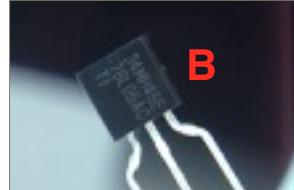
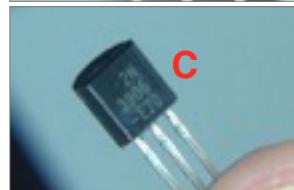


ARRL ETP Solder 101 24-Hour Clock Kit Construction Manual

A Functional Approach

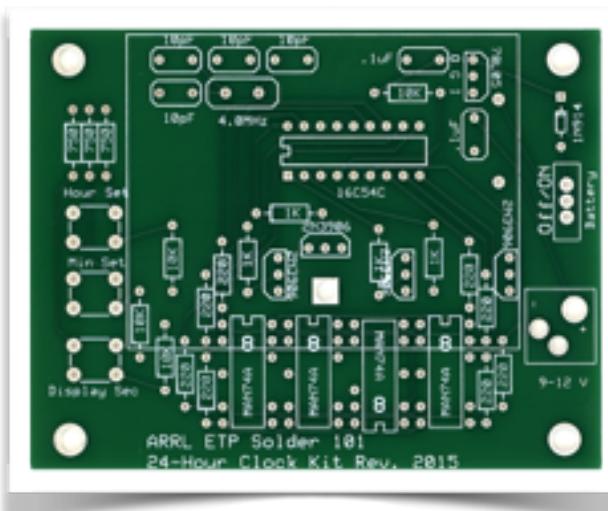
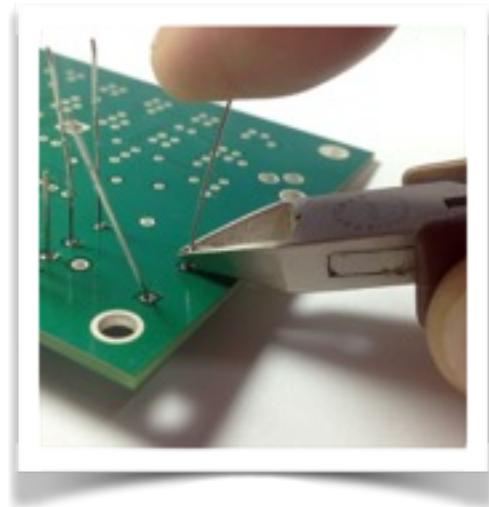
Parts Inventory

Cross-check the parts against this parts list. Note the resistor color codes, especially the 10K (brn-blk-org) and 1K (brn-blk-red) resistors, which may be difficult to tell apart. (Use good lighting and a magnifier.) Use care to correctly identify the 78L05 voltage regulator, which is similar in appearance to the 2N3906 transistors. The 0.1 μ F and 10pF capacitors may also look very similar.

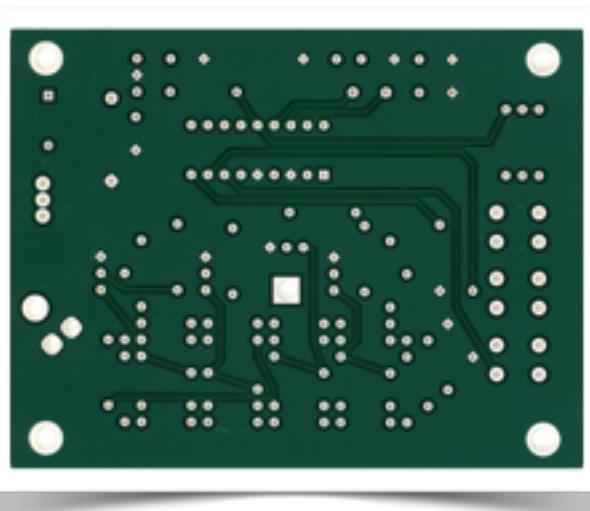
<i>QTY</i>	<i>Description</i>	
<input type="checkbox"/>	1 printed circuit board	
<input type="checkbox"/>	1 PIC16C54 microcontroller [A]	
<input type="checkbox"/>	1 18-pin DIP socket	
<input type="checkbox"/>	1 78L05 voltage regulator [B]	
<input type="checkbox"/>	4 2N3906 PNP transistor [C]	
<input type="checkbox"/>	4 7-segment LED	
<input type="checkbox"/>	1 1N914 diode	
<input type="checkbox"/>	1 4 MHz crystal	
<input type="checkbox"/>	4 10pF capacitor (100) [D]	
<input type="checkbox"/>	2 0.1 μ F capacitor (104) [E]	
<input type="checkbox"/>	8 220 ohm 1/4 W resistor (red-red-brn)	
<input type="checkbox"/>	3 750 ohm 1/4 W resistor (vio-grn-brn)	
<input type="checkbox"/>	4 1K ohm 1/4 W resistor (brn-blk-red) [F]	
<input type="checkbox"/>	4 10K ohm 1/4 W resistor (brn-blk-org) [G]	
<input type="checkbox"/>	3 SPST pushbutton switch	
<input type="checkbox"/>	1 3-AA cell battery holder	
<input type="checkbox"/>	1 vertical power jack, 2.1x5.5 mm	
<input type="checkbox"/>	1 2-56 1/2-inch screw	
<input type="checkbox"/>	1 2-56 nut	

Safety

- Apply power to the board only when instructed.
- Double-check part identification and polarity (if any) before soldering.
- Wear eye protection when soldering and trimming component leads. Use care when clipping off the excess leads because they can flip up and cause eye injury. A good technique is to hold the lead with your fingers while you clip the lead off just at the top of the volcano-shaped joint.
- Work in a well-lit, well-ventilated workplace.
- Use an appropriate soldering iron and tip.
- Use only small-gauge rosin core solder.



Clock PCB - Component Side



Clock PCB - Solder Side

Preparation (optional)

- The hole spacing of the resistors in this kit is 0.4 inches. If you have a lead bending tool, you can pre-bend all of the resistor leads to this spacing.

Power Circuit

Locate the 1N914 diode. Note the banded end of the diode (the cathode). Install the diode at the appropriate location, taking care to install it with the banded end turned to match the band of the component outline. Mount the diode flush with the surface of the board.

Install a 10K-ohm resistor (brn-blk-org) at the specified location near the 78L05 voltage regulator. All resistors should mount flush with the surface of the board.

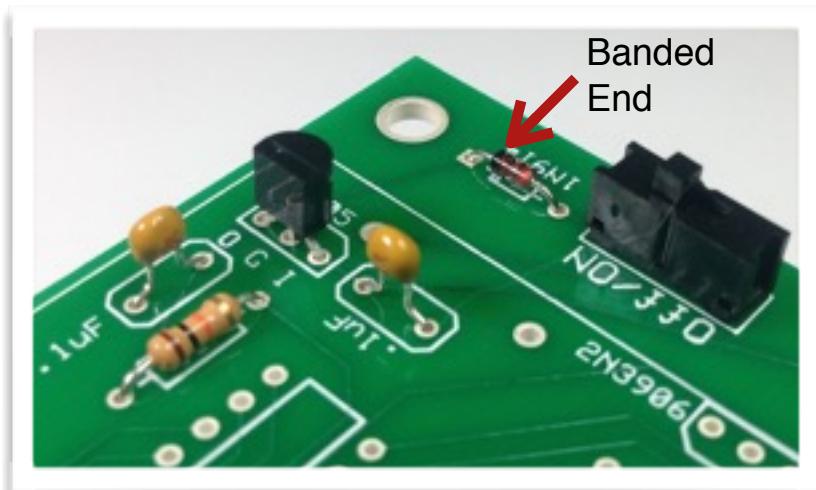
Install the two $0.1\mu\text{F}$ capacitors (104) at the specified locations near the 78L05 voltage regulator. Don't force the capacitors too close to the board, but don't leave them standing with long legs, either.

Solder all leads and clip off any excess.

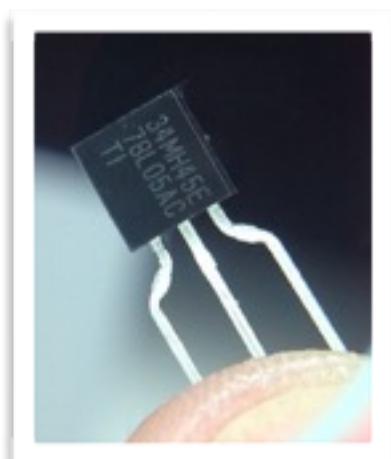
Install the 78L05 voltage regulator. Don't confuse the voltage regulator with the 2N3906 transistors. The voltage regulator and its outline on the board both have a flat side — which should be aligned.

Push the voltage regulator into the holes until the component body is about 1/8 inch above the board surface. Tack solder the center lead, straighten the component, then solder the outer two leads.

Solder and clip off excess leads, inspect your work, and touch up any solder joints.



Power circuit, showing orientation of diode.



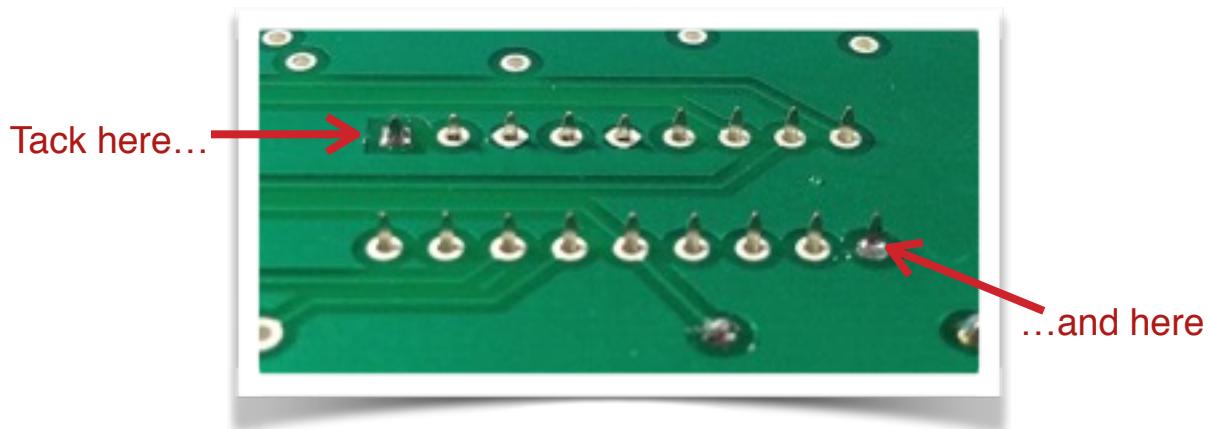
78L05 voltage regulator

PIC Socket Installation

Locate the 18-pin IC socket. One end of the socket is marked with a notch. The socket outline on the circuit board also has a notch. When you install the socket, turn the socket so that the notches match up.



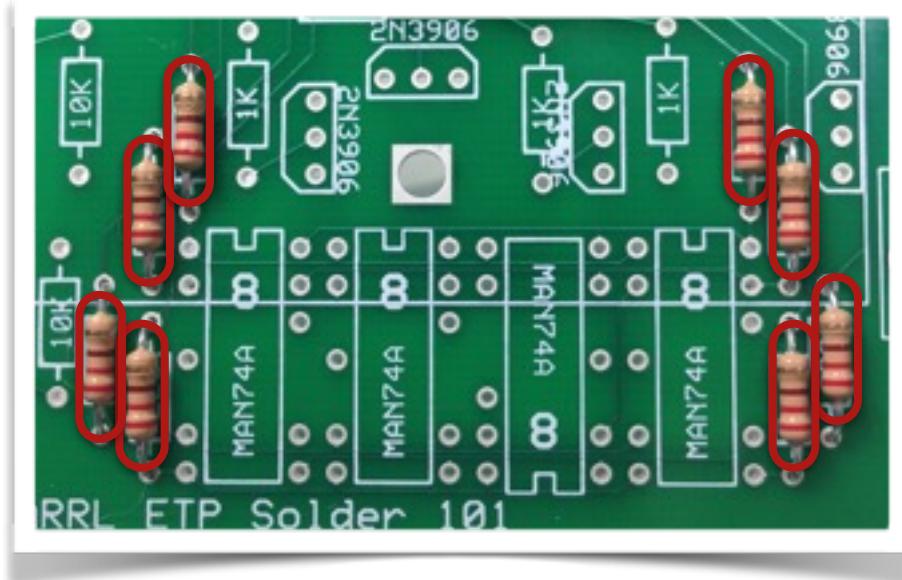
Hold the socket in place flush against the board and solder two opposite corner pins.



The socket should be flush against the circuit board. If it isn't, re-melt the solder on the pins you tacked while pressing down on the socket with your finger. When the socket is flush against the board, solder the remaining pins of the socket. You will install the integrated circuit itself later.

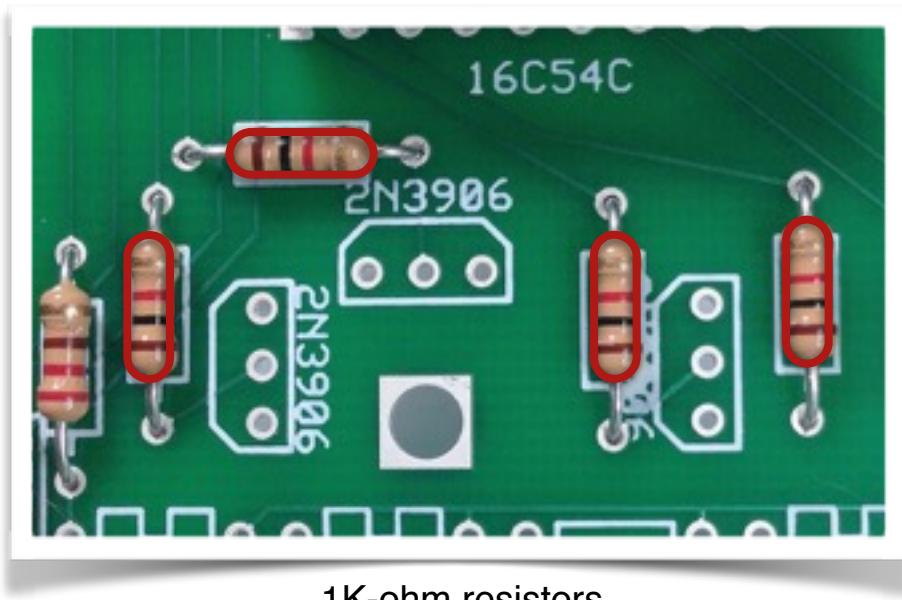
Current Limiting Resistor Installation

Install eight 220-ohm resistors (red-red-brn) at the indicated locations, flush against the circuit board. Solder and clip the excess leads.



220-ohm resistors

Install four 1K-ohm resistors (brn-blk-red) at the indicated locations, flush against the circuit board. Solder and clip the excess leads.



1K-ohm resistors

Install three 750-ohm resistors (vio-grn-brn) at the indicated locations, flush against the circuit board. Solder and clip the excess leads.



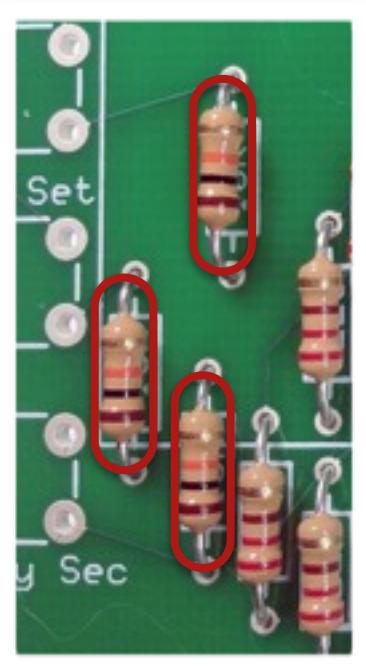
750-ohm resistors

Time-setting pushbutton switch installation

The time-setting pushbutton switches have four pins. Turn the switches so the pins stick out on the right and left of the switch and install them in the indicated locations. If you have to force the switches to get the pins into the circuit board mounting holes, you might have the switches oriented incorrectly.



Solder two pins at opposite corners of each switch and check that each switch is flush against the board. If not, re-melt the solder while applying pressure on the switch with your finger. Once each switch is flush, solder the remaining pins.



10K-ohm resistors

Display 7-Segment LED installation

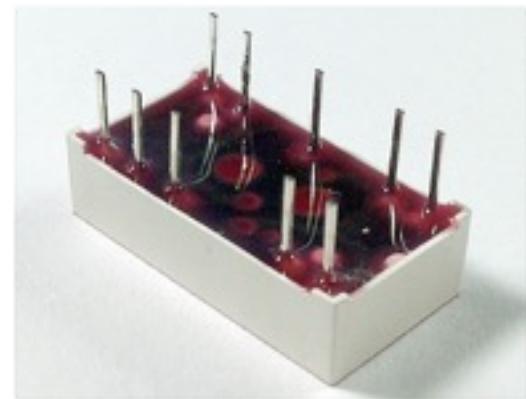
Locate the four 7-segment LEDs that make up the time display. The pins on the back of these LEDs are not arranged symmetrically — this helps you install the LEDs correctly. If you try to force the LEDs in the wrong direction, you can bend the pins and damage the LEDs.

Notice that the 10s-minute digit on the board is upside down. This allows the decimal point of that LED to function as the upper dot of the colon separating the hour and minute digits on the display. (Pretty clever, huh?)

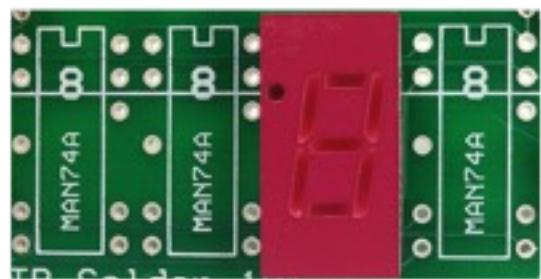
Install four 7-segment LEDs as indicated on the board (Remember, the third LED from the left is installed rotated 180° from the others!). Don't force the LED pins into the mounting holes.

Mount the LEDs by tack soldering opposite corner pins, as you did with the IC socket. Press on each LED as you heat the tacked pins to ensure the LEDs are flush with the board.

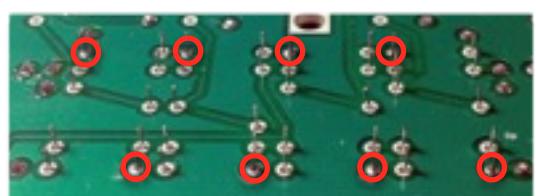
When all four LEDs are flush and straight, solder the remaining pins and trim the excess pin lengths.



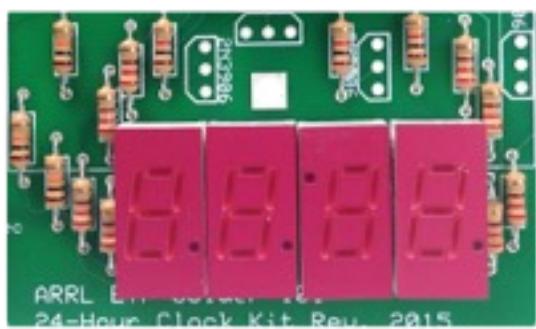
Pins on back of 7-segment LED.



LED display 10s-minute digit.



Tack-soldered LEDs



Four LEDs soldered in place.

Oscillator installation

Install the 4MHz crystal in the indicated position. The orientation of the crystal is not critical. Solder the crystal flush with the board and clip off excess leads.

Install the four 10pF capacitors in the indicated locations. Solder and clip off excess leads.



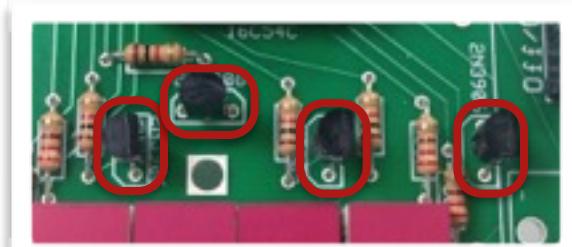
Crystal oscillator and loading capacitors

Switching transistor installation

Locate the four 2N3906 transistors. Notice that they have a flat side, and that the component outline also has a flat side. Install the transistors in the indicated locations so their flat sides face the same direction as the flat sides of the component outlines.

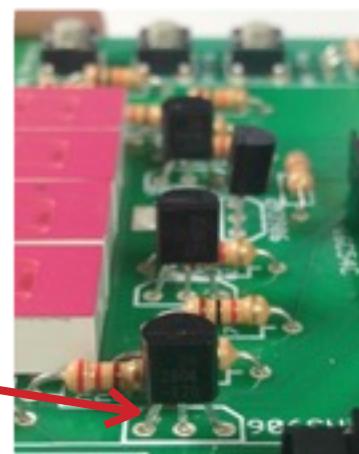
Carefully press down on the transistors until they are approximately 1/8-inch above the top of the circuit board.

Tack solder the center lead of each transistor, straighten the transistor, and solder the outer two leads. Solder and clip off excess leads.



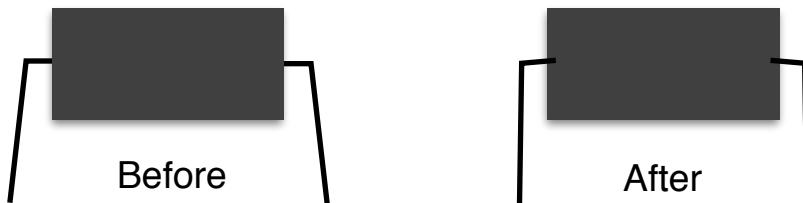
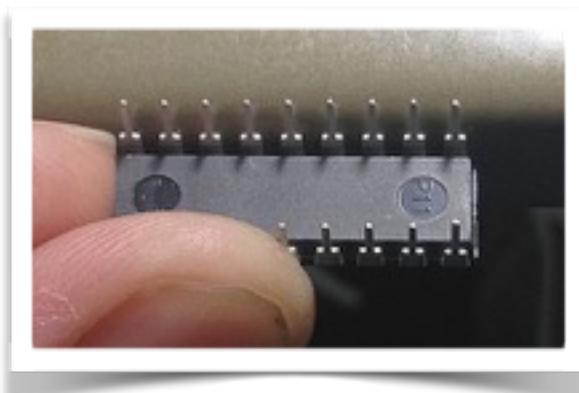
2N3906 switching transistor locations.

~1/8-inch
above top
of board



Microcontroller Installation

You will now install the PIC 16C54 microcontroller. To align the pins of the PIC with the holes in the socket, turn the PIC over and gently bend the pins on each side inward until they are at a 90° angle with the bottom of the PIC. (The edge of a table is a good flat surface to press the legs against.)



Bending PIC leads before insertion. (end view)

The notch on one end of the PIC indicates where pin 1 is located. The IC socket also has a notch at one end, as does the component outline on the board. When you insert the PIC into the socket, make sure the notches are all pointing in the same direction.



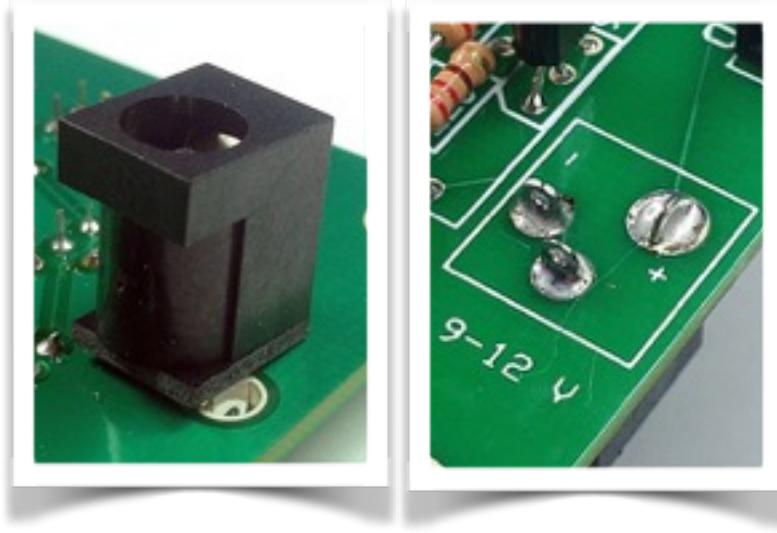
Carefully place the PIC in position and check the orientation of the pins relative to the socket. Once you are satisfied that the pins and socket line up, press with both thumbs to rock the PIC into the socket.



Once in place, inspect the PIC pins to ensure that none got bent or crimped under the IC or pushed outward away and to the side of the socket.

Power Connector Installation

Locate the power connector. The power connector is installed from the bottom, or **solder side of the board**. Install the connector and hold it in place against the work surface while you tack solder a single pin.



Check that the connector is flush against the circuit board surface. If necessary, re-melt the solder joint while applying light pressure to properly seat the connector. When it is flush, completely solder the other two pins.

You do not need to completely fill the mounting holes of the power connector, but be sure your solder wets both surfaces and forms a smooth, shiny joint. (This is a very common point of failure for circuit boards.)

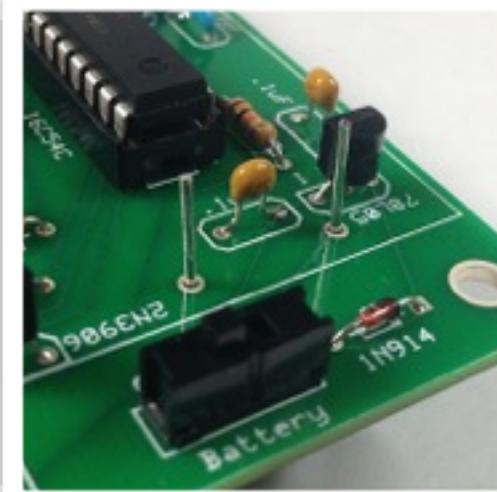
STOP HERE FOR DAY 1 - YOU WILL COMPLETE THE ASSEMBLY AFTER INSPECTION BY THE QUALITY CONTROL DEPARTMENT.

Back-Up Battery Holder installation

Carefully bend the two leads on the back of the battery holder out at a 90° angle, and install the battery holder **from the solder (bottom) side of the circuit board.**

Before you solder the battery holder leads, use the 2-56 screw and nut to fasten the battery holder to the back of the PCB. Do not over-tighten the nut, or you may damage the screw, battery holder, or both.

Solder and trim the battery holder leads **from the component (top) side of the board.**



Tests and operation

It's now time to fire-up your completed project. Install the wall wart barrel plug into the power connector on the back of the clock, then plug the wall wart into an outlet. The digits of your clock should illuminate and the center colon dots should blink at 1-second intervals.

Press and hold the hour-set switch to advance the hours digits. Release the switch at the desired hour. Likewise, press and hold the minute-set switch to set the correct minutes.

To see the seconds, press and hold the seconds display switch for as long as you want to see the seconds displayed. Once released, the time display returns to normal hours and minutes format.

Final Set-up and Operation

Disconnect the wall wart from the outlet and install 3-AA cells in the battery holder. **Install the batteries using the correct polarities, as indicated in the battery holder.** The clock should start operating on batteries, but the primary source of power is the wall wart. The display may be dimmer when operated off the back-up batteries.

Once you reconnect the wall wart to a wall outlet and set the proper time, your clock project is ready to enjoy and show off to your students and classroom visitors.

This completes construction of your 24-hour digital clock.



Wall wart must be center pin positive, with a 9-12 VDC output.

