# DC COUPLING PREAMPLIFIER

MODEL 150-1300

IM-150-1300-2

# INSTRUCTION MANUAL

HEWLETT PACKARD

hp

SANBORN DIVISION

# DC COUPLING PREAMPLIFIER

**MODEL 150-1300**

**IM-150-1300-2**

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HEWLETT PACKARD hp SANBORN DIVISION

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WALTHAM, MASS. 02154

# OPERATING MANUAL

## SANBORN DC COUPLING PREAMPLIFIER

## Model 150-1300

Sanborn Company

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# SECTION I

# DESCRIPTION AND DATA

## 1. FUNCTIONAL DESCRIPTION

The Sanborn DC Coupling Preamplifier Model 150-1300 is a simplified general purpose Preamplifier designed for use in the Sanborn "150" Series of Recording Systems. It is used for voltage measurements up to 100 cycles, with single–ended or push–pull input signals. The instrument features an ATTENUATOR which introduces fixed attenuation factors between X1 and X1000.

## 2. CHARACTERISTICS
### (Including Driver Amplifier and Galvanometer)

SENSITIVITY
50 mv./cm. to 50 volts/cm.

SIGNAL RANGE
Reads from 5 millivolts to 250 volts.

FREQUENCY RANGE
Zero to 100 cycles. See fig. 1.

RISE TIME
Five milliseconds (approx.). See fig. 1.

CALIBRATION
Internal, 100 mv. ± 1%.

STABILITY
Less than 0.5 mm. drift per hour.

INPUT IMPEDANCE
Resistive, five megohms each input terminal to ground.

INPUT SIGNALS
Push–pull or single–ended.

IN–PHASE REJECTION

Any signal component appearing at the push–pull input terminals with the same amplitude and polarity is an "in–phase component". A fraction of the in–phase voltage appears on the recording. The table shows the fraction of this in–phase voltage which appears on the record, and lists the maximum in–phase voltage which the Preamplifier will tolerate.

| ATTENUATOR SETTING | IN–PHASE LIMIT | FRACTION ON RECORD |
|---|---|---|
| X1 | 5 volts | Less than 1/1000 |
| X2 | 10 volts | Less than 1/50 |
| X5 | 25 volts | Less than 1/50 |
| X10 | 50 volts | Less than 1/50 |
| X20 | 100 volts | Less than 1/50 |
| X50 | 250 volts | Less than 1/50 |
| X100 | 500 volts | Less than 1/50 |
| X200 | 500 volts | Less than 1/50 |
| X500 | 500 volts | Less than 1/50 |
| X1000 | 500 volts | Less than 1/50 |

The instantaneous voltage "a" exists between one input lead and ground. The instantaneous voltage "b" exists between the other input lead and ground. The preamplifier measures the differential voltage. A small fraction of the in–phase voltage appears on the recording.

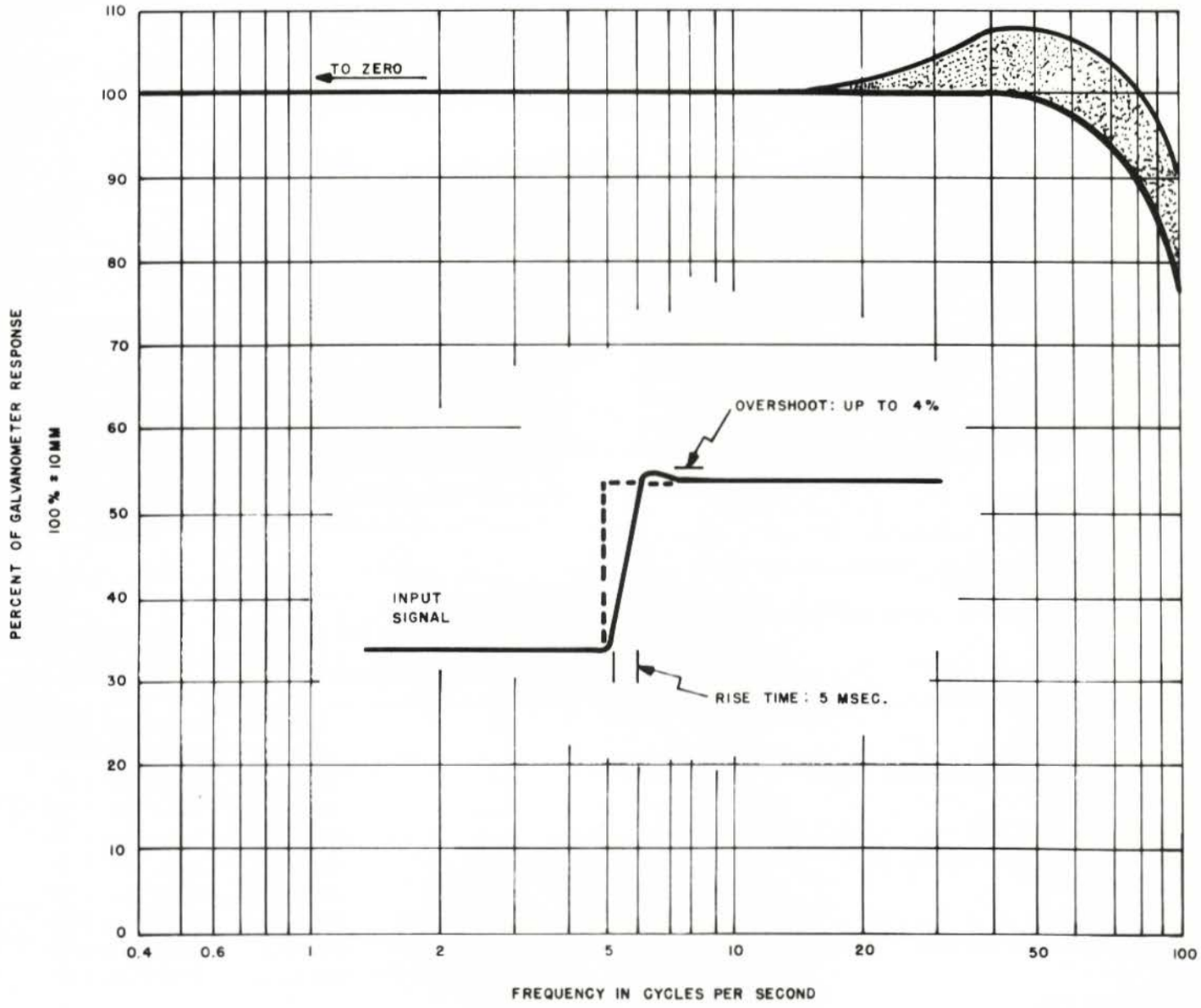
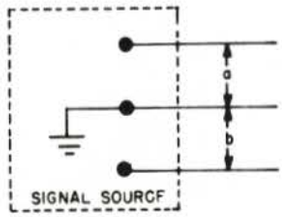



*Figure 1. Combined Response Characteristics of the Sanborn DC Coupling Preamplifier, Driver Amplifier and Galvanometer.*

## 2. CHARACTERISTICS (Cont.)




Differential voltage = a − b

$$\text{In-phase voltage} = \frac{a + b}{2}$$

## 3. FRONT PANEL DATA

ATTENUATOR
A multi-position switch which attenuates the input voltage by the ratios marked on the panel.

SENSITIVITY
Adjusts the gain of the amplifier. Clockwise rotation increases the gain.

BALANCE
A protective button covers the BALANCE control. Eliminates the residual internal unbalance of the Amplifier.

POSITION
Sets the stylus base line. Clockwise rotation moves the stylus up-scale.

CAL 100MV
Impresses 100MV on one grid of V1301 for calibration.

USE-OFF-CAL-CAL ADJ
Sets the Preamplifier for operation, calibration, or grounds the input circuit to protect the system.

INPUT
Three circuit jack for applying the input signal through a three terminal phone plug.

# SECTION II

# OPERATING PROCEDURES

## 1. BASIC PROCEDURES

There are four basic procedures in operating the Sanborn DC Coupling Preamplifier:



## 2. CONNECTING THE PREAMPLIFIER

Apply power and allow 30 minutes warmup for stability. Connect the signal to the INPUT jack on the panel or to J204 at the Driver Amplifier rear, as shown in figure 2. Always remove the plug from the INPUT socket when using J204.

**a.** With the push-pull (balanced) connections, the recording shows the potential between the two signal terminals. In-phase signals between these two terminals and ground are rejected. (See paragraph 2 section 1.)

**b.** With the single-ended (unbalanced) connections, the recording shows the potential between the live terminal and ground.

**c.** To record the difference of two single-ended signals, connect one signal between one push-pull input terminal and ground, and connect the other signal between the other input terminal and ground. The instantaneous average of the two signals is present at the two input terminals as an in-phase potential. A fraction of this in-phase potential appears on the record; see paragraph 2, Section I, for in-phase rejection data.

**d.** To record the sum of two (or more) signals, connect to the Preamplifier as a single-ended (unbalanced) signal through an external mixing circuit. Always correct for the attenuation of the mixing circuit when interpreting the recording.

## 3. BALANCING THE PREAMPLIFIER

Balancing is important but is usually not required as an operational step. Avoid the possibility of out-of-balance operation by checking the balancing after each warmup period and before each series of recordings.

**a.** After 30 minutes warmup, set the panel controls for balancing:

ATTENUATOR..... OFF
POSITION..... to center the stylus

**b.** Turn the SENSITIVITY control back and forth from one end of its rotation to the other, and watch the stylus. There should be no stylus motion.

**c.** If the stylus moves, remove the chrome button marked BALANCE and adjust the control with a screwdriver for zero stylus motion while the SENSITIVITY control is turning.

**d.** Replace the chrome button. The Preamplifier is now balanced.

## 4. CALIBRATING THE PREAMPLIFIER

Calibration adjusts the DC Coupling Preamplifier to its rated sensitivity of 50 millivolts per centimeter.

a. After warmup, and balancing, set the panel controls for calibration:

ATTENUATOR..... X1

USE-OFF-CAL-CAL ADJ ..... CAL
POSITION ..... to center the stylus

b. Intermittently press the CAL button, and adjust the SENSITIVITY control for a two centimeter deflection on the recording.

c. Return the USE-OFF-CAL-CAL ADJ switch to OFF. The Preamplifier is now calibrated.

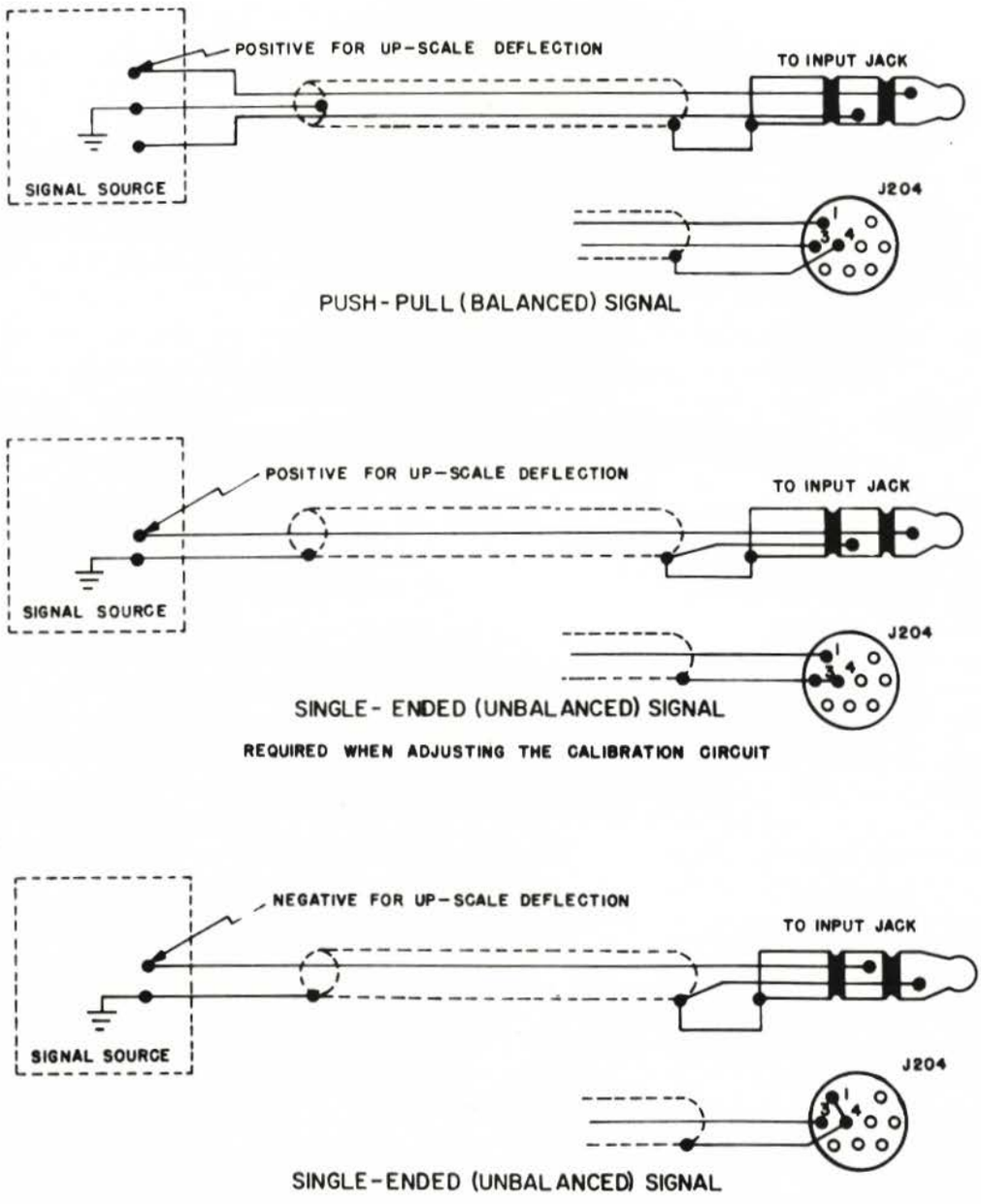



*Figure 2. Input Circuit Connections to INPUT Jack or to J204 at Rear of Driver Amplifier.*

## 5. OPERATION

a. After warmup, balancing, and calibration, set the panel controls for operation:

ATTENUATOR ..... OFF
USE-OFF-CAL-CAL ADJ ..... USE
POSITION ..... to center the stylus

Then advance the ATTENUATOR for a convenient stylus deflection, or set the appropriate attenuation factor for the expected signal.

b. Turn on the paper drive motor and start the recording.

c. Read the input signal in volts from the formula: Volts = (.05)(cm deflection)(ATTENUATOR setting)

# SECTION III

# MAINTENANCE

## 1. INTRODUCTION

This Section contains the installation and maintenance data for the Sanborn DC Coupling Preamplifier Model 150–1300, when used in the "150" series of Sanborn recording equipment. The data includes trouble shooting procedures to help locate the source of faulty or erratic operation and instructions for all control adjustments which are not normally used in operation.

## 2. REMOVING AND REPLACING PREAMPLIFIERS

**a.** To remove a Preamplifier, turn off the POWER switch on the associated Power Supply. Loosen the thumb–nuts behind the chrome handles on the Preamplifier and pull the Preamplifier from its recess.

**b.** To replace a Preamplifier, check that the POWER switch on the associated Power Supply is turned off. Insert the new Preamplifier into the vacant space, taking care that the multi–circuit connector at the Preamplifier chassis rear becomes properly engaged with the mating connector on the Driver Amplifier. Align the two small dowels at the top corners of the Preamplifier with the corresponding holes in the framework. Then press the Preamplifier in firmly and tighten the thumb–nuts.

## 3. ADJUSTING THE CALIBRATION CIRCUIT VOLTAGE

The calibration circuit is adjusted by the +80V ADJ control located at the Driver Amplifier rear. It is set at manufacture, and should require adjustment only after extended use, or after replacing the glow tube voltage regulator in the Driver Amplifier.

**a.** Connect a laboratory type cadmium cell (1.019 volts) to the INPUT jack on the Preamplifier panel as shown in figure 3.

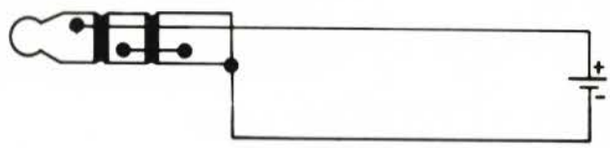



*Figure 3. Connecting 1.019 volt Cell.*

**b.** Set the Preamplifier controls for calibration circuit adjustment:

ATTENUATOR ..... X1
SENSITIVITY ..... fully clockwise
POSITION ..... to center the stylus
USE-OFF-CAL-CAL ADJ ..... OFF

**c.** Locate the +80V ADJ control R236 at the Driver Amplifier rear. See figure 4.

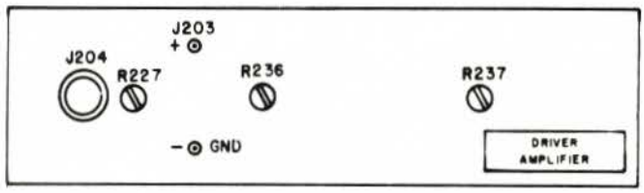



*Figure 4. Driver Amplifier, Rear View*

**d.** Intermittently turn the USE-OFF-CAL-CAL ADJ switch between OFF and CAL ADJ. and adjust the +80V ADJ control R236 for minimum stylus motion.

**e.** Remove the standard cell. The calibration voltage is now adjusted for both the Sanborn DC Coupling Preamplifier Model 150–1300 or the Sanborn AC–DC Preamplifier Model 150–1000. Recalibrate the Preamplifier before further operation.

## 4. ADJUSTING THE DAMPING CONTROL

The Damping control affects the transient and frequency response of the recording. Refer to the Instruction Manual for the Sanborn Driver Amplifier and Power Supply Model 150–200/400, 150–200A/400.

## 5. ADJUSTING THE VOLTAGE REGULATOR CONTROL

This control sets the regulated plate supply voltage at +250 volts. Refer to the Instruction Manual for the Sanborn Driver Amplifier and Power Supply Model 150–200/400, 150–200A/400.

## 6. TROUBLE SHOOTING

Figure 5 is a block diagram showing one channel of a Sanborn "150" series Recording System. This drawing shows the possible locations of trouble: (1) the signal and the operating techniques, (2) the power line, (3) the Preamplifier, (4) the Driver Amplifier, (5) the Power Supply, (6) the Galvanometer. This paragraph shows how to track down the trouble by a process of elimination.

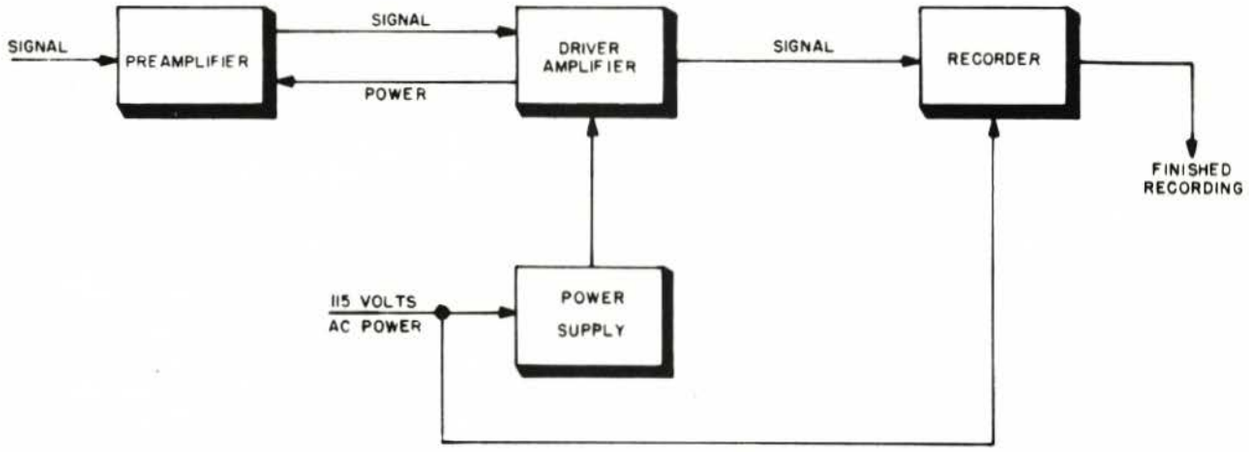



*Figure 5. Simplified Block Diagram of "150" Series Recording System.*

## TROUBLE SHOOTING (Cont.)

| TEST | SYMPTOM | LOCATION OF FAULT |
|---|---|---|
| 1. Repeat the steps of connecting the signal, balancing, calibration, etc., at the Preamplifier. | **CASE 1.** The system now operates normally, with no apparent fault. | The fault was probably in the operating technique. This is the most common cause of unsatisfactory operation. |
| | **CASE 2.** One or more steps do not proceed normally. | The operation techniques are not at fault if the operating instructions are followed exactly. The trouble is probably in the signal, or somewhere in the system. Continue with test No. 2. |
| 2. Check that the signal applied to the Preamplifier is within the signal ratings. | **CASE 1.** The signal is outside the ratings. | The signal is probably at fault. This is a common cause of unsatisfactory operation. |
| | **CASE 2.** The signal is inside the ratings. | The signal is normal, and the fault is somewhere else in the system. Continue with test No. 3. |
| 3. Measure the line voltage and frequency. | **CASE 1.** Line voltage and frequency are outside the rated limits. | The fault is probably in the line voltage or frequency. |
| | **CASE 2.** Line voltage and frequency are inside the rated limits. | Line voltage and frequency are not at fault, and the trouble is somewhere else in the system. Continue with test No. 4. |
| 4. Check the non–operational adjustments of the Driver Amplifier and the Preamplifier, as given in the instruction manuals. | **CASE 1.** One or more adjustments require re–setting. | These adjustments were possibly at fault. |
| | **CASE 2.** The adjustments are normal. | Non–operational adjustments are not at fault, and the trouble is somewhere else in the system. Continue with test No. 5. |

## TROUBLE SHOOTING (Cont.)

| TEST (Cont.) | SYMPTOM (Cont.) | LOCATION OF FAULT (Cont.) |
|---|---|---|
| 5. Check the Preamplifier by removing it from the Driver Amplifier, and replacing it with one which is known to be good. Turn the POSITION control of the replacement Preamplifier back and forth over its range. Figure 6 shows an alternate plug-in circuit which may be used if a replacement Preamplifier is not available. | **CASE 1.** The fault disappears, and the writing arm controls smoothly over the entire width of the chart. | The fault probably lies in the Preamplifier which was removed, and the rest of the system is probably normal. Replace the original Preamplifier. |
| | **CASE 2.** The fault remains, the writing arm motion is missing, irregular, or incomplete. | The fault is probably in the Driver Amplifier, Power Supply, or Galvanometer (or other indicator). Replace the original Preamplifier and see the Instruction Manual for the Driver Amplifier and Power Supply. |
| **6.** If test No. 5 shows that the fault is in the Preamplifier, check for a defective tube in the Preamplifier. | **CASE 1.** Tubes check normal. | The fault is probably not caused by a defective tube. Continue with No. 7. |
| | **CASE 2.** Defective tubes are replaced, but the fault remains. | Continue with No. 7. |
| | **CASE 3.** Defective tubes are replaced and the fault disappears. | The fault was probably caused by the defective tube. |
| **7.** If the fault was not caused by defective tubes (test No. 6), check the voltage and resistance at each tube socket terminal as shown in the following table. | For normal operation, the voltage and resistance should be close to the values shown in the table. | Abnormal voltage or resistances at any point indicate a defective component somewhere in the corresponding circuit. Refer to the schematic diagram to help locate the faulty component. |

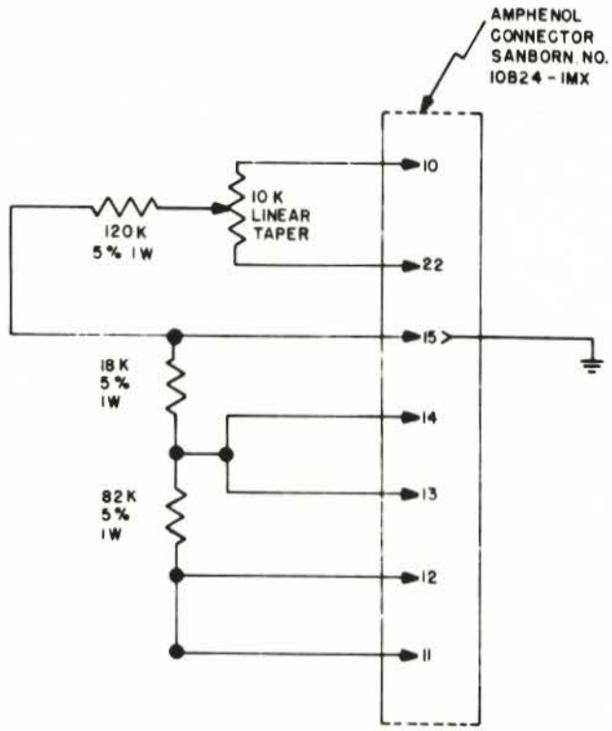



*Figure 6. Dummy Preamplifier Schematic Diagram.*

## TABLE 1

### Sanborn DC Coupling Preamplifier Model 150–1300

Measure d–c voltage each tube socket terminal to ground with DC VTVM.

INPUT ..... none
SENSITIVITY ..... full left
ATTENUATOR .....X2
POSITION ..... to center the stylus
USE-OFF-CAL-CAL ADJ ..... OFF

Measure heater voltage across heater terminals with AC VTVM.

Turn off and let cool. Measure resistance to ground at each tube socket terminal.

| Tube | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| V1301 | 500K | 1.25M | 1.5M | 0 | 0 | 500K | 1.25M | 1.5M | NC |
| | +80V | OV | +.55V | 7.6VAC | | +80V | OV | +.55V | OV |

# SECTION IV

# THEORY

## 1. INTRODUCTION

The Sanborn DC Coupling Preamplifier is one of the group of plug–in Preamplifiers used in the "150" series of Sanborn Recording Systems. It is a simple push–pull d–c amplifier, built for exceptional stability, linearity, and operating flexibility.

## 2. COMPLETE RECORDING SYSTEM

Figure 7 is a simplified diagram showing one channel of a Sanborn Recording System using a DC Coupling Preamplifier. The Preamplifier and Driver Amplifier interconnect through a 24–contact plug. The Driver Amplifier supplies filament, plate, and bias voltage to the Preamplifier. The Preamplifier amplifies the input signal and supplies it to the Driver Amplifier, which drives the Galvanometer in the Recorder.

## 3. PREAMPLIFIER: GENERAL DESCRIPTION

The signal circuit is shown as part of the simplified block diagram figure 8. The signal (push–pull or single–ended) is fed into the DC Coupling Preamplifier through the INPUT socket J1301 or through J204 at the Driver Amplifier rear. The USE–OFF–CAL switch S1301 sets the preamplifier for operation, or for calibration, or grounds the grids of the Preamplifier to protect the system. The ATTENUATOR switch S1302 reduces the signal by the ratios indicated on the Preamplifier panel. The push–pull direct–coupled amplifier V1301 amplifies the signal approximately 20 times. BALANCE control R1330 in the cathode circuit corrects the unbalance between the two sides of the push–pull circuit.

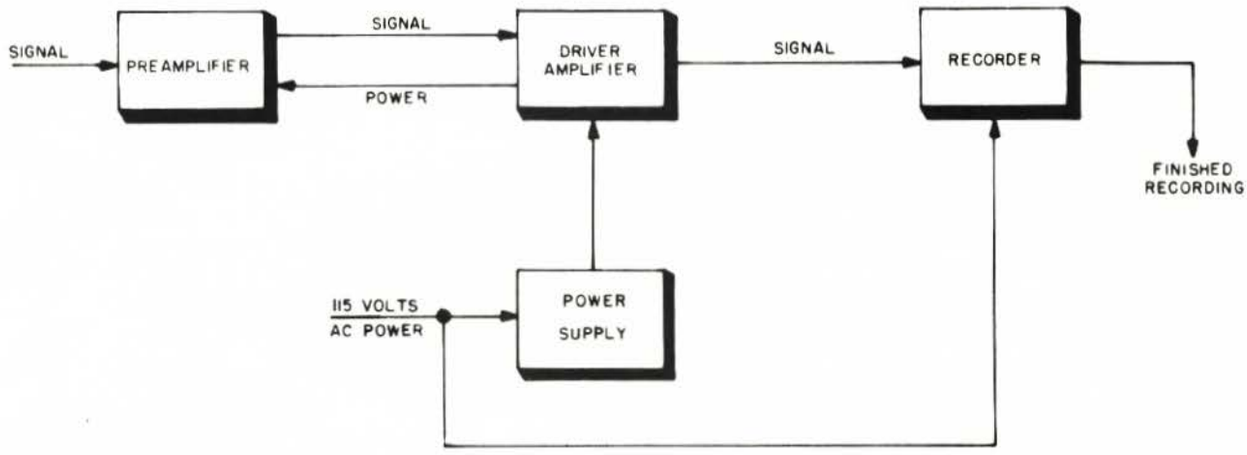



*Figure 7. Simplified Block Diagram of "150" Series Recording System.*

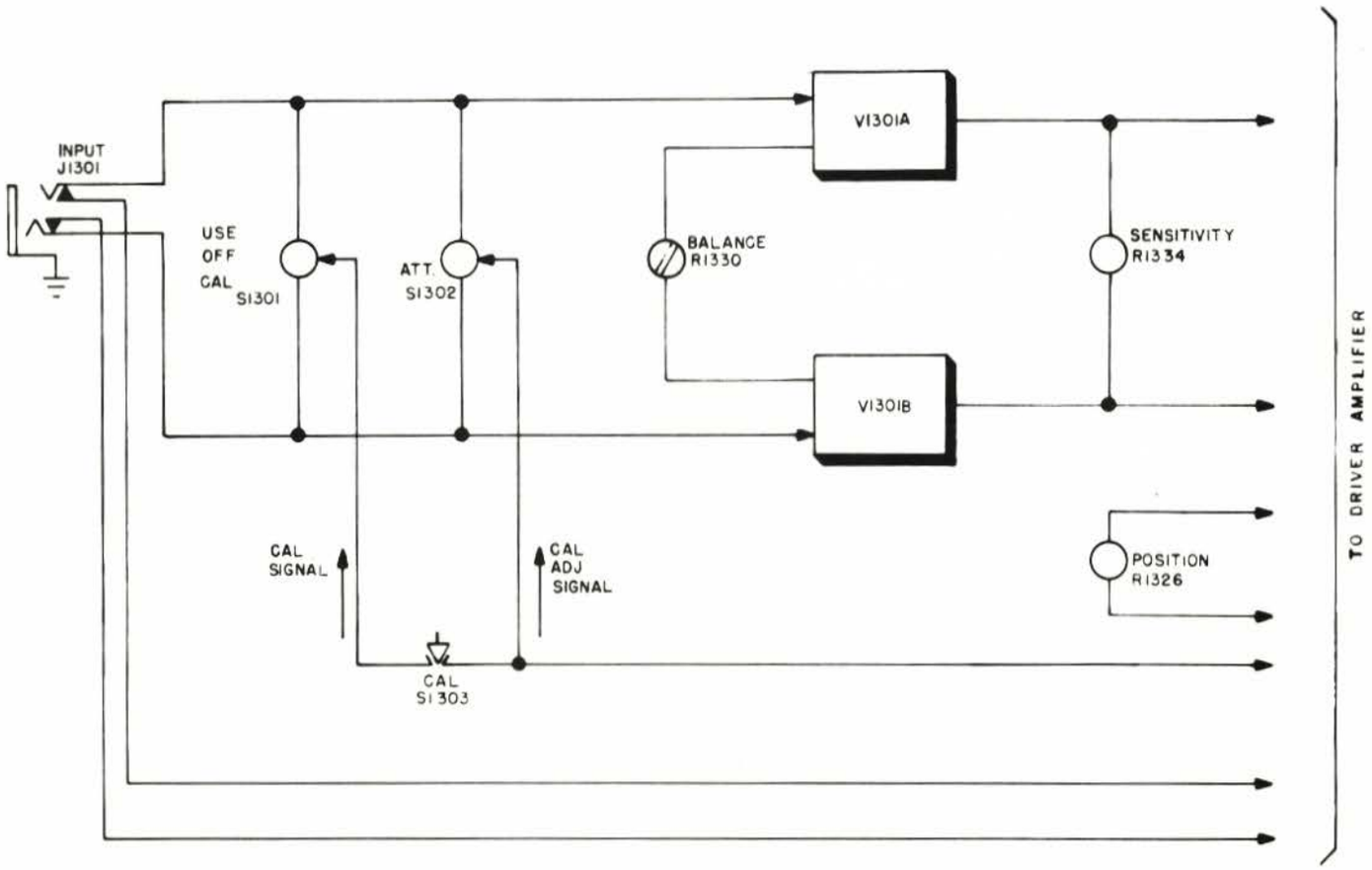



*Figure 8. DC Coupling Preamplifier 150–1300, Simplified Diagram*

The SENSITIVITY control R1334 in the plate circuit controls the gain of the Preamplifier. The output signal is fed into the Driver Amplifier.

The POSITION control R1326 selects the position of the Galvanometer writing arm (or other indicator) which corresponds to zero input signal to the Preamplifier. The control is mechanically a part of the Preamplifier, and is electrically a part of the Driver Amplifier. Its theory of operation is given with the Driver Amplifier theory.

## 4. CALIBRATION CIRCUIT

The calibration circuit is shown in the simplified block diagram, figure 8, and the simplified schematic diagram figure 9. There are two calibration signals in the calibration circuit, the CAL ADJ signal and the CAL signal.

a. The CAL ADJ signal is fed into the ATTENUATOR switch S1302, and is used when adjusting the CAL signal to 100 millivolts (see paragraph 3, Section III). This CAL ADJ signal is taken from 80,000 ohm resistance network fed from +80 volt calibration supply. When this signal is adjusted to exactly 1.019 volts by comparing with a standard voltage cell, the CAL signal will be exactly 100 millivolts. This adjustment is made by R236 at the Driver Amplifier rear.

b. The CAL signal is fed to the USE-OFF-CAL-CAL ADJ switch S1301 by pressing the CAL switch S1303. This 100 millivolt CAL signal is used when setting the SENSITIVITY control R1334 to calibrate the entire system to its basic sensitivity of 50 mv./cm (paragraph 4, Section II).

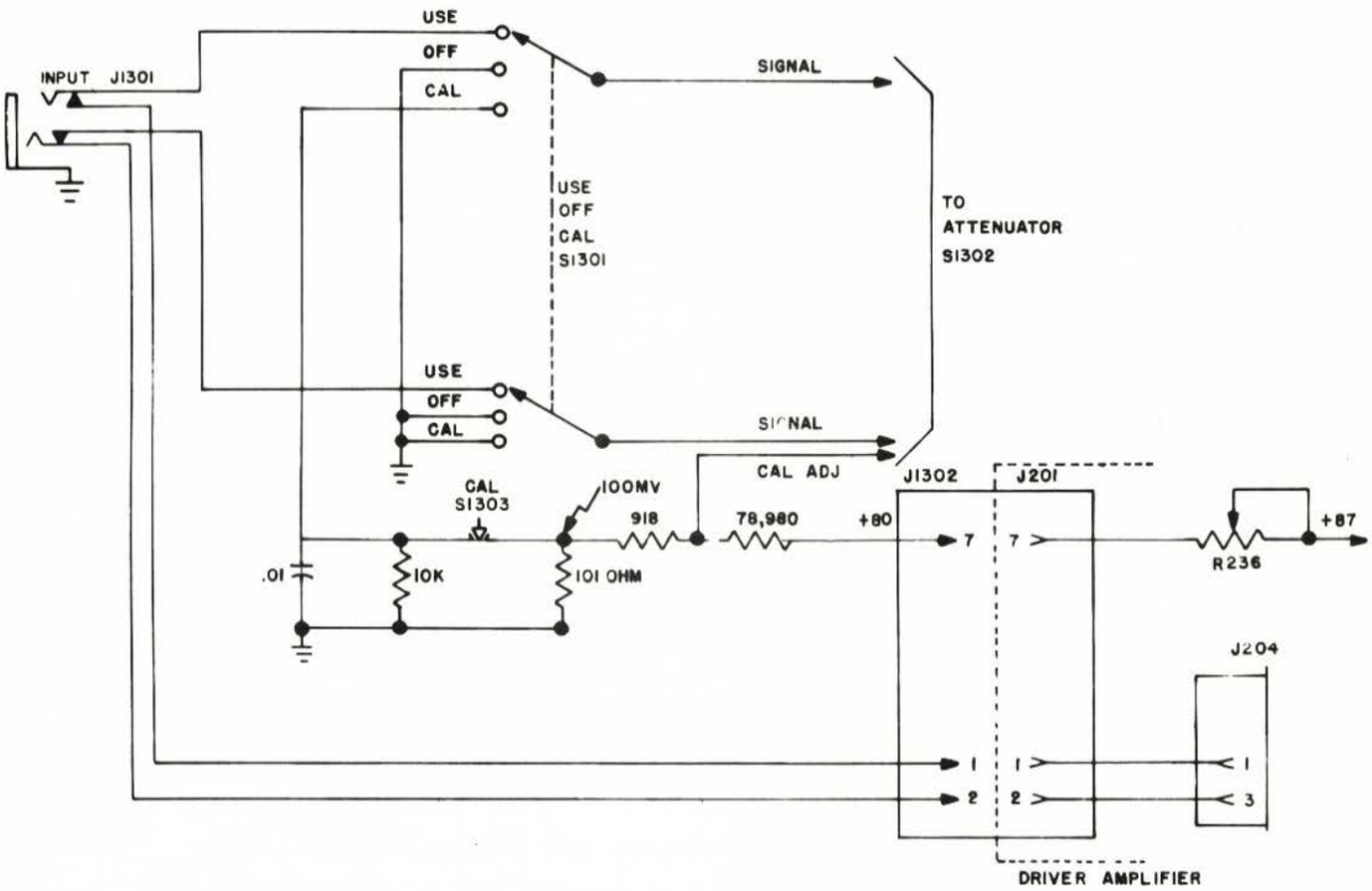



*Figure 9. Input Circuit Simplified Schematic Diagram.*

## 5. INPUT CIRCUIT: THEORY

The Input Circuit is shown in the simplified schematic diagram, figure 9. The signal is fed into the Preamplifier through the INPUT jack J1301, or through the input socket J204 at the Driver Amplifier rear. Only one input circuit may be used at one time. When the USE–OFF–CAL switch S1301 is at OFF, both leads marked "signal" are connected to ground. This shorts the ATTENUATOR switch S1302 and connects the grids to ground, to protect the equipment during preliminary adjustments, warm-up, etc. When the USE–OFF–CAL switch S1301 is at USE, both leads marked "signal" are connected to the INPUT jack J1301 and J204 on the Driver Amplifier rear. This connects the input signal to the ATTENUATOR switch S1302 for actual operation. When the USE–OFF–CAL switch S1301 is at CAL, the upper lead marked "signal" is connected to the 100 millivolt calibration signal circuit, and the lower lead marked "signal" is connected to ground. This position is used when calibrating the Preamplifier.

## 6. GRID CIRCUIT: THEORY

The grid circuit is shown in the simplified schematic diagram, figure 10. With the ATTENUATOR switch S1302 at OFF, the grids of V1301A and V1301B are grounded. This isolates the push–pull amplifier from the input signal and the calibration voltage. With the ATTENUATOR switch at CAL ADJ, the grid of V1301A is connected to the tip of the input jack through the USE–OFF–CAL switch (which must be in the USE position). The grid of V1301B is connected to a tap on the calibration circuit voltage dividing network. (See figure 9). To use this ATTENUATOR position, connect a 1.019 volt stand-

ard voltage cell to the tip of the INPUT jack. If the voltage from the calibration circuit voltage dividing network is the same as that of the standard voltage cell, turning the USE–OFF–CAL switch between OFF and USE will not change the grid–to–grid voltage of the push–pull amplifier, and there will be zero motion of the galvanometer stylus (or other indicator). If motion is present, the "Cal Voltage Adjust" control at the Driver Amplifier rear is adjusted for zero motion. The voltage at the CAL position of the USE–OFF–CAL switch will then be 100 millivolts when CAL button is depressed.

With the ATTENUATOR switch at any one of its other positions, the input signal to the push–pull amplifier is attenuated by the ratio indicated on the panel (X1, X2, X5, X10, X20, X50, X100, X200, X500, X1000).

Capacitors C1302, C1303, and C1304 short out any radio or upper audio frequencies which might otherwise be present between grid and cathode, or cathode and ground, of the push–pull amplifier. These could overload the amplifier and cause non–linearity or other spurious effects.

Cathode resistors R1329, R1330, and R1331 provide individual cathode degeneration for each side of the push–pull circuit. If the circuit components are

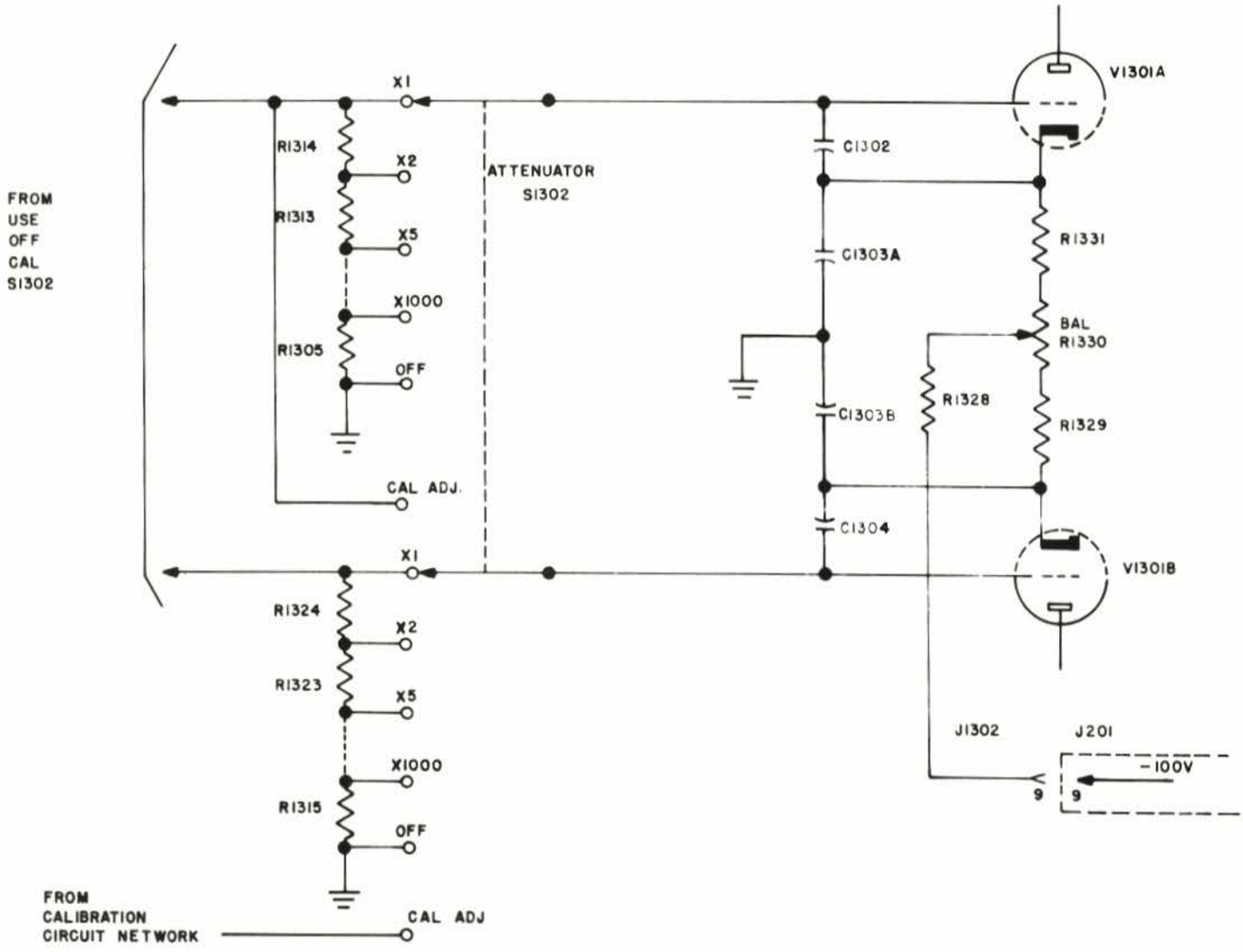



*Figure 10. Grid Circuit Simplified Schematic Diagram.*

perfectly matched, the BAL control R1330 will be set at the mid–point of its resistance range. This gives equal cathode degeneration for each side of the circuit and equal voltages at the plates of V1301A and V1301B. If the components are not perfectly matched, as is the usual case, the BAL control R1330 is moved from its mid–point until the plate potentials are made equal.

The BAL control tap is returned to the –100 volt supply through R1328, which is 1.2 megohm resistor. This high resistance provides the excellent in–phase rejection characteristic of the Preamplifier.

Amplifier operation is shown by treating the instrument as an elementary push–pull amplifier (see figure 11).

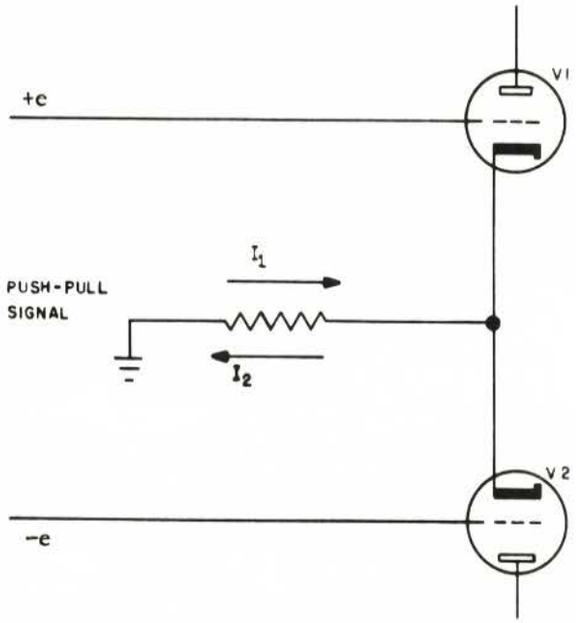



*Figure 11. A Push–Pull Signal Impressed on Grids.*

The in–phase voltage is the portion of the instantaneous input terminal signal which appears at both input terminals at the same amplitude and polarity with respect to ground. With a push–pull signal the in–phase components equal $\frac{a+b}{2}$ where "a" is the instantaneous voltage between one input terminal and ground, and "b" is the instantaneous voltage between the other input terminal and ground. Only a very small fraction of this in–phase voltage will appear on the record because of the inherent in–phase rejection of the Preamplifier.

Note that the Preamplifier ideally responds only to the Signal Component a–b, where "a" and "b" are as defined previously.

With a true push–pull signal which has no in–phase voltage component, the signal voltage +e at the grid of V1 is exactly equal and opposite to the signal –e at the grid of V2. The signal current through the plate circuit of V1 is therefore equal and opposite to the signal current through the plate circuit of V2 (assuming perfect balance). These current components flow through the cathode resistor in opposite directions as shown in figure 11, and cancel out. The cathode resistor in the absence of any in–phase components has no effect on push–pull signals because no signal voltage is developed across it, and the stage operates at full gain for push–pull signals.

When a pure in–phase signal is applied (this can be done by connecting the two grids together and applying a signal between the grids and ground) the signal voltage at the grid of V1 is exactly equal and of the same potential as the signal voltage at the grid of V2.

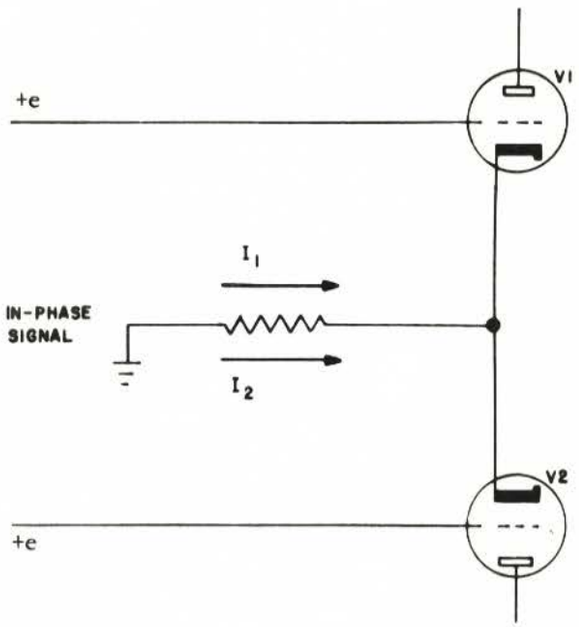



*Figure 12. An In–phase Signal Impressed on Grids.*

The signal current through the plate circuit of V1 is therefore exactly equal to and in the same direction as the signal current through the plate circuit of V2 (assuming perfect balance). These current components flow through the cathode resistor in the same direction, as shown in figure 12, and develop a voltage drop across this resistor. This voltage gives a large amount of cathode degeneration, and this stage therefore operates at greatly reduced gain for in–phase signals, or for the in–phase component of a push–pull signal.

Operation with a single–ended input signal is shown by treating the instrument as an elementary push–pull amplifier shown in figure 13.

With a single–ended signal applied to the grid of V1, signal current components will flow through the cathode resistor. The voltage drop across the cathode resistor approaches +e/2 as shown in figure 13. As a result, the grid to cathode potential of V1 approaches +e/2 and the grid to cathode potential of V2 approaches −e/2, and the Preamplifier operates though a push–pull signal were applied to the input terminals.

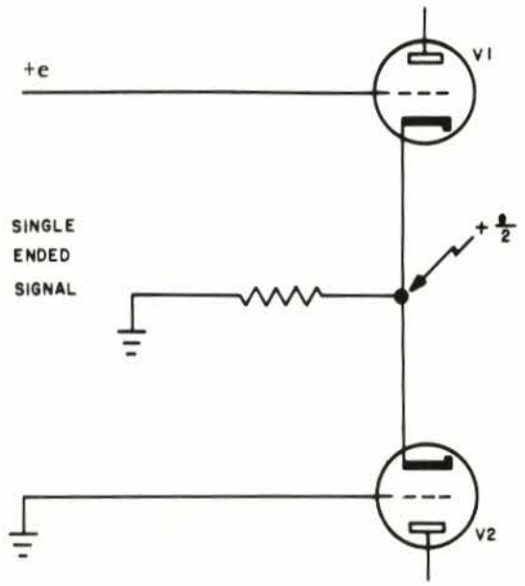



*Figure 13. Single Ended Signals Impressed on Grids.*

The 1.2 megohm cathode resistor R1328 provides good in–phase rejection. The lower end of this resistor is returned to the −100 volt supply to bring the stage to its correct operating point for best linearity.

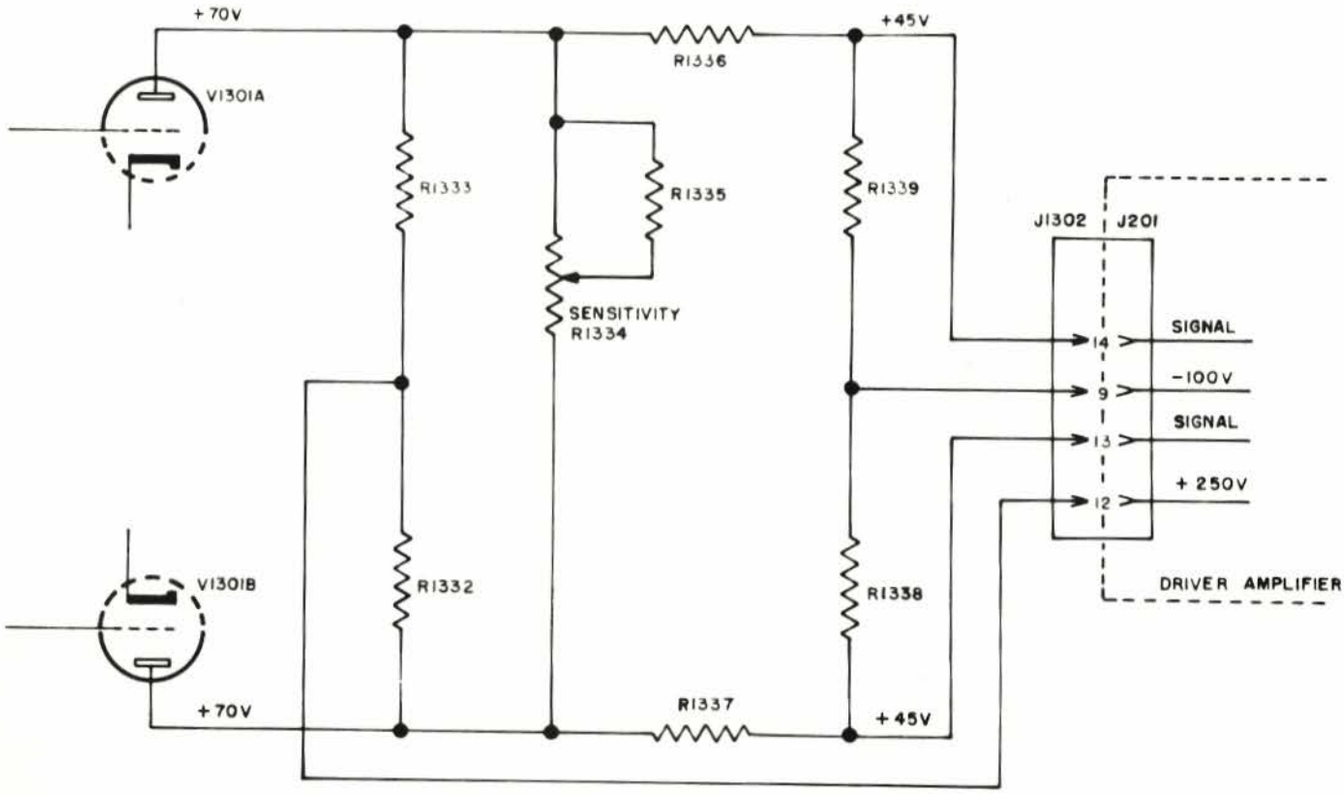



*Figure 14. Plate Circuit Simplified Schematic Diagram.*

## 7. PLATE CIRCUIT: THEORY

The plate circuit is shown in the simplified schematic diagram figure 14.

The SENSITIVITY control R1334 controls the gain of the amplifier by changing the plate–to–plate load resistance of the stage. Rotating the control between its limits gives a change in gain of approximately 2.7. This control is set for the required system sensitivity, in millivolts of signal per centimeter deflection of the galvanometer stylus (or other indicator).

The SENSITIVITY control is also used to indicate amplifier balance. With the amplifier out of balance the no–signal plate voltages are unequal.

Turning the SENSITIVITY control varies the plate load and feeds the unbalance as a signal to the galvanometer. When the BAL control is properly set, the plate–to–plate voltage becomes zero, and turning the SENSITIVITY control gives no motion of the galvanometer stylus or other indicator.

R1333 and R1332 are a part of the plate load resistance network. These resistors furnish the plate current path for the stage.

Voltage dividing network R1336 and R1339 reduce the static plate voltage (+70 v) to the level required by the Driver Amplifier input (+45 v). R1337 and R1338 are a similar network on the other side of the circuit. By returning the network to a -100 volt potential, the static voltage is reduced with only a slight loss in signal level.

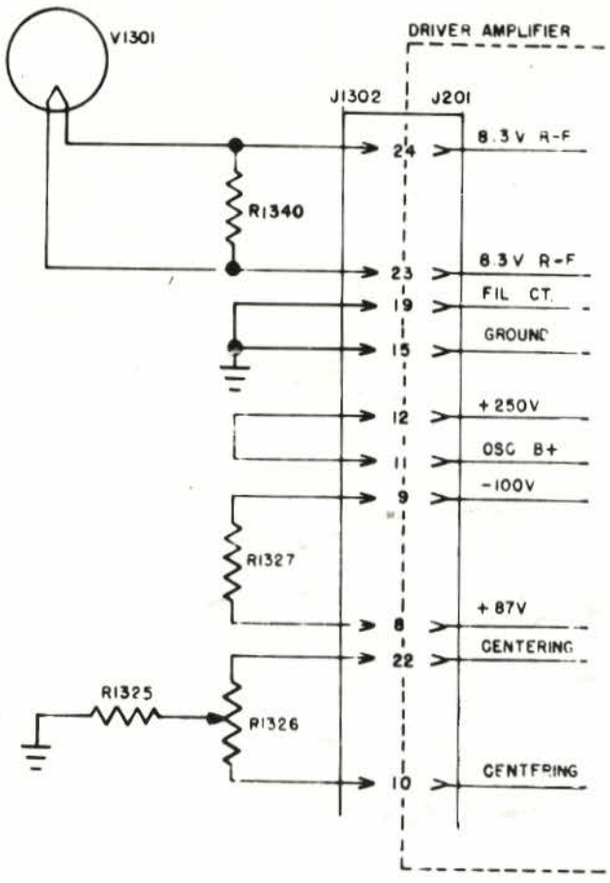



*Figure 15. Simplified Schematic Diagram of Control Circuits.*

## 8. CONTROL CIRCUITS

The control circuits are shown in the simplified schematic diagram figure 15. Terminals 23 and 24 supply the r–f heater voltage for V1301. The r–f oscillator inside the Driver Amplifier is designed to feed two type 5751 tubes (or equivalent). Resistor R1340 takes the place of the second tube, to properly load the r–f supply.

Terminal 19 is the center tap for the regulated 6.3 volt filament supply. Most Preamplifiers connect this terminal to ground (as here).

The connections between terminals 12 and 11 supply plate voltage to the r–f oscillator. This oscillator supplies the r–f heater voltage and the -100 volt bias voltage.

Resistor R1327 draws 400 microamperes to increase the current from terminal 9 (-100 volt supply) to 0.6 ma, which is the value required for proper operation.

Resistors R1326 (POSITION control) and R1325 control the no–signal base line position of the galvanometer writing arm (or other indicator). This control is exactly as shown here for all "150" series Preamplifiers, and is described in the Driver Amplifier Theory of Operation.

MAINTENANCE MANUAL

SANBORN DC COUPLING PREAMPLIFIER

MODELS 150-1300, 150-1300Z

- CONTENTS -

SYSTEM TROUBLE CHECK

SANBORN 150 SYSTEM

RECORDER

DRIVER AMPLIFIER AND POWER SUPPLY
DC COUPLING PREAMPLIFIER MODEL 150-1300

Save time by first finding out where the fault is, by following these steps in sequence:

1. IS THERE ACTUALLY A FAULT?

Check the operator's technique - try the measurements again - see that the operators aren't trying something the system is not built for - check line voltage and frequency.

2. IS THE FAULT IN THE GALVANOMETER?

Power OFF: Check that there is NO roughness when moving writing arm with finger.

Power OFF: Measure resistance at pins 1 and 2 of OUTPUT socket on 150-400 Power Supply, or directly at rear pins of padding resistor terminal boards on galvanometer cap. Resistance should be 3150-3250 ohms.

Power ON: Measure voltage at pins 1 and 2 of OUTPUT socket on 150-400 Power Supply, or directly at rear pins of padding resistor terminal boards on galvanometer cap. Each 32 volts change should give 10 millimeter of stylus deflection (12.5 divisions on narrow Permapaper).

Final check: Exchange the connections of the suspected galvanometer and its neighbor (in multi-channel system). If symptom moves over to next channel, the galvanometers are normal.

3. IS THE FAULT IN THE PREAMPLIFIER OR THE DRIVER AMPLIFIER/POWER SUPPLY?

Replace Preamplifier by one known to be good, or by dummy Preamplifier. If the fault remains, the trouble is probably in the Driver Amplifier/Power Supply. If the fault disappears, the trouble was probably in the Preamplifier.

4. DID THESE STEPS POINT OUT THE TROUBLE?

By now, you should have found the unit at fault. If not, the trouble may be system-wide or may be impossible to track down by this method. What to do: Use the Trouble Shooting Charts and Checkout Charts.

TROUBLE SHOOTING CHART

SANBORN DC COUPLING PREAMPLIFIER MODEL 150-1300

| SYMPTOM | POSSIBLE CAUSE | CHECK |
|---|---|---|
| Preamplifier will not work at all. | Loose Preamplifier | Check that Preamplifier is plugged in firmly. |
| | Defective tube | Check V1301. |
| | R-f oscillator in Driver Amplifier not working. | See Driver Amplifier trouble shooting chart. |
| Cannot move stylus over entire chart with POSITION control. | Defective resistor | Check R1325, R1326 |
| | Matched-pair resistors out of tolerance | Check for balance of stage. See note at end of chart. |
| Cannot feed input signals from rear. | Plug left in front INPUT jack. | Remove plug |
| Drift | Signal drift | Check signal with meter. |
| | Drift in high-frequency components in signal or in the in-phase component | High-frequency or in-phase components can overload the grids and not show on the record. This causes a non-linearity, which can appear as drift. Check with meter and oscilloscope. |
| Drift | Defective tube | Check V1301 |
| | Line voltage drifting widely, or drifting outside the rated limits. | Check with meter. |
| | Drifting resistor value | See if the balanced position of the BAL control moves around. If it does, check the matched-pair resistors in the amplifier stage. |
| | Inadequate warmup | Warm up for 30 minutes minimum. |
| Erratic stylus motion, noise, or microphonics | Defective tube | Check V1301 |

| SYMPTON | POSSIBLE CAUSE | CHECK |
|---|---|---|
| | Noisy circuit element | Look for noisy circuit element. An oscilloscope helps here, with input plug disconnected. |
| Microphonics, noise | Loose input connection | Check for electrically and mechanically tight joint in the input circuit. Insert connector all the way. |
| | Noise pickup in the signal, or picked up from an external source. | Check input signal with oscilloscope for noise component. Even high-frequency components which do not record directly can overload grid with resulting non-linearity and modulation of signal. Shield lead wires to avoid capacitive pickup. Use twisted pair to avoid inductive pickup. Avoid ground loops. |
| | Erratic signal | Check signal with oscilloscope. |
| Low sensitivity | Defective tube. | Check V1301 |
| | Low heater voltage | Adjust r-f oscillator on Driver Amplifier. |
| | Improper calibration of Preamplifier. | Check calibration method. |
| | +80 volt supply not adjusted. | Readjust, see Section III, Paragraph 3. |
| Too sensitive to in-phase signals. (Same thing as a low in-phase rejection). | Defective tube | Check V1301 |
| | In-phase component greater than expected. | Check with oscilloscope to see that there are no in-phase signal peaks which could exceed the rated limits. |
| | Misadjustment of R1340 on Preamplifier chassis. | Readjust as stated in Instruction Manual Supplement IM-150-1300-1A Rev. |
| | Matched-pair resistors out-of-tolerance. | Check for balance; see note at end of this chart. |
| Poor a-c in-phase rejection | Open or out-of-tolerance condenser. | Check for match ±10% C1302 C1304. |

| SYMPTOM | POSSIBLE CAUSE | CHECK |
|---|---|---|
| Non-linear | Low heater voltage | Readjust r-f oscillator on Driver Amplifier. |
| | Defective tube | Check V1301 |
| | Excessive in-phase component in signal, or signal with high transient peaks which overload grids. | Check with oscilloscope to see that there are no signal or in-phase component which exceed the rated limits. |
| Unsatisfactory frequency or transient response, too slow or fast a rise time, cannot adjust damping control in Driver Amplifier with this Preamplifier. | Improper adjustment of Damping circuit in Driver Amplifier. | Readjust |
| | Open condenser | Check C1301 |
| | Defective tube | Check V1301 |
| | Open resistor | Check R1301 |
| Stylus stays at one side of recording channel while instrument on. | Defective tube | Check V1301 |
| | Shorted condenser | Cehck C1302, C1304, C1303A, B |
| | Out-of-tolerance resistor | Check all resistors in amplifier circuit. |
| 150-1300Z only: Zero Suppression will not work. | Improper signal connection. | Re-connect properly |
| | Trying to suppress negative signals | Designed for positive signal suppression only. Make a positive signal out of the component you wish to suppress, by using a battery in series with the signal, positive terminal toward the Preamplifier. |
| 150-1300Z only: Zero Suppression inaccurate | Inaccurate adjustment of calibration circuit voltage. | Readjust as outlined in check chart or in the Instruction Manual. |
| | High source impedance | Input impedance of Preamplifier is five megohms. If source impedance is appreciable with respect to five megohms, the Preamplifier will load down the signal source. |

| SYMPTOM | POSSIBLE CAUSE | CHECK |
|---|---|---|
| Cannot balance | Defective tube | Check V1301 |
| | Misadjustment of R1340 on Preamplifier chassis. | Readjust |
| Baseline shift when moving ATTENUATOR | Grid current | Check for balance; see note at end of chart. |
| | High in-phase voltage | With push-pull input, the residual balance of the ATTENUATOR resistor string allows a small amount of the in-phase voltage to appear on the recording. This small fraction will usually not be the same in magnitude and polarity' on all the attenuator positions. Eliminate by reducing the in-phase voltage, or by staying on the same ATTENUATOR position. |

NOTE:

When unbalance is suspected (which may be caused by matched resistors out of balance, tube ageing, etc.), this may be conveniently checked by successively shorting together the grids, then the cathodes, then the plates of the amplifying stage. Proper amplifier balance between the point of test and the output is indicated when the stylus comes to near mid-scale on applying the short (POSITION control at center). This also indicates that the unbalance is located between the point of the test short and the Preamplifier input. This same test can be used to track down drift, erratic or noisy components, interference, etc.

PERIODIC MAINTENANCE

SANBORN DC COUPLING PREAMPLIFIER

MODEL 150-1300

This is recommended every 500 hours of operation or every 3 to 6 months, as determined by experience.

1. Remove the Preamplifier, inspect above-chassis on the Preamplifier for loose tubes, controls, and plug-in components.
2. Inspect under the chassis for loose resistors, condensers, terminal boards, etc.
3. Look for evidence of overheated components - check visually and by smell for burned insulation, transformers, resistors, condensers, etc.
4. Look for frayed or burned-away insulation.
5. Check for dents, panel scratches, corrosion, and other mechanical abuse. See that all locking controls will lock firmly, and that all plug buttons are in place. Controls, connections, meters, indicators, etc., must be firmly fastened to the panel. See that all knobs are fastened firmly.
6. Blow out dust and dirt with an air hose.
7. Check that the blue-ribbon connector will mate properly with Driver Amplifier.
8. Insert the Preamplifier back into the Driver Amplifier.
9. Go through the steps of the Check Chart.

CHECK CHART

SANBORN DC COUPLING PREAMPLIFIER

MODEL 150-1300

1. Insert the Preamplifier into a Driver Amplifier which is known to be good.

2. Warm up for 30 minutes.

3. Check out the balancing circuits:
   a. Set fine BAL control R1330 and coarse BAL control R1340 to mechanical center.
   b. Sensitivity control R1334 fully counterclockwise.
   c. Check range Position control R1326 and then leave stylus at center.
   d. Attenuator to X1.
   e. USE-OFF-CAL-CAL ADJ to OFF.
   f. Turn SENSITIVITY control fully clockwise.
   g. Recenter stylus with fine BAL control R1330. If R1330 will not recenter stylus place R1330 back to its mechanical center.
   h. If step (g) would not center stylus: turn coarse bal control R1340 very slowly to center stylus.
   i. Make final centering adjustment if necessary with fine BAL control R1330.

4. Adjust the calibration circuit voltage (150-1300 only):
   a. Set SENSITIVITY full clockwise. USE-OFF-CAL-CALADJ to OFF. POSITION to center the stylus, ATTENUATOR to X1.
   b. Plug in 1.019 volts from laboratory type cadmium standard cell for single-ended up-scale measurement.
   c. Adjust +80 volt control at Driver Amplifier rear for zero stylus motion while turning switch between CAL and CAL ADJ. One adjustment is valid for all preamplifiers using this voltage source.

5. Check out the sensitivity:
   a. Set ATTENUATOR to X2. USE-OFF-CAL-CAL. ADJ to CAL. POSITION to center stylus.
   b. Turn SENSITIVITY full right and press CAL button - resulting stylus motion should be at least 13 mm. (16 1/4 mm. with narrow Premapaper).
   c. Turn SENSITIVITY full left and press CAL button - resulting stylus motion should be at least 3 mm. (3 3/4 mm. with narrow Permapaper).

6. Check out the d-c in-phase rejection at X1 - should be 1,000:1 or higher at X1.
   a. Set ATTENUATOR to X1 and plug in a five-volt in-phase signal. Stylus motion should be less than one millimeter.

6. Check out the d-c in-phase rejection at X1- should be 1,000:1 or higher at X1 (Cont.)

   b. Repeat with opposite polarity.

7. Adjust the calibration circuit voltage (150-1300Z only):

   a. Set SENSITIVITY full clockwise. USE-OFF-CAL to USE. POSITION to center the stylus ATTENUATOR to X1. Plug in 1.019 volts from laboratory type cadmium cell.

   b. Set ZERO SUPPRESSION dial to 204. Intermittently move the ZERO SUPPRESSION OUT/IN switch between OUT and IN, and adjust the +80 ADJ control for minimum stylus motion.

VOLTAGE AND RESISTANCE CHART

SANBORN DC COUPLING PREAMPLIFIER

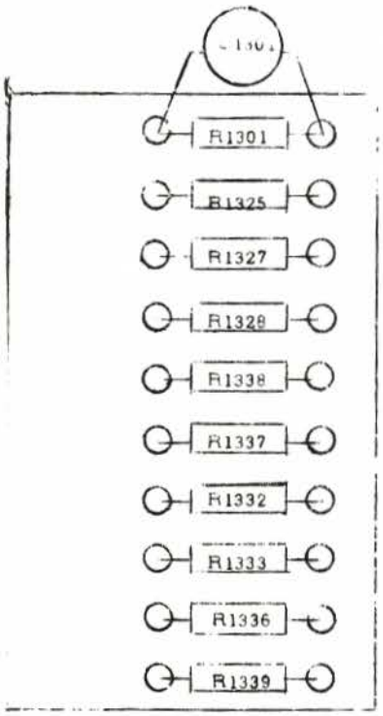
MODEL 150-1300

| V1301 PIN | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| VOLTS | +80 | 0 | +.55 | 7.6 a-c | 7.6 a-c | +80 | 0 | +.55 | 0 |
| RESIST-ANCE | 500K | 1.25M | 1.5M | 0 | 0 | 500K | 1.25M | 1.5M | NC |

Measure DC voltage each tube socket terminal to ground with DC VTVM.

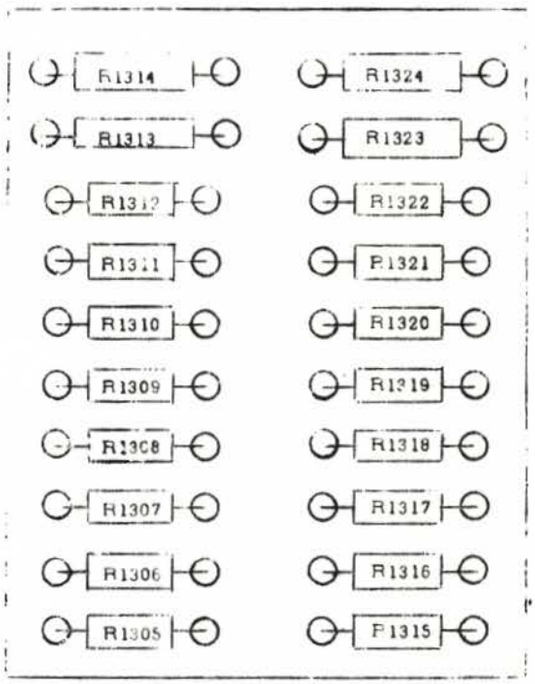
| | |
|---|---|
| INPUT | NONE |
| SENSITIVITY | Full left |
| ATTENUATOR | X2 |
| POSITION | To center the stylus |
| USE-OFF-CAL-CAL ADJ | OFF |

Measure heater voltage across heater terminals with AC VTVM. Turn OFF and let cool. Measure resistance to ground at each tube socket terminal.




E1301

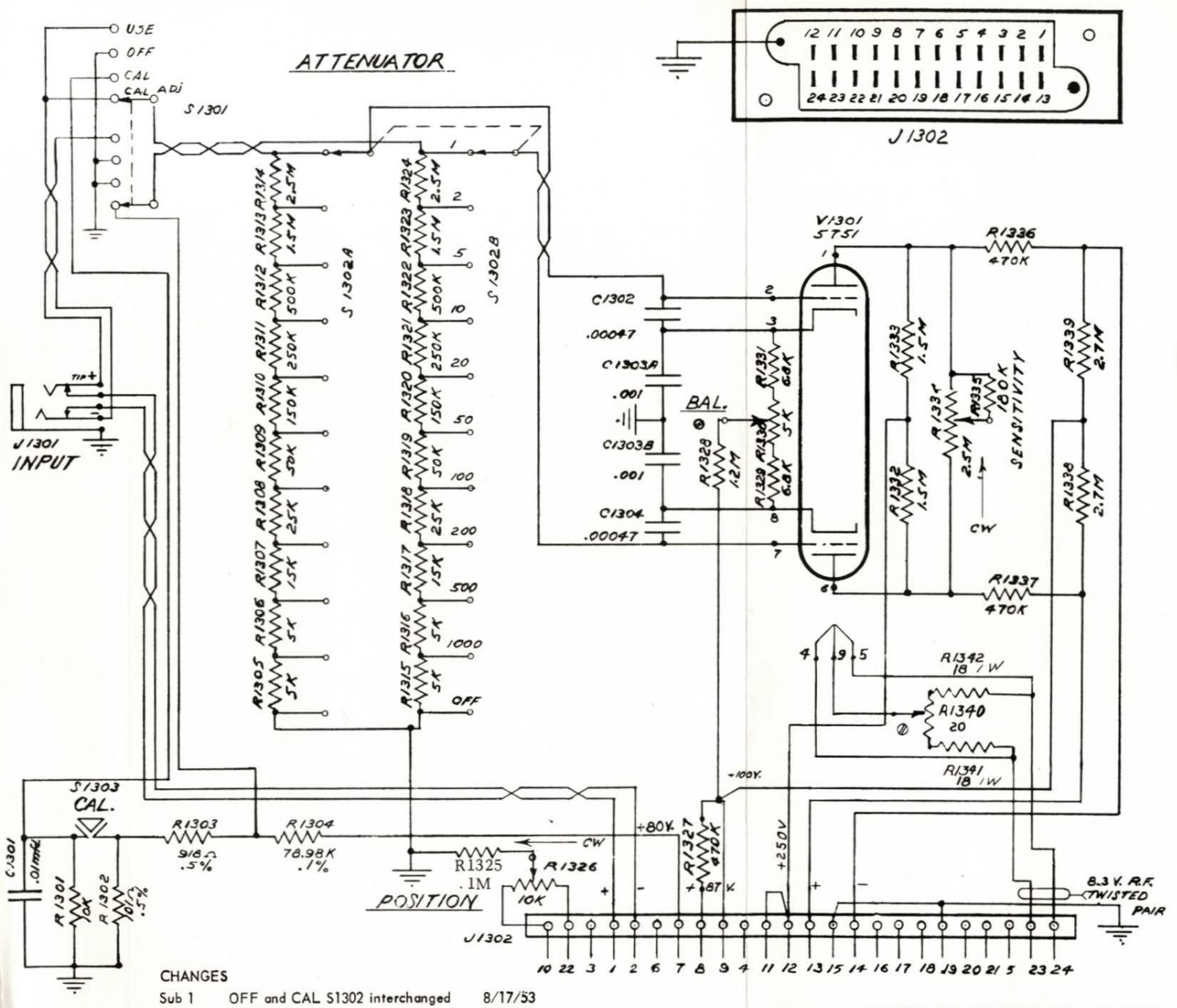
LOCATED UNDERNEATH CHASSIS




E1305

LOCATED ON TOP OF CHASSIS

COMPONENTS LOCATION ON RESISTOR BOARDS




CHANGES

| | | |
|---|---|---|
| Sub 1 | OFF and CAL S1302 interchanged | 8/17/53 |
| Sub 2 | J1302 terminal numbers rearranged | 8/26/53 |
| Sub 3 | R1329 and R1331 changed from 10K to 6.8K | 10/1/53 |
| CR7581 | R1340 was 56 ohms 2W<br>R1341 and R1342 added | 7/19/56 |
| CR7582 | S1301 was 3 position, S1302 was 12 position | 7/25/56 |
| CR9006 | Resistor R1325 was .12M. | 6/12/58 |

SANBORN DC COUPLING PRE-AMPLIFIER
MODEL 150-1300
SCHEMATIC: 150-1300-C1 SUB 6

**SANBORN COMPANY**
WALTHAM MASS.
AUGUST 1962
CR9006 RPL-150-1300-4

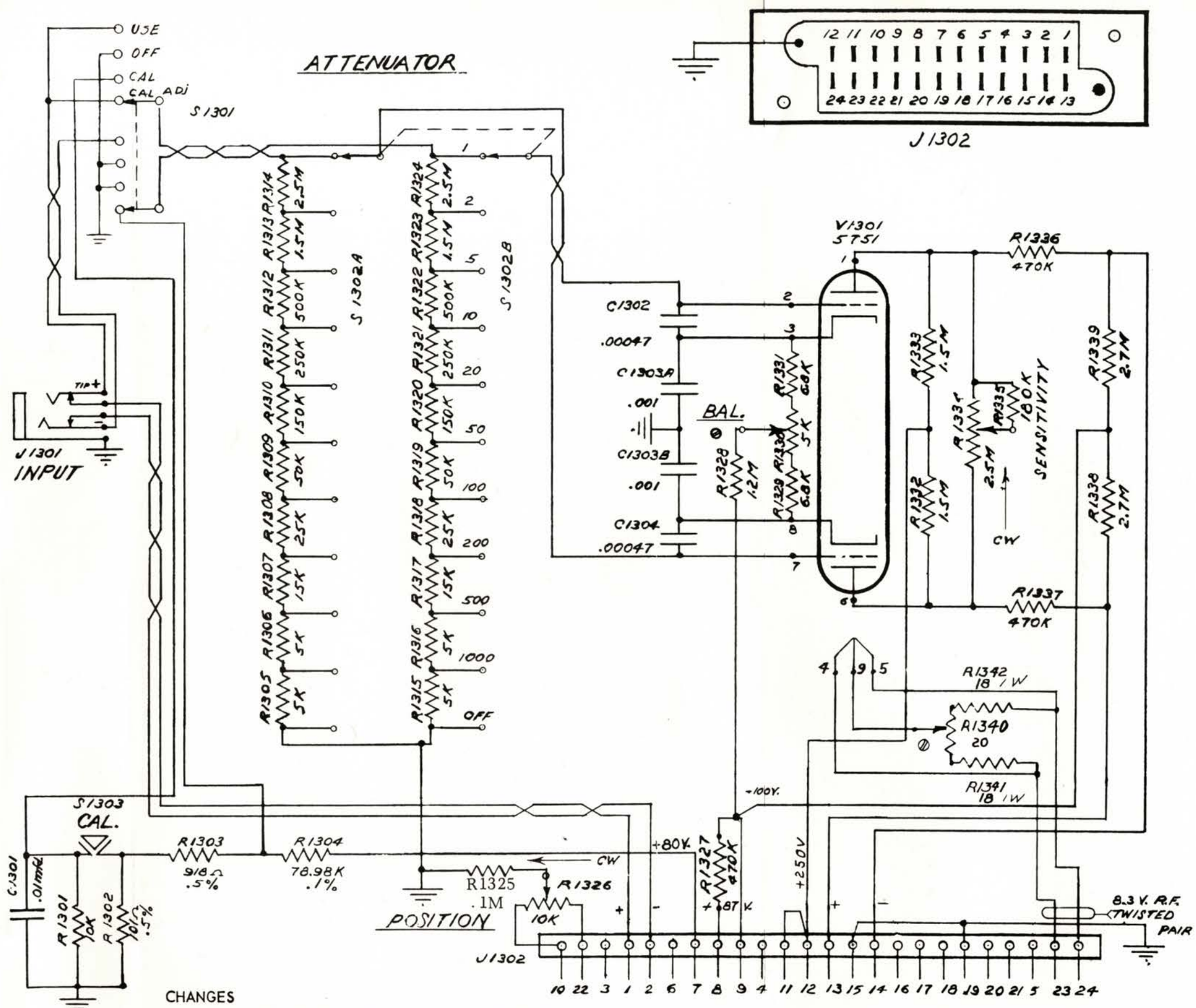
| SYMBOL | DESCRIPTION | SANBORN NO. | CODE |
|---|---|---|---|
| C1301 | .01 mfd 500V ceramic | 8E-6 | 36C1(SPR), 8TM5S1C(CD), DD-103(CEN) |
| *C1302 | .00047 mfd 500V ceramic | 8E-9P | Sanborn matched |
| C1303A, B | .001 x .001 mfd 500V ceramic | 8E-10 | 29C7(SPR) |
| *C1304 | .00047 mfd 500V ceramic | 8E-9P | Sanborn matched |
| J1301 | 2-contact Junior Jack | 10G2-6FX | 7048(MAL) |
| J1302 | Amphenol 24-contact male conn | 10B24-1MX | 26-159-24(AMP) |
| R1301 | 10K 5% 1/2W Comp | 50A-103J | EB(AB), BTS(IRC), SI1/2(SPE) |
| R1302 | 101 ohm 1/2% 1/2W WW | 54A-32D | WW3(IRC), WM3(MEP), 103(BON) |
| R1303 | 918 1/2% 1/2W WW | 54A-34D | WW3(IRC), WM3(MEP), 103(BON) |
| R1304 | 78.98K 1/10% 1/2W WW | 54A-33T | WW3(IRC), WM3(MEP), 103(BON) |
| R1305 | 5K 1% 1/4W Comp | 50H-502G | C11(WEL), DCC(IRC) |
| R1306 | 5K 1% 1/4W Comp | 50H-502G | C11(WEL), DCC(IRC) |
| R1307 | 15K 1% 1/4W Comp | 50H-153G | C11(WEL), DCC(IRC) |
| R1308 | 25K 1% 1/4W Comp | 50H-253G | C11(WEL), DCC(IRC) |
| R1309 | 50K 1% 1/4W Comp | 50H-503G | C11(WEL), DCC(IRC) |
| R1310 | 150K 1% 1/4W Comp | 50H-154G | C11(WEL), DCC(IRC) |
| R1311 | 250K 1% 1/4W Comp | 50H-254G | C11(WEL), DCC(IRC) |
| R1312 | 500K 1% 1/4W Comp | 50H-504G | C11(WEL), DCC(IRC) |
| R1313 | 1.5M 1% 1/2W Comp | 50J-155G | C12(WEL) |
| R1314 | 2.5M 1% 1/2W Comp | 50J-255G | C12(WEL) |
| R1315 | 5K 1% 1/4W Comp | 50H-502G | C11(WEL), DCC(IRC) |
| R1316 | 5K 1% 1/4W Comp | 50H-502G | C11(WEL), DCC(IRC) |
| R1317 | 15K 1% 1/4W Comp | 50H-153G | C11(WEL), DCC(IRC) |
| R1318 | 25K 1% 1/4W Comp | 50H-253G | C11(WEL), DCC(IRC) |
| R1319 | 50K 1% 1/4W Comp | 50H-503G | C11(WEL), DCC(IRC) |
| R1320 | 150K 1% 1/4W Comp | 50H-154G | C11(WEL), DCC(IRC) |
| R1321 | 250K 1% 1/4W Comp | 50H-254G | C11(WEL), DCC(IRC) |
| R1322 | 500K 1% 1/4W Comp | 50H-504G | C11(WEL), DCC(IRC) |
| R1323 | 1.5M 1% 1/2W Comp | 50J-155G | C12(WEL) |
| R1324 | 2.5M 1% 1/2W Comp | 50J-255G | C12(WEL) |
| R1325 | .1M 5% 1/2 W Comp. | 50AB-104 J | EB(AB), |
| R1326 | 10K 10% 2W Linear taper Pot | 56A-11 | U-1031(AB) |
| R1327 | 470K 5% 1/2W Comp | 50AB-474J | EB(AB) |
| R1328 | 1.2M 5% 1/2W Comp | 50A-125J | EB(AB) BTS(IRC) SI1/2(SPE) |
| *R1329 | 6.8K 5% 1/2W Comp | 50A-682JPG | Sanborn matched |
| R1330 | 5K 20% 1/2W Hi-Torque Pot | 56A-49 | 37(CLAR) |
| *R1331 | 6.8K 5% 1/2W Comp | 50A-682JPG | Sanborn matched |
| *R1332 | 1.5M 5% 1/2W Comp | 50AB-155JPG | Sanborn matched |
| *R1333 | 1.5M 5% 1/2W Comp | 50AB-155JPG | Sanborn matched |
| R1334 | 2.5M 30% 1/2W modified CCW Log Taper Pot | 56A-54 | 37(CLAR) |
| R1335 | 180K 5% 1/2W Comp | 50A-184J | EB(AB), BTS(IRC), SI1/2(SPE) |
| *R1336 | 470K 5% 1/2W Comp | 50AB-474JPG | Sanborn matched |
| *R1337 | 470K 5% 1/2W Comp | 50AB-474JPG | Sanborn matched |
| *R1338 | 2.7M 5% 1/2W Comp | 50AB-275JPG | Sanborn matched |
| *R1339 | 2.7M 5% 1/2W Comp | 50AB-275JPG | Sanborn matched |
| R1340 | 20 ohm 5% 2W Variable | 56A-77 | 43(CLAR) |
| R1341 | 18 ohm 5% 1W Comp | 51D-180J | GB(AB) |
| R1342 | 18 ohm 5% 1W Comp | 51D-180J | GB(AB) |
| S1301 | 1-deck 4 position 2 pole wafer switch | 62B-48 | Special Grisby-Allison |
| S1302 | 2-deck 11 position wafer switch | 62B-26 | 4 (Grisby-Allison) |
| S1303 | Micro switch | 62C-3 | 3MO3-1A (ACR) |
| V1301 | Type 5751 tube | 68A-37 | RCA, GE |
| XV1301 | Mounts V1301 | 10G9-3FX | 9723-5(EB), 167PHSPTD(ELC) |
| Skirted knob with white dot and line for ATTENUATOR | | 32A-27 | S-381-64-DD-L(KK) |
| Plug button for HUM | | 22B-3 | BS-48154(UCF) |

*The following condensers are matched within 10%: (C1302, C1304)

*The following resistors are matched within 2%: (R1329, R1331), (R1332, R1333), (R1336, R1337), (R1338, R1339).

Vendor coding is by vendor type no. and vendor abbreviation.

| | | | |
|---|---|---|---|
| AB | Allen Bradley | HDM | Harry Davier Molding Co. |
| ACR | Acro | HELI | Helipot |
| AMP | Amphenol | IRC | International Resistance Co. |
| ARR | Arrow-Hart & Hegeman | KK | Kurz Kasch |
| BON | Bond Electronics | MAL | Mallory |
| CD | Cornell Dubilier | MEP | Mepco |
| CEN | Centralab | SPE | Speer |
| CLAR | Clarostat | SPR | Sprague |
| EB | Eby | UCF | United Carr Fastener |
| ELC | Elco | WEL | Welwyn |




## CHANGES

| | | |
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| Sub 2 | J1302 terminal numbers rearranged | 8/26/53 |
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| CR7582 | S1301 was 3 position, S1302 was 12 position | 7/25/56 |
| CR9006 | Resistor R1325 was .12M. | 6/12/58 |

SANBORN DC COUPLING PRE-AMPLIFIER
MODEL 150-1300
SCHEMATIC: 150-1300-C1 SUB 6

**SANBORN COMPANY**
WALTHAM MASS.
AUGUST 1962
CR9006 RPL-150-1300-4