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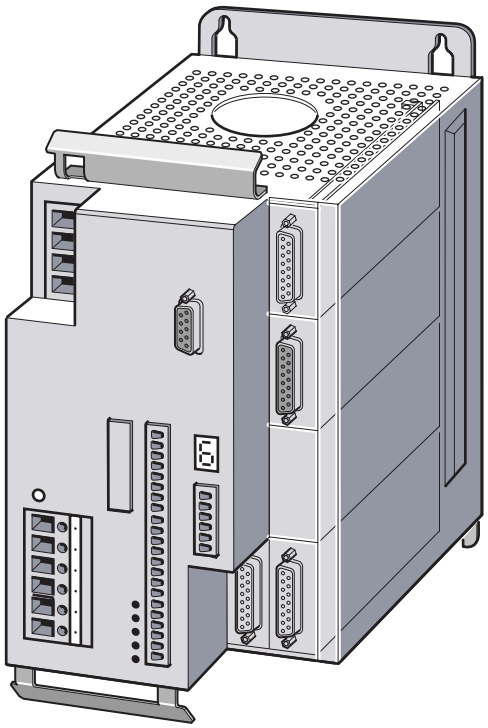
Telemecanique

by Berger Lahr

Technical documentation



Twin Line Drive 13x

Drive system for AC-synchro-nous-servomotors

TLD13x

Operating system: 1.1xx

Ordering no.:TLADOCD03ME

Edition: -001, 08.02

Twin Line™

Motion Products

TLD13x General Hazard Statement

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- Read and understand this bulletin in its entirety before installing or operating Twin Line drive system products. Installation, adjustment, repair, and maintenance of these drive systems must be performed by qualified personnel.
- Disconnect all power before servicing the power controller. WAIT SIX MINUTES until DC bus capacitors discharge, then measure DC bus capacitor voltage between the DC+ and DC- terminals to verify that the DC voltage is less than 45 V (see Fig. 1.5 on page 1-5). The DC bus LED is not an accurate indication of the absence of DC bus voltage.
- The motor can produce voltage at its terminals when the shaft is rotated! Prior to servicing the power controller, block the motor shaft to prevent rotation.
- DO NOT short across DC bus terminals or touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers and close enclosure door before applying power or starting and stopping the drive system.
- The user is responsible for conforming to all applicable code requirements with respect to grounding all equipment. For drive controller grounding points, refer to Fig. 1.5 on page 1-5.
- Many parts in this drive system, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools.

Before servicing drive system:

- Disconnect all power.
- Place a “DO NOT TURN ON” label on the drive system disconnect.
- Lock the disconnect in open position.

Failure to follow these instructions will result in death or serious injury.

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Glossaries

Abbreviations

Abbreviation	Meaning
AC	Alternating current
ASCII	American Standard Code for Information Interchange
COS	Controller Operating System
DC	Direct current
E	Encoder
E.l.c.b.	Earth leakage circuit-breaker
EG	European Community
EMC	Electromagnetic compatibility
EN	European Norm
EU	European Union
HMI	Human-Machine Interface, plug-in hand-held operating unit
I/O	Input / output
Inc	Increment
IT system	I: isolated; T: terre (Fr.), ground. Power system with no connection to ground, not earthed
LED	Light-Emitting Diode
M	Motor
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Agency
PC	Personal Computer
PELV	Protected Extra-Low Voltage
PLC	Programmable logic controller
RC	Residual current

Product name

Abbreviation	Product designation	Term used
TLD13x	Twin Line Drive 13x	Power electronic system
TLHMI	Twin Line HMI	Human machine interface HMI
TLCT	Twin Line Commissioning Tool	Commissioning Software
TLHBC	Twin Line Holding Brake Controller	Holding Brake Controller
TLBRC	Twin Line Ballast Resistor Controller	Ballast Resistor Controller

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Technical Terms

Actual position of the drive system	The actual position of the drive system gives the absolute or relative positions of driven components in the system.
Actual position of the motor	See Angular position of the motor.
Angular position of the motor	The angular position of the motor corresponds to the angular position of the rotor in the motor housing, and is referenced to the zero point or index point of the position sensor.
Control response	Speed at which a drive reacts to a disturbance or to a change in the input signal
DC-Bus	The DC-bus generates the necessary direct current for operating the motor and provides the amplifier with the necessary energy. The DC-Bus acts as a buffer to energy fed back by the motor.
Default values	Preset values for the parameters of the Twin Line drive before the first commissioning, factory settings
Direction of rotation	Rotation of the motor shaft in a clockwise or counter-clockwise direction. A clockwise direction of rotation is given when the motor shaft rotates clockwise as the observer faces the end of the protruding shaft.
Drive solution	The drive solution comprises the drive system with its Twin Line drive and motor, as well as the system mechanics forming an integral part of the chain of motion.
Drive system	The drive system consists of the Twin Line drive, motor and auxiliary power and control devices (i.e. brake controller, HMI, etc.).
ESIM1-C,ESIM2-C	Encoder simulation module for outputting position data of the motor as A/B signal with an index pulse to the external controller or to a second Twin Line controller.
Electronic gear	An input speed is recalculated by the Twin Line drive using the values of an adjustable gear ratio to produce a new output speed for the motor movement.
Encoder	Sensor for recording the angular position of a rotating element. Mounted on the motor, the encoder signals the angular position of the rotor.
Error class	Reaction of the Twin Line drive to an operational malfunction corresponding to one of five error classes
Forcing	To change signal states irrespective of the hardware switching status in the unit; with the commissioning tool, for example. The hardware signals remain unchanged.
HIFA-C	Module with Hiperface interface for connecting an encoder made by Stegmann.
High/open	Signal status of an input or output signal; when no signal is present, signal voltage is high (high level).
HMI	Hand-held operating unit which can be plugged into the Twin Line drive. HMI: Human-machine interface.
I^2t monitoring	Predictive temperature monitoring. On the basis of the motor current, the expected heating of unit components is calculated in advance. Should a limit value be exceeded, the Twin Line drive reduces the current.
Incremental signals	Angular steps of an encoder in the form of square-wave pulse sequences. Relative changes in position are signalled by the number of pulses contained in the pulse sequence.

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Index pulse	Encoder signal for referencing the rotor position in the motor. The encoder sends one index pulse per revolution.
Input device	Input device is the device which can be connected to the RS-232 interface for the purpose of commissioning; it is either the HMI hand-held operating unit or a PC with the Commissioning Software.
IT network	Power system with no connection to ground I: isolation; T: terre (French): ground.
Limit switch	Switches which signal any overrun on the permissible travel.
Low/open	Signal status of an input or output signal; when no signal is present, signal voltage is low (low level).
Module code	Internal electronic code (8 bit) which describes the hardware and the functionality of modules. This code is held in an EEPROM in every module.
Node guarding	Monitoring function at the RS-232 interface.
Optically isolated	Electrical transmission of signals with electrical isolation
Parameter	Device data and values which can be set by the user.
Power amplifier	This is the unit that controls the motor. The power amplifier generates currents for controlling the motor in accordance with the signals from the control unit.
Power controller	See Power amplifier.
PULSE-C	Pulse direction interface for recording external position presets via pulse direction signals or $Pulse_{forward}$/$Pulse_{backward}$ for the positioning of the motor.
Pulse direction signals	Digital signals with variable pulse frequencies which signal changes in position and rotation direction via separate signal wires.
Quick stop	This function is used to command rapid deceleration of the motor by the power amplifier. To achieve rapid deceleration, the power amplifier must be operational during the entire deceleration period, the motor must be dimensioned to allow for sufficient stopping torque, and the power amplifier must be able to absorb the system mechanical load energy/power during the deceleration.
RS-232 interface	Communications interface of the Twin Line drive for the connection of a PC or the HMI hand-held operating unit
RS-422-C	Encoder direction interface that allows the Twin Line controller to input position data from an external encoder. This signal can originate from machine mounted encoders or from encoder simulation modules such as the ESIM-C.
RS-422 level	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.
RS-485-C	Fieldbus module which enables the Fieldbus to be used via a multipoint connection with serial data transmission. A multipoint connection - in contrast to a point-to-point connection - can swap data with several devices on the bus.
RS-485 level	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. RS-485 signal transmission is bidirectional.
Sense regulation	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.

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SinCos An encoder for registering the position of the rotor of the servomotor as an analog sine-cosine signal and as digital position data via the HIFA-C module. Motor data are held in the SinCos and are read into the drive once the Twin Line drive is switched on.

SSI-C Synchronous serial interface for encoder simulation with serial transmission of absolute position data. The module generates the signals of an SSI encoder.

Transformation ratio This defines the transmission ratio of the reference voltage to the SIN or COS signal voltage. It is used in specifying resolvers.

User units A user unit corresponds to the maximum precision at which a distance, speed or acceleration value can be input. User units can be set for parameters involving speed, position, and acceleration.

Watchdog Device in the unit which detects internal faults. If a fault occurs, the amplifier is switched off immediately.

Zero-clamp Taking over the present actual position as the new setpoint position. It is used with the quick stop function when the drive is switched in at zero speed and set to the present position.

Written conventions and note 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 leads to a noticeable response from the unit, this will be given after the description of the action to be carried out. In this way you will receive 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.

Menu paths "→" In the Twin Line Commissioning Tool commissioning software an action is launched via 'Menu → Menu item → ...'. For example, 'File → Save' in the menu 'File'; under the menu item 'Save' saves data to the data storage medium.

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

Passages which are preceded by this symbol may have to be discussed in more detail with Schneider Electric's customer service. Refer to "Service Information", page 9-1 for contact information.

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1 The drive

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 to be added to or repaired.

Scope of supply of the drive

The scope of supply of the TLD13x drive includes:

No.	Qty.	Designation	Order no.
1	1	TLD132, TLD134, TLD136 or TLD138,	See Fig 1.4
2	1	Hood for front cover	-
3	1	Shielding terminal SK 14 for motor connection	TLATE
4	1	Connector mountings for the terminal strips	-

Modules

Option module configurations for the drive:

No.	Qty.	Designation	Order no.
5	1	RS422-C encoder module or PULSE-C pulse direction module	See Fig 1.4
5	1	HIFA-C Hiperface module	See Fig 1.4
5	1	ESIM1-C or ESIM2-C module, or SSI-C module for encoder simulation	See Fig 1.4

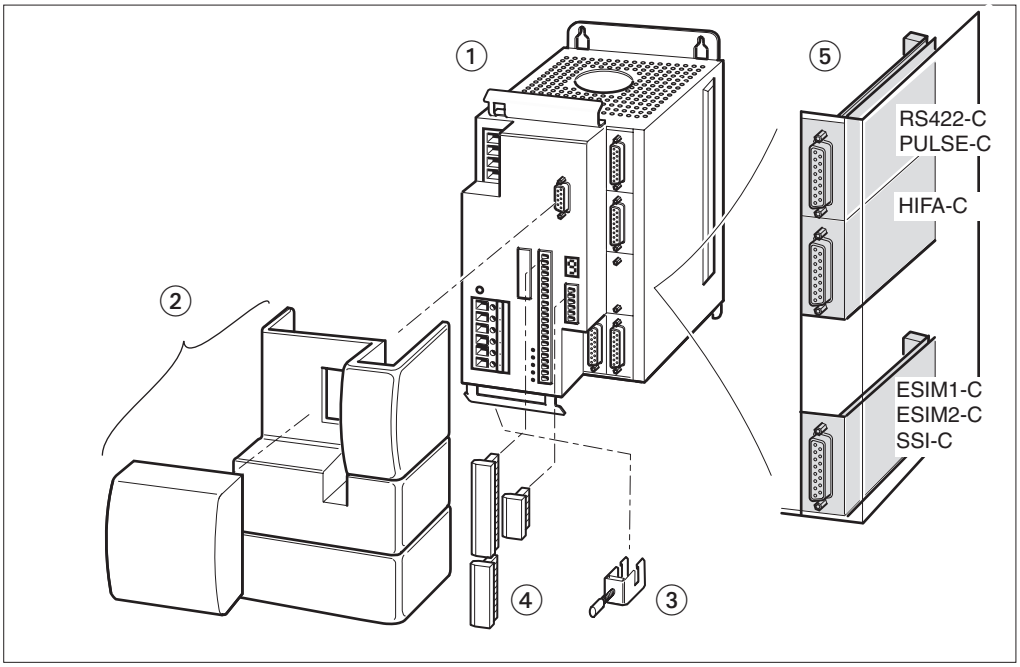

Fig.1.1 TLD13x and modules

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Accessories Accessories for the drive:

No.	Qty.	Designation	Order no.
1	1	Commissioning software with online documentation on data storage medium, English	TLAPSCA
2	1	Human-Machine Interface HMI with manual	TLAPHOO
3	1	Motor cable 1.5 mm^2 with motor connector Motor cable 2.5 mm^2 with motor connector Motor cable 4 mm^2 with motor connector	TLACPAAAxxx1 [1)] TLACPAABxxx1 [1)] TLACPAACxxx1 [1)]
4	1	Sensor cable for Hiperface module HIFA-C	TLACFABAxxx1 [1)]
5	1	Pulse direction cable for module PULSE-C Encoder cables for RS-422-C module, open at one end only	TLACDCBHyyy [2)] TLACDCACyyy [2)]
6	1	Cable for module RS-422-C,plug at each end Encoder cables for ESIM1-C, ESIM2-C, SSI-C modules	TLACDCAEyyy [2)] TLACDCAEyyy [2)]
7	1	RS-232 programming cable 5 m 10 m	TLACDPBG 050 TLACDPBG 100
8	1	Holding brake controller TLHBC	TLABHO
9	1	Ballast resistor controller TLBRC	TLABBO
10	1	External ballast resistor BWG 250072 (100 W, 72 Ohm) BWG 250150 (100 W, 150 Ohm) BWG 500072 (200 W, 72 Ohm) BWG 500150 (200 W, 150 Ohm)	 TLABRA TLABRB TLABRC TLABRD

1) Cable length xxx: 003, 005, 010, 020, 3 m (9.84 ft.), 5 m (16.4 ft.), 10 m (32.8 ft.), 20 m (65.6 ft.), longer cable lengths on request;.
2) Cable length yyy: 005, 015, 030, 050: 0.5m, 1.5 m, 3 m, 5 m.

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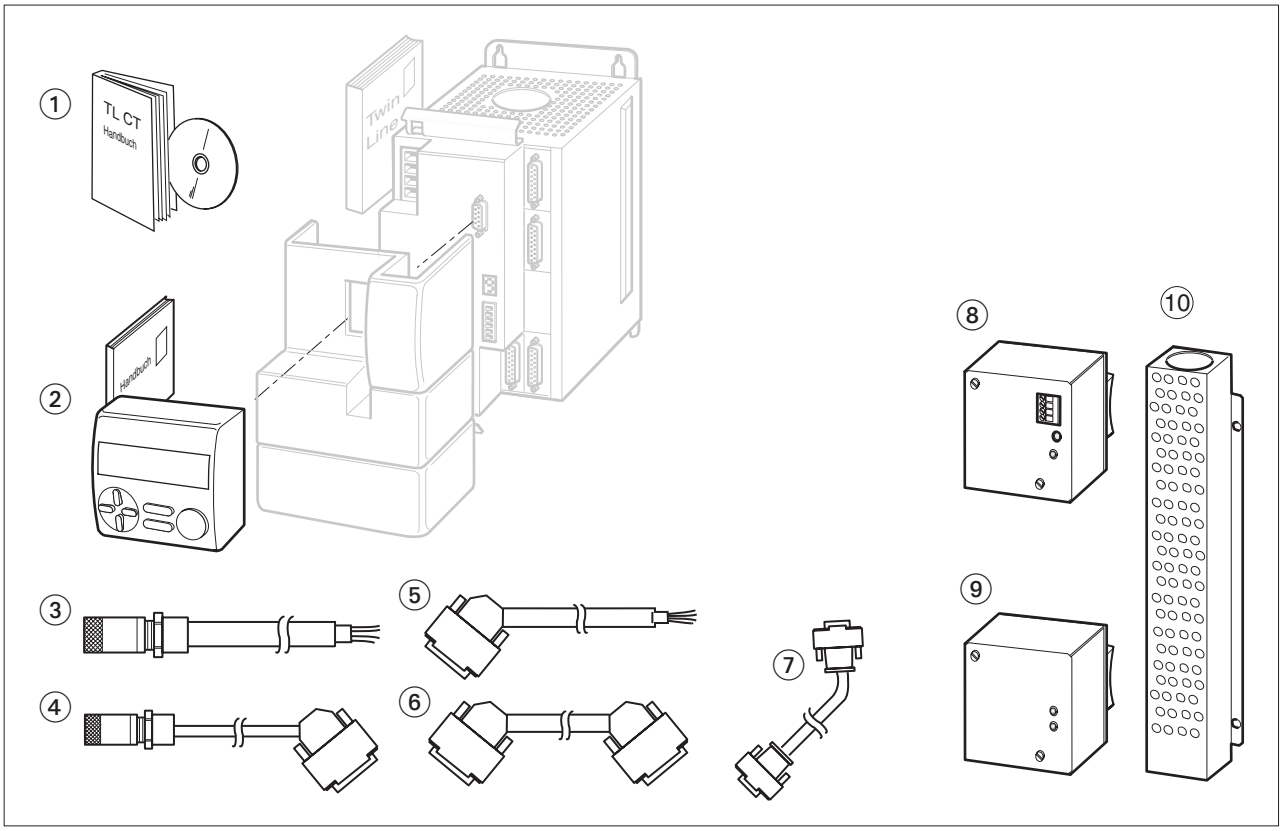

Fig.1.2 Accessories for the TLD13x

1.2 Documentation and literature

Manuals for the drive

Twin Line HMI, Manual for the Human-Machine Interface HMI, Order no.: TLADOCHMIME

Twin Line Commissioning Tool, Manual for the commissioning software, English Order no.: TLADOCTLCTE

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1.3 Unit series

The drive TLD13x is a member of the Schneider Electric Twin Line unit series for controlling stepping motors and AC servomotors. The drive functions as a stand-alone power amplifier with an integrated control and power unit. It can run an AC synchronous servomotor with current, speed or positional control.

The drive is available with four power amplifiers with a similar housing design. Electrical connections and functional scope are identical for all four units.

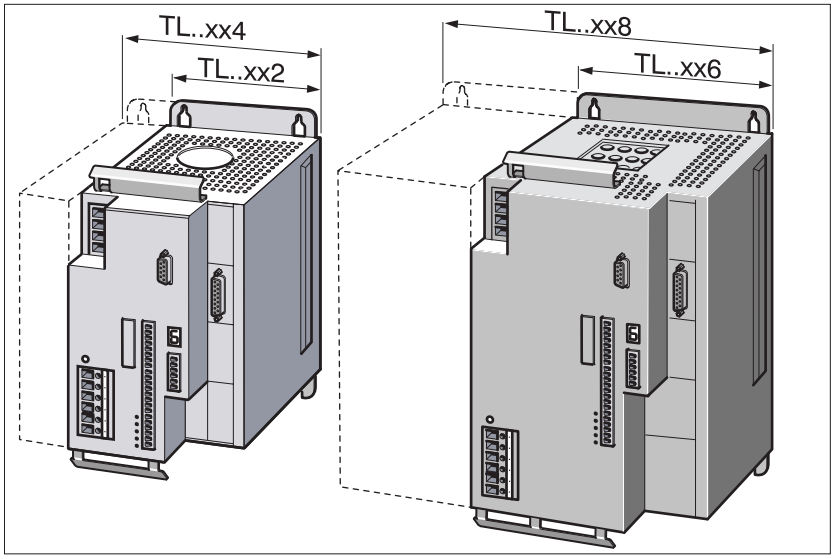

Fig.1.3 Drive system TLD132, TLD134, TLD136 and TLD138

The power class of the drive is indicated by the last digit in the device name ‘TLD13x’ of the type code.

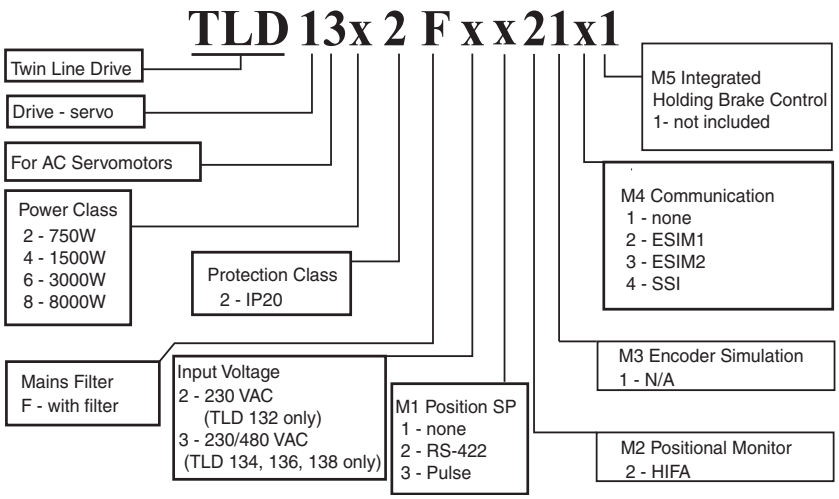

Fig.1.4 Type code of the drive TLD13x

The drive is supplied with a built-in mains filter as standard.

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1.4 Drive overview

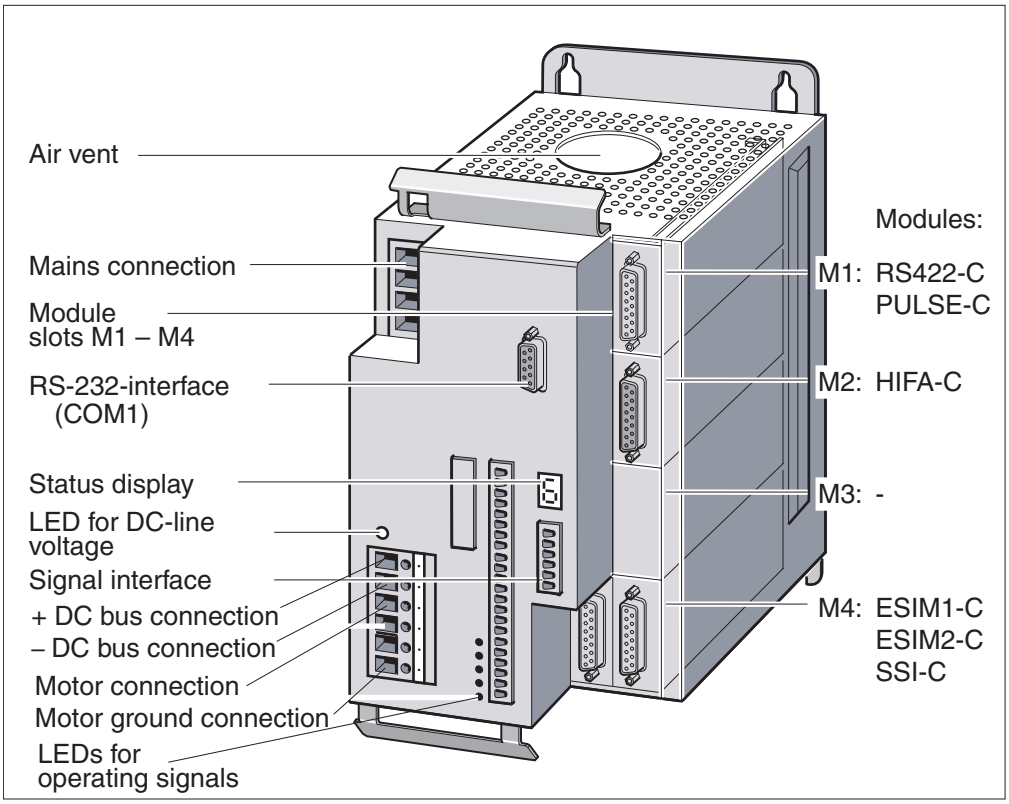

Fig.1.5 Drive system TLD13x

Mains connection

The power supply for the amplifier is connected to the mains:

- TLD132: 230 V_{AC}, single phase
- TLD134 etc: 400/480 V_{AC}, three phases.

A drive with a built-in mains filter can be operated without any further noise suppression on the supply side.

The power supply for control loops and for controlling the fan must be provided by an external 24 V_{DC} power supply.

Motor connection

The drive supplies the power for a permanent-field AC synchronous servomotor via the three-phase connection. The motor connection is short-circuit protected and is checked for ground faults when the amplifier is enabled.

Internal ballast resistor

In braking mode the motor returns energy to the drive. The energy is absorbed by DC-Bus capacitors and reduced by the internal ballast resistor.

DC-Bus connection

The DC-Bus voltage for the drive is taken from the intermediate circuit terminal. If the internal ballast resistor cannot cope with dissipating the excess energy as heat, a ballast resistor controller with an external ballast resistor can be connected to the DC-bus terminal.

Two Twin Line units of the same power class and connected together via the DC-Bus connection can offload excess braking energy onto each other.

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Status display A seven-segment display provides information about the operating status of the drive. If there is an operating malfunction the display will flash and display an error code.

LED for DC-Bus voltage The LED comes on when the DC-Bus voltage is present.

LEDs for operating signals Five LEDs display the signal states of these adjacent inputs: positive and negative limit switches, motor stop signal, power amplifier enable state and automatic operation.

Signal interfaces The input and output signals are supplied to the signal interface and an external 24 Vdc supply injected for the closed-loop control unit.

RS-232 interface The RS-232 connection is the communications interface of the unit and is used for connecting a PC or the HMI hand-held operating unit.

Air outlet and fan A built-in fan draws cold air into the controller from below to cool the power amplifier and ballast resistor. It discharges the warmed air through the upper air outlet vents. Temperature sensors on the power amplifier's heat sink protect the unit from overheating.

Module slots Four module slots allows the drive to be matched flexibility drive to your particular area application. The minimum configuration required to drive an AC servomotor is a module in slot M2. The other module slots expand the scope of functions of the drive.

Configuration variants Several modules are available for variants slots M1, M2 and M4 for configuring the drive for a particular installation.

Slot	Functions when module fitted	Possible modules fitted
M1	External setpoint signals for moving and positioning the motor	PULSE-C or RS-422-C
M2	Motor position feedback to drive	HIFA-C
M4	Encoder simulation module	ESIM1-C, ESIM2-C or SSI-C

Slot M3 remains free for later extensions.

Parameter memory All settings of the drive are administered in a motor data record, two records for control parameters and one for movement parameters. The parameters are stored in the unit, protected against power outages, and can be displayed and changed via the RS-232 interface on the PC, via the HMI hand-held operating unit or over the Fieldbus.

Motor data record The motor data record is read in automatically at the start of commissioning and after a change of motors or selected with the commissioning software.

Control parameters The two control parameter records contain two independent controller settings. It is possible to switch between sets either via the signal interface or via a manual control unit. The parameter values of both sets are preset and can be optimized for operation in the system.

Movement parameters The set of movement parameters contains specific data for the various operating modes of the drive. Should the operating mode change, the controller will switch over to the appropriate set of movement parameters.

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1.5 Modules of the drive

The block diagram shows the modules and interface signals of the drive.

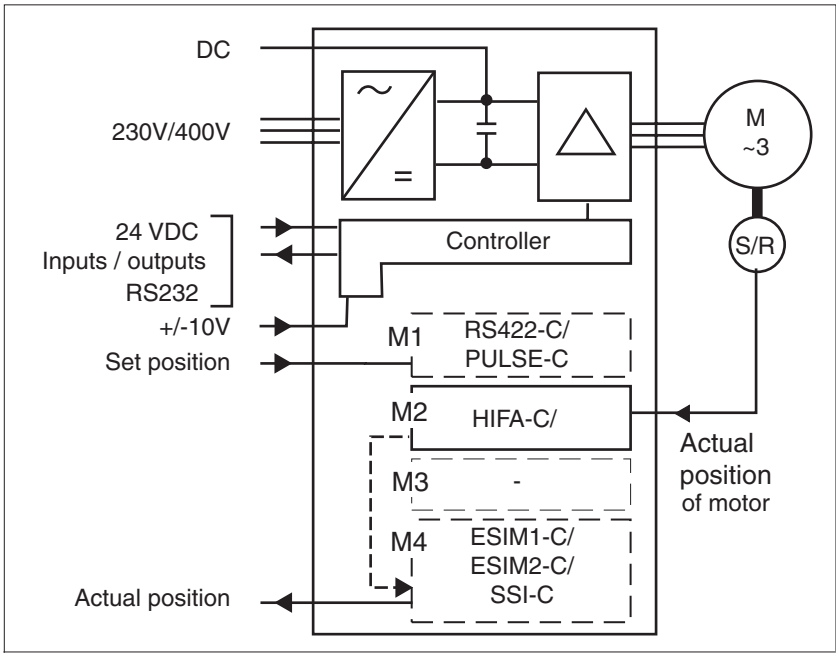

Fig.1.6 Block diagram with modules and interface signals

Module HIFA-C The HIFA-C Hiperface module is used for positional feedback with AC servomotors with Hiperface encoders manufactured by Stegmann.

A Hiperface encoder registers with high resolution the position of the rotor of the AC servomotor and sends it as an analog signal to the Hiperface module.

The Hiperface module passes the position data to the drive while simultaneously generating A/B signals for encoder simulation with the ESIM1-C or ESIM2-C modules or for determining the absolute actual position with SSI-C.

Module PULSE-C The PULSE-C pulse-direction module passes on externally injected frequency signals to the drive as reference signals for positioning. The module registers the position data as pulse-direction signal or as $pulse_{forward}$ / $pulse_{back}$ signal.

Module RS-422-C The RS-422-C encoder module evaluates externally injected encoder signals as reference signals for positioning. The signals take the form of A/B signals from an encoder, from a higher-ranking controller or from the encoder simulation of a first drive.

Module ESIM1-C The ESIM1-C encoder simulation module outputs the position data of the AC servomotor as an A/B signal. The A/B signal emulates a quadradure encoder directly connected to the servomotor. The signal can be used as the reference command for another Twin Line controller equipped with a RS-422-C module, or it can be sent to a higher-ranking (supervisory) controller for evaluation.

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Module ESIM2-C The ESIM2-C module has the same function as the ESIM1-C module except that the ESIM2-C routes the encoder signals out of the device via two signal interfaces.

Module SSI-C From the position data of the AC servomotor and an initial value, the SSI-C synchronous serial interface module generates an absolute position for encoder simulation.

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1.6 Module configuration, operating modes and functions

Overview

Depending on the module configuration, the drive functions in one manual and several automatic modes, which can be swapped during travel.

- Manual mode with positioning
- Speed mode
- Current mode
- Electronic gear via a module in slot M1

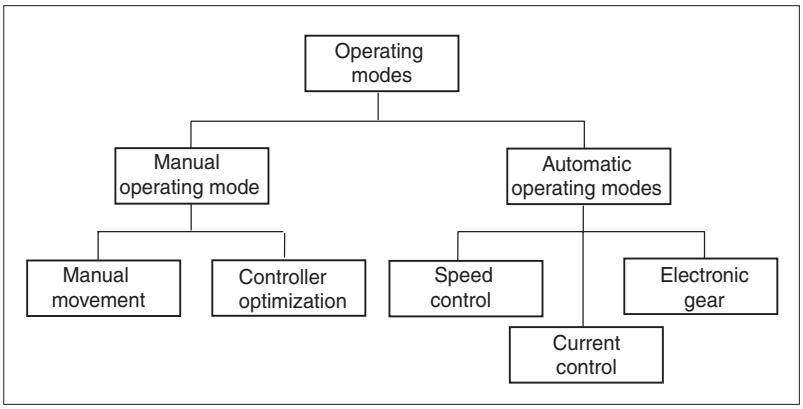

Fig.1.7 Operating modes of the drive TLD13x

The following table shows the modules that require to be fitted for each operating mode, and possible configurations for additional functions.

	Minimum module configuration in slot			
Operating mode	**M1**	**M2**	**M3**	**M4**
Manual operation, speed control, current control	-	HIFA-C	-	-
Electronic gear	PULSE-C or RS-422-C	HIFA-C	-	-

	Module configuration for additional functions			
Function	**M1**	**M2**	**M3**	**M4**
Encoder simulation for external position control	possible	mandatory	-	ESIM1-C ESIM2-C or SSI-C

Manual movement

In manual movement the drive moves the motor speed-controlled in two speed steps with no position reference. Movement direction and speed are controlled with the HMI hand-held unit or a computer using the commissioning software via signal interface inputs.

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Speed control

In automatic speed control mode the motor is speed-controlled. The speed setting is controlled with the HMI hand-held unit or a computer using the commissioning software via the signal interface ±10 V input.

A positioning controller with external position control can be set up with a module for encoder simulation and a higher-order controller.

Current control

In current control automatic operating mode the drive controller uses a preset ±10 V setpoint value to calculate the motor current required to accelerate the drive system load-free up to the configurable speed limit.

The setpoint is specified via the analog ±10 V input of the signal interface, with the HMI hand-held operating unit or via a PC using the commissioning software.

Electronic gear

The electronic gear operating mode is used when one or more AC servomotors are to operate in position control to follow the reference signal of a higher-ranking (supervisory) controller or of an encoder.

The reference signals are fed in via the RS-422-C encoder module or the PULSE-C pulse-direction module. A new position setpoint value is calculated from these signals and a selected gear ratio.

In electronic gear mode a slave controller can be set up when the actual position of the first drive is reported to the RS-422-C encoder module of a second unit via the ESIM1-C or ESIM2-C module for encoder simulation.

An example of an application for the electronic gear mode is to operate pressure rollers and counter-pressure rollers with different diameters.

Controller optimization

Operating mode for setting up the drive. Controller optimization is used for matching control behavior to the particular system. It is also used when the controller is first being commissioned or later modified. The positioning controller uses a signal generator for optimizing the controller.

Controller optimization can only be carried out manually with the optimization tool. During optimization, control parameters can be set and tested by means of a jump function.

Signal generator

A signal generator has been built into the drive especially for rapid start-up and can be used for optimizing the operating behaviour of an AC servomotor in the system.

The signal generator is a function which is only used during set-up. It is activated in the background to optimize the drive's control behavior.

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1.7 Guidelines and standards

1.7.1 Declaration of conformity and CE labelling

The EG guidelines 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 guidelines describe the main requirements made of a product. The technical details are laid down in the harmonized standards, which for Germany take the form of 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 labeling

With the declaration of conformity and the CE labeling of the product the manufacturer certifies that the product complies with all relevant requirements of the EC guidelines. The manufacturer is permitted to sell and use the product throughout the EC.

Machine guideline

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

It is the responsibility of the integrator/end user to ensure that the machine in which the Twin Line drive system is incorporated conforms to the Machinery Directive.

EMC guideline

The EC guidelines 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 drive system's compliance with the EMC guideline cannot be checked until it has been installed into a machine or installation. The instructions provided in the installation section of this manual must be followed to ensure satisfactory electromagnetic compatibility of the Twin Line drive system when installed within the machine.

It is the responsibility of the integrator/end user to ensure that the machine in which the Twin Line drive system is incorporated conforms to the EMC directive.

Low voltage guideline

The EC guideline on low voltages (73/23/EEC) lays down safety requirements for 'electrical apparatus' as protection against the risks which can originate in such devices and which can be created in response to external influences.

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

- Protection class 1
- Pollution degree 2 for the IP20 controller

Declaration of conformity

The declaration of conformity certificates that the device satisfies the requirements of the EC guideline cited. For the Twin Line drive system a declaration of conformity in accordance with the EC low voltages guideline has been issued.

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EC Declaration of Conformity 2001

BERGER LAHR

BERGER LAHR GmbH & Co.KG
Breslauer Str. 7
D-77933 Lahr

☐ Machine Directive 98/37/EEC, Appendix IIA
☒ EMC Directive 89/336/EEC
☒ 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
Part number:	TLDx1x2…, TLCx1x2…, TLDx3x2…, TLCx3x2…, TLCx1x5…, TLCx3x5…,TLABH…, TLABB…
Material number:	01634xxxxxxxx, 01635xxxxxxxx, 0162501101706, 0162501101606
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:	15. Nov. 2001
Name/Department:	W. Brandstätter / MOM-E

Fig.1.8 Conformity as per the EC low voltages guideline

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1.7.2 Regulations and standards

Standards concerning recommended installation, operation, maintenance, repair, and adjustment of the Twin Line drive system	EN 60204 - Part 1: 1999: Electrical equipment of machines, General requirements
	NFPA 70: 1999: National Electrical Code
	NEMA ICS1.1: Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control
	NFPA 79: 1997: Electrical Standard for Industrial Machinery
	EN60529: 2001: Degrees of protection provided by enclosures (IP Code)
	EN61508-1: 1998: Functional safety of electrical / electronic / programmable electronic safety-related systems, Part 1: General design principles
	IEC 61131-3, Programmable controllers—Programming languages
	NFPA 70E: 2000: Standard for Electrical Safety Requirements for Employee Workplaces
	NEMA ICS7.1 Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems
Standards regarding compliance with EMC Directive	EN 61000-4-1: 2000: Testing and measurement techniques–Overview of IEC61000-4 series (noise immunity testing procedures)
	EN 50082-2: 1995: Electromagnetic Compatibility–Generic immunity standard–Industrial environment
	EN61800-3: 1996: Adjustable speed electrical power drive systems–EMC product standard including specific test methods
	EN61000-4-5: 2001: Electromagnetic compatibility (EMC)–Testing and measurement techniques–Surge immunity test
Standards regarding compliance with Low Voltage Directive	EN50178: 1997: Electronic Equipment for use in Power Installations
	EN60664-1: 2000: Insulation coordination for equipment within low-voltage systems–Principles, requirements, and tests
Standards regarding compliance with Underwriters Laboratories requirements	UL508C 2nd Edition: UL Standard for Safety for Power Conversion Equipment
	UL840 2nd Edition: UL Standard for Insulation Coordination Including Clearances and Creepage Distances for Equipment
	UL1004 5th Edition: UL Standard for Safety for Electric Motors

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2 Safety

2.1 Hazard categories

Safety notes and general information are indicated by hazard messages in the manual. In addition there are symbols and instructions affixed to the Twin Line controller that warn of possible hazards and help to operate the controller safely.

Depending on the seriousness of the hazard, the messages are divided into three hazard categories. The symbols shown emphasize the degree of hazard present.

DANGER

⚠ DANGER

DANGER indicates an imminently hazardous situation which, if not avoided, **will result** in death or serious injury.

WARNING

⚠ WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, **can result** in death or serious injury.

CAUTION

⚠ CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, **can result** in minor or moderate injury.

CAUTION

CAUTION, used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, **can result** in property damage.

The signal word is followed by a statement of the hazard (for example, electric shock) and may be accompanied by a pictogram depicting the hazard or additional descriptive information concerning the hazard.

Following the statement of hazard is information on how to avoid or mitigate the hazard.

The last portion of the hazard message states the consequences of failure to follow the information contained in the hazard message.

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2.2 Safety instructions

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- Read and understand this bulletin in its entirety before installing or operating Twin Line drive system products. Installation, adjustment, repair, and maintenance of these drive systems must be performed by qualified personnel.
- Disconnect all power before servicing the power controller. WAIT SIX MINUTES until DC bus capacitors discharge, then measure DC bus capacitor voltage between the DC+ and DC- terminals to verify that the DC voltage is less than 45 V. The DC bus LED is not an accurate indication of the absence of DC bus voltage.
- The motor can produce voltage at its terminals when the shaft is rotated! Prior to servicing the power controller, block the motor shaft to prevent rotation.
- DO NOT short across DC bus terminals or touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers and close enclosure door before applying power or starting and stopping the drive system.
- The user is responsible for conforming to all applicable code requirements with respect to grounding all equipment.
- Many parts in this drive system, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools.

Before servicing drive system:

- Disconnect all power.
- Place a “DO NOT TURN ON” label on the drive system disconnect.
- Lock the disconnect in open position.

Failure to follow these instructions can result in death, serious injury or equipment damage.

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⚠WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of the control signal paths and, for certain critical control functions, provide a means to achieve a safe state during and after a signal path failure. Examples of critical control functions are Emergency Stop and Overtravel Stop. Refer to NEMA ICS1.1 *Safety Guidelines for the Application, Installation and Maintenance of Solid State Control* and NEMA ICS7.1 *Safety Standards for construction and Guide for Selection, Installation and Operation of Adjustable –Speed Drive Systems* for further information
- Separate or redundant control paths must be provided for critical control functions.
- System control signal paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failure of the link.

Failure to follow these instructions can result in death, serious injury or equipment damage.

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2.3 Use for the purpose intended

2.3.1 Ambient conditions

Ambient temperature	0 °C to +50 °C
Transportation and storage temperature	-40 °C to +70 °C
Relative humidity	15 % to 85% (no condensation permissible)
Operating altitude, No derating required for h <1000 m above m.s.l	
Vibration stress during operation to IEC 68-2-6	
Number of cycles:	10
Frequency range:	10Hz to 500Hz
Acceleration:	20m/s^2
Continuous shocks to IEC 68-2-29	
Number of shocks:	1000/direction (X,Y,Z for each clockwise, Counter-clockwise direction, total 6000)
Peak acceleration:	150m/s^2
Protection type	IP20

2.3.2 Intended use

The drive is an electrical device for actuating and controlling a variable-speed drive with a permanent-field synchronous servomotor (AC servomotor).

The drive is intended for use only with the synchronous servomotors approved by Schneider Electric for use with Twin Line controllers. Contact your local Schneider Electric representative for information on product compatibility. The motor connections of multiple drives should not be connected to each other. The drive may be used for industrial applications in the system configuration described.

The drive must be installed and operated in an environment which meets Pollution Degree 2. The controller is an open device that must be installed in a control cabinet that maintains a Pollution Degree 2 environment in its interior.

The drive may only be set up and operated after correct EMC installation has taken place. It may only be used with the cables and accessories specified in this manual.

The drive may not be powered from an ungrounded power system (IT Network). The internal interference suppression filters require a grounded power system for proper operation.

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2.3.3 Suitability in safety critical applications

Twin Line products are designed for general-purpose motion control. These products are intended for integration into machine control systems where the machine safety considerations have been addressed by the system design. Examples of such methods include, but are not limited to, apparatus selection, system configuration, guarding or by warning.

Unless stated in the product specifications, **the Twin Line product has not been evaluated for control of safety critical machine functions. Direct application of this apparatus to a safety critical function can create a hazard to personnel and property.** Prior to considering this equipment for operation of safety critical control functions, engineering evaluation for suitability is required.

Should questions arise concerning the suitability of this apparatus for a specific application, contact Schneider Electric.

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2.4 Qualification of the personnel

Work on and with the drive may only be carried out by qualified personnel.

Qualified personnel can use their technical training, knowledge and experience to assess the work to be done and to recognize and avoid possible hazards.

Qualified personnel will be aware of the current standards, regulations and accident prevention regulations which must be observed when working on the drive system.

2.5 Safety devices

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

Safety devices coupled with the unit protect the system and operating personnel.

Savety devices	Tasks and protective functions
Limit switch signals	Monitoring the permissible ranges of movement in order to protect personnel and the system
Stop switch signal	Stops the drive system using the stopping parameters set for Quick Stop. Once at standstill, the position control loop holds the motor shaft stationary

⚠WARNING

LOSS OF BRAKING TORQUE

- No holding torque is available during loss of power or drive controller fault.
- When required (i.e., for protection of personnel), use a separate braking function for holding torque. Refer to NEMA ICS7.1 *Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable - Speed Drive Systems* for additional information.
- Availability of sufficient braking torque for rapid stopping requires that the controller be properly adjusted and, if required, fitted with a properly dimensioned ballast resistor. Refer to the appropriate sections of this instruction manual for setting the Quick Stop function and the dimensioning of ballast resistors.

Failure to follow these instructions can result in death, serious injury or equipment damage.

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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
Phase failure	Monitor motor connections; error message if motor not connected
Overvoltage and undervoltage	Monitor DC-Bus for overvoltage and undervoltage, functional safety and device protection
Temperature	Monitor motor and power amplifier with sensors for excess temperature, functional safety and device protection
Overheating	I^2t monitoring of motor, internal ballast resistor and power amplifier for temperature rises in the threshold range during motor operation and standstill, functional safety and device protection
Positioning error	Contouring error threshold for excess positional deviation, functional safety
Motor speed	Speed threshold for maximum permitted speed, functional safety and device protection
Data connection with an operating unit	Functionality of connection when motor controlled via operating unit, functional safety

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3 Technical data

3.1 Mechanical data

3.1.1 Drive system TLD13x

Weight	TLD132 with 4 modules	2.7 kg (6.0 lb.)
	TLD134 with 4 modules	3.7 kg (8.2 lb.)
	TLD136 with 4 modules	6.6 kg (14.6 lb.)
	TLD138 with 4 modules	10.8 kg (23.9 lb.)
Enclosure rating	Enclosure Type Rating (IP)	Open (IP20)

Dimensions

	TLD132		TLD134		TLD136		TLD138	
	mm	in.	mm	in.	mm	in.	mm	in.
Width A	108.0	4.3	128.0	5.1	178.0	7.1	248.0	9.9
Height B	212.5	8.5	212.5	8.5	260.0	10.4	260.0	10.4
Depth C	184.5	7.4	214.5	8.6	244.5	9.8	244.5	9.8
Front width D	105.5	4.2	125.5	5.0	176.0	7.0	246.0	9.8
Connection dimension E	53.0	2.1	83.0	3.3	130.0	5.2	200.0	8.0
Additional dimension F	-	-	-	-	-	-	120.0	4.8

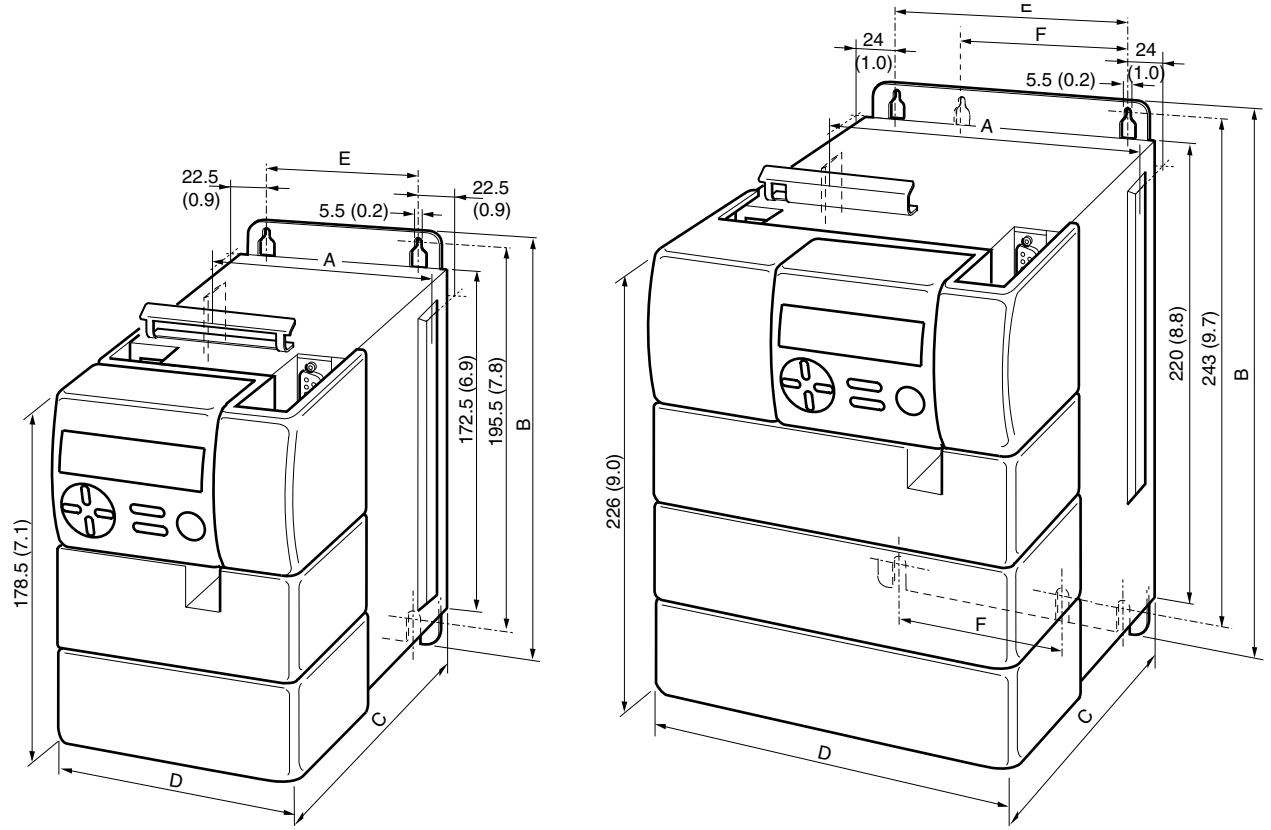

Fig.3.1 Dimensions TLD132, TLD134, TLD136 and TLD138. The Twin Line HMI shown in the drawing is an option.

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3.1.2 Accessories

Holding brake controller TLHBC	Dimensions (H x W x D)	107 x 104 x 76 mm (4.3 x 4.2 x 3.0 in.)
	Installation on DIN rail	55 mm (2.2 in.)
Ballast resistor controller TLBRC	Dimensions (H x W x D)	107 x 104 x 76 mm (4.3 x 4.2 x 3.0 in.)
	Number of DC bus connections	2
	Installation on DIN rail	55 mm (2.2 in.)

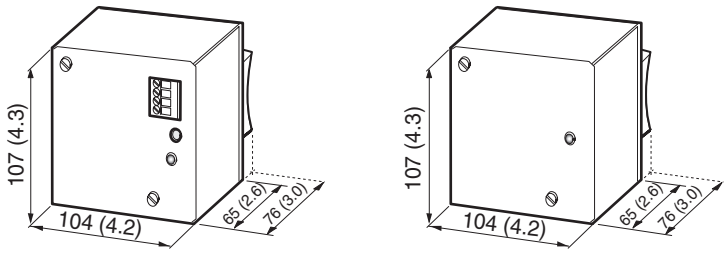

Fig. 3.2 Holding brake controller (left) and ballast resistor controller (right)

Ballast resistors BWG 250xxx and BWG 500xxx

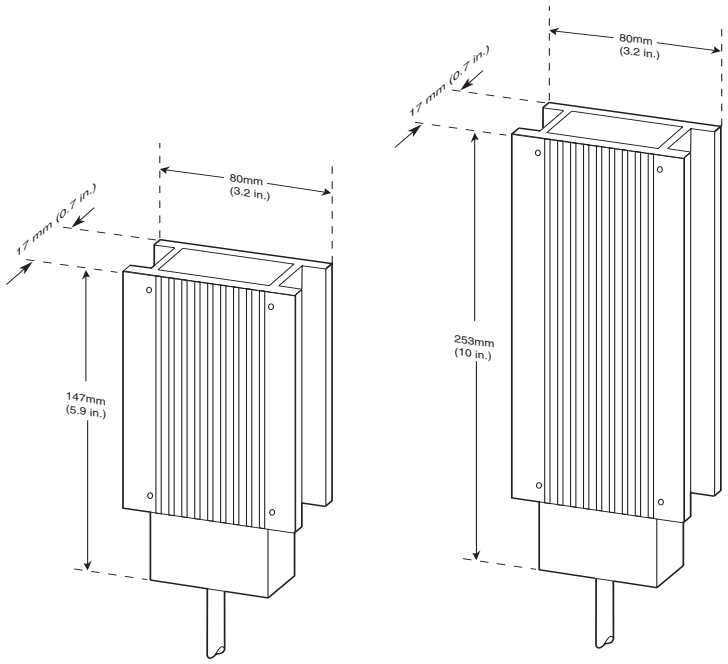

Fig. 3.3 Size and mounting dimensions of the ballast resistor in the versions with 100 W and 200 W continuous power

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3.2 Electronic data

3.2.1 Drive system

Mains connection

	TLD132	TLD134	TLD136	TLD138
Mains voltage [Vac] [1]	230	230	230	230
(-20%, +10%)	240	230/400	230/400	230/400
	—	277/480	277/480	277/480
Input phases	1	3	3	3
Mains frequency [Hz]	47 - 63	47 - 63	47 - 63	47 - 63
Current consumption [A] [2]	6.5	4	7.5	20
Starting current [A]	< 60	< 60	< 60	< 60
Power factor [cosφ]	> 0.55	> 0.6	> 0.6	> 0.6
Power loss [W] [3]	min. 20 / max. 150	min. 20 / max. 140	min. 20 / max. 380	min. 40 / max. 430
Mains buffering [ms]	< 5	< 3	< 3	< 3
Operational overvoltage (EN 61800-3 and EN61000-4-5)	between phases: 1 kV, phases to earth 2 kV			
Input mains overvoltage category (UL840)	category III [4]			
Leakage current [mA] [5]	< 30	< 30	< 30	< 30
Fuse, external [A]	10 (Class CC)	10 (Class CC)	10 (Class CC)	25 (Class CC)

1) Suitable for use on grounded systems only. Maximum voltage to ground should not exceed 300 Vac. Maximum available short-circuit current must not exceed 5000 A.
2) A mains reactor is required if, over any 2 minute period, the motor average power flow to the load is greater than 50% of the motor controller's power class. See page 3-7 for recommended reactors. Maximum available short-circuit current must not exceed 5000 A.
3) The power loss depends on several factors: motor speed, motor current, length of cable, torque and use of the internal ballast resistor.
4) The Twin Line family of products has been designed according to standard UL840. Installation of a surge arrester on the branch circuit supplying power to the Twin Line drive is recommended. Use Schneider Electric SDSA3650 surge arrester or equivalent.
5) Leakage currents are measured with an RC circuit in accordance with IEC60990. The value can be higher if measured directly. Advice on using earth leakage circuit breakers on request.

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Motor connection

		TLD132	TLD134	TLD136	TLD138
Power class [1) 2) 3)][kW] at	230 V	0.75	0.75	1.5	4
	400 V	–	1.5	3	8
	480 V	–	1.5	3	8
Switching frequency [kHz] switch-selectable to [kHz]		8 / 16	8 / 16	8 / 16	4 / 8
Rated current [A r.m.s.], r.m.s. [4)]		3	3	6	16
Rated current [Apk], amplitude		4.24	4.24	8.48	22.63
Rated current [Apk], maximum value at lower switching frequency during motor movement		8.48	8.48	28.28	45.26
Rated current [Apk], maximum value at higher switching frequency during motor movement		8.48	5.66	18.85	38.18
Maximum speed [r.p.m.] [5)]		6000	6000	6000	6000
Cable length [6)] [m]		20	20	20	20

1) Max. shaft output with typical motor, for rated current and at 230 Vac or 400 Vac mains voltage
2) A mains reactor is required if, over any 2 minute period, the motor average power flow to the load is greater than 50% of the motor controller's power class. See page 3-7 for recommended reactors.
3) Refer to section 3.2.3 for UL certification power class deratings.
4) Continuous operation at maximum surrounding air/ambient temperature
5) When used with a 8-pole (4-pole pair) motor.
6) Longer lengths on request

Internal load circuit

	TLD132	TLD134	TLD136	TLD138
Continuous rating P_{AV} [W]	30	50	200	80
Max. energy per braking W_{PEAK} [Ws]	50	80	100	130

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24 Vdc supply

24 Vdc (+) to 0 Vdc (-) [Controller Terminals S31–32(+) to S33–34(-)]	
Function:	Power amplifier internal power demand
Supply isolation requirements:	PELV System (per EN50178)
Input protection	Protected against reverse-polarity
Voltage range:	20 V to 30 V
Allowable voltage ripple:	<2 V_{SS}
Grounding of power supply output	The power supply negative output conductor must be bonded to ground.
Power amplifier input current:	<2.5 A
Current rating of terminals and internal interconnecting jumper	8 A
IO24 Vdc (+) to 0 Vdc (-) [Controller Terminals S07–08(+) to S33–34(-)]	
Function:	Signal interface power demand
Supply isolation requirements:	PELV System (per EN50178)
Input protection	Protected against reverse-polarity
Voltage range:	20 V to 30 V
Allowable voltage ripple:	<2 V_{SS}
Grounding of power supply output	The power supply negative output conductor must be bonded to ground.
Input current:	<2.5 A maximum (all digital outputs sourcing 400 mA)
Current rating of terminals and internal interconnecting jumper	8 A

DC bus connection

A maximum of two drives can be interconnected. Only drives with the same power class can be connected together.

Signal interface

Digital signal inputs	Reverse-polarity-protected No electrical isolation Debounced, debounce interval 0.7 to 1.5 ms
DC-voltage U_{high}	12 V to 30 V (I ≥ 3 mA)
DC-voltage U_{low}	≤ 5 V (I ≤ 0,5 mA)
Current at 24 V	≤ 7 mA
Digital signal outputs	Inductive loadability (150 mH / 11 W) Short-circuit protected
DC-voltage	≤ 30 V
Switching current	≤ 400 mA
Voltage drop at 400 mA	≤ 1 V
Analog signal input	
Voltage range	+10 V to -10 V
Input resistance	5 kΩ

UL 508C certification

Twin Line apparatus that has undergone UL508C certification is listed in the section entitled ‘UL 508C certification’ on page 3-7.

3.2.2 Modules

Note: Detailed data on individual modules can be found in the chapter entitled ‘Electrical installation’ on page 4-11.

HIFA-C Hiperface module

Encoder supply voltage	+10 V / 150 mA Short-circuit and overload-protected Not protected against connection to an external power supply
Signal inputs	
Sine / cosine (SIN, COS)	1 V_{SS} with 2.5 V offset 0.5 Vss at 100 kHz
Input resistance	2 x1 kΩ to 0 Vdc
Monitoring of motor temperature (T_MOT)	1 V - 4.8 V
Typ. Values: 0 / 25 / 100 / 140°C	4.8 / 4.34/ 1.32/ 0.53 V
Short circuit or overload	< 0.1 V
Cable break, no sensor	> 4.9 V
RS-485	asynchronous, half-duplex

RS-422-C encoder module

Signal inputs (A, B, I)	RS-422 compatible Connected electrically to 0 Vdc
Input frequency	≤ 400 kHz 1 600 000 Inc/s
Output	
Encoder supply with sense active	5 V ± 5%, max. 300 mA +Sense and -Sense for cable length compensation Short-circuit and overload-proof

PULSE-C pulse direction module

Signal inputs	
Symmetrical	Compatible with RS-422-voltage
Asymmetrical	4.5 V to 30 V Connected electrically to 0 Vdc
Input resistance	5 kΩ
Input frequencies:	
Stepping frequency (PULSE/PV, DIR/PR)	≤ 200 kHz
Signal outputs	Open collector outputs Short-circuit-proof
Output voltage	≤ 30 V
Output current, maximum	≤ 50 mA

ESIM1-C encoder simulation module

Signal outputs (A, B, I)	RS-422- voltage-compatible connected electrically to 24VGND

ESIM2-C encoder simulation module

Signal outputs (A, B, I)	RS-422- voltage compatible connected electrically to 24VGND

Interface signals A, B, I are parallel at both receptacles

SSI-C Synchronous-serial interface module-C

Signal input (CLK)	RS-422- voltage-compatible 53 kHz to 2 Mhz electrically connected to 24VGND
Signal output (DATA)	Compatible with RS422 voltage Connected electrically to 24VGND

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3.2.3 UL 508C certification

The Twin Line Drive 13x is certified to UL 508C with the following ratings.

Mains connection

Unit	Mains voltage [V]	Mains frequency [Hz]	Current [A]	Phases
TLDX32	230	47-63	6	1
TLDX34	480	47-63	3.2	3
TLDX36	480	47-63	5.5	3
TLDX38	480	47-63	10	3

Motor data

Unit	Motor voltage [V]	Motor frequency [Hz]	Motor current [A]	Phases
TLDX32	0-230	0-400	3	3
TLDX34	0-480	0-400	3	3
TLDX36	0-480	0-400	6	3
TLDX38	0-480	0-400	16	3

Accessories

- Ballast resistor controller, TL BRC
- Holding brake controller, TL HBC

3.2.4 Accessories

TLHBC holding brake controller

Supply voltage, input 20 V to 30 V
Input current Input current = 0.5 A + brake current

Output, brake
DC-voltage (no voltage reduction) 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 1.5 A

DC-voltage (with voltage reduction active) 9.5 V to 15 V
Current at 12 V 0.5 A to 2 A

Electrical isolation between 24 V input, control input and brake output

TLBRC ballast resistor controller

Own power supply via DC bus connection
Switch-on threshold, selectable
for TLD132 drives 420 V
for TLD134, TLD136, and TLD138 controllers 760 V

Input line reactors

Controller	Reactor P/N [1), 2)]	Ratings
TLD132	RL01201	1.25 mH, 12 A, 600 V, 3-coil
TLD134	RL00803	5.00 mH, 8 A, 600 V, 3-coil
TLD136	RL01202	2.50 mH, 12 A, 600 V, 3-coil
TLD138	RL02502	1.20 mH, 25 A, 600 V, 3-coil

1) Reactors are available from MTE Corporation, Menomonee Falls, WI. Refer to the MTE website, www.mtecorp.com, for additional ratings and outline dimensions.

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2) Reactors are open construction. Type 1 enclosed reactors are available. Change the next to last digit of the part number from 0 to 1 to include a Type 1 enclosure.

TLACPAAxxxx1 motor cable

Motor cables are available from Schneider Electric with the cross-sections indicated. These cables are available in different lengths. Refer to section 10 of this manual for complete cable part numbers. The specifications of the Schneider Electric motor cable are as follows.

Rated voltage:	600 Vac UL and CSA
Construction:	
TLACPAAAxxx1	4x16 AWG/1.5 mm^2 + 2x17 AWG/1.0 mm^2
TLACPAABxxx1	4x14 AWG/2.5 mm^2 + 2x17 AWG/1.0 mm^2
TLACPAACxxx1	4x12 AWG/4.0 mm^2 + 2x17 AWG/1.0 mm^2
Shield	Braided with 90% coverage
Jacket:	Oil-resistant PUR
Flex Cycles:	Minimum of 1 million cycles/moderate flexing
Temperature rating:	-40 °C to +85 °C (static) -5 °C to +85 °C (flexing)
Minimum bend radius	10 x diameter (static) 10 x diameter (flexing)
Cable diameters:	
TLACPAAAxxx1	0.45 inches (11.3 mm)
TLACPAABxxx1	0.55 inches (14.1 mm)
TLACPAACxxx1	0.61 inches (15.4 mm)

Encoder cable specification

Encoder cables of different lengths are available from Schneider Electric. Refer to section 10 of this manual for complete cable part numbers. The specifications of the Schneider Electric encoder cable are as follows:

Rated voltage:	300 Vac UL and CSA
Construction:	10x22 AWG/0.25 mm^2 + 2x20 AWG/0.5 mm^2 conductors grouped in 6 twisted pair
Shield	Braided with 90% coverage
Jacket:	Oil-resistant PUR
Flex Cycles:	Minimum of 1 million cycles/moderate flexing
Temperature rating:	-40 °C to +85 °C (static) -5 °C to +85 °C (flexing)
Minimum bend radius	10 x diameter (static) 10 x diameter (flexing)
Cable diameters:	0.35 inches (8.8 mm)

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4 Installation

4.1 Electromagnetic compatibility (EMC) and equipment grounding requirements

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

The drive 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 are taken during installation.

⚠WARNING

UNINTENDED EQUIPMENT ACTION

Follow the EMC mitigation methods and procedures shown in the instruction manual to prevent unintended operation or actions by the drive and auxiliary equipment as well as to minimize compliance issues with the EMC directive.

- Always use shielded cable for the motor, control, 24 Vdc, and communications connections to the power amplifier and auxiliary equipment.
- Use the shielded cable assemblies recommended by Schneider Electric.
- Install the shielded cable and terminate the shields as indicated in this section of the instruction manual.
- Use a metallic enclosure and metal mounting plates for the power amplifier and auxiliary equipment.
- Ground and bond the apparatus as described in this section.

Failure to follow these instructions can result in death, serious injury or equipment damage.

Motor leads and encoder cables are especially critical signal circuits. Use only the motor and encoder cables recommended by Schneider Electric. Schneider Electric motor and encoder cables have been tested for EMC stability. In addition, these cables can be used as trailing cables.Refer to “Accessories and spare parts“ on page 10-1 for information on cables available from Schneider Electric.

To ensure signal integrity, it is recommended that Schneider Electric communication and data cables be used. Refer to section10 on page 10-1 for information concerning Schneider Electric data and communication cables.

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Control cabinet setup

EMC measures	Effect
Use zinc 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
Bond the control cabinet, door, and mounting plate by means of metal braid or cables with a diameter greater than 8 AWG (10 mm^2).	Reduction of EMC emissions
Mount power components and control components separately, at a minimum distance 25 cm (9.75 in). Reduce interference injection from either component by using separate mounting panels with individual connection to star-point ground.	Reduction of common coupling path injection
Fit switching devices such as contactors, relays, or solenoids with interference suppressors or spark suppressors (e.g. diodes, varistors, RC elements).	Reduction of radiated and conducted emissions

Cabling

EMC measures	Effect
Keep cables as short as possible. Do not coil excess cable. Keep ground cables short and direct from star-point to outlying ground connection.	Avoidance of capacitive and inductive interference injection
When terminating cable shields, always use cable clamps that make contact with a large surface area around the entire periphery of the shield. For cables passing through the wall of the enclosure, terminate the shield to the closest grounded mounting plate inside the enclosure.	Reduction of EMC emissions
Lay the cables spatially separated from each other: - Signal cables and power cables [>8 in. (20 cm)] - Mains and motor cables [>8 in. (20 cm)] - Mains filter input and output cables	Reduction of mutual interference injection, reduction of emissions, increasing resistance to interference
When splicing cables, connect large surface areas of cable shields. Use cable sleeves and tapes for complete shield coverage of the conductors.	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 the digital signal cables at each end or via Sub-D housing	Avoidance of interference on control cables, reduction of emissions
Ground the shield of the analog signal lines at the power amplifier end only. At the other end, connect a capacitor from ground to the shield, e.g. 10nF/100 V metalized polyester MKT	Avoidance of ground current flow due to power-frequency ground voltage differences
Use only shielded motor cables with copper braiding and at least 85% covering. Ground a large surface area of the shield at each end. Only use motor and encoder cables recommended by Schneider Electric.	Management of interference currents, reduction of emissions
If the motor and machine are not conductively connected (for example use of non-metallic, insulated or irregular mounting surface), bond the motor to the machine with a bonding strap [>6 AWG (10 mm^2)].	Reduction of emissions, increase in resistance to interference

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EMC measures	Effect
Ground unused control circuit cable wires at both ends of the cable. Unused motor cables should be insulated at both ends.	Additional shielding effect for control wiring, guarding of stray voltage on unused motor conductors.
For 24 Vdc power supply connections longer than 6.5 feet (2 m), use twisted pair conductor for the 0 V and 24 Vdc supply wires.	Avoidance of noise injection on power supply cables.

Power supplies

EMC measures	Effect
The controller must be operated from a grounded-neutral mains power source. Do not operate the controller from corner-grounded, resistance-grounded, or ungrounded (IT) power sources.	Minimize presence of overvoltage from mains, maintain effectiveness of mains filter, and comply with validated EMC configuration.
The negative bus of the 24 Vdc power source feeding the controller must be bonded to ground.	Comply with validated EMC configuration.
Use twisted pair, shielded conductor for the 24 Vdc power supply connections of the TLD13x drives.	Reduce emissions and comply with validated EMC configuration.

⚠ DANGER

HAZARDOUS VOLTAGE - INADEQUATE GROUNDING

- The power amplifier and auxiliary equipment must be grounded before applying power. Refer to Fig. 4.1 and sections 4.4 and 4.5 of this manual for information concerning the proper grounding of Twin Line product.
- The cross-sections of the grounding conductors used to ground the individual power amplifiers and auxiliary equipment should comply with applicable codes.
- Do not use metallic conduits as a ground conductor. Use a conductor housed within the conduit as the ground conductor. The grounding conductor cross-section should comply with applicable installation codes.
- When cable shields are used as ground conductors, the shield must have a cross-section no smaller than the power conductors housed within the shield. If the shield does not have sufficient cross-section, then a separate power conductor housed within the shield and of sufficient cross-section must be used as the grounding conductor. The shield should be terminated to the grounding conductor at both ends of the shielded cable assembly.

Failure to follow this instruction can result in death, serious injury or equipment damage.

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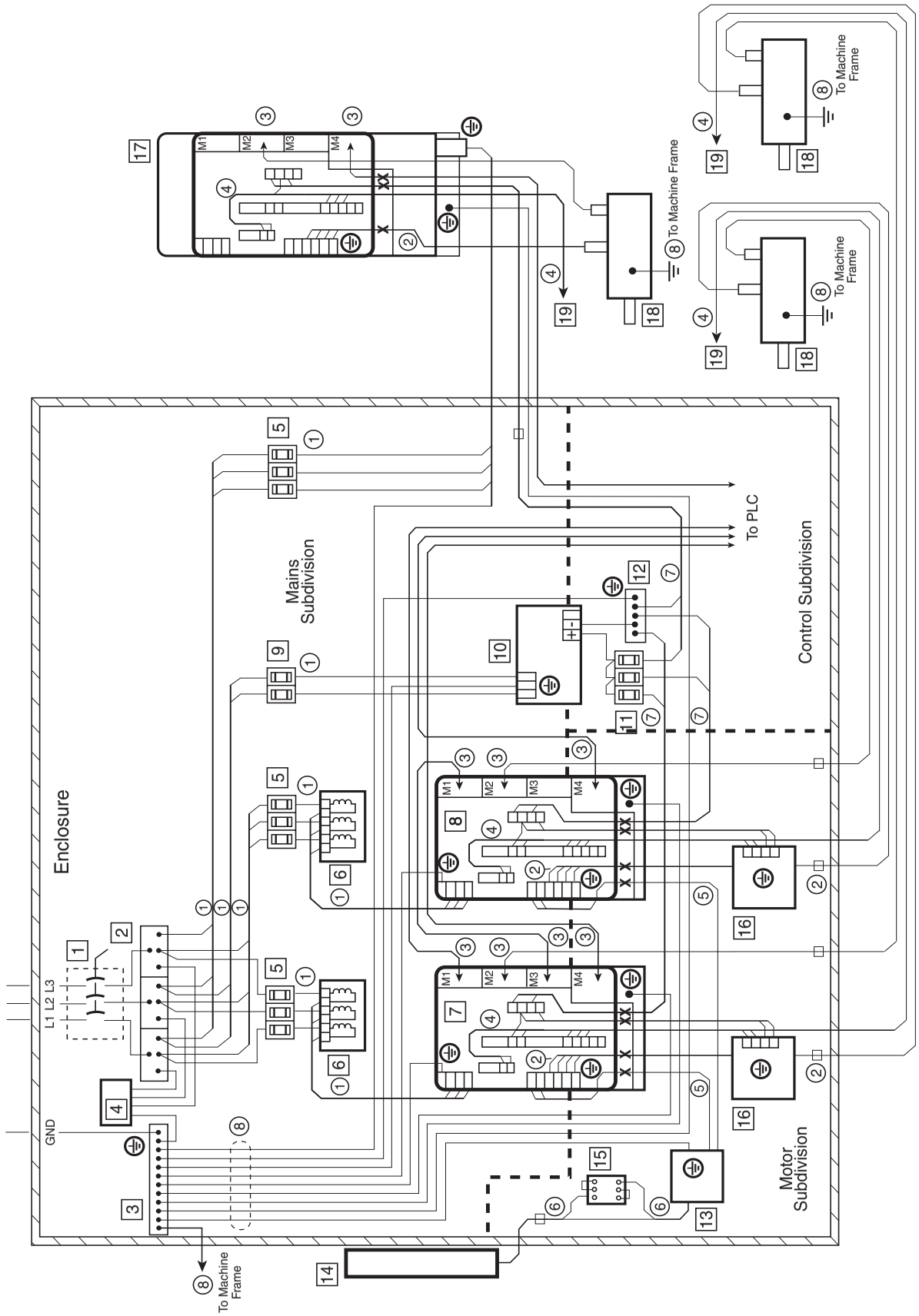

Fig. 4.1 Typical apparatus interconnection showing EMC measures and equipment grounding requirements

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Cable	Description
①	Individual conductor or multi-conductor power cable. Refer to section 4.4.1 and 4.4.2 for details.
②	Multi-conductor shielded motor cable. Refer to section 4.4.3, 4.4.4, and 4.5.1 for details.
③	Multi-conductor shielded communication/encoder cable. Refer to sections 4.4.9 through 4.4.14 for details.
④	Multi-conductor control cable. Refer to section 4.4.7 for details.
⑤	Multi-conductor shielded power cable. Refer to section 4.4.5 for details.
⑥	Multi-conductor shielded power cable. Refer to section 4.5.2 for details.
⑦	Multi-conductor twisted shielded control cable. Refer to section 4.4.6 for details. *NOTE: Shielded control cable is required on the TLD134 controllers. Use multi-conductor twisted control cable for all other controllers.*
⑧	Ground bonding conductors. Use a cross section no smaller than the mains input conductor of the associated component.

Component	Description
1	Disconnect means
2	Power distribution block
3	Power ground bar
4	Surge arrester (if required)
5	Controller input mains fuses
6	Controller input mains reactor
7	TLD134 controller (lead)
8	TLD134 controller (follow)
9	24 Vdc power supply input mains fuses
10	24 Vdc power supply
11	24 Vdc fuses
12	24 Vdc ground bar
13	TLBRC ballast resistor controller
14	Ballast resistor
15	GV2
16	TLHBC holding brake controller
17	TLD134 controller
18	Servomotor
19	Limit switches

Symbol	Description
⏚	Safety ground connection.
	Cable shield terminated at controller grounding bar
	Example of SK14 cable clamp on controller grounding bar ① Keep exposed cable ends short ② Flatten shielding when tightening
	Cable shield terminated to enclosure sheet metal at or near the exit point from enclosure
	Example of cable clamp used to connect cable shield to enclosure sheet metal

4.2 System components

Besides the components included in the scope of delivery, the following system components may also be required.

- Synchronous servomotor with SinCos
- Motor cable
- SinCos cable
- Signal cable to fit device version:
  ESIM1-C/ESIM2-C modules: encoder cable for ESIM1-C
  SSI-C module: serial data cable for SSI-C
  RS-422-C module: cable for RS-422-C
  PULSE-C module: cable for PULSE-C
- RS-232 cable with PC connecting plug
- Mains disconnect, fuses, cable, and surge arrester
- External 24 V power supply
- Ballast resistor and controller (as required)
- Reactor for mains connection depending on motor power requirements
- Brake controller (as required)
- Control cabinet
- NC control or PLC for automatic operation
- PC or laptop with WINDOWS® 95, 98 or NT for commissioning with commissioning software.

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4.3 Mechanical installation

⚠CAUTION

EQUIPMENT DAMAGE HAZARD

- Do not install or operate any equipment that appears damaged.
- Block debris (such as wire strands, metal turnings, or filings) from entering into the equipment during unpacking and installation. Do not operate equipment that may contain debris.
- If fastening hardware falls into the equipment, locate and remove the lost pieces before applying power.

Failure to follow this instruction can result in death, serious injury or equipment damage.

Before installation...

▶ Check the drive for outwardly visible damage such as dents in the housing or broken connection terminals. Do not install damaged drives or auxiliary equipment.

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4.3.1 Mounting the TLD13x drive

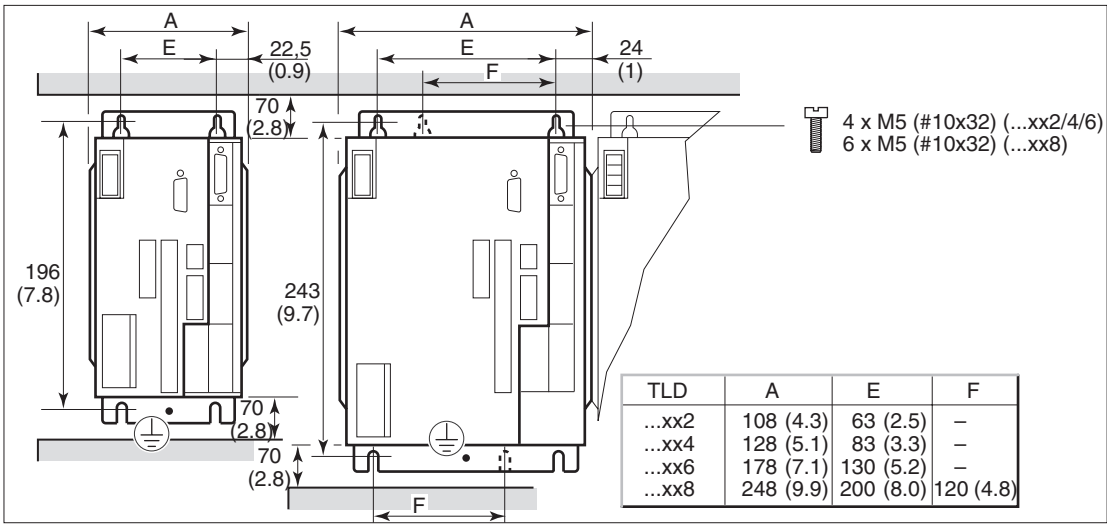
Control cabinet

The enclosure must be big enough to allow both drive and accessories, such as ballast resistor controller and holding brake controller, to be firmly mounted and installed in compliance with EMC requirements.

Operating heat from the controller and other components, as well as the heat produced by the ballast resistors, must be dissipated by means of the enclosure thermal management system.

Mounting distances

The drive is fitted with a built-in fan. Ventilation slots on and under the drive must be kept at least 70 mm (3 in.) away from neighboring drives or walls.



TLD	A	E	F
...xx2	108 (4.3)	63 (2.5)	–
...xx4	128 (5.1)	83 (3.3)	–
...xx6	178 (7.1)	130 (5.2)	–
...xx8	248 (9.9)	200 (8.0)	120 (4.8)

Fig. 4.2 Mounting distances, dimensions in mm (in.)

- ▶ Position the drive in the enclosure such that the heated air flow from other apparatus (for example, external ballast resistor) does not result in undesired heating of the drive or its cooling air.
- ▶ Mount the drive vertically with the mains connection at the top.
- ▶ Mount the drive on a galvanized or plated metal surface. The drive mounting feet must be in good contact with the mounting surface across their entire contact area.

Painted surfaces have an insulating effect. Before fixing the controller to a painted mounting surface, scratch off the paint over a wide surface area in the places where the drive is to be attached, This will ensure that the drive has a good electrical connection with the mounting surface.

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4.3.2 Fitting drive label

Fig. 11.1 on page 11-1 of this manual provides artwork that can be photocopied to make a drive label supplying information about the meaning of all operating states displayed on the 7-segment display and the signal interface assignments.

- ▶ Photocopy the artwork on page 11-1 of this manual.
- ▶ Attach the appropriate drive label on the right-hand inside sidewall of the hood.
- ▶ After the electrical installation has been completed, attach the drive hood. Lead the cables for connection to the mains and the cables for both upper signal connections out through the top of the hood. Lead the motor cable and other signal cables out through the bottom.

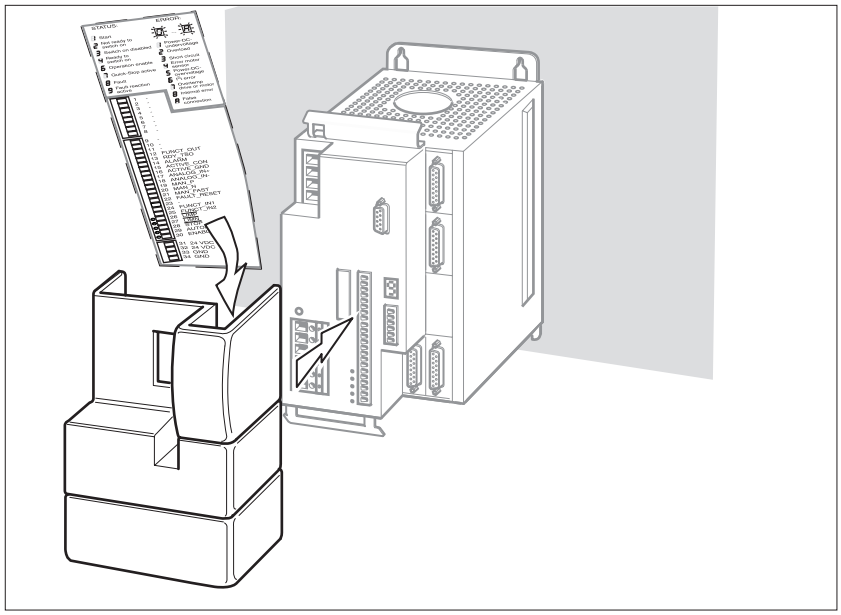

Fig.4.3 Attaching the drive label in the side of the hood

Hazard label for all drives

The controller and certain accessories are shipped with an English safety label applied to the front of the housing. An additional French language version of this label is supplied with the controller or accessory. Affix the label as required to the product housing.

4.3.3 Installing accessories on the drive

Mains filter The drive is supplied with a built-in mains filter as standard.

Mains reactor A mains reactor is required if, over any 2 minute period, the motor average power flow to the load is greater than 50% of the motor drive's power class. Both open construction and Type 1 enclosed reactors are available. See page 3-7 for recommended reactors and supplier. Refer to sections 4.4.1 and 4.4.2 for electrical installation requirements.

Brake controller Refer to section 4.5.1 for mechanical and electrical installation requirements.

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4.4 Electrical installation

⚠ DANGER

HAZARDOUS VOLTAGE

Before installing, adjusting, repairing or maintaining the Twin Line drive or its accessories:

- Read and understand the procedures in this section of the instruction manual.
- Read and understand section 2, *Safety*, of this instruction manual.
- Read and understand the grounding requirements found in section 4.1, *Electromagnetic compatibility, EMC,* of this instruction manual.
- Obey the safety-related work practices found in NFPA 70E, *Standard for Electrical Safety Requirements for Employee Workplaces*.

Installation, adjustment, repair, and maintenance of the Twin Line drive or its accessories must be performed by qualified personnel.

Failure to follow these instructions can result in death, serious injury or equipment damage.

⚠ WARNING

UNINTENDED EQUIPMENT ACTION / LOSS OF CONTROL

- Follow the EMC mitigation methods and procedures shown section 4.1 of this instruction manual to prevent unintended operation by the drive controller and auxiliary equipment.
- To maintain the ElectroMagnetic Compatibility (EMC) of the overall system, any electrical apparatus mounted adjacent to or interconnected with the Twin Line drive must not generate electrical emissions that interfere with the expected operation of the Twin Line drive nor be detrimentally affected by emissions from the Twin Line drive.
- The designer of any control scheme must consider the potential failure modes of the control signal paths and, for certain critical control functions, provide a means to achieve a safe state during and after a signal path failure. Examples of critical control functions are Emergency Stop and Overtravel Stop. Refer to NEMA ICS1.1 *Safety Guidelines for the Application, Installation and Maintenance of Solid State Control* and NEMA ICS7.1 *Safety Standards for construction and Guide for Selection, Installation and Operation of Adjustable –Speed Drive Systems* for further information.
- System control signal paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failure of the link.

Failure to follow these instructions can result in death, serious injury or equipment damage.

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4.4.1 Mains connection for single-phase controllers

⚠WARNING

OVERCURRENT PROTECTIVE DEVICES MUST BE PROPERLY COORDINATED

- To achieve published fault withstand current ratings, install the specified fuses listed in section 3.2.1 of this instruction manual.
- Do not connect the drive to a power feeder whose short circuit capacity exceeds the short circuit rating listed in section 3.2.1 of this instruction manual!

Failure to follow these instructions can result in death, serious injury or equipment damage.

CAUTION

EQUIPMENT DAMAGE HAZARD

Drives with single-phase inputs must be connected to the same mains phases if the drive DC busses are paralleled. For systems where the drive power inputs are connected to neutral, the interconnection of the DC busses of two drives connected to different phases will result in overvoltage that can destroy the drives.

Failure to follow these instructions can result in death, serious injury or equipment damage.

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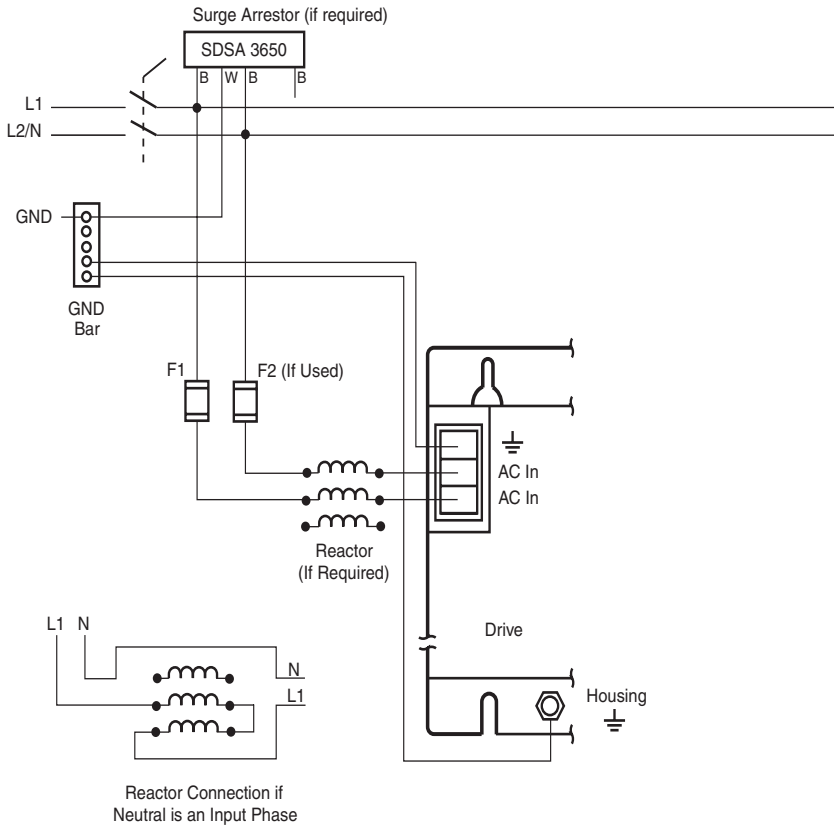

Fig. 4.4 Mains connection for single-phase drives

All controllers

▶ Connect the drive as shown in Fig. 4.4. A disconnecting means must be installed on the branch circuit feeding the drive. **Use of a surge arrester is recommended! Refer to section 3.2.1 for a recommended arrester.**

- Ground the drive as shown. Due to the magnitude of the leakage current, compliance with EN50178 requires the presence of an additional grounding connection. The additional grounding connection should connect the controller housing to the enclosure grounding bar as shown in Fig. 4.4.
- Install fuses as shown in Fig. 4.4. Refer to section 3.2.1 for required fuses. If the power system neutral is an input phase to the controller, do not install a fuse in the neutral conductor.
- When a reactor is required, use the reactors specified in section 3.2.4. The specified reactor is a three-phase design. One coil is left unconnected. If the power system neutral is an input phase to the controller, connect two reactor coils in series with the L1 phase as shown in Fig. 4.4. Do not connect a reactor coil in the neutral conductor.
- For drives with a hood, the input conductors must be routed upwards from the point of connection.
- Drive power terminals must be used with conductor cross-sections based on 60 °C or 75 °C insulated copper conductors.

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The controller mains terminals are compatible with 16 to 14 AWG (1.5 to 2.5 mm^2) solid or stranded copper conductor. Torque the terminal screws to 4.5–5.6 lb-in (0.4–0.5 N•m). The input mains terminals do not require wire end ferrules.

Wire end ferrules

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

- When connecting TLD132 drives using 14 AWG (2.5 mm^2) wires, do not use end ferrules with a plastic collar.
- Use only square end ferrules to ensure that they cannot work loose after the screws are tightened.
- Strip the insulation from the cable to a length of 0.4 in. (10 mm).

Earth leakage circuit breaker

If a fault occurs, fault currents with a DC component may arise. Use an earth leakage circuit breaker capable of detecting fault currents with a pulsating DC component as required by the installation.

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4.4.2 Mains connection for three-phase controllers

⚠WARNING

OVERCURRENT PROTECTIVE DEVICES MUST BE PROPERLY COORDINATED

- To achieve published fault withstand current ratings, install the fuses specified in section 3.2.1 of this instruction manual.
- Do not connect the drive to a power feeder whose short circuit capacity exceeds the short circuit rating listed in section 3.2.1 of this instruction manual.

Failure to follow these instructions can result in death, serious injury or equipment damage.

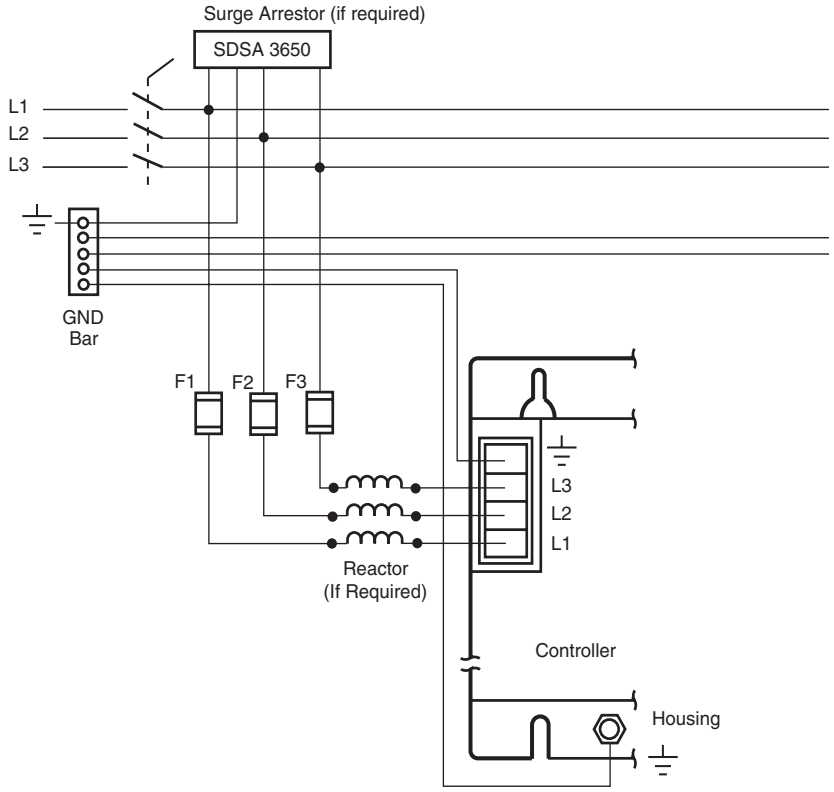

Fig. 4.5 Mains connection for three-phase controllers

All drives

▶ Connect the drive as shown in Fig. 4.5. A disconnecting means must be installed on the branch circuit feeding the controller. **Use of a surge arrester is recommended! Refer to section 3.2.1 for a recommended arrester.**

- Ground the drive as shown. Due to the magnitude of the leakage current, compliance with EN50178 requires the presence of an additional grounding connection. The additional grounding connection should connect the drive housing to the enclosure grounding bar as shown in Fig. 4.5.
- Install fuses as shown in Fig. 4.5. Refer to section 3.2.1 for required fuses.

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- When a reactor is required, use the reactors specified in section 3.2.4.
- For drives with a hood, the cable must be routed upwards from the point of connection.
- Three-phase drives are not suitable for operation from single-phase power.
- Drive power terminals must be used with conductor cross-sections based on 60 °C or 75 °C insulated copper conductors.

▶ The mains terminals are suitable for use with solid or stranded copper conductor cross-sections as shown in the following table. Torque the terminal screws to 4.5–5.6 lb-in (0.4 - 0.5 N•m). The input mains terminals do not require wire end ferrules.

Mains connection	TLD134	TLD136	TLD138
Conductor cross-section [mm^2]	1.5–4	1.5–4	2.5–4
Conductor cross-section [AWG]	16–12	16–12	14–12

Wire end ferrules

If you are using wire end ferrules, note the following:

- Use only square end ferrules to ensure that they cannot work loose after the screws are tightened.
- Strip the insulation from the cable to a length of 0.6 in. (15 mm).

Earth leakage circuit breaker

If a fault occurs, fault currents with a DC component may arise. Use an earth leakage circuit breaker capable of detecting fault currents with a pulsating DC component as required by the installation.

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4.4.3 Motor connection TLD13x

⚠ DANGER

HAZARDOUS VOLTAGE – SERVOMOTOR-GENERATED AND COUPLED VOLTAGE

- The servomotor can produce voltage at its terminals when the shaft is rotated! Prior to installation or servicing, block the servomotor shaft to prevent rotation.
- DO NOT contact the motor terminals or circuits connected to the motor terminals when the motor shaft is turned!
- AC voltage from the drive or servomotor can couple voltage to unused conductors in the motor cable. Insulate both ends of unused conductors in the motor cable.

Failure to follow these instructions can result in death, serious injury or equipment damage.

⚠ DANGER

HAZARDOUS VOLTAGE – INADEQUATE GROUNDING

When cable shields are used as ground conductors, the shield must have a cross section no smaller than the power conductors housed within the shield. If the shield does not have a sufficient cross section, then a separate power conductor housed within the shield and of sufficient cross section must be used as the grounding conductor. The shield should be terminated to the grounding conductor at both ends of the shielded cable assembly.

Failure to follow this instruction can result in death, serious injury or equipment damage.

Connecting motor cable

▶ Use factory-assembled cables from Schneider Electric. Refer to section 10 for available cables.

▶ Connect motor wires and protective ground to terminals U, V, W, and Ground. Assignment of wires must be the same at the motor as at the controller or the feedback signal sense will be incorrect.

- Controller power terminals must be used with conductor cross-sections based on 60 °C or 75 °C insulated copper conductors.

Terminal	Connection	Color (number)
U	Motor wire	Black (1)
V	Motor wire	Black (2)
W	Motor wire	Black (3)
⏚	Ground wire	GRN/YEL
Shield clamp	Shield	–

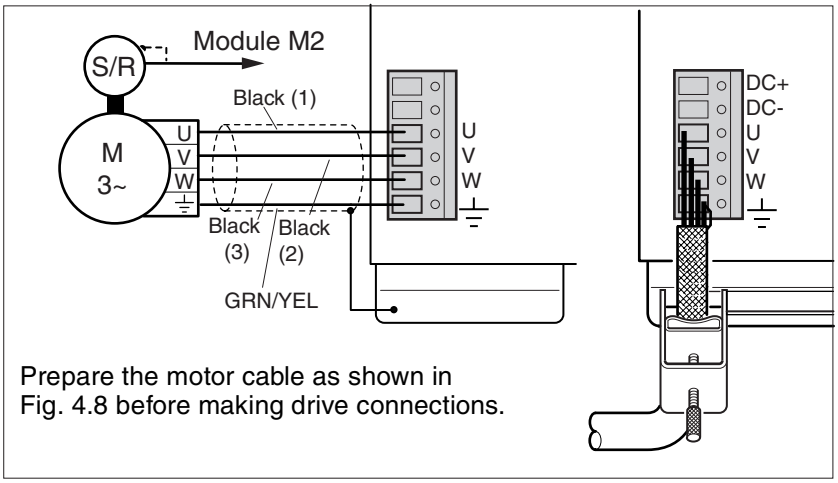

Fig. 4.6 Connecting the motor cable to the drive

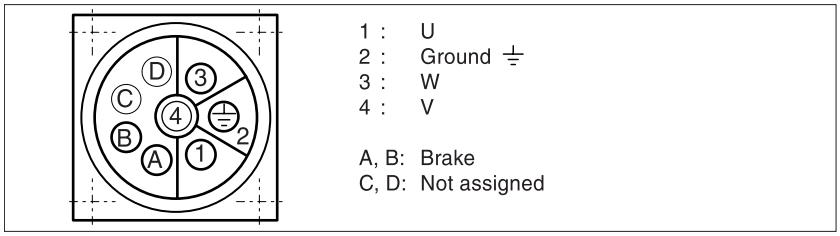

Fig. 4.7 Connection of the motor cable to a SER or RIG motor (connector on motor viewed from plug side). For general arrangement of connector pinout for non-SER and non-RIG motors, contact motor manufacturer.

	TLD132	TLD134	TLD136	TLD138
Conductor cross section AWG (mm^2)	16 (1.5)	16–14 (1.5–2.5)	16–14 (1.5–2.5)	12 (4)
Max. cable length [1] ft (m)	66 (20)	66 (20)	66 (20)	66 (20)
Tightening torque for terminal screws (DC+, DC-, U, V, W, Ground) lb-in (N•m)	4.5–5.6 (0.4–0.5)	5.6–6.8 (0.5–0.6)	5.6–6.8 (0.5–0.6)	5.6–6.8 (0.5–0.6)

1) Longer cable lengths on requests

- The motor terminals of the drive do not require wire end ferrules.
- For drives with a hood, the cable must be routed upwards from the point of connection.

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Preparing the motor cable Refer to the dimensions in Fig. 4.8 when preparing the motor cable.

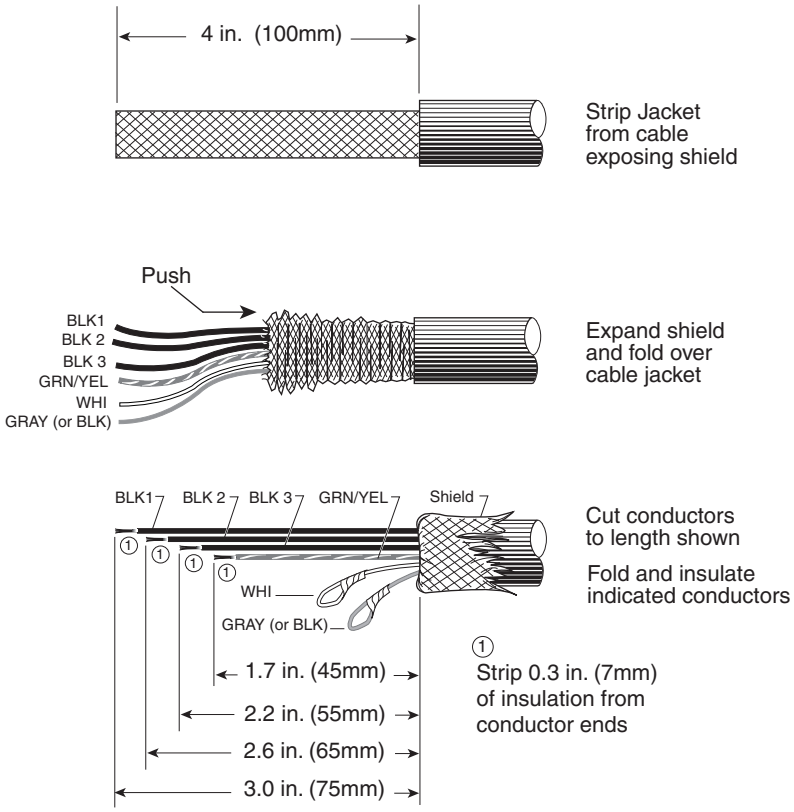

Fig. 4.8 Preparing the motor cable termination–drive end

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

- Use only square end ferrules to ensure that they cannot work loose after screws are tightened.
- When connecting TLD132 controllers using 14 AWG (2.5 mm^2) wires, do not use end ferrules with a plastic collar.
- The wire must fill the wire end ferrule over its whole length to ensure 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, to the drive housing, and to the enclosure entry point with a large surface area connection. Connect the shield braid to the drive housing using the shield clamp provided. Refer to Fig. 4.6 for shield clamp installation.
- The motor cable and signal cables must be laid at a distance of at least 8 in. (20 cm) from each other. If the distance is less than this, the motor cable and signal cables must be separated by grounded screening plates.

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4.4.4 Motor connection with holding brake to TLD13x drive

⚠DANGER

HAZARDOUS VOLTAGE – SERVOMOTOR-GENERATED AND COUPLED VOLTAGE

- The servomotor can produce voltage at its terminals when the shaft is rotated! Prior to installation or servicing, block the servomotor shaft to prevent rotation.
- DO NOT contact the motor terminals or circuits connected to the motor terminals when the motor shaft is turned!
- AC voltage from the controller or servomotor can couple voltage to unused conductors in the motor cable. Insulate both ends of unused conductors in the motor cable.

Failure to follow these instructions can result in death, serious injury or equipment damage.

⚠DANGER

HAZARDOUS VOLTAGE – INADEQUATE GROUNDING

When cable shields are used as ground conductors, the shield must have a cross section no smaller than the power conductors housed within the shield. If the shield does not have a sufficient cross section, then a separate power conductor housed within the shield and of sufficient cross section must be used as the grounding conductor. The shield should be terminated to the grounding conductor at both ends of the shielded cable assembly.

Failure to follow this instruction can result in death, serious injury or equipment damage.

The brake of motors with a holding brake is controlled via the holding brake control module. Refer to section 7.3 on page 7-8 for more information on the functioning of the module.

Refer to section 4.4.3 and Fig. 4.7 for motor cable selection and motor connector terminal assignments.

Connecting the motor cable

▶ Use factory-assembled cables from Schneider Electric. Refer to section 10 for available cables.

▶ Connect the motor wires and protective ground to terminals U, V, W, and Ground. The assignment of wires must be the same at the motor as at the drive or the feedback signal will be incorrect.

- Controller power terminals must be used with conductor cross-sections based on 60 °C or 75 °C insulated copper conductors.

For information on the use of wire end ferrules or motor conductor EMC measure, refer to section 4.4.3 on page 4-17.

Connect the holding brake to the holding brake control module as follows:

▶ Fit the supplied insulation tube over the white and gray (or black) wires of the motor cable.

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▶ Connect the holding brake control wires:
- white brake cable: terminal B+ of the holding brake control module
- gray (or black) brake cable: terminal B- of the holding brake control module

▶ Torque the connections to 2.5–2.8 lb-in (0.22–0.25 N•m).

The current required by the holding brake control module depends on the holding brake pick-up current (see the Schneider Electric motor catalog for values):

Holding brake control module input current [A]= 0.5 A + pick-up current [A]

Note: The brake pick-up current can be computed from the brake pick-up power and brake nominal voltage:

Brake Pick-up current [A] = Brake Pick-up power [W]/ Brake Nominal voltage [V]
The nominal voltage for Schneider Electric SER motors is 24 Vdc.

▶ Set the voltage reduction switch as follows:
1: voltage reduction on (for SER and RIG motors)
0: voltage reduction off

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4.4.5 Connecting the DC busses of two drives

CAUTION

EQUIPMENT DAMAGE HAZARD

- Do not interconnect the DC bus of more than two drives.
- Do not interconnect controllers of different power classes.
- Do not interconnect the DC bus of drives operated from two different power sources. Operation from power sources of differing electrical characteristics (number of phases, voltage, short-circuit available current, voltage phase shift, or voltage balance) can damage one or both drives.
- If one of the two interconnected drives requires a mains reactor, both drives must be equipped with a mains reactor.
- Each drive must be individually fused as shown in sections 4.4.2 and 4.4.3 of this instruction manual.
- Drives with single-phase inputs must be connected to the same mains phases if the drive DC busses are to be interconnected. For systems where the drive power inputs are connected to neutral, the interconnection of the DC busses of two drives connected to different phases will result in overvoltage that can destroy the drives.
- Cross-connection of the drive DC busses (i.e. DC+ of one drive to DC- of the opposite drive) will cause damage to both drives upon application of power.

Failure to follow these instructions can result in death, serious injury or equipment damage.

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Connecting DC Bus Cables

▶ Join the DC bus connections of the two drives: DC+ to DC+ and DC- to DC-. Ground the shield to both controller housings.

- Drive power terminals must be used with conductor cross-sections based on 60 °C or 75 °C insulated copper conductors.

	TLD132	TLD134	TLD136	TLD138
Tightening torque of the terminal screws				
[lb-in]	4.5–5.6	5.6–6.8	5.6–6.8	5.6–6.8
[N•m]	0.4–0.5	0.5–0.6	0.5–0.6	0.5–0.6

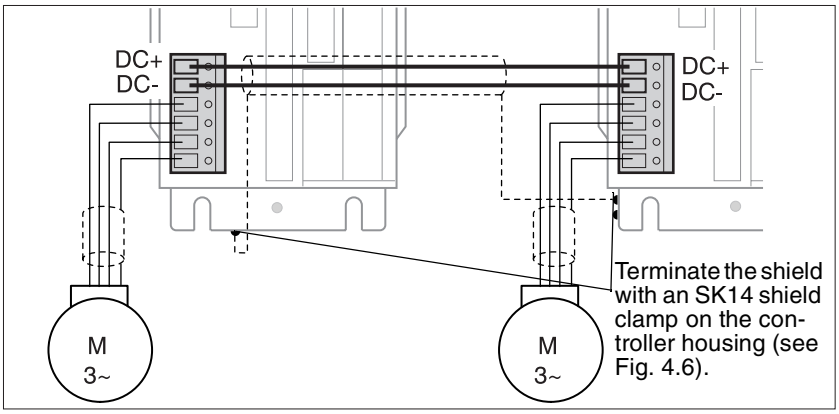

Fig. 4.9 Interconnecting the DC busses of two drives

In the case of drives with a hood, the cable must be routed downwards from the connection.

Cable specification

- Insulated 2-core cable with shield
- The cable shield cross-section must be suitable for grounding at both ends.
- Maximum cable length: 6.5 feet (2 m)

  Minimum cross-section: no less than the mains connection
- Reference Belden 7421AS (2 x #16 AWG/1.5 mm^2), 7434AS (2 x #14 AWG/2.5 mm^2) or 7443AS (2 x #12 AWG/4mm^2) cable or equivalent.

EMC measures

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

- The shield braiding of the DC bus cable must be connected to the controller housing with a large surface area connection. For the shield connection, use a Schneider Electric shield clamp, part no. TLATE. See section 10.2 on page 10-2 for more information.
- Exposed cable ends may only remain unshielded at terminal points for a maximum of 0.8 in. (20 mm).

Function

Two drives can offload excess braking energy onto each other via the DC bus connection. In counter cyclic operation, in which one motor is accelerated while the other is simultaneously braked, some of the energy can be exchanged between the drives.

When two drives use the same ballast resistor controller, the DC bus connections of both drives are interconnected. All the information found in this section must be observed when two drives share a ballast resistor controller. Refer to section 4.5.2 for more information.

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4.4.6 Connecting the 24 V supply voltage

⚠WARNING

UNINTENDED EQUIPMENT ACTION

The Twin Line drive and certain auxiliary equipment require the use of an external 24 Vdc power supply. Improper selection or installation of the power supply can result in unintended equipment action due to electromagnetic interference or inadvertent grounds of the control wiring.

- Use a power supply suitable for Protective Extra Low Voltage (PELV) operation.
- Bond the negative power output terminal of the power supply to the enclosure ground bar. Refer to NFPA 79 *Electrical Standard for Industrial Machinery* and EN60204-1 *Electrical equipment of machines, General requirements* for control circuit grounding practices.
- Do not connect any protective device (i.e. fuses) or switch between the negative output of the 24 V power supply and any connected load.
- For 24 Vdc power supply connections longer than 6.5 ft. (2 m), use twisted pair conductor for the 0 V and 24 Vdc supply wires.

Failure to follow these instructions can result in death, serious injury or equipment damage.

⚠CAUTION

CONTACT WELDING AND DAMAGE

The Twin Line drive 24 Vdc input (pins 31 and 32) is not equipped with inrush current limitation. If power is fed via a switching contact to the 24 Vdc input, contact welding or damage may result during power-up if the 24 Vdc power source has no transient output current limitation (i.e. transformer-rectifier-capacitor power supply). Contact damage can be mitigated in the following ways.

- Use a power supply that will limit the transient output current to a value less than the damage level of the contact.
- If the power supply transient output current is unknown or greater than permissible for the contact and switching of the 24 Vdc power supply is required, switch the mains input connection to the power supply instead of the output.

Failure to follow this instruction can result in death, serious injury or equipment damage.

▶ Connect a 24 Vdc power supply to the drive as shown in Fig. 4.10. The power supply must be compatible with PELV operation (negative output terminal bonded to the enclosure ground bar). Use a Schneider Electric ABL7RE24xx power supply or equivalent.

- Controller power supply terminals must be used with conductor cross-sections based on 60 °C or 75 °C insulated copper conductors.

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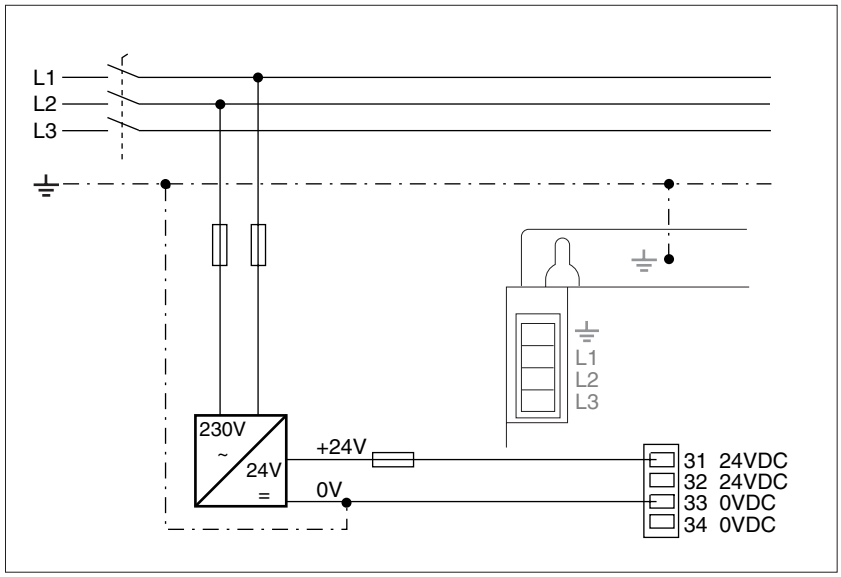

Fig. 4.10 Example of 24 V connection for single-phase and three-phase controllers

Pin	Signal	Active	Explanation	I/O
31	24 Vdc	-	24 Vdc supply voltage, internally connected to pin 32	-
32	24 Vdc	-	24 Vdc supply voltage	-
33	0 Vdc	-	0 V for 24 Vdc voltage, connected internally to pin 34 and pin 16 (ACTIVE-0V)	-
34	0 Vdc	-	0 V for 24 Vdc voltage	-

- Pins 32 (24 Vdc) and 34 (0 VDC) can be used as a 24 V output for further consumers or for cascading several Twin Line drives. The F6 fuse rated current should not exceed 8 A.
- In computing the 24 V power supply current demand, make sure that any additional consumers, such as the holding brake, the holding brake controller, the signal interface outputs, and fans are included with the Twin Line power amplifier demand.
- The motor shaft position information is retained during mains power loss if, prior to power loss, the power amplifier is commanded off (ENABLE = 0) and the 24 V supply voltage remains energized. Motor shaft movement during power loss may not alter the stored shaft position information.
- Lay the 24 V supply line at a distance of at least 8 in. (20 cm) from other lines to ensure EMC protection. For cable lengths of more than 6.5 feet (2 m), make a twisted pair of the 0 V and 24 V supply wires. Reference Belden 7421A (2 x 16 AWG/1.5 mm^2) cable or equivalent.
- To ensure that emission limits are met in TLD134 drives, use a shielded cable for the 24 Vdc and signal interface to the controller. Refer to Fig. 4.1 on page 4-4. Reference Belden 7421AS (2 x 16 AWG/1.5 mm^2) cable or equivalent.
- The torque for terminal screws 1–34 is 2.5–2.8 lb-in (0.22–0.25 N•m).

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4.4.7 Connection to the signal interface

The drive can be controlled via the lines of the signal interface.

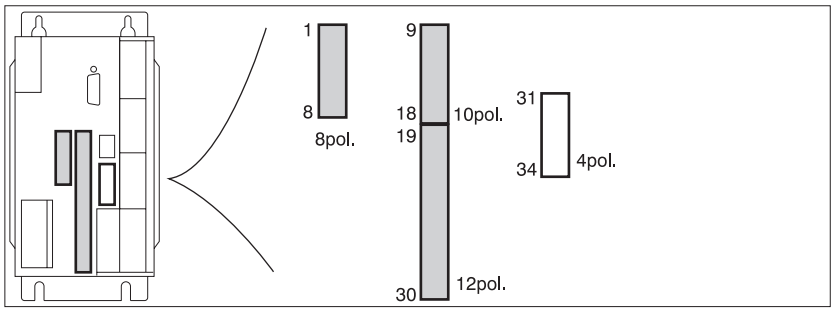

Fig. 4.11 Signal interface: 1-30: inputs / outputs, 31-34: 24 V power supply connection

Connection Remove all power before wiring the connections to the signal interface.

▶ Wire the signal interface connections as required by the operating mode selected.

⚠WARNING

LOSS OF CONTROL DURING OR FOLLOWING A MOTION

Using the $\overline{\text{LIMP}}$, $\overline{\text{LIMN}}$, and $\overline{\text{STOP}}$ input functions can provide a degree of protection against common types of motion hazards (i.e. over travel of a motion due to improperly programmed motion sequences).

- Use of the $\overline{\text{LIMP}}$, $\overline{\text{LIMN}}$, and $\overline{\text{STOP}}$ input functions require the connection of signals from external sensors or limit switches to the drive. The signals used should originate from separate sensors and limit switches from those used during normal machine control.
- The external sensors and limit switches must be properly located on the machine motion being controlled.
- The $\overline{\text{LIMP}}$, $\overline{\text{LIMN}}$, and $\overline{\text{STOP}}$ input functions cannot protect against certain failures within the drive or at the sensors. For the control of critical motions of the machine, use redundant control signal paths to assure a safe state during failure.

Failure to follow these instructions can result in death, serious injury or equipment damage.

▶ Connect inputs $\overline{\text{LIMP}}$, $\overline{\text{LIMN}}$, and $\overline{\text{STOP}}$ to the +24 V voltage if they are not being used.

▶ The shield on the analog signal inputs should be terminated on the drive ground bar. At the opposite end of the analog cable shield, connect a capacitor between ground and the shield (e.g. 10 nf/100 V metalized polyester MKT).

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The terminal blocks of the signal interface must only be wired up when the unit is in a de-energized state.

Pin	Signal	Active	Explanation	I/O
1 - 11	-	-	Not assigned	-
12	FUNCT_OUT	high	No fault or speed zero, can be configured via 'Settings.FCT_out', max. 400 mA	O
13	RDY_TSO	high	Operational readiness, active in operating states 4 to 7, max. 400 mA	O
14	$\overline{\text{ALARM}}$	low	Error or warning message, max. 400 mA	O
15	ACTIVE_CON	high	Motor energized, control signal for brake controller TL HBC, max. 400 mA	O
16	ACTIVE_GND	high	0 V signal for brake controller TL HBC, internally to 24VGND	O
17	ANALOG_IN+	-	Analog control input ±10 V	I
18	ANALOG_IN-	-	Analog control input 0 V, reference potential to pin 17 ANALOG_IN+	I
19	MAN_P	high	Manual movement, clockwise direction of motor rotation	I
20	MAN_N	high	Manual movement, counter-clockwise direction of motor rotation	I
21	MAN_FAST	high	Manual selection slow (low) or fast (high)	I
22	FAULT_RESET	high	Reset error message	I
23	-	-	Not assigned	-
24	FUNCT_IN1	-	Parameter set 1 (low) or 2 (high)	I
25	FUNCT_IN2	high	Change operational function	I

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Pin	Signal	Active	Explanation	I/O
26	$\overline{\text{LIMP}}$	low [1)]	Limit switch signal, clockwise direction of motor rotation	I
27	$\overline{\text{LIMN}}$	low [1)]	Limit switch signal, counter-clockwise direction of motor rotation	I
28	$\overline{\text{STOP}}$	low [1)]	Quick-Stop	I
29	AUTOM	high	Automatic operation (high) or manual operation (low)	I
30	ENABLE	high	Enable power amplifier (high) or disable (low)	I

1) Signal level with default setting of the parameters 'Settings.SignEnabl' and 'Settings.SignLevel'

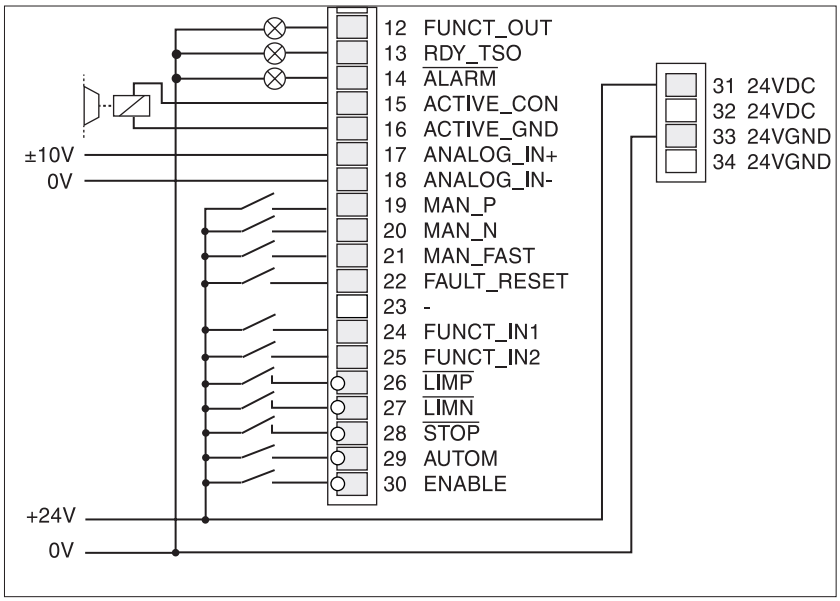

Fig.4.12 Inputs and outputs of the signal interface

Cable specification

Cables for digital signals:

- Minimum cross-section 25 AWG (0.14 mm^2), max. cross-section 16 AWG (1.5 mm^2)
- Maximum length of the minimum cross-section 49 feet (5 m).
- Reference Belden 7400A (2 x 20 AWG/0.5 mm^2) through Belden 7408A (25 x 20 AWG/0.5 mm^2) cable or equivalent.

Cables for analog signals ANALOG_IN+, ANALOG_IN-:

- Two-conductor twisted, shielded cable 16 AWG (1.5mm^2).
- Maximum allowable length 600 feet (180 m)
- Reference Belden 7421AS (2 x 16 AWG/1.5 mm^2) cable or equivalent.

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Function The drive can be controlled manually or automatically via the lines of the signal interface. Five LEDs at the signal interfaces are used to indicate when signal inputs are energized.

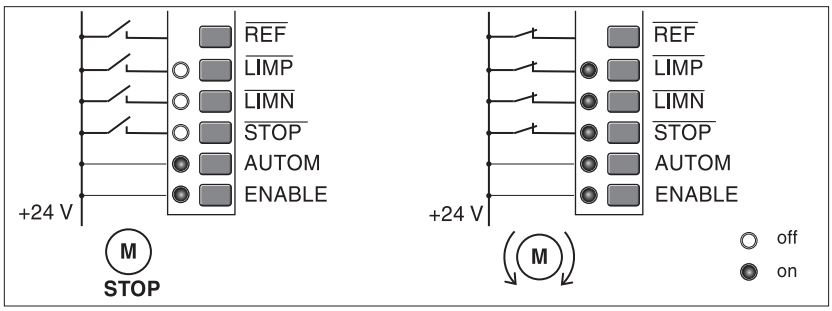

Fig.4.13 LED display of signal interface

Enabling choice for the input signals $\overline{\text{LIMP}}$, $\overline{\text{LIMN}}$ and $\overline{\text{STOP}}$ and evaluation as active low or high can be changed via the parameters ‘Settings.SignEnabl’ and ‘Settings.SignLevel’. See page 7-3.

Output signals remain unchanged for at least 0.5 ms.

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4.4.8 Connection to the RS-232 interface

Connection The RS-232 interface, equipped with a 9-pole Sub-D female connector connected to a PC or to the Twin Line HMI. The drive supplies the Twin Line HMI with the operational power via pin 9.

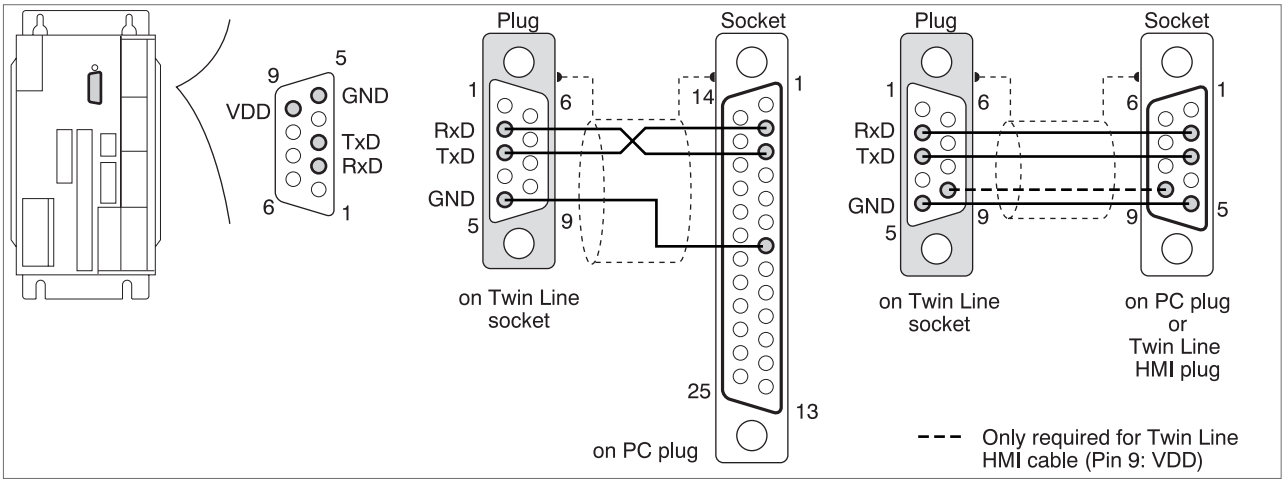

Fig.4.14 Cables for the RS-232 interface at the PC or Twin Line HMI View: Solder side of cable connectors

Pin	Signal	Color [1)]	Pair	Explanation	I/O
1	-		-	not occupied	
2	TxD	brown	1	transmitted data to the manual device	O
3	RxD	white	1	received data from the manual device	I
4	-		2	not occupied	
5	GND	green	2	ground	-
6	-		-	not occupied	
7	-		-	not occupied	
8	-		3	not occupied	
9	VDD	yellow	3	10 V_{DC}-supply for the TL HMI	O

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

Cable specification

- Shielded cable
- Maximum cable length 49 feet (15 m)
- Minimum cross-section of the signal conductors 22 AWG (0.25 mm^2); minimum cross-section for VDD and 0 V conductors: 20 AWG (0.5 mm^2)
- Ground shield at both ends

Function The drive is started up and operated via the serial RS-232 interface. Use the TLCT commissioning software here to connect up the Twin Line HMI hand-held operating unit or a PC.

The Twin Line HMI can be plugged directly into the unit or connect it by cable to the unit. It is supplied with voltage by the unit.

Networking of additional units via the RS-232 interface is not possible.

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4.4.9 Connection to the RS-422-C module (drive setpoint input)

Module interface The RS-422-C module is equipped with a 15-pin, Sub-D female connector (M1 hardware).

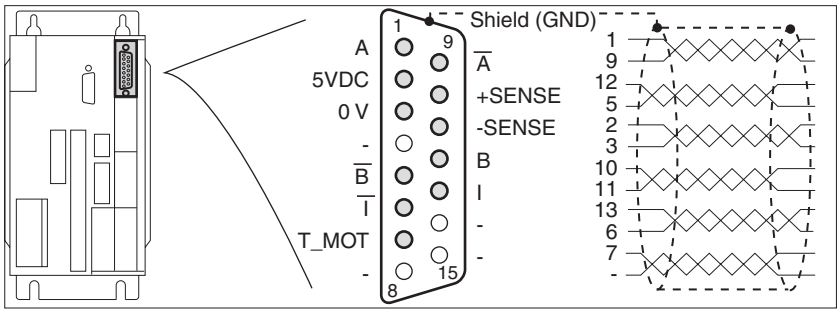

Fig. 4.15 Interface of the encoder module

Pin	Signal	Color [1]	Pair	Explanation	I/O
1	A	white	1	Encoder signal channel A	I
9	$\overline{A}$	brown	1	Channel A, negated	I
12	B	green	2	Encoder signal channel B	I
5	$\overline{B}$	yellow	2	Channel B, negated	I
2 [2]	5Vdc	red	3	Encoder supply, 5 V, max. 300 mA	O
3	0 V	blue	3	Encoder supply, 0 V	O
10	+SENSE	violet	4	Sense line positive, connect on encoder side to 5Vdc [3]	I
11	-SENSE	black	4	Sense line negative, connect on encoder side to 0 V [3]	I
13	I	gray	5	Channel index pulse	I
6	$\overline{I}$	pink	5	Channel index pulse, negated	I
7 [2]	T_MOT (5Vdc)	gray / pink	6	Line monitoring, connect signal at encoder to pin 2: 5Vdc	I
4	-	red / blue	6	Not assigned	-
8	-		-	Not assigned	-
14	-		-	Not assigned	-
15	-		-	Not assigned	-

1) Color details refer to the cable which is available as an accessory.
2) Connect together signals 2 (5Vdc) and 7 (T_MOT) for line monitoring in the encoder plug
3) Sense line must be connected for activating the 5Vdc.

In the case of controllers with a hood, the cable must be routed downwards from the connection.

Cable specification

Use factory-assembled cables from Schneider Electric. Refer to section 10 for available cables.

- Shielded cable
- Minimum cross-section for the signal conductors: 22 AWG (0.25 mm^2); minimum cross-section for the 5 Vdc and 0 V conductors: 20 AWG (0.5 mm^2)
- Twisted pair wires
- Ground shield at both ends.
- Maximum cable length: 328 feet (100 m)

To protect against interference, the shield for digital cables is grounded at both ends. Differences in potential can lead to excessive current in the shield. Shield currents can be controlled by means of bonding conductors. Recommended cross-section of the bonding conductors is 5 AWG (16 mm^2) for lengths not exceeding 656 feet (200 m). For lengths over 656 feet (200 m) use 4 AWG (20 mm^2). Bonding conductors should connect to the ground bar of the enclosure containing the Twin Line controller or, if no ground bar is present, directly to the Twin Line controller housing.

CAUTION

ENCODER DAMAGE HAZARD

The encoder can be damaged if connected with power present on the Twin Line drive. Remove all power from the Twin Line drive, including 24 Vdc power, before connecting the encoder.

Failure to follow this instruction can result in death, serious injury or equipment damage.

Function

Setpoints are specified via externally injected A/B signals and index pulse under electronic gear operating mode.

The RS-422-C module receives the A/B encoder signals and index pulse as a position setpoint for the drive. The maximum input frequency is 400 kHz.

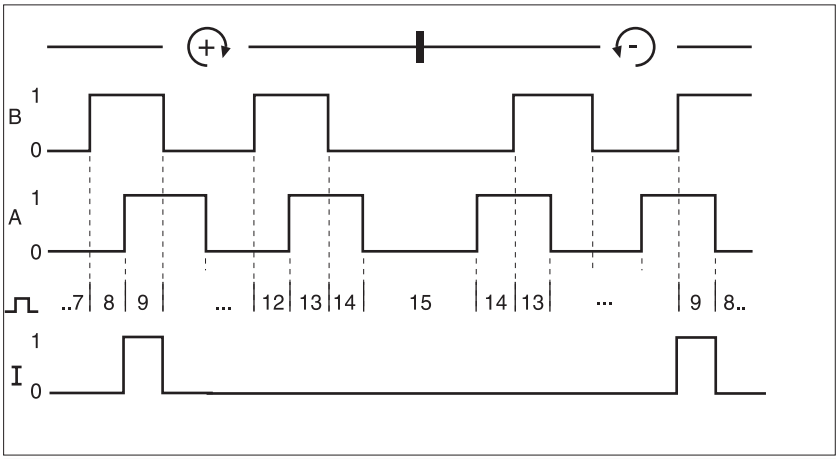

Fig. 4.16 Timing diagrams with A, B and index pulse signal, counting forwards and backwards

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Monitoring The T_MOT signal displays wire break at low signal.

Position data transmission errors with excessive voltage drop: the difference of the ground potential of 24 VGND to other connected devices must be less than 1 volt. Otherwise use larger cross-section cable for 24 VGND.

The pin assignments for the signals of the ESIM1-C/ESIM2-C and the RS-422-C modules are identical. A 1:1 cable can be used for a connection.

4.4.10 Connection to the PULSE-C module (drive setpoint input)

Module interface

The PULSE-C module is fitted with a 15-pin, Sub-D male connector (M1 hardware).

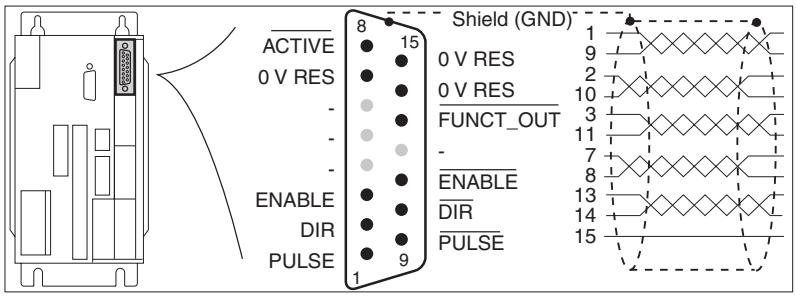

Fig. 4.17 Interface of the pulse direction module

Pin	Signal	Color [1]	Pair	Explanation	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	Sense of rotation "Dir“ or motor step backwards "PR“	I
10	$\overline{\text{DIR}}$ ($\overline{\text{PR}}$)	yellow	2	Sense of rotation "Dir“ or motor step backwards "PR“, inverted	I
3	ENABLE	gray	3	Enable signal	I
11	$\overline{\text{ENABLE}}$	pink	3	Enable signal, inverted	I
7	0 V RES	gray/pink	4	Ground, internally via resistor [2] to 0 Vdc	I
8	$\overline{\text{ACTIVE}}$	red/blue	4	Drive ready [3]	O
13	$\overline{\text{FUNCT\_OUT}}$	white/green	5	Reserved, internally to Low level	O
14	0 V RES	brown/ green	5	Ground, internally via resistor [2] to 0 Vdc	I
15	0 V RES	white/yel- low	6	Ground, internally via resistor [2] to 0 Vdc	I
4	-	blue	-	Not assigned	-
12	-	red	-	Not assigned	-
5	-	black	-	Not assigned	-
6	-	purple	-	Not assigned	-

1) Color specifications relate to the cable which is available as an accessory.
2) PTC 4 ohm resistor.
3) Open collector output with emitter connected to pin 8.

For controllers with a hood, the cable must be led upwards from the point of connection.

Cable specification

Use factory-assembled cables from Schneider Electric. Refer to section 10 for available cables.

- Shielded cable
- Minimum cross-section for the signal conductors: 25 AWG (0.14 mm^2)
- Twisted pair wires
- Ground shield at both ends.

- Maximum length at RS-422 connection: 328 feet (100 m). With open collector connection: up to 33 feet (10 m).

To protect against interference, the shield for digital cables is grounded at both ends. Differences in potential can lead to excessive current in the shield. Shield currents can be controlled by means of bonding conductors. Recommended cross-section of the bonding conductors is 5 AWG (16 mm^2) for lengths not exceeding 656 feet (200 m). For lengths over 656 feet (200 m) use 4 AWG (20 mm^2). Bonding conductors should connect to the ground bar of the enclosure containing the Twin Line drive or, if no ground bar is present, directly to the Twin Line drive housing.

Function

Setpoints are specified via externally injected pulse direction signals under electronic gear operating mode.

Reference signals for step-by-step positioning of the motor and control signals for the motor current, angular resolution, and for enabling the power amplifier are transmitted via the pulse direction interface. At the same time, the controller signals operational readiness of the drive or a possible malfunction via the interface.

PULSE (PV), DIR (PR)

The square-wave signals PULSE (PV) and DIR (PR) can be combined for two operating modes. The operating mode is set with the parameter 'M1.PULSE-C'.

- PULSE/DIR: Pulse direction signal

  PV/PR: $Pulse_{forward}$ - $Pulse_{backward}$ signal

Pulse direction operating 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.

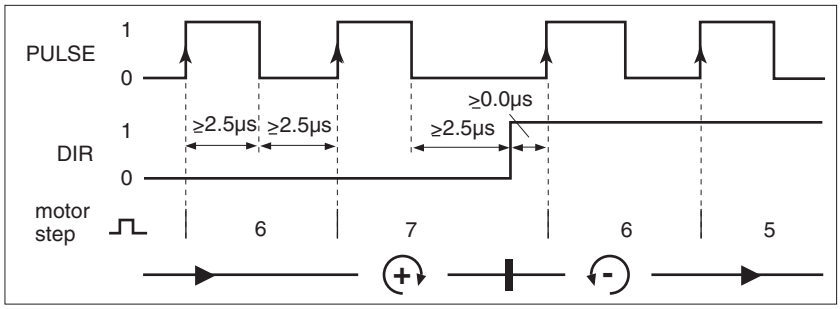

Fig. 4.18 Pulse direction signal

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

1) When viewed from the shaft-end of the servomotor.

$Pulse_{forward}$ - $pulse_{backward}$ operating mode

The PV (PULSE) signal is used to execute a movement of the motor in a clockwise direction, and the PR (DIR) signal a movement in an counter-clockwise direction.

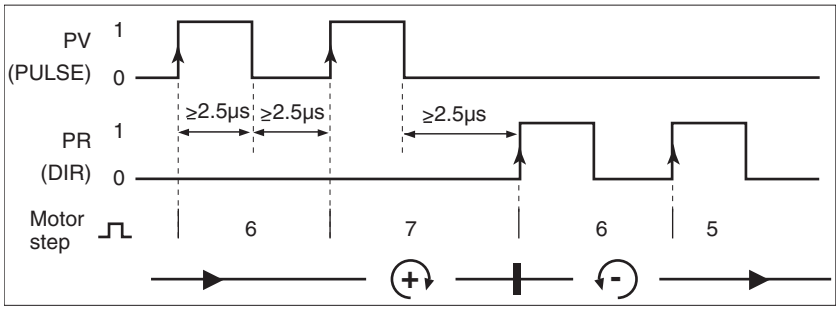

Fig. 4.19 $Pulse_{forward}$/$Pulse_{backward}$ signal

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

1) When viewed from the shaft-end of the servomotor.

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

ENABLE

The ENABLE signal enables the power amplifier so that the motor can be controlled.

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

If there is no operating fault, the $\overline{\text{ACTIVE}}$ output will transition to 0 within 100 ms after the power amplifier is enabled (ENABLE set to 1).

$\overline{ACTIVE}$

The output shows the operational readiness of the drive.

Pin	Signal	Function	Value
8	$\overline{\text{ACTIVE}}$	Power amplifier is disabled Power amplifier is enabled	high low

$\overline{\text{ACTIVE}}$ is an open collector output to pin 7. The logically negated signal function is available at the ACTIVE-CON output of the signal interface.

$\overline{FUNCT\_OUT}$

The output signals an error event or zero speed. The meaning of the signal is set with the "Settings.FCT_out" parameter. For further information see page 7-6.

Pin	Signal	Function	Value
13	$\overline{\text{FUNCT\_OUT}}$	Error or speed ≠ 0 No error or speed = 0	high/open low

$\overline{\text{FUNCT\_OUT}}$ is an open collector output to GND. The logically negated signal function is available at the FUNCT_OUT output of the signal interface.

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Circuit of the signal inputs

⚠WARNING

UNINTENDED EQUIPMENT ACTION / LOSS OF CONTROL

Operation of the PULSE-C module differential inputs using single-ended outputs can reduce the electrical noise immunity of the signal transmission.

- Driving the PULSE-C module inputs with single-ended outputs is not recommended if PULSE-C input signal integrity is critical to the motion system operation.
- Single-ended outputs are not recommended as the drive for the differential inputs of the PULSE-C module if the motion equipment is being installed in an electro magnetically noisy environment.
- If single-ended outputs are used to drive the PULSE-C module inputs, limit the maximum cable length to less than 33 feet (10m) and limit the maximum operating frequency to less than 50kHz.
- Use shielded twisted-pair cable to connect the PULSE-C module.

Failure to follow these instructions can result in death, serious injury or equipment damage.

It is recommended that signal inputs be switched via the RS-422 transceiver interface and not the single-ended open collector interface.

Fig. 4.20 shows a typical input circuit for the signal inputs PULSE (PV), DIR (PR), and ENABLE. Up to 10 inputs of a PULSE-C module can be connected to a single RS-422-C transmitter output.

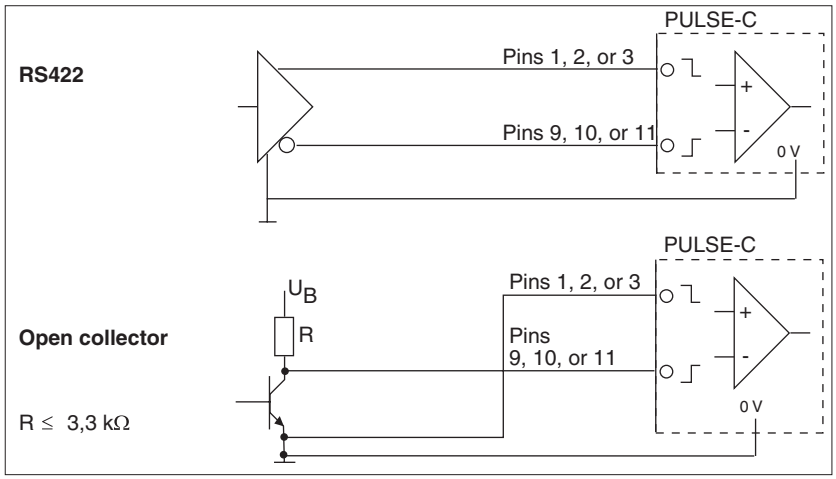

Fig. 4.20 Circuit of the signal inputs, L: Cable length

For cable lengths ≤ 33 feet (10 m) and frequencies ≤50 kHz, single-ended open collector outputs can be used provided that only low-level electromagnetic interference is present.

4.4.11 Connection to the HIFA-C module (motor position feedback input)

Module interface The HIFA-C module is equipped with a 15-pin, Sub-D female connector (M2 hardware).

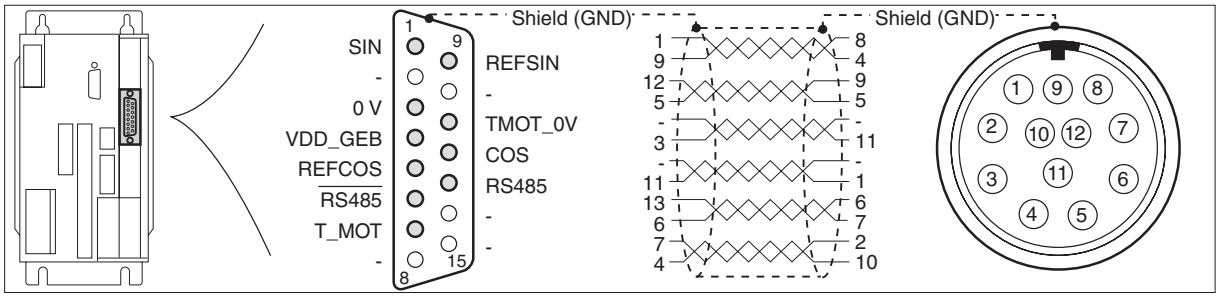

Fig. 4.21 Interface of the Hiperface module and plug for the AC servomotor, both viewed from the solder side

Pin	Signal	Motor, pin	Color [1)]	Pair	Explanation	I/O
1	SIN	8	white	1	Sine signal	I
9	REFSIN	4	brown	1	Reference for sine signal, 2.5 V	O
12	COS	9	green	2	Cosine signal	I
5	REFCOS	5	yellow	2	Reference for cosine signal, 2.5 V	O
2	-	-	-	3	Not assigned	-
3	0 V	11	blue	3	0 V	O
10	-	-	-	4	Not assigned	-
11	TMOT_0 V	1	black	4	0 V to T_MOT	-
13	RS-485	6	gray	5	Receive and send data	I/O
6	$\overline{\text{RS-485}}$	7	pink	5	Receive and send data negated	I/O
7	T_MOT	2	gray / pink	6	Temperature sensor PTC to TMOT_GND	I
4	VDD_GEB	10	red / blue	6	10 V supply for encoder, max. 150 mA	O
8	-			-	Not assigned	-
14	-			-	Not assigned	-
15	-			-	Not assigned	-

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

In the case of drives with a hood, the cable must be routed downwards from the connection.

Cable specification Use factory-assembled cables from Schneider Electric. Refer to section 10 for available cables.

- Shielded cable
- Maximum cable length: 49 feet (15 m)
- Minimum cross-section for the signal conductors: 22 AWG (0.25 mm^2); minimum cross-section for VDD_GEB and 0 V conductors: 20 AWG (0.5 mm^2)
- Twisted pair lines
- Ground shield at both ends.
- Maximum cable length: 328 feet (100 m)

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To protect against interference, the shield for digital cables is grounded at both ends. Differences in potential can lead to excessive current in the shield. Shield currents can be controlled by means of bonding conductors. Recommended cross-section of the bonding conductors is 5 AWG (16 mm^2) for lengths not exceeding 656 feet (200 m). For lengths over 656 feet (200 m) use 4 AWG (20 mm^2). Bonding conductors should connect to the ground bar of the enclosure containing the Twin Line controller or, if no ground bar is present, directly to the Twin Line controller housing.

Function

SinCos connection for motor position feedback to the drive.

The SinCos (located in the motor) determines the position of the motor's rotor and sends analog and digital position data to the HIFA-C Hiperface module. In addition, the drive reads the motor parameter set from the SinCos memory via the digital interface of the module.

The Hiperface module is compatible with the following two encoder types manufactured by Stegmann.

Encoder type	Sine / cosine periods per revolution
SinCos SRS50/60	1024, Single-turn encoder
SinCos SRM50/60	1024, Multiple-turn encoder (4096 revolutions)

The Hiperface module carries out precise interpolation for these encoder types. A resolution of 16384 increments per revolution is possible.

Temperature monitoring

The temperature of the motor winding is monitored by a PTC temperature sensor in the motor and transmitted via the T_MOT signal to the drive.

Wire breaks

The T_MOT signal is monitored for wire breaks and short circuits.

4.4.12 Reserved

4.4.13 Connection to the ESIM1-C and ESIM2-C modules (encoder simulation output)

Module interface

The ESIM1-C module is equipped with a 15-pin Sub-D female connector (M4 hardware). The ESIM2-C module is equipped with two 15-pin Sub-D female connectors (M4 hardware).

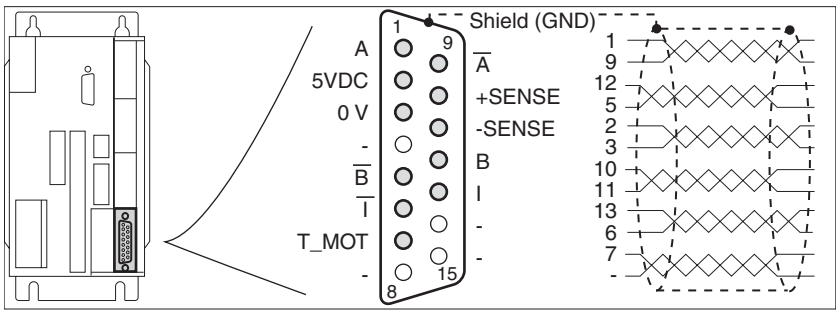

Fig. 4.22 Interface of the encoder module

Pin	Signal	Color [1]	Pair	Explanation	I/O
1	A	white	1	Channel A	I
9	$\overline{A}$	brown	1	Channel A, negated	I
12	B	green	2	Channel B	I
5	$\overline{B}$	yellow	2	Channel B, negated	I
2	5Vdc	red	3	Internal bridge on pin 10 for activating +SENSE Internal bridge on pin 7 for activating T_MOT	O
3	0 V	blue	3	Internal bridge on pin 11 for activating -SENSE	O
10	+SENSE	violet	4	Internal bridge on pin 2 for activating +SENSE	I
11	-SENSE	black	4	Internal bridge on pin 3 for activating -SENSE	I
13	I	gray	5	Channel index pulse	I
6	$\overline{I}$	pink	6	Channel index pulse,negated	I
7 [2]	T_MOT	gray / pink	6	Internal bridge on pin 2 for activating T_MOT [2]	I
4	-	red / blue	6	Not assigned	-
8	-	-	-	Not assigned	-
14	-	-	-	Not assigned	-
15	-	-	-	Not assigned	-

1) Color details refer to the cable which is available as an accessory.
2) Only necessary with connection to RS-422-C module.

For units with a hood, the cable must be led downwards from the point of connection.

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Cable specification

Use factory-assembled cables from Schneider Electric. Refer to section 10 for available cables.

- Shielded cable
- Minimum cross-section for the signal conductors is 25 AWG (0.14 mm^2)
- Twisted pair wires
- Ground shield at both ends.
- Maximum cable length of 328 feet (100 m)

To protect against interference, the shield for digital cables is grounded at both ends. Differences in potential can lead to excessive current in the shield. Shield currents can be controlled by means of bonding conductors. Recommended cross-section of the bonding conductors is 5 AWG (16 mm^2) for lengths not exceeding 656 feet (200 m). For lengths over 656 feet (200 m) use 4 AWG (20 mm^2). Bonding conductors should connect to the ground bar of the enclosure containing the Twin Line drive or, if no ground bar is present, directly to the Twin Line drive housing.

Function

Signals for indicating the actual position are output at the incremental encoder connection. There are two phase-shifted signals, A and B and an index pulse. The A/B signals are generated and sent by the motor encoder module. The index pulse is generated in the ESIM module.

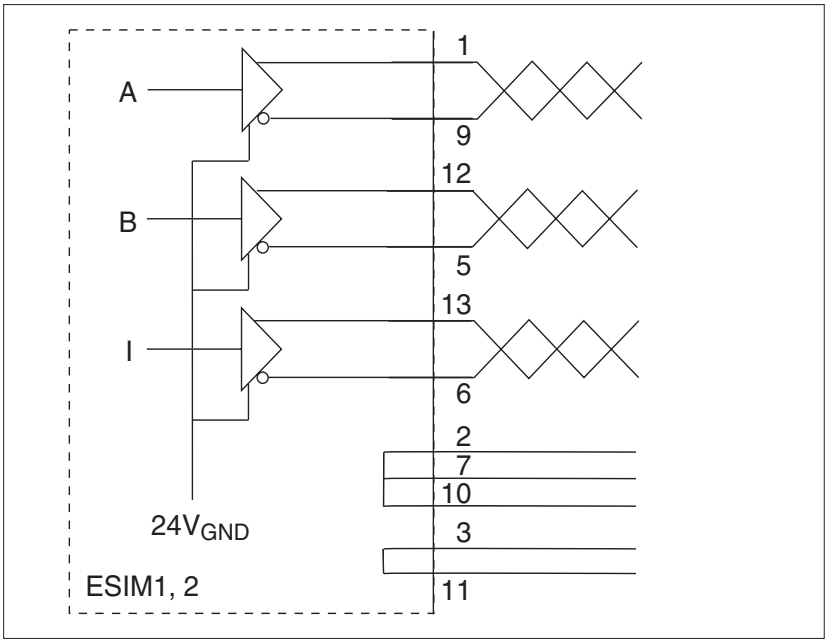

Fig. 4.23 Circuit for ESIM1/2-C

Resolution

Resolution of the encoder simulation: SinCos: 4096 increments per revolution.

The initial position for the index pulse is related to the absolute zero position of the motor and can be configured with the "M4.p_indESIM" parameter. The value is shown in increments with a tolerance of ±2 increments.

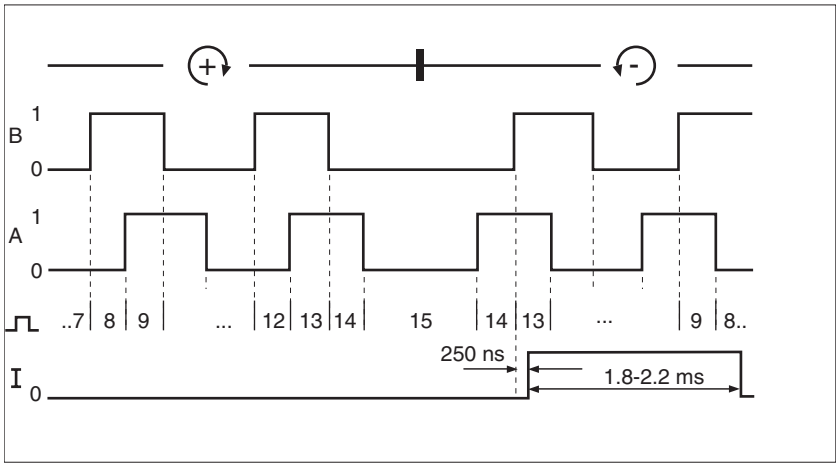

Fig. 4.24 Timing diagram with A, B and index pulse signal, counting forwards and backwards

Incorrect transmission of position data when voltage drop excessive.
The difference in the ground potential of 24VGND between two units connected via ESIM1-C/ESIM2-C or RS-422-C must be less than 1 volt. Otherwise use cable of larger cross-section for 24VGND.

The pin assignments for the signals of the ESIM1-C/ESIM2-C and the RS-422-C modules are identical. A 1:1 cable can be used for a connection.

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4.4.14 Connection to the SSI-C module

Module interface

The SSI-C module is equipped with a 15-pole sub-D connector (M4 thread).

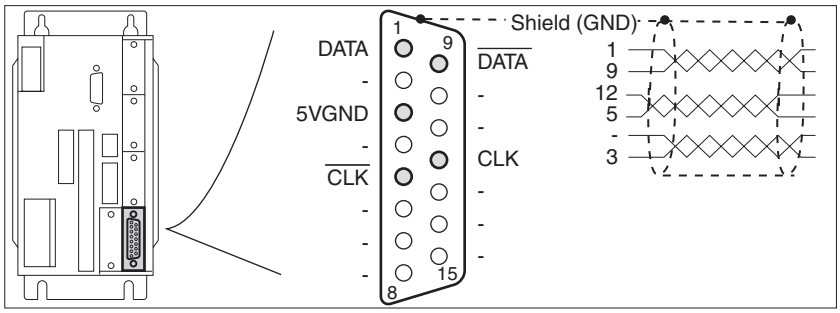

Fig.4.25 Interface of the synchronous serial interface module

Pin	Signal	Color [1)]	Pair	Explanation	I/O
1	DATA	white	1	Data line	I
9	$\overline{\text{DATA}}$	brown	1	Data line, negated	I
12	CLK	green	2	Shift clock	O
5	$\overline{\text{CLK}}$	yellow	2	Shift clock, negated	O
2	-	red	3	Internal bridge on pins 7 and 10	-
3	5VGND	blue	3	Ground	I
4	-	-	-	Not assigned	-
6	-	-	-	Not assigned	-
7	-	-	-	Internal bridge on pin 2	-
8	-	-	-	Not assigned	-
10	-	-	-	Internal bridge on pin 2	-
11	-	-	-	Internal bridge on pin 3	-
13	-	-	-	Internal bridge on pin 6	-
14	-	-	-	Not assigned	-
15	-	-	-	Not assigned	-

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

For units with a hood the cable must be led downwards from the point of connection.

Cable specification

Use factory-assembled cables from Schneider Electric. Refer to section 10 for available cables.

- Shielded cable
- Minimum cross-section for the signal conductors: 25 AWG (0.14 mm^2)
- Twisted pair wires
- Ground shield at both ends.
- Maximum length: 328 feet (100 m)

To protect against interference, the shield for digital cables is grounded at both ends. Differences in potential can lead to excessive current in the shield. Shield currents can be controlled by means of bonding conductors. Recommended cross-section of the bonding conductors is 5 AWG (16 mm^2) for lengths not exceeding 656 feet (200 m). For lengths over 656 feet (200 m) use 4 AWG (20 mm^2). Bonding conductors should connect to the ground bar of the enclosure containing the Twin Line drive or, if no ground bar is present, directly to the Twin Line drive housing.

Function Encoder simulation with serial transmission of absolute position data.

The module sends actual position values to the position control of an external NC controller. The actual position is output serially via the data line as a 25 bit data word. The starting position is specified by the rotary transducer of the engine when the 24 V supply voltage is switched on

The data rate is clock-pulse controlled. One period of oscillation may not exceed 2 MHz (≤ 0.5 µs) nor be less than 53 kHz (≥ 19µs).

The 25-bit data word is made up of one filler bit and 24 bits for the position data. The position is saved with the falling edge of the first cycle.

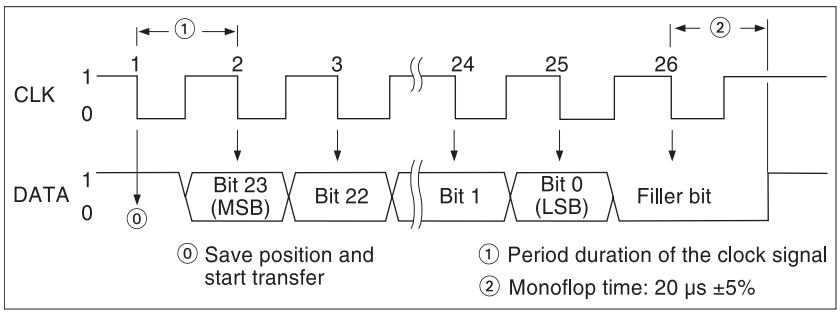

Fig.4.26 Transmission of position with synchronous serial interface

New position data are only transmitted when the clock signal is interrupted for the duration of at least one monoflop period following transmission of a complete data word. If the clock signal is not interrupted it is possible that the same position will be read out repeatedly.

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4.5 Connecting accessories to the standard unit

4.5.1 Holding brake controller TLHBC

⚠ DANGER

HAZARDOUS VOLTAGE – SERVOMOTOR-GENERATED AND COUPLED VOLTAGE.

- The servomotor can produce voltage at its terminals when the shaft is rotated! Prior to installation or servicing, block the servomotor shaft to prevent rotation.
- DO NOT contact the motor terminals or circuits connected to the motor terminals when the motor shaft is turned!
- AC voltage from the drive or servomotor can couple voltage to unused conductors in the motor cable. Insulate both ends of unused conductors in the motor cable.

Failure to follow these instructions can result in death, serious injury or equipment damage.

⚠ DANGER

HAZARDOUS VOLTAGE – INADEQUATE GROUNDING

When cable shields are used as ground conductors, the shield must have a cross-section no smaller than the power conductors housed within the shield. If the shield does not have sufficient cross-section, then a separate power conductor housed within the shield and of sufficient cross-section must be used as the grounding conductor. The shield should be terminated to the grounding conductor at both ends of the shielded cable assembly.

Failure to follow these instructions can result in death, serious injury or equipment damage.

The brake of motors with a holding brake is controlled via the TLHBC holding brake controller.

Connection

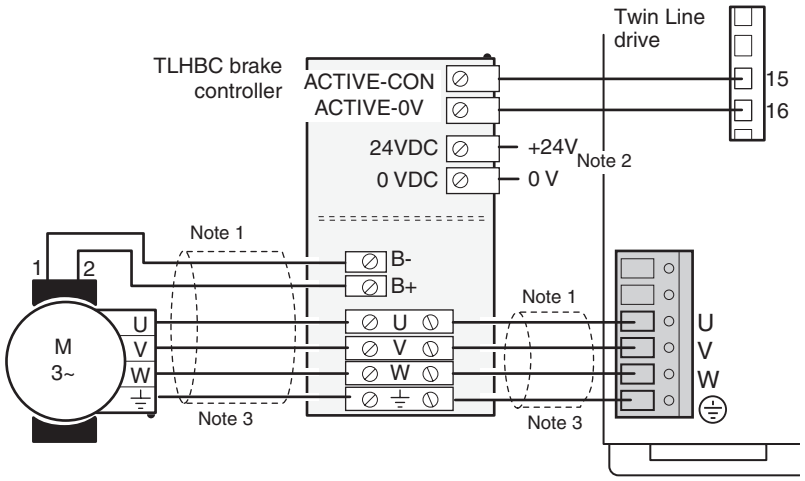
▶ Use factory-assembled cables from Schneider Electric. Refer to section 10 for available cables.

▶ Refer to section 4.4.3 and Fig. 4.7 for motor cable selection and motor connector terminal assignments.

Terminal	Connection	Color (number)
U	motor wire	Black (1)
V	motor wire	Black (2)
W	motor wire	Black (3)
⏚	ground wire	GRN/YEL
B+	Brake +	White
B–	Brake –	Gray (or Black)

Refer to Fig. 4.6 and section 4.4.3 for connection of the motor conductors and ground to the TLD13x drive.

- Brake controller power terminals must be used with conductor cross-sections based on 60 °C or 75 °C insulated copper conductors.



Note 1: The assignment of the motor wires must be the same at the motor, the HBC controller, and the Twin Line drive or the feedback sense will be incorrect.

Note 2: Connect to pins 32 and 34 respectively on the Twin Line drive.

Note 3: Terminate the motor cable shields at TLHBC and TL drive respectively using SK14 shield clamps.

Fig. 4.27 Connection of the TLHBC holding brake drive

Refer to Fig. 4.28 for dimensions when preparing the motor cable for connection to the holding brake controller.

The lead preparation shown is compatible with the motor-side and controller-side connections to the holding brake controller. Refer to Fig. 4.8 for the motor cable lead preparation required at the power amplifier.

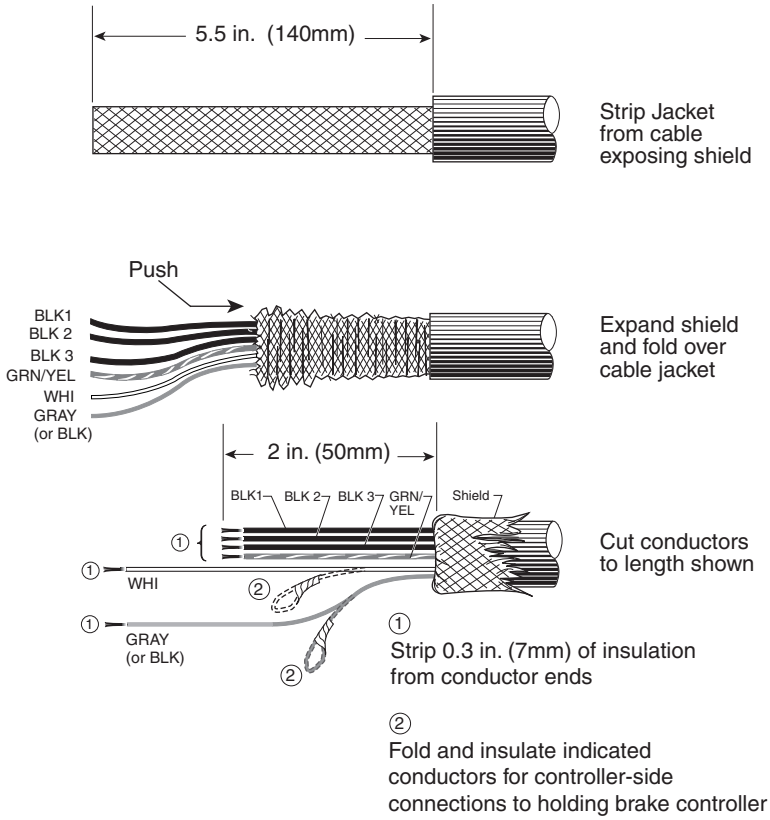


Fig. 4.28 Preparing the motor cable termination to the holding brake controller.

Motor and drive-side power connectors

- ▶ If ferrules are installed, use only square end ferrules.
- ▶ Use the GRN/YEL ground wire to connect to the ground terminal on the holding brake controller. Torque the terminal to 17–20 lb-in (1.5–1.8 N•m).
- ▶ Attach the Black1, Black 2, and Black 3 wires to terminals U, V and W respectively.Torque the terminals to 17–20 lb-in (1.5–1.8 N•m).
- ▶ Push the shield clamp over the bare shield of the motor cable. Use the shield clamp to fix the cable to the housing of the TLHBC controller.

Brake connectors

- ▶ If ferrules are installed, use only square end ferrules.
- ▶ Connect the holding brake to the holding brake controller:
  - white brake cable: terminal B+ of the HBC controller
  - gray (or black) brake cable: terminal B- of the HBC controller

  Torque the connections to 2.5–2.8 lb-in (0.22–0.25 N•m)

Control connections

- ▶ Connect the control terminals ACTIVE-CON and ACTIVE-0V of the brake controller to the signal interface of the Twin Line drive. Torque the terminals to 4.5–5.6 lb-in (0.4–0.5 N•m).

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▶ Connect the 24 Vdc power supply to the holding brake controller. Torque the terminals to 4.5–5.6 lb-in (0.4–0.5 N•m).

To ensure proper coordination of the braking function, the 24 Vdc power for the HBC should be supplied from the 24 Vdc and 0 Vdc terminals of the drive.

The current required by the holding brake controller depends on the holding brake pick-up current (see the Schneider Electric motor catalog for values):

Brake controller input current [A] = 0.5 A + pick-up current [A]

Note: The brake pick-up current can be computed from the brake pick-up power and the brake nominal voltage:

Brake pick-up current [A] = Brake pick-up power [W] / Brake nominal voltage [V]
Nominal voltage for the Schneider Electric SER and RIG motors is 24 Vdc.

▶ Set the switch for voltage reduction:
1: Voltage reduction on (for SER and RIG motors)
0: Voltage reduction off

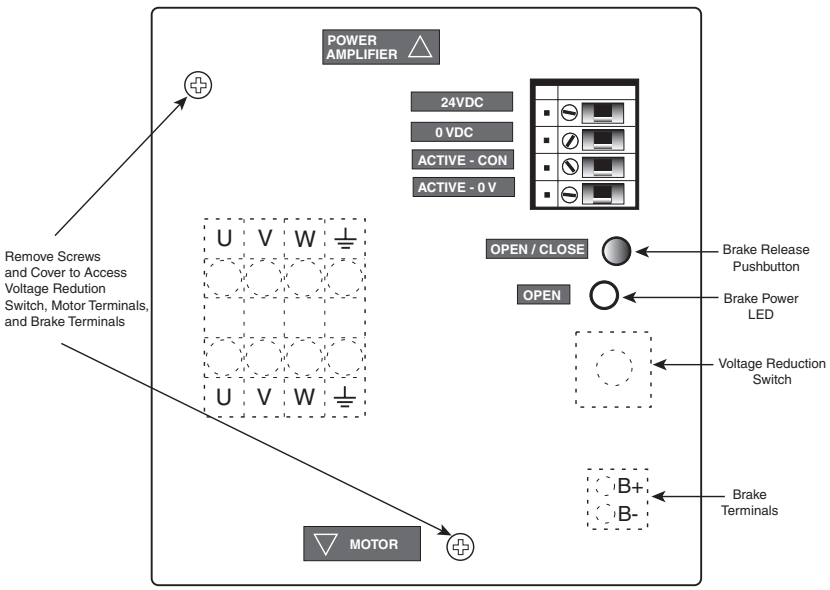

Fig. 4.29 TLHBC general arrangement (front view)

4.5.2 Ballast resistor and ballast resistor controller TLBRC

External ballast resistor

An external ballast resistor can be connected via a TLBRC ballast resistor controller to the DC bus terminals of the drive.

An additional resistor will be needed when the motor has to brake sharply at brief intervals and the internal resistor cannot cope with dissipating the braking energy fed back into the DC bus. If the DC bus voltage rises above the permitted threshold value, the drive reports error '5 - DC-line overvoltage' and switches the power amplifier off immediately.

⚠WARNING

LOSS OF BRAKING TORQUE

- No holding torque is available during loss of power or drive fault.
- When required (i.e. protection of personnel), use a separate braking function for holding torque. Refer to NEMA ICS7.1 *Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable - Speed Drive Systems* for additional information.
- Availability of sufficient braking torque for rapid stopping requires that the drive be properly adjusted and, if required, the controller be fitted with a properly dimensioned ballast resistor. Refer to the appropriate sections of this instruction manual for setting the Quick Stop function and the dimensioning of ballast resistors

Failure to follow these instructions can result in death, serious injury or equipment damage.

Dimensioning aid

For specification purposes, the elements that contribute a share to the absorption of braking energy are quantified. This allows the dimensions of the external ballast resistor to be determined.

An additional external ballast resistor is required when the kinetic energy to be absorbed W_{kin} exceeds the sum of the internal shares, including the internal ballast resistor.

Kinetic energy W_{kin}

The kinetic energy is calculated from the kinetic or rotational energy of the drive train.

Internal energy absorption

Braking energy is absorbed internally through the following mechanisms:

- DC-Bus capacitor W_{ZW}
- Internal ballast resistor W_{IN}
- Electrical losses in the drive W_E
- Mechanical losses in the drive W_M

DC bus capacitors

The energy W_{ZW} depends in a square-law function on the difference between the DC bus voltage before the braking operation and the switching threshold of the external ballast resistor.

The voltage before the braking operation depends on the mains voltage. The energy absorption by the DC-Bus capacitors is lowest when the mains voltage is highest. Use the energy values that correspond to the available mains voltage.

Unit	Mains voltage [V]	TLD132	TLD134	TLD136	TLD138
Internal capacitance [µF]		340	235	470	1175
Energy absorption [1)][Ws]	230	10	53	106	264
Energy absorption [1)] [Ws]	400	-	23	47	116
Energy absorption [1)] [Ws]	480	-	3	7	16

1) Available energy absorption with +10% of nominal mains voltage.

The available energy absorption capacity of the DC bus capacitors will vary with available input mains voltage. Always check the braking performance of the drive with the maximum expected mains voltage.

Energy absorption of the internal ballast resistor

Two key values relating to the internal ballast resistor determine its energy absorption.

- The constant power P_{AV} specifies how much energy can be dissipated on a continuous basis without overloading the ballast resistor.
- The maximum energy W_{peak} limits the higher heat loss which can be dissipated in the short term.

If the continuous power limit is exceeded for a certain length of time, the ballast resistor must remain at a reduced load for a corresponding length of time. This ensures that the ballast resistor will not be destroyed.

Key values P_{AV} and W_{peak} for the internal ballast resistor can be found in section 3.2.1 on page 3-4.

Electrical losses W_E

The electrical losses W_E in the drive can be estimated from the peak power of the drive. The maximum power loss is around 10% of peak power for a typical efficiency factor of 90%. If the current on braking is lower, the power loss will be reduced accordingly.

Mechanical losses W_M

The mechanical losses result from absorption through friction which occurs when the system is running. Mechanical losses can be ignored if the system requires a much longer time to coast to a halt than the time in which the system is to be halted under braking. The mechanical losses can be calculated from the load torque and the speed from which the motor is to stop.

Example TLD134

Braking a motor with the following data (drive connected to a 400 V mains):

- Starting speed: n = 4000 $min.^{-1}$
- Moment of inertia of rotor: J_R = 4 $kgcm^2$
- Moment of inertia of load: J_L = 6 $kgcm^2$

The energy to be absorbed is given by:

$W_B = 1/2 * J * (2*\pi*n)^2$

to 88 Ws

Electrical and mechanical losses are ignored.

23 Ws are absorbed in the DC bus capacitors at a mains voltage of 400 V.

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The internal ballast resistor must absorb the remaining 65 Ws. It can absorb 80 Ws in the form of a pulse, see section 3.2.1 on page 3-4. The internal ballast resistor is sufficient if the load is stopped once under braking.

If the braking operation is repeated on a cyclical basis, the continuous power rating must be taken into account. If the cycle time is longer than the ratio of the energy to be absorbed W_B and the continuous power P_{AV}, the internal ballast resistor is enough. If braking takes place more frequently, the internal ballast resistor will not be sufficient.

In the example, the ratio W_B/P_{AV} is 1.3 s. For shorter cycle times, an external ballast resistor with TLBRC will be required.

Sizing the external ballast resistor

The selection of an external ballast resistor is determined by the required peak power and continuous power with which the ballast resistor can be operated.

The resistance value R is given by the peak power required.

$R = U^2 / P_{max}$

U : switching threshold [V]

P_{max} : required peak power [W]

R: resistance [Ohm]
> 28 Ohm

Fig. 4.30 Calculating the resistance R of an external ballast resistor

Select resistors on the following criteria:

- Resistors must be connected in parallel to keep resistance below the required level. Remember the lower limit of 28 Ω.
- The sum of the continuous power ratings of the individual resistors must together provide the required continuous power.

Standard ballast resistors

The ballast resistors approved by Schneider Electric have the following properties.

	Resistor [Ω]	**Continuous power [W]**
BWG 250072	72	100
BWG 250150	150	100
BWG 500072	72	200
BWG 500150	150	200

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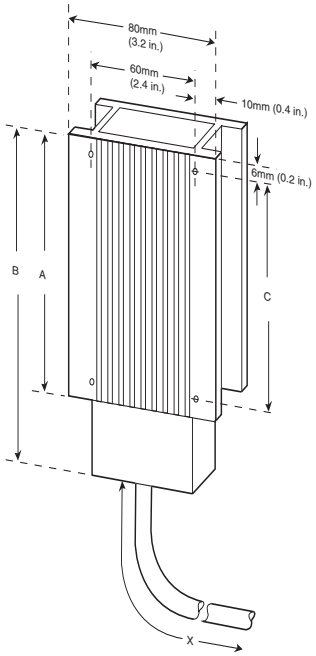
When mounted vertically, the connecting cable must be led out downwards.



	A	B	C
BWG 250xxx	110 +/-1.5 (4.4)	147 (6)	98 (4)
BWG 500xxx	216 +/-1.5 (8.6)	253 (10)	204 (8)

Fig. 4.31 Size and mounting dimensions of the ballast resistor in the versions with 100 W and 200 W continuous power

⚠ WARNING

HOT COMPONENTS

Avoid contact with the BWG braking resistor. Resistor case temperature may exceed 480 °F (250 °C).

The resistor temperature is controlled by the resistor power dissipation and the ability of the resistor environment to remove heat. The inherent temperature limitation built into the external resistor does not preclude the presence of hazardous temperatures on the resistor case.

- The mounting and location of the resistor must consider the worst-case power dissipation expected by the application.
- Install resistors in appropriate enclosure or restricted area.
- Provide sufficient cooling air and clearance.
- Do not mount on or enclose with combustible material.

If a user thermostat or thermal switch is provided to limit temperature, then the switch must operate to remove all mains and DC bus power from the Twin Line controller.

Failure to follow these instructions can result in death, serious injury or equipment damage.

The resistors meet protection grade IP54 and can be installed in a type 1 environment. The resistors are equipped with a permanently attached 0.75 m (2.46 ft.) 3-wire temperature-resistant cable for connection to the TLC-BRC ballast resistor controller. The resistors will fuse open if permanently connected to the DC bus supply but have no internal protec-

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tion against current overload or overtemperature. Barriering and guarding the resistor is required to prevent contact with the case of the resistor. Additional precautions must be taken to ensure that adequate ventilation is provided to dissipate the expected power during operation. The cable must be protected against mechanical damage where routed outside of the enclosure containing the Twin Line drive.

Ballast resistor overload protection

Protection of the ballast resistors against overload can be accomplished in several ways. Direct thermal protection is possible using a thermostat or thermal switch mounted in the vicinity of the ballast resistor. Indirect thermal protection is also possible and can be accomplished using a current overload relay to sense the current through the ballast resistor. When using thermostats or current overload relays for protection, tripping of the protective device must ultimately remove all mains and DC bus power from the Twin Line drive.

Another form of indirect thermal protection uses a Schneider Electric GV2 current-sensitive overload switch. The switch is connected in series with the ballast resistor and opens the resistor circuit in the event that the resistor overload capacity capability has been exceeded. No additional mains or DC bus contactors are required.

⚠WARNING

LOSS OF BRAKING TORQUE

Tripping of the GV2 current-sensitive overload switch will open the ballast resistor circuit. THIS CAN RESULT IN CONTROLLER SHUTDOWN AND LOSS OF BRAKING TORQUE.

- Always verify that the ballast resistor circuit has sufficient capacity for the application.
- When required (i.e. protection of personnel), provide alternative braking means for safety-critical applications. Refer to NEMA ICS7.1 *Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable - Speed Drive Systems* for additional information.

Failure to follow these instructions can result in death, serious injury or equipment damage.

The GV2 current-sensitive switch is a three-pole device. The three power poles of the GV2 are connected in series to act as a single switch contact. The GV2 is then connected in series with the ballast resistor to open the ballast resistor circuit in the event of overload.

The following GV2 current-sensitive switches are recommended for each of the Schneider Electric ballast resistors. With the GV2 trip current dial set at the maximum allowable setting, the resistor can operate at the power rating shown in the table. The adjustment range of the current trip dial will allow the trip current to be set as low as 60% of the maximum recommended setting (36% rated power).

Ballast Resistor	Power Rating	Current-Sensitive Switch	Max. Recommended Setting
BWG250072	100 W	GV2 M06	1.2 A
BWG250150	100 W	GV2 M05	0.8 A
BWG500072	200 W	GV2 M06	1.6 A
BWG500150	200 W	GV2 M06	1.2 A

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Ballast resistor controller TLBRC

When a predetermined DC bus voltage is reached, the TLBRC ballast resistor controller switches an external ballast resistor into the DC bus connection of the drive.

Two Twin Line drives can be connected to one ballast resistor controller. When two units use the same ballast resistor controller, the DC bus connections of both drives are intertied.

⚠CAUTION

EQUIPMENT DAMAGE HAZARD

- Do not interconnect the DC bus of more than two drives.
- Do not interconnect drives of different power classes.
- Do not interconnect the DC bus of drives operated from two different power sources. Operation from power sources of differing electrical characteristics (number of phases, voltage, short-circuit available current, voltage phase shift, or voltage balance) can damage one or both drives.
- If one of the two interconnected drives requires a mains reactor, both drives must be equipped with a mains reactor.
- Each drive must be individually fused as shown in section 4.4.1 and 4.4.2 of this instruction manual.
- Drives with single-phase inputs must be connected to the same mains phases if the controller DC busses are to be interconnected. For systems where the drive power inputs are connected to neutral, the interconnection of the DC busses of two drives connected to different phases will result in overvoltage that can destroy the drives.
- Cross-connection of the drive DC busses (i.e. DC+ of one drive to DC- of the opposite controller) will cause damage to both drives upon application of power.

Failure to follow this instruction can result in death, serious injury or equipment damage.

Refer to section 4.4.5 for further information concerning the interconnection of the DC busses of two drives.

Two or more ballast resistors can be connected to the ballast resistor controller. If two resistors are used, connect them to the two sets of terminals provided, R+, R-, and Ground. If more than two resistors are connected in parallel, use wire end ferrules of the correct size to connect the resistors.

A switch, internal to the ballast resistor controller, must be set according to the drive used.

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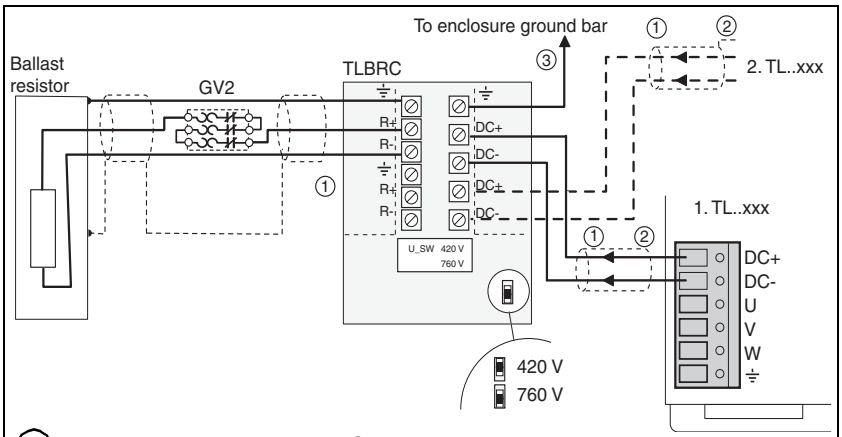

1. Terminate the shield with SK14 shield clamp on the TLBRC housing.
2. Terminate the shield with SK 14 shield clamp on the controller housing.
3. The grounding conductor cross section must not be less than the cross section of the mains conductor feeding the power amplifiers.

Fig. 4.32 Connection of the ballast resistor controller

Connection

⚠ DANGER

HAZARDOUS VOLTAGE

- Read and understand the TLBRC installation procedure in its entirety before proceeding. Installation, adjustment, repair and maintenance of the TLBRC and associated ballast resistor must be performed by qualified personnel.
- Disconnect all power before connecting TLBRC and the ballast resistor to the Twin Line drive.
- WAIT SIX MINUTES until DC bus capacitors on Twin Line drive discharge, then measure DC bus capacitor voltage between DC+ and DC- terminals to verify DC voltage is less than 45 V (see Fig.1.5 on page1-5).
- The DC bus LED is not an accurate indication of the absence of DC bus voltage.
- DO NOT short across DC bus terminals or touch unshielded components or terminal strip screw connections with voltage present.
- Many parts in this drive system, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools.

Failure to follow these instructions will result in death or serious injury.

⚠DANGER

HAZARDOUS VOLTAGE – INADEQUATE GROUNDING

When cable shields are used as ground conductors, the shield must have a cross-section no smaller than the power conductors housed within the shield. If the shield does not have sufficient cross-section, then a separate power conductor housed within the shield and of sufficient cross-section must be used as the grounding conductor. The shield should be terminated to the grounding conductor at both ends of the shielded cable assembly.

Failure to follow this instruction can result in death, serious injury or equipment damage.

Refer to Fig. 4.32 for connection of the ballast resistor controller to the ballast resistor, GV2, and Twin Line controller.

- Ballast resistor controller terminals must be used with conductor cross-sections based on 60 °C or 75 °C insulated copper conductors.

▶ Remove all power. Open the TLBRC.

▶ Set the switch to match the controller's part number:
For TLD132 controllers, set the switch to 420 V.
For TLD134, TLD136, and TLD138 controllers, set the switch to 760 V.

⚠CAUTION

EQUIPMENT DAMAGE HAZARD

The installer must set the voltage selector switch on the ballast resistor controller.

- For TLD132 controllers, the voltage selector switch must be set to 420 V.
- For TLD134, TLD136, and TLD138 controllers, the voltage selector switch must be set to 760 V.

Improper switch selection can result in damage to the ballast resistor or ballast resistor controller.

Failure to follow this instruction can result in death, serious injury or equipment damage.

▶ Connect the TLBRC to the drive with a 2-wire shielded cable. Connect the DC+ and DC- terminals on the ballast resistor controller to the DC bus terminals DC+ and DC- of the Twin Line drive. Torque the TLBRC terminals to 5.6–6.8 lb-in (0.5–0.6 N•m). Use an SK14 shield clamp to connect a large area of the cable shield to the drive's grounding bar.

▶ Connect the ground terminal of the TLBRC to the ground bar of the enclosure containing the servo system. Torque the TLBRC terminals to 5.6–6.8 lb-in (0.5–0.6 N•m). Use an SK14 shield clamp to connect a large area of the cable shield to the TLBRC grounding bar.

▶ Connect the ballast resistor and GV2 with 3-core shielded cables to the R terminals in the ballast resistor controller. Connect the grounding conductor to the ground terminal of the TLBRC controller. Torque the TLBRC terminals to 5.6–6.8 lb-in (0.5–0.6 N•m). Use

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an SK14 shield clamp to connect a large area of the cable shield to the TLBRC grounding bar.

▶ Additional SK14 shield clamps are required for a second controller and a second ballast resistor. Refer to section 10.2 on page 10-2 for ordering information.

DC bus cable specification

- Shielded 2-core cable
- Ground the cable shield at each end
- Maximum cable length: 6.5 feet (2 m)
- Minimum cross-section: not less than the drive mains connection
- Reference Belden 7421AS (2 x #16 AWG/ 1.5 mm^2), 7434AS (2 x #14 AWG/2.5 mm^2) or 7443AS (2 x #12/4 mm^2) cable or equivalent.

The ballast resistor controller obtains its supply voltage from the DC bus connection.

Ballast resistor cable specification

Additional ballast resistor cable is required for connection of the GV2 to the TL BRC ballast resistor controller and for extending the ballast resistor connections as required.

- Shielded 3-core cable
- Ground the cable shield at each end
- Maximum cable length 10 feet (3 m)
- Reference Belden 7422AS (3x#16 AWG/ 1.5mm^2) cable or equivalent

EMC measures

The DC bus connection is a source of interference and must be carefully laid:

- The shield braid must be connected to the drive housing with a large surface area connection. Use the supplied shield clamp for the connection to the housing.
- Cables may be unshielded only for a distance less than 0.8 in. (20 mm).

	Switch position 1 [1)]	**Switch position 2**
Drive part no.	TL134/6/8	TL132
Switching threshold [V]	760	420
Maximum switched continuous power [W]	1000	500
Smallest resistance [Ω]	30	30

1) Factory setting

The cable length between TLBRC and the drive may not exceed 2 metres.

Standard drive set-up

When the TLBRC is used, the internal ballast resistor must be switched off. The "Settings.TL_BRC“ parameter informs the unit whether a ballast resistor controller has been connected.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and units [ ]	Value range	Default value	R/W rem.
PA.p_maxBusr	16:57	4.1.40	Maximum permissible ballast power [W]	TLD132P: 25 - 170 W TLD134P: 37 - 255 W	25W / 37W	R/ – rem.

System commissioning notes

- The drive does not monitor the external ballast resistor for overheating. The ballast resistor controller will switch off if overheating occurs.
- Test the ballast resistor controller during set-up under realistic conditions to ensure that sufficient braking capacity and power dissipation capabilities exist with the ballast resistor and controller.

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4.6 Wiring examples

4.6.1 Manual operation

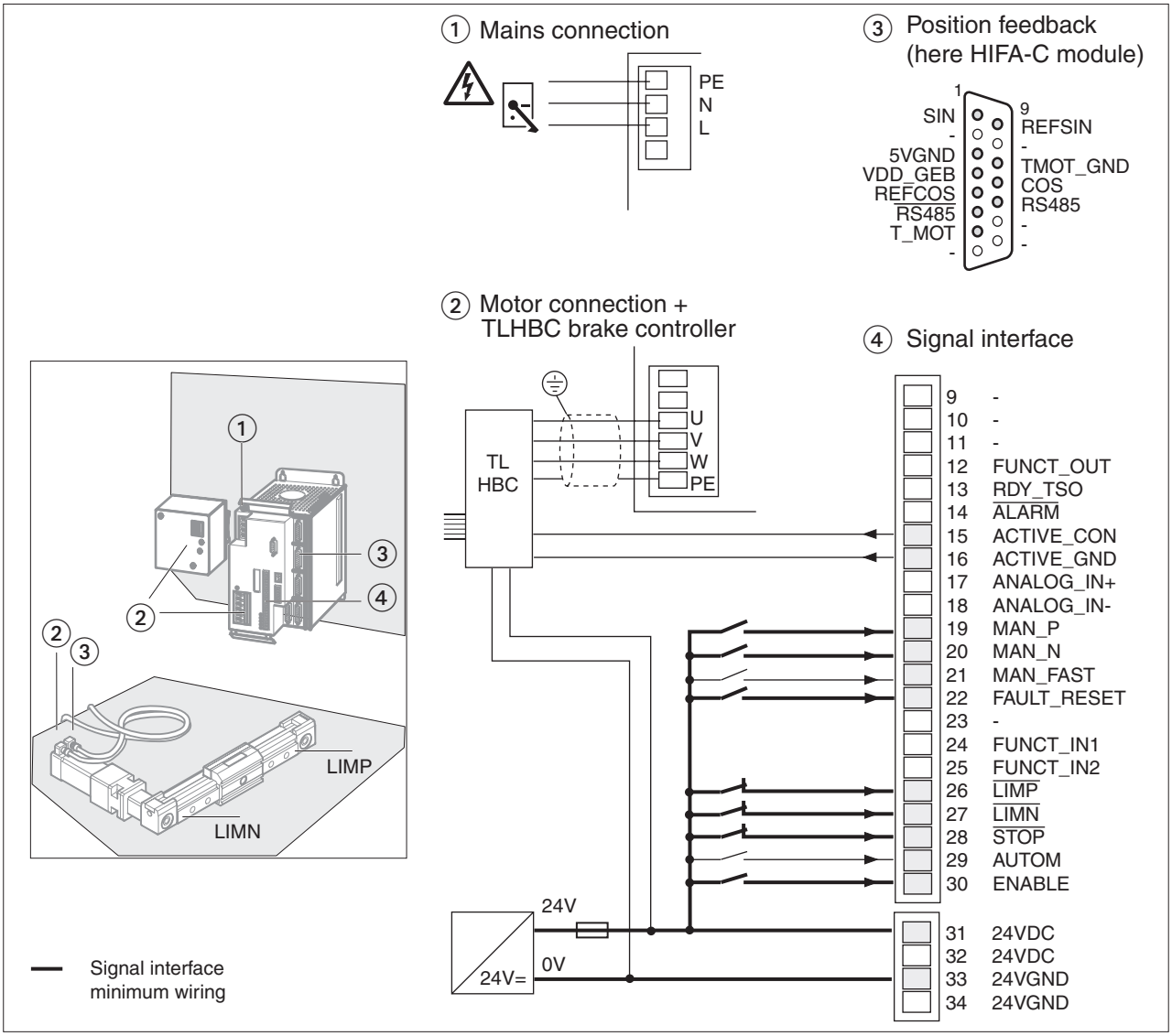

Fig.4.33 Wiring for manual operation via inputs and outputs

Connection

▶ Wiring up the mains connection (1):

- For single-phase Twin Line units see page 4-12
  For three-phase Twin Line units see page 4-15
- Wiring up a 24 V connection, see page 4-24

▶ Wiring up the motor connection (2) and the brake controller (for motors with holding brake):

- See page 4-47.

▶ Installing motor position acknowledgement (3):

- Wiring Hiperface connection for SinCos motors, see page 4-39

▶ Wiring up the signal interface for manual operation (4)

- The complete pin assignment of the signal interface is described from 4-38.
- You can find the minimum pin assignment for manual operation in the following table.

Pin	Signal	Active	Explanation	I/O
15	ACTIVE_CON	high	Motor energized, signal for TL HBC brake controller, max. 400 mA	O
16	ACTIVE_GND	high	0 V signal for TL HBC brake controller, internally to 24VGND	O
19	MAN_P 1)	high	Manual movement , clockwise direction of motor rotation	I
20	MAN_N 1)	high	Manual movement, counter-clockwise direction of motor rotation	I
21	MAN_FAST	high	Manual selection slow (low) or fast (high)	I
22	FAULT_RESET 1)	high	Reset error message	I
26	$\overline{\text{LIMP}}$ 1)	low	Limit switch signal, clockwise direction of motor rotation	I
27	$\overline{\text{LIMN}}$ 1)	low	Limit switch signal, counter-clockwise direction of motor rotation	I
28	$\overline{\text{STOP}}$ 1)	low	Quick-Stop	I
30	ENABLE 1)	high	Enable power amplifier (high) or disable (low)	I

1) Minimum configuration of the signal interface for start-up

Pin	Signal	Active	Explanation	I/O
31	24VDC 1)	-	24 V_{DC} supply voltage	I
33	24VGND 1)	-	GND for 24 V_{DC} voltage	I

1) Minimum configuration of the signal interface for start-up

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4.6.2 Automatic operation with ±10 V setpoint specified by an NC-controller

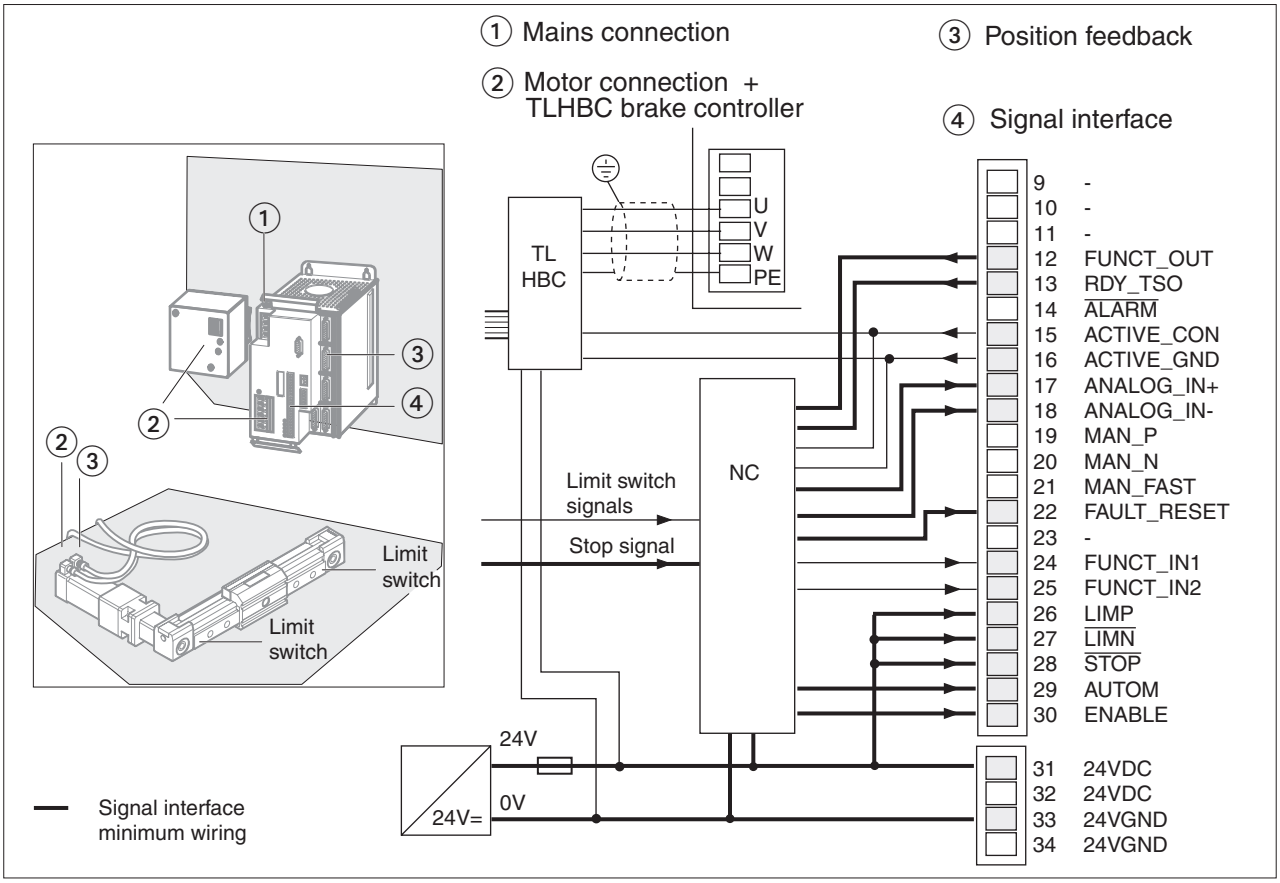

Fig.4.34 Wiring for automatic operation with ±10 V setpoint input

Pin	Signal	Active	Explanation	I/O
12	FUNCT_OUT	high	No error or speed zero, can be configured via 'Settings.FCT_out', max. 400 mA	O
13	RDY_TSO [1)]	high	Operational readiness, active in operating states 4 to 7, max. 400 mA	O
15	ACTIVE_CON	high	Motor energized, control signal for TL HBC brake controller, max. 400 mA	O
16	ACTIVE_GND	high	0 V signal for TL HBC brake controller, internally to 24VGND	O
17	ANALOG_IN+ [1)]	-	Analogue control input ±10 V	I
18	ANALOG_IN- [1)]	-	Analogue control input 0 V, potential reference to pin 17 ANALOG_IN+	I
22	FAULT_RESET [1)]	high	Reset error message	I
24	FUNCT_IN1	-	Parameter set 1 (low) or 2 (high)	I
25	FUNCT_IN2	high	Change operational function	I
26	$\overline{\text{LIMP}}$[1)]	low	Limit switch signal, clockwise direction of motor rotation	I
27	$\overline{\text{LIMN}}$[1)]	low	Limit switch signal, counter-clockwise direction of motor rotation	I
28	$\overline{\text{STOP}}$[1)]	low	Quick stop	I
29	AUTOM [1)]	high	Automatic operation (high) or manual operation (low)	I
30	ENABLE [1)]	high	Enable power amplifier (high) or disable (low)	I

1) Minimum configuration of the signal interface for automatic operation with ±10 V setpoint input

4.7 Function test

▶ Perform the following checks before powering any equipment:

- Has the apparatus been grounded as described in section 4 of this manual?
- Have all overcurrent protection devices been installed as described in section 4 of this manual?
- Have all EMC measures recommended in section 4 of this manual been implemented?
- Are any live cable ends exposed?
- Are all cables and connectors safely installed and connected?
- Are the control lines connected correctly?

For this test and the first stages of start-up, run the motor decoupled from the system so that the motor and system will suffer no damage if the motor starts up unexpectedly.

4.7.1 Function test with SinCos motor

Using TLCT to read operational status code

A PC equipped with the TLCT software can be used to read the operational status code of the drive. Use of the TLCT allows the equipment installer to monitor the state of the drive with the enclosure door closed thereby preventing exposure to hazardous voltages. Refer to document TLADOCTLCTE Manual for the Commissioning Software for information on operation of the TLCT software. The operational status code is read from the display on the lower left corner of the main window of the TLCT software.

▶ Switch on the 24 V power supply.

System check and initialization

The drive carries out a self-test and checks the internal operating data, the parameters, the internal monitoring devices, and the connected sensing equipment. It also reads in the motor data from the SinCos.

The operational status indicator on the drive changes to '3'.

▶ Close the enclosure door. Switch on the mains power supply for the power amplifier.

The drive checks the motor data for completeness. The DC bus is charged to make DC bus voltage available to the power amplifier.

Unit with SinCos motor OK

The operational status indicator changes to '4'.

The power amplifier is ready to be switched on and the drive is correctly installed. The first manual test can be carried out via commands from a PC equipped with the TLCT.

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4.7.2 Reserved

4.8 Installation troubleshooting

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- Read and understand this bulletin in its entirety before installing or operating Twin Line drive system products. Installation, adjustment, repair, and maintenance of these drive systems must be performed by qualified personnel.
- Disconnect all power before servicing the power controller. WAIT SIX MINUTES until DC bus capacitors discharge, then measure DC bus capacitor voltage between the DC+ and DC- terminals to verify that the DC voltage is less than 45 V (see Fig.1.5 on page 1-5). The DC bus LED is not an accurate indication of the absence of DC bus voltage.
- The servomotor can produce voltage at its terminals when the shaft is rotated! Prior to servicing the power controller, block the servomotor shaft to prevent rotation.
- DO NOT short across DC bus terminals or touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers and close enclosure door before applying power or starting and stopping the drive system.
- The user is responsible for conforming to all applicable code requirements with respect to grounding all equipment. For drive grounding points, refer to Fig.1.5 on page 1-5.
- Many parts in this drive system, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools.

Before servicing drive system:

- Disconnect all power.
- Place a “DO NOT TURN ON” label on the drive system disconnect.
- Lock the disconnect in open position.

Failure to follow these instructions can result in death, serious injury or equipment damage.

Operational status indicator '2'

If the drive hangs in the switching-on state '2', this indicates an internal fault in the drive which can only be identified and corrected by Schneider Electric. Refer to section 9-1 on page 9-1 for service information.

Operational status indicator '3'

If the display does not change from '3' to '4', make the following checks:

- Is the mains supply voltage present at the drive mains terminals, and does the available voltage correspond to the allowable drive input voltage rating?
- Is the motor encoder cable present and connected correctly? Without the position sensor signal the drive cannot control the motor properly.
- The HIFA-C encoder interface requires a SinCos-equipped motor.

Operational status indicator flashing

The drive has detected a fault. Refer to section 8.1 on page 8-1 for a list of the causes of faults, their diagnosis, and rectification.

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5 Commissioning

5.1 Commissioning procedure

Where can I find information on...	TLD13x drive manual	TLHMI manual	TLCT software manual	TLCT help
Commissioning step by step	•	–	–	•
Settings and parameter list	•	–	–	–
Commissioning procedure	•	–	–	•
Detailed information on operation using...	–	TLHMI	TLCT	TLCT

Always carry out the following start-up steps any time the operating conditions are changed, even if the drive has already been configured. Incorrectly set values could cause permanent damage to the drive and the motor.

Commissioning

What you need to do...	Page references
Make sure the Twin Line unit is correctly installed and wired up. When carrying out this check, use the wiring diagrams of the system configuration or the wiring examples in section 4.6.	Page 4-59
Make sure the limit switches work if these are installed.	Page 5-11
Check the functioning of the holding brake controller if motors with holding brake are used	Page 5-12
Check and set critical device parameters	Page 5-12
Optimize controller settings. To do so, install the motor and...	
- Set the reference variables and the record data	Page 5-20
- Optimize the speed controller	Page 5-22
- Optimize the position controller	Page 5-31

Next steps...

After commissioning is completed the unit can be tested in its various operating modes.

- For information on these operating modes see page 6-3.
- The signals, parameters, and conditions for changing operating modes are described on page 6-3.

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5.2 Safety instructions

Commissioning may only be carried out by qualified personnel with a knowledge of automatic control engineering.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

Twin Line controllers are software driven devices that require programming and parameter adjustments for proper operation. Incorrectly set parameters or programming steps can cause unintended actions.

- Verify operation of the machinery after programming and after programming changes.
- Verify operation of the controller after changing parameter settings.
- If possible, verify critical circuits, initial parameter adjustments, and programming instructions with the motor disconnected from the driven machinery. Once initial verification is complete, reconnect the motor and verify the operation of the overall system.
- If the controller is replaced or changed, it is necessary to reprogramming the parameters and the program.

If controller verification is done with a stand-alone test motor, the motor frame must be securely anchored to prevent unintended movement or toppling during rapid acceleration or deceleration.

Failure to follow these instructions can result in death, serious injury or equipment damage.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

Digital or analog signal inputs serve as setpoint inputs for torque, velocity or position commands, change parameter sets, switch between manual and automatic mode and toggle between selectable operation modes. Unintended equipment operation may occur, if signals are incompletely or incorrectly wired or improper signal levels are applied to the signal inputs.

- Verify the Twin Line unit is correctly and completely wired.
- Verify proper signal levels applied to the signal inputs.
- If possible, verify operation modes with the motor disconnected from the driven machinery. Once initial verification is complete, reconnect the motor and verify operation of the overall system.

If controller verification is done with a stand-alone test motor, the motor frame must be securely anchored to prevent unintended movement or toppling during rapid acceleration or deceleration.

Failure to follow these instructions can result in death, serious injury or equipment damage.

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⚠WARNING

UNINTENDED EQUIPMENT OPERATION

In applications where the Twin Line unit is integrated in an external control loop (for example, position or velocity control loop of an external NC) the ESIM module provides feedback signals to the external controller. If the feedback signals to the external controller are not connected or properly wired, or if the sign of the feedback signals is improperly evaluated or if the sign of the setpoint signal is incorrectly applied, then unintended movements may occur.

- Verify correct and proper feedback wiring.
- Verify correct sign of feedback signal.
- Verify correct sign of setpoint signal.
- If possible, verify operation modes with the motor disconnected from the driven machinery. Once initial verification is complete, reconnect the motor and verify operation of the overall system.

If controller verification is done with a stand-alone test motor, the motor frame must be securely anchored to prevent unintended movement or toppling during rapid acceleration or deceleration..

Failure to follow these instructions can result in death, serious injury or equipment damage.

⚠WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of the control signal paths and, for certain critical control functions, provide a means to achieve a safe state during and after a signal path failure. Examples of critical control functions are Emergency Stop and Overtravel Stop. Refer to NEMA ICS1.1 *Safety Guidelines for the Application, Installation and Maintenance of Solid State Control* and NEMA ICS7.1 *Safety Standards for construction and Guide for Selection, Installation and Operation of Adjustable –Speed Drive Systems* for further information
- System control signal paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failure of the link.

Failure to follow these instructions can result in death, serious injury or equipment damage.

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⚠WARNING

LOSS OF CONTROL

No driving, electrical braking, or holding torque is available from the motor during loss of mains power, error class 3 or 4 controller faults, or during failure of some components.

- Availability of sufficient braking torque for rapid stopping requires that the drive be properly adjusted and, if required, fitted with a properly dimensioned ballast resistor. Refer to the appropriate sections of this instruction manual for setting the Quick Stop function and the dimensioning of ballast resistors.
- Verify all electrical and mechanical braking functions for proper sequencing, sufficient torque production, and braking capacity prior to verifying critical machine movements that require an operational braking system.
- When possible, initially verify velocity and motion profiles / movements on portions of the machine travel where loss of braking would not create a collision with a mechanical end stop or similar function.
- Braking system verification should include operation with machine loading to values consistent with the worst-case expected braking requirements and duty-cycle during usual, unusual and emergency scenarios.
- When required (i.e. protection of personnel), use a separate braking function for holding or stopping torque. Refer to NEMA ICS7.1 *Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable - Speed Drive Systems* for additional information.
- Verify all braking systems for suitability of application (i.e. capacity, redundancy, stopping versus holding) based on applicable machinery standards.

Failure to follow these instructions can result in death, serious injury or equipment damage.

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5.3 Commissioning tools

5.3.1 Overview

Two input devices are available for commissioning tasks, configuring tasks, and diagnostics:

- The Twin Line Human-Machine Interface (HMI): a hand-held operating unit designed for attachment to the Twin Line drive.
- The Twin Line Commissioning Tool (TLCT): commissioning software used in conjunction with a PC equipped with WINDOWS® NT, WINDOWS 95, or WINDOWS 98.

To carry out a complete commissioning sequence, the Twin Line Commissioning Tool is required!

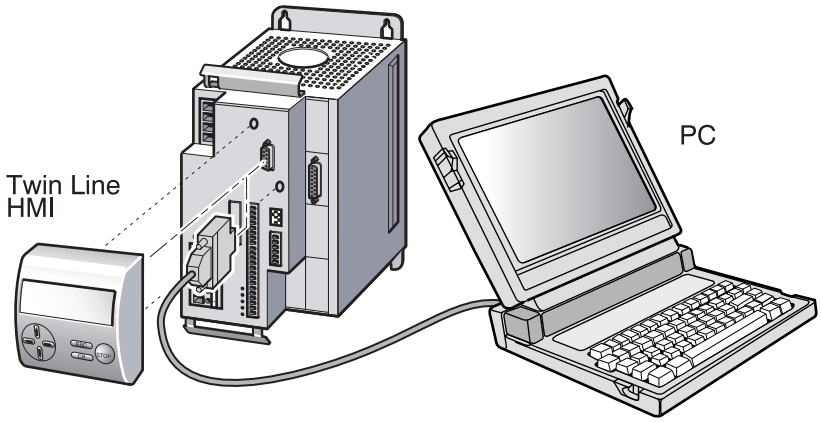

Fig. 5.1 Commissioning with the hand-held operating unit or the PC

5.3.2 The Twin Line HMI hand-held operating unit

Human-Machine Interface HMI

The Twin Line HMI is a plug-in hand-held operating unit with an LCD display of 3 x 16 characters. It is plugged directly into the RS-232 interface, but can also be connected to the RS-232 interface via a serial cable.

Twin Line HMI manual

Operation of a Twin Line drive with an HMI is described in the Twin Line HMI manual.

Menu structures for the TLD13x

The Twin Line HMI operates under menu guidance. When the drive is switched on, the menu structures and the parameter values displayed on the HMI auto-configure to the drive to which it is connected. For the TLD13x drive system, the menu items illustrated in Fig. 5.2 are available on the first and second levels:

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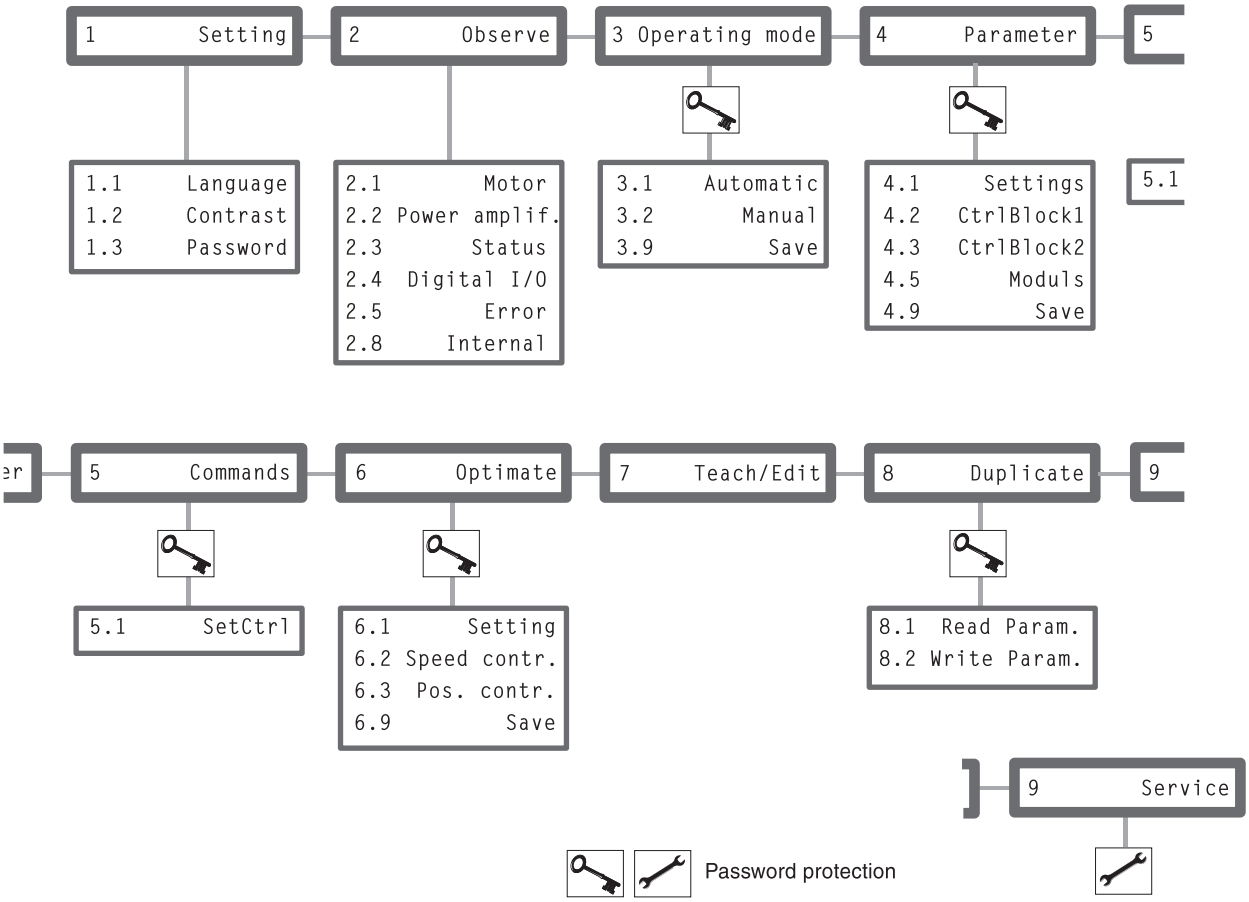

Fig. 5.2 First and second menu levels of the Twin Line HMI with TLD13x

First menu level	Meaning
1 Settings	Settings specific to the Twin Line HMI
2 Observe	Device, motor and movement data as well as error displays
3 Operating mode	Selection and launch of the operating mode and settings for the operating mode
4 Parameters	Controller and movement parameters with settings for the controller and the modules
5 Commands	Selection of the control parameters set
6 Optimize	Optimization of the control loops
7 Teach / edit	Process data for list control
8 Duplicate	Copy parameter sets to other Twin Line units
9 Service	Password-protected, for servicing purposes only

To assist in the location of parameters with the Twin Line HMI, the menu paths for each parameter are provided in this manual. For example, HMI menu '8.2' means: On the first menu level select item '8 Duplicate'; next, on the second level, select the menu item '8.2 Write Param.'.

For information on operating the Twin Line HMI please refer to the Twin Line HMI manual.

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5.3.3 Commissioning software Twin Line Commissioning Tool

Twin Line Commissioning Tool

The Twin Line Commissioning Tool commissioning software provides a graphical user interface as well as a way of loading and saving control parameters and motor data. With the software you can test the input and output signals of the drive, trace signal paths on the screen, and interactively optimize drive behavior.

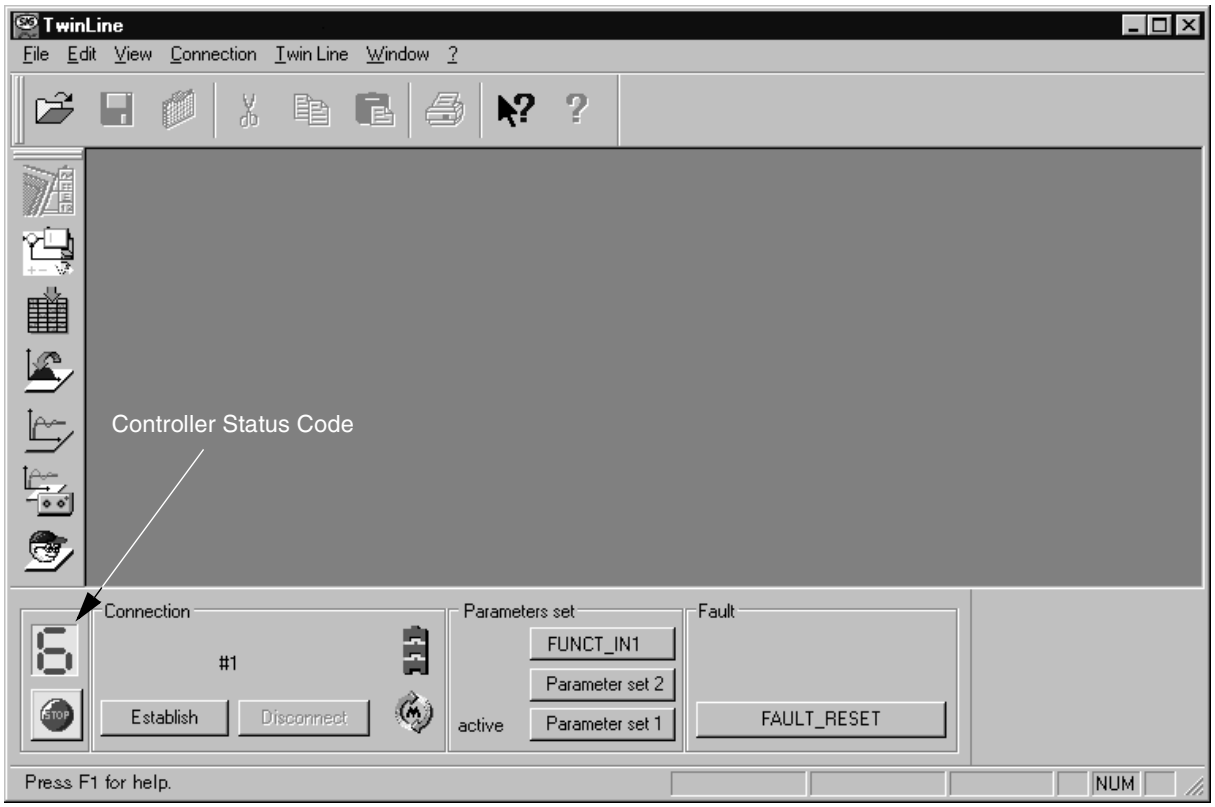

Fig. 5.3 Twin Line Commissioning Tool commissioning software

The software provides more extensive features than the Twin Line HMI, such as:

- Remote display of drive status code
- Adjusting the drive settings via a graphical interface
- Extensive diagnostic tools for optimization and maintenance
- Long-term recording as an aid to assessing operating behavior
- Archiving all device settings and recordings with export functions for data processing.

TLCT manual

Operating a Twin Line drive with the Twin Line Commissioning Tool is described in the TLCT manual. The manual is included in the software package as a printable PDF file which can be displayed on the screen.

Requirements for the use of the Twin Line Commissioning TooL

The Twin Line Commissioning Tool software requires a a PC platform equipped with WINDOWS® 2000, WINDOWS NT, WINDOWS 95, or WINDOWS 98, and an RS-232 port. The PC and the Twin Line drive must be linked by an RS-232 cable.

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Menu structure All of the commands of the commissioning software can be activated via the menu items and the program's buttons.

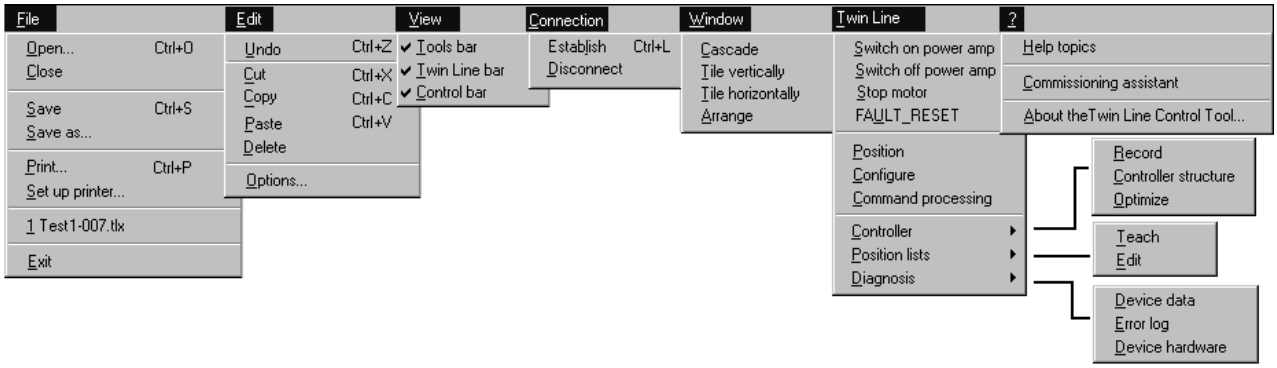

Fig. 5.4 The menu structure of the Twin Line Commissioning Tool

Throughout this manual all references to a menu item quote the complete menu path; for example, 'Twin Line → Position'.

Software help The Twin Line Commissioning Tool provides detailed help functions that can be accessed within the program via the F1 key.

Commissioning assistant The commissioning assistant provides a step by step guide through the commissioning process. The assistant is launched via the menu item '? → Commissioning assistant'.

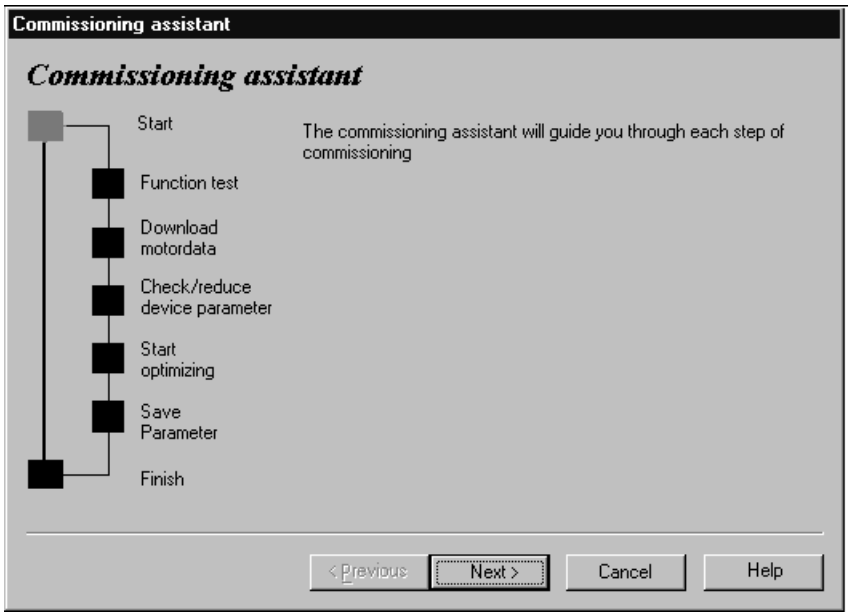

Fig. 5.5 Commissioning with the assistant in the Twin Line Commissioning Tool

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5.4 Commissioning the drive

5.4.1 Commissioning stages

Before putting the unit into operation make sure that all cables and system components have been wired and connected correctly.

With 24 Vdc power only, check whether the internal fan is running.

Commissioning should be done in the following sequence:

- Make sure the limit switches and holding brake controller are working
- Check and set the limit value parameters for current and speed controllers
- Check the motor's direction of rotation and manual movement.
- Optimize the drive settings.

5.4.2 Powering and monitoring the drive during commissioning

⚠WARNING

LIMIT AND PROTECTIVE PARAMETERS MUST BE PROPERLY SET

Incorrectly set limit or protective parameters cannot provide intended protection. Review all limit and protective settings prior to operating the servomotor. Examples of limit or protective functions include but are not limited to the following.

- Motor thermal protection settings (I_maxM, I_nomM, T_maxM, I2tM, I_0M)
- Drive thermal protection settings (P_maxBusr)
- Motor velocity limits (n_maxM, n_max0)
- Drive current limits (I_maxSTOP)
- Control loop error limits (Flt_pDiff)

Failure to follow these instructions can result in death, serious injury or equipment damage.

⚠WARNING

MACHINERY MOTION HAZARD

During operation, keep all personnel and material out of the motion hazard zone surrounding the moving parts of the machine!

Failure to follow this instruction can result in death, serious injury or equipment damage.

Requirements A personal computer (PC) equipped with the Twin Line Commissioning Software must be connected to the drive via an RS-232 cable of sufficient length to allow the PC to be brought outside of the enclosure housing the drive. The enclosure should be closed when power is present.

▶ Close the enclosure door. Switch on the external 24 Vdc supply voltage and then the mains voltage for the drive.

Refer to Fig. 5.3 for the location of the drive status code on the Twin Line software main window. The drive status code (as displayed with the TLCT) should change from 1 to 3 or 4.

If the display flashes, this indicates a fault. Refer to section 8.1 on page 8-1 for a listing which includes the causes of faults, their diagnosis, and rectification.

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5.4.3 Checking the limit switches

⚠WARNING

LOSS OF CONTROL DURING OR FOLLOWING A MOTION

Using the $\overline{\text{LIMP}}$, $\overline{\text{LIMN}}$, and $\overline{\text{STOP}}$ input functions can provide a degree of protection against common types of motion hazards (i.e. over travel of a motion due to improperly programmed motion sequences).

- Refer to section 7.2.1 of this instruction manual for descriptions of the $\overline{\text{LIMP}}$, $\overline{\text{LIMN}}$, and $\overline{\text{STOP}}$ input functions. Use of the functions is generally recommended.
- Use of the $\overline{\text{LIMP}}$, $\overline{\text{LIMN}}$, and $\overline{\text{STOP}}$ input functions require the connection of signals from external sensors or limit switches to the drive. The signals used should originate from separate sensors and limit switches from those used during normal machine control.
- The external sensors and limit switches must be properly located on the machine motion being controlled.
- To operate, the $\overline{\text{LIMP}}$, $\overline{\text{LIMN}}$, and $\overline{\text{STOP}}$ input functions must be enabled in the controller software.
- The $\overline{\text{LIMP}}$, $\overline{\text{LIMN}}$, and $\overline{\text{STOP}}$ input functions cannot protect against certain failures within the drive or at the sensors. For the control of critical motions of the machine, use redundant control signal paths to assure a safe state during failure.

Failure to follow these instructions can result in death, serious injury or equipment damage.

▶ With 24 Vdc applied to the drive, use the Twin Line commissioning software to monitor the state of register I/O.QWO_ACT while manually operating the limit switches connected to the $\overline{\text{LIMP}}$, $\overline{\text{LIMN}}$, and $\overline{\text{STOP}}$ inputs (pins 26 through 28 respectively of the signal interface). With the normally-closed limit switches connected to pins 26 through 28 inactive (circuit closed to +24 V, input active), the displayed state of the associated input should be “1”. As each limit switch is activated, the displayed state should change from “1” to “0”. Input pins 26 through 30 are equipped with LED indicators located adjacent to the input terminals. When the input is activated, the LED associated with the input is illuminated.

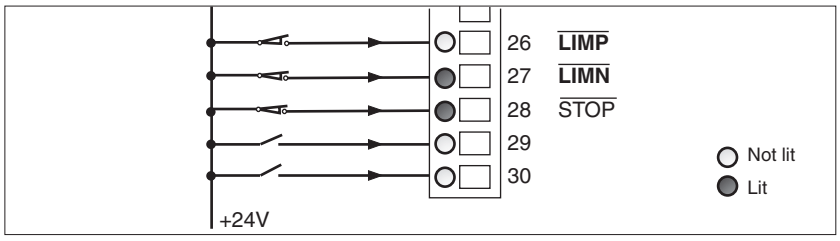

Fig. 5.6 Positive limit switch tripped

The operation of input ports $\overline{\text{LIMP}}$, $\overline{\text{LIMN}}$, and $\overline{\text{STOP}}$ can be enabled or disabled using the parameter “Settings.SignEnabl”. Their evaluation as active high or active low can be changed by parameter “Settings.SignLevel”. See page 7-3.

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The limit switch which limits the work area during clockwise rotation must be connected to LIMP. The limit switch which limits the work area during counter-clockwise rotation must be connected to LIMN. Refer to section 5.4.8 for definitions of direction of rotation.

5.4.4 Checking the holding brake

Perform this test when the motor is equipped with a holding brake.

⚠WARNING

MACHINERY MOTION HAZARD

Release of the motor brake can cause unintended machine movement.

- Block or clamp the machinery to prevent motion. Uncouple the motor from the machinery during the test. Once the test is completed, couple the motor and unblock /unclamp the machinery.
- During test, keep all personnel and material out of the motion hazard zone surrounding the moving parts of the machine!

Failure to follow these instructions can result in death, serious injury or equipment damage.

With 24 Vdc power applied to the drive, use the Twin Line Commissioning Software to command the brake.

TLCT: Open the "Twin Line → Diagnosis → device data → Input_Output“ window.

- Select "Force QWO“. Switch the "ACTIVE/PIN15" output several times in order to successively release and apply the brake. The LED on the drive will light up when the brake has been activated and thereby released.
- Check the brake function: The shaft can be moved by hand with the brake released, but not when the brake is applied.

5.4.5 Reading in the motor data

Motor data set

The drive holds a motor data set in its memory. This motor data set contains technical information about the motor such as the nominal and peak torque, the nominal current and speed and the number of pole pairs. It cannot be modified by the user.

This means that the power amplifier cannot be switched on until the motor data have been loaded.

Motors with Hiperface interface

In the case of motors with the Hiperface sensor no motor data needs to be entered. The SinCos or SinCos Hiperface sensor in the motor saves all of the motor data. When the drive starts the data are read in, saved, and transferred to the start-up program automatically.

5.4.6 Setting device parameters

Selecting the control parameters set

The parameter values of the speed and position controllers are held in control parameter sets. The drive saves two separate parameter sets which are initialized at first start-up with the factory setting and with values from the motor data set.

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The parameter sets are successively selected and optimized. You can set the parameter set with the hand-held HMI operating unit via menu item "5.1 SetCtrl“, or with the commissioning software via the “parameter set” button on the control bar. Drive parameter sets are selected with the "Commands.setCtrl" parameter.

Setting limits

⚠WARNING

LIMIT AND PROTECTIVE PARAMETERS MUST BE PROPERLY SET

Incorrectly set limit or protective parameters cannot provide intended protection. Review all limit and protective settings prior to operating the servomotor. Examples of limit or protective functions include but are not limited to the following.

- Motor thermal protection settings (I_maxM, I_nomM, T_maxM, I2tM, I_0M)
- Drive thermal protection settings (P_maxBusr)
- Motor velocity limits (n_maxM, n_max0)
- Controller current limits (I_maxSTOP)
- Control loop error limits (Flt_pDiff)

Failure to follow these instructions can result in death, serious injury or equipment damage.

Setting limits on certain parameters can be important. For example, if the maximum torque possible from the motor can exceed the maximum allowable stress level of an element of the driven machinery, then setting appropriate limits on the peak available motor current can prevent damage.

▶ Select parameter set 1.

Set the current and speed limit parameters listed in the table on page 5-14 before operating the motor as part of the system. Suitable limits must be calculated from the system configuration and motor characterisitics. As long as the motor is running outside of the system, there is no need to change the default settings.

▶ Select parameter set 2 and proceed as for set 1.

Selecting the chopper frequency

The chopper frequency is set via the "Settings.f_Chop" parameter. The lowest possible frequency is the factory preset.

The 24 V power supply must be switched off and on again in order to activate the chopper frequency setting.

If the chopper frequency is changed from the factory setting, both the nominal current I_nomPA and the maximum current I_maxPA will be automatically reduced.

Registering a ballast resistor controller

If an external ballast resistor controller is connected, you must set the 'Settings.TL_BRC' parameter to '1'.

TLCT: Setting parameters

▶ Open the parameters window via 'Twin Line → Configuring' and enter the limit values for current and speed.

TLHMI: Setting parameters ▶ Limit values are entered through the menus shown in the following table.

Parameter name	Idx:Sidx	TL-HMI	Explanation and units [ ]	Value range [1)]	Default value	R/W rem.
CtrlBlock1.I_max CtrlBlock2.I_max	18:2 19.2	4.2.2 4.3.2	Current limitation in all operating modes including drive optimization. Not in operating modes Manual and Quick Stop (100=1Apk)	0...max.current [1)]	–	R/W rem.
CtrlBlock1.n_max CtrlBlock2.n_max	18:5 19.5	4.2.3 4.3.3	Max. speed [r.p.m.]	0..."Servomotor.n_maxM“	–	R/W rem.
Commands.SetCtrl	28:4	5.1.0	Switching control parameter sets	UINT16 0: - 1: parameter set 1, 2: parameter set 2	1	R/W -
Settings. I_maxSTOP	28:22	4.1.3	Current limitation for quick stop [Apk]	0...max. current [1)]	–	R/W rem.
Manual.I_maxMan	28:25	3.2.14	Max. current for manual movement [Apk]	0...max. current [1)]	–	R/W rem.
Settings.TL_BRC	28:26	4.1.14	External ballast resistor controller TLBRC	0: not connected 1: connected	0	R/W rem.
Settings.f_Chop	12:17	4.1.21	switching frequency of power module, (default value=1; 0 for TLxx38)	0: 4kHz 1: 8kHz 2: 16kHz	1	R/W rem.

1) Max. current: the lower of the two values, "Servomotor.I_maxM“ and "PA.I_maxPA“

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5.4.7 Checking inputs and outputs

The switching states of the inputs and outputs of the signal interface can be monitored with the commissioning software or with the Human-Machine Interface HMI. In addition the signal states of the inputs and outputs can be forced with the commissioning software - independently of the hardware signals that are present in the signal interface.

⚠WARNING

UNINTENDED EQUIPMENT ACTION / LOSS OF CONTROL

Forcing the signal interface inputs or outputs can cause unintended equipment action / loss of control.

- Do not force inputs or outputs unless the function of the input or output is known and understood.
- When forcing outputs during validation, apply power only to the function intended for actuation by the forcing operation.
- During forcing, keep all personnel and material out of the motion hazard zone surrounding the moving parts of the machine!

Failure to follow these instructions can result in death, serious injury or equipment damage.

Parameters for inputs and outputs

The states of the signal interface inputs and outputs are displayed in bit-coded form. Input data is contained in the 'I/O.IW0_act' and 'I/O.IW1_act' parameters, while output data is contained in 'I/O.QW0_act' and 'I/O.QW1_act'. The values 1 and 0 indicate whether an input or output is active.

0: The input or output carries 0 V.

1: The input or output carries 24 V.

Displaying signal states with TLCT

▶ Select the menu item 'Twin Line → Diagnostics → Device hardware' and click on the 'Inputs / outputs' tab.

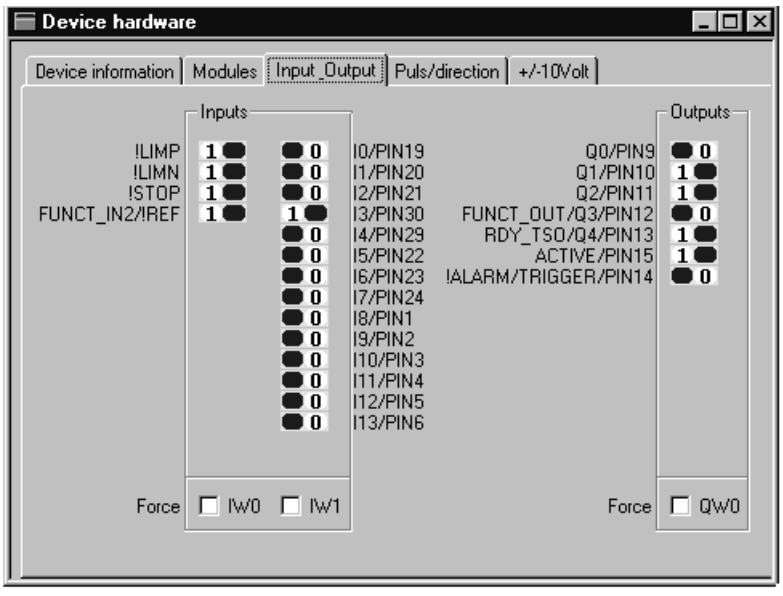

Fig. 5.7 Switching the inputs / outputs of the signal interface with the TLCT software

▶ Activate the 'Force' check box to modify inputs and outputs.

If the drive has a PULSE-C module installed and "Electronic gear" is active, the reference frequency values and direction for setpoint positioning can be observed and changed via'Pulse / direction' tab.

For detailed information on displaying and modifying signals with the commissioning software, see the diagnostics section in the Twin Line Commissioning Tool manual.

Displaying signal states with TLHMI

▶ Change to the menu item '2.4.1 IW0_act' or '2.4.10 QW0_act'.

'IW0_act' and 'IW1_act' show the inputs in bit-coded form, 'QW0_act' and 'QW1_act' show the outputs.

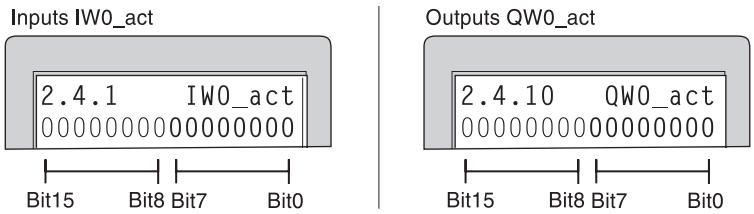

Fig. 5.8 Observing inputs / outputs of the signal interface with Human-Machine Interface HMI

The switching states of input and output signals cannot be changed with the Human-Machine Interface HMI.

For detailed information on displaying signals with the Human-Machine Interface HMI see the Twin Line HMI manual.

Displaying analog inputs

The value at the analog input, pins 17 and 18 of the signal interface, can be displayed via:

- TLHMI
- TLCT

TLCT: Displaying analog input

▶ Open the diagnostics window via menu item "Twin Line → Diagnosis → device data“ and the "+/-10Volt“ tab.

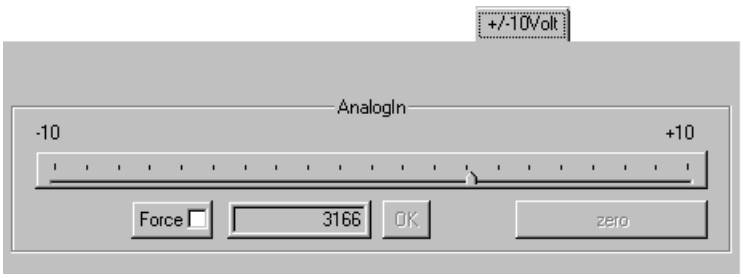

Fig. 5.9 Displaying and setting the analog input with the TLCT software

▶ Click on the "Force“ button to change the voltage of the analog input.

Details on displaying and changing signals with the commissioning software can be found in the "TLCT“ manual, in the chapter on diagnostic functions.

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5.4.8 Validating controller direction of rotation or direction of movement

⚠WARNING

UNINTENDED EQUIPMENT ACTION

Twin Line drives regulate motor current, speed, and position using speed and directional feedback information from a motor-mounted sensor. Incorrect connection of the motor phase wiring to the power amplifier output can cause the motor to accelerate to maximum speed when the drive is enabled.

Follow these instructions before attempting initial operation of a Twin Line drive or any time the motor or drive is replaced or changed.

- Verify that the motor phase connections are wired as illustrated in sections 4.4.3 and 4.4.4 of this instruction manual.
- Set the speed limit and current limit parameters of the controller to values that will prevent damage to the motor and driven machinery. Refer to section 5.4.6 for a table listing the speed and current limit parameters.
- When initially validating the ability of the drive to regulate motor speed, do so with the motor disconnected from the driven load.
- Motor rotation direction cannot be corrected by swapping the motor phases. Motor directional rotation can only be corrected via software programming. Refer to section 5.4.8 for directional conventions and procedures for setting rotational direction.

Failure to follow these instructions can result in death, serious injury or equipment damage.

The following conventions apply:

- A clockwise direction of rotation is defined as a clockwise movement of the motor shaft when viewed from the shaft end of the motor.
- With the VEL.velocity parameter signed positive and the Motion.invertDir parameter set to 0, the motor will rotate in a clockwise direction.
- With the Manual.startMan parameter set to 0, the resulting motion will cause a clockwise direction of rotation of the motor.

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When establishing the direction of rotation of the machine, follow these steps:

1. Initiate a manual movement with the motor uncoupled from the driven load to validate the encoder and motor phase connections.
2. Establish the required direction of rotation of the driven machinery.
3. Validate the direction of rotation of the motor with respect to the machine. If incorrect, use the Motion.invertDir parameter to correct the direction of rotation. DO NOT attempt to change the direction of motor rotation by changing the encoder or motor phase connections.
4. Couple the motor to the load and validate the direction of rotation.
5. Validate that the directional sense of all limit switches associated with a specific direction of motion is correct.

Manual movement with TLHMI

▶ With the Human Machine Interface HMI start manual movement by selecting menu item '3.2.11 Start'. Use the cursor keys to specify the direction of the movement.

▶ Test the direction of rotation. If the right cursor key is pressed, the motor shaft must rotate clockwise.

Detailed information on manual movement using the Human Machine Interface can be found in the TLHMI instruction manual.

Manual movement with TLCT

▶ In the commissioning software, select "Twin Line → Switch on power amp" to activate the power amplifier.

▶ Select "Twin Line → Positioning" to open the 'Positioning" dialog box. Select 'Manual' to start manual movement.

▶ Test the direction of rotation. Press one of the two right buttons in the dialog box to rotate the motor shaft clockwise.

Detailed information on manual movement using the commissioning software can be found in the TLCT instruction manual.

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5.5 Optimizing the drive

5.5.1 Controller structure

The Twin Line drive is capable of closed-loop current or position control. This is achieved using a cascaded control architecture incorporating a current, speed, and position controller. In addition, the reference variable of the speed controller can be smoothed by an upstream filter.

Set-up of the controllers is accomplished by first tuning the current control loop (inner loop), then the speed loop, and then finishing with the position loop (outermost loop). Automatic tuning of the current loop occurs when the motor parameters are entered into the Twin Line controller. Tuning of the speed and position loops requires that the commissioning personnel implement a series of tests to arrive at the correct drive settings. During each tuning operation, the drive that supplies the reference command to the loop being tuned is temporarily switched out.

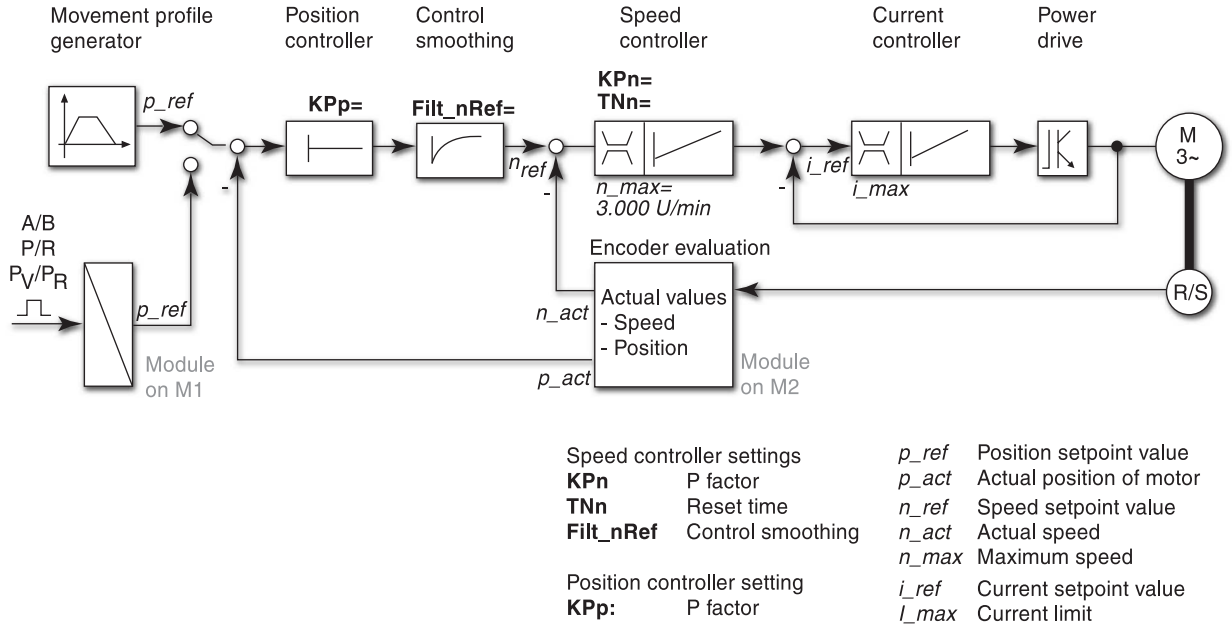

Fig. 5.10 Controller structure

Current controller The motor's drive torque is determined by the current controller. The current controller has been optimized using the stored motor data.

Speed controller The speed controller exerts a decisive influence on the speed at which the drive reacts. The dynamics of the speed controller depend on

- the moments of inertia of the drive
- the torque of the motor
- the rigidity and elasticity of the elements in the power flow path
- the hysteresis and non-linearities of the mechanical drive elements
- the friction and instantaneous load disturbances present in the drive train

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Position controller

The positioning controller reduces the contouring error to zero. The set-point for the position control loop is generated by the Twin Line controller's movement profile generator.

A requirement for good response of the position controller is an optimized speed control loop.

5.5.2 Configuring the optimization utility

Use the optimization utility to match the drive to the application requirements of the system. The utility is available with the Human-Machine Interface HMI and also with the commissioning software. Some functions are:

- Selection of the control loops to be tuned (higher-ranking control loops are switched off automatically).
- Defining reference signals: waveshape, amplitude, frequency, and starting point.
- Testing control response with a signal generator.
- On screen display and assessment of the control response with the commissioning software

TLCT: Setting reference signals

▶ Start the optimization utility via the menu item 'Twin Line → Controller → Optimize'.

Throughout the text and software, the term "jump function" is used. The jump function is known in mathematical terms as a step function, u(t).

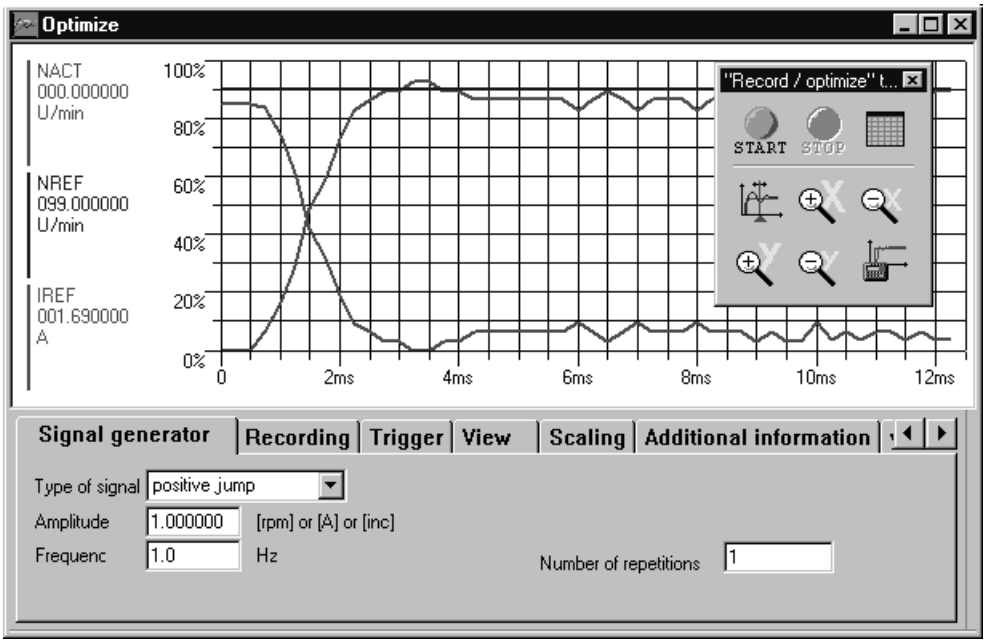

Fig. 5.11 Optimizing with the commissioning software

The window shows a graphic display of the speed reference signal and the response of the speed controller. Up to four response signals can be transmitted and displayed simultaneously. The utility is configured via the tabs.

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▶ Select the tab 'Reference variable' to set the values for the reference signal:

- Waveshape: _Positive jump
- Amplitude: 100 rpm
- Frequency: 1 Hz
- Number of repetitions: 1

It is only with the waveshape 'Jump' and 'Square wave' that the total dynamic behavior of a control loop can be understood. Refer to the "recording type" pull-down menu tab of the TLCT for all signal paths accessible with the waveshape "Jump".

TLCT: Setting signals to be recorded

▶ Select the 'Recording' tab to set the signals and default values for recording display:

- Use the 'select recording values' tab to select the signals which are to be displayed as a jump response from the control loop:

  n_act - the actual speed of the motor

  n_ref - the setpoint speed of the speed controller

  I_ref - the setpoint current of the current controller

- In the 'Timebase' field: 1 ms
- In the 'Recording type' field: Speed controller (the speed controller is being optimized).
- In the 'Measurements' field: 100, (measured data acquired for 100*1 ms)
- The 'Long-term measurement' and 'Loop' fields remain switched off.

Under the 'View' tab you can still modify the default values for the diagrammatic presentation of the individual signals. The other tabs for optimizing the drive can be left on the default settings.

TLCT: Inputting controller values

Speed and position controller parameters are set based on the procedures described in sections 5.5.3 through 5.5.8. These parameters must be tested by initiating a jump function.

A jump function is initiated immediately after recording is started. To initiate recording, press the button on the tool bar of the 'Optimize' window.

The speed and position controller settings can be modified in the parameters window of group 'CtrlBlock1' or 'CtrlBlock2'. Select parameter set 1 if the first parameter set is activated.

Algorithm for optimizing controllers

The Twin Line Commissioning Tool uses an algorithm to automatically optimize the drive. When the user calls up the algorithm, it determines the optimum parameter set for the combination of motor and controller connected.

Optimization is carried out by approximation using the "aperiodic limiting case" method. Theoretical controller settings are calculated based on an estimated value for the total moment of inertia.

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TLHMI: Setting reference signals

▶ Start the optimization utility via menu '6 Optimize'

▶ Set the reference signal:

- Select waveshape 'Jump' under '6.1.1 Ref_Typ': 1
- Select repeat frequency under '6.1.2 Ref_Frequ': 1Hz
- Select amplitude under '6.1.3 Amplitude': 100 rpm
- Select number of repetitions (cycles) under '6.1.4 CycleCnt': 1.

TLHMI: Setting controller values

Speed and position controller parameters are set based on the procedures described in sections 5.5.3 through 5.5.8. These parameters must be tested by initiating a jump function.

Speed controller settings are entered through '6.2 Speed contr.'. Proper tuning practices require that the speed controller must be optimized first.

Once a a controller setting is entered, the Human-Machine Interface HMI will ask whether a jump function should be started using the value which has been entered. Confirm by pressing Enter, respond in the negative by pressing Esc.

Recordings cannot be made with the TLHMI.

5.5.3 Optimizing the speed controller

The optimum setting for complex mechanical control systems assumes practical experience with setting and adjustment procedures for control equipment. This includes an ability to calculate control parameters and to apply tuning procedures.

Mechanical systems of a lower level of complexity can usually be optimized successfully with one of the following tuning procedures:

- Procedure A: Setting based on a rigid mechanism with a known and constant load inertia
- Procedure B: Setting per the Ziegler Nichols method
- Procedure C: Setting per the aperiodic limiting case method

The speed controller settings are adjusted through the following parameters:

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default-Value	R/W rem.
CtrlBlock1.KPn	18.7	6.2.1	Speed controller P-factor (1000=1Amin/rev)	UINT16 0...32767	0.1	R/W rem.
CtrlBlock1.TNn	18.8	6.2.2	Speed controller integral time I-factor (100=1ms)	UINT16 0...32767	5	R/W rem.

Once initial speed controller settings have been determined, check and optimize the values obtained, as described in 'checking and optimizing default settings' on page 5-29.

Determining the mechanics of the system

Decide which one of the following two systems best describes the mechanics of the machine being evaluated in order to assess and optimize its response behavior.

- System with rigid mechanism
- System with less rigid mechanism

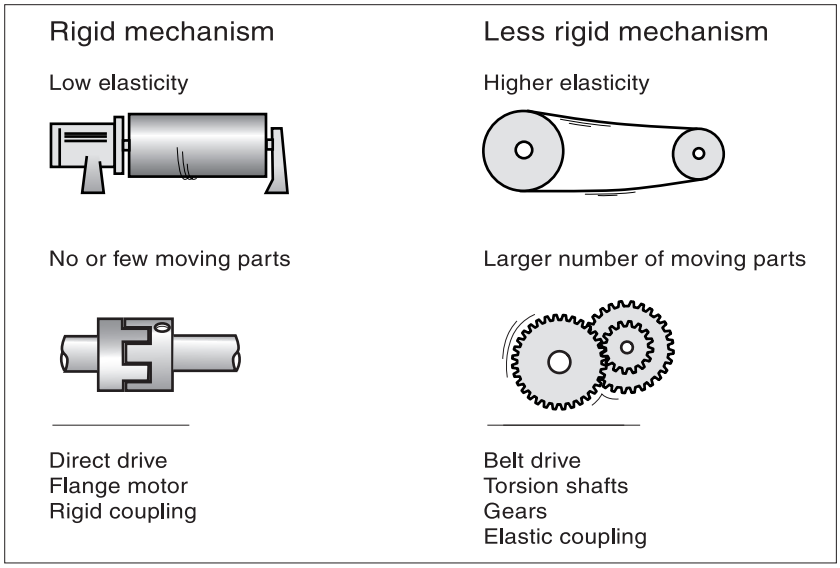

Fig. 5.12 Mechanical systems with rigid and less rigid mechanisms

▶ Connect the motor to the driven machinery.

⚠WARNING

LOSS OF CONTROL

When the jump function is enabled, the motor will start and run at a constant speed until the NOT[LIMP], NOT[LIMN], NOT[STOP] or STOP input functions are activated.

- Validate the operation of the NOT[LIMP], NOT[LIMN] and NOT[STOP] limit switches before initiating any tuning procedures.
- The external sensors and limit switches must be properly located on the machine motion being controlled.
- To operate, the NOT[LIMP], NOT[LIMN] and NOT[STOP] input functions must be enabled in the drive software.
- Validate that all machine EMERGENCY STOP systems function properly before initiating any tuning procedures

Failure to follow these instructions can result in death, serious injury or equipment damage.

▶ Carry out a function check of the limit switches once the motor has been installed. Refer to section 5.4.3 for checking the limit switches.

Switching off the speed reference filter

The speed reference filter can be used to improve the response behavior while optimizing the speed control. The filter must be switched off during the initial set-up of the speed controller.

▶ Deactivate the reference filter. Set the filter time constant 'Filt_nRef' to the lower limit value of 0.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default-Value	R/W rem.
CtrlBlock1.Filt_nRef	18:20	4.2.8	Speed reference filter time constant (100=1ms)	UINT16 0...32767	0	R/W rem.

5.5.4 Procedure A: Rigid mechanism and known moments of inertia

Assumptions for using the control settings in the following table are as follows:

- a known and constant inertia of load and motor
- a rigid mechanism

Determining drive values

The P-factor 'CtrlBlock1.KPn' and the reset time 'CtrlBlock1.TNn' are a function of the inertia of the motor and of the external inertia.

▶ Determine the values with the aid of the following table. J_L: Mass moment of inertia of load J_M: Mass moment of inertia of the motor

	$J_L=J_M$		$J_L=5 * J_M$		$J_L=10 * J_M$	
J_L[kgcm^2]	KPn	TNn	KPn	TNn	KPn	TNn
1	0.0125	8	0.008	12	0.007	16
2	0.0250	8	0.015	12	0.014	16
5	0.0625	8	0.038	12	0.034	16
10	0.125	8	0.075	12	0.069	16
20	0.250	8	0.150	12	0.138	16

▶ Initiate a jump function.

▶ Check the drive settings as described in “Checking and optimizing default settings“ on page 5-29.

If oscillations occur using the setting values from the table, this is an indication that the mechanism is not sufficiently rigid. Should this occur, use Procedure C 'Aperiodic limiting case' to determine the default settings of the controller values.

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5.5.5 Procedure B: Ziegler Nichols

⚠CAUTION

SUSTAINED OSCILLATIONS DURING TUNING

Use of the Ziegler Nichols tuning method will subject the motor and driven machinery to sustained speed or position oscillations. Do not use this tuning method if the machine drivetrain is prone to resonance (i.e. torsional, etc.) or if the driven machinery could be damaged by rapid speed or position oscillation.

Failure to follow this instruction can result in death, serious injury or equipment damage.

A requirement which must be satisfied before the setting values can be worked out by the Ziegler Nichols method is that the speed controller be permitted to be run briefly in the unstable (or oscillatory) range for the purpose of making settings.

Determining controller values

The critical gain of the speed controller needs to be determined as part of optimization procedure:

▶ Set the reset time 'CtrlBlock1.TNn' to maximum: TNn = 327.67 ms.

If load torque is present with the motor at standstill, the reset time 'TNn' should be set only to the level at which no uncontrolled change in the motor position occurs.

In the case of drive systems in which the motor is subjected to load while at standstill - for example, with vertical axis operation - a reset time of 'Infinite' can lead to unwanted position deviations and means that the reset time must be reduced. However, reductions of reset time can de-optimize the tuning procedure.

▶ Initiate a jump function.

▶ After the first test, check the maximum amplitude of overshoot of the setpoint current value 'I_ref'. With the Twin Line Commissioning Tool, click beneath the highest point of the 'I_ref' recording and read off the value on the display.

The amplitude of the reference variable – the default was 100 rpm – must be limited to ensure that the setpoint current value 'I_ref' stays below the maximum value 'CtrlBlock1.I_max'. However, the value must be sufficiently large so that friction effects of the machinery do not dominate the control loop response.

▶ Start a jump function once more if it was necessary to change 'n_ref'. Check the amplitude of ‘I.ref’ during the jump function to ensure that the value is less than ‘CtrlBlock1.I_max’.

▶ Increase the P-factor in small steps until 'n_act' reacts with a marked oscillation. **The P-factor is now the same as the critical gain.**

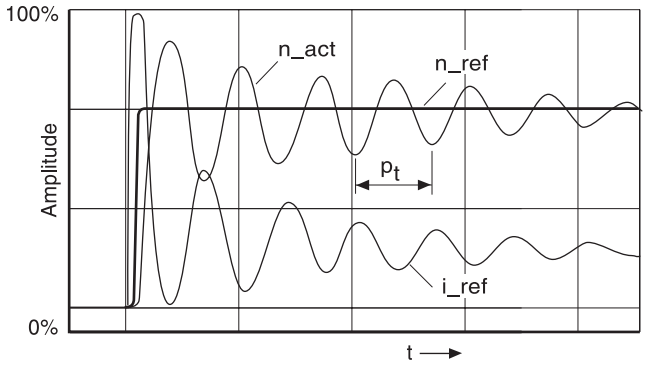

Fig. 5.13 Period of oscillation Pt at critical gain

▶ Measure the period of oscillation P_t. To do so set a reference point at the start of the oscillation period and click on the end point of the period. The difference in ms now appears under 'DIFF' on the status bar.

▶ Use the following formula to calculate the optimized setting for the P-factor 'KPn' and reset time 'TNn':

KPn = 0.35 * critical gain

TNn = 0.94 * period of oscillation P_t

▶ Enter the optimized values and check the drive settings as described in “Checking and optimizing default settings“ on page 5-29.

Example

- Start with

  KPn = 0.01 Amin/rev

  TNn = 327.67 ms.

- Increase the KPn to critical gain.
- Critical gain at KPn = 0.048 Amin/rev. Measured period of oscillation P_t = 3 ms.
- From this the optimized values are calculated:

  KPn = 0.35 * 0.048 Amin/rev = 0.0168 Amin/rev TNn = 0.94 * 3 ms = 2.82 ms.

TLADOCD03ME, -001, 08.02

5.5.6 Procedure C: Aperiodic limiting case

Determining drive values

For optimization purposes, the P-factor of the speed controller is set to the value at which the controller adjusts the speed 'n_act' as quickly as possible without overshooting.

▶ Set the reset time ‘CtrBlock1.TNn” to the maximum value: TNn=327.67 ms.

If load torque is present with the motor at standstill, the reset time 'TNn' should be set to a value at which no uncontrolled change in the motor position occurs.

In the case of drive systems in which the motor is subjected to load while at standstill - for example, with vertical axis operation - a reset time of 'Infinite' can lead to unwanted position deviations and means that the reset time must be reduced. However, reductions of reset time can de-optimize the tuning procedure.

▶ Initiate a jump function.

▶ After the first test check the maximum amplitude of overshoot of the setpoint current value 'I_ref'. With the Twin Line Commissioning Tool, click beneath the highest point of the 'I_ref' recording and read off the value on the display.

The amplitude of the reference variable – the default was 100 rpm – must be limited to ensure that the setpoint current value 'I_ref' stays below the maximum value 'CtrlBlock1.I_max'. However, the value must be sufficiently large so that friction effects of the machinery do not dominate the control loop response.

▶ Start the jump function once more if it was necessary to change 'n_ref'. Check the amplitude of 'I_ref' during the jump function to ensure that the value is less than CtrlBlock1.I_max.

▶ Increase or decrease the P-factor in small steps until 'n_act' changes as fast as possible without overshoot. The leftmost diagram in Fig. 5.5 shows the response required. Overshoot (as shown in the right diagram) must be reduced by reducing the 'KPn' value.

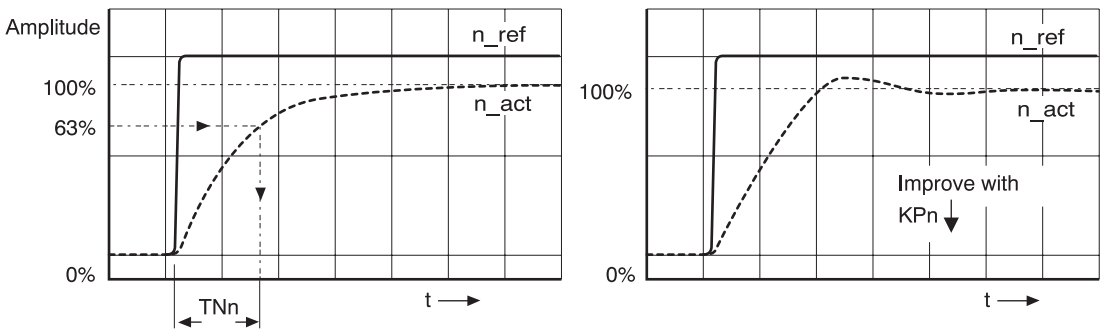

Fig. 5.14 Determining 'TNn' in the aperiodic limiting case

Steady-state error between 'n_ref' and 'n_act' results from setting 'TNn' to 'Infinite'.

In the case of drive systems which experience oscillation when the aperiodic limiting case is reached, the P-factor 'KPn' must be reduced to the point at which no oscillations can be detected. This scenario occurs frequently with linear motion applications using a toothed belt drive.

Graphic determination of the 63% value

Determine graphically the point at which the actual speed 'n_act' reaches 63% of the final value. The reset time 'TNn' is then measured as a value on the time axis. The commissioning software will help with the evaluation:

- Under the 'Scaling' tab select the channel for 'n_act' and enter the final value of 'n_act' as 100% mark.
- Determine the point on the recording where the amplitude reaches 63%. Place the cursor on the ‘n_act’ curve at the 63% point and click.
- If the 'n_ref' jump begins at 0 ms, the time value, ‘TNn’, can be read directly off the status bar under “ABS”.
- If 'n_ref' begins later than 0 ms, measure the distance from the jump point by setting a reference point at the start of the reference jump and click on the end point. The difference in ms now appears under 'DIFF' on the status bar.
- Enter this value for 'TNn' and check the controller settings as described in “Checking and optimizing default settings“ on page 5-29.

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5.5.7 Checking and optimizing default settings

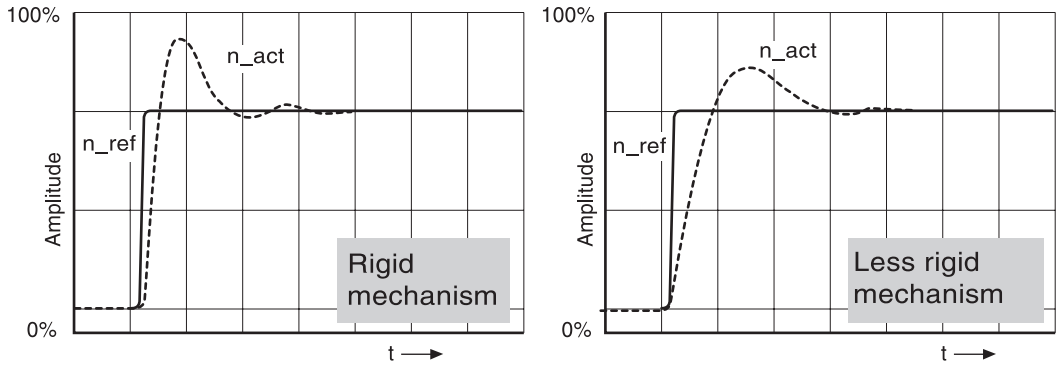

Fig. 5.15 Jump responses with good control response without reference smoothing

The drive is properly set when the jump response is approximately identical to the waveforms shown. Good control response can be recognized by

- rapid rise time
- an overshoot not exceeding 40% (20% is recommended)

If the control response does not correspond to the waveforms shown, change 'KPn' in steps of about 10% and then initiate a jump function once again:

- If the drive is too slow: increase 'KPn'.
- If the drive tends to oscillate: decrease 'KPn'.

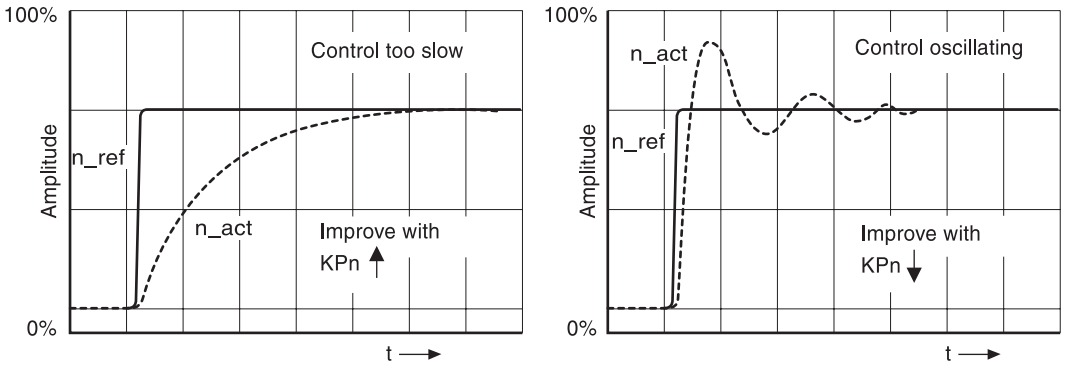

Fig. 5.16 Optimizing poor settings of the speed controller

If the motor hunts even with the factory settings, or if the drivetrain is not a mechanically rigid mechanism, satisfactory control response may not be possible by adjusting the values of 'KPn' and 'TNn'. It will be necessary to adapt the settings in the position loop to compensate for the mechanical system. Contact your Schneider Electric representative for further information. The position controller must be adapted to the particular application. Hunting can be recognized by significant motor speed fluctuations after a speed change or continuous acceleration and deceleration of the motor.

Effect of the speed reference filter on control response and stability

A speed controller with a rapid response can be modified to reduce the overshoot of the jump response by using the speed reference filter. The use of the filter is only recommended for systems with a rigid mechanism. The filter does allow a rapid control response, but the stability of the mechanical system can be affected, rendering it susceptible to oscillation.

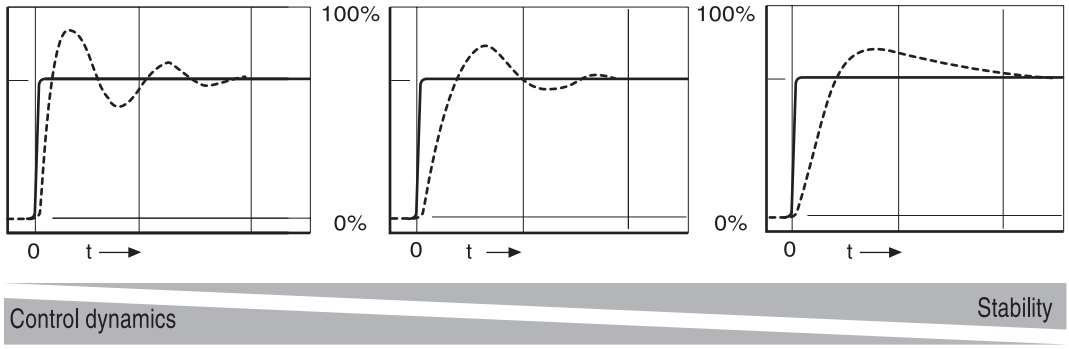

Fig. 5.17 Relationship of control response and stability

- Control response: the speed at which the actual value follows the setpoint value
- Stability: the tendency of the actual value to fluctuate. Fewer oscillations mean good stability.

Switching on the speed reference filter

Determine graphically the point at which the actual speed 'n_act' reaches 63% of the final value. The filter value 'Filt_nRef' may be read off on the time axis as shown in the left-hand part of the following diagram. The method for graphically determining the 63% value is described on page 5-28 (determination of the reset time 'TNn').

▶ Set the value 'CtrlBlock1.Filt_nRef' to the time value obtained.

▶ Start a jump function with an amplitude of 10% of the maximum speed value.

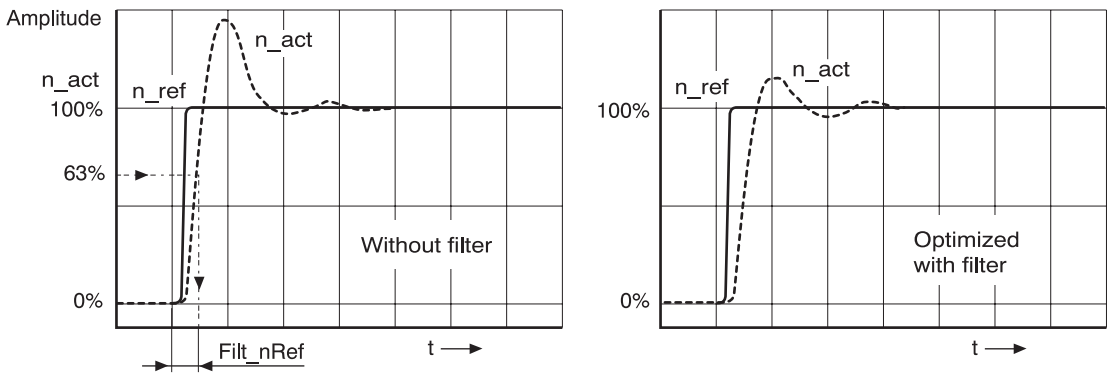

Fig. 5.18 Determining Filt_nRef from the jump response (left). Response with speed reference filter active (right).

With a less rigid mechanism, overshoot can actually get worse. In such a case, reset the value 'Filt_nRef' to its original value.

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5.5.8 Optimizing the position controller

A requirement for optimization of the position controller is a good control response of the inner speed control circuit.

To set the position control you will need to optimize the P-factor of the position controller 'KPp' within two limits:

- 'KPp' too great: overshooting of the mechanism, instability of the controller
- 'KPp' too small: large contour error

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
CtrlBlock1.KPp	18:15	6.3.1	Position controller P-factor [1/s]	0 - 3.276.7	1.4	R/W rem.

TLCT: setting the reference signal

▶ Via 'Twin Line → Controller → Optimize' and the 'Recording' tab, select the position controller in the 'Recording type' field.

▶ Under the tab 'Reference variable' set the values for the reference signal:

- Waveshape: 'Jump'
- Amplitude of approximately 1/10 of a motor revolution
  - with the HIFA–C Hiperface module: 1600 Inc

TLCT: Selecting recording signals

▶ In the 'Recording' tab under 'Recording objects' and 'Processing' select the following signals for recording:

- Setpoint of the position controller 'p_ref'
- Actual position of the position controller 'p_act'
- Actual speed of the motor 'n_act'
- Setpoint current of the current controller 'I_ref'

Controller values for the position controller can be changed in the same parameter group that was used for the speed controller.

TLHMI: Setting the reference signal

▶ Set the reference signal under '6.1 Settings':

- Waveshape: 'Jump' under '6.1.1 Ref_Typ' = 1
- Amplitude for about 1/10 of a motor revolution under '6.1.3 Amplitude':
  - with the HIFA–C Hiperface module: 1600 Inc

Controller values for the position controller can be changed under '6.3 Position controller'.

Recordings cannot be made with the with the TLHMI.

Optimizing the position control value

- ▶ Start a jump function with the default controller values.
- ▶ After the first test, check the setting of the values 'n_act' and 'I_ref' for current and speed control. The values must not cross into the range of current and speed limiting.

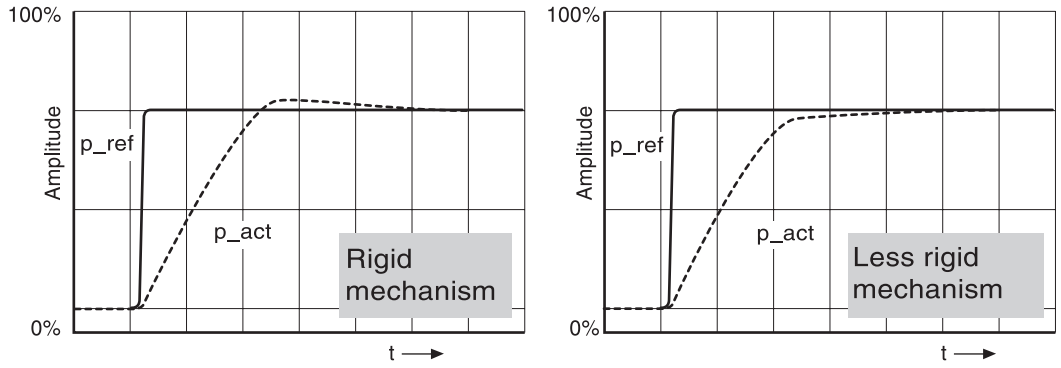

Fig. 5.19 Jump responses of a position controller with a good control response

The proportional factor 'KPp' is at its optimum setting when the motor reaches its target position rapidly and with little or no overshooting.

If the control response does not correspond to that shown in Fig. 5.19, change the P-factor 'KPn' in steps of about 10% and then initiate a jump function once again:

- If the position controller tends to oscillate: decrease 'KPp'.
- If the actual position value is too slow following the setpoint value: increase 'KPp'.

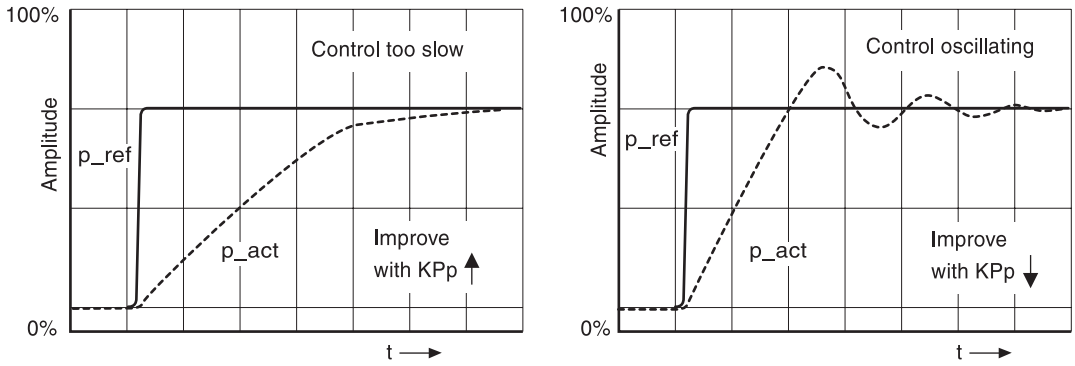

Fig. 5.20 Optimizing poor settings of the position controller

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6 Operating modes of the drive

Modes of operation and command sets are summarized in each of the following sections. The example table, located below, gives an overview of the information contained in each section, along with usage notes. Additional manuals are required to correctly implement these features. Please refer to the following manuals before attempting to complete a system configuration.

- For HMI features, refer to manual TLADOCHMIME.
- For commissioning software (TLCT), refer to manual TLADOC TLCTE.

Parameter Name	Idx:Sidx	TL-HMI Address	Explanation and unit [ ]	Range of values	Default Value	R/W rem
Manual.I_maxMan	28:25	3.2.14	max. current manual movement [Apk]	0..max. current 0..29999	1000	R/W rem.
Name of each adjustment or monitoring parameter. These names are used as references in the commissioning software.	Index and Sub-index values. Used by FieldBus programming equipment.	Routing address to a specific menu within the HMI menu hierarchy.	Short description of the command or monitoring feature.	Programmers description and data type. **UINT**–unsigned integer, **INT**–integer, Word size: 16 or 32 bits	Default value	Permitted access method and data retention. **R**– read only, **W**– write only, **R/W**– both, **rem** indicates non-volatile storage

⚠WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of the control signal paths and, for certain critical control functions, provide a means to achieve a safe state during and after a signal path failure. Examples of critical control functions are Emergency Stop and Overtravel Stop. Refer to NEMA ICS1.1 *Safety Guidelines for the Application, Installation and Maintenance of Solid State Control* and NEMA ICS7.1 *Safety Standards for construction and Guide for Selection, Installation and Operation of Adjustable –Speed Drive Systems* for further information
- System control signal paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failure of the link.

Failure to follow these instructions can result in death, serious injury or equipment damage.

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6.1 Operating modes and access

The drive has four operating modes and two setup modes. These modes are described in detail in the following sections. Access channels are used to provide instructions to the drive controller. The access channel table, shown below, describes the operating modes that can be used with each type of signal interface. Note that the available modes differ between access channel types. During configuration, pairs of automatic operation modes can be selected with TLCT. While final selection of the operating mode is based on signal input FUNCT_IN2.

	Access channels	
Operating modes and functions [1)]	**TLHMI, TLCT**	**I/O of signal interface**
Manual mode	•	•
Automatic current mode	-	•
Automatic speed mode	-	•
Automatic electronic gear	-	•
Controller setup	•	-

1) •: access possible, –: no access

6.1.1 Operating modes

Operating modes

The controller functions in four operating modes:

- Manual movement mode
- Automatic current mode
- Automatic speed mode
- Automatic electronic gear mode (if a module is installed in slot M1)

In addition to these modes, a background utility is also loaded at start up. This utility is activated by the HMI or commissioning software, if they are present. The utility works to collect background information used by these tools.

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6.1.2 Selecting operating mode

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

Digital or analog signal inputs serve as setpoint inputs for torque, velocity or position commands, change parameter sets, switch between manual and automatic mode and toggle between selectable operation modes. Unintended equipment operation may occur, if signals are incompletely or incorrectly wired or improper signal levels are applied to the signal inputs.

- Verify the Twin Line unit is correctly and completely wired.
- Verify proper signal levels applied to the signal inputs.
- If possible, verify operation modes with the motor disconnected from the driven machinery. Once initial verification is complete, reconnect the motor and verify operation of the overall system.

If controller verification is done with a stand-alone test motor, the motor frame must be securely anchored to prevent unintended movement or toppling during rapid acceleration or deceleration.

Failure to follow these instructions can result in death or serious injury, or equipment damage.

Switching between manual and automatic mode

The operator can switch between the mode during operation. The drive switches between the automatic modes without stopping the motor. When switching between manual and automatic mode, the motor stops briefly and activates the drive parameters and specific settings for the new operating mode.

If a malfunction occurs before or during the mode change, the drive responds in accordance with an error class; see “Diagnosis and error rectification“, page 8-1.

The AUTOM input signal is used to switch between manual and automatic mode.

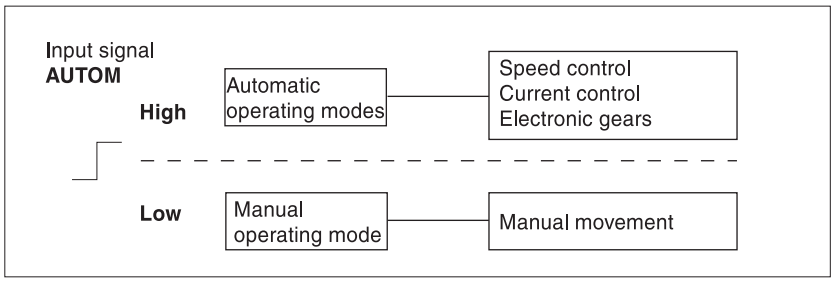

Fig. 6.1 Switching with the AUTOM input signal

I/O signal	Function	Value
AUTOM	Manual mode on Automatic mode on	low/open high

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Activate manual mode

Condition: AUTOM signal to low level

Operating mode	Starting conditions for the mode	Starting the mode
Manual movement	Motor standstill and no fault	MAN_N or MAN_P input signal active or manual movement signal via input unit

Select automatic mode

Condition: AUTOM signal to high level

The automatic mode is set with the FUNCT_IN2 signal input and the "Settings.FCT_in2" parameter: use the "Settings.FCT_in2" parameter to select a pair of modes and activate one of them with FUNCT_IN2.

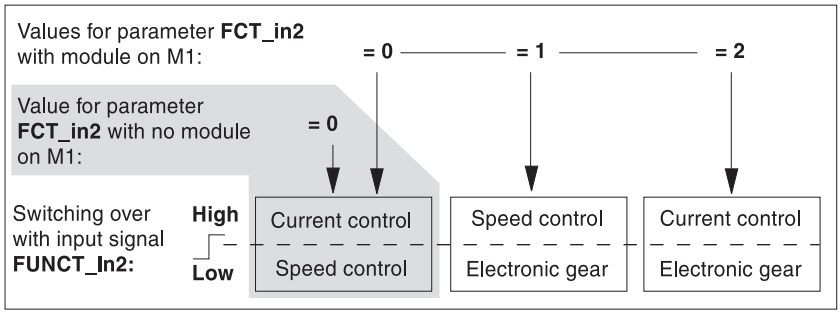

Fig. 6.2 Changing the automatic modes with and without a module in slot M1; M1 is grayed out without a module

The "Settings.FCT_in2" parameter is displayed in the operating software and can be configured in the commissioning software and on the HMI handheld unit if a module for electronic gear mode is installed at slot M1. With no module at slot M1 the "Settings.FCT_in2" parameter is not displayed.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Settings.FCT_in2	17:1	4.1.6	Selecting two reversible automatic modes via FUNCT_IN2 input signal: low/high	0: speed/current controller 1: position/speed controller 2: position/current controller	1	R/W rem.

I/O signal	Function	Value
FUNCT_IN2	FCT_in2 = 0: speed control current regulation	 low/open high
	FCT_in2 = 1: electronic gear speed control	 low/open high
	FCT_in2 = 2: electronic gear current regulation	 low/open high

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6.2 Manual movement

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

Digital or analog signal inputs serve as setpoint inputs for torque, velocity or position commands, change parameter sets, switch between manual and automatic mode and toggle between selectable operation modes. Unintended equipment operation may occur, if signals are incompletely or incorrectly wired or improper signal levels are applied to the signal inputs.

- Verify the Twin Line unit is correctly and completely wired.
- Verify proper signal levels applied to the signal inputs.
- If possible, verify operation modes with the motor disconnected from the driven machinery. Once initial verification is complete, reconnect the motor and verify operation of the overall system.

If controller verification is done with a stand-alone test motor, the motor frame must be securely anchored to prevent unintended movement or toppling during rapid acceleration or deceleration.

Failure to follow these instructions can result in death or serious injury, or equipment damage.

In manual movement mode the drive operates under speed control. The AUTOM input signal must be at low level.

In manual movement the motor can be moved at two speed levels via the commissioning software, via the Human-Machine Interface HMI or via the following input signals for manual operation.

I/O signal	Function	Value
MAN_N	Travel in counter-clockwise direction	high
MAN_P	Travel in clockwise direction	high
MAN_FAST	Slow speed Fast speed	low / open high
AUTOM	Manual operating mode Automatic operating mode	low / open high

Movement parameters

The speed values for both speed levels can be set, as can the maximum current for limiting the torque.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values [1)]	Default value	R/W rem.
Manual.I_maxMan	28:25	3.2.14	Max. current manual operation [A]	0 - max. current	–	R/W rem.
Manual.n_slowMan	42:3	3.2.12	Speed for slow manual movement [rpm]	± max. speed	–	R/– rem.
Manual.n_fastMan	42:4	3.2.13	Speed for fast manual movement [rpm]	± max. speed	–	R/– rem.

1) Max. current: Lower of the two values 'Servomotor.I_maxM' and 'PA.I_maxPA' Max. speed: Device-limited value of 'Servomotor.n_maxM'

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Example Simple, partially automated travel can be achieved by controlling signals for manual movement by hand-operated switches and cam switches.

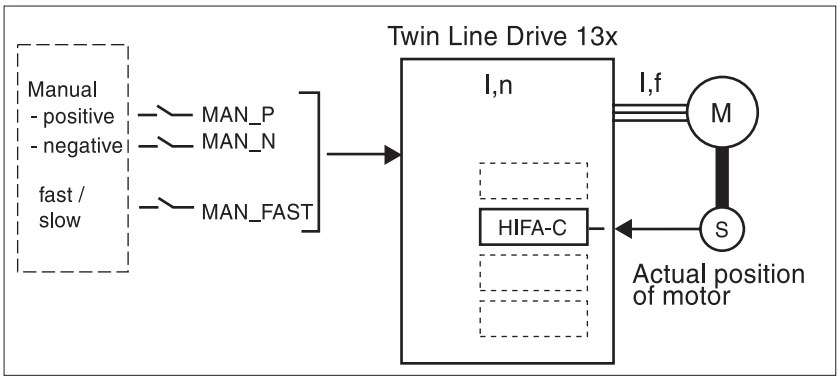

Fig.6.3 Manual operation with speed control

6.3 Speed and current control

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

Digital or analog signal inputs serve as setpoint inputs for torque, velocity or position commands, change parameter sets, switch between manual and automatic mode and toggle between selectable operation modes. Unintended equipment operation may occur, if signals are incompletely or incorrectly wired or improper signal levels are applied to the signal inputs.

- Verify the Twin Line unit is correctly and completely wired.
- Verify proper signal levels applied to the signal inputs.
- If possible, verify operation modes with the motor disconnected from the driven machinery. Once initial verification is complete, reconnect the motor and verify operation of the overall system.

If controller verification is done with a stand-alone test motor, the motor frame must be securely anchored to prevent unintended movement or toppling during rapid acceleration or deceleration.

Failure to follow these instructions can result in death or serious injury, or equipment damage.

Under speed and current control the motor runs in accordance with a configurable default value for speed or current. Speed or current control is only active in automatic operation.

The reference variable is specified via the ±10 V analog input of the signal interface as a voltage between +10 V and -10 V.

I/O signal	Function	Value
Analog_IN+	Analog signal for setpoint input	±10 V
Analog_IN-	Reference potential for the analog signal	0 V
AUTOM	Automatic operation Manual operation	high low / open

The drive reads in the ±10 V setpoint input cyclically according to the controller clock and converts it at 12 bit resolution into a setpoint value for the motor movement.

Switching over to speed or current control

When the drive changes over to ±10 V speed or current control (the power amplifier must be enabled), the motor immediately runs at the standardized ±10 V analogue value being input or, if an input device is active, at the value specified by the input device.

Speed and current limits

To provide protection for the drive system, speed and current limiting must be matched to the drive system in question. This is effected with the two parameters 'n_max' and 'I_max'. See “Setting device parameters“ on page 5-12.

Speed control

The drive uses the ±10 V setpoint specification to calculated a setpoint speed for the motor. The speed for a voltage figure of 10 V can be set via the scaling value 'n_RefScal' .

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Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values [1)]	Default value	R/W rem.
Settings.n_RefScal	12:10	4.1.22	Setpoint speed with 10 V input signal [rpm]	0 .. max. speed	3000	R/W rem.

1) Max. speed: Device-limited value of 'Servomotor.n_maxM'

Current control

The drive uses a preset ±10 V setpoint value to calculate the current required to accelerate the motor up to the speed limit limited by the torque. The motor current provided is roughly proportional to the torque of the motor. Unloaded the motor therefore accelerates up to the configurable speed limit.

The current for a voltage figure of 10 V can be set via the scaling value 'Settings.I_RefScal' .

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values [1)]	Default value	R/W rem.
Settings.I_RefScal	12:3	4.1.20	Setpoint current with 10 V input signal [rpm]	0 - max. current	300	R/W rem.

1) Max. current: Lower of the two values 'Servomotor.I_maxM' and 'PA.I_maxPA'

Example

A position control facility with speed-regulated operation and external position control can be set up with the ESIM1-C encoder simulation module and an NC controller.

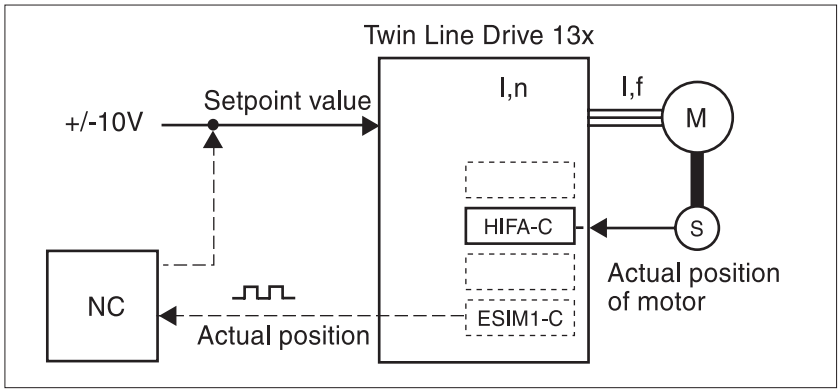

Fig.6.4 Speed and current control with ±10 V setpoint input

Options for current and speed control

The curve of the setpoint speed or the setpoint current can be changed depending on the ±10 V input value with the aid of an offset or a voltage window.

6.3.1 Analog value offset

The "Settings.offset_0V" parameter can be used to vary the offset for the ±10V input on the operator side, which changes the relationship between input voltage and current or speed setpoint value (or torque) depending on the setting of "Settings.FCT_in2".

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Settings.offset_0V	20:58	4.1.38	Offset to shift of the 0V input voltage [mV]	-5000..+5000	0	R/W rem.

Small deviations in the zero area can be compensated with the analog value offset.

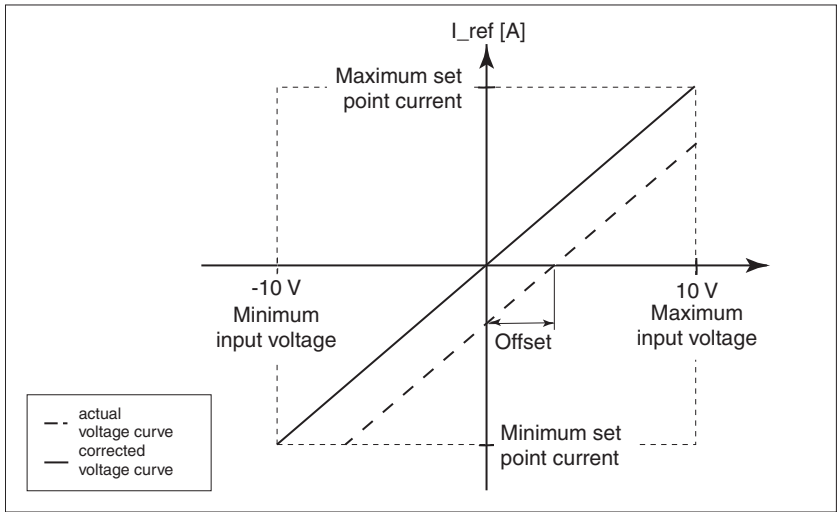

Fig. 6.5 Analog value offset for the ±10 V input

The figure "Analog value offset for the ±10V input" also applies for the speed setpoint value depending on the ±10V input.

6.3.2 Analog value voltage window

An analog value voltage window can be set with "Settings.win_10V" for the ±10 V input. The setpoint current value takes the value 0 here.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Settings.win_10V	20:59	4.1.39	Voltage window within which its analog value is equal to 0 [mV] Example: Setting value of 20 mV means that the range -20 mV to +20 mV is interpreted as 0 mV	0..1000	0	R/W rem.

Once the voltage window range is left, a setpoint value ≠ 0 is generated.

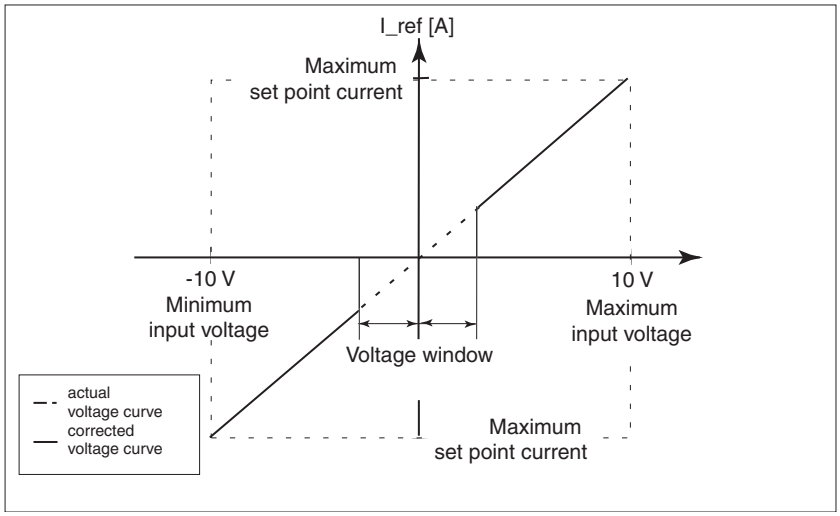

Fig. 6.6 Analog value voltage window around the value 0 V for the ±10 V input

The figure "Analog value voltage window around the value 0V for the ±10V input" also applies for the speed setpoint value depending on the ±10V input.

6.4 Electronic gear

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

Digital or analog signal inputs serve as setpoint inputs for torque, velocity or position commands, change parameter sets, switch between manual and automatic mode and toggle between selectable operation modes. Unintended equipment operation may occur, if signals are incompletely or incorrectly wired or improper signal levels are applied to the signal inputs.

- Verify the Twin Line unit is correctly and completely wired.
- Verify proper signal levels applied to the signal inputs.
- If possible, verify operation modes with the motor disconnected from the driven machinery. Once initial verification is complete, reconnect the motor and verify operation of the overall system.

If controller verification is done with a stand-alone test motor, the motor frame must be securely anchored to prevent unintended movement or toppling during rapid acceleration or deceleration.

Failure to follow these instructions can result in death, serious injury or equipment damage.

In the electronic gear operating mode, the drive calculates a new position setpoint for the motor to move to, from a predefined position and an adjustable gear ratio. This operating mode is used when one or several motors is to follow the reference signal from a NC control unit or an encoder.

In order to work in electronic gear mode, the encoder module RS-422-C or the pulse/direction module PULSE-C must be inserted in slot M1. Depending on the module, different types of signal can be supplied:

- A/B signals with the RS-422-C module
- Pulse-direction or pulse forward/pulse backward signals with the PULSE-C module.

The”standstill window” function can be enabled with electronic gear mode.

Gear factor

The gear factor is the ratio between motor increments and externally fed reference increments for motor movement. The gear factor is defined with the parameters for numerators and denominators. A negative numerator value reverses the motor’s direction of rotation. The gear ratio is preset to 1:1.

$$\text{Gear factor} = \frac{\text{Motor increments}}{\text{Reference increments}} = \frac{\text{Gear factor numerator}}{\text{Gear factor denominator}}$$

At a setting of 1000 reference increments the motor should rotate 2000 motor increments. This yields a gear ratio of 2:1 or a gear factor of 2.

A new gear ratio is activated when the numerator value is supplied.

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Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default value	R/W rem.
Settings.Gear_Num	17:3	4.1.8	Numerator of the gear ration of the electronic gear	-32768...32767	1	R/W rem.
Settings.Gear_Den	17:4	-	Denominator of the gear ration of the electronic gear	1...32767	1	R/W rem.

The resolution used by the drive for calculating the gear ratio is

- 16384 pulses per revolution with Hiperface motors

Current limiting

To provide protection for the drive system, current limiting must be matched to the drive system in question. This is effected with the parameter 'CtrlBlock1/2.I_max'. See “Setting device parameters“ on page 5-12.

Position control

In electronic gear operating mode the drive internally activates position control in order to control deviations of the motor setpoint and actual positions by resetting to zero. If this operating mode is switched on, the drive accepts the current position of the motor as the new value for the setpoint position of the motor.

Pulses injected via the PULSE-C or RS422-C module are evaluated by the drive immediately this operating mode is activated. These pulses will not be accepted:

- Before the operating mode was activated
- In the case of emergency braking with quick stop
- While there is an active fault of error classes 1 - 3. The error class determines how the drive will react to an error.

Contouring error

If the pulse frequency at the setpoint input changes quickly, the drive will not be able to follow a positioning setpoint directly. A temporary contouring error results. To prevent this contouring error resulting in the power amplifier being switched off, the contouring error limit value and the error class can be set, see “Monitoring internal signals“ from page 7-5.

Example

An NC controller sends a position setpoint to two drive units. The motors perform proportional positioning movements corresponding to the gear ratios.

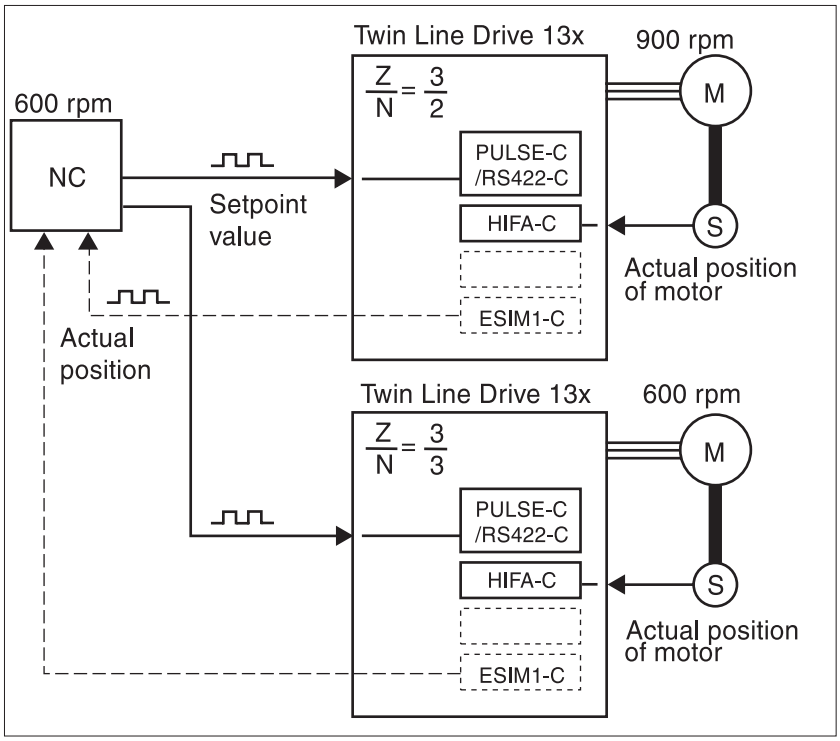

Fig.6.7 Electronic gear with setpoint from an NC controller

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The setpoint can also be preset with an incremental encoder or sent to a second unit via the encoder simulation of an first drive instead of via an NC controller.

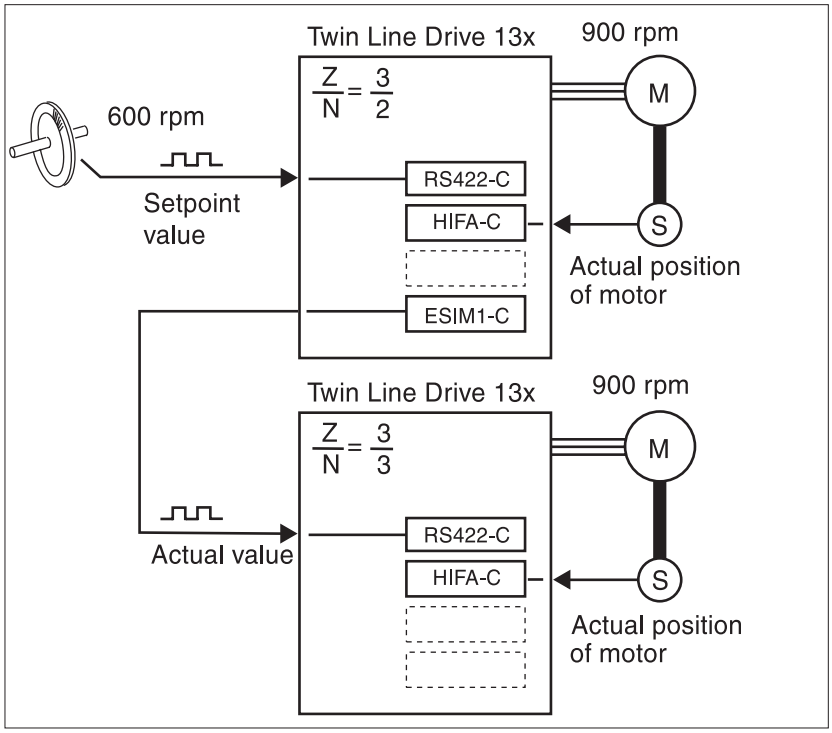

Fig. 6.8 Electronic gear with setpoint via encoder signals

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7 Functions of the drive

7.1 Quick stop function

⚠WARNING

LOSS OF BRAKING TORQUE

- No holding torque is available during loss of power or drive controller fault.
- When required (i.e., for protection of personnel), use a separate braking function for holding torque. Refer to NEMA ICS7.1 *Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable - Speed Drive Systems* for additional information.
- Availability of sufficient braking torque for rapid stopping requires that the controller be properly adjusted and, if required, fitted with a properly dimensioned ballast resistor. Refer to the appropriate sections of this instruction manual for setting the Quick Stop function and the dimensioning of ballast resistors.

Failure to follow these instructions can result in death, serious injury or equipment damage.

The quick stop (emergency stop) function stops the motor during a malfunction or other critical event. Quick stop can be triggered:

- via the $\overline{\text{STOP}}$ input signal
- by a stop command issued through a connected input device
- when limit switches signal via the LIMP, LIMN input signals
- by an operational malfunction which necessitates an emergency stop.

Maximum current for Quick-Stop

In the event of a quick stop, the drive stores superfluous braking energy in the power amplifier and releases it as heat through brake resistors. If the voltage exceeds the permissible power amplifier voltage, the drive switches off the power amplifier and displays error 5 "Overvoltage". The motor then runs down under no braking.

The current for the emergency braking torque should be set such that the drive comes to a halt with maximum deceleration but without tripping out.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values [1)]	Default Value	R/W rem.
Settings. I_maxSTOP	28:22	4.1.3	Current limitation for Quick-Stop [Apk]	0..max. current 0..29999	1000	R/W rem.

1) Max. current: the lower of the two values "Servomotor.I_maxM" and "PA.I_maxPA"

If the drive frequently trips with error 5 "Power amplifier overvoltage" on quick stop, the maximum braking current must be reduced, the drive load reduced or an external ballast resistor installed.

Zero-clamp

The Quick-Stop function remains active until the motor has come to a complete stop. Then the drive switches to zero-clamp or switches the power amplifier off – with a fault response of error class 2.

For zero-clamp the drive switches on the position control loop, sets the setpoint position equal to the actual position and holds the position with the configured motor current "CtrlBlock1/2.I_max".

Acknowledging Quick-Stop

Quick-Stop must be acknowledged with the FAULT_RESET input signal or the error confirmation of an input device.

I/O signal	Function	Value
FAULT_RESET	Resetting an error message	low -> high

If the motor has been stopped by Stop, the $\overline{\text{STOP}}$ signal must first be reset.

If Quick-Stop has been triggered by the limit switch signals $\overline{\text{LIMN}}$ or $\overline{\text{LIMP}}$, the drive must be moved back into the area of movement in manual mode; see “Moving the drive out of the limit switch area“ on page 7-4.

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7.2 Monitoring functions

7.2.1 Monitoring of axis signals

Limit switch signal and STOP signal

⚠WARNING

LOSS OF CONTROL DURING OR FOLLOWING A MOTION

Using the LIMP, LIMN, and STOP input functions can provide a degree of protection against common types of motion hazards (i.e. over travel of a motion due to improperly programmed motion sequences).

- Refer to section 4.4.7 of this instruction manual for descriptions of the LIMP, LIMN, and STOP input connection requirements.
- Use of the LIMP, LIMN, and STOP input functions require the connection of signals from external sensors or limit switches to the controller. The signals used should originate from separate sensors and limit switches from those used during normal machine control.
- The external sensors and limit switches must be properly located on the machine motion being controlled.
- To operate, the LIMP, LIMN, and STOP input functions must be enabled in the controller software.
- The LIMP, LIMN, and STOP input functions cannot protect against certain failures within the controller or at the sensors. For the control of critical motions of the machine, use redundant control signal paths to assure a safe state during failure.

Failure to follow these instructions can result in death, serious injury or equipment damage.

During drive movement the two limit switches are monitored via the input signals LIMN and LIMP. Should the drive come to a limit switch, the drive stops the motor with quick stop. Limit switch overshooting is signalled at the input device. Align the limit switches such that the drive cannot pass through the limit switch limits. Here you could use longer actuator flags, for example.

The input signalSTOP stops the motor with quick stop. The current operational function remains switched on and will be implemented again as soon as the STOP signal is reset and quick stop is acknowledged with the FAULT_RESET input signal.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default value	R/W rem.
Settings.SignEnabl	28:13	4.1.10	Signal enable for monitoring inputs 0: inactive 1: active	0..15 Bit0:LIMP Bit1: LIMN Bit2: STOP Bit3: -	7	R/W rem.
Settings.SignLevel	28:14	4.1.11	Signal level for monitoring inputs 0: reaction at 0-level 1: reaction at 1-level	Bit0: LIMP Bit1: LIMN Bit2: STOP Bit3: -	0	R/W rem.

Moving the drive out of the limit switch area

The drive must be moved out of the limit switch area and back into the valid travel area in manual mode.

- ▶ Switch to manual mode with the AUTOM input signal
- ▶ Activate and hold the manual movement signal to retract the drive to the permissible movement range: if the LIMP limit switch signal was triggered, the MAN_N signal must be enabled.
- ▶ Acknowledge the Quick-Stop stop with FAULT_RESET. The correct manual movement signal must remain reset to enable the drive to check whether the retraction direction is correct.

If the drive does not move back into the travel area, check whether manual mode has been activated and the correct manual movement signal held.

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7.2.2 Monitoring internal signals

Monitoring systems protect motor, power amplifier and load resistors from overheating, and ensure functional and operational safety. You will find a list of all safety devices under “Safety devices“ on page 2-6.

The drive displays error messages and warnings by causing the 7-segment display to blink. In addition, connected user interface devices will displays an error message.

Temperature monitoring

Sensors monitor the temperature of motor and power amplifier. If the temperature of one of these components approaches its permitted limit, the drive will display a warning. If the temperature exceeds the limit for more than five seconds, the drive switches off the amplifier and the control loop to protect them from overheating.

If the motor temperature switch is used instead of a sensor, only the upper temperature limit can be monitored and no advanced warning is provided. All temperature limits are permanently set.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default-Value	R/W rem.
PA.T_warnPA	16:10	2.2.15	Temperature warning threshold of the current amplifier [K]	1..512	353	R/ W rem.
PA.T_maxPA	16:11	2.2.16	Max. permitted temperature of the current amplifier [K]	1..512	358	R/ W rem.

I^2t monitoring

If the drive is working with high peak currents, temperature monitoring with sensors may be too slow. With I^2t monitoring the closed-loop control calculates the rise in temperature versus time. If the I^2t threshold is exceeded, the motor, amplifier or load resistor current is reduced to its rated value.

If the temperature drops below the threshold, the rated component can once again be operated at the limit of its performance.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default-Value	R/W rem.
PA.I2tPA	16:13	2.2.10	Max. permitted time for max. current at high speed [ms]	1..32767	3000	R/W rem.
PA.I2t_warnB	16:14	2.2.12	Warning threshold for make time of an internal ballast resistor [ms]	1..32767	10	R/ W rem.
PA.I2tB	16:15	2.2.11	Max. permitted make time of internal ballast resistor [ms]	1..32767	11	R/ W rem.
PA.I2t_n0PA	16:47	2.2.13	Max. permitted time for max. current at low speed [ms]	1..32767	4100	R/ W rem.

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Contouring error monitoring

Contouring error monitoring checks for positional discrepancies between the actual position of the motor and its setpoint. If the difference exceeds a contouring error threshold, the drive reports a fault. The threshold for the contouring error deviation can be set

In addition the error class for a contouring error can be changed; see below under “Changing the error class“.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default-value	R/W rem.
Settings.p_maxDiff	12:11	4.1.23	Maximum permitted contour error of the position controller [inc]	0 - 131072 Eight motor revolutions	16384	R/W rem.

Warning signal at the function output

The monitoring signal can be evaluated by an external controller via the FUNCT_OUT output of the signal interface and via the $\overline{\text{FUNCT\_OUT}}$ signal of the PULSE-C interface. The interface output can be configured with 'Settings. FCT_out' and performs one of five message tasks.

Settings.Fct_out	FUNCT_OUT = high, $\overline{\text{FUNCT\_OUT}}$ = low
1	No overtemperature power amplifier or motor
2	I^2t limit not exceeded
3	No contouring error
4	No group error message
5	Speed is zero

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Settings.FCT_out	17:2	4.1.5	FUNCT_OUT output signal messaging task	0..6 0: reserved 1: overtemp. motor or power amplifier 2: I2T limit value for motor, power amplifier or internal ballast resistor 3: following error 4: message 1, 2, or 3: overload 5: standstill 6: control deviation in standstill window	5	R/W rem.

The signal at the function output remains set for at least two seconds, even if the cause of the message has already been cleared.

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Changing the error class

⚠WARNING

LOSS OF CONTROL DURING OR FOLLOWING A MOTION

Setting the error class to zero may result into motion without any braking function if a contouring error occurs. It is thereby recommended to avoid this setting for the error class.

Failure to follow these instructions can result in death, serious injury or equipment damage.

The response of the drive to an error is divided into error classes and can be adjusted. This enables the user to set the error response of the drive for the current operating conditions.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default-value	R/W rem.
Settings.Flt_pDiff	28:24	4.1.13	Error response to contouring errors	0..3 0: Error class (warning) 1: Error class 1 2: Error class 2 3: Error class 3	3	R/W rem.

7.3 Braking function with TLHBC

For motors fitted with a holding brake, the brake prevents unintended movement of the motor when power is removed. The drive controls the holding brake with the holding brake controller (available as an accessory).

Holding brake control system

The holding brake control system amplifies the ACTIVE_CON control signal from the signal interface, and controls the brake in such a way that it responds quickly while generating as little heat as possible. The brake connection is located in the same cable as the power connections to the motor. It is separated from the drive's signal connections in the event of motor cable insulation failure.

Standard unit

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" as soon as the amplifier is enabled and the motor has holding torque. The brake opens after a time delay required for releasing the brake. The time delay can be adjusted.

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

The time delay can be set with the "Settings.t_brk_off" and "Settings.t_brk_on" parameters.

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Releasing the brake

When the brake is opened, the "Settings.t_brk_off" parameter delays the drive's response to the enable command.

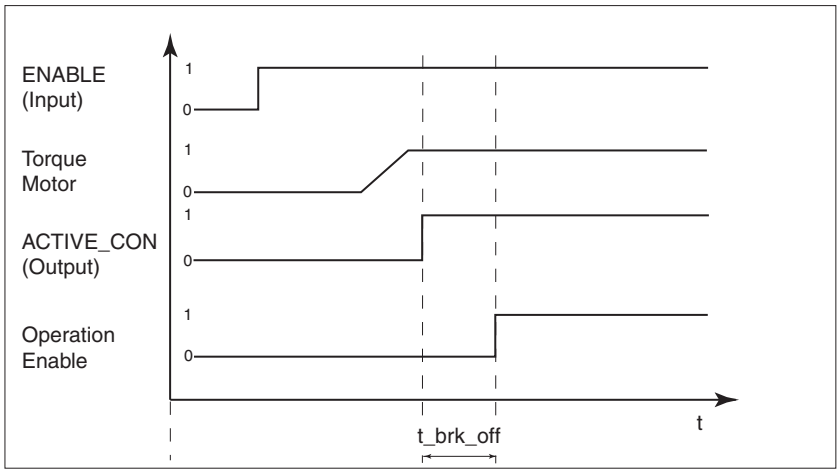

Fig. 7.1 Releasing the holding brake

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Settings.t_brk_off	12:22	4.1.36	Time delay for brake release [ms]	0..200	0	R/W rem.

The setting for the "Settings.t_brk_off" parameter depends on the motor type and can be read on the motor type plate.

Applying the brake

When the brake is applied, the controller ACTIVE_CON switches to "low" after a disable. However, the controller remains active for the period specified in the "Settings.t_brk_off" parameter.

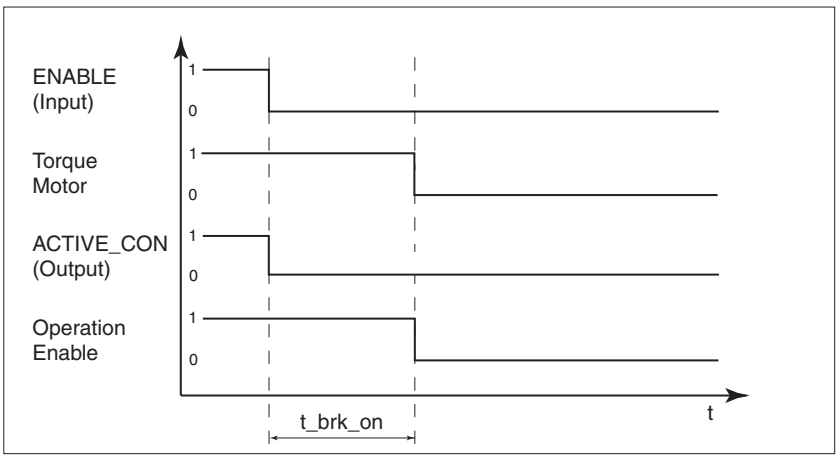

Fig. 7.2 Applying the holding brake

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Settings.t_brk_on	12:23	4.1.37	Time delay for drive with holding brake applied [ms]	0..100	0	R/W rem.

The setting for the "Settings.t_brk_on" parameter depends on the motor type and can be read on the motor type plate.

Voltage reduction

The holding brake controller switch must be set depending on the motor type to implement a voltage reduction, if required.
1: voltage reduction on, for SER... motors
0: voltage reduction off

The control voltage from the holding brake control system is variable if the voltage reduction function is switched on. The voltage is then 24 V for approx. 100 ms and afterwards falls back to its holding voltage of 12 V. The holding brake controller can be checked with a button in the TLHBC.

The diagram below shows the voltage reduction for t_brk_off = 0 and t_brk_on = 0.

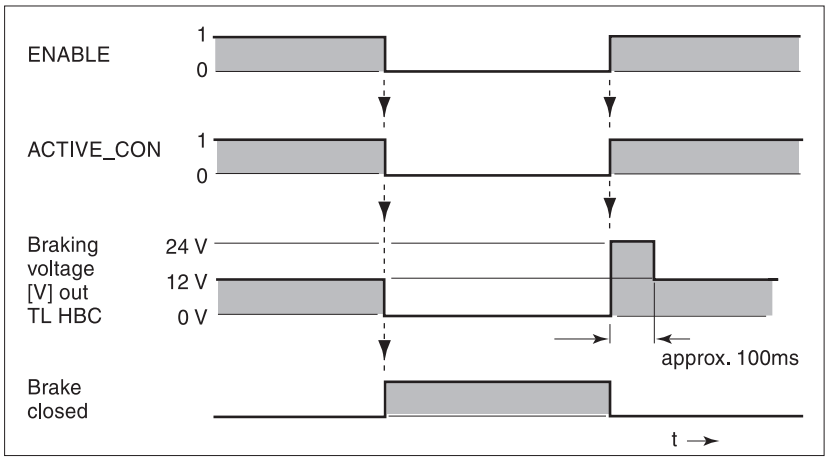

Fig. 7.3 Time diagram, brake function with voltage reduction on

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.

The LED flashes on overload or short-circuit.

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7.4 Standstill window

When motor is held at zero speed under active closed-loop control, small variations in the speed may prevent the condition from being recognised. If the motor remains in the standstill window for the period of time, defined in 'Settings.p_winTime', the control system will report that it is at standstill.

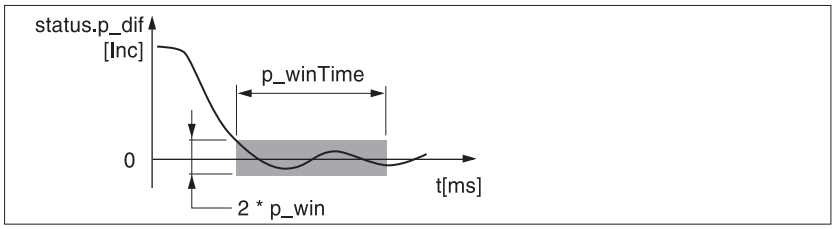

Fig. 7.4 Standstill window

The 'Settings.p_win' and 'Settings.p_winTime' registers define the size of the window.

The FUNCT_OUT output displays whether the control deviation is in the standstill window via the "Settings.FCT_out" = 6 parameter (note: FUNCT_OUT is low active).
The function is only active in electronic gear or position control.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Settings.p_win	12:13	4.1.24	Standstill window, permissible control deviation [Inc]	UINT16 0 ... 32767	10	R/W rem.
Settings.p_winTime	12:15	4.1.25	Time for which control deviations must apply in the standstill window for standstill to be signalled [ms]	UINT16 0 ... 32767	1	R/W rem.
Settings.FCT_out	17:2	4.1.5	FUNCT_OUT output signal messaging task	0..5 0: reserved 1: overtemp. motor or power amplifier 2: I2T limit value for motor, power amplifier or internal ballast resistor 3: following error 4: message 1, 2, or 3: overload 5: standstill 6: control deviation in standstill window	5	R/W rem.
Status.xMode_act	28:3	2.3.5.5	Current axis operating mode with additional information'	UINT16 0 ... 32767 Bit 6: Controller deviation in standstill window	–	R/– –

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8 Diagnosis and error rectification

8.1 Operational status indicators and transitions

Status display in the unit

The D2 LED on the motor plug lights, when voltage is present in the DC-Bus.

The 7-segment display represents the operating states of the drive in coded form.

Display	Operating status
0	24 V switched on
1	Initialization
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 device is working in the operating mode selected
7	A quick stop is being executed
8, 9	An error has been detected and the error response activated
0 ... A flashing	Indicates the error value

Operating transitions

The conditions for changing between the operating states displayed and the reactions of the drive to an error follow a fixed sequence.

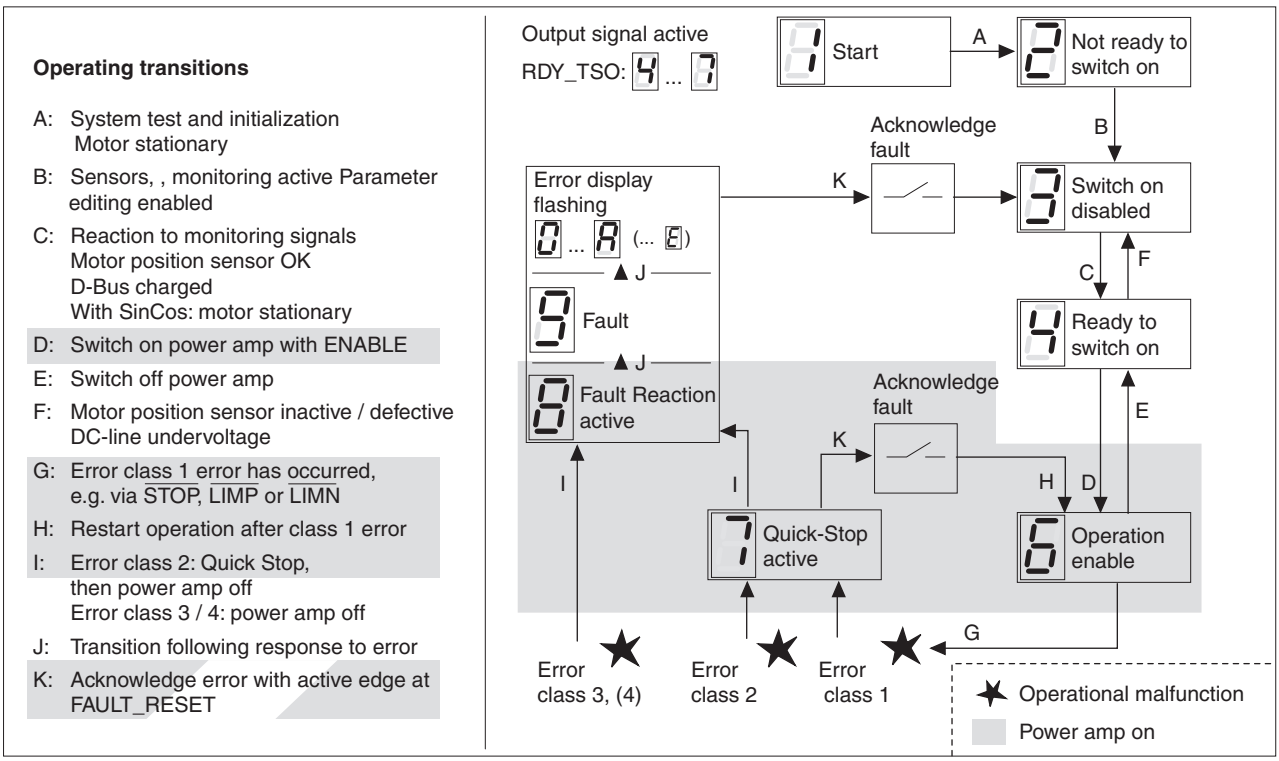

Fig.8.1 Operating states and transitions of the drive

8.2 Error display and rectification

Error display

The cause of a particular operating malfunction is displayed

- by a flashing number in the seven-segment display
- by the error response of the drive
- in the commissioning software as an error message on the control bar and in the error memory list.
- in the display of the Human-Machine Interface HMI as an error message and in the error memory list.

The drive responds to a fault with the limit switch or $\overline{\text{STOP}}$ signal by initiating a Quick-stop without displaying an error message on the unit. The cause of the interruption is recorded in the error memory and can be accessed via the Human-Machine Interface HMI or the commissioning software.

Resetting error messages

Once the error has been corrected, the message can be reset

- via the FAULT_RESET input signal
- via the commissioning software with the “Reset” button
- by switching off the power supply to the drive.

Error response

The drive triggers an error response when a malfunction occurs. Depending on the seriousness of the fault, the unit responds in accordance with one of the contouring error classes:

Error class	Reaction	Meaning
0	Warning	Message only, no interruption to movement operations
1	Quick stop	The motor stops with quick stop, the power amplifier and controller stay switched on, stop control is activated.
2	Quick stop with switch-off	The motor stops with a quick stop, the power amplifier and controller switch are off at standstill.
3	Fatal error	The power amplifier and controller switch are off. The unit cannot be activated until the fault is corrected.
4	Uncontrolled operation	The power amplifier and controller switch are off. The error response can only be reset by switching off the unit.

Error rectification

Display	Error	Error class	Cause	Error rectification
dark	Display dark	-	No power supply	Check power supply and fuses
	Display dark	-	Power supply wrongly connected	Connect properly
1	Undervoltage	2	DC-line voltage below threshold value for quick stop	Check or increase mains voltage
	Undervoltage	3	DC-line voltage below threshold value for switching off the drive	Check for mains failure

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Display	Error	Error class	Cause	Error rectification
2	Contouring error	1...3	Contouring error	Reduce load or acceleration, the error response can be configured via 'Flt_pDiff'
	Reference encoder in slot M1	1	Cable fault to RS422 or sensor broken	Check sensor cable / sensor, replace cable
	Maximum motor speed	3	Exceeding the maximum motor speed under shift operation	Reduce vertical loading
3	Motor output	3	Short circuit or earth fault in the motor line or in the motor Overcurrent due to poor setting of current controller Incorrect motor parameters Motor defective	Check the connections or motor, replace the cable or motor. Select the correct motor data set
4	position sensor	3	No signal from motor position sensor Motor connected with wrong sensor or sensor broken	Check sensor cable / sensor. Replace cable
5	Overvoltage	3	DC-Bus overvoltage	Use an external brake resistor
6	I^2t for power amplifier	0	I^2t monitoring for power amplifier in operation or at a standstill	Reduce the time at peak current, load or peak torque. Absorb the standstill torque with the holding brake
	I^2t for motor	0	I^2t monitoring for motor	Reduce the load, use a motor with a higher rated power
	I^2t for ballast	0	I^2t monitoring for ballast resistor	Reduce the load, connect an external resistor, improve ventilation.
7	Overtemperature power amplifier	3	The power amplifier is overheating	Reduce the make time for peak current, load or peak torque
	Overtemperature motor	3	The motor is overheating The temperature sensor is not connected	Allow the motor to cool. Reduce the load. Use a motor with a higher rated power. The PTC sensor is defective.Check or replace the motor encoder cable
8	Watchdog	4	Internal system error	Switch the unit off and back on. Replace the unit
	Control system error	4	System error, e.g. division by 0 or time-out checks, insufficient EMC	Comply with EMC protective measures. Switch the unit off and back on. Replace the power amplifier if problem persists.
9	Phase monitoring motor	3	Motor phase current imbalance. The motor cable is defective. Power amplifier transistor is defective	Check the motor cable and connection, replace the motor, replace the unit
A	Short circuit I/O		Short circuit in the digital outputs. No 24 V for signal interface.	Check the connections and wiring
E	Positioning controller system error	3	Cause of error corresponding to error number in error memory	Rectification dependent on error number
	Positioning controller system error	4	Cause of error corresponding to error number in error memory	Rectification dependent on error number
u	24 V power interruption	4	24 V power supply fallen below 18.2 V	Ensure 24 V_{DC} power. Check short-term power interruptions during load change of power supply.

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Display	Error	Error class	Cause	Error rectification
None [1)]	Limit switch	1	Limit switch overshot	Traverse drive into movement zone, match the positioning data to the axis range, special message in the error memory
	Stop	1	Stop signal activated, line interrupted	Check line for the $\overline{\text{STOP}}$ terminals signal
	Node Guarding	1	Connection monitoring for the manual control unit activated	Check the RS-232 connection at the controller
	Timeout	1	Protocol error	Time-out exceeded during exchange of data with the manual control unit, start transmission again

1) No error display, operating status continues to be displayed.

Error response can be configured with the “Settings.FIt_AC” parameter.

With the commissioning software TLCT and the TLHMI the current and the last 20 error messages are displayed.

TLCT: Error display

▶ Select 'Twin Line → Diagnosis → Error memory'. A dialog box which displays the error messages appears.

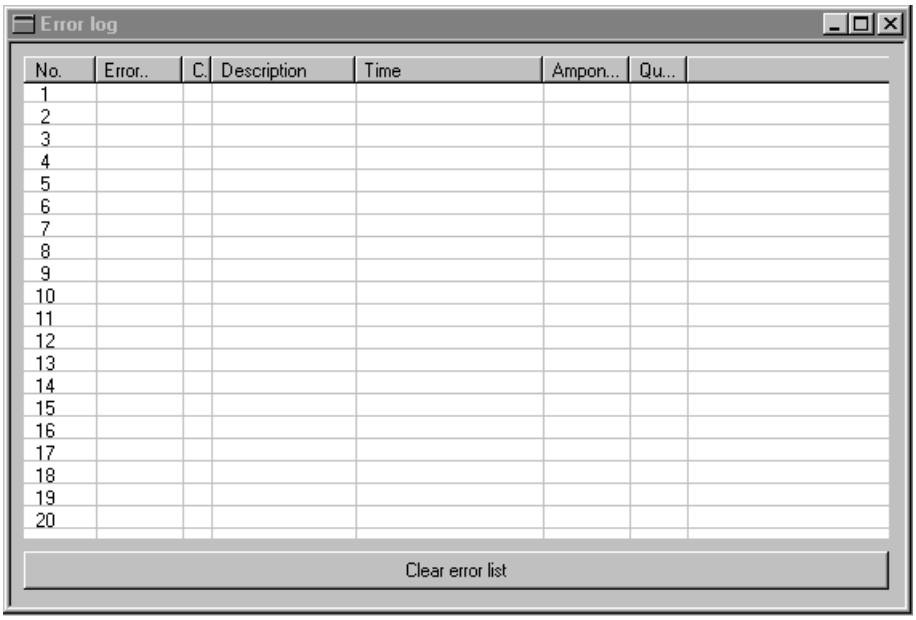

Fig.8.2 Error messages

Error messages are displayed showing status, error class, time when error occurred and a short description. The error number is given as a hexadecimal value.

Additional information is given in column labelled “Qualifier”. At the error message E1855, “Initialization error in parameter IxSix -> Qualifier” the Qualifier identifies the index/sub-index of the parameter, for which the error has been detected. You will find the parameter in the list of parameters in chapter 12.

As an example, if the Qualifier is showing 00290023h, this is parameter 29:23 „Motion.v_target0“.

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A detailed error message is given in the following sumcheck error messages:

- 181Bh: “error in processing manual movement ->Qualifier”
- 181Fh: “error in processing reference movement ->Qualifier”
- 1855h: “Initialization error in parameter IxSix -> Qualifier”
- 181Dh: “error in changing user operating mode ->Qualifier”

More detailed information can be found in the Qualifier. For example, 00001846h, this is error message No. E1846 in the error list.

▶ Acknowledge the current error message with the ”Reset” button on the command bar of the program.

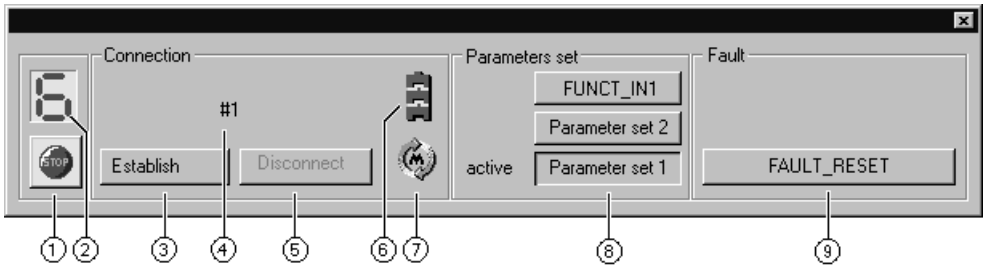

Fig.8.3 Reset button, 9

TL HMI: Error display

▶ Via the menu item “2.5 Error” change to the menu items for displaying error messages.

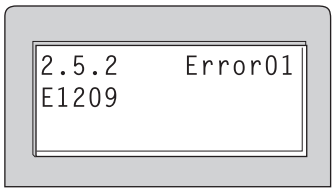

Fig.8.4 Displaying an error value

The cursor keys may be used to scroll through the error entries:

Menu item	Meaning
2.5.1 StopFault	Cause of the last interruption
2.5.2 Error01	1st error entry, oldest message
2.5.3 Error02	2nd.error entry, more recent message, if present
...	...

The meaning of the error values is given in the Human-Machine Interface HMI manual.

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8.3 Malfunctions in movement mode

Faults	Cause	Correction
The motor jerks briefly	The motor phases are swapped	Check the motor cable and connection: connect motor phases U, V and W in the same way on the motor and unit sides
No motor movement	The motor has seized	Release the motor brake
	Break in the motor line	Check the motor cable and connection. One or more motor phases are not connected.
	No torque	Set the parameters for max. current, max. speed to higher than zero
	Incorrect operating mode selected	Set the input signal and parameters for the desired operating mode.

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9 Service, Maintenance and Warranty

9.1 Service Information

Technical and commercial service requests, including warranty and on-site services, should be directed to your Schneider Electric authorized distributor or the Schneider Electric Customer Support Center at 1-888-SQUARED (1-888-778-2733).

Maintenance

The Twin Line controller requires no maintenance.

- ▶ Periodically check the control cabinet filter at the TLD unit's location. Inspection intervals are determined by ambient conditions at the site.

Repairs to the TLD unit are to be carried out only by Schneider Electric authorized personnel.

Warranty

Unauthorized disassembly of the controller will void the warranty.

9.2 Shipping, storage and disposal

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- Read and understand this bulletin in its entirety before installing or operating Twin Line drive system products. Installation, adjustment, repair, and maintenance of these drive systems must be performed by qualified personnel.
- Disconnect all power before servicing the power controller. WAIT SIX MINUTES until DC bus capacitors discharge, then measure DC bus capacitor voltage between the DC+ and DC- terminals to verify that the DC voltage is less than 45 V (see Fig. 1.5 on page 1-5). The DC bus LED is not an accurate indication of the absence of DC bus voltage.
- The servomotor can produce voltage at its terminals when the shaft is rotated! Prior to servicing the power controller, block the servomotor shaft to prevent rotation.
- DO NOT short across DC bus terminals or touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers and close enclosure door before applying power or starting and stopping the drive system.
- The user is responsible for conforming to all applicable code requirements with respect to grounding all equipment. For drive controller grounding points, refer to Fig. 1.5 on page 1-5.
- Many parts in this drive system, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools.

Before servicing drive system:

- Disconnect all power.
- Place a “DO NOT TURN ON” label on the drive system disconnect.
- Lock the disconnect in open position.

Failure to follow these instructions can result in death, serious injury or equipment damage.

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Deinstallation

▶ Save the parameter settings of the unit:

With the commissioning software, select 'File → Save' to save all values on the PC's data storage medium.

With the Human-Machine Interface, select menu '8.1 Read Param.' to copy the parameter set into the Human-Machine Interface copy memory.

▶ Switch the unit off.

▶ Disconnect the power supply.

▶ Mark all connections to the unit.

▶ Disconnect the motor cable.

▶ Pull out the interface connector.

▶ Remove the unit from the control cabinet.

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

Storage Store the unit within the specified storage limits for room temperature and humidity.

Protect the unit from dust and dirt.

Disposal When servicing or decommissioning, dispose of this equipment in accordance with the applicable standards for this classification of equipment. The power electronic system is made from many recyclable materials. Some materials may require special disposal procedures.

For recycling purposes, split 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 relevant environmental protection laws. Check with and conform to local laws and procedures before disposing of these components.

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10 Accessories and spare part

10.1 List of accessories

Accessories The following accessories are available for drives:

Qty	Designation	Order Number
1	Commissioning software TLCT with on-line documentation on data carrier, multilingual	TLAPSCA
1	HMI hand-held operating unit with manual	TLAPHOO
1	Motor cable 1.5 mm^2 with motor plug motor Motor cable 2.5 mm^2 with motor plug Motor cable 4 mm^2 with motor plug	TLACPAAAxxx1 [1] TLACPAABxxx1 [1] TLACPAACxxx1 [1]
1	Sensor cable for Hiperface module HIFA-C	TLACFABAxxx1 [1]
1	Pulse direction cable for module PULSE-C Encoder cables for RS-422-C module, open at one end only	TLACDCBHyyy [2] TLACDCACyyy [2]
1	Cables for module RS-422-C,plug at each end Encoder cables for ESIM1-C, ESIM2-C, SSI-C modules	TLACDCAEyyy [2] TLACDCAEyyy [2]
1	RS-232 programming cable 5 m RS-232 programming cable 10 m	TLACDPBG 050 TLACDPBG 100
1	Holding brake controller TLHBC	TLABHO
1	Ballast resistor controller TL BRC	TLABBO
1	External ballast resistor BWG 250072 (100 W, 72 Ohm) BWG 250150 (100 W, 150 Ohm) BWG 500072 (200 W, 72 Ohm) BWG 500150 (200 W, 150 Ohm)	 TLABRA TLABRB TLABRC TLABRD

1) Cable length xxx: 003, 005, 010, 020: 3 m, 5 m, 10 m, 20 m, longer lengths on request;
2) Cable length yyy: 005, 015, 030, 050: 0.5m, 1.5 m, 3 m, 5 m.

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10.2 List of spare parts

Power electronic system

Qty.	Designation	Order no.
1	TLD132, TLD134, TLD136 or TLD138	See Fig.1.5
1	SK14 shielding terminal	TLATE
1	Connector caps for the terminal strips	-

10.3 Suppliers

Reserved.

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11 Unit label

11.1 Illustration of the drive label

▶ The label shown below is provided as a guide. It may be copied and attached to the inside of the Twin Line unit's cover.

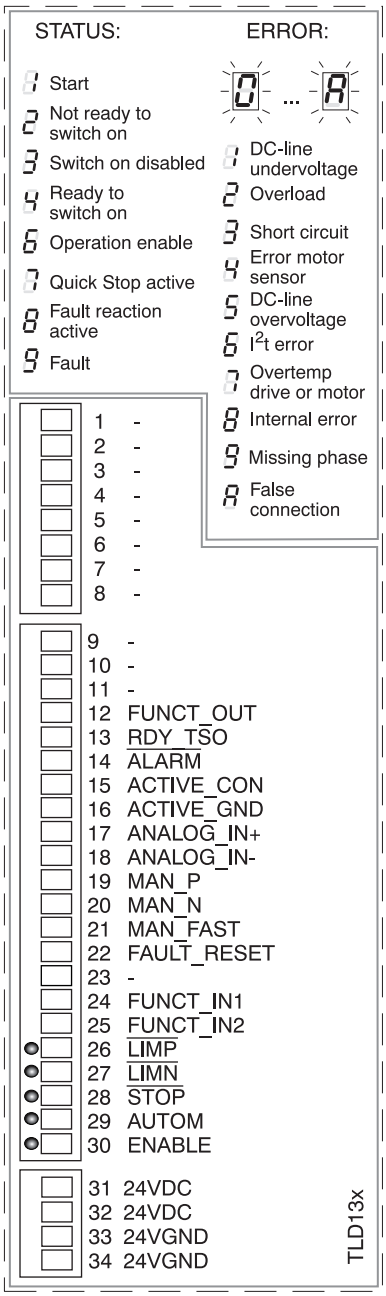

Fig.11.1 Unit label

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12 Parameters

12.1 Overview

Parameter groups

The parameters of the Twin Line unit are grouped in functional blocks.

- Settings, Page 12-2:
  Behavior of the input and output signals of the signal interface, modification of error responses, gear ratios, parameters for the ±10 V interface and general control system settings
- PA, Page 12-3:
  Parameters of the power amplifier, system settings
- Servomotor, Page 12-5:
  Motor-specific settings. These settings cannot be modified with the Human-Machine Interface HMI.
- CtrlBlock1, CtrlBlock2, Page 12-7:
  Settings for the control loops, stored in control parameter sets 1 and 2.
- Manual, Page 12-8:
  Parameter settings for manual mode
- I/O, Page 12-8:
  Switching states of the inputs and outputs of the signal interface
- M1, Page 12-9:
  Settings for modules in slot M1
- M4, Page 12-9:
  Settings for modules in slot M4
- Status, Page 12-9:
  System settings: Device-specific and current parameters such as temperature values of the power amplifier, motor and internal ballast resistor, control loop parameters and setpoint and actual values.

Instructions on inputting values

The 'max. current' and 'max. speed' values under 'Range of values' correspond to the lesser maximum values of power amplifier and motor. The unit will automatically limit to the lower value.

Temperature in Kelvin [K] = temperature in degree Celsius [°C] + 273, for example: 358 K = 85 °C

What does this mean?

Idx:Sidx: Index and subindex for identifying a parameter, can be input with the commissioning software in the 'Monitor' window.

R/W: Value can be read or written. R/- means the value is read only.

rem: The value is retentive; it is retained in the memory even after the unit is switched off.

Info page: Further information on the parameter will be found on the page specified.

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12.2 Parameter groups

12.2.1 Parameter group Settings

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values [1)]	Default Value	R/W rem.	Info Page
name1	11:1	–	User device name 1	0..4294967295	538976288	R/W rem.	–
name2	11:2	–	User device name 2	0..4294967295	538976288	R/W rem.	–
Password	11:3	1.3	Password for configuring with a hand-held operating unit	0..9999 0: No password protection	0	R/W rem.	–
I_RefScal	12:3	4.1.20	Setpoint current at 10 V input signal [Apk]	0.. max. current	300	R/W rem.	6-8
n_RefScal	12:10	4.1.22	Setpoint speed at 10 V input signal [rpm]	0..max. speed	3000	R/W rem.	6-8
p_maxDiff	12:11	4.1.23	Maximum permissible Following error of the position controller [Inc]	0..131072 8 motor revolutions	16384	R/W rem.	7-6
p_win	12:13	4.1.24	Standstill window, permissible control deviation [Inc]	UINT16 0 ... 32767	10	R/W rem.	7-11
p_winTime	12:15	4.1.25	Time for which control deviations must apply in the standstill window for standstill to be signalled [ms]	UINT16 0 ... 32767	1	R/W rem.	7-11
f_Chop	12:17	4.1.21	Switching frequency of the power module, (default value=1; 0 for TLxx38)	0: 4kHz 1: 8kHz 2: 16kHz	1	R/W rem.	–
t_brk_off	12:22	4.1.36	Time delay for holding brake release [ms]	0 .. 200	0	R/W rem.	7-9
t_brk_on	12:23	4.1.37	Time delay for controller with holding brake applied [ms]	0 .. 100	0	R/W rem.	7-9
FCT_in2	17:1	4.1.6	Selecting two switchable automatic modes via FUNCT_IN2 input signal: low/ high	0..2 0: speed controller/current controller 1: position controller/speed controller 2: position controller/current controller.	1	R/W rem.	6-10
FCT_out	17:2	4.1.5	FUNCT_OUT output signal messaging task	0..6 0: reserved 1: overtemp. motor or power amplifier 2: I^2T limit value for motor, power amplifier or internal ballast resistor 3: contouring error 4: message 1, 2, or 3: overload 5: standstill 6: control deviation in standstill window	5	R/W rem.	7-6
Gear_Num	17:3	4.1.8	Counter of the gear factor of the electronic gear	-32768..32767	1	R/W rem.	6-12

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Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values [1)]	Default Value	R/W rem.	Info Page
Gear_Den	17:4	–	Denominator of the gear factor of the electronic gear	1..32767	1	R/W rem.	6-12
offset_0V	20:58	4.1.38	Offset for linear shift of the 0V input voltage [mV]	–	0	R/W rem.	6-3
win_10V	20:59	4.1.39	Voltage window within which its analog value is equal to 0 [mV] Example: Setting value of 20 mV means that the range -20 mV to +20 mV is interpreted as 0 mV	–	0	R/W rem.	6-11
SignEnabl	28:13	4.1.11	Signal enable for monitoring inputs 0: blocked 1: released	0..15 Bit0: LIMP Bit1: LIMN Bit2: STOP Bit3: -	7	R/W rem.	7-3
SignLevel	28:14	4.1.11	Signal level for monitoring inputs 0: reaction at 0-level 1: reaction at 1-level	0..7 Bit0: LIMP Bit1: LIMN Bit2: STOP Bit3: -	0	R/W rem.	7-3
I_maxSTOP	28:22	4.1.3	Current limitation for Quick-Stop [Apk]	0..max. current 0..29999	1000	R/W rem.	5-14, 7-1
Flt_AC	28:23	4.1.12	Error response to power failure of 2 phases	1..3 1: Error class 1 2: Error class 2 3: Error class 3	3	R/W rem.	-
Flt_pDiff	28:24	4.1.13	Error response to Contouring errors	0..3 0: Error class (warning) 1: Error class 1 2: Error class 2 3: Error class 3	3	R/W rem.	-
TL_BRC	28:26	4.1.14	External ballast resistor controller TL BRC	0: not connected 1: connected	0	R/W rem.	–

1) Max. current: the lower of the two values "Servomotor.I_maxM" and "PA.I_maxPA"
Max. speed: device-limited value of “Servomotor.n_maxM”

12.2.2 Parameter group PA

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values [1)]	Default Value	R/W rem.	Info Page
KPid	12:4	–	Current controller longitudinal direction (d) P factor [V/A]	0..32767	–	R/– rem.	–
KIid	12:5	–	Current controller longitudinal direction (d) I factor [ms]	13..32767	500	R/– rem.	–
KPiq	12:8	–	Current controller transverse direction (q) P factor [V/Apk]	0..32767	100	R/– rem.	–
KIiq	12:9	–	Current controller transverse direction (q) I factor [ms]	13..32767	500	R/– rem.	–
I_maxfw	12:18	–	Field-weakening controller, max. field current [A]	0..32767	–	R/– rem.	–

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Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values [1]	Default Value	R/W rem.	Info Page
KPfw	12:19	–	Field-weakening controller P-factor [A/V]	1..32767	300	R/– rem.	–
Kifw	12:20	–	Field-weakening controller reset time [ms]	26..32767	500	R/– rem.	–
Serial	16:2	–	Module serial number	0..4294967295	–	R/– rem.	–
I_maxPA	16:8	2.2.1	Peak current of the unit [Apk]	1..32767	1000	R/– rem.	–
I_nomPA	16:9	2.2.2	Rated current of the unit [Apk]	1..32767	300	R/– rem.	–
T_warnPA	16:10	2.2.15	Temperature warning threshold of the current amplifier [K]	1..512	353	R/– rem.	7-5
T_maxPA	16:11	2.2.16	Max. permitted temperature of the current amplifier [K]	1..512	358	R/– rem.	7-5
U_maxDC	16:12	2.2.17	Max. permissible power amplifier voltage on the DC bus [V]	1..20000	4000	R/– rem.	–
I2tPA	16:13	2.2.10	Max. permitted time for max. current at high speed [ms]	1..32767	3000	R/– rem.	7-5
I2t_warnB	16:14	2.2.12	Warning threshold for make time of an internal ballast resistor [ms]	1..32767	10	R/– rem.	7-5
I2tB	16:15	2.2.11	Max. permitted make time of internal ballast resistor [ms]	1..32767	11	R/– rem.	7-5
F_maxChop	16:16	2.2.18	Permitted switching frequency of the current amplifier	0: 4 kHz, 1: 8 kHz 2: 16 kHz	1	R/– rem.	-
U_BalOn	16:20	2.2.20	Switch on DC-bus voltage for ballast	1..20000	4300	R/– rem.	-
U_minDC	16:21	2.2.19	DC-Bus undervoltage for switching off the drive	1..20000	1500	R/– rem.	-
U_BalOff	16:46	2.2.21	Ballast step-down [should be less that the switch-on threshold (hysteresis)]	1..32767	4100	R/– rem.	-
I2t_n0PA	16:47	2.2.13	Max. permitted time for max. current at low speed [ms]	1..32767	4100	R/– rem.	7-5
P_maxB	16:49	–	Internal ballast rated current [W]	1..32767	30	R/– rem.	-
I_maxPAr	16:52	2.2.3	Reduced maximum current of the unit [A]	1..32767	1000	R/– rem.	-
I_nomPAr	16:53	2.2.4	Reduced nominal current of the unit [Apk]	1..32767	300	R/– rem.	-

1) Max. current: the lower of the two values "Servomotor.I_maxM" and "PA.I_maxPA"

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12.2.3 Parameter group Servomotors

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values [1)]	Default Value	R/W rem.	Info Page
principIM	13:1	–	Motor type	0xA1: stepping motor 0xA2: synchronous servomotor 0xA3: asynchronous motor	0	R/– rem.	-
infoM	13:3	–	Motor calibration carried out	0..65535	–	R/– rem.	-
adj1Sen	13:4	–	1. Alignment information of the position sensor	0..65535 Calibration value SinCos/ resolver alignment offset = "eps_e_b"	–	R/– rem.	-
adj2Sen	13:5	–	2. Alignment information of the position sensor	0..65535	0	R/– rem.	-
reserve	13:6	–	Position offset low word	0..65535	–	R/– rem.	-
reserve	13:7	–	Position offset high word	0..65535	–	R/– rem.	-
TypeM	13:8	2.1.1	Motor type, consecutive numbers	0: no motor selected -..: Resolver motors +..: SinCos motors - 2147483648..2147483648	0	R/– rem.	-
SensorM	13:9	2.1.5	Motor encoder type	0: unknown 1: Resolver 2: SNS (SinCos) 3: SRS (SinCos Singleturn) 4: SRM (SinCos Multiturn)	0	R/– rem.	-
CountSen	13:10	–	Number of marks of position sensor per motor revolution	0..5	1	R/– rem.	-
n_maxM	13:11	2.1.9	Maximum permissible motor speed [rpm]	0 .. 13200	3000	R/– rem.	-
n_nomM	13:12	2.1.14	Nominal motor speed [rpm]	0..12000	3000	R/– rem.	-
I_maxM	13:13	2.1.8	Max. motor current [Apk]	0..32767	1000	R/– rem.	-
I_nomM	13:14	2.1.10	Nominal motor current [Apk]	0..32767	100	R/– rem.	-
M_nomM	13:15	2.1.15	Nominal torque [Ncm]	0..32767	100	R/– rem.	-
M_maxM	13:16	2.1.16	Peak torque [Ncm]	0..32767	200	R/– rem.	-
U_nomM	13:17	2.1.17	Nominal motor voltage [V]	0..32767	6000	R/– rem.	-
PolepairM	13:18	2.1.25	Motor pole-pair number	1..100	4	R/– rem.	-
KeM	13:20	2.1.26	Motor EMF constant Ke [Vs]	1..10000	1000	R/– rem.	-
JM	13:21	2.1.27	Motor moment of inertia [kgmm2]	0..32767	30	R/– rem.	-
R_UVM	13:22	2.1.28	Motor connection resistance [Ohm]	1..10000	100	R/– rem.	-

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values [1]	Default Value	R/W rem.	Info Page
L_qM	13:23	2.1.35	Motor inductance q-direction [mH]	1..10000	50	R/– rem.	-
L_dM	13:24	2.1.36	Motor inductance d-direction [mH]	1..10000	50	R/– rem.	-
T_maxM	13:26	2.1.30	Max. motor temperature [K]	0..512	393	R/– rem.	-
I2tM	13:27	2.1.37	I^2t motor: max. permitted time at max. current "Servomotor.I_maxM" [ms]	0..32767	3000	R/– rem.	-
fR	13:28	2.1.21	Resolver frequency	0: 3.5 kHz, 1: 5 kHz 2: 6.5 kHz 3: 10 kHz	–	R/– rem.	-
PolepairR	13:29	2.1.20	Pole-pair number of resolver	1..10	1	R/– rem.	-
TempTypeM	13:30	2.1.38	Temperature sensor type (PTC / NTC)	0: PTC 1: NTC	1	R/– rem.	-
T_warnM	13:32	2.1.29	Motor temperature early warning [K]	1..32767	353	R/– rem.	-
Tcal_t1	13:33	–	Temperature characteristic 1, value 1	0..32767	1	R/– rem.	-
Tcal_t2	13:34	–	Temperature characteristic 1, value 2	0..32767	2	R/– rem.	-
Tcal_t3	13:35	–	Temperature characteristic 1, value 3	0..32767	3	R/– rem.	-
Tcal_t4	13:36	–	Temperature characteristic 1, value 4	0..32767	4	R/– rem.	-
Tcal_t5	13:37	–	Temperature characteristic 1, value 5	0..32767	5	R/– rem.	-
Tcal_t6	13:38	–	Temperature characteristic 1, value 6	0..32767	6	R/– rem.	-
Tcal_t7	13:39	–	Temperature characteristic 1, value 7	0..32767	7	R/– rem.	-
Tcal_t8	13:40	–	Temperature characteristic 1, value 8	0..32767	8	R/– rem.	-
Tcal_u1	13:41	–	Temperature characteristic 2, value 1	0..32767	1	R/– rem.	-
Tcal_u2	13:42	–	Temperature characteristic 2, value 2	0..32767	2	R/– rem.	-
Tcal_u3	13:43	–	Temperature characteristic 2, value 3	0..32767	3	R/– rem.	-
Tcal_u4	13:44	–	Temperature characteristic 2, value 4	0..32767	4	R/– rem.	-
Tcal_u5	13:45	–	Temperature characteristic 2, value 5	0..32767	5	R/– rem.	-
Tcal_u6	13:46	–	Temperature characteristic 2, value 6	0..32767	6	R/– rem.	-
Tcal_u7	13:47	–	Temperature characteristic 2, value 7	0..32767	7	R/– rem.	-

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Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values [1]	Default Value	R/W rem.	Info Page
Tcal_u8	13:48	–	Temperature characteristic 2, value 8	0..32767	8	R/– rem.	–
name1M	13:50	–	Motor name, 1st part	0..4294967295	0	R/– rem.	–
name2M	13:51	–	Motor name, 2nd part	0..4294967295	0	R/– rem.	–
name3M	13:52	–	Motor name, 3rd part	0..4294967295	0	R/– rem.	–
name4M	13:53	–	Motor name, 4th part	0..4294967295	0	R/– rem.	–
I_0M	13:54	2.1.13	Motor continuous current at standstill (Apk)	1..32767	100	R/– rem.	–

1) Max. current: the lower of the two values "Servomotor.I_maxM" and "PA.I_maxPA"

12.2.4 Parameter group CtrlBlock1, CtrlBlock2

Parameter Name	Idx:Sidx [2]	TL-HMI [3]	Explanation and unit [ ]	Range of values [1]	Default Value	R/W rem.	Info Page
I_max	18:2 19:2	4.2.2 4.3.2	Current limitation in all operating modes including controller optimization. Not in manual or quick stop operating modes [Apk]	0..max. current 0..29999	1000	R/W rem.	5-14
n_max	18:5 19:5	4.2.3 4.3.3	max. speed [rpm]	0..13200	6000	R/W rem.	5-14
KPn	18:7 19:7	4.2.5 4.3.5 6.2.1	Speed controller P-factor [Amin/rev]	0..32767	10	R/W rem.	5-22
TNn	18:8 19:8	4.2.6 4.3.6 6.2.2	Speed controller integral time I-factor [ms]	26..32767	500	R/W rem.	5-22
TVn	18:9 19:9	4.2.7 4.3.7 6.2.3	Speed controller lead time. D-factor [ms]	0..32767	0	R/W rem.	-
KFPn	18:10 19:10	4.2.15 4.3.15 6.2.4	Speed controller feed forward control P-factor [A*min/rev]	0..32767	0	R/W rem.	-
KFDn	18:11 19:11	4.2.16 4.3.16 6.2.5	Speed controller feed forward control D-factor [A*min/rev]	0..4998	0	R/W rem.	-
K1n	18:12 19:12	–	Speed controller feed forward control actual speed [As*min/rev]	0..32767	0	R/W rem.	-
KPp	18:15 19:15	4.2.10 4.3.10 6.3.1	Position controller P-factor [1/s]	0..32767	14	R/W rem.	-
TVp	18:16 19:16	4.2.11 4.3.11 6.3.2	Position controller derivative time D-factor (ms)	0..32767	0	R/W rem.	-

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Parameter Name	Idx:Sidx [2]	TL-HMI [3]	Explanation and unit [ ]	Range of values [1]	Default Value	R/W rem.	Info Page
KFPp	18:18 19:18	4.2.17 4.3.17 6.3.3	Position controller feed forward control speed	0..32767	100	R/W rem.	-
KFAp	18:19 19:19	4.2.18 4.3.18 6.3.4	Acceleration precontrol speed controller [As*min/U]	0..32767	0	R/W rem.	-
Filt_nRef	18:20 19:20	4.2.8 4.3.8	Filter time constant reference variable filter of the setpoint speed [ms]	0..32767	0	R/W rem.	5-24

1) Max. current: the lower of the two values "Servomotor.I_maxM" and "PA.I_maxPA"
2) 18:xx: CrtlBlock1, 19:xx: CrtlBlock2
3) The HMI menus "6.2..." and "6.3..." are for optimization

12.2.5 Parameter group Manual

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values [1]	Default Value	R/W rem.	Info Page
I_maxMan	28:25	3.2.14	Max. current manual movement [Apk]	–	1000	R/W rem.	5-14
n_slowMan	42:3	3.2.12	Speed for slow manual movement [rpm]	0..6000	60	R/W rem.	6-6
n_fastMan	42:4	3.2.13	Speed for fast manual movement [rpm]	0..6000	240	R/W rem.	6-6

1) Max. current: the lower of the two values "Servomotor.I_maxM" and "PA.I_maxPA"
Max. speed: device-limited value of “Servomotor.n_maxM”

12.2.6 Parameter group I/O

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
IW0_act	33:1	2.4.1	Input word 0 With 'forcing' (e.g. with TL CT): read access shows force state	0..65535 Bit0: LIMP Bit1: LIMN Bit2: STOP Bit3: FUNCT_IN2 Bit4: MAN_P Bit5: MAN_N Bit6: MAN_FAST Bit7: ENABLE Bit8: AUTOM Bit9: FAULT_RESET Bit10: – Bit11: FUNCTION Bit12: – Bit13: –	–	R/– –	-
QW0	34:1	2.4.10	Output word 0 With 'forcing' (e.g. with TL CT): read access shows force state	0..65535 Bit0..2: - Bit3: FUNCT_OUT Bit4: RDY_TSO: Bit5: ACTIVE Bit6: ALARM Bit7 ..13: -	–	R/W –	-

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12.2.7 Parameter group M1

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
PULSE-C	21:10	4.5.1	Setting position encoder PULSE-C	0..10 Bit2: max. frequency 0: 200 kHz, 1: 25 kHz Bit3: Signal form: 0: PULSE-DIR 1: PV-PR	0	R/W rem.	-

12.2.8 Parameter group M4

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
p_indESIM	24:9	4.5.5	Encoder simulation: position of index pulse [Inc]	0..16383 Position value is based on the current module position at which the index pulse is output	1000	R/W rem.	-

12.2.9 Parameter group Status

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
serial_no	1:20	2.8.5	Device serial number, max. 9 digits	0..4294967295	0	R/– –	–
AnalogIn	20:8	2.3.3.1	Analog input at input ANALOG_IN [mV]	–	0	R/– –	–

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
driveStat	28:2	2.3.5.1	Status word for the operating status of the unit	0..429496795 Bit0..3: Current operating status: - 1: Start - 2: Not Ready to switch on - 3: Switch on disabled - 4: Ready to switch on - 5: Switched on - 6: Operation enable - 7: Quick-Stop active - 8: Fault reaction active - 9: Fault Bit4: reserved Bit5=1: Internal monitoring detects errors Bit6=1: External monitoring detects errors Bit7=1: Warning message Bit8..15: not assigned Bit16..20: current mode (unit-specific) 1..7: not assigned 8: function generator (current controller) 9: function generator (speed controller) 10: function generator (position controller) 11: ±10 V current controller 12: ±10 V speed controller 13: ±10 V position controller (reserved) 14: manual speed mode 15: electronic gear without offset adjustment, position controlled (AC) or with position reference (SM)	–	R/– –	–
xMode_act	28:3	2.3.5.5	Current axis mode with additional information	0..65535 Bit0..4: current mode (unit-specific) 8: function generator (current controller) 9: function generator (speed controller) 10: function generator (position controller) 11: ±10 V current controller 12: ±10 V speed controller 13: ±10 V position controller (reserved) 14: manual speed mode 15: electronic gear without offset adjustment, position controlled (AC) or with position reference (SM)	–	R/– –	7-11
Sign_SR	28:15	2.3.4.1	Saved signal states of external monitoring signals 0: not active, 1: enabled	0..15 Bit0: LIMP Bit1: LIMN Bit2: STOP Bit3: -	–	R/– –	-

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Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
FltSig	28:17	2.3.4.3	Monitoring signals 0: not active, 1: activated	0..4294967295 Bit0: Power up error Bit1: DC-Bus undervoltage Lim1 Bit2: DC-Bus undervoltage Lim2 Bit3: Motor line ground fault Bit4: Motor line short circuit Bit5: DC-Bus overvoltage Bit6: Overtemperature ballast Bit7: Overtemperature motor Bit8: Overtemperature Power amplifier Bit9: I^2t power amplifier Bit10: reserved Bit11: I^2t motor Bit12: I^2t ballast Bit13: Phase monitoring motor Bit14: Phase monitoring line Bit15: Watchdog Bit16: Internal system error Bit17: Pulse block/SAM error Bit18: Protocol error HMI Bit19: max. speed exceeded Bit20: Cable break reference encoder Bit21: Cable break actual position encoder Bit22: Position deviation error Bit23: Line failure 24 V Bit24: Contouring error Bit25: Short circuit in the digital outputs Bit26: Incorrect limit switch Bit27: Prewarning temperature motor Bit28: Prewarning temperature power amplifier Bit29: Bit30: SAM warning Bit31: Nodeguard	–	R/– –	-

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
FltSig_SR	28:18	2.3.4.4	Saved monitoring signals	Bit0: Power up error Bit1: DC-Bus undervoltage Lim1 Bit2: DC-Bus undervoltage Lim2 Bit3: Motor line ground fault Bit4: Motor line short circuit Bit5: DC-Bus overvoltage Bit6: Overtemperature ballast Bit7: Overtemperature motor Bit8: Overtemperature Power amplifier Bit9: I^2t power amplifier Bit10: reserved Bit11: I^2t motor Bit12: I^2t ballast Bit13: Phase monitoring motor Bit14: - Bit15: Watchdog Bit16: Internal system error Bit17: Pulse disable Bit18: Protocol error HMI Bit19: max. speed exceeded Bit20: Cable break reference encoder Bit21: Cable break actual position encoder Bit22: Position deviation error Bit23: Line failure 24 V Bit24: Contouring error Bit25: Short circuit in the digital outputs Bit26: Incorrect limit switch Bit27: Prewarning temperature motor Bit28: Prewarning temperature power amplifier Bit29: Bit30: Bit31:	–	R/– –	-
action_st	28:19	2.3.4.8	Action word, Saved error class bits	0..65535 Bit0: Error class 0 Bit1: Error class 1 Bit2: Error class 2 Bit3: Error class 3 Bit4: Error class 4 Bit5: reserved Bit6: Actual speed = 0 Bit7: Clockwise rotation drive Bit8: Counter-clockwise rotation drive Bit9: Current limit active Bit10: Speed limit active Bit11: Reference = 0 Bit12: Drive time-delayed Bit13: Drive accelerated Bit14: Drive operates constant	–	R/– –	-
ActCtrl	31:4	2.3.5.3	Active controller parameter set	0..2 0: Reserved 1: Parameter set1 active 2: Parameter set2 active	–	R/– –	-

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Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
p_ref	31:5	2.3.1.2	Setpoint position of position controller [Inc]	-2147483648..+2147483647	–	R/– –	-
p_act	31:6	2.3.1.1	Motor position/rev. [Inc]	-2147483648..+2147483647	–	R/– –	-
p_dif	31:7	2.3.1.10	Contouring error [Inc]	-2147483648..+2147483647	–	R/– –	-
n_ref	31:8	2.3.2.2	Setpoint speed [rpm]	-32768..32767	–	R/– –	-
n_act	31:9	2.3.2.1	Actual speed [rpm]	-32768..32767	–	R/– –	-
I_ref	31:10	2.3.3.11	Setpoint current [A]	-32768..32767	–	R/– –	-
Id_ref	31:11	–	Setpoint current d-component [A]	-32768..32767	–	R/– –	-
I_act	31:12	2.3.3.10	Current motor current [A]	-32768..32767	–	R/– –	-
Id_Act	31:13	–	Current motor current d-component [A]	-32768..32767	–	R/– –	-
uq_ref	31:14	–	Setpoint voltage q-component [V]	-32768..32767	–	R/– –	-
ud_ref	31:15	–	Setpoint voltage d-component [V]	-32768..32767	–	R/– –	-
p_abs	31:16	2.3.1.11	Absolute position per motor revolution (modulo value) [inc]	0..32767 HIFA-C: 0..16383	–	R/– –	-
I2tM_act	31:17	2.3.7.1	I^2t total motor	0..100	–	R/– –	-
I2tPA_act	31:18	2.3.7.2	I^2t total power amplifier	0..100	–	R/– –	-
I2tB_act	31:19	2.3.7.3	I^2t total ballast	0..100	–	R/– –	-
UDC_act	31:20	2.3.3.2	Power amplifier voltage [V]	0..32767	–	R/– –	-
Iu_act	31:21	–	Motor phase current phase U [A]	-32768..32767	–	R/– –	-
Iv_act	31:22	–	Motor phase current phase V [A]	-32768..32767	–	R/– –	-
TM_act	31:24	2.3.6.1	Temperature of motor [°C]	0..200	–	R/– –	-
TPA_act	31:25	2.3.6.2	Temperature of power amplifier [°C]	35..100	–	R/– –	-
p_refGear	31:26	2.3.1.6	Setpoint position of electronic gear [Inc]	-2147483648..2147483647	–	R/– –	-
v_refGear	31:27	2.3.2.5	Setpoint speed of electronic gear [Inc]	-2147483648..2147483647	–	R/– –	-
v_ref	31:28	–	Speed of the position controller setpoint value p_ref [Inc/s]	-2147483648..2147483647	–	R/– –	-

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
acc_ref	31:29	2.3.2.10	Acceleration of the position controller setpoint p_ref [rpm*s]	1..1000	–	R/– –	-
v_refM1	31:43	2.3.2.5	Speed from input value increments counted on module on M1 [Inc/s]	I-2147483648..2147483647	–	R/– –	-
StopFault	32:7	2.5.1	Cause of last interruption, error number	1..65535	–	R/– –	–

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