INSTRUCTIONS

For Assembly of the Pill Reminder Shield Board

Shrimpware LLC
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1) **TOOLS AND SUPPLIES**.

Before beginning assembly of the shield board, the following tools and supplies should be at hand:

a) Tools:
   i) Soldering Iron
   ii) Needle Nose Pliers
   iii) Diagonal Cutter
   iv) Wire stripper
   v) Small (jewelers) straight screwdriver (for 3.5 mm screw terminals and trim pot)

b) Supplies:
   i) Electrical solder
   ii) Electrical tape
   iii) Solder wick or solder remover
   iv) #22 AWG solid copper wire, insulated
   v) Shield PC board
   vi) Shield parts kit (see parts list)

c) Optional (see photo 1, below):
   i) Soldering iron stand
   ii) PC board adjustable soldering stand
   iii) Magnifier
   iv) Multi-meter

Photo 1. PC Board Adjustable Soldering Stand and Multimeter.

2) **ASSEMBLY INSTRUCTIONS**.

a) **Soldering**. Assembly of the Shield Board requires that you have knowledge of skill of electronic soldering. A good tutorial on this subject can be found at:

https://learn.sparkfun.com/tutorials/how-to-solder---through-hole-soldering

b) **General instructions**: Before beginning assembly, please read through and understand these general instructions:

i) All parts are mounted on the top side of the board. The top side of the board is the side with the silk screen printing on it – see photo 2, below.

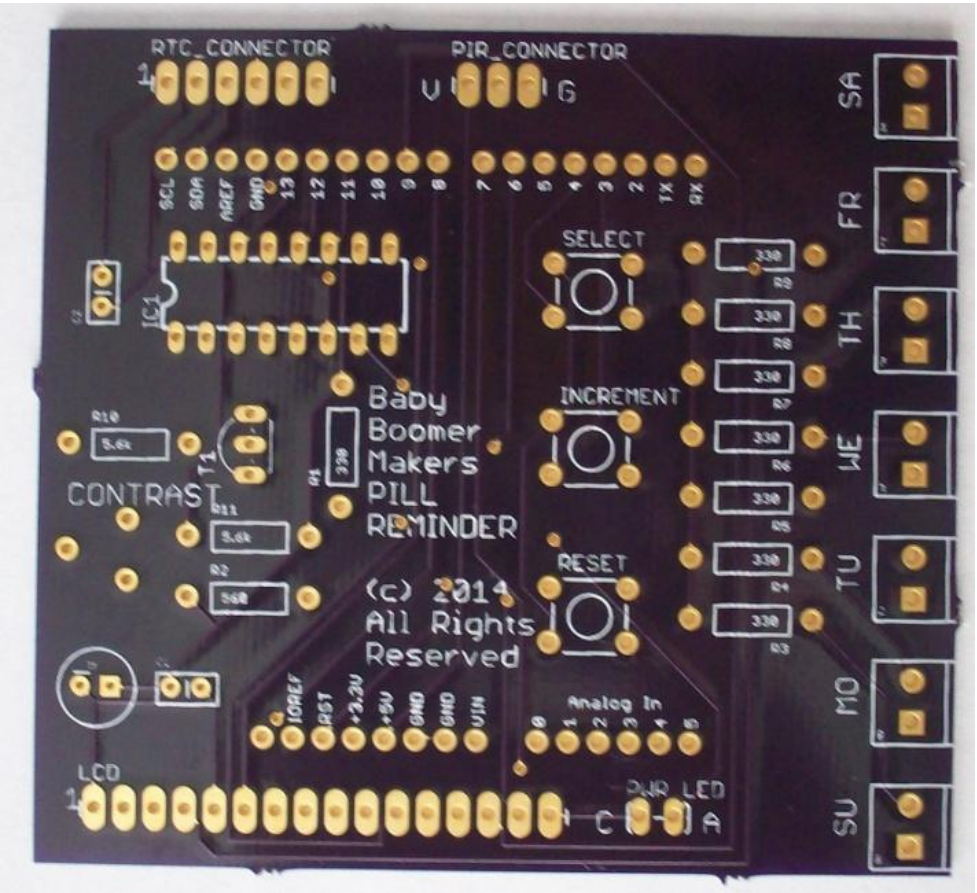

Photo 2. Top Side of Blank Shield Board.

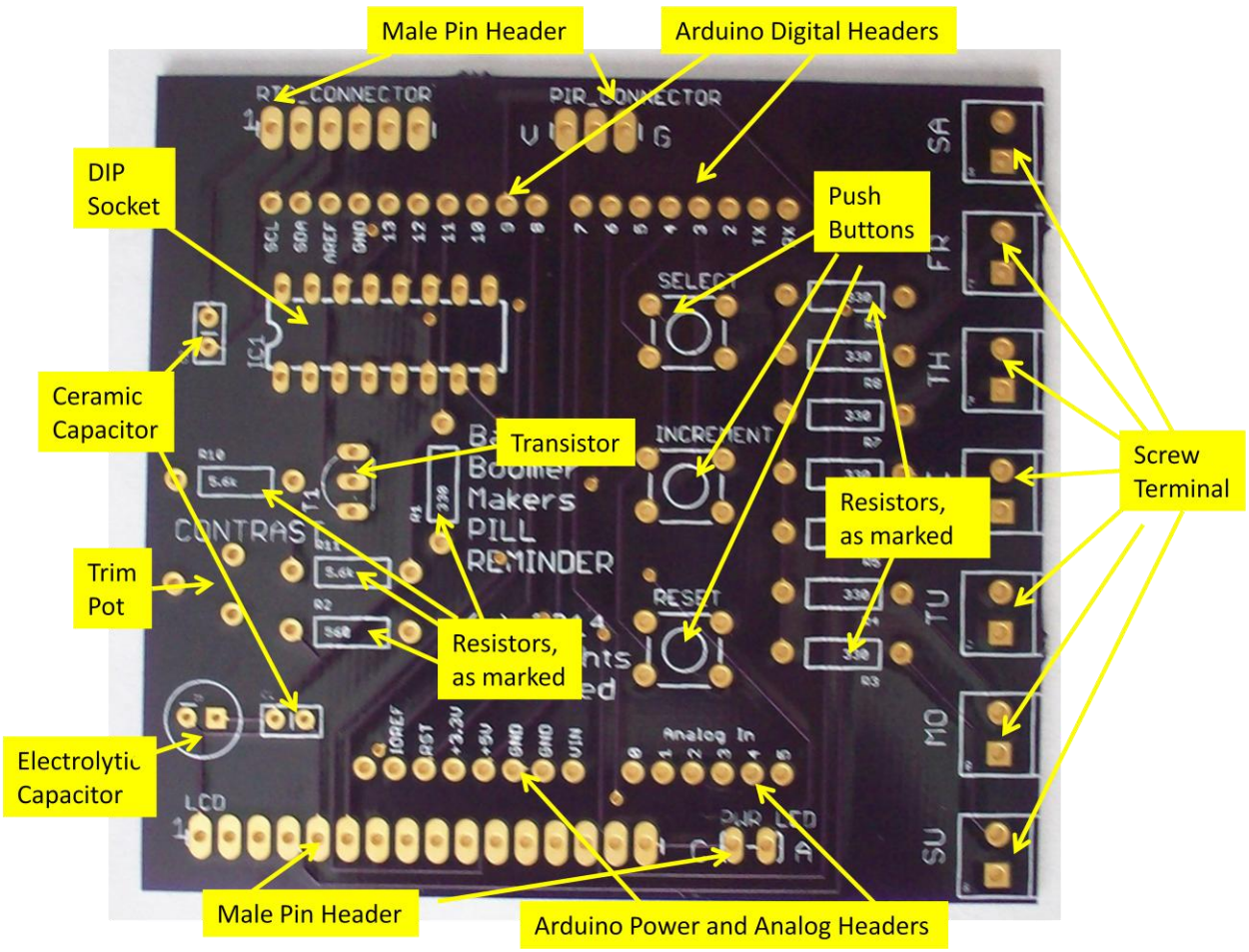

Photo 2a. Shield Board with Major Parts Identified.

ii) All parts are soldered on the <u>bottom</u> side of the board only.

iii) The following parts have rigid pins and do not grip the board to hold the part in place when the board is inverted to solder the pins on the bottom. It is recommended to place the part on the top of the board, align the part as necessary, and apply electrical tape to hold the part in place for soldering. As soon as the board is inverted for soldering on the bottom side, solder the two pins at opposite ends (diagonally, in the case of the DIP socket) first to hold the part rigidly. Then solder the remaining pins to the board.

(1) <u>0.1" male pin headers</u>. Care must be taken to keep these parts in vertical alignment as they tend to tilt sideways because they are loose in the holes in the board. Place these parts into the holes so that the short pin ends protrude through to the bottom of the PC board. Align each connector vertically and use electrical tape to hold it firmly into the holes, with the plastic center pieces firmly seated

into the top side of the PC board and the connector straight up and down and not slanted sideways.

(2) Arduino headers. The headers require extreme care to ensure that they are fully seated on the PC board and absolutely vertical when they are soldered into place. After assembly, they must fit into the Arduino without undue stress and strain. The same techniques apply as for the 0.1" pin headers, above. Extra care and diligence is advised.

(3) DIP socket. The DIP socket is easier to solder since it has two rows of pins that will prevent it from tilting. However, it should be taped or otherwise affixed to the top side of the PC board so that it stays in place when the board is inverted for soldering.

iv) The three pushbutton switches have pins that are bowed outward to snap into a PC board. Once inserted into the PC board properly, the pins will hold the pushbuttons in place when the board is inverted for soldering. Care must be taken to ensure that the pushbuttons are inserted into the PC board in the proper orientation. The underside of the pushbuttons has a plastic line between sets of two pins. These pins are shorted together. They should align front to back of the PC board. The pins make contact with the conductors on the PC board even before they are soldered into place. It is recommended to check for proper alignment with a multimeter before soldering the pushbuttons into place. See the assembly instruction details for this step in the Shield assembly for further details.

c) Inspect PC shield board for damage and deburr edges.

i) File down any burs on the board edges to avoid cuts and scrapes

ii) Visually inspect the board for any damage or defects, such as:
(1) Breaks in conformal coating, except for solder pads and vias.
(2) Ensure that holes are drilled in the center of each component solder pad.

iii) Place the multimeter in resistance measurement and check that there is an open circuit between the Arduino connecter pin labeled "+5V" and any one of the Arduino pins labeled "GND". Refer to photo 2, above, for details. If there is not an open circuit between these contacts on a bare shield board, then the board has a power short and should not be used.

d) Solder 0.1" male pin headers to the PC board.

i) If necessary, break the long 0.1" spaced pin header strips into individual connectors, as follows, per photo 3, below:
(1) One 16 pin header
(2) One 6 pin header
(3) One 3 pin header

(4) One 2 pin header

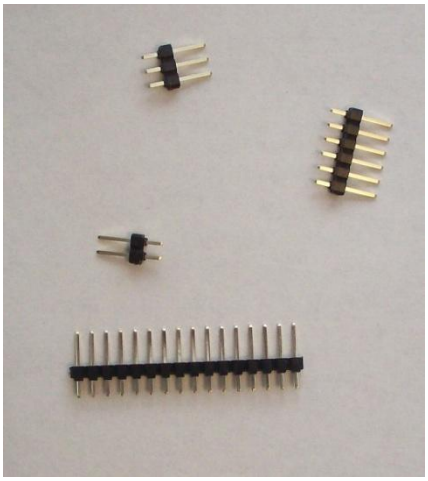

Photo 3. Male Pin Headers for Shield Board

ii) Place the 16 pin header into the "LCD" connector holes in the Shield Board, as shown in photo 4, below:

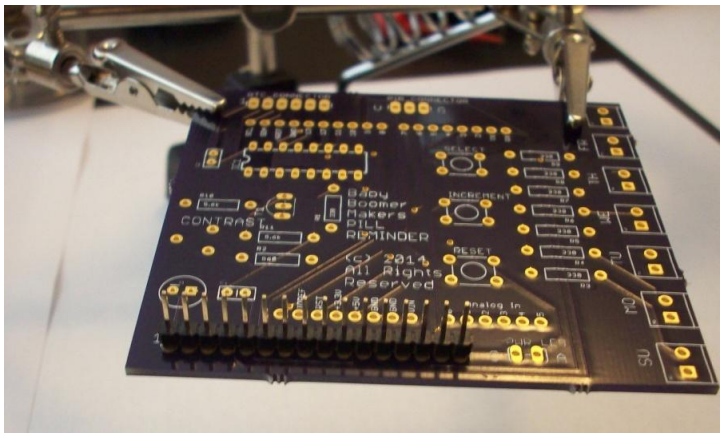

Photo 4. LCD Pin Header Placement on Shield Board.

iii) Use electrical tape to hold the pin header in place and vertical, as shown in photo 5, below.

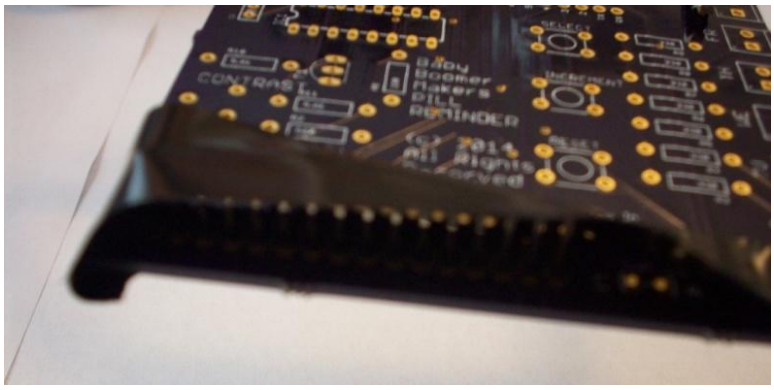

Photo 5. Tape Holding Pin Header in Place for Soldering.

iv) Invert the shield board and solder the two end pins first to hold the connector in place. Then solder the remaining pins.

e) Repeat this procedure for:
   i) 2 pin header (Power LED)
   ii) 6 pin header (RTC module)
   iii) 3 pin header (PIR module).

   See Photo 6 for completed pin headers.

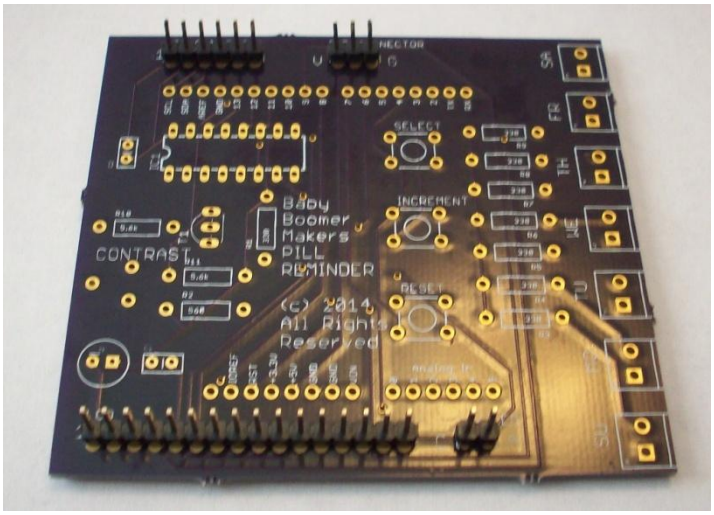

Photo 6. Pin Headers Soldered on Shield Board.

f) **Solder Arduino header connectors to PC board**. The Arduino header connectors are shown in photo 7, below. They are placed per photo 2a, above. *NOTE: the Arduino header pins must be straight vertically and must be in a line with each other, or else they will not mate properly with the Arduino Uno board*. Two methods to achieve this are described below.

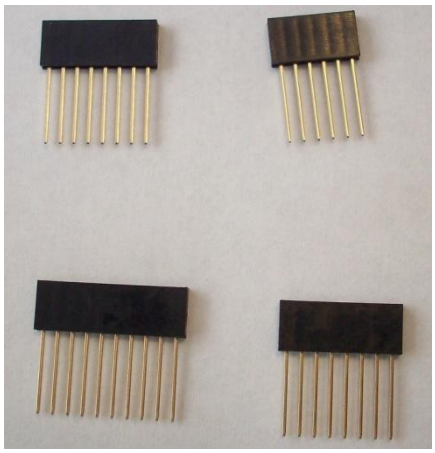

Photo 7. Arduino Headers.

i) Method 1: Place the headers, one at a time, into the proper holes in the Shield board. Use electrical tape to secure the header in place. Invert the board and make sure that the metal pins are vertical, perpendicular to the board. For the second connector on each side, make sure that the pins are in absolute alignment with the pins on the connector just in front or in back of it. Solder the two pins at each end to hold the connector in place; then solder the remaining pins. Repeat this step for each of the 4 headers.

ii) Method 2: Put all 4 headers through the proper holes in the shield board and plug the metal ends into an Arduino Uno board, so that the header pins are well seated into the mating connectors on the Arduino. Using electrical tape, tape the shield board up flush against the plastic body of all for connectors. Glue the insides of the plastic connectors to the shield using a hot glue gun or other glue compatible with plastic. Let the glue dry thoroughly. Carefully unplug the shield, invert the shield board and solder the end pins of each connector to hold them in place. Then solder the remainder of the pins.

With either method, check for proper seating of the shield into an Arduino before proceeding on to the next steps. If a connector has to be removed, it is best to use diagonal cutters to cut through the plastic body of the header and then use solder wick or a solder removing tool to remove as much solder as possible from each pin. Use long nose pliers and the soldering iron to loosen the remaining solder on each pin and remove the pins, one at a time using solder wick or solder removal tool to clean and solder out of the mounting holes on the shield board. *Note: removal of the Arduino headers is very difficult and extreme care should be taken in this assembly step to ensure that it is done correctly the first time!* After completing this step, the shield board should look like photo 8.

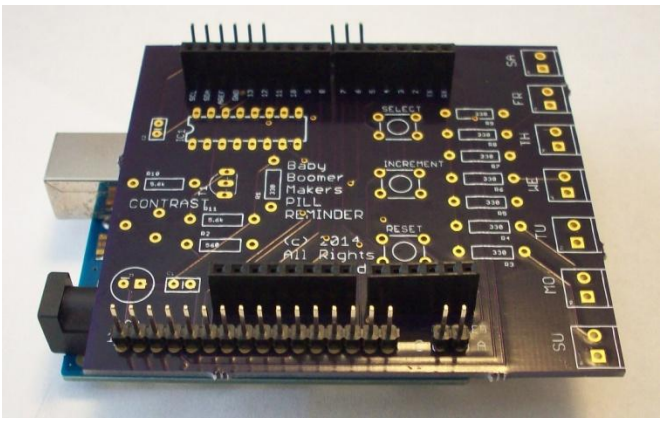

Photo 8. Arduino Headers Mounted on Shield Board Plugged into an Arduino.

Unplug the shield board from the Arduino after the header pin alignment test.

g) **Solder screw terminal connectors to PC board**. There are 7, two-position, 3.5mm screw terminals that need to be soldered to the rear of the shield board, as indicated on photo 2a, above. Starting with either end (SU or SA), place a screw terminal through the holes at the top of the board so that the wiring terminals point outward from the rear of the board. Use electrical tape to hold the screw terminal fast to the top side of the board and in neat alignment with the rear of the board. Invert the board and solder both leads. Repeat the procedure for the remaining six screw terminals, one at a time.

h) **Solder 16 pin DIP socket to PC board**. Place the 16 pin dual in-line (DIP) socket into the top of the board, as indicated in photo 2a, above. Use electrical tape to hold it fast to the board. Invert the board and solder two pins at diagonally opposite ends of the socket to hold the socket in place. Then solder the remaining pins on the socket.

i) **Place and solder (3) pushbutton switches**. Locate the position of three pushbutton switches on photo 2a, above. The pushbuttons have pins that are bowed outward to snap into a PC board. The pushbutton pins are spaced wider in one direction than the other, so the pins should align only one way. *Do not force the buttons into the board.* Make sure that pin alignment is correct. Another check is to look at the bottom of each pushbutton. The pairs of pins that are shorted together inside each switch is denoted by a line in the plastic connecting pairs of pins. These plastic lines should be aligned front to back of the shield board (not side to side). Once each pushbutton switch is inserted into the shield board, check for correct alignment using the resistance setting on the multimeter as follows:

   i) RESET: Place one lead of the multimeter to the “RST” pin of the Arduino power header and the other lead to a “GND” connection on the same Arduino header. The multimeter should read an open circuit. Push the RESET button and the multimeter should read a short circuit while the button is depressed. Once tested correctly, invert

the board and solder all 4 pins of the RESET button pins in place, and recheck with a multimeter as described above.

ii) INCREMENT: Place one lead of the multimeter to Arduino pin "D2" on the lower Arduino digital header, and the other lead to a "GND" connection on the Arduino power header. The multimeter should read an open circuit. Push the INCREMENT button and the multimeter should read a short circuit while the button is depressed. Once tested correctly, invert the board and solder all 4 pins of the INCREMENT button pins in place, and recheck with a multimeter as described above.

iii) SELECT: Place one lead of the multimeter to Arduino pin "D3" on the lower digital Arduino header, and the other lead to a "GND" connection on the Arduino power header. The multimeter should read an open circuit. Push the SELECT button and the multimeter should read a short circuit while the button is depressed. Once tested correctly, invert the board and solder all 4 pins of the SELECT button pins in place, and recheck with a multimeter as described above.

After this step, the Shield Board should look like photo 9, below:

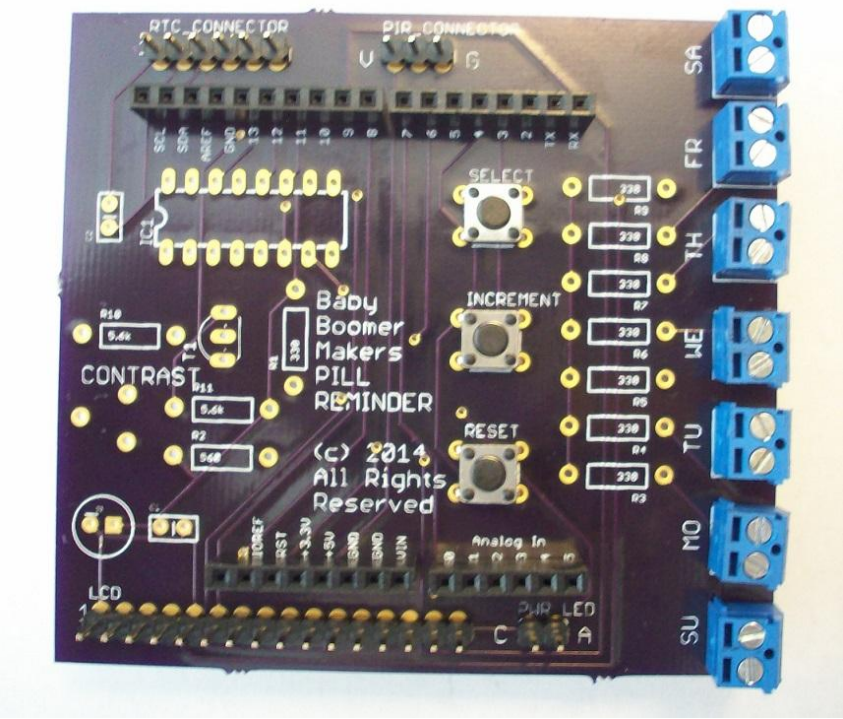

Photo 9. Shield Board with Screw terminals and Pushbuttons Attached.

j) **Place and solder 10Kohm trim potentiometer**. Locate the 10K ohm potentiometer (trim pot). The trim pot leads are arranged in a triangle. The trim pot pins are aligned with the shield board as shown in photo 9, under the word "CONTRAST". In order for the trim pot to fit properly on the board, the center pin (apex of the triangle) needs to be

bent outward from under the pot and then down to fit where the hole in the shield board is. Use long nose pliers to make the bends. See photo 10 for details.

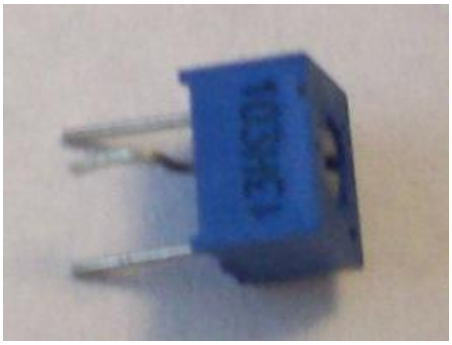

Photo 10. Trip Pot with Bent Wiper Lead.

Insert the trim pot into the board and bend the leads from the underside of the board to hold the trim pot in place. Solder all three leads. Clip off the excess leads using diagonal cutters after soldering. After soldering in the trim pot, it should look like photo 11.

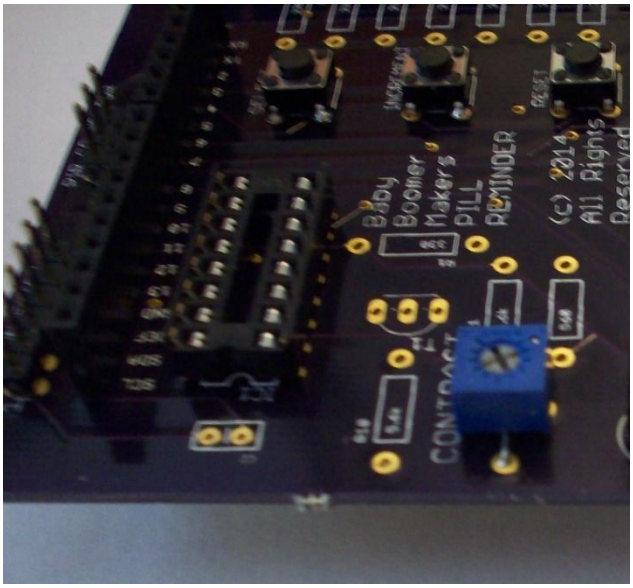

Photo 11. Trim Pot Soldered on Shield Board.

In order to test the trim pot, put the multimeter on a resistance setting. Place one lead of the multimeter to LCD pin 3 (third pin down from the front of the 16 pin male pin header labeled "LCD"). Place the other lead of the multimeter to one of the "GND" pins of the Arduino power header. Rotate the pot control with a jeweler's screwdriver and observe zero ohms at one extreme of pot rotation and approximately 10K ohms (10,000 ohms) at the other extreme end of the rotation. Move the multimeter lead from "GND" to "+5V" of the same Arduino power header and observe the opposite effect (zero and approximately 10K ohms at the opposite ends of pot rotation). Leave the pot

approximately in the center of its rotation at this time. If these readings are not observed, then the pot is installed incorrectly or is bad.

k) **Place and solder the 100 uf electrolytic capacitor**. Locate the electrolytic capacitor. The electrolytic capacitor is mounted in the circular outline at the lower left hand end of the board shown in photo 2a, above. The round hole is for the negative side and the square hole is for the positive side. The negative lead is shorter and has a silver stripe on the body of the capacitor. The positive lead is longer and does not have the stripe on the capacitor body. *Electrolytic capacitors are polarized and it is important to mount the positive and negative leads correctly.* With the device in the proper orientation, insert the leads through the holes and bend them on the underside of the board to hold the device in place. Then solder the leads. Clip off excess leads above the solder joints with a diagonal cutter. The board should look like photo 12, below.

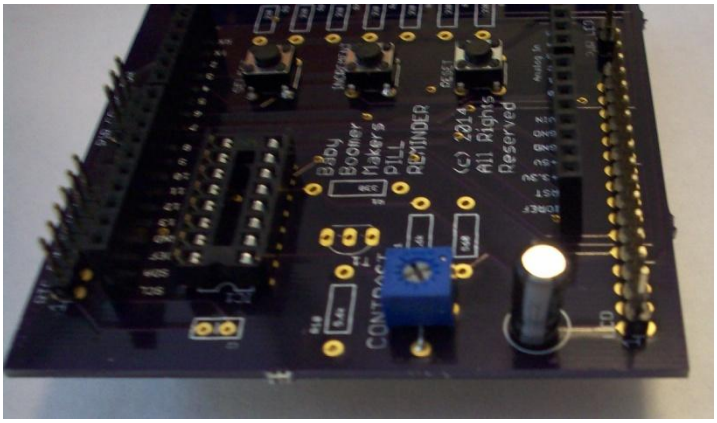

Photo 12. Shield Board with Electrolytic Capacitor Installed.

l) **Place and solder (2) 0.1 uf ceramic capacitors.** There are two, 0.1 uf capacitors to be mounted. One is mounted to the right of the IC (the 16 pin DIP socket). The other is mounted just to the back (left) of the electrolytic capacitor. Refer to photo 2a, above. These devices are <u>not polarized</u> and can be inserted in any direction. Place the leads through the holes in the board, bend the leads on the bottom side of the board to hold the capacitors in place, invert the board and solder the leads. Clip off excess leads with diagonal cutters.

m) **Place and solder 2N2222 transistor.** The transistor mounts in a "D" shaped area below the DIP sockets, as shown in figure 2a, above. The transistor has a "D" shaped cross section and the three leads of the transistor must be placed in the holes in the board such that the cross section matches the "D" pattern in the silkscreen. Insert the transistor leads in the holes on the board and bend the leads back on the underside of the board to hold the transistor in place. Invert the board and solder the leads. Use a diagonal cutter to clip off the excess leads above the solder joints.

n) **Place and solder (2) 5.6Kohm axial lead resistors**. Two 5.6K ohm resistors mount (1) below and (2) next to the transistor, as shown in figure 2a, above. Resistors are color coded as to their value, but it is best to check them with the resistance setting on your multimeter to make sure that you place the right parts in the right locations. The value read on the multimeter will not be exactly the specified value; it may typically vary from the specified value by +/- 5% or so. Resistors are not polarized. Bend the leads on either side of each resistor so that the resistor body lies flat on the board when the leads are inserted fully through the designated holes. Bend the leads back on the underside of the board to hold the resistors in place. Invert the board and solder the resistor leads. Clip off excess lead wire with a diagonal cutter.

o) **Place and solder 560 ohm axial lead resistor**. One 560 ohm resistor is mounted directly below the 5.6K ohm resistor that is below the transistor. Refer to photo 2a for details. Check the 560 ohm resistor with a multimeter and then mount it to the board in the same manner as for the two 5.6K ohm resistors, above.

p) **Place and solder (8) 330 ohm axial lead resistor or wire shunt**. The Shield Board has provision to mount eight 330 ohm resistors. Seven of these are near the screw terminals and one is near the transistor below the DIP socket. These resistors are current limit resistors for the 7 AM/PM LED pairs and one for the power LED. If the LEDs that you are using have internal resistors, then it is necessary to solder a piece of #22 - #26 wire in these resistor locations. The resistor values can also be varied depending upon the type and desired brightness of the LEDs.

   The resistors are mounted to the shield board in the same manner as the 5.6K ohm and 560 ohm resistors, above. In the event that the LEDs have internal resistors, prepare and solder in a "shunt" wire in each resistor location. A shunt wire is a piece of wire where about 0.7 cm of insulation is left on the wire, as shown in photo 13, below. The bare leads are bent 90 degrees from the insulated body and inserted through the holes where resistor leads would normally go. They are soldered to the board in the same manner as if the wire were a resistor.

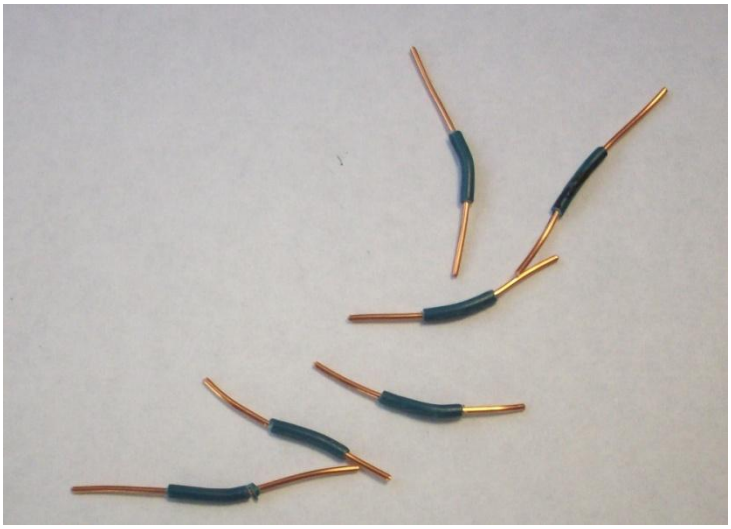

Photo 13. Shunt Wires, for LEDs with Internal Resistors.

q) **Inspect the board**. Carefully inspect all solder joints for good solder flow and no shorts. Make sure that there is adequate solder on each joint and that there are no cold joints. Clean off any debris from the bottom of the board with a clean cloth and/or compressed air.

r) **Insert the 74HC595 IC into the 16 pin DIP socket**. Pin 1 on the socket faces the front of the PC board. Pin 1 on the IC may be denoted with an indented dot on the package near one corner pin of the IC. Alternatively, the pin 1 side of the IC may have a "U" shaped notch in the package. Photo 14 shows placement of the IC in the socket where pin 1 is denoted with the U shaped notch.

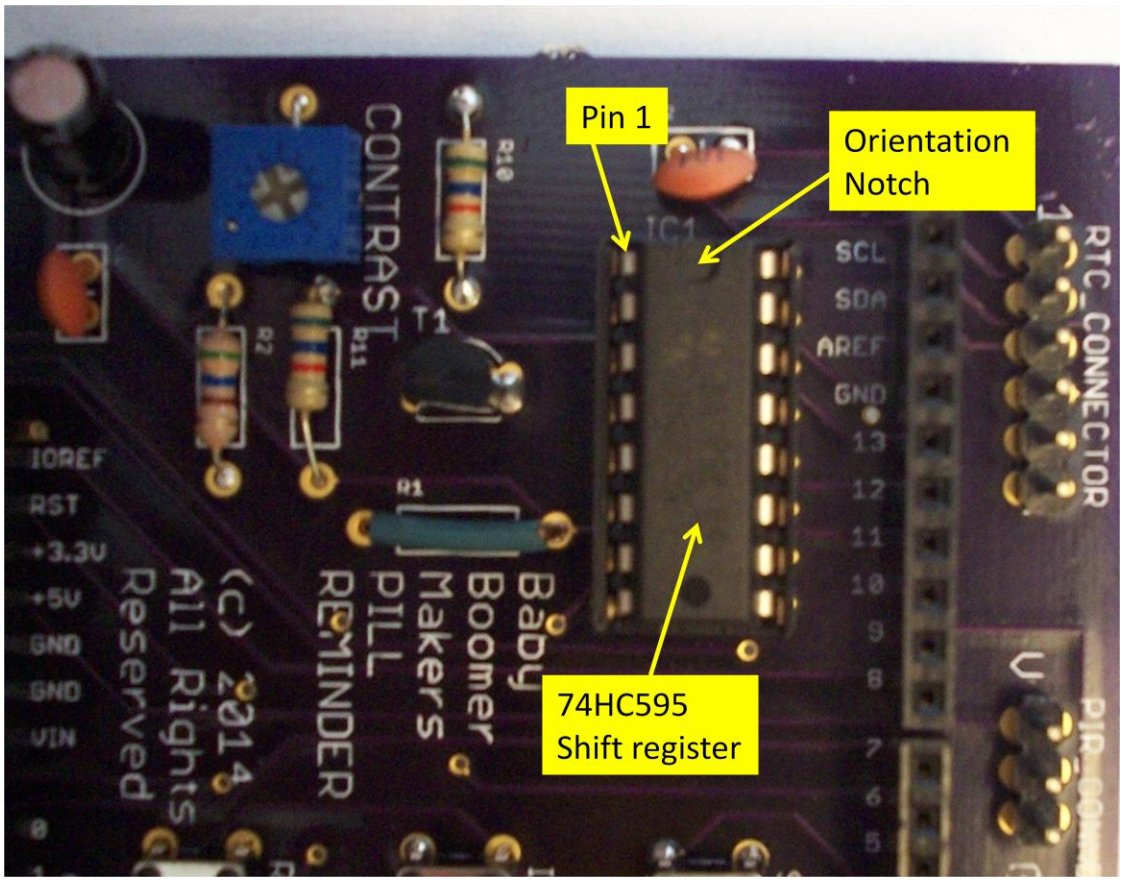

Photo 14. Shift Register Placement and Orientation

Note that the pins of a DIP IC usually flare outward from the package and may need to be bent inward in order to fit into the socket. This can be done by placing the IC sideways on a rigid flat surface so that one side of pins is flat on the surface. Grasping the plastic top and bottom of the IC package only, gently rotate the package upward so that the pins on the flat surface bend to a 90 degree angle with the package. Repeat the produce for the pins on the opposite side of the IC. The IC should then insert directly into the socket. Inspect carefully to make sure that all of the pins are in the socket and that none are bent under the IC.

3) **TESTING**.

A full test of the completed Shield Board requires assembly and integration of the Pill Reminder and all of its electronic components. The assembled Shield Board can be given a quick "smoke test" by inserting it into an Arduino Uno and then powering up the Uno. Use the multimeter on a voltage setting to check the voltage between the shield board Arduino power header pin "+5V" and ""GND". The voltage should read close to 5.0 volts. The shield board is now ready to be assembled into the Pill reminder.
