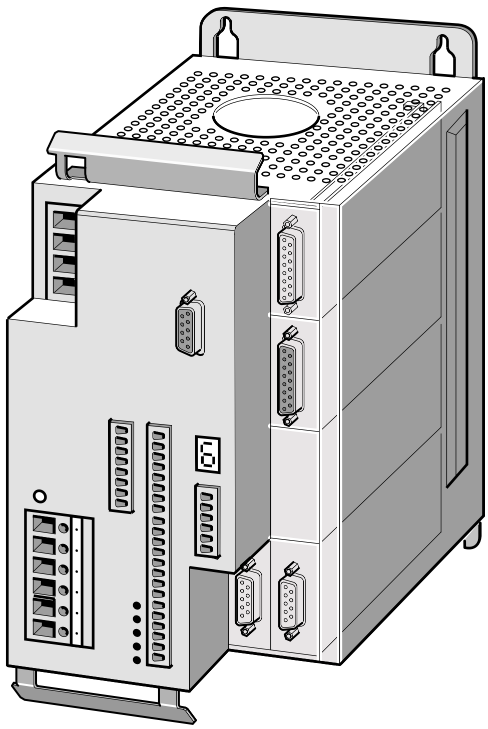
Telemecanique

by Berger Lahr

Technical documentation



Twin Line Controller 53x

Programmable Positioning controller for AC synchronous servomotors

TLC53x

Operating system: 1.1xx

Order No.: TLADOCC53ME

Edition: -000, 08.02

Twin Line™

Motion Products

TLC53x 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 1-7). 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 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 1-7.
- 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.

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Glossaries

Abbreviations

Abbrevia-tion	Meaning
AC	Alternating current
ASCII	American Standard Code for Information Interchange
COS	Controller Operating System
DC	Direct current
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/O	Inputs / 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

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Product name

Abbreviation	Product designation	Term used
TLC53x	Twin Line Controller 53x	Controller
TLHMI	Twin Line HMI	Human machine interface HMI
TLCT	Twin Line Commissioning Tool	Commissioning Software
TLHBC	Twin Line Holding Brake Controller	Holding Brake Controller
TLBRC	Twin Line Ballast Resistor Controller	Ballast Resistor Controller

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Technical Terms

Actual position of the drive system	The actual position of the drive system gives the absolute or relative positions of moved components in the system.
Actual position of the motor	See Angular position of the motor.
Angular position of the motor	The angular position of the motor corresponds to the angular position of the rotor in the motor housing, and refers to the zero point or index point of the position sensor.
CAN-C	Fieldbus module which connects the positioning controller to a CAN Fieldbus. The selection of a Fieldbus profile defines whether the device works with CAN bus, CANOpen or DeviceNet protocol.
Control response	Speed at which a controller reacts to a disturbance or to a change in the input signal.
DC-bus	The DC-bus generates the necessary direct current for operating the motor and provides the amplifier with the necessary energy. The DC-bus acts as a buffer to energy fed back by the motor.
Default values	Preset values for the parameters of the Twin Line 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.
ESIM3-C	Encoder simulation module for outputting position data for the motor as A/B signal to a higher-ranking (supervisory) device or another Twin Line controller.
Electronic gear	An input speed is recalculated by the Twin Line controller using the values of an adjustable gear ratio to produce a new output speed for the motor movement.
Encoder	Sensor for recording the angular position of a rotating element. Mounted on the motor, the encoder signals the angular position of the rotor.
Error class	Reaction of the Twin Line controller to an operational malfunction corresponding to one of five error classes
Forcing	To change signal states irrespective of the hardware switching status in the controller; with the control tool, for example. The hardware signals remain unchanged.
Functional safety	A part of the overall safety of the machine or equipment under control which depends on the correct functioning of specific systems.
HIFA-C	Module with Hiperface interface for connecting an encoder made by Stegmann.
High/open	Signal status of an input or output signal; when no signal is present, signal voltage is high (high level).
HMI	Hand-held operating unit which can be plugged into the Twin Line controller. HMI: Human-machine interface.
I^2t monitoring	Predictive temperature monitoring. On the basis of the motor current, the expecting heating of controller components is calculated in advance. Should a limit value be exceeded, the Twin Line controller reduces the controller current.

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IBS-C	Fieldbus module which couples the power controller to an Interbus Fieldbus.
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.
Internal unit	The actual position of the drive system gives the absolute or relative positions of moved components in the system.
IT system	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 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-C	Pulse direction interface for recording external position presets via pulse direction signals or $\text{Pulse}_{\text{forward}}$/$\text{Pulse}_{\text{backward}}$ for the positioning of the motor.
Pulse direction signals	Digital signals with variable pulse frequencies which signal changes in position and rotation direction via separate signal wires.
Quick stop	This function is used to command rapid deceleration of the motor by the power amplifier. To achieve rapid deceleration, the power amplifier must be operational during the entire deceleration period, the motor must be dimensioned to allow for sufficient stopping torque, and the power amplifier must be able to absorb the system mechanical load energy/power during the deceleration.
RS-232 interface	Communications interface of the Twin Line controller for the connection of a PC or the HMI hand-held operating unit.
RS-422C	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.

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RS-485-C Fieldbus module which enables the Fieldbus to be used via a multipoint connection with serial data transmission. A multipoint connection - in contrast to a point-to-point connection - can swap data with several devices on the bus.

RS-485 level The signal status is calculated from the differential voltage of one positive and one inverted negative signal. Two signal wires must therefore be connected for one signal. 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.

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

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

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

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

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

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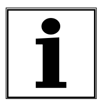
Written conventions and note symbols

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 you will receive direct confirmation that a particular step has been correctly carried out.

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

Menu paths "➞" In the Twin Line ControlTool operating 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. You will find contact addresses for Schneider Electric under "Service Information", page 9-1.

Controller software operating system supported by this instruction manual

The controller software operating system version supported by this manual is 1.1.xx. This number also appears on the front cover of the instruction manual. To verify that this is the correct instruction manual for your product, compare the software version that appears on the controller label or controller carton label with the operating system version number shown here. If the software operating system version numbers do not agree, then **you do not have the correct instruction manual for the product!** Instruction manuals can be obtained from www.schnedierautomation.com or, in North America, by contacting a Schneider Electric Company representative.

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1 The controller

1.1 Controller and accessories

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

Keep the original packaging in case the unit has to be returned to the manufacturer to be added to or repaired.

IP20 controller The basic TLC53x controller includes:

No.	Qty.	Designation	Order no.
1	1	TLC532, TLC534, TLC536 or TLC538,	See Fig. 1.6
2	1	Hood for front cover	-
3	1	Shielding terminal SK 14 for motor connection	TLATE
4	1	Separable connectors for the terminal strips	-

Modules Option module configurations for the controller:

No.	Qty.	Designation	Order no.
6	1	RS-422C encoder module or PULSE-C pulse direction module	See Fig. 1.6
6	1	HIFA-C Hiperface module	See Fig. 1.6
6	1	ESIM3-C Encoder simulation module	See Fig. 1.6
6	1	Fieldbus module PBDP-C, CAN-C, RS485-C or IBS-C	See Fig. 1.6

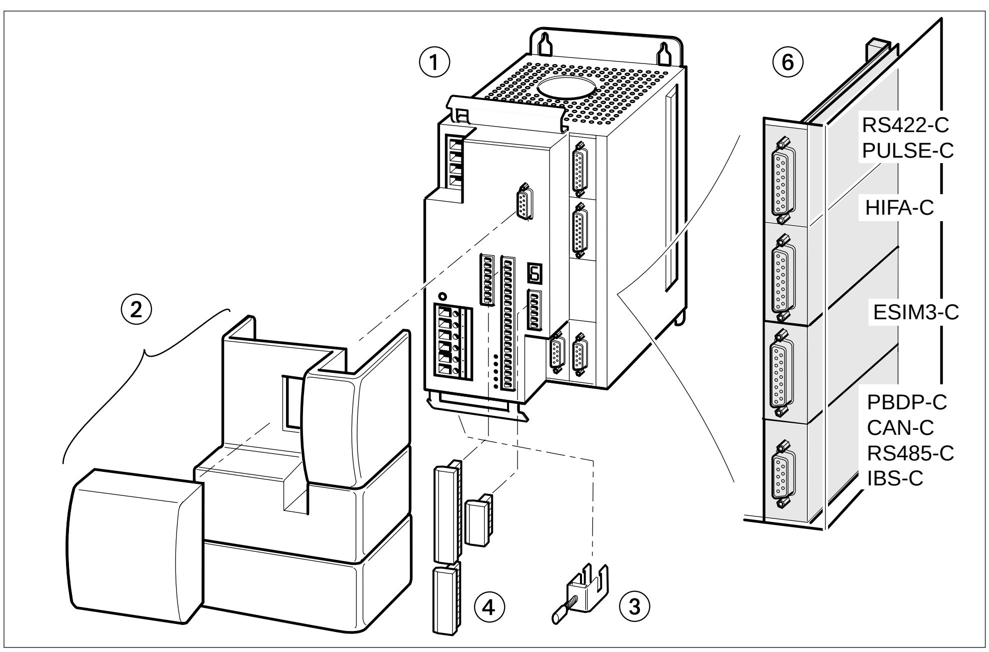

Fig. 1.1 TLC53x IP20 controller and modules

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IP54 controller The TLC53x5 controller includes:

Item	Qty	Designation	Order Number
1	1	TLC5325, TLC5345	See Fig. 1.6
2	1	Mains plug (round plug, 4-pin)	-
3	1	Shielding terminal SK14 for motor connection	TLATE
4	1	Sub-D cover for RS-232 interface	-
5	1	Insulation sleeving for control connections for holding brake	-
-	1	Integrated holding brake controller HBC (optional)	See Fig. 1.6

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

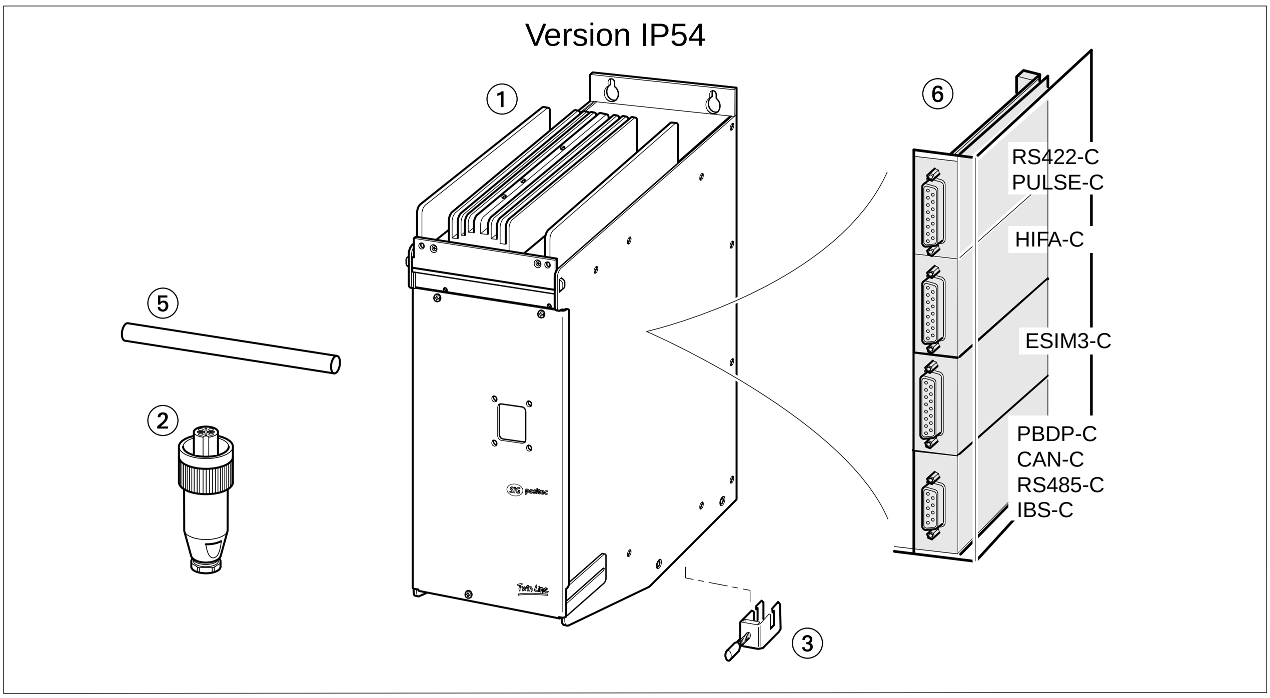

Fig. 1.2 TLC53x IP54 controller and modules

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

Item	Qty	Designation	IP20 Controller/ IP54 Controller (IP20/IP54)	Order Number
1	1	Commissioning software with online documentation on data carrier, multilingual	IP20/IP54	TLAPSCA
2	1	Hand-held operating unit HMI with manual	IP20/IP54	TLAPHOO
3	1	Motor cable 16 AWG (1.5 mm^2)with motor plug Motor cable 14 AWG (2.5 mm^2)with motor plug Motor cable 12 AWG (4 mm^2)with motor plug	IP20/IP54	TLACPAAAxxx1 1) TLACPAABxxx1 1) TLACPAACxxx1 1)
4	1	Sensor cable for Hiperface module HIFA-C	IP20/IP54	TLACFABAxxx1 1)
5	1	Pulse direction cable for module PULSE-C	IP20/IP54	TLACDCBByyy1 1)
6	1	Cables for module RS422-C	IP20/IP54	TLACDCBCyyy1 1)
7		Fieldbus cables for modules CAN-C Fieldbus cables for modules IBS-C	IP20/IP54 IP20/IP54	TLACDCBAyyy1 1) TLACDCBFyyy1 1)
-	1	CAN terminator, 9-pin socket CAN terminator, 9-pin plug	IP20/IP54	TLATA TLATB
8	1	RS-232 programming cable 5 m RS-232 programming cable 10 m	IP20/IP54 IP20/IP54	TLACDPBG 050 TLACDPBG 100
9	1	Holding brake controller TLHBC	IP20	TLABHO
10	1	Ballast resistor controller TLBRC	IP20	TLABBO
11	1	External ballast resistor BWG 250072 (100W, 72 Ohm) BWG 250150 (100W, 150 Ohm) BWG 500072 (200W, 72 Ohm) BWG 500150 (200W, 150 Ohm)	IP20	 TLABRA TLABRB TLABRC TLABRD
12	1	Terminal block angle TS 15 2)	IP54	TLATLR
13	1	Set of grommets type KDT/Z 3)	IP54	TLATKR

1) Cable length xxx: 003, 005, 010, 020, 3 m (9.84 ft.), 5 m (16.4 ft.), 10 m (32.8 ft.), 20 m (65.6 ft.), longer cable lengths on request;.
2) This terminal block mounting rail is compatible with Phoenix Contact MBK terminal blocks or equivalent.
3) The inside diameter of the grommets must match the diameter of the cables used.

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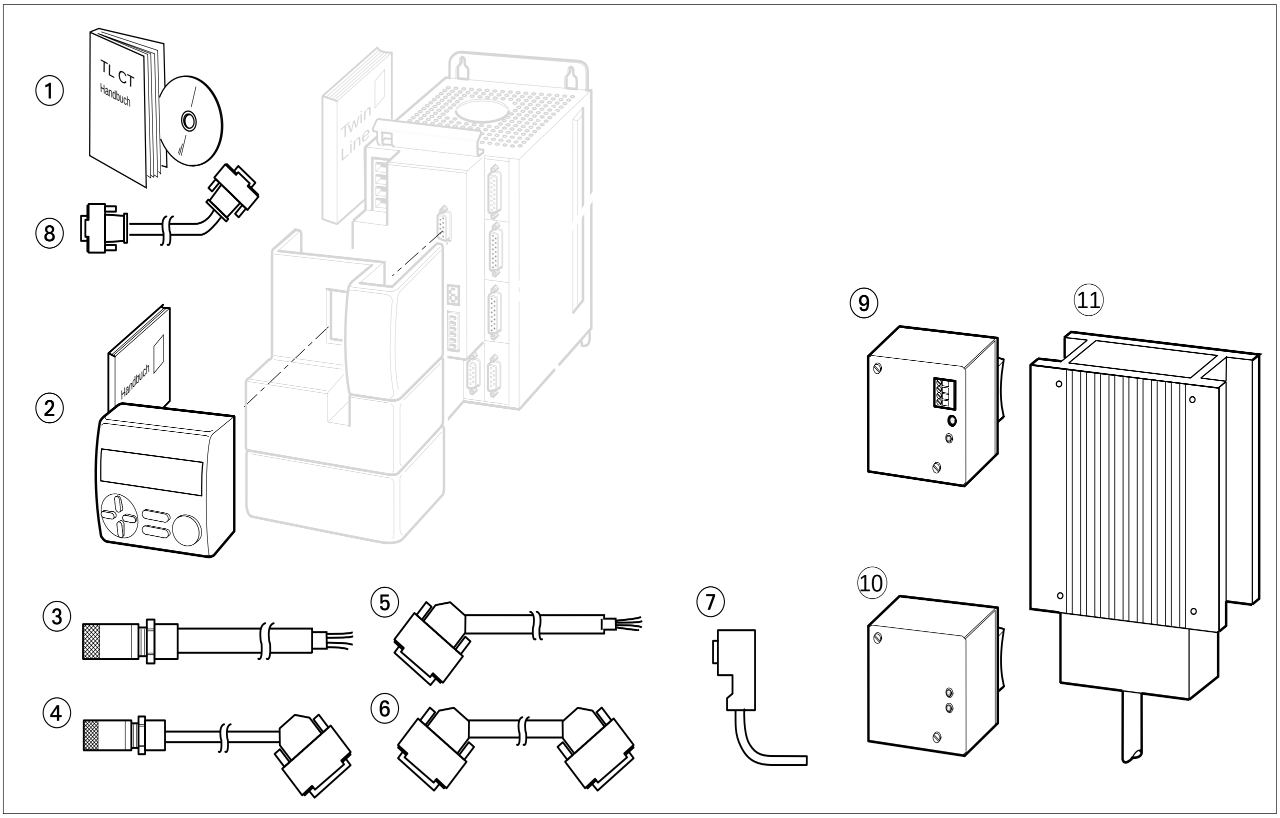

Fig. 1.3 Accessories for the TLC53x

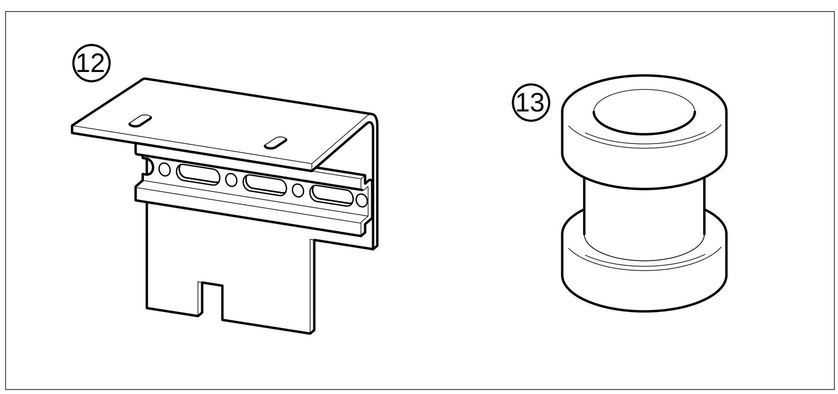

Fig. 1.4 Special accessories for the TLC53x IP54 controller

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1.2 Documentation and literature

Manuals for the controller

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

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

1.3 Product family

The controller TLC53x forms part of Schneider Electric's Twin Line series product family for controlling stepper motors and AC servomotors. The controller has built-in control electronics and a power amplifier that works as a stand-alone amplifier or as part of a Fieldbus configuration. It can control the position of an AC synchronous servomotor and carry out positioning operations on its own.

The TLC53x controller is available with four power amplifiers with a similar housing design. Electrical connections and functional scope are identical for all four units.

The controller comes in two versions with identical functions:

- TLC53x IP20 controller for use in a control cabinet
- TLC53x IP54 controller with protection grade IP54 (category 2 per DIN EN60529) for use outside the control cabinet close to the motor.

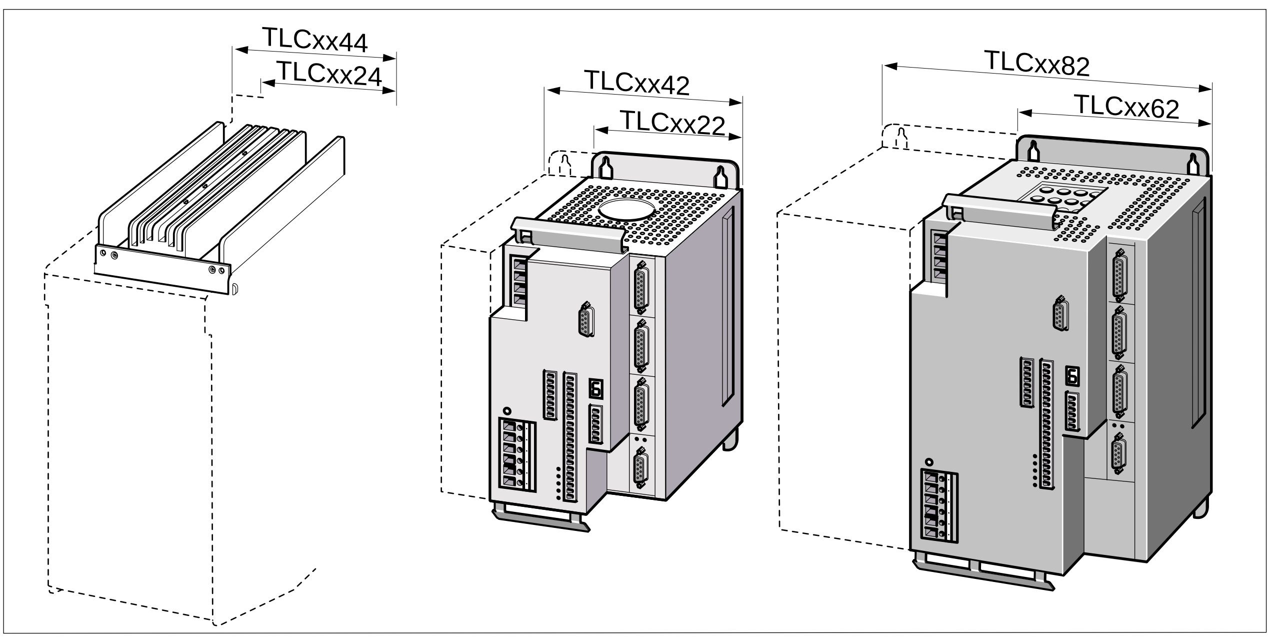

Fig. 1.5 Controller general arrangements

Type code

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

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Version Figure 1.6 describes the Twin Line controller configuration management.

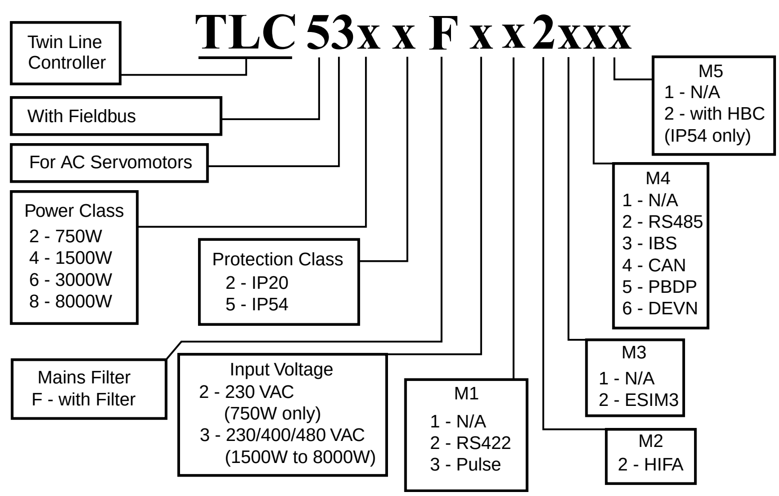

Fig. 1.6 Type code of the controller TLC53x

IP54 Controller There is an option to supply the controller with built-in holding brake control. This option is designated by “2” in the M5 configuration code field.

Accessories TLHBC and TLBRC are generally not suitable for use with IP54 controllers as they only have IP20 protection.

The internal ballast resistor of the IP54 controller has greater capacity than that of the IP20 controller.

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1.4 Controller overview

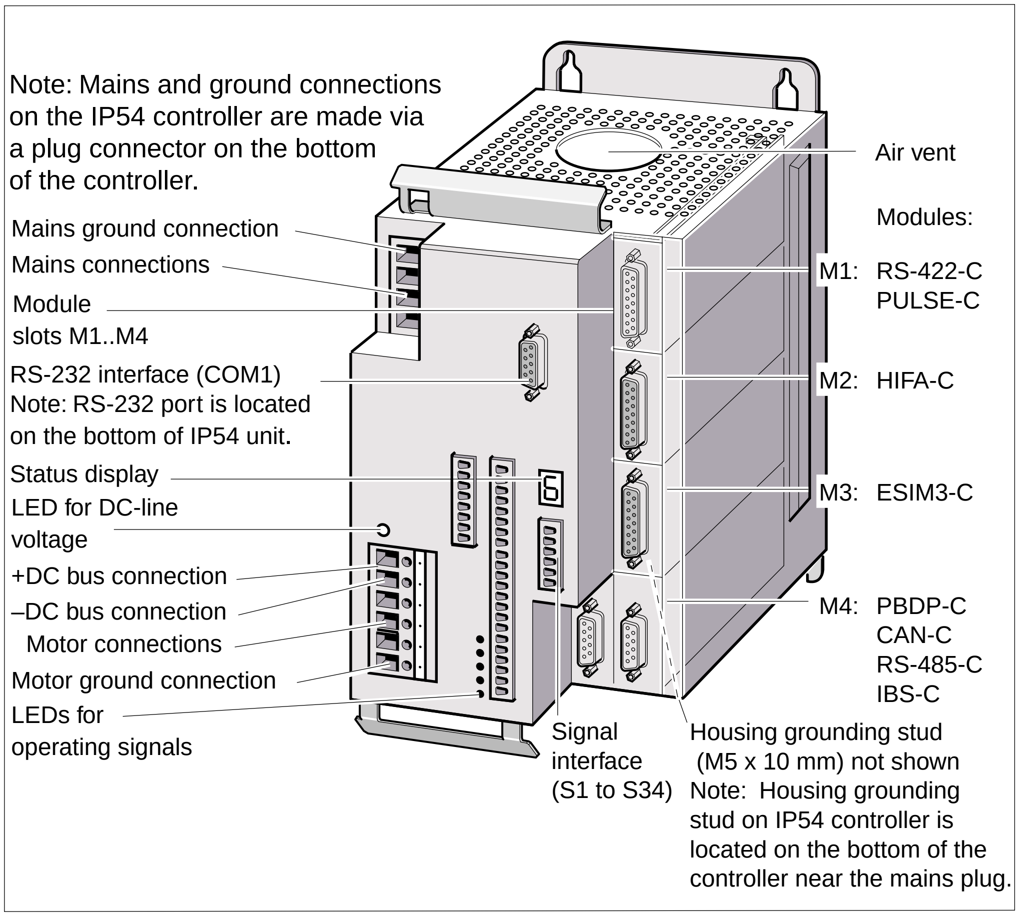

Fig. 1.7 Programmable Positioning controller TLC53x

Mains connection

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

- TLC532: 230 Vac, one phase
- TLC534, TLC536, and TLC538: 230/400/480 Vac, three phases.

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

The power supply for control loops and for controlling the fan must be provided by an external 24 Vdc power supply.

Motor connection

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

Internal ballast resistor

In braking mode, the motor returns energy to the controller. The energy is absorbed by DC bus capacitors and dissipated as heat by the internal ballast resistor.

Housing ground stud

In addition to the ground terminal at the mains input connector, a chassis grounding stud is provided as a supplementary controller grounding connection when required (EN50178 requirements for devices with high leakage current to ground). The grounding stud is provided on both the IP20 and IP54 controllers.

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DC bus connection A connection to the DC bus of the controller is present at the DC bus terminals. If the internal ballast resistor cannot dissipate the excess energy as heat, a ballast resistor controller with an external ballast resistor can be connected to the DC bus terminal.

Two Twin Line controllers of the same power class connected together via the DC bus connection can offload excess braking energy onto each other.

Status display A seven-segment display provides 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 DC bus voltage is present.

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

Signal interfaces The input and output signals are supplied to the signal interface via contacts and an external 24 Vdc supply

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

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

Module slots Four module slots allow you to match the controller to your particular application. Refer to Fig. 1.7 for the location of the module slots. The minimum configuration required to drive an AC servomotor is a module in slot M2. The other module slots expand the scope of functions of the 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.

Module slot functions and variants Several modules are available for slots M1, M2, M3, and M4 for configuring the controller for a particular installation.

Slot	Functions when module fitted	Possible modules fitted
M1	External setpoint signals for moving and positioning the motor	PULSE-C or RS-422-C
M2	Motor position feedback to controller	HIFA-C
M3	Encoder simulation module	ESIM3-C
M4	Fieldbus module for integrating into the following Fieldbus systems: Profibus-DP, CAN-Bus, CANOpen, DeviceNet, serial on-line connection or Interbus	PBDP-C, CAN-C, RS-485-C or IBS-C

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

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

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

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

1.5 Modules of theTLC53x controller

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

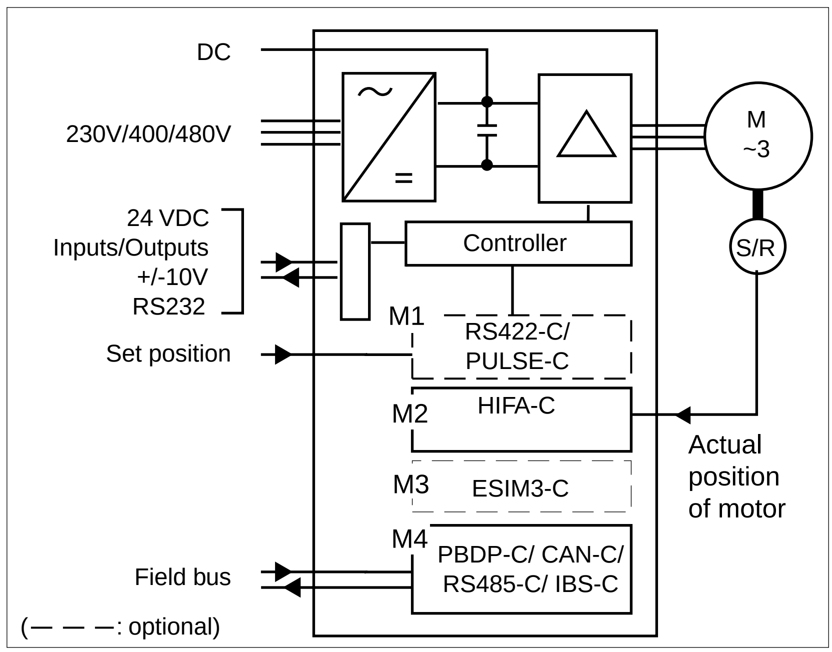

Fig. 1.8 Block diagram with modules and interface signals

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

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

The Hiperface module passes the position data to the controller.

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

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

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Module ESIM3-C The ESIM3-C encoder simulation module outputs the position data of the AC servomotor as an A/B signal. The A/B signal emulates a quadradure encoder directly connected to the servomotor. The signal can be used as the reference command for another Twin Line controller equipped with a RS-422-C module, or it can be sent to a higher-ranking (supervisory) controller for evaluation.

Module PBDP-C The PBDP-C Fieldbus module serves to integrate the controller into the Profibus-DP Fieldbus. The controller works as a command receiver or as a slave device. It executes the control and work commands from a higher-ranking (supervisory) controller.

Module CAN-C The CAN-C Fieldbus module couples the controller to a CAN-C, CAN-Open or DeviceNet Fieldbus.

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

Module RS-485-C The RS-485-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 - is able to swap data with several devices.

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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 with positioning
- Speed mode
- Point-to-point mode
- Electronic gear via a module in slot M1
- Referencing

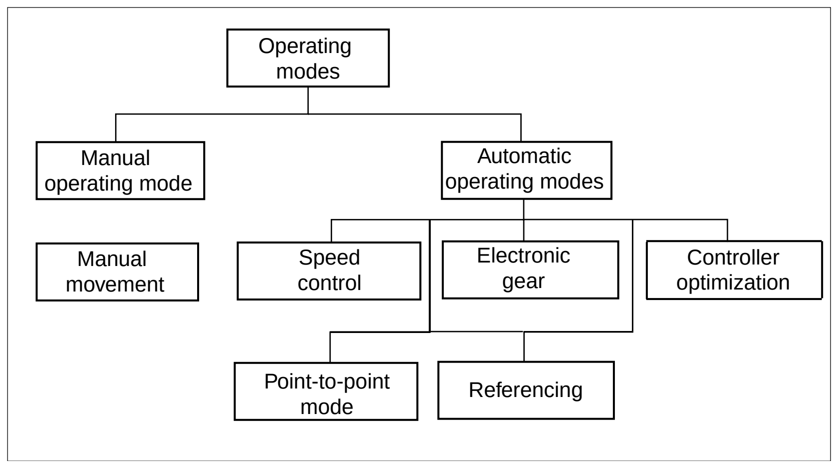

Fig. 1.9 Operating modes of the controller TLC53x

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	optional	HIFA-C	optional	optional
Electronic gear mode	PULSE-C or RS-422-C	HIFA-C	optional	optional

Manual movement with positional reference

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

Speed mode

In speed mode, the motor is given a set speed and a movement is started with no defined target position. The motor continues to move at this speed until a new speed is set or the mode is terminated.

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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 means of a positioning command. The positioning distance is given either in absolute terms with reference to the axis zero point or in relative terms with reference to the current axis position.

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

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

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

In a referencing movement, the motor is moved to a defined position, the zero or reference point, on the axis in order to create an absolute dimension reference between the position of the motor and the axis. The reference point is used as the point of reference for all following absolute positioning operations.

Dimension setting offers the chance to define the current motor position as the new axis reference point to which all following position data relate.

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

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

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

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

Fieldbus mode There are four modules available for Fieldbus operation:

- Profibus-DP with the PBDP-C module
- CAN-Bus, CANOpen or DeviceNet with the CAN-C module
- Serial RS-485 bus with the RS-485-C module
- Interbus-S with the IBS-C module

Refer to the device instruction manuals for information concerning the connecting, programming, and operating of the controller in a Fieldbus system.

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List control While the positioning controller is carrying out a movement command, the direction of movement is monitored in the background by means of list control. When a list position is reached, the positioning controller responds with the relevant reaction 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 positioning controller switches to the new speed value in the list, and moves the motor at this speed.

Teach-In Entries can be made in the list with the HMI hand-held operating unit, the commissioning software, or via the Fieldbus. For entering position values, the positioning controller offers Teach-In processing: the motor is moved to successive list positions with respect to the reference point, and these positions are then committed to the parameter memory together with a value for trigger output or speed.

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1.7 Guidelines and standards

1.7.1 Declaration of conformity and CE labelling

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

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

CE labelling

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

Machine guideline

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

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

EMC guideline

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

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

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

Low voltage guideline

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

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

- Protection class 1
- Pollution degree 2 for the IP20 controller, 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 theTwin Line drive system a declaration of conformity in accordance with the EC low voltages guideline has been issued.

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EC Declaration of Conformity 2001

BERGER LAHR

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

- ☐ Machine Directive 98/37/EEC, Appendix IIA
- ☒ EMC Directive 89/336/EEC
- ☒ Low Voltage Directive 73/23/EEC
  the above directives have been amended by the CE Marking Directive 93/68/EEC

We hereby declare that the products designated below correspond, in their design and construction as well as in the version marketed by us, to the requirements of the listed EC directives. This declaration loses its validity if changes are made to the products which have not been agreed with us.

Designation:	3-phase motor amplifiers with/without electronic control and accessories
Part number:	TLDx1x2…, TLCx1x2…, TLDx3x2…, TLCx3x2…, TLCx1x5…, TLCx3x5…,TLABH…, TLABB…
Material number:	01634xxxxxxxx, 01635xxxxxxxx, 0162501101706, 0162501101606
Harmonised norms applied, especially:	EN 50178 Classification VDE 0160: 1998.04 EN 61800-3 Classification VDE 0160: 1997.08, category 2 according to BERGER LAHR test conditions
national norms and technical specifications applied, especially:	UL 508C BERGER LAHR test conditions 200.47-01 EN
Company stamp:	Berger Lahr GmbH & Co. KG Postfach 11 80 · D-77901 Lahr Breslauer Str. 7 · D-77933 Lahr
Date/Signature:	15. Nov. 2001
Name/Department:	W. Brandstätter / MOM-E

Fig. 1.10 Conformity as per the EC low voltages guideline

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1.7.2 Regulations and standards

Standards concerning recommended installation, operation, maintenance, repair, and adjustment of the Twin Line drive system

EN 60204 - Part 1: 1999: Electrical equipment of machines, General requirements

NFPA 70: 1999: National Electrical Code

NEMA ICS1.1: Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control

NFPA 79: 1997: Electrical Standard for Industrial Machinery

EN60529: 2001: Degrees of protection provided by enclosures (IP Code)

EN61508-1: 1998: Functional safety of electrical / electronic / programmable electronic safety-related systems, Part 1: General design principles

NFPA 70E: 2000: Standard for Electrical Safety Requirements for Employee Workplaces

NEMA ICS7.1 Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems

Standards regarding compliance with EMC Directive

EN 61000-4-1: 2000: Testing and measurement techniques–Overview of IEC61000-4 series (noise immunity testing procedures)

EN 50082-2: 1995: Electromagnetic Compatibility–Generic immunity standard–Industrial environment

EN61800-3: 1996: Adjustable speed electrical power drive systems–EMC product standard including specific test methods

EN61000-4-5: 2001: Electromagnetic compatibility (EMC)–Testing and measurement techniques–Surge immunity test

Standards regarding compliance with Low Voltage Directive

EN50178: 1997: Electronic Equipment for use in Power Installations

EN60664-1: 2000: Insulation coordination for equipment within low-voltage systems–Principles, requirements, and tests

Standards regarding compliance with Underwriters Laboratories requirements

UL508C 2nd Edition: UL Standard for Safety for Power Conversion Equipment

UL840 2nd Edition: UL Standard for Insulation Coordination Including Clearances and Creepage Distances for Equipment

UL1004 5th Edition: UL Standard for Safety for Electric Motors

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2 Safety

2.1 Hazard categories

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

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2.2 Safety instructions

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- Read and understand this bulletin in its entirety before installing or operating Twin Line drive system products. Installation, adjustment, repair, and maintenance of these drive systems must be performed by qualified personnel.
- Disconnect all power before servicing the power controller. WAIT SIX MINUTES until DC bus capacitors discharge, then measure DC bus capacitor voltage between the DC+ and DC- terminals to verify that the DC voltage is less than 45 V (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 servomotor can produce voltage at its terminals when the shaft is rotated! Prior to servicing the power controller, block the servomotor shaft to prevent rotation.
- DO NOT short across DC bus terminals or touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers and close enclosure door before applying power or starting and stopping the drive system.
- The user is responsible for conforming to all applicable code requirements with respect to grounding all equipment. For drive controller grounding points, refer to Fig. 1.7 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.

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2.3 Use for the purpose intended

2.3.1 Ambient conditions (controller and accessories)

	Transportation and storage temperature	-40°C to +70°C
	Operating altitude, No derating required for h <1000 m above m.s.l.	
	Vibration stress during operation to IEC 68-2-6	
	Number of cycles:	10
	Frequency range:	10Hz to 500Hz
	Acceleration:	20m/s^2
	Continuous shocks to IEC 68-2-29	
	Number of shocks:	1000/direction (X,Y,Z for each clockwise, counter-clockwise direction, total 6000)
	Peak acceleration:	150m/s^2
IP20 controller and accessories	Enclosure type rating (IP):	Open (IP20)
	Surrounding air temperature:	0 °C to +50 °C
	Relative humidity:	15% to 85% (no condensation permissible)
	Pollution degree rating (UL508C):	Pollution Degree 2
IP54 controller only	Enclosure type rating (IP):	Type 1 (IP54)[1]
	Protection grade of internal cooling air duct:	IP24 Ambient
	Ambient temperature:	0°C to + 45°C
	Relative humidity:	15% to 85% (no condensation permissible)
	Pollution degree rating (UL508C):	Pollution Degree 3

2.3.2 Intended use

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

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

The controller must be installed and operated in an environment which meets Pollution Degree 2 (Pollution Degree 3 for the IP54 controller). The IP20 controller is an open device that must be installed in a control cabinet that maintains a Pollution Degree 2 environment in its interior. The the IP54 device is aType 1 enclosed device.

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

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

1. Category 2 per DIN EN60529. Interior enclosure pressure equalized to exterior ambient pressure via flexible diaphragm.

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2.3.3 Suitability in safety critical applications

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

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

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

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2.4 Qualification of the personnel

Work on and with the 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.

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 monitors a range of signals from system and installation components.

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

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

⚠WARNING

LOSS OF BRAKING TORQUE

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

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

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The following components and limit values are monitored internally:

Monitoring	Task and protective functions
Short-circuit	Monitor motor cable for short-circuits between phases; functional safety and device protection
Phase failure	Monitor motor connections; error message if motor not connected
Overvoltage and undervoltage	Monitor DC bus for overvoltage and undervoltage; functional safety and device protection
Temperature	Monitor motor and power amplifier with sensors for excess temperature; functional safety and device protection
Overheating	I^2t monitoring of motor, internal ballast resistor and power amplifier for temperature rises in the threshold range during motor operation and standstill; functional safety and device protection
Positioning error	Contouring error threshold for excess positional deviation; functional safety
Motor speed	Speed threshold for maximum permitted speed, functional safety and device protection
Data connection with a supervisory device	Functionality of connection when motor controlled via supervisory device; functional safety

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3 Technical data

3.1 Mechanical data

3.1.1 Controller TLC53x (IP20)

Weight	TLC532 with 3 modules	2.7 kg (6.0 lb.)
	TLC534 with 3 modules	3.7 kg (8.2 lb.)
	TLC536 with 3 modules	6.6 kg (14.6 lb.)
	TLC538 with 3 modules	10.8 kg (23.9 lb.)
Enclosure rating	Enclosure Type Rating (IP)	Open (IP20)

Dimensions

	TLC532		TLC534		TLC536		TLC538	
	mm	in.	mm	in.	mm	in.	mm	in.
Width A	108.0	4.3	128.0	5.1	178.0	7.1	248.0	9.9
Height B	212.5	8.5	212.5	8.5	260.0	10.4	260.0	10.4
Depth C	184.5	7.4	214.5	8.6	244.5	9.8	244.5	9.8
Front width D	105.5	4.2	125.5	5.0	176.0	7.0	246.0	9.8
Connection dimension E	63.0	2.5	83.0	3.3	130.0	5.2	200.0	8.0
Additional dimension F	-	-	-	-	-	-	120.0	4.8

Dimensions in mm (in.)

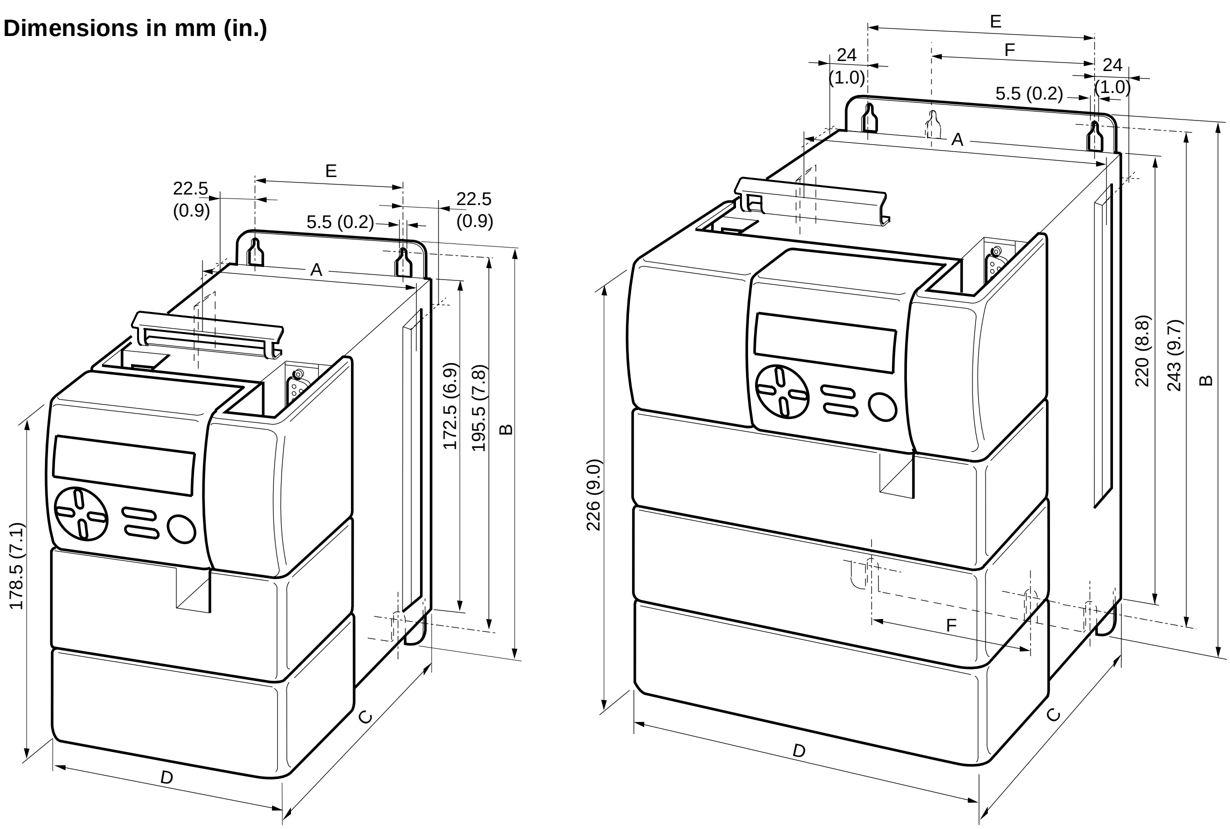

Fig. 3.1 Dimensions of TLC532, TLC534, TLC536, and TLC538. The Twin Line HMI shown in the drawing is an option.

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3.1.2 Controller TLC53x (IP54)

Weight	TLC5325F with 3 modules	8.5 kg (18.8 lb.)
	TLC5345F with 3 modules	11 kg (24.3 lb.)
Enclosure rating	Enclosure Type Rating (IP)	Type 1 (IP54)[1]

Dimensions

	TLC5325		TLC5345	
	mm	in.	mm	in.
Width A	127.0	5.1	147.0	5.9
Height B	360.0	14.4	360.0	14.4
Depth C	245.0	9.8	275.0	11
Front width D	127.0	5.1	127.0	5.1
Connection dimension E	80.0	3.2	100.0	4.0

Dimensions in mm (in.)

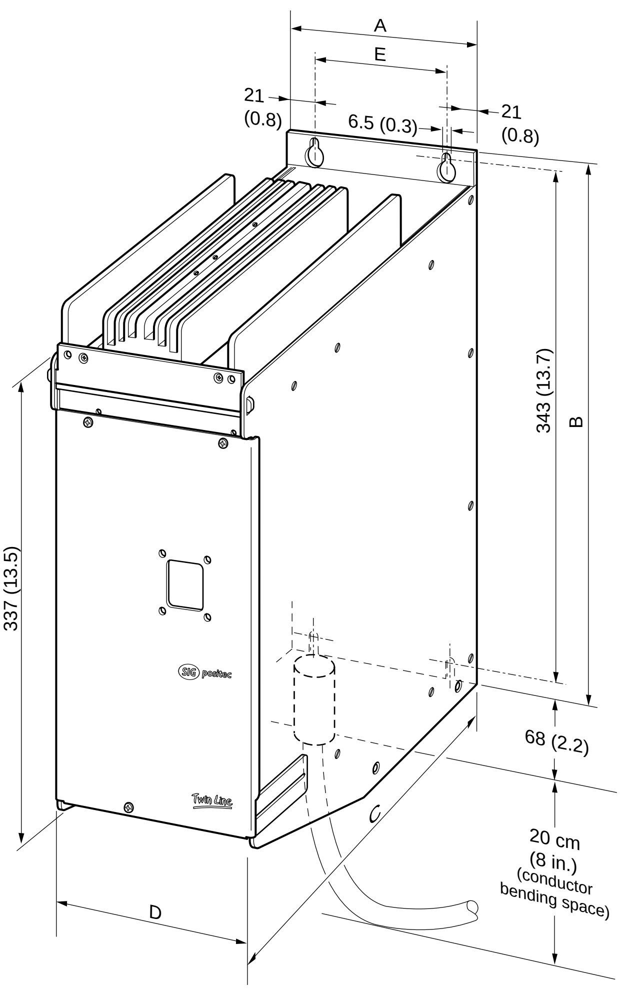

Fig. 3.2 Dimensions TLC53x (IP54)

1. Category 2 per DIN EN60529. Interior enclosure pressure equalized to exterior ambient pressure via flexible diaphragm.

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3.1.3 Accessories

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

Dimensions in mm (in.)

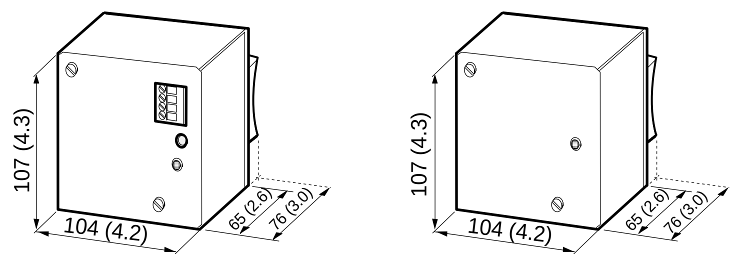

Fig. 3.3 Holding brake controller (left) and ballast resistor controller (right)

Ballast resistors BWG 250xxx and BWG 500xxx

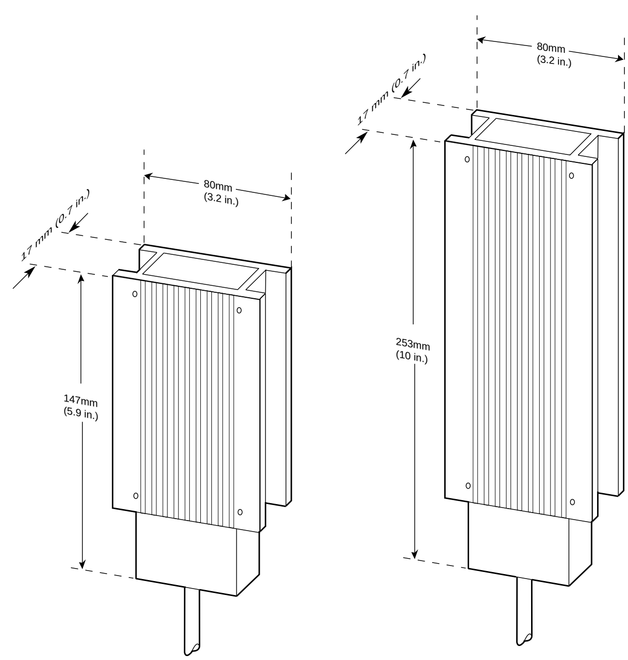

Fig. 3.4 Size and mounting dimensions of the ballast resistor in the versions with 100 W and 200 W continuous power

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3.2 Electronic data

3.2.1 Controller

Mains connection

	TLC532	TLC534	TLC536	TLC538
Mains voltage [Vac] 1)	230	230	230	230
(-20%, +10%)	240	230/400	230/400	230/400
	—	277/480	277/480	277/480
Input phases	1	3	3	3
Mains frequency [Hz]	47 - 63	47 - 63	47 - 63	47 - 63
Current consumption [A] 2)	6.5	4	7.5	20
Starting current [A]	< 60	< 60	< 60	< 60
Power factor [cosφ]	> 0.55	> 0.6	> 0.6	> 0.6
Power loss [W] 3)	min. 20 / max. 150	min. 20 / max. 140	min. 20 / max. 380	min. 40 / max. 430
Mains buffering [ms]	< 5	< 3	< 3	< 3
Operational overvoltage (EN 61800-3 and EN61000-4-5)	between phases: 1 kV, phases to eart h 2kV			
Input mains overvoltage category (UL840)	category III 4)			
Leakage current [mA] 5)	< 30	< 30	< 30	< 30
Fuse, external [A]	10 (Class CC)	10 (Class CC)	10 (Class CC)	25 (Class CC)

1) Suitable for use on grounded systems only. Maximum voltage to ground should not exceed 300 Vac. Maximum available short-circuit current must not exceed 5000 A.
2) A mains reactor is required if, over any 2 minute period, the motor average power flow to the load is greater than 50% of the motor controller's power class. See page 3-9 for recommended reactors. Maximum available short-circuit current must not exceed 5000 A.
3) The power loss depends on several factors: motor speed, motor current, length of cable, torque and use of the internal ballast resistor.
4) The Twin Line family of products has been designed according to standard UL840. Installation of a surge arrester on the branch circuit supplying power to the Twin Line 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.

Motor connection

	TLC532	TLC534	TLC536	TLC538
Power class 1) 2) 3)[kW] at 230 V 400 V 480 V	0.75 – –	0.75 1.5 1.5	1.5 3 3	4 8 8
Switching frequency [kHz] switch-selectable to [kHz]	8 / 16	8 / 16	8 / 16	4 / 8
Rated current [A r.m.s.], r.m.s. 4)	3	3	6	16
Rated current [Apk], amplitude	4.24	4.24	8.48	22.63
Rated current [Apk], maximum value at lower switching frequency during motor movement	8.48	8.48	28.28	45.26
Rated current [Apk], maximum value at higher switching frequency during motor movement	8.48	5.66	18.85	38.18
Maximum speed [r.p.m.] 5)	6000	6000	6000	6000
Cable length 6) [m]	20	20	20	20

1) max. shaft output with typical motor, for rated current and at 230 Vac or 400 Vac mains voltage
2) A mains reactor is required if, over any 2 minute period, the motor average power flow to the load is greater than 50% of the motor controller's power class. See page 3-9 for recommended reactors.
3) refer to section 3.2.3 for UL certification power class deratings.
4) continuous operation at maximum surrounding air/ambient temperature
5) when used with a 8-pole (4-pole pair) motor.
6) longer lengths on request

Internal load circuit of IP20 controller

	TLC532	TLC534	TLC536	TLC538
Continuous rating P_{AV} [W]	30	50	200	80
Max. energy per braking W_{PEAK} [Ws]	50	80	100	130

Internal ballast circuit in IP54 controller

Fan	Ambient temperature [°C]	Continuous output P_{AV} [W]	
		TLC532	TLC534
yes	25	170	255
	35	127	190
	45	85	127
no	25	60	90
	35	42	63
	45	25	37

All specifications apply for a surface temperature of 70 °C on the ballast heat sink.

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24 Vdc supply

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

DC bus connection

A maximum of two 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. 5ms
DC-voltage U_{high}	12 V to 30 V ($I \geq 3$ mA)
DC-voltage U_{low}	≤ 5 V ($I \leq 0{,}5$ mA)
Current at 24 V	≤ 7 mA
Digital signal outputs	Inductive loadability (150 mH / 11 W) Short-circuit protected
DC-voltage	≤ 30 V
Switching current	≤ 400 mA
Voltage drop at 400 mA	≤ 1 V
Analog signal input	
Voltage range	+10 V to -10 V
Input resistance	5 kΩ

UL 508C certification

Twin Line apparatus that has undergone UL508C certification is listed in the section entitled ‘UL 508C certification’ on page 3-8.

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3.2.2 Modules

Note: Detailed data on individual modules can be found in the chapter entitled "Electrical installation" on page 4-12.

HIFA-C Hiperface module	Encoder supply voltage	+10 V / 150 mA Short-circuit and overload-protected Not protected against connection to an external power supply
	Signal inputs	
	Sine / cosine (SIN, COS)	1 V_{SS} with 2. 5V offset 0.5 Vss at 100 kHz
	Input resistance	2 x1 kΩ to 0 Vdc
	Monitoring of motor temperature (T_MOT)	1 V - 4.8 V
	Typ. Values: 0 / 25 / 100 / 140°C	4.8 / 4.34/ 1.32/ 0.53 V
	Short circuit or overload	< 0.1 V
	Cable break, no sensor	> 4.9 V
	RS-485	asynchronous, half-duplex
RS-422-C encoder module	Signal inputs (A, B, I)	RS-422 compatible Connected electrically to 0 Vdc
	Input frequency	≤ 400 kHz 1 600 000 Inc/s
	Output	
	Encoder supply with sense active	5 V ± 5%, max. 300 mA +Sense and -Sense for cable length compensation Short-circuit and overload-proof
PULSE-C pulse direction module	Signal inputs	
	Symmetrical	Compatible with RS-422-voltage
	Asymmetrical	4.5 V to 30 V Connected electrically to 0 Vdc
	Input resistance	5 kΩ
	Input frequencies:	
	Stepping frequency (PULSE/PV, DIR/PR)	≤ 200 kHz
	Signal outputs	Open collector outputs Short-circuit-proof
	Output voltage	≤ 30 V
	Output current, maximum	≤ 50 mA
RS-485-C module	Signal inputs / outputs	in accordance with RS-485 standard electrically isolated 4-wire interface
	Transmission rates	1200, 2400, 4800, 9600 19200, 38400 Baud
PBDP-C module	Signal inputs / outputs	in accordance with RS-485 standard electrically isolated
	Transmission rate	≤ 12 MBaud
CAN-C module	Signal inputs / outputs	level to ISO 11898 electrically isolated
	Transmission rate	≤ 1 MBaud

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IBS-C module	Signal inputs / outputs	in accordance with INTERBUS specification, category 1 Two-wire remote bus
	Transmission rate	500 kBaud
	For units with the IBS-C module, 0 Vdc is internally connected to ground.	
ESIM3-C simulation module	Signal outputs (A,B)	RS422-compatible Connected electrically to 0 Vdc
	Output frequency	< 155 kHz

3.2.3 UL 508C certification

The Twin Line Controller 53x is certified to U L508C with the following ratings.

Mains connection

Unit	Mains voltage [V]	Mains frequency [Hz]	Current [A]	Phases
TLCX32	230	47-63	6	1
TLCX34	480	47-63	3.2 [1), 2)]	3
TLCX36	480	47-63	5.5 [3)]	3
TLCX38	480	47-63	10 [4)]	3

1) 2.4 A for IP54 controllers.
2) IP20 controller power class must be derated to 1200 W at 480 V and 600 W at 230 V. IP54 controller power class must be derated to 900 W at 480 V and 450 W at 230 V.
3) IP20 controller power class must be derated to 2200 W at 480 V and 1100 W at 230 V.
4) IP20 controller power class must be derated to 4000 W at 480 V and 2000 W at 230 V.

Motor data

Unit	Motor voltage [V]	Motor frequency [Hz]	Motor current [A]	Phases
TLCX32	0-230	0-400	3	3
TLCX34	0-480	0-400	3	3
TLCX36	0-480	0-400	6	3
TLCX38	0-480	0-400	16	3

Accessories

- Ballast resistor controller, TLBRC
- Holding brake controller, TLHBC

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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 (no voltage reduction)	20 V to 30 V
Current at 24 V for 100 ms	0.5 A to 2.5 A
Continuous current	0.5 A to 1.5 A
DC-voltage (with voltage reduction active)	9.5 V to 15 V
Current at 12 V	0.5 A to 2 A

Electrical isolation betwe e n 24V input, control input and brake output

TL BRC ballast resistor controller

Own power supply via DC bus connection
Switch-on threshold, selectable

For TLC532 controllers	420 V
For TLC534, TLC536, and TLC538 controllers	760 V

Input line reactors

Controller	Reactor P/N 1), 2)	Ratings
TLC532	RL01201	1.25 mH, 12 A, 600 V, 3-coil
TLC534	RL00803	5.00 mH, 8 A, 600 V, 3-coil
TLC536	RL01202	2.50 mH, 12 A, 600 V, 3-coil
TLC538	RL02502	1.20 mH, 25 A, 600 V, 3-coil

1) Reactors are available from MTE Corporation, Menomonee Falls, WI. Refer to the MTE website, www.mtecorp.com, for additional ratings and outline dimensions.
2) Reactors are open construction. Type 1 enclosed reactors are available. Change the next to last digit of the part number from 0 to 1 to include a Type 1 enclosure.

TLACPAAxxxx1 motor cable

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

Rated voltage: 600 Vac UL and CSA

Construction:

TLACPAAAxxx1	4x16 AWG/1.5 mm^2 + 2x17 AWG/1.0 mm^2
TLACPAABxxx1	4x14 AWG/2.5 mm^2 + 2x17 AWG/1.0 mm^2
TLACPAACxxx1	4x12 AWG/4.0 mm^2 + 2x17 AWG/1.0 mm^2

Shield	Braided with 90% coverage
Jacket:	Oil-resistant PUR
Flex Cycles:	Minimum of 1 million cycles/moderate flexing
Temperature rating:	-40 °C to +85 °C (static) -5 °C to +85 °C (flexing)
Minimum bend radius	10 x diameter (static) 10 x diameter (flexing)

Cable diameters:

TLACPAAAxxx1	0.45 inches (11.3 mm)
TLACPAABxxx1	0.55 inches (14.1 mm)
TLACPAACxxx1	0.61 inches (15.4 mm)

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Encoder cable specification

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

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

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4 Installation

4.1 Electromagnetic compatibility (EMC) and equipment grounding requirements

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

Cabling

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

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

Power supplies

EMC measures	Effect
The controller must be operated from a grounded-neutral mains power source. Do not operate the controller from corner-grounded, resistance-grounded, or ungrounded (IT) power sources.	Minimize presence of overvoltage from mains, maintain effectiveness of mains filter, and comply with validated EMC configuration.
The negative bus of the 24 Vdc power source feeding the controller must be bonded to ground.	Comply with validated EMC configuration.
Use twisted pair, shielded conductor for the 24 Vdc power supply connections of the TLCx34 IP20 controllers.	Reduce emissions and comply with validated EMC configuration.

⚠ DANGER

HAZARDOUS VOLTAGE - INADEQUATE GROUNDING

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

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

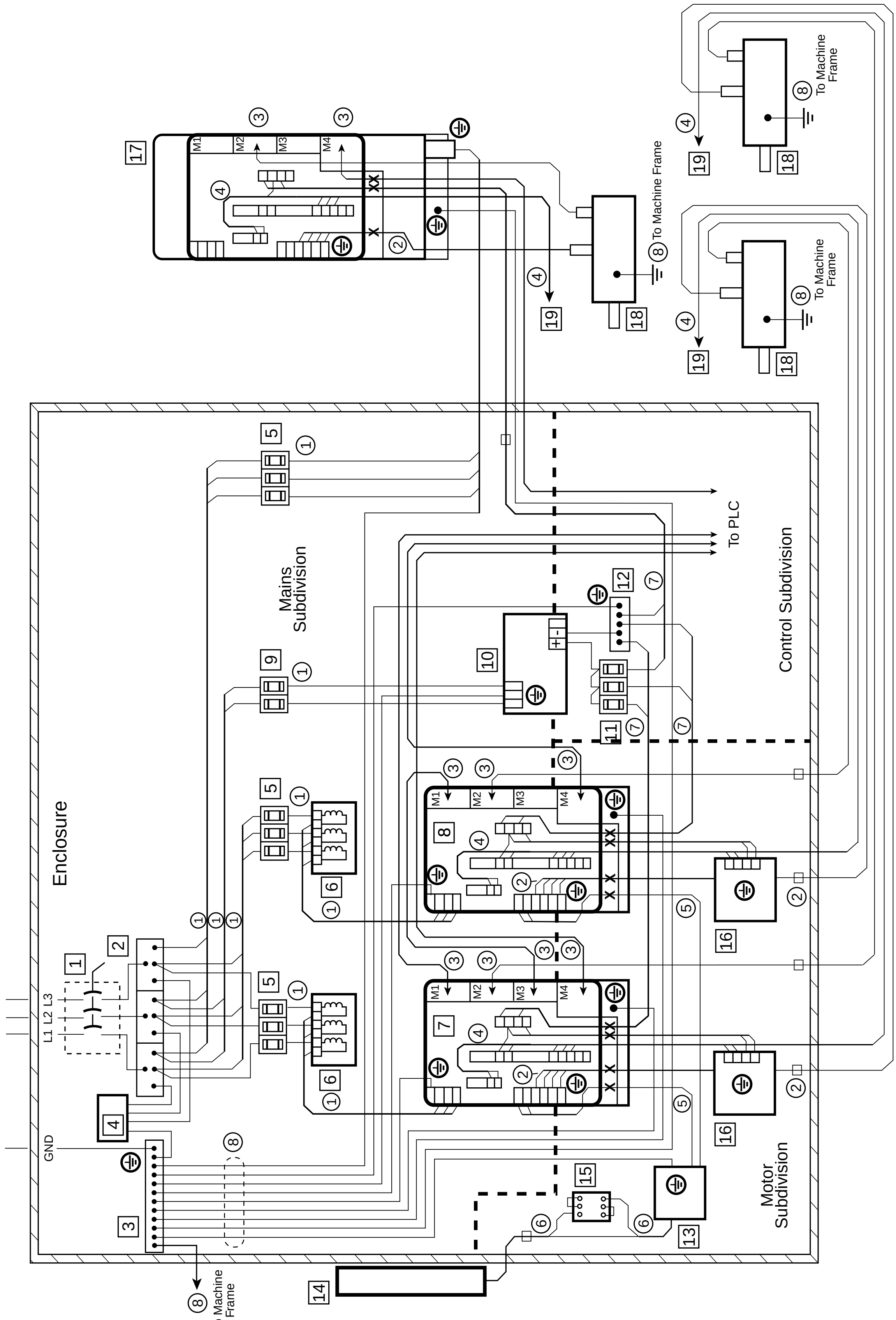

Fig. 4.1 Typical apparatus interconnection showing EMC measures and equipment grounding requirements

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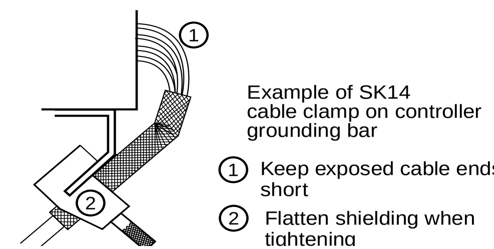
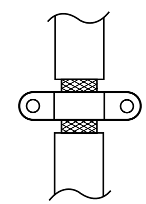
Cable	Description
①	Individual conductor or multi-conductor power cable. Refer to section 4.4.2 and 4.4.3 for details.
②	Multi-conductor shielded motor cable. Refer to section 4.4.4, 4.4.5, and 4.5.1 for details.
③	Multi-conductor shielded communication/encoder cable. Refer to sections 4.4.9 through 4.4.18 for details.
④	Multi-conductor control cable. Refer to section 4.4.8 for details.
⑤	Multi-conductor shielded power cable. Refer to section 4.4.6 for details.
⑥	Multi-conductor shielded power cable. Refer to section 4.5.2 for details.
⑦	Multi-conductor twisted shielded control cable. Refer to section 4.4.7 for details. *NOTE: Shielded control cable is required only on the TLCx34 IP20 controllers. Use multi-conductor twisted control cable for all other controllers.*
⑧	Ground bonding conductors. Use a cross section no smaller than the mains input conductor of the associated component.

Component	Description
1	Disconnect means
2	Power distribution block
3	Power ground bar
4	Surge arrester (if required)
5	Controller input mains fuses
6	Controller input mains reactor
7	TLC5342 controller (lead)
8	TLC5342 controller (follow)
9	24 Vdc power supply input mains fuses
10	24 Vdc power supply
11	24 Vdc fuses
12	24 Vdc ground bar
13	TLBRC ballast resistor controller
14	Ballast resistor
15	GV2
16	TLHBC holding brake controller
17	TLC5345 controller
18	Servomotor
19	Limit switches

Symbol	Description
	Safety ground connection.
	Cable shield terminated at controller grounding bar 
	Cable shield terminated to enclosure sheet metal at or near the exit point from enclosure 

4.2 System components

Besides the components included with the IP20 controller, the following system components may also be required.

- Synchronous servomotor with Sincoder
- Motor cable
- Sincoder cable
- Signal cable to fit device version:
  RS-422-C module: cable for RS-422-C
  PULSE-C module: cable for PULSE-C
  PBDP-C module: bus cable for Profibus-DP
  CAN-C module: bus cable for CAN-Bus, CANOpen and DeviceNet
  RS-485-C module: bus cable for serial on-line bus
  IBS-C module: bus cable for Interbus
- RS-232 cable with PC connecting plug
- Mains disconnect, fuses, cable, and surge arrester
- External 24 V power supply
- Ballast resistor and controller (as required)
- Reactor for mains connection depending on motor power requirements
- Brake controller (as required)
- Control cabinet
- NC control or PLC for automatic operation
- PC or laptop with WINDOWS® 95, 98 or NT for commissioning with operating software.

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4.3 Mechanical installation

⚠ CAUTION

EQUIPMENT DAMAGE HAZARD

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

Failure to follow 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.

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4.3.1 Mounting the TLC53x IP20 controller

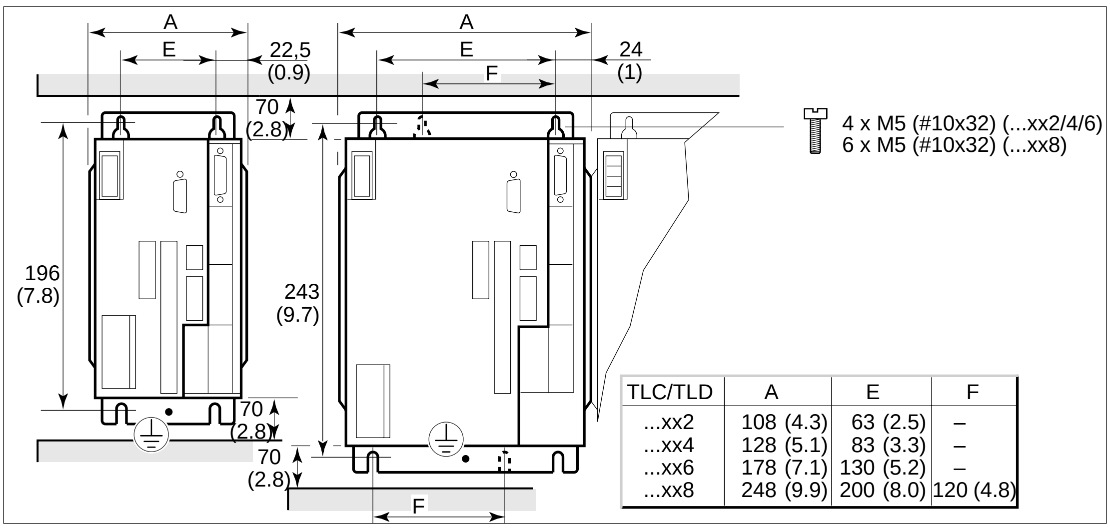
Control cabinet

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

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

Mounting distances

The 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.



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

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

- ▶ Position the controller in the enclosure such that the heated air flow from other apparatus (for example, external ballast resistor) does not result in undesired heating of the 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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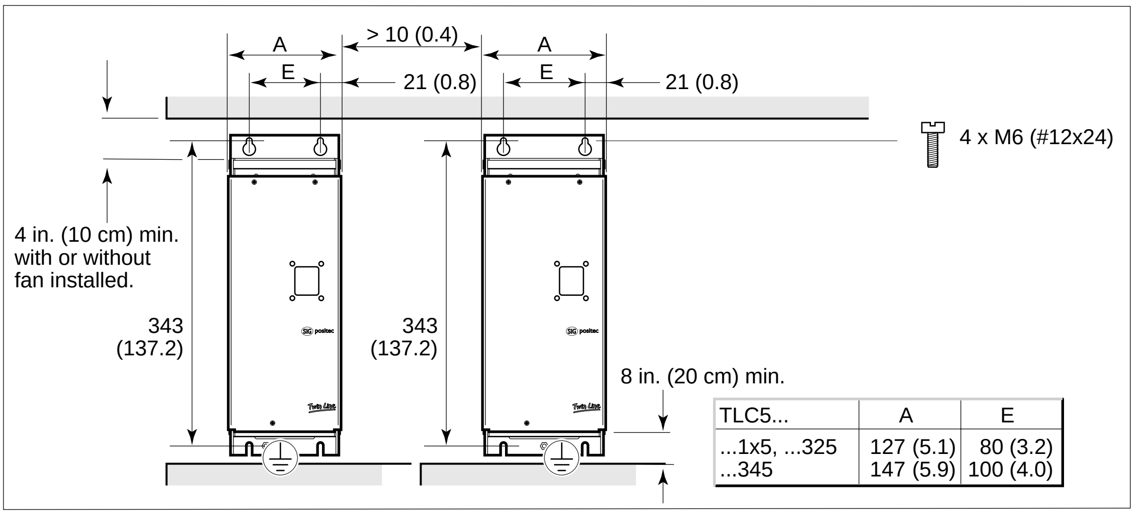
4.3.2 Mounting the TLC53x IP54 controller

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 8 in. (20 cm) 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 in order to maintain its water resistance rating.



TLC5...	A	E
...1x5, ...325	127 (5.1)	80 (3.2)
...345	147 (5.9)	100 (4.0)

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

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4.3.3 Fitting controller labels

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

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

IP20 controller

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

IP54 controller

- ▶ Attach the label to the side of the Twin Line Controller.

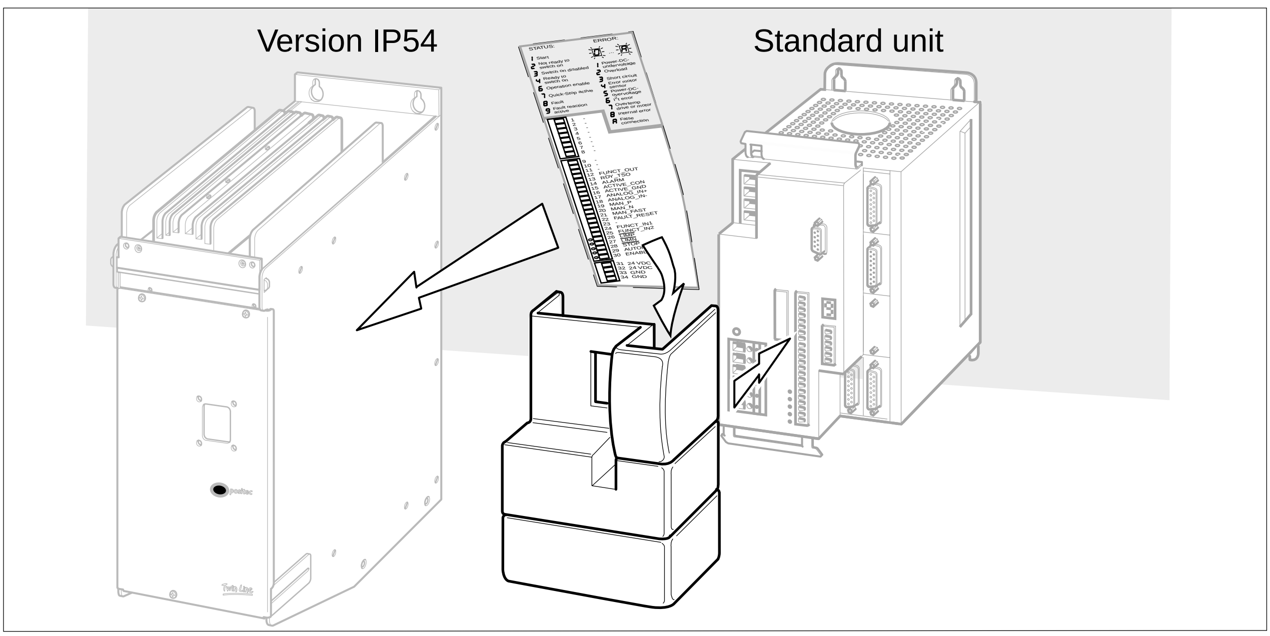

Fig. 4.4 Attaching the controller label in the side of the hood or to the side of the Twin Line Controller

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.

Mains reactor A mains reactor is required if, over any 2 minute period, the motor average power flow to the load is greater than 50% of the motor controller's power class. Both open construction and Type 1 enclosed reactors are available. See page 3-9 for recommended reactors and supplier. Refer to sections 4.4.2 and 4.4.3 for electrical installation requirements.

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

4.3.5 Installing accessories on the IP54 controller

Terminal angle The IP54 controller offers a terminal angle as an accessory which is used 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.

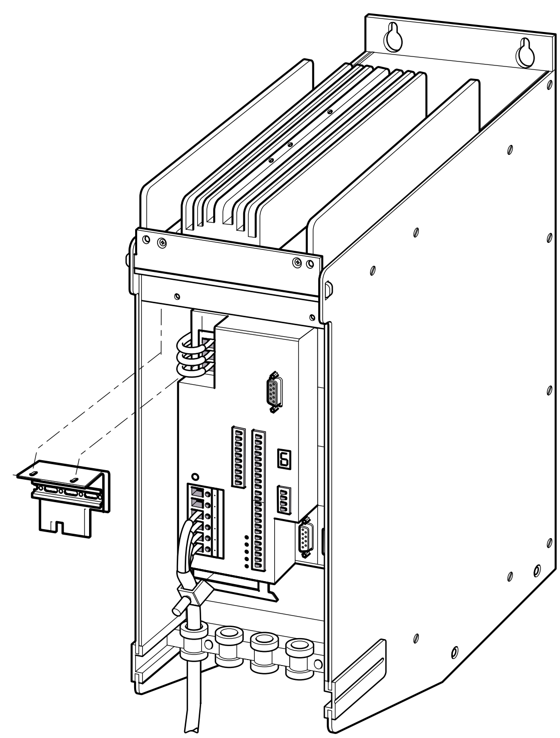

Fig. 4.5 Connection of terminal angle

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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 TLC53x IP54 controllers

For IP54 controllers, most of the electrical connections 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, D-shell connector
- Mains connections via circular power plug

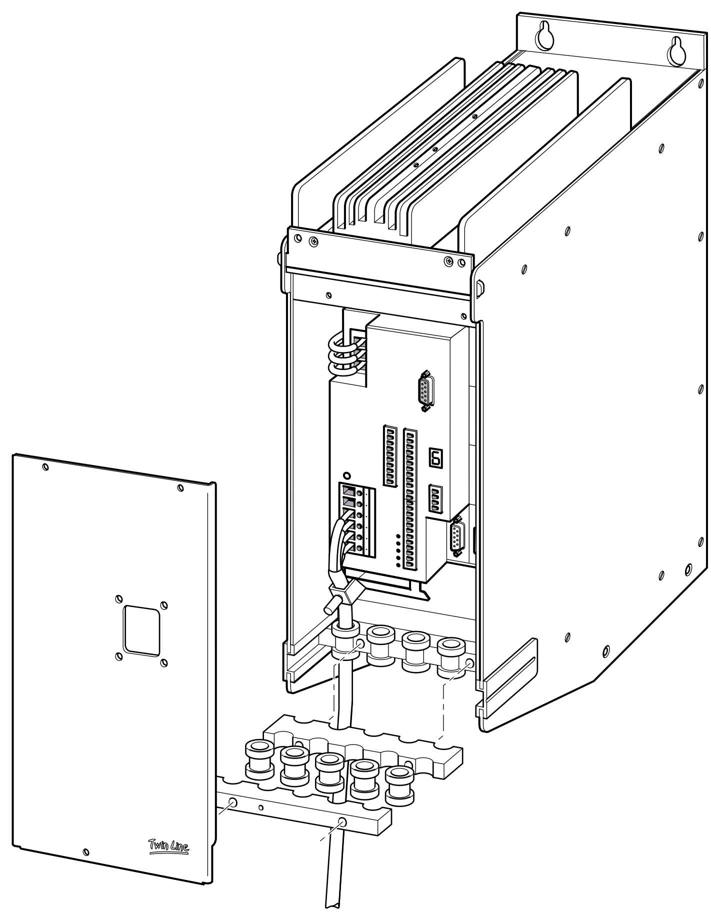

Fig. 4.6 Connection example for the IP54 controller

▶ Open the front plate via the three mounting screws.

▶ Make the necessary connections to:

- The servomotor and encoder
- The position command signal
- The Fieldbus
- The signal interface for manual operation

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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.
- ▶ Connect the controller grounding point (located at the back of the controller near the bottom) to ground as shown in Fig. 4.1.
- ▶ Close the front plate with the three screws.

The holding brake controller can be factory supplied as an option.

A fan and the holding brake control module are already connected to pins 32 and 34.

It is possible to fit an additional fan on the IP54 controllers to increase the ballast power.

- ▶ Recommended fan: Schneider Electric TLAMSR (24 Vdc, 0.11 A, with ball bearings)
- ▶ Mount the fan to the top of the heat sink fins using M4 screws (threaded holes are provided in the heatsink).

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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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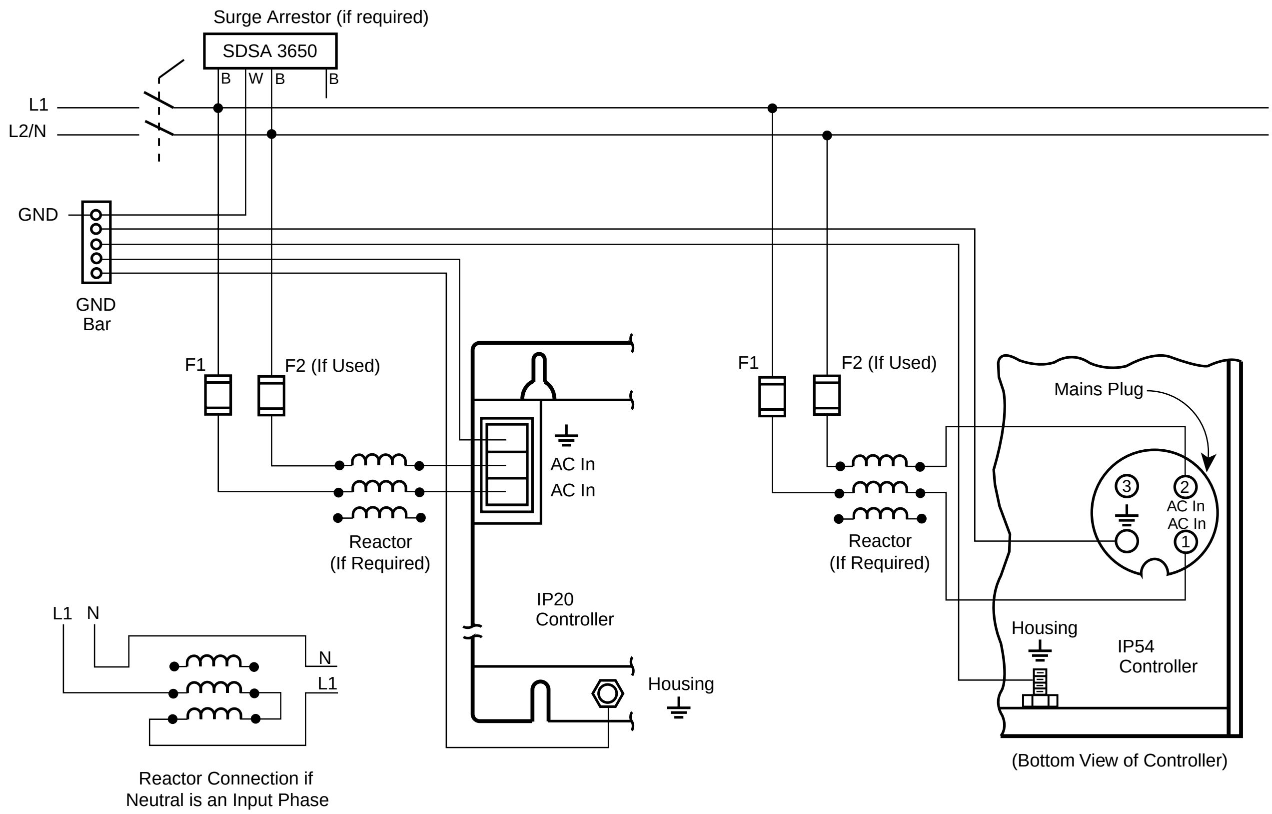

Fig. 4.7 Mains connection for single-phase controllers

All controllers

▶ Connect the controller as shown in Fig. 4.7. A disconnecting means must be installed on the branch circuit feeding the controller. **Use of a surge arrester is recommended! Refer to section 3.2.1 for a recommended arrester.**

- Ground the controller as shown. Due to the magnitude of the leakage current, compliance with EN50178 requires the presence of an additional grounding connection. The additional grounding connection should connect the controller housing to the enclosure grounding bar as shown in Fig. 4.7.
- Install fuses as shown in Fig. 4.7. Refer to section 3.2.1 for required fuses. If the power system neutral is an input phase to the controller, do not install a fuse in the neutral conductor.
- When a reactor is required, use the reactors specified in section 3.2.4. The specified reactor is a three-phase design. One coil is left unconnected. If the power system neutral is an input phase to the controller, connect two reactor coils in series with the L1 phase as shown in Fig. 4.7. Do not connect a reactor coil in the neutral conductor.
- For controllers with a hood, the input conductors must be routed upwards from the point of connection.
- Controller power terminals must be used with conductor cross-sections based on 60 °C or 75 °C insulated copper conductors.

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IP20 controller

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

IP54 controller

CAUTION

EQUIPMENT DAMAGE HAZARD

The mains plugs of single-phase and three-phase IP54 controllers are interchangeable. Connection of a single-phase controller to a mains plug connected for three-phase power may result in controller damage.

Failure to follow these instructions can result in equipment damage.

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^2) three-core cable with an external diameter of 0.26–0.31 in. (6.5–8 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 N•m).

Wire end ferrules

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

- When connecting TLC532 controllers using 14 AWG (2.5 mm^2) wires, do not use end ferrules with a plastic collar.
- Use only square end ferrules to ensure that they cannot work loose after the screws are tightened.
- Strip the insulation from the cable to a length of 0.4 in. (10 mm).

Earth leakage circuit breaker

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

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4.4.3 Mains connection for three-phase controllers

⚠ WARNING

OVERCURRENT PROTECTIVE DEVICES MUST BE PROPERLY COORDINATED

- To achieve published fault withstand current ratings, install the fuses specified in section 3.2.1 of this instruction manual.
- Do not connect the 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 or serious injury.

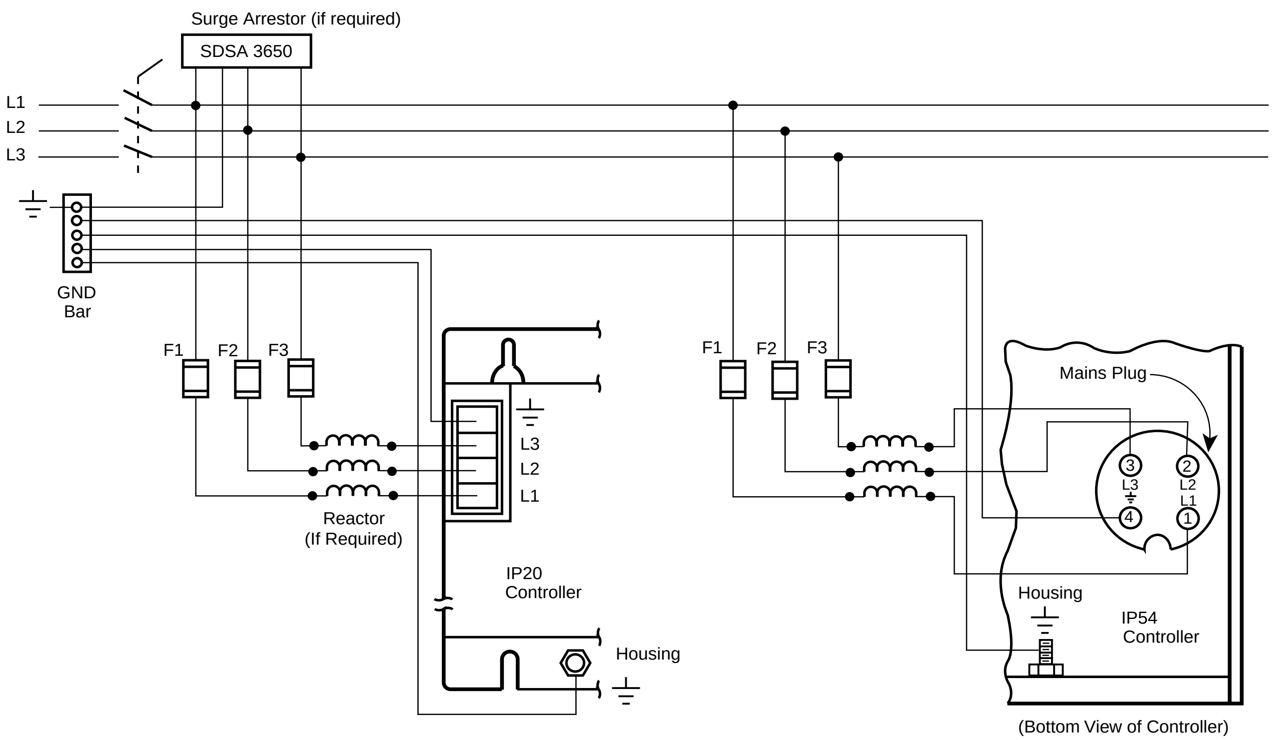

Fig. 4.8 Mains connection for three-phase controllers

All controllers

▶ Connect the controller as shown in Fig. 4.8. A disconnecting means must be installed on the branch circuit feeding the controller. **Use of a surge arrester is recommended! Refer to section 3.2.1 for a recommended arrester.**

- Ground the controller as shown. Due to the magnitude of the leakage current, compliance with EN50178 requires the presence of an additional grounding connection. The additional grounding connection should connect the controller housing to the enclosure grounding bar as shown in Fig. 4.8.
- Install fuses as shown in Fig. 4.8. Refer to section 3.2.1 for required fuses.
- When a reactor is required, use the reactors specified in section 3.2.4.

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- For controllers with a hood, the cable must be routed upwards from the point of connection.
- Three-phase controllers are not suitable for operation from single-phase power.
- Controller power terminals must be used with conductor cross-sections based on 60 °C or 75 °C insulated copper conductors.

IP20 controller

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

Mains connection	**TLC534**	**TLC536**	**TLC538**
Conductor cross-section [mm^2]	1.5–4	1.5–4	2.5–4
Conductor cross-section [AWG]	16–12	16–12	14–12

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) four-core with an external diameter of 0.25–0.31 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 N•m).

Wire end ferrules

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

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

Earth leakage circuit breaker

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

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4.4.4 Motor connection TLC53x

⚠ DANGER

HAZARDOUS VOLTAGE – SERVOMOTOR-GENERATED AND COUPLED VOLTAGE

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

Failure to follow these instructions 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 cable

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

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

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

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

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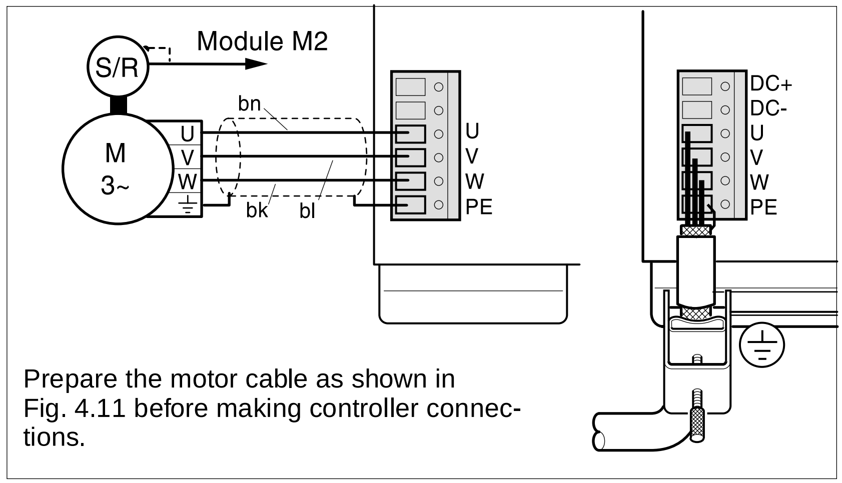

Fig. 4.9 Connecting the motor cable to the controller

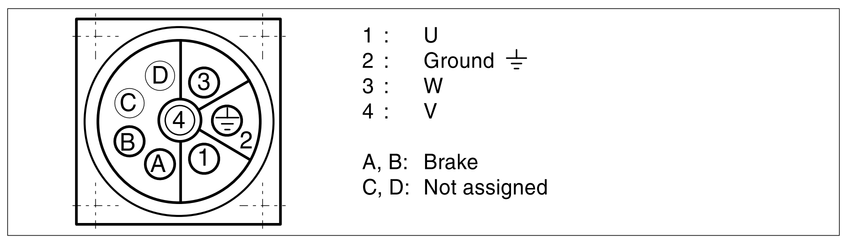

Fig. 4.10 Connection of the motor cable to a SER or RIG motor (connector on motor viewed from plug side). For general arrangement of connector pinout for non-SER and non-RIG motors, contact motor manufacturer.

	TLC532	TLC534	TLC536	TLC538
Conductor cross section AWG (mm^2)	16 (1.5)	16–14 (1.5–2.5)	16–14 (1.5–2.5)	12 (4)
max. cable length 1) ft (m)	66 (20)	66 (20)	66 (20)	66 (20)
Tightening torque for terminal screws (DC+, DC-, U, V, W, Ground) lb-in (N•m)	4.5–5.6 (0.4–0.5)	5.6–6.8 (0.5–0.6)	5.6–6.8 (0.5–0.6)	5.6–6.8 (0.5–0.6)

1) Longer cable lengths on requests

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

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Preparing the motor cable IP20 controller

Refer to the dimensions in Fig. 4.11 when preparing the motor cable.

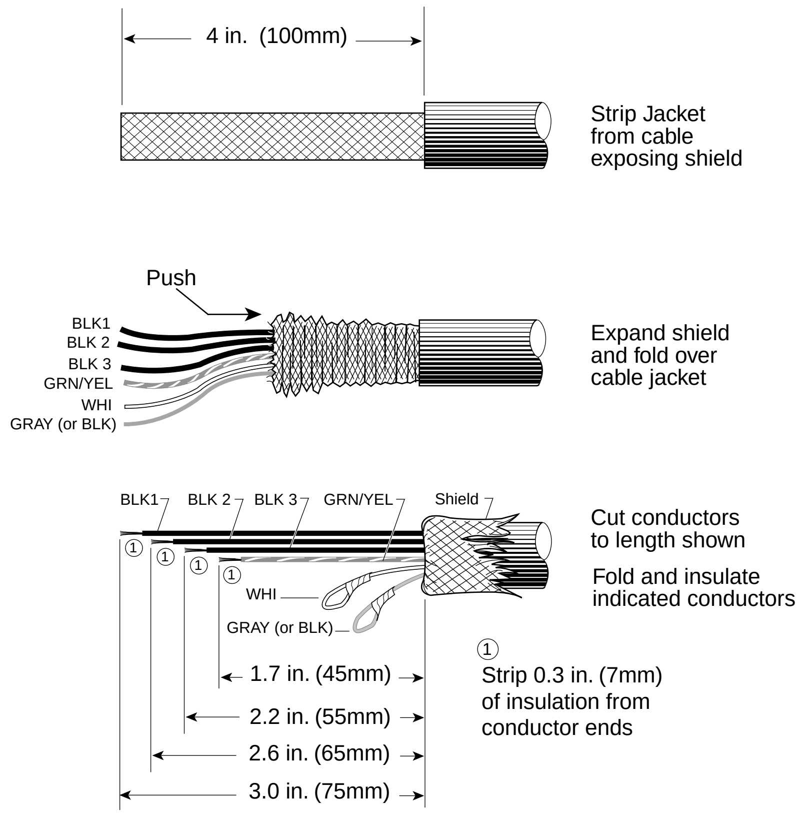

Fig. 4.11 Preparing the motor cable termination–controller end

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IP54 Controller with holding brake

Refer to the dimensions in Fig. 4.12 when preparing the motor cable. If no holding brake is integrated, use the dimensions in Fig. 4.11.

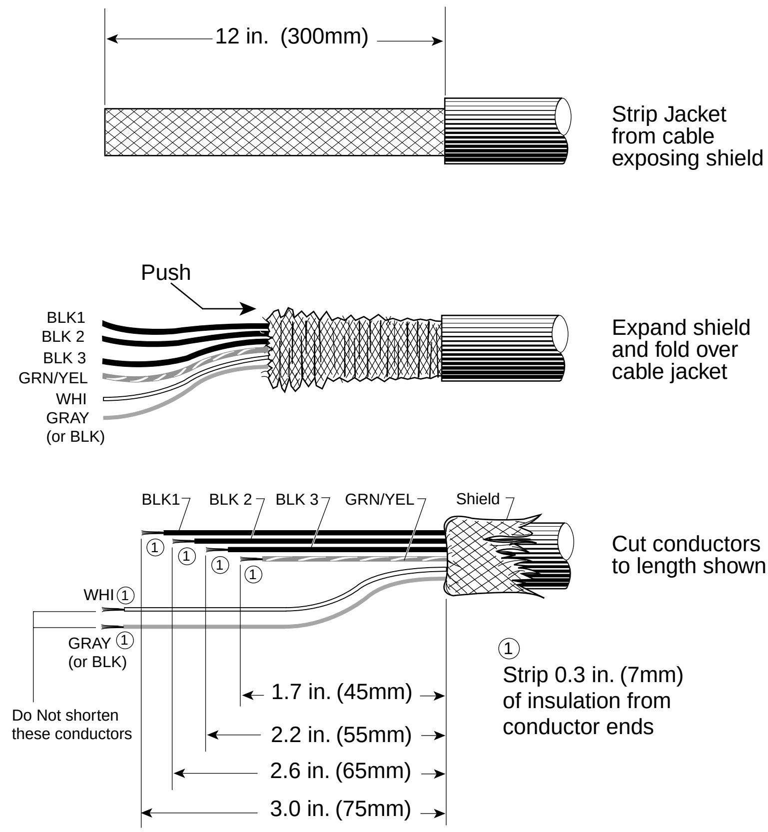

Fig. 4.12 Preparing the motor cable termination–controller end (IP54 w/HBC)

Wire end ferrules

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

- Use only square end ferrules to ensure that they cannot work loose after screws are tightened.
- When connecting TLC532 controllers using 14 AWG (2.5 mm^2) wires, do not use end ferrules with a plastic collar.
- The wire must fill the wire end ferrule over its whole length to ensure maximum current carrying capacity and vibration resistance.

EMC measures

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

- The shield braiding of the motor cable must be connected to the motor housing, to the controller housing, and to the enclosure entry point with a large surface area connection. Connect the shield braid to the controller housing using the shield clamp provided. Refer to Fig. 4.9 for shield clamp installation.
- The motor cable and signal cables must be laid at a distance of at least 8 in. (20 cm) from each other. If the distance is less than this, the motor cable and signal cables must be separated by grounded screening plates.

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4.4.5 Motor connection with holding brake to TLC53x controller

⚠ DANGER

HAZARDOUS VOLTAGE – SERVOMOTOR-GENERATED AND COUPLED VOLTAGE

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

Failure to follow these instructions 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 4.4.4 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 the motor wires and protective ground to terminals U, V, W, and Ground. The assignment of wires must be the same at the motor as at the controller or the feedback signal will be incorrect.

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

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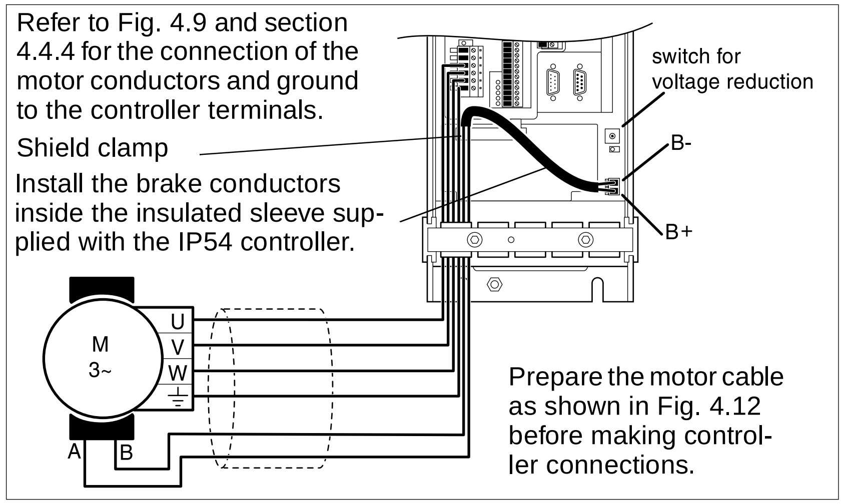

Fig. 4.13 Connecting the motor cable and holding brake controls to the controller

For information on the use of wire end ferrules or motor conductor EMC measure, refer to section 4.4.4 on page 4-20.

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

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

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

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

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

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

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

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

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

The voltage reduction function is described in section 7.10 on page 7-30.

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4.4.6 Connecting the DC busses of two controllers

CAUTION

EQUIPMENT DAMAGE HAZARD

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

Failure to follow these instructions can result in equipment damage.

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Connecting DC Bus Cables

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

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

	TLC532	TLC534	TLC536	TLC538
Tightening torque of the terminal screws [lb-in] [N•m]	 4.5–5.6 0.4–0.5	 5.6–6.8 0.5–0.6	 5.6–6.8 0.5–0.6	 5.6–6.8 0.5–0.6

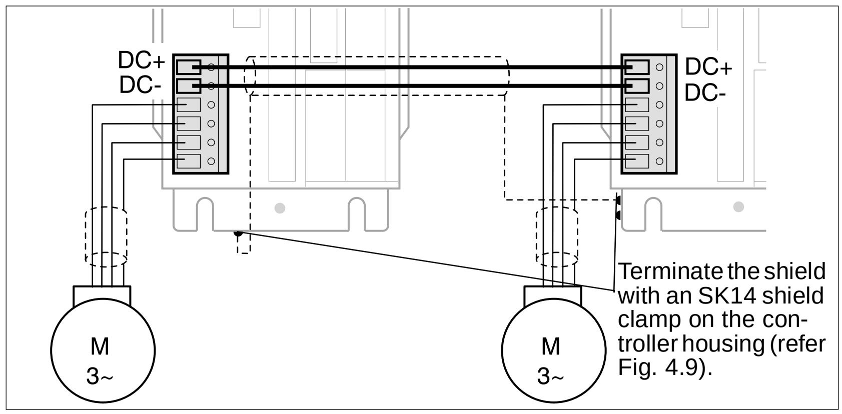

Fig. 4.14 Interconnecting the DC busses of two controllers

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

Cable specification

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

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

EMC measures

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

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

Function

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

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

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4.4.7 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.

▶ Connect a 2 4Vdc power supply to the controller as shown in Fig. 4.15. The power supply must be compatible with PELV operation (negative output terminal bonded to the enclosure ground bar). Use a Square D ABL7RE24xx power supply or equivalent.

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

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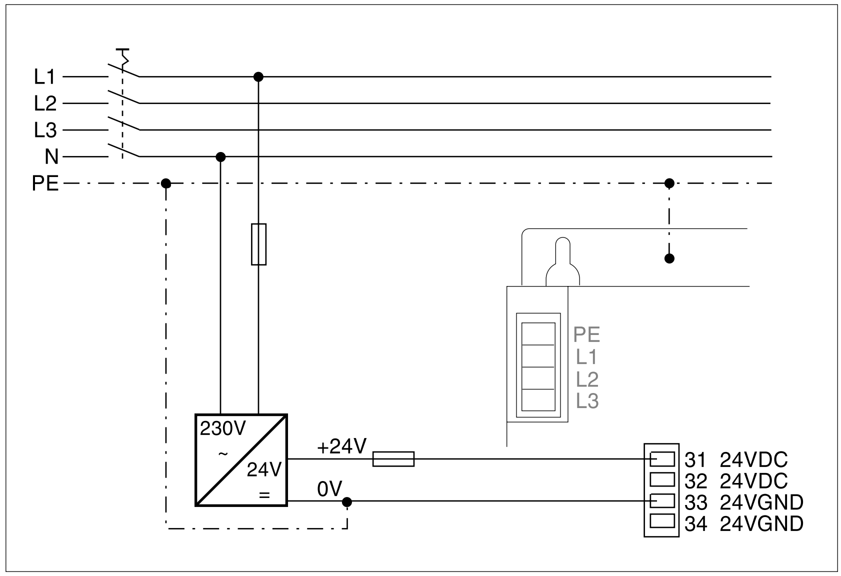

Fig. 4.15 Example of 24 V connection for single-phase and three-phase controllers

Pin	Signal	Active	Explanation	I/O
31	24 Vdc	-	24 Vdc supply voltage, internally connected to pin 32	-
32	24 Vdc	-	24 Vdc supply voltage	-
33	0 Vdc	-	0 V for 24 Vdc voltage, connected internally to pi n34 and pin 16 (ACTIVE-0V)	-
34	0 Vdc	-	0 V for 24 Vdc voltage	-

- Pins 32 (24 Vdc) and 34 (0 VDC) can be use d as a 24V output for further consumers or for cascading several Twin Line controllers. The F6 fuse rated current should not exceed 8 A.
- In computing the 2 4V power supply current demand, make sure that any additional consumers, such as the holding brake, the holding brake controller, the signal interface outputs, and fans are included with the Twin Line power amplifier demand.
- The motor shaft position information is retained during mains power loss if, prior to power loss, the power amplifier is commanded off (ENABLE = 0) and the 24 V supply voltage remains energized. Motor shaft movement during power loss may not alter the stored shaft position information.
- Lay the 2 4V supply line at a distance of at least 8 in. (20 cm) from other lines to ensure EMC protection. For cable lengths of more than 6.5 feet (2 m), make a twisted pair of the 0 V and 24 V supply wires. Reference Belden 7421A (2 x 16 AWG/1.5 mm^2) cable or equivalent.
- To ensure that emission limits are met in TLCx34 IP20 controllers, use a shielded cable for the 24 Vdc and signal interface to the controller. Refer to Fig. 4.1 on page 4-4. Reference Belden 7421AS (2 x 16 AWG/1.5 mm^2) cable or equivalent.
- The torque for terminal screws 1–34 is 2.5–2.8 lb-in (0.22–0.25 N•m).

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IP54 Controller

- The fan and holding brake control modules are already connected to pins 32 and 34.

4.4.8 Connection to the signal interface

The positioning controller can be controlled via the lines of the signal interface.

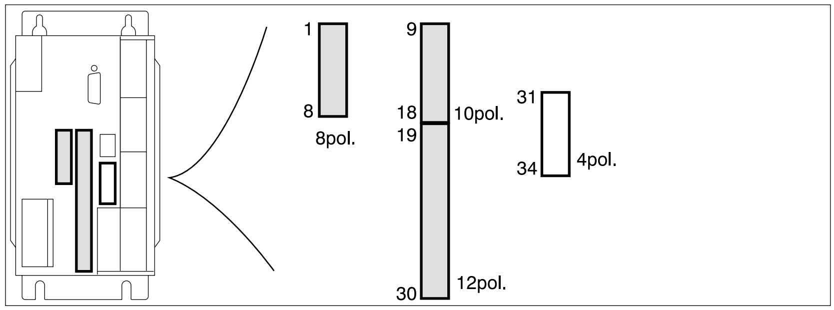

Fig. 4.16 Signal interface: 1-30: inputs / outputs, 31-34: 24 V power supply connection

Connection

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

▶ Wire the signal interface connections as required by the operating mode selected. See also the wiring examples starting on page 4-75.

⚠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 7.9.1 of this instruction manual for descriptions of the $\overline{LIMP}$, $\overline{LIMN}$, and $\overline{STOP}$ input functions. Use of the functions is generally recommended.
- 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.

▶ Connect inputs $\overline{LIMP}$, $\overline{LIMN}$, and $\overline{STOP}$ to the +24 V voltage if they are not being used or switch them out via the parameter 'Settings.SignEnabl'. See page 7-27.

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

Variable interface connections

The assignment of signal interface connections depends on the state of the 'Settings.IO_mode' parameter, see page 6-5.

- 'IO_mode' = '0': input signals are used for setting addresses and baud rates in Fieldbus operation. The controller reads the address and baud rate immediately upon power-up of the 24 Vdc power supply.
- 'IO_mode' = '1': input signals I_0 to I_13 and output signals Q_0 to Q_4 can be assigned to user-selectable functions.
- 'IO_mode' = '2': input signals and output signals are assigned to pre-defined/fixed functions.

The following table shows the assignment of interface connections. Identical assignment of signals are shown in the left-hand column by an arrow '⇒'.

Pin	Signal at IO_mode=0/1	Signal at IO_mode=2	Active	Explanation	I/O
1	ADR_1 / I_8	DATA_1	high	ADR_1: Bit 0 for the network address DATA_1: Bit 0 for selecting a list number	I
2	ADR_2 / I_9	DATA_2	high	ADR_2: Bit 1for the network address DATA_2: Bit 1 for selecting a list number	I
3	ADR_4 / I_10	DATA_4	high	ADR_4: Bit 2 for the network address DATA_4: Bit 2 for selecting a list number	I
4	ADR_8 / I_11	DATA_8	high	ADR_8: Bit 3 for the network address DATA_8: Bit 3 for selecting a list number	I
5	ADR_16 / I_12	DATA_16	high	ADR_16: Bit 4 for the network address DATA_16: Bit 4 for selecting a list number	I
6	ADR_32 / I_13	DATA_32	high	ADR_32: Bit 5 for the network address DATA_32: Bit 5 for selecting a list number	I
7	⇒	IO24VDC	-	Power supply for inputs / outputs	I
8	⇒	IO24VDC	-	Power supply for inputs / outputs	I
9	Q_0 / Q_0	AUTOM_ACK	high	AUTOM_ACK: acknowledgment signal to AUTOM signal	O
10	Q_1 / Q_1	AXIS_ADD_INFO	high	AXIS_ADD_INFO: additional information on current movement	O
11	Q_2 / Q_2	AXIS_END	high	AXIS_END: end of movement processing, drive at standstill	O
12	Q_3 / Q_3	AXIS_ERR	high	AXIS_ERR: fault detection during movement	O
13	Q_4 / Q_4	RDY_TSO/Q4	high	RDY_TSO: data set ready, 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+	-	Analogue control input ±10 V	I

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Pin	Signal at IO_mode=0/1	Signal at IO_mode=2	Active	Explanation	I/O
18	⇒	ANALOG_IN-	-	Analogue control input 0 V, reference (5000 ohm input impedance) for pin 17 ANALOG_IN+	I
19	BAUD_1 / I_0	MAN_P	high	BAUD_1: Bit 0 for setting baud rate MAN_P: manual movement, positive motor rotation	I
20	BAUD_2 / I_1	MAN_N	high	BAUD_2: Bit 1 for setting baud rate MAN_N: manual movement, negative motor rotation	I
21	BAUD_4 / I_2	MAN_FAST	high	BAUD_4: Bit 2 for setting baud rate MAN_FAST: manual selection slow or fast	I
22	CAPTURE1 or I_5	FAULT_RESET	high	CAPTURE1: high speed input for exact capture of present position data[2)] FAULT_RESET: reset fault signal	I
23	⇒	CAPTURE2 or I_6	high	CAPTURE2: high speed input for exact capture of present position data [2)]	I
24	ADR_64 / I_7	TEACH_IN	high	ADR_64: Bit 6 for the network address 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	MODE_2 / I_4	AUTOM	high	MODE_2: bit1 for setting Fieldbus profile AUTOM: automatic mode (high) or manual mode (low), acknowledgement via AUTOM_ACK	I
30	MODE_1 / I_3	ENABLE	high	MODE_1: bit0 for setting field bus profile 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”.

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Minimum interface connections

You must make the following signal interface connections:

- Pin 26: $\overline{\text{LIMP}}$
- Pin 27: $\overline{\text{LIMN}}$
- Pin 28: $\overline{\text{STOP}}$
- Connect pins 31 (24 Vdc) and 33 (24 VGND) to the 24 Vdc power supply.
- Pin 7 and Pin 8 must be connected to Pin 31 (24 Vdc) even if the signal interface is not used. A master contact can be inserted in series with this circuit to disable the controller IO.

Cable specification

Cables for digital signals:

- Minimum cross-section: 25 AWG (0.14 mm^2); maximum cross-section: 16 AWG (1.5 mm^2)
- Maximum allowable length of the minimum cross-section conductor: 49 feet (15 m).
- Reference Belden 7400A (2 x 20 AWG/0.5 mm^2) through Belden 7408A (25 x 20 AWG/0.5 mm^2) cable or equivalent.

Cables for analog signals:

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

Function

The signal interface can be used to control the positioning controller manually or in an automated mode, to report operating states and to control periphral devices.

The signal interface is principally designed for Fieldbus operation. Signal inputs such as MAN_N, MAN_P, or AUTOM and outputs such as AXIS_ERR, AXIS_END, AUTOM_ACK are not required for it. In Fieldbus operation these signals are changed and evaluated via transmitted and received data.

The signal interface can operate in three pin assignment modes:

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

Pin assignment can be changed by means of the 'Settings.IO_mode' parameter. Refer to section 6.1 on page 6-3 for more information.

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Setting address and baud rate in Fieldbus operation

Condition: parameter 'Settings.IO_mode' = 0:

Immediately upon switching on the 24 Vdc to the controller, the device address and baud rate will be read via signal input pins.

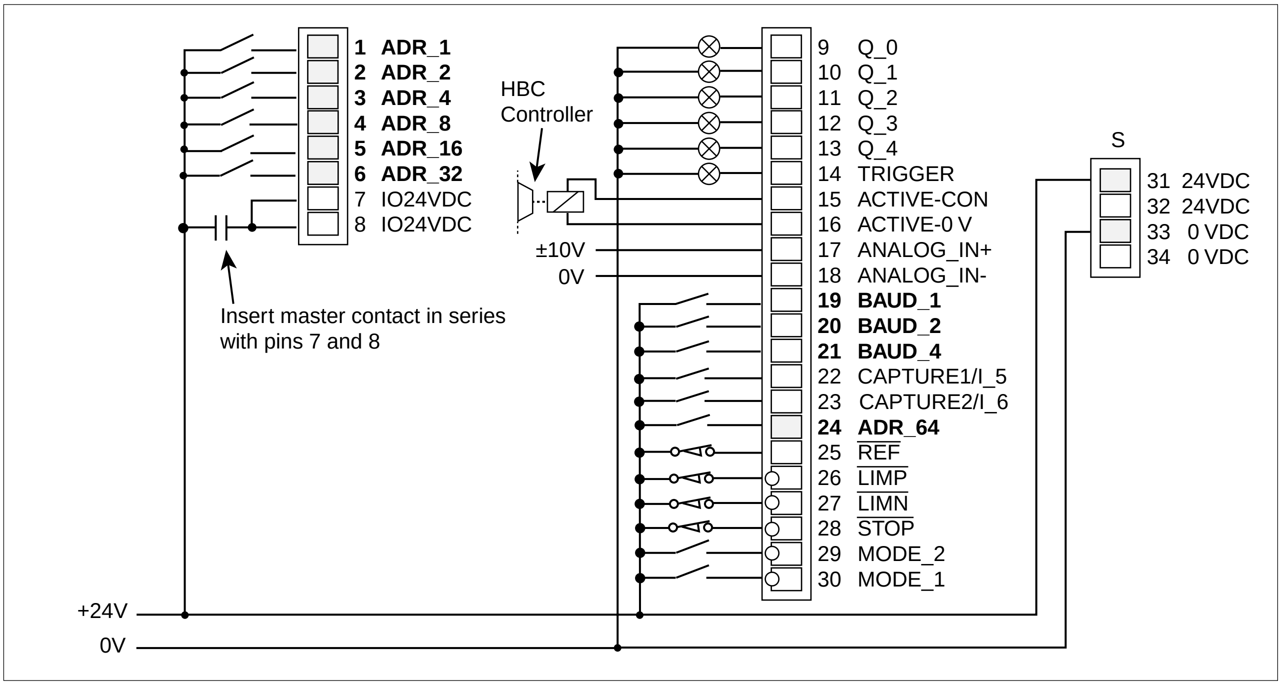

Fig. 4.17 Signal interface inputs for Fieldbus addressing

Network address

The network address is bit-coded via inputs ADR_1 to ADR_64. 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 connect to 24 V (logic 1). The remaining inputs remain open (logic 0).

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Baud rate

For Fieldbus modules CAN-C and RS-485-C, the baud rate can be specified bit-coded at inputs BAUD_1 to BAUD_4 when the controller is powered-up. BAUD_1 is the lowest value bit.

Baud rate CAN-C	Baud rate RS-485-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 to the supervisory controller. A network branch can only be run at one baud rate which must be set on all the devices on the branch.

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 controller is powered 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.

Free assignment of interface

Parameter '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 means of Fieldbus commands.

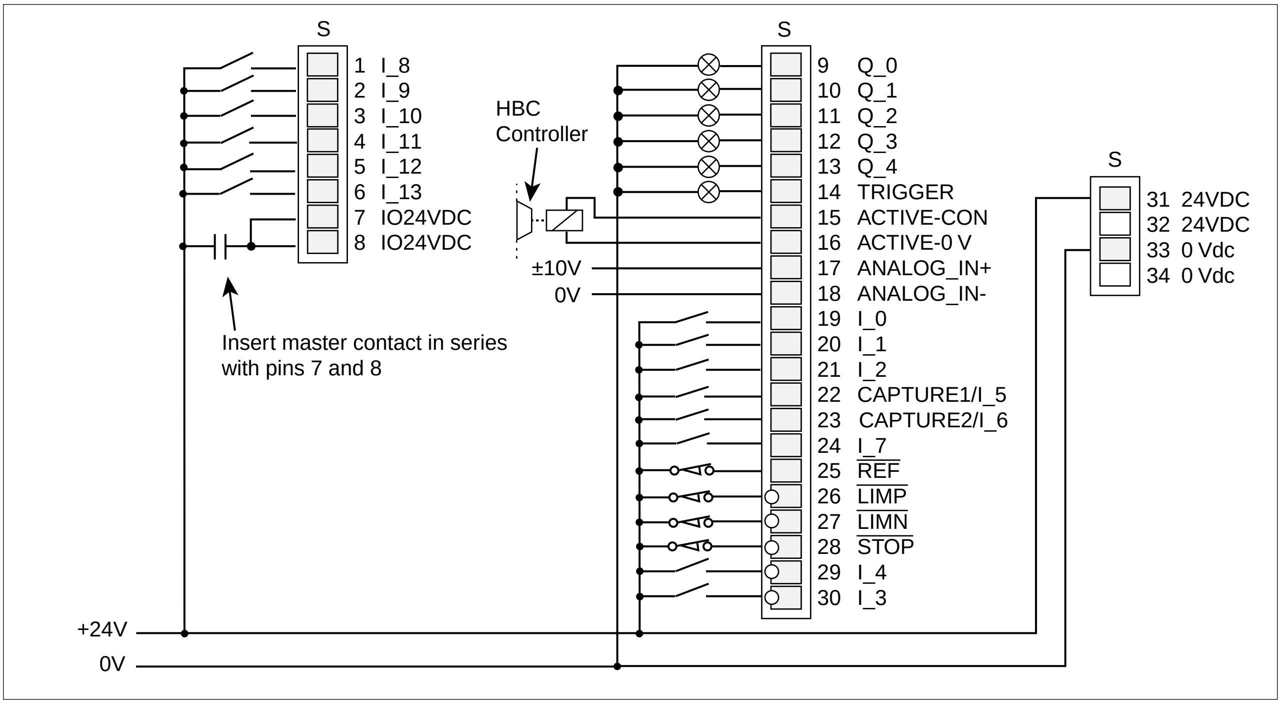

Fig. 4.18 Signal interface inputs and outputs for free assignment

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

- Read input signals via the 'I/O.IW1_act' parameter“
- Write output signals via the 'I/O.QW0_act' parameter.

Refer to section 5.4.7 on page 5-14 for checking the operation of the inputs and outputs of the signal interface.

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Fixed Assignment of Interface Parameter 'Settings.IO_mode'=2:

With fixed assignment, control signals and switching signals for manual mode and for Teach-In are available at the signal interface.

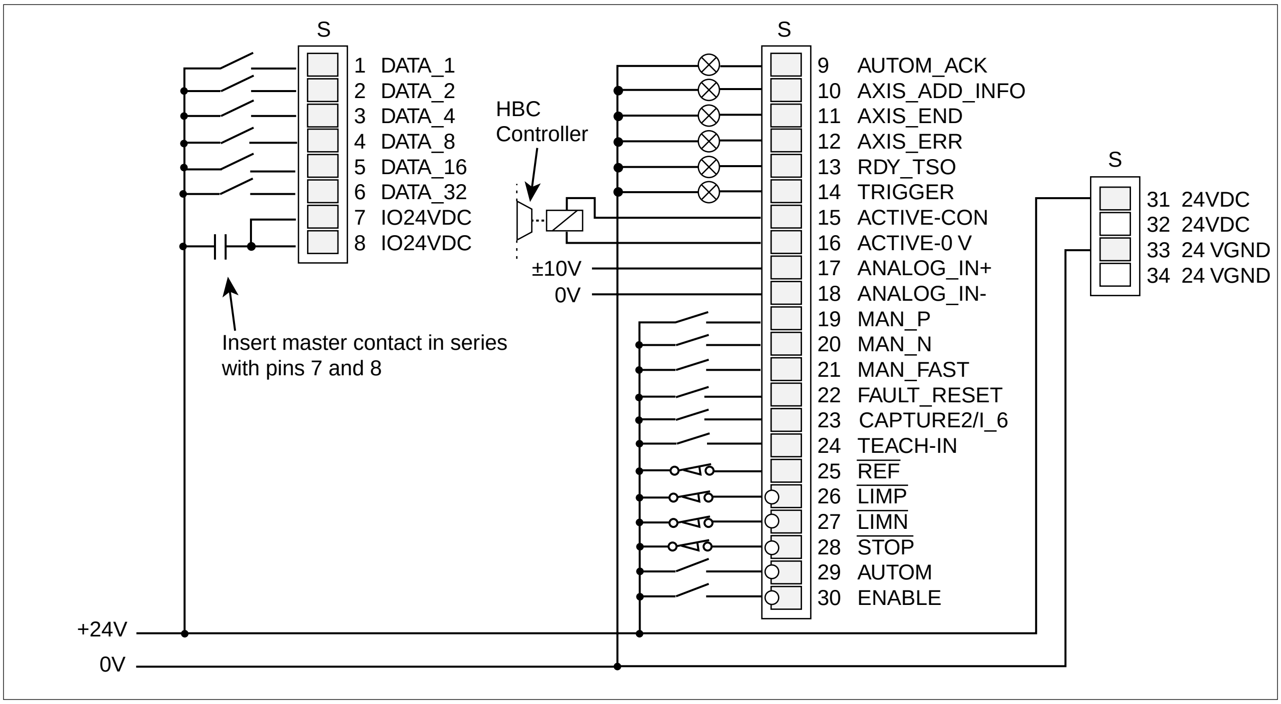

Fig. 4.19 Signal interface inputs and outputs for fixed assignment

Refer to section 6.2 on page 6-11 for manual movement and section 7.2 on page 7-8 for Teach-In mode.

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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.

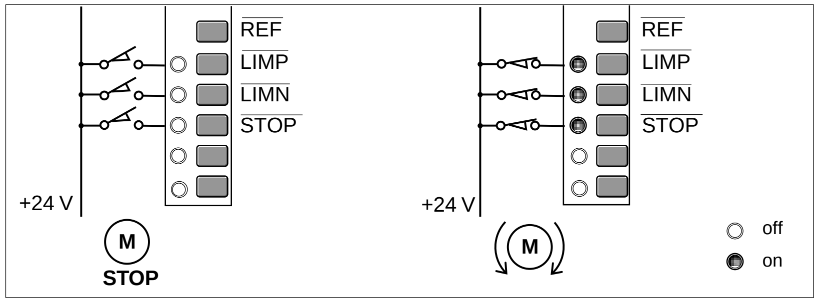

Fig. 4.20 LED display of signal interface

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

Output signals remain unchanged for at least 0.5 ms.

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

Connection The RS-232 interface, equipped with a 9-pin Sub-D female connector (M3 hardware), is connected to a PC or to the Twin Line HMI. The controller supplies the Twin Line HMI with the operating power vi a pin9.

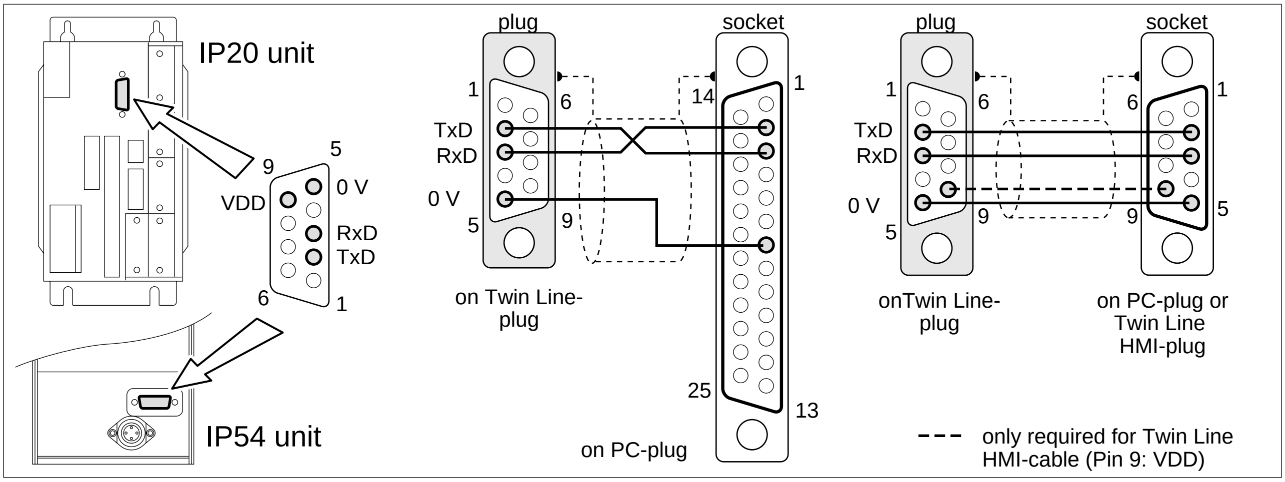

Fig. 4.21 Cables for the RS-232 interface at the PC or Twin Line HMI View: Solder side of cable connectors

Pin	Signal	Color 1)	Pair	Explanation	I/O
1	-	-	-	Not assigned	-
2	TxD	brown	-	Send data to the input device	O
3	RxD	white	-	Data received from the input device	I
4	-	-	-	Not assigned	-
5	0 V	green	-	0 V	-
6	-	-	-	Not assigned	-
7	-	-	-	Not assigned	-
8	-	-	-	Not assigned	-
9	VDD	yellow	-	10 Vdc supply for the TL HMI	O

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

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

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

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

Function The controller is started up and operated via the serial RS-232 interface. Use a Twin Line Commissioning Tool running on a PC or the HMI hand-held operating unit to connect to the controller.

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

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

TLADOCC53ME, -000, 08.02

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

Module interface The HIFA-C module is equipped with a 15-pin, Sub-D female connector (M3 hardware).

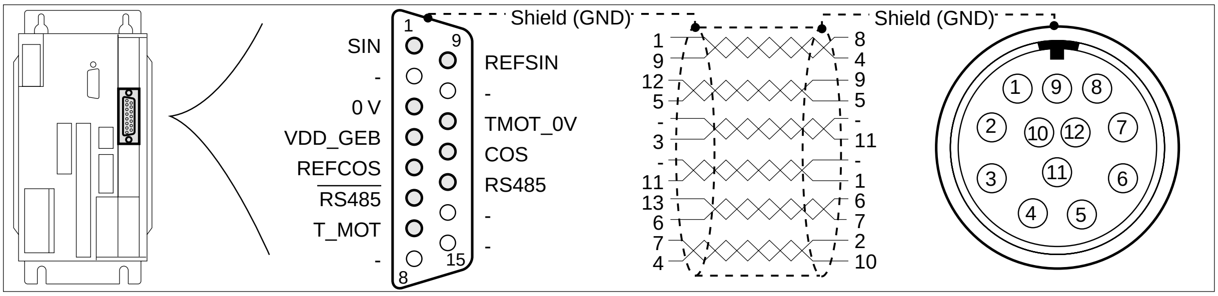

Fig. 4.22 Interface of the Hiperface module and plug for the AC servomotor, both viewed from the solder side

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

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

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

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 Sincoder connection for motor position feedback to the positioning controller.

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

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

Encoder type	Sine / cosine periods per revolution
SinCoder SNS50/60	1 or 1024
SinCos SRS50/60	1024, Single-turn encoder
SinCos SRM50/60	1024, Multiple-turn encoder (4096 revolutions)

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

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

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

TLADOCC53ME, -000, 08.02

4.4.11 Reserved

4.4.12 Connection to the RS-422-C module (controller setpoint input)

Module interface The RS-422-C module is equipped with a 15-pin, Sub-D female connector (M3 hardware).

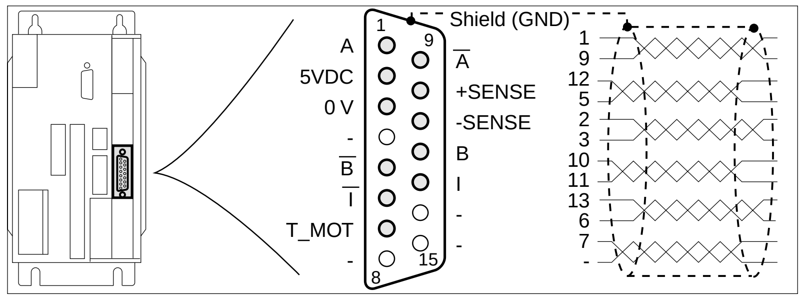

Fig. 4.23 Interface of the encoder module

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

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

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

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Cable specification

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

- Shielded cable
- Minimum cross-section for the signal conductors: 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 theTwin 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 RS-422-C module receives the A/B encoder signals and index pulse as a position setpoint for the positioning controller. The maximum input frequency is 4 0 0kHz.

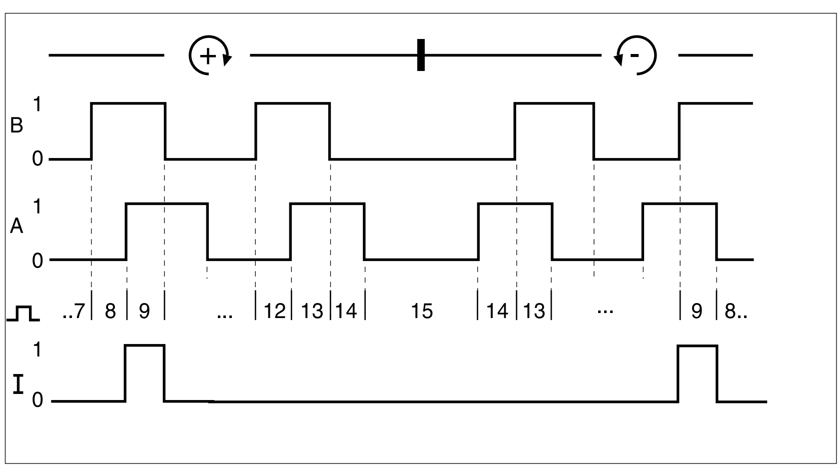

Fig. 4.24 Time diagram with A-, B, and index pulse signal, counting forwards and backwards

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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 24 VGND terminals of any two Twin Line controllers connected via RS-422-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 24 VGND terminals, increase the cross-sectional area of the 24 VGND conductor between the individual Twin Line controllers and their respective 24 VGND power supplies or insert an RS-422 isolator between controllers with large ground voltage differences.

4.4.13 Connection to the PULSE-C module (controller setpoint input)

Module interface The PULSE-C module is fitted with a 15-pin, Sub-D male connector (M3 hardware).

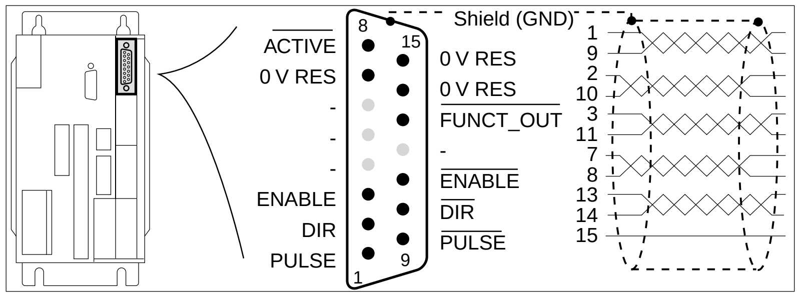

Fig. 4.25 Interface of the pulse direction module

Pin	Signal	Color [1)]	Pair	Explanation	I/O
1	PULSE (PV)	white	1	motor step "Pulse“ or motor step forwards "PV“	I
9	$\overline{\text{PULSE}}$ ($\overline{\text{PV}}$)	brown	1	motor step "Pulse“ or motor step forwards "PV“, inverted	I
2	DIR (PR)	green	2	sense of rotation "Dir“ or motor step backwards "PR“	I
10	$\overline{\text{DIR}}$ ($\overline{\text{PR}}$)	yellow	2	sense of rotation "Dir“ or motor step backwards "PR“, inverted	I
3	ENABLE	gray	3	enable signal	I
11	$\overline{\text{ENABLE}}$	pink	3	enable signal, inverted	I
7	0 V RES	gray/pink	4	ground, internally via resistor [2)] to 0 Vdc	I
8	$\overline{\text{ACTIVE}}$	red/blue	4	drive ready [3)]	O
13	$\overline{\text{FUNCT\_OUT}}$	white/green	5	reserved, internally to Low level	O
14	0 V RES	brown/ green	5	ground, internally via resistor [2)] to 0 Vdc	I
15	0 V RES	white/yel- low	6	ground, internally via resistor [2)] to 0 Vdc	I
4	-	blue	-	not assigned	-
12	-	red	-	not assigned	-
5	-	black	-	not assigned	-
6	-	purple	-	not assigned	-

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

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

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

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

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

To protect against interference, the shield for digital cables is grounded at both ends. Differences in potential can lead to excessive current in the shield. Shield currents can be controlled by means of bonding conductors. Recommended cross-section of the bonding conductors is 5 AWG (16 mm²) for lengths not exceeding 656 feet (200 m). For lengths over 656 feet (200 m) use 4 AWG (20 mm²). 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: $\text{Pulse}_{\text{forward}}$ - $\text{Pulse}_{\text{backward}}$ 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.

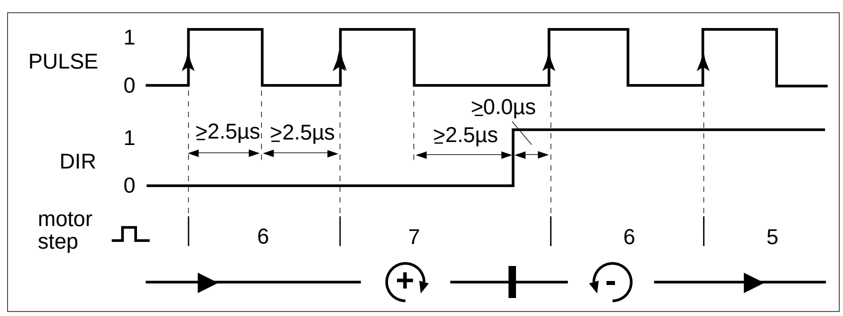

Fig. 4.26 Pulse direction signal

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

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

Pulse$_{forward}$ - pulse$_{backward}$ operating mode

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

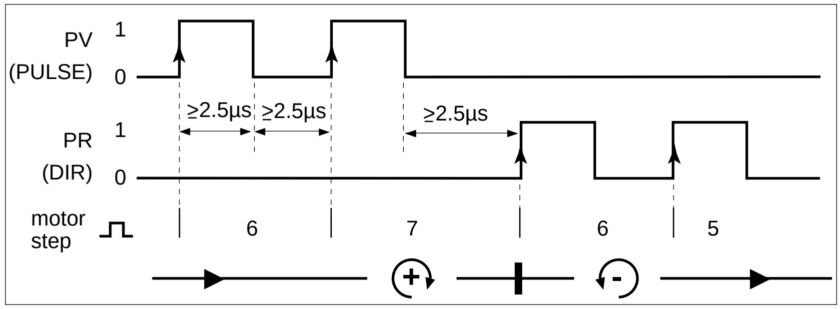

Fig. 4.27 Pulse$_{forward}$/Pulse$_{backward}$ signal

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 counterclockwise 1) direction of rotation	low -> high

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

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

ENABLE

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

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

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

$\overline{\text{ACTIVE}}$

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.

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Circuit of the signal inputs

⚠ WARNING

UNINTENDED EQUIPMENT ACTION / LOSS OF CONTROL

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

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

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

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

Fig. 4.28 shows a typical input circuit for the signal inputs PULSE (PV), DIR (PR), and ENABLE. Up to 10 inputs of a PULSE-C module can be connected to a single RS-422-C transmitter output.

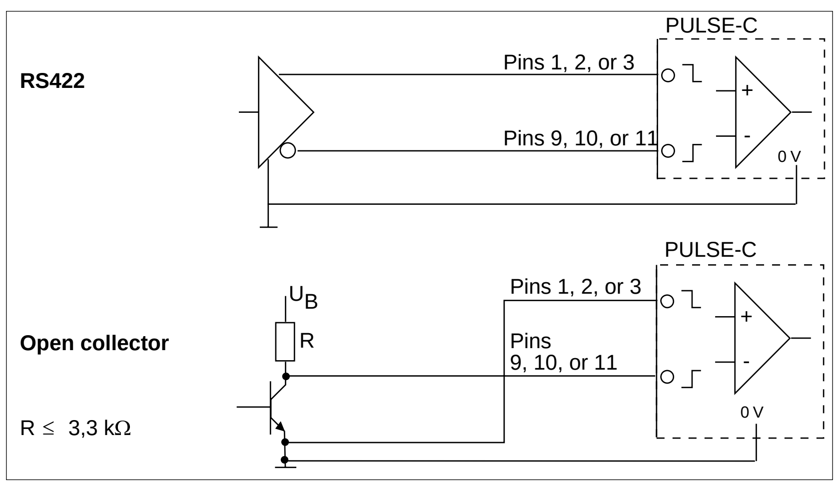

Fig. 4.28 Circuit of the signal inputs, L: Cable length

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.

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4.4.14 Connection to the PBDP-C module (Fieldbus input)

Module interface The PBDP-C module is fitted with a 9-pin, SUB-D female connector (UNC hardware).

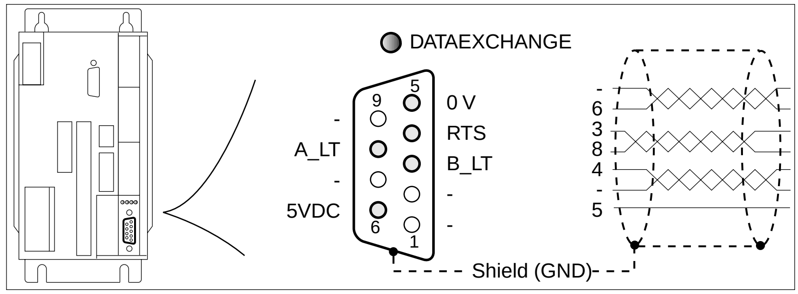

Fig. 4.29 Fieldbus module interface connection

Pin	Signal	Color	Pair	Explanation	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 line, inverted	I/O
8	A_LT	-	2	data line	I/O
4	RTS	-	3	transmission request	O
9	-	-	3	not assigned	-
5	0 V	-	-	0 V	-

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

Cable specification for connection to a bus terminal Use factory-assembled cables from Schneider Electric. Refer to section 10 for available cables.Shielded cable

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

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

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Function Using the PBDP-C Fieldbus module, the controller can be connected as a slave device to a Profibus-DP network.

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

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

Setting the address The address can be set via the 'M4.addrPbd' parameter or via inputs ADR_1 to ADR_64 of the signal interface, see section 4.4.8 on page 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.

TLADOCC53ME, -000, 08.02

4.4.15 Connection to the CAN-C module (Fieldbus input)

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

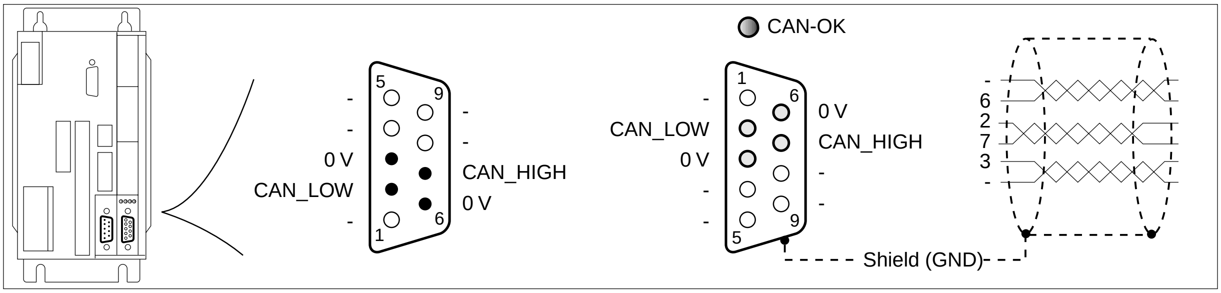

Fig. 4.30 Interface connections of the Fieldbus module with plug and socket

Pin	Signal	Color [1)]	Pair	Explanation	I/O
1	-	-	1	not assigned	-
6	0 V	green	1	0 V	-
2	CAN_LOW	white	2	Data wire, inverted	I/O
7	CAN_HIGH	brown	2	Data wire	I/O
3	0 V	gray	3	0 V	-
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 controllers with a hood, the cable must be led downwards from the point of connection.

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

- Shielded cable
- Minimum cross-section for the signal conductors: 25 AWG (0.14 mm^2)
- Twisted pair lines
- Ground shield at both ends.
- Maximum length dependent on the number of devices, the baud rate, and the signal times. The higher the baud rates, the shorter the bus cable.
  Guide values: 131 feet (40 m) at 1 Mbit/s; 1640 feet (500 m) at 100 kbit/s
  Guide values for DeviceNet: 328 feet (100 m) at 500 kbit/s; 1640 feet (500 m) at 125 kbit/s

TLADOCC53ME, -000, 08.02

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 theTwin Line controller housing.

Function Using the CAN-C Fieldbus module, the controller can be connected on the following networks:

- CAN-Bus
- CANOpen
- DeviceNet

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

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

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 up when a connection to the master exists. 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 via the 'M4.addrCan' parameter (see page 12-19) or via inputs ADR_1 to ADR_64 of the signal interface (see section 4.4.8 on page 4-30).

Baud rate The baud rate can be set with the 'M4.baudCan' parameter (see page 12-20) or via inputs BAUD_1 to BAUD_4 of the signal interface (see section 4.4.8 on page 4-30).

Fieldbus profile The Fieldbus profile can be set with the "M4.profilCAN“ parameter (see section 12.2.19 on 12-19) or via inputs MODE_1 and MODE_2 of the signal interface (see section 4.4.8 on page 4-30).

Terminating resistors A terminating resistor of 120 Ω is required at both ends of the network. An appropriate terminator plug is available from Schneider Electric (order separately). See section 10.1 on page 10-1.

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.

4.4.16 Connection to the RS-485-C module (Fieldbus input)

Module interface The RS-485-C module is fitted with 9-pin, SUB-D male and female connectors (M3 hardware). Pin assignment is identical for both interface connections.

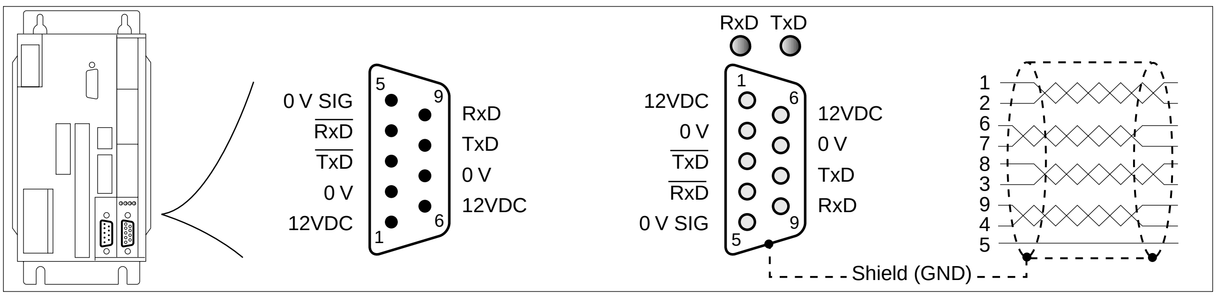

Fig. 4.31 Fieldbus module interface connection

Pin	Signal	Color	Pair	Explanation	I/O
1	12Vdc	-	1	Power supply	O
6	12Vdc	-	1	Power supply	O
2	0 V	-	2	0 V for 12 Vdc power supply	O
7	0 V	-	2	0 V for 12Vdc power supply	O
3	TxD	-	3	Transmitted data	O
8	$\overline{\text{TxD}}$	-	3	Transmitted data, inverted	O
4	RxD	-	4	Received data	I
9	$\overline{\text{RxD}}$	-	4	Received data, inverted	I
5	0 V SIG	-	-	Signal 0 V	-

The combined output current from the 12 Vdc outputs of the two Sub-D connectors must not exceed 150 mA.

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

- Shielded cable
- Minimum cross-section for the signal conductors: 25 AWG (0.14 mm^2)
- Twisted pair wires
- Ground shield at both ends.
- Maximum length: 1312 feet (400 m)

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

TLADOCC53ME, -000, 08.02

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 theTwin Line controller housing.

Function Using the RS-485-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-ranking (supervisory) device on the bus, a master. By way of acknowledgement, the controller sends status information such as device status and processing status back to the master device. The exchange of data is carried out using a special communications protocol.

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

Display Two LEDs on the RS-485-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 section 4.4.8 on 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 section 4.4.8 on page 4-30.

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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4.4.17 Connection to the IBS-C module (Fieldbus input)

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).

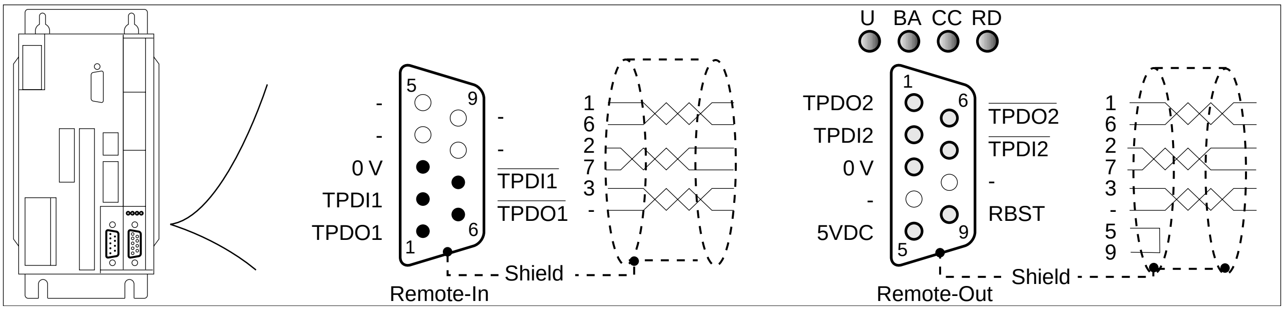

Fig. 4.32 Fieldbus module interface connection

Pin	Signal Remote-In	Signal Remote-Out	Color [1)]	Pair	Explanation	I/O
1	TPDO1	TPDO2	white	1	received data	I
6	$\overline{\text{TPDO1}}$	$\overline{\text{TPDO2}}$	brown	1	received data, inverted	I
2	TPDI1	TPDI2	green	2	transmitted data	O
7	$\overline{\text{TPDI1}}$	$\overline{\text{TPDI2}}$	yellow	2	transmitted data, inverted	O
3	G0 V	0 V	blue	3	0 V	-
8	-	-	red	3	not assigned	-
4	-	-	gray	-	not assigned	-
9	-	RBST	pink	-	Remote-Out only: Connect pin 9 to pin 5 in the cable plug to enable the output transceiver.	I
5	-	5Vdc	black	-	Remote-Out only: Connect pin 9 to pin 5 in the cable plug to enable the output transceiver.	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 Use factory-assembled cables from Schneider Electric. Refer to section 10 for available cables.

- Shielded cable
- Maximum cable length: 49 feet (15 m)
- Minimum cross-section for the signal conductors: 25 AWG (0.14 mm^2)
- Twisted-pair wires
- Connect the shield to the shell of each Sub-D connector. Do not connect the shield directly to earth. The Sub-D connector shell is connected to ground via an internal capacitor.
- Maximum length: 1300 feet (400 mm)

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

Function Using the IBS-C Fieldbus module, the controller can be connected to an Interbus network as a slave device. 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 formation. Connection to preceding and next device in the loop is made in each case via Remote-In and Remote-Out connections respectively.

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 unit in the network ring.

Baud rate The baud rate is permanently set to 500kBit/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.

TLADOCC53ME, -000, 08.02

4.4.18 Connection to the ESIM3-C module (encoder simulation output)

Module interface The ESIM3-C module is equipped with a 15-pin Sub-D female connector (M3 hardware).

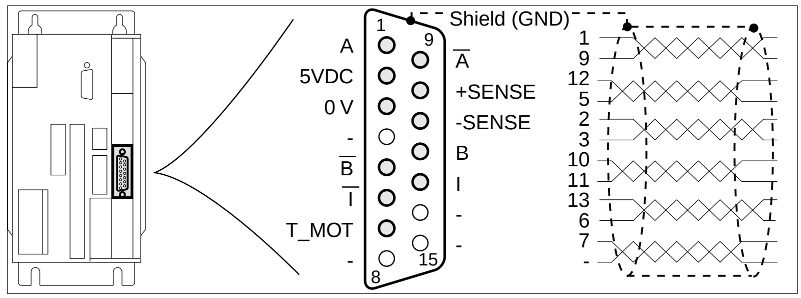

Fig. 4.33 Interface of the encoder module

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

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

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

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Cable specification

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

- Shielded cable
- Minimum cross-section for the signal conductors is 25 AWG (0.14 mm^2)
- Twisted pair wires
- Ground shield at both ends.
- Maximum cable length of 328 feet (1 0 0m)

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 outputting the actual position are taken off at the incremental encoder connection. These are two phase-shifted signals, A and B. The A/B signals are generated and passed on by the motor encoder module.

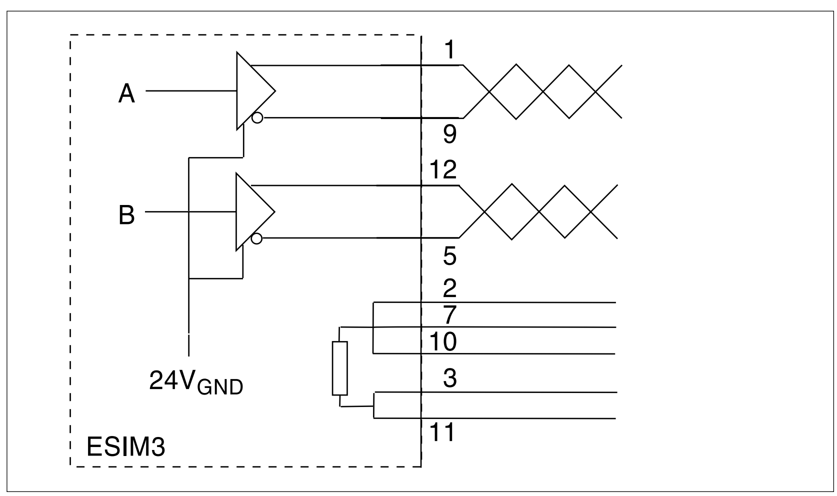

Fig. 4.34 ESIM3-C Module Output

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

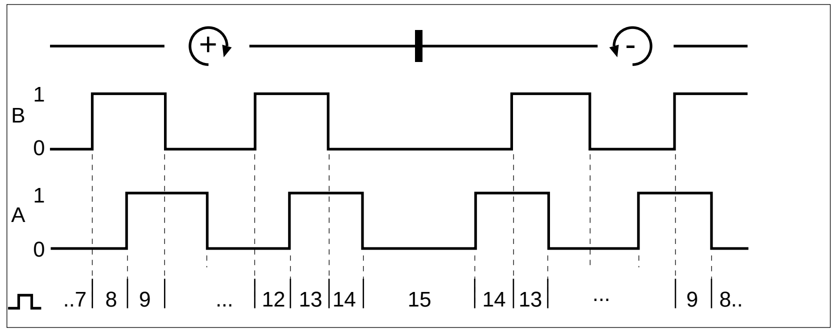


Fig. 4.35 Time diagram with A and B counting forwards and backwards

Incorrect transmission of position data when the ground voltage drop is excessive. The potential difference between the 24 VGND terminals of any two Twin Line controllers connected via RS-422-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 24 VGND terminals, increase the cross-sectional area of the 24 VGND conductor between the individual Twin Line controllers and their respective 24 VGND power supplies or insert an RS-422 isolator between controllers with large ground voltage differences.

The pin assignments for the relevant signals of modules ESIM3-C and RS-422-C are identical. A 1:1 cable can be used for a connection.

4.5 Connecting accessories to the IP20 controller

4.5.1 Holding brake controller TL HBC

⚠ DANGER

HAZARDOUS VOLTAGE – SERVOMOTOR-GENERATED AND COUPLED VOLTAGE.

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

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

⚠ DANGER

HAZARDOUS VOLTAGE – INADEQUATE GROUNDING

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

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

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

Connection

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

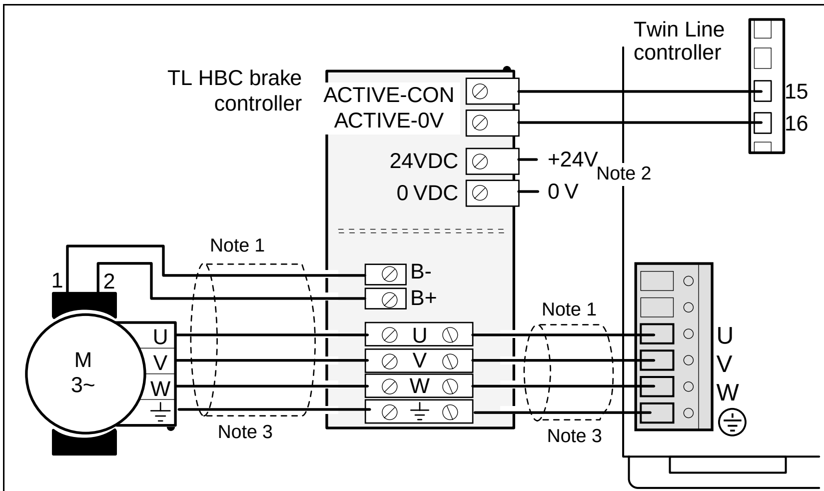
▶ Refer to section 4.4.4 and Fig. 4.10 for motor cable selection and motor connector terminal assignments.

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

TLADOCC53ME, -000, 08.02

Refer to Fig. 4.9 and section 4.4.4 for connection of the motor conductors and ground to the TLC53x controller.

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



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

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

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

Fig. 4.36 Connection of the TLHBC holding brake controller

Refer to Fig. 4.37 for dimensions when preparing the motor cable for connection to the holding brake controller.

The lead preparation shown is compatible with the motor-side and controller-side connections to the holding brake controller. Refer to Fig. 4.11 for the motor cable lead preparation required at the power amplifier.

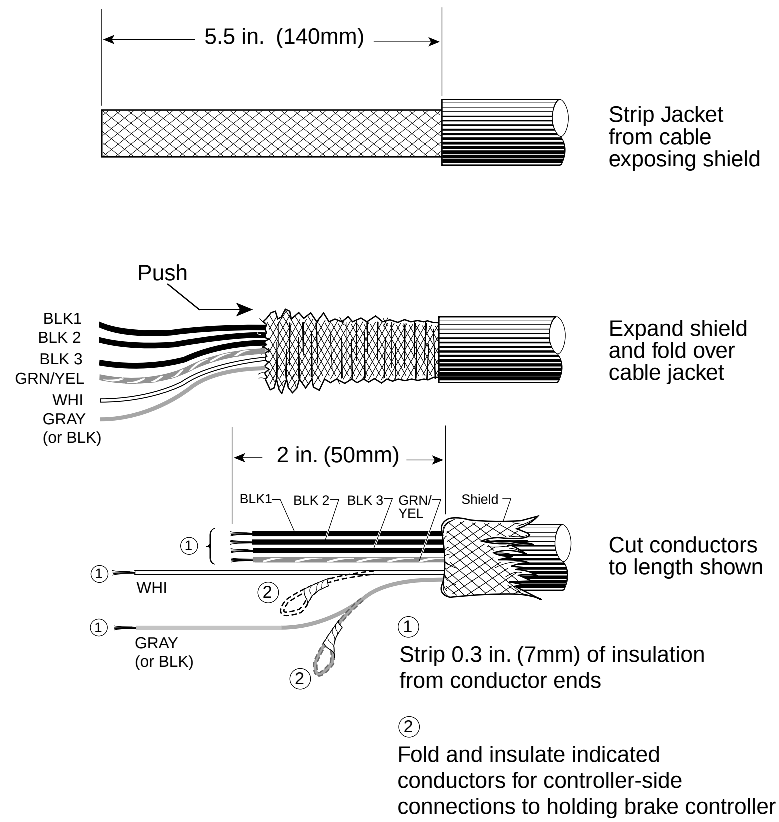


Fig. 4.37 Preparing the motor cable termination to the holding brake controller.

Motor and controller-side power connectors

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

Brake connectors

- ▶ If ferrules are installed, use only square end ferrules.
- ▶ Connect the holding brake to the holding brake controller:
  - white brake cable: terminal B+ of the HBC controller
  - gray (or black) brake cable: terminal B- of the HBC controller
  Torque the connections to 2.5–2.8 lb-in (0.22–0.25 N•m)

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Control connections

- ▶ Connect the control terminals ACTIVE-CON and ACTIVE-0V of the brake controller to the signal interface of the Twin Line controller. Torque the terminals to 4.5–5.6 lb-in (0.4–0.5 N•m).
- ▶ Connect the 24Vdc power supply to the holding brake controller. Torque the terminals to 4.5–5.6 lb-in (0.4–0.5 N•m).

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

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

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

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

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

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

The voltage reduction function is described in section 7.10 on page 7-30.

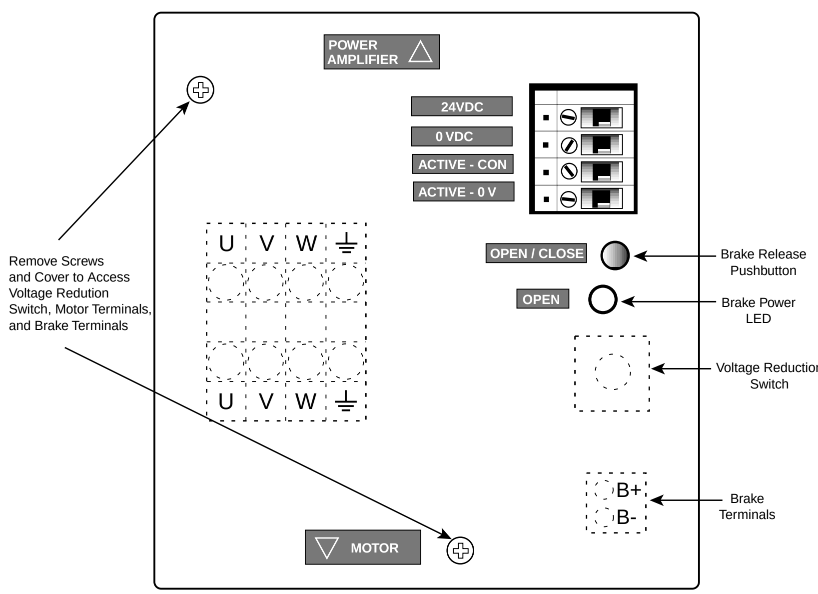

Fig. 4.38 TLHBC general arrangement (front view)

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4.5.2 Ballast resistor and ballast resistor controller TLBRC

External ballast resistor

An external ballast resistor can be connected via a TLBRC ballast resistor controller to the DC bus terminals of the IP20 controllers. Although the TLBRC controller and ballast resistors can be connected to the IP54 controllers, the IP20 rating of these accessories limits their use with IP54 controllers.

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

⚠ WARNING

LOSS OF BRAKING TORQUE

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

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

Dimensioning aid

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

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

Kinetic energy W_{kin}

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

Internal energy absorption

Braking energy is absorbed internally through the following mechanisms:

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

DC bus capacitors

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

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

Unit	Mains voltage [V]	TLxx32	TLxx34	TLxx36	TLxx38
Internal capacitance [µF]		340	235	470	1175
Energy absorption [1)] [Ws]	230	10	53	106	264
Energy absorption [1)] [Ws]	400	-	23	47	116
Energy absorption [1)] [Ws]	480	-	3	7	16

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

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

Energy absorption of the internal ballast resistor

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

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

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

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

Electrical losses W_E

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

Mechanical losses W_M

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

Example TLxx34

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

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

The energy to be absorbed is given by:

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

to 88 Ws

Electrical and mechanical losses are ignored.

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

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

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

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

Sizing the external ballast resistor

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

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

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

U :	switching threshold [V]
P_{max} :	required peak power [W]
R:	resistance [Ohm] > 28 Ohm

Fig. 4.39 Calculating the resistance R of an external ballast resistor

Select resistors on the following criteria:

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

Standard ballast resistors

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

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

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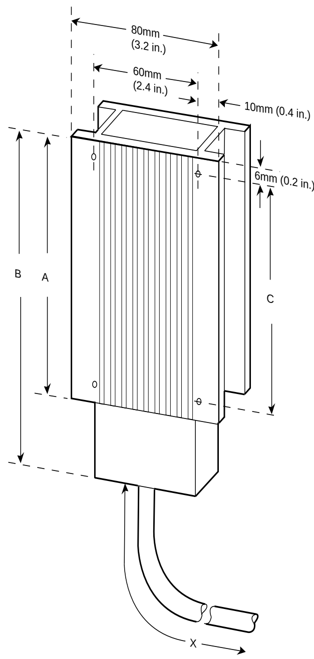
When mounted vertically, the connecting cable must be led out downwards.



x = 0.75m (2.46 ft.)

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

Fig. 4.40 Size and mounting dimensions of the ballast resistor in the versions with 100 W and 200 W continuous power

⚠WARNING

HOT COMPONENTS

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

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

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

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

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

The resistors meet protection grade IP54 and can be installed in a type 1 environment. The resistors are equipped with a permanently attached 0.75 m (2.46 ft.) 3-wire temperature-resistant cable for connection to the TLC-BRC ballast resistor controller. The resistors will fuse open if permanently connected to the DC bus supply but have no internal protection against current overload or overtemperature. Barriering and guarding the resistor is required to prevent contact with the case of the resistor. Additional precautions must be taken to ensure that adequate ventilation is provided to dissipate the expected power during operation. The cable must be protected against mechanical damage where routed outside of the enclosure containing the Twin Line controller.

Ballast resistor overload protection

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

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

⚠WARNING

LOSS OF BRAKING TORQUE

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

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

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

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

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

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

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Ballast resistor controller TL BRC

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

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

⚠ CAUTION

EQUIPMENT DAMAGE HAZARD

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

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

Refer to section 4.4.6 for further information concerning the interconnection of the DC busses of two controllers.

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

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

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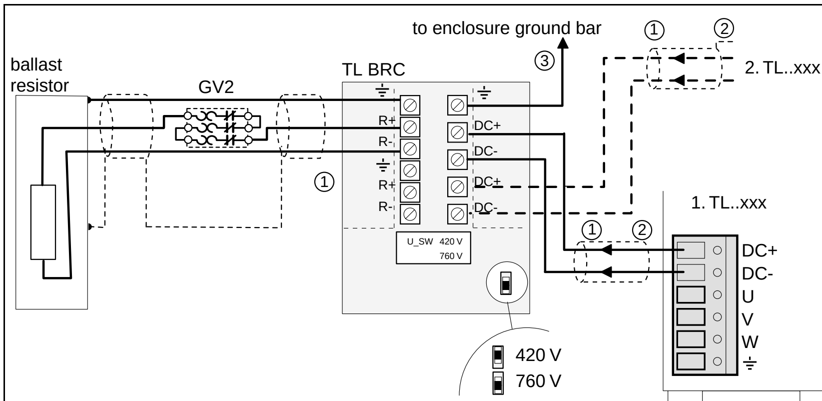

1. Terminate the shield with SK14 shield clamp on the TL BRC housing.
2. Terminate the shield with SK 14 shield clamp on the controller housing.
3. The grounding conductor cross section must not be less than the cross section of the mains conductor feeding the power amplifiers.

Fig. 4.41 Connection of the ballast resistor controller

Connection

⚠ DANGER

HAZARDOUS VOLTAGE

- Read and understand the TLBRC installation procedure in its entirety before proceeding. Installation, adjustment, repair and maintenance of the TLBRC and associated ballast resistor must be performed by qualified personnel.
- Disconnect all power before connecting TLBRC and the ballast resistor to the Twin Line controller.
- WAIT SIX MINUTES until DC bus capacitors on Twin Line controller discharge, then measure DC bus capacitor voltage between DC+ and DC- terminals to verify DC voltage is less than 45 V (see Fig. 1.7 on page1-7).
- The DC bus LED is not an accurate indication of the absence of DC bus voltage.
- DO NOT short across DC bus terminals or touch unshielded components or terminal strip screw connections with voltage present.
- Many parts in this drive system, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools.

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

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⚠ DANGER

HAZARDOUS VOLTAGE – INADEQUATE GROUNDING

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

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

Refer to Fig. 4.41 for connection of the ballast resistor controller to the ballast resistor, GV2, and Twin Line controller.

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

▶ Remove all power. Open the TL BRC.

▶ Set the switch to match the controller's part number:
For TLC532 controllers, set the switch to420 V.
For TLC534, TLC536, and TLC538 controllers, set the switch to 760 V.

⚠ CAUTION

EQUIPMENT DAMAGE HAZARD

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

- For TLC532 controllers, the voltage selector switch must be set to 420 V.
- For TLC534, TLC536, and TLC538 controllers, the voltage selector switch must be set to 760 V.

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

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

▶ Connect the TLBRC to the controller with a 2-wire shielded cable. Connect the DC+ and DC- terminals on the ballast resistor controller to the DC bus terminals DC+ and DC- of the Twin Line controller. Refer to the table on page 4-21 for controller terminal torques. Torque the TLBRC terminals to 5.6–6.8 lb-in (0.5–0.6 N•m). Use an SK14 shield clamp to connect a large area of the cable shield to the controller's grounding bar.

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

▶ Connect the ballast resistor and GV2 with 3-core shielded cables to the R terminals in the ballast resistor controller. Connect the grounding conductor to the ground terminal of the TLBRC control-

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ler. Torque the TLBRC terminals to 5.6–6.8 lb-in (0.5–0.6 N•m). Use an SK14 shield clamp to connect a large area of the cable shield to the TLBRC grounding bar.

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

DC bus cable specification

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

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

Ballast resistor cable specification

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

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

EMC measures

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

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

	Switch position 1 1)	**Switch position 2**
controller part no.	TL..xx4/xx6/xx8	TL..xx2
switching threshold [V]	760	420
maximum switched continuous power [W]	1000	500
smallest resistance [Ω]	30	30

1) factory setting

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

Standard controller set-up

When the TL BRC is used, the internal ballast resistor must be switched off. The "Settings.TL_BRC“ parameter informs the unit whether a ballast resistor controller has been connected. Refer to section 5.4.6 on page 5-11 for further information.

IP54 Controller

The ballast power that can be dissipated depends on the ambient temperature and whether or not a fan is being used. Refer to the power specifications in section 3.2.1 on page 3-4.

If the actual ballast power exceeds the maximum permissible ballast power, the controller output to the motor will be shut down.

The maximum permissible ballast power is defined by the "PA.P_maxBusr“ parameter.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and units [ ]	Value range	Default value	R/W rem.
PA.p_maxBusr	16:57	4.1.40	maximum permissible ballast power [W]	TLC5325: 25 - 170 W TLC5345: 37 - 255 W	25W / 37W	R/ – rem.

Note: The parameter "P_maxBusr" can only be viewed in the IP54 units.

CAUTION

EQUIPMENT DAMAGE HAZARD

For IP54 controllers, the setting of the permissible power limit in register P_maxBusr must be adjusted based on the ambient air temperature surrounding the controller (the temperature of the ballast resistor heatsink in the IP54 controller is indirectly computed).

- Set P_maxBusr per the table found on page 3-5 of this instruction manual for the maximum allowable power dissipation of the internal ballast resistor based on the controller maximum ambient air temperature and presence or absence of external fan.
- When the ambient temperature must be estimated, it is better to set the P_maxBusr to the minimum setting to protect the controller.

Improper parameter setting can result in damage to the ballast resistor and ballast resistor switch in the version P controller.

Failure to follow these instructions can result in equipment damage.

System commissioning notes

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

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4.6 Wiring examples

4.6.1 Manual set-up and operation on the Fieldbus

Functions Manual set-up using the Teach-In function, manual movement via I/O, operation via Fieldbus with fixed I/O assignment.

Presets Parameter settings: “Settings.IO_mode” = 2, refer to section 6-1, beginning on page 6-3 for changing operating modes and access control.

Manual movement via I/O and Teach-In: AUTOM=0 Fieldbus operation: AUTOM=1.

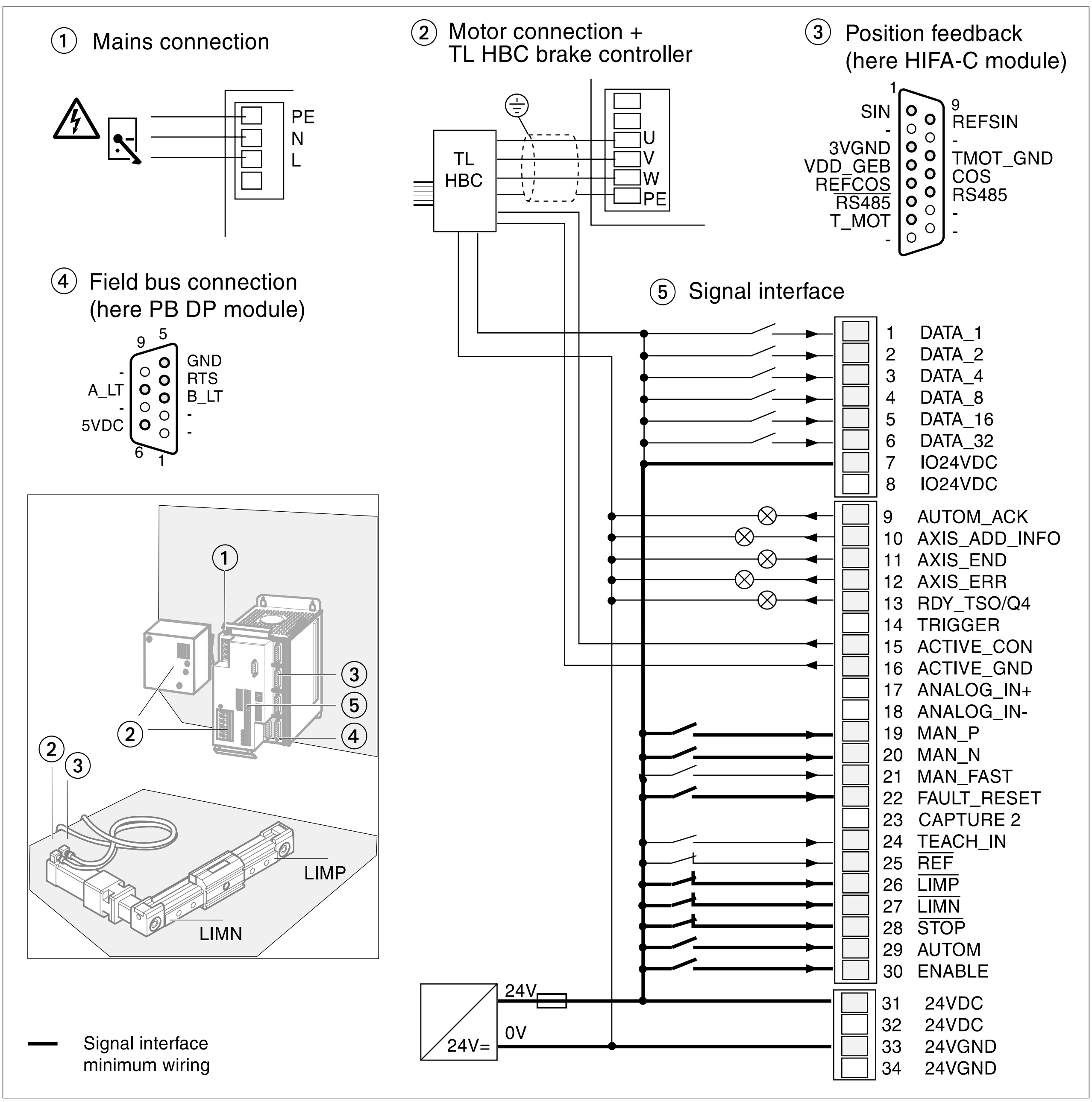

Fig. 4.42 Wiring for manual operation via inputs and outputs

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Connection

▶ Wiring up the mains connection (1):

- For single-phase Twin Line controllers refer page 4-15 for three-phase Twin Line controllers refer page 4-18
- Wiring up a 2 4V connection, refer page 4-28

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

- For the motor connection refer page 4-20
- For the brake controller refer page 4-24.

▶ Installing motor position acknowledgement (3)

- Wiring Hiperface connection for Sincoder motors, refer page 4-41

▶ Wiring Fieldbus connection (4)

- Profibus DP refer page 4-50
- CAN-Bus refer page 4-52
- Serial bus refer page 4-54
- Interbus-S refer page 4-56.

▶ Wiring signal interface for manual operation (5)

- The complete pin assignment of the signal interface is described from page 4-24 through 4-30.
- The minimum pin assignment for manual operation is given in the following table.

Pin	Signal	Active	Explanation	I/O
1	DATA_1	high	Bit 0 for selecting a list number	I
2	DATA_2	high	Bit 1 for selecting a list number	I
3	DATA_4	high	Bit 2 for selecting a list number	I
4	DATA_8	high	Bit 3 for selecting a list number	I
5	DATA_16	high	Bit 4 for selecting a list number	I
6	DATA_32	high	Bit 5 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 to AUTOM signal	O
10	AXIS_ADD_INFO	high	additional information on current movement	O
11	AXIS_END	high	end to movement processing, drive at standstill	O
12	AXIS_ERR	high	fault detection when processing movement command	O
13	RDY_TSO	high	operational readiness, output max. 400 mA	O
15	ACTIVE_CON	high	motor under current, control signal for brake controller TL HBC, max. 400 mA [2)]	O
16	ACTIVE_0V	high	0 V signal for brake controller, internally connected to 0 VGND [2)]	I
19	MAN_P [1)]	high	manual movement, positive motor rotation	I
20	MAN_N [1)]	high	manual movement, negative motor rotation	I

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Pin	Signal	Active	Explanation	I/O
21	MAN_FAST	high	manual selection slow (low) or fast (high)	I
22	FAULT_RESET 1)	high	reset fault signal	I
24	TEACH_IN	high	trigger signal for storing current setpoint in the list data memory	I
25	$\overline{\text{REF}}$	low	reference switch signal	I
26	$\overline{\text{LIMP}}$ 1)	low	limit switch signal, positive motor rotation	I
27	$\overline{\text{LIMN}}$ 1)	low	limit switch signal, negative motor rotation	I
28	$\overline{\text{STOP}}$ 1)	low	stop motor	I
29	AUTOM 1)	high	automatic mode via Fieldbus (high), manual operation (low)	I
30	ENABLE 1)	high	enable power amplifier (high) or disable (low)	I
31, 32	24 VDC 1)	–	24 VDC power supply	I
33, 34	GND 1)	–	GND for 24 VDC	I

1) Minimum pin assignment of signal interface for start-up
2) IP54 controller: Holding brake control module is factory wired to these terminals

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4.6.2 Operation via Fieldbus, configuration via TLHMI or TLCT

Functions Operation via Fieldbus or local operating units (TLHMI or TLCT) with signal interface pins assigned for hardware control by a Numerical Controller (NC) device, Fieldbus settings through local operating units.

Presets Parameter setting: 'Settings.IO_mode' = 1, refer to section 6.1 beginning on page 6-3, for changing operating modes and access control.

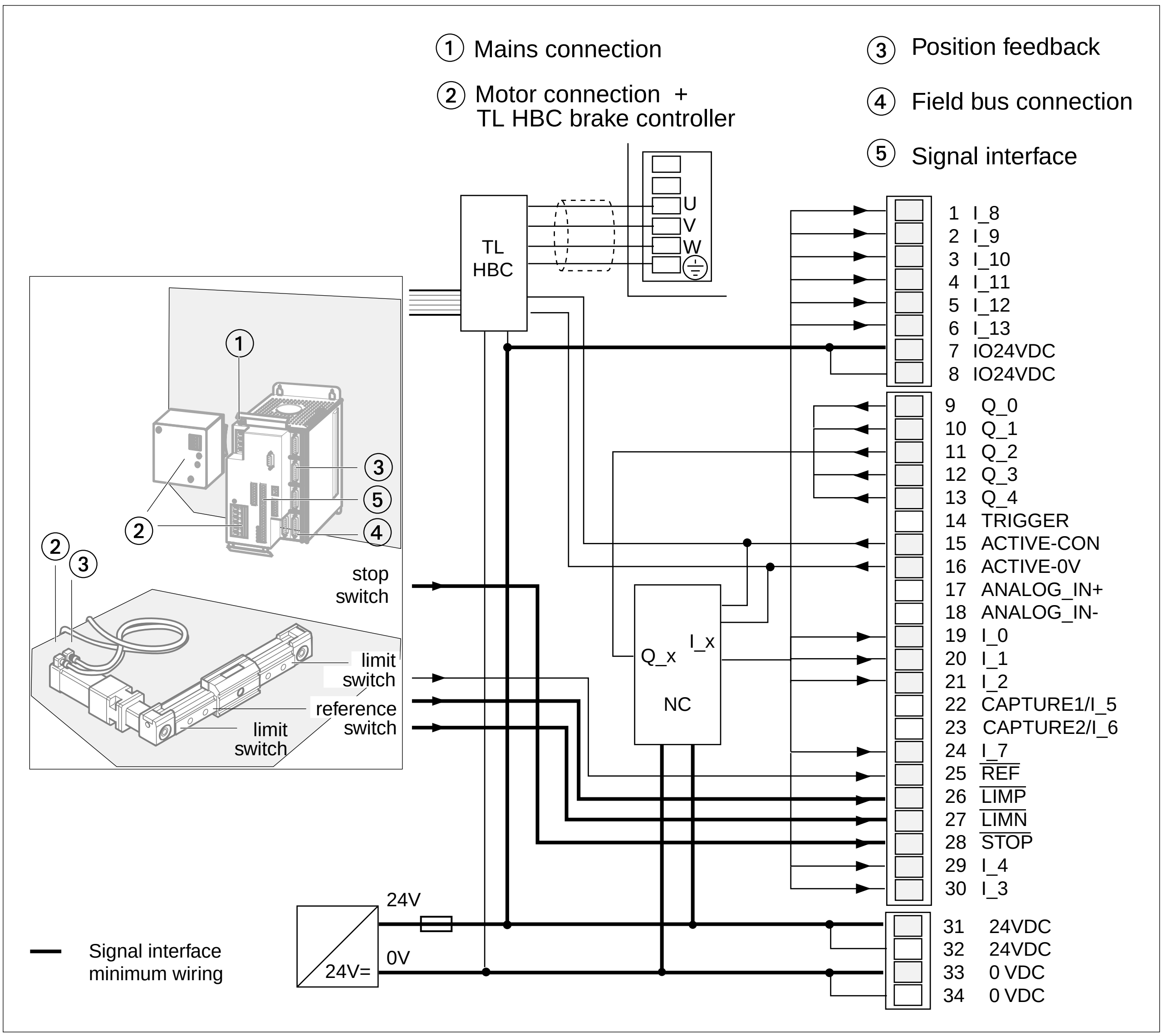

Fig. 4.43 Wiring for automated operation on Fieldbus, local operation via TLHMI, TLCT, or NC.

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Pin	Signal	active	Explanation	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
15	ACTIVE-CON	high	motor powered, control signal for brake controller TLHBC, max. 400mA [2)]	O
16	ACTIVE-0V	high	0 V signal for brake controller, internally connected to 0 Vdc [2)]	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
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, positive motor rotation	I
27	$\overline{\text{LIMN}}$ [1)]	low	limit switch signal, negative 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	0 Vdc [1)]	–	0 V for 0 Vdc	I

1) Minimum pin assignment of signal interface for start-up
2) IP54 controller: Holding brake control module factory wired to these terminals.

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4.6.3 Operation via Fieldbus, Fieldbus configuration via inputs

Functions Operation only via Fieldbus master (supervisory) device, Fieldbus settings via signal interface inputs. On powering up the Twin Line controller, Fieldbus address 7 is set. Baud rate and processing profile are not to be set so pins 19, 20, 21, 29, and 30 are set to 0 VDC.

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, refer to section 6.1 beginning on page 6-3, for changing operating modes.

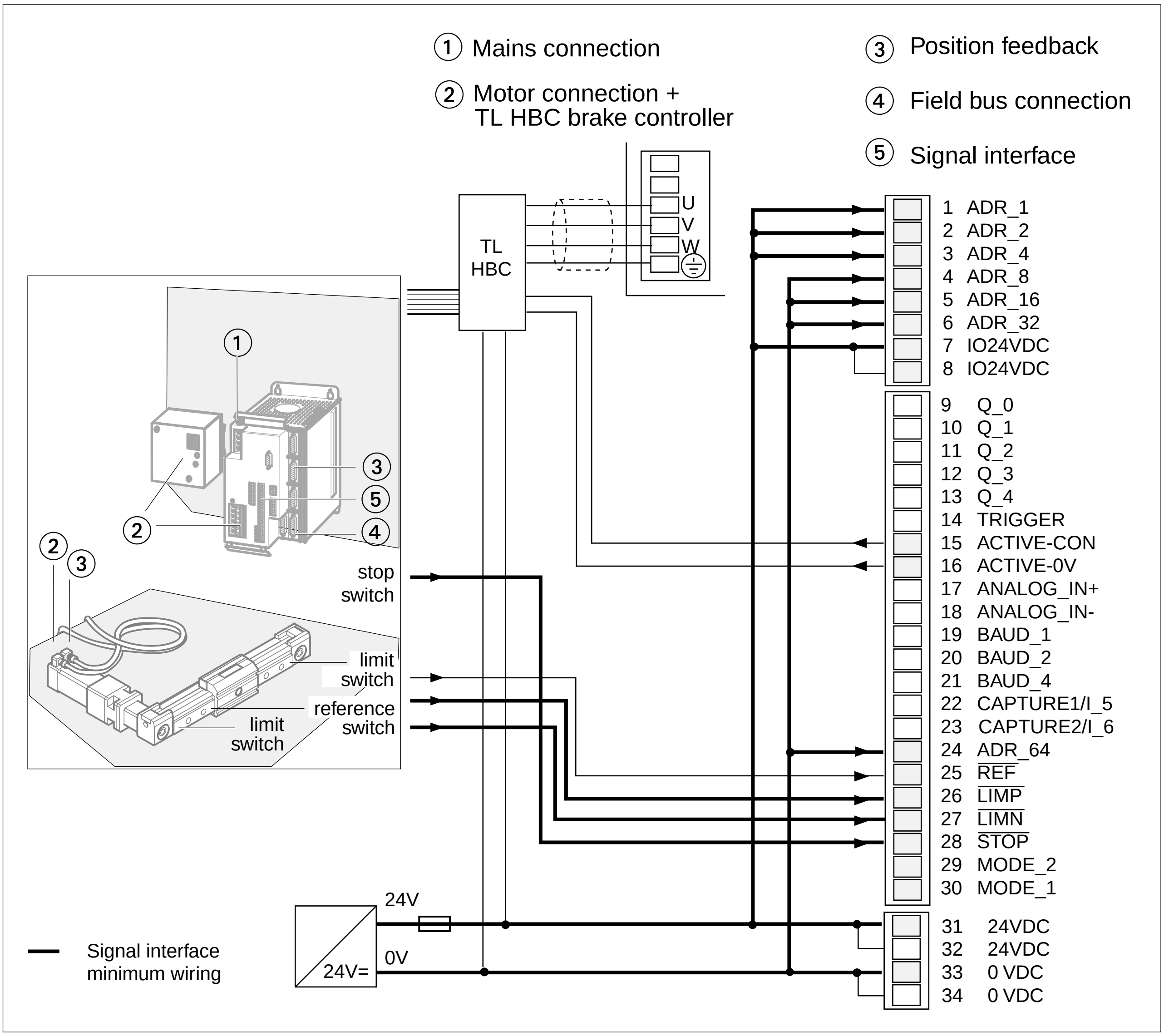

Fig. 4.44 Wiring for automated operation only on Fieldbus

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Pin	Signal	active	Explanation	I/O
1	ADR_1	high	Bit 0 for network address	I
2	ADR_2	high	Bit 1 for network address	I
3	ADR_4	high	Bit 2 for network address	I
4	ADR_8	high	Bit 3 for network address	I
5	ADR_16	high	Bit 4 for network address	I
6	ADR_32	high	Bit 5 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 powered, control signal for brake controller TLHBC, max. 400 mA [2)]	O
16	ACTIVE-0V	high	0 V signal for brake controller, internally connected to 0 Vdc [2)]	O
19	BAUD_1	high	Bit 0 for setting the baud rate	I
20	BAUD_2	high	Bit 1 for setting the baud rate	I
21	BAUD_4	high	Bit 2 for setting the baud rate	I
24	ADR_64 [1)]	high	Bit 6 for network address	I
25	$\overline{\text{REF}}$	low	reference switch signal	I
26	$\overline{\text{LIMP}}$ [1)]	low	limit switch signal positive motor rotation	I
27	$\overline{\text{LIMN}}$ [1)]	low	limit switch signal negative 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
	0 V [1)]	–	0 V	I

1) minimum pin assignment of signal interface for start-up
2) IP54 controller: Holding brake control module factory wired to these terminals.

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4.7 Function test

▶ Perform the following checks before powering any equipment:

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

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

Certain controller parameters must be tested and adjusted before control signals may be sent to the motor. Parameters settings will be discussed in chapter 5, 'Set-up'. The following function tests must therefore be conducted with power present on the controller and auxiliary apparatus, but with the controller output disabled.

▶ Disconnect the plugs from the controller's Fieldbus interface to ensure that the power amplifier cannot be enabled through the Fieldbus. Connect a PC equipped with TLCT to the controller using an RS-232 cable of sufficient length to allow the PC to be brought outside the enclosure housing the controller.

▶ Switch the signal interface ENABLE input to Low after connecting the signal input.

4.7.1 Function test with Sincoder motor

Using TLCT to read operational status code

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

▶ Switch on the 24V power supply.

System check and initialization

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

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

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

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

Unit with Sincoder motor OK The operational status indicator changes to '4'.

The power amplifier is ready to be switched on and the controller is correctly installed. Carry out the first manual test via the input signals of the signal interface or via commands from a PC equipped with the TLCT.

4.7.2 Reserved

4.8 Installation troubleshooting

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- Read and understand this bulletin in its entirety before installing or operating Twin Line drive system products. Installation, adjustment, repair, and maintenance of these drive systems must be performed by qualified personnel.
- Disconnect all power before servicing the power controller. WAIT SIX MINUTES until DC bus capacitors discharge, then measure DC bus capacitor voltage between the DC+ and DC- terminals to verify that the DC voltage is less than 45 V (see Fig. 1.7 on page 1-7). The DC bus LED is not an accurate indication of the absence of DC bus voltage.
- The servomotor can produce voltage at its terminals when the shaft is rotated! Prior to servicing the power controller, block the servomotor shaft to prevent rotation.
- DO NOT short across DC bus terminals or touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers and close enclosure door before applying power or starting and stopping the drive system.
- The user is responsible for conforming to all applicable code requirements with respect to grounding all equipment. For drive controller grounding points, refer to Fig. 1.7 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', make the following checks:

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

Operational status indicator flashing

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

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5 Commissioning

5.1 Commissioning procedure

Where can I find information on...	TLC53x controller manual	TLHMI manual	TLCT software manual	TLCT help
Commissioning step by step	•	–	–	•
Settings and parameter list	•	–	–	–
Commissioning procedure	•	–	–	•
Detailed information on operation using...	–	TLHMI	TLCT	TLCT

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

Commissioning

What you need to do...	Page references
Make sure the Twin Line unit is correctly installed and wired up. When carrying out this check, use the wiring diagrams of the system configuration or the wiring examples in section 4.6.	Page 4-75
Make sure the limit switches work if these are installed.	Page 5-10
Check the functioning of the holding brake controller if motors with holding brake are used	Page 5-11
Check and set critical device parameters	Page 5-11
Check out the direction of rotation and carry out a test run	Page 5-12
Optimize controller settings. To do so, install the motor and... - Set the reference variables and the record data - Optimize the speed controller - Optimize the position controller	 Page 5-21 Page 5-23 Page 5-32

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

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

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5.2 Safety instructions

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

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

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

- Validate operation of the machinery after programming and after programming changes.
- Validate operation of the controller after changing parameter settings.
- If possible, validate 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 validation 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.

⚠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.

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⚠ WARNING

LOSS OF CONTROL

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

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

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

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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, or WINDOWS 98.

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

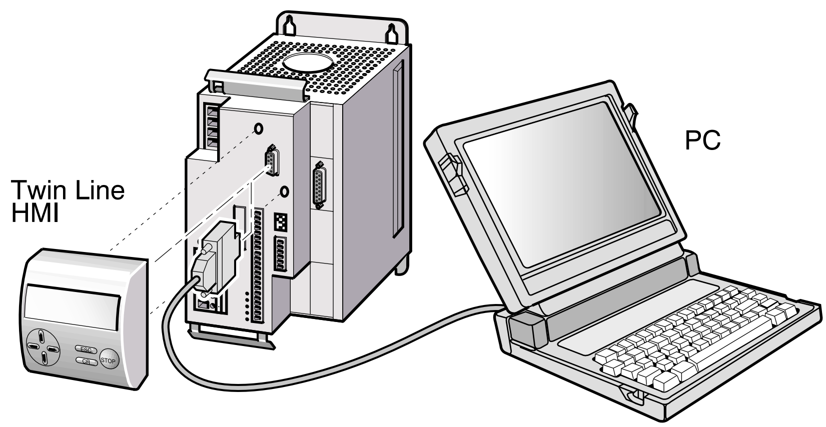

Fig. 5.1 Commissioning with the hand-held operating unit or the PC

5.3.2 The Twin Line HMI hand-held operating unit

Human-Machine Interface HMI

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

Twin Line HMI manual

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

Menu structures for the TLC53x

The Twin Line HMI operates under menu guidance. When the controller is switched on, the menu structures and the parameter values displayed on the HMI auto-configure to the controller to which it is connected. For the TLC53x controller, the menu items illustrated in Fig. 5.2 are available on the first and second levels:

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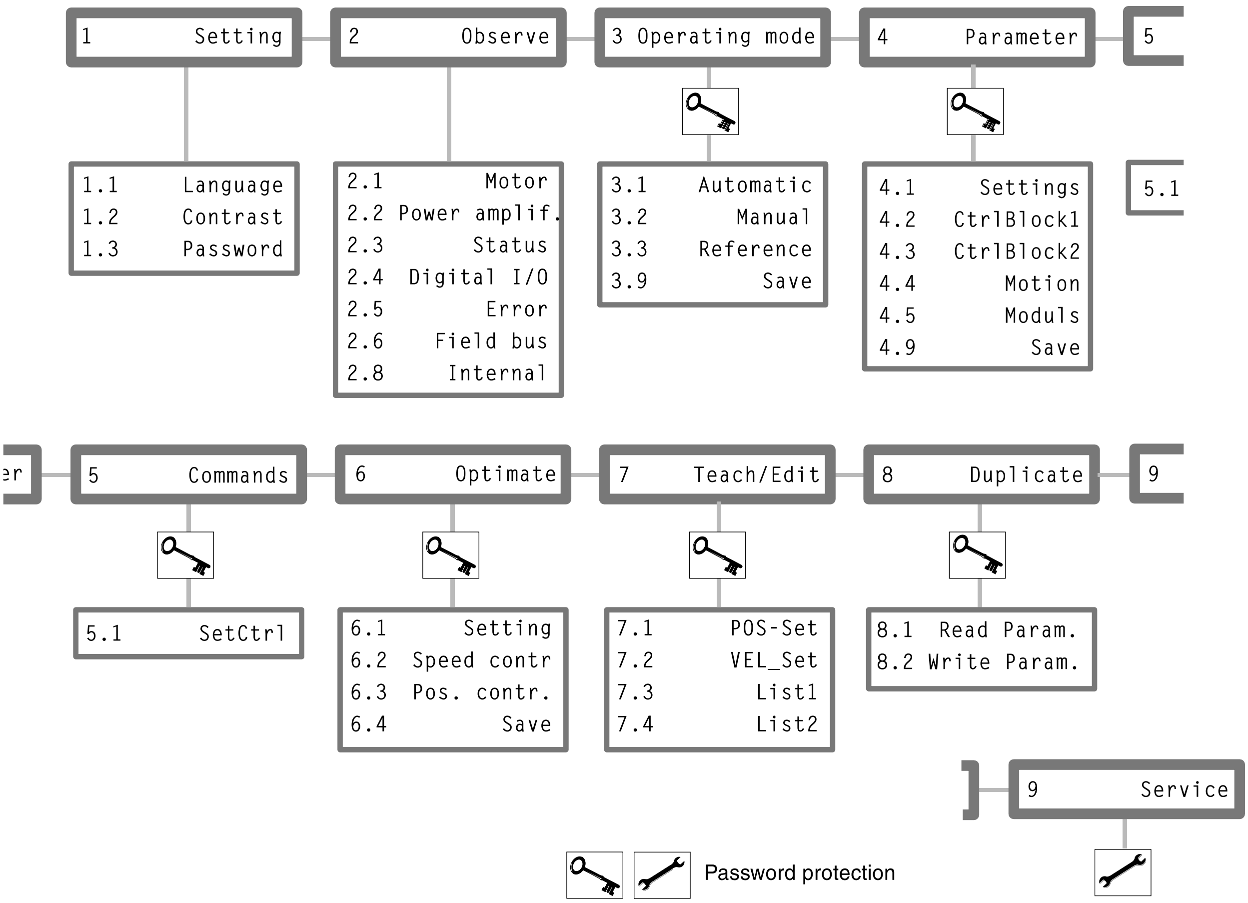

Fig. 5.2 First and second menu levels of the Twin Line HMI with TLC53x

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

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

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

5.3.3 Operating software Twin Line Commissioning Tool

Twin Line Commissioning Tool

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

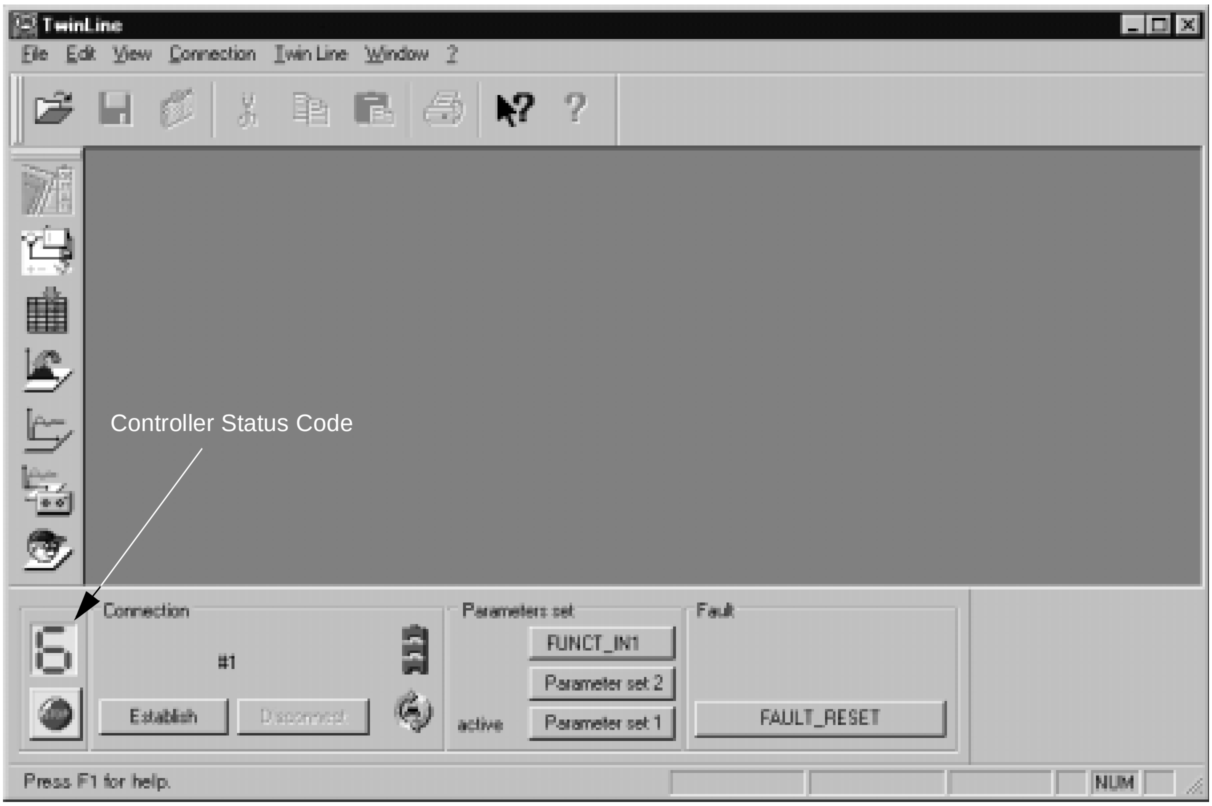

Fig. 5.3 Twin Line Commissioning Tool operating software

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

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

TLCT manual

Operating a Twin Line 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.

Requirements for the use of the Twin Line Commissioning TooL

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

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

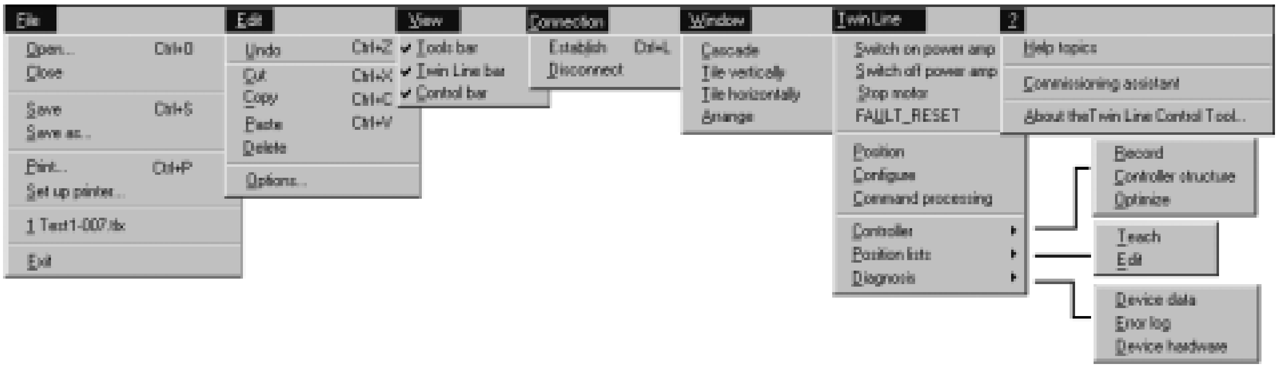

Fig. 5.4 The menu structure of the Twin Line Commissioning Tool

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

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

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

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

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5.4 Commissioning the controller

5.4.1 Commissioning stages

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

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

Commissioning should be done in the following sequence:

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

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 servomotor. Examples of limit or protective functions include but are not limited to the following.

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

Failure to follow these instructions can result in death 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 24Vdc 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.

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5.4.3 Checking the limit switches

⚠WARNING

LOSS OF CONTROL DURING OR FOLLOWING A MOTION

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

- Refer to section 7.9.1 of this instruction manual for descriptions of the LIMP, LIMN, and STOP input functions. Use of the functions is generally recommended.
- Use of the LIMP, LIMN, and STOP input functions require the connection of signals from external sensors or limit switches to the controller. The signals used should originate from separate sensors and limit switches from those used during normal machine control.
- The external sensors and limit switches must be properly located on the machine motion being controlled.
- To operate, the LIMP, LIMN, and STOP input functions must be enabled in the controller software.
- The LIMP, LIMN, and STOP input functions cannot protect against certain failures within the controller or at the sensors. For the control of critical motions of the machine, use redundant control signal paths to assure a safe state during failure.

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

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

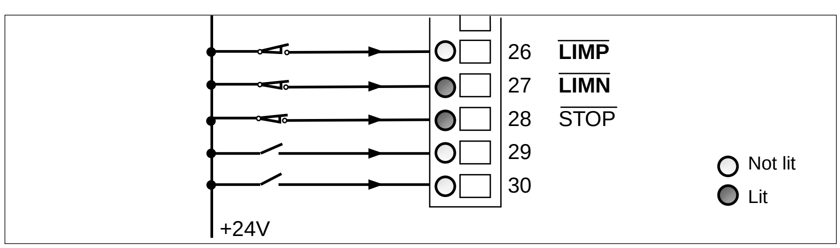

Fig. 5.6 Positive limit switch tripped

The operation of input ports LIMP, LIMN, and STOP can be enabled or disabled using the parameter "Settings.SignEnabl". Their evaluation as active high or active low can be changed by parameter "Settings.SignLevel". See page 7-27.

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

5.4.4 Checking the holding brake

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

WARNING

MACHINERY MOTION HAZARD

Release of the motor brake can cause unintended machine movement.

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

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

All controllers

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

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

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

5.4.5 Reading in the motor data

Motor data set

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

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

Motors with Hiperface interface

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

5.4.6 Setting device parameters

Selecting the control parameters set

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

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

Setting limits

⚠WARNING

LIMIT AND PROTECTIVE PARAMETERS MUST BE PROPERLY SET

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

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

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

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

▶ Select parameter set 1.

Set the current and speed limit parameters listed in the table on page 5-13 before operating the motor as part of the system. Suitable limits must be calculated from the system configuration and motor characterisitics. As long as the motor is running outside of the system, there is no need to change the default settings.

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

Selecting the chopper frequency

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

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

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

Registering a ballast resistor controller

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

TL CT: Setting parameters

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

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

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

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

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5.4.7 Checking inputs and outputs

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

⚠ WARNING

UNINTENDED EQUIPMENT ACTION / LOSS OF CONTROL

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

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

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

Parameters for inputs and outputs

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

0: The input or output carries 0 V.

1: The input or output carries 24 V.

Inputs and outputs can be configured with fixed or free signal interface pin assignment. The parameter 'Settings.IO_mode' permits you to switch between settings, see page 6-5.

	Inputs			**Outputs**	
Bit	**I/O.IW0_act**	**I/O.IW1_act permanently assigned**	**I/O.IW1_act freely assignable**	**I/O.QW0_act permanently assigned**	**I/O.QW0_act freely assignable**
0	$\overline{\text{LIMP}}$	MAN_P	I_0	AUTOM_ACK	Q_0
1	$\overline{\text{LIMN}}$	MAN_N	I_1	AXIS_ADD_INFO	Q_1
2	$\overline{\text{STOP}}$	MAN_FAST	I_2	AXIS_END	Q_2
3	$\overline{\text{REF}}$	ENABLE	I_3	AXIS_ERR	Q_3
4	-	AUTOM	I_4	RDY_TSO	Q_4
5	-	FAULT_RESET	I_5	ACTIVE_CON	ACTIVE_CON
6	-	CAPTURE2	I_6	TRIGGER	TRIGGER
7	-	TEACH_IN	I_7	-	-
8	-	DATA_1	I_8	-	-
9	-	DATA_2	I_9	-	-
10	-	DATA_4	I_10	-	-
11	-	DATA_8	I_11	-	-

	Inputs			Outputs	
Bit	**I/O.IW0_act**	**I/O.IW1_act permanently assigned**	**I/O.IW1_act freely assignable**	**I/O.QW0_act permanently assigned**	**I/O.QW0_act freely assignable**
12	-	DATA_16	I_12	-	-
13	-	DATA_32	I_13	-	-
14	-	-	-	-	-
15	-	-	-	-	-

Displaying signal states with TLCT

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

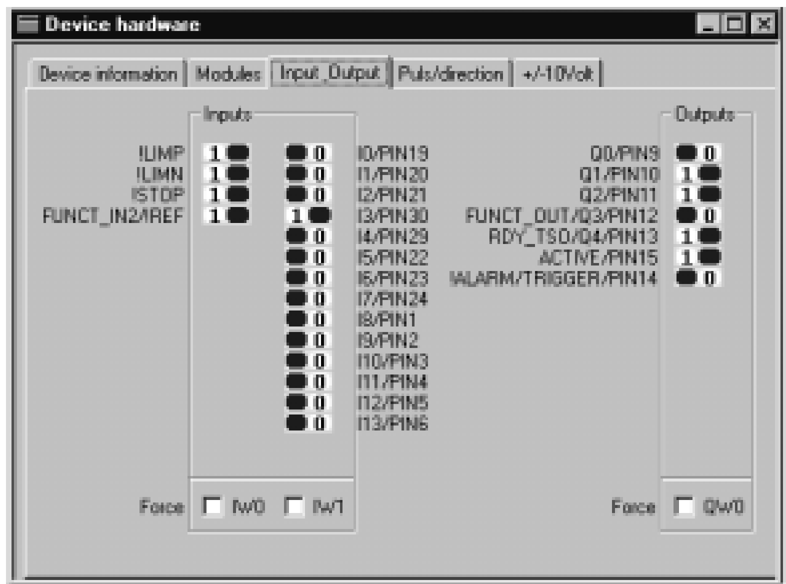

Fig. 5.7 Switching the inputs / outputs of the signal interface with the TLCT software

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

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

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

Displaying signal states with TLHMI

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

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

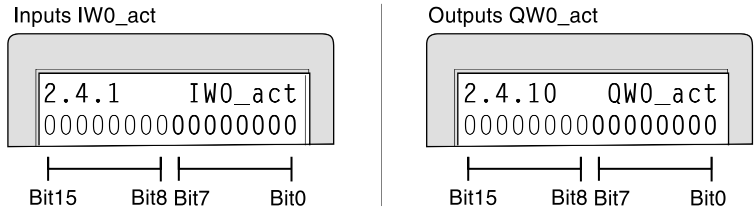

Fig. 5.8 Observing inputs / outputs of the signal interface with Human-Machine Interface HMI

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

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

Displaying analog inputs

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

- TLHMI
- TLCT
- Fieldbus

TLCT: Displaying analog input

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

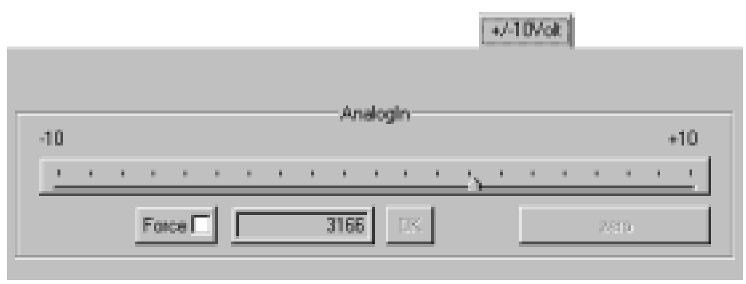

Fig. 5.9 Displaying and setting the analog input with the TLCT software

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

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

Fieldbus and HMI: Displaying analog input

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

Parameter name	Idx:Sidx	TL-HMI	Explanation and units [ ]	Value range	Default value	R/W rem.
Status.AnalogIn	20:8	2.3.3.1	analog input at input ANALOG_IN [mV]	INT16	0	R/W rem.

5.4.8 Validating controller direction of rotation or direction of movement

⚠WARNING

UNINTENDED EQUIPMENT ACTION

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

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 4.4.4 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 5.4.6 for a table listing the speed and current limit parameters.
- When initially validating the ability of the controller to regulate motor speed, do so with the motor disconnected from the driven load.
- Motor rotation direction cannot be corrected by swapping the motor phases. Motor directional rotation can only be corrected via software programming. Refer to section 5.4.8 for directional conventions and procedures for setting rotational direction.

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

Operating facilities The test operation with a manual movement can be carried out using the TL CT operating software, the HMI hand-held operating unit or via the signal interface.

If you want to use the Twin Line controller with the preset signal interface pin assignment, carry out the test run via the signal interface. Set the ‘Settings.IO_mode’ parameter to 2.

The following conventions apply:

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

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

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

Manual movement with TL HMI

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

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

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

Manual movement with TL CT

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

▶ Select “Twin Line → Positioning” to open the ‘Positioning” dialog box. Select ‘Manual’ to start manual movement.

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

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

Manual movement via the signal interface

For manual movement via the signal interface, the “Settings.IO_mode” parameter must be on 2.

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

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The following signals must be switched:

I/O signal	Function	Value
MAN_N	Stop the motor Move counter-clockwise	low / open high
MAN_P	Stop motor Move clockwise	low / open high
$\overline{\text{STOP}}$ [1)]	Stop motor with quick stop Operation enablement	low high / open
AUTOM	Manual movement A utomatic operation	low / open high
ENABLE	Power amplifier switched off Power amplifier enabled	low / open high

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

- ▶ Activate manual movement: deactivate the AUTOM input signal.
- ▶ Switch on the power amplifier: activate the ENABLE input signal.
- ▶ Turn motor shaft in clockwise direction: activate input signal MAN_P.

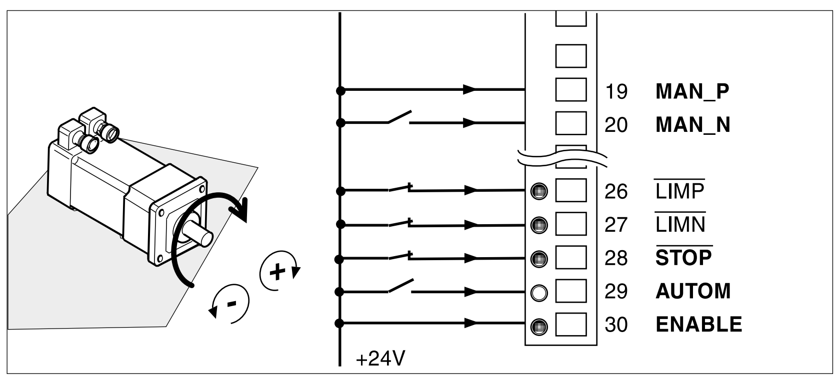

Fig. 5.10 Checking the motor’s direction of rotation

When the MAN_FAST signal is connected, you can choose between fast and slow movement.

For manual movement the preset movement parameters for slow and fast motor speed and for maximum motor current can be changed. Please refer to page 6-10 for detailed information.

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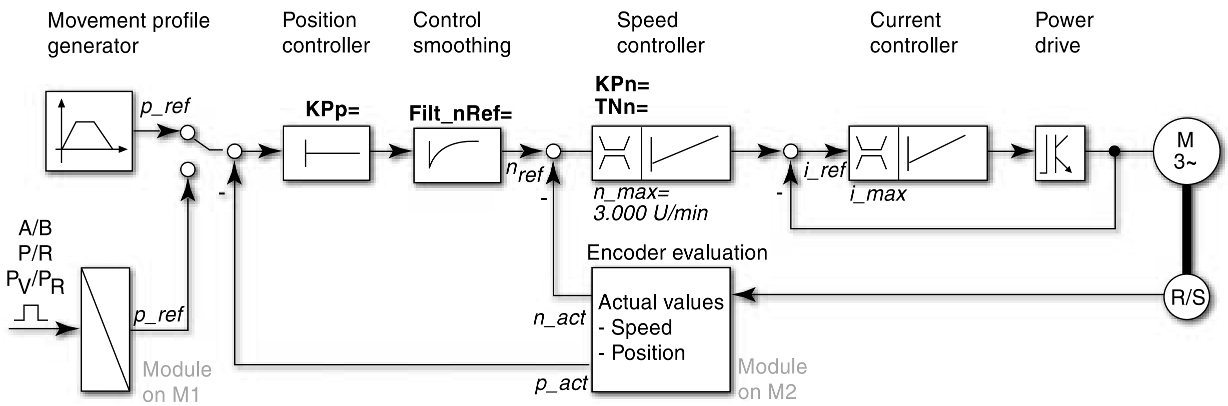
5.5 Optimizing the controller

5.5.1 Controller structure

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

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



Speed controller settings

KPn	P factor
TNn	Reset time
Filt_nRef	Control smoothing

Position controller setting

KPp:	P factor

p_ref	Position setpoint value
p_act	Actual position of motor
n_ref	Speed setpoint value
n_act	Actual speed
n_max	Maximum speed
i_ref	Current setpoint value
I_max	Current limit

Fig. 5.11 Controller structure

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

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

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

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Position controller

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

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

5.5.2 Configuring the optimization utility

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

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

Controller optimization can only be started in manual operation:

▶ If the parameter ‘Settings.IO_mode’=2, the AUTOM signal must be set to LOW via the signal interface.

TL CT: Setting reference signals

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

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

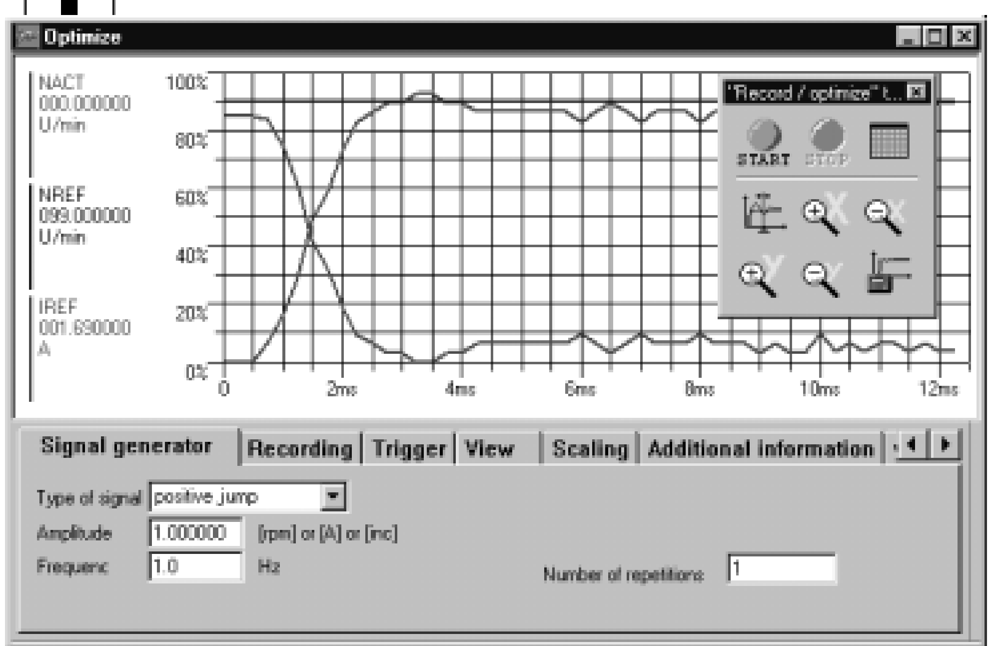

Fig. 5.12 Optimizing with the commissioning software

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

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

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

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

TLCT: Setting signals to be recorded

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

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

  n_act - the actual speed of the motor

  n_ref - the setpoint speed of the speed controller

  I_ref - the setpoint current of the current controller

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

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

TLCT: Inputting controller values

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

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

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

Algorithm for optimizing controllers

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

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

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TLHMI: Setting reference signals

▶ Start the optimization utility via menu '6 Optimize'

▶ Set the reference signal:

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

TL HMI: Setting controller values

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

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

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

Recordings cannot be made with the TLHMI.

5.5.3 Optimizing the speed controller

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

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

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

The speed controller settings are adjusted through the following parameters:

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

Once initial speed controller settings have been determined, check and optimize the values obtained, as described in ‘checking and optimizing default settings’ on page 5-30.

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Determining the mechanics of the system

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

- System with rigid mechanism
- System with less rigid mechanism

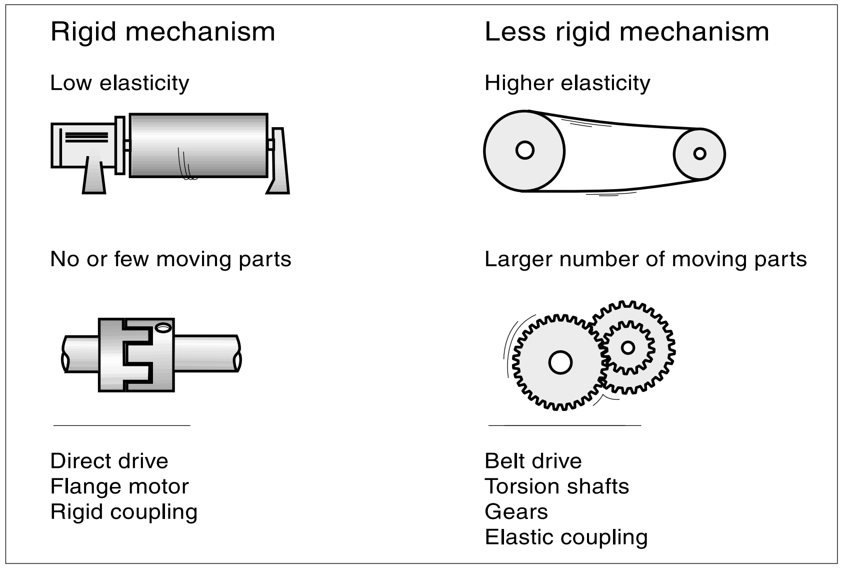

Fig. 5.13 Mechanical systems with rigid and less rigid mechanisms

▶ Connect the motor to the driven machinery.

⚠WARNING

LOSS OF CONTROL

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

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

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

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

Switching off the speed reference filter

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

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

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

5.5.4 Procedure A: Rigid mechanism and known moments of inertia

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

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

Determining controller values

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

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

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

▶ Initiate a jump function.

▶ Check the controller settings as described in 'Checking and optimizing default settings' on page 5-30.

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

5.5.5 Procedure B: Ziegler Nichols

⚠CAUTION

SUSTAINED OSCILLATIONS DURING TUNING

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

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

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

Determining controller values

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

- ▶ Set the reset time 'CtrlBlock1.TNn' to maximum: TN n =327.6 7ms.

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

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

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

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

- ▶ Start a jump function once more if it was necessary to change 'n_ref'. Check the amplitude of ‘I.ref’ during the jump function to ensure that the value is less than ‘CtrlBlock1.I_max’.
- ▶ Increase the P-factor in small steps until 'n_act' reacts with a marked oscillation. **The P-factor is now the same as the critical gain.**

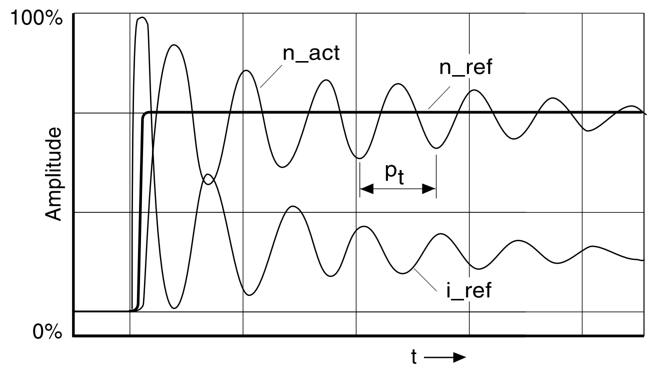

Fig. 5.14 Period of oscillation Pt at critical gain

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

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

  KPn = 0.35 * critical gain

  TNn = 0.94 * period of oscillation P_t

- ▶ Enter the optimized values and check the controller settings as described in 'Checking and optimizing default settings' on page 5-30.

Example

- Start with

  KPn = 0.01 Amin/rev

  TNn = 327.67 ms.

- Increase the KPn to critical gain.
- Critical gain at KPn = 0.0 4 8Amin/rev. Measured period of oscillation P_t = 3 ms.
- From this the optimized values are calculated:

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

5.5.6 Procedure C: Aperiodic limiting case

Determining controller values

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

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

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

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

▶ Initiate a jump function.

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

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

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

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

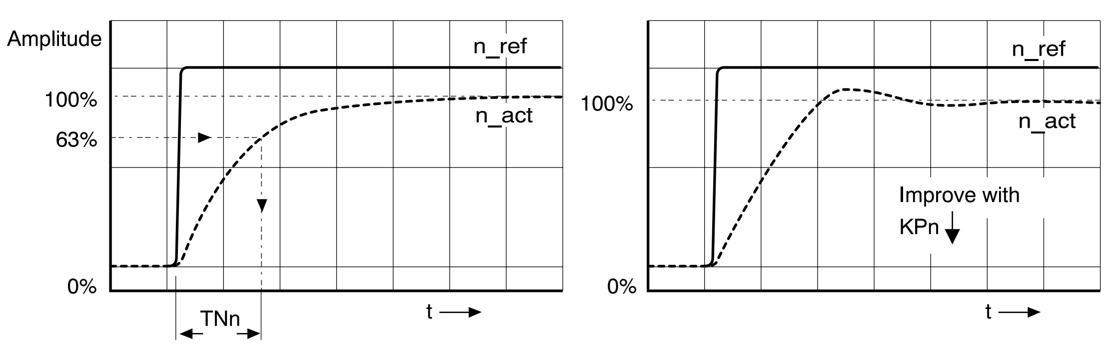

Fig. 5.15 Determining 'TNn' in the aperiodic limiting case

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

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

Graphic determination of the 63% value

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

- ▶ Under the 'Scaling' tab select the channel for 'n_act' and enter the final value of 'n_act' as 100% mark.
- ▶ Determine the point on the recording where the amplitude reaches 63%. Place the cursor on the ‘n_act’ curve at the 63% point and click.
- ▶ If the 'n_ref' jump begins at 0 ms, the time value, ‘TNn’, can be read directly off the status bar under “ABS”.
- ▶ If 'n_ref' begins later than 0 ms, measure the distance from the jump point by setting a reference point at the start of the reference jump and click on the end point. The difference in ms now appears under 'DIFF' on the status bar.
- ▶ Enter this value for 'TNn' and check the controller settings as described in ’Checking and optimizing default settings’ on page 5-30.

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5.5.7 Checking and optimizing default settings

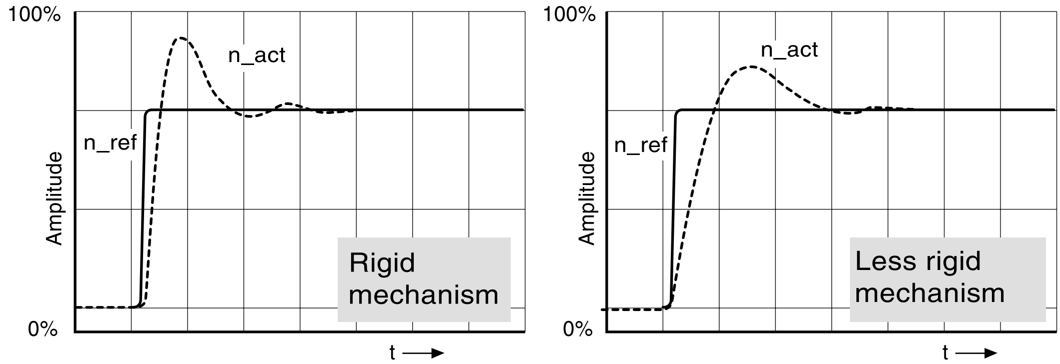

Fig. 5.16 Jump responses with good control response without reference smoothing

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

- Rapid rise time
- An overshoot not exceeding 40% (20% is recommended)

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

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

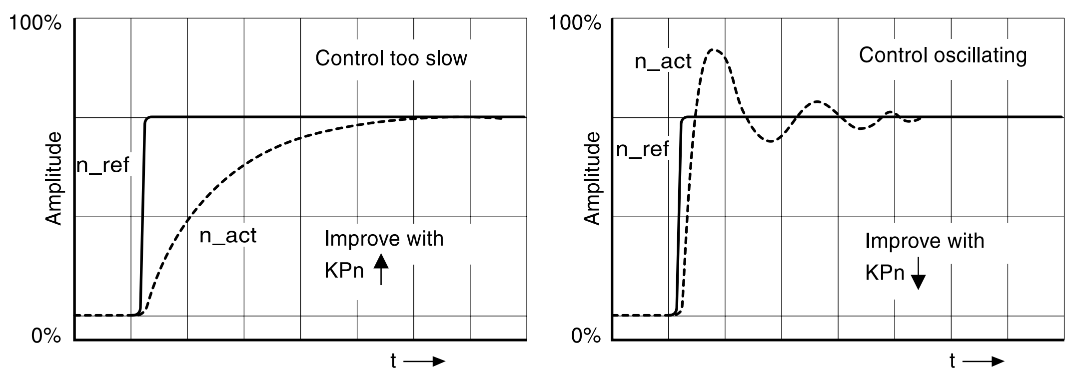

Fig. 5.17 Optimizing poor settings of the speed controller

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

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Effect of the speed reference filter on control response and stability

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

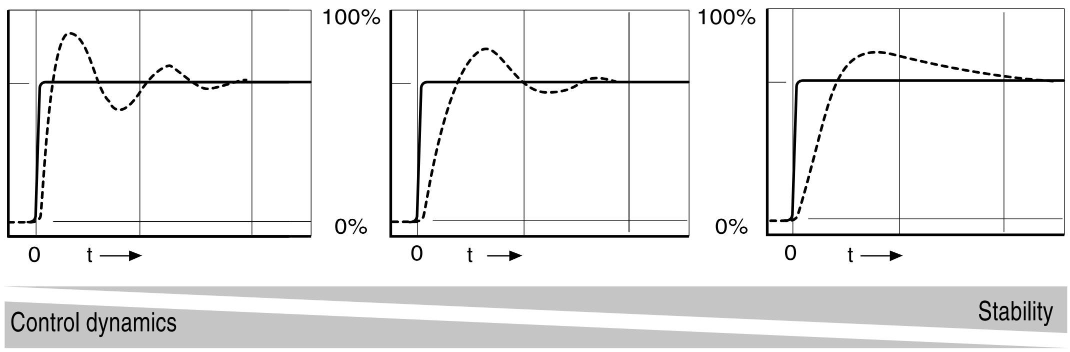

Fig. 5.18 Relationship of control response and stability

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

Switching on the speed reference filter

Determine graphically the point at which the actual speed 'n_act' reaches 63% of the final value. The filter value 'Filt_nRef' may be read off on the time axis as shown in the left-hand part of the following diagram. The method for graphically determining the 63% value is described on page 5-29 (determination of the reset time 'TNn').

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

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

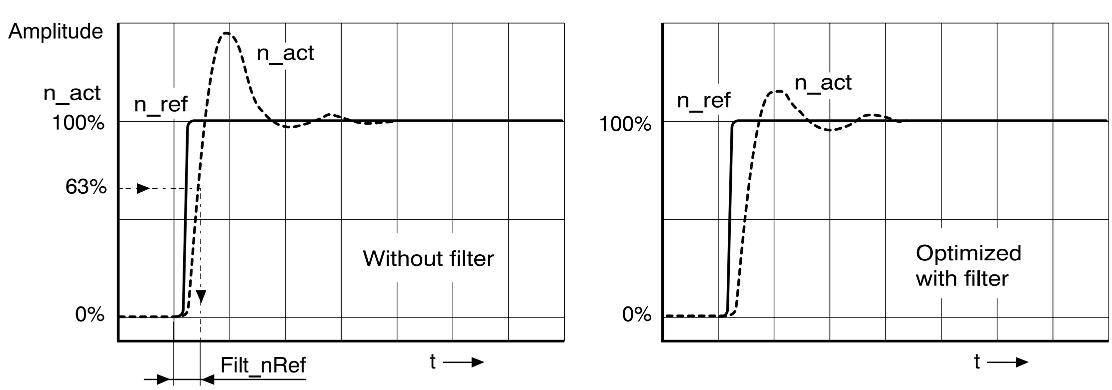

Fig. 5.19 Determining Filt_nRef from the jump response (left). Response with speed reference filter active (right).

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

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5.5.8 Optimizing the position controller

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

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

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

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

TL CT: setting the reference signal

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

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

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

TL CT: Selecting recording signals

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

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

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

TL HMI: Setting the reference signal

▶ Set the reference signal under '6.1 Settings':

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

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

Recordings cannot be made with the with the TLHMI.

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Optimizing the position control value

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

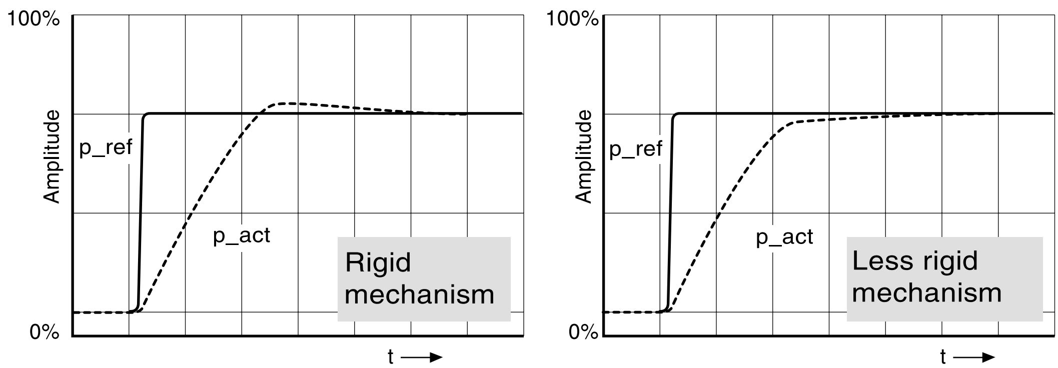

Fig. 5.20 Jump responses of a position controller with a good control response

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

If the control response does not correspond to that shown in Fig. 5.20, change the P-factor 'KPn' in steps of about 10% and then initiate a jump function once again:

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

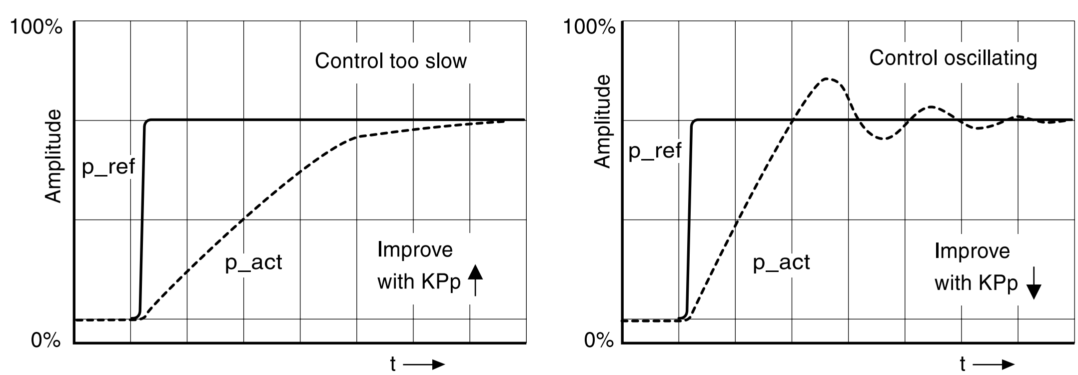

Fig. 5.21 Optimizing poor settings of the position controller

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6 Operating modes of the positioning controller

This chapter contains a description of the programmable 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 TLADOCHMIME.
- For communication cards, refer to each card’s operating manual.
- For commissioning software (TLCT), refer to manual TLADOC TLCTE.

Parameter Name	Idx:Sidx	TL-HMI Address	Explanation and unit [ ]	Range of values	Default Value	R/W rem
PTP.p_absPTP	35:1	3.1.1.1	Starts absolute positioning mode when values are transmitted.	INT32 -2147483648 …. + 2147483647	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

⚠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.

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6.1 Operating modes and access

The controller has five operating modes and two setup modes. These modes are described in detail in the following sections. Access channels are used to provide instructions to the drive controller. The access channel table, shown below, describes the operating modes that can be used with each type of signal interface. Note that the available modes differ between access channel types.

	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	•	–	•
Controller setup	•	–	–

1) •: Access possible, –: No access

6.1.1 Operating modes

Operating modes

The controller functions in five operating modes:

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

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6.1.2 Access channels

Local and remote access

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

- locally, via the RS-232 interface using the HMI hand-held control unit or the TLCT commissioning software
- remotely, via Fieldbus commands
- remotely, via the I/O signals.

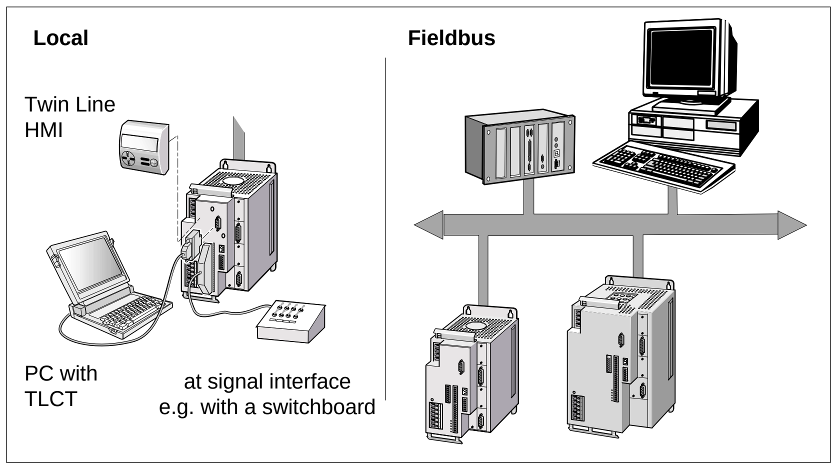

Fig. 6.1 Local and remote access to Twin Line devices

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 local control units or Fieldbus 1: Access via Fieldbus only	0	R/W –

Local channels are available again when the Fieldbus master enables them via this parameter or when Fieldbus operation is interrupted.

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6.1.3 Access control programmable inputs

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

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Settings.IO_mode	29:31	4.4.25	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 functions. Functions are pre-defined.	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.

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

1) •: Access possible, –: No access

IO_mode=2

Connector Pins S1 through S34 are assigned if ‘Settings.IO_mode’ = 2. Operating modes and functions can be initiated locally via the AUTOM input signal or via the Fieldbus.

- AUTOM=0, Low level: locally via HMI hand-held control unit, TLCT commissioning software or signal interface.
- AUTOM=1, High level: via Fieldbus.

The following table shows the possible operating modes depending on the status of the AUTOM signal.

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

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Operating modes and functions [1)]	Access channels TL HMI, TL CT	I/O signal interface	Fieldbus
Referencing	0	–	1
Controller setup	0	–	-

1) “0”: AUTOM=0, “1”: AUTOM=1

If the AUTOM signal changes, the new operating mode will be selected when the current operation has been completed. The controller confirms that the change has taken place via 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 activated operation via Fieldbus activated	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.

The signal interface can be used to switch between manual and automatic mode which is set via parameters. To do so, the signal interface inputs and outputs must be permanently assigned.

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 –

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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 324mm 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 Lin ePosition' menu. Settings can be entered into the dialog box, and the operating mode initiated using the 'PTP' register.

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6.1.5 Monitoring the set operating mode

Status-Parameter

The controller has global and operating mode specific status registers for monitoring detailed operation.

Global information about the controller's operating and processing status is supplied by the "Status.driveStat" status register.

The current operating mode can be monitored by means of status registers or via signal interface outputs.

Parameter 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 Bit 0..3: Actual. 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 Bit 5=1: internal monitoring fault (FltSig) Bit 6=1: external monitoring fault (FltSig_SR) Bit 7=1: warning Bit13: x_add_info Bit14: x_end Bit15: x_err Bit 16-20: current mode (Bit 0–4: Status.xMode_act) Bit 21: drive controller is referenced (ref_ok) Bit 22: drive controller is approaching standstill (see section 7.5). (p_win)	–	R/–

For additional information, see 'Operational status indicators and transitions' on page 8-1.

Global status bits

Status bits (bit 13 - bit 15) in the global status register are copied from the status bits of the operating mode specific status register:

Status bit	Function	Value
Bit 13: x_add_info	Additional information depending on operating mode	Low/High
Bit 14: x_end	Operation running Operation finished, motor stopped	Low High
Bit 15: x_err	Fault-free operation Fault has occurred	Low High

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Operating mode specific status parameters

Each operating mode has its own status register that contains information about the processing status in bits 13 to 15.

For example, PTP operation is as follows:

Parameter 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 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 13: Setpoint reached Bit 14: motion_end Bit 15: motion_err	–	R/–

Status via I/O signals

Evaluation of the operating status via the signal interface can be used when fixed interface assignment has been set.

I/O signal	Function	Value
AXIS_ADD_INFO	Additional information depending on operating mode	Low/High
AXIS_END	Operation running Operation 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 operation initiated, bit 14 changes to ‘0’. When the operation is finished, bit 14 changes back to '1' indicating that further operations can be performed.

When one operation is followed immediately by another operation in a different operating mode, bit 14’s signal change to '1' is suppressed,

If bit 15 shows a '1', a fault has occurred which must be corrected before operation continues. The controller’s reaction is determined by the fault category and severity. See the “Diagnosis and Error Rectification” chapter, page 8-1.

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6.1.6 Status monitoring in movement mode

Status parameters In movement mode the controller can be monitored by means of the registers in the Status register set. These registers are read only.

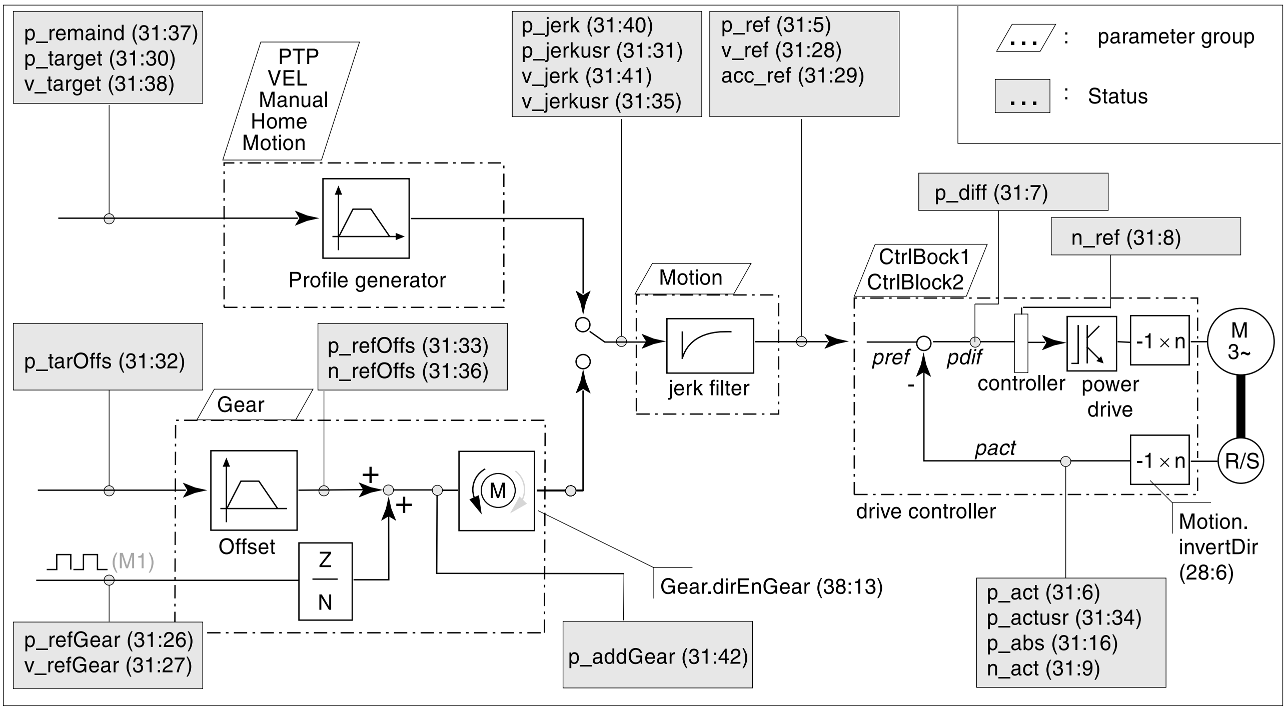

Fig. 6.2 Monitoring movement with status parameters

Parameter groups Each operating mode has an associated parameter group. They are:

- PTP Group: Settings for Point-to-Point operation
- VEL Group: Settings for speed mode
- Gear Group: Settings for the electronic gear operating mode
- Motion Group: Settings for all operating modes: jerk filter, direction of rotation, software limit switches, normalization, and ramp settings.

Option settings for manual mode are located in the “Manual” program group. Homing options are in the “Home” group. A list of all parameter groups is located in the ’Parameters’ chapter on page12-1.

Profile generator Target position and final speed are user input values. The profile generator uses these values to work out a motion profile appropriate for the operating mode selected. Output values from the profile generator and from an upstream jerk filter are converted into motor movements by the drive controller. The jerk filter automatically adjusts user inputs to smooth out motor operation. Additional information on the jerk filter is located in the “Ramp Function” chapter on page 7-17.

In the electronic gear operating mode, positioning values are calculated from input pulses that are 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.

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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 operation can be carried out via the:

- HMI hand-held control unit
- Commissioning software
- Fieldbus
- Signal interface inputs if I/O assignment is fixed

Operation by means of operating software or HMI hand-held control unit

The commissioning software and HMI hand-held control unit support this operating mode by means of special dialog boxes and menu options. Additional details on these functions may be found in the commissioning software and HMI control unit manuals.

Starting manual operation

The starting conditions for manual movement depend on the setting of the signal interface assignment. The setting can be changed using the ‘Settings.IO_mode’ parameter, see page 6-5.

- Free assignment, parameter value ‘Settings.IO_mode’ = 0 or 1: The positioning controller switches to manual movement as soon as the movement is initiated via a control unit or by means of the ‘Manual.startMan’ parameter via the Fieldbus. Manual movement can not be initiated via the signal interface if the interface assignment is free.
- Fixed assignment, parameter value ‘Settings.IO_mode’ = 2: If the input signal AUTOM = 0, manual operation can be initiated via the interface inputs or via a control unit as soon as the AUTOM_ACK output changes to low. If the input signal AUTOM = 1, manual movement can be initiated with the ‘Manual.startMan’ parameter via the Fieldbus as soon as AUTOM_ACK goes high.

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

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

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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 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 travel with transfer of control bits	UINT16 Bit 0: pos. sense of rotation Bit 1: neg. sense of rotation Bit 2: 0:slow 1:fast	0	R/W –
Manual.statusMan	41:2	–	Acknowledgement: manual travel	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/W –

Enabling and starting manual movement via interface signals:

I/O Signal	Function	Value
I: AUTOM	Switch to manual mode Switch to automatic mode	low/open high
O: AUTOM_ACK	Manual mode possible Manual mode not possible	low/open high
I: MAN_N	Movement in negative sense of rotation	high
I: MAN_P	Movement in positive sense 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 operating modes:

- Mode One
- Mode Two

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

Parameter 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 travel	UINT16 0: Mode One 1: Mode Two	0	R/W rem.

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Mode One 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 positioning 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 high and bit 2 high will set a positive direction and fast speed.

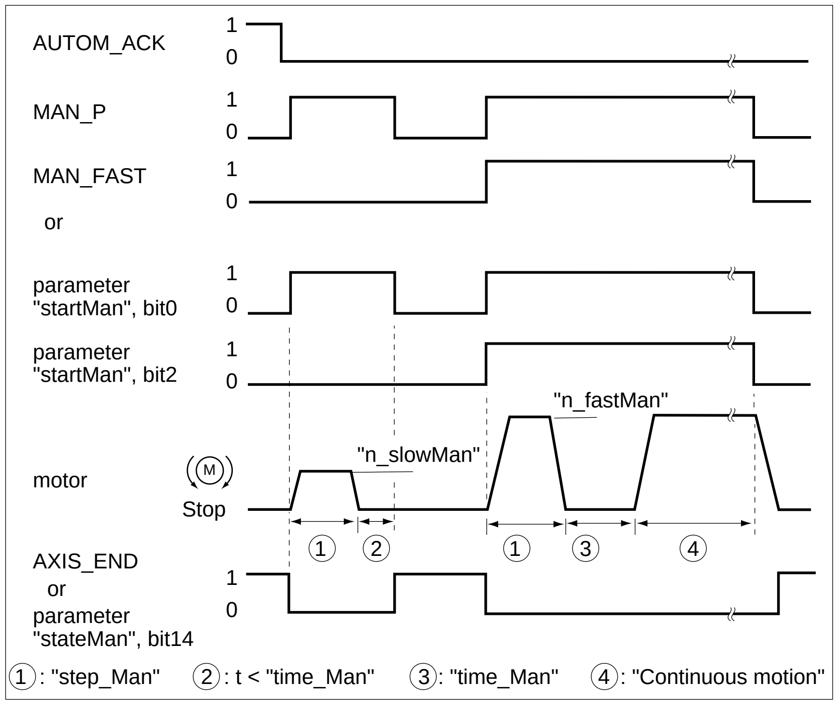

Fig. 6.3 Mode one movement, slow and fast

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 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 positioning controller will stop the motor immediately.

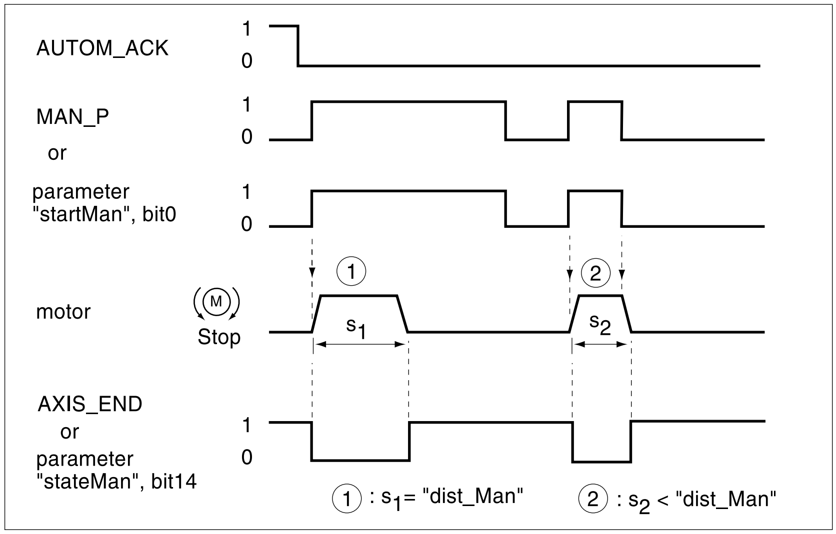

Fig. 6.4 Mode Two manual movement

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

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', 'jerk filter', and 'quick stop’ functions.
- Position-dependent speed or signal changes can be found in the “List control and list data processing” section.
- Creating list data with “Teach-In processing” can be found in “Teach-In processing” section.
- Adapting user-defined and internal units is described in the 'normalizing' section.
- Unit and movement supervision is set using the 'monitoring functions' and 'standstill window' sections.
- Current limitation for manual operation is set via the 'Manual. I_MaxMan' parameter.

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

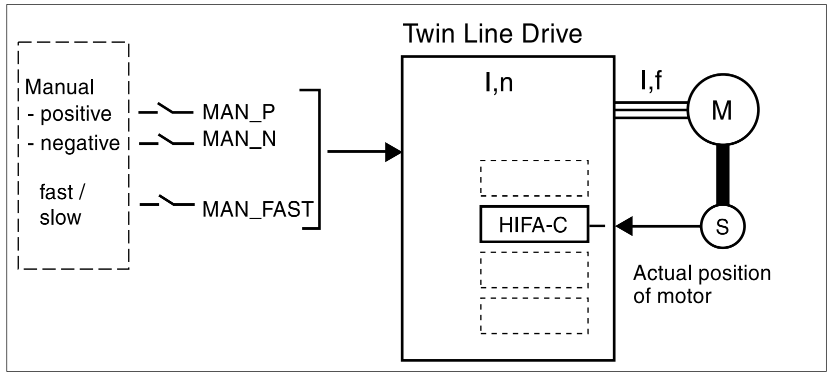

Fig. 6.5 Manual operation via input and output signals

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, movement is initiated at a set speed with no defined finishing point. The motor moves at this speed until a different speed is set or the operating mode is completed.

Speed mode can be carried out via:

- The HMI hand-held control unit
- The commissioning software
- Fieldbus.

Operation via commissioning software or HMI hand-held control unit

The commissioning software and the HMI hand-held control unit support this operating mode through special dialog boxes and menu options. Additional detail may be found in the commissioning software and control unit manuals.

Starting speed mode

As soon as a speed value is communicated to the controller via the 'VEL.velocity' register, the unit changes to speed mode and accelerates to the set speed.

Processing in speed mode is completed when the difference between the set and actual speeds are zero or when the operating mode is interrupted by a fault response. The register “VEL.stateVEL” gives information on the processing status.

Parameter 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	0	R/W –
VEL.StateVEL	36:2	–	Acknowledgement: speed profile mode	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 13: setpoint speed reached Bit 14: vel_end Bit 15: vel_err		R/–

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 positioning area limits.

New ramp settings are transmitted when a speed value is communicated using the 'VEL.velocity' parameter.

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

- Acceleration and delay behavior can be changed using the 'ramp function', 'jerk filter', and 'quick stop' functions.
- Position-dependent speed or signal changes can be found in the “List control” and “List data processing“ sections.
- Creating list data with “Teach-In processing” can be found in “Teach-In processing” section.
- Changing the relationship between user defined and internal units is described in the 'normalizing' section.
- Unit and movement supervision is set using the 'monitoring functions' and 'standstill window' sections.

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.

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

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

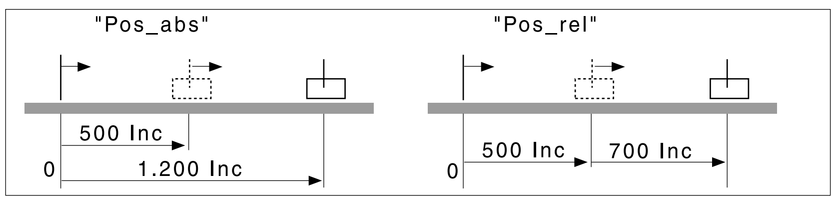

Fig. 6.6 Point-to-point positioning, absolute and relative

PTP mode can be executed via the:

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

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

The commissioning software and HMI hand-held control unit support this operating mode through special dialog boxes and menu options. Additional detail may be found in the commissioning software and control unit manuals.

Initiating PTP mode

As soon as the positioning value is transmitted in the 'PTP.p_absPTP' or 'PTP.p_relPTP' registers, the positioning controller changes to PTP operation, and starts the positioning process at the set speed stored in the 'PTP.v_target' register.

The positioning process is complete 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' register gives information on the state of the operation.

If a different operating mode is active, relative positioning may only be initiated when the motor is at standstill.

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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	Start of absolute positioning with transfer of absolute target position value [usr]	INT32 -2147483648...2147483647	0	R/W –
PTP.StatePTP	35:2	–	Acknowledgement: PTP positioning	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: Setpoint reached Bit14: motion_end Bit15: motion_err	–	R/–
PTP.p_relPTP	35:3	3.1.1.2	Start of relative positioning with value transfer for travel [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 value is not relevant for positioning	–	R/W –
PTP.v_tarPTP	35:5	3.1.1.5	Setpoint speed of PTP positioning [usr]	INT32 -2147483648...2147483647	Motion. v_target 0	R/W –

Continuing PTP operation

If a positioning process is interrupted (by an external stop signal, for example) processing can be continued and completed by writing to the 'PTP.continue' register. The cause of the interruption must first be corrected before operation can resume.

The value transmitted via 'PTP.continue' is not critical; any value may be used.

Settings for PTP operation

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

New ramp settings are applied when the motor starts with a new target position.

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

- Acceleration and delay behavior can be changed using the 'ramp function', 'jerk filter', and 'quick stop' functions.
- Position-dependent speed or signal changes can be found in the “List control” and “List data processing“ sections.
- Creating list data with “Teach-In processing” can be found in “Teach-In processing” section.
- Changing user-defined units and internal units is described in the 'normalizing' section.
- Unit and movement supervision is set using the 'monitoring functions' and 'standstill window' 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 the electronic gear operating mode, the positioning controller calculates a new position setpoint from a predefined position and an adjustable gear ratio. This operating mode is used when one or several motors are used to follow the reference signal from an NC control unit or an encoder.

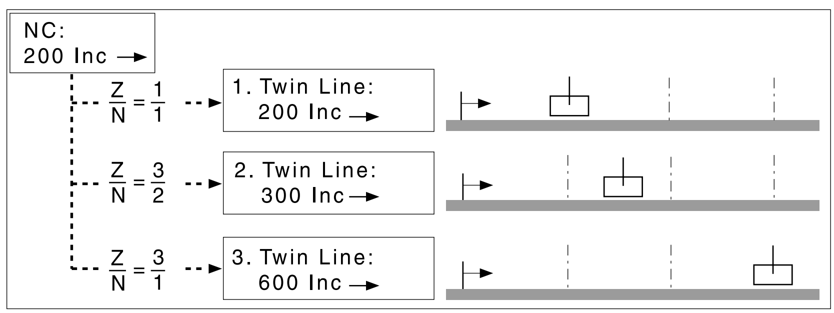

Fig. 6.7 Electronic gear with three Twin LIne units, speed ratio adjustable via gear ratio (Z, N)

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

Electronic gear mode requires the RS-422C encoder module or the PULSE-C pulse-direction module to be inserted in slot M1. Depending on the module, different types of signals can be supplied:

- A/B signals, with four-way evaluation of sensor signals, can be used with the RS-422C module
- Pulse-direction, or pulse forward/pulse backward signals, can be used with the PULSE-C module.

The electronic gear operating mode can be carried out via:

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

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

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

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Initiating electronic gear

This operating mode is switched on via the 'Gear.startGear' register. If reference pulses are supplied, the controller offsets them against the gear ratio and directs the motor to the new setpoint.

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

The process is complete when gear processing has been deactivated and the motor has come to a halt, or when the operating mode has been interrupted. If the controller switches from the operating status 6 ‘Operation enable' to a different status, gear processing is automatically deactivated (for example, when the motor is stopped by quick stop). The 'Gear.stateGear' register gives information on the processing status.

Synchronization

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

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

  There are various conditions attached to synchronization with compensating movement, additional information may be found in ’Synchronization with compensating movement’ on page 6-25.

The type of synchronization used is set by means of the 'Gear.startGear' register. This register also initiates the operating mode.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Gear.startGear	38:1	3.1.1.1	Start of electronic gear ratio processing with selection of processing mode	UINT16 0: deactivated: 1: gear ratio with position referencing activated	0	R/W –
Gear.stateGear	38:2	–	Acknowledgement: gear ratio processing	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 13: gear_sync_window Bit 14: gear_end Bit 15: gear_err	–	R/–

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6.5.1 Gear settings

Overview

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

- Gear ratio
- Current limit
- Speed of travel
- Maximum contouring error (following error)
- PTP offset value
- Direction of rotation enable / disable

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

- Acceleration and delay behavior may be changed with the 'current limitation', 'jerk filter', and 'quick stop’ functions.
- Position-dependent signal changes may be carried out via “list control and list data processing“ functions.
- Creating list data with “Teach-In processing” can be found in “Teach-In processing” section.
- Unit and movement supervision may be set using the 'monitoring’ and 'standstill window’ functions.

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.

A new gear ratio is activated when the numerator value is supplied.

Parameter 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 factor numerator	INT32 -2147483648...2147483647	1	R/W –
Gear.denGear	38:8	–	Gear ratio factor denominator	INT32 1...2147483647	1	R/W –

The resulting positioning motion is dependent on the resolution of the motor used, e.–g.

- 16384 pulses/rev. for Hiperface motors
- 4096 pulses/rev. for resolver motors

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Current limitation

The maximum values for acceleration and deceleration are derived from the current limit. They are not limited by ramp functions as in PTP mode, for example. To protect the drive system, the current limit must be set, using the following registers, to match the system that has been constructed:

Parameter	Description	Additional Information
CtrlBlock1/2.I_max	Acceleration/Deceleration in the electronic gear operation mode	’Setting device parameters’ chapter, page 5-11.
	Deceleration during quick stop, if "Settings.SignQstop“= 0	’Quick stop function’, chapter, page 7-19
Settings.ImaxSTOP	Deceleration during quick stop, if "Settings.SignQstop“= 1	’Quick stop function’, chapter, page 7-19
	Deceleration if error with error class 1 or 2 occurred	’Diagnosis and error rectification’ chapter, page 8-1

Speeds

The maximum speed in electronic gear mode is set by means of 'Gear.n_maxGear'. Speed normalization is not provided.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Gear.n_maxGear	38:5	3.1.3.3	Max. speed [rpm]	INT32 1..12000	3000	R/W rem.

Contouring errors (following errors)

If the pulse frequency at the setpoint input changes too quickly, the drive controller will not be able to follow a positioning setpoint. A temporary contouring error results. To prevent this contouring error from leading to a power amplifier trip, the contouring error threshold value must be set. See ’Following error monitoring’ on page 7-29.

Direction enabling

Direction enabling prevents any movement opposite to the desired direction of travel. This condition might occur during compensating or offset movements. Direction enabling is set by means of the 'Gear.dirEnGear' register.

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

TLADOCC53ME, -000, 08.02

Example gear processing

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

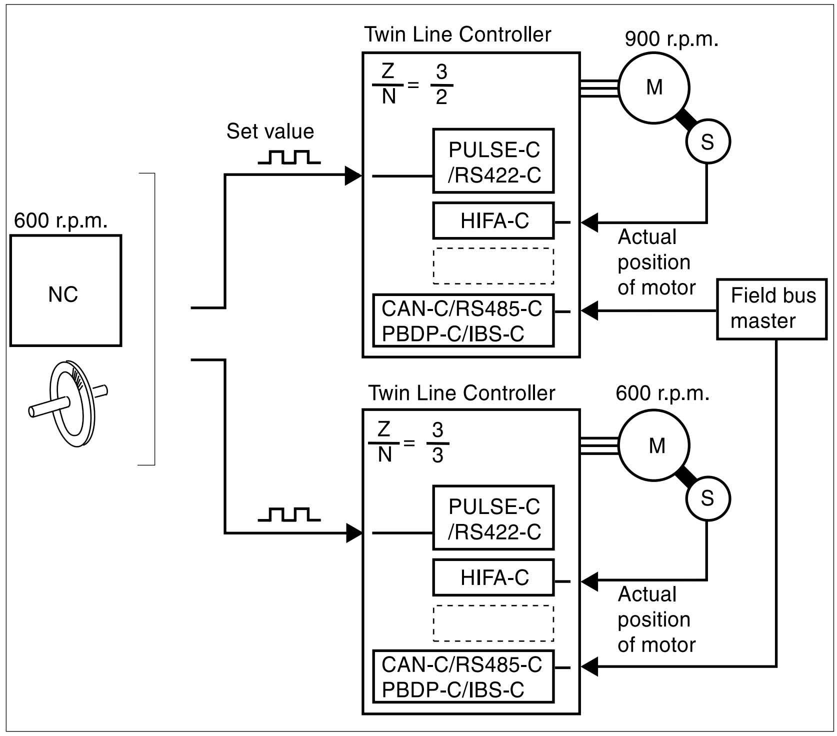

Fig. 6.8 Electronic gear with setpoint preset via NC control unit or encoder

6.5.2 Synchronization with compensating movement

Synchronization with compensating movement can be used to uncouple and recouple the positioning controller for a short time in a coupled gear system. This action can take place without losing synchronization with the other gears. In making its compensating movement, the positioning controller takes into consideration all reference pulses, position changes, and offset entries that have occurred during the interruption, and attempts to move to the exact position that it would have reached without the interruption.

Conditions for a compensating movement

The positioning controller can be uncoupled from synchronous operation by means of 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.

Starting a compensating movement

The electronic gear operating mode with compensating movement is initiated by means of the 'Gear.startGear' = 2 parameter.

When activated, the positioning controller attempts to catch up as quickly as possible with accumulated reference pulses. It is limited by the maximum current 'CtrlBlock1/2.I_max' and the maximum speed parameter, 'Gear.n_maxGear'. When gear processing is activated, the control deviation caused by the accumulated pulses may not exceed the contouring error threshold parameter, 'Settings.p_maxDiff'. Otherwise the positioning controller will signal a contouring error.

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Determining positional deviation

The positional deviation during gear processing can be determined by comparing parameters 'Status.p_addGear' and ' Status.p_ref'.

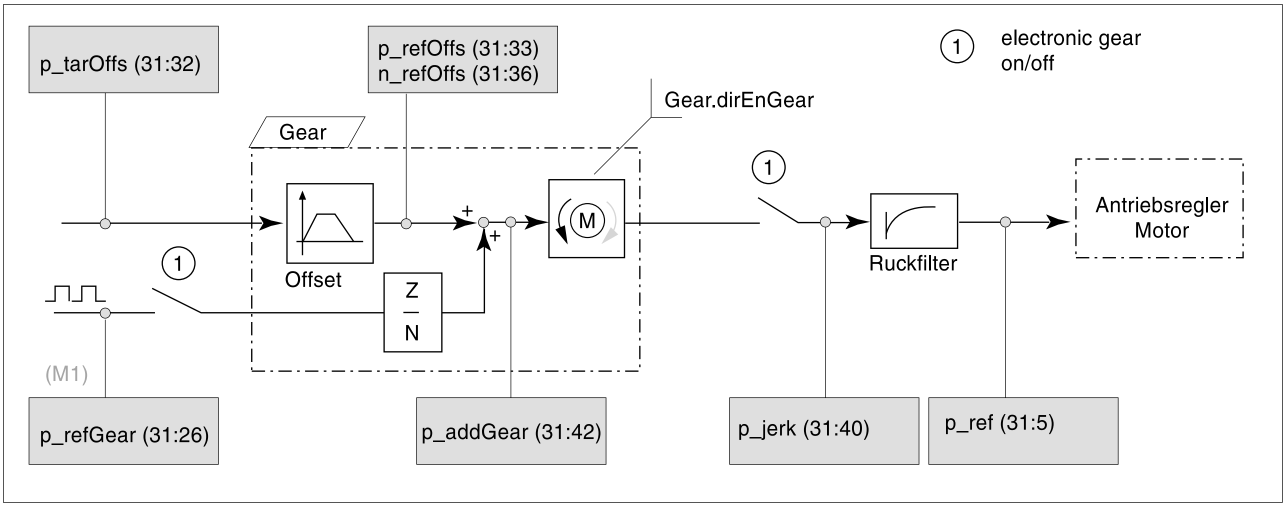

Fig. 6.9 Parameters for establishing positional deviation

If electronic gear mode has been deactivated, register 'Status.p_addGear' is no longer updated. Positional deviation can then be determined by means of the positional value 'Gear.p_refGear' at the gear input, and the gear ratio.

Direction presets

Before gear processing is activated, the direction of any compensating movement can be preset by means of the 'Gear.dirEnGear' register. To ensure that the direction is correctly enabled, the direction enabling function must be taken into consideration. Uni-directional control can be set via the 'Motion.invertDir' parameter.

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6.5.3 Offset positioning

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

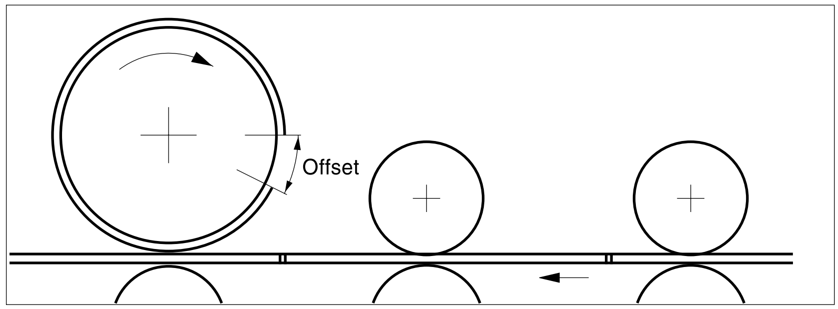

Fig. 6.10 Offset for bridging an empty area when printing

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 are, therefore, subject to the type of encoder used.

The 'State' register gives information on the state of the operation.

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

Settings Similar to PTP positioning, offset movements are defined as a linear ramp profile with acceleration and deceleration ramps as well as a final speed. The offset movement is added to the incoming pulse register (p_refGear).

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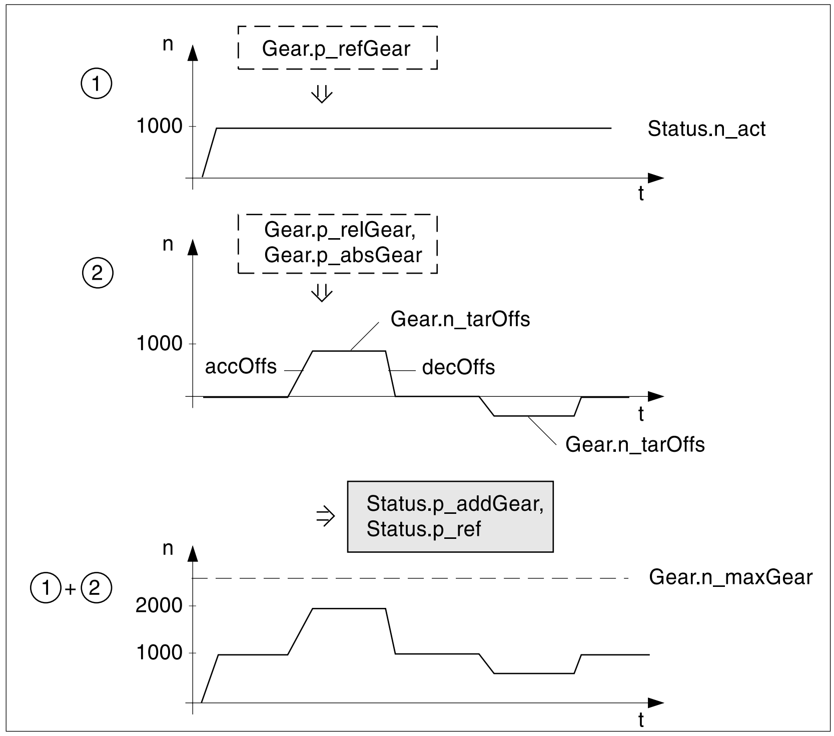

Fig. 6.11 Constant movement with superimposed offset positioning

If gear processing has been deactivated, the offset value is immediately applied to the reference pulses with no limitation from offset ramp values. This function may be used to adjust for PTP movement that was commanded while gear mode was deactivated.

Dimension setting

The operator is able to switch freely between absolute and relative movement. The positioning area of an absolute value can be set to a defined value by means of 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' register. The current position value and speed can be determined via 'Status.p_refOffs' and 'Status.n_refOffs' registers.

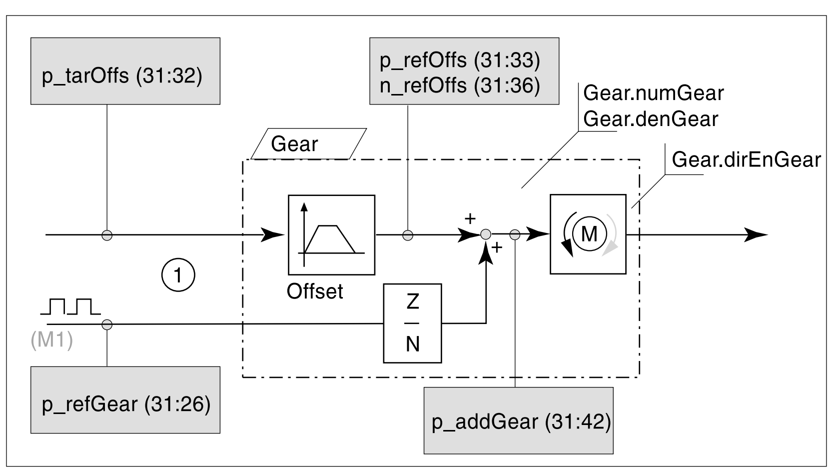

Fig. 6.12 Supervision of offset positioning

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Parameter 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	INT32 -2147483648...2147483647	0	R/W –
Gear.stateOffs	39:2	–	Acknowledgement: offset positioning	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 13: offset set position reached Bit 14: offset_motion_end Bit 15: offset_motion_err	–	R/–
Gear.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 –
Gear.n_tarOffs	39:5	3.1.3.8	Setpoint speed of offset positioning [Inc]	INT32 -12000..12000	60	R/W –
Gear.phomeOffs	39:6	3.1.3.9	Sizing in offset positioning [Inc]	INT32 -2147483648...2147483647	0	R/W –
Gear.accOffs	39:7	-	Acceleration ramp for offset positioning [r.p.m/s]	INT32 60..2.000.000	600	R/W –
Gear.decOffs	39:8	-	Deceleration ramp for offset positioning [r.p.m/s]	INT32 60..2.000.000	600	R/W –

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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 operating mode, an absolute motor reference scale is established in relation to a defined axis position. Referencing is possible by means of:

- Reference movement or
- Dimension setting.

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

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

Referencing operating mode can be carried out via the:

- HMI hand-held control unit,
- Commissioning software
- Fieldbus.

Operation with the commissioning software or HMI control unit

The commissioning software and the HMI control unit support this operating mode with special dialog boxes and menu options. Detailed operation is described in the commissioning software and HMI control unit manuals.

Referencing with parameters

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

- Reference movement, using 'Home.startHome'
- Dimension setting, using 'Home.startSetP'

The 'Home.StateHome' register gives information on the state of the operation.

Successful referencing is indicated by bit 5, 'ref_ok'= 1 in the 'Status.xMode_act' register.

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6.6.1 Reference movement (Homing)

The positioning 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 $\overline{\text{LIMP}}$
- 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 LIMN, LIMP, and 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.

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

The level of the REF reference switch can be inverted using bit 3 in the "Settings.SignLevel" register.

Parameter 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 operating mode referencing	UINT16 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 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: ref_end Bit 15: ref_err	–	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 run-out travel and safety distance [usr]	INT32 -2147483648...2147483647	6	R/W rem.
Home.p_outHome	40:6	3.3.5	Run-out distance, is automatically approached when reference is found [usr]	UINT32 0: Run-out disabled >0: Run-out distance [usr]	0	R/W rem.
Home.p_disHome	40:7	3.3.6	Safety distance of switching edge to reference point	UINT32 0...2147483647	200	R/W rem.

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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 operating modes, a reference movement must be completed before the operating mode may be changed.

Further settings and functions for this operating mode may be found under:

- Adapting user-defined units and internal units with 'normalising'.

Example 1 Reference movement towards limit switch

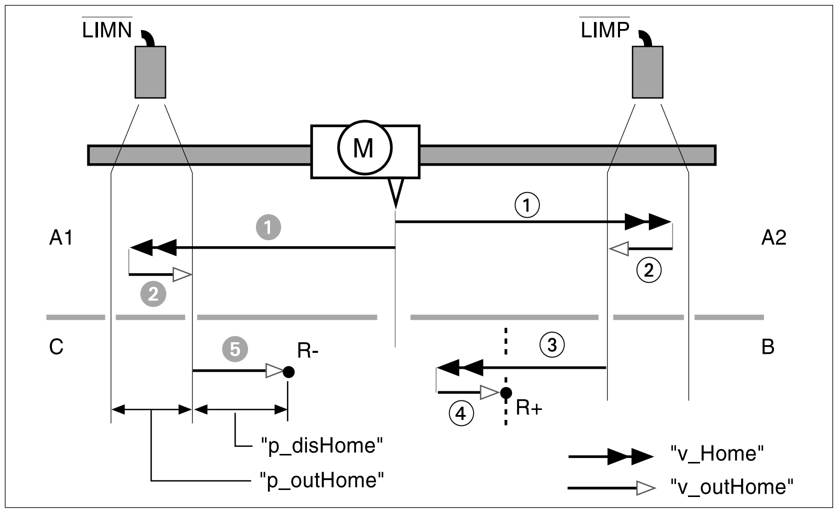

Fig. 6.13 Reference movements to limit switch with movement to index pulse and to safety gap

Movement to the positive limit switch (A2) with index pulse (B), reference point is 'R+'

1. Movement at search speed 'Home.v_Home' to $\overline{\text{LIMP}}$ limit switch
2. Movement to the switching edge at clearance speed 'Home.v_outHome'
3. Movement to the index pulse at search speed
4. Movement to the index pulse at clearance speed

Movement to negative limit switch (A1) with additional safety gap (C), reference point is 'R-'

5. Movement at search speed 'Home.v_Home'
6. Movement to switching edge at clearance speed 'Home.v_outHome'
7. Movement to distance 'Home.p_disHome' at clearance speed.

Example 2 Reference movement to reference switch

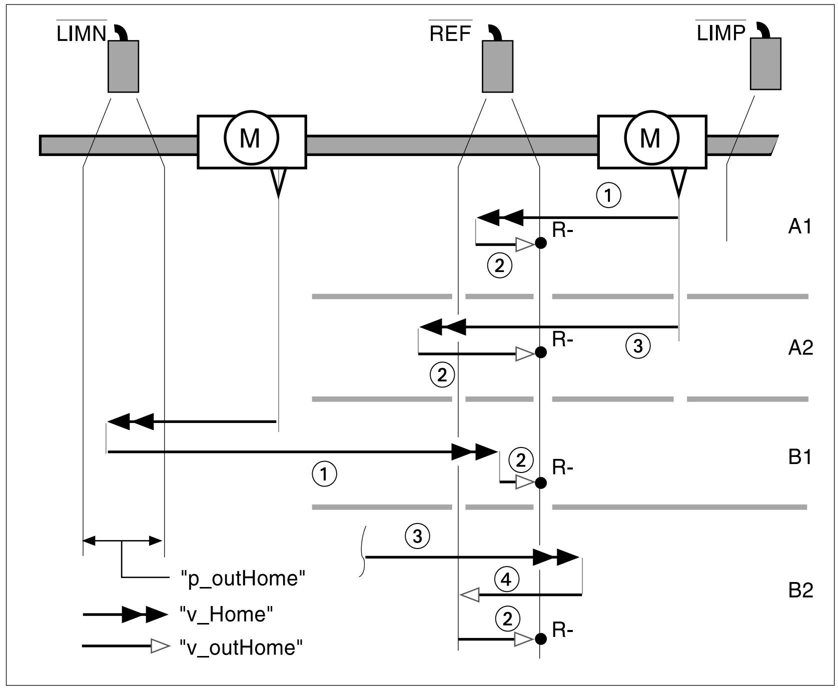

Fig. 6.14 Reference movement to reference switch with first movement in negative sense of rotation

Movement to the reference switch with the first movement in a negative direction, REF switch first in front of (A1, A2) then behind the starting point (B1, B2), reference point is 'R-'

Additional movements when travelling through switching window (A2, B2).

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 to first switching edge at clearance speed

6.6.2 Dimension setting

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

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 Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Home.startSetp	40:3	3.3.2	Set current and reference position (set absolute position) [usr]	INT32 -2147483648...2147483647	0	R/W –
Home.stateHome	40:2	–	Acknowledgement: referencing	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: ref_end Bit 15: ref_err	–	R/–
Status.xMode_act	28:3	2.3.5.5	Current axis operating mode with additional information	UINT16 Bit 0..4: Actual operation mode Bit 5=1: Controller is referenced ('ref_OK')	–	R/– –

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

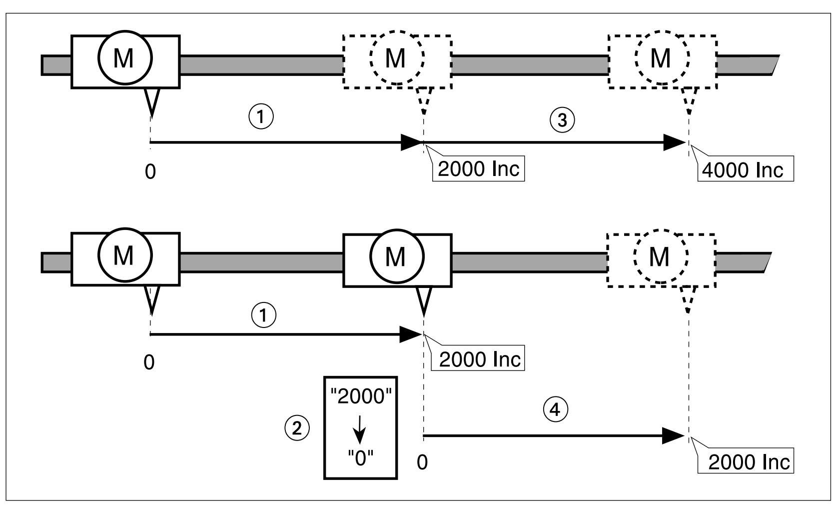

Fig. 6.15 Positioning by 4000 increments with and without dimension setting

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- The motor positions 2000 incs (1) with the start on the reference point.
- By calling up referencing by dimension setting, the current position is set to the scale position in user-defined units (2).
- New movement command by 2000 incs is triggered
  - new target position without dimension setting (3): 4000 incs
  - new target position with dimension setting (4): 2000 incs.

By this method, crossing absolute position limits during a positioning operation is avoided, as the zero point is continuously tracked.

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7 Functions of the controller

7.1 List control and list processing

Overview

List control and list processing establish automated functions within the controller. Two types of lists are used: position / speed lists and position / signal lists. Position / speed lists consist of a sequential list of positions and speeds. When this list is used a complex series of speeds can be established during the movement from one position to another. Position / signal lists define output signals which are transmitted as the controller moves from one position to another. Detailed operation is described below.

▶ Position/speed list

Operates in PTP and VEL modes

Comparison value: Status.p_jerkusr

▶ Position/signal list

Operates in PTP, VEL, manual, and electronic gear modes

Comparison value: Status.p_actusr

When the motor moves to the current value located in the list, an interface signal is changed or a new speed value is activated.

The controller can store two separate lists with 64 entries. A list type must be assigned before values can be input.

- Position / speed list: A separate speed is stored in this list for every position entry.
- Position / signal lists: A dedicated output pin (TRIGGER) will change to the programmed state of every entry in the position list.

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 7-5.

initiating list-driven operation

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. The list may be restarted by selecting the starting and finishing positions, all list entries remain set.

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Monitoring list-driven operation

The processing status in list-driven mode can be evaluated via two registers. Bit14 (“List quit”), in the “List.stateList” register, gives global information on the status of the function:

- 0: list-driven mode active
- 1: list-driven mode completed

The register “List.actList” gives detailed information on the processing status. It displays the last activated list position.

- -1: no list entry yet activated
- 0 ... 63: last activated entry

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	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 deactivated.	UINT16 0: deactivate list control 1: activate list 1 2: activate list 2	0	R/W –
List.stateList	44:2	–	Acknowledgment and status: List data processing	UINT16 Bit 15: list_err Bit 14: list_quit 0: list-driven operation active 1: list-driven operation completed Bit 0,1: - 0: no list active - 1: list 1 active - 2: list 2 active	–	R/– –
List.actList	44:18	–	last activated list	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 (requires 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 (requires finishing number > starting number)	UINT16 0...63	63	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 (requires 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 (requires finishing number > starting number)	UINT16 0...63	63	R/W rem.

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Processing list data

List entries in the non-active list can be changed before and during list driven operation either manually, with the Fieldbus function, or with the Teach-In function.

The following items must be considered when changing list values:

- The controller stores position and speed values in user-defined units.
- List entries are selected via list numbers and evaluated in ascending sequence. 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 to the whole list. The list type cannot be changed within a list.

Entries in both lists can be accessed via parameter groups 'L1Data0' to 'L1Data63' for list 1 and 'L2Data0' to 'L2Data63' for list 2.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
L1Data0.typeList1	1100:1	7.3.1.1	List 1: list type for ALL 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 -21474834648..2147483647	0	R/W rem.
L1Data0.signList1	1100:3	7.3.2.3	List 1: signal state	UINT16 0, 1	0	R/W rem.
L1Data0.velList1	1100:4	7.3.2.4	List 1: setpoint speed [usr]	INT32 -'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.
L2Data0.typeList2	1200:1	7.4.1.1	List 2: list type for ALL following list entries (1202:x...1263:x)	UINT16 1: pos./signal 2: pos./speed	1	R/W rem.
L2Data0.posList2	1200:2	7.4.2.1 7.4.2.2	List 2: position [usr]	INT32 -21474834648..2147483647	0	R/W rem.
L2Data0.signList2	1200:3	7.4.2.3	List 2: signal state	UINT16 0, 1	0	R/W rem.
L2Data0.velList2	1200:4	7.4.2.4	List 2: setpoint speed [usr]	INT32 -'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.

Example of position / signal list

In the example below, list-driven operation begins with a point-to-point positioning command that is 510 mm from the reference point and with a speed of 100 r.p.m. Trigger pulses are sent at the positions shown. Position normalization is set for 1 user-defined unit to equal 1mm.

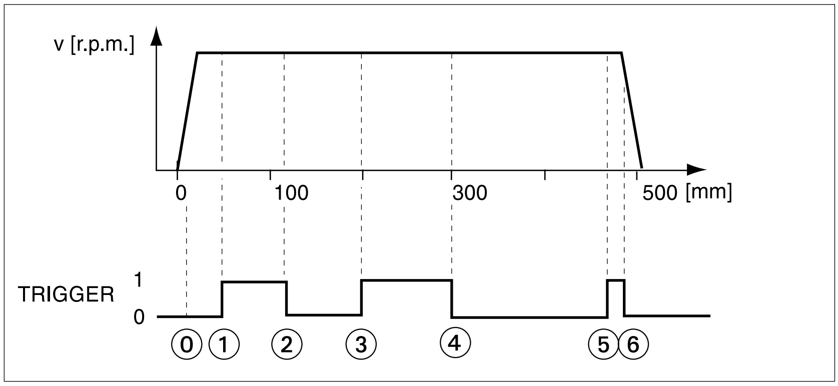

Fig. 7.1 Positioning with position / signal list

▶ Positioning values for list processing should be located between the starting and finishing positions, and may be entered manually, via Fieldbus, or via Teach-In function.

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Example list:

Reference point (Fig. 7.1)	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 when using the position/ signal list.

Example of command sequence

▶ Define the starting position within the list as position 0 using "List.bgnList1“= 0 (Lst.Nr.1100.x)

▶ Define the ending position within the list as position 6 using "List.endList1“= 6 (Lst.Nr.1106.x)

▶ Activate list 1 with 'List.startList'=1

▶ Initiate positioning process.

The trigger signal will be changed when the position from the list corresponds to the current position of the motor pick-up. (Note: See “Triggering accuracy).

Triggering the trigger signal

Successive trigger signals must be at least 3 ms apart. If smaller intervals are commanded, a trigger signal error of several milliseconds may occur.

Triggering accuracy

The accuracy of the trigger signal is influenced by hardware and software dependent factors.

- Accuracy may be affected by hardware causes, such as temperature, power supply, or output load. (Error: max. +/-20 µs.)
- Accuracy may be affected by software latency. (Error: max. +/-30 µs, at low speeds +/- 5 Inc.)

Trigger signals are shifted by an additional factor during an acceleration or deceleration phase (as compared to the trigger point during a constant speed phase).

Example at 10000 rev/(min*s):

- Acceleration: triggering 12 µs later
- Braking: triggering 12µs earlier

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Trigger level

The default level of the trigger signal is set via the “I/O.OutTrig” register. This is used to set the first trigger level after the start of list processing or after list processing has been interrupted.

The register can only be changed if no list processing is active.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
I/O.OutTrig	34:9	–	Setting trigger output when signal list is inactive	UINT16 0: Low level 1: High level	0	R/W –

Example of position / speed list

List-driven operation is carried out using an absolute positioning process from the reference point to the 6,000 incs position. The starting speed is 100 r.p.m.

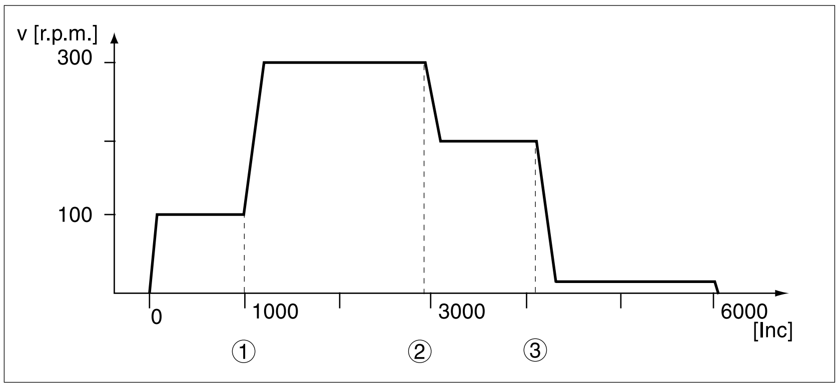

Fig. 7.2 Positioning with position / speed list

Example list:

Reference point (Fig. 7.1)	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.

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Example of command sequence

- ▶ Activate position / speed list mode by setting ’L2Data0.typeList2’ = 2.
- ▶ Enter data list position values between the starting and finishing points manually or by using TLHMI, TLCT, Fieldbus, or byTeach-In.
- ▶ Define the starting position within the list as position 5 using ’List.bgnList2’= 5 (Lst.Nr.1205.x)
- ▶ Define the ending position within the list as number 7 using ’List.endList2’=7 (Lst.Nr.1207.x)
- ▶ Activate list 2 using 'List.startList'=2
- ▶ Initiate positioning.

The change in speed is triggered when the position from the list matches the profile generator position monitored in register “Status.p_jerkusr.”

Triggering time

The positioning controller checks at intervals of 1 ms to see if a setpoint requiring a new speed value has been reached.

The trigger times must be at least 1 ms apart, or triggering of the next speed change is delayed by 1 ms.

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7.2 Teach-In processing

Overview

Teach-In processing provides the chance to register current position values by moving the motor, and copying them to a previously assigned memory area. The size of the available memory depends on the extent of the free list memory. If the list is empty, up to 64 position entries can be stored.Teach-In processing can be carried out via:

- HMI hand-held control unit
- Commissioning software
- Fieldbus
- Signal interface inputs

Data are stored in a position / signal list or in a position / speed list. List values for speed or signal status can be added to using:

- HMI hand-held control unit
- Commissioning software
- Fieldbus.

The positioning controller reads the position values as absolute values in user-defined units.

Operation controlled by commissioning *software or HMI hand-held control unit*

The software and the HMI unit support this operating function with special dialogue boxes and menu items. For more details on this operating function, please refer to the Twin Line Commissioning software and Twin Line HMI manual.

InitiatingTeach-In processing

The following are the requirements for initiatingTeach-In processing:

- Axis position defined by referencing or encoder position recorded on initialization
- Output switched on and ready
- Motor in the positioning area
- Motor at standstill
- ForTeach-In via signal interface: ‘Settings.IO_Mode’=2

BeforeTeach-In processing of list positions, the position/signal list or position/speed list type must be set, and list 1 or 2 selected.

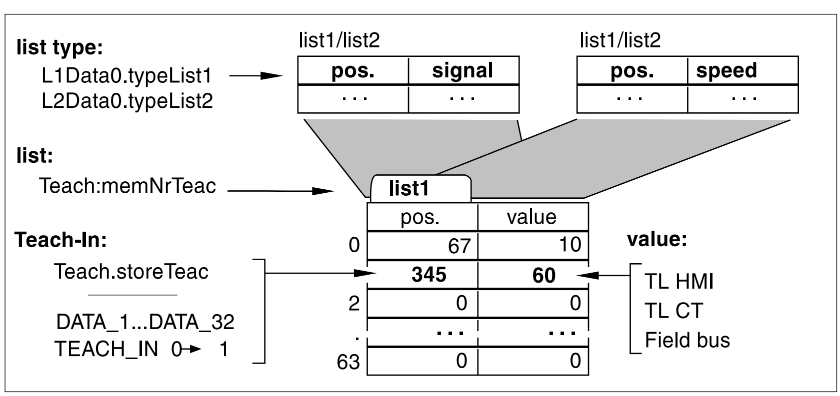

Fig. 7.3 List setting

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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.

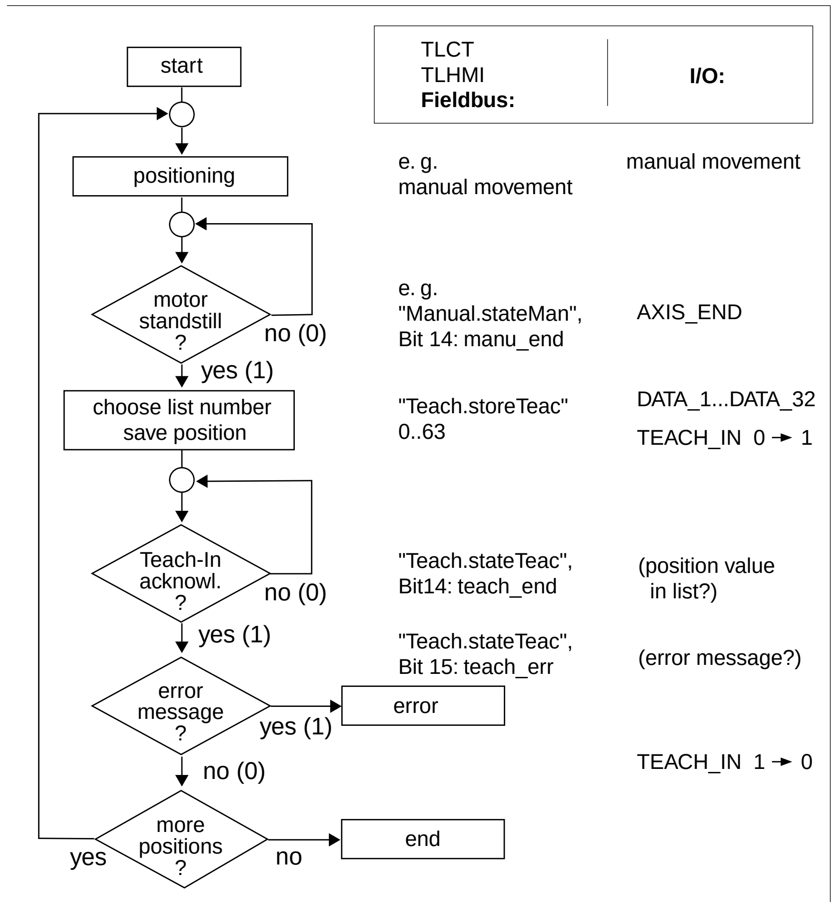

Fig. 7.4 Teach-In process

After each positioning process, the list data can be changed directly or via a connected input device.

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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 unit [ ]	Range of values	Default-Value	R/W rem.
Teach.storeTeac	43:1	–	Teach-In processing, select memory address, list number for storing position value Example: 000010: list number 2	UINT16 0...63 Bit 0..5: list number	0	R/W –
Teach.stateTeac	43:2	–	Acknowledgement:Teach-In processing	UINT16 Bit15: teach_err Bit14: teach_end	–	R/– –
Teach.memNrTeac	43:3	–	List forTeach-In processing	UINT16 1: List 1 of list processing 2: List 2 of list processing 3: set data	1	R/W –
Teach.p_actTeac	43:4	–	current motor position inTeach-In processing [usr]	INT32	–	R/– –
L1Data0.typeList1	1100:1	7.3.1.1	List 1: list type for ALL following list entries (1101:x...1163:x)	UINT16 1: pos./signal 2: pos./speed	1	R/W rem.
L2Data0.typeList2	1200:1	7.4.1.1	List 2: list type for ALL following list entries (1202:x...1263:x)	UINT16 1: pos./signal 2: pos./speed	1	R/W rem.

Teach-In 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.

Before saving the position, the list number must be set via the DATA_1 to DATA_32 inputs.

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 Inputs not given are zero.	low/open

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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 normalization of the motor position/commutation sensor cannot be changed by the user.

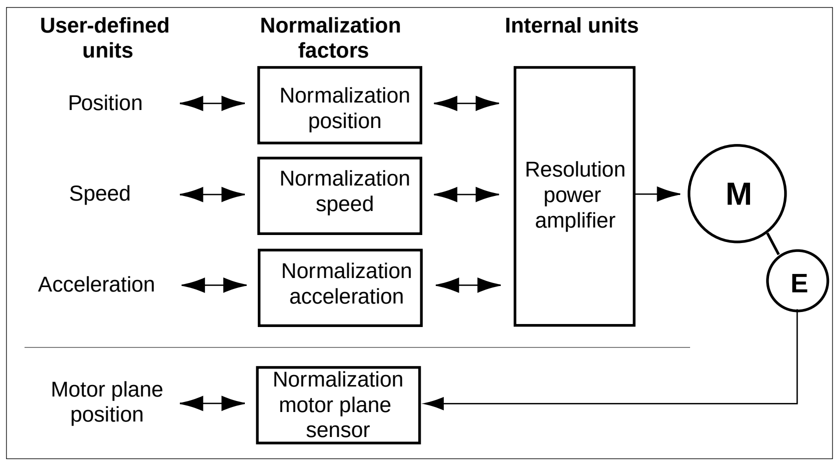

Fig. 7.5 Normalization

7.3.1 User-defined units and normalization factors

User-defined units

User defined units establish a relationship between user program entries and actual motor movement. Initially these values are set to a base (or default) relationship. This relationship may be changed by modifying normalization factors.

Normalization factors are initially set to default ratios that match standard definitions or that relate to the physical hardware. The initial settings are:

- Position values are set to the resolution of the motor encoder. For a SinCos with 16384 incs/revolution, the default will be set to (1/16384) rev = 1 usr
- Speed values are set to a r.p.m. multiple, the default is 1 r.p.m. = 1 usr
- Acceleration values are set to a multiple of the velocity per second, the default is (r.p.m) / s = 1 usr.

Normalization factors

The relationship of a user-defined unit to a motor revolution may be changed by means of the normalization factors.

Normalization factors are set using registers. Each normalization factor is given as a fraction with numerator and denominator. A new factor is set by specifying the numerator.

When normalization factors are entered 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.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Motion.pNormNum	29:7	4.4.20	Position calibration numerator	INT32 -2147483648..2147483647	1	R/W rem.
Motion.pNormDen	29:8	–	Position calibration denominator	INT32 -2147483648..2147483647	16384	R/W rem.
Motion.vNormNum	29:9	4.4.21	Speed calibration numerator	INT32 1..2147483647	1	R/W rem.
Motion.vNormDen	29:10	–	Speed calibration denominator	INT32 1..2147483647	1	R/W rem.
Motion.aNormNum	29:11	4.4.22	Acceleration calibration numerator	INT32 1..2147483647	1	R/W rem.
Motion.aNormDen	29:12	–	Acceleration calibration denominator	INT32 1..2147483647	1	R/W rem.

After the normalization factors have been changed, all related usr values must also be changed in order to obtain the same motor behavior. This applies to user-defined values that are internal to the controller, or external values located in any master devices.

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.

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7.3.2 Setting normalization factors

Normalization factor, positioning

Additional normalization considerations are described in the example below. These examples assume a motor resolution of 16384 increments per revolution.

The positioning normalization factor links the number of motor revolutions for an axis positioning operation to the number of user-defined units required for it.

$$\text{Normalization factor for positioning} = \frac{\text{Revolutions [rev]}}{\text{User-defined unit [usr]}}$$

Fig. 7.6 Normalization factor for positioning process

Three different situations must be considered when setting user-defined units:

1. The user-defined resolution corresponds to the motor resolution. For example, 1 motor revolution = 16384 user-defined units. In this situation, any motor position can be reached.
2. The user-defined resolution is higher than the motor resolution. For example, 1 motor revolution is equal to 16384 increments, and 1 revolution is defined as equal to 32768 user-defined units. In this case, the motor can only move in increments of two usr increments.
3. The user-defined resolution is lower than motor resolution. For example, 1 motor revolution is equal to 16384 increments, and 1 revolution is set equal to 4096 user-defined units. In this case the motor can only move in increments of four motor increments.

In order to achieve the same positioning movement from the motor after the positioning normalization factor has been changed, the following non-volatile 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'.

Referencing parameters Home.p_disHome and Home.p_outHome must be adjusted correctly or an error in referencing movement may occur. If this occurs, the parameter values should be increased.

⚠ 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.

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Example 1 Setting 1111 user-defined units to correspond to 3 motor revolutions. This gives:

- Normalization factor = 3/1111 [rev./usr].

If a relative positioning operation of 900 user-defined units is made, the motor will move 900 usr * 3/1111 rev./usr = 2.4302 revolutions, corresponding to an internal resolution of 39,817 increments.

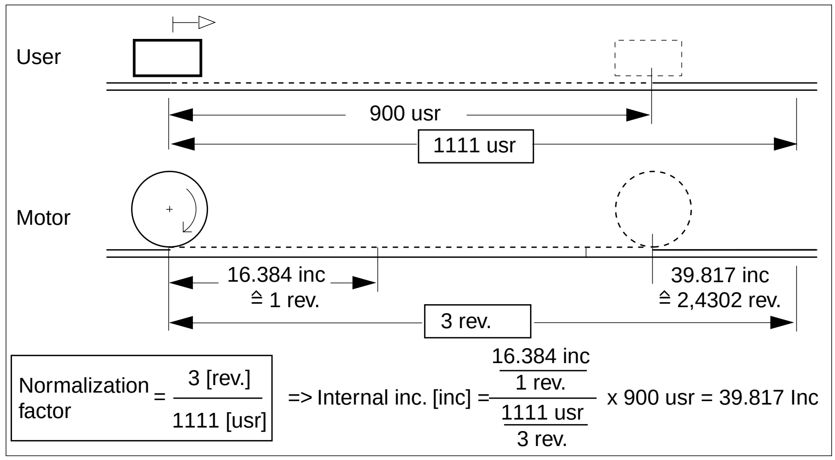

Fig. 7.7 Example: Positioning

Example 2 Changing a stepping motor to a servo motor

resolution stepping motor [Incr/rev.]	**resolution servo motor [rev/usr]**
1000	1/1000
19200	1/19200

Example 3 Calculating a normalization factor for positioning in units of length: 3 motor revolutions correspond to a distance o f 1000 µm. Each user-defined unit [usr] is to correspond to a 10µm step.

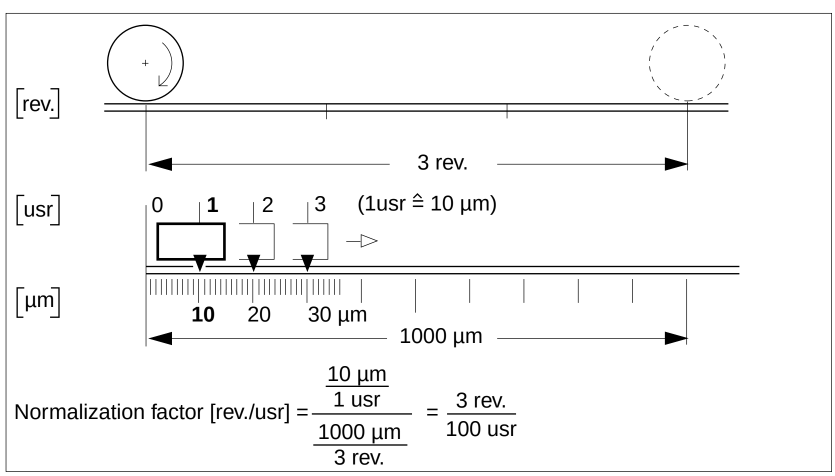

Fig. 7.8 Example: Positioning normalization factor

One user-defined unit moves the motor 3/100 of a revolution.

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Normalization factor, speed

The speed normalization factor describes the relationship between the number of motor revolutions and the time required for them.

$$\text{Normalization factor for speed} = \frac{\text{Revolutions [rev]}}{\text{Unit of time [min]}}$$

Fig. 7.9 Normalization factor for speed

Example 1

Setting a user-defined speed of (1/10) rev./min:

- Normalization factor = (1/10) rev./min
- 1 user-defined unit is set equal to (1/10) rpm * (1/60) min/sec * 16384 inc. = 27 Inc/s

If a user-defined speed of 52 is entered, the motor will turn at 5.2 rev./min or 1420 Inc/s.

Example 2

To simulate the resolution of a stepping motor with a resolution of 1000 Inc/revolution to a speed resolution of 1 Hz:

- 1 user-defined unit is set equal to 1Hz = 1 Inc/s = 1/1000 rev./s = 60/1000 rev. min
- Normalization factor = 6/100 [rev./min].

Normalization factor, acceleration

The acceleration normalization factor is used to define the smallest unit available for setting acceleration.

$$\text{Normalization factor for acceleration} = \frac{\text{Speed [r.p.m.]}}{\text{Unit of time [s]}}$$

Fig. 7.10 Acceleration normalization factor

Example 1

Setting acceleration in steps of 10 rev. / (min * s); 1 motor revolution/s^2 is set equal to 16384 Inc/s^2

- Normalization factor = 10 rev./(min*s)
- 1 user-defined unit is set equal to 10/(1 * 60) * 16384 = 2731 Inc/s^2:

Example 2

To simulate the resolution of a stepping motor with a resolution of 1000 Inc/revolution to an acceleration resolution of 1 Hz/ms:

- 1 user-defined unit is set equal to 1 Hz/ms = 1 Inc/(s*ms) = 1000 rev/s^2 = 60 rev./(min*s)
- Normalization factor = 60/1 [rev./(min*s)].

Example 3

Setting rad/s^2, 1 rad= 1 rev/(2*π)
1 user-defined unit is set equal to 1 rad/s^2 = 1 rev/(2*π *s^2) = 60/(2*π) rev/(min*s)

Normalization factor = 30/π [rev/(min*s)], (π = 3,141)

Setting e.g. 300.000 / 31416

7.3.3 Residual value in user-defined normalization

Movement data is given in user-defined units for all operating modes except for the electronic gear operating mode. The positioning controller works internally with the resolution of the motor to find the nearest internal position that relates 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 in the movement, or a change from an operating mode with one internal resolution to another mode with a different user-defined resolution. The differential value can be interrogated via the ’Status.p_remaind’ register.

Parameter 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 calibration of position setpoint p_ref [Inc]	INT32	–	R/–

In Teach-In processing, a residual value = 0 shows that the present position of the motor can be calculated exactly from the stored user-defined position. If the residual value does not equal zero, the nearest user-defined position is stored.

Example of residual value

Motor resolution is 16384 Inc/rev.

User-defined unit resolution [usr]: 1024 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 interruption, 'Status.p_remaind' displays the value 5 as the distance to the nearest user-defined unit.

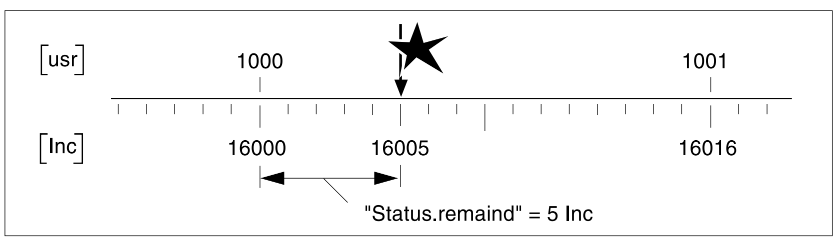

Fig. 7.11 Residual value after interruption to movement at 16005 Inc

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7.4 Ramp function

The controller uses the ramp functions to control the acceleration and deceleration behavior of the motor. The slope and shape of the ramp are described by the ramp function. The ramp slope shows the motor's change of speed, and the shape of the ramp shows the acceleration over time.

Ramp slope

The slope of the acceleration and deceleration ramps can be set on the controller with the 'Motion.Acc' and 'Motion.Dec' registers.

The controller absorbs excess braking energy during deceleration. If the DC-line voltage exceeds the permissible threshold in this process, the controller switches off the power output and displays error 5 'DC-line overvoltage'. The motor will then coast down with no braking.

The slope of the deceleration ramp should be set in such a way that the motor brakes as quickly as possible without causing the output to trip due to overvoltage. The current limitation in 'CtrlBlock1/2.I_max' must be coordinated with the deceleration ramp.

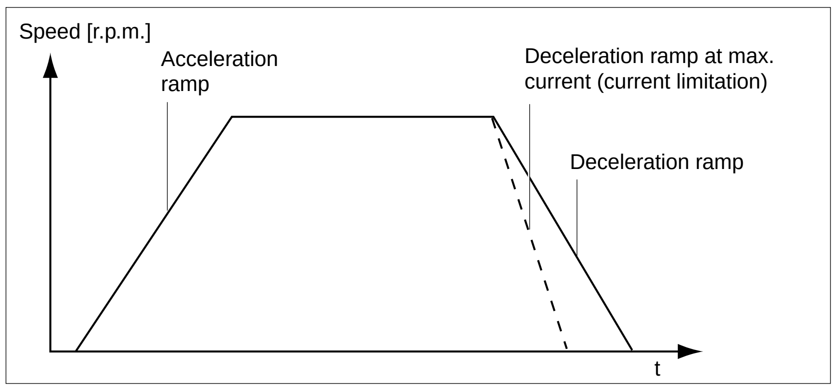

Fig. 7.12 Acceleration and deceleration ramps

Ramp slope settings are given in user-defined units.

Ramp shape

The controller uses a linear ramp for acceleration and deceleration.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Motion.acc_type	29:25	4.4.13	Shape of acceleration curve	UINT16 1: linear	1	R/W rem.
Motion.acc	29:26	4.4.14	Acceleration	UINT32 60...2000000	600	R/W rem.
Motion.dec	29:27	4.4.15	Delay [usr]	UINT32 60...2000000	600	R/W rem.

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Jerk filter The jerk filter smooths sudden changes in speed so that the controller provides smooth changes in movement.

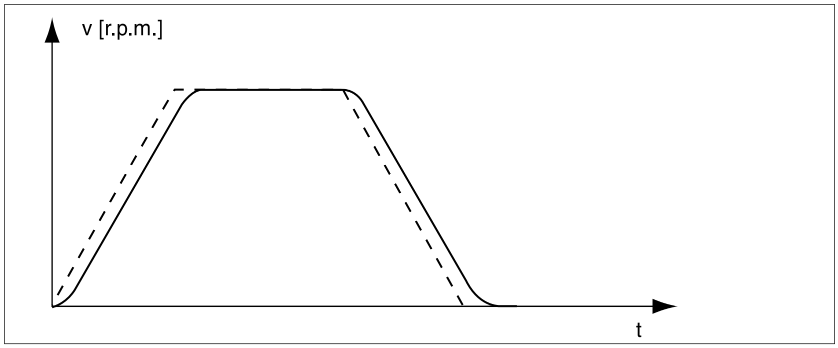

Fig. 7.13 Acceleration ramp with and without (dotted line) jerk filter

The jerk filter can be switched off with the 'Motion.Filt_jerk' parameter. The jerk filter is switched off when braking is carried out in quick stop mode.

Parameter 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: off 3 .. 30: filter setting value	0	R/W rem.

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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.
- Availability of sufficient braking torque for rapid stopping requires that the controller be properly adjusted and, if required, fitted with a properly dimensioned ballast resistor. Refer to the appropriate sections of this instruction manual for setting the Quick Stop function and the dimensioning of ballast resistors.

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

The quick stop (emergency stop) function stops the motor during a malfunction or other critical event. Quick stop can be triggered:

- via the $\overline{\text{STOP}}$ input signal
- by a stop command issued through a connected input device
- when limit switches signal via the LIMP, LIMN input signals
- when the software limit switch areas SW_LIMP, SW_LIMN are exceeded
- by an operational malfunction which necessitates an emergency stop

Quick stop remains active until the motor has come to a halt. In the event of a fault category 1 fault response, the power amplifier remains on.

Quick stop via current or deceleration ramp

Signals which trigger quick stop can use the 'Settings.SignQstop' register to define whether the motor is to be stopped by the quick stop current function or through a deceleration ramp. The deceleration ramp is set under 'Motion.Dec'. between these lines.

If the quick stop “Deceleration mode” is used the current limitation is set by “CtrlBlock1/2.I_max”.

In the electronic gear operating mode, only quick stop via current limit (Quick Stop Current) mode can be selected.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Settings.SignQstop	28:20	4.1.26	Check signals which initiate quick stop 0: Deceleration ramp 1: Quick stop current	UINT16 Bit 0: LIMP Bit 1: LIMN Bit 2: STOP Bit 3: REF Bit 4: 6: - Bit 7: SW_STOP	0	R/W rem.

Maximum current for quick stop

The controller absorbs excess braking energy during a quick stop. If the DC-line voltage exceeds the permissible threshold, the controller switches off the power amplifier and displays error 5 'DC-line overvoltage'. The motor then coasts down with 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.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values 1)	Default Value	R/W rem.
Settings. I_maxSTOP	28:22	4.1.3	Current limit for quick stop [100=1A]	UINT16 0 - max. current	–	R/W rem.

1) Max. current: Lower of the two values 'Servomotor.I_maxM' and 'PA.I_maxPA'

If the controller trips frequently during quick stop, displaying error 5 'DC-line overvoltage', the maximum braking current must be reduced or an external load resistor attached.

Acknowledging quick stop

Quick stop must be acknowledged via the FAULT_RESET input signal or via Fieldbus command or via the error confirmation function of an input device.

I/O signal	Function	Value
FAULT_RESET	Resets a fault message	low / open -> high

If the motor is brought to a halt using STOP, the $\overline{\text{STOP}}$ signal must be reset first

If quick stop has been triggered by limit switch signals $\overline{\text{LIMN}}$ or $\overline{\text{LIMP}}$, the drive must be moved back into the normal area of travel for example by use of manual mode see area of travel in manual mode, see ’Moving the drive out of the limit switch area’ on page 7-27.

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7.6 Standstill window

When motor is held at zero speed under active closed-loop control, small variations in the speed may prevent the condition from being recognised. If the motor remains in the standstill window for the period of time, defined in 'Settings.p_winTime', the control system will report that it is at standstill.

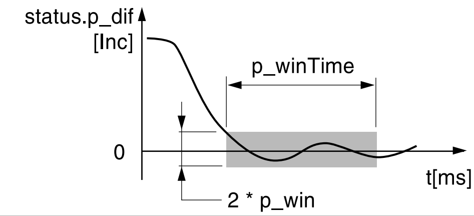

Fig. 7.14 Standstill window

The 'Settings.p_win' and 'Settings.p_winTime' registers define the size of the window.

The "Settings.p_winTout" register is used to set the length of time before an error is reported if the standstill window has not been reached.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Settings.p_win	12:13	4.1.24	Standstill window, permissible control deviation [Inc]	UINT16	10	R/W rem.
Settings.p_winTime	12:15	4.1.25	Time for which control deviations must apply in the standstill window for standstill to be signalled [ms]	UINT16	1	R/W rem.
Settings.p_winTout	12:21	4.1.27	Time within which standstill must be reported [ms] 0: deactivated	UINT16 0 ... 32767	0	R/W rem.
Status.xMode_act	28:3	2.3.5.5	Current axis operating mode with additional information'	UINT16 Bit 6: Controller deviation in standstill window	–	R/– –

7.7 Reversal of direction of rotation

The drive's direction of rotation can be reversed using the parameter 'Motion.invertDir'. When this is done, the limit switch connections must be swapped.

If the direction of rotation is reversed, all other parameter values can be used unchanged.

▶ Reverse the drive's direction with the “Motion.invertDir“ register.

The limit switch which limits the working area during clockwise rotation must be connected to LIMP. The limit switch which limits the working area during counter-clockwise rotation must be connected to LIMN.

Parameter 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 direction of rotation	UINT16 0: no inversion 1: direction of rotation inverted	0	R/W rem.

7.8 Fast position capture

Position values can be recorded via two channels with adjustable parameters. The capture inputs have an input delay of 100 µs. This delay fluctuates by max. +/-10 µs. If the drive speed is constant, the error is a maximum of +/-5 µs.

The 'Capture.TrigSign' register defines the signal source for a position value capture. Three signal inputs are possible; CAPTURE1 or CAPTURE2 (from the signal interface), or the index pulse of a position sensor in slot M1. If M1 is not occupied, the 'Capture.TrigType' parameter is not displayed.

A position recording can be triggered by the rising or falling edge of the signal. Edge polarity is set with the 'Capture.TrigLevl' register.

Initiating position capture

The 'Capture.TrigStart' register activates a new recording procedure. Any stored position values are first deleted. As soon as a new position value has been recorded, the signal level of the 'Capture.TrigStat' register changes from '0' to '1'. This value remains stored until a new process is triggered for this channel.

Either the actual position of the motor or the numerator value of the reference sensor is recorded as the saved position, with the other value in each case being calculated and entered by the positioning controller. The position values can be interrogated with 'Capture.TrigPact1/2' and 'Capture.TrigPref1/2'.

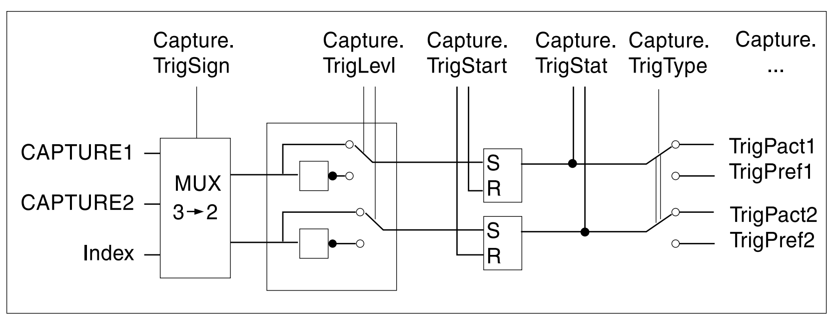

Fig. 7.15 Fast position capture, Signal pattern and parameter

Continuous position capture

Position capture can be carried out once or continuously, as set in bit 15 in 'Capture.TrigStart':

- Bit 15=0: The position value following the first trigger event is stored. Further values are ignored until the process is re-initiated.
- Bit 15=1: Every trigger event updates the position value.

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Parameter 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 Bit 3..2: Signal - channel 2 (K2) Bit 1..0: Signal - channel 1 (K1) Examples: 4: binary 01 00 => CAPTURE2 (channel 2), CAPTURE1 (channel 1), 9: 10 01 => index pulse set-point sensor (channel 2), CAPTURE2 (channel 1)	UINT16 bits 0..1 channel 1 (K1) bits 2..3 channel 2 (K2) - 00: CAPTURE1 - 01: CAPTURE2 - 10: index pulse setpoint sensor (with module on M1) - 11: index pulse actual position sensor (for SM with module on M2)	4	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 Bit 0: set trigger level on channel 1 Bit 1: set trigger level on channel 2	3	R/W –
Capture.TrigStart	20:16	–	start triggering (bits0..1): 0: no change 1: reset triggering and repeat cancel triggering (Bit 14=1) repeat triggering (bit15) 0: trigger once 1: trigger continuously	UINT16 Bit 0: trig. on channel 1 Bit 1: trig. on channel 2 Bit 14: cancel trig. Bit 15: repeat trig.	0	R/W –
Capture.TrigStat	20:17	–	Status of trigger channels	UINT16 Bit 0: triggering on channel 1 running Bit 1: triggering on channel 2 running	–	R/– –
Capture.TrigPact1	20:18	–	Actual position of motor on triggering on channel 1 [Inc]	INT32	–	R/– –
Capture.TrigPact2	20:19	–	Actual position of motor on triggering on channel 2 [Inc]	INT32	–	R/–
Capture.TrigPref1	20:20	–	Setpoint of electrical gear ratio on triggering on channel 1 [Inc]	INT32	–	R/–
Capture.TrigPref2	20:21	–	Setpoint of electrical gear ratio on triggering on channel 2 [Inc]	INT32	–	R/–

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7.9 Monitoring functions

7.9.1 Monitoring of axis signals

Positioning limits

The motor can be moved to any point within the axis positioning range by specifying an absolute positioning process.

The axis travel range is specified in internal units over a range -2^{31} to $+2^{31}$ increments. The resolution of the motor encoder in increments is specified as the internal unit.

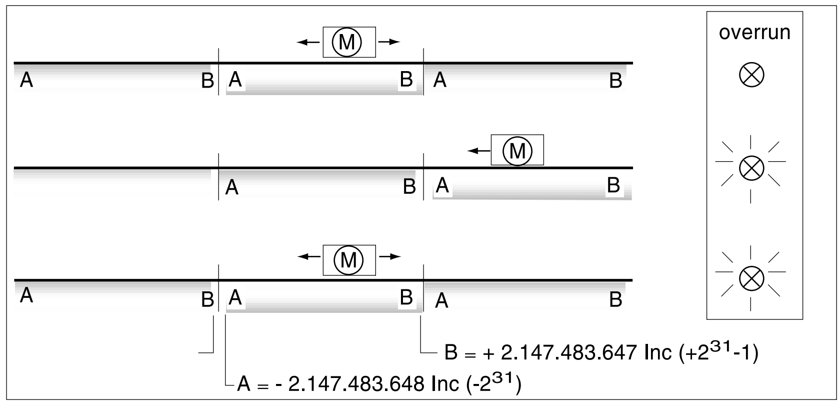

Fig. 7.16 Positioning range and range overrun

If the motor crosses beyond the positioning limits, the internal monitoring signal for position overrun is set and the work area is moved by 2^{32} units. The “Status.IntSigSr“ parameter displays a position overrun on bit 2.

The monitoring signal remains set when the motor moves back into the valid area. It is reset by re-referencing the system, or by switching the controller off and then on.

It is possible to cross positioning limits and create an overrun in the speed, electronic gear, referencing, and manual modes. If limits have been crossed in point to point positioning mode, numeric values will be used from the new work area.

Teach-In processing is not possible if limits have been crossed as positions are no longer defined. Crossing range limits can be prevented by activating software limit switches.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Status.IntSigSr	29:34	2.3.4	Monitoring signals 0: not active, 1: activated	UINT32 Bit 2: position overflow	-	R/ – –

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Software limit switches

The software limit switch position is set with registers ’Motion.SW_LimP’ and ’Motion.SW_LimN’, and is activated with ’Motion.SW_Enabl’. The setting of the activation register determines if position monitoring by means of the software limit switch range is used. Depending on the controller setting, the motor can stop before it reaches the limit switch position. Bits 5 and 6 of the ’Status.IntSigSr’ register signal if the limit switch position is crossed.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W 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 pos. 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) Bit 6: SW limit switch, neg. sense of rotation (SW_LIMN)	–	R/–

Limit switch signal and STOP signal

⚠WARNING

LOSS OF CONTROL DURING OR FOLLOWING A MOTION

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

- Refer to section 4.4.8 of this instruction manual for descriptions of the LIMP, LIMN, and STOP input connection requirements.
- Use of the LIMP, LIMN, and STOP input functions require the connection of signals from external sensors or limit switches to the controller. The signals used should originate from separate sensors and limit switches from those used during normal machine control.
- The external sensors and limit switches must be properly located on the machine motion being controlled.
- To operate, the LIMP, LIMN, and STOP input functions must be enabled in the controller software.
- The LIMP, LIMN, and STOP input functions cannot protect against certain failures within the controller or at the sensors. For the control of critical motions of the machine, use redundant control signal paths to assure a safe state during failure.

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

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During motion, both limit switches are monitored with input signals LIMN and LIMP. If the drive reaches a limit switch, the controller stops the motor. The triggering of the limit switch is signalled on the user interface. It is important to set the limit switches so that braking delays do not cause the system to cross the switch contact closure region. If necessary, use longer actuator lugs.

The STOP input signal stops the motor by means of quick stop. Further processing is possible if:

- The STOP signal is cancelled and
- Quick stop has been acknowledged
- A new movement command is activated

The 'Settings.SignEnabl' and 'Settings.SignLevel' parameters are used to change the enabling of input signals REF, LIMP, LIMN and STOP and set their polarity as active low or high:

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Settings.SignEnabl	28:13	4.1.10	Signal enable for monitoring inputs 0: inactive 1: active	UINT16 Bit 0: LIMP Bit 1: LIMN Bit 2: STOP Bit 3: 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 Bit 0: LIMP Bit 1: LIMN Bit 2: STOP Bit 3: 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.

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 Settings.IO_mode=2, change to manual operation using the input signal AUTOM.

Activate and hold the manual movement signal in order to move the drive into the permitted area of travel. If limit switch signal LIMP has been triggered, signal MAN_N must be activated and vice-versa.

If the drive does not move back into the area of travel, check to see if manual mode has been activated and the correct manual movement signal activated.

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7.9.2 Monitoring internal signals

Monitoring systems protect motor, power amplifier and load resistors from overheating, and ensure functional and operational safety. All safety devices are listed under “safety devices” on page 2-3.

The controller displays error messages and warnings by causing the 7-segment display to blink. In addition, connected user interface devices will display an error message.

Temperature monitoring

Sensors monitor the temperature of the motor and power amplifier. If the temperature of one of these components approaches its permitted limit, the controller will display a warning. If the temperature exceeds the limit for more than five seconds, the controller signals a temperature fault and switches off the amplifier and control loop to protect the system from overheating.

If a motor temperature switch is used instead of a sensor, only the upper temperature limit can be monitored and no advance warning is provided. All temperature limits are permanently set.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
PA.T_warnPA	16:10	2.2.15	Temperature warning threshold of the current amplifier [K]	UINT16	–	R/ – rem.
PA.T_maxPA	16:11	2.2.16	Max. permitted temperature of the current amplifier [K]	UINT16	–	R/ – rem.

I^2t monitoring

If the controller is working with high peak currents, temperature monitoring with sensors may be too slow. I^2t temperature monitoring may be used instead. With I^2t monitoring, the closed-loop control calculates the rise in temperature versus time. If the I^2t threshold is exceeded, the motor, amplifier, or load resistor current is reduced to its rated value.

If the temperature drops below the threshold, the related component can once again be operated at the limit of its performance.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
PA.I2tPA	16:13	2.2.10	Max. permitted time for max. current at high speed [ms]	UINT16	–	R/ – rem.
PA.I2t_warnB	16:14	2.2.12	Warning threshold for make time of an internal ballast resistor [ms]	UINT16	–	R/ – rem.
PA.I2tB	16:15	2.2.11	Max. permitted make time of internal ballast resistor [ms]	UINT16	–	R/ – rem.
PA.I2t_n0PA	16:47	2.2.13	Max. permitted time for max. current at low speed [ms]	UINT16	–	R/ – rem.

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Following error monitoring

Following error monitoring checks for positional discrepancies between the actual position of the motor and its setpoint. If the difference exceeds a following error threshold, the position controller reports a fault.The following error deviation threshold can be set.

In addition, the error class for a following error can be changed, see 'Monitoring parameters' below.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Settings.p_maxDiff	12:11	4.1.23	Maximum permitted following error of the position controller [Inc]	UINT32 0 - 131072 Eight motor revolutions With resolver motor max. 8*4096 Inc	16384	R/ – rem.

Monitoring parameters

The parameters listed in the 'Status' set can be used to monitor unit status and operating status. Examples are:

- “Status.FltSig“ (28:17), “Status.FltSig_SR“ (28:18) and “Status.IntSigSr“ (29:34) can be used for monitoring internal unit signals
- “Status.action_st“ (28:19) can be used for monitoring the operating status
- “Status.StopFault“ (32:7) can be used to determine the cause of the last interruption.

Information on using the monitoring facilities built into the unit, using the Fieldbus, is given in 'Diagnosis and error rectification' on page 8-1.

7.10 Braking function with TLHBC

For motors fitted with a holding brake, the brake prevents unintended movement of the motor when power is removed. The controller controls the holding brake with 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 is located in the same cable as the power connections to the motor. It is separated from the controller's signal connections in the event of motor cable insulation failure.

IP20 controller

For set-up and functional testing, the holding brake can be released with the push-button switch located on the front of the holding brake control system.

IP54 controller

Set-up and functional testing of the holding brake can be controlled with the TLCT commissioning software or the TLHMI.

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 / open
ACTIVE-0V	GND connection for ACTIVE-CON	low

Voltage reduction

The control voltage from the holding brake control system will be variable if the voltage reduction function is switched on. If selected, the voltage will be set to 24 V for approximately 100 ms and then fall back to a holding voltage of 12V.

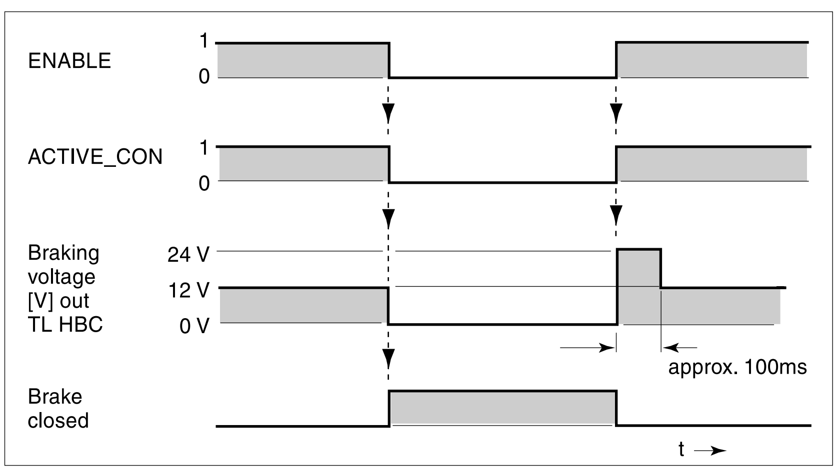

Fig. 7.17 Time diagram, brake function with voltage reduction on

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

The LED flashes on overload or short-circuit.

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8 Diagnosis and error rectification

8.1 Operational status indicators and transitions

Status display in the unit

The D2 LED on the motor plug lights when voltage is present on the DC-line.

The 7-segment display shows the operating states of the controller in coded form.

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

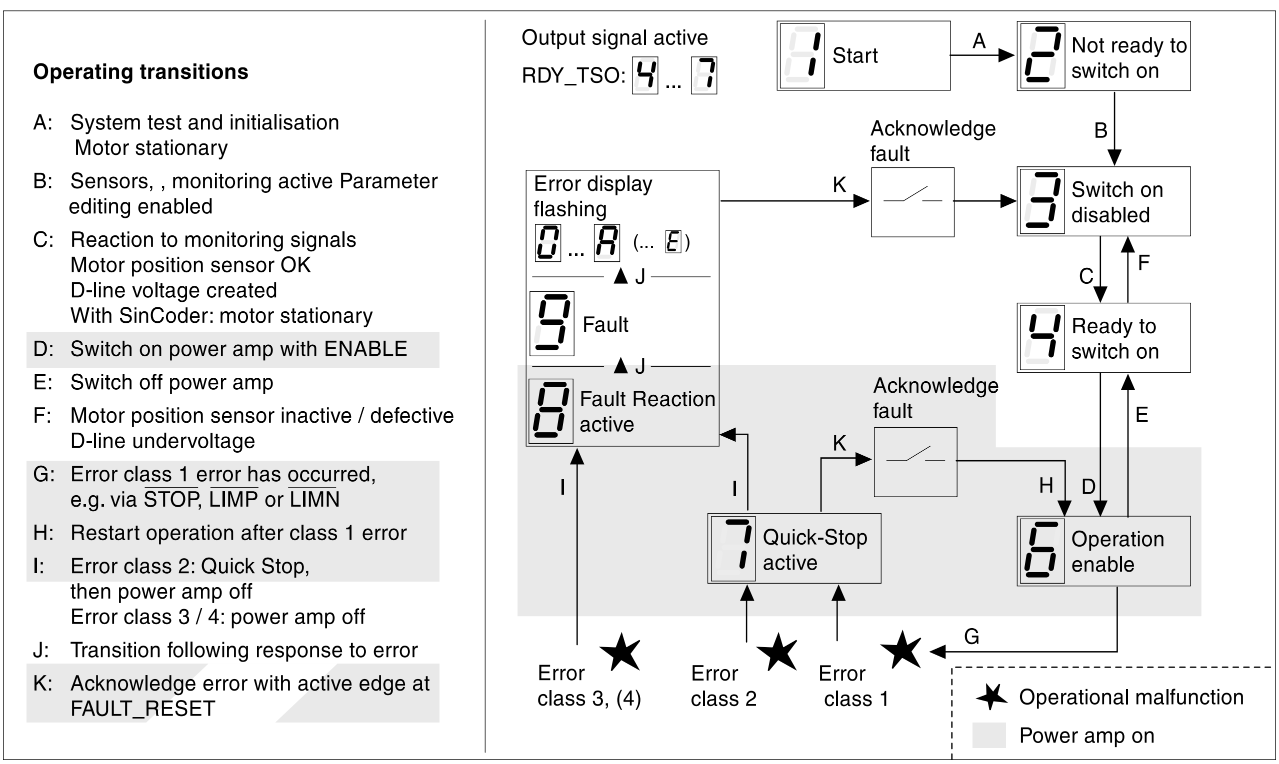

Fig. 8.1 Operating states and transitions of the controller

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Operating transitions Operating transitions and error reactions follow a fixed sequence. This sequence is shown in Fig. 8.1.

Changes to the operating status are controlled via the “Commands.driveCtrl” parameter.

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.
Commands.driveCtrl	28:1	-	Control word for status change, default setting Bit0..3='0', write access automatically triggers edge change 0->1.	UINT16 Bit0: Disable power amplifier Bit1: Enable power amplifier Bit2: Stop (quick stop) Bit3: FaultReset Bit4..15: not assigned	0	R/ – –

8.2 Error display and rectification

Error display The cause of a particular operating malfunction is displayed

- By a flashing number in the seven-segment display

  by the error response of the controller
- In the commissioning software, as an error message on the control bar and in the error memory list
- In the display of the Human-Machine Interface (HMI) as an error message and in the error memory list
- Bit-coded in the registers 'Status.FltSig', `Status.FltSig_SR`, Status.IntSigSR`and `Status.Sign_SR`.

The controller reacts to a fault from a limit switch or $\overline{\text{STOP}}$ signal by initiating a quick stop. An error message is not displayed on the unit. The cause of the interruption is, however, recorded in the error memory and can be accessed via the Human-Machine Interface (HMI) or the commissioning software.

Resetting error messages Once the error has been corrected, the message can be reset

- via the commissioning software with the Reset button
- by setting the input signal FAULT_RESET
- by Fieldbus command “Commands.driveCtrl”
- 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	Reaction	Meaning
0	Warning	Message only, no interruption to movement operations
1	Quick stop	The motor stops with a quick stop, the power amplifier and controller stay switched on, the stop control is activated.
2	Quick stop with switch-off	The motor stops with a quick stop, the power amplifier and controller switch are off at standstill.
3	Fatal error	The power amplifier and controller switch are off. The unit cannot be activated until the fault is corrected.
4	Uncontrolled operation	The power amplifier and controller switch are off. The error response can only be reset by switching off the unit.

Error rectification

Display	Error	Error class	Cause	Error rectification
dark	Display dark	-	No power supply.	Check power supply and fuses.
	Display dark	-	Power supply connected incorrectly.	Connect properly.
1	Undervoltage	2	DC-line voltage below threshold value for quick stop.	Check or increase mains voltage.
	Undervoltage	3	DC-line voltage below threshold value for switching off the drive.	Check for mains failure.
2	Contouring error	1...3	Contouring error.	Reduce load or acceleration, the error response can be configured via 'Flt_pDiff'.
	Reference encoder in slot M1	1	Cable fault to RS-422 or sensor broken.	Check sensor cable / sensor, replace cable.
	Maximum motor speed	3	Exceeding the maximum motor speed under shift operation.	Reduce vertical loading.
3	Motor output	3	Short circuit or earth fault in the motor line or in the motor overcurrent due to poor current controller setting. Incorrect motor parameters. Motor defective.	Check the connections or motor. Replace the cable or motor. Select the correct motor data set
4	Position sensor	3	No signal from motor position sensor. Motor fitted with wrong sensor or sensor broken.	Check sensor cable / sensor. Replace cable
5	Overvoltage	3	DC-line overvoltage.	Use an external brake resistor.
6	I^2t for power amplifier	0	I^2t monitoring for power amplifier in operation or at a standstill.	Reduce the time at peak current, load or peak torque. Absorb the standstill torque with the holding brake.
	I^2t for motor	0	I^2t monitoring for motor.	Reduce the load, use a motor with a higher rated power.
	I^2t for ballast	0	I^2t monitoring for ballast resistor.	Reduce the load, connect an external resistor, improve ventilation.

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Display	Error	Error class	Cause	Error rectification
7	Overtemperature power amplifier	3	The power amplifier is overheating.	Reduce the make time for peak current, load or peak torque.
	Overtemperature motor	3	The motor is overheating. The temperature sensor is not connected.	Allow the motor to cool. Reduce the load. Use a motor with a higher rated power. The PTC sensor is defective. Check or replace the motor encoder cable.
8	Watchdog	4	Internal system error.	Switch the unit off and back on. Replace the unit.
	Control system error	4	System error, e.g. division by 0 or time-out checks, insufficient EMC.	Comply with EMC protective measures. Switch the unit off and back on. Replace the power amplifier if problem persists.
9	Phase monitoring motor	3	Motor phase current imbalance. The motor cable is defective. The power amp transistor is defective.	Check the motor cable and connection, replace the motor, replace the unit.
A	Short circuit I/O		Short circuit in the digital outputs. No 24 V for signal interface.	Check the connections and wiring.
E	Positioning controller system error	3	Cause of error corresponds to error number in error memory.	Rectification dependent on error number.
	Positioning controller system error	4	Cause of error corresponds to error number in error memory.	Rectification dependent on error number.
None 1)	Limit switch	1	Limit switch overshot.	Bring the drive into movement zone, match the positioning data to the axis range. Special message in the error memory shows the limit switch that is connected in the wrong direction.
	Stop	1	Stop signal activated, line interrupted.	Check the line for the $\overline{\text{STOP}}$ terminals signal
	Node Guarding	1	Connection monitoring for the manual control unit activated.	Check the RS-232 connection at the controller.
	Timeout	1	Protocol error.	Time-out exceeded during exchange of data with the manual control unit, start transmission again.

1) No error display, operating status continues to be displayed.

IP54 Controller The following error can occur in the IP54 controller.

Display	Cause	Correction
None	Functions disabled due to condensation	Allow unit to dry and reduce humidity

General The commissioning software TL CT and the TL HMI, display the last 20 error messages.

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TL CT: Error display

▶ Select 'Twin Line → Diagnosis → Error log'. An error message dialog box will appear.

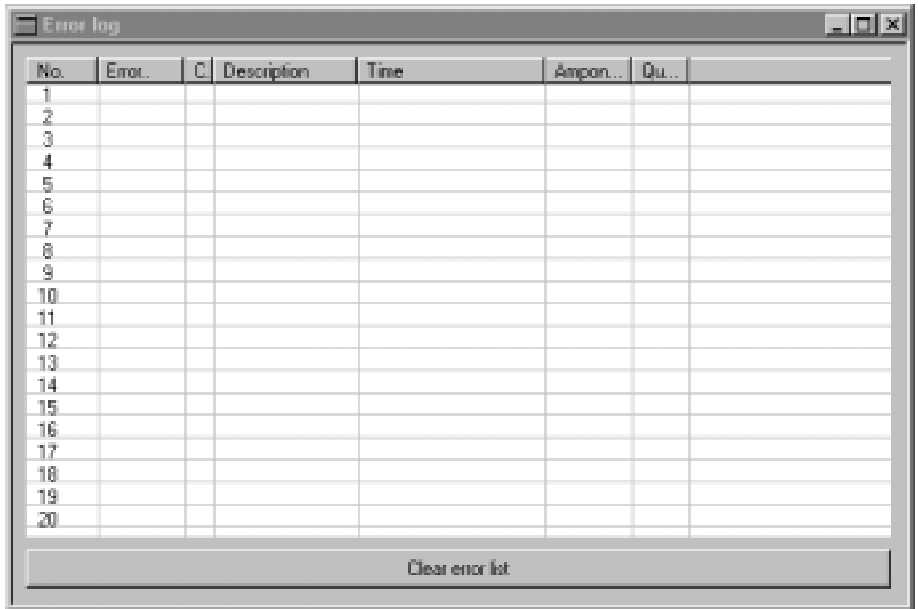

Fig. 8.2 Error messages

Error messages are displayed showing status, error class, time when the error occurred, and a short description. The error number is given as a hexadecimal value.

Additional information is given in column labelled “Qualifier.” For the error message E1855, “Initialization error in parameter IxSix -> Qualifier”, the Qualifier identifies the index/sub-index of the parameter that had the error. A list of registers is given in chapter 12.

As an example, if the 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 in manual operating mode”
- 181Fh: “Error while in reference motion mode”
- 181Dh: “Error mode with external reference signals is active”

More detailed information may be found in the Qualifier. For example, 00001846h is error message No. E1846 in the error list.

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▶ When an error occurs, it may be cleared with the 'Reset' button on the command bar of the program.

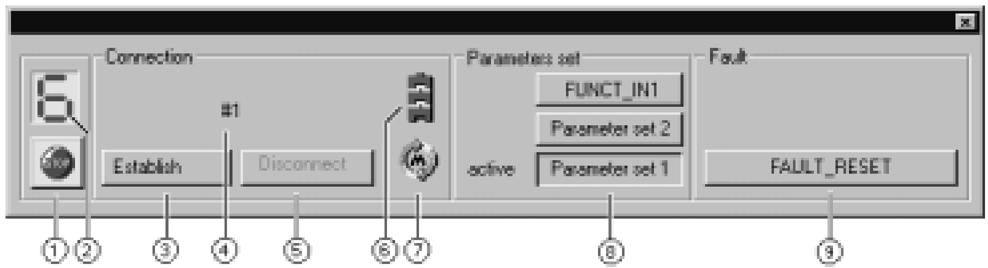

Fig. 8.3 Reset button, 9

TL HMI: Error display

▶ The HMI displays errors via menu item 2.5, “Error.” Existing errors will show as codes in sub menu items.

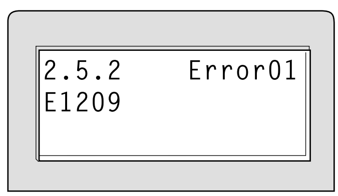

Fig. 8.4 Displaying an error value

The cursor keys may be used to scroll through the error entries:

Menu item	Meaning
2.5.1 StopFault	Cause of the last interruption
2.5.2 Error01	1st error entry, oldest message
2.5.3 Error02	2nd.error entry, more recent message, if present
...	...

The meaning of the error values is given in the Human-Machine Interface HMI manual.

Fieldbus: evaluating error messages

In Fieldbus operation, device faults are reported as asynchronous errors by the controller’s monitoring facility. An asynchronous error is recognised by the status word 'fb_statusword'. Signal status '1' indicates an error or warning message. Details on the cause of the fault can be determined via registers.

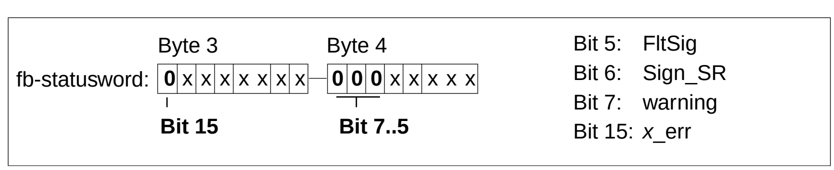

Fig. 8.5 Error evaluation for asynchronous error

- Bit 5, 'FltSig': status of an internal monitoring signal, e.g. overtemperature in power amplifier. Details are available via registers 'Status.FltSig_SR' and 'Status.IntSigSR.'
- Bit 6, 'Sign_SR': status of an external monitoring signal, e.g. interruption of movement through STOP input. Details are available via the register 'Status.Sign_SR.'

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- Bit 7, 'warning': warning message from the controller, e.g. I^2T error in power amplifier. Details are available via registers 'Status.FltSig_SR' and 'Status.IntSigSR.'

Besides asynchronous errors, synchronous communications errors in Fieldbus operation are also reported. For example, errors from an unauthorised 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 sub-index values:

Index	Explanation
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, ...	20th error entry, if present, the latest error value is found here

Further information on each fault report can be obtained from the subindex.

Additional information can be read about in the “ErrMem0.ErrQual” register.

Parameter			Explanation and unit [ ]	Range of values	Default-	R/W
Name	Idx:Sidx	TL-HMI			Value	rem.
Status.StopFault	32:7	2.5.1	Cause of last interruption, error number	UINT16	0	R/–
ErrMem0.ErrNum	900:1	–	Coded error number	UINT16 0...65535	–	R/–
ErrMem0.Class	900:2	–	Error class	UINT16 0...65535	–	R/–
ErrMem0.Time	900:3	–	Error moment since power amplifier switched on [ms]	UINT16 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.

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8.3 Malfunctions in movement mode

Faults	Cause	Correction
The motor jerks briefly	The motor phases are swapped	Check the motor cable and connection: connect motor phases U, V, and W in the same way on the motor and unit sides.
No motor movement	The motor has seized	Release the motor brake.
	Break in the motor line	Check the motor cable and connection. One or more motor phases are not connected.
	No torque	Set the parameters for max. current, max. speed to higher than zero.
	Incorrect operating mode selected	Set the input signal and parameters for the desired operating mode.

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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

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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)

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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

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Error number	Error class	Meaning
E141E	0	SAM warning
E141F	0	Node guarding
E1500	1	SAM: Class 1 error forced
E1501	2	SAM: Class 2 error forced
E1502	3	SAM: Class 3 error forced
E1503	4	SAM: Class 4 error forced
E1504	3	SAM: Error at Safe Stopping Process: insufficient brake ramp
E1505	1	SAM: Safe operational stop ignored
E1506	1	SAM: Reduced safe setup speed exceeded
E1507	1	SAM: Safe limited increments exceeded
E1508	1	SAM: Safe limited absolute position exceeded
E1509	1	SAM: Terminal positions exceeded
E150A	2	SAM: Emergency stop executed
E150B	0	SAM: Not ready for Fault Reset
E150C	0	SAM: Not ready for SAM Disable
E150D	3	SAM: Safe Operational Stop in fault state ignored
E150E	0	SAM: Parameter is not readable
E150F	0	SAM: Parameter not writable in this state
E1510	0	SAM: Wrong password
E1511	0	SAM: Timeout during parameter download (default values loaded)
E1512	0	SAM: Parameter not existent
E1513	0	SAM: Parameter checksum not writable in this state
E1514	0	SAM: Parameter checksum wrong (default values loaded)
E1515	0	SAM: Warning: low temperature
E1516	0	SAM: Warning: high temperature
E1517	2	SAM: 24VDC overvoltage
E1518	4	SAM: 24VDC undervoltage
E1519	2	SAM: Short circuit at outputs of channel A to GND
E151A	4	SAM: System error: 5V supply
E151B	4	SAM: System error: 5V supply
E151C	2	SAM: SAM 24VDC overvoltage (SW)
E151D	2	SAM: SAMSTART: Max. permissible pulse length exceeded
E151E	2	SAM: System error: RAM
E151F	4	SAM: System error: Stack overrun
E1520	4	SAM: System error: Program sequence check (communication)
E1521	4	SAM: System error: Program sequence check (idle task)
E1522	4	SAM: System error: Program sequence check (MS task)
E1523	2	SAM: Cross circuit at output
E1524	2	SAM: System error: Input
E1525	2	SAM: System error: PROM checksum error

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Error number	Error class	Meaning
E1526	0	SAM: Parameter value out of range
E1527	2	SAM: Parameter block checksum error
E1528	2	SAM: System error: SPI Framing Error
E1529	2	SAM: Unequal input states
E152A	2	SAM: Cross circuit at output (unequal states)
E152B	3	SAM: Error in position acquisition (unequal values)
E152C	3	SAM: Error in speed acquisition (unequal values)
E152D	2	SAM: Error in I/O current monitoring
E152E	2	SAM: System error: Error in SAM24VDC monitoring (unequal values)
E152F	2	SAM: System error: Drive Release / SAM jumper
E1530	2	SAM: System error: SAM24VDC overvoltage cut off unit
E1531	2	SAM: System error: SPI short circuit
E1532	2	SAM: System error: UART short circuit
E1533	0	SAM: EEPROM wrong checksum (default values loaded)
E1534	0	SAM: SAM Module exchanged (default values loaded)
E1535	4	SAM: System error: Position acquisition (commutating position)
E1536	2	SAM: Unequal checksum of parameters
E1537	0	SAM: SAM Boot Program: Illegal address
E1538	1	SAM: Reduced Safe Operating Speed exceeded
E1539	2	SAM: Input SAMSTART low instead of high (Auto Start)
E153A	2	SAM: Input SAMSTART high instead of low (Safe Start)
E153B	2	SAM: Guard confirmation: Max. permissible pulse length exceeded
E153C	2	SAM: System error: Unequal states of SAM state machine
E153D	0	SAM: FAULT RESET not possible (non resettable error)
E153E	2	SAM: Wrong voltage at inputs
E153F	2	SAM: Output AUX_OUT_A (Cross circuit to other output)
E1540	2	SAM: Output INTERLOCK_OUT_A (Cross circuit to other output)
E1541	2	SAM: Output RELAY_A (Cross circuit to other output)
E1542	2	SAM: Output SAFETY24V_A (Cross circuit to other output)
E1543	2	SAM: Output AUX_OUT_A (Cross circuit to 24V)
E1544	2	SAM: Output INTERLOCK_OUT_A (Cross circuit to 24V)
E1545	2	SAM: Output RELAY_A (Cross circuit to 24V)
E1546	2	SAM: Output SAFETY24V_A (Cross circuit to 24V)
E1547	2	SAM: System error: Output drive of channel A defect
E1548	2	SAM: System error: Input ESTOP_A
E1549	2	SAM: System error: Input GUARD1_A
E154A	2	SAM: System error: Input 3POSSWITCH_A
E154B	2	SAM: System error: Input SETUPMODE_A
E154C	2	SAM: System error: Input SAFETY_REF_A
E154D	2	SAM: System error: Input GUARD2_A

Error number	Error class	Meaning
E154E	2	SAM: System error: Input INTERLOCK_IN_A
E154F	2	SAM: System error: Input GUARD1CONF_A
E1550	2	SAM: Short circuit at output of channel B to GND
E1551	4	SAM: System error: UART Overrun/Framing error
E1552	3	SAM: Encoder resolution is set to 0
E1553	2	SAM: System error: CPU synchronization
E1554	2	SAM: No motor movement for 36h
E1555	2	SAM: System error: Timeout high priority test (5 sec)
E1556	2	SAM: System error: Timeout low priority test
E1557	3	SAM: dec_Qstop (max. permissible brake ramp) is set to 0
E1558	2	SAM: Output AUX_OUT_B (Cross circuit to other output)
E1559	2	SAM: Output INTERLOCK_OUT_B (Cross circuit to other output)
E155A	2	SAM: Output RELAY_B (Cross circuit to other output)
E155B	2	SAM: Output SAFETY24V_B (Cross circuit to other output)
E155C	2	SAM: Output AUX_OUT_B (Cross circuit to 24V)
E155D	2	SAM: Output INTERLOCK_OUT_B (Cross circuit to 24V)
E155E	2	SAM: Output RELAY_B (Cross circuit to 24V)
E155F	2	SAM: Output SAFETY24V_B (Cross circuit to 24V)
E1560	2	SAM: System error: Output drive of channel B defective
E1561	2	SAM: System error: Input ESTOP_B
E1562	2	SAM: System error: Input GUARD1_B
E1563	2	SAM: System error: Input 3POSSWITCH_B
E1564	2	SAM: System error: Input SETUPMODE_B
E1565	2	SAM: System error: Input SAFEFUNCIN_B
E1566	2	SAM: System error: Input GUARD2_B
E1567	2	SAM: System error: Input INTERLOCK_IN_B
E1568	2	SAM: System error: Input GUARD1CONF_B
E1569	2	SAM: SAM24VGND not connected
E156A	4	SAM: System error: Temperature sensor
E156B	2	SAM: Difference between 24VDC and SAM24VDC too large
E156C	4	SAM: SAM24VDC Overvoltage (HW)
E156D	4	SAM: Switch off temperature (HW)
E156E	2	SAM: System error: Unequal SamOpMode
E156F	2	SAM: System error: A/D Converter
E1570	4	SAM: Unequal software revisions
E1571	3	SAM: Safe Operational Stop in fault state ignored
E1572	4	SAM: System error: Software is not compatible with hardware
E1573	1	SAM: Error during Safe Deceleration Process
E1574	2	SAM: Safe operational stop repeatedly ignored
E1575	4	SAM: Error accumulation at Safe Stopping Process: Insufficient brake ramp

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Error number	Error class	Meaning
E1576	4	SAM: Input INTERLOCK_IN isn't turning to high (time out if t_Relay=2)
E1577	4	SAM: Input INTERLOCK_IN is high even if it is set to ignore in configuration
E1578	3	SAM: Setup Speed (n_maxRed) is higher than Automatic speed (n_maxAuto)
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	Homing position not defined or homing 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 homing is active
E1823	0	CanMaster: invalid object number
E1824	0	CanMaster: invalid CAN-ID

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Error number	Error class	Meaning
E1825	0	Command or parameter write not allowed in actual operating mode
E1826	0	SWLIM causes error
E1827	0	Recording position of HW limit switch not defined
E1828	0	Homing error, limit switch not enabled
E1829	0	Homing error at /LIMP
E182A	0	Homing 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	Homing error at /STOP
E1850	0	Homing error at /REF
E1851	3	Error while calculating electronic gear information
E1852	3	DSP timeout

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Error number	Error class	Meaning
E1853	3	Gear mode: change of reference signal too large
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	Invalid data set number
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

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Error number	Error class	Meaning
E187A	0	Processing not possible due to invalid or missing actual position transducer
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
E187F	0	
E1880	0	
E1A00	0	
E1A01	0	
E1A02	0	
E1A03	0	
E1A04	0	
E1A05	0	
E1A06	0	
E1A07	0	
E1A08	0	
E1A09	0	
E1A0A	0	
E1A0B	0	
E1A0C	0	
E1A0D	0	
E1A0E	0	
E1A0F	0	
E1A10	0	
E1A11	0	
E1A12	0	
E1A13	0	
E1A14	0	
E1A15	0	
E1A16	0	
E1A17	0	
E1A18	0	
E1A19	0	
E1A1A	0	
E1A1B	0	
E1A1C	0	
E1A1D	0	
E1A1E	0	
E1A1F	0	
E1A20	0	

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Error number	Error class	Meaning
E1A21	0	
E1A22	0	
E1A23	0	
E1A24	0	
E1A25	0	
E1A26	0	
E1A27	0	
E1A28	0	
E1A29	0	
E1A2A	0	
E1A2B	0	
E1A2C	0	
E1A2D	0	
E1A2E	0	
E1A2F	1	
E1A30	1	
E1A31	0	
E1A32	0	
E1A33	0	
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

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Error number	Error class	Meaning
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
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

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Error number	Error class	Meaning
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

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9 Service, Maintenance and Warranty

9.1 Service Information

Technical and commercial service requests, including warranty and on-site services, should be directed to your Schneider Electric authorized distributor or the Schneider Electric Customer Support Center at 1-888-SQUARED (1-888-778-2733).

Maintenance

The Twin Line controller requires no maintenance.

▶ Periodically check the control cabinet filter at the TLC unit’s location. Inspection intervals are determined by ambient conditions at the site.

Repairs to the TLC unit are to be carried out only by Schneider Electric authorized personnel.

Warranty

Unauthorized disassembly of the controller will void the warranty.

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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 1-7). The DC bus LED is not an accurate indication of the absence of DC bus voltage.
- The servomotor can produce voltage at its terminals when the shaft is rotated! Prior to servicing the power controller, block the servomotor shaft to prevent rotation.
- DO NOT short across DC bus terminals or touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers and close enclosure door before applying power or starting and stopping the drive system.
- The user is responsible for conforming to all applicable code requirements with respect to grounding all equipment. For drive controller grounding points, refer to Fig. 1.7 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.

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Deinstallation

- ▶ Save the parameter settings of the unit:

  With the commissioning software, select 'File → Save' to save all values on the PC's data storage medium.

  With the Human-Machine Interface, select menu '8.1 Read Param.' to copy the parameter set into the Human-Machine Interface copy memory.

- ▶ Switch the unit off.
- ▶ Disconnect the power supply.
- ▶ Mark all connections to the unit.
- ▶ Disconnect the motor cable.
- ▶ Pull out the interface connector.
- ▶ Remove the unit from the control cabinet.

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

Storage Store the unit within the specified storage limits for room temperature and humidity.

Protect the unit from dust and dirt.

Disposal When servicing or decommissioning, dispose of this equipment in accordance with the applicable standards for this classification of equipment. The 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.

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10 Accessories and spare parts

10.1 List of accessories

Accessories The following accessories are available for IP20 and IP54 controllers:

Qty	Designation	IP20 Controller/ IP54 Controller (IP20/IP54)	Order Number
1	Commissioning software TL CT with on-line documentation on data carrier, multilingual	IP20/IP54	TLAPSCA
1	HMI hand-held operating unit with manual	IP20/IP54	TLAPHOO
1	Motor cable 16 AWG (1.5 mm^2) with motor plug Motor cable 14 AWG (2. 5mm^2) with motor plug Motor cable 12 AWG (4mm^2) with motor plug	IP20/IP54	TLACPAAAxxx1 1) TLACPAABxxx1 1) TLACPAACxxx1 1)
1	Sensor cable for Hiperface module HIFA-C	IP20/IP54	TLACFABAxxx1 1)
1	Pulse direction cable for module PULSE-C	IP20/IP54	TLACDCBByyy 1)
1	Cables for module RS-422-C	IP20/IP54	TLACDCBCyyy 1)
1	Fieldbus cable for module CAN-C, IBS-C	IP20/IP54	 TLACDCBAyyy1) TLACDCBFyyy1)
1	CAN terminator, 9-pin socket CAN terminator, 9-pin plug	IP20/IP54	TLATA TLATB
1	RS-232 programming cable 5m RS-232 programming cable 1 0m	IP20/IP54	TLACDPBG 050 TLACDPBG 100
1	Holding brake controller TLHBC	IP20	TLABHO
1	Ballast resistor controller TL BRC	IP20	TLABBO
1	External ballast resistor BWG 250072 (100 W, 72 Ohm) BWG 250150 (100 W, 150 Ohm) BWG 500072 (200 W, 72 Ohm) BWG 500150 (200 W, 150 Ohm)	IP20	 TLABRA TLABRB TLABRC TLABRD
1	Terminal angle TS 15 e.g. for terminals from PhoenixContact, Type MBK	IP54	TLATLR
1	Set grommets, type KDT/Z 2)	IP54	TLATKR

1) Cable length xxx: 003, 005, 010, 020, 3 m (9.84 ft.), 5 m (16.4 ft.), 10 m (32.8 ft.), 20 m (65.6 ft.), longer lengths on request;
2) The inside diameter of the grommets must match the diameter of the cables used.

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10.2 List of spare parts

Motion controller

Qty.	Designation	Order no.
1	TLC532, TLC534, TLC536 or TLC538	See Fig. 1.6
1	SK14 shielding terminal	TLATE
1	Connector caps for the terminal strips	-
1	IP54 Fan Kit	TLAMSR

10.3 Suppliers

Reserved.

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11 Unit label

11.1 Illustration of the controller label

▶ The label shown below is provided as a guide. It may be copied and attached to the inside of theTwin Line unit’s cover.

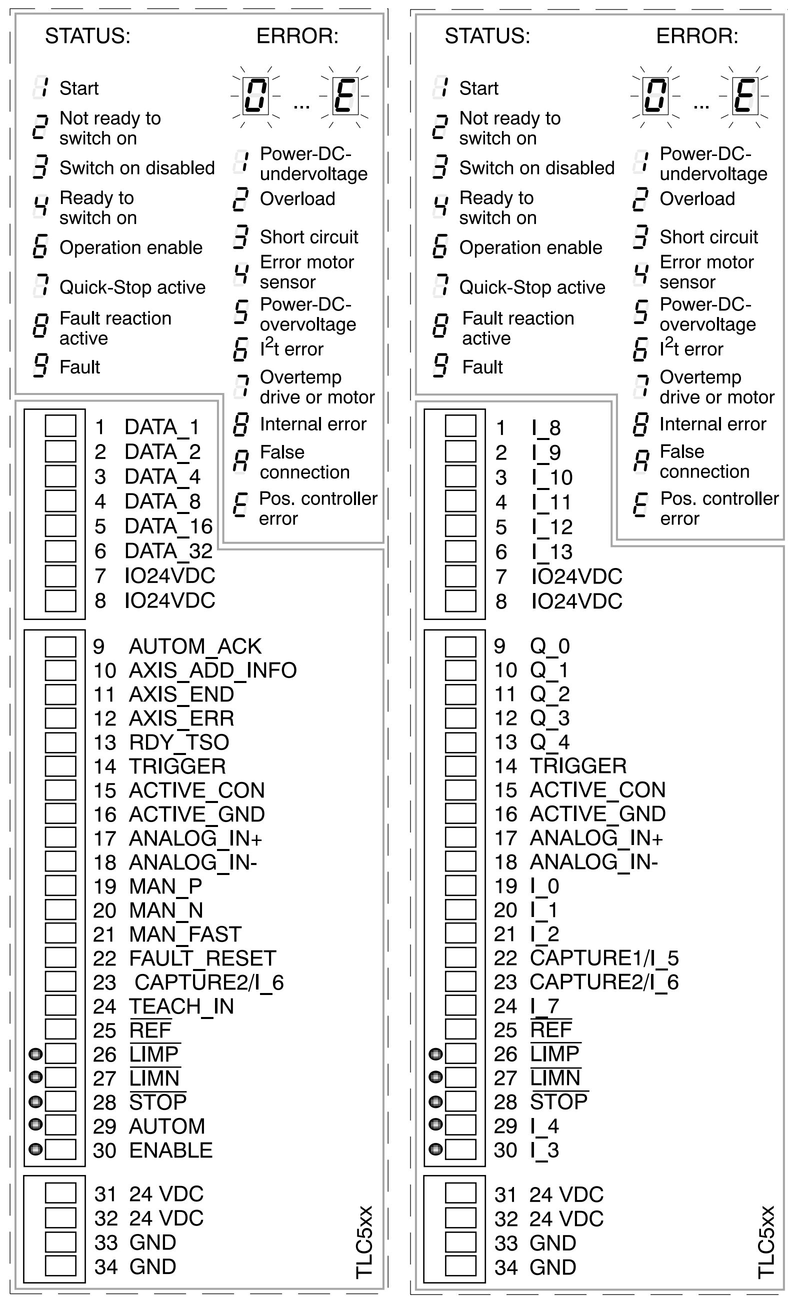

Fig. 11.1 Unit label

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12 Parameters

12.1 Overview

Parameter groups The parameters of the Twin Line controller are grouped by function.

- Settings, Page 12-3:
  Behavior of the input and output signals of the signal interface, modification of error responses, gear ratios, parameters for the ±10 V interface and general control system settings
- Commands, Page 12-4:
  Transmission of parameter sets, power amplifier system settings, controller
- PA, Page 12-5:
  Power amplifier parameters, system settings
- Servomotor, Page 12-6:
  Motor-specific settings. These settings cannot be modified with the Human-Machine Interface HMI.
- CtrlBlock1, CtrlBlock2, Page 12-8:
  Settings for the control loops, stored in control parameter sets 1 and 2.
- Motion, Page 12-9:
  Parameter settings for all operating modes: jerk filter, direction of rotation, software limit switches, normalization and ramp settings
- Manual, Page 12-10:
  Parameter settings for manual mode
- VEL, Page 12-11:
  Settings for speed mode
- PTP, Page 12-11:
  Settings for point-to-point mode
- Gear, Page 12-12:
  Settings for electronic gear mode with offset superimposition
- Home, Page 12-13:
  Settings for referencing mode
- Teach, Page 12-14:
  Settings forTeach-In operating function
- List, Page 12-14:
  Settings for the list-controlled operation function
- List1Data0..List1Data63, Page 12-16:
  List data input data
- List2Data0..List2Data63, Page 12-17:
  List data input data
- Capture, Page 12-17:
  Operating function settings for capturing position data
- I/O, Page 12-18:
  Switching states of the inputs and outputs of the signal interface
- M1, Page 12-18:
  Settings for modules in slot M1
- M4, Page 12-19:
  Settings for modules in slot M4

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- Status, Page 12-20:
  System settings: Device-specific and current parameters such as temperature values of the power amplifier, motor and internal ballast resistor, control loop parameters, setpoints, 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 will automatically limit to the lesser value.

Temperature in Kelvin [K] = temperature in degree Celsius [°C]+ 273, for example: 358 K = 85 °C

What does this mean?

Idx:Sidx: Index and subindex for identifying a parameter, can be input with the commissioning software in the 'Monitor' window.

R/W: Value can be read or written. R/- means the value is read only.

rem: The value is non-volatile; it is retained in the memory even after the unit is switched off.

Info page: Further information on the parameter will be found on the page specified.

Access channel information is specific. Use the information that is relevant for controlling the unit through the selected access channel.

Access channel	Specifications
Fieldbus, signal interface	Idx:Sidx:
TLHMI	Menu items under TL-HMI
TLCT	Parameter group.individual parameters, e.g. “Settings.SignEnabl"

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12.2 Parameter groups

12.2.1 Parameter group Settings

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values 1)	Default Value	R/W rem.	Info Page
name1	11:1	–	User device name 1	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	Configuration password, for use with a hand-held operating unit	UINT16 0..9999 0: No password protection	0	R/– rem.	-
p_maxDiff	12:11	4.1.23	Maximum permitted contour error of the position controller [inc]	UINT32 0 - 131072 Eight motor revolutions With resolver motor max. 8*4096 inc	16384	R/W rem.	7-29
p_win	12:13	4.1.24	Standstill window, permissible control deviation (inc)	UINT16 0..32767	16	R/W rem.	7-21
p_winTime	12:15	4.1.25	length of time for which control deviations must lie within standstill window for standstill to be reported [ms] 0: standstill monitoring switched off	UINT16 0..32767	0	R/W rem.	7-21
f_Chop	12:17	4.1.21	Switching frequency of the current module, (default value=1; 0 for TLxx38)	UINT16 0: 4kHz 1: 8kHz 2: 16kHz	1	R/W rem.	5-13
p_winTout	12:21	4.1.27	time within which standstill must be reported [ms] 0: deactivated	UINT16 0 ... 32767	0	R/W rem.	7-21
SignEnabl	28:13	4.1.10	Signal enable for monitoring inputs 0: inactive 1: active	UINT16 Bit0 : LIMP Bit1 : LIMN Bit2 : STOP Bit3 : REF	7	R/W rem.	7-39
SignLevel	28:14	4.1.11	Signal level for monitoring inputs 0: reaction at 0-level 1: reaction at 1-level	UINT16 Bit0 : LIMP Bit1 : LIMN Bit2 : STOP Bit3 : REF	0	R/W rem.	7-27
SignQstop	28:20	4.1.26	Check signals which initiate quick stop 0: Deceleraton ramp 1: Quick stop ramp	UINT16 Bit0 : LIMP Bit1 : LIMN Bit2: STOP Bit3: REF Bit6: - Bit7: SW_STOP	0	R/W rem.	7-19
I_maxSTOP	28:22	4.1.3	Current limit for quick stop [100=1Apk]	UINT16 0 - max. current	–	R/W rem.	5-13, 7-20
Flt_AC	28:23	4.1.12	Error response to mains failure of 2 stages	UINT16 1: Error class 1 2: Error class 2 3: Error class 3	3	R/– rem.	-

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Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values [1)]	Default Value	R/W rem.	Info Page
Flt_pDiff	28:24	4.1.13	Error response to contour error	UINT16 1: Error class 1 2: Error class 2 3: Error class 3	3	R/W rem.	-
TL_BRC	28:26	4.1.14	external ballast resistance control TLBRC	UINT16 0: not connected 1: connected	0	R/W rem.	5-13
IO_mode	29:31	4.1.4	Significance of I/O signal assignment	UINT16 0: setting Fieldbus parameters via I/O assignment 1: I/O freely available 2: I/O assigned functions	0	R/W rem.	6-5

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

12.2.2 Parameter group 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 Ranges to be saved: Bit0: Parameters 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	–	Initialize parameters with default values Factory settings	UINT16 1: Start initialization	–	R/W –	-
stateDef	11:9	–	Processing state param. 'Commands.default'	UINT16 0: Initializing 1: Initialization completed	–	R/– –	-
driveCtrl	28:1	–	Control word for change of state, presetting bit 0..3='0', write access automatically triggers change of slope 0->1	UINT16 Bit0: disable amplifier Bit1: enable amplifier Bit2: stop (quick stop) Bit3: FaultReset Bits4..15: not assigned	0	R/W –	8-2
SetCtrl	28:4	5.1.0	Switch control parameters set	UINT16 0: - 1: parameter set 1 2: parameter set 2	1	R/W –	5-13
OnlAuto	29:30	–	Access to the mode setting	UINT16 0: access via local control units or Fieldbus 1: access via Fieldbus only	0	R/W –	6-4
del_err	32:2	5.4	Deletion of all entries in error memory	UINT16 0	0	R/W –	8-23

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12.2.3 Parameter group PA

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values 1)	Default Value	R/W rem.	Info Page
KPid	12:4	–	Current controller longitudinal direction (d) P factor (10=1V/A)	UINT16	–	R/– rem.	-
KIid	12:5	–	Current controller longitudinal direction (d) I factor [100=1ms]	UINT16	–	R/– rem.	-
KPiq	12:8	–	Current controller transverse direction (q) P factor [10=V/Apk]	UINT16	–	R/– rem.	-
KIiq	12:9	–	Current controller transverse direction (q) I factor [ms]	UINT16	–	R/– rem.	-
I_maxfw	12:18	–	Field-weakening controller, max. field current [100=1Apk]	UINT16 -	–	R/– rem.	-
KPfw	12:19	–	Field-weakening controller P-factor [1000=1Apk/V]	UINT16 -	–	R/– rem.	-
Kifw	12:20	–	Field-weakening controller reset time (100 = 1ms)	UINT16 -	–	R/– rem.	-
I_maxPA	16:8	2.2.1	Peak current of the unit [100=1Apk]	UINT16	1000	R/– rem.	-
I_nomPA	16:9	2.2.2	Nominal current of the unit [100=1Apk]	UINT16	–	R/– rem.	-
T_warnPA	16:10	2.2.15	Temperature warning threshold of the current amplifier [K]	UINT16	–	R/– rem.	7-28
T_maxPA	16:11	2.2.16	Max. permitted temperature of the current amplifier [K]	UINT16	–	R/– rem.	7-28
U_maxDC	16:12	2.2.17	Max. permitted DC-line voltage on the DC-bus [10=1V]	UINT16	–	R/– rem.	-
I2tPA	16:13	2.2.10	Max. permitted time for max. current at high speed [ms]	UINT16	–	R/– rem.	7-28
I2t_warnB	16:14	2.2.12	Duty cycle warning threshold for internal ballast resistor [ms]	UINT16	–	R/– rem.	7-28
I2tB	16:15	2.2.11	Max. permitted duty of internal ballast resistor [ms]	UINT16	–	R/– rem.	7-28
F_maxChop	16:16	2.2.18	Permitted switching frequency of the current amplifier	UINT16 0: 4 kHz 1: 8 kHz 2: 16 kHz	–	R/– rem.	
I2t_n0PA	16:47	2.2.13	Max. permitted time for max. current at low speed [ms]	UINT16	–	R/– rem.	-
P_maxB	16:49	–	Internal ballast rated current [W]	UINT16	–	R/– rem.	-

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values 1)	Default Value	R/W rem.	Info Page
I_maxPAr	16:52	2.2.3	Reduced peak current of the unit [100=1Apk]	UINT16	–	R/– rem.	-
I_nomPAr	16:53	2.2.4	Reduced nominal current of the unit [100=1Apk]	UINT16	–	R/– rem.	-
P_maxBusr	16:57	4.1.40	maximum permissible ballast power [W]	TLC5325: 25 - 170 W TLC5345: 37 - 255 W	25/37	R/W rem.	4-58

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

12.2.4 Parameter group Servomotors

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values 1)	Default Value	R/W rem.	Info Page
infoM	13:3	–	Motor calibration carried out	UINT16 -	–	R/– rem.	-
adj1Sen	13:4	–	1. Alignment information of the position sensor	UINT16 Calibration value Sincoder/ resolver alignment offset = "eps_e_b"	–	R/– rem.	-
adj2Sen	13:5	–	2. Alignment information of the position sensor	UINT16	–	R/– rem.	-
reserve	13:6	–	Reserved	UINT16	–	R/– rem.	-
reserve	13:7	–	Reserved	UINT16	–	R/– rem.	-
TypeM	13:8	2.1.1	Motor type, consecutive numbers	INT32 0: No motor selected -..: Resolver motors +..: Sincoder motors	0	R/– rem.	-
SensorM	13:9	2.1.5	Motor encoder type	UINT16 0: Unknown 1: Resolver 2: SNS (Sincoder) 3: SRS (SinCos single turn) 4: SRM (SinCos multiple turn)	0	R/– rem.	-
CountSen	13:10	–	No. of lines of position sensor per motor revolution	UINT16	–	R/– rem.	-
n_maxM	13:11	2.1.9	Maximum permitted motor speed [rpm]	UINT16	–	R/– rem.	-
n_nomM	13:12	2.1.14	Nominal motor speed [rpm]	UINT16	–	R/– rem.	-
I_maxM	13:13	2.1.8	Max. motor current [100=1Apk]	UINT16	–	R/– rem.	-
I_nomM	13:14	2.1.10	Nominal motor current [100=1Apk]	UINT16	–	R/– rem.	-
M_nomM	13:15	2.1.15	Nominal torque [Ncm]	UINT16	–	R/– rem.	-
M_maxM	13:16	2.1.16	Peak torque [Ncm]	UINT16	–	R/– rem.	-
U_nomM	13:17	2.1.17	Nominal motor voltage [10=1V]	UINT16	–	R/– rem.	-

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Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values 1)	Default Value	R/W rem.	Info Page
PolepairM	13:18	2.1.25	Motor pole-pair number	UINT16	–	R/– rem.	-
KeM	13:20	2.1.26	Motor EMF constant Ke [100=1Vs]	UINT16	–	R/– rem.	-
JM	13:21	2.1.27	Motor mass moment of inertia [10=1kgmm2]	UINT16	–	R/– rem.	-
R_UVM	13:22	2.1.28	Motor connection resistance [100=1Ohm]	UINT16	–	R/– rem.	-
L_qM	13:23	2.1.35	Motor inductance q-direction [100=1mH]	UINT16	–	R/– rem.	-
L_dM	13:24	2.1.36	Motor inductance d-direction [100=1mH]	UINT16	–	R/– rem.	-
T_maxM	13:26	2.1.30	Max. motor temperature [K]	UINT16	–	R/– rem.	-
I2tM	13:27	2.1.37	I2t motor: max. permitted time at max. current servomo-tor.I_maxM [ms]	UINT16	–	R/– rem.	-
fR	13:28	2.1.21	Resolver frequency	UINT16 0: 3.5 kHz 1: 5 kHz 2: 6.5 kHz 3: 10 kHz	–	R/– rem.	-
PolepairR	13:29	2.1.20	Pole-pair number of resolver	UINT16	1	R/– rem.	-
TempTypeM	13:30	2.1.38	Temperature sensor type (PTC / NTC)	UINT16 0: PTC 1: NTC	1	R/– rem.	-
T_warnM	13:32	2.1.29	Motor temperature prewarning [K]	UINT16	–	R/– rem.	-
Tcal_t1	13:33	–	Temperature characteristic 1, value 1	UINT16	–	R/– rem.	-
Tcal_t2	13:34	–	Temperature characteristic 1, value 2	UINT16	–	R/– rem.	-
Tcal_t3	13:35	–	Temperature characteristic 1, value 3	UINT16	–	R/– rem.	-
Tcal_t4	13:36	–	Temperature characteristic 1, value 4	UINT16	–	R/– rem.	-
Tcal_t5	13:37	–	Temperature characteristic 1, value 5	UINT16	–	R/– rem.	-
Tcal_t6	13:38	–	Temperature characteristic 1, value 6	UINT16	6	R/– rem.	-
Tcal_t7	13:39	–	Temperature characteristic 1, value 6	UINT16	–	R/– rem.	-
Tcal_t8	13:40	–	Temperature characteristic 1, value 8	UINT16	–	R/– rem.	-
Tcal_u1	13:41	–	Temperature characteristic 2, value 1	UINT16	–	R/– rem.	-
Tcal_u2	13:42	–	Temperature characteristic 2, value 2	UINT16	–	R/– rem.	-

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Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values 1)	Default Value	R/W rem.	Info Page
Tcal_u3	13:43	–	Temperature characteristic 2, value 3	UINT16	–	R/– rem.	-
Tcal_u4	13:44	–	Temperature characteristic 2, value 4	UINT16	–	R/– rem.	-
Tcal_u5	13:45	–	Temperature characteristic 2, value 5	UINT16	–	R/– rem.	-
Tcal_u6	13:46	–	Temperature characteristic 2, value 6	UINT16	–	R/– rem.	-
Tcal_u7	13:47	–	Temperature characteristic 2, value 7	UINT16	–	R/– rem.	-
Tcal_u8	13:48	–	Temperature characteristic 2, value 8	UINT16	–	R/– rem.	-
ResolutM	13:49	2.1.6	Resolution of the position sensor [inc/rev.]	UINT32	–	R/– rem.	-
name1M	13:50	–	Motor name, 1st part	UINT32	–	R/– rem.	-
name2M	13:51	–	Motor name, 2nd part	UINT32	–	R/– rem.	-
name3M	13:52	–	Motor name, 3rd part	UINT32	–	R/– rem.	-
name4M	13:53	–	Motor name, 4th part	UINT32	–	R/– rem.	-
I_0M	13:54	2.1.13	Motor continuous current at standstill (100=1Apk)	UINT16	–	R/– rem.	-

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

12.2.5 Parameter group CtrlBlock1, CtrlBlock2

Parameter Name	Idx:Sidx 1)	TL-HMI 2)	Explanation and unit [ ]	Range of values 3)	Default Value	R/W rem.	Info Page
I_max	18:2 19:2	4.2.2 4.3.2	Current limit in all operating modes including controller optimization. Not in manual or quick stop operating modes [100=1Apk]	UINT16 0 - max.current	10	R/W rem.	5-27
n_max	18:5 19:5	4.2.3 4.3.3	Max. speed [rpm]	UINT16 0...'Servomotor.n_maxM'	6000	R/W rem.	5-13
KPn	18:7 19:7	4.2.5 4.3.5 6.2.1	Speed controller P-factor [1000=A*min/rev]	UINT16 0...32767	10	R/W rem.	5-23
TNn	18:8 19:8	4.2.6 4.3.6 6.2.2	Speed controller integral time I-factor [100=1ms]	UINT16 0...32767	500	R/W rem.	5-23
TVn	18:9 19:9	4.2.7 4.3.7 6.2.3	Speed controller derivative time D-factor [100=1ms]	UINT16 0...32767	0	R/W rem.	-
KFPn	18:10 19:10	4.2.15 4.3.15 6.2.4	Speed controller feed forward control P-factor [100=1A*min/rev]	UINT16 0...32767	0	R/W rem.	-

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Parameter Name	Idx:Sidx 1)	TL-HMI 2)	Explanation and unit [ ]	Range of values 3)	Default Value	R/W rem.	Info Page
KFDn	18:11 19:11	4.2.16 4.3.16 6.2.5	Speed controller feed forward control D-factor [10 000=1mAs*min/rev]	UINT16 0...32767	0	R/W rem.	-
K1n	18:12 19:12	–	Speed controller feed forward control actual speed [100=1mA*min/rev]	UINT16 0...32767	0	R/– rem.	-
KPp	18:15 19:15	4.2.10 4.3.10 6.3.1	Position controller P-factor [10=1/s]	UINT16 0...32767	14	R/W rem.	5-23
TVp	18:16 19:16	4.2.11 4.3.11 6.3.2	Position controller derivative time D-factor (100=1ms)	UINT16 0...32767	0	R/W rem.	-
KFPp	18:18 19:18	4.2.17 4.3.17 6.3.3	Position controller feed forward control speed [-]	UINT16 0...32767	100	R/W rem.	-
KFAp	18:19 19:19	4.2.18 4.3.18 6.3.4	Speed controller feed forward control acceleration (10 000=1As*min/rev)	UINT16 0...32767	0	R/W rem.	-
Filt_nRef	18:20 19:20	4.2.8 4.3.8	Filter time constant reference variable filter of the setpoint speed (100=1ms)	UINT16 0...32767	0	R/W rem.	5-31

1) Control parameter sets 1 (18:xx), sets 2 (19:xx)
2) The HMI-menus "6.2..." and "6.3..." are for optimization
3) Max. current: Lower of the two values 'Servomotor.I_maxM' and 'PA.I_maxPA'

12.2.6 Parameter group Motion

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
Filt_jerk	28:5	4.4.26	Jerk filter	UINT16 0: off 3..30: filter setting value	0	R/W rem.	7-18
invertDir	28:6	4.4.27	Inversion of sense of rotation	UINT16 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
SW_LimN	29:5	4.4.6	Software limit switch for pos. Position limit LIMN condition: SW_LimN > SW_LimP [usr]	INT32 -2147483648..2147483647	-2147483648	R/W rem.	7-26
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.	7-38
pNormNum	29:7	4.4.20	Position calibration numerator	INT32 -2147483648..2147483647	1	R/W rem.	7-12
pNormDen	29:8	–	Position calibration denominator	INT32 -2147483648..2147483647	16384	R/W rem.	7-12
vNormNum	29:9	4.4.21	Speed calibration numerator	INT32 1..2147483647	1	R/W rem.	7-12

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Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
vNormDen	29:10	–	Speed calibration denominator	INT32 1..2147483647	1	R/W rem.	7-12
aNormNum	29:11	4.4.22	Acceleration calibration numerator	INT32 1..2147483647	1	R/W rem.	7-12
aNormDen	29:12	–	Acceleration calibration denominator	INT32 1..2147483647	1	R/W rem.	7-12
n_max0	29:21	4.4.28	Speed limit for travel profile [r.p.m.]	UINT32 1 .. 'Servomotor.n_maxM'	3000	R/W rem.	-
v_target0	29:23	4.4.11	Setpoint speed [usr]	UINT32 1..n_max0	60	R/W rem.	-
acc_type	29:25	4.4.13	Shape of acceleration curve	UINT16 1: linear 2: -	0	R/W rem	7-17
acc	29:26	4.4.14	Acceleration [usr]	UINT32 60...2000000	600	R/W rem.	7-17
dec	29:27	4.4.15	Deceleration [usr]	UINT32 60...2000000	600	R/W rem.	7-17

12.2.7 Parameter group Manual

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
I_maxMan	28:25	3.2.14	max. current in manual mode (100=1Apk)	UINT16 0...Max. current	1000	R/W rem.	5-13
startMan	41:1	3.2.1	Start of manual travel with transfer of control bits	UINT16 Bit 2: 0:slow 1:fast Bit1: negative rotation Bit0: positive rotation	–	R/ W–	6-12
statusMan	41:2	–	Acknowledgement: Manual travel	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 Bit14: manu_end Bit15: manu_err	-	R/—	6-12
typeMan	41:3	3.2.2	Type of Manual Travel	UINT16 0.: Mode One 1: Mode Two	0	R/W rem.	6-12
n_slowMan	41:4	3.2.3	Speed for slow manual travel [usr]	UINT32 1...2147483647	60	R/W rem.	6-13
n_fastMan	41:5	3.2.4	Speed for fast manual travel [usr]	UINT32 1...2147483647	180	R/W rem.	6-13
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	20	R/W rem.	6-13

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Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
time_Man	41:8	3.2.7	Mode one waiting time [ms]	UINT16 1..30000	500	R/W rem.	6-13

12.2.8 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	–	R/W –	6-16
stateVEL	36:2	–	Acknowledgement: speed profile mode	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: sepoint speed reached Bit14: vel_end Bit15: vel_err	–	R/– –	6-16

12.2.9 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 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: Setposition reached Bit14: motion_end Bit15: motion_err	–	R/– –	6-9, 6-19

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
p_relPTP	35:3	3.1.1.2	Start of relative positioning with value transfer for travel [usr]	INT32 -2147483648...2147483647	–	R/W –	6-19
continue	35:4	3.1.1.3	Continuation of interrupted positioning with transfer of any value	UINT16 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

12.2.10 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	Start of electronic gear ratio processing with selection of processing mode	UINT16 0: deactivated 1: immediate synchronisation 2: synchronisation with compensating movement	–	R/W –	6-21
stateGear	38:2	-	Acknowledgement: gear ratio processing	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: gear_end Bit15: gear_err	–	R/– –	6-21
n_maxGear	38:5	3.1.3.3	Max. speed [rpm]	INT32 1..12000	3000	R/W rem.	6-23
numGear	38:7	3.1.3.2	Gear ratio factor numerator	INT32 -2147483648...2147483647	1	R/W –	6-22
denGear	38:8	–	Gear ratio factor denominator	INT32 1...2147483647	1	R/W –	6-22
modeGear	38:9	3.1.3.5	Handling of accumulated control pulses when activating gear function	UINT16 1: reset 2: execute	1	R/W -	-
DirEnGear	38:13	–	Release of movement direction, Reversing the sense of rotation inverts the movement direction	INT16 1: positive direction 2: negative direction 3: both directions	3	R/W rem.	6-23
p_absOffs	39:1	3.1.3.6	Start of absolute offset positioning with transfer of position	INT32 -2147483648...2147483647	0	R/W –	6-29

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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 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 [inc/s]	INT32 -12000..12000	60	R/W –	6-29
phomeOffs	39:6	3.1.3.9	Sizing in offset positioning [inc]	INT32 -2147483648...2147483647	0	R/W –	6-29
accOffs	39:7	3.1.3.10	Acceleration ramp for offset positioning [r.p.m/s]	INT32 60..2.000.000	600	R/W –	6-29
decOffs	39:8	3.1.3.11	Deceleration ramp for offset positioning [r.p.m/s]	INT32 60..2.000.000	600	R/W –	6-29

12.2.11 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 operating mode referencing	UINT16 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 –	6-31
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 Bit14: ref_end Bit15: ref_err	–	R/– –	6-31
startSetp	40:3	3.3.2	Sizing on sizing position (set absolute position) [usr]	INT32 -2147483648...2147483647	–	R/W –	6-34
v_Home	40:4	3.3.3	Speed for search of reference switch [usr]	INT32 -2147483648...2147483647	60	R/W rem.	6-31
v_outHome	40:5	3.3.4	Speed for processing run-out and safety distance [usr]	INT32 -2147483648...2147483647	6	R/W rem.	6-31

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Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
p_outHome	40:6	3.3.5	Run-out distance, is automatically approached when reference is found [usr]	UINT32 0: Run-out disabled > 0: Run-out distance [usr]	0	R/W rem.	6-31
p_disHome	40:7	3.3.6	Safety distance of switching edge to reference point	UINT32 0...2147483647	200	R/W rem.	6-31

12.2.12 Parameter group Teach

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default-Value	R/W rem.	Infos page
storeTeac	43:1	–	Teach-In processing, select memory address, list number for storing position value (0...63) Example: 000010: list number 2	UINT16 Bit0..5: list number	0	R/W –	7-9
stateTeac	43:2	–	Acknowledgement: Teach-In processing	UINT16 Bit15: teach_err Bit14: teach_end	–	R/– –	7-9
memNrTeac	43:3	–	Memory selection for Teach-In processing	UINT16 1: List 1 of list processing 2: List 2 of list processing	1	R/W –	7-9
p_actTeac	43:4	–	current motor position in Teach-In processing [usr]	INT32	–	R/– –	7-9

12.2.13 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 processing, current list-driven operation is first deactivated	UINT16 0:deactivate list driven operation 1: activate List 1 2: activate List 2	0	R/W –	7-2
stateList	44:2	–	acknowledgement and status: list data processing	UINT16 Bit15: list_err Bit14: list_quit 0: list data processing active 1: list data processing completed Bit0,1: - 0: No list active - 1: List 1 active - 2: List 2 active	–	R/– –	7-2
cntList1	44:4	–	List 1: number of available list entries	UINT16	64	R/– –	7-2
bgnList1	44:6	–	List 1: starting number, first entry for list data processing starting number < finishing number	UINT16 0...63	0	R/W rem.	7-2
endList1	44:7	–	List 1: finishing number, last entry for list data processing finishing number > starting number	UINT16 0...63	63	R/W rem.	7-2

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Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
cntList2	44:12	–	List 2: number of available list entries	UINT16	64	R/– –	7-2
bgnList2	44:14	–	list 2 starting number, first entry for list data processing starting number < finishing number	UINT16 0...63	0	R/W rem.	7-2
endList2	44:15	–	List 2: finishing number, last entry for list data processing finishing number > starting number	UINT16 0...63	63	R/W rem.	7-2
actList	44:18	–	Last activated list	INT16 -1: no list entries activated yet 0..63: last activated list entry	0	R/– –	7-2

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12.2.14 Parameter group List1Data0..List1Data63

Specified here: List1Data0: Index 1100,
List1Data1 to List1Data63 via 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: pos./signal 2: pos./speed	1	R/W rem.	7-3
posList1	1100:2	7.3.2.1 7.3.2.2	List 1: position	INT32	0	R/W rem.	7-3
signList1	1100:3	7.3.2.3	List 1: signal state	UINT16 0, 1	0	R/W rem.	7-3
velList1	1100:4	7.3.2.4	List 1: setpoint speed [usr]	INT32 -'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.	7-3

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12.2.15 Parameter group List2Data0..List2Data63

Specified here: List2Data0: Index 1200,
List2Data1 to List2Data63 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 (1202:x...1263:x)	UINT16 1: pos./signal 2: pos./speed	1	R/W rem.	7-3
posList2	1200:2	7.4.2.1 7.4.2.2	List 2: position [usr]	INT32	0	R/W rem.	7-3
signList2	1200:3	7.4.2.3	List 2: signal state	UINT16 0, 1	0	R/W rem.	7-3
velList2	1200:4	7.4.2.4	List 2: setpoint speed [usr]	INT32 -'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.	7-3

12.2.16 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: Signal - channel 1 (K1) Examples: 4: binary 01 00 => CAPTURE2 (channel 2), CAPTURE1 (channel 1) 9: 10 01 => index pulse, setpoint sensor (channel 2), CAPTURE2 (channel 1)	UINT16 Bits 0..1/ Bits 2..3 (K1/K2): - 00: CAPTURE1 - 01: CAPTURE2 - 10: index pulse setpoint sensor (with module on M1) - 11: index pulse actual position sensor (for SM with module on M2)	4	R/W –	7-24
TrigType	20:14	–	Position source for position storage	UINT16 0: actual position sensor 1: setpoint position sensor	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 Bit0: set trigger level on channel 1 Bit1: set trigger level on channel 2	1	R/W –	7-24
TrigStart	20:16	–	start triggering (bits 0..1): 0: no change 1: reset triggering and repeat cancel triggering (bit 14=1) repeat triggering (bit15) 0: trigger once 1: trigger continuously	UINT16 Bit0: trig. on channel 1 Bit1: trig. on channel 2 Bit14: cancel trig. Bit15: repeat trig.	0	R/W –	7-24

Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
TrigStat	20:17	–	Status of trigger channels	UINT16 Bit0: triggering on channel 1 running Bit1: triggering on channel 2 running	0	R/– –	7-24
TrigPact1	20:18	–	Actual position of motor on triggering on channel 1 (inc)	INT32	-	R/– –	7-24
TrigPact2	20:19	–	Actual position of motor on triggering on channel 2 (inc)	INT32	-	R/– –	7-24
TrigPref1	20:20	–	Setpoint of electrical gear ratio on triggering on channel 1 (inc)	INT32	-	R/– –	7-24
TrigPref2	20:21	–	Setpoint of electrical gear ratio on triggering on channel 2 (inc)	INT32	-	R/– –	7-24

12.2.17 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 TLCT): read access shows force state	UINT16 Bit0: LIMP Bit1: LIMN Bit2: STOP Bit3: REF	–	R/– –	-
IW1_act	33:4	2.4.2	Input word 1, With 'forcing' (e.g. with TLCT): read access shows force state	UINT16 - Bit0...Bit4: I_0...I_4 - Bit5: CAPTURE1 - Bit6: CAPTURE2 - Bit7...Bit13: I_7...I_13	–	R/– –	-
QW0	34:1	2.4.10	Output word 0, With 'forcing' (e.g. with TLCT): read access shows force state	UINT16 - Bit0 ...Bit4: Q_0...Q_4 - Bit5: ACTIVE-CON - Bit6: TRIGGER	–	R/W –	-
OutTrig	34:9	–	Setting trigger output if signal list inactive	UINT16 0: Low level 1: High level	0	R/W –	7-6

12.2.18 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	UINT16 Bit2: Max. frequency 0: 200 kHz, 1: 25 kHz Bit3: Signal shape: 0: PULSE-DIR 1: PV-PR	4	R/W rem.	-

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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	RS-485 interface, processing mode incl. Profile selection only readable via Fieldbus	UINT32	0	R/W rem.	-
baudSer	24:12	4.5.11	RS-485 interface, baud rate [baud] only readable via Fieldbus	UINT32 0 = Autobaud 9600 = 9600 Baud 19200 = 19200 Baud 38400 = 38400 Baud	9600	R/W rem.	-
addrSer	24:13	4.5.12	RS-485 interface, address only readable via Fieldbus	UINT16	1	R/W rem.	-
toutSer	24:14	4.5.13	RS-485 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	R/W rem.	-
baudIbs	24:17	4.5.16	Interbus-S, baud rate (kbaud) only readable via Fieldbus	UINT32	500	R/W rem.	-
toutIbs	24:18	4.5.17	Interbus-S, timeout time [ms] only readable via Fieldbus	UINT16 0...65535 0: monitoring inactive	0	R/W rem.	-
profilPbd	24:20	4.5.20	Profibus-DP, processing mode incl. Profile choice only readable via Fieldbus	UINT32	0	R/W rem.	-
addrPbd	24:21	4.5.21	Process bus - DP, address only readable via Fieldbus	UINT16 0..126	126	R/W rem.	-
profilCan	24:23	4.5.25	CAN, processing mode incl. Profile choice only readable via Fieldbus	UINT32	0	R/W rem.	-
addrCan	24:24	4.5.26	CAN, address only readable via Fieldbus	UINT16 0..127	127	R/W rem.	-

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Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
baudCan	24:25	4.5.27	CAN, baud rate [baud] only readable via Fieldbus	UINT32	125k	R/W rem.	-
toutCan	24:26	4.5.28	CAN, timeout time [ms]	UINT16 0...65535 0: monitoring inactive	0	R/W rem.	-
busDiag	24:30	2.6.5	Bus diagnosis for DeviceNet (DNSTATE)	0: OFFLINE 1: ONLINE 2: LINK_OK 3: FAILURE 4: TIMED_OUT 5: IDLE	-	R/- -	-

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	–	R/– -.	-
p_DifPeak	12:16	2.3.1.9	Max. contouring error reached [Inc] write access resets value	UINT32	0	R/W –	-
AnalogIn	20:8	2.3.3.1	analog input at input ANALOG_IN [mV]	INT16	0	R/– –	5-16
driveStat	28:2	2.3.5.1	Status word for the operational state of the device	UINT32 Bit0..3: act. 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 error (FltSig) Bit6=1:external monitoring error (FltSig_SR) Bit7=1: warning Bit13: x_add_info Bit14: x_end Bit15: x_err Bits16-20: current operating mode (Bit0-4: Status.xmode_act) Bit21: drive is referenced (ref_ok) Bit22: drive in standstill window (p_win)	–	R/– –	6-8

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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, bits 0 - 4: List of possible operating modes for your TL unit will be found in the section 'Operating modes'	UINT16 Bit0..4 device-specific: - 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) - 7 set mode - 8: function generator (current controller) - 9: function generator (speed controller) - 16..31: reserved Bit5=1: drive is referenced ('ref_OK') Bit6:- Bit7: reserved Bit8..15: not assigned	–	R/– –	6-34, 7-21
Sign_SR	28:15	2.3.4.1	Saved signal states of external monitoring signals 0: Not active, 1: Activated.	UINT16 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	Saved monitoring signals 0: Not active, 1: Activated	UINT32 Bit0: Fault, power up Bit1: DC-line undervoltage Lim1 Bit2: DC-line undervoltage Lim2 Bit3: Motor line earth fault Bit4: Motor line short circuit Bit5: DC-line 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: Contour 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/– –	-

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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 Bit0: Fault, power up Bit1: DC-line undervoltage Lim1 Bit2: DC-line undervoltage Lim2 Bit3: Motor line earth fault Bit4: Motor line short circuit Bit5: DC-line overvoltage Bit6: Overtemperature ballast Bit7: Overtemperature motor Bit8: Overtemperature power amplifier Bit9: I^2t power amplifier Bit 10: 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 HCI 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: Contour 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 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: Anticlockwise rotation drive Bit9: Current limit active Bit10: Speed limit active Bit11: Reference = 0 Bit12: Drive time-delayed Bit13: Drive accelerated Bit14: Drive operates constant	0	R/– –	-

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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 Bit0..1: reserved Bit2: position overrun Bit3..4: reserved Bit5: SW limit switch, clockwise sense of rotation (SW_LIMP) Bit6: SW limit switch, anti-clockwise sense of rotation (SW_LIMN) Bit7: stop via control word (SWSTOP) Bit8..14: reserved Bit15: amplifier not active Bit16..31: reserved	–	R/– –	7-26
ActCtrl	31:4	2.3.5.3	Active controller parameter set	UINT16 0: Reserved 1: Parameter set1 active 2: Parameter set2 active	–	R/– –	-
p_ref	31:5	2.3.1.2	Setpoint position of rotor [inc]	INT32	–	R/– –	-
p_act	31:6	2.3.1.1	Motor position / rev. [inc]	INT32	–	R/– –	-
p_dif	31:7	2.3.1.10	Contouring error [inc]	INT32	–	R/– –	-
n_ref	31:8	2.3.2.2	Setpoint speed [rpm]	INT16	–	R/– –	-
n_act	31:9	2.3.2.1	Actual speed [rpm]	INT16	–	R/– –	-
I_ref	31:10	2.3.3.11	Setpoint current [100=1Apk]	INT16	–	R/– –	-
Id_ref	31:11	–	Setpoint current d-component [100=1A]	INT16	–	R/– –	-
I_act	31:12	2.3.3.10	Current motor current [100=1A]	INT16	–	R/– –	-
Id_Act	31:13	–	Current motor current d-component [100=1A]	INT16	–	R/– –	-
uq_ref	31:14	–	Setpoint voltage q-component [10=1V]	INT16	–	R/– –	-
ud_ref	31:15	–	Setpoint voltage d-component [10=1V]	INT16	–	R/– –	-
p_abs	31:16	2.3.1.11	Absolute position per motor revolution (modulo value) [inc]	UINT16 RESO-C: 0...4095 HIFA-C: 0...16383	–	R/– –	-
I2tM_act	31:17	2.3.7.1	I^2t total motor [%]	INT32	–	R/– –	-
I2tPA_act	31:18	2.3.7.2	I^2t total power amplifier [%]	INT32	–	R/– –	-
I2tB_act	31:19	2.3.7.3	I^2t total ballast [%]	INT32	–	R/– –	-
UDC_act	31:20	2.3.3.2	DC-line voltage [10=1V]	INT16	–	R/– –	-

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Parameter Name	Idx:Sidx	TL-HMI	Explanation and unit [ ]	Range of values	Default Value	R/W rem.	Info Page
Iu_act	31:21	–	Motor phase current phase U [100=1A]	INT16	–	R/– –	-
Iv_act	31:22	–	Motor phase current phase V [100=1A]	INT16	–	R/– –	-
TM_act	31:24	2.3.6.1	Temperature of motor [°C]	INT16	–	R/– –	-
TPA_act	31:25	2.3.6.2	Temperature of power amplifier [°C]	INT16	–	R/– –	-
p_refGear	31:26	2.3.1.6	Setpoint position of electronic gear ratio [inc]	INT32	–	R/– –	-
v_refGear	31:27	2.3.2.5	Setpoint speed of electronic gear ratio [inc/s]	INT32	–	R/– –	-
v_ref	31:28	–	Speed of the rotor position setpoint value p_ref [inc/s]	INT32	–	R/– –	-
acc_ref	31:29	2.3.2.10	Acceleration of the position controller setpoint p_ref [rpm*s]	UINT16	–	R/– –	-
p_target	31:30	2.3.1.5	Target position of travel profile generator [usr]	INT32	–	R/– –	-
p_jerkusr	31:31	2.3.1.4	Actual position of travel profile generator [usr]	INT32	–	R/– –	-
p_tarOffs	31:32	2.3.1.8	Target position of offset positioning in electronic gear ratio [inc]	INT32	–	R/– –	-
p_refOffs	31:33	2.3.1.7	Actual position of offset positioning in electronic gear ratio [inc]	INT32	–	R/– –	-
p_actusr	31:34	2.3.1.3	Actual position of motor in operator units [usr]	INT32	–	R/– –	-
v_jerkusr	31:35	2.3.2.3	Actual speed of travel profile generator [usr]	INT32	–	R/– –	-
n_refOffs	31:36	2.3.2.6	Actual speed of offset positioning in electronic gear ratio [r.p.m.]	INT32	–	R/– –	-
p_remaind	31:37	–	Residual value of position calibration of position setpoint p_ref [inc]	INT32	–	R/– –	
v_target	31:38	2.3.2.4	Target speed of travel profile generator	INT32	–	R/– –	-
p_jerk	31:40	–	Setpoint position at jerk filter input [Inc]	INT32	–	R/– –	-
p_addGear	31:42	2.3.1.15	Checksum output position electronic gear [Inc]	INT32 -2147483648...2147483647	0	R/– –	-
v_refM1	31:43	2.3.2.5	Speed from input value increments counted on module on M1 [Inc/s]	INT32 -2147483648...2147483647	0	R/– –	-
StopFault	32:7	2.5.1	Cause of last interruption, error number	UINT16	–	R/– –	

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	–	Coded error number	UINT16 0...65535	–	R/– –	8-7
Class	900:2	–	Error class	UINT16 0...65535	–	R/– –	8-7
Time	900:3	–	Error moment since power amplifier switched on [ms]	UINT16 0...65535	–	R/– –	8-7
AmpOnCnt	900:4	–	Number of switch-on cycles of power amplifier	UINT16 –	–	R/– –	8-7
ErrQual	900:5	–	Additional information for assessing error	UINT16 –	0	R/– –	8-7

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