# µServo drive user's guide

Features:

- Precise positioning with adjustable PID filter.
- Closed loop operation with incremental encoder feedback.
- Short circuit protection.
- Overtemperature protection.
- Fixed current limiting at 6.5A.
- Built in low inerthia switch and 4X step multiplier.
- Adjustable servo error lockout limit.
- Integrated heatsink.
- Miniature mechanical footprint.
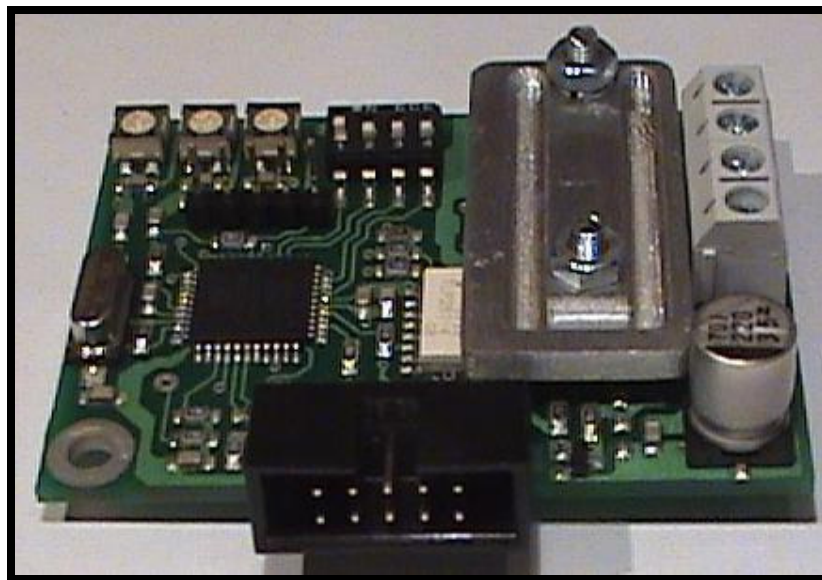
Introduction:

Micro servo drive is a 2nd generation DC servomotor controller of CNCdrive.
**The device is able to position one brushed DC servomotor in closed loop.**
The position feedback device must be an incremental encoder with A and B channels.
The servo controller has 30Volts and 5Ampers continious current capability, it's ideal to drive small CNC lathes and mills and it may be used in robotic and other applications where closed loop fast positioning is required.
This document describes electrical specifications, signals, connections and pinouts of the servo controller.

1.) Connections and pinouts

a.) Main connector
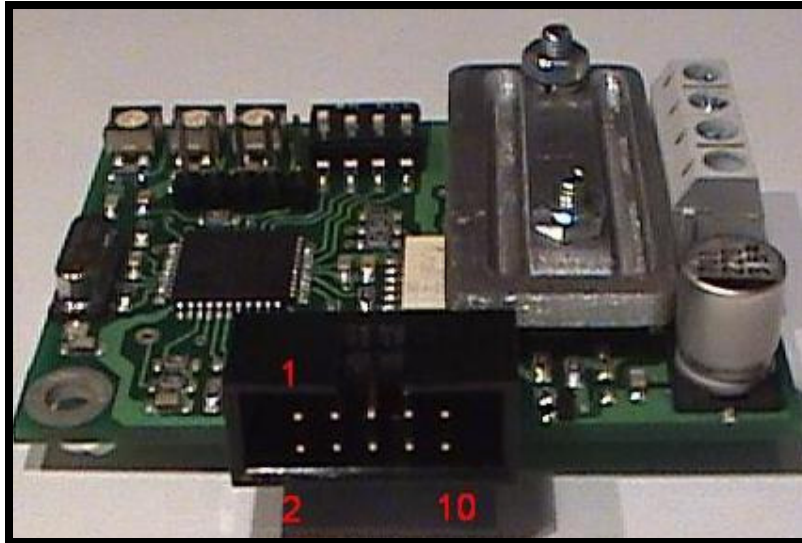
Pin1. - **Encoder channel A input.**
   A TTL level (0..5V) signal must applied to this input.

Pin2. - **Encoder channel B input.**
   A TTL level (0..5V) signal must applied to this input.

Pin3. - **Vdd output for the encoder.**

Pin4. - **Encoder ground terminal.**
   Same as pin 6.

Pin5. - **Step signal input.**
   Motor rotates one increment on every rising edge on this signal.
   A TTL level (0..5V) signal must applied to this input.

Pin6. - **Grounding input from step/direction source.**
   Step & dir signals should be referenced to this ground level.
   This signal is also the gound input terminal for the digital supply Voltage.

Pin7. - **Direction signal input.**
   Indicates direction of rotation, read on every rising edge on Pin5.
   A TTL level (0..5V) signal must applied to this input.

Pin8. - **5V input to supply digital part of the controller.**
   Use a regulated Voltage source on this input and never exceed values   listed
   in the electric specifications – digital part section. Exceeding these values may
   cause permament damage in the device!

Pin9. - Bidirectional fault output and reset input line.

Under normal operation this line is internally pulled up to Vdd.
In case of an internal error, the controller pulls this line low indicating the problem.
This line may pulled up externally to Vdd by another device, switch, pushbutton etc. in this case the device resets itself.
The line may also pulled to ground potential, in this case the controller stops operation and releases the motor outputs and freewheels the motor while the line is pulled low.

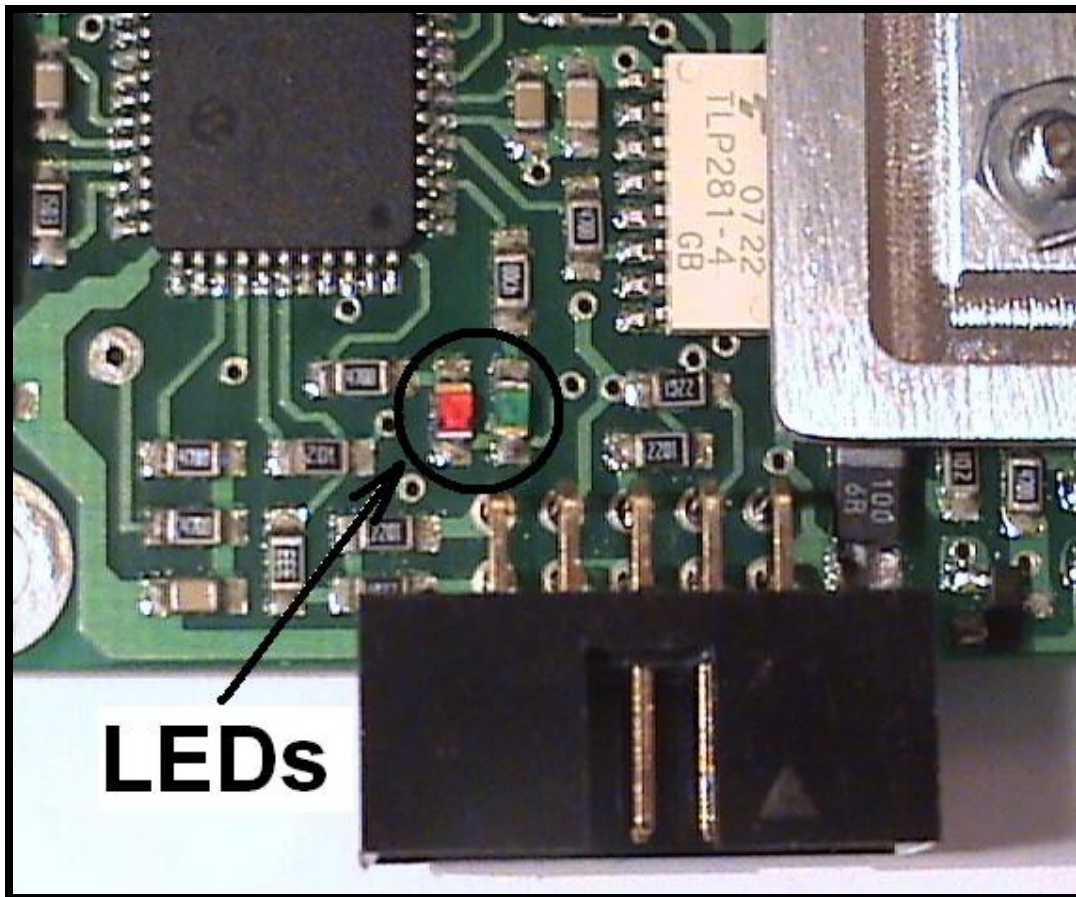**Pin10. - Ground terminal.**

Same as pin 6.

b.) Motor and motor power supply connector
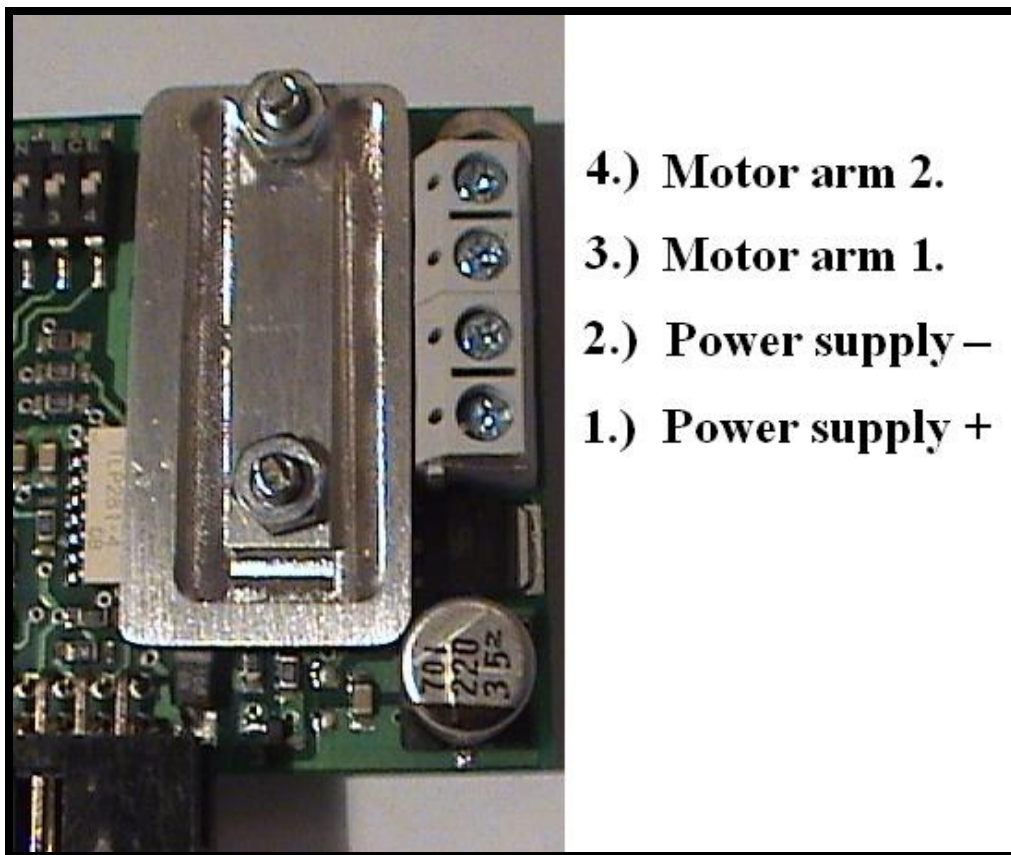
Pinout of the connector:

1.) **Power supply +**
   Connect motor power supply positive terminal here.
2.) **Power supply –**
   Connect motor power supply negative (GND) terminal here.
3.) **Motor arm 1.**
   Connect motor terminal 1. here.
4.) **Motor arm 2.**
   Connect motor terminal 2. here.

2.) Signs and errors.

There are two LEDs on the board, one green and one red LED.

🟩 Under normal operation, the green LED is blinking with around 2Hz frequency and the red (error LED) is off.

a.) Overcurrent and/or overtemperature error

The device has active current limiting at typicaly 6.5Ampers. If the load is too heavy on the motor outputs or there's a short circuit, the motor outputs are tristated and the controller stops operation automaticly.

If the temperature of the power stage reaches 160°C, the current capability is reduced and the current limit treshold is lower until the device reaches the 175°C temperature, then the motor outputs are tristated and the controller stops operation. There's a 15°C hysteresis, when the controller detects overtemperature, it cannot be restarted until the temperature falls under 160°C again.

🟥 Both overcurrent and overtemperature error signes are blinking red(error) LED.

b.) Servo error lockout

Servo error limit can be set with the built in microswitches to 128,512,2048,4096 encoder increments.
When the limit value is reached, in other words when the absolute value of the **commanded position – real position > error limit** then the motor outputs are tristated and the controller stops operation.

■ The sign of this error is continious red LED on.

When any of the errors occurs, the error line in the main connector (Pin9.) is pulled to ground level by the internal logic of the controller indicating the error to other controllers or to external devices which are also connected to this line.
The error can be cleared with appliing Vdd (5Volts) to the error line externally or switch off and on the device.

3.) Reset and stop circuit

There's only one pin (pin9. in the main connector) for both reset and stop functions.
Under normal operation this line is an input, but it's pulled to Vdd with a weak pullup resistor inside the controller. The controller is running under normal operation when this line is left unconnected and not pulled to any Voltage levels by any external devices.

When the line pulled to GND, the controller stops working, the Green LED stops blinking, the error LED stays in off state, the outputs are tristated and the controller stops working. This condition exist until the line is pulled to Vdd externally or if the line is released and the controller is restarted with power down and up again.

The error line is bidirectional, that means that the controller can also pull this line to low (GND) in case of any internal errors, like short circuit, overtemperature, etc.

When the error line pulled to Vdd externally, the controller resets, this clears fault condition and the controller starts working again.

4.) Micro DIP switch settings.
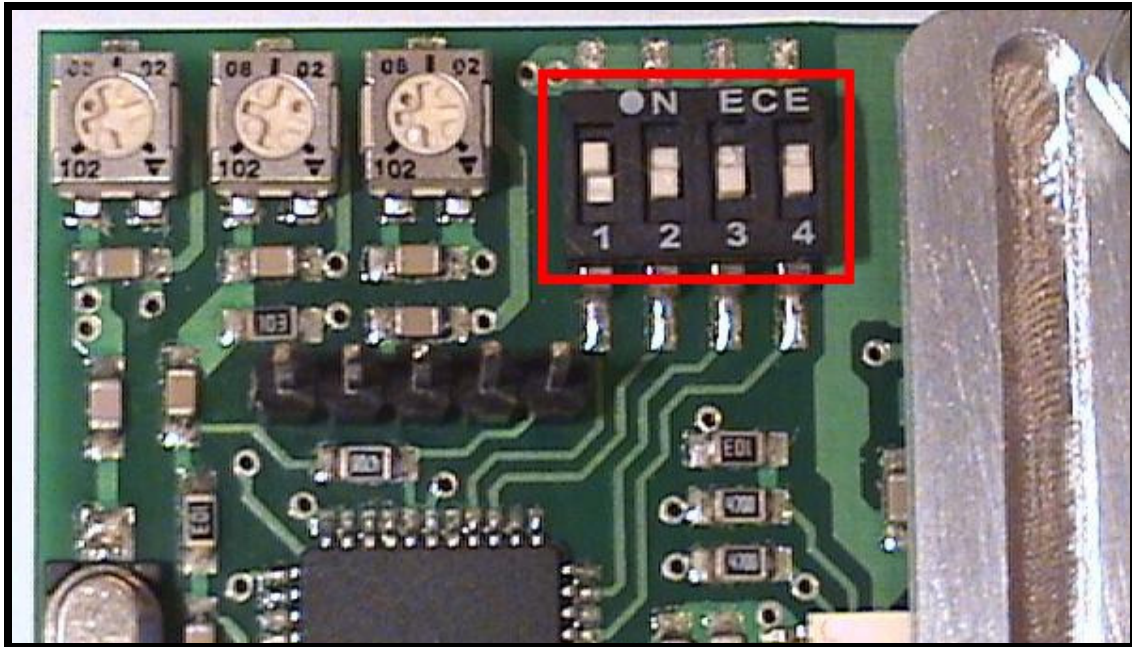
The DIP switch contains 4 on/off switches.
The meaning of the switches follows:

- Switch 1.

   0 - Low inerthia compensation on
   1 - Low inerthia compensation off

- Switch 2.

   0 - Step multiplier = 1X
   1 - Step multiplier = 4X

- Switches 3-4.

   00 - error limit = +-128 steps
   01 - error limit = +-512 steps
   10 - error limit = +-2048 steps
   11 - error limit = +-8192 steps

   The switch settings are only read by the controller at startup, new switch settings sensed and accepted only after restarting the device.

   Note: Switch positions: 0= down, 1=up.

5.) Analog servo error measurement
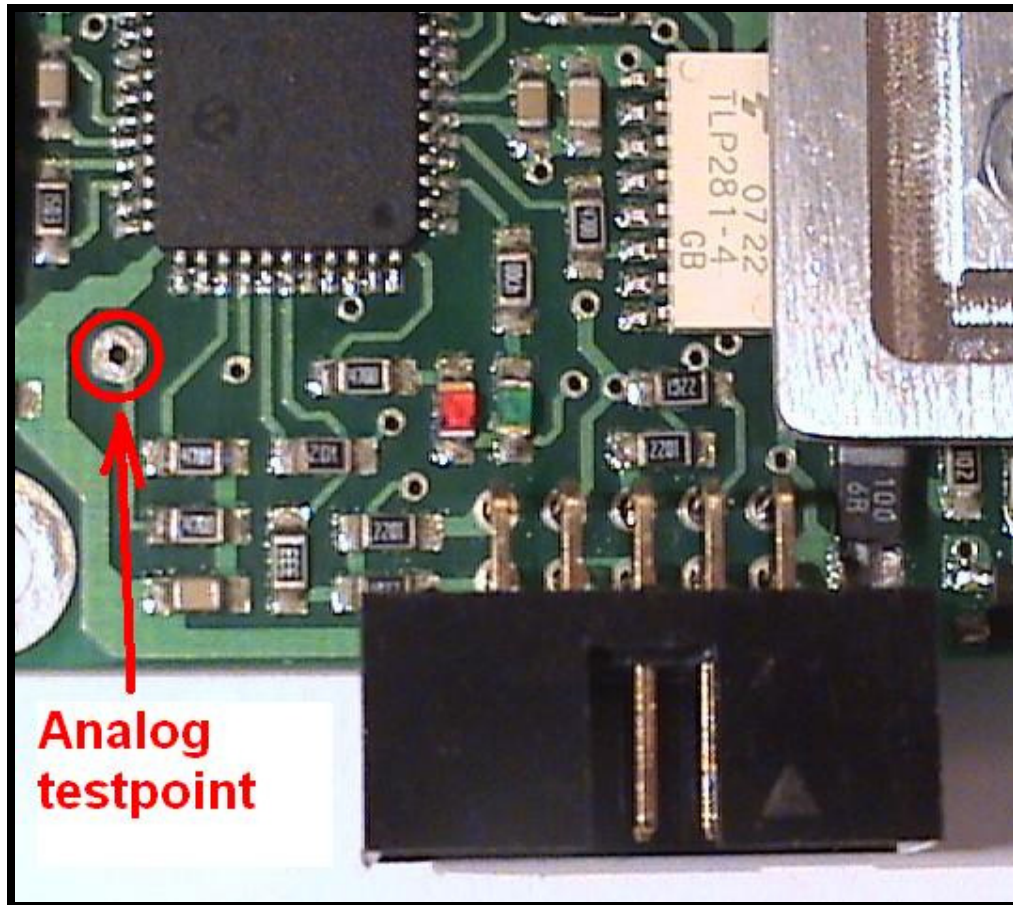
Analog testpoint

There's a testpoint on the board with an analog output, the analog signal is proportional to the servo error.
Place an oscilloscope probe onto the testpoint and to the ground potential.
When the servoerror is 0 increments, in other words the rotor is in the commanded position, the voltage on the testpoint is 2.5VDC (VDD/2).

When the servo error is equal to the error limit(see point4.), the Voltage on the testpoint is Vdd (5VDC).

When the servo error is equal to -error limit, the Voltage on the testpoint is 0VDC.

6.) PID parameter settings

There are 3 potentiometers placed onto the board.
The set value of the potentiometers are monitored by the controller continiously under operation.
A PID controller which is commonly used in automatition implemented into the drive, user have to set P,I and D terms to fit to the plant (servomotor+mechanics).
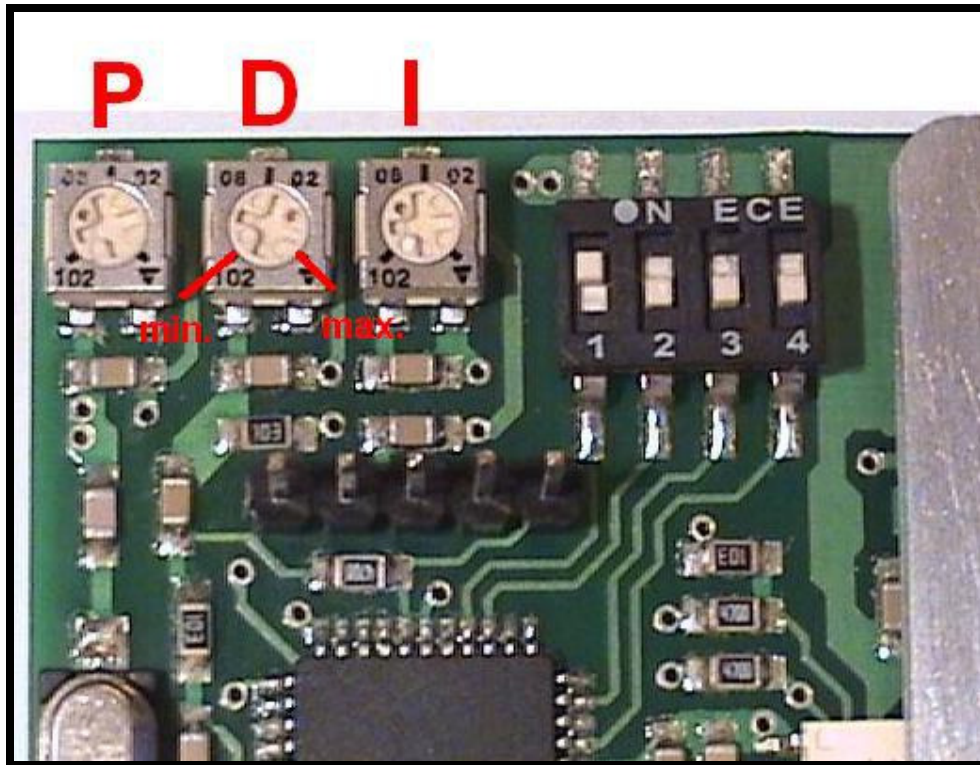
The functions of the potentiometers:

Pot. P.) Proportional term, gain
Increasing the PID gain causes less servo error, faster response, but it also decrease stability of the control loop.
Pot. D.) Differential term, damping
Increasing the damping causes slower response, but increases stability of the loop.
Pot. I.) Integral term, integral gain
Integral gain is to trim out following error and this term is responsible for settling into correct position. Increasing this gain decreases following error, makes the settling faster and more precisible, but it also decrease stability.

The potentiometers have two end-limits (signed with max. and min. on the above picture), care must be taken to do not overturn/overtorque them with the screwdriver!

7.) Step and direction interface

Step(Pin5.) and direction(pin6.) input pins found in the main connector.
When a rising edge occurs on the step pin, the controller rotates the motor one increment to CW or CCW, the direction of rotation depends on the state of the direction pin.
The inputs are not isolated from the digital power supply, the signals are on the digital PSU's potential, it is recommended to opto isolate the signal when connected to the computer.
Alternatively the 5V for the logic part can be the PC's 5V supply e.g. from the USB port, this is safe, because the power bridge of the controller is isolated from the logic part.

8.) Incremental encoder interface

The controler loop is closed in position. An incremental encoder which is tipically connected onto the motor's backshaft provides the position feedback for the controller. The encoder must be an incremental type with at least A and B channels. Some encoders have Index channel, but the controller does not use this channel, there's no need for the Index channel to use the encoder with the uservo controller. The encoder must have TTL level outputs on the A and B channels otherwise Voltage level translation is nessessary.

9.) Current limiting

Continious current flow is limited by the drive at tipically 5Ampers and peak-current is limited at tipicaly 6.5Ampers. When motor current rises above 6.5A, the outputs turned of for a short time, while current falls under 5A.
If the load is too heavy on the outputs or there's a short circuit, the drive will be unable to limit the current and the current will rise above 10A, in this case automatic shutdown occurs to protect the drive against overcurrent, the outputs are tristated and the controller stops working. Fault condition can be cleared in the way written in point 2.a. of this documentation.

7.) Step and direction interface

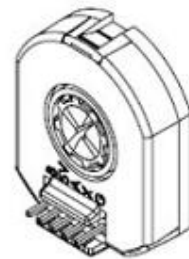**Step(Pin5.) and direction(pin6.) input pins found in the main connector.**
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10.) Optional end/limit swithes.
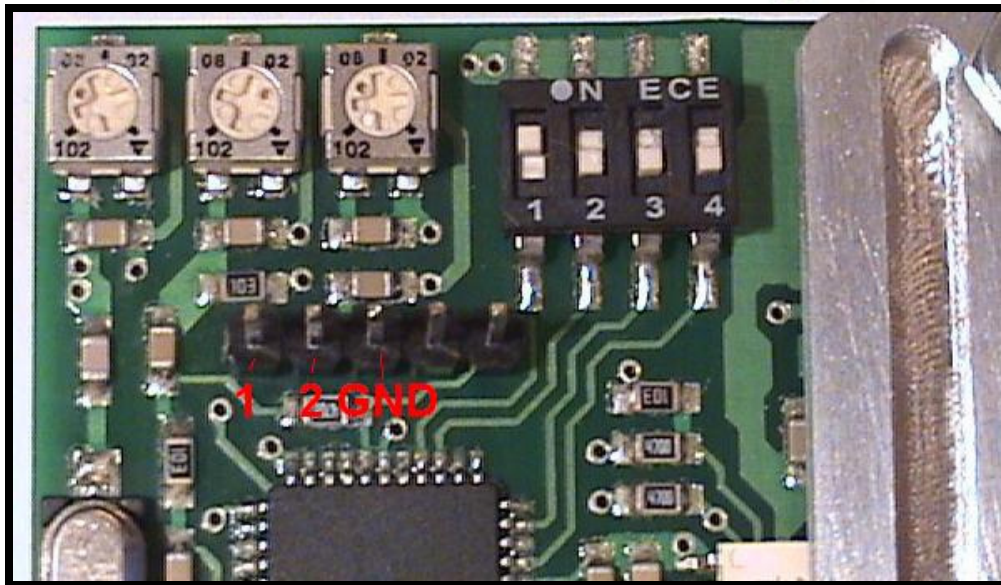
There's an option to connect two safety limit switches to the controller.
The factory programming terminal has two pins(pin 1. and 2.), which are inputs and used to disable the running of the controller to one-one direction.

A default open type switch can be connected onto the pins, when the machine runs onto the limitswitch, it should pull the line low. In this case one direction of rotation is disabled and the motor is freeweeled to that direction.
The two switches are for disable the two directions independently, so 1-1 limit switch can be placed separately wired onto the machine's axis.
When the machine runs onto the limit switch, only one direction is disabled, therefor the axis can be moved down from the switch with step and direction signals that commands the machine to the oposite direction.
It is important to use the correct input for the correct direction and do not exchange the pins for the directions, otherwise they will not work as they have to.

Never apply any Voltage to the other 2 pins in this pin connector, those pins are used for factory programming of the device. Appliing Voltage to those pins may cause permament damage to the device.

11.) Important notices, what can damage the device!

Exceeding digital supply maximum allowed Voltage.
Exceeding motor supply maximum allowed Voltage.
Reverse polarity connection on digital supply connector.
Reverse polarity connection on power supply connector.
Overvoltage on encoder channels or on any digital pins.

Always take care and check these connections for the correct Voltage levels and polarity before applying Voltage to the device.

12.) Troubleshooting (FAQ)

Q: When I power up the controller and try to rotate the shaft of the motor, the motor jumps out of position and do not stop for a while, after some rotations it stops with error. (Red LED on.)

A: The encoder A & B channels connected backwards and the controller moves the motors in wrong direction. Exchange A and B channel wire connections of the encoder in the main connector.

Q: I have an absolut encoder attached to my motor can I use it?

A: No, the encoder must be an incremental type with at least A and B quadrate channels and must have TTL level signals. Resolvers with sin/cos signals will also not work.

Q: What CNC controller software should I use?

A: Any controller software with step and direction signals will work.

Q: I have a big motor, which has higher current and voltage rating then the drive, can I use it?

A: Yes, but the motor supply must be equal or lower than 30VDC, the current will be limited automaticly at 6.5Amps, so you may get lower torque than the rated of your motor.

Q: I like to drive the device with a PLC, is it possible and if yes, how?

A: PLCs often have 24V outputs and the servo controller accepts TTL level (0..5V) signals. You must use a resistor-zener diode clamping circuit externally on the outputs of the PLC to translate the 24V outputs to TTL (0..5V) Voltage level.

13.) Electric specifications:

Digital supply

	Symbol	Min	Typ	Max	Unit
Digital Supply Voltage	**Vdd**	**4.5**	**5**	**5.5**	**V**
Digital Supply Current	**Idd**	**80**	**100**	**140**	**mA**

Motor Supply

	Symbol	Min	Typ	Max	Unit
Motor Supply Voltage Range	**Vm**	**8**	**-**	**28**	**V**
Continious current capability	**Icm**	**5**	**5**	**5**	**A**
Peak current capability	**Ipm**	**6.5**	**7**	**8.5**	**A**
Overcurrent detection* level	**Iov**	**9**	**10**	**11**	**A**

*Overcurrent shutdown occurs when drive is unable to regulate the current under the overcurrent detection level for more than 100usec, this may happen under too heavy load or in short circuit on the motor output pins.

Termal management

	Symbol	Min	Typ	Max	Unit
Termal shutdown*	**Ts**	**170**	**175**	**175**	**°C**
Termal hysteresis before new powerup enabled	**Th**	**-15**	**-15**	**-15**	**°C**

*Measured in the power switching element's core.
 The cooling rib surface feels hot above 60°C for bare human hand, avoid touching it when the device is under operation. This temperature is measured in the switching elements' core, the cooling-rib's temperature can be lower than the listed values at overtemperature shutdown.

Incremental Encoder

	Symbol	Min	Typ	Max	Unit
Encoder Supply Voltage	**Ve**	**Vdd-0.6**	**Vdd**	**Vdd+0.6**	**V**
Encoder Channels' Volage*	**Vech**	**Vdd-0.6**	**Vdd**	**Vdd+0.6**	**V**
Encoder frequency max.**		**1**	**1**	**1**	**MHz**

*Encoder must be a TTL level type with single ended A and B channel quadrate outputs.
**Digital filers protects encoder lines from noise and fault triggering, the filter works upto 1Mhz frequency.

Step and direction interface

	Symbol	Min	Typ	Max	Unit
Step signal minimum pulse width.	Tc	1	-	infinity	usec
Direction signal minimal allowed valid time after step pulse rising edge.*	Tdv	1	-	infinity	usec
Step signal frequency		0	-	300	kHz

*Direction signal must be on valid voltage level after the rising edge of the step signal for at least 1usec.

Mechanical dimensions:
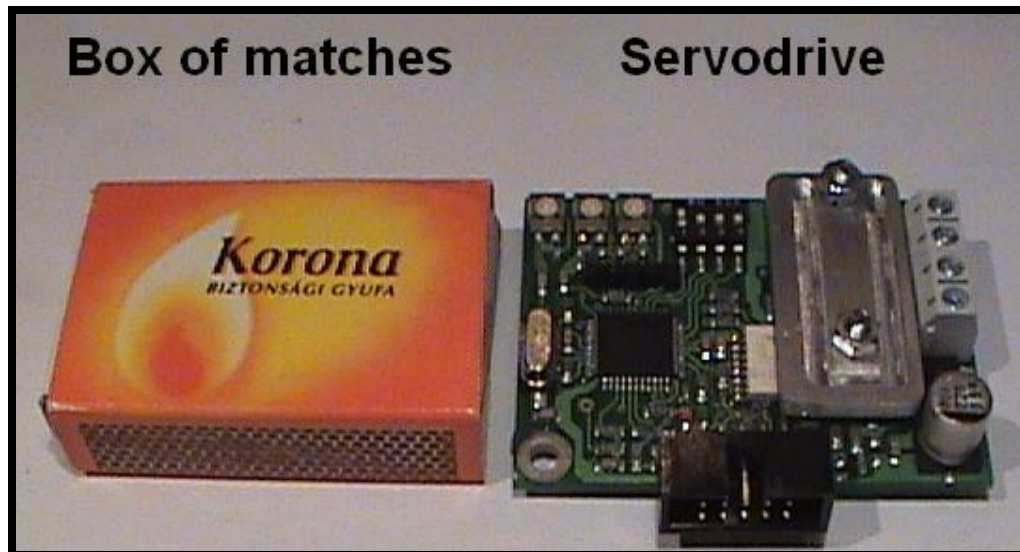
Width: 60mm (app. 2.4 inch)
Length: 45mm (app. 1.8 inch)
Height: 16mm (app. 0.63 inch)

Safety notes:

-This device is used to control machines' movements. Moving machines and moving objects/parts in machines can be hazardous, always take care when operating these devices.
-Always wear safety glowes and glasses when using the devices and/or your automatic machines.
-Always use isolation transformers to supply the devices!
-Avoid touching the cooling rib of the controller, it can get hot under operation and may cause injury when touching.

The device is protected by international Chipset, Schematics and Firmware Patents, copying the device in any form is forbidden!

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More informations at: http://www.cncdrive.com