TECHLINE
IMPROVING FLEXIBILITY

CANopen

User manual v1.1

LINAK.COM/TECHLINE

LINAK®
WE IMPROVE YOUR LIFE

Contents

Preface

Dear User,

We are delighted that you have chosen a product from LINAK®.
LINAK systems are high-tech products based on many years of experience in the manufacture and development of actuators, electric control boxes, controls, and chargers.

This user manual does not address the end-user, but is intended as a source of information for the manufacturer of the equipment or system only, and it will tell you how to install, use and maintain your LINAK electronics. It is the responsibility of the manufacturer of the end-use product to provide a User Manual where relevant safety information from this manual is passed on to the end-user.

We are confident that your LINAK product/system will give you many years of hassle-free operation. Before our products leave the factory they undergo full function and quality testing. If you should experience any problem with your LINAK product/system please contact your local supplier. LINAK subsidiaries and some distributors have authorised service centres, which are always ready to help you.

LINAK provides warranty on all LINAK products. The warranty, however, is subject to correct use in accordance with the specifications, maintenance being done correctly and any repairs being carried out at a service centre, which is authorised to repair LINAK products.
Changes in installation and use of LINAK products/systems can affect their operation and durability. The products are not to be opened by unauthorised personnel.

This User Manual has been written based on our present technical knowledge. We are constantly striving to update both our products and the associated information we therefore reserve the right to carry out technical modifications without prior notice.

This user manual refers to the CANopen software version: SW01050007V3-1

LINAK A/S

LINAK® application policy

The purpose of the application policy is to define areas of responsibilities in relation to applying a LINAK product defined as hardware, software, technical advice, etc. related to an existing or a new customer application.

LINAK products as defined above are applicable for a wide range of applications within Medical, Furniture, Desk, and Industry areas. Yet, LINAK cannot know all the conditions under which LINAK products will be installed, used, and operated, as each individual application is unique.

The suitability and functionality of the LINAK product and its performance under varying conditions (application, vibration, load, humidity, temperature, frequency, etc.) can only be verified by testing, and shall ultimately be the responsibility of the LINAK customer using any LINAK product.

LINAK shall be responsible solely that LINAK products comply with the specifications set out by LINAK and it shall be the responsibility of the LINAK customer to ensure that the specific LINAK product can be used for the application in question.

About LINAK® CAN bus actuators

Summary

This document describes the capabilities of LINAK TECHLINE® CANopen components and the requirements for controlling these. It specifies the technologies involved, the environmental data specification and the functional description.

LINAK TECHLINE CANopen actuators are primarily designed with focus on industrial automation.

The communication protocol relies on the CiA 301 standard. The contents of this document assume that the reader is familiar with the CiA 301 standard.

In addition to full position control, the CANopen actuator can provide feedback information about the piston position, service data and full diagnostics. It also provides system identification data and actual current at runtime.

Functional overview

The LINAK ® TECHLINE ® CANopen offers a communication profile defined in CiA DS 301 V 4.0.2. This includes a command set for controlling the actuator in addition to feedback status.

- Process Data Objects PDO
- Service Data Objects SDO
- Objects with special functions for synchronization, error alert and response.
  - Synchronization object (SYNC)
  - Emergency object (EMCY)
- Network Management Objects (NMT) for initialization, error monitoring and status monitoring of the device.
  - NMT commands
  - Boot-up messages
  - Heartbeat messages

Command details

Run in/out

In and out movement is performed by sending the proper identifier while the actuator is in CANopen mode. In Service mode, movement is achieved by using the LINAK® BusLink PC software or by applying the proper signals to the Manual run wires. Using manual run, a start-up delay of up to 150 ms must be expected due to safety measures.

Position

Max/min. position: Stroke length
Level setting steps: 0.1 mm

Load, ramping up and down and specific actuator type (spindle/gear box) should be taken into account in regard to accuracy.
The Position SetPoint can be set dynamically.
If the new SetPoint involves a change in running direction, the ramps will follow the pre-set ramp time.

Maximum current in/out

Applying a current limit will induce a degree of mechanical overload protection to the installation.

Max. current limit: Fixed limit*
Level setting steps: 0.25 A

*The custom current limit setting cannot overrule the fixed factory setting which insures partially protection of the electronics and mechanics. See "Internal monitoring" on page 16 for details.

Speed control

The speed is controlled using Pulse Width Modulation (PWM).

Min. duty cycle:	0 %
Max. duty cycle:	100 %
Level setting steps:	0.5 %

Closed loop speed control will ensure a more accurate speed. In order to obtain this, the maximum speed is reduced to approximately 80%. The actual speed will be influenced by the gear and spindle size in the actuator.
The speed setting can be changed dynamically at run time.

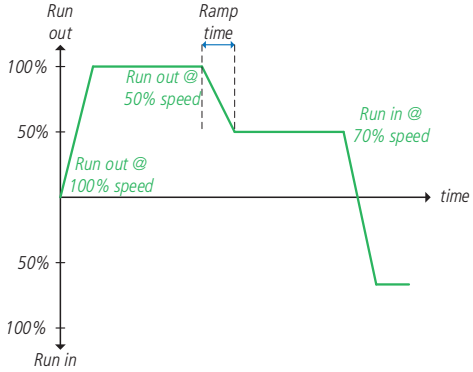

Figure 1. Speed control Graphics

Running conditions

In order to run the actuator please take the following into account.

- If the Heartbeat is not present the actuator will not accept any PDO commands.
- Commands must be resend if communication is interrupted or the Heartbeat signal is missing.
- RUN IN and RUN OUT commands cannot be issued if errors are present (error code != 0).
- Heartbeat status can be read with status bit 5.
- Upon entering OPERATIONAL actuator requires a STOP or CLEAR ERROR command.

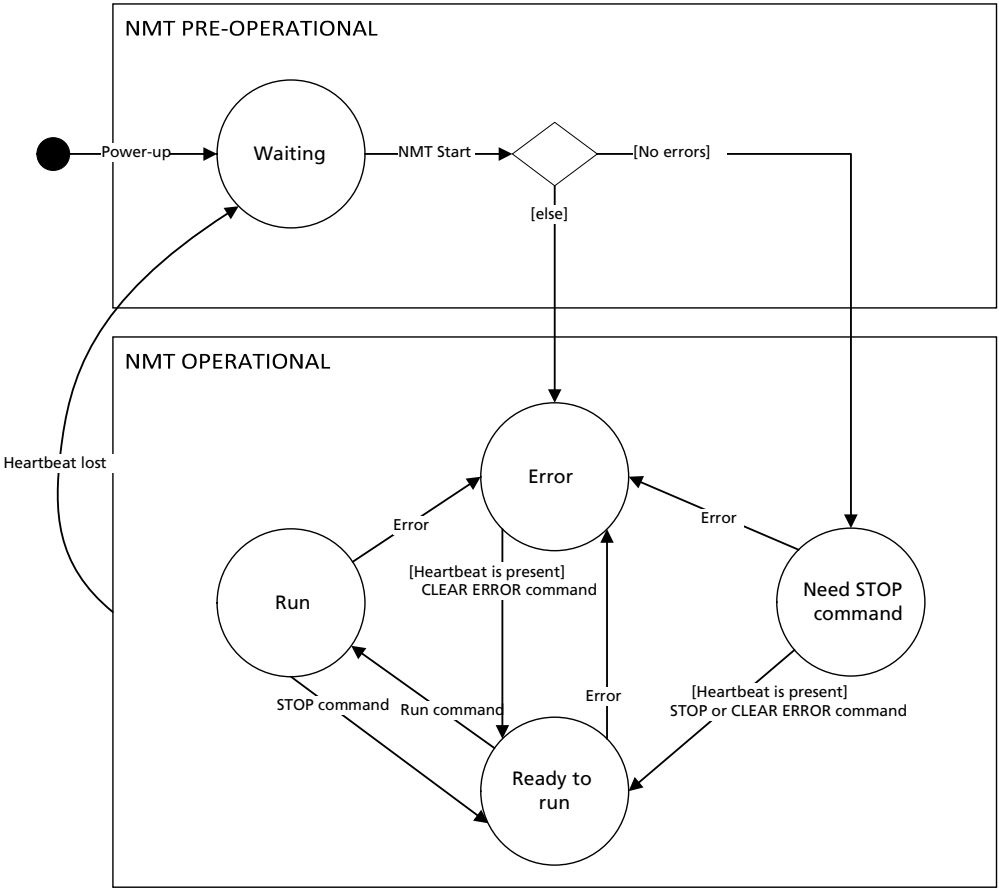

Figure 2. Running conditions

Starting procedures

Follow the example below to complete the startup procedures necessary for successful communication.

CAN ID (hex)	Data (hex)								Description
	0	1	2	3	4	5	6	7	
701	05								Master Heartbeat. Sent every 100ms
720	00								Actuator boot-up
620	23	16	10	01	C8	00	01	00	Configure actuator as heartbeat consumer with 200ms heartbeat time
5A0	60	16	10	01	00	00	00	00	Actuator response
000	01	20							
1A0	00	00	00	C1	01	00	00	C0	TPDO1
220	03	FB	FB	FB	FB	FB	00	00	Stop command
1A0	00	00	00	C1	00	00	00	C0	TPDO1. Need STOP Command cleared
220	01	FB	FB	FB	FB	FB	00	00	Run out command
1A0	A1	00	06	C8	00	31	00	CO	TPDO1. Actuator is running out
1A0	F7	01	00	C2	00	00	00	CO	TPDO1. Actuator reached EOS out
220	02	FB	FB	FB	FB	FB	00	00	Run in command
1A0	60	00	06	D0	00	32	00	C0	TPDO1. Actuator is running in
1A0	00	00	00	C1	00	00	00	C0	TPDO1. Actuator reached EOS in

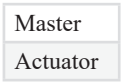

Figure 3. Starting procedures

Process Data Objects (PDO)

RPDO1 is mapped to 0x2000
TPDO1 is mapped to 0x2001

Command details

Index	Subindex	Command	Data type	Details	Description	Unit
Ox2000	1	Position	UINT16	0-64255 64256 64257 64258 64259 64260 64261 64262-65535	Run to position Clear ErrorCode register (see 0x1001) Command run actuor out Command run actutor in Command stop actuator* Command run to actuator out, Revocery mode Command run to actuator in, Recovery mode Invalid value, actuator will not run	0.1 mm/bit
	2	Current	UINT8	0-250 251 252-255	Maximum current limit Use default current value Invalid value, actuator will not run	0.25 A/bit
	3	Speed	UINT8	0-200 201-250 251 252-255	Speed to use Use 100% speed Actuator default speed value Invalid value, actuator will not run	0.5%/bit
	4	Soft start	UINT8	0-250 251 252-255	Start ramping time (ms) Use default soft start value Invalid value, actuator will not run	0.05 s/bit
	5	Soft stop	UINT8	0-250 251 252-255	Stop ramping time (ms) Use default soft stop value Invalid value, actutor will not run	0.05s/bit

Table 1. Command details.

Feedback status details

Index	Subindex	Command	Data type	Details	Description	Unit
Ox2001	1	Position	UINT16	0-64255 64256-65023 65024 65025-65535	Position of actuator piston Reserved Position lost Reserved	0.1 mm/bit
	2	Current	UINT8	0 1-250 251-253 254 255	Not running Measured motor current Reserved Fault in current measurement circuit Reserved	0.25 A/bit
	3	Status flags	UINT8	b0 b1 b2 b3 b4 b5 b6-b7	EOS in EOS out Over current Running out Running in CANopen heartbeat needed Reserved	8bit independent status bit-indicators
	4	Error codes	UINT8	0 1 2 3 4 5 6 7 8	No error Need stop command Hall error Over voltage Under voltage Failed to maintain heartbeat EOS error Temperature error Heart beat error (internal)	8bit error code indicating the currently active error of highest priority
				9 10 254 255	SMPS error (internal) Current measurement (internal) Internal fault (not specified) External fault (not specified)	
	5	Speed	UINT8	0-4015 4016-65535	Speed of actuator piston Reserved	0.1mm/s/bit
	6	Input state	UINT8	b0-b1 b2-b3 b4-b5 b6-b7	Input 1 level Input 2 level Input 3 level Reserved (always1)	25% /bit

Table 2. Feedback status details. .

Service Data Objects (SDO)

Index	Subindex	Data type	Access	Name	Details	Unit	Description
0x1000				Device type		see CiA 301 7.5.2.1	
0x1001				Error register		see CiA 301 7.5.2.2	
0x1005				CO B- IDSYNC		see CiA 301 7.5.2.5	Default value is used (0x80)
0x1009				Manufacturer hard-ware version		see CiA 301 7.5.2.9	PCBA name
0x1014				CO B- IDEMCY		see CiA3017.5.2.17	Default value is used (0x80 + Node- ID)
0x1015				Inhibit time EMCY		see CiA 301 7.5.2.18	Default value is used (0)
0x1016				Consumer heartbeat time		see CiA 301 7.5.2.19	Only one consumer heartbeat at time is supported
0x1017				Producer heartbeat time		see CiA 301 7.5.2.20	
0x1018				Identity object		see CiA 301 7.5.2.21	
	1	UINT32	R	Vendor ID	0x000004AA		LINAK
	2	UINT32	R	Producer code			Software number (e.g. 1050000)
	2	UINT32	R	Revision number			CANopen interface revision
	4	UINT32	R	Serial number			Same as UIN
0x1200				SDO server parameter		see CiA 301 7.5.2.33	
	1						Default value is used (0x600+ Node-ID)
	2						Default value is used (0x580 + Node-ID)
0x1400				RPDO communication parameter		see CiA 301 7.5.2 35	
	1						Default value is used (0x200 + Node-ID)
	2						event-driven (manufacturer-specific)
0x1600				RPDO mapping parameter		see CiA 301 7.5.2 36	1 to 1 mapping of 0x2000 (Actuator Command)
0x1800				TPDO communication parameter		see CiA 301 7.5.2 37	
	1	UINT32					Default value is used (0x180+ Node-ID)
	2	UINT8		Transmission Character			event-driven (manufacturer-specific)
	5	UINT16		Event timer	250	1ms/bit	
0x1A00				TPDO mapping parameter		see CiA 301 7.5.2 38	1 to 1 mapping of 0x2001 (Actuator Status)

Table 3. Service Data Objects.

Index	Subindex	Data type	Access	Name	Details	Unit	Description
OX4000		Record		Diagnostic			Actuator diagnostic parameters
	0	UINT8	R	Highest sub-index supported			
	1	UINT8	RW	Current limit out		0.25A/bit	
	2	UINT8	RW	Current limit in		0.25A/bit	
	3	UINT16	RW	Soft start time out		1ms/bit	
	4	UINT16	RW	Soft start time in		1ms/bit	
	5	UINT16	RW	Soft stop time out		1ms/bit	
	6	UINT16	RW	Soft stop in		1ms/bit	
	7	UINT8	RW	Maximum speed	0-200 201-255	0.5%/bit 100%	
	8	UINT16	RW	Virtual EOS out position		0.1mm/bit	
	9	UINT16	RW	Virtual EOS in position		0.1mm/bit	
	10	UINT32	R	UIN		8 number format	
	11	UINT32	R	SW variant [x]		SWxxxxxxxVy-x	Software number (e.g. 105000)
	12	UINT32	R	SW version Major [y]			
	13	UINT32	R	SW version Minor [z]			
	15	UINT32	R	Config production order number			
	15	UINT32	R	Production date		yyyymmdd	
	16	UINT8	R	Maximum current seen		0.25A/bit	
	17	UITN8	R	Maximum FET temperature seen		1 ^{0}C/bit-40	
	18	UINT32	R	Maximum ambient temperature seen		1 ^{0}C/bit-40	
	19	UINT8	R	Minimum ambient temperature seen		1 ^{0}C/bit-40	
	20	UINT32	R	Current usage		1As/bit	
	21	UINT32	R	Runtime		1s/bit	
	22	UINT8	R	Number of stops due to overvoltage			
	23	UINT8	R	Number of stops due to FET over temperature			
	24	UINT8	R	Number of stops due to ambient over temperature			
	25	UINT8	R	Number of stops due to low voltage			
	26	UINT	R	Number of stops due to hall errors			
	27	UINT8	R	Number of stops due to EOS switch errors			
	28	UINT8	R	LINAK current overload out stops			
	29	UINT8	R	LINAK current overload in stops			
	30	UINT8	R	Resettable Custom current overload out stops			
	31	UINT8	R	Resettable Custom current overload in stops			

	32	UINT16	R	Communication errors			
	33	UINT16	R	Number of EOS out			
	34	UINT16	R	Number of EOS in			
	35	UINT32	R	Number of starts out			
	36	UINT32	R	Number of starts in			
	37	UINT32	R	Total piston distance		1m/bit	
	38	UINT16	R	Last stop reason id 0			Stop reason id
	39	UINT8	R	Last stop count id 0			Number of consecutive stop reasons of the same type
	40	UINT32	R	Last stop powered time id 0			Powered time when the last stop occured
	41	UINT16	R	Last stop reason id 1			Stop reason id
	42	UINT8	R	Last stop count id 1			Number of consecutive stop reason of the same type
	43	UINT32	R	Last stop powered time id 1			Powered time when the last stop occured
	44	UINT16	R	Last stop reason id 2			Stop reason id
	45	UINT8	R	Last stop count id 2			Number of consecutivve stop reason of the same type
	46	UINT32	R	Last stop powered time id 2			Powered time when the last stop occured
	47	UINT16	R	Last stop reason id 3			Stop reason id
	48	UINT8	R	Last stop count id 3			Number of consecutive stop reason of the same type
	49	UINT32	R	Last stop powered time id 3			Powered time when the last stop occured
	50	UINT16	R	Last stop reason id 4			Stop reason id
	51	UINT8	R	Last stop count id 4			Number of consecutive stop reason occured
	52	UINT32	R	Last stop powered time id 4			Powered time when the last stop occured
	53	UINT32	R	Total corrected distance			

Table 4. Service Data Objects.

Internal monitoring

A number of parameters are monitored during operation to prevent overloading the electronics and to minimise the risk of mechanical damage.

Current limits and measurements

The principle behind the current measurement is an 'above limit' and 'below limit' accumulating counter. When the Timeout counter reaches a specific value the current cut-off goes into effect. The timeout value is pre-set at 200 to 500ms depending on actuator type.

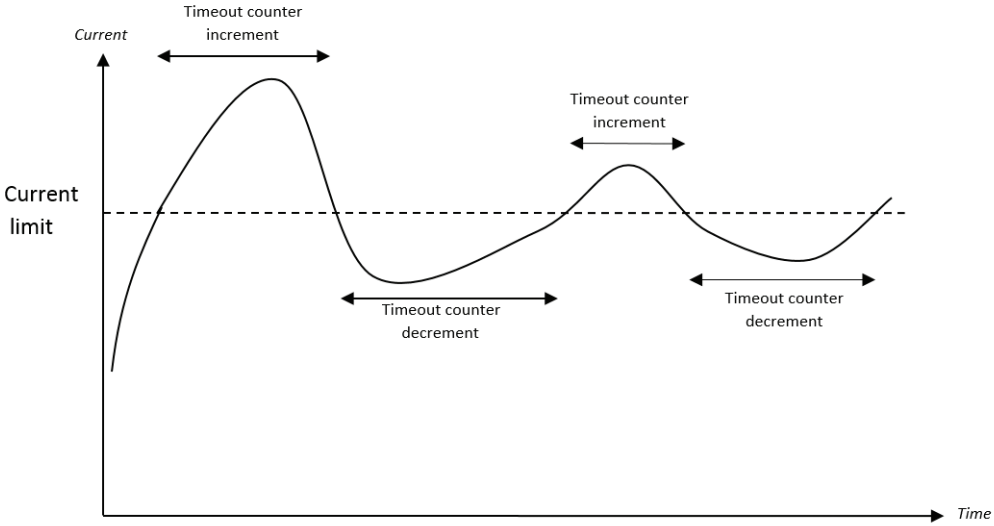

Figure 3. Dynamic current limit principle.

In case of current limit activation (Timeout counter max is reached), the actuator will stop and an over current error is triggered. The error is cleared when the actuator is activated in the opposite direction or by issuing a Clear error command.

Custom over current limit can only be lower than or equal to the fixed factory setting.

Voltage
The supply voltage level is monitored in order to maintain a safe operation and to protect the circuitry.

Temperature
Two temperature monitoring circuits are in place to measure the absolute temperature of the board and the centre temperature of the H-bridge.

H-bridge
The H-bridge conditions are monitored at all times. Several conditions are required in order to run.
Among these are:

- Correct voltage supplies
- Heartbeat safety signal
- Correct temperatures
- No errors

Parameters
In addition to the immediate monitoring, a number of parameters are saved for long-term evaluation.
These include:

- Number of starts in either direction
- Reason for last stop
- Total running time
- Under and over voltage
- Maximum current
- Number of current overloads in either direction

These parameters will help the engineer sort out existing issues. Considering a combination of parameter values, the lifetime load can indicate a potential failure before it happens and thereby prevent downtime.

Environmental data and tests

The CAN bus actuators fulfil the environmental requirements as defined:

Operational environment

Ambient temperature: -30°C to 65°C (full performance only from +5°C to 40°C)
Relative humidity: 30% to 80% @ 30°C
Pressure: 700hPa to 1060hPa

Storage environment

Ambient temperature: -55°C to 105°C
Relative humidity: 30% to 80% @ 30°C
Pressure: 700hPa to 1060hPa

Supply voltage

The actuator will be available in two supply voltage ranges, 12 VDC, 24 VDC, and 48 VDC. The accepted supply voltage range is specified according to ISO16750-2012.

Supply voltage	V_{MIN}	V_{TYP}	V_{MAX}	Reference	Note
12 V	10.5 V	12 V	16 V	ISO 16750-2:2012 - Code D	Motor running
	6 V	12 V	39 V	ISO 16750-2:2012 - Code A	Motor not running CAN communication possible
24 V	18 V	24 V	32 V	ISO 16750-2:2012 - Code H	Motor running
	10 V	24 V	39 V	ISO 16750-2:2012 - Code E	Motor not running CAN communication possible

Table 4. Voltage supply levels.

Power loss

In case of power loss, the actuator position and other important data is saved by the on-board microcontroller.

Over voltage

If the voltage rises above the set limit, the system will enter overvoltage protection mode and shut down.

EMC

The Electromagnetic Compatibility tests performed on the LINAK® CANopen actuator comply with the TECHLINE® Electrical Test Specification. The scope of tests is verified and accredited by DELTA A/S test laboratory.

Norm/Standard	Test decription
ISO 16750-2:2012	Supply voltage range
	Overvoltage
	Superimposed alternating voltage
	Slow lowering and raising the voltage supply
	Momentary drop in supply voltage
	Reset behaviour for voltage drop
	Reversed voltage
	Ground reference and supply offset
	Open circuit test
	Short circuit protection
	Load dump – Test pulse 5a
	Load dump test pulse 5b
ISO 7637-2:2011	Test pulse 1
	Test pulse 2a
	Test pulse 2b
	Test pulse 3a
	Test pulse 3b
ISO 16750-2:2012	Test pulse 4
ISO 7637-2:2011	Voltage transient emission test on power supply lines
ISO 7637-3:2007	Electric transient transmission by cap. and inductive coupling
CISPR 25 IEC:2008	Conducted disturbance voltage measurement
	Radiated emission – ALSE method
CISPR 16-1-2:2010	Conducted emission
CISPR 16-2-3:2010	Radiated emission
ISO 10605 2nd Ed.	ESD immunity
IEC 61000-4-2 2nd Ed.	ESD immunity
ISO 11452-1:2005, ISO 11452-2:2004, ISO 11452-4:2011, ISO 11452-5:2002	Interference immunity
IEC 61000-4-3:2006	Interference fields immunity test
IEC 61000-4-8:2010	Power frequency magnetic field
IEC 61000-4-4:2004	Burst transients
IEC 61000-4-5:2006	Surge transients

Table 5. LINAK TECHLINE EMC test overview.

BusLink service interface

The BusLink service interface offers a wide range of settings and status feedback options. Use the LINAK® USB2LIN cable and the LINAK BusLink PC software will gain access to:

BusLink settings

- Initialisation
- Current limit settings
- Soft start/stop timing

BusLink feedback

- Run time parameters
- Number of starts and stops
- Maximum current and temperature
- Error messages

The actuator can also be run manually using BusLink control interface. During normal CAN operation, BusLink manual run is disabled. The service interface is only intended to run with the BusLink PC software tool.

Figure 4. LINAK USB2LIN service cable.

Figure 5. LINAK adapter cable.

See the BusLink Quick Guide for details on how to connect to the specific actuator model.

The USB2LIN service cable and adapter cable suitable for CAN actuators can be ordered as

USB2LIN adapter	USB2LINO6
LA14CAN/ LA25CAN Adapter	0965205-A
LA33CAN/ LA36CAN/ LA37Can Adapter	0968011-A

Installing LINAK® CANopen actuators

Introduction

This section will assist you in the installation of the LINAK CANopen actuator. Going through parameters and procedures necessary for a successful implementation.

- Connections
- Electrical installation
- Communication

Connections

The tables below define the wire connections to the LINAK TECHLINE CANopen actuators. The colours are consistent with all LINAK TECHLINE CANopen actuators. The pinning definition provided by CiA 303-1 for mini-fit connector do **not** comply with the definition below.

Single connector actuators

Power connector, 8-pin mini-fit connector

LINAK cable	Description
Brown	+ Power supply (12/24/48VDC)
Blue	- Power supply (GND)
Black	Manual run in
Red	Manual run out
White	Service interface GND
Purple	Service interface DATA
Yellow	CAN H
Green	CAN L

Table 6. Power and communication wire colour.

By default, cables are supplied with flying leads.

Dual connector actuators

Power connector, 6-pin mini-fit connector

LINAK cable	Description
Brown	+ Power supply (12/24/48VDC)
Blue	- Power supply (GND)

Table 7. Power wire colours.

Communication connector, 6-pin micro-fit connector

LINAK cable	Description
Black	Manual run in
Red	Manual run out
White	Service interface GND
Purple	Service interface
Yellow	CAN H
Green	CAN L

Table 8. Communication wire colours.

Electrical installation

Physical specifications

LINAK CANopen actuators provide a physical layer according to ISO 11898-2.

Speed	250 kbps
Max bus length	250 meters
Max stub length	11 meters
Accumulated stub length	55 meters
Max node count	127
Cable impedance	120 Ω (±10%)

Power supply

The power supply for the LINAK CANopen actuator should be kept separate from the CANopen power supply, if such one exists.

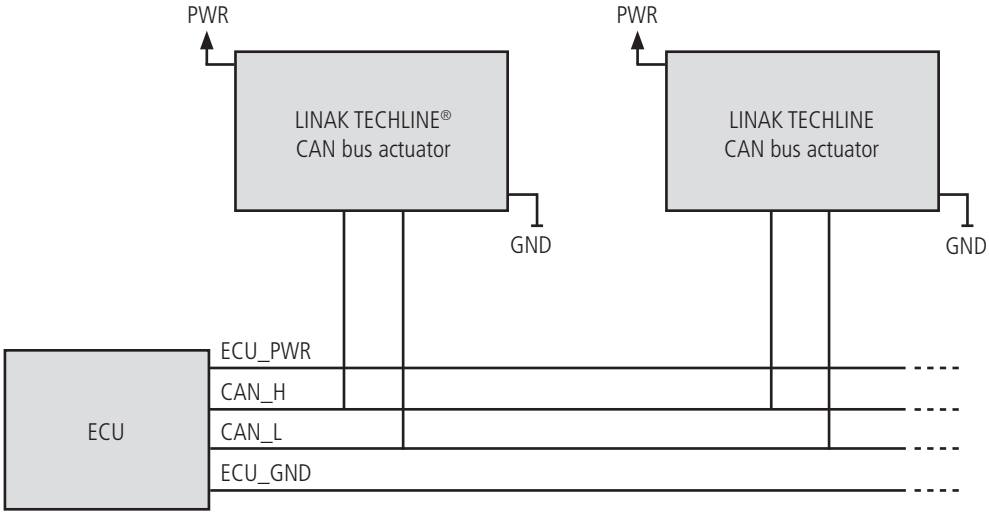

Figure 5. Power supply connection setup.

The power supply for the LINAK® CAN bus actuator should be kept separate from the CAN bus power supply, if such one exists.

Electronic Datasheet

An ***eds*** file can be obtained by contacting Linak. The ***eds*** file complies with the CiA 306 standard. An XML based ***xdd*** file format, defined according to CiA311 is also available.

Connection diagram

During the optional manual run mode, the actuator will continue to send status feedback on the CAN bus. However, if other CAN devices are active on the network, manual run mode will be disengaged. The Service interface is also accessible during manual run mode.

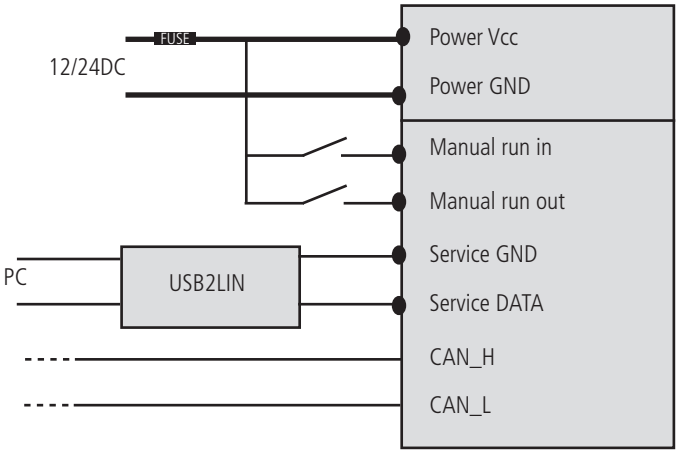

Figure 6. Connection pinout.

Termination

Termination resistors of 120 Ω should be connected according to figure 7. The actuator does not have internal termination.

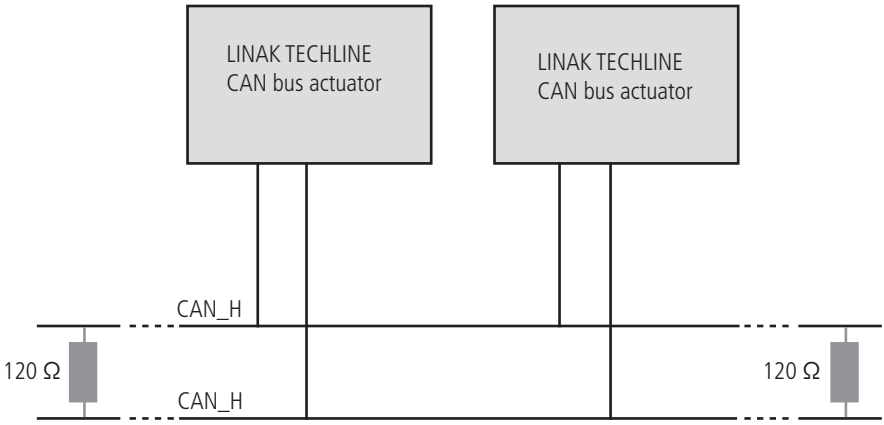

Figure 7. Termination connection diagram.

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