



General Overview Assembly Notes

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Tech Note 1

Introduction

It is most important for both the success and enjoyment of your building experience that you take the time to make a few preparations.

Workspace

You will need a clean well lighted workspace. And since your project will extend over at least several days, it is important that you be able to maintain the status of the project between sessions. Otherwise it is likely that parts will be misplaced or steps omitted. Finally, choose your location so that it will not be available to small children or animals since beyond the potential damage to your project, there are safety concerns.

Tools & Test Instruments

Quality tools are critical to the success of both the construction phase of your project and its long term performance and reliability. We have prepared a technical discussion (Recommended Tools & Test Instruments , Tech Note # 3) which discusses the tools and test equipment that we consider essential. You will find it included with your documentation package. It is much more important to purchase fewer quality tools and instruments (our technical bulletin identifies the essential tools & instruments) rather than to have many of mediocre quality. As your interest in project building grows, consider adding the convenience tools and instruments to your workshop.

Soldering Skill

Soldering skills are essential. We have prepared a soldering tutorial (Soldering Tutorial, Tech Note #2). It is included with your documentation package. We can't stress strongly enough the importance of quality solder connections. If you have any doubt about your skill in this area please review our tutorial. Find some scrap boards, terminals, and wire to refine your skills before beginning this project.

Safety

This project requires the use of tools that if used improperly can cause bodily harm. Plus you will be working with voltage levels that are three to five times that presented by the typical "wall socket". These voltages are sufficient to inflict bodily harm or death. Please don't dismiss this warning. Use care in all steps. Use eye protection when using power equipment. Finally if you have been working and find yourself tired - take the time to rest before you continue. Both you and the project will benefit.

Instruction Review

Review all of the associated instructions. We endorse the project phase completion approach in which you will complete one phase, perform the visual inspection and then move to the next. The typical phases are :

1. Part Acquisition
2. PC Board Assembly
3. PC Board Verification Testing
4. Chassis Subassembly Installation & Wiring
5. System Checkout

It is very important that you take the time to examine and thoroughly understand all of the documentation provided. If you have any issues which are not clear, please feel free to call or write for clarification.



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Parts Acquisition

During this phase you will gather the components you will need to build your project. Although you will be purchasing your parts by supplier & component type, upon arrival they should be grouped by major subassembly. The major subassemblies are:

- pc board(s),
- the chassis internal,
- the chassis front panel,
- the chassis rear panel, and
- the remote power supply enclosure & components if required.

Since most parts will be resident on the pc board module(s) associated with your project we have provided several parts lists each associated with the individual pc board module. This will facilitate this “assembly grouping” as the parts arrive.

The “chassis internal” grouping should contain all chassis transformers, tube sockets, spacer hardware, grounding lugs, terminal strips, and any other components or hardware that will be mounted on the chassis main plane of your project. The front panel is usually the “operator control” panel and will contain all lamps or LEDs, switches, and volume and balance potentiometers. The rear panel usually houses the Input / Output connections, power cord, and fuse holder.

You should assemble your pc board modules by part type. For example you will install all pc board terminals first followed by diodes followed by ½ watt resistors and so on until the assembly is complete. Therefore as your parts begin to arrive it would be useful to create sub-groups in each of the aforementioned subassembly group by component type. The following list identifies the component types (plus sequence of assembly as well) associated with the pc board modules:

Table 1

PC Board Component Types & Assembly Sequence

1. PC Board Solder Turret Terminals
2. PC Board Mounting Spacers
3. PC Board Wire Jumpers
4. Diodes, Rectifier Power
5. Diodes, Zener
6. Resistors, Small, Carbon, Metal Film (< 1 Watt)
7. IC's (Dual Inline Package Types)
8. Fuse Clips
9. Small Capacitors
 - Polystyrene
 - Silver Mica
 - Small Electrolytic
 - Ceramic Disk
10. Signal Transistors & FETs
11. Power Resistors,
 - Metal Oxide
 - WW (>1 Watt)
12. DIP Relays
13. Trimpots
14. Large Capacitors
 - Axial Electrolytic
 - Radial Electrolytic
 - Large Coupling (e.g. WIMAs)
15. Tube Sockets
16. Relay Sockets
17. Power Semiconductors
 - TO-220 (Metal Tab)
 - TO-220 w/ HeatSink
 - TO-3 w/ HeatSink
18. PCB Transformers



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PC Board Assembly

Refer to Table 1 (PC Board Component Type & Assembly Sequence on page 2) . It describes the sequence you will be installing each component type. You should have the following tools available for this procedure:

- Soldering Station w/ Chrome plated 1/8" tip & Damp Sponge
- 60/40 Non Residue Rosin Core Solder (0.031 Diameter)
- Component Lead Cutting Shears
- Solder Sucker Tool
- Solder Wick (de-soldering braid)
- Small Needle Nose Pliers
- Magnifying Glass (for visual inspection)

Suggested Suppliers and associated part numbers are provided in our Soldering tutorial (Tech Note # 2).

Begin the assembly of your pc board in the sequence shown in Table 1.

1. PC Board Turret Terminals - These terminals will facilitate the external connections to your board as you move to the chassis assembly phase. Look closely at the instructions to be sure which side to insert these terminals. - In some cases it is better to have these terminals available at the foil side of the board (vs. The component side of the board) For example, in the CAE ST-70 it is much more convenient to have the terminals extend from the foil side of the board as all connections are made to this surface.
2. PC Board Mounting Spacers - Likewise the orientation of the pc board spacers is dependent upon how the board assembly will reside relative to the chassis. Using the CAE-ST-70 as an example, the driver board (B-3a) will have the spacers on the foil side while the power supply / regulator module (B-S7P) will have the spacers on the component side.
3. Wire Jumpers - Unless the length is less than ½ inch it is preferable to use insulated jumpers. In either case I recommend using solid 22 to 20 gauge wire. Although not mandatory, your board will have a cleaner look if you have the jumpers run adjacent to the surface of the board with the inserts at right angle to the jumper. Jumpers are designated by the symbol
4. Rectifier diodes should be inserted next. Remember that they have a polarity - there is a correct orientation (and an incorrect orientation). They are typically designated on the board stuffing diagram with a rectangle with a bar at one end. The bar denotes the diode cathode and therefore identifies the orientation. Be particularly careful with rectifier diodes - if inserted incorrectly you could possibly damage some components upon power up. I recommend a thorough visual inspection comparison to the stuffing guide at the end of this step.
5. Zener Diodes - Same precaution as step 4.
6. Resistors, Small - Resistors have no polarity considerations however I would recommend an orientation which will make visible their value (some manufacturers stamp the value on one side). This will facilitate any testing or troubleshooting. Most of these resistors have their value represented via a standard color code. If you are not proficient with this code, I strongly recommend having your ohmmeter available to check the value of each resistor before insertion. The little time you invest now will provide cheap insurance against problems during startup.
7. Fuse Clips - Place the fuse inside the pair of clips to help gauge the correct orientation and positioning. Be sure to mount them flush to the pc board.

PC Board Assembly (cont.)

1. Small Capacitors - Most small capacitors do not have an orientation, but some do. Therefore be aware of this distinction. It is also recommended that the value of the capacitor appear visible after installation as was previously recommended. Finally, some polystyrene capacitors have a plastic body which cannot tolerate the temperature of the soldering iron. I recommend mounting them with a slight space (1/16") between the board and capacitor. Since their leads are usually very small (about 28 gauge) you should be able to perform the solder operation quickly.
2. Small Signal Transistors & FET's - Small signal transistors clearly have a correct orientation. Please refer to our stuffing guide which illustrates the "top down" view (in some instances a X-Ray view) of how these parts should be inserted. You could also consult our components illustration diagram (Figure 1) to become familiar with the lead orientation of these devices.
3. Power Resistors (Metal Oxide & Wire Wound) - Power resistors are by design expected to be a temperature above ambient. As such it is good practice to include a small space (about 3/16") between the pc board surface and the power resistor. You will find that we have designed our board pad spacing to accommodate a slight radius on these parts such that the component will remain in place while you solder it in. Again. These parts usually have their value stamped on one side and it would be useful to have that information appear at the top after insertion.
4. Dual Inline Package (DIP) Relays - DIP relays have the same footprint as 14 or 16 pin DIL IC's and likewise have a correct orientation.
5. Trimpots - Two types of trimpots have been designed into CAE products - horizontal and vertical. The vertical trimpots will be installed perpendicular to the printed circuit plane. Both are intended to be accessed by the operator for establishing bias or other semi routine adjustments. You should take every precaution to minimize any rough handling.
6. Large Capacitors (>1/4" diameter or larger dimension) - Large capacitors usually include most electrolytic or output coupling polypropylene types. The polypropylene types do not have a polarity however the electrolytic types do. The documentation we provide shows all polarized capacitors with a "+" designator. You can also consult our components illustration diagram (Figure 1) to help visualize those which are polar. If you are unsure however you can simply assume that they all have a polarity and install them accordingly.
7. Tube Sockets - Tube sockets should be firmly inserted into the pc board such that they flush with the board. The most important consideration with tube sockets is to be certain that you have a good solder connection at the board. Many times these sockets will have significant oxidation on the metal tabs. If you suspect this to be the case, you can "tin" the leads before you insert the socket into the board. If you do be sure to clean the terminals to the point that you preserve the original dimensions.
8. Relay Sockets - Same considerations as tube sockets.

PC Board Assembly (cont.)

9. Power Semiconductors - Prepare your power devices before you insert them into the pc board. Do not attempt to attach the heatsink after the component has been installed - this is, at best, difficult. In some cases, the TO-220 electrical device will be attached to a rectangular heatsink (see diagram in Figure 1). When you assemble TO-220 style power semiconductors and the associated heatsink, observe the orientation of the heatsink, screw, lockwasher and nut. Always use heat sink compound between the heatsink and electrical component and tighten well. This is probably the most tedious part of you project but omitting the heat sink compound will insure reliability problems. When finished there should be a parallel relationship between the long sides of the part and heatsink.

In some cases TO-220 type components will be assembled as a “sandwich” of board, heatsink, silicon heatsink compound, and electrical component. In this case, before you begin, locate the electrical component and place its metal tab against the board at the mounting hole to locate the component’s associated lead holes and position. Mark the leads and bend them at right angles to the electrical component (facing the metal tab side) so that the inserted leads and mounting hole are in alignment. Now you can begin to build the assembly. First place a star washer on a ½” screw (usually 6-32) and insert the screw through the pc board from the foil side. Next, in the following order place the heatsink (fins up of course), heatsink compound, electrical component (metal tab down against the heatsink and compound), and finally the retaining nut.

TO-3 style devices will be assembled as a “sandwich” of board, heatsink, silicon heatsink compound, and transistor. To complete this assembly first insert place a star washer on two (5/8” to 1”) 6-32 screws. Insert each through the pc board from the foil side of the board. On the component side place a 5/15” hex nut on each screw and tighten. Next install the heatsink (be sure the holes line up correctly) with the fins pointing away from the board surface. Next install the TO-3 device (hopefully you have placed a generous amount of heat sink compound on the surface of the TO-3 device) with the leads pointing into the associated holes in the board. Finally place an additional two star washers and then ¼” 6-32 hex nuts onto the protruding screw threads. Tighten the screws. This technique will insure an adequate airflow around the heatsink and insulate the pc board from the heat of the device.

17. PCB Transformers - Insert the pins of the transformer into the board until it is flush with the board. Transformers are polar but this only need concern you if you are inserting an 8 pin style - look careful to be sure pin 1 (identified by a dot or “1” label) is inserted in the correct hole position. It is not possible to incorrectly install 6 pin types. CAE has traditionally specified “Signal” brand “ST” style board mounting transformers. However if for any reason you plan to ship your project it would be wise to “wire-tie” the transformer to the pc board to insure that the transformer does not detach from the board should it encounter rough handling. This is not required for normal operation.

Once you have completed the board assembly, take the time to visually examine each connection. Using a magnifying glass check all solder connections - especially the IC pins. Look for solder bridges, and “cold solder joints” (solder should be shiny not dull). Repair all suspect connections using solder wick. Next check the polarity of all diodes, IC, electrolytic capacitors, IC’s, discrete transistors, FET’s, Take a 15 minute break and repeat the inspection again.



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PC Board Verification Testing

OK, you have completed the pc modules. Hopefully that was fun (except for the silicon heatsink stuff). Before we move on to the chassis assembly, you should read the following and perform a few of the measurements indicated. These suggestions are general - they are intended to find gross problems only. Don't become too concerned with exact numbers here - but should you encounter a reading that falls well into the danger area, stop immediately and go back over the circuit board looking for polarity errors or solder bridges.

Dry Module Tests

Before applying power check the resistance of the power terminal (relative to ground) Look of suspiciously low resistance. High Voltage related terminals (>100 volts) should have resistance readings greater than 5K ohms. Low voltage related terminals (<100 volts) should be greater than 25 ohms. Take these readings with your ohmmeter leads first in one direction then reverse the leads and measure again. Use the higher of the two as the accepted reading.

Power Sequence Verification

The modification of commercial units will usually require the use of existing power supplies and some circuitry. Therefore it is essential to have a copy of the service manual. You can obtain complete service manuals for the Dynaco PAS preamp, and MK-3 and ST-70 power amplifiers at our web site (www.curcioaudio.com). Failure to have this information at your disposal will make your task difficult at least and possibly result in some system damage. In particular connections made to existing power supplies should be checked for proper voltage before connection to the CAE module.

Initial Power Application

Before applying power, connect the CAE module's power connections via a 0.1A fast blow fuse and an ammeter. Do not install any tubes at this time. Next apply power and carefully observe all components for signs of overheating or excess current indication (excessive current would be : low voltage > 500 mA, high voltage > 30mA for preamps, > 100 mA for power amps). Carefully measure all regulator output points for correct voltage (should be within +/- 2%). Power down and wait several minutes for the capacitors to discharge. Now install the tubes and re-apply power. Except for filament currents (which do not need to be monitored) carefully observe the components and currents again for signs of overheating or excessive currents. Now excessive currents would be : low voltage >500 mA, high voltage > 75 mA for preamps, > 150 mA for power amps.



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Chassis Sub-Assembly & Wiring

Chassis Mechanical

Many CAE projects are designed to “drop into” existing Dynaco products. Although it is possible to retain the existing wiring and simply attach our modules I strongly recommend that you completely rewire the amplifier. Given the average age of these amplifiers, the wiring and solder connections are very suspect. The teflon wire we recommend will have much better reliability in a tube environment than PVC types. Full manuals for select Dynaco products are available at our website (www.curcioaudio.com) to assist you.

CAE products which do not utilize the existing Dynaco chassis will need to be housed in a new enclosure. Some of our products have custom enclosures from specified vendors (identified in the parts list). In other projects, our customers have all but rejected the idea of pre drilled enclosures (preferring instead to “personalize” their project) and therefore we no longer offer pre drilled enclosures.

For those who wish to completely personalize their project, I recommend that you place the components for each major subassembly in place to visualize how they will appear when completed. Pay particular attention to the possible wiring routings and how this wiring will relate to both the components of each subassembly and also the other subassemblies.

Next complete the front and rear panel layouts including any wiring that is confined to these subassemblies. Next complete the main chassis subassembly. This includes the assembled pc board modules and other chassis components. Also complete all wiring which is confined to this subassembly. Once all of the subassemblies are completed begin to wire the main chassis subassembly to the adjacent subassembly one by one until all are completed. Observe the clean wiring practice previously discussed.



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Chassis Sub-Assembly & Wiring (cont.)

Wiring

We recommend the use of 22 gauge teflon insulated stranded wire for all internal wiring with any of our projects. Using four colors (red, black, green, and white) it will be possible to group your connections by function (ac power, HV power, filament, signal input, signal output, etc.) using twisted groups. For example, should the input module of our power amplifier has sever functional groupings:

- filament power
- feedback
- input signal
- HV & gnd & ref
- +out & - out

I recommend a twisted group for each. In the case of the filament, two twisted black wires would suffice. In the case of the feedback, input signal, and + & - out, you could use a black & white twisted pair for each. Finally for the HV / gnd / ref group a three wire twisted group (red, black, white) should be used. These groups should be routed logically to their destination so as not to couple into another twisted group. This technique is easy, inexpensive, and sonically outstanding.

Before you begin I would suggest constructing several twisted pairs (red / black, black / white, red / green, and black / black) of about 20" each. In addition create about 20" of a red / white / black triple. In the balance of your wiring there may be a few instances where a greater element count twist may be required. In those cases you can build as you go. Finally if you are concerned with shielding, you can also purchase 1/4" diameter braid and fish through the twisted pair. Do not use the braid to carry the current only to shield (connect only to the source end).

For power connections simply twist the This is available for a number of both national electronics distributors as well a audio specialty distributors. Using heavier gauge wire, or "audiophile" branded wire is not recommended. There are several reasons:

- It is more than adequate to carry the currents associated with your project
- Twisted pair teflon insulated stranded wire sounds as good as any "audiophile interconnect"
- It will easily stand up to the heat required to make the solder connections
- It is simply easy (except for stripping the insulation) to work with



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System Checkout

CAE products have been designed to be able to tolerate a wide variation in most component tolerance and as a result require minimal adjustments. Therefore most will be ready at his point for the application of power.

However some of our circuits are very sensitive to the proper operating currents and in these cases an adjustment potentiometer has been included. Those which require calibration adjustments will have as part of their documentation a step by step procedure describing the steps, circuit points to be monitored, adjustment control, and expected results. Please be sure to review your documentation for this information.

Troubleshooting

Dry Tests

Nearly all of the problems encountered with initial start up are related to poor connections and soldering. Therefore it is imperative as a preventative measure that you visually examine all of your connections. This is particularly true with our double sided boards where it is necessary to solder both sides of the component lead. If any connection appears suspect follow the instructions in our soldering tech note to repair the connection.

The second most troublesome problem is with components which have been inserted incorrectly (polarity). Be sure the diodes, transistors, integrated circuits, and electrolytic capacitors are in the proper location and correctly oriented. Once again a visual inspection compared against the stuffing guide will resolve a great number of problems.

Finally, on several occasions, we have seen components installed which are the wrong value. This is most common with color coded parts such as resistors. For example a 100 ohm 1% metal film resistor has color bands - brown/black/black/black/brown while a 1000 ohm 1% metal film resistor has color bands - brown/brown/black/black/brown. It is very easy to confuse the two. If you assembled your pc boards as suggested (in component type groups) hopefully you measured the value of each resistor with your ohmmeter before insertion as described. Also check capacitor values carefully. It would be easy to mistake a 0.001 uF disc capacitor with a 100 pf capacitor.

Infrequent but sometimes a problem are wiring errors. If you have confirmed the correctness of the previous items you can check the wiring by either tracing each lead or with you ohmmeter set to its lowest setting. Look for 0 ohms from end to end. If you obtain a reading of 10 ohms or so you are probably not looking at the same lead. Where you have used twisted groups be sure you have not interchanged the wiring. This is most common with twisted pairs where the “hot” lead is reversed with the “neutral” lead.



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Troubleshooting (cont.)

Tests Under Power

Warning: Lethal voltages will be present during all of these tests. Please exercise the greatest care to avoid any contact with any components.

Most problems that you will encounter will reveal themselves as a deviation from proper DC voltage potential. Therefore as a first measure it is always useful to check the circuit's DC voltages.

As we have noted before, use only a high quality voltmeter. Use the DC Volts setting and if you have a manually adjustable voltage level setting, set it one step higher than the expected voltage level. Also, be very careful with your voltmeter leads. On many occasions a slight slip will cause far more problems than are already present.

Once you have located a suspect component(s) always power down and wait several minutes for the electrolytic capacitors to discharge - then replace the part. During the process be careful not to disturb the wiring - always examine the integrity of the wiring after you have made the repair to avoid creating additional problems.

If you should encounter a defective part, be sure to consider both the cause and the effect. If for example you find a overheated resistor, consider what may have caused it to overheat and replace that part as well.

The best place to start is in the power supply and regulator section. Keep a notepad handy to record the values. Measure (relative to ground) all of the voltages at the input and output of the regulators. Regulated voltages should be within 2% of that specified on the system schematic. Input voltages to the regulators (right off the rectifier filter bank) will have greater tolerances (+/- 20%). If at this point you find a discrepancy, stop. The problem is likely in the regulator circuit. To be sure power down, wait several minutes for the electrolytic capacitors to discharge, and then disconnect the amplifier circuit from the regulator lines. Power up and take your measurements again. If correct, the problem is in the amplifier circuitry. If not correct, suspect the regulator and probably one of the semiconductors. It is common with regulator failures that several of the semiconductors fail in rapid sequence - therefore more than one is likely defective. Therefore we strongly recommend replacement of all of the regulator semiconductors if you encounter this problem.

If you have determined that the problem is not in the regulator, the next step is to isolate the section of the amplification circuitry that may be defective. Try to isolate the defect by channel and or section (e.g. line stage vs. phono stage with preamps, or driver stage vs. output stage with power amps). In this manner you can localize your investigation. Also, because we are dealing with a multi channel project, it is very useful to compare one channel against the other. Usually one will be operative and therefore provide the choose to repair the other. Take and record the voltages at the pins of each tube, FET, and transistor (you can ignore the regulator associated devices as we have already confirmed its operation).

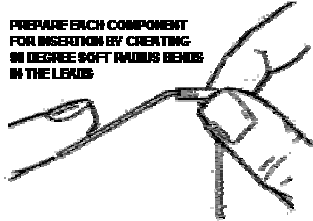
If you have an oscilloscope you should apply an input signal to the input and try to follow the signal through each stage of the amplifier. Usually there will be an increase in level (except for cathode followers and source followers) - but there should not be a decrease in level. This usually indicates a problem in that stage.

These steps will usually resolve 90 % of all problems. However if you prefer not to get into this kind of diagnosis, please feel free to call us for preparation for return to our lab for resolution.

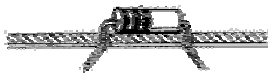
PC Board Component Illustrations

Component Insertion

PREPARE EACH COMPONENT FOR INSERTION BY CREATING 90 DEGREE SOFT RADIUS BENDS IN THE LEADS

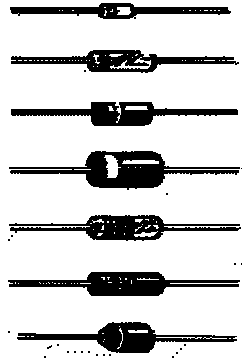


INSERT THE COMPONENT'S LEADS THROUGH THE ASSOCIATED HOLES IN THE PC BOARD, THEN SLIGHTLY BEND EACH TO CAPTURE THE PART AGAINST THE BOARD.



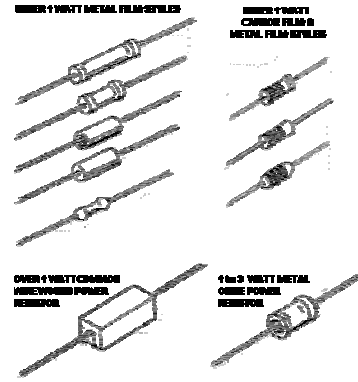
Diode Styles

Signal, Power & Zener Diodes
1. Have the Following Possible Forms &
2. Are Bipolar (Have ONE Correct Orientation)



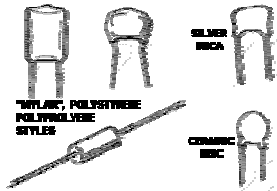
Resistor Styles

RESISTORS ARE AVAILABLE IN MANY STYLES



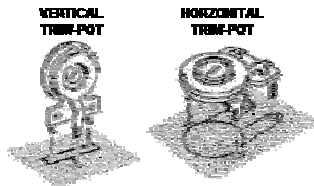
Mylar Capacitor Types

NON-ELECTROLYTIC CAPACITOR STYLES



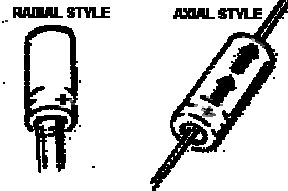
Trimpot Types

PC BOARD TRIMPOT STYLES

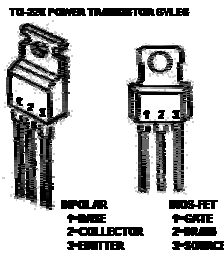


Electrolytic Capacitors

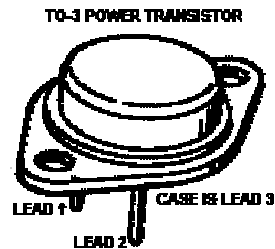
PC BOARD ELECTROLYTIC CAPACITORS
1. Have the Following Possible Forms &
2. Are Bipolar (Have ONE Correct Orientation)



Power Transistors & MOS-FETS, TO-220 Style



Power Transistor, TO-3 Package

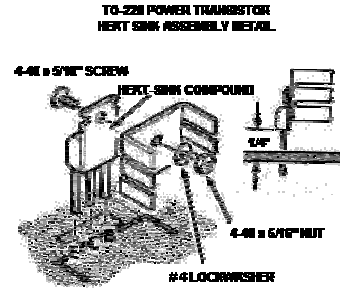
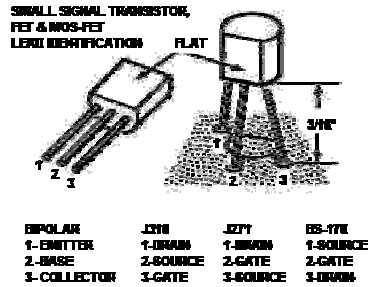
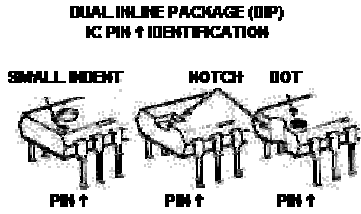


IC DIP Orientation

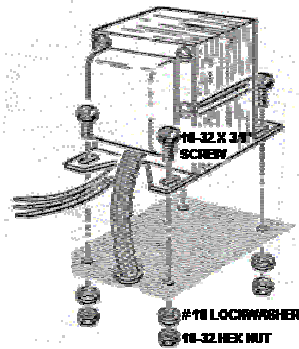
Small Signal Transistor

TO-220 HeatSink Assy

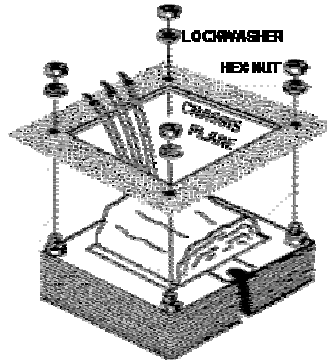
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Chassis Surface Power Transformer Install



Through Chassis Power Transformer Install



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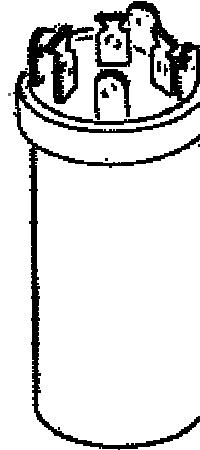
Chassis Mount Component Illustrations

Fuse Holder

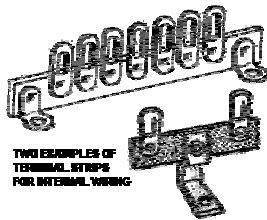


Dyna "Quad" Capacitor

"QUAD" FOUR SECTION
ELECTROLYTIC CAPACITOR

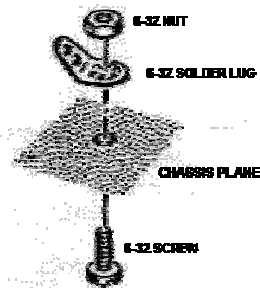


Terminal Strips



Ground Lug Installation

GROUND LUG
INSTALLATION DETAIL



Line Cord Installation Illustration

LINE CORD ASSEMBLY PROCEDURE

