CAN SAE J1939

User Manual

CAN | J1939

LINAK®

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Preface

Dear User,

We are delighted that you have chosen a LINAK® product.

LINAK systems are high-tech products based on many years of experience in the manufacture and development of actuators, lifting columns, desk frames, electric control boxes, controls, batteries, accessories and chargers.

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

We are convinced that your LINAK product/system will give you many years of problem-free operation.

Before our products leave the factory, they undergo both function and quality testing. Should you, nevertheless, experience problems with your product/system, you are always welcome to contact your supplier.

LINAK subsidiaries and some distributors situated all over the world have authorised service centres, which are always ready to help you. Locate your local contact information on the back page.

LINAK provides a warranty on all products. (See warranty section).

This 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 systems can affect their operation and durability. The products may only be opened by authorised personnel.

This User Manual has been written based on the present technical knowledge. LINAK reserves the right to carry out technical modifications and keeps the associated information updated.

LINAK A/S

Terms of use

LINAK® takes great care in providing accurate and up-to-date information on its products. However, the user is responsible for determining the suitability of LINAK products for a specific application.

Due to continual development, LINAK products are subject to frequent modifications and changes. LINAK reserves the rights to conduct modifications, updates, and changes without any prior notice. For the same reason, LINAK cannot guarantee the correctness and actual status of imprinted information on its products.

LINAK uses its best efforts to fulfil orders. However, for the reasons mentioned above, LINAK cannot guarantee availability of any particular product at any given time. LINAK reserves the right to discontinue the sale of any product displayed on its website or listed in its catalogues or in other written material created and produced by LINAK, LINAK subsidiaries, or LINAK affiliates.

All sales are subject to the 'Standard Terms of Sale and Delivery for LINAK A/S' available on LINAK websites.

About LINAK® CAN bus actuators

LINAK TECHLINE® CAN bus actuators are primarily designed with focus on mobile agriculture and industrial automation. The communication protocol relies on the SAE J1939 standard. The contents of this document assume that the reader is familiar with the SAE J1939 standard.

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

CAN bus specifications

This section describes the requirements of the CAN bus hardware and software interface:

The physical layer is in accordance with J1939-15	
Speed	125 kbps, 250 kbps, 500 kbps, or AutoBaud (changeable in Actuator Connect™ or BusLink)
Max. bus length	40 metres
Max. stub length	3 metres
Max. node count	10 (30*)
Wiring	Unshielded twisted pair
Cable impedance	120 Ω (±10%)

The maximum cable length delivered by LINAK is no longer than 3 metres. Consequently, all system tests carried out are limited to consist of 3-meter cables. Non-error tolerant physical layer with the following specifications: Low-power mode is according to ISO 11898-5.

Standards

The following standards and revisions are the bases of the LINAK TECHLINE CAN bus software:

SAE J1939-21 DEC2010	Data Link Layer
SAE J1939-31 APR2014	Network Layer
SAE J1939-71 APR2014	Application Layer
SAE J1939-73 JUL2013	Application Layer - Diagnostics DM14 (Memory access request) DM15 (Memory access response) DM16 (Binary data transfer)
SAE J1939-81 JUN 2011	Network Management
SAE J1939-82 AUG 2008	Compliance - Truck and bus (Complies with the relevant parts of the SAE J1939-82)

* The SAE J1939-15 can accept up to 30 nodes. See section 3.1 of J1939-15 May 2014 for details.

Connection diagram

9- and 12-pin

Power

BROWN	12/24/48 V DC	2
BLUE	GND	1

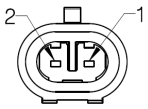
Control

RED	Extends the actuator HW Addressing pin 2	5
BLACK	Retracts the actuator HW Addressing pin 3	4
ORANGE*	Split power supply V DC	1
LIGHT BLUE	HW Addressing pin 1	6
YELLOW	CAN_H	2
GREEN	CAN_L	3
GREY	Not to be connected	0

Communication

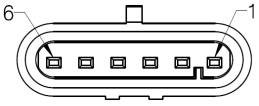
VIOLET	Parallel data	7
WHITE	Parallel GND	8

AMP



Deutsch

AMP



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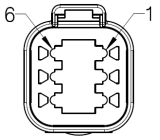
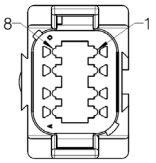


Deutsch



12-pin only available with flying leads. Connections (Deutsch and AMP) only valid for 9-pin.

*Split power supply and a motor supply (Brown), which refer to a common GND (Blue).

This approach is used to maintain power on the intelligent part of the actuator. In case the main supply is disconnected, split power supply allows e.g. that the position is maintained. The main supply may be disconnected for reasons related to safety, maintenance or installation.

Actuator Connect™ is available for CAN bus actuators and can be used for:

Diagnostics, manual run and configuration. The newest version is available online here.

Connect the actuator to Actuator Connect via a USB adapter cable (must be purchased separately) to enable and configure various features.

I/O specifications

9- and 12-pin

<table>
<tr><th>Input/Output</th><th colspan="2">Specification</th><th colspan="2">Comments</th></tr>
<tr><td>Description</td><td colspan="2">CAN bus is compatible with the SAE J1939 standard. Uses CAN messages to command movement, setting parametres and to deliver feedback from the actuator. Actuator identification is provided, using hardware and software addressing.</td><td colspan="2">CAN SAE J1939</td></tr>
<tr><td>Brown</td><td colspan="2">12/24/48 V DC</td><td colspan="2" rowspan="2">Note: Do not swap the power supply polarity on the Brown and Blue wires!
The PCB is coupled to the housing through a capacitor.</td></tr>
<tr><td>Blue</td><td colspan="2">GND
For more information, see the section ‘Power supply’</td></tr>
<tr><td>Red</td><td>Extends the actuator / Hardware addressing (2)</td><td rowspan="2">The signal becomes active at:
> 67% of V_{IN}
The signal becomes inactive at:
< 33% of V_{IN}
Input current: 10 mA</td><td rowspan="2">Manual run:
If not connected to VCC at startup:</td><td rowspan="2">Hardware addressing:
When used for Hardware addressing, connect to VCC or negative (GND)</td></tr>
<tr><td>Black</td><td>Retracts the actuator / Hardware addressing (1)</td></tr>
<tr><td>Orange**</td><td colspan="2">Split power supply V_{CC} communication only.
24 V DC with ≈28 mA current consumption.
48 V DC with ≈16 mA current consumption.
Connect to positive. The split power supply uses the common GND from the power supply (Blue wire).</td><td colspan="2">Used only if the actuator supports split power supply.</td></tr>
<tr><td>Light Blue</td><td colspan="2">Hardware addressing (3)</td><td colspan="2">When used for Hardware addressing, connect to VCC or negative (GND).</td></tr>
<tr><td>Yellow</td><td colspan="2">CAN_H</td><td colspan="2" rowspan="2">Actuators with CAN bus do not contain the 120 Ω terminal resistor. The physical layer is in accordance with J1939-15.*
Speed: Autobaud up to 500 kbps (CAN bus prior to version 3.0 up to 250 kbps)
Wiring: Unshielded twisted pair</td></tr>
<tr><td>Green</td><td colspan="2">CAN_L</td></tr>
<tr><td>Grey</td><td colspan="2">Not to be connected</td><td colspan="2"></td></tr>
<tr><td>Violet</td><td colspan="2">Parallel data</td><td colspan="2" rowspan="2">Only Actuator Connect™ can be used as service interface.
Use Grey adapter cable</td></tr>
<tr><td>White</td><td colspan="2">Parallel GND</td></tr>
</table>

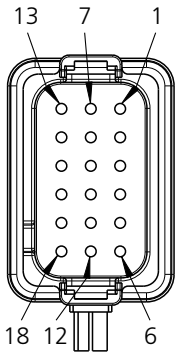
* J1939-15 refers to twisted pair and shielded cables.
The standard/default cables delivered with CAN actuators do not comply with this.

** Split power supply (Orange) and a motor supply (Brown), which refer to a common GND (Blue).

Connection diagram

18-pin

Deutsch



Power

4	+ Split power supply
5*	+ 12/24/48 V DC
6*	+ 12/24/48 V DC
11*	GND
12*	GND

Control

7	Extends the actuator
8	Retracts the actuator
10*	Parallel data and service port

Communication

17	CAN_H
18	CAN_L
9	Not to be connected
13	Address 1 [LSB]
14	Address 2
15	Address 3
16	Address 4 [MSB]

NOT to be connected

1	Do not connect
2	Do not connect
3	Do not connect

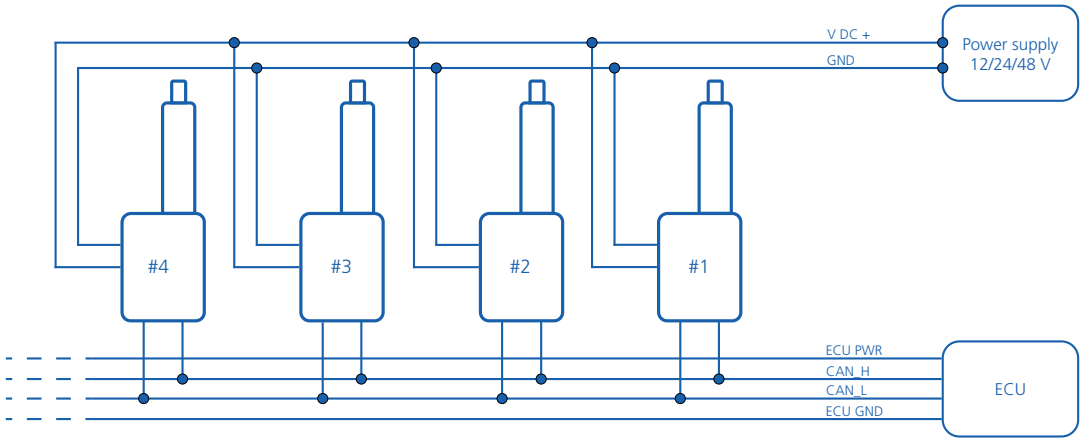
I/O specifications

18-pin

Input/Output	Specification	Comments
Description	CAN bus is compatible with the SAE J1939 standard. Uses CAN messages to command movement, setting parametres and to deliver feedback from the actuator. Actuator identification is provided, using hardware and software addressing.	CAN J1939
Pin 4	+ Split power supply	Note: Do not swap the power supply polarity on the Brown and Blue wires! The PCB is coupled to the housing through a capacitor.
Pin 5	12/24/48 V DC For more information, see the section 'Power supply'	
Pin 11	GND	Common ground for motor, split power supply, service port, and internal parallel connection
Pin 12	GND	
Pin 7	Extends the actuator	The signal becomes active at: > 67% of V_{IN} = ON The signal becomes inactive at: < 33% of V_{IN} = OFF Input current: 10 mA
Pin 8	Retracts the actuator	
Pin 10	Parallel data and service port	Only Actuator Connect™ can be used as service interface. Use Grey adapter cable
Pin 17	CAN_H	Actuators with CAN bus J1939 do not contain the 120 Ω terminal resistor. The physical layer is in accordance with J1939-15.
Pin 18	CAN_L	
Pin 9	Not to be connected	Factory interface: Connecting these pins may damage the actuator
Pin 13	Address 1 [LSB]	Pins 13 to 16 are dedicated for CAN ID or LIN ID. The four inputs can deliver 16 unique addresses. Note that manual run is not possible while setting the address.
Pin 14	Address 2	
Pin 15	Address 3	
Pin 16	Address 4 [MSB]	
Pin 1	Not to be connected	Factory interface: Connecting these pins may damage the actuator
Pin 2		
Pin 3		

Electrical installation

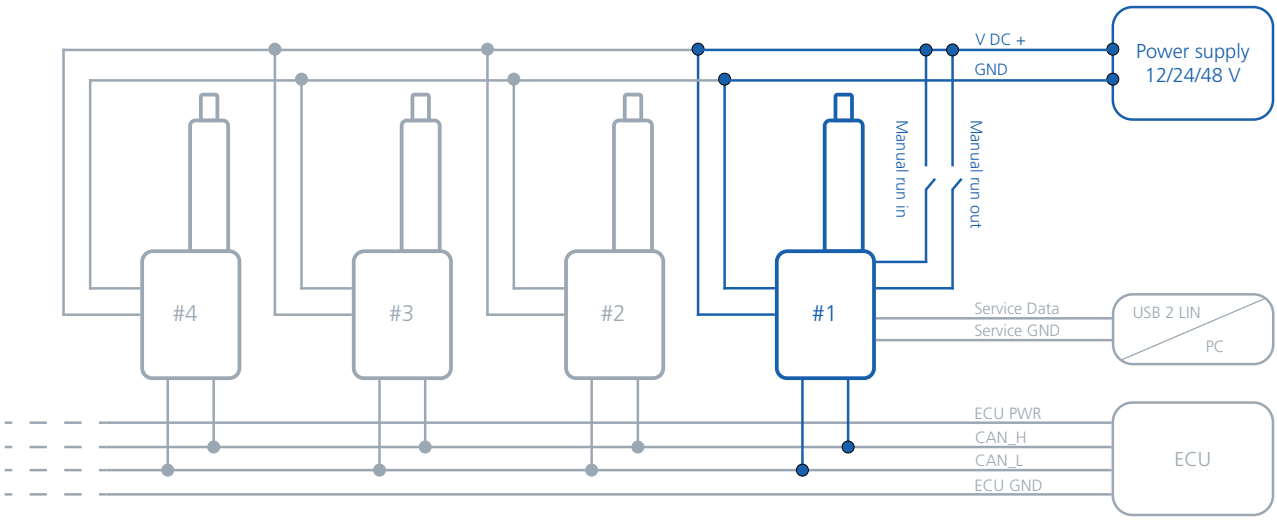
The J1939-15 defines the Reduced Physical Layer, 250 Kbps, Unshielded Twisted Pair (UTP), and runs with separate communication and power supply wires.



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

Manual run

During Manual run mode where Inputs 1-3 are low or floating on power-up, the actuator will continue sending status feedback on the CAN bus. However, if other CAN devices are active on the network, Manual run mode will be disengaged. The CAN software address range 128-247 is reserved for this mode. The service interface is also accessible during Manual run mode.



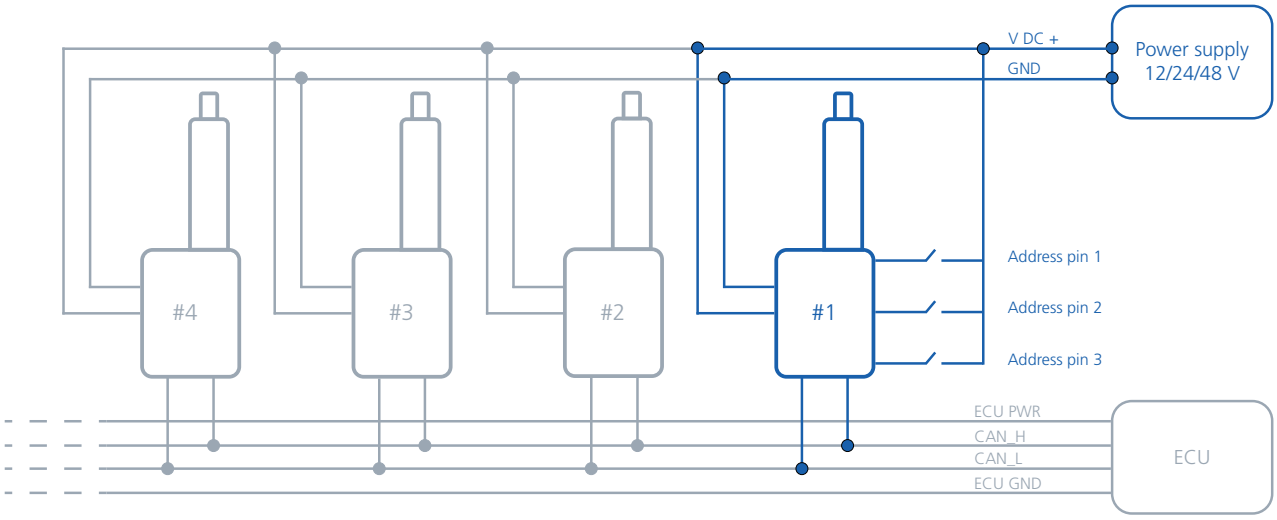
For more information about wiring colours, please see the connection diagram.

CAN hardware addressing

HW addressing determines the initial actuator address. A number of input pins, depending on the actuator model, are available for address configuration. The set configuration will be read by the actuator at power-up. If all address pins are open (not connected), the actuator will enter Manual run mode.

9-pin connector

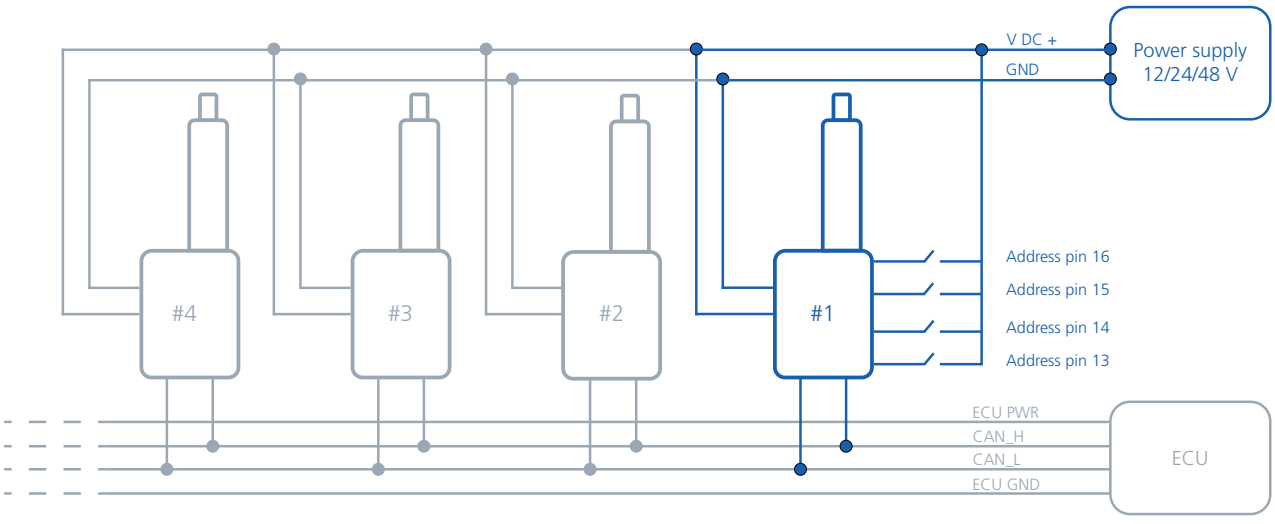
Black	Red	Light Blue	Address			
Address pin 3 [MSB]	Address pin 2	Address pin 1 [LSB]	HW	Node	CAN	
Open	Open	Open	N/A	0x80 (128)	Manual run	
Open	Open	High	1	0x81 (129)	0x86	(134)
Open	High	Open	2	0x82 (130)	0x85	(133)
Open	High	High	3	0x83 (131)	0x84	(132)
High	Open	Open	4	0x84 (132)	0x83	(131)
High	Open	High	5	0x85 (133)	0x82	(130)
High	High	Open	6	0x86 (134)	0x81	(129)
High	High	High	7	0x87 (135)	0x80	(128)



CAN hardware addressing

18-pin connector

Pin 16	Pin 15	Pin 14	Pin 13	Address			
Address pin 4 [MSB]	Address pin 3	Address pin 2	Address pin 1 [LSB]	HW	Node	CAN	
Open	Open	Open	Open	N/A	0x80 (128)	Manual run	
Open	Open	Open	High	1	0x81 (129)	0x86	(134)
Open	Open	High	Open	2	0x82 (130)	0x85	(133)
Open	Open	High	High	3	0x83 (131)	0x84	(132)
Open	High	Open	Open	4	0x84 (132)	0x83	(131)
Open	High	Open	High	5	0x85 (133)	0x82	(130)
Open	High	High	Open	6	0x86 (134)	0x81	(129)
Open	High	High	High	7	0x87 (135)	0x80	(128)
High	Open	Open	Open	8	0x88 (136)	0xF7	(247)
High	Open	Open	High	9	0x89 (137)	0xF7	(247)
High	Open	High	Open	10	0x8A (138)	0xF7	(247)
High	Open	High	High	11	0x8B (139)	0xF7	(247)
High	High	Open	Open	12	0x8C (140)	0xF7	(247)
High	High	Open	High	13	0x8D (141)	0xF7	(247)
High	High	High	Open	14	0x8E (142)	0xF7	(247)
High	High	High	High	15	0x8F (143)	0xF7	(247)



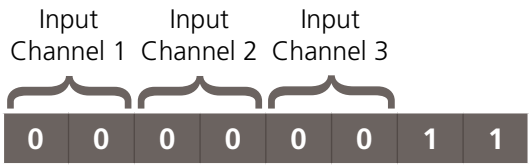
CAN hardware addressing

The AUX inputs are all-purpose inputs for external devices such as buttons and sensors. Each of the three input channels consists of two bits which represent the voltage level on the input channel, thereby allowing four levels of the VCC to be expressed through a CAN bus message.

Each channel consists of two bits divided into four levels of VCC:

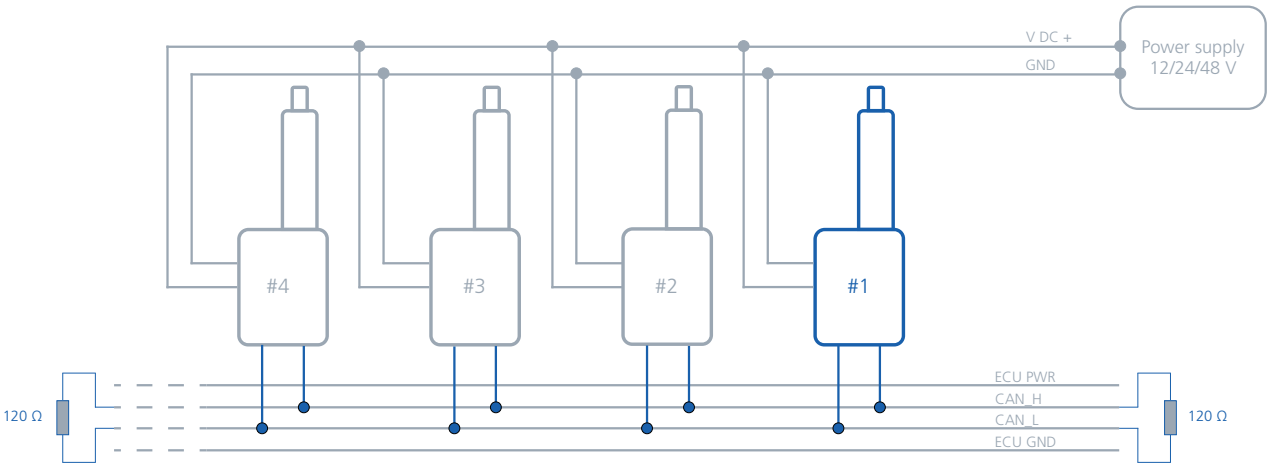
Input bits		VCC				
1	1	■	■	■	■	76-100%
1	0	■	■	■		51-75%
0	1	■	■			26-50%
0	0	■				0-25%

The three AUX inputs will be present in the last byte of Proprietary B, general status feedback.



Termination

Termination resistors of 120 Ω shall be connected according to the figure below. The actuator does not have internal termination.



Parallel

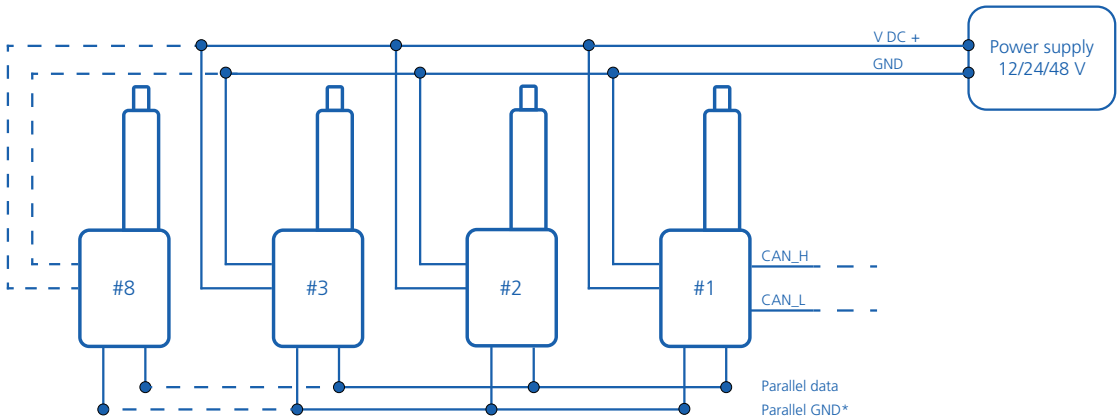
The industrial LINAK® actuators can be ordered with parallel functionality. If this feature is enabled, it is possible to run up to 8 actuators in a parallel system with just one actuator communicating CAN to the master. The system works as a critical parallel, meaning that all actuators must be present in the system and have the exact same configuration (both mechanical and software functionality).

Below is a checklist to ensure that the system operates as intended:

Action	Description
Set up parallel in Actuator Connect™	Each actuator must be configured to operate in parallel (2-8 actuators). This can be set up using the Actuator Connect™ tool. *Please note: In some cases this is pre-configured from factory.*
Wire up the system	The actuators feature internal communication for parallel synchronisation and error codes.
Check cable lengths	Keep the total length of the communication line below 40 metres to avoid communication dropouts. In a parallel system with 8 actuators this would result in signal cable lengths of <5 metres.
Check power supply	The system can be designed with either one main power supply or it can be supplied by individual supplies corresponding to the number of actuators in the system. Please respect actuator specifications regarding voltage level and current consumption! Make sure that the power supplies have a common GND and the same potential.

Parallel

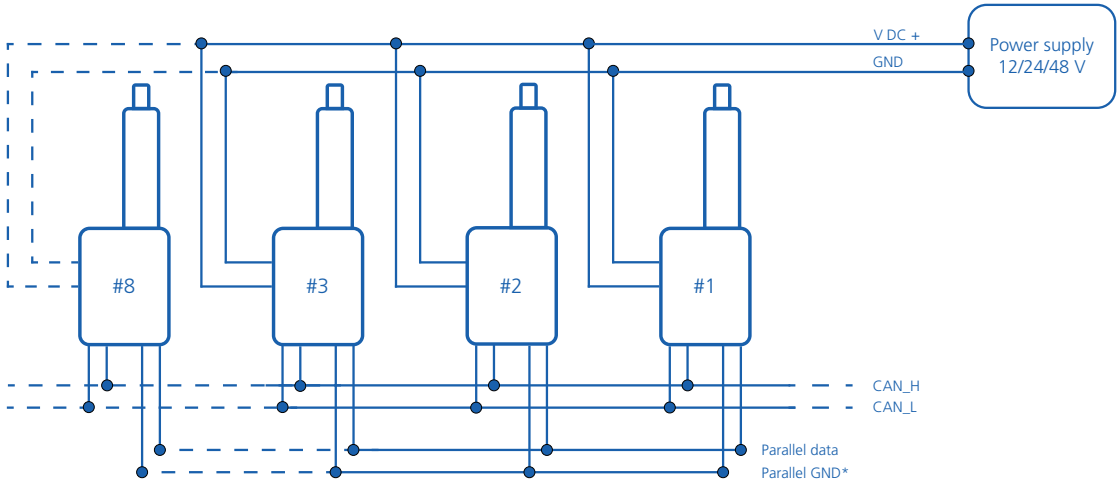
Option 1 - A simple parallel setup



In a simple parallel setup there is only one actuator connected to the bus communication. This actuator receives run commands and shares data with the bus controller. The remaining actuators in the system are only connected to internal parallel communication. This way, the internal communication ensures that the system operates in parallel and stops in case of an obstacle, or when other errors occur on one of the actuators.

The actuators share simple error messages with the master, which can be distributed via the bus communication.

Option 2 - Bus communication on all actuators



If there is a need for e.g. monitoring the real-time data of each actuator, it is possible to connect all actuators as nodes to the bus communication. This will provide comprehensive usage data, which can be used to enhance performance in the application. Similar to option 1, this requires that all actuators are connected to internal parallel communication.

* Please be aware that the Parallel GND wire (White) is not applicable for the 18-pin connector. The 18-pin connector has GND connections on pin 11 and 12.

Getting started

This section further describes how to communicate with CAN bus J1939 actuators and contains examples of typical user scenarios and application solutions. All examples include references to registers which are further described in detail below.

Functional overview

The LINAK® TECHLINE CAN bus J1939 offers a command set for controlling the actuator. This is split up into Commands and Configuration Management (Proprietary A), Status (Proprietary B), and Diagnostics.

	Commands and Configuration Management	
J1939 **Proprietary A**	Commands	Run forwards Run backwards Run to position Stop
	Setup values	Current limit in/out Soft start/stop time Max. speed
	Status	
J1939 **Proprietary B**	Running status	Current Speed
	Counters	Number of endstops reached Number of starts
	Error status	Hall sensor Overvoltage Undervoltage CAN communication Endstop reached Power on block state Overtemperature
	Diagnostics	
Set up	Actuator address CAN bus transmission rate	
Identification	Unique ID number (UIN) Software ID Production order number Production date	
Historical values	Max. current recorded Max. / Min. temperatures recorded Number of endstops Number of starts	
Usage	Current · time [A · s] Runtime	
Reason for last stop	Overtemperature Over- / Undervoltage Overcurrent Communication error	

Power supply

CAN bus J1939 actuators are available with the following supply voltage range: 12 V, 24 V, and 48 V DC. These versions are available with or without split power supply. The accepted supply voltage range is specified for the version as shown below:

Supply voltage	Function	Voltage range			Valid for
		V_{MIN}	V_{TYP}	V_{MAX}	
12 V	Motor	10.5 V	12 V	16 V	18-pin only
	CAN bus J1939 communication*	6 V	12 V	32 V	
24 V	Motor	18 V	24 V	32 V	9-pin and 18-pin
	CAN bus J1939 communication*	10 V	24 V	39 V	
48 V	Motor	36 V	48 V	58 V	9-pin only
	CAN bus J1939 communication*	10 V	48 V	60 V	

* When split power supply is used, the CAN bus J1939 interface will be powered via a separate power input (split supply) from the motor, while the motor power is still used as common ground (GND). If split power supply is not used, the CAN bus J1939 interface will be powered via the motor supply.

Configuration

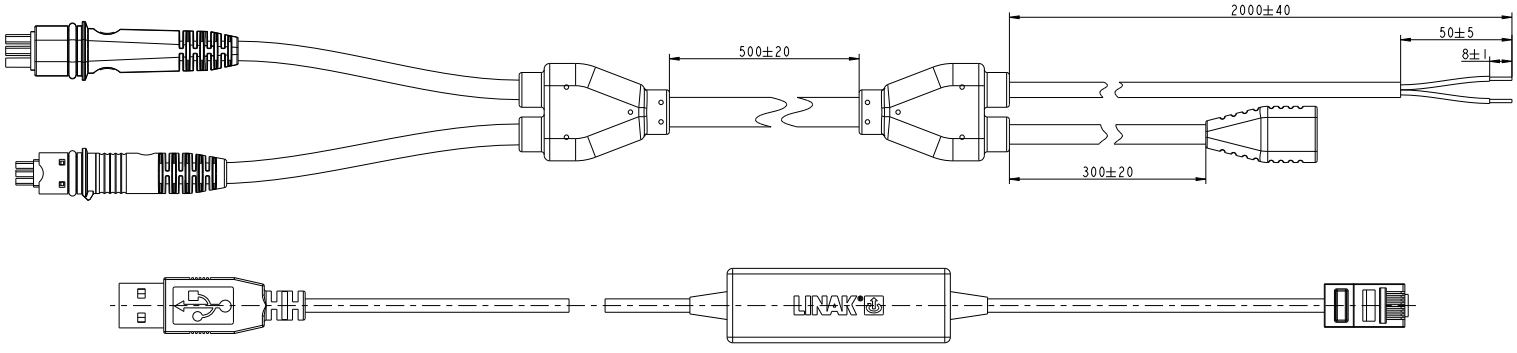
Before being integrated into a CAN bus J1939 system, a few of the actuator parametres must be checked and eventually changed. This preparation is done via the use of the configuration tool Actuator Connect™ and guarantees that the actuator is able to execute basic functionality.

Further fine-tuning may be required to fulfil system or application requirements. Via this tool it is also possible to access historical usage data and real-time monitoring.

Valid for LA33, LA36, LA37, LA76 and LA77:

9-pin

A separate configuration cable kit (item no. 0367996 = straight Y-cable + USB2LIN) is required to use Actuator Connect™ on a PC. This cable must be connected to the 9-pin connector on the actuator side. On the opposite side, power must be applied to the flying leads, and the USB connector must be inserted into your PC.



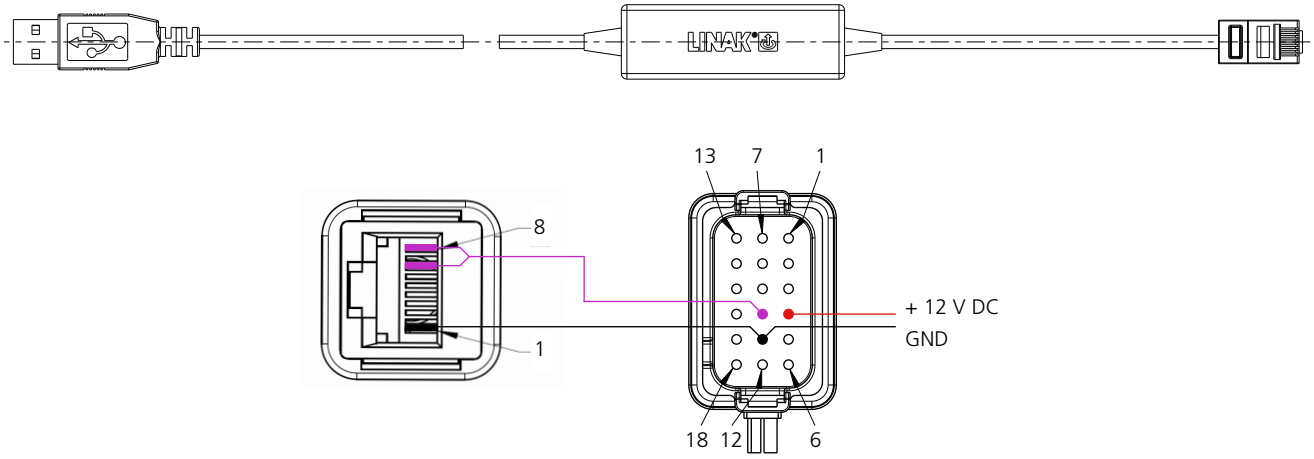
For more information about wiring/connector, please see the connection diagram.

Configuration

Valid for LA33, LA36, LA37, LA76 and LA77:

18-pin

In addition to the wiring diagram provided below, a separate USB configuration cable (USB2LIN06-X) is required in order to use Actuator Connect™ on a PC. This cable should be connected to the RJ45 connector on the actuator. On the other end, ensure that power is supplied to Red and Black on the 18-pin connector (flying leads), and plug the USB connector into your PC.



Parameters to be verified by Actuator Connect™

Parameters	Description
Actuator address	Valid range: 128-247 Default address: 200 (0xC8)
Bit rate (kbps)	50/100/125/250/500 Auto

Command examples

Before the actuator can engage movement, some general prerequisites must be fulfilled. Timing (e.g. when the actuator is still moving), environmental conditions and errors may indicate that the actuator is in a state where further operation is not possible.

General run prerequisites

Step	Read/ Write	Proprietary data*	Action
1	Write	Proprietary A 03 FB _ _ _ _ _ _	"Position" must be set to = FB 03 for 'Stop'. To prevent unintended movement, it is required to send a 'Stop' command before running the actuator.
2	Read	Proprietary B _ _ _ _ 00 _ _ _	"Error Code" must be = 00.
3	Read	Proprietary B _ _ _ 80 _ _ _ _	"Status Flags" must be set to either: 80 for 'Idle', 81 for 'Endstop reached in', 82 for 'Endstop reached out'

Run the actuator outwards

Step	Read/ Write	Proprietary data*	Action
1		-	Check that general run prerequisites are fulfilled.
2	Write	Proprietary A _ _ FB _ _ _ _ _	"Current" must be set to a value. 00-FA = Current limit 0.25 A/bit FB = Default current limit set via Actuator Connect™ FC-FF = Reserved
3	Write	Proprietary A _ _ _ FB _ _ _ _	"Speed" must be set to a value. 00-FA = Speed 0.5% /bit 201-250 = 100% speed FB = Default speed set via Actuator Connect FC-FF = Reserved
4	Write	Proprietary A _ _ _ _ FB _ _ _	"Soft Start" must be set to a value. 00-FA = Start ramp time 0.05 s/bit FB = Default speed set via Actuator Connect FC-FF = Reserved
5	Write	Proprietary A _ _ _ _ _ FB _ _	"Soft Stop" must be set to a value. 00-FA = Stop ramp time 0.05 s/bit FB = Default speed set via Actuator Connect FC-FF = Reserved
6	Write	Proprietary A _ _ _ _ _ _ FF FF	"Reserved" byte 6 and 7 must be set to FF
7	Write	Proprietary A 01 FB _ _ _ _ _ _	"Position" must be set to = FB 01 for 'Run out'
8**	Read	Proprietary B _ _ _ 88 _ _ _ _	"Status Flags" change to 88 to indicate that the actuator is running out

* Proprietary A must be sent periodically to keep the signal alive. Must be updated in periods no longer than 250 ms.

** Optional.

Run the actuator to target position (150 mm)

Step	Read/ Write	Proprietary data*	Action
1		-	Check that general run prerequisites are fulfilled.
2	Write	Proprietary A _ _ FB _ _ _ _ _	"Current" must be set to a value. 00-FA = Current limit 0.25 A/bit FB = Default current limit set via Actuator Connect™ FC-FF = Reserved
3	Write	Proprietary A _ _ _ FB _ _ _ _	"Speed" must be set to a value. 00-FA = Speed 0.5% /bit 201-250 = 100% speed FB = Default speed set via Actuator Connect FC-FF = Reserved
4	Write	Proprietary A _ _ _ _ FB _ _ _	"Soft Start" must be set to a value. 00-FA = Start ramp time 0.05 s/bit FB = Default speed set via Actuator Connect FC-FF = Reserved
5	Write	Proprietary A _ _ _ _ _ FB _ _	"Soft Stop" must be set to a value. 00-FA = Stop ramp time 0.05 s/bit FB = Default speed set via Actuator Connect FC-FF = Reserved
6	Write	Proprietary A _ _ _ _ _ _ FF FF	"Reserved" byte 6 and 7 must be set to FF
7	Write	Proprietary A DC 05 _ _ _ _ _ _	"Position" must be set to = 05 DC for 'Run to Target Position 150 mm' 1 bit/0.1 mm = 1500 = 0x 05 DC
8**	Read	Proprietary B _ _ _ 88 _ _ _ _	"Status Flags" change to 88 or 90 to indicate that either: 88 = actuator is running out 90 = actuator is running in

* Proprietary A must be sent periodically to keep the signal alive. Must be updated in periods no longer than 250 ms.

** Optional.

Clear error in overcurrent situation

If an overcurrent occurs, the actuator will be stopped and blocked in that direction until an activation in the opposite direction has been made or the system has been re-powered.

Step	Read/Write	Proprietary data*	Action
1	Read	Proprietary B _ _ _ 84 _ _ _ _	Confirm that "Status Flags" are set to = 84 for 'Overcurrent'
2	Write	Proprietary A 02 FB _ _ _ _ _ _	"Position" must be set to run in the opposite direction of the blockage. Set to = FB 01 for 'Run out' or set to = FB 02 for 'Run in'
3	Read	Proprietary B _ _ _ 88 _ _ _ _	"Status Flags" change to 88 or 90 to indicate that either: 88 = actuator is running out 90 = actuator is running in

* Proprietary A must be sent periodically to keep the signal alive. Must be updated in periods no longer than 250 ms.

Communication

Proprietary A (Run command)

Proprietary A	
Function	General request
Description	Write to Proprietary A to clear error state, run out, run in or run to a specific position in addition to setting speed and current limit
Minimum transmission rate	250 ms
PGN	0x00EF00

Byte 7 [MSB]	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0 [LSB]
Reserved Write 0xFF	Reserved Write 0xFF	Soft Stop [ms*50]	Soft Start [ms*50]	Speed [%*0.5]	Current [mA*250]	Position [mm*0.1] [MSB]	Position [LSB]

Byte(s)	Name	Details	SLOT
Byte 7 Byte 6	Reserved	Always write 0xFF	Not applicable
Byte 5	SoftStop	0-250 Stop ramping time (50 ms/bit) 251, 255 Actuator default value 252-254 Reserved. Do not run, regardless of other bytes in request	SLOT 322: SAEtm19 (0.05 s/bit: 0 s - 12.5 s)
Byte 4	SoftStart	0-250 Start ramping time (50 ms/bit) 251, 255 Actuator default value 252-254 Reserved. Do not run, regardless of other bytes in request	SLOT 322: SAEtm19 (0.05 s/bit: 0 s - 12.5 s)

Proprietary A (Run command)

Byte(s)	Name	Details	SLOT
Byte 3	Speed	0-199 Speed to use (0.5%/bit: 0% - 99.5%) OR Holding force to use (1 W/bit: 0 W - 250 W) 200-250 Use 100% speed 251 Actuator default value 252-255 Reserved. Do not run, regardless of other bytes in request	SLOT 299: SAEpc18 (0% - 125%) OR SLOT 283: SAEmd01 (0 W - 250 W)
Byte 2	Current	0-250 Maximum current to use (250 mA/bit) 251 Actuator default value 252-255 Reserved. Do not run, regardless of other bytes in request	SLOT 410: SAEec09 (0.25 A/bit: 0.0 A - 62.5 A)
Byte 1 Byte 0	Position	0-64255 Run to position (0.1 mm/bit) 64256 Clear ErrorCode register 64257 Command run actuator out 64258 Command run actuator in 64259 Command stop actuator* 64260 Command run actuator out, Recovery mode 64261 Command run actuator in, Recovery mode 64264-65535 Reserved. Do not run, regardless of other bytes in request	SLOT 283: SAEmd01 (0.1 mm/bit: 0 mm - 6.43 m)

* This command is mandatory after power-up and communication time-out (5 s)

Proprietary B (Feedback)

Proprietary B	
Function	General request
Description	Read status parameters, motor and actuator piston position
Minimum transmission rate	100 ms
PGN	0x00FF00

Byte 7 [MSB]	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0 [LSB]
External InputState	Speed [mm*0.1 s] [MSB]	Speed [LSB]	ErrorCode: 8-bit error code	StatusFlags: Bit-field	Current [mA*250]	Position [mm*0.1] [MSB]	Position [LSB]

Byte(s)	Name	Details	SLOT
Byte 7	InputState	b0,1 = Input 1 level (25% of V_{CC}/bit) b2,3 = Input 2 level b4,5 = Input 3 level b6,7 = Input 4 level	Not defined
Byte 6 [4-7]	Reserved	Always reads 0xF_	Not applicable
Byte 6 [0-3] Byte 5	Speed	Speed feedback 0-4015 Speed of actuator piston (0.1 mm/s /bit) 4016-4095 Reserved	Not defined

Proprietary B (Feedback)

Byte(s)	Name	Details	SLOT
Byte 4	ErrorCode	8-bit error code indicating the currently active error of highest priority 0 = No error detected 1 = Position sensor 2 = Overvoltage 3 = Undervoltage 4 = Communication sync 5 = Endstop switch 6 = Run command overruled 7 = Temperature 8 = Internal motor controller 9 = Internal power supply 10 = Internal current measurement 11 = Parallel arbitration 12 = Position not changing 13 = Position initialisation not possible 14 = Alone in parallel system 15 = Incorrect number in parallel system 16 = Hardware 17 = BLDC motor 18 = Parallel communication 19 = Parallel running 20 = Parallel setup stopped	Not defined
Byte 3	StatusFlags	8 independent status bit-indicators b0 = Endstop reached in b1 = Endstop reached out b2 = Overcurrent b3 = Running out b4 = Running in b5 = Heartbeat lost b6 = Actuator is running outside nominal conditions b7 = Reserved for future use (always set to 1)	Not defined
Byte 2	Current	Measured motor current 0 Not running 1-250 Measured motor current 251-253 Reserved 254 Fault in current measurement circuit 255 Reserved	SLOT 410:SAEec09 (0.25 A/bit: 0.25 A - 62.5 A)
Byte 1 Byte 0	Position	Position feedback 0-64255 Position of actuator piston 64256-65023 Reserved 65024 Position lost 65025-65535 Reserved	SLOT 14: SAEds04 (0.1 mm/bit: 0 mm - 6.43 m)

Proprietary B3 (Feedback Parallel)

Proprietary B3	
Function	General request
Description	Read parallel status, ID source and status
Minimum transmission rate	100 ms
PGN	0x00FF02

Byte 7 [MSB]	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0 [LSB]
Reserved	Reserved	Reserved	Reserved	Reserved	Status	Error code	ID

Byte(s)	Name	Details	SLOT
Byte 7 : Byte 3	Reserved	Always reads 0xFF	Not applicable
Byte 2	Status	8 independent status bit indicators b0 = Parallel system is in Endstop reached out b1 = Parallel system is in Endstop reached in b2 = Parallel running outside nominal conditions b3-7 = Reserved for future use (always set to 1)	Not defined
Byte 1	ErrorGroup	0 No error detected 1 Current overload 2 Hardware 3 Temperature 4 Overvoltage 5 Undervoltage 6 N/A / analogue input out of range 7 Position not changing 8 Run signal overruled 9 Position initialisation not possible 10 Parallel start up 11 Parallel running 12 N/A / BLDC motor 13 N/A / Endstop switch 14 Parallel communication 15 Parallel setup stopped 24 Other error (not specified) 25 Position lost	Not defined
Byte 0	ID	CAN ID of the actuator that has the error in byte 1. ID will be = 0 if no error is active in the system, or error code is "Parallel start-up" (the actuator that is reporting the error is irrelevant in this case, as it just reports that the system has woken up with the wrong number of actuators).	Not defined

Diagnostics

Application Layer - Diagnostic

The following diagnostics messages are used in the retrieval of diagnostics data according to SAEJ1939-73 section 5.7.14.1.2:

- DM14 Memory access request
- DM15 Memory access response
- DM16 Binary data transfer

Pointer type: 1 = Directed spatial addressing (parameter IDX)

Pointer extension: 1 = SPM space

Return codes

The status return code for any diagnostics function indicating an error or warning:

0x01	OK
0x80	Invalid parameter index
0x81	Invalid action mode
0x82	Write access denied
0x83	Value underflow
0x84	Value overflow
0x85	Invalid enumerator value

Diagnostics overview

Setup values

Pointer / IDX		Data size	Description	SLOT ID	SLOT name	Access	Example	Meaning
[dec]	[hex]		Setup values					
516096	0x07E000	U8	Current limit out [mA*250]	410	SAEec09	R/W	60	15 A
516097	0X07E001	U8	Current limit in [mA*250]	410	SAEec09	R/W	24	6 A
516098	0X07E002	U16	Soft start time out [ms]	132	SAEtm02	R/W	1,500	1.5 s
516099	0X07E003	U16	Soft start time in [ms]	132	SAEtm02	R/W	500	500 ms
516100	0X07E004	U16	Soft stop time out [ms]	132	SAEtm02	R/W	2,000	2 s
516101	0X07E005	U16	Soft stop time in [ms]	132	SAEtm02	R/W	300	300 ms
516102	0X07E006	U8	Maximum speed [%*0.5]	299	SAEpc18	R/W	180	90%
516103	0X07E007	U16	Virtual ESS out position [mm * 0.1]	14	SAEds04	R/W	2,000	200 mm

Setup values

Pointer / IDX		Data size	Description	SLOT ID	SLOT name	Access	Example	Meaning
516104	0X07E008	U16	Virtual ESS in position [mm * 0.1]	14	SAEds04	R/W	50	5 mm
516105	0X07E009	U8	Actuator address	35	SAEsa01	R/W	123	123
516106	7E00A	U16	CAN bus speed [Manufacturer defined: Kbit/s] (Allowed values are: 250)	283	SAEmd01	R/W	Example 1: 250 Example 2: 33018	Example 1: 250 kbit/s Example 2: 250 kbit/s with autobaud enabled

Identification

Pointer / IDX		Data size	Description	SLOT ID	SLOT name	Access	Example	Meaning
[dec]	[hex]		Identification					
516107	0x07E00B	U32	UIN	283	SAEmd01	R	12345678	Serial number
516108	0X07E00C	U32	Software identification (SW variant)*	283	SAEmd01	R	SW1234-567V1-	SW variant 1234567 version 1
516109	0X07E00D	U32	Software identification (SW version Major)*	283	SAEmd01	R		
516110	0X07E00E	U32	Software identification (SW version Minor)*	283	SAEmd01	R		
516111	0X07E00F	U32	Production order number*	283	SAEmd01	R		
516112	0X07E010	U32	Production date	283	SAEmd01	R	20150728	July 28th 2015

History values

Pointer / IDX		Data size	Description	SLOT ID	SLOT name	Access	Example	Meaning
[dec]	[hex]							
516113	0x07E011	U8	Max. current seen [mA*250]	410	SAEec09	R	61	15.25 A
516114	0X07E012	U8	Max. FET temperature seen [°C - 40]	67	SAEtp01	R	138	98°C
516115	0X07E013	U8	Max. ambient temperature seen [°C - 40]	67	SAEtp01	R	82	42°C
516116	0X07E014	U8	Min. ambient temperature seen [°C - 40]	67	SAEtp01	R	36	-4°C

Usage totals

Pointer / IDX		Data size	Description	SLOT ID	SLOT name	Access	Example	Meaning
[dec]	[hex]							
516117	7E015	U32	Current usage [As]	283	SAEmd01	R	21605	Total power consumed: 6 Ah
516118	7E016	U32	Run time [s]		SAEtm06	R	4321	Total running time: 1h 12 m 1s

Reason for last stop, stop counters and communication error counter

Pointer / IDX		Data size	Description	SLOT ID	SLOT name	Access	Example	Meaning
[dec]	[hex]							
516119	7E017	U16	Reason for last stop	64	SAEct05	R		
516120	71018	U8	Overvoltage stops	133	SAEct03	R		
516121	7E019	U8	FET overtemperature stops	133	SAEct03	R		
516122	7E01A	U8	Ambient overtemperature stops	133	SAEct03	R		
516123	7E01B	U8	Low voltage stops	133	SAEct03	R		
516124	7E01C	U8	Hall error stops	133	SAEct03	R		
516125	7E01D	U8	Endstop switch error stops	133	SAEct03	R		
516126	7E02E	U8	LINAK current overload out stops	133	SAEct03	R		

Reason for last stop, stop counters and communication error counter

Pointer / IDX		Data size	Description	SLOT ID	SLOT name	Access	Example	Meaning
516127	7E01F	U8	LINAK current overload in stops	133	SAEct03	R		
516128	7E0120	U8	Resettable custom current overload out stops	133	SAEct03	R/W		
516129	7E0121	U8	Resettable custom current overload in stops	133	SAEct03	R/W		
516130	7E0122	U16	Communication errors	208	SAEct03	R		

Activation counter

Pointer / IDX		Data size	Description	SLOT ID	SLOT name	Access	Example	Meaning
[dec]	[hex]							
516131	7E023	U32	Number of endstops reached outwards	209	SAEct07	R		
516132	7E024	U32	Number of endstops reached inwards	209	SAEct07	R		
516133	7E025	U32	Number of starts outwards	209	SAEct07	R		
516134	7E026	U32	Number of starts inwards	209	SAEct07	R		
516135	7E027	U32	Total piston distance [5*m]	38	SAEds09	R	178	890 m
516136	7E028	U16	Interval between CAN Proprietary B transmissions rounded down to the nearest multiple of 5 [ms]	132	SAEtm02	R	100	100 ms

Diagnostic Troubleshoot Codes (DTC)

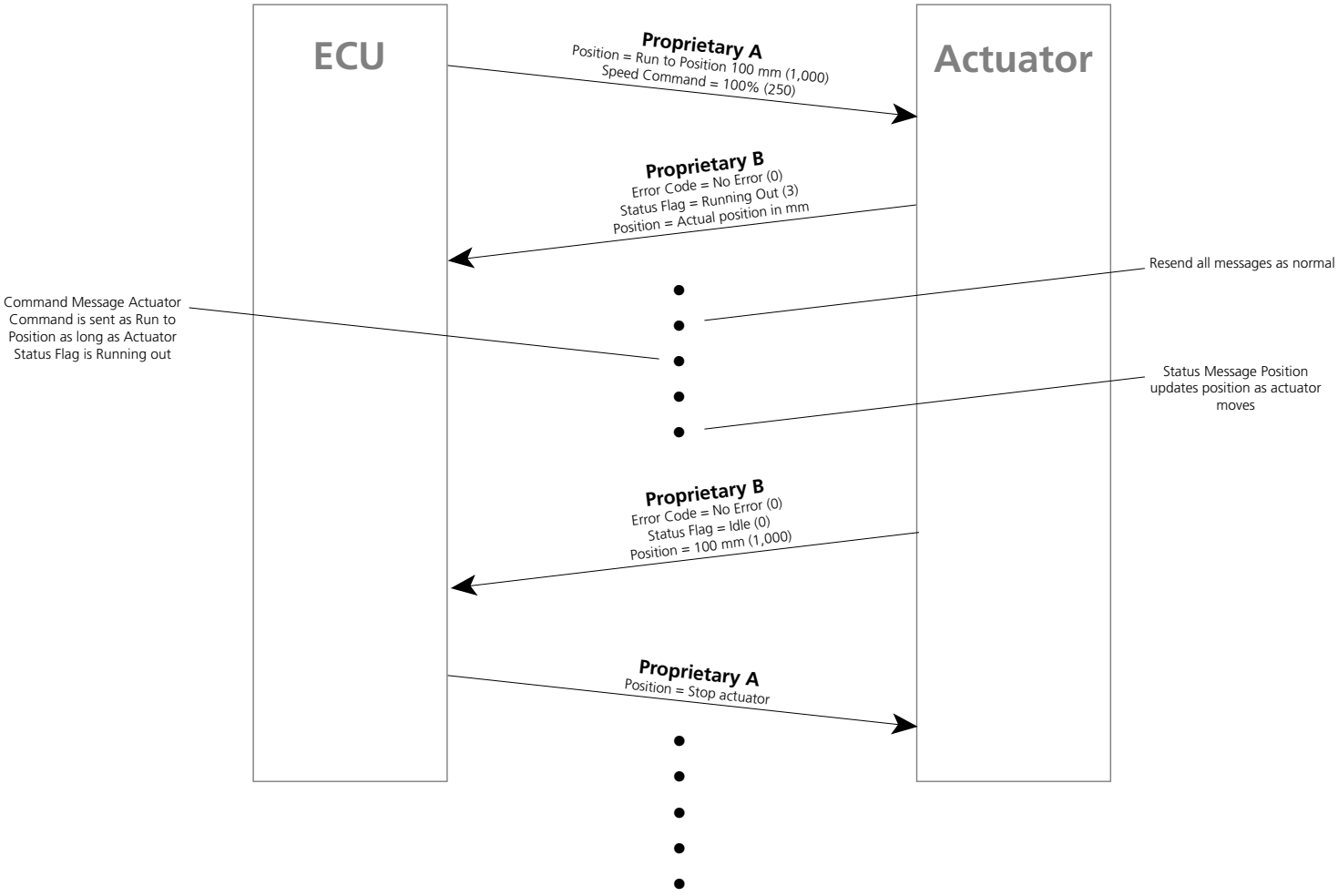
SPN	Name	FMI
0x7E400	Actuator	FMI3 = Voltage above normal or shorted to high
0x7E401	Actuator	FMI4 = Voltage below normal or shorted
0x7E402	Actuator	FMI6 = Current above normal or shorted to high
0x7E403	FET Temperature	FMI15 = Data valid but above normal operating range (least significant level)
0x7E404	Ambient Temperature	FMI15 = Data valid but above normal operating range (least significant level)

Diagnostics overview

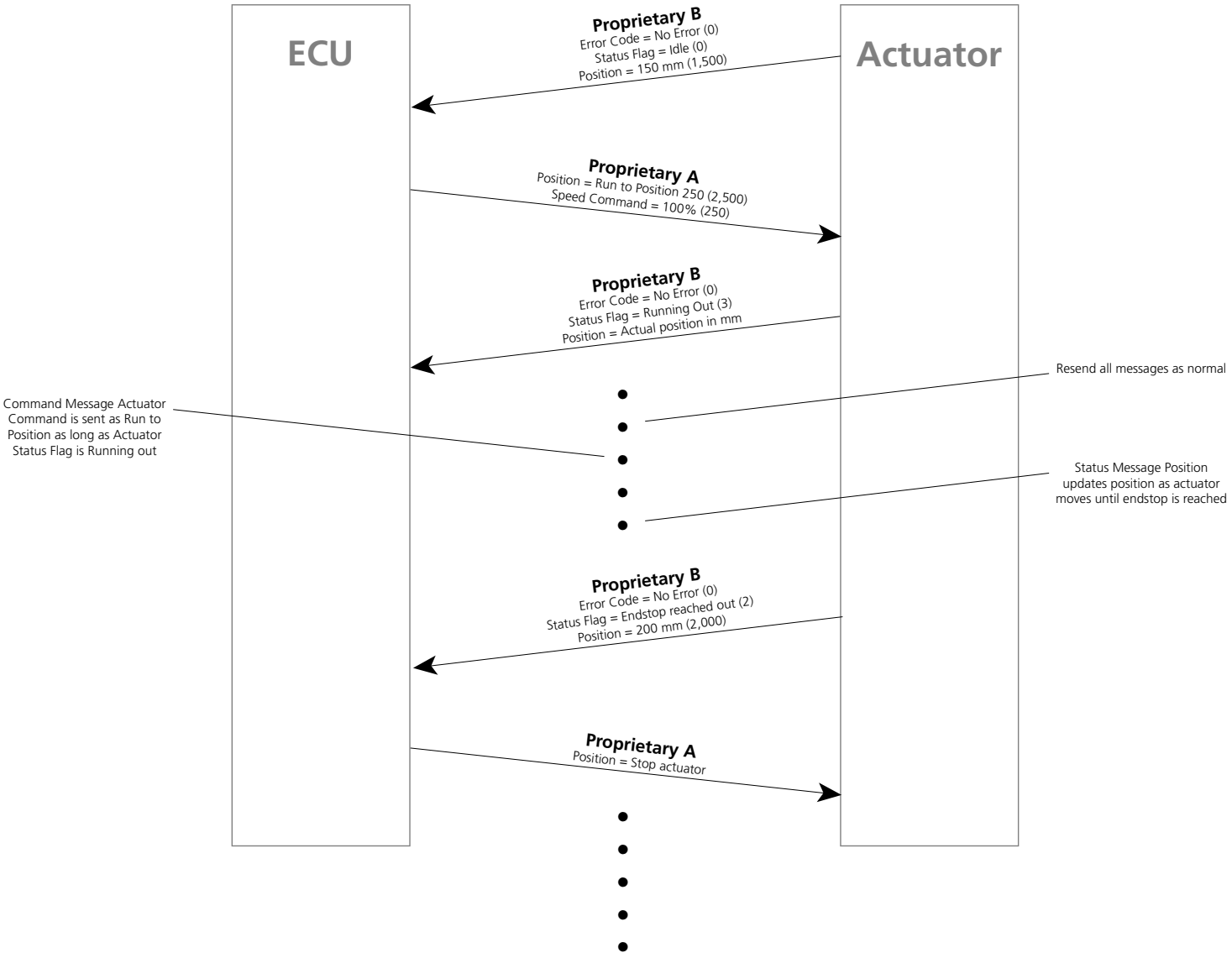
Pointer / IDX		Data size	Description	SLOT ID	SLOT name	Access	Example	Meaning
[dec]	[hex]		Setup values					
516096	0x7E000	U8	Current limit out [mA*250]	410	SAEec09	R/W	60	15 A
516097	0x07E001	U8	Current limit in [mA*250]	410	SAEec09	R/W	24	6 A
516098	0x07E002	U16	Soft start time out [ms]	132	SAEtm02	R/W	1,500	1.5 S
516099	0x07E003	U16	Soft start time in [ms]	132	SAEtm02	R/W	500	500 ms
516100	0x07E004	U16	Soft stop time out [ms]	132	SAEtm02	R/W	2,000	2 s
516101	0x07E005	U16	Soft stop time in [ms]	132	SAEtm02	R/W	300	300 ms
516102	0x07E006	U8	Max. speed [%*0.5]	299	SAEpc18	R/W	180	90%
516103	0x07E007	U16	Virtual endstop reached out position [mm*0.1]	14	SAEds04	R/W	2,000	200 mm
516104	0x07E008	U16	Virtual endstop reached in position [mm*0.1]	14	SAEds04	R/W	50	5 mm
516105	0x07E009	U8	Actuator address	35	SAEsa01	R/W	123	123
516106	0x07E00A	U16	CAN bus speed [Manufacturer defined: kbit/s] (Allowed values are: 250)	283	SAEmd01	R/W	250 33018	Fixed 250 kbps 250 kbps with Autobaud enabled

Use cases

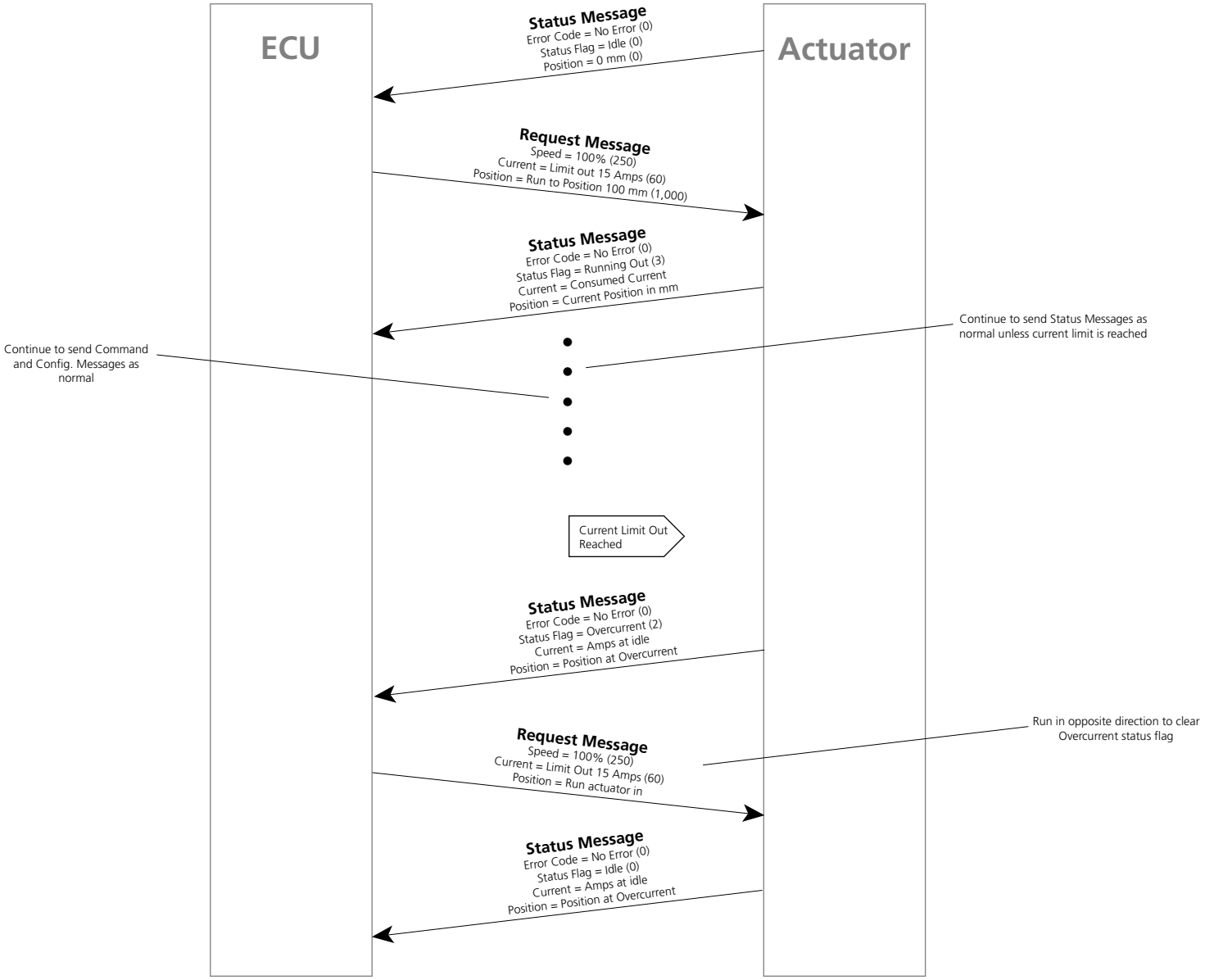
Example 1: 0 to 100 mm ‘Run to Position’ on a 200 mm actuator



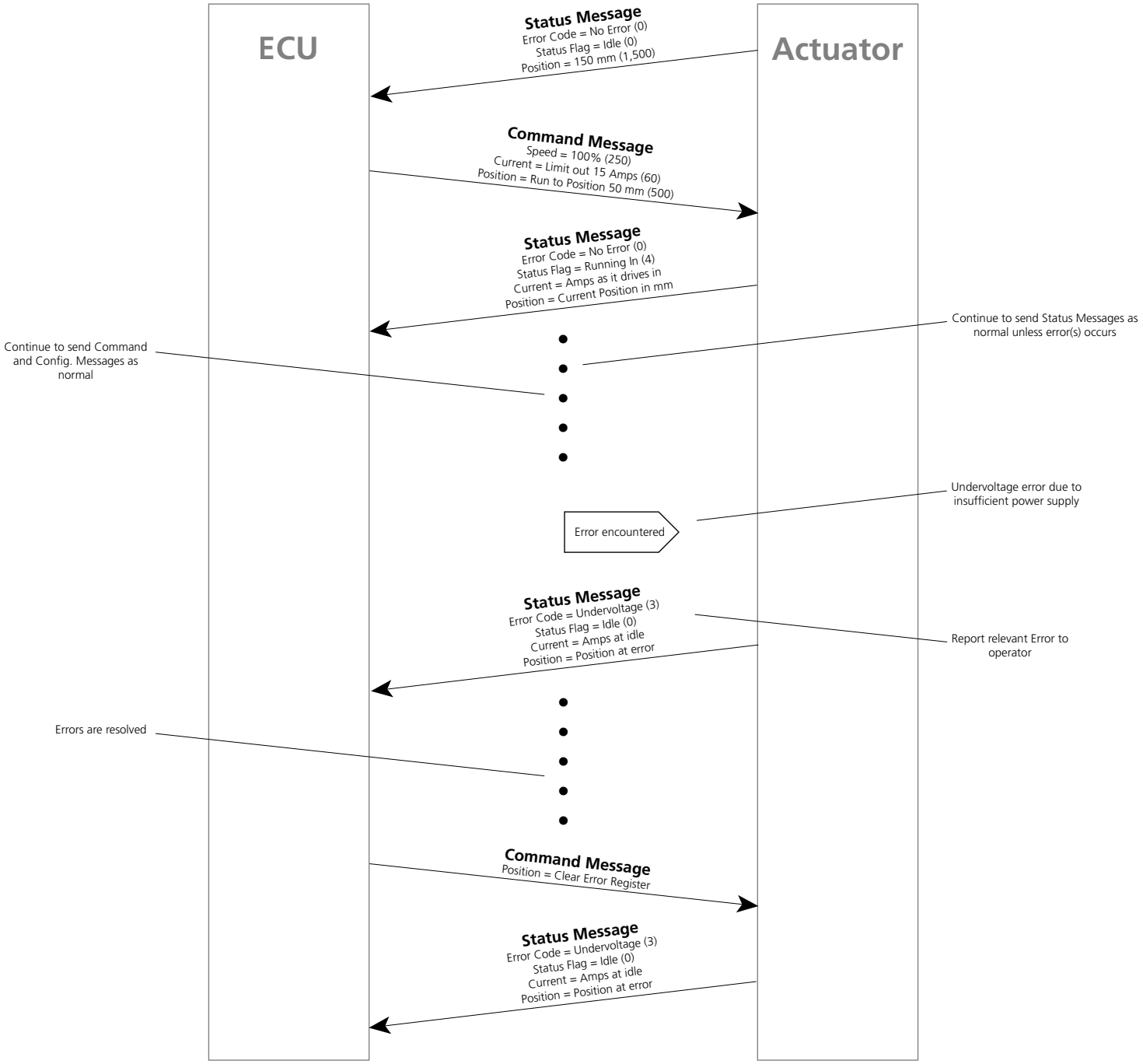
Example 2: 150 to 250 mm 'Run to Position' on a 200 mm actuator



Example 3: 0 to 100 mm ‘Run to Position’ on a 200 mm actuator: Overcurrent limit reached



Example 4: 150 to 50 mm 'Run to Position' on a 200 mm actuator: Undervoltage error



FAQ

Problem	Cause / Solution
Why is the actuator not running despite giving it a 'Run' command?	1. Make sure that power is applied from the power supply. 2. Send a 'Stop' (0x03FB) command before sending a 'Run' command. 3. Make sure Proprietary A is sent at least every 250 ms.
Feedback data is available but the actuator is not able to run.	Some actuators are designed with a split supply PCB. This means that the controller can receive data from the actuator despite not supplying V_{CC} to the motor itself from a power supply.
Why does the PLC show a reversed data order?	Some controllers may reverse the byte order. Please make sure the correct Most Significant Byte [MSB] and Least Significant Byte [LSB] are matching your configuration.
The master does not receive any response from the actuator.	1. Make sure the device has the expected address. The address can be changed via Actuator Connect™. 2. Make sure CAN High and CAN Low are not swapped.

Error codes

Error	Description
0	**No error detected** No LINAK defined error detected.
1	**'Run' command overruled** As a safety precaution to prevent unintentional movement at power-up, the actuator will not run until a 'Stop' command or 'Clear error' command has been sent.
2	**Position sensor** Position sensors are outside of expected operating range. VCC motor OK. Example: 10 pulses were reported on one Hall sensor and no Hall pulses on the other. Send 'Clear error' command to clear error. If the error persists, contact LINAK or replace the product.
3	**Overvoltage** Input supply voltage is above operating voltage level. Consult the documentation for correct voltage levels. The error will automatically be cleared when voltage is within operating limits.
4	**Undervoltage** Input supply voltage is below operating voltage level. Consult the documentation for correct voltage levels. The error will automatically be cleared when voltage is within operating limits.
5	**Communication sync.** Heartbeat from the master is not within the expected heartbeat interval. Consult the documentation for minimum requirements for heartbeat interval.
6	**Endstop switch (N/A for bus interfaces)** Endstop switches are behaving unexpectedly. Example: Both endstop switches have been activated simultaneously for more than 100 ms. Perform the initialisation process by running the actuator fully extended and retracted.
7	**Temperature** Internal actuator temperature is above operating limit. Consult the documentation for correct temperature levels. The error will automatically be cleared when the temperature is within operating limits.
8	**Motor controller** Internal motor controller hardware error. Send 'Clear error' command to clear error. If the error persists, contact LINAK or replace the product.

Error codes

Error	Description
9	**Internal power supply** The internal power supply is behaving unexpectedly. Send 'Clear error' command to clear error. If the error persists, contact LINAK or replace the product.
10	**Internal current measurement** Internal current reference is outside the expected limits. Send 'Clear error' command to clear error. If the error persists, contact LINAK or replace the product.
11	**Parallel arbitration** Start-up parallel configuration procedure in progress.
12	**Position not changing** Internal position sensor is behaving unexpectedly and motor might stall. Please check your application for blockage or other irregularities. If the error persists, contact LINAK or replace the product.
13	**Position initialisation not possible** Internal initialisation parameters missing. Contact LINAK.
14	**Alone in parallel system** Incorrect number of actuators in parallel system.
15	**Incorrect number in parallel system** Incorrect number of actuators in parallel system or wrongly configured.
254	**Other internal error (Not specified)** Unspecified internal hardware/software error. Send 'Clear error' command to clear error. If the error persists, contact LINAK or replace the product.
255	**Other external error (Not specified)** Unspecified external hardware/software error. Please inspect your application for possible issues. Send 'Clear error' command to clear error.

Parallel error codes

Error	Description
6	**Analogue input out of range (N/A for bus interfaces)** Analogue input signal is outside operating limits. Servo or Proportional. Consult the documentation for correct input signal.
7	**Position not changing** Internal position sensor is behaving unexpectedly and motor might stall. Please check your application for blockage or other irregularities. If the error persists, contact LINAK or replace the product.
8	**Run signal overruled** Communication has been overruled by a higher priority input. Communication is split into the following priorities: 1. Bus communication (CAN bus, Ethernet, etc.) 2. LINAK service tool (Actuator Connect™) 3. Manual run using Red and Black wires Send a 'Clear error' command to continue.

Parallel error codes

Error	Description
9	**Position initialisation not possible** Internal initialisation parameters missing. Contact LINAK.
10	**Parallel start-up** Error in parallel setup. The number of connected actuators does not match your configuration. Check the configuration by using the LINAK tool Actuator Connect.
11	**Parallel running** The actuators are performing the internal setup and are not ready for operation.
12	**BLDC motor** Internal hardware error. Send 'Clear error' command to clear error. If the error persists, contact LINAK or replace the product.
13	**Endstop switch (N/A for bus interfaces)** Endstop switches are behaving unexpectedly. Both endstop switches have been activated simultaneously for more than 100ms. Perform the initialization process by running the actuator fully extended and retracted.
14	**Parallel communication** Error in internal parallel communication. More than 5 communication errors in 500 ms. Please check the wire connections and re-power the complete setup.
15	**Parallel setup stopped** One or more actuators cannot comply with commands and stop. Master commands 'Stop' to other actuators in the network. Send 'Clear error' command to clear error. If the error persists, check your application and wire connections and re-power your complete setup.
24	**Other error** Actuator receives an undefined error code. This can be due to outdated firmware. Send 'Clear error' command to clear error. If the error persists, contact LINAK or replace the product.
25	**Position lost** Follow the relevant initialisation procedures by running the actuators from fully retracted to fully extended. If the error persists, contact LINAK or replace the product.

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