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NOTE TO THE BUILDER

The FENCODER manuals are open to revision based on your needs. If you have suggestions for improvement or clarification, please write or call.

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Introduction

You'll find assembling your own FENCODER is a satisfying and economical experience and will appreciate being in charge of quality control of an instrument you want to be reliable. Your kit has been checked for completeness, and all critical components have been tested.

The unit is easy to assemble. High quality machined socket pins have been furnished for the integrated circuits (IC). These socket pins are provided to reduce the possibility of overheating the integrated circuits if you haven't totally mastered the soldering technique. If you're an old pro and want the utmost reliability, you **may** consider omitting the socket pins for all ICs except the 27256 EPROM and the 80C451 CPU (identified later) if you have the necessary skill and are willing to put up with the extra hassle to replace an IC that goes belly up during burn-in. With the quality of socket pins used, however, we feel that the socket pins should be used without concern.

The four most important hints for a top quality FENCODER:

1. **PAY SPECIAL ATTENTION TO SOLDERING TECHNIQUE.**
2. Observe static control procedures to the letter.
3. Take your time a few extra hours will help insure a top quality instrument.
4. Follow the instructions exactly. Call or write for any clarifications if something goes wrong let it be our fault. We have made every effort to insure accuracy so don't omit any parts called for and don't install parts not called for.

Additional important hints:

- **$** Make any corrections as noted in the CURRENT NOTES sheet packed with the kit.
- **$** Scan the **entire** Assembly Manual before starting work on the kit.
- **$** Before starting on the first step, read all previous directions.
- **$** Follow the assembly instructions exactly; **don't jump steps**. Some techniques in later parts of the assembly rely on instructions previously given.
- **$** **Read the entire step before doing it** clarification or cautions may come after the description of the step.
- **$** **Don't use just the drawings for assembly** necessary detail might be in the text.
- **$** Double-check component identification before installing the component and before soldering it in.
- **$** Figure on putting in about 15-20 hours for assembly, calibration and testing. But please don't hurry.
- **$** **Watch your eyes when cutting off component leads!** Either wear protective glasses or place a finger on the lead being cut.
- **$** When using the battery charger for testing and calibration, be **CAREFUL** double check all power and transducer connections and take extra care that the power leads from the battery charger aren't allowed to make contact with other leads or the case. The heavy currents available from the charger can wreak havoc with the FENCODER components.

Tools and Materials

The only tools you'll need are found on any electronics work bench -- long-nose and diagonal cutting pliers, Phillips-head & slotted screw driver, and soldering equipment.

Your solder iron must have a 700-800EF element and a **small**, preferably new, iron-clad screwdriver tip. Do not use an iron with a large tip. If you look at one of the PC boards in the kit you will see that the soldering pads are close together. Ideally, the width of the tip should be 1/16" or less wide, which is just about the size of the smaller soldering pads on the PC board. If you use a larger tip you may re-melt adjacent soldered joints or part of the tip will burn off the green solder mask around the solder pads. We prefer the 700EF tip when using the solder provided. If you don't have one, both Weller and Ungar make reasonable cost temperature controlled soldering irons. If you don't see any future use for such a solder iron, find a friend with one that you can borrow. A 25 watt pencil type solder iron is approximately equal to a 700EF controlled temperature iron.

> Weller's model WLC100 is a low-cost solder station with adjustable temperature, iron holder and tip cleaning sponge. Online pricing runs $30 to $50. It comes with ST3 tip (.12 inch wide), and we would prefer you get an additional ST6 tip (.03 wide for $5) for this project.
>
> Radio Shack carries a number of solder irons. Their #64-2184 is a switch able 20/40 watt solder station with holder and sponge for $22.

The solder included in this kit is 60% tin and 40% lead and contains rosin flux. After an assembly is completely soldered, the flux **MUST** be thoroughly cleaned from the board or it can cause eventual corrosion. There should be about five feet of solder left after the three PC boards are complete. If your current solder iron tip is in bad shape, replace the tip before starting. Be sure to pay extra attention to soldering techniques explained later.

You'll need a VOM (voltmeter) during the calibration portion of the assembly to adjust the LCD contrast voltage and the reference voltage. Most any reliable VOM is OK, but if a 3 1/2 or 4 1/2 digit hand-held unit can be borrowed for a few hours, it will simplify the calibration. The ohmmeter might come in handy for double-checking the value of a resistor if the colors are hard to interpret or your bifocals are a little out of date.

You'll also need:

- $ #0 or #1 Phillips-head screwdriver
- $ .050 inch Allen wrench
- $ needle-nose pliers
- $ RTV cement (silicone seal)
- $ quick-set epoxy
- $ Xacto knife, razor blade or sharp utility knife
- $ 12 volt battery charger as power supply during testing
- $ thermometer to at least 65EC/150EF for burn-in testing
- $ 4 inch diagonal cutters (preferably with flush cutting edge)
- $ cellulose sponge for cleaning soldering iron tip
- $ 3" x 8" (or larger) heavy glass for socket pin installation (or similar flat, non-heat conducting material
- $ smooth-jaw vise for press-nut installation (Figure 7)
- $ 409, Fantastik or similar spray household cleaner
- $ Lacquer thinner (medium or fast dry) or denatured alcohol solvent for flux removal (lacquer thinner is best)
- $ Standard ring/spade terminal crimp tool and wire stripper to crimp tubing clamps.

Packaging

As the assembly instructions progress, small drawings will help select parts from the packaging. It's recommended that you leave the parts packages intact until you need the part in the assembly. There are a few very small parts that might be lost. **DO NOT** remove the integrated circuits or the completed display driver PC board assembly from their protective packaging until you've read the next section on handling CMOS integrated circuits and have completed the antistatic workstation described in a later section.

Packages:

1. Integrated circuits stored in antistatic rails and packed in an antistatic bag.
2. Integrated circuits packed in black antistatic box.
3. Display PC Board assembly packed in an antistatic bag.
4. PC Boards.
5. Package of altitude and airspeed sensors with special data sheets.
6. Bag of switches.
7. Bag of socket pins.
8. Bag of hardware and fasteners.
9. Bag of tubing, wire and plastic parts for aircraft installation.
10. Two sort pads with electronic parts for PC Boards.
11. Bag of miscellaneous electronic parts and matched resistors for PC Boards.
12. Package of faceplate & display components.
13. Sheet metal parts.

The sort pads contain most of the small electronic parts. Each sort pad is labeled with information that will speed identification of the parts and indicate the location that the part will be installed. The designator number (i.e. R14 or C11) indicates the part type and the location where it will be installed. These parts are **usually** in the order that they will be installed. Parts are grouped with like parts (i.e. resistors, capacitors etc.).

The column of information next to the component on the sort pad is a guide of colors (explained later) or numbers **(the marked value)** to positively identify each part. The assembly instructions will also repeat this marking to prevent mixing up parts. To save time later, now is a good time to go through the sort pads (after reading the color code chart in Figure 16) and make sure each part is marked with the proper code or marking. Although we take pains to eliminate any packaging errors, it is your responsibility to not trust us, and double-check that the proper part is installed in the proper place.

CAUTION: The two resistors R33 and R34 are matched with each other, as are R35 and R36. These resistors are packaged separately in pairs. Although the values are the same for each pair it is imperative that these parts not be interchanged. Only specialized lab equipment could put the pairs back together.

In addition to the part marking that is called out in the instructions, there will probably be other marks on the part. These represent lot numbers, dates, etc. A few parts are not marked and will have to be identified by description. The marking called out may also be preceded or followed by other numbers or letters. You may have to search all sides of some parts for the marks, as there is no pattern in their placement.

Handling ICs

Almost all the integrated circuits in the FENCODER are CMOS circuits that are vulnerable to static electricity, particularly when they are not yet installed in the circuit. A static discharge that can not be felt can zap or ruin a part or lead to later failure. Do not open the carrier packages or handle the IC's until you are ready to install them, and then follow the assembly/installation instructions exactly. A **prime** cause of integrated circuit failure is due to static discharge damage. An IC exposed to a static discharge does not necessarily die at that instant. It may weaken the circuit for eventual failure however.

Definitions

The following are some terms that will be used throughout this assembly manual:

PC Board - Printed circuit board, the flat, green boards with a million holes to solder components in. There are three of them in the FENCODER (one is already assembled). These boards eliminate the rat's nest of wires that were necessary years ago.

Component Side - The side of the PC board that the components are installed. This side is marked with white lines and numbers (designators) to help locate and identify the proper location for the components.

Solder Side - The opposite side from the component side of a PC board. This is the side where the component leads will be soldered.

IC - Integrated circuit. An electronic circuit that contains more than one and sometimes thousands of components shrunk down to microchip size.

EPROM - Electrically-programmable read only memory. This is the integrated circuit that has been programmed with the software, or program that the microprocessor will follow to operate the FENCODER.

Designator - This is the symbol (i.e. U3, R21, C45 etc) and white outline on the PC board that helps locate the proper part in the proper place on the board.

Trimpot - A variable resistor with a screwdriver adjustment.

Soldering Tips

NOTE: This section is very important for both first time kit builders and old pros. Analysis of service records over a three year period show that of all the kits returned for repair, over 90% are due to soldering errors. All of those solder errors are missed or incomplete joints... many of which are easily seen by the naked eye. Soldering of electronic components to printed circuit boards is not a difficult task. This section is a mini-course in how to solder and what good and bad solder joints look like. The next section will deal with how to clean and INSPECT the PC boards for bad solder joints after the soldering is complete.

Soldering materials, tools, techniques and inspection could make the difference between bringing your FENCODER up at the first shot, spending hours in troubleshooting, or even shipping a printed circuit board back for repair.

Soldering of electronic components is not difficult to master. Most soldering mistakes are due to incomplete joints (which may not cause a problem until 6 months later!).

Use a small soldering iron with a 700-800EF element and a iron-clad (no copper), screwdriver tip. For best results, use only the rosin-core solder provided with the kit. **NEVER** use acid-core solder.

The solder included in this kit has a core of rosin flux. All fluxes are corrosive. Rosin flux is corrosive when it's hot, and that is when it does it's work. Hot rosin cleans metallic oxides from the joint, which enables the molecules of the solder to intermix with those of the work. When the rosin cools, its corrosive properties diminish to **almost** nothing. When the assembly is finished, it is **imperative** that the flux be thoroughly

cleaned from the PC board and joints to prevent future damage. Removal of the flux is also necessary for inspection of the joints.

While the rosin flux removes oxides during soldering, it will not remove body oils from handling. The PC boards must be cleaned before starting assembly. Also, before starting and as necessary during assembly, wash your hands to reduce body oils that can contaminate the leads of the components or the PC boards. Instructions for pre-assembly cleaning of the PC boards are in a later section.

SOLDERING - With a 700EF (apx. 25 watt) solder iron, touch the tip of the iron with light pressure to make good heat contact to **both** the component lead and the PC board solder pad for three seconds (on the solder side of the PC board), then apply the solder to the **lead and pad** (not the iron) until about 3/16 inch (small pad... more on larger pads) of the solder melts (about 1-2 seconds) and flows down the lead and into the hole and spreads out on the pad. Leave the iron in contact with the joint for another second. Don't force-feed the solder, it should melt on contact or the joint is not getting enough heat. For components with larger leads such as switches, pre-heat 3 to 5 seconds longer before applying solder.

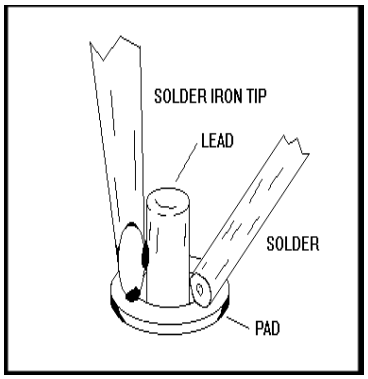

Figure 1 Soldering a component to the PC board.

If it is the first solder joint of a series, it helps to brush the tip of the hot iron across a wet sponge (cellulose type!) to clean the tip by generating a bit of steam, and then put a small drop of solder to the tip to help make thermal contact with the component lead when the tip is applied. If you see oxides starting to build up on the tip of the iron or the heat of the iron is not getting transferred to the pad and component lead during the first three seconds, clean the tip with the sponge and apply another small drop of solder. You should be able to do about 10 to 20 joints in a series before having to clean the tip again. You can't overkill on cleaning the tip, it just adds a little more time.

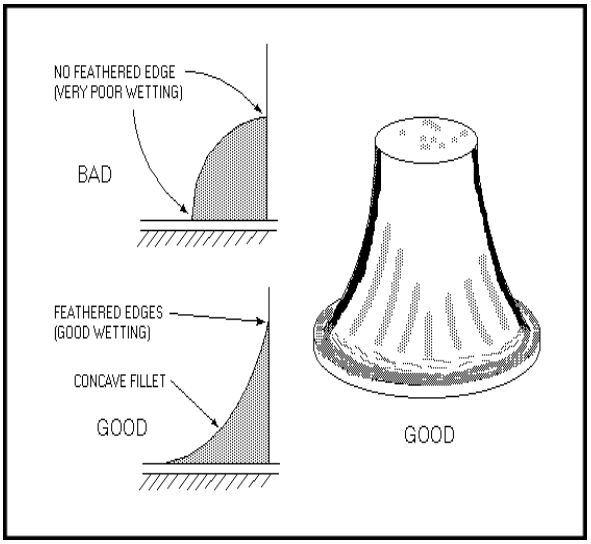

Figure 2 Good wetting is the sign of a proper solder joint.

GOOD SOLDER JOINTS - A good solder joint will look like Figure 2. It should have a shiny, smooth appearance and exhibit wetting as exemplified by a concave meniscus between the pad and the lead. A feathered edge is created by the solder to the part being joined. An appearance of adhesion of the solder to the parts is exhibited. A comparison with the poor solder joint in the figure shows a non-wetting condition that result in the solder forming a ball or bead on the surface, much as water beads form on a well waxed surface. Note there is no feathered edge apparent.

Figure 3 shows two acceptable solder joints. The less than ideal solder joint on the right, although starting to form a ball, still has proper wetting at both the solder pad and the component lead. Note that the solder has not extended outside the diameter of the solder pad.

With the proper amount of heat and solder, some solder should wick through the PC board hole so that there is a fillet and wetting between the solder pad and the lead on the component side of the PC board. Too much solder going through the hole to the component side can cause a **short circuit** to another component lead or pad. Too little solder will leave the pad on the component side of the board flat and if you look carefully, you can probably see part of the hole in the pad. As long as the joint on the solder side of the board is a smooth

fillet, you can still see the outline of the solder pad, and **some solder has wicked through to the other side**, the joint will be OK.

BAD SOLDER JOINTS - In Figure 4, the solder line of solder joint number 1 does not completely cover the solder pad. However, 80% of the pad is covered and wetting is complete and well feathered to both the solder pad and the component lead. Solder joint number 2 is acceptable but marginal. Solder is recessed into the hole about 25%, but again extends 360E around the lead and wets at least 80% of the solder pad.

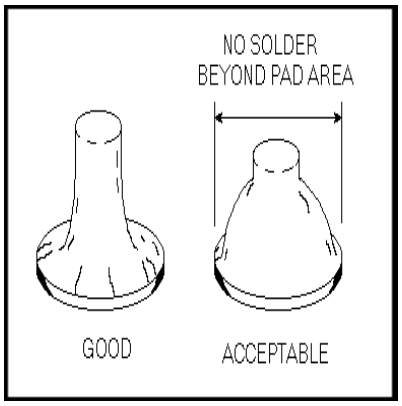

Figure 3 Acceptable solder joints.

Three samples of poor solder joints are shown in Figure 5. Solder joint number 1 has less than 80% of solder wetting to the solder pad (actually, 0% in this drawing). The solder in joint number 2 does not completely encircle the component lead and wets only a small part of the solder pad. Solder joint number 3 shows the component side (opposite from where we're soldering) has only a small blob of solder extending through the PC board hole, and no wetting to either the top of the solder pad or the lead.

Component leads on switches and other large parts will need more heat so preheat longer and linger longer (wow) or use an optional 800F element. These joints will also require more solder.

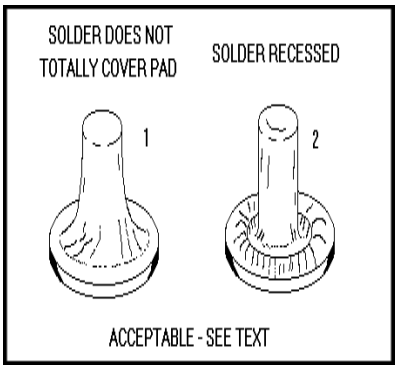

Figure 4 Two more acceptable, but less ideal solder joints.

INSPECTION - After a PC board assembly is completed and cleaned, **close** visual inspection of solder joints using the above criteria is vital. Examination should be done with at least a five power loupe or magnifying glass. Resolder any rejects, clean the board again and inspect. If you are diligent in following the routine of clean, inspect and repair, you will eliminate the cause of most failures.

If you must remove a soldered-on component, it is worthwhile to invest a few dollars in a solder sucker to remove the solder from the hole so the component can be easily removed. Be careful not to overheat or over stress pads and ruin your board. A DIP or SIP component is harder to remove and a solder sucker is a must. If you're unsure, get some help rather than ruin your board. If the DIP or SIP component is being removed because it is bad, carefully clip all the leads on the component side of the board and then remove the leads one at a time. Once the component is removed, carefully clean out the hole with a 1/32 drill **(no larger)** in a hand chuck.

Examination of returned units indicates that most people are not preheating the joint enough before applying the solder (or applying the solder so fast the joint cools) resulting in a joint that looks more like a blob than a fillet. This leaves a poor joint with the pad and wire lead and little if any of the solder wicks through to the other side. This usually happens when you get bored soldering all those leads and start speeding up. The joints look OK while you're zipping along but are not getting enough heat or solder. Keep a slow rhythm using the method described above.

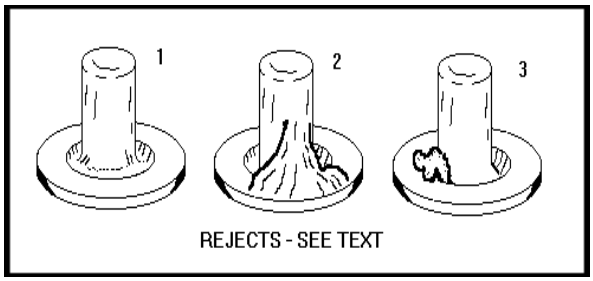

Figure 5 Three samples of rejects.

Remember these hints and you should complete your FENCODER with a perfect soldering job.

Cleaning and Checking the PC Boards

When the soldering is completed on an assembly, the flux must be removed. This is an important step that must not be hurried. When properly cleaned, the PC board will be as clean looking as when you removed it from the package, with no flux visible on the joints even when viewed with a strong magnifying glass.

Use either medium or fast-dry lacquer thinner or commercial flux remover (Radio Shack sells in spray cans) for a cleaner. Lacquer thinner is actually better than the commercial flux remover. Check the label to make sure that there are no oils added that would leave a film after the solvent evaporates. A half-pint of cleaner (two cans of RS spray) should handle all three boards, but don't skimp. If you have a kitchen sprayer that you can sacrifice, it works nicely to apply the lacquer thinner. Observe proper ventilation for the cleaner used. Do not allow the cleaner to remain on the assembly for more than two minutes. Also discontinue cleaning if the solvent appears to be attacking the green solder mask or the epoxy silkscreen on the PC board.

Hold the PC board at about a 45 degree angle with the solder side up. Spray (or slowly pour) the solvent so that it runs across and off the board. This solvent will dissolve the flux and carry it off the board. If you hold the board flat, the flux just gets diluted and then is still there when the solvent evaporates. Then hold the assembly vertical and spray rinse with additional cleaner so the cleaner carries off the dissolved flux. Immediately dry the board with compressed air. Repeat until the solder side of the assembly is free from flux. Rinse the component side of the assembly and blow dry. Do a final rinse of both sides of the assembly and blow dry. You will have to alternately blow one side and then the other to evaporate any cleaner that is pushed to the other side of the board through the holes in the board. Make sure to blow under all components and inside all the little socket pins. If you do not have access to an air compressor, a hand-held hair drier will have to be substituted.

Do not quit until the PC board is thoroughly clean. If you are going to take more than two weeks to build the kit, you should clean the flux from each assembly as it is completed.

Use a good light and magnifying glass to thoroughly check all the solder connections. In addition to the criteria listed in the section on soldering look for solder bridges (unintentional connection of two adjacent solder connections) and any component lead not soldered at all. If necessary, repair any bridges, solder any missed connections or solder any suspicious looking joints and clean as necessary.

Because of the green solder mask that is applied to all the PC boards, it is almost impossible to have a solder bridge unless there is a big gob of solder. Don't use anything other than the hot solder iron tip to try to remove a suspected bridge or you may end up cutting a trace connection that is supposed to be there.

With a light source behind you, hold the board as if the solder side were a mirror and reflect the light back into your eyes. Solder joints that are properly done will seem to blend into the rest of the board because the fillet reflects light to the sides. Solder joints that are not soldered, or lacking solder will really show up as shiny spots, as the flat pad acts like a mirror.

Installing Components on a PC Board

Since both hands will be busy soldering, you will need to hold the PC board with something else. There will be a component sticking out one side of the board and the component leads sticking out the other side. One way that works easily, is to use a small cardboard box or plastic parts tray to set the assembly on when installing and soldering components. When installing the components, the component leads will go down inside or outside the walls of the box. Or be creative.

Double check all component locations on the PC board before soldering them in place, it's no fun taking them back out. Some designator symbols may be hard to read because they are printed on a thru hole of the PC board. Use the assembly drawing to resolve any ambiguities. With some exceptions, all the numbered

symbols increase in value in columns that proceed from bottom to top and then to the right. Additional tear-out assembly drawings are in Appendix C.

Vias are holes through the PC boards that join a trace on one side with a trace on the other side. Vias are smaller than holes that accept component leads. If a via accidentally gets filled with solder, just leave it.

Bend the component leads so that the **value** marking on the component is visible after installation. This will make it easier to detect incorrect locations and troubleshooting.

If you can get the component to stay in place with friction when you turn the PC board over for soldering, it will be much easier to get out if it's ever necessary to remove it. Otherwise, spread the leads slightly to keep the component in place.

Pay careful attention to legends and symbols printed on the PC board that indicate orientation of diodes and capacitors. Match the band on one end of diodes with the band on the PC board. Match the + lead of electrolytic capacitors with the + on the PC board. We normally design the PC boards so that the + on electrolytic capacitors, the bands on diodes and the number 1 pin or front of integrated circuits all face the same direction.

Additional hints will be given as the assembly progresses.

CAUTION: Be careful when clipping off component leads, wear eye protection or put your finger on the lead that you are cutting.

There are two PC board assemblies and, except for the hardware and soldering of the socket pins and other connectors, each board will be completed separately. The order of assembly is as follows:

1. Build anti-static workstation.

2. Install press-fit hardware on A/D PC board.

3. Clean PC boards before soldering.

4. Install socket pins and connectors on A/D and CPU boards. This will give you maximum practice with your soldering technique with parts that are relatively indestructible. Inspect work.

5. Assemble the A/D board. Observe antistatic procedures when installing sensitive components. Inspect work.

6. Assemble the CPU board. Observe antistatic procedures when installing sensitive components. Inspect work.

7. Clean flux from boards. Check and repair all soldering and clean again if necessary.

8. Join A/D and CPU PC boards while observing antistatic procedures.

9. Install integrated circuits in sockets while observing antistatic procedures.

10. Faceplate assembly.

11. Assemble complete unit. Perform initial test of FENCODER.

12. High temperature operational burn-in for reliability.

Make Corrections to Assembly Manual

Occasionally there are corrections, clarifications or additions to the FENCODER manuals which will be listed on a separate correction sheet contained in the kit.

__ 1. Make corrections to all manuals per the corrections sheet. Either cut and paste the corrections in the proper place or make a note at the proper place in the manual to refer to the corrections sheet when that step in the manual is reached.

Building an Antistatic Workstation

As discussed earlier, many of the solid state components are susceptible to static damage. A simple antistatic workstation made from household and shop materials will reduce any static damage potential to acceptable levels.

When you walk across an insulating surface or shift your position on the insulating seat of your chair your body becomes charged. That is, the voltage potential of your body with respect to ground changes. You are actually converting mechanical energy into electrical energy, and the electrical energy is stored in your body capacitance. Potentials on the order of 5,000 volts, which is more than enough to damage an IC, are commonplace.

The lower the humidity is, the more the danger of generating damaging static charges. If the humidity level is 50% or more, static handling problems are greatly reduced. So if you're working in one of those dry areas in the middle of winter, take utmost care when the assembly manual says to use antistatic procedures.

It also helps to avoid wool and synthetic clothing 100% cotton is the best to avoid static buildups.

The components that are susceptible to static damage in this kit have all been packaged in conductive antistatic materials. They are the CMOS integrated circuits and some transistors. As much as possible, those items will be installed last so that you won't have to worry about static problems while installing all the little resistors, capacitors etc.

Figure 6 shows the layout of a homemade antistatic station. The purpose of the station is to keep your body, the assembly you're working on and the tools all at the same voltage potential. Normally the conductive work plate is made from a material that will carry off any static charge while at the same time allowing working PC boards to lay on them without shorting anything out. Since operating boards won't be laid on the plate an aluminum sheet or layers of foil can be used.

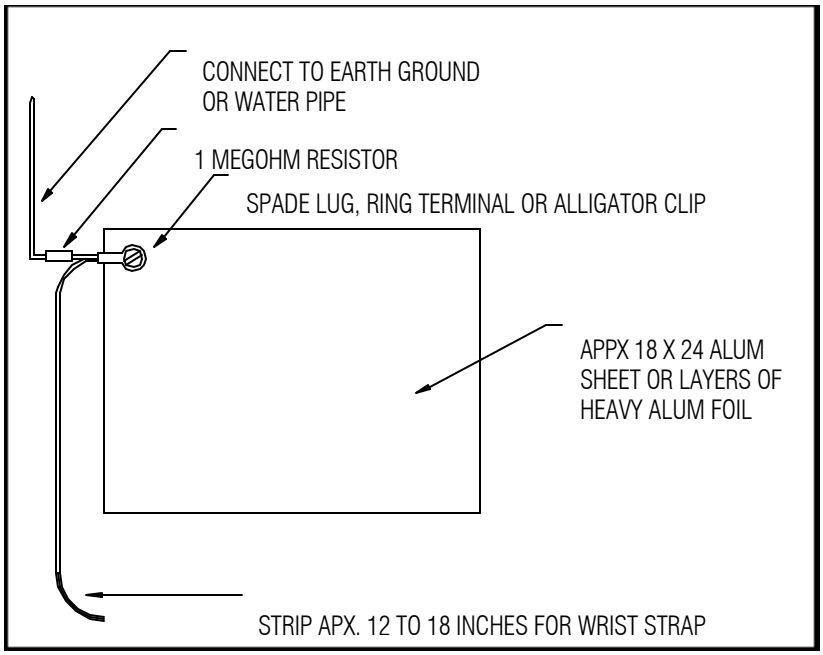

Figure 6 Antistatic station layout.

__ 1. Locate the 1 megohm resistor marked STATIC/BRBKGN from the sort pad and solder a

length of shop wire to one end. Make the wire long enough to reach a ground point from your work location. The ground point on a three plug socket will work OK. The 1 megohm resistor is small enough to carry away static charges and large enough to protect you from shock. Wire size is not important.

__ 2. Cut another length of 16 or 18 gage (large enough to stand some flexing) stranded wire that will connect the ground plate with your wrist. Make it long enough to give some freedom of movement. Strip about a foot of insulation off one end. This will be wrapped around your wrist when antistatic procedures are necessary.

__ 3. Strip the opposite end of the wrist strap wire as necessary and connect it and the unsoldered end of the resistor to a connector that will attach to the ground plate.

__ 4. Connect as shown in Figure 6.

When using the antistatic workstation, wrap the bare wire loosely around your wrist and keep tools, solder iron, parts, your body and the assembly in contact with the ground plate at all times. If you get up and come back always touch the ground plate or wrist strap first to discharge your body before handling any components.

Install PC Board Press Nuts

____1. Locate the A/D PC board marked 2035 after the copyright notice. Locate the four #4-40 press nuts and install one at a time from **the solder side** (see page 4) into the four large holes in the PC board until the lip is flush to the board. The press nut must be square to the hole during installation and there must be a smooth, hard backup at least .5 inch in diameter from the component side of the PC board. Use a shop press or drill press if you have one. Otherwise the press nuts can be installed using a vise with **smooth** jaws or smooth pieces of metal between the jaws. Another alternative is to use a pop rivet gun.

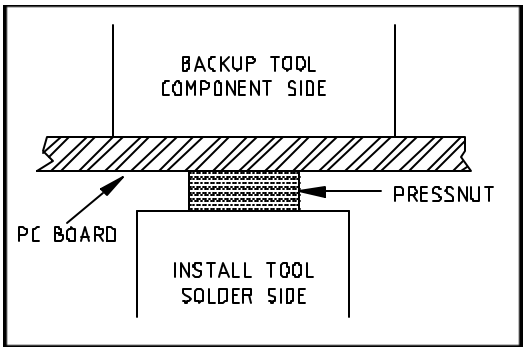

Figure 7 Installing press nut.

Cleaning the PC Boards before Assembly

During soldering, the flux in the solder acts as a cleaner for both the part and the soldering pad on the PC board. Soldering will be easier, however, if any existing oils on the boards due to handling etc. are removed.

Spray a household cleaner similar to 409 to both sides of the two large PC boards and scrub with a brush. Rinse with plenty of HOT water and thoroughly dry with compressed air or a hair drier. After drying, and during all subsequent handling, keep your hands as clean as possible and handle the PC boards by the edges as much as possible to reduce body oils getting on solder locations before the parts are soldered.

The display driver PC board that is factory assembled and packed in an anti-static bag does not need to be cleaned.

Install Socket Pins

Continuous strip machined socket pins are provided for all IC devices in DIP packages. This is to protect the devices from soldering heat, and to facilitate troubleshooting and repair. Socket pins may or may not be gold plated in the contact area. Recent findings have indicated that gold plated sockets for integrated circuits have no benefit over tin plated sockets unless the leads of the IC's are also gold plated.

Each group of socket pins is installed on the board at a "U" location. "U" is the component designator for integrated circuit.

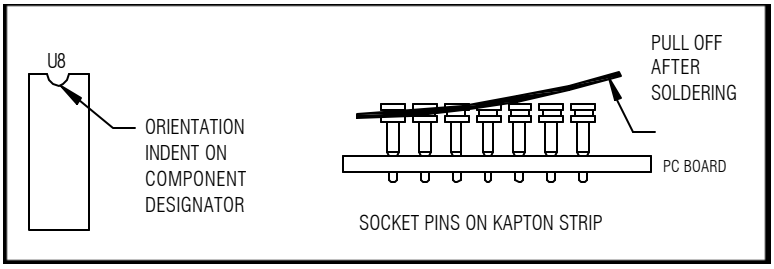

Figure 8 Component designator identification and socket pin installation.

The indentation on the designator orients the integrated circuit that will be installed in the socket pins later in the assembly. In each of the following steps, two strips of sockets pins will be cut to size and installed at each integrated circuit location. Use small diagonal cutters or scissors to cut the plastic strip leaving the proper number of pins. The plastic will be removed after the socket pins are soldered.

__ 1. Lay the A/D PC board marked 2035 on a flat surface with designators up.

__ 2. Cut 16 strips of 4 socket pins each and insert at eight 8 pin DIP positions.
(U8,U10,U12,U14,U15,U16,U17,U18)

__ 3. Cut 2 strips of 7 socket pins each and insert at the 14 pin DIP position.
(U6)

__ 4. Cut 6 strips of 8 socket pins each and insert at three 16 pin DIP positions.
(U7,U9,U13)

__ 5. Cut 2 strips of 9 socket pins each and insert at the 18 pin DIP position.
(U20)

Lay a flat, hard sheet of material (preferably glass, a poor heat conductor that does not melt easily) across the top of the socket pins, then carefully turn the PC board over, using the material to keep the socket pins in place. A heavy piece of flat glass or a thinner piece of glass on a hard surface works best. Lay the glass-socket-board sandwich on a flat surface with the PC board now lying on the upside-down socket pins. If the PC board is warped, it helps to weight the board down with a hand tool or other weight so all socket pins are **flush to the PC board**.

When soldering the socket pin strips, do about every fourth pin on all the socket strips, turn the board over to see how it's going (**vertical and flush**) and then flip back over and finish the remainder. If your solder iron has a little flat spot, you can lightly push down on the end of the socket pin to apply heat. Otherwise, gently touch the solder pad and the socket pin at the same time, press lightly down to hold the pin vertical and apply solder to the socket pin. If you leave the socket pin sticking up in the air on the component side of the PC board instead of flush, the pin will be more likely to break off at the small diameter.

If a socket pin needs to be straightened, be sure to heat the solder first or the pin may break.

__ 6. Solder every fourth pin, flip the board over and check that all the socket pins are vertical and flush to the PC board. If not, reheat the solder joints while pressing down on the socket pin (with something other than a bare finger) and adjust your technique.

__ 7. Solder all the remaining socket pin leads.

__ 8. Grab a corner of each plastic strip with needle nose pliers and pull the strip from the socket pins. If any of the socket pins are not in line or are not flush, reheat the solder for that individual pin and repair.

__ 9. Lay the CPU PC board marked 2036 on a flat surface in the same manner as the A/D board so that socket pins can be installed.

NOTE: Socket pins are **NOT** used at U23, U26, U27 and U30.

__ 10. Cut 8 strips of 4 socket pins each and insert at four 8 pin DIP positions. (U21,U32,U33,U35)

__ 11. Cut 6 strips of 7 socket pins each and insert at three 14 pin DIP positions. (U25,U28,U29)

__ 12. Cut 6 strips of 8 socket pins each and insert at three 16 pin DIP positions. (U22,U24,U34)

__ 13. Cut 2 strips of 10 socket pins each and insert at the 20 pin DIP position. (U31)

__ 14. Invert the PC board and solder the sockets the same as the A/D PC board. Inspect.

__ 15. Locate and install two test pin clips on the A/D PC board. They look like a very small cotter pin with a colored plastic sleeve around the shaft. One goes into the hole marked AGND to the right of U14 and the other goes into the hole marked 4.0000V just below R23. Be careful to not confuse the AGND hole with the one in the W3 outline.

Install Misc. Sockets

Continue with the CPU PC board.

__ 1. Locate the small header and install at J1 (J3 not used) observing that orientation of the header matches the white designator pattern on the PC board. Solder one pin, turn the board over and make sure the header is straight and flush to the PC board. The solder may be melted again to straighten the part. Solder the other pin.

__ 2. Locate the code switch socket and install at J2 making sure the socket is flush to the PC board.

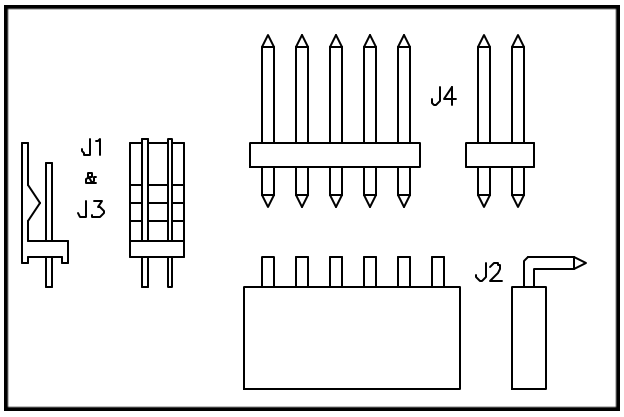

Figure 9 CPU board sockets.

__ 3. Locate the display cable header and install at J4 with the short pins through the PC board.

__ 4. Locate the large, square, 68 pin microprocessor socket and install at U23 observing important orientation. Use Figure 25 and the white designator outline to make **certain** that the **inside** beveled corner matches the figure and designator. The diamond on the inside of the socket should also

match the Pin 1 diamond on the designator. Solder two opposite pins, check that the socket is flush and solder the remainder. The small pins on the socket allow solder to travel easily to the other side of the board. Don't apply so much solder that a solder blob on the other side of the board can short between two pins.

__ 5. Locate the 28 pin adapter socket marked AAries@ with a rams head on it. Be careful not to confuse this with the socket in the next instruction. This socket changes the holes for a wide 28 pin IC to allow a 28 pin narrow IC to be installed. Identify the front of the socket by a half-moon cut-out at one end of the plastic. Carefully remove the cardboard that is keeping all the leads spaced correctly. Install at U27 with the half-moon on the socket matching the half-moon designator on the PC board.

__ 6. Locate the 28 pin socket. It looks like the socket pins with a black plastic frame. Identify the front of the socket by a half-moon in the cross rail or a square notch where pin #1 is (just above and left of U26 on board). Cut this front cross rail out so the **CUT 512 & JMP 512** designators will be accessible for possible future software upgrades. Install at U26.

This completes the hardware and socket installation for the A/D and CPU PC boards.

Audio Transducer Assembly

__ 1. Locate the red and white Teflon hookup wires with terminals attached (approximately 2.25 inches long). Strip about ¼ inch of insulation off the end opposite the terminal. Tin the stripped ends with a small amount of solder.

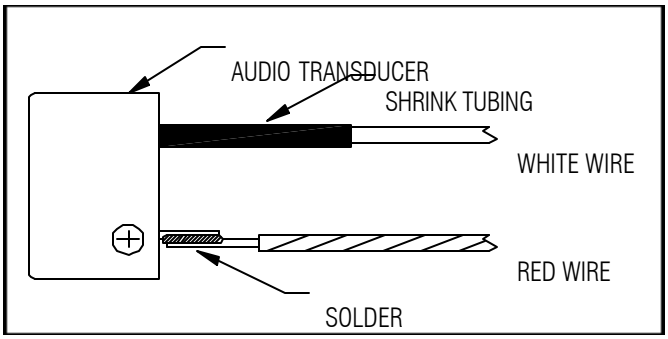

Figure 10 Audio transducer assembly. Note wire polarity.

__ 2. Locate the 3/32 inch heat shrink tubing (smaller diameter of the two sizes) and cut two pieces **2** inch long. Slip one on each wire. The shrink tubing will cover the solder connections to the pin terminals of the audio transducer that will be made next.

__ 3. Identify the plus terminal on the audio transducer - marked QMX-12. Hold the transducer lightly in a small vise or other tool. Lay the tinned end of the red wire alongside the plus terminal as shown in **Error! Reference source not found.**. Pick up a fresh solder blob on the iron and solder the **red** wire to the **plus** terminal of the transducer.

__ 4. Solder the white wire to the other terminal.

__ 5. Inspect the joints. Clean the joints with a little solvent and a rag or paper towel.

__ 6. Slip the shrink tubing up the wire and over the solder joint until it touches the back of the transducer. Hold the tip of the solder iron NEAR and under the tubing until it fits snug.

__ 7. Twist the two wires with twists about every **3** inch.

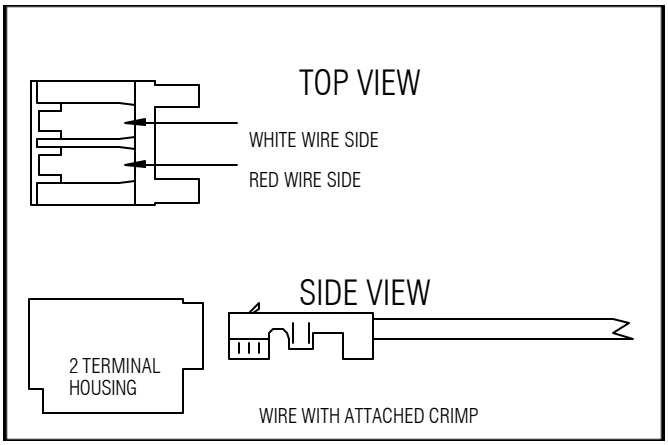

Figure 11 Audio wire housing detail.

__ 8. Locate the small white terminal housing and insert the two crimp terminals on the ends of the wires into it as shown in Figure 11. Study the figure to make sure you understand the alignment of the terminal to the housing in regard to the little barb on the top of the terminal. The terminals should go in until the little barb on the top of the terminal clicks into place.

__ 9. Remove the faceplate components from their package and carefully store the display, gaskets, fiber-optic backlight etc., so the audio transducer can be attached to the faceplate.

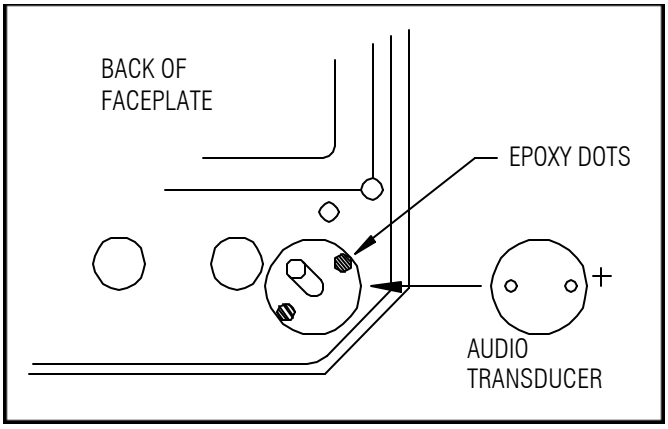

Figure 12 Attaching the audio transducer to the back of the faceplate.

__ 10. Use Figure 12 as a guide to install the black cylinder-shaped audio transducer, being sure to observe the orientation of the plus terminal (red wire). Remove the "REMOVE AFTER WASHING" label if present. Two SMALL drops of quick-set epoxy are applied to the slight recess area as shown in the figure. The surface of the audio transducer which will join the epoxy should be slightly roughened. The epoxy amount should be just enough to hold the part firmly. If the audio transducer should ever fail it would need to be broken off to install a replacement so don't overdo the epoxy. The epoxy must also not enter the hole in the center of the recess that allows the sound to go out the front of the faceplate. (Read the next step for more epoxy use).

__ 11. For additional strength, add some epoxy about 1/8 inch deep and around the two leads on the back of the audio transducer.

__ 12. Lay the faceplate assembly aside to let the epoxy set. Brace the transducer or hold it down with some weight so that it stays flush.

Sensor Assembly

Before starting to solder components to the A/D PC board, the altitude and airspeed sensors will be assembled to their tubing (Figure 13). Before starting, check to be sure that the serial numbers scratched on top the sensors match the enclosed Sensor Table sheets (airspeed has two barbs and altitude has one). Notify Rocky Mountain Instrument if there is a mismatch.

__ 1. Locate the clear plastic tubing and cut four pieces: 3.2", 2.4", 1.2" and 1.1".

CUT GUIDE
3.2
2.4
1.2
1.1

__ 2. Boil about one cup of water, remove from heat and throw the four cut pieces of tubing into the hot water to soften for about 5 minutes while reading the next step.

__ 3. Locate and remove the altitude sensor from its package. It is the sensor with only one barb connection. Install the 1.2" tubing to the altitude sensor. You may use a little spit or lightly soaped water for lubrication but is usually not necessary. Get a good grip on both the sensor (watch the leads) and the tubing and slip the tubing over the barb until the end of the tubing is touching or almost touching the sensor body. It helps to do it all at once. DO NOT clamp the sensor in a vise or any other tool... only hands count!

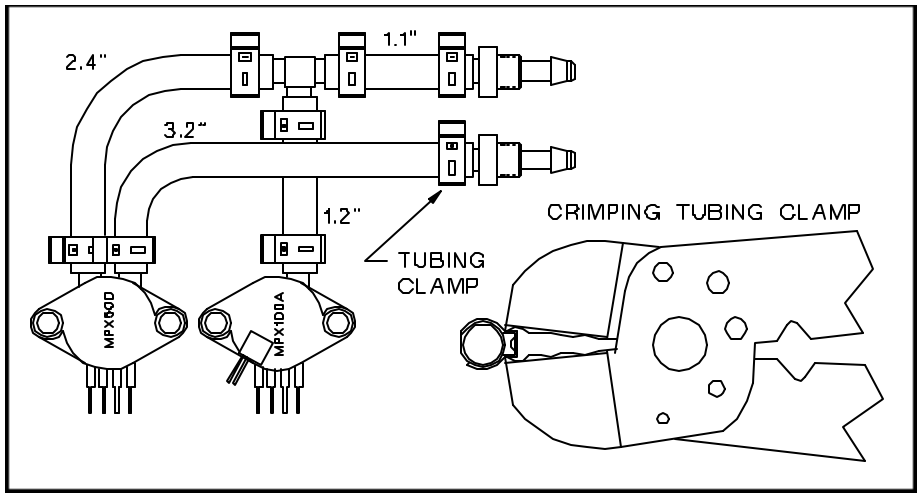

Figure 13 Airspeed sensor (left) and altitude sensor (right) assembly. Note the position of the threads on the brass bulkhead fittings. Crimp tubing clamps with a standard wire crimper –stripper as shown.

__ 4. Locate the airspeed sensor with the two barbs and install the 3.2" and 2.4" tubing. Note the marking on the sensor and use Figure 13 to identify which length tubing goes on which barb.

__ 5. Locate three of eight metal tubing clamps and, one at a time, slip over the tubes just installed to the sensors until the clamp is centered over the largest diameter of the barbs protruding from the sensors. Crimp the tubing clamp closed using the nose of a standard ring/spade crimp and wire stripping tool as shown in Figure 13.

__ 6. Slip three of the remaining five tubing clamps over the three tubes just attached. Make sure they don't fall off during further assembly.

__ 7. Locate one of the two brass bulkhead fittings. Install to the 3.2" tubing that is attached to the airspeed sensor. Make sure that the threaded ends of the bulkhead fittings are away from the assembly as they have to be inserted through a hole in the chassis later. These fittings will also need some lubricant. Slip the loose tubing clamp to position it over the largest diameter of the barb of the bulkhead fitting and crimp.

__ 8. Install the remaining bulkhead fitting to the 1.1" tube (watch thread position). Position a tubing clamp over the largest diameter of the bulkhead fitting and crimp. Slip the last tubing clamp over the tube and make sure it doesn't fall off in further assembly.

__ 9. Locate and install the tubing tee as shown in Figure 13. Position the three previously installed tubing clamps over the largest diameter of the barbs and crimp.

Set the assembly aside for later.

A/D PC Board Bill of Materials

A bill of materials (parts) list will be given for each PC board assembly. "ITEM" is the component designator that is used in the schematic and on the PC board to locate the part. "RMI#" is the Rocky Mountain Instrument part number if a replacement is needed. "Manufacturer" and "Mfg Part Number" is additional information that would enable part replacement from other than RMI. It will also contain the quantity used for some parts.

Item	RMI#	Description	Manufacturer	Mfg Part Number
RESISTORS				
R8	RBQ7711	7.71K .1% QW 25ppm	PRP	GP1/4
R9	RBQ1762	17.6K .1% QW 50ppm	Various	RN55C1762B
R10	RJQ103	10K 5% QW	"	
R11	RJQ562	5.6K 5% QW	"	
R11A	RJQ471	470ohm 5% QW	"	
R12	RJQ562	5.6K 5% QW	"	
R13	RFQ2002	20.0K 1% QW	Mepco	RN55D2002F
R14	RDQ3122	31.2K .1% QW 50ppm	Various	RN55C3122B
R15	RFQ2002	20.0K 1% QW	Mepco	RN55D2002F
R16	RJQ103	10K 5% QW	Various	
R17	RJQ392	3.9K 5% QW	"	
R18	RFQ1002	10.0K 1% QW	Mepco	RN55D1002F
R19	RJQ224	220k 5% QW	"	
R20	RFQ6981	6.98K 1% QW	"	RN55D6981F
R21	RBQ1004	1.00M .1% QW 25ppm	PRP	GP1/2
R22	RBQ7711	7.71K .1% QW 25ppm	"	GP1/4
R23	RJQ393	39K 5% QW	Mepco	
R24	RTT104S	100K CERMET TRIMPOT	"	RJ26FW104
R25	RBQ1022	10.2K .1% QW	"	RN55C1022B
R26	RBQ2551	2.55K .1% QW	"	RN55C2551B
R27	RFQ1211	1.21K 1% QW	"	RN55D1211F
R27A	RFQ1003	100K 1% QW	"	RN55D1003F
R28	RFQ1432	14.3K 1% QW	"	RN55D1432F
R29	RFQ4991	4.99K 1% QW	"	RN55D4991F
R30	RFQ4991	4.99K 1% QW	"	RN55D4991F
R31	RFQ4991	4.99K 1% QW	"	RN55D4991F
R32	RFQ4021	4.02K 1% QW	"	RN55D4021F
R33	RMP011	1.00K MP .01% TT 2ppm R34	PRP	RMI MP1-1
R34	RMP012	24.3K MP .01% TT 2ppm R33	"	RMI MP1-2
R35	RMP011	1.00K MP .01% TT 2ppm R36	"	RMI MP2-1
R36	RMP012	24.3K MP .01% TT 2ppm R35	"	RMI MP2-2
CAPACITORS				
C4	1721	10uFD 25v TANTALUM	Sprague	199D106X9025CA1
C5	1705	.001uFD MONO CERAMIC	Mepco	CN15C102K
C6	1724	.0047uFD 50v POLYPROP	Digikey	P-3472
C7	1726	82pFD MONO CERAMIC	Mepco	CN15C820K
C8	1725	30pFD MONO CERAMIC	"	CN15C300K
C9	1707	.1uFD MONO CERAMIC	"	CW20C104K
C10	1707	.1uFD MONO CERAMIC	"	CW20C104K
C11	1707	.1uFD MONO CERAMIC	"	CW20C104K
C12	1716	22uFD 25v ELECTROLYTIC	Sprague	199D226X9025DA1
C13	1717	33uFD 16v ELECTROLYTIC	"	199D336X9016DA1

C15	1721	10uFD 25v TANTALUM	Sprague	199D106X9025CA1
C16	1728	.0022uFD MONO CERAMIC	Mepco	CW15C222K
C17	1728	.0022uFD MONO CERAMIC	"	CW15C222K
C19	1729	.22uFD MONO CERAMIC	Mepco	CY20C224M
C22	1729	.22uFD MONO CERAMIC	Mepco	CY20C224M
C24	1723	1uFD 100v POLYESTER	Digikey	E-1105
C25	1706	.01uFD MONO CERAMIC	Mepco	CW15C103K
C26	1723	1uFD 100v POLYESTER	Digikey	E-1105
C27	1723	1uFD 100v POLYESTER	"	E-1105
C28	1723	1uFD 100v POLYESTER	"	E-1105
IC'S				
U6	1839	FLIP FLOP	Various	74C74AN
U7	1840	ANALOG SWITCH	"	CD4053BCN
U8	1841	DUAL COMPARATOR	"	LM393N
U9	1842	8 - 1 ANALOG MULTI.	Siliconx	DG508ABK
U10	1843	BUFFER OPAMP	Analog Device	OP42GP
U11	1844	DUAL N-JFET	MicroPower	MP842-52
U12	1843	INTEGRATOR OPAMP	Analog Device	OP42GP
U13	1846	VOLTAGE REFERENCE	Analog Dev.	AD588AD
U14	1815	DUAL OPAMP	Linear Tech	LT1013CN8
U15	1848	OPAMP	Various	LM741CN
U16	1849	OPAMP	TI	TLC271CP
U17	1850	CHOPPER OPAMP	Linear Tech	LTC1050CN8
U18	1850	CHOPPER OPAMP	"	LTC1050CN8
U19	1853	TEMP TRANSDUCER	National	LM335Z
U20	1851	SWITCH CAP BLOCK	Linear Tech	LTC1043CN
TRANSISTORS				
Q1	1902	N-JFET	National	PN5434
Q2	1902	N-JFET	"	PN5434
Q4	1903	N-JFET	Various	2N4391
Q5	1904	PNP TRANSISTOR	"	2N3906
CONNECTORS				
	1976	TRANSDUCER SOCKET	SAMTEC	T-121-T
	1990	TEST POINT CLIP	Mouser	
PC BOARD				
	2035	Analog PC BOARD	RMI	2035
MISC				
	2072	AIRSPEED SENSOR, STD.	Sensym	SPX50DP
	2072	AIRSPEED SENSOR, LOW	Sensym	SPX10DP
	2073	ALTITUDE SENSOR	"	SPX100AP

A/D PC Board Assembly

The A/D PC board contains the circuitry to convert the pitot and static pressures into digital values that can be used by the microprocessor. The A/D PC board assembly is shown in Figure 14 without the sensor plastic tubing which can be seen in Figure 13.

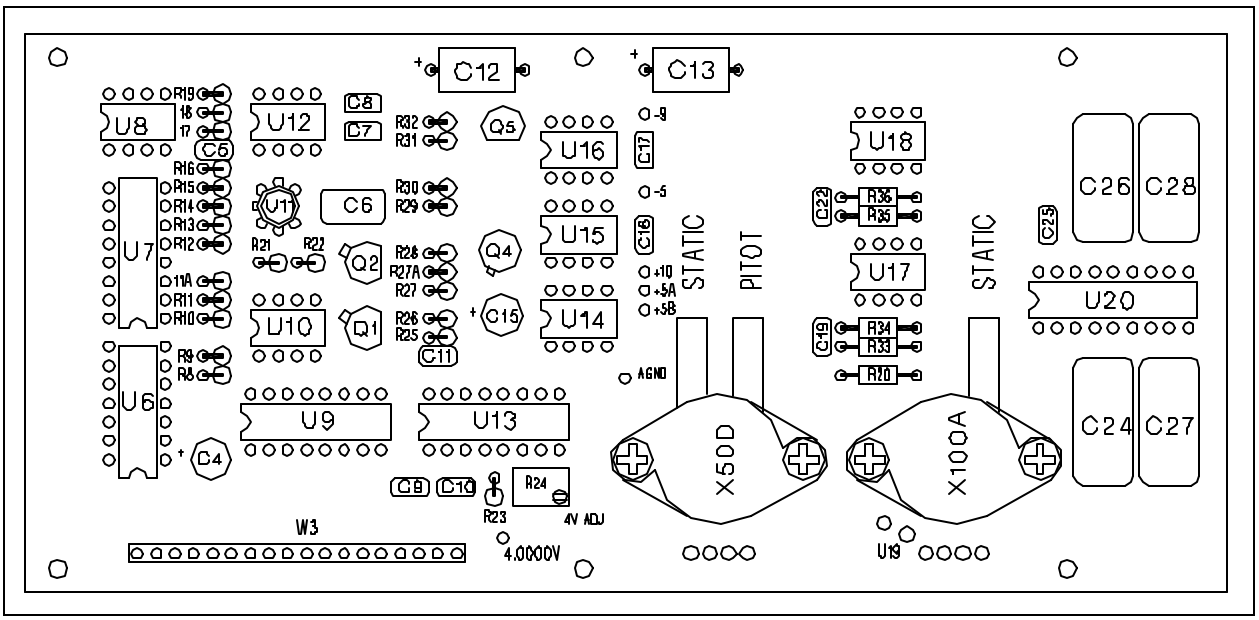

Figure 14 The A/D PC board assembly is shown without the pitot and static tubes for clarity. A large, tear-out copy of this drawing is in Appendix C.

Many of the resistors and diodes on the two PC boards are mounted vertically to save space. Only one lead is bent as shown in Figure 15, with leads slightly spread for friction. Hold the resistor body rigid in one hand and fold the lead around by pushing with one finger in the middle of the lead. The lead bend should not be sharp nor should it be a big loop. Hold the resistor while bending so the marking value can be seen after installation. If you're fussy, all the markings should read from the top to the bottom so it is easier to double check your work. Install all vertical components so the body and wire orientation matches the assembly drawing detail and the designators on the PC board. Some of the other vertical parts are polarized and must have the body in the proper hole.

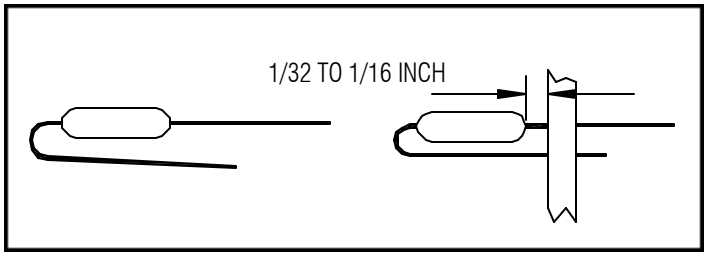

Figure 15 Vertical resistor or diode mounting.

Locate and install the following resistors from the sort pads. A group of resistors will be bent and inserted and then checked before soldering.

__ 1. R8 - 7.71k .1% marked 7711 or 7.71K

__ 2. R9 - 17.6k .1% marked 1762

__ 3. R10 - 10k 5% marked BR-BK-OR

__ 4. R11 - 5.6k 5% marked GN-BL-RD

__ 5. (R)11A (R missing) - 470ohm 5% marked YL-VI-BR

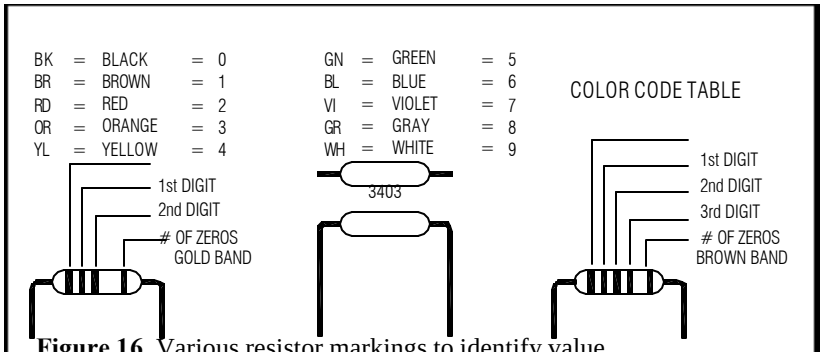

Figure 16 Various resistor markings to identify value

The resistors should remain in place with friction when the board is turned over. If not, spread the leads apart slightly. Solder only one lead on each part. This lets you take a final check to make sure the part is the proper height above the PC board before soldering the other lead. Be sure to maintain the 1/16-1/32 inch standoff height as shown in Figure 15. If everything looks OK, solder the remaining leads and then snip off the excess lead wire. The lead wire should be cut at the smallest diameter of the solder fillet where the lead wire starts.

__ 6. R12 - 5.6k 5% marked GN-BL-RD

__ 7. R13 - 20.0k 1% marked 2002 or RD-BK-BK-RD

__ 8. R14 - 31.2k .1% marked 3122

__ 9. R15 - 20.0k 1% marked 2002 or RD-BK-BK-RD

__ 10. R16 - 10k 5% marked BR-BK-OR

__ 11. (R)17 (R missing) - 3.9k 5% marked OR-WH-RD or OR-WH-RD-RD-WH (2% resistor)

__ 12. (R)18 (R missing)- 10.0k 1% marked 1002 or BR-BK-BK-RD

__ 13. R19 - 220k 5% marked RD-RD-YL

Double check your work, solder the long lead and clip, check to see that resistors are standing straight and the proper height, and solder and clip the remaining leads.

__ 14. R21 - 1.00m .1% marked 1004 or 1.00M (R20 comes later!)

__ 15. R22 - 7.71k .1% marked 7711 or 7.71K

__ 16. R23 - 39k 5% marked OR-WH-OR

Double check your work, solder the long lead and clip, check to see that resistors are standing straight and the proper height, and solder and clip the remaining leads.

__ 17. R25 - 10.2k .1% marked 1022

__ 18. R26 - 2.55k .1% marked 2551

__ 19. R27 - 1.21k 1% marked 1211 or BR-RD-BR-BR

__ 20. (R)27A (R missing) - 100k 1% marked 1003 or BR-BK-BK-OR

__ 21. R28 - 14.3k 1% marked 1432 or BR-YL-OR-RD

__ 22. R29 - 4.99k 1% marked 4991 or YL-WH-WH-BR

__ 23. R30 - 4.99k 1% marked 4991 or YL-WH-WH-BR

__ 24. R31 - 4.99k 1% marked 4991 or YL-WH-WH-BR

__ 25. R32 - 4.02k 1% marked 4021 or YL-BK-RD-BR

Double check your work, solder the long lead and clip, check to see that resistors are standing straight and the proper height, and solder and clip the remaining leads.

The next resistors are installed in a flat position with the body touching the PC board. To bend the leads, hold the resistor in one hand and bend both leads down at the same time with the other being sure to hold the resistor so that the value marking can be seen after installation. See Figure 16 to see the shape of the leads.

Open only ONE of the matched pair packages at a time so there is no possibility of them getting mixed up with resistors from the other package.

__ 26. R33 - 1.00k .1% marked as such

__ 27. R34 - 24.3k .1% marked as such

Double check your work, solder one lead and clip, check to see that resistors are flat and solder and clip the remaining leads.

Open the other matched pair package.

__ 28. R35 - 1.00k .1% marked as such

__ 29. R36 - 24.3k .1% marked as such.

__ 30. R20 - 6.98k 1% marked 6981 or BL-WH-GR-BR from the sort pad.

Double check your work, solder one lead and clip, check to see that resistors are flat and solder and clip the remaining leads.

__ 31. Locate and install trimpot R24 - 100k marked 104 or 100K. This is the trimpot with the adjusting screw on top after installation. Solder and clip. This trimpot adjusts the 4.0 volt reference voltage.

This completes the resistor installation on the A/D PC board.

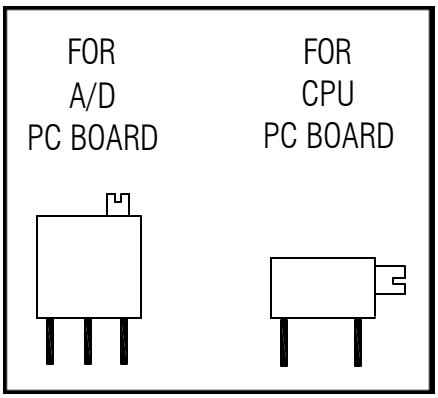

Figure 17 The two trimpots in the kit.

Locate from the sort pads and install the following ceramic capacitors (see Figure 18). After inserting the capacitor, spread the leads slightly so the capacitor won't fall out when the PC board is turned over. Do not spread the leads so much that the capacitor is tight to the PC board the capacitor coating that goes part way up the leads should not be down inside the hole when the part is soldered on but should be approximately 1/16 inch from the board surface.

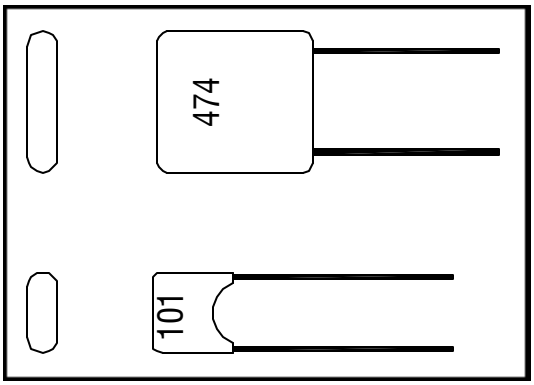

Figure 19 Ceramic capacitors.

__ 1. C5 - .001µFD 50v marked 102

__ 2. C7 - 82pFD 50v marked 82 or 820

__ 3. C8 - 30pFD 50v marked 30

__ 4. Locate the three .1µFD 50v marked 104 capacitors and insert. (C9,C10,C11)

__ 5. Locate the two .0022µFD 50v marked 222 capacitors and insert. (C16,C17)

__ 6. Locate the two .22µFD 50v marked 224 capacitors and insert. (C19,C22)

__ 7. C25 - .01µFD 50v marked 103

Double check your work, flip the board over to see that the insulation on the capacitor lead is approximately 1/16 inch from the surface of the board, solder one lead and clip, check again, then solder and clip the remaining leads.

__ 8. Locate and install the two 10µFD 25v tantalum capacitors - marked 10 25 or 106 25. These capacitors are polarized, which means that the lead with the plus sign must go toward the plus sign on the PC board designator. The heavy line on tantalum capacitors always points to the **positive** lead. Solder and clip.
(C4,C15)

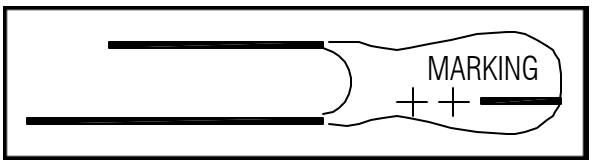

Figure 20 Tantalum capacitor. The dark line always points to the positive "+" lead.

__ 9. Locate and install C12, the 22µFD 25v (or higher voltage) axial type electrolytic capacitor, observing proper polarity. See Figure 21. The capacitor will have a heavy line or band to identify the **negative** lead while the PC board designator will show the location of the positive lead. The body should touch the PC board.

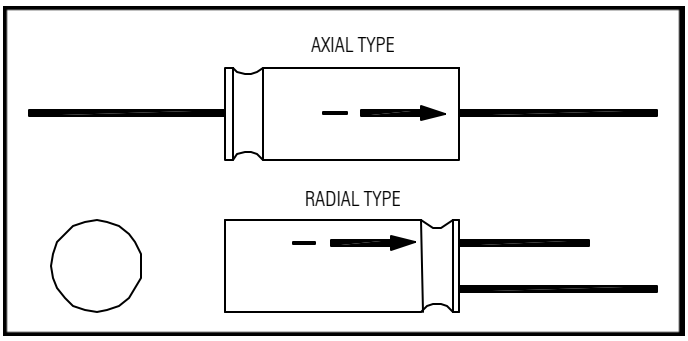

Figure 21 Two types of electrolytic capacitors. Note the polarity markings showing the negative lead.

__ 10. C13 axial type - 33µFD or 47µFD, 16v (or higher voltage).
Solder and clip.

Locate the one small and four large polypropylene capacitors. They are shaped similar to the ceramic capacitors but are much larger. The four large caps may have square corners.

__ 11. Install the small .0047µFD 50v polypropylene capacitor C6 - marked 472 or .0047. Make sure there is 1/32 to 1/16 of the bare leads showing on the component side of the board before soldering one lead, checking and then soldering the other lead. Clip.

__ 12. Install the four large 1µFD 100v polypropylene capacitors marked 105 or 1J100 in the same manner as above. Solder and clip.
(C24,C26,C27,C28)

Antistatic procedures should be carried out for the remainder of the A/D PC board assembly. Inspect all of your work up to this point before hooking up to the wrist strap.

The transistors and the one small IC in a transistor shaped housing will be installed next. They are packed in the black antistatic box. All of these will be installed as shown in Figure 22 with the tops .30 to .35 inches above the surface of the PC board. Spread the leads on the solder side to hold the transistor package the proper height above the board. When soldering, do one lead on all, check height and then do one more lead on each part. That will give each part a little more time to cool between each lead.

The flat on the one type of transistor package and the tab on the other type must be aligned with the designator on the PC board. A few designators have both the flat and tab shown because that part may be in either type of package.

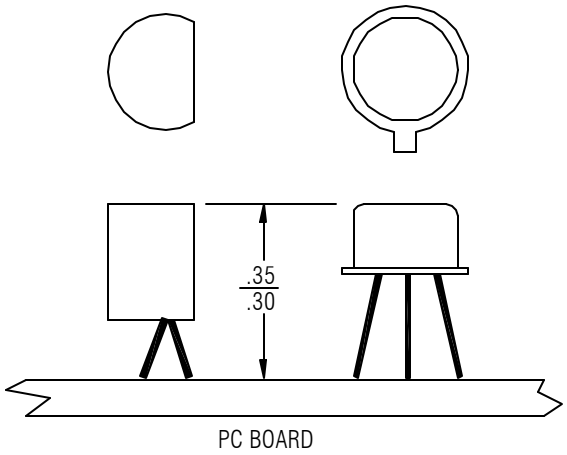

Figure 22 Two types of transistors that are used in this kit. Note mounting height.

__ 1. Locate and install two NJFET transistors marked PN5434, 2N5434, J108 or J109 (Q1,Q2)

__ 2. Q4 - NJFET transistor marked 2N4391

__ 3. Q5 - PNP transistor marked 2N3906

__ 4. U11 - Matched NJFET pair with 6 leads marked LS3954A, LS840AL or MP842

Solder and clip.

The last item is to install the altitude and airspeed sensor assembly at the location shown in Figure 14.

__ 1. Note that the top of the sensors have the factory printing in white (sort of). Bend the four leads on each sensor approximately 70E down at a point two thirds of the way from the tip to where the lead narrows. Use square-nosed pliers and do all the leads at the same time so that the bends are even.

Solder-cup socket pins will be used to join the airspeed and altitude sensors to the PC board. The pins are lightly pressed into the PC board holes and are also later soldered.

__ 2. Locate four of the eight cup socket pins for the airspeed sensor and install. Hold each pin with a small needle nose pliers and push it into the PC board hole until flush. The thin lead on the bottom of the pin may be broken off before starting them into the hole. After all pins are inserted, turn the pins so that the open cups of the pins are facing the **edge** of the PC board. Do NOT solder yet.
(X50D)

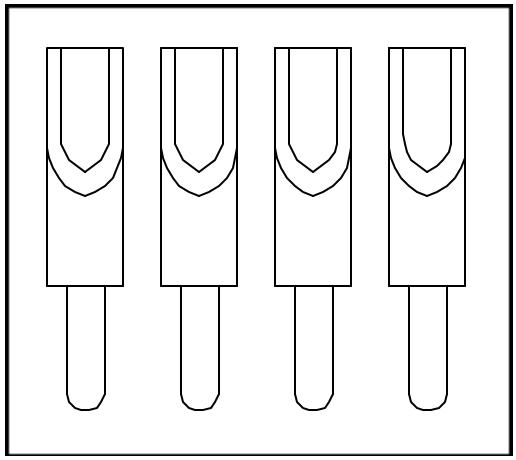

Figure 23 Sockets for the altitude and airspeed sensors.

__ 3. Install the airspeed sensor, aligning the four leads so they insert into the cups of the socket pins. The socket pins can tilt toward the sensor to better match the leads from the sensor. The rest of the assembly can go where it wants for now. Slip two white .125 thick nylon spacers between the sensor and the PC board. Install two #4-40 x .75 machine screws as shown in Figure 24. Make sure all four leads go into their sockets and snug the screws.

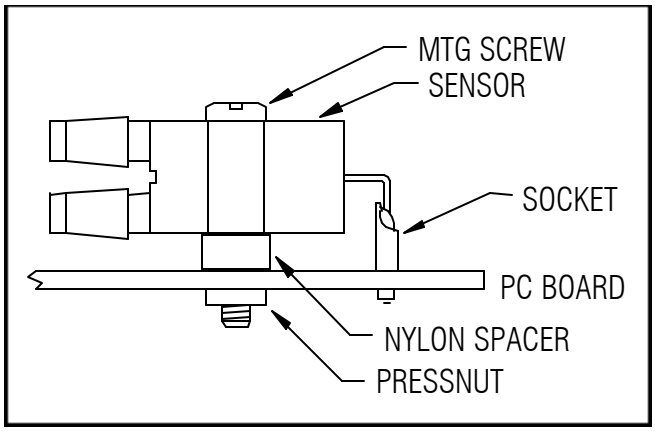

Figure 24 Airspeed sensor mounting detail. The cups on the sockets face the opposite direction on the altitude sensor.

__ 4. Install six more of the cup socket pins, four for the altitude sensor and two for the attached temperature sensor. After all pins are inserted, turn the pins so that the open cups of the pins are also facing toward the **edge** of the PC board. Do NOT solder yet.
(X100)

__ 5. Install the altitude sensor with two .125 thick nylon spacers between the sensor and PC board and two #4-40 x .75 machine screws the same way as the other sensor. Make sure all four leads go into their sockets. Shape the two attached temperature sensor leads so the ends of the leads go into the two remaining cup sockets. When shaping sensor leads, avoid excess bending near the body of the transistor or the lead may break off.

__ 6. Solder all the sensor leads into their sockets. Touch a drop of solder to the tip of the iron and lightly press the cup socket towards the sensor with the iron. This will heat the cup socket and the heat will pass on to the sensor lead. Apply solder so that a good wetted joint is formed between the sensor lead and the cup socket. Be careful to not let the iron touch and heat up a neighboring cup socket or you may form a solder bridge between sockets. Make sure all leads are soldered, straight and not shorted.

__ 7. Turn the board over and solder the bottom ends of the cup sockets. Don't press too hard sideways on the socket leads or you may tilt the cup socket on the top side of the PC board. When finished, check the top side of the assembly again for straightness and shorts.

__ 8. Clean the assembly now if there will be more than two weeks before all assemblies are complete and cleaned. Inspect the finished A/D PC board, repair and clean again if necessary. Observe static precautions.

This completes the soldering on the A/D PC board.

__ 1. Apply a little RTV cement along the tops of the capacitor pairs C24-C27 and C26-C28 so that they help support each other (IF they are the square type, RTV is NOT required).

Set the assembly aside until later.

CPU PC Board Bill of Materials

Item	RMI#	Description	Manufacturer	Mfg Part Number
RESISTORS				
R37	RTF104	100K CERMET TRIMMER	Mepco	RJ26FP104
R38	RJQ562	5.6K 5% QW	Various	
R39	RJQ393	39K 5% QW	"	
R40	NOT USED			
R41	NOT USED			
R42	RN5104	100K X 5 SIP NETWORK	Panasonic	EXB-F6E104G
R43	RJQ472	4.7K 5% QW	Various	
R44	RJQ472	4.7K 5% QW	"	
R45	RFQ3573	357K 1% QW	Mepco	RN55D3573F
R46	RFQ6042	60.4K 1% QW	"	RN55D6042F
R46A	NOT USED			
R47	RJQ103	10K 5% QW	Various	
R48	RFQ1543	154K 1% QW	Mepco	RN55D1543F
R49	Jumper	0 ohms using cut-off lead		
R50	RJQ223	22K 5% QW	"	
R51	RJQ472	4.7K 5% QW	"	
R52	RFQ3922	39.2K 1% QW	Mepco	RN55D3922F
R53	RJQ473	47K 5% QW	Various	
R54	RJQ123	12K 5% QW	"	
R55	RJQ473	47K 5% QW	"	
R56	RJQ332	3.3K 5% QW	"	
R57	RJQ471	470 5% QW	"	
R58	RFQ2802	28.0K 1% QW	"	RN55D2802F
R59	RFQ2493	249K 1% QW	"	RN55D2493F
R60	RJQ184	180K 5% QW	"	
R61	RFQ1002	10.0K 1% QW	"	RN55D1002F
R62	NOT USED			
R63	NOT USED			
R64	RJQ472	4.7K 5% QW	"	
R65	NOT USED			
R66	NOT USED			
R67	RJQ471	470 5% QW	"	
CAPACITORS				
C29	1708	.47uFD MONO CERAMIC	Mepco	CZ30C474M
C30	1725	30pFD 50V CERAMIC	Mouser	21CB030
C31	1725	30pFD 50V CERAMIC	"	21CB030
C32	1721	10uFD 25v TANTALUM	Sprague	199D106X9025CA1
C33	1721	10uFD 25v TANTALUM	"	199D106X9025CA1
C34	NOT USED			
C35	1720	100uFD 25v ELECTROLYTIC	"	P-6239
C36	1722	220uFD 16v ELECTROLYTIC	"	P-5139
C37	1709	2.2uFD 16v TANTALUM	Sprague	199D225X9016AA1
C38	1709	2.2uFD 16v TANTALUM	"	199D225X9016AA1
C39	1718	330uFD 10v ELECTROLYTIC	Digikey	P-5125
C40	1719	10uFD 50v ELECTROLYTIC	"	P-6264
C41	1727	470pFD MONO CERAMIC	Mepco	CW15C471M
C42	1707	.1uFD MONO CERAMIC	"	CW20C104K
C43	1707	.1uFD MONO CERAMIC	"	CW20C104K

C44	1727	470pFD 50v CERAMIC	"	CW20C471M
C45	1704	100pFD 50v CERAMIC	Mouser	21CB100
C46	1709	2.2uFD 16v TANTALUM	Sprague	199D225X9016AA1
C47	1707	.1uFD MONO CERAMIC	Mepco	CW20C104K
C48	1727	470pFD MONO CERAMIC	"	CW15C471M
C49	1727	470pFD MONO CERAMIC	"	CW15C471M
C50	NOT USED			
IC'S				
U21	14-0001	RESET ASSEMBLY	RMI	
U22	1829	DIVIDER	GE	CD74HC40103E
U23	1826	CPU	Signetics	SC80C451ACA68
U24	1830	BINARY COUNTER	Motorola	MC14040BCP
U25	1831	3 INPUT NAND	National	MC74C10N
U26	1827	EPROM	Various	27128
U27	34-0006	NVRAM	Dallas Semi	STK10C48-P451
U28	1832	QUAD 2 INPUT OR	National	MC74C32N
U29	1833	HEX INVERTER	"	MC74C04N
U30	NOT USED			
U31	1808	ADDRESS LATCH	Motorola	MC74HC373N
U32	1834	DUAL BIFET OP AMP	"	LF353N
U33	1835	DUAL NAND DRIVER	TI	SN75477P
U34	1836	8 BIT LATCH/DRIVER	"	UCN-5821A
U35	1837	VOLTAGE CONVERTER	Linear Tech	LT1054CN8
U36	1838	5V REGULATOR	Motorola	LM340AT-5.0
U37	1821	REGULATOR	National	LM2931CT
U38	NOT USED			
TRANSISTORS				
Q6	1901	DARLINGTON	Motorola	MPSA63
Q7	NOT USED			
DIODES				
CR1	1920	SILICON DIODE	Motorola	1N4002
CR2	1920	SILICON DIODE	"	1N4002
CR3	1921	SCHOTKY DIODE	"	1N5818
VR2	NOT USED			
VR3	1922	4.7v ZENER DIODE	"	1N750A
VR4	1923	4.3v ZENER DIODE	"	1N5229
VR5	1923	4.3v ZENER DIODE	"	1N5229
VR6	1925	SURGE DIODE	"	1N6286
CONNECTORS				
	1950	SOCKET PIN	Adv. Intr.	KSS200-49TG
	1963	68 PIN PLCC SOCKET	Yamaichi	IC113-0684-005
	1978	28 PIN EPROM SOCKET	TI	C7228-59
J1	1964	2 PIN SPOX HEADER	Molex	10-32-1023
J2	1967	CODE SWITCH SOCKET	Samtec	SSQ10602TSRA
J3	NOT USED			
J4	1968	DISPLAY HEADER	Samtec	TSW-105-07-S-D
J5	1969	15 PIN D-SUB	AMP	745782-3
J6	1970	9 PIN D-SUB	"	745781-3
	1990	TEST POINT CLIP	Mouser	ME151-206-100

SWITCHES

SW1	2004	TOGGLE SWITCH	C&K	7105-P3Y9-AV2-I
SW2	2004	TOGGLE SWITCH	C&K	7105-P3Y9-AV2-I

PC BOARD

	2036	MAIN PC BOARD	Various	2036

MISC ELECTRONIC PARTS

X1	NOT USED			
F1	2071	150ma POLY FUSE	Raychem	RXE017
Y1	2074	XTAL - 7.3728MHZ	Various	
L1	2075	FERRITE BEAD	FairRite	2643004201
L2	2075	FERRITE BEAD	"	2643004201
L3	2075	FERRITE BEAD	"	2643004201

CPU PC Board Assembly

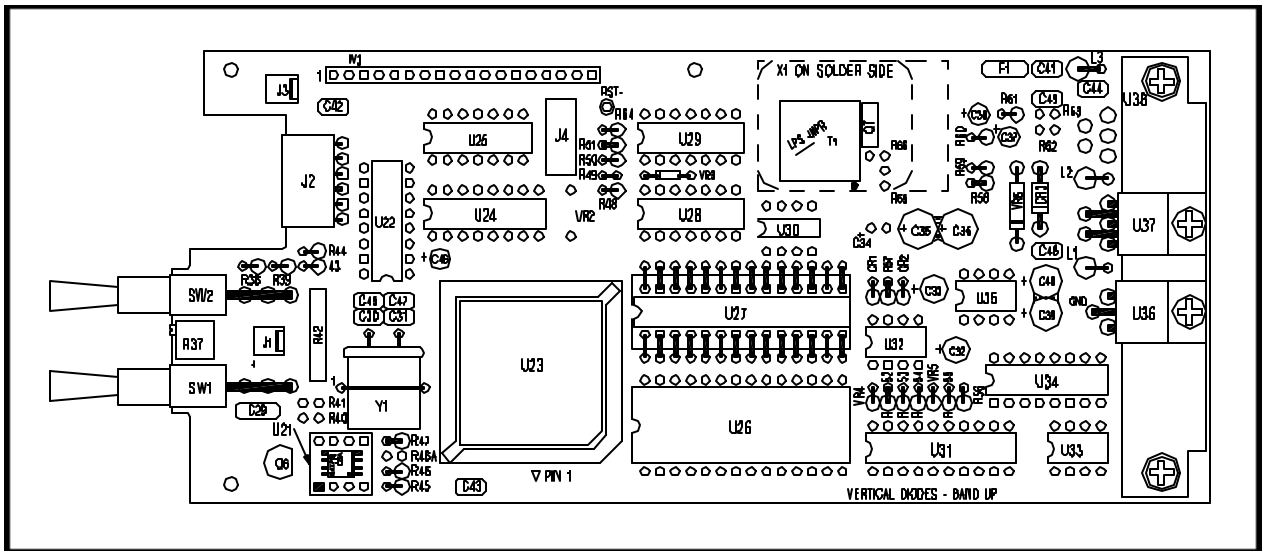

Figure 25 CPU PC board assembly. Note that J5 and J6 are installed on the solder side of the board. Observe the little dabs of TRV adhesive on the capacitor groups C35-C36 and C39-C40. Details are in text. Large tear-out drawing is in Appendix C.

The CPU PC board contains the microprocessor circuitry to operate the FENCODER in addition to power supplies and display and transponder interfaces.

Locate and install the following resistors from the sort pads. A group of resistors will be bent and inserted and then checked before soldering.

__ 1. R38 - 5.6k 5% marked GN-BL-RD

__ 2. R39 - 39k 5% marked OR-WH-OR

__ 3. R40 - NOT USED

__ 4. R41 - NOT USED

__ 5. Locate and install two 4.7k 5% resistors marked YL-VI-RD (R43,R44)

__ 6. R45 - 357k 1% marked 3573 or OR-GN-VI-OR

__ 7. R46 - 60.4k 1% marked 6042 or BL-BK-YL-RD

__ 8. R46A - NOT USED

__ 9. R47 - 10k 5% marked BR-BK-OR

__ 10. R48 - 154k 1% marked 1543 or BR-GN-YL-OR

__ 11. R49 – Hairpin bend a cut-off resistor lead and install here as a zero ohm jumper.

__ 12. R50 - 22k 5% marked RD-RD-OR

__ 13. Locate and install two 4.7k 5% resistors marked YL-VI-RD (R51,R64)

Double check your work, solder the long lead and clip, check to see that resistors are standing straight and the proper height, and solder and clip the remaining leads.

The next group of resistors is right above U31. The "R" and the numbers in the designators may be separated from each other because of the lack of space. Also note that some of the locations on the PC board are for VR or CR diodes.

__ 14. R52 - 39.2k 1% marked 3922 or OR-WH-RD-RD

__ 15. R53 - 47k 5% marked YL-VI-OR

__ 16. R54 - 12k 5% marked BR-RD-OR

__ 17. R55 - 47k 5% marked YL-VI-OR

__ 18. R56 - 3.3k 5% marked OR-OR-RD

__ 19. R57 - 470 5% marked YL-VI-BR

Double check your work, solder the long lead and clip, check to see that resistors are standing straight and the proper height, and solder and clip the remaining leads.

__ 20. R58 - 28.0k 1% marked 2802 or RD-GR-BK-RD

__ 21. R59 - 249k 1% marked 2493 or RD-YL-WH-OR

__ 22. R60 - 180k 5% marked BR-GR-YL

__ 23. R61 - 10.0k 1% marked 1002 or BR-BK-BK-RD

__ 24. R62 – NOT USED – leave open.

__ 25. R63 - NOT USED – leave open

R67 will be installed on the solder side of the PC board after the capacitors have been installed.

PEACE OF MIND NOTE: R65, R66 , T1, Q7, LPS JMPR and X1 are not used in this assembly.

Double check your work, solder the long lead and clip, check to see that resistors are standing straight and the proper height, and solder and clip the remaining leads.

__ 26. Locate and install trimpot R37 - 100k marked 104 or 100K. This is the trimpot with the leads coming out of the flat surface. Solder and clip. This trimpot adjusts the headset audio volume.

__ 27. Locate and install resistor network R42 - 100k marked 100K. See Figure 26. This is a polarized part. Pin number 1 may be identified by a stripe, a dot or the number 1. This pin must go in the hole marked with a 1 on the

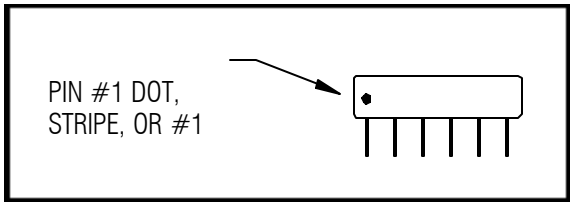

Figure 26 Resistor SIP network.

designator. Flip the board over and tack one pin with a drop of solder on the tip of the iron while holding the network straight with the other hand. Check that the part is straight and solder all pins including the one that was just tacked.

This completes the resistor installation on the CPU PC board except for R67.

Locate from the sort pads and install the following diodes. Be sure to observe the banded polarity markings.

__ 1. Locate and install two 1N4002 diodes. These will be installed vertically and must have the body oriented per the designator and as shown in Figure 25 **AND** with the band UP.
(CR1,CR2)

__ 2. Locate and install two vertical 1N5229 zener diodes observing body and band orientation as above.
(VR4,VR5)

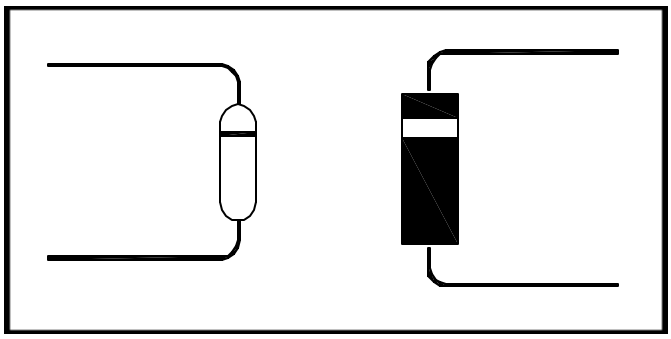

Figure 27 Diode identification. Note the polarizing band on one end of the body.

Solder and clip.

__ 3. Locate and install one 1N750 zener diodes. It will be mounted horizontal with the body touching the PC board. Observe band polarity. VR2 not used.
(VR3)

__ 4. CR3 - 1N5818 diode. Horizontal mount. The leads need to be bent fairly close to the body ends. Observe band polarity. Save the two clipped off leads for use below.

__ 5. VR6 - 1N6286 surge suppressor. Horizontal mount. Tight leads.

Solder and clip.

__ 6. Locate the 30.9k 1% resistor - marked 3092 or OR-BK-WH-RD from the sort pad. It will be identified by OAT TEST. Bend the lead over as if the resistor were to be installed vertically. Clip the long lead off to match the short lead. Solder one of the saved CR3 leads to each of the resistor leads with about **3** inch overlap. This resistor will be used during testing as a substitute outside air temperature probe. Set the resistor aside until later (Reliability Burn-In).

Locate from the sort pads and install the following ceramic capacitors.

__ 1. C29 .47**F**FD 50v marked 474

__ 2. Locate and install two 30pFD 50v marked 30.
(C30,C31)

__ 3. Locate and install four 470pFD 50v marked 471.
(C41,C44,C48,C49) all in upper right/center rear of board.

__ 4. Locate and install three .1**F**FD 50v marked 104
(C42,C43,C47)

__ 5. C45 100pFD 50v marked 101.

Double check your work, flip the board over to see that the insulation on the capacitor lead is approximately 1/16 inch from the surface of the board, solder one lead and clip, check again, then solder and clip the remaining leads.

__ 6. Locate and install two 10FFD 25v tantalum capacitors marked 10 25 or 106 25 - observe polarity. (C32,C33)

__ 7. Locate and install three 2.2FFD 16v tantalum capacitors marked 2.2 16 or 225 16 observe polarity. (C37,C38,C46)

Solder and clip.

__ 8. Locate the 100FFD 25v (or higher voltage) radial leaded electrolytic capacitor and install observing polarity. Be sure that this radial capacitor is **flush** to the PC board. C34 not used. (C35)

__ 9. C36 220FFD 16v (or higher voltage) marked as such.

__ 10. C39 330FFD 10v (or higher voltage) marked as such.

__ 11. C40 10FFD 50v (or higher voltage) marked as such.

Solder and clip.

__ 12. Install R67 as shown in Figure 28 on the **SOLDER** side of the PC board. Equally cut both leads of R67 so that the overall length of the resistor and leads is about 11/16 inch. Position one lead as shown at point "A" in the figure with the lead touching the already soldered R57 lead (center of three leads). Hold in place with one hand and tack with a little blob of solder on the tip of your iron. Position the lead at point "B" and repeat. Solder both joints if more solder is necessary. Cut any excess R67 lead off. Make sure that there are no shorts to other leads.

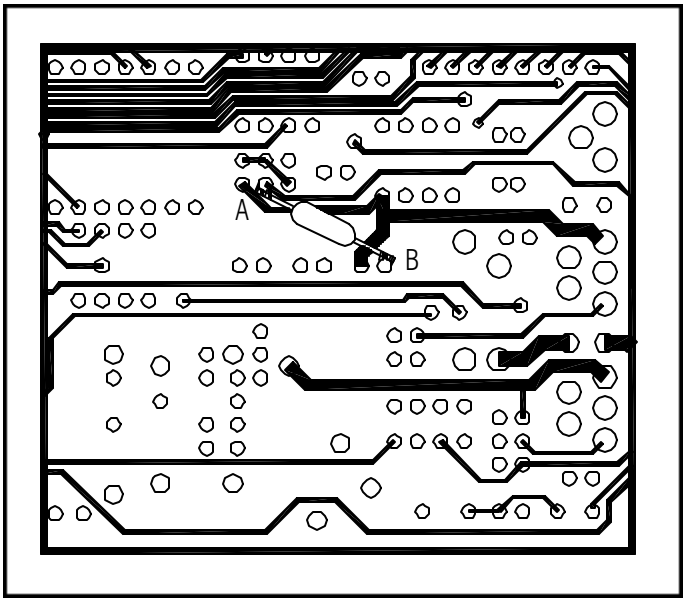

Figure 28 Install R67 on the bottom side of the PC board. Point "A" is the bottom of the bare lead of R57. Point "B" is the negative lead of C36.

__ 13. The two capacitors C35-C36 and the two capacitors C39-C40 should be anchored together with little dabs of RTV adhesive as shown in Figure 25. There is really no good time to do this because working around the uncured adhesive is no fun. This should be done between now and before the cover is installed. The first time an overnight break is taken in the assembly, do this step and check it off then. A reminder will be given later.

This completes the capacitor installation on the CPU PC board.

__ 1. Locate and install the 150ma fuse F1 - marked X017. This is really a temperature sensitive resistor that acts like a fuse. It never needs replacing. After the over current condition is corrected it resets itself. It protects the unit from complete shutdown if for some reason the outside air temperature wiring is shorted to aircraft ground. Solder and clip.

__ 2. Locate and install the 7.3728MHZ crystal Y1. It is silver and shaped just like the designator on the PC board. Insert both leads and then bend the crystal down to fit in the designator pattern. Take one of the cut off resistor leads and form across the top of the crystal and into the holes on each side. This will act as support for the crystal. Solder and clip. If the crystal can still be easily moved, form the support wire to provide the needed support.

__ 3. Locate and install a darlington transistor Q6 - marked MPSA63. Solder and clip.

Locate the two D subminiature headers that will be installed on the solder side of the PC board. See Figure 29.

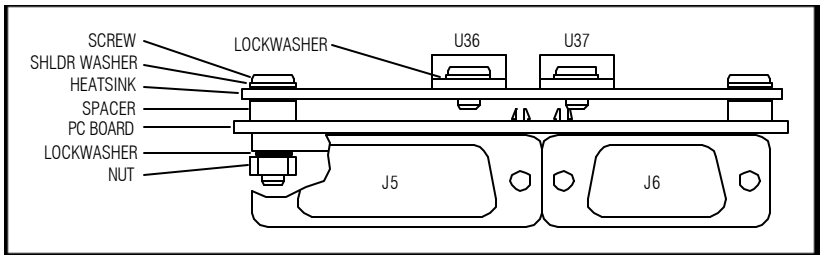

Figure 29 Rear view of the CPU PC board assembly showing location of J5 and J6 and the heatsink – voltage regulator ICs mounting detail.

__ 1. Position both the 15 and 9 pin D subminiature headers **from the solder** side of the PC board. There is a forked prong sticking out of each of the two mounting holes. One set of forked prongs will be removed from the **OUTSIDE** mounting hole of each header to make room for the heatsink mounting screw. Identify the **OUTSIDE** mounting hole ground lead prong on each header. Remove one header at a time and break off the **OUTSIDE** mounting hole set of ground prongs so a screw will be able to go through the hole. Push the prongs up through the hole of the header until the horizontal part of the metal can be grabbed using needle-nose pliers. Wiggle the ground strap up and down until it breaks loose from the back of the threaded nut plate in the corner below the threads.

__ 2. Insert the 15 pin D-sub header from the **SOLDER** side of the PC board and solder a pin on either end. Make sure the header is flush to the board. Reheat and push flush if not. Solder remaining leads.

__ 3. Insert the 9 pin D-sub header from the **SOLDER** side of the PC board and solder as above.

__ 4. Solder the two inside mounting hole ground prongs.

__ 5. Optionally clean. Inspect the CPU PC board assembly. Once the heatsink assembly is finished the solder joints on J5 and J6 can't be inspected.

The voltage regulator IC's and their heatsink will be installed next. See the right hand side of Figure 25 for location and Figure 30.for mounting detail.

__ 1. Locate and install the heatsink. It is a rectangular shaped aluminum flat with a notch out of two corners. The heatsink is under U36 and U37 (U38 not used). Install a nylon shoulder washer on a #4-40 x .625 pan head machine screw. Insert this into one of the two mounting holes in the heatsink. Install a 1/8" thick spacer over the screw. Put the screw, shoulder washer, heatsink and spacer assembly through the proper mounting hole on the outside of the PC board. Note that the notches in the heatsink face the rear of the board. Fasten with a #4-40 split lock washer and hex nut.

__ 2. Repeat with another screw, shoulder washer, spacer, lock washer and hex nut in the other end of the heatsink. The shoulder washers should fit down into the heatsink hole. Tighten both assemblies.

__ 3. Locate the voltage regulator with five leads marked LM2931C. Bend only the **CENTER** and **TWO OUTSIDE** leads down as shown in Figure 30. Clamp a .03 to .05 thick piece of metal in a vise, hold the voltage regulator in the position shown and bend the leads one at a time. Or use the metal back of one of the voltage regulators to bend the leads around. Do not clamp IC in vise!

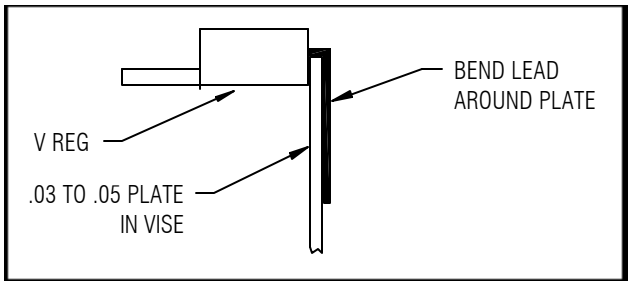

Figure 30 Bending the voltage regulator leads using a thin metal plate held in a vise.

__ 4. Locate the remaining voltage regulator with three leads marked 340 or 7805 and bend only the **TWO OUTSIDE** leads.

__ 5. Position the three lead voltage regulator U36 on the heatsink with the two bent leads through the proper PC board holes and judge the position to bend the remaining lead. Remove the regulator and bend the lead using small needle nose pliers. Install the regulator in place with a #4-40 x .187 pan head machine screw and a split lock washer. Hold the regulator square and tighten the screw.

__ 6. Repeat the above procedure with the five-lead voltage regulator at U37.

Solder and clip.

__ 7. Locate the three metal ferrite noise suppressor beads. They are cylindrical with a small hole running lengthwise. Pass a cut-off component lead (largest possible) through the ferrite bead and shape so that it will mount like one of the vertical resistors. Orient the assembly as shown in Figure 25. Solder and clip.
(L1,L2,L3)

__ 8. Locate the two toggle switches. Install at their proper place and solder one lead. Make sure that the switches are STRAIGHT and FLUSH. Solder the remaining leads.
(SW1,SW2)

__ 9. Clean all the PC board assemblies if not previously cleaned. Refer to the section on page 7.

__ 10. IMPORTANT! IMPORTANT! One at a time, using a good light, visually check all the solder connections on all the PC assemblies. Look for: solder “bridges” (unintentional connection of two adjacent solder connections), component lead not soldered, lack of solder, leads not clipped or white flux residue. If necessary, repair any “bridges', solder any missed connections, solder any suspicious looking joints and clean again as necessary. If you have problems with the FENCODER operating... remember to come back to this step. Remember, approximately 95% of equipment failures are due to poor solder joints!

NOTE: Peace of mind... the two small parts left in the black box are for the outside air temperature sensor. See appendix A. The ICs will be used shortly.

Observe antistatic procedures and join the A/D PC board assembly and the CPU PC board assembly together.

__ 11. Locate the 18 wire jumper, insert at W3 on the CPU assembly **from** the SOLDER side. Brace or hold the PC board assembly so that the jumper is at a 90E angle (important!) with the PC board and solder the two outside leads on the **component** side of the board. Check that the jumper is straight and solder the remaining leads.

__ 12. Install the jumper to the W3 position of the A/D PC board assembly again **from** the **SOLDER** side of the board and solder on the **component** side. The total assembly is a little unwieldy to handle. Be creative in bracing the combination.

That is the end of the soldering.

__ 13.Clean the flux from joining the two PC board assemblies together.

Main Assembly

Continue to observe antistatic procedures and install the PC boards into the chassis as shown in Figure 31.

__ 1. Locate the sheet metal chassis. Stand the chassis vertical on the back end. Pick up the PC board assemblies one in each hand, orient in the proper direction and slip the two assemblies into the

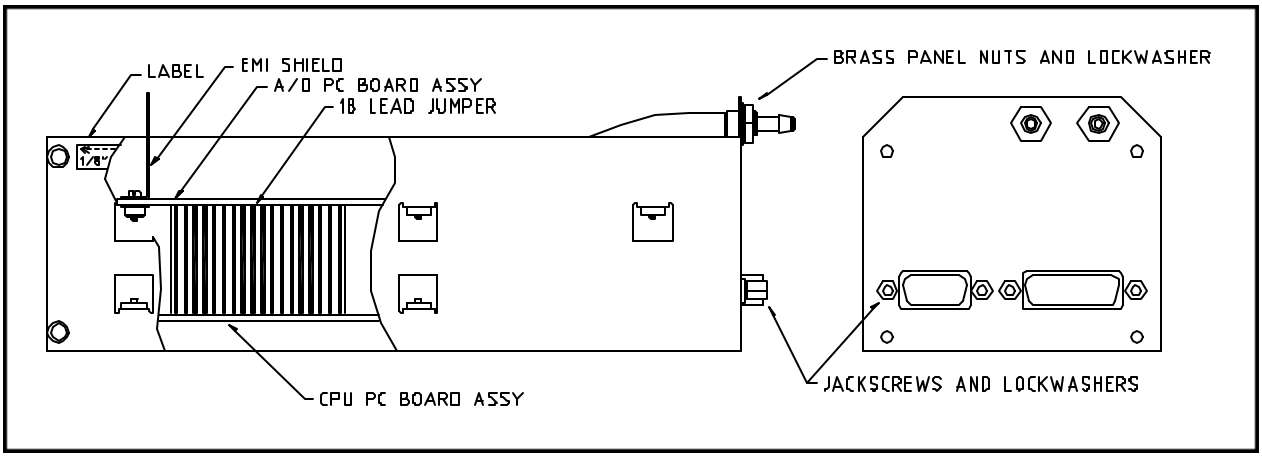

Figure 31 PC board assemblies location in the main chassis. PC board components are not shown for clarity.

chassis from the front. Spread the chassis apart slightly so the 18 lead jumper will go by the tabs on the chassis. Towards the end, the D-sub connectors need to be fed through the openings in the back of the chassis. DO NOT insert the brass bulkhead fittings through their openings yet.

__ 2. Start the four #4-40 jackscrews, each with a split lock washer, to help hold down the back of the CPU PC board.

__ 3. Install three #4-40 x **3** machine screws (no lock washers) in the middle and two front mounting holes on the CPU PC board. Tighten all screws and jackscrews.

__ 4. Install four #4-40 x **3** machine screws (no lock washers) into the four rear holes of the A/D PC board. The 18 pin jumper should squash towards the middle of the unit.

__ 5. Locate the L-shaped EMI shield and install with the short L leg pointing to the front of the unit. Use #4-40 x **3** screws and #4 split lock washers. Tighten all screws.

This is a reminder about applying RTV adhesive on the capacitor groups of the CPU PC board.

Set the chassis assembly aside until later.

Faceplate Assembly

Antistatic procedures will not be needed until the Display PC board assembly is installed.

__ 1. Locate the non-glare plastic sheet with protective film on each side and try to fit into the back cavity of the faceplate. Trim the size if needed. It should just fit but not be snug. Leave the protective films in place.

__ 2. Locate the two black plastic squares to construct the gaskets. Use an Xacto knife or similar to remove the middle of the blanks, leaving a border approximately .10 (1/10) inch wide on all four sides. If you're steady, freehand will work the edges won't be seen.

Use the cross-section assembly drawing as a guide during the following steps. Before proceeding, wash your hands to help eliminate contamination on the LCD conductive pads (they are semi-transparent and located in the step where the front and back glasses are joined) and the conductive rubber connectors.

__ 3. Install one of the black gaskets into the faceplate recess.

__ 4. Remove the films from **BOTH** sides of the plastic front lens (back film is thin & clear), determine the dull non-glare side, and install with the non-glare side to the front of the FENCODER.

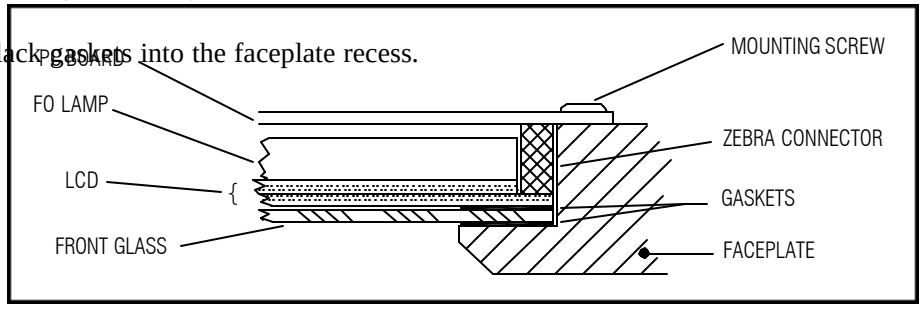

Figure 32 Location of display components in the faceplate assembly.

__ 5. Install the remaining black gasket.

__ 6. To determine the top and bottom of the LCD display, look at the front of the display at an angle in the light to see the digit pattern. After you have figured out the top from the bottom, remove the very thin, clear protective film from the front of the LCD display by lightly scratching one of the corners until you catch the film. The film will peel off **easily**. If you think the protective film has already been removed, again hold the display at an angle to the light. If the front surface of the display is as shiny as the two edge connector ledges, then the film has been removed. The film is duller than the normal front. Exercise caution that you don't remove the front polarizer instead. Install the display.

__ 7. Locate the two Zebra display connectors. These are light blue silicon rubber strips 2.8 x .15 x .07. The connectors are actually a long row of alternating strips of conducting rubber and insulating rubber (thus the Zebra moniker) sandwiched by two insulating sides for support. These strips will provide separate conduction paths for each of the pads on the Display Driver PC board and the matching pad on the Liquid Crystal Display. Install one on either side of the display by laying them in the ledges with the black stripe vertical.

__ 8. Locate the fiber-optic lamp. It is about 1/16 inch thick, white color, with the light-pipe fibers coming out one end and then making a 180° turn around behind the lamp (the “tail”). All of the individual fibers are then gathered into a round, black, plastic housing behind the lamp. Place the front of the lamp into the faceplate cavity on top of the LCD and between the two Zebra connectors. The lamp tail fibers should be on the side above the **ALRT** toggle switch hole and will match up with the end notch on the Display PC board assembly.

Observe antistatic procedures.

__ 9. Remove from its anti-static bag, and position the Display Driver PC board assembly so the six mounting holes in the PC board line up with the threaded holes in the faceplate. The PC board assembly will set up off the back faceplate surface because of the Zebra connectors. Installing the mounting screws will apply the proper amount of squeeze to the rubber connectors. Start two of the #4-40 x .187 pan head screws at diagonal corners to hold the assembly in line. Start the remaining four screws and turn until they just touch the PC board, then alternately tighten each screw about 1/2 turn until the screws have pulled the PC board assembly flush to the back of the faceplate surface. Snug all screws.

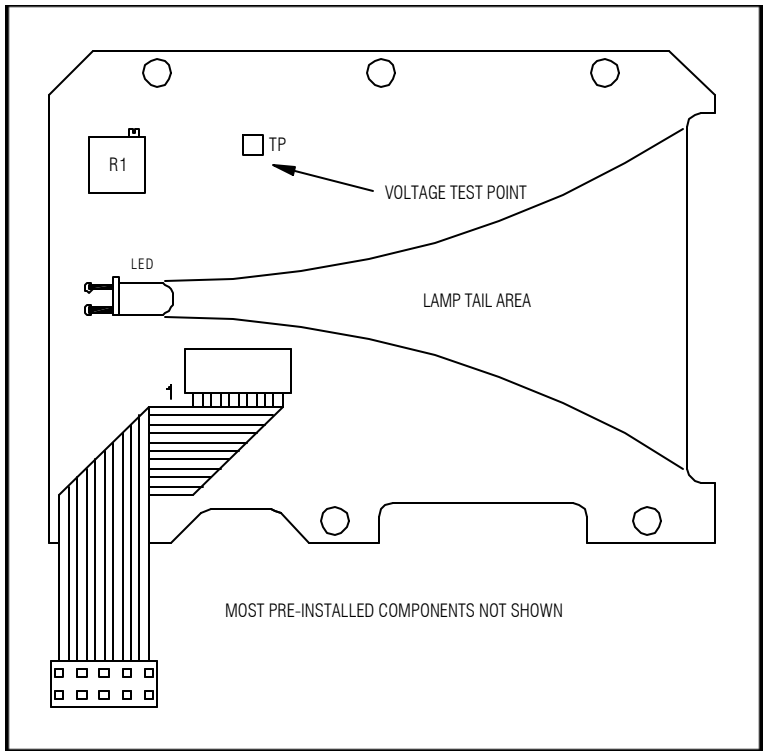

Figure 33 Display PC board assembly already assembled by RMI.

__ 10. Locate the rotary code switch and remove and discard nut and lock washer, if present. Screw the switch into the rear of the faceplate until it lightly bottoms, then back it out until the six connection leads are horizontal and the switch brand label is facing the top of the unit.

__ 11. Be sure the ribbon cable is folded as shown in Figure 33. The ribbon should go right across the top of the switch and flush to the back of the faceplate assembly and then turn down past the switch.

__ 12. Slide the black, plastic housing on the tail of the fiber-optic lamp over the LED on the PC board assembly until it snaps into place. Position, as much as is possible, the tail fibers so they fin into the PC board assembly notch.

This completes the faceplate assembly.

Joining Faceplate and Chassis Assemblies

Continue to observe antistatic procedures.

__ 1. Install the faceplate assembly on the chassis assembly. Insert the two toggle switches into their proper holes in the faceplate. As the two assemblies go together, match the six leads on the code switch to the socket on the CPU PC board.

__ 2. Install four #4-40 x .150 flat head machine screws (DO NOT SUBSTITUTE OTHER SCREWS) to join the faceplate and chassis assemblies together.

__ 3. Install the knob on the shaft with a .050 Allen wrench. One of the screws should go against the flat on the shaft. Leave about .050 inch space between the back of the knob and the front of the faceplate for the push switch to work.

Install Integrated Circuits on A/D PC Board

Continue to observe antistatic procedures. Locate the antistatic bag containing the ICs, open and lay the rails on the antistatic plate. When identifying the integrated circuits, the prefix and suffix of the part number may be different from the assembly manual "marked" text. Rely on the numbers. Any potential confusion will be detailed. Refer to the A/D Assembly Drawing.

__ 1. Remove one end of each IC antistatic rail and slide the IC's out on the antistatic plate so their legs are standing on the plate. Don't scatter them around, they SHOULD be in installation order.

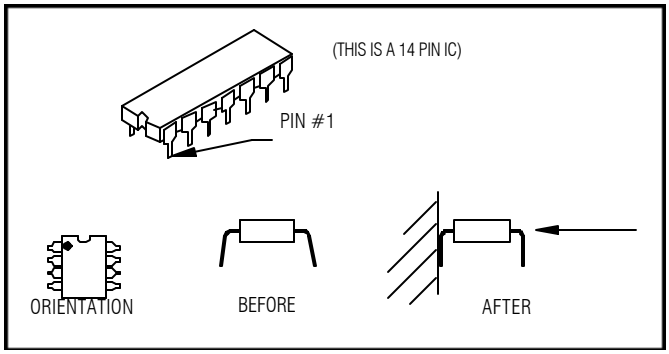

Figure 34 Forming integrated circuit leads for easy insertion into sockets. Also note the relationship between the "dot" and cutout to identify pin #1.

The integrated circuits in DIP packages have the pins splayed outward to hold the IC in the PC board when a socket is not used. To ease insertion of the IC into it's socket, bend the leads to point straight down as shown above by holding the body of the IC and pressing the leads against the plate. Take extra time to make sure that all the leads are started into the socket pins before pressing them home. Double check each one to make sure that a lead has not buckled under or out from the integrated circuit.

CAUTION: All IC's must be installed with the polarizing indent and/or pin #1 dot oriented to match the designator indent on the PC board. Installing an IC backwards is a common mistake. Be careful.

The three integrated circuits under the sensor assembly will be installed first so that the tubing bulkhead fittings may be inserted into their holes.

__ 2. Install 8 pin chopper opamp IC U17 - marked LT1050.

__ 3. Install 8 pin chopper opamp IC U18 - marked LT1050.

__ 4. Install 18 pin switched capacitor block IC U20 - marked LT1043.

__ 5. Carefully insert the two pitot-static tubing bulkhead connectors into the two holes in the chassis. Install two **3** lock washers and **3**-28 nuts. Tighten.

__ 6. Install 14 pin flip flop IC U6 - marked 74C74.

__ 7. Install 16 pin analog switch IC U7 - marked 4053.

__ 8. Install 8 pin dual comparator IC U8 - marked LM393.

__ 9. Install 16 pin analog multiplexer IC U9 - marked DG458, DG508 or MUX08.

__ 10. Install 8 pin opamp IC U10 - marked LT1022 or OP42.

__ 11. Install 8 pin opamp IC U12 - marked LT1022 or LT1023 or OP42.

__ 12. Install 16 pin voltage reference IC U13 - marked AD588.

__ 13. Install 8 pin dual opamp IC U14 - marked LT1013.

__ 14. Install 8 pin opamp IC U15 - marked LM741

__ 15. Install 8 pin opamp IC U16 - marked TLC271.

Install Integrated Circuits on CPU PC Board

Continue to observe antistatic procedures and refer to the CPU Assembly Drawing.

__ 1. Install 8 pin reset assembly U21 - marked MAX708 packed in black box. DO NOT use the dot on the little IC for orientation. Pin1 is the square-shaped pad of the 8 through-hole pads.

__ 2. Install 16 pin divider IC U22 - marked 40103.

__ 3. Install 68 pin microprocessor IC U23 - marked 80C451 or 87C451. It will be packed with the IC's that won't fit in the antistatic rails. Note that one corner is beveled this corner must match the bevel in the socket (marking on top of the IC will appear upside down). Pressing down on the IC will snap it into the socket after making sure that the IC is square and won't bend any leads over when installed. The top surface of the IC will be about 1/32" (.030) below the level of the socket... if not push harder.

The 68 pin microprocessor is normally removed with a special tool. If it ever becomes necessary to remove the FP, it can be done by using two proper size tools that will fit under the FP through the two opposite corner notches and evenly prying the chip out.

__ 4. Install 16 pin binary counter IC U24 - marked 4040.

__ 5. Install 14 pin triple 3 input NAND gate IC U25 - marked 74C10.

__ 6. Install wide 28 pin EPROM IC U26 - marked with a label. The label covers up the erase window for re-programming the EPROM and will be marked with the version number of the software that it contains.

__ 7. Install narrow 28 pin NVRAM IC U27 - marked STK10C48.

__ 8. Install 14 pin quad 2 input OR gate IC U28 - marked 74C32.

__ 9. Install 14 pin hex inverter IC U29 - marked 74C04 or 4069 or 14069.

__ 10. Nothing installed at U30.

__ 11. Install 20 pin address latch IC U31 - marked 74C373.

__ 12. Install 8 pin dual bifet opamp IC U32 - marked LF353.

__ 13. Install 8 pin dual NAND driver IC U33 - marked 75477 or 1472 or 5712.

__ 14. Install 16 pin 8 bit latch/driver IC U34 - marked 5821.

__ 15. Install 8 pin voltage inverter IC U35 - marked LT1054.

Note: The transistor (marked AD590) and capacitor (marked 104) remaining in the anti-static box are for the outside air temperature assembly that will be completed in Appendix A.

Double check your work. Check for bent IC leads.

This is a reminder about applying RTV adhesive on the capacitor groups of the CPU PC board.

Final Connections

__ 1. Plug the audio transducer into J1. Confirm that the red positive wire matches the plus on the designator. Carefully form the excess leads to make room for the cover later.

__ 2. Plug the display ribbon cable into J4. The ribbon cable should not have to be twisted if the previous folds were correct. The brown wire should match up with the number 1 on the designator. You may have to form a kink in the cable to take up excess length.

Prepare for Power-Up

A 12 volt auto battery charger will be used to power the FENCODER during test and burn-in. To connect the power and ground leads to the unit, the 9 pin D-sub connector will be partially assembled. If you wish to use a lab power supply, plug/un-plug the FENCODER to turn it on/off instead of using the main power switch on the power supply. Lab power supplies may have a too slow ramp-up of voltage for the FENCODER to function properly.

__ 1. Cut two 20-24 gage aircraft installation wires long enough to allow connection between the FENCODER and your aircraft circuit breaker and ground connection. The 24 gage twisted pair wire with shield included in the kit for the outside air temperature probe may be used IF you don't need all eight feet for the outside air temperature probe.

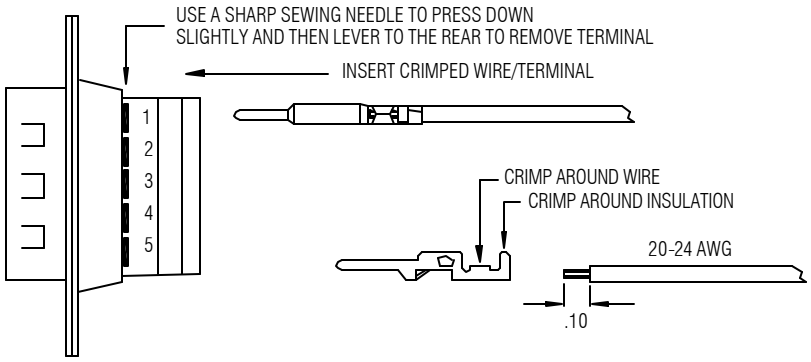

Figure 35 Installing D-sub terminals into the housing.

__ 2. Locate two of the crimp terminals for the D-sub connectors and attach them to the two wires as shown.

__ 3. Strip the other ends of the wires so the battery charger leads can be attached. Tag, label or mark the ends of the wires positive and negative.

__ 4. Locate the smaller 9 pin D-sub connector and insert the negative identified wire into stall #1 and the positive identified wire into stall #2. The terminals will only go in one way, rotate the terminal 90E or 180E until it slips in. The terminal will lock in with a slight click. Gently tug each wire after installation to make sure it is locked in.

__ 5. Leave the battery charger off and connect the negative wire from stall #1 to the negative lead of the charger and the positive wire from stall #2 to the positive lead of the charger.

Initial Power-Up

The temperature dependent display driver voltage will be adjusted first.

__ 1. Connect the common lead of your voltmeter to the ground test pin on the A/D PC board. The pin, marked “AGND” is about in the center of the board.

__ 2. Connect the positive lead of your voltmeter to the test pin at the top of the display driver PC board - marked “V'.

NOTE: If your charger has a charge/trickle option switch, we recommend the charge position. Also, some of the better quality "smart" chargers think that the low current draw of the FENCODER is a fully charged "battery" and reduce their voltage/current which can cause intermittent operation. Also, if you have a standard experimenter's or lab power supply, turning the power on/off with the voltage control knob or power supply switch can cause improper operation. In this case plug/unplug the connector to turn the unit on/off.

__ 3. The moment of truth! Turn the battery charger on. Excuse the dramatics very, very, very seldom does anything bad happen. Adjust the trimpot R5 (on top of the display driver PC board) until the voltage equals about 3.8 volts. The display may be blank until this is done. The trimpot is a multi-turn type that sometimes needs about 10 turns for the mechanical linkage to engage if the trimpot was left at one end of the travel. Turn the trimpot counter-clockwise to increase the voltage.

__ 4. Turn the battery charger off. Remove voltmeter leads. Turn battery charger on. This off/on is necessary to reset the display driver ICs if the driver voltage was initially low.

__ 5. The unit first shows **Err** in the lower left of the display and **tbLS** in the altimeter position. This message will be explained later. Toggle BOTH the **[ALRT]** and **[DALT]** switches up at the same time (hold down on the top of the faceplate to hold the unit down) and the display will blank. When you release the switches the word **InIt** MAY be displayed in the altimeter position. If so, press and hold in on **[ACK]** and at the same time, again toggle BOTH the **[ALRT]** and **[DALT]** switches up at the same time. When you release the switches the word **tESt** is displayed in the altimeter position. This will remain for about 10 seconds and then digits should appear on the display. VSI should settle to zero FPM, altimeter setting should be 29.92 and the altitude will read some value but not necessarily near correct. Airspeed may read zero or some value. The outside air temperature will indicate **EE** (error or out of range).

NOTICE: Some letters are difficult or impossible to represent on a display that is designed for numbers. Use your imagination when interpreting messages. Some letters like "L" work well while others like "T" are converted to a lower case "t". The lower case letter "t" still is not perfect but close. Letters like "K" that are impossible are not used. The alphabet looks like this:

AbCdEFGH IJ_LMnOP_rStUu__y_ 0 123456789

Note the difference between the letter B and the number 6.

If you have a 4**2** digit voltmeter or better, the voltage reference on the A/D PC board can be adjusted for optimum **initial** accuracy. The voltage reference integrated circuit provides a voltage output that is within **"**.003 volts, which will enable the FENCODER to operate within TSO accuracy specifications. This accuracy can be slightly improved by adjusting the voltage reference to a precise 4.000 volts. Most hand-held digital voltmeters are 3**2** digit types where you can only read the first two digits right of the decimal, so cannot be used for adjusting the 4.000 volts.

The FENCODER can also use software to correct/calibrate out any errors, so if a precision voltmeter is not available, the airspeed and altitude can be calibrated using instructions in the FENCODER operations manual.

__ 7. If a precision voltmeter is available (4**2** digits or better), adjust the reference voltage using trimpot R24 (at bottom center of the A/D PC assembly). Connect the common lead of the voltmeter to the AGND test point on the A/D PC board and the positive lead to the 4.000v test point. Adjust R24 to 4.000v. If you have a 3**2** digit or analog type meter, you will not see any change when adjusting.

__ 8. If a precision voltmeter is not available, adjust trimpot R24 to the midpoint. Turn the adjusting screw one way or the other 14 turns or until you hear a clicking noise on each turn, then turn the screw the opposite way 6 turns.

__ 9. A good check of the A/D PC board assembly is to see that all the converter voltages are operational. Remove the positive lead of the voltmeter from the 4.000 volt test point and check all the converter voltages. There are five test points in a line almost under the PITOT tubing that connects to the airspeed transducer. The values are marked right next to the test point. Voltages will normally not be exact. If you have an analog voltage meter you will have to swap the common and positive leads when measuring the two negative voltages.

__ 10. Also check the three main power supply voltages (+12, -12 and +5D) at the W3 connection to see that all are operational ("12 voltages normaly read approximately "11.4 volts).

If the unit does not settle down in about a minute, it may be because the FENCODER puts very little load on your battery charger and it is turning itself on and off. Try powering the unit from a 12 volt battery only or with both a battery and the unit connected to the charger before requesting service help.

__ 11. Turn off the battery charger and unplug the power connector from the back of the unit for now.

Miscellaneous Final Assembly

__ 1. Locate the adhesive-backed label sheet and the adhesive-backed sheet of clear plastic. The clear plastic will be used as a protector for the labels as the label material has its own adhesive. Use a scissors and cut between the top three and bottom three labels. Cut between the two calibration labels and the serial number label. Set the two calibration labels aside. They may be needed when the static/encoder/transponder certification is done. Cut appropriate sized pieces of the clear plastic, remove the backing and stick them over the two label pieces. Cut the two short screw, one connection and one serial number label to size leaving a little bit of white on the outside of the outlines.

__ 2. Locate and install the two short-screw labels, one on either side of the chassis with the arrow pointing to the TOP screw holding the chassis to the faceplate. See Figure 31 for location. If this screw is ever lost, it must be replaced with one with no more than .15 inch (5/32") overall length or the liquid crystal display will be broken.

__ 3. Locate the cover and install. Fit the two D-subs and the pitot/static tubes through the proper holes. Install with four #4-40 x .25 pan head machine screws and split lockwashers. Tighten the screws but don't try to pull the cover and the back of the chassis up flush or the cover chassis will be bent.

__ 4. Locate and install the connection label on the back of the cover above the two D-sub connectors. This will also identify the pitot/static connections. Locate and install the serial number label on the right side of the cover.

Reliability Burn-In

The reliability of present day microcircuits is exceptional. But failures do occur. Over 90% of all electronic component failures occur during the first few hours of operation. Manufacturers of electronic products such as the FENCODER subject the finished unit to varying degrees of reliability testing to eliminate weak components. Generally, the more stress given the unit (within limits), the more reliable it will be.

Avionics manufacturers generally only subject the finished product to a 48 hour operational burn-in at elevated temperatures, and offer 2 and 3 year warranties, so it's not necessary to go crazy with reliability testing. The testing program described here will help ensure a FENCODER with a long life.

The test program will be:

Cold soak for one hour while operating
High temperature burn-in for 48 hours while operating
Cold soak for one hour while operating
Diagnostics check-out and calibration
Shelf operation (optional)

__ 1. Connect the battery charger and FENCODER. Locate the 30.9k resistor and outside air temperature substitute that was previously constructed and plug through stalls #5 and #9 of the 9 pin D-sub connector and into the unit. Put the FENCODER in the freezer section of a refrigerator or freezer and the battery charger outside. Turn the battery charger on, exit the Err/tbLS error and close the door and leave it for one hour.

The minimum storage temperature of the FENCODER is -55EC (-67EF) which is way colder than any home freezer will go. The minimum operating temperature is -30EC (-22EF).

While the unit is getting cold soaked, set up for the high temperature burn-in ('high" in this case will not exceed 65EC (148EF). Put a 100 watt light bulb on an extension cord under a 16 x 12 x 6 inch box. Other box sizes may be used by adjusting the wattage of the light bulb or punching holes in the box. The ambient temperature should be about room temperature. Lay the bulb on a small glass oven casserole cover on a workbench or table. When the FENCODER is placed in the box, it will be positioned at one end so that the face will be away from the bulb and toward one of the box walls when the box is placed over the whole mess. Position the box (flaps out with some weights on the flaps) over the lighted bulb and stick a meat thermometer through one side of the box so that the temperature measuring will be about two inches from the table (the use of more sophisticated thermometers is encouraged). Let the temperature stabilize (about 1/2 to 1 hour) and check the temperature. The ideal temperature would be exactly 60EC (140EF).

The important point is to **NOT** exceed 65EC at any time. If the temperature is too high, switch to a 75 watt bulb or punch some holes in the box.

Don't put the FENCODER into the box until you are sure that it won't go over 65EC.

__ 2. Remove the FENCODER from the freezer and let it set at room temperature for about 15 minutes, then put it in the box with the battery charger connected and the unit operating. For the first few hours, keep an eye on the temperature as a double check. At least every 12 hours, turn the unit off and on a few times using the battery charger switch.

__ 3. While the unit is toasting in the box, this is a good time to build the outside air temperature probe and assemble the encoder wire harness. Complete the instructions in Appendix A and Appendix B.

__ 4. At the end of the 48 hours, remove the unit and let it set at room temperature for about 15 minutes.

__ 5. Repeat the cold soak (step #2) for one hour.

Operating Controls

The **TOGGLE SWITCHES** are three position switches that return to the normal center position when released after being pressed up or down.

In this manual pressing the toggle switch up toward the DALT label on the panel will be shown as **[DALT]** and pressing the toggle switch down toward the TAS/T label will be shown as **[TAS/T]**.

The **SETTING SWITCH** rotates clockwise or counter-clockwise in "clicks" and also has an additional momentary switch that is activated by pushing the knob. In this manual turning the knob will be shown as **[SET]** and pushing the knob will be shown as **[ACK]** (for acknowledge).

Loading the Lookup Tables

Set the FENCODER up in a place where the controls are easy to operate and the display easy to read. You might want to place a heavy book or similar on top of the FENCODER to hold it down during table entry. Connect the battery charger and turn it on. The unit will show **Err** in the lower left of the display and **TbLs** in the altimeter position. This message means that the computer has detected that the lookup tables necessary for accurate operation of altitude and airspeed have not been loaded and it is going to use a generic set of tables. The message is a reminder that even though the unit will operate for test purposes it should NOT be used in an aircraft until the proper lookup tables have been entered.

Toggle both the **[ALRT]** and **[DALT]** switches at the same time to exit from the tables error condition. After the unit exits the error condition the word **tESt** will be displayed in the altimeter position for about 10 seconds and then digits should appear on the display. VSI should settle to zero FPM and the altimeter setting should be 29.92. The altitude probably won't be anywhere near the neighborhood of your location and the airspeed could read zero or some positive value. The outside air temp will be approximately minus 10EC to plus 40EC with the substitute OAT resistor plugged in.

In the following, directions will be explicit. The bulk of control operation and different modes of operation that help understand what is going on are covered in detail in the operation manual.

Plan on about an hour to load in the tables. Once loaded, the tables are saved in a nonvolatile memory. The nonvolatile memory does not need a battery to operate, so even if power is disconnected the tables will not be lost. There are three tables, one for the airspeed sensor, one for the altitude sensor and one for the temperature sensor attached to the altitude sensor. The table information was generated by laboratory equipment and represents or characterizes the sensors over the range of pressures and temperatures that the FENCODER could be exposed to. The computer uses these tables to accurately convert the sensor voltage output into the airspeed and altitude values. Each sensor has it's own characteristics so if for some reason any sensor is ever replaced, it will come with it's own table.

At the end of each table is a check number which is calculated from all the other numbers in that table. When you finish entering a table, the check number is entered and must equal the value that the computer has calculated. If an error has been made, you can step through the entries and check them against the list.

__ 1. Locate the two Sensor Tables sheets of paper. Both the altitude and temperature tables are on the same sheet. Press in on the knob and hold and then push both **[ALRT]** and **[DALT]** at the same time. The display blanks and **OPt** appears in the lower left display.

__ 2. Rotate the knob either direction until **tbL** appears.

__ 3. Press **[DALT]**. **tbL 1** will appear in the altitude position.

__ 4. Press **[DALT]**. **100** will appear in the airspeed position and a six digit number will appear in the five altitude digits and one digit of the VSI. Note that the sixth digit is to the right and smaller. The entry on the Sensor Table sheet has that digit smaller and to the right to match the display.

This six digit number is one of the generic table numbers that was loaded in when the FENCODER was first turned on. There may be some letters in this number. The table entry will be made with hexadecimal ($base_{16}$) numbers which includes the first six letters of the alphabet. These numbers are "0123456789ABCDEF". Note that the entries on the Sensor Table sheets include these letters. Again note the difference between the letter B (shown on the display in lower case) and the number 6.

The first digit of the **100** appearing in the airspeed indicates the table number we are entering and the next two digits are the particular entry of that table that is being shown and that we will replace. Note that all the entries on the Sensor Table list are identified with a three digit number.

__ 5. Select the Sensor Table sheet for altitude that begins with the 100 entry.

__ 6. Press **[ACK]**. The first digit will turn to a zero and the last five digits will have a dash in them.

__ 7. Turn **[SET]** until the digit shown matches that in the Sensor Table list entry.

Note that if the knob is turned CCW from the zero position, it rolls under to F and if you keep turning CW until F is reached, the next click will roll back to zero.

During all of the table entry process you can never back up. If you continue on to the second digit and then discover that the first digit is incorrect, you must continue on. Don't worry if you make a mistake, all your entries are saved and after the entire table is entered you can step through the table and just change the mistake. You don't have to reenter everything again.

__ 8. Press **[ACK]**. The second digit will turn to a zero and it can be adjusted in the same manner.

__ 9. Continue **[SET]**ing and **[ACK]**ing through all six digits. When the sixth digit has been **[ACK]**ed, another six digit number will appear and the airspeed indicator will change to **101**.

__ 10. Do all the 1XX entries in the Sensor Table list. After the last entry is done (the check number) the computer compares the check number that you entered with what it calculates the check number should be. If they agree the display will show **tbL** in the lower left and **tbL 1** in the altitude position. If they do not agree, there was an error in entry and the altitude position will show **Err**. Press **[ALRT]** and **[DALT]** at the same time to leave the error condition. Then start the entry process over again for **tbL 1**. As each six digit number appears, check it against the Sensor Table entry. If it is correct, press **[DALT]** to step to the next six digit number. When you find an incorrect entry, press **[ACK]** to reenter the number. Then continue to step through looking for any other errors.

__ 11. With **tbL** in the lower left display and **tbL 1** in the center, turn **[SET]** until **tbL 2** appears in the center. Press **[DALT]** to start the entry process for table 2. This is the temperature sensor table. Complete as with table 1.

__ 12. Locate the Sensor Table sheet with airspeed (300) data. With **tbL** in the lower left display and **tbL 2** in the center, turn **[SET]** until **tbL 3** appears in the center. Press **[DALT]** to start the entry process for table 3. This is the airspeed sensor table. Complete as with table 1 and 2.

__ 13. With **tbL** in the lower left display and **tbL 1, tbL 2** or **tbL 3** in the center, press **[ALRT]**. The display will show only **tbL** in the lower left. Press **[ALRT]** again and the FENCODER will resume normal operation. If all three tables have been entered correctly, you will not see the **Err/tbLS** message again.

__ 14. Turn the battery charger off. Turn the battery charger on. If the FENCODER shows **tESt** for about 10 seconds and then starts operation, the tables are correct. If the **Err/tbLS** shows again,

press and hold in the [ACK] knob while pressing [ALRT] and [DALT] at the same time to exit the error condition and double check the tables using the above instructions.

Operational Checkout

There are six different sections of the FENCODER. If all six of these sections are operational then the unit will perform as it should. The six sections are: 1) display, 2) computer, 3) altitude, 4) airspeed, 5) outside air temperature and 6) the transponder interface.

If the display is normal, the display and computer sections are operating. One of the menu selections explained in the programming section of this manual turns on all the segments of the display to confirm proper operation. See the **Srv/dSPLy** (service/display) menu entry in the programming section.

If the pressure altitude (29.92 in setting window) is near your altitude, the altimeter section is OK. If you can get an accurate local altimeter setting, that would yield a more accurate result. To see that the airspeed section is working, slip an appropriate size tube on the pitot port and blow on the tube to see that the airspeed operates (MOUTH PRESSURE ONLY). Outside air temperature is OK if the reading is about 10 to 40 degrees with the substitute resistor plugged in.

For a complete transponder interface (encoder) test, read the **Encoder Service Tests** portion in the installation section of this manual and perform ENCODER 2 TEST. You do not have to connect the power to L1 and L2 as described as you still have the power through the 9-pin D-sub connector. The test jumper leads can be slipped through the 9-pin D-sub connector holes like the substitute air temperature resistor.

The operation, programming and installation manuals contain details regarding operation and calibration of the FENCODER. Altitude calibration is very easy if a KNOWN altitude and an ACCURATE altimeter setting is available. Airspeed calibration requires an air data test set or construction of a homemade manometer as detailed in Appendix B of the programming manual.

After installation, you must have the integrated static pressure, transponder and encoder system tested and inspected by an appropriately rated facility per paragraph (c), Appendix E, of Part 43 of the FAR. The equipment used for the altimeter/encoder/transponder test also has the capability to test airspeed indicators. This would be a good time to check and possibly calibrate the airspeed.

If you wish, you may connect the actual outside air temperature probe to the unit although it is not necessary until the FENCODER is installed in the aircraft. Make certain that the wiring can be installed in the aircraft with the plug already attached to the wire. Or add appropriate connectors in the probe leads.

Shelf Testing

While the unit is already operating, this is a good time to read through the operation manual to learn and actually try out each option and function. Use the **Srv/SHO1** menu item described in the programming manual that will perform an active demo of the FENCODER. Also, with some creative blowing and sucking on tubes connected to the pitot and static ports of the FENCODER you can create enough situations to observe the unit in action.

You may leave the FENCODER connected and operating with the battery charger for as long as you wish. Running it won't wear it out just give it more reliability.

* APPENDIX A *

Outside Air Temperature Probe

The figure shows the AD590 temperature sensor and AD590 assembly. When handling the sensor, be sure to observe reasonable static protection precautions.

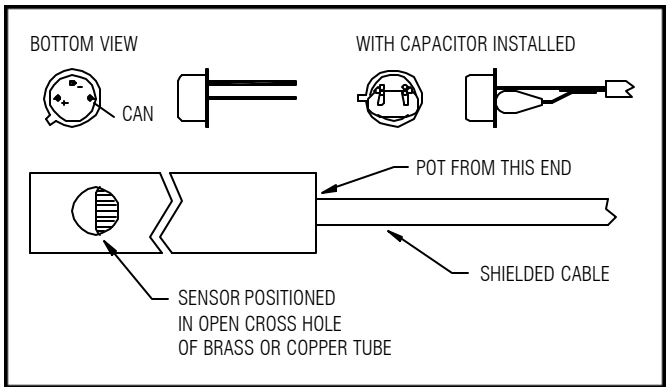

Figure 36 Outside air temperature sensor details. Bottom of figure is one possible OAT probe.

Prepare one end of a proper length (OK to shorten) of the supplied twisted pair, shielded cable as follows:

__ 1. Remove the outer insulation for 1 inch (don't cut shield wires!). Use a needle or sharp tool to unbraid the shield wires. Gather about a third of the shield wires and twist them into a wire and fold it out of the way for now. Gather the remaining shield wires and cut them completely off.

__ 2. Strip 3/16 inch from each of the two black and white wires. Heat your solder iron, apply a small blob of solder to the tip and "tin" each of the bare leads. This keeps the stranded wire together and makes it easier to solder the lead to the sensor later.

__ 3. Cut two 1/2 inch pieces of the small shrink tubing and slide one over each insulated wire. You may want to wrap a temporary piece of electrical tape around the assembly to hold the shrink tubing so that they won't keep falling off during assembly and soldering.

__ 4. Cut a 1-1/2 length of the large shrink tubing and slip over the entire cable for later use.

__ 5. Locate the temperature sensor (marked AD590) and the .1FFD ceramic capacitor (marked 104) from the black anti-static box. Use the figure to identify the lead marked "CAN" and bend it about 45E out of the way. Trim the capacitor leads to about 3/8 inch long. Position and hold the capacitor as shown in the figure and then trim the "+" and "-" leads off so the ends of the sensor leads match the ends of the capacitor leads.

__ 6. Hold the capacitor and sensor in one hand so that the end of a capacitor lead and the end of a sensor lead are touching. Melt a small blob of solder on the tip of your solder iron to and temporarily solder tack the two leads together. Now that the assembly is better held together, position and solder the other capacitor and sensor lead together.

__ 7. Lightly clamp the previously prepared cable in a vise so the black and white wires are in a position to solder the sensor assembly to them.

__ 8. Overlap the "+" lead of the joined capacitor and sensor with the WHITE wire and with your free hand apply the solder iron with a little solder on the tip to the junction. Make sure you have a good joint. Repeat with the "-" lead and the BLACK wire.

__ 9. Slip the two small shrink tubes down over the two completed joints and shrink into place.

__ 10. Overlap the twisted shield wire with the "CAN" lead from the sensor and trim the shield wire so the overlap will be about 1/4 inch. Solder the shield and "CAN" lead.

__ 11. Slide the large shrink tube up until it touches the back of the AD590. Shrink into place. This completes the attachment of the AD590 sensor to the wire cable.

__ 12. You may wish to test the sensor before potting and installing by cutting the cable to length and adding the wires to the 9 pin D-sub housing. Reverse connection of the sensor will not damage the sensor.

Since the variety of possible installation locations is so large, a specific design can not be given, but the following points are universal:

- If the metal case of the transducer itself is not exposed to the outside air, the thermal connection between the transducer and the probe material that is exposed to the air should be metal to metal with little if any insulating adhesives etc. between them.

- The mass of the probe material should be as small as possible. The intent of this and the previous instruction is to minimize the time for the transducer to respond to a change in temperature.

- Use minimum solder heat when connecting the leads to the wiring harness. Cover the finished joints with shrink tubing and mark both ends of the wires with the proper polarity.

- Minimize the strain placed on the leads entering the transducer. If the transducer can be inserted into a probe far enough, pot the wires with RTV cement or similar compounds.

- Direct moisture contact between the two leads (on bare wires) will affect the accuracy of the temperature readout.

- It is OK to clip off the little polarity tab with diagonal cutters if necessary.

We would appreciate any sketches or descriptions of your design to pass on to other builders. Thanks.

* APPENDIX B *

Encoder Wire Harness

The thirteen wire shielded cable provides the coded altitude data to the transponder. The µENCODER end of the cable should be made up first, and then the transponder end will be connected during installation using the transponder installation instructions and/or the wiring tables in Appendix A of the µENCODER Installation Manual.

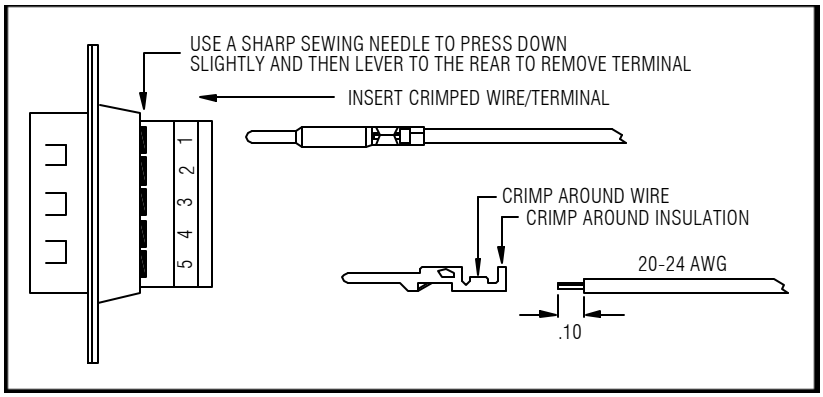

Figure 37 D-sub assembly.

__ 1. Locate the 15 wire cable provided. Strip off .9 inches of the outer insulation and foil shield by SCORING the outside of the cable and flexing it to break the insulation. Cut off the two unused black wires (one is just a filler) and the white wire with brown stripe near the edge of the outer insulation.

__ 2. Fold the bare drain wire back over the insulation.

__ 3. Strip each remaining wire and install crimp terminals as shown in the figure. If you do not have access to a terminal crimping tool, use a needle-nose pliers to bend each arm, one at a time, around the wire/insulation like a person folding his arms, and then apply a SMALL amount of solder on the terminal/wire connection.

__ 4. Install the terminals into their proper stalls from the back of the 15-pin D-sub housing according to the following table.

stall#	color/stripe	function
1	brown	A2
2	red	A4
3	orange	B1
4	yellow	B2
5	green	B4
6	blue	C1
7	violet	C2
8	grey	C4
9	white	A1
10	white/black	D4 (only needed for operation over 30,750 feet)
12	white/red	14/28v
14	white/yellow	com
15	white/orange	strobe

__ 5. Locate the metal shield cover and install per the SHIELD ASSEMBLY steps, page 5 of the Installation manual. Trim any protruding excess shield and drain wire.

* APPENDIX C *

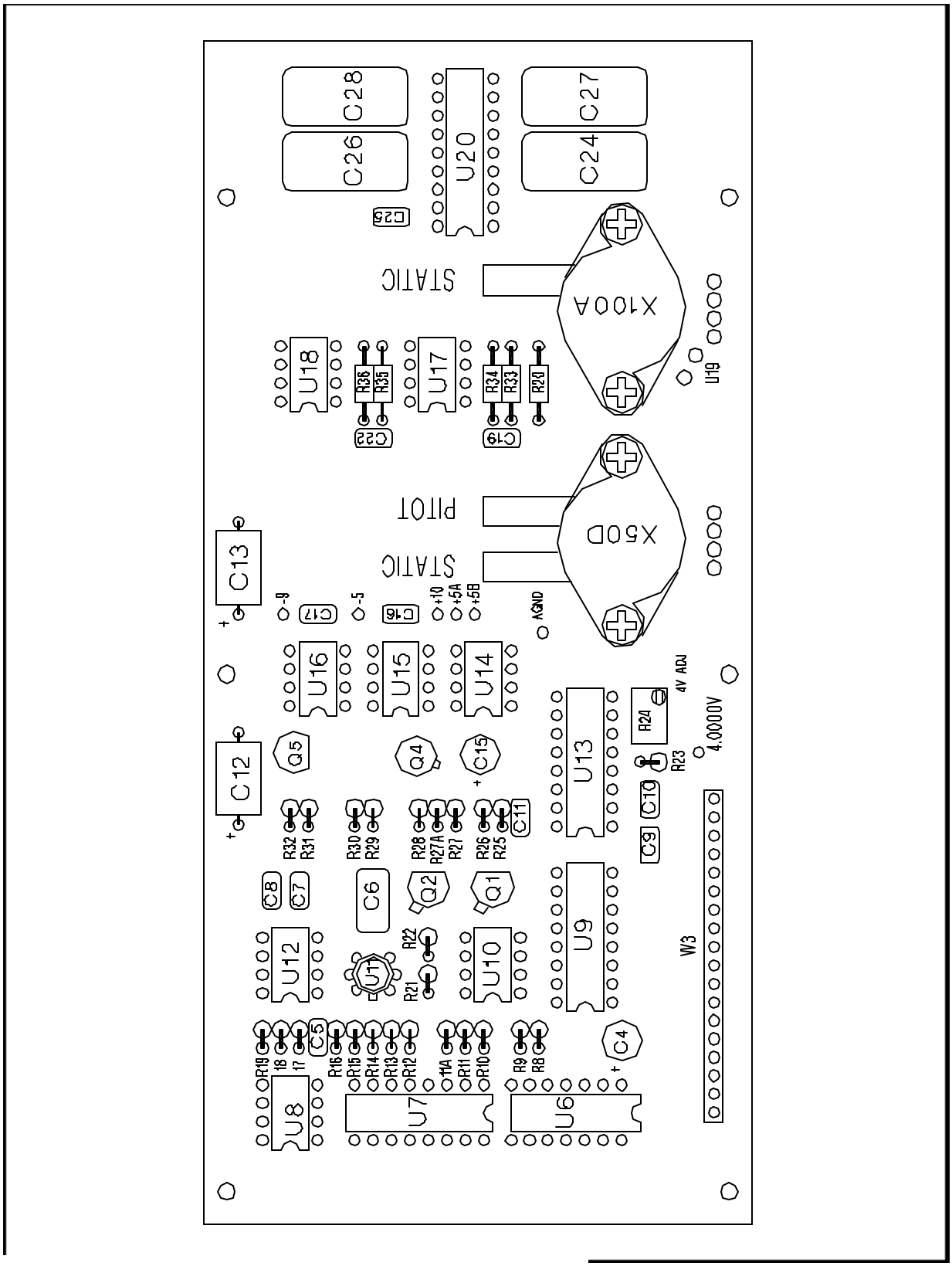

Figure 38 A/D PC board assembly.

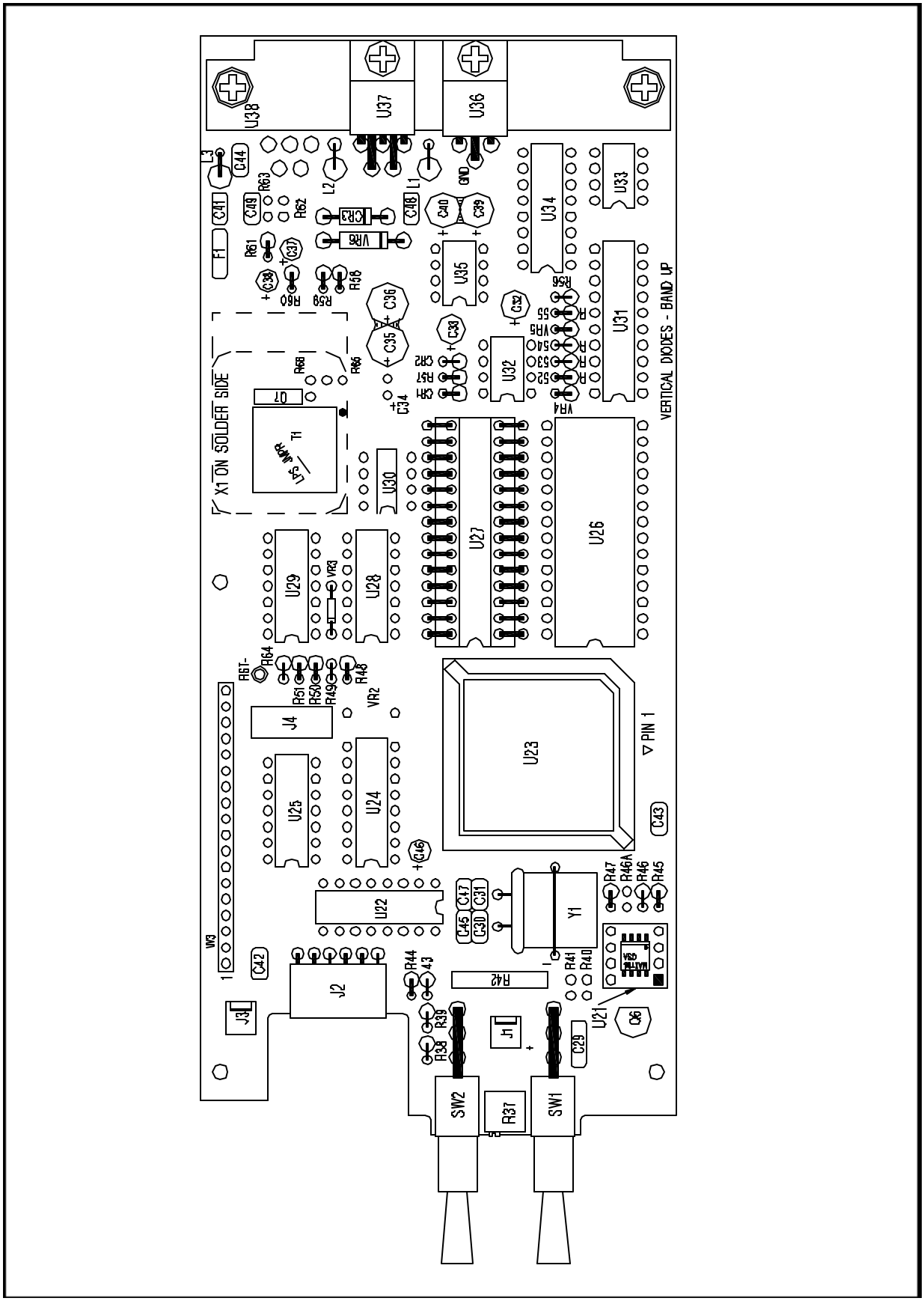

Figure 39 CPU PC board assembly.