TECHLINE®
IMPROVING FLEXIBILITY

# CAN bus
# SAE J1939

## CAN bus option for LA36

LINAK®
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# 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 sure that your LINAK product/system will give you many years of problem-free operation. Before our products leave the factory they undergo full function and quality testing. Should you nevertheless experience problems with your LINAK product/system, you are always welcome to contact your local dealer. LINAK subsidiaries and some distributors situated all over the world have authorised service centres, which are always ready to help you.

LINAK provides a warranty on all its products. 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 products/systems can affect their operation and durability. The products are not to be opened by unauthorised personnel.

The User Manual has been written based on our present technical knowledge. We are constantly working on updating the information and we therefore reserve the right to carry out technical modifications.


**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 CAN bus components and the requirements for controlling these. It specifies the technologies involved, the environmental data specification and the functional description.

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 the reader is familiar with the SAE J1939 standard.

Each LINAK actuator with CAN bus interface has the ability to act as a CAN bus node in the CAN bus cluster. The CAN bus actuator is able to provide feedback information about the piston position, error codes and other information. It also provides system identification data and actual current at runtime. It is also possible to send input commands to the system and invoke actuator movement based on direction.

## Revision history

The following documentation supports this software release:
LA36CAN prototype: SW01050000V0-2933

## Functional overview

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

| | | |
|---|---|---|
| **J1939 Proprietary A** | **Commands and Configuration Management** | |
| | Commands | Run forward/backward/to position/stop |
| | Setup values | Current limit in/out |
| | | Max. speed |
| **J1939 Proprietary B** | **Status** | |
| | Running status | Current |
| | | Postition |
| | Status flags | Direction |
| | | Position |
| | | Endstop reached |
| | | Overcurrent |
| | Counters | Number of endstops |
| | | Number of starts |
| | Error status | Hall sensor |
| | | Overvoltage |
| | | Undervoltage |
| | | CAN communication |
| | | End of stroke |
| | | Power on block state |
| | | Overtemperature |

Table 1. Command set, configuration management and status feedback.

## Functional overview

| | Diagnostics | |
|---|---|---|
| **SAE J1939-73 Diagnostics** | Setup | Actuator address |
| | | CAN bus transmission rate |
| | Identification | Unique ID number (UIN) |
| | | Software ID |
| | | Production order number |
| | | Production date |
| | Historic values | Max. current recorded |
| | | Max./min. temperatures recorded |
| | Usage | Current/time [A-s] |
| | | Runtime |
| | Reason for last stop | Overtemperature |
| | | Over/undervoltage |
| | | Overcurrent |
| | | Component error |
| | | Communication error |

Table 2. Diagnostics setup.

# Command details

### Run in/out

In and out movement is performed by sending the proper identifier while the actuator is in CAN bus 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. When the actuator is in CAN bus mode, Service mode and manual run is disabled. Using manual run, a start-up delay of up to 150 ms must be expected due to safety measures.

### Position

The actuator will drive to the set position.

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

Load and ramping up and down should be taken into account in regard to accuracy.

### 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 page 14 for details.

### Speed control

The speed is controlled using 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.

# Status feedback details

A number of status parameters can be observed while the actuator is *not* in sleep mode.

## Status flag feedback

| Value | Function | Comment |
|-------|----------|---------|
| 0 | EOS in | The actuator has reached the physical or virtual endstop in |
| 1 | EOS out | The actuator has reached the physical or virtual endstop out |
| 2 | Overcurrent * | The actuator has measured a current larger than permitted for a longer period of time than allowed |
| 3 | Running out | Will indicate that the actuator is running outwards |
| 4 | Running in | Will indicate that the actuator is running inwards |
| 5 | Reserved | Always 1 |
| 6 | Reserved | Always 1 |
| 7 | Reserved | Always 1 |

Table 3. Status flags overview.

* An Overcurrent flag will prevent the actuator from further movement in the same direction. To clear the flag, order the actuator to run in the opposite direction.

## Error code feedback

| Value | Function | Comment |
|-------|----------|---------|
| 0 | No error | No error detected |
| 1 | Hall error | Hall position sensor or magnet is not responding as expected |
| 2 | Overvoltage | The actuator has measured a voltage larger than permitted |
| 3 | Undervoltage | The actuator has measured a voltage lower than permitted while running |
| 4 | Failed to Keep CAN signal alive | Failed to maintain *CAN keep alive signal*. No Configuration Message received for 3 seconds while in a run condition |
| 5 | EOS error | The actuator is experiencing unexpected behaviour |
| 6 | Power on Block State | Must be cleared after power up. This will prevent an unintentional movement |
| 7 | Temperature error | One of the two temperature sensors report a higher temperature than permitted |

Table 4. Error codes overview.

* Error codes must be cleared in order to continue, except Error 6 'Power on Block State' which must be cleared using the 'Stop' command. Error codes are enumerated, indicating the active error of the highest priority.

# Status feedback details

### Position feedback

| Value | Function | Comment |
|---|---|---|
| 0 - 64255 | Position | Position in 1/10$^{th}$ mm |
| 65024 | Position lost | Position discrepancy or actuator is not initialised |

Table 5. Position feedback overview.

### Current feedback

| Value | Function | Comment |
|---|---|---|
| 0 | Not running | Current level is indicating no activity |
| 1 - 250 | Current | Measured motor current |

Table 6. Current feedback overview.

### Soft start/stop

To reduce mechanical stress, a ramp up and ramp down time can be set in both directions.

Hard stop           0 sec
Min. ramp time:     300 ms
Max. ramp time:      30 sec.

A ramp down time between 0 and 300 ms is not allowed in order to minimise the effect of back EMF from the motor.

# 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 | 250 kbps |
| 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 not longer than 3 metres. Consequently, all system tests carried out are limited to consist of 3 meter cables.

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

**Other parameters**

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 relevant parts of the SAE J1939-82.

# 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 200ms but it is configurable.
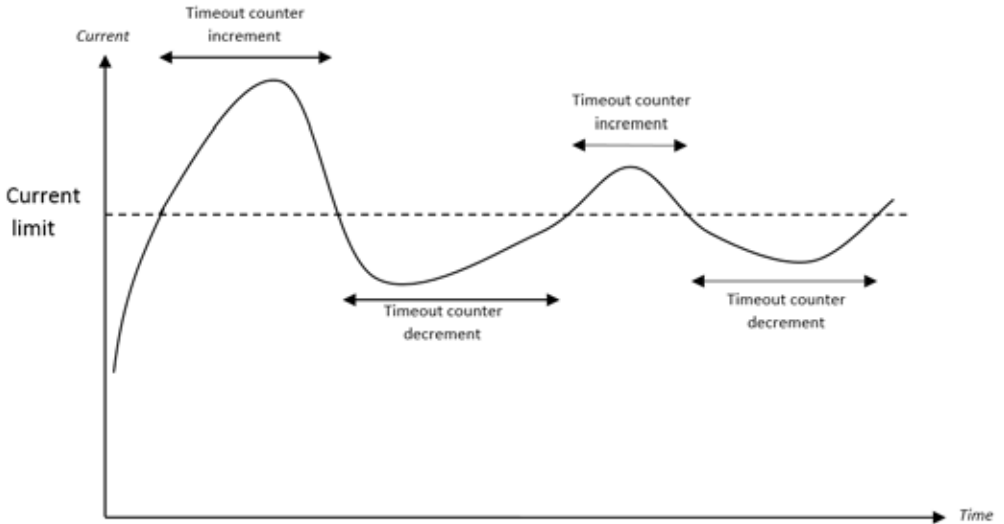


Figure 1. Dynamic current limit principle.

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.

Motor current measurements and factory limits for the LA36CAN are:
For a 12 VDC version LA36CAN:   30A
For a 24 VDC version LA36CAN:   20A

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

# Internal monitoring

### 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.

## Sleep mode

The sleep and wakeup functionality is according to ISO11898-5. The current consumption in sleep mode is:

| Supply voltage | Sleep mode current consumption | | |
|---|---|---|---|
| | 25 °C | 60 °C  * | 85 °C  * |
| **12 V** | 100 µA | (1.0 mA) | (1.2 mA) |
| **24 V** | 250 µA | (2.0 mA) | (2.4 mA) |

Table 3. Sleep mode current consumption.

* The current consumption at 60°C - 85°C is subject to change.


Entering sleep mode

The actuator will enter sleep mode after a preset default time of 5 min. Conditions for entering sleep mode are one of the following:

• No CAN bus activity
• No Service interface activity
• No manual drive activity


Exiting sleep mode

• Any CAN bus activity
• Service interface activity
• Activating manual run
• Power up

## 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 and 24 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 | 16 V | ISO 16750-2:2012 - Code A | Motor not running<br>CAN communication possible |
| **24 V** | 18 V | 24 V | 32 V | ISO 16750-2:2012 - Code H | Motor running |
| | 10 V | 24 V | 32 V | ISO 16750-2:2012 - Code E | Motor not running<br>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 approx. 40 volts, the system will enter overvoltage protection mode and shut down.

# Environmental data and tests

## EMC

The Electromagnetic Compatibility tests performed on the LINAK CAN bus actuator comply with the TECHLINE®
Electrical Test Specification. The scope of tests are 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 2. LINAK USB2LIN service 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 LA36CAN can be ordered as PN: 0367997.

# Installing LINAK CAN bus actuators

## Introduction

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

• Connections
• Electrical installation
• Communication
• Start-up procedures (not included in this version)

## Connections

The tables below define the wire connections to the LINAK TECHLINE® CAN bus actuators. These colours are consistent with all LINAK TECHLINE CAN bus actuators.

### Single connector actuators

Power connector, 8-pin mini-fit connector

| LINAK cable | Description |
|---|---|
| Brown | + Power supply (12/24VDC) |
| 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.

### Dual connector actuators

Power connector, 6-pin mini-fit connector

| LINAK cable | Description |
|---|---|
| Brown | + Power supply (12/24VDC) |
| 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.

By default, cables are supplied with flying leads.

# Electrical installation

The J1939-15 defines the Reduced Physical Layer, 250K bits/sec, Un-Shielded Twisted Pair (UTP) and runs with separate communication and power supply wires.
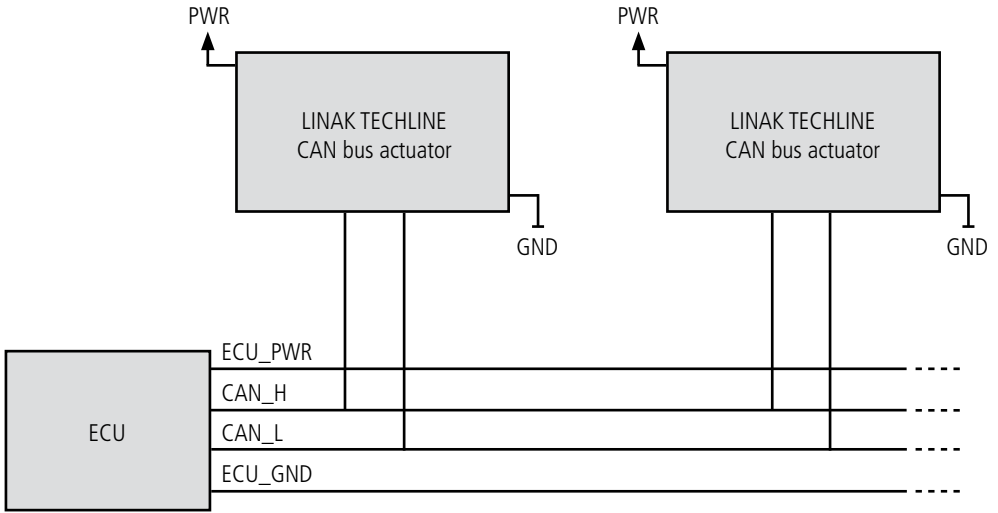


Figure 3. Power supply connection setup.

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

# Electrical installation

## Manual run mode

If manual run mode is engaged, the Service interface is enabled.
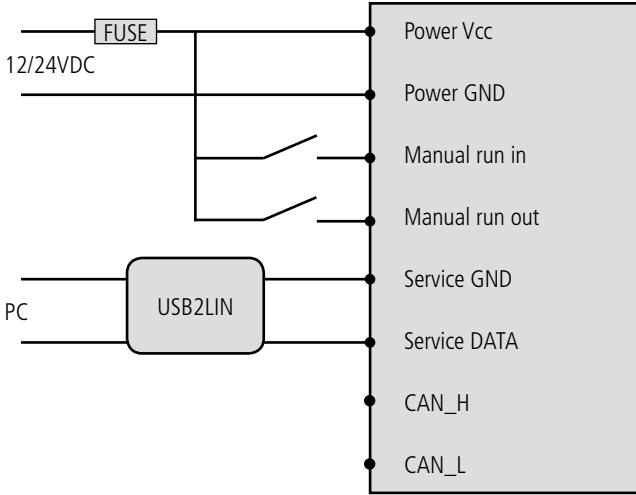


Figure 4. Manual run connection diagram.

## Termination

Termination resistors of 120 Ω are connected according to the figure below.
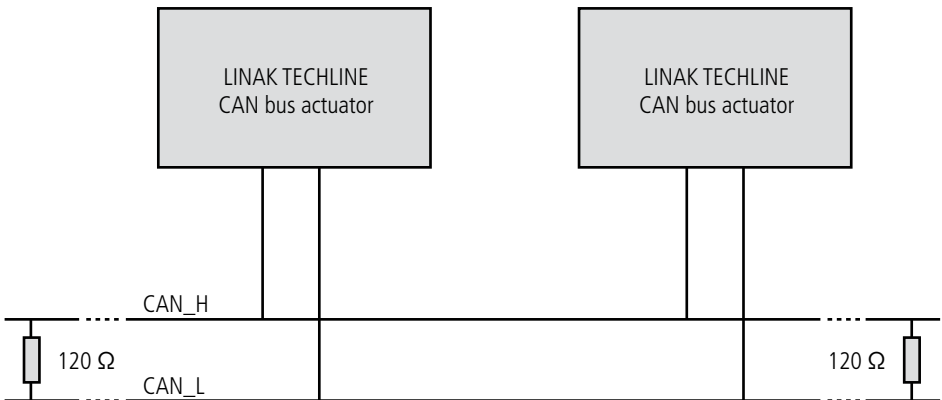


Figure 5. Manual run connection diagram.

# Communication

The installation must be performed by qualified personnel with knowledge of CAN bus communication and the SAE J1939 standard. Only the sections of the standard which are relevant for the installation will be discussed.

- SAE J1939-21   Data Link Layer          Proprietary A, Proprietary B
- SAE J1939-73   Application Layer         Diagnostics
- SAE J1939-81   Network Management

Test

LINAK can provide a test script compiled for the Vector VN16xx interface family and a PC application, supporting the PCAN interface from PEAK Systems.

Data range definition

| Range name | 1 byte | 2 bytes |
|---|---|---|
| Valid signal | 0 - 250<br>0x00 - 0xFA | 0 - 64255<br>0x0000 - 0xFAFF |
| Parameter specific indicator | 251<br>0xFB | 64256 - 64511<br>0xFB00 - 0xFBFF |
| Reserved range for future indicator bits | 252 - 253<br>0xFC - 0xFD | 64512 - 65023<br>0xFC00 - 0xFDFF |
| Error indicator | 254<br>0xFE | 65024 - 65279<br>0xFE00 - 0xFEFF |
| Not available, not installed or not requested | 255<br>0xFF | 65280 - 65535<br>0xFF00 - 0xFFFF |

# Communication

## 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.. |
| Min. transmission rate | 250ms |
| PGN | 0x00EF00 |

Data field

8 bytes containing all changeable data.

| B7 (Sent last) | B6 | B5 | B4 | B3 | B2 | B1 | B0 (Sent first) |
|---|---|---|---|---|---|---|---|
| Reserved, write 0xFF | Reserved, write 0xFF | Reserved, write 0xFF | Reserved, write 0xFF | Speed [%*0.5] | Current [mA *250] | Position [mm*0.1] MSB | Position LSB |

Data field definition

| Byte(s) | Name | Details | SLOT |
|---|---|---|---|
| B4-B7 | Reserved | Always write 0xFF | Not applicable |
| B3 | Speed | 0-199    Speed to use (0.5%/bit: 0%-99.5%)<br>200-250  Use 100% speed<br>251       Actuator default value<br>252-255  Reserved. Do not run, regardless of other bytes in request | SLOT 299: SAEpc18 (0% - 125%) |
| B2 | Current | 0-250     Maximum current to use<br>251       Actuator default value<br>252-255  Reserved. Do not run, regardless of other bytes in request | SLOT 410: SAEec09 (0.25 A/bit: 0.0A - 62.5A) |
| B0-B1 | Position | 0-64255    Run to position<br>64256      Clear ErrorCode register<br>64257      Command run to actuator out<br>64258      Command run to actuator in<br>64259      Command stop actuator*<br>64260-65535  Reserved. Do not run, regardless of other bytes in request | SLOT 283: SAEmd01 (0.1 mm/bit: 0mm - 6.43m) |

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

# Communication

## Proprietary B

Function:                General status
Description            Read status parameters, motor current and actuator piston position.

Min. transmission rate   100ms
PGN                   0x00FF00, 65280d

<u>Data field</u>

8 bytes containing all status information.

| B7 (Sent last) | B6 | B5 | B4 | B3 | B2 | B1 | B0 (Sent first) |
|---|---|---|---|---|---|---|---|
| Reserved, always 0xFF | Reserved, always 0xFF | Reserved, always 0xFF | ErrorCode: 8-bit error code | StatusFlags: Bit-field | Current [mA *250] | Position [mm*0.1] MSB | Position LSB |

# Communication

## Proprietary B

Data field definition

| Byte(s) | Name | Details | SLOT |
|---------|------|---------|------|
| **B5-B7** | Reserved | Always reads 0xFF | Not applicable |
| **Bits 24-31**<br>**B4** | ErrorCode | 8-bit error code indicating the currently active error of highest priority<br>0 = No error<br>1 = Hall error<br>2 = Overvoltage<br>3 = Undervoltage<br>4 = Failed to maintain CAN keep alive signal<br>5 = EOS error<br>6 = Power on block state<br>7 = Temperature error<br>8 = Heart beat error (internal)<br>9 = SMPS error (inernal) | Not defined |
| **Bits 32-39**<br>**B3** | StatusFlags | 8 independent status bit-indicators<br>b0 = EOS in<br>b1 = EOS out<br>b2 = Overcurrent<br>b3 = Running out<br>b4 = Running in<br>b5 = Reserved<br>b6 = Reserved<br>b7 = Reserved | Not defined |
| **Bits 40-47**<br>**B2** | Current | Measured motor current<br>0        Not running<br>1-250    Measured motor current<br>251-253  Reserved<br>254      Fault in current measurement circuit<br>255      Reserved | SLOT 410:SAEec09<br>(0.25 A/bit: 0.25A - 62.5A) |
| **Bits 48-63**<br>**B0-B1** | Position | Position feedback<br>0-64255        Position of actuator piston<br>64256-65023  Reserved<br>65024         Position lost<br>65025-65535  Reserved | SLOT 14: SAEds04<br>(0.1 mm/bit: 0mm - 6.43m) |

# Application Layer - Diagnostics

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:       0 = 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 code |
| 0x82 = Write access denied |
| 0x83 = Value underflow |
| 0x84 = Value overflow |
| 0x85 = Invalid enumerator value |

# Application Layer - Diagnostics

## Diagnostics overview

| Pointer/IDX | Data size | Description | SLOT Id | SLOT name | Access | Example | Meaning |
|---|---|---|---|---|---|---|---|
| | | Setup values | | | | | |
| 516096 | U8 | Current limit out [mA*250] | 410 | SAEec09 | R/W | 60 | 15A |
| 516097 | U8 | Current limit in [mA*250] | 410 | SAEec09 | R/W | 24 | 6A |
| 516098 | U16 | Soft start time out [ms] | 132 | SAEtm02 | R/W | 1500 | 1.5s |
| 516099 | U16 | Soft start time in [ms] | 132 | SAEtm02 | R/W | 500 | 500ms |
| 516100 | U16 | Soft stop time out [ms] | 132 | SAEtm02 | R/W | 2000 | 2s |
| 516101 | U16 | Soft stop time in [ms] | 132 | SAEtm02 | R/W | 300 | 300ms |
| 516102 | U16 | Maximum speed [%*0.5] | 299 | SAEpc18 | R/W | 180 | 90% |
| 516103 | U16 | Virtual EOS out position [mm * 0.1] | 14 | SAEds04 | R/W | 2000 | 200mm |
| 516104 | U16 | Virtual EOS in position [mm * 0.1] | 14 | SAEds04 | R/W | 50 | 5mm |
| 516105 | U8 | Actuator address | 35 | SAEsa01 | R/W | 123 | 123 |
| 516106 | U16 | Can-bus speed [Manufacturer defined: Kbit/s] (Allowed values are: 250) | 283 | SAEmd01 | R/W | 250 | 250Kbit/s |
| | | Identification | | | | | |
| 516107 | U32 | UIN | 283 | SAEmd01 | R | 12345678 | Serial number |
| 516108 | String[20] | Software identification (SW variant/ build number) [ASCII, text (variable, NULL delimited)] | 258 | SAEatnd0200 | R | SW1234567V1-1234 | SW variant 1234567 version 1 build 1234 |
| 516109 | String[20] | Production order number [ASCII, text, variable, NULL delimited] | 258 | SAEatnd0200 | R | | |
| 516110 | U32 | Production date | 283 | SAEmd01 | R | 20150728 | July 28th 2015 |

# Application Layer - Diagnostics

## Diagnostics overview

| Pointer/ IDX | Data size | Description | SLOT Id | SLOT name | Access | Example | Meaning |
|---|---|---|---|---|---|---|---|
| | | Historic values | | | | | |
| 516110 | U8 | Maximum current seen [mA*250] | 410 | SAEec09 | R | 61 | 15.25A |
| 516111 | S16 | Maximum FET temperature seen [°C - 40] | 67 | SAEtp01 | R | 138 | 98°C |
| 516112 | S16 | Maximum ambient temperature seen [°C - 40] | 67 | SAEtp01 | R | 82 | 42°C |
| 516113 | S16 | Minimum ambient temperature seen [°C - 40] | 67 | SAEtp01 | R | 36 | -4°C |
| | | Usage totals | | | | | |
| 516114 | U32 | Current usage [As] | 283 | SAEmd01 | R | 21605 | Total power consumed: 6Ah |
| 516115 | U32 | Run-time [s] | 64 | SAEtm05 | R | 4321 | Total running time: 1h12m1s |

# Application Layer - Diagnostics

## Diagnostics overview

| Pointer/ IDX | Data size | Description | SLOT Id | SLOT name | Access | Example | Meaning |
|---|---|---|---|---|---|---|---|
| | | Reason for last stop, stop counters and communication error counter | | | | | |
| 516116 | U16 | Reason for last stop | 64 | SAEtm05 | R | 2 | Overtemperature |
| 516117 | U8 | Overvoltage stops | 133 | SAEct03 | R | | |
| 516118 | U8 | FET overtemperature stops | 133 | SAEct03 | R | | |
| 516119 | U8 | Ambient overtemperature stops | 133 | SAEct03 | R | | |
| 516120 | U8 | Low voltage stops | 133 | SAEct03 | R | | |
| 516121 | U8 | Hall error stops | 133 | SAEct03 | R | | |
| 516122 | U8 | EOS switch error stops | 133 | SAEct03 | R | | |
| 516123 | U8 | LINAK current overloads out stops | 133 | SAEct03 | R | | |
| 516124 | U8 | LINAK current overload in stops | 133 | SAEct03 | R | | |
| 516125 | U8 | Custom current overloads out stops | 133 | SAEct03 | R | | |
| 516126 | U8 | Custom current overload in stops | 133 | SAEct03 | R | | |
| 516127 | U16 | Communication errors | 208 | SAEct05 | R | | |
| | | Activation counters | | | | | |
| 516128 | U16 | Number of EOS in | 208 | SAEct05 | R | | |
| 516129 | U16 | Number of EOS out | 208 | SAEct05 | R | | |
| 516130 | U32 | Number of starts in | 209 | SAEct07 | R | | |
| 516131 | U32 | Number of starts out | 209 | SAEct07 | R | | |

## Application Layer - Diagnostics

### Diagnostic Trouble Code (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 Temp | FMI15 = Data valid, but above normal operating range (least significant level) |
| 0x7e404 | AMB Temp | FMI15 = Data valid, but above normal operating range (least significant level) |

# Application Layer - Diagnostics

## Diagnostics examples

The following two examples are made in accordance with SAEJ1939-73 Section 5.7.14.

Example 1: Read "Reason for last stop".

# Application Layer - Diagnostics

## Diagnostics examples

**MA Request (Write memory)**

| Field | Value |
|---|---|
| Length/Number Requested | 1 = Write only one data object |
| Pointer Type | 1: Directed Spatial Addressing |
| Command | SAEJ1939-73 Section 5.7.14.6: 2=Write |
| SAE reserved | Always 1 |
| Pointer | 5180P6 (Current limit out) [mA*256)] |
| Pointer extension | 0 = SPN Space |
| Key/User_Level | 1 = User level "writer" configurable to not require authentication |

**MA Binary Data**

| Field | Value |
|---|---|
| Length/Number Allowed | 1 = Writing the requested object is allowed. |
| SAE reserved | Always 1 |
| Status | 0 = Proceed |
| SAE reserved | Always 1 |
| Error indicator / EDC Parameter | 0xFFFFFF = No error indicator avail |
| EDCP extension | 0xFF = No further data |
| Seed | 0xFFFF = No further key required of tool |

**MA Response (Proceed)**

| Field | Value |
|---|---|
| Data | 2 = Length of data is 2 |
| | 3A = Current limit out = 8A |

**MA Response (Proceed)**

| Field | Value |
|---|---|
| Length/Number Allowed | 1 = Writing the requested object is allowed. |
| SAE reserved | Always 1 |
| Status | 4 = Operation completes |
| SAE reserved | Always 1 |
| Error indicator / EDC Parameter | 0xFFFFFF = No error indicator avail |
| EDCP extension | 0xFF = No further data |
| Seed | 0xFFFF = No further key required of tool |

**MA Request (Operation complete)**

| Field | Value |
|---|---|
| Length/Number Requested | 0 (DO NOT CARE) |
| Pointer Type | 0? (DO NOT CARE) |
| Command | 4 = Operation completed |
| SAE reserved | Always 1 |
| Pointer | 0xFFFFFF = No further data |
| Pointer extension | 0xFF = No further data |
| Key/User_Level | 0xFFFF = No further key required of tool |

Example 2: Write "Current limit out".

# Network Management

Processes and messages are associated according to SAEJ1939-81 Section 4.2.1.1.
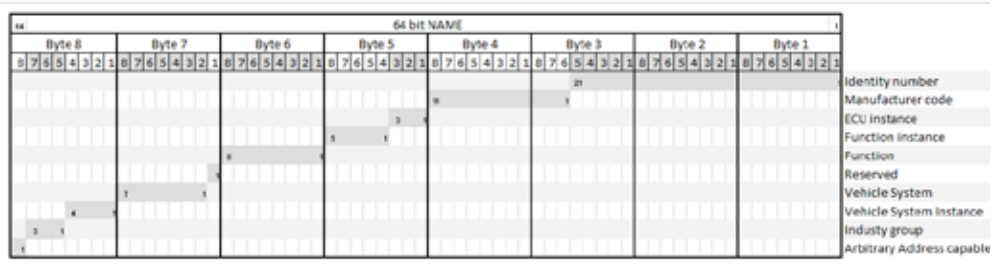


(1) The serial number contained in the Identity number is a unique ID assigned to each actuator.

(2) ECU instance can be utilised if two or more ECU's are present on the network.

(3) Function instance is suitable when two or more actuators are present on the same network where the actuators only differ on e.g. Left and Right.

| Parameter Name | Size in Bits | Start Byte | Start Bit | Details |
|---|---|---|---|---|
| Identity Number | 21 | 1 | 1 | Lower 21 bits of UIN (Unique Serial Number) |
| Manufacturer Code | 11 | 3 | 6 | 690 (LINAK A/S) |
| ECU Instance | 3 | 5 | 1 | Default 0 |
| Function Instance | 5 | 5 | 4 | Determined by address strapping, Section 2.1.14.3 (2.3.3) |
| Function | 8 | 6 | 1 | Default 132 (Utility Machine Control) |
| Reserved | 1 | 7 | 1 | Always 0 |
| Vehicle System | 7 | 7 | 2 | Default 24 (Utility Vehicles) |
| Vehicle System Instance | 4 | 8 | 1 | Configurable from 0-15 |
| Industry Group | 3 | 8 | 5 | Default 2 (Agriculture and Forestry Equipment) |
| Arbitrary Address Capable | 1 | 8 | 8 | Always 1: Capable of selecting source address |

# Network Management

Examples

CAN identifier

| | CAN-ID | Type | Length | Data |
|---|---|---|---|---|
| | 00EEFFC8h | | 8 | 78 56 44 56 00 84 30 A0 |
| | 18FF00C8h | | 8 | 42 00 00 E0 00 FF FF FF |

Receive

| 18 | Priority, Reserved bit and Data page |
|---|---|
| FF00 | Parameter format (PF) and Parameter Specific (PS) |
| C8 | Source Address (SA) |

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