Wall-mounted
positioning unit
with power drive for regulated
stepping motor

WDP5-228

Doc. no. 212.875/DGB 10.92

Ident no.: 00441106140

Edition: c077 Oct. 92

Safety requirements

Please read the following safety requirements prior to installation, operation, maintenance and repair of the device.

- The intended use of the device is described in this manual in chapter "Purpose" and must be observed.
- Installation, maintenance and repair of the device shall be performed by a qualified electrician.
  National regulations concerning
  – accident prevention
  – installation of electrical and mechanical systems
  – radio interference suppression
  shall be observed.
- The technical data of the device, particularly the ambient conditions, shall be observed.
- The device shall only be operated by trained personnel.
  BERGER LAHR offers training courses.
- The warranty is invalidated in case of unauthorized modification or opening of the device.
- Please ask your BERGER LAHR technical consultant prior to installing accessories not listed in the chapter "Description of accessories".
  The address is to be found on the rear cover.
- The safety symbols and notes on the device and in the manual shall be observed.

Explanation of symbols

ATTENTION
Reference to a danger for the device or components, possibly resulting in the endangering of human life.
DANGER
Reference to a direct endangering of human life.

DANGER
High voltage at component, do not touch.

DANGER
High temperature at component, do not touch.

ATTENTION
Warning against electrostatic discharge (ESD).
Only touch the PC-board or component in an electrostatically-protected environment.

NOTE
Important or additional information concerning the device or the manual.

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Proposals
Improvements

WDP5-228

Edition: c077 Oct. 92
Doc. no.: 212.875/DGB 10.92

Sender:

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Please inform us, using this form, if you have discovered any errors when reading this document.

We should also appreciate any new ideas and proposals.

Proposals and/or improvements:

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1 General description

1.1 Structure and characteristics

The WDP5-228 positioning unit (fig. 1-1) consists of the processor unit and 1000 W power drive and serves to control a regulated drive.

A regulated wall-mounted stepping motor, which is commuted electronically, is used as a drive.

The different operating modes allow several control configurations. The positioning units may be incorporated in a complex control system in a very versatile way.

A maximum of 124 positioning units (124 axles) may be operated via a network with a PC.

The unit is designed for wall-mounting in a control cabinet.

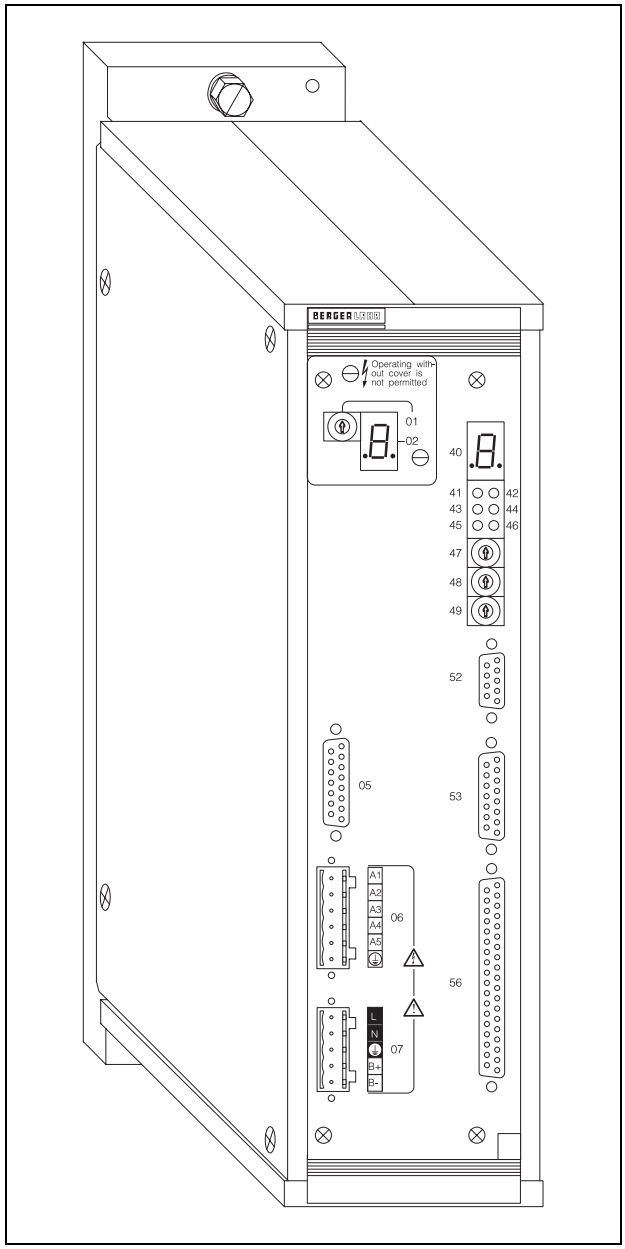


Fig. 1-1 WDP5-228 positioning unit

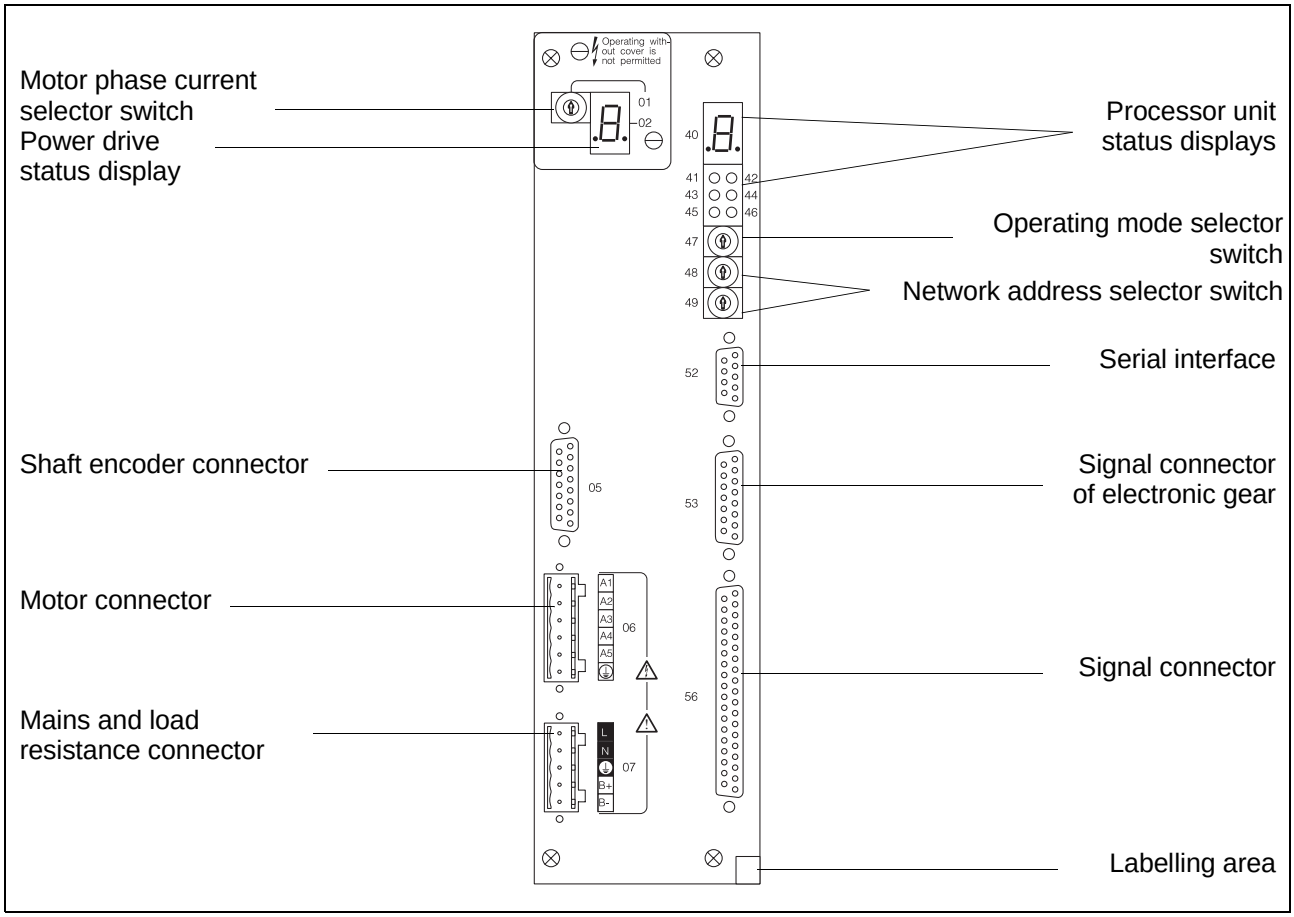


Fig. 1-2 Front panel

The following operating elements and displays are disposed on the front panel (fig. 1-2):

Motor phase current selector switch (01)
for setting the motor phase current

Power drive status display (02)
Seven-segment display for indication of operating status and malfunctions

Shaft encoder connector (05)
for a regulated wall-mounted stepping motor

Motor connector (06)
for a regulated, wall-mounted 5-phase stepping motor

Mains and load resistance connector (07)
for supplying the power drive and an external load resistor with voltage

Processor unit status displays (40 to 46)
Seven-segment display and LEDs for indication of operating status and malfunctions

Operating mode selector switches (47)
for setting the operating modes

Network address selector switch (48 and 49)
for setting the network address

RS 485 serial interface (52)
for data transfer of movement and setting values

Electronic gear signal connector (53)
for transfering an external reference variable

Signal connector (56)
for signal inputs and outputs and voltage supply of the processor unit

Labelling area
for the mounting location number

1.2 Purpose

The WDP5-228 positioning unit is used to control a wall-mounted 5-phase stepping motor (see 5-phase stepping motor catalogue, doc. no. 371). The unit may be used as a drive unit in various applications. Depending on the application, one of the operating modes described in chapter 1.3.5 can be set at the unit.
The unit is designed for wall-mounting in a control cabinet.

1.2.1 System configuration possibilities

Depending on the selected operating mode, the WDP5-228 positioning unit may be incorporated in a system in the following ways.

1.2.1.1 Serial mode

In serial mode (fig. 1-3), the individual movement commands are transferred serially and initiated on a PC or a terminal.

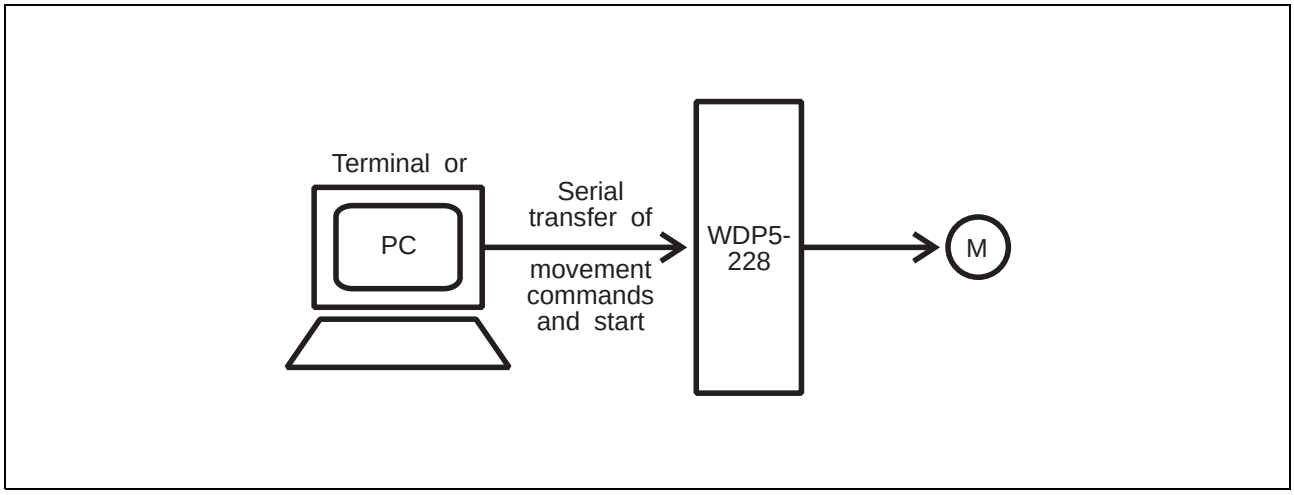


Fig. 1-3 Serial mode

1.2.1.2 Network mode

In network mode, a maximum of 124 WDP5-228 and other networkable BERGER LAHR units (e.g. SDP 5) units may be operated via a PC provided that 4 serial ports per 31 systems are available.

NOTE
The PRO-SDP/PC1 software must be installed on the PC to enable operation.

The operating modes "Memory", "Serial" and "Parallel" are possible in network mode, they are selected on the PC.

NOTE
Programs and unit parameters can be written on the PC and loaded into one or several WDP5-228 units at a later time (off-line programming).

1. Network mode "Memory"

In network mode "Memory" (fig. 1-4), stored programs are selected and processed by a PLC or relay controller.
Programming is effected with a PC.

The PC serves as a programming unit in the first place and is not required for program execution.

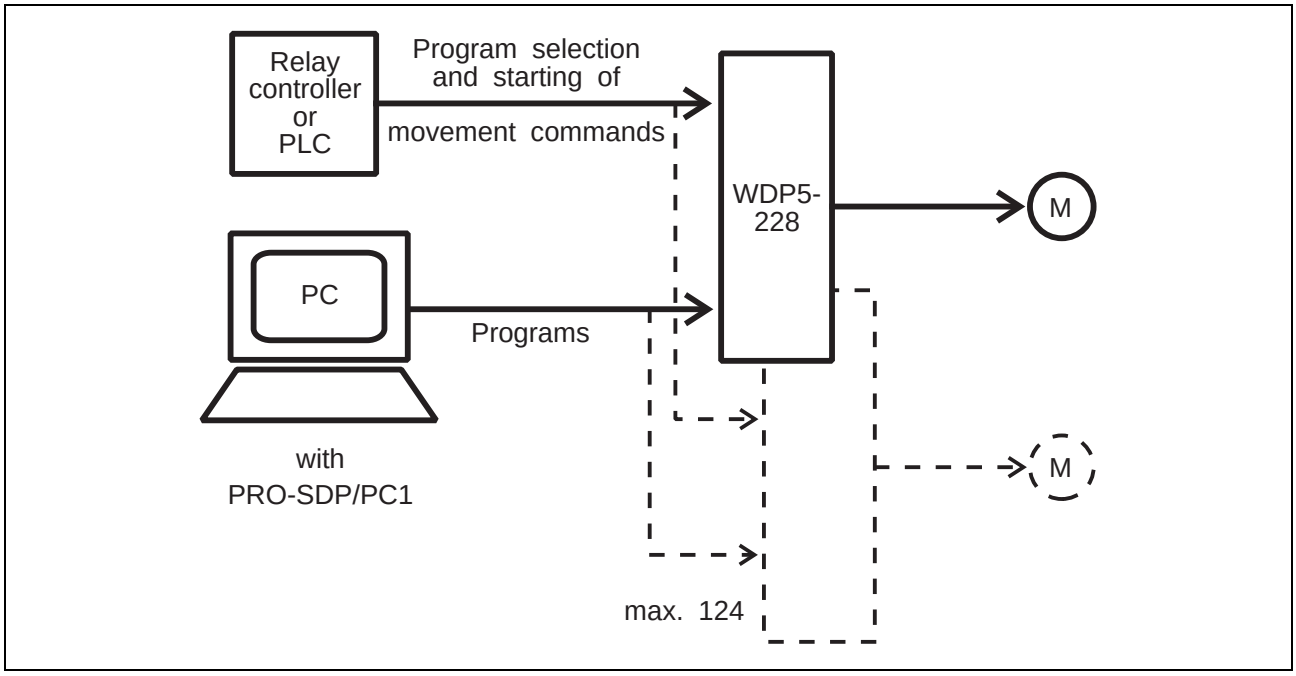


Fig. 1-4 Network mode "Memory"

2. Network mode "Serial"

In operating mode "Serial" (fig. 1-5), the individual movement commands are transferred serially and initiated by a PC.

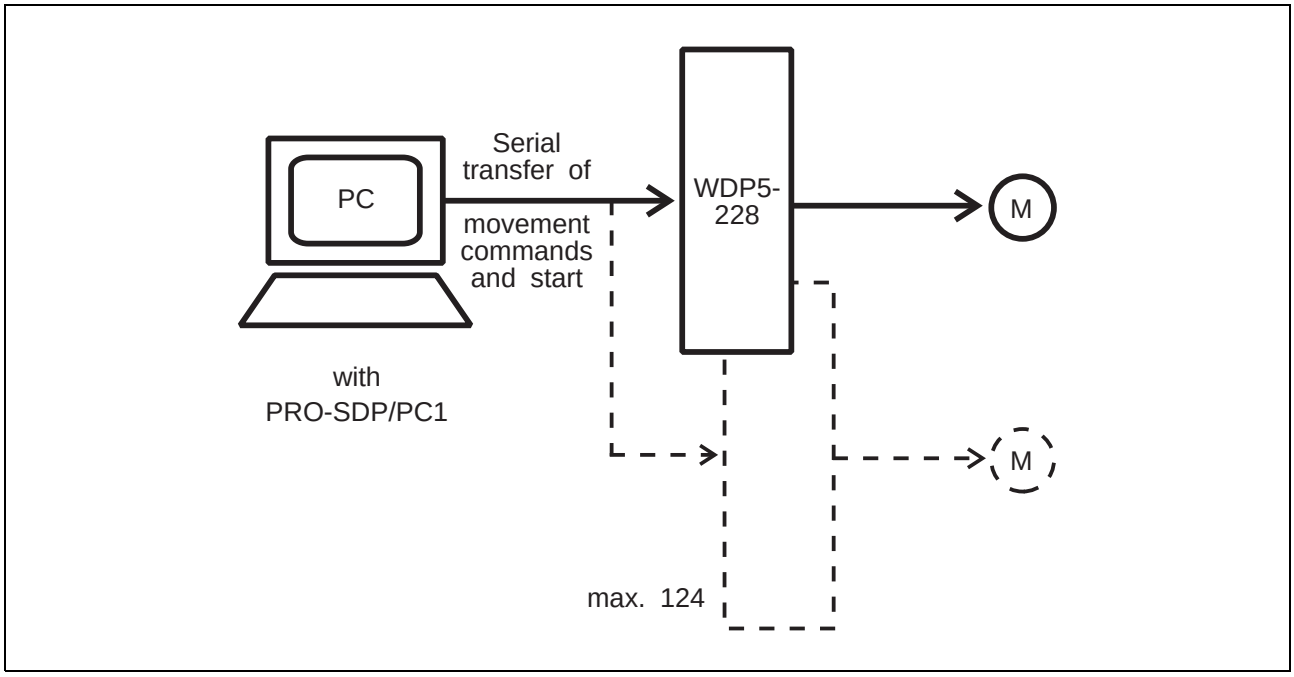


Fig. 1-5 Network mode "Serial"

3. Network mode "A-/R-Parallel"

In operating mode "A-/R-Parallel" (fig. 1-6 and 1-7), individual movement commands are transferred in parallel and initiated by a PLC or relay controller.
A block of 8 decade switches is employed for reading in the movement commands. The decade switch value is transmitted:
– via the MP 940 decade switch interface
– with the aid of a parallel transmission protocol directly from the PLC.

A maximum of 16 decade switch interfaces may be connected.

A PC allows modifying parameters, testing inputs and displaying the travel position.
The PC is not required for processing.

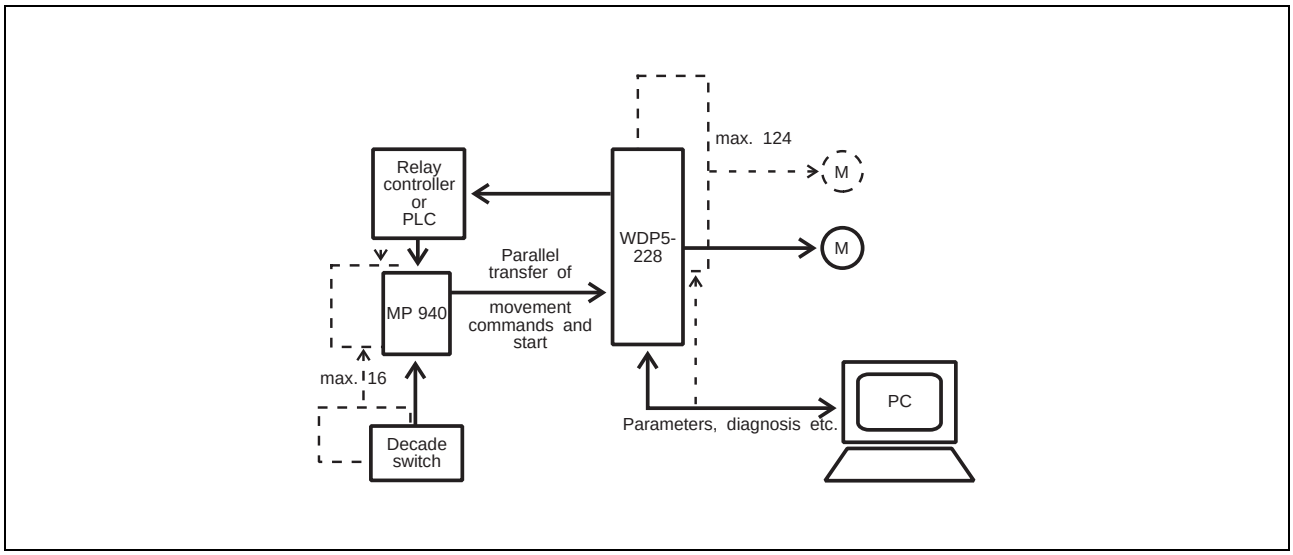


Fig. 1-6 Network mode "A-/R-Parallel" with MP 940

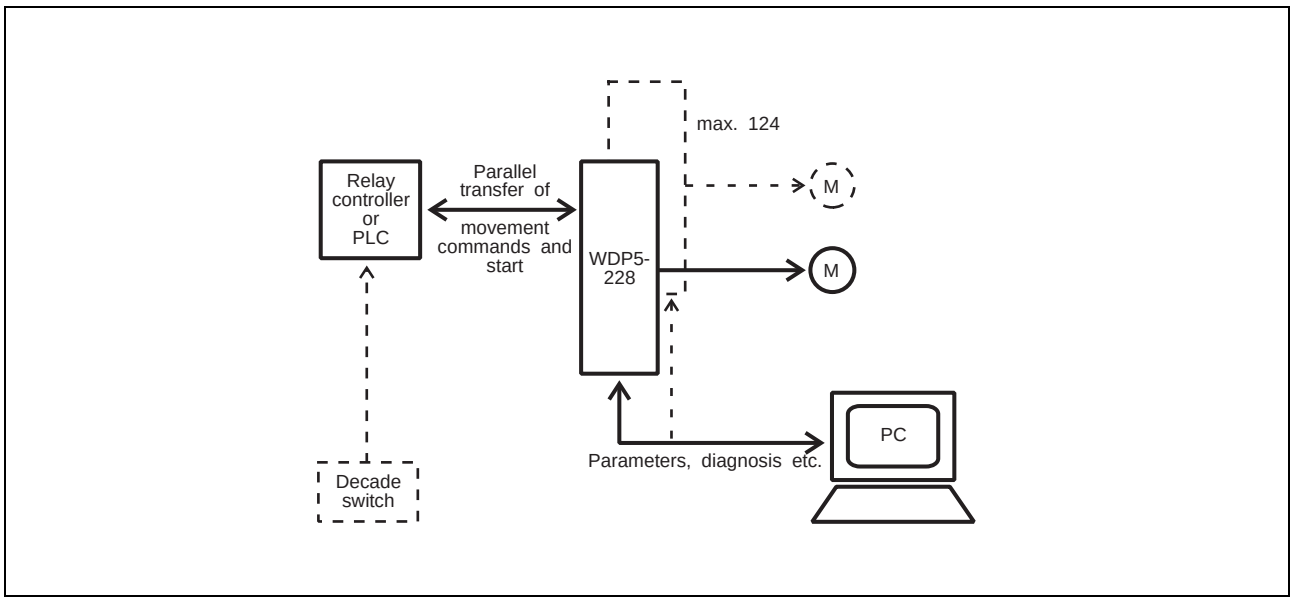


Fig. 1-7 Network mode "A-/R-Parallel" without MP 940

1.2.1.3 Serial polling mode

In operating mode "Serial polling mode" (fig. 1-8), a maximum of 31 networkable BERGER LAHR units can be operated through a serial interface e.g. by a PC, terminal, PLC or series 300 units.

For this purpose, the WDP5-228 units are controlled by a simple ASCII protocol, individual movement commands transferred and movements initiated.

The condition to be fulfilled is the communication in a master/ slave configuration, as described in chapter 1.3.5.3.

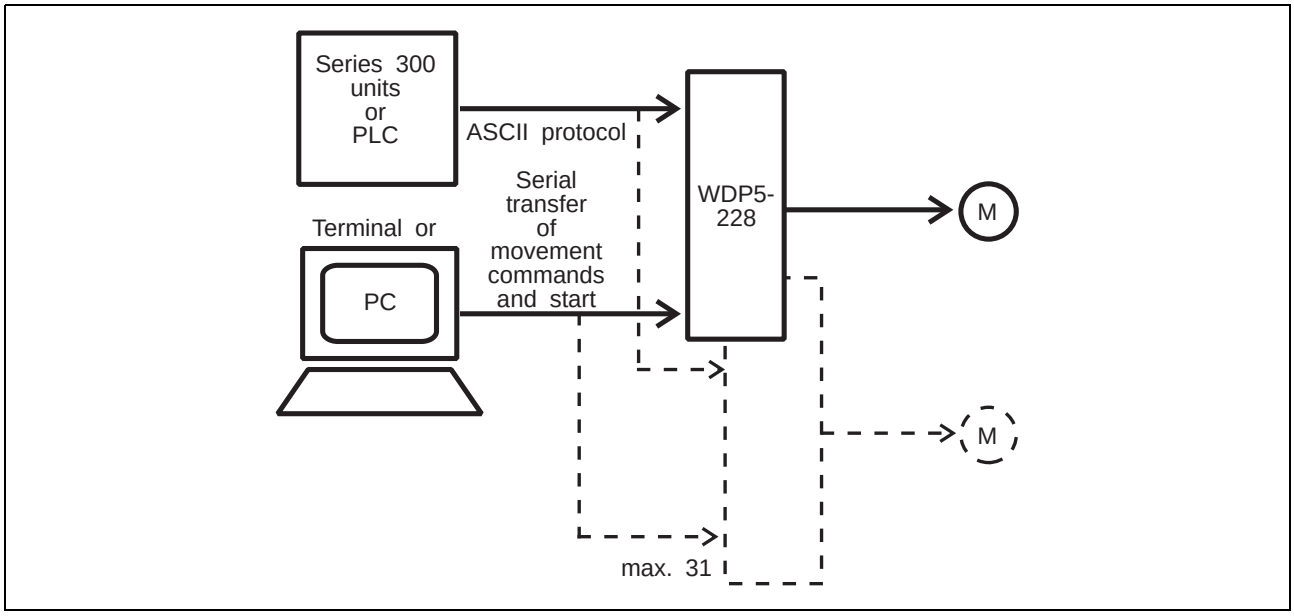


Fig. 1-8 Serial polling mode

1.3 Function

1.3.1 Hardware components

Two PC-boards with a size of 6 HU in eurocard format accomodating the power electronic system and microprocessor control functions are installed in the unit. The most important function blocks of the unit are evident in the block circuit diagram (fig. 1-9):

The **signal interface** is used for opto-isolation of the input and output signals between the external controller and the internal electronic system.

The **electronic gear signal interface** is used to transfer an external preset pulse sequence to the movement processor.

A **DC/DC power supply unit** generates the different internal electronic operating voltages.

The **serial interface** allows connection to external programming and control units.

The **management processor** coordinates the movement commands as well as the input and output functions. A maximum of 16 programs are managed here in storage mode ("Memory").

The **status displays** and **selector block** communicate with the management processor. The operating mode and the network address are set with the selector switches. A seven-segment display indicates malfunctions.

The **power supply unit** is a sophisticated AC/DC converter. It must be supplied with a 230 VAC or 115 VAC voltage. The energy generated by the stepping motor during braking can be intermediately stored here up to a certain extent. An external **load resistor** must be connected for reducing surplus braking energy.

The **power drive** transfers the energy supplied by the main module to the regulated wall-mounted stepping motor in a suitable way.
The selector switch is used for setting the motor phase current.
A seven-segment display indicates malfunctions.
The shaft encoder signals of the regulated drive are transmitted to the movement processor and electronic commutation.

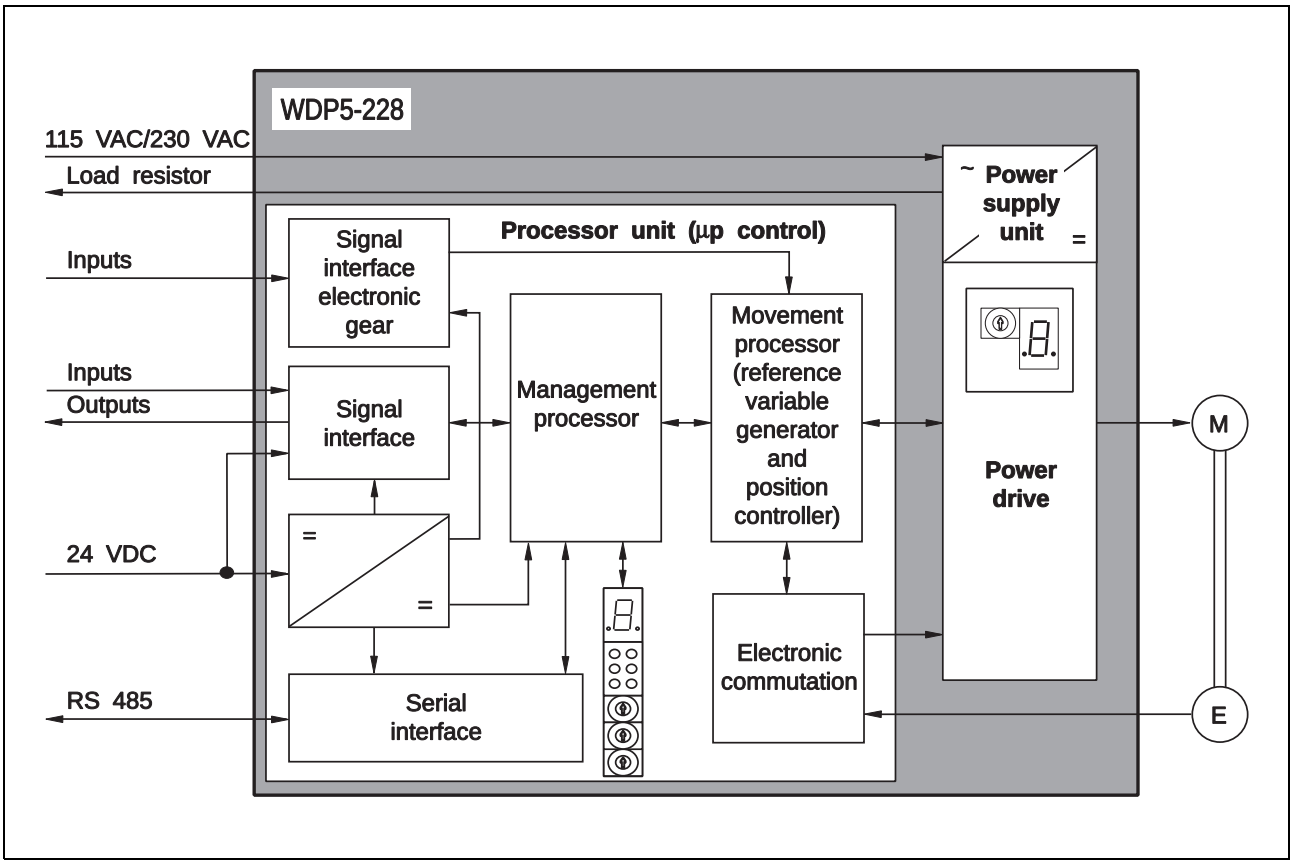


Fig. 1-9 Block diagram

The movement processor consists of the **reference variable generator** and the **position controller**.

The **movement processor** calculates the movement commands using the respectively valid parameter values. The resulting pulse sequence including the acceleration and deceleration ramp is transmitted to the power drive.

With the aid of **electronic commutation**, the electric rotating field is switched, thus ensuring that the load angle defined by the position controller is adhered to at all times.

1.3.2 Reference variable generator

The WDP5-228 positioning unit is a regulated, closed-circuit 1-axle drive system (fig. 1-11). The current reference variable (current setpoint) is compared to the current motor position (actual position). The difference between the setpoint and the actual position forms the input signal (following error) for the PID position controller.

The reference variable generator depends on the selected sub-mode "MD":

Point-to-point (default)

The reference variable is determined from a positioning command. Frequency "F", acceleration "L" and setpoint "X" can be preset.

Frequency characteristics

The reference variable is determined from a frequency command. Acceleration "L" and frequency "VY" can be preset.

NOTE
Calculation of the reference variables:
– Travel [incr.]
– Speed [incr. x Hz]
– Acceleration [incr. Hz/ms] is effected with the unit "Increments" (examples see appendix).

Electronic gear

The reference variable is fed via the electronic gear input (fig. 1-10) and can be multiplied by a gear ratio "EZ/EN". Three different pulse signals can be evaluated at the electronic gear input with parameter "GI":

– A/B signals
– Pulse/direction signals
– $Pulse_{forward}$/$pulse_{backward}$ signals

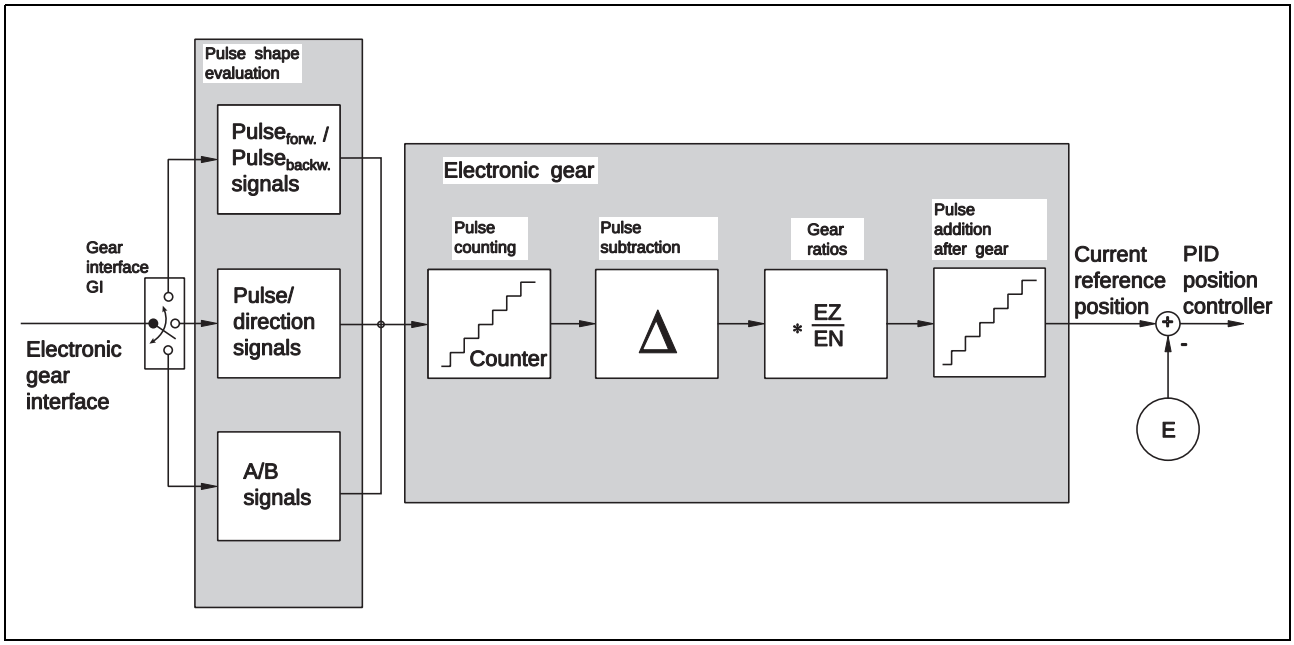


Fig. 1-10 Block diagram – electronic gear

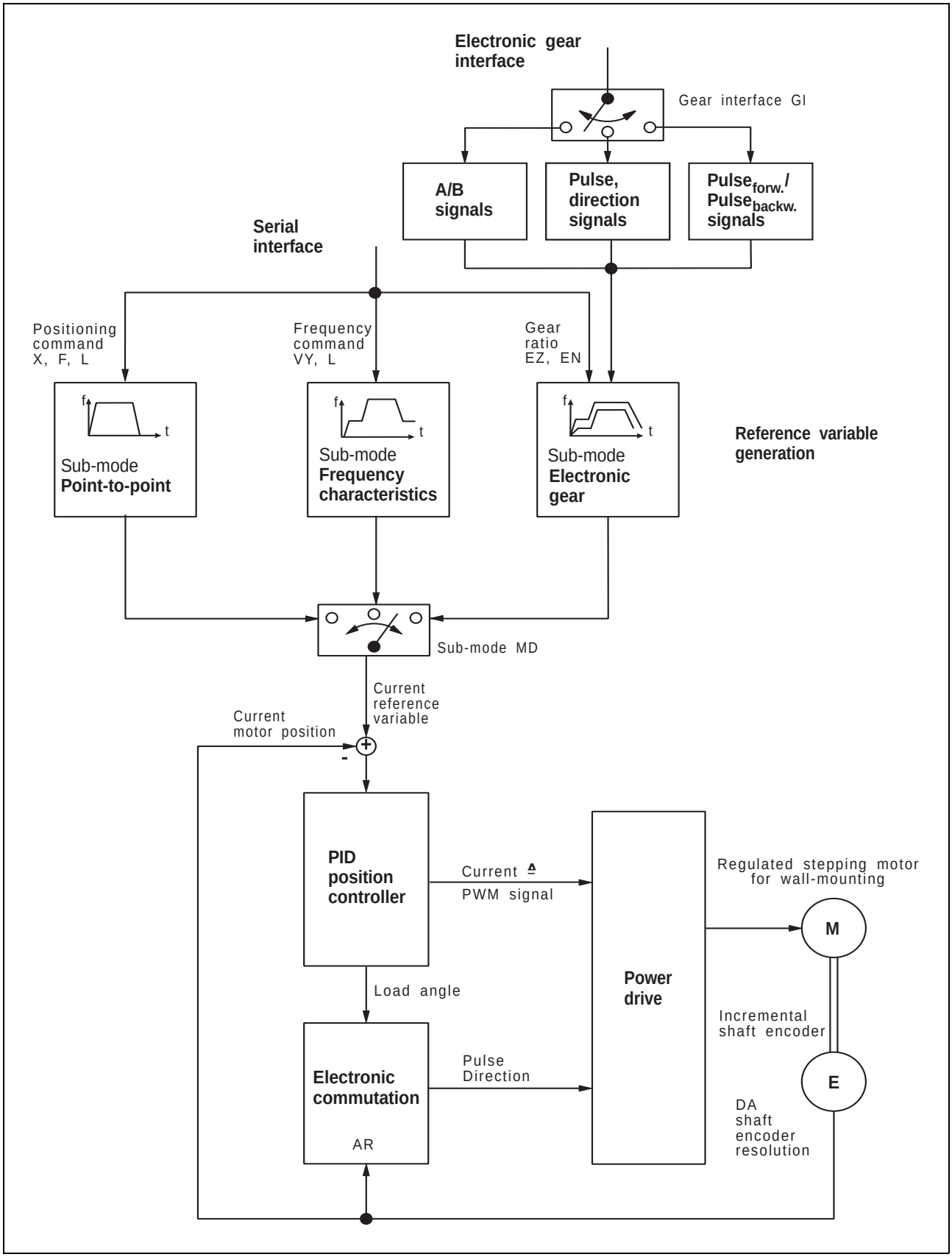


Fig. 1-11 WDP5-228 function chart

1.3.3 PID position controller

The PID position controller (proportional, integral, differential controller) is of digital design. Its control response is determined by three characteristics:

Dynamics	Response time of the control circuit in case of reference variable changes or positional variations
Stability	Oscillatory characteristics of the control circuit in the end position (setpoint)
Rigidity	Motor torque referring to deviation from the setpoint

The PID position controller (fig. 1-12) is designed in parallel structure in such a way that the proportional component "KP", the differential component "KD" and the integral component "KI" can be set separately without influencing each other. Individual controller components may be disabled.

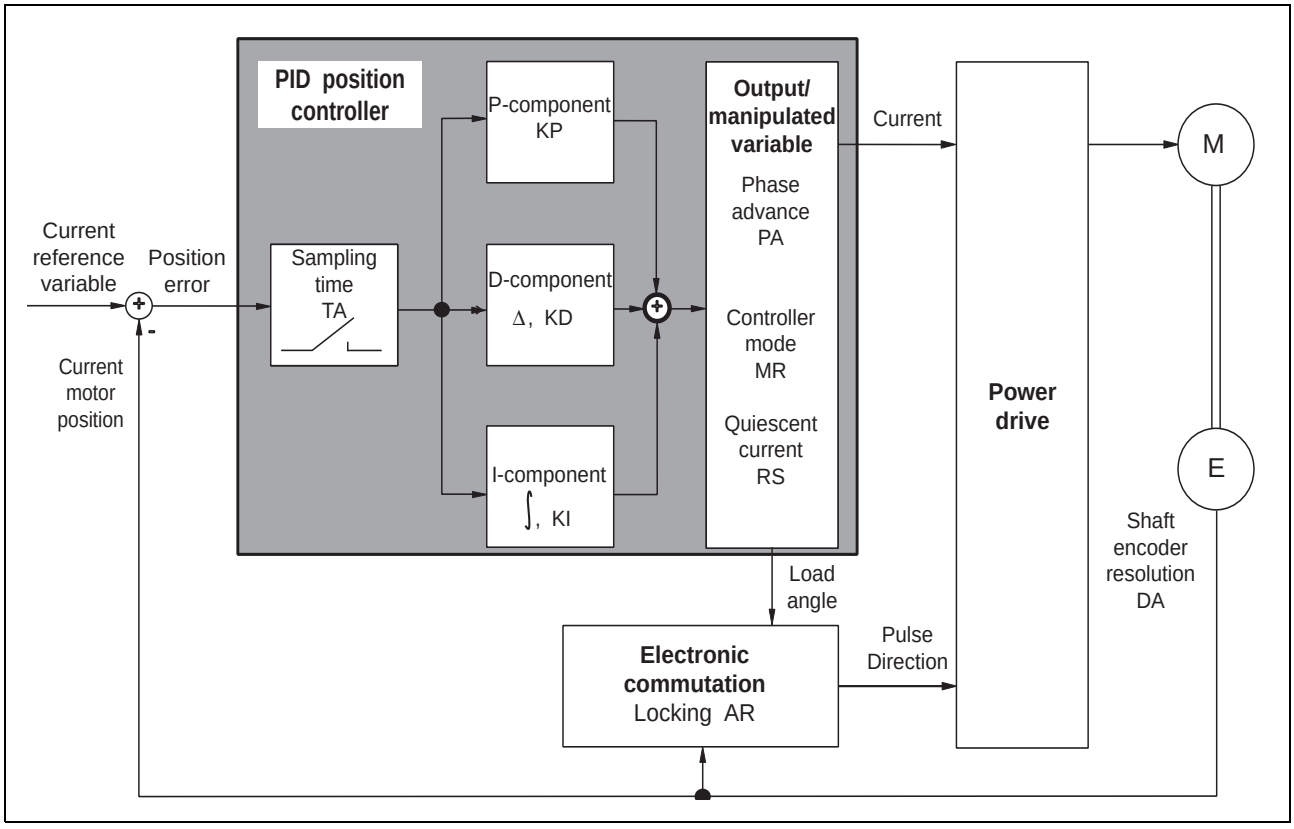


Fig. 1-12 Block diagram – PID position controller

1.3.3.1 Control parameters

Proportional component "KP"

The control parameter "KP" (fig. 1-13) directly defines the drive rigidity. Proportional gain must be as high as possible, because the higher the KP value:

- the higher the rigidity;
- the higher the control circuit dynamics and thus the positioning speed;
- the lower the following errors.

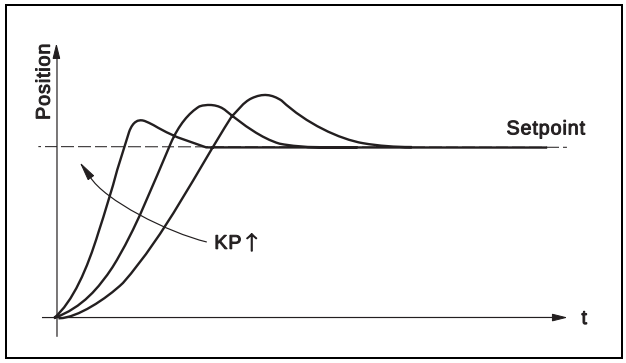


Fig. 1-13 Control parameter "KP"

Differential component "KD"

The control parameter "KD" (fig. 1-14) determines the response to control deviation changes. "KD" serves as a measure for the controller attenuation. The position control circuit must be operated with a sufficiently high differential component to prevent the drive from becoming unstable.

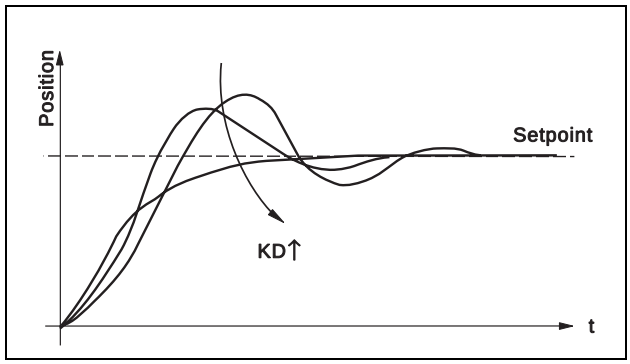


Fig. 1-14 Control parameter "KD"

Integral component "KI"

The control parameter "KI" (fig. 1-15) compensates for permanent control deviation. The following error is consequently almost zero when stationary.
The integral component "KI" is reasonably employed where exact positioning is required despite permanent external load moments (e.g. in case of vertical axle) or friction moments.
The following conditions hold true:

- The higher "KI" the nearer the controller gets to the stability limit.
- The KI component slows down the control circuit, i.e. the end position is reached exactly, however, it takes longer than without KI component. With increasing KI component, the motor shows a better transient response and overshoot response in the end position.

If no integral component "KI" is programmed, the integral component "IS" is automatically activated because of the factory setting.

NOTE
The automatic integral component "IS" only takes effect if the positional reference variable does not change and the motor stands still.

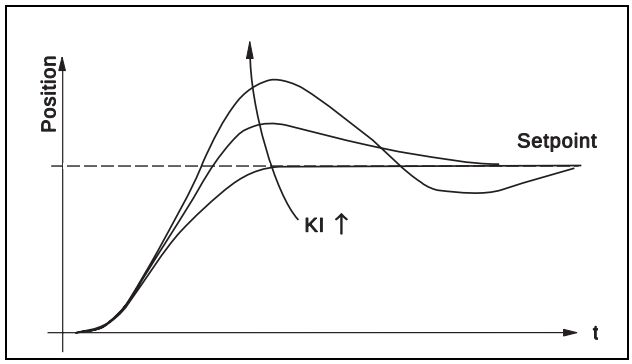


Fig. 1-15 Control parameter "KI"

Phase advance "PA"

Advance of the electric rotating field as compared to the rotating field of the rotor can be determined with the parameter "PA". As a result, the torque is reduced less at higher speeds.

Controller mode "MR"

The parameter "MR" allows setting two different controller modes:

Current controller	Rotating field variations are achieved via the manipulated variable "Current". The "load angle" is fixed. This results in synchronous operation and running smoothness of the motor.
Load angle controller	Rotating field variations are achieved via the manipulated variables "Current" and "Load angle". This allows setting a higher rigidity, however, running smoothness is not as high as in current controller mode.

Quiescent current "RS"

The quiescent current flowing through the motor with the PID position controllers switched off or locking activated can be determined with parameter "RS".

Shaft encoder resolution "DA"

The parameter "DA" must correspond with the shaft encoder resolution of the motor.

NOTE
The setting values and further parameters are described in chapter 2.6. The parameter values can be saved in one out of a maximum of four parameter sets and reloaded at a later time.

1.3.4 Electronic commutation and locking

With the aid of electronic commutation the electric rotating field is commuted such that the "load angle" defined by the PID position controller is adhered to at all times.

The parameter "AR" permits switching off electronic commutation as soon as the motor reaches the target position. This ensures that the motor is absolutely rigid and stands still in the target position. The "AR" value defines the time (in ms) during wich the motor must be within a specified frame to activate locking.

1.3.5 Operating modes

Depending on system configuration, two main operating modes (fig. 1-16) are possible with the WDP5-228 positioning unit.

1.3.5.1 Serial mode

Automatic run

The individual jobs and commands are directly transferred to the WDP5-228 and started via the serial interface in this operating mode. The instructions are transferred in ASCII format 7 bit, even parity bit and one stop bit to the positioning unit. The transmission speed is 1200 or 9600 bauds.
The following sub-modes are available in automatic run:

- *Point-to-point*
- *Frequency characteristics*
- *Electronic gear*.

Manual movement

This operating mode serves to align or correct the axle position manually.
The speeds "slow manual movement" and "fast manual movement" are possible. The motor rotates at "Manual frequency slow" or "Manual frequency fast" as long as the input state is fulfilled.
The manual reference movements are used to synchronize the mechanical zero with the zero point of the positioning unit.

A reference point can be set as a reference value for the system of dimensions.

1.3.5.2 Network mode

The operating modes "Install", "Memory", "Serial", "A-Parallel" and "R-Parallel" are available in network mode.
The transmission speed is 9600 bauds or 38.4 kbauds.
Programming can be effected independently of the executing system, i.e. offline.
The programs are saved and archived on hard disk or disk.

Operation and setting of the network modes is effected on the PC with the aid of the following software:

– PRO-SDP/PC1
  Menue system (BPRO) for comfortable operation and networking of 1 to 124 units (4 interfaces x 31 units).

Operating mode "Memory"

Automatic run

In automatic run, movement commands are stored in the WDP5-228 and stored programs executed in this operating mode. A maximum of 16 programs with approx. 1000 movement commands are possible. The individual programs are selected and the movement commands started via the signal interface.
Program execution is usually effected via a PLC or, in simple applications, via a switch by the user.
The following sub-modes are available:

– *Point-to-point*
– *Frequency characteristics*
– *Electronic gear.*

Manual movement

Manual movement is used to align or correct the axle position manually.
The speeds "slow manual movement" and "fast manual movement" are possible. The motor rotates at "Manual frequency slow" or "Manual frequency fast" as long as the input state is fulfilled.
The manual reference movements synchronize the mechanical zero with the zero point of the positioning unit.
A reference point can be set as a reference value for the system of dimensions.

Teach-in

In teach-in mode, manually approached positions are stored as movement commands in the positioning unit.

Operating mode "Serial"

Automatic run

The individual jobs and commands are transferred to the WDP5-228 and started via the BERGER LAHR network in this operating mode. The transmission speed is 9600 bauds or 38.4 kbauds.
The following sub-modes are available:

– *Point-to-point*
– *Frequency characteristics*
– *Electronic gear*

Manual movement

The manual movement is used to align or correct the axle position manually.
The speeds "slow manual movement" and "fast manual movement" are possible. The motor rotates at "Manual frequency slow" or "Manual frequency fast" as long as the input state is fulfilled.
The manual reference movements synchronize the mechanical zero with the zero point of the positioning unit.

A reference point can be set as a reference value for the system of dimensions.

Operating mode "R-Parallel"

Automatic run

This operating mode is used to transfer the positioning job as a 4-bit data stream. Transfer is effected in handshaking mode via the controller inputs and outputs. The transferred position values are interpreted as incremental positions.
Its main function is the data input via decade switches with the aid of additional hardware (MP 940).
It allows connecting a maximum of 16 modules (decade switch block and MP 940) at the same time.
Handshaking is designed in such a way that any PLC in the process is able to transfer calculated commands via the standard inputs and outputs independently of its cycle time.
The command is divided into 6 decades for the positioning distance and two decades for the movement frequency (stated in percent of the maximum speed).

Point-to-point is the only sub-mode possible.

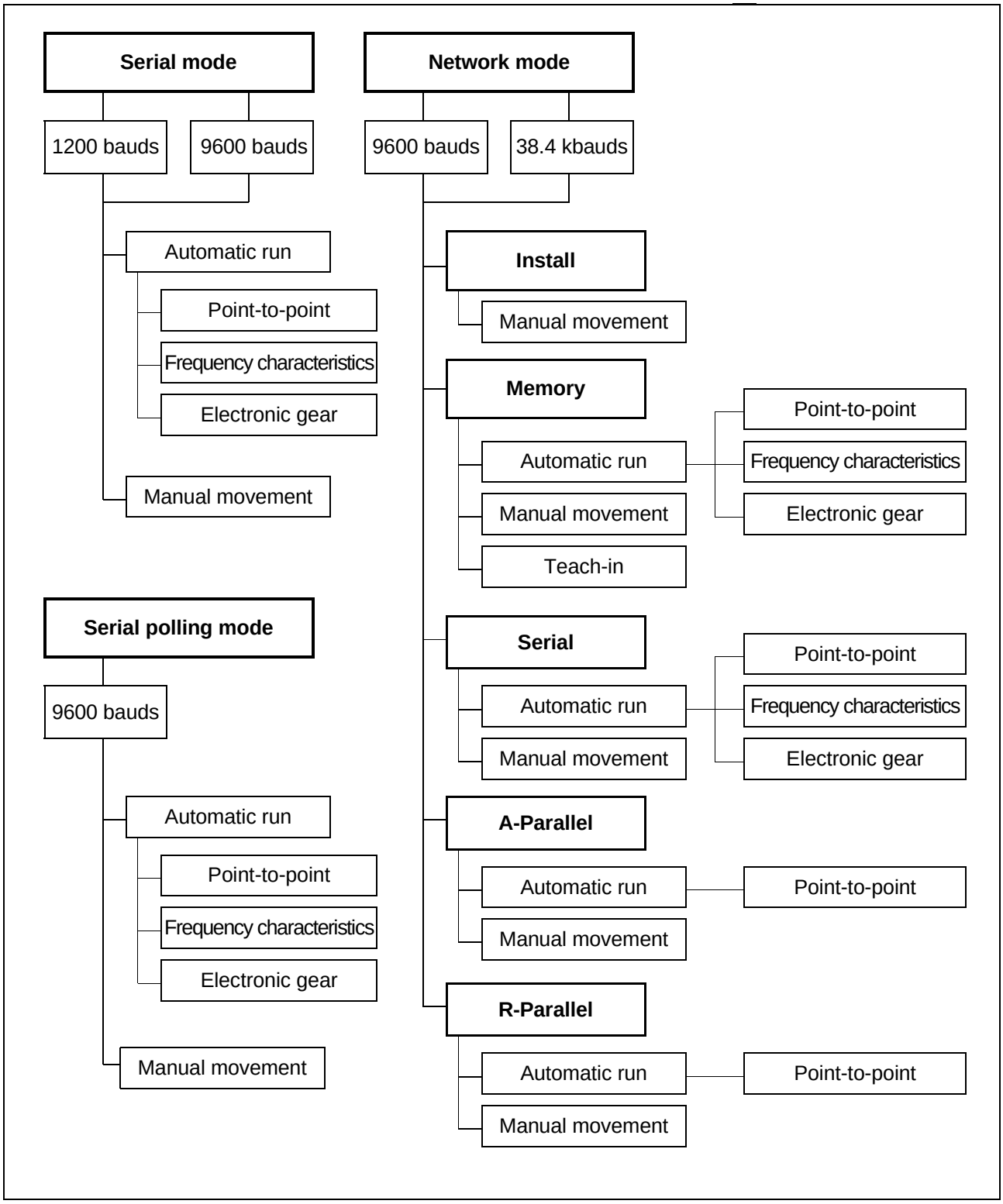


Fig. 1-16 Operating modes

Manual movement

The manual movement is used to align or correct the axle position manually.
The movement speeds "slow manual movement" and "fast manual movement" are possible. The motor rotates at "Manual frequency slow" or "Manual frequency fast" as long as the input condition is fulfilled.
The manual reference movements synchronize the mechanical zero with the zero point of the positioning unit.
A reference point can be set as a reference value for the system of dimensions.

Operating mode "A-Parallel"

This operating mode is identical to operating mode "R-Parallel" exept that the transferred position values are interpreted as absolute positions.

NOTE
The **network operating mode "Install"** is used to set and check the control.
In so doing, movement programs and movement parameters can be exchanged between the PC and controller as well as the input and output interface of the controller checked.
Manual movement is possible.

1.3.5.3 Serial polling mode

Automatic run

The individual jobs and commands are transferred to the WDP5-228 immediately after polling the unit and started via the serial interface in this operating mode. The instructions are transferred in ASCII format 7 bit, even parity bit and one stop bit to the positioning unit. The transmission speed is 9600 bauds.

The following sub-modes are available in automatic run:

- *Point-to-point*
- *Frequency characteristics*
- *Electronic gear*

Manual movement

This operating mode serves to align or correct the axle position manually.
The speeds "slow manual movement" and "fast manual movement" are possible. The motor rotates at "Manual frequency slow" or "Manual frequency fast" as long as the input state is fulfilled.
The manual reference movements are used to synchronize the mechanical zero with the zero point of the positioning unit.

A reference point can be set as a reference value for the system of dimensions.

Master/slave principle in serial polling mode

The WDP5-228 communicates with the master e.g. PC through an RS 485 serial interface in a master/slave configuration (fig. 1-17).

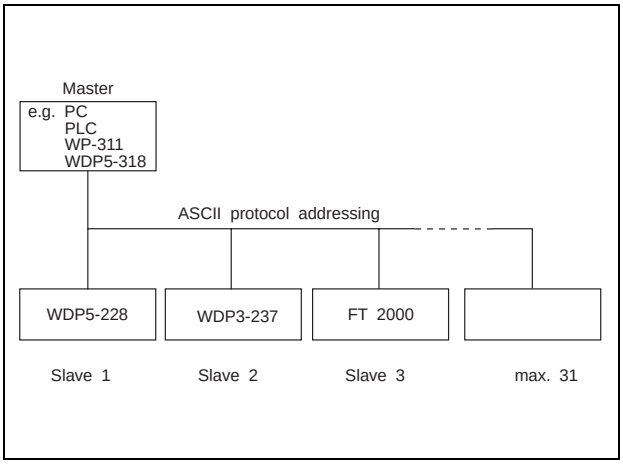


Fig. 1-17 Networking scheme

In order to ensure safety of communication, slaves only execute the commands issued by the master and may not send data without being requested to do this. Such a request is possible by a special polling order, where the master selects the slave with which it intends to communicate subsequently (see chapter 3.5.3).

The communication link with a previously selected slave is aborted upon receiving a different address.

Thereafter, the master can communicate with the slave on a one-to-one basis.

1.3.5.4 Sub-modes

The following sub-modes are possible depending on the selected operating mode (serial mode or network mode):

Point-to-point	In this operating mode (factory setting), the travel, frequency and acceleration for the axle movement from point A to point B is predefined.
Frequency characteristics	In this operating mode, the frequency and acceleration for the axle movement is predefined.
Electronic gear	In this operating mode, an external signal together with a gear ratio is predefined for the axle movement.

1.4 Technical data

1.4.1 Electrical data

1.4.1.1 Mains connection

Supply voltage, adaptable	115 VAC -20%/+15% 230 VAC -20%/+15%
Starting current	30 A
Fuse	6.3 A, slow-blow
Frequency	50 to 60 Hz
Power consumption	max. 1600 VA
Power loss	max. 120 W

1.4.1.2 Motor connection

Protected in case of short-circuit between motor phases

Maximum cable length	
without motor cable filter	50 m
with motor cable filter	100 m
Wire cross-section	0.75 mm^2
Shield connection	on both sides
Motor voltage	325 VDC
Phase current in 16 steps	0.75 to 4.5 A

1.4.1.3 Further supply voltages

Processor unit

Supply voltage	24 VDC
Min. operating voltage (in the unit)	20 VDC
Max. operating voltage (in the unit)	30 VDC
Power consumption	max. 500 mA
Ripple voltage	< 500 mV_{ss}

Serial interface

RS 485 four-wire interface

Supply voltage output	12 VDC
Min. operating voltage (in the unit)	9 VDC
Max. operating voltage (in the unit)	18 VDC
Power output	max. 150 mA

1.4.1.4 Shaft encoder connection

Maximum cable length	100 m
Wire cross-section	2 x 0.5/10 x 0.25 mm^2
Shield connection	on both sides

1.4.1.5 Signal connection - electronic gear

Maximum cable length	100 m
Wire cross-section	2 x 0.5/10 x 0.25 mm^2
Shield connection	on both sides
Voltage	5 V ± 5%
Current	max. 300 mA

1.4.1.6 Signal connection

Maximum cable length	100 m
Wire cross-section	0.25 mm^2
Shield connection	on both sides

Electrical properties of the inputs

Opto-isolated, polarity reversal protection

Signal voltage level	24 V
Maximum input voltage	30 V
Typical input current at 24 V	7 mA
Turn-on voltage	15 V
Turn-off voltage	4 V

ATTENTION
Separation of the signal inputs and the 24 VDC supply voltage at the signal connector from the mains must be ensured. The maximum voltage to ground must not exceed 60 VDC.

Electrical properties of the outputs

Opto-isolated, polarity reversal protection, inductive loadability, short-circuit protected

Maximum voltage	30 V
Maximum switching current	400 mA
Voltage drop at 400 mA	2 V

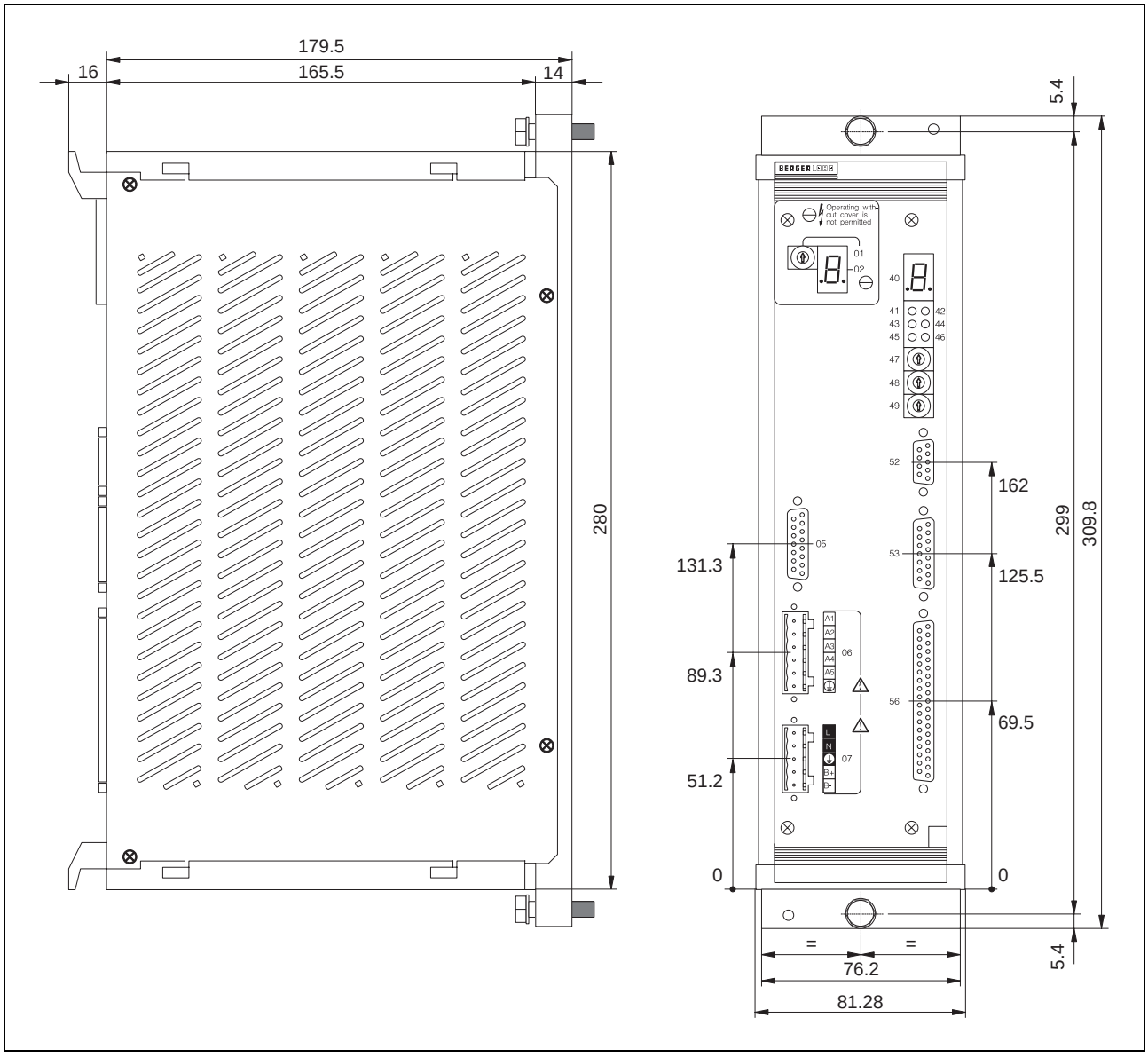


Fig. 1-18 WDP5-228 dimensions

1.4.1.7 Device protection

Type of protection	IP 20 in accordance with DIN 40050/IEC 529
Class of protection	1
Protective circuits	Overtemperature detection Short-circuit monitoring Undervoltage and overvoltage detection

1.4.2 Mechanical data

Dimensions		see fig. 1-18
Weight		
	without heat sink	approx. 3.3 kg
	with heat sink	approx. 6.9 kg

1.4.3 Environmental conditions

Ambient temperature	0°C to 50°C
Storage temperature	-25°C to +70°C
Humidity class	F according to DIN 40040
Radio interference suppression when using additional power or motor cable filters (see accessories)	according to VDE 0871-A
Overvoltage protection	according to VDE 0160 class 2
Noise immunity	according to VDE 0843/IEC 801

2 Installation

2.1 Delivered items

The delivery must be checked for completeness.

The delivery items include (fig. 2-1):

Qty.	Designation
1	WDP5-228.XX
1	Connector shell – motor connector
1	Connector shell – mains connector
1	Heat transfer compound
1	WDP5-228 documentation

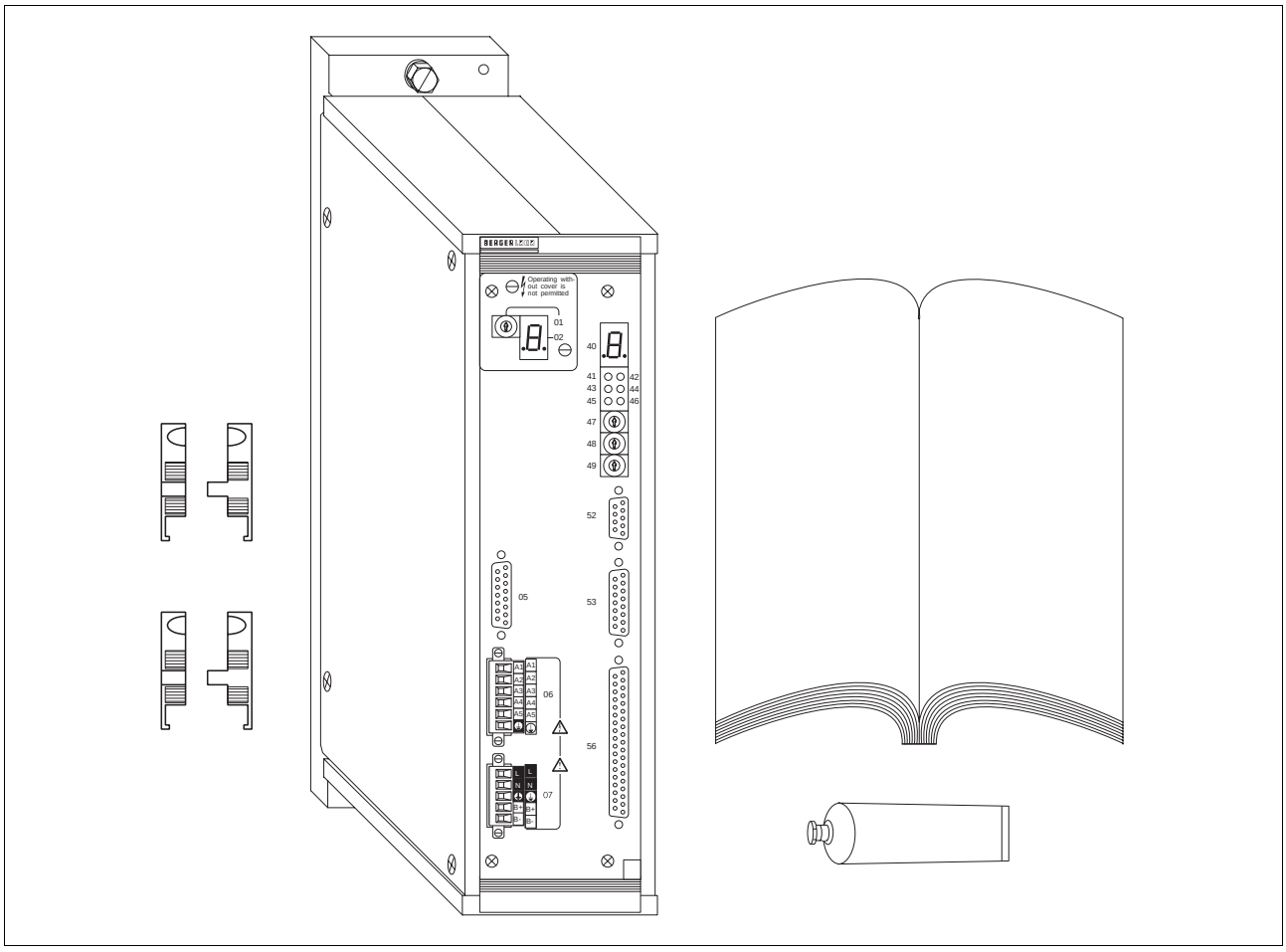


Fig. 2-1 Delivered items

2.2 Accessories

The following accessories (see chapter 6.2) must be ordered separately:

Designation	**Order number**
Cable for electronic gear	see appendix
Crossover adapter for RS 485 interface	62501511001
D 690 interface tester	62010690006
D 731 terminal adapter	62010731006
Heat sink	62500901000
Interface cable male/female	see appendix
Interface cable male/male	see appendix
Load resistor	62501100600
Mains filter	62501100200
ML 52 decade switch block	62300052000
Motor cable	see appendix
Motor cable filter	62501100100
MP 923 interface converter (RS 485/RS 232)	62020923000
MP 924 interface distributor	62020924006
MP 940 decade switch interface	62020940000
PRO-SDP/PC1 software (version 2.01 or higher)	61700023010
Regulated stepping motor	see catalogue doc. no. 371
Shaft encoder cable	see appendix
Signal cable	see appendix
Terminal program BTERM	61700040610
Ventilator set	62501201000
WDP5-228 set of connectors	62501000300

2.3 Mounting

The unit must be installed in a control cabinet and ventilated externally. The mounting panel should be heat-conducting and have a smooth mounting surface as heat losses of the unit are dissipated via the mounting flange.
The maximum power loss of the unit is 120 W.

ATTENTION
Clean air supply in the control cabinet must be ensured.

NOTE
In case of insufficient heat dissipation, a heat sink and a ventilator set may be installed additionally, see chapter 6.2.7 and 6.2.8.

Uniform temperature conditions can be achieved with the heat sinks and ventilators recommended by BERGER LAHR. If other solutions are used, temperature measurement at the mounting flange is necessary. The maximum permissible temperature at the mounting flange and the power loss are evident in fig. 2-2.
A fork wrench is required for mounting the unit, further special tools are not required.

1. Drill two holes in the mounting panel, dimensions see fig. 1-18.

2. Apply heat transfer compound between the rear panel and mounting panel.

3. Fasten the unit with two M6 screws.

NOTE
If devices are combined, the distances between their central axes must be observed; See table (values given in mm).

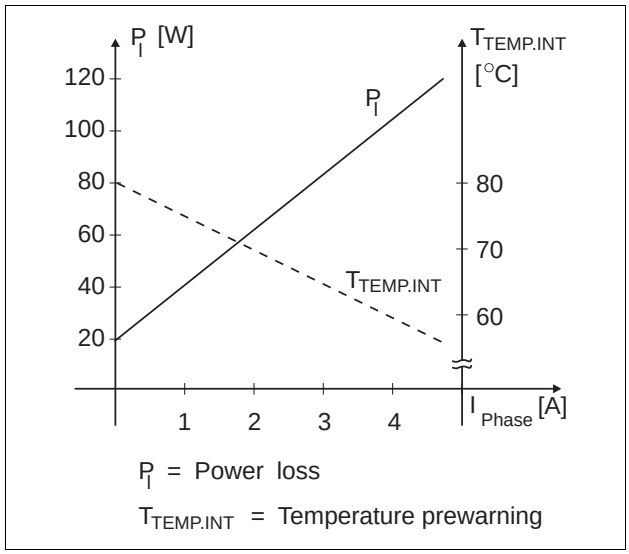


Fig. 2-2 Power loss diagram

Central axis distance (mm) for combined units	WD5-008	WDP5-118	WDP5-228	WDP5-318	WP-111	WP-231	WP-311
WD5-008	87	87	87	87	74	74	74
WDP5-118	87	87	87	87	74	74	74
WDP5-228	87	87	87	87	74	74	74
WDP5-318	87	87	87	87	74	74	74
WP-111	74	74	74	74	61	61	61
WP-231	74	74	74	74	61	61	61
WP-311	74	74	74	74	61	61	61

NOTE
The mounting procedure with heat sink and ventilator set is described in chapters 6.2.7 and 6.2.8.

2.4 Cabling

ATTENTION
Cabling may only be performed in accordance with VDE 0105 by specially trained personnel.

ATTENTION
The mains connector must be unplugged every time cabling is performed.

ATTENTION
Lay power, motor and signal cables in different ducts.

2.4.1 Mains connection

NOTE
The power drive is supplied via the power cable.

1. Loosen screws and remove mains connector (fig. 2-3).
2. Provide the power cable connector with wire end ferrules.
3. Fasten three litz wires with screws:

L	Phase (115 or 230 VAC)
N	Neutral
⏚	Protective conductor

4. Screw cable to connector shell.
5. Put the two halves of the connector shell together.
6. Fasten connector on the front panel (item 07).

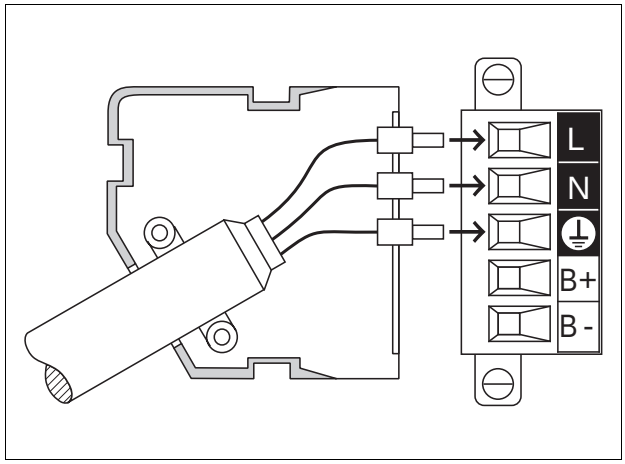


Fig. 2-3 Mains connection – unit side

ATTENTION
The mains connector must neither be plugged in, nor the supply voltages switched on.

NOTE
A mains filter can be inserted to avoid interference, see chapter 6.2.11.

NOTE
A load resistor must be connected to B+/B-, if status display "4" of the power drive lights up when braking in operation, see chapter 6.2.1.

2.4.2 Motor connection

1. Loosen screws and remove motor connector (fig. 2-4).

2. Provide motor cable connector with wire end ferrules.

3. Fasten six litz wires with screws:

Unit side	Wire	Motor side
A1	yellow	Connector 1
A2	blue	Connector 2
A3	pink	Connector 3
A4	grey	Connector 4
A5	brown	Connector 5
⏚		Shield connector

ATTENTION
The cable must be screened on both sides.

4. Put the two halves of the connector shell together.

5. Fasten connector on the front panel (item 06).

NOTE
A motor cable filter must be inserted in case of cables exceeding 50 m in length, see chapter 6.2.10.

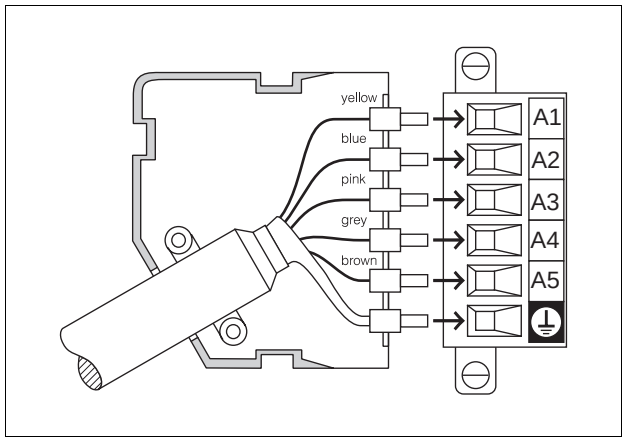


Fig. 2-4 Motor connection – unit side

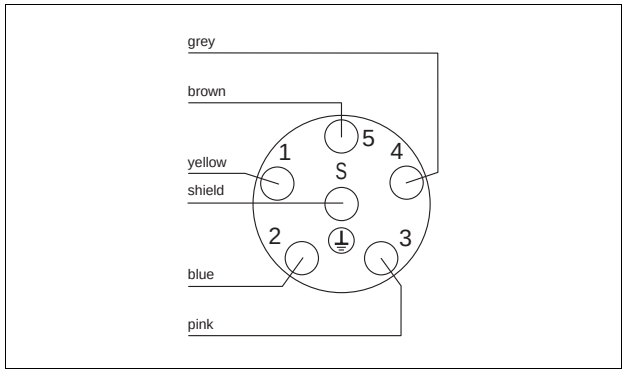


Fig. 2-5 Motor connection – motor side

2.4.3 Shaft encoder connection

1. Solder the litz wires to the connector according to fig. 2-6.
2. Push the shield back and fasten with cable tie.
3. Screw two hexagon head bolts (fig. 2-7) into the connector shell.
4. Put connector into connector shell.
5. Fasten cable and shield to the connector shell without strain.

ATTENTION
There must be a good electrical connection between the shield and the connector shell.
The cable must be screened on both sides.

6. Insert two caps in unused cable entries.
7. Fix the two halves of the connector shell with two screws.
8. Fasten connector on the front panel (item 05) with screws.
9. The litz wires of the shaft encoder cable must be twisted in pairs in accordance with fig. 2-8. Litz wires 7-9 and 8-10 must be connected on the motor side.
10. Establish the connection on the motor side.

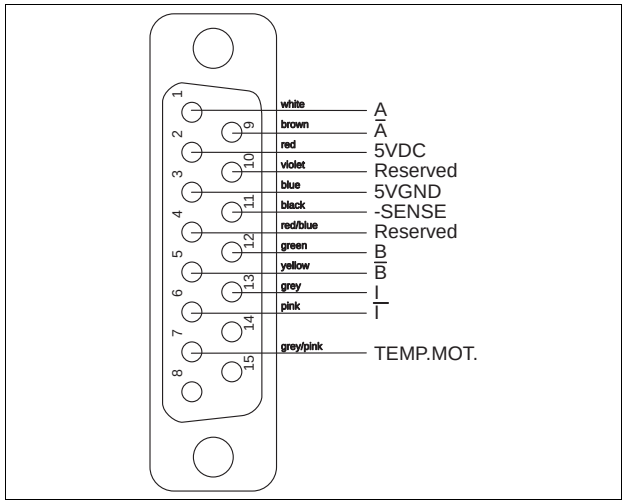


Fig. 2-6 Shaft encoder connector – unit side

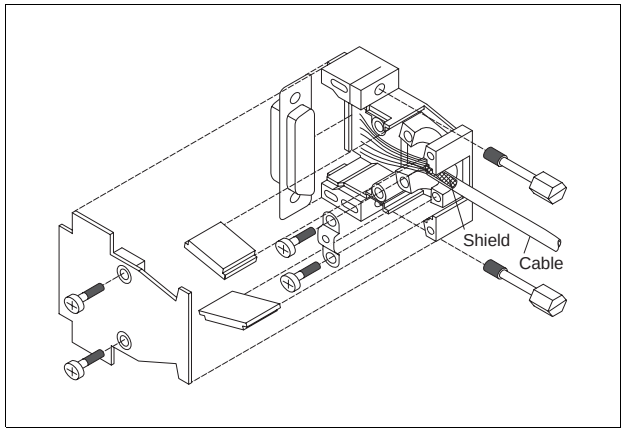


Fig. 2-7 Shaft encoder connector assembly – unit side

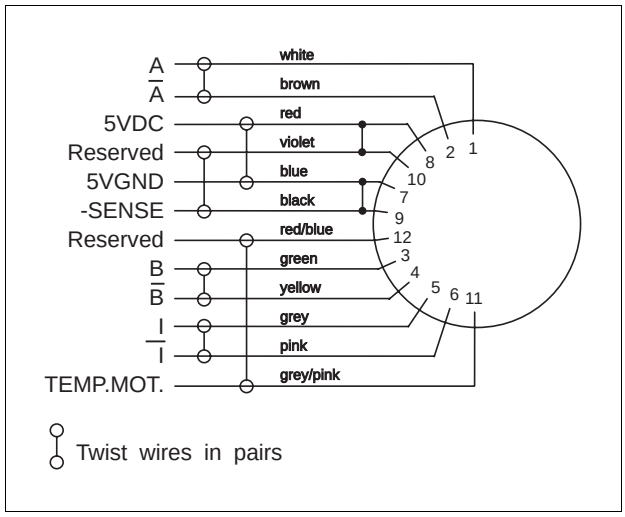


Fig. 2-8 Shaft encoder connector – motor side

2.4.4 Signal connection

1. Solder the litz wires to the connector depending on the operating mode in accordance with chapters 2.4.4.1 to 2.4.4.4.

ATTENTION
Free, unassigned pins must not be wired.

2. Push the shield back and fix with cable tie.

3. Screw two hexagon head bolts (fig. 2-9) into the connector shell.

4. Put connector into connector shell.

5. Fasten the cable and shield to the connector shell without strain.

ATTENTION
A good electrical connection must be established between the shield and the connector shell.
Screen the cable on both sides.

6. Insert two caps in unused cable entries.

7. Fix the two halves of the connector shell with two screws.

8. Fasten the connector on the front panel (item 56).

ATTENTION
Separation of all signal connections from the mains must be ensured. The voltage to ground must not exceed 60 VDC. All signal circuits are connected to ground via a 1 Mohm leakage resistor.

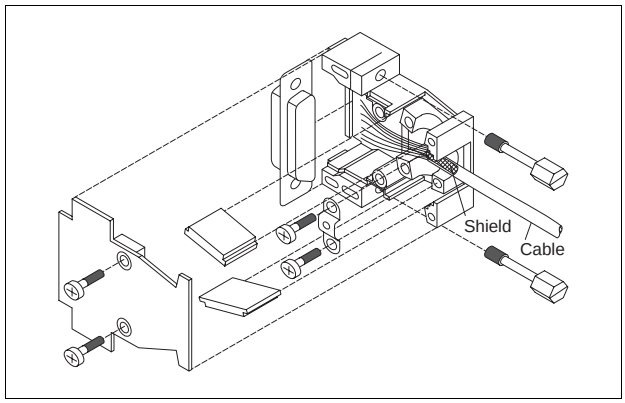


Fig. 2-9 Signal connector assembly – unit side

2.4.4.1 Signal connection in serial mode

Pin	Abbreviation	Meaning
1	$\overline{\text{LIM.X-}}$	Negative limit switch ←
2	-	-
3	-	-
4	-	-
5	LOAD	Store position ←
6	$\overline{\text{ADD.REF.}}$	Additional reference switch ←
7	MAN.X-	Manual movement, CCW rotation ←
8	MAN.L/H	Slow/fast manual movement ←
9	-	-
10	-	-
11	-	-
12	-	-
13	FOLLOW.F.	Following error limit →
14	FAULT/CL	Error →
15	READY O.	Ready for operation →
16	24VDC	System supply voltage ←
17	24VDC	System supply voltage ←
18	IO24VDC	I/O supply voltage ←
19	IO24VDC	I/O supply voltage ←
20	$\overline{\text{LIM.X+}}$	Positive limit switch ←
21	-	-
22	-	-
23	$\overline{\text{STOP}}$	Stop ←
24	-	-
25	AUTOM	Automatic operation ←
26	MAN.X+	Manual movement, CW rotation ←
27	MAN.REF.	Manual reference movement ←
28	-	-
29	-	-
30	-	-
31	-	-
32	TEMP.OK	Temperature o.k. →
33	INPOS	Position reached →
34	-	-
35	24VGND	System supply voltage ground ←
36	24VGND	System supply voltage ground ←
37	IOGND	I/O supply voltage ground ←

$\overline{\text{active-low}}$ signal ← input → output

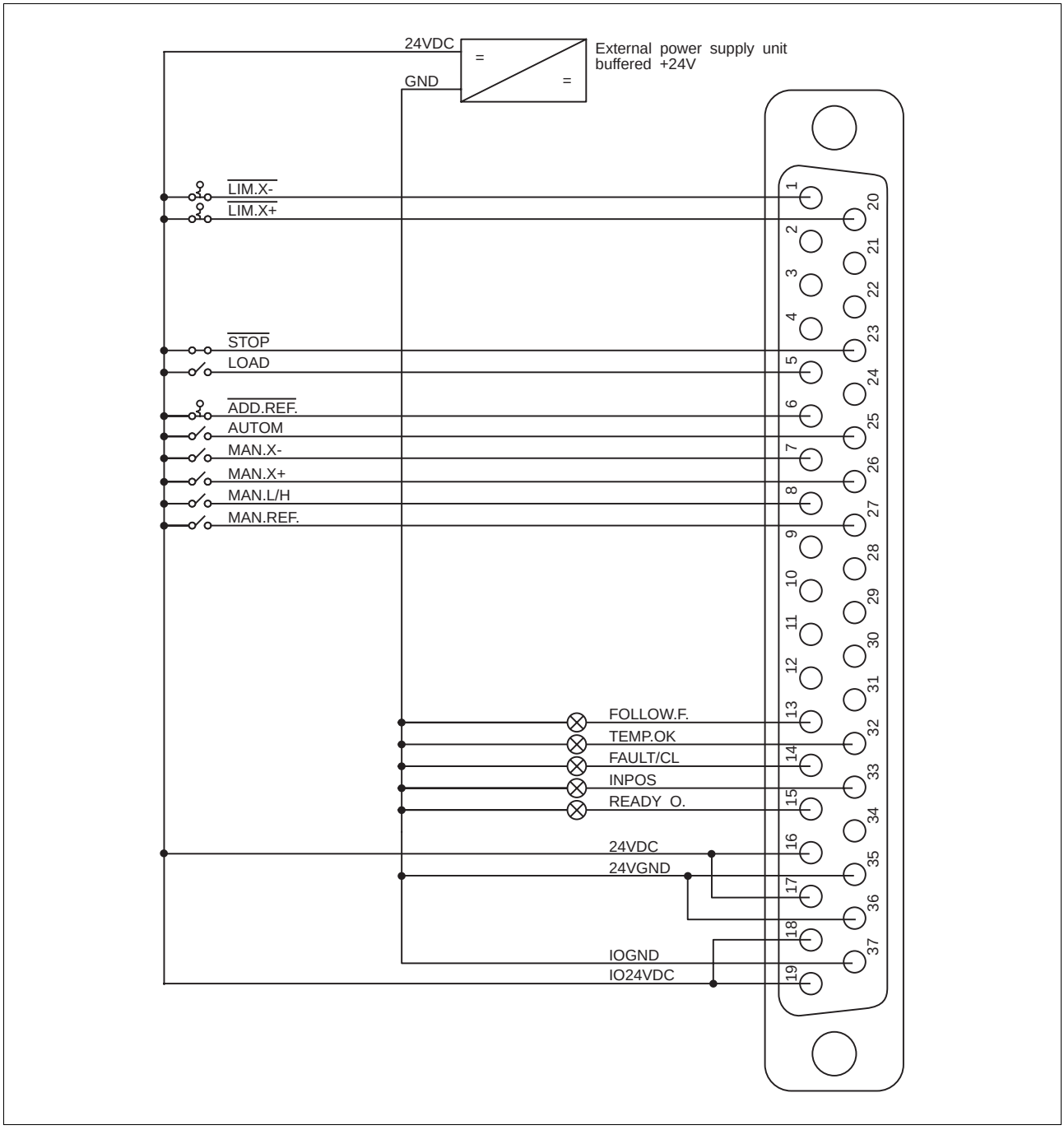


Fig. 2-10 Example of wiring for serial mode

2.4.4.2 Signal connection in network mode "Memory"

Pin	Abbreviation	Meaning	
1	$\overline{\text{LIM.X-}}$	Negative limit switch	←
2	-	-	
3	-	-	
4	START	Start	←
5	LOAD	Store position	←
6	$\overline{\text{ADD.REF.}}$	Additional reference switch	←
7	MAN.X-	Manual movement, CCW rotation	←
8	MAN.L/H	Slow/fast manual movement	←
9	DATA4	Program number 2^2	←
10	DATA1	Program number 2^0	←
11	-	-	
12	-	-	
13	FOLLOW.F.	Following error limit	→
14	FAULT/CL	Error	→
15	READY O.	Ready for operation	→
16	24VDC	System supply voltage	←
17	24VDC	System supply voltage	←
18	IO24VDC	I/O supply voltage	←
19	IO24VDC	I/O supply voltage	←
20	$\overline{\text{LIM.X+}}$	Positive limit switch	←
21	-	-	
22	-	-	
23	$\overline{\text{STOP}}$	Stop	←
24	RS/CL.A.	Program start	←
25	AUTOM	Automatic operation	←
26	MAN.X+	Manual movement, CW rotation	←
27	MAN.REF.	Manual reference movement	←
28	DATA8	Program number 2^3	←
29	DATA2	Program number 2^1	←
30	-	-	
31	-	-	
32	TEMP.OK	Temperature o.k.	→
33	INPOS	Position reached	→
34	END/$\overline{\text{L.A.}}$	Program end	→
35	24VGND	System supply voltage ground	←
36	24VGND	System supply voltage ground	←
37	IOGND	I/O supply voltage ground	←

$\overline{\text{active-low signal}}$ ← input → output

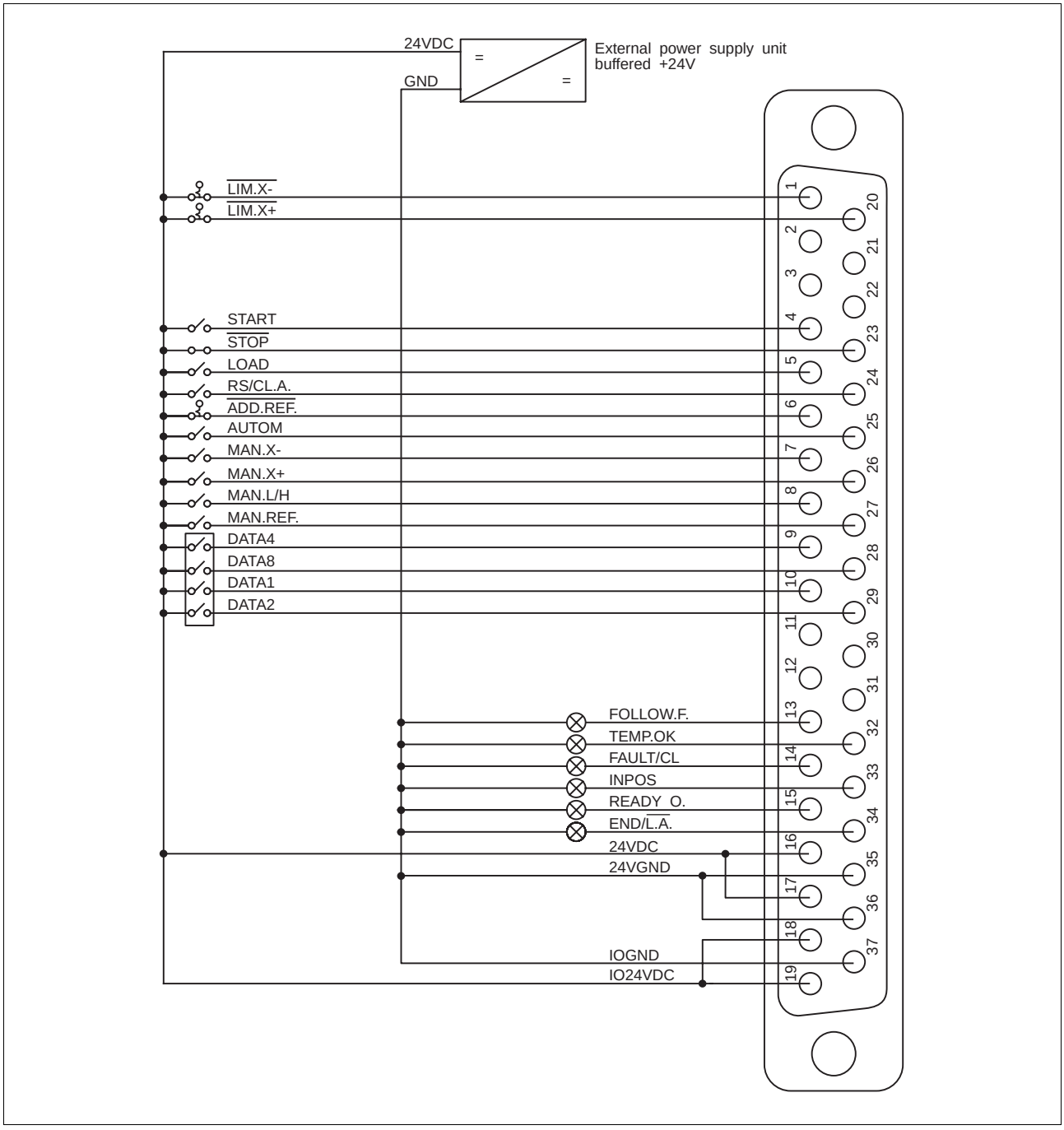


Fig. 2-11 Example of wiring for network mode "Memory"

2.4.4.3 Signal connection in network mode "Serial"

Pin	Abbreviation	Meaning	
1	$\overline{\text{LIM.X-}}$	Negative limit switch	←
2	-	-	
3	-	-	
4	-	-	
5	LOAD	Store position	←
6	$\overline{\text{ADD.REF.}}$	Additional reference switch	←
7	MAN.X-	Manual movement, CCW rotation	←
8	MAN.L/H	Slow/fast manual movement	←
9	-	-	
10	-	-	
11	-	-	
12	-	-	
13	FOLLOW.F.	Following error limit	→
14	FAULT/CL	Error	→
15	READY O.	Ready for operation	→
16	24VDC	System supply voltage	←
17	24VDC	System supply voltage	←
18	IO24VDC	I/O supply voltage	←
19	IO24VDC	I/O supply voltage	←
20	$\overline{\text{LIM.X+}}$	Positive limit switch	←
21	-	-	
22	-	-	
23	$\overline{\text{STOP}}$	Stop	←
24	-	-	
25	AUTOM	Automatic operation	←
26	MAN.X+	Manual movement, CW rotation	←
27	MAN.REF.	Manual reference movement	←
28	-	-	
29	-	-	
30	-	-	
31	-	-	
32	TEMP.OK	Temperature o.k.	→
33	INPOS	Position reached	→
34	-	-	
35	24VGND	System supply voltage ground	←
36	24VGND	System supply voltage ground	←
37	IOGND	I/O supply voltage ground	←

$\overline{\text{active-low}}$ signal ← input → output

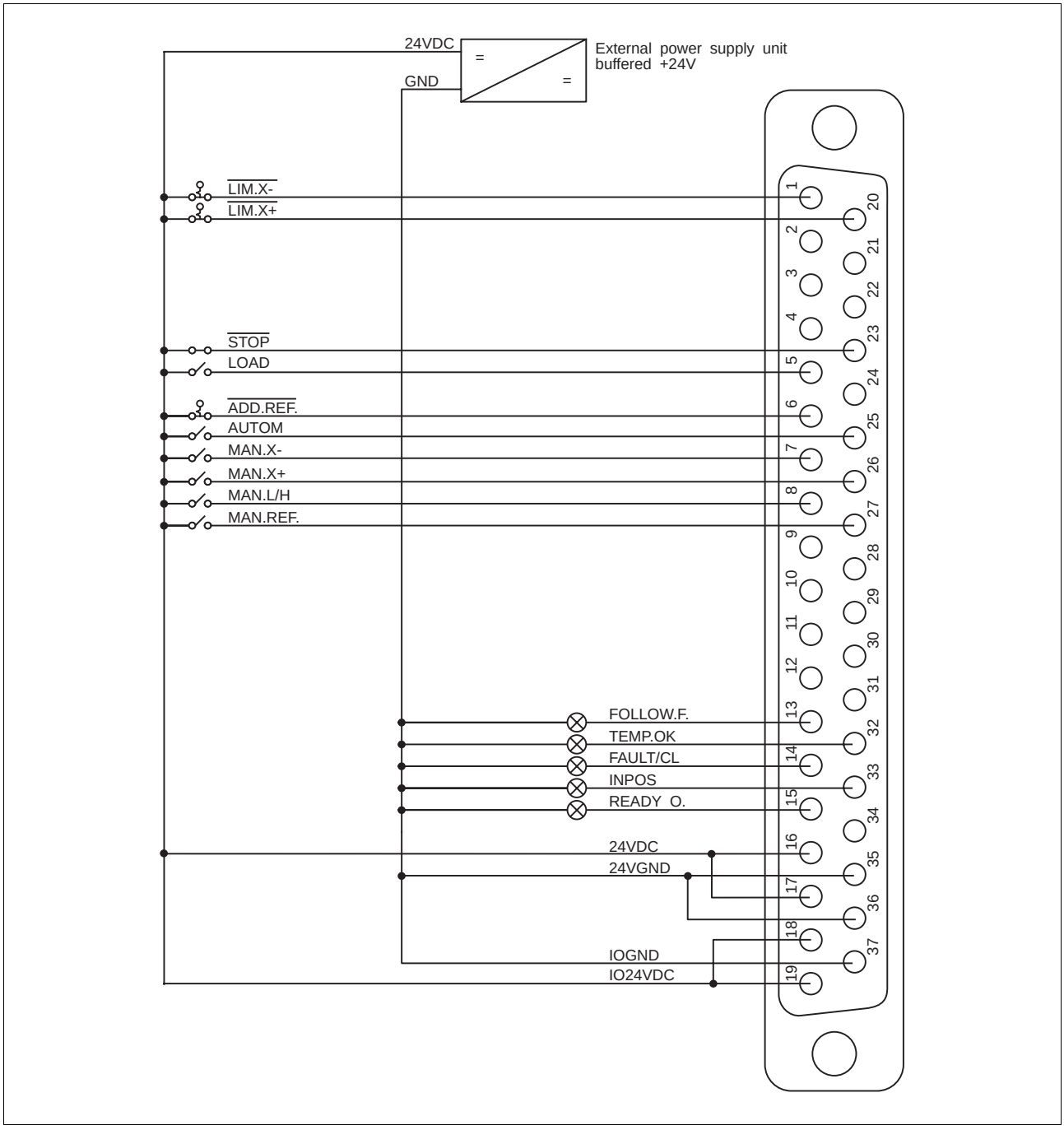


Fig. 2-12 Example of wiring for network mode "Serial"

2.4.4.4 Signal connection in network mode "A/R-Parallel"

Pin	Abbreviation	Meaning	
1	$\overline{\text{LIM.X-}}$	Negative limit switch	←
2	-	-	
3	-	-	
4	START	Start	←
5	LOAD	Load	←
6	$\overline{\text{ADD.REF.}}$	Additional reference switch	←
7	MAN.X-	Manual movement, CCW rotation	←
8	MAN.L/H	Slow/fast manual movement	←
9	DATA4	Decade value 2^2	←
10	DATA1	Decade value 2^0	←
11	-	-	
12	-	-	
13	FOLLOW.F.	Following error limit	→
14	FAULT/CL	Error and clock signal	→
15	READY O.	Ready for operation	→
16	24VDC	System supply voltage	←
17	24VDC	System supply voltage	←
18	IO24VDC	I/O supply voltage	←
19	IO24VDC	I/O supply voltage	←
20	$\overline{\text{LIM.X+}}$	Positive limit switch	←
21	-	-	
22	-	-	
23	$\overline{\text{STOP}}$	Stop	←
24	RS/CL.A.	Clock acknowledge	←
25	AUTOM	Automatic operation	←
26	MAN.X+	Manual movement, CW rotation	←
27	MAN.REF.	Manual reference movement	←
28	DATA8	Decade value 2^3	←
29	DATA2	Decade value 2^1	←
30	-	-	
31	-	-	
32	TEMP.OK	Temperature o.k.	→
33	INPOS	Position reached	→
34	END/$\overline{\text{L.A.}}$	Load acknowledge	→
35	24VGND	System supply voltage ground	←
36	24VGND	System supply voltage ground	←
37	IOGND	I/O supply voltage ground	←

$\overline{\text{active-low signal}}$ ← input → output

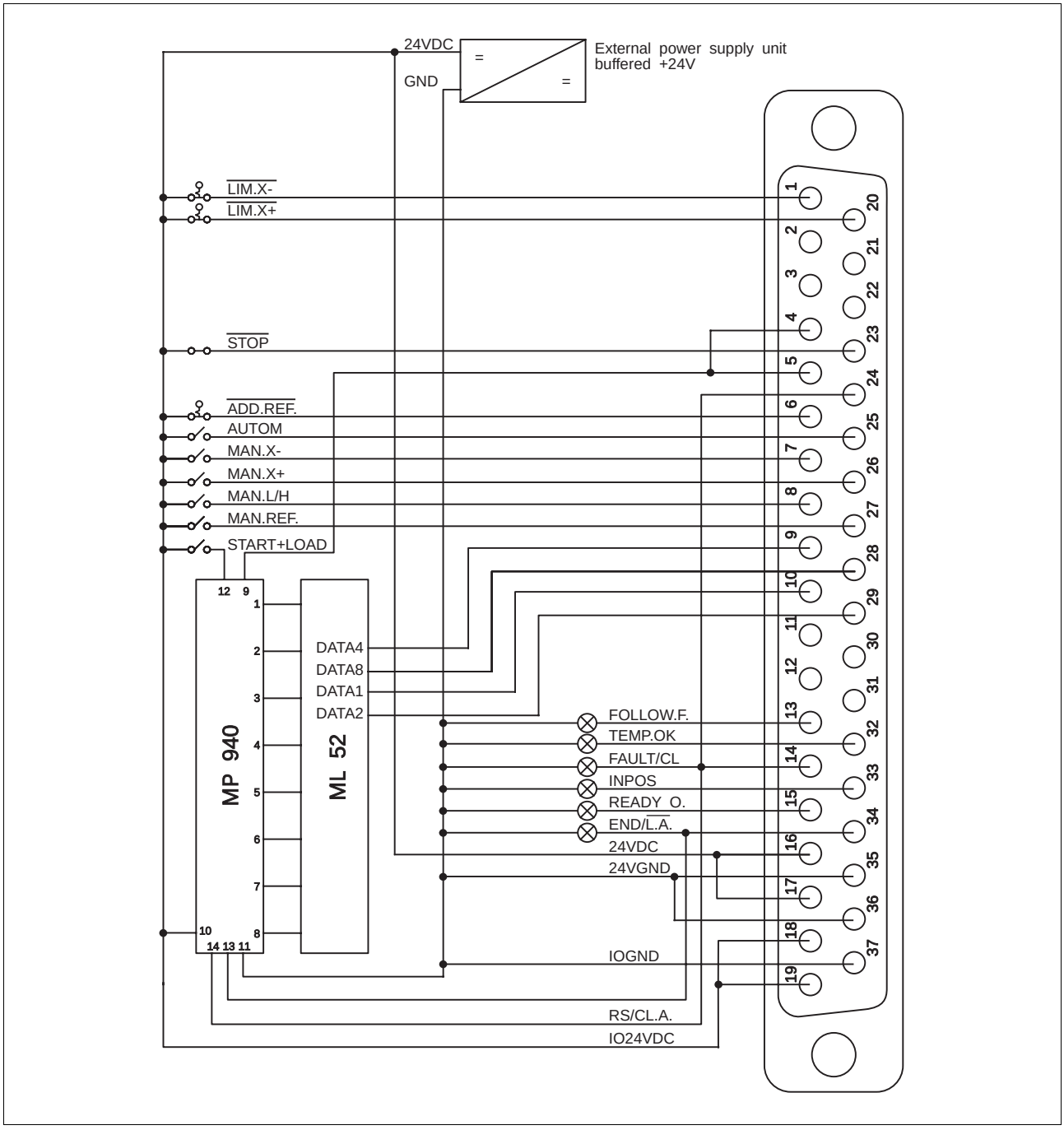


Fig. 2-13 Example of wiring for network mode "A-/R-Parallel" with MP 940 decade switch interface

NOTE
Should a decade switch block other than ML 52 be used, wiring must be effected as per chapter 6.2.2.

NOTE
The MP 940 decade switch interface is described in chapter 6.2.3.

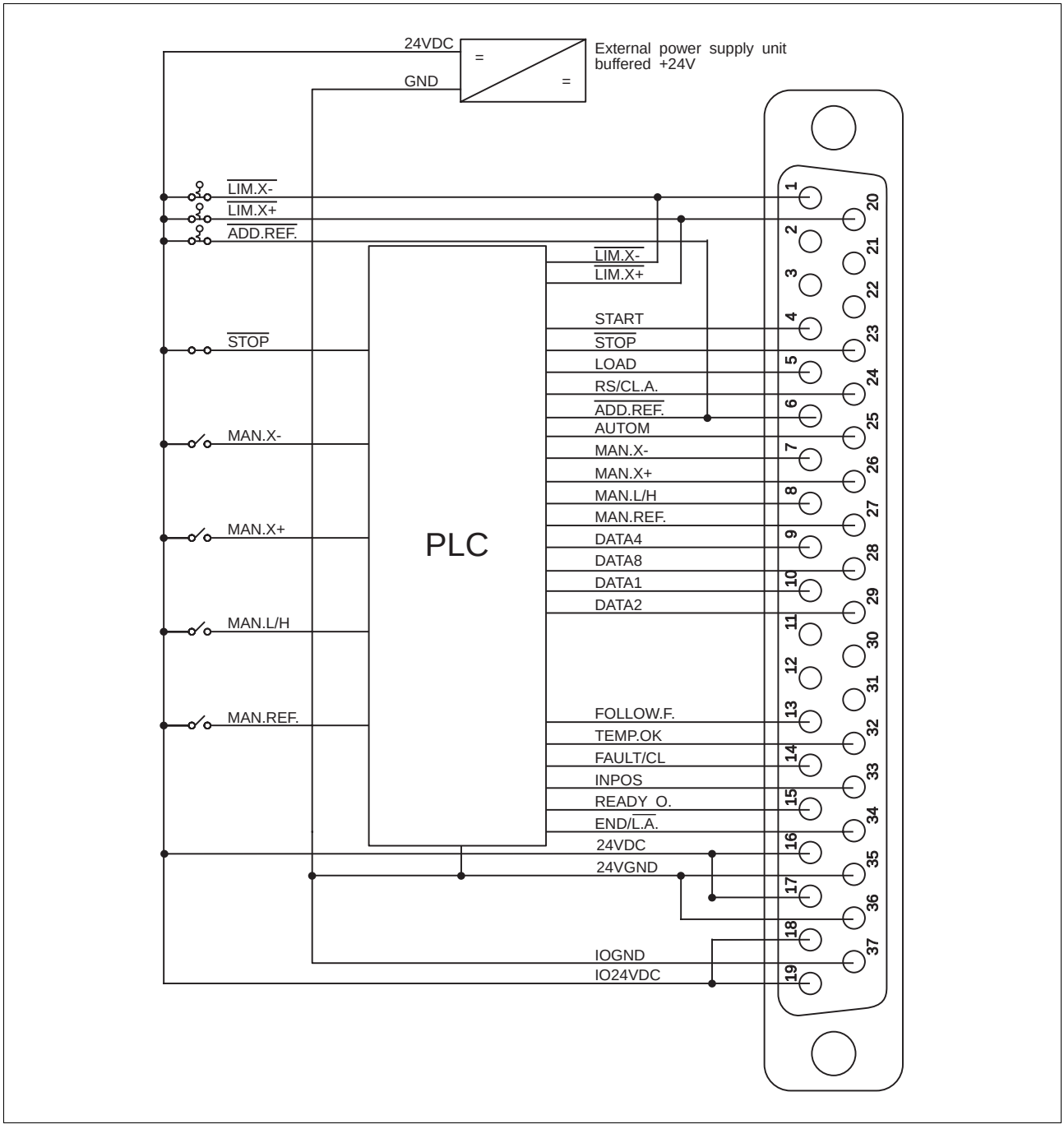


Fig. 2-14 Example of wiring for network mode "A-/R-parallel" without decade switch interface

2.4.5 Serial interface (RS 485)

NOTE
The serial interface (RS 485) is operated as a four-wire interface.

1. Solder litz wires to connector according to fig. 2-15.

Pin	Signal	Meaning	Direction
1, 6	+12V	MP 923 supply voltage	→
2,7	GND	MP 923 supply voltage ground	→
3	$\overline{\text{TxD}}$	Transmit data inverted	→
4	$\overline{\text{RxD}}$	Receive data inverted	←
5	RGND	Signal ground	
8	TxD	Transmit data	→
9	RxD	Receive data	←

← input → output

2. Push shield back and fix with cable tie.

3. Screw two hexagon head bolts (fig. 2-16) into the connector shell.

4. Put connector into connector shell.

5. Fasten cable and shield to the connector shell without strain.

ATTENTION
A good electrical connection must be established between the shield and the connector shell.
The cable must be screened on both sides.

6. Insert two caps in unused cable entries.

7. Fix the two halves of the connector shell with two screws.

8. Fasten connector on the front panel (item 52).

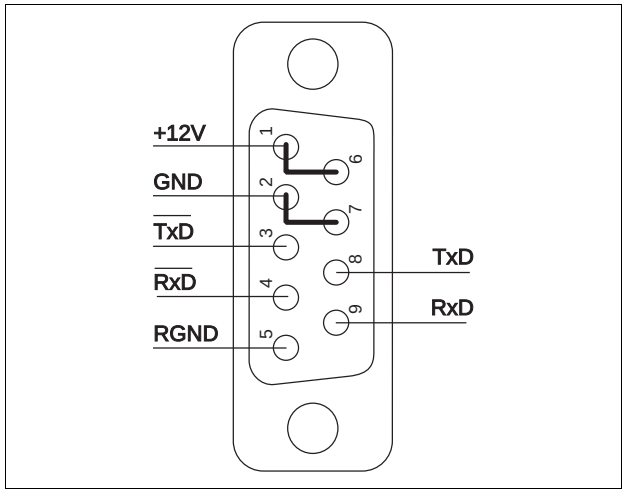


Fig. 2-15 Interface connection – unit side

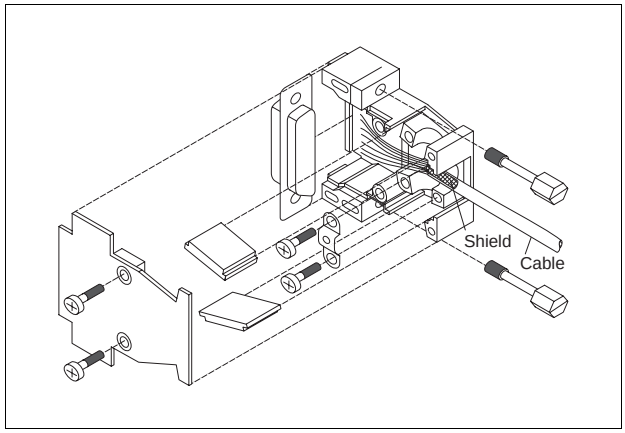


Fig. 2-16 Interface connector assembly

NOTE
The MP 923 interface converter may be used for a computer which is equipped with a RS 232C interface, see chapter 6.2.14.

NOTE
The MP 924 interface distributor may be used in network mode to control eight units, see chapter 6.2.15.

For serial polling mode, the serial interface shall be cabled in accordance with chapter 2.4.5 and the connections between master and slave established in accordance with fig. 2-17 or fig. 2-18.

NOTE
The crossover adapter can be used for crossing the transmit and receive lines.

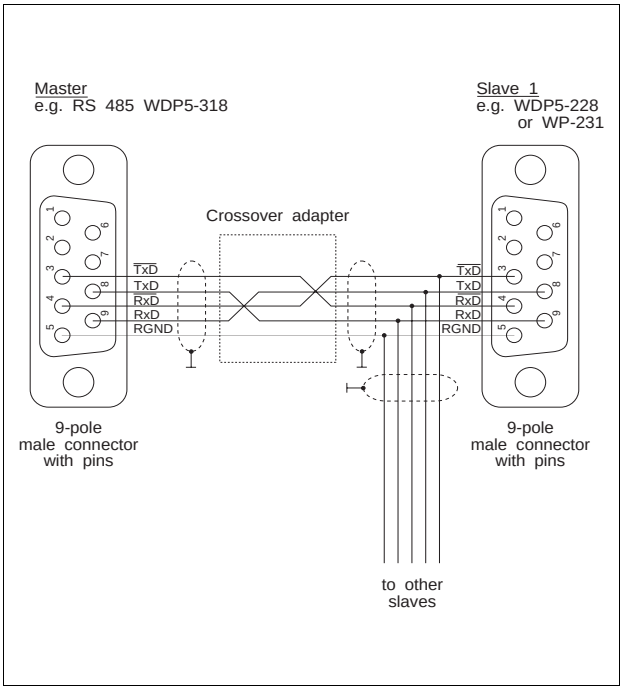


Fig. 2-17 Master/slave cabling with crossover adapter

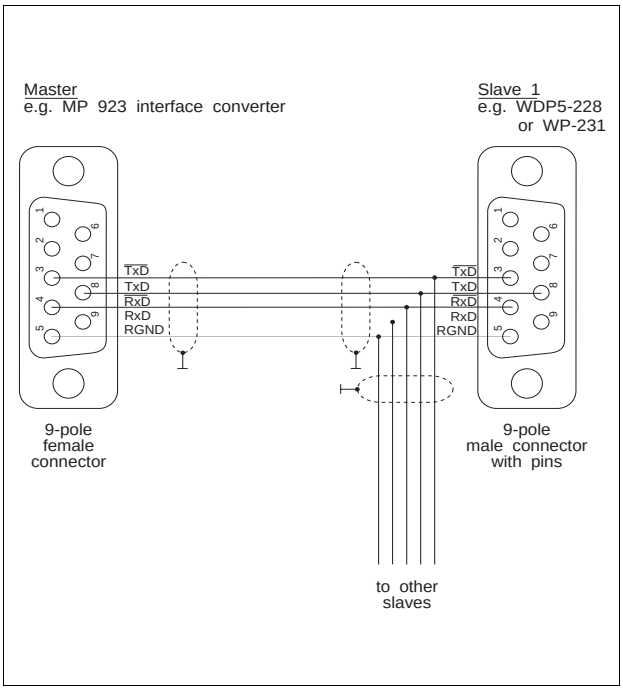


Fig. 2-18 Master/slave cabling with MP 923

2.4.6 Signal connection - electronic gear

1. Solder litz wires to connector according to fig. 2-19.
2. Push shield back and fix with cable tie.
3. Screw two hexagon head bolts (fig. 2-20) into connector shell.
4. Put connector into connector shell.
5. Fasten cable and shield to the connector shell without strain.

ATTENTION
A good electrical connection must be established between the shield and the connector shell.
The cable must be screened on both sides.

6. Insert two caps in unused cable entries.
7. Fix the two halves of the connector shell with two screws.
8. Fasten connector on the front panel (item 53).

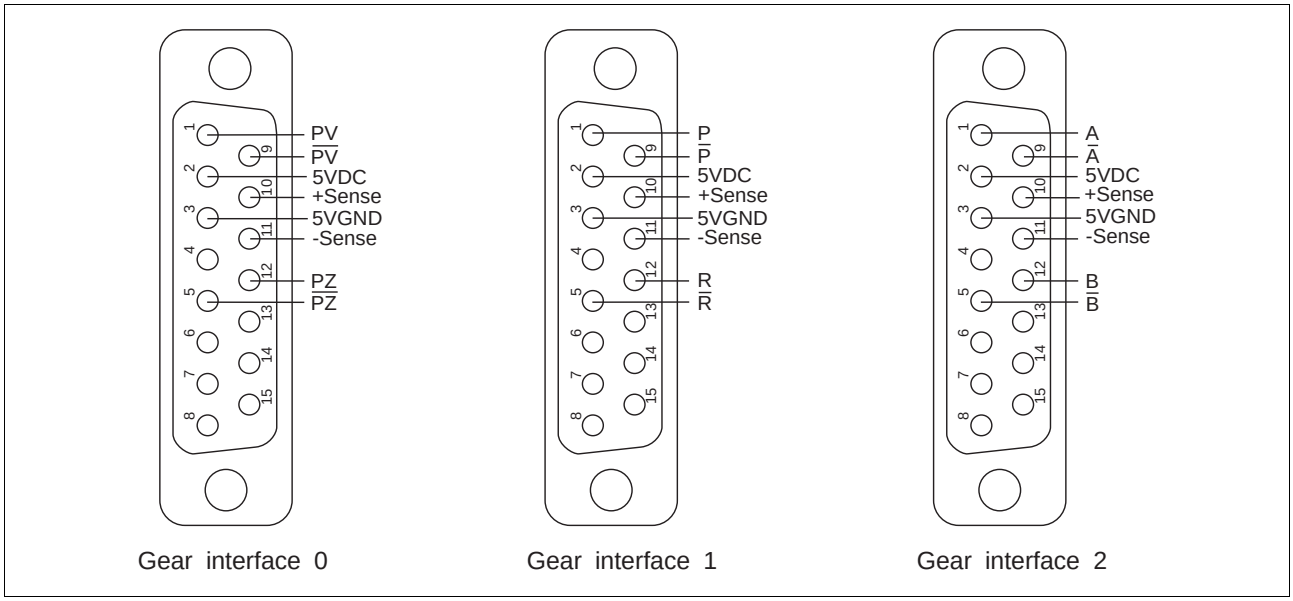


Fig. 2-19 Gear connector – unit side

NOTE
The 5 VDC and +SENSE as well as the 5 VGND and -SENSE lines must be bridged on the shaft encoder side, see shaft encoder connection.

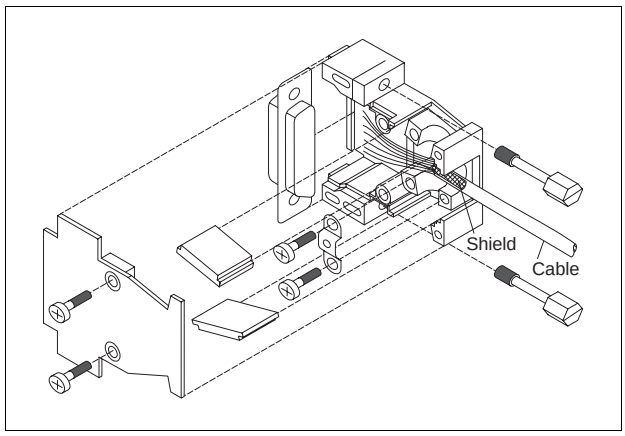
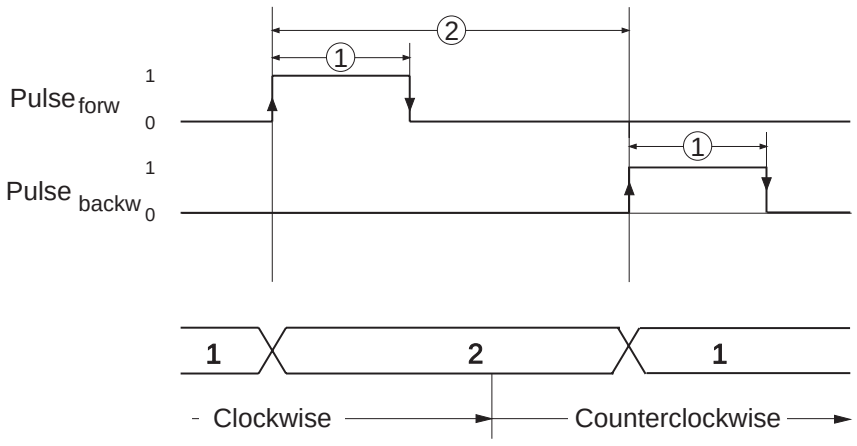


Fig. 2-20 Gear connector assembly – unit side

2.4.6.1 Type of signal pulse$_{forward}$/pulse$_{backward}$ (GI=0)

Pin	Abbreviation	Meaning
1	$\overline{PV}$	$\overline{Pulse}_{forward}$ ←
2	5VDC	Signal generator – supply voltage →
3	5VGND	Signal generator – supply voltage ground →
4		
5	PZ	$Pulse_{backward}$ ←
6	-	-
7	-	-
8	-	-
9	PV	$Pulse_{forward}$ ←
10	+SENSE	Sense regulator 5 V ←
11	-SENSE	Sense regulator ground ←
12	$\overline{PZ}$	$\overline{Pulse}_{backward}$ ←
13	-	-
14	-	-
15	-	-

$\overline{\text{active-low signal}}$ ← input → output



Counting in case of positive pulse edge

① Minimum pulse width = 1 µs
② ≥ 2 µs

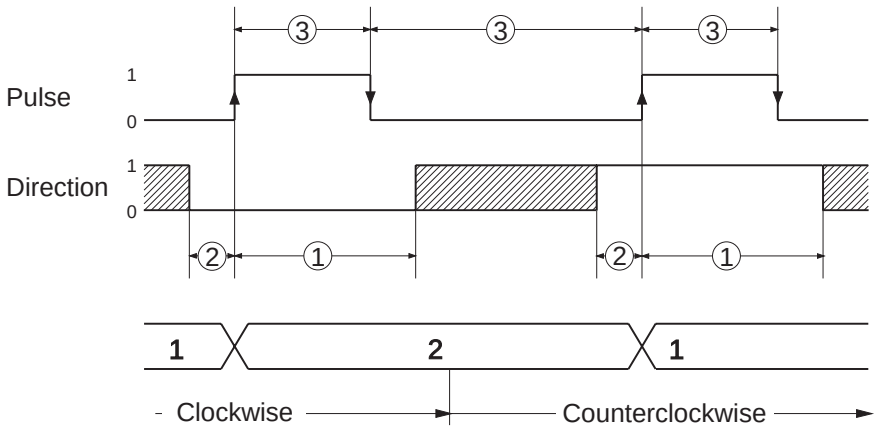
f_{max} (pulse $_{forw}$ or pulse $_{backw}$) = 500 kHz

Bild 2-21 Timing diagram – pulse$_{forward}$/pulse$_{backward}$

2.4.6.2 Type of signal pulse/direction (GI=1)

Pin	Abbreviation	Meaning
1	$\overline{P}$	$\overline{Pulse}$ ←
2	5VDC	Signal generator – supply voltage →
3	5VGND	Signal generator – supply voltage ground →
4		
5	R	Direction ←
6	-	-
7	-	-
8	-	-
9	P	Pulse ←
10	+SENSE	Sense regulator 5 V ←
11	-SENSE	Sense regulator ground ←
12	$\overline{R}$	$\overline{Direction}$ ←
13	-	-
14	-	-
15	-	-

$\overline{\text{active-low}}$ signal ← input → output



Counting in case of positive pulse edge

Direction = 0 ⇒ CW rotation of motor
Direction = 1 ⇒ CCW rotation of motor

Undefined area

① Hold time ≥ 1.5 µs
② Setup time ≥ 0.5 µs
③ Minimum pulse width ≥ 1µs

f_{max}(pulse) = 500 kHz

Fig. 2-22 Timing diagram – pulse/direction

2.4.6.3 Type of signal shaft encoder signals A/B (GI=2)

Pin	Abbreviation	Meaning
1	A	Shaft encoder signal A ←
2	5VDC	Signal generator – supply voltage →
3	5VGND	Signal generator – supply voltage ground →
4		
5	$\overline{B}$	$\overline{\text{Shaft encoder signal B}}$ ←
6	-	-
7	-	-
8	-	-
9	$\overline{A}$	$\overline{\text{Shaft encoder signal A}}$ ←
10	+SENSE	Sense regulator 5 V ←
11	-SENSE	Sense regulator ground ←
12	B	Shaft encoder signal B ←
13	-	-
14	-	-
15	-	-

$\overline{\text{active-low signal}}$ ← input → output

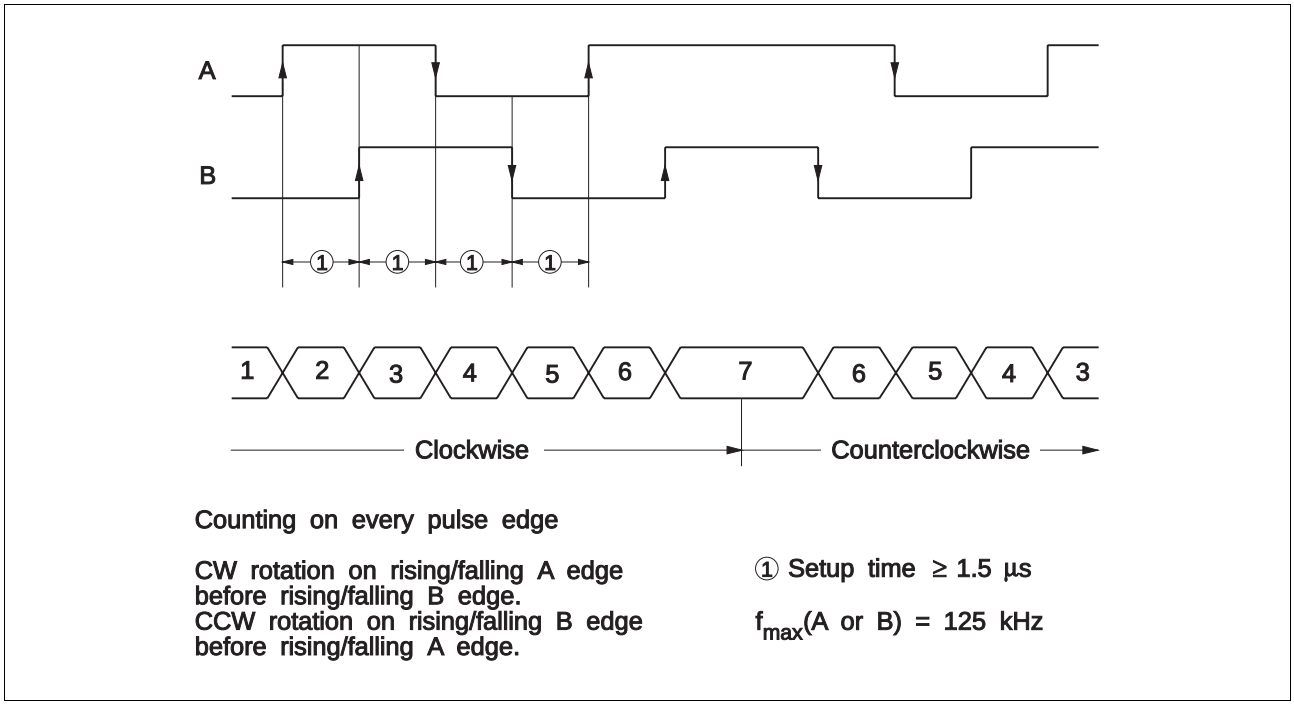


Fig. 2-23 Timing diagram – shaft encoder signals A/B

2.5 Starting up

2.5.1 Defaults

The following table shows the standard parameter setting ex works. Modification of parameters see chapter 3 "Operation".

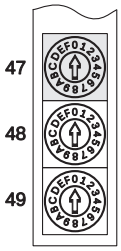
Instruction/Parameter	**Meaning**	**Range**	**Factory setting**
Sub-mode"MD"	Sub-modes: 0 Point -to-point 1 Frequency characteristics[1)] 2 Electronic gear[1)]	0 to 2	0
Gear interface "GI"[1)]	Gear interface in sub-mode "Electronic gear" 0 $Pulse_{forward}/Pulse_{backward}$ 1 Pulse/direction 2 Shaft encoder signal A/B	0 to 2	2
Phase advance "PA"	Phase advance of the electrical rotating field as compared to the rotor field	5 to 100 kHz	35 kHz
Shaft encoder resolution "DA"	Shaft encoder resolution of the respective motor	500 to 1000 marks	1000 marks
Differential component "KD"	The differential component determines the response to control deviation changes	0 to 32767	1400
Proportional component "KP"	Proportional gain defines the drive rigidity	0 to 32767	200
Integral-action component "KI"	The integral component compensates for permanent control deviation	0 to 32767	0
Sampling time "TA"	Time interval in which the set position is compared to the actual position and the PID-position controller calculates a new reference variable	500, 1000, 2000 µs	1000 µs
Automatic integral component "IS"	The integral component is used to ensure that the motor reaches its setpoint and the control deviation at standstill is 0.	0 to 32767	1
Controller mode "MR"	Controller mode 0 Current controller 1 Load angle controller	0 to 1	0
Quiescent current "RS"	Quiescent current for switch-on phase, locking or malfunction	0 to 100 %	50%
Locking "AR"	Locking the electronic commutation interrupts automatic rotating field commutation (0 = switched off)	0 to 65535 ms	0 ms
Following error "XL"	The following error serves to optimize the acceleration values	0 to 4000 increments	1000 incr.

Instruction/Parameter	Meaning	Range	Factory setting
Positioning window "PW"	Criteria for a terminated positioning process	1 to 4000 increments	10 incr.
Gear ratio "EZ"[1)]	Gear ratio "Numerator" in sub-mode "Electronic gear"	± 30000[7)]	0
Gear ratio "EN"[1)]	Gear ratio "Denominator" in sub-mode "Electronic gear"	1 to 30000	1
Gear ratio "GZ"	Gear ratio "Numerator" in sub-mode "Point-to-point"	± 1 to ± 30000[7)]	1
Gear ratio "GN"	Gear ratio "Denominator" in sub-mode "Point-to-point"	1 to +30000	1
Gear ratio "decimal"[2)]	Gear ratio "Decimal" in sub-mode "Point-to-point"	0.1 to 100.0	1.0
"Ramp gradient"	Ramp gradient in sub-mode "Point to point" or "Frequency characteristics"	8 to 32767 Hz/ms	100 Hz/ms
Set frequency "F"	Set frequency in sub-mode "Point-to-point"	8 to 195000 Hz[5)] 8 to 390000 Hz[6)]	4000 Hz
Set frequency "VY"[1)]	Set frequency in sub-mode "Frequency characteristics"	± 195000 Hz[5)] ± 390000 Hz[6)]	0 Hz
Manual frequency slow	Step frequency (speed) at which the servo stepping motor is controlled during slow manual movement	8 to 195000 Hz[5)] 8 to 390000 Hz[6)]	1000 Hz
Manual frequency fast	Step frequency (speed) at which the servo stepping motor is controlled during fast manual movement	8 to 195000 Hz[5)] 8 to 390000 Hz[6)]	4000 Hz
Manual frequency REF IN	Frequency for manual reference movement towards the reference switch	8 to 195000 Hz[5)] 8 to 390000 Hz[6)]	8000 Hz
Settling time t_E[3)]	Time span in which a stable input signal is detected	1 to 255 ms	4 ms
Reference position	Reference dimension after setting the reference point or switching the unit on	± 8300000	0
Readings [4)]	Number of times an 8-digit decade value is read in	1 to 255	2
Decade settling time[4)]	Number of read-in repeats for detecting a decade value	5 to 255 (x 100 µs)	5 x 100 µs

1) Not available in operating mode "A-/R-parallel"
2) In serial mode only
3) Not available in serial mode
4) In network mode "A-/R-parallel" only
5) Shaft encoder with 500 marks
6) Shaft encoder with 1000 marks
7) Negative gear ratio numerator means direction reversal, the limit switches must be interchanged.

1. The supply voltage of the unit must not be switched on.

2. Set the desired operating mode at the selector switch (47):

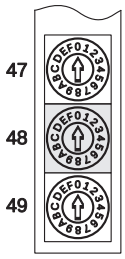


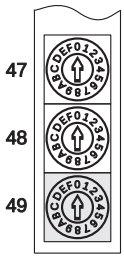
Position	Operating mode
0	No function
1	No function
2	Serial mode with 1200 bauds (ASCII 7 bits, even parity bit, one stop bit)
3	Serial mode with 9600 bauds (ASCII 7 bits, even parity bit, one stop bit)
4	No function
5	No function
6	Network mode with 9600 bauds
7	Network mode with 38.4 kbauds
8	No function
9	Serial polling mode with 9600 bauds
A to F	No function

NOTE
The network operating modes "Install", "Memory", "Serial", "R-Parallel" or "A-Parallel" can be set via the PC network mode, see PRO-SDP/PC1 documentation.

3. Verify that all connectors have been connected correctly.

4. Network address setting in network mode or serial polling mode:





– The value of tens of the network address is set with selector switch (48).

– The value of ones of the network address is set with selector switch (49).

The network address may range from 1 to 31 (decimal setting).

5. Set motor phase current at selector switch (01) in accordance with the motor type plate and the following diagram (fig. 2-24):

Position	Phase current in A
0	0.75
1	1.00
2	1.25
3	1.50
4	1.75
5	2.00
6	2.25
7	2.50
8	2.75
9	3.00
A	3.25
B	3.50
C	3.75
D	4.00
E	4.25
F	4.50

ATTENTION
The set phase current must be less or equal to the nominal phase current stipulated on the motor type plate (the lower the set phase current, the lower the motor torque).

ATTENTION
The cover must be screwed back on after setting.

6. Plug in mains connector and switch on the supply voltage for the power drive and processed unit. The seven-segment displays (items 02 and 40) indicate "readiness" by lighting of the point.

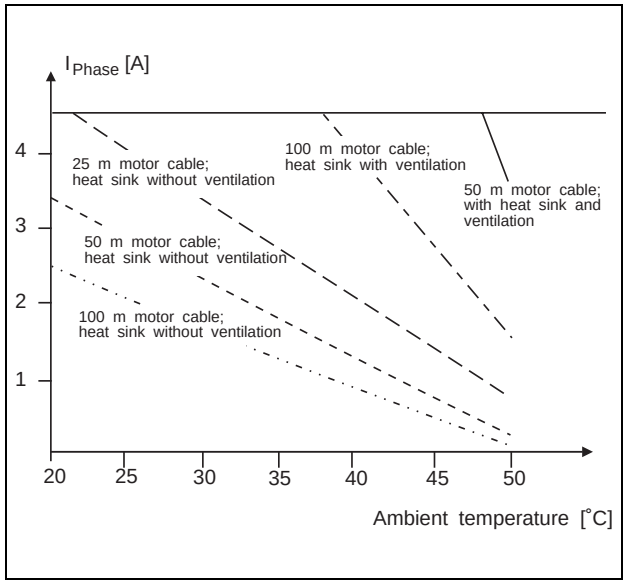


Fig. 2-24 Admissible phase current as a function of ambient temperature and motor cable length

2.5.2 Testing

A manual movement and/or a manual reference movement should be performed as per chapter 3 for checking cabling and settings.

NOTE
The test can only be conducted, if the shaft encoder resolution "DA" of the employed motor corresponds with the "DA" value.

NOTE
If the test is conducted in network mode, a valid network address must be set, see chapter 2.5.1.

NOTE
The settings are selected in such a way that simple positioning is possible.
The drive characteristics of the motors can be optimized for customer-specific applications in accordance with chapter 2.6 by modifying the controller parameters.
In addition to setting the control parameters, phase advance in accordance with the motor type must be programmed as per chapter 2.6.

2.6 Setting the PID position controller

The PID position controller can be employed in serial as well as in network mode.
The parameters are set in serial mode on the terminal or PC; in network mode on the PC using the PRO-SDP/PC1 software.

2.6.1 Conditions

ATTENTION
The appropriate shaft encoder resolution "DA" and phase advance "PA" must be set for optimum controller setting.

Shaft encoder resolution "DA"

The shaft encoder resolution "DA" of the respective motor is evident in the 5-phase stepping motor catalogue doc. no. 371.
4-fold evaluation of the shaft encoder signal is effected in the controller, i.e. the pulses issued by the shaft encoder are multiplied by four. This must be taken into account in the setpoint presettings for position, frequency and acceleration (example of calculation see appendix).
The shaft encoder resolution is programmed with the "DA" command. It is as follows:

- for a shaft encoder with 500 marks DA=500
- for a shaft encoder with 1000 marks DA=1000

Phase advance "PA"

Phase advance "PA" defines advance of the electric rotating field as compared to the rotor field. It depends on the motor and power drive and must be programmed in accordance with the following table.

Motor type	PA value	DA value
VRDM 568/50 LV	50	500
VDRM 597/50 LV	35	1000*
VRDM 5910/50 LV	30	
VRDM 5913/50 LV	25	
VRDM 51117/50 LW	20	
VRDM 51122/50 LW	15	

* The shaft encoder resolution (1000 marks) must be specified when ordering a motor.

2.6.2 Controller setting "TA", "KP", "KD" and "KI"

The following parameters must be set.

Controller setting	Range	Factory setting
Sampling time "TA"	500, 1000, 2000 µs	1000 µs
Proportional component "KP"	0 to 32767	200
Differential component "KD"	0 to 32767	1400
Integral component "KI"	0 to 32767	0

1. For this, locking must be deactivated (AR=0).

2. Enter the "TA" value depending on the load **rigidly** connected to the motor shaft. For this, it is compared to the rotor's moment of inertia of the employed motor. The following rules apply:

$J_{external}$ J_{Rotor}	TA=500
$J_{Rotor} \leq J_{external} \leq 10 \times J_{Rotor}$	TA=1000
$J_{external} > 10 \times J_{Rotor}$	TA=2000

   Flexibly connected external moments of inertia must not be added to $J_{external}$.

NOTE
Sampling time "TA" should be kept as low as possible, as higher proportional gains "KP" can be selected the lower it is.

3. Set parameters "KP" and "KD" as follows:

NOTE
The KD factor must always correspond to the KP factor and should be within the following range:
3 x KP ≤ KD ≤ 12 x KP

NOTE
A basic setting which has proven well in practice, never causing instability and gives satisfactory results, is the following:
KD = 7 x KP

   Increase the value for "KP" and "KD" step by step (KP = 200, 300, 400 ...). Make sure that the condition KD = 7 x KP is always fulfilled. Repeat this procedure until the drive gets near the stability limit and becomes unstable.

4. Reduce the value for "KP" and "KD" by approx. 20% to stabilize the motor position.

5. If $J_{external} > 10 \times J_{Rotor}$, increase "KD" step by step (KD = 7 x KP, 8 x KP, 9 x KP ... 11 x KP) until the stability limit is reached.

6. If the motor is unstable, reduce the value for "KD" by 2 x KP.

7. If no deviation from the setpoint is desired in case of continuous, external load, increase the value for "KI" step by step (KI = 1, 2, 3 ...) until the motor shows an oscillating transient response in the desired positioning processes.

NOTE
When selecting the KI factor, the following limit should not be exceeded: **KI ≤ KP/50**

8. If no integral component "KI" is programmed, the automatic integral component "IS" shall always be programmed (factory setting =1). For this purpose, increase the value for "IS" step by step (IS = 1, 2, 3, ...) until the motor reaches its setpoint and the control deviation at standstill is 0.

ATTENTION
If a drive is programmed without "KI" in point-to-point mode, the integralcomponent"IS" shall always be programmed as the positioning window programmed with "PW" is not reached due to external mechanical influences (friction, load, etc.). Thus, the movement is not found to be terminated and a subsequent movement command cannot be executed.

9. If the motor oscillates, reduce the value for "KI" and possibly "IS" by 1 to stabilize the motor.

10. If a high degree of rigidity is desired and reduced running smoothness is acceptable, load angle controller mode can be activated with the command MR=1. Increase the values "KP", "KI", "KD" and possibly "IS" as described in steps 3 to 8.

11. The network function "RECORD" allows checking and, if necessary, correcting the controller setting in network mode (see PRO-SDP/PC1 documentation).
The following data and settings are used in the following diagrams:

Motor data	**Settings**
Motor type VRDM 5913/50 LV	TA=1000
$J_{external}$ = 4.0 kgcm^2	MR=0
J_{Rotor} = 1,8 kgcm^2	DA=1000
I_{nom} = 2 A	I_{max} = 3,0 A

Settings for "RECORD" function
– Reference step X_{nom} = 200 increments
– Measurement time reference = 1 ms
– Number of measuring points = 300

Fig. 2-25 shows the controller step response with the standard factory setting. Positioning time is approx. 25 ms.

Setting values:
KP=200, KD=1400, KI=0

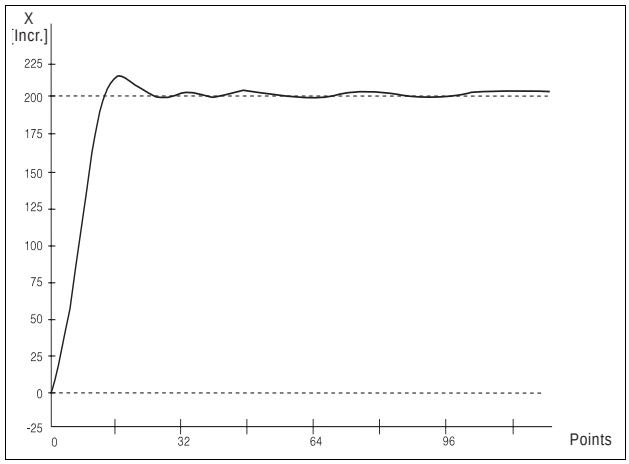


Fig. 2-25 Controller step response with basic setting

As evident in fig. 2-26, proportional gain "KP" is first increased in steps of 100 whereby
KD = 7 x KP is maintained.

Setting values:
KP=300, KD=2100, KI=0

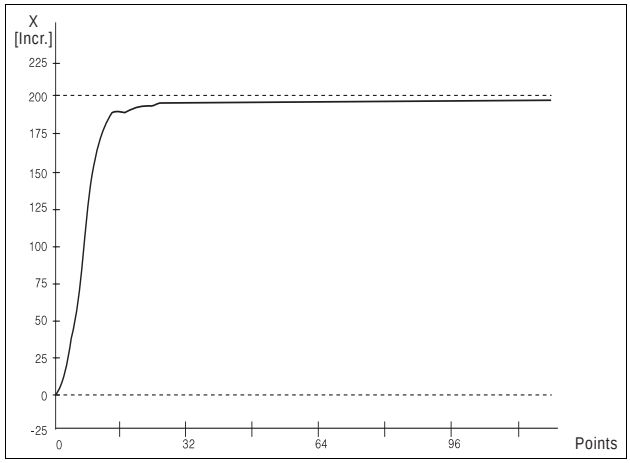


Fig. 2-26 Increasing KP and KD component (K=300)

As evident in fig. 2-27, proportional gain "KP" is increased in steps of 100 until the motor becomes unstable (inclination to oscillation, noise generation).

Setting values:
KP=500, KD=3500, KI=0

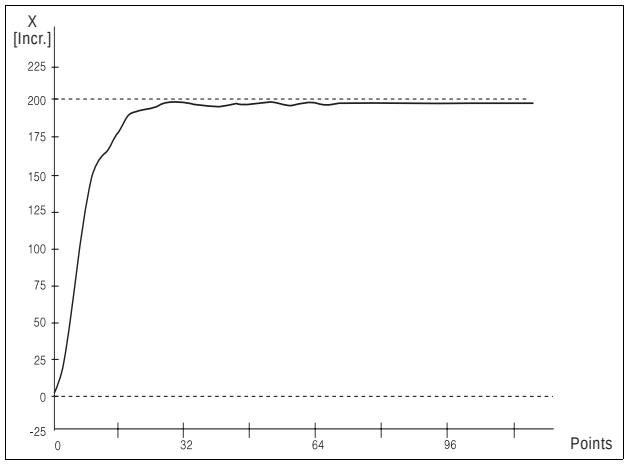


Fig. 2-27 Increasing KP and KD component (KP=500)

The drive in fig. 2-28 is overcompensated and attenuation "KD" (e.g. KD = 9 x KP) is too high. The drive curve towards the setpoint is not steep enough (extremely aperiodic approach to the motor position).

Setting values:
KP=300, KD=2700, KI=0

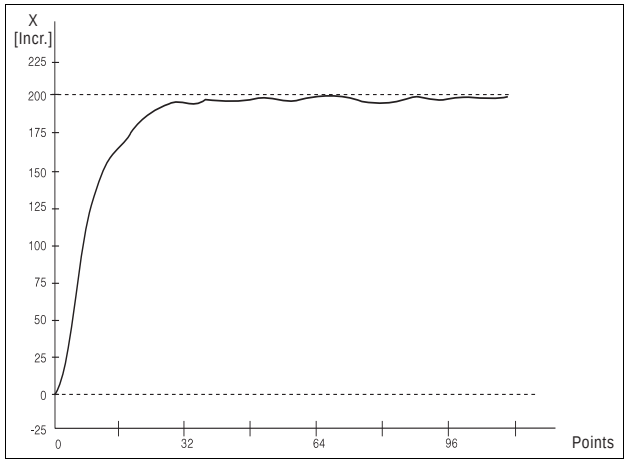


Fig. 2-28 KD component KD = 9 x KP

Drive attenuation in fig. 2-29 is too weak KD = 5 x KP. This is evident from the transient and overshoot response. The positioning time is approx. 50 ms.

Setting values:
KP=300, KD=1500, KI=0

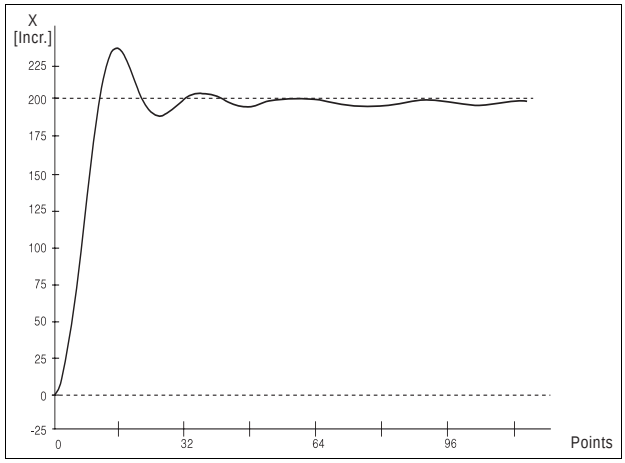


Fig. 2-29 KD component KD = 5 x KP

Fig. 2-30 shows the optimum KD value. The drive quickly reaches the setpoint (positioning time = 15 ms) and stays there without further overshooting.

Setting values:
KP=300, KD=2000, KI=0

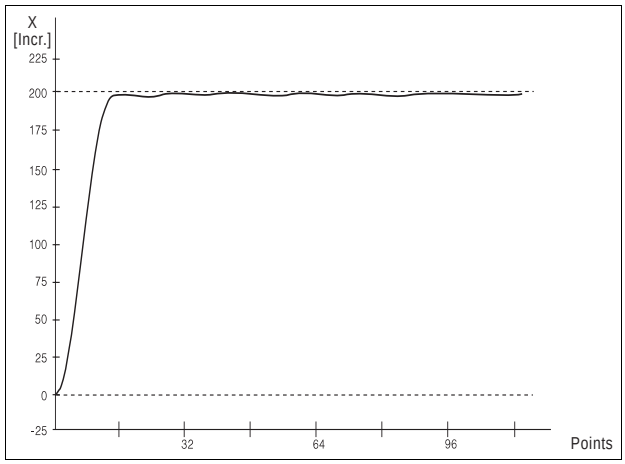


Fig. 2-30 KD component KD = 6.6 x KP

If "KP" and "KD" have been optimized, an integral component is added.
Fig. 2-31 clearly shows that the positioning process is much slower than without KI component, that is the slower it is, the smaller the KI component.
With KI component, the positioning time may be 10 times higher. Overshooting response is also recognizable. I.e. the drive overshoots the setpoint and gradually reapproaches the setpoint.

Setting values:
KP=300, KD=2000, KI=6

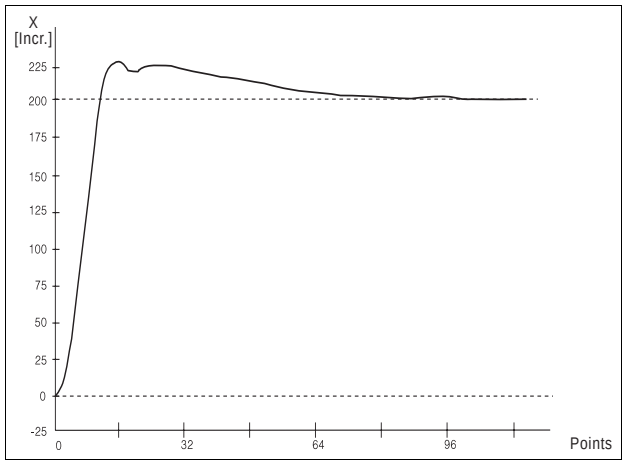


Fig. 2-31 KP and KD component optimized and KI = 6

The selected I component in fig. 2-32 is too high.
The formula KI = KP/50 is not observed.
The motor overshoots the target. In addition, there is a risk of ever increasing continuous oscillation.

Setting values:
KP=300, KD=2000, KI=12

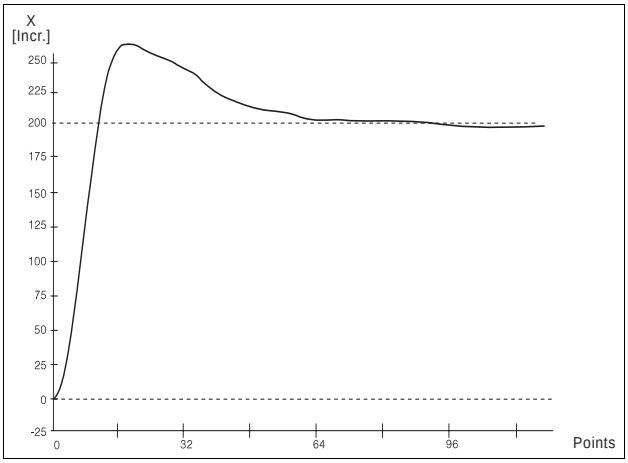


Fig. 2-32 KP and KD component optimized and KI = 12

The position controller is operated with the settings as per fig. 2-33 as it has the lowest positioning time and no overshooting occurs.

Setting values:
KP=300, KD=2000, KI=0

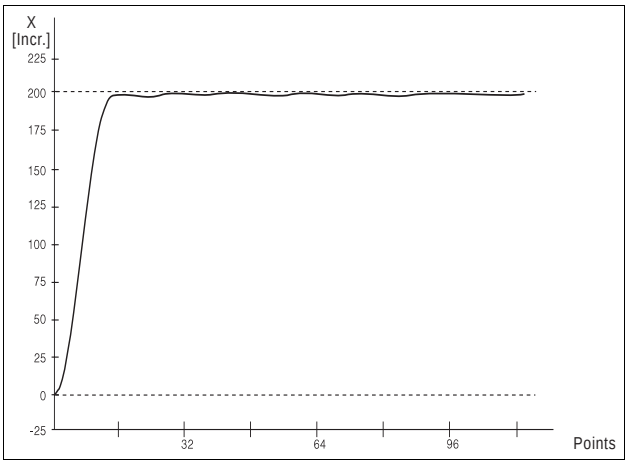


Fig. 2-33 KD component KD = 6.6 x KP

2.6.3 Further settings

Controller mode "MR"

With the command "MR" the current controller or load angle controller mode can be selected.

MR=0: Current controller
The current controller ensures optimum synchronism and maximum running smoothness. The degree of rigidity which is obtainable is not as high as with the load angle controller.

MR=1: Load angle controller
With the load angle controller, a considerably higher proportional gain as with the current controller is achieved, as a result of which the rigidity is considerably increased. The load angle controller is preferably employed in fast short-distance positioning, where running smoothness plays a less important role.

NOTE
Extremely high KP values (KP>1000) can usually only be achieved if the sampling time (TA=500) is reduced simultaneously.

NOTE
When switching over from 1 controller mode to the other, the controller parameters ("TA", "KP", "KD", "KI") must be recalibrated subsequently. It is very useful to save the optimized parameters of the different controller modes in a parameter set with the command "SV".

Electronic commutation and locking "AR"

If the motor is in the actual position, the command "AR" can be used to interrupt automatic commutation of the rotating field. The regulated stepping motor remains absolutely rigid in the actual position. In locking state, the programmed quiescent current "RS" is applied to the motor.

The command "AR" is used to determine whether locking is necessary or for how long the motor must remain within the specified frame until locking takes effect and the commutator switches from regulated operation to the locking state.

The command "AR" can be programmed:

AR=0:
Locking disabled (factory setting)

AR=1 to 32767 ms:
Period of time in which the motor has to remain within the frame until locking takes effect.

It must be noted that the frame depends on the shaft encoder employed. The frame has 8 increments for a shaft encoder with 1000 marks, 4 increments for a shaft encoder with 500 marks.

NOTE
Due to the fixed locking position typical of the stepping motor, a positional variation of up to 5 increments for a shaft encoder with 1000 marks or 3 increments for a shaft encoder with 500 marks is possible.

If AR>0, switching from the regulated to the locked state is always effected automatically if the locking conditions are fulfilled.

Switching from the locked to the regulated state is effected without delay, if either the current reference position changes or the motor is rotated out of the frame by external influence (external load moment).

NOTE
When locked, the quiescent current preprogrammed with "RS" is applied to the motor.

ATTENTION
The controller parameters "KP", "KD", "KI" and "TA" may only be modified when unlocked. This means, AR=0 must be set before optimizing the controller parameters. If desired, locking may be enabled after optimizing.

Maximum motor speed

The maximum desired motor speed is set to

$$n_{max} = 5850\ min^{-1}$$

This value represents the absolute top limit irrespective of the motor, shaft encoder resolution or power drive and applies to all sub-modes.

The maximum motor frequency depends on the shaft encoder resolution:

195 kHz for a shaft encoder with 500 marks
390 kHz for a shaft encoder with 1000 marks

ATTENTION
Higher frequencies must not be programmed in sub-modes "Point-to-point" and "Frequency characteristics". The maximum motor movement frequency must not be exceeded after calculating the transmission in sub-mode "Electronic gear".

Quiescent current "RS"

Quiescent current is supplied to the motor if the position controller is inactive or the motor is locked.

This is the case,

1. while starting up, until a sub-mode is activated,
2. when locked, if the locking conditions are fulfilled,
3. when fatal errors occur (following error, commutator error, etc.).

The quiescent current is stated in percent of the maximum current $I_{max.}$ set at the power drive.

The quiescent current can be programmed in a range from 0 to 100% (factory setting is 50%).

NOTE
The quiescent current must never exceed the nominal current of the employed motor. As the quiescent current determines the maximum torque when locked (holding torque), the selected values should not be too low. Recommended value is 50%.

Example:

Nominal motor current:
I_{nom} = 2.4 A
Set at the power drive:
$I_{max.}$ = 2.5 A
Set RS=50%.

→ A quiescent current of 1.25 A is now applied, i.e. when locked, a holding torque of 1.25 A/2.4 A x $M_{max.}$ corresponding to 52% of the nominal motor torque.

Following error limit "XL"

The "XL" command is used to program the following error limit (set position - actual position) in a range from 0 to 4000 increments (factory setting 1000). If the specified following error limit is exceeded, LED 41 (output FOLLOW.F. is active) lights up. It goes out, if the following error falls below the specified value.

The parameters and displays serve to optimize the acceleration values. It can be determined whether an excessive following error occurs while positioning and the drive is overloaded. Temporary overloading is permissible.

Following error

The following error monitoring feature is used to detect an excessive following error.

The following error limit is:

2000 increments for a shaft encoder with 500 marks
4000 increments for a shaft encoder with 1000 marks

If the following error exceeds the specified limit, controller operation is stopped, electronic commutation interrupted and the motor locked. This holds true for all operating states irespective of the current motor speed.

LED 41 (output FOLLOW.F. is active) and LED 42 (output FAULT/CL is active) as well as status display "0" of the processor unit light up.

A following error represents a fatal error. It is necessary to restart the system.

ATTENTION
The drive must be dimensioned and the acceleration values selected in such a way that the follow-ing error limit is not exceeded under any circumstances - not even temporarily - , as this causes immediate interruption of the movement.

Positioning window "PW"

The command "PW" is used to program the positioning window in a range from 1 to 4000 increments (factory setting 10 for a shaft encoder with 500 and 1000 marks).
If the motor is within a positioning window for at least 2 x TA at the end of positioning, LED 44 (output INPOS is active) lights up. In this position, the deviation must not exceed the specified PW value. LED 44 (output INPOS is active) also lights up if the motor is moved out of the specified positioning window by subsequent loading moments.

NOTE
In sub-mode "Point-to-point", the positioning window serves as a criteria for a terminated positioning process. Subsequent jobs will not be executed before LED 44 (output INPOS is active) lights up. It is necessary to select a sufficiently large positioning window to make sure that the motor safely reaches the positioning window without causing program interruption, even in case of external load or friction moments.

Integral component "IS"

The command "IS" is used to program the automatic I component in the range from 0 to 32767 (factory setting = 1).
The automatic I component only takes effect at standstill. Thus, the motor is operated during the movement using the good dynamic characteristics of a sheer PD position controller. The advantage of an additional I component is used ar standstill.

3 Operation

3.1 Operating possibilities

The possibilities of operating the WDP5-228 depend on the operating mode selector switch (47) position and input signal AUTOM:

NOTE
The unit only recognizes the operating mode selector switch position after switching the supply voltage on.

Operating mode selector switch position	Operating mode	Input signal AUTOM*	Operating possibility	Reference
0	No function			
1	No function			
2	Serial mode at 1200 bauds	0	Manual movement (fast, slow, transfer reference dimension)	see chapter 3.3.1
			Limited operation via terminal or PC	see chapter 3.3.1.5
3	Serial mode at 9600 bauds	1	Automatic run with operation via terminal or PC - Sub-mode "Point-to-point" - Sub-mode "Frequency characteristics" - Sub-mode "Electronic gear"	see chapter 3.3.2 and 3.3.3
4	No function			
5	No function			
6	Network mode at 9600 bauds	0	Manual movement (fast, slow, reference movement, set reference point)	see chapter 3.4
			Teach-in (in network mode "Memory")	see chapter 3.4.2
			Limited operation via PC with PRO-SDP/PC1 software	see chapter 3.4
7	Network mode at 38.4 kbauds	1	Automatic run ("Memory", "Serial" and "A-/R-Parallel") with operation via terminal or PC - Sub-mode "Point-to-point" - Sub-mode "Frequency characteristics" (only "Memory" and "Serial") - Sub-mode "Electronic gear" (only "Memory" and "Serial")	see chapter 3.4
8	No function			
9	Serial polling mode at 9600 bauds	0	Manual movement (fast, slow, transfer reference dimension)	see chapter 3.5.1
			Limited operation via terminal or PC	see chapter 3.5.1.5
		1	Automatic run with operation via terminal or PC - Sub-mode "Point-to-point" - Sub-mode "Frequency characteristics" - Sub-mode "Electronic gear"	see chapters 3.5.2 and 3.5.3
A - F	No function			

* 0 = input inactive 1 = input active

3.2 Starting up

ATTENTION
The set supply voltage for the power drive must correspond with the stipulated supply voltage (see type plate).

ATTENTION
Do not touch live parts of the unit or system and avoid contact with electrically conductive objects.

ATTENTION
While positioning, no persons or objects must linger in the moving range of the system.

ATTENTION
The unit must be grounded with a protective conductor.

ATTENTION
The basic settings of the unit must meet the requirements, see chapter 2.5.

The following conditions must be fulfilled before switching on the unit:

Condition	**Reference**
Do the environmental conditions correspond with the technical data?	see chapter 1.4
Is there sufficient space for air supply and discharge?	see chapter 1.4
Has the unit been cabled correctly?	see chapter 2.4
Has the desired operating mode been set at the selector switch?	see chapter 2.5.1
Has the motor phase current been adjusted correctly?	see chapter 2.5.1
Have the desired PID position controller parameters been set?	see chapter 2.6

NOTE
The desired operating mode must have been set when switching on (see chapter 2.5.1). Modification of an operating mode is only recognized on switching the unit on again.

1. Switch on the supply voltage for the power drive (115 or 230 VAC).

2. Switch on the supply voltage for the processor unit (24 VDC).

3. The unit is "ready", if the point of the seven-segment display for the power drive (item 02) and for the processor unit (item 40) lights up.

NOTE
After switching on, the parameters "L", "F", "KP", "KI", "KD", "XL" and "PW" of parameter set 0 are accepted as current parameters.

3.2.1 Starting or activating the position controller

After switching on the unit (feeding the 24V supply voltage), the processor unit is initialized and the regulated stepping motor is operated with the set quiescent current ("RS" command). The electronic commutator and the step angle switching are still disabled. The commutator and the position controller are activated by one of the following actions:

– Triggering a manual movement or a manual reference movement

– Activating the input AUTOM in "Serial mode" or in the network operating modes (except "Install").

NOTE
The electronic commutator and the position controller are only initialized when performing these actions for the first time. The first movement command can be executed after the initialization time of approx. 1.5 sec.

ATTENTION
When initializing or activating the commutator and the position controller, take care that **no alternating load torques** affect the motor within the total time (1.5 sec.).
Further, the total of all external torques acting upon the motor (static loads or friction moments e.g. caused by brake or similar factors) **must not exceed** 25% of the torque to be generated by the motor.

3.2.2 Operation with brake

The operation with brake is described below.
The brake must **never** be applied when the position controller is activated.
In case of a minimum deviation from set speed, the motor would generate its full torque which acts against the brake.

ATTENTION
This leads to motor and power drive overheating within a short time.

The timing diagrams are evident in fig. 3-1.

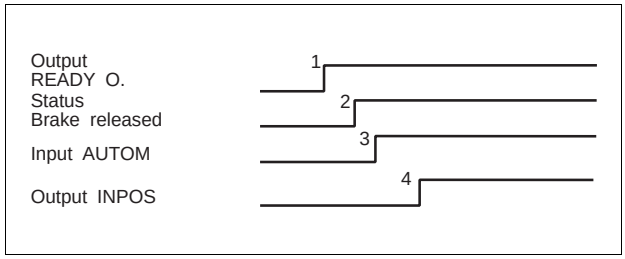


Fig. 3-1 System starting with brake

1. After feeding the 24 V supply voltage and internal system starting, the controller signals the readiness of the system after approx. 4 sec. The brake can be released with this signal.

2. When the brake-specific opening times (**approx. 40 ms**) have passed, the brake is released and the stepping motor controlled with the set quiescent current.

3. The position controller is activated by activating the input AUTOM or a manual movement.

4. If the input AUTOM is connected, the successful **activation of the position controller** is indicated via the output INPOS. The unit is activated and ready to execute movement commands.

3.3 Serial mode

In this operating mode, the individual jobs and commands are directly transferred to the WDP5-228 via the serial interface and initiated. The instructions are transferred to the positioning unit in ASCII format 7 bits, even parity bit and one stop bit. The transmission speed is 1200 or 9600 bauds.

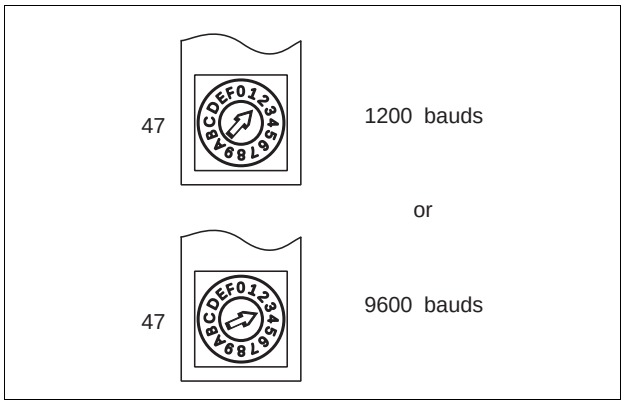


Fig. 3-2 Operating mode selector switch

The following operating possibilities are available in serial mode:

Manual movement

- Slow manual movement
  The regulated stepping motor rotates at "Manual frequency slow" which can be modified as a parameter. The parameter value is adjustable, factory setting 1 kHz.

- Fast manual movement
  The regulated stepping motor rotates at "Manual frequency fast" which may be modified as a parameter. The parameter value is adjustable, factory setting 4 kHz.

- Manual reference movement
  The regulated stepping motor rotates at a frequency of 8 kHz until the desired limit or reference switch is detected.

  On detecting the selected limit switch and braking, the stepping motor leaves the limit or reference switch at a frequency of 500 Hz and stops. This position serves as the reference point for the system of dimensions.

- Setting the manual reference point
  The reference position (factory setting 0) which may be modified as a parameter, is accepted as the new reference value for the system of dimensions by activating two inputs. A reference movement is not required.

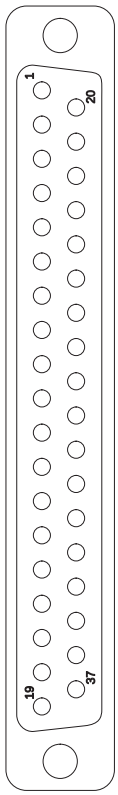
Automatic run

- Operation via terminal or PC
  at a transmission speed of 1200 bauds or 9600 bauds

The following sub-modes are available:

- Point-to-point MD = 0
- Frequency characteristics MD = 1
- Electronic gear MD = 2.

Control signals in serial mode



Pin	Abbreviation	Meaning	
1	$\overline{\text{LIM.X-}}$	Negative limit switch	←
2	-	-	
3	-	-	
4	-	-	
5	LOAD	Store position	←
6	$\overline{\text{ADD.REF.}}$	Additional reference switch	←
7	MAN.X-	Manual movement, CCW rotation	←
8	MAN.L/H	Slow/fast manual movement	←
9	-	-	
10	-	-	
11	-	-	
12	-	-	
13	FOLLOW.F.	Following error limit	→
14	FAULT/CL	Error	→
15	READY O.	Ready for operation	→
16	24VDC	System supply voltage	←
17	24VDC	System supply voltage	←
18	IO24VDC	I/O supply voltage	←
19	IO24VDC	I/O supply voltage	←
20	$\overline{\text{LIM.X+}}$	Positive limit switch	←
21	-	-	
22	-	-	
23	$\overline{\text{STOP}}$	Stop	←
24	-	-	
25	AUTOM	Automatic operation	←
26	MAN.X+	Manual movement, CW rotation	←
27	MAN.REF.	Manual reference movement	←
28	-	-	
29	-	-	
30	-	-	
31	-	-	
32	TEMP.OK	Temperature o.k.	→
33	INPOS	Position reached	→
34	-	-	
35	24VGND	System supply voltage ground	←
36	24VGND	System supply voltage ground	←
37	IOGND	I/O supply voltage ground	←

$\overline{\text{active-low signal}}$ ← input → output

3.3.1 Manual movement

NOTE
Position control is activated by triggering a manual action (e.g. set dimensions or manual movement). Any locks which are in effect are cancelled.

3.3.1.1 Slow manual movement

1. Deactivate input AUTOM.

2. Select the sense of rotation:
   – For positive sense of rotation in clockwise direction viewed to motor shaft: activate input MAN.X+.
   – For negative sense of rotation in counterclockwise direction viewed to motor shaft: activate input MAN.X-.

   → The motor rotates at "Manual frequency slow" in the selected direction, as long as input MAN.X+ or MAN.X- is active and the limit switch is not reached or $\overline{\text{STOP}}$ activated.

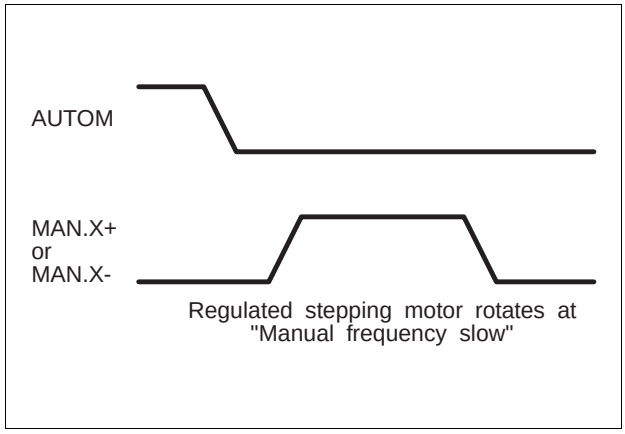


Fig. 3-3 Slow manual movement

NOTE
If input MAN.X+ or MAN.X- is activated only for a short time (<0.5 s), the motor performs a step.

NOTE
The motor accelerates/decelerates with the ramp gradient stored in parameter set 0 during manual movement.

NOTE
The parameter "Manual frequency slow" is adjustable, factory setting 1 kHz.

3.3.1.2 Fast manual movement

1. Deactivate input AUTOM.

2. Select the sense of rotation:
   – For positive sense of rotation in clockwise direction viewed to motor shaft:
   activate input MAN.X+ and MAN.L/H simultaneously (longer than settling time t_E).
   – For negative sense of rotation in counterclockwise direction viewed to motor shaft:
   activate input MAN.X- and MAN.L/H.

   → The motor rotates at "Manual frequency fast" in the desired direction, as long as the inputs MAN.X+ or MAN.X- and MAN.L/H are active.

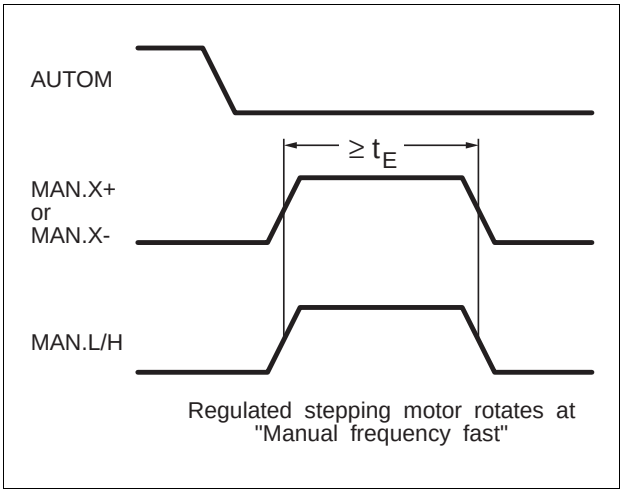


Fig. 3-4 Fast manual movement

NOTE
The motor accelerates/decelerates with the ramp gradient stored in parameter set 0 during manual movement.

NOTE
The parameter "Manual frequency fast" is adjustable, factory setting 4 kHz.

3.3.1.3 Manual reference movement

NOTE
Reference movement principle see chapter 6.3.

1. Deactivate input AUTOM.

2. For performing a movement towards the limit switch in clockwise direction:
activate inputs MAN.X+ and MAN.REF simultaneously (longer than settling time t_E).

3. For performing a movement towards the limit switch in counterclockwise direction:
activate inputs MAN.X- and MAN.REF simultaneously (longer than settling time t_E).

4. For performing a movement towards the additional reference switch:
activate inputs MAN.L/H and MAN.REF simultaneously (longer than settling time t_E).

   → The motor keeps rotating at a frequency of 8 kHz in the selected direction until the limit switch or additional reference switch is detected. It then leaves the limit switch at a frequency of 500 Hz and stops. This position serves as the reference point for the system of dimensions.

NOTE
A reference movement may be interrupted by activating input $\overline{\text{STOP}}$.

NOTE
The motor accelerates/decelerates with the ramp gradient stored in parameter set 0 during manual movement.

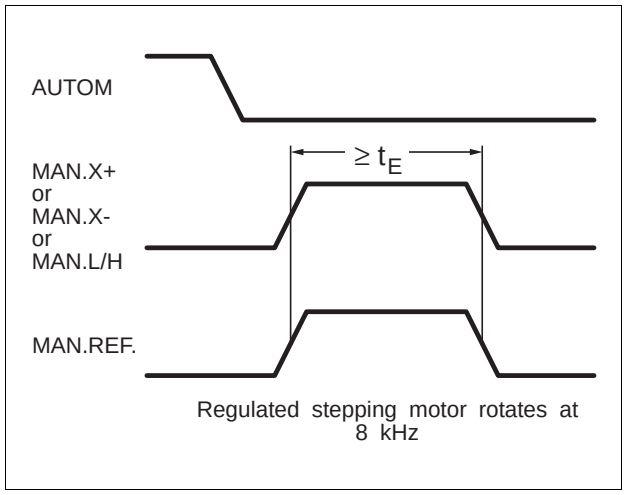


Fig. 3-5 Manual reference movement

3.3.1.4 Setting manual reference point

1. Deactivate input AUTOM.
2. Activate inputs MAN.REF and LOAD simultaneously (longer than settling time t_E).

   → The value of the "reference position" serves as the new reference value for the system of dimensions.

NOTE
The motor accelerates/decelerates with the ramp gradient stored in parameter set 0 during manual movement.

NOTE
The parameter "reference position" is adjustable, factory setting 0.

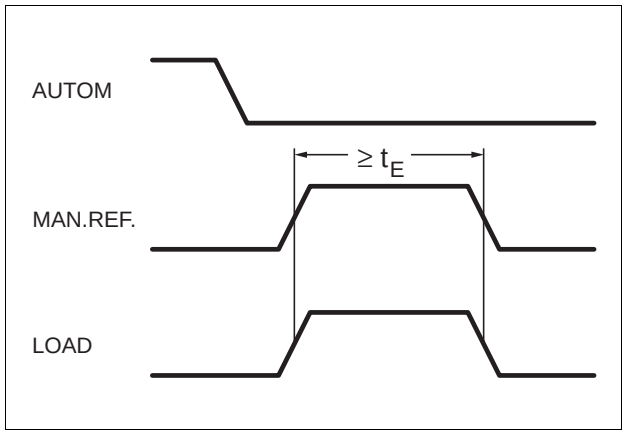


Fig. 3-6 Setting manual reference point

3.3.1.5 Manual movement (limited with PC)

Operation is effected with the commands and all additional characters listed in chapter 3.3.3.

3.3.2 Automatic run

1. Switch off supply voltage for processor unit.

2. Set operating mode selector switch (47) to "2" for a transmission speed of 1200 bauds or to "3" for 9600 bauds.

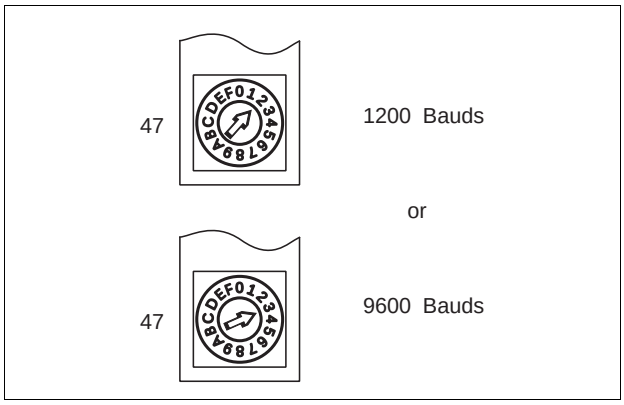


Fig. 3-7 Operating mode selector switch

3. Connect terminal or PC to serial interface.

4. Switch on supply voltage for processor unit.
   → LED 43 lights up, output READY O. is active.

NOTE
After switching the processor unit on, readiness of the power drive is expected within a period of 15 sec. or checked.

5. Activate input AUTOM.
   → LED 44 lights up, output INPOS is active.

NOTE
Position control is immediately active.

6. Positioning jobs are transferred and initiated with the aid of commands and orders. Parameters can be modified.

7. Further operation is described in chapter 3.3.3.

NOTE
Examples of calculation and acknowledgements of all sub-modes are listed in the appendix, see chapters 6.4 and 6.5.

3.3.3 Operation with terminal or PC

Commands are instructions to the unit-internal operating system. They are immediately executed without special acknowledgement.

The transmission protocols are called up with the aid of commands and transferred to the WDP5-228. The transmission protocols will be described in more details on the following pages.

Commands are divided into action commands (A), setting commands (S), mixed commands (M), direct commands (D) and init values (I).

A command group consists of an action and a setting command. The action command triggers an action after the start command (e.g. positioning).

Command	Meaning	Range	Factory setting
M90[1)]	Activate transmission protocol 0		
M92[1)]	Activate transmission protocol 1		
M93[1)]	Position acknowledgement in sub-mode "Point-to-point"		
M22[1)]	Activate transmission protocol 2		
STO[2)]	Save RAM content in EEPROM		
SI[1)]	System information	0 to 16	
P[1)]	Output position in sub-mode "Point-to-point"		
FS[1)]	Deliver fatal error message in clear text		
S[1)]	Issue status or error message		
M99	Stops the movements in sub-modes - Point-to-point - Frequency characteristics		
E	Start or execute command		
SR1)	Software reset		

1) Also possible during manual movement

2) only possible for device variant with EEPROM (WDP5-228.0X1-01)

Command	Type	Meaning	Range	Factory setting
MD=	A	Activate sub-mode	0 = Point-to-point 1 = Frequency character. 2 = Electronic gear	0
X=	A	Setpoint to be approached, travel	± 8300000	0
G25	A	Reference movement towards negative limit switch		
G26	A	Reference movement towards positive limit switch		
G27	A	Reference movement towards additional reference switch		
G28=	E	Enter reference position	± 8300000	0
G29	A	Set reference point		
G90	E	Set system of absolute dimensions		
G91	E	Set system of incremental dimensions		
L=[1)]	E	Ramp gradient in sub-mode - point-to-point - frequency characteristics	8 to 32767 Hz/ms	100 Hz/ms
F=[1)]	E	Should-be frequency in sub-mode point-to-point	8 to 195000 Hz[2)] 8 to 390000 Hz[3)]	4000 Hz
VY=	A	Should-be frequency in sub-mode frequency characteristics	± 195000 Hz[2)] ± 390000 Hz[3)]	0 Hz
EZ=	A	Gear ratio "Numerator" in sub-mode "Electronic gear"	± 30000[5)]	0
EN=	M	Gear ratio "Denominator" in sub-mode "Electronic gear"	1 to 30000	1
SV	M	Save parameter set	0 to 3	0

Command	Type	Meaning	Range	Factory setting
RD=	M	Read parameter set	0 to 3	0
KP[1)4)]	M	Proportional component for position controller	0 to 32767	200
KI[1)4)]	M	Integral component for position controller	0 to 32767	0
KD[1)4)]	M	Differential component for position controller	0 to 32767	1400
XL=[1)4)]	M	Following error for position controller	0 to 4000 increments	1000 incr.
PW=[1)4)]	M	Position window	1 to 4000 increments	10 incr.
M96=	D	Manual frequency slow	8 to 195000 Hz[2)] 8 to 390000 Hz[3)]	1000 Hz
M97=	D	Manual frequency fast	8 to 195000 Hz[2)] 8 to 390000 Hz[3)]	4000 Hz
GZ=	D	Gear ratio "Numerator" in sub-mode "Point-to-point"	± 1 to ± 30000[5)]	1
GN=	D	Gear ratio "Denominator" in sub-mode "Point-to-point"	1 to 30000	1
M95=	D	Gear ratio "Decimal" in sub-mode "Point-to-point"	0.1 to 100.0	1.0
PA=[4)]	I	Phase advance	5 to 100 kHz	35 kHz
DA=[4)]	I	Shaft encoder resolution	500 or 1000 marks	1000
MR=[4)]	I	Controller mode	0 = Current controller 1 = Load angle controller	0
GI=[4)]	I	Gear interface in sub-mode "Electronic gear"	0 = $Pulse_{forw}$/$pulse_{backw}$ signals 1 = Pulse/direction signals 2 = A/B signals	2
RS=[4)]	I	Quiescent current	0 to 100%	50%
AR=[4)]	I	Locking	0 to 65535 ms	0 ms
TA=[4)]	I	Controller sampling time	500, 1000, 2000 µs	1000 µs
IS=	I	Automatic integral component	0 to 32767	1

1) These commands can be saved with "SV" or read with "RD"
2) Shaft encoder with 500 marks
3) Shaft encoder with 1000 marks
4) Also possible during manual movement
5) Negative gear ratio numerator means direction reversal, the limit switlches must be interchanged.

The letters A, S, M, D and I in 2nd column "Type" have the following meaning:

A = Action command

Action command A is an action-triggering command, e.g. starting a positioning process or activating a new gear ratio in sub-mode "Electronic gear". The start command "E" respectively is required for triggering the action.

S = Setting command

The setting command only takes effect in combination with an action command, e.g. the ramp gradient only takes effect in combination with a movement command.

M = Mixed command

Basically, these can also be referred to as setting commands, however, with the difference, that activation by the start command "E" is also possible without transferring an additional action command.

D = Direct command

Commands are activated without special acknowledgement immediately after being transferred.

I = Init value

They have the same effects as mixed commands, however, these instructions include values for initializing the processor unit.

NOTE
If an action command is preceded by several setting commands for saving, loading and modifying parameters, the following internal processing sequence must be taken into consideration:

1. Saving a parameter set "SV=".
2. Reading a parameter set "RD=".
3. Modifying individual parameters e.g. "KP=".
4. Action command, e.g. "X=".

Example:

1. SV = 0 (Save parameter set)
2. KP = 256 (modify parameter)
3. L = 500 (modify parameter)
4. X = 1000 (action command)

Data record structure:

Instructions consist of commands, orders and parameters together with additional characters. Instructions are transmitted from the terminal or PC to the positioning unit.
The data record always starts with a colon at the line beginning and ends with <CR>:

```
:Instruction 1 ... Instruction n<CR>
```

Several instructions can be transmitted in one line, with a maximum of 80 characters per line.
<BLANK>, <TAB> or comma may be used as separators between the instructions. An equal sign may be used between the instruction and the value in an instruction with data transfer.
There may only be one action command in a data record.

NOTE
If an order is entered several times in one line, it is overwritten. No error message will be issued. This allows e.g. correcting a faulty input by entering a new value once again.

Additional character	**Meaning**
:	Beginning of data record
<CR>	End of data record
<LF>	Line feed
,	Separator between instructions
=	Separator between instructions and the appropriate value
<BLANK>	Separator between instruction components
<TAB>	Separator between instruction components
<DEL>	Deletes the last entered character of a record; the deleted character is output.
<BS>	Deletes the last entered character of a record; the deleted character is not output.
<CTRL>X	Deletes the entire record; it must be entered before <CR>.
<Break>	Any positioning process is immediately interrupted. The reference point must then be redefined.

Programming examples:

```
:G28=2000, G29,E<CR>
:X=1000, E<CR>
```

or

```
:G28=2000<CR>
:G29<CR>
:E<CR>
```

Transmission protocol 0

Transmission protocol 0 is active on switching the unit on or called up with the "M90" command.

NOTE
After entering an incorrect instruction, transmission protocol 0 responds with the negative acknowledgement "(EXXX)<CR><LF>". Input of an order is followed by the acknowledgement "X<CR><LF>" or "(EXXX)<CR><LF>".

Input	Display	Comment
	Version 00.16<CR><LF>	Initializing after switching on
:G28=0 G29 E<CR>	- X<CR><LF>	Enter reference position and set reference point
:G91 F=1000<CR>	-	Incremental dimensions/movement frequency
:X1000<CR>	-	Prepare positioning job
:E<CR>	- - X<CR><LF>	Start positioning job Motor performs positioning Positioning terminated
:F2000X2000 E<CR>	- X<CR><LF>	Prepare new job and start Positioning terminated
:X100000 E<CR> :M99	- - - (E␣␣6)<CR><LF> X<CR><LF>	Prepare new job and start Motor performs positioning Movement is interrupted by $\overline{\text{STOP}}$; Motor stops Motor stands still
:E	- X<CR><LF>	Continue interrupted movement Interrupted movement terminated
:P<CR>	- <X␣␣␣65487><CR><LF>	Check current position
:S<CR>	- (E␣␣6)<CR><LF>	Query status/error number
:FS<CR>	- ff␣Kein␣fat␣F <CR><LF>	Fatal error message, if there was no status = E 81 before
:M93<CR>	- - -	Initialization on position acknowledgement at the end of the movement
:G28=1234 G29 E<CR>	- <X␣␣␣␣1234><CR><LF>	Enter reference position and set reference point = 1234
:X1000 E<CR>	- <X␣␣␣␣1000><CR><LF>	Position acknowledgement at the end of the movement
:G91 X2000 E<CR>	- <X␣␣␣␣3000><CR><LF>	Incremental dimension Positioning terminated
:E<CR>	- <X␣␣␣␣5000><CR><LF>	Start movement Positioning terminated

Transmission protocol 1

Transmission protocol 1 is called up with the "M92" command.
It is used if the unit is operated via a terminal or from the host via a terminal program.
The main difference from transmission protocol 0 consists in the fact that every character transmitted from the host to the WDP5-228 is immediately sent back from the WDP5-228 to the host (echo mode).

Input	**Display**	**Comment**
	`Version 00.16<CR><LF>`	Initializing after switching on
`:M92<CR>`	`-`	Activate echo mode
`:P<CR>`	`:P<CR><LF>` `<X␣-------><CR><LF>`	Check position Undefined position (no reference)
`:S<CR>`	`:S<CR><LF>` `(E␣99)<CR><LF>`	Status test Status AUTOM
`:FS<CR>`	`:FS<CR><LF>` `ff␣Kein␣fat␣F <CR><LF>`	Check error status

Transmission protocol 2

Transmission protocol 2 is called up with the "M22" command. The unit only responds if it is prompted by the host. The host immediately receives a positive acknowledgement (A<LF><CR>) or a negative acknowledgement (N<LF><CR>) for every instruction transferred which only indicates whether the input was accepted as a valid command.

Data may then follow depending on the job.

NOTE
As the unit cannot issue an acknowledgement itself at the end of a movement, the system state must be polled at intervals.

Input	Display	Comment
	Version 00.16<CR><LF>	Initializing after switching on
:M22<CR>	- A<CR><LF>	Activate transmission protocol 2 A = positive acknowledgement
:G91 G28=0 G29 E<CR>	- A<CR><LF>	System of incremental dimensions, enter reference position and set reference point; positive acknowledgement without data
:P<CR>	- A<CR><LF> <X␣0><CR><LF>	Position Positive acknowledgement without data Position feedback
:Y<CR>	- N<CR><LF>	Inadmissible order; Negative acknowledgement
:S<CR>	- A<CR><LF> (E␣74)<CR><LF>	Query status/error number Positive acknowledgement Error number
:F1000 X100000 E<CR>	- A<CR><LF>	Prepare new job and start
:P<CR>	- A<CR><LF> <X␣␣␣5234><CR><LF>	Motor is positioning Positive acknowledgement Current position on rising edge
:S<CR> :M99	- A<CR><LF>(E␣99)<CR><LF> -	No error Status "Automatic mode active" Manual stop
:S<CR>	- A<CR><LF>(E␣␣6)<CR><LF>	Status test – Message "Positioning interrupted by $\overline{\text{STOP}}$"
:P<CR>	- A<CR><LF><X␣6711><CR><LF>	Motor stops Current position on falling edge
:FS<CR>	- A<CR><LF>ff␣Kein␣fat␣F ␣␣␣<CR><LF>	Check for fatal error
:P<CR>	- A<CR><LF> <X␣␣␣7711><CR><LF>	Motor stops Positive acknowledgement Current motor position
:E<CR>	- A<CR><LF> <X␣␣␣10000><CR><LF>	Start interrupted movement Positive acknowledgement Setpoint reached
:SI5<CR>	- A<CR><LF> 05XW␣␣␣10000 ␣␣␣␣XI␣␣␣9995<CR><LF>	System information via XW/XI Positive acknowledgement Current setpoint Current actual position

The following feedback formats are possible amongst others:

NOTE
The same number of characters is always output. The gaps are filled up with blanks "␣".

Version␣00.16<CR><LF>	After switching on
X<CR><LF>	Action command executed
A<CR><LF> or N<CR><LF>	Transmission protocol 2 active
<X␣␣␣␣␣␣␣0><CR><LF>	Position check or "M93" active
<X␣␣␣10000><CR><LF>	
<X␣␣␣10000><CR><LF>	
<X␣-------><CR><LF>	System has no reference
(E␣␣6)<CR><LF>	Status/error number
(E␣74)<CR><LF>	
(E103)<CR><LF>	
ff␣kein␣fataler␣Fehler<CR><LF>	Fatal error in clear text
07␣Positive␣Grenze␣erreicht<CR><LF>	
1d-keine-Programmnummer	
01␣V1␣␣␣␣␣00.18␣␣␣␣␣V2␣␣␣␣␣00.16<CR><LF>	Explanation see adjacent table
02␣ST1␣00001000␣␣␣␣␣ST2␣01000101<CR><LF>	
03␣IN1␣11111110␣␣␣␣␣IN2␣01111111<CR><LF>	Feedback format command "SI": The characters are fed back in ASCII code. The feedback format has been defined in such a way that the data can simply be evaluated also by using a high-level language (e.g. with sscanf in C).
04␣OUT␣00001000␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣<CR><LF>	
05␣XW␣␣␣␣␣␣␣␣0␣␣␣␣␣XI␣␣␣␣␣␣␣␣-5<CR><LF>	
06␣VY␣␣␣␣␣␣␣␣0␣␣␣␣␣XD␣␣␣␣␣␣␣␣5<CR><LF>	
07␣F␣␣␣␣␣␣4000␣␣␣␣␣L␣␣␣␣␣␣␣100<CR><LF>	
08␣DA␣␣␣␣␣␣1000␣␣␣␣␣PA␣␣␣␣␣␣␣35<CR><LF>	
09␣GI␣␣␣␣␣␣␣␣2␣␣␣␣␣RS␣␣␣␣␣␣␣50<CR><LF>	
10␣AR␣␣␣␣␣␣␣␣0␣␣␣␣␣MR␣␣␣␣␣␣␣␣0<CR><LF>	
11␣GZ␣␣␣␣␣␣␣␣1␣␣␣␣␣GN␣␣␣␣␣␣␣␣1<CR><LF>	
12␣EZ␣␣␣␣␣␣␣␣0␣␣␣␣␣EN␣␣␣␣␣␣␣␣1<CR><LF>	
13␣TA␣␣␣␣␣␣1000␣␣␣␣␣KP␣␣␣␣␣␣␣256<CR><LF>	
14␣KI␣␣␣␣␣␣␣␣0␣␣␣␣␣KD␣␣␣␣␣␣␣2000<CR><LF>	
15␣XL␣␣␣␣␣␣␣1000␣␣␣␣␣PW␣␣␣␣␣␣␣␣10<CR><LF>	
16␣IS␣␣␣␣␣␣␣␣␣1␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣<CR><LF>	

```
          1         2         3
01234567890123456789012345678901
NN␣TTT␣VWWWWWWWW␣␣␣␣␣TTT␣VWWWWWWWW
```

N=Line no.
T=Text
V=Preceding sign

Every line is terminated with <CR><LF>.

NOTE
All the system information from line 01 to 16 is indicated with the command SI = 0.

System information "SI"

Line	Meaning	
01	V1: Software version processor section	V2: Software version controller section
02	ST1: System status byte 1 Bit Current sub-mode 0 to 3: 0000 Point-to-point 0001 Frequency characteristics 0010 Electronic gear	ST2: System status byte 2 Bit 0 Controller mode: 0 = inactive; 1 = active Bit 1 Reference point: 0 = not available; 1 = available Bit 2 Current dimension: 0 = incremental; 1 = absolute Bit 3 last positioning interrupted: 0 = uninterrupted; 1 = interrupted
	Bit 4 sub-mode active: 0 = manual movement; 1 = automatic run	Bit 4 not used
	Bit 5 not used	Bit 5 Motor or heat sink temperature: 0 = temp. too high; 1 = temp. o.k.
	Bit 6 not used	Bit 6 Battery status: 0 = flat; 1 = o.k.
	Bit 7 not used	Bit 7 EEPROM option: 0 = not provided; 1 = provided
03	IN1: Input states 1 NOTE State: 0 = input 0 V 1 = input 24 V Bit 0 Stop Bit 1 Automatic run Bit 2 Start Bit 3 Program start Bit 4 Program no. 2^0 Bit 5 Program no. 2^1 Bit 6 Program no. 2^2 Bit 7 Program no. 2^3	IN2: Input states 2 NOTE Status: 0 = input 0 V 1 = input 24 V Bit 0 Manual clockwise rotation Bit 1 Manual counterclockwise rotation Bit 2 Fast manual movement Bit 3 Manual reference movement Bit 4 Store Bit 5 Additional reference switch Bit 6 Positive limit switch Bit 7 Negative limit switch
04	OUT: Output states NOTE State: 0 = output 0 V 1 = output 24 V Bit 0 Ready Bit 1 Position reached Bit 2 Program end Bit 3 Error Bit 4 Temp.o.k. Bit 5 Following error limit exceeded Bit 6 not used Bit 7 not used	
05	XW: Motor setpoint	XI: Actual motor position
06	VY: Max. should-be frequency in sub-mode "Frequency characteristics"	XD: Positional difference XD = XW - XI
07	F: Max. should-be frequency in sub-mode "Point-to-point"	L: Ramp gradient
08	DA: Shaft encoder resolution	PA: Phase advance
09	GI: Gear interface in sub-mode "Electronic gear" O = $Pulse_{forw}/Pulse_{backw}$ 1 = Pulse/direction 2 = A/B shaft encoder signals	RS: Quiescent current Quiesecnt current with contr. inactive Given in percentage of max. current
10	AR: Locking	MR: Controller mode: 0 = Current contr.; 1 = Load angle contr.
11	GZ: Gear ratio "Numerator" in sub-mode "Point-to-point	GN: Gear ratio "Denominator" in sub-mode "Point-to-point"
12	EZ: Gear ratio "Numerator" in sub-mode "Electronic gear"	EN: Gear ratio "Denominator" in sub-mode "Electronic gear"
13	TA: Sampling time	KP: Proportional component
14	KI: Integral component	KD: Differential component
15	XL: Following error limit for display	PW: Programmable positioning window
16	IS: Automatic integral component	

Error and status messages

In protocols 0, 1 and 2, a status/error number can be indicated in column "Display". The messages will be explained in the following tables.

Error message	Meaning
(E 4)	Right limit switch actuated
(E 5)	Left limit switch actuated
(E 6)	Stop triggered
(E 14)	Undefined position
(E 16)	Input value too low
(E 17)	Input value too high
(E 70)	Parity error
(E 71)	Receiver overflow or break at input
(E 73)	Input buffer full
(E 74)	Inadmissible command
(E 75)	Line does not start with ":"
(E 76)	No value stated or incorrect format
(E 77)	Start attempt without valid data
(E 78)	Internal counter overflow, set dimensions!
(E 81)	System error, request clear text message with FS
(E101)	Motor does not stand still, $v_{mot} \neq 0$
(E102)	Specify value
(E103)	Action command not executed
(E104)	Job interrupted by automatic run/manual switching
(E106)	EEPROM option not installed or defective
(E107)	Command not permitted in the currently selected sub-mode

Status message	Meaning
(E 98)	Manual movement, no error has occurred
(E 99)	Automatic run, no error has occurred

3.4 Network mode

The following network modes are possible:

- "Install"
  Installation and diagnosis mode
- "Memory"
  Storage mode
- "Serial"
  Serial mode
- "A-Parallel"
  Parallel mode in the system of absolute dimensions
- "R-Parallel"
  Parallel mode in the system of incremental dimensions

Manual movement

- Slow manual movement
- Fast manual movement
- Manual reference movement
- Setting the manual reference point
- Teach-in
- Limited operation via PC

Automatic run

- Operation via PC with the PRO-SDP/PC1 software at a transmission speed of 9600 bauds or 38.4 kbauds.

Signal control in automatic run depends on the selected network mode:

"Memory"	see chapter 3.4.2
"Serial"	see chapter 3.4.3
"A-/R-Parallel"	see chapter 3.4.4

NOTE
Operation is described in the PRO-SDP/PC1 documentation.

NOTE
Examples of calculation and acknowledgements in all submodes are listed in the appendix, see chapters 6.4 and 6.5.

3.4.1 Network mode activation

1. Switch off supply voltage for processor unit.

   Operation and setting of the network operating modes is effected on the PC with the aid of the following software:
   - PRO-SDP/PC1
     Menue system (BPRO) for comfortable operation and networking of 1 to 124 units (4 interfaces x 31 units).

2. Set operating mode selector switch (47) to "6" for a transmission speed of 9600 bauds or to "7" for 38.4 kbauds.

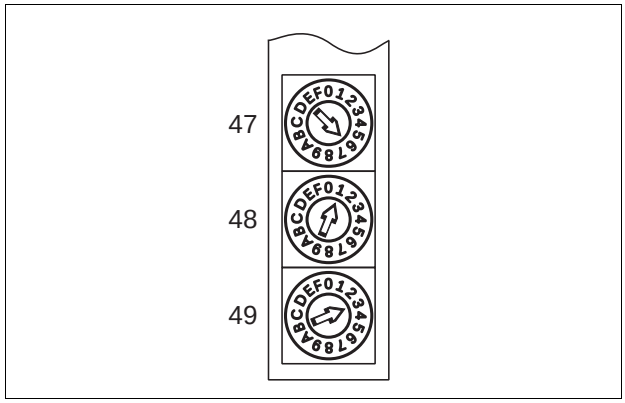


Fig. 3-8 Selector switch

3. Set the desired network address (range 1-31) at selector switches (48) and (49):

   Selector switch (48) = value of tens
   Selector switch (49) = value of ones
   (e.g. "13", see fig. 3-8)

4. Switch on supply voltage for processor unit.
   → Network mode is active.
   LED 43 and 46 light up.

5. Further operation in operating mode

   - "Memory", see chapter 3.4.2
   - "Serial", see chapter 3.4.3
   - "A-/R-Parallel", see chapter 3.4.4

3.4.2 Network mode "Memory"

Network mode "Memory" offers the following operating possibilities:

Manual movement

- Slow manual movement
  The regulated stepping motor rotates at the "Manual frequency slow" which can be modified as a parameter. The parameter value is adjustable, factory setting 1 kHz.

- Fast manual movement
  The regulated stepping motor rotates at the "Manual frequency fast" which can be modified as a parameter. The parameter value is adjustable, factory setting 4 kHz.

- Manual reference movement
  The regulated stepping motor rotates at a frequency of 8 kHz until the desired limit or reference switch is detected.
  On detection of the selected limit switch and braking, the stepping motor leaves the limit or reference switch at a frequency of 500 Hz and stops. This position serves as the reference point for the system of dimensions.

- Set manual reference point
  The "reference position" (factory setting 0) which can be modified as a parameter, is accepted as the new reference value for the system of dimensions by activating two inputs. A reference movement is not required.

- Manually approached positions are stored as movement commands in teach-in mode. The movement program prepared in this way can be executed in automatic run.

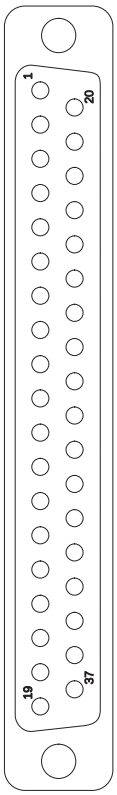
Automatic run

- Automatic run of stored programs

The following sub-modes are possible:

- Point-to-point MD = 0
- Frequency characteristics MD = 1
- Electronic gear MD = 2.

Control signals in network mode "Memory"



Pin	Abbreviation	Meaning	
1	$\overline{\text{LIM.X-}}$	Negative limit switch	←
2	-	-	
3	-	-	
4	START	Start	←
5	LOAD	Store position	←
6	$\overline{\text{ADD.REF.}}$	Additional reference switch	←
7	MAN.X-	Manual movement, CCW rotation	←
8	MAN.L/H	Slow/fast manual movement	←
9	DATA4	Program number 2^2	←
10	DATA1	Program number 2^0	←
11	-	-	
12	-	-	
13	FOLLOW.F.	Following error limit	→
14	FAULT/CL	Error	→
15	READY O.	Ready for operation	→
16	24VDC	System supply voltage	←
17	24VDC	System supply voltage	←
18	IO24VDC	I/O supply voltage	←
19	IO24VDC	I/O supply voltage	←
20	$\overline{\text{LIM.X+}}$	Positive limit switch	←
21	-	-	
22	-	-	
23	$\overline{\text{STOP}}$	Stop	←
24	RS/CL.A.	Program start	←
25	AUTOM	Automatic operation	←
26	MAN.X+	Manual movement, CW rotation	←
27	MAN.REF.	Manual reference movement	←
28	DATA8	Program number 2^3	←
29	DATA2	Program number 2^1	←
30	-	-	
31	-	-	
32	TEMP.OK	Temperature o.k.	→
33	INPOS	Position reached	→
34	END/$\overline{\text{L.A.}}$	Program end	→
35	24VGND	System supply voltage ground	←
36	24VGND	System supply voltage ground	←
37	IOGND	I/O supply voltage ground	←

$\overline{\text{active-low signal}}$ ← input → output

3.4.2.1 Manual movement

NOTE
Position control is activated by triggering a manual action (e.g. setting dimensions or manual movement).

Slow manual movement

1. Deactivate input AUTOM.
2. Select the sense of rotation:
   – For positive sense of rotation in clockwise direction viewed to motor shaft: activate input MAN.X+.
   – For negative sense of rotation in counterclockwise direction viewed to motor shaft: activate input MAN.X-.

   → The motor keeps rotating at "Manual frequency slow" in the selected direction until input MAN.X+ or MAN.X- are active and the limit switch is not detected.

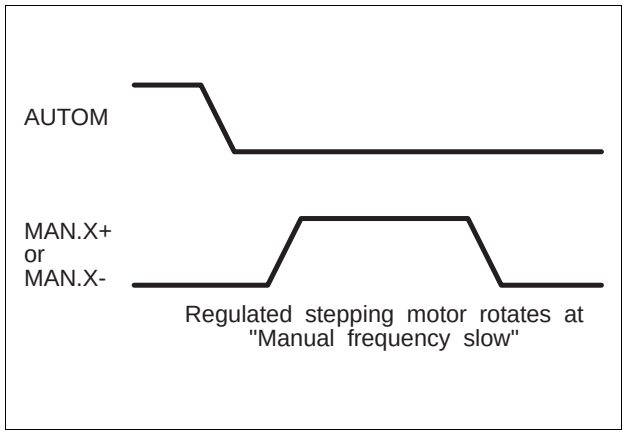


Fig. 3-9 Slow manual movement

NOTE
If input MAN.X+ or MAN.X- is only activated temporarily (<0.5 s), the motor performs a step.

NOTE
The motor accelerates/decelerates with the ramp gradient stored in parameter set 0 during manual movement.

NOTE
The parameter "Manual frequency slow" can be modified, factory setting 1 kHz.

Fast manual movement

1. Deactivate input AUTOM.

2. Select the sense of rotation:
   – For positive sense of rotation in clockwise direction viewed to motor shaft:
   activate input MAN.X+ and MAN.L/H simultaneously (longer than settling time t_E).
   – For negative sense of rotation in counterclockwise direction viewed to motor shaft:
   activate input MAN.X- and MAN.L/H simultaneously (longer than settling time t_E).

   → The motor keeps rotating at "Manual frequency fast" in the desired direction, as long as the inputs MAN.X+ or MAN.X- and MAN.L/H are active.

NOTE
The motor accelerates/decelerates with the ramp gradient stored in parameter set 0 during manual movement.

NOTE
The parameter "Manual frequency fast" can be modified, factory setting 4 kHz.

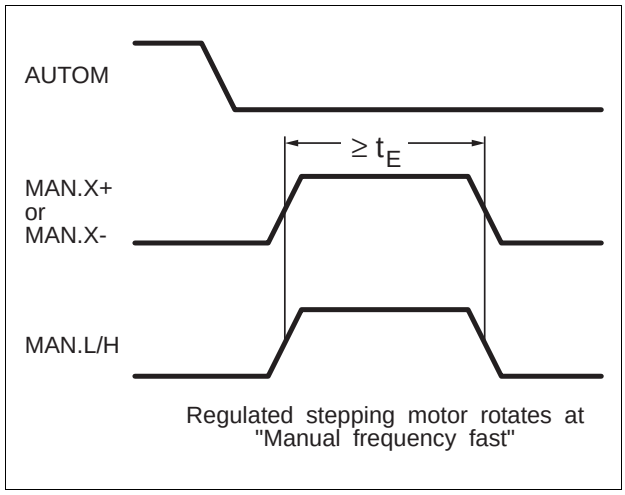


Fig. 3-10 Fast manual movement

Manual reference movement

NOTE
Reference movement principle see chapter 6.3.

1. Deactivate input AUTOM.

2. For movement towards the limit switch in the positive sense of rotation:
activate inputs MAN.X+ and MAN.REF. simultaneously (longer than settling time t_E).

3. For movement towards the limit switch in the negative sense of rotation:
activate inputs MAN.X- and MAN.REF. simultaneously (longer than settling time t_E).

4. For movement towards the additional reference switch:
activate inputs MAN.L/H and MAN.REF. simultaneously (longer than settling time t_E).

   → The motor keeps rotating at frequency REF_IN, which may be modified as a parameter, in the selected direction until the limit switch or additional reference switch is detected. It then leaves the limit switch at a frequency of 500 Hz and stops. This position serves as the reference point for the system of dimensions.

NOTE
A reference movement can be interrupted by activating input $\overline{\text{STOP}}$.

NOTE
The motor accelerates/decelerates with the ramp gradient stored in parameter set 0 during manual movement.

NOTE
The parameter "Manual frequency REF_IN" can be modified. The factory setting is 8 kHz.

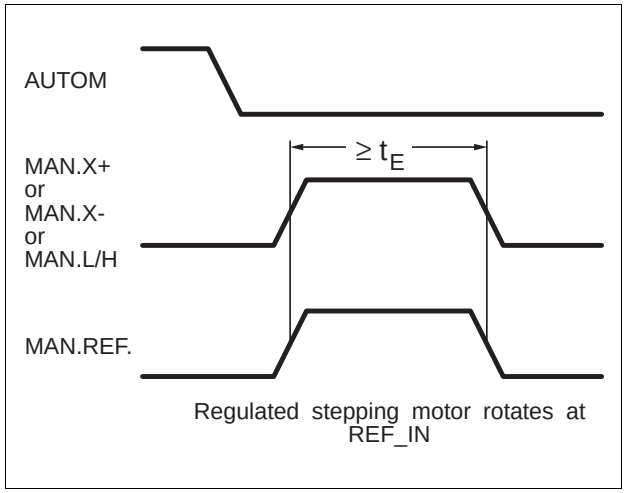


Fig. 3-11 Manual reference movement

Setting manual reference point

1. Deactivate input AUTOM.
2. Activate inputs MAN.REF. and LOAD simultaneously (longer than settling time t_E).

   → The value of the reference position serves as the new reference value for the system of dimensions.

NOTE
The parameter "reference position" can be modified, factory setting 0.

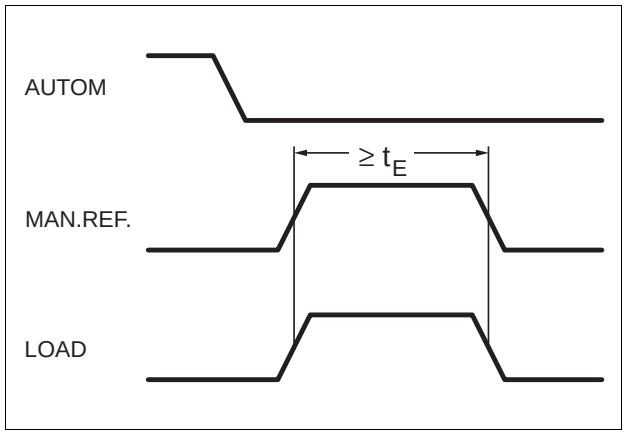


Fig. 3-12 Setting manual reference point

NOTE
Fig. 3-13 shows an example of wiring the function "Setting manual reference point".

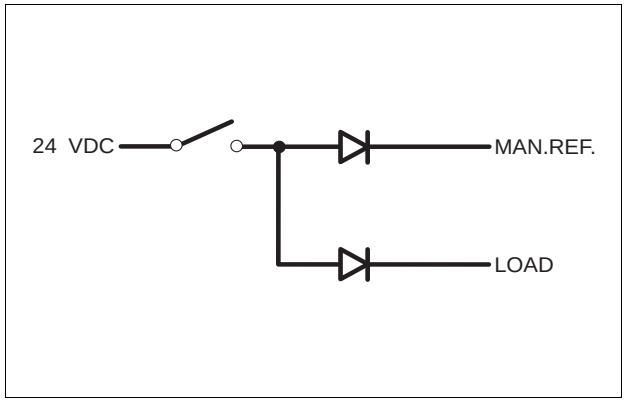


Fig. 3-13 Wiring example of "setting manual reference point"

3.4.2.2 Teach-in

NOTE
After switching the processor unit on, power drive readiness is expected within a period of 15 sec. or checked.

1. Activate input AUTOM.
   → LED 44 lights up, output INPOS is active.

NOTE
Position control is immediately active.

2. Activate network mode "Memory".

3. Deactivate input AUTOM.

4. Perform reference movement or set manual reference point.

5. Define the desired program number under which the teach-in positions must be stored by activating or deactivating the four inputs DATA1 to DATA8 in accordance with the following principle:

DATA8	DATA4	DATA2	DATA1	Program number
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	10
1	0	1	1	11
1	1	0	0	12
1	1	0	1	13
1	1	1	0	14
1	1	1	1	15

0 = input inactive 1 = input active

NOTE
A program number should be selected under which no program has been stored yet. This program would otherwise be overwritten.

6. Activate inputs RS/CL.A. and LOAD simultaneously (longer than settling time t_E).
   → The program number is selected.
   → LED 42 and LED 44 light up.
   The output signals FAULT/CL and INPOS are active.
   → The program is selected.

7. Approach the desired position manually, see chapter 3.4.2.1.

8. Activate input LOAD temporarily (longer than settling time t_E).
   → The position is stored as an absolute position.
   → LED 44 lights up, output INPOS is active.

9. Approach and store the next position.

NOTE
The individual positions should be approached during the mechanical reversal of the system in the same direction as in the automatic run later.
The individual positions are always stored as absolute positions.

10. The program prepared in teach-in mode can be edited with the PC, see PRO-SDP/PC1 documentation. Automatic program execution is effected as described in chapter 3.4.2.3.

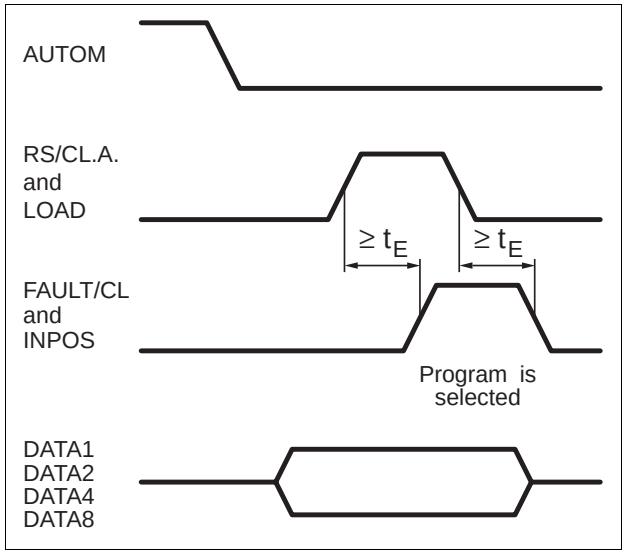


Fig. 3-14 Program selection

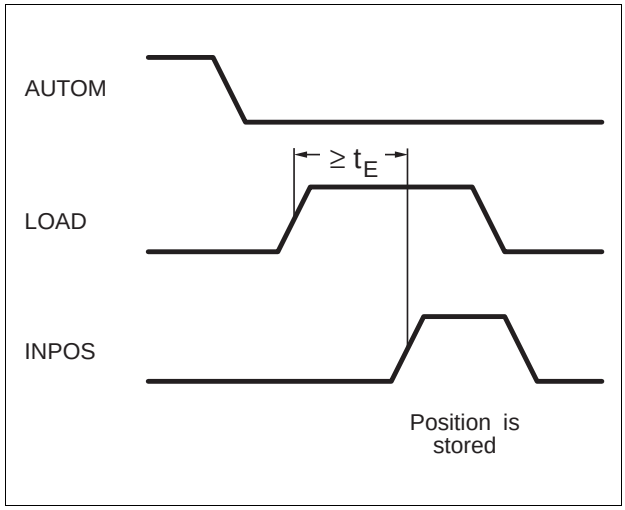


Fig. 3-15 Teach-in

NOTE
Fig. 3-16 shows an example of wiring the function "Teach-in".

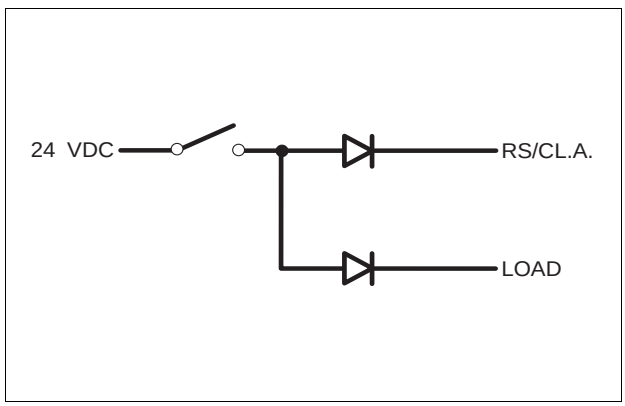


Fig. 3-16 Wiring example of Teach-in

3.4.2.3 Automatic run

In network mode "Memory", programs which were loaded into the WDP5-228 with a PC or programs prepared in teach-in mode can be executed automatically.
Communication with the subordinate controller (e.g. PLC) is effected via parallel inputs and outputs:

Inputs	Meaning
DATA1 DATA2 DATA4 DATA8	Selecting one of the 16 programs. The program selected via these inputs is executed.
START	Starting execution of a command group
RS/CL.A.	Resetting the program pointer back to the program beginning

Outputs	Meaning
INPOS	Last command group has been executed ready for a new START.
END/$\overline{\text{L.A.}}$	The last command group in the selected program has been executed.
FAULT/CL	A fault has occurred in the run.
READY O.	Unit is ready for operation.

NOTE
The inputs $\overline{\text{LIM.X+}}$, $\overline{\text{LIM.X-}}$, $\overline{\text{ADD.REF.}}$ and $\overline{\text{STOP}}$ are also evaluated by the unit.

NOTE
After switching the processor unit on, readiness of the power drive is expected within a period of 15 sec. or checked.

NOTE
Position control is immediately active.

Program selection

1. Specify the desired program number by activating or deactivating the four inputs DATA1 to DATA8 in accordance with the following principle:

DATA8	DATA4	DATA2	DATA1	Program number
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	10
1	0	1	1	11
1	1	0	0	12
1	1	0	1	13
1	1	1	0	14
1	1	1	1	15

0 = input inactive 1 = input active

2. Select the 1st command group with the signal START or RS/CL.A.

The signal times to be adhered to are evident in fig. 3-17.

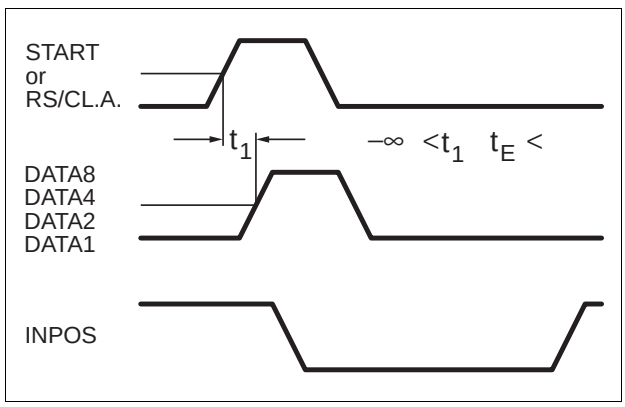


Fig. 3-17 Program selection

Setting program pointer to program beginning

Activate input RS/CL.A.

→ The program pointer is set to the beginning of the selected program.

The signal times which must be adhered to are evident in fig. 3-18.

NOTE
The "M20" command has the same effect.

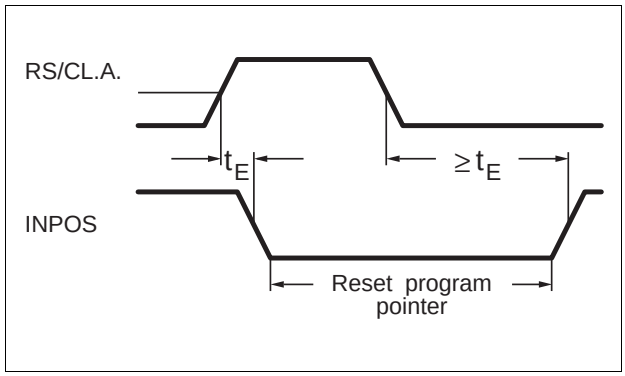


Fig. 3-18 Setting program pointer to program beginning

Starting movement commands

Activate input START.

→ The output signal INPOS is not active.
→ The next movement command is executed.
The output INPOS is set to 0V.

The signal times which must be adhered to are evident in fig. 3-19.

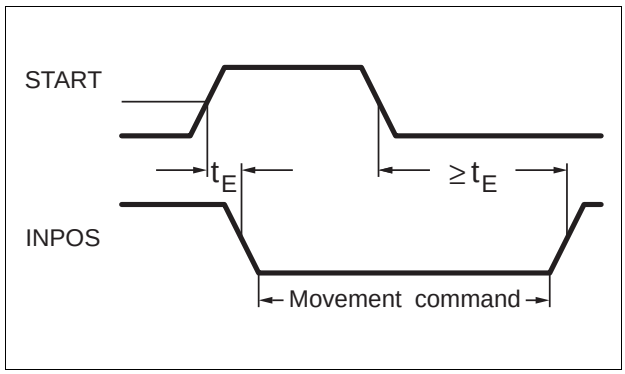


Fig. 3-19 Starting movement commands

NOTE
The signal times shown in fig. 3-20 must be observed at the end of the program or in case of errors.

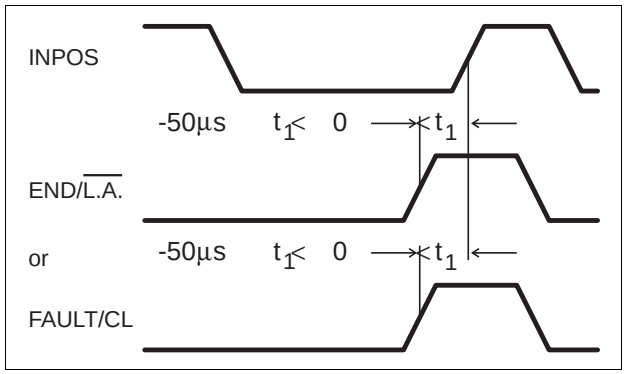


Fig. 3-20 Status message

Starting at program beginning

Activate inputs RS/CL.A. and START.

→ The program pointer is set to the beginning of the selected program and the first movement command is executed.

The signal times which must be adhered to are evident in fig. 3-21.

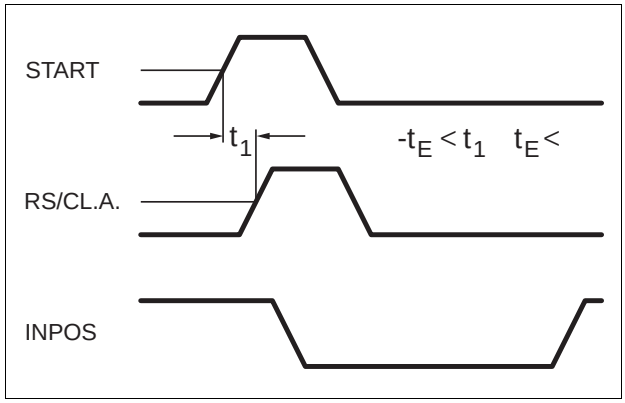


Fig. 3-21 Starting at program beginning

3.4.2.4 System setting

NOTE
System setting see PRO-SDP/PC1 or PRO-SDP/PC2 documentation.

The following parameters may be modified within the specified ranges:

Parameter		Range	Factory setting
L=[1]	Ramp gradient in sub-mode "Point-to-point" and "Frequency characteristics"	8 to 32767 Hz/ms	100 Hz/ms
F=[1]	Set frequency in sub-mode "Point-to-point"	8 to 195000 Hz[2] 8 to 390000 Hz[3]	4000 Hz
EZ=	Gear ratio "Numerator" in sub-mode "Electronic gear"	± 30000[4]	0
EN=	Gear ratio "Denominator" in sub-mode "Electronic gear"	1 to 30000	1
KP=[1]	Proportional component for position controller	0 to 32767	200
KI=[1]	Integral component for position controller	0 to 32767	0
KD=[1]	Differential component for position controller	0 to 32767	1400
XL=[1]	Following error for position controller	0 to 4000 incr.	1000 incr.
PW=[1]	Positioning window	1 to 4000 incr.	10 incr.
	Manual frequency slow	8 to 195000 Hz[2] 8 to 390000 Hz[3]	1000 Hz
	Manual frequency fast	8 to 195000 Hz[2] 8 to 390000 Hz[3]	4000 Hz
	Manual frequency REF_IN (for manual reference movement)	8 to 195000 Hz[2] 8 to 390000 Hz[3]	8000 Hz
	Gear ratio "Numerator" in sub-mode "Point-to-point"	± 1 to ± 30000[4]	1
	Gear ratio "Denominator" in sub-mode "Point-to-point"	1 to 30000	1
	Settling time t_E	1 to 255 ms	4 ms
	Reference position	± 8300000	0

1) These parameters can be saved with command "SV" or read with command "RD".
2) Shaft encoder with 500 marks
3) Shaft encoder with 1000 marks
4) Negative gear ratio numerator means direction reversal, the limit switches must be interchanged.

The initialization values for the processor unit are listed in the following table.

Init values		Range	Factory setting
PA =	Phase advance	5 to 100	35
DA =	Shaft encoder resolution	500 or 1000 marks	1000 marks
MR =	Controller mode	0 = Current controller 1 = Load angle controller	0
GI =	Gear interface in sub-mode "Electronic gear"	0 = $Pulse_{forw}/pulse_{backw}$ signals 1 = Pulse/direction signals 2 = A/B signals	2
RS =	Quiescent current	0 to 100%	50%
AR =	Locking	0 to 65535 ms	0 ms
TA =	Controller sampling time	500, 1000, 2000 µs	1000 µs
IS=	Automatic integral component	0 to 32767	1

3.4.2.5 Programming

The programs are prepared with the following commands. The commands are divided into action commands (A) and setting commands (S):

Order	Type	Meaning	Range
MD=	A	Activate sub-mode	0 = Point-to-point 1 = Frequency characteristics 2 = Electronic gear
X=	A	Setpoint to be approached (depending on the system of dimensions)	± 8300000
G25	A	Reference movement towards negative limit switch	
G26	A	Reference movement towards positive limit switch	
G27	A	Reference movement towards additional limit switch	
G29=	S	Enter reference position and set reference point	± 8300000
G90	S	Set system of absolute dimensions	
G91	S	Set system of incremental dimensions	
L=[1)]	S	Ramp gradient in sub-mode "Point-to-point" and "Frequency characteristics"	8 to 32767
F=[1)]	S	Set frequency in sub-mode "Point-to-point"	8 to 195000 Hz[2)] 8 to 390000 Hz[3)]
VY=	A	Set frequency in sub-mode "Frequency characteristics"	± 195000 Hz[2)] ± 390000 Hz[3)]
EZ=	A	Gear ratio "Numerator" in sub-mode "Electronic gear"	± 30000[4)]
EN=	S	Gear ratio "Denominator" in sub-mode "Electronic gear"	1 to 30000
SV=	S	Save parameter set	0 to 3
RD=	S	Read parameter set	0 to 3
BEG	A	Block start	
END	A	Block end	
T=	A	Time delay (x 10 ms)	0 to 6553
M20	S	Program pointer to program beginning	
KP=[1)]	S	Proportional component for position controller	0 to 32767
KI=[1)]	S	Integral component for position controller	0 to 32767
KD=[1)]	S	Differential component for position controller	0 to 32767
XL=[1)]	S	Following error for position controller	0 to 4000 increments
PW=[1)]	S	Positioning window	1 to 4000 increments

1) These commands may be saved as parameters with command "SV" and read with command "RD".
2) Shaft encoder with 500 marks
3) Shaft encoder with 1000 marks
4) Negative gear ratio numerator means direction reversal, the limit switches must be interchanged.

The letters A and S in the 2nd column have the following meaning:

A = Action command

The action command A triggers an action such as positioning or activates a new gear ratio in sub-mode "Electronic gear". An external start signal is necessary for activating the action.

S = Setting command

The setting command only takes effect in combination with an action command, e.g. the ramp gradient only takes effect in combination with a movement command.

NOTE
If an action command is preceded by several setting commands for saving, loading and modifying parameters, the following internal processing sequence must be taken into consideration:

1. Saving a parameter set "SV=".
2. Reading a parameter "RD=".
3. Modifying individual parameters e.g. "KP=".
4. Action command, e.g. "X=".

Example:

1. SV = 0 (save parameter set)
2. KP = 256 (modify parameter)
3. L = 500 (modify parameter)
4. X = 1000 (action command).

Program example for sub-mode "Point-to-point"

Progr.	Line	Command	Meaning
00	01	MD 0	Action command: Activate sub-mode "Point-to-point"
00	02	KP 300	
00	03	KD 2100	
00	04	KI 1	
00	05	G25	Action command: Reference movement
00	06	F 50000	
00	07	L 200	
00	08	X 1000	Action command: Positioning by 1000 increments
00	09	M20	

Program example for sub-mode "Frequency characteristics"

00	01	MD 1	Action command: Activate sub-mode "Frequency characteristics"
00	02	KP 300	
00	03	KD 2100	
00	04	KI 1	
00	05	L 500	
00	06	VY 50000	Action command: Set frequency
00	07	L 200	
00	08	VY 0	Action command: Set frequency (motor stands still)
00	09	M20	

Program example for sub-mode "Electronic gear"

00	01	MD 2	Action command: Activate sub-mode "Electronic gear"
00	02	KP 300	
00	03	KD 2100	
00	04	KI 1	
00	05	EN 1	
00	06	EZ 1	Action command: Transfer gear ratio
00	07	EZ 2	Action command: Transfer gear ratio
00	08	EZ 0	Action command: Transfer gear ratio Gear ratio (deactivate)
00	09	M20	

3.4.2.6 Execution of program instructions

A program is executed in such a way that a command block is respectively triggered by an external start until the next action command occurs.

If a job is interrupted, it can be terminated by triggering another start.

The only exception is an interruption of a timing function. In such a case, the following action command is executed when another start is triggered.

NOTE
When changing programs, it must be noted that not all the commands are valid in all sub-modes.

When executing a program, the sub-mode status is maintained until a new sub-mode is activated with the command "MD".

Program pointer manipulation

On activating the automatic run (starting the controller with input AUTOM active or switching from manual to AUTOM) as well as after switching the network operating mode to "Memory" the program pointers of all movement programs are initialized in the 1st line.

The program pointer is maintained during program execution, i.e. when changing the program number, operation can be continued at the position where the change was made using the inputs DATA1 to DATA8 when switching back to the previous program number.

The program pointer can be reset to the beginning with the command "M20" directly in the program run.

Block processing

A processing block is marked in the program with the commands "BEG" and "END".

After starting the processing block, the following action commands are directly triggered, i.e. no particular start is required for the individual action commands in this processing block.
A processing block is only acknowledged if the entire block has been processed without faults. If an error occurs in the processing block, block processing can be continued at the interrupted action command by triggering another start.
This does not hold true if an error occurs when processing a timing function. In such a case, the action command is triggered after the interrupted timing function by triggering a new start.
Only after interruption of a processing block via a fault (e.g. STOP) can the program number be changed or the program pointer reset to the pointer beginning by the RS/CL.A. signal.

A processing block can only be interrupted by changing operating modes (manual or another network mode) between the individual action commands, changing the program number or activating the RS/CL.A. signal does not take effect when block processing is active.

Timing function

With the aid of action command "T", time delays between the individual jobs can be realized. The time range available is 10 ms to 65530 ms, resolution is 10 ms.

The acknowledgement procedure for the timing function is effected in the same way as for processing any other action command. The time delay refers to the period between removing and activating signal INPOS.

Execution of the example program sub-mode "Point-to-point"

1. Start: Line 1 is activated (activation of sub-mode "Point-to-point")

Progr.	Line	Command	Meaning
1→ 00	01	MD 0	Action command: Activate sub-mode "Point-to-point"
00	02	KP 300	
00	03	KD 2100	
00	04	KI 1	
00	05	G25	Action command: Reference movement
00	06	F 50000	
00	07	L 200	
00	08	X 1000	Action command: Positioning by 1000 increments
00	09	M20	

2. Start: Lines 2 to 5 are activated (reference movement)

00	01	MD 0	Action command: Activate sub-mode "Point-to-point"
00	02	KP 300	
00	03	KD 2100	
00	04	KI 1	
2→ 00	05	G25	Action command: Reference movement
00	06	F 50000	
00	07	L 200	
00	08	X 1000	Action command: Positioning by 1000 increments
00	09	M20	

3. Start: Lines 6 to 8 are activated (positioning)

Progr.	Line	Command	Meaning
00	01	MD 0	Action command: Activate sub-mode "Point-to-point"
00	02	KP 300	
00	03	KD 2100	
00	04	KI 1	
00	05	G25	Action command: Reference movement
00	06	F 50000	
00	07	L 200	
3→ 00	08	X 1000	Action command: Positioning by 1000 increments
00	09	M20	

4. Start: Lines 9 and 1 are activated (activation of sub-mode)

NOTE
The program pointer is reset to the program beginning (line 1) with the command "M20".

4→ 00	01	MD 0	Action command: Activate sub-mode "Point-to-point"
00	02	KP 300	
00	03	KD 2100	
00	04	KI 1	
00	05	G25	Action command: Reference movement
00	06	F 50000	
00	07	L 200	
00	08	X 1000	Action command: Positioning by 1000 increments
00	09	M20	

Example program for block processing and timing function

Progr.	Line	Command	Meaning
1→ 00	01	MD 0	Action command: Activate sub-mode "Point-to-point"
2→ 00	02	BEG	Action command: Trigger block processing
00	03	KP 300	
00	04	KD 2100	
00	05	KI 1	
00	06	G25	Action command: Reference movement
00	07	T 500	Action command: Wait time 5 seconds
00	08	F 50000	
00	09	L 200	
00	10	X 1000	Action command: Positioning by 1000 increments
00	11	END	Action command: Terminate block processing
00	12	M20	

Brief description of the program sequence for block processing and timing function

1st start: Triggering sub-mode "Point-to-point"

2nd start: Activating block processing, the following activities are subsequently performed:
- reference movement (lines 03 to 06)
- wait time after terminating the reference movement (line 07)
- positioning (lines 08 to 10)
- deactivating block processing (line 11).

NOTE
The program pointer is reset to the program beginning (line 01) with command "M20").
The program pointer is thus at program line 01, i.e. this action command is triggered by the 3rd start.

3.4.2.7 PLC request

A PLC request may be enabled in the unit in network mode "Memory".
This PLC request allows the PLC to inform the superior PC on the process status. Whether a PLC request exists can be checked via the PC.
The PLC request is set via inputs DATA1 to DATA8. Consequently, 16 different process states may be indicated to the PC, e.g. PLC request number

0 deleting old program
loading new program
1 loading new parameters into the unit

Setting a PLC request

1. Activate network mode "Memory", see PRO-SDP/PC1 documentation.

2. Specify the desired PLC request number by activating or deactivating the four inputs DATA1 to DATA8 in accordance with the following table.

DATA8	DATA4	DATA2	DATA1	PLC request no.
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
1	0	1	0	10
1	0	1	1	11
1	1	0	0	12
1	1	0	1	13
1	1	1	0	14
1	1	1	1	15

0 = input inactive 1 = input active

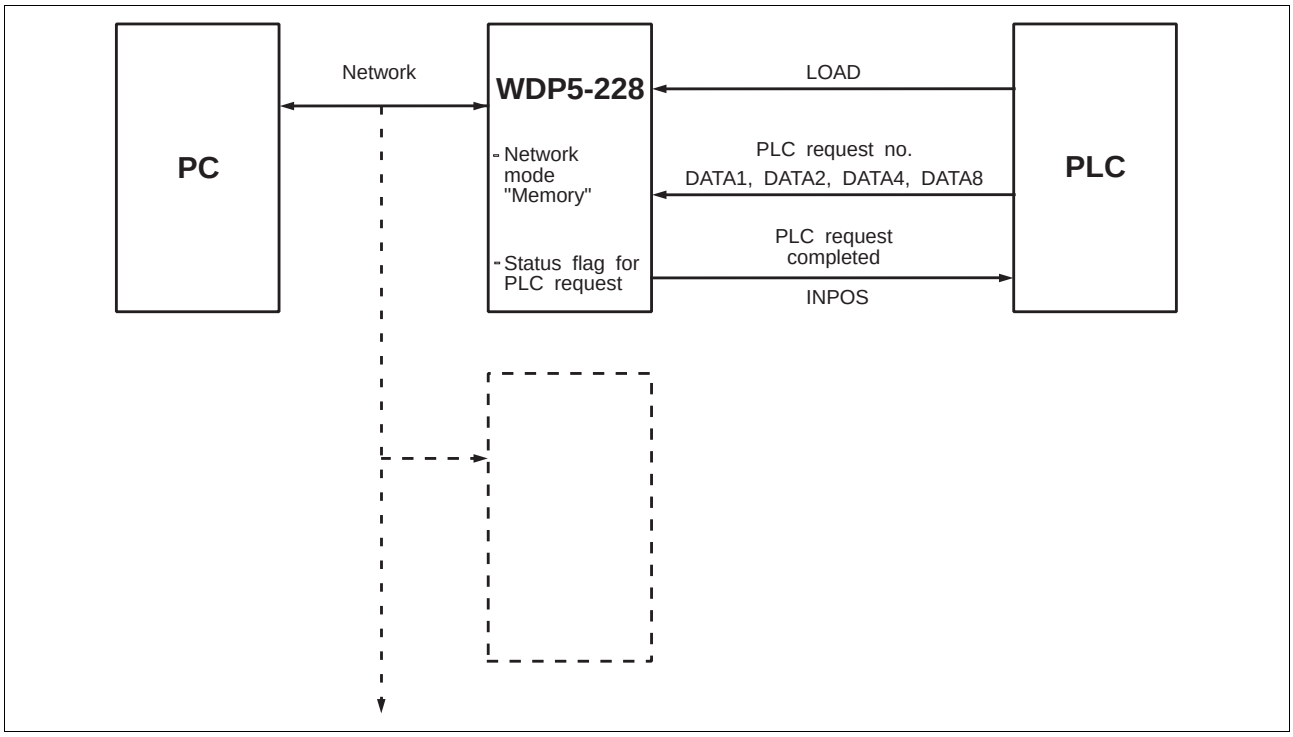


Fig. 3-22 PLC request

3. Activate input LOAD.
   → PLC request is stored in the unit.
   → The INPOS output signal is inactive.

4. On detection of a PLC request (check unit status) in network mode "Memory": Activate network mode "Install", read PLC request no. and trigger the appropriate activities (e.g. load new parameters or program) on the PC, see PRO-SDP/PC1 documentation.

NOTE
The program pointers are reset after exiting from network mode "Memory".

5. Activate network mode "Memory".
   → PLC request is deleted in the positioning unit.
   → The INPOS output signal is active.

6. The PLC subsequently controls process execution.

ATTENTION
The signal times evident in fig. 3-23 must be observed when setting a PLC request.

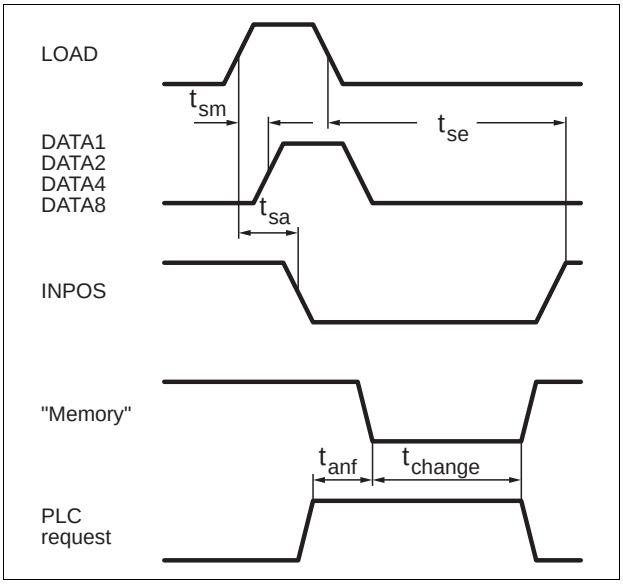


Fig. 3-23 Timing diagram for PLC request

Abbreviation	Meaning	Minimum	Typical	Maximum
t_{sm}	Time delay between storage and modification of the PLC request number	-∞	0	t_E
t_{sa}	Time delay between storage and detection of the PLC request	t_E	t_E	
t_{se}	Time delay between termination of storage and PLC request modification completed	t_E	t_{anf} + t_{change}	
t_{anf}	Time delay between detection of the PLC request and switching over to network mode "Install"			
t_{change}	Time delay between switching over from network mode "Install" to "Memory" (modification time for PC)			

3.4.3 Network mode "Serial"

Network mode "Serial" offers the following operating possibilities:

Manual movement

- Slow manual movement
  The regulated stepping motor rotates at the "Manual frequency slow" which can be modified as a parameter. The parameter value is adjustable, factory setting 1 kHz.

- Fast manual movement
  The regulated stepping motor rotates at the "Manual frequency fast" which may be modified as a parameter. The parameter value is adjustable, factory setting 4 kHz.

- Manual reference movement
  The regulated stepping motor keeps rotating at a frequency of 8 kHz, until the desired limit or reference switch is detected.

  On detecting the selected limit switch and braking, the stepping motor leaves the limit or reference switch at a frequency of 500 Hz and stops. This position serves as the reference point for the system of dimensions.

- Set manual reference point
  The "reference position" (factory setting 0), which can be modified as a parameter, is accepted as the new reference value for the system of dimensions by activating two inputs. A reference movement is not required.

Automatic run

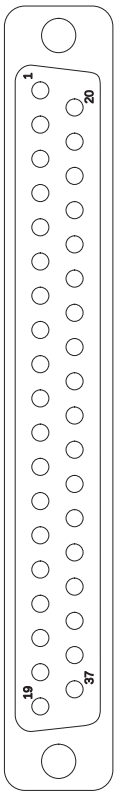
Operation and setting on the PC is effected with the aid of the following software:

- PRO-SDP/PC1
  Menue system (BPRO) for comfortable operation and networking of 1 to 124 units (4 interfaces x 31 units).

The following sub-modes are possible:

- Point-to-point MD = 0
- Frequency characteristics MD = 1
- Electronic gear MD = 2.

Control signals in network mode "Serial"



Pin	Abbreviation	Meaning	
1	$\overline{\text{LIM.X-}}$	Negative limit switch	←
2	-	-	
3	-	-	
4	-	-	
5	LOAD	Store position	←
6	$\overline{\text{ADD.REF.}}$	Additional reference switch	←
7	MAN.X-	Manual movement, CCW rotation	←
8	MAN.L/H	Slow/fast manual movement	←
9	-	-	
10	-	-	
11	-	-	
12	-	-	
13	FOLLOW.F.	Following error limit	→
14	FAULT/CL	Error	→
15	READY O.	Ready for operation	→
16	24VDC	System supply voltage	←
17	24VDC	System supply voltage	←
18	IO24VDC	I/O supply voltage	←
19	IO24VDC	I/O supply voltage	←
20	$\overline{\text{LIM.X+}}$	Positive limit switch	←
21	-	-	
22			
23	$\overline{\text{STOP}}$	Stop	←
24	-	-	
25	AUTOM	Automatic operation	←
26	MAN.X+	Manual movement, CW rotation	←
27	MAN.REF.	Manual reference movement	←
28	-	-	
29	-	-	
30	-	-	
31	-	-	
32	TEMP.OK	Temperature o.k.	→
33	INPOS	Position reached	→
34	-	-	
35	24VGND	System supply voltage ground	←
36	24VGND	System supply voltage ground	←
37	IOGND	I/O supply voltage ground	←

$\overline{\text{active-low}}$ signal ← input → output

3.4.3.1 Manual movement

NOTE
Position control is activated by triggering a manual action (e.g. setting dimensions or manual movement).

Slow manual movement

1. Deactivate input AUTOM.
2. Select the sense of rotation:
   – For positive sense of rotation in clockwise direction viewed to motor shaft: activate input MAN.X+.
   – For negative sense of rotation in counterclockwise direction viewed to motor shaft: activate input MAN.X-.

   → The motor keeps rotating at "Manual frequency slow" in the selected direction as long as input MAN.X+ or MAN.X- is active and the limit switch is not detected or $\overline{\text{STOP}}$ activated.

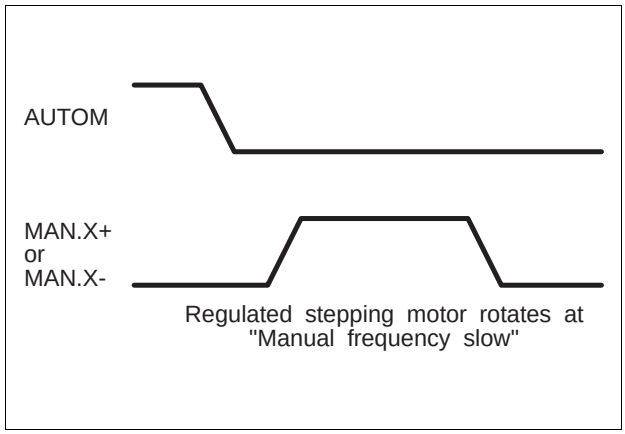


Fig. 3-24 Slow manual movement

NOTE
If input MAN.X+ or MAN.X- is only activated for a short time (<0.5 s), the motor performs a step.

NOTE
The motor accelerates/decelerates with the ramp gradient stored in parameter set 0 during manual movement.

NOTE
The parameter "Manual frequency slow" can be modified, factory setting 1 kHz.

Fast manual movement

1. Deactivate input AUTOM.

2. Select the sense of rotation:
   – For positive sense of rotation in clockwise direction viewed to motor shaft:
   activate input MAN.X+ and MAN.L/H simultaneously (longer than settling time t_E).
   – For negative sense of rotation in counterclockwise direction viewed to motor shaft:
   activate input MAN.X- and MAN.L/H simultaneously (longer than settling time t_E).

   → The motor keeps rotating at "Manual frequency fast" in the desired direction as long as inputs MAN.X+ or MAN.X- and MAN.L/H are active.

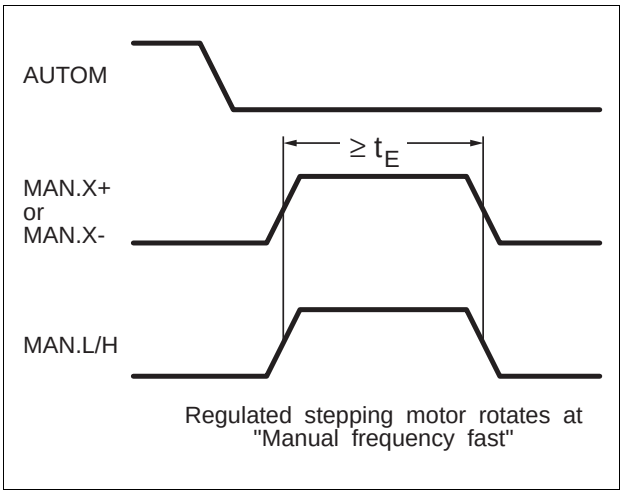


Fig. 3-25 Fast manual movement

NOTE
The motor accelerates/decelerates with the ramp gradient stored in parameter set 0 during manual movement.

NOTE
The parameter "Manual frequency fast" can be modified, factory setting 4 kHz.

Manual reference movement

NOTE
Reference movement principle see chapter 6.3.

1. Deactivate input AUTOM.

2. For performing a movement towards the limit switch in clockwise direction:
activate inputs MAN.X+ and MAN.REF. simultaneously (longer than settling time t_E).

3. For performing a movement towards the limit switch in counterclockwise direction:
activate inputs MAN.X- and MAN.REF. simultaneously (longer than settling time t_E).

4. For performing a movement towards the additional reference switch:
activate inputs MAN.L/H and MAN.REF. simultaneously (longer than settling time t_E).

   → The motor keeps rotating in the desired direction at frequency REF_IN, which may be modified as a parameter, until the limit switch or additional reference switch is detected. It then leaves the limit switch at a frequency of 500 Hz and stops. This position serves as the reference point for the system of dimensions.

NOTE
A reference movement can be interrupted by activating input $\overline{\text{STOP}}$.

NOTE
The motor accelerates/decelerates with the ramp gradient stored in parameter set 0 during manual movement.

NOTE
The parameter "Manual frequency REF_IN can be modified, factory setting is 8 kHz.

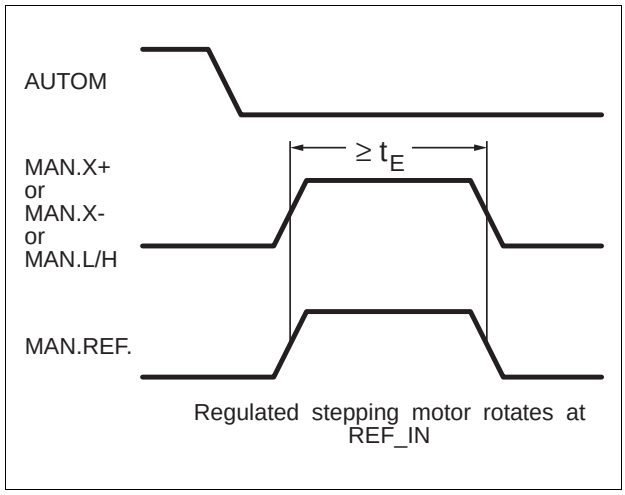


Fig. 3-26 Manual reference movement

Setting manual reference point

1. Deactivate input AUTOM.

2. Activate inputs MAN.REF. and LOAD simultaneously (longer than settling time t_E).

   → The value of the reference position serves as the new reference value for the system of dimensions.

NOTE
The parameter "reference position" can be modified, factory setting 0.

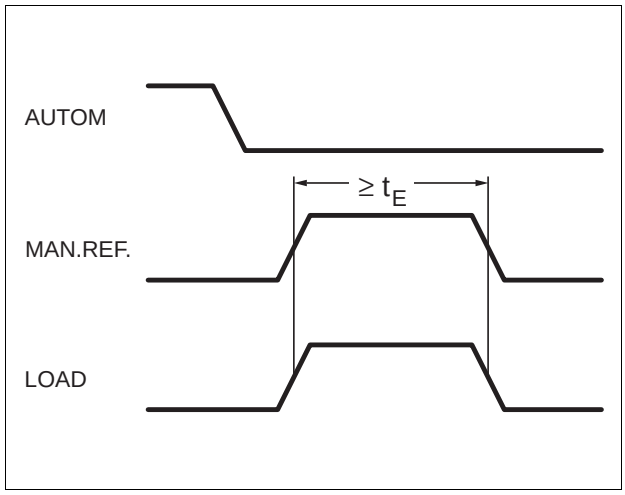


Fig. 3-27 Setting manual reference point

3.4.3.2 Automatic run

1. Switch off supply voltage for processor unit.

2. Set operating mode selector switch (47) to "2" for a transmission speed of 1200 bauds or "3" for 9600 bauds.

3. Switch on supply voltage for processor unit.
   → LED 43 lights up, output READY O. is active.

NOTE
After switching the processor unit on, power drive readiness is expected within a period of 15 sec. or checked.

4. Activate input AUTOM.
   → LED 44 lights up, output INPOS is active.

NOTE
Position control is immediately active.

5. Positioning jobs are transferred and initiated with commands and orders. Parameters can be modified.

6. Further operation is described in chapter 3.4.3.4.

3.4.3.3 System setting

NOTE
System setting see PRO-SDP/PC1 documentation.

The following parameters may be modified within the specified ranges:

Parameter		Range	Factory setting
L=[1]	Ramp gradient in sub-mode "Point-to-point" and "Frequency characteristics"	8 to 32767	100
F=[1]	Set frequency in sub-mode "Point-to-point"	8 to 195000 Hz[2] 8 to 390000 Hz[3]	4000 Hz
EZ=	Gear ratio "Numerator" in sub-mode "Electronic gear"	± 30000[4]	0
EN=	Gear ratio "Denominator" in sub-mode "Electronic gear"	1 to 30000	1
KP=[1]	Proportional component for position controller	0 to 32767	200
KI=[1]	Integral component for position controller	0 to 32767	0
KD=[1]	Differential component for position controller	0 to 32767	1400
XL=[1]	Following error for position controller	0 to 4000 incr.	1000 incr.
PW=[1]	Positioning window	1 to 4000 incr.	10 incr.
	Manual frequency slow	8 to 195000 Hz[2] 8 to 390000 Hz[3]	1000 Hz
	Manual frequency fast	8 to 195000 Hz[2] 8 to 390000 Hz[3]	4000 Hz
	Manual frequency REF_IN (for manual reference movement)	8 to 195000 Hz[2] 8 to 390000 Hz[3]	8000 Hz
	Gear ratio "Numerator" in sub-mode "Point-to-point"	±1 to ± 30000[4]	1
	Gear ratio "Denominator" in sub-mode "Point-to-point"	1 to 30000	1
	Settling time t_E	1 to 255 ms	4 ms
	Reference position	± 8300000	0

1) These parameters can be saved with command "SV" or read with command "RD".
2) Shaft encoder with 500 marks
3) Shaft encoder with 1000 marks
4) Negative gear ratio numerator means direction reversal, the limit switches must be interchanged.

The initialization values for the processor unit are listed in the following table.

Init values		Range	Factory setting
PA =	Phase advance	5 to 100	35
DA =	Shaft encoder resolution	500 or 1000 marks	1000 marks
MR =	Controller mode	0 = Current controller 1 = Load angle controller	0
GI =	Gear interface in sub-mode "Electronic gear"	0 = $Pulse_{forw}$/$pulse_{backw}$ signals 1 = Pulse/direction signals 2 = A/B signals	2
RS =	Quiescent current	0 to 100%	50%
AR =	Locking	0 to 65535 ms	0 ms
TA =	Controller sampling time	500, 1000, 2000 µs	1000 µs
IS =	Automatic integral component	0 to 32767	1

3.4.3.4 Operation with PC

The commands listed in the following table are classified into action commands (A), setting commands (S) and mixed commands (M).

A command group consists of an action and a setting command. The action command triggers a positioning job after the start instruction.

Commands	Type	Meaning	Range
MD=	A	Activate sub-mode	0 = Point-to-point 1 = Frequency characteristics 2 = Electronic gear
X=	A	Setpoint to be approached (depending on the system of dimensions)	± 8300000
G27	A	Reference movement towards additional limit switch	
G25	A	Reference movement towards negative limit switch	
G26	A	Reference movement towards positive limit switch	
G29=	S	Enter reference point	± 8300000
G90	S	Set system of absolute dimensions	
G91	S	Set system of incremental dimensions	
L=[1)]	S	Ramp gradient in sub-mode "Point-to-point" and "Frequency characteristics"	8 to 32767
F=[1)]	S	Set frequency in sub-mode "Point-to-point"	8 to 195000 Hz[2)] 8 to 390000 Hz[3)]
VY	A	Set frequency in sub-mode "Frequency characteristics"	± 195000 Hz[2)] ± 390000 Hz[3)]
EZ=	A	Gear ratio "Numerator" in sub-mode "Electronic gear"	± 30000[4)]
EN=	M	Gear ratio "Denominator" in sub-mode "Electronic gear"	1 to 30000
SV=	M	Save parameter set	0 to 3
RD=	M	Read parameter set	0 to 3
KP=[1)]	M	Proportional component for position controller	0 to 32767
KI=[1)]	M	Integral component for position controller	0 to 32767
KD=[1)]	M	Differential component for position controller	0 to 32767
XL=[1)]	M	Following error for position controller	0 to 4000
PW=[1)]	M	Positioning window	1 to 4000

1) These commands may be saved with command "SV" and read with command "RD".
2) Shaft encoder with 500 marks
3) Shaft encoder with 1000 marks
4) Negative gear ratio numerator means direction reversal, the limit switches must be interchanged.

The letters A, S and M in the 2nd column "Type" have the following meaning:

A = Action command

An action command A triggers an action such as positioning or activates a new gear ratio in sub-mode "Electronic gear". An external start signal is respectively required for activating the action.

M = Mixed command

These are basically setting commands, however, with the difference that activation by a start signal is also possible in some operating modes without transferring an additional action command.

S = Setting command

The setting command only takes effect in combination with an action command, e.g. the ramp gradient only takes effect in combination with a movement command.

NOTE
If an action command is preceded by several setting commands for saving, loading and modifying parameters, the following internal processing sequences must be taken into consideration:

1. Saving a parameter set "SV=".
2. Reading a parametr set "RD=".
3. Modifying individual parameters e.g. "KP=".
4. Action command, e.g. "X=".

Example:

1. SV = 0 (save parameter set)
2. KP = 256 (modify parameter)
3. L = 500 (modify parameter)
4. X=1000 (action command).

3.4.4 Network mode "A-/R-Parallel"

The following operating possibilities are available in network mode "A-Parallel" and "R-Parallel":

Manual movement

– Slow manual movement
The regulated stepping motor rotates at the "Manual frequency slow" which may be modified as a parameter. The parameter value is adjustable, factory setting 1 kHz.

– Fast manual movement
The regulated stepping motor rotates at the "Manual frequency fast" which may be modified as a parameter. The parameter value is adjustable, factory setting 4 kHz.

– Manual reference movement
The regulated stepping motor rotates at frequency REF_IN, which may be modified as a parameter, until the desired limit or reference switch is detected.
On detecting the selected limit switch and braking, the stepping motor leaves the limit switch or reference switch at a frequency of 500 Hz, which may be modified as a parameter, and stops. This position serves as the reference point for the system of dimensions.

– Setting manual reference point
The reference position (factory setting 0), which can be modified as a parameter, is accepted as the new reference value for the system of dimensions by activating two inputs. A reference movement is not required.

NOTE
Setting a reference point is not absolutely necessary in network mode "R-Parallel".

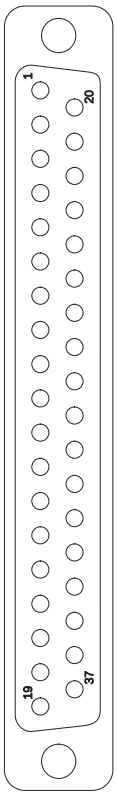
Automatic run

– Automatic run with parallel data transfer
"A-Parallel" in the system of absolute dimensions
"R-Parallel" in the system of incremental dimensions

The following sub-mode is possible:

– Point-to-point MD = 0.

Control signals in network mode "A-/R-Parallel"



Pin	Abbreviation	Meaning	
1	$\overline{\text{LIM.X-}}$	Negative limit switch	←
2	-	-	
3	-	-	
4	START	Start	←
5	LOAD	Load	←
6	$\overline{\text{ADD.REF.}}$	Additional reference switch	←
7	MAN.X-	Manual movement, CCW rotation	←
8	MAN.L/H	Slow/fast manual movement	←
9	DATA4	Decade value 2^2	←
10	DATA1	Decade value 2^0	←
11	-	-	
12	-	-	
13	FOLLOW.F.	Following error limit	→
14	FAULT/CL	Error and clock signal	→
15	READY O.	Ready for operation	→
16	24VDC	System supply voltage	←
17	24VDC	System supply voltage	←
18	IO24VDC	I/O supply voltage	←
19	IO24VDC	I/O supply voltage	←
20	$\overline{\text{LIM.X+}}$	Positive limit switch	←
21	-	-	
22	-	-	
23	$\overline{\text{STOP}}$	Stop	←
24	RS/CL.A.	Clock acknowledge	←
25	AUTOM	Automatic operation	←
26	MAN.X+	Manual movement, CW rotation	←
27	MAN.REF.	Manual reference movement	←
28	DATA8	Decade value 2^3	←
29	DATA2	Decade value 2^1	←
30	-	-	
31	-	-	
32	TEMP.OK	Temperature o.k.	→
33	INPOS	Position reached	→
34	END/$\overline{\text{L.A.}}$	Load acknowledge	→
35	24VGND	System supply voltage ground	←
36	24VGND	System supply voltage ground	←
37	IOGND	I/O supply voltage ground	←

$\overline{\text{active-low signal}}$ ← input → output

3.4.4.1 Manual movement

NOTE
Position control is activated by triggering a manual action (e.g. setting dimensions or manual movement).

Slow manual movement

1. Deactivate input AUTOM.
2. Select the sense of rotation:
   – For positive sense of rotation in clockwise direction viewed to motor shaft: activate input MAN.X+.
   – For negative sense of rotation in counterclockwise direction viewed to motor shaft: activate input MAN.X-.

   → The motor keeps rotating in the selected direction and "Manual frequency slow" as long as input MAN.X+ or MAN.X- is active and the limit switch is not detected.

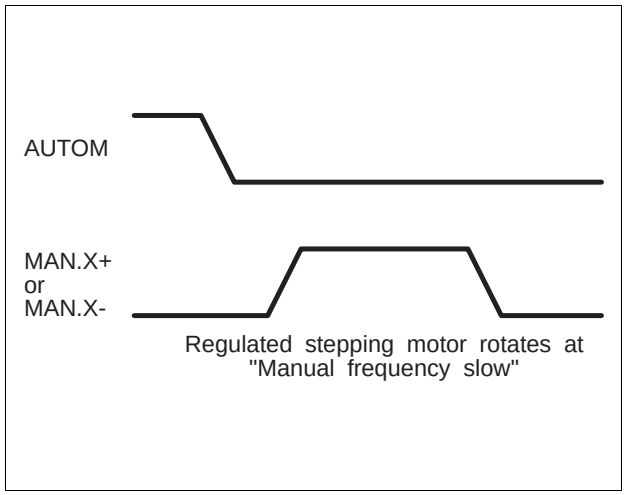


Fig. 3-28 Slow manual movement

NOTE
If input MAN.X+ or MAN.X- is only activated for a short time (<0.5 s), the motor performs a step.

NOTE
The motor accelerates/decelerates with the ramp gradient set in parameter set 0 during manual movement.

NOTE
The parameter "Manual frequency slow" can be modified, factory setting 1 kHz.

Fast manual movement

1. Deactivate input AUTOM.

2. Select the sense of rotation:
   – For positive sense of rotation in clockwise direction viewed to motor shaft:
   activate input MAN.X+ and MAN.L/H simultaneously (longer than settling time t_E).
   – For negative sense of rotation in counterclockwise direction viewed to motor shaft:
   activate input MAN.X- and MAN.L/H simultaneously (longer than settling time t_E).

   → The motor rotates in the desired direction at "Manual frequency fast" as long as the inputs MAN.X+ or MAN.X- and MAN.L/H are active.

NOTE
The motor accelerates/decelerates with the ramp gradient set in parameter set 0 during manual movement.

NOTE
The parameter "Manual frequency fast" can be modified, factory setting 4 kHz.

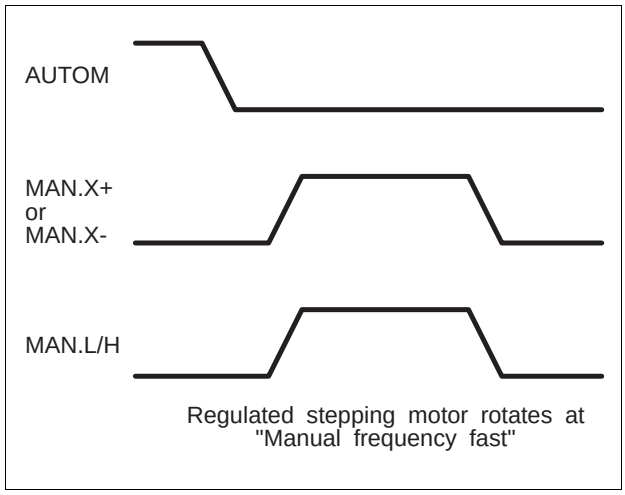


Fig. 3-29 Fast manual movement

Manual reference movement

NOTE
For reference movement principle see chapter 6.3.

1. Deactivate input AUTOM.

2. For performing a movement towards the limit switch in clockwise direction:
activate inputs MAN.X+ and MAN.REF. simultaneously (longer than settling time t_E).

3. For performing a movement towards the limit switch in counterclockwise direction:
activate inputs MAN.X- and MAN.REF. simultaneously (longer than settling time t_E).

4. For performing a movement towards the additional reference switch:
activate inputs MAN.L/H and MAN.REF. simultaneously (longer than settling time t_E).

   → The motor keeps rotating in the selected direction at frequency REF_IN, which may be modified as a parameter, until the limit switch or additional reference switch is detected. It then leaves the limit switch at a frequency of 500 Hz and stops. This position serves as the reference point for the system of dimensions.

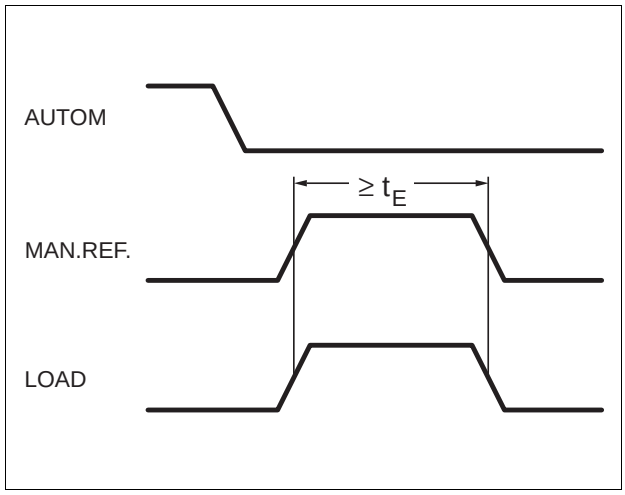


Fig. 3-30 Manual reference movement

NOTE
A reference movement can be interrupted by activating input $\overline{\text{STOP}}$.

NOTE
The motor accelerates/decelerates with the ramp gradient set in parameter set 0 during manual movement.

NOTE
The parameter "Manual frequency REF_IN" can be modified, factory setting is 8 kHz.

Setting manual reference point

NOTE
No reference point is required in the system of incremental dimensions.

1. Deactivate input AUTOM.
2. Activate inputs MAN.REF. and LOAD simultaneousy (longer than settling time t_E).

   → The value of the reference position serves as the new reference value for the system of dimensions.

NOTE
The parameter "reference position" can be modified, factory setting 0.

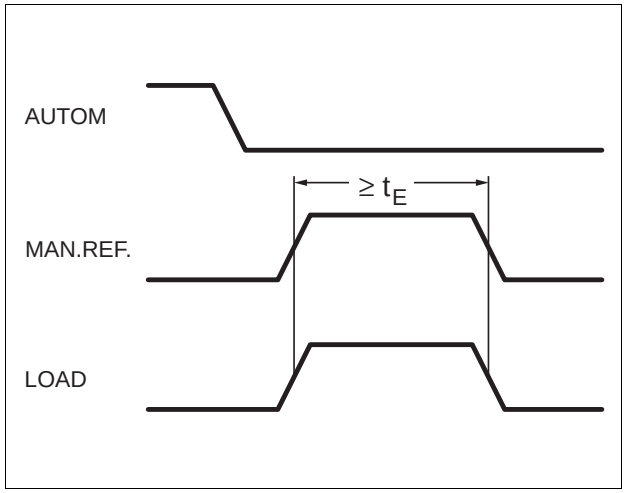


Fig. 3-31 Setting manual reference point

3.4.4.2 Automatic run

NOTE
A reference point must be set in the system of absolute dimensions, see chapter 3.4.4.1.

1. Activate input AUTOM.
   → LED 44 lights up, output INPOS is active.

NOTE
Position control is immediately active.

2. Set the position and frequency value at the block of 8 decade switches, range:

   Position: ±799999
   (increments, absolute or incremental dimensions)
   Frequency: 00-99 (00=100%)
   percentage of the motor frequency set in parameter set 0, factory setting 4000 Hz.

3. Activate input LOAD.
   → Output signal END/$\overline{\text{L.A.}}$ is activated.
   → Output signal FAULT/CL is deactivated. (Any error message is deleted.)

4. Read in decade values with the control signals RS/CL.A. and FAULT/CL in accordance with timing diagram (fig. 3-32).

   The output FAULT/CL functions as a synchronization clock for the data transfer. On every edge change, the unit prompts the PLC to send the next decade (1, 4). The PLC then applies the decade value to the unit. Afterwards, the PLC confirms existance of the decade (2, 5) via the RS/CL.A. signal. The unit accepts the decade value (3, 6). It must be noted that the unit queries every single decade at intervals of 1000 µs. The number of queries per decade depends on the adjustable parameter value in "decade settling time". The decade value must be applied for an appropriate period to ensure save data transfer. On detection of inadmissible data, an error message is issued.

   After reading in all 8 decades, the process is repeated depending on the number of "readings" set as a parameter value. The 8 decade values are hereby compared with the previously applied values. An error message is issued on incongruence of the values.

   The output END/$\overline{\text{L.A.}}$ is deactivated at the end of loading. If output FAULT/CL is inactive, positioning can be initiated.

ATTENTION
The decade values must not be modified during the specified "readings". Otherwise, an error message will be issued. (Output FAULT/CL is active).
In such a case, reading must be repeated completely.

ATTENTION
The signal times for the parallel data transfer stipulated in the table must be observed.

5. Activate input START.
   → The output signal INPOS is deactivated. The motor is positioning (parameter set 0 motor acceleration, factory setting =100 Hz/ms).
   → Output signal INPOS is reactivated after terminating the movement.

NOTE
The inputs START and LOAD can also be activated simultaneously for reading in and starting immediately.

NOTE
An input test can be conducted with the PC (suitable for detecting wiring errors, e.g. of the decade switches).

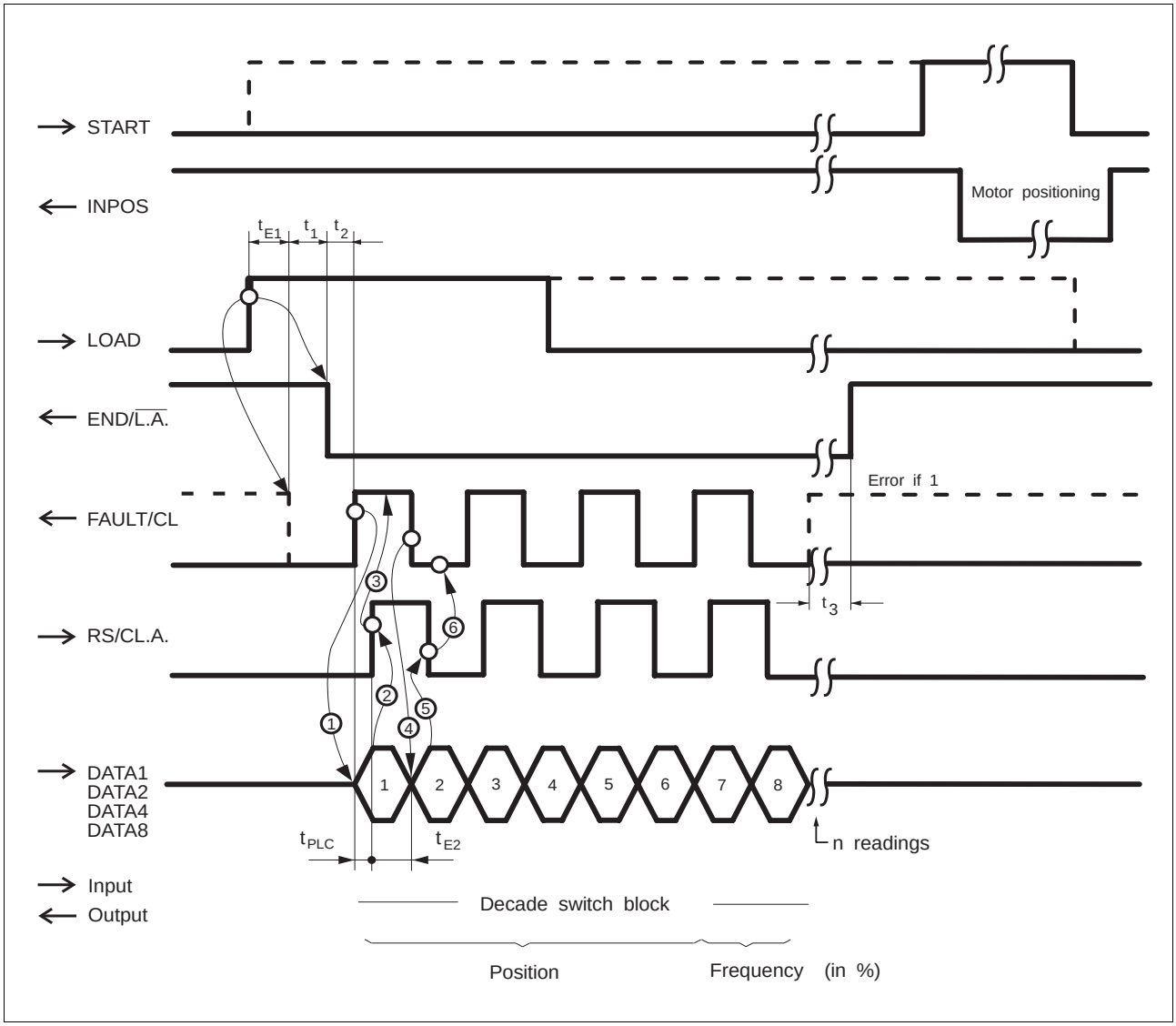


Fig. 3-32 Timing diagram for parallel data transfer

Abbreviation	Meaning	Minimum	Factory setting	Maximum	Unit
t_{E1}	"Settling time"	1	4	255	ms
t_1	Wait time if an error has occured in the previous reading cycle		400		µs
t_2	Time delay between END/$\overline{\text{L.A.}}$ = 0 and the first decade request with FAULT/CL = 1.		100		µs
t_{PLC}	Time delay between data request and validity acknowledgement		PLC-dependent		µs
t_{E2}	"Decade settling time"	5	5	255	x100 µs
t_3	Wait time, if an error has ocurred in the previous reading cycle		400		µs

3.4.4.3 System setting

The following parameters can be modified within the specified ranges:

NOTE
System setting see documentation PRO-SDP/PC1 .

Parameter		**Range**	**Factory setting**
L=	Ramp gradient	8 to 32767	100
F=	Set frequency ≙ 100% setting	8 to 195000 Hz[1)] 8 to 390000 Hz[2)]	4000 Hz
KP=	Proportional component for position controller	0 to 32767	200
KI=	Integral component for position controller	0 to 32767	0
KD=	Differential component for position controller	0 to 32767	1400
XL=	Following error for position controller	0 to 4000 increments	1000
PW=	Positioning window	1 to 4000 increments	10
	Manual frequency slow	8 to 195000 Hz[1)] 8 to 390000 Hz[2)]	1000 Hz
	Manual frequency fast	8 to 195000 Hz[1)] 8 to 390000 Hz[2)]	4000 Hz
	Manual frequency REF_IN (for manual reference movement)	8 to 195000 Hz[1)] 8 to 390000 Hz[2)]	8000 Hz
	Gear ratio "Numerator"	± 1 to± 30000	1
	Gear ratio "Denominator"	1 to 30000	1
	Settling time t_E	1 to 255 ms	4 ms
	Readings	1 to 255	2
	Decade settling time	5 to 255 (x 100 µs)	5 x 100 µs
	Reference position	± 8300000	0

1) Shaft encoder with 500 marks
2) Shaft encoder with 1000 marks

The initialization values for the processor unit are listed in the following table.

Init values		**Range**	**Factory setting**
PA =	Phase advance	5 to 100	35
DA =	Shaft encoder resolution	500 or 1000 marks	1000 marks
MR =	Controller mode	0 = Current controller 1 = Load angle controller	0
RS =	Quiescent current	0 to 100%	50%
AR =	Locking	0 to 65535 ms	0 ms
TA =	Controller sampling time	500, 1000, 2000 µs	1000 µs
IS=	Automatic integral component	0 to 32767	1

3.5 Serial polling mode

In this operating mode, the individual jobs and commands are directly transferred to the WDP5-228 via the serial interface and initiated.

The data format, polling type (discrete or group polling), used control codes, character transfer as well as the general order syntax are described in chapter 3.5.4.

3.5.1 Activating the serial polling mode

1. Switch off supply voltage for processor unit.
2. Set operating mode selector switch (47) to "9".
3. Set desired network address (range 1-31) at selector switch (48) or (49):

   Selector switch (48) = value of tens
   Selector switch (49) = value of ones
   (e.g. "12", see fig. 3-33)

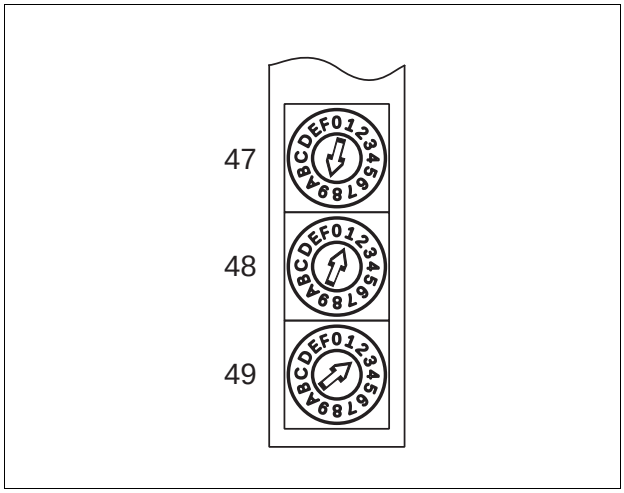


Fig. 3-33 Operating mode selector switch

4. Switch on supply voltage for processor unit:
   → Serial polling mode is active.
   LED 43 lights up.
5. Perform the subsequent operating possibilities.

The following operating possibilities are available in serial polling mode:

Manual movement

– Slow manual movement
  The regulated stepping motor rotates at "Manual frequency slow" which can be modified as a parameter. The parameter value is adjustable, factory setting 1 kHz.

– Fast manual movement
  The regulated stepping motor rotates at "Manual frequency fast" which may be modified as a parameter. The parameter value is adjustable, factory setting 4 kHz.

– Manual reference movement
  The regulated stepping motor rotates at a frequency of 8 kHz until the desired limit or reference switch is detected.

  On detecting the selected limit switch and braking, the stepping motor leaves the limit or reference switch at a frequency of 500 Hz and stops. This position serves as the reference point for the system of dimensions.

– Setting the manual reference point
  The reference position (factory setting 0) which may be modified as a parameter, is accepted as the new reference value for the system of dimensions by activating two inputs. A reference movement is not required.

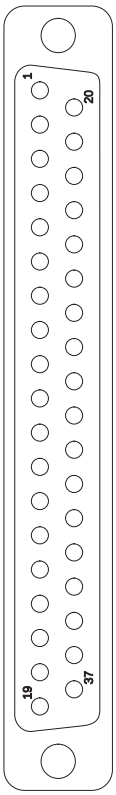
Automatic run

– Operation via terminal or PC
  at a transmission speed of 9600 bauds

The following sub-modes are available:

– Point-to-point MD = 0
– Frequency characteristics MD = 1
– Electronic gear MD = 2.

Control signals in serial polling mode



Pin	Abbreviation	Meaning	
1	$\overline{\text{LIM.X-}}$	Negative limit switch	←
2	-	-	
3	-	-	
4	-	-	
5	LOAD	Store position	←
6	$\overline{\text{ADD.REF.}}$	Additional reference switch	←
7	MAN.X-	Manual movement, CCW rotation	←
8	MAN.L/H	Slow/fast manual movement	←
9	-	-	
10	-	-	
11	-	-	
12	-	-	
13	FOLLOW.F.	Following error limit	→
14	FAULT/CL	Error	→
15	READY O.	Ready for operation	→
16	24VDC	System supply voltage	←
17	24VDC	System supply voltage	←
18	IO24VDC	I/O supply voltage	←
19	IO24VDC	I/O supply voltage	←
20	$\overline{\text{LIM.X+}}$	Positive limit switch	←
21	-	-	
22	-	-	
23	$\overline{\text{STOP}}$	Stop	←
24	-	-	
25	AUTOM	Automatic operation	←
26	MAN.X+	Manual movement, CW rotation	←
27	MAN.REF.	Manual reference movement	←
28	-	-	
29	-	-	
30	-	-	
31	-	-	
32	TEMP.OK	Temperature o.k.	→
33	INPOS	Position reached	→
34	-	-	
35	24VGND	System supply voltage ground	←
36	24VGND	System supply voltage ground	←
37	IOGND	I/O supply voltage ground	←

$\overline{\text{active-low signal}}$ ← input → output

3.5.2 Manual movement

NOTE
Position control is activated by triggering a manual action (e.g. set dimensions or manual movement). Any locks which are in effect are cancelled.

3.5.2.1 Slow manual movement

1. Deactivate input AUTOM.
2. Select the sense of rotation:
   – For positive sense of rotation in clockwise direction viewed to motor shaft: activate input MAN.X+.
   – For negative sense of rotation in counterclockwise direction viewed to motor shaft: activate input MAN.X-.

   → The motor rotates at "Manual frequency slow" in the selected direction, as long as input MAN.X+ or MAN.X- is active and the limit switch is not reached or $\overline{\text{STOP}}$ activated.

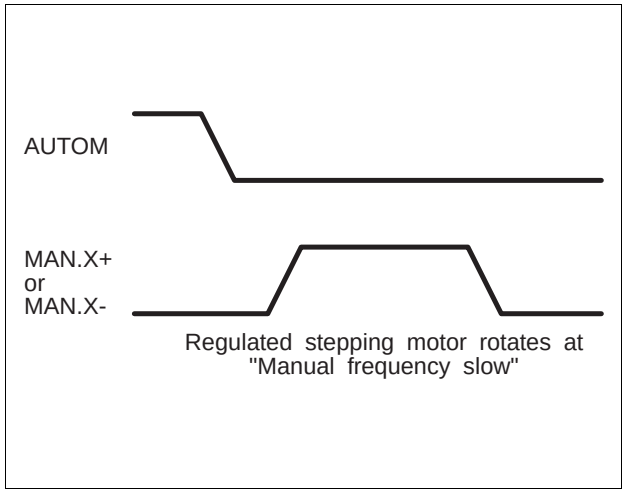


Fig. 3-34 Slow manual movement

NOTE
If input MAN.X+ or MAN.X- is activated only for a short time (<0.5 s), the motor performs a step.

NOTE
The motor accelerates/decelerates with the ramp gradient stored in parameter set 0 during manual movement.

NOTE
The parameter "Manual frequency slow" is adjustable, factory setting 1 kHz.

3.5.2.2 Fast manual movement

1. Deactivate input AUTOM.

2. Select the sense of rotation:
   – For positive sense of rotation in clockwise direction viewed to motor shaft:
   activate input MAN.X+ and MAN.L/H simultaneously (longer than settling time t_E).
   – For negative sense of rotation in counterclockwise direction viewed to motor shaft:
   activate input MAN.X- and MAN.L/H.

   → The motor rotates at "Manual frequency fast" in the desired direction, as long as the inputs MAN.X+ or MAN.X- and MAN.L/H are active.

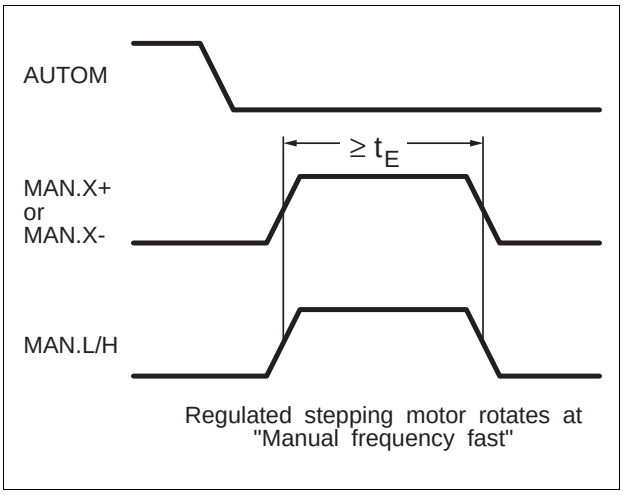


Fig. 3-35 Fast manual movement

NOTE
The motor accelerates/decelerates with the ramp gradient stored in parameter set 0 during manual movement.

NOTE
The parameter "Manual frequency fast" is adjustable, factory setting 4 kHz.

3.5.2.3 Manual reference movement

NOTE
Reference movement principle see chapter 6.3.

1. Deactivate input AUTOM.

2. For performing a movement towards the limit switch in clockwise direction:
activate inputs MAN.X+ and MAN.REF simultaneously (longer than settling time t_E).

3. For performing a movement towards the limit switch in counterclockwise direction:
activate inputs MAN.X- and MAN.REF simultaneously (longer than settling time t_E).

4. For performing a movement towards the additional reference switch:
activate inputs MAN.L/H and MAN.REF simultaneously (longer than settling time t_E).

   → The motor keeps rotating at a frequency of 8 kHz in the selected direction until the limit switch or additional reference switch is detected. It then leaves the limit switch at a frequency of 500 Hz and stops. This position serves as the reference point for the system of dimensions.

NOTE
A reference movement may be interrupted by activating input $\overline{\text{STOP}}$.

NOTE
The motor accelerates/decelerates with the ramp gradient stored in parameter set 0 during manual movement.

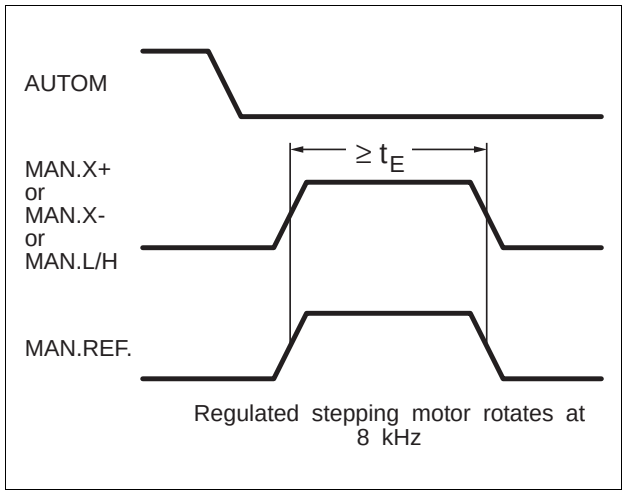


Fig. 3-36 Manual reference movement

3.5.2.4 Setting manual reference point

1. Deactivate input AUTOM.
2. Activate inputs MAN.REF and LOAD simultaneously (longer than settling time t_E).

   → The value of the "reference position" serves as the new reference value for the system of dimensions.

NOTE
The motor accelerates/decelerates with the ramp gradient stored in parameter set 0 during manual movement.

NOTE
The parameter "reference position" is adjustable, factory setting 0.

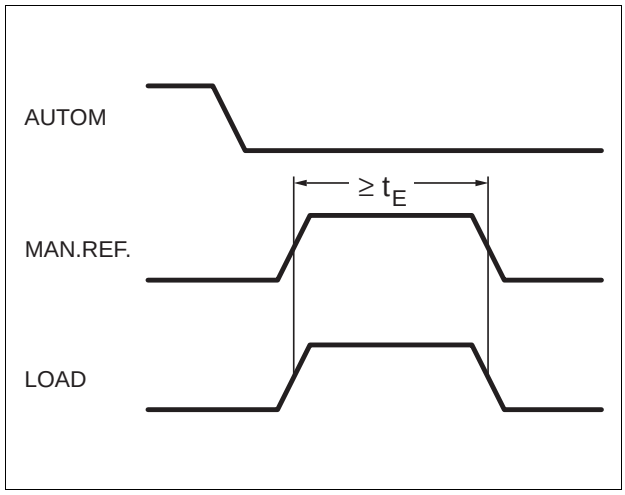


Fig. 3-37 Setting manual reference point

3.5.2.5 Manual movement (limited with PC)

Operation is effected with the commands and all additional characters listed in chapter 3.5.4.

3.5.3 Automatic run

1. Switch off supply voltage for processor unit.

2. Set operating mode selector switch (47) to "9" and operating mode selector switch (48) or (49) to the desired address.

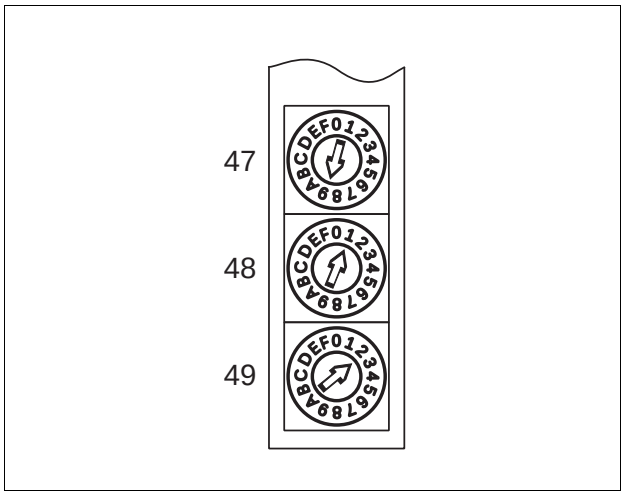


Fig. 3-38 Operating mode selector switch

3. Connect terminal or PC to serial interface.

4. Switch on supply voltage for processor unit.
   → LED 43 lights up, output READY O. is active.

NOTE
After switching the processor unit on, readiness of the power drive is expected within a period of 15 sec. or checked.

5. Activate input AUTOM.
   → LED 44 lights up, output INPOS is active.

NOTE
Position control is immediately active.

6. Positioning jobs are transferred and initiated with the aid of commands and orders. Parameters can be modified.

7. Further operation is described in chapter 3.5.4.

NOTE
Examples of calculation and acknowledgements of all submodes are listed in the appendix, see chapters 6.4 and 6.5.

3.5.4 Operation with terminal or PC

Commands are instructions to the unit-internal operating system. They are immediately executed without special acknowledgement.

Commands are divided into action commands (A), setting commands (S), mixed commands (M), direct commands (D) and init values (I).

A command group consists of an action and a setting command. The action command triggers an action after the start command (e.g. positioning).

Command	Meaning	Range	Factory setting
STO	Save RAM content in EEPROM		
SI[1)]	System information	0 to 16	
P[1)]	Output position in sub-mode "Point-to-point"		
FS[1)]	Deliver fatal error message in clear text		
S[1)]	Issue status or error message		
SK	Output status check		
BA	Activate broadcast processing	0 = no 1 = yes	0
M99	Stops the movements in sub-modes - Point-to-point - Frequency characteristics		
E	Start or execute command		
SR1)	Software reset		

1) Also possible during manual movement

Command	Type	Meaning	Range	Factory setting
MD=	A	Activate sub-mode	0 = Point-to-point 1 = Frequency character. 2 = Electronic gear	0
X=	A	Setpoint to be approached, travel	± 8300000	0
G25	A	Reference movement towards negative limit switch		
G26	A	Reference movement towards positive limit switch		
G27	A	Reference movement towards additional reference switch		
G28=	E	Enter reference position	± 8300000	0
G29	A	Set reference point		
G90	E	Set system of absolute dimensions		
G91	E	Set system of incremental dimensions		
L=[1)]	E	Ramp gradient in sub-mode - point-to-point - frequency characteristics	8 to 32767 Hz/ms	100 Hz/ms
F=[1)]	E	Should-be frequency in sub-mode point-to-point	8 to 195000 Hz[2)] 8 to 390000 Hz[3)]	4000 Hz
VY=	A	Should-be frequency in sub-mode frequency characteristics	± 195000 Hz[2)] ± 390000 Hz[3)]	0 Hz
EZ=	A	Gear ratio "Numerator" in sub-mode "Electronic gear"	± 30000[5)]	0
EN=	M	Gear ratio "Denominator" in sub-mode "Electronic gear"	1 to 30000	1
SV	M	Save parameter set	0 to 3	0
RD=	M	Read parameter set	0 to 3	0

Command	Type	Meaning	Range	Factory setting
KP[1)4)]	M	Proportional component for position controller	0 to 32767	200
KI[1)4)]	M	Integral component for position controller	0 to 32767	0
KD[1)4)]	M	Differential component for position controller	0 to 32767	1400
XL=[1)4)]	M	Following error for position controller	0 to 4000 increments	1000 incr.
PW=[1)4)]	M	Position window	1 to 4000 increments	10 incr.
M96=	D	Manual frequency slow	8 to 195000 Hz[2)] 8 to 390000 Hz[3)]	1000 Hz
M97=	D	Manual frequency fast	8 to 195000 Hz[2)] 8 to 390000 Hz[3)]	4000 Hz
GZ=	D	Gear ratio "Numerator" in sub-mode "Point-to-point"	± 1 to ± 30000	1
GN=	D	Gear ratio "Denominator" in sub-mode "Point-to-point"	1 to 30000	1
M95=	D	Gear ratio "Decimal" in sub-mode "Point-to-point"	0.1 to 100.0	1.0
PA=[4)]	I	Phase advance	5 to 100 kHz	35 kHz
DA=[4)]	I	Shaft encoder resolution	500 or 1000 marks	1000
MR=[4)]	I	Controller mode	0 = Current controller 1 = Load angle controller	0
GI=[4)]	I	Gear interface in sub-mode "Electronic gear"	0 = $Pulse_{forw}$/$pulse_{backw}$ signals 1 = Pulse/direction signals 2 = A/B signals	2
RS=[4)]	I	Quiescent current	0 to 100%	50%
AR=[4)]	I	Locking	0 to 65535 ms	0 ms
TA=[4)]	I	Controller sampling time	500, 1000, 2000 µs	1000 µs
IS=[4)]	I	Automatic integral component	0 to 32767	1

1) These commands can be saved with "SV" or read with "RD"
2) Shaft encoder with 500 marks
3) Shaft encoder with 1000 marks
4) Also possible during manual movement
5) Negative gear ratio numerator means direction reversal, the limit switlches must be interchanged.

The letters A, S, M, D and I in 2nd column "Type" have the following meaning:

A = Action command

Action command A is an action-triggering command, e.g. starting a positioning process or activating a new gear ratio in sub-mode "Electronic gear". The start command "E" respectively is required for triggering the action.

S = Setting command

The setting command only takes effect in combination with an action command, e.g. the ramp gradient only takes effect in combination with a movement command.

M = Mixed command

Basically, these can also be referred to as setting commands, however, with the difference, that activation by the start command "E" is also possible without transferring an additional action command.

D = Direct command

Commands are activated without special acknowledgement immediately after being transferred.

I = Init value

They have the same effects as mixed commands, however, these instructions include values for initializing the processor unit.

NOTE
If an action command is preceded by several setting commands for saving, loading and modifying parameters, the following internal processing sequence must be taken into consideration:

1. Saving a parameter set "SV=".
2. Reading a parameter set "RD=".
3. Modifying individual parameters e.g. "KP=".
4. Action command, e.g. "X=".

Example:

1. SV = 0 (Save parameter set)
2. KP = 256 (modify parameter)
3. L = 500 (modify parameter)
4. X = 1000 (action command)

3.5.4.1 Data record structure

Instructions consist of commands, orders and parameters together with additional characters. Instructions are transmitted from the terminal or PC to the positioning unit WDP5-228.

Several instructions can be transmitted in one line, with a maximum of 80 characters per line.
<BLANK>, <TAB> or comma may be used as separators between the instructions. An equal sign may be used between the instruction and the value in an instruction with data transfer.
There may only be one command with data output in a data record (e.g. "P", "S", "FS", "SI" or "SK").

NOTE
If an order is entered several times in one line, it is overwritten. No error message will be issued. This allows e.g. correcting a faulty input by entering a new value once again.

Additional character	Meaning
<CR>	End of data record
<LF>	Line feed
,	Separator between instructions
=	Separator between instructions and the appropriate value
<BLANK>	Separator between instruction components
<TAB>	Separator between instruction components
<DEL>	Deletes the last entered character of a record; the deleted character is output.
<BS>	Deletes the last entered character of a record; the deleted character is not output.
<CTRL>X	Deletes the entire record; it must be entered before.
<Break>	Any positioning process is immediately interrupted. The reference point must then be redefined.

3.5.4.2 Data format

The following data format is used for data transfer:

- ASCII
- 7 bits
- Even parity
- 9600 bauds
- 1 stop bit

Due to the data word width of 7 bit, transmission of ASCII characters above 127 is not possible.

3.5.4.3 Polling

In order to ensure a safe and reliable communication between the master and several slaves no slave may send data without being polled.

Discrete addressing

With a special polling order the master selects the slave with which it intends to communicate.

NOTE
The first order to be issued after switching on must always be the device polling order.

Order: #<Address><CR>
Adress values 1 ... 31

The data format for the polling order must be strictly observed. A 1 or 2-digit address value is acceptable.

The polled slave issues positive or negative acknowledgement in response to each order, depending upon whether the order was valid or invalid.

NOTE
The polling order is not acknowledged by the slave in order to optimize the response time.

The slave does not send an acknowledgement if a transmission error occurs.

In case of a successful data receipt, the slave issues positive or negative acknowledgement within the so-called timeout period of 200 ms.

Example:

The master polls slave 14, it issues the following order:

#	1	4	<CR>
23h	31h	34h	0Dh

The master is now able to communicate with the polled slave on a one-to-one basis.

A polled device deselects itself in case of the following states:

- different device address or faulty polling string
- character error e.g. parity etc.
- broadcast address (#0<CR>), in case of BA=1 commands are executed without acknowledgement
- connecting line interruption (Break)

Group polling (broadcast polling)

Several slaves can be polled simultaneously with the polling order #0 if they have been prepared for group polling with the order BA=1.

BA=1 means: Slave reacts to address #0
BA=0 means: Slave does not react to address #0 (factory setting)

A programming example for group polling is described in chapter 3.5.4.8.

NOTE
After switching on, the device is always set to BA=0.

3.5.4.4 Control codes

Abbreviation	ASCII value	Meaning
<CR>	0Dh	Carriage return
<ACK>	06h	Acknowledge (positive acknowledgement)
<NAK>	15h	Not acknowledge (negative acknowledgement)

3.5.4.5 Character transfer

The characters are transferred as ASCII characters (see table in appendix) or in ASCII-encoded hexadecimal format, depending on the order used.

For the the ASCII-encoded hexadecimal format a byte value (8 bits) is encoded in hexadecimal format and then converted to ASCII format.

Example:
Binary value 10001110 = 142 dec = 8E hex
"8" ASCII = 38 hex
"E" ASCII = 45 hex

3.5.4.6 General order syntax

Order	Data direction	Meaning
<Order>[data]<CR>	-->	Order to slave
<ACK>[data]<CR>	<--	Received order was found to be correct by the slave. It returns positive acknowledgement. Optionally, data can be transferred.
<NAK><CR>	<--	The slave does not recognize the order.
No acknowledgement	<--	The slave has detected a transmission error and does not send any acknowledgement. Error rectification see chapter 4.2.2.5

3.5.4.7 Status check ("SK")

An additional order - the status check - has been introduced which allows the fast determination of a moving axle status and a possible transmission error rectification.

Different device status are interrogated with the aid of an order.

Master		Slave	Comments
-------->	SK<CR>	-------->	Interrogate status check
<-------	<ACK><feedback value><CR>	<-------	Status check data output

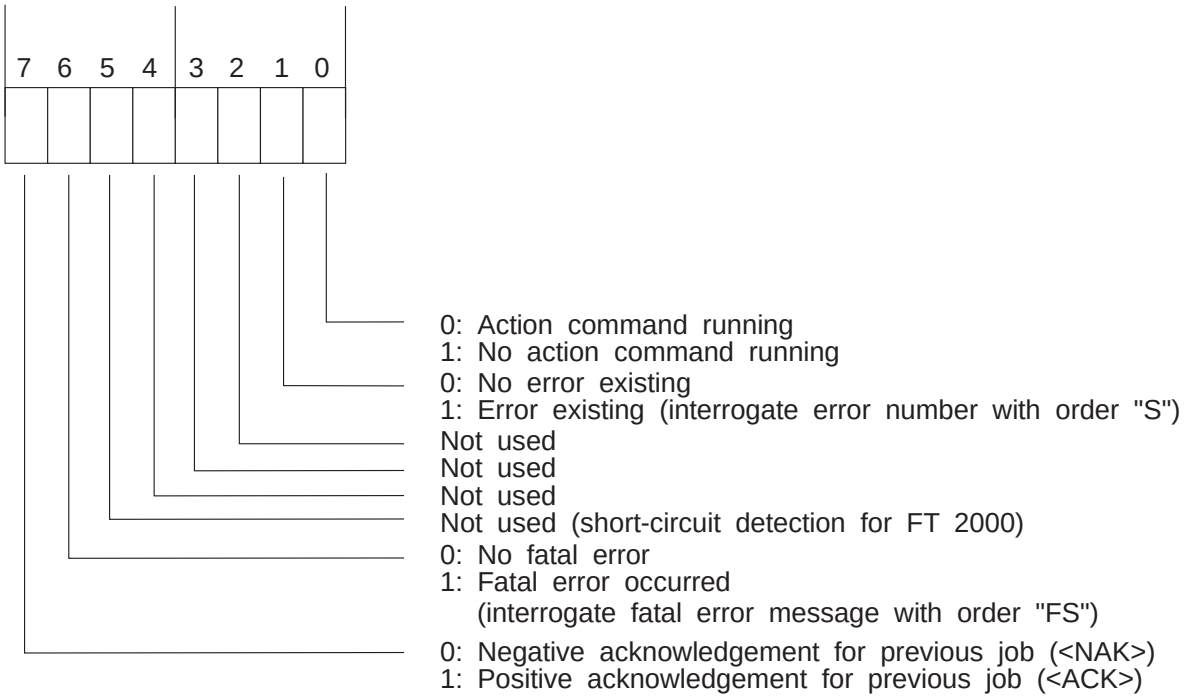
Feedback value encoding

The binary coded feedback value is issued as ASCII-encoded hexadecimal value.

Value: 10000001 = 81h

Transferred value: "81" (38h, 31h) (characters issued by the slave)

Data encoding in the feedback value



Explications on feedback value encoding

Bit 0: indicates whether the last action command has been executed or a new command is executed immediately upon transfer. Bit 1 and bit 0 are simultaneously set if a processing error (e.g. positioning process interrupted by STOP) occurs.

Example: Execute positioning and check whether positioning process has been terminated

	Master		Slave
	-------->	X1000E<CR>	-------->
	<-------	<ACK><CR>	<-------
	-------->	SK<CR>	-------->
1)	<-------	<ACK>81<CR>	<-------
		•	
		•	
	-------->	SK<CR>	-------->
2)	<-------	<ACK>81<CR>	<-------

1) Action command is executed (motor positioned)

2) Action command is terminated (motor in final position)

Bit 1: indicates whether an error has occurred e.g. positioning process has been interrupted by STOP. The error number may be issued with the order "S" (status and error message).

Bit 6: indicates whether the controller has detected a fatal error e.g. power drive failure. Work may only be continued after switching off the controller or performing a software test.

Bit 7: indicates whether the controller issued a positive or negative acknowledgement in response to the last instruction transferred. Thus, the master can interrogate whether the last job triggered positive or negative acknowledgement if it has detected a transmission error.

The following feedback formats are possible amongst others:

NOTE
The same number of characters is always output. The gaps are filled up with blanks "␣".

<ACK><X␣␣␣10000><CR>	Position check
<ACK><X␣------><CR>	System has no reference
<ACK>(E␣␣6)<CR>	Status/error number
<ACK>ff␣kein␣fataler␣Fehler<CR>	Fatal errors in clear text
<ACK>07␣Positive␣Grenze␣erreicht<CR>	
<ACK>81<CR>	Status check interrogation
Request single line Master ——— SI1<CR> ———→ Slave <ACK>01␣V1␣␣␣␣␣00.18␣␣␣␣␣V2␣␣␣␣␣00.16<LF><CR>	Explanation see adjacent table Feedback format command "SI": The characters are fed back in ASCII code. The feedback format has been defined in such a way that the data can simply be evaluated also by using a high-level language (e.g. with sscanf in C). 1 2 3 01234567890123456789012345678901 NN␣TTT␣VWWWWWWW␣␣␣␣␣TTT␣VWWWWWWW N = Line no. T = Text V = Preceding sign Meaning of the individual feedback formats see table "System information SI"
Request complete system information Master ——— SI0<CR> ———→ Slave <ACK>01␣V1␣␣␣␣␣00.18␣␣␣␣␣V2␣␣␣␣␣00.16<LF>	
02␣ST1␣00001000␣␣␣␣␣ST2␣01000101<LF>	
03␣IN1␣11111110␣␣␣␣␣IN2␣01111111<LF>	
04␣OUT␣00001000␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣<LF>	
05␣XW␣␣␣␣␣␣␣␣␣0␣␣␣␣␣XI␣␣␣␣␣␣␣␣-5<LF>	
06␣VY␣␣␣␣␣␣␣␣␣0␣␣␣␣␣XD␣␣␣␣␣␣␣␣␣5<LF>	
07␣F␣␣␣␣␣␣␣4000␣␣␣␣␣L␣␣␣␣␣␣␣␣100<LF>	
08␣DA␣␣␣␣␣␣1000␣␣␣␣␣PA␣␣␣␣␣␣␣␣35<LF>	
09␣GI␣␣␣␣␣␣␣␣␣2␣␣␣␣␣RS␣␣␣␣␣␣␣␣50<LF>	
10␣AR␣␣␣␣␣␣␣␣␣0␣␣␣␣␣MR␣␣␣␣␣␣␣␣␣0<LF>	
11␣GZ␣␣␣␣␣␣␣␣␣1␣␣␣␣␣GN␣␣␣␣␣␣␣␣␣1<LF>	
12␣EZ␣␣␣␣␣␣␣␣␣0␣␣␣␣␣EN␣␣␣␣␣␣␣␣␣1<LF>	
13␣TA␣␣␣␣␣␣1000␣␣␣␣␣KP␣␣␣␣␣␣␣␣256<LF>	
14␣KI␣␣␣␣␣␣␣␣␣0␣␣␣␣␣KD␣␣␣␣␣␣␣2000<LF>	
15␣XL␣␣␣␣␣␣1000␣␣␣␣␣PW␣␣␣␣␣␣␣␣10<LF>	
16␣IS␣␣␣␣␣␣␣␣␣1␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣␣<LF><CR>	

System information "SI"

Line	Meaning			
01	V1: Software version processor section		V2: Software version controller section	
02	ST1: System status byte 1 Bit Current sub-mode 0 to 3: 0000 Point-to-point 0001 Frequency characteristics 0010 Electronic gear		ST2: System status byte 2	
			Bit 0 Controller mode	0 = inactive 1 = active
			Bit 1 Reference point	0 = not available 1 = available
			Bit 2 Current dimension	0 = incremental 1 = absolute
			Bit 3 last positioning interrupted	0 = uninterrupted 1 = interrupted
	Bit 4 sub-mode active	0 = manual movement 1 = automatic run	Bit 4 not used	
	Bit 5 not used		Bit 5 Motor or heat sink temperature	0 = temp. too high 1 = temp. o.k.
	Bit 6 not used		Bit 6 Battery status	0 = flat 1 = o.k.
	Bit 7 not used		Bit 7 EEPROM option	0 = not provided 1 = provided
03	IN1: Input states 1 NOTE State: 0 = input 0 V 1 = input 24 V Bit 0 Stop Bit 1 Automatic run Bit 2 Start Bit 3 Program start Bit 4 Program no. 2^0 Bit 5 Program no. 2^1 Bit 6 Program no. 2^2 Bit 7 Program no. 2^3		IN2: Input states 2 NOTE Status: 0 = input 0 V 1 = input 24 V Bit 0 Manual clockwise rotation Bit 1 Manual counterclockwise rotation Bit 2 Fast manual movement Bit 3 Manual reference movement Bit 4 Store Bit 5 Additional reference switch Bit 6 Positive limit switch Bit 7 Negative limit switch	
04	OUT: Output states NOTE State: 0 = output 0 V 1 = output 24 V Bit 0 Ready Bit 1 Position reached Bit 2 Program end Bit 3 Error Bit 4 Temp.o.k. Bit 5 Following error limit exceeded Bit 6 not used Bit 7 not used			
05	XW: Motor setpoint		XI: Actual motor position	
06	VY: Max. should-be frequency in sub-mode "Frequency characteristics"		XD: Positional difference XD = XW - XI	
07	F: Max. should-be frequency in sub-mode "Point-to-point"		L: Ramp gradient	
08	DA: Shaft encoder resolution		PA: Phase advance	
09	GI: Gear interface in sub-mode "Electronic gear" O = $Pulse_{forw}/Pulse_{backw}$ 1 = Pulse/direction 2 = A/B shaft encoder signals		RS: Quiescent current Quiesecnt current with contr. inactive Given in percentage of max. current	
10	AR: Locking		MR: Controller mode	0 = Current contr. 1 = Load angle contr.
11	GZ: Gear ratio "Numerator" in sub-mode "Point-to-point		GN: Gear ratio "Denominator" in sub-mode "Point-to-point"	
12	EZ: Gear ratio "Numerator" in sub-mode "Electronic gear"		EN: Gear ratio "Denominator" in sub-mode "Electronic gear"	
13	TA: Sampling time		KP: Proportional component	
14	KI: Integral component		KD: Differential component	
15	XL: Following error limit for display		PW: Programmable positioning window	
16	IS: Automatic integral component			

3.5.4.8 Program examples

Serial polling mode

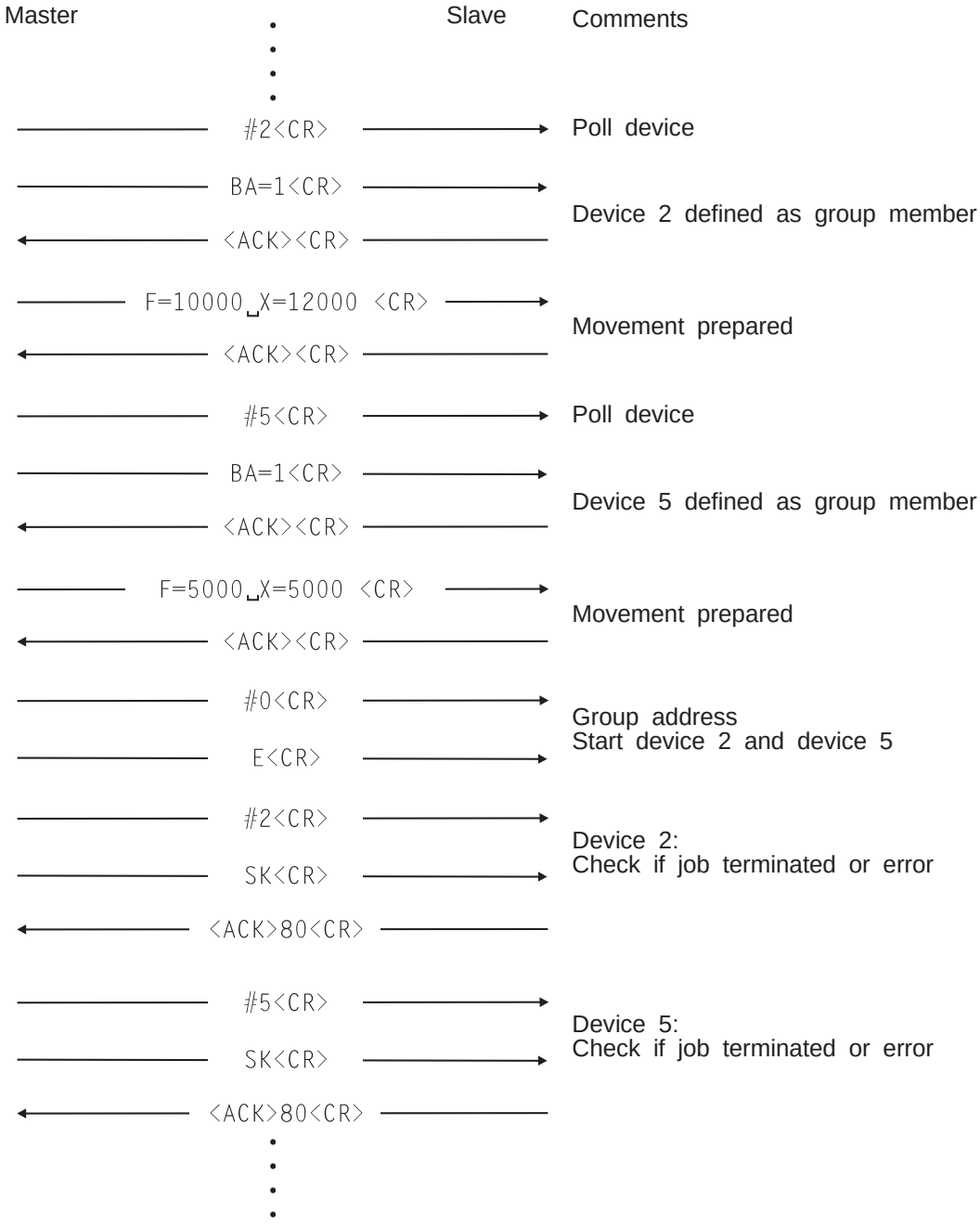
The current device address shall be 10_D. After switching on, the motor shall perform the following positioning starting from its current position:
- Speed = 10.000 Hz
- Acceleration = 50 Hz/ms
- Position 1 = 12 000 increments

The current setpoint shall be issued during the movement. After terminating the movement, the following positioning shall be performed:
- Speed = 5 000 Hz
- Position 2 = 0 increments = start position

Master	Slave	Comments
#10<CR>	→	Poll device
G28=0 G29E<CR>	→	Set current motor position = 0
	← <ACK><CR>	
F=10000␣L=50␣X=12000␣E␣<CR>	→	Trigger 1. positioning
	← <ACK><CR>	
P<CR>	→	Issue position value
	← <ACK><X␣␣␣␣␣15<CR>	
SK<CR>	→	Issue status check
	← <ACK>80<CR>	Positioning not yet terminated
• • • •		Position check and status check until positioning is terminated
SK<CR>	→	Indicator bit for positioning terminated
	← <ACK>81<CR>	
F=5000␣X=0␣E␣<CR>	→	Trigger 2. positioning
	← <ACK><CR>	
SK<CR>	→	Issue status check
	← <ACK>80<CR>	Positioning not yet terminated
• • • •		Position check and status check until positioning is terminated
SK<CR>	→	Issue status check
	← <ACK>81<CR>	Indicator bit for positioning terminated

Group processing

Device 2 and device 5 shall be prepared separately and then simultaneously started:



3.5.4.9 Error and status messages

The current status message or error identification after an error may be issued by the "S" order.

Error message	Meaning
(E 4)	Right limit switch actuated
(E 5)	Left limit switch actuated
(E 6)	Stop triggered
(E 14)	Undefined position
(E 16)	Input value too low
(E 17)	Input value too high
(E 73)	Input buffer full
(E 74)	Inadmissible commnad
(E 76)	No value stated or incorrect format
(E 77)	Start attempt without valid data
(E 78)	Internal counter overflow, set dimensions!
(E 81)	System error, request clear text message with FS
(E101)	Motor does not stand still, $v_{mot} \neq 0$
(E102)	Specify value
(E103)	Action command not executed
(E104)	Job interrupted by automatic run/ manual switching
(E106)	EEPROM option not installed or defective
(E107)	Command not permitted in the currently selected sub-mode
(E110)	More than one order with data output available

Status message	Meaning
(E 98)	Manual movement, no error has occurred
(E 99)	Automatic run, no error has occurred

3.6 Switching off

The connected motor is no longer supplied with current after switching off the supply voltage for the power drive, i.e. it has no holding torque.

NOTE
Make sure that vertical axle loads are prevented from dropping (e.g. motor with brake) before switching the supply voltage off.

Switch off supply voltages for power drive and processor unit.

4 Malfunctions

4.1 Status displays

The seven-segment display (02) indicates malfunctions in the power drive, see chapter 4.2.1.

The seven-segment display (40) indicates malfunctions of the processor unit, see chapter 4.2.2.

LEDs 41 to 46 indicate operating states and malfunctions. They refer to the following signal outputs:

LED 41 (red)	FOLLOW F. (Following error limit)
LED 42 (red)	FAULT/CL (Fault/Clock)
LED 43 (green)	READY O. (Ready for operation)
LED 44 (green)	INPOS (Position reached)
LED 45 (green)	Several functions
LED 46 (green)	END/$\overline{\text{L.A.}}$ (Program end/ load acknowledge)

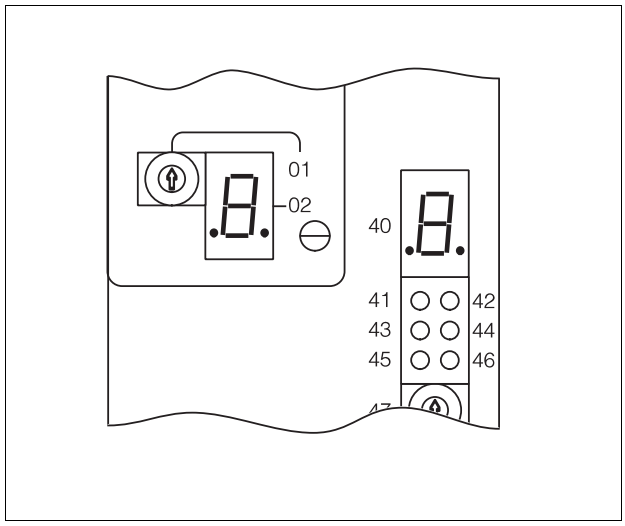


Fig. 4-1 Status displays

4.2 Trouble-shooting table

4.2.1 Power drive

The following table summarizes possible malfunctions which are indicated by the seven-segment display of the power drive as well as their causes and rectification.

Display	Cause	Rectification
■ Flashing	Internal error	Replace unit
0	Temperature at mounting flange >60°C Unit remains operable!	Reduce phase current
		Attach heat sink or enlarge existing heat sink, see chapter 6.2.7
		Provide existing heat sink with ventilator set, see chapter 6.2.8
2	Load circuit active	Choose lower acceleration value
3	Temperature at mounting flange too high	Reduce phase current
		Attach heat sink or enlarge existing heat sink, see chapter 6.2.7
		Provide existing heat sink with ventilator set, see chapter 6.2.8
4	Short-circuit in connector, cable or motor; Phase to phase, phase to ground	Switch off unit and remote short-circuit
		Replace motor
	Braking energy of the motor too high; load resistor missing	Connect load resistor, see chapter 6.2.1
6	Unit set to 230 VDC; input voltage 115 VDC	Apply appropriate supply voltage
	Supply voltage outside the permissible tolerance range	
8	Processor unit not ready	See processor unit trouble-shooting tables

4.2.2 Processor unit

4.2.2.1 Serial mode

The following table summarizes the malfunctions which are possible in serial mode as well as their causes and rectification.

Display	Cause	Rectification
■ Flashing	Battery failure	Call BERGER LAHR
	Power drive failure	Restart system
	Travel too long	
	RAM or EPROM error (LED 45 flashes)	Replace unit
	Following error	Increase current in power drive
		If necessary, use more powerful motor
		Restart system
		Compare value at for "PA" with PA value in motor table (see chapter 2.6)
	Excessive temperature of motor or fault on shaft encoder line	Check motor
		Check shaft encoder line
	Hardware error e.g. – RAM error of position controller – Position controller defective	Replace unit
	On manual movement: Manual positioning interrupted by signal at limit switch or $\overline{\text{STOP}}$	Move mechanism outside limit switch area or deactivate STOP
	Input $\overline{\text{LIM.X-}}$, $\overline{\text{LIM.X+}}$, $\overline{\text{ADD.REF}}$ or $\overline{\text{STOP}}$ not cabled	Check cabling

4.2.2.2 Network mode "Memory"

The following table summarizes malfunctions possible in network mode "Memory" as well as their causes and rectification.

Display	Cause	Rectification
■ Flashing	Battery failure	Call BERGER LAHR
0	Power drive failure	Restart system
	Travel too long	
	RAM or EPROM error (LED 45 flashes)	Replace unit
	Following error	Compare value set for "PA" with PA value in motor table (see chapter 2.6)
		- Select a lower ramp gradient value (= acceleration) - Eliminate any external disturbances (load moments, friction moments, etc.)
		If necessary, increase current in power drive
		If necessary, use more powerful motor
		Restart system
	Excessive temperature of motor or fault on shaft encoder line	Check motor
		Check shaft encoder line
	Hardware error e.g. - RAM error of position controller - Position controller defective	Replace unit
	Inadmissible network address set	Set admissible network address (see chapter 3.4)
1	On automatic run: Limit switch actuated	Check system Positioning may be terminated by repeated activation of input START
	On automatic run: Interference on limit switch line	
3	Input $\overline{\text{STOP}}$ activated	Check system; Reactivate input START and terminate positioning
	Malfunction at input $\overline{\text{STOP}}$	
5	On manual movement: Manual movement interrupted by signal at limit switch or $\overline{\text{STOP}}$	Move mechanism outside limit switch area or deactivate STOP
	Input $\overline{\text{LIM.X-}}$, $\overline{\text{LIM.X+}}$, $\overline{\text{ADD.REF}}$ or $\overline{\text{STOP}}$ not cabled	Check cabling
6	System has no reference point	Perform reference movement
		Set reference point
7	Input START activated although program end reached	Set program pointer back to program beginning

4.2.2.3 Network mode "Serial"

The following table summarizes the malfunctions possible in network mode "Serial" as well as their causes and rectification.

Display	Cause	Rectification
■ Flashing	Battery failure	Call BERGER LAHR
0	Power drive failure	Restart system
	Travel too long	
	RAM or EPROM error (LED 45 flashes)	Replace unit
	Following error	Compare value set for "PA" with PA value in motor table (see chapter 2.6)
		- Select a lower ramp gradient value (= acceleration) - Eliminate any external disturbances (load moments, friction moments, etc.)
		If necessary, increase current in power drive
		If necessary, use more powerful motor
		Restart system
	Excessive temperature of motor or fault on shaft encoder line	Check motor
		Check shaft encoder line
	Hardware error e.g. - RAM error of position controller - Position controller defective	Replace unit
	Inadmissible network address set	Set admissible network address (see chapter 3.4)
I [1] S [2]	On automatic run: Limit switch actuated	Check system; positioning may be terminated by repeated activation of input START
	On automatic run: Interference on limit switch line	
3 [1] 7 [2]	Input $\overline{\text{STOP}}$ activated	Check system; Reactivate input START and terminate positioning
	Malfunction at input $\overline{\text{STOP}}$	
S	On manual movement: Manual movement interrupted by signal at limit switch or $\overline{\text{STOP}}$	Move mechanism outside limit switch area or deactivate STOP
	Input $\overline{\text{LIM.X-}}$, $\overline{\text{LIM.X+}}$, $\overline{\text{ADD.REF}}$ or $\overline{\text{STOP}}$ not cabled	Check cabling

[1] Display, if output END/$\overline{\text{L.A.}}$ = 0.

[2] Display, if output END/$\overline{\text{L.A.}}$ = 1.

4.2.2.4 Network mode "A-/R-Parallel"

The following table summarizes malfunctions possible in network mode "A-/R-Parallel" as well as their causes and rectification.

Display	Cause	Rectification
■ Flashing	Battery failure	Call BERGER LAHR
0	RAM or EPROM error (LED 45 flashes)	Replace unit
	Power drive failure	Restart system
	Travel too long	
	Following error	Compare value set for "PA" with PA value in motor table (see chapter 2.6)
		- Select a lower ramp gradient value (= acceleration) - Eliminate any external disturbances (load moments, friction moments, etc.)
		If necessary, increase current in power drive
		If necessary, use more powerful motor
		Restart system
	Excessive temperature of motor or fault on shaft encoder line	Check motor
		Check shaft encoder line
	Hardware error e.g. - RAM error of position controller - Position controller defective	Replace unit
	Inadmissible network address set	Set admissible network address (see chapter 3.4)
1	Limit switch actuated	Check system; positioning may possibly be terminated by reactivating input START
	Interference on limit switch line	
	No reference point available	Perform manual reference movement
		Set reference point
5	Start attempt without valid data	Effect read-in cycle
	Error while reading in the decade switch values	Read in again
	Manual positioning interrupted by signal at limit switch or $\overline{\text{STOP}}$	Move mechanism outside limit switch area or deactivate STOP
	Input $\overline{\text{LIM.X-}}$, $\overline{\text{LIM.X+}}$, $\overline{\text{ADD.REF}}$ or $\overline{\text{STOP}}$ not cabled	Check cabling
7	Input $\overline{\text{STOP}}$ activated	Check system; Reactivate input START and terminate positioning
	Malfunction at input $\overline{\text{STOP}}$	

4.2.2.5 Serial polling mode

Transmission error master ----> slave

If the slave detects a transmission error, it does not return an acknowledgement to the master and deselects itself. The master can detect the transmission error by means of an acknowledgement failure timeout check and respond as required by the application in question (e.g. repeat the order).

Example:

Data direction	**Command**	**Observations**
Master ---> Slave	X<Wert>E<CR>	Start positioning
Master ---> Slave	<ACK><CR>	Positive acknowledgement
Master ---> Slave	SK<CR>	Interrogate status check
	Error occurs	Slave detects transmission error
		Timeout period runs out
		Master detects timeout of the slave and attempts to repeat the job
Master ---> Slave	#1<CR>	Master polls slave 1
Master ---> Slave	SK<CR>	Interrogate status check
Master ---> Slave	<ACK>80<CR>	Slave returns value

Transmission error slave ----> master

When the master detects a transmission error, it cannot determine whether the previous order sent triggered positive ACK or negative AK acknowledgement by the slave. Therefore, it is uncertain whether the slave had interpreted and executed the order properly or whether it was invalid.

Repetition of the command might have fatal consequences.

In order to prevent such consequences, the WDP5-228 was provided with the system order "SK" (status check) (see chapter 3.5.4). The master may use this order to detect whether the last job sent was accepted by the slave or not.

4.2.3 Error messages

4.2.3.1 Error messages in all operating modes

The error numbers are encoded in hexadecimal format.

Error message	Possible cause	Rectification
Error 05 Stop signal detected	Stop triggered or STOP signal interference	
Error 07 Positive limit reached	Limit switch for positive sense of rotation triggered	
Error 08 Negative limit reached	Limit switch for negative sense of rotation triggered	
Error 0A Positive format limit reached	Range of values in the positive sense of rotation exceeded (+ 8300000 increments)	
Error 0B Negative format limit reached	Range of values in the negative sense of rotation exceeded (- 8300000 increments)	
Error 18 Range exceeded in relative positioning	Calculated setpoint in relative positioning out of the permissible moving range: ± 8300000	Change parameter "reference position"
Error 43 Overflow caused by GF	Setpoint calculated with gear ratio (≥ 1) out of the permissible moving range: ± 8300000	Network mode "Memory": Set new reference point in the program (command "G29=") Network mode "A-/R-Parallel": Enter new reference position and activate
Error 44 Overflow caused by GF	Movement with gear ratio (< 1) is out of the permissible moving range: ± 8300000	Network mode "Memory": Set new reference point in the program (command "G29=").
Error 45 Movement command without reference point	No reference movement performed before first positioning	Perform manual or automatic reference movement (commands "G25", G26", "G27") before positioning for the first time or set reference point (command "G29 =") before the first positioning
Error 47 Power drive not ready	Power drive failure	Check power drive
Error 4F Additional reference switch not found	The additional reference switch is not detected in the reference movement (command "G27").	Connect additional reference switch
		Check cabling
		Check additional reference switch
Error 60 Internal communication error	System error	Call BERGER LAHR
Error 64 Controller not ready	Hardware error	Call BERGER LAHR
Error 65 Motor does not stand still	Switching off sub-mode impossible, as motor speed ≠ 0	Set speed to 0 before switching over
Error 66 Precise input value required	Command only accepts certain values (e.g. "TA")	Enter admissible value

Error message	Possible cause	Rectification
Error 67 Action command not executed	Enter new action command, although prepared action command has not been triggered yet	Trigger prepared action command
Error 68 Job interrupted by switching over to manual	Switching over to manual movement, although job in preparation	
Error 69 Checksum error in instruction/parameter set	System error	Call BERGER LAHR
Error 6A No EEPROM available or EEPROM defective	Execution with data storage in the buffered RAM	Call BERGER LAHR
	EEPROM not provided or defective	
Error 6B Instruction in current sub-mode not permitted	Transferred instruction is not permitted in the current sub-mode (e.g. "VY" in sub-mode "Point-to-point")	
Error 70 RAM error of controller	Hardware error	Call BERGER LAHR
Error 71 Commutation error	Motor speed exceeded 6000 rpm	
	Fault in shaft encoder signal	
Error 72 Internal communication error detected by R-component	System error	Call BERGER LAHR
Error 73 Following error	Following error detected	Correct "PA" value setting
		Select a lower ramp gradient value (= acceleration)
		Eliminate any interference (load moments, friction moments)
		Possibly increase current in power drive
		If necessary, employ more powerful motor
		Restart system
Error 74 Excessive temperature of motor or fault on shaft encoder line	Maximum motor temperature exceeded	Reduce motor current
		Cool down motor
	Fault on shaft encoder line	Check shaft encoder line connection

4.2.3.2 Error messages in network mode

Error message	Possible cause	Rectification
Error 90 Inadmissible control byte	Control byte in protocol not permitted	Call BERGER LAHR
Error 92 Inadmissible command (code byte not defined)	Command not possible with this unit	
Error 93 Command in current network mode not permitted	Command with deactivated input AUTOM	Activate input AUTOM
	Command impossible in current network mode	Switch over to appropriate network mode
Error 94 Switching over between network operating modes impossible (AUTOM inactive)	Switching over to network mode with input AUTOM inactive	Activate input AUTOM
Error 95 Stop command in current operating mode impossible	Stop command in network mode "Memory" and "A-/R-Parallel" triggered	
Error 96 Switching over from manual to network mode "Serial" (remaining data deleted)	Switching over to manual movement although not all the transferred jobs have been processed	Wait until all transferred jobs have been processed in network mode "Serial"
Error A0 Deletion of more than 16 programs	More than 16 programs have been transferred for deletion	Check data record for the deletion of programs
Error A2 Inadmissible number of bytes in parameter data record	Incorrect number of values in parameter set	Check parameter set
Error A3 Parameter error: Frequency manual slow	Entered value out of range	Enter admissible value
Error A4 Parameter error: Frequency manual fasst	Entered value out of range	Enter admissible value
Error A5 Parameter error: Settling time	Entered value out of range	Enter admissible value
Error A6 Parameter error: Gear ratio numerator	Entered value out of range	Enter admissible value
Error A7 Parameter error: Gear ratio denominator	Entered value out of range	Enter admissible value
Error A8 Parameter error: Frequency REF IN	Entered value out of range	Enter admissible value
Error A9 Parameter error: Frequency REF OUT	Entered value out of range	Enter admissible value

Error message	Possible cause	Rectification
Error AA Parameter error: Readings in parallel mode	Entered value out of range	Enter admissible value
Error AB Parameter error: Decade settling time	Entered value out of range	Enter admissible value
Error AC Parameter error: Reference position	Entered value out of range	Enter admissible value
Error AF Overflow in customer positioning with new gear ratio	With a gear ratio <1, the customer position exceeds the admissible range of values ± 8300000	Set motor position to a lower value by setting the reference point (manual movement, "G29=")
Error B0 Program number already assigned	Program number in the unit used for loading a new program has already been assigned	Delete program number in the unit
Error B1 Program memory full	Program memory full	Delete programs in the unit
Error B2 Checksum error in the program	Checksum of movement program incorrect	Recompile program
Error B3 Too many programs in a data record	More programs transferred than selectable in the unit (max. 16)	Reduce the number of programs
Error B4 Number of transferred program bytes incorrect	Incorrect number of program bytes	Recompile program
Error B5 Timeout during read-in cycle in parallel mode	Data transfer takes longer than 5 seconds	Check handshaking in network mode "A-/R-Parallel"
Error B6 Inadmissible number of programs to be stored	Number of programs to be stored = 0 or > 16	Correct number
Error B8 Program number not assigned	Selected program number not assigned in the unit	Correct program number
Error B9 Incorrect unit code in the transferred data record	Data record not suitable for this type of unit	Process data record with correct unit code
Error C0 Transferred data block too large	Data block > 64 bytes received	Correct length of data block
Error C1 Inadmissible command code	Command code in network mode "Serial" not permitted	Correct command code
Error C2 Inadmissible command format	Incorrect number of bytes of the command data record in network mode "Serial"	Check command data record
Error C4 No job prepared or prepared job deleted	Attempt to delete a prepared job, although no job has been prepared	

Error message	Possible cause	Rectification
Error C5 More than one action command in the data record	More than one action command in the data record	Only transfer one action command per data record
Error C6 Setting command several times or complementary commands in a data block	e.g. command "G90" and "G91" transferred in a data block (complementary commands)	Check commands in data block
Error C7 Movement frequency range exceeded	Entered value out of range	Enter admissible value
Error C8 Ramp gradient range exceeded	Entered value out of range	Enter admissible value
Error C9 Frequency range "M21" exceeded	Entered value out of range	Enter admissible value
Error CA Online-Execute not permitted, as job already prepared	Job transferred with "Prepare" not yet triggered with "Start"	Trigger previous job with "Start" or cancel with "Erase"
Error CB Online-Start without preparing a job	Attempt to start a prepared job although no job prepared	Prepare job with "Prepare" first
Error CC Online-Execute without data requires prior Online-Execute with data	Movement repeat triggered by Online-Execute although no Online-Execute with data previously triggered	Perform Online-Execute with data
Error D1 Value specified for "KP" out of range	Entered value out of range	Enter admissible value
Error D2 Value specified for "KI" out of range	Entered value out of range	Enter admissible value
Error D3 Value specified for "KD" out of range	Entered value out of range	Enter admissible value
Error D4 Value specified for "XL" out of range	Entered value out of range	Enter admissible value
Error D5 Value specified for "PW" out of range	Entered value out of range	Enter admissible value
Error D6 Value specified for "RD" out of range	Entered value out of range	Enter admissible value
Error D7 Value specified for "SV" out of range	Entered value out of range	Enter admissible value
Error D8 Value specified for "MD" out of range	Entered value out of range	Enter admissible value

Error message	Possible cause	Rectification
Error D9 Value specified for "EZ" out of range	Entered value out of range	Enter admissible value
Error DA Value specified for "EN" out of range	Entered value out of range	Enter admissible value
Error E0 Command not permitted in current sub-mode	Network mode "Serial": Command transferred which is not permitted in the current sub-mode (e.g. "VY" in sub-mode "Point-to-point")	Check program
Error E1 Command not permitted in the current sub-mode	Network mode "Memory": Command transferred which is not permitted in the current sub-mode	Check program
Error E2 Value specified for "VY" out of range	Entered value out of range	Enter admissible value
Error E3 Command "RECORD/ STEP" impossible	Network mode "Memory" or "A-/R-Parallel" selected	Activate network mode "Serial"
	Sub-mode "Frequency characteristics" and "Electronic gear" selected	Activate sub-mode "Point-to-point"
	Motor not at rest	Wait until positioning terminated
Error E4 Error in intialization data record	Entered value out of range	Enter admissible value

4.3 Repair work

ATTENTION
Any repair work required may only be performed by BERGER LAHR!

Mark the respective connections when disassembling the unit.

The adjusted parameters as well as the mounting location number of the old unit must be transferred when replacing a unit.

4.4 Storage, shipment

The following must be noted when storing units or pc-boards:

- the maximum air humidity (see chapter 1.4) must not be exceeded.
- the storage temperature (see chapter 1.4) must be observed.
- protect the stored parts against dust and dirt.
- make sure that units or pc-boards provided with the symbol

  are only unpacked, stored and installed in an electrostatically protected environment.
- it must be ensured that units or pc-boards equipped with accumulators are connected to the supply voltage at least once a month.
- the original packing material must not be thrown away.

When shipping units or pc-boards it must be ensured that

- units or pc-boards are shipped in their original packing.
- Pc-boards without batteries or accumulators are packed in wrapping electrically conducting on both sides (possibly original wrapping).
- Pc-boards equipped with batteries or accumulators are packed in wrapping electrically conductive on the outside and antistatic on the inside (possibly original wrapping).
- units or pc-boards provided with the symbol

  are only packed in an electrostatically protected environment.

5 Maintenance

5.1 Maintenance chart

Interval	Maintenance work	Reference
Every 2 years for unit variant with battery-buffered memory	Replace battery	see chapter 5.2.1

5.2 Maintenance contract

5.2.1 Replacing the battery

DANGER
Disconnect mains power supply plug.

1. Dismount the unit.
2. Unscrew four screws on the right-hand side and remove side panel, pulling it towards the front.

ATTENTION
Avoid touching the sensitive CMOS circuits!

3. Connect the battery plug of the new battery to the 2nd terminal pair.
4. Disconnect the battery plug of the old battery.
5. Remove the old battery and insert the new battery.
6. Slide side panel into place and fix with the four screws.
7. Install the unit.

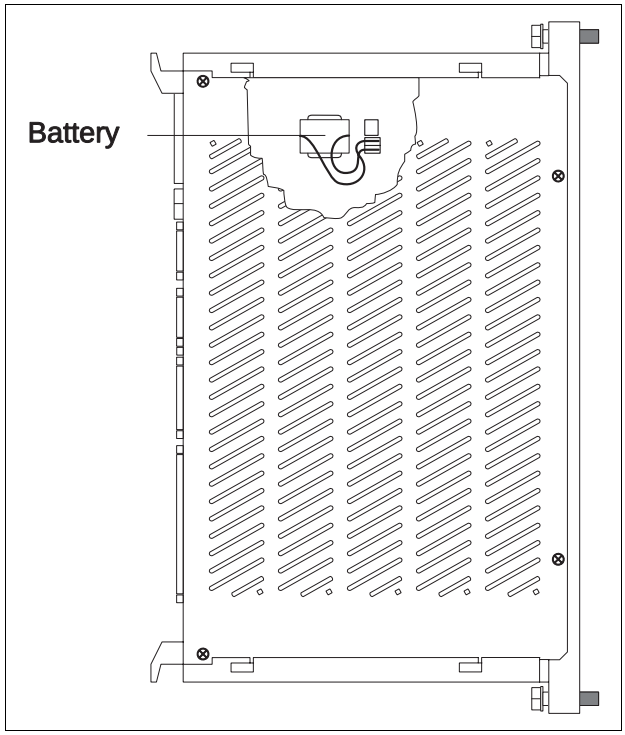


Fig. 5-1 Replacing the battery

5.3 Maintenance contract

In order to avoid times of standstill in case of unit failure, BERGER LAHR offers individual maintenance and service contracts.

Appropriate information can be obtained from the following address:

Berger Lahr GmbH & Co. KG
Abteilung Technische Dienste
Breslauer Str. 7
D-77933 Lahr

Telephone no. (07821) 946-02

6 Appendix

6.1 Unit variants

WDP5-228.0 x 1-0 x

Power drive supply voltage	
5	230 VAC
6	115 VAC

Memory	
0	Battery-buffered
1	EEPROM

6.2 Accessories

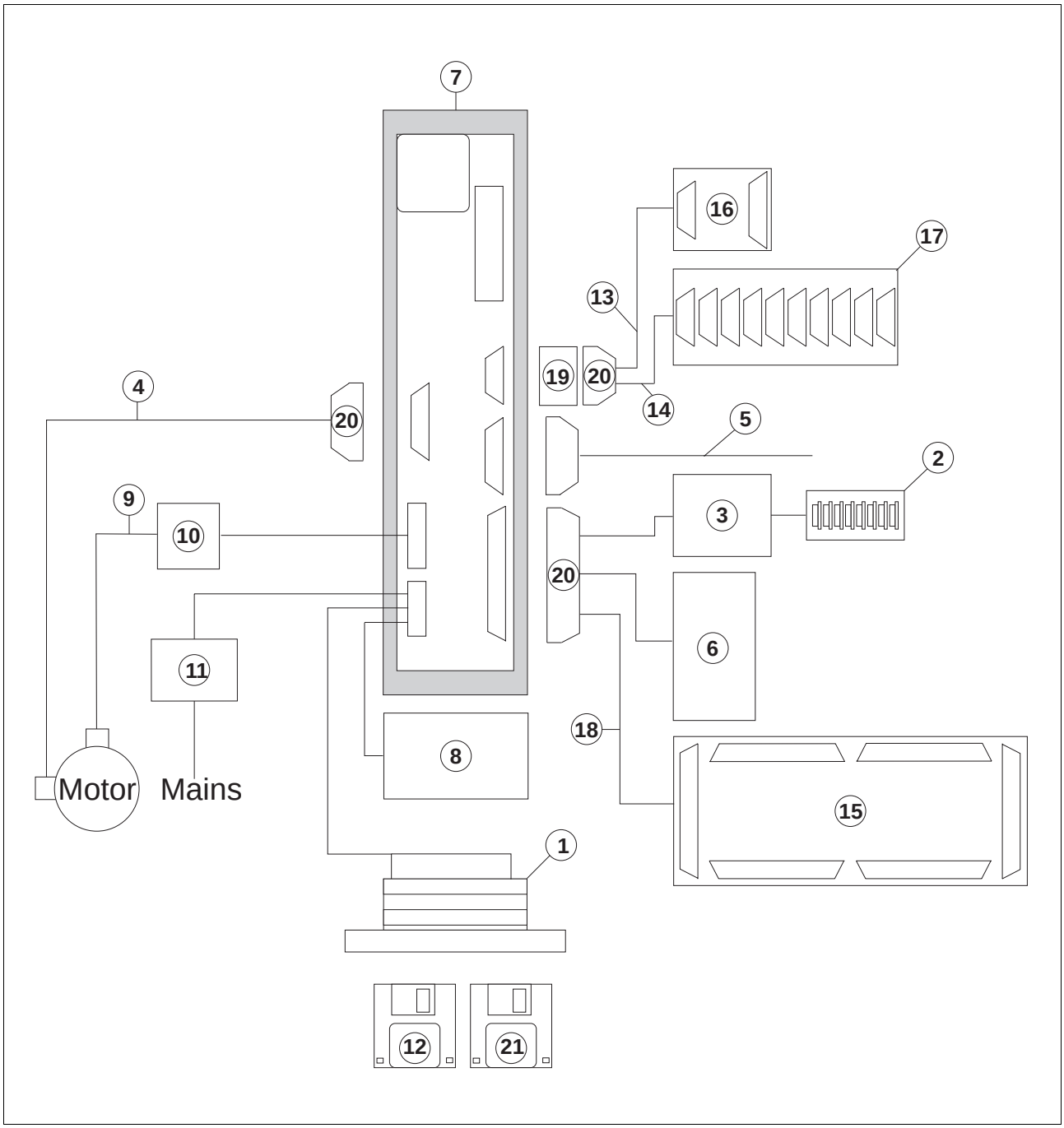


Fig. 6-1 Accessories

The following accessories may be ordered separately:

Item	Designation	Order number	Reference
1	Load resistor	62501100600	see chapter 6.2.1
2	ML 52 decade switch block	62300052000	see chapter 6.2.2
3	MP 940 decade switch interface	62020940000	see chapter 6.2.3
4	Shaft encoder cable	62501404xxx	see chapter 6.2.4
5	Cable for electronic gear	62501406xxx	see chapter 6.2.5
6	D 731 terminal adapter	62010731006	see chapter 6.2.6
7	Heat sink	62500901000	see chapter 6.2.7
8	Ventilator set	62501201000	see chapter 6.2.8
9	Motor cable	62501301xxx	see chapter 6.2.9
10	Motor cable filter	62501100100	see chapter 6.2.10
11	Mains filter	62501100200	see chapter 6.2.11
12	PRO-SDP/PC1 network software (version 2.01 or higher)	61700023010	see documentation Doc. no. 212.599
13	Interface cable male/female	62501412xxx	see chapter 6.2.12
14	Interface cable male/male	62501405xxx	see chapter 6.2.12
15	D 690 interface tester	62010690006	see chapter 6.2.13
16	MP 923 interface converter	62020923000	see chapter 6.2.14
17	MP 924 interface distributor	62020924006	see chapter 6.2.15
18	Signal cable	6250140xxxx	see chapter 6.2.16
19	Crossover adapter for RS 485 interface	62501511001	see chapter 6.2.17
20	WDP5-228 set of connectors	62501000300	see chapter 6.2.18
21	Terminal program BTERM	61700040610	see documentation Doc. no. 212.926

6.2.1 Load resistor

The HSD 70 load resistor is used to reduce surplus braking energy.

ATTENTION
Good heat dissipation must be ensured when mounting the load resistor.

1. Loosen screws and remove mains connector (fig. 6-2).
2. Remove the connector shell.
3. Prepare two load resistor connections by providing wire end ferrules on the connector side.
4. Fasten two litz wires B+ and B-.
5. Fasten the cable to the connector shell.
6. Put the two halves of the connector shell together.
7. Fasten the connector on the front panel (item 07).

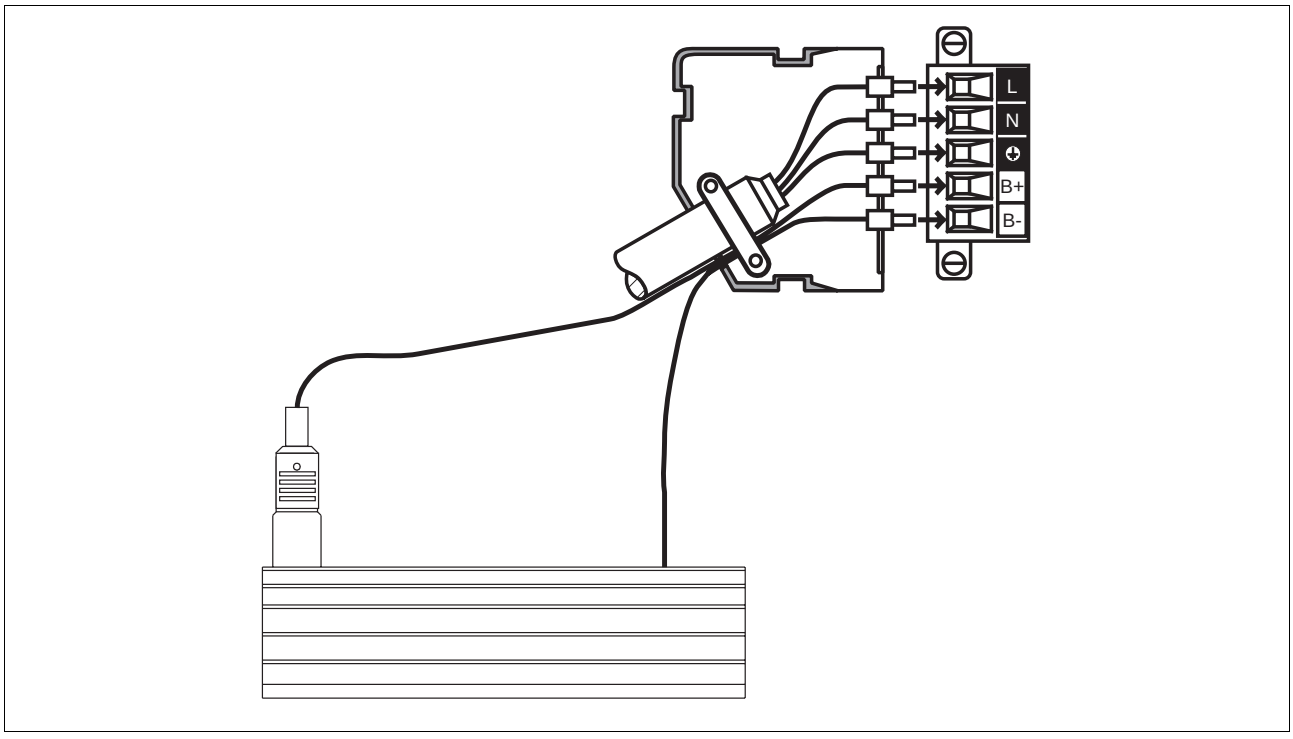


Fig. 6-2 Load resistor connection

6.2.2 ML 52 decade switch block

The desired position and speed are set on the ML 52 block of 8 decade switches and transferred to the positioning unit via the MP 940 decade switch interface (see chapter 6.2.3). Setting ranges:

Position: ±799999
(full/half step or increments, absolute or incremental dimensions)

Frequency: 00 - 99
(percentage of the maximum frequency set on the positioning unit, 00=100%)

The decade switch block is wired and connected to the unit as evident in figures 6-3 and 6-4.

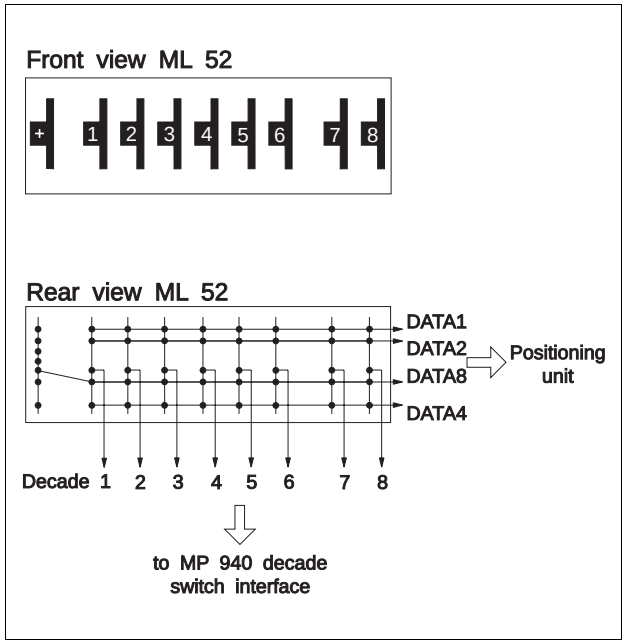


Fig. 6-3 ML 52 decade switch block wiring

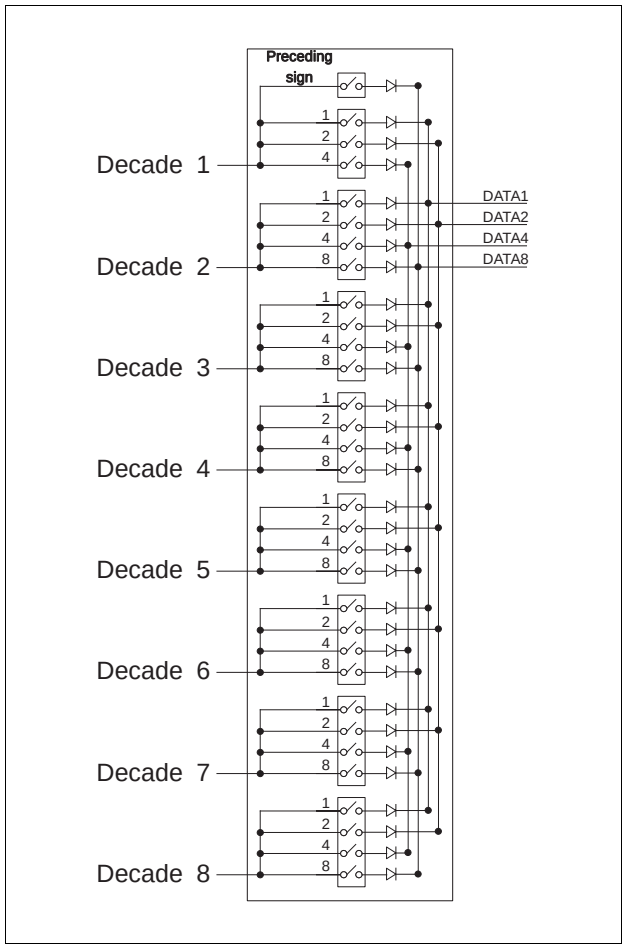


Fig. 6-4 ML 52 decade switch block assignment

6.2.3 MP 940 decade switch interface

6.2.3.1 General description

The MP 940 decade switch interface serves for the parallel data transfer, of a desired position and speed to a BERGER LAHR positioning unit (e.g. WDP5).
The desired position and speed can be set on the block of 8 decade switches e.g. ML 52 (see chapter 6.2.2) and transferred to the positioning unit via the MP 940 decade switch interface.
Data transfer is effected with the aid of 4 data lines and 3 handshaking lines.
A maximum of 16 decade switch blocks can be switched parallel, thus allowing presetting a maximum of 16 different values.

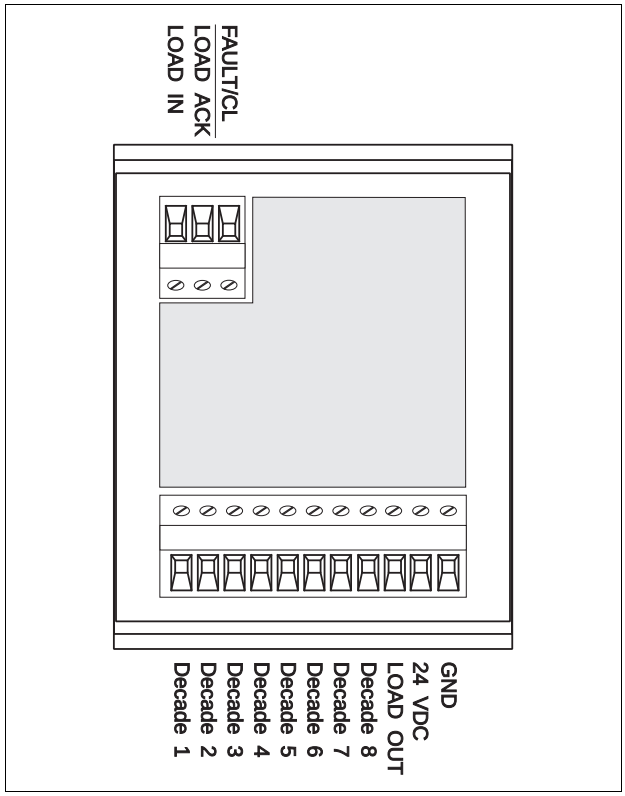


Fig. 6-5 MP 940 decade switch interface

6.2.3.2 Technical data

Electric data

Supply voltage	24 VDC ±10%
Current consumption	50 mA
Signal voltages	24 VDC ±10%

Mechanical data

Dimensions	67 x 77 x 40 mm
Weight	107 g

Environmental conditions

Storage temperature	-25°C to 70°C
Operating temperature	0°C to 55°C
Humidity class	F as per DIN 40 040

6.2.3.3 System integration

The MP 940 decade switch interface (fig. 6-6) is integrated in a system with a BERGER LAHR positioning unit.

6.2.3.4 Delivered items

Qty.	Designation	Order number
1	MP 940 decade switch interface	62020940000

6.2.3.5 Accessories

Qty.	Designation	Order number
1	ML 52 decade switch block	62300052000

6.2.3.6 Mounting

The foot of the MP 940 decade switch interface snaps into position on DIN EN 500 35 and DIN EN 500 22 mounting rails.

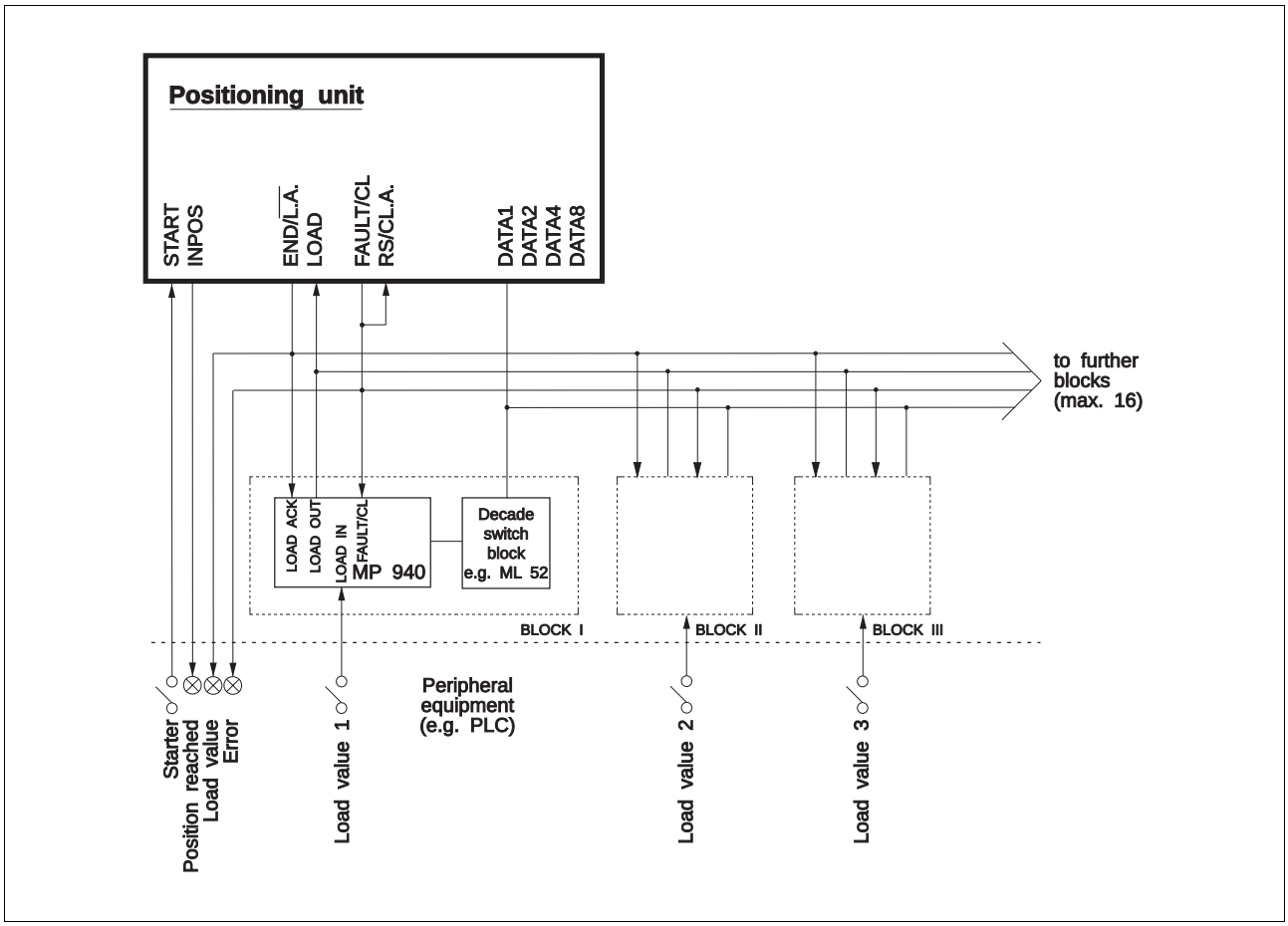


Fig. 6-6 System integration of MP 940 decade switch interface

6.2.3.7 Starting up

1. Switch off supply voltage and connect decade switch interface to the positioning unit and peripheral equipment (e.g. PLC) as shown in fig. 6-6.

NOTE
The inputs START and LOAD may be bridged for triggering an automatic start after loading has been completed.

2. In case the ML 52 decade switch block is used, this must be connected to the positioning unit and MP 940 as shown in fig. 6-3.

NOTE
The ML 52 decade switch block is switched as evident in fig. 6-4.

3. Set parallel mode (system of absolute and incremental dimensions) on the positioning unit.

4. Switch on supply voltage, set decade value on the decade switch block and read in according to the timing diagram (fig. 6-7).
Adjusting range:

Position: ±799999
(full/half step or increments, absolute or incremental dimensions)
Frequency: 00 - 99
(percentage of the maximum frequency set on the positioning unit; 00=100%)

NOTE
On activation of the input signal LOAD IN, the decade switch interface transfers the decade value to the positioning unit.
A start may be triggered, if no error (FAULT/CL = 0) has occurred and output signal END/L.A. is active.
Loading must be repeated, if an error (FAULT/CL = 1) has occurred.

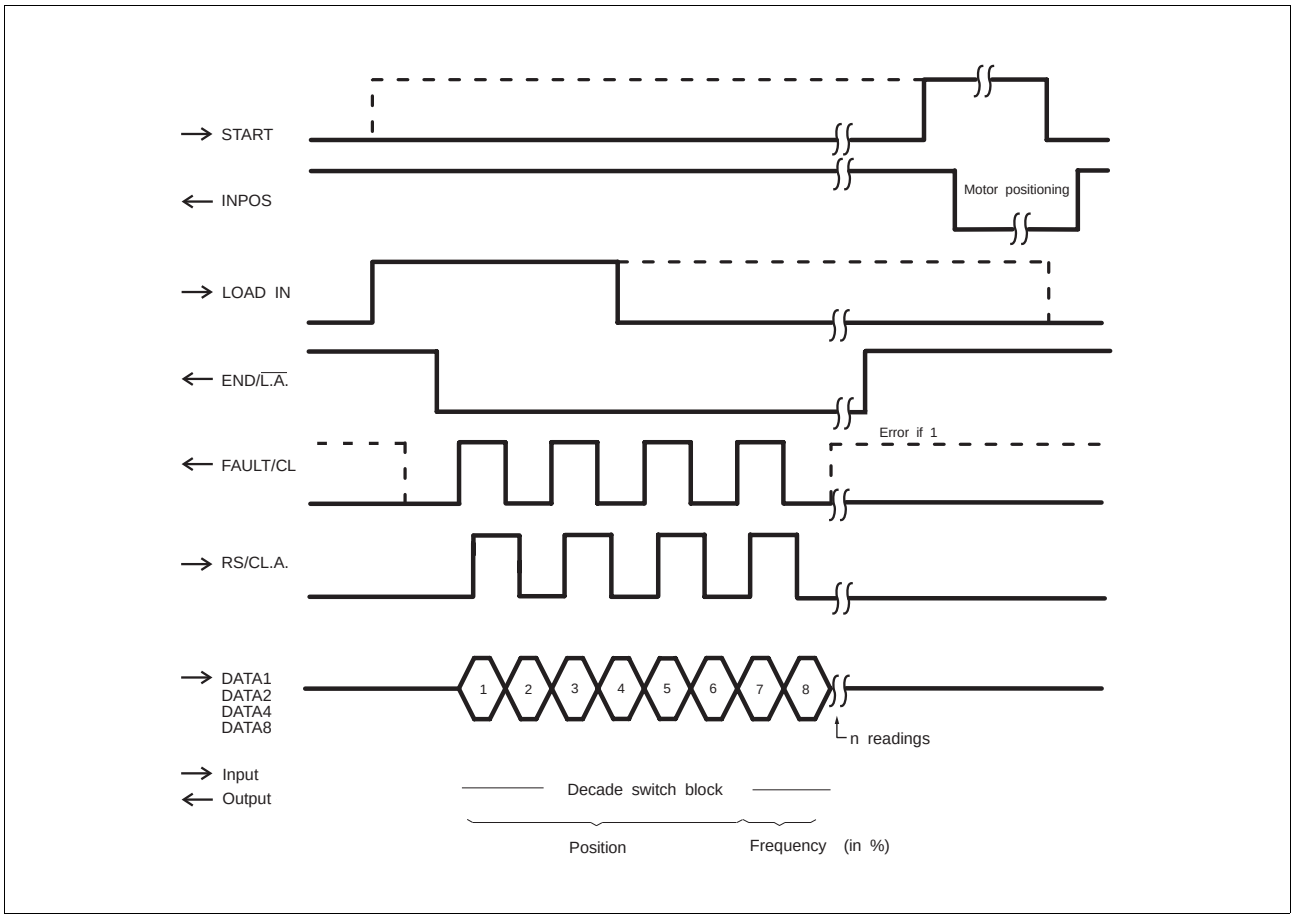


Fig. 6-7 Timing diagram for parallel data transfer

6.2.4 Shaft encoder cable

The following shaft encoder cable lengths may be ordered under the following number:

Cable length	Order number
5 m	62501404050
10 m	62501404100
15 m	62501404150
20 m	62501404200
50 m	62501404500

The shaft encoder cable comprises:

Designation	Order number
15-pole connector	N4-673-247
Connector shell (15-pole)	N4-673-237
12-pole female connector	N8-704-89
12 contacts	N8-704-90
Cable	H6-928-50

Shaft encoder connection is illustrated and described in chapter 2.4.3.

6.2.5 Cable for electronic gear

The cable for the electronic gear can be ordered in the following lengths:

Cable length	**Order number**
5 m	62501406050
10 m	62501406100
15 m	62501406150
20 m	62501406200
50 m	62501406500

The cable for the electronic gear comprises:

Designation	**Order number**
15-pole connector	N4-673-247
Connector shell (15-pole)	N4-673-237
Cable	H6-928-50

Signal connection of the electronic gear is illustrated and described in chapter 2.4.6.

6.2.6 D 731 terminal adapter

6.2.6.1 General description

The D 731 terminal adapter serves to connect the following wall-mounted BERGER LAHR units to a controller e.g. PLC:

- WP-XXX (positioning unit)
- WDP5-XXX (positioning unit with power drive)

The D 731 terminal adapter mainly consists of a pc-board accommodating 1 sub-D connector, 32 LEDs and 2 terminal strips. The LEDs indicate the signal states of all inputs and outputs. The signal states of the outputs are indicated by yellow LEDs, the signal states of the inputs by green LEDs.
All inputs and outputs are connected to the terminal strips. The terminal pin assignment will be shown on the following page.
Connection of the WP/WDP signal connector is established with the aid of a cable and the sub-D connector.
An additional operating voltage does not have to be connected.

6.2.6.2 Technical data

Electrical data

Signal voltage	24 V ±10%
Current consumption per LED	approx. 2 mA ±10%
Voltage drop at tester	< 0.1 V

Mechanical data

Dimensions	approx. 113 x 78 x 52 mm
Weight	approx. 180 g

Environmental conditions

Storage temperature	-25°C to 70°C
Operating temperature	0°C to 55°C
Humidity class	F according to DIN 40 040

NOTE
The unit is subject to the extra-low voltage safety regulations.

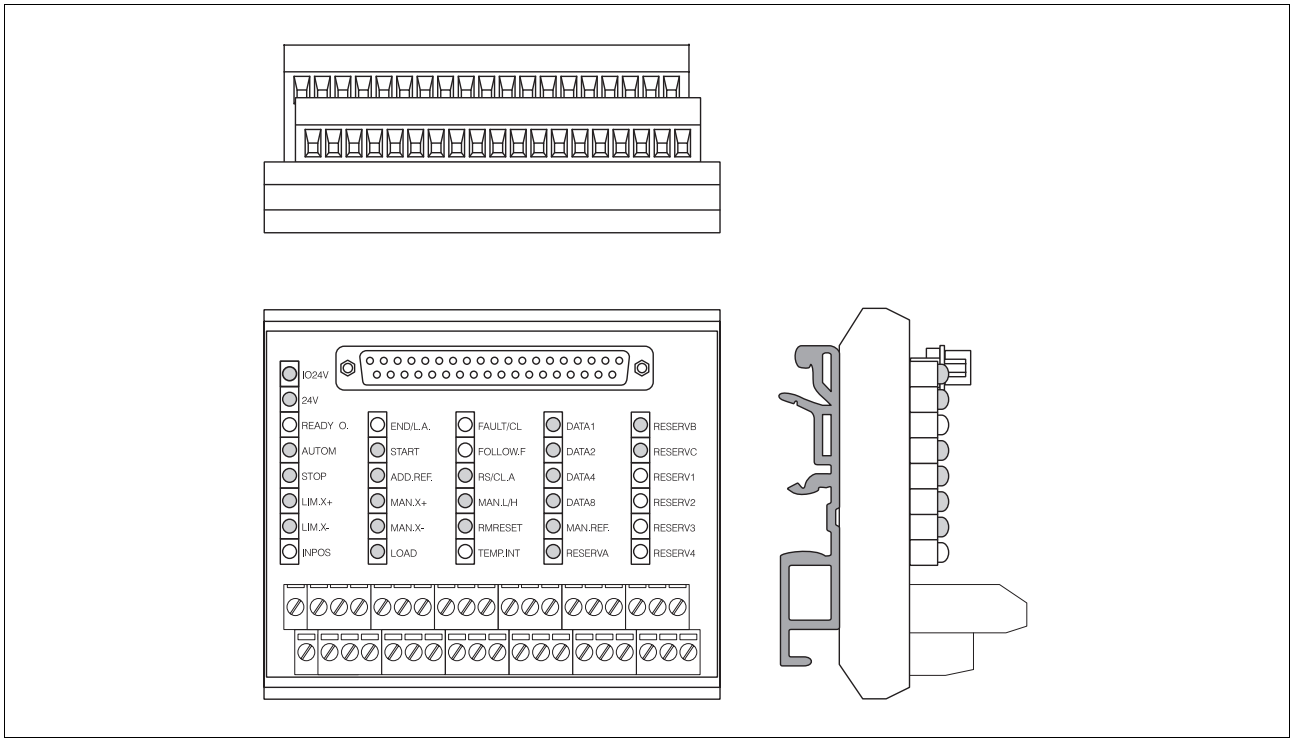


Fig. 6-8 D 731 terminal adapter

Terminal pin assignment

Pin	Abbreviation	Meaning	Signal logic	← I/→ O
1	$\overline{\text{LIM.X-}}$	Negative limit switch	Active-low	←
2	RESERVE A			
3	RESERVE C			
4	START	Start	Active-high	←
5	LOAD	Store position	Active-high	←
6	$\overline{\text{ADD.REF.}}$	Additional reference switch	Active-low	←
7	MAN.X-	Manual movement, CCW rotation	Active-high	←
8	MAN.L/H	Slow/fast manual movement	Active-high	←
9	DATA4	Program number 2^2	Active-high	←
10	DATA1	Program number 2^0	Active-high	←
11	RESERVE 1			
12	RESERVE 3			
13	FOLLOW.F.	Following error limit	Active-high	→
14	FAULT/CL	Error/clock	Active-high	→
15	READY O.	Ready for operation	Active-high	→
16	24V	System supply voltage		←
17	24V	System supply voltage		←
18	IO24V	I/O supply voltage		←
19	IO24V	I/O supply voltage		←
20	$\overline{\text{LIM.X+}}$	Positive limit switch	Active-low	←
21	RESERVE B			
22	RM RESET	Rotation monitoring reset	Active-high	←
23	$\overline{\text{STOP}}$	Stop	Active-low	←
24	RS/CL.A	Program start/Clock acknowledge	Active-high	←
25	AUTOM	Automatic operation	Active-high	←
26	MAN.X+	Manual movement, CW rotation	Active-high	←
27	MAN.REF.	Manual reference movement	Active-high	←
28	DATA8	Program number 2^3	Active-high	←
29	DATA2	Program number 2^1	Active-high	←
30	RESERVE 4			
31	RESERVE 2			
32	TEMP.INT.	Temperature monitoring - heat sink	Active-high	→
33	INPOS	Position reached	Active-high	→
34	END/$\overline{\text{L.A.}}$	Program end/Load acknowledge	Active-high/low	→
35	24VGND	System supply voltage ground		←
36	24VGND	System supply voltage ground		←
37	IOGND	I/O supply voltage ground		←
38	–	Shield connection		

I = input O = output

6.2.6.3 Delivered items

Qty.	Designation	Order number
1	D 731	62010731006

6.2.6.4 Accessories

Qty.	Designation	Order number
1	Cable	62501408015

6.2.6.5 Mounting

The terminal adapter foot snaps into position on conventional DIN EN mounting rails.

6.2.6.6 Starting up

1. Switch off WP/WDP unit and controller.
2. Connect the D 731 terminal adapter cable to the WP/WDP unit, see fig. 6-9.

ATTENTION
Only use the original cable (see accessories) or a screened signal cable.

3. Tighten the fastening screws of the connector.
4. Connect the terminal adapter to the controller.
5. Switch on WP/WDP unit and controller.

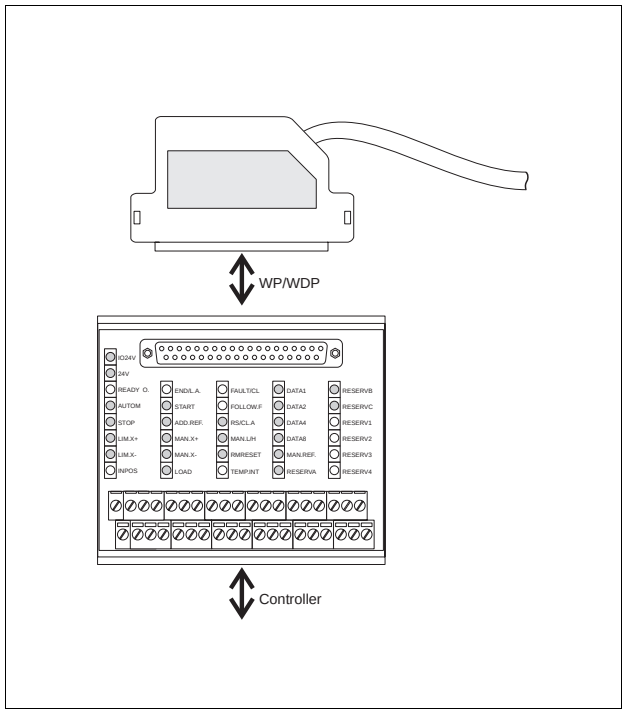


Fig. 6-9 Starting the D 731 terminal adapter

6.2.7 Heat sink

6.2.7.1 BERGER LAHR heat sinks

Correct cooling of the positioning unit is achieved with the BERGER LAHR heat sink.

The heat sink (fig. 6-10 and 6-11) can be attached inside or outside the switch cabinet.

NOTE
It must be noted that more space is required and that the distance between the centre lines between the individual units must be observed when several units are combined, see cable (stated in mm).

Central axis distance (mm) for combined units	WD5-008	WDP5-118	WDP5-228	WDP5-318	WP-111	WP-231	WP-311
WD5-008	87	87	87	87	74	74	74
WDP5-118	87	87	87	87	74	74	74
WDP5-228	87	87	87	87	74	74	74
WDP5-318	87	87	87	87	74	74	74
WP-111	74	74	74	74	61	61	61
WP-231	74	74	74	74	61	61	61
WP-311	74	74	74	74	61	61	61

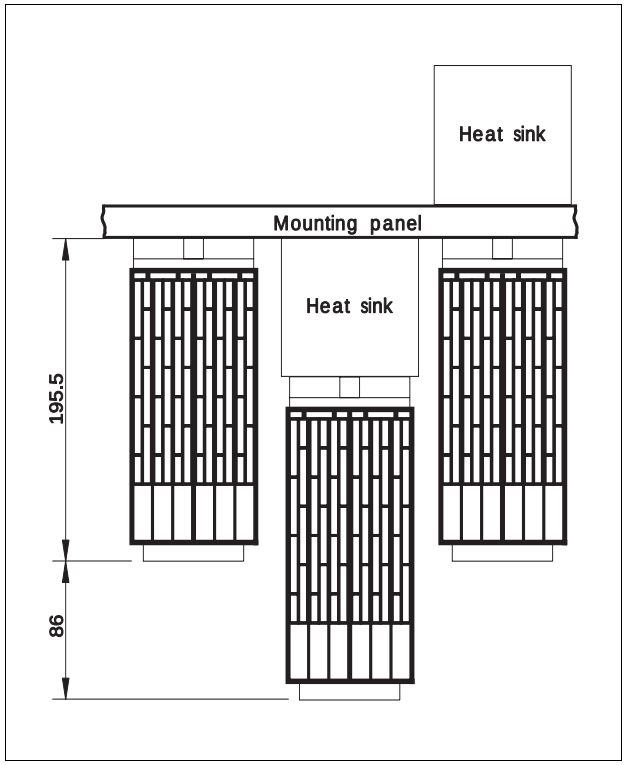


Fig. 6-10 Mounting head sink

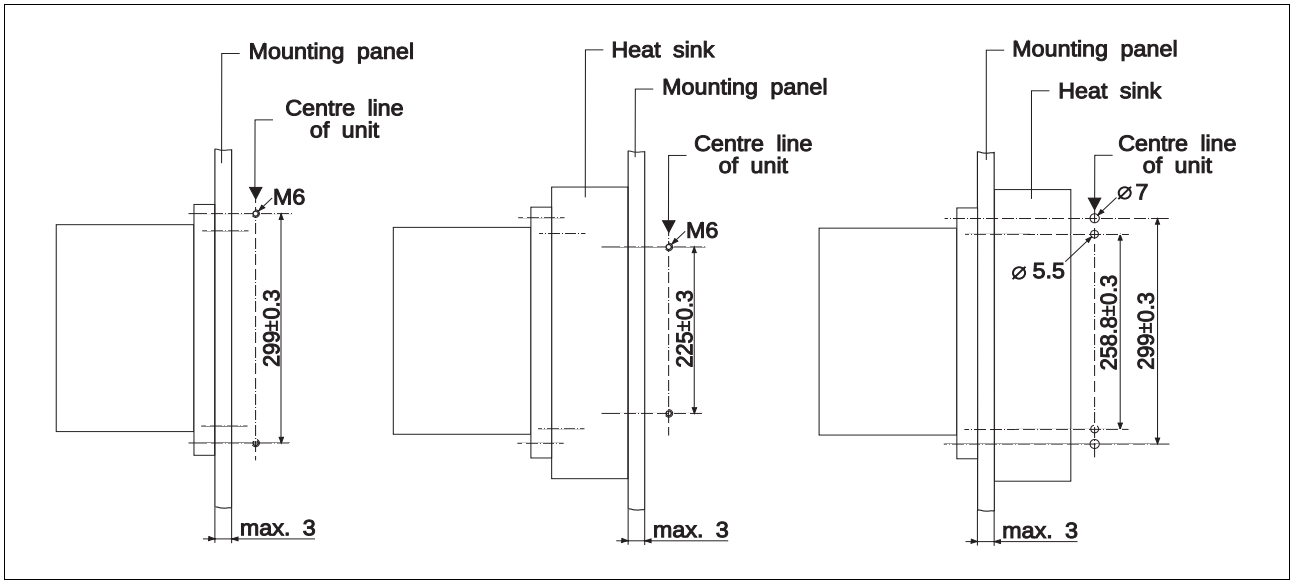


Fig. 6-11 Drilling pattern

Mounting the heat sink inside the cabinet

1. The heat sink is mounted inside the cabinet (fig. 6-10).
2. Drill two holes in the mounting panel (fig. 6-11) and cut M6 thread.
3. Fasten the heat sink (fig. 6-12) to the mounting panel with two screws.
4. Apply heat transfer compound between the unit's rear panel and the heat sink.
5. Put the unit down on two side bolts of the heat sink and tighten two screws (SW 10).

NOTE
In case of unit combinations, the gaps between the individual units (see table page 14) must be observed.

Mounting the heat sink outside the cabinet

1. The heat sink is mounted outside the cabinet surface (fig. 6-10).
2. Drill four holes (fig. 6-11) in the mounting panel.
3. Remove the guide bolts from the heat sink.
4. Apply the heat transfer compound between the heat sink and mounting panel.
5. Fasten the heat sink (fig. 6-12) to the mounting panel with two bolts.
6. Apply the heat transfer compound between the unit's rear panel and mounting panel.
7. Lower the unit onto two bolts of the heat sink and tighten two screws (SW 10).

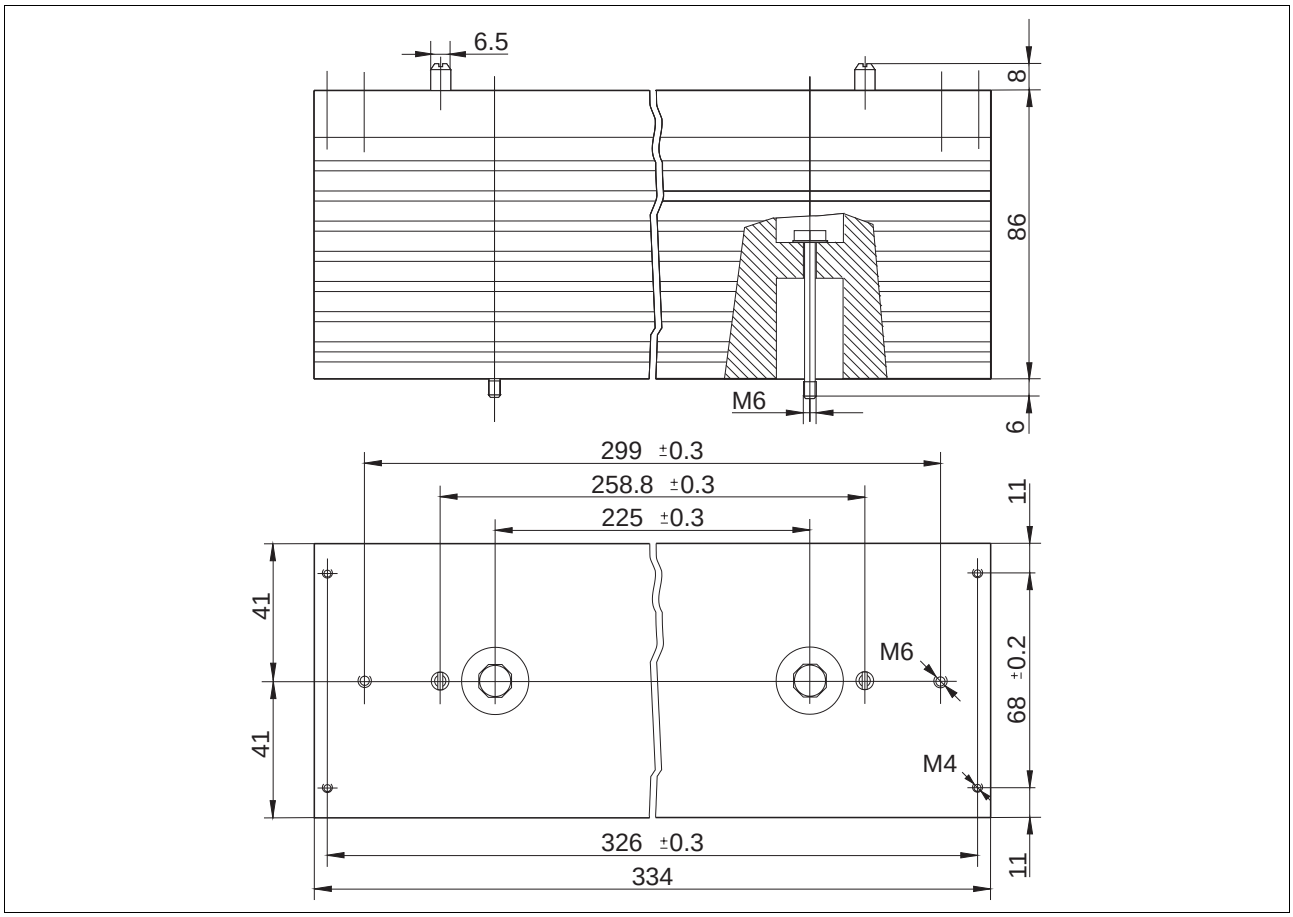


Fig. 6-12 Heat sink dimensions

6.2.7.2 Heat sink dimensioning

If a non-BERGER LAHR heat sink is used, it must be sized for wall-mounting as described below. Determine the thermal resistance in order to be able to select a heat sink with adequate heat dissipation capacity. The following factors are required for calculating the thermal resistance R_{th}:

Power loss P_l of the unit

Ambient temperature T_{amb}

Prewarning temperature $T_{TEMP.INT}$ of the unit

1. Calculating the power loss P_l

As the first step, determine the power loss P_l to be dissipated by the heat sink. Essentially, P_l depends on the motor cable and the phase current. To calculate the power loss, use the following formula:

$$P_l = \frac{1+c.d.f.}{2} \; x \; (k_1 \, C_c \, L_c + k_2 \, I_{Ph} + P_i \,)$$

$\frac{(1+c.d.f.)}{2}$ = Influence of cyclic duration factor with

c.d.f. = cyclic duration factor in %

$k_1 \, C_c \, L_c$ = Influence of motor cable with
k_1 = 0.04 W/nF
C_c = Capacity of motor cable in nF at 100 m
L_c = Motor cable length in m

$k_2 \, I_{Ph}$ = Influence of phase current with
k_2 = 23.5 W/A
I_{Ph} = Phase current in A
P_i = 5 W intrinsic loss

This results in the following general formula:

$$P_l = \frac{1 + c.d.f.}{2} \; x \; (0.04 \, \frac{W}{nFm} \; x \, C_c L_c + 23.5 \, \frac{W}{A} \; x \, I_{Ph} + 5W)$$

If the BERGER LAHR accessory motor cable is used, the following formula is applicable for calculating the power loss:

$$P_l = \frac{1 + c.d.f.}{2} \; x \; (0.4 \, \frac{W}{m} \; x \, L_c + 23.5 \, \frac{W}{A} \; x \, I_{Ph} + 5W)$$

The cable capacity C_c is 10 nF at 100 m.

2. Calculating the required thermal resistance R_{th}

Use the following basic formulae:

$$R_{th} = \frac{T_{TEMP.INT} - T_{amb}}{P_l}$$

$$T_{TEMP.INT} = T_{max} - k_0 I_{Ph}$$

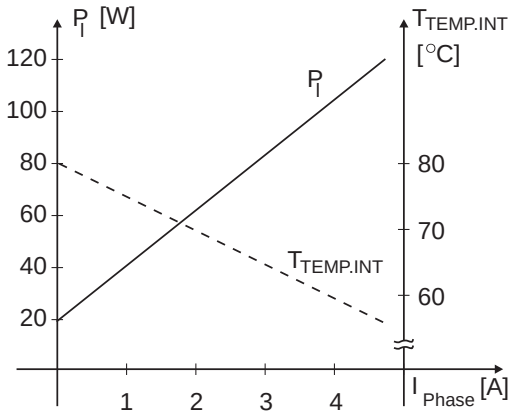
$$T_{TEMP.INT} = 80°C - 5 \, \frac{°C}{A} \; x \; I_{Ph}$$

to calculate the thermal resistance as follows:

$$R_{th} = \frac{80° - 5 \, \frac{°C}{A} \; x \; I_{Ph} - T_{amb}}{P_l}$$

$T_{TEMP.INT}$ = Prewarning temperature
T_{max} = Maximum admissible temperature at mounting flange
$k_0 I_{Ph}$ = Influence of phase current on prewarning temperature
I_{Ph} = Phase current
T_{amb} = Ambient temperature
P_l = Power loss

To check the heat sink size, a temperature measurement should be carried out at the mounting flange. The temperature at the mounting flange should be less than the prewarning temperature $T_{TEMP.INT}$ of the unit. See figure 6-13.



P_l = Power loss

$T_{TEMP.INT}$ = Temperature prewarning

Fig. 6-13 Power loss diagram

NOTE
The thermal resistance of the heat sink available from BERGER LAHR is 0.5 K/W without additional ventilation and 0.17 K/W when using a fan. It is also possible to ventilate the unit in-stead of the heat sink (1 m/s minimum airstream).

6.2.8 Ventilator set

The heat sink may be equipped with a ventilator set to enhance heat dissipation.

The ventilator set (fig. 6-14) is attached to the bottom of the heat sink and fastened with two screws.

Connect the ventilator set to the external 24 VDC supply voltage.

Further ventilators may be switched in parallel via the 2nd terminal pair.

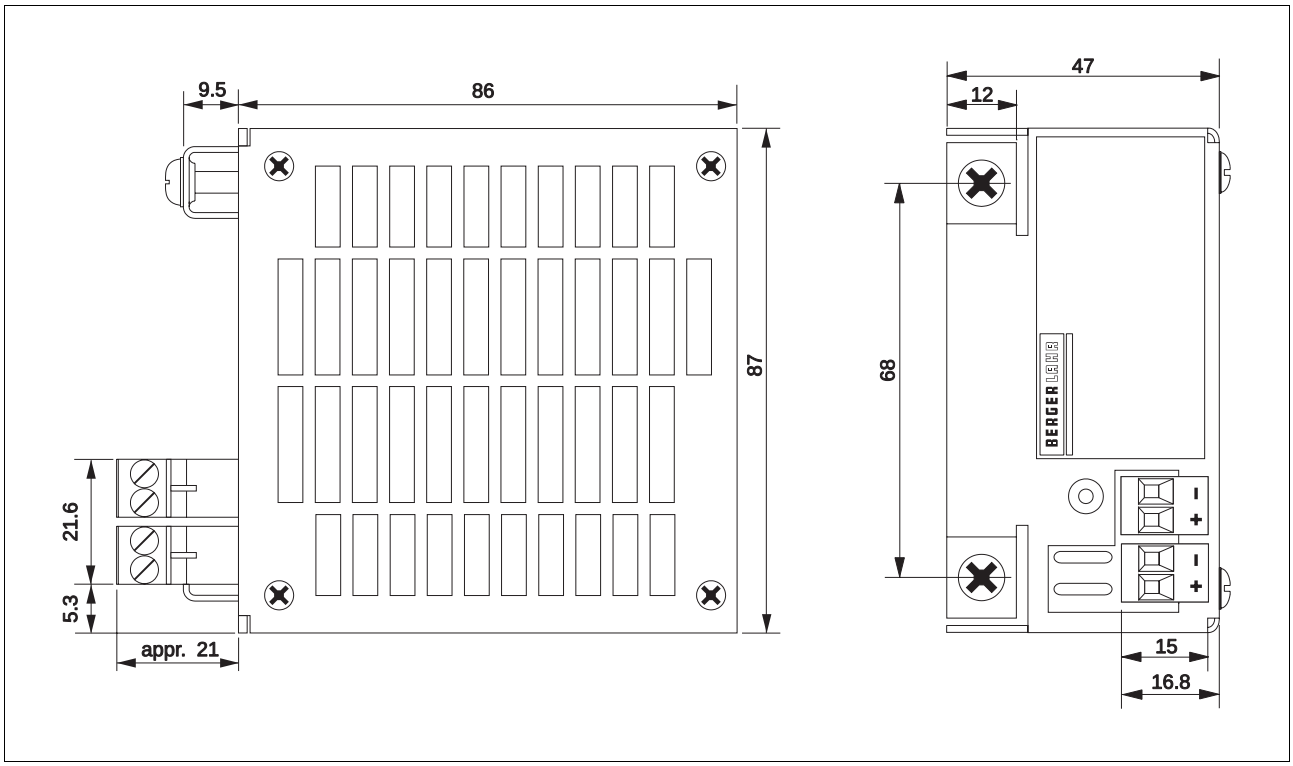


Fig. 6-14 Ventilator set dimensions

6.2.9 Motor cable

The motor cable may be ordered in the following lengths:

Cable length	Order number
5 m	62501301005
10 m	62501301010
15 m	62501301015
20 m	62501301020
50 m	62501301050

The motor cable comprises:

Designation	Order number
6-pole connector	N8-704-91
6 contacts	N8-704-92
Cable	H6-928-51

The motor connection is illustrated and described in chapter 2.4.2.

6.2.10 Motor cable filter

The motor cable filter is inserted in the motor line in case of motor cables exceeding 50 m in length and for radio interference suppression (even below 50 m) in accordance with VDE 0871/limit class A. The filter must be installed in the switch cabinet near the device and provided with external ventilation.

Only use the motor cable approved by BERGER LAHR. Other cables could generate higher currents due to a higher capacity, which could lead to the destruction of the devices.

Ambient conditions

Storage temperature	-25°C to +70°C
Operating temperature	
up to a phase current of 4 A	0°C to 50°C
up to a phase current of 5 A	0°C to 40°C
Humidity class	F acc. to DIN 40 040 (non-condensing)

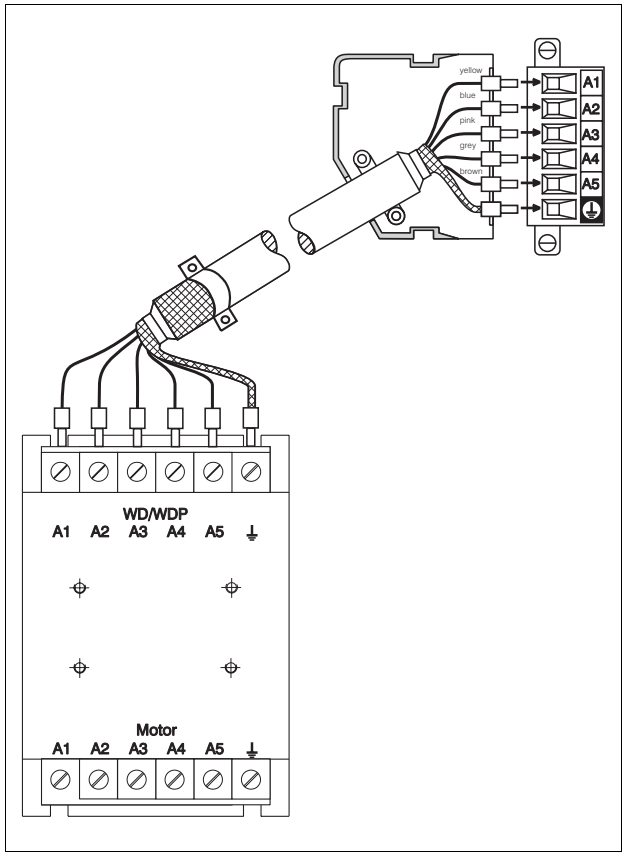


Fig. 6-15 Motor cable filter

6.2.11 Mains filter

The mains filter is inserted in the supply line for radio interference suppression in accordance with VDE 0871/limit class A.

Ambient conditions

Storage temperature	-25°C to +70°C
Operating temperature	0°C to +55°C
Humidity class	F acc. to DIN 40040
Humidity class, tested to IEC 68 part 2-3 at:	
Air temperature	+40°C, +2°C
Relative humidity non-condensing	93%, +2%, -3%

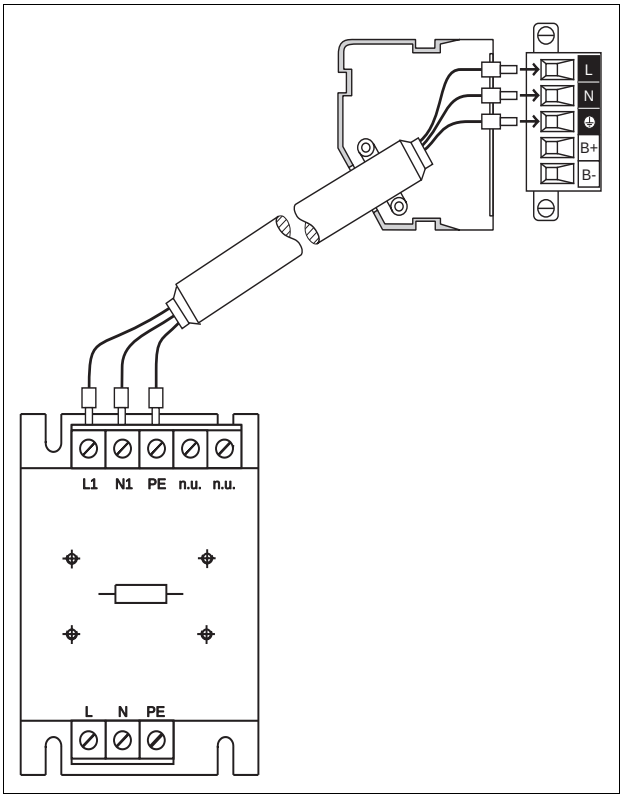


Fig. 6-16 Mains filter

6.2.12 Interface cable

Interface cable male/female

The following interface cable lengths are available:

Cable length	Order number
1 m	62501402010
2 m	62501402020
5 m	62501402050
10 m	62501402100
25 m	62501402250

The interface cable comprises:

Qty.	Designation	Order number
1	9-pole male connector	N4-673-246
1	9-pole female connector	N4-673-001
2	Connector shell (9-pole)	N4-673-236
1	Cable	H6-928-30

The interface connection is illustrated and described in chapter 2.4.5.

Interface cable male/male

The following interface cable lengths are available:

Cable length	Order number
1 m	62501405010
2 m	62501405020
5 m	62501405050
10 m	62501405100
25 m	62501405250

The interface cable comprises:

Qty.	Designation	Order number
2	9-pole male connector	N4-673-246
2	Connector shell (9-pole)	N4-673-236
1	Cable	H6-928-30

The interface connection is illustrated and described in chapter 2.4.5.

6.2.13 D 690 interface tester

6.2.13.1 General description

The D 690 interface tester serves to test the signal states for the BERGER LAHR wall-mounted units:

- WD5-XXX (power drive)
- WP-XXX (positioning unit)
- WDP5-XXX (positioning unit with power drive)

The D 690 interface tester mainly consists of a pc-board accommodating 6 sub-D connectors or female connectors respectively and 43 LEDs. The meaning of the LED signals will be explained on the following page. The signal states of the outputs are indicated by yellow LEDs, the signal states of the inputs by green LEDs. The interface tester is divided into two halves. As evident in fig. 6-17, one half is intended for WD units and the second half for WP/WDP units. The interface tester is inserted in the signal line of the units.
Connection of an additional operating voltage is not required.
The diagnostic connectors disposed at the front of the pc-board can be used for measuring and testing purposes.

6.2.13.2 Technical data

Electrical data

Signal voltage WP/WDP section	24 V ±10%
Signal voltage WD section	3.5 to 24 V ±10%
Current consumption per LED	approx. 2 mA
Voltage drop at tester	0.1 V

Mechanical data

Dimensions	approx. 205 x 80 x 32 mm
Weight	approx. 150 g

Environmental conditions

Storage temperature	-25°C to 70°C
Operating temperature	0°C to 55°C
Humidity class	F according to DIN 40 040

NOTE
The unit is subject to the extra-low voltage safety regulations.

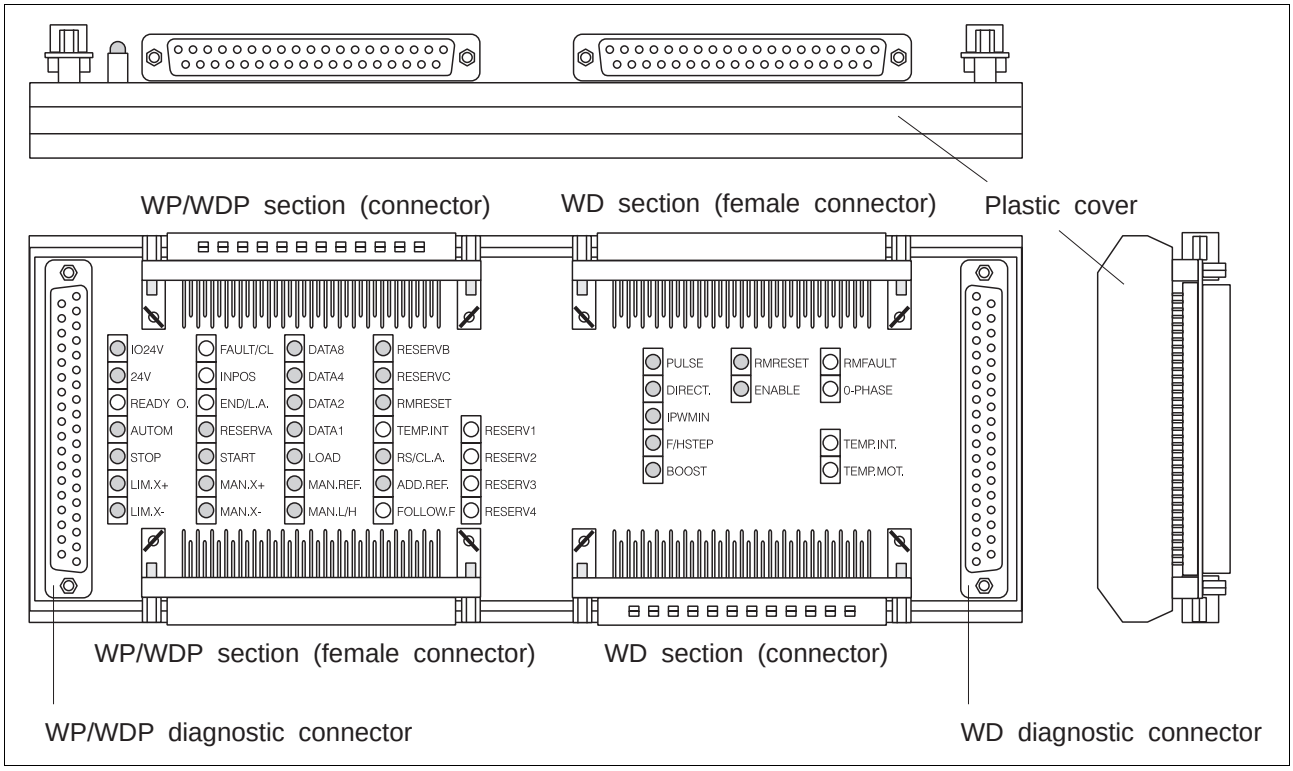


Fig. 6-17 D 690 interface tester

WD section

Pin	Abbreviation	Meaning	Signal logic	← I/→ O
1/20	PULSE	Pulse	Pulse	←
2/21	DIRECT.	Direction	Selectable	←
3/22	ENABLE	Power drive enable	Active-high	←
4/23	IPWMIN	PWM current control	Pulse	←
5/24	F/H STEP	Step angle full step/half step	Selectable	←
6/25	BOOST	Current increase	Active-high	←
7/26	RM RESET	Rotation monitoring reset	Active-high	←
8/27	RM FAULT	Rotation monitoring fault	Active-low	→
9/28	0-PHASE	Zero phase	Active-high	→
10/29	TEMP.INT.	Temperature monitoring - heat sink	Active-low	→
11/30	TEMP.MOT	Temperature monitoring - motor	Active-low	→

WP/WDP section

Pin	Abbreviation	Meaning	Signal logic	← I/→ O
18	IO24V	I/O supply voltage		←
19	IO24V	I/O supply voltage		←
16	24V	System supply voltage		←
17	24V	System supply voltage		←
15	READY O.	Ready for operation	Active-high	→
25	AUTOM	Automatic operation	Active-high	←
23	$\overline{\text{STOP}}$	Stop	Active-low	←
20	$\overline{\text{LIM.X+}}$	Positive limit switch	Active-low	←
1	$\overline{\text{LIM.X-}}$	Negative limit switch	Active-low	←
14	FAULT/CL	Error/Clock	Active-high	→
33	INPOS	Position reached	Active-high	→
34	END/$\overline{\text{L.A.}}$	Program end/Load acknowledge	Active-high/low	→
4	START	Start	Active-high	←
26	MAN.X+	Manual movement, CW rotation	Active-high	←
7	MAN.X-	Manual movement, CCW rotation	Active-high	←
28	DATA8	Program number 2^3	Active-high	←
9	DATA4	Program number 2^2	Active-high	←
29	DATA2	Program number 2^1	Active-high	←
10	DATA1	Program number 2^0	Active-high	←
5	LOAD	Store position	Active-high	←
27	MAN.REF.	Manual reference movement	Active-high	←
8	MAN.L/H	Slow/fast manual movement	Active-high	←
22	RM RESET	Rotation monitoring reset	Active-high	←
32	TEMP.INT.	Temperature monitoring - heat sink	Active-high	→
24	RS/CL.A	Program start/Clock acknowledge	Active-high	←
6	$\overline{\text{ADD.REF.}}$	Additional reference switch	Active-low	←
13	FOLLOW.F.	Following error limit	Active-high	→
35	24VGND	System supply voltage ground		←
36	24VGND	System supply voltage ground		←
37	IOGND	I/O supply voltage ground		←

I = input O = output

6.2.13.3 Delivered items

Qty.	Designation	Order number
1	D 690	62010690006

6.2.13.4 Accessories

Qty.	Designation	Order number
1	Cable 1.5 m for WD	62501402015
1	Cable 1.5 m for WDP	62501408015
2	Feet	00050090045

6.2.13.5 Mounting

The interface tester foot snaps into position on the conventional DIN EN mounting rails.

6.2.13.6 Starting up

1. Switch off WP/WDP or WD unit.
2. Connect the D 690 interface tester between the WP/WDP or WD unit and the peripheral equipment with the cable, see fig. 6-18.

ATTENTION
Inserting the interface tester may impair noise immunity of the signal inputs. Only use the delivered cable or a screened signal cable.

3. Tighten the fastening screws of the connector.
4. Switch on WP/WDP or WD unit.
5. If desired, the signal states may be tested at the diagnostic connector with a measuring unit. Pin assignment of the diagnostic connector corresponds with the pin assignment of the signal connector.
6. Test interface.

NOTE
Only those outputs which are connected by the customer can be tested.

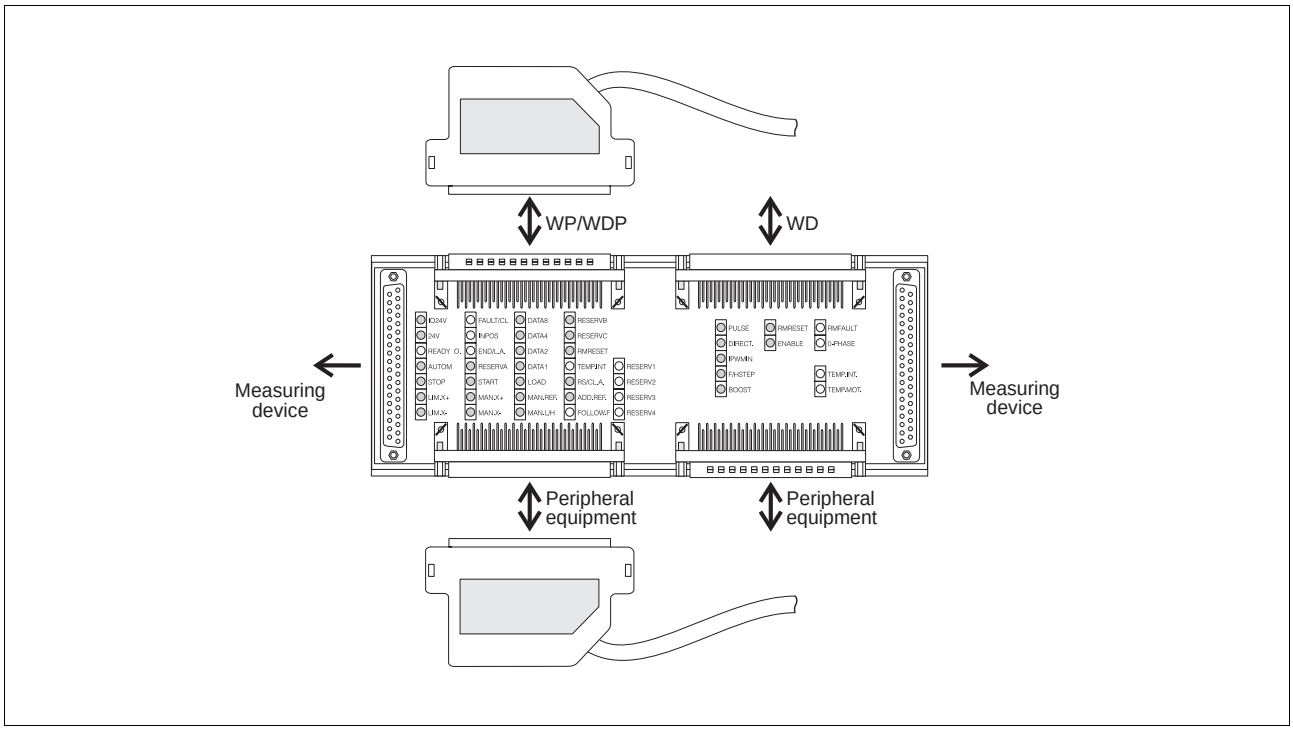


Fig. 6-18 Starting the D 690 interface tester

6.2.14 MP 923 interface converter

6.2.14.1 General description

The MP 923 interface converter is used for the data transfer from one RS 485 (RS 422) interface to a V24 (RS 232) interface and vice-versa.

The interface converter must be supplied with 12 VDC via the power supply unit connector (2-pole diode connector, female) or the RS 485 (RS 422) connector. The BERGER LAHR positioning units (e.g. WDP5) are supplied via the RS 485 (RS 422) connector.

6.2.14.2 Technical data

Electric data

Voltage supply	9.6 to 15 VDC/150 mA
Interfaces	RS 485 (RS 422)
	V24 (RS 232)

Mechanical data

Dimensions	97 x 65 x 30 mm
Weight	approx. 130 g

Environmental conditions

Storage temperature	-25°C to 70°C
Operating temperature	0°C to 55°C
Humidity class	F according to DIN 40 040

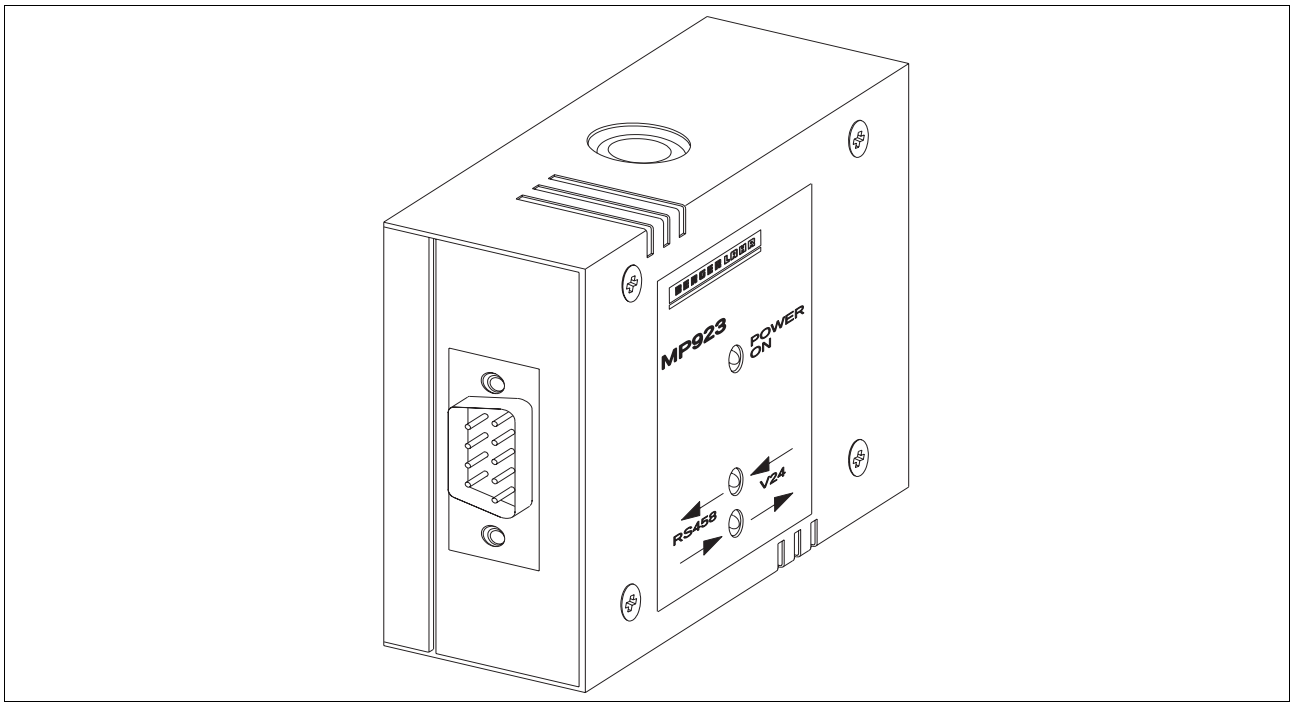


Fig. 6-19 MP 923 interface converter

6.2.14.3 Delivered items

Qty.	Designation	Order number
1	MP 923	62020923000
1	9-pole female connector	N4-673-1
1	Connector shell (9-pole)	N4-673-236
1	25-pole connector	N4-673-248
1	Connector shell (25-pole)	N4-673-238
4	Locking screw	N4-673-158

6.2.14.4 Accessories

Qty.	Designation	Order number
1	Interface cable compl.	see chapter 6.2.12

6.2.14.5 Starting up

1. Connect MP 923 interface converter as shown in fig. 6-20.

NOTE
The MP 923 is supplied with a 12 VDC voltage via the power supply unit connector or the RS 485 (RS 422) connector (e.g. with BERGER LAHR WDP5 positioning units).

ATTENTION
The interface cables must be screened on both sides via the connector shells!

ATTENTION
For reasons of noise immunity, the V24 (RS 232) cable should be as short as possible (max. 15 m)!

2. Switch on supply voltage.
   → The "POWER ON" LED lights up. The two other LEDs are out.

3. Start data transfer.
   → Depending on the direction in which data transfer takes place, one of the two LEDs "RS 485 → V24" or "RS 485 ← V24" flashes.

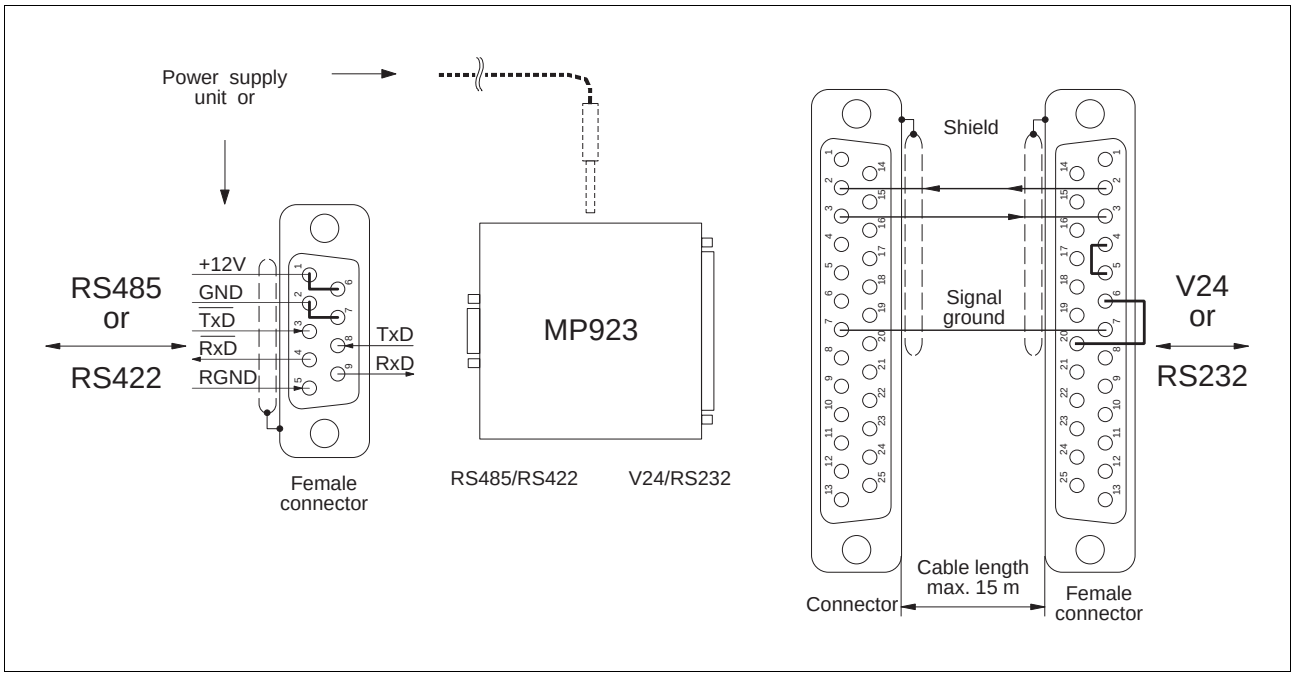


Fig. 6-20 Starting the MP 923 interface converter

6.2.14.6 Status displays

The status displays indicate the operating status or malfunctions.

LED	Lights up	Does not light up	Flashes
"POWER ON"	Supply voltage available	No supply voltage available	
"RS 485 → V24"	RS 485 (RS 422) interface incorrectly connected (signal connections TxD ($\overline{TxD}$) and RxD ($\overline{RxD}$) interchanged)	No data transfer from RS 485 (RS 422) to V24 (RS 232)	Data transfer from RS 485 (RS 422) to V24 (RS 232)
"RS 485 ← V24"	V24 (RS 232) interface incorrectly connected (pin 2 and 3 interchanged)	No data transfer from V24 (RS 232) to RS 485 (RS 422)	Data transfer from V24 (RS 232) to RS 485 (RS 422)

6.2.15 MP 924 interface distributor

6.2.15.1 General description

The MP 924 interface distributor allows operating a maximum of 9 BERGER LAHR units linked in a network via a PC. In case more than 9 units (max. 124 units) must be operated in network mode, several MP 924 interface distributors must be connected.

6.2.15.2 Technical data

Electrical data

10 serial interfaces	RS 485 (RS 422)

Mechanical data

Dimensions	approx. 205 x 80 x 32 mm
Weight	approx. 260 g

Environmental conditions

Storage temperature	- 25°C to 70°C
Operating temperature	0°C to 55°C
Humidity class	F DIN 40040

6.2.15.3 Delivered items

Qty.	Designation	Order number
1	MP 924	62020924006

6.2.15.4 Accessories

Qty.	Designation	Order number
1	9-pole connector	N4-673-246
1	Connector shell (9-pole)	N4-673-236
1	Signal cable for RS 485 (RS 422)	H6-923-30
1	Interface cable compl.	see chapter 6.2.12

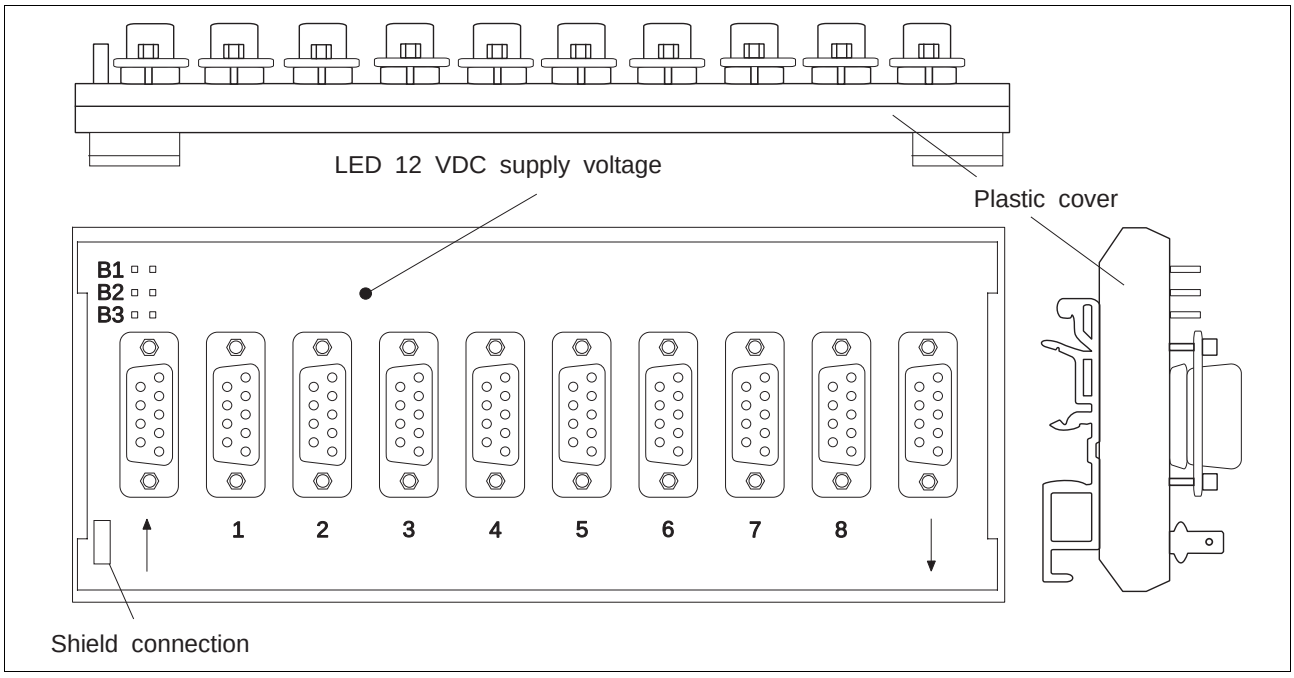


Fig. 6-21 MP 924 interface distributor

6.2.15.5 Starting up

1. Connect MP 924 interface distributor according to fig. 6-22. Use MP 923 interface converter for interface conversion RS 232 ↔ RS 485 (RS 422) (see chapter 6.2.14).

ATTENTION
The interface cable must be screened on both sides (connect MP 924 shield connector to protective ground).

ATTENTION
The RS 232 cable must be kept as short as possible for reasons of noise immunity.

ATTENTION
Line terminal must never be connected.

2. When several MP 924 interface distributors are used, they must be connected according to fig. 6-22.

3. Select network mode at the connected units and switch on units.

ATTENTION
The same baud rate must be set at all units in network mode.

ATTENTION
When using the MP 923 interface converter, at least one unit at the MP 924 interface distributor must be switched on to ensure that MP 923 is supplied with voltage.

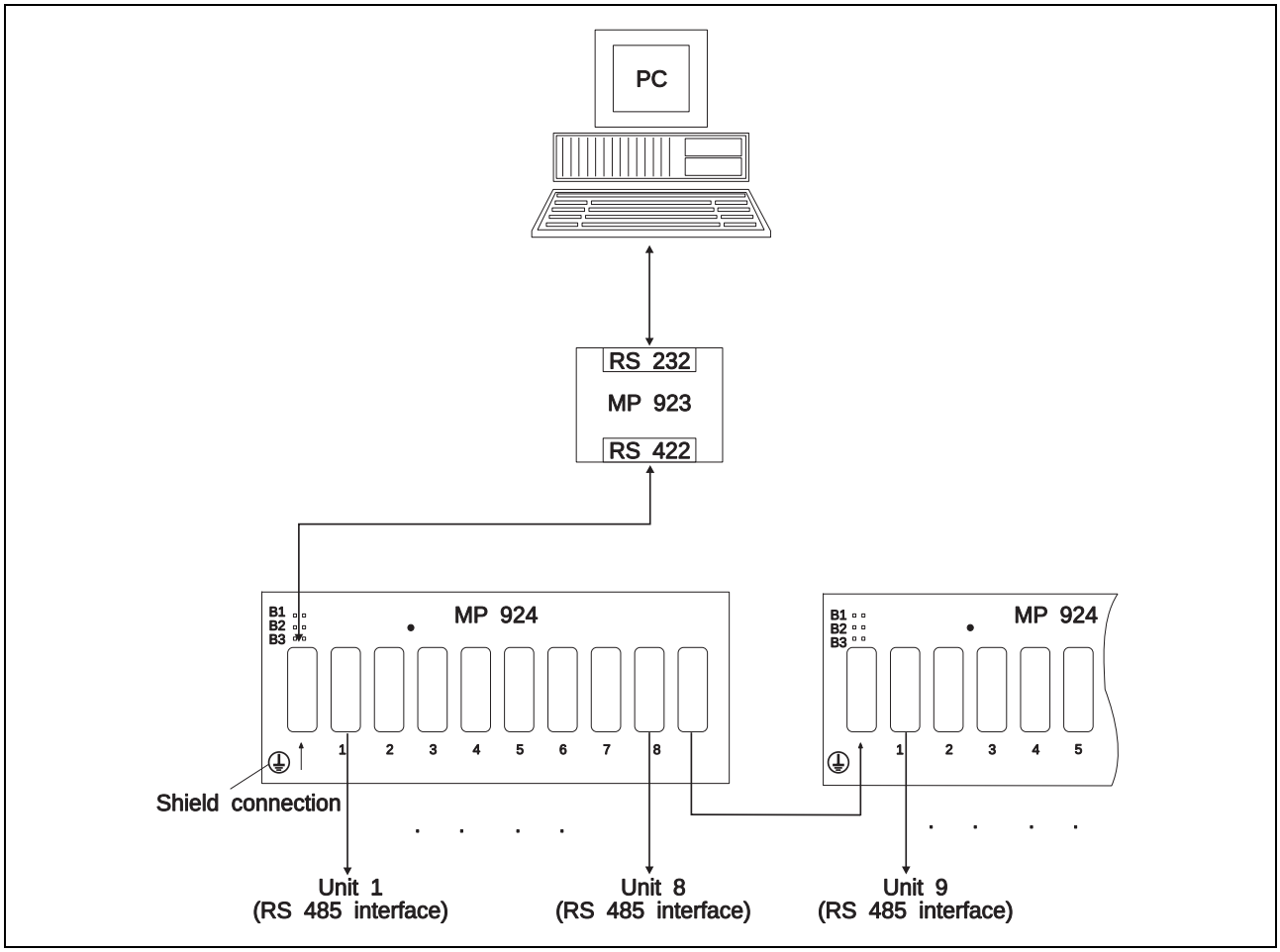


Fig. 6-22 Cabling of MP 924 interface distributor

6.2.16 Signal cable

There are two different signal cables:

- Signal cable with male connector on device side and no connector on the other end
- Signal cable with male connector on device side and a 37-pole female connector on the other end

The signal cable with no connector on one end is available with the following lengths:

Cable length	Order number
1 m	62501407010
2 m	62501407020
5 m	62501407050
10 m	62501407100

The signal cable comprises:

Qty.	Designation	Order number
1	37-pole connector	N4-673-249
1	Connector shell	N4-673-239
1	Cable	H6-928-44

The signal cable with male connector on device side and 37-pole female connector on the other end is available with the following lengths:

Cable length	Order number
1 m	62501408010
2 m	62501408020
5 m	62501408050
10 m	62501408100

The signal cable comprises:

Qty.	Designation	Order number
1	37-pole female connector	N4-673-203
1	37-pole male connector	N4-673-249
2	Connector shell	N4-673-239
1	Cable	H6-928-44

The signal connection is illustrated and described in chapter 2.4.4.

6.2.17 Crossover adapter for RS 485 interface

The crossover adapter for RS 485 interface is used to interchange the transfer and receive lines for the master/slave mode.

6.2.18 WDP5-228 set of connectors

The set of connectors comprises:

Qty.	Designation	Order number
2	9-pole connector	N4-673-246
2	Connector shell (9-pole)	N4-673-236
2	15-pole connector	N4-673-247
2	Connector shell (15-pole)	N4-673-237
1	37-pole connector	N4-673-249
1	Connector shell (37-pole)	N4-673-239

6.3 Reference movement principle

ATTENTION
The limit switch areas must not be overrun.

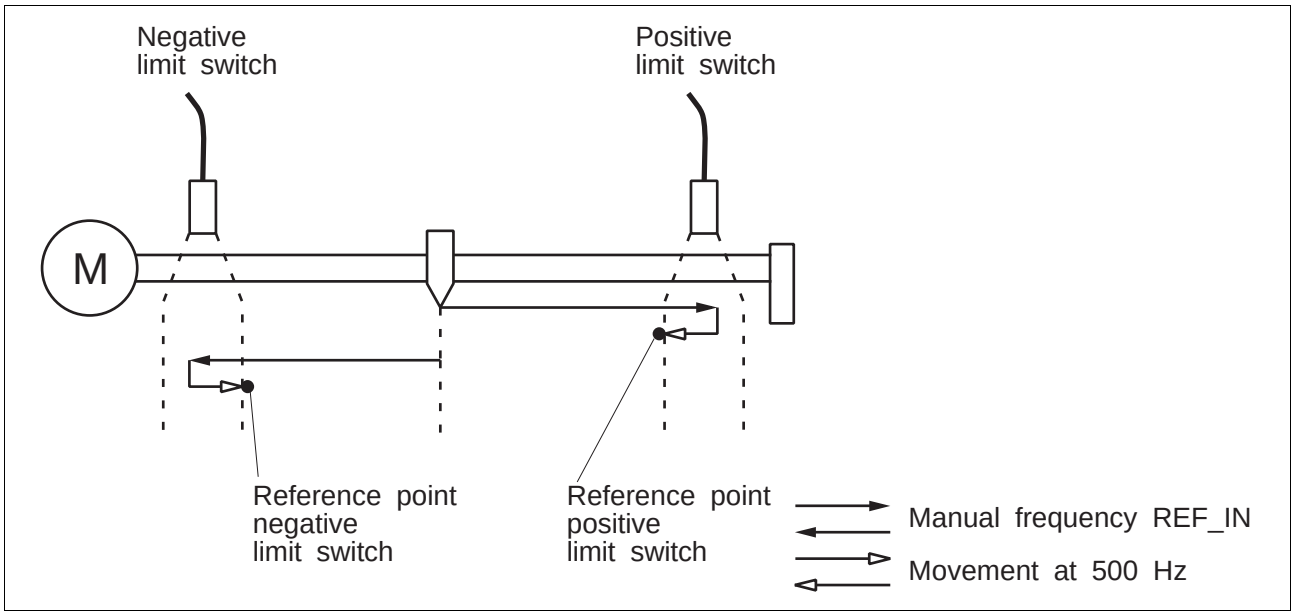


Fig. 6-23 Principle of reference movement towards limit switch

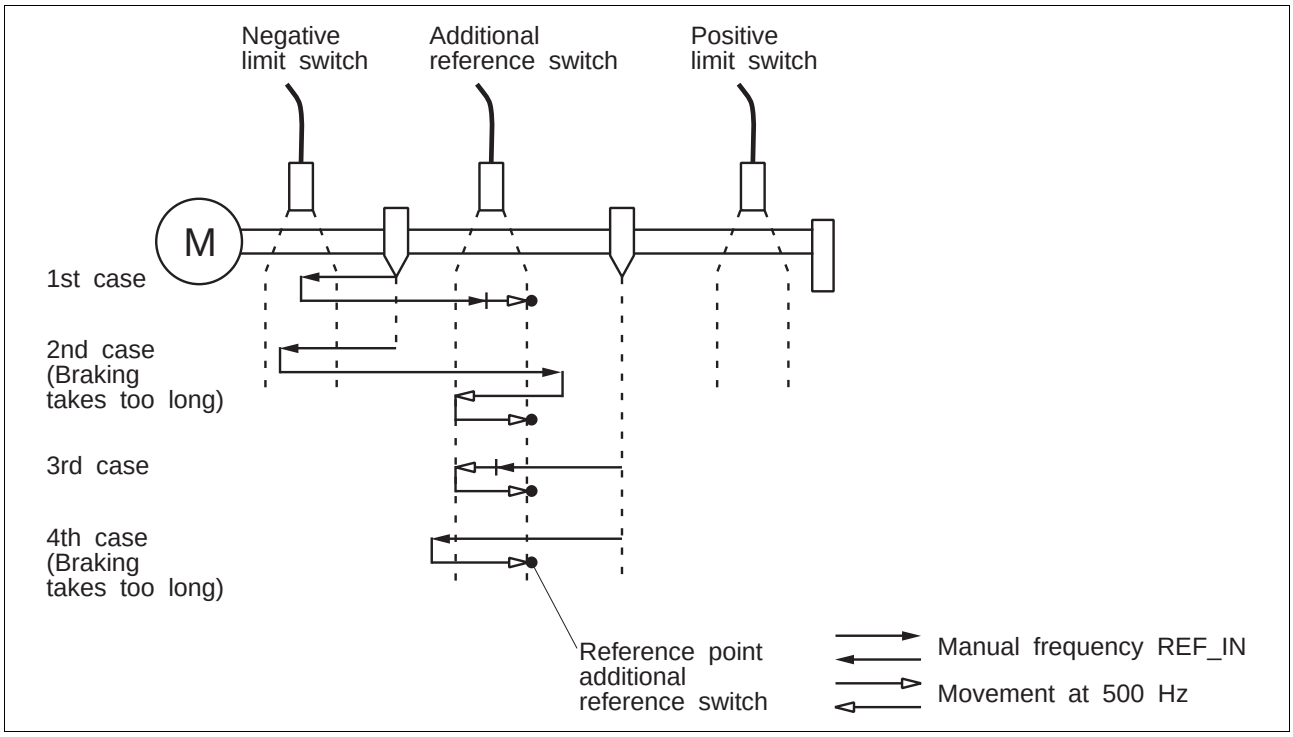


Fig. 6-24 Principle of reference movement towards additional reference switch

6.4 Formulae and calculations

6.4.1 Position sensor with 4-fold evaluation

The information content was quadrupled (so-called 4-fold evaluation) by means of suitable electronic evaluation so that 4/N path units are obtained per revolution, whereby a shaft encoder revolution corresponds to a motor revolution (N = number of marks per revolution).

NOTE
The shaft encoder resolution is at the same time the unit in which all path, speed and acceleration data required for positioning is given.

Angular unit

An angular unit which is referred to as an increment in the following, is determined from the following formula:

1 increment = 2 π/4N [rad]

N = number of marks on the shaft encoder disk
2 π = 360° = full angle (1 revolution)

e.g. N = 1000 strokes per circumference
1 increment = 2 π/4 x 1000
= 0.00157 [rad]
= 0.09°
4 x N = 4000 increments/revolution (four-fold evaluation)

Speed

The speed (rotating frequency of the motor) is output in the frequency unit Hertz (Hz) in accordance with the following formula:

1 Hz = 1 increment/s

e.g. shaft encoder disk with 1000 marks
4000 Hz = 4000 increments/s
= 4000 x 0.00157 [rad]/s = 2 π/s
= 4000 x 0,09°/s = 360°/s
= 1 revolution per second.

When converting revolutions/min into Hertz or vice versa, the following results:

n [revolutions/min] = (60/(4xN)) x f [Hz]

whereby
n motor speed [revolutions/min]
f rotating frequency in increments per second (Hz)
N number of marks on the shaft encoder disk

e.g. f = 200 kHz and N = 1000
n = (60/4(4x1000)) x 200 kHz
n = 3000 [revolutions/min]

Acceleration

The unit in which acceleration data is defined is one Hertz per millisecond:

1 Hz/ms = 1 increment/s/ms

e.g. shaft encoder disk with 1000 marks
1000 Hz/ms = 1000 increments/s/ms
= 1000 x 0.00157 [rad]/s/ms
= 1000 x 0.09°/s/ms
= 90°/s/ms

I.e. acceleration to a speed of 90° per second (= 1/4 revolution per second) is performed in 1 ms; a speed of 1 revolution per second would be reached in 4 ms.

6.4.2 Relation between drive moment and motor current

There is a current flow at the motor which corresponds to the drive moment expected of it. I.e. an unloaded stepping motor is "cold". There is the following relation:

$M = K_t \times I$

M torque generated by the motor (drive moment)
K_t torque constant (motor and power-specific)
I actual motor current.

6.4.3 Rigidity

The rigidity is proportional to the proportional gain "KP". The following formula applies:

Rigidity = const x KP
= torque/balance

const motor-specific torque constant
KP proportional gain

6.4.4 Maximum frequency of electronic gear

When selecting the gear ratio it must be noted that the maximum motor speed (5850 revolutions/min) must not be exceeded!
I.e. the counting frequency of the pulse counter multiplied by the gear ratio must be less the maximum motor frequency (increments per second) which depends on the shaft encoder resolution.

$$f_{numerator,max} \; x \; \frac{EZ}{EN} \leq f_{motor,max}$$

e.g.
a) N = 1000 marks, this results in the following for f_{max} = 390 kHz

f_{max} = N_{max} x 4000/60
= 195 x 2000 = 390 kHz

b) Assuming that gear ratio is 2 (EZ = 2000, EN = 1000)
c) Shaft encoder signals A/B must be supplied.

This results in
$f_{numerator,max}$ = $f_{motor,max}$ x EN/EZ
= 390 kHz x 1000/2000
= 195 kHz

The four-fold evaluation of the A/B signals results in:
$f_{A,max}$ = $f_{B,max}$ = 195 kHz/4
= 48.75 kHz

6.4.5 Acceleration time/ramp

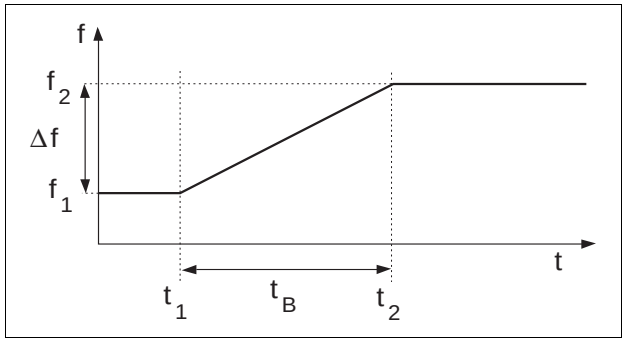


Fig. 6-25 Ramp gradient definition

Acceleration time

$$t_B = t_2 - t_1 = \frac{f_2 - f_1}{a} = \frac{\Delta f}{a}$$

t_B [ms]
f [incr./s]
a [incr. Hz/ms]

e.g. acceleration time from f_1 = 50000 [incr./s] to f_2 = 100000 [incr./s] with a = 1000 [incr .x Hz/ms]

$\Delta f = f_2 - f_1$ = 100000 [incr./s] - 50000 [incr./s]
= 50000 [incr./s]

$$t_B = \frac{5000}{1000} \frac{[incr/s]}{[incr/s/ms]} = 50 \; ms$$

Ramp gradient for frequency modification

$$a = \frac{f_2 - f_1}{t_2 - t_1} = \frac{\Delta f}{t_B}$$

t_B acceleration time [ms]
Δf frequency modification [incr/C]
a ramp gradient [incr. x Hz/ms]

NOTE
This is also valid for the special case f_1 = 0 and t_1 = 0

Ramp gradient for speed change

$$a = \frac{\Delta n}{t_B} \; x \; \frac{N}{15}$$

Δn speed change [rpm]
N number of marks of shaft encoder [marks/rev]
t_B acceleration time [ms]
a Ramp gradient [incr. x Hz/ms]

6.5 Flow-charts

6.5.1 Acknowledgement in sub-mode "Point-to-point"

The end of a reference or normal movement in automatic run is indicated by activation of output INPOS. This acknowledgement is given when the motor reaches the positioning window programmed with the command "PW" and the reference variable generator has processed the job.
Should the load moment at the shaft be so high that the motor does not reach the positioning window, positioning can be interrupted by switching over from automatic run to manual movement.

NOTE
In serial mode, an additional acknowledgement is given with "X" or "<XPOSITION>", if "M93" has been activated.

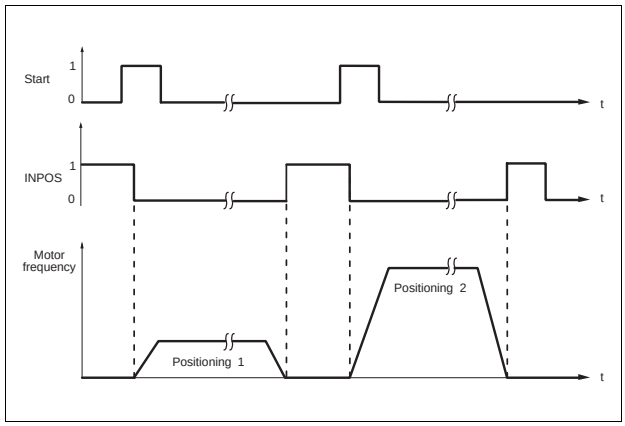


Fig. 6-26 Flow-chart in sub-mode "Point-to-point"

6.5.2 Acknowledgement in sub-mode "Frequency characteristics"

In this operating mode, trouble-free reception of admissible action commands is merely acknowledged by activation of output INPOS. An exception is the movement at a frequency XY<8. During such a movement, the motor ramps down to frequency 0 and the acknowledgement by activation of output INPOS is only given if the final frequency 0 is reached.
This means that the movement frequency can be modified at any time by defining a new frequency value. The condition for a frequency change is the acknowledgement of the previous job (signal INPOS = 1).

NOTE
Due to the index resolution of 8 increments a frequency "XY" causes the motor to stand still.

NOTE
In serial mode, an "X" is issued as an additional acknowledgement.

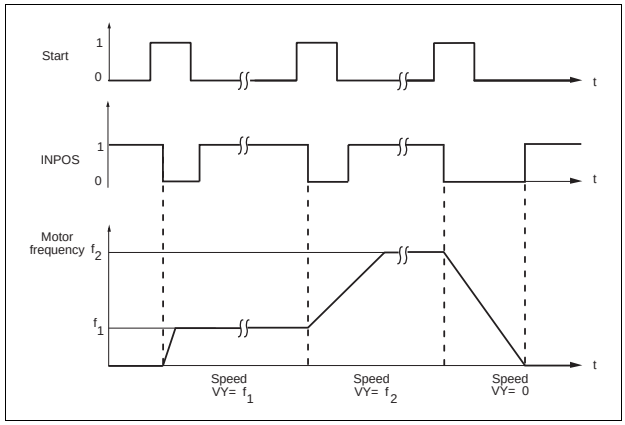


Fig. 6-27 Flow-chart in sub-mode "Frequency characteristics"

6.5.3 Acknowledgement in sub-mode "Electronic gear"

In this sub-mode, trouble-free reception of the admissible action commands is merely acknowledged by activation of output INPOS. The actual movement is triggered by pulses at the gear interface, which may be generated by a guide spindle or something similar. The condition for changing the gear ratio is the acknowledgement of the previous job (signal INPOS = 1).

NOTE
In serial mode, an "X" is issued as an additional acknowledgement.

The gear ratio can be varied by combining the values EZ = <VALUE> and EN = <VALUE> in such a way that the axle rotates faster or slower than the guide spindle by the ratio EZ/EN.

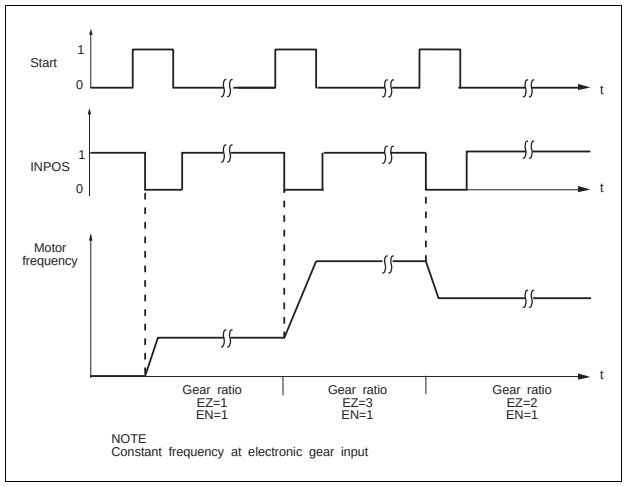


Fig. 6-28 Flow-chart in sub-mode "Electronic gear"

6.6 Terminology

Absolute dimensions	Reference system of dimensions used in positioning. The reference point for positioning is the reference point for the system.
Action command	Action command A is a command triggering an action, e.g. activation of a new gear ratio in sub-mode "Electric gear"
Additional reference switch	Additional switch for reference movement.
Block processing	The commands "BEG" and "END" are used to mark a processing block in a flow chart (combination of several action commands for processing via a start in network mode "Memory").
Clockwise rotation	Sense of rotation of the motor in clockwise direction (viewed from front to motor shaft).
Command	Commands are instructions to the unit-internal operating system. They are executed immediately without a special acknowledgement.
Controller mode	The controller mode determines the manipulated variable. A distinction is made between current controller and load angle controller.
Counterclockwise rotation	Sense of rotation of the motor in counterclockwise direction (viewed from front to motor shaft).
Current controller	The controlled variable "Current" generates a motor torque.
Decade settling time	Number of reading repeats of a decade value in parallel data transfer.
Direct command	Commands are activated immediately after the transfer without a special acknowledgement.
Dynamics	Response time of the drive to reference variable changes or positional variations.
Electric commutation	Electric commutation commutes the electric rotating field such that the load angle defined by the PID controller is strictly adhered to at all times.
Following error	The current positional variation (desired value - actual value) is referred to as the following error.
Following error limit	Limit for the following error (nominal value – actual value) which can be programmed with command "XL". It is used to optimize acceleration setting.
Gear ratio	Multiplier used in positioning which consists of the numerator and denominator (reduction gear or speed-transforming gear).
Incremental dimensions	Reference system of dimensions for the positioning unit. The reference point for positioning is the current position.

Incremental shaft encoder	Incremental shaft encoders are provided with a certain number (N) of marks on a disk, they indicate a change of position.
Increments	An increment is referred to as an angular unit, it is calculated according to the following formula 1 increment = 2 π/4 N
Init values	The init values are used for initializing the processor unit.
Limit switch	Switch limiting the travel and reference movement.
Load angle controller	A combination of the controlled variable "Current" and "Load angle" generates the motor torque.
Load resistor	Reduces the braking energy of the motor.
Locking	In the target position, automatic commutation of the rotating field can be prevented.
Low rigidity of motor	This means that the torque generated by the motor on deviating from the setpoint is lower than it could be with reference to the amount of deviation. The drive is not dynamic enough.
Manual frequency	Motor speed during slow ("Manual frequency slow") or fast ("Manual frequency fast") manual movement.
Mixed command	Commands of this type can basically also be considered setting commands, with the difference that activation by a start signal is also possible without transferring an additional action command.
Network mode	Positioning mode used in a network of positioning units. Several units are linked with a host via a physical connection. The units are selected by means of addressing.
Parallel mode	Operating mode of the positioning unit for parallel transfer of movement commands, e.g. movement command transfer via decade switches.
Parameter	These instructions can be edited with a parameter editor and subsequently transferred to the controller as a complete parameter set.
Phase advance	The phase advance feature determines advance of the electric rotating field as compared to the rotor’s rotating field.
Phase current	Current flowing through the winding of a stepping motor
Phase sensor	Incremental shaft encoders only are flanged to the motor shaft as a path measuring system.
Power control card	Card equipped with an electronic system for driving the motor.

Quiescent current	The motor is supplied with quiescent current if the position controller is inactive and the motor is in locking state.
Readings	Number of times a complete decade switch block is read in parallel data transfer.
Reference movement	Movement of the motor towards the right or left limit switch or additional reference switch for setting a reference point for the system of dimensions.
Reference movement frequency	Motor speed at which a movement to the limit/reference switch ("REF IN") and a movement away from the limit/reference switch ("REF OUT") to the reference point is performed.
Reference position	Position value after a reference movement or reference point setting.
Reference variable generation	Reference variable generation depends on the selected sub-mode. Calculation is described in chapter 6.4.
Rigidity	Motor torque referred to deviation from the setpoint.
RS 485 interface	Serial interface for the network.
Serial mode	Operating mode of the positioning unit for serial transfer of movement commands.
Setting command	This command only takes effect in combination with an action command, e.g. the ramp gradient only takes effect in combination with a movement command.
Settling time	Time during which an input signal must be stable so that the positioning unit can recognize it.
Stability	The stability is determined by oscillation of the control circuit in the end position (setpoint).
Step angle	Angle of rotation through which the motor shaft rotates for each control pulse.
Step response	The step response indicates the response of the controlled variable (here: current motor position) to a sudden reference variable change (here: current reference position) in terms of time.The step response represents a highly dynamic load for the control circuit which makes the entire transient response of the control circuit evident.
Storage mode	Operating mode of the positioning unit for processing stored programs.
Timing function	Time delays between the individual jobs can be realized with the aid of action command "T" in network mode "Memory".
Unstable control circuit	This means that the motor continuously oscillates with a constant amplitude and frequency, although there is no changing reference variable or an external load moment.

6.7 Abbreviations

a	Ramp gradient
A	Action command
A/R	Absolute/incremental
ASCII	American Standard Code for Information Interchange
CMOS	Complementary Metal-Oxide Semiconductor
D	Direct command
Doc. no.	Documentation number
E	Encoder
Δf	Frequency change
HU	Height unit
I	Initialization value
LED	Light Emitting Diode
M	Mixed command or Motor
M	Motor
Δn	Speed change
N	Number of shaft encoder increments
P	Parameter
PC	Personal Computer
PLC	Programmable Logic Controller
S	Setting command
SW	Wrench size
t_B	Acceleration time

6.8 ASCII table

HEX	DEZ	CHAR	HEX	DEZ	CHAR	HEX	DEZ	CHAR	HEX	DEZ	CHAR	HEX	DEZ	CHAR
00h	000	(NUL)	1Ah	026	(SUB)	34h	052	4	4Eh	078	N	68h	104	h
01h	001	(SOH)	1Bh	027	(ESC)	35h	053	5	4Fh	079	O	69h	105	i
02h	002	(STX)	1Ch	028	(FS)	36h	054	6	50h	080	P	6Ah	106	j
03h	003	(ETX)	1Dh	029	(GS)	37h	055	7	51h	081	Q	6Bh	107	k
04h	004	(EOT)	1Eh	030	(RS)	38h	056	8	52h	082	R	6Ch	108	l
05h	005	(ENQ)	1Fh	031	(US)	39h	057	9	53h	083	S	6Dh	109	m
06h	006	(ACK)	20h	032	blk	3Ah	058	:	54h	084	T	6Eh	110	n
07h	007	(BEL)	21h	033	!	3Bh	059	;	55h	085	U	6Fh	111	o
08h	008	(BS)	22h	034	"	3Ch	060	<	56h	086	V	70h	112	p
09h	009	(HT)	23h	035	#	3Dh	061	=	57h	087	W	71h	113	q
0Ah	010	(LF)	24h	036	$	3Eh	062	>	58h	088	X	72h	114	r
0Bh	011	(VT)	25h	037	%	3Fh	063	?	59h	089	Y	73h	115	s
0Ch	012	(FF)	26h	038	&	40h	064	@	5Ah	090	Z	74h	116	t
0Dh	013	(CR)	27h	039	’	41h	065	A	5Bh	091	[	75h	117	u
0Eh	014	(SO)	28h	040	(	42h	066	B	5Ch	092	\	76h	118	v
0Fh	015	(SI)	29h	041	)	43h	067	C	5Dh	093	]	77h	119	w
10h	016	(DLE)	2Ah	042	*	44h	068	D	5Eh	094	^	78h	120	x
11h	017	(DC1)	2Bh	043	+	45h	069	E	5Fh	095	_	79h	121	y
12h	018	(DC2)	2Ch	044	,	46h	070	F	60h	096	‘	7Ah	122	z
13h	019	(DC3)	2Dh	045	-	47h	071	G	61h	097	a	7Bh	123	{
14h	020	(DC4)	2Eh	046	.	48h	072	H	62h	098	b	7Ch	124	|
15h	021	(NAK)	2Fh	047	/	49h	073	I	63h	099	c	7Dh	125	}
16h	022	(SYN)	30h	048	0	4Ah	074	J	64h	100	d	7Eh	126	~
17h	023	(ETB)	31h	049	1	4Bh	075	K	65h	101	e	7Fh	127	⌂
18h	024	(CAN)	32h	050	2	4Ch	076	L	66h	102	f			
19h	025	(EM)	33h	051	3	4Dh	077	M	67h	103	g			

7 Index