maxon motor

maxon motor control 4-Q-DC Servo Control LSC 30/2

Order number 250521

Operating Instructions June 2010 Edition

The LSC 30/2 (**L**inear **S**ervo **C**ontroller) is a linear 4-Q-Servoamplifier used to control DC motors up to approx. 50 W that are powered by permanent magnets.

It allows the following operating modes:

- IxR compensation
- Voltage regulator
- Digital encoder control
- DC tacho control
- Current control

The required operating mode is easily selected using a DIP switch.

There are also several ways of choosing the set value input:

- ± 10 V to connect to layout systems, such as a positioning controller
- auxiliary voltages ± 3.9 V are already provided by the LSC for use with external potentiometer
- well suited for fixed speed adjustment using internal potentiometer

Its wide input voltage, ranging from 12 – 30 VDC, makes the LSC very flexible for use with different voltage sources. The modular-style aluminum housing offers several fastening options, notably plugging into a 19" rack (3HE). Separable screw terminal strips and a robust controller design make the amplifier ideal for immediate use.

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The latest edition of these operating instructions may be downloaded from the Internet as a PDF-file under www.maxonmotor.com category Service & Downloads, Order number 250521 or in the e-shop http://shop.maxonmotor.com.

1 Safety Instructions

Skilled personnel
Only skilled, experienced personnel should install and start the equipment

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

Load disconnected
For initial operation, the motor should be free running, i.e. with the load disconnected.

Additional safety equipment
Any electronic equipment is, in principle, not fail-safe. Machines and apparatus must therefore be fitted with independent monitoring and safety equipment. If the equipment breaks down, if it is operated incorrectly, if the control unit breaks down or if the cables break etc., it must be ensured that the drive or the complete apparatus is kept in a safe operating mode.

Repairs
Repairs may only be carried out by authorized personnel or the manufacturer. It is dangerous for the user to open the unit or carry out any repairs.

Danger
Ensure that no apparatus is connected to the electrical supply during installation of the LSC 30/2! After switching on, do not touch any live parts!

Max. supply voltage
Make sure that the supply voltage is between 12 and 30 VDC. Voltages higher than 32 VDC or of the wrong polarity will destroy the unit.

Electrostatic sensitive device (ESD)

2 Technical Data

2.1 Electrical data

Supply voltage V_{CC} ..... 12 – 30 VDC
Max. output voltage ..... 25 V
Max. output current I_{max} ..... 2 A
Max. power output ..... 50 W
It is advisable to consider mounting on a heat sinking surface if ambient temperature is high and there is a high power loss in the LSC !

2.2 Inputs

Set value “+Set / -Set” ..... configurable ..... -10 ... +10 V or -3.9 ... +3.9 V
Disable “Dis IN” ..... Disable ..... min. V_{CC} - 1 V
Enable ..... max. Gnd + 1 V
DC tacho “+T / -T” ..... min. 2 VDC, max. 50 VDC
Encoder signals “Ch A / Ch B” ..... max. 100 kHz, TTL level

2.3 Outputs

Status reading “Ready” ..... Open collector ..... max. 30 VDC (I_L < 20 mA)
Error ..... “Ready” = high impedant
Ready ..... “Ready” = Gnd

2.4 Voltage output

Auxiliary voltages “+Vaux / -Vaux” ..... +3.9 VDC, max. 2 mA / -3.9 VDC, max. 2 mA
Encoder supply voltage “+Venc” ..... +5 VDC, max. 80 mA

2.5 Motor connections

Motor +; Motor -

2.6 Trim potentiometers

n_{max}
IxR compensation
Offset
I_{max}
gain

2.7 Protection

Heat monitoring of power stage ..... T > 85°C

2.8 LED indicator

green LED ..... READY
red LED ..... ERROR

2.9 Ambient temperature / humidity range

Operation ..... 0...+45°C
Storage ..... -40...+85°C
No condensation ..... 20...80 %

2.10 Mechanical data

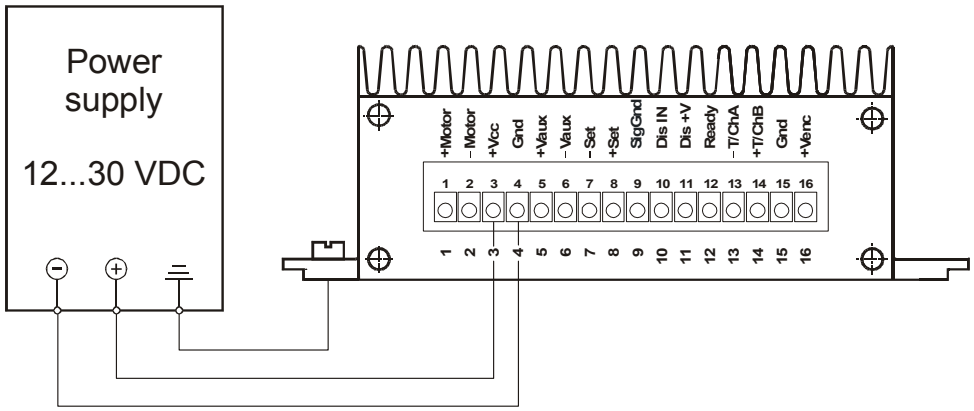
Weight ..... approx. 330 g
Mounting plate ..... for 4 screws M4
Dimensions ..... see dimension drawing, chapter 10

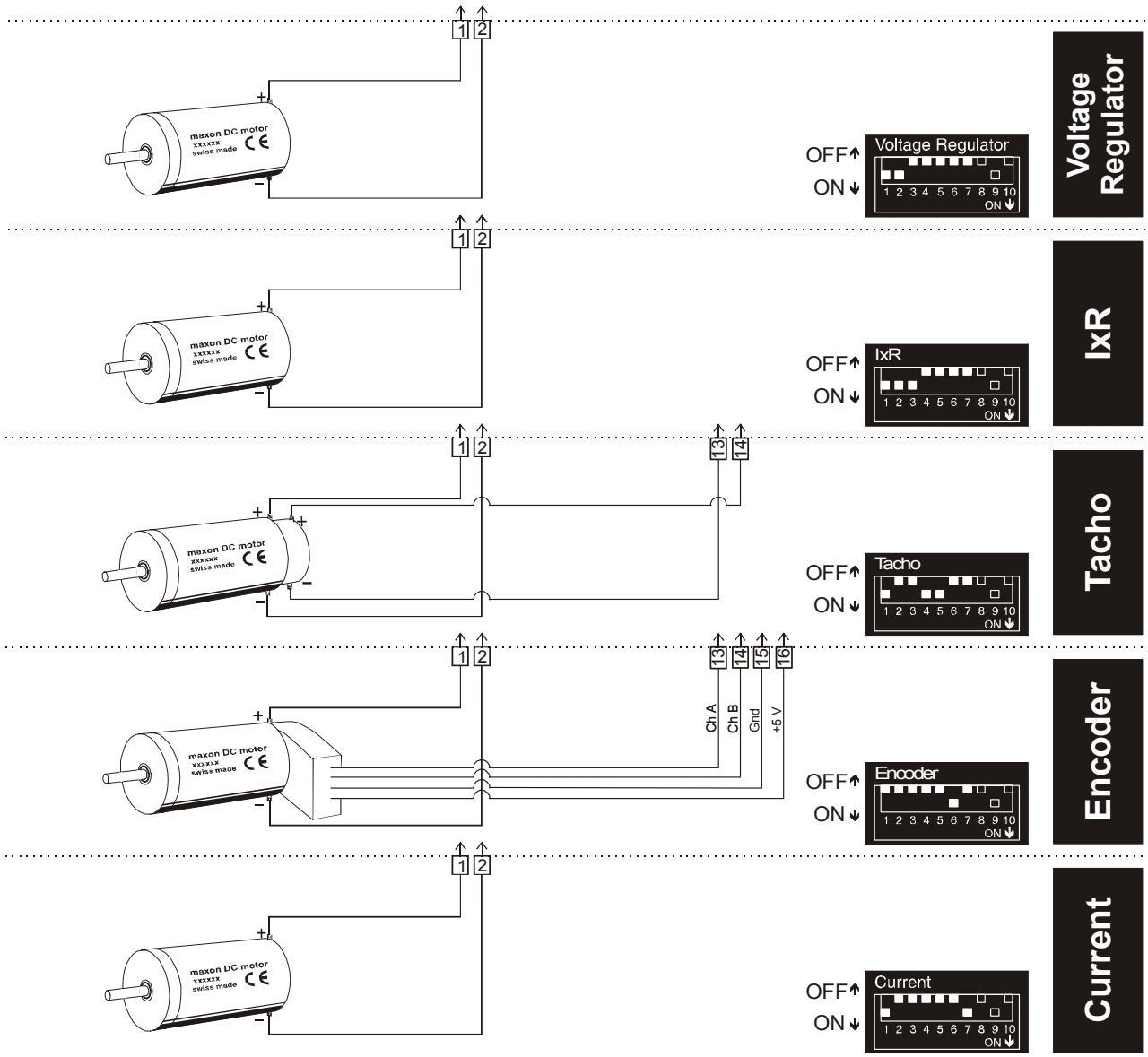
2.11 Terminals

separable PCB terminals 16-pole
Pitch ..... 3.5 mm
suitable for wire cross-section ..... AWG 28-18
0.14 ... 1 mm^2 multiple-stranded; 0.14 ... 1.3 mm^2 single wire

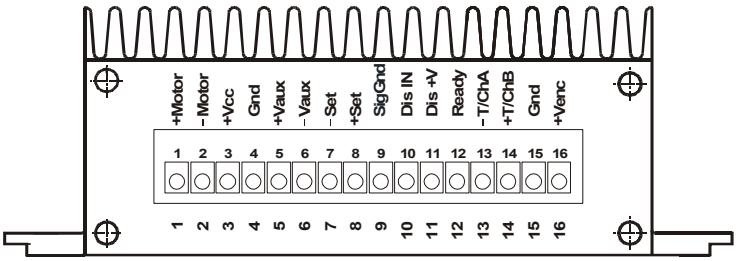
3 Minimum External Wiring

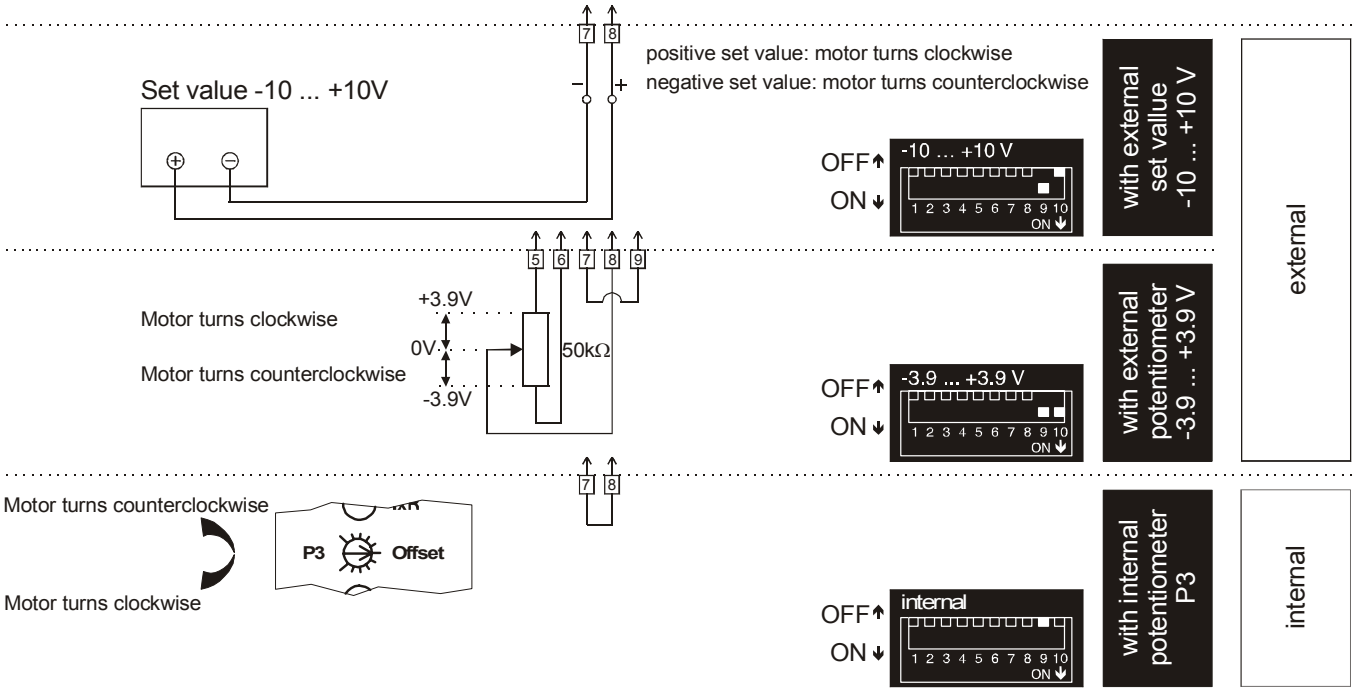
3.1 Operating mode





3.2 Set value input





4 Start-up Procedure

4.1 Power supply layout

Any available power supply can be used as long as it meets the minimum requirements set out below.
During set-up and adjustment phases, we recommend separating the motor mechanically from the machine to prevent damage from uncontrolled motion.

Power supply requirements	
Output voltage	V_{CC} min. 12 VDC; V_{CC} max. 30 VDC
Ripple	< 5 %
Output current	depending on load, continuous max. 2A

The required voltage can be calculated as follows:

Known values:
- ⇨ Operating torque M_B [mNm]
- ⇨ Operating speed n_B [rpm]
- ⇨ Nominal motor voltage U_N [V]
- ⇨ Motor no-load speed at U_N, n_0 [rpm]
- ⇨ Speed/torque gradient of motor $\Delta n/\Delta M$ [rpm/mNm]

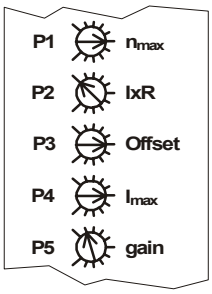
Sought values:
- ⇨ Supply voltage V_{CC} [V]

Solution:

$$V_{CC} = \frac{U_N}{n_0} \cdot (n_B + \frac{\Delta n}{\Delta M} \cdot M_B) + 5V$$

Choose a power supply capable of supplying this calculated voltage under load. The formula takes into account a 5 V maximum voltage drop at the power stage.

4.2 Function of potentiometers



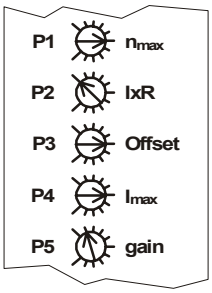
Potentiometer		Function	Turning direction	
			left ↺	right ↻
P1	n_{max}	maximum speed at maximum set value	Speed lower	Speed higher
P2	IxR	IxR compensation	weak compensation	strong compensation
P3	Offset [1]	Adjustment = 0 rpm at 0 V set value	Motor turns CCW	Motor turns CW
P4	I_{max}	Current limit	lower min. approx. 0 A	higher max. approx. 2 A
P5	gain	Speed control gain	lower	higher

[1] **P3** can also be used for the set value input (see 5.1.1)

4.3 Adjusting the potentiometers

4.3.1 Pre-adjustment

With pre-adjustment, the potentiometers are set in a preferred position.
Units in the original packing are already pre-set.



Pre-adjustment of potentiometers		
P1	n_{max}	50 %
P2	IxR	0 %
P3	Offset	50 %
P4	I_{max}	50 %
P5	gain	10 %

4.3.2 Adjustment

Encoder operation
DC tacho operation
Voltage regulator
IxR compensation

1. Apply max. set value (10 V or 3.9 V) and turn potentiometer **P1 n_{max}** until required max. speed is reached.
2. Adjust potentiometer **P4 I_{max}** to required limit value.
   Limited current in the 0…2 A range can be adjusted in linear fashion with the **P4** potentiometer.
   Important: The limit value I_{max} should be below the nominal current (max. permissible continuous current) as per motor data sheet.
3. Slowly increase potentiometer **P5 gain** until the gain is set sufficiently high.
   Important: If the motor is unsteady, vibrates or makes noises, the selected amplification is too high.
4. Apply 0 V set value and adjust the motor to speed 0 rpm with potentiometer **P3 Offset**.
   Important: DIP switch **S9** must be set in the "ON ↓" position for offset adjustment.

Applicable to IxR compensation only:

5. Slowly increase potentiometer **P2 IxR** until compensation is set sufficiently high so that the motor speed does not drop or only drops very slightly at higher motor load.
   Important: If the motor is unsteady, vibrates or makes noises, the selected compensation is too high.

Current regulator

1. Adjust potentiometer **P4 I_{max}** to required limit value.
   Limited current in the 0…2 A range can be adjusted in linear fashion with the **P4** potentiometer.
   Important: The limit value I_{max} should be below the nominal current (max. permissible continuous current) as per motor data sheet.
2. Apply 0 V set value and adjust the motor to current 0 A with potentiometer **P3 Offset**.
   Important: DIP switch **S9** must be set in the "ON ↓" position for offset adjustment.

Note:

- DIP switch **S10** in position:
  "ON ↓": Set value range -3.9 ... +3.9 V equivalent to approx. -2 ... +2 A motor current
  "OFF ↑": Set value range -10 ... +10 V equivalent to approx. -2 ... +2 A motor current
- In current regulator operation, potentiometers **P1 n_{max}**, **P2 IxR** and **P5 gain** are not active.

5 Inputs and Outputs

5.1 Inputs

5.1.1 Set value "Set"

The set value can be applied externally via an analogue voltage or internally using potentiometer **P3**.

If the set value is applied externally using the "+Set" and "-Set" connections, DIP switch **S9** must be in the "ON↓" position.

Two different ranges can be selected to apply an external analogue set value. The required range is determined by the position of DIP switch **S10**.

Set value range -10 ... +10 V		
	Input voltage range	-10 ... +10V
	Input wiring	differential
	Input impedance	200 kΩ (differential)
	positive set value	(+Set) > (-Set) positive motor voltage or current
	negative set value	(+Set) < (-Set) negative motor voltage or current
	DIP switch **S10**	OFF↑
	DIP switch **S9**	ON↓

Use of external potentiometer

Set value range -3.9 ... +3.9 V		
	Input voltage range	-3.9 ... +3.9 V
	Input wiring	differential
	Input impedance	200 kΩ (differential)
	positive set value	(+Set) > (-Set) positive motor voltage or current
	negative set value	(+Set) < (-Set) negative motor voltage or current
	DIP switch **S10**	ON↓
	DIP switch **S9**	ON↓
	recommended potentiometer	50 kΩ (linear)

Use of internal potentiometer P3

If the set value is adjusted internally via potentiometer **P3**, DIP switch **S9** must be in the "OFF↑" position.

P3 = 50 ... 100 % (right end stop)	positive motor voltage or current
P3 = 50 ... 0 % (left end stop)	negative motor voltage or current
Input wiring	(+Set) = (-Set) short-circuited
DIP switch **S10**	optional
DIP switch **S9**	OFF↑

5.1.2 "Disable"

Enabling or disabling the power stage.

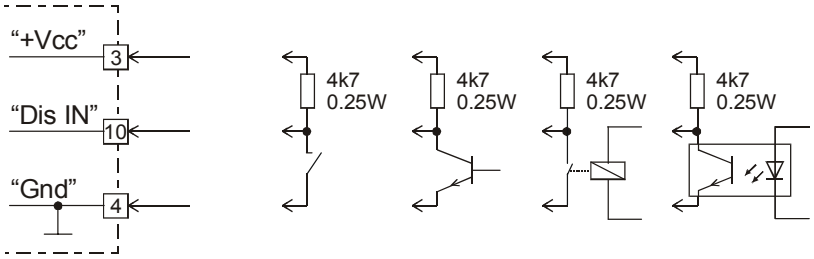
If the "Dis IN" connection is not connected or at Gnd potential, the power stage is activated (Enable).

Release "Enable"		
	minimum input voltage	Gnd
	maximum input voltage	+1 VDC referenced to Gnd
	maximum input current	2 mA

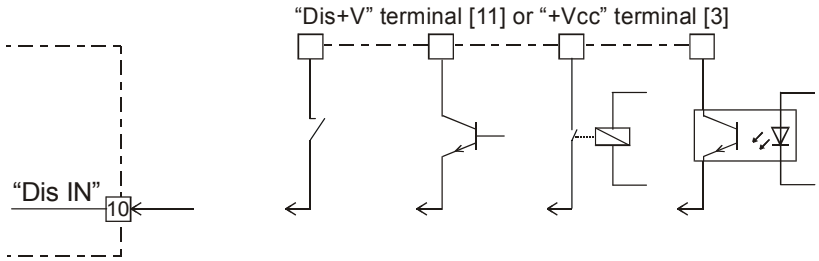
If the "Dis IN" terminal is connected with "Dis+V" or the voltage is higher than V_{CC} -1V, the power stage becomes high impedant and the motor shaft freewheels and slows down (Disable).

Block "Disable"		
	minimum input voltage	V_{CC} - 1 VDC
	maximum input voltage	V_{CC}
	maximum input current	2 mA

Wiring examples:
a) Switch open = "Disable"; switch closed = "Enable"



b) Switch open = "Enable"; switch closed = "Disable"



5.1.3 DC tacho

+T	positive tacho voltage	terminal [14]
-T	negative tacho voltage	terminal [13]
	minimum input voltage	2.0 V
	maximum input voltage	50.0 V
	Input impedance	approx. 20 kΩ

Speed control range:
The speed range is set using Potentiometer **P1 n_{max}** (max. speed at maximum set value).
For full speed control with ± 10 V or ± 3.9 V, the tacho input voltage range must be at least ± 2 V.

Example for a DC-tacho with 0.52 V / 1000 rpm:
2.0 V tacho voltage is equivalent to a speed of approx 3850 rpm. If the full set value range has been used, the lowest adjustable speed with the n_{max} potentiometer is 3850 rpm.
Lower speed ranges can be reached through a reduced set value range or by using a DC tacho with a higher output voltage, such as 5 V / 1000 rpm.

5.1.4 Encoder

ChA	Channel A	terminal [13]
ChB	Channel B	terminal [14]
	Encoder supply voltage +Venc	+5 VDC, max. 80 mA
	max. encoder input frequency	DIP switch **S8** OFF↑: 100 kHz DIP switch **S8** ON↓: 6 kHz
	Voltage level	TTL low max. 0.8 V high min. 2.0 V

The maximum encoder input frequency can be selected with DIP switch **S8**. Standard adjustment is max. encoder frequency of 100 kHz.

DIP switch **S8** OFF↑: "high"	
Max. input frequency is 100 kHz	
Encoder pulses per revolution	maximum motor speed
1000	6 000 rpm
512	11 719 rpm
500	12 000 rpm
256	23 437 rpm
128	46 874 rpm

DIP switch **S8** ON↓: "low"	
Max. input frequency is 6 kHz	
Encoder pulses per revolution	maximum motor speed
128	2 812 rpm
64	5 625 rpm
32	11 250 rpm
16	22 500 rpm

Note:
To achieve good control characteristics, encoders should be operated at a small number of pulses per revolution with the DIP switch **S8** in position ON↓ "low".

5.2 Outputs

5.2.1 Auxiliary voltage “+Vaux” and “-Vaux”

Auxiliary voltage for supplying an external potentiometer (50 kΩ).

+Vaux	positive auxiliary voltage	terminal [5]
	Output voltage	+3.9 VDC referenced to Sig_Gnd
	Max. output current	2 mA

-Vaux	negative auxiliary voltage	terminal [6]
	Output voltage	-3.9 VDC referenced to Sig_Gnd
	Max. output current	2 mA

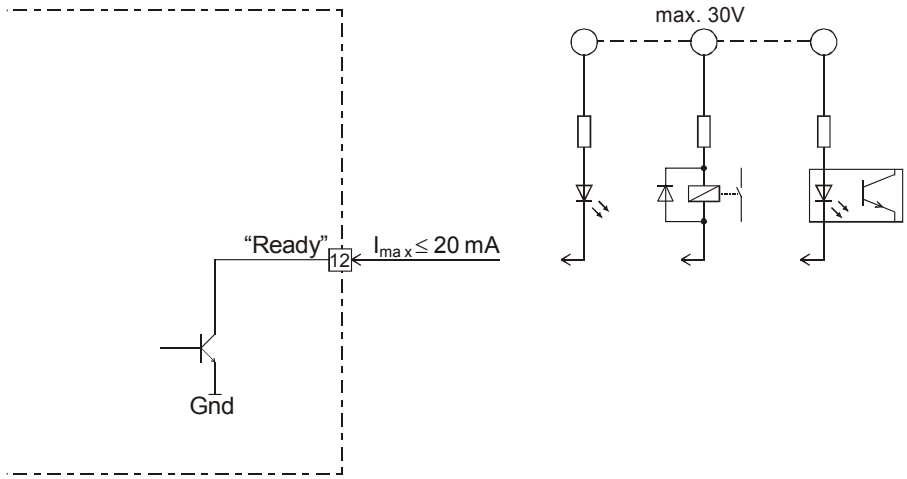
5.2.2 Encoder supply “+Venc”

Auxiliary voltage for supplying the encoder

+Venc	Encoder supply voltage	terminal [16]
	Output voltage	+5.0 VDC referenced to Gnd
	Max. output current	80 mA

5.2.3 Status reading “Ready”

The readiness or error status can be reported to a higher level control through the “Ready signal”. In normal circumstances, i.e. with no errors, the “Open Collector” output is switched to Gnd.
In the event of an error (overheating), the output transistor is blocked.



Input voltage range	max. 30 VDC
max. load current	20 mA

6 Operating Status Display

A red and green LED shows the operating mode.

6.1 No LED

Reason:

- No supply voltage
- Fuse faulty
- Wrong polarity of supply voltage

6.2 Green LED

- Supply voltage applied
- No error status (overheating)

6.3 Red LED

If the power stage temperature exceeds a limit of approx. 85°C,
the power stage is switched off. (Disable - status).
The red LED comes on and the green LED goes out.

If the power stage temperature falls below approx. 60°C, the motor is restarted.
(Enable - status)
The red LED goes out and the green LED comes on.

Reason:

- High ambient temperature
- High power loss in the LSC
- Bad convection
- Heat sinking surface too small

7 Error Handling

Error	Possible cause of error	Action
Motor does not turn	Supply voltage V_{CC}< 12 VDC	Check terminal [3] voltage "V_{CC}"
	Disable not activated	Check terminal [10] "Dis IN"
	Overheating disconnection active	Loss output in the LSC too high
	Set value input 0 V	Check terminal [7] "-Set" and [8] "+Set"
	Incorrect operating mode selected	Check adjustments at DIP switch
	Bad contact	Check terminals
	Incorrect wiring	Check wiring
	Current limit too low	Check adjustment Potentiometer **P4 I_{max}**
Speed not controlled	Encoder mode: encoder signals	Check "ChA" [13] "ChB" [14] sequence
	Tacho mode: tacho signals	Check polarity "-T" [13] and "+T" [14]
	IxR mode: compensation incorrect	Check adjustment Potentiometer **P2 IxR**

8 EMC-compliant installation

Power supply (+V_{CC} - Power Gnd)

- No shielding normally required.
- Star point-shaped wiring if several amplifiers are supplied by the same power supply.

Motor cable

- No shielding normally required.

Encoder cable

- Although the LSC 30/2 does not have a line receiver, using an encoder with a line driver is recommended as this improves interference resistance.
- Use cable shielding in electromagnetically harsh environment.
- Connect shielding on both sides (LSC housing).
- Use separate cable.

Analogue signals (Set, Tacho, Vaux)

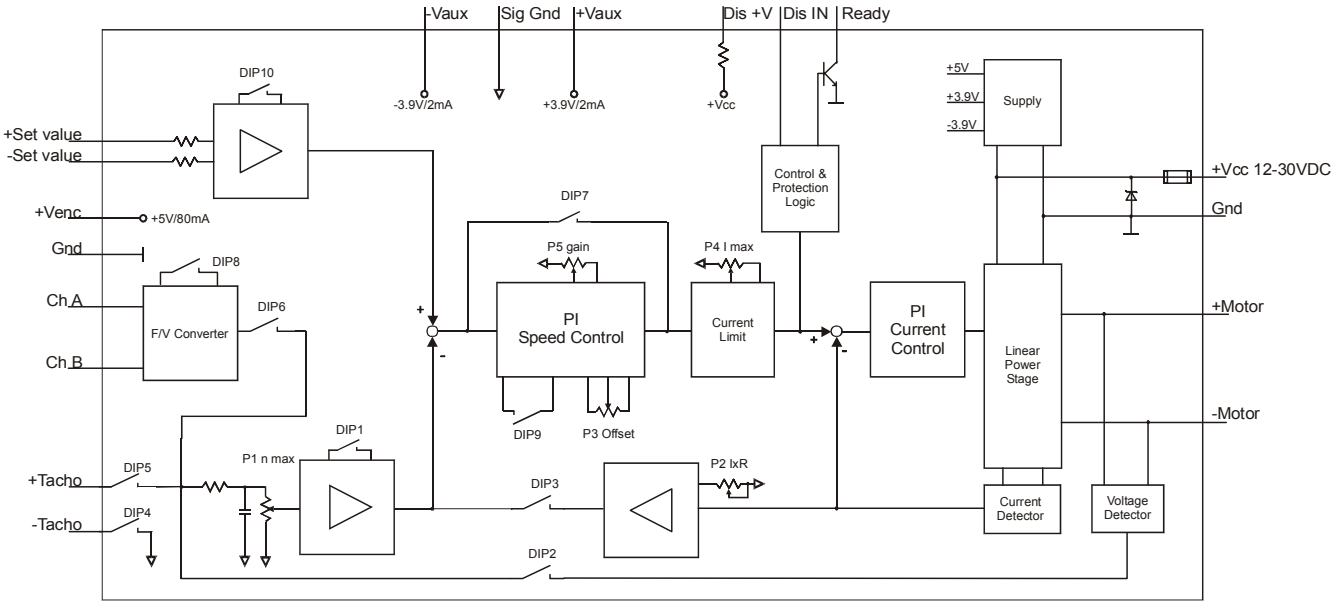
- No shielding normally required.
- Use cable shielding with analogue signals with small signal level and electromagnetically harsh environment.
- Normally connect shielding on both sides (LSC housing). Place shielding on one side if there are 50/60 Hz interference problems.

Digital signals (Disable, Ready)

- No shielding necessary.

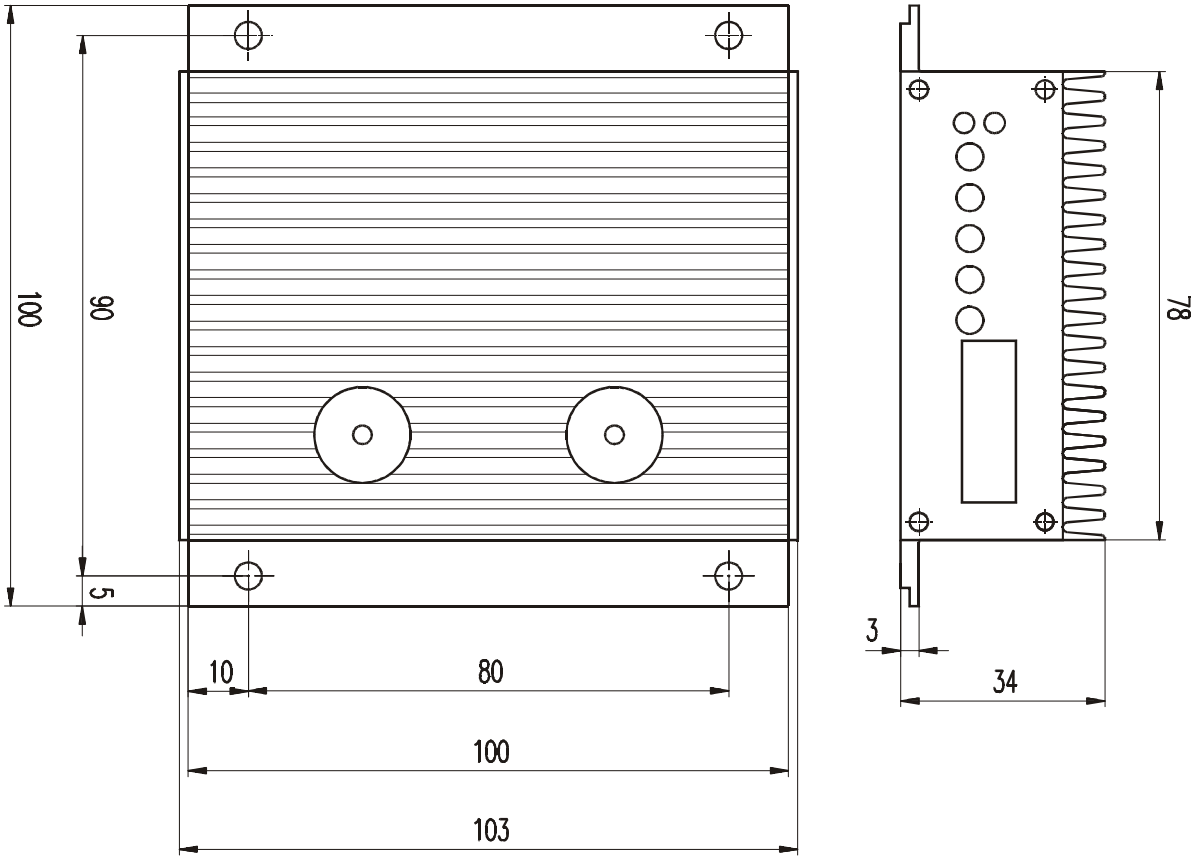
In practical terms, only the complete equipment, comprising all individual components (motor, amplifier, power supply unit, EMC filter, cabling etc.) can undergo an EMC test to ensure interference-free CE-approved operation.

9 Block Diagram



10 Dimension Drawing

Dimensions in [mm]



11 Spare Parts List

maxon motor order number	Designation
282310	16 poles pluggable PCB connector pitch 3.5 mm