This is the Revision E version of the BS2Hub8 RoboBrick. The status of this project is work in progress.

BS2Hub8 Robobrick (Revision E)

Table of Contents

This document is also available as a PDF document.

1. Introduction

The BS2Hub8 RoboBrick is a master RoboBrick that can control up to 8 slave RoboBricks. It is controlled by a Basic Stamp 2® from Parallax. It has two terminals that can be connect to a battery between 6 and 9 volts. It has an on board 5 volt voltage regulator to provide power to the slave RoboBricks. The is a connector that can be connected to a DB9 connector and used to communicate with a controlling PC via RS−232 voltage levels.

2. Programming

We may eventually put a few examples of programming the BS2Hub8 RoboBrick here. Basically, it is programmed using the Parallax Basic for the Basic Stamp 2.

```
' Even numbered pins inputs and odd number pins are outputs.
' (Remember for the BS2, 1=output and 0=input.)
dirs = $aaaa

' Set all outputs to high:
high 1
high 3
high 5
high 7
high 9
high 11
high 13
high 15

' To copy a Switch8−B (on N2) to LED10−B (on N1):
switches var byte
loop:
    ' Send command 0 (Read switches) to Switch8−B:
    serout 11, 396, [0]
    ' Receive the switch readings from Switch8−B:
    serin 10, 396, [switches]
    ' Send switch values to LED10−B:
    serout 9, 396, [switches]
    goto loop
```

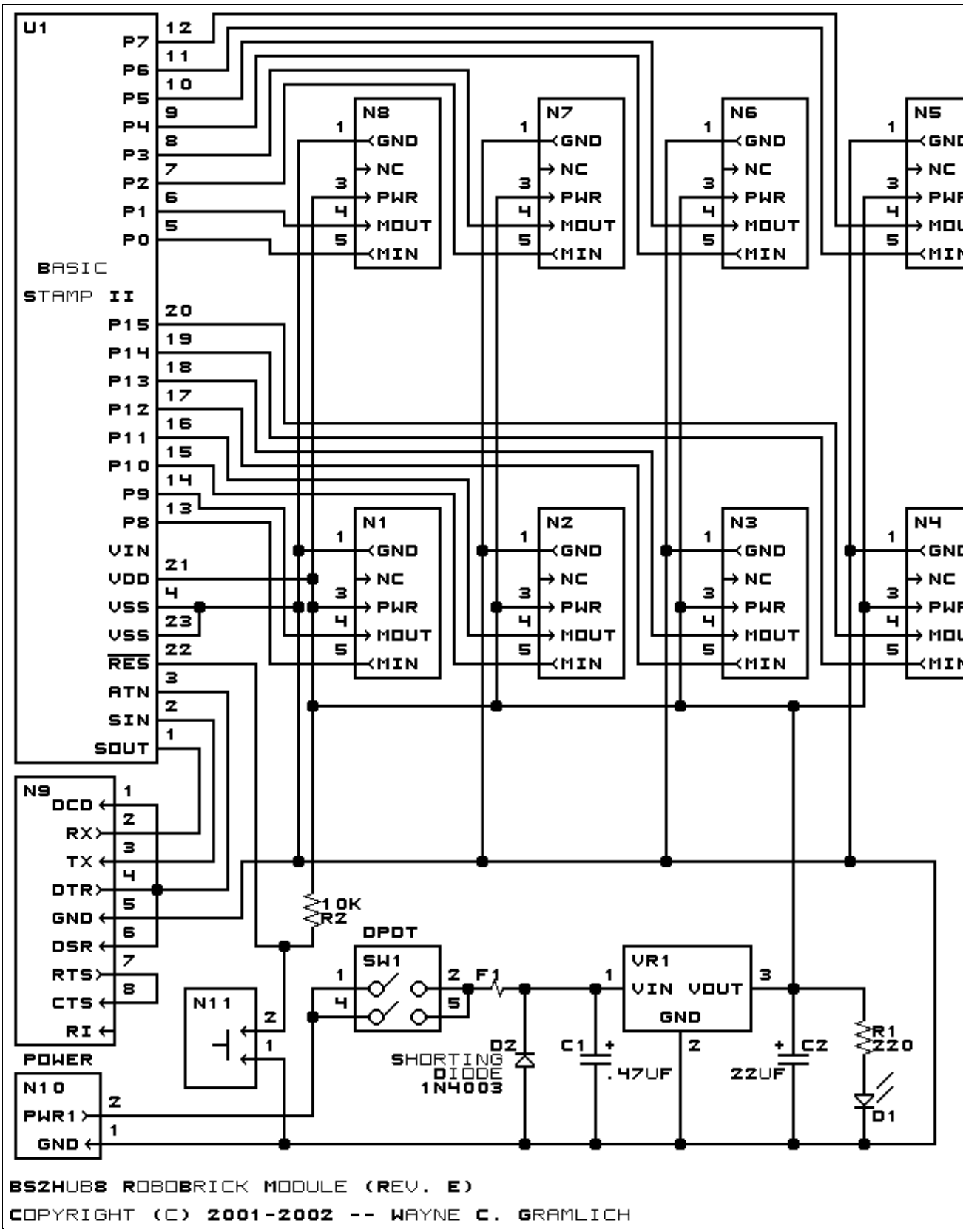
Connector	Input	Output
N1 (Top)	P8	P9
N2	P10	P11
N3	P12	P13
N4	P14	P15
N5	P6	P7
N6	P4	P5
N7	P2	P3
N8 (Bottom)	P0	P1

3. Hardware

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

3.1 Circuit Schematic

The schematic for the BS2Hub8 RoboBrick is shown below:



The parts list kept in a separate file −− bs2hub8.ptl.

3.2 Printed Circuit Board

The printed circuit board files are listed below:

bs2hub8_back.png
: The solder side layer.

bs2hub8_front.png
: The component side layer.

bs2hub8_artwork.png
: The artwork layer.

bs2hub8.gbl
: The RS−274X "Gerber" back (solder side) layer.

bs2hub8.gtl
: The RS−274X "Gerber" top (component side) layer.

bs2hub8.gal
: The RS−274X "Gerber" artwork layer.

bs2hub8.gml
: The RS−274X "Gerber" mask layer.

bs2hub8.drl
: The "Excellon" NC drill file.

bs2hub8.tol
: The "Excellon" tool rack file.

3.2 Construction Instructions

The construction instructions are kept in a separate file document to be a little more printer friendly.

4. Software

The software for the BS2Hub8 is developed by the user.

5. Issues

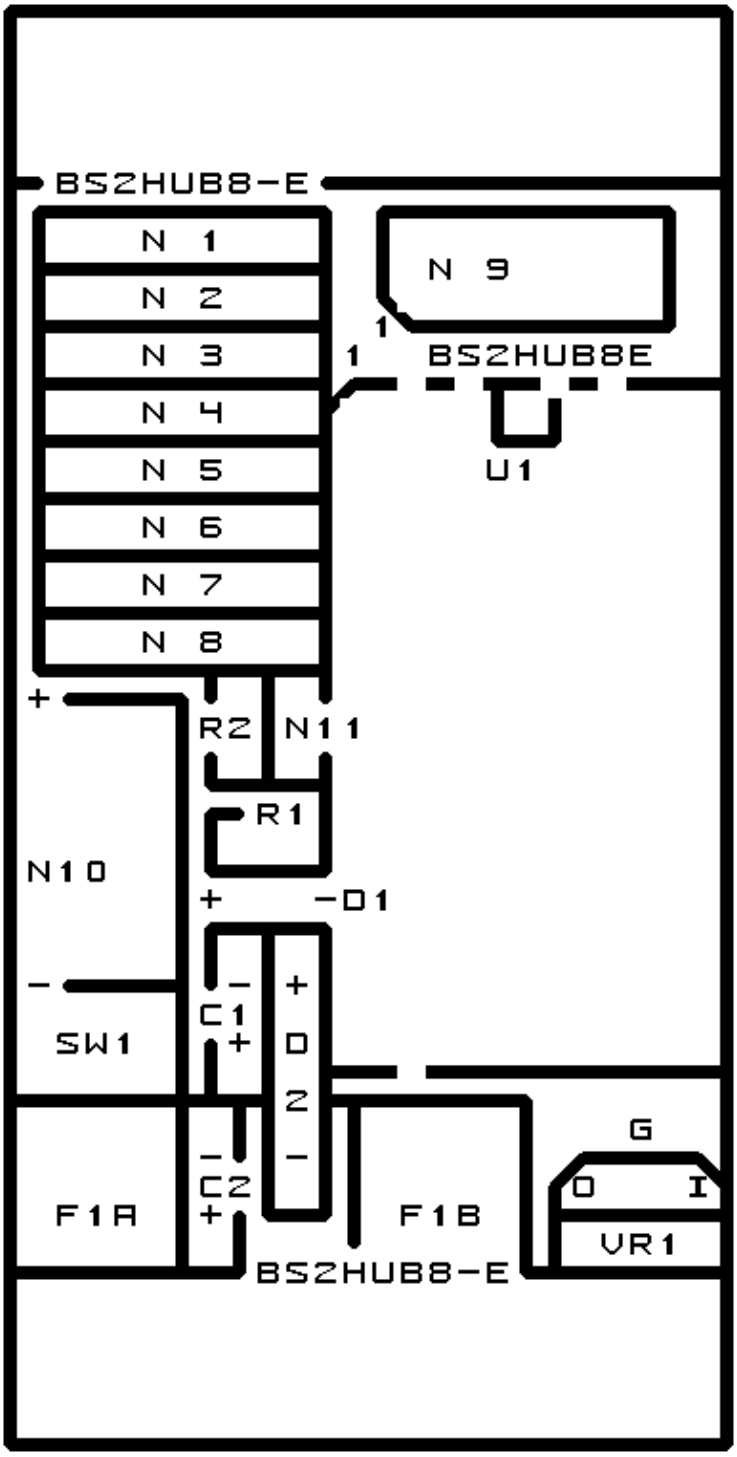
The following issues have come up:

- The fuse should be replaced by a PolySwitch resettable device.
- The 2x5 connector should be replaced by 1x6 connector that is compatible with the PIC876Hub11.

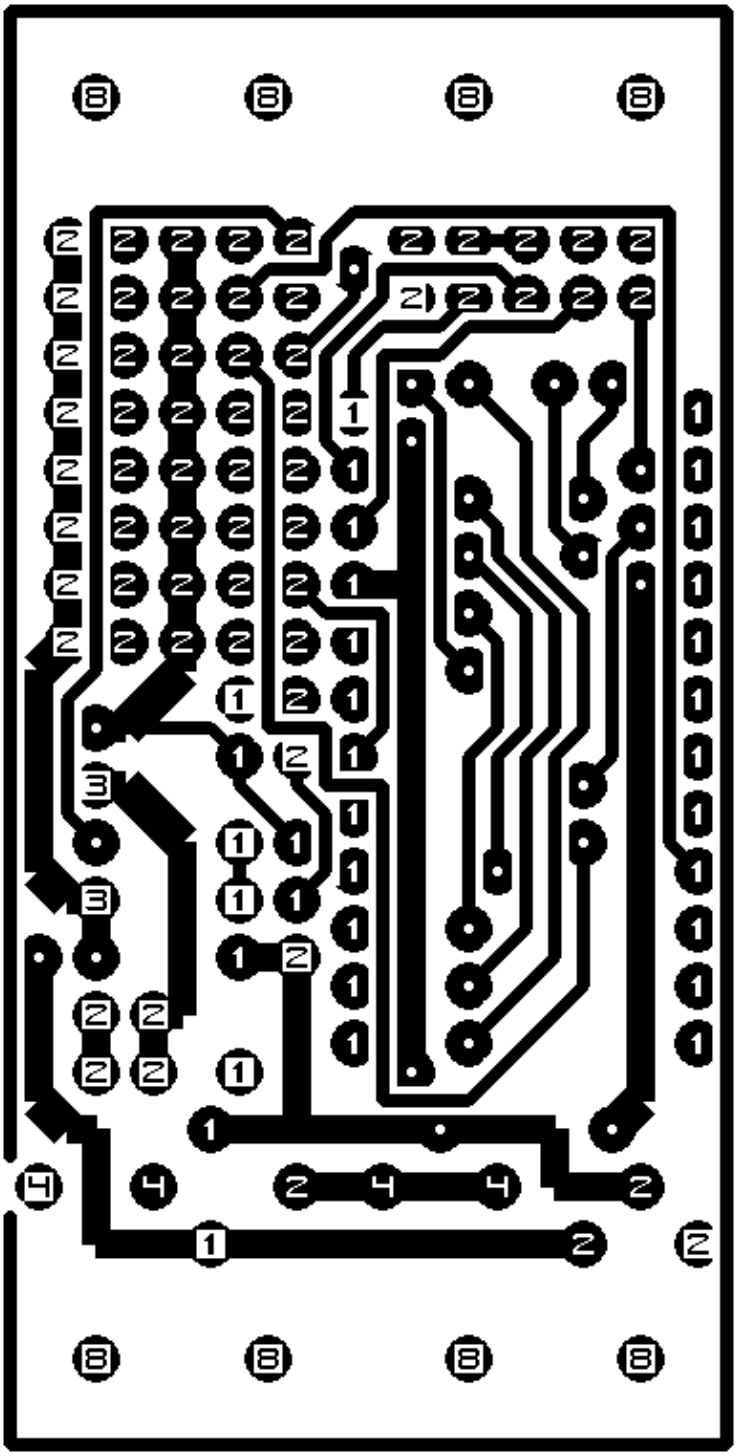
A. Appendix A: Parts List

```
# Parts list for BS2Hub8 RoboBrick (Rev. E)
#
C1: Capacitor470nF − .47uF Tantalum Capacitor [Jameco: 33531]
C2: Capacitor22uF − 22uF Tantalum Capacitor [Jameco: 94094]
D1: LEDGreen − Small Green LED [Jameco: 34606]
D2: 1N4001 − 1 Amp 50 PIV Silicon Diode [Jameco: 35975]
F1: Fuse5x20mmSide.BS2Hub8E − 5 x 20 mm Fuse Holder Clips [Jameco: 102859]
# F2 is the fuse that plugs into F1; it is not really a second
# fuse on the PCB.
F2: Fuse5x20mm1A − 250V 1A 5x20mm fuse [Jameco: 103907]
# Can substitute 4 2x5 Male headers for 8 1x5 male headers [Jameco: 153699]
N1−8: Header1x5.BS2Hub8 − 1x5 Male Header [5/80 Jameco: 117196]
N9: Header2x5.DB9 − 2x5 Male Header [10/80 Jameco: 117196]
N10: TerminalStrip2.BS2Hub8 − 2 Junction Terminal Strip [Jameco: 189675]
N11: Header1x2.BS2Hub8 − 1x2 Male Header [2/40 Jameco: 160881]
# N12 is the Socket for U1; it is not listed on the PCB.
N12: Socket24DIP − 24−pin DIP socket (.6" wide) [Jameco: 39351]
R1: Resistor220.Vertical − 220 Ohm 1/4 Watt Resistor [Jameco: 30470]
R2: Resistor10K.Vertical − 10K Ohm 1/4 Watt Resistor [Jameco: 29911]
SW1: SwitchSmallDPST − Small DPDT Power Switch [Jameco: 161816]
U1: BasicStamp2 − Basic Stamp II [Jameco: 130892]
VR1: LM2940CG−5 − 5 Volt Low Dropout Voltage Regulator [Jameco: 107182]
# A heat sink is needed on the voltage regulator:
# 1 Heat Sink [Jameco: 158051]
# 1 #6−32 .375" Screw [Jameco: 42446]
# 1 #6 internal lock washer [Jameco: 106868]
# 1 #632 Hex Nut [Jameco: 42420]
# A serial port cable is needed:
N13: CableDB9Female − 9−pin DB9 Connector[Jameco: 109217]
N14: CableHeader2x5 − 2x5 Female Ribbon Cable Connector [Jameco: 138376]
# A battery pack is needed to run the whole thing:
# 1 4 AA Battery Pack [Jameco: 105857]
# 4 AA Batteries [Jameco: 198707]
```

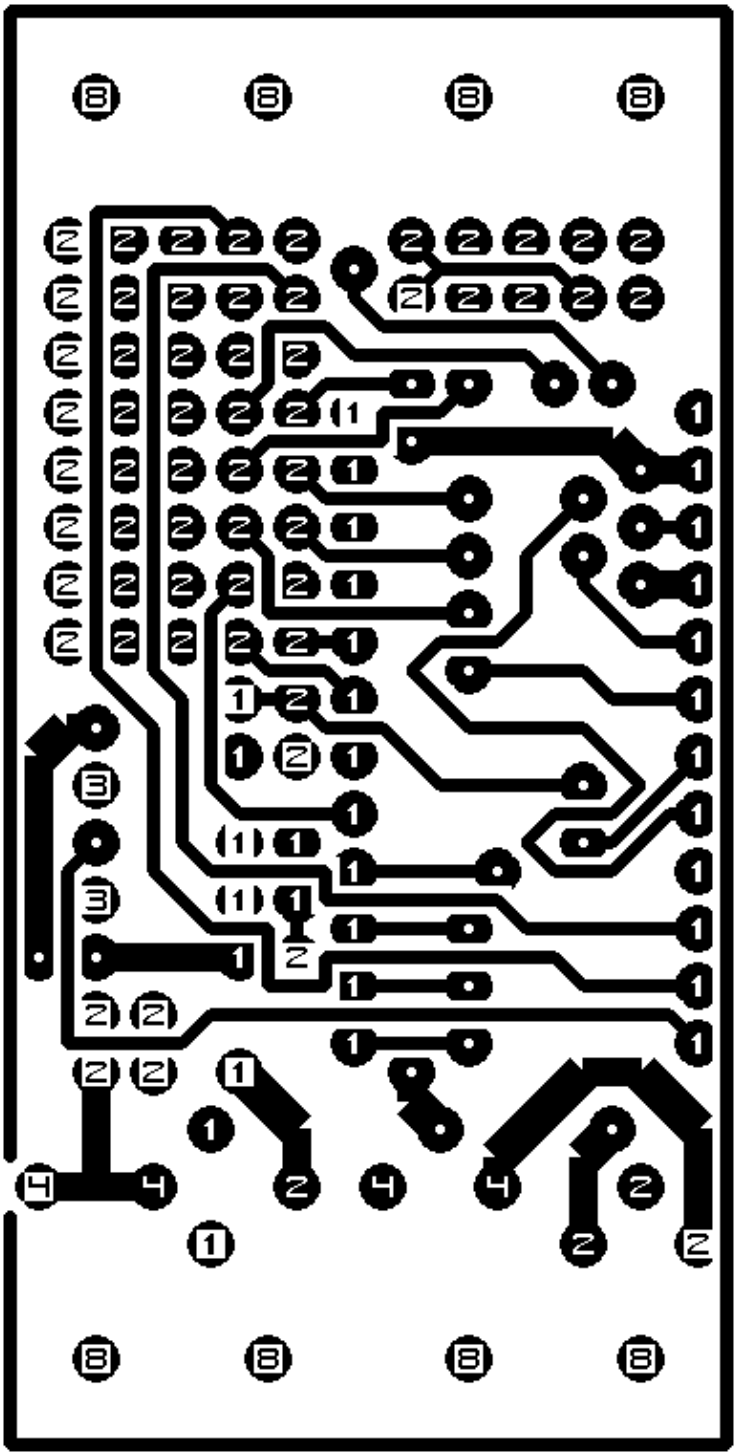
B. Appendix B: Artwork Layer



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 BS2Hub8 (Rev. D) RoboBrick are listed below:

1. Orient the board vertically with N1 in the upper left corner. By convention, the top edge is north, the bottom edge is south, the left edge is west, and the right edge is east. The 24−pin socket will goes on the east side of the board; please do not install the socket yet. [step1.jpg]
2. Take a 2×5 male header and install it in the north east corner at N9. When installing, start by soldering only one pin. Then turn the board upside down and verify that the connector is properly seated. If not, re−heat the pin you initially soldered and re−seat the connector. When you are satisfied that the connector is properly seated, turn the board back over again and solder the remaining 9 pins. [step2.jpg]
3. Take another 2×5 male header and orient it horizontally. Using some diagonal cutters, snip off 2 pins corresponding to pins 3 and 4 in the diagram below:

1	X	5	7	9
2	X	6	8	10

   Pins 3 and 4 are in the positions marked `X'. Using the same procedure as in the previous instruction, install the 2×5 header in north west corner at N1 and N2. The snipped of pins must be on the west side. Again, solder one pin first, verify seating, and solder the remaining nine pins. [step3.jpg]
4. Using the same procedure as the preceding instruction, install 3 more 2×5 headers at positions N3&N4, N5&N6, and N7&N8 respectively. Again, be sure to snip off the two pins prior to soldering one pin, verify seating, and solder the remaining pins. [step4.jpg]
5. Take the 24−pin IC socket and orient it so that the notch is pointing up. Frequently, the IC sockets are not very well marked as to which pin is pin 1. If the socket gets installed upside down, no real harm is done, since the socket is symmetrical. As with the male headers, solder 1 pin first, verify seating, and solder the remaining 23 pins. In the picture, the notch is highlighted with some white ink. [step5.jpg]
6. Take a 1×2 male header and install it at position N11. There may be a little interference between N11 and the IC socket. If so, sand, file, or scrap off a little on the edge of N11 until it fits in without tipping over any. Again, solder 1 pin, verify seating, and solder the remaining pin. [step6.jpg]
7. Find the 10K Ohm resistor. It has a color code of Brown−Black−Orange. Frequently, orange is followed by a Gold or Silver band. This is resistor R2 and it is going to be installed vertically (not flat.) With the Brown band on top, bend the lead 180 degrees until it is pointing down. (Resistors are symmetrical, so no harm is done if you have the gold band on top.) Insert the lead coming out the bottom (i.e. near the gold band) into the bottom hole of R2; the remaining lead goes into the bottom. Turn the board over, spread the leads a little to keep the resistor from falling out, and solder one lead. Turn the board front−side up, and verify the resistor is sitting straight up. If not, re−heat the lead you soldered to re−seat the resistor. When you are happy with the resistor position, solder the remaining lead. Finally, using diagonal cutters, snip the two leads close to the board. [step7.jpg]
8. Find the 220 Ohm resistor. It has a color code of Red−Red−Brown, typically with either a gold or silver band at the end. Again, this resistor is going to be installed vertically. Using the same technique as in the previous instruction, bend the lead over 180 degrees, and insert the bottom (gold/silver) side into the west hole of R1; the other bent lead goes into the east hole of R1. Spread the leads, solder one lead, verify seating, solder the remaining lead, and snip off the excess leads close to the board. [step8.jpg]
9. Take the small green LED and orient it so that the long lead is west. The long lead is the positive lead and the slightly shorter lead is the negative one. LED's are not symmetrical; if you put them in backwards, they will not operator properly. The silk screen for this part is confusing. The LED will be installed in the two holes that are immediately south of R1. Thus, the long lead will be inserted into

the hole just to the east of "+" sign on the slik screen. The negative lead goes into the hole on the east. As before, turn the board over, spread the leads, solder one, verify seating, solder the remaining lead, and snip off excess leads. [step9.jpg]

10. Take D2, the tubular diode labeled with 1N4001, and orient it so that the end with the circular band painted around it is pointing south. The end with the band is negative and the other end is positive. Diodes are not symmetric, if it is installed backwards, the board will not work properly. Bend both leads down by 90 degrees. Align the leads so that they go through the two holes of D2. Insert the positive lead into the north hole and the negative lead into the south hole. Turn the board over, spread the leads, solder one lead, verify seating, solder the other lead, and snip the excess leads off. [step10.jpg]
11. Find the two terminal blue terminal block and orient it so that the wires will enter the block from the west. Insert the terminal block into the holes for N10. Turn the board over while carefully holding the terminal block in place. Solder one lead, verify seating, and solder the remaining lead. [step11.jpg, step12.jpg]
12. Using a fine point pen carefully mark the north terminal with a `+' and the some terminal with a `−'. Some people will take a red magic marker and mark the north terminal as red as a way of remembering that the positive battery lead (usually colored red) goes into the top terminal and the negative battery lead (usually colored black) goes into the south terminal. [step13.jpg]
13. Find the .47µF tantalum capacitor. This is capacitor C1. Orient the capacitor so that the lead marked with a `+' is south and the lead marked with a `−' is north. Like diodes, tantalum capacitors are not symmetrical, if they are installed backwards, they will not work properly. (Indeed, they have this nasty tendency to go `bang!' and emit a puff of blue smoke.) Insert the positive lead into the south hole and the other lead into the north hole. Please note that the artwork for the Rev. D boards has the + and − signs for C1 reversed. Turn the board over, spread the leads, solder one lead, verify seating, solder the other lead, and snip the excess leads off. [step14.jpg]
14. Find the 22µF tantalum capacitor. This is capacitor C2. This capacitor is going to be oriented on its side rather than vertically. The reason for this is because the fuse will be resting on top of the C2. As in the previous instruction, find the `+' and `−' leads and orient the capacitor with the `+' lead south. Now bend the capacitor over on its side by 90 degrees. Now the capacitor is pointing to the right and leads are pointing straight down towards the board. Put the `+' lead into the south hole (labeled `+') and the `−' lead into the north hole (labeled `−'.) You know the drill, turn the board over, spread the leads, solder one lead, verify seating, solder the other lead, and snip off the excess leads. [step15.jpg]
15. Find the little switch SW1. While the switch is symmetrical, we need to snip off two leads on one end in order for it to fit in the 4 available holes. Turn the switch over and snip off two leads as indicated by `X's below:

X	O	O
X	O	O

    Now flip the switch over so that the 4 remaining leads are on the right and insert it into the 4 holes labeled SW1. While holding the switch in place with your hand, carefully turn the board over, and solder in 1 lead. As usual, verify seating prior to soldering in the remaining 5 leads. [step16.jpg]
16. It is possible to install the fuse clips backwards. To prevent this, please find both fuse clips and snap them onto the fuse. While the fuse is 20mm long, the spacing for the fuse clip is closer to 25mm long. Place the whole fuse and fuse clip assembly into the 4 holes labeled F1 on the board. There will be some additional space between the fuse ends and the fuse clip edges; this is OK. Remember the fuse goes over capacitor C2, so it might be necessary to push C2 down a little to get everything to fit. Again, while holding the fuse assembly in one hand, turn the board over and solder in one lead of each fuse clip. To prevent burns, it is a good idea to hold the assembly by the glass fuse rather than the metal clips. After seating has been verified, solder the the fuse clips all the way in. [step17.jpg]

17. Take the LM2940 voltage regulator and orient it so that the lettering is facing you. The LM2940 is component VR1. Bend the middle lead a little towards you and the two outer leads a little away from you. Now rotate VR1 90 degrees clockwise around its vertical axis of symmetry. Insert VR1 into the three holes labeled VR1. Turn the board over, spread the leads a little, solder one lead, verify seating, solder the remaining leads, and snip off any excess leads. [step18.jpg, step19.jpg]
18. Find the heat sink and orient it such that the fins are pointing to the left with the hole on top. Using the screw and nut, attach the heat sink to VR1, such that VR1 is enclosed by the heat sink. [{Missing picture with heat sink.}]
19. Build the RS−232 cable. Take the ten lead cable and snip a quarter of an inch of one lead off. This lead will be inserted into the DB−9 connector. The other end of the cable will be inserted into the 2×5 female connector. If you look closely on both connectors, there is a small arrow that shows where pin 1 is. It is important that the cable connect pin 1 to pin 1. Use a vise to crimp the cable down on both connectors. [{missing pictures here.}]

The assembly of the BS2Hub8 (Rev. D) RoboBrick is complete.

Check Out

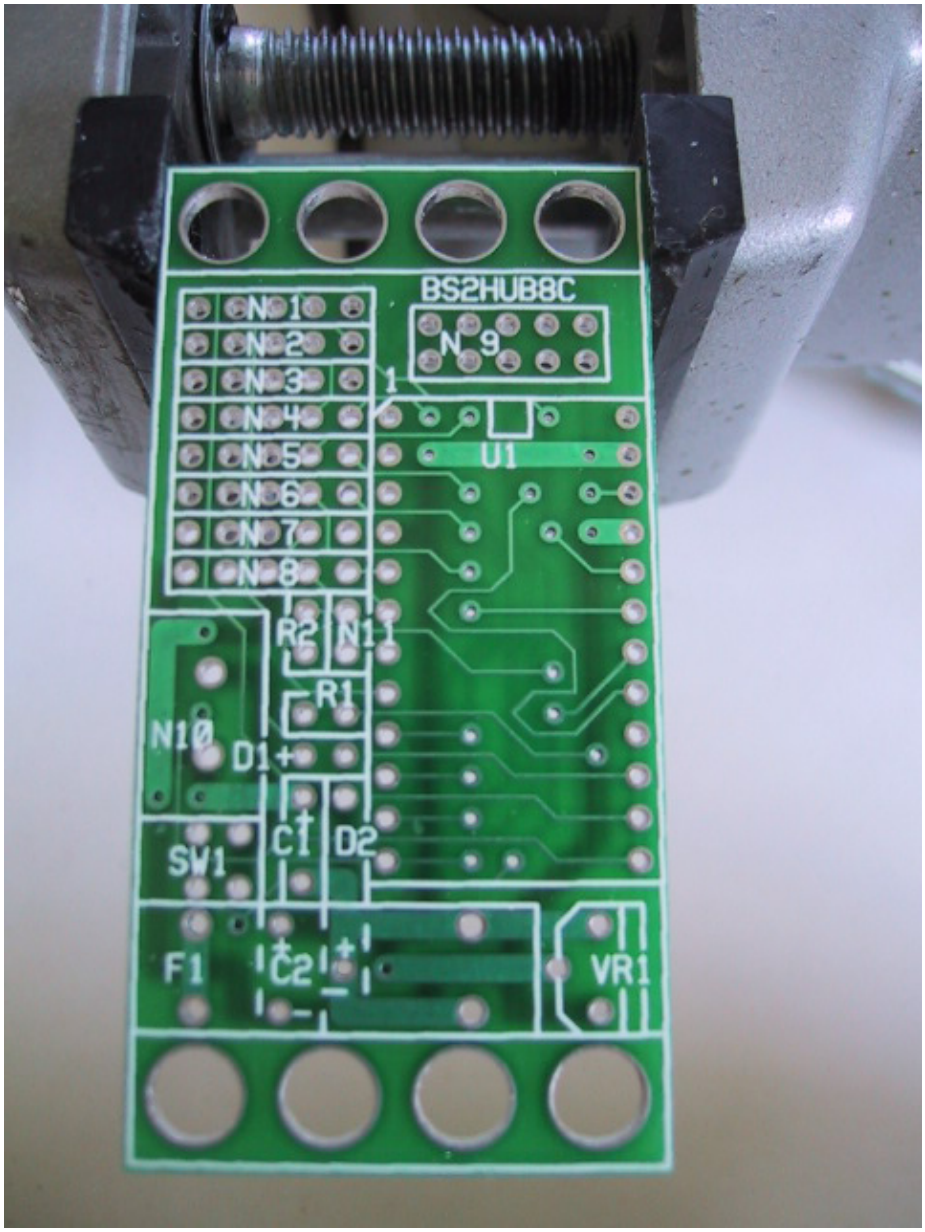
Perform the following steps to check out the BSHub8:

1. Take your Basic Stamp 2 (or pin compatible) and put it away. You will not be needing it until after you have done some prior check out steps.
2. Get a multi−meter and put it into resistance mode.
3. Verify that the circuit between the two connections on the terminal strip is open (i.e. infinite resistance.) If you measure anything other than an open circuit, you've got a short circuit between the power lines. The most likely cause of this problem is you have diode D2 in backwards. The band was supposed to be pointing south. Remove it and reinstall it properly.
4. Put one lead of the multi−meter into the south terminal of the terminal strip. This is the ground terminal.
5. Verify that you have a short between the ground terminal and pin 1 of connectors N1 through N8.
6. Verify that you have a short between the ground terminal and the middle component lead of the 3−terminal regulator.
7. Get out your magnifying glass and verify that the + signs of the two capactors are south. If you install the capacitors backwards, they blow up and stink. If this unfortunate event occurs, remove the capacitor, throw it away, and install a new one with the + sign pointing south this time.
8. Verify that there is a short between the ground terminal and pins 4 and 23 of the 24 pin socket. (Pin 4 is the 4th pin down from the north west corner of the socket, and pin 23 is the 2nd pin down from the north east corner.)
9. Push the switch to the west to turn it off.
10. Hook up your 6 volt battery back so that the black wire goes to the south terminal (i.e. ground terminal) and the red wire goes to north terminal of the terminal strip. Put your hand on the battery pack to verify that it is not getting warm. If it is getting warm, you've got a power supply short and you need to track it down and fix it.
11. Flip the switch back and forth and verify that the green LED lights up when the switch is to the east. If the LED does not light up, the most likely problem is that you have installed the LED backwards. Snip it out, clean the solder out of the pads and install a new one.
12. Put your multi−meter into 20 Volt range.
13. Verify that pin 3 of connectors N1 through N8 are at 5 volts.
14. Verify that pin 21 of the 24−pin socket is as 5 volts. (Pin 21 is the 4th pin down from the north−west corner of the socket.)

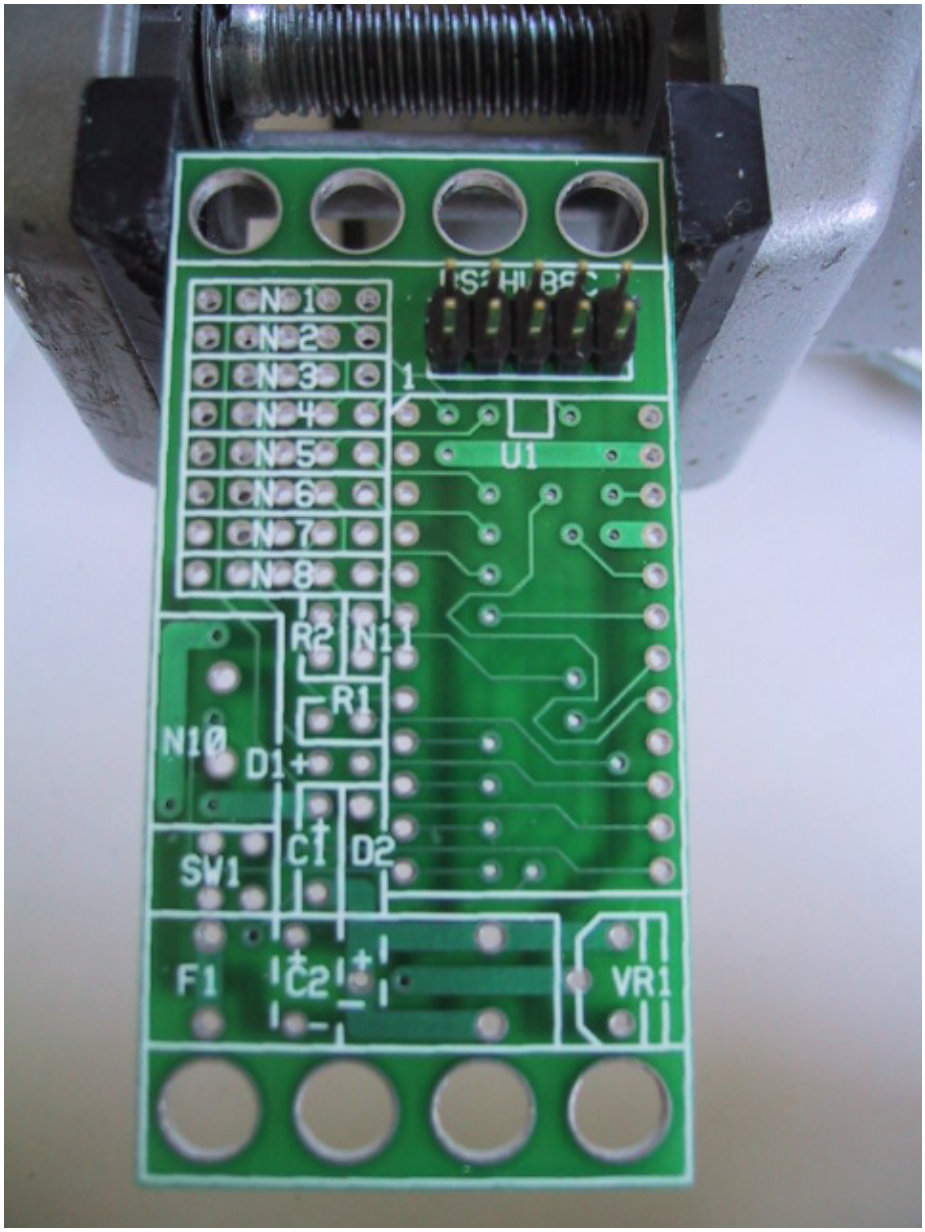
15. Put your finger on the heat sink and verify that it is still cold. An LED dissapates almost no power.
16. Turn off the BSHub8.
17. Install the RS−232 cable on N9. Plug the other end into the machine that is running your Basic Stamp download software.
18. Fire up the Basic Stamp software.
19. Plug in your Basic Stamp 2 (or pin compatible.) Be sure that you plug the Basic Stamp in right side up.
20. Power up the BS2Hub8 and verify that that your software can talk to it.

You are done.

Step 1


BS2HUB8C
N1
N2
N3
N4
N5
N6
N7
N8
N9
1
U1
R2
N11
R1
N10
D1
C1
D2
SW1
F1
C2
VR1

Step 2



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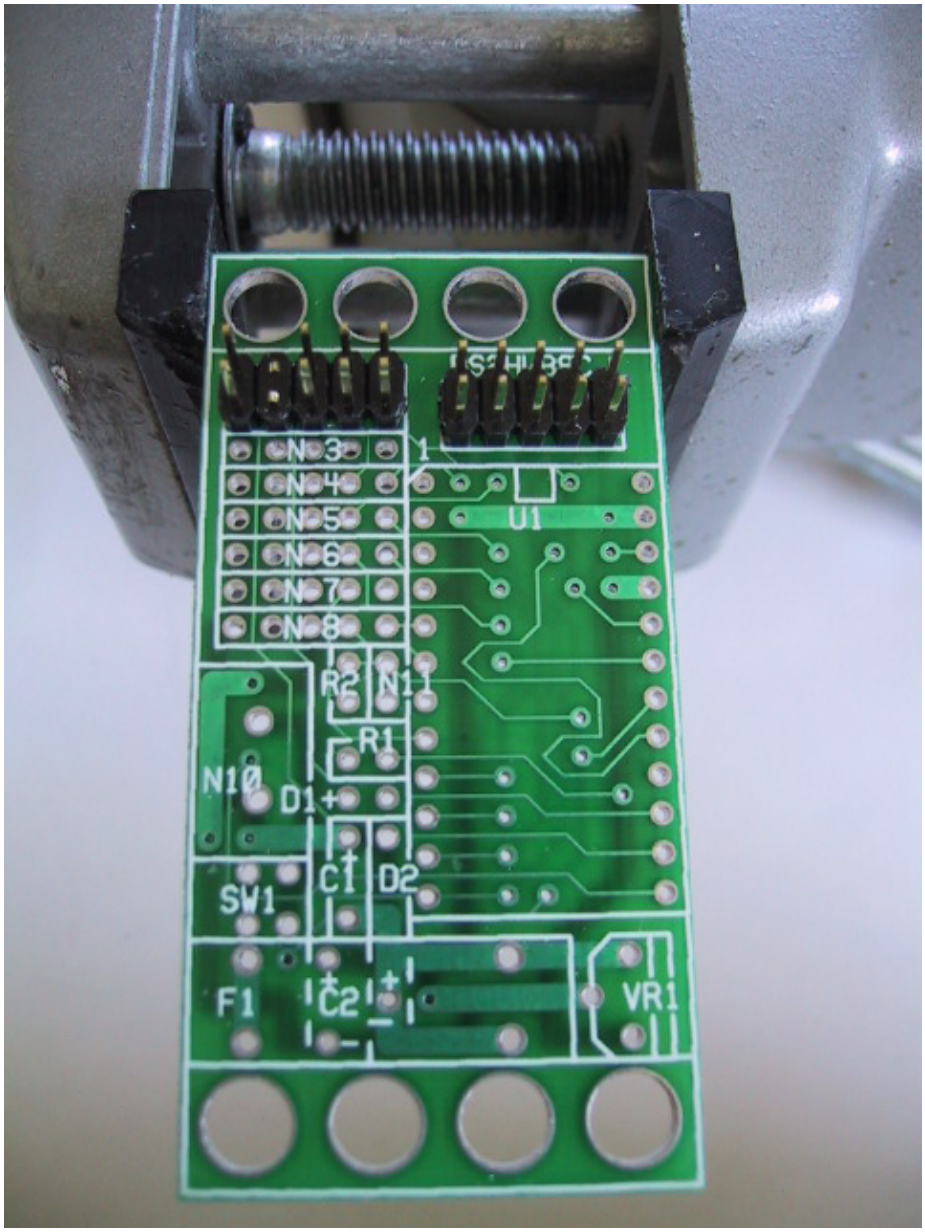

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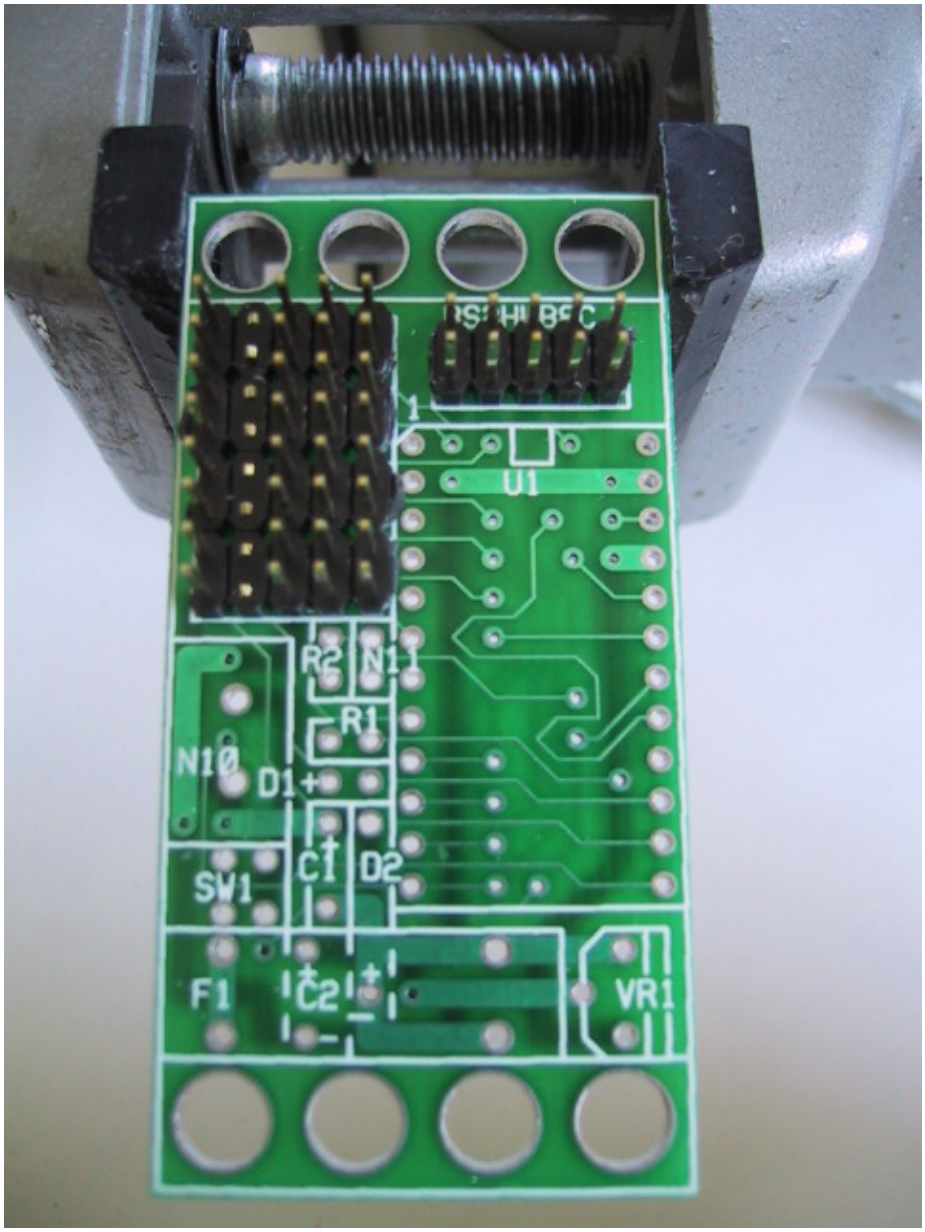

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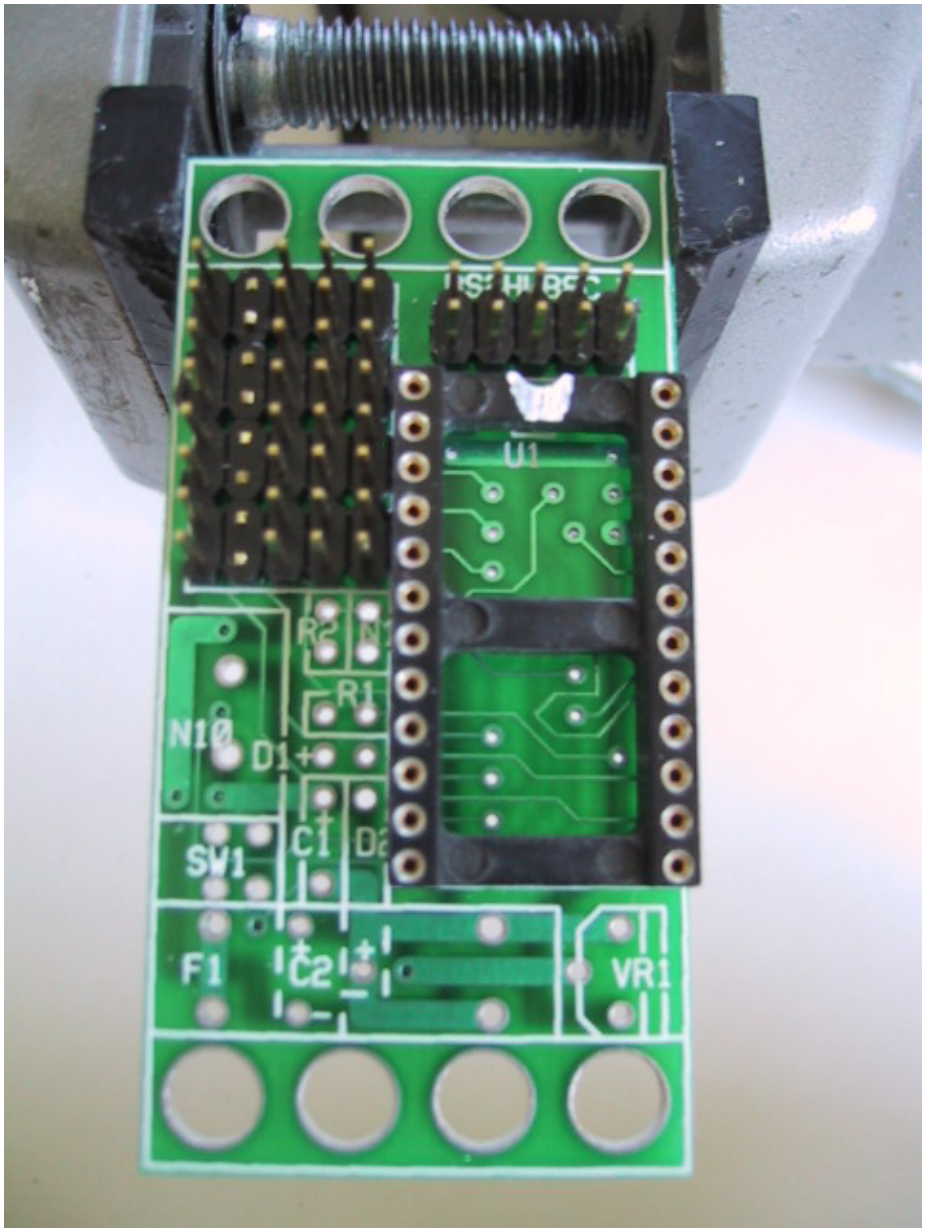

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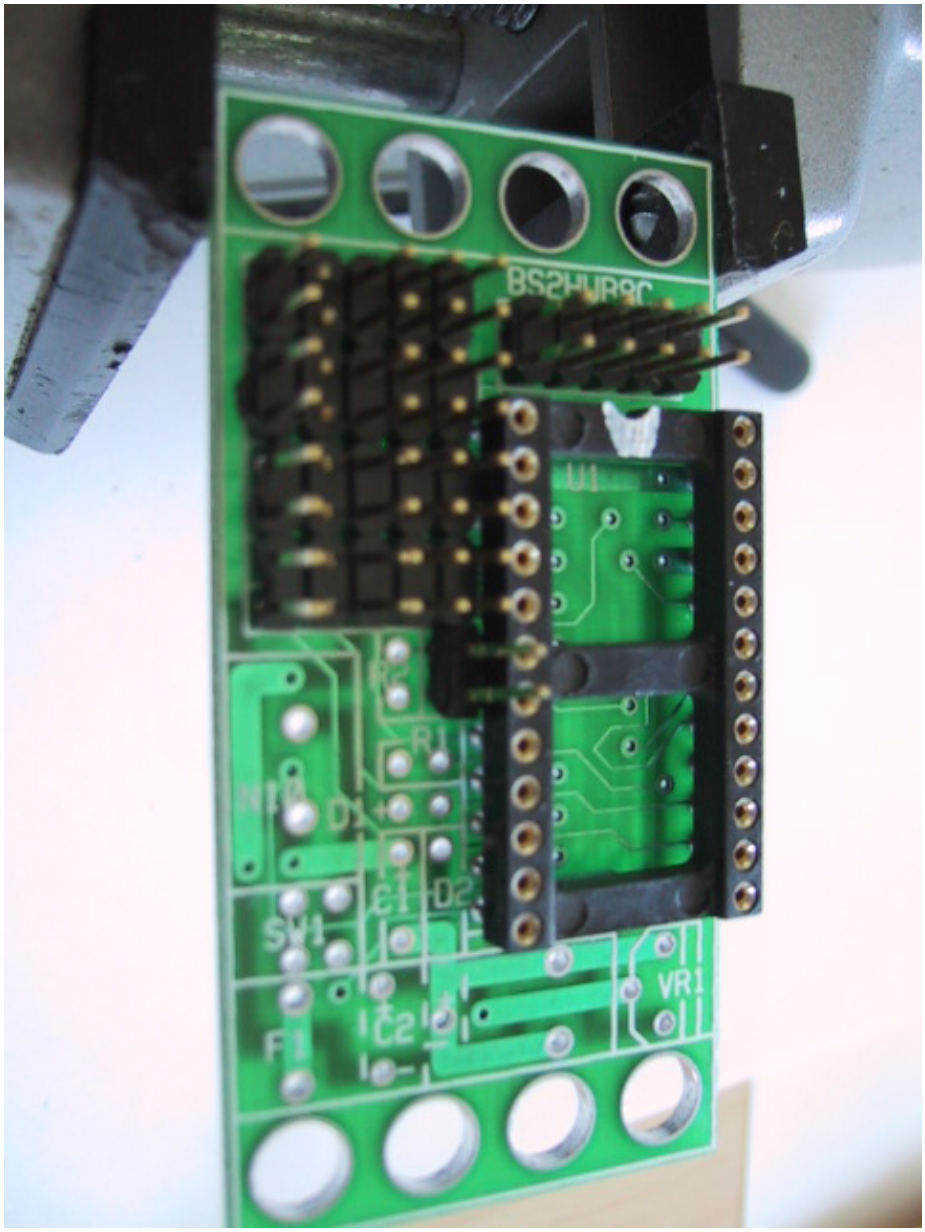

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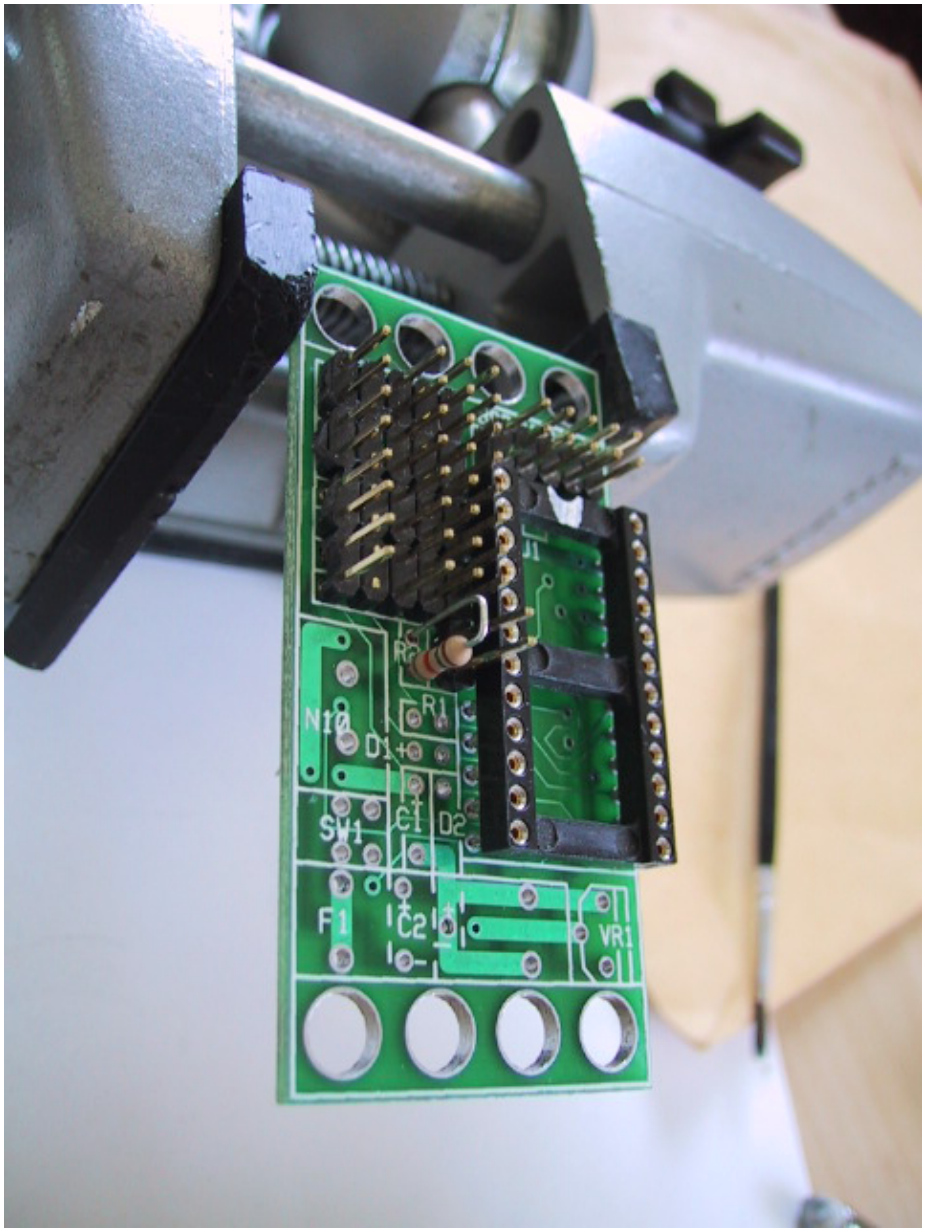

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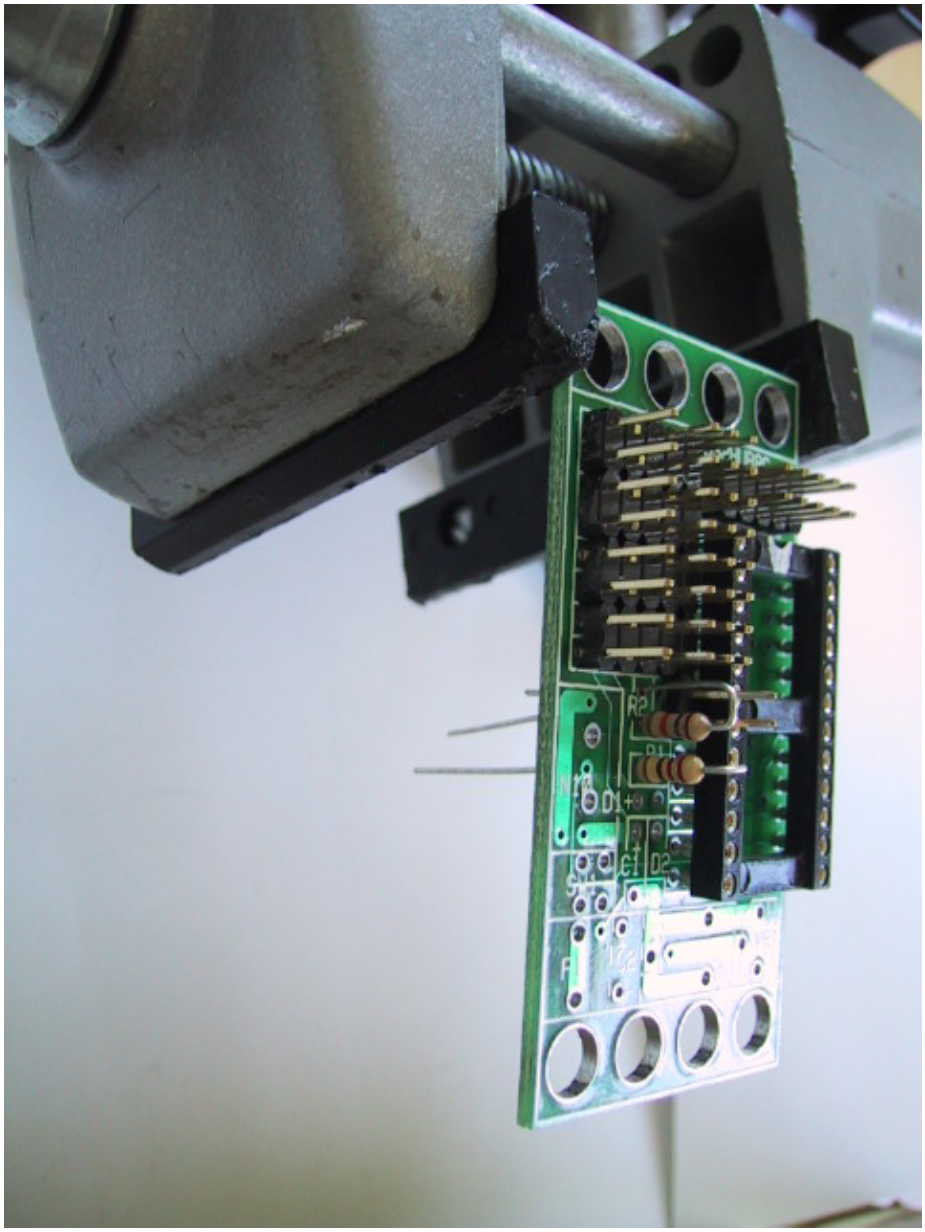

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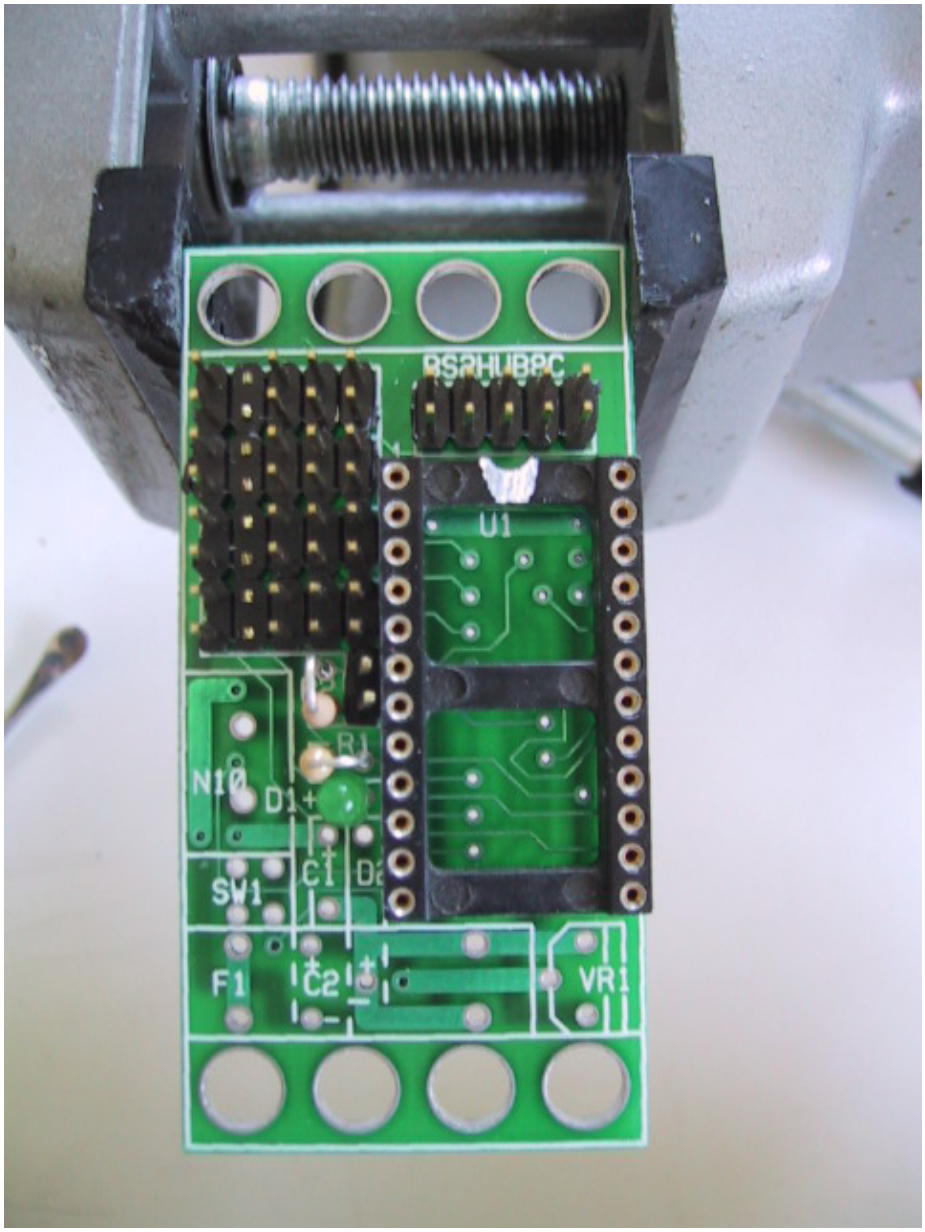

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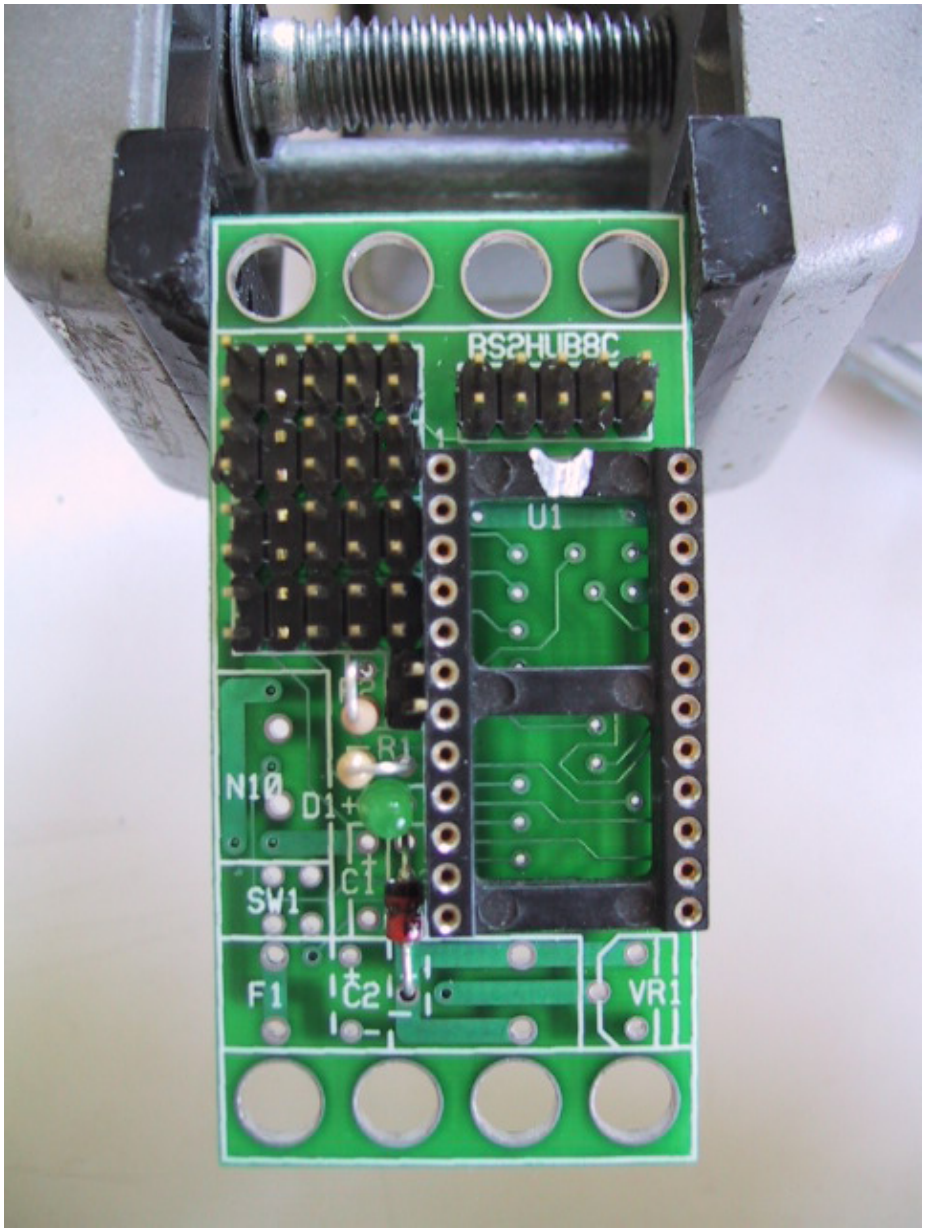

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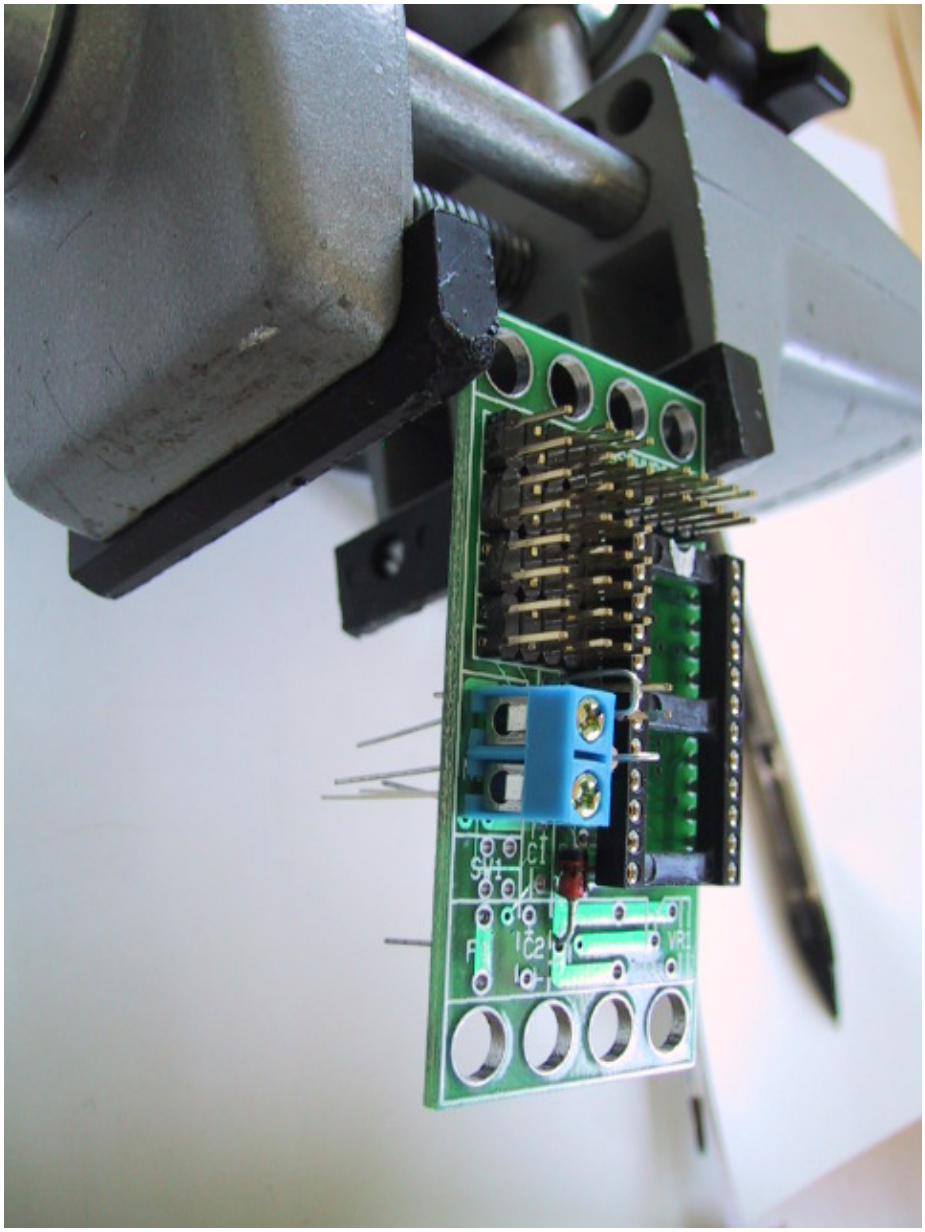

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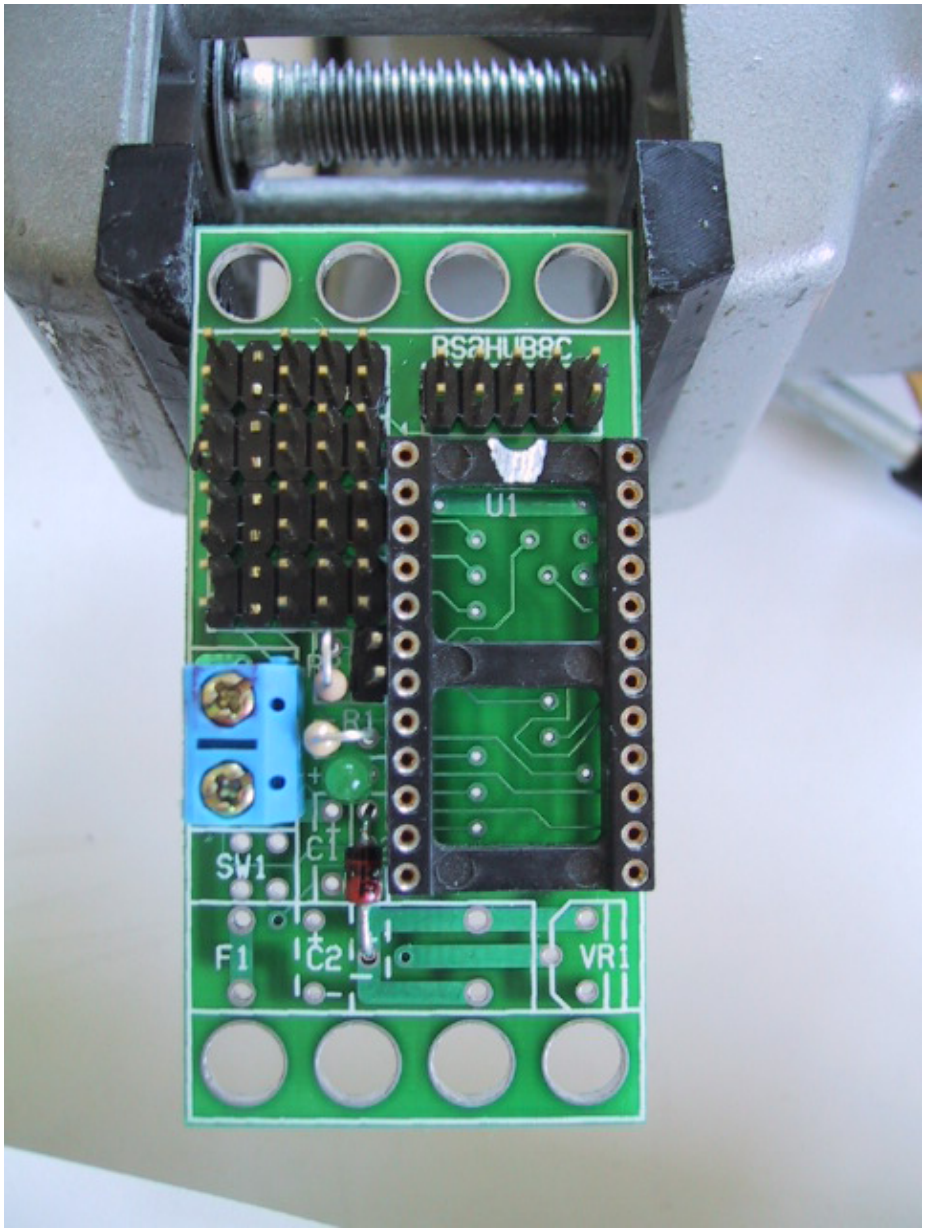

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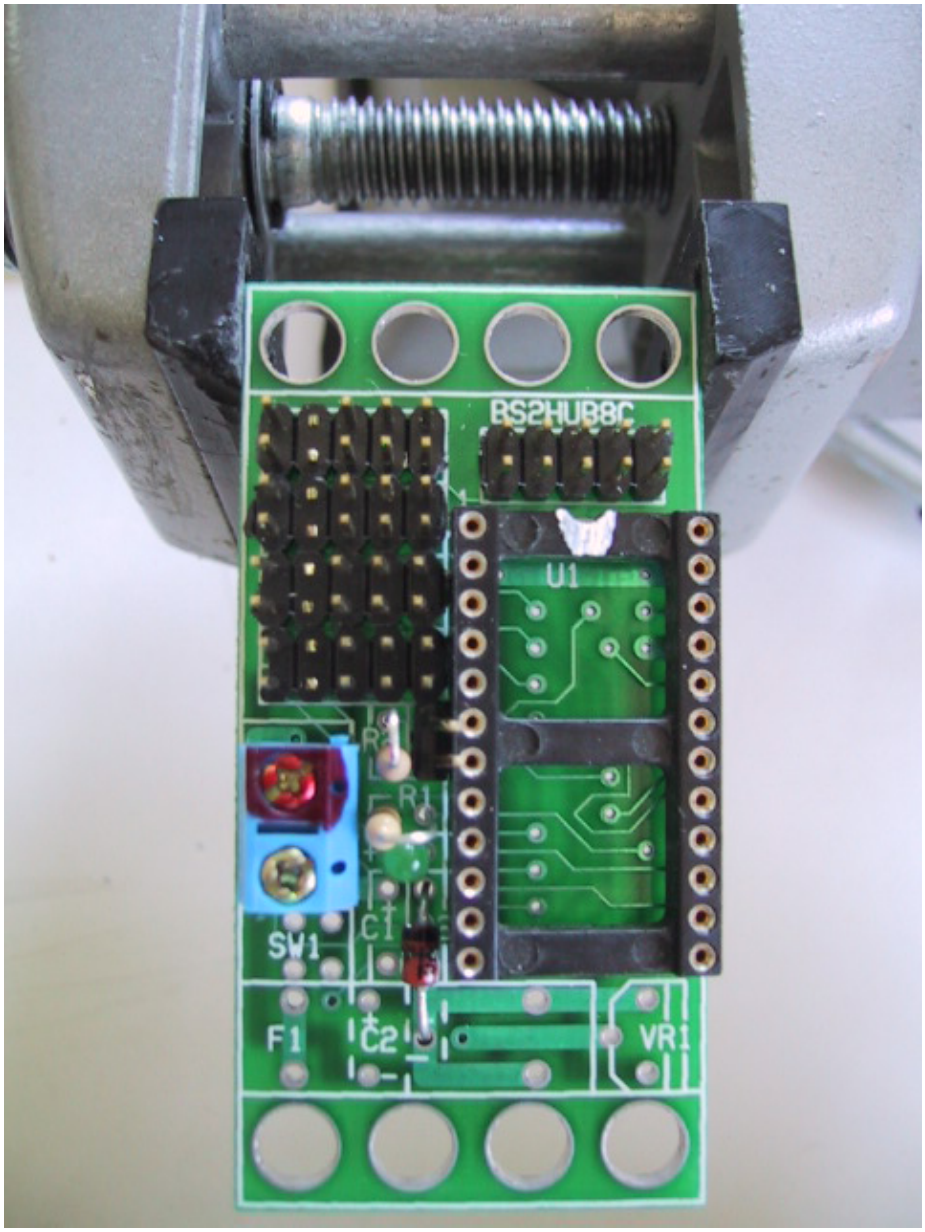

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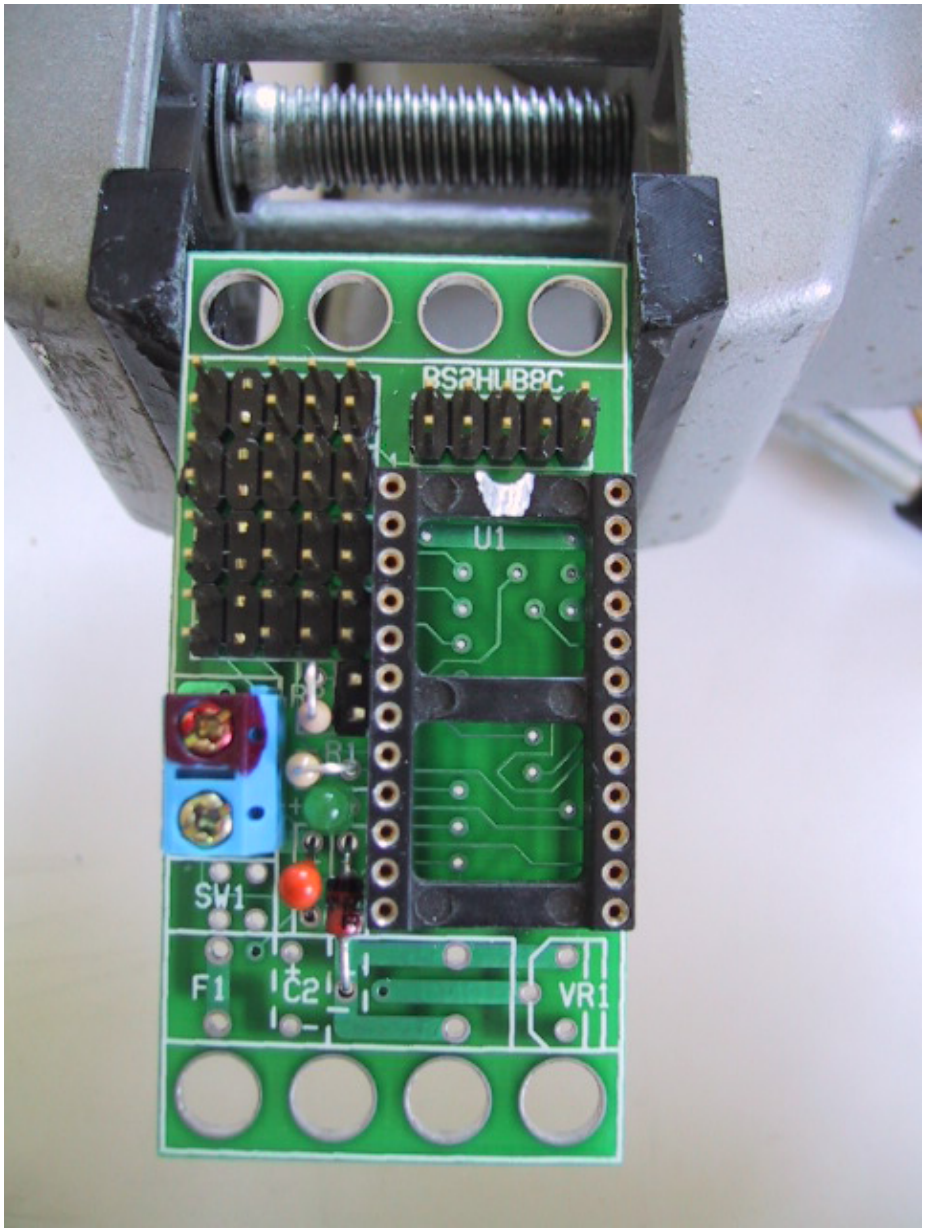

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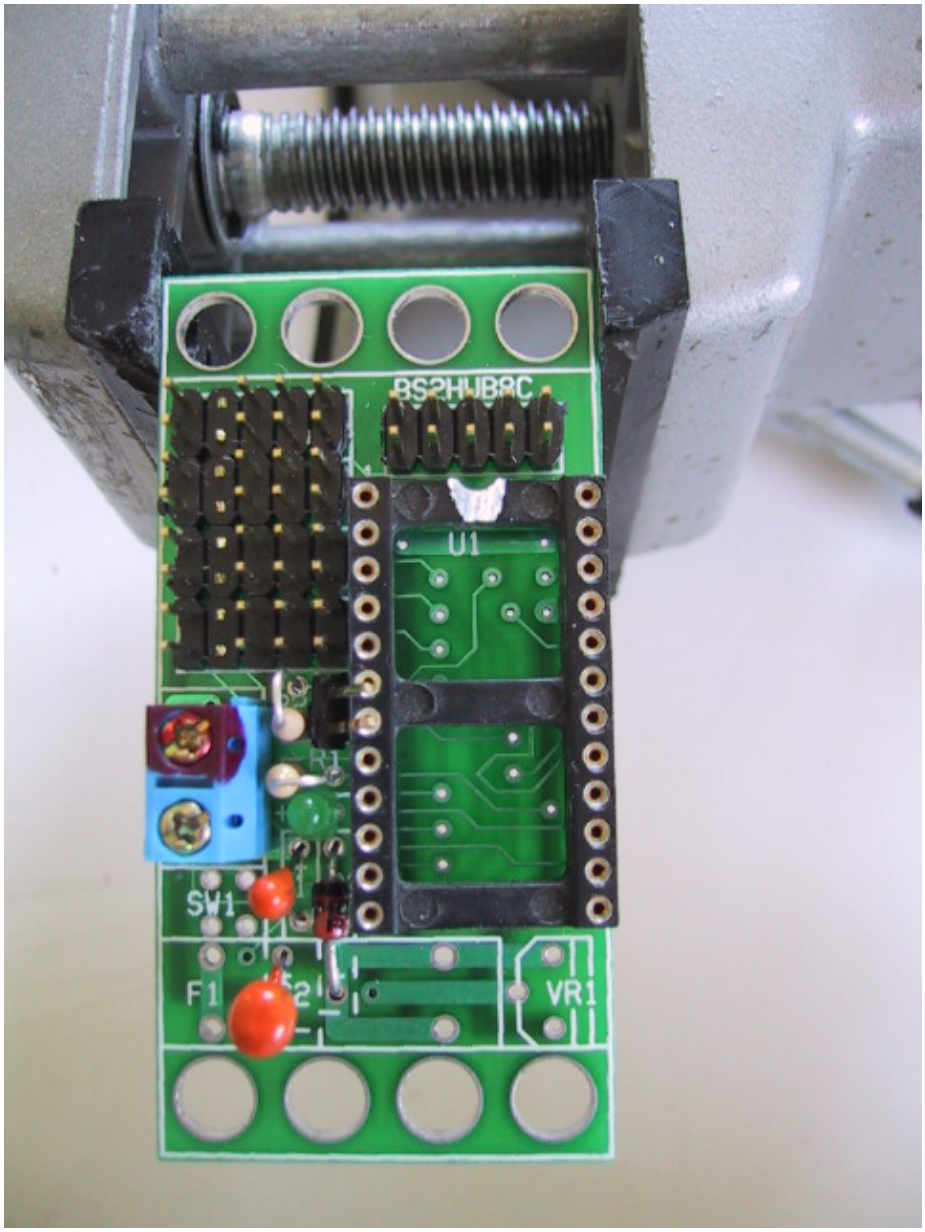

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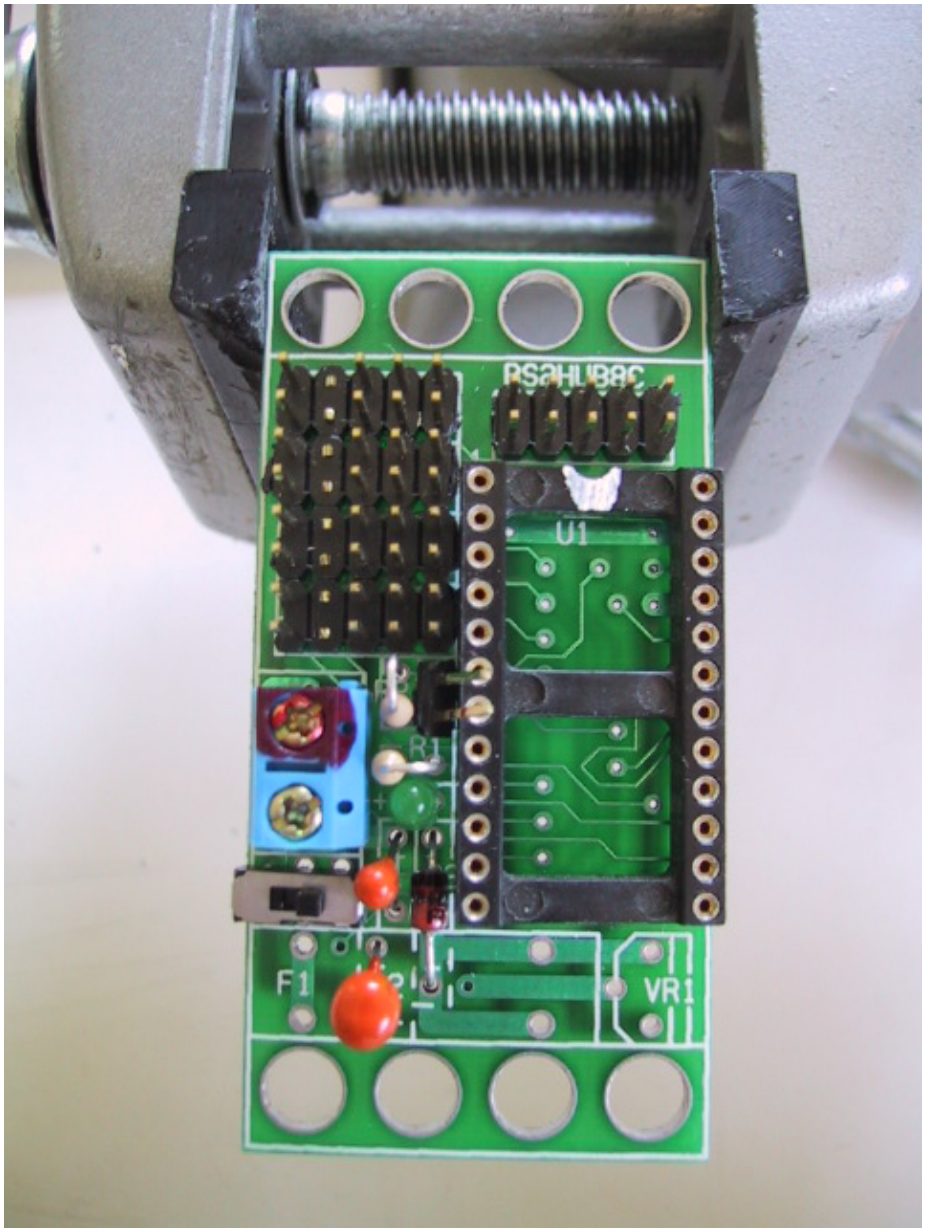
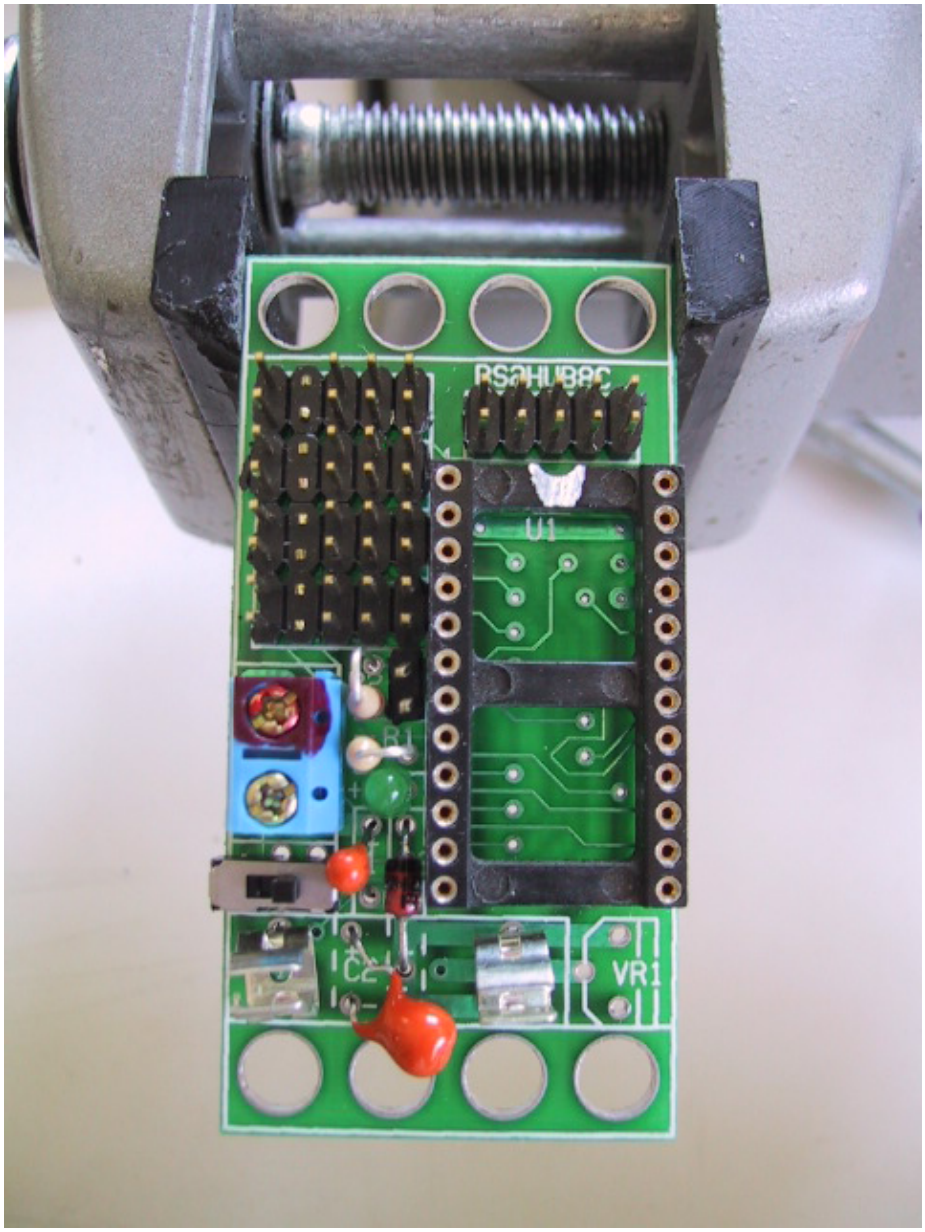


Step 17



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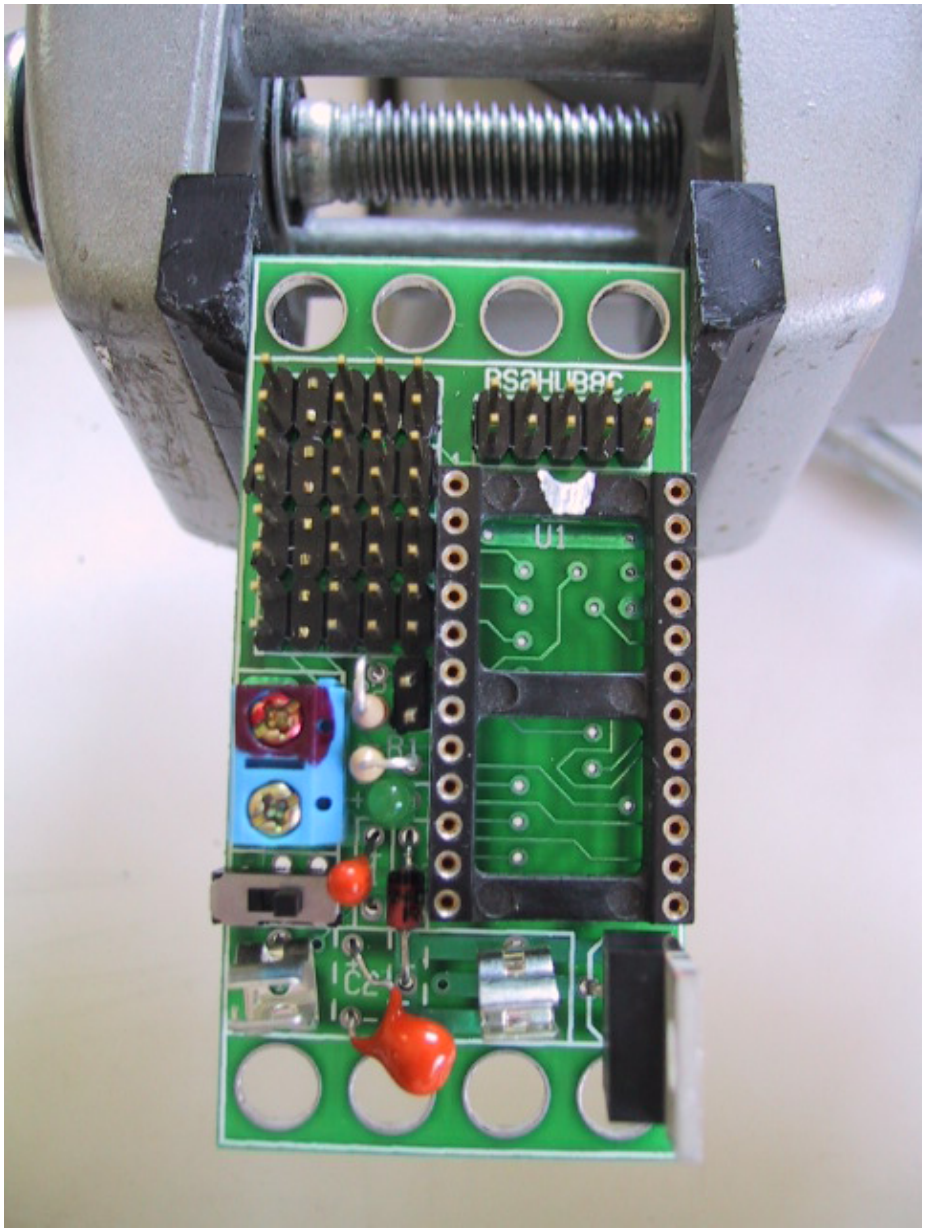

Step 19