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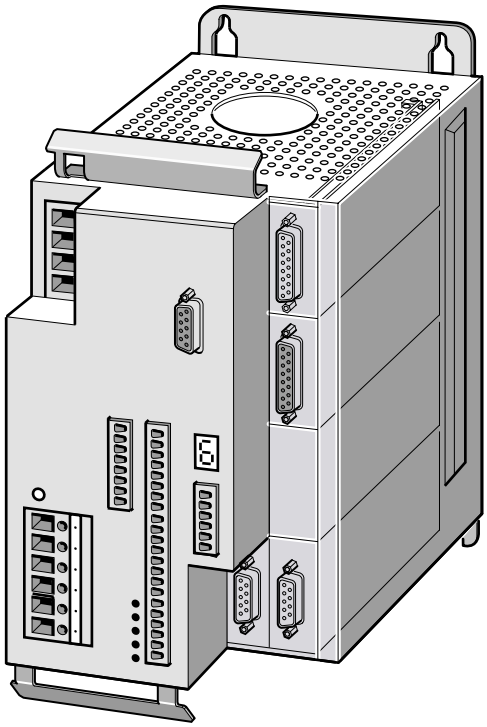
Telemecanique

by Berger Lahr

Technical documentation



Twin Line Controller 51x

Positioning controller for stepper motors

TLC51x

Operating system: 1.1xx

Order no.: TLADOCC51ME

Edition: -001, 04.03

Twin Line™

Motion Products

TLC51x 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. 1.7 on page 1-8). 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. 1.7 on page 1-8.
- 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.

TLADOCC51ME, -001, 04.03

Table of Content

TLADOCC51ME, -001, 04.03

TLADOCC51ME, -001, 04.03

TLADOCC51ME, -001, 04.03

TLADOCC51ME, -001, 04.03

Glossaries

Abbreviations

Abbreviation	Meaning
AC	Alternating current
ASCII	American Standard Code for Information Interchange
COS	Controller Operating System
DC	Direct current
DC link	DC link
DP	Decentralized Periphery
E	Encoder
EC	European Community
EMC	Electromagnetic compatibility
EN	European Norm
EU	European Union
HMI	Human-Machine Interface, plug-in hand-held operating unit
I	Incremental encoder
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
SM	Stepping motor

Product name

Abbreviation	Product designation	Term used
TLCT	Twin Line Commissioning Tool	Commissioning software
TLHBC	Twin Line Holding Brake Controller	Holding brake controller
TLHMI	Twin Line HMI	HMI hand-held operating unit
TLC51x	Twin Line Controller 51x	Controller

TLADOCC51ME, -001, 04.03

Technical Terms

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 refers to the zero point or index point of the position sensor.
CAN-C	Fieldbus module which connects the controller to a CAN Fieldbus. The selection of a Fieldbus profile defines whether the device works with CAN bus, CANOpen or DeviceNet protocol.
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 controller 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 controller 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 controller and the motor.
Electronic gear	An input speed is recalculated by the Twin Line controller using the values of an adjustable gear ratio to derive 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 controller to an operational malfunction corresponding to one of five error classes
ESIM3-C	Encoder simulation module for outputting position data of the motor as A/B signal to the external controller or to a second Twin Line controller.
Forcing	To change signal states irrespective of the hardware switching status in the controller; with the commissioning tool, for example. The hardware signals remain unchanged.
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 controller. HMI: Human-machine interface.
IBS-C	Fieldbus module which couples the power controller to an Interbus Fieldbus.
Incremental encoder	See encoder
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.
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.

TLADOCC51ME, -001, 04.03

Internal units	Resolution of the power amplifier with which the motor is directed to the new setpoint. Internal units are given in increments.
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
PBDP-C	Fieldbus module with which the positioning controller can be integrated into a Profibus-DP network
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 controller.
Power controller	See Power amplifier.
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 in the event of faults, the stop command or for fast braking of the motor in an emergency.
RS-232 interface	Communications interface of the Twin Line controller for the connection of a PC or the HMI hand-held operating unit.
RS422-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 ESIM3-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.
RS485-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.
RS485 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. RS485 signal transmission is bidirectional.
Safety	Freedom from unacceptable risk.
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.
SMART	Operating system software of the positioning controller
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.

TLADOCC51ME, -001, 04.03

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 controller, this will be given after the description of the action to be carried out. In this way the user 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 controller.

Passages which are preceded by this symbol may have to be discussed in more detail with Schneider Electric customer service. Contact addresses for Schneider Electric can be found under "Service Information", page 9-1.

TLADOCC51ME, -001, 04.03

1 The controller

1.1 Scope of supply

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

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

IP20 controller The scope of supply of the TLC51x controller includes:

Item	Qty.	Designation	Order no.
1	1	TLC5112, TLC5122	See Fig. 1.6
2	1	Hood for front cover	-
3	1 or 2	SK 14 shielding terminal for motor connection	TLATE
4	1	Connector caps for the terminal strips	-

Modules Option module configurations for the controller:

Item	Qty.	Designation	Order no.
5	1	RS422-C encoder module or PULSE-C pulse/direction module or	See Fig. 1.6
5	1	RM-C speed monitoring ESIM3-C Encoder simulation module	See Fig. 1.6
5	1	Fieldbus module PBDP-C, CAN-C, RS485-C or IBS-C	See Fig. 1.6

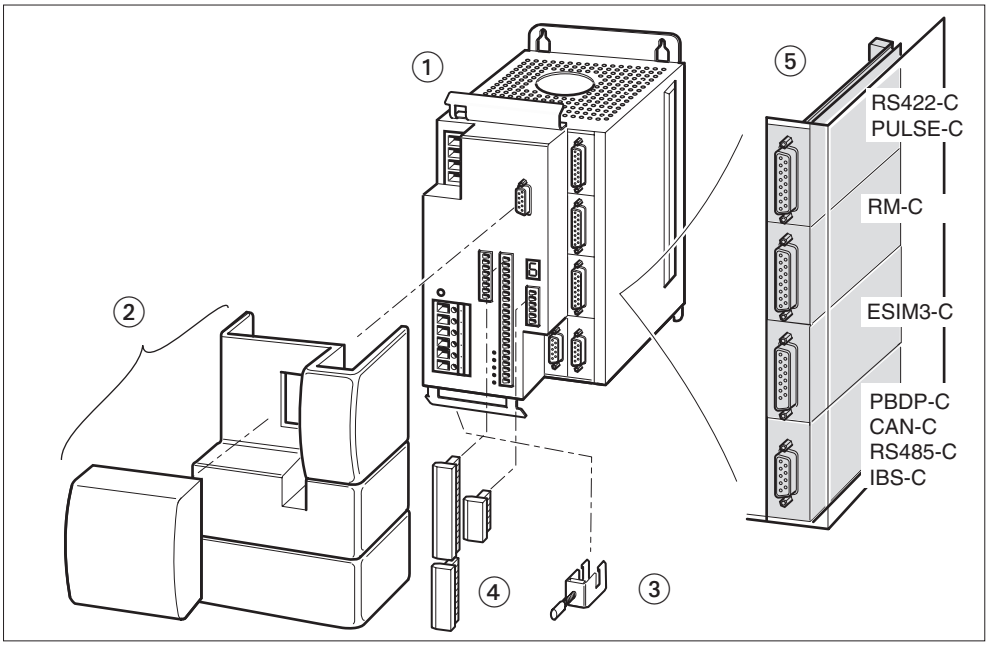


Fig. 1.1 TLC51x IP20 controller and modules

TLADOCC51ME, -001, 04.03

IP54 controller The scope of supply of the TLC51x IP54 controller includes:

Item	Qty.	Designation	Order no.
1	1	TLC5115, TLC5125	See Fig. 1.6
2	1	Power plug (round plug, 4-pin)	-
3	1	Shielding terminal SK14 for motor connection	TLATE
4	1	Sub-D cover for RS-232 interface	-
-	1	Integrated HBC holding brake controller (optional)	See Fig. 1.6

Modules Optional modules are identical with those of the IP20 controller.

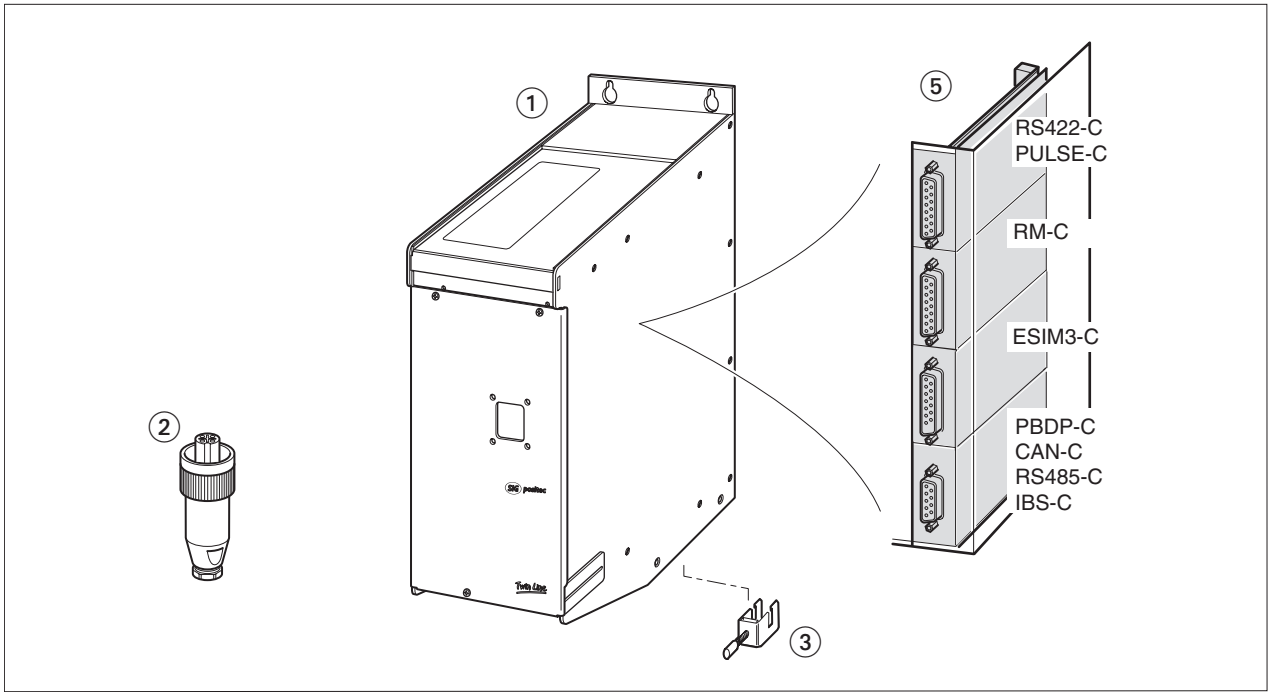


Fig. 1.2 TLC51x and IP54 controller and modules

TLADOCC51ME, -001, 04.03

Accessories Accessories for the IP20 controller and for IP54 controller are:

Item	Qty.	Designation	IP20 controller/ IP54 controller (IP20/IP54)	Order no.
1	1	Commissioning software with online documentation on data medium, English	IP20/IP54	TLAPSCA
2	1	HMI hand-held operating unit with manual	IP20/IP54	TLAPHOO
3	1	Connector set for complete assembly	IP20/IP54	TLATD
4	1	Motor cable 16 AWG (1.5 mm^2)with motor plug	IP20/IP54	TLACPVAAxxx1 [1]
5	1	Encoder cables for RM-C module with 15 pin Sub-D connector	IP20/IP54	TLACFVBAxxx1 [1]
5	1	Pulse direction cable for PULSE-C module	IP20/IP54	TLACDCBByyy [2]
5	1	Encoder cable for module RS422-C	IP20/IP54	TLACDCBCyyy [2]
6		Fieldbus cables for modules CAN-C IBS-C RS485-C	IP20/IP54	 TLACDCBAyyy [2] TLACDCBFyyy [2] TLACDCBDyyy [2]
-	1	CAN terminator, 9-pin socket CAN terminator, 9-pin plug	IP20/IP54	TLATA TLATB
7	1	RS-232 programming cable 5 m RS-232 programming cable 10 m	IP20/IP54	TLACDPBG 050 TLACDPBG 100
8	1	Holding brake controller TLHBC	IP20	TLABHO
9	1	External mains filter for controllers without internal filters for TLC511 D, 4A for TLC512 D, 10A	IP20	Please contact your local Schneider Electric office
10	1	Terminal angle with top-hat rail TS 15, e.g for Phoenix Contact type MBK terminals	IP54	TLATLR
11	1	Set of grommets type KDT/Z	IP54	TLATKR

1) Cable length xxx: 003, 005, 010, 015, 020: 3 m (9.84 ft.), 5 m (16.4 ft.), 10 m (32.8 ft.), 15 m (49.2 ft.), 20 m (65.6 ft.), longer cable lengths on request. Please contact your local Schneider Electric office
2) Cable length yyy: 005, 015, 030, 050: 0.5 m (1.64 ft.), 1.5 m (4.92 ft.), 3 m (9.84 ft.), 5 m (16.4 ft.).

TLADOCC51ME, -001, 04.03

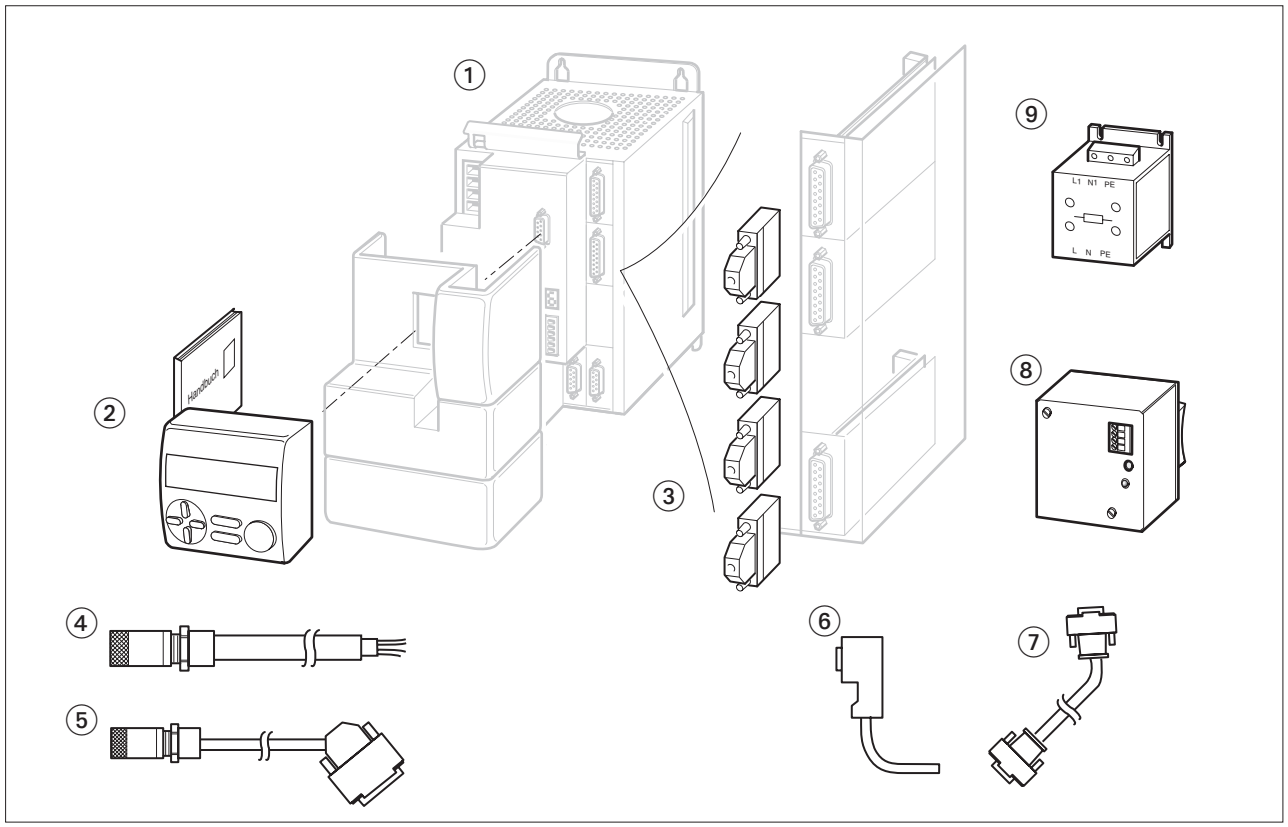


Fig. 1.3 Accessories for the TLC51x IP20 controller

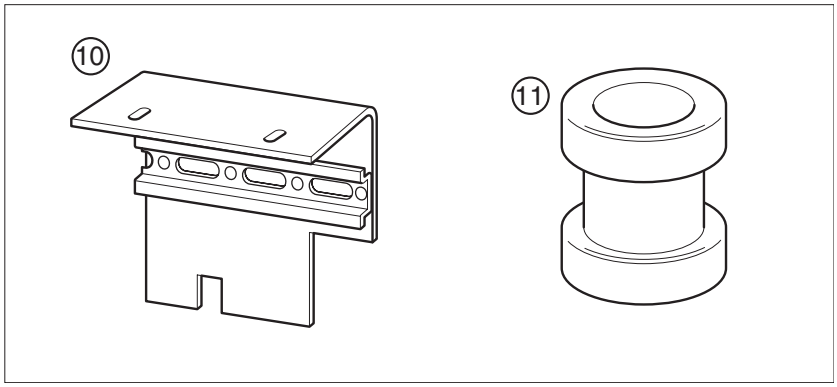


Fig. 1.4 Special accessories for the TLC51x IP54 controller

TLADOCC51ME, -001, 04.03

1.2 Documentation and literature

Manuals for the controller

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

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

TLADOCC51ME, -001, 04.03

1.3 Product Family

The controller TLC51x forms part of the Twin Line device series for controlling stepper motors and AC servomotors. The controller with built-in control electronics and power amplifier works as a stand-alone amplifier or as part of a Fieldbus configuration. It can control positioning on a stepper motor and carry out positioning operations on its own.

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

The controller comes in two versions with identical functions:

- Standard controller, TLC51x, as IP20, for use in a control cabinet
- TLC51x IP54, with protection grade IP54 (category 2 per DIN EN60529) for use outside the control cabinet close to the motor

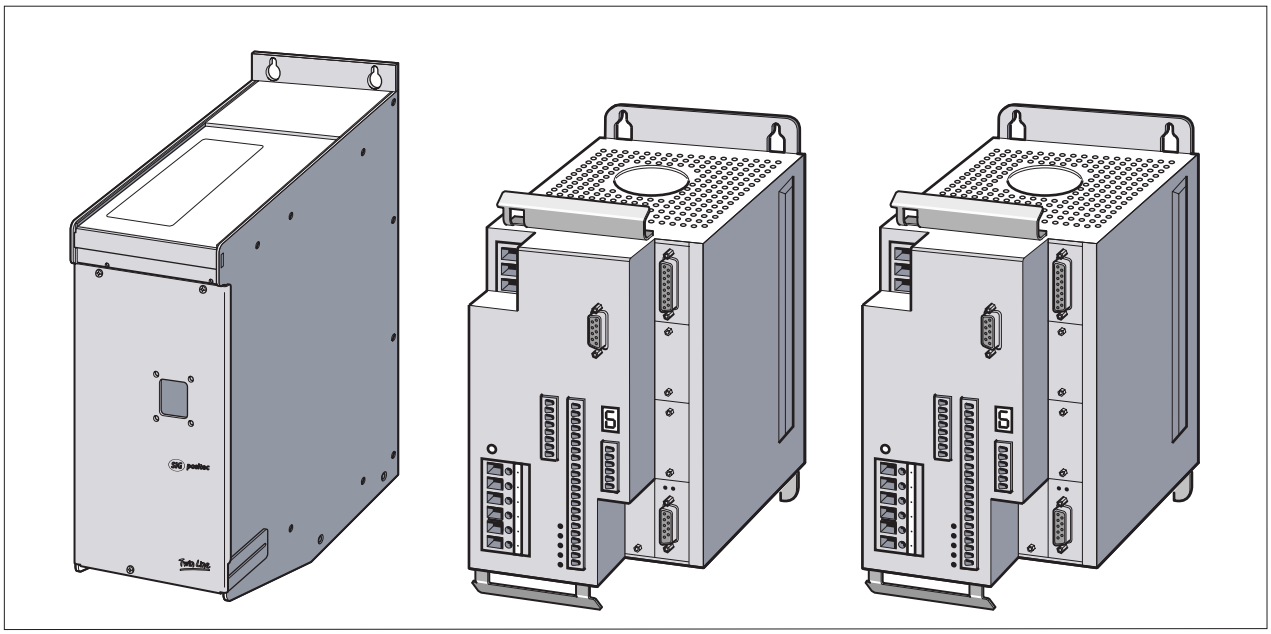


Fig. 1.5 Controller TLC511 IP54, TLC511 and TLC512

Type code The power class of the controller is indicated by the sixth digit in the device name type code.

TLADOCC51ME, -001, 04.03

Version Figure 1.6 describes the Twin Line controller configuration management.

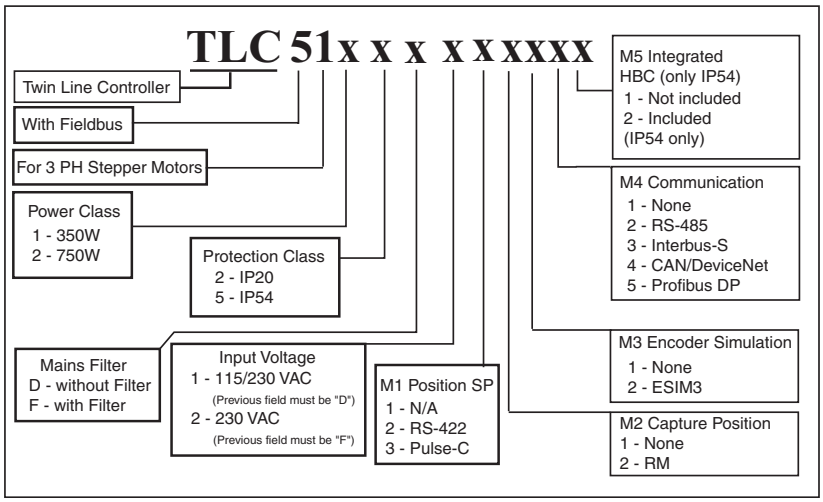


Fig. 1.6 Type code of the controller TLC51x

The ESIM3-C encoder simulation module is only possible in connection with RM-C.

IP54 controller The controller is optionally available with built-in holding brake control.

TL HBC and TL BRC accessories are not suitable for IP54 version, as they only have IP20 protection.

1.4 Controller overview

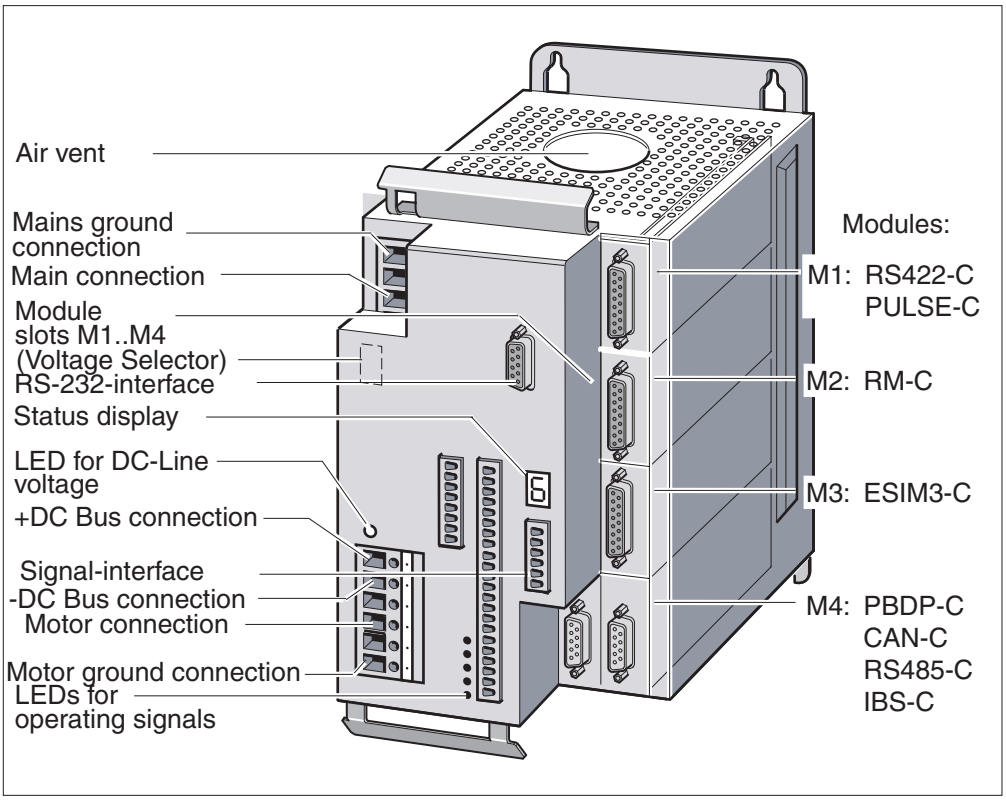


Fig. 1.7 Controller TLC51x

Mains connection The power supply for the amplifier is connected to the line power output: A position controller with a built-in line power filter can be operated without any further noise suppression on the supply side.

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

Motor connection The controller supplies the power for a permanent-field AC synchronous stepper over the three-phase connection. The motor connection is short-circuit protected and is checked for ground faults when the amplifier is enabled.

DC-Bus connection The DC-Bus voltage for the controller is taken from the intermediate circuit terminal. The capacity of the built-in DC-Bus capacitors at the DC-Bus connection can be increased with external capacitors for short-term absorption of excess braking energy.

Status display A 7-segment display shows information about the operating status of the controller. 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 and automatic operation.

TLADOCC51ME, -001, 04.03

Voltage selector switch

The controller can be connected to 115 V or 230 V power with the voltage selector switch. The voltage selector switch is only available with controllers without mains filters (D option).

The voltage selector switch is always supplied with IP54 controllers.

Signal interfaces

The input and output signals are routed via the signal interface and there is an external 24 V_{DC} supply voltage.

RS-232 interface

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

Air outlet and fan

A built-in fan feeds cool air into the unit from below to cool the power amplifier. It discharges the warmed air through the upper air vents. Temperature sensors on the power amplifier's heat sink protect the unit from overheating.

Module slots

Four module slots allow the controller to be customized for your particular area of application. The other module slots offer additional functions for the controller.

Note: The module slots are not user-configurable. The Twin Line controller must be ordered from the factory with the module slots populated with the desired modules. Field configuration of the module slots is not recommended.

Configuration variants

Various types of modules can be selected for the slots. This allows the controller to be set to a desired system configuration.

Slot	Functions when module fitted	Possible modules
M1	External setpoint signals for moving and positioning the motor	RS422-C or PULSE-C
M2	Actual position of an encoder for speed monitoring of the motor	RM-C
M3	Output of the change in the motor position as incremental signals, e.g. to control a slave drive	ESIM3-C
M4	Fieldbus module for integration into the following Fieldbus systems: Profibus-DP, CAN-Bus, CANOpen, DeviceNet, serial online connection or Interbus-S	PBDP-C, CAN-C, RS485-C or IBS-C

Parameter memory

All settings of the controller are administered for movement parameters. The parameters are stored in the controller, protected against power outages, and can be displayed and changed via the RS-232 interface on the PC, with the HMI hand-held operating unit or over the Fieldbus.

Movement parameters

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

TLADOCC51ME, -001, 04.03

Memory for device data

Device data are all parameter values of the Twin Line controller that can be stored in the EEPROM memory of the Twin Line controller safe from power outages.

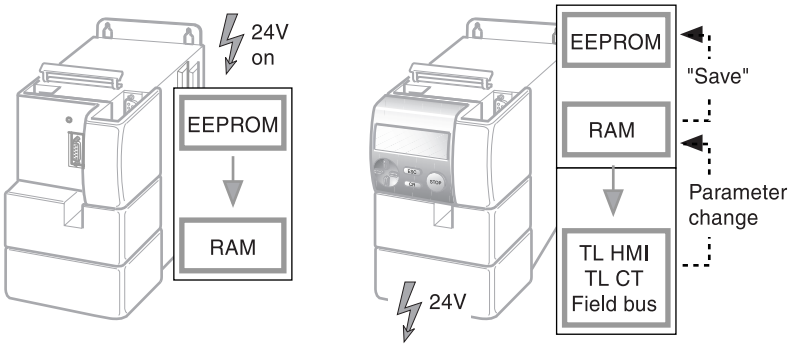


Fig. 1.8 Memory ranges and parameter storage

Once the 24 V power supply is switched on, the parameters are automatically copied to the Twin Line controller RAM from the internal EEPROM memory. The Twin Line controller operates with the RAM device data only.

The following options are available for backing up parameters from RAM to the EEPROM:

- with the TL HMI hand-held operating unit: back up with "Save"
- with the TL CT commissioning software: back up with special button fields and menu items
- via the Fieldbus: back up with the parameters "Commands.eeprSave"

TLADOCC51ME, -001, 04.03

1.5 Modules of the TLC51x controller

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

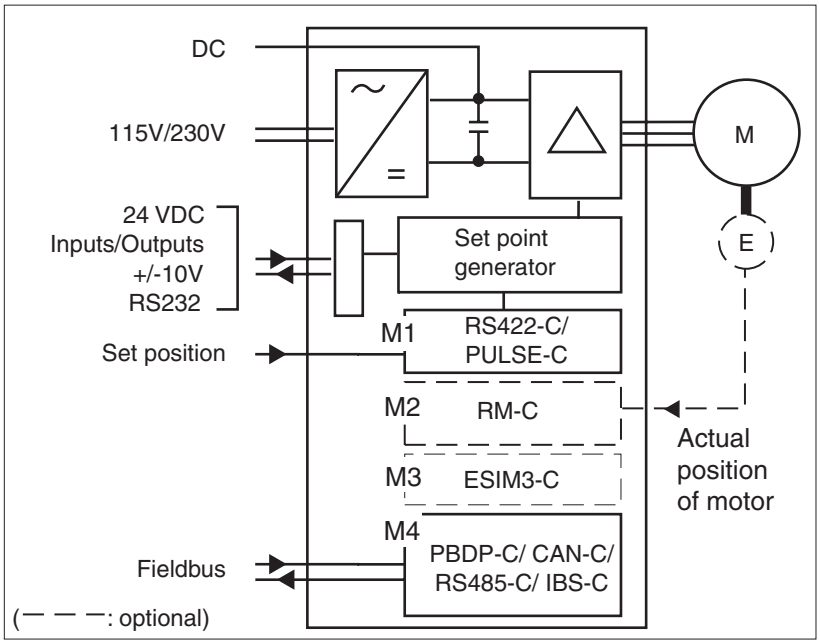


Fig. 1.9 Block diagram with modules and interface signals

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

RS422-C module The RS422-C encoder module evaluates externally fed encoder signals as reference signals for positioning. The signals take the form of A/B signals from an encoder, from a higher-order controller or from the encoder simulation of a master controller.

Module RM-C The controller receives A/B signals for position monitoring of the stepper motor and a signal that checks the motor temperature over the RM-C speed monitoring module. The encoder electronics in the motor receives the required operating power from the speed monitoring connection.

Speed monitoring is built into the system as an option.

Module ESIM3-C The ESIM3-C encoder simulation module outputs the position data of the stepper motor as an A/B signal.

Module PBDP-C The PBDP-C Fieldbus module serves to integrate the controller into the Profibus-DP Fieldbus. The controller operates as a command receiver or slave. It executes the control and work commands received from a higher-order controller. The Fieldbus module is optional.

Module CAN-C The CAN-C Fieldbus module couples the controller to a CAN-, CANOpen or DeviceNet Fieldbus system. The Fieldbus module is optional.

IBS-C module The IBS-C Fieldbus module allows the controller to be used as a slave device in an Interbus network. The Fieldbus module is optional. The module is designed to Interbus specification version 1.

TLADOCC51ME, -001, 04.03

RS485-C module The RS485-C Fieldbus module permits Fieldbus applications 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. The Fieldbus module is optional.

TLADOCC51ME, -001, 04.03

1.6 Controller configuration, operating modes and functions

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

- Manual movement
- Speed mode
- Point-to-point mode
- Electronic gear
- Referencing
- Oscillator

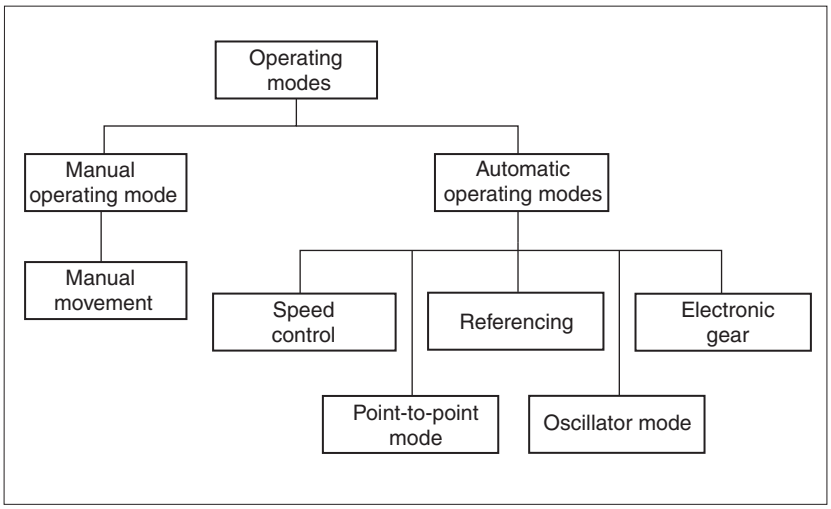


Fig. 1.10 Operating modes of the controller TLC51x

The following table shows the modules required for each operating mode and possible configurations for additional functions.

	Minimum module configuration in slot			
Operating mode	**M1**	**M2**	**M3**	**M4**
Manual mode, Speed mode, Point-to-point mode, Referencing movement, Oscillator mode	optional	optional	optional	optional
Recording reference pulses Electronic gear	PULSE-C or RS422-C	optional	optional	optional
Operation with speed monitoring	optional	RM-C	optional	optional

TLADOCC51ME, -001, 04.03

Manual movement with position reference

In manual movement mode the controller moves the motor a defined distance or in continuous motion at a constant speed. Distance, speed rates and the time for changing from incremental to continuous motion are adjustable.

Speed mode

In speed mode a setpoint speed is specified for the motor, and movement is initiated with no defined finishing point. The motor continues to move at this speed until a new speed is set or the mode is terminated.

Point-to-point mode

In point-to-point mode (also PTP mode) the motor is moved from a point A to a point B by a positioning command. The positioning distance is given in absolute terms with reference to the zero point of the axis or in relative terms with reference to the current axis position.

Oscillator mode

In oscillator mode the motor is speed-controlled. The speed is set via the ±10V-input of the signal -interface.

Electronic gear

The electronic gear operating mode is used when one or more stepper motors are to follow the reference signal of a higher-order controller or an encoder and are run under position control.

The reference signals are fed in via the RS422-C encoder module or the PULSE-C pulse-direction module. A new position setpoint value is calculated from these signals with an adjustable gear factor.

Referencing

In referencing mode, an absolute scale reference of the motor position at a defined axis position is established. Referencing can be carried out by a referencing movement or by dimension setting.

In a referencing movement a defined position on the axis, the zero or reference point, is targeted to establish the absolute scale reference of the motor position to the axis. The reference point is used as the point of reference for all subsequent absolute positioning operations.

Dimension setting allows the current motor position to be defined as the new axis reference point to which all subsequent position data relate.

Fieldbus mode

Parameters can be set and positioning jobs can be run via the optional Fieldbus module (slot M4). There are four modules available for Fieldbus mode:

- Profibus-DP with the PBDP-C module
- CAN-Bus, CANOpen or DeviceNet with the CAN-C module
- Serial RS485 bus with the RS485-C module
- Interbus-S with the IBS-C module

Additional information on connecting, programming and operating the controller on a Fieldbus can be found in the relevant manuals.

TLADOCC51ME, -001, 04.03

List control

While the controller is carrying out a movement command, the direction of movement is monitored in the background by list control. When a list position is reached, the controllerresponds with the relevant event depending on the list type.

- List type for position values and signal values: when the motor reaches a list position, the output signal "TRIGGER" is set or reset depending on the list entry.
- List type for position values and speed values: when the motor reaches a position value, the controller switches to the new speed value in the list, and moves the motor at this speed.

Entries can be made in the list with the HMI hand-held operating unit, the commissioning software or via the Fieldbus.

Teach mode

The controller offers Teach mode processing for entering the position values: Depending of the reference point, list positions are approached in succession and transferred to the parameter memory with a value for the trigger output or the speed.

TLADOCC51ME, -001, 04.03

1.7 System integration of the TLC51x controller

The controller has various interfaces for control and monitoring of the unit in a drive system. The interfaces include:

- The RS-232 port for connecting the HMI hand-held unit or a computer with the TL CT commissioning software
- The inputs and outputs of the signal interface
- The Fieldbus connector, if a Fieldbus module is installed in slot M4

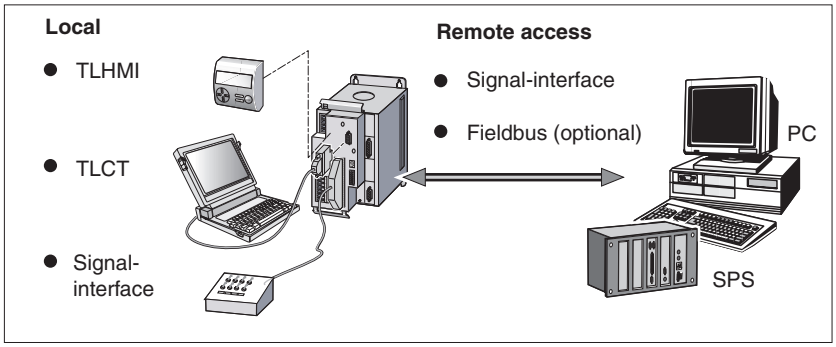


Fig. 1.11 Options for access to the controller

Local access to the unit's functions is available via the RS-232 interface. Local operation is usually used for commissioning or setup work such as Teach mode.

The controller can be accessed locally with a control panel via the signal interface or remote-controlled, e.g. with a PLC.

Fieldbus mode is remote-controlled, generally via a central Fieldbus controller.

Options for use

Combination of the access options gives three usage cases for a controller with a Fieldbus module. If a module is not installed at slot M4, the controller can only be operated by remote control through the signal interface inputs and outputs (I/O). The usage cases can be set with the "Settings.IO_mode" parameter. In all cases the unit can still be controlled locally with an operating unit.

For details on setup and usage of the controller in the various usage cases see chapter "Operating modes of the controller" from page 6-1.

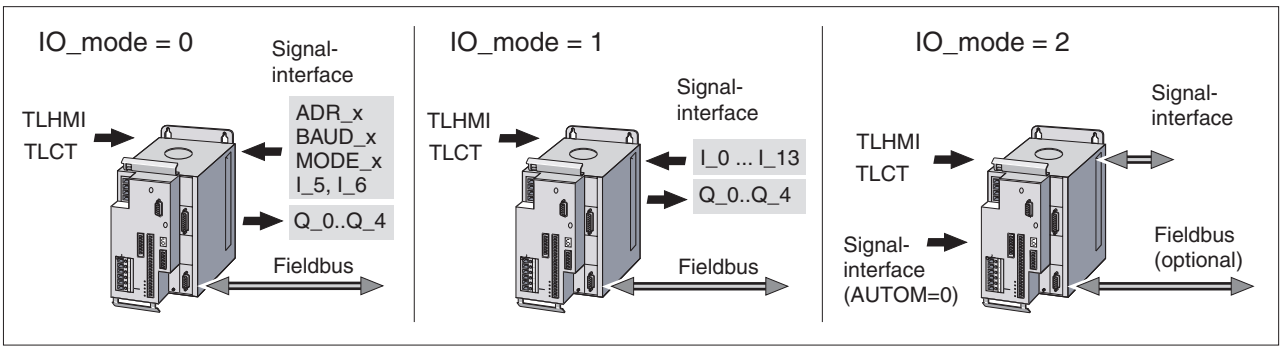


Fig. 1.12 Usage cases for operating the controller

TLADOCC51ME, -001, 04.03

	IO_mode=0	IO_mode=1	IO_mode=2
Operation/setting parameters via - TL CT - TL HMI - Fieldbus [1)]	•	•	•
Setting Fieldbus parameters via inputs	•	–	–
Manual movement and Teach mode via I/O, switching between automatic and manual mode via AUTOM input	–	–	•
Number of freely available inputs and outputs	2 / 5	14 / 5	- / -

1) If a Fieldbus module is installed

IO_mode = 0 Fieldbus mode with Fieldbus parameters set via I/O

The signal interface parameters are used to set Fieldbus parameters. Depending on the Fieldbus module, address, baud rate and Fieldbus mode are directly available after switching on the unit.

IO_mode = 1 Fieldbus mode with freely available I/O assignments

If the signal interface inputs and outputs can be freely assigned, they can be used for additional tasks and controlled and evaluated over the Fieldbus.

IO_mode = 2 Preassigned I/O processing with or without Fieldbus

The controller is operated via the signal interface:

If a Fieldbus module is integrated, movement jobs can also be started over the Fieldbus. Movement mode can be monitored via the outputs. With a Fieldbus module the device status can be evaluated with status messages. If a Fieldbus module is not installed, "IO_mode"=2 is always set.

TLADOCC51ME, -001, 04.03

1.8 Guidelines and standards

1.8.1 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 controller conforms to EN 50178 and to the following peripheral conditions:

- Protection class 1
- Pollution degree 2 for the IP20 controller, Pollution degree 3 for the IP54 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.

TLADOCC51ME, -001, 04.03

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. 1.13 Conformity as per the EC low voltages guideline

TLADOCC51ME, -001, 04.03

1.8.2 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
	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

TLADOCC51ME, -001, 04.03

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 unit safely.

Depending on the seriousness of the hazard, the messages are divided into three hazard categories. The signal words 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.

TLADOCC51ME, -001, 04.03

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 (see Fig. 1.7 on page 1-8). 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 stepper 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. 1.7 on page 1-8.
- 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.

TLADOCC51ME, -001, 04.03

⚠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. 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.

2.3 Use for the purpose intended

2.3.1 Ambient conditions (controller and accessories)

	Transport and storage temperature	-40 °C to +70 °C
	Operating height No derating required for	h <1000 m above m.s.l.
	Vibration stress during operation to DIN IEC 68-2-6	
	Number of cycles:	10
	Frequency range:	10Hz to 500Hz
	Acceleration:	20m/s^2
	Continuous shocks to DIN IEC 68-2-29	
	Number of shocks:	1000/direction (X,Y,Z for each clockwise, counter-clockwise direction, total 6000)
	Peak acceleration:	150m/s^2
IP20 controller and accessories	Protection grade	IP20
	Ambient temperature	0 °C to +50 °C
	Relative humidity	15% to 85% (no condensation permissible)
IP54 controller only	Protection grade	IP54, category 2
	Protection grade of internal cooling air duct	IP34
	Ambient temperature (from serial number 1010020048 with protection against short-term condensation)	0 °C to +45 °C
	Relative humidity:	15% to 85% (no condensation permissible)

TLADOCC51ME, -001, 04.03

IP54 controllers can be operated outside the switch cabinet, but not outside and not in environments with serious contamination (due to jamming of the fan).

2.3.2 Intended use

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

Only a stepper motor may be operated with the controller. The motor must be approved by Schneider's local representative for operation with the unit.

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

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

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

The controller must be installed and operated in an environment which meets at least protection grade IP54. The standard unit must therefore be installed and properly mounted in a control cabinet. IP54 controllers can be operated outside the switch cabinet, but not outside and not in environments with serious contamination (due to jamming of the fan).

The controller may only be set up and operated after correct EMC installation. It may only be used with the cables and accessories specified by Schneider's local representative.

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

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.

2.4 Qualification of the personnel

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

Qualified personnel are people who, by technical training, knowledge and experience, are able to assess the work to be done and to recognize and avoid possible hazards.

TLADOCC51ME, -001, 04.03

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

2.5 Safety devices

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

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

Safety devices	Task and protective functions
Limit switch signals	Monitoring the permissible ranges of movement 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.

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

The following components and limit values are monitored internally:

Monitoring	Task and protective functions
Short-circuit	Monitor the motor wiring for short circuit between the motor phases; functional safety and device protection
Overvoltage and undervoltage	Monitor DC Bus for overvoltage and undervoltage; functional safety and device protection
Temperature	Monitor motor and power amplifier [1)] with sensors for excess temperature; device protection
Speed error	With units with speed monitoring following error limit value if position deviation is too great; functional safety
Motor speed	Speed threshold for maximum permitted speed; device protection
Data connection with an operating unit	Functioning of connection when motor controlled via operating unit; functional safety

1) Motor monitoring only with devices with optional speed monitoring

TLADOCC51ME, -001, 04.03

TLADOCC51ME, -001, 04.03

3 Technical data

3.1 Mechanical data

3.1.1 Controller TLC51x (IP20)

Weight TLC5112, TLC5122 with 3 modules 2.7 kg (6.0 lb.)

Device protection Protection grade to DIN EN 60529: 1991 IP20

Dimensions

	TLC5112	TLC5122
Width	108 mm (4.25 in.)	108 mm (4.25 in.)
Height	212.5 mm (8.37 in.)	212.5(8.37 in.)
Depth	184.5 mm (7.26 in.)	184.5 mm (7.26 in.)
Front width	105.5 mm (4.15 in.)	105.5 mm (4.15 in.)
Connection dimension	63 mm (2.48 in.)	63 mm (2.48 in.)

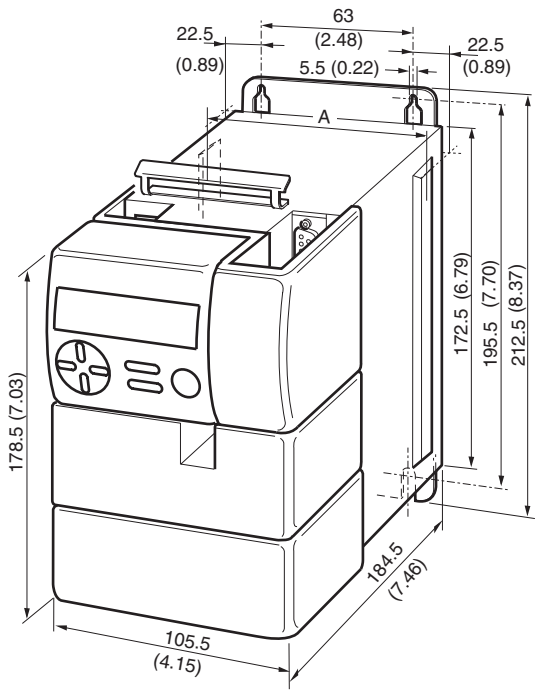


Fig. 3.1 Dimensions TLC5112 and TLC5122 in mm (in.).
The HMI manual operating unit illustrated is optional.

TLADOCC51ME, -001, 04.03

3.1.2 Controller TLC51x (IP54)

Weight	TLC511 IP54 with 3 modules	8 kg (17.63 lb.)
	TLC512 IP54 with 3 modules	8 kg (17.63 lb.)
Device protection	Protection grade to DIN EN 60529: 1991	IP54, category 2

Dimensions

	TLC5115	TLC5125
Width A	127 mm (5.0 in.)	127 mm (5.0 in.)
Height B	360 mm (14.17 in.)	360 mm (14.17 in.)
Depth C	245 mm (9.65 in.)	245 mm (9.65 in.)
Front width D	127 mm (5 in.)	127 mm (5 in.)
Connection dimension E	80 mm (3.15 in.)	80 mm (3.15 in.)

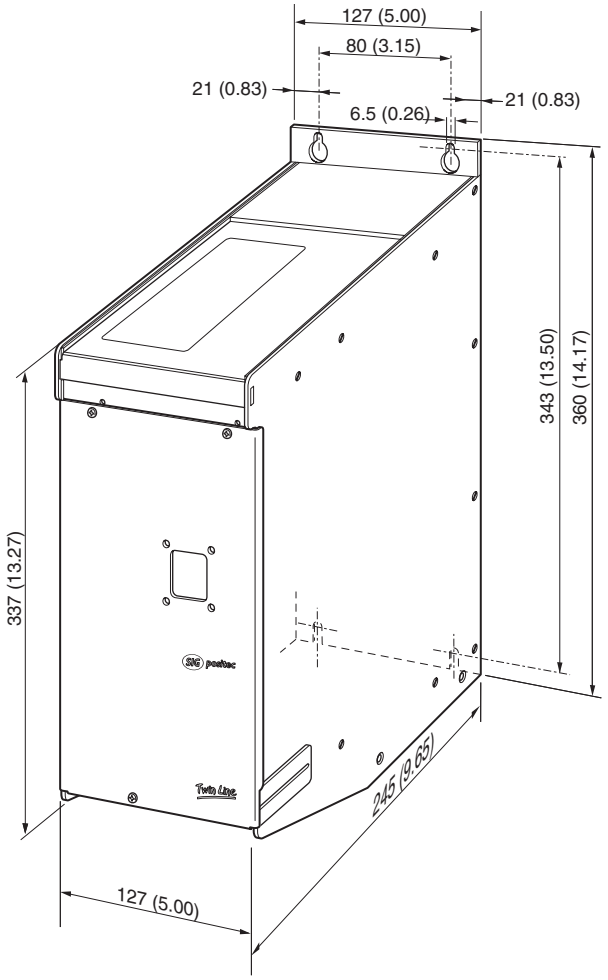


Fig. 3.2 Dimensions TLC51x IP54 in mm (in.)

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3.1.3 Accessories

Holding brake controller TL HBC	Dimensions (H x W x D)	107 mm x 104 mm x 76 mm (4.3 x 4.2 x 3.0 in)
	Installation on DIN rail	55 mm (2.165 in)

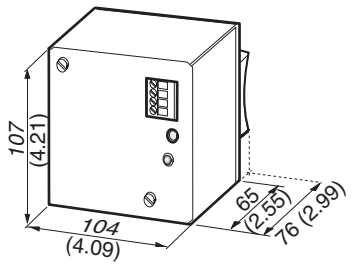

Fig. 3.3 Holding brake controller

TLADOCC51ME, -001, 04.03

3.2 Electronic data

3.2.1 Controller

Mains connection

	TLC511/TLC511 IP54	TLC512/TLC512 IP54
Mains voltage [V_{AC}] only with TLC51xD:	1 x 230 -20%/+15% 1 x 115 -20%/+15%	1 x 230 -20%/+15% 1 x 115 -20%/+15%
Mains frequency [Hz] 1)	47 - 63	47 - 63
Current consumption [A] 2)	2 (230 V) 4 (115 V)	5 (230 V) 10 (115 V)
Starting current [A]	< 60	< 60
Power factor cosφ	> 0.6	> 0.6
Power loss [W] 3)	≤ 40	≤ 60
Mains buffering [ms]	< 5	< 5
Operational overvoltage (EN61800-3 and EN61000-4-5)	between phases: 1 kV; phase to earth: 2 kV	
Input mains overvoltage category (UL840)	category III 4)	
Leakage current 5) [mA]	< 30	< 30
Fuse, external [A] / characteristics at 230 V at 115 V	 10 (Class CC) 10 (Class CC)	 10 (Class CC) 10 (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. Maximum available short-circuit current must not exceed 5000 A.
3) The power loss depends on several factors: motor speed, motor current and length of cable.
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 controller is recommended. Use Square D 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.

TLADOCC51ME, -001, 04.03

Motor connection

	TLC511/TLC511 IP54	TLC512/TLC512 IP54
Power class [1] [kW]	0.35	0.75
Switching frequency [kHz]	16	16
Rated current [A r.m.s.], r.m.s.	3	7
Max. speed [rpm]	3000	3000
Cable length [2] [m]	20	20
Cable cross-section [mm^2]	1.5 (16 AWG)	1.5 (16AWG)

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

24 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 DIN 19240)
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: (without loading of the outputs)	<2.5 A

DC bus connection

A maximum of two controllers can be interconnected. Only controllers 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 ($I \geq 3$ mA)
DC voltage U_{low}	≤ 5V ($I \leq 0.5$ mA)
Current at 24 V	≤ 7 mA
Digital signal outputs	Inductive capacity (150 mH / 11 W) Short-circuit-proof
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 3-8.

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3.2.2 Modules

Note: Detailed data on individual modules can be found in the chapter entitled "Electrical installation" from page 4-13.

Encoder simulation module ESIM3-C	Signal outputs (A, B)	RS422-voltage-compatible Connected electrically to 24GND
RM-C speed monitoring	Signal inputs (A, B, I)	RS422-level Connected electrically to 24VGND
	Input frequencies:	≤ 400 kHz 1 600 00 Inc/s
	Encoder pitch	1000 lines
	Output Encoder power supply (SENSE)	5 V ± 5%, ≤ 300 mA sense-controlled Short-circuit and overload-proof
RS422-C encoder module	Signal inputs (A, B, I)	RS422 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 Asymmetrical	Compatible with RS422-voltage 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
RS485-C module	Signal inputs/outputs	in accordance with the RS485 standard electrically isolated 4-wire interface
	Transmission rates	1200, 2400, 4800, 9600 19200, 38400 baud
PBDP-C module	Signal inputs/outputs	in accordance with the RS485 standard electrically isolated
	Transmission rate	≤ 12 Mbaud
CAN-C module	Signal inputs/outputs	level to ISO 11898 electrically isolated
	Transmission rate	≤ 1 Mbaud
IBS-C module	Signal inputs/outputs	in accordance with INTERBUS specification category 1 Two-wire remote bus

TLADOCC51ME, -001, 04.03

	Transmission rate	500 kbaud
	For units with the IBS-C module, 24 VGND is internally connected to PE.	
IP54 controller *Option holding brake controller*	Supply voltage, input	20 V to 30 V
	Input current	Input current = 0.1 A + brake current
	Output, brake	not short-circuit-proof
	Current at 24 V for 100 ms	max. 2.5 A
	DC voltage	20 V to 30 V
	With voltage drop	
	Continuous current	max. 1.25 A
	DC voltage	9.5 V to 15 V

TLADOCC51ME, -001, 04.03

3.2.3 UL 508C certification

The controller TLC51x is certified to UL 508C with the following data.

Mains connection

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

Motor data

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

Accessories

- Holding brake controller, TLHBC
  Power supply 24 V

3.2.4 Accessories

TL HBC holding brake controller

Supply voltage, input	20 V to 30 V
Input current	Input current = 0.5 A + brake current
Output, brake	
DC-voltage	20 V to 30 V
Current at 24 V for 100 ms	0.5 A to 2.5 A
Continuous current	0.5 A to 1.5 A
DC voltage with voltage drop	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.

TLADOCC51ME, -001, 04.03

4 Installation

4.1 Electromagnetic compatibility (EMC) and equipment grounding requirements

Strong electromagnetic interference occurs in the power area of the controller. 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 controller 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 controller 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 or serious injury.

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.

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
Ground 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

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EMC measures	Effect
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
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.

TLADOCC51ME, -001, 04.03

⚠ 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 these instructions will result in death or serious injury.

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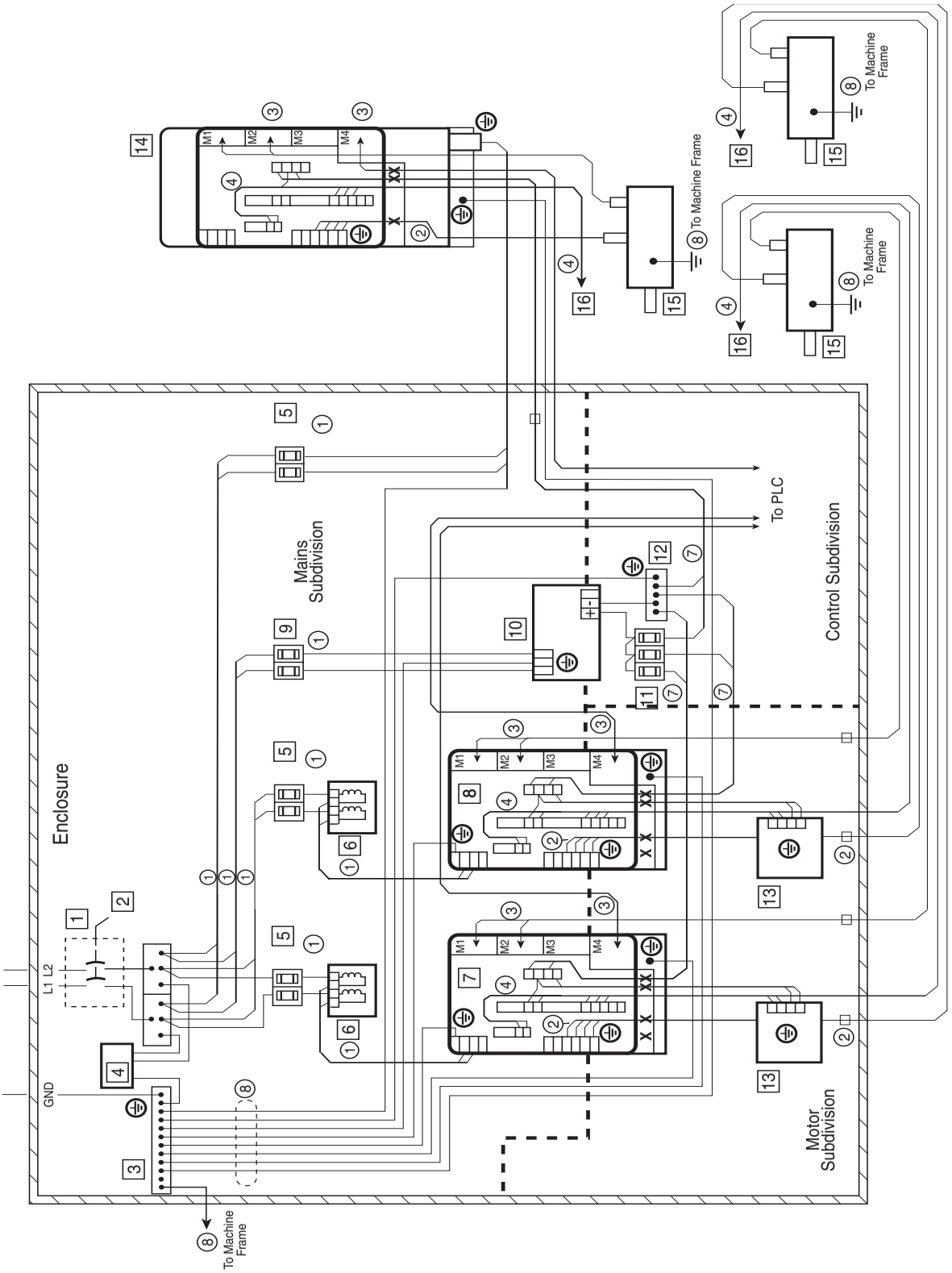

Fig. 4.1 EMC measures and subdivisions of the control cabinents

Cable	Description
①	Individual conductor or multi-conductor power cable. Refer to sections 4.4.2 for details
②	Multi-conductor shielded motor cable. Refer to sections 4.4.3, 4.4.4 and 4.4.5 for details.
③	Multi-conductor shielded communication/encoder cable. Refer to section 4.4.12 for details.
④	Multi-conductor control cable. Refer to section 4.4.7 for details.
⑤	Multi-conductor shielded power cable. Refer to section 4.4.2 for details.
⑥	Multi-conductor shielded power cable. Refer to section 4.4.2 for details.
⑦	Multi-conductor twisted shielded control cable. Refer to section 4.4.7 for details.
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	TLC51x2 controller
8	TLC51x2 controller
9	24 Vdc power supply input mains fuses
10	24 Vdc power supply
11	24 Vdc fuses
12	24 Vdc ground bar
13	TLHBC holding brake controller
14	TLC51x5 controller
15	Stepper motor
16	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

⚠WARNING

UNINTENDED EQUIPMENT ACTION

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

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

Motor leads and encoder cables are especially critical signal circuits. Use the cables recommended by your local agent. They are tested for EMC safety. These cables can also be used as trailing cables.

Information on the cables can be found in section "Accessories and spare parts" on page 10-1.

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4.2 System components

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

- Three-phase stepper motor
- Motor cable
- Signal cable to fit device version:
  ESIM3-C module: encoder cable for ESIM3-C
  RS422-C module: external setpoint encoder cable
  PULSE-C module: pulse/direction external setpoint cable
  RM-C module: encoder cable for RM-C
  PBDP-C module: bus cable for Profibus-DP
  CAN-C module: bus cable for CAN-Bus, CANOpen and DeviceNet
  RS485-C module: bus cable for serial online bus
  IBS-C module: bus cable for Interbus
- RS-232 cable with PC connection plug
- Mains cable and line fuses
- External power supply, 24 V_{DC} with safe separation - PELV
- External mains filter for units with no built-in mains filter
- Additional filters and chokes for line connection and motor connection, depending on system configuration
- Control cabinet
- NC control or PLC for automatic operation
- PC or laptop with WINDOWS® 95, 98, NT or 2000 for commissioning with the commissioning software.

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 these instructions can result in injury or equipment damage.

Before installation...

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

4.3.1 Installing the TLC51x IP20 controller

Control cabinet

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

Operating heat from the controller and other components must be dissipated by means of the enclosure thermal management system.

Mounting distances

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

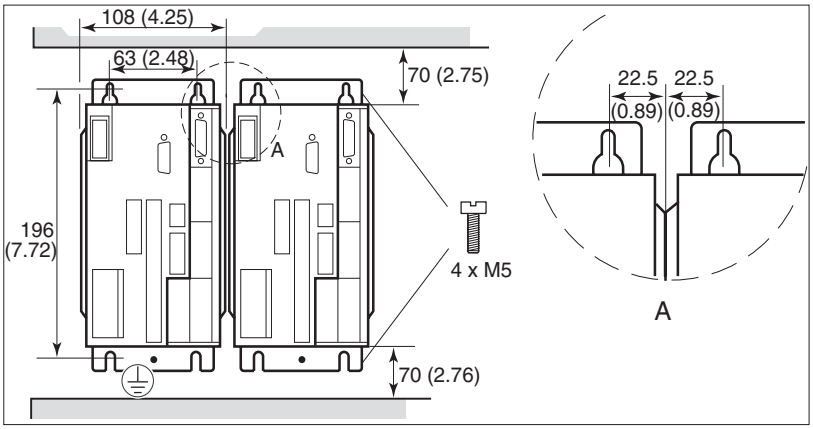

Fig. 4.2 Installation clearances, dimensions in mm (in.)

- ▶ Position the controller in the enclosure such that the heated air flow from other apparatus does not result in undesired heating of the controller or its cooling air.
- ▶ Mount the controller vertically with the mains connection at the top.
- ▶ Mount the controller on a galvanized or plated metal surface. The controller 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 controller is to be attached, This will ensure that the controller has a good electrical connection with the mounting surface.

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4.3.2 Installing the TLC51x IP54 controller

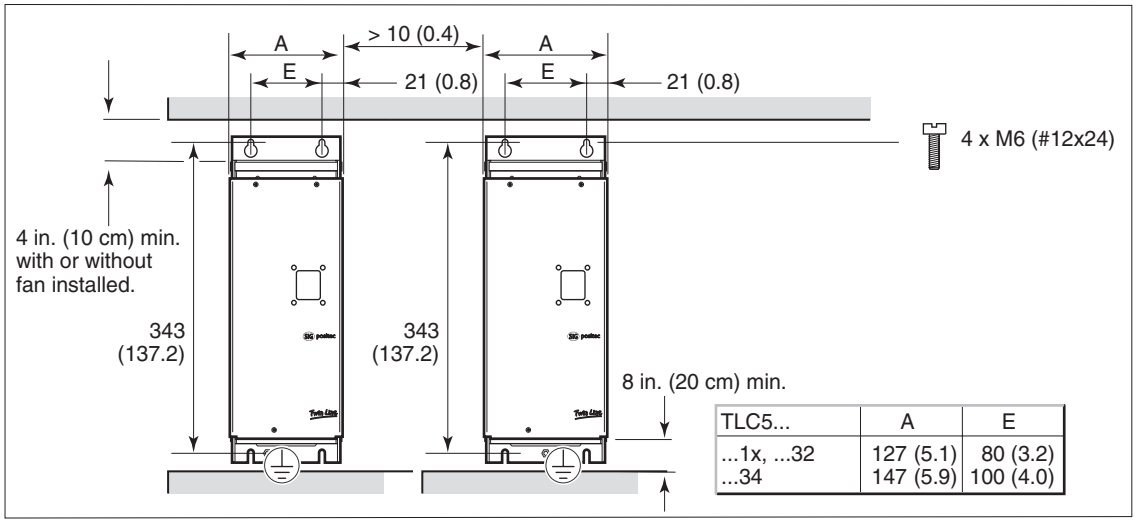
Mounting distances

IP54 controllers must be mounted at a minimum distance of 10 mm (0.4 in.) from neighboring devices.

Controller connections are routed out of the bottom of the housing. There must be 20 cm (8 in.) of space under the controller so that the connecting cables are not flexed as they exit the bottom of the controller.

There is a ventilation element on the bottom of the controller. Do not remove the protective cover!

The controller must be mounted vertically to maintain its water resistance rating.



TLC5...	A	E
...1x, ...32	127 (5.1)	80 (3.2)
...34	147 (5.9)	100 (4.0)

Fig. 4.3 Mounting distances, dimensions in mm (in.)

4.3.3 Fitting controller label

The controller label provides information on the meaning of all operating states displayed on the 7-segment display, and on signal interface assignment. An example of the controller label for copying is provided in section "Unit label", page 11-1.

▶ Photocopy the artwork on page 11-1 of this manual.

IP20 controller

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

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

IP54 controller

▶ Stick the label to the side of the Twin Line controller.

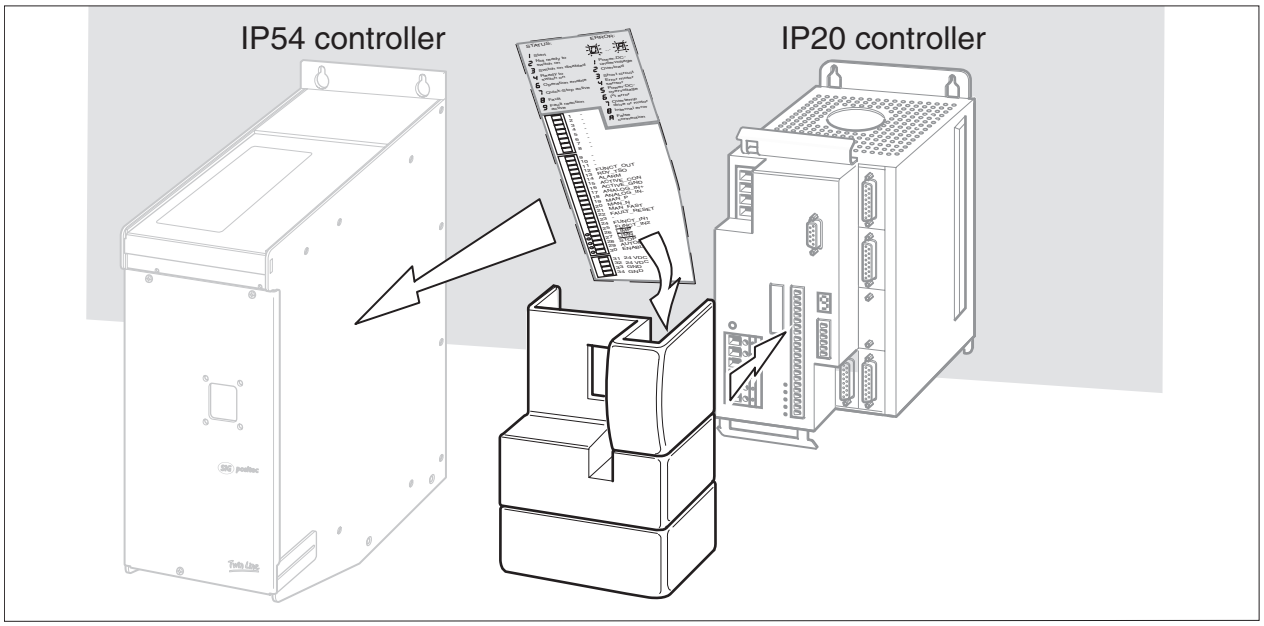


Fig. 4.4 Attaching the controller label in the side of the hood or to the side of the Twin Line Controller

Hazard label for all controllers

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.

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4.3.4 Installing accessories on the IP20 controller

Mains filter

The controller is supplied with a built-in mains filter as standard. A special version of the controller can also be ordered without a mains filter.

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

Do not use the controllers with external mains filters unless you can make test measurements at the controller of the functioning and the EMC of a selected mains filter.

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

- "F": with mains filter, e.g. TLC51x F
- "D": without mains filter, e.g. TLC51x D

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

▶ Fit the mains filter near the mains connection and on the same mounting plate. The length of the cable to the controller must not exceed 50 cm (19.69 in.). **The cable must be shielded and the shield must be grounded at both ends.**

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4.3.5 Installing accessories on the IP54 controller

Terminal angle The IP54 controller offers a terminal angle as an accessory for additional wiring.

- ▶ Open the front plate with the three mounting screws.
- ▶ Fix the terminal angle to the top left-hand side of the top of the housing, using two M3 screws.
- ▶ Close the front plate with the three screws.

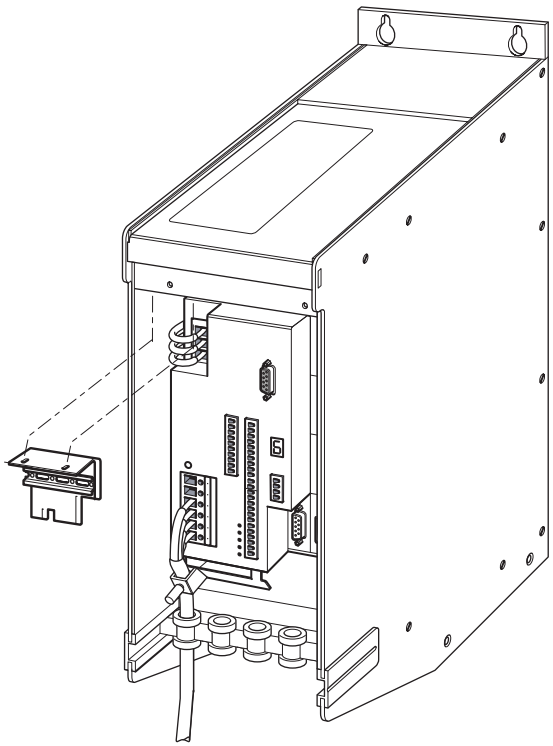

Fig. 4.5 Connection of terminal angle

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4.4 Electrical installation

⚠ DANGER

HAZARDOUS VOLTAGE

Before installing, adjusting, repairing or maintaining the Twin Line controller 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 controller or its accessories must be performed by qualified personnel.

Failure to follow these instructions will 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 controller must not generate electrical emissions that interfere with the expected operation of the Twin Line controller nor be detrimentally affected by emissions from the Twin Line controller.
- 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 Electrical installation TLC51x IP54 controllers

Most of the electrical connections for TLC51x IP54 controllers are made inside the housing.

The following connections are made to the underside of the housing:

- Connection for PC or HMI operating unit via 9-pin, sub-D socket
- Mains connection via circular power plug

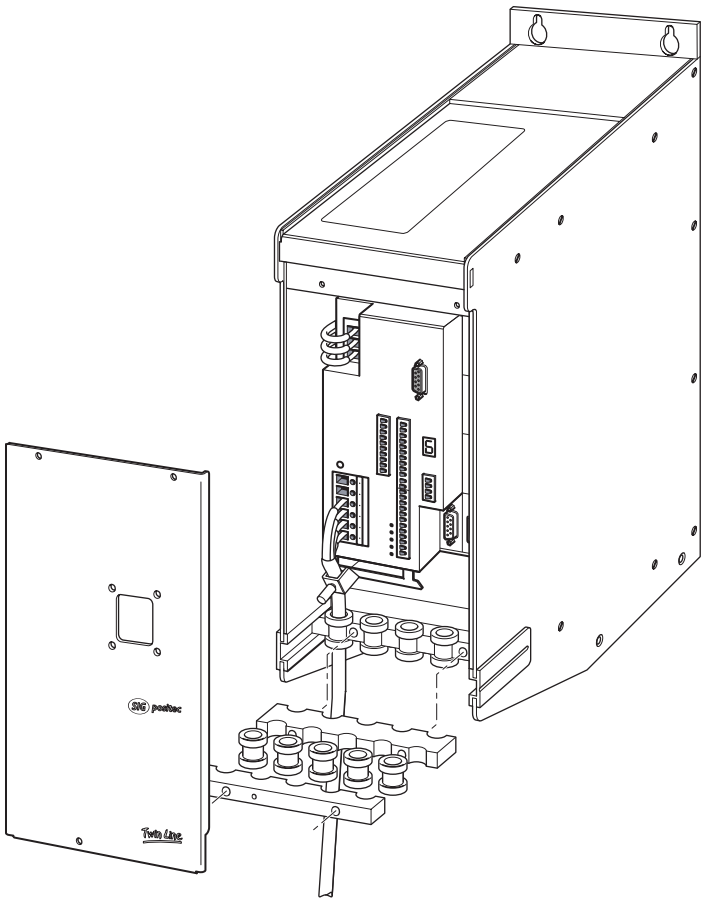

Fig. 4.6 Connection example for the TLC51x IP54 controller

▶ Open the front plate via the three mounting screws.

▶ Make the necessary connections to:

- The motor
- The position command signal
- The Fieldbus
- The signal interface for manual operation

Details on individual connections are located in the following sub-sections:

- ▶ Place the grommets on the cables. Use split grommets on cables with finished ends. Only use grommets whose inside diameter matches that of the cables.
- ▶ Mount the grommets as shown in Fig. 4.6.
- ▶ Ground the controller at the grounding point at the back of the controller near the bottom. Connect them to the system ground and the machine bed.
- ▶ Close the front plate with the three screws.

The holding brake controller can be built into the unit as an optional extra.

The fan and the holding brake controller are already connected to pins 32 and 34.

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4.4.2 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 controller 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

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

Failure to follow these instructions can result in equipment damage.

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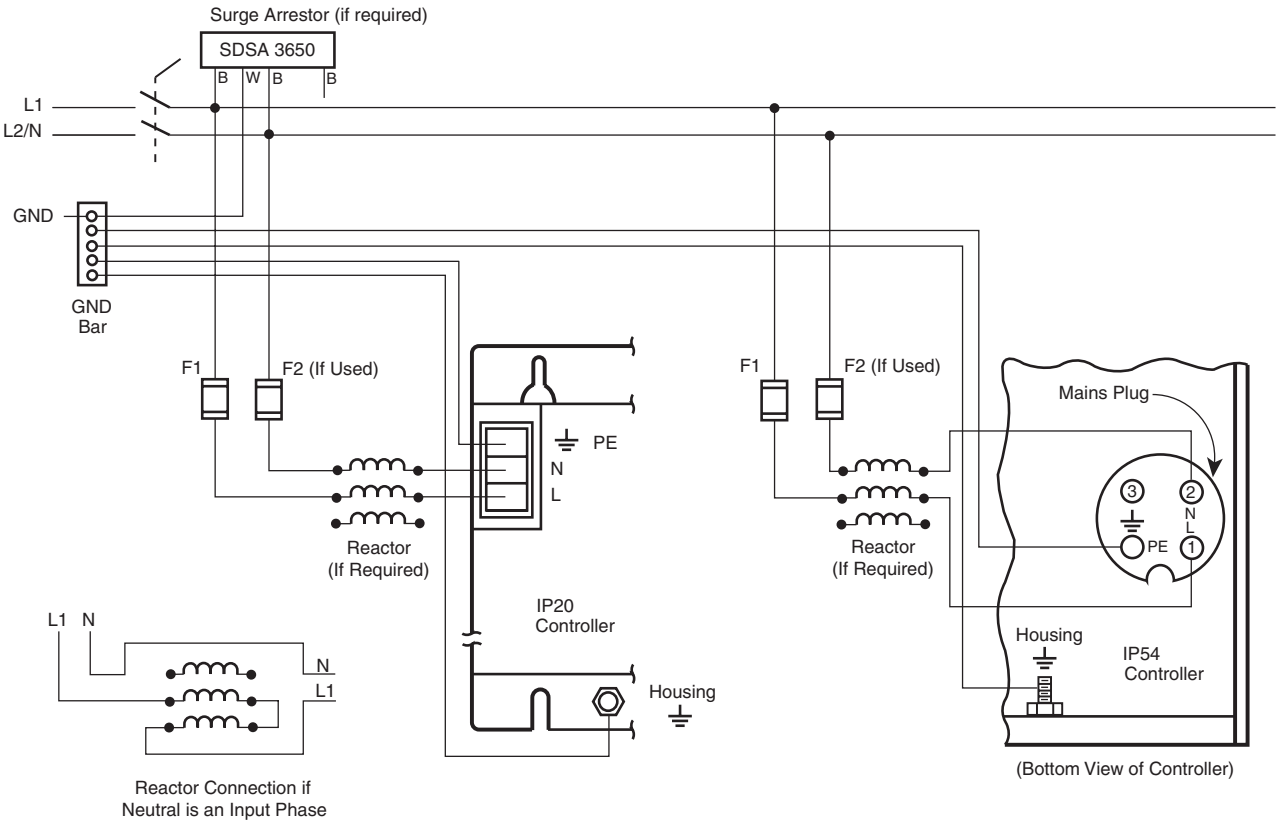

Fig. 4.7 Mains connection for single-phase controllers

IP20 controller

▶ In the case of the single-phase unit, connect the power cables to screw terminals PE, N and L

- The correct torque for the terminal screws is 4.5–5.6 lb-in (0.4–0.5 Nm).
- For units without a mains filter, any power cable over 20 cm (0.79 in.) in length must be shielded between the filter and the unit terminals and grounded at both ends.
- For controllers with a hood, the cable must be led upwards from the point of connection.

IP54 controller

▶ The controller mains connections are through a plug supplied with the controller (see item 2 of section 1.1). The plug is compatible with 16 AWG (1.5 mm) three-core cable with an external diameter of 0.26–0.31 in. (6.5–8.0 mm). The plug is attached to the cable ends using screw connections in the plug. Torque the screws to 4.5–5.6 lb-in (0.4–0.5 Nm).

Both versions

- The connection cross-section for the power cables is 1.5 (16 AWG) to 14 AWG (2.5 mm^2).
- The additional PE terminal must be connected to the housing because of the high leakage currents.

Wire end ferrules

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

- Do not use end ferrules with a plastic collar on wires with a cable cross-section of 14 AWG (2.5 mm^2).
- Only use square end ferrules to ensure that they do not work loose.
- Strip the insulation from the cable to a length of 0.39 in. (10 mm).

Ground leakage circuit-breaker

If a fault occurs, fault currents with DC component may arise. For single-phase units, an earth leakage circuit breaker for fault currents with a pulsating DC component can be fitted.

TLADOCC51ME, -001, 04.03

4.4.3 Motor connection TLC51x

⚠ DANGER

HAZARDOUS VOLTAGE – STEPPER-GENERATED AND COUPLED VOLTAGE

- The stepper can produce voltage at its terminals when the shaft is rotated! Prior to installation or servicing, block the stepper 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 stepper 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 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 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 will result in death or serious injury.

Connecting motor wires

▶ 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
U	Motor cable	Brown (bn)
V	Motor cable	Blue (bl)
W	Motor cable	Black (bk)
PE	Protective conductor (shield tracer wire)	-

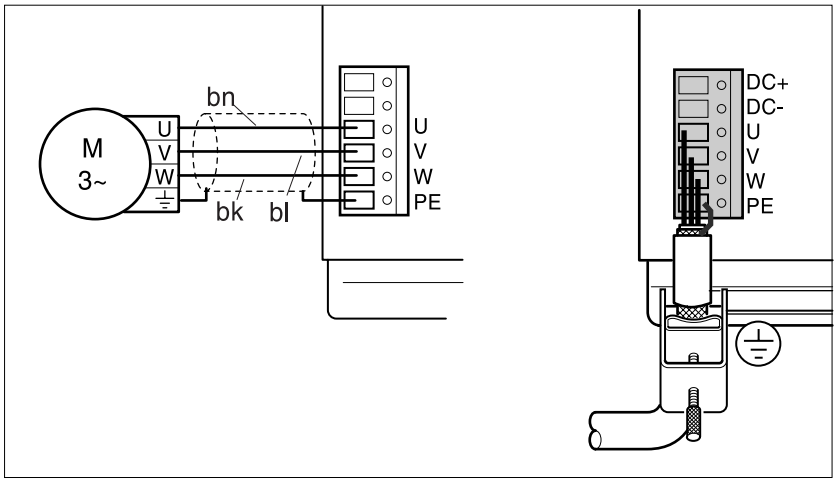

Fig. 4.8 Motor cable connection to controller

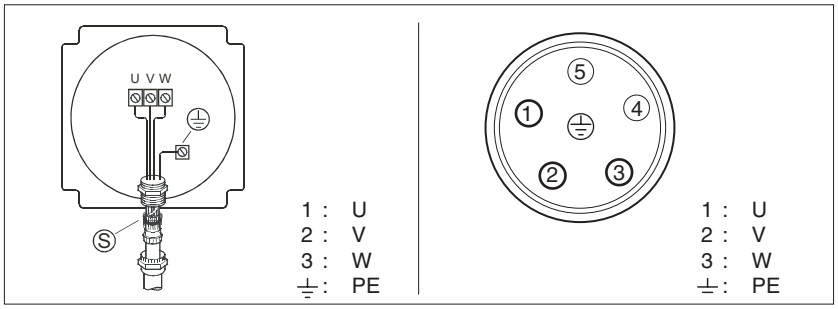

Fig. 4.9 Motor cable connected to motor with terminal box or plug

Cable connection to the drive terminal

- cable cross-section: 1.5 mm^2 (16 AWG)
- maximum cable length: 20 m (787.4 in.)
- The correct torque for the terminal screws is 0.4 Nm - 0.5 Nm.
- The individual conductors of the cable can be connected without wire end ferrules.

Preparing the motor cable on the drive side

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

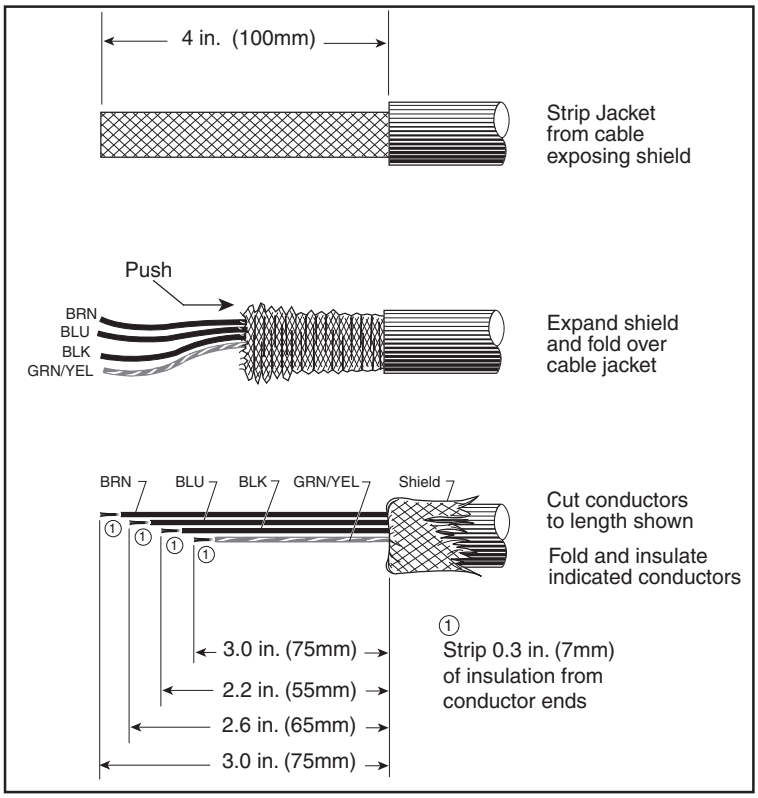

Fig. 4.10 Preparing the motor cable

Wire end ferrules

If wire end ferrules are used, pay attention to the following:

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

EMC measures

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

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

4.4.4 Cable gland connection to the motor terminal box

⚠DANGER

HAZARDOUS VOLTAGE – STEPPER-GENERATED AND COUPLED VOLTAGE

- The stepper can produce voltage at its terminals when the shaft is rotated! Prior to installation or servicing, block the stepper 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 stepper 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.

When connecting a stepper motor with a terminal box use a motor cable with the following specification:

Stepper motor cable specification

- 1 Lead PE green/yellow 1.5 mm^2 (16 AWG)
- 3 Leads for the motor connection 1.5 mm^2 (16 AWG) (Leads colored or black with printing)
- Lead insulation: PP/PE or TPM (low capacity < 70 pF/m)
- Overall shield, coverage min. 90%
- Cable - diameter: 8.5 - 11.5 mm

Cable gland specification

Motor Size	Cable gland type	Cable diameter
VRDM 36x	PG 13.5 or M 20x1.5mm	6mm to 12mm
VRDM 39x	PG 16 or M 20x1.5mm	9mm to 13mm
VRDM 3Bx	PG 16 or M 20x1.5mm	9mm to 13mm

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Preparing the motor cable on the motor side

Prepare and mount the cable gland according to the following figure.

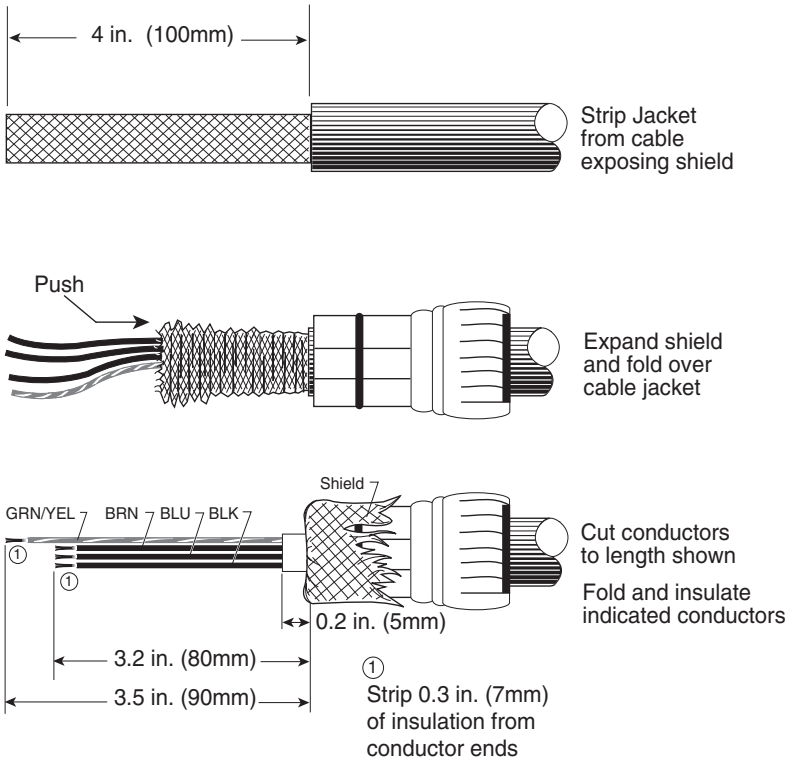

Fig. 4.11 Preparing the Cable on the motor side

Wire end ferrules

Pay attention to the following:

- Only use square end ferrules to ensure that they do not work loose.
- The wire must fill the wire end ferrule over its entire length. With this, it ensures that the connection has the maximum current-carrying capacity and vibration resistance.

EMC measures

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

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

Removing the cover

For connecting the cable to the motor, remove the cover from the motor.

For motors with a holding brake:

▶ Remove the 4 screws from the cover (1).Do **not** remove the 3 screws from the holding brake (2)!

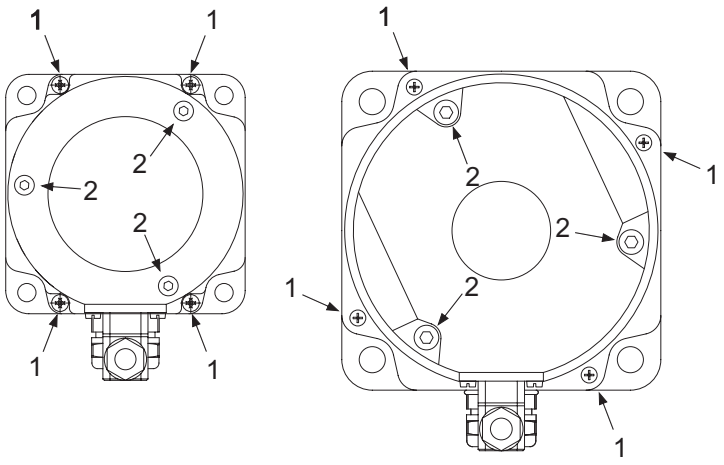

Fig. 4.12 VRDM39x (left) and VRDM3Bx (right)

▶ Carefully pull the cover, where the holding brake is mounted, off.

Pay attention to the Woodruff Key and the O-seal.The Woodruff Key has to be on the shaft and the O-seal has to be pressed onto the cover.

For motors without a holding brake:

▶ Remove the 4 screws from the cover.

▶ Carefully pull the cover off.

▶ Pay attention to the O-seal. The O-seal has to be pressed onto the cover.

Cable connection

▶ Connect the cable with the cable gland to the motor. The threads of the cable gland at the motor housing must be tightened to a torque of 7.5 Nm. The union nut of the cable gland must be tightened to a torque of 5 Nm.

▶ Connect the wires according to the following schematic figure

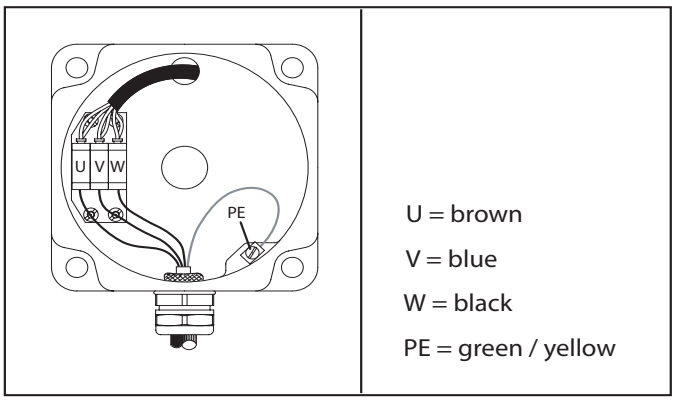

Fig. 4.13 Schematic view of motor connection

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Closing the motor

After the cable is connected to the motor, the motor has to be closed.

For motors with a holding brake:

- ▶ Set the holding brake onto the second shaft end.
- ▶ Ensure that the Woodruff Key and the O-seal are correct attached.
- ▶ Rotate the shaft until the Woodruff Key snaps in.
- ▶ Push the holding brake assembly completely onto the motor.
- ▶ Screw the 4 screws to a torque of 0.8 Nm.

For motors without a holding brake:

- ▶ Ensure that the O-seal is correctly attached onto the cover.
- ▶ Put the cover onto the motor.
- ▶ Screw the 4 screws to a torque of 0.8 Nm.

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4.4.5 Motor connection with holding brake to TLC51x IP54 controller

⚠DANGER

HAZARDOUS VOLTAGE – STEPPER-GENERATED AND COUPLED VOLTAGE

- The stepper can produce voltage at its terminals when the shaft is rotated! Prior to installation or servicing, block the stepper 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 stepper 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 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 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 will result in death or serious injury.

The brake of motors with a holding brake is controlled via the holding brake control module. Refer to section 7.10 on page 7-30 for more information on the functioning of the module.

Refer to section 4.4.3 and Fig. 4.10 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 motor wires and protective conductor to terminals U, V, W and PE. Wiring assignment for motor and unit must match.

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

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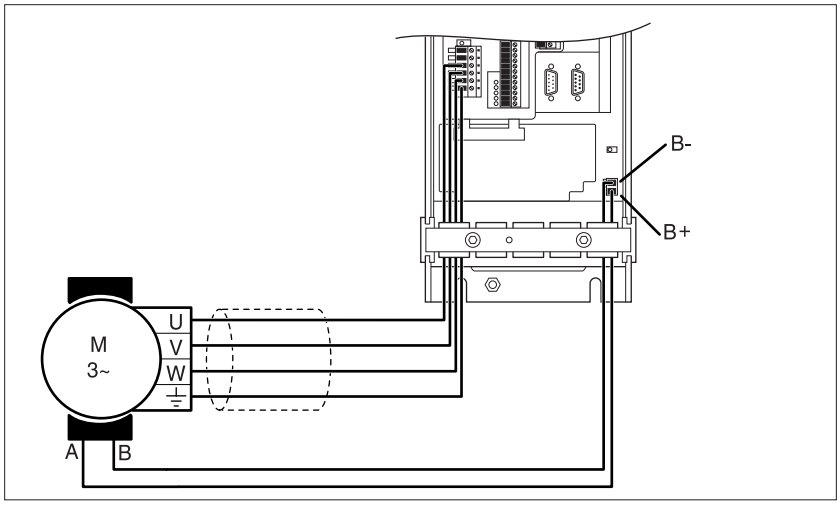

Fig. 4.14 Connecting the motor cable and holding brake controls to the controller

Details on connecting the motor cable to the motor, the use of wire end ferrules and EMC measures can be found in the chapter entitled "Motor connection TLC51x" from page 4-19.

A holding brake connection can be built into the unit as an optional extra.

▶ Connect the control connections to the holding brake terminals B+ and B-.

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

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

The voltage reduction function is described in the chapter entitled "Braking function with Holding Brake Control (TLHBC)" from page 7-27.

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4.4.6 Connecting the 24 V supply voltage

⚠WARNING

UNINTENDED EQUIPMENT ACTION

The Twin Line controller 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 or serious injury.

⚠CAUTION

CONTACT WELDING AND DAMAGE

The Twin Line controller 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 these instructions can result in injury or equipment damage.

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▶ Route the 24 V wires to the controller over a grounded 24 Vdc transformer (PELV).

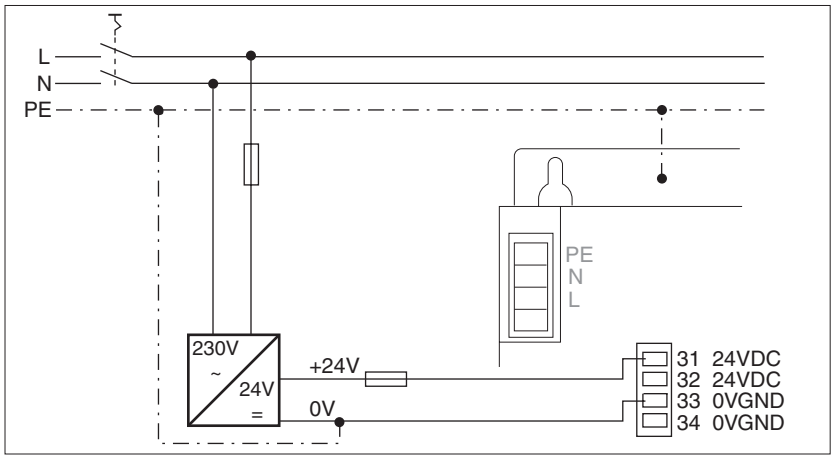

Fig. 4.15 24 V connection

Pin	Signal	Active	Meaning	I/O
31	24 Vdc	-	24 Vdc supply voltage, internally connected to pin 32	-
32	24 Vdc	-	24 Vdc supply voltage	-
33	0 VGND	-	0 V for 24 Vdc voltage, connected internally to pins 34 and 16 (ACTIVE_0V)	-
34	0 VGND	-	0 V for 24 Vdc voltage	-

- The second 24 Vdc and 0 V connection can be used as a 24 V output for further consumers or for cascading several Twin Line controllers; the maximum terminal current is 7.5 A.
- In selecting the 24 V power supply unit it is important to take into account any additional consumers, such as the holding brake and the holding brake controller.
- To ensure that the motor retains its position when the power is off, the external 24 V power supply must remain on and no external torque may be applied to the motor.
- Lay the 24 V supply line at a distance of at least 20 cm (8 in.) from other lines to ensure EMC protection. For wiring longer than 2 m (6.5 feet), 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.
- The torque for terminal screws 1-34 is 0.22 Nm to 0.25 Nm (2.5–2.8 lb-in).

IP54 contoller

- Fan and holding brake control modules are connected to pins 32 and 34.

4.4.7 Connection to the signal interface

The controller can be controlled manually or automatically via the signal interface wires.

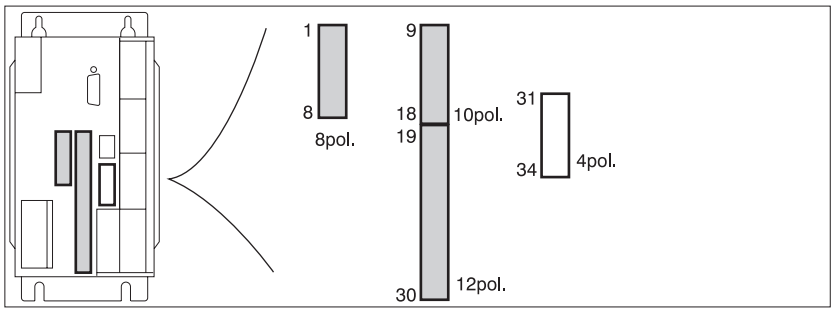

Fig. 4.16 Signal interface: 1-30: inputs/outputs, 31-34: 24 V connection

Connection

▶ The connections of the signal interface should be wired up as required by the selected operating mode. See also the wiring examples starting on page 4-64.

⚠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 7.7.1 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 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 $\overline{\text{LIMP}}$, $\overline{\text{LIMN}}$, 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 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 or serious injury.

▶ Connect inputs $\overline{\text{LIMP}}$, $\overline{\text{LIMN}}$ and $\overline{\text{STOP}}$ to the +24 V voltage if they are not being used or switch them out via the parameter Switch off "Settings.SignEnabl", see page 7-24.

- The torque for terminal screws 1-34 is 0.22 Nm to 0.25 Nm.

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

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Variable interface connections

The assignment of signal interface connections depends on the switching status of the "Settings.IO_mode" parameter see page 6-4.

The following table shows the assignment of interface connections.

IO_Mode=0

- Input signals are used to set the Fieldbus parameters of network address, baud rate and Fieldbus profile. This is the preset for switching on the controller with Fieldbus module. The input signals are imported when the controller is started.

Pin	Signal at IO_mode=0	Active	Meaning	I/O
1	ADR_1	high	Bit0 for network address	I
2	ADR_2	high	Bit1 for network address	I
3	ADR_4	high	Bit2 for network address	I
4	ADR_8	high	Bit3 for network address	I
5	ADR_16	high	Bit4 for network address	I
6	ADR_32	high	Bit5 for network address	I
7	IO24VDC	-	Power supply for inputs/outputs	I
8	IO24VDC	-	Power supply for inputs/outputs	I
9	Q_0	high	Freely assignable output	O
10	Q_1	high	Freely assignable output	O
11	Q_2	high	Freely assignable output	O
12	Q_3	high	Freely assignable output	O
13	Q_4	high	Freely assignable output	O
14	TRIGGER	high	Trigger output, signal value is switched via position/signal list	O
15	ACTIVE_CON	high	Motor under power, control signal for TL HBC brake controller, output max. 400 mA [1)]	O
16	ACTIVE_0V	high	0 V signal for TL HBC brake controller, internally connected to 0VDC[1)]	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	BAUD_1	high	Bit0 for setting the baud rate	I
20	BAUD_2	high	Bit1 for setting the baud rate	I
21	BAUD_4	high	Bit2 for setting the baud rate	I
22	I_5	high	Freely assignable input	I
23	I_6	high	Freely assignable input	I
24	ADR_64	high	Bit6 for network address	I
25	$\overline{\text{REF}}$	low [2)]	Reference switch signal	I
26	$\overline{\text{LIMP}}$	low [2)]	Limit switch signal clockwise motor rotation	I
27	$\overline{\text{LIMN}}$	low [2)]	Limit switch signal counter-clockwise motor rotation	I
28	$\overline{\text{STOP}}$	low [2)]	Stop motor	I
29	MODE_2	high	Bit1 for setting Fieldbus profile	I
30	MODE_1	high	Bit0 for setting Fieldbus profile	I

1) For IP54 controller: Holding brake connection hard wired.
2) Signal level for default setting of "Settings.SignEnabl" and "Settings.SignLevel" parameters

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IO_Mode=1

- The input signals I_0 to I_13 and output signals Q_0 to Q_4 can be freely set.

Pin	Signal at IO_mode=1	Active	Meaning	I/O
1	I_8	high	Freely assignable input	I
2	I_9	high	Freely assignable input	I
3	I_10	high	Freely assignable input	I
4	I_11	high	Freely assignable input	I
5	I_12	high	Freely assignable input	I
6	I_13	high	Freely assignable input	I
7	IO24VDC	-	Power supply for inputs/outputs	I
8	IO24VDC	-	Power supply for inputs/outputs	I
9	Q_0	high	Freely assignable output	O
10	Q_1	high	Freely assignable output	O
11	Q_2	high	Freely assignable output	O
12	Q_3	high	Freely assignable output	O
13	Q_4	high	Freely assignable output	O
14	TRIGGER	high	Trigger output, signal value is switched via position/signal list	O
15	ACTIVE_CON	high	Motor under power, control signal for TL HBC brake controller, output max. 400 mA [1)]	O
16	ACTIVE_0V	high	0 V signal for TL HBC brake controller, internally connected to 0VDC [1)]	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	I_0	high	freely assignable input	I
20	I_1	high	freely assignable input	I
21	I_2	high	freely assignable input	I
22	I_5	high	Freely assignable input	I
23	I_6	high	Freely assignable input	I
24	I_7	high	Freely assignable input	I
25	$\overline{\text{REF}}$	low [2)]	Reference switch signal	I
26	$\overline{\text{LIMP}}$	low [2)]	Limit switch signal clockwise motor rotation	I
27	$\overline{\text{LIMN}}$	low [2)]	Limit switch signal counter-clockwise motor rotation	I
28	$\overline{\text{STOP}}$	low [2)]	Stop motor	I
29	I_4	high	Freely assignable input	I
30	I_3	high	Freely assignable input	I

1) For IP54 controller: Holding brake connection hard wired.
2) Signal level for default setting of "Settings.SignEnabl" and "Settings.SignLevel" parameters

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IO_Mode=2 • Input signals and output signals are assigned to pre-defined/fixed functions.

Pin	Signal at IO_mode=2	Active	Meaning	I/O
1	DATA_1	high	DATA_1: Bit0 for selecting a list number	I
2	DATA_2	high	DATA_2: Bit1 for selecting a list number	I
3	DATA_4	high	DATA_4: Bit2 for selecting a list number	I
4	DATA_8	high	DATA_8: Bit3 for selecting a list number	I
5	DATA_16	high	DATA_16: Bit4 for selecting a list number	I
6	DATA_32	high	DATA_32: Bit5 for selecting a list number	I
7	IO24VDC	-	Power supply for inputs/outputs	I
8	IO24VDC	-	Power supply for inputs/outputs	I
9	AUTOM_ACK	high	AUTOM_ACK: acknowledgment signal to AUTOM signal	O
10	AXIS_ADD_INFO	high	AXIS_ADD_INFO: additional information on current movement	O
11	AXIS_END	high	AXIS_END: end of movement processing, drive at standstill	O
12	AXIS_ERR	high	AXIS_ERR: fault detection during movement	O
13	RDY_TSO	high	RDY_TSO: ready for operation, active in operating states 4 to 7, max. 400 mA	O
14	TRIGGER	high	Trigger output, signal value is switched via position / signal list	O
15	ACTIVE_CON	high	Motor powered, control signal for brake controller TL HBC, output max. 400 mA [1]	O
16	ACTIVE_0V	high	0 V signal for brake controller TL HBC, internally connected to 0 VDC[1]	O
17	ANALOG_IN+	-	Analog control input ±10 V	I
18	ANALOG_IN-	-	Analog control input 0 V, reference (5000 ohm input impedance) for pin 17 ANALOG_IN+	I
19	MAN_P	high	BAUD_1: Bit 0 for setting baud rate MAN_P: manual movement, positive motor rotation	I
20	MAN_N	high	BAUD_2: Bit 1 for setting baud rate MAN_N: manual movement, negative motor rotation	I
21	MAN_FAST	high	BAUD_4: Bit 2 for setting baud rate MAN_FAST: manual selection slow or fast	I
22	FAULT_RESET	high	FAULT_RESET: reset fault signal	I
23	CAPTURE2	high	CAPTURE2: high speed input for exact capture of present position data [2]	I
24	TEACH_IN	high	TEACH_IN: trigger signal for storing current setpoint in list data memory	I
25	$\overline{\text{REF}}$	low [3] [4]	Reference switch signal	I
26	$\overline{\text{LIMP}}$	low[3]	Limit switch signal positive motor rotation	I
27	$\overline{\text{LIMN}}$	low[3]	Limit switch signal negative motor rotation	I
28	$\overline{\text{STOP}}$	low[3]	Quick-Stop	I
29	AUTOM	high	AUTOM: automatic mode (high) or manual mode (low), acknowledgement via AUTOM_ACK	I
30	ENABLE	high	ENABLE: enable (high) or disable (low) power amplifier	I

1) IP54 controller: Holding brake control module is factory wired to these terminals.
2) High speed scan capability is present only when IO_mode = 0. Input reverts to standard scan speed when IO_mode = 1.
3) Signal level for default setting of 'Settings.SignEnabl' and 'Settings.SignLevel' parameters.
4) The factory default state of $\overline{\text{REF}}$ input is “disabled”.

Minimum interface assignment

The following signal interface connections must be made:

- Pin 26: $\overline{\text{LIMP}}$
- Pin 27: $\overline{\text{LIMN}}$
- Pin 28: $\overline{\text{STOP}}$
- Pin 31: 24 VDC
- Pin 33: 0 VDC
- Pin 7 and Pin 8 must be connected even if the signal interface is not used.

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 with minimum cross-section 49 feet (15 m)

Function

The signal interface can be used to control the controller manually or automatically, report operating states and control peripheral devices.

The signal interface is primarily designed for Fieldbus mode. Signal inputs such as MAN_N, MAN_P or AUTOM and outputs such as AXIS_ERR, AXIS_END or AUTOM_ACK are not required here. In Fieldbus mode these signals are changed and evaluated using receive and send data.

The signal interface can operate in three pin assignment modes:

- Settings for address, baud rate and Fieldbus profile in Fieldbus mode
- Free assignment of interface
- Fixed assignment of interface

Pin assignment can be changed with the parameter "Settings.IO_mode", see "Access control for selecting operating mode or function", page 6-4.

Setting address and baud rate in Fieldbus mode

Condition:

After switching on the controller, device address and baud rate can be specified via input signals.

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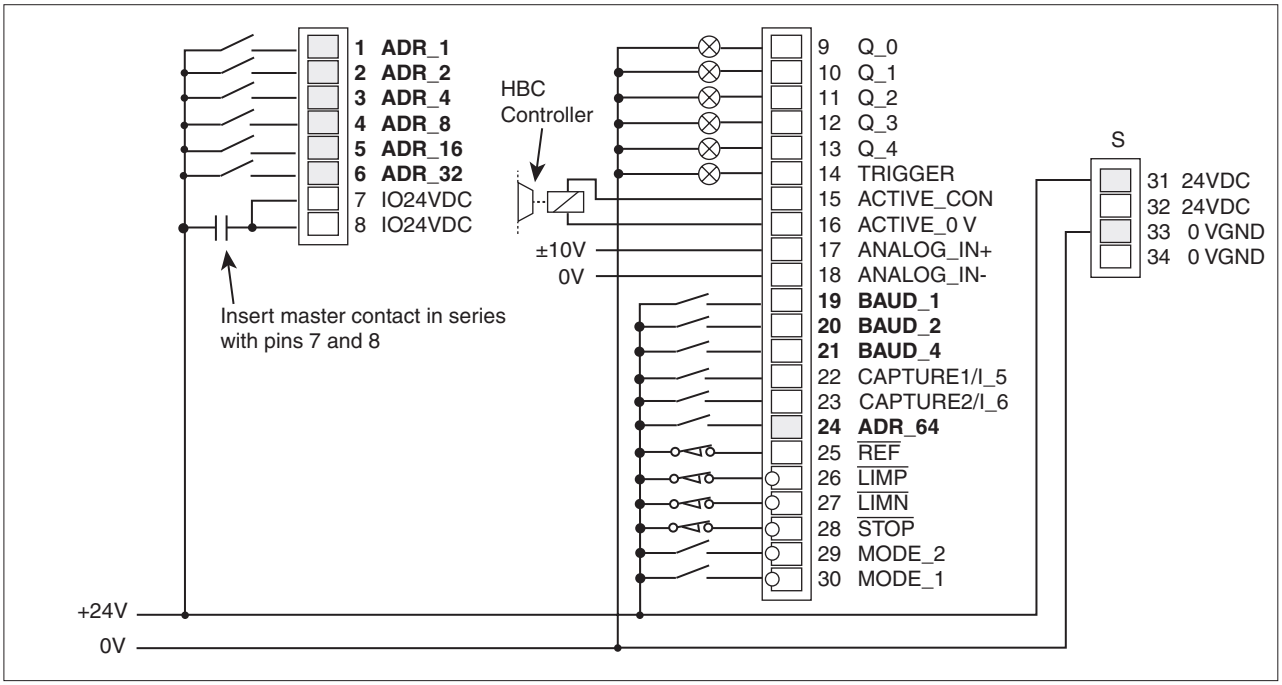

Fig. 4.17 Signal interface inputs for Fieldbus addressing

Network address

The network address is bit-coded via inputs ADR_1 to ADR_64 for Fieldbus modules PBDP-C, CAN-C, and RS485-C. ADR_1 is the lowest value bit.

Network address:	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**...**	**125**	**126**	**127**
Pin: input											
1: ADR_1 [1)]	0	1	0	1	0	1	0	...	1	0	1
2: ADR_2 [1)]	0	0	1	1	0	0	1	...	0	1	1
3: ADR_4 [1)]	0	0	0	0	1	1	1	...	1	1	1
4: ADR_8 [1)]	0	0	0	0	0	0	0	...	1	1	1
5: ADR_16 [1)]	0	0	0	0	0	0	0	...	1	1	1
6: ADR_32 [1)]	0	0	0	0	0	0	0	...	1	1	1
24: ADR_64	0	0	0	0	0	0	0	...	1	1	1

1) Required for DeviceNet

Example: For address 17, inputs ADR_16 and ADR_1 must carry 24 V. The remaining inputs remain open.

Baud rate

For the CAN-C and RS485-C Fieldbus modules, the baud rate can be specified bit-coded at inputs BAUD_1 to BAUD_4 when the unit is started up.

Baud rate CAN-C	Baud rate RS485-C	BAUD_4	BAUD_2	BAUD_1
20 kbaud	1200 baud	0	0	0
125 kbaud 1)	9600 baud	0	0	1
250 kbaud 1)	19.2 kbaud	0	1	0
500 kbaud 1)	38.4 kbaud	0	1	1
800 kbaud	reserved	1	0	0
1 Mbaud	reserved	1	0	1
reserved	reserved	1	1	0
reserved	reserved	1	1	1

1) Can be set in DeviceNet

If an illegal baud rate is set, Fieldbus processing cannot be activated. The Twin Line controller issues an error message on a connected operating unit. A network branch can only be run on one baud rate, which must be set on all devices.

Profile setting

For the CAN-C Fieldbus module, the Fieldbus profile can be set in bit-coded form via inputs MODE_1 and MODE_2 when the unit is started up.

Profile	MODE_2	MODE_1
CAN-Bus	0	0
CANOpen profile	0	1
DeviceNet profile	1	0

A network branch can only be run with one network profile which must be set on all devices on the branch.

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Free assignment of interface Condition: "Settings.IO_mode"=1:

With free interface assignment, inputs I_0 to I_13 and outputs Q_0 to Q_4 can be assigned additional functions by Fieldbus commands.

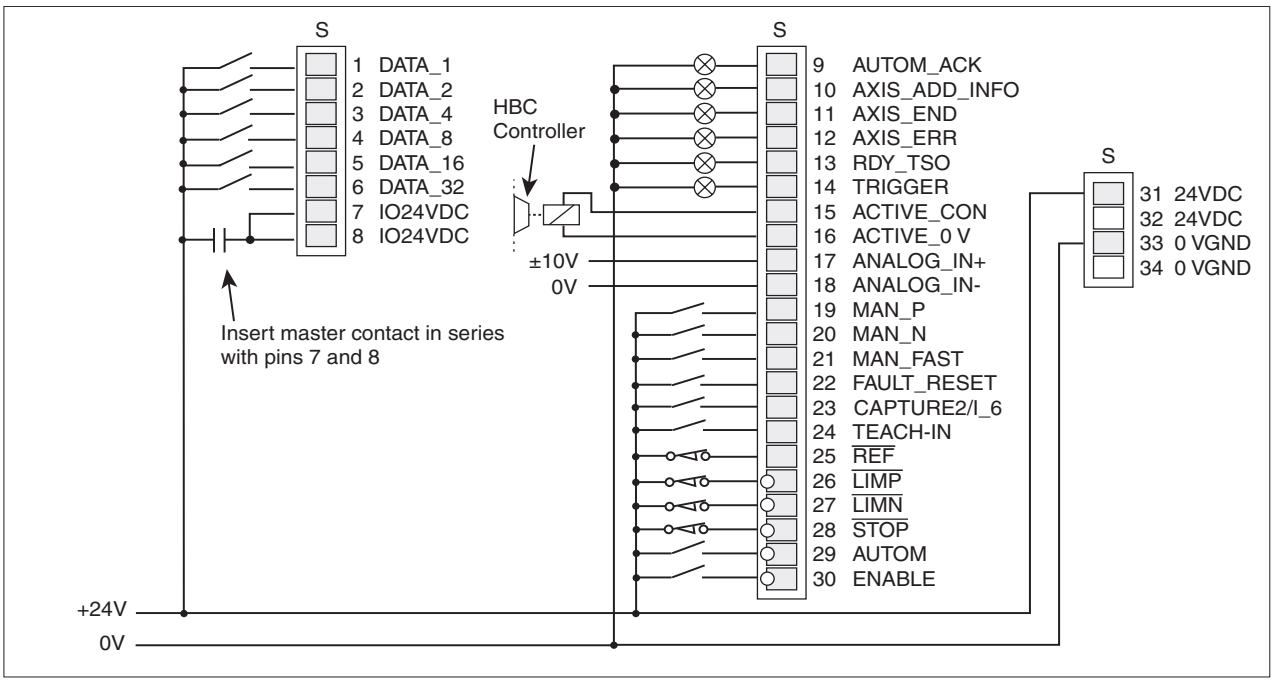

Fig. 4.18 Signal interface inputs and outputs for free assignment

Input and output signal states can be read and changed via parameters:

- Read input signals with the "I/O.IW1_act" parameter
- Write output signals with the "I/O.QW0_act" parameter

For more detailed information see "Setting and checking signal interface inputs and outputs" on page 5-18.

Fixed assignment of interface

Condition: "Settings.IO_mode" = 2:

With fixed assignments control and switching signals for manual mode and Teach mode are available on the signal interface.

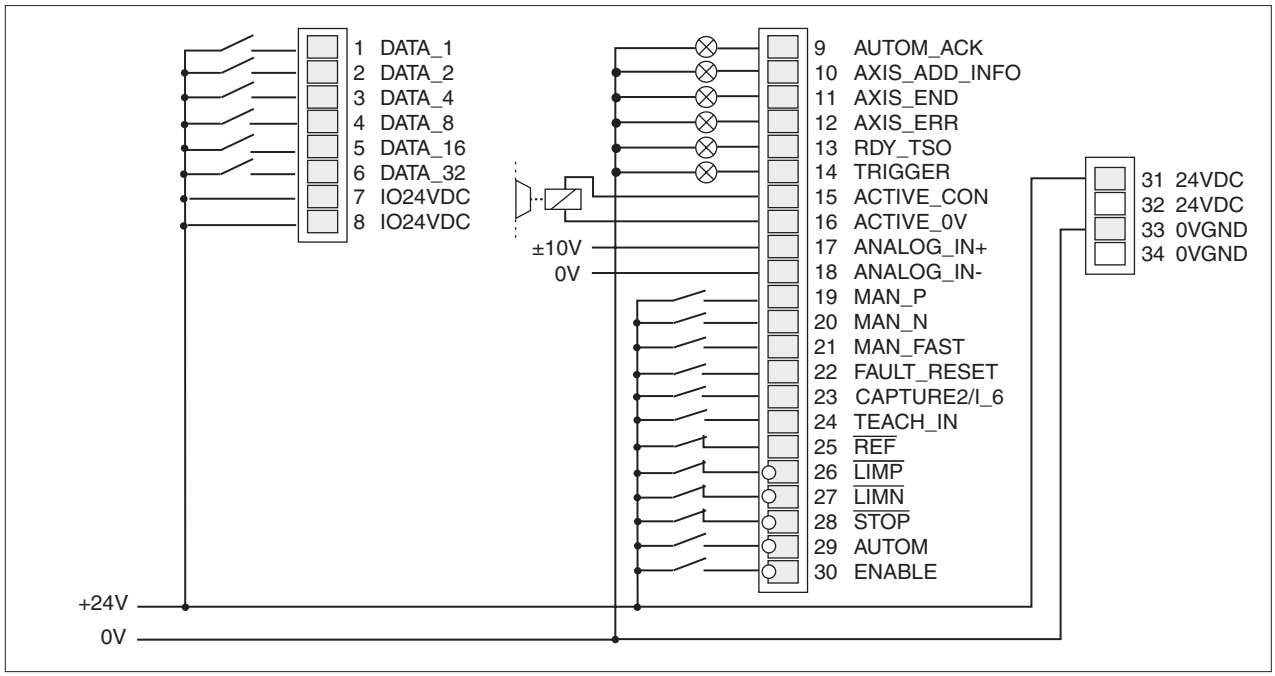

Fig. 4.19 Signal interface inputs and outputs with fixed assignment

Manual mode is described on page 6-11 in "Manual movement" and Teach mode on page 7-8 in "Teach Mode".

Signal interface LEDs

Five LEDs at the signal interface show when current is flowing through signal inputs.

The controller will abort movement as soon as one of the signal inputs LIMP, LIMN or STOP becomes active.

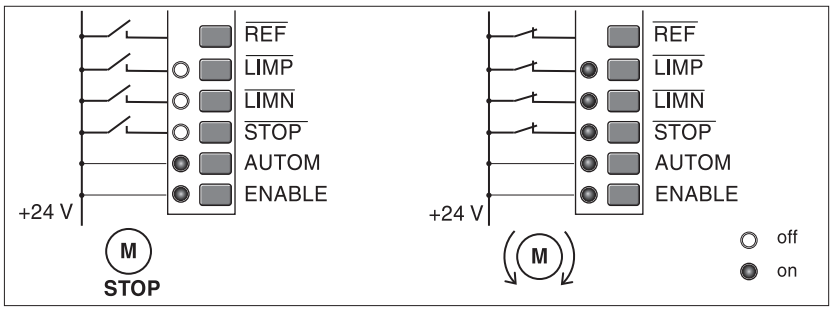

Fig. 4.20 LED display of signal interface

Enabling of the input signals LIMP, LIMN", REF and STOP and evaluation as active low or high can be changed via the parameters Changing "Settings.SignEnabl" and "Settings.SignLevel". See page 7-27.

Output signals remain unchanged for at least 0.5 ms.

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4.4.8 Connection to the RS-232 interface (HMI or PC interface)

Connection The RS-232 interface equipped with a 9-pin Sub-D female connector is connected to the PC or to the Twin Line HMI. The controller supplies the Twin Line HMI with the operating voltage via pin 9.

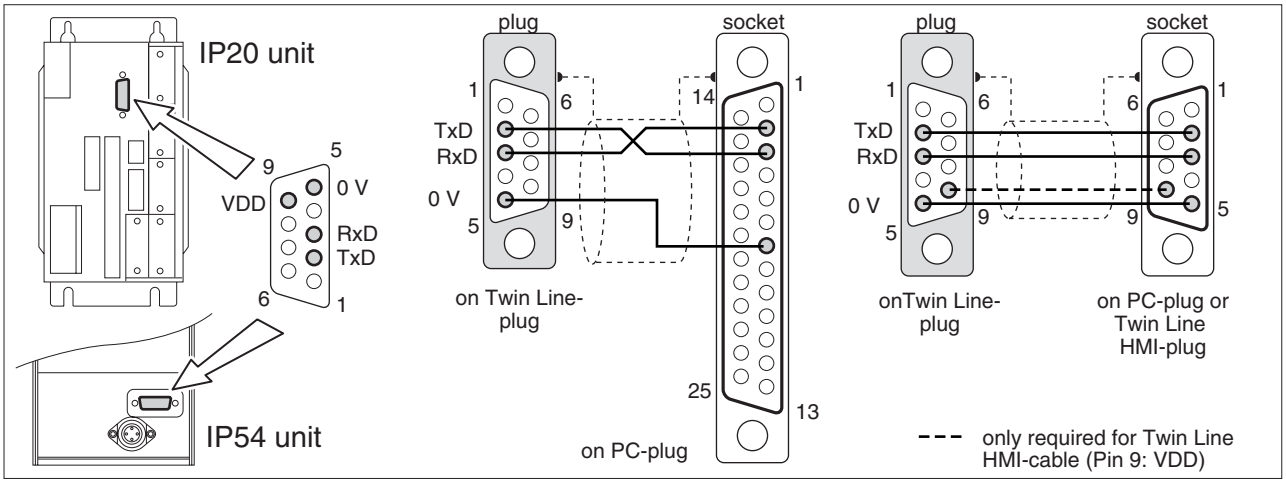

Fig. 4.21 Cables for the RS-232 interface at the PC or Twin Line HMI View: Solder side of cable connectors

Pin	Signal	Color [1)]	Pair	Meaning	I/O
1	-	-	-	Not assigned	-
2	TxD	brown	-	Transmitted data to input device	O
3	RxD	white	-	Data received from input device	I
4	-	-	-	Not assigned	-
5	GND	green	-	Ground	-
6	-	-	-	Not assigned	-
7	-	-	-	Not assigned	-
8	-	-	-	Not assigned	-
9	VDD	yellow	-	10 V_{DC} supply for the TL HMI	O

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

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

- Shielded cable
- Cable length maximum 49 feet (15 m)
- Minimum cross-section of the signal conductors 22AWG (0.25 mm^2), for supply voltage and ground line 20 AWG (0.5 mm^2)
- Ground shield at both ends.

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

The controller is started up and operated via the serial RS-232 interface. Connect the HMI hand-held unit or a computer to the Twin Line Commissioning Tool commissioning software.

The Twin Line HMI can be plugged directly into the controller or connected by cable. The controller supplies power to the HMI.

Multiple units cannot be networked via the RS-232 interface.

TLADOCC51ME, -001, 04.03

4.4.9 Connection to the RS422-C module

Module interface

The RS422-C module is equipped with a 15-pin, Sub-D female connector (M1 hardware).

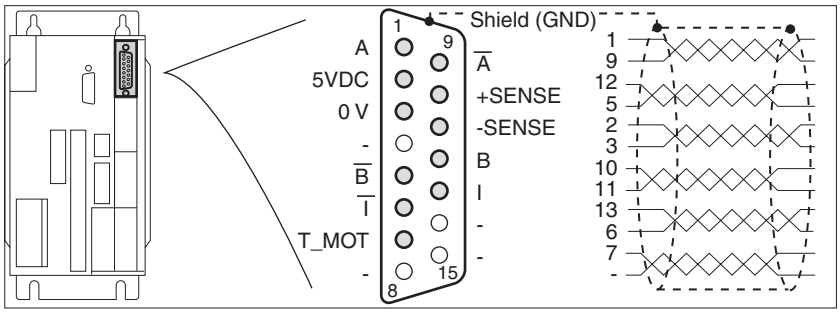

Fig. 4.22 Module interface connection for the encoder module

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 controller. Remove all power from the Twin Line controller, including 24 Vdc power, before connecting the encoder.

Failure to follow this instruction can result in equipment damage.

Function

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

The RS422-C module receives the A/B encoder signals and index pulse as a position setpoint for the controller. The maximum input frequency is 400 kHz.

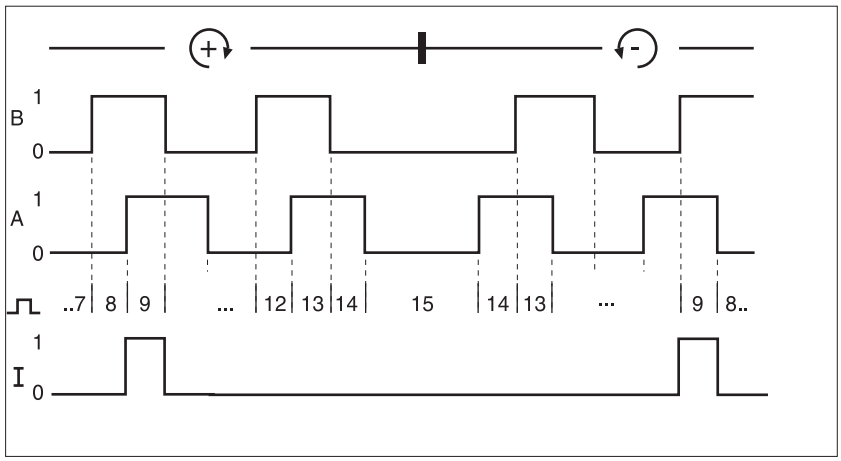

Fig. 4.23 Time diagram with A-, B, and index pulse signal, counting forwards and backwards

TLADOCC51ME, -001, 04.03

Monitoring The T_MOD signal displays wire break at low signal.

Incorrect transmission of position data when the ground voltage drop is excessive. The potential difference between the 0 VDC terminals of any two Twin Line controllers connected via RS422-C to a common encoder must be less than 1 V or the encoder data may be incorrectly read. To reduce the net voltage difference between the controller 0 VDC terminals, increase the cross-sectional area of the 0 VDC conductor between the individual Twin Line controllers and their respective 0 VDC power supplies or insert an RS422 isolator between controllers with large ground voltage differences.

TLADOCC51ME, -001, 04.03

4.4.10 Connection to the PULSE-C module

Module interface

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

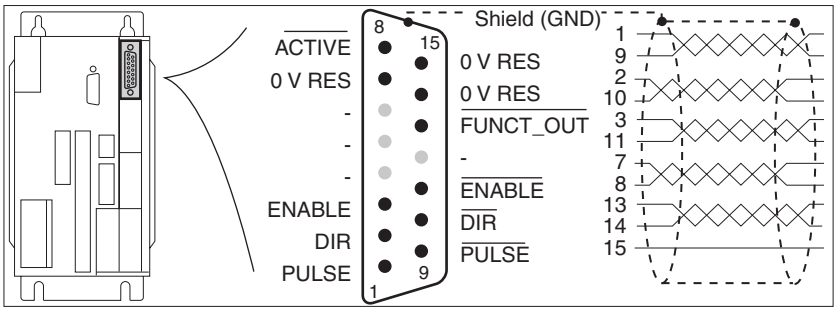

Fig. 4.24 Module interface connection for the pulse/direction module

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.

TLADOCC51ME, -001, 04.03

- Maximum length at RS422 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 controller or, if no ground bar is present, directly to the Twin Line controller 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.

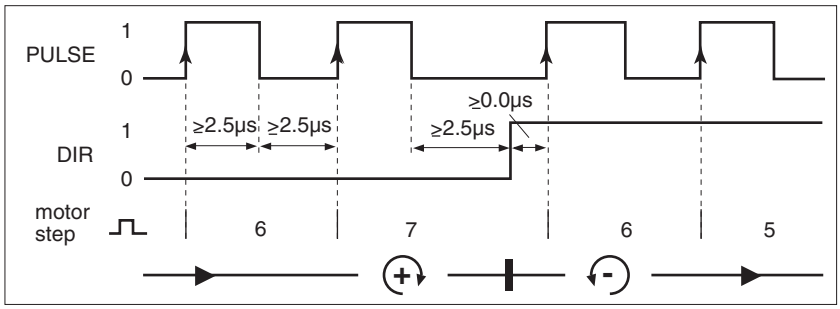

Fig. 4.25 Pulse direction signal

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 stepper.

$Pulse_{forward}$ - $pulse_{backward}$ 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.

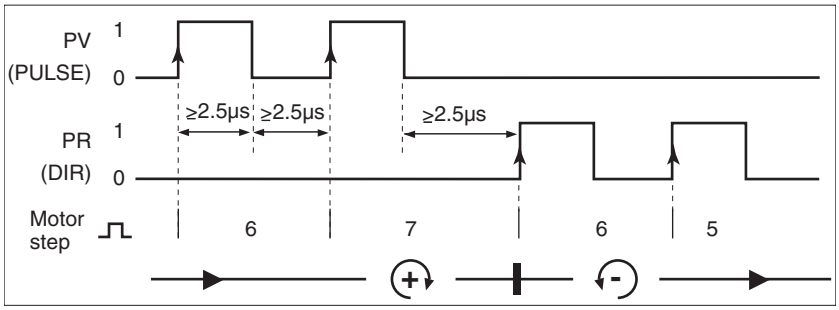

Fig. 4.26 $Pulse_{forward}$ - $Pulse_{backward}$ signal

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 stepper.

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 controller.

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.

TLADOCC51ME, -001, 04.03

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 or serious injury.

It is recommended that signal inputs be switched via the RS422 transceiver interface and not the single-ended open collector interface.

Fig. 4.27 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 RS422-C transmitter output.

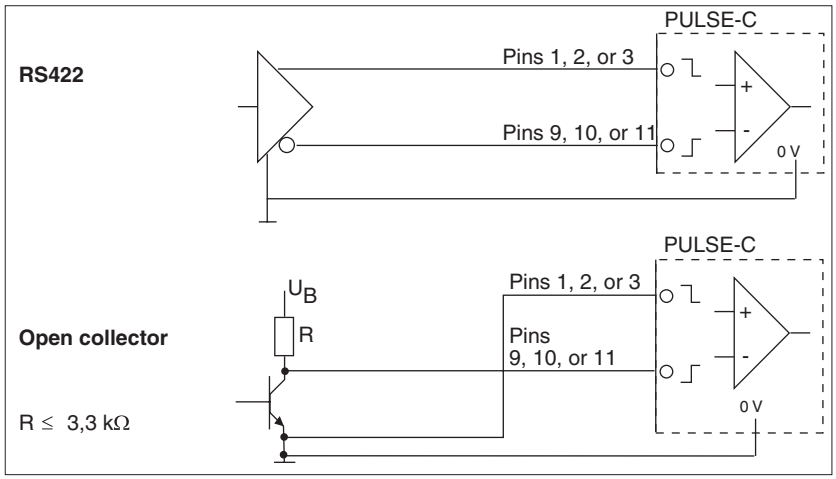

Fig. 4.27 Circuit of the signal inputs, L: Cable length

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 ESIM3-C module

Module interface

The ESIM3-C module is equipped with a 15 pin Sub-D female connector.

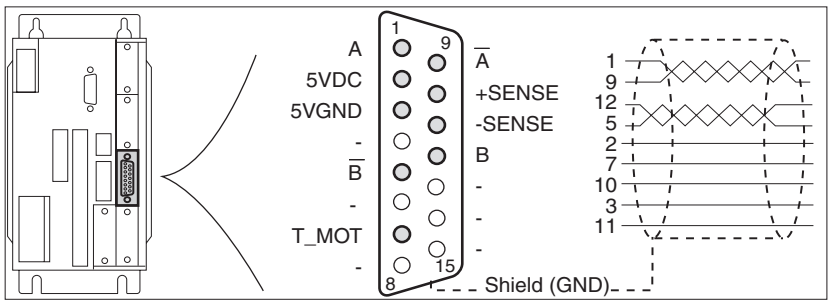

Fig. 4.28 Module interface connection for encoder simulation

Pin	Signal	Color [1]	Pair	Meaning	I/O
1	A	white	1	Channel A	O
9	$\overline{A}$	brown	1	Channel A, negated	O
12	B	green	2	Channel B	O
5	$\overline{B}$	yellow	2	Channel B, negated	O
2	5VDC	red	3	Internal bridge to Pin 10 to activate +SENSE Internal bridge to Pin 7 to activate T_MOT [2]	I
3	5VGND	blue	3	Internal bridge to Pin 11 to activate -SENSE [2]	I
10	+SENSE	purple	4	Internal bridge to Pin 2 to activate +SENSE [2]	O
11	-SENSE	black	4	Internal bridge to Pin 3 to activate -SENSE [2]	O
13	-	-	-	Not assigned	O
6	-	-	-	Not assigned	O
7	T_MOT	pink/pink	6	Internal bridge to Pin 2 to activate T_MOT [2]	O
4	-	red/blue	6	Not assigned	-
8	-	-	-	Not assigned	-
14	-	-	-	Not assigned	-
15	-	-	-	Not assigned	-

1) Color details refer to the cable available as an accessory.
2) Only required for connection to RS422-C

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

Cable specification

- Shielded cable
- Minimum cross-section of signal wires 25 AWG (0.14 mm^2)
- Twisted-pair wires
- Shield grounded at both ends
- Maximum length 81.5 feet (100 m)

TLADOCC51ME, -001, 04.03

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 Signals for indicating the actual position are output at the incremental encoder connection. They are two out-of-phase signals A and B. The A/B signals are generated and sent by the motor-encoder module.

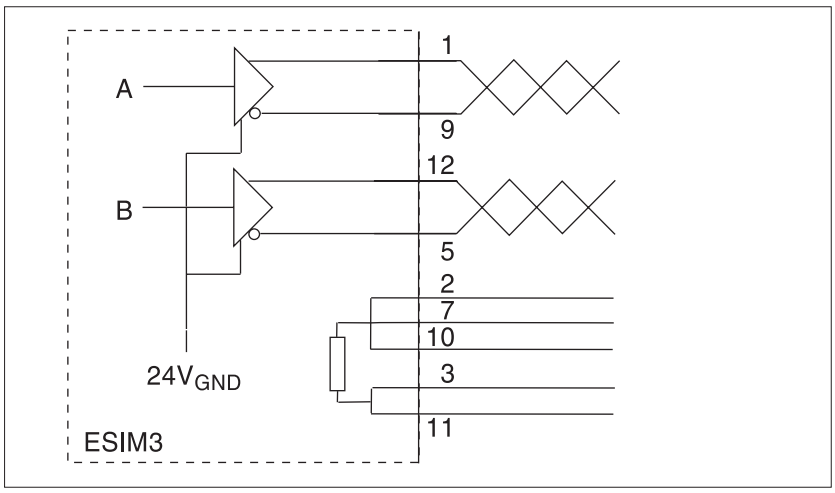

Fig. 4.29 ESIM3-C module output

Resolution Resolutions of the encoder simulation:

Encoder with 1000 lines: 4000 Inc/rev.

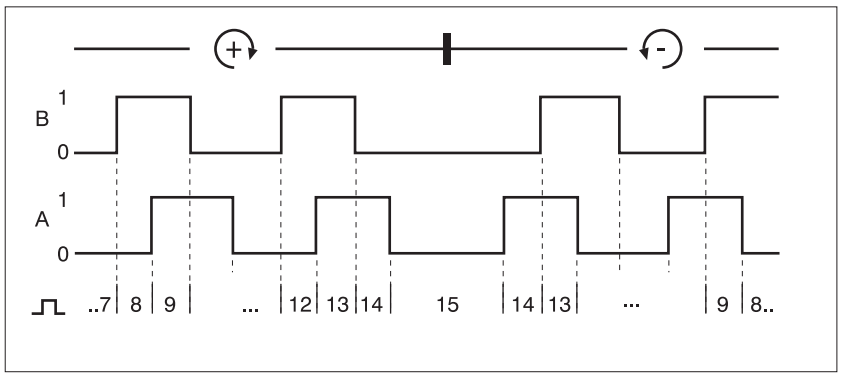

Fig. 4.30 Timing diagram with A and B signal, counting forwards and backwards

Incorrect transmission of position data when the ground voltage drop is excessive. The potential difference between the 0 VDC terminals of any two Twin Line controllers connected via RS422-C to a common encoder must be less than 1 V or the encoder data may be incorrectly read. To reduce the net voltage difference between the controller 0 VDC terminals, increase the cross-sectional area of the 0 VDC conductor between the individual Twin Line

controllers and their respective 0 VDC power supplies or insert an RS422 isolator between controllers with large ground voltage differences.

The pin assignments for the signals of the ESIM3-C and RS422-C modules are identical. A 1:1 cable can be used for a connection.

TLADOCC51ME, -001, 04.03

4.4.12 Connection to the RM-C module

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

Module interface The interface is equipped with a 15 pin Sub-D female connector.

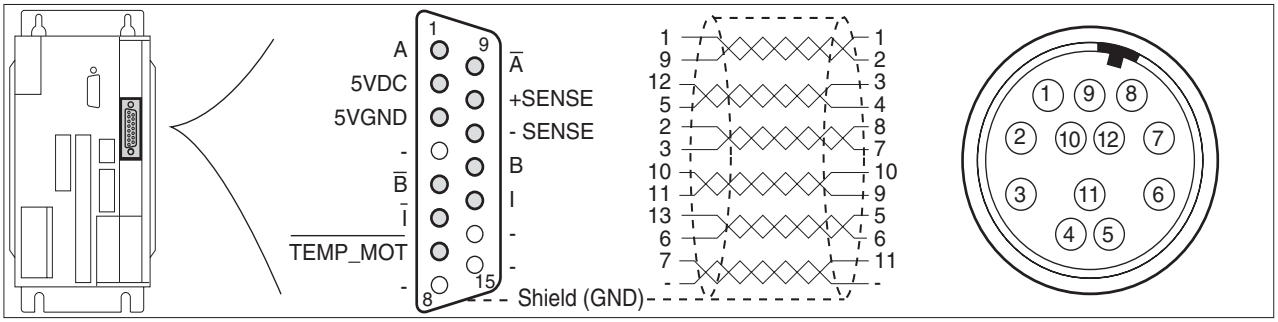

Fig. 4.31 Interface for speed monitoring, motor plug view: Solder side

Pin	Signal	Color [1]	Pair	Meaning	I/O
1	A	white	1	Encoder signal channel A	I
9	$\overline{A}$	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	Encoder supply, 5V, max. 300mA	O
3	5VGND	blue	3	Encoder supply, ground	O
10	+SENSE	purple	4	Sense line positive [2]	I
11	-SENSE	black	4	Sense line negative [2]	I
13	I	gray	5	Channel index pulse	I
6	$\overline{I}$	pink	5	Channel index pulse, negated	I
7	$\overline{TEMP\_MOT}$	pink/pink	6	Temperature error, inverted	I
4	-	red/blue	6	Not assigned	-
8	-	-	-	Not assigned	-
14	-	-	-	Not assigned	-
15	-	-	-	Not assigned	-

1) Color details refer to the cable available as an accessory.
2) Sense line must be connected for activating the 5VDC.

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

Cable specification

- Shielded cable
- Minimum cross-section of signal wires 22 AWG (0.25 mm^2), 5VDC and 5VGND 20 AWG (0.5 mm^2)
- Twisted-pair wires
- Shield grounded at both ends
- Maximum cable length 81.5 feet (100 m)

⚠CAUTION

UNINTENDED EQUIPMENT OPERATION

Permanent damage to external encoder may occur!

- Only connect cable when power supply is switched off. Otherwise the encoder may be permanently damaged.

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

Function

The angular position of the motor is transferred incrementally over the connection with A/B rectangular signals. The unit detects stepper errors by comprison with the setpoint position and reports a following error if the limit value of 6.4° is exceeded. The monitoring can be disabled with the "Settings.monitorM" parameter, see chapter "Setting phase current and device parameters" from page 5-12.

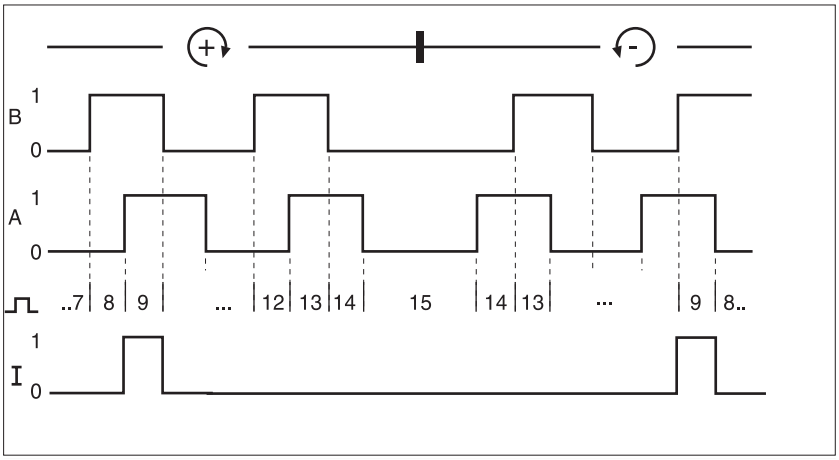

Fig. 4.32 Timing diagram with A, B and index pulse signal, counting forwards and backwards

Monitoring

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

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

Encoder type

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

TLADOCC51ME, -001, 04.03

4.4.13 Connection to the PBDP-C module

Module interface

The PBDP-C module is fitted with a 9-pin, SUB-D female connector.

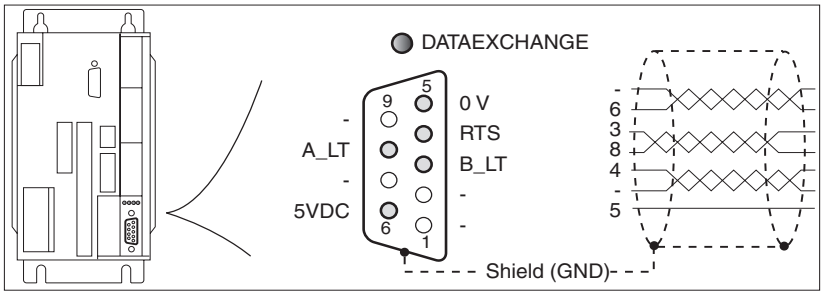

Fig. 4.33 Fieldbus module interface connection

Pin	Signal	Color	Pair	Meaning	I/O
1	-	-	1	Not assigned	-
6	5VDC	-	1	Power supply, max. 10 mA for terminator	O
2	-	-	-	Not assigned	-
7	-	-	-	Not assigned	-
3	B_LT	-	2	Data wire, negated	I/O
8	A_LT	-	2	Data wire	I/O
4	RTS	-	3	Transmission request	O
9	-	-	3	Not assigned	-
5	GND	-	-	Ground	-

A bus terminal forms the docking station to the Profibus. Data lines between module and bus terminal are wired up 1:1.

Terminals A_LT and B_LT must be connected to wires A and B in the network in accordance with the minimum wiring requirement.

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

Cable specification for connection to a bus terminal

- Shielded cable
- Minimum cross-section of signal wires: 25 AWG (0.14 mm^2)
- Twisted-pair wires
- Shield grounded at both ends
- Maximum length 81.5 feet (100 m)

To protect against interference, the shield for digital cables is connected at both ends. Differences in potential can lead to excessive current in the shield, and these have to be prevented with 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

The controller can be connected to a Profibus-DP network as a slave device with the PBDP-C Fieldbus module.

The controller receives data and commands from a higher-order device on the bus, a master device. The controller sends status information such as device status and processing status back to the master device as acknowledgement. Data exchange is with a special communications protocol.

Data are exchanged cyclically between master and slave devices. Every device in the network is identified by a unique address which can be set as desired.

Setting the address

The address can be set with the "M4.addrPbd" parameter or inputs ADR_1 to ADR_64 of the signal interface, see 4-30.

Baud rate

The baud rate is determined by the transmission speed of the master device.

Display

The DATAEXCHANGE LED displays signal connection to the Profibus master device.

Fieldbus manual

The integration of a Twin Line controller into the Fieldbus is described in the installation and set-up chapters of the Fieldbus manuals from Schneider Electric.

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4.4.14 Connection to the CAN-C module

Module interface

The CAN-C module is fitted with 9 pin SUB-D male and female connectors. Pin assignment is identical for both interface connections.

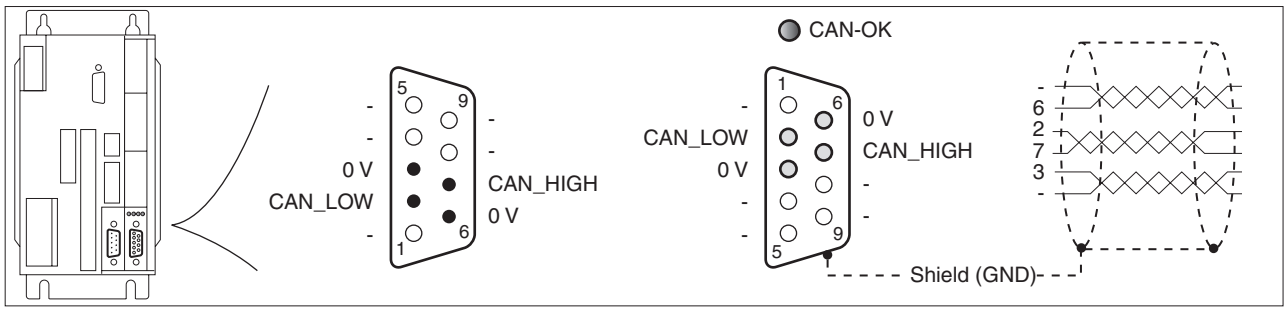

Fig. 4.34 Interface connections of the Fieldbus module with plug and socket

Pin	Signal	Color [1)]	Pair	Meaning	I/O
1	-	-	1	Not assigned	-
6	GND	green	1	Ground	-
2	CAN_LOW	white	2	Data wire, negated	I/O
7	CAN_HIGH	brown	2	Data wire	I/O
3	GND	gray	3	Ground	-
8	-	pink	3	Not assigned	-
4	-	-	-	Not assigned	-
9	-	-	-	Not assigned	-
5	-	-	-	Not assigned	-

1) Color details refer to the cable available as an accessory – the colors used match the CAN guidelines. Remember that the colors do not match the DeviceNet specification.

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

Cable specification

- Shielded cable
- Minimum cross-section of signal wires: 25 AWG (0.14 mm^2)
- Twisted-pair wires
- Shield grounded at both ends
- Maximum length depends on the number of devices, the baud rate and signal times. The higher the baud rates, the shorter the bus cable has to be. Recommended values: 40 m at 1 Mbit/s, 500 m at 100 kbit/s Recommended values for DeviceNet: 100 m at 500 kbit/s, 500 m at 125 kbit/s.

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

The controller can be connected with the CAN-C Fieldbus module on the following networks:

- CAN-Bus
- CANOpen
- DeviceNet

The controller receives data and commands from a higher-ranking (supervisory) master device on the bus, a master device. The controller sends status information such as device status and processing status back to the master device as acknowledgement. Data exchange is carried out with a special communication protocol.

Every device in the network is identified by a unique address which can be set as desired.

CAN-Bus display

The CAN-OK LED on the CAN-C module lights for approx. two seconds when the Fieldbus data have been correctly received.

CANOpen display

The CAN-OK LED on the CAN-C module lights when there is a connection to the device. If the connection is broken, the LED flashes: 0.5 sec on / 0.5 sec off.

DeviceNet display

The CAN-OK LED on the CAN-C module displays the status of the DeviceNet node:

DeviceNet status	Display
OFFLINE	Flashes (0.2 sec on / 0.8 sec off)
ONLINE (Duplicate MAC ID Check)	Flashes (0.8 sec on / 0.2 sec off)
LINK_OK	On
TIMEOUT/FAILURE	Flashes (0.2 sec on / 0.2 sec off)

Setting the address

The address can be set with the "M4.addrCAN" parameter (see page 12-20) or inputs ADR_1 to ADR_64 of the signal interface (see page 4-30).

Baud rate

The baud rate can be set with the "M4.baudCan" parameter, see page 12-20, or inputs BAUD_1 to BAUD_4 of the signal interface, see page 4-30.

Fieldbus profile

The Fieldbus profile can be set with the "M4.profilCAN" parameter, see page 12-21 or inputs MODE_1 and MODE_2 of the signal interface, see page 4-30.

Terminating resistors

A terminating resistor of 120 Ω must be connected at both ends. You will find an appropriate terminator plug in the "Accessories and spare parts" chapter.

Fieldbus manual

The integration of a Twin Line controller into the Fieldbus is described in the installation and set-up chapters of the Fieldbus manuals from Schneider Electric.

TLADOCC51ME, -001, 04.03

4.4.15 Connection to the RS485-C module

Module interface

The RS485-C module is fitted with 9 pin male and female connectors. Pin assignment is identical for both interface connections.

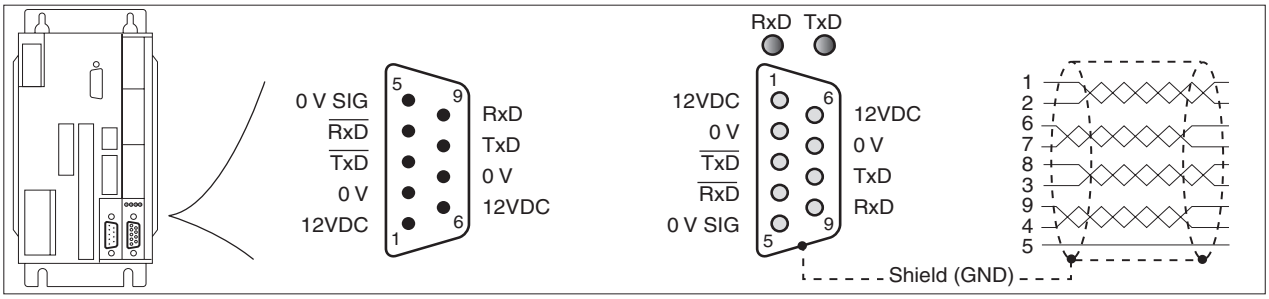

Fig. 4.35 Fieldbus module interface connection

Pin	Signal	Color	Pair	Meaning	I/O
1	12VDC	white	1	Power supply	O
2	GND	brown	1	Ground for 12VDC power supply	O
6	12VDC	green	2	Power supply	O
7	GND	yellow	2	Ground for 12VDC power supply	O
8	TxD	pink	3	Transmitted data	O
3	$\overline{\text{TxD}}$	gray	3	Transmitted data, negated	O
9	RxD	red	4	Received data	I
4	$\overline{\text{RxD}}$	blue	4	Received data, negated	I
5	SGND	black	-	Ground	-

Only one 12 VDC output of the two Sub-D connections may be loaded with a current of max. 150 mA.

Cable specification

- Shielded cable
- Minimum cross-section of signal wires: 25 AWG (0.14 mm^2)
- Twisted-pair wires
- Shield grounded at both ends
- Maximum length 1312 ft (400 m)

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

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 Using the RS485-C Fieldbus module, the controller can be connected to a serial bus as a slave device.

The controller receives data and commands from a higher-order device on the bus, a master device. The controller sends status information such as device status and processing status back to the master device as achnowledgement. Data exchange is with a special communications protocol.

Every device in the network is identified by a unique address which can be set as desired.

Display Two LEDs on the RS485-C module show the transfer of transmitted and received data.

Setting the address The address can be set via the "M4.addrSer" parameter or via inputs ADR_1 to ADR_16 of the signal interface. See page 4-30.

Baud rate The baud rate can be set via the "M4.baudSer" parameter or via inputs BAUD_1 to BAUD_4 of the signal interface, see page 4-36.

Fieldbus manual The integration of a Twin Line controller into the Fieldbus is described in the relevant Fieldbus manual in the chapter on installation and set-up.

TLADOCC51ME, -001, 04.03

4.4.16 Connection to the IBS-C module

Module interface The IBS-C module is fitted with a 9-pin, Sub-D male connector for Remote-in and a 9-pin, Sub-D female connector for Remote-out (both with UNC hardware).

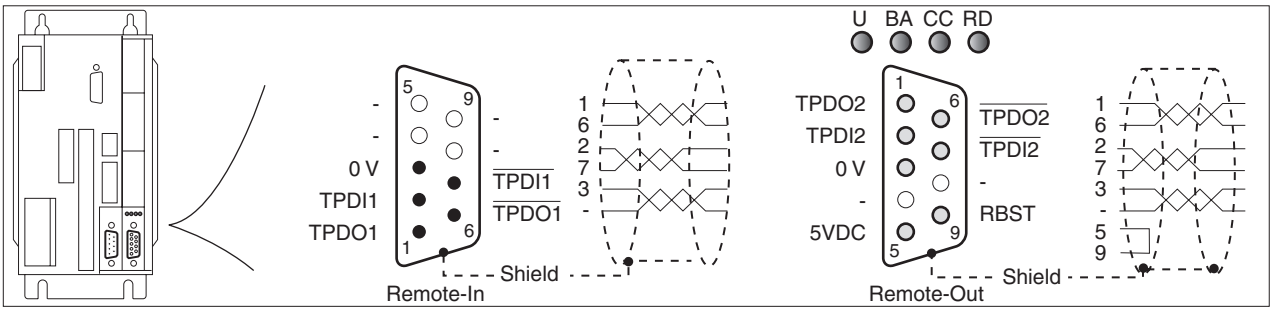

Fig. 4.36 Fieldbus module interface connection

Pin	Signal Remote-In	Signal Remote-Out	Color [1]	Pair	Meaning	I/O
1	TPDO1	TPDO2	white	1	Received data	I
6	$\overline{\text{TPDO1}}$	$\overline{\text{TPDO2}}$	brown	1	Received data, negated	I
2	TPDI1	TPDI2	green	2	Transmitted data	O
7	$\overline{\text{TPDI1}}$	$\overline{\text{TPDI2}}$	yellow	2	Transmitted data, negated	O
3	GND	GND	blue	3	Ground	-
8	-	-	red	3	Not assigned	-
4	-	-	gray	-	Not assigned	-
9	-	RBST	pink	-	Only for Remote-Out: Signal inputs for additional board In cable connector with Pin5: connect 5VDC	I
5	-	5VDC	black	-	Only for Remote-Out: 5 V power In cable connector with Pin9: connect RBST	O

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

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

Cable specification

- Shielded cable
- Minimum cross-section of signal wires: 25 AWG (0.14 mm^2)
- Twisted-pair wires
- Shield grounded at both ends
- maximum length 1312 ft (400 m)

To protect against interference, the shield for digital cables is connected at both ends. Differences in potential can lead to excessive current in the screen, and these have to be prevented by 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 The controller can be connected to an Interbus network as a slave device with the IBS-C Fieldbus module. The Interbus is a standardized Fieldbus for data exchange for sensors and actuators.

During processing, the controller swaps process data with the master device, e.g. a PLC or PC with Interbus master interface. The master device controls and monitors all connected slave devices.

Devices on the Interbus are networked in a ring topology. Connection to the neighboring device is made in each case via Remote-In and Remote-Out.

Display The Fieldbus module signals status and diagnostic information through four LEDs:

LED Designation	Color	Explanation, if active
U	Green	Power supply OK
BA	Green	Remote bus connection OK
CC	Green	Remote bus OK
RD	Red	Remote bus to the next slave device switched off

Setting the address The address is derived from the position of the Twin Line controller in the network ring.

Baud rate The baud rate is permanently set to 500 kbit/s.

Fieldbus manual The integration of a Twin Line controller into the Fieldbus is described in the installation and set-up chapters of the Fieldbus manuals from Schneider Electric.

4.5 Connecting accessories to the IP20 controller

4.5.1 Holding brake controller TL HBC

⚠ DANGER

HAZARDOUS VOLTAGE – STEPPER-GENERATED AND COUPLED VOLTAGE.

- The stepper can produce voltage at its terminals when the shaft is rotated! Prior to installation or servicing, block the stepper 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 stepper 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 will result in death or serious injury.

TLADOCC51ME, -001, 04.03

⚠ 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 will result in death or serious injury.

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

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

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

Motor connection

Terminal	Connection	Color
U	Motor cable	Brown (bn)
V	Motor cable	Blue (bl)
W	Motor cable	Black (bk)
PE	Protective conductor (shield tracer wire)	-
B+	Brake wire	Red (rd)
B-	Brake wire	Grey (gr)

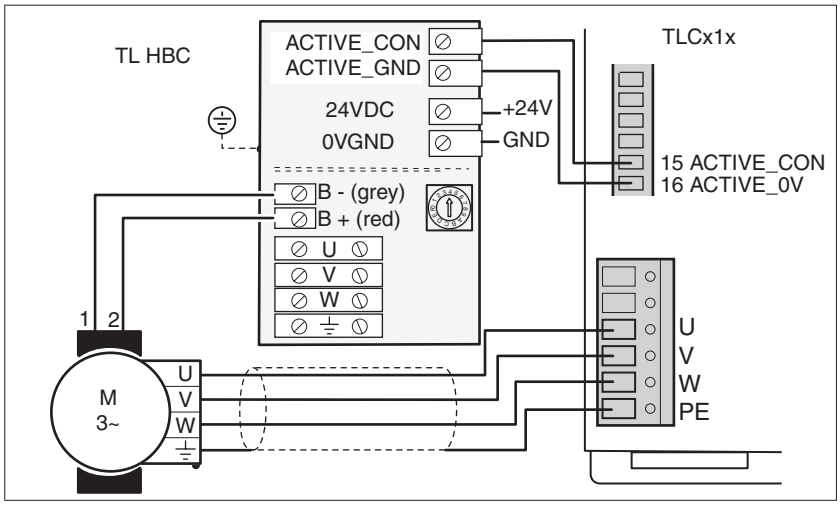

Fig. 4.37 Connection of the TL HBC holding brake controller

▶ Only use square end ferrules to ensure that they do not work loose.

▶ Connect the control connections to the holding brake terminals B+ and B-.

- ▶ Connect the control terminals ACTIVE_CON and ACTIVE_0V of the brake controller and the signal interface.
- ▶ Connect the 24 VDC power supply to the holding brake controller.

Only use cables with the following specifications:

	TLC511	TLC512
Cable cross-section	16 AWG (1.5 mm^2)	16 AWG (1.5 mm^2)
Max. cable length [1)]	65.6 feet (20 m)	65.6 feet (20 m)

1) Longer cables on request

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

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

- ▶ Set the switch for voltage reduction to "1".

The voltage reduction function is described in chapter "Braking function with Holding Brake Control (TLHBC)" on page 7-27.

4.5.2 External capacitors

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

Only use cables with the following specifications:

	TLC511	TLC512
Dielectric strength	≥ 450 V	≥ 450 V
External capacity	< 500 µF	< 1000 µF

TLADOCC51ME, -001, 04.03

Cable specification

- Shielded cable
- Shield grounded at both ends
- Maximum cable length 9.84 ft (3 m)
- Minimum cross-section: 16AWG (1.5 mm^2)

Connection

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

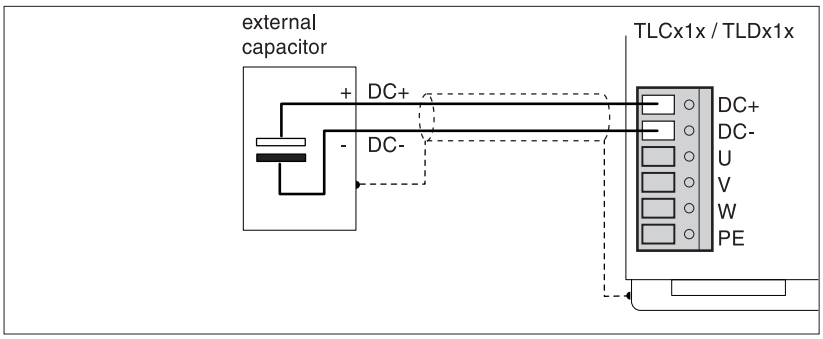

Fig. 4.38 Connection of an external capacitor

4.6 Wiring examples

4.6.1 Manual setup and operation via Fieldbus

Functions Manual setup with Teach mode function, manual movement via I/O, operation over Fieldbus with fixed I/O pin assignments

Presets Parameter setting: "Settings.IO_mode"=2, see chapter"Operating modes of the controller", from page 6-1.

Manual movement via I/O and Teach mode is achieved when AUTOM=0.
Fieldbus mode is achieved when AUTOM=1.

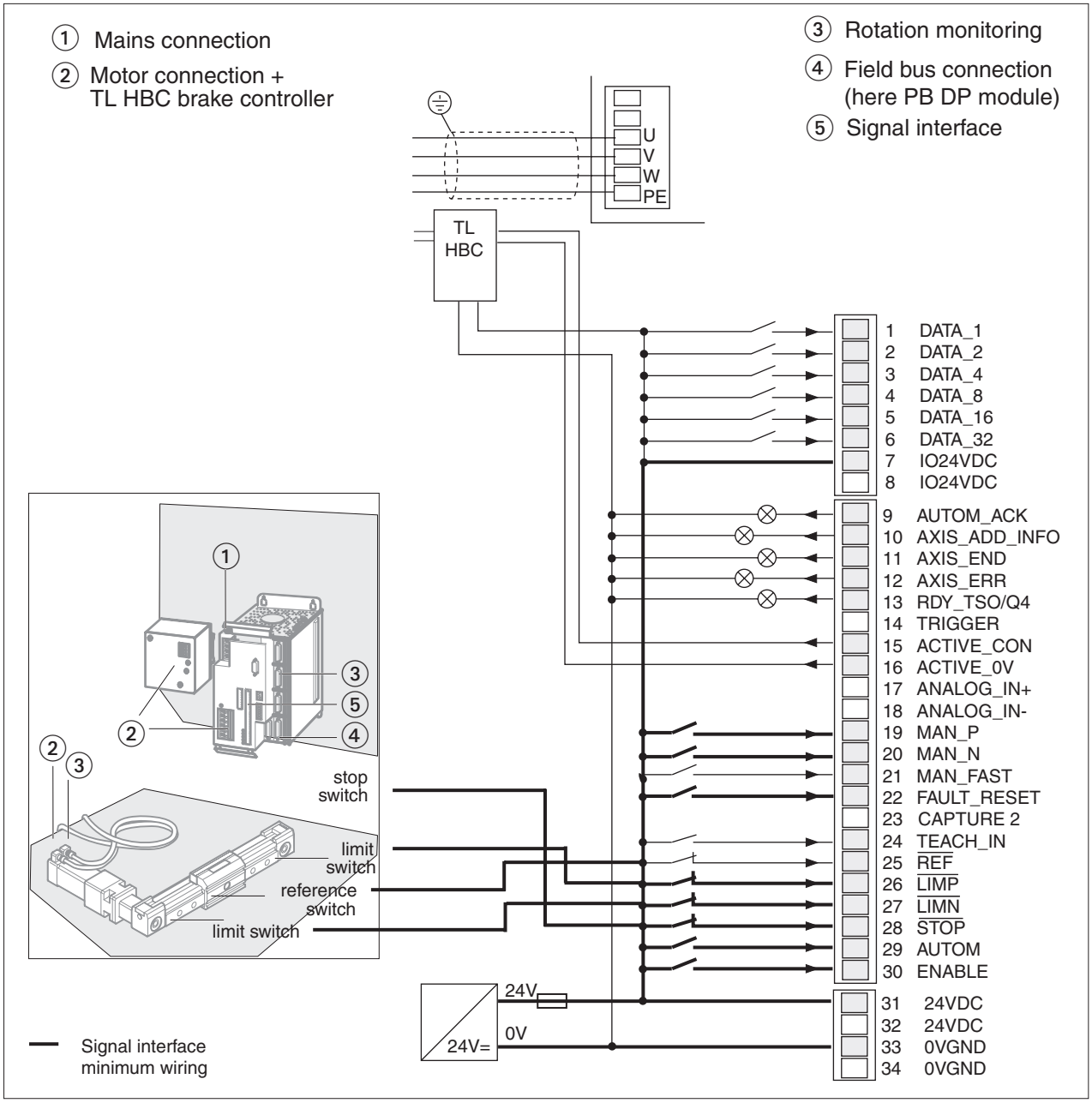

Fig. 4.39 Wiring for manual mode via inputs and outputs

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Connection

▶ Wiring up the mains connection (1):

- For single-phase units see page 4-16.
- 24 V connection wiring, see page 4-28.

▶ Wiring motor connection (2) and holding brake controller in motors with holding brakes:

- Motor connection see page 4-19.
- Holding brake controller see page 4-60.

▶ Installing motor speed monitoring (3), see page 4-51.

▶ Wiring up the Fieldbus connection (4):

- Profibus DP see page 4-53.
- CAN-Bus see page 4-55.
- RS485-C see page 4-57.
- Interbus-S see page 4-59.

▶ Wiring signal interface for manual operation:

- The complete signal interface assignments are described from 4-30.
- See the table below for the I/O assignment.

Pin	Signal	Active	Meaning	I/O
1	DATA_1	high	Bit0 for selecting a list number	I
2	DATA_2	high	Bit1 for selecting a list number	I
3	DATA_4	high	Bit2 for selecting a list number	I
4	DATA_8	high	Bit3 for selecting a list number	I
5	DATA_16	high	Bit4 for selecting a list number	I
6	DATA_32	high	Bit5 for selecting a list number	I
7	IO24VDC [1)]	–	Power supply for inputs/outputs	I
8	IO24VDC	–	Power supply for inputs/outputs	I
9	AUTOM_ACK	high	Acknowledgement signal at AUTOM signal	O
10	AXIS_ADD_INFO	high	Supplementary information on current movement job	O
11	AXIS_END	high	End of processing of a movement job, drive at standstill	O
12	AXIS_ERR	high	Error detection during processing of a movement job	O
13	RDY_TSO:	high	Ready for operation, output max. 400 mA	O
15	ACTIVE_CON	high	Motor under power, control signal for brake controller TL HBC, max. 400 mA [2)]	O
16	ACTIVE_0V	high	0 V signal for brake controller, internally on 0VGND [2)]	I
19	MAN_P [1)]	high	Manual movement clockwise motor rotation	I
20	MAN_N [1)]	high	Manual movement counter-clockwise motor rotation	I
21	MAN_FAST	high	Manual selection slow (low) or fast (high)	I
22	FAULT_RESET [1)]	high	Resetting error messages	I

TLADOCC51ME, -001, 04.03

Pin	Signal	Active	Meaning	I/O
24	TEACH_IN	high	Trigger signal for saving the current setpoint position in the list data memory	I
25	$\overline{\text{REF}}$	low	Reference switch signal	I
26	$\overline{\text{LIMP}}$ 1)	low	Limit switch signal clockwise motor rotation	I
27	$\overline{\text{LIMN}}$ 1)	low	Limit switch signal counter-clockwise motor rotation	I
28	$\overline{\text{STOP}}$ 1)	low	Stop motor	I
29	AUTOM 1)	high	Automatic mode via Fieldbus (high), manual mode (low)	I
30	ENABLE 1)	high	Enable (high) or lock (low) power amplifier	I
31, 32	24 VDC 1)	–	24 VDC power supply	I
33, 34	GND 1)	–	GND for 0 VDC voltage	I

1) I/O assignment of signal interface for commissioning
2) For IP54 controller: Holding brake connection hard wired.

4.6.2 Operation by Fieldbus, configuration by TLHMI or TLCT

Functions Operation with this wiring example is only possible if a Fieldbus module is installed at M4.

Operation by Fieldbus or local operating units TLHMI or TLCT with signal interface with free pin assignment, Fieldbus settings by local operating units.

Presets Parameter setting: "Settings.IO_mode" = 1, see chapter "Operating modes of the controller", from page 6-1.

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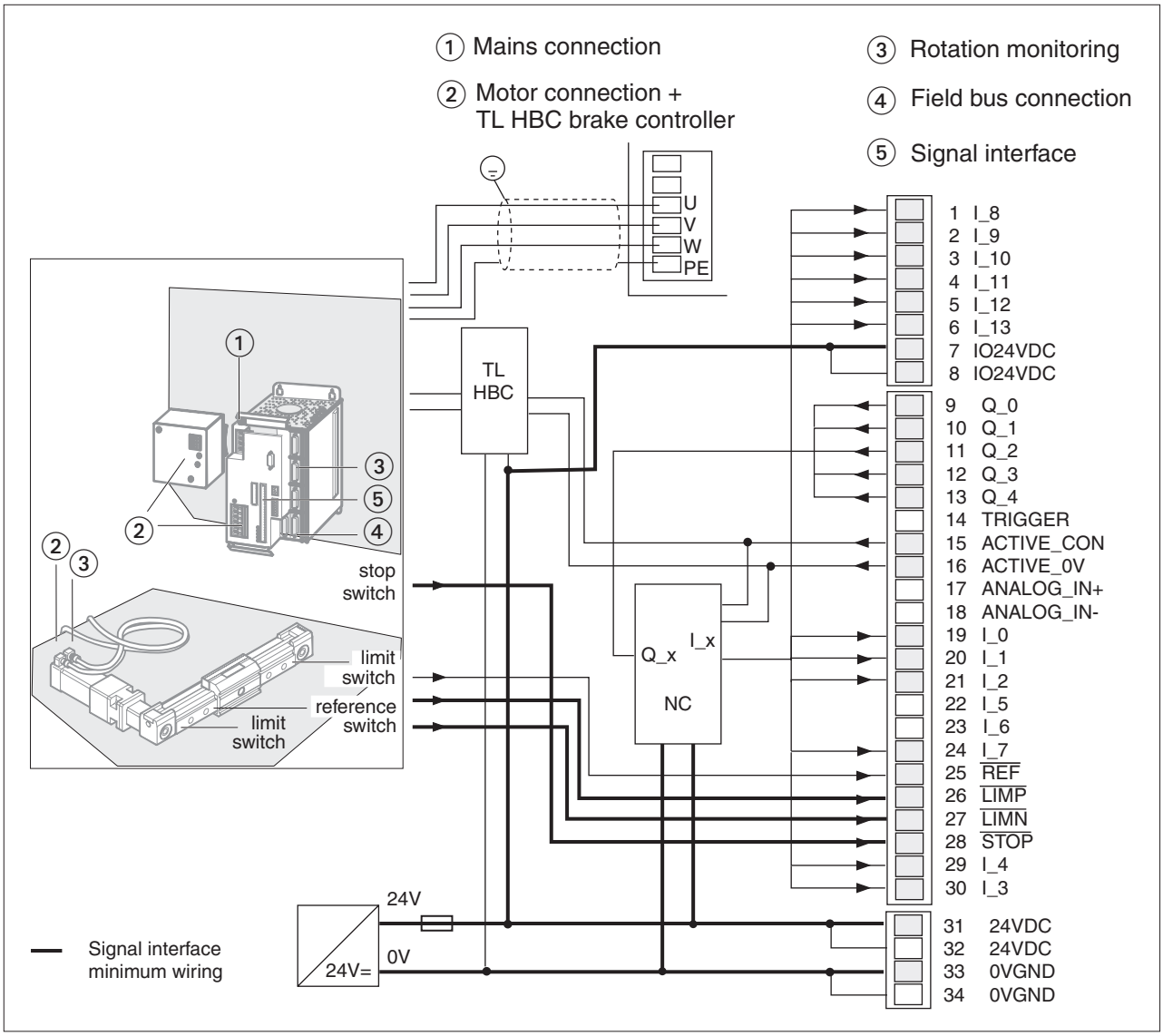

Fig. 4.40 Wiring for automated operation on Fieldbus

Connection

▶ Wiring up the line connection:

- For single-phase unit's see page 4-16.
- 24 V connection wiring, see page 4-28.

▶ Wiring motor connection and holding brake controller in motors with holding brakes:

- Motor connection see page 4-19.
- Holding brake controller see page 4-60.

▶ Installing motor speed monitoring, see page 4-51.

▶ Wiring up the Fieldbus connection:

- Profibus DP see page 4-53.
- CAN-Bus see page 4-55.
- RS485-C see page 4-57.
- Interbus-S see page 4-59.

▶ Wiring signal interface:

- The complete signal interface assignments are described from 4-30.

See the table below for the I/O assignment.

Pin	Signal	Active	Meaning	I/O
1	I_8	high	Freely assignable input	I
2	I_9	high	Freely assignable input	I
3	I_10	high	Freely assignable input	I
4	I_11	high	Freely assignable input	I
5	I_12	high	Freely assignable input	I
6	I_13	high	Freely assignable input	I
7	IO24VDC [1)]	–	Power supply for inputs/outputs	I
8	IO24VDC	–	Power supply for inputs/outputs	I
9	Q_0	high	Freely assignable output	O
10	Q_1	high	Freely assignable output	O
11	Q_2	high	Freely assignable output	O
12	Q_3	high	Freely assignable output	O
13	Q_4	high	Freely assignable output	O
14	TRIGGER	high	Trigger output, signal value is switched via position/signal list	O
15	ACTIVE_CON	high	Motor with power, control signal for TL HBC brake controller, max. 400mA [2)]	O
16	ACTIVE_0V	high	0 V signal for brake controller, internally on 0VGND [1)]	I
19	I_0	high	Freely assignable input	I
20	I_1	high	Freely assignable input	I
21	I_2	high	Freely assignable input	I
22	I_5	high	Freely assignable input	I

TLADOCC51ME, -001, 04.03

Pin	Signal	Active	Meaning	I/O
23	I_6	high	Freely assignable input	I
24	I_7	high	Freely assignable input	I
25	$\overline{\text{REF}}$	low	Reference switch signal	I
26	$\overline{\text{LIMP}}$ 1)	low	Limit switch signal clockwise motor rotation	I
27	$\overline{\text{LIMN}}$ 1)	low	Limit switch signal counter-clockwise motor rotation	I
28	$\overline{\text{STOP}}$ 1)	low	Stop motor	I
29	I_4	high	Freely assignable input	I
30	I_3	high	Freely assignable input	I
31, 32	24 VDC 1)	–	24 VDC power supply	I
33, 34	GND 1)	–	GND for 0VDC	I

1) I/O assignment of signal interface for commissioning
2) For IP54 controller: Holding brake connection hard wired.

4.6.3 Operation by Fieldbus, Fieldbus configuration via inputs

Functions Operation with this wiring example is only possible if a Fieldbus module is installed at M4.

Operation via Fieldbus master, operation via local operating units, Fieldbus parameters set via signal interface inputs. The settings are read and enabled when the controller is switched on. In this example Fieldbus address 7 is set. Baud rate and processing profile are not set here. The inputs are set to 24VGND.

Inputs I_5 and I_6 are available as freely assignable inputs, outputs Q_0 to Q_4 as freely assignable outputs.

Presets Parameter setting: "Settings.IO_mode" = 0, see chapter "Operating modes of the controller", from page 6-1.

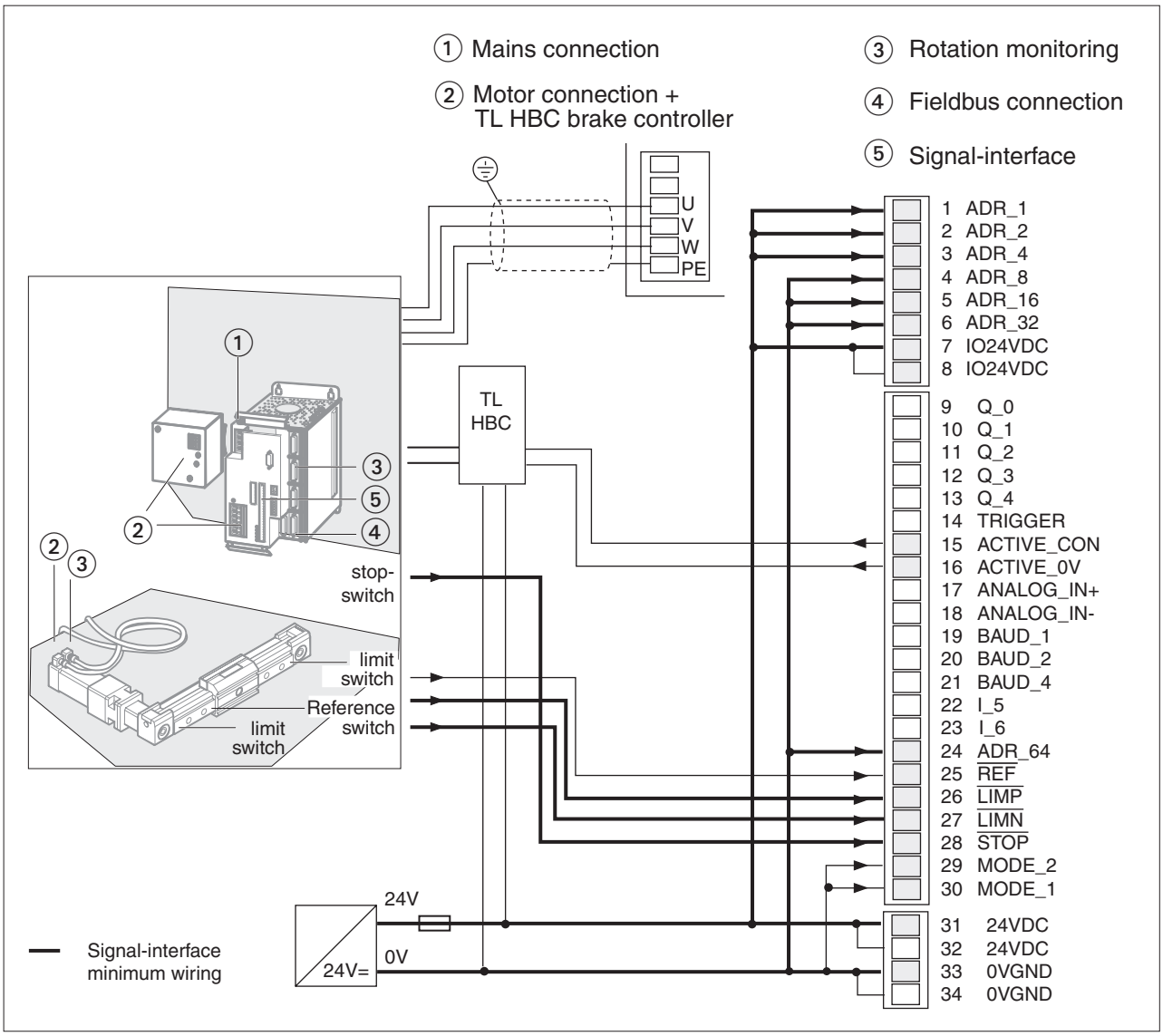

Fig. 4.41 Wiring for automatic operation only on Fieldbus

Pin	Signal	Active	Meaning	I/O
1	ADR_1	high	Bit0 for network address	I
2	ADR_2	high	Bit1 for network address	I
3	ADR_4	high	Bit2 for network address	I
4	ADR_8	high	Bit3 for network address	I
5	ADR_16	high	Bit4 for network address	I
6	ADR_32	high	Bit5 for network address	I
7	IO24VDC [1)]	–	Power supply for inputs/outputs	I
8	IO24VDC	–	Power supply for inputs/outputs	I
15	ACTIVE_CON	high	Motor with power, control signal for TL HBC brake controller, max. 400mA [2)]	O
16	ACTIVE_0V	high	0 V signal for brake controller, internally on 0VGND [1)]	O
19	BAUD_1	high	Bit0 for setting the baud rate	I
20	BAUD_2	high	Bit1 for setting the baud rate	I
21	BAUD_4	high	Bit2 for setting the baud rate	I
24	ADR_64 [1)]	high	Bit6 for network address	I
25	$\overline{\text{REF}}$	low	Reference switch signal	I
26	$\overline{\text{LIMP}}$ [1)]	low	Limit switch signal clockwise motor rotation	I
27	$\overline{\text{LIMN}}$ [1)]	low	Limit switch signal counter-clockwise motor rotation	I
28	$\overline{\text{STOP}}$ [1)]	low	Stop motor	I
29	MODE_2	high	Bit1 for setting Fieldbus profile	I
30	MODE_1	high	Bit0 for setting Fieldbus profile	I
	24 VDC [1)]	–	24 VDC power supply	I
	GND [1)]	–	GND for 0VDC 0VDC	I

1) Minimum pin assignment of signal interface for commissioning
2) For IP54 controller: Holding brake connection hard wired.

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

For this test and the first stages of commissionung the engine should be run decoupled from the system. This means that the motor and system will not be damaged if the motor starts up unexpectedly.

Certain unit parameters must be tested and adjusted before control signals may be sent to the motor.

Parameters will be set during commissioning; the following function test must therefore be conducted when the power amplifier is switched off.

- ▶ Disconnect the plugs from the unit's Fieldbus interface to ensure that the power amplifier cannot be switched on through the Fieldbus
- ▶ Set the ENABLE input of the signal interface to Low if system is assigned the signal input.

⚠WARNING

UNINTENDED EQUIPMENT ACTION
Possible destruction of motor!

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

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

System check and initialization

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

Unit OK

The status display first changes from 1 to 2, then to 3 and 4.

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

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

- ▶ Switch off the power supply again.

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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. 1.7 on page 1-7). 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 stepper 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. 1.7 on page 1-7.
- 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.

Operational status indicator "2"

If the controller hangs in the switching-on state "2", this indicates an internal fault in the controller 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", check whether the line voltage is switched on and the line voltage connections are correctly wired.

Operational status indicator flashing

The controller has detected a fault. In "Diagnosis and error rectification" from page 8-1 a list of the causes of faults can be found.

The controller status can be checked via error status signals while it is starting up via I/O. There is a flow diagram and signal curves in chapter "Diagnosis and error rectification" from page 8-1.

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5 Commissioning

5.1 Commissioning procedure

Where can I find information on...	TLC51x controller manual	TL HMI manual	TL CT software manual	TL CT help
Commissioning step by step	•	–	–	•
Settings and parameter list	•	–	–	–
Commissioning procedure	•	–	–	•
Detailed information on operation using...	–	TLHMI	TLCT	TLCT

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

What you need to do...	Info
Make sure the Twin Line controller is correctly installed and wired up. When carrying out this check, use the wiring diagrams of the system configuration or the wiring examples in "Wiring examples" on page 4-64.	"Installation" from page 4-1
Make sure the limit switches work if these are installed.	page 5-16
Check the functioning of the holding brake controller if you are using motors with holding brake	page 5-17
Setting phase current and device parameters.	page 5-12
Check direction of rotation and conduct test run.	page 5-21
Optimizing movement behavior.	page 5-24

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

- For information on these operating modes see page 6-1.
- The signals, parameters and conditions for changing operating modes are described on page 6-1.

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5.2 Safety notes

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 validation is complete, reconnect the motor and validate 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 or serious injury.

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⚠WARNING

UNINTENDED EQUIPMENT OPERATION

Signal inputs serve as setpoint inputs for position commands. 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 controller 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.

⚠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. 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.

TLADOCC51ME, -001, 04.03

⚠WARNING

LOSS OF CONTROL

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

- Availabiltiy of sufficient braking torque for rapid stopping requires that the drive be properly tuned and, if required, fitted with a suitable ballast resistor for dynamic braking. 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.
- It is recommended to verify veloctiy and motion profiles / movements of the machine travel where loss of braking would not result in a collision or activating the mechanical stop.
- Verification of braking system should be performed with the most demanding duty cycle which needs the maximum braking torque and for the routine duty cycle.
- 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.
- Ensure there is no overloading caused by short-time load impact.

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 controller.
- The Twin Line Commissioning Tool (TLCT): commissioning software used in conjunction with a PC equipped with WINDOWS® NT, WINDOWS 95, WINDOWS 98 or WINDOWS 2000.

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

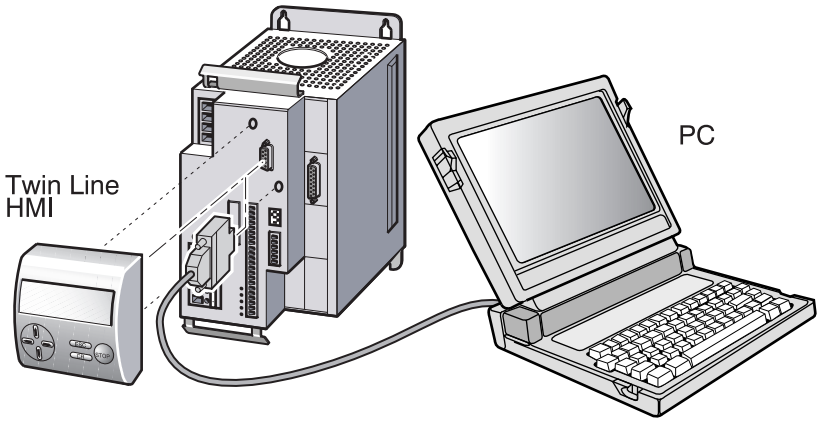

Fig. 5.1 Commissioning with the hand-held operating unit or the PC

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

The operation of a Twin Line controller with the HMI unit is described in the Twin Line HMI manual.

Menu structures for the TLC51x

The Twin Line HMI is menu-controlled. When the controller is switched on, the menu structures and parameter values displayed are automatically adapted to the device type connected. The following menu items are available on the first and second levels for the controller TLC51x:

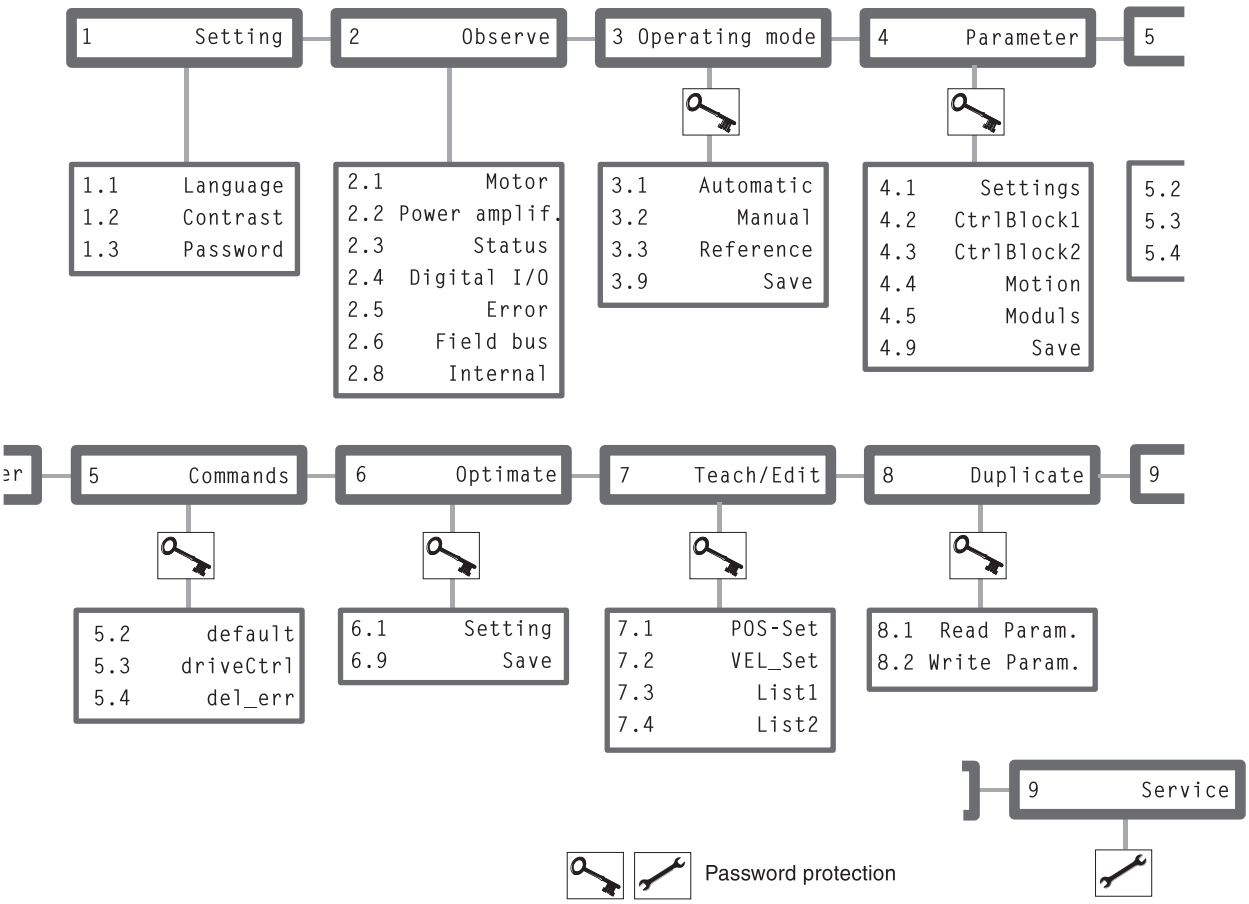

Fig. 5.2 First and second menu levels of the Twin Line HMI with TLC51x

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 with the controller
8 Duplicate	Copy parameter sets to other Twin Line controllers
9 Service	Password-protected, for servicing purposes only

So that all parameters can be found easily with the Twin Line HMI, the menu paths for each parameter are provided in the manual. For example, HMI menu "3.3.2" means: on the first menu level select item "3 Operating Mode"; next, on the second level, select the menu item "3.3 Reference". At the third level the "startSetup" parameter is under "3.3.2 Setting dimensions".

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

TLADOCC51ME, -001, 04.03

5.3.3 Twin Line Commissioning Tool software

Twin Line Commissioning Tool

The Twin Line Commissioning Tool software offers a graphical user interface for setting parameters, commissioning and for diagnosis of the controller. The software can be used to test the input and output signals of the controller and to track signal curves on the monitor.

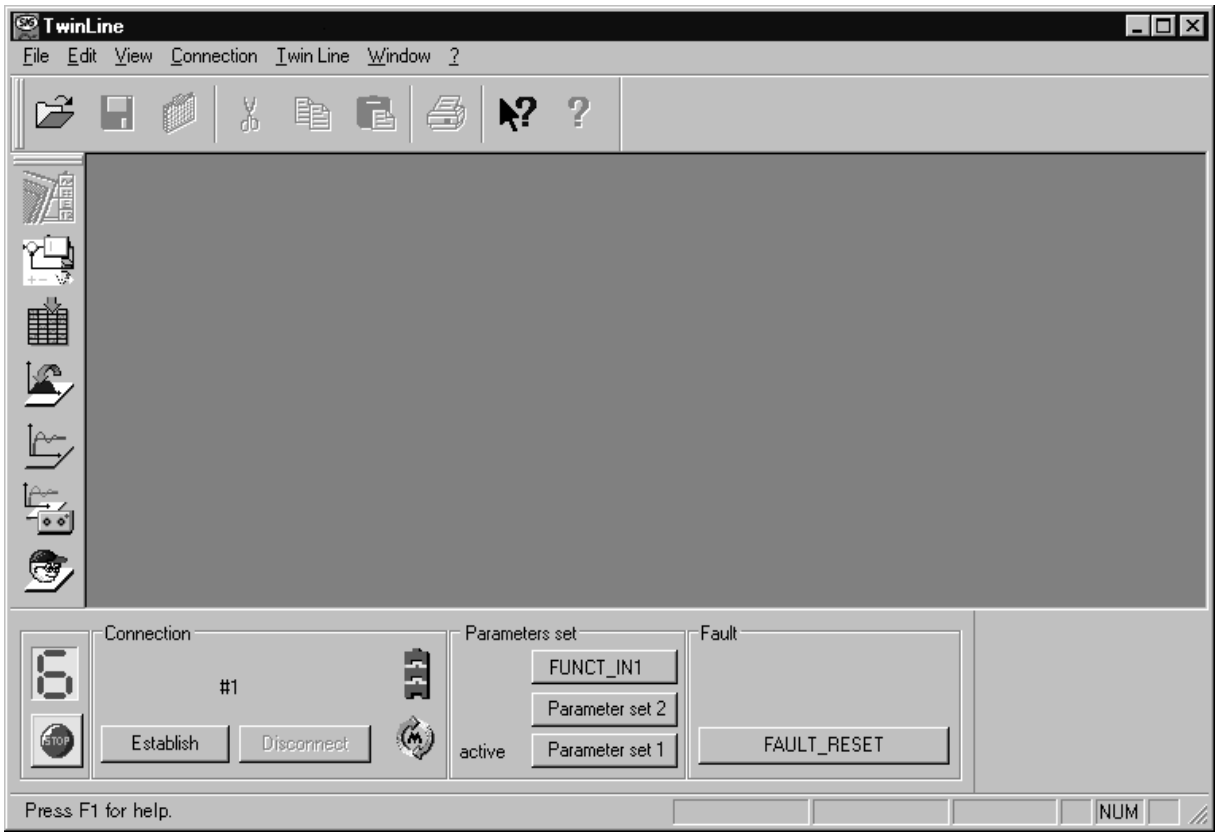

Fig. 5.3 Twin Line Commissioning Tool software

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

- Extensive diagnostic tools for optimization and maintenance
- Simultaneous display of different values, graphical user interface
- Long-term recording as an aid to assessing operating behavior
- Archiving all device settings and recordings with export functions for data processing

TLCT manual

Operation of a Twin Line controller 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.

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Requirements for the use of the Twin Line Commissioning Tool

A PC or laptop with a free serial port and running Windows NT, Windows 95, Windows 98 or Windows 2000 is required to work with the Twin Line Commissioning Tool.

The PC and the Twin Line controller must be linked by the RS-232 cable.

Menu structure

All commissioning software commands can be executed with the menu items and the program buttons.

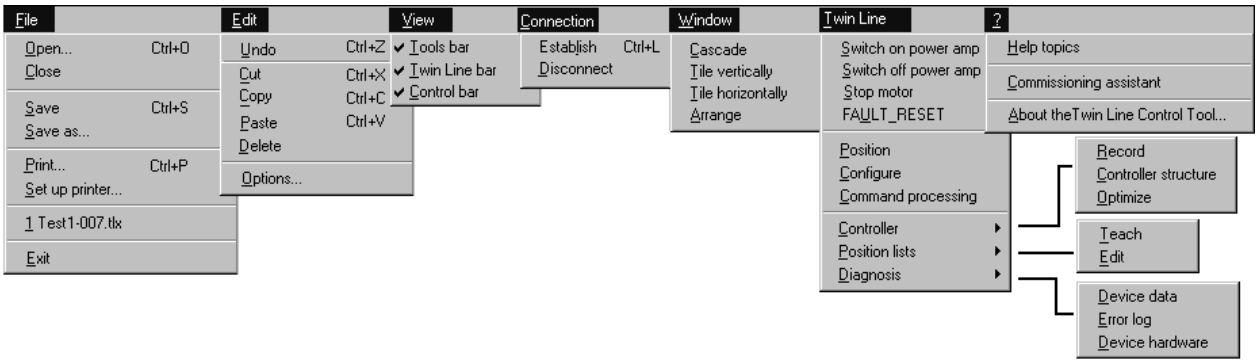

Fig. 5.4 The menu structure of the Twin Line Commissioning Tool

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

Software help

The Twin Line Commissioning Tool provides detailed help functions which you can access 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'.

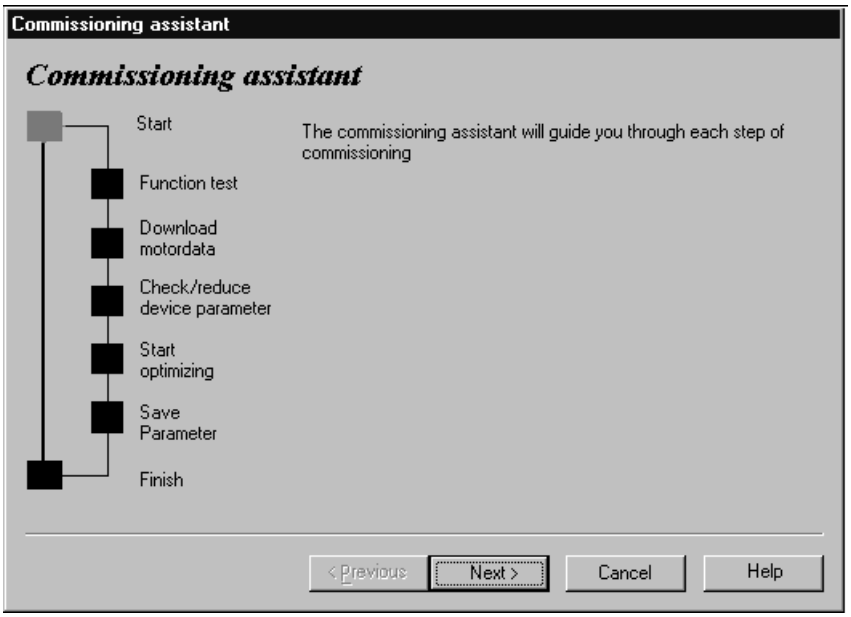

Fig. 5.5 Commissioning with the assistant in the Twin Line Commissioning Tool

5.4 Commissioning the controller

5.4.1 Commissioning stages

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

Commissioning should be done in the following sequence:

- Make sure the limit switches and holding brake controller are working.
- Testing and setting the phase current.
- Check the motor's direction of rotation and manual movement.
- Optimizing the movement behavior.

5.4.2 Powering and monitoring the controller 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 stepper. Examples of limit or protective functions include but are not limited to the following.

- Motor current (I_0, I_const, I_acc)
- Rotation monitor enabled (In settings→monitiorM→RM active)
- Velocity limits (n_max0)

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

⚠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 or serious injury.

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

- ▶ Disconnect the plugs from the controller's Fieldbus interface to ensure that the power amplifier cannot be enabled through the Fieldbus.
- ▶ The ENABLE signal must be set to low level to prevent the motor from being actuated.
- ▶ Close the enclosure door. Switch on the external 24 Vdc supply voltage and then the mains voltage for the controller.

Refer to Fig. 5.3 for the location of the controller status code on the Twin Line software main window. The controller 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.

After commissioning is complete, reconnect the Fieldbus to the power amplifier.

5.4.3 Setting phase current and device parameters

⚠WARNING

LOSS OF CONTROL

Incorrect drive parameters will result in unintended equipment action, loss of torque or motor damage.

Check drive parameters before enabling the drive.

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

Setting device parameters

The corresponding parameter view must be selected to set the device parameters.

The parameter display contains information required to enable programs such as the TL CT commissioning software or the HMI handleld unit to identify a parameter. The parameter display can also provide information on setting options, presets and parameter properties. Note that the parameters of the Twin Line controller are grouped into functionally similar blocks, referred to as parameter groups. A parameter display has the following features:

Parameter			Explanation and unit [ ]	Range of values	Default	R/W
Group.Name	Idx:Sidx	TL-HMI			Value	rem.
VEL.velocity	36:1	3.1.2.1	Start of a speed change with transfer of set-point speed [usr]	INT32 -2147483648..2147483647	–	R/W –

Where:

- **Group.Name:** Parameter designation made up of a combination of the name of the parameter group (="group") and the name of that specific parameter (="name").
- **Idx:Sidx:** Index (="Idx") and subindex (="Sidx") for identification of a parameter, input options with the TL CT commissioning software in the "Monitor" window, selection of the parameter in field mode.
- **TL-HMI:** Menu item of the three-level menu structure in the HMI that corresponds to a parameter; for more information see the chapter on "The Twin Line HMI hand-held operating unit" on page 5-6.
- **Explanation and unit [ ]:** Detailed explanation of the parameter and its unit.
- **Range of values:** Includes the data type, the variable numerical range for the parameter and the bit assignment of the parameter. The data type is significant for operation via Fieldbus.
- **Default value:** Value set by the manufacturer.
- **R/W:** Information on reading and writing the values (R:= read, i.e. readable and W:= write, i.e. writable).
  "R/-" – values can be read only,
  "R/W" – values can be read and written.
- **rem.:** The value is retentive; it is retained in the memory even after the unit is switched off.
  To ensure that the value is retained, the user must save the data to the non-volatile memory before shutting down the unit.

TLADOCC51ME, -001, 04.03

This procedure can be run in TL CT by selecting "Save in EEP-ROM".
"rem." - values are non-volatile,
"-" - values are not non-volatile.

Instructions on input of values:

The "max. current" and "max. speed" values under "Range of values" correspond to the lower maximum values of power amplifier and motor. The unit limits automatically to the lower value.

Temperatures in Kelvin [K] = temperature in degrees Celsius [°C] + 273,: for example: 385 K = 85 °C

Use the specifications relevant for controlling the unit through the particular access channel.

Access channel	Specifications
Fieldbus	Idx:Sidx
TLHMI	Menu items under "TL-HMI"
TLCT	"Group Name", e.g. "Settings.SignEnabl"

Phase current

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

⚠CAUTION

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

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

Failure to follow these instructions can result in equipment damage.

⚠CAUTION

UNINTENDED EQUIPMENT OPERATION
If the phase current is set at the maximum rated phase current of the motor, the temperature at the center of the stator may rise up to 100 ^{o}C with an ambient temperature of 25 ^{o}C.
However, with an improper flanging the temperature may rise even higher. It is ,therefore, important to check the motor temperature periodically to ensure trouble-free functioning of the motor.

Failure to follow these instructions can result in equipment damage.

The values for the maximum allowable rated phase current are shown on the motor nameplate.

▶ Test the phase current setting for the parameters "Settings.I_O", "Settings.I_acc" and "Settings.I_const" and reduce the values to maximum allowable rated phase current of the motor.

TL CT: Setting phase current

▶ Open the parameters window with "Twin Line → Configuring" and enter the limit values for current and speed in the "Settings" parameter group.

TL HMI: Setting phase current

▶ Input the limit values under the menu items which are shown in the table.

Enabling and disabling speed monitoring

The "Settings.monitorM" parameter checks the encoder connection and the motor temperature. If no encoder is connected during commissioning, the unit reports a line fault.

Disable the "Settings.monitorM" parameter during commissioning if an encoder is not connected yet.

Parameter			Explanation and unit [ ]	Range of values	Default	R/W
Group.Name	**Idx:Sidx**	**TL-HMI**			**Value**	**rem.**
Settings.I_0	14:10	4.1.30	Max. phase current at standstill [Arms]	0...10 A	0.9 A	R/W rem.
Settings.I_acc	14:11	4.1.31	Phase current during acceleration and deceleration [Arms]	0...10 A	0.9 A	R/W rem.
Settings.I_const	14:12	4.1.32	Max. phase current during steady movement [Arms]	0...10 A	0.9 A	R/W rem.
Settings.monitorM	14:18	4.1.35	Motor monitoring, with module in M2 only 0: deactivated 1: activated	UINT16 Bit0: Speed monitoring Bit1: Temperature monitoring 0...3	3	R/W rem.
Motion.invertDir	28:6	4.4.27	Inversion of sense of rotation	UINT16 0: no inversion 1: sense of rotation inverted	0	R/W rem.

Temperature monitoring is only available optionally with rotation monitoring.

TLADOCC51ME, -001, 04.03

5.4.4 Starting the programable controller

Requirements Either a computer with the Twin Line Commissioning Tool commissioning software installed or the HMI hand-held unit must be connected to the controller.

The power amplifier must be switched off so the motor is not controlled.

▶ Switch on the external 24 V_{DC} power supply and then the line voltage for the power amplifier.

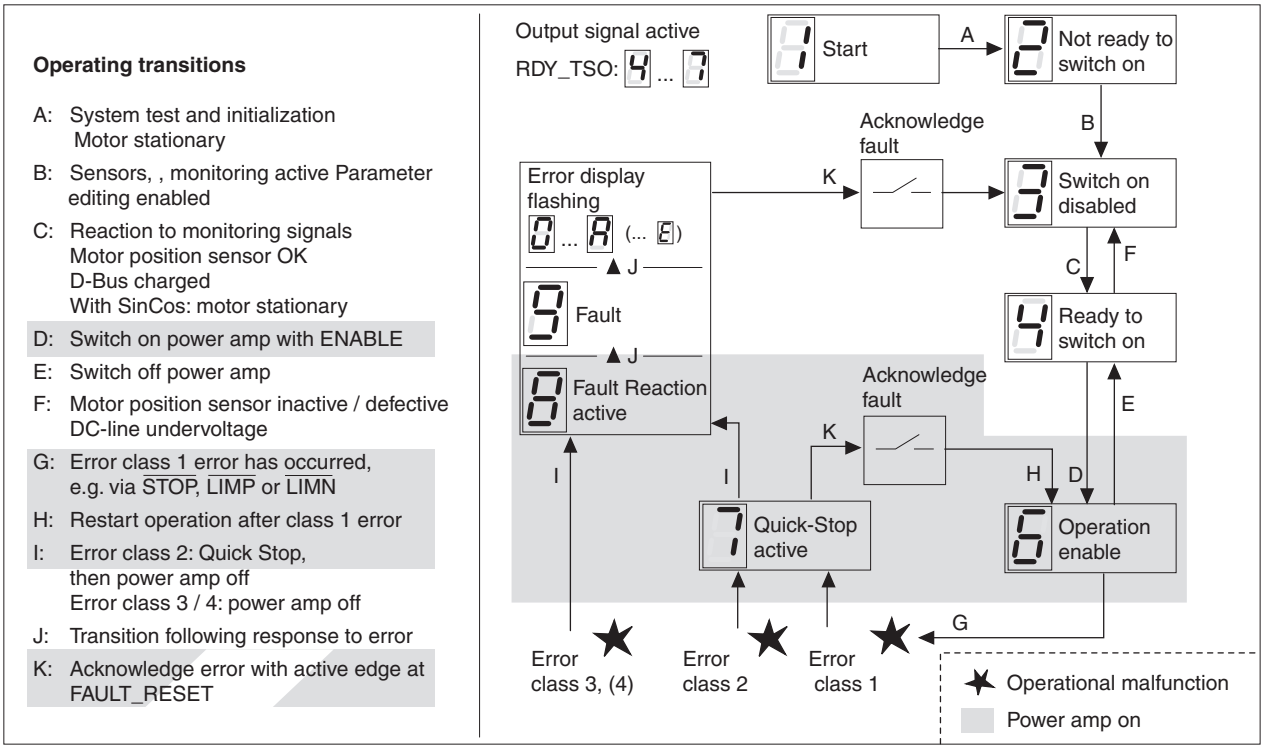

Fig. 5.6 Operating states and transitions of the controller

The status display of the controller changes from "1" to "3" or "4".

If the display flashes, this indicates a fault. Information on rectifying faults can be found in the section entitled "Diagnosis and error rectification" from page 8-1.

5.4.5 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 7.7.1 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 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 $\overline{\text{LIMP}}$, $\overline{\text{LIMN}}$, 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 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 or serious injury.

▶ Trip the limit switches manually while observing the LEDs for the positive limit switch signal $\overline{\text{LIMP}}$ and the negative limit switch signal $\overline{\text{LIMN}}$. The LEDs remain on unless the limit switches have been tripped.

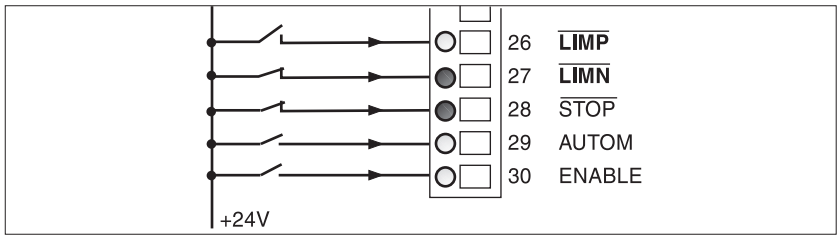

Fig. 5.7 Positive limit switch tripped

Enabling 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 Changing "Settings.SignEnabl" and "Settings.SignLevel". See page 7-27.

The limit switch, which limits the work area during clockwise rotation, must be connected to $\overline{\text{LIMP}}$. The limit switch, which limits the work area during counter-clockwise rotation, must be connected to $\overline{\text{LIMN}}$.

TLADOCC51ME, -001, 04.03

5.4.6 Checking the 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 or serious injury.

Carry out this test when a motor is being used with a holding brake.

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

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

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

IP54 controller

Check the brake function with the TL CT or the TL HMI.

TL CT: Open the "Twin Line →Diagnosis →device data →Input_Output" window.

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

TLADOCC51ME, -001, 04.03

5.4.7 Setting and checking signal interface 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 or serious injury.

Parameters for inputs and outputs

The current switching states are displayed in bit-coded form - for the inputs in the parameters "I/O.IW0_act" and "I/O.IW1_act" and for the outputs in the parameters "I/O.QW0_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.

Inputs and outputs can be configured with fixed or in case there is a Fieldbus module, with free signal interface pin assignment. The "Settings.IO_mode" parameter allows the user to switch between settings, see page 6-1.

	Inputs				Outputs	
Bit	**I/O.IW0_act**	**I/O.IW1_act permanently assigned**	**I/O.IW1_act Fieldbus mode**	**I/O.IW1_act freely assignable**	**I/O.QW0_act permanently assigned**	**I/O.QW0_act Fieldbus mode/ freely assignable**
0	$\overline{\text{LIMP}}$	MAN_P	BAUD_1	I_0	AUTOM_ACK	Q_0
1	$\overline{\text{LIMN}}$	MAN_N	BAUD_2	I_1	AXIS_ADD_INFO	Q_1
2	$\overline{\text{STOP}}$	MAN_FAST	BAUD_4	I_2	AXIS_END	Q_2
3	$\overline{\text{REF}}$	ENABLE	MODE_1	I_3	AXIS_ERR	Q_3
4	-	AUTOM	MODE_2	I_4	RDY_TSO	Q_4
5	-	FAULT_RESET	I_5	I_5	ACTIVE_CON	ACTIVE_CON
6	-	CAPTURE2	I_6	I_6	TRIGGER	TRIGGER
7	-	TEACH_IN	ADR_64	I_7	-	-
8	-	DATA_1	ADR_1	I_8	-	-
9	-	DATA_2	ADR_2	I_9	-	-
10	-	DATA_4	ADR_4	I_10	-	-

TLADOCC51ME, -001, 04.03

	Inputs				Outputs	
Bit	**I/O.IW0_act**	**I/O.IW1_act permanently assigned**	**I/O.IW1_act Fieldbus mode**	**I/O.IW1_act freely assign-able**	**I/O.QW0_act permanently assigned**	**I/O.QW0_act Fieldbus mode/ freely assign-able**
11	-	DATA_8	ADR_8	I_11	-	-
12	-	DATA_16	ADR_16	I_12	-	-
13	-	DATA_32	ADR_32	I_13	-	-

TL CT: Displaying signal states

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

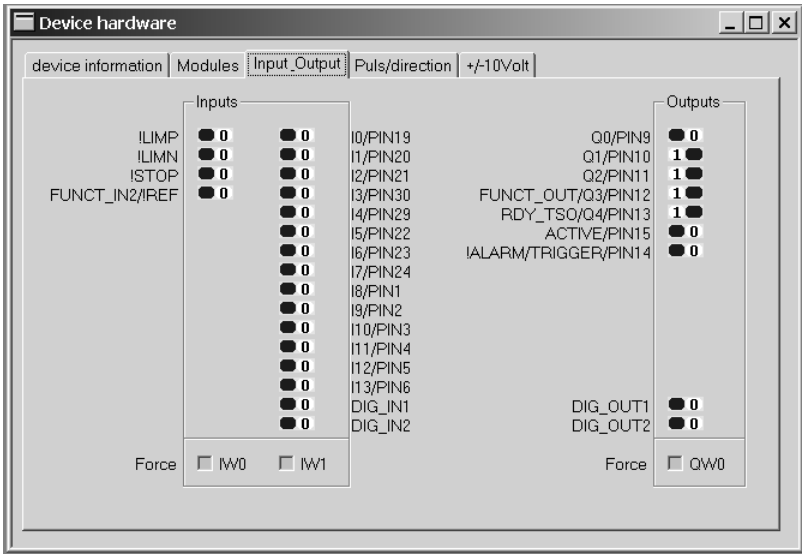

Fig. 5.8 Switching the inputs/outputs of the signal interface with the commissioning software

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

Details on displaying and changing signals with the commissioning software in the TL CT manual can be found in the chapter on diagnostic functions.

TL HMI: Displaying signal states

▶ Change to "2.4.1 IW0_act", "2.4.2 IW1_act" or "2.4.10 QW0_act".

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

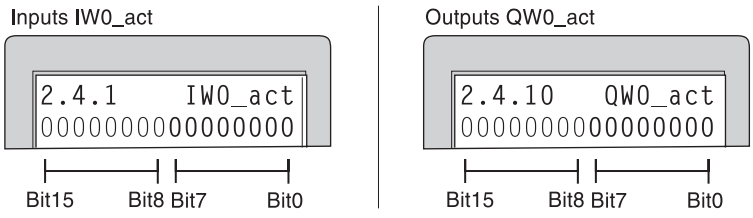

Fig. 5.9 Observing inputs/outputs of the signal interface with the HMI hand-held unit

The switching states of input and output signals cannot be changed with the HMI hand-held unit.

For detailed information on displaying signals with the HMI hand-held unit 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 by:

- TL HMI
- TL CT
- Fieldbus

TL CT: Displaying analog input

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

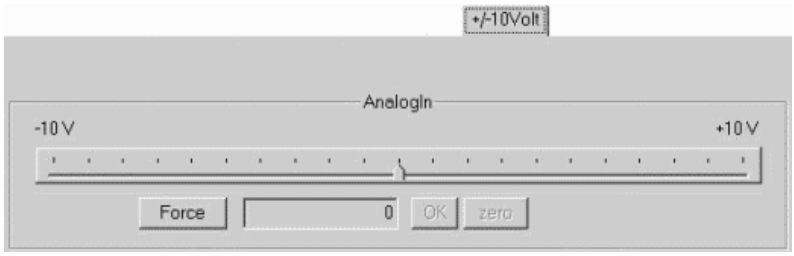

Fig. 5.10 Displaying and setting the analog input with the commissioning software

▶ Switch on the "Force" field to change the voltage of the analog input.

Details on displaying and changing signals with the commissioning software can be found in the TL CT manual in the chapter on diagnostic functions.

Fieldbus: Displaying analog input

▶ The analog input is read and set using the "Status.AnalogIn" parameter.

Parameter			Explanation and unit [ ]	Range of values	Default	R/W
Group.Name	**Idx:Sidx**	**TL-HMI**			**Value**	**rem.**
Status.AnalogIn	20:8	2.3.3.1	Analog input at input ANALOG_IN [mV]	INT16 -10000 ... +10000	0	R/- -

TLADOCC51ME, -001, 04.03

5.4.8 Validating controller direction of rotation or direction of movement

⚠WARNING

UNINTENDED EQUIPMENT ACTION

Improper direction of rotation of the motor is caused by wrong wiring or incorrect device parameter

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

- Verify that the motor phase connections are wired as illustrated in sections 4.4.3 and 4.4.5 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 5.4.3 for a table listing the speed and current limit parameters.
- When initially validating the direction of rotation 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 or serious injury.

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 Bit 0 to 1, the resulting motion will cause a clockwise direction of rotation of the motor.

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.

TLADOCC51ME, -001, 04.03

The controller is supplied with a parameter preset so its operation can be tested with a manual movement.

Operating options

Test mode with manual movement can be run with the TL CT commissioning software, the HMI hand-held unit or the signal interface.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Settings.IO_mode	29:31	4.1.4	Significance of I/O signal assignment	UINT16 0..2 0: Setting the Fieldbus parameters via inputs 1: I/O freely available 2: I/O assigned functions	0	R/W rem.

If the end switches or stop switches are not connected, the signals $\overline{\text{LIMP}}$, $\overline{\text{LIMN}}$ or $\overline{\text{STOP}}$ must be set to +24 V.

Manual movement with TL HMI

- ▶ Start the manual movement with the HMI hand-held unit with "3.2.11 Start" in the menu. The direction of movement is set with the cursor keys.
- ▶ Check the direction of rotation: The motor shaft must rotate clockwise when the right-hand button is pressed.

For details on manual movement with the HMI hand-held unit see the TL HMI manual.

Manual movement with TL CT

- ▶ Enable the power amplifier with "Twin Line → Switch on power amplifier".
- ▶ Open the "Positioning" dialog box with "Twin Line → Positioning" and start the manual movement from the "Manual" tab.
- ▶ Check the direction of rotation: the motor shaft must rotate clockwise when one of the "Motor clockwise rotating" buttons is pressed.

For details on manual movement with the commissioning software see the TL HMI manual.

TLADOCC51ME, -001, 04.03

Manual movement via the signal interface

If a Fieldbus module is installed, the "Settings.IO_mode" parameter must be set to 2 for manual movement via the signal interface. The following signals must be switched.

I/O signal	Function	Value
MAN_N	Stop motor Movement in counter-clockwise direction	low/open high
MAN_P	Stop motor Movement in clockwise direction	low/open high
$\overline{\text{STOP}}$ 1)	Stop motor with Quick-Stop Mode release	low high/open
AUTOM	Manual mode Automatic mode	low/open high
ENABLE	Power amplifier switched off Power amplifier released	low/open high

1) Signal level for default setting of "Settings.SignEnabl" and "Settings.SignLevel"

- ▶ Switch on manual mode: Deactivate AUTOM input signal.
- ▶ Switch on power amplifier: Enable ENABLE input signal.
- ▶ Rotate motor shaft clockwise: Enable MAN_P input signal.

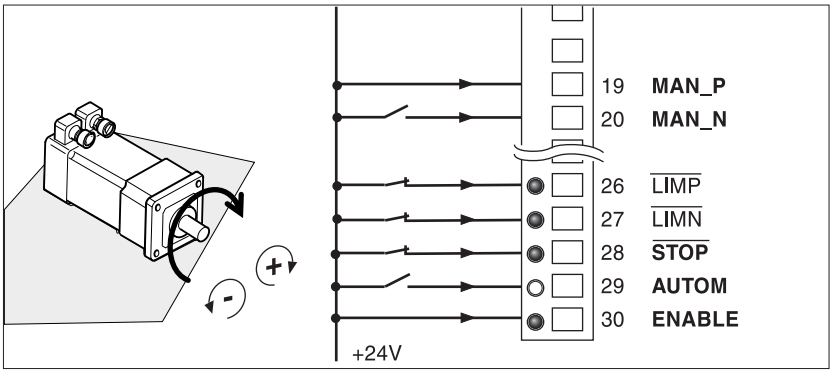

Fig. 5.11 Check the motor's direction of rotation

If the MAN_FAST signal is connected, you can switch between fast and slow movement mode.

For manual movement the preset movement parameters for slow and fast motor speed ad for maximum motor current can be changed; see page 6-25.

TLADOCC51ME, -001, 04.03

5.4.9 Optimizing the controller

The controller provides as default a ramp function with linear acceleration and deceleration ramps. In addition, the ramp shape can be further optimized by values of the torque characteristic of the motor.

Setting the linear ramp function

The linear ramp is optimized in three steps.

- Estimating the slope for the acceleration and deceleration.
- Setting start-stop speed.
- Selecting setpoint speed.

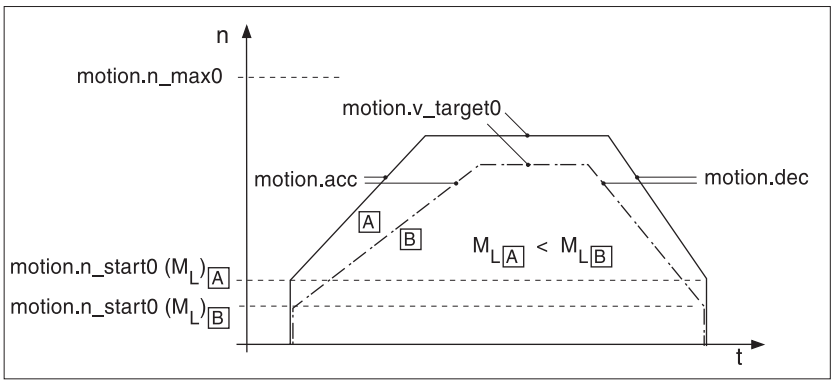

Fig. 5.12 Linear ramp settings with variable load M_L

Setting the slope of the ramps

The slopes of the ramp function are entered in the "Motion.acc" and "Motion.dec" parameters. The values can be estimated with the following formulas.

- $\alpha = (M_M - M_L) / J_{Ges}$
- Motion.acc $\leq 30 * \alpha / \pi$
  Motion.dec $\leq 30 * \alpha / \pi$

Characteristic value	Meaning	Unit
M_M	Available motor torque	Nm
M_L	External load torque	Nm
J_{Ges}	External moment of inertia	kgm^2
α	Angular acceleration	rad/sec^2
Motion.acc	Acceleration parameters	[rev/(min*s)]
Motion.dec	Deceleration parameters	[rev/(min*s)]

TLADOCC51ME, -001, 04.03

Start-stop speed

A special property of stepper motors is the extremely fast acceleration from standstill, which can be set as start-stop speed with the "Motion.n_start0" parameter.

The start-stop speed can be set at up to 60 rpm depending on external load, but should be at least 12 rpm. A lower speed value set too low may cause mechanical resonances in the stepper motor at low, external damping.

Too high a value for the start-stop speed can be recognized by the fact that only reduced ramp values for acceleration and deceleration can be set.

Setpoint speed

The motor setpoint speed depends on the application requirements. It is set with the "Motion.v_target0" parameter and is limited by the maximum speed of the motor "Motion.n_max0".

Torque characteristic of the motor

The available torque of the stepper motor, apart from its size and the type of electrical control, primarily depends on the speed. The interdependence of speed and torque is shown as a typical characteristic of a stepper motor in motor data sheets.

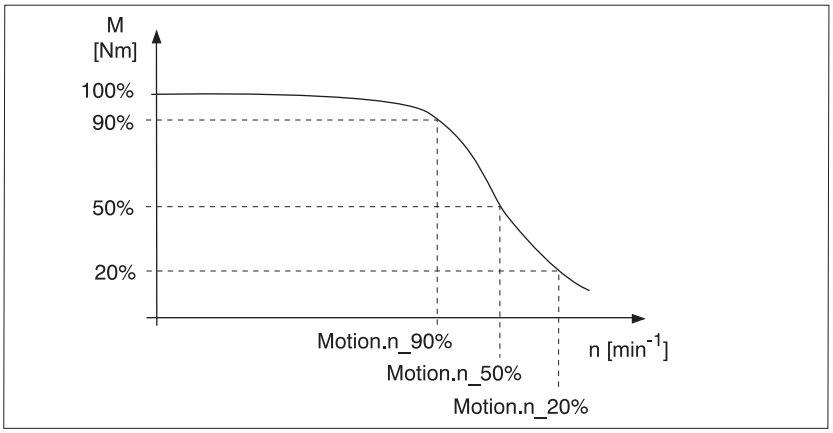

Fig. 5.13 Typical torque characteristic of a stepper motor

In the higher speed range the available torque decreases greatly with increasing speed. The available acceleration is also correspondingly reduced. In addition to the acceleration values of the ramp, there are three interpolation points for optimized operation.

Entering 90%, 50%, 20% interpolation points

Take the speed values at which 90%, 50% and 20% of the maximum torque are available from the table depending on the motor type and enter the values at the parameters "Motion.n_90%", "Motion.n_50%" and "Motion.n_20%". The speed settings can only be made in operating modes 1 to 4 and 8 to 9.

	VRDM368	VRDM397	VRDM3910	VRDM3913	VRDM31117	VRDM31122
Motion.n_90%	420	660	600	480	360	360
Motion.n_50%	1260	1620	1260	1020	720	690
Motion.n_20%	2580	2940	2400	1860	1800	1380

The default values of motor type VRDM31122 are used below.

Parameter			**Explanation and unit [ ]**	**Range of values**	**Default**	**R/W**
Name	**Idx:Sidx**	**TL-HMI**			**Value**	**rem.**
Motion.n_90%	14:15	4.4.30	Motor speed with 90% of standstill torque [rpm]	UINT16 1..3000	360	R/W rem.
Motion.n_50%	14:16	4.4.31	Motor speed with 50% of standstill torque [rpm]	UINT16 1..3000	690	R/W rem.
Motion.n_20%	14:27	4.4.32	Motor speed with 20% of standstill torque [rpm]	UINT16 1..3000	1380	R/W rem.
Motion.n_max0	29:21	4.4.28	Speed limit for travel profile [rpm]	UINT32 1..3000	3000	R/W rem.
Motion.n_start0	29:22	4.4.10	Start-stop speed [rpm]	UINT32 1..n_max0 0..3000	12	R/W rem.
Motion.v_target0	29:23	4.4.11	Setpoint speed [usr]	UINT32 1..n_max0 1..2147483647	60	R/W rem.
Motion.acc_type	29:25	4.4.13	Shape of acceleration curve	UINT16 1..2 1: linear 2: exponential	1	R/W rem.
Motion.acc	29:26	4.4.14	Acceleration [usr]	UINT32 1 .. 2 147 483 647	600	R/W rem.
Motion.dec	29:27	4.4.15	Deceleration [usr]	UINT32 1 .. 2 147 483 647	600	R/W rem.

TLADOCC51ME, -001, 04.03

6 Operating modes of the controller

This chapter contains a description of the features of the drive controller. 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 TL HMI (document TLADOCH-MIME).
- For communication cards, refer to each card's operating manual.
- For commissioning software, refer to manual TL CT (document TLADOCTLCTE).

Parameter Name	**Idx:Sidx**	**TL-HMI Address**	**Explanation and unit [ ]**	**Range of values**	**Default Value**	**R/W rem**
Commands.OnlAuto	29:30	–	Access to the mode setting	UINT16 0: access via all access channels 1: access only via the channel that has set this parameter	0	R/W –
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

TLADOCC51ME, -001, 04.03

⚠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 or serious injury.

TLADOCC51ME, -001, 04.03

6.1 Operating modes and access

The controller has six operating 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.

	Access channels			
Operating modes and functions [1)]	**TL HMI**	**TL CT**	**I/O of signal interface**	**Fieldbus Slave**
Manual mode	•	•	•	•
Point-to-point mode	•	•	–	•
Speed mode	•	•	–	•
Electronic gear	•	•	–	•
Referencing	•	•	–	•
Oscillator mode	–	•	–	•

1) •: access possible, –: no access

6.1.1 Operating modes

Operating modes

The controller functions in six operating modes:

- Manual movement mode
- Automatic point-to-point mode
- Automatic speed mode
- Automatic electronic gear (if a module is installed in slot M1)
- Automatic referencing mode
- Automatic oscillator mode

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.

6.1.2 Access channels

Local and remote access

Data exchange and control of Twin Line devices can be carried out through various access channels:

- Locally, via the RS-232 interface using the HMI hand-held control unit and the TL CT commissioning software.
- Remotely, via Fieldbus commands.
- Remotely, via the I/O signals.

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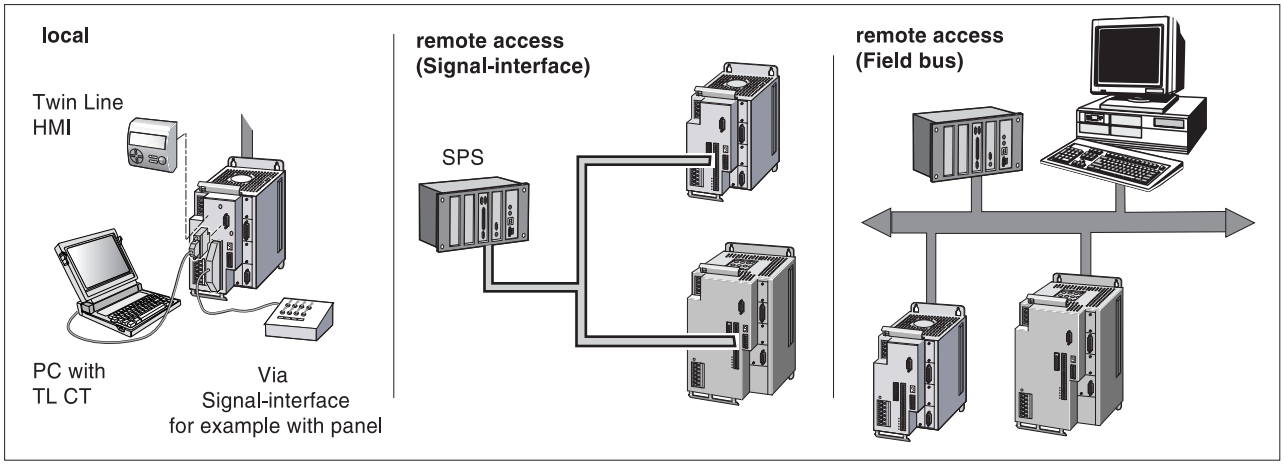

Fig. 6.1 Local and remote access to Twin Line units

Automatic access security

If an operating mode is set through an access channel, any active commands using this channel must be completed before another access channel can change the mode. One exception exists for the Stop command. The Stop command is always active and may be entered from any interface.

Channel access to the Twin Line device can be enabled and disabled using the 'Commands.OnlAuto' parameter.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Commands.OnlAuto	29:30	–	Access to the mode setting	UINT16 0: Access via all channels 1: Access only via the channel that has set this parameter	0	R/W –

If this parameter has been set to “1”, access via other channels is not available until the channel that has set the parameter resets it to “0”, or the access port is interrupted (for example, using Fieldbus mode).

6.1.3 Access control for selecting operating mode or function

Access channels are enabled and operating modes selected using the "Settings.IO_mode" parameter.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Settings.IO_mode	29:31	4.1.4	Sets the functions available on connector pins S1 through S34. See the table in section 4.4.8 for additional information.	UINT16 0: Sets Fieldbus parameters via I/O assignment 1: I/O freely available. Functions are user definable. 2: I/O assigned with function	0	R/W rem.

IO_mode=0 or 1

Connector pins S1 through S34 can be used to assign Fieldbus configuration settings if 'Settings.IO_mode'= 0. These pins are available for I/O if 'Settings.IO_mode'= 1. In both cases, the HMI hand-held control unit, TLCT commissioning software, and Fieldbus have equal priority in initiating operating modes.

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IO_mode=2 If the parameter is "Settings.IO_mode"=2, the signal interface inputs and outputs have a fixed assignment. Operating modes and functions can be started locally depending on the AUTOM input signal or via the Fieldbus.

- AUTOM=0, low level: locally with the HMI hand-held unit, TL CT commissioning software or signal interface
- AUTOM=1, high level: via Fieldbus

The following table shows the operating modes and functions available depending on the status of the AUTOM signal.

	Access channels			
Operating modes and functions [1]	**TL HMI**	**TL CT**	**I/O of signal interface**	**Fieldbus**
Manual mode	0	0	0	1
Point-to-point mode	0	0	–	1
Speed mode	0	0	–	1
Electronic gear	0	0	–	1
Referencing	0	0	–	1
Oscillator mode	–	0	–	1

1) •: access possible, –: no access

If the AUTOM signal changes, the new operating mode is activated after completion of the current process. The controller confirms the change with the AUTOM_ACK output signal.

I/O signal	Function	Value
AUTOM	Local operating mode selection on Operation via Fieldbus on	low/open high
AUTOM_ACK	Local operating mode selection enabled Operation via Fieldbus enabled	low high

6.1.4 Selecting the operating mode

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

- Commands entered in this register may be executed immediately upon receipt by the drive controller.
- Before sending any commands, ensure that the machine is clear and ready for motion.

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

Operating modes in the Twin Line controller are set by means of movement commands. The HMI hand-held operating unit and the commissioning software offer movement commands as menu items and dialog boxes. In Fieldbus operation, movement commands are given via parameters.

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Operation can be switched between manual mode and automatic mode, which can be set via parameters, via the signal interface. This requires fixed assignment of the signal interface.

The current operating mode can be monitored by means of the bits in the 'Status.xMode_act' register.

Example of PTP operation

The register for initiating the PTP operating mode with absolute positioning is:

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
PTP.p_absPTP	35:1	3.1.1.1	Begins absolute positioning mode when values are transmitted to this register.	INT32 -2147483648...2147483647	0	R/W –

PTP operating mode can be initiated using the HMI hand-held control unit by selecting menu option '3.1.1.1 p_absPTP.'

In Fieldbus mode, the index and subindex are used for starting the operating mode. The command for PTP positioning with a 324 mm position value is:

Sending/receiving data	Comments	
command 04 01 00 23. 00 00 01 44h	04: 01 00 23h: 01 44h:	sf=0, recording access Subindex 1: Index 35 324 mm
acknowledgement 00 23 00 06 . 00 00 00 00h	23h: 00 06h:	ref_ok=1, PTP operation motion_end=0, amplifier on

Operating mode changes may be monitored by means of status information that is sent back as an acknowledgement.

In the commissioning software, the 'Position' dialog box is opened from the 'Twin Line → Position' menu. Settings can be entered into the dialog box, and the operating mode initiated using the 'PTP' register.

TLADOCC51ME, -001, 04.03

6.1.5 Monitoring the set operating mode

The set operating mode can be monitored by status parameters or signal interface outputs.

Status Parameter

The controller has a global and a mode-specific status parameter for monitoring operations.

The status parameter "Status.driveStat" supplies global information on the unit's operating status and the processing status.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Status.driveStat	28:2	2.3.5.1	Status word for the operating status	UINT32 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 fault (FltSig) Bit6=1: External monitoring fault (FltSig_SR) Bit7=1: Warning Bit13: x_add_info Bit14: x_end Bit15: x_err Bit16-20: Current operating mode (Bit0-4: Status.xMode_act) Bit21: Drive is references (ref_ok) Bit22: 0	–	R/–;–

Global status bits

The status bits (Bit13 - Bit15) in the status parameter are taken unchanged from the status bits of operating mode specific status parameters: The global status bits have the same significance as the status bits of the individual mode:

Status bit	Function	Value
Bit13: x_add_info	Additional information depending on operating mode	Low/High
Bit14: x_end	Process running Process finished, motor stopped	Low High
Bit15: x_err	Fault-free operation Fault has occurred	Low High

TLADOCC51ME, -001, 04.03

Mode-specific status parameters

Every operating mode has its own status parameter, which contains information on the processing status in bits 13 to 15.

For example, the following applies for PTP operation:

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
PTP.statePTP	35:2	3.2.14	Acknowledgement: PTP positioning	UINT16 0..65535 Bit0: error LIMP Bit1: error LIMN Bit2: error HW_STOP Bit3: error REF Bit5: error SW_LIMP Bit6: error SW_LIMN Bit7: error SW_STOP Bit13: set position reached Bit14: motion_end Bit15: motion_err	–	R/– –

Status via I/O signals

The operating states via the signal interface can be evaluated if the interface assignment is fixed.

I/O signal	Function	Value
AXIS_ADD_INFO	Additional information depending on operating mode	low/high
AXIS_END	Process running Process finished, motor stopped	low high
AXIS_ERR	Fault-free operation Fault has occurred	low high

As soon as an operating mode has been set and the process initiated, bit14 changes to "0". When the process is finished, bit14 changes back to "1" thereby indicating that further process steps can now be executed.

Bit14 signal change to "1" is suppressed if one process is followed immediately by a new process in a different operating mode.

If bit15 shows "1", a fault has occurred and must be corrected before processing continues. The controller reacts according to one of the fault categories depending on the seriousness of the fault, see chapter "Diagnosis and error rectification", page 8-1.

TLADOCC51ME, -001, 04.03

6.1.6 Status monitoring in movement mode

Status parameters

In movement mode the controller can be monitored with the parameters in the Status parameter set. The parameters are read only.

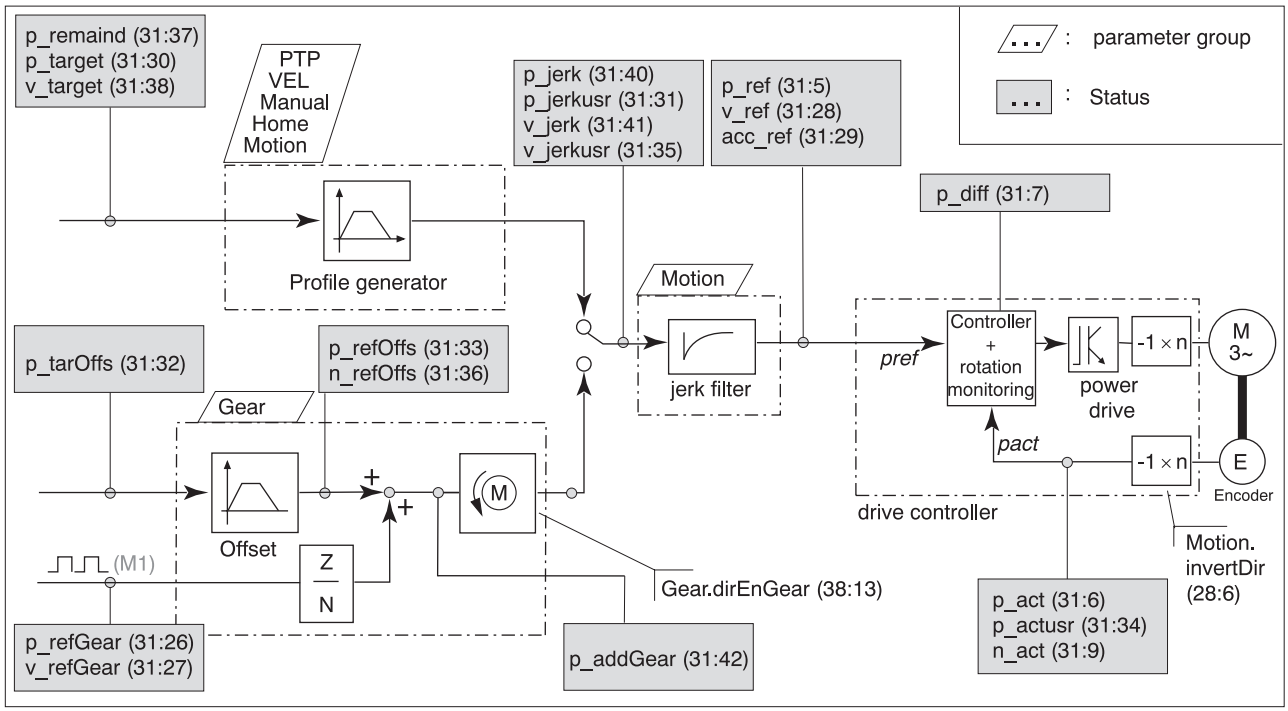

Fig. 6.2 Monitoring movement mode with status parameters

Oscillator mode is not shown in the diagram for the sake of clarity. For more information see chapter "Oscillator mode".

Parameter sets

Operating modes are set via parameters in parameter groups specific to that mode:

- PTP group: settings for Point-to-Point mode
- VEL group: settings for speed mode
- Gear group: settings for electronic gear mode with superimposed offset
- Motion group: parameter settings for all modes: jerk filter, direction of rotation, software limit switches, standardization and ramp settings

Setting options for manual mode are in the "Manual" parameter group, and those for homing are in the "Home" group. A list of all parameter groups can be found in the chapter entitled "Parameters", page 12-1.

Profile generator

Target position and final speed are input values to be entered by the user. The profile generator uses these values to calculate a motion profile dependent on the selected operating mode. The output values from the profile generator and an upstream jerk filter are converted into motor movements by the drive controller. Information on the jerk filter can be found in chapter "Ramp function" from page 7-19.

In the electronic gear operating mode, positioning values are calculated from the input pulses fed in via a module in the M1 slot. An additional positioning offset can be superimposed by entering an offset position. The offset position is processed via the profile generator.

TLADOCC51ME, -001, 04.03

6.2 Manual movement

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

- Commands entered in this register may be executed immediately upon receipt by the drive controller.
- Before sending any commands, ensure that the machine is clear and ready for motion.

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

Overview

Manual movement can be carried out in two modes: Mode One or Mode Two. In Mode One, the motor moves over a fixed distance in response to a user input transition. If the user input is maintained, the drive controller switches to continuous movement. In Mode Two, the motor begins in the same way as Mode One by moving over a fixed distance in response to a user input transition. Mode Two differs from Mode One because, if the start signal is removed before the destination has been reached, the controller will stop the motor immediately.

Manual mode can be executed by

- HMI hand-held operating unit
- Commissioning software
- Fieldbus
- Signal interface inputs when the signal interface is permanently assigned.

Operation with commissioning software or the HMI hand-held operating unit

The commissioning software and the HMI hand-held operating unit support this operating mode with special dialog boxes and menu items. Details on this can be found in the manuals for the commissioning software and the HMI hand-held operating unit.

Initiating manual operation

The initiating conditions for a manual movement depend on the settings of the signal interface assignments. The setting is changed with the "Settings.IO_mode" parameter, please refer to page 6-4.

- Free assignment, parameter value "Settings.IO_mode"=0 or 1: The controller switches to manual movement as soon as the movement is initiated by a control unit or the "Manual.startMan" parameter over the Fieldbus. A manual movement via the signal interface is not possible with free assignment of the interface.
- Fixed assignment, parameter value "Settings.IO_mode"=2:
  With input signal AUTOM = 0 manual mode can be started via the interface inputs or with an operating unit as soon as the AUTOM_ACK output changes to Low level. If the input signal displays AUTOM = 1, the manual movement can be started with the parameter "Manual.startMan" over the Fieldbus as soon as AUTOM_ACK references high level.

The motor can be moved in both directions with two speeds via the input signals MAN_P, MAN_N and MAN_FAST only with fixed assignment.

Manual movement is initiated by means of the “Manual.startMan” register. The current axis position is the start position for the manual move-

TLADOCC51ME, -001, 04.03

ment. Values for programmable position and speed settings are entered in user-defined units.

Manual movement is finished when the motor has stopped and

- in Mode One, the direction signal is inactive
- in Mode Two, the fixed distance has been covered,
- or the operating mode has been interrupted by a fault response.

The “Manual.statusMan” register gives information on the status of the operation.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Manual.startMan	41:1	3.2.1	Start of manual movement with transfer of control bits	UINT16 Bit 0: pos. sense of rotation Bit 1: neg. sense of rotation Bit 2: 0:slow 1:fast	–	R/W –
Manual.statusMan	41:2	–	Acknowledgement: manual movement	UINT16 Bit 0: Error LIMP Bit 1: Error LIMN Bit 2: Error HW_STOP Bit 3: Error REF Bit 5: Error SW_LIMP Bit 6: Error SW_LIMN Bit 7: Error SW_STOP Bit 14: manu_end Bit 15: manu_err	–	R/– –

Manual movement enabled and started via the interface signals:

I/O signal	Function	Value
I: AUTOM	Switching to Manual operating mode Switching to Automatic operating mode	low/open high
O: AUTOM_ACK	Manual mode possible Manual mode not possible	low/open high
I: MAN_N	Traverse in counter-clockwise direction of rotation	high
I: MAN_P	Traverse in clockwise direction of rotation	high
I: MAN_FAST	Slow speed Fast speed	low/open high

Selecting manual movement mode

Manual movement can be carried out in two processing modes:

- Mode One
- Mode Two

TLADOCC51ME, -001, 04.03

The operating mode can be changed by means of the "Manual.typeMan" parameter.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Manual.typeMan	41:3	3.2.2	Type of manual movement	UINT16 0..1 0: Mode One 1: Mode Two	0	R/W rem.

Mode One via Fieldbus

On receiving the start signal for manual movement, the motor first travels along a defined path, "Manual.step_Man". If the start signal is still present after a certain delay, "Manual.time_Man", the controller changes to continuous movement until the start signal is cancelled.
Bit 2 is used to set the speed (0 = slow, 1 = fast). Using bit 0 or 1 with bit 2 will set direction and speed. For example bit 0 low and bit 2 high will set a positive direction and fast speed.

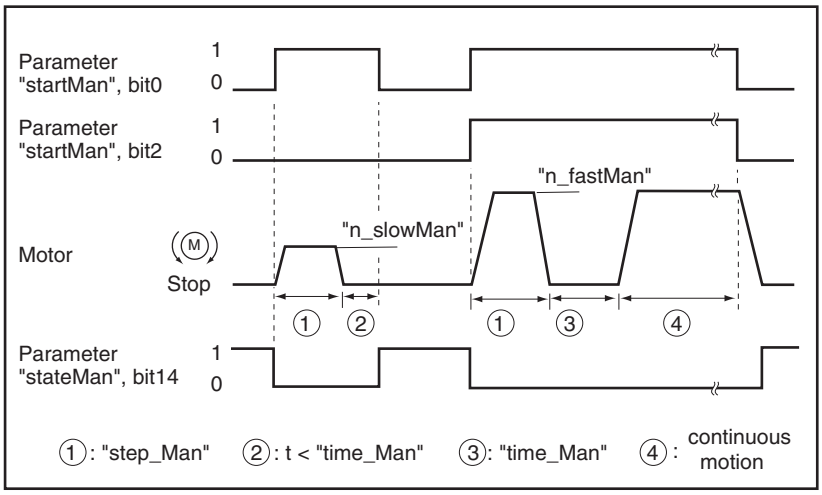

Fig. 6.3 Mode One movement, slow and fast

Parameters in Mode One

The fixed distance, delay and manual movement speed can be set. If the fixed distance is zero, manual movement starts directly with continuous movement, irrespective of the delay.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Manual.n_slowMan	41:4	3.2.3	Speed for slow manual travel [usr]	UINT32 1...2147483647	60	R/W rem
Manual.n_fastMan	41:5	3.2.4	Speed for fast manual travel [usr]	UINT32 1...2147483647	180	R/W rem
Manual.step_Man	41:7	3.2.6	Fixed distance travel, defined travel on manual travel start [usr]	UINT16 0..65535	20	R/W rem
Manual.time_Man	41:8	3.2.7	Mode One waiting time [ms]	UINT16 1..30000	500	R/W rem

Mode Two via Fieldbus

With every start signal for manual movement, the motor moves a defined distance. If the start signal is removed before the destination has been reached the controller will stop the motor immediately.

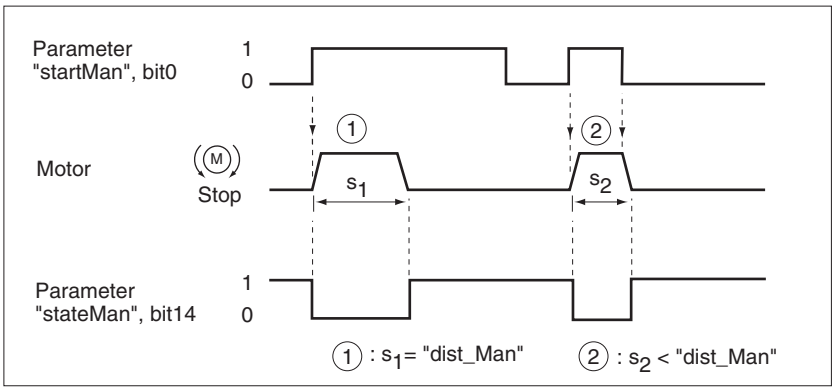

Fig. 6.4 Mode Two manual movement using Fieldbus

Parameters in Mode Two

The distance to be covered and manual movement speed can be set.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Manual.n_slowMan	41:4	3.2.3	Speed for slow manual travel [usr]	UINT32 1...2147483647	60	R/W rem
Manual.n_fastMan	41:5	3.2.4	Speed for fast manual travel [usr]	UINT32 1...2147483647	180	R/W rem
Manual.dist_Man	41:6	3.2.5	Fixed distance travel, defined travel per jog cycle on travel-limited fixed distance [usr]	UINT16 1..65535	20	R/W rem.

Settings

Additional manual operation settings and functions are described in the following sections:

- Acceleration and delay behavior can be changed using the 'ramp function', and 'quick stop' functions.
- Position-dependent speed or signal changes can be found in the “List control and list data processing” section.
- Adapting user-defined and internal units is described in the 'normalising' section.
- Unit and movement supervision is set using the 'monitoring functions' sections.

TLADOCC51ME, -001, 04.03

Example A simple, partially automated movement mode can be set up by controlling the signals for manual movement with a manually operated switch and cam switches.

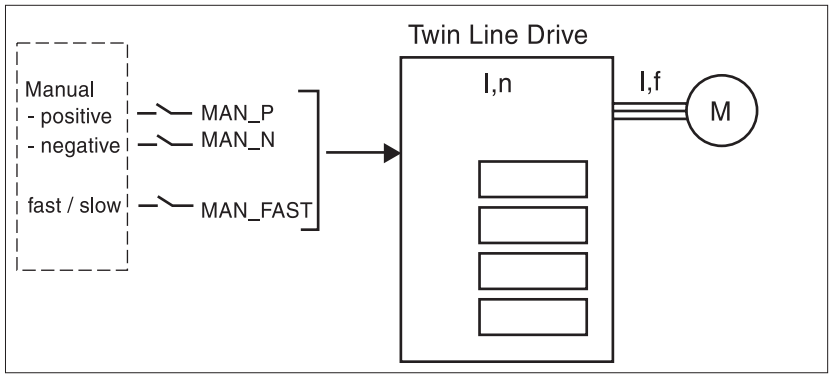

Fig. 6.5 Manual mode using input and output signals

6.3 Speed mode

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

- Commands entered in this register may be executed immediately upon receipt by the drive controller.
- Before sending any commands, ensure that the machine is clear and ready for motion.

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

In speed mode a setpoint speed is specified for the motor, and movement is initiated with no defined finishing point. The motor moves at this speed until a different speed is set or the operating mode is terminated.

Speed mode can be carried out by:

- HMI hand-held operating unit
- The commissioning software
- Fieldbus

Operation with commissioning software or the HMI hand-held operating unit

The commissioning software and the HMI hand-held operating unit support this operating mode with special dialog boxes and menu items. Details on this can be found in the manuals for the commissioning software and the HMI hand-held operating unit.

Initiating speed mode

As soon as a speed value is sent to the controller with the "VEL.velocity" parameter, the unit changes to speed mode and accelerates up to the set speed.

Processing in speed mode is completed when the set speed and actual speed are zero or when the operating mode is interrupted by a fault response. The parameter "VEL.stateVEL" shows information on the processing status.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
VEL.velocity	36:1	3.1.2.1	Start of speed change with transfer of setpoint speed [usr]	INT32 -2147483648..2147483647	–	R/W –
VEL.stateVEL	36:2	–	Acknowledgement: Speed profile mode	UINT16 0..65535 Bit0: error LIMP Bit1: error LIMN Bit2: error HW_STOP Bit3: error REF Bit5: error SW_LIMP Bit6: error SW_LIMN Bit7: error SW_STOP Bit13: setpoint speed reached Bit14: vel_end Bit15: vel_err	–	R/– –

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Settings

The set speed is transmitted in user-defined units and can be changed while the motor is in motion. Speed mode is not limited by the positioning range limits.

New ramp settings are transmitted when a speed value is sent with the "VEL.velocity" parameter.

Additional settings and functions for speed mode are described in the following sections:

- Acceleration and delay behavior can be changed using "ramp function" and "quick stop function".
- Position-dependent speed or signal changes can be found in the "list control and list data processing" sections.
- Adapting user-defined and internal units are described in the "normalization" section.
- Unit and movement supervision is set using the "monitoring functions" sections.

TLADOCC51ME, -001, 04.03

6.4 Point-to-point mode

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

- Commands entered in this register may be executed immediately upon receipt by the drive controller.
- Before sending any commands, ensure that the machine is clear and ready for motion.

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

Point-to-point mode (PTP mode, PTP: Point to Point) positions the motor from a point A to a point B with a positioning command. The positioning distance is given in absolute terms with reference to the zero point of the axis or in relative terms with reference to the current axis position.

Before absolute positioning can be carried out, the reference point must be defined by a referencing process.

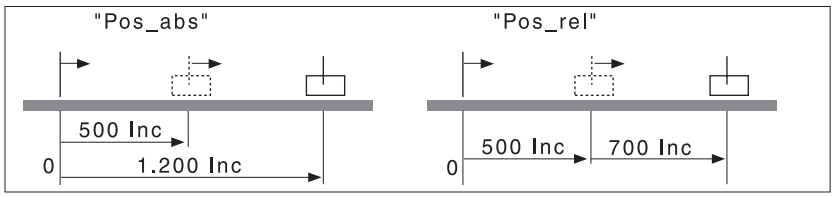

Fig. 6.6 Point-to-point positioning, absolute and relative

PTP mode can be executed by:

- HMI hand-held operating unit
- Commissioning software
- Fieldbus

Operation with commissioning software or the HMI hand-held operating unit

The commissioning software and the HMI hand-held operating unit support this operating mode with special dialog boxes and menu items. Details on this can be found in the manuals for the commissioning software and the HMI hand-held operating unit.

Initiating PTP mode

As soon as the positioning value is transmitted in the "PTP.p_absPTP" or "PTP.p_relPTP" parameters, the controller changes to PTP mode and starts the positioning process at the set speed stored in the "PTP.v_target" parameter.

The positioning process is finished when the target position has been reached and the motor has stopped, or when the operating mode is interrupted by a fault response. The "PTP.StatePTP" parameter shows information on the status of the process.

If a mode other than PTP mode is active, relative positioning may only be initiated when the motor is at standstill.

TLADOCC51ME, -001, 04.03

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
PTP.p_absPTP	35:1	3.1.1.1	Start of absolute positioning with transfer of absolute target position value [usr]	INT32 -2147483648..2147483647	–	R/W –
PTP.statePTP	35:2	3.2.14	Acknowledgement: PTP positioning	UINT16 0..65535 Bit0: error LIMP Bit1: error LIMN Bit2: error HW_STOP Bit3: error REF Bit5: error SW_LIMP Bit6: error SW_LIMN Bit7: error SW_STOP Bit13: Set position reached Bit14: motion_end Bit15: motion_err	–	R/– –
PTP.p_relPTP	35:3	3.1.1.2	Start of relative positioning with transfer of the value for the distance [usr]	INT32 -2147483648..2147483647	0	R/W –
PTP.continue	35:4	3.1.1.3	Continuation of interrupted positioning with transfer of any value	UINT16 0..65535 value is not relevant for positioning	–	R/W –
PTP.v_tarPTP	35:5	3.1.1.5	Setpoint speed of PTP positioning [usr]	INT32 1....2147483647	Motion. v_target 0	R/W –

Continuing PTP operation

If a positioning process is interrupted, e.g. by an external stop signal, processing can be continued and completed by writing to the "PTP.continue" parameter. The cause of the interruption must first be deactivated.

The value transmitted via "PTP.continue" is not analyzed.

Settings for PTP operation

Position and speed values are given in user units. If one of the values changes, the controller responds immediately.

New ramp settings are accepted when the motor starts with a new predefined position.

Additional settings and functions for PTP operation are described in the following sections:

- Acceleration and delay behavior can be changed using "ramp function" and "quick stop function".
- Position-dependent speed or signal changes can be found in the "list control and list data processing" sections.
- Adapting user-defined and internal units are described in the "normalization" section.
- Creating list data with the "Teach mode processing".
- Unit and movement supervision is set using the "monitoring functions" sections.

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6.5 Electronic gear

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

- Commands entered in this register may be executed immediately upon receipt by the drive controller.
- Before sending any commands, ensure that the machine is clear and ready for motion.

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

In electronic gear mode, the controller calculates a new position setpoint for the motor to move to from a predefined position and an adjustable gear factor. This mode is used when one or more motors is to follow the reference signal from a NC control unit or an encoder.

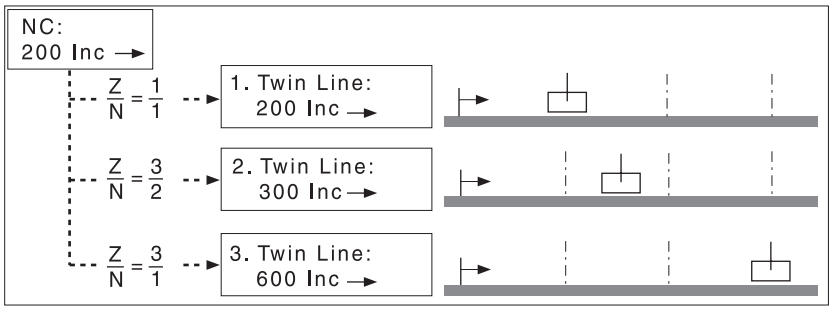

Fig. 6.7 Electronic gear with three Twin Line controllers, gear ratio adjustable via gear factor (Z, N)

A PTP offset movement can be superimposed on the positioning process, and this can be used to alter the position setpoint.

To work in electronic gear mode, the RS422-C encoder module or the PULSE-C pulse/direction module must be inserted in slot M1. Different types of signal can be fed depending on the module:

- A/B signals with four-way evaluation of sensor signals with the RS422-C module
- Pulse/direction signal or $pulse_{forward}$/$pulse_{backward}$ signals with the PULSE-C module.

Electronic gear mode can be executed by:

- HMI hand-held operating unit
- Commissioning software
- Fieldbus

Operation with commissioning software or the HMI hand-held operating unit

The commissioning software and the HMI hand-held operating unit support this operating mode with special dialog boxes and menu items. For additional detail, please refer to the commissioning software and the HMI control unit manuals.

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Initiating electronic gear

This mode is activated with the "Gear.startGear" parameter. If reference pulses are fed in, the controller offsets them against the gear factor and positions the motor at the new setpoint.

Position values are given in internal increments. The controller reacts to any change in the values immediately. Electronic gear mode is not limited by the positioning area boundaries.

The process is finished when gear processing has been deactivated and the motor stationary, or if the mode was interrupted. If the controller switches from the operating status "6 Operation enable" to a different status, gear processing is automatically deactivated, e.g. if the motor is stopped by Quick Stop. The "Gear.stateGear" parameter shows information on the processing status.

Synchronization

In electronic gear mode the controller operates synchronously in a coupled gear arrangement, e.g. with other drives. If the controller switches from gear processing for a short time, it loses synchronization with the other drives. When gear processing is restarted, the drive has two ways of re-establishing synchronization.

- Immediate synchronization: The controller follows reference pulses from the moment when gear processing is activated. Reference pulses, offset entries and position changes that have occurred before the mode started are not taken into consideration.
- Synchronization with compensating motion: when gear processing is activated, the drive makes a compensatory movement in an attempt to reach the position which it would have gone to if no interruption had taken place.

  There are various conditions attached to synchronization with compensatory movement. For more information on this subject see "Synchronization with compensating movement", page 6-26.

The type of synchronization required is set by the "Gear.startGear" parameter, which also initiates the mode.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Gear.startGear	38:1	3.1.3.1	Starting an electronic gear process with selection of the processing mode	UINT16 0..2 0: disabled 1: immediate synchronization 2: synchronization with compensatory movement	–	R/W –
Gear.stateGear	38:2	–	Acknowledgement: gear processing	UINT16 0..65535 Bit0: error LIMP Bit1: error LIMN Bit2: error HW_STOP Bit3: error REF Bit5: error SW_LIMP Bit6: error SW_LIMN Bit7: error SW_STOP Bit13: - Bit14: gear_end Bit15: gear_err	–	R/– –

6.5.1 Gear settings

Overview Regardless of the type of synchronization, electronic gear mode uses the following adjustments:

- Gear ratio
- Maximum acceleration and deceleration
- Maximum speed
- PTP offset value
- Direction of rotation enable /disable
- Filter for reference encoder speed

Gear ratio The gear ratio is the relationship between externally supplied reference pulses and output pulses for motor movement. The gear ratio is defined by means of numerator and denominator registers. A negative numerator value reverses the motor's sense of rotation. The gear ratio is preset to 1:1.

$$\text{Gear ratio} = \frac{\text{Motor increments}}{\text{Reference increments}} = \frac{\text{Gear ratio numerator}}{\text{Gear ratio denominator}}$$

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.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Gear.numGear	38:7	3.1.3.2	Gear ratio numerator	INT32 -2147483648..2147483647	1	R/W –
Gear.denGear	38:8	–	Gear ratio denominator	INT32 1..2147483647	1	R/W –

The resulting positioning path depends on the current motor resolution; this is 19200 pulses per revolution with stepper motor units.

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Acceleration/deceleration

The maximum values for acceleration and deceleration are set with "Gear.a_maxGear". In the case of active gear the drive always decelerates with this value with a Quick-Stop and with errors of error class 1 or 2. The settings in "Settings.SignQstop" do not influence the deceleration behavior with active gear.

Parameter			Explanation and unit [ ]	Range of values	Default	R/W
Group.Name	Idx:Sidx	TL-HMI			Value	rem.
Gear.a_maxGear	38:6	3.1.3.20	Maximum value for acceleration and deceleration in [rpm*s] Acceleration normalization is not considered	UINT32 120.. 120000	600	R/W –

Movement speeds

The maximum speed in electronic gear mode is set with "Gear.n_maxGear". A speed normalization is not considered.

Parameter			Explanation and unit [ ]	Range of values	Default	R/W
Group.Name	Idx:Sidx	TL-HMI			Value	rem.
Gear.n_maxGear	38:5	3.1.3.3	Max. speed [rpm]	INT32 1..3000	3000	R/W rem.

Contouring errors (following errors)

If the pulse frequency at the setpoint input changes quickly, the drive will not be able to follow a positioning setpoint directly. A temporary following error results. This following error can have any values.

Direction enabling

Direction enabling prevents any movement opposed to the desired direction of travel, which could occur with compensatory or offset movements. Direction enabling is set by the "Gear.dirEnGear" parameter.

Parameter			Explanation and unit [ ]	Range of values	Default	R/W
Group.Name	Idx:Sidx	TL-HMI			Value	rem.
Gear.dirEnGear	38:13	-	Release of movement direction, Reversing the sense of rotation inverts the movement direction	INT16 1..3 1: positive direction (clockwise) 2: negative direction (counter-clockwise) 3: both directions	3	R/W rem.

Current settings

If the drive is in "electronic gear" mode, the standstill current is phase current with inactive gear "Settings.I_O" effective.
With active gear the phase current for acceleration and deceleration "Settings.I_acc" is always effective, regardless of whether and how the motor is rotating.

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Filter for reference encoder speed

The reference encoder speed is smoothed by a filter to ensure smooth synchronization at constant reference speed, even with stepper motor units. The filter parameters "Gear.Flt_nGear" and "Gear.Flt_rGear" must be set accordingly.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Gear.Flt_nGear	38:9	3.1.3.21	Parameters for speed filter. 0 = filter deactivated 1..8 = filter activated	UINT16 0..8	4	R/W rem.
Gear.Flt_rGear	38:14	3.1.3.22	Tripping threshold for speed filter. [Incr. / ms^2]	UINT16 1..100 Speed change from which the filtering of the reference speed is disabled.	15	R/W rem.

The higher the value "Gear.Flt_nGear" for the speed filter is set, the stronger the filtering.

The filtering of the reference encoder speed can be switched off with the "Gear.Flt_rGear" parameter (speed change). The higher the gear factor the higher the value should be set.
Rule of thumb: Value = 2 * numerator/denominator.
To reach an improved synchronization, it is recommended that a higher value be selected; in contrast a lower value yields improved dynamics.

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Gear processing example

An NC controller sends a position setpoint to two units. The motors execute different, proportional positioning movements in accordance with the gear ratios.

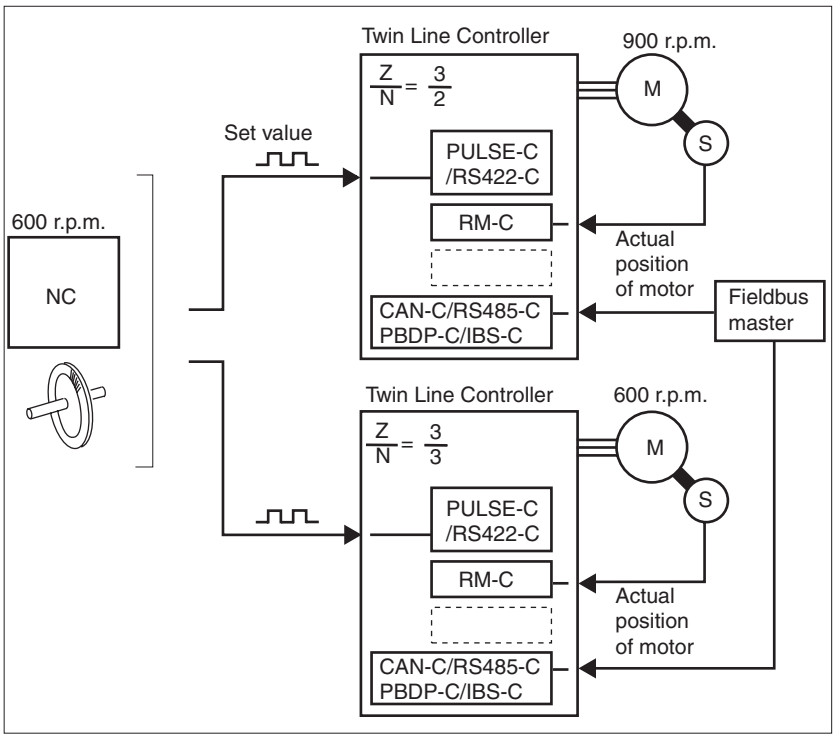

Fig. 6.8 Electronic gear with setpoint preset via NC controller or encoder

6.5.2 Synchronization with compensating movement

Synchronization with compensatory movement can be used to uncouple and recouple the controller for a short time in a coupled gear system without losing synchronization with the gear group. In making its compensatory movement the controller considers all reference pulses, position changes and offset entries which have occurred during the interruption, and attempts to move to the exact position it would have reached without the interruption.

Conditions for a compensatory movement

The controller can be uncoupled from synchronous operation by the following actions:

- Switching off the operating mode by setting 'Gear.startGear' = 0
- Initiating a different operating mode
- Quick stop

The power amplifier must remain switched on. If it is switched off, all stored reference pulses will be lost when it is switched on again.

Initiating a compensatory movement

Electronic gear mode with compensatory movement is started with the "Gear.startGear" = 2 parameter.

The controller attempts to catch up reference pulses that have accumulated before the operating mode was activated as quickly as possible. They are limited in this by the maximum acceleration "Gear.a_maxGear" and the maximum speed "Gear.n_maxGear".

Determining positional deviation

A positional deviation during gear processing can be established by comparing the parameters "Status.p_addGear" and " Status.p_ref".

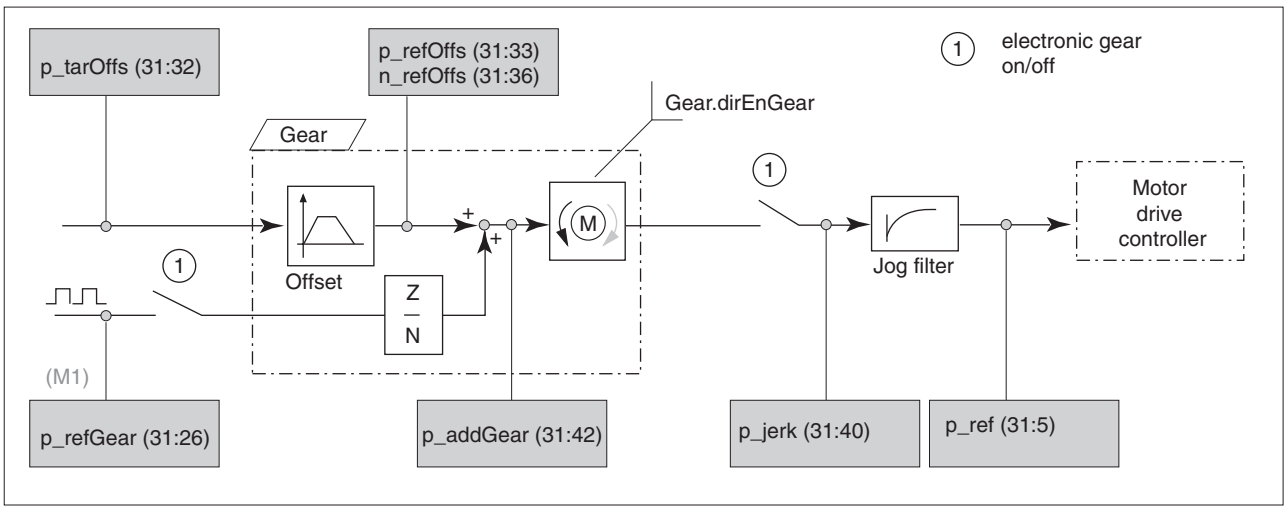

Fig. 6.9 Parameters for determining a positional deviation

Direction preset

Before gear processing is activated, the direction of any compensatory movement can be preset with the "Gear.dirEnGear" parameter. To ensure that the direction is correctly enabled, the direction inversion function must be taken into consideration.
This can be established with the "Motion.invertDir" parameter.

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6.5.3 Offset positioning

A point-to-point offset positioning operation can be superimposed on a positioning operation in electronic gear mode. This is used to alter the position setpoint of the position controller by adding the offset value. For example, it can be used to trigger a position offset in continuous processing.

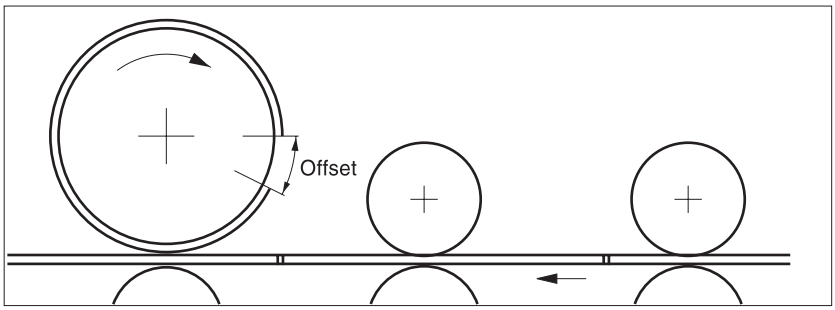

Fig. 6.10 Offset for bridging an empty area when printing

Offset displacement is initiated as soon as the "Gear.p_absOffs" or "Gear.p_relOffs" parameter is transmitted. Offset values are given in internal incremental units as relative or absolute values. They therefore depend on the type of encoder used.

The "Gear.StateOffs" parameter shows information on the status of the operation.

If the mode changes from electronic gear to a different mode, any running offset positioning operation is immediately interrupted and the current positioning operation is finished.

Settings The offset movement is added to the reference pulses of a running gear processing operation. PTP positioning can be set to be executed by ramp or jump. The following information assumes a ramp setting.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Gear.ModeOffs	39:9	3.1.3.12	Processing mode of an absolute or relative positioning	UINT16 0..1 0: Jump 1: Ramp	0	R/W rem.

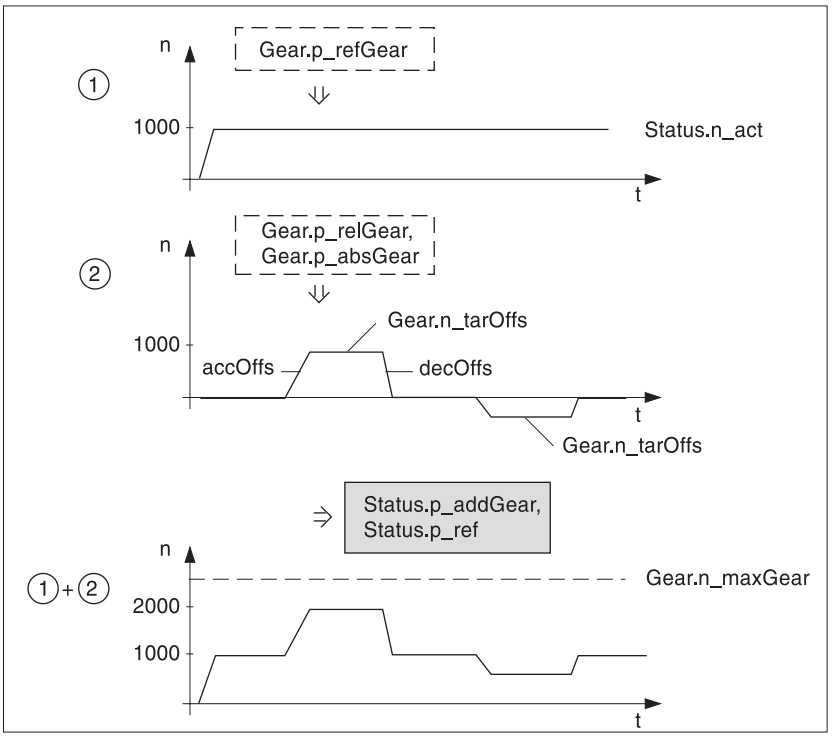

Fig. 6.11 Constant movement with superimposed offset positioning

If gear processing has been deactivated, the offset value is immediately set off against the reference pulses with no limitation from offset ramp values. For example, a setpoint position can be corrected for synchronization with compensatory movement.

Dimension setting The operator is free to switch freely between absolute and relative movement. The positioning area of an absolute value can be set to a defined value with the offset parameter "Gear.phomeOffs". This does not cause the motor to move.

Monitoring

The position preset is given as an absolute value in increments in the "Status.p_tarOffs" parameter. The current position value and speed can be determined with "Status.p_refOffs" and "Status.n_refOffs".

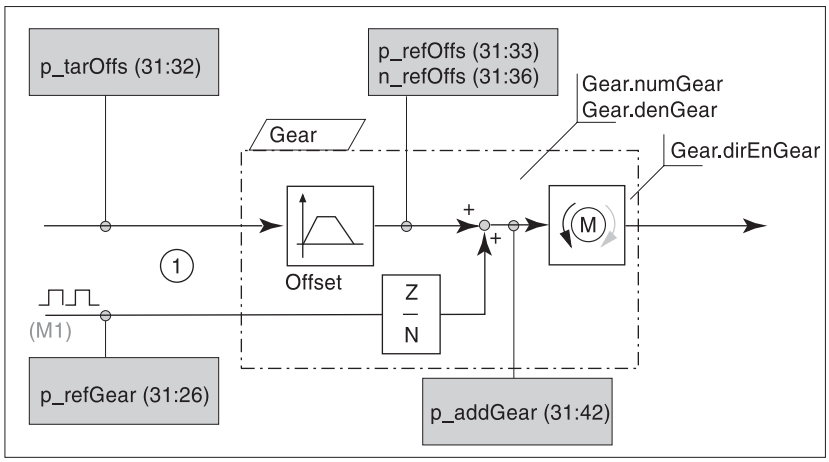

Fig. 6.12 Supervision of offset positioning

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Gear.p_absOffs	39:1	3.1.3.6	Start of absolute offset positioning with transfer of position value [Inc]	INT32 -2147483648..2147483647	0	R/W –
Gear.stateOffs	39:2	–	Acknowledgement: Offset positioning	UINT16 0..65535 Bit0: error LIMP Bit1: error LIMN Bit2: error HW_STOP Bit3: error REF Bit5: error SW_LIMP Bit6: error SW_LIMN Bit7: error SW_STOP Bit13: offset set position reached Bit14: offset_motion_end Bit15: offset_motion_err	–	R/– –
Gear.p_relOffs	39:3	3.1.3.7	Start of relative offset positioning with transfer of distance value [Inc]	INT32 -2147483648..2147483647	0	R/W –
Gear.phomeOffs	39:6	3.1.3.9	Dimension setting in offset positioning [Inc]	INT32 -2147483648...2147483647	0	R/W –
Gear.n_tarOffs	39:5	3.1.3.8	Setpoint speed of offset positioning [rpm]	INT32 1..3000	60	R/W –
Gear.accOffs	39:7	3.1.3.10	Acceleration ramp for offset positioning [rev/(min*s)]	INT32 60..2000000	300	R/W –
Gear.decOffs	39:8	3.1.3.11	Deceleration ramp for offset positioning [rev./(min*s)]	INT32 60..2000000	300	R/W –

TLADOCC51ME, -001, 04.03

6.6 Referencing

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

- Commands entered in this register may be executed immediately upon receipt by the drive controller.
- Before sending any commands, ensure that the machine is clear and ready for motion.

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

Overview

In referencing mode, an absolute scale reference of the motor position at a defined axis position is established. Referencing is possible by:

- Reference movement or
- Dimension setting

In a reference movement, a defined position on the axis (a zero or reference point) is defined through the hardware in order to establish the absolute scale reference of the motor position to the axis.

Dimension setting offers the option of defining a point on the axis as the reference point from which all following position data is referred.

Referencing mode can be run with:

- HMI hand-held operating unit
- Commissioning software
- Fieldbus

Operation with commissioning software or the HMI hand-held operating unit

The commissioning software and the HMI hand-held operating unit support this operating mode with special dialog boxes and menu items. Detailed operation is described in the commissioning software and the HMI hand-held operating unit manuals.

Referencing with parameters

Referencing operating mode can be initiated using the Fieldbus via two parameters:

- Reference movement with "Home.startHome"
- Dimension setting with "Home.startSetP"

The "Home.StateHome" parameter shows information on the state of the operation.

Successful referencing is indicated by bit5, "ref_ok"= 1 in the "Status.xMode_act" parameter. The complete assignments of the "Status.xMode_act" parameter can be found on page 12-22.

6.6.1 Reference movement (Referencing)

The controller offers a choice of four standard reference movements. In addition to these, a reference movement can be applied to the index pulse of the motor. The following movements are supported:

- movement to the negative limit switch $\overline{\text{LIMN}}$
- movement to the positive limit switch $\overline{\text{LIMP}}$

TLADOCC51ME, -001, 04.03

- movement to reference switch $\overline{\text{REF}}$, beginning with movement in a negative sense of rotation
- movement to reference switch $\overline{\text{REF}}$, beginning with movement in a positive sense of rotation

The corresponding signal inputs $\overline{\text{LIMN}}$, $\overline{\text{LIMP}}$, and $\overline{\text{REF}}$ must be connected. Search and clearance speeds, as well as safety gap and clearance distance are all adjustable in user-defined units for the reference movement.

A reference movement must be completed for the new reference point to be valid. If the movement is interrupted, it must be restarted. In contrast to the other modes, a reference movement must be completed before the operating mode can be changed.

The reference movement can be executed with or without an index pulse.

Search and clearance speeds and also safety gap and withdrawal path can all be set in user-defined units for the reference movement without index pulse.

Search and clearance speeds can also be set for reference movement with index pulse. However, clearance from the switching range is with an index pulse. This means that a movement of 1.1 revolutions in the requested direction is initiated with simultaneous activation of the capture processing. The drive is stopped as soon as the index pulse is overrun. Then it is positioned at the calculated index pulse position.

The $\overline{\text{REF}}$ switch does not have to be enabled for reference travel. If the $\overline{\text{REF}}$ switch is enabled, it takes on the function of an additional STOP switch.

The level of the $\overline{\text{REF}}$ reference switch can be inverted using bit 3 in the "Settings.SignLevel" register.

Additional setting options

The following additional parameters can be set in referencing mode:

- Home.DefPosTyp
- Home.RefAppPos

If the speed or ramp setting is changed for withdrawal from the switching area, the end position of the reference movement may be changed. The "Home.DefPosTyp" parameter can be used to save the motor position at the time of the signal change at the limit and reference switch. The precision of the position record is approximately equal to the position distance covered in 1 ms.

The "Home.RefAppPos" parameter can be used to set the user position (= zero point of application) to the reference point (= machine zero point) after completion of a reference movement. The negative position difference between reference position and user position is derived and the calculated value is set in the "Home.RefAppPos" parameter.

TLADOCC51ME, -001, 04.03

6.6.2 Reference movement without index pulse

The table below shows the parameters with which the reference movement without index pulse can be started, executed and acknowledged at the end or reference switch.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Home.startHome	40:1	3.3.1.1 3.3.1.2 3.3.1.3 3.3.1.4 3.3.1.5 3.3.1.6 3.3.1.7 3.3.1.8	Start of referencing mode	UINT16 1..8 **1: LIMP** **2: LIMN** **3: REFZ neg. sense of rotation** **4: REFZ pos. sense of rotation** 5: LIMP with index pulse 6: LIMN with index pulse 7: REFZ neg. sense of rotation with index pulse 8: REFZ pos. sense of rotation with index pulse	–	R/W –
Home.stateHome	40:2	–	Acknowledgement: referencing	UINT16 0..65535 Bit0: error LIMP Bit1: error LIMN Bit2: error HW_STOP Bit3: error REF Bit5: error SW_LIMP Bit6: error SW_LIMN Bit7: error SW_STOP Bit14: ref_end Bit15: ref_err	–	R/– –
Status.xMode_act	28:3	2.3.5.5	Current axis operating mode with additional information,	UINT16 0..65535 Bit0..4: Current mode (unit-specific) [List of optional modes for your TL unit can be found in "Operating modes of the controller" See "Parameter group Status" for the exact coding] Bit5: Drive is referenced ("ref_OK") Bit6: Control deviation in position window (SM not assigned) Bit7: reserved Bit8..15: not assigned	–	R/– –
Home.v_Home	40:4	3.3.3	Speed for search of reference switch [usr]	INT32 -2147483648..2147483647	60	R/W rem.
Home.v_outHome	40:5	3.3.4	Speed for processing withdrawal path and safety distance [usr]	INT32 -2147483648..2147483647	6	R/W rem.
Home.p_outHome	40:6	3.3.5	Max. withdrawal path with activated reference switch [usr]	UINT32 0..2147483647 0: withdrawal disabled >0: withdrawal path [usr]	0	R/W rem.

TLADOCC51ME, -001, 04.03

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Home.p_disHome	**40:7**	**3.3.6**	**Safety distance from switching edge to reference point [usr]**	**UINT32 0..2147483647**	**200**	**R/W rem.**
Home.DefPosTyp	40:10	–	Reference position for processing safety distance and index pulse search	UINT16 0 .. 1 0: Setpoint position at standstill after deceleration because of signal change at limit or reference switch 1: Save current motor position on signal change at limit or reference switch	0	R/W rem.
Home.RefAppPos	40:11	–	Application position at reference point [usr]	INT32 -2146483648 .. 2146483647	0	R/W rem.
Home.RefSwMod	40:9	3.3.10	Processing sequence with reference movement to REF	UINT16 0..3 Bit0: Rotation reversal at REF 0: permissible (standard operation) 1: not permissible Bit1: Movement direction safety distance 0: away from switch 1: into switch area	0	R/W rem.

Reference movement towards limit switch without index pulse

A reference movement to the negative limit switch with additional safety distance is shown below: the reference point is "R-".

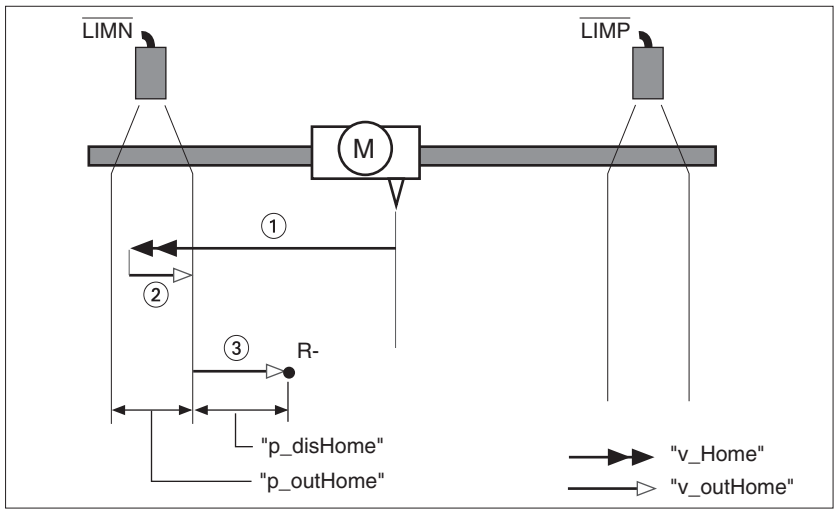

Fig. 6.13 Reference movements to limit switch with movement to safety distance

① movement at search speed "Home.v_Home"

② movement to switching edge at clearance speed "Home.v_outHome"

③ movement to distance "Home.p_disHome" at clearance speed.

Reference movement to limit switch without index pulse

- movement to the reference switch with the first movement in negative direction, $\overline{\text{REF}}$ switch first in front of (A1, A2) then behind the starting point (B1, B2), reference point is "R-"
- additional movements when traveling through switching window (A2, B2)

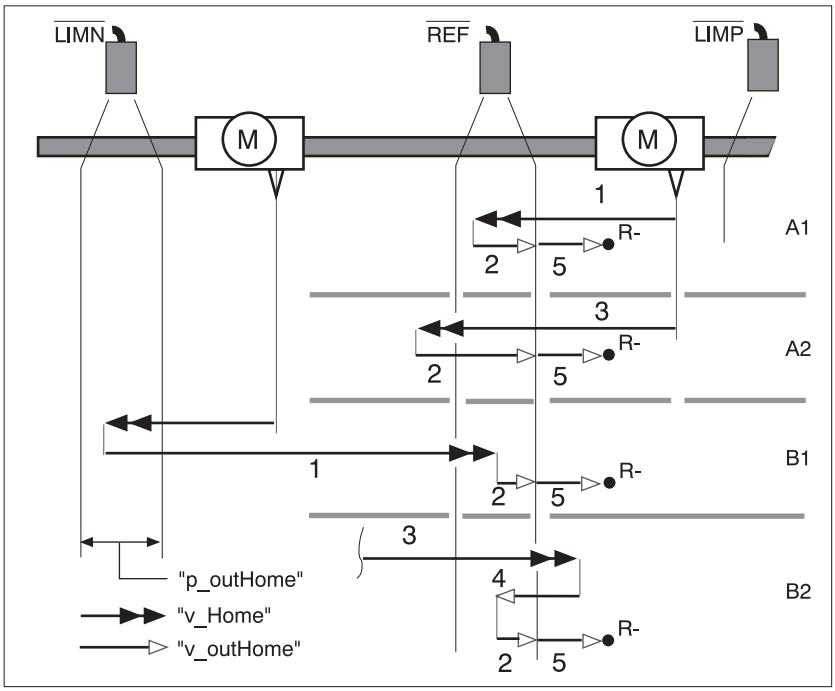

Fig. 6.14 Reference movement to reference switch with first movement in negative sense of rotation

① movement to reference switch at search speed "Home.v_Home"
② movement to switching edge at clearance speed "Home.v_outHome"
③ over-rapid movement to reference switch at search speed
④ return movement at clearance speed in switch area
⑤ movement to distance "Home.p_disHome" at clearance speed.

Special setting options with reference movement to REF

During reference movement to REF "Home.RefSwMod" can be used to set whether a reversal of direction is permissible and whether a movement should be executed in the safety area.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Home.RefSwMod	40:9	3.3.10	Processing sequence with reference movement to REF	UINT16 0..3 Bit0: Rotation reversal at REF 0: permissible (standard operation) 1: not permissible Bit1: Movement direction safety distance 0: away from switch 1: into switch area	0	R/W rem.

This yields the following four cases:

- Case A: Bit0 = 0 and Bit1 = 0 [standard/default setting], i.e. direction reversal at REF is permissible and the safety distance movement is executed away from the switch.
- Case B: Bit0 = 1 and Bit1 = 0, i.e. direction reversal at REF is not permissible and the safety distance movement is executed away from the switch.
- Case C: Bit0 = 0 and Bit1 = 1, i.e. direction reversal at REF is permissible and the safety distance movement is executed into the switch area.
- Case D: Bit0 = 1 and Bit1 = 1, i.e. direction reversal at REF is actually not permissible and the safety distance movement is executed into the switch area. However, an automatic direction reversal takes place when processing the safety distance because of this setting.

TLADOCC51ME, -001, 04.03

The following diagram shows the special setting options offered by "Home.RefSwMod".
Example: Reference movement to REF in negative rotation direction without index pulse
- Bit0 = 1, i.e. rotation reversal at REF is not permissible.
- $\overline{\text{LIMP}}$ activated on start is permissible
- Error, if $\overline{\text{LIMN}}$ activated on start or during processing

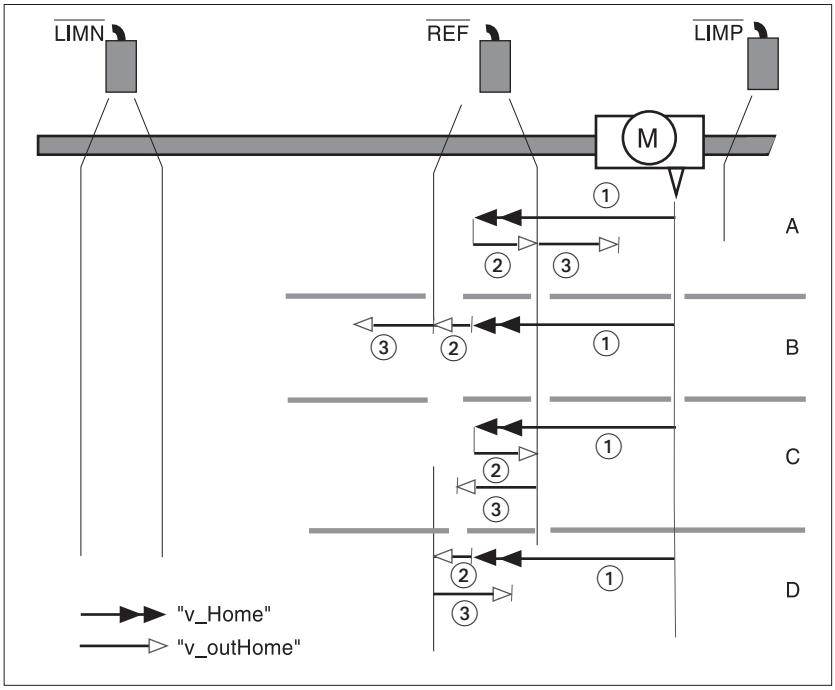

Fig. 6.15 Settings of "Home.RefSwMod"

Options for reference movement to reference switch depending on the setting of "Home.RefSwMod" with initial movement in negative rotation direction:

① movement at search speed "Home.v_Home" to switch
② movement to switching edge at clearance speed "Home.v_outHome"
③ movement safety distance

6.6.3 Reference movement with index pulse

Requirements and general information

A reference movement is only possible when using an encoder with the appropriate module.

If a capture process is active, a reference movement with index pulse is not initiated.

The system resource "fast positioning control" is assigned during processing of a reference movement. This means that the write accesses of the capture parameters are blocked. After the reference movement with index pulse, a new setting of the capture parameters is required.

Because the end position is set by the index pulse, by reading the value of pactmodulo after the first processing you receive a value suitable for control of reproducibility.

The table below shows the parameters with which the reference movement with index pulse can be started, executed and acknowledged at the limit or reference switch.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Home.startHome	40:1	3.3.1.1 3.3.1.2 3.3.1.3 3.3.1.4 3.3.1.5 3.3.1.6 3.3.1.7 3.3.1.8	Start of referencing mode	UINT16 1..8 1: LIMP 2: LIMN 3: REFZ neg. sense of rotation 4: REFZ pos. sense of rotation **5: LIMP with index pulse** **6: LIMN with index pulse** **7: REFZ neg. sense of rotation with index pulse** **8: REFZ pos. sense of rotation with index pulse**	–	R/W –
Home.stateHome	40:2	–	Acknowledgement: referencing	UINT16 0..65535 Bit0: error LIMP Bit1: error LIMN Bit2: error HW_STOP Bit3: error REF Bit5: error SW_LIMP Bit6: error SW_LIMN Bit7: error SW_STOP Bit14: ref_end Bit15: ref_err	–	R/– –
Status.xMode_act	28:3	2.3.5.5	Current axis operating mode with additional information	UINT16 0..65535 Bit0..4: Current mode (unit-specific) [List of optional modes for your TL unit can be found in "Operating modes of the controller" See "Parameter group Status" for the exact coding] Bit5: Drive is referenced ("ref_OK") Bit6: Control deviation in position window (SM not assigned) Bit7: reserved Bit8..15: not assigned	–	R/– –

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Home.v_Home	40:4	3.3.3	Speed for search of reference switch [usr]	INT32 -2147483648..2147483647	60	R/W rem.
Home.v_outHome	40:5	3.3.4	Speed for processing withdrawal path and safety distance [usr]	INT32 -2147483648..2147483647	6	R/W rem.
Home.p_outHome	40:6	3.3.5	Max. withdrawal path with activated reference switch [usr]	UINT32 0..2147483647 0: withdrawal disabled >0: withdrawal path [usr]	0	R/W rem.
Status.p_diffind	**31:48**	**–**	**Distance between switch and index pulse after reference movement [Inc]**	**INT32 -2147483648 .. 2147483647**	**–**	**R/– –**
Home.DefPosTyp	40:10	–	Reference position for processing safety distance and index pulse search	UINT16 0 .. 1 0: Setpoint position at standstill after deceleration because of signal change at limit or reference switch 1: Save current motor position on signal change at limit or reference switch	0	R/W rem.
Home.RefAppPos	40:11	–	Application position at reference point [usr]	INT32 -2146483648 .. 2146483647	0	R/W rem.
Home.RefSwMod	40:9	3.3.10	Processing sequence with reference movement to REF	UINT16 Bit0: Rotation reversal at REF 0: permissible (standard operation) 1: not permissible	0	R/W rem.

Reference movement towards limit switch with index pulse

A reference movement to the positive limit switch with additional safety distance is shown below: The reference point is "R+".

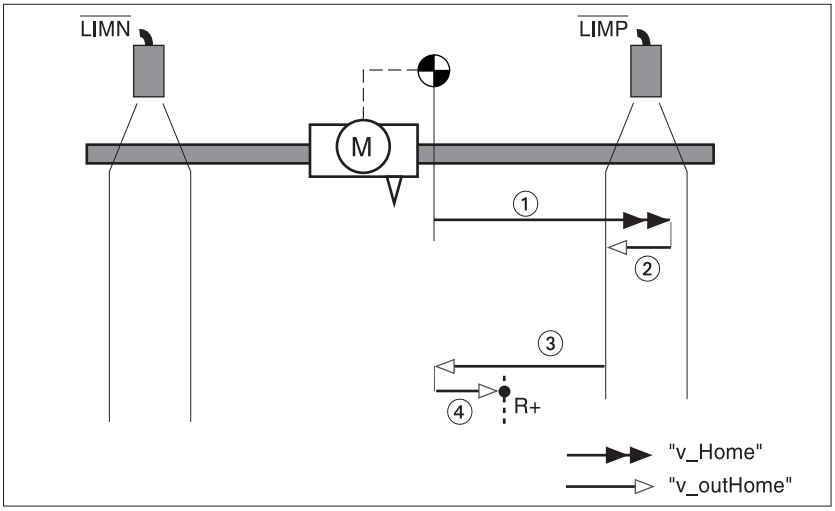

Fig. 6.16 Reference movement towards limit switch

① movement at search speed "Home.v_Home" to LIMP limit switch
② movement to switching edge at clearance speed "Home.v_outHome"
③ Search movement index pulse at clearance speed.
④ movement to index pulse at clearance speed

TLADOCC51ME, -001, 04.03

Reference movement to limit switch with index pulse

- movement to the reference switch with the first movement in a negative direction, $\overline{\text{REF}}$ switch first in front of (A1, A2) then behind the starting point (B1, B2)
- additional movements when traveling through switching window (A2, B2)

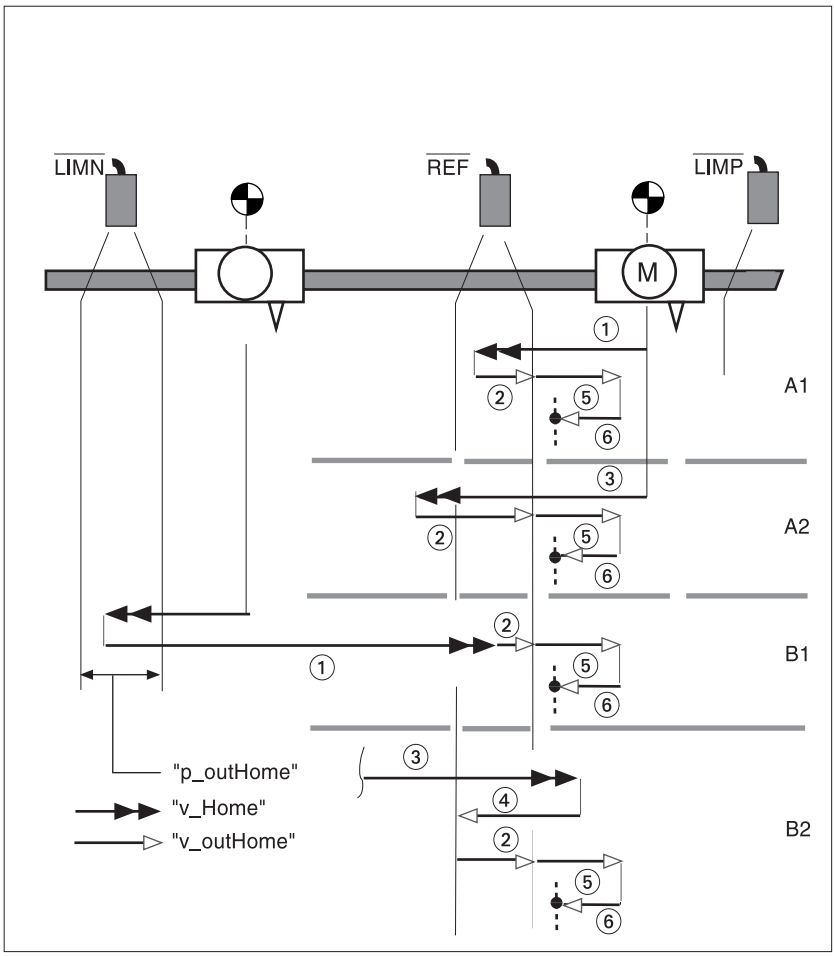

Fig. 6.17 Reference movement to reference switch with first movement in negative sense of rotation

① movement to reference switch at search speed "Home.v_Home"
② movement to switching edge at clearance speed "Home.v_outHome"
③ over-rapid movement to reference switch at search speed
④ return movement at clearance speed in switch area
⑤ search movement index pulse at clearance speed.
⑥ movement to index pulse at clearance speed

Special setting options with reference movement to REF

During reference movement to REF "Home.RefSwMod" can be set to determine whether a rotation reversal is permissible.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Home.RefSwMod	40:9	3.3.10	Processing sequence with reference movement to REF	UINT16 Bit0: Rotation reversal at REF 0: permissible (standard operation) 1: not permissible	0	R/W rem.

This yields the following cases:

- Case A: Bit0 = 0 [standard/default setting], i.e. rotation reversal at REF is permissible.
- Case B: Bit0 = 1, i.e. rotation reversal at REF is not permissible.

The following diagram shows the special setting options offered by "Home.RefSwMod". Example: reference movement to REF in negative rotation direction with index pulse

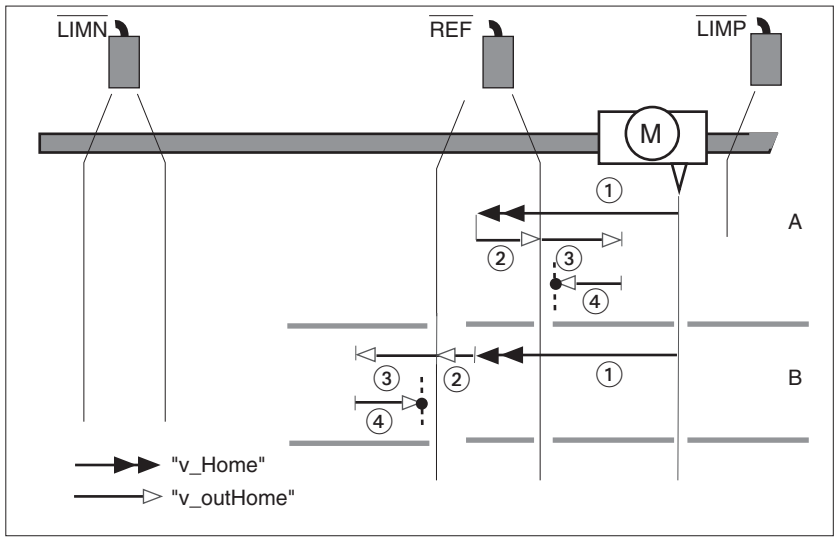

Fig. 6.18 Settings of "Home.RefSwMod"

Options for reference movement to reference switch depending on the setting of "Home.RefSwMod" with initial movement in negative rotation direction:

① movement at search speed "Home.v_Home" to switch
② movement to switching edge at clearance speed "Home.v_outHome"
③ search movement index pulse at clearance speed.
④ movement to index pulse at clearance speed

6.6.4 Referencing by dimension setting

Referencing by dimension setting moves the reference point for setpoints to the new scale position. The position value is transmitted in user-defined units in the "Home.startSetp" parameter.

Referencing by dimension setting can only be carried out when the motor is at a standstill. Any active position deviation is retained and can still be compensated by the position controller after dimension setting has taken place.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Home.startSetp	40:3	3.3.2	Sizing on sizing position (set absolute position) [usr]	INT32 -2147483648..2147483647	–	R/W –
Home.stateHome	40:2	–	Acknowledgement: referencing	UINT16 Bit0: error LIMP Bit1: error LIMN Bit2: error HW_STOP Bit3: error REF Bit5: error SW_LIMP Bit6: error SW_LIMN Bit7: error SW_STOP Bit13: – Bit14: ref_end Bit15: ref_err	–	R/– –
Status.xMode_act	28:3	2.3.5.5	Current axis mode with additional information	UINT16 0..65535 Bit0..4: Current mode (unit-specific) [List of optional modes for your TL unit can be found in "Operating modes of the controller" See "Parameter group Status" for the exact coding] Bit5: Drive is referenced ("ref_OK") Bit6: Control deviation in position window (SM not assigned) Bit7: reserved Bit8..15: not assigned	–	R/– –

Example Dimension setting can be used to carry out a continuous motor movement without exceeding positioning limits.

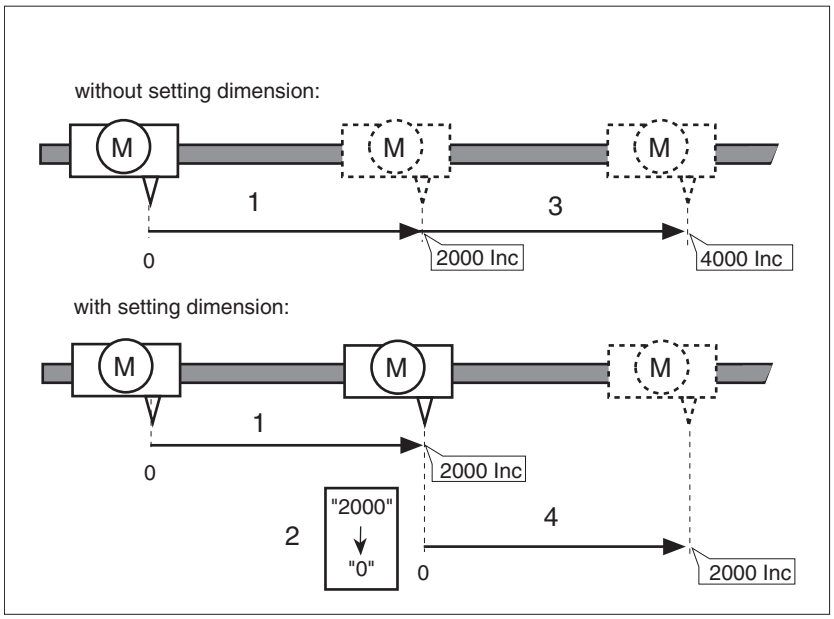

Fig. 6.19 Positioning by 4000 increments with and without dimension setting

① The motor positions 2000 increments with the start on the reference point.

② By calling up referencing by dimension setting, the current position is set to the scale position in user-defined units.

③ After triggering a new movement order at 2000 increments the new target position without dimension setting is 4000 increments.

④ After triggering a new movement order at 2000 increments the new target position with dimension setting is 2000 increments.

This method avoids crossing absolute position limits during a positioning operation because the zero point is continuously tracked.

TLADOCC51ME, -001, 04.03

6.7 Oscillator mode

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

- Commands entered in this register may be executed immediately upon receipt by the drive controller.
- Before sending any commands, ensure that the machine is clear and ready for motion.

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

In oscillator mode the motor is moved in accordance with a voltage-dependent speed preset over the 10 V input.

If the input voltage changes, the drive will accelerate or decelerate to the new setpoint speed with the acceleration and deceleration values set by "Motion.acc" and "Motion.dec".

Oscillator mode can be executed by:

- Commissioning software
- Fieldbus

Operation with the commissioning software

The commissioning software supports oscillator mode with special dialog boxes and menu items. You will find details on this in the manual for the TL CT commissioning software.

Overview

The following structural view shows the effects of the parameters on the setpoint speed, which can be set in oscillator mode.

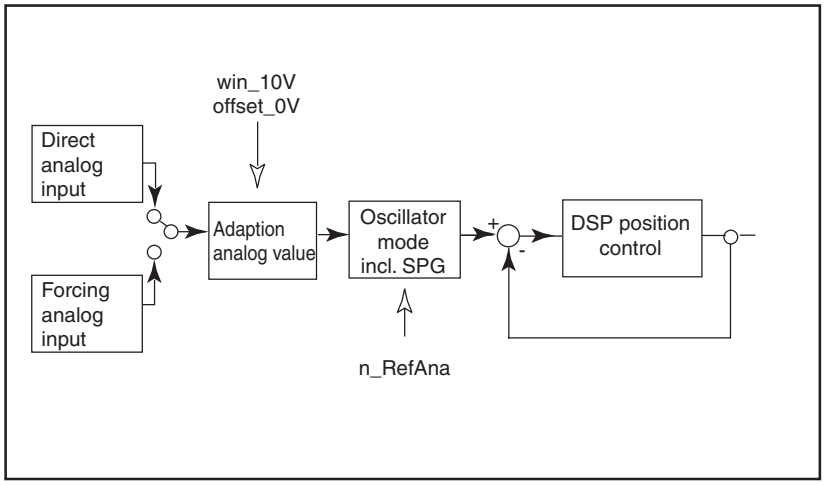

Fig. 6.20 Overview of how the variable parameters in oscillator mode operate

Starting oscillator mode

Oscillator mode is set with the "Oscillator.startOszi" parameter.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Oscillator.startOszi	51:1	3.1.9.1	Starting oscillator mode	UINT16 0..1 0: deactivated (setpoint=0) 1: setpoint via +/-10 V interface	–	R/W –

Acknowledging oscillator mode

The "Oscillator.state Oszi" parameter shows information on the processing status in oscillator mode. Processing in oscillator mode is stopped when the mode has been "disabled" and the drive is stationary or if the motor speed has the value 0 as the result of an error.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Oscillator.stateOszi	51:2	–	Acknowledgement: Oscillator mode	UINT16 0..65535 Bit0: error LIMP Bit1:error LIMN Bit2: error HW_STOP Bit3: error REF Bit4: not assigned Bit5: error SW_LIMP Bit6: error SW_LIMN Bit7: error SW_STOP Bit8-Bit12: not assigned Bit13: setpoint speed reached 0: Actual speed <> setpoint speed 1: actual speed = set speed Bit14: oscillator_end 0: process active 1: process inactive Bit15: oscillator_err 0: no error 1: Error	–	R/– –

Options for speed control

The curve of the setpoint speed can be changed depending on the 10 V analog input value with:

- Setting the setpoint speed at 10 V
- Preprocessing the analog value using an offset or a voltage window

TLADOCC51ME, -001, 04.03

Setpoint speed at 10 V input signal

The "Oscillator. n_RefAna" parameter can be used to specify the setpoint speed for a 10 V input signal.

Parameter			Explanation and unit [ ]	Range of values	Default	R/W
Group.Name	Idx:Sidx	TL-HMI			Value	rem.
Oscillator. n_RefAna	51:3	3.1.9.2	Setpoint speed at 10 V input signal [rpm]	INT16 0 .. 13200 (Note: max. motor speed must not be exceeded)	3000	R/W rem.

Analog value offset

The "Settings.offset_0V" parameter can be used to vary the offset for the ±10V input, whereby the interconnection between input voltage and speed changes.

Parameter			Explanation and unit [ ]	Range of values	Default	R/W
Group.Name	Idx:Sidx	TL-HMI			Value	rem.
Settings.offset_0V	20:58	4.1.38	Offset to shift of the 0V input voltage [mV]	UNIT 16 -5000..+5000	0	R/W rem.

Small deviations in the zero area can be compensated with the user offset.

The diagram below shows this more clearly:

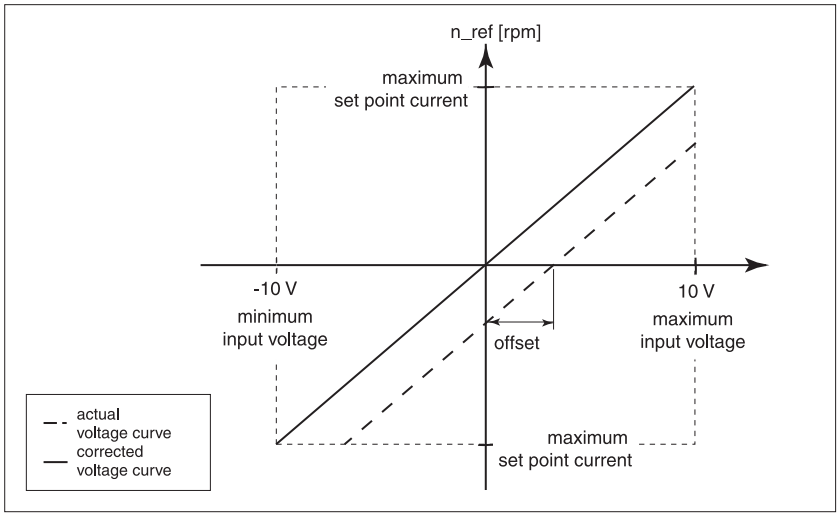

Fig. 6.21 User value offset for the 10 V input

Analog value voltage window

An analog value voltage window can be set with "Settings.win_10V" for the 10 V input. The setpoint speed takes the value 0 here.

Parameter			Explanation and unit [ ]	Range of values	Default	R/W
Group.Name	Idx:Sidx	TL-HMI			Value	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	UINT16 0..1000	0	R/W rem.

Once the analog value voltage window range is left, a setpoint value ≠ 0 is generated.

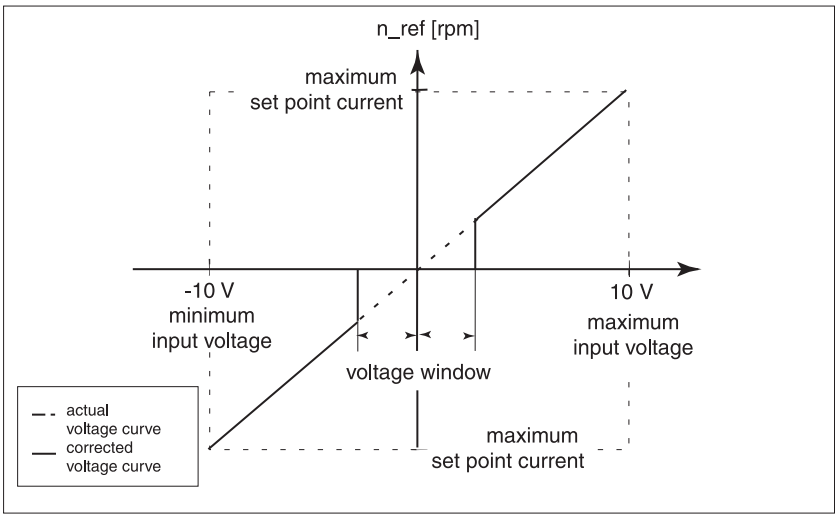

Fig. 6.22 Analog value voltage window around the value 0 V for the 10 V input

Information on additional settings

List data for a position/speed list cannot be processed oscillator mode.

7 Functions of the controller

7.1 List control and list processing

Overview

List-driven mode runs in the background while a movement command is being carried out. If the motor reaches an axis position which is stored in the list, an interface signal is changed or a new speed value activated.

The controller can store two separate lists with 64 list fields each for position entries. A list type must be assigned before inputting values in a list.

- Position / speed list: A separate speed is stored in this list for every position entry.
- Position / signal lists: Stores a signal level for every position entry to which the interface output TRIGGER is set.

I/O signal	Function	Value
TRIGGER	Output signal which is switched by means of a position / signal list	Low/open

The accuracy of the time at which the controller sets the output signal depends on various hardware and software related factors, see "Triggering accuracy" on page 7-6.

Initiating list-driven operation

List-driven operation can be used with different operating modes depending on the list type.

Position / Speed list type

- Point-to-point mode
- Speed mode

The comparison value is the “Status.p_jerkusr” parameter. This value is compared with the position value in the list and the relevant response carried out in the controller.

Position / Signal list type

- Point-to-point mode
- Speed mode
- Manual movement operating mode
- Electronic Gear mode
- Oscillator mode

The comparison value is the “Status.p_actusr” parameter. This value is compared with the position value in the list and the relevant response carried out in the controller.

TLADOCC51ME, -001, 04.03

List-driven operation can be initiated via

- The HMI hand-held control unit
- Commissioning software
- Fieldbus

List-driven operation is initiated by selecting the list and a starting number in the range between the first and last number. If an operating mode is switched on, the controller changes the TRIGGER output or the speed setting when list and axis position match.

The list can be changed during a running operation by selecting the inactive list. By deactivating the current list, list processing can be interrupted at any point in the positioning process.

When the specified finishing number is reached, list-driven operation is stopped. To restart it, the list only needs to be selected again as the starting and finishing positions as well as all list entries remain set.

Monitoring list-controlled operation

The processing status of the list-controlled mode can be evaluated via two parameters. Bit14, "list_quit" of the "List.stateList" parameter gives global information on the status of the function:

- 0: list-driven mode active
- 1: list-driven mode completed

The parameter "List.actList" gives detailed information on the processing status. It displays the last activated list position.

- -1: no list entry activated yet
- 0 ... 63: last activated entry

Parameter Group.name	Idx:Sidx	TL-HMI	Explanation and units [ ]	Value range	Default Value	R/W rem.
List.startList	44:1	3.1.5.1 3.1.5.2 3.1.6.1 3.1.6.2	Activate new list-driven operation, current list-driven operation is first deactivated.	UINT16 0 : deactivate list control 1 : activate list 1 2 : activate list 2	0	R/W –
List.stateList	44:2	–	Acknowledgement and status: list-driven operation	UINT16 Bit15: list_err Bit14: list_quit Bit 0,1: 0 : no list active 1 : list 1 active 2 : list 2 active	–	R/– –
List.actList	44:18	–	last activated list: Current processing number starting number =< active proc.No. =< fin.No.	INT16 -1: no list entry activated 0..63: last activated list entry	0	R/– –
List.cntList1	44:4	–	List 1: number of available list entries	UINT16	64	R/– –
List.bgnList1	44:6	–	List 1: starting number, first entry for list data processing starting number < finishing number	UINT16 0...63	0	R/W rem
List.endList1	44:7	–	List 1: finishing number, last entry for list data processing finishing number > finishing number	UINT16 0...63	63	R/W rem.

TLADOCC51ME, -001, 04.03

Parameter Group.name	Idx:Sidx	TL-HMI	Explanation and units [ ]	Value range	Default Value	R/W rem.
List.cntList2	44:12	–	List 2: number of available list entries	UINT16	64	R/– –
List.bgnList2	44:14	–	List 2: starting number, first entry for list data processing starting number < finishing number	UINT16 0...63	0	R/W rem
List.endList2	44:15	–	List 2: finishing number, last entry for list data processing finishing number > starting number	UINT16 0...63	63	R/W rem.

TLADOCC51ME, -001, 04.03

Processing list data

All list data in the non-active list can be changed before and during list-driven operation via the TLHMI, TLCT commissioning software, Fieldbus or with teach mode. For details on teach mode please refer to page 7-8.

When changing list values, please pay attention to the following:

- The controller stores position and speed values in user-defined units.
- List entries are selected via list numbers and executed in ascending order. In the same way, position entries within the range defined by the starting and finishing numbers, must be entered in their correct ascending or descending order.
- The assigned list type applies for the whole list. The list type cannot be changed within a list.
- The end of list parameter value can be changed while the list is used.This may help to change the control range through the list based on the control situation.

The entries in both lists can be accessed via parameter groups “L1Data0” to “L1Data63” for list 1 and “L2Data0” to “L2Data63” for list 2.

Parameter Group.name	Idx:Sidx	TL-HMI	Explanation and units [ ]	Value range	Default Value	R/W rem.
L1Data0.typeList1	1100:1	7.3.1.1	List 1: list type for all the following list entries (1101:x...1163:x)	UINT16 1: pos. / signal 2: pos. / speed	1	R/W rem.
L1Data0.posList1	1100:2	7.3.2.1 7.3.2.2	List 1: Position [usr]	INT32 -2147483648..2147483647	0	R/W rem.
L1Data0.signList1	1100:3	7.3.2.3	List 1: signal status	UINT16 0, 1	0	R/W rem.
L1Data0.velList1	1100:4	7.3.2.4	List 1: set speed [usr]	UINT32 -'Motion.n_max0'... +'Motion.n_max0' settings dependent on operating mode PTP: 0: PTP.Vtarget <>0: stored value VEL: 0: VEL.velocity <>0: stored value	0	R/W rem.
L2Data0.typeList2	1200:1	7.4.1.1	List 2: list type for all the following list entries (1201:x...1263:x)	UINT16 1: pos. / signal (default) 2: pos. / speed	1	R/W rem.
L2Data0.posList2	1200:2	7.4.2.1 7.4.2.2	List 2: position [usr]	INT32 - 2147483648..2147483647	0	R/W rem.
L2Data0.signList2	1200:3	7.4.2.3	List 2: signal status	UINT16 0, 1	0	R/W rem.
L2Data0.velList2	1200:4	7.4.2.4	List 2: set speed [usr]	UINT32 -”Motion.n_max0”... +”Motion.n_max0” settings dependent on operating mode PTP: 0: PTP.Vtarget <>0: stored value VEL: 0: VEL.velocity <>0: stored value	0	R/W rem.

TLADOCC51ME, -001, 04.03

Example of position / signal list

List-driven operation begins with a point-to-point positioning operation from the reference point to the position 510 mm at a speed of 100 r.p.m. Position normalization is set for 1 user-defined unit to equal 1mm.

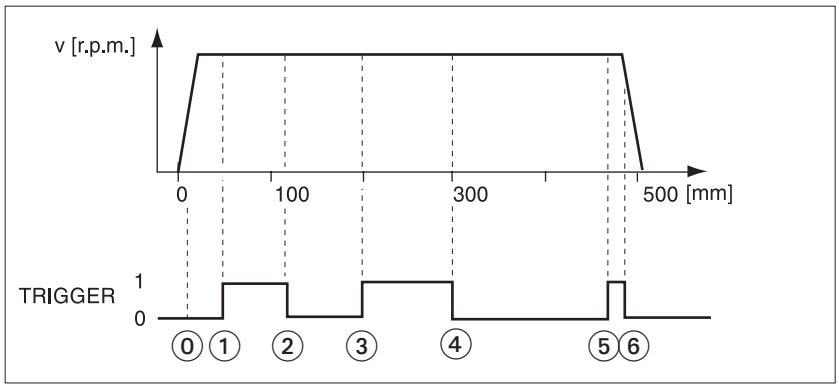

Fig. 7.1 Controller with position / signal list

- ▶ Activate positon/speed list with "Data0.typeList1" = 1,
- ▶ Enter position values of the list between start and end position via TL HMI, TL CT, Fieldbus or with teach mode list 1.

Activated list excerpt for the example:

Graphics point	List number 1100:x...1163:x	List type 1xxx:1	Position 1xxx:2	Trigger signal 1xxx:3	Speed 1xxx:4
0	1100	1	10	0	0
1	1101	1	50	1	0
2	1102	1	120	0	0
3	1103	1	200	1	0
4	1104	1	300	0	0
5	1105	1	470	1	0
6	1106	1	490	0	0
-	...	...	...	0	0

The “Speed” column has no significance for list control via the position / signal list.

- ▶ Starting position list number 1 with “List.bgnList1”= 0 (Lst.Nr.1100.x)
- ▶ Finishing position list number 6 with “List.endList1”= 6 (Lst.Nr.1106.x)
- ▶ Activate list 1 with “List.startList”=1
- ▶ Initiate positioning process.

The trigger signal is changes when the position from the list corresponds to the current position of the motor encoder.

Triggering the trigger signal

Two successive trigger signals must be at least 3 ms apart. Smaller intervals are possible; however, the trigger signal can then be delayed for several milliseconds.

Triggering accuracy

The time at which the trigger signal switches varies by values which are influenced by hardware and software dependent factors.

- Determined by hardware causes such as temperature, power supply or output load: Variation: max. +/-20 µs.
- Determined by software causes: Variation: max. +/-30 µs, at low speeds +/- 25 Inc.

Trigger signals are shifted by an additional factor during an acceleration or deceleration phase by comparison with the trigger point during a constant speed phase.

Example at 10000 rpm:

- Acceleration: triggering 12 µs later
- Braking: triggering 12µs earlier

Trigger level

The inactive level of the trigger signal is set by means of the “I/O.OutTrig” parameter. This is used to set the first trigger level after the start of list-driven operation or after a list-driven operation has been interrupted.

The parameter can only be changed when no list-driven operation is active.

Parameter			Explanation and units [ ]	value range	Default	R/W
Group.name	**Idx:Sidx**	**TL-HMI**			**value**	**rem.**
I/O.OutTrig	34:9	–	Setting trigger output when signal list inactive	UINT16 0: Low level 1: High level	0	R/W –

Example of position / speed list

List-driven operation is carried out with an absolute positioning process from the reference point to the 6,000 incs position. The starting speed is 100 r.p.m.

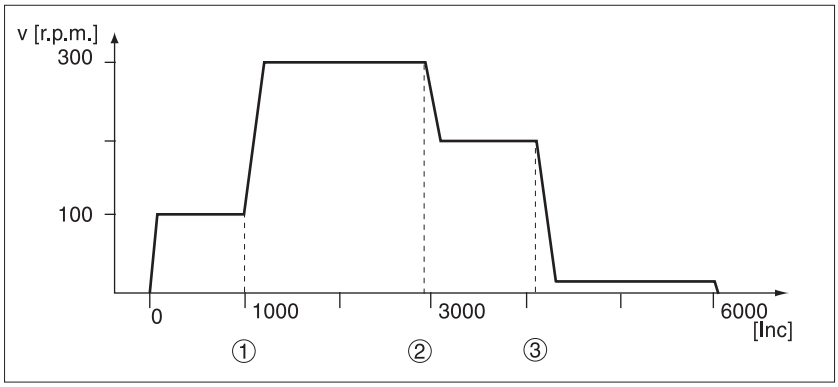

Fig. 7.2 Controller with position / speed list

▶ Activate position / speed list with “L2Data0.typeList2” = 2,

▶ Entering position values for list data between starting and finishing position via TL HMI, commissioning software, Fieldbus or by teach mode.

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Activated list excerpt for the example:

Graphics point	List number 1200:x...1263:x	List type 1xxx:1	Position 1xxx:2	Trigger signal 1xxx:3	Speed 1xxx:4
1	1205	2	1000	0	300
2	1206	2	2800	0	200
3	1207	2	4200	0	10
-	...	...	...	...	0

The trigger signal column has no significance for list control via the position/speed list.

- ▶ Starting position list number 5 with “List.bgnList2”= 5 (Lst.number.1205.x)
- ▶ finishing position list number 7 with “List.endList2”=7 (Lst.number.1207.x)
- ▶ Activate list 2 with “List.startList”=2
- ▶ Initiate positioning.

The change in speed is triggered when the position from the list matches the current set position.

The processing status of list control can be monitored by means of the parameters “List.stateList” and “list_quit”.

Triggering time

The controller checks at intervals of 1 ms whether a setpoint has been reached which triggers a new speed value.

The trigger times must be at least 1 ms apart. Otherwise triggering of the next speed change is delayed by 1 ms.

TLADOCC51ME, -001, 04.03

7.2 Teach Mode

Overview

Teach mode offers the opportunity to capture current position values by moving the motor and automatically copying data to a previously defined memory area. The size of the available memory is based on the amount of free list memory. If the memory is otherwise unused, position values for up to 64 list entries can be stored. Teach mode can be carried out via:

- HMI hand-held control unit
- Commissioning software
- Fieldbus
- Signal interface inputs (only when IO_Mode=2).

The position values are stored in selected data memory for list data. Further settings such as speed values for processing can be set via

- HMI hand-held control unit
- Commissioning software
- Fieldbus.

The controller reads the position values as absolute values in user-defined units.

Operation controlled by commissioning software or HMI hand-held control unit

The commissioning software and the HMI unit support this operating function with special dialog boxes and menu items. Details can be found in the commissioning software and HMI manuals.

Initiating teach mode

The following are requirements for initiating teach mode:

- Axis position defined by referencing or encoder position recorded on initialization
- Output switched on and ready
- Motor in the positioning area
- Motor at standstill

Before teach mode is used for list positions, the data memory must be selected with the “Teach.memNrTeac” parameter:

- List data 1 (position / signal list)
- List data 2 (position / speed list).

For programming list position, the list type must be set via the parameter “L1Data0.TypeList1” or “L2Data0.TypeList2”.

When control is carried out via TL HMI, commissioning software or Fieldbus, the memory number where the position is stored is selected via the parameter “Teach.storeTeac”. When control is carried out via the signal interface, the memory number is selected via the inputs DATA_1...DATA_32.

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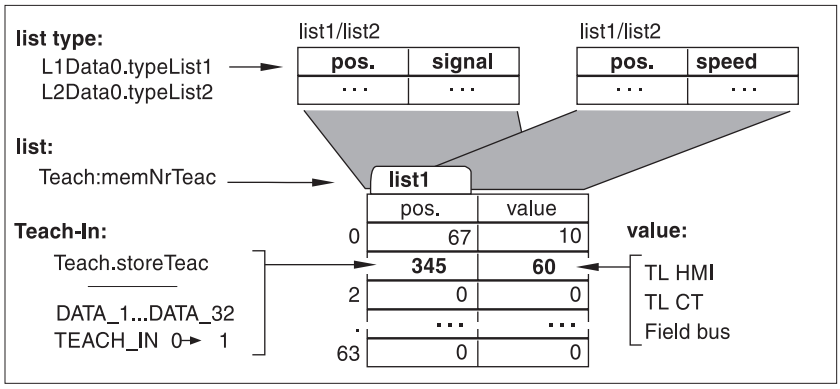

Fig. 7.3 List settings

Control of theTeach-In process via the signal interface is only possible if the ‘Settings.IO_mode’ parameter = 2, and the AUTOM input signal is set to low.

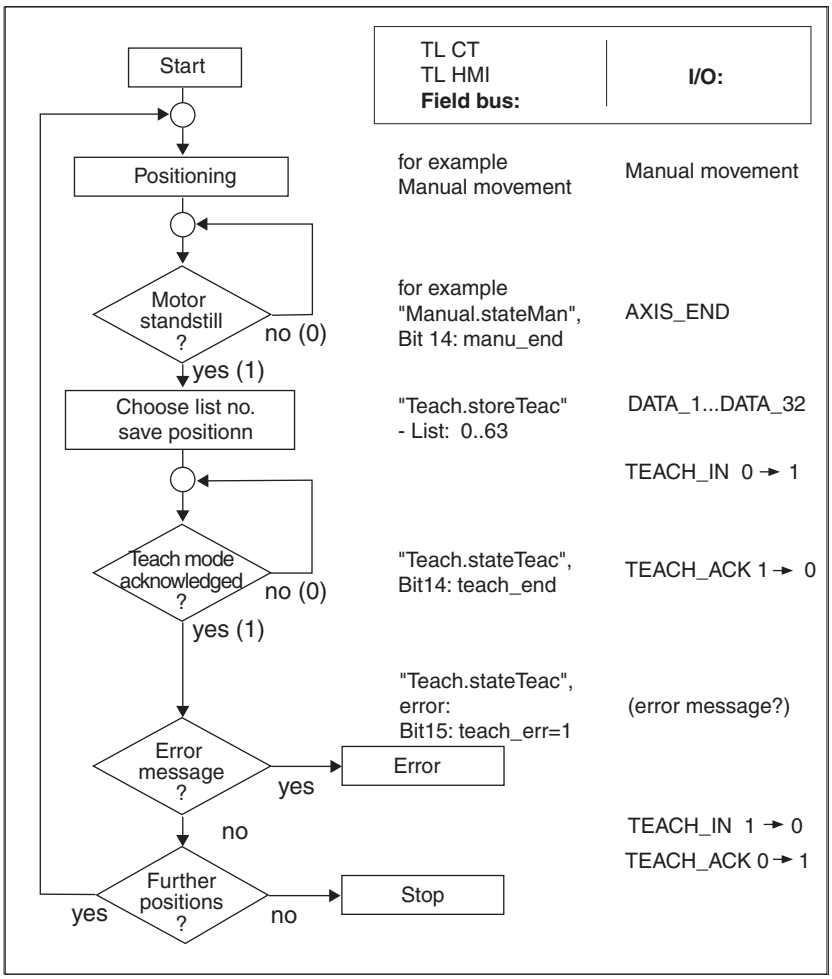

Fig. 7.4 Teach mode process

After each positioning process, the list data can be changed directly via a connected input device.

The signal sequence for teach mode via the signal interface is shown in Fig. 7.5 on page 7-11.

Teach-In via Fieldbus

Positioning is carried out by means of Fieldbus commands, and the selection of list, list type and list number can be set by means of parameters.

Parameter Group.name	Idx:Sidx	TL-HMI	Explanation and units [ ]	Value range	Default value	R/W rem.
Teach.storeTeac	43:1	–	Teach mode, select memory location number in list data memory for storing a position value example: 00010: List number 2	UINT16 50..63 for list data bits 0..5: list number	0	R/W –
Teach.stateTeac	43:2	–	acknowledgement: teach mode	UINT16 Bit15: teach_err Bit14: teach_end	–	R/—
Teach.memNrTeac	43:3	–	Data memory selection for teach mode	UINT16 1: list 1 of list data processing 2: list 2 of list data processing	1	R/W –
Teach.p_actTeac	43:4	–	Motor position stored during teach mode [usr]	INT32	–	R/—
L1Data0.typeList1	1100:1	7.3.1	List 1: list type for all the following list entries (1101:x...1163:x)	UINT16 1: pos./ signal 2: pos. / speed	1	R/W rem.
L2Data0.typeList2	1200:1	7.4.1	List 2: list type for all the following list entries (1201:x...1263:x)	UINT16 1: pos. / signal 2: pos. / speed	1	R/W rem.

Teach mode via signal interface

The motor is positioned for example via manual movement signals. List and list type must be set by means of parameters or a control unit.

The list number must be set via inputs DATA_1 to DATA_32 in order to store the position. The acknowledgement signal is the output DETAIL_2 (TEACH_ACK).

I/O signal	Function	value
DATA_1 DATA_2 DATA_4 DATA_8 DATA_16 DATA_32	Selection of a list set, bit-coded examples: list number 5=000101: DATA_4=1, DATA_1=1 list number 35=100011: DATA_32=1, DATA_2=1, DATA_1=1 non-specified inputs are zero	low/open
TEACH_IN	Reset request Trigger saving	low low->high

TLADOCC51ME, -001, 04.03

7.3 Normalization

Overview Normalization translates user-defined units into the controller's internal units and vice versa. The controller stores position, speed and acceleration values in user-defined units. It then applies its own normalization factor to each value.

For this reason neither positional nor speed values need to be recalculated and re-entered if the motor is changed and the new motor has a different resolution.

The user cannot alter the normalization of the motor position sensor.

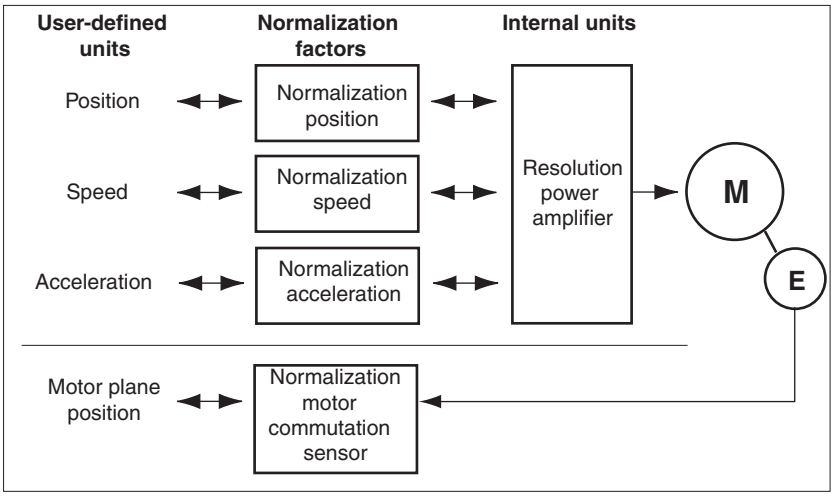

Fig. 7.5 Normalization

7.3.1 Normalization factor, controller value and user value

The normalization factor is described by the ratio of "controller value" to "user value".

$$\text{Normalization factor} = \frac{\text{Controller value}}{\text{User value}}$$

Fig. 7.6 The normalization factor

The units for normalization factor and "controller value" depend on the type of normalization. The "user value" must be given in user units [usr] for all normalization factors.

Normalization factor	User value	Controller value
Position normalization [rev/usr]	Position [usr]	Motor revolution [rev]
Speed normalization [rev/(min*usr)]	Speed [usr]	Motor speed [rpm]
Acceleration normalization [rev./(min*s*usr)]	Acceleration/ deceleration [usr]	Motor speed [rev/(min*s)]

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Normalization factors are set with parameters. A new factor is activated when the numerator value is transferred.

When entering normalization factors note that the ratio can be shown as a complete break.

When entering normalization factors with the commissioning software or the HMI hand-held control unit, the input field for the denominator is automatically displayed when the numerator field is called up.

The values of the normalization factor can only be changed when the power amplifier is inactive. Values entered in user units are converted into internal controller values when the power amplifier is activated. The range of values is checked at the same time.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Motion.pNormNum	29:7	4.4.20	Position normalization numerator	INT32 -2147483648..2147483647	1	R/W rem.
Motion.pNormDen	29:8	–	Position normalization denominator	INT32 -2147483648..2147483647	19200	R/W rem.
Motion.vNormNum	29:9	4.4.21	Speed normalization numerator	INT32 1..2147483647	1	R/W rem.
Motion.vNormDen	29:10	–	Speed normalization denominator	INT32 1..2147483647	1	R/W rem.
Motion.aNormNum	29:11	4.4.22	Acceleration normalization numerator	INT32 1..2147483647	1	R/W rem.
Motion.aNormDen	29:12	–	Acceleration normalization denominator	INT32 1..2147483647	1	R/W rem.

After the normalization factors have been changed, the relevant usr values must also be changed accordingly to ensure the same motor behavior. This applies to the system's non-volatile parameters and user-defined values.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

- Changes to user units (usr) affect the relationship between program settings and actual motor movement.
- When user units are changed, the change effects must be considered for all movement modes, including manual and limit switch operation.

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

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7.3.2 Setting normalization factors

Normalization factor, positioning

The positioning normalization factor set the relationship of the number of motor revolutions required for the number of user-defined units.

It is described by the "controller value" to "user value" ratio and given in rev/usr.

$$\text{Normalization factor for positioning} = \frac{\text{Revolutions [rev]}}{\text{User-defined unit [usr]}}$$

Fig. 7.7 Normalization factor for positioning

The minimum user resolution is the value at which a change of 1 usr effects a change in the motor position – depending on the motor type.

Motor type	Motor resolution	Min. user resolution
Stepper motor with incremental encoder	19200 Inc/rev.	1/19200

The following observations refer to a motor resolution of 1 motor revolution = 19200 Inc.

Three situations can be distinguished when setting user-defined units:

- User-defined resolution corresponds to motor resolution, e.g.
  1 motor revolution ≡ 19200 user-defined units.

  Any motor position can be approached.

- User-defined resolution is higher than motor resolution, e.g.
  1 motor revolution ≡ 19200 increments
  1 revolution ≡ 38400 user-defined units.

  Motor will move only if user-defined units change by two.

- User-defined resolution is lower than motor resolution, e.g.
  1 motor revolution ≡ 19200 increments
  1 revolution ≡ 4800 user-defined units.

  Every fourth motor position can be approached.

To achieve the same positioning movement from the motor after the positioning normalization factor has been changed, the following retentive parameters must be adjusted in addition to the user-defined values in the application: for manual movement: "Manual.dist_Man" and "Manual.step_Man", for referencing "Home.p_disHome" and "Home.p_outHome".

For example, if the reference parameters are not adjusted, en error may occur during the reference movement. The safety distance may be insufficient for leaving the switch area of the limit or reference switch in this case.

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

- Changes to user units (usr) affect the relationship between program settings and actual motor movement.
- When user units are changed, the change effects must be considered for all movement modes, including manual and limit switch operation.

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

If an existing controller is replaced by this controller and the same positioning jobs as before will be used, the normalization must be set to correspond to the former controller.

Example 1 Control of an older stepper motor unit at 1000 inc/rev, i.e. a positioning at 1000 usr should correspond to one motor revolution.

User value = 1000 usr

Controller value = 1 rev

$$\text{Position normalization} = \frac{1\ \text{rev}}{1000\ \text{usr}}$$

Example 2 Positioning of 1111 user-defined units is to correspond to 3 motor revolutions. This gives:

User value = 1111 usr

Controller value = 3 rev

$$\text{Position normalization} = \frac{3\ \text{rev}}{1111\ \text{usr}}$$

If you carry out a relative positioning operation of 900 user-defined units now, the motor will move 900 usr * 3/1111 rev/usr = 2 4302 revolutions.

Example 3 Calculation of a normalization factor for positioning in units of length: 1 motor revolution corresponds to a path of 100 mm. Every user unit [usr] should correspond to one 0.01 mm step.

This gives: 1 usr ≡ 0.01 mm * 1 rev/100 mm = 1/10000 rev.

$$\text{Position normalization} = \frac{1\ \text{rev}}{10000\ \text{usr}}$$

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Example 4 Setting positioning in 1/1000 rad, 1rad = 1 rev/(2*π), π = 3.1416 (rounded)

User value = 1 usr

Controller value = 1/(2*π*1000) rev

$$\text{Position normalization} = \frac{1\ \text{rev}}{2*3{,}1416*1000\ \text{usr}} = \frac{1\ \text{rev}}{6283{,}2\ \text{usr}} = \frac{10\ \text{rev}}{62832\ \text{usr}}$$

Normalization factor, speed The speed normalization factor describes the connection between the number of motor revolutions and the time required for them.

It is described by the "controller value" to "user value" ratio and given in rpm per usr.

$$\text{Normalization factor for speed} = \frac{\text{Revolutions [rev]}}{\text{Unit of time [min]}}$$

Fig. 7.8 Normalization factor for speed

The minimum user resolution is the value at which a change of 1 usr effects a change in the motor speed.

Motor type	Motor resolution	Min. user resolution
Stepper motor with incremental encoder	19200 Inc/rev.	1 / 81.92

Example 1 Setting corresponding to stepping motor resolution of 1000 Inc/rev. The speed resolution is to be 1 Hz or 1/1000 rev/s.:

User value = 1 usr

Controller value = 60/1000 rpm

$$\text{Speed normalization} = \frac{60\ \text{rev}}{1000\ \text{min} * 1\ \text{usr}} = \frac{3\ \text{rev}}{50\ \text{min*usr}}$$

Example 2 Setting the speed in steps of 1/10 rpm:

User value = 10 usr

Controller value = 1 rpm

$$\text{Speed normalization} = \frac{1\ \text{rev}}{1\ \text{min} * 10\ \text{usr}} = \frac{1\ \text{rev}}{10\ \text{min*usr}}$$

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Example 3 Linear axis moves by 100 mm in one motor revolution; values should be entered in steps of 1 mm/s.

This gives: 1 usr ≡ 0.01 rev/s = 60/100 rpm

User value = 1 usr

Controller value = 60/100 rpm

$$\text{Speed normalization} = \frac{60\ \text{rev}}{100\ \text{min} * 1\ \text{usr}} = \frac{3\ \text{rev}}{5\ \text{min*usr}}$$

Example 4 Setting the speed in 1/10 rad/s, 1rad = 1 rev/(2*π), π = 3.14 (rounded)

User value = 1 usr

Controller value = 60/(2*π*10) rpm

$$\text{Speed normalization} = \frac{60\ \text{rev}}{100\ \text{min} * 1\ \text{usr}} = \frac{600\ \text{rev}}{628\ \text{min*usr}} = \frac{150\ \text{rev}}{157\ \text{min*usr}}$$

Normalization factor, Acceleration The acceleration normalization factor is used to define the smallest unit for the acceleration setting

The normalization factor for speed is described by the ratio of "controller value" to "user value" and given in rev/(min*s) per usr.

$$\text{Normalization factor for acceleration} = \frac{\text{Speed [r.p.m.]}}{\text{Unit of time [s]}}$$

Fig. 7.9 Acceleration normalization factor

The minimum user resolution is the value at which a change of 1 usr effects a change in the motor acceleration – depending on the motor type.

Motor type	Motor resolution	Min. user resolution
Stepper motor with incremental encoder	19200 Inc/rev.	12.21 / 1

Example 1 Setting corresponding to stepping motor resolution of 1000 Inc/rev. The acceleration resolution is to be 1 Hz/ms:
1/1000 rev /(s*ms) or 60 rev /(min*s) is:

User value = 1 usr

Controller value = 60 rev/(min*s)

$$\text{Speed normalization} = \frac{60\ \text{rev}}{1\ \text{min*s} * 1\ \text{usr}} = \frac{60\ \text{rev}}{1\ \text{min*s*usr}}$$

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Example 2 Setting acceleration in steps of 1/10 rev/(min*s):

User value = 1 usr

Controller value = 10 rev/(min*s)

$$\text{Speed normalization} = \frac{10\ \text{rev}}{1\ \text{min*s} * 1\ \text{usr}} = \frac{10\ \text{rev}}{1\ \text{min*s*usr}}$$

Example 3 Linear axis moves 100 mm at one motor revolution; values should be entered in steps of 10 mm/s^2.

User value = 1 usr

Controller value = 0.1 rev/s^2 = 60/10 rev/(min*s)

$$\text{Acceleration normalization} = \frac{60\ \text{rev}}{10\ \text{min*s} * 1\ \text{usr}} = \frac{6\ \text{rev}}{1\ \text{min*s*usr}}$$

Example 4 Setting in rad/s^2, 1 rad= 1 rev/(2*π)
1 user-defined unit ≡ 1 rad/s^2 = 1 rev/(2*π *s^2) = 60/(2*π) rev/(min*s)
π = 3.14 (rounded)

User value = 1usr

Controller value = 60/(2*π) rev/(min*s)

$$\text{Acceleration normalization} = \frac{60\ \text{rev}}{2*3{,}14\ \text{min*s} * 1\ \text{usr}} = \frac{6000\ \text{rev}}{628\ \text{min*s*usr}} = \frac{1500\ \text{rev}}{157\ \text{min*s*usr}}$$

TLADOCC51ME, -001, 04.03

7.3.3 Residual value in user-defined normalization

If the movement data are given in user-defined units, the controller calculates in internal units corresponding to the resolution 19200 Inc/rev and moves to the nearest internal position corresponding to the user-defined position.

Discrepancies can occur between the actual position of the motor and the nearest possible user-defined position due to an interruption to the movement or a change from an operating mode with internal resolution to one with user-defined resolution. The differential value can be interrogated via the “Status.p_remaind” parameter.

Parameter Group.name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default-Value	R/W rem.
Status.p_remaind	31:37	–	Residual value of position normalization of position setpoint p_ref [Inc]	INT32	–	R/– –

During teach mode, if the residual value = 0, current motor position can be calculated exactly from the stored user position. If the residual value is not equal to zero, the closest user position is stored.

Example of residual value

Motor resolution is 19200 Inc/rev.

Resolution of user-defined unit [usr]: 1200 Inc./rev. => 1 usr = 16 Inc

The motor follows a change of one user-defined position by rotating 16 increments.

If the drive remains on 16005 Inc due to the movement being interrupted, “Status.p_remaind” displays the value 5 as the distance to the nearest user-defined unit.

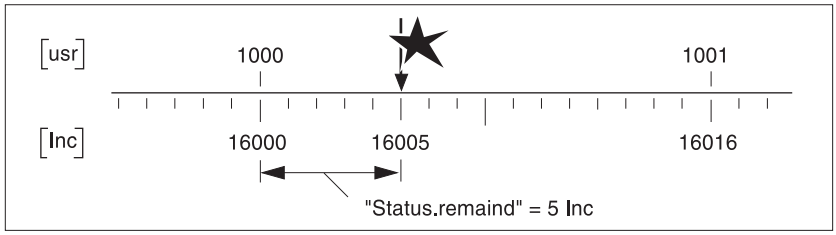

Fig. 7.10 Residual value after interruption to movement at 16005 Inc

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7.4 Ramp function

The controller uses the ramp functions to control the acceleration and deceleration behaviour of the motor. The gradient and shape of the ramp describe the ramp function. The ramp gradient shows the motor's change of speed, and the shape of the ramp the acceleration over time.

Ramp gradient

The ramp gradient for the acceleration and deceleration ramps can be set on the controller with the "Motion.acc" and "Motion.dec" parameters.

The controller absorbs excess braking energy during deceleration. If the DC link voltage exceeds a permissible threshold in this process, the controller switches off the power amplifier and displays error 5 "DC link overvoltage". The motor then runs down under no braking.

The gradient for the deceleration ramp should be set in such a way that the motor brakes as quickly as possible without causing the output to trip out due to overvoltage.

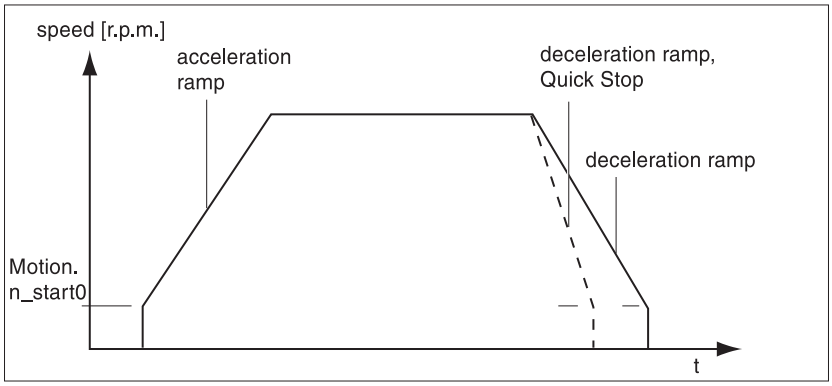

Fig. 7.11 Acceleration and deceleration ramps

Settings for the ramp gradient are given in user-defined units. For the steps to optimize the ramp function see "Optimizing the controller" on page 5-24.

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Ramp shape

The controller can use a linear ramp and a motor-optimized ramp as the ramp shape for the acceleration and deceleration phases.

The linear ramp is always used as the ramp shape for a quick stop ramp.

The motor-optimized ramp is used to compensate for the typical stepper motor torque reduction at increasing speed by reducing the acceleration.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Motion.n_max0	29:21	4.4.28	Speed limit for travel profile [rpm]	UINT32 1...3000	3000	R/W rem.
Motion.n_start0	29:22	4.4.10	Start-stop speed [rpm]	UINT32 1..n_max0	12	R/W rem.
Motion.acc_type	29:25	4.4.13	Shape of acceleration curve	UINT16 1: linear 2: motor-optimized ramp	1	R/W rem.
Motion.acc	29:26	4.4.14	Acceleration [usr]	UINT32 1...2147483647	600	R/W rem.
Motion.dec	29:27	4.4.15	Deceleration [usr]	UINT32 1...2147483647	600	R/W rem.

Jerk filter

The jerk filter is used to smooth sudden changes in speed to produce smooth, non-jerky changes in speed.

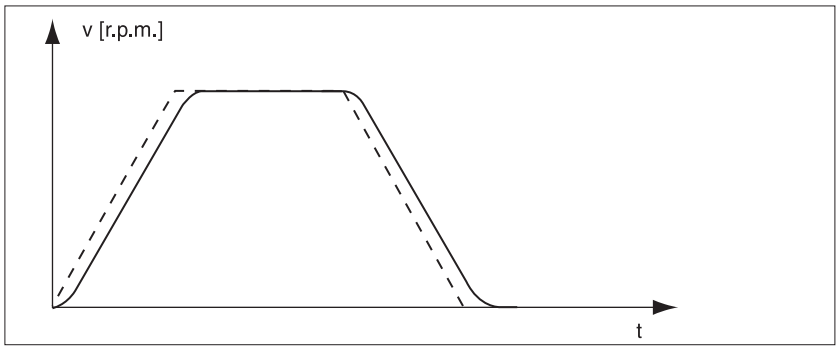

Fig. 7.12 Acceleration ramp with and without (dotted line) jerk filter

The jerk filter can be switched off by the "Motion.Flt_jerk" parameter.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Motion.Filt_jerk	28:5	4.4.26	Jerk filter	UINT16 0..30 0: off 3..30: filter setting value	0	R/W rem.

7.5 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.

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

Quick-Stop is an emergency braking function for motor in the event of a fault. Quick-Stop can be triggered:

- By the $\overline{\text{STOP}}$ input signal
- By the stop command issued through a connected input device
- When limit switches via the $\overline{\text{LIMP}}$, $\overline{\text{LIMN}}$ or $\overline{\text{REF}}$ input signals
- When the software limit switch areas SW_LIMP or SW_LIMN are passed
- By an operational malfunction that requires an emergency stop

Quick-Stop remains active until the motor has come to a complete stop. In the event of a fault category 1 fault response, the power amplifier remains on.

Quick-Stop via deceleration ramp or Quick-Stop ramp

The "Settings.SignQstop" parameter defines whether the motor is stopped by the Quick-Stop ramp or the deceleration ramp. The deceleration ramp is set under "Motion.Dec". The deceleration for the Quick-Stop ramp is set with the "Settings.dec_Stop" parameter.

This does not apply for electronic gear mode. The deceleration for the Quick-Stop ramp is always set with the "Gear.a_maxGear" parameter.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Settings.SignQstop	28:20	4.1.26	Control signals that trigger the Quick-Stop via 0: deceleration ramp 1: ramp for Quick-Stop	UINT16 Bit0: LIMP Bit1: LIMN Bit2: STOP Bit3: REF Bit4..6: unassigned Bit7: SW_STOP	0	R/W rem.
Settings.dec_Stop	28:21	–	Deceleration for Quick-Stop [rev/(min*s)]	60..2000000	6000	R/W rem.

Settings for Quick-Stop

The controller absorbs excess braking energy during a Quick-Stop. If the DC Bus voltage exceeds a permissible threshold, the controller switches off the power amplifier and displays error 5 "DC link overvoltage". The motor then runs down under no braking.

The current for the deceleration torque should be set such that the controller comes to a halt with maximum deceleration but without tripping out.

If the controller trips out frequently during Quick-Stop, or the motor experiences a free wheel condition, the quick stop deceleration must be reduced.

Acknowledging Quick-Stop

Quick-Stop must be acknowledged with the FAULT_RESET input signal or the error confirmation of an input device.

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 7-27.

7.6 Reversal of direction of rotation

If the motor's direction of rotation has to be reversed, all the parameter values can be used unchanged.

▶ Reverse the sense of rotation using the “Motion.invertDir” parameter.

The limit switch which limits the working area during clockwise rotation must be connected to $\overline{\text{LIMP}}$. The limit switch which limits the working area during counter-clockwise rotation must be connected to $\overline{\text{LIMN}}$.

Parameter Group.name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default-Value	R/W rem.
Motion.invertDir	28:6	4.4.27	Inversion of sense of rotation	UINT16 0: no inversion 1: sense of rotation inverted	0	R/W rem.

TLADOCC51ME, -001, 04.03

7.7 Fast position capture

Position values can be recorded via two channels whose parameters can be adjusted. The capture inputs have an input delay period of 100 µs. This delay period has a maximum spread of +/-10 µs. At constant drive speed the jitter is a maximum of +/-5 µs.

The parameter "Capture.TrigSign" defines the signal source of a position value capture. The I_5/CAP1 and I_6/CAP2 inputs of the signal interface or the index pulse of a position encoder in slot M1.

A capture can be triggered by a rising or falling signal slope. The slope change is set with the "Capture.TrigLevl" parameter. Changes to the parameter "Capture.TrigLevl" are only activated when the positioning detection is restarted by writing to the "Capture.TrigStart" parameter.

Starting position capture

The "Capture.TrigStart" parameter activates a new recording procedure. Any stored position value is first deleted. As soon as a new position value has been recorded, the signal level of the "Capture.TrigStat" parameter changes from "0" to "1". The value remains stored until a new process is triggered for this channel.

The positíoning controller calculates the position values from the elapsed trime and the speed at the setpoint and actual position. The position values can be interrogated via "Capture.TrigPact1/2" and

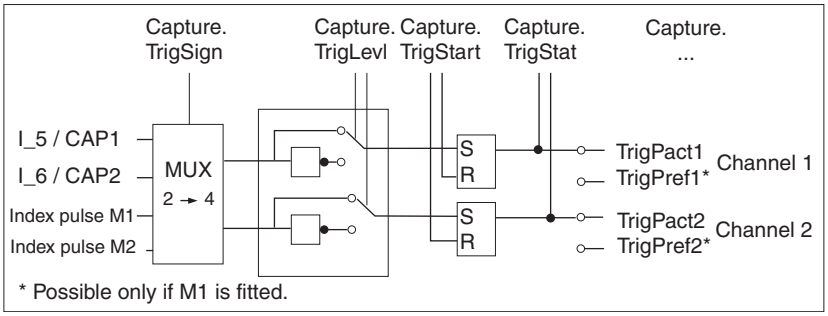

Fig. 7.13 Fast position capture, signal pattern and parameter

Continuous position capture

Position capture can be executed once or continuously. It can be set in bit15 in "Capture.TrigStart":

- Bit15=0: the position value after the first triggering is stored. Further values are ignored until the process is restarted.
- Bit15=1: every triggering updates the position value.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Capture.TrigSign	20:13	–	Selection of trigger signals for position storage Bit3.0.2: signal - channel 2 (K2) Bit1.0.0: signal - channel 1 (K1) Examples: 4: binary 01 00 => CAPTURE2 (K2), CAPTURE1 (K1) 9: 10 01 => CAPTURE2 (K2), Indexp. setpoint pos. (K1)	UINT16 0..15 bits 0..1/bits 2..3 (K1/K2): - 00: CAPTURE1 - 01: CAPTURE2 - 10: index pulse setpoint pos. encoder (with module at M1) - 11: index pulse actual pos. encoder (at SM with module at M2)	4	R/W –
Capture.TrigType	20:14	–	Position source for position storage	UINT16 0..1 0: actual position encoder 1: setpoint position encoder	1	R/W –
Capture.TrigLevl	20:15	–	Signal level for trigger channels bit state: 0: triggering at 1->0 change 1: triggering at 0->1 change	UINT16 0..3 Bit0: set trigger level on channel 1 Bit1: set trigger level on channel 2	3	R/W –
Capture.TrigStart	20:16	–	start triggering (bits0..1): 0: no change 1: reset triggering and restart cancel triggering (Bit14=1) repeat triggering (Bit15) 0: trigger once 1: trigger continuously	UINT16 0..3 Bit0: trig. on channel 1 Bit1: trig. on channel 2 Bit14: cancel trig. Bit15: trig. repeat	0	R/W –
Capture.TrigStat	20:17	–	Status, triggering executed	UINT16 0..3 Bit0: triggering on channel 1 Bit1: triggering on channel 2	–	R/– –
Capture.TrigPact1	20:18	–	Actual position of motor on triggering on channel 1 [Inc]	INT32 -214748364..2147483647	–	R/– –
Capture.TrigPact2	20:19	–	Actual position of motor on triggering on channel 2 [Inc]	INT32 -214748364..2147483647	–	R/– –
Capture.TrigPref1	20:20	–	Setpoint of elect. gear on triggering on channel 1 [Inc]	INT32 -214748364..2147483647	–	R/– –
Capture.TrigPref2	20:21	–	Setpoint of elect. gear on triggering on channel 2 [Inc]	INT32 -214748364..2147483647	–	R/– –

TLADOCC51ME, -001, 04.03

7.8 Monitoring functions

7.8.1 Monitoring of axis signals

Positioning limits

The motor can be moved to any point on the axis within the axis positioning range by specifying an absolute positioning process.

The axis travel range is specified in internal units in the range -2^{31} to $+2^{31}$ increments. The resolution of the motor encoder in increments is specified as the internal unit.

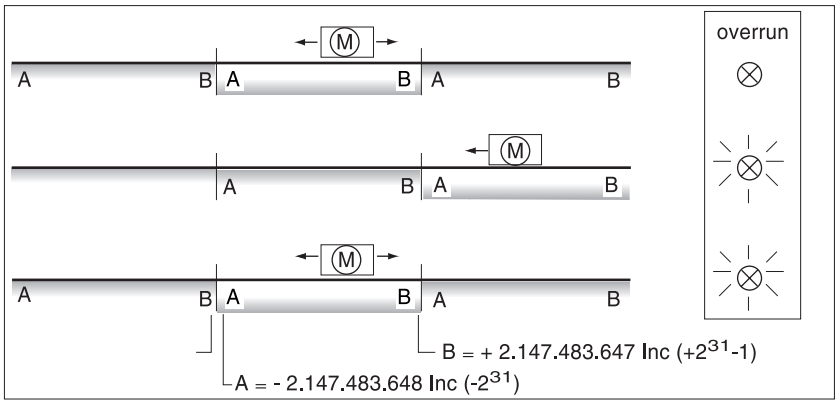

Fig. 7.14 Positioning range and range overrun

If the motor crosses the positioning limits, the internal monitoring signal for position overrun is set and the work area moved by 2^{32} units. The "Status.IntSigSR" parameter displays a position overrun on bit2.

The monitoring signal remains set when the motor moves back into the valid area. It is reset by a new referencing procedure or by switching the controller off and on.

Positioning limits can be crossed in speed mode, electronic gear mode, referencing and manual mode. In Point to Point positioning, after limits have been crossed, values are used in the new work area.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Status.IntSigSr	29:34	2.3.4.2	Monitoring signals in controller 0: not active, 1: activated	UINT32 0..4294967295 Bit0..1: reserved Bit2: position overflow Bit3..4: reserved Bit5: SW limit switch, pos. sense of rotation (SW_LIMP) Bit6: SW limit switch, neg. sense of rotation (SW_LIMN) Bit7: stop via control word (SWSTOP) Bit8..14: reserved Bit15: amplifier not active Bit16..31: reserved	-	R/– –

Software limit switches

The software limit switch position is set with the "Motion.SW_LimP" and "Motion.SW_LimN" parameters and activated with "Motion.SW_Enabl". The determining factor for position monitoring of the software limit switch range is the setpoint of the position controller. Depending on the controller setting, therefore, the motor can stop before it reaches the limit

switch position. Bits5 and 6 of the "Status.IntSigSr" parameter signal that the limit switch position has been crossed.

Parameter			Explanation and unit [ ]	Range of values	Default	R/W
Group.Name	Idx:Sidx	TL-HMI			Value	rem.
Motion.SW_LimP	29:4	4.4.5	Software limit switch for pos. position limit LIMP condition: SW_LimP > SW_LimN [usr]	INT32 -2147483648..2147483647	2147483647	R/W rem.
Motion.SW_LimN	29:5	4.4.6	Software limit switch for neg. position limit LIMN condition: SW_LimN > SW_LimP [usr]	INT32 -2147483648..2147483647	-2147483648	R/W rem.
Motion.SW_Enabl	29:6	4.4.7	Set monitoring of software limit switches 0: deactivated 1: activated	UINT16 Bit5: SW_LIMP Bit6: SW_LIMN	0	R/W rem.
Status.IntSigSr	29:34	2.3.4	Monitoring signals 0: not active, 1: activated	UINT32 Bit5: SW limit switch, pos. sense of rotation (SW_LIMP) Bit6: SW limit switch, neg. sense of rotation (SW_LIMN)	–	R/– –

Limit switch signal and $\overline{STOP}$ signal

⚠ WARNING

LOSS OF CONTROL DURING OR FOLLOWING A MOTION

Using the $\overline{LIMP}$, $\overline{LIMN}$, and $\overline{STOP}$ 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 $\overline{LIMP}$, $\overline{LIMN}$, and $\overline{STOP}$ input connection requirements.
- Use of the $\overline{LIMP}$, $\overline{LIMN}$, and $\overline{STOP}$ 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 $\overline{LIMP}$, $\overline{LIMN}$, and $\overline{STOP}$ input functions must be enabled in the controller software.
- The $\overline{LIMP}$, $\overline{LIMN}$, and $\overline{STOP}$ 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 or serious injury.

During motion, both limit switches are monitored by input signals $\overline{LIMN}$ and $\overline{LIMP}$. If the drive reaches a limit switch, the controller stops the motor. The triggering of the limit switch is signalled on the input device. Set up the limit switches in such a way that the drive cannot cross the switch restriction. For example, use longer actuator lugs.

TLADOCC51ME, -001, 04.03

The $\overline{\text{STOP}}$ input signal stops the motor by Quick-Stop. Further processing is possible if:

- The STOP signal is canceled and
- Quick-Stop has been acknowledged and
- A new movement command is activated

Enabling the input signals $\overline{\text{REF}}$, $\overline{\text{LIMP}}$, $\overline{\text{LIMN}}$ and $\overline{\text{STOP}}$ and evaluation as active low or high can be changed with the parameters Changing "Settings.SignEnabl" and "Settings.SignLevel":

Parameter			Explanation and unit [ ]	Range of values	Default	R/W
Group.Name	Idx:Sidx	TL-HMI			Value	rem.
Settings.SignEnabl	28:13	4.1.10	Signal enable for monitoring inputs 0: blocked 1: released	UINT16 0..15 Bit0: LIMP Bit1: LIMN Bit2: STOP Bit3: REF	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	UINT16 0..15 Bit0: LIMP Bit1: LIMN Bit2: STOP Bit3: REF	0	R/W rem.

The REF switch does not have to be enabled for the reference movement. If the REF switch is enabled, it takes on the function of an additional STOP switch (exception: reference movement to REF).

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.

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.

7.8.2 Monitoring internal signals

Monitoring systems protect motor, power amplifier and load resistors from overheating, and ensure functional and operational safety. A list of all safety devices can be found in "Safety devices" on page 2-5.

The controller displays error messages and warnings by causing the 7-segment display to flash. In addition a connected control panel displays an error text.

Temperature monitoring

Sensors monitor the temperature of the motor and power amplifier. If the power amplifier or motor exceed aq limit temperatire, the controller switches off the power amplifier to protect it from overheating and reports a temperature error. All temperature limits are permanently set.

Monitoring parameters

The parameters listed in the "Status" set can be used to monitor unit status and operating status with parameters. They include

- "Status.FltSig" (28:17), "Status.FltSig_SR" (28:18) and "Status.IntSigSR" (29:34) for monitoring internal unit signals
- "Status.action_st" (28:19) for monitoring the operating status
- "Status.StopFault" (32:7), with which the cause of the last interruption can be determined

Information on evaluating the monitoring facilities built into the unit over the Fieldbus can be found in "Diagnosis and error rectification" on page 8-1.

TLADOCC51ME, -001, 04.03

7.8.3 Monitoring communications with Fieldbus

The following diagnostic values are available to monitor Fieldbus communications.

- Content of controller transmission data
- Content of controller receive data
- Bus statistics for determining the frequency of communications errors

The diagnostic values can be read as follows:

- TL HMI
- TL CT
- Fieldbus

TL CT: Displaying objects

▶ Open the diagnostics window with "Twin Line → Diagnosis → device data".

▶ Enter index and subindex of the desired diagnostic value in the "device data" window.

Sending and receiving data

The current content of the sending and receiving data can be determined with the following diagnostic values. See the Fieldbus manuals for the byte assignments.

Parameter			Explanation and unit [ ]	Range of values	Default	R/W
Group.Name	Idx:Sidx	TL-HMI			Value	rem.
M4.busTxD	24:33	2.6.2	Sending data online command processing (Byte 1 ... 4)	UINT32 0...4294967295	0	R/– –
M4.busTxD5_8	24:34	2.6.2	Sending data online command processing (Byte 5 ... 8)	UINT32 0...4294967295	0	R/– –
M4.busRxD	24:28	2.6.1	Receiving data online command processing (Byte 1 ... 4)	UINT32 0...4294967295	0	R/– –
M4.busRxD5_8	24:29	2.6.1	Receiving data online command processing (Byte 5 ... 8)	UINT32 0...4294967295	0	R/– –

TLADOCC51ME, -001, 04.03

Bus statistics The bus statistics can be used to find information on the number of timeout errors and bus cycles. The total of all errors that resulted in breaking a connection can be determined. The following diagnostic values in the M4 parameter group are available:

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
M4.busTout	24:31	2.6.6	Bus statistics timeout: Total number of broken connections caused by timeout (node guarding)	UINT16 0...65535	0	R/ W–
M4.busError	24:32	2.6.7	Bus statistics transmission error: total of all errors that resulted in a connection break	UINT16 0...65535	0	R/ W–
M4.busCycle	24:35	2.6.6	Bus statistic bus cycles: total number of all processed bus cycles	UINT32 0...4294967295	0	R/ W–

TLADOCC51ME, -001, 04.03

7.9 Braking function with Holding Brake Control (TL HBC)

For motors fitted with a holding brake, the brake prevents unintended movement of the motor when not under power. The controller controls the holding brake via the holding brake control system (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 which is in the same cable as the power connections to the motor, is safely separated from the controller's signal connections in the event of insulation breaks occurring in the motor cable.

Standard unit

For set-up and function test, the holding brake can be released with the push-button switch located on the front of the holding brake control system.

IP54 Version

For set-up and function testing the holding brake can be controlled via the TL CT commissioning software or the TL HMI.

Brake signals

ACTIVE-CON switches to “high” and releases the brake as soon as the amplifier is enabled and the motor has holding torque.

I/O signal	Function	Value
ACTIVE-CON	Brake disengaged, no braking torque/ Brake engaged, braking torque	high / low
ACTIVE-0V	0 V connection for ACTIVE-CON	low

Voltage reduction

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.

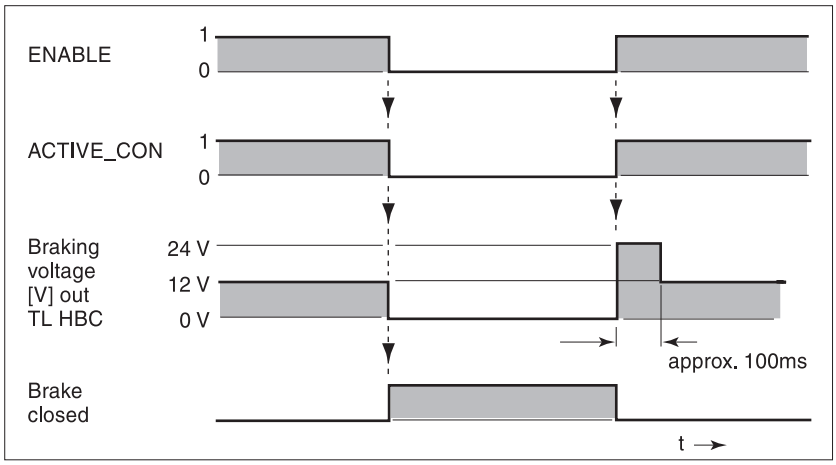

Fig. 7.15 Timing diagram, brake function with voltage reduction on

When the supply voltage is switched on, the holding brake control system and the switch/test functions are reset. No voltage is present on the control terminals of the brake, and the control system LED is off.

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 there is power in the DC link.

The 7-segment display shows the operating states of the controller in coded form.

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

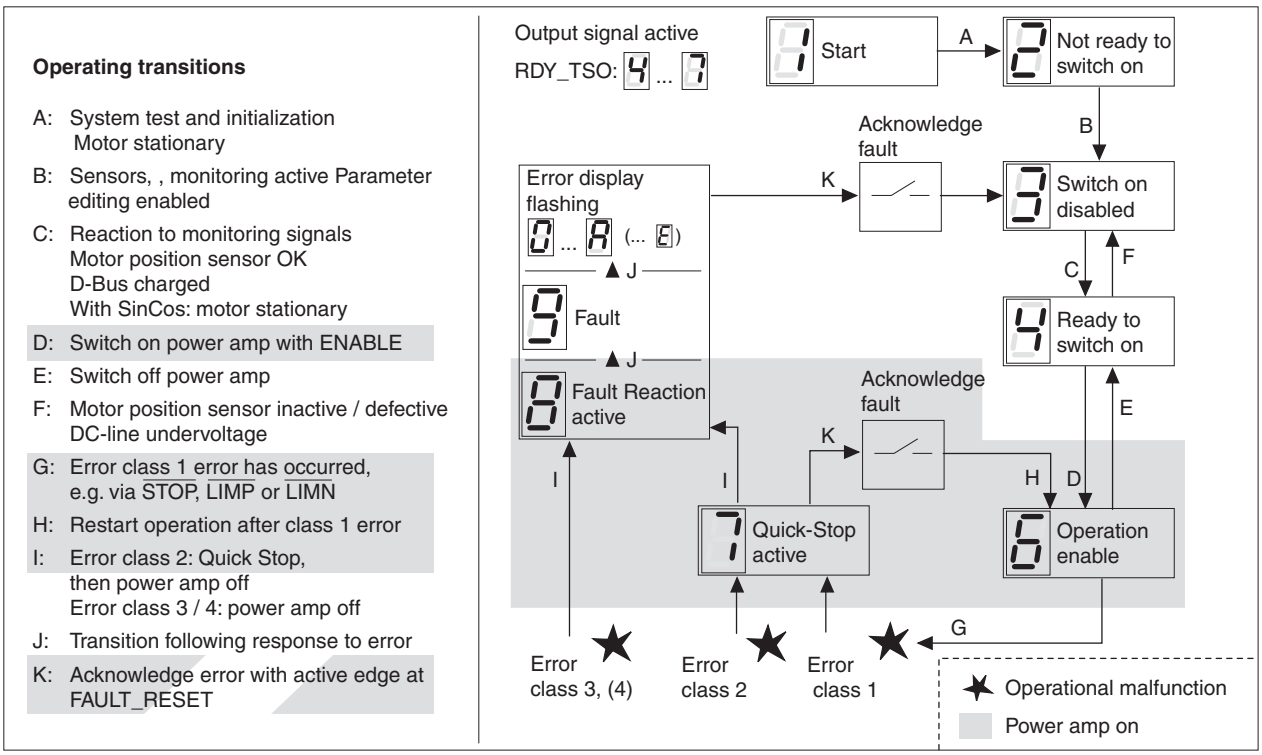

Fig. 8.1 Operating states and transitions of the controller

Operating transitions

The conditions for changing between the operating states displayed and the response of the controller to an error follow a fixed sequence.

Changing the operating status is controlled by the "Commands.driveCtrl" parameter.

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Commands. driveCtrl	28:1	-	Control word for state change, default Bit0..3="0", Write access automatically triggers slope change 0->1.	UINT16 0..15 Bit0: disable amplifier Bit1: enable amplifier Bit2: stop (Quick-Stop) Bit3: FaultReset Bit4..15: not assigned	0	R/W –

8.2 Error display and rectification

Error display

The cause of an operating malfunction is displayed

- By a flashing number in the seven-segment display
- In the commissioning software as an error message on the control bar and in the list of the error memory
- In the display of the HMI hand-held unit as an error message and in the list of the error memory
- Bit-coded in the parameters "Status.FltSig", "Status.FltSig_SR", "Status.IntSigSR" and "Status.Sign_SR"
- By the error response of the controller

The controller responds to a fault with the limit switch or Stop signal by initiating a Quick-Stop and displaying "7" for QuickStopActive. The cause of the interruption is recorded in the error memory and can be accessed via the HMI hand-held unit or the commissioning software.

Resetting error messages

Once the error has been corrected, the message can be reset

- By setting the FAULT_RESET input signal
- By the commissioning software with the Reset button
- By switching off the power supply to the controller

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Error response

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

Error class	Response	Meaning
0	Warning	Message only, no interruption to movement operations
1	Quick-Stop	The motor stops with Quick Stop, the power amplifier remains switched on.
2	Quick-Stop with shut-off	The motor stops with Quick-Stop, the power amplifier switches off at standstill.
3	Fatal error	Power amplifier switches off. The unit can only be reactivated after the error has been corrected.
4	Uncontrolled operation	Power amplifier switches off. The error response can only be reset by switching off the unit.

Error rectification

Display	Error	Error class	Cause	Troubleshooting
dark	display dark	-	No power supply	Check power supply and fuses
	display dark	-	Power supply wrongly connected	Connect properly
1	Undervoltage	3	DC link voltage below threshold value for switching off the drive	Check line voltage and check connections to unit
2	Contouring error	3	Drive blocked; start-stop frequency too high; movement frequency or acceleration too high	Reduce load or motor torque check settings for motor current set start-stop frequency lower; reduce movement frequency or acceleration
	Reference encoder at M1	1	Cable fault to RS422 or sensor defective	Check encoder cable and encoder, replace cable
	Maximum motor speed	3	Maximum motor speed exceeded	reduce pulse frequency
3	Motor cable	3	Short circuit or ground fault in motor cable	Check connections, replace motor cable
4	Position sensor	3	Only with TLC51x with speed monitoring: encoder or encoder cable defective	Check encoder cable and encoder, replace cable
5	Overvoltage	3	DC link overvoltage	Use external capacitor
7	power amplifier overtemperature	3	The power amplifier is overheating	Reduce load, use current drop to reduce power
	Motor overtemperature	3	The motor is overheating Temperature sensor is not connected	Allow motor to cool Reduce load, use a motor with a higher rated power, use current drop to reduce power, check or replace motor encoder cable
8	Watchdog	4	Internal system error	Switch unit off and on, replace unit
	Control system error	4	System error, e.g. division by 0 or time-out checks, insufficient EMC	Comply with EMC protective measures, switch unit off and on, contact your local service representative
O	Error at outputs		Short circuit in digital outputs, No 24 V for signal interface IO 24 VDC	Check connections and wiring supply pin 7 and 8 with 24 V_{DC}

TLADOCC51ME, -001, 04.03

Display	Error	Error class	Cause	Troubleshooting
I	Controller system error	3	Cause of error corresponding to error number in error memory	Correction dependent on error number
	Controller system error	4	Cause of error corresponding to error number in error memory	Correction dependent on error number
None [1)]	Limit switch	1	Limit switch is or was activated, wire interrupted	Traverse drive to movement range, match positioning data to axis range special report in 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 RS-232 connection at controller
	Timeout	1	Error in communication protocol	Timeout exceeded during exchange of data with manual control unit, restart transmission

1) No error display, operating status continues to be displayed.

IP54 controller The following error can occur in IP54 controller.

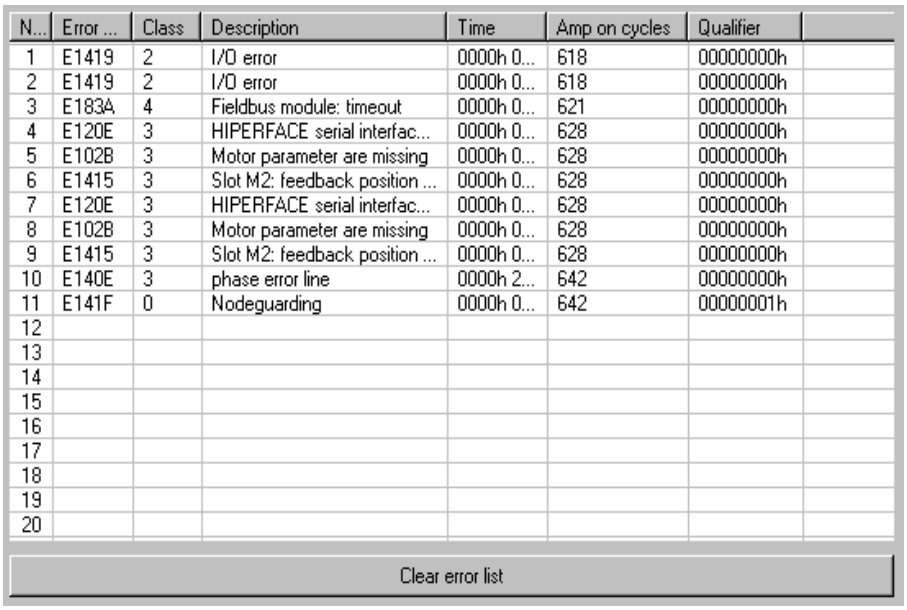
Display	Cause	Troubleshooting
Dark	Functions disabled due to condensation	Allow unit to dry and reduce humidity

With the commissioning software TL CT and the TL HMI the current and the last 20 error messages are displayed.

TLADOCC51ME, -001, 04.03

TL CT: Error display

▶ Select "Twin Line → Diagnosis → Error memory". A dialog box which displays the error messages appears.



N...	Error ...	Class	Description	Time	Amp on cycles	Qualifier
1	E1419	2	I/O error	0000h 0...	618	00000000h
2	E1419	2	I/O error	0000h 0...	618	00000000h
3	E183A	4	Fieldbus module: timeout	0000h 0...	621	00000000h
4	E120E	3	HIPERFACE serial interfac...	0000h 0...	628	00000000h
5	E102B	3	Motor parameter are missing	0000h 0...	628	00000000h
6	E1415	3	Slot M2: feedback position ...	0000h 0...	628	00000000h
7	E120E	3	HIPERFACE serial interfac...	0000h 0...	628	00000000h
8	E102B	3	Motor parameter are missing	0000h 0...	628	00000000h
9	E1415	3	Slot M2: feedback position ...	0000h 0...	628	00000000h
10	E140E	3	phase error line	0000h 2...	642	00000000h
11	E141F	0	Nodeguarding	0000h 0...	642	00000001h
12						
13						
14						
15						
16						
17						
18						
19						
20						

Clear error list

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 Qu.., Qualifier. At the error message "E1855 initialization error in parameter IxSix -> Qualifier" the Qualifier identifies the index/subindex 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, Qualifier is showing 00290023h. This is parameter 29:23 "Motion.v_target0".

A detailed error message is given in the following sumcheck error messages:

- 181Bh: "error while processing manual movement -> Qualifier"
- 181Fh: "error while processing reference movement -> Qualifier"
- 181Dh: "error in changing user mode -> Qualifier"

More detailed information can be found in the Qualifier; e.g. 00001846h, this is error message No. E1846 in the error list.

TLADOCC51ME, -001, 04.03

▶ Acknowledge the current error message with the "Reset" button on the command bar of the program.

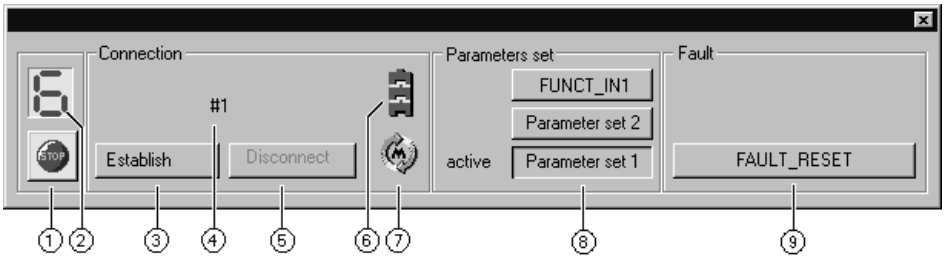


Fig. 8.3 Reset button, 9

TL HMI: Error display

▶ Use menu item "2.4 Error" to change to the menu items for displaying error messages.

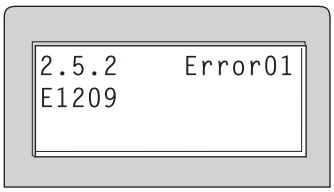


Fig. 8.4 Displaying an error value

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	1. error entry, oldest report
2.5.3 Error02	2. error entry, later report, if present
...	...

The meaning of the error values with cause and troubleshooting information is given in the HMI hand-held unit manual.

Fieldbus: evaluating error messages

In Fieldbus operation device faults are reported as asynchronous errors by the controller's monitoring facility. An asynchronous error is recognized by the status word "fb_statusword". Signal status "1" indicates an error or warning message. Details on the cause of the error can be determined via parameters.

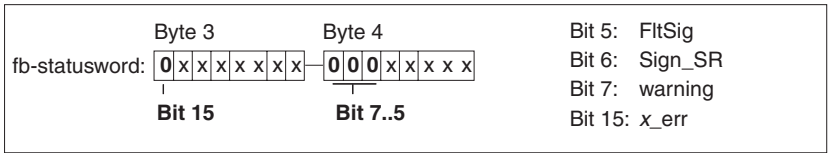


Fig. 8.5 Error evaluation for asynchronous error

- Bit5, "FltSig": message from internal monitoring signal e. g. overtemperature power amplifier. Details of parameters "Status.FltSig_SR" and "Status.IntSigSR"
- Bit6, "Sign_SR": message from external monitoring signal e. g. movement interruption by $\overline{\text{STOP}}$ input. Details of "Status.Sign_SR" parameter

TLADOCC51ME, -001, 04.03

- Bit7, "warning": controller warning message
  Details of parameters
  "Status.FltSig_SR" and "Status.IntSigSR"

Besides asynchronous errors, synchronous errors are also reported in Fieldbus operation, triggered by a communication error, e.g. by unauthorized access or an incorrect command. Both error types are described in the controller's Fieldbus manual.

Error display over the Fieldbus

The controller saves the last 20 error messages in a separate error memory. In addition, the current error cause is saved in the "Status.StopFault" parameter. The error messages are arranged in chronological order and can be read via index and subindex values:

Index	Meaning
900:1, 900:2, 900:3, ...	1. error entry, oldest report
901:1, 901:2, 901:3, ...	2. error entry, later report, if present
	...
...919:1, 919:2, 919:3, ...	20. error entry. if present, the latest error value is found here

Further information on each fault report can be obtained from the subindex.

The additional information can be read with the parameter "ErrMem0.-ErrQual".

Parameter Group.Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Status.StopFault	32:7	2.5.1	Cause of last interruption, error number	UINT16	0	R/– –
ErrMem0.ErrNum	900:1	2.5.2	Coded error number	UINT16 0..65535	–	R/– –
ErrMem0.Class	900:2	–	Error class	UINT16 0..65535	–	R/– –
ErrMem0.Time	900:3	–	Error time since power amplifier switched on [s]	UINT32 0...65535	–	R/– –
ErrMem0. AmpOnCnt	900:4	–	Number of switch-on cycles of power amplifier	UINT16	–	R/– –
ErrMem0.ErrQual	900:5	–	Additional information for assessing error	UINT16	0	R/– –
Commands.del_err	32:2	5.4	Deletion of all entries in the error memory	UINT16 0	0	R/W –

The error cause for each error message is saved in coded form as an error number under "Status.ErrNum". The table on page 8-9 shows error numbers and their explanation.

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 cable	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 operating mode you want

TLADOCC51ME, -001, 04.03

8.4 Table of error numbers

Error number	Error class	Meaning
E1001	0	Parameter does not exist
E1002	0	Parameter does not exist
E1003	0	Parameter does not exist
E1004	0	Parameter does not exist
E1005	0	Communication protocol: unknown service
E1006	0	Communication protocol: invalid service
E1007	0	Communication protocol: segment service not initialized
E1008	0	Parameter not writable
E1009	0	Parameter not readable
E100A	0	Parameter out of range
E100B	0	Communication protocol: parameter or command processing not complete
E100C	0	Command not allowed while drive is active
E100D	0	Successive table entries must be different
E100E	0	System: insufficient non-volatile memory
E100F	0	Non-volatile memory defective
E1010	0	Non-volatile memory booted
E1011	0	Non-volatile memory reading error
E1012	0	Non-volatile memory writing error
E1013	0	No valid parameter set
E1014	0	No data exists, upload not possible
E1015	0	Function not allowed
E1016	0	Write protected against actual user level
E1017	0	Maximum permissible current is exceeded
E1018	0	Input value exceeds allowed speed
E1019	0	Operating mode does not exist
E101A	0	Communication protocol: service not supported
E101B	0	Password not correct
E1021	0	System: program checksum not correct
E1022	0	Bootstrap address error
E1023	0	Wrong or missing module
E1024	0	Quick stop caused by LIMP
E1025	0	Quick stop caused by LIMN
E1026	0	Quick stop caused by STOP
E1027	0	No power amplifier found
E1028	0	Power amplifier not factory-adjusted
E1029	0	Power-amplifier changed, Power amplifier not factory-adjusted
E102A	0	Motor not factory-adjusted
E102B	0	Motor parameters are missing

TLADOCC51ME, -001, 04.03

Error number	Error class	Meaning
E102C	0	Non-volatile memory initialized
E102D	0	HIPERFACE module not adjusted
E102E	0	Flashing not possible while drive is active
E102F	0	No firmware stored in Flash
E1031	0	Command not allowed while drive is waiting for reference pulse of SinCoder
E1032	0	Flash delete error (Timeout)
E1033	0	Motor is rotating during power-on
E1034	0	Drive not active
E1035	0	Non-volatile checksum error
E1036	0	Hiperface encoder memory is blank, no motor parameters can be read
E1037	0	Hiperface encoder memory not correctly formatted
E1038	0	Analog input +-10V not adjusted
E1039	0	Reference position module not available
E103A	0	Wrong EEPROM Block length
E103B	0	Activation of amplifier not permitted
E103C	0	Wrong amplifier type
E103D	0	Parameter write error with active gear mode
E103E	4	No connection to the SAM module
E103F	4	Transmission timeout to SAM module
E1040	3	Transmit error to SAM module
E1041	4	SAM module not supported by obsolete CPU module
E1042	4	Update of SAM software required
E1043	4	Update of Operating Software required to support SAM module
E1044	4	Analog channels on analog module not calibrated
E1045	4	SAM module is in programming mode
E1046	4	SAM module is not in programming mode
E1047	4	No communication to SAM module
E1200	0	Communication protocol: parameter or command processing not finished
E1201	0	Serial interface: buffer overflow
E1202	0	Serial interface: Transmission error
E1203	0	Serial interface: Transmission error
E1204	0	Serial interface: Transmission error
E1205	0	Serial interface: Transmission error
E1206	0	Parameter for trace trigger not correct
E1207	0	Trace not completely configured
E1208	0	Parameter out of range
E1209	0	Read/write not possible while trace data are being read
E120A	0	Read/write not possible while trace is active
E120B	0	Trace buffer too small for configured trace
E120C	0	Parameter out of range (table range)

TLADOCC51ME, -001, 04.03

Error number	Error class	Meaning
E120D	0	Function not implemented
E120E	0	HIPERFACE serial interface: transmission error
E120F	0	HIPERFACE: data in non-volatile memory of sensor are not correct
E1210	0	No feedback module found
E1211	0	Warning: feedback module exchanged
E1212	0	Unknown sensor connected with HIPERFACE module
E1213	0	HIPERFACE: insufficient non-volatile memory
E1214	0	HIPERFACE-Sensor not adjusted
E1215	0	System: watchdog
E1216	0	System: Illegal Address
E1400	2	Power up error
E1401	2	Undervoltage DC bus limit 1: quick stop
E1402	3	Undervoltage DC bus limit 2: drive error
E1403	3	Ground fault on motor outputs
E1404	3	Shorted motor outputs or overcurrent detected
E1405	3	DC bus overvoltage
E1406	3	Ballast resistor overtemperature
E1407	3	Motor overtemperature
E1408	3	Power module overtemperature
E1409	0	I^2t power module supervision error
E140A	3	Commutation error
E140B	0	I^2t motor supervision error
E140C	0	I^2t dynamic brake supervision error
E140D	3	Phase error, motor outputs
E140E	3	Phase error, line
E140F	4	System watchdog
E1410	4	Internal system fault
E1411	3	Save-Standstill
E1412	0	Serial interface transmission error
E1413	3	Speed limit exceeded
E1414	3	Slot M1: external setpoint signals not correctly connected
E1415	3	Slot M2: feedback position sensor not correctly connected
E1416	3	Position following error with position controller module M1
E1417	4	24 V power supply failure
E1418	0	Position following error
E1419	2	I/O error
E141A	1	Limit switch not correctly installed
E141B	0	Motor overtemperature warning
E141C	0	Power amplifier overtemperature warning
E141D	0	Device excess temperature

TLADOCC51ME, -001, 04.03

Error number	Error class	Meaning
E141E	0	SAM warning
E141F	0	Node guarding
E1800	0	Parameter does not exist
E1801	0	Write protected against actual user level
E1802	0	Password not correct
E1803	0	Serial interface: initialization parameter not correct
E1804	4	Serial interface: no send/receive buffer
E1805	2	Serial interface: initialization not completed
E1806	0	Precondition not met
E1807	0	Parameter does not exist
E1808	2	Serial interface: send buffer too small
E1809	2	Serial interface: send string not convertible
E180A	2	Serial interface: receive buffer too small
E180B	0	Serial interface: transmission error
E180C	0	Serial interface: transmission error
E180D	0	Serial interface: transmission error
E180E	0	Serial interface: transmission error
E180F	0	Serial interface: error in communication protocol
E1810	0	Serial interface: transmission error
E1811	0	Parameter read/write allowed only during active axis mode
E1812	4	Parameter does not exist
E1813	0	System: DSP-clock missed once
E1814	4	System: DSP clock total failure
E1815	0	Parameter for trace channel not correct
E1816	1	System: function not ready
E1817	0	Parameter out of range
E1818	0	Error while calculating internal values
E1819	0	Command or parameter write, only allowed during motion standstill
E181A	0	Position overflow occurred
E181B	0	Error in manual operating mode
E181C	0	Referencing position not defined or referencing procedure not completed
E181D	0	Operation mode with external reference signals is active
E181E	0	Drive is blocked or brake engaged
E181F	0	Error while in reference motion mode
E1820	1	Error in position list
E1821	0	Function not implemented
E1822	0	Command or parameter write not allowed while referencing is active
E1823	0	CanMaster: invalid object number
E1824	0	CanMaster: invalid CAN-ID
E1825	0	Command or parameter write not allowed in actual operating mode

TLADOCC51ME, -001, 04.03

Error number	Error class	Meaning
E1826	0	SWLIM causes error
E1827	0	Recording position of HW limit switch not defined
E1828	0	Referencing error, limit switch not enabled
E1829	0	Referencing error at /LIMP
E182A	0	Referencing error at /LIMN
E182B	0	CanMaster: invalid object attribute
E182C	0	CanMaster: DefineObject reports error
E182D	0	CanMaster: Initialization reports error
E1832	4	Initializing hardware indicates error
E1833	4	System: not enough system memory
E1835	4	Fieldbus module: FIFO timeout
E1836	4	Fieldbus module: error during boot
E1837	4	Fieldbus module: error in initialization
E1838	4	Fieldbus module: communication parameter not correct
E1839	4	Fieldbus module: indicates error
E183A	4	Fieldbus module: timeout
E183B	4	Fieldbus module: unknown FIFO object
E183C	4	Fieldbus module: state machine indicates error
E183D	4	System: internal communication, write request to DSP with error
E183E	4	System: internal communication, read request to DSP with error
E1840	4	System: data interface type mismatch
E1841	0	Change of operation mode still active
E1842	4	Acceleration distance too large
E1843	0	Quick stop caused by LIMP
E1844	0	Quick stop caused by LIMN
E1845	0	Quick stop caused by REF
E1846	0	Quick stop caused by STOP
E1847	0	Quick stop caused by LIMP, negative movement direction
E1848	0	Quick stop caused by LIMN, positive movement direction
E1849	0	Internal position range exceeded
E184A	4	DSP bootstrap loader timeout
E184B	4	DSP indicates wrong program version
E184C	3	Invalid non-volatile memory data
E184D	4	Internal overflow
E184E	0	Command or parameter write is locked from other interface
E184F	0	Referencing error at /STOP
E1850	0	Referencing error at /REF
E1851	3	Error while calculating electronic gear information
E1852	3	DSP timeout
E1853	3	Gear mode: change of reference signal too large

TLADOCC51ME, -001, 04.03

Error number	Error class	Meaning
E1854	0	Command not allowed while operation mode active (xxxx_end=0)
E1855	2	Initialization error with parameter IxSix -> Qualifier
E1856	0	Command or write parameter not allowed while drive is active
E1857	0	Read or write parameter only allowed while drive is active
E1858	0	Quick stop active
E1859	0	Fault reaction active or fault active
E185A	0	Incorrect user input, user input only permitted in gear mode
E185B	0	Automatic operation active
E185C	0	Manual operation active
E185D	0	Login missing
E185E	0	System: PSOS-task not found
E185F	0	System: profile generation or gear mode braking
E1860	0	Quick stop caused by SWLIM
E1861	0	Quick stop caused by SWSTOP
E1862	0	Quick stop caused by internal SWSTOP
E1863	0	Read or write parameter only allowed while drive is active
E1864	0	Reference position module not available
E1865	0	More than one signal HWLIM/REF active
E1866	0	Call with direction bits=0 before new manual motion is required
E1867	0	List processing: final number set lower than initial number
E1868	0	List-driven operation: position values not in correct ascending or descending order
E1869	0	List-driven operation: current position is behind position of last selected list entry
E186A	0	List processing: signal list is active
E186B	0	Deactivation of current list-driven operation due to change of operating mode
E186C	2	Timeout: drive has not reached standstill window
E186D	1	Error when changing operating mode
E186E	4	Device type not defined
E186F	1	User input cannot be processed in the current operating state
E1870	0	External memory module not present
E1871	1	
E1872	0	External memory RAM error
E1873	0	Internal position adaptation to 0 because of out of range
E1874	0	External memory FLASH error
E1875	0	External memory RAM error
E1876	1	Unable to process synchronous start signal
E1877	0	Reference switch /REF not found between /LIMP and /LIMN
E1878	0	Reference motion on /REF without reversal of the direction of rotation, invalid limit switch / LIM actuated
E1879	0	Reference motion on /REF without reversal of the direction of rotation, not allowed to over-travel / LIM or /REF
E187A	0	Processing not possible due to invalid or missing actual position transducer

TLADOCC51ME, -001, 04.03

Error number	Error class	Meaning
E187B	0	Processing not possible during reference movement to index pulse
E187C	0	Processing not possible as fast position capture is active
E187D	1	Index pulse not found
E187E	0	Repeatability of the index pulse movement not ensured, index pulse too close to the switch
E1C00	0	Flash: busy
E1C01	0	Flash: not initialized
E1C02	0	Flash: Invalid segment number
E1C03	0	Flash: Configuration name too long
E1C04	0	Flash: Checksum error in the boot configuration
E1C05	0	Flash: Delete error
E1C06	0	Flash: Invalid mode
E1C07	0	Flash: Write error
E1C08	0	Flash: Invalid handle
E1C09	0	Flash: Insufficient free memory
E1C0A	0	Flash: invalid segment content
E1C0B	0	No memory module found
E1C0C	0	Firmware and application program incompatible
E1C0D	0	Flash: Invalid user data
E1C0E	0	
E1C10	0	Invalid memory range
E1C11	0	Address out of the valid memory range
E1C12	0	RAM: Out of range
E1C13	0	RAM: Invalid initialization
E1C20	0	Insufficient memory for user data
E1C21	0	Invalid memory address from the application
E1C30	0	Axis busy
E1C31	0	Stop shaft when reaching a breakpoint
E1C32	0	Hardware configuration error
E1C33	0	CAN module not available
E1C34	0	Array: Lower limit undershoot
E1C35	0	Array: Upper limit exceeded
E1C36	0	Firmware error
E1C37	0	Invalid retaining range
E1C38	0	Application: Division by Zero
E1C39	0	Application: Cycle time exceeded overrun (%s)
E1C3A	0	Insufficient memory location
E1C3B	0	Invalid function call
E1C40	0	Axis: Invalid mode
E1C41	0	Axis: Wrong mode
E1C42	0	Application data save busy

TLADOCC51ME, -001, 04.03

Error number	Error class	Meaning
E1C43	0	Input parameter out of range
E1C44	0	Parameter not valid for local axis
E1C51	0	CAN SDO buffer overflow
E1C52	0	CAN invalid node ID
E1C53	0	CAN invalid object
E1C54	0	External CAN node error
E1C55	0	CAN object not initialized
E1C56	0	Maximum number of CAN objects reached
E1C57	0	CAN invalid PDO number
E1C58	0	CAN PDO: Function code missing
E1C59	0	CAN synchronous time window > SYNC period
E1C5A	0	CAN unknown NMT service
E1C5B	0	CAN action not allowed with current NMT state
E1C5C	0	CAN Heartbeat time monitoring exceeded
E1C5D	0	CAN Exceeded maximum number of heartbeat users
E1C5E	0	Command is not allowed in actual CAN-state
E1C5F	0	Timeout, no SDO response
E1C60	0	No event task initialized
E2000	0	FIRST_TLCT_ERROR
E2001	0	Timeout
E2002	0	Invalid data received
E2003	0	Invalid frame received
E200A	0	SCAN-LOGIN has failed
E200C	0	Timeout during SCAN-LOGIN
E200D	0	SCAN-LOGOUT has failed
E200E	0	Timeout during SCAN-LOGOUT
E2015	0	Polling Error
E2016	0	Timeout when polling the device
E2017	0	LOGIN has failed
E2018	0	Timeout during LOGIN
E2019	0	Reading of object list has failed
E201A	0	Timeout while reading object list
E201B	0	Reading command objects has failed
E201C	0	Timeout while reading command objects

TLADOCC51ME, -001, 04.03

9 Service, Maintenance and Warranty

9.1 Service Information

For technical and commercial service requests, including warranty and on-site services, please call your local Schneider Electric office.

Maintenance

The Twin Line controller requires no maintenance.

- ▶ Periodically check the control cabinet filter at the Twin Line controller's location. Inspection intervals are determined by ambient conditions at the site.

Repairs to the Twin Line controller are to be carried out only by Schneider Electric authorized personnel.

Warranty

Unauthorized disassembly of the controller will void the warranty.

TLADOCC51ME, -001, 04.03

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. 1.7 on page 1-8). 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. 1.7 on page 1-8.
- 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.

TLADOCC51ME, -001, 04.03

Deinstallation

- ▶ 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 positioning controller 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.

TLADOCC51ME, -001, 04.03

TLADOCC51ME, -001, 04.03

10 Accessories and spare parts

10.1 List of accessories

Accessories The following accessories are available for IP20 and for IP54 controllers:

Qty.	Designation	IP20 controller/ IP54 controller (IP20/IP54)	Order no.
1	Commissioning software with online documentation on data medium, English	IP20/IP54	TLAPSCA
1	HMI hand-held operating unit with manual	IP20/IP54	TLAPHOO
1	Connector set for complete assembly	IP20/IP54	TLATD
1	Motor cable 16 AWG (1.5 mm^2)with motor plug	IP20/IP54	TLACPVAAxxx1 [1]
1	Encoder cables for RM-C module with 15 pin Sub-D connector	IP20/IP54	TLACFVBAxxx1 [1]
1	Pulse direction cable for PULSE-C module	IP20/IP54	TLACDCBByyy [2]
1	Encoder cable for module RS422-C	IP20/IP54	TLACDCBCyyy [2]
1	Fieldbus cable for module CAN-C IBS-C RS485-C	IP20/IP54	 TLACDCBAyyy [2] TLACDCBFyyy [2] TLACDCBDyyy [2]
1	CAN terminator, 9-pin socket CAN terminator, 9-pin plug	IP20/IP54	TLATA TLATB
1	RS-232 programming cable 5 m RS-232 programming cable 10 m	IP20/IP54	TLACDPBG 050 TLACDPBG 100
1	Holding brake controller TLHBC	IP20	TLABHO
1	Terminal angle with top-hat rail TS 15, e.g for Phoenix Contact type MBK terminals	IP54	TLATLR
1	Set of grommets type KDT/Z [3](Murrplastic GmbH, see chap. 10.3, suppliers)	IP54	TLATKR
1	External mains filter for controllerts without internal filters for TLC511 D, 4A for TLC512 D, 10A	IP20	Please contact your local Schneider Electric office

1) Cable length xxx: 003, 005, 010, 015, 020: 3 m (9.84 ft.), 5 m (16.4 ft.), 10 m (32.8 ft.), 15 m (49.2 ft.), 20 m (65.6 ft.), longer cable lengths on request. Please contact your local Schneider Electric office
2) Cable length yyy: 005, 015, 030, 050: 0.5 m (1.64 ft.), 1.5 m (4.92 ft.), 3 m (9.84 ft.), 5 m (16.4 ft.).
3) The inside diameter of the grommets must match the diameter of the cables used.

TLADOCC51ME, -001, 04.03

10.2 List of spare parts

Controller

Qty.	Designation	Order no.
1	TLC511, TLC512	See Fig. 1.6
1	SK14 shielding terminal	TLATE
1	Connector caps for the terminal strips	-

TLADOCC51ME, -001, 04.03

11 Unit label

11.1 Illustration of the controller label

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

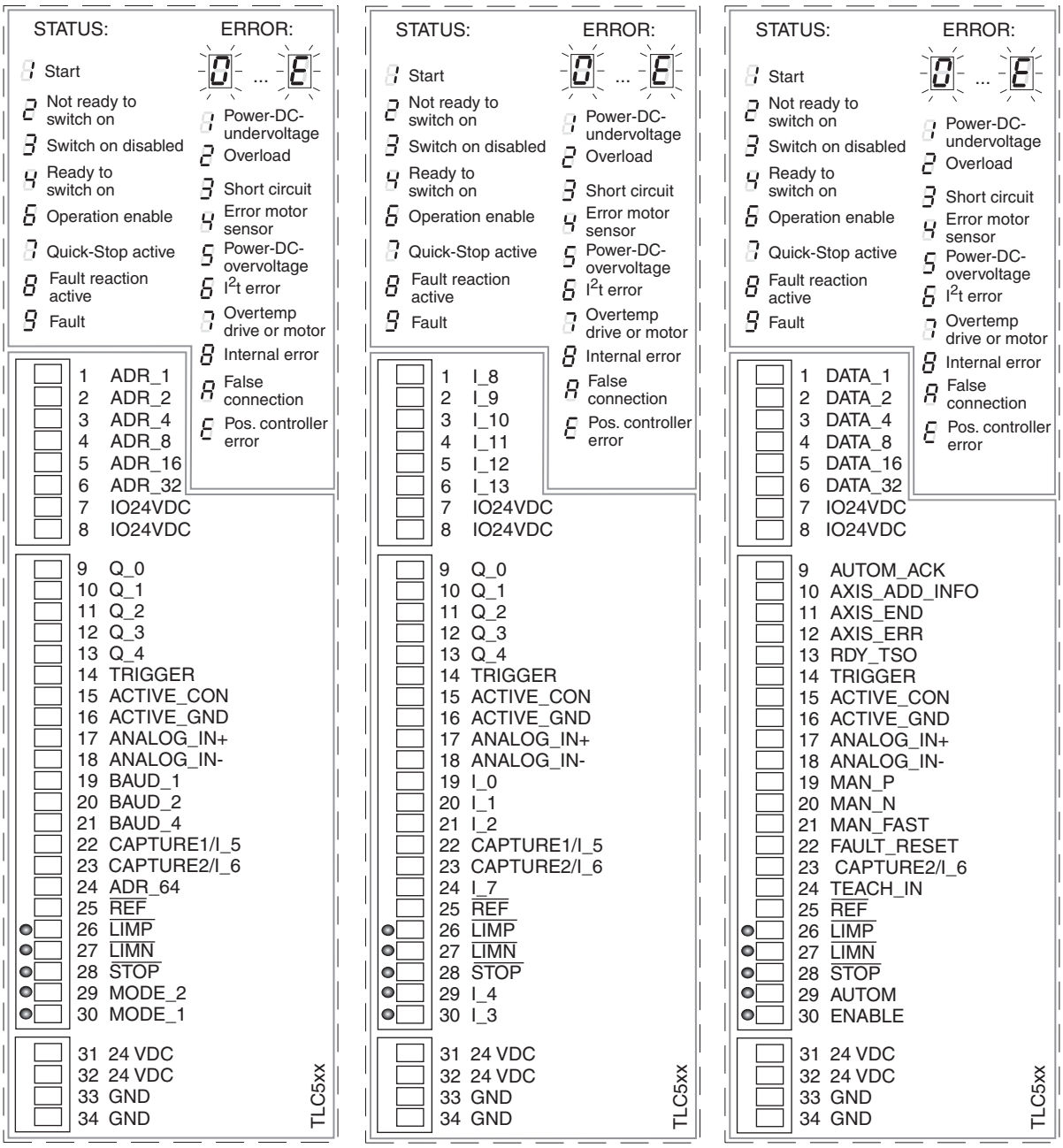


Fig. 11.1 Unit label

TLADOCC51ME, -001, 04.03

12 Parameters

12.1 Overview

Parameter groups

The parameters of the Twin Line controller are grouped in functional blocks.

- Settings, page 12-3:
  Behavior of the input and output signals of the signal interface, modification of error responses, gear factors, parameters for the ±10 V interface and general control system settings
- Commands, page 12-4:
  Transmission of parameter sets, system settings for power amplifier, controller
- PA, page 12-5:
  Parameters of the power amplifier, system settings
- Motion, page 12-5:
  Parameter settings for all operating modes: jerk filter, direction of rotation, software limit switches, standardization and ramp settings.
- Manual, page 12-7:
  Parameter settings for manual mode
- VEL, page 12-8:
  Settings for speed mode
- PTP, page 12-8:
  Settings for point-to-point mode
- Gear, page 12-9:
  Settings for electronic gear mode with offset superimposition
- Home, page 12-10:
  Settings for referencing mode
- Oscillator, page 12-11:
  Settings for oscillator mode
- Teach, page 12-12:
  Settings for the teach mode
- List, page 12-13:
  Settings for the list-controlled operation function mode
- List1Data0..List1Data63, page 12-14:
  List data input data
- List2Data0..List2Data63, page 12-15:
  List data input data
- Capture, page 12-15:
  Settings for the operating function for capturing position data
- I/O, Page 12-16:
  Switching states of inputs and outputs of the signal interface
- M1, page 12-18:
  Settings for modules in slot M1
- M3, page 12-18:
  Settings for modules in slot M3
- M4, page 12-18:
  Settings for modules in slot M4

TLADOCC51ME, -001, 04.03

- Status, page 12-19:
  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
- ErrMem0...ErrMem19, page 12-26:
  Storage of last 20 error messages. Older messages are shifted towards ErrMem0.

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 limits automatically to the lower value.

Temperature in Kelvin [K] = temperature in degree Celsius [°C] + 273, for example: 358K=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. To do this the value must be saved in EEPROM ("Commands.eeprSave").

Info page: Further information on the parameter will be found on the page specified.

Use the specifications relevant for controlling the unit through the particular access channel.

Access channel	Specifications
Fieldbus Signal interface	Idx:Sidx:
TL HMI	Menu items under TL-HMI
TL CT	Parameter group individual parameters e. g. "Settings.SignEnabl"

TLADOCC51ME, -001, 04.03

12.2 Parameter groups

12.2.1 Parameter group Settings

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
name1	11:1	–	User device name 1	UINT32 0..4294967295	538976288	R/W rem.	–
name2	11:2	–	User device name 2	UINT32 0..4294967295	538976288	R/W rem.	–
Password	11:3	1.3	Password for configuring with a hand-held operating unit	UINT16 0..9999 0: No password protection	0	R/W rem.	–
I_0	14:10	4.1.30	Phase current standstill (100=1Arms)	UINT16 0..1000	90	R/W rem.	5-14
I_acc	14:11	4.1.31	Phase current acceleration/ deceleration (100=1Arms)	UINT16 0..1000	90	R/W rem.	5-14
I_const	14:12	4.1.32	Phase current constant movement (100=1Arms)	UINT16 0..1000	90	R/W rem.	5-14
SM_toggle	14:17	4.1.33	Short maximum motor motion when power amplifier switched on	UINT16 0: disabled 1: activated	1	R/W rem.	–
monitorM	14:18	4.1.35	Motor monitoring, with module in M2 only 0: deactivated 1: activated	UINT16 0..3 Bit0: Speed monitoring Bit1: Temperature monitoring	3	R/W rem.	5-14
offset_0V	20:58	4.1.38	Offset for linear shift of the 0V input voltage [mV]	INT16 –5000.. +5000	0	R/W rem.	6-47
win_10V	20:59	4.1.39	Voltage window within which its analog value is equal to 0 [mV] Example: set value of 20 mV means the range - 20 mV to + 20 mV will be interpreted as 0 mV	UINT16 0..1000	0	R/W rem.	6-48
SignEnabl	28:13	4.1.10	Signal enable for monitoring inputs 0: blocked 1: released	UINT16 0..15 Bit0: LIMP Bit1: LIMN Bit2: STOP Bit3: REF	7	R/W rem.	7-27
SignLevel	28:14	4.1.11	Signal level for monitoring inputs 0: reaction at 0-level 1: reaction at 1-level	UINT16 0..15 Bit0: LIMP Bit1: LIMN Bit2: STOP Bit3: REF	0	R/W rem.	7-27
SignQstop	28:20	4.1.26	Control signals that trigger a Quick-Stop: 0: Deceleration ramp 1: Quick-Stop ramp	UINT16 0..255 Bit0: LIMP Bit1: LIMN Bit2: STOP Bit3: REF Bit4..6: – Bit7: SW_STOP	0	R/W rem.	–

TLADOCC51ME, -001, 04.03

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
dec_Stop	28:21	–	Deceleration ramp for Quick-Stop [rev./(min*s)]	UINT32 1.. 2147483647	6000	R/W rem.	7-21
IO_mode	29:31	4.1.4	Significance of I/O signal assignment	UINT16 0..2 0: Setting the Fieldbus parameters via inputs 1: I/O freely available 2: I/O assigned with function	0	R/W rem.	5-22

12.2.2 Parameter group Commands

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
eeprSave	11:6	3.9 4.9 6.9	Save parameter values in EEPROM memory 1: Save the range	UINT16 0..31 Ranges to be saved: Bit0: Parameter Bit1: Set data Bit2: List data List1 Bit3: List data List2 Bit4: User-def. data	–	R/W –	–
stateSave	11:7	–	Processing state of "Commands.eeprSave"	UINT16 0: Saving 1: Saving completed	–	R/– –	–
default	11:8	5.2 9.1	Factory setting	UINT16 2: Run factory setting	–	R/W –	–
stateDef	11:9	–	Processing state param. "Commands.default"	UINT16 0: Initializing 1: Initialization completed	–	R/– –	–
driveCtrl	28:1	–	Control word for state change, default Bit0..3="0", Write access automatically triggers slope change 0->1.	UINT16 0..15 Bit0: disable amplifier Bit1: enable amplifier Bit2: stop (Quick-Stop) Bit3: FaultReset Bit4: QuickstopRelease (TLC units only, internal accesses only) Bit5..15: not assigned	0	R/W –	8-2

TLADOCC51ME, -001, 04.03

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
OnlAuto	29:30	–	Access to the mode setting	UINT16 0..65535 0: access via all channels 1: access only via the channel that has set this parameter	1	R/W –	6-4
del_err	32:2	5.4	Deletion of all entries in error memory	UINT16 0..1	0	R/W –	8-7

12.2.3 Parameter group PA

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
Serial	16:2	–	Module serial number	UINT32 0..4294967295	–	R/W rem.	–
I_maxPA	16:8	2.2.1	Peak current of the unit [100=1Arms]	UINT16 1..32767	1000	R/W rem.	–
U_maxDC	16:12	2.2.17	Max. permitted DC link voltage on the DC-bus [10=1V]	UINT16 1..20000	4000	R/W rem.	–
U_minDC	16:21	2.2.19	DC link undervoltage for switching off the drive	UINT16 1..20000	1500	R/W rem.	–
I_nomPA	16:9	2.2.2	Nominal current of the unit [Arms] (100 = 1 Arms)	UINT16 1..32767	1000	R/– –	–

12.2.4 Parameter group Motion

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
n_90%	14:15	4.4.30	Motor speed with 90% of standstill torque [rpm]	UINT16 1..3000	360	R/W rem.	5-26
n_50%	14:16	4.4.31	Motor speed with 50% of standstill torque [rpm]	UINT16 1..3000	690	R/W rem.	5-26
n_20%	14:27	4.4.32	Motor speed with 20% of standstill torque [rpm]	UINT16 1..3000	1380	R/W rem.	5-26
Filt_jerk	28:5	4.4.26	Jerk filter	UINT16 0..30 0: off 3..30: filter setting value	0	R/W rem.	7-20
invertDir	28:6	4.4.27	Inversion of sense of rotation	UINT16 0..1 0: no inversion 1: sense of rotation inverted	0	R/W rem.	7-22
SW_LimP	29:4	4.4.5	Software limit switch for pos. Position limit LIMP condition: SW_LimP > SW_LimN [usr]	INT32 –2147483648..2147483647	2147483647	R/W rem.	7-26

TLADOCC51ME, -001, 04.03

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
SW_LimN	29:5	4.4.6	Software limit switch for neg. Negative limit LIMN condition: SW_LimN > SW_LimP [usr]	INT32 - 2147483648..2147483647	–2147483647	R/W rem.	7-26
SW_Enabl	29:6	4.4.7	Set monitoring of software limit switches 0: deactivated 1: activated	UINT16 0..96 Bit5: SW_LIMP Bit6: SW_LIMN	0	R/W rem.	7-26
pNormNum	29:7	4.4.20	Position normalization numerator	INT32 - 2147483648..2147483647	1	R/W rem.	7-12
pNormDen	29:8	–	Position normalization denominator	INT32 - 2147483648..2147483647	19200	R/W rem.	7-12
vNormNum	29:9	4.4.21	Speed normalization numerator	INT32 1..2147483647	1	R/W rem.	7-12
vNormDen	29:10	–	Speed normalization denominator	INT32 1..2147483647	1	R/W rem.	7-12
aNormNum	29:11	4.4.22	Acceleration normalization numerator	INT32 1..2147483647	1	R/W rem.	7-12
aNormDen	29:12	–	Acceleration normalization denominator	INT32 1..2147483647	1	R/W rem.	7-12
n_max0	29:21	4.4.28	Speed limit for travel profile [rpm]	UINT32 1..3000	3000	R/W rem.	5-26
n_start0	29:22	4.4.10	Start-stop speed [rpm]	UINT32 1..n_max0 0..3000	12	R/W rem.	5-26
v_target0	29:23	4.4.11	Setpoint speed [usr]	UINT32 1..n_max0 1..2147483647	60	R/W rem.	5-26
acc_type	29:25	4.4.13	Shape of acceleration curve	UINT16 1..2 1: linear 2: Exponential	1	R/W rem.	5-26
acc	29:26	4.4.14	Acceleration [usr]	UINT32 1.. 2 147 483 647	600	R/W rem.	5-26
dec	29:27	4.4.15	Deceleration [usr]	UINT32 1.. 2 147 483 647	600	R/W rem.	5-26

TLADOCC51ME, -001, 04.03

12.2.5 Parameter group Manual

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
startMan	41:1	3.2.1	Start of manual movement with transfer of control bits	UINT16 0..7 Bit2: 0: slow 1: fast Bit1: neg. sense of rotation Bit0: pos. sense of rotation	–	R/W –	6-12
statusMan	41:2	–	Acknowledgement: manual movement	UINT16 0..65535 Bit0: error LIMP Bit1: error LIMN Bit2: error HW_STOP Bit3: error REF Bit5: error SW_LIMP Bit6: error SW_LIMN Bit7: error SW_STOP Bit14: manu_end Bit15: manu_err	–	R/– –	6-12
typeMan	41:3	3.2.2	Type of manual movement	UINT16 0..1 0: Mode One 1: ModeTwo	0	R/W rem.	6-13
n_slowMan	41:4	3.2.3	Speed for slow manual movement [usr]	UINT32 1..2147483647	60	R/W rem.	6-14
n_fastMan	41:5	3.2.4	Speed for fast manual movement [usr]	UINT32 1..2147483647	180	R/W rem.	6-14
dist_Man	41:6	3.2.5	Fixed distance travel, defined travel per jog cycle on travel-limited fixed distance [usr]	UINT16 1..65535	20	R/W rem.	6-14
step_Man	41:7	3.2.6	Fixed distance travel, defined travel on manual travel start [usr]	UINT16 0..65535 0: Continuous operation	20	R/W rem.	6-13
time_Man	41:8	3.2.7	Mode One waiting time [ms]	UINT16 1..30000	500	R/W rem.	6-13

TLADOCC51ME, -001, 04.03

12.2.6 Parameter group VEL

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
velocity	36:1	3.1.2.1	Start of speed change with transfer of setpoint speed [usr]	INT32 –2147483648..2147483647	–	R/W –	6-16
stateVEL	36:2	–	Acknowledgement: Speed profile mode	UINT16 0..65535 Bit0: error LIMP Bit1: error LIMN Bit2: error HW_STOP Bit3: error REF Bit5: error SW_LIMP Bit6: error SW_LIMN Bit7: error SW_STOP Bit13: setpoint speed reached Bit14: vel_end Bit15: vel_err	–	R/– –	6-16

12.2.7 Parameter group PTP

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
p_absPTP	35:1	3.1.1.1	Start of absolute positioning with transfer of absolute target position value [usr]	INT32 –2147483648..2147483647	–	R/W –	6-6, 6-19
statePTP	35:2	3.2.14	Acknowledgement: PTP positioning	UINT16 0..65535 Bit0: error LIMP Bit1: error LIMN Bit2: error HW_STOP Bit3: error REF Bit5: error SW_LIMP Bit6: error SW_LIMN Bit7: error SW_STOP Bit13: Set position reached Bit14: motion_end Bit15: motion_err	–	R/– –	6-8, 6-19
p_relPTP	35:3	3.1.1.2	Start of relative positioning with transfer of the value for the distance [usr]	INT32 -2147483648..2147483647	0	R/W –	6-19
continue	35:4	3.1.1.3	Continuation of interrupted positioning with transfer of any value	UINT16 0..65535 value is not relevant for positioning	–	R/W –	6-19
v_tarPTP	35:5	3.1.1.5	Setpoint speed of PTP positioning [usr]	INT32 1..2147483647	Motion.v_target0	R/W –	6-19

TLADOCC51ME, -001, 04.03

12.2.8 Parameter group Gear

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
startGear	38:1	3.1.3.1	Starting an electronic gear process with selection of the processing mode	UINT16 0..2 0: deactivated 1: Immediate synchronization: 2: synchronization with compensatory movement	–	R/W –	–
stateGear	38:2	–	Acknowledgement: gear processing	UINT16 0..65535 Bit0: error LIMP Bit1: error LIMN Bit2: error HW_STOP Bit3: error REF Bit5: error SW_LIMP Bit6: error SW_LIMN Bit7: error SW_STOP Bit13: – Bit14: gear_end Bit15: gear_err	–	R/– –	–
n_maxGear	38:5	3.1.3.3	maximum speed [rpm]	INT32 1..3000	3000	R/W rem.	–
a_maxGear	38:6	3.1.3.20	Maximum acceleration [rpm*s)] Note: Acceleration normalization is not considered	UINT32 120..120000	600	R/W rem.	–
numGear	38:7	3.1.3.2	Gear factor numerator	INT32 –2147483648..2147483647	1	R/W –	–
denGear	38:8	–	Gear factor denominator	INT32 1..2147483647	1	R/W –	–
Flt_nGear	38:9	3.1.3.21	Parameters for speed filter. 0 = filter deactivated 1...8 filter activated	UINT16 0..8	4	R/W –	–
DirEnGear	38:13	–	Release of movement direction, If the direction is inverted, the release of movement direction is reversed	INT16 1..3 1: positive direction 2: negative direction 3: both directions	3	R/W rem.	–
Flt_rGear	38:14	3.1.3.22	Tripping threshold for speed filter.	UINT16 1..100 Speed change from which the filtering of the reference speed is disabled [Inc/ms2]The higher the gear factor the higher the value should be set. Rule of thumb: Value = 2 * numerator/denominator. Select a higher value for better synchronism, select lower value for better dynamics.	15	R/W rem.	–
p_absOffs	39:1	3.1.3.6	Start of absolute offset positioning with transfer of position	INT32 –2147483648..2147483647	0	R/W –	–

TLADOCC51ME, -001, 04.03

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
stateOffs	39:2	–	Acknowledgement: Offset positioning	UINT16 0..65535 Bit0: error LIMP Bit1: error LIMN Bit2: error HW_STOP Bit3: error REF Bit5: error SW_LIMP Bit6: error SW_LIMN Bit7: error SW_STOP Bit13: offset set position reached Bit14: offset_motion_end Bit15: offset_motion_err	–	R/– –	6-29
p_relOffs	39:3	3.1.3.7	Start of relative offset positioning with transfer of travel value [inc]	INT32 –2147483648..2147483647	0	R/W –	6-29
n_tarOffs	39:5	3.1.3.8	Setpoint speed of offset positioning [rpm]	INT32 1..12000	60	R/W –	6-29
phomeOffs	39:6	3.1.3.9	Dimension setting in offset positioning [Inc]	INT32 –2147483648..2147483647	0	R/W –	6-29
accOffs	39:7	3.1.3.10	Acceleration ramp for offset positioning [rev/(min*s)]	INT32 60..2000000	300	R/W –	6-29
decOffs	39:8	3.1.3.11	Deceleration ramp for offset positioning [rev./(min*s)]	INT32 60..2000000	300	R/W –	6-29
ModeOffs	39:9	3.1.3.12	Processing mode of an absolute or relative positioning	UINT16 0..1 0: Jump 1: profile	0	R/W rem.	–

12.2.9 Parameter group Home

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
startHome	40:1	3.3.1.1 3.3.1.2 3.3.1.3 3.3.1.4 3.3.1.5 3.3.1.6 3.3.1.7 3.3.1.8	Start of referencing mode	UINT16 1..8 1: LIMP 2: LIMN 3: REFZ neg. sense of rotation 4: REFZ pos. sense of rotation 5: LIMP with index pulse 6: LIMN with index pulse 7: REFZ neg. sense of rotation with index pulse 8: REFZ pos. sense of rotation with index pulse	–	R/W –	6-32

TLADOCC51ME, -001, 04.03

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
stateHome	40:2	–	Acknowledgement: referencing	UINT16 0..65535 Bit0: error LIMP Bit1: error LIMN Bit2: error HW_STOP Bit3: error REF Bit5: error SW_LIMP Bit6: error SW_LIMN Bit7: error SW_STOP Bit14: ref_end Bit15: ref_err	–	R/– –	6-32, 6-38
startSetp	40:3	3.3.2	Sizing on sizing position (set absolute position) [usr]	INT32 –2147483648..2147483647	–	R/W –	6-43
v_Home	40:4	3.3.3	Speed for search of reference switch [usr]	INT32 –2147483648..2147483647	60	R/W rem.	6-32, 6-39
v_outHome	40:5	3.3.4	Speed for processing withdrawal path and safety distance [usr]	INT32 –2147483648..2147483647	6	R/W rem.	6-32
p_outHome	40:6	3.3.5	Max. withdrawal path with activated reference switch [usr]	UINT32 0..2147483647 0: Withdrawal disabled >0: Withdrawal path [usr]	0	R/W rem.	6-32
p_disHome	40:7	3.3.6	Safety distance from switching edge to reference point [usr]	UINT32 0..2147483647	200	R/W rem.	6-33
RefSwMod	40:9	3.3.10	Processing sequence with reference movement to REF	UINT16 0..3 Bit0: Rotation reversal at REF 0: permissible (standard operation) 1: not permissible Bit1: Movement direction safety distance 0: away from switch 1: into switch area	0	R/W rem.	6-33
DefPosTyp	40:10	–	Reference position for processing safety distance and index pulse search	UINT16 0.. 1 0: Setpoint position at standstill after deceleration because of signal change at limit or reference switch 1: Save current motor position on signal change at limit or reference switch	0	R/W rem.	6-33
RefAppPos	40:11	–	Application position at reference point [usr]	INT32 –2146483648.. +2146483647	0	R/W rem.	6-33

12.2.10 Parameter Group Oscillator

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
startOszi	51:1	3.1.9.1	Starting oscillator mode	UINT16 0..2 0: deactivated (setpoint=0) 1: Setpoint via +/-10 V interface	0	R/W –	6-46

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
stateOszi	51:2	–	Acknowledgement: oscillator mode	UINT16 0..65535 Bit0: error LIMP Bit1: error LIMN Bit2: error HW_STOP Bit3: error REF Bit4: not assigned Bit5: error SW_LIMP Bit6: error SW_LIMN Bit7: error SW_STOP Bit8-Bit12: not assigned Bit13: setpoint speed reached 0: Actual speed <> setpoint speed 1:actual speed = setpoint speed Bit14: oscillator_end 0: Process active 1: Process inactive Bit15: oscillator_err 0: no error 1: Error	–	R/– –	6-46
n_RefAna	51:3	3.1.9.2	Setpoint speed at +10 V input signal [rpm]	INT16 0.. 13200 (Note: max. motor speed must not be exceeded)	3000	R/W rem.	6-47

12.2.11 Parameter group Teach

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
storeTeac	43:1	–	Teach mode Selecting memory List number for storing a position value (0...63) Example: 000010: List number 2	UINT16 0..65535 Bit0.5: List number	0	R/W –	7-10
stateTeac	43:2	–	Acknowledgement: Teach mode	UINT16 0..65535 Bit15: teach_err Bit14: teach_end	–	R/– –	7-10
memNrTeac	43:3	–	Data storage for Teach mode	UINT16 1..2 1: List data list 1 2: List data list 2	1	R/W –	7-10
p_actTeac	43:4	–	Motor position stored during Teach mode processing [usr]	INT32 –2147483648..2147483647	–	R/– –	7-10

TLADOCC51ME, -001, 04.03

12.2.12 Parameter group List

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
startList	44:1	3.1.5.1 3.1.5.2 3.1.6.1 3.1.6.2	Activate new list control	UINT16 0..2 0: no list active 1: list 1 2: list 2	0	R/W –	7-2
stateList	44:2	–	Acknowledgment and status: List control	UINT16 0..65535 Bit15: list_err Bit14: list_quit 0: list-controlled operation active 1: list-controlled operation completed Bit0.1: – 0: no list active – 1: list 1 active – 2: list 2 active	–	R/– –	7-2
typeList1	44:3	–	List 1: List type	UINT16 1: pos./signal 2: pos./speed	1	R/– –	7-4
cntList1	44:4	–	List 1: number of available list entries	UINT16 0..64	64	R/– –	7-2
bgnList1	44:6	–	List 1: Starting number of the list control starting number <= finishing number	UINT16 0..63	0	R/W rem.	7-2
endList1	44:7	–	List 1: Finishing number of the list control finishing number >= starting number	UINT16 0..63	63	R/W rem.	7-2
chgList1	44:9	–	List1: Change by other interfaces	UINT16 0..65535 0: no change <>0: change	0	R/W –	–
typeList2	44:11	–	List 2: List type	UINT16 1: Pos./signal 2: Pos./speed	1	R/– –	7-10
cntList2	44:12	–	List 2: number of available list entries	UINT16 0..64	64	R/– –	7-3
bgnList2	44:14	–	List 2: Starting number of the list control starting number <= finishing number	UINT16 0..63	0	R/W rem.	7-3
endList2	44:15	–	List 2: Finishing number of the list control finishing number > = starting number	UINT16 0..63	63	R/W rem.	7-3
actList	44:18	–	List: activated processing number	INT16 –1..63 –1: no list entry activated yet 0..63: last activated list entry Range preset by start and end number of the list control	–1	R/– –	7-2

TLADOCC51ME, -001, 04.03

12.2.13 Parameter group List1Data0..List1Data63

Specified here: L1Data0: Index 1100
L1Data1 to L1Data63 with index:1101 to 1163

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
typeList1	1100:1	7.3.1.1	List 1: list type for ALL following list entries (1101:x...1163:x)	UINT16 1..2 1: pos./signal 2: pos./speed	1	R/W rem.	7-4
posList1	1100:2	7.3.2.1 7.3.2.2	List 1: Position [usr]	INT32 –2147483648..2147483647	0	R/W rem.	7-4
signList1	1100:3	7.3.2.3	List 1: signal state	UINT16 0, 1	0	R/W rem.	7-4
velList1	1100:4	7.3.2.4	List 1: setpoint speed [usr]	INT32 –2147483648..2147483647 -"Motion.n_max0".. +"Motion.n_max0" setting dependent on operating mode PTP: 0: PTP.Vtarget; <>0: stored value VEL: 0: VEL.velocity; <>0: stored value	0	R/W rem.	7-4

12.2.14 Parameter group List2Data0..List2Data63

Specified here: L2Data0: Index 1200
L2Data1 to L2Data63 via index 1201 to 1263

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
typeList2	1200:1	7.4.1.1	List 2: list type for all following list entries (1201:x...1263:x)	UINT16 1..2 1: pos./signal 2: pos./speed	1	R/W rem.	7-4, 7-10
posList2	1200:2	7.4.2.1 7.4.2.2	List 2: Position [usr]	INT32 -2147483648..2147483647	0	R/W rem.	7-4
signList2	1200:3	7.4.2.3	List 2: signal state	UINT16 0..1	0	R/W rem.	7-4
velList2	1200:4	7.4.2.4	List 2: setpoint speed [usr]	INT32 –2147483648..2147483647 -"motion.n_max0"... "Motion.n_max0" setting dependent on operating mode PTP: 0: PTP.Vtarget; <>0: stored value VEL: 0: VEL.velocity; <>0: stored value	0	R/W rem.	7-4

12.2.15 Parameter group Capture

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
TrigSign	20:13	–	Selection of trigger signals for position storage Bit3..2: Signal - channel 2 (K2) Bit1.0.0: Signal - channel 1 (K1) Examples: 4: binary 01 00 => CAPTURE2 (K2), CAPTURE1 (K1) 9: 01 00 => CAPTURE2 (K2), index pos. setpoint pos. (K1)	UINT16 0..15 bits0..1/bits2..3 (K1/K2): – 00: CAPTURE1 – 01: CAPTURE2 – 10: index pulse setpoint pos. encoder (with module at M1) – 11: index pulse actual pos. encoder (at SM with module at M2)	4	R/W – –	7-24
TrigType	20:14	–	Position source for position storage	UINT16 0..1 0: actual position encoder 1: setpoint position encoder	1	R/W – –	–
TrigLevl	20:15	–	Signal level for trigger channels bit state: 0: triggering at 1->0 change 1: triggering at 0->1 change	UINT16 0..3 Bit0: set trigger level on channel 1 Bit1: set trigger level on channel 2	3	R/W – –	7-24

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
TrigStart	20:16	–	Start triggering (bits0..1): 0: no change 1: reset triggering and repeat cancel triggering (Bit14=1) repeat triggering (bit15) 0: trigger once 1: trigger continuously	UINT16 0..3 Bit0: trig. on channel 1 Bit1: trig. on channel 2 Bit14: cancel trig. Bit15: Trig. repeat	0	R/W –	7-24
TrigStat	20:17	–	Status, triggering executed	UINT16 0..3 Bit0: triggering on channel 1 Bit1: triggering on channel 2	0	R/– –	7-24
TrigPact1	20:18	–	Actual position of motor on triggering on channel 1 [Inc]	INT32 –214748364..2147483647	–	R/– –	7-24
TrigPact2	20:19	–	Actual position of motor on triggering on channel 2 [Inc]	INT32 –214748364..2147483647	–	R/– –	7-24
TrigPref1	20:20	–	Setpoint of elect. gear on triggering on channel 1 [Inc]	INT32 –214748364..2147483647	–	R/– –	7-24
TrigPref2	20:21	–	Setpoint of elect. gear on triggering on channel 2 [Inc]	INT32 –214748364..2147483647	–	R/– –	7-24

12.2.16 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	UINT16 0..65535 Bit0: LIMP Bit1: LIMN Bit2: STOP Bit3: REF Bit12: – Bit13: – Additional bits (independent from IO_ mode assignment) if IOM-C analog module is fitted Bit14: DIG_IN1 Bit15: DIG_IN2	–	R/–	– –

TLADOCC51ME, -001, 04.03

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
IW1_act	33:4	2.4.2	Input word 1 Assignment depends on parameters "Settings.IO_mode": With "forcing" (e.g. with TL CT): read access shows force state	UINT16 0..65535 "Settings.IO_mode"=0/1/2: – Bit0: BAUD_1/I_0/MAN_P – Bit1: BAUD_2/I_1/MAN_N – Bit2: BAUD_4/I_2/ MAN_FAST – Bit3: MODE_1/I_3/ENABLE – Bit4: MODE_2/I_4/AUTOM – Bit5: I_5/I_5/FAULT_RESET additional: CAPTURE1 – Bit6: I_6/I_6/I_6 additional: CAPTURE2 – Bit7: ADR_64/I_7/ TEACH_IN – Bit8: ADR_1/I_8/DATA_1 – Bit9 ADR_2/I_9/DATA_2 – Bit10: ADR_4/I_10/DATA_4 – Bit11: ADR_8/I_11/DATA_8 – Bit12: ADR_16/I_12/ DATA_16 – Bit13: ADR_32/I_13/ DATA_32 Additional bits if IOM-C analog module is fitted: – Bit14: DIG_IN1/DIG_IN1/ DIG_IN1 – Bit15: DIG_IN2/DIG_IN2/ DIG_IN2	–	R/– –	–
QW0	34:1	2.4.10	Output word 0 With "forcing" (e.g. with TL CT): read access shows force state	UINT16 0..65535 "Settings.IO_mode"=0/1/2: – Bit0: Q_0/Q_0/ AUTOM_ACK – Bit1: Q_1/Q_1/ AXIS_ADD_INFO – Bit2: Q_2/Q_2/AXIS_END – Bit3: Q_3/Q_3/AXIS_ERR – Bit4: Q_4/Q_4/RDY_TSO – Bit5: ACTIVE_CON/ ACTIVE_CON/ACTIVE_CON – Bit6: TRIGGER/TRIGGER/ TRIGGER – Bit7..Bit13: not assigned Additional bits if IOM-C analog module is fitted: – Bit14: DIG_OUT1/ DIG_OUT1/DIG_OUT1 – Bit15: DIG_OUT2/ DIG_OUT2/DIG_OUT2	–	R/W –	–
OutTrig	34:9	–	Setting trigger output when signal list inactive	UINT16 0..1 0: Low level 1: High level	0	R/W –	7-6

12.2.17 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 UINT16 Bit2: Max. frequency 0: 200 kHz, 1: 25 kHz Bit3: Signal form: 0: PULSE–DIR 1: PV–PR	0	R/W rem.	–

12.2.18 Parameter group M3

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
p_indESIM	23:9	4.5.4	End coder simulation: Position of index pulse [Inc]	UINT16 0..16383 Actual position value is based on "Status.p_abs" at which the index pulse is output	1000	R/W rem.	–

12.2.19 Parameter group M4

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
profilSer	24:11	4.5.10	RS485-interface, processing mode incl. profile selection only readable via Fieldbus	UINT32 0..4294967295	0	R/W rem.	–
baudSer	24:12	4.5.11	RS485-interface, baud rate [baud] only readable via Fieldbus	UINT32 0..38400 0 = autobaud 9600 = 9600 baud 19200 = 19200 baud 38400 = 38400 baud	9600	R/W rem.	–
addrSer	24:13	4.5.12	RS485 interface, address only readable via Fieldbus	UINT16 1..31	1	R/W rem.	–
toutSer	24:14	4.5.13	RS485 interface, monitoring time for a timeout signal [ms] only readable via Fieldbus	UINT16 0..65535 0: monitoring inactive	0	R/W –	–
profilIbs	24:16	4.5.15	Interbus-S, processing mode incl. profile selection only readable via Fieldbus	UINT32 0..4294967295	0	R/W rem.	–
baudIbs	24:17	4.5.16	Interbus-S, baud rate (kbaud) only readable via Fieldbus	UINT32 500000..2000000	500000	R/W rem.	–
toutIbs	24:18	4.5.17	Interbus-S, timeout time [ms] only readable via Fieldbus	UINT16 0..640 0: monitoring inactive	640	R/W rem.	–
profilPbd	24:20	4.5.20	Profibus-DP, processing mode incl. profile selection only readable via Fieldbus	UINT32 0..429496795	0	R/W rem.	–
addrPbd	24:21	4.5.21	Profibus-DP, address only readable via Fieldbus	UINT16 0..126	126	R/W rem.	–

TLADOCC51ME, -001, 04.03

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
profilCan	24:23	4.5.25	CAN-C, processing mode incl. profile selection only readable via Fieldbus	UINT32 0..2 0: CAN–Bus 1: CanOpen 2: DeviceNet	0	R/W rem.	–
addrCan	24:24	4.5.26	CAN-C, address only readable via Fieldbus	UINT16 0..127	127	R/W rem.	–
baudCan	24:25	4.5.27	CAN-C, baud rate [baud] only readable via Fieldbus	UINT32 20000..1000000	125k	R/W rem.	–
toutCan	24:26	4.5.28	CAN-C, timeout time [ms]	UINT16 0..65535 0: monitoring inactive	0	R/W rem.	–
busRxD	24:28	2.6.1	Receiving data Online command processing (Byte 1...4)	UINT32 0.. 4294967295	0	R/– –	–
busRxD5_8	24:29	2.6.1	Receiving data Online command processing (Byte 5... 8)	UINT32 0.. 4294967295	0	R/– –	–
busDiag	24:30	2.6.5	Bus diagnosis for DeviceNet (DNSTATE)	UINT16 0..65535 0: OFFLINE 1: ONLINE 2: LINK_OK 3: FAILURE 4: TIMED_OUT 5: IDLE 0..65535	–	R/– –	–
busTout	24:31	2.6.6	Bus statistics timeout: Total number of broken connections caused by timeout (node guarding)	UINT16 0.. 65535	0	R/W –	7-30
busError	24:32	2.6.7	Bus statistics Transmission error Total of all errors that resulted in a connection break	UINT16 0.. 65535	0	R/W –	7-30
busTxD	24:33	2.6.2	Sending data Online command processing (Byte 1... 4)	UINT32 0.. 4294967295	0	R/– –	7-29
busTxD5_8	24:34	2.6.2	Sending data Online command processing (Byte 5... 8)	UINT32 0.. 4294967295	0	R/– –	7-29
busCycle	24:35	2.6.6	Bus statistic Bus cycles Total number of all processed bus cycles	UINT32 0.. 4294967295	0	R/W –	7-30

12.2.20 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	UINT32 0..4294967295	0	R/W rem.	–

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
p_DifPeak	12:16	2.3.1.9	Max. following error reached [Inc] write access resets value	UINT32 0..131072	0	R/W –	–
AnalogIn	20:8	2.3.3.1	Analog input at input ANALOG_IN [mV]	INT16 –10000..+10000	0	R/– –	5-20

TLADOCC51ME, -001, 04.03

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	UINT32 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 fault (FltSig) Bit6=1: external monitoring fault (FltSig_SR) Bit7=1: Warning message Bit8..11: not assigned Bit12..15: Mode-specific coding of the processing status Bit13: x_add_info Bit14: x_end Bit15: x_err Bit16–20: current operating mode (corresponds to Bit0–4: Status.xmode_act) 0: not used 1: manual positioning mode 2: referencing 3: PTP positioning 4: speed profile 5: electronic gear with offset adjustment, position controlled (AC) or with position reference (SM) 6: Electronic gear speed controlled 7: not used 8: function generator (current controller) 9: function generator (speed controller) 10: function generator (position controller) 11..15: cannot be set 16: Function generator in disabled status 17: Current regulation 18: Oscillator mode 19..30: reserved 31: not used Bit21: drive is referenced (ref_ok) Bit22: control deviation in position window (SM not assigned)	–	R/– –	6-7

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
xMode_act	28:3	2.3.5.5	Current axis operating mode with additional information, Bit0..4: List of possible operating modes for your TL unit will be found in the "Operating modes" chapter	UINT16 0..65535 Bit0..4: Current mode (unit-specific) [List of optional modes for your TL unit can be found in "Operating modes"] 0: not used 1: manual positioning mode 2: referencing 3: PTP positioning 4: speed profile 5: electronic gear with offset adjustment, position controlled (AC) or with position reference (SM) 6: Electronic gear speed controlled 7: not used 8: function generator (current controller) 9: function generator (speed controller) 10: function generator (position controller) 11..15: cannot be set 16: Function generator in disabled status 17: Current regulation 18: Oscillator mode 19..30: reserved 31: not used Bit5: Drive is referenced ("ref_OK") Bit6: Control deviation in position window (SM: not assigned) Bit7: reserved Bit8..15: not assigned	–	R/– –	6-38
Sign_SR	28:15	2.3.4.1	Saved signal states of external monitoring signals 0: not active, 1: activated	UINT16 0..15 Bit0: LIMP Bit1: LIMN Bit2: STOP Bit3: REF	–	R/– –	–

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..429496795 UINT32 Bit0: Power up error Bit1: DC link undervoltage Lim1 Bit2: DC link undervoltage Lim2 Bit3: Motor line ground fault Bit4: Motor line short circuit Bit5: DC link 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: Following 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: not assigned	–	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	UINT32 0..419496795 Bit0: Power up error Bit1: DC link undervoltage Lim1 Bit2: DC link undervoltage Lim2 Bit3: Motor line ground fault Bit4: Motor line short circuit Bit5: DC link 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: Following 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	UINT32 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	1	R/– –	–

TLADOCC51ME, -001, 04.03

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
IntSigSr	29:34	2.3.4.2	Monitoring signals in positioning controller 0: not active, 1: activated	UINT32 0..4294967295 Bit0..1: reserved Bit2: position overflow Bit3..4: reserved Bit5: SW limit switch, pos. sense of rotation (SW_LIMP) Bit6: SW limit switch, neg. sense of rotation (SW_LIMN) Bit7: stop via control word (SWSTOP) Bit8..14: reserved Bit15: amplifier not active Bit16..31: reserved	–	R/– –	7-25
p_ref	31:5	2.3.1.2	Setpoint position of rotor [inc]	INT32 –2147483648..+2147483647	–	R/– –	–
n_act	31:9	2.3.2.1	Actual speed [rpm]	INT16 –32768..32767	–	R/– –	–
p_abs	31:16	2.3.1.11	Absolute position per motor revolution (modulo value) [inc]	UINT16 0..32767 RESO-C: 0..4095 HIFA-C: 0..16383	–	R/– –	–
UDC_act	31:20	2.3.3.2	DC link voltage [10=1V]	INT16 0..32767	–	R/– –	–
Iu_act	31:21	–	Motor phase current phase U [100=1A]	INT16 –32768..32767	–	R/– –	–
Iv_act	31:22	–	Motor phase current phase V [100=1A]	INT16 –32768..32767	–	R/– –	–
v_ref	31:28	–	Speed of the rotor position setpoint value p_ref [inc/s]	INT32 –2147483648..2147483647	–	R/– –	–
p_target	31:30	2.3.1.5	Target position of travel profile generator [usr]	INT32 –2147483648..2147483647	–	R/– –	–
p_jerkusr	31:31	2.3.1.4	Actual position of movement profile generator [usr]	INT32 –2147483648..2147483647	–	R/– –	–
p_actusr	31:34	2.3.1.3	Actual position of motor in user-defined units [usr]	INT32 –2147483648..2147483647	–	R/– –	–
v_jerkusr	31:35	2.3.2.3	Actual speed of movement profile generator [usr]	INT32 –2147483648..2147483647	–	R/– –	–
p_remaind	31:37	–	Residual value of position normalization of position setpoint p_ref [Inc]	INT32 –2147483648..2147483647	–	R/– –	7-18
v_target	31:38	2.3.2.4	Target speed of movement profile generator	INT32 –2147483648..2147483647	–	R/– –	–
p_jerk	31:40	–	Setpoint position at jerk filter input [Inc]	INT32 –2147483648..2147483647	–	R/– –	–
v_jerk	31:41	–	Setpoint speed at jerk filer input [Inc]	INT32 –2147483648..2147483647	–	R/– –	–
v_refM1	31:43	2.3.2.5	Speed from input value increments counted on module on M1 [Inc/s]	INT32 –2147483648..2147483647	–	R/– –	–
p_refusr	31:44	–	Setpoint position of rotor position [usr]	INT32 –2147483648..2147483647	–	R/– –	–

TLADOCC51ME, -001, 04.03

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
v_refusr	31:45	–	Speed of rotor position setpoint p_ref [usr]	INT32 –2147483648..2147483647	–	R/– –	–
p_diffind	31:48	–	Distance between switch and index pulse after reference movement [Inc]	INT32 –2147483648.. 2147483647	–	R/– –	–
StopFault	32:7	2.5.1	Cause of last interruption, error number	UINT16 1..65535	–	R/– –	8-7

12.2.21 Parameter group ErrMem0..ErrMem19

ErrMem0: Index 900
ErrMem1 to ErrMem19 via index 901 to 919

Parameter Name	Idx:Sidx	TL HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
ErrNum	900:1	2.5.2	Coded error number	UINT16 0..65535	–	R/– –	8-7
Class	900:2	–	Error class	UINT16 0..65535	–	R/– –	8-7
Time	900:3	–	Error time since power amplifier switched on [s]	UINT32 0..4294967295	–	R/– –	8-7
AmpOnCnt	900:4	–	Number of switch-on cycles of power amplifier	UINT32 0..4294967295	–	R/– –	8-7
ErrQual	900:5	–	Additional information for assessing error	UINT32 0..4294967295	–	R/– –	8-7

TLADOCC51ME, -001, 04.03

Index

TLADOCC51ME, -001, 04.03

TLADOCC51ME, -001, 04.03

TLADOCC51ME, -001, 04.03

TLADOCC51ME, -001, 04.03

TLADOCC51ME, -001, 04.03

TLADOCC51ME, -001, 04.03