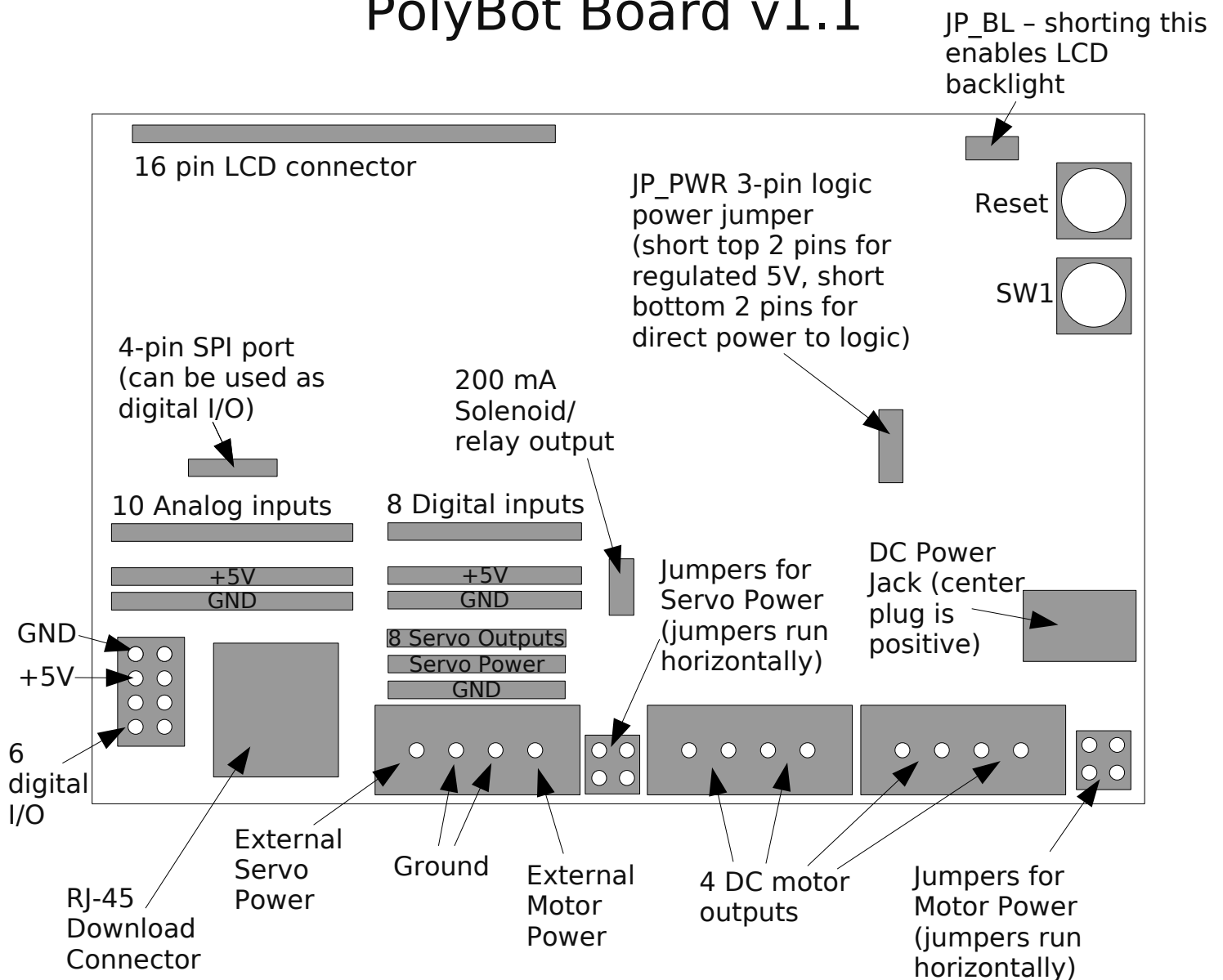


# PolyBot Board

## User's Guide

V1.11  
9/20/08

# PolyBot Board v1.1



## Notes:

- When using external servo power, remove the Servo Power Jumpers
- When using external motor power, remove the Motor Power Jumpers
- Do not plug in servos backwards. White wire on servo goes to the servo output pin.

## **Powering the PolyBot board**

Main power is applied to the PolyBot board through the DC power jack located on the lower right portion of the board. The center plug is the positive terminal. The voltage sent here is used to power the microcontroller, LCD, and support chips.

The board may be operated in one of 2 modes determined by the JP\_PWR jumper. If the top 2 pins of JP\_PWR are shorted, then the voltage sent on the DC power jack is regulated to +5V. Use this setting if you intend to use a battery with a voltage greater than 7V.

The other mode for JP\_PWR is enabled when the lower 2 pins are shorted. In this setting the voltage applied to the DC power jack is directly connected to the microcontroller, LCD, and support chips. Use this setting only if your battery voltage is between 4.5V and 5.5V. This setting is optimal for use with 4 AA rechargeable batteries (4 x 1.2V). If you plan to also use an AC wall adapter with this jumper setting, make sure you use one which is a regulated type (like a Jameco 319986PS).

**Warning:** When sending the battery voltage directly to the board components, be careful not to apply more than 5.5V. Doing so will burn out a number of components on the board!

## **Using separate servo and motor batteries**

The PolyBot board has jumpers that allow running the microcontroller at one voltage and the servos/motors at a different voltage. When these jumpers are connected, the voltage applied to the DC power jack is used to power the motors and the servos.

Removing both the JP\_MTR jumpers allows a different voltage to be applied to the DC motors. There are 2 jumpers to handle more current. Once the jumpers have been removed, the motor power can be connected to the 2 right inputs of the screw terminal block located just right of the RJ-45 jack. Motor power should be between 5V and 36V.

Removing both the JP\_SRV jumpers allows a different voltage to be applied to the servos. There are 2 jumpers to handle more current. Once the jumpers have been removed, the servo power can be connected to the 2 left inputs of the screw terminal block located just right of the RJ-45 jack. Servo power should be between 5V and 6V.

With all jumpers removed (JP\_MTR and JP\_SRV), you may run the motors, servos, and board logic at 3 different voltages.

**Warning:** If you plan to use a different voltage for the motors or servos than the voltage for the logic, then make sure the appropriate jumpers are removed.

## **Downloading a program to the PolyBot board**

Before a program can be downloaded, the PolyBot board needs to be in download mode. Enter download mode by resetting the board with the download cable connected. The LCD should show a countdown timer. You must start the download before the timer reaches 0.

After you have compiled a program into a .hex file, use the 'avrdude' program to download the .hex file into the flash memory. For example, if you wanted to download a file 'test.hex' using com3, then use the following command:

```
avrdude -pm32 -Pcom3 -cbutterfly -b57600 -u -U flash:w:test.hex
```

If you have the default Makefile, you can just type 'make download'.

## **Over-current and reverse polarity protection**

The PolyBot board comes with a resettable fuse. This fuse is rated at 1.85A. If the current drawn by the board exceeds this rating the fuse will trip. If this occurs, you will need to remove power from the board and then reconnect power. If your application requires greater current, you can substitute the fuse with one with a higher current rating.

The fuse will also trip if power is applied to the board with reverse polarity. If this occurs, again you will need to remove power and then reconnect with the correct polarity.

One thing to note is that when the fuse does trip, the fuse itself becomes **very** hot and stays hot until power is removed. When the fuse is operating normally, it is only warm to the touch.

The external motor and servo power inputs are not run through this fuse. There is no protection on either of those inputs.

## **Analog and digital inputs**

The analog and digital inputs accept .1" spacing headers. Next to each input is a +5V and ground header port. You can make sensor connectors with 4 male header pins. Cut one of the pins and the header will plug into the input.

The digital inputs already have pull up resistors to 5V.

## **DC motor outputs**

On the board are 2 754410 chips which provide a total of 4 1-amp DC motor outputs. If you have a motor that needs more current, you can bridge 2 or more outputs for more of current. Just connect the corresponding outputs pins together to drive the motors. You must ensure that your software drives the motor outputs correctly, otherwise you will short power and ground.

DC motors generate a lot of electrical noise and one way to reduce this is to place capacitors across the motor terminals as close as possible to the motor itself. Do this if you find that operating DC motors affects the operation of the board.

## **Servo output ports**

There are 8 servo outputs port which can be used to control standard hobby servos. The 3 pins for each connector are the servo signal, power, and ground. If the servo jumpers are in place the voltage sent to the servos is the voltage on the power jack.

## **Relay/solenoid output port**

A relay or solenoid can be controlled using the 2-pin relay/solenoid port. Connect these pins to the coil of a relay or solenoid. The relay/solenoid port uses a 2n3904 to supply up to 200mA of current to activate a relay or solenoid.

If you find that you need more current than 200mA, you may substitute the 2n3904 transistor with one that supplies more current (for example, a 2n6427). 1000mA is the recommended maximum current to run through this output port.

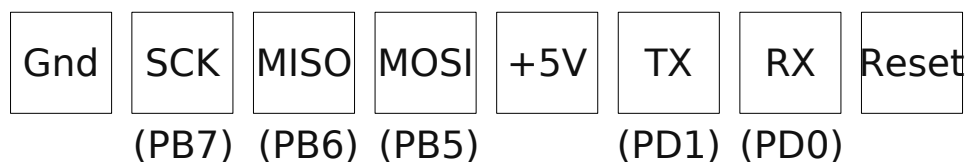
## **CON1 and SPI Detail**

The following detail the pinout for the CON1 and SPI ports



## **RJ-45 connector pinout**

This is the pinout of the connector on the as viewed on the board:



# **PolyBot Board assembly instructions**

**Before you start:** The following instructions will help you assemble the board and perform incremental tests. Use these instructions as a checklist as you install each component.

## **Step 1: IC Sockets and Headers**

When installing headers, make sure they are attached at a right angle to the circuit board (when soldering the female headers, use the male headers to keep them aligned). The male headers need to be cut as they come attached in one row.

1. Solder in all the IC sockets. Make sure the notch on the socket matches the notch printed on the circuit board. Make sure you install sockets in the correct locations – removal is very difficult. **NOTE:** Do not install any chips in the sockets at this point.
2. Solder in the JP\_SRV and JP\_MTR headers. Each is a 2x2 male header.
3. Solder in the JP\_BL header. This is a 1x2 male header.
4. Solder in the JP\_PWR header. This is a 1x3 male header.
5. Solder in the Relay header. This is a 1x2 male header.
6. Solder in the A\_INPUT headers. These are 1x10 female headers. **NOTE:** Make sure the 3 headers are aligned because you will be connecting sensors perpendicular to the connectors. Use the 1x16 male header or the 2x3 male headers to keep the connectors aligned as you solder them. It is very important to keep the connectors aligned.
7. Solder in the D\_INPUT headers. These are 1x8 female headers. **NOTE:** Make sure the 3 headers are aligned because you will be connecting sensors perpendicular to the connectors. Use the 1x16 male header or the 2x3 male headers to keep the connectors aligned as you solder them. It is very important to keep the connectors aligned.
8. Solder in the servo headers. These are four 2x3 male headers.
9. Solder in the SPI and CON1 headers. These are 1x4 female headers.
10. Solder in the LCD connector. This is a 1x16 female header. Try to keep this connector as close to perpendicular to the PCB as possible since the LCD plugs into this connector.

## **Step 2: Power Supply**

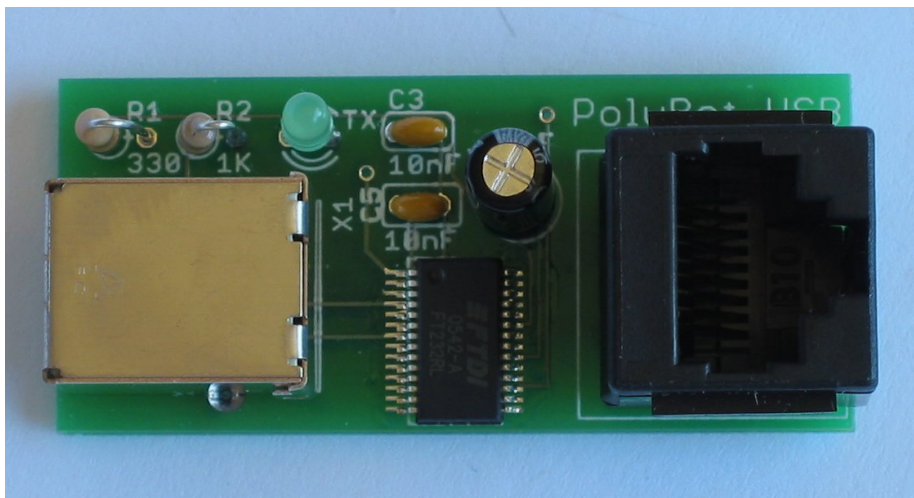
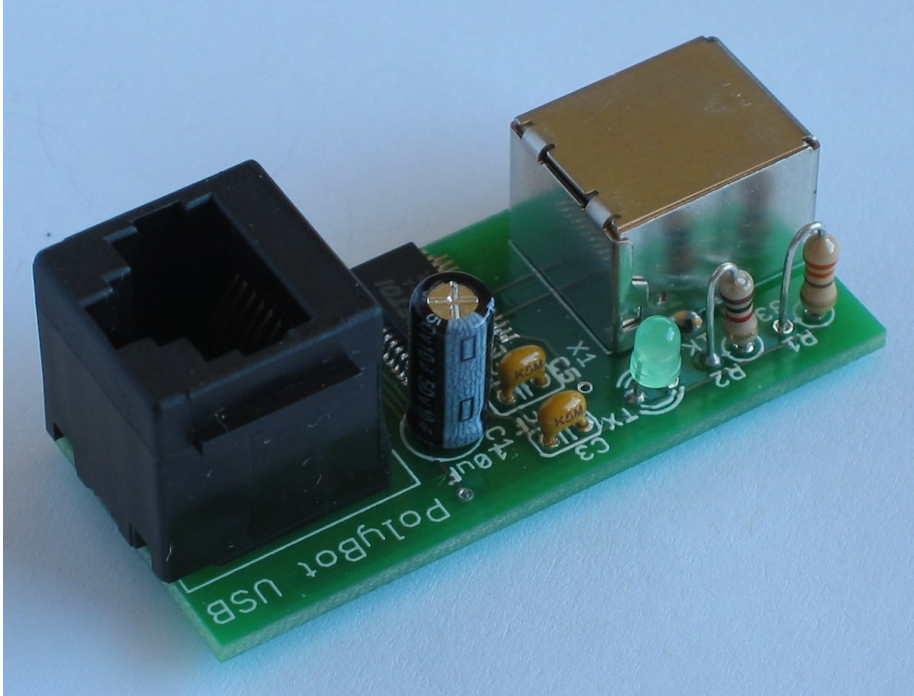
1. Solder the Red PWR LED. The longer leg goes into the hole closer to the ATmega32.
2. Solder the R\_PWR resistor. This is a 330 Ohm resistor (orange-orange-brown).
3. Solder F1, 1N5401 (silver band faces up), 7805, and the 1uH inductor.
4. Solder C15. This capacitor is polarized. Make sure the arrows point towards the F1 fuse.
5. Solder in the power jack.

6. Install a jumper across the lower 2 pins of JP\_PWR.

You are now ready to apply power to the board. Apply 5V (4xAA rechargeable batteries – not alkaline) to the power jack. The Red power LED should turn on and stay lit. Leave the power connected for a minute or so; the LED should stay lit during this time. If power and ground are shorted, the LED should turn off while power is connected.

Remove power and the Red LED should fade off. If the LED turns off immediately, check the C15 capacitor (470uF).

### **Step 3: Assemble the download board**



1. Solder the Green (TX) LED to the download board. The longer leg of the LED goes into the left hole (the hole towards the 1K resistor).
2. Solder the 330 Ohm resistor (orange-orange-brown) and 1K resistor (brown-black-red).
3. Solder the 3 capacitors: .01uF (103), .01uF (103), and 10uF (this is polarized)

#### **Step 4: Downloading to the ATmega32**

1. Solder the 1x16 male headers to the LCD display. Install the JP\_BL jumper.
2. Solder the Reset resistor (47K, yellow-purple-orange), R\_RELAY (1K, brown-black-red), R\_BL (10 ohm, brown-black-black-gold), and R\_LED (330, orange-orange-brown).
3. Solder the RJ-45 jack.
4. Solder the 16 Mhz crystal, the 22pF capacitors, and C11 (104 capacitor).
5. Solder the SW1 and RST switch.
6. Install the ATmega32 microcontroller. Note the orientation of the chip.
7. Install the LCD display.
8. Solder the green LED. The longer leg goes in the hole closer to the ATmega32.

Connect the PolyBot board and download board with an ethernet cable. Apply power to the PolyBot board.

Make sure the compiler and PolyBot board library are installed on the computer you will use. Download the drivers for the USB download board (go to [www.ftdichip.com](http://www.ftdichip.com) and download the latest VCP drivers for the 232R). Connect the cable to the download board and to the USB port of the computer. Install the driver and make sure the COM port is set to 57600 baud.

Open a command line terminal and go to the directory where you installed the PolyBot board library. Reset the board while the download board is connected. You should see a countdown timer appear on the LCD. The board is now ready to accept a program download.

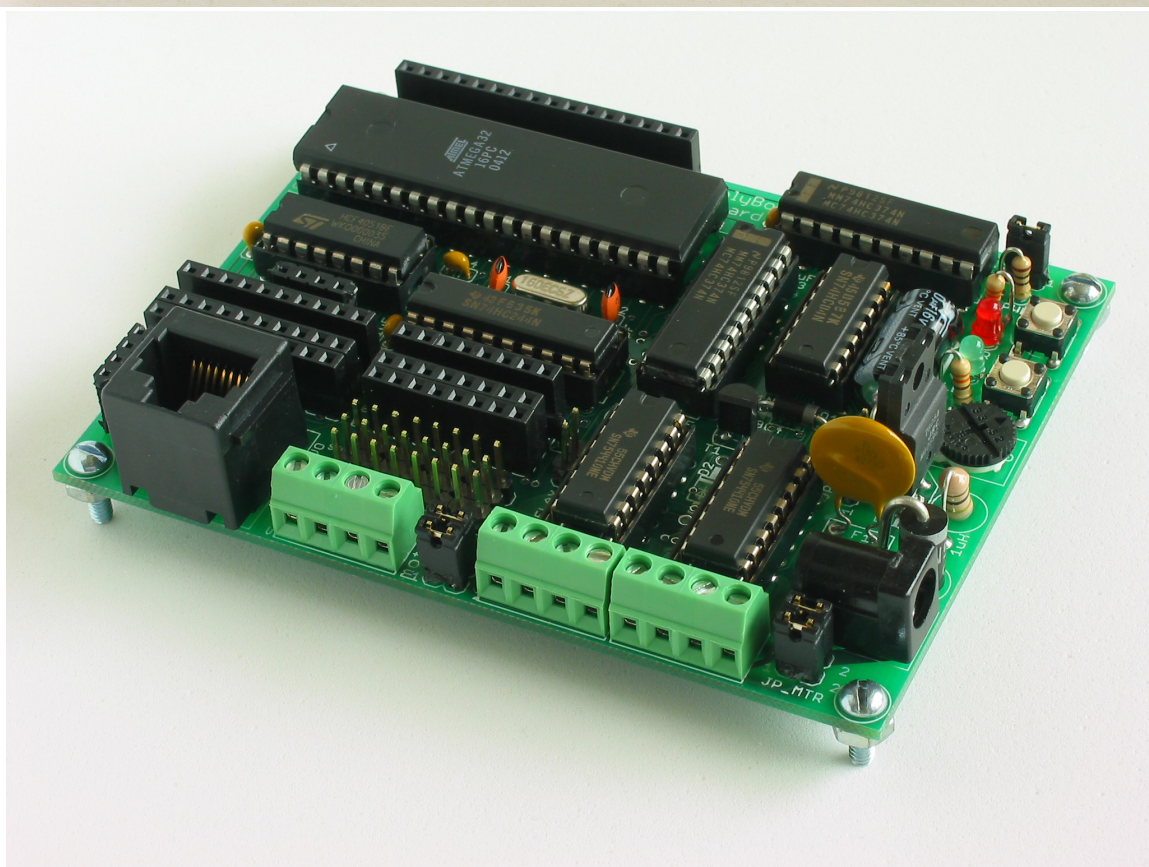
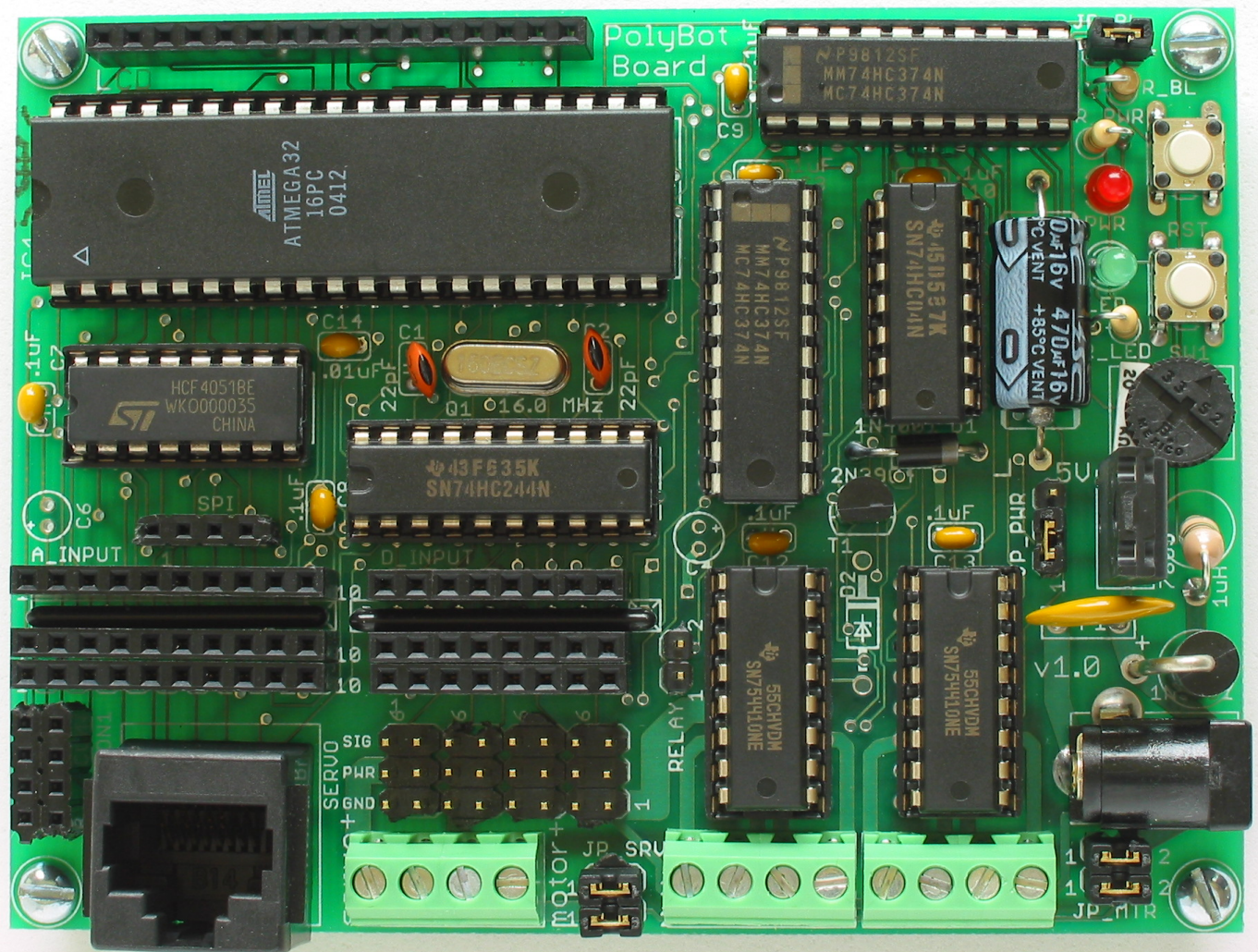
Next, type `make download`. The program should download to the board and you should see the countdown timer again. Press SW1 and your program should start running. The display should print the message 'PolyBot Board'. If it does, continue to the next step.

#### **Step 5: Install remaining components**

1. Solder the D1 diode. The silver band point toward the right side.
2. Solder the .01uF capacitor (103).
3. Solder both resistor networks. The side with the gray dot should point toward the right side.
4. Solder and install all remaining components.

Your PolyBot board is now complete! Make sure to test all inputs and outputs for functionality.





## Parts list

	Part number	Supplier
.1uF capacitor	80-C315C104M5U	Mouser
.01uF capacitor	80-C315C103M5U	Mouser
22pF capacitor	140-50N2-220J	Mouser
RJ-45 connector	154-UL6882	Mouser
1.0uH inductor	434-23-1R0	Mouser
Tactile switch	653-B3F-1000	Mouser
4 pin terminal block	158-P02EK381V4	Mouser
10k potentiometer	652-3352T-1-203	Mouser
36 pin female header	517-974-01-36	Mouser
470uF capacitor	199216CH	Jameco
74hc374	45858	Jameco
74hc04	45209	Jameco
Cd4051	13098	Jameco
74hct541	99303	Jameco
16 MHz crystal	137891CH	Jameco
1n4001	35975	Jameco
1n5401	36249	Jameco
1.85A fuse	200029CH	Jameco
47k resistor network	98087	Jameco
1K resistor		Jameco
10 ohm resistor	29882	Jameco
330 ohm resistor	30867	Jameco
47K ohm resistor	31149	Jameco
10 pin ribbon cable	135538	Jameco
74hc244	74HC244	Futurlec
5V regulator	7805T	Futurlec
40 pin male double header	HEADD40	Futurlec
16 pin female single header	FHEADS16	Futurlec
8 pin female single header	FHEADS8	Futurlec
10 pin female single header	FHEADS10	Futurlec
16x2 LCD with backlight	LCD16X2BL	Futurlec
Red LED	LED3R	Futurlec
Green LED	LED3G	Futurlec
Shorting blocks	HDSHOB	Futurlec
20 pin socket	ICS20	Futurlec
16 pin socket	ICS16	Futurlec
14 pin socket	ICS14	Futurlec
40 pin socket	ICS40	Futurlec
2.1mm DC power jack	G7946	Electronics Goldmine
ATMega32 microcontroller	ATMEGA32-16PI-ND	Digikey
TI 754410 H-bridge	296-9911-5-ND	Digikey