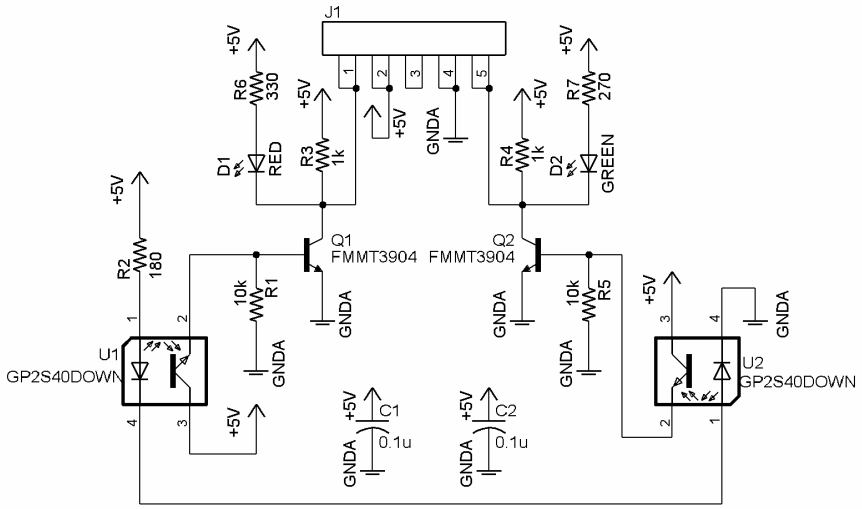
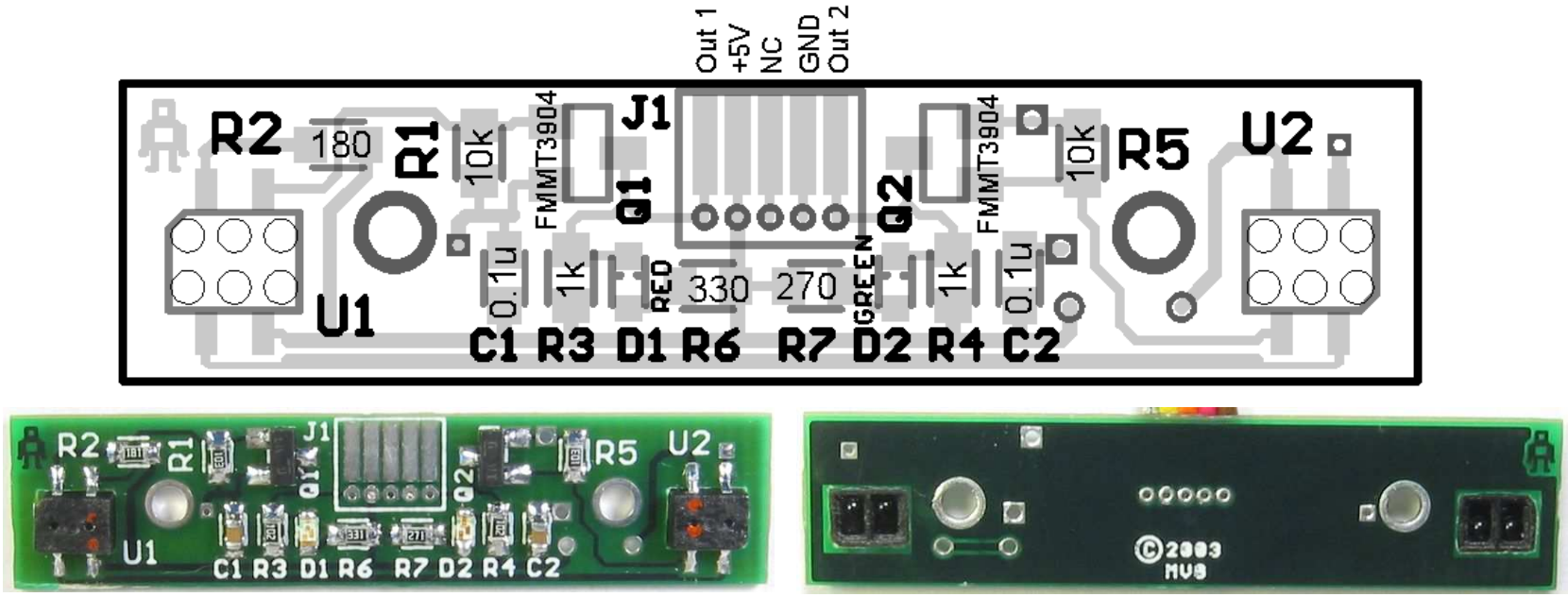
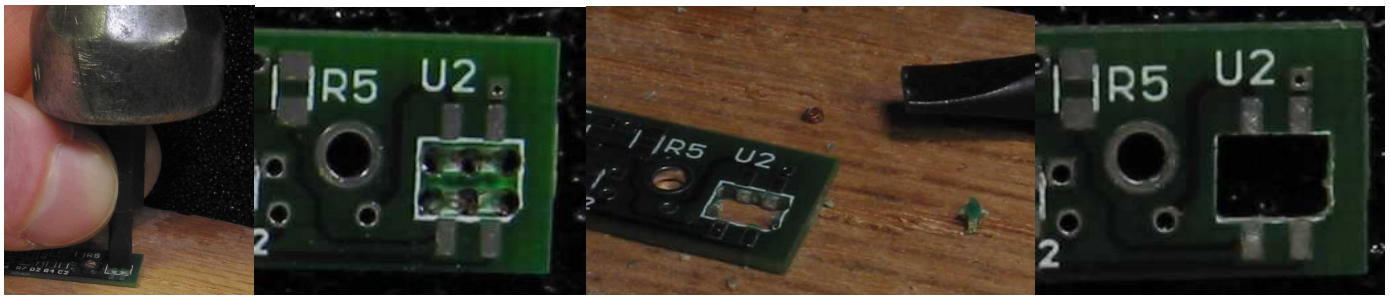


Micro Line Sensor	
Rev A. (Shipped)	
4/12/03	Monty Goodson



Board Preparation

U1 & U2 are mounted upside down, protruding through the board. That is, when the board is viewed from the top, the lenses should point down. Holes for U1 & U2 need to be cut out. Use small wire clippers to snip the web between the drill-holes and use an Xacto knife to shave down the sides until the detector fits. If small wire clippers are not handy, use a small flat-blade screwdriver or a small chisel to cut the web as shown in the figures below. Also, shave off any tab stubs on the board edges with an Xacto knife.



Board Soldering

The MEGAbitty LineSensor board has a number of small surface-mount components that may be challenging to solder if you don't already have a lot of soldering experience and a good soldering iron. Consider seeking out some simpler learn-to-surface-mount solder kits to practice on. A number of MEGAbitty product users attempting surface-mount soldering for the first time have found the soldering to be not too bad, however. The following section presents some soldering tips for the LineSensor components. There is also a good surface-mount soldering guide on www.avrfreaks.org: Look for the "Low Cost SMD Soldering Guide."

First, use a good temperature-controlled soldering iron, such as the popular Hakko 936. Some connections heat up readily, while other connections, like pads connected to the ground plane, take a bit more energy. A temperature controlled iron will increase the power to the tip as needed to maintain the desired temperature. A fixed-wattage iron, on the other hand, will always apply the same amount of power, which will often be more than needed. The extra power can overheat and damage parts. With a temperature-controlled iron, use as low of temperature as possible that still allows solder to flow readily into the joint within a few seconds of heating.

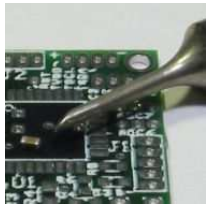


Figure 1: micro-bevel tip

Figure 2: fine-point tip

Second, use a small soldering tip. My favorite is a "micro bevel" (Hakko P900M-T-1C) (Figure 1) – it seems to provide a good mix of contact area for better heating, and fine edge for precision. I've also used a fine-point tip (Figure 2) but didn't like it as well as the micro bevel.

Third, use small gauge solder. The typical .032" RadioShack solder is too big and will flood the small joints and potentially result in solder bridges.

Anchor the board to provide a stable surface for soldering. This can be done simply by taping the ends down to a flat surface, or by mounting it with the screw holes. If possible, anchor the board to a surface that can be freely repositioned to achieve the best angle for soldering each component.

When assembling the board, make sure that soldering a component on will not restrict access to other unsoldered pads. I usually start in the center with R6 and R7 and work towards the ends.

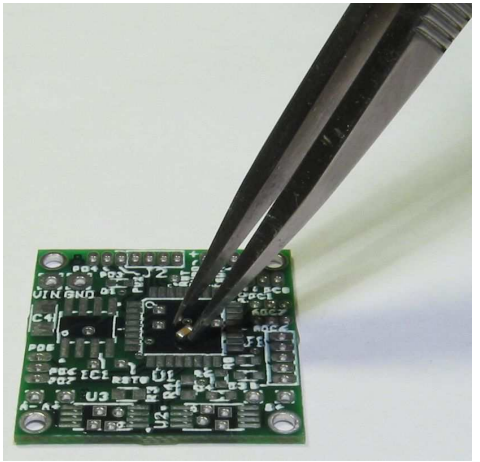


Figure 3: Fine tipped tweezers are necessary for soldering small parts.

Soldering the Rs & Cs

Soldering the small resistors and capacitors can be challenging, but is not too bad if you use fine-tip tweezers (Figure 3). Place a tiny amount of solder on one of the pads, use tweezers to place and hold the component, and heat the joint until the part settles into the solder. Now the opposite

side can be soldered as usual. Touch up the first side to insure there is a good solder joint. Choose the first pad after looking at the board images above – choose the side that connects to the smaller copper area to insure the first joint is easy to heat up. While there are thermal-reliefs for pads connected to planes, they don't provide enough "relief" as they probably should.

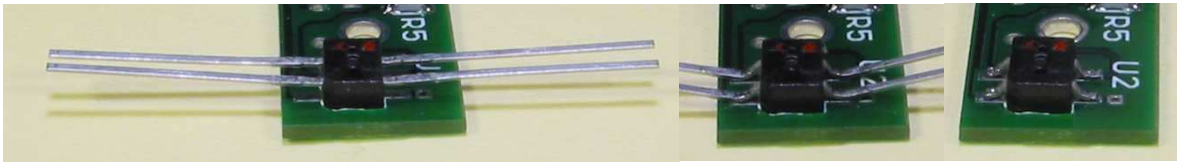
Soldering the Transistors and LEDs

The LED's are a bit trickier than the caps and resistors. Be careful about squeezing them too hard with the tweezers (especially while heating?), as the lens and body appears to be glass and can chip. As with all LEDs, polarity is important. Look closely at the top (glass part) of the LED and find the little square LED die just off center as seen in Figure 4 – a magnifying glass helps here. This die should line up with the little white silk-screened stubs located between the LED pads on the board.

Figure 4: Proper LED orientation

The transistors may be soldered in the same fashion as the other components – melt a little solder onto an easily accessible pad, anchor the part down to that pad, and finish off the remaining pads. Be sure to touch up the first pad to insure a good joint.

Soldering the Sensors



Carefully straighten the leads of U1 & U2 – bending more than a few times may make break them. Note that one corner of the sensor is beveled – orient the sensor so that this corner matches up with the beveled corner in the board diagram on page 2. Depending on how the MEGAbitty Line Sensor board is to be used, either mount the sensors with the lens side flush with the back side of the board and bend the leads down as shown above, or mount the sensors so that they protrude beyond the back side of the board and the leads lie flat. Keep in mind that there should be at least ~1mm between the sensor's lenses and the surface to be detected for proper operation. Cut each lead so that it covers about ½ to ¾ of the pad. For reference, the cut leads on the left of the part in the final picture above are about right; the leads on the right are too long and will be hard to solder.

Final Inspection

Carefully inspect each solder joint using a magnifying glass or pocket microscope. Apply a little more solder to joints that look a little dry; use solder-wick to remove and bridges; and redo joints that look dull (wick old solder away and apply new solder). Check all part orientations to make sure no chips are rotated or backwards, and all LED's and diodes are correct. Once confident that all is soldered properly, use an ohm meter to make sure there are no shorts between power and ground.

First Power

If everything looks good then it's time to try it out! The board is designed to use 5V, so you will need a 5V power supply. If you're lucky enough to have a power supply with an adjustable current limit, then set the current to ~50mA and apply 5V to the board. If you have a MEGAbitty controller board, you can tap 5V off of the regulated "+5V" net. (See the MEGAbitty Controller Assembly document for appropriate locations.) The current limiting is nice because if there is a problem, there isn't enough current to do too much damage. If your power supply has a current reading, then expect to see ~13mA when the board is over a black surface, ~28mA for one indicator LED on, and ~43mA for both indicator LED's on. If the board is placed on a white surface, the red and green LEDs (D1 & D2) should light immediately upon applying power. If they don't, move the board further or closer to the white surface. If there is still no light, move on to the "Troubleshooting" section.

Troubleshooting

1. If the indicator LED's don't light upon applying power with the sensor bottom between 1-5mm from a white surface, measure the voltage across the caps (C1 & C2) to make sure the board has power. If it doesn't, check for continuity between the board's "+5V" trace and the power supply, and between the "GND" trace and the supply. Also check for a short between "+5V" and "GND".

2. Next check the voltage of the outputs. It's possible that the detector is working properly, but the indicator LED's are backwards, or not working. The output should be around 5V with the detector over a black surface and under 1V directly over a white surface. If the outputs change between black and white surfaces, then proceed to troubleshooting step 4.

3. Next check for a voltage drop across the sensor's IR emitters (pins 1 & 4). There should be about a 1.2V drop. If there isn't, remove power from the board and use an ohm meter to check for continuity between the sensor pins and the board. If the sensor leads were not bent down far enough before soldering, there could be a gap between the board and the lead. It may look soldered from the top, but it may really not be.

4. Check the polarity of the indicator LEDs. Make sure the LEDs are oriented with the little square die visible within the package closest to the transistors (Q1 or Q2), and check the voltage drop across each LED with the diode test function of a multimeter (be sure to disconnect power from the board first though!) First measure the voltage drop with the positive meter lead at the diode's anode (side farthest from the little square die) and then at the cathode (side closest to the little square die) – the voltage drop should be lower in the first case. If the voltage drop is lower with the positive meter lead at the cathode, then the LED is probably backwards. If the voltage drop is the same in either direction, then the LED has a bad solder connection, or is burned out – possibly by too much heat while soldering. Check for continuity between the LED pins and the board.

RefDes	Description	Manufacturer	Manufacture Part #	Vendor	Vendor Part #	Qty in Kit
U1,U2	PHOTOINTERRUPTER REFLEC 6.5MM PC	Sharp	GP2S40	DigiKey	425-1096-5-ND	2
Q1,Q2	SOT-23 SOT-23 NPN GEN PUR	Fairchild Semiconductor	MMBT3904	Mouser	512-MMBT3904	2
D1	LED SUPER RED CLR THIN 0603 SMD	Lite-On Inc.	LTST-C191KRKT	DigiKey	160-1447-1-ND	1
D2	LED GREEN CLEAR THIN 0603 SMD	Lite-On Inc.	LTST-C191GKT	DigiKey	160-1443-1-ND	1
C1,C2	CAP .10UF 16V CERAMIC X7R 0603	Kemet	C0603C104K4RACTU	DigiKey	399-1096-1-ND	3
R1,R5	RES 10K OHM 1/10W 5% 0603 SMD	Panasonic - ECG	ERJ-3GEYJ103V	DigiKey	P10KGCT-ND	3
R2	RES 180 OHM 1/10W 5% 0603 SMD	Panasonic - ECG	ERJ-3GEYJ181V	DigiKey	P180GCT-ND	2
R3,R4	RES 1.0K OHM 1/10W 5% 0603 SMD	Panasonic - ECG	ERJ-3GEYJ102V	DigiKey	P1.0KGCT-ND	3
R6	RES 330 OHM 1/10W 5% 0603 SMD	Panasonic - ECG	ERJ-3GEYJ331V	DigiKey	P330GCT-ND	2
R7	RES 270 OHM 1/10W 5% 0603 SMD	Panasonic - ECG	ERJ-3GEYJ271V	DigiKey	P270GCT-ND	2

Resistor R2 sets the current through the infrared LEDs at about 10mA, while R6 and R7 sets the current through the indicator LEDs at about 10mA apiece. The output transistor pull-up resistors R3 & R4 insure the output is high and the transistor is properly biased when the indicator LEDs are off. The board should draw around 10mA over a black surface and ~43mA over a white surface. To save power, higher resistor values could be used on the indicator LED's (or the LED's could be removed all together), but the output voltage for a given distance will be affected.

With the component values shown, the output voltage should remain under 1V for a white surface ~1mm-5mm from the detector, and should increase to 5V over a few mm beyond 5mm. By keeping the output voltage under 1V over a wide range, the detector will work well with the MEGAbitty Controller Board interrupt inputs.