Rexroth
Bosch Group

Controllers, Motors, Electrical Accessories

Three-phase Motors, Stepping Motors

RE 82 720/2003-10

The Drive & Control Company

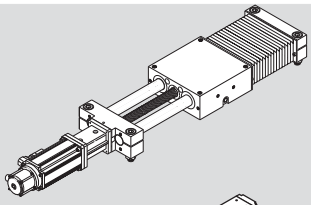
Rexroth Linear Motion Technology

Ball Rail Systems	Standard Ball Rail Systems Super Ball Rail Systems Ball Rail Systems with Aluminum Runner Blocks High-Speed Ball Rail Systems Corrosion-Resistant Ball Rail Systems Wide Ball Rail Systems	
	Ball Rail Systems with Integrated Measuring System Braking and Clamping Units for Ball Rail Systems Rack and Pinion for Ball Rail Systems Miniature Ball Rail Systems Cam Roller Guides	
Roller Rail Systems	Standard Roller Rail Systems Wide Roller Rail Systems Heavy Duty Roller Rail Systems Roller Rail Systems with Integrated Measuring System Braking and Clamping Units for Roller Rail Systems Rack and Pinion for Roller Rail Systems	
Linear Bushings and Shafts	Linear Bushings, Linear Sets Shafts, Shaft Support Rails, Shaft Support Blocks	
	Ball Transfer Units Traditional Engineering Components	
Screw Drives		
Linear Motion Systems	Linear Motion Slides	– Ball Screw Drive – Toothed Belt Drive
	Linear Modules	– Ball Screw Drive – Toothed Belt Drive – Rack and Pinion Drive – Pneumatic Drive – Linear Motor
	Compact Modules	– Ball Screw Drive – Toothed Belt Drive – Linear Motor
	Precision Modules	– Ball Screw Drive
	Ball Rail Tables	– Ball Screw Drive – Linear Motor
	Controllers, Motors, Electrical Accessories	– Servomotors – Three-phase Motors, Stepping Motors
	Linear Actuators	

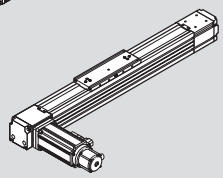
Controllers, Motors, Electrical Accessories
Three-phase Motors, Stepping Motors

Controllers, Motors, Electrical Accessories
Three-phase Motors, Stepping Motors

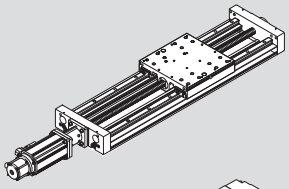
From individual systems to complete solutions



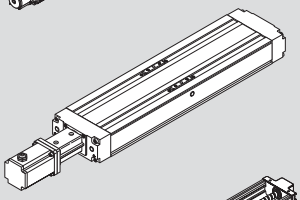
Linear Motion Slides



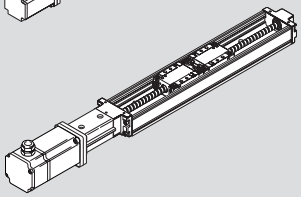
Linear Modules



Ball Rail Tables

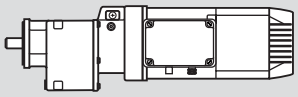


Compact Modules

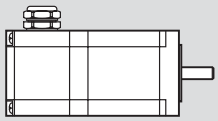


Precision Modules

Three-phase motor



Three-phase stepping motor

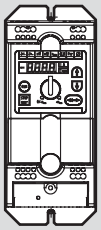


Control cabinet solutions

Services

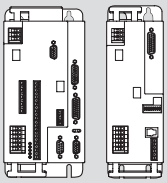
Drive selection

Application examples



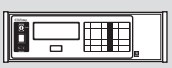
MOVITRAC®

Frequency inverter
Competitively priced, user-friendly control of three-phase asynchronous motors



Twin Line

Power electronics
Stepping motor output stage with or without integrated controller



PROFI step

Single- and multi-axis positioning control with power output module

The complete solution

PC

PC board
Motion control for CNC applications

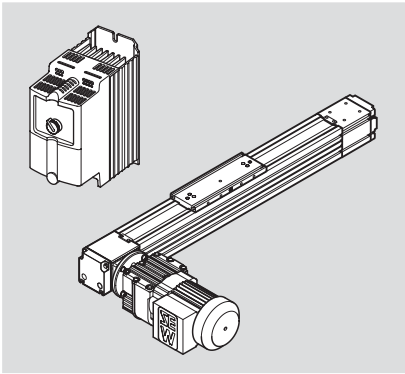
Components wired up in housing

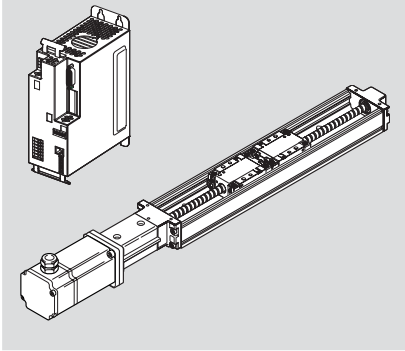
Project engineering
Commissioning & start-up
Software development

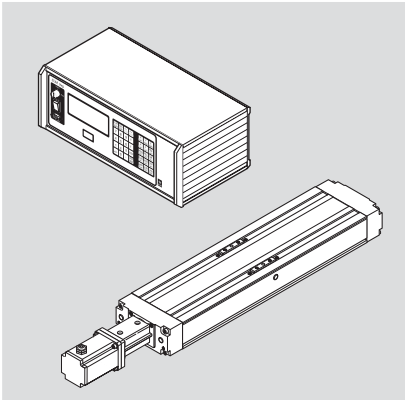
$$M_{eff} = \sqrt{\frac{(M_{a.req} + M_{tot})^2 \cdot t_{a.req}}{t_{cycle} + t_p}}$$

Calculation principles
Sample calculation

Applications with X-Y or gantry axes, portal applications







Three-phase Motors
MOVITRAC®07 Frequency Inverter

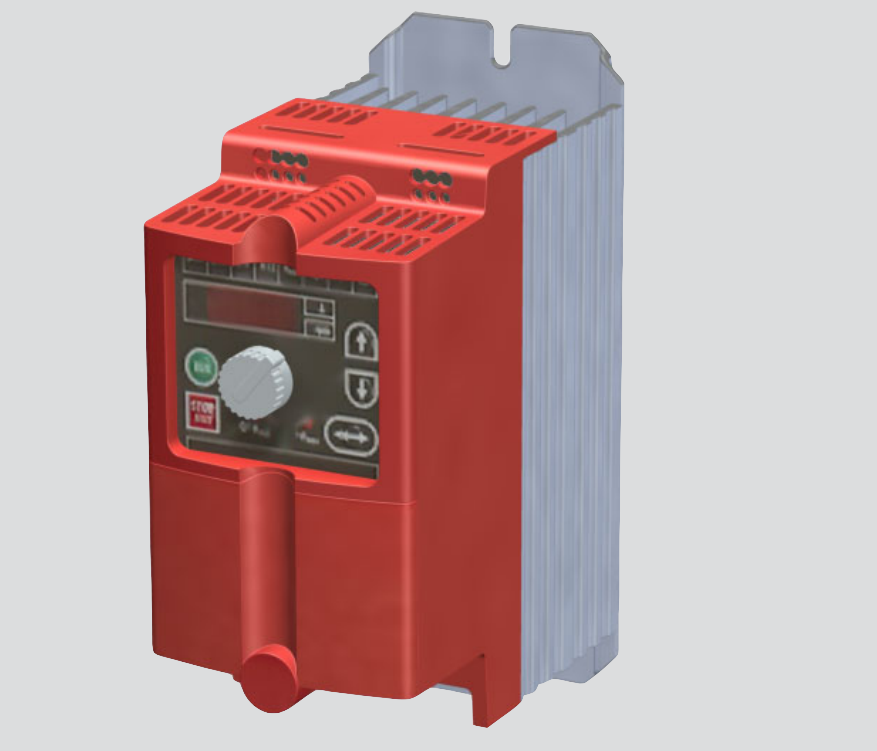
Product description

The compact frequency inverters of the MOVITRAC®07 series are designed for user-friendly and cost-effective control of three-phase asynchronous motors.

Users can choose between several options:

From 2- to 4-quadrant inverters as individual components right through to completely wired PLC units installed in a control cabinet.

MOVITRAC inverters are mainly used in transportation and positioning systems with few stations, as well as for simple processing operations such as cutting, sawing, or adhesive application.



Advantages

Start-up is quick and easy: Just enter all the parameters using the integrated keypad. The compact book shape is ideal for installation in a control cabinet.

Features

- Automatic motor adaptation in the standard U/f control mode
- Integrated control panel (display with 5 keys) with guided-menu operation
- "Plug-and-play" start-up
- Integrated setpoint potentiometer

Control functionality

- VFC or U/f control mode
- Automatic brake triggering via the inverter
- DC current braking
- Slip compensation for high static speed accuracy
- Parameter locking to prevent parameter variations
- Speed monitoring, monitoring of motor and generator power limits
- Error memory with all relevant operating data at error occurrence time
- Standardized operation, parameter input and wiring across the MOVITRAC®07 series
- The standard system bus allows up to 64 drives to be networked as slaves via PC or PLC
- RS 485 interface for PC communication (MOVITOOLS software)

Technical data

The speed can be preselected via:

- six fixed frequencies
- an analog setpoint
- system bus (SBus)
- Profibus-DP via gateway (up to 8 drive units)

The lowest recommended motor rating in the range is 0.37 kW for 4-pole motors, with a supply voltage of 1 x 230 V AC, 50/60 Hz. With integrated line filter and braking chopper. As a space-saving option, the brake resistor can be installed in the unit's heat sink.

Optional features

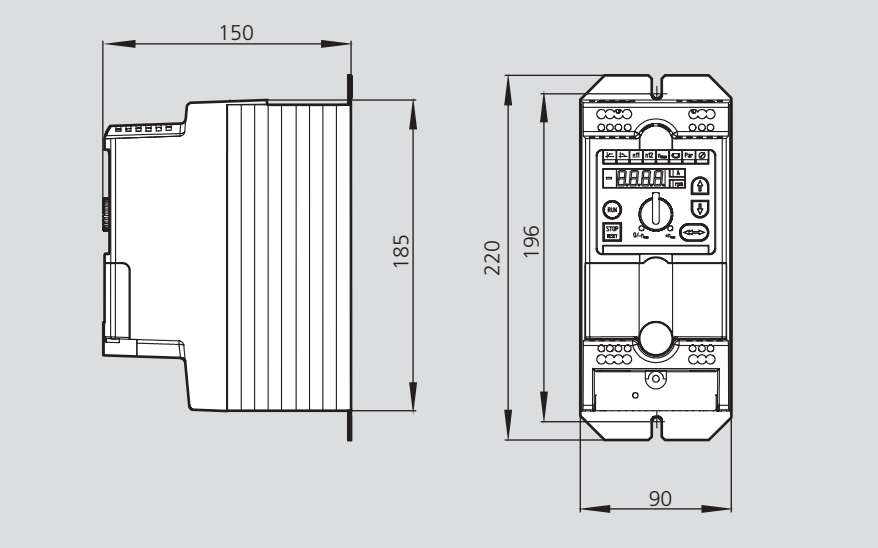
Brake resistor: An additional brake resistor increases the frequency inverter's feedback output, which permits its use in highly dynamic and vertical applications.

Output choke: Serves to suppress radiated interference from the unshielded motor cable. This means there is no need to use a shielded motor cable.

MOVIDRIVE: For more complex requirements, such as positioning with the aid of a rotary encoder or integrated positioning and motion control, we recommend using a custom-designed MOVIDRIVE inverter.

MOVITRAC®07	Unit	All sizes	
Power supply mode		Single-phase	Three-phase
Supply voltage	V	1 x AC 200 ... 240 +/-10%	3 x AC 380 ... 500 +/-10%
Line frequency	Hz	(50 ... 60) +/-5%	
Output voltage	V	3 x 0 ... supply voltage	
Output speed	rpm	0 ... 5500	
Current limitation		150% rated current for 60 s max.	
Immunity		complies with EN 61800-3	
Emissions (EMC installation)		limit class B (single-phase) / A (three-phase)	
Enclosure		to EN 55011 and EN 55014; complies with EN 61800-3 IP20	
Weight	kg	1.5	2.0

MOVITRAC®07 dimensions



Three-phase Motors
MOVITRAC®07 Frequency Inverter

Ordering code, MOVITRAC®07

Motor rating (kW)	MOVITRAC®07 type	Supply voltage (V)	Part number
0.37	MC07A004-2B1-4-00	1x230	1130-395-14
0.55	MC07A005-2B1-4-00	1x230	1130-395-15
0.55	MC07A005-5A3-4-00	3x400	1130-395-17
0.75	MC07A008-2B1-4-00	1x230	1130-395-16
0.75	MC07A008-5A3-4-00	3x400	1130-395-18

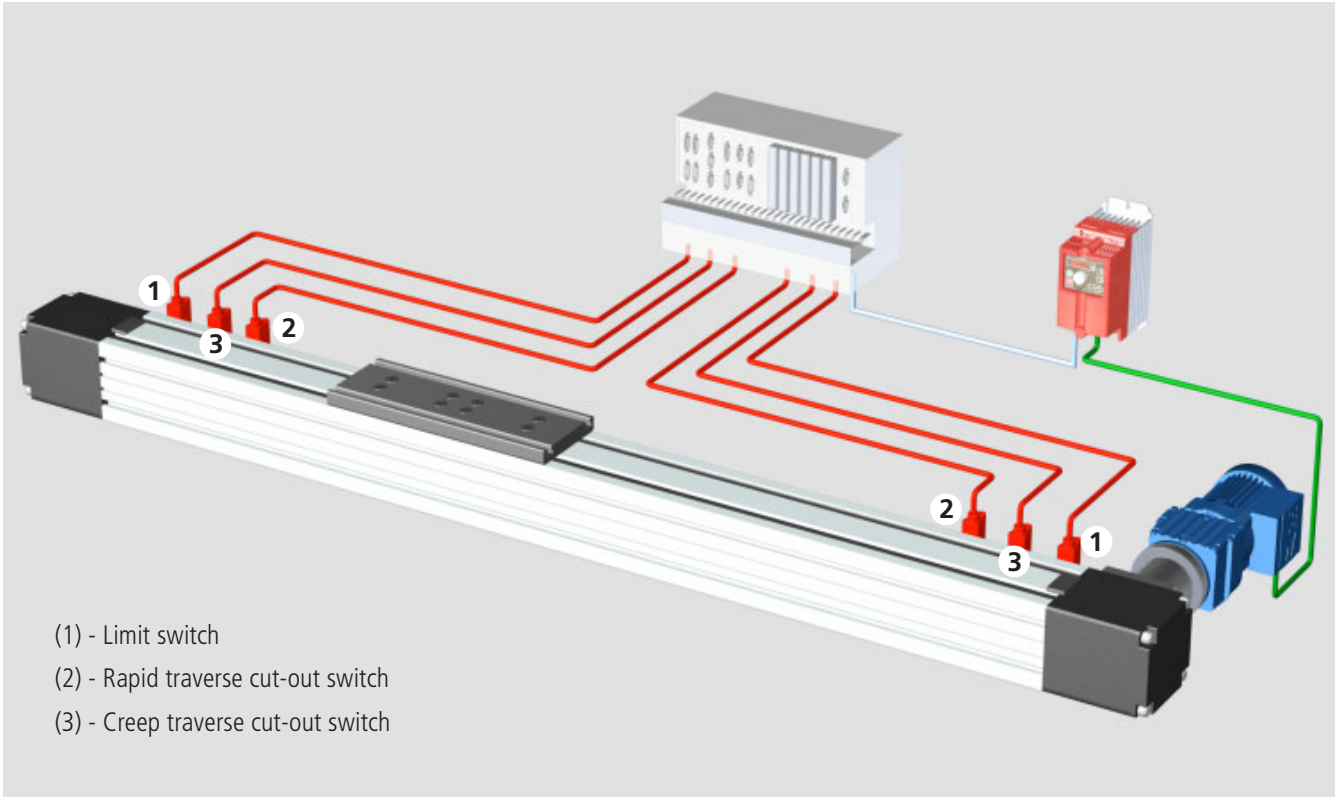
Ordering code, accessories

Accessory	Part number
Brake resistor 250 W, 72 Ω for 0.37-0.75 kW	1130-395-19
Output choke HD 002	1130-395-20

Application examples

A typical use for very simple positioning by means of initiators/proximity switches. Positioning accuracy is determined by the limit switch and the mode of operation.

The frequency inverter is controlled via a master PLC. An E-stop switch must be provided separately.



(1) - Limit switch
(2) - Rapid traverse cut-out switch
(3) - Creep traverse cut-out switch

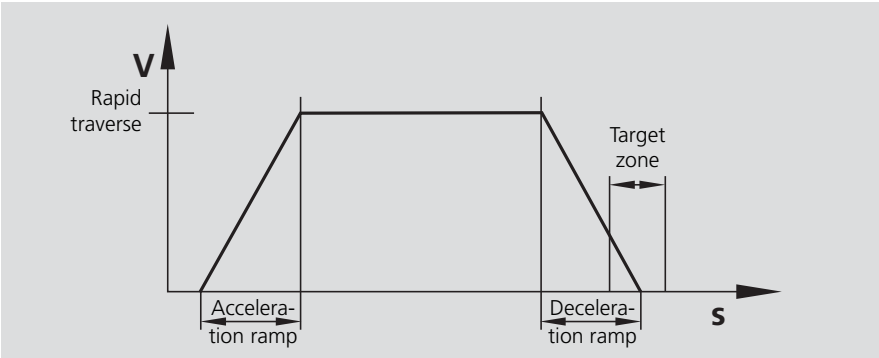
Positioning via rapid traverse cut-out with defined deceleration ramp

Requirements

- Mode of operation: VFC
- One initiator (2) at each end for rapid traverse cut-out
- One limit switch (1) at each end to assure E-stop

Applications with reduced accuracy requirements

- Simple handling axis
- Film/foil cutters
- Palletizers



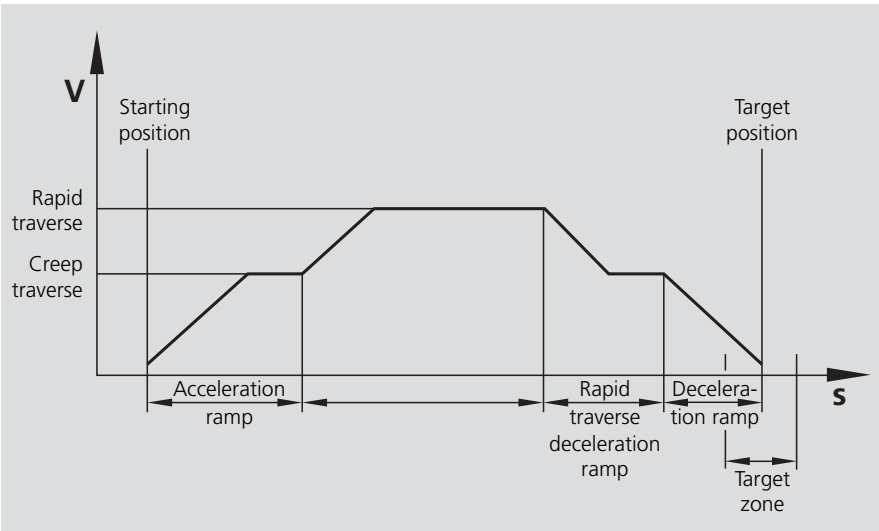
Positioning via rapid/ creep traverse cycle

Requirements

- Mode of operation: VFC
- One initiator (2) at each end for rapid-to-creep traverse switch-over
- **Additionally,** one creep traverse cut-out switch (3) at each end
- One limit switch (1) at each end to assure E-stop

Applications with high accuracy requirements

- Vertical conveyors
- Loading/unloading devices
- Palletizers



Three-phase Motors
Three-phase Gear Motors

SEW range of motors

SEW supplies three-phase gear-motor combinations optimally matched to linear motion systems.

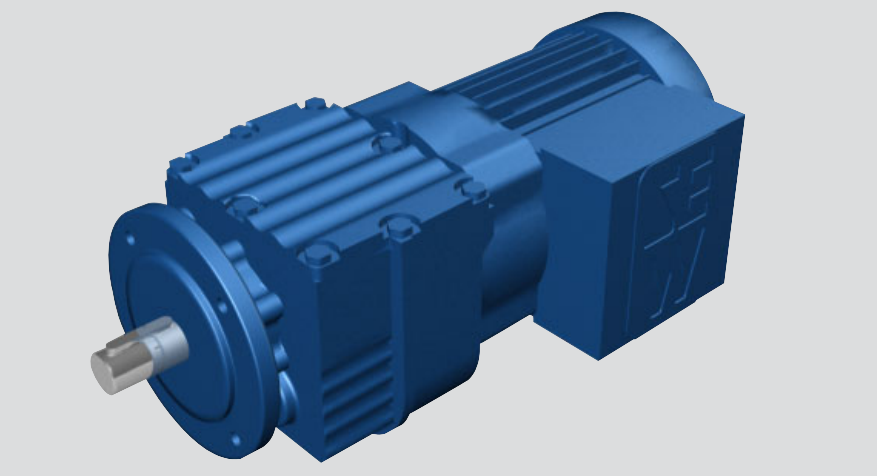
Product description

Three-phase gear motors serve as drive units in countless applications, thanks to their proven robust design and simple start-up.

Linear motion technology uses three-phase drive units for simple tasks, e.g. as reversing drives and for positioning applications with low accuracy requirements.

The range of SEW motors comprises:

- spur gear motors
- worm gear motors
- bevel gear motors
- solo motors



Advantages

- Supply of complete drive units (frequency inverter, motor, gear unit, mounting flange, coupling and linear motion system)
- Motors are selected/customized to suit the specific application and linear motion system
- Reliable long-life motor-gear combinations with high availability that comply with all major international standards

Technical data

Power range:	0.12 to 0.75 kW (or higher)
Input voltage:	220 … 240 V AC / 380 … 415 V AC or special voltage
On request:	Motors with integrated frequency inverter, with analog/digital control or Profibus interface (MOVIMOT®)

Optional features:

- Brake (24 V DC, 230 V AC, 400 V AC, special voltage)
- Manual brake release
- PTC thermistors or thermostat
- Dahlander pole-changing circuit
- Additional centrifugal mass (heavy fan)
- Encoder and encoder mount
- Plug connector
- External fan
- Explosion proof design (ATEX100a)
- and many more

Ordering code

Customer-specific design

Danfoss Bauer range of motors

Danfoss Bauer supplies three-phase gear-motor combinations optimally matched to linear motion systems.

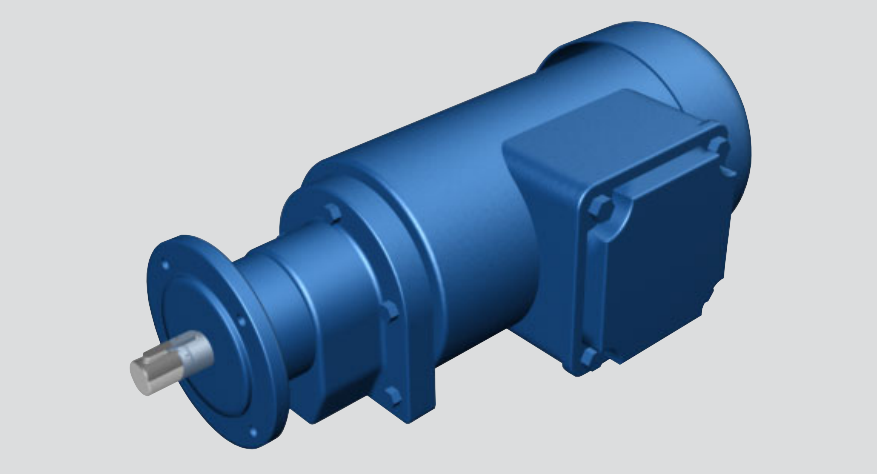
Product description

Three-phase gear motors serve as drive units in countless applications, thanks to their proven robust design and simple start-up.

Linear motion technology uses three-phase drive units for simple tasks, e.g. as reversing drives and for positioning applications with low accuracy requirements.

The range of Danfoss Bauer motors comprises:

- spur gear motors
- worm gear motors
- bevel gear motor
- solo motors



Advantages

- Supply of complete drive units (frequency inverter, motor, gear unit, flange, coupling and linear motion system)
- Motors are selected/customized to suit the specific application and linear motion system
- Reliable long-life motor-gear combinations with high availability that comply with all major international standards

Technical data

Power range:	0.03 to 0.75 kW (or higher)
Input voltage:	220 … 240 V AC / 380 … 415 V AC or special voltage
On request:	Motors with integrated frequency inverter, with analog/digital control or Profibus interface (EtaSolution series K)

Optional features:

- Brake (24 V DC, 230 V AC, 400 V AC, special voltage)
- Manual brake release
- PTC thermistors or thermostat
- Dahlander pole-changing circuit
- Additional centrifugal mass (heavy fan)
- Encoder and encoder mount
- Plug connector
- CAGE CLAMPS®
- External fan
- Explosion proof design (ATEX100a)
- and many more

Ordering code

Customer-specific design

Stepping Motors
TLD011 Twin Line Power Electronics

Product description

The TLD011 belongs to the TWIN LINE family of stepping motor control systems. It operates as a stand-alone power amplifier with integrated control and power unit.

Mounting

Four mounting holes provided on the mounting plate for easy fixing.

Operating functions

The TLD011 controls a stepping motor in accordance with a preset reference value. The setpoint signal is generated by a positioning or NC controller and made available as a pulse signal at the PULSE-C interface.

If a rotation monitor is fitted, the power electronic system recognizes lost steps which may, for example, occur as a result of motor stalling or overloading.

Mains connection

The power supply for the amplifier is connected to the mains connection. The unit features a built-in mains filter and can therefore be operated without any further noise suppression on the supply side.

Motor connection

The unit supplies current to a stepping motor via the three-phase motor connection. The maximum power output is monitored by the unit. The motor connection is short-circuit protected and is checked for ground faults when enabled.

DC-line connection

The device's DC-line voltage is available at the DC-line terminals. DC-line capacitors can be supported by external capacitors in order to absorb sudden, excess braking energy.

PULSE-C interface

This interface is used to define the setpoint incrementally as a pulse signal. Control signals for enabling the amplifier and the current setpoint are also transmitted via this interface. Output signals at the PULSE-C interface report malfunctions or operational readiness.

Rotation monitoring (optional)

The power electronic system receives A/B signals for monitoring the stepping motor's position, as well as a signal for checking the motor temperature, via the rotation monitoring function. The encoder's electronic circuits receive the power supply they need from the rotation monitoring connection. Rotation monitoring can be fitted to the unit as an optional extra.

Signal interface

The power required for control loops and for controlling the fan must be provided by an external 24 V DC power supply via the signal interface. Cables for a holding brake are connected at the brake terminal.

Status display

A 7-segment display gives information on the operating status of the power electronics. If a malfunction occurs, the display will show the fault code.

DIP switch

The 8-way DIP switch is used to configure the stepping resolution and set the control signal functions.

Rotary switch

The maximum motor r.m.s. current is limited by means of the rotary switch. The setting value for the maximum motor current is given on the motor's type plate.

LED for DC-line voltage

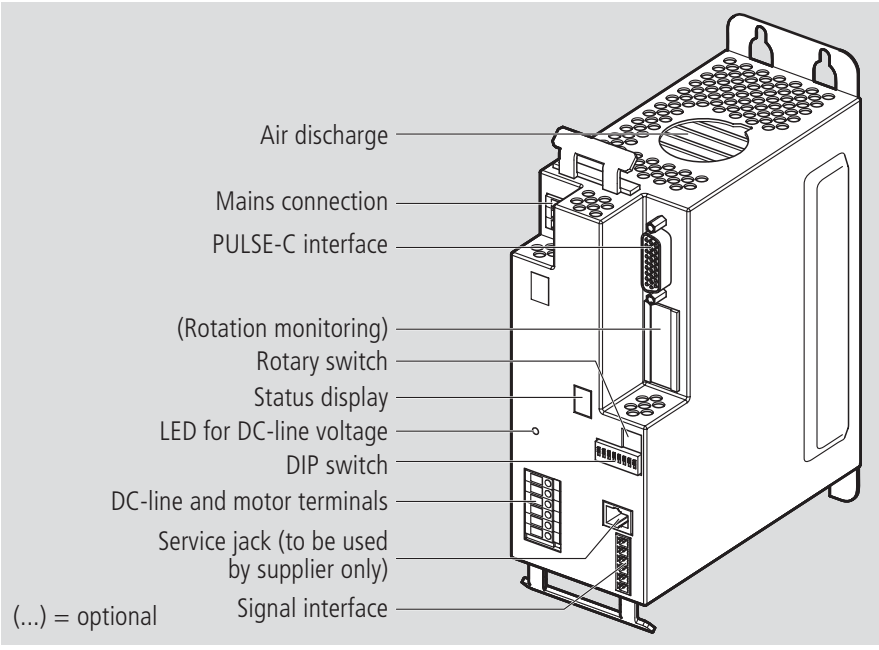
The LED lights up when voltage is present in the DC-line.

Air discharge and fan

A built-in fan sucks cold air into the unit from below and discharges the operating heat from the unit through the upper air outlet vents. Temperature sensors on the power amplifier's heat sink protect the unit from overheating.

Advantages

- Compact design
- Same mechanical design for all power classes
- Power supply to the unit directly from the mains, no transformer needed
- Integrated mains filter, heat sink and fan
- Device suspension integrated in the housing
- All electrical connections accessible from the front
- Shielding connection and strain relief are integrated in the device
- Easy, user-friendly operation, parameterization and control
- Integrated brake trigger signal
- Various operating modes
- Continuity with identical control panel functions for all three-phase stepping motor units
- Simple EMC-compliant installation
- Multilingual documentation and controlling units
- Complete solution for power engineering tasks
- Modularity for customized systems solutions



Stepping Motors
TLD011 Twin Line Power Electronics

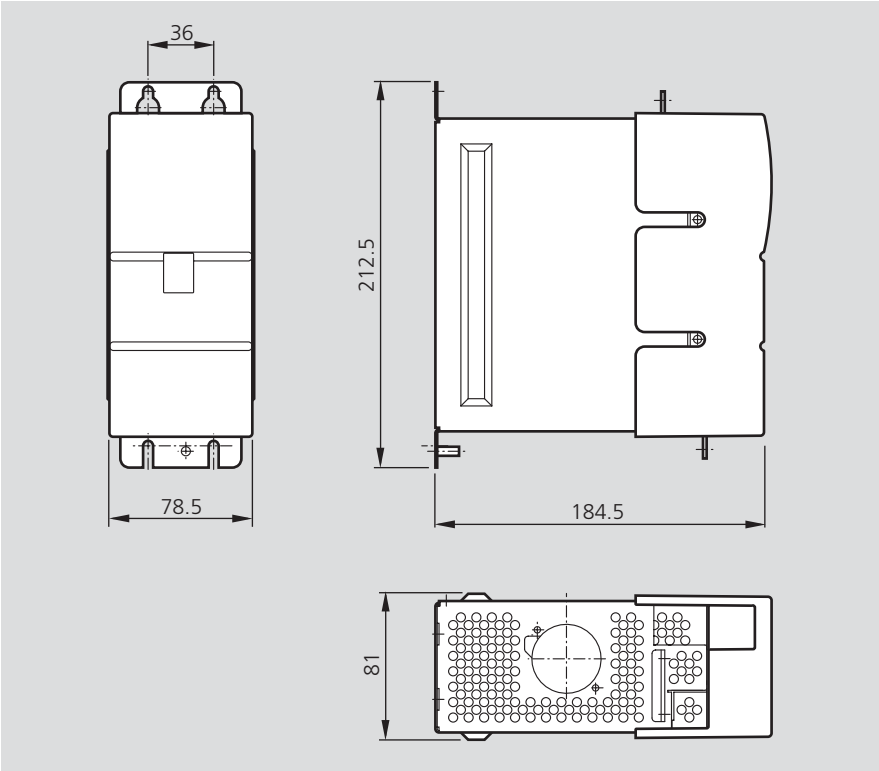
Technical data

TLD011	Unit	
Mains voltage	V	1 x 230 -20% / +15%
Mains frequency	Hz	47 - 63
Current consumption	A	2
Starting current	A	< 60
Output speed	rpm	max. 3000
Emissions (EMC-compliant installation)		complies with EN 61800-3
Enclosure		IP20
Weight	kg	2.2
Cable length*	m	20

* Cable lengths > 20 m on request

Signal inputs			
24 V DC supply	PELV, DIN 19240, polarized		
	Input		
		Voltage range	20 V to 30 V
		Ripple	< 2 V_{pp}
	Current consumption		≤ 1.5 A
PULSE-C interface	Signal inputs		
		Symmetric	RS 422 voltage compatible
		Asymmetric	4.5 V to 30 V
		Input resistance	5 kΩ
		Input frequencies: Stepping rate Motor current control (PWM)	 ≤ 200 kHz 6 kHz to 25 kHz
	Number of steps		200, 400, 500, 1000, 2000, 4000, 5000, 10000
	Signal outputs		Open collector outputs, short-circuit proof
		Output voltage	≤ 30 V
		Output current, maximum	50 mA
Brake controller	Signal output		Short-circuit proof
		Output voltage	≤ 30 V
		Output current, maximum	1.7 A
		Voltage drop at 0.5 A	≤ 1 V

TLD011 dimensions without rotation monitoring



Ordering code

	Part number
TLD011, incl. documentation:	1130-415-08

Version with rotation monitoring on request

Ordering code for cable sets

Cable set comprising:	Part number Length in m (max. 20 m)	Cable supply condition – motor side		Cable supply condition – controller side Twin Line
		Terminal box (standard motor)	with connector	
Motor cable	1130-801-30	10	20	30
Motor and brake cables	1130-801-31	11	21	31
Motor and encoder cables	1130-801-32	-	22	32
Motor, brake and encoder cables	1130-801-33	-	23	33

Stepping Motors
TLC411 Twin Line Positioning Controller

Product description

The TLC411 positioning controller belongs to the TWIN LINE family of stepping motor control systems.

This positioning controller can operate either as a stand-alone power amplifier with integrated control and power unit or in a fieldbus system.

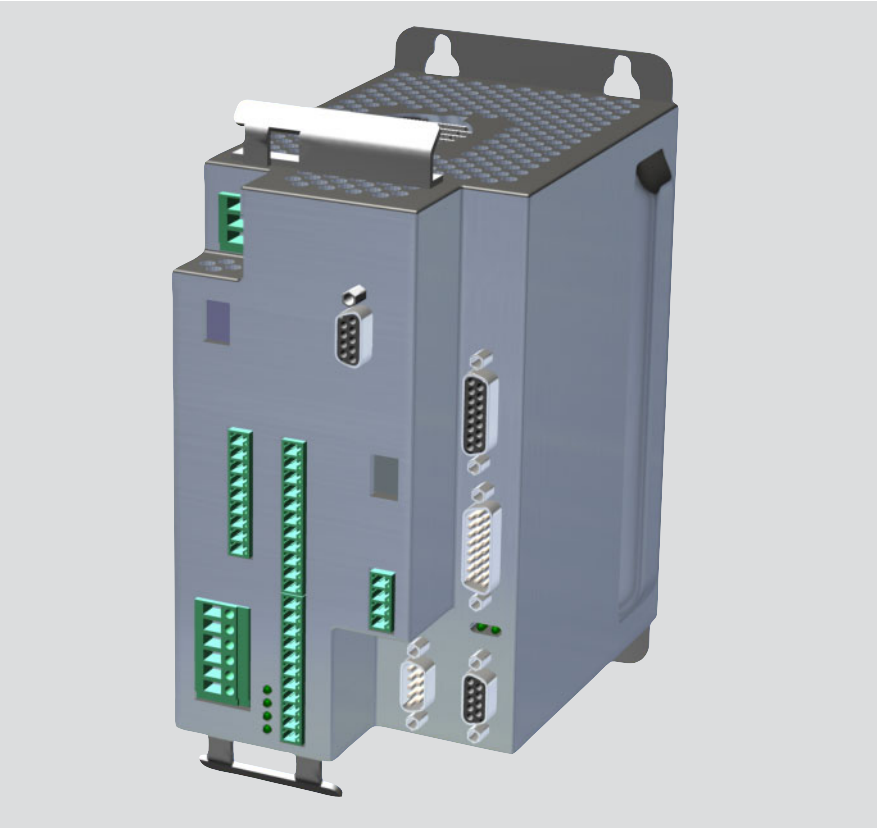
TLC411 Twin Line positioning controllers are exceptionally adaptable single-axis positioning controllers with integrated power electronics.

The Twin Line positioning drives act as intelligent actuators in a typical automation system. The master control system has access to parameters, system variables and the positioning functionality of the drives via digital signal interfaces, serial communication or standard fieldbus systems.

The integrated intelligence of the drive system shifts the positioning functions and corresponding control loops from the control system level to the field level, while considerably reducing the wiring outlay and relieving the load on the master control system. This design results in coherent structures within the automation solution, which simplify start-up operation, increase flexibility for expansion and reduce maintenance costs. Twin Line devices may thus be replaced or ex-changed without difficulty, because the master control system can simply transfer all parameters to the new device.

Depending on the control functionality, fully adaptable, process-compatible inputs and outputs reduce the need for extra peripheral components, resulting in significant cost savings.

A jolt-limiter which may be connected during operation ensures smooth mechanical operation and a longer machine service life.



Mounting

Four mounting holes provided on the mounting plate for easy fixing.

Mains connection

The power supply for the amplifier is connected to the mains connection. The unit features a built-in mains filter and can therefore be operated without any further noise suppression on the supply side. The power required for the control loops and for fan control must be provided by an external 24 V DC power supply.

Motor connection

The unit supplies current to a stepping motor via the three-phase motor connection. The motor connection is short-circuit protected and is checked for ground faults when enabled.

DC-line connection

The device's DC-line voltage is available at the DC-line terminals. DC-line capacitors can be supported by external capacitors in order to absorb sudden, excess braking energy.

Status display

A 7-segment display gives information on the operating status of the positionning controller. If a malfunction occurs, the display will show the fault code.

LED for DC-line voltage

LED lights up when voltage is present in the DC-line.

LEDs for operating signals

Five LEDs display the signal states of these adjacent inputs: positive and negative limit switches, motor stop signal, power amplifier enablement, and manual/automatic operation.

Signal interfaces

Input and output signals are routed through the signal interface, and an external 24 V DC power supply is also fed in through it.

RS 232 interface

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

Air discharge and fan

A built-in fan sucks cold air into the unit 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

The positioning controller can be flexibly adapted to suit the desired area of application with the help of four module slots and a choice of several module alternatives. The modules expand the functional scope of the positioning controller and allow it to be customized to any desired system configuration.

Parameter memory

All the positioning controller settings are administered in a data set. The parameters are stored in the unit safe from power failures, and can be displayed and changed via the RS 232 interface on a PC, through the HMI hand-held operating unit or through the field bus.

Stepping Motors
TLC411 Twin Line Positioning Controller

Advantages

- Compact design
- Same mechanical design for all power classes
- Power supply to the unit directly from the mains, no transformer needed
- Integrated mains filter, heat sink and fan
- Device suspension integrated in the housing
- All electrical connections accessible from the front
- Shielding connection and strain relief are integrated in the device
- Options for operation, parameterization and control:
  - Twin Line HMI (Human Machine Interface) plug-in hand-held operating unit
  - Twin Line CT (Control Tool) software, under Windows 98/NT/2000
  - master control system
- Integrated brake trigger signal
- Various fieldbuses (e.g. RS 485) can be configured
- Various operating modes
- Simple EMC-compliant installation
- User-friendly operation
- Multilingual documentation and controlling units
- Complete solution for power engineering tasks
- Modularity for customized systems solutions

Custom configuration of interfaces

Twin Line positioning controllers are configured according to customer specifications. The modular design enables the devices to be adapted precisely to various drive tasks and interface requirements. An optional module for rotation monitoring can be used for controllers with integrated stepping motor power electronics. Device parameters and commands can be transmitted via the standard Profibus-DP interface.

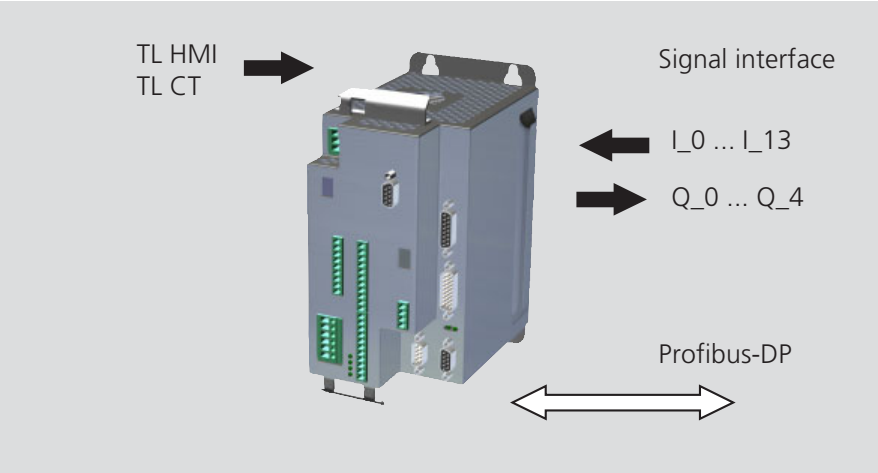
Functions

The TLC411 positioning controller with Profibus-DP module can be operated in two modes as described below.

In both modes, the device can be controlled locally via the hand-held operating unit TL HMI or TL CT software.

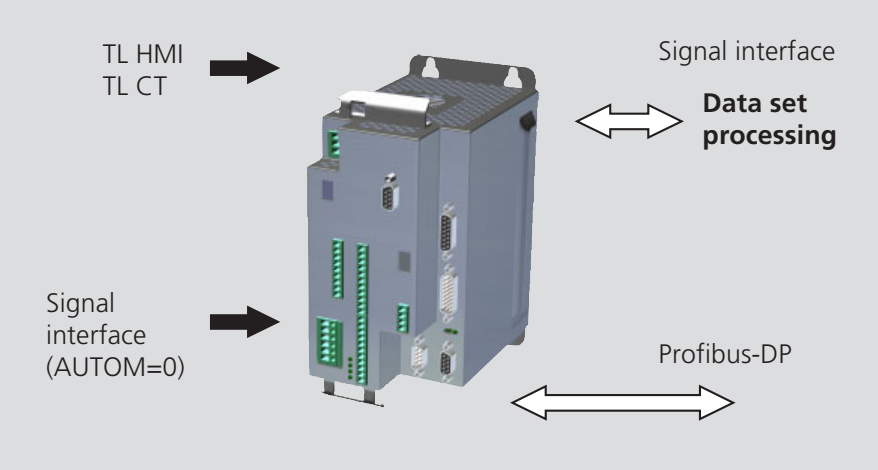
There are 64 data sets (of which 50 are freely selectable) stored in the data set memory. These can be accessed and changed by a master (e.g. PC, PLC) via the digital signal interface or the Profibus-DP interface.

Mode 1: Profibus-DP operation with free I/O assignment



All of the described functions can be performed using Profibus-DP commands. The inputs and outputs of the signal interface can be freely assigned, i.e. they can also be used for additional tasks and accessed and evaluated via the Profibus-DP.

Mode 2: I/O data set processing with or without Profibus-DP



The positioning controller is operated via the signal interface. Travel data sets are selected and initiated by remote control via the inputs. If a Profibus-DP module is integrated, travel commands can also be initiated through the Profibus-DP.

Travel jobs can be monitored using the outputs. If a Profibus-DP module is integrated, the device status can be evaluated by means of status reports. If no Profibus-DP is installed, operating mode 2 is set by default.

Stepping Motors
TLC411 Twin Line Positioning Controller

Functions

Data set processing

Every data set represents a travel job which is executed in point-to-point positioning mode.

The individual position sets in data set processing with point-to-point positioning consist of the following data:

- Relative or absolute units system
- Target position
- Travel speed
- Acceleration and deceleration ramps

The travel data sets can be called up using the Twin Line HMI hand-operated controller, the Twin Line Control Tool software, inputs of the signal interface, or an integrated fieldbus module. These interfaces can also be used to approach the position values in teach-in processing and to store the current position value in the data set memory.

An extensive command set is available for the following applications:

- Data set processing for point-to-point positioning
- Data set processing for point-to-point positioning with a speed profile
- Activate cam controller signal output, i.e. parameterize ON/OFF positions and the output state
- Set acceleration/deceleration ramps
- Read or write position
- Initiate reference run
- Write and read all parameters
- Set and reset outputs (depending on operating mode)
- Read inputs (depending on operating mode)
- Error handling

Point-to-point

In point-to-point mode, a positioning command is used to position from point A to point B. The positioning may be absolute (relative to the zero-point of the axis) or relative (based on the current axis position).

Reference run

Referencing assigns a defined axis position to a specific mechanical position of the motor in the system. Referencing may be performed either by setting the dimensions to the current motor position or by executing a reference run.

The following reference run types are available:

- Travel to positive or negative limit switches or to additional switches

Manual run

Motor runs from a single step to continuous motion can be initiated by operating the manual inputs or via the Twin Line HMI and Twin Line CT software.

Teach-in

Teach-in stores the current position value in the selected memory area. You can teach in up to 2 x 64 absolute switching positions of the integrated camshaft function or the 50 paths sets for data set processing via input/output signals, Twin Line HMI or the Twin Line CT. The data may also be read, written and copied via fieldbus, Twin Line HMI or Twin Line CT.

Cam controller signal output

If the movement exceeds an absolute position value acquired/modified in teach-in mode, the output will be set according to the modified output state, i.e. this high-speed output will be set or reset based on the new position.

Parameterization

The parameters of the positioning controller and integrated power electronics of devices with an attached communication module can be read and written by the master (PC, PLC etc.) via fieldbus or RS 485. Twin Line devices may thus be replaced without difficulty, increasing flexibility for expansions and reducing maintenance costs.

The plug-in Twin Line HMI controller and Twin Line CT start-up software also enable complete device parameterization as well as transfer of all parameters from one device to another.

Acceleration and braking ramps

The following ramp shapes may be defined for the positioning controller:

- Linear ramp
- Motor-optimized ramp, i.e. an optimized ramp that compensates for the torque drop typical of stepping motors at increasing speed

In addition, a jolt filter may be connected to achieve jolt-free acceleration or braking phases, regardless of the current speed.

Quick-stop

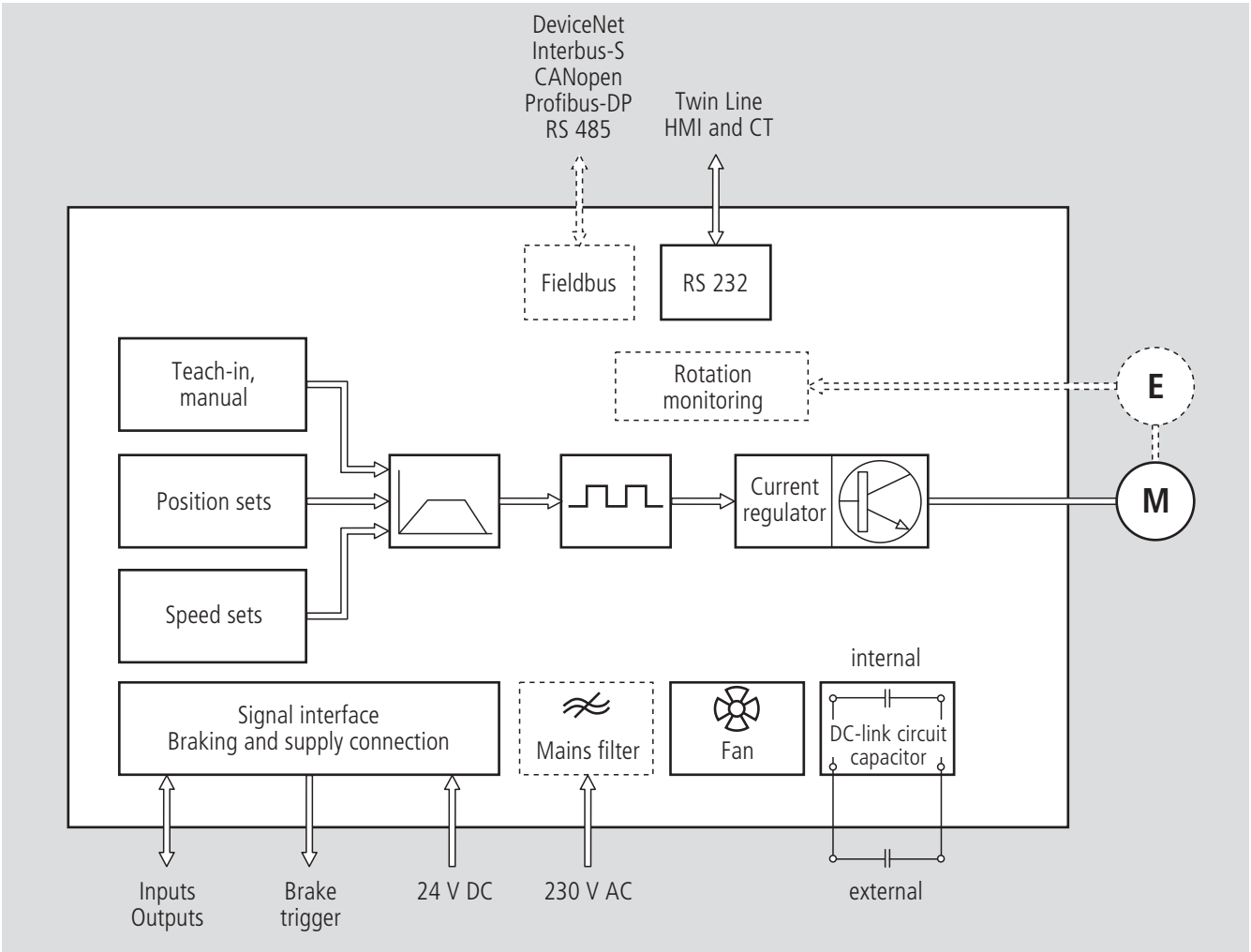
Quick-stop is designed to bring the motor to a stop as quickly as possible.

Quick-stop uses a linear braking ramp.

Rotation monitoring (optional)

A shaft-encoder interface module, which enables the Twin Line positioning controller to detect mechanical motor overload, is available as an optional accessory.

The rotation monitoring system compares the set and actual motor positions and returns a rotary error and stops the motor if the difference exceeds the drag-error limit (approx. 6.4°). The motor must be equipped with an encoder (1000 increments) for the rotation monitoring system to function.



Stepping Motors
TLC411 Twin Line Positioning Controller

Technical data

Weight: 2.7 kg

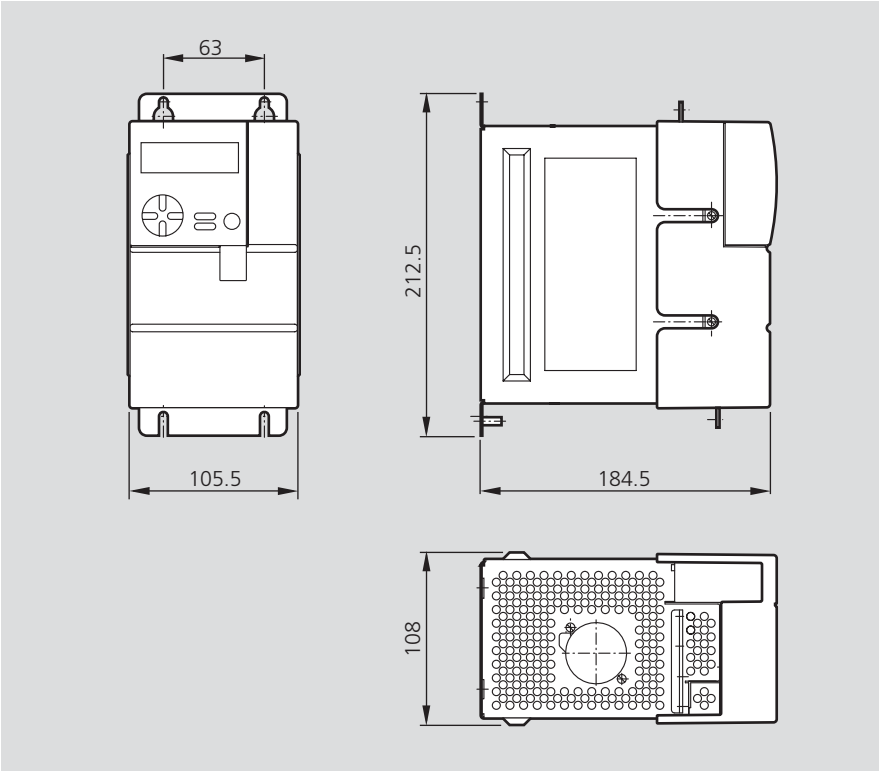
Device protection class according to EN 60529:1991 IP20

TLC411	Unit	
Mains voltage	V	1 x 230 -20% / +15%
Mains frequency	Hz	47 - 63
Current consumption	A	2
Starting current	A	< 60
Output speed	rpm	max. 3000
Emissions (EMC-compliant installation)		complies with EN 61800-3
Enclosure		IP20
Weight	kg	2.7
Cable length*	m	20

* Cable lengths > 20 m on request

Signal inputs		
24 V DC supply	PELV, DIN 19240, polarized	
	Input	
	Voltage range	20 V to 30 V
	Ripple	< 2 V_{pp}
	Input current without loading the outputs	< 2.5 A
Signal inputs		Polarized, no galvanic isolation
	Debounced	0.7 to 1.5 ms
	DC voltage U_{high}	12 to 30 V (I ≤ 3 mA)
	DC voltage U_{low}	≤ 5 V (≤ 0.5 mA)
	Current	7 mA at 24 V
Signal outputs		Short-circuit proof
	Inductive loadability	150 mH/11 W
	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

TLC411 dimensions



Stepping Motors
Start-up Accessories

Start-up options:

- Twin Line Human Machine Interface (TL HMI)
- Twin Line Control Tool Software (TL CT)

Product description Twin Line Human Machine Interface (TL HMI)

The Twin Line Human Machine Interface (TL HMI) is a plug-in control unit for controlling, parameterizing and diagnosing the TLC411.

The TL HMI has an LCD display consisting of 3 lines with 16 characters each, and is either inserted into the receptacle provided on the device or connected to the RS 232 communication interface via a 10 m serial cable.

The TL HMI operates in 4 languages (D, GB, F, I) and comes with a brief operating manual.

Advantages

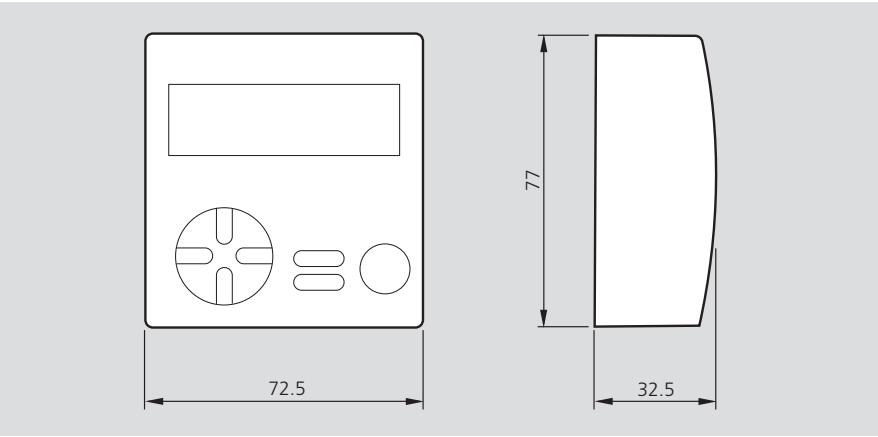
You can use the TL HMI to

- call up information on motor status, operating mode and operating status
- check and modify parameter values
- diagnose errors
- move motors at the touch of a key
- copy device configurations to other devices

Technical data

Voltage supply:	9 to 15 V
Current consumption:	max. 100 mA

Dimensions



Twin Line Control Tool Software (TL CT) Product description and advantages

The Twin Line Control Tool (TL CT) control software works together with the Twin Line family of power electronics and positioning controllers.

The Twin Line Control Tool is used for speedy start-up and diagnostics and can be used straight "out of the box" with any Twin Line device with an RS 232 interface.

TL CT software functions

- Entry and display of device parameters
- Archiving and duplication of device data
- Manual motor positioning via the PC
- Recording, evaluation and archiving of travel profiles
- Offline and online processing of parameters and travel jobs
- Diagnosis of operating malfunctions

Depending on the type of the connected device, a variety of additional functions are also available:

- Programming travel jobs
- Post-processing travel lists and travel sets
- Reference runs

System requirements

Microsoft Windows 95, Windows 98 or Windows NT

Hardware requirements

- IBM compatible PC with 80486 processor + coprocessor or, preferably, 80586 processor (Pentium)
- 8 MB RAM
- Approx. 5 MB disc space
- Super VGA graphics board
- CD-ROM drive
- 1 free serial interface on the PC and an RS 232 data cable for data exchange

Ordering code

Type	Description	Part number
TLD011F	Power electronics*	1130-415-08
TLC411F	Positioning controller, standard interface, digital I/O*	1130-415-09
TLC411F-PBDP	Positioning controller, Profibus interface*	1130-415-10
Twin Line HMI	Plug-in control device, for TLC411 only	1130-415-11
Twin Line CT	Start-up software, for TLC411 only	1135-200-05

Other devices/modules are available on request.
* incl. documentation on CD

Ordering code for documentation

Type	Description	Part number
TLD011	Hard copy, German	1130-896-27
TLD011	Hard copy, English	1130-896-28
TLC411	Hard copy, German	1130-896-29
TLC411	Hard copy, English	1130-896-30

Ordering code for cable sets

Cable set comprising:	Part number Length in m (max. 20 m)	Cable supply condition – motor side		Cable supply condition – controller side TwinLine
		Terminal box (standard motor)	with connector	
Motor cable	1130-801-30	10	20	30
Motor and brake cable	1130-801-31	11	21	31

Stepping Motors
PROFI step and PROFI step eco Positioning Controller

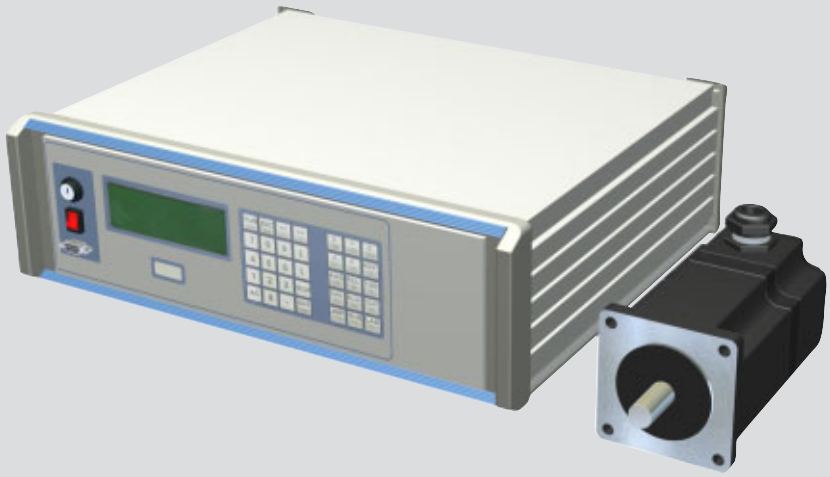
Product description

PROFI step and PROFI step eco are positioning controllers for three-phase stepping motors.

The controllers have an integrated PLC (program and sequence control) which allows multiple motion sequences and functions to be programmed and controlled. Programs can be input directly using the integrated keypad and display, or through a PC using the software provided. Users can quickly master the simple programming language and write their own executable programs.

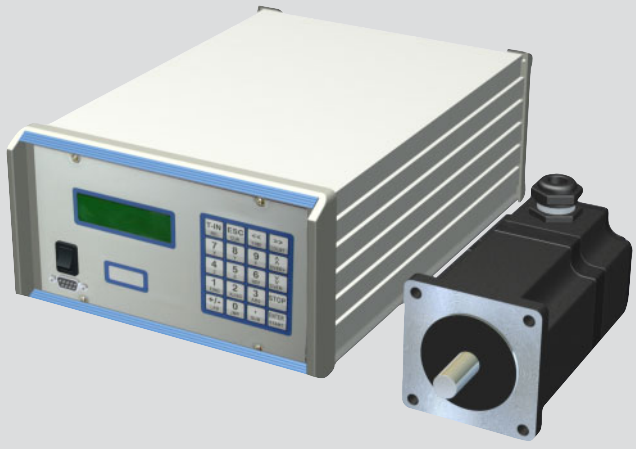
The PROFI step positioning controller is modular and can be easily expanded to suit customer requirements. It supports extremely complex motion sequences and can be programmed to the most demanding application requirements.

PROFI step



The compact, cost-optimized PROFI step eco positioning controller was specifically designed for single-axis motion sequences.

PROFI step eco



Applications

- Handling systems
- Positioning and feed functions
- Dosing/dispensing systems
- Palletizers
- Test systems and test beds
- Laboratory equipment

Advantages

- Clearly structured keypad and display
- Ready for connection to 230 V AC
- Powerful and economical
- Simultaneous axis positioning and control of complex machine motion sequences
- Installation in 19" rack or table-top housing

- Installation and start-up are simple and straightforward:
  1. Wire up motor or connect controller via plug-in connector.
  2. Connect inputs and outputs to controller.
  3. Enter program and parameters or use axis keys for manual control.

- Easy programming (see program example on the following pages)
- VMC Workbench software with a host of useful features (e.g. project management, remote maintenance, etc.) included free of charge
- Documentation included free of charge

Stepping Motors
PROFI step and PROFI step eco Positioning Controller

Technical data

	PROFI step	PROFI step eco
Installation	table-top housing or 19" rack	table-top housing or 19" rack
Display	4x20-chars text display	4x20-chars text display
Membrane keypad	35 keys	20 keys
Number of axes	1 to 4	1
Digital inputs	24	8
Digital outputs	16	8
Digital input expansion	expandable to 48	–
Digital output expansion	expandable to 32	–
Analog input expansion	expandable to 4	–
Analog output expansion	expandable to 2	–
Holding brake control	up to 4 holding brakes	1 holding brake max.
RS 232	standard	standard
RS 485	at customer request	–
Software (in PROFI step)	MC step	MC step
Customer-specific software	possible	–
E-stop circuit	standard	–
Remote maintenance	at customer request	–
External control panel	at customer request	–
Special items	at customer request	–

Function description

Input

Digital input, opto-decoupled, 24 V DC, 10 mA

The digital inputs are wired to a 37-pin D-SUB connector (with I/O expansion, 2 D-SUB connectors).

Analog input 0-10 V DC, 5 kΩ, 8 bit

The analog inputs/outputs are wired to 9-pin D-SUB connectors.

Output

Digital output, short-circuit proof, 24 V DC, 1 A

The digital outputs are wired to a 25-pin D-SUB connector (with I/O expansion, 2 D-SUB connectors).

Analog output 0-10 V DC, 20 mA, 8 bit

Holding brake control

Holding brake output to HAN3 Harting connector (holding brake is operated via an output)

E-stop circuit

Including 12-pin round connector for connection to the PROFI step, a positive-action relay to cut off the voltage supply to the power output stages and the outputs 9-16

RS 232 interface

- For program UPLOADS/DOWNLOADS
- For command transmission from the PC to the controller

MC step program and memory space

- 11 user-defined commands
- Program memory with 1200 lines
- The number of programs depends on the program length (e.g. 3 programs of 400 lines each).

Teach-in function (via keypad)

All positions can be loaded via a teach-in function.

Safety devices
Safety functions

- Interrogation of hard limit switches
- Soft limit switches
- Short-circuit proof PLC outputs
- Operating voltage monitoring for power sections
- Temperature monitoring for power sections

PROFI step optional components and customized solutions

Customer-specific software

- Roll feed
- Drilling programs
- Palletizers
- Adhesive application

Remote maintenance (on request)

If a modem is connected to the controller, malfunctions can be diagnosed and corrected by remote maintenance.

External control panel (on request)

- Hand-held terminal with 4x20-chars LCD display and 20 membrane keys
- Electric handwheel and E-stop key for remote controller operation

RS 485 interface

- Proprietary fieldbus system for controlling a decentralized I/O module, control and operating elements and power sections

MC 1 program and memory space
(solution of complex tasks)

- Multitasking (four parallel PLC programs)
- Macrotechnology possible
- Symbolic programming
- Up to 16,000 PLC commands
- Program memory for up to 28,000 variables
- 32 timers (0.1 s and 0.01 s)

Stepping Motors
PROFI step and PROFI step eco Positioning Controller

Programming

MC step programming commands

ABS	Absolute positioning
REL	Relative positioning
REF	Reference run
F > >	Feed rate
TIM	Queuing
CNT	Counter function
INP	Program inputs
OUT	Program outputs
LBL	Define flag
JMP	Conditional/unconditional jump to a line, flag or program
SUB	Conditional/unconditional subroutine jump to a line, flag or program

Additional functions

Linear interpolation

If a program line contains two absolute positioning commands one after the other, motions on the two axes concerned will be controlled in linear interpolation mode.

Waiting for input

1. Via keypad

It is possible to stop the program at a given point by setting a flag. The display will now show the next line in the program. Up to four commands can be edited in this line. Once the edits have been confirmed via the ENTER key, the program will restart and execute the edited commands.

2. Via PC

A flag can be set to stop the program at a given point, e.g. in order to wait for a data upload via the RS 232 interface. As soon as the upload is complete it will be executed. Subsequently the automatic program mode will be resumed. C++, Delphi and Visual Basic drivers are available for programming this function.

Online mode

The controller is delivered with a single-command program installed which permits online command processing via PC. C++, Delphi and Visual Basic drivers are available for programming this function.

External START/STOP

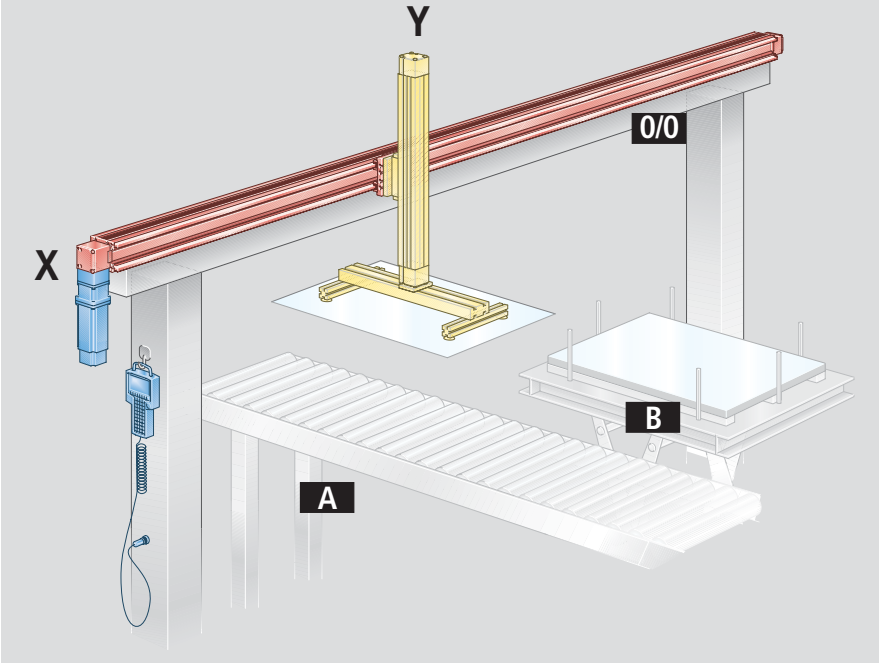
When this function is activated, the automatic program mode can be started or stopped via two external switches.

BCD inputs

In the automatic mode, one of 32 programs can be selected via a BCD switch.

Programming example

Handling application for a two-axis pick and place system



Two-axis handling application – pick and place system

Task:

The axes execute a reference run and then wait in stand-by position (0/0). On receipt of a START signal, parts are picked from a conveyor belt (position A 2000/1000) and moved to a stacking unit (position B 0/1000).

Program

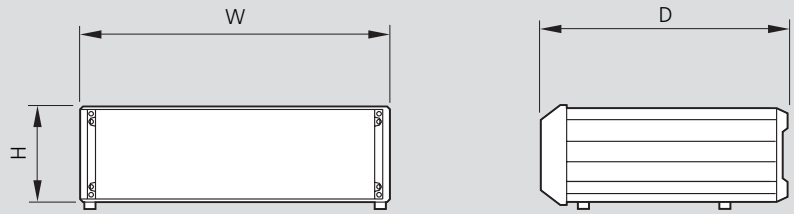
Line	Command	Command option	Command data	Comment
1	REF	Y		Reference run of axis Y
2	REF	X		Reference run of axis X
3	INP	=1?	1	Wait until input 1 (START) is at high level
	F>>	Y	2500	Set speed of Y axis to 2500 mm/min
	F>>	X	2500	Set speed of X axis to 2500 mm/min
4	ABS	X	2000	Move X axis to absolute position +2000 mm at max. speed
5	ABS	Y	1000	Move Y axis to absolute position +1000 mm at max. speed
6	OUT	SET	1	Set output 1 to ON (close the gripper)
	TIM		10	Wait 1 second
	ABS	Y	0	Move Y axis to absolute position 0 mm at max. speed
7	ABS	X	0	Move X axis to absolute position 0 mm at max. speed
8	ABS	Y	950	Move Y axis to absolute position 950 mm at max. speed
9	F>>	Y	60	Set speed of Y axis to 600 mm/min
	ABS	Y	1000	Move Y axis to absolute position 1000 mm
10	F>>	Y	2500	Set speed of Y axis to 2500 mm/min
	OUT	RE	1	Set output 1 to OFF (open the gripper)
	TIM		10	Wait 1 second
	ABS	Y	0	Move Y axis to absolute position 0 mm
11	JMP	LIN	3	Unconditional jump to line 3

Note: A program line can contain up to 4 commands.

Stepping Motors
PROFI step and PROFI step eco Positioning Controller

Dimensions

PROFI step / PROFI step eco



PROFI step	H	W	D
1-axis, PROFI step eco in table-top housing	162 mm	257 mm	440 mm[1)] 376 mm[2)]
1- to 3-axis, table-top housing	162 mm	470 mm	440 mm[1)] 376 mm[2)]
4-axis, table-top housing	324 mm	470 mm	440 mm[1)] 376 mm[2)]

[1)] with connector; [2)] without connector

Ordering code

Device designation	Type		Housing		E-stop circuit		I/O expansion		Holding brake	
Part number		**Output stage for**		**Design**		**Description**		**Inputs/ Outputs**		**Number**
PROFI step 1131-212-01	01	one axis	01	19" rack	00	without	00	standard 24/16 dig. I/O	00	without
	02	two axes	02	Table-top housing	01	with	01	48/32 dig. I/O	01	one
	03	three axes					02	24/16 dig. I/O + 4/2 ana. I/O	02	two
	04	four axes					03	48/32 dig. I/O + 4/2 ana. I/O	03	three
									04	four
PROFI step eco 1131-212-02			01	19" rack					00	without
			02	Table-top housing					01	one

Ordering example

Single-axis application with PROFI step eco in table-top housing

Ordering data		Description
1131-212-02		
Housing	**= 02**	Table-top housing
Holding brake	**= 00**	without

Three-axis application with PROFI step X-Y-Z arrangement, including E-stop switch, with I/O expansion for sensors, actuators

Ordering data		Description
1131-212-01		
Type	**= 03**	Three output stages
Housing	**= 02**	Table-top housing
E-stop circuit	**= 01**	With E-stop circuit
I/O expansion	**= 02**	48/32 dig. I/O
Holding brake	**= 01**	One (Z-axis stepping motor with brake)

Ordering code for cable sets

Cable set comprising:	Part number Length in m (max. 20 m)	Cable supply condition – motor side		Cable supply condition – controller side PROFI step
		Terminal box (standard motor)	with connector	
Motor cable	1130-801-30	10	20	10
Motor and brake cables	1130-801-31	11	21	11

Stepping Motors

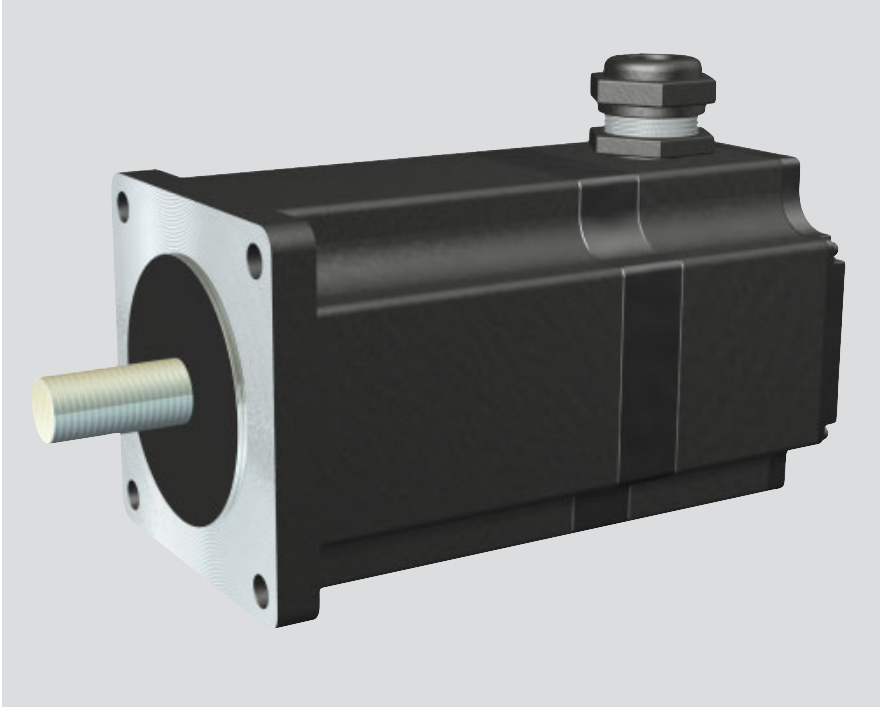
Product description

Three-phase stepping motors are extremely robust, maintenance-free drives. They are controlled by positioning controllers to execute precise, step-by-step rotary movements according to programmed commands.

The range of applications is broad and varied, including point to-point positioning according to programmable travel profiles and dynamic short-time movements (infeed motion) in the textile industry.

Three-phase stepping motors with LW winding can be operated using the TLD011/TLC411 and three-phase stepping motors with LN winding using the PROFI step positioning controls at resolutions from 200 to 1000 steps per revolution or, in micro-step mode, from 2000 to 10000 steps per revolution. When operated using a TLC411 positioning controller, resolutions of 19200 steps per revolution can be achieved.

The application potential of three-phase stepping motors can be increased even further with optional features such as rotation monitoring, holding brakes, or rugged, low-backlash planetary gears.



Advantages

- Sinusoidal commutation and a special structure combine to give a stepping motor that runs very quietly and almost totally resonance-free.
- High power density, with up to 50% more torque than conventional stepping motors of comparable size, thanks to the optimized internal geometry.
- More power, simpler wiring, compact electronics and advanced production methods keep the prices low.
- An excellent drive concept for a wide range of applications. Simple positioning tasks can be performed reliably and cost-effectively with no great technical outlay.

Technical data

Motor type		VRDM 368	VRDM 397	VRDM 3910	VRDM 3913
Number of steps		200 / 400 / 500 / 1000 / 2000[1] / 4000[1] / 5000[1] / 10000[1] / 19200[2]			
Step angle	(°)	1.8 / 0.9 / 0.72 / 0.36 / 0.18[1] / 0.09[1] / 0.072[1] / 0.036[1]			
Maximum torque	(Nm)	1.5	2.0	4.0	6.0
Mass moment of inertia	($kgcm^2$)	0.38	1.1	2.2	3.3
Holding torque	(Nm)	1.70	2.26	4.52	6.78
Weight	(kg)	1.1	2.05	3.1	4.2
Enclosure		IP56 (motor housing), IP41 (shaft end, front)			
Insulant class		F			

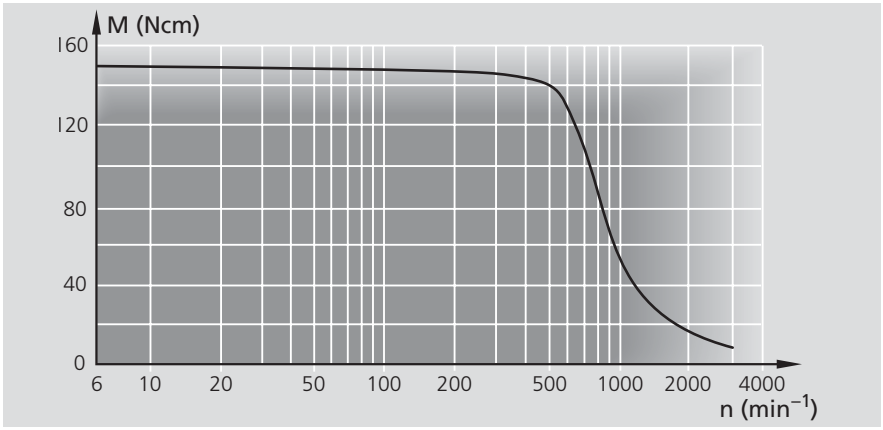
[1] Micro-step mode [2] with TLC411 only

Stepping Motors

Torque/speed characteristics

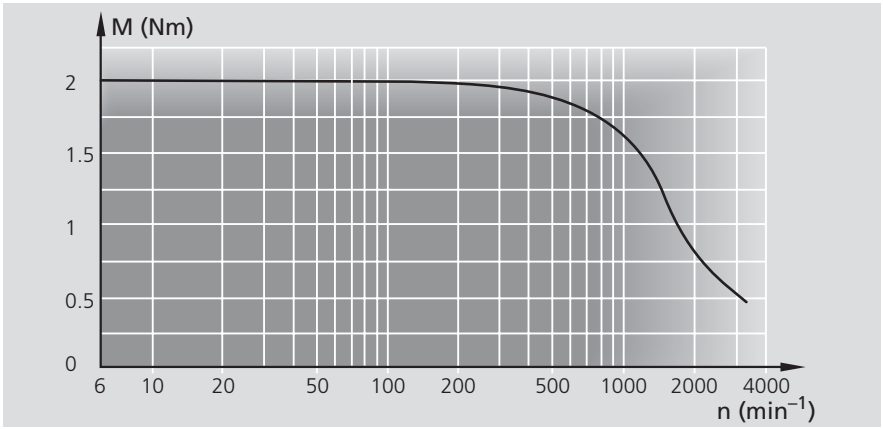
Power controller
Twin Line 325 V
Motor
VRDM 368 / 50 LWx

Power controller
PROFI step 130 V
Motor
VRDM 368 / 50 LNx



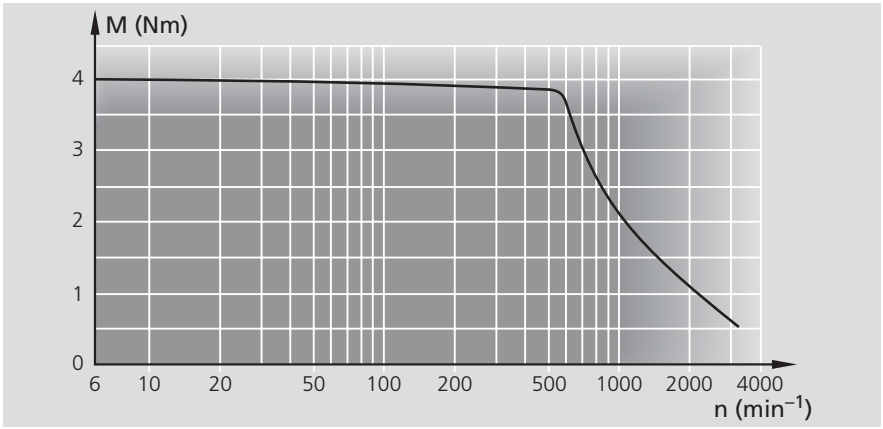
Power controller
Twin Line 325 V
Motor
VRDM 397 / 50 LWx

Power controller
PROFI step 130 V
Motor
VRDM 397 / 50 LNx



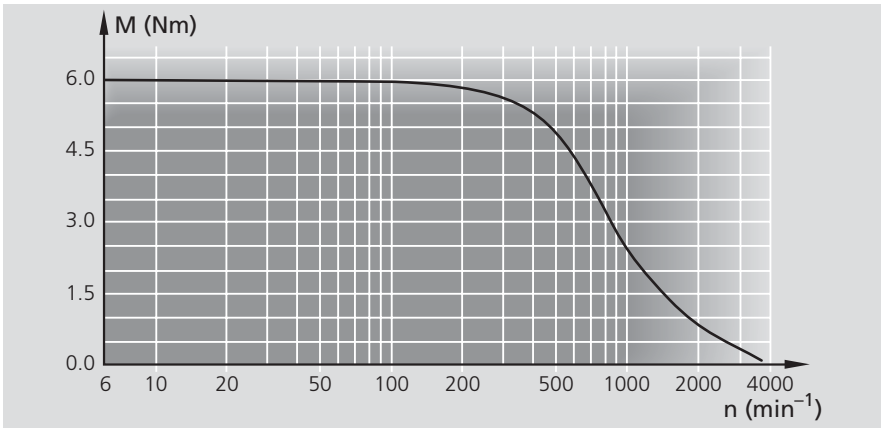
Power controller
Twin Line 325 V
Motor
VRDM 3910 / 50 LWx

Power controller
PROFI step 130 V
Motor
VRDM 3910 / 50 LNx



Power controller
Twin Line 325 V
Motor
VRDM 3913 / 50 LWx

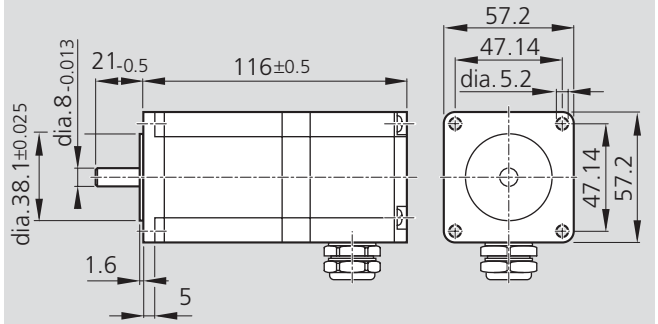
Power controller
PROFI step 130 V
Motor
VRDM 3913 / 50 LNx



The torque/speed characteristics are based on 1000 steps/revolution.

Dimensions

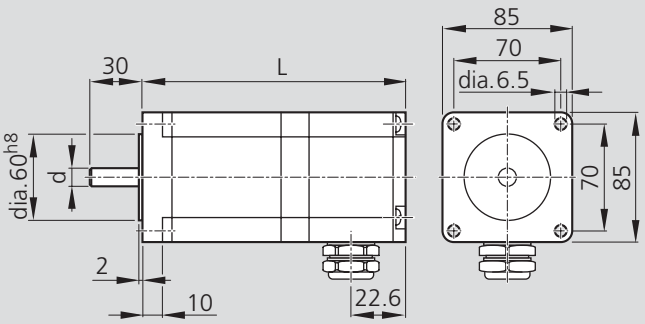
VRDM 368 / 50 LWB, VRDM 368 / 50 LNB



VRDM 397 / 50 LWB, VRDM 397 / 50 LNB

VRDM 3910 / 50 LWB, VRDM 3910 / 50 LNB

VRDM 3913 / 50 LWB, VRDM 3913 / 50 LNB



Type	L	d_{h6}
VRDM 397	110	12
VRDM 3910	140	12
VRDM 3913	170	14

Ordering code

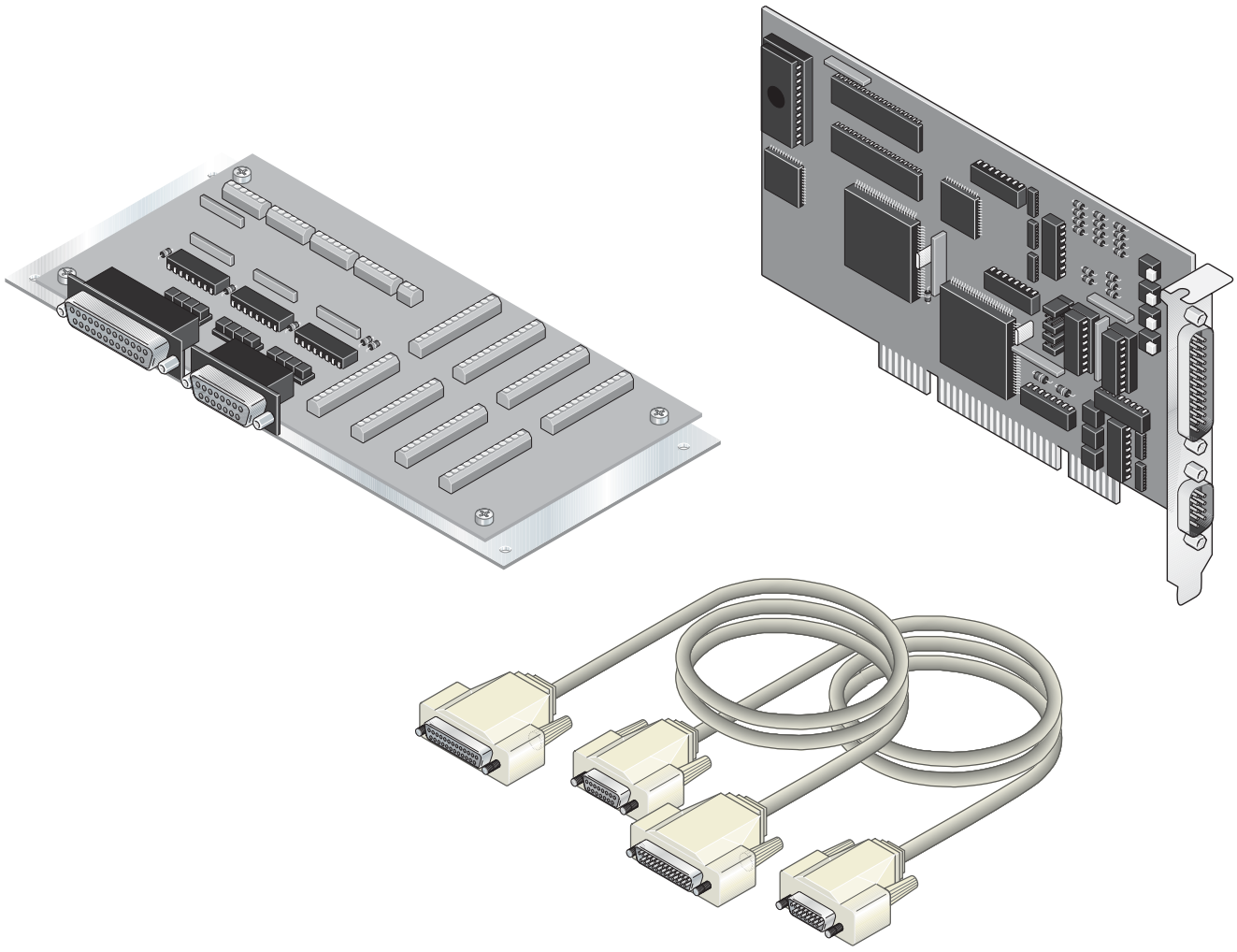
Part number	Motor type	Power controller
8611-027-06	VRDM 368 / 50 LWB	Twin Line
8611-028-06	VRDM 397 / 50 LWB	
8611-029-06	VRDM 3910 / 50 LWB	
8611-030-06	VRDM 3913 / 50 LWB	
8611-031-06	VRDM 368 / 50 LNB	PROFI step
8611-032-06	VRDM 397 / 50 LNB	
8611-033-06	VRDM 3910 / 50 LNB	
8611-034-06	VRDM 3913 / 50 LNB	

Three-phase stepping motors are supplied complete with terminal box. Optional accessories include a connector, gearbox, encoder and holding brake.

PC Boards
TURBO STEP 45 PCI

Product description

The four/eight-axis stepping motor controller TURBO STEP 45 PCI is a standard PC board that can be installed in any PC with PCI bus. It can control up to eight stepping motors or servomotors. In the case of controllers with incremental inputs (stepping motor interface), the motors are controlled in two groups of four axes.



The controller is equipped with an integral high-speed processor, memory, timer, pulse shaper and software to generate and output motor signals directly from the PC without taking up any of the PC's internal computing resources. This permits extremely precise controlling of step pulse timing.

While this being done, the PC executes the CNC program or a program written by the user. The program sends commands consisting of only a few bytes to the controller. These commands set the ramps and the velocity and initiate axis movements.

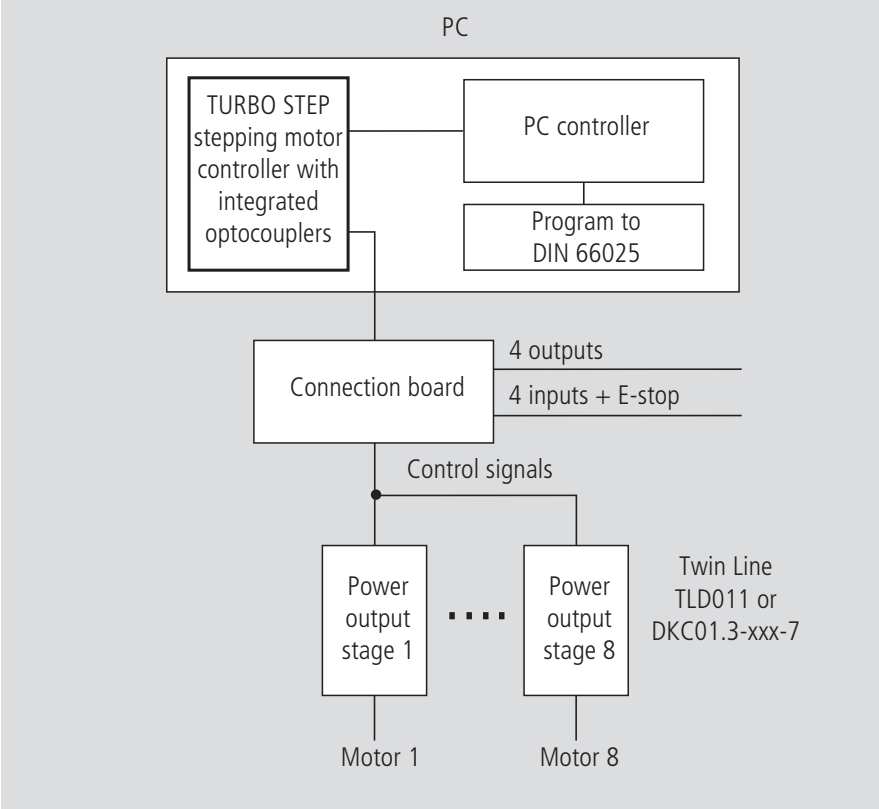
While the controller is executing a move command, the PC program has plenty of time to process the next command, perform other calculations or control a user-specific chart or diagram. The PC also has sufficient time available to provide ergonomically optimum visualization of data on the monitor.

The controller encompasses virtually all useful and desirable functions, e.g. continuous curves made up of arcs and linear segments with a common start and stop ramp, tangential control for a rotary axis, 2 to 4-axis reference point interpolation, and much more.

All electrical inputs and outputs are isolated from the PC voltages via optocouplers. All external connections are protected by HF filters. This ensures optimum protection against electromagnetic interference.

The controller generates step and direction signals for controlling the power amplifiers of the stepping motors or the incremental inputs of servo amplifiers. The step and direction signals can be output directly at a voltage level of 5 V or using an isolated external voltage level of up to 12 V.

The Twin Line TLD011 stepping motor power electronics and the digital control unit DKC01.3-xxx-7 can be readily connected to the controller.



Applications

- Machining
- Measuring
- Material transport
- Adhesive application, etc.

Advantages

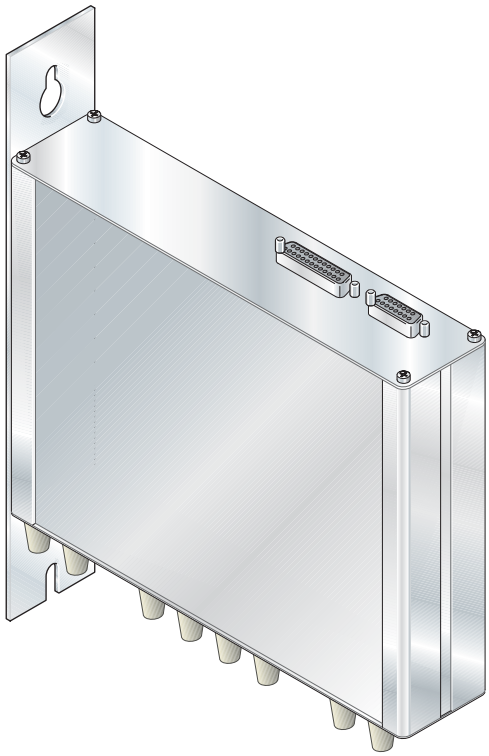
- Effortless programming of control sequences via PC
- Up to 8 axes per PC controller board
- Optocoupler inputs/outputs for guaranteed protection of the PC
- Maximum economy
- Inexpensive and powerful
- Easily mounted using connection board
- Motion sequencing via PC

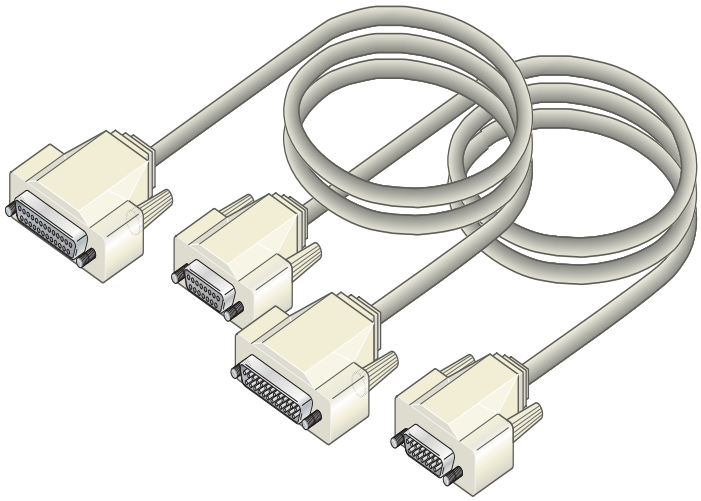
PC Boards
CNC 45 S Controller Module

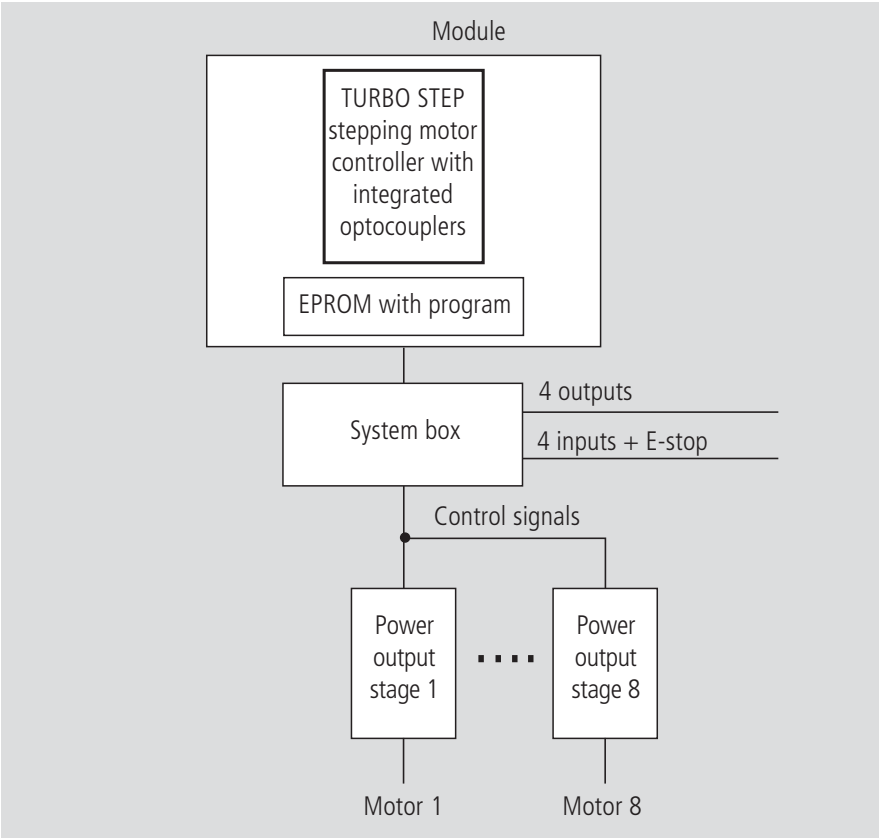
Product description

The command set and the function principle of the CNC 45 S controller module are identical to those of the TURBO STEP 45 PCI. The CNC 45 S is a stand-alone device which manages without an expensive PC.

A PC is, however, required to write the program for storage on the controller module's PC board. The completed CNC program is compiled and stored in an EPROM. This EPROM is then mounted on the controller module's PC board. Once the PC board has been reinstalled in the controller module, the system is ready to operate.







Applications

- Machining
- Measuring
- Material transport
- Adhesive application

Advantages

- Effortless programming of control sequences via the controller module
- Up to 8 axes per PC board
- Maximum economy
- Inexpensive and powerful
- Easily mounted using system box

Technical data TURBO STEP 45 PCI

System components

TURBO STEP 45 PCI controller module, connection board, driver, CNC program, hardware test program

Installation and connection

For installation in a PCI slot. Wiring of motors, switches and signals via connection board. The controller derives its power from the PC bus voltage (5 V). The maximum current consumption is 300 mA, i.e. the load on the computer power supply is insignificant.

Output signals

Step and direction for each axis, min. level 5 V, as well as 1.5 A Darlington driver with protective diodes for free output bits (relays or solenoid valves)

Input signals

End positions, E-stop, free input bits, max. level 24 V, presettable to high- or low-active

CNC program to DIN 66025

Command editor and sequential program with perfect syntax test and help system. Clear presentation on color monitor, exceptionally user-friendly handling.

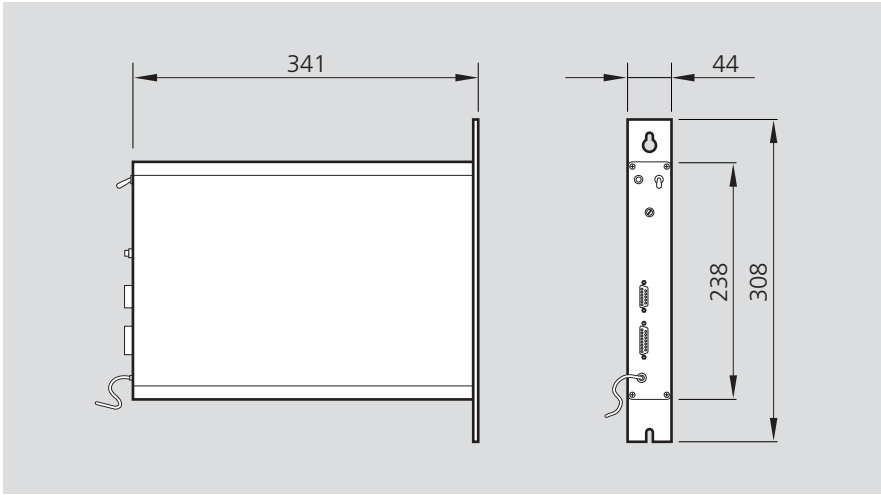
Drivers

Libraries for C++ and Turbo-Pascal, as well as DLL file for Windows applications

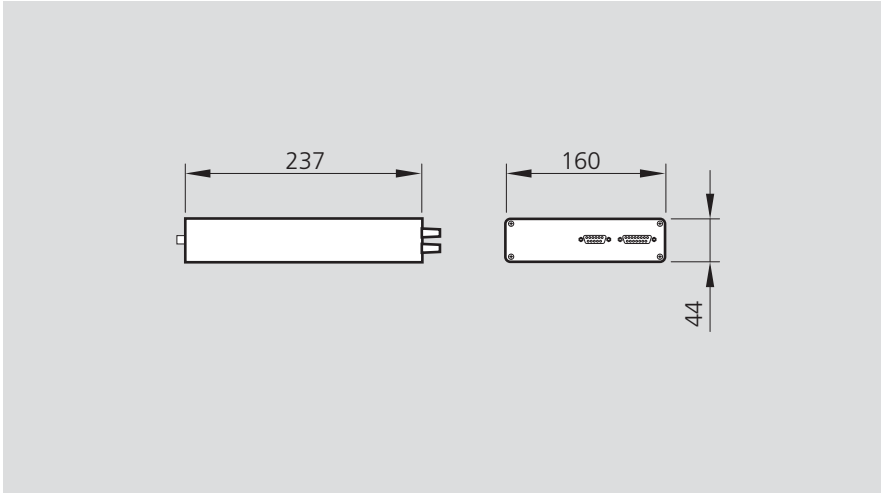
Move commands in the numerical range -32768.. + 32767:	**TURBO STEP 45 PCI**
Linear interpolation X, Y	up to max. 50 kHz
Linear interpolation X, Y, Z	up to max. 50 kHz
Linear interpolation X, Y, U	up to max. 50 kHz
Circular interpolation X, Y	up to max. 50 kHz
Circular interpolation X, Y with tangential control in U	up to max. 25 kHz
Elliptical interpolation X, Y	up to max. 25 kHz
Elliptical interpolation X, Y with tangential control in U	up to max. 25 kHz

Move commands in the numerical range $-1.07 \cdot 10^9$.. + $1.07 \cdot 10^9$..	**TURBO STEP 45 PCI**
Independent move commands X, Y, Z, U	up to max. 25 kHz
Spline interpolation X, Y, Z, U	up to max. 25 kHz

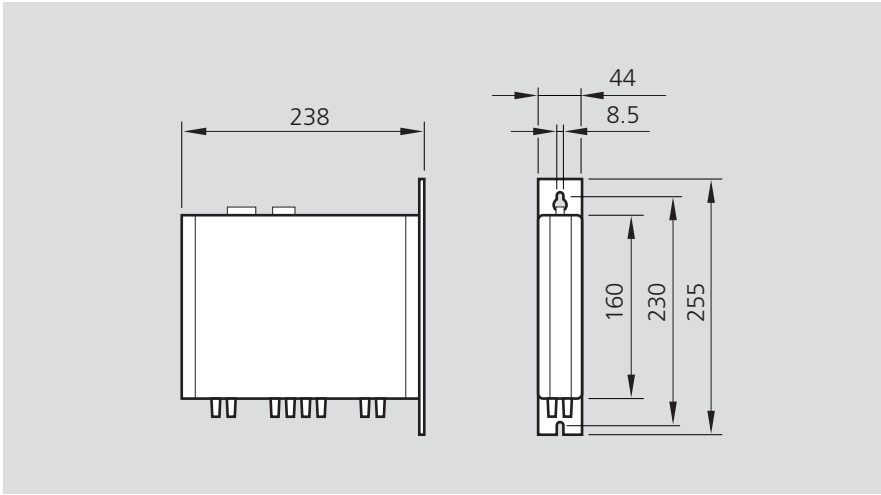
Dimensions
CNC 45 S controller module



System box

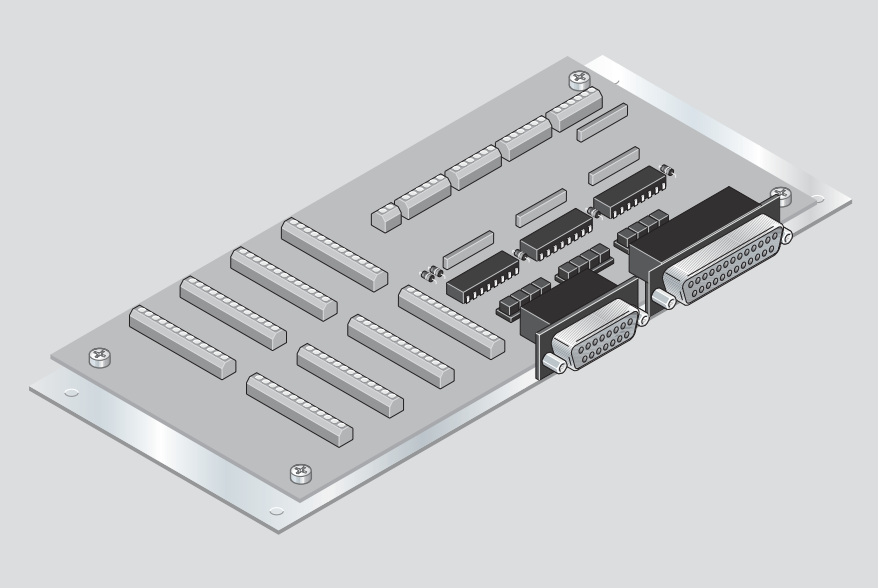


System box for wall mounting



PC Boards
Accessories

Connection board for TURBO STEP 45 PCI



Connection board with two sub-D cables for reliable, solderless connection of the controller to the motor amplifiers, limit switches, solenoid valves, etc.

Design: board on mounting plate

Signal levels are selectable and can be adapted to the motor amplifier inputs.

System box for CNC 45 S

This connection box simplifies wiring of the controller, the output stages, limit switches, and other peripherals. All connections are made via screw terminals, thus eliminating the need for soldering.

The system box comes standard with two connection cables (length: 1 m each).

The wall-mounting system box is ideal for the CNC 45 S because it can be mounted alongside.

Ordering code

Device name Part number	Design		
	Axes	Option	Description
TURBO STEP 45 PCI 1131-212-20	1 to 8	01	TURBO STEP 45 PCI with German documentation
		02	TURBO STEP 45 PCI with English documentation
		03	TURBO STEP 45 PCI with connection board and German documentation
		03	TURBO STEP 45 PCI with connection board and English documentation
CNC 45 S 1131-211-90	1 to 4	01	CNC 45 S Controller Module with system box 1
		02	CNC 45 S Controller Module with system box 2

Control Cabinet Solutions

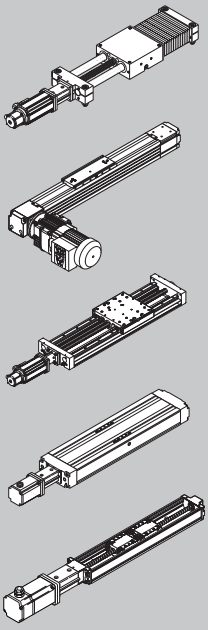
The product spectrum ranges from drive concepts comprising individual components right through to complete electrical solutions.

With a package of individual components (linear motion system with motor, power amplifier, controller, etc.), the wiring and start-up is left to the user.

In a complete solution (linear motion system with motor and control cabinet), all of the electrical components are already installed in a control cabinet, wired up and ready for operation.

Other services, such as start-up and programming, are also available.

Components



Linear motion system

Servo amplifier

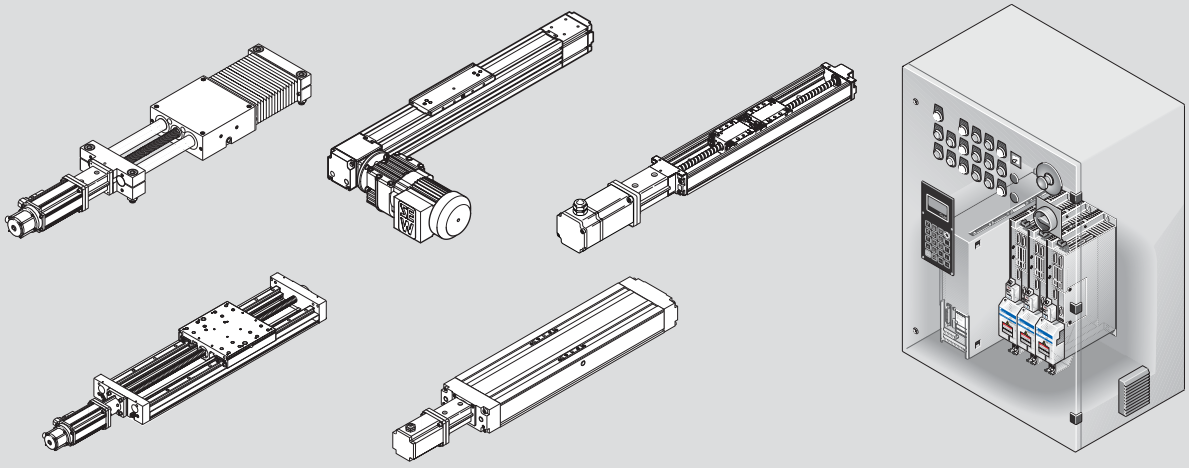
Frequency inverter

Stepping motor output stage

Positioning controller

Path controller

Complete solution



Advantages

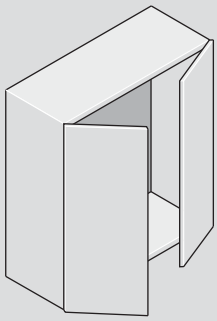
- A complete drive solution from a single source
- All components in the drive package are optimally tuned to each other: from the linear motion system right through to the power electronics and controller in the control cabinet
- Customer-specific solutions for a wide and varied range of tasks in many industries
- Many years' experience in control cabinet design and fabrication
- High quality standards
- Individual and series applications
- A competent partner for realization of complex projects
- Control cabinet components (relays, contactors, terminals, etc.) from renowned manufacturers according to customer specifications
- Plug-in cable connections
- Additional measuring devices can be integrated
- Comprehensive, multilingual documentation (wiring diagrams, layout, parts list)
- Tested in accordance with VDE guidelines
- EMC design, CE marking
- Voltage supply adaptable to international mains power

Other designs on request

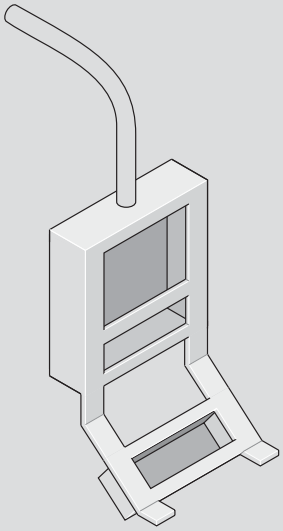
Housing types

Large control cabinets

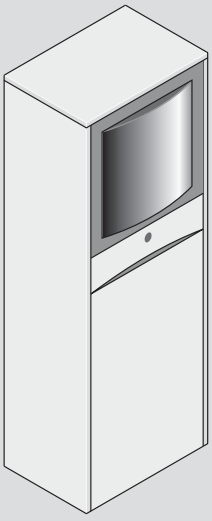
Small control cabinets



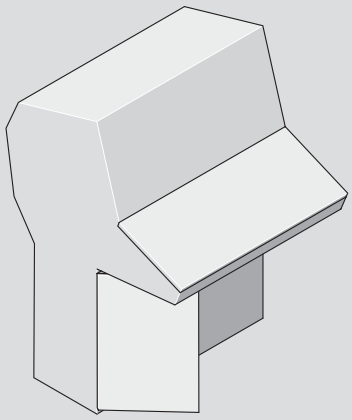
Operating panel



PC control cabinets



Desk cabinets



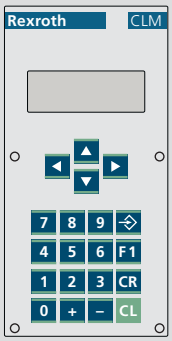
Control Cabinet Solutions

Operation and visualization

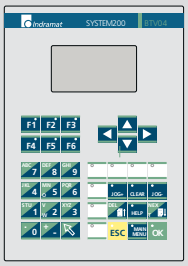
Elements for installation in the cabinet door:

- Operator panels, 7-segment displays
- Sensors, switches, signal lamps
- Decade switches, potentiometers
- Monitors and keypads

Control and display panel

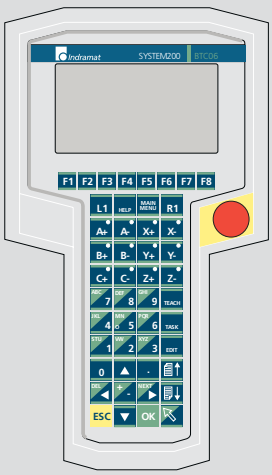


Operator panel



Decade switch

Hand-held control terminals

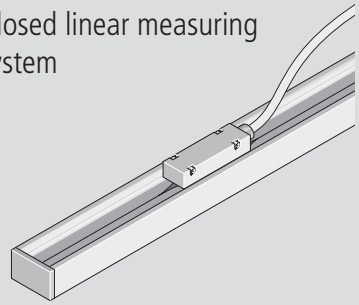


Measuring devices / Sensors

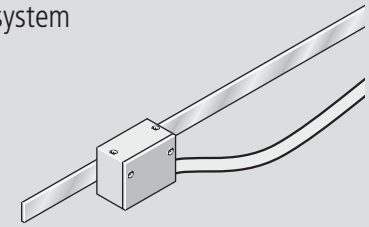
for temperature, force, velocity, position measurements, etc.

Linear position/velocity measurement

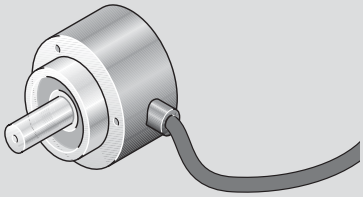
Closed linear measuring system



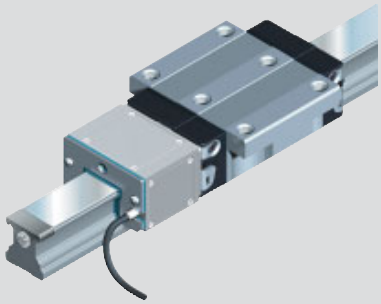
Open linear measuring system



Rotary position/speed measurement



IMS integrated measuring system



Barcode scanner

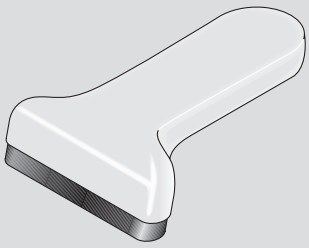
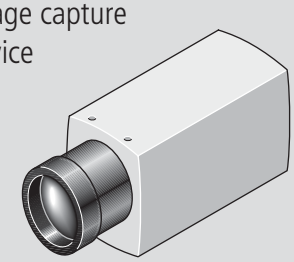


Image capture device



Other designs

- Mobile (wheel-mounted) control cabinet
- Safety features:
  - E-stop devices
  - Connection of safety light grid, safety switches, etc.
  - Enhanced protection (air conditioned – not EEx versions)
- Special paint finishes
- Special sizes
- Control panels
- Installation of customer–supplied components

Services

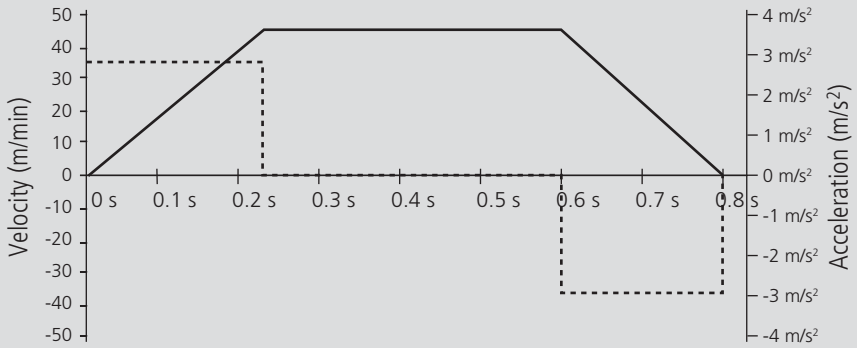
Support and consulting at the planning stage

Are you planning a new machine, line or system?

Your targets will be defined by:

- Accuracy
  - Running accuracy
  - Repeatability
  - Positioning accuracy
  - Synchronization
- Motion profile
  - Travel distance
  - Velocity
  - Acceleration
  - Independent motion
  - Dependent motion
  - (Linear, circular, elliptical or spline interpolation)
- Installation orientation (horizontal, vertical, inclined)
- Mass to be moved
- Mass center of gravity
- Process forces (machining, feed, pressing or additional friction forces)

Typical trapezoidal motion profile



The following criteria have to be considered:

- Technical and economic feasibility
- Physical limits
- Optimum customer benefit
- Complete cycle approach

Our support and advice in the selection of our linear motion systems is completely free of charge. It includes calculation of the drive system (rotary or linear motor) to meet your specific requirements. This way, you can be assured that the associated drive and control electronics will be optimally selected and configured.

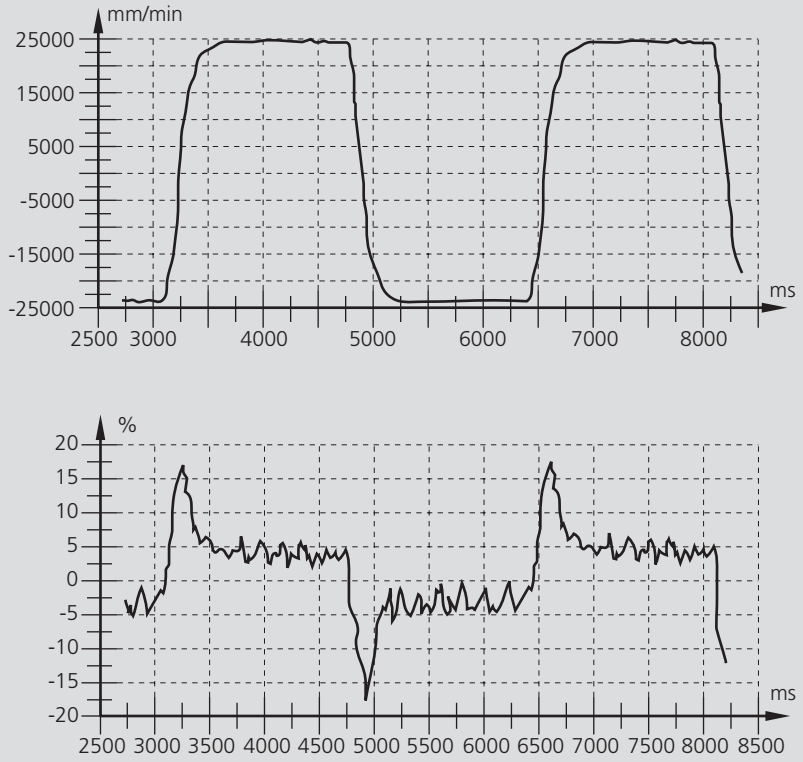
Start-up

If desired, our experienced service specialists can assist you during the start-up of your system. Your benefit:

- More rapid start-up
- All mechanical and drive parameters and limits are known
- Safety through avoidance of errors
- Optimized drive systems
- Operator training

These services will be charged at cost. Please ask for our current list of service charges.

Typical oscillogram



Software development

We can develop a sequence program for the supplied control system on the basis of your technical specifications.

The program will be loaded into the system and fine-tuned as required on site by one of our control and software specialists, who will also train your operating personnel.

These services will be charged at cost. Please ask for our current list of service charges.

General technical services

We also offer the following additional services:

- Plug-in cables in any required length for motors, controllers and PC interfaces
- Expert, speedy and cost-effective repairs
- Quick replacement deliveries (in Germany within 24 hours)
- Product training
- Technical advice regarding EMC / fieldbuses / engineering / concept development
- Hotline for start-up problems

Drive Selection
Calculation Principles

Systems with toothed belt drive

Selection procedure similar to that for ball screw drives. The feed constant and reduction ratio need special consideration. Selection support is available on request.

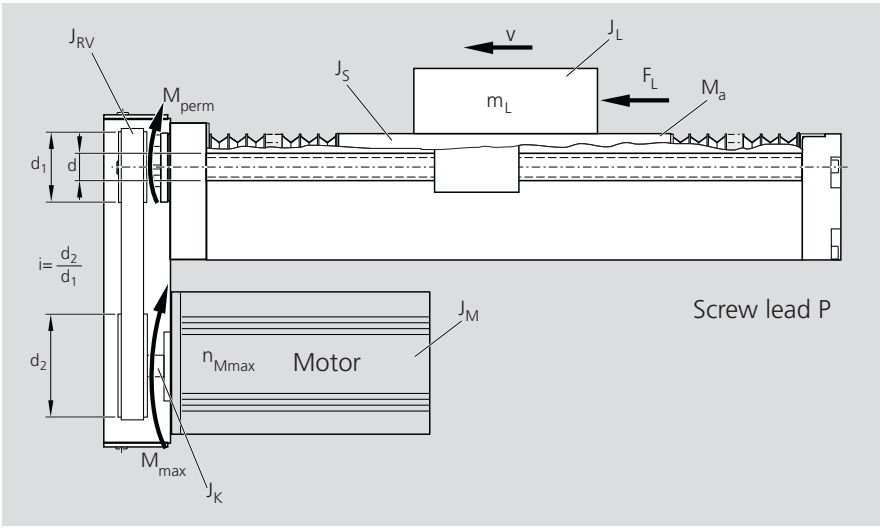
Systems with rack and pinion drive or linear motor

Selection support is available on request.

Systems with ball screw drive

Note:
The following calculation principles are for provisional dimensioning of linear motion systems only.

An exact calculation of the complete drive (motor and controller) – particularly with regard to thermal considerations – is only possible when the whole motion sequence is known, including dead times, feed forces and environmental conditions.



Servomotor acceleration characteristics

The calculation for stepping motors is similar, but with certain restrictions. Support is available on request.

M_L must be added in the direction of motion and subtracted in the opposite direction.

Horizontal installation:

(1) $M_a = 0.8 \cdot M_{max} - M_{fr} \pm M_L$ $\qquad M_{max} \leq M_{perm}$

Vertical installation:

(2) $M_a = 0.8 \cdot M_{max} - M_{fr} - M_w \pm M_L$ $\qquad M_{max} \leq M_{perm}$

$$M_L = \frac{1.592 \cdot 10^{-4}}{i} \cdot F_L \cdot P$$

Moment due to weight
(vertical installation)

Condition: $S \cdot M_w < M_{brake}$

S : safety
recommended value $S \geq 2$

m_{tot}: according to the relevant linear motion system catalog, plus weight of:
+ motor
+ coupling or timing belt side drive
+ trailing cables

$$(3)\quad M_w = \frac{1.561 \cdot 10^{-3}}{i} \cdot m_{lin} \cdot P$$

Fixed base plate, moving carriage: $m_{lin} = m_m + m_L$

Fixed carriage, moving base plate: $m_{lin} = m_{tot} - m_m$

Mass moment of inertia, system with additional load

See calculation in the relevant linear motion systems catalog

For handling: $6 \cdot J_M > J_L$

For machining: $1{,}5 \cdot J_M > J_L$

(4) $J_S =$ from relevant linear motion systems catalog

Mass moment of inertia

J_S : from linear motion systems catalog

J_L : $J_L = \frac{J_S}{i^2} + J_K + J_{RV} + J_{BR}$

J_M : see motor data in catalog

$$(5)\quad J_{tot} = \frac{J_S}{i^2} + J_M + J_K + J_{RV} + J_{BR}$$

Speed

v : see linear motion systems catalog

$$(6)\quad n_1 = \frac{i \cdot v}{P} \cdot 1000 \qquad n_1 \leq n_{Mmax}$$

Acceleration time

$$(7)\quad t_a = J_{tot} \cdot \left(\frac{n_1 \cdot 0.10472}{M_a} \right)$$

Acceleration

$$(8)\quad a = \frac{v}{t_a \cdot 60}$$

Acceleration distance

$$(9)\quad s_a = 0.5 \cdot a \cdot t_a^2$$

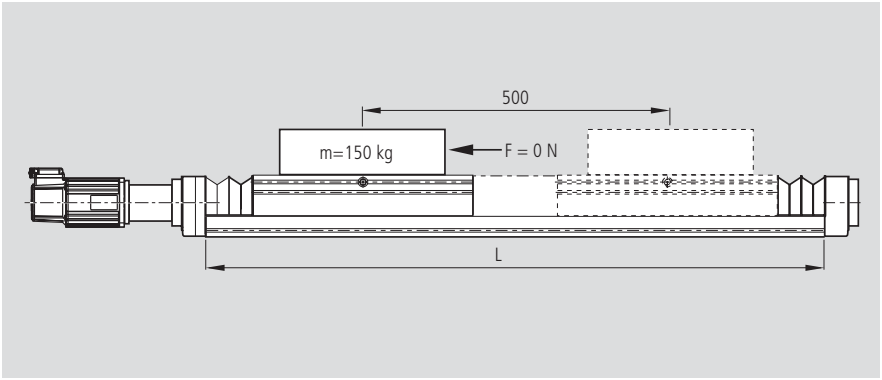
Drive Selection
Sample Calculation

Ball Rail Table
TKK 30-325 Al

- L_T = 320 mm
- 2% preload
- with bellows
- with MKD071B-061-KG1-KN motor (motor attachment and coupling, without gear)

Starting data:

A mass of 150 kg is to be moved 500 mm within a maximum of 1.0 s (total time). The axis is installed horizontally.



Note

This calculation example is of a representative nature only. Calculations for other linear motion systems are performed analogously. The related values and charts can be found in the catalog for the linear motion system used. When dimensioning the drive, always take the motor/controller combination into consideration as the effective speed and maximum torque depend on the combination used. The selection tables can be found in the sections referring to the different controllers.

Selection of the ball screw drive

Taken from the Ball Rail Tables catalog

Velocity calculation:

$$v_{average} = \frac{\text{effective stroke}}{\text{total time}} = \frac{0.5\ \text{m}}{1.0\ \text{s}} = 0.5\ \text{m/s} = 30\ \text{m/min}$$

According to the graph "Maximum velocity", the permissible ball screw drives for v = 30 m/min and L ≈ 1100 mm are:

32 x 20; 32 x 32

Selected ball screw drive: 32 x 20

According to the graph "Motor/controller selection data", the motor/controller combination MKD071B-061-KG1-KN and DKC01.3-040-7-FW with a maximum torque/force limit (overload factor OF) = 143% = > M_{Mmax} (= 11.3 Nm):

Calculation

Length L

$Travel_{max}$ = (stroke + 2 · excess travel) = 500 mm + 2 · 40 mm = 580 mm
with excess travel = (2 · P) = 2 · 20 = 40 mm

L = 1020 (from table, short carriage with bellows)
Max. travel = 582 mm

Acceleration torque M_a

$$M_a = 0.8 \cdot M_{Mmax} - M_{fr} = 0.8 \cdot 11.3 \text{ Nm} - 1.21 \text{ Nm} = 7.83 \text{ Nm} \quad (1)$$

$M_{Mmax} = 17.4 \text{ Nm} < M_{perm} = 35 \text{ Nm}$ (from "Max. permissible drive torque" graph)

Mass moment of inertia J_{tot}

with $J_S = 2465 \cdot 10^{-6} \text{ kgm}^2$ (4)

Formulas and data from Ball Rail Tables catalog

$J_k = 200 \cdot 10^{-6} \text{ kgm}^2$ (from Ball Rail Tables catalog)

$J_L = J_S + J_K + J_{BR}$ (value from table) $= (2465 + 200 + 72) \cdot 10^{-6} \text{ kgm}^2$
$= 2737 \cdot 10^{-6} \text{ kgm}^2$

For handling:

$$J_M > \frac{J_L}{6} > \frac{2737 \cdot 10^{-6}}{6} \rightarrow 456 \cdot 10^{-6} \text{ kgm}^2$$

$J_M = 8.7 \text{ kgcm}^2 = 870 \cdot 10^{-6} \text{ kgm}^2$ (value from table)

$870 \cdot 10^{-6} \text{ kgm}^2 > 456 \cdot 10^{-6} \text{ kgm}^2$ => condition met

$J_{tot} = J_L + J_M = (2737 + 870) \cdot 10^{-6} \text{ kgm}^2 = 3607 \cdot 10^{-6} \text{ kgm}^2$

Selected velocity v

$v_{average} = 30$ m/min (5)

$$v_{max} = \frac{n \cdot P}{i \cdot 1000} = \frac{4400 \text{ 1/min} \cdot 20 \text{ mm}}{1 \cdot 1000} = 88 \text{ m/min}$$

=> selected v = 50 m/min

Speed n

$$n_1 = \frac{i \cdot v}{P} \cdot 1000 = \frac{1 \cdot 50 \text{ m/min}}{20 \text{ mm}} \cdot 1000 = 2500 \text{ min}^{-1} \quad (6)$$

v = 50 m/min = 0.833 m/s, i =1 (value from "Maximum velocity" graph)

Drive Selection
Sample Calculation

Acceleration time t_a

$$t_a = J_{tot} \cdot \left(\frac{n \cdot 0.10472}{M_a}\right) = 3607 \cdot 10^{-6} \cdot \left(\frac{2500 \cdot 0.10472}{7.83}\right) s = 0.1206 \text{ s} \quad (7)$$

Acceleration a

$$a = \frac{v}{t_a \cdot 60} = \frac{50 \text{ m/min}}{0.1145 \text{ s} \cdot 60} = 6.91 \text{ m/s}^2 \quad (8)$$

Acceleration distance s_a

$$s_a = 0.5 \cdot a \cdot t_a^2 = 0.5 \cdot 6.91 \text{ m/s}^2 \cdot (0.1206 \text{ s})^2 = 50.3 \text{ mm} \quad (9)$$

Discrete travel step s_c
at constant velocity

$$s_c = s - 2 \cdot s_a = 500 \text{ mm} - 2 \cdot 50.3 \text{ mm} = 399.4 \text{ mm}$$

Constant velocity v_c

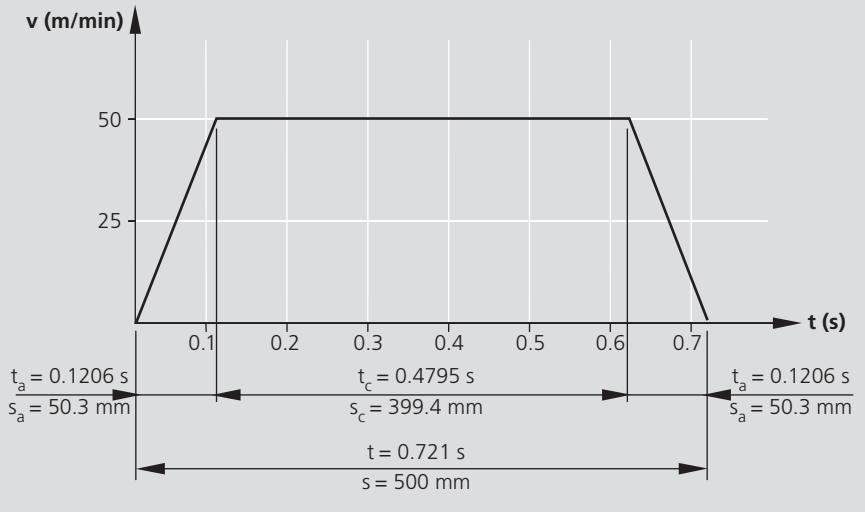
$$v_c = 50 \text{ m/min} = 0.833 \text{ m/s}$$

Discrete time step t_c
at constant velocity

$$t_c = \frac{s_c}{v_c} = \frac{0.4046 \text{ m}}{0.833 \text{ m/s}} = 0.4795 \text{ s}$$

Total time t

$$t = 2 \cdot t_a + t_c = 2 \cdot 0.1206 \text{ s} + 0.4795 \text{ s} = 0.721 \text{ s}$$

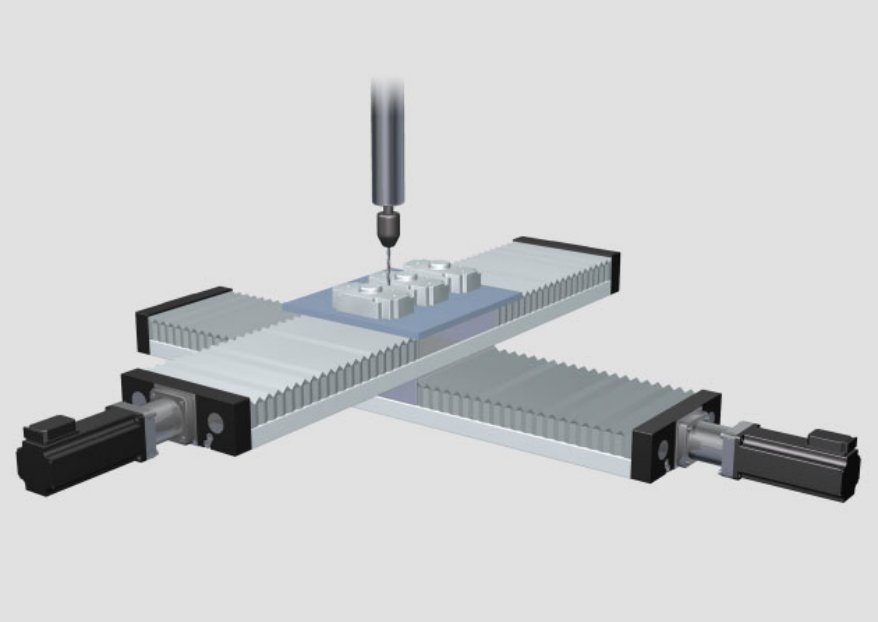


Symbols used

d_1	=	Diameter of driving sprocket (at motor shaft)	[mm]
d_2	=	Diameter of driven sprocket (at screw shaft)	[mm]
F_L	=	Feed force	[N]
P	=	Screw lead	[mm]
i	=	Gear reduction	[-]
M_a	=	Max. acceleration torque of motor	[Nm]
M_{max}	=	Max. torque of motor	[Nm]
M_{fr}	=	Friction moment	[Nm]
M_L	=	Load moment	[Nm]
M_w	=	Moment due to weight	[Nm]
M_{perm}	=	Maximum drive torque	[Nm]
m_m	=	Moved mass (carriage)	[kg]
m_L	=	Additional load	[kg]
m_{tot}	=	Total mass (including guide system)	[kg]
m_{lin}	=	Linear moved mass	[kg]
J_L	=	Mass moment of inertia, additional load	[kgm^2]
J_M	=	Mass moment of inertia, motor	[kgm^2]
J_{BR}	=	Mass moment of inertia, motor brake	[kgm^2]
J_{tot}	=	Total reduced mass moment of inertia	[kgm^2]
J_S	=	Mass moment of inertia, system and additional load	[kgm^2]
J_K	=	Mass moment of inertia, coupling (on motor side)	[kgm^2]
J_{RV}	=	Mass moment of inertia, timing belt side drive	[kgm^2]
v	=	Max. velocity (desired or mechanical limit)	[m/min]
n_1	=	Motor speed	[1/min]
n_{Mmax}	=	Max. motor speed	[1/min]
s_a	=	Acceleration distance	[m]
a	=	Acceleration	[m/s^2]
t_a	=	Acceleration time	[s]

Application Examples

X-Y axes



The simplest way to approach a position on a two-dimensional plane is by means of an X-Y axis arrangement. The X-axis carries the Y-axis which, in turn, carries the mass to be moved (tool, workpiece, measuring device, etc.).

The application above shows a machining setup with the workpiece positioned in a horizontal plane below the machining station. The reverse case – i.e. with the workpiece fixed and the tool moving – is also possible.

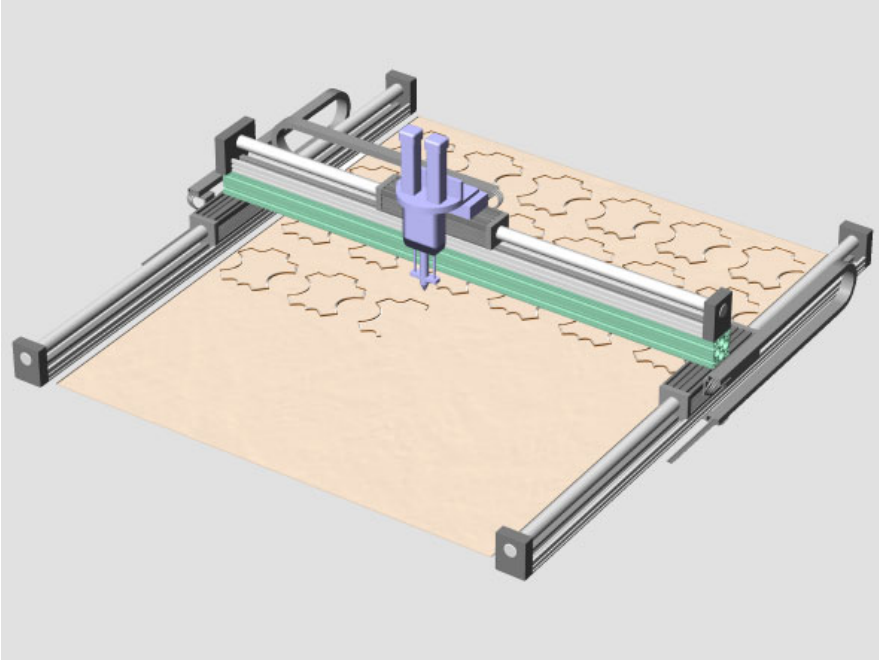
The example shown here consists of Ball Rail Tables with servo motor drives.

This combination achieves excellent running accuracy, high rigidity, precise synchronization and high positioning accuracy. The bellows cover used guarantees excellent protection against process media and dirt. The contour and force-locking mounting options allow easy and precise mounting of the customer's attachments.

Applications:

- Drilling, milling, screw-driving
- Welding
- Measuring
- Component placement, parts handling
- Adhesive application

Gantry axes, master-slave operation, "electronic shaft"



Where more demanding requirements are made on the mechanical strength and dynamics of a system, two X-axes are arranged in parallel, carrying one or more Y-axes.

If the application does not allow a connecting shaft to be installed for torque transmission between the X-axes, each of the two X-axes is fitted with an individual drive motor and the axes are connected via an "electronic shaft" (functionality of the drive controller or control system). The drives of the two axes must be perfectly synchronized both in normal operation and in the event of malfunction. To ensure this, one axis functions as the master and the other as the synchronized slave.

With a gantry arrangement, the slave is synchronized to the master after activation of the drive, resulting in perfect alignment of the mechanically linked parallel axes.

The application shown above is a cutting system with linear motor axes.

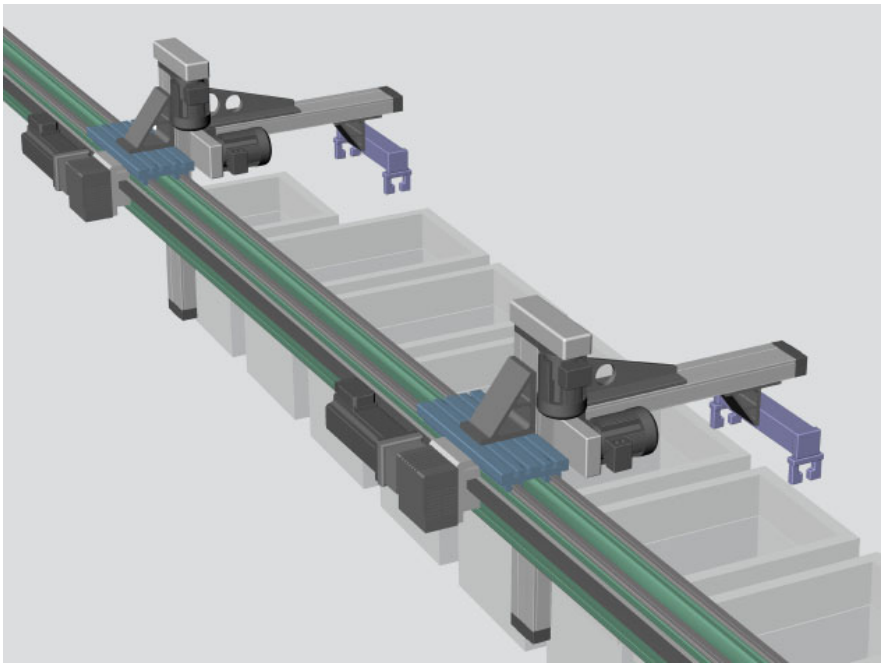
The cutting tool is arranged on the Y-axis, which rests on an aluminum profile supported by the two X-axes. The use of linear motors enables highly dynamic tool travel over X-Y areas.

Applications:

- Water jet cutting
- Laser cutting
- Flying saws
- Adhesive application
- Pick and place

Application Examples

Cantilever variant



Three-dimensional motion sequences can be categorized according to dependent and independent movements. In dependent (interpolated) movements, the linear axes move along defined paths in a mutually coordinated manner. Where the movements performed by the individual axes are unrelated, the positioning motion is termed independent.

Handling systems usually transport, stack or sort workpieces or products.

Machine tools carry out three-dimensional operations with either the tool or the workpiece moving.

The example above shows a handling device which transfers workpieces from one immersion bath to the next.

A gripper fitted to the Y-axis holds the workpieces during transportation. A connecting bracket is used to fix the Y-axis to the Z-axis which performs the vertical movement. Two such Y-Z-axis setups travel simultaneously on a Linear Module powered by a rack and pinion drive.

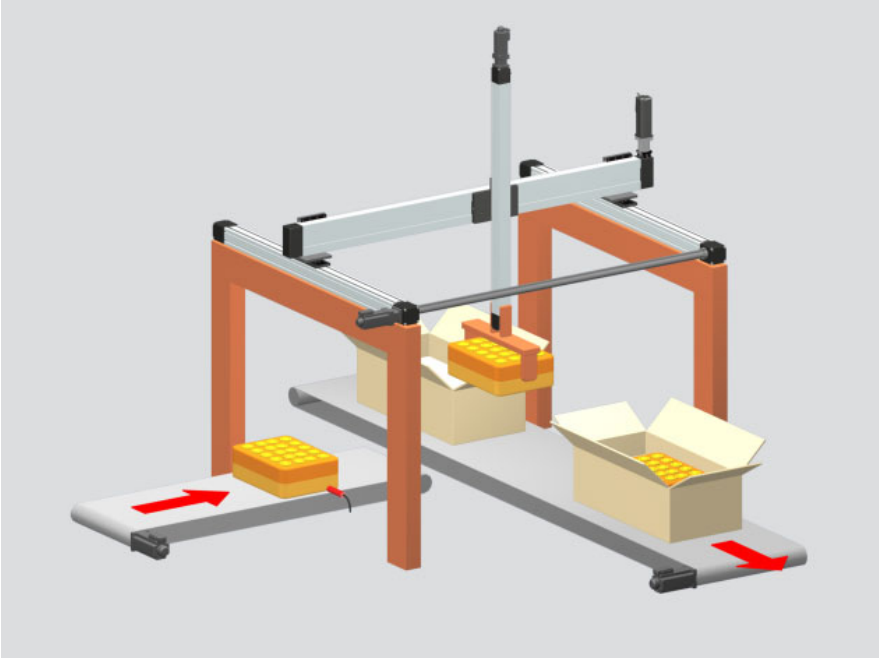
The rack and pinion drive on the X-axis enables the two Y-Z units to carry out independent movements. High throughput rates and an optimum cost-benefit ratio can be achieved in this way.

The use of a cantilevered Y-axis results in a compact design, thus saving valuable production space.

Applications:

- Palletizers
- 3D pattern millers
- Tool changers
- Paint stations
- Handling systems

Portal design



Applications involving three-dimensional movements over great distances are most efficiently managed by a system in portal design.

Such a system places high demands on the mechanical components. Criteria such as deflection, rigidity and vibration behavior must all be duly considered.

The best option for such applications is to use parallel linear motion systems in the lower axis, with the cross axis supported at each end.

The example shown above is a pick and place system which picks products off a conveyor belt and takes them to a position where they are stacked in cardboard boxes.

The Z-axis is fitted with a gripper which holds the products during transportation. The module body of the Z-axis travels vertically while the carriage is stationary. The Z-axis carriage is mounted to that of the Y-axis (cross axis) by means of a connecting bracket. The Y-axis is supported at both ends and also moved horizontally by the carriages of the two parallel X-axes. Mechanical drive coupling via the connecting shaft ensures perfectly synchronized motion of the two X-axes.

The MKR/CKR Linear Modules with belt drive used here allow highly dynamic three-dimensional travel and achieve outstanding pick-and-place throughput rates.

The wide choice of combination options in linear motion systems, connecting elements and drive systems allows optimum portal design solutions for every application.

Notes

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