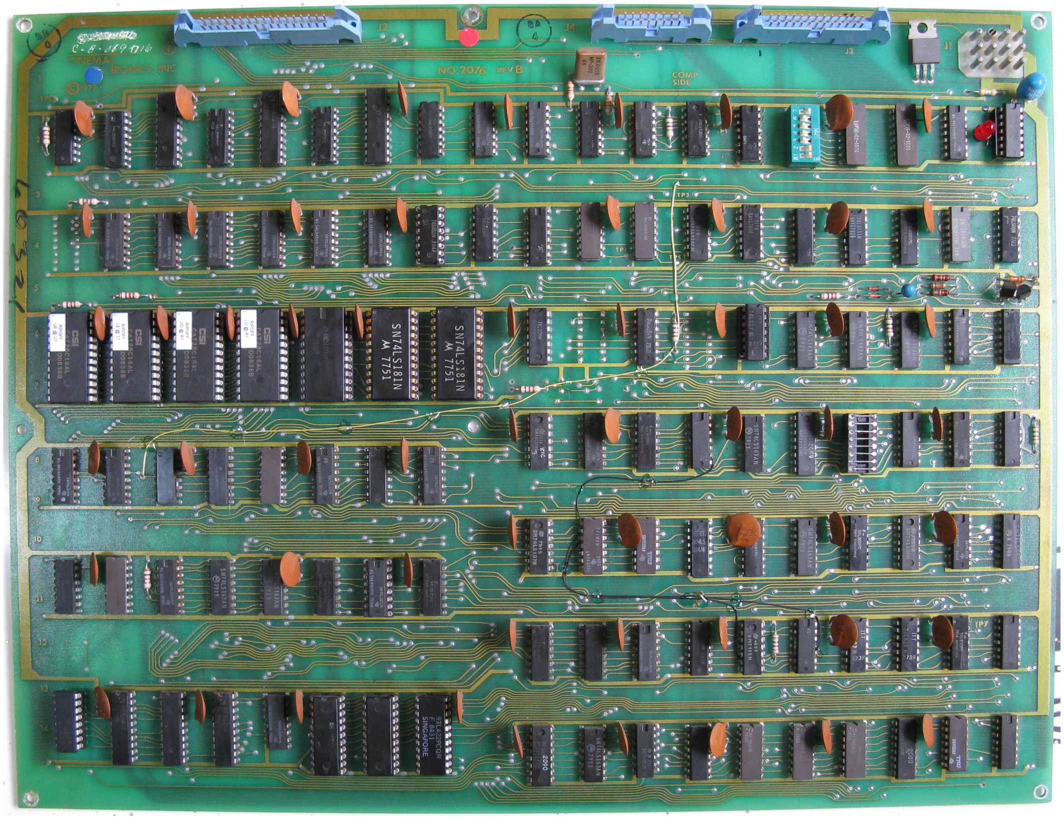
Cinematronics CPU Board Revision 'B' to 'K' Conversion

Introduction:

Cinematronics manufactured several arcade video games from 1977 through 1980 that were based on a specific CPU board that is typically referred to as the CCPU.



Revision 'B' CCPU board

Some Vectorbeam games also used a version of the board with a few subtle design differences. Unfortunately, Vectorbeam did not indicate the version number on their PCBs. They did have part numbers on them so a study of those might reveal if there were different ones used on different games. The typical Cinematronics CCPU boards were revisions 'B', 'H', and 'K' (latest).

Company	Game Title	CCPU Version	EPROMs
Vectorbeam	Space War	?, My 1979 Space War has the "reset LED" feature which would indicate a rev. H or K.	2 x 2716
Vectorbeam	Speed Freak	?	?
Vectorbeam	Star Hawk	?	?
Vectorbeam	Barrier	?	?
Cinematronics	Space Wars	B	2 x 2716
Cinematronics	Rip Off	B, K	4 x 2716
Cinematronics	Star Castle	K	4 x 2716
Cinematronics	Armor Attack	K	4 x 2732
Cinematronics	Solar Quest	K	4 x 2732

There were some differences in the copper trace design between the rev. 'B' and 'H' boards. I don't know what differences, if any, existed between 'H' and 'K'. I am not aware of any differences so I will only refer to 'B' and 'K' from this point forward. Some games will simply not run on a rev. 'B' board. I assume that any game that uses more than two of the 2716 (2kx8) EPROMs must be upgraded from rev. 'B' to 'K'. My experience is that the factory had released some games such as Rip Off that had rev. 'B' boards that had been upgraded at the factory, not 100%, but enough to allow the game to operate. The most common modification that was omitted when upgrading a rev. 'B' board was the "reset LED" circuit.

The following is a list of the factory changes that were made to a rev. 'B' board to allow it to run Rip Off. This would most likely also work for Star Castle.

Note 1	A 'flywire' is simply a jumper wire that was added to the top or bottom of the PCB to make a connection.
Note 2	Specific chips are located on the PCB using a column designated by a letter followed by a row designated by a number. A specific pin is indicated using a dot followed by a number. i.e.: A2.5 = column A, row 2, pin 5
Note 3	A 'via' is a solder-filled hole or plated-through hole in a PCB that connects a trace on the top with a trace on the bottom.
Note 4	A location on the schematic for a signal or component is indicated using sheet numbers 1 through 6 followed by row letter and column number. i.e.: sch 5A7 = schematic sheet 5, row A, column 7

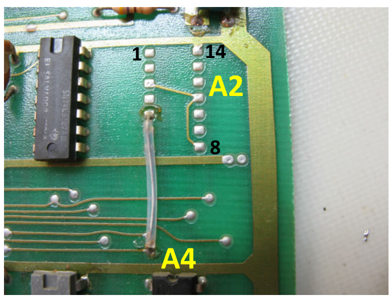
Rev. 'B' boards that were factory modified to run Rip Off have the following changes:

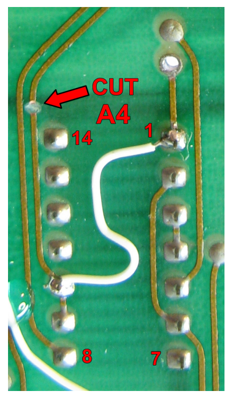
1. Top: A flywire was added from A2.5 to a trace via (just above and connected to A4.1).

2.

   a. A better way to make this connection:

      i. Bottom: Connect a flywire from A4.1 to A4.9 or A4.10.
      ii. Bottom: Cut the trace that connects A4.10 to A2.5. This trace cut is not required unless you are installing the "reset LED" circuit.

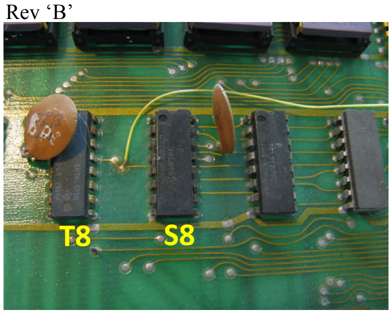




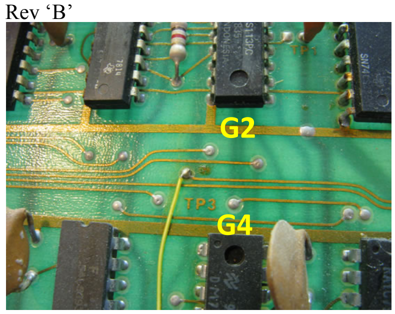
3. Top: From via near G4 (above text "TP3")(trace comes from A8.8 [74LS107, sch 5A7] and J4.10 and B6.9 [74LS04 sch5A7]) add flywire to via between S8 & T8 (trace on bottom runs up to T2.4 [sch 2D6])(trace on top runs right across to N9.15 [sch 3C7]). Adding this connection will hardwire the board for the "JMI" option.

   a. Note that on a rev. 'K' board, the "JMI" jumper exists in the same location where on rev. 'B' says "TP3".
   b. The flywire for this on a rev. 'B' board is long whereas the jumper on a rev. 'K' board is very short because a rev. 'K' board brings a new trace up to the jumper for this option.

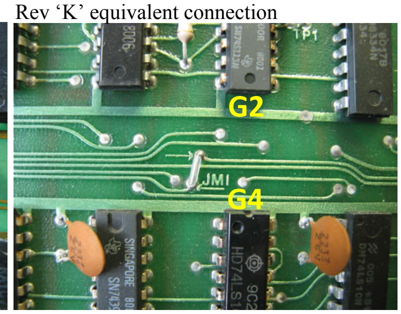
Rev 'B'



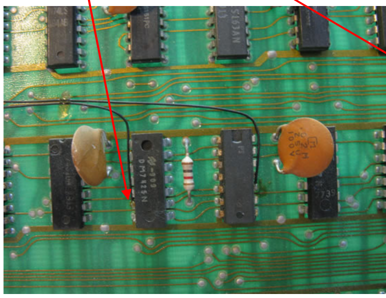
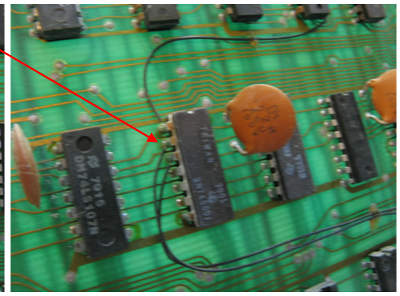
Rev 'B'



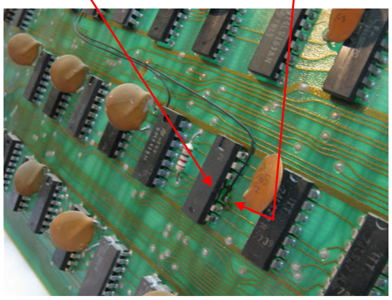
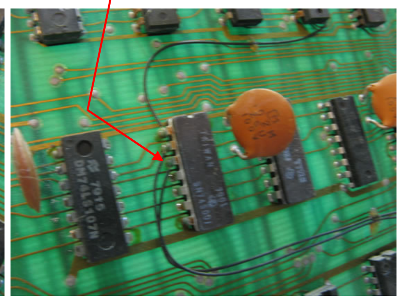
Rev 'K' equivalent connection



4. Top: A flywire connects F12.6 [7425] to I10.2 [74S00, sch 5C4]

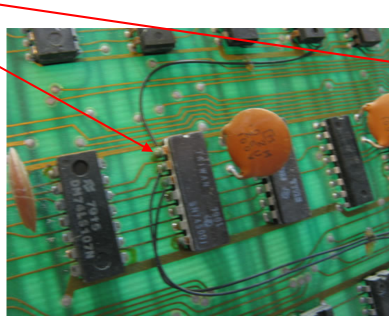
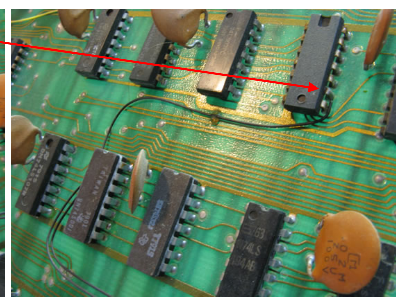



5. Top: E12.10 and E12.11 pins cut off. E12.10 pad has flywire to I10.3

The point here is to connect D10.6 to I10.3. The above flywire works because there's a trace from E12.10 pad to D10.6.

6. Top: I10.1 to G8.9 [74LS107 signal CLKI, sch 6C7]

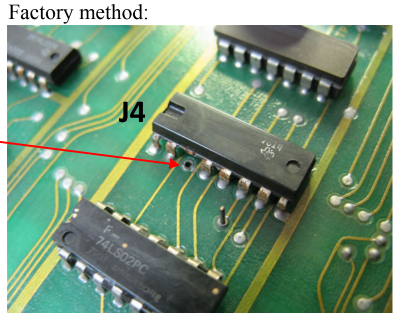



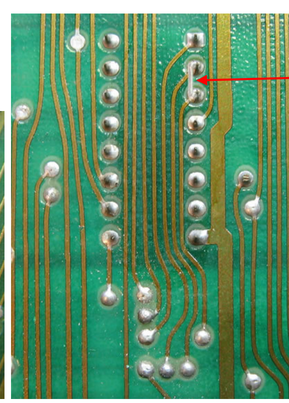
7. Connect J4.2 to EPROMs U7, R7, T7, P7 at pin 19 [signal CE(A10)] of all of them.

   a. Top: J4.3 [74265] pin cut off (Note: This refers to chip at J4, not the ribbon connector J4).
   b. Bottom: J4.2 flywire to pad of J4.3 (because J4.3 pin was removed).

Factory method:

J4.3



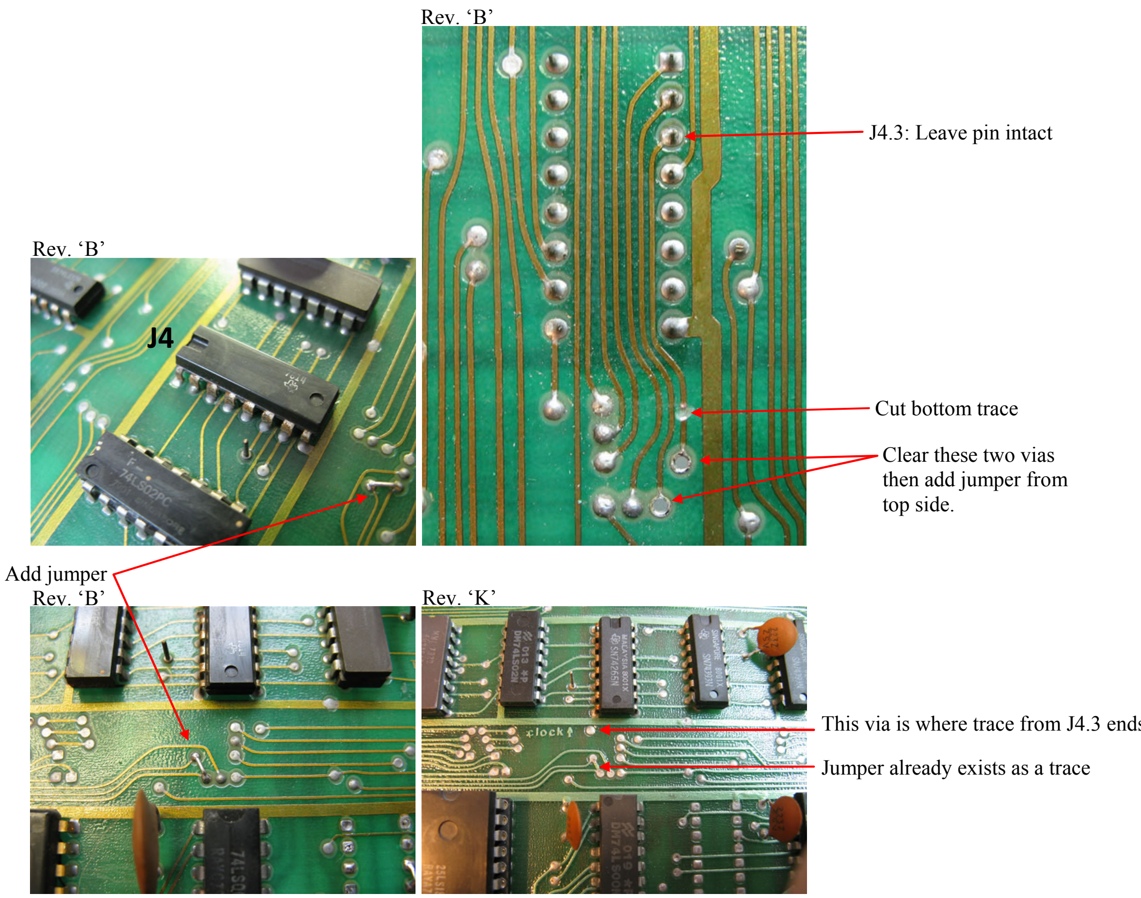


Jumper

c. A preferable alternative method is to leave the J4.3 pin intact and cut the trace on the bottom of the board after it leaves the J4.3 pin. This allows the use of a dip socket at J4 or to do the same thing without cutting off the chip pin. It is also the method used by the design of the rev. ‘K’ board.

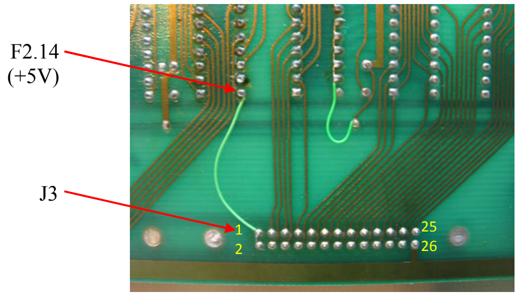
i. Cut trace on bottom between J4.3 pad and via.
ii. Leave chip pin 3 intact.
iii. Top side add 3mm jumper between two vias just above J6.

1. Note that rev. ‘K’ board has this jumper included as a trace and the trace on the bottom that comes from J4.3 ends at a via (has a break) before it gets to the jumpered vias so it’s already open.



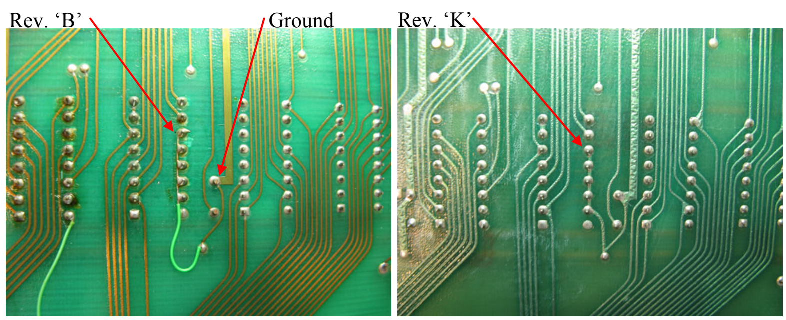
8. Bottom: Flywire from F2.14 (+5V) to J3.1 and J3.2.

    a. This connection brings +5V to the control panel port but Rip Off and Star Castle do not make use of it. It could be used as a +5V supply at the control panel if you wanted to add some sort of LED lighting.
    b. Technically, the control panel wiring drawings for Star Castle and Rip Off indicate that J3.1 is no connection and only J3.2 is +5V.

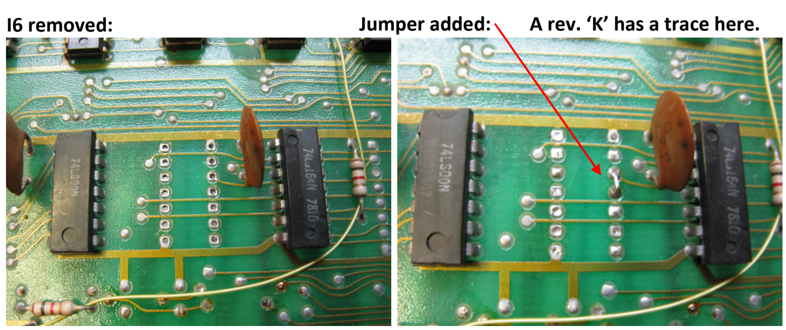


9. Bottom: The DIP switch block at E2 is missing some ground connections. A flywire is used to add a ground connection from a nearby via or decoupling capacitor to E2.2, E2.3, E2.4, E2.5, E2.6.

    a. Some boards have a switch block that contains only 7 switches, not 8, so pins 1 and 16 are left open and empty.



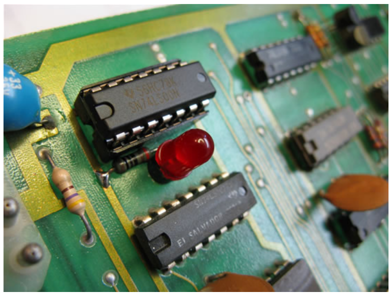
10. Optional: rev. 'K' boards do not populate I6 [74LS08]. This chip can be omitted because the rev. 'K' board has a trace that jumpers I6.11 to I6.12. On a rev. 'B' board, you can remove I6 and add a short jumper between these two pins. Doing so will eliminate one chip and the one gate that was in the circuit but not serving any useful purpose. Removing the chip will save a tiny amount of power and leave the board with one less chip that can fail in the future.



This completes the minimum requirements to upgrade a rev. 'B' board to rev. 'K'. The board will now run games such as Rip Off and Star Castle (games that use four 2716 EPROMs).

The "Reset LED":

Another major enhancement that was added to rev. 'K' boards is the "reset LED" circuit located at A2. The operation of the LED indicates immediately if and when the CCPU is operating normally. Obviously it is very handy to be able to simply look at the LED and know whether or not the game is running correctly. It's a great troubleshooting feature.


Reset LED added to rev. 'B' board

A rev. 'B' board has no chip located at A2. Adding one is easy but before you can do that, the A2 pads must be isolated from the traces. The routing of the traces at A2 is much different between rev. 'B' and 'K'. I once traced out the circuit (by following the traces) at A2 and it made no sense at all, as if it was even finished.

The proper operation of the reset LED is simple. Upon powerup, the LED turns on for about 1/2 second and then goes off and stays off. If the LED stays on or flickers, the CCPU board has a problem that requires service. If the LED never comes on at all at powerup, check the power supply voltage. If it is too low, the LED either won't light at all or it will just stay on because the CCPU isn't running properly or possibly at all.

The CCPU board only requires +5VDC to operate. It does not require any other power supply voltage and it does not require connections from the control panel nor the monitor to operate. In other words, you can connect only a +5VDC (up to 3A) benchtop power supply and just check the LED for proper operation to know if the game is operating correctly. This check is simple but extremely effective because the "reset LED" will indicate the vast majority of failures. Failures that will not be indicated include bad inputs (i.e. from the control panel and DIP switches) and bad outputs (i.e. to the monitor and sound board).

If your CCPU board "reset LED" is on solid or flashing, even briefly, your board requires service. Typical troubleshooting methods include (but are not limited to) the following repair procedures:

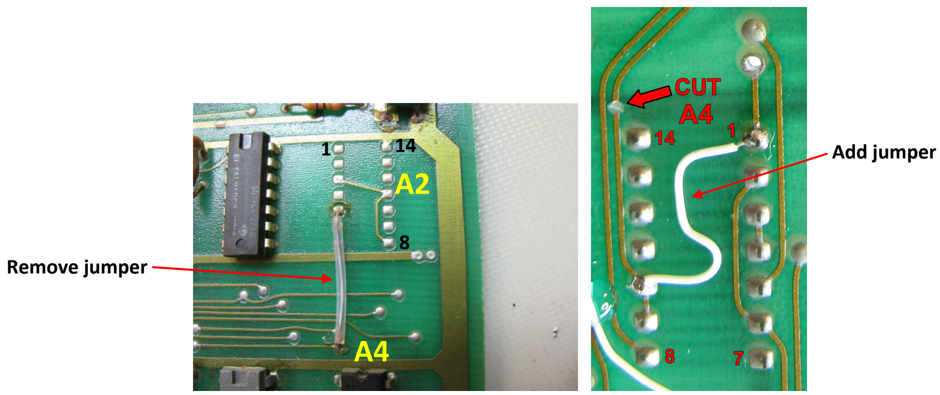
- Visual inspection for opens and shorts due to scratches, foreign materials on the PCB, etc.
- Visual inspection for improperly inserted chips such as bent pins, backwards chips, broken resistors or capacitors, etc.
- Checking for excessive current draw, an abnormally hot chip, etc.
- Verification of the EPROM chips.
- Automated testing of the SRAM chips.
- Use of signature analysis, digital analyzer, oscilloscope, etc. to track down failed chips.

Installing the “Reset LED” on a rev. ‘B’ board:

To add the “reset LED” to a rev. ‘B’ board, perform the following steps:

1. If not done in the previous section, then

    a. Top: At A2 remove the factory jumper wire that connects A2.5 to a trace via that is near and connected to A4.1.
    b. Bottom: Add a new flywire from A4.1 to A4.9.
    c. Bottom: Cut the trace between A2.5 and A4.10 to isolate the A2.5 pad for later use with the “reset LED”.



2. Clear all holes at A2 of solder.

3. Cut several traces near A2 pads to isolate them. One original trace from A2.1 to A2.4 can be left intact. After all the pads at A2 are isolated, they can be wired for the new "reset LED" circuit.

    a. Bottom:
        i. Cut 1 trace at A2.4 (the one going to A2.6, not the one that goes to A2.1).
        ii. Cut 1 trace at A2.5
        iii. Cut 1 trace at A2.6
        iv. Cut 2 traces at A2.9
        v. Cut 2 traces at A2.10
        vi. Cut 1 trace at A2.12
        vii. Cut 1 trace at A2.13

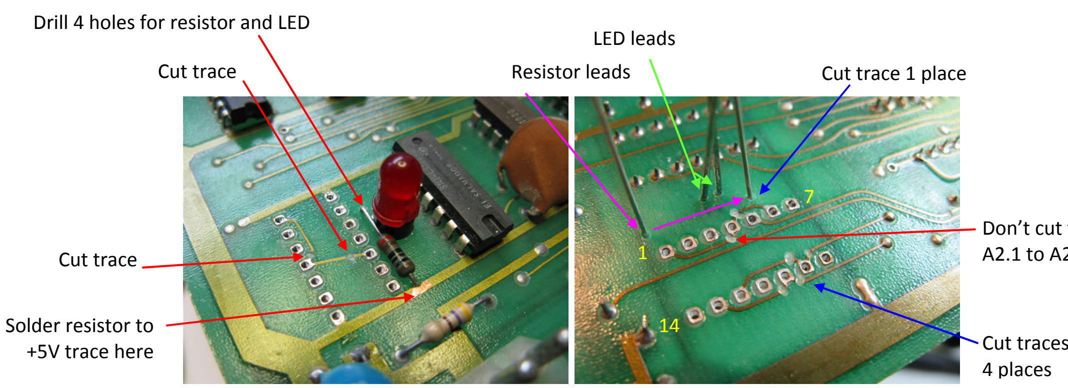
    b. Top:
        i. Cut 1 trace at A2.3
        ii. Cut 1 trace at A2.8
        iii. Cut 2 traces at A2.11

4. Using a dremel and a small bit, drill two new holes (diameter 0.031" to 0.041") to support a standard T1-3/4 (5mm) red LED between A2 and B2. The LED will be inserted into these holes. The two new holes should be positioned 0.1" apart and 0.20" left of A2.3 and A2.4.

5. As above, drill two new holes (spaced 0.4") for the new 100 ohm resistor between A2 and B2. The resistor will lie between the A2 chip socket and the new LED. Drill the first hole for the resistor precisely on the edge of the +5V trace that runs just above A2. The second hole should be 0.4" down from the first one and land about 0.1" left of the A2.5 pad.

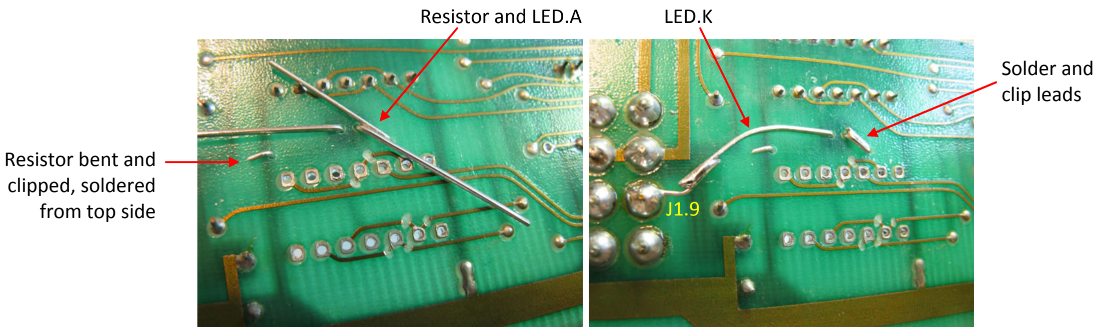
6. Install the resistor into its new holes. Solder one lead of the resistor on the top side to the +5V trace. You will have to scrape a small area of solder mask off of the trace before soldering to it.

7. Install the LED into its holes such that the cathode is facing upwards toward the main power connector.



8. Next you will bend the resistor and LED leads over 90° to form the following connections.

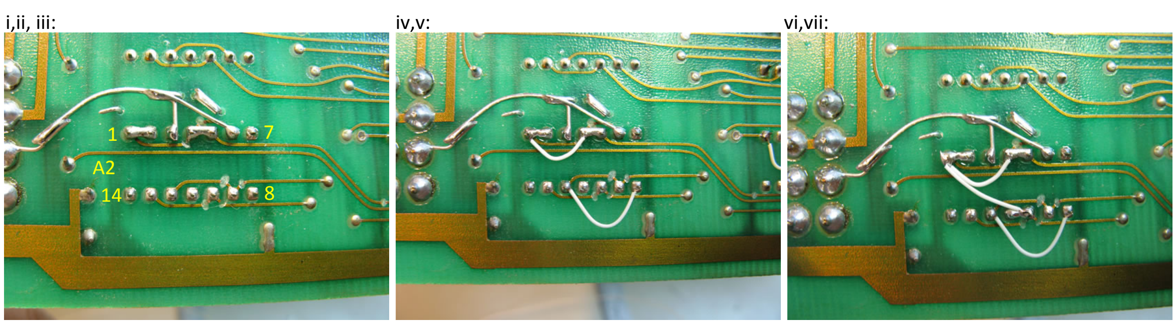
   a. Bottom: Bend the LED.K (cathode) up and solder to J1.9. Add a short length of fine gauge solid wire if necessary to reach the pad at J1.9.
   b. Bottom: Bend the other resistor lead to LED.A (anode) and solder.



9. Install a new DIP14 socket into A2 and solder.

10. Bottom: Add flywires as follows:

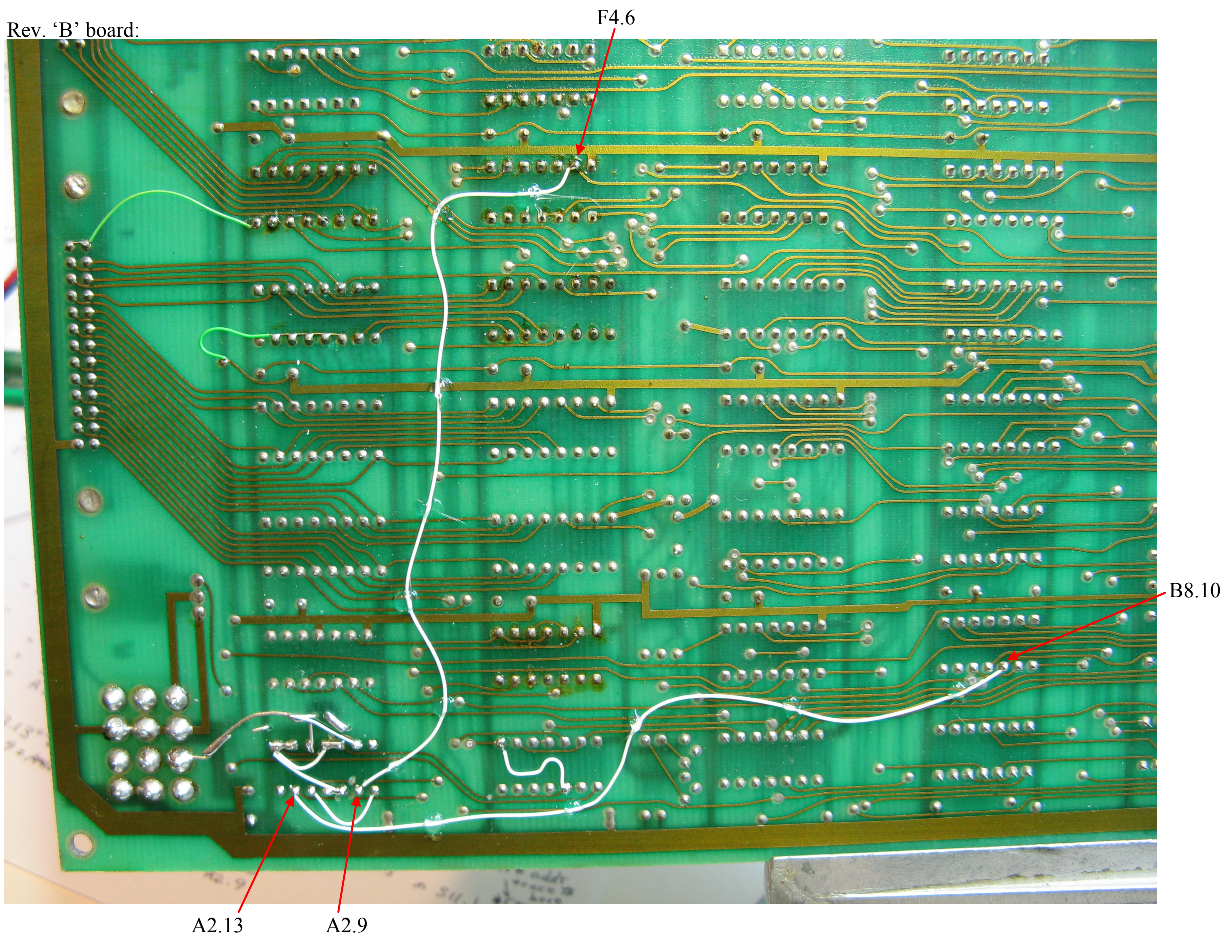
    i. LED.K to A2.3 and A2.6
    ii. A2.1 to A2.2
    iii. A2.4 to A2.5
    iv. If you accidentally previously cut the trace A2.1 to A2.4, add a new flywire to make this connection.
    v. A2.8 to A2.12
    vi. A2.10 to A2.11
    vii. A2.11 to A2.1



11. Add the following flywires to the bottom of the PCB to connect the new "reset LED" circuit to the source signals.

    a. B8.10 [74LS107, signal /RESET] to A2.13 [74LS00]
    b. F4.6 [signal /PROCEED] to A2.9

Rev. 'B' board:



12. Install a new 74LS00 [quad NAND gate] into the new socket at A2.

13. Secure all of the longer flywires to the PCB using small dabs of hotmelt glue.

This completes the installation of the "reset LED" circuit.