KOLLMORGEN
Seidel

BIT CONNECT

Interface modul integrated in digifas™ 7100-SPS and digifas™ 7200-SPS

CE

Commissioning / technical description

Edition 05/98

Previous editions

Edition	Comments
02 / 95	First edition, valid from software version 4L21/4B30
01 / 97	Layout changed, new functions, some corrections, valid from software version 7x10
05 / 98	SSD version, reference traverse 5, valid from software versions 7B24/7A22/7L30

Technical changes improving performance and specifications, may be made without prior notice !

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Safety instructions

Warning signs : you must observe the important instructions in the text, which are indicated by the following symbols:

hazard from electricity and its effects

general warning general instruction

- **Only properly qualified personnel are permitted to perform activities such as transport, installation, commissioning and maintenance. Properly qualified persons are those who are familiar with transport, installation, assembly, commissioning and operation of the products, and who have the appropriate qualifications for their job. The qualified personnel must know and observe the following standards and directives:**
  IEC 364 and CENELEC HD 384 or DIN VDE 0100
  IEC Report 664 or DIN VDE 0110
  national accident prevention regulations or BGV A2

- **Read the available documentation before carrying out installation and commissioning. Incorrect treatment of the servo amplifier can lead to injury to persons or material damage. It is vital that you keep to the technical data and information on connection requirements (nameplate and documentation).**

- **The servo amplifiers contain electrostatically sensitive components which may be damaged by incorrect handling. Discharge your body before touching the servo amplifier. Avoid contact with highly insulating (artificial fabrics, plastic film etc.). Place the servo amplifier on a conductive surface.**

- **Do not open the units. Keep all covers and switchgear cabinet doors closed in operation. Otherwise there are deadly hazards with the possibility of severe danger to health or material damage.**

- **In operation, depending on the degree of enclosure protection, servo amplifiers can have bare components which are live and hot surfaces. Control and power cables can carry a high voltage even when the motor is not rotating.**

- **Never undo the electrical connections of the servo amplifier when it is live. There is a danger of electric arcing and danger to persons and contact.**

- **Wait at least two minutes after disconnecting the servo amplifier from the mains supply voltage before touching live sections of the equipment or undoing connections (e.g. contacts, screwed connections). Capacitors can have dangerous voltages present up to two minutes after switching off the supply voltages. To be sure, measure the voltage in the intermediate circuit and wait until it has fallen below 40V.**

Directives and standards

Servo amplifiers are components which are intended to be incorporated into electrical machines and plant.

When the servo amplifiers are incorporated into machines or plant, the intended operation of the amplifiers is forbidden until it has been established that the machine or plant fulfills the requirements of the EC Directive on Machines 89/392/EEC and the EC Directive on EMC 89/336/EEC. EN 60204 and EN 292 must also be observed.

In connection with the Low Voltage Directive 73/23/EEC, the harmonized standards of the EN 50178 series are applied to the servo amplifiers, together with EN 60439-1, EN 60146 and EN 60204.

The manufacturer of the machine or plant is responsible for ensuring that the machine or plant meets the limits which are laid down by the EMC regulations. Advice on the correct installation for EMC – such as shielding, grounding, arrangement of filters, treatment of connectors and laying out the cabling – is included in this documentation.

CE -conformance

Conformance to the following directives is mandatory for the supply of servo amplifiers within the European Community:

since January 1st 1996 : EC EMC Directive 89/336/EEC
since January 1st 1997 : EC Low-Voltage Directive 73/23/EEC

The correct installation for EMC is shown in the installation instructions for the servo amplifier. These instructions also show the components which are required (cables, mains filters etc.)

Any divergence from the configuration and installation which is described in the documentation means that you will be responsible for the performance of new measurements to ensure that the regulatory requirements are met.

Only on condition that the components which we have specified are used and the installation rules are observed can we guarantee that the servo amplifier conforms to the following standards for industrial areas:

EC EMC Directive	**89/336/EEC**
EC Low Voltage Directive	**73/23/EEC**

I General

I.1 About this manual

This manual describes the wiring, commissioning and range of functions of the interface module BIT CONNECT. It is part of the complete documentation of the digifas™ 7100 and digifas™ 7200 series of digital servo amplifiers.

The installation and commissioning of the servo amplifier, as well as all the standard functions, are described in the corresponding installation instructions.

Other parts of the complete documentation for the digifas™ 7100 and digifas™ 7200 series of digital servo amplifiers:

Title	Manufacturer	Order No.
Operating manual for BS7200 user software	Seidel	83107
Operating manual for digifas™ 7200	Seidel	83003
Operating manual for digifas™ 7100	Seidel	83498

This manual is intended for the use of qualified personnel with the following qualifications:

Installation : Electrically trained personnel
Commissioning : Personnel trained in control technology

We offer training and familiarization courses on request.

I.2 “Use as directed” for the BIT CONNECT interface module

The BIT CONNECT interface module is permanently built into digital servo amplifiers of the digifas™ 7100-SPS and digifas™ 7200-SPS series.
These servo amplifiers are to be used only on three-phase 400V industrial earthed mains supplies.
The digifas™ 7100-SPS and digifas™ 7200-SPS series of servo amplifiers are exclusively intended for closed-loop driving of brushless synchronous servomotors from the 6SM series.
The BIT CONNECT interface module is used only to connect the servo amplifier to a control which has PLC-compatible inputs/ outputs.
The servo amplifiers are components which are installed in electrical equipment or machines, and can only be commissioned as integral components of such equipment or machines.
You must prepare a hazard analysis before commissioning the equipment or machine.

Only on condition that the components which we have specified are used and the installation rules are observed can we guarantee that the servo amplifier conforms to the following standards for industrial areas:

EC EMC Directive 89/336/EEC
EC Low Voltage Directive 73/23/EEC

I.3 Brief description

Designed for simple automation tasks, the BIT CONNECT option is an inexpensive means of operating servo drives as speed and position controllers. No previously required CNC controllers or positioning modules are needed.

The BIT CONNECT interface module is integrated in the digifas™ 7100 or digifas™ 7200 servo amplifier. BIT CONNECT can be controlled by manufacturer-independent controllers via 10 I/O lines. It is connected via a 12-pin MINI-Combicon connector.

Parameterization of the servo amplifier (current controller, speed controller and position controller) and input of motion block parameters are performed via the BS7200 user software. The number of a task which follows automatically can also be entered.

The stored motion data blocks (max. 15 motion data blocks) are requested and started by the controller. Intermediate stops can be triggered and a contouring error message cleared by the controller. The “In Position” and “Contouring Error” signals can be evaluated by the controller.

There is a dwell time in the order of magnitude of standard controller response times in between the execution of individual motion tasks.

The digital control inputs and outputs are also available to the servo amplifier for further use. Analog setpoint input SW +/— has no function.

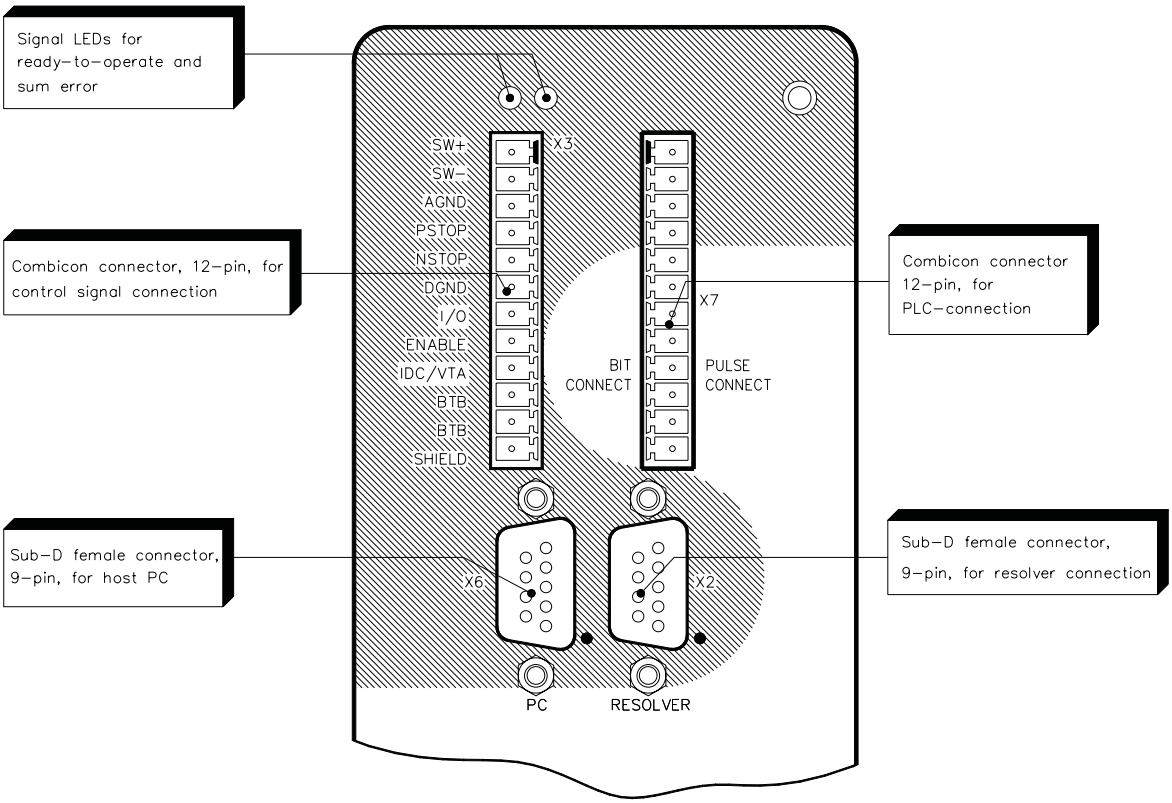
New functions

- Motion tasks can automatically be performed sequentially (following task).
  This makes it possible to create speed profiles and simple handling tasks.
- Two new kinds of relative motion block enable register mark control systems and similar applications.
- The control system can select from up to 15 constant speeds.
  (Endless loop of a relative motion task for a rotary axis)
- Changeover option between current motion tasks (flying start – only when the ramp type is set to “trapezoidal”)
- Ten different types of reference traverse/homing.
- The maximum speed (final speed) can now be set to up to 6000 min^{-1}.
- Motion block data can now also be printed out.

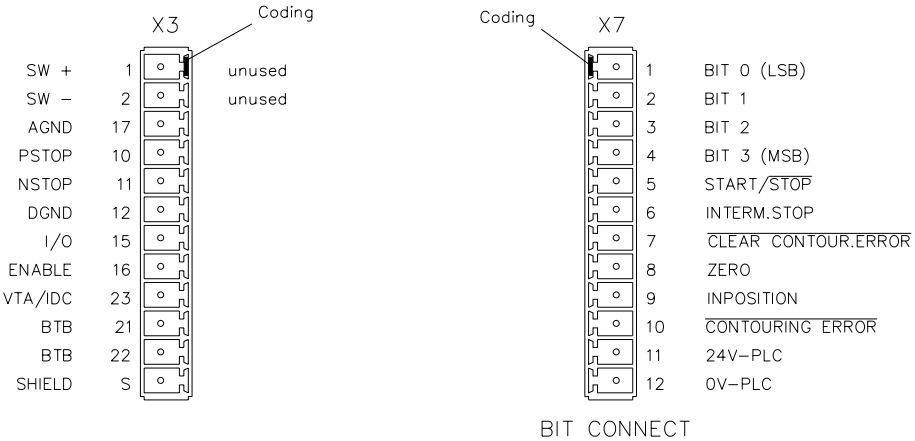
I.4 Specifications

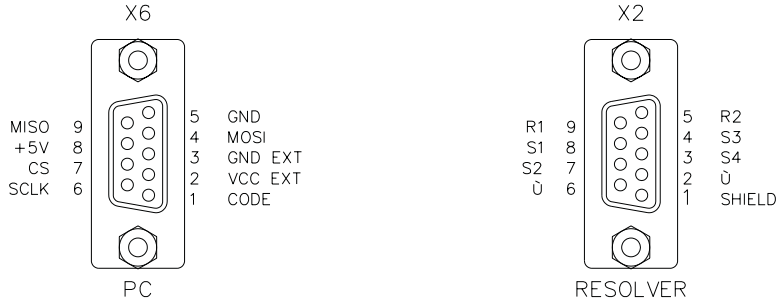
Control inputs: 24 V/7 mA, PLC-compatible	
Motion task address	Bit0 to Bit3 in binary for 15 motion tasks and one move to reference point
Start/$\overline{\text{Stop}}$	Positioning
Zero initiator	Zero reached
$\overline{\text{Clear Contouring Error}}$	Clear contouring error message
INT-Stop	Intermediate stop
Signal outputs: open emitter, 24 V/30 mA, PLC-compatible	
In Position	Position reached
$\overline{\text{Contouring error}}$	Acceleration and/or speed not achieved, position error
Supply inputs as per IEC 1131	
24V - PLC, 18...30V, 100mA	Supply for interface optocoupler
0V - PLC	Supply for interface optocoupler
Connections	
Connector	Connector: MiniCombicon, 12-pin, encoded at PIN1
Line	Line: up to 50 m long, 12x0.5mm², unshielded
Relevant times	
Waiting time between 2 motion tasks	t_Z , dependent on controller response time
Adress time (min.)	$t_a \geq 4$ms
Start delay (max.)	$t_s \leq 2$ms
Motion task parameters	
No.	Number of motion data block
Type	Selection of relative/absolute motion task
s_nom [mm]	Traversing distance
v_nom [mm/s]	Traversing speed
t_acc [ms]	Time needed to accelerate from 0 to v_nom
t_dec [ms]	Time needed to decelerate from v_nom to 0
Next No.	Number of the following task (will be started automatically)
Intermediate Stop	Automatic pause between the current and the following task
Max. adjustable final motor speed	
Final speed	6000 min^{-1}

I.5 Front view of digifas™ 7100/7200 BIT CONNECT with functional units



I.6 Pin assignments of digifas™ 7100/7200 with BIT CONNECT





I.7 Description of signals

All inputs and outputs on Mini-Combicon connector X7 are isolated from the amplifier potential via optocouplers. The optocouplers are supplied by the controller via terminals X7/11 (+24V) and X7/12 (0V) according to IEC 1131. The logic is PLC-compatible and rated for +24 V/7mA. A high level in the range +12V to +30V and a low level in the range 0V to 7V are not triggered. Unless specified otherwise, the signals are in a HIGH-active state.

Inputs to servo amplifier

Bit 0 to Bit 3 : Selection of motion task in binary code (Bit 0 is LSB)

Start / $\overline{\text{Stop}}$: The selected motion task is started or stopped

Intermediate stop : A motion task is interrupted during execution

$\overline{\text{Clear contouring error}}$: (LOW-active or open) Clear a contouring error after a “Contouring error” signal has been signalled and re-enable the position control in the servo amplifier. **The contouring error can only be cleared if the amplifier is disabled.**

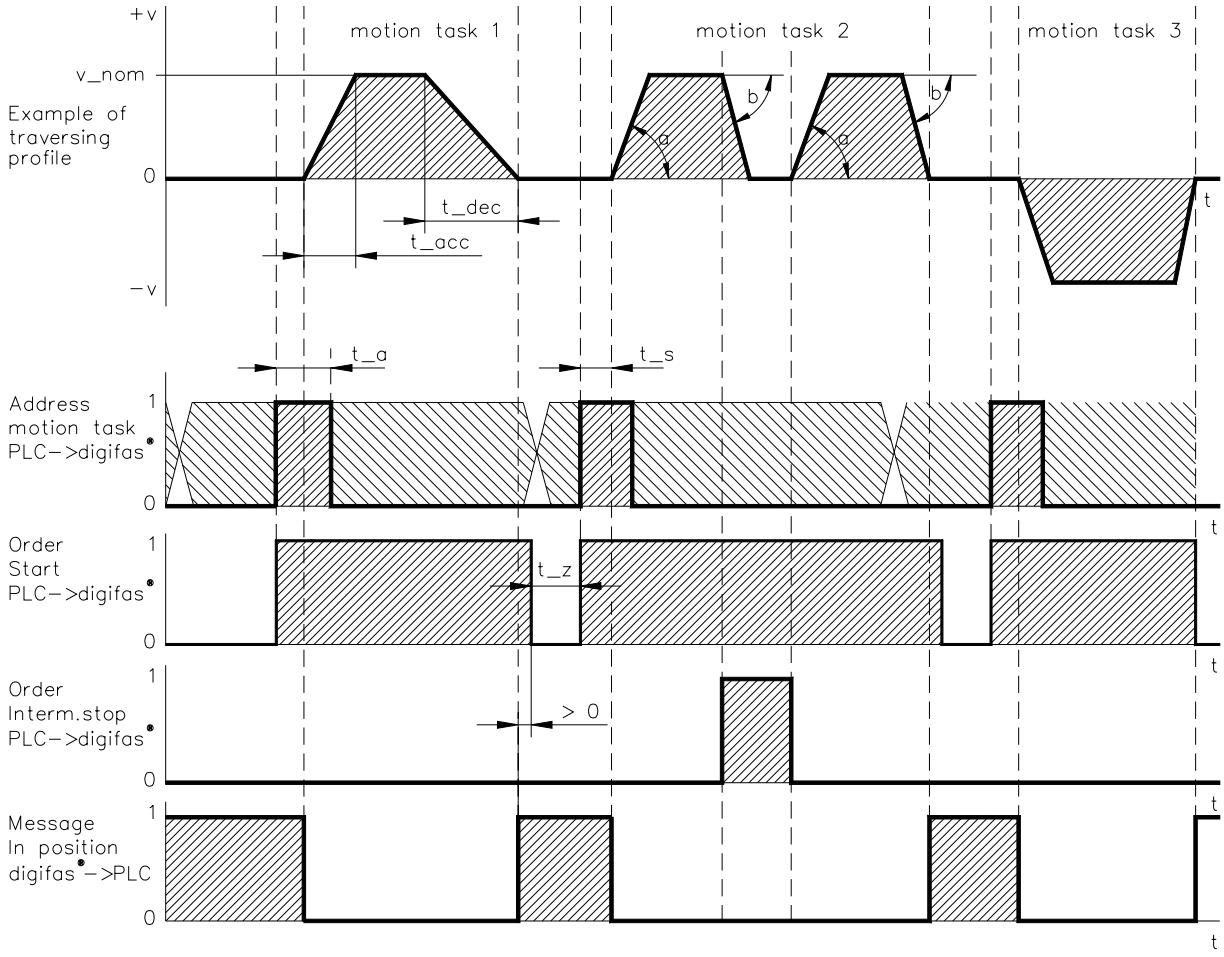
Zero : Input for reference switch (zero-point proximity switch)

Outputs from servo amplifier

$\overline{\text{Contouring error}}$: (LOW-active) Signal to controller that the load has left the preselected contouring error window and that the amplifier has then performed an emergency braking operation. The position controller remains disabled then until the signal is cleared via the “Clear contouring error” input.

In Position : The position controller signals the completion of a successful positioning operation to the controller via the position controller.

I.8 Demo traversing profile and signal diagram



The distance travelled is calculated from the area below the speed curve. The deceleration and acceleration times for one intermediate stop are identical to the default times set in the motion data block (as shown above in motion order 2).

- **t_z** Waiting time between 2 motion orders: dependent from controller response time (min.2ms)
- **t_a** Minimum address time: address should be present for longer than 2 ms after the start signal is given in order to bridge the start-up delay safely
- **t_s** Maximum start delay: less than 2 ms, internal delay in amplifier
- **t_{acc}** acceleration time from v=0 to v=v_{nom}
- **t_{dec}** deceleration time from v=v_{nom} to v=0
- **a** acceleration
- **b** deceleration
- **1** High level
- **0** Low level
- **v** Speed
- **t** Time

II Installation and commissioning

II.1 Installation

Ensure that the switchgear cabinet is properly isolated (barrier, warning signs etc.). The individual supply voltages will only be turned on again during commissioning.

Residual charge in the capacitors can still have a dangerous level even several minutes after switching off the mains supply. Measure the voltage in the DC-link circuit, and wait until it has fallen below 40V.

Even when the motor is not rotating, the control and power leads may still be live.

Electronic equipment is not proof against failure. The user is responsible for making sure that, in the event of a failure of the servo amplifier, the drive is brought to a safe state for personnel and for the machinery, for instance by using a mechanical brake.

Drives with servo amplifiers and CONNECT modules are remote-controlled machines. They can start to move at any time, without warning. Bring this to the attention of the operating and service personnel by using appropriate warning signs.

Take appropriate safety measures to ensure that an unintended starting of the machine cannot lead to dangerous situations for personnel or machinery. Software limit switches cannot replace the hardware limit switches on the machine.

Install the servo amplifier as described in the installation manual for digifas™ 7100 or digifas™ 7200 respectively. The wiring for the analog setpoint input and the positioning interface in accordance with the installation manual does not apply.

Use whichever wiring diagram is valid for the amplifier concerned, in Chap. II.1.2 of this manual, for the connection of the CONNECT interface.

Always install and wire up the equipment in a de-energized state. Neither the mains power supply, nor the 25V auxiliary supply, nor the operating voltage of any other equipment which is connected may be switched on. Never loosen the electrical connections to the servo amplifier while it is live. This could result in destruction of the electronics.

Because of the internal representation of the position-control parameters, the position control can only be operated if the final limit speed of the drive is no more than 6000 revs/min. All information about resolution, incremental step size, positioning accuracy etc. refers to calculated values. Non-linearities in the mechanism (backlash, elasticity etc.) are not taken into account.

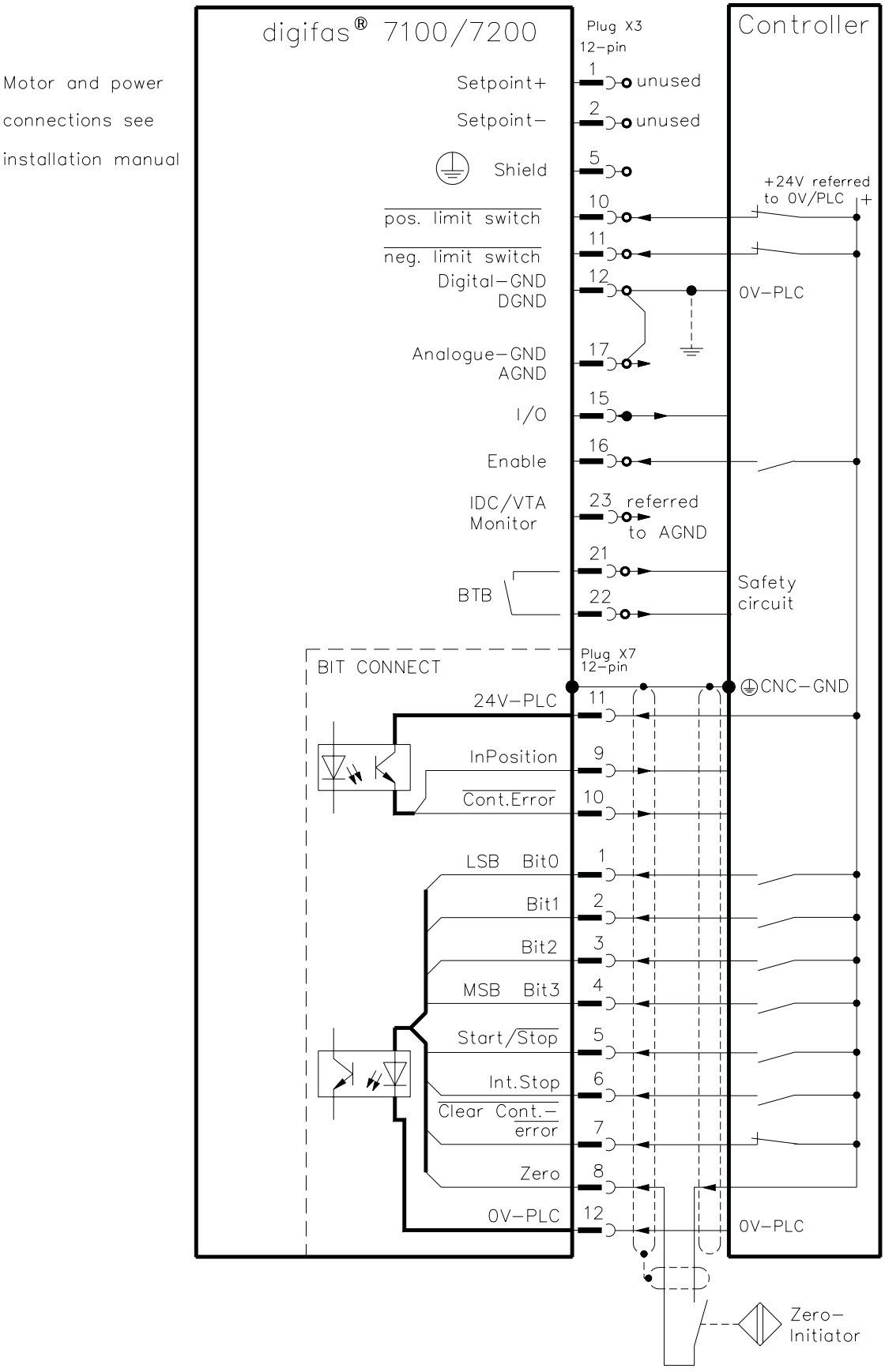
If it is necessary to alter the final limit speed of the motor, then all the position control and motion block parameters which were previously entered must be adjusted.

II.1.1 Connections

We recommend the following line cross-sections in compliance with EN 60204:

Mains connection, motor connection, digital control lines	Refer to digifas™ 7100 / 7200 installation manuals
BIT CONNECT (X7)	up to 50m long, 12 x 0,5 mm² Cable type: Ölflex

II.1.2 Wiring diagram of digifas™ 7100-SPS / 7200-SPS



II.2 Commissioning

II.2.1 Checklist for linear axis

The parameter values specified below for testing the correct functioning of the position controller do not apply to all systems and may in fact be hazardous to some systems. It is therefore imperative that you check the values for correctness. If you have to change values, please bear in mind that this is only a functional test. Set absolutely safe values which cannot cause damage to the machine under any circumstances.

II.2.1.1 Functional test of linear axis

1. — Optimize the speed controller using the “Reversing mode” service function
2. — Shut down the drives and disable the enable signal for the amplifier
3. — Select the CONNECT menu screen in the user software and set the position controller parameters (after checking to see if the system permits the values) as follows:

Parameter	Setting	Parameter	Setting
Kp	0,5...1	t_emerg.	Min. permissible deceleration time of system
Ff	1	type of move to refernce point	Depending on application
Axis Type	linear	Zero offset	0
Counting direction	Depending on application	Limit switch 2	70% of permissible traverse distance relative to zero
Resolution	Traverse distance per motor revolution	Limit switch 1	30% of permissible traverse distance relative to zero
v_max	Less than 50% of maximum load speed	In Position	Window larger than necessary for application
t_acc_min	Double min. permissible acceleration time of system	Contouring error	Window larger than necessary for application

4. — Enter motion task parameter blocks 0 (move to reference point), 1 and 2 (without Next No.).

No	Type	s_nom	v_nom	t_acc	t_dec
0	Absolute	0	1% of max. load speed	Double min. permis. acceleration time of system	Double min. permis. deceleration time of system
1	Absolute	40% of permissible traverse distance	10-20% of max. load speed	Double min. permis. acceleration time of system	Double min. permis. deceleration time of system
2	Absolute	60% of permissible traverse distance	10-20% of max. load speed	Double min. permis. acceleration time of system	Double min. permis. deceleration time of system

5. — Switch on the drive and enable the amplifier enable signal (permission push-button).
6. — Execute a movement to the reference point (motion task 0).
   Check to see if the load is present at the reference point.
7. — Execute motion task 1.
   Check the position of the load (s_nom(1) viewed from reference point).
8. — Execute motion task 2.
   Check the position of the load (s_nom(2) viewed from reference point).

II.2.1.2 Optimizing the linear axis

The current, speed and position controllers function as a classic cascade control. A correct, i.e. stiff, setting of the inner speed control is therefore a prerequisite for optimizing the position controller.

1. - Execute motion tasks 1 and 2 alternately.
2. - Change the Ff factor until a minimum “Contouring error” message (actual-value display on Connect page) is displayed during constant speed.

User tip:

If the direction of rotation is positive, the contouring error should be positive since the drive then lags slightly (increase Ff). If the negative contouring error position (reduce Ff), the drive leads its setpoint (i.e. it is overloaded).
This also applies, by analogy, to the negative direction of rotation.

3. - Repeat steps 1 and 2 in several steps using a different speed (v_nom) and different acceleration/deceleration times until the desired load speed and acceleration/deceleration characteristics are set. Depending on the mass to be driven, it may not be possible to achieve the required load speed using the Ff factor alone. In this case, increase the Kp factor slightly.
4. - Increase the Kp factor until the regulator begins to oscillate slightly, then reduce the Kp factor slightly. The transient response during acceleration can be observed on the amplifier speed monitor (VTA) and, if necessary, the Kp factor can be adapted.
5. - Finally, set the following application parameters:
   Software limit switches 1 and 2, contouring error window, In Position window, zero offset, t_acc_min, v_max, t_emerg.

Enter the desired motion task parameter blocks.

Warning :

If the final limit speed of the motor has to be changed, then all the position control parameters which were previously entered must be adjusted !

If Irms and / or Ipeak are changed, after the position controller has been optimized, then Kp and Ff must be adjusted !

II.2.2 Checklist for rotary axis

The parameter values specified below for testing the correct functioning of the position controller do not apply to all systems and may in fact be hazardous to some systems. It is therefore imperative that you check the values for correctness. If you have to change values, please bear in mind that this is only a functional test. Set absolutely safe values which cannot cause damage to the machine under any circumstances whatsoever.

II.2.2.1 Functional test of rotary axis

1. — Optimize the speed controller using the “Reversing mode” service function
2. — Shut down the drives and disable the enable signal for the amplifier
3. — Select the CONNECT menu screen in the user software and set the position controller parameters (after checking to see if the system permits the values) as follows:

Parameter	Setting	Parameter	Setting
Kp	0,5...1	t_emerg.	Min. permissible deceleration time of system
Ff	1	type of move to refernce point	Depending on application
Axis Type	round	Zero offset	0
Counting direction	Depending on application	Limit switch 2	-
Resolution	Traverse distance per motor revolution	Limit switch 1	-
v_max	Less than 50% of maximum load speed	In Position	Window larger than necessary for application
t_acc_min	Double min. permis.acceleration time of the system	Contouring error	Window larger than necessary for application

4. — Enter motion task parameter blocks 0 (move to reference point) and 1 (without Next No.).

No	Type	s_nom	v_nom	t_acc	t_dec
0	Absolute	0	1% of max. load speed	Double min. permis. acceleration time of system	Double min. permis. deceleration time of system
1	Absolute	40% of permissible traverse distance	10-20% of max. load speed	Double min. permis. acceleration time of system	Double min. permis. deceleration time of system

5. — Switch on the drives and enable the amplifier enable signal (permission push-button).
6. — Execute a movement to the reference point (motion task 0).
   Check to see if the load is present at the reference point.
7. — Execute motion task 1.
   Check the position of the load (s_nom(1) viewed from the reference point).

II.2.2.2 Optimizing the rotary axis

The current, speed and position controllers function as a classic cascade control. A correct, i.e. stiff, setting of the inner speed control is therefore a prerequisite for optimizing the position controller.

1. - Execute motion task 1 again.
2. - Change the Ff factor until a minimum “Contouring error” (actual-value display on the Connect page) is displayed during constant speed.

User tip:

If the direction of rotation is positive, the contouring error should be positive since the drive then lags slightly (increase Ff). If the contouring error is negative (reduce Ff), the drive leads its setpoint (i.e. it is overloaded).
This also applies to the negative direction of rotation by analogy.

3. - Repeat step sizes 1 and 2 in several steps using a different speed (v_soll) (reference speed) and different acceleration/deceleration times until the desired load speed and acceleration/deceleration characteristics are reached. Depending on the mass to be driven, it may not be possible to achieve the required load speed using the Ff factor alone. In this case, increase the Kp factor slightly.
4. - Increase the Kp factor until the controller begins to oscillate, then reduce the Kp factor slightly. The transient response during acceleration can be observed on the amplifier speed monitor (VTA) and, if necessary, the Kp factor can be adapted.
5. - Finally, set the following parameters of the application:
   Contouring error window, In Position window, zero offset, t_acc_min, v_max, t_emerg.
   Enter the desired motion task parameter blocks.

Warning :

If the final limit speed of the motor has to be changed, then all the position control parameters which were previously entered must be adjusted !

If Irms and / or Ipeak are changed, after the position controller has been optimized, then Kp and Ff must be adjusted !

III User software

III.1 General

The digital servo amplifiers of the digifas™ 7100/7200 series have to be adapted to the operating characteristics of your machine. The BS7200 user software is a user-friendly means of parameterizing the two digifas™ 7100 and 7200 regulator types.

Only the part of the BS7200 user software relevant to the BIT CONNECT interface module is described in this section. Instructions for handling the software and parameters of the current regulator speed controller are described in the BS7200 operating manual.

The “Connect” menu item is displayed in the menu line of the user software. You will find all the parameters relevant to setting the position controller under this menu item. You can select a motion task parameter block in the motion task field.

The following **actual values** are displayed in online mode on the CONNECT menu screen:

s_act	Current position of load	(0 to 99 ,999,999.999 mm)
s_fault	Current contouring error of load	(0 to 99.999 mm)
v_act	Current speed of load	(0 to 99,999.999 m/s)
dig_in	Status of digital inputs The physical levels of the digital inputs are displayed **Bit 3|Bit 2|Bit 1|Bit 0|Start/$\overline{\text{Stop}}$*|int. stop|$\overline{\text{clear contouring error}}$|zero** *only if controller is enabled	

III.2 Functions and parameters

III.2.1 Functional description

III.2.1.1 Reference traverse

Motion task No. 0 has a special meaning. It can be entered as an absolute task only and is used for the movement to the reference point.

You can shift the zero crossing of the motor shaft anywhere within a single rotation using the “zero offset” parameter. After a movement to reference position, the drive signals “In Position” and thus enables the position controller in the servo amplifier.

Take care that the position of the zero point of the machine (reference point) allows the subsequent positioning operations. The software limit switches which are set as parameters in the digifas™ may possibly be ineffective. The axis could drive into the hardware limit switches or the mechanical stop. There is a risk of damage.

If, for instance, the reference point (zero point of the machine) is approached too fast, and the drive has a high inertial mass moment, then the axis may overshoot this point and drive into into the hardware limit switches or the mechanical stop. There is a risk of damage.

The position controller cannot be operated without a previous reference traverse.

When the 25V auxiliary voltage is switched on, a reference traverse has to be started.

The start signal must not be removed during the reference traverse. The start signal must remain present until the “In Position” message appears.

Start precondition :

Enable	= 1	Intermediate stop	= 0
Bit0 - Bit3	= 0	Start	= 0 $\rightarrow$ 1
Clear contouring error	= 1	v_nom	$\leq$ 10% from v_max

III.2.1.1.1 Reference offset

Reference offset is used to define the reference point to be a position other then the zero position. Physically, nothing is changed by the reference offset, but the offset value is used as a reference value within the positioning control. A traverse to the reference position will thus not stop at the zero position, but at the position determined by the reference offset value.
The reference offset must be set before starting the reference traverse.
A change of the reference offset value will only take effect for the next reference traverse.

Setting range:	-20% resolution ... +maximum path entry	
In this case :	resolution	= numerical value of the preset resolution in mm
	maximum path entry	= 32767 * resolution < 999.999,99 mm.
		If the resolution is larger than 30,52 mm/turn, then the max. possible entry is limited to 999.999,99 mm.

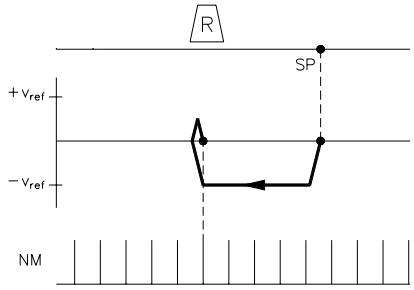
III.2.1.1.2 Type of reference traverse

You can select which type of reference traverse should be performed.
Selection: 1-, 1+, 2-, 2+, 3-, 3+, 4-, 4+, 5-, 5+

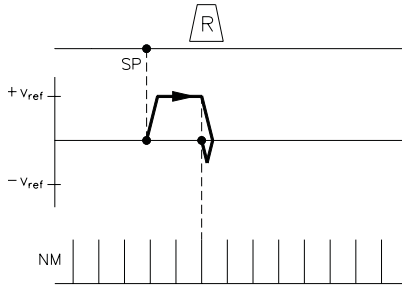
Reference traverse 1 (1-, 1+) homing to a reference switch with zero mark recognition

Traverses to a reference switch. In this case reference traversing is also possible without a hardware limit switch. One of the conditions below must be fullfilled :

1 negative (positive count direction)



1 negative (negative count direction)



“Reference traverse 1 negative” is thus compatible with the reference traverse of the older software version (before version 6C40) when the reference offset (Mux 108) is set to 0.

The reference point is always set at a zero-crossing point of the resolver (zero mark).

A 2-pole resolver always has precisely one zero point per turn, which means that positioning at the zero point is unambiguous within a motor turn. If the transition edge of the reference switch is close to the zero crossing of the resolver, the positioning at the zero point may vary by one motor turn.

Reference traverse 2 (2-, 2+) homing to a hardware limit switch with zero mark recognition

The reference point is set at the first zero crossing (zero mark) of the resolver outside the limit switch.

Reference traverse 3 (3-, 3+) homing to a reference switch without zero mark recognition

The reference point is set at the transition of the reference switch.

Reference traverse 4 (4-, 4+) homing to a hardware limit switch without zero mark recognition

The reference point is set at the transition of the hardware limit switch.

The repetition accuracy for homing without zero mark recognition depends on the traversing speed and the mechanical construction of the reference switch or limit switch.

Reference traverse 5 (5-, 5+) homing to the next resolver zero mark

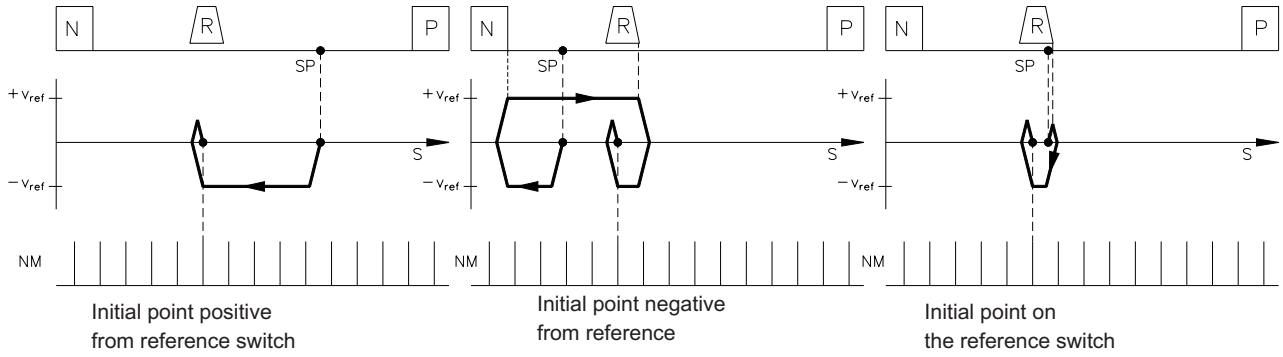
The reference point is set to the next zero mark of the resolver.

On the following sides you can see the the traversing sequences during homing for every possible initial situation (positive count direction).

Legend					
N	Limit switch NSTOP	P	Limit switch PSTOP	SP	Initial position
R	Reference switch	vref	Set speed value	NM	Zero mark of the resolver

Sequence for reference traverse 1-

(with reference switch, traverse direction negative, 3 initial situations, positive count direction, with zero mark)



Initial point positive from reference switch

Initial point negative from reference

Initial point on the reference switch

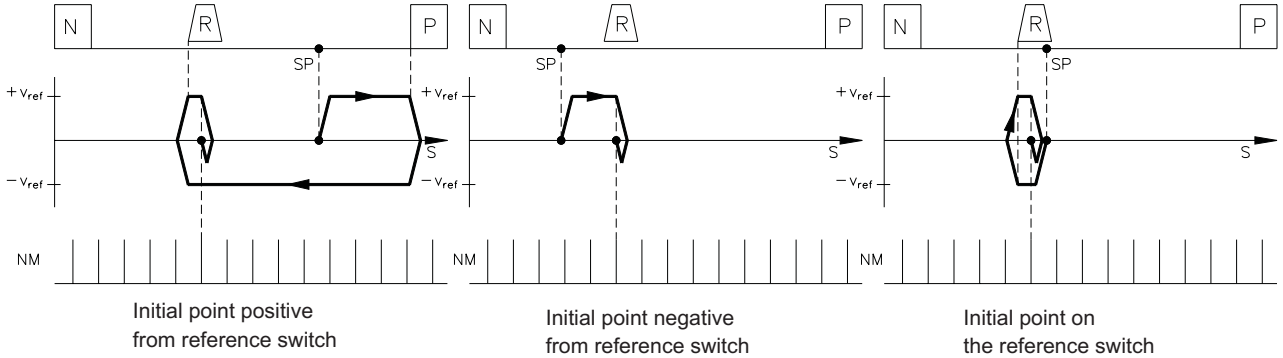
Attention !

Before starting the reference traverse, check the safety of the system to ensure that the load can also be moved if the limit switches are disconnected or defective.

The STOP limit switch function must be activated to achieve the full reference traversing functionality.

Sequence for reference traverse 1+

(with reference switch, traverse direction positive, 3 initial situations, positive count direction, with zero mark)



Initial point positive from reference switch

Initial point negative from reference switch

Initial point on the reference switch

Attention !

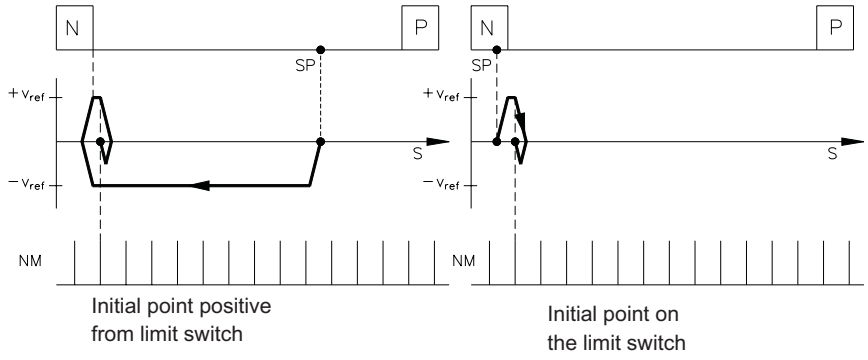
Before starting the reference traverse, check the safety of the system to ensure that the load can also be moved if the limit switches are disconnected or defective.

The STOP limit switch function must be activated to achieve the full reference traversing functionality.

Legend					
N	Limit switch NSTOP	P	Limit switch PSTOP	SP	Initial position
R	Reference switch	vref	Set speed value	NM	Zero mark of the resolver

Sequence for reference traverse 2-

(without reference switch, traverse direction negative, 2 initial situations, positive count direction, with zero mark)



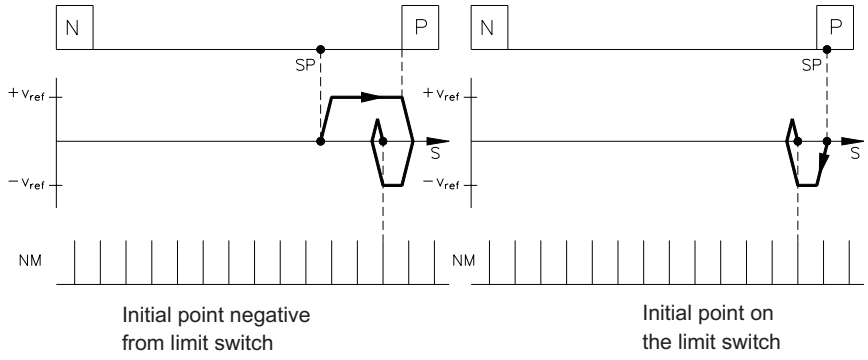
Attention !

Hardware limit switches must be present and connected.

The STOP limit switch function must be activated.

Sequence for reference traverse 2+

(without reference switch, traverse direction positive, 2 initial situations, positive count direction, with zero mark)



Attention !

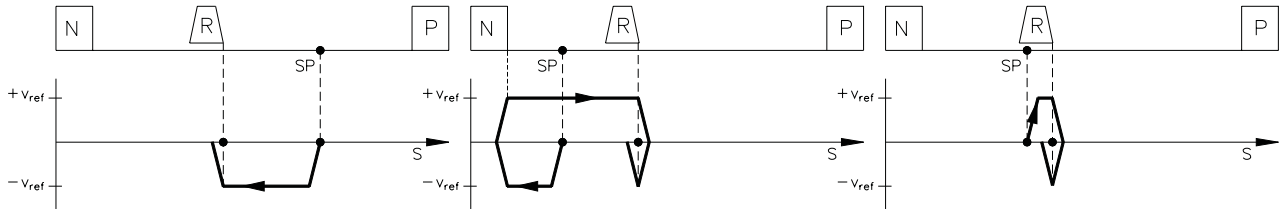
Hardware limit switches must be present and connected.

The STOP limit switch function must be activated.

Legend					
N	Limit switch NSTOP	P	Limit switch PSTOP	SP	Initial position
R	Reference switch	vref	Set speed value	NM	Zero mark of the resolver

Sequence for reference traverse 3-

(with reference switch, traverse direction negative, 3 initial situations, positive count direction, without zero mark)



Initial point positive from reference switch

Initial point negative from reference switch

Initial point on the reference switch

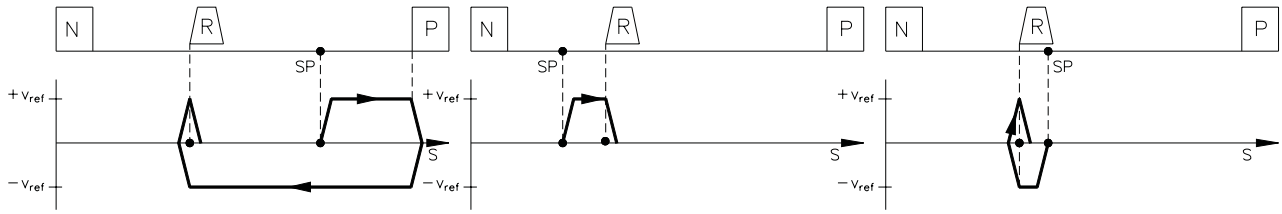
Attention !

Before starting the reference traverse, check the safety of the system to ensure that the load can also be moved if the limit switches are disconnected or defective.

The STOP limit switch function must be activated.

Sequence for reference traverse 3+

(with reference switch, traverse direction positive, 3 initial situations, positive count direction, without zero mark)



Initial point positive from reference switch

Initial point negative from reference switch

Initial point on the reference switch

Attention !

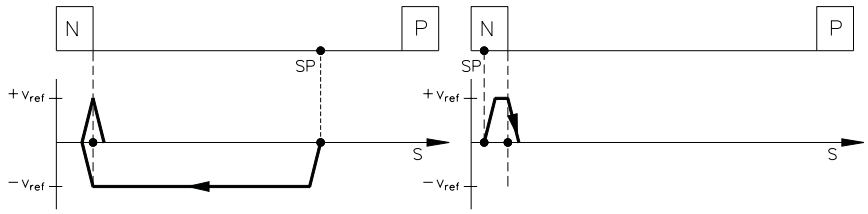
Before starting the reference traverse, check the safety of the system to ensure that the load can also be moved if the limit switches are disconnected or defective.

The STOP limit switch function must be activated to achieve the full reference traversing functionality.

Legend					
N	Limit switch NSTOP	P	Limit switch PSTOP	SP	Initial position
R	Reference switch	v_{ref}	Set speed value	NM	Zero mark of the resolver

Sequence for reference traverse 4-

(without reference switch, traverse direction negative, 2 initial situations, positive count direction, without zero mark)



Initial point positive from limit switch

Initial point on the limit switch

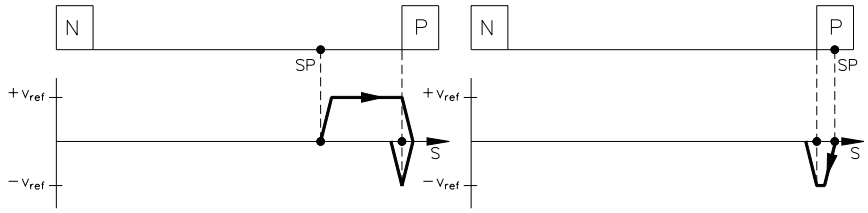
Attention !

Hardware limit switches must be present and connected.

The STOP limit switch function must be activated.

Sequence for reference traverse 4+

(without reference switch, traverse direction positive, 2 initial situations, positive count direction, without zero mark)



Initial point negative from limit switch

Initial poin ton the limit switch

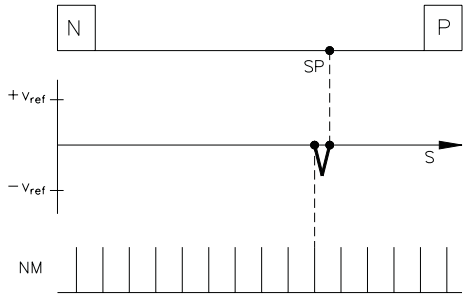
Attention !

Hardware limit switches must be present and connected.

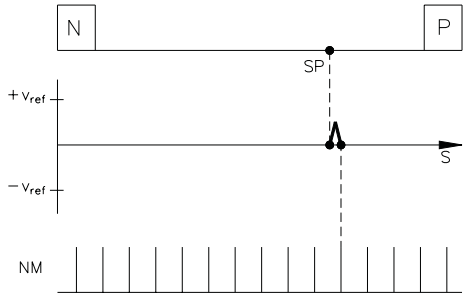
The STOP limit switch function must be activated.

Legend					
N	Limit switch NSTOP	P	Limit switch PSTOP	SP	Initial position
R	Reference switch	vref	Set speed value	NM	Zero mark of the resolver

Reference traverse 5 negative (without reference switch, positive traverse direction, positive count direction, with zero mark)



Reference traverse 5 positive (without reference switch, negative traverse direction, positive count direction, with zero mark)



Behaviour when reference traverse 5 is started several times sequentially:

The position controller can keep the motor in zero-position only by overrunning the zero mark by ±1 count. When reference traverse 5 is restarted, it is possible that the motor makes a full turn. This behaviour depends on the rotor position (1count before / behind the zero mark) and count direction.

III.2.1.2 Starting a motion task

Once the position controller is enabled by a reference traverse, a motion task can be started by creating a motion task number (between 1 and 15).
Refer to the signal diagram in Chapter I.8 for the timing for starting a task.

Start preconditions:

Enable	= 1
Bit 0-Bit 3	= Task No. 1 to 15 in binary code
Clear contouring error	= 1
Intermediate stop	= 0
Start	= 0 → 1

If the start preconditions are fulfilled, the amplifier accelerates within the acceleration time defined in the motion task up to the speed defined in the motion task and maintains this speed until it reaches the braking point calculated from the deceleration time. At this point, the amplifier brakes the drive within the set deceleration time and positions the drive at the target position. The drive remains stationary in a closed position loop in this position.
The amplifier signals correct execution of the selected motion task via the “In Position” output.

Aborting a motion task

The task can be aborted at any time by cancelling the start signal. The drive then slows down to standstill within the set deceleration time and remains stationary in a closed position loop in this position.

III.2.1.3 Intermediate stop

If a task has been started, it can be aborted using the intermediate stop signal. In this case, the drive decelerates to v = 0 within the set deceleration time **t_dec** and remains in this position. No “In Position” signal is given. When the intermediate stop signal is cancelled, the drive accelerates within **t_acc** to the speed defined in the old motion task **even if a different motion task has been selected in the meantime**.

Warning:

The command “Intermediate Stop” takes precedence over the “STOP” command (start signal removed). This means that it is not possible to break off the motion task or start a new motion task during an intermediate stop.

Intermediate stop preconditions:

Enable	= 1
Start	= 1
Intermediate stop	= 0 → 1

III.2.1.4 Teach-in

You can use this function to generate motion tasks by moving the load by hand to the desired positions (when the controller output stage is disabled) and importing these position values to the motion task parameter block.

You can also guide the load to the desired position when the output stage is enabled using the cursor keys on the PC-AT and enter this position value in the motion task parameter block.

III.2.1.4.1 Teach-in when output stage is disabled

Warning !

Make sure that the drive supply is switched off in a manner which is safe for personnel. This is achieved by removing the enable signal and additionally switching off the mains supply (L1, L2, L3).
Any brake which is present must also be released.
This method of operation requires that the axis can be moved by hand without any danger. Especial care is required for vertical axes.

Once the reference traverse is completed, perform the following steps:

1. Cancel the enable signal.
2. Switch off power supply L1, L2 and L3 to the amplifier
3. Select the motion task screen.
4. Select the motion task you want to perform a teach-in.
5. Enable the teach-in mode by pressing function key **F5** (“TEACH-IN” is displayed in the status line).
6. Move the load to the desired position by hand.
7. End the teach-in routine by pressing function key **F5**. The current actual position of the load is adopted as the nominal position for the selected motion task and displayed.
8. Complete the motion task parameters (type, acceleration time, deceleration time, speed, next task).
9. Save the motion task parameters by executing the “Save to EEPROM” function from the “Administrate” menu screen.

III.2.1.4.2 Teach-in when output stage is enabled

Warning !

Make sure that no person is within the range of movement of the machine during the Teach-in operation.

Once the reference traverse and regulator optimization is completed, carry out the following steps:

1. Select the motion task screen.
2. Select the motion task you want to perform a teach-in.
3. Enable the teach-in mode by pressing function key **F5** (“TEACH-IN” is displayed in the status line).
4. Enable the output stage (power supply switched on and enable input at high level). You can then move the drive via cursor keys $\boxed{\rightarrow}$ (positive direction) and $\boxed{\leftarrow}$ (negative direction).

   Each time you press the cursor keys, the load moves by one step size (jogging mode). The calculated step size varies depending on the resolution:

   $$Step\ size = \frac{\mathrm{Re}solution}{4096\ Steps\ /\ turn}$$

   For example: resolution = 100 mm/turn

   $$Step\ size = \frac{100 mm\ /\ turn}{4096\ Steps\ /\ turn} = 0{,}024\ mm\ /\ Step$$

   All data on resolution, increment, positioning accuracy, etc. refer to theoretical values. Nonlinearities in the mechanics (backlash, elasticity, etc.) are not taken into account.

   If you hold the cursor key down for longer than 3 seconds, the drive moves at a constant speed in the selected direction. Drive speed is 1% of max. machine speed v_max.
5. End the teach-in routine by pressing function key **F5**. The current actual position of the load is adopted as the nominal position for the selected motion task and displayed.
6. Complete the motion task parameters (type, acceleration time, deceleration time, speed, next task).
7. Save the motion task by executing the “save to EEPROM” function from the “Administrate” menu screen.

III.2.2 Description of parameters on CONNECT menu screen

The parameters can be printed out and saved.

III.2.2.1 Kp, P-gain

Defines the proportional gain of the position controller. Setting range: 0 to 8

Effects:	Value too low	—	Too much runout, drive runs too softly
	Value too high	—	Drive oscillates

III.2.2.2 Ff, feed forward factor

Defines the speed feed forward factor of the position controller. The feed forward factor serves to relieve the P controller. The better the Ff factor, the better the dynamic range of the P controller can be utilized. The most favourable setting (usually 1.0) depends on external factors such as friction, dynamic resistance and rigidity.
Setting range: 0 to 2

Effects:	Value too low	—	Dynamic range of the P controller is limited. Drive lags
	Value too high	—	Dynamic range of the P controller is limited. Drive leads

III.2.2.3 Axis type

You can choose whether to operate the axis as a linear axis or as a rotary axis via this parameter. Depending on whether a linear or a rotary axis was selected, the software limit switches are handled differently. Selection: Linear/Rotary

Linear

A linear axis is an axis with a **limited traverse range**. The gear can be of any design, e.g. a ball bearing spindle, a toothed belt or a gear with a crank arm. The linear axis moves over a distance predefined by the software limit switches in the absolute and relative modes. The following devices can function as a linear axis:

Feed drive, Lifting table, Adjusting drive

Rotary

A rotary axis is an axis with an **unlimited traversing range**. In this case, the software limit switches have no meaning. **The rotary axis always moves in the relative mode, even if its tasks are entered as absolute.** The current position is zeroed whenever the axis is restarted.
The following devices can function as a rotary axis:

Traverse drive, Rotary indexing table, Conveyor belt (endless), Winder, Roll drive

III.2.2.4 Counting direction

Presets the counting direction of the position values (positive/negative).

Effects:	positive	—	Position values are incremented in a positive direction of rotation (cw rotation when looking at motor shaft)
	negative	—	Position values are incremented in a negative direction of rotation (ccw rotation when looking at motor shaft)

In both cases, the actual position is incremented!

III.2.2.5 Resolution

This parameter establishes a relationship between the integrated measuring system and the position of the load. **The resolution defines what traverse distance the load has to cover within one turn of the motor shaft.** The calculated resolution takes into account all transmission ratios and gears between the motor and load. Nonlinearities of the mechanics (play, elasticity, etc.) are not taken into account. Absolute positioning accuracy accounting for inaccuracy and temperature response of the resolver measuring circuit is ±25 angular minutes.
Setting range: 0.01 to 999.9 mm/turn

Example: number of motor turns: i = 10 rev, traverse distance at i motor turns: s = 50 mm

Resolution = s / i $\mathrm{Re}solution = \frac{50\,mm}{10\,turn} = 5mm\,/\,turn$

The theoretically attainable positioning accuracy **ds** can now be expressed as

$$ds = \frac{resolution}{4096\,steps\,/\,turn} = \frac{5\,mm\,/\,turn}{4096\,steps\,/\,turn} = 0{,}0012207\,mm\,/\,step$$

Effects:

Value too low	—	Required physical values are not reached
Value too high	—	Required physical values are exceeded

If you change the resolution, it is abolutely vital that you check that all the parameters on the CONNECT menu screen and in the MOTION TASKS are within the permitted min/max limits. Adjust the parameters if necessary !

Program behaviour after entering resolution parameter

A distinction is made between internal parameters and menu values. Internal parameters are the values which the program uses internally in order to operate the position controller. Menu values are the current (input) parameters displayed on the menu screens.

Case 1: You enter a resolution value **identical to the previous value** in the input field
The program recalculates the internal parameters. The menu values are left unchanged.

Case 2: You enter a resolution value **different to the previous value** in input field
In this case, the assignments between the menu values and internal parameters have to be redefined. The program gives you the opportunity to choose between the two variants via the query “Adapt menu values Y/N”:
Answer “Y” : Adapt menu values and leave internal parameters unchanged.
This option is recommendable if you changed the resolution because the load was positioned correctly from a mechanical point of view but the actual position was displayed incorrectly.
Answer “N” : Leave menu values unchanged and adapt internal parameters.
This option is recommendable if you changed the resolution because the load was incorrect mechanically but the setpoint defaults must not be changed.

Warning !
After a change, the new parameter set is only available in the operating memory of the amplifier. In order to save it permanently, it is necessary to carry out the function “Save to EEPROM” in the “Administrate” menu screen.

III.2.2.6 v_max, maximum speed

This parameter adapts the maximum traverse speed to the machine's performance limits.
The upper limit value is dependent on the selected max. final drive speed (BS7200 operating manual, speed controller, **max. 6000 rpm**). The input value serves as a limit value for the "v_nom" input in the motion tasks.
During commissioning, you can limit the speed by using v_max (without changing the settings in the motion tasks).
A smaller vallue of v_max overrides the v_nom of the motion tasks.

Effects:	Value too low	—	Max. speed cannot be set
	Value too high	—	Mechanics become susceptible to damage

III.2.2.7 Ramp type

Determines which type of acceleration or braking ramp should be used in carrying out a motion task.

Selection : trapeze / sine²

Trapeze

The drive is linearly accelerated up to the target speed with constant acceleration (acceleration time from the motion task).

Sinus²

The drive is accelerated up to the target speed within the acceleration time (motion task), using an acceleration ramp without steps. The resulting speed curve has a sine²-characteristic.

III.2.2.8 t_acc_min, maximum acceleration

A drive is always designed in such a way that it can deliver more power than the application requires. This parameter defines the limit value for the maximum mechanical acceleration which the drive must not exceed. At the same time, it represents the minimum value for the "t_acc" and "t_dec" inputs in the motion tasks.
Setting range: 10 to 2550 ms

Effects:	Value too low	—	Mechanics are placed under heavy load and become susceptible to damage
	Value too high	—	The required rate of acceleration cannot be reached

III.2.2.9 t_emerg., maximum deceleration

Defines the limit value for deceleration. In an emergency situation (contouring error, software limit switch, starting a non-existing motion task), the drive is braked within the defined emergency deceleration time, provided that electrical power is still available. In this case, deceleration time may be less than the shortest deceleration and acceleration time t_acc_min.
Setting range: 10 to 2550 ms

Effects:	Value too low	—	The mechanics and/or drive may be damaged
	Value too high	—	The drive does not decelerate quickly enough

III.2.2.10 Type of reference traverse

You can choose which kind of reference traverse should be carried out. A detailed description of the various types of reference traverse can be found in Chapter III.2.1.1 .
Selection: 1-, 1+, 2-, 2+,3-, 3+, 4-, 4+, 5-, 5+

III.2.2.11 Zero offset

This input shifts the mechanical zero point of the axis within a single revolution. The largest amount by which the zero point can be shifted is dependent on the resolution setting.
The parameter is only relevant for the reference traverse types 1-/1+/2-/2+/5-/5+
Setting range: 0 to 100% resolution

III.2.2.12 Reference offset

Reference offset is used to define the reference point to be a position other then the zero position. Physically, nothing is changed by the reference offset, but the offset value is used as a reference value within the positioning control. A traverse to the reference position will thus not stop at the zero position, but at the position determined by the reference offset value.
The reference offset must be set before starting the reference traverse.
A change of the reference offset value will only take effect for the next reference traverse.
Setting range: -20% resolution ... +maximum path entry
In this case : resolution = numerical value of the preset resolution in mm
maximum path entry = 32767 * resolution < 99,999.99 mm.
If the resolution is larger than 30.52 mm/turn, then the max. possible entry is limited to 999,999.99 mm.

III.2.2.13 Limit switch 2

Software limit switch 2 belongs to the watch functions of the position controller. It is only active in the linear mode and checks whether the current position is greater than the setpoint. In this case the drive brakes with emergency deceleration and remains stationary in closed position loop. The direction of rotation (positive counting direction) is disabled. You must drive away from limit switch 2 in the negative count direction.
Setting range: 0 to maximum distance input (do not enter negative values !)

Effects: Value too low — No movement is possible if less than limit switch 1
Value too high — Mechanical stop is reached

III.2.2.14 Limit switch 1

Software limit switch 1 belongs to the watch functions of the position controller. It is only active in the linear mode and checks whether the current position is less than the setpoint. In this case the drive brakes with emergency deceleration and remains stationary in closed position loop. The direction of rotation (negative counting direction) is disabled. You must drive away from limit switch 1 in the positive count direction.
Setting range: — 20% resolution to maximum distance input

Effects: Value too low — Mechanical stop is reached
Value too high — No movement is possible if greater than limit switch 2

III.2.2.15 In Position

Sets the position window. Defines the distance from the nominal position at which the “In Position” signal is to be output. The drive moves precisely to the target position.
Setting range: 0 to 10% resolution

Effects:	Value too low	—	Positioning time increases, no In Position signal is given
	Value too high	—	In Position will be given to the PLC too early

Residual distance processing

The rotary and linear axes have a “residual distance processing” characteristic for relative tasks. Although the drive stops at the target position after a traverse movement, the motor may stand 1/4096th of a revolution off the target position for control reasons. This minimum positioning error is taken into account at the start of the new relative task to ensure that no cumulative errors occur.
The residual distance processing characteristic refers exclusively to deviations during positioning operations. Rounding errors (max. 0.5/4096ths of revolution) during the target position calculation cannot be compensated. This means that moving incremental dimensions in combination with relative tasks always lead to minor cumulative positional deviations. Depending on the required degree of accuracy, this error can be avoided by either executing no inkremental dimensions or by returning to the start position via an absolute task.

III.2.2.16 Contouring error

The contouring error is the maximum permissible difference between the nominal and actual position values during the procedure. The contouring error input is defined as a +/- window. If the load exits this window, the position controller generates an error message and brakes the drive with emergency deceleration (t_emerg).
Setting range: 0 to 49% resolution

Effects:	Value too low	—	Acceleration operation is aborted
	Value too high	—	Contouring error is not detected

III.2.2.17 Motion task

The motion task is selected via this input. Task numbers ranging from 0 to 15 can be entered. The selected motion task then appears in the input line when the motion task screen is set up.
Setting range: 0 to 15

Warning !

If a motion task in changed, it must be transmitted to the amplifier. This is done by operating the function key F6. After a change the new parameter set is only available in the operating memory of the amplifier. In order to save it permanently, it is necessary to carry out the function “Save to EEPROM” in the “Administrate” menu screen.

III.2.3 Description of parameters on MOTION TASKS menu screen

Warning !

As a result of the internal representation of the controller parameters, certain combinations of values for speed, braking and acceleration times cannot be displayed.
In this case, the braking and acceleration times will be adjusted automatically by the controller. This adjustment is indicated by an asterix next to the motion task.

The motion task screen displays the motion tasks saved to the servo amplifier. One input line is assigned to each motion task. The following parameters can be edited on this line:

III.2.3.1 No

Use this parameter to select the motion task to be generated or changed. The motion task numbers are decimal numbers in binary code with Bit 0 as the LSB and Bit 3 as the MSB.
Input range: 0 to 15
The motion task “0" is only used for a reference traverse (type = ”absolute", s_setp = 0)

III.2.3.2 Type

This parameter defines whether or not the motion task is to be interpreted as a relative or absolute task. Selection: absolute / relative / relative1 / relative2

absolute	: a traverse to an absolute position, referred to the reference point.
relative	: relative to the last target position (if the load is within the InPosition window) relative to the actual position (if the load is not within the InPosition window)
relative 1	: relative to the last target
relative 2	: relative to the actual position

III.2.3.3 s_nom

This parameter defines the distance to be traversed in mm.

Setting range:	Absolute	0 to max. distance
	Relative	—max to +max

For cummulative relative motion tasks, note that each turn is resolved internally with 16 Bit /0...65535). If the path cannot be exactly described with this resolution, then approximation errors may occur.

III.2.3.4 v_nom

This parameter defines the traversing speed in mm/s. Setting range: 0 to v_max
If, at a later time, v_max is set to a value which is less than v_nom, then the controller will use the smaller value.

III.2.3.5 t_acc

This parameter defines the acceleration time up to v_nom

Setting range: 5ms or $t\_acc\_\min \cdot \frac{v\_nom}{v\_\max}$... 2550 ms

III.2.3.6 t_dec

This parameter defines the deceleration time from v_nom to zero.

Setting range: 5ms or $t\_acc\_\min \cdot \frac{v\_nom}{v\_\max}$ ... 2550 ms

The longest possible time can be calculated with a minimum acceleration of 1 m/s² according to the following formula:

e.g. v_nom = 500 mm/s —> a = 1 m/s² —> t_dec = t_acc = **v_nom/a**=0.5 s=500 ms

III.2.3.7 Next No.

Number of the following task, which should be started automatically after finishing the current task. The entry “0" means that no following task is to be started.

The InPosition signal is only enabled when the last motion task (i.e. no more tasks following) has been processed. Since the stepping sequence depends on the internal setpoint generator, an increase of the InPosition window does not produce any acceleration.

Entry range : 0...15

III.2.3.8 IntStop

Determines whether there should be an intermediate stop between the current task and the next task (**with ramp type TRAPEZE only. If the ramp type is SINE², an intermediate stop occurs always**).

Selection: with / without

IV Appendix

IV.1 CONNECT data sheet

The default values listed below are for the purpose of first-time commissioning. Check to see if these values meet your system's requirements.

Display text	Dim	min	max	Default	actual value
Kp	—-	0	8	**1**	
Ff	—-	0	2	**1**	
Axis type	—-	linear	rotary	**rotary**	
Counting direction	—-	positive	negative	**positive**	
Resolution	mm/turn	0.01	999.99	**10**	
v_max	mm/s	0	Conversion to nom.speed	**250**	
Ramp type	—	trapeze	sine²	**trapeze**	
t_acc_min	ms	10	2550	**100**	
t_emerg.	ms	10	2550	**50**	
Type of reference traverse	—	1+/1-	5+/5-	**1-**	
Zero offset	mm	0	Resolution	**0**	
Reference offset	mm	-20% Resolution	max.distance	**0**	
Limit switch 2	mm	0	max.distance	**300**	
Limit switch 1	mm	-20% Resolution	max.distance	**-2**	
In Position	mm	0	10% Resolution	**0.1**	
Contouring error	mm	0	49% Resolution	**2**	

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Place, date Signature

IV.2 Motion task parameter block data sheet

No	Type	s_nom	v_nom	t_acc	t_dec	Next No.	IntStop
0	absolute	0					
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

Customer Cabinet No. Eqpt. No.

Place, date Signature

IV.3 Index

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