Figure E-1

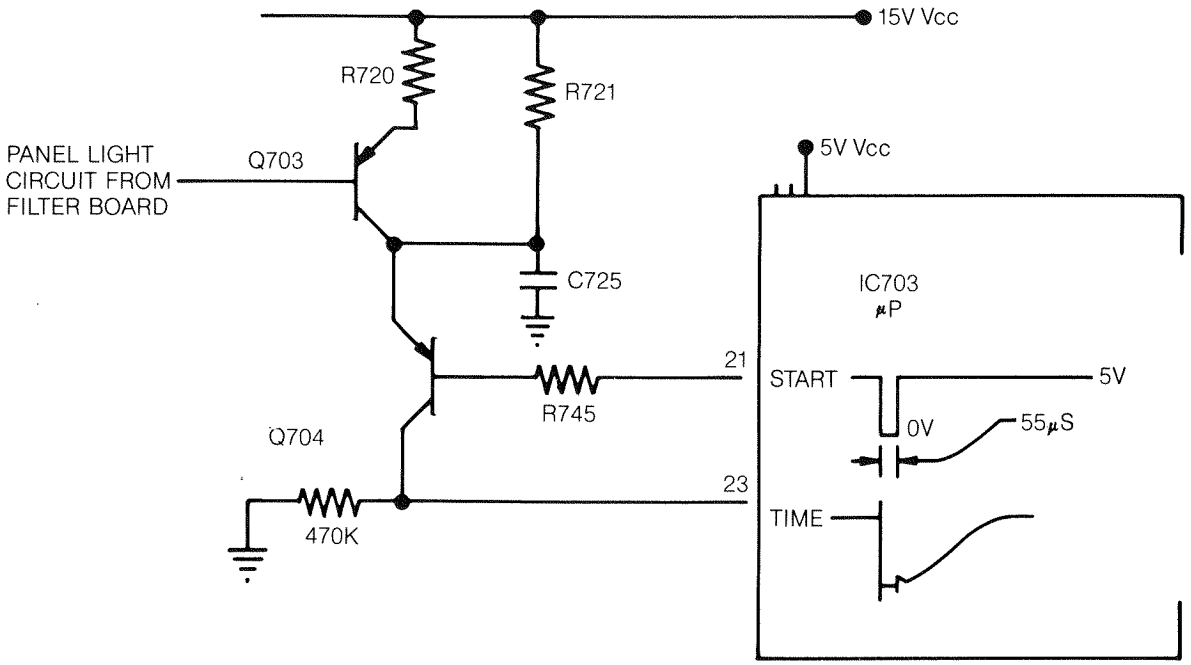


Figure E-2a

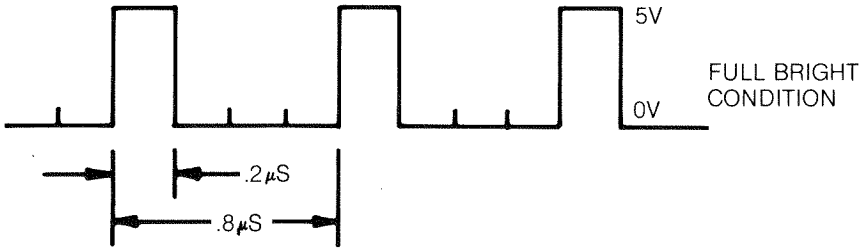


Figure E-2b

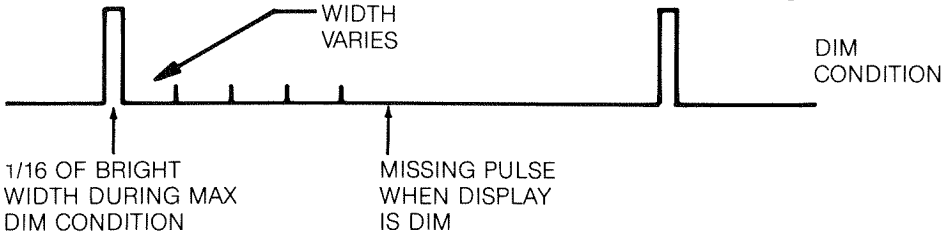
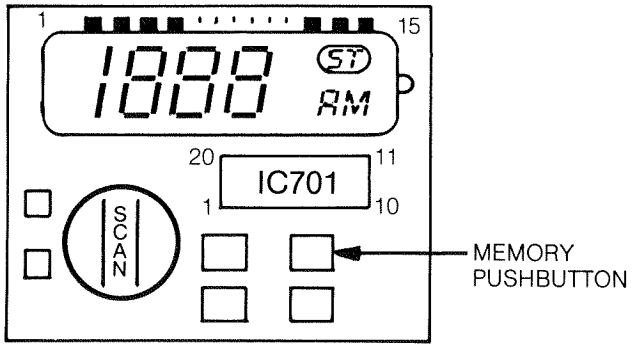


Figure E-2c



E LOGIC BOARD DC-DC CONVERTER THEORY

The DC-DC converter, in the 1986 ETR is used to supply the necessary voltages for the tuning loop and the fluorescent display. The input to the circuit is the A line, approximately 13 to 14 volts. The outputs include (−)6.5 volts for the audio mute circuit, (−)21, (−)18, and (−)16 volts for the display and (+)13 volts for the tuning loop operational amplifier

Figure E-3 is a simplified schematic showing the switch transistor Q705, the regulator transistors Q706 and Q707, and the converter transformer T701. Overall, the supply is a "flyback" transformer circuit. Resistor R727 causes base current to flow from transistor Q705 which increases the collector current through Q705. Resistor R725 limits the Q705 collector current during this cycle. As the current increases in Q705, the magnetic field from the primary (pins 5 and 6) is coupled into the secondary (pins 1 and 2). With the transformer inversion the resultant base-drive is in-phase and therefore delivers positive feedback. This action "charges" the transformer, magnetically. The positive feedback continues until either the transformer saturates or the regulator transistors Q706 and Q707 shut down transistor Q705. When transistor Q707 conducts, it causes a short across the secondary of T701 which removes the positive feedback from Q705, causing the magnetic field to collapse. As the magnetic field continues to collapse, transistor Q705 is held in the cut-off condition. After discharge, the turn-on cycle starts again as described earlier. The turn-on (transformer charge) cycle and turn-off cycle continue at an approximate 8KHz rate. The rate varies with changes in load because as power is used (withdrawn), the start cycle starts either sooner or later and depends upon the regulator circuit.

Regulator transistors Q706 and Q707 use the +8 volt supply, which is very stable, for a voltage reference. The basic regulator circuit is shown in Figure E-4a, but first review Figure E-4b, which is the Q706 circuit. Note that the base is grounded. Therefore the emitter must become at least (−)0.7 volts for the base to appear positive in order to turn transistor Q706 on, and to cause collector current to flow. Resistors R732 (2.4K) and R731 (5.6K) form a voltage divider which is the heart of the regulator circuit. As the (−)21 volt line changes, the series current through R731 and R732 also changes, which alters the potential of the emitter of Q706. Transistor Q706 is turned on to turn Q705 off which will reduce the regulated output voltage by reducing the next charge cycle in T701. When Q706 conducts from collector to emitter, Q707 also conducts. Therefore, resistor R727 is pulled up to the supply line. Referring back to Figure E-3, note that if Q707 is conducting it will connect the emitter and base of Q705 to the same potential, and therefore, the transistor Q705 will turn off. Note also that these waveforms are not actual signals.

During the collapse of the magnetic field in T701, a large reverse voltage is induced into the secondary of the transformer. Because this voltage is much higher than the reverse voltage capability of the Q705 B-E junction, diode D713 is used to dissipate this energy in R726 when the diode conducts to the supply line. This protects Q705 from reverse breakdown. Resistor R726 also limits the maximum forward drive current to Q705 to a level high enough to fully saturate the transistor, yet low enough so the base of Q705 is not damaged by excessive base current.

Figure E-5 shows how the 13-volt supply is developed using the secondary of T701 and diode D712. Components D712, C725, R724 and C727 form a capacitive input filter. Therefore, the voltage at the junction of D712 and C725 is approximately equal to the peak T701 secondary voltage, typically 30 to 33 volts. The 13-volt level is achieved and maintained by zener diode DZ702. This voltage is used for the synthesizer 13-volt supply.

The basic (−)21-volt supply is shown in Figure E-7. Using an independent rectifier D715 on the secondary of T701, a negative voltage is developed. Capacitor C732 forms a capacitive input filter and again the output is approximately equal to the peak voltage on the primary. This voltage is sensed by regulator transistors Q706 and Q707, via R731, as explained earlier (and shown in Figures E-3 and E-4).

The display tube filament is driven from an independent secondary on transformer T701 as shown in Figure E-7. The filament supply is also referenced to the −21-volt supply. Because this winding has a low ratio compared to the primary, the output voltage is low, typically 2 volts. When measuring the voltage on the three wires leading to the display tube, it is important to measure the difference between the two filament lines. The typical difference is from 1.8 to 2.2 volts, with a nominal level of −18 volts to ground. Therefore, you should expect to see three negative voltages on these lines: −16, −18, and

– 21 volts. The offset voltage of 3 volts is established by zener diode DZ703 which is connected between the – 21 supply and the filament supply. The filament supply becomes – 21 less 3 volts or – 18 volts. The second line is an additional 2 volts positive which is – 16 volts with respect to ground. These connections and voltages are illustrated in Figure E-7. Resistor R743 (20K) is necessary to maintain a stable current flow through zener DZ703 and therefore a stable offset voltage. Resistors R740 (39K) on the logic board and R741 (18K) form a simple voltage divider from the – 21 volt supply to form the – 6.5 volt supply. Note that if the mute DC line is unplugged the – 21 volt supply will not change but the audio mute circuit will be disabled.

Figure E-8 is a reprint of the DC-DC converter schematic. The components not explained are routine parts such as L703 and C742 which form an L-C filter for the 13-volt supply, or C741, C737, C736 and C734 which are for high frequency filtering. Other components are considered to be self-explanatory in the circuit application.

Because the DC-DC converter is basically a closed-loop oscillator it is important that virtually all components be properly soldered into the circuit and be of proper value. Many single components can completely disable the oscillator, making troubleshooting very difficult. DC voltages can be very misleading because of the extreme pulse size on both the primary and secondary of T701. Therefore we strongly suggest the use of an oscilloscope with a 10X probe. DC voltages are reliable after the various filter diodes. These voltages are noted in Figure E-3 through E-8. The filter and control diodes are:

D716	Filament	approximately – 16 volts
D715	Display	approximately – 21 volts
D712	Plus supply	approximately + 30 volts
DZ702	+ 13V supply	approximately + 13 volts
DZ703	Filament offset	approximately – 18 volts

Figure E-3

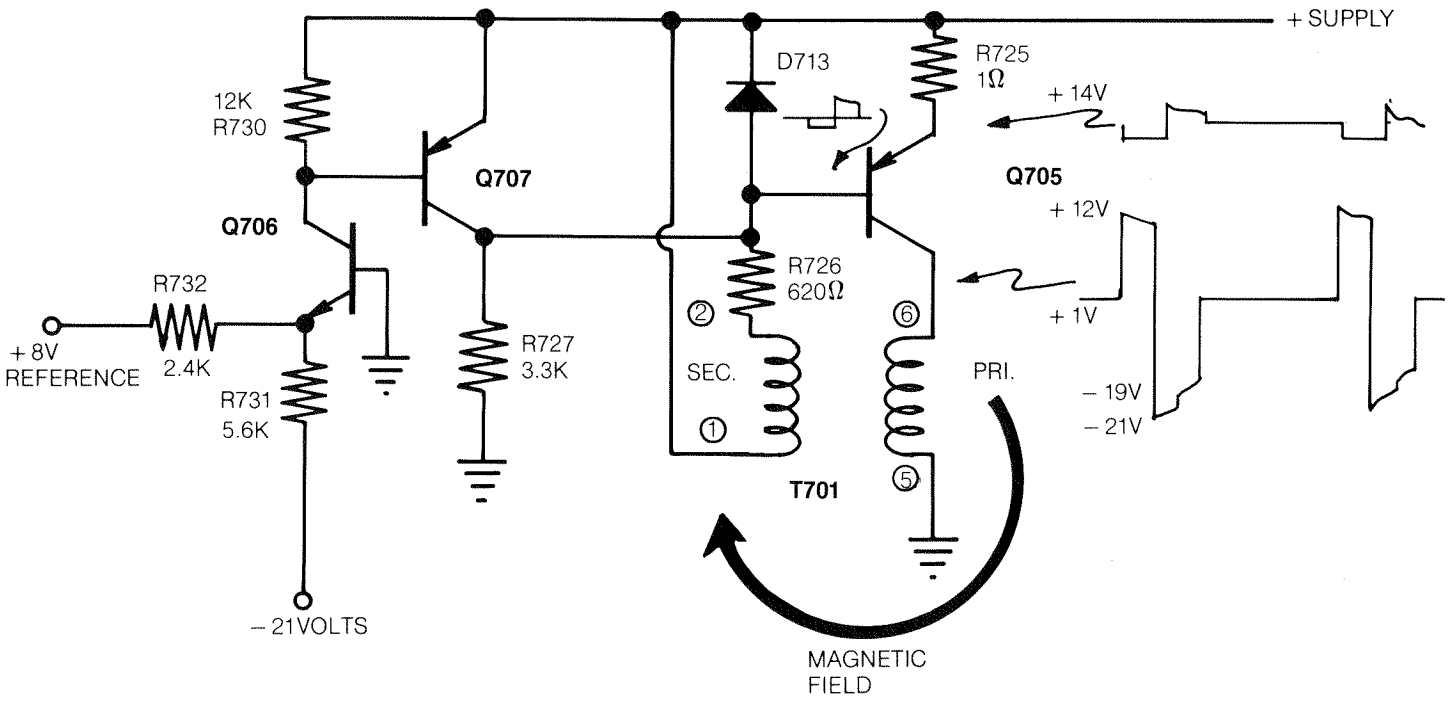


Figure E-4a

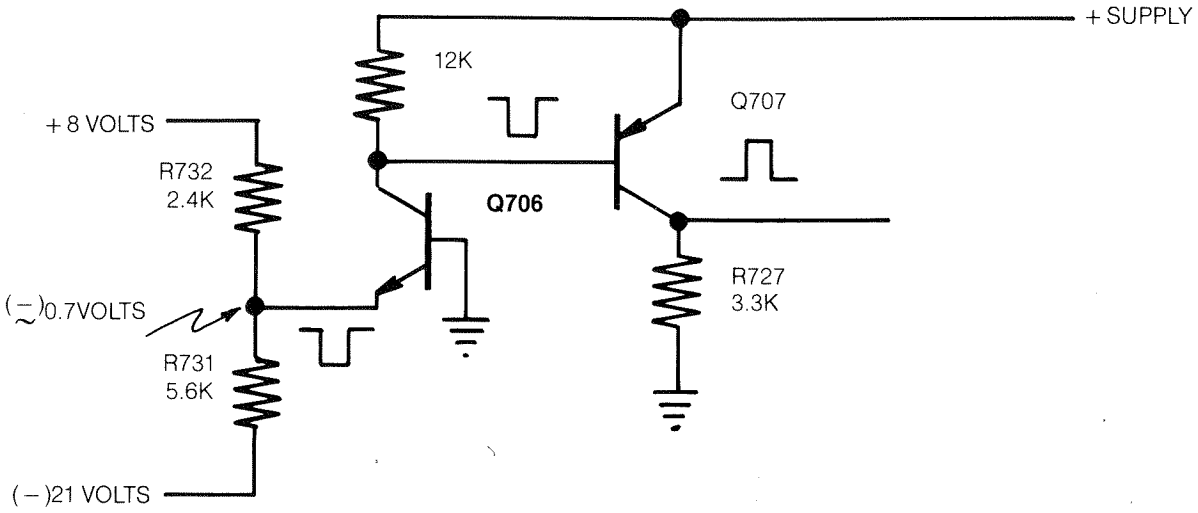


Figure E-4b

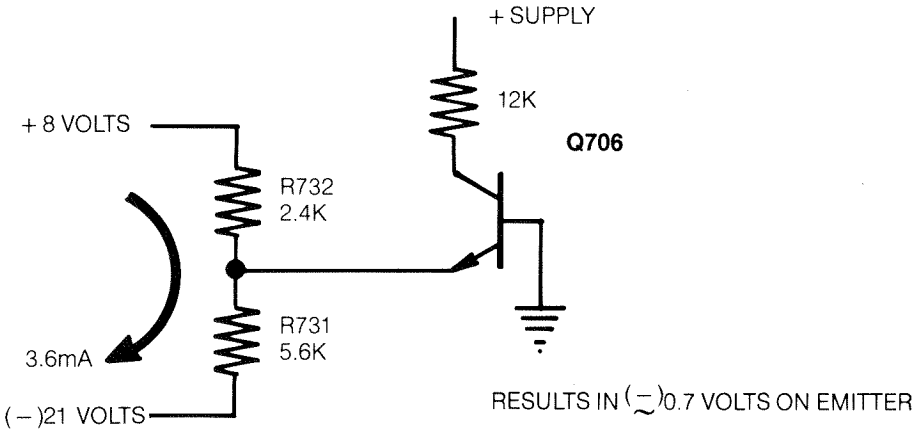


Figure E-5

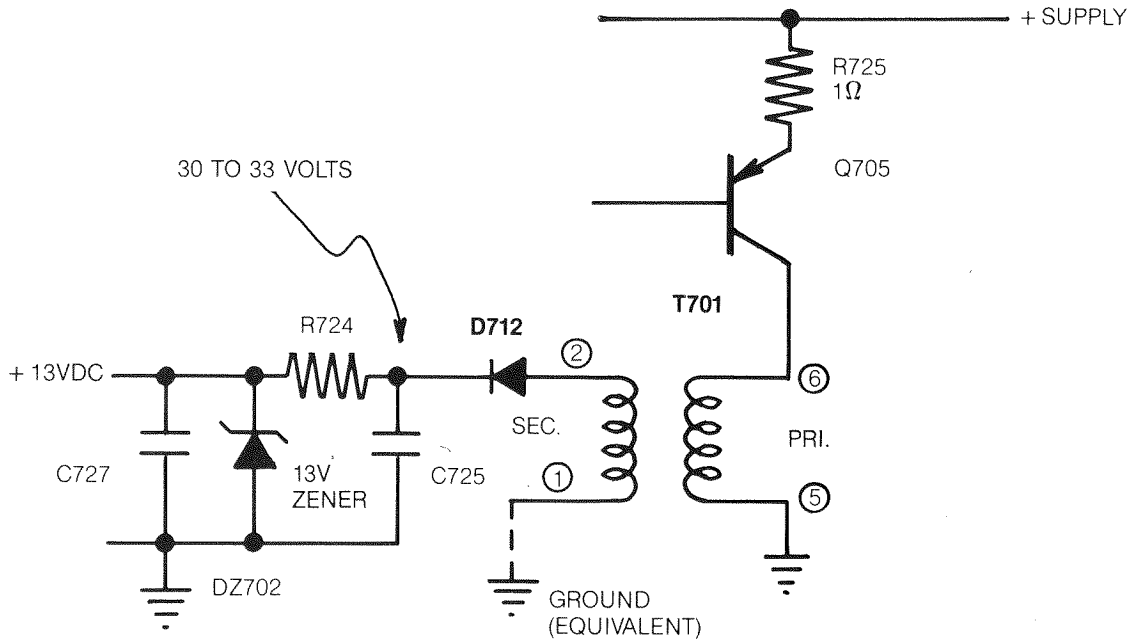


Figure E-6

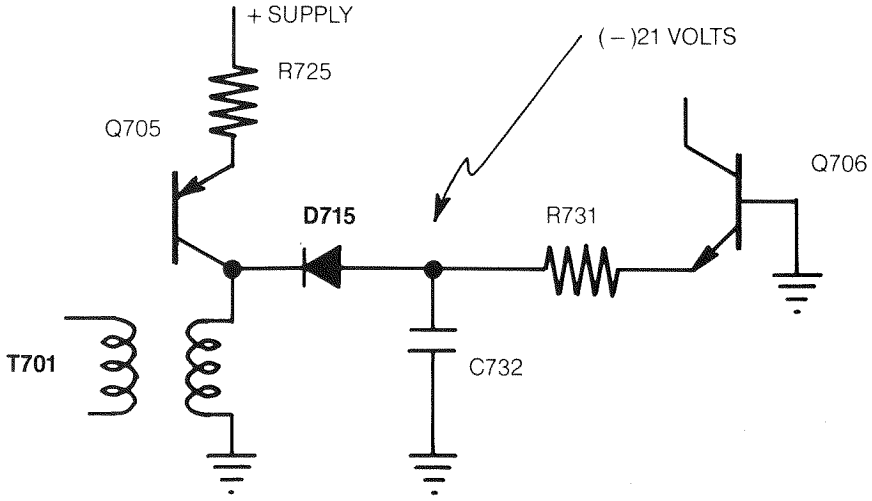


Figure E-7

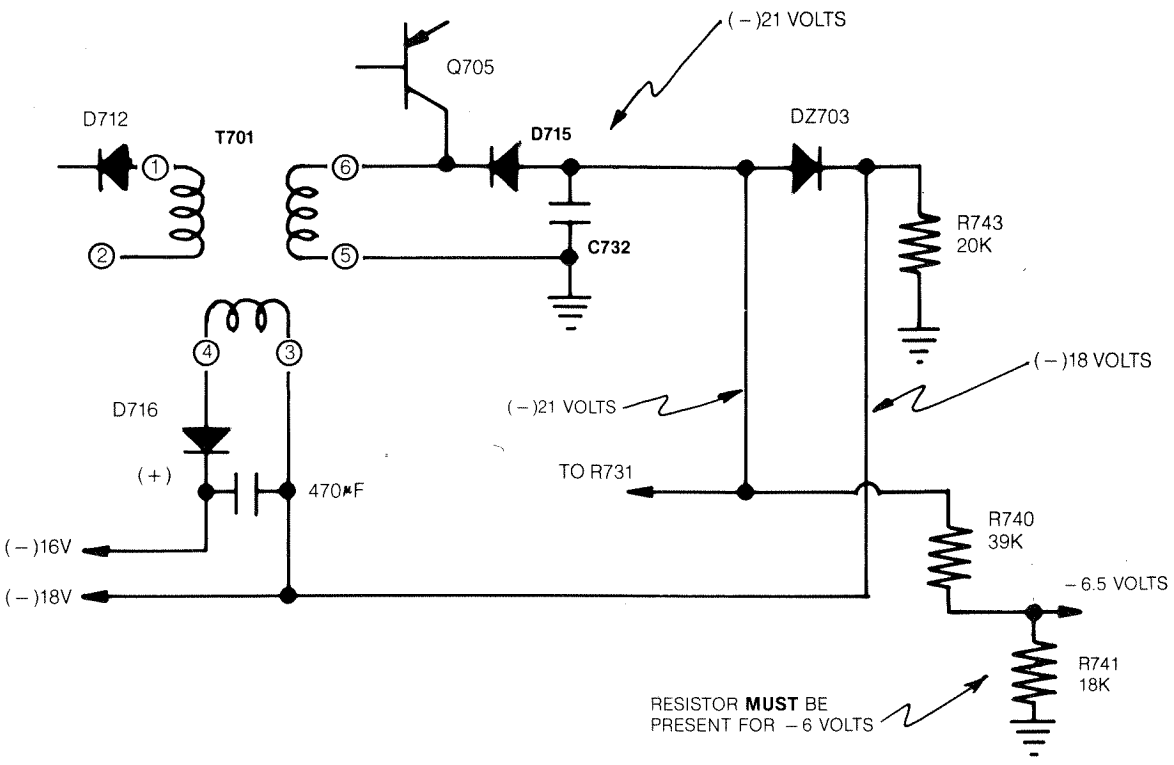
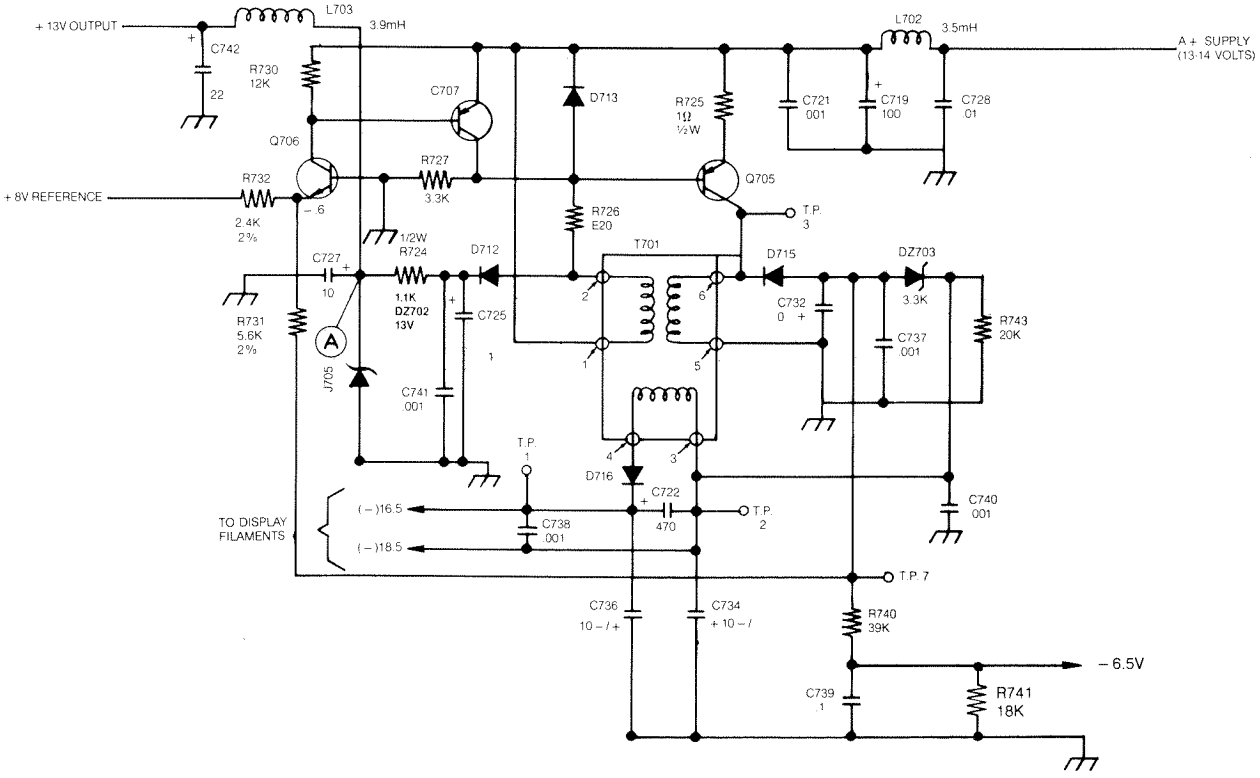


Figure E-8



E DISASSEMBLY/ASSEMBLY PROCEDURES

Caution: The Disassembly of these radios requires de-soldering of several connections which disable the radio. It is therefore advisable to isolate each problem to a specific panel before proceeding with complete disassembly.

Note: The numbers in parentheses which follow the headings indicate the steps which must be completed before attempting to proceed with the next disassembly instructions. **Disconnect all power to unit**.

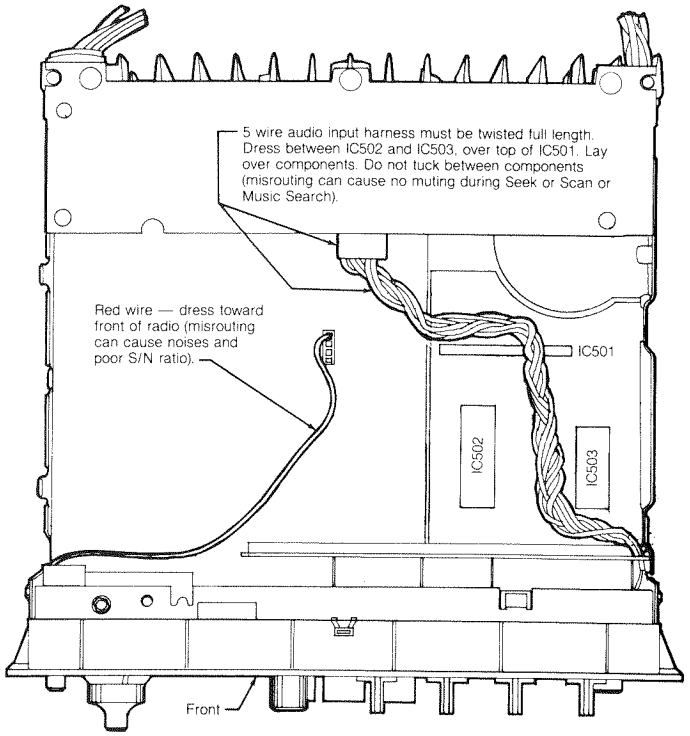
1. **Bezel**/Pull the volume, bass, treble, balance, fader, outer and inner tune/function knobs off their control shafts. Remove the two 4B screws (one on each side of the bezel). Pull the bezel forward off the chassis.
2. **Top Cover**/Remove the two 6/32 taptite screws from the rear top corners, and two 6B screws on the front of the cover. Slide the cover to the rear until the front edge notch is clear of the tab in the chassis. Lift off cover.
3. **Bottom Cover**/Remove one 6/32 screw that holds the A+ choke to the heat sink and unclip the foot of the choke from the slot in the cover. Remove two 6/32 screws that hold the cover to the heat sink, and five 6B screws along front edge of cover. Slide the cover to the rear until it clears the bezel ears on the front of the chassis. Lift cover off.
4. **Audio Panel (2, 3)**/Remove the single 6/32 screw in the plastic wire dress clamp that holds the A+ connector assembly and antenna socket to the heat sink. Remove the clamp, wires and socket from the heat sink. Remove the electrical connections that go to the filter, stereo, and tone panels. (Some assemblies may require de-soldering of the 5-wire connector to the tone panel.) Remove the four screws which attach the heat sink to the chassis, then lift off audio panel and heat sink as an assembly.
5. **Filter Panel (2, 3)**/Remove the taptite screw from the plastic wire dress clamp to free the A+ wires. Remove the screw that holds the 5 and 8-volt regulator heat sink to the chassis. Remove the electrical connections from the power switch, pilot light and logic panel along the outside edge of the panel. De-solder one eyelet at the rear edge of the logic shield. Lift the panel from the eyelet mounting tab. When the eyelet is clear of the logic shield, slide forward until the two tabs at the rear of the panel are clear of the slots in the heat sink. Lift out panel. **Caution: Do not power up the radio with the regulator panel ungrounded.**
6. **Logic Panel (1, 2, 3, 5)**/De-solder the black ground wire from the chassis. Remove the electrical connections between the logic panel and AM-FM, stereo, and cassette music search panels (where applicable). Remove the hex nut and de-solder the tab that holds the display/keyboard section of the logic panel. Rotate downward until the display/keyboard clears the tune/function switch shaft. Remove the 4B screw and de-solder the tab that holds the bottom section to the logic shield, then lift rearward while disconnecting the 3-pin jumper to expose the center section. Remove the nylon spacer and locking washer from the tune/function switch. Remove one 4B screw from the rear of the center panel section, and lift panel from chassis.
7. **AM-FM Panel (2, 3, 4)**/Remove the electrical connections between the AM-FM, logic and stereo panels. De-solder two eyelet locations and one ground tab at the rear center of the panel. Rotate the panel upward from the center of the radio, with care taken to release the tabs that engage the side of the chassis. The panel must be re-aligned if removed (AM and FM, electrically).
8. **Stereo Panel (2, 3)**/Remove the electrical connections to the stereo panel from AM-FM, logic and tone panels. Remove connections from the Dolby, deck tape/radio switch, and music search panels in cassette tape models. De-solder two eyelet locations on the inside edge and lift the panel out from the center while disengaging panel tabs from chassis slots.
9. **Tone Panel (1, 2, 3, 4, 7, 8)**/Remove five hex nuts at the front of the chassis on volume, bass, treble and speaker controls. In some (early production) cassette models, remove the electrical connections from the Dolby panel. Pull the tone panel backward off the chassis. Take care to note correct lead dress for the interconnecting wiring.
10. **Cassette Panel (2, 3, 5)**/Straighten the twist tabs that hold the panel to the underside of the chassis. De-solder the one eyelet which provides chassis ground. Remove the connections between the panel, music search panel, deck, logic panel and stereo panel. Lift panel from chassis.
11. **Cassette Deck (1, 2, 3)**/Remove two hex nuts that attach the cassette front bracket to the chassis. Remove the electrical connections from the cassette panel and stereo panel. Remove electrical connections going to music search panel. Remove deck from chassis.
12. **Music Search Panel (1, 2, 3, 11)**/Remove electrical connections between deck and panel. Straighten the two twist tabs holding the panel to the deck and lift the panel away from the deck. Remove two screws holding the deck to the front bracket, and remove the deck. Remove three screws holding the switches to the front bracket and lift the switch and LED panels away from the front bracket.
13. **Reassembly Instructions**/Follow dissassembly instructions in exact reverse order. Use extra care to ensure correct lead-dress in all cases. Avoid pinching or damaging wire connections and jumpers.

Special Service Notes

1. When servicing radios described in Section E of LAR 1986 with a single bench power supply, turn the radio off then back on again to reset the Microprocessor. Otherwise, the Microprocessor may transmit strange information to the display or operate the radio in some peculiar mode.
2. This radio has a volatile memory. If the battery line is open, the radio **will not operate properly**. Strange characters on the display are typical indications that the memory power supply is open.
3. Only one tune voltage line exists for both AM and FM. Therefore a tune voltage is present in AM when the radio is in FM and vice versa.
4. The Dolby NR circuit functions only in tape player mode in the 1985 radio models.
5. This stereo decoder has a "blend" function for improved signal-to-noise with weak signals. This means that the presence of the stereo light does not necessarily mean that stereo separation is present, particularly at low signal levels.
6. **Do not** ground the rear audio output channels. These circuits are in a bridge configuration where all speaker lines are "hot." Grounding one of these lines will destroy the associated output ICs.
7. The tone controls (treble and bass) will have very little effect upon a 1KHz tone modulation.
8. The radio display dimming circuit needs the ground return provided by the pilot lamp. If the lamp is removed (or defective), the display will remain in the "Dim" mode.
9. A flashing "AM" or "FM" symbol on the display means that the radio is in a "Scan" mode and will change frequency within approximately eight (8) seconds unless disabled by depressing one of the tune controls (Memory, Scan or Seek).
10. The lead dress of some circuits is critical. See line drawings for critical areas. Test by holding the Seek button in while listening for good muting on all four speakers.
11. The AM I.F. frequency is now 450KHz, not 455KHz.
12. The rear stud of this radio is metric.
13. In order to see and adjust the 19KHz stereo decoder signal at pin 16, IC502, a pull-up resistor of 15 K ohms must be connected from IC502, pin 16, to B+ on the PC board. Remove resistor after completion of test.
14. A service cable kit is available which consists of the **components only** for fabrication by service personnel. The kit includes individual 24 AWG conductors approximately 6 to 8 inches long, each with a pin connected on one end. These pins will be inserted into the miniature Berg connectors (also supplied). A strip of header pins is provided, and these will need to be cut to meet specific requirements. Each conductor will have to be soldered to the pin at the header end of the lead.

To order the kit, requisition as follows:
Service Cable Kit, P/N424-9725

1986 Lead Dress For ETR



Top of Radio Shown