maxon motor

maxon motor control	4-Q-DC Servo Control (LSC)

Order number 108302/108303

Operating Instructions	May 2001 edition

The linear servo controller (LSC) is a servo amplifier for the speed controlled operation of permanent magnet DC motors of up to 50 Watt output power.
It works on the linear (proportional) principle.

Advantages

- Small dimensions, matching the Eurocard format, in protective housing
- Overtemperature protection
- Current limit adjustable using potentiometer
- Input setting by means of external potentiometer or with external control voltage level
- Simple to connect with screw-type terminals
- Only one supply voltage required

Operation features

- 4-Quadrant operation - speed controlled operation, driving and braking in both directions
- Different modes of operation - DC tacho speed control, encoder speed control, IxR compensation or use as voltage regulator (U_{adj})
- Good control characteristics - PI-controller with adjustable P-portion for a stable speed behaviour
- Ballast circuit = «braking help» - the LSC absorbs up to 5W (continuously) during braking

Safety Instructions

Skilled Personnel
Handling of the equipment shall only be performed by experienced, skilled personnel.

Statutory Regulations
The user must ensure that the servo controller and the components belonging to it are assembled and connected according to local statutory regulations.

Additional Safety Equipment
Electronic apparatus is basically not fail-safe. Machines and apparatus must therefore be fitted with independent monitoring and safety equipment.

Repairs
Repairs may be made by authorised personnel only or by the manufacturer. It is dangerous for the user to open the unit or make repairs to it.

Max. Supply Voltage
Make sure that the supply voltage is between 12 and 30 VDC.
Attention: Voltage higher than 30 VDC or wrong polarity will destroy the unit.

Electrostatic Sensitive Device (ESD)

Table of Contents

The latest edition of these operating instructions may also be found in the internet under http://www.maxonmotor.com («Downloads» in the category «Service & Support»).

1 Technical Data

Electrical Data

Continuous output power .... max. 50 W
Operating voltage range V_{cc} .... 12 - 30 VDC
Motor operating voltage .... $\pm 6 \ldots \pm 24$ VDC
Motor current limit adjustable.. 0 ... 2 A

Input

Set value input U_{Soll} (Diff. voltage) .... configurable by jumper   -10 ... +10 VDC
-3.9 ... +3.9 VDC
DC tacho input voltage U_{Tacho} .... approx. min. ± 2.6 to max. ± 50 VDC
Disable feature with switch having floating terminals .... activ/low
(Switch closed = output stage Disabled)
additional for encoder operation:
    Encoder .... channel A, channel B, „home" Impuls, max. 100 kHz

Output

Reference voltage for external potentiometer .... ± 3.9 V, max. 2 mA
(preferably 47 kOhm)
Supply voltage for encoder .... 5 V, max. 60 mA

Ambient temperature- / Humidity range

Operation .... -10 ... +45°C
Overtemperature protection....... Shut down when housing reaches approx. 80°C
Storage .... -40 ... +85°C
noncondensating .... 20 ... 80 %

Mechanical data

Weight... 330 g
Dimensions (W x H x D) .... 120 x 100 x 40 [mm]
Mounting plate .... for M4 screws
Distance between threads .... 80 x 90 [mm]

Notice

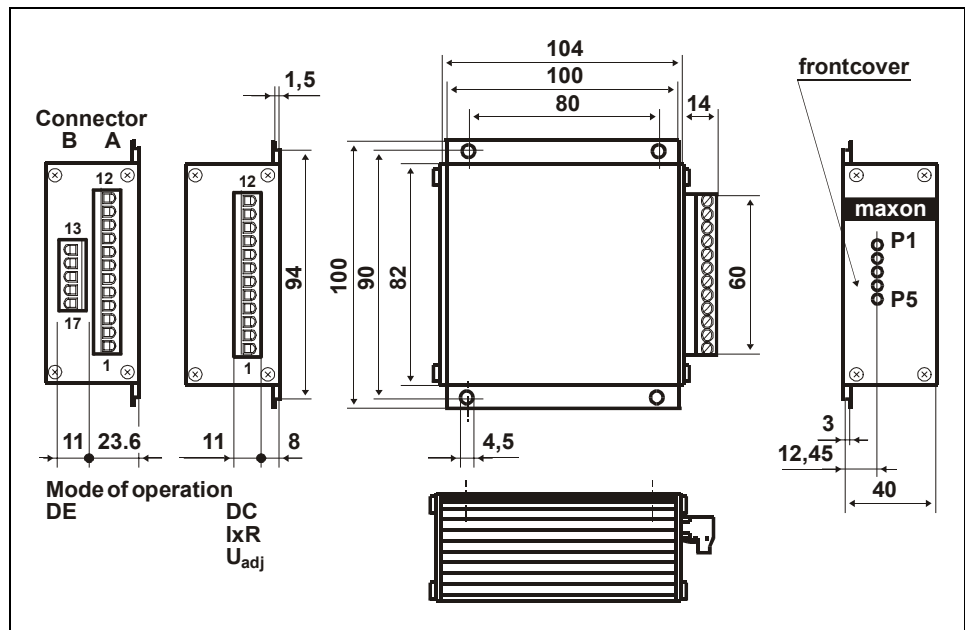Ideally the servo controller should be mounted onto a heat sink, if high ambient temperature or long duty cycles appear.

2 Block Diagram
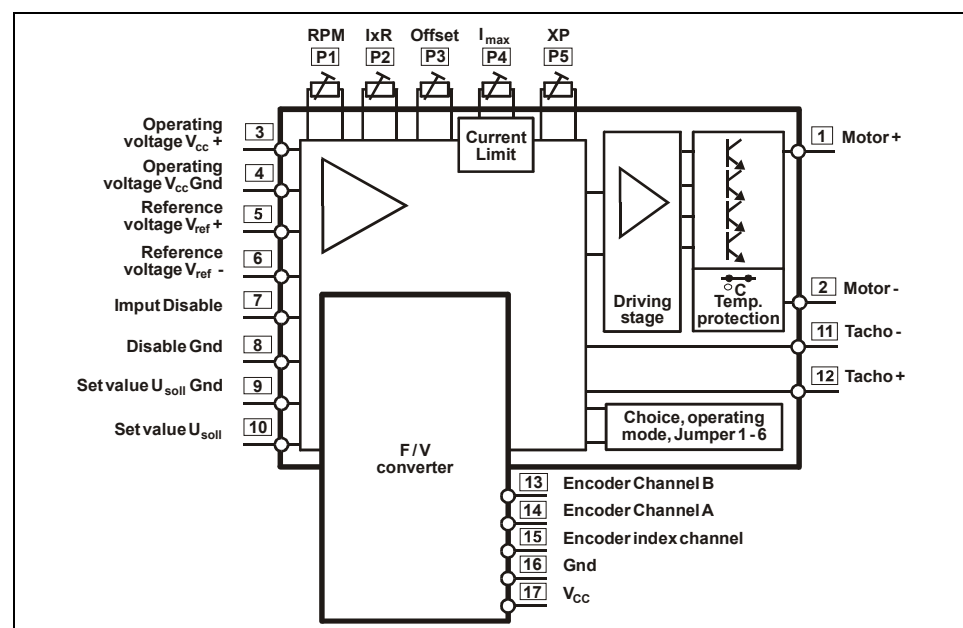
3 Dimension Drawing

Dimensions in [mm]

4 Connection

1	Motor +	
2	Motor -	
3	V_{CC} +	Operating voltage
4	V_{CC} Gnd	Operating voltage
5	V_{ref} +	Reference voltage
6	V_{ref} -	Reference voltage
7	Disable	Disable Input
8	Gnd	Disable Gnd
9	U_{Set} -	Set Value
10	U_{Set} +	Set Value
11	U_{Tacho} -	
12	U_{Tacho} +	
A	**Connector**	

13	Channel B	Encoder
14	Channel A	Encoder
15	n.c. or Index	Encoder «home» (if available)
16	Gnd	
17	V_{CC}	
B	**Connector**	

5 Installation

Different adjustments are required depending on the mode of operation. All tasks are to be done in the sequence shown in the table.

Tools required are:

One small screwdriver for the adjustments of the potentiometers.

One small Phillips type screwdriver for the LSC front plate.

One Multimeter for current and voltage measurements.

Mode of operation / Item Task	**DC** DC tacho speed control	**I x R** IxR Compensation	**DE** Digital encoder speed control	**U$_{adj}$** Voltage regulator operation
1. Pre-adjust potentiometers	x	x	x	x
2. Connect Set value circuit	x	x	x	x
3. Install plug-in jumpers	x	x	x	x
4. Arrange power source	x	x	x	x
5. Make remaining connections	x	x	x	x
6. Adjust max. desired speed	x	x	x	x
7. Adjust current limit	x	x	x	x
8. Adjust Offset	x	x	x	x
9. Adjust amplification (XP)	x	x	x	
10. Options	if required			

Item	Task	DC	I x R	DE	U$_{adj}$
1.	**Pre-adjust potentiometers**	**X**	**X**	**X**	**X**

By pre-adjusting the potentiometers you put yourself in a preferred starting position. Damage to the motor due to high currents is avoided. LSC units in original packing are already pre-adjusted. In all other cases or if in doubt proceed as shown.
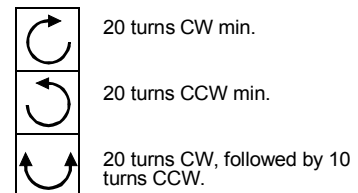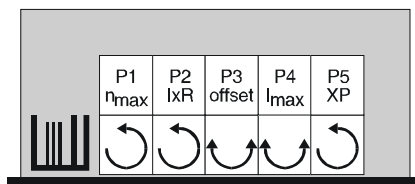
Important: The total adjustment range of the potentiometers is 20 turns (7200°). This is guarantee for precise adjustment. A built-in friction clutch prevents any damage to the potentiometers in case of over-adjustment.

P1 n$_{max}$ | P2 IxR | P3 offset | P4 I$_{max}$ | P5 XP

20 turns CW min.

20 turns CCW min.

20 turns CW, followed by 10 turns CCW.

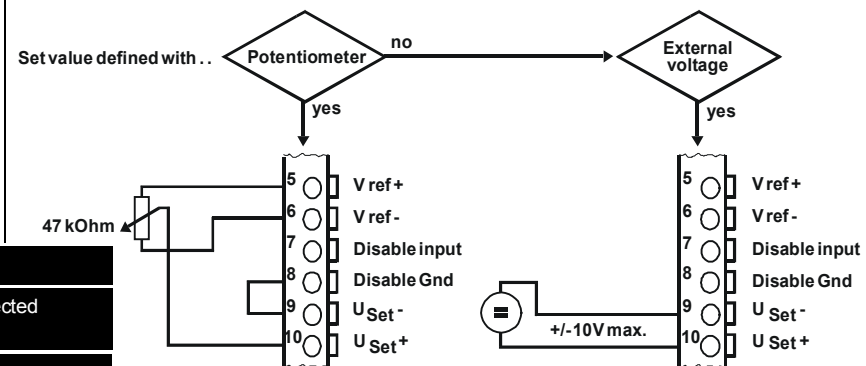| Item	Task	DC	I x R	DE	U$_{adj}$
2.	**Connect Set value circuit**	**X**	**X**	**X**	**X**

The Set value must be defined by either an external potentiometer or an external voltage source.

a) Potentiometer
- Connect potentiometer (recommended value 47 kOhm).
- Install a wire jumper between terminal 8 and 9.

b) External voltage source
- Connect a voltage source of +/- 10V max. between terminals 9 and 10.

Warning:

Disable Gnd	8	These may be interconnected
U$_{Set}$ -	9	
Motor -	2	None of these may be interconnected with any of the others. Potentials are not identical i.e. at different levels.
V$_{cc}$ Gnd	4	
Ref. Voltage -	6	
Disable Gnd	8	

Item	Task	DC	I x R	DE	U$_{adj}$
3.	**Install plug-in jumpers**	**X**	**X**	**X**	**X**

The jumpers No. 1 - 6 are located directly behind the LSC front cover. Installing a plug on top of a pair of pins interconnects these two pins. A maximum of three jumper plugs is required. Jumpers in locations 2 - 6 define the operating mode and location 1 defines the chosen Set value.

With Set value potentiometer

With external Set value voltage

1. Remove front cover

2. Install jumper plugs

offene Brücke / open Jumper

3. Re-install front cover
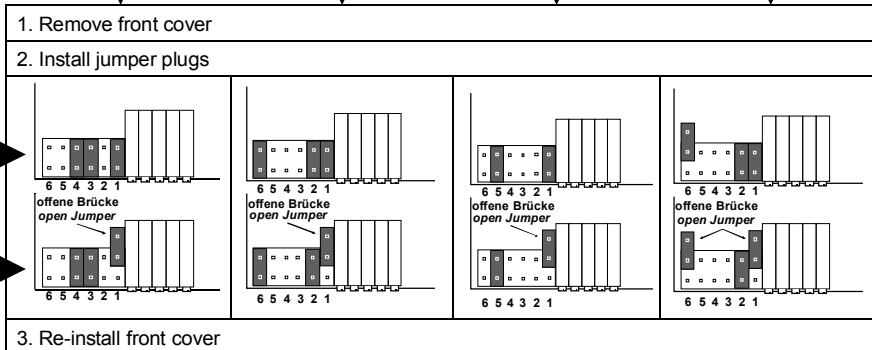
Item	Task	DC	I x R	DE	U_adj
4.	**Arrange power source**	X	X	X	X

You may use any power supply of your own choice as long as it meets the requirements shown on the right.

Power supply requirements:

Output voltage	According to the motor's minimum requirements, 30V DC max, 12V DC min.
Output current	2 A max.
Ripple	<5%
Potential	Galvanic separation from the line is recommended.

Please note:
- Local Safety regulations.
- While installing and adjusting we recommend:
  Mechanically separate the motor from the driven device to preclude damage due to unexpected motion.

Known data:
Operating torque M_B [mNm]
Operating speed n_B [rpm]
Nominal motor voltage U_N [Volt]
(According to catalog, motor data, line 2)
Motor no load speed n_0 [rpm] at U_N
(According to catalog, motor data, line 3)
Motor speed / Torque gradient $\Delta n/\Delta M$ [rpm/mNm] (According to catalog, motor data, line 5)
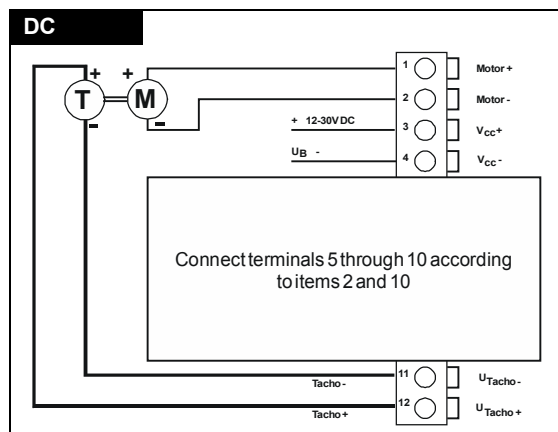
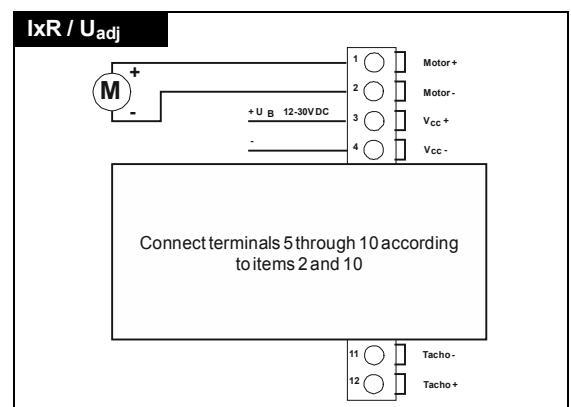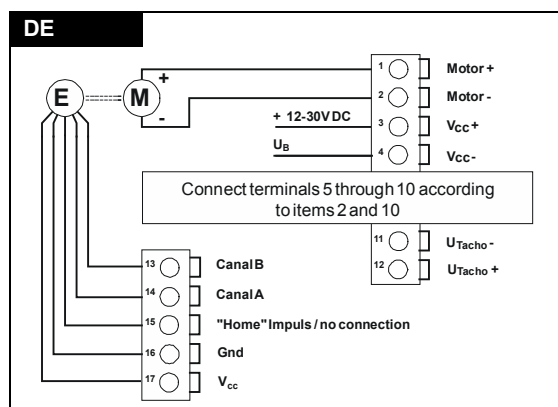**Data sought:**
Operating Voltage U_B [Volt]

Solution:

$$U_B = \frac{U_N}{n_0}(n_B + \Delta n/\Delta M \cdot M_B) + 6$$

- Select a power supply capable of providing this voltage under load.

Important:
- The maximum voltage must be in proper relationship with the desired operating point of the motor.
- The formula takes a 6 Volt voltage drop in the LSC into account.

Item	Task	DC	I x R	DE	U_adj
5.	**Make remaining connections**	X	X	X	X

DC

Connect terminals 5 through 10 according to items 2 and 10

1	Motor +	
2	Motor -	
3	Vcc+	+ 12-30V DC
4	Vcc -	U_B -
11	U_{Tacho} -	Tacho -
12	U_{Tacho} +	Tacho +

Warning:

Disable Gnd	8	These may be interconnected
U_{Set} -	9	
Motor -	2	None of these may be interconnected with any of the others. Potentials are not identical i.e. at different levels.
Vcc Gnd	4	
Ref. Voltage -	6	
Disable Gnd	8	

DE

Connect terminals 5 through 10 according to items 2 and 10

1	Motor +	
2	Motor -	
3	Vcc+	+ 12-30V DC
4	Vcc-	U_B
11	U_{Tacho} -	
12	U_{Tacho} +	
13	Canal B	
14	Canal A	
15	"Home" Impuls / no connection	
16	Gnd	
17	Vcc	

IxR / U_adj

Connect terminals 5 through 10 according to items 2 and 10

1	Motor +	
2	Motor -	
3	Vcc +	+ U_B 12-30V DC
4	Vcc -	-
11	Tacho -	
12	Tacho +	

Item	Task	DC	I x R	DE	U_adj
6.	**Adjust max. desired speed**	X	X	X	X

When either the potentiometer is in one of its extreme positions or the Set value voltage at its maximum level, then the motor is to achieve its maximum speed.
Different Set values result in respectively changed motor shaft speeds. Change in polarity causes reversal in shaft rotation.
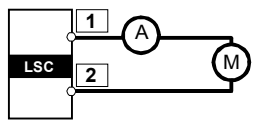
1.	Operating voltage pins 3/4	Power ON according value in item 4
2.	Set value input pin 9/10	Adjust to max.
3.	Potentiometer **P1**	Turn **P1** CW until the desired shaft speed (Voltage on motor terminals resp. in case of U_{adj}) is reached.

Item	Task	DC	I x R	DE	U_adj
7.	**Adjust current limit**	X	X	X	X

Adjust the max. permissible motor current with potentiometer **P4**.
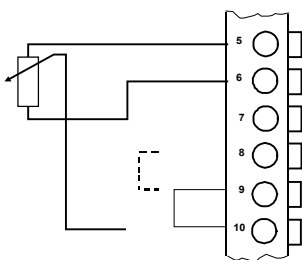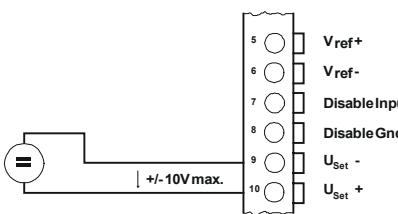As a result, the motor can only be loaded down to the defined max. current.

Important: A current range from 0 to 2 A applies for both directions of rotation.

1a.	Connect DC Amp-meter in series with motor, lock motor shaft.	
2.	Adjust set value	Turn **P4** CW or CCW until the desired max. motor current has been reached.

Item	Task	Potentiometer	External voltage
8.	**Adjust Offset**	X	X

The Offset adjustment (=Zero Adjust) causes the speed control circuit to be in position «Null» when Set value is «Null». Adjustment is done with potentiometer **P3**.

As a result, the motor shaft stands still when the Set value is 0 Volt.

1.	Remove Potentiometer connection from Pin 10.	1.	Adjust set value to 0 Volt.
2.	Switch wire jumper from 8-9 to 9-10	2.	Turn **P3** CW or CCW until motor shaft stands still or the voltage at the motor terminals is 0.
3.	Turn **P3** CW or CCW until motor shaft stands still or the voltage at the motor terminals is 0.		
4.	Move wire jumper from position 9/10 back to 8/9. Reconnect potentiometer.		

Item	Task	DC	DE	I x R	U_ad
9.	**Adjust amplification (XP)**	X	X	X	

Potentiometers **P5**, **P2** respectively, are used to adjust the control accuracy of the system.

Caution: Poor adjustment (excessive amplification) causes the LSC to oscillate. Motor as well as LSC heat up.

Current amplification is ineffective in case of voltage regulator operation. **P5** only influences the output voltage.

1.	Max. Set value	External potentiometer, external voltage respectively in MAX position.	
2.	Turn **P5** CW until the circuit begins to oscillate, the motor hums.	Turn **P2** CW until the circuit begins to oscillate, the motor hums.	
3.	Turn **P5** CCW until oscillations cease.	Turn **P2** CCW until oscillations cease, over the entire motor speed range.	

Item	Task	DC	I x R	DE	U_adj
10.	**Options**	X	X	X	X

Disable:
- The LSC can be Disabled/enabled with a simple SPST switch.
- Closing the contact causes the motor to come to an un-aided stop.
- An offset current of typically 10 mA measured in the motor circuit is normal. This means that the unloaded motor could keep rotating slowly.

Schalter offen = Betrieb
open switch = run

Schalter geschlossen = freigeschaltet
closed switch = disable