Instruction Manual
LPE 4310 C linear positioning system with stepping motor

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Purpose of instruction manual

This instruction manual describes the features of the LPE 4310C linear positioning system and provides guidelines for its use.

Improper use of this instrument or failure to follow these instructions may cause injury or equipment damage. All individuals responsible for operating this instrument must therefore be properly trained and aware of the hazards, and must carefully follow these operating instructions and the safety precautions detailed within. **Contact the manufacturer if you do not understand any part of this instruction manual.**

Handle this manual with care:
- It must be readily available throughout the lifecycle of the instrument.
- It must be provided to any individuals who assume responsibility for operating the instrument at a later date.
- It must include any supplementary materials provided by the manufacturer.

The manufacturer reserves the right to continue developing this instrument model without documenting such development in each individual case. The manufacturer will be happy to determine whether this manual is up-to-date.

Conformity

This instrument corresponds to the state of the art and meets all legal requirements set forth in EC directives as evidenced by the CE label.

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1 Safety precautions

1.1 Appropriate use

This linear positioning system is especially suitable for automatically setting tools, stops or spindles, particularly for sheet metal forming equipment, wood-processing equipment, packing lines, printing equipment, filling units and other types of special machines.

Always observe the operating requirements—particularly the permissible supply voltage—indicated on the rating plate and in the “Technical data” section of this manual.

The instrument may only be handled as indicated in this manual. Modifications to the instrument are prohibited. The manufacturer is not liable for damages caused by improper use or failure to follow these instructions. Violations of this type render all warranty claims null and void.

1.2 Shipping, assembly, electrical connections and start-up

Only technical personnel who are appropriately trained and authorized by the operator of the facility may assemble the instrument and set up its electrical connections.

The instrument may only be operated by appropriately trained individuals who have been authorized by the operator of the facility.

Specific safety precautions are given in individual sections of this manual.

1.3 Troubleshooting, maintenance, repairs, disposal

The individual responsible for the electrical connections must be notified immediately if the instrument is damaged or if errors occur.

This individual must take the instrument out of service until the error has been corrected and ensure that it cannot be used unintentionally.

This instrument requires no maintenance.

Only the manufacturer may perform repairs that require the housing to be opened.

The electronic components of the instrument contain environmentally hazardous materials and materials that can be reused. For this reason the instrument must be recycled in accordance with the environmental guidelines of the jurisdiction in question once it has been taken permanently out of service.

1.4 Symbols

The symbols given below are used throughout this manual to indicate instances when improper operation could result in the following hazards:

WARNING! This warns you of a potential hazard that could lead to bodily injury up to and including death if the corresponding instructions are not followed.

WARNING: This warns you of a potential hazard that could lead to significant property damage if corresponding instructions are not followed.

INFORMATION: This indicates that the corresponding information is important for operating the instrument properly.

2 Instrument description

2.1 Features

The LPE 4310C linear positioning unit is a robust, complete mechatronic system consisting of a stepping motor and integrated electronic control. Positioning is extraordinarily accurate thanks to the unit's precision ball screw and integrated absolute measuring system, the latter of which eliminates the need for a time-consuming reference run. The connection to a bus system simplifies wiring.

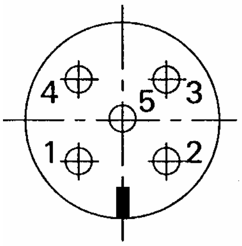
2.2 Installation

Bores are provided for mounting the LPE4310 linear unit onto the machine in question.

2.3 Pin assignment

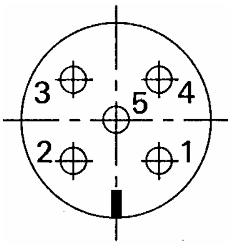
A round, 5-pin plug for the supply voltage and two round, 5-pin sockets for connecting the CAN bus are located on the side of the LPE 4310C.
Plug and socket are both Binder series 763 connectors.

Supply voltage connector:
(External top view)



1 +24VDC (final stage)
2 ground (final stage)
3 +24VDC (control unit)
4 ground (control unit)
5 unused

CAN bus connector
(External top view)



1	unused
2	CAN_GND
3	CAN_H
4	CAN_L

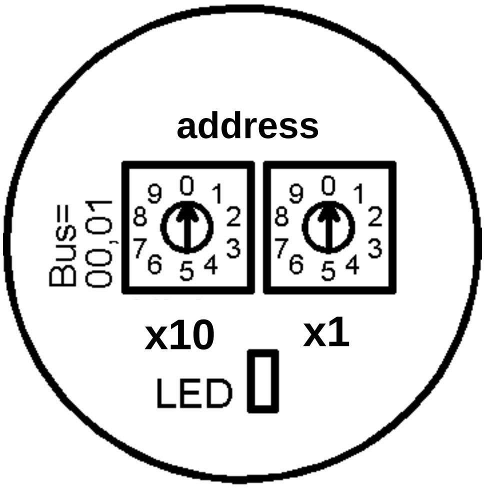
2.4 Setting the device address

Removing the protective cap provides access to two rotary switches for setting the device address at the bus.

The rotary switches indicate the tens and ones places of the address selected. If the switches are resting in the positions 00 or 01 the address is set using the CAN-Bus with SDO# 2026.
The delivery setting is 00, the LPE4310C reports to the bus with the address 1.

If the switches have been used to set the address, this value cannot be changed via the CAN bus.

Switch configurations:



Important: Always replace the protective cap after setting the address. This will prevent dust and contaminants from entering the instrument.

3 Start-up

After the supply voltage has been hooked up, the LPE4310 C should be run through an initial reference loop prior to positioning. This consists of moving 3.125 mm (5/8 of a revolution) forwards and then again in reverse.
The start-up reference loop is triggered when the corresponding command byte is transferred via the interface.

Positioning sequence (with reference loop)

The LPE4310 C distinguishes between the following steps of a positioning sequence:

1. New position value is smaller than the current value: position approached directly.
2. New position value is larger than the current value: the instrument reverses by 3.125 mm and approaches the exact position after resuming forward motion.

3. New position value after forward run (no reference loop): the instrument always approaches the position from the reverse; if necessary, it will also move 3.125 mm forwards.

Once the target position has been reached, the instrument compares it to the internal absolute value. If a discrepancy is detected, the instrument then sets the “positioning error” status bit.

Positioning sequence (without reference loop)

The "positioning without loop run" mode is primarily used for moving short distances in order to make fine corrections. In this case, each position is approached directly. This does NOT eliminate any play present in the spindle in question.

4 CAN bus

CAN open (corresponding to CiA DS 301 Version 4.02) is used as the protocol at the CAN bus interface:
- one transmit and one receive SDO per device
- one asynchronous transmit and receive PDO, active by default
- one synchronous transmit and receive PDO, active by default (PDO 1)
- one heartbeat object every 500 ms

4.1 Table of entries implemented from object dictionary

Name	Index number	Function	Range of values	Back up?	Delivery state	R/W
device type	1000	returns a “0” when read	0		0	R
error register	1001	Bit 0: general error Bit 4: communication error	8 bit			R
error list	1003	sub index 0: quantity sub index 1 and 2: most recent emergency error	8 bit 32 bit			R
sync ID	1005	COB ID for the sync command	32 bit	no		R/W
comm cycle	1006	communication cycle time	32 bit	no		R/W
sync window	1007	synchronous window time	32 bit	no		R/W
guard time	100C	guard time in ms 0 = off	16 bit	no		R/W
life time	100D	life-time factor	16 bit	no		R/W
emcy ID	1014	COB ID for emergency message	32 bit	no		R
emcy inhibit	1015	inhibit time for emergency message	16 bit	no		R/W
consumer heartbeat	1016	sub index 0: quantity = 2 sub index 1 and 2: bit 15-0: heartbeat time in ms bit 23-16: node ID of producer	8 bit 32 bit	no		RR/ W
heartbeat producer	1017	cycle time for heartbeat via PSE312U 0 = off	16 bit	no		R/W
identity	1018	identity object: sub index 0: index number sub index 1-4: 0	8 bit 32 bit	no		R

receive PDO 1 communication parameter	1400	sub index 0: index number sub 1: COB ID of this PDO sub 2: PDO type	8 bit 32 bit 8 bit	 no no	 200h act. 255	RR/ W R/W
transmit PDO 1 communication parameter	1800	sub index 0: index number sub 1: COB ID of this PDO sub 2: PDO type sub 3: inhibit time	8 bit 32 bit 8 bit 16 bit	 no no no	 180h act. 1 0	R R/W R/W R/W R/W

Name	Index number	Function	Range of values	Back up?	Delivery state	R/W
	2000: 0...9	10 open registers	16 bit	yes	0	R/W
target value	2001	target position to be achieved in 1/20 mm	±31 bit	yes	0	R/W
actual value	2003	current actual position in 1/20 mm writing onto this index number causes the current position to be "referenced" onto the transferred value	±31 bit	no		R/W
referencing value	2004	correction factor for the target, actual and limit switch values	±31 bit	yes	0	R/W
positioning window	2006	permissible difference between target and actual values for “position reached”	1...100 16 bit	yes	1	R/W
actual value assessment, numerator	2010	Based on a resolution of 0.5 mm per increment, these values can be used to apply any user-specific resolution to the drive. The actual resolution is given by the numerator (20 increments per rotation); the denominator shows the desired resolution (default is also 20 increments per rotation = 0.5 mm per increment).	1…32767 16 bit	yes	20	R/W
actual value assessment, denominator	2011		1…850 16 bit	yes	20	R/W
target speed, positioning	2012	Value in 1/100 mm per second. maximum speed to be used during positioning runs	200…200 16 bit	yes	2000	R/W
target speed, manual	2013	Value in 1/100 mm per second. maximum speed to be used during positioning runs	50…1000 16 bit	yes	1000	R/W
initial speed	2014	Value in 1/100 mm per second. maximum speed to be used during positioning and manual runs	20…750 16 bit	yes	750	R/W
acceleration	2015	Value in 1/100 mm per second during positioning runs	1…50 16 bit	yes	10	R/W
upper limit	2016	maximum permitted target position permissible values: 1…2000 +referencing value	±31 bit	yes	2000	R/W
lower limit	2017	minimum permitted target position permissible values: 0…1999 +referencing value	±31 bit	yes	0	R/W
op. current for positioning runs	2018	value in mA	150…2300 16 bit	yes	1500	R/W

op. current for manual runs	2019	value in mA	20…1300 16 bit	yes	500	R/W
op. current for acceleration phase	201A	value in mA	150…2300 16 bit	yes	1000	R/W

Name	Index number	Function	Range of values	Back up?	Delivery state	R/W
command byte	2024	Bit 0: manual run to larger values Bit 1: manual run to smaller values Bit 2: transfer target value; positioning will only take place if this bit is set in the PDO transfer Bit 4: release: the axle will only move if this bit is set Bit 6: run without a reference loop Bit 7: complete start-up reference loop	8 bit	no	0	R/W
status	2025	Bit 0: position reached Bit 1: unused Bit 2: drive is running Bit 3: start-up reference loop completed Bit 4: power available to motor Bit 5: positioning run aborted Bit 6: potentiometer error Bit 8: movement opposite loop direction Bit 9: PDO command received Bit 10: positioning error (obstruction) Bit 11: manual rotation Bit 12: incorrect target value Bit 13: power was unavailable to motor Bit 14: positive range limit Bit 15: negative range limit	0...FFFFh 16 bit	no		R
CAN address	2026	address of drive in CAN bus; this value is ignored if the address switch is used.	1...127 16 bit	yes	1	R/W
baud rate	2027	0: 50 kBaud 1: 125 kBaud 2: 250 kBaud 3: 500 kBaud 4: 1000 kBaud	0...4 16 bit	yes	3	R/W
holding current 2	202A	current to motor immediately after completion of run; in mA	0…500 16 bit	yes	500	R/W
holding current	202B	current to motor at standstill; in mA	0…500 16 bit	yes	150	R/W
idle period	202E	idle period in ms when reversing the direction of rotation	10...1500 16 bit	yes	50	R/W
time for hold. current 2	202F	amount of time after completed run during which holding current 2 is available; in ms	10…200 16 bit	yes	500	R/W
actual speed	2030	current speed in 1/100 mm per second	0…200 16 bit	no		R
obstr. limit	203C	number of lost motor increments before an obstruction is recognized	5…2000	yes	100	R/W
Umot limit	203D	voltage limit for motor power bit given in increments of 0.1 V	150…240 16 bit	yes	190	R/W

Umot filter	203E	average time for measuring current power to motor; given in 5 msec increments	100…1000 16 bit	yes	100	R
device temperature	203F	internal device temperature in °C	0…100 16 bit	no		R

Name	Index number	Function	Range of values	Back up?	Delivery state	R/W
production date	2040	year and week of manufacture (given as an integer)	YYWW 16 bit	yes		R
serial number	2041	serial device number	0...65565 16 bit	yes		R
version	204E	software version number	16 bit	no	7	R
delivery state	204F	a “-1” generates the delivery state without modifying the device address. a “-2” generates the delivery state a “1” backs up the parameters in the EEPROM. reading after backup returns a 0 if backup has proceeded correctly; otherwise a -1 is returned.	-1, -2 or 1 16 bit	no		R/W
Test	2501	sub index 1: a “1” calls up test mode	only 1 valid 16 bit	no		W
Test2	2502	sub index 1: lower potentiometer support sub index 2: upper potentiometer support sub index 3: asymmetry of the 1 bit encoder	16 bit	yes		R/W

4.2 PDO definition

1) Receive PDO (from the perspective of the LPE4310C)
Address: 200h + device address (possible values: 201h...27Fh)

Assignment (cannot be modified):

Bit	Byte	Meaning	Corresponding SDO index number
0-7	0	command byte	2024h
8-31	1-3	unused	
31-63	4-7	target value	2001h

2) Transmit PDO (from the perspective of the LPE4310C)
Address: 180h + device address (possible values: 181h...1FFh)

Assignment (cannot be modified):

Bit	Byte	Meaning	Corresponding SDO index number
0-15	0,1	status	2025h
16-31	2,3	unused	
31-63	4-7	actual value	2003h

4.3 Detailed description of status bits

Bit 0: target position achieved

This bit is set

- when a transferred target position has been reached successfully
- after running a start-up reference loop, when the actual value corresponds to the previously transferred target value

This bit is deleted

- after transferring a target position when the difference from the actual value is larger than the positioning window (SDO no. 2006)
- by a manual run
- any time the “start-up reference loop completed” bit is deleted
- if an invalid target value has been transferred

Bit 2: Drive is running

This bit is set

- when the drive is rotating

This bit is deleted

- when the drive is on standstill

Bit 3: start-up reference loop completed

This bit is set

- after a start-up reference loop has been successfully completed (no further runs may be executed if an obstacle is encountered during this reference loop)

This bit is deleted

- after the instrument is switched on
- when a start-up reference loop is started
- if the direction of rotation or running direction for target positions is modified
- by the “generate delivery state” command

Bit 4: power supply to motor available

This bit is set

- if the supply voltage for the motor is in place

This bit is deleted

- if the supply voltage for the motor is not in place

Bit 5: positioning run aborted

This bit is set

- if a positioning run is aborted because release has been withdrawn

This bit is deleted

- when a new run command is transmitted

Bit 6: potentiometer error

This bit is set

- if no learning run had been performed with the drive
- if the voltage measured at the potentiometer lies outside of the permissible positioning range

This bit is deleted

- after a valid learning run

Bit 8: movement in reverse loop direction

This bit is set
- for manual runs in the direction opposite that of the positioning run
A subsequent manual run in the direction of the positioning run will not delete this bit
- during a positioning sequence in the direction opposite that of the reference loop

This bit is deleted
- when a transferred target position has been reached successfully (in the direction of the reference loop)- after the start-up reference loop

Bit 9: PDO run command received (Toggle-Bit)
Deleted after the system has been switched on

This bit is changed
- by transmitting a PDO with a control bit or a target value differing from the previous values when the “transferring target value” bit is set

Bit 10: Positioning error (obstruction)

This bit is set
- if a positioning run is aborted because the instrument is overloaded (obstructions, extreme difficulty running)

This bit is deleted
- by transmitting a new positioning command
- after a start-up reference loop has been correctly executed

Bit 11: manual rotation

This bit is set
- if, while on standstill, the drive is turned externally by more than the value in the positioning window

This bit is deleted
- by transmitting a new positioning command
- after a start-up reference loop has been correctly executed

Bit 12: incorrect target value

This bit is set
- when a transferred target value lies outside of the limit switches; also set if, for instance, the selected offsets result in a target value outside of these limits

This bit is deleted
- by transmitting a valid target value

Bit 13: power was unavailable to motor

This bit is set
- if the power to the motor is less than 18 V when initiating a positioning run or start-up reference loop

This bit is deleted
- if the power to the motor is greater than 18 V when initiating a positioning run or start-up reference loop

Bit 14 / 15: forward / reverse limit reached

This bit is set
- if the final limiting value is reached during a manual run
(but not if reached during a positioning run)
- if a limit is modified such that the current position lies beyond the limit
- if the instrument approaches a position near a limit value and this value is exceeded during the reference loop

This bit is deleted
- by initiating a positioning run, a start-up reference loop or a manual run

5 Procedure for Positioning

5.1 Start-up reference loop

- The drive must be switched on before it can be controlled using PDOs.
- Execute start-up reference loop (transmit PDO with command byte 90h or SDO to index number 2024h: 90h). drive begins run
- Wait until the drive returns the “start-up reference loop completed" message (query PDO status bit 3 or SDO index number 2025 h: bit 3)
- Delete release if necessary (transmit PDO with command byte 0 or SDO to index number 2024h: 0).
- Withdrawing release during execution will abort a start-up reference loop.
- Other run commands are ignored during a start-up reference loop.

5.2 Positioning run

- Transfer target value (PDO with command byte 14h and target value, or target value to SDO index number 2001h): drive begins run
- Abort run by deleting release (transmit PDO with command byte 0 or transmit SDO to index number 2024h: 0).
- If a new target value is transferred during a positioning run, the instrument will immediately proceed to the new target. This will occur with no interruption provided the direction of rotation does not need to be altered.
- If a manual run is transmitted during a positioning run, the positioning run will be aborted (speed will be reduced to that of a slow run) and the operator may proceed with the manual run.

The following sequence of steps is also possible:
Starting conditions: release has not been set.
- Target value transferred (no release in the command byte for PDO transfer)
- Set release: drive begins run

5.3 Positioning run without a reference loop

The sequence corresponds to that of a positioning run with a reference loop; in addition to setting the release, however, bit 6 in the command byte also has to be set.

5.4 Manual run

- Transfer manual run (transmit PDO with command byte 11h/12h or transmit SDO to index number 2024h: 11h/12h.): drive begins run
- End manual run by deleting manual run (transmit PDO with command byte 10h or transmit SDO to index number 2024h: 10h) or by deleting release (transmit PDO with command byte 0 or SDO to index number 2024h: 0).

- Transferring a target value during a manual run will end the run and the instrument will immediately move on to the transmitted position.

6 Special features

6.1 Speed and acceleration

The start-up reference loop and manual run are performed at the maximum speed specified in SDO no. 2013; positioning runs are performed at the maximum speed specified in SDO no. 2012.

6.2 Response of drive if it encounters an obstacle or is repositioned manually

If during a run the difference between the number of motor increments counted and the actual number of increments executed is larger than the positioning window (SDO# 2006), the instrument will recognize an obstruction, abort the run and set bit 10 in the status byte. If the drive is moved outside of the positioning window by hand, the instrument recognizes manual rotation and sets bit 11 in the status byte.
New run commands can then be transmitted with no further steps to take.

6.3 Calculating the absolute physical position

The LPE4310C linear drive includes an absolute measuring system capable of covering a range of 100 mm (20 spindle rotations).
When it is delivered, the drive is positioned at 800, the upper limit switch is positioned at 2000, and the lower limit switch positioned at 0.

The referencing process affects all transferred values, i.e., the target value, actual value and upper and lower limit switches.

There are two ways of setting the referencing value:
a) Directly, by writing the referencing value to SDO index number 2004h
b) Indirectly, by writing an actual value to SDO index number 2003h. This allows you to assign any "actual" value you wish to the current physical actual value. The resulting difference is then the referencing value. This value will immediately be included in calculations for each transferred value and can also be read under SDO index number 2004h.

6.4 Using actual value assessment factors to set the spindle pitch

Index numbers 2010 (numerator factor) and 2011 (denominator factor) can be used to modify the instrument’s internal resolution from 20 increments per rotation to any desired numerical value.
Both factors are set to a value of 20 by default, resulting in a resolution of 0.05 mm.
The numerator factor represents the actual resolution of the LPE4310C and the denominator factor corresponds to the desired resolution for the numerical value at

the bus.
Example: desired resolution: 0.1 mm per increment: numerator factor: 20, denominator factor: 10.

The numerator factor may be set to a value between 1 and 32767.
The denominator factor can only be set to values between 1 and 850, as the resulting numerical values could otherwise be off-scale.

7 Technical data

Ambient conditions	
operating temperature	0 °C to +45 °C
storage temperature	-10 °C to +70 °C
relative humidity	0…80 %
protection class	IP54
resistance to vibration as stipulated in DIN IEC 68-2-27	10…55 Hz 1.5 mm / 55…1000 Hz 10 g / 10…2000 Hz 5 g
shock resistance as stipulated in DIN IEC 68-2-6	50 g 11 ms
EMC standards	CE
conformity	CE declaration of conformity available upon request
weight	4,500 g
Electrical data	
nominal power output	20 W (30 % OT, basis time: 10 min)
supply voltage	24 VDC ± 25 %
nominal current, motor	3 A
nominal current, electronic components of control unit	0.1 A
positioning accuracy	± 0.05 mm
interface	CAN bus
Physical data	
nominal positioning power	1000 N
self-holding power	1000 N, brief current
upstroke speed	20 mm/s
piston	adapter M 12 x 1.25
upstroke	75 mm (others available upon request)
maximum axial thrust	1000 N
maximum radial force	100 N

8 Dimension drawing