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# **LinMot®**

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## **SCALA**

Parameter Control Using Analog Signals

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**Table of contents**

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<b>1. System description</b> .....	3
1.1 System overview.....	3
1.2 Selection of parameters.....	3
1.3 Characteristics.....	4
1.4 Scalable parameters.....	5
1.5 Conditions.....	8
1.6 Error messages.....	8
<b>2. Commissioning</b> .....	9
2.1 Installation of the SCALA-software.....	9
2.2 Connecting to higher-level control.....	9
<b>A. Examples</b> .....	10
A.1 Speed and force of two motors.....	10
A.2 Adjust working range.....	11
<b>B. -10V / +10V interface</b> .....	13

# 1. System description

## 1.1 System overview

This application permits the user to scale different motor parameters of a *LinMot*<sup>®</sup> servo controller with analog voltages. For example the speed, amplitude or force of a curve can be changed during operation. Each of the four analog inputs can scale a freely selectable parameter. The parameter can be linked to each of the four motors of a servo controller.

### Applications

This software can be used to change motion parameters during operation. Example applications are:

- Adjust the stroke of the linear motor
- Shift a curve during operation
- Adjust the speed of the linear motor
- Adjust force of a linear motor

## 1.2 Selection of parameters

All parameters of a linear motor have an identification number, which is called “token”. Scalable parameters are addressed via this token. The token of the respective parameter is found with the parameter descriptions in chapter 1.4.

By installing this software option the parameter directory of the servo controller is extended. The directory “Scala” is added to the main directory, as shown in figure 1-1. For space reasons only the directory of input A is completely drawn. The directories B - D are identical. **WARNING:** An analog input must not be used as scaling input and trigger input simultaneously.

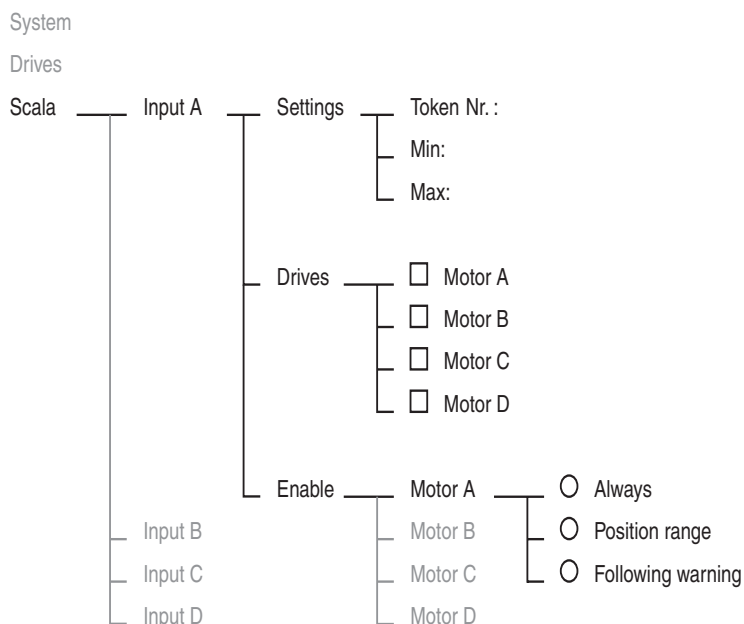
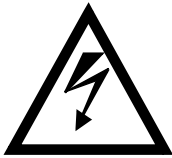


Fig. 1-1: Parameter directory ‘SCALA’ software

In the directory ‘**Scala\Input X\Settings\Token Nr**’ the token number of the parameter being scaled is entered. In the same directory also the lower and the upper limit of the scaled parameter must be entered. In the directory ‘**Scala\Input X\Drives**’ the motors which will be affected by the scaled parameter are selected. These settings can only be done when the servo controller is stopped.

In the directory ‘**Scala\Input X\Enable\Motor X**’ a condition for scaling can be selected.



The minimum and maximum values must be held within the indicated range defined in the tables. Erratic motion will occur if values out of the range are entered. Do not scale the same parameter for one motor by two different inputs.

### 1.3 Characteristics

The scalable parameters are set with analog input voltages between 0V and +10Vdc. The characteristic curve of the analog input has constant ranges from 0V to 0,5V and from 9,5V to 10V input voltage. If the input voltage is in such a range the parameter is adjusted to its minimum, respectively maximum value. Between 0.5V to 9.5V the analog input has a linear effect on the parameter it is controlling.

The parameter value is linked with the following formulas with the input voltage:

$$out = \frac{(U_{IN} - 0.5V)}{9V} \cdot (out_{MAX} - out_{MIN})$$

out : actual parameter value  
 U<sub>IN</sub>: input voltage  
 out<sub>MAX</sub>: upper limit  
 out<sub>MIN</sub>: lower limit

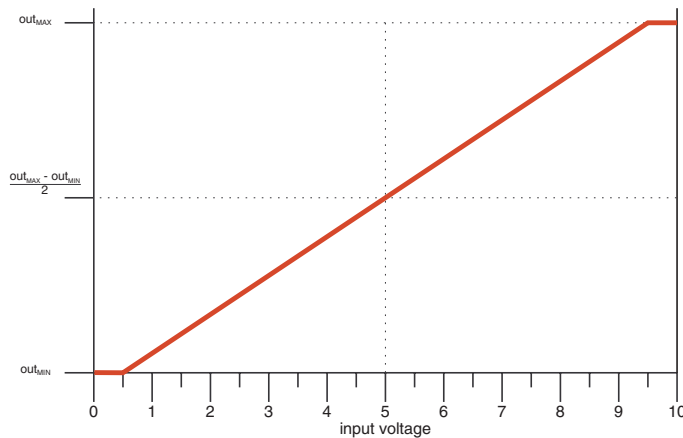


Fig. 1-2: Characteristic curve

**Resolution**

The analog inputs are sampled with 10 bits resolution, i.e. between 0V and 10V 1024 steps are available.

**Inverted characteristics**

By exchanging the extreme values, i.e. the minimum value is larger than the maximum value, the scaling characteristic can be inverted.

## 1.4 Scalable parameters

All “Live” (user settable) parameters of a linear motor can be scaled. The individual parameters are represented by so-called “Tokens” represented by a decimal number. For each parameter a minimum and maximum value must be indicated, in which range the value of the parameter can be scaled.

In the following subsections all scalable parameters are described. For each parameter the necessary information is summarized in a table. A more detailed description of the parameters can be found in the *LinMot*<sup>®</sup> manual.

In each table further information to the parameter is given beside the token-number. In the column ‘**Min**’ the minimum possible value of the parameter is indicated. In the column ‘**Max**’ the maximum possible value is indicated. When setting the upper and lower limits, its values must be held within the indicated values. In the column ‘**Unit**’ the scaling of a parameter is indicated. To find for example the parameter-value for a position, the position must be divided the by the unit.

Example: The minimum position shall be defined with 50mm. These 50mm must be divided by 0,01953 mm. Thus the parameter-value 2560 corresponds to a position of 50 mm.

### Disable scaling

When a analog input is not used for scaling a parameter but for other purposes, then the token number must be set to zero.

### Position parameters

Position - parameters affect the position of an attached linear motor.

#### Minimum Position

Lower limit of positioning range.

Minmal Position	Token	Min	Max	Unit
Ex00 / Ex000	32789	-32256	32256	0.01953mm

#### Maximum Position

Higher limit of positioning range.

Maximal Position	Token	Min	Max	Unit
Ex00 / Ex000	32790	-32256	32256	0.01953mm

#### 0V Position

In the **Analog** mode this parameter defines the position to be assumed with 0V input voltage.

0V Position	Token	Min	Max	Unit
Ex00 / Ex000	32791	-32256	32256	0.01953mm

#### 10V Position

In the **Analog** mode this parameter defines the position to be assumed with 10V input voltage.

10V Position	Token	Min	Max	Unit
Ex00 / Ex000	32792	-32256	32256	0.01953mm

## System description

### '0' Position

Defines the position assumed in the **Two Point** mode when the trigger is at a logic 0 (low).

'0' Position	Token	Min	Max	Unit
Ex00 / Ex000	32795	-32256	32256	0.01953mm

### '1' Position

Defines the position assumed in the **Two Point** mode when the trigger is at a logic 1 (high).

'1' Position	Token	Min	Max	Unit
Ex00 / Ex000	32796	-32256	32256	0.01953mm

## Curve parameters

These parameters affect directly the characteristics of active curves.

**Warning:** In order to get a save switching of curves, only use very few different values on the **Curve Number** parameters. I.e. the difference between the lower and the upper limit should be as small as possible (2-4).

### Curve Number

In the Continuous Curve mode the motion profile stored in the servo controller and bearing the number in Curve Number is run over cyclically.

Curve Number	Token	Min	Max	Unit
Ex00 / Ex000	32878	1	63	-

### Rise Curve Number

In the Trigger Curve mode the motion profile with this number is run on the rising slope of the trigger signal.

Rise Curve Number	Token	Min	Max	Unit
Ex00 / Ex000	32787	1	63	-

### Fall Curve Number

In the Trigger Curve mode the motion profile with this number is run on the falling slope of the trigger signal.

Fall Curve Number	Token	Min	Max	Unit
Ex00 / Ex000	32788	1	63	-

### Curve Position Offset

This parameter sets the position offset of the motion profile.

Curve Position Offset	Token	Min	Max	Unit
Ex00 / Ex000	33106	-32256	32256	0.01953mm

### Curve Amplitude

This parameter sets the amplitude of the motion profile. The value range is from 0 to 100%.

Curve Amplitude	Token	Min	Max	Unit
Ex00 / Ex000	33107	0	4096	0.000244%

### Curve Speed

This parameter sets the speed of the motion profile. The value range is from 0 to 100%.

Curve Speed	Token	Min	Max	Unit
Ex00 / Ex000	33108	0	4096	0.000244%

## Filter parameter

Filter parameters affect the dynamic behavior of a linear motor if no curves are run.

### Max Speed

This value sets the upper speed limit. It is disregarded when a motion profile is being run. The maximal value should be set to the maximal speed of the motor.

Max Speed	Token	Min	Max	Unit
Ex00 / Ex000	32827	6	24576	0.1907mm/s

### Max Acceleration

This value sets the upper limit for acceleration. It is disregarded when a motion profile is being run.

Max Acceleration	Token	Min	Max	Unit
Ex00 / Ex000	32828	1	1536	238.4mm/s <sup>2</sup>

## Control parameters

These parameters directly affect the controller behavior. Uncontrolled increasing of the parameters P, D and I can lead to dangerous oscillations. These parameter should be changed only if very different load masses are moved.

### Max Current

Determines the maximum current that can be applied to the motor by the controller. Through the maximum current this parameter also determines the maximum force of the motor. The maximum values of these parameters depend on the selected servo controller and the configured max. current (Ex00 series).

Max Current	Token	Min	Max	Unit
Ex00 2A	32825	0	85	23.4mA
Ex00 3A	33052	0	128	23.4mA
Ex000	32825	0	256	23.4mA

### Current Offset

Enables a static force sustained by the motor to be compensated.

Current Offset	Token	Min	Max	Unit
Ex00	32870	-64	64	23.4mA
Ex000	32870	-128	128	23.4mA

### P

Proportional part of the controller.

P	Token	Min	Max	Unit
Ex00 / Ex000	32822	0	32640	23.4mA/mm

### D

Derivative part of the controller.

D	Token	Min	Max	Unit
Ex00 / Ex000	32823	0	32640	15mass/mm

### I

Integrator of the controller.

I	Token	Min	Max	Unit
Ex00 / Ex000	32861	0	32640	45.7mA/(ms)

## System description

### FF Friction

Determines what constant current is to be fed forward for a slider motion.

FF Friction	Token	Min	Max	Unit
Ex00 / Ex000	33058	0	255	23.4mA

### FF Acceleration

Determines what current must be fed forward to obtain the desired acceleration.

FF Acceleration	Token	Min	Max	Unit
Ex00 / Ex000	33073	0	32640	0.1 mA/(m/s <sup>2</sup> )

### FF Deceleration

Determines what current must be fed forward to obtain the desired deceleration.

FF Deceleration	Token	Min	Max	Unit
Ex00 / Ex000	33057	0	32640	0.1 mA/(m/s <sup>2</sup> )

## 1.5 Conditions

The parameter '**Scala\Input X\Enable\Motor X**' allows the user to set a condition for the scaling of a parameter. Three possibilities are available:

- **Always:** The selected parameter is always scaled.
- **Position range:** The selected parameter is scaled only if the motor is in a defined position range. The position range can be adjusted for each motor by the parameter '**\Drives\Drive X\Position monitoring**'.
- **Following warning:** The selected parameter is scaled only if a following error is occurring. Tolerances for a following error can be adjusted for each motor under '**\Drives\Drive X\Position monitoring**'.

## 1.6 Error messages

The 'SCALA' application software examines the indicated tokens for the following criteria:

- Is the parameter valid (motor parameter)?
- Can the parameter be found?
- Is the parameter a "Live"-parameter?

If one of the above conditions is not fulfilled, then an appropriate application-error is raised. The servo controller shows the occurrence of this error by one long (approximately. 1sec) flash of the STAT A LED and eight short flashes of the STAT B LED. In the Error-Inspector more exact information about the error can be obtained.



## 2. Commissioning

### 2.1 Installation of the SCALA-software

- 1 Terminate any open *LinTalk* programs.
- 2 Copy the file *SC01.ini* from the installation source to the *LinTalk* folder (mostly *C:\Lin1r3rx*).
- 3 Select *Install Package* from the *Special* menu in *LinTalk*.
- 4 Login with ID: *Install* and password *NTI* (capital letters).
- 5 Open the folder *App / Scala*.
- 6 Select the file *Scal1301.ipk* and click OK.
- 7 Wait till the installation has completed and terminate the *Package Installer*.
- 8 The servo controller is ready to operate with the SCALA software now.

### 2.2 Connecting to higher-level control

It is very important that the analog signals of the higher-level control are feed to the *LinMot®* servo controller without noise. The connection must be kept as short as possible and made with shielded cables.

If a higher-level control with -10/+10Vdc signals is used a signal level adjustment must be made. This adjustment can be done with the *LinMot® Break Out Modul analog* (M01-analog/Article-No. 0150-1933). See Appendix B for detailed description.

## A. Examples

### A.1 Speed and force of two motors

#### Scenario

In a two-axis system the two linearmotors 'A' and 'B' are operated in the 'Trigger Curve' mode. The speed of both motors shall be scaled with one analog signal. In addition the force of motor 'B' should be adjusted in the range from 50% to 100% by a second signal.

The selected servo controller is an *E200-MT* type, which is configured to 2A max. current output (parameter directory `\Drives\Drive X\Control Switches`).

#### Speed scaling

First we search the informations for the parameter 'Curve Speed':

Curve Speed	Token	Min	Max	Unit
Ex00 / Ex000	33108	0	4096	0.000244%

Enter the token number 33108 in the parameter directory under '`\Scala\InputC\Settings\Token`'. In the same directory also the minimum and maximum values (0 and 4096) must be entered. The appropriate motors must be selected now. In the directory '`\Scala\InputC\Drives`' select motors 'A' and 'B'.

#### Force scaling

To adjust the force of motor 'B' the maximum current of this motor is adjusted. The force of the motor is linked with the constant  $c_F$  to its current. The maximum current is controlled by the parameter 'Max Current':

Max Current	Token	Min	Max	Unit
Ex00 2A	32825	0	85	23.4mA
Ex00 3A	33052	0	128	23.4mA
Ex000	32825	0	256	23.4mA

Since the selected servo controller is an Ex00/2A type the first line of the table applies. In the parameter '`\Scala\InputD\Settings\Token`' the token number 32825 must be entered.

To adjust the current between 50% and 100% the minimum value must be set to the half of the maximum value, i.e. 43 (only integer numbers can be entered). Hence the parameter '`\Scala\InputD\Settings\Min`' is set to 43 and the parameter '`\Scala\InputD\Settings\Max`' to 85.

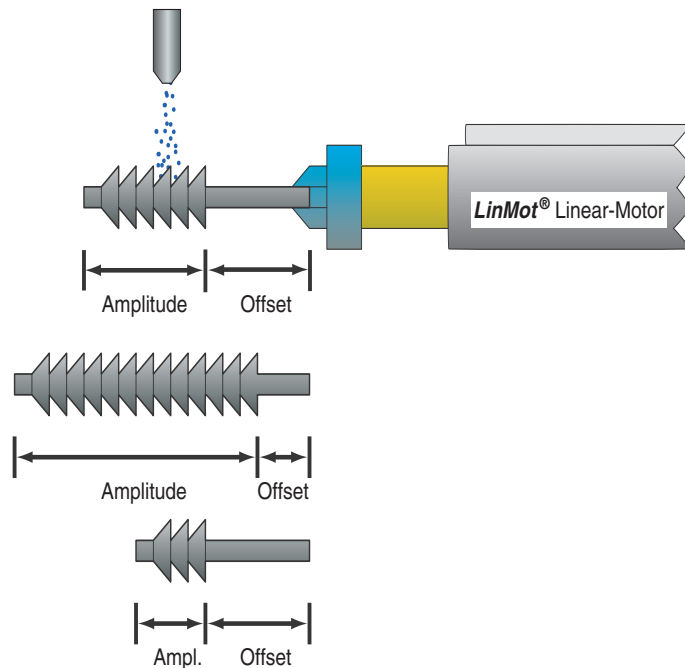
In the directory '`\Scala\InputD\Drives`' motor 'B' has to be selected.

The system works in accordance with the demands made at the beginning now.

### A.2 Adjust working range

#### Scenario

In a coating station the thread of screws must be moved back and forth under a nozzle. The screws have different lengths of thread and stud. Figure A-1 shows how this machine works.



**Abbildung A-1: Coating of different screws**

The length of the thread is defined as amplitude of a curve, the length of the stud as offset from the zero point. The lengths of studs ranges from 10mm to 60mm. The lengths of threads ranges from 20mm to 100mm. The motor is attached to channel A.

#### Task

With analog inputs (potentiometers) the lengths of studs and threads of the screws to be coated shall be adjusted. Additionally the speed of the movement shall be made variable. On input 'B' the lengths of studs and on input 'C' the lengths of threads shall be made adjustable with voltages between 0V and 10V. The speed shall be controlled by Input 'D'.

#### Solution

The motor is operated in '**Continuous Curve**' mode with an curve between 0mm and 10mm. This is the maximum length of the thread. With the '**SCALA**' software the curve-parameters '**Curve Position Offset**' for the stud length, '**Curve Amplitude**' for the thread length and '**Curve Speed**' for the motion speed are scaled.

First the settings for the stud length are made:

Curve Position Offset	Token	Min	Max	Unit
Ex00 / Ex000	33106	-32256	32256	0.01953mm

The minimum value must be set to 10mm (minimum stud length), the maximum value to 60mm (maximum stud length). The correct values can be found by dividing with the value 'Unit'.

These values have to be entered:

```
\Scala\InputB\Settings\Token: 33106
\Scala\InputB\Settings\Min: 512
\Scala\InputB\Settings\Max: 3072
\Scala\InputB\Drives: Motor A
```

Settings for the thread length:

Curve Amplitude	Token	Min	Max	Unit
Ex00 / Ex000	33107	0	4096	0.0244%

The minimum thread length is 20mm. This are 20% of the maximum thread length. The parameters for the thread length are as following:

```
\Scala\InputC\Settings\Token: 33107
\Scala\InputC\Settings\Min: 820
\Scala\InputC\Settings\Max: 4096
\Scala\InputC\Drives: Motor A
```

Finally the settings for the speed adjustment:

Curve Speed	Token	Min	Max	Unit
Ex00 / Ex000	33108	0	4096	0.000244%

```
\Scala\InputD\Settings\Token: 33108
\Scala\InputD\Settings\Min: 0
\Scala\InputD\Settings\Max: 4096
\Scala\InputD\Drives: Motor A
```

The configuration for this example is done know.

## B. -10V / +10V interface

The *LinMot*<sup>®</sup> servo controllers are working with input signals between 0V and 10V. Some superior control systems are working with signals between -10V and +10V. To control a *LinMot*<sup>®</sup> servo controller with this kind of interface a signal level adjustment must be made.

This adjustment can be done with the *LinMot*<sup>®</sup> Break Out Modul analog (M01-analog / Art.-No. 0150-1932).

The input  $U_{IN-}$  of the *LinMot*<sup>®</sup> Break Out Modul is connected to ground and the superior controller output is connected to the  $U_{IN+}$  input.

The characteristics will change as follows:

$$\text{out} = \frac{(U_{IN} + 9V)}{18V} \cdot (\text{out}_{MAX} - \text{out}_{MIN})$$

scalingfactor:  $a = (U_{IN} + 9V)/18V$   
output value  $\text{out} = a \cdot (\text{out}_{MAX} - \text{out}_{MIN})$

out : actual parameter value  
 $U_{IN}$ : input voltage  
 $\text{out}_{MAX}$ : upper limit  
 $\text{out}_{MIN}$ : lower limit

$U_{IN}$ : input value  
out: output value  
 $\text{out}_{MAX}$ : max. output value  
 $\text{out}_{MIN}$ : min. output value

**Index**

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**Symbols**

'0' Position 6  
'1' Position 6

**Numerics**

0V Position 5  
10 V Position 5

**A**

Applications 3

**B**

Break Out Moduls 13

**C**

Characteristics 4  
Commissioning 9  
Conditions 8  
Controller  
  D 7  
  I 7  
  P 7  
Current Offset 7  
Curve Amplitude 6  
Curve Number 6  
Curve Position Offset 6  
Curve Speed 6

**D**

D - part 7  
Disable scaling 5

**E**

Error messages 8  
Examples 10

**F**

Fall Curve Number 6  
FF Acceleration 8  
FF Deceleration 8  
FF Friction 8

**H**

higher-level control 9

**I**

I - part 7  
Installation 9  
Invert characteristics 4

**M**

Max Acceleration 7  
Max Current 7  
Max Speed 7  
Maximal Position 5  
Minimal Position 5

**P**

P - part 7  
Parameter directory 3

**R**

Resolution 4  
Rise Curve Number 6

**T**

Token 3