

This is the Revision C version of the [SonarDT1 RoboBrick](#). The status of this project is [finished](#).

SonarDT1 Robobrick (Revision C)

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1. Introduction

The Sonar1 RoboBrick is used to provide a RoboBrick interface to the [SRF04](#) sonar range finder from [Devantech](#).

2. Programming

The SonarDT1 RoboBrick is focused on operating the Devantech SRF04. In addition, it has the ability to control 1 servo, so that the SonarDT1 RoboBrick can be mounted on a standard hobby servo as a scanning platform. Lastly, there are some LED's that can provide direct feedback on the current distance being measured by the SRF04. Only the low order 5 bits of the high order byte are shown. (The B revision has a hardware bug that prevents D1 from lighting; this will be fixed in the next revision.)

There are some commands to automatically scan a server back and forth taking readings as it scans. The servo is started at an initial position (see Set/Read Sweep Initial Position.) There is a fixed distance between servo positions (see Set/Read Sweep Increment.) There is a time delay that is used to between changing sweep position that is measured in units of approximately 20mS (see Set/Read Sweep Delay.) There are a total number of different positions that must be less than or equal to 16 (see Set/Read Sweep Positions.) Each time the servo stops a position, a reading is taken and stored into an distance array. The distance array is read using the Read Array High and Low and the Read Array High Only commands. There is a sweep counter that is incremented each time the servo changes directions (see Set/Read Sweep Counter.) Finally, enabling the sweep servo also turns the sonar sensor into continuous measurement mode (See Set/Read Sweep Enable.)

The SonarDT1 commands are summarized in the table below:

Command	Send/ Receive	Byte Value							Discussion	
		7	6	5	4	3	2	1		0
Read Distance Low	Send	0	0	0	0	0	0	0	0	Return the low order byte <i>llllllll</i> of the distance
	Receive	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	
Read Distance High	Send	0	0	0	0	0	0	0	1	Return the high order byte <i>hhhhhhh</i> of the

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	Receive	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	distance
Read Distance High and Low	Send	0	0	0	0	0	0	1	0	Return the low and high order bytes <i>llllllll</i> <i>hhhhhhhh</i> of the distance
	Receive	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	
	Receive	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	
Trigger Distance Measure	Send	0	0	0	0	0	0	1	1	Trigger a Single Distance Measurement
Disable Servo	Send	0	0	0	0	0	1	0	0	Disable Servo
Enable Servo	Send	0	0	0	0	0	1	0	1	Enable Servo
Disable Continuous Measurement	Send	0	0	0	0	0	1	1	0	Disable Continuous Measurement
Enable Continuous Measurement	Send	0	0	0	0	0	1	1	1	Enable Continuous Measurement
Increment Servo	Send	0	0	0	0	1	0	0	0	Increment servo position by one.
Decrement Servo	Send	0	0	0	0	1	0	0	1	Decrement servo position by one.
Read Servo	Send	0	0	0	0	1	0	1	0	Return servo value <i>ssssssss</i> of the distance
	Receive	<i>s</i>	<i>s</i>	<i>s</i>	<i>s</i>	<i>s</i>	<i>s</i>	<i>s</i>	<i>s</i>	
Read Enables	Send	0	0	0	0	1	0	1	1	Return servo enable <i>s</i> and continuous distance measurement <i>m</i>
	Receive	0	0	0	0	0	0	<i>m</i>	<i>s</i>	
Set Servo Low	Send	0	0	0	1	<i>l</i>	<i>l</i>	<i>l</i>	<i>l</i>	Set the low order 4 bits of the servo position to <i>llll</i> .
Set Servo High	Send	0	0	1	0	<i>h</i>	<i>h</i>	<i>h</i>	<i>h</i>	Set the high order 4 bits of the servo position to <i>hhhh</i> .
Set Sweep Initial Position	Send	0	1	0	0	0	0	0	0	Set sweep initial position to <i>pppppppp</i> .
	Send	<i>p</i>	<i>p</i>	<i>p</i>	<i>p</i>	<i>p</i>	<i>p</i>	<i>p</i>	<i>p</i>	
Set Sweep Increment	Send	0	1	0	0	0	0	0	1	Set the sweep increment to <i>iiiiiii</i> .
	Send	<i>i</i>	<i>i</i>	<i>i</i>	<i>i</i>	<i>i</i>	<i>i</i>	<i>i</i>	<i>i</i>	
Set Sweep Positions	Send	0	1	0	0	0	0	1	0	Set the total number of sweep positions to <i>pppppp</i> (16).
	Send	0	0	0	<i>p</i>	<i>p</i>	<i>p</i>	<i>p</i>	<i>p</i>	
Set Sweep Delay	Send	0	1	0	0	0	0	1	1	Set the sweep delay to <i>ddddddd</i> .
	Send	<i>d</i>	<i>d</i>	<i>d</i>	<i>d</i>	<i>d</i>	<i>d</i>	<i>d</i>	<i>d</i>	
Set Sweep Counter	Send	0	1	0	0	0	1	0	0	Set the sweep counter to <i>ccccccc</i> .
	Send	<i>c</i>	<i>c</i>	<i>c</i>	<i>c</i>	<i>c</i>	<i>c</i>	<i>c</i>	<i>c</i>	
Set Sweep Enable	Send	0	1	0	0	0	1	1	<i>s</i>	Set the sweep enable to <i>s</i> . Enabling the sweep flag also enables continuous measurement.
Read Sweep Initial Position	Send	0	1	0	0	1	0	0	0	Read the sweep low position of <i>pppppppp</i> .
	Receive	<i>p</i>	<i>p</i>	<i>p</i>	<i>p</i>	<i>p</i>	<i>p</i>	<i>p</i>	<i>p</i>	
Read Sweep Increment	Send	0	1	0	0	1	0	0	1	Read the sweep increment <i>iiiiiii</i> .
	Receive	<i>i</i>	<i>i</i>	<i>i</i>	<i>i</i>	<i>i</i>	<i>i</i>	<i>i</i>	<i>i</i>	
Read Sweep Positions	Send	0	1	0	0	1	0	1	0	Read the total number of sweep positions <i>pppppp</i> .
	Receive	0	0	0	<i>p</i>	<i>p</i>	<i>p</i>	<i>p</i>	<i>p</i>	
Read Sweep Delay	Send	0	1	0	0	1	0	1	1	Read the sweep delay <i>ddddddd</i> .
	Receive	<i>d</i>	<i>d</i>	<i>d</i>	<i>d</i>	<i>d</i>	<i>d</i>	<i>d</i>	<i>d</i>	
	Send	0	1	0	0	1	1	0	0	Read the sweep counter <i>ccccccc</i> .

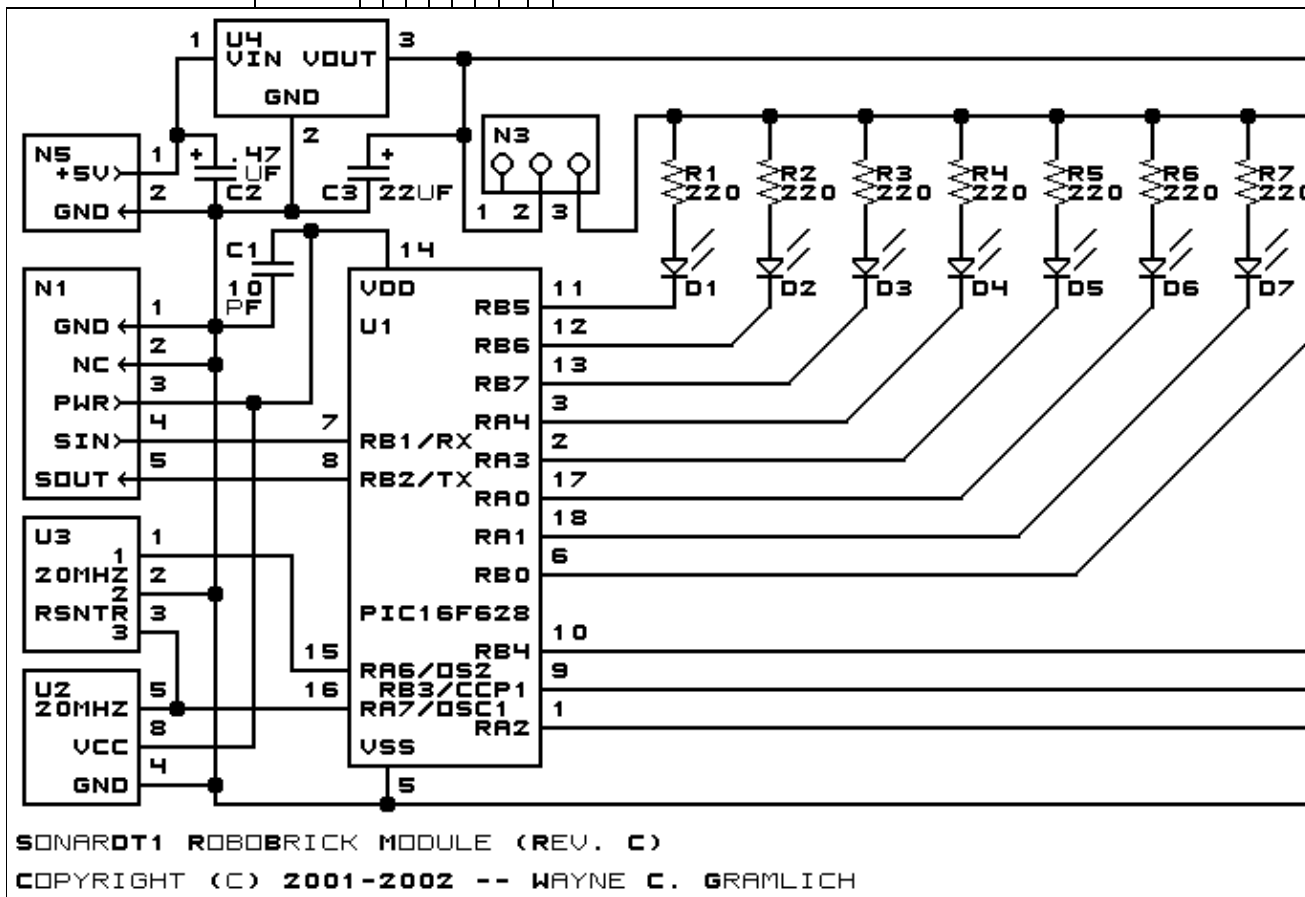
Read Sweep Counter	Receive	<i>c c c c c c c c</i>	
Read Sweep Enable Flag	Send	0 1 0 0 1 1 0 1	Read the sweep enable flag <i>s</i> .
	Receive	0 0 0 0 0 0 0 <i>s</i>	
Read Array High and Low	Send	0 1 0 1 <i>i i i i</i>	Read sonar distance array value at index <i>iiii</i> (15). Both the high order and order bytes of <i>hhhhhhh hlllllll</i> are returned.
	Receive	<i>h h h h h h h h</i>	
	Receive	<i>l l l l l l l l</i>	
Read Array High Only	Send	0 1 1 0 <i>i i i i</i>	Read sonar distance array value at index <i>iiii</i> (15). Only high order byte of <i>hhhhhhh h</i> is returned.
	Receive	<i>h h h h h h h h</i>	
Shared Commands	Send	1 1 1 1 1 <i>c c c</i>	Execute shared command <i>ccc</i> .

3. Hardware

The hardware consists of a circuit schematic and a printed circuit board.

3.1 Circuit Schematic

The schematic for the Sonar1 RoboBrick is shown below:



The parts list kept in a separate file -- [sonardt1.plt](#).

3.2 Printed Circuit Board

The printed circuit board files are listed below:

[sonardt1_back.png](#)

The solder side layer.

[sonardt1_front.png](#)

The component side layer.

[sonardt1_artwork.png](#)

The artwork layer.

[sonardt1.gbl](#)

The RS-274X "Gerber" back (solder side) layer.

[sonardt1.gtl](#)

The RS-274X "Gerber" top (component side) layer.

[sonardt1.gal](#)

The RS-274X "Gerber" artwork layer.

[sonardt1.drl](#)

The "Excellon" NC drill file.

[sonardt1.tol](#)

The "Excellon" tool rack file.

3.3 Construction Instructions

The [construction instructions](#) are found in a separate file to make them a little more printer friendly.

4. Software

The software for the SonarDT1 RoboBrick is in the following files:

[sonardt1.ucl](#)

The μ CL source code.

[sonardt1.asm](#)

The PIC16F628 assembly code.

[sonardt1.lst](#)

The listing file.

[sonardt1.hex](#)

The Intel[®] hex file.

5. Issues

The following fabrication issues came up:

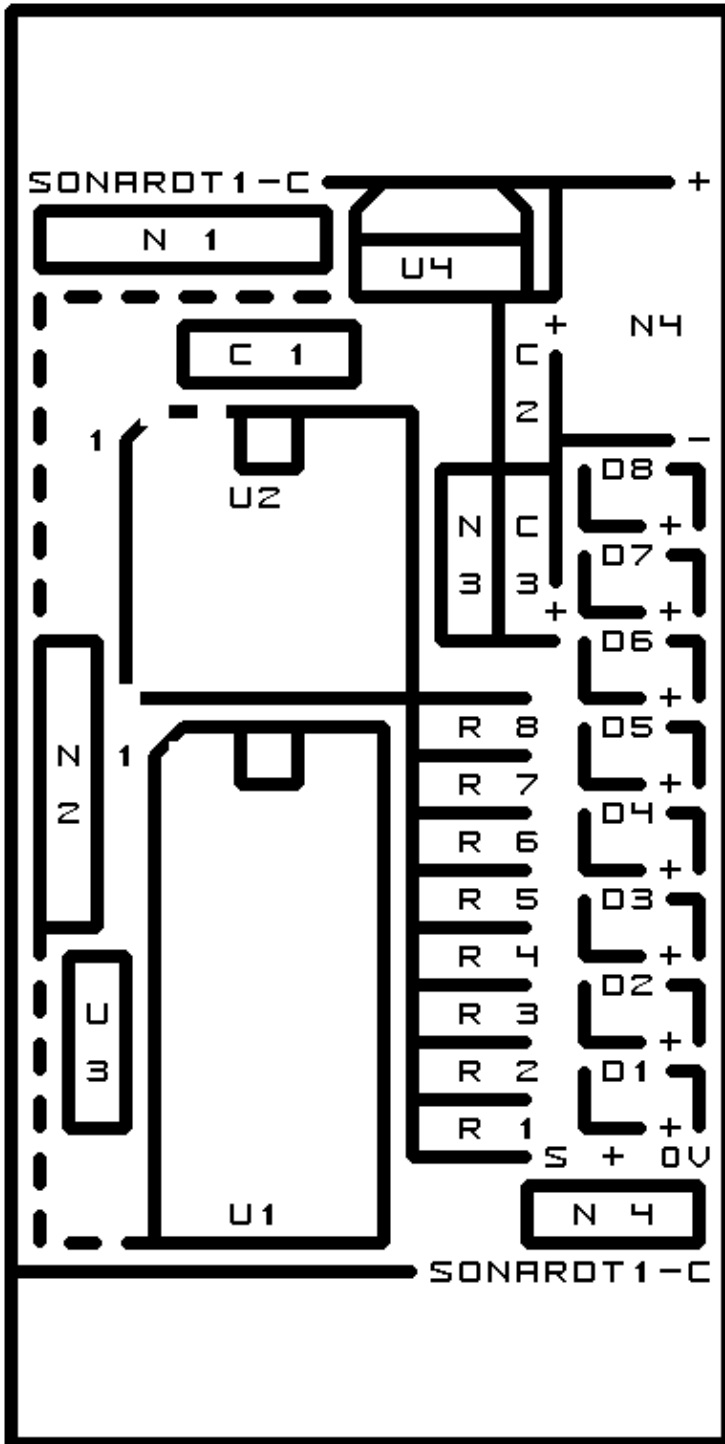
- The SRF04 chews a lot of current in continuous mode. It needs to have its own power regulator.
- LED D1 does not light. This is because RA5 is input only on the PIC16F628. This needs to be fixed. RA6 is available though.

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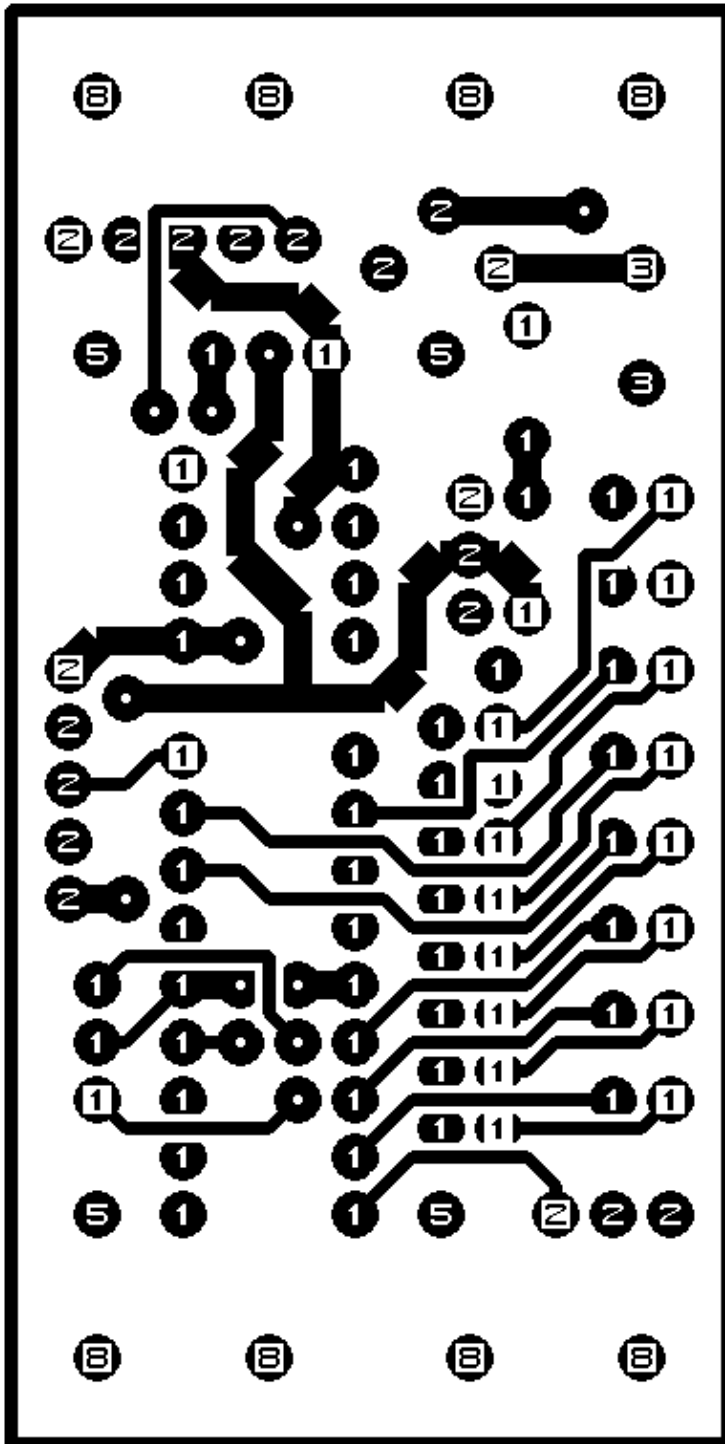
A. Appendix A: Parts List

```
# Parts list for SonarDT1 RoboBrick (Rev. C)
#
# B1 is the SRF04 Sonar board that plugs into N2;
# it is not listed on the PCB.
B1: SRF04 - Devantech SRF04 Sonar Ranger [Acroname: R93-SRF04]
C1: Capacitor10pF - 10pF Ceramic Capacitor [Jameco: 15333]
C2: Capacitor470nF - .47uF Tantalum Capacitor [Jameco: 33531]
C3: Capacitor22uF - 22uF Tantalum Capacitor [Jameco: 94094]
D1-8: LEDGreen - Small Green LED [Jameco: 34606]
R1-8: Resistor220.Vertical - 220 Ohm 1/4 Watt Resistor [Jameco: 30470]
N1: Header1x5.RBSlave.SonarDT1 - 1x5 Male Header [5/40 Jameco: 160881]
N2: Header1x5SonarDT1 - 1x5 Female Header [5/36 Digikey: 929974-01-36-ND]
N3: Header1x3.SonarDT1_LED - 1x3 Male Header [3/40 Jameco: 160881]
N4: Header1x3.SonarDT1_Servo - 1x3 Male Header [3/40 Jameco: 160881]
N5: TerminalStrip2.SonarDT1 - 2 Junction Terminal Strip [Jameco: 189675]
# N6 is a the socket for U1; it is not listed on the PCB.
N6: Socket18DIP - 18-pin DIP socket [Jameco: 65584]
# N7: is the 1x5 Male Header that solders into the SRF04 board;
# it is not listed on the PCB.
N7: Header1x5.SonarDT1 - 1x5 Male Header [5/40 Jameco: 160881]
U1: PIC16F628.SonarDT1.RevC - [Digikey: PIC16F628-20/P-ND]
U2: Oscillator20MHzHalf - Half Height 20MHz Oscillator [Digikey: X220-ND]
U3: Resonator20MHz - 20MHz Ceramic Resonator w/capactiros [Digikey: X909-ND]
U4: LM2940CG-5 - 5 Volt Low Drop Out Voltage Regulator [Jameco: 107182]
# Each RoboBrick should have a connector cable:
N8-9: CableHeader1x5 - 1 x 5 Female Shell [Jameco: 163686]
N10-17: CablePinFemale - Female Pin [Jameco: 100765]
N18-19: CablePinMale - Male Pin [Jameco: 145357]
N20: ShortingBlock - .1" Shorting Block - [Jameco: 22023]
```

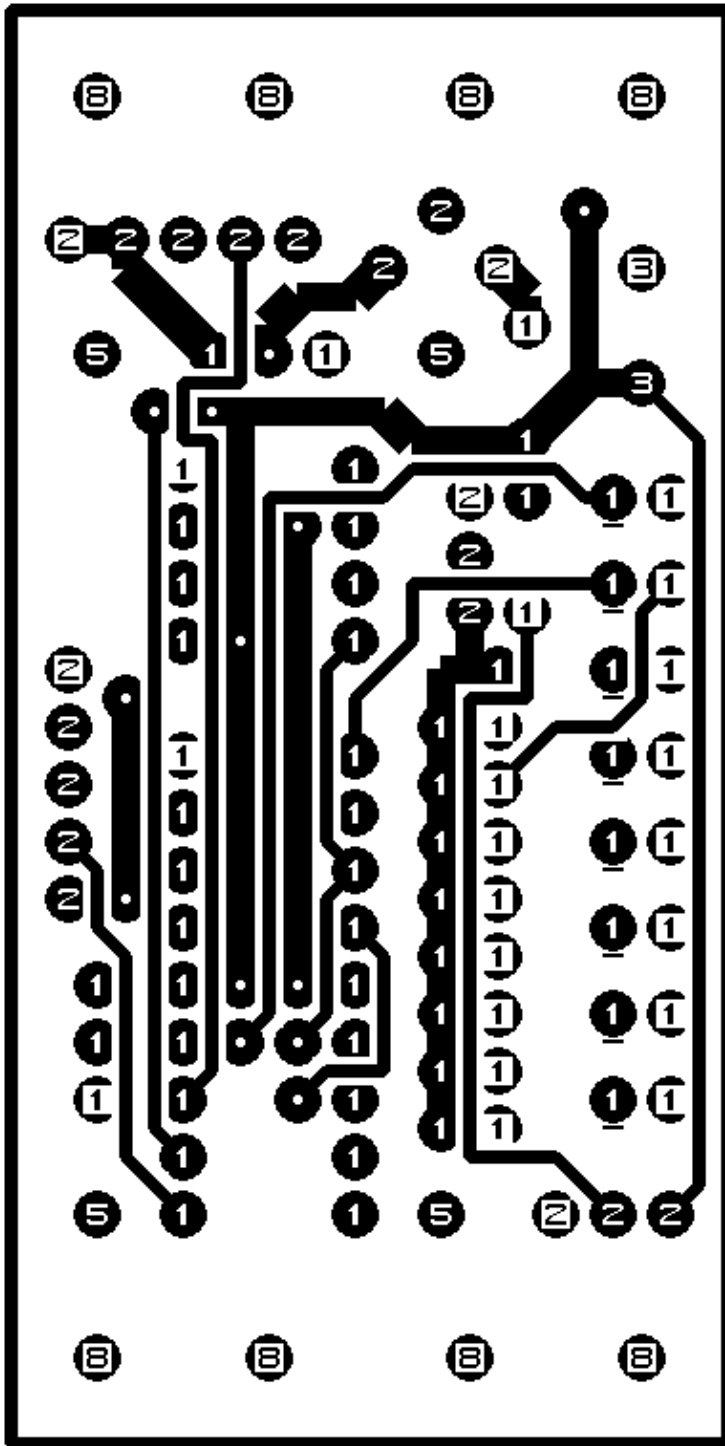
B. Appendix B: Artwork Layer



C. Appendix C: Back (Solder Side) Layer



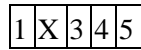
D. Appendix D: Front (Component Side) Layer



E. Appendix E: Construction Instructions

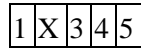
The instruction steps for building the Light4 (Rev. B) RoboBrick are listed below:

1. Take the board and orient it vertically. By convention the upper edge is north, the lower edge is south, the left edge is west, and the right edge is east. Orient the board so that N1 is in the north west corner. [\[Step1\]](#)
2. Take a 1×5 male header and using some diagonal cutters, snip off pin 2 using the diagram below:



- Pin 2 is the pin marked with an `X'. Insert the header into N1 with pin 1 to the west. Turn the board over and solder one pin. If the header is not pointing straight up, re-heat the pin and reposition the header until it is straight up. Now solder the remaining 4 pins. [\[Step2\]](#)
3. Find a 1×3 male header, insert it into N4, solder one pin, verify that it is still vertical, re-heat and reposition if necessary, and solder the remaining 2 pins in. [\[Step3\]](#)
 4. Find a 1×3 male header, insert it into N3 in the north east corner and repeat the steps from the previous instruction. Note that the legend for N3 can be a little hard to read some times. [\[Step4\]](#)
 5. Find the 1×5 female header, insert it into N2, solder one pin, verify that it is still vertical, re-heat and reposition if necessary, and solder the remaining 4 pins in. [\[Step5\]](#)
 6. Find a 10pF capacitor and insert it into C1. Spread the leads a little so it will not fall out. Turn the board over and solder one lead. Turn the board over again and verify that the capacitor is still positioned vertically. If not, re-heat the lead you just soldered and reposition the capacitor. Now solder the remaining lead. Snip off the excess capacitor leads. [\[Step6\]](#)
 7. Find a 220 Ohm resistor (Red Red Brown). Bend both leads 90 degrees so that the resistor comfortably fits into R1. Just for consistency, place the red band to the east. (Resistors are symmetric, so there is no damage done if you install the resistor with the red band west.) Turn the board over, and spread the leads a little to keep it from coming out. Solder one lead. Now turn it over to verify that the position is acceptable. If not, re-heat the lead you just soldered and get it positioned to your liking. Solder in the remaining lead. Snip off the excess leads sticking out the back. [\[Step7\]](#)
 8. Repeat the preceding instruction with five more of the same resistors and insert them into R2 through R6. Solder them as in the preceding instruction. [\[Step8\]](#)
 9. Find a small green LED. The LED has one lead that is slightly longer than the other. The longer lead is the positive (`+') lead and the shorter lead is the negative (`-') lead. Insert the first LED into D1 with the positive lead on the east, and the negative lead on the west. It is important that you get the LED oriented correctly; otherwise the LED's will not work. Solder one lead, verify that the LED is flat against the board, re-heat and reposition if necessary, and solder the remaining lead. [\[Step9\]](#)
 10. Using the previous instruction, install the remaining 5 green LED's into D2 through D6. You may find that the LED's are just a tiny bit too wide. If so, just use your diagonal cutters to snip off the plastic edge from both sides of each diode. [\[Step10\]](#)
 11. Install the crystal oscillator into U2 with pin 1 in the north west. Pin 1 is the square corner or the corner with the dot next to it. If the dot is missing or not particularly close to a corner, use the square corner to find pin 1 instead. Spread the leads to hold the crystal in. Solder one lead, verify position, solder the remaining leads, and snip off the excess. [\[Step11\]](#)
 12. Install the 18-pin DIP socket into U1. Place pin 1 to the north west. The sockets typically have a notch on the end that has pin 1. In the picture, the notch is highlighted with some white marker. If the socket is installed the upside down, no harm occurs. [\[Step12\]](#)
 13. Find the pre-programmed PIC16F628 and insert it into the socket at U1 with pin 1 pointing up. [\[Step 13 picture is missing\]](#)

14. For this next step we are going to install a male header on the SRF04. The two metal cans on the SRF04 are the ultrasonic transducers for the SRF04; they are on the *front* side of the SRF04. The male header will go on the *back* side of the SRF04, pointing *away* from the two metal cans. {We need a picture here}.
15. Find the 1×5 male header and snip off pin 2 as shown in the diagram below:



Pin 2 is marked with an `X'. Orient the SRF04 so that the ultrasonic transducers are pointing down and so that the five holes are on the north. Insert the 1×5 header into the 5 holes with pin 1 to the west. Solder one pin, verify that it is vertical, re-heat and reposition if necessary, and solder in the remaining 4 pins. [[Step14](#)]

16. {Install the two screws (what size).} [{{picture missing}}]
17. Insert the SRF04 into N2. [{{picture missing}}]
18. Insert the shorting block onto N3 on the north two pins. [{{picture missing}}]

The assembly of the SonarDT1 (Rev. B) RoboBrick is complete.

SonarDT1 RoboBrick (Revision B) Check Out

Perform the following steps to test out the SonarDT1 RoboBrick:

1. Make sure that both the PIC16F628 (U1) and the 20MHz oscillator (U2) are not plugged into their respective sockets.
2. The pinouts for the connectors are listed below:

N1 – RoboBrick Cable Connector

N1				
1	2	3	4	5
GND	n/c	+5V	SIN	SOUT

N2 – SRF04 Connector

N2	
1	GND
2	n/c
3	TRIG
4	ECHO
5	+5V

N3 – LED's Enable Header

N3	
3	+5V
2	LED's
1	n/c

N4 – Servo Connector

N4		
1	2	3
SIG	+5V	GND

3. The pin-outs for the two sockets are listed below:

U1 -- PIC16F628

U1			
1	RA2	RA1	18
2	RA3	RA0	17
3	RA4	OSC1	16
4	RA5		15
5	GND	+5V	14
6			13
7	RB1		12
8	RB2		11
9	TB3		10

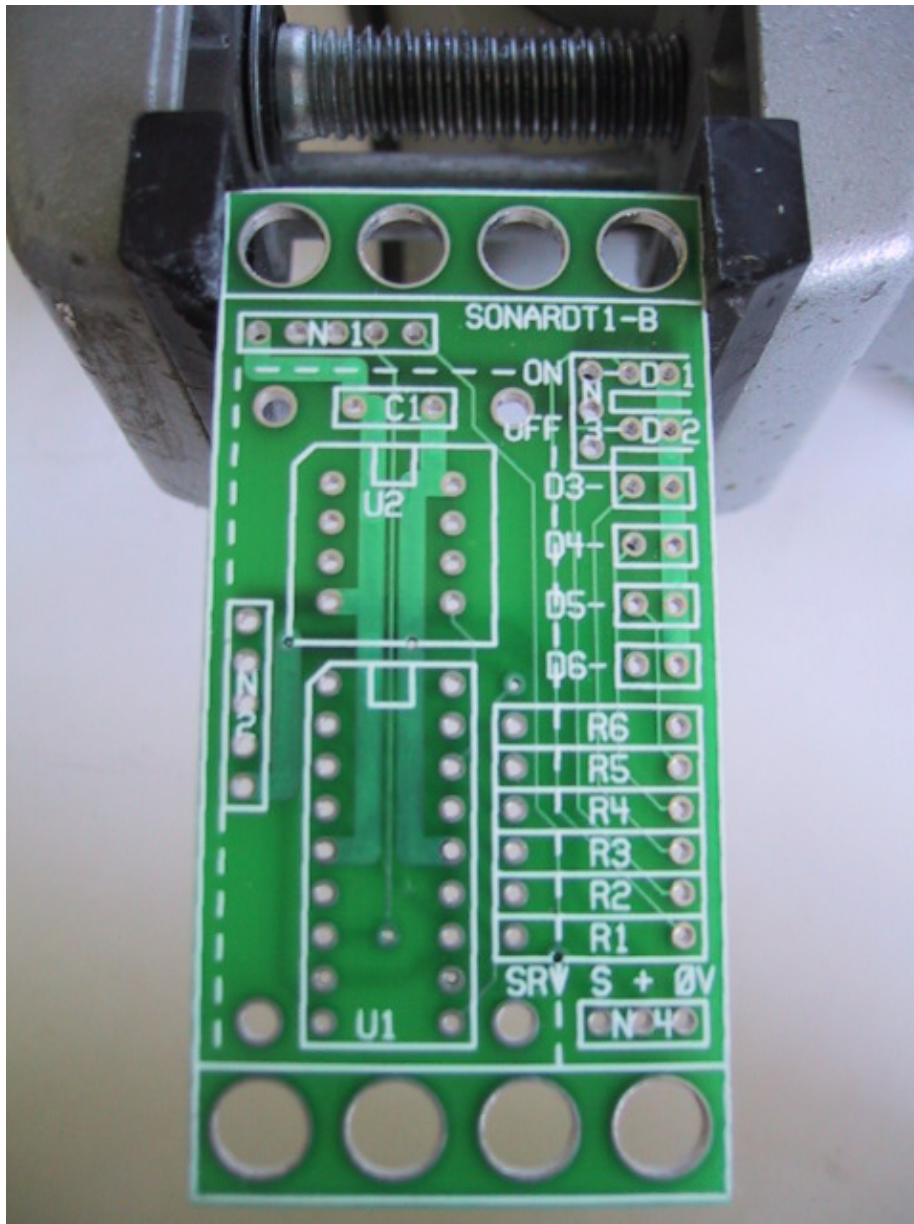
U2 – 20MHz Oscillator

U2			
1		+5V	8
2			7
3			6
4	GND	20MHz	5

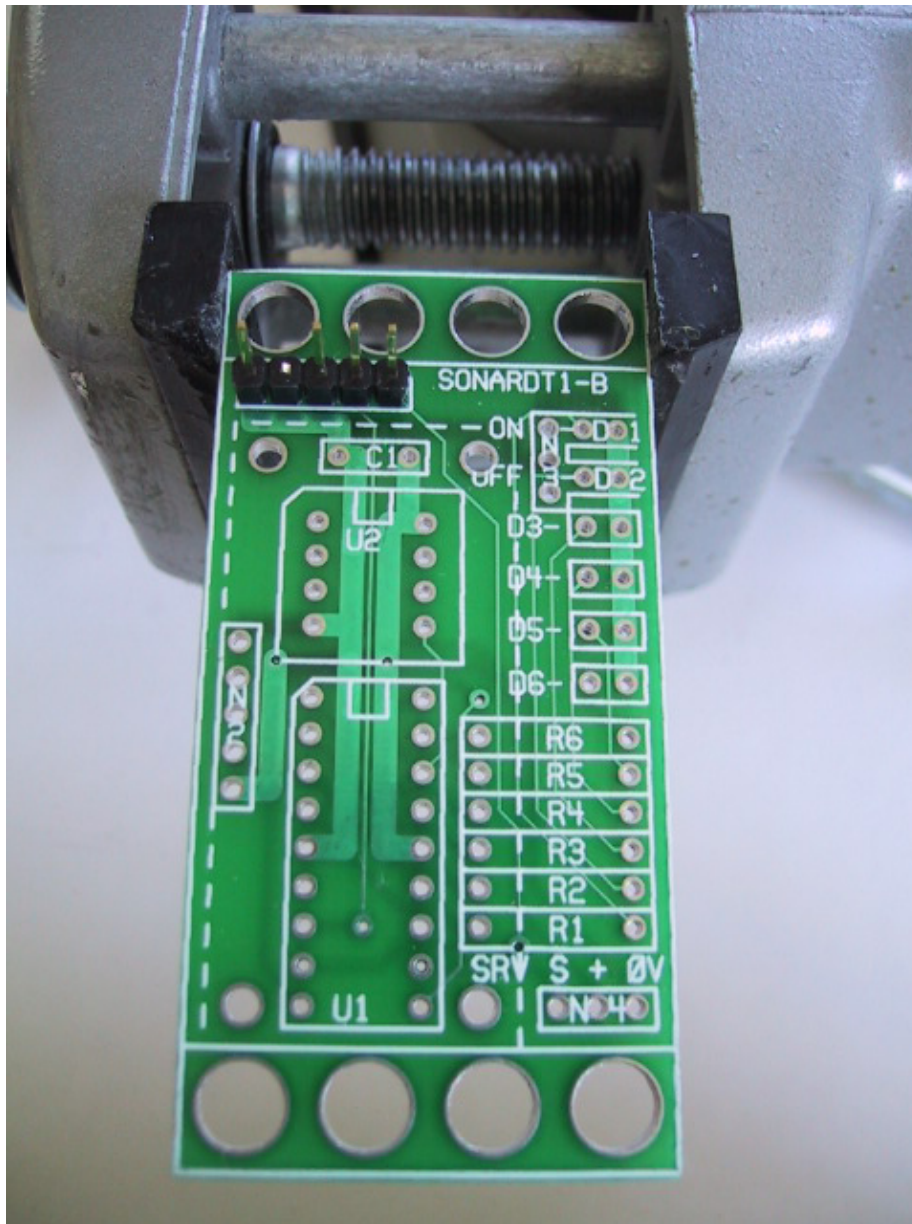
- Using a continuity checker (i.e. an ohm meter), verify that N1–1, N2–1, N4–3, U1–5, and U2–4 are all connected. (N1–1 means connector N1, pin 1.)
- Using a continuity checker, verify that N1–3, N2–5, N3–3, N4–2, U1–14, and U2–8 are all connected together. When testing N2, you will have to stick a wire into the appropriate hole of the female socket to get electrical connectivity out.
- Using a continuity checker, verify that N1–1 and N1–3 are *not* connected together (i.e. there is no power supply short).
- Apply 5 volts to the SonarDT1 RoboBrick. This is done easily by connecting a standard RoboBrick cable from a master RoboBrick such as the [BS2Hub8](#) RoboBrick or the [PIC876Hub10](#) RoboBrick.
- Using a volt meter, verify that there is 5 volts from U1–5 (GND) to U1–14 (+5V). These are the upper two pins.
- Put a shorting block across pins 2 and 3 of N3. This is the upper two pins.
- Using a wire that is bare on both ends, plug one end into U1–5. Now tap pins tap pins 17, 18, 1, 2, 3, and 4 of U1 to verify that the LED's light up one by one. If they do not light up, you've got the LED's installed backwards or you installed the shorting block on the wrong pins.
- Turn the power off. Plug the PIC16F628 into U1. Plug the SRF04 into N2. Apply power. The LED's should start to show the distance being read from the SRF04. Using your hand in front of the SRF04, move your hand forward and backwards to watch the LED's count in binary.

You are done.

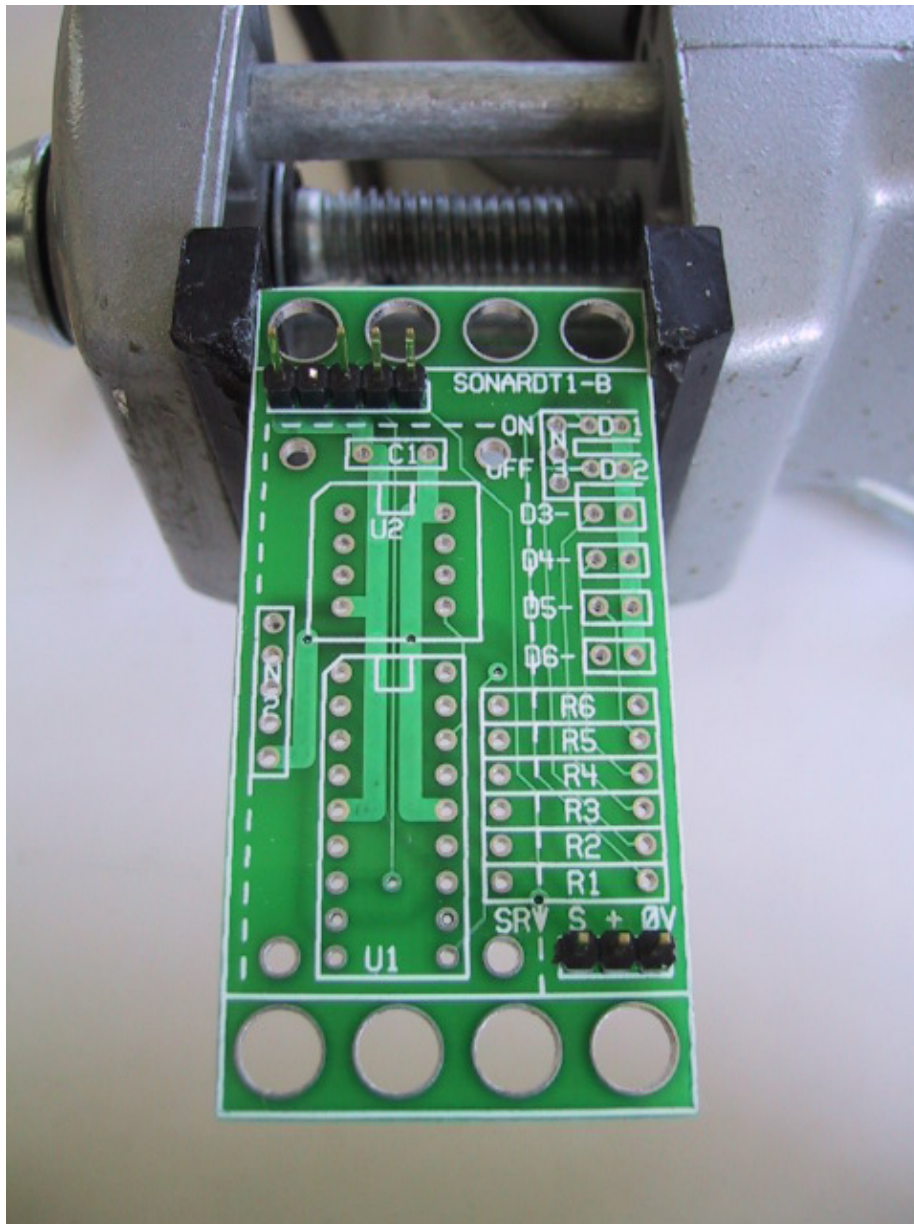
Step 1



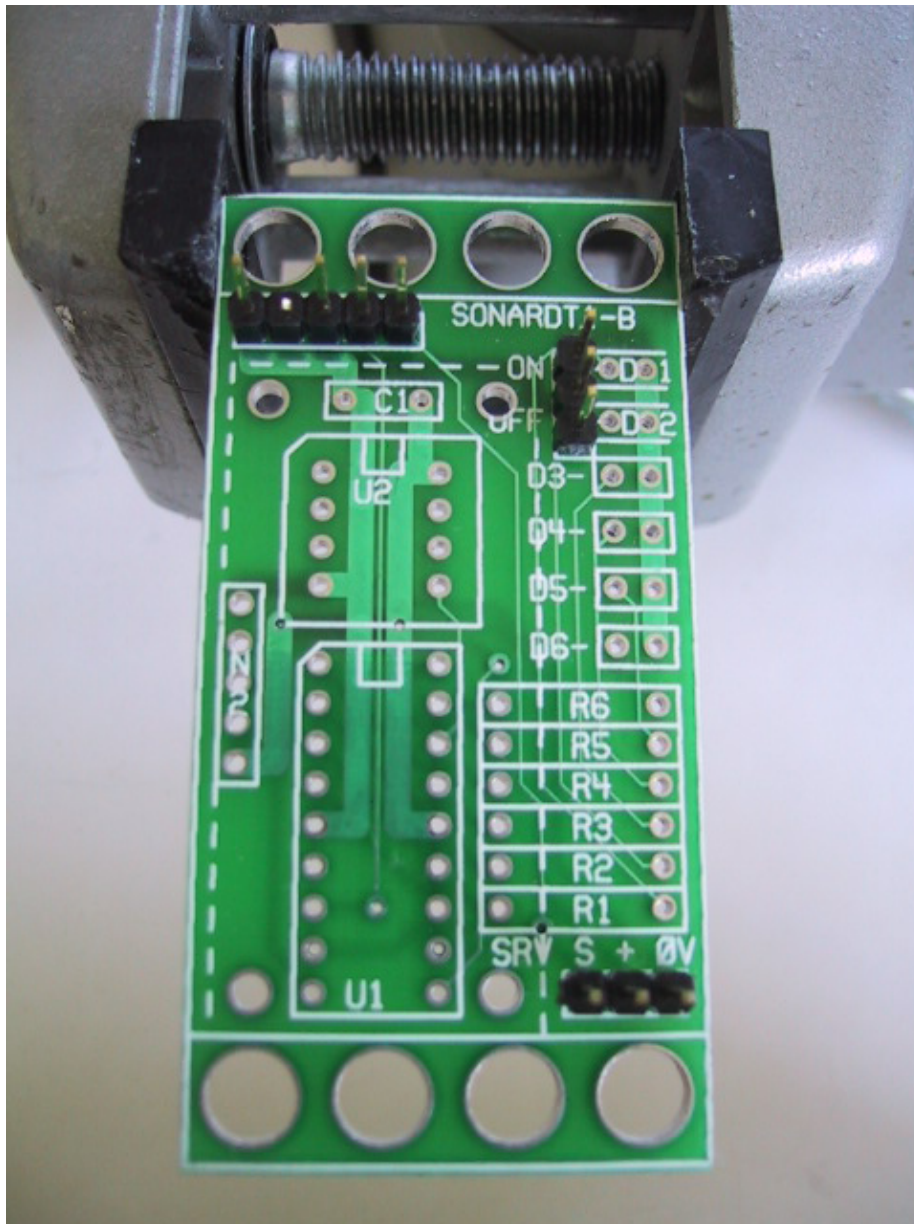
Step 2



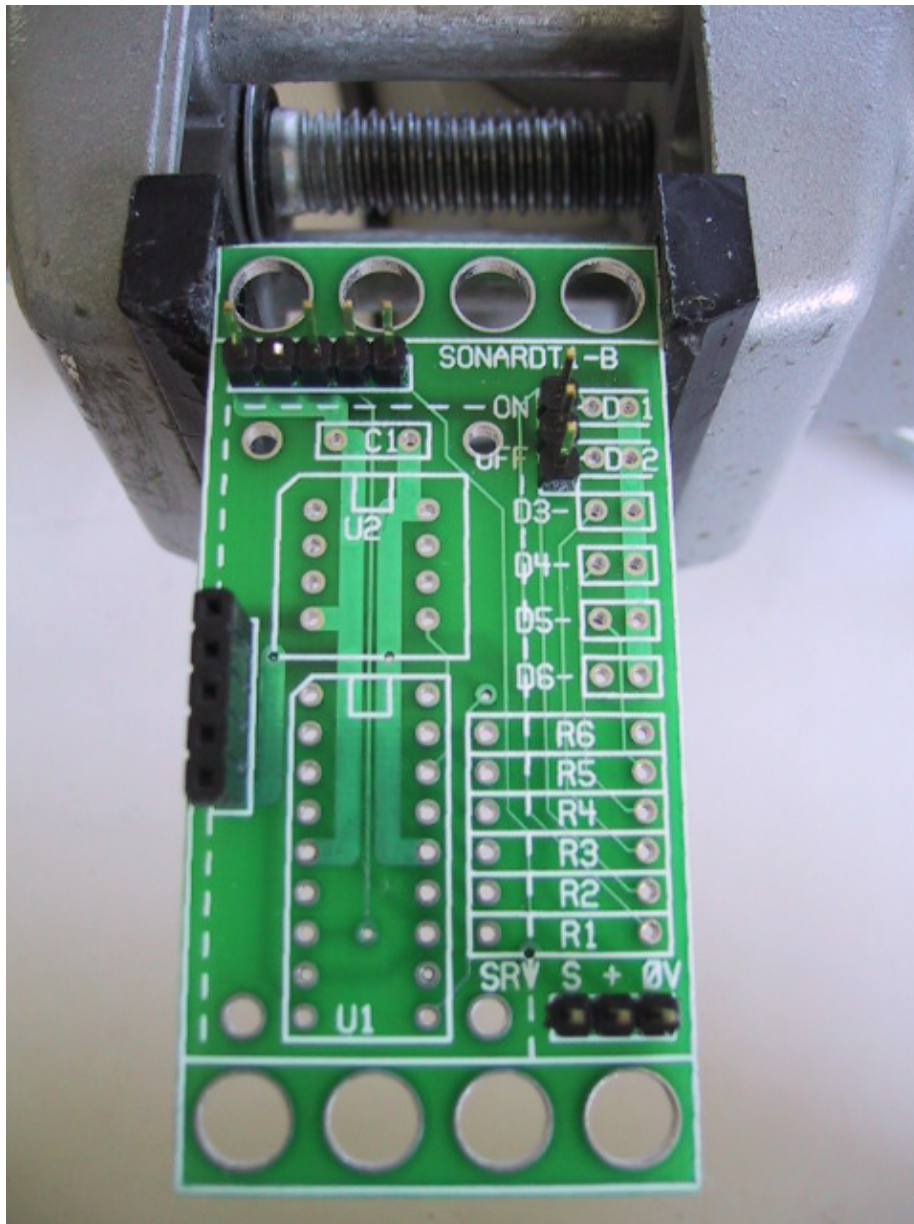
Step 3



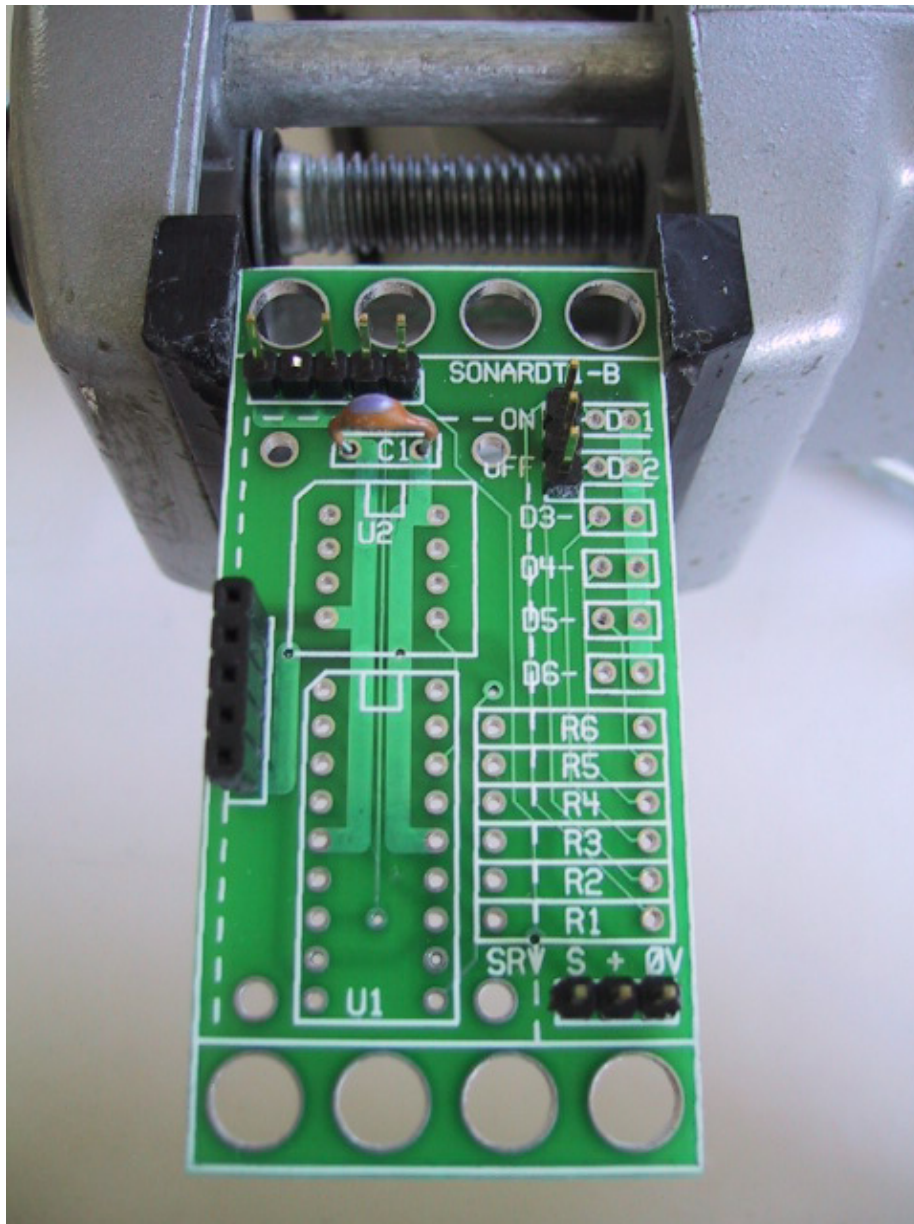
Step 4



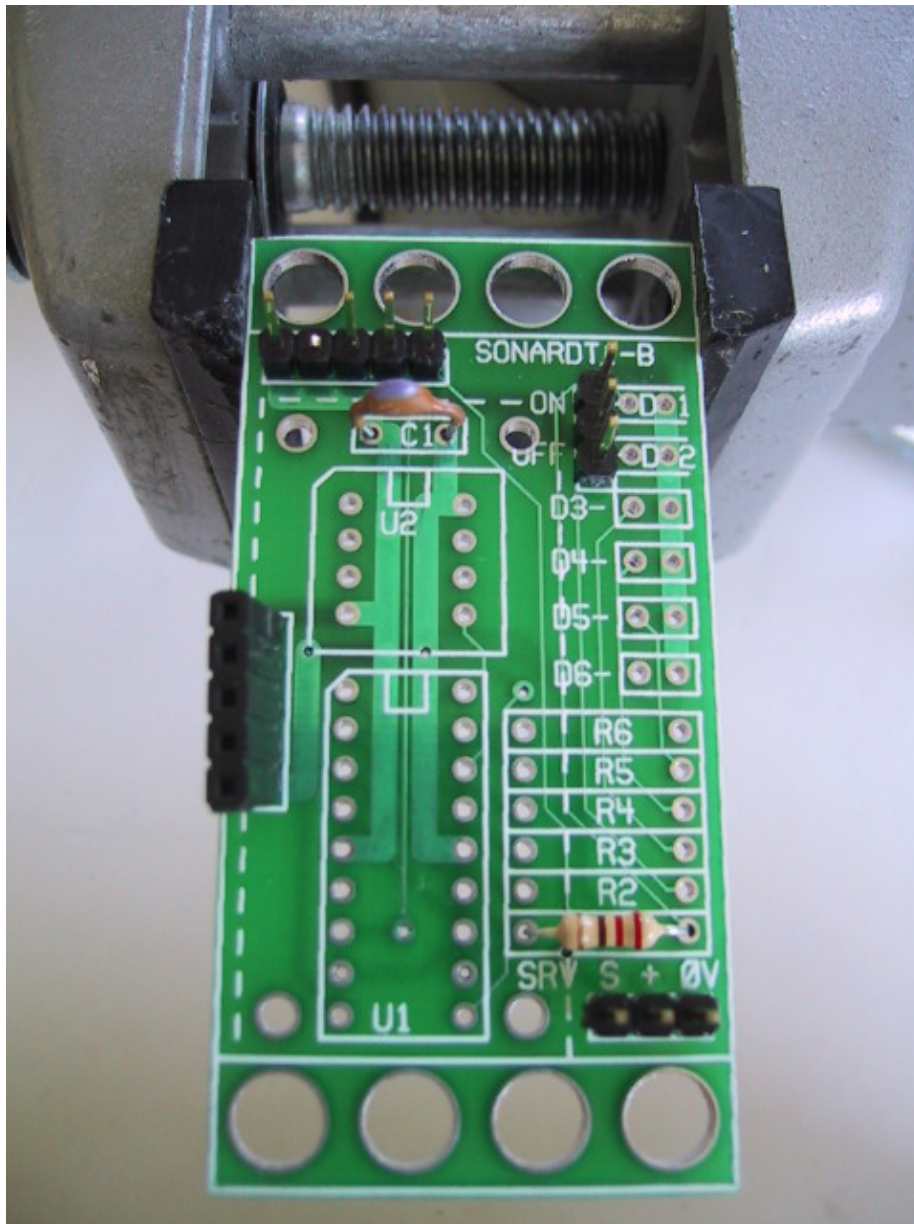
Step 5



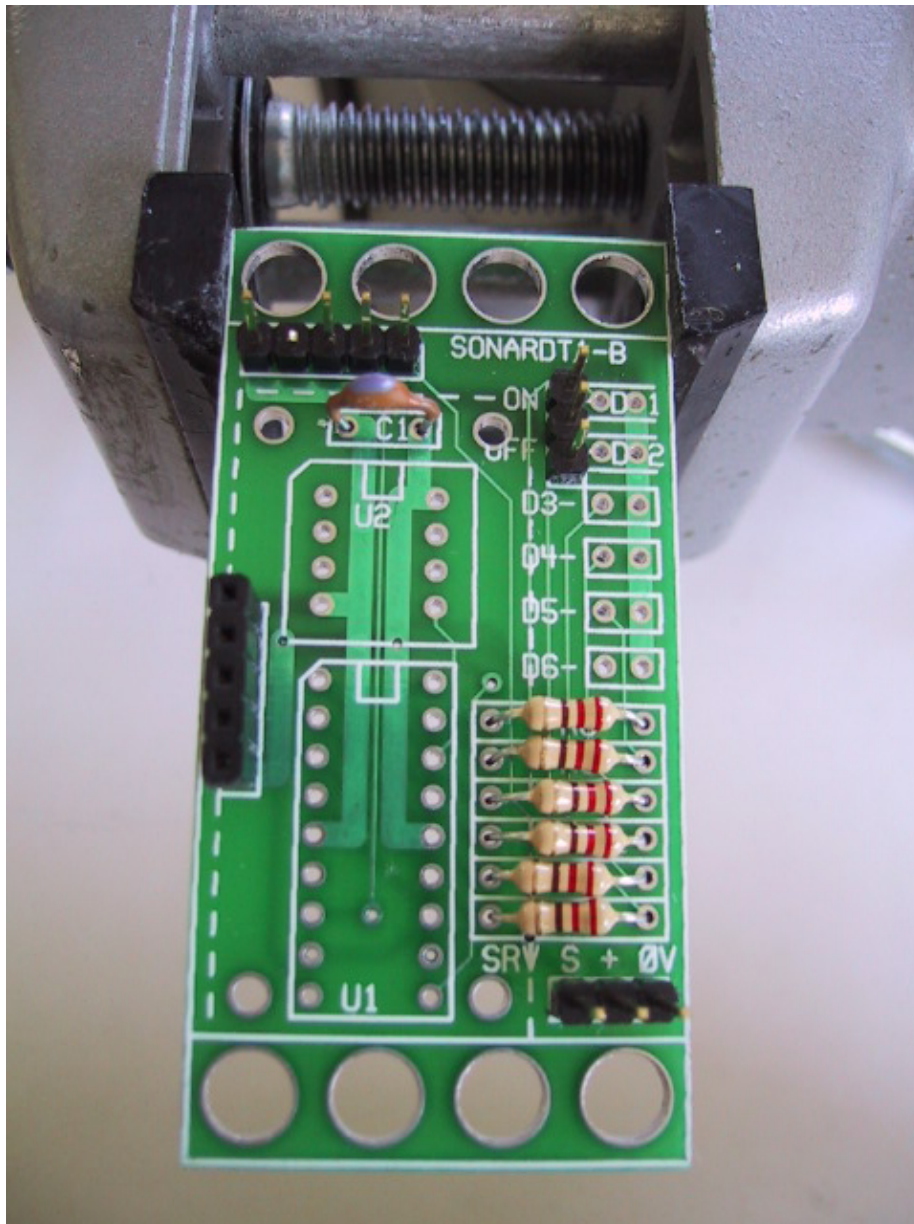
Step 6



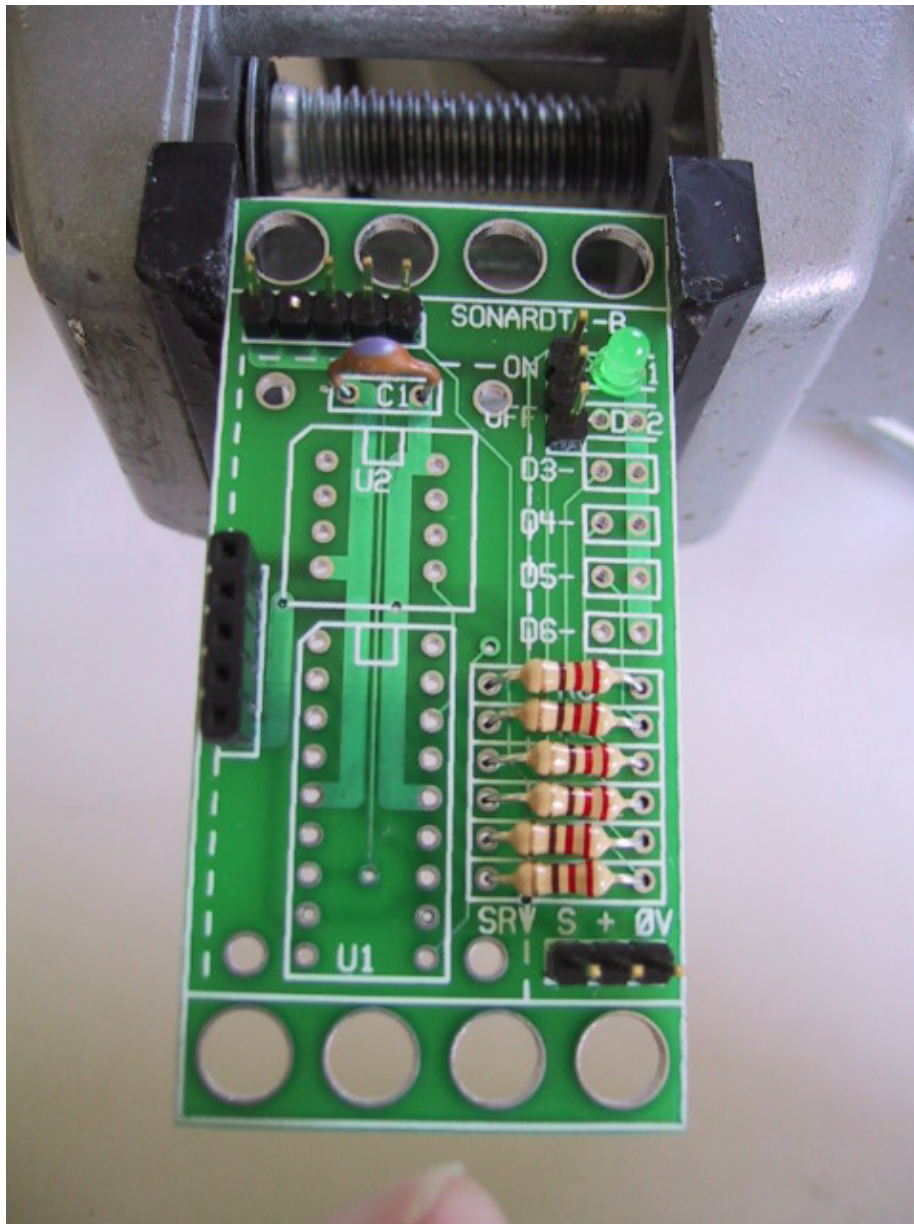
Step 7



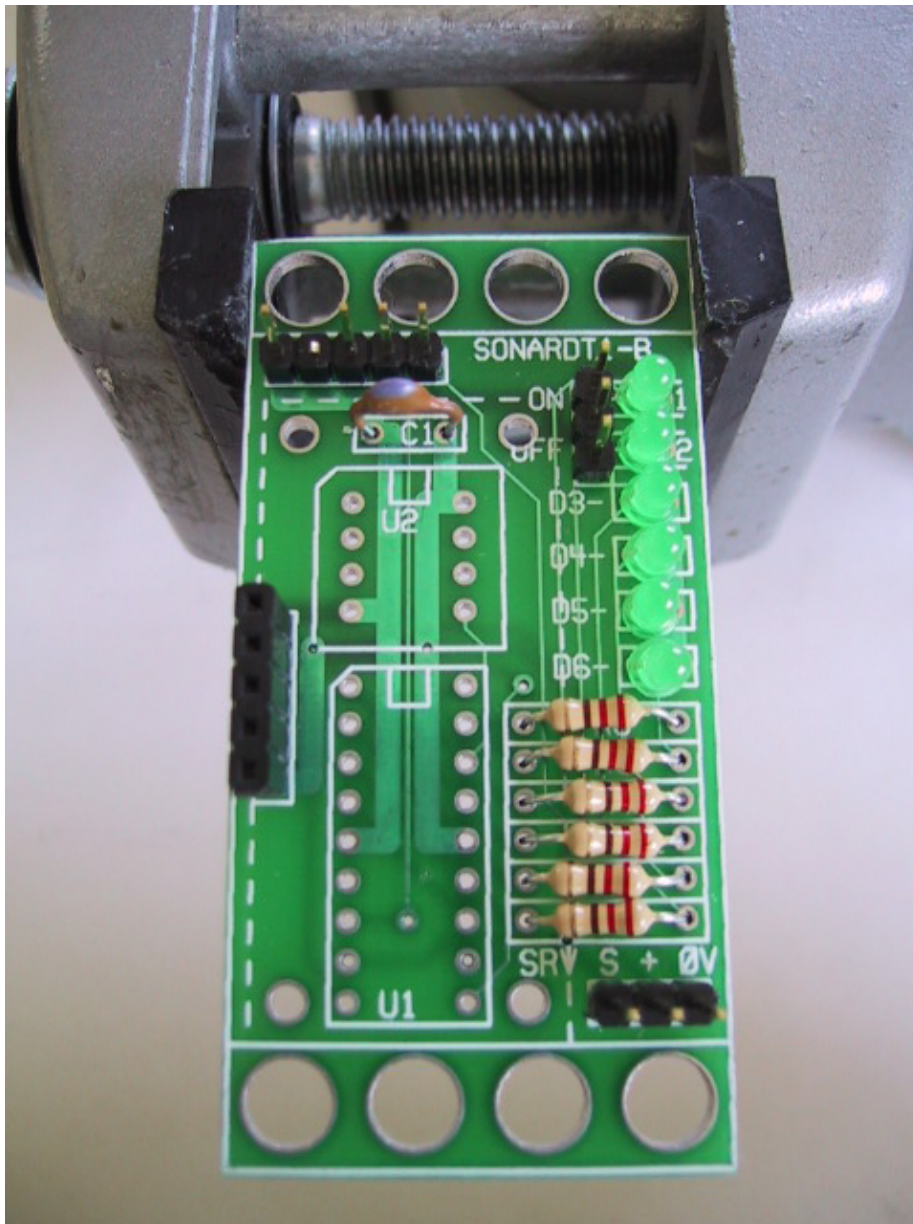
Step 8



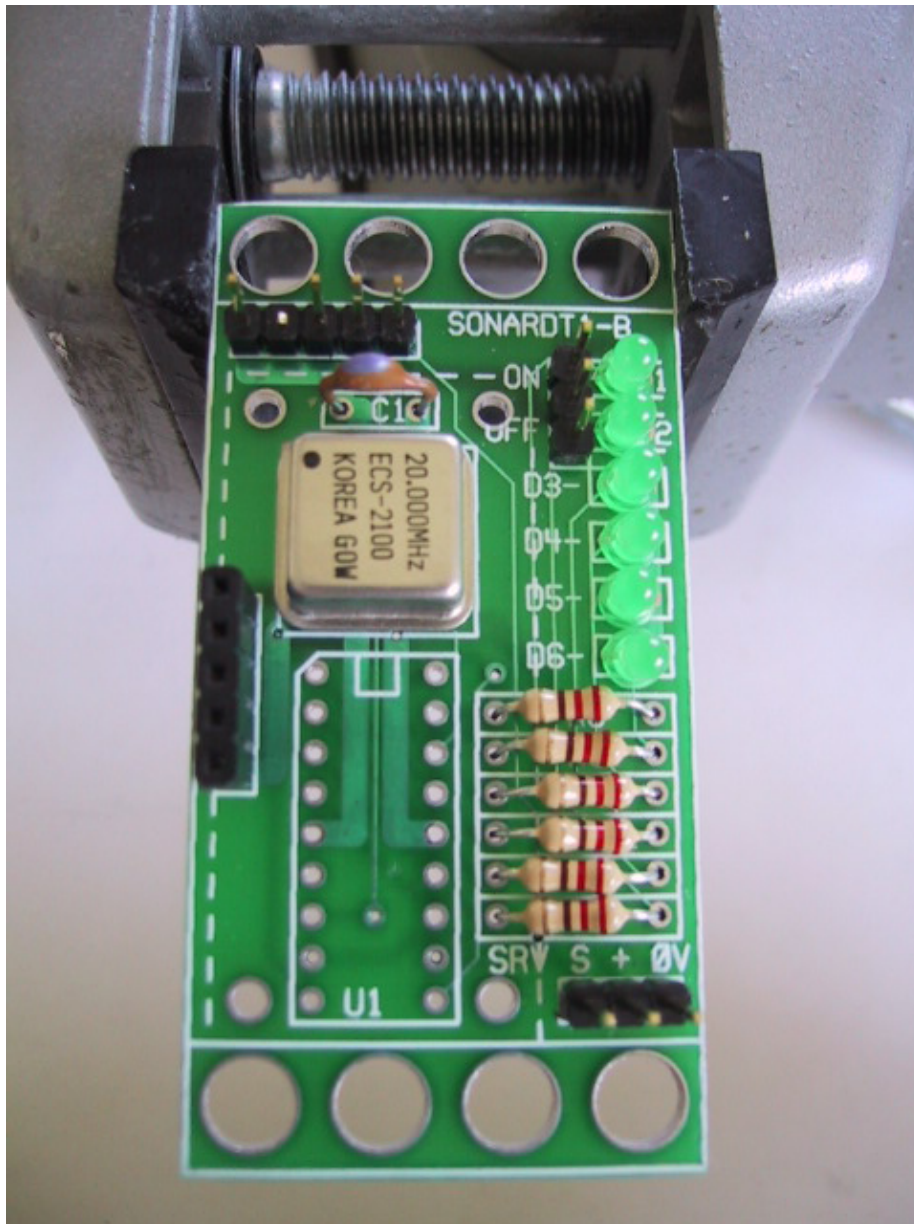
Step 9



Step 10



Step 11



Step 12



Step 14

