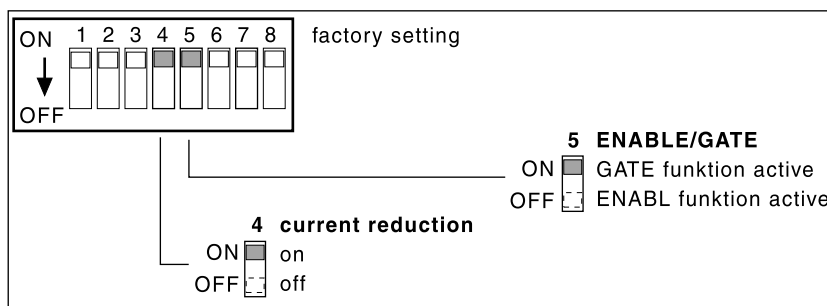


Fig. 5.3 Setting current reduction and ENABLE/GATE function

Current reduction Current reduction reduces the motor current to approximately 70% 100 ms after the last pulse slope is received. This allows the motor to cool while at a standstill.



If the motor drives a vertical axis, the current reduction may result in loads sinking because the torque is reduced to about 70% along with the phase current.

ENABLE (GATE) The ENABLE (GATE) signal at the signal interface can carry out two functions:

- ENABLE function: enable and disable power amplifier, DIP 5 = OFF
- GATE function: enable and disable pulse input, DIP 5 = ON

An error message is also acknowledged with a positive slope at the ENABLE/GATE input.

In a multi-axis system the GATE function enables switching between individual axes by enabling the pulses for the active axis and leaving them blocked for the remaining axes.

DIP 6 and 8 Pulse mode and speed monitoring

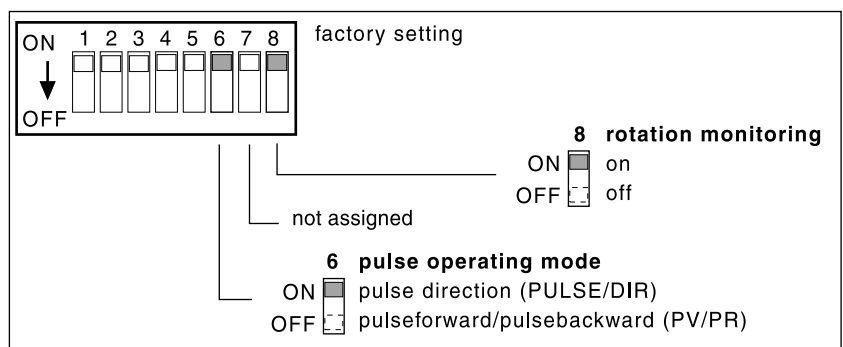


Fig. 5.4 Setting the function of the PULSE/DIR signals and speed monitoring

Pulse mode The position setpoint values can be fed to the signal interface as a pulse-direction signal or as a pulse-forward and pulse-backward signal. The power electronic system converts input signals to a motor movement in accordance with the DIP switch setting.



Only pulse/directions signals are evaluated in the unit without speed monitoring. The DIP switch setting is not relevant.

Speed monitoring

Speed monitoring can be disabled with the DIP switch. Then the unit no longer monitors following errors, even with persistent encoder signals.

The DIP switch setting is not relevant in the unit without speed monitoring.

5.3.3 Checking the function of the limit switches

The motor traverse range can be secured with limit switches. The limit switch signals must be monitored by the external controller and interrupted for power control if the setpoint pulses are triggered.

- ▶ Check the functioning of the limit switches before commissioning the motor in the system.

5.3.4 Checking the holding brake

Carry out this test when you are using a motor with a holding brake.



WARNING!

Danger of injury if the brake function fails!

Protect the danger zone before starting up, and carry out function test with no load.

Check the brake function with the push-button switch on the holding brake controller.

If the holding brake controller is to enable the button, the controller must not be switched by the power electronic system:

- ▶ Disconnect the ACTIVE_CON control cable at the power electronic system or switch off the 24 V supply to the power electronic system.
- ▶ Press the button on the holding brake controller several times to alternately release and re-apply the brake. The LED on the controller will light up when the brake has been activated and thereby released.
- ▶ Check the brake function: the shaft can be moved by hand when the brake is not applied, but not when the brake is applied.

5.3.5 Motor test run


WARNING!

*Danger of injury and damage to system parts resulting from unexpected motor acceleration!
Run the first test run with no coupled load.
If the motor is already installed in the plant, ensure that any unexpected motor movements will not cause any damage.*

Checking motor direction of rotation

- ▶ Switch on the external 24 V_{DC} power supply and the 230 V power for the power circuit.
- ▶ Enable the ENABLE signal if the ENABLE function has been selected with DIP switch 5=OFF.

The operational status indicator changes to "4". Power amplifier is enabled.

- ▶ Start the first test with low pulse frequency. If the DIR signal is disabled, the motor must rotate in the clockwise or positive direction.

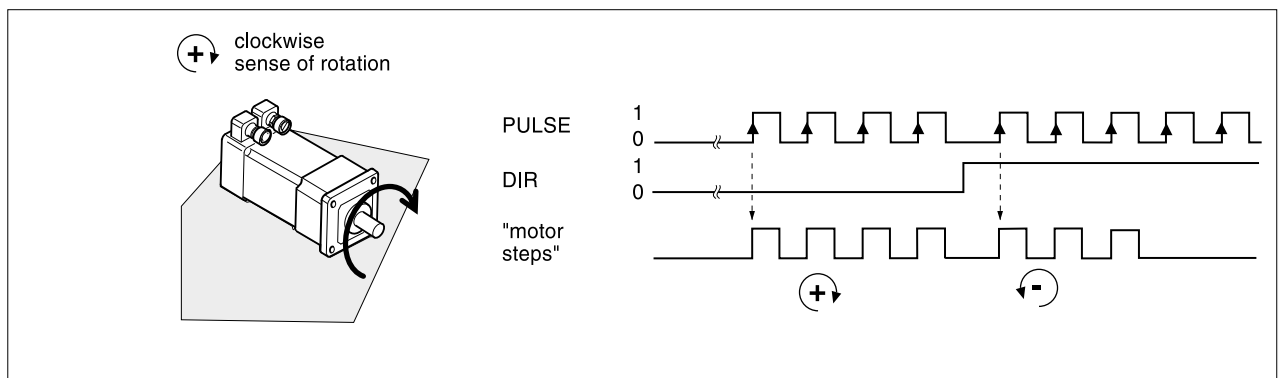


Fig. 5.5 Direction of rotation of motor

In the model without encoder the motor direction of rotation can be reversed by switching two motor phases.

If the motor follows the pulse signals, the control of the motor is correct.

- ▶ Switch off the power supply and install the motor in the system.

5.3.6 Optimizing the movement behavior of the motor

Calculating and testing cut-off frequencies

For optimum operation of the motor with the power electronic system the cut-off frequencies must be set for the start/stop and the acceleration phase at the NC controller.

The cut-off frequencies of a motor are determined from the motor torque and the external moment of inertia from the characteristic curve diagram of the stepper motor.

- ▶ Calculate the moment of inertia of the system reduced to the axis.
- ▶ Use the characteristic diagram of the motor and the motor torque to calculate the values for the
 - maximum start-stop frequency
 - the slope of the frequency ramp

Start-stop frequency

The unloaded motor accelerates without stepping errors from standstill with the start-stop frequency. If the motor is subject to external inertial forces, a lower frequency than the start-stop frequency must be selected.

The same applies for the cut-off frequency for braking the motor to speed 0.

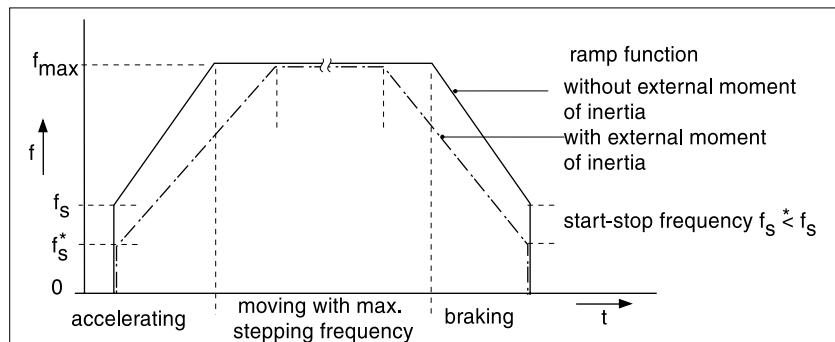


Fig. 5.6 Characteristics of the linear ramp with and without external moments of inertia

The pulse frequency must be limited to the start-stop frequency before reversion of the direction of rotation so the change of direction can be executed without increment loss.

Frequency ramp

In the acceleration and braking range above the start-stop frequency the control frequency must be continuously changed corresponding to the frequency ramp. The slope of the frequency ramp depends on the external moment of inertia and the motor type.

- ▶ Program the frequency data into the NC or positioning controller and start a test run under actual load conditions.

6 Operating functions

6.1 Positioning mode

The power electronic system moves a stepper motor in accordance with a setpoint. The setpoint signal is generated by a positioning or NC controller and fed to the PULSE-C interface as a pulse signal.

If speed monitoring is also installed and enabled by DIP switch, the power electronic system records the position of the motor and reports increment losses, which may occur as a result of blocking or overload of the motor.

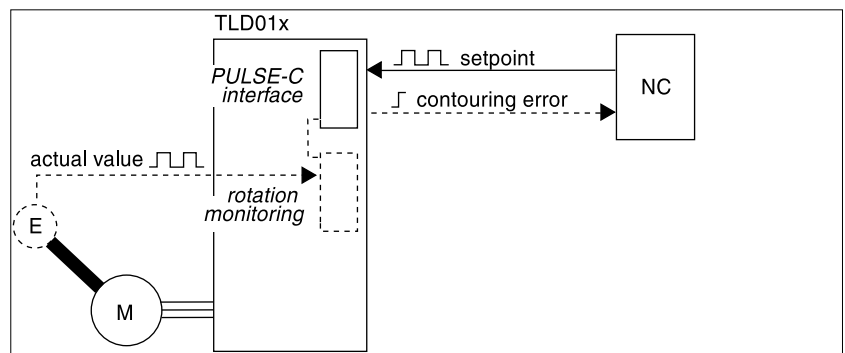


Fig. 6.1 Positioning controller of a stepper motor with speed monitoring

Setpoint value The setpoint value is sent as pulse-direction signal "P/R". If an encoder connection is installed, the setpoint value can be preset as pulse forward/pulse backward signal "PV/PR".

6.2 Functions of the power electronic system

6.2.1 Monitoring functions

Different monitoring systems protect the motor and power amplifier from overload and overheating and detect drive position deviations. You will find an overview of all monitoring functions in "Safety devices" on page 2-3.

The 7-segment display of the power electronic system shows error messages and warnings as flashing signals.

Temperature monitoring

Sensors in the power electronic system measure the temperature of the power amplifier. If an encoder connection is installed, the operating temperature of the motor can be recorded and monitored over the encoder cable.

If the temperature of the motor or power amplifier exceeds the permissible limit temperature for more than five seconds, the power electronic system shuts off the power amplifier and reports a temperature error.

Following error

If speed monitoring is installed, the angular position of the motor is transferred incrementally over the connection with A/B rectangular signals. The unit detects stepper errors by comparison with the setpoint position and reports a following error if the limit value of 6.4° is exceeded.

Error message over the PULSE-C interface

A following error can be reported to the NC controller over the FUNCT_OUT output of the PULSE-C interface. The power amplifier is blocked simultaneously and the ACTIVE switches to high.

6.2.2 Braking function with TL HBC

In motors fitted with a holding brake the brake prevents unintended movement of the motor when not under power. The power electronic system controls the holding brake directly or with the TL HBC holding brake controller, which is available as an accessory.

Holding brake controller

The TL HBC holding brake controller amplifies the ACTIVE_CON control signal from the signal interface, and controls the brake in such a way that it responds quickly whilst generating as little heat as possible.

The holding brake can be released with the push-button switch fitted to the holding brake controller for commissioning and function tests.

Braking signals

ACTIVE_CON switches to "high" and opens the brake as soon as the power amplifier is enabled and the motor has holding torque.

I/O signal	Function	Value
ACTIVE_CON	Brake will be opened or is open	high
ACTIVE_CON	Brake will be applied or is applied	low

Voltage reduction

The control voltage of the holding brake controller is variable when the voltage drop is activated. The voltage is then 24 V for approx. 100 ms and afterwards falls back to its holding voltage of 12 V.

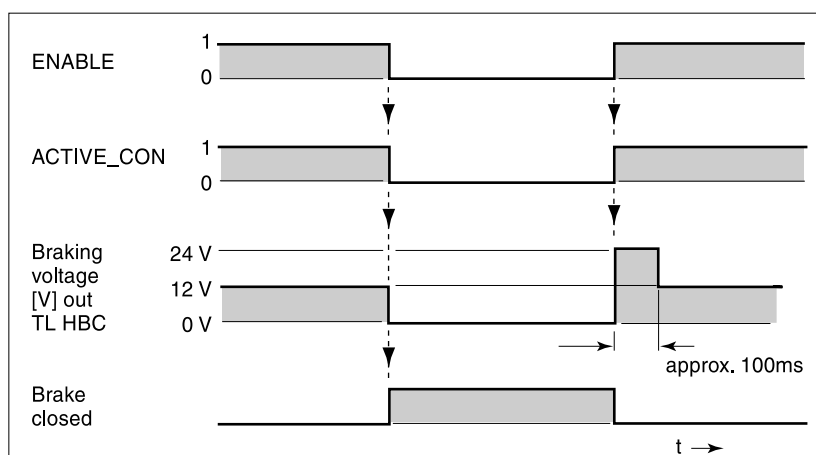


Fig. 6.2 Time diagram, brake function with voltage reduction on

When the power is switched on, the holding brake control system and the button function are reset. No voltage is present on the control terminals of the brake, and the control system LED is off.

7 Diagnosis and troubleshooting

7.1 Operational status indicators and transitions

Status display in the unit The D2 LED on the motor plug lights when there is power in the DC link.

The 7-segment display shows the operating states of the power electronic system in coded form.

Display	Operating status
0	24 V switched on
1	Initialization of the unit electronics
2	The power amplifier is not ready to switch on
3	Switching on the power amplifier is disabled
4	The power amplifier is ready to switch on
6	The unit is working in the selected mode
7	A Quick-Stop is being executed
8, 9	An error has been detected and the error response activated
0 - A flashing	Indicates an error value

Operating transitions The conditions for changing between the operating states displayed and the response of the power electronic system to an error follow a fixed sequence.

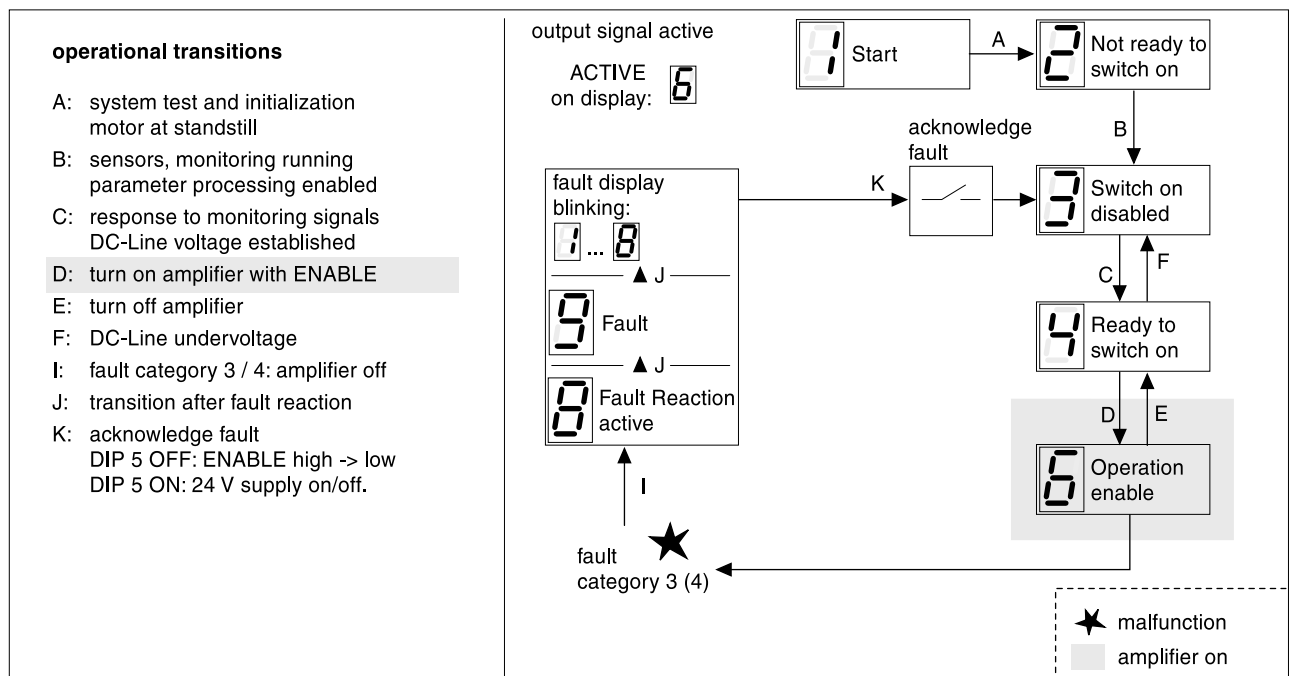


Fig. 7.1 Operating states and transitions of the power electronic system

7.2 Error display and troubleshooting

- Error display* The cause of an operating malfunction is displayed
- by a flashing number in the seven-segment display
 - by the error response of the power electronic system and motor

Resetting error messages When the fault is corrected, the message can be acknowledged by return of the ENABLE signal to the signal interface. DIP switch 5 must be set to OFF.

If DIP switch 5 is set to ON, the GATE function is enabled. In this case an error message can only be acknowledged by briefly switching off the 24 V power supply.

Error response The power electronic system triggers an error response when a malfunction occurs. Depending on the seriousness of the fault, the unit responds in accordance with one of the following error classes:

Error class	Response	Meaning
0	Warning	Message only, no interruption to movement operations
3	Fatal error	The power amplifier and controller switch off. The unit can only be reactivated after the error has been corrected.
4	Uncontrolled operation	The power amplifier and controller switch off. The error response can only be reset by switching off the unit.

Troubleshooting

Display	Error	Error class	Cause	Troubleshooting
dark	Display dark	-	No power supply	Check power supply and fuses
	Display dark	-	Power supply wrongly connected	Connect properly
1	Undervoltage	3	DC link voltage below threshold value for switching off the drive	Check line voltage and check connections to unit
2	Following error	3	Drive blocked; start-stop frequency too high; movement frequency or acceleration too high	Reduce load or motor torque check settings for motor current set start-stop frequency lower; reduce movement frequency or acceleration
2	Maximum motor speed	3	Maximum motor speed exceeded	Reduce pulse frequency
3	Motor cable	3	Short circuit or ground fault in motor cable	Check connections, replace motor cable
4	Position sensor	3	Only with TLD01x with speed monitoring: encoder or encoder cable defective	Check encoder cable and encoder. Replace cable, replace motor
5	Overvoltage	3	DC link overvoltage	Use external capacitor
7	Power amplifier overtemperature	3	The power amplifier is overheating	Reduce load, use current drop to reduce power
7	Motor overtemperature	3	Only with TLD01x with encoder connection: motor overheating Temperature sensor not connected or defective	Allow motor to cool, use a motor with a higher rated power, use current drop to reduce power, check or replace motor encoder cable

Display	Error	Error class	Cause	Troubleshooting
8	Watchdog	4	Internal system error	Switch unit off and on, replace unit
C	Timing error	4	Timing of GATE, STEP2_INV or PULSE not retained	Checking timing response of signals at PULSE-C interface.

7.3 Malfunctions in movement mode

Faults	Cause	Correction
Motor does not rotate and has no holding torque	Signal input PWM: high	Disable current controller (PWM)
	Signal input ENABLE: low	Enable power amplifier release (ENABLE)
	Motor incorrectly connected	Connect motor correctly
Motor does not rotate but has holding torque	Signal input GATE: high	Disable GATE signal with GATE function to release pulses
	Pulse frequency	Check timing and signal voltage level of pulse signals (PULSE, DIR)
Motor does not rotate uniformly	Pulse frequency	Check timing and signal voltage level of pulse signals (PULSE, DIR)
	Overload	Reduce load
	Motor defective	Replace motor
Motor rotates in the wrong direction	The motor phases are swapped	Check motor connection, replace
	+DIR/-DIR incorrectly connected PV/PR signals swapped	Check signals, connect correctly
Motor torque too low	Phase current wrongly set	Set motor phase current as required by motor type label and phase current table at commissioning

8 Service, maintenance and warranty

8.1 Service address

Contact your local service representative with any questions or problems. He will refer you to a customer service representative near you on request.

Maintenance

The Twin Line unit requires no maintenance

- Check the filter in the switch cabinet ventilator regularly. Inspection intervals depend on the ambient conditions on site.



Have repairs to the unit carried out only by your local service representative to ensure that the unit continues to operate reliably.

Warranty

If the unit is opened the warranty is canceled.

8.2 Shipping, storage and disposal

**DANGER!**

*Electric shock from high voltage!
Switch off the power supply at the main switch before removing the unit.*



⦿ > 4 min
(or 10 min)

DANGER!

*Electric shock from high voltage!
Before starting work on the connections of the power unit or on the motor terminals, wait for the 4 minutes discharge time and then measure the residual voltage on the DC-link terminals DC+ and DC-. The residual voltage must not exceed $48 V_{DC}$ before you start work on the connections. If additional DC-link capacitors are connected, the discharge period is increased to 10 minutes. Wait for this period and then measure the residual voltage.*

Shipping The unit must be protected against impact while in transit. Use the original packaging for this purpose.

Storage Store the unit only under the permissible ambient conditions for room temperature and humidity.

Protect the unit from dust and dirt.

Disposal The power electronic system is made from various materials which can be recycled or which must be separately disposed of.

For recycling purposes, separate the unit into the following parts

- housing, screws and terminals for ferrous metal recycling
- cables for copper recycling
- connectors, hood for plastics recycling

Circuit boards and electronic components must be disposed of separately in accordance with the applicable environmental protection laws. Send these parts for special waste disposal.

9 Accessories and spare parts

9.1 List of accessories

Accessories for the power electronic system are:

Qty.	Designation	Order no.
1	Connector set for complete assembly	6250 1519 001
1	Motor cable 1.5 mm ²	6250 1317 xxx ¹⁾
1	Pulse direction cable for PULSE-C interface 2 x socket, 15-pin 1 x socket, 15-pin, one end open	6250 1447 yyy ²⁾ 6250 1452 yyy ²⁾
1	Encoder cable for speed monitoring	6250 1440 xxx ¹⁾
1	Holding brake controller TL HBC	6250 1101 606
1	External line filter for units without internal filters for TLD011 NF, 4 A for TLD012 NF, 10 A	5905 1100 200 6250 1101 606

1) Cable length xxx: 003, 005, 010, 020, 3 m, 5 m, 10 m, 20 m, longer cables on request

2) Cable length yyy: 005, 015, 030, 050: 0.5 m, 1.5 m, 3 m, 5 m;

9.2 List of spare parts

Power electronic system

Qty.	Designation	Order no.
1	TLD011, TLD012	Type code
1	SK14 shielding terminal	6250 1101 400
1	Documentation on the TLD01x on CD-ROM, multilingual	9844 1113 138

10 Unit label

10.1 Illustration of the unit label

- Copy the unit label and stick it on the inside of the Twin Line unit's hood.

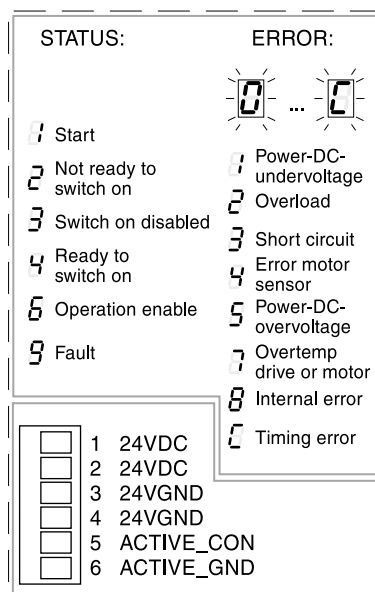


Fig. 10.1 Unit label

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Safety note

Twin Line units are drives designed for general use. They are state of the art and are designed to be as safe as possible. However, drives and drive controllers that are not specifically designed for safety functions are not approved for applications where the functioning of the drive could endanger persons. The possibility of unexpected or unbraked movements can never be totally excluded without additional safety equipment. For this reason personnel must never be in the danger zone of Twin Line drives unless additional suitable safety equipment prevents any personal danger. This applies for operating the machine during production and also for all service and maintenance work on drives and the machine.

The machine design must ensure personal safety.

Suitable measures for prevention of property damage are also required.

The following constraints must be observed for applications conforming to UL508C

- Input mains overvoltage category III (UL840): The Twin Line product range has been designed in accordance with standard UL840. A UL Recognized Transient Voltage Surge Suppressor, conforming to UL 1449, with a maximum clamping voltage of 4kV, shall be provided in all phases of the line side of the drive in the end installation. Use Square D SDSA3650 surge arrester or equivalent.
- Branch circuit fuse class CC 600V according to UL248 required
- Max. surrounding air temperature 50 °C

