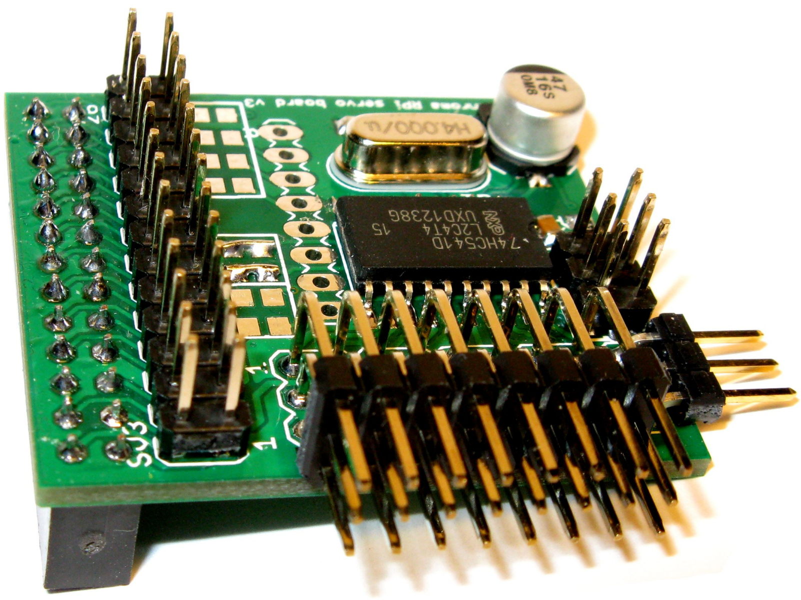
Chroma Servo Board v3
for
Raspberry Pi

(A, A+, B, B+, 2 and Odroid C1)

(Firmware 0.1 and 0.2)

2015-10-01



Content

Setup

Before connecting the servo board

Before connecting the servo board to your Raspberry Pi you will need to disable the boot console output to the serial port and disable the default serial login console. If you don't do this before connecting the servo board, your Raspberry Pi might not boot properly. Follow the instructions below depending on hardware.

Raspberry Pi 2

Simply run the raspi-config tool:

```
sudo raspi-config
```

Select ”8 Advanced options” and then ”8A Serial”. You are now being asked if you would like a login shell to be accessible over serial. Answer: **No**.

Before connecting the servo board, shutdown RPi and remove power!

Raspberry Pi

The easy procedure for Raspberry Pi 2 can also be applied to Raspberry Pi if you have the latest version of the raspi-config tool. Update the tool with:

```
sudo apt-get install raspi-config
```

Now follow the instructions for Raspberry Pi 2.

In case you are having trouble with the above you can try the somewhat harder way described below.

Disable boot time output

Edit the file: `/boot/cmdline.txt` Remove the following text:

```
console=ttyAMA0,115200 kgdboc=ttyAMA0,115200
```

You can use the command: `sudo nano /boot/cmdline.txt`

Disable serial console

Edit the file: `/etc/inittab` Remove the following line:

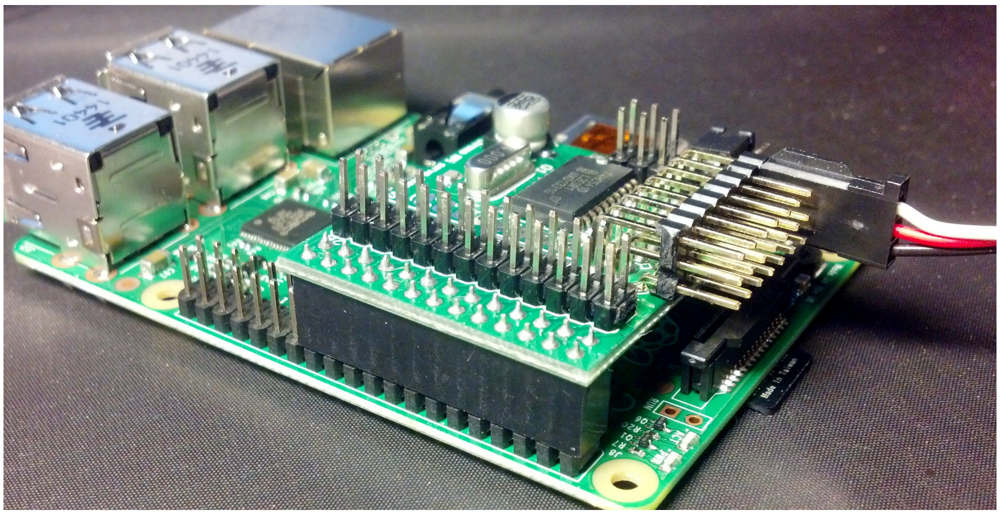
```
T0:23:respawn:/sbin/getty -L ttyAMA0 115200 vt100
```

You can use the command: `sudo nano /etc/inittab`

Before connecting the servo board, shutdown RPi and remove power!

Connecting the servo board: Raspberry Pi A+, B+ and 2

The servo board should be mounted as seen on the picture below.

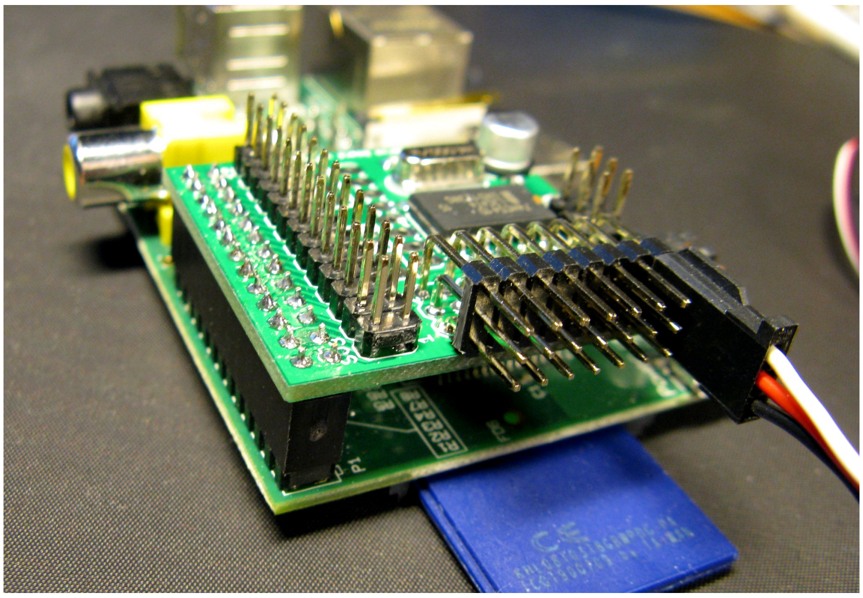


Make sure the the 2x13 female header on the servo board align in both directions with the 2x20 pin header. Pin 1 to Pin 1.

Do not connect one servo board on top of another!

Connecting the servo board: Raspberry Pi A and B

The servo board should be mounted above the Raspberry Pi, as seen on the picture below.

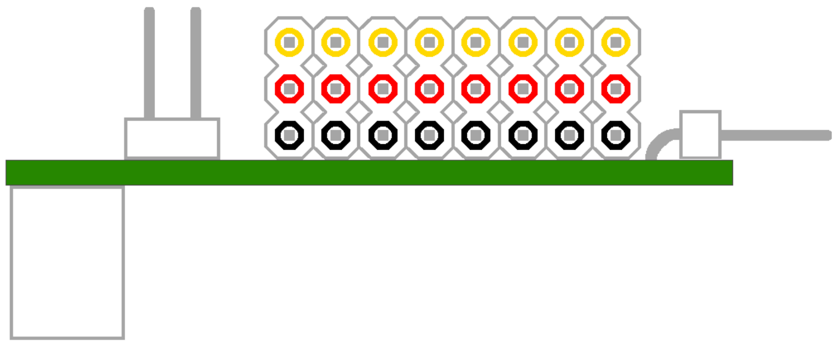


Make sure the the 2x13 female header on the servo board align in both directions with the 2x13 pin header on the Raspberry pi. Pin 1 to Pin 1.

Do not connect one servo board on top of another!

Connecting servos

When connecting servos make sure ground wire of servo is closest to the edge of the servo board. See picture below (black – ground, red – 5V, orange – signal). Also make sure the servo connector is aligned.



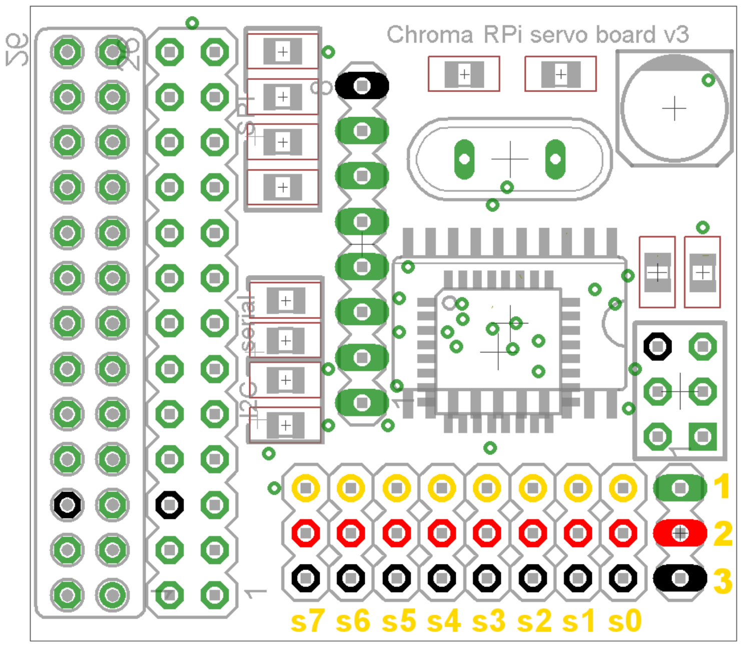
Power options

There are many ways to power the RPi and the servo board.

WARNING:

When the servo board is powered by the RPi and the RPi is powered by 5V from micro-USB, the poly fuse (On early RPi's) will make the voltage drop if much current is drawn. Commanding one or more servos to move at full speed at the same time might reboot your RPi and destroy contents of SD-card. The same goes for attaching a servo in run time.

Power connector/jumper



The green-red-black 3-pin connector/jumper to the right of the servo-connection block on the above illustration is:

1. +5V on Raspberry Pi
2. +5V on servos
3. Ground

With no jumper installed servo +5V is disconnected from Raspberry Pi +5V and servos are powerless unless an ESC/BEC or battery is connected to one of the eight servo connections.

Examples:

Power:	RPi and servo powered from micro-USB connector.
Jumper:	Between 1 and 2.
Note:	Since power from micro-USB connector goes via poly fuse (on early RPi's), voltage will drop even with modest load. RPi might reboot possibly trashing content of SD-card. Can work with one servo and no load.
Power:	RPi powered via micro-USB, Servos powered via connected ESC/BEC.
Jumper:	No jumper!
Note:	RPi is driven from micro-USB, servos are driven from ESC's BEC.
Power:	RPi and servos powered via connected ESC/BEC. (BEC must be 5V stable)
Jumper:	Between 1 and 2.
Note:	Do not connect micro-USB!
Power:	RPi powered via micro-USB, servos from external source (battery) 5V.
Jumper:	No jumper: Connect external 5V to pin 2 and external ground to pin 3.
Note:	
Power:	RPi and servos powered from external source (battery) 5V.
Jumper:	Between 1 and 2. Connect external 5V to servo 5V, connect external ground to servo ground.
Note:	Since power is supplied via a servo-connector, a servo can not be connected there. Max 7 servos.
Power:	RPi and servos powered from external source (battery) 5V, another way.
Jumper:	Between 1 and 2. Connect external 5V to pin 2 of 2x13 pin header, connect external ground to pin 6 of 2x13 pin header.
Note:	All 8 servo connectors can be used.

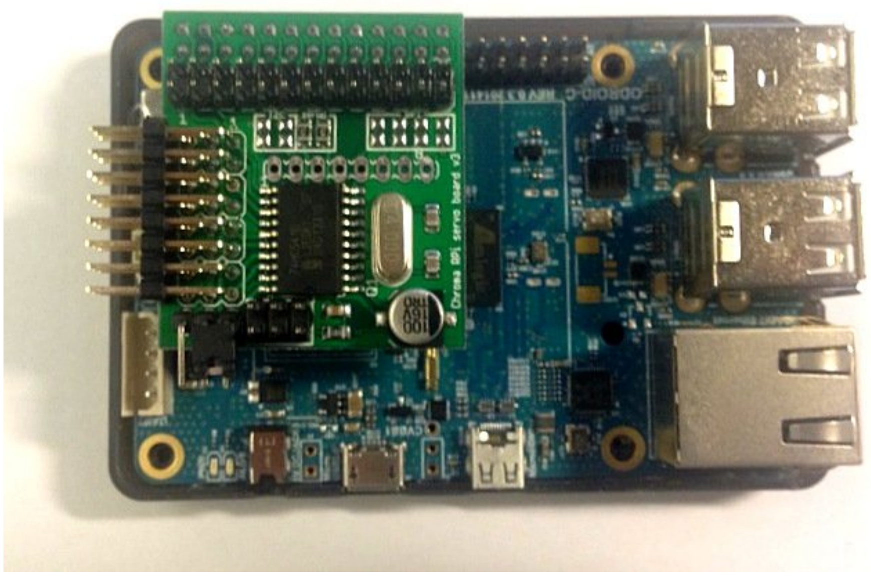
Setup for Odroid C1

This section only applies if the servo board is used on an Odroid C1 instead of a Raspberry Pi.

Section ”Connecting Servos” apply to both the Odroid C1 and the Raspberry pi. ”Power Options” above MIGHT also apply to both. The variants where the Raspberry pi (Odroid C1 in this case) is fed with power from ESC or any other way where power is fed into the GPIO-port is not tested with the Odroid C1!

Connecting the servo board

Be very careful not to misalign the board and place it as on the picture below. It should go all the way to the left.



Communication

The examples in the Raspberry pi section ”Getting started” below should apply to the Odroid C1 as well, but the serial port to use is: `/dev/ttyS2` instead of /dev/ttyAMA0.

Also the ”Installing new firmware” section applies but using /dev/ttyS2 instead of /dev/ttyAMA0 as stated above.

Getting started

How to get started to actually control servos. See the protocol section to learn more about the diffrent commands.

Using shell

Set serial port to 9600 bps:

```
stty -F /dev/ttyAMA0 9600
```

Start servo test:

```
echo "st" > /dev/ttyAMA0
```

Stop servo test with any command or a wrong command:

```
echo "serr" > /dev/ttyAMA0
```

Using minicom

Install minicom (Internet connection requiered)

```
sudo apt-get install minicom
```

Start minicom in setup mode as root to configure it, only needed once:

```
sudo minicom -s
```

Select ”Serial port setup”
Press ”a” and change Serial device to /dev/ttyAMA0
Press enter
Press ”e” and choose 9600 bps by pressing ”c”.
Press enter
Press enter to exit ”serial port setup”

Select ”Screen and keyboard”
Press ”q” to enable local echo.
Press enter to exit ”Screen and keyboard”

Select ”Save setup as dfl” to save this as your default setting.

Select ”Exit from Minicom”

From now on you can start minicom and issue commands to the servo board when you like:

```
minicom
```

Just try issuing the servo test command:

```
st
```

Using Python

To use the serial port from Python, you will need the serial module:

```
sudo apt-get install python-serial
```

Sample Python script:

```
import time
import serial

s = serial.Serial("/dev/ttyAMA0",9600)

s.open()

s.write("st\n")     # Servo test command
time.sleep(5)       # Wait for 5 seconds
s.write("serr\n")   # Wrong command to stop servo test

s.close()
```

The protocol

It's a small and simple ASCII protocol. Start of command is ”s” and end of command is enter (line feed or return). Default serial port setting of servo board is 9600 8N1.

Every command will either be answered with an ”ACK” or a ”NACK” if not understood. The only exception is the firmware version command ”sn” that will answer with the string ”01” for firmware version 0.1.

The only command that makes a persistent change (remembered after power loss) is the Set Initial position All command: ”sia”.

Overview

Command	**Name**	**Description**
`st`	Servo Test	All servos move slowly between -100% and 100%
`sa`	Servo All	Change position of all 8 servos with one command
`sav`	Servo All Velocity	Change speed for all 8 servos with one command
`S0` … `s7`	Servo N	Set position (and speed) for servo N.
`sia`	Servo Initial position All	Set default position for all 8 servos. Saved and used at power up.
`sbr`	Servo Bit Rate	Change serial communication speed.
`sn`	Servo versioN	Returns firmware version ”NN”. Example ”02” for version 0.2.
`se`	Servo Enable	Enable servo output (default)
`sd`	Servo Disable	Disables servo output (tristates output buffer IC)
`so`	(Servo) Output	Experimental: Controls 8 hole connectors center 6 pins.

Servo Test

Has no parameters and will move all servos in sync between -100% and 100% at about 0.2% per millisecond. Any command or a wrong command will abort.

Servo All Velocity

Set speed at which servos should move when using ”sa”-command.

Takes 0 to 8 parameters. Any parameter omitted is interpreted as 0.
Parameters is servo speed in steps of 10% per second from 1 to 255 or 0 for fastest possible speed. First parameter is speed for first servo, second parameter is speed for second servo and so on.

Examples:

```
sav 1 10 20 20
```

Sets first servo to move at slowest possible speed: 10% per second, second servo at 100% per second, third and fourth at 200% per second. Servo five to eight will move as fast as possible.

```
sav
```

Sets all servos to move as fast as possible

sav 100

First servo is set to move at 1000% per second. Remaining seven is set to move as fast as possible.

Servo All

Set position for servos

Takes 0 to 8 parameters. Any parameter omitted is interpreted as 0.
Parameters is servo position in promille from -1000 to 1000 (-2500 to 1900 is allowed for going beyond defined range). First parameter is position for first servo, second parameter is position for second servo and so on.

Examples:

```
sa 0 1000 500 -1000
```

Moves first servo to 0%, second to 100%, third to 50% and fourth to -100% the remaining 4 will be moved to 0%.

```
sa
```

All eight servos are moved to 0%

sa -1500

First servo is moved to -150% all other servos are moved to 0%.

Servo N

Move one servo to a given position at a given speed.

Takes 0 to 2 parameters. Any parameter omitted is interpreted as 0.

First parameter is servo position in promille from -1000 to 1000 (-2500 to 1900 is allowed for going beyond defined range)
Second parameters is servo speed in steps of 10% per second from 1 to 255. 0 for fastest possible.

Examples:

```
s0 1000 0
```

Will move the first servo to 100% Only physical speed of servo limits speed.

```
s0 1000
```

Will move the first servo to 100% Only physical speed of servo limits speed. The same as above

```
s1 500
```

Will move the second servo to 50% Only physical speed of servo limits speed.

```
s6 -1000 5
```

Will move the seventh servo to -100% at roughly 50% / second.

```
s2 1300 1
```

Will move the third servo to 130% at roughly 10% / second.

If the second parameter is given and is diffrent from 0, the given speed will be used in subsequent ”sa”-commands overriding any previous ”sav” commands.

Servo Initial position All

Sets default position for servos, used at powerup.

Takes 0 to 8 parameters. Any parameter omitted is interpreted as 0.
Parameters is servo position in promille from -1000 to 1000 (-2500 to 1900 is allowed for going beyond defined range). First parameter is position for first servo, second parameter is position for second servo and so on. This command will not move any servo, just save the values to be used on power up.

Examples:

```
sia 0 1000 500 -1000 -780 -50 -5 -2000
```

At every power up first servo is set to 0%, second to 100%, third to 50%, fourth to -100%, fifth to -78%, sixth to -5%, seventh to 0.5% and eight to -200%.

Servo Bit Rate

Set bit rate to be used in serial communication.

Takes 0 to 1 parameter. Any parameter omitted is interpreted as 0.
Takes a number 0..6 for bit rate according to below table:

Parameter	**Bit rate**
0	9600 (default)
1	19200
2	38400
3	N/A
4	N/A
5	N/A
6	500000

500000 bps does not seem to work with Raspberry Pi uart.

Examples:

```
sbr 2
```

Serial port speed is changed to 38400 bps. ACK is sent before changing speed.

Servo versioN

Returns firmware version.

Takes no parameters.

Example:

```
sn
```

Returns firmware version ”NN”. Example ”02” for version 0.2. Only command that will not return ACK/NACK. (” and ” not included in return string)

Servo Enable

Enables servo pulses output (default)

Takes no parameters

Example:

```
se
```

Servo Disable

Disables servo pulses output. (by tristating buffer IC output)

Takes no parameters

Example:

```
sd
```

No output pulses will be sent to servos, commands will be accepted as usual, and any changes to servo positions will be seen upon giving the ”se”-command.

This makes it possible to save power by ”disabling” servos.

New commands for Firmware version 0.2

(Servo) Output

Experimental – might be removed/replaced in future firmware.

Controls state of the center 6 pins of the 8 hole connector in the middle of the board.
Pin 1 of the connector is 3.3V power from Raspberry Pi. Pin 2..7 is controlable output signals, either 0V or 3.3V max current draw is a few mA. Pin 8 is GND.

Pin 1 is the one closest to servo connectors.

Takes 0 to 6 parameters. Any parameter omitted is interpreted as 0. First parameter is state of pin 2 of 8 hole connector., second is pin 3 and so on. Parameters interpreted as such:
0 = 0V, anything else = 3.3V.

Examle:

```
so 1 0 0 0 0 1
```

Will set pin 2 and 7 of 8 hole connector to 3.3V, the rest to 0V.

```
so 1 0 1
```

Will turn pin 2 and 4 of 8 hole connector to 3.3V, the rest to 0V.

```
so
```

Will turn all 6 signal pins of 8 hole connector to 0V.

```
so 1 1 1 1 1 1
```

Will turn all 6 signal pins of 8 hole connector to 3.3V.

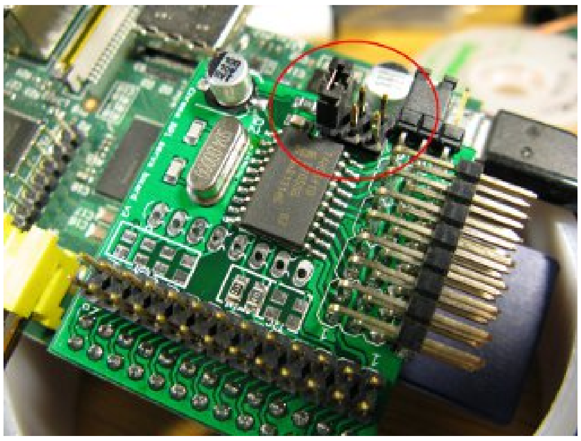
```
so 12 77 0 123 33 1
```

Will turn all but pin 4 of 8 hole connector to 3.3V.

Installing new firmware

Boards shipped after 2014-03-09 has optiboot installed which allows for easy installation of new firmware without tools.
Check http://electronics.chroma.se/ for latest firmware.

1. Disconnect all servos/ESC's
2. Download the new firmware to the Raspberry Pi (or compile your own). Let's assume it is named: main.hex
3. On your pi: `sudo apt-get install avrdude`
4. Put a jumper on the servo boards ISP-connector shorting pin 5 and 6. (You can borrow the power jumper that came with the board). See picture.



5. Now type the following as one line on your pi:

```
avrdude -c arduino -p atmega8 -P /dev/ttyAMA0 -b 19200
-U flash:w:main.hex
```

6. Hit enter and quickly remove the jumper (in that order).

If it fails, repeat steps 4 to 6.

Software changes

Version 0.1

- First version.

Version 0.2

- 38400 bps works.
- NACK on unsupported bit rates.
- Experimental support for digital I/O of 8 hole connector.

Specification

Size

PCB Size: 39.6 mm x 35.7 mm
Total Size: 43.8 mm x 42.5 mm

Total height:18.5 mm

Electrical

(No servos connected.)

3.3V average current consumption:	3 mA
5V current consumption:	<1 mA
Servo rail maximum continous current:	4A

Pinout

All pins in the 26 pin female header, is passed through to the 26 pin male header.
The servo board is only internally connected to the following pins within 26 pin header:

1. 3.3V
2. 5V
6. Ground
8. Servo board RX (This is RPi TX pin)
10. Servo board TX (This is RPi RX pin)

If the two unmounted 0805-resistors (0 ohm) in the I2C-square is mounted, the following pins will also be connected:

3. Raspberry Pi SDA0 (SDA1 on newer RPi's)
   Connected to Pin 1 in 8-hole connector
   and to ATmega8 SDA line (pin 27 of MCU)
5. Raspberry Pi SCL0 (SCL1 on newer RPi's)
   Connected to Pin 2 in 8-hole connector
   and to ATmega8 SCL line (pin 28 of MCU)

If the four unmounted 0805-resistors (0 ohm) in the SPI-square is mounted, the following pins will also be connected:

19. Raspberry Pi SPI0 MOSI
    Connected to Pin 4 in 8-hole connector
    and to ATmega8 MOSI pin (pin 15 of MCU)

21. Raspberry Pi SPI0 MISO
    Connected to Pin 5 in 8-hole connector
    and to ATmega8 MISO pin (pin 16 of MCU)

23. Raspberry Pi SPI0 SCLK
    Connected to Pin 6 in 8-hole connector
    and to ATmega8 SCK pin (pin 17 of MCU)

24. Raspberry Pi SPI0 CE
    Connected to Pin 3 in 8-hole connector

    and to ATmega8 SS pin (pin 14 of MCU)

Hints for hacking

There are no i2C pull-up resistors on the servo board. The Raspberry Pi already has 1.8 kohm pull-up resistors.

If running the board WITHOUT an RPi and only having access to one voltage level, pin 1 (3.3V) and pin 2 (5V) of the 26 pin header (male or female) can be connected together and the board can then be fed with a single voltage between 3.3V and 5V. (DO NOT forget to remove the connection between pin 1 and 2 if the board is connected to a Raspberry Pi again)

If you would like to use the servo board and a GPS receiver at the same time on the same serial port it might be achieved because the Raspberry Pi will only send commands to the Servo board and only receive data from the GPS (this might be false depending on GPS, but with NMEA it's usually true).

First test the servo board to make sure it works normally and you receive ”ACK” on commands.On the board are two 470 ohm resistors (marked 471) that connects the Servo board serial port to the Raspberry Pi serial port.

Desolder or just cut away the 470 ohm resistor that connects the Servo board TX to Raspberry Pi RX. Make sure it's the right resistor!

It is the resistor closest to ”ial” in the text ”Ser**ial**” on the PCB and closest to pin 15 in 26 pin pin header and furtherst away from the 90 degree angeled servo connector block. When connecting the GPS only connect GPS TX to Raspberry Pi RX on pin 10 which is available on the servo board pin header pin 10. Do not connect GPS RX at all.