"E" SERIES REPRODUCER

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Design Innovators - Quality Manufacturers

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1.0 GENERAL DESCRIPTION

The Audi-Cord Corporation "E" SERIES Reproducers and their companion recorders represent a new generation of cost-value engineered cartridge machines containing the latest in solid state components and modern hardware, designed into a readily accessable modular unit with a minimum of discreet wiring. The only moving parts are the solenoid and the associated tape engaging mechanism.

The "E" SERIES contains all the controls and features common to others on the market, as well as some features unique to Audi-Cord Corporation. To obtain the maximum benefit of these features, study 3.0 of this manual carefully.

The "E" SERIES Machines are designed in harmony with the 1976 NAB Cartridge Standards and it's intent; however, certain level and response parameters are supplied to levels more consistent with the needs of the U.S. domestic market use. These parameters are readily altered by the user to the 1976 NAB Standard when required, following instructions located in Section 7.0, Electrical Maintenance.

1.1 UN-PACKING

Please un-pack carefully and retain the shipping materials until a full inspection is completed.

Before plugging the "E" Series into the proper power source examine the equipment for shipping damage both exterior and interior. Audi-Cord Corporation makes every possible attempt to design the equipment and the packing such that they will arrive in safe condition; however, rough handling by the carrier cannot always be avoided. Examine each circuit card to insure it has not worked loose from its socket and inspect heavy members such as the transformers to insure they have not been broken loose or shifted on their mountings.

If damage has occurred, please notify Audi-Cord first for advise on claims so that we may avoid unnecessary delay to the repair and your use of the equipment.

1.2 MODELS AND OPTIONS AVAILABLE

The "E" Series Reproducers are available in four basic models consisting of mono and stereo with one tone or three NAB tones. These base models are:

Model E10:	Monophonic;	1kHz Primary Cue only
Model E11:	Monophonic;	3 NAB Cue Tones
Model E15:	Stereophonic;	1kHz Primary Cue only
Model E16:	Stereophonic;	3 NAB Cue Tones

These same reproducers are available in common cabinets which contain three individual units. These models are:

Model E30:	3 Monophonic Units	- Same as E10
Model E31:	3 Monophonic Units	- Same as E11
Model E35:	3 Stereophonic Units	- Same as E15
Model E36:	3 Stereophonic Units	- Same as E16

Cabinets

The "E" Series Reproducers are available in a variety of cabinets and packaging options. These include both desk and rack mountings in single or multiple units within a single housing.

The standard desk mounted cabinets are designed with a slip-lift removable cover for cleaning and adjustment. To remove this cover, grasp firmly and slide forward approximately 1/2 inch and lift upward.

2.0 SPECIFICATIONS: "E" SERIES REPRODUCERS

Rated Audio Output	+8dBm max., factory pad installed for 0 dBm output
Amplifier Overload Capability	+18 dBm min., +20 dBm clipping, Loss Pad Out
Minimum Input Level	+8 dBm min. from 160 nWb/m fluxivity, Pad Out
Rated Output Impedance	600 ohms or 150 ohms Balanced Selectable
Amplifier Output Impedance	*300 ohms on 600 ohms tap *90 ohms on 150 ohms tap
Amplifier Distortion	0.5% max total harmonic @+18 dBm
Hum and Noise	-52 dB re 160 nWb/m @ 1kHz, Mono -48 dB re 160 nWb/m @ 1kHz, Stereo
Signal to Noise (*typical tape*)	-47 dB re 160 nWb/m @ 1kHz
Crosstalk, Cue to Program	50 dB or better @ 1kHz
Crosstalk, Program to Program	50 dB or better @ 1kHz
Start Time	0.12 Sec. Max. @ Min. Solenoid Damping
Stop Time	0.08 Sec. Max. @ Min. Solenoid Damping
Equalization	*Per NAB Cartridge Standard, 1964, Adjustable, due to customer demand
Equalization Adjustment	Both high and low frequencies Adjustable
Frequency Response	± 2 dB to NAB Standard Tape Specifications, typically limited by head contour effects @ low frequencies.

**DOES NOT FULLY MEET THE 1976 NAB STANDARDS*

Phase Stability	± 90 degrees, Long Term @ 12 kHz *Transport is long-term phase stable for selected cartridge under controlled measurements. It is appreciated that phase differential over a group of cartridges and long term use is difficult to acheive unless stringent maintenance and operator techniques are applied. This specification, therefore, represents a best case intent and cannot be guaranteed in the user's application under present typical operations.*
Cue Tones	1kHz Primary, Standard, 150 Hz Secondary Cue and 8 kHz Tertiary, Optional
Cue Inhibit Time	1.75 sec ± .25 sec. Electronic Timed
SEC/TER Cue Switching	Sinking (*Open Collector*) Logic
Cue Switching Loads	100 ma. max., +40 VDC open circuit max.
Logging Output Isolation	40 dB min., from 10K ohm source
Cue Sensor Bandwidth	±5% min @ 6 dB points
Cue Sensor Gain	10 dB minimum Reserve @ NAB Std. Level
Tape Speed	7.5 IPS, Hysteresis Synchronous Direct Drive
Timing Accuracy	.2%, 250 Sec. Tape Method
Effective Speed Accuracy	.2% NAB Method
Flutter	0.15% weighted peak, Maximum

Remote Control (*all inputs are grounded signalled*)	12 Pins permanently wired for: Start Stop Run Lamp Ready Lamp Secondary Cue Out Tertiary Cue Out Gnd (*Chassis*) +24 DC Logging Cue Output
Cartridge Capability	NAB AA size only
Max. Temp. Rise	20 C Max. above 25 C ambient
Recommended Max. Ambient	40 C Max.
Power Requirements	117 Volts, 60 Hz, 50 VA max. (*117 Volts, 50 Hz, on special order*)
Dimensions	5 3/4W x 5 1/4H x 14 1/2L
Weight	Approx. 13 LBS.

3.0 OPERATION

3.1 GETTING THE MOST FROM THE CARTRIDGE SYSTEM

It is Audi-Cord's desire that every owner of the "E" Series Reproducer obtain long and satisfactory service from the equipment; however, since the "E" Series is manufactured to accommodate a wide variety of cartridges from several manufacturers', it is often true that optimum performance is the result of the users knowledge of the differences in these cartridges and their best applications. If these factors are well known, the mechanical fit of the machine and the cartridge can often be optimized by the skilled technician for best performance. Characteristics which most often influence performance of a given cartridge in any machine are as follows:

1. The mechanical fit of the cartridge to the heads and the keyhole opening.

2. The pressure pad design adequacy and fit to the heads as well as interference to the tape guides. In erase/record applications for instance, only a few types will adequately wrap these off center head designs.

3. The friction loss of the cartridge and tape and its' pulling tension. Unlimited tension cannot be handled by the transport since the capstan and roller surface engagement area is limited in the inherent design. Tension typically increases significantly with longer time loads and in wear life.

4. Contamination of the head surfaces if poor tape and lubricant is encountered.

5. The internal quality control and maintenance routines.

The above characteristics are all important if failure of the system is to be avoided. It is unfortunately true that all cartridges are not the same in design and, it is virtually impossible to produce a cartridge transport that performs perfectly with all the types; therefore, the user must select the cartridge and tape best suited to his needs and then make such minor adjustments to the transport as necessary to obtain optimum performance.

Our Service Department will provide assistance when needed and excellent general information is to be found in our Users' Manual and the occasional updates that have been issued.

3.2 SELECTING AND USE OF THE CUSTOMER OPERATING OPTIONS

Replay Reminder Options:

The "E" Series playbacks are equipped with the Replay Lock and Reminder which is incorporated within the transport logic system. Three jumpers are located at the top of the logic card. These are lettered A, B, and C from top to bottom. Each machine is shipped with these links in place. To alter the replay reminder operation it is only necessary to clip out the appropriate link(s) as below:

(A) Replay by removing and re-installing a cartridge or push Stop P.B. for reset = as shipped, all links in place.

(B) Replay by removing cartridge only = clip out link #A.

(C) "Played" indicates but does not prevent "Ready" and "Replay" = cut #C only.

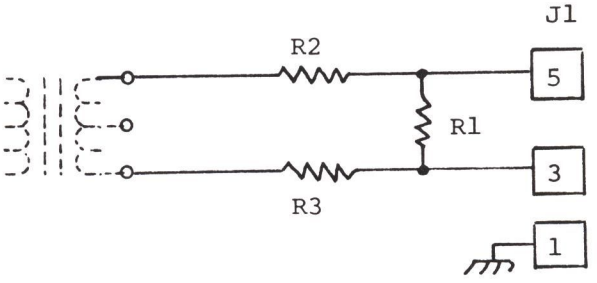
(D) Total defeat, unit returns to Ready, no "Played" indication = cut #B only.

3.3 CONSTRUCTING OUTPUT PADS

The "E" Series Reproducer is designed for +18dBm maximum audio output before amplifier clipping occurs and can be used to deliver up to +8dBm in 600 ohms as required by the 1976 NAB Cartridge Standards; however, most domestic U.S. audio consoles have at best limited inputs suitable for this level without installation of loss pads which are most usually constructed at the source, such as the cartridge machine.

To avoid delay in connecting the "E" Series to most consoles and systems, Audi-Cord has elected to ship these machines with internal pads constructed for the more common 0dBm output level requirement.

The following table and drawing will show the design of the internal loss pad located in each channel of the Output Wiring Card 151-76. This card is easily removed by removing the four (4) tapped screws of the output sockets J1 and J2 and un-plugging the card from the mother board. Refer to the following table and the card pictorial drawing in Section 9 for location and values of the loss pad components for various needs.



VALUE R2 AND R3	VALUE R1	LOSS dB	600 ohms OUTPUT RATING
0 ohms (wire)	Inf. (open)	0	+8 dBm
120 ohms	390 ohms	4	+4 dBm
180 ohms	*470 ohms	*8	* 0 dBm
240 ohms	120 ohms	14	-6 dBm
270 ohms	60 ohms	20	-12 dBm
270 ohms	22 ohms	28	-20 dBm

* Factory Installed

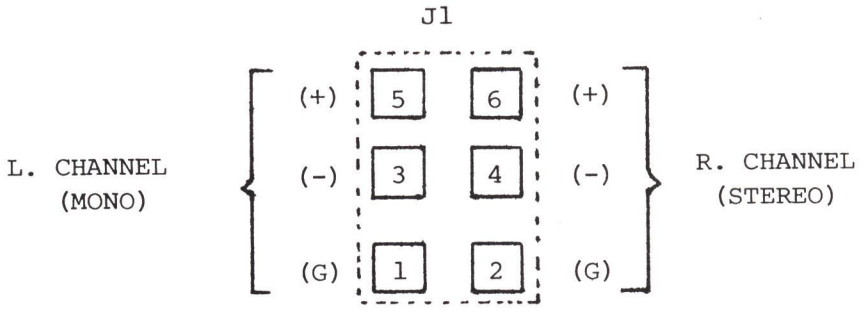
3.4 OPERATING CONTROLS AND INDICATORS

READY LIGHT	Indicates that the cartridge is in place and the machine is ready to play.
START PUSHBUTTON	Places the machine in the run mode.
RUN LIGHT	Indicates that the transport is in the run mode.
STOP PUSHBUTTON	Stops the transport and/or resets the logic when replay lock is chosen to provide this option.

CARTRIDGE SENSOR	Signals the logic when a cartridge is in place and turns the motor "On". Also signals the logic when the cartridge is installed and triggers other optional circuit functions to reset.
POWER LIGHT	Indicates power is on and +24DC is present.
PLAYED LIGHT	Indicates that the cartridge in place has received the Primary Cue tone , and has been played.

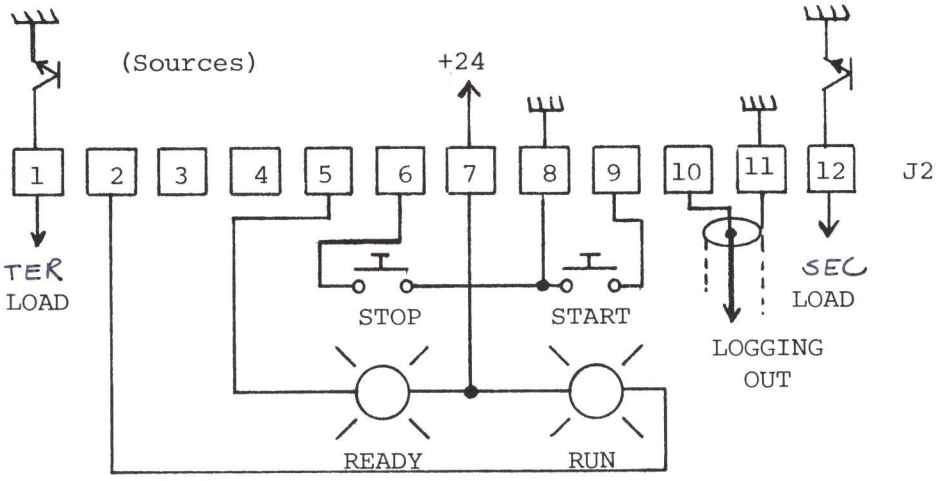
3.5 AUDIO CONNECTIONS

The program output is connected to J1 located on the rear panel using the mating plug supplied. Two wire shielded cable is recommended for this connection. If the required length is more than a few feet, the shunt capacitance effect should be considered to avoid possible high frequency losses. When connecting shields, it is usually desirable to connect to chassis ground on one end only to avoid possible hum loops between the cartridge machine and the connected console or amplifier. The connection diagram is as follows:



3.6 REMOTE CONTROL CONNECTIONS

The 12 pin remote control connector J2 is factory connected for the 10 normally required outputs. The typical remote control connections are as indicated in the pin diagram below.



3.7 OPERATOR PERIODIC MAINTENANCE

The operator is often charged with, or may find it necessary to perform periodic cleaning maintenance and other inspection to insure proper operation of tape cartridge machines. These maintenance routines may be daily or weekly depending upon the amount of use. These typical maintenance functions are as follows:

CLEAN HEADS, PRESSURE ROLLER, and CAPSTAN SURFACES.
These cleaning functions are very important if good air quality is to be achieved. Dirt on heads can cause high frequency losses in replay or recording due to tape spacing from the head gaps and, under worst cases, cause total loss of audio or the cue functions.

Lubricant build-up on the pressure roller surface or the capstan surface seriously degrades pulling capability due to loss of contact friction on these driving surfaces and under worst cases will cause serious "wow" or slip of the tape.

Clean these surfaces with denatured alcohol or isopropol alcohol solvents readily available at most hardware stores, by saturating and wringing dry a soft cloth or swab to avoid dripping of solvent into the motor bearing, etc. Do not use solvents such as Xyolene or Kerosene since these seriously degrade rubber parts.

INSPECT CARTRIDGE and TAPE FOR PROPER OPERATION.
These inspections, especially before re-recording can save the failure later on. Do not attempt to record tape which is slick on either the oxide or the lubricant (rear) surface. Slick oxide surface usually means that much of the oxide is missing and proper recorded levels cannot be achieved without serious distortion and loss of high frequency material. The cue tones especially will usually be weak and may not function properly.

Loss of lubricant means that pulling tension has seriously increased and will soon cause "slip" in the playing sound. It is almost certain that short life will be experienced before breakage of the tape occurs.

Proper operation of cartridges are normally detected during daily use. The careful operator may observe potential recurring failures and avoid their occurrence. Periodic audio drop-out, for instance, may relate to a badly deformed pressure pad or increasing tension which may overcome the pressure pad conformity.

Erroneous cues can indicate "pops" on the cue channel which cause false tripping or stop of the drive system. Failures of these types should result in setting aside the cartridge for further off air testing to determine if they should be used or if machine maintenance is required.

4.0 CIRCUIT DESCRIPTIONS

4.1 POWER SUPPLY AND SWITCHING CIRCUITS

The three D.C. power supplies and the power switching circuits are located on plug-in card 151-52. Refer to the schematic in Section 9.

Diodes D1 and D2 provide rectified DC from the center tapped winding of the power transformer to capacitor C1 for smoothing. This approximately 33 volts DC is fed to edge connection pin 2 for the companion recorder when used and to the input of the 24 volt regulator U1 for further filtering, and use in the machine control circuits. It is also fed thru diode D3 and resistor R1 to the solenoid switching circuit explained later.

Diodes D5 and D6 in a similar manner supply approximately 18 volts DC to the input of the 12 volt regulator U2. This regulated and filtered 12 volts DC is used for the audio and logic control circuits.

Transistor Q1 is a power switch for the solenoid. Capacitor C5 is charged to the 33 volts DC supply when the machine is idle and serves as a "boost" voltage source to accelerate the solenoid when Q1 is first turned on by the logic driver. Diodes D8 and D9 serve as transient suppressors for the solenoid inductance and diode D10 acts as an isolation diode for the Run Lamps.

Integrated circuit U3 (light activated SCR) along with diodes D11 thru D14 serve as an isolated AC switch to turn the capstan motor on or off from the logic signal "MOTOR=0".

Diodes D4 and D7 protect their respective voltage regulators from accidental reverse voltage failure.

4.2 LOGIC CIRCUITS

The logic to control all playing functions and transfer functions for a companion recorder is located on plug-in circuit card 151-73. Refer to the schematic in Section 9.

The schematic is formatted such that most input signals are shown on the left side with output decision signals exiting on the right side. Internal word statements define some of the major signal paths for assistance in understanding. The logic 1 state is at or near +12DC volts and logic 0 state is at or near chassis ground potential.

Integrated circuit U3 is a two section SET-RESET Latch. Section 2 is the START-STOP Latch, and Section 1 is used as the REPLAY-REMINDER Latch. Section 1 of I.C. U1 is the steering gate for the START signal; Ready =0 and Start =0 are both present. Pin 3 is at logic 1, setting the RUN Latch to Run =1.

Section 1 of Integrated circuit U1 integrates the CUE and STOP signals to reset U3. Section 2 of U4 is the cue inhibit timer operating at 1.75 seconds each time the input is gated from the Run =1 signal. Section 4 of U2 integrates this inhibit signal with the Cue =1 logic signal from the cue detector. Section 1 of I.C. U4 is gated from the Run =1 signal and produces a time burst of .5 seconds for use in the mating recorder to time the 1kHz Primary Cue Tone.

Section 2 of I.C. U2 integrates the cartridge sensor signal Cart In =1 and the Replay Reminder latch signal shen used to produce the output Ready =0. Section 3 of U2 integrates the Cart In =1 or Stop Pushbutton action to reset the Replay Reminder latch U3. Sections 2, 3, and 4 of U1 are signal inverters to produce drive for the output driver transistors.

Transistors Q1 thru Q4 are darlington current amplifiers for the lamp and other load sources external to the card.

To assist in troubleshooting the various signal lines are stated in the "true" terms. For instance, the signal statement Start =0 refers to the "0" ground level required. At all other times, the inverse is assumed; typically due to pull up resistors or other gate status that may be connected.

4.3 PROGRAM AMPLIFIER(S)

The program playing pre-amplifier(s) and output amplifier(s) are located on card assembly 151-74. Refer to the schematic in Section 9.

The play head(s) are connected via a 3 pin connecting cable located on the rear of the circuit card.

I.C. U1 is a low noise packaged pre-amplifier with approximately 40 dB of mid-range gain. Two frequency equalizers are provided in the gain loops. For L. Channel of stereo or mono models, R8 is the Adjustable low frequency equalizer of limited range in the inverting feedback section. C5 sets the crossover frequency for R8, which is adjusted typically at 50Hz to improve the low frequency loss and contour effect of the head used. The base gain is established by R5 and C4 while the equalized portion is set by R7. Capacitor C6 bypasses the mid to high frequencies.

R2 is the adjustable portion of the high frequency shunt equalizer, while C2 and R3 establishes the crossover frequency of the equalizer. Resistor R4 establishes the DC feedback bias in conjunction with R6. Level control R9 allows for output level adjustment.

I.C. U2 is a 4 section FET analog control switch to control turn off of the audio during non-running periods. Resistors R19, R20, and R24 and Capacitor C11 provide a ramp-up and ramp-down time to avoid audio pops.

Transistor Q1 is a split phase pre-driver for the complimentary output amplifier Q2 and Q3. The output is coupled thru C9 to the primary of the line transformer.

The R. Channel of stereo models is identical to the description of the L. Channel above except for the change in part number designations.

4.4 CUE AMPLIFIER AND DETECTORS

The cue pre-amplifier and passive detector amplifiers along with their DC detectors for all 3 tones are located on card assembly 151-75. Refer to the schematic in Section 9.

The cue head is connected via a 3 pin connecting cable located on the rear of the circuit card.

Integrated circuit U1 is configured in a two stage equalized pre-amplifier with output essentially constant for the 3 NAB cue tone flux levels. This output is connected thru R8 and C8 to section 2 of I.C. U2 which acts as the isolation amplifier for logging signal outputs, used frequently in automation and accessory controllers.

This output is routed to pin 10 of the remote socket J2 and is often valuable for cue track monitoring and test functions.

Section 1 of I.C. U2 is configured as a bridged T passive amplifier tuned to the 1kHz center frequency. This circuit is stable and will require no further tuning. The output is connected via C13 to Transistor Q1. This is a zero bias A.C. detector coupled thru R21 to C14. These components along with R22 form a time constant to delay turn on of Q2 for approximately 20 milli-seconds to immunize the circuit from short transients and remove "clatter". Q2 derives the logic signal Cue =1 for automatic stop control.

Section 1 of I.C. U3 is similarily the 150 Hz Secondary Cue passive amplifier while section 2 is typically used as the 8kHz tertiary signal. In some cases, this circuit is tuned to other frequencies as customer option.

I.C. U4 is used as the control gate for the SEC and TER outputs. Transistors Q7 and Q8 are the output load drivers.

4.5 OUTPUT CIRCUITS AND MOTHER BOARD

The Output Wiring Card 151-76 is located at the rear of the playback and is removed by loosening the four output jack mounting screws and unplugging from the mother board.

This card contains the output audio pads and the foil wiring for the output circuits, both audio and remote control.

The mother board 151-77 contains the input RF filter and motor phase shift capacitor as well as the foil wiring and interconnecting devices for cards, panel, motor, and companion recorder when required.

5.0 TRANSPORT DESCRIPTION

5.1 THE TAPE DRIVE SYSTEM

The tape drive system in the "E" Series Reproducers consists of the air damped solenoid, a tensilized mylar drive band, a unique pressure regulating driving roller and the cross-shaft.

The cross-shaft is suspended within the stress relieved deck casting on two adjustable ball bearing end pivots which allow rotating freedom without undesired end lash. The regulating drive roller is eccentric in design to provide extra mechanical advantage without increasing solenoid throw. Internal to this roller is a neoprene rubber insert of similar hardness to the pressure roller material except, it contains approximately one-third the pressure surface area. This design affords a three to one pressure storage as a series element for the solenoid. Since all DC solenoids change in pull with internal heat effects, these shifts in pull cause changing pressure and indent of the pressure roller. This will result in tape drift on the capstan if not contained in some manner. The system used in the "E" Series deck, combined with the inherent clearance of the pressure roller bearing, affords an excellent correction for normal service and wear factors.

5.2 HEAD MOUNTINGS AND TAPE GUIDES

The head mountings are of inverted design, allowing for top adjustment of the heads and easy removal from the deck when desired. The entire assembly is mounted with two screws and is re-located exactly by locating pins and mating holes in the deck surface.

The tape guides are of two piece design to allow for exact adjustment to the tape width and are reversible for wear when required.

5.3 CARTRIDGE SENSOR

The cartridge sensor consists of a moving plunger located directly in the cartridge center and a grounding contact at the rear of the mechanism. This system is ultra simple and durable, requiring only occasional cleaning to insure that the contact operates properly.

5.4 CARTRIDGE GUIDES AND HOLD DOWNS

Two types of cartridge holding systems are used in the "E" Series. The monophonic models make use of an adjustable position angle device on the right side and a spring along the left side to reference the right side of the cartridge against the right guide.

Stereo models combine the right guide with a top pressure spring, and a similar hold down is placed on the left side. This arrangement tends to place the pressure on the outer ribs of the cartridge and assists in more precise position of the left corner post without center warp of those carts using center guide devices.

In all cases a center hold down spring is used to assist to stabilize the center area of the cart and close any gaps due to warp of the plastic shells.

6.0 TRANSPORT DIAGNOSIS AND MAINTENANCE

6.1 TRANSPORT FAILURE OR CARTRIDGE AND TAPE FAILURE

The user of tape cartridge machines is often confronted with tape and drive failures such as "wow" or slip in operation which can seriously degrade air sound. It is often assumed that something is wrong with the machines pull (torque), and the engineer is asked to make an adjustment to "fix" the problem. Unfortunately, it is not possible to "fix" a transport drive to pull tape under unlimited demand and is often erroneous and damaging to adjust the motor and solenoid spacing in such attempts. The tape cartridge system is limited by several inherrent factors historic to the endless loop cartridge design. These are the keyhole and the size of the pressure roller and capstan which it will accomodate. It must be recognized that with the small shaft and roller surface area, the lubricant necessary to the tapes very operation, etc., that the pull under clean and new condition of all members is limited and is constantly being changed by condition of the roller and shaft. Under nominal conditions, tests indicate that the tape slip crosses the 0.2% speed specification when pull required to move the tape is approximately 4.5 ounces for typical tape. For this reason, the 1976 NAB Cartridge Recording Standards sets a 3 ounce maximum pulling tension for the tape and cartridge design and maximum load used. Most Cartridges supplied will meet this requirement when new, however; tests indicate that many increase in tension to exceed this requirement in just a moderate amount of use and exceed the 4.5 ounce typical useful drive tension in 200 use trips or so.

If slip from higher than useful pulling tensions occur for an extended period of time, serious wear of the pressure roller and capstan running surfaces will occur, degrading these parts performance to the point that renewal will become necessary to restore original capability. The pressure roller can be easily replaced, however, restoring the hardened rough surface of the capstan shaft is typically a factory maintenance or expensive replacement cost.

Tape Pull and Its Sources: In many cases the pulling difficulty is related to worn out or damaged pressure rollers. In most cases the user feels that better service without maintenance or attention should be realized.

Audi-Cord Corporation uses a pressure roller which is 0.312" high rather than the more common 0.375" high. Since the height the pressure roller can be above the deck surface is limited by the cartridge keyhole, a roller of 0.375" high must be located such that approximately 0.093" of the rubber area is below the bottom of the tape and 0.032" is above the tape. This off center action will cause the tape to tend upward on the capstan shaft unless pressure is carefully maintained both on the roller indent and the tape (cartridge) back tension. To prevent this, Audi-Cord uses the 0.312" high roller which can locate the tape on center of the rubber. Such a roller will inherently reduce the amount of friction applicable to the capstan by approximately 20% and the consequent loss of pull. Typical design allows 18 to 20 ounces of deadweight pull on the tape. This is more than adequate to insure good performance of any useable cartridge design. The 1976 NAB Standard for cartridge and tape pull recognizes the effect of tape and head life and states the pulling tension at 3 ounces maximum. Unfortunately, not all cartridges and tapes are able to operate within this specification.

All the pressure rollers in common use for cartridge machines are interchangeable. The user may, if life considerations are most important, exchange the pressure roller for one of 0.375" height with consequent improvement in brute pull and degradation of the guidance of the tape. This practice is not recommended except in the worst offender cases. A more frequent replacement of the pressure roller is a better alternative. A routine replacement of once a year, depending upon use is recommended. Do not clean a pressure roller with rubber softening solvents such as tolulene, etc. Commercial grade alcohol such as denatured or isopropol is recommended. If unusual applications are encountered, contact the Audi-Cord Service Dept. for assistance and advice.

For the reasons presented above, the user must give serious consideration to the diagnosis of fault in the operation of cartridge machines in his studio operations. Many factors contribute and many can be avoided. Some of the factors of which the user should become aware of are as follows:

(A) Long tape loads should be avoided except where absolutely necessary. The longer the tape load, the higher the risk of exceeding pull limitations.

(B) Be aware that cartridge designs that add extra friction surfaces such as extra posts, etc., typically pull harder than simple loop cartridges and may result in less wear trip life.

(C) Periodically inspect cartridge and tape condition. Look for slick oxide surface, cupping, wrinkling along tape edges, or worn out lubricant. These are signs of extra tightening of the tape supply hub and should be discarded or carefully tested before further use.

If transport maintenance is required, it is usually due to necessary removal of the motor or solenoid, or loose cross-shaft bearings which allow too much side to side motion of the cross-shaft, relieving bottom roller contact on the capstan. If wear has caused a change of pressure roller diameter, it is more desirable to replace the roller than to attempt the critical position of the motor adjustment which is vertically related to the new diameter of the roller, is important to the horizontal drive attitude of the tape in motion, and critical if good tape guidance is to be realized in stereo application.

6.2 ADJUSTMENT OF THE CROSS-SHAFT MECHANISM

The cross-shaft is adjusted for "0" end lash consistent with free rotation. The center of the pressure roller shaft and the center of the capstan shaft are offset such that the pressure roller is .010" to the right (facing) or nearer the tape return side of the cartridge. This insures a slight tape wrap and maximum tape contact to the capstan.

Access to the end bearing retaining screws is gained by removing the stainless overlay plate. Remove the two cartridge side guides, the head mounting frame, and the solenoid drive band to loosen the plate.

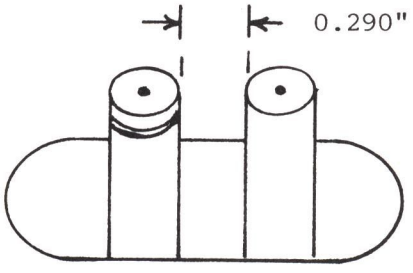
It is best to take up the bearing slack by adjusting the outer (R.H.) end bearing only, leaving the L.H. bearing in place to maintain the roller centering on the capstan.

6.3 SOLENOID ADJUSTMENT

This adjustment is made by releasing the top clamp screw in the end of the solenoid plunger, allowing the band to move in the clamps. Pull the solenoid in electrically and push gently on the end of the plunger to feel the bottom position. Proper adjustment sets the plunger as close to bottoming without pull-in "click" as possible. (approx. .015" from bottom). The pressure regulator within the drive roller compensates for the solenoid pull properly when this plunger setting is close to correct.

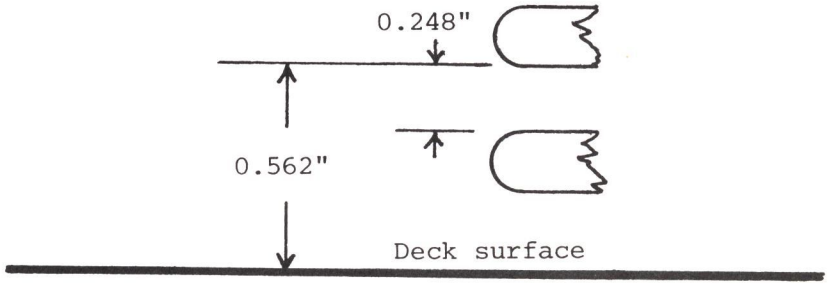
6.4 MOTOR ADJUSTMENT

The motor shaft is located exactly 0.290 inches to the rear of the pressure roller shaft when it is in the vertical position. Use a parallel precision gauge for this adjustment. A drill bit shank will serve as an emergency locating gauge. Use 19/64 or letter drill "L".



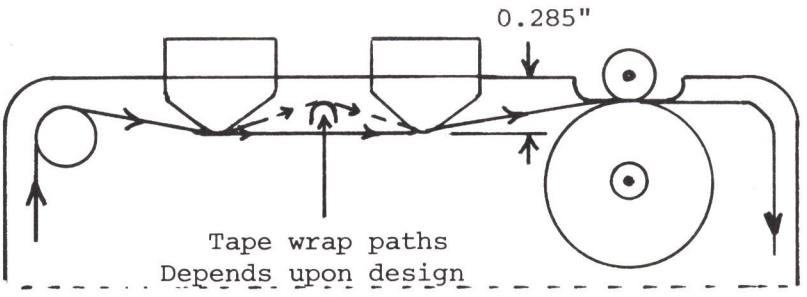
6.5 TAPE GUIDE AND HEAD HEIGHT ADJUSTMENT

The lower guiding surface of the upper guides is located 0.562 inches above a precision flat surface. The upper guiding surface of the lower guides is set typically 0.248 inches lower. This may be done by precision measurement to the surface plate or by using a penetrating gauge such as a Johannsen block.



6.6 HEAD PENETRATION, ANGLE, AND CARTRIDGE TAPE WRAP

The proper head penetration is 0.285 ± .010. A convenient means of measurement is to scratch a line on the front edge of a typical clear cartridge cover.



The head angle has been traditionally designed to face straight to the front in cartridge machines with pressure pads and a center post in place to create the center of the heads wrap. This center wrap has always been less than the outer wrap, however, some of the modern cartridge designs have removed the center guide and its assistance in tape wrap in lieu of the added skew often caused by this center member. With these cartridges and those which the pressure pad is small, it is often necessary to angle the head physically in the mount to better provide head gap contact with the tape and avoid otherwise worse result in tape "drop-out" due to loss of conformity to the head surface under changing tensions of the tape.

It is unfortunately impossible for Audi-Cord Corporation to provide machines "fine tuned" to the users' cartridge and of course the design allows a minimum of change of angle adjustment of the head front surface. Therefore, the user is faced with determining if the head angle should be and can be changed to improve tape "drop outs" with the type of cartridge he uses, and if he should use one specific type of cartridge. The process is at best one of experimentation with results. Audi-Cord will offer service consultation and our best advise in such cases to assist the user in getting the best performance possible from the equipment.

7.0 ELECTRICAL MAINTENANCE

7.1 HEAD AZIMUTH AND PHASE ADJUSTMENT

Head Azimuth - Monophonic:

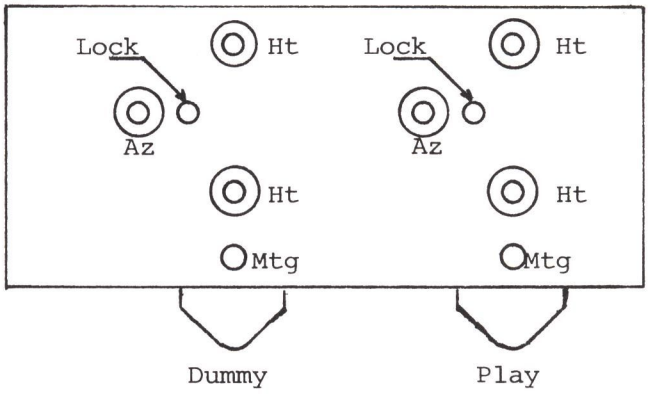
Verify that the head height, penetration, and zenith are as recommended in the Transport Maintenance Section before attempting the following adjustments:

1. Connect a 600 ohm resistor to the audio output connector. Connect a VTVM across this load.

2. Play a known standard 15 kHz azimuth tape.

3. Adjust the play head azimuth for maximum output as read on the VTVM.

4. Tighten the head lock screw, observing that the output reading remains at maximum.



Phase Adjustment - Stereophonic

1. Connect 600 ohm loads to both L and R output of the audio connector.

2. Connect a VTVM across the Left Channel Load. Adjust the play head azimuth for maximum output reading from a 15 kHz full track azimuth tape.

3. Connect the vertical input of an oscilloscope across this channel. Connect the horizontal input (or channel 2 of a two trace scope triggered from channel 1 zero crossing) to the Right Channel output. Adjust the play head azimuth for in-phase display of the two channels. Refer to Figure 1 below for typical phase displays.

   (Phase jitter is normal during these tests.)

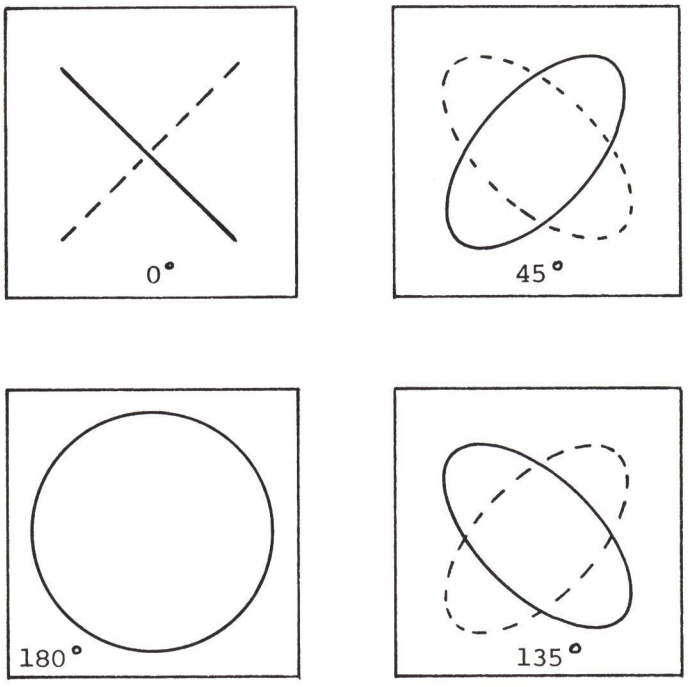


Fig. 1

4. Play a full track tape with frequencies from about 1 kHz through 15 kHz in several nonharmonically related frequencies. Observe that the phase display remains in phase for all frequencies.

5. Tighten the head lock screw, observing that phase shift does not occur.

7.2 FREQUENCY RESPONSE AND EQUALIZATION ADJUSTMENT

1. Install a known accurate frequency response tape such as the NAB Standard Tape or one prepared on a calibrated Audi-Cord record/play machine.

2. Play the tape and observe the results for frequencies above 1 kHz. Adjust the Hi frequency equalization control R2 *(and the companion R23 for Right channel of stereo units)* for flattest response of frequencies from 1 kHz through 15 kHz.

3. Observe frequencies from 1 kHz down to 50 Hz. Write down each output level and apply fringing corrections if a full track tape is used.

4. Adjust the Lo frequency equalization control R8 *(and the companion R29 for Right Channel of stereo units)* for flattest response from 50 Hz through 1 kHz.

7.3 PROGRAM OUTPUT LEVEL

1. Play a standard level tape of the operating flux level choice. Adjust the program Play Level Control R9 *(and the companion R30 for Right channel of stereo units)* for the desired output. Do not exceed +0 dBm.

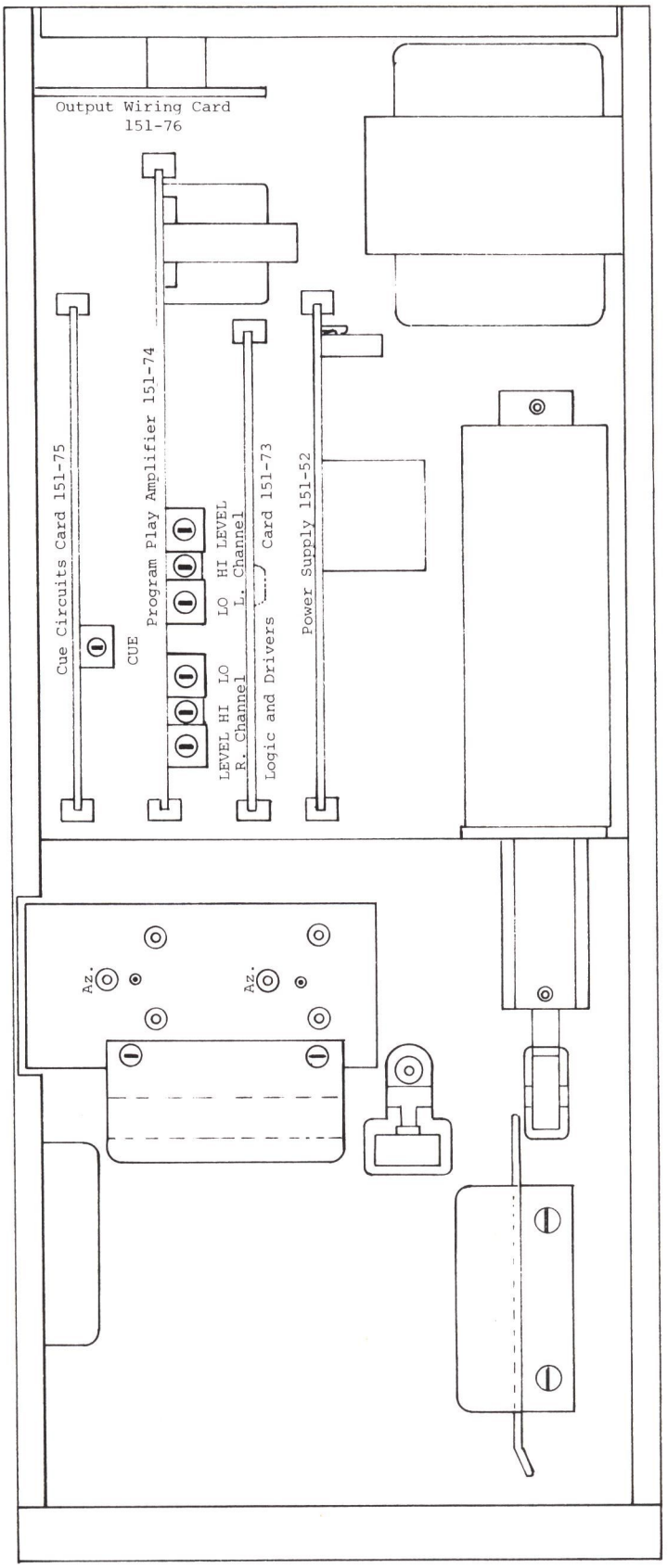
   NOTE: Audi-Cord playbacks are factory adjusted for 0 dBm from a reference fluxivity of 160 nWb/m at 1kHz in accordance with the 1976 NAB Cartridge Standards. A loss pad of 8 dB design is factory installed.

7.4 CUE DETECTORS GAIN

1. Record a tape with each tone at 6 dB below normal recorded level. Refer to "Cue Tone Level" of the recorder instructions for method of adjusting a recorder oscillator.

2. Play this tape and adjust R9 for reliable operation of each sensor.

   NOTE: Audi-Cord playback sensors utilize a specially equalized preamplifier and closely designed switching electronics. There should be only a very minor difference in the single cue gain setting for any tone at proper recorded level. A single control in combination with wide rejection latitude of the sensor will tolerated considerable difference in recorded level as required.



CONTROLS and ADJUSTMENTS LOCATION

8.0 TROUBLESHOOTING

The maintenance of this equipment precludes that the technician is acquainted to a high degree with solid state logic and the troubleshooting techniques required for proper diagnosis of these circuits.

Many of the voltages to be measured in the "E" Series are current limited by high series resistances or impedances. Typical 20,000 ohms per volt multi-meters though useful, may frequently burden the voltage measurement in such a manner as to leave the indications inaccurate. For instance, a voltage measurement on the 50 volt range *(1 meg ohm internal meter impedance)* with a 470K ohm pull-up resistor to 12 volts would result in a reading of approximately 8 volts instead of 12 volts as a logic HI indication. No serious difficulty would likely result in such a measurement, only confusion of the operator. For this reason, it is desirable to use high impedance measuring instruments for troubleshooting when these are available.

8.1 MECHANICAL FAILURES IN THE DRIVE SYSTEM

The "E" Series transport and other mechanical members are designed with a minimum of moving parts and maximum of simplicity. The description of the transport in Section 5.0 contains information valuable in understanding the mechanism and some clues to the operation. The Transport Maintenance (Section 6.0) describes several adjustments when removal and replacement is necessary. Other failures that occur are often related to the mechanical compatibility with specific cartridges and the operating peculiarities. Some of these are:

Recording Drop-Out: These failures are most often due to improper contact of the tape to the head during tape motion. Some of the causes are improper pressure pad, small pads which are not on center with the head gap, cartridge not held into full head penetration position due to lack of keyhole pull-in spring, lack of wrap between the heads because the center post has been removed on some carts, and tape that sheds excessive dirt on the head surface.

To make judgements on these performances, remove the cartridge hold down spring and carefully observe the tape running path. If it does not touch and maintain on the output side of the record head, it may be necessary to pivot the head for better tape contact.

If the cartridge is pushed away from the forward position due to lack of keyhole spring to hold it forward, it will be necessary to add sufficient cartridge hold down spring pressure to hold the cart in place against the heads. It is often difficult to adjust heads and springs to accommodate a variety of carts in usage. For this reason, it is often desirable to standardize on a minimum of types, or a single type for general use.

Tape Pulling Difficulties: These failures are probably the most misunderstood and frequent complaints. They have always existed in cartridge systems due to tension increases during life operation, and more recently aggravated by added tension posts, etc., within the cartridge designs along with the wider spread use of long loads in music and mixed commercial programming. The mechanical failures usually relate to worn pressure rollers, polished motor shafts, high pressure pad friction, and interference with the keyhole preventing the pressure roller shaft from having rotating freedom, effectively preventing pressure transfer to the capstan, and roller surfaces. Physical examination will usually reveal the solution to these difficulties.

8.2 ENVIRONMENTAL CONTRIBUTIONS TO CUE FAILURES

The cue system of cartridge machines is relied upon to perform in a fully automatic and unheard manner without failure if full satisfaction is to be realized. However, since these systems are actually low level, passive receivers operating on descrete tones assigned, they often are more important to the operations than the program audio.

Environments which influence the cue system include all the failures apparent on program audio including tape condition, drop-outs, speed changes, etc., as well as RF peaks that may be detected from close proximity of transmitter antennas and AC line transients. In diagnosis of the cue circuits, the use of the logging output can be invaluable since all the cue channel signals are present on this output.

Observe the content of the cue signals looking for "pops" that may be from improper erasure, error signals that may have been inadvertently recorded, and any other signal content that may cross the time/frequency of the detectors.

8.3 LOGIC AND CONTROL CIRCUITS DIAGNOSIS

The schematics and pin terminal signal statements for the "E" Series will frequently be in logic terms. The statement will be in the "true" logic state as written. For instance, the term "Cart. In=1" relates that if the cartridge is properly in place, the voltage will be at logic 1 (HI), or 12 volts in the case of CMOS logic such as used in this equipment. If the cartridge is not in place, the reverse statement is true. In this case the voltage will be logic 0 (LO) or near 0 volts.

Refer to the schematics in Section 9.0 for signal lines in and out. Also observe carefully the signal lights for their function. This will offer valuable clues as to the logic portion which has failed. Since some signals can be influenced by their interconnecting circuits thru feedback, unplug the rear connectors and mating recorder connectors for test purposes and replug one at a time if their failure is indicated. Most failure components encountered are plug-in and may easily be replaced from spares for the final correction.

8.4 PROGRAM AMPLIFIER SYSTEM DIAGNOSIS

Failure components are likely to consist of the plug in I.C.s, head, or cable. Simple signal injection at the head cable connector along with an oscilloscope at strategic locations thru the circuit will usually result in isolating the difficulty. If extensive troubleshooting is required it may be desirable to prepare an extension cable. The connectors are inexpensive and readily available.

8.5 CUE CIRCUITS DIAGNOSIS

The failure components again are likely to be I.C.s or transistors. Signal injection at the head cable should be from a tunable oscillator attenuated to approximately 1MV RMS level. The oscilloscope should be of DC coupled design to measure the DC signals derived for logic circuits used at the output.

8.6 PARTS IDENTIFICATION AND ORDERING PARTS

Electronic parts and purchased hardware parts used in the "E" Series are identified on the schematic section applicable in most cases. These part numbers are common Distributor Network parts numbers and are not proprietary Audi-Cord numbers. Therefore, they are readily available

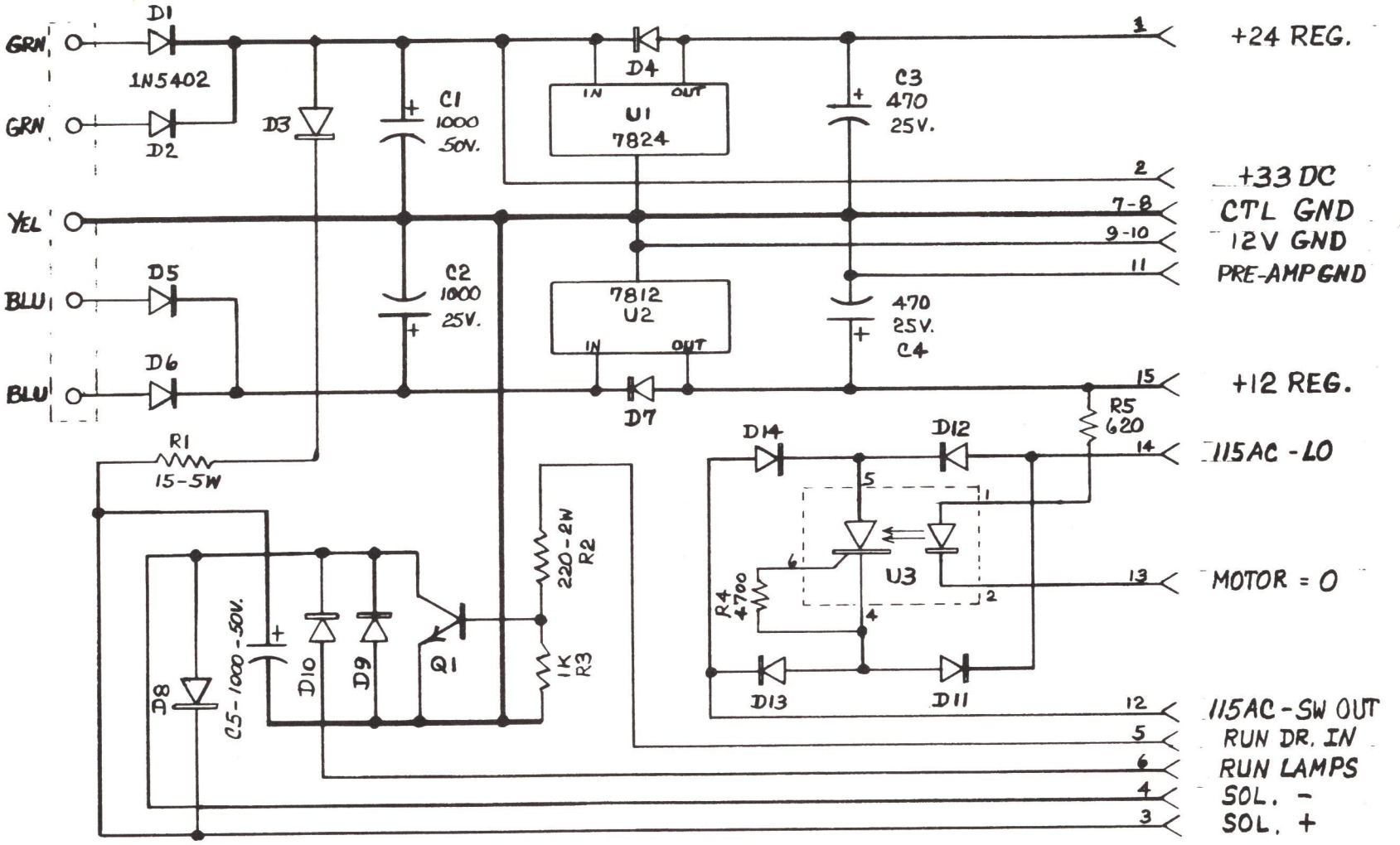
from local sources in many cases as well as from Audi-Cord stock. For these reasons, we do not compile parts lists for inclusion into this book.

Audi-Cord can supply any part required. Simply refer to the Model Number, Serial Number, symbol number and card assembly or other common term description and address parts orders to our Service Department, who will properly supply the parts required. We also offer recommended spare parts lists and kits of these parts at nominal costs to assist the owner in his maintenance spare stock needs.

8.7 SYMPTOMS AND CAUSE DIAGNOSIS CHART

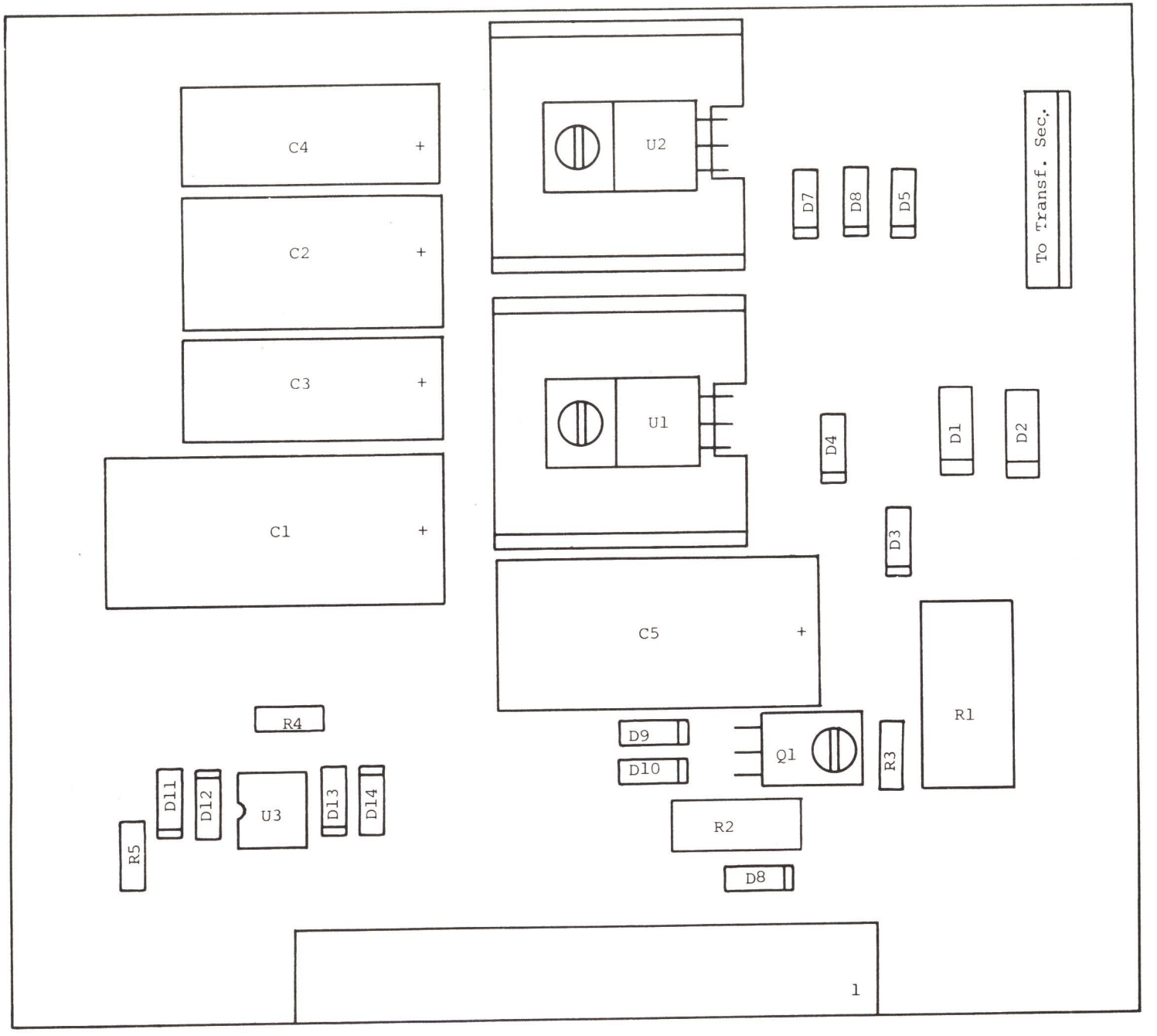
The following chart does not preclude many other possible similar failures but is intended to aim the technician in the proper section that most likely contains the failure.

SYMPTOM	INDICATION	POSSIBLE CAUSE	ACTION
No Power Apparent	No "Power" Lite	Fuse Blown, Switch "OFF", Line Cord not Connected	Check Visually or with Ohmeter
	Fuse OK, Power "ON"	R.F. Choke RFC1 or RFC2 Open	Check for Open, Place Ohmeter across line terminals, Turn on Power Switch. Should read Transf. Primary
No DC-Above Tests OK	No "Power" Lite +12 or +24 Dead	Transformer Sec. Open	Check Transf. With Ohmeter
		Power Supply 151-52	Replace Card
Motor Does Not Run	No "Ready" Lite	Logic Card, U1	Replace or Test
		Cartridge Sensor Shorted	Temporarily Remove Wire to Sensor. If "Ready" and Motor operates, repair Sensor.
	"Ready" Lite On	Logic Card, Q1	Replace or Test
		Power Supply Card, U3	Jumper Across Pin 4 & 5. See if Motor runs.
		Motor Winding Open	Check With Ohmeter
		Motor Capacitor Open	Substitute in Parallel
Solenoid Does Not Operate	No Motion	Solenoid Open; RUN lite is Operating	Check with Ohmeter (Approx. 40 ohms)
	No "Run" Lite	Q4 Open on Logic	Replace
		U3 Open on Logic	Replace
No Play Audio One or More Tracks	No Output at Pin 5 on 151-74	U1 on card 151-74	Replace or Test
		Open Head or Cable	Check for Continuity (500 ohms)
Won't Stop	"Run" Lite Stays On	Shorted Q4 on Logic, Q1 on pwr. Supply	Replace
High Freq. Loss	All Channels	Head Dirty	Clean With Alcohol
Tape Slips	Sounds Slow	Cartridge Too Tight	Replace
		Pressure Roller Dirty	Clean With Alcohol
Hum in Audio	Loud Roar	Open Filter Capac. on P.S.	Replace
		Grounded Head	Replace
		Broken Deck Ground Wire	Repair
Will not Cue	Doesn't Stop on Cue No Sig's @J2 Pin 10	U1 or U2 on 151-75 Card	Replace
		Open Head or Lead	Use Ohmeter for Continuity
	Sig's @J2, Pin 10	Cue Gain R9 Turned Down	Reset to level
		U2, Q1, or Q2 on 151-75	Replace or Test
	Cue=1 Sig is OK	U2, U1, or U3 on Logic	Replace
Played Doesn't Latch	Re-Starts After Cue Stops OK	Check Jumpers on Logic	See "Operating"
		U2 or U3 Logic	Replace

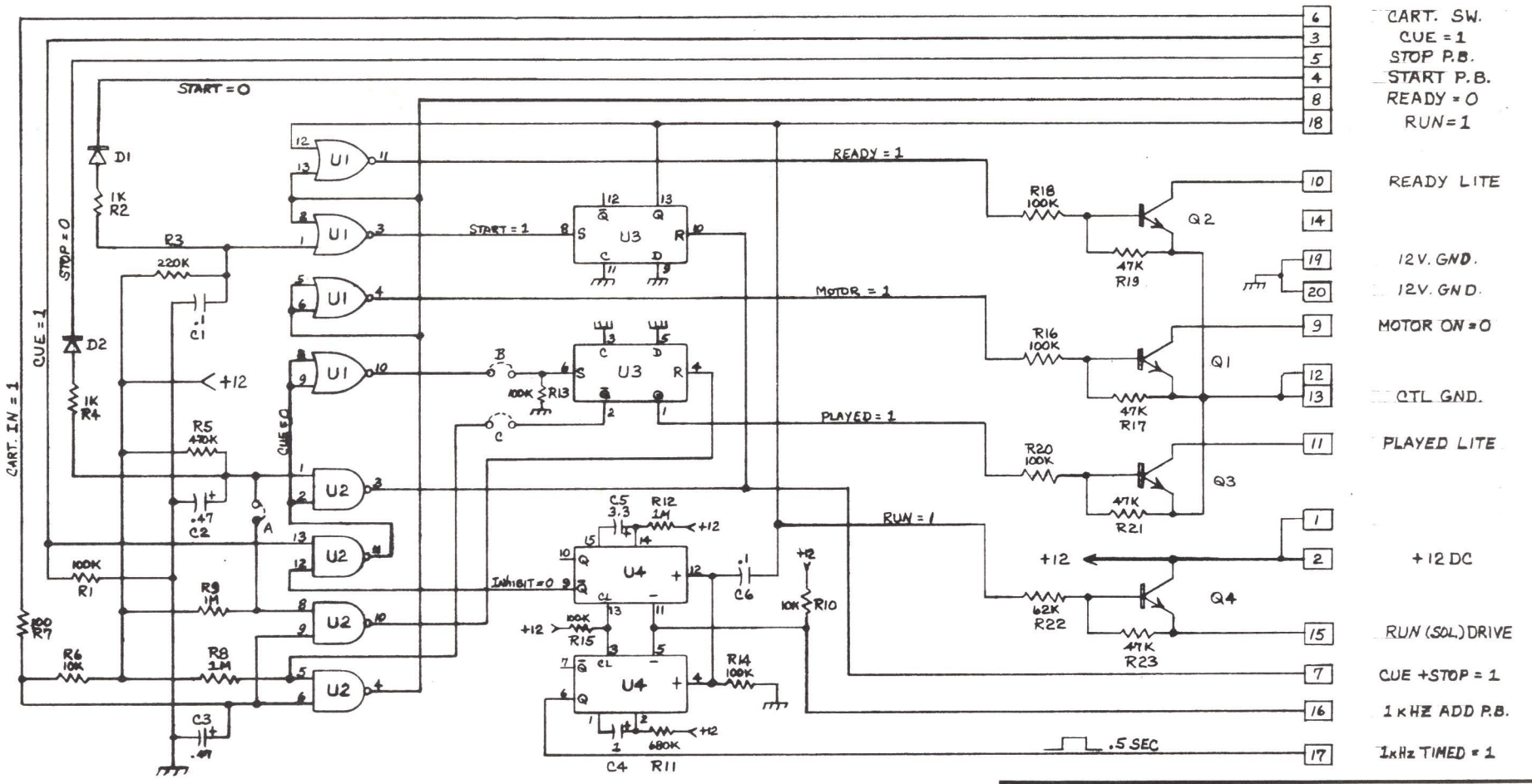


Q1 - MJE 181
U1 - 7824 / LM340T-24
U2 - 7812 / LM340T-12
U3 - H11C3
D3 THRU D14 - 1N4002

POWER SUPPLY AND SWITCHING CARD		
6-82	"S" SERIES	C.L.M.
AUDI-CORD CORPORATION NORMAL, IL 61761		1-151-52



POWER SUPPLY AND SWITCHING CARD 151-52



U1 - CD4001 / MC14001
U2 - CD4011 / MC14011
U3 - CD4013
U4 - CD4098 / MC14528B
Q1 THRU Q4 - 2N5307
D1, D2 - 1N914

RESISTORS ARE 1/4 W. - 5%
CAPACITORS ARE IN MFD.

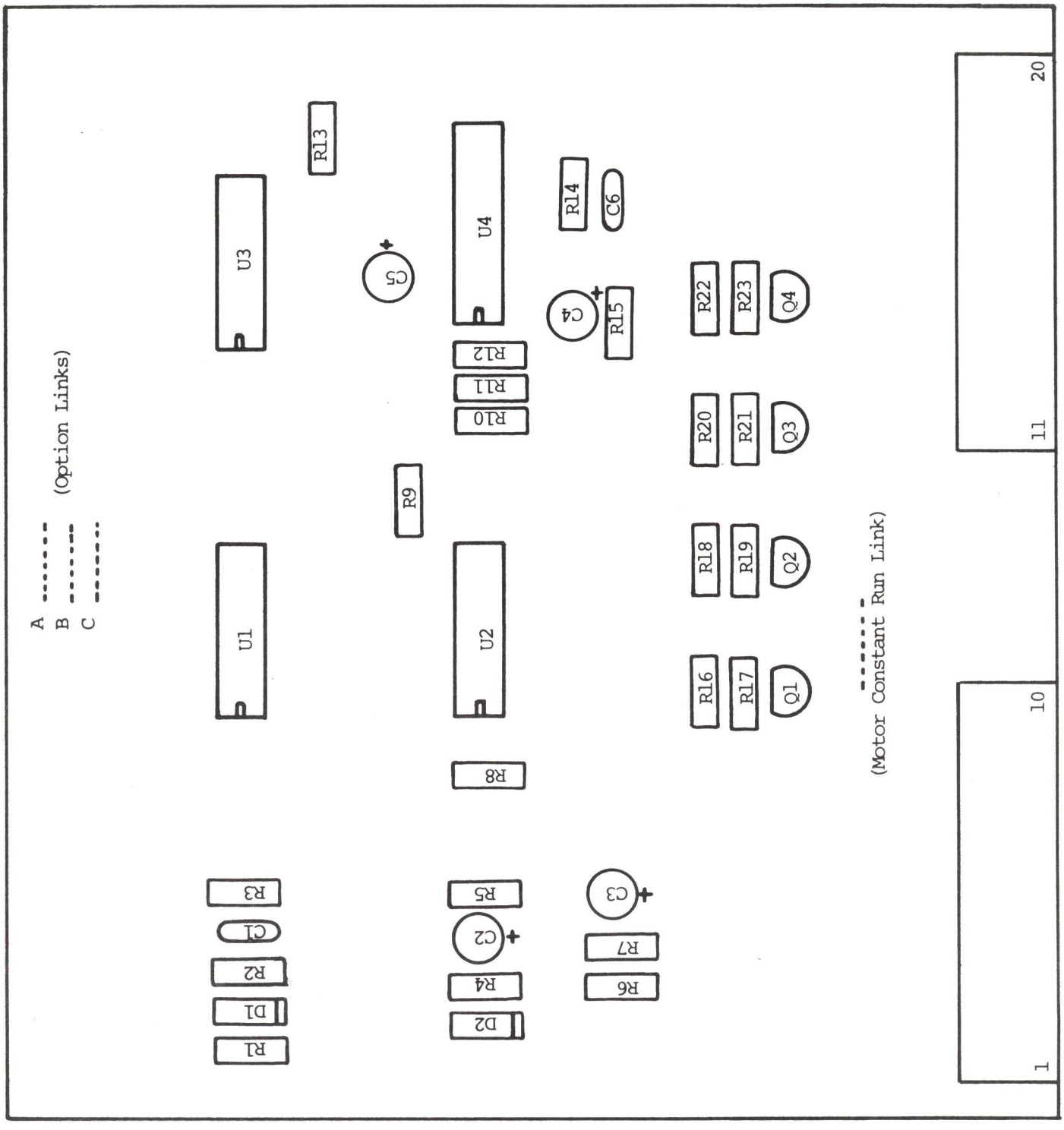
SCHEMATIC:
LOGIC AND DRIVERS CARD 151-73

SCALE:	APPROVED BY:	DRAWN BY
DATE:		REVISED

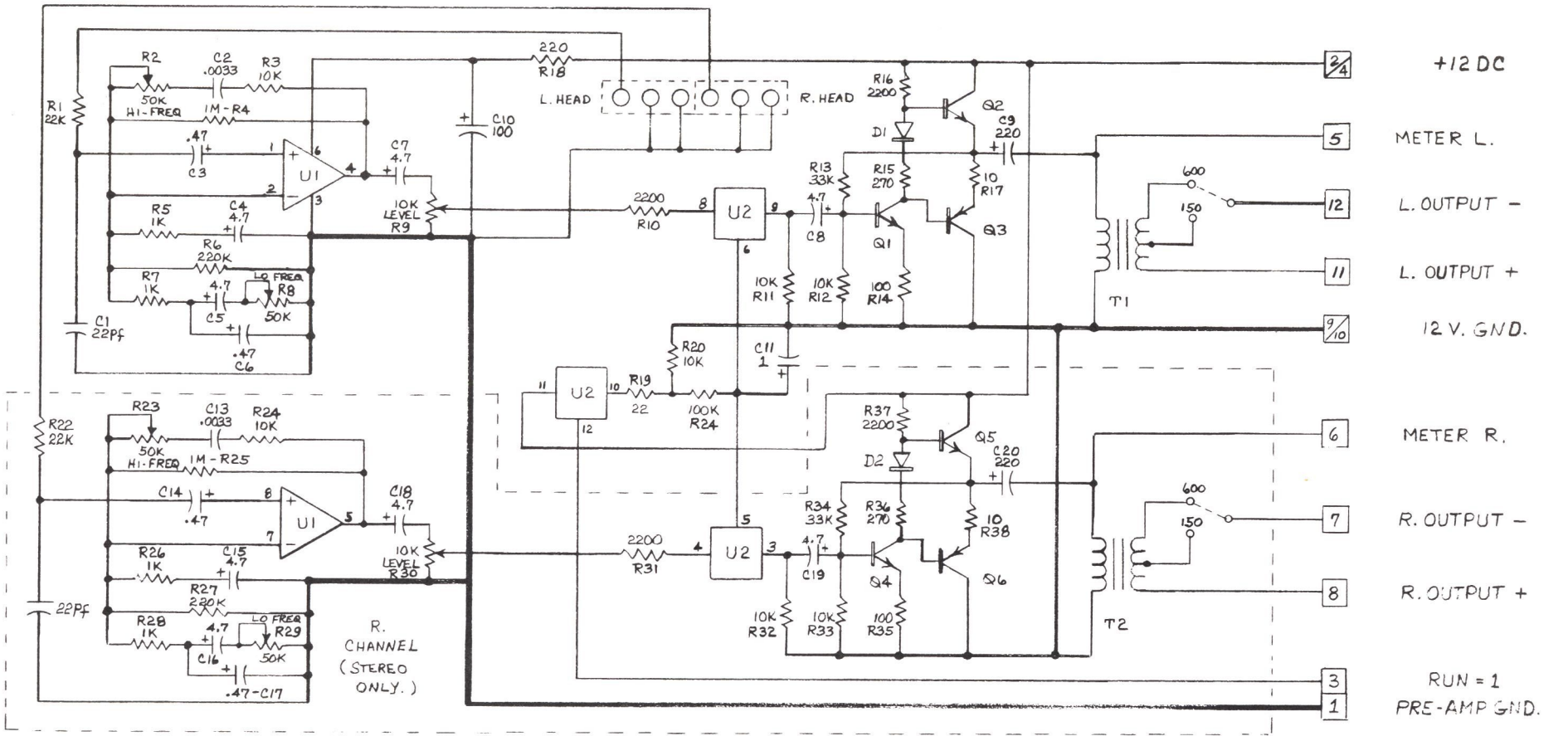
AUDI-CORD CORPORATION
NORMAL, ILL. 61761

"E" SERIES PLAYBACK

DRAWING NUMBER 2-151-73



PLAYBACK LOGIC AND DRIVERS CARD 151-73



U1 - LM387
U2 - CD4016
Q1, Q2, Q4, Q5 - MPS 6513
Q3, Q6 - MPS 6517
D1, D2 - IN4002

ALL CAPACITORS ARE IN Mfd EXCEPT AS NOTED
ALL RESISTORS ARE ¼ WATT - 5% TOL.

SCHEMATIC : PROGRAM PLAY AMPLIFIER, 151-74

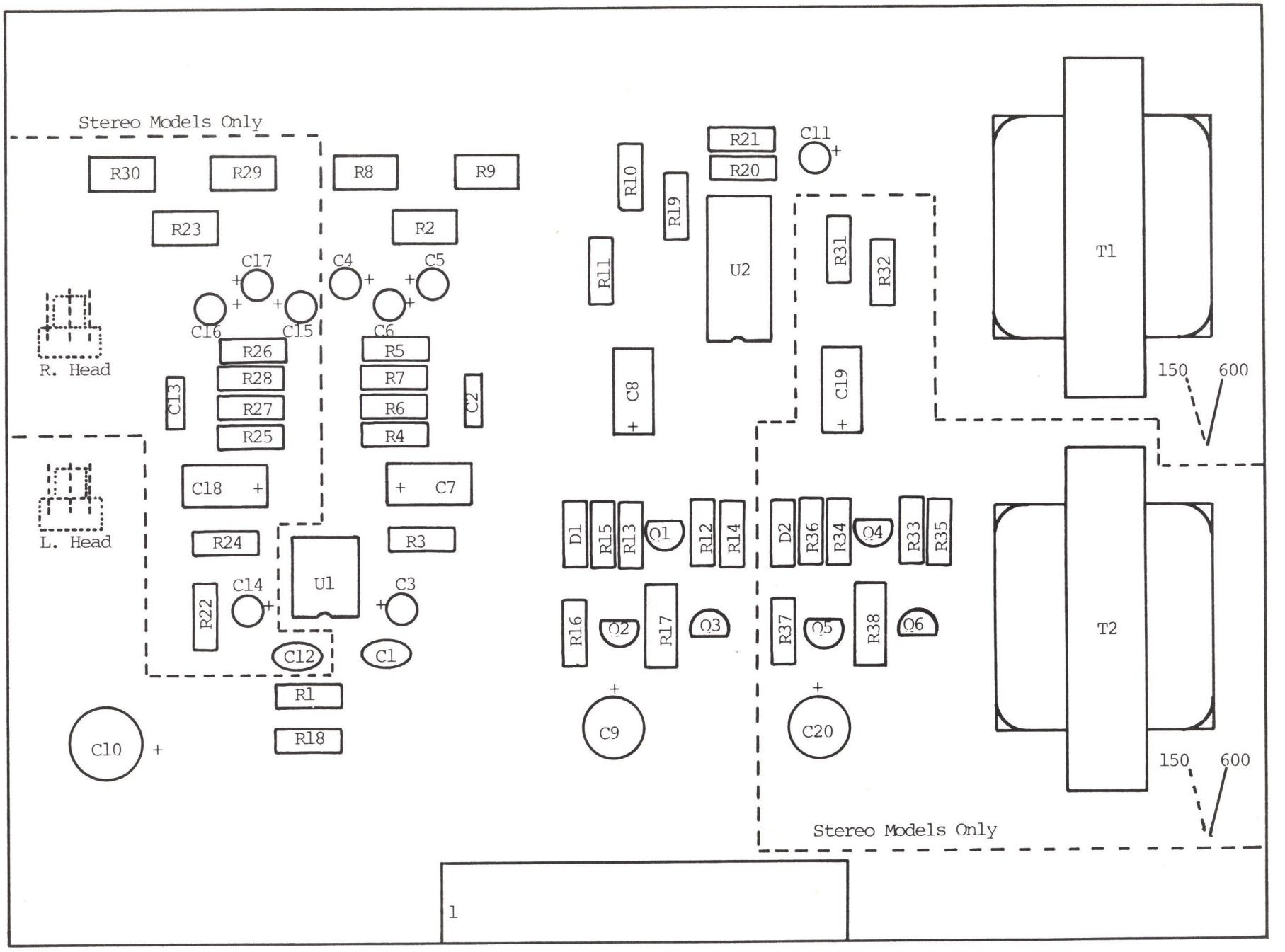
SCALE:	APPROVED BY:	DRAWN BY C.L.M
DATE: 3-84		REVISED

AUDI-CORD CORPORATION
NORMAL, ILL. 61761

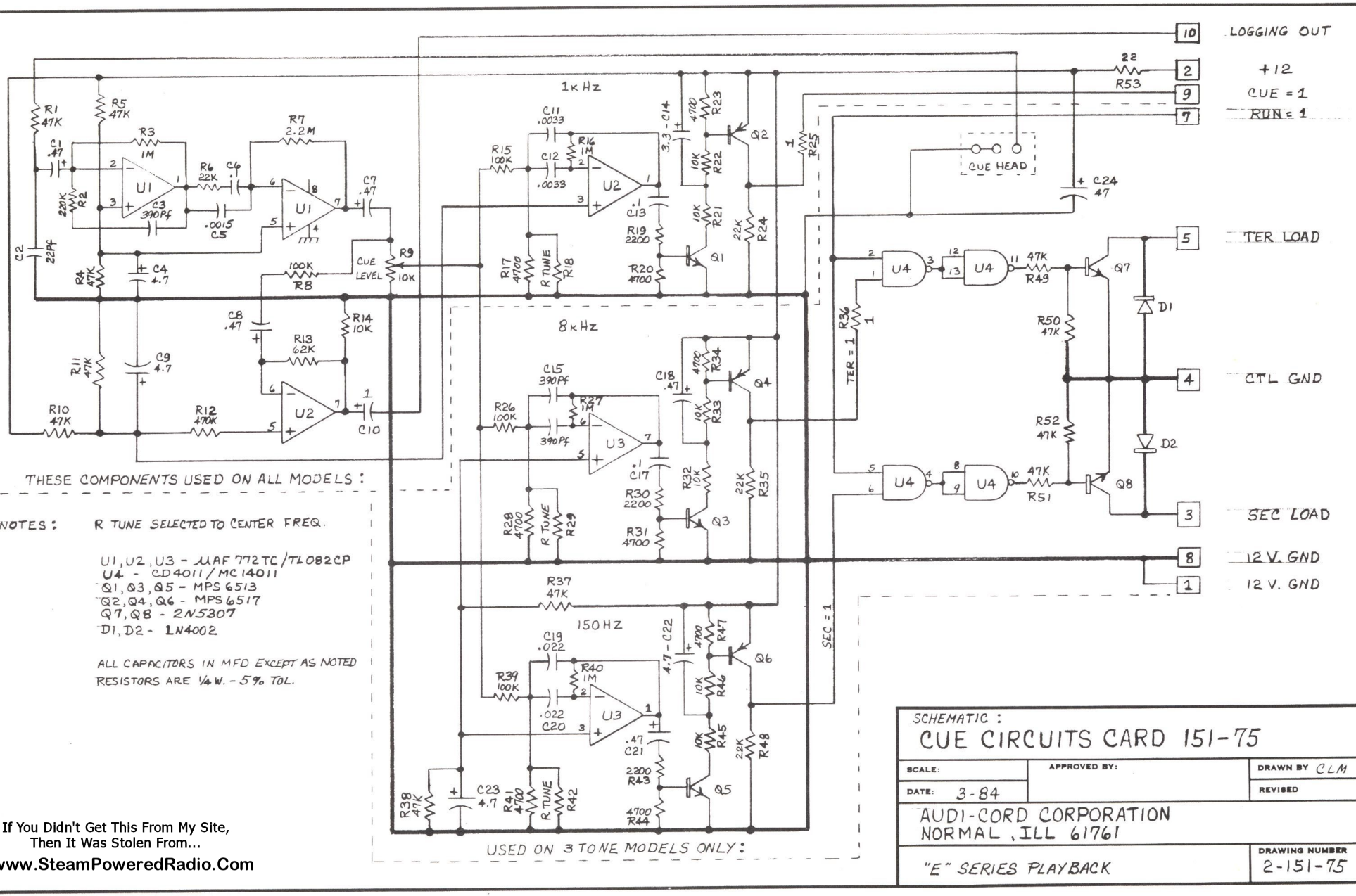
"E" SERIES PLAYBACK

DRAWING NUMBER 2-151-74

11X17 PRINTED ON NO. 1000H CLEARPRINT



PROGRAM PLAY AMPLIFIER CARD 151-74



NOTES: R TUNE SELECTED TO CENTER FREQ.

U1, U2, U3 - MAF 772 TC / TL082 CP
U4 - CD4011 / MC14011
Q1, Q3, Q5 - MPS 6513
Q2, Q4, Q6 - MPS 6517
Q7, Q8 - 2N5307
D1, D2 - 1N4002

ALL CAPACITORS IN MFD EXCEPT AS NOTED
RESISTORS ARE 1/4 W. - 5% TOL.

SCHEMATIC :
CUE CIRCUITS CARD 151-75

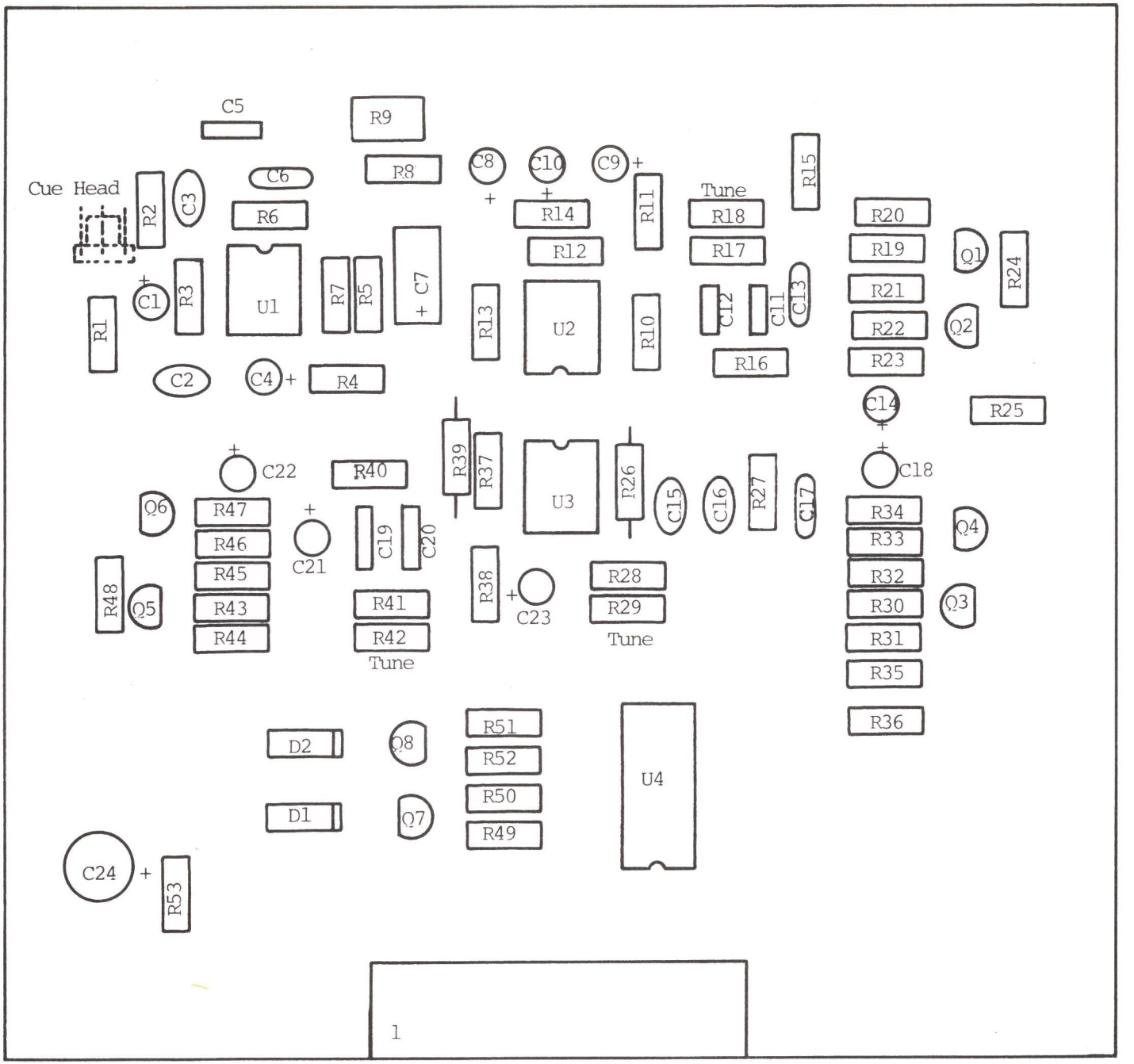
SCALE:	APPROVED BY:	DRAWN BY CLM
DATE: 3-84		REVISED

AUDI-CORD CORPORATION
NORMAL, ILL 61761

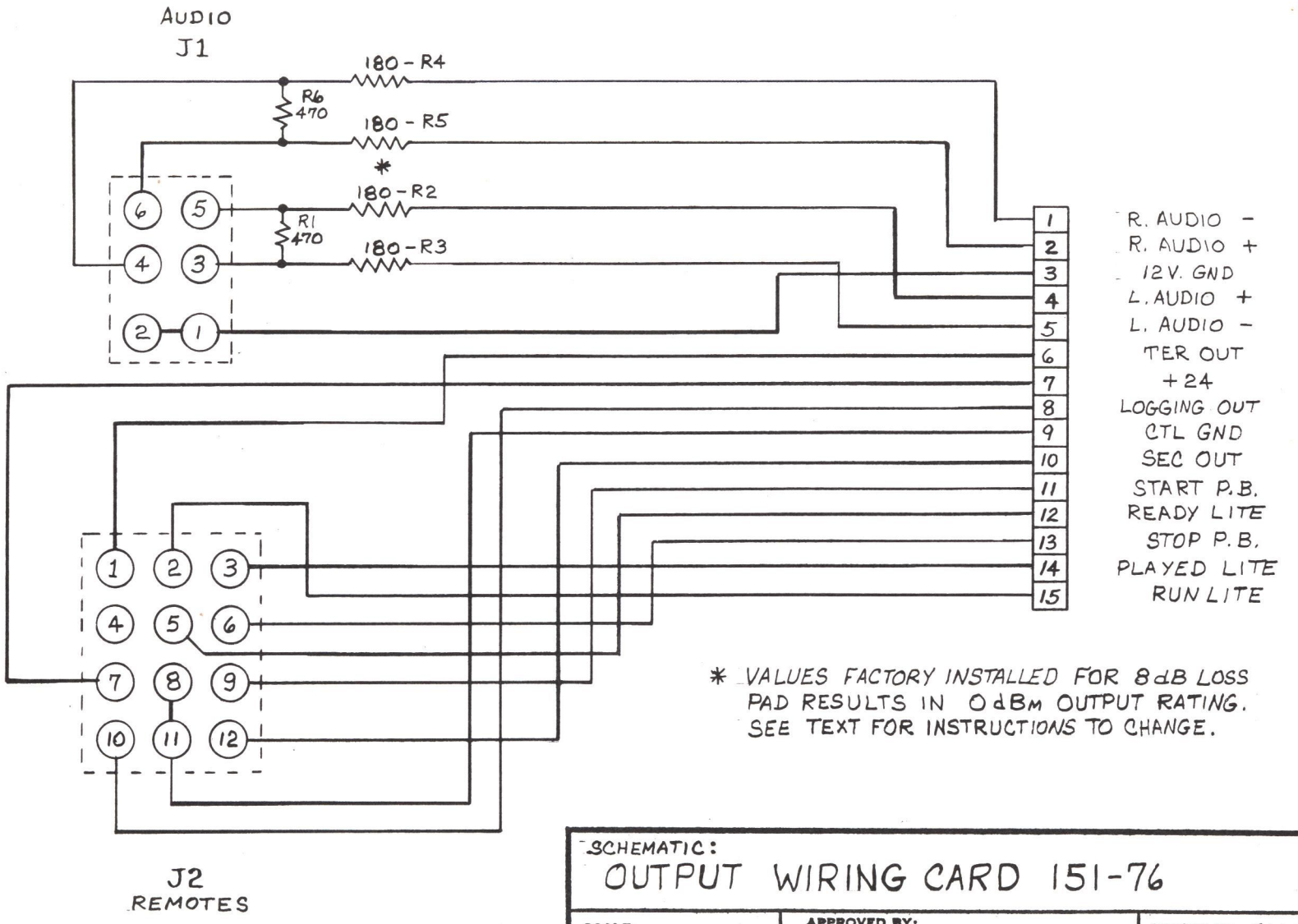
"E" SERIES PLAYBACK

DRAWING NUMBER 2-151-75

11X17 PRINTED ON NO. 1000H CLEARPRINT



CUE CIRCUITS CARD 151-75



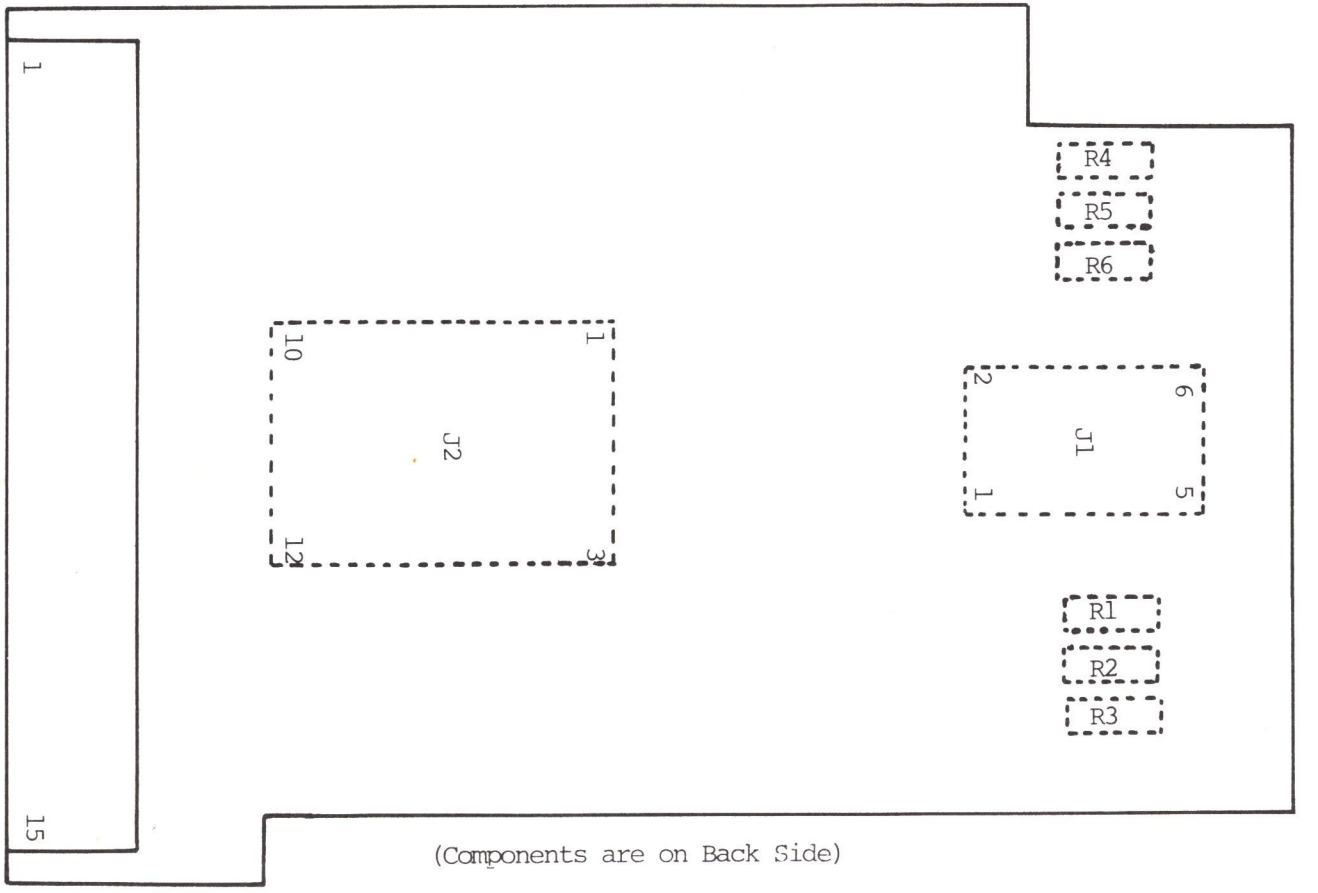
* VALUES FACTORY INSTALLED FOR 8dB LOSS PAD RESULTS IN 0dBm OUTPUT RATING. SEE TEXT FOR INSTRUCTIONS TO CHANGE.

SCHEMATIC:
OUTPUT WIRING CARD 151-76

SCALE:	APPROVED BY:	DRAWN BY CLM
DATE: 8-84		REVISED

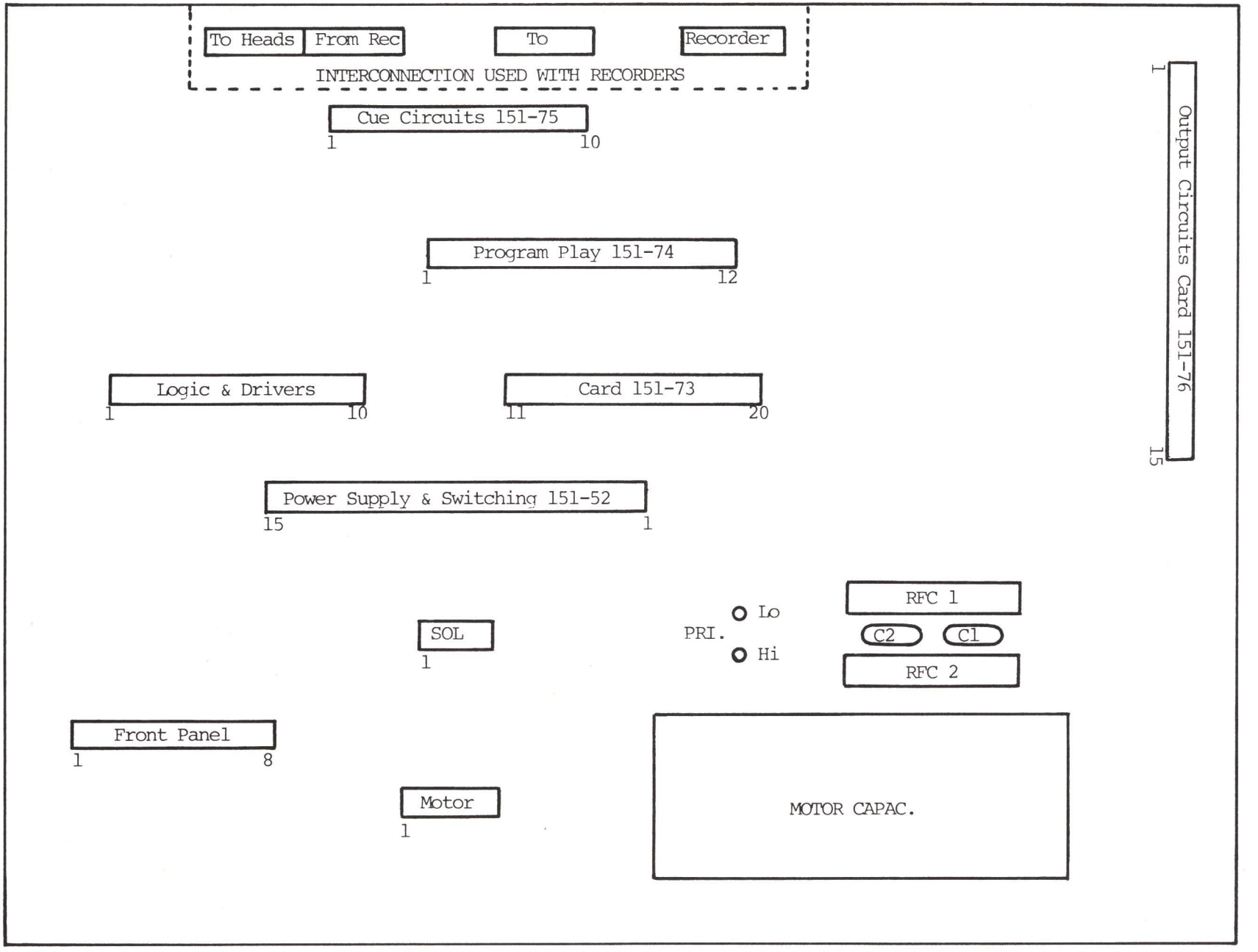
AUDI-CORD CORPORATION
NORMAL, ILL 61761

E SERIES PLAYBACK	DRAWING NUMBER 1-151-76

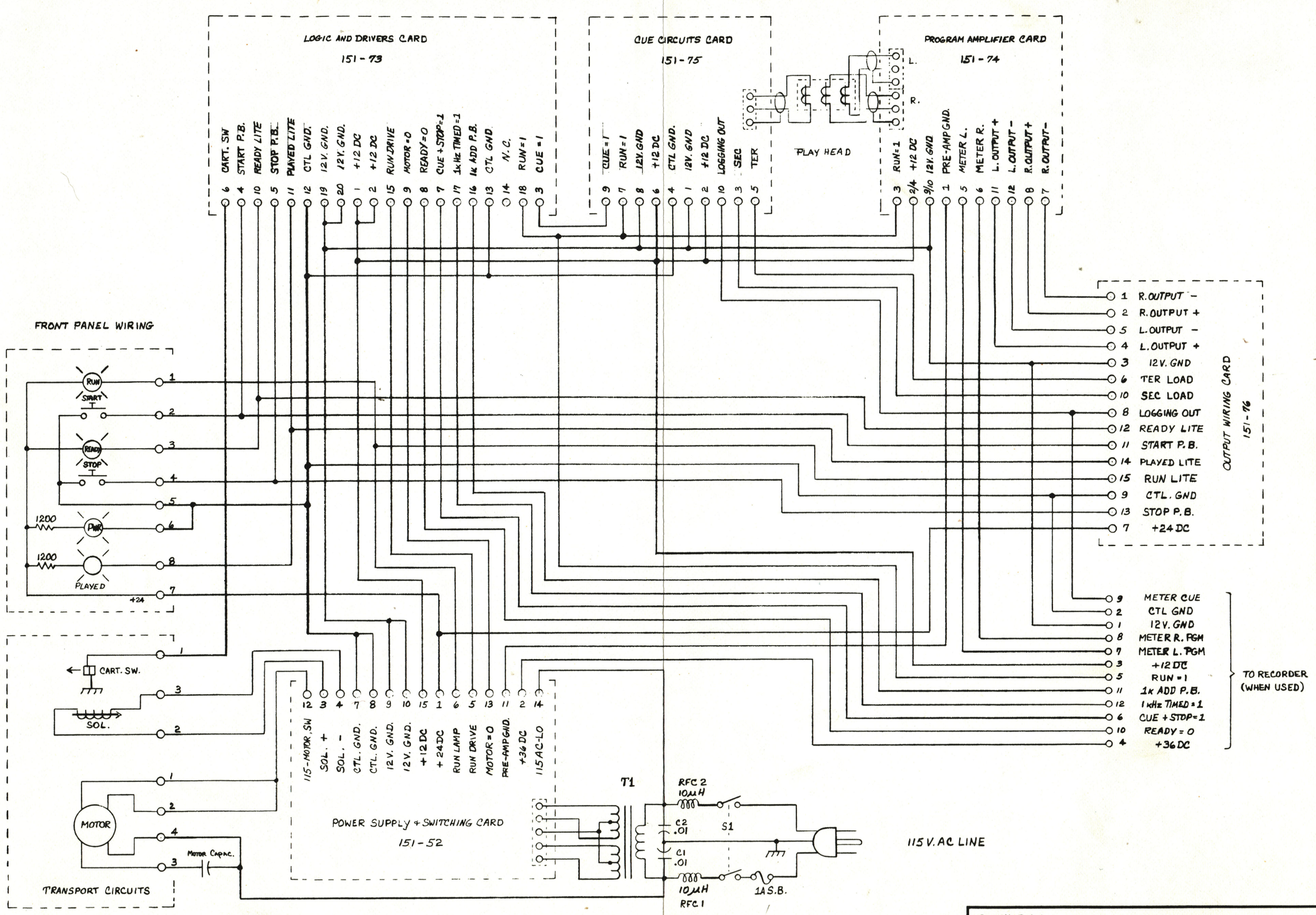


(Components are on Back Side)

OUTPUT WIRING CARD 151-76



PLAYBACK MOTHER BOARD 151-77



SCHEMATIC:
INTERCONNECTIONS, MOTHER BOARD 151-77

SCALE:	APPROVED BY:	DRAWN BY CLM
DATE: 3-84		REVISED

AUDI-CORD CORPORATION
NORMAL, ILL. 61761

"E" SERIES PLAYBACK

DRAWING NUMBER 3-151-77

11.0 WARRANTY

Audi-Cord Corporation warrants this product to the original owner to be free of defect in workmanship or materials for one year. Exception is applied to fuses, lamps, and other materials considered as maintenance replacement items of short, useful life which are guaranteed for 90 days. Audi-Cord Corporation will replace or repair such defective material when returned to its factory, if so requested, at the purchaser's expense.

Audi-Cord Corporation shall not be liable for any expenses for repairs, materials, or loss of use incurred by the purchaser without our prior written consent. Further, Audi-Cord Corporation shall not be liable for damage or loss caused by abuse, misuse, or application; nor, do we assume warranty of performance with cartridges, tapes, and peripheral equipment supplied by others.

SERVICE POLICY

Audi-Cord Corporation further warrants satisfaction of our products for their useful life and will provide the necessary service and parts to insure this satisfaction at fair and equitable costs. Complete service and reconditioning facilities are available at our factory for our customers who choose to use them.

All shipments and inquiries should be made prepaid to our Service Department. Advance notice of return, though desirable, is not necessary if a clear description of the difficulty or service required is included along with return shipping instructions.

Our Engineering and Customer Service Departments will provide advice in service or operation as needed without charge or obligation.