

# YAPSC : 10V

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*Users' manual*

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# 1 Introduction - before you start

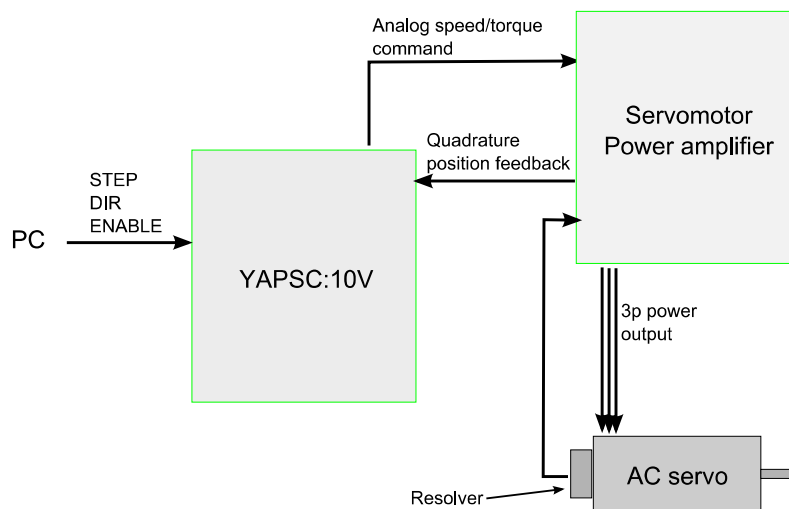
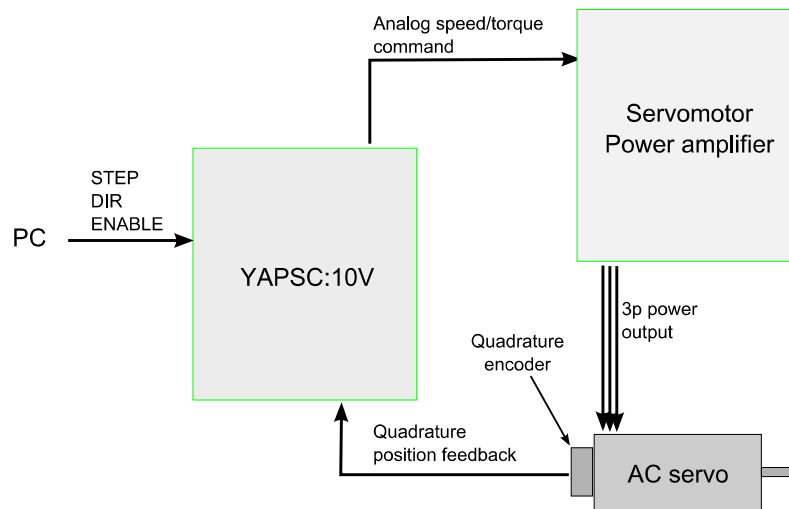
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YAPSC:10V allows the use of analog-operated servo amplifiers, either torque or speed controlled. This board takes STEP/DIR position command from the PC (MACH3, EMC etc.), position feedback from a quadrature encoder, and outputs an analog command to the servo amp.

Please note the difference between **YAPSC** and **YAPSC:10V**. These two projects share a part of the dsPic's source code but the manuals are different! **YAPSC** is a board WITH a power stage to control DC servos; whereas **YAPSC:10V** has no power stage and cannot drive a servomotor without a servo power amplifier.

If you are looking for the DC servomotor controller, this is not the right manual you are looking into! You will find links at the end of this document for each versions of YAPSC.

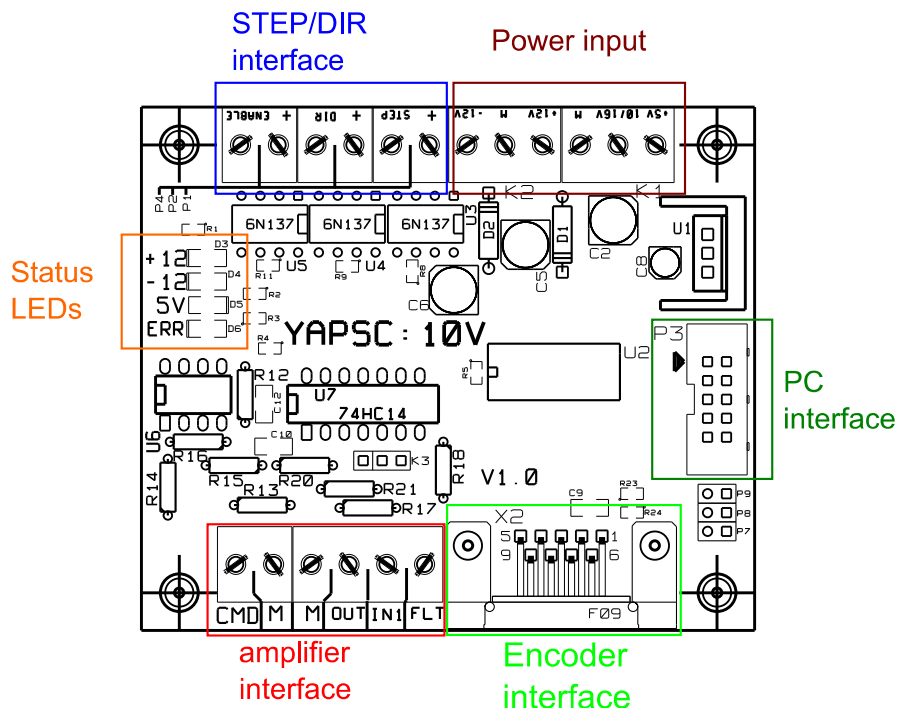
Below are the two big scheme of YAPSC:10V application:



## 2 Features

- Takes position feedback from quadrature encoder on the servo (resolvers cannot be used directly but some amps can output quadrature signals from the resolver feedback)
- Compatible with both torque and speed controlled amps
- Takes STEP/DIR command from PC
- ENABLE signal from PC can disable the amp
- Output amplitude can be selected from +/-0V to +/-10V, to feed +/-10V or +/-5V amps
- Jumper selected TTL or differential quadrature encoder input
- FAULT input from the servo amp
- Reset/ENABLE output to the servo amp
- One additional input for future use
- Programmable max error limit : 0 (disabled) to 32768
- PID tuning program for linux, windows (and probably Mac OS) : YTT (under development)
- STEP/DIR input multiplier (allows faster speed)
- 1MHz max step and encoder rate!

## 3 Physical Description



### 3.1 Status LEDs

There are 4 LEDs on the board:

### 3.1.1 +12V

Green LED. Lit when the OpAmp +12V supply is present.

### 3.1.2 -12V

Green LED. Lit when the OpAmp -12V supply is present.

### 3.1.3 5V

Green LED. Lit when the dsPIC +5V is present

### 3.1.4 ERR

This LED is dark under normal operation.

#### 3.1.4.1 Power up

During power up, ERR LED is lit during the power-up procedure. If the ERR led is stuck and the amplifier is disabled, connect the Prog. Key and open a serial terminal. Cycle the power OFF and ON. You should read the initialization status and see where the process blocks.

#### 3.1.4.2 FAULT

Under FAULT condition, ERR LED is lit.

#### 3.1.4.3 Max. error exceeded

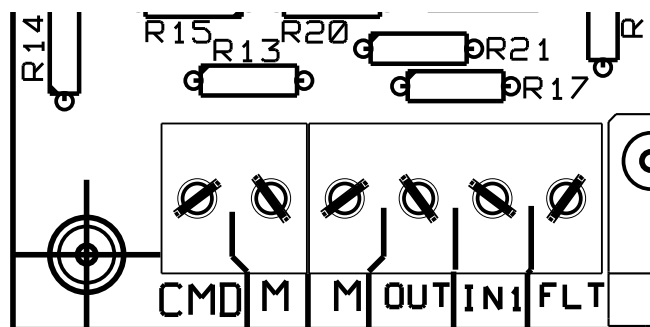
The ERR LED blinks (~2Hz, ON-ON-OFF-OFF)

#### 3.1.4.4 Firmware fatal error

Depending on the error trap the firmware fell into, the blinking can be different (ex: ON-OFF-OFF-OFF). Look at the source code to learn more about it.

## 3.2 Power inputs

At least 2 voltages are required: +12V and -12V. Both logic and OpAmp needs power supply for the board to work.



### 3.2.1 K1

K1 is the logic power supply input.

### 3.2.1.1 +5V

Logic +5V supply. You can connect it directly to a 5V power source, or use the regulated voltage from 10 to 16V input to supply 5V to other logic/boards. The board's power consumption is maximum 300mA plus encoder consumption (generally ~10-20mA)

### 3.2.1.2 M

Common ground

### 3.2.1.3 10/16V

Input to the LM7805 voltage regulator. 10 to 16V, max 300mA + encoder consumption

## 3.2.2 K2

K2 is the OpAmp supply voltage input.

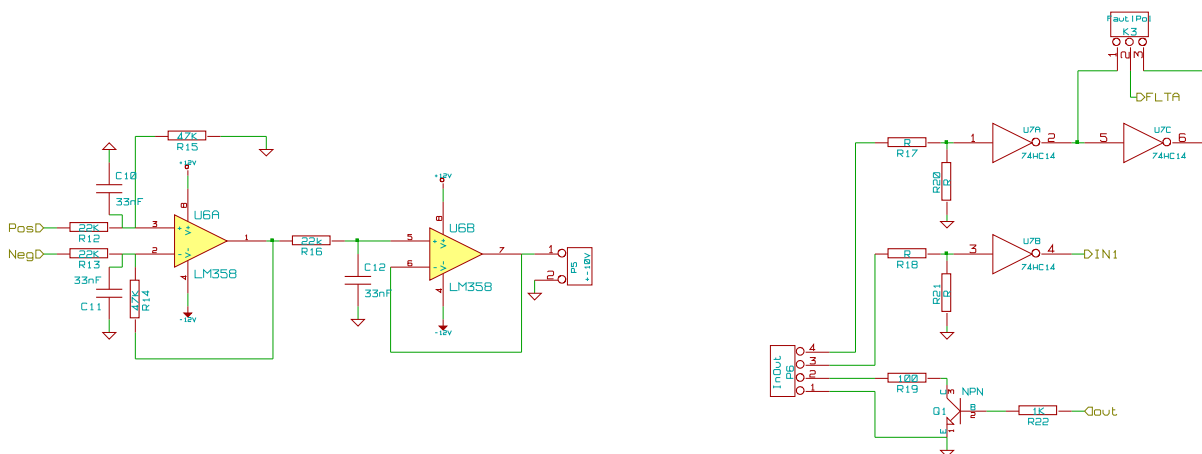
### 3.2.2.1 +12V

12 to 16V positive supply. 30mA max consumption

### 3.2.2.2 -12V

-16 to -12V negative supply. 30mA max consumption

## 4 Interface with the servo amp



## 4.1 Outputs

### 4.1.1 CMD Output

The analog output (**CMD**) controls an amplifier for servo-motor working in torque mode (torque at the motor shaft proportional to **CMD**) or speed mode (RPM of the motor proportional to **CMD**). **CMD** output of the YAPSC:10V board must be connected to the analog input of the amp.

Don't forget to wire the ground! In case the analog input of the amp is differential, connect

CMD to the + (positive) input and the ground **M** on the - (negative) input of the amp. For differential input amp, you **must** use two wires, one for the ground **M** and the other for **CMD**. Those two cables must be at least twisted, but it's better to have them twisted and shielded. You must, independently of those two wires, link a cable (min. 0,5mm<sup>2</sup> section area) between **M** and the amp's ground

### 4.1.2 OUT output

The "OUT" output is an open-collector output, designed to drive 0-30V 100mA loads, such as relays etc.

*To come : example schematics*

#### 4.1.2.1 Enable/Reset

Under running conditions (i.e motor is powered and YAPSC taking STEP/DIR commands), OUT is forced low.

If YAPSC is disabled (see section 5.2.1), the **OUT** output is floating.

If a FAULT condition is detected (look in section 4.2.1), then **OUT** will be floating and the ERROR led will blink.

## 4.2 Inputs

There are two Schmitt-trigger (digital) inputs which can be configured.

By changing the values of (R17,R20) and (R18/R21) the two inputs can work with 5V, 12V or 24V logic:

5V logic	24V logic
R17 = R18 = 1KΩ	R17 = R18 = 39,2KΩ
R20 = R21 = 47KΩ	R20 = R21 = 10KΩ
Low level : L = 2,5V	Low level : L = 12V
High level : H = 3V	High level : H = 15V

#### 4.2.1 FLT input

This input is the feedback from the servo amp. In case that a problem (overtemp, overvoltage, ...) is detected by the amp, it can notify YAPSC. On a FAULT condition, YAPSC:10V goes into disabled mode : **CMD=0** and the **STEP/DIR** commands are ignored.

**FLT** input can be configured either to be active-low or active high:

Polarity :	Active high	Active low
<b>K3 strap position:</b>	1 – 2	2 – 3
<b>Fault operation:</b>	If <b>FLT</b> is <b>High</b> , FAULT condition If <b>FLT</b> is <b>Low</b> , normal operation	If <b>FLT</b> is <b>Low</b> , FAULT condition If <b>FLT</b> is <b>High</b> , normal operation

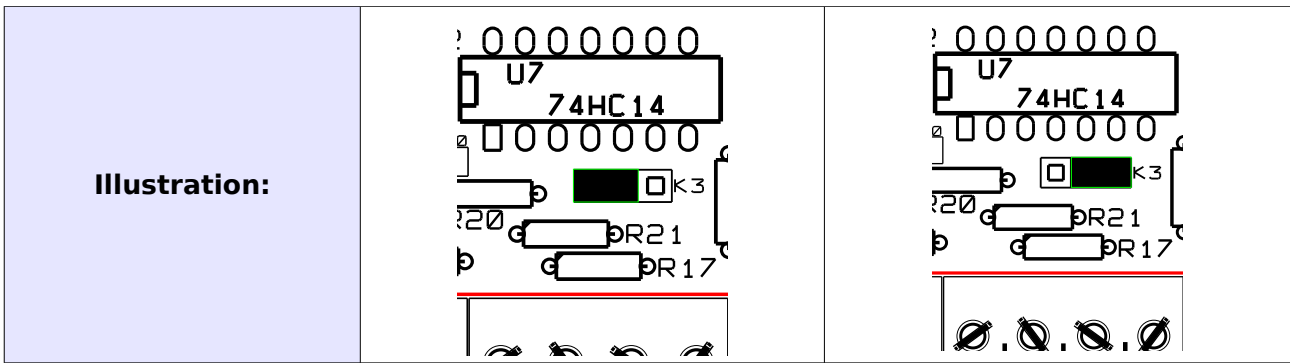


Illustration:

The **FLT** input is pulled down, so when not connected **FLT** is low. If the amp does not have an output to be linked to **FLT**, **K3** should be placed 1-2 and **FLT** left unconnected.

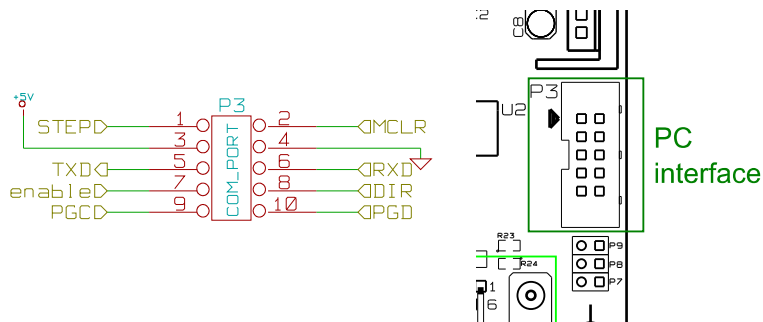
#### 4.2.2 IN1 input

Schmitt-trigger input.

*Reserved for future use.*

## 5 Interface with the computer

### 5.1 HE10



HE10 connector P3 provides all the following:

#### 5.1.1 RS232 port

For configuring YAPSC:10V via a serial port terminal (I.e hyperterminal on Windows) or via YTT (read section 8.1).

Pin 6 (RXD) : data in

Pin 5 (TXD) : data out

Port configuration : 9600bps, 8n, 1stop, no flow control.

**The RS232 pins are NOT optoisolated! For maximum security, please use the optoisolated USB prog. key.**

#### 5.1.2 ICSP

The dsPIC30F4012 can be programmed via an ICD2, pickit2 or other programming tool. The program can also be debugged under operation with Microchip's ICD2/3 (or other compatible tools).

Pin 2 : MCLR Master Clear



Pin 9 : PGC

Pin 10 : PGD

**MCLR, PGC and PGD are NOT optoisolated! Please be aware that any power failure could be fatal to the programmer and your computer!**

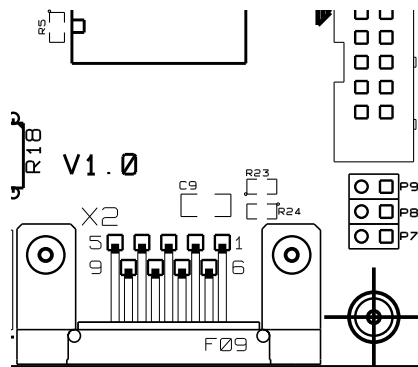
### 5.1.3 STEP/DIR/ENABLE

The control signals are available on P3 to link directly with a control card which is already protected (optoisolated, ...); or you can monitor the input signals to test the optocouplers, etc. These 3 inputs are pulled-up with a 4K7 resistor to +5V, and are reversed polarity compared to the optoisolated inputs.

### 5.1.4 Power

Ground (pin 4) and +5V (pin 3) are available to power the prog. Key's optoisolators, and for the ICD to monitor +5V voltage.

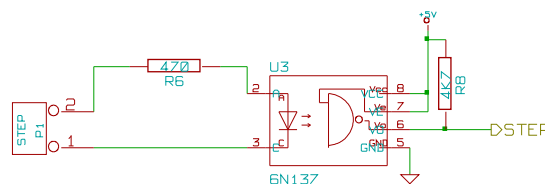
## 5.2 STEP/DIR/ENABLE



The command input are optoisolated and provide minimum 600V insulation. The diodes requires at least 2mA to work properly.

Below is the **STEP** input schematic, which is the same for **DIR** and **ENABLE** inputs.

**Note:** The + mark on the silk screen represents the cathode connection (ex: pin2 of P1)



PHTRANS is a 6N137 fast rate (10Mbps) optocoupler. It can be replaced by the 6N136 but with a reduced maximum stepping rate of 300KHz.

### 5.2.1 ENABLE

When the **ENABLE** input is powered state, the **YAPSC:10V** performs the PID calculation, takes the **STEP** commands and outputs the command to the servo amp, unless a FAULT condition occurs (s. 4.2.1).

If **ENABLE** is left open (or lead shorted), the board won't read the **STEP** commands, won't perform PID calculation and **CMD** output will be at **0V** : the board is disabled.

## 5.2.2 STEP

If the board is enabled (s. 4.2.1 & 5.2.1), on rising edge of STEP input the position command is increased or decreased depending on the state of the DIR input.

If the board is disabled, (s. 4.2.1 & 5.2.1), the input state and changes of STEP are ignored.

Maximum stepping rate : 1MHz

Minimum pulse width = 500ns

## 5.2.3 DIR

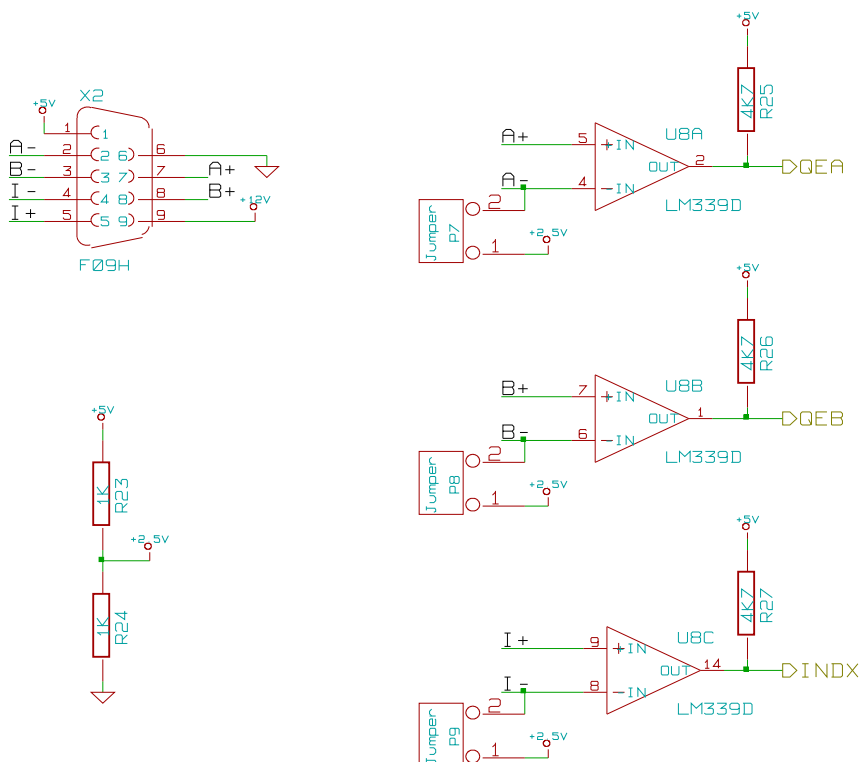
The DIR command sets the direction of the pulse:

If DIR is powered, each pulse on STEP decreases the position command; Otherwise, the position command is increased on each pulse on STEP.

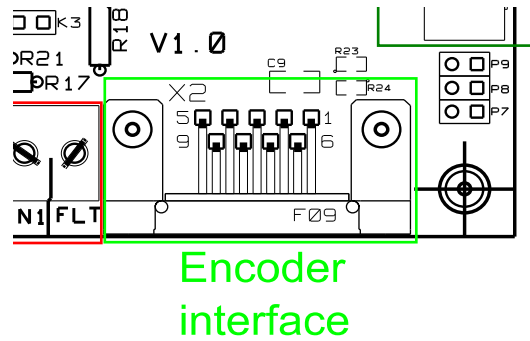
# 6 Encoder connection

The encoder input has 3 inputs for a quadrature encoder : A, B and index pulse (called **I**, **C** or **Z** depending on the manufacturer).

It can be configured either for differential link or single-end (TTL) signals, depending on the encoder's link type. A male 9 pins sub-D connector can be plugged on the board's connector **X2**, whose pinout is represented below.



## 6.1 Differential link encoder

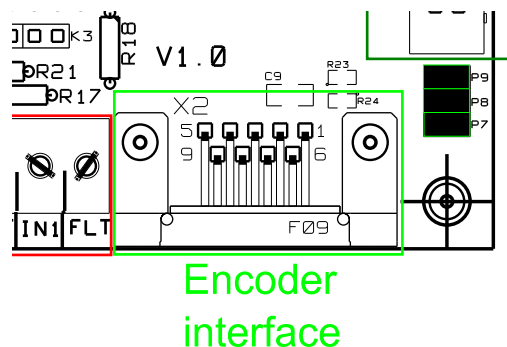


- **Remove P7, P8 and P9**
- Link **A+/A-** to the **A** output of the encoder, **B+/B-** to the **B** output of the encoder
- Link **I+/I-** to the index output **C** (can be called **Z** or **I**) of the encoder, if present
- Link the ground (or negative supply) of the encoder to the sub-D9's **pin number 6**
- Depending on the supply voltage required by the encoder, link the +5V or +12V (sub-D9's pins 1 or 9) to the positive supply of the encoder
- Once the encoder cord is fully linked, you can plug the connector onto YAPSC:10V's X2 connector.

### You should note that:

- If the encoder allows it (check the corresponding datasheet), link a 120Ohms resistor between A+ and A-; between B+ and B- and between I+ and I- as close as possible to the sub-D9 plug used to make the encoder cord. This will help noise immunity.
- Contrary to +5V supply, the +12V supply is **NOT** a regulated voltage. It comes directly from **K1** connector, so you should check that this voltage meets the encoder's specifications.

## 6.2 TTL Encoder



- Place **P7, P8** et **P9**
- Link **A+** th the **A** output of the encoder, **B+** to the **B** output of the encoder. **A-** and **B-** are not linked
- Link **I+** to the index output of the encoder (Called **C, I** or **Z**) if present on the encoder. **I-** is not linked
- Link the ground (or negative supply) of the encoder to the sub-D9's **pin number 6**
- Depending on the supply voltage required by the encoder, link the +5V or +12V (sub-D9's pins 1 or 9) to the positive supply of the encoder
- Once the encoder cord is fully linked, you can plug the connector onto YAPSC:10V's X2

connector.

**Do NEVER link a differential link encoder while P7, P8 or P9 are in position! The encoder could be damaged if that was the case!**

**Note:**

- You may have to place capacitors (100uF+1uF electro +100nF ceramic) between the encoder's ground and positive supply if the cables between the encoder and YAPSC:10V is long, and more generally if the encoder is sensitive to electrical noise.
- If the encoder needs a very precise +5V regulated power supply, do not use the 5V output (pin 1) but rather use a LM7805 type regulator and its capacitors as close to the encoder as possible. This regulator will be powered by the +12V (pin9).

## 7 Configuring the board

Each commands are sent trough the RS232 port and validated by pressing the [ENTER] key (serial port sends "\r\n" to the board).

This section refers to RS232-terminal configuration; A dedicated software called **YTT (YAPSC Tuning Tool)** eases the configuration of the board (look in section 8).

Here are the available commands:

### 7.1.1 PID gains

**P** sets the P gain (usally P=0,001 to 0,1)

**I** sets the I gain (usally I=0,0001 to 0,01)

**D** sets the D gain (usally P=0,0001 to 0,01)

**EXAMPLE:**

```
P0,001
I0,0001
D0
```

### 7.1.2 Maximal error

This parameter is the error (in pulses; ie lines \*4) over which the amp is disabled (no torque). Send the **L** command :

```
L1024
```

Sets the max. error to 1024 pulses (=256 lines)

**NOTE:** *following command disables the max error monitoring. Please do not use this mode unless you are absolutely sure of what you are doing!*

```
L0
```

**NOTE:** When the maximum error is reached, the ERROR led blinks and the error is reported on the serial port. To reset the board, you have to cycle power OFF and ON or to reset the board (short MCLR and GND pins, see section 5.1.2)

### 7.1.3 Maximum output

To match the output swing to any type of amplifier, the output swing can be limited. The output swing is expressed in percent of 10,5V:

M50

Will set the output swing to +5,25/-5,25V

M95

Sets the output swing to +10V/-10V

### 7.1.4 STEP input multiplier

For fast displacements, the 1MHz STEP limit of the interpolator's maximum STEP rate (ex: MACH3 is limited to ~30-40KHz on the parallel port) may not be enough. If the resolution can be reduced, you can set the multiplier to a higher value than 1.

#### EXAMPLE:

X2

Multiply the STEP inputs by 2. Each pulse on STEP will move the motor's position of 2 pulses (½ line)

#### EXAMPLE:

X-1

Inverts the direction. It is equivalent to invert the DIR input.

## 8 Annex

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### 8.1 YTT (YAPSC Tuning Tool)

YTT is currently under development and has no web page. Check the [YAPSC:10V](#) tread for latest news.

### 8.2 YAPSC

The first version of YAPSC is a DC servomotor controller equipped with a power stage.

Links:

- Original tread on the French forum usinages.com : [www.usinages.com/carte-servos-a-dspic-t648.html](http://www.usinages.com/carte-servos-a-dspic-t648.html)
- YAPSC-related stuff on my web page (French) : [http://max-mod-shop.com/index.php?option=com\\_content&view=category&id=17:-yapsc&Itemid=4&layout=default](http://max-mod-shop.com/index.php?option=com_content&view=category&id=17:-yapsc&Itemid=4&layout=default)
- dspic-servo tread on cnczone.com : <http://www.cnczone.com/forums/showthread.php?t=40940>

### 8.3 dspic-servo

This is the original work from Lawrence Glaister I based YAPSC on. It is located at <http://www.members.shaw.ca/swstuff/dspic-servo.html>

### 8.4 Licence

Unless specified, the project files are released under GPL3. Read the included file [gpl-3.0-standalone.html](#)

This manual is NOT under GPL, I (Charles-Henri Maximilien MOUSSET) reserve all right on it. Copying or modifying in any way (partially or entirely) this manual's content is forbidden unless I explicitly authorize you to do so.

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## **8.5 Contact**

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PM "MaX-MoD" on usinages.com

## Document Rev

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<b>Date</b>	<b>Description</b>
04/04/09	Corrected board silkscreen on power input connector