150-1000
AC-DC
PREAMPLIFIER

OPERATING AND SERVICE MANUAL

HEWLETT PACKARD hp SANBORN DIVISION

IM-150-1000-2

INSTRUCTION MANUAL

Sanborn AC-DC Preamplifier

Model 150-1000

Sanborn Company

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INSTRUCTION MANUAL SUPPLEMENT
IM-150-1000-2A

SANBORN AC-DC PREAMPLIFIER
MODEL 150-1000

The Instruction Manual IM-150-1000-2 for the AC-DC Preamplifier should be corrected as follows:

Page 9, paragraph 6d

This paragraph does not apply here, should replace paragraph 3d at top of page.

SECTION I

DESCRIPTION AND DATA

1. FUNCTIONAL DESCRIPTION

The Sanborn AC–DC Preamplifier Model 150–1000 is a general–purpose plug–in 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 a RANGE control calibrated directly in terms of voltage sensitivity, and a DC ZERO SUPPRESSION control which can suppress single–ended positive d–c voltages up to 20 times the full scale value.

2. TABULATION OF CHARACTERISTICS
(Including Driver Amplifier and Galvanometer)

SENSITIVITY
AC: 1 mv./cm. to 2 volts/cm.
DC: 1 mv./mm. to 2 volts/mm.

SIGNAL RANGE
AC: reads from 0.1 mv. to 10 volts.
DC: reads from 1 mv. to 100 volts.

FREQUENCY RANGE
AC: 1–100 cycles. See fig. 1.
DC: 0–100 cycles. See fig. 1.

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

CALIBRATION
Internal. AC: 2 mv. ±1%.
DC: 20 mv. ±1%.

STABILITY
AC: Drift less than 0.2 mm./hr.
DC: Drift less than 1 mm./hr. after 90 min. warmup.

INPUT IMPEDANCE
DC: Five megohms each input terminal to ground.
AC: Same, with 0.1 MFD in series with each input.

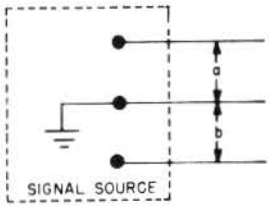
INPUT SIGNALS
Push–pull or single–ended.

ZERO SUPPRESSION
To 20 times full scale voltages, with 500 volt maximum limit.

DC vs AC
In both AC and DC operation, the system records the waveform of the signal. AC operation is more sensitive than DC by a factor of ten, and the frequency response does not extend to zero cycles (see fig. 1). With DC operation, the response of the recording extends to zero cycles, and zero suppression facilities are available.

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.

RANGE	IN–PHASE LIMIT	FRACTION ON RECORD
.001	5.0 volts	Less than 1/1000
.002	5.0 volts	Less than 1/1000
.005	2.0 volts	Less than 1/25
.01	3.0 volts	Less than 1/25
.02	5.0 volts	Less than 1/25
.05	12.5 volts	Less than 1/25
.1	25 volts	Less than 1/25
.2	25 volts	Less than 1/25
.5	25 volts	Less than 1/25
1.0	25 volts	Less than 1/25
2.0	25 volts	Less than 1/25



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.

$$\text{Differential voltage} = a - b$$

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

3. FRONT PANEL DATA

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

SENSITIVITY
Adjusts the gain of the Preamplifier during calibration, so that the values of sensitivity marked on the RANGE switch are accurate. Clockwise rotation increases the gain.

AC/DC
Connects the Preamplifier for AC (condenser–coupled) operation, or DC (direct–coupled) operation.

ZERO SUPPRESSION IN/OUT
Makes the zero suppression facilities of the Preamplifier available or not as required.

ZERO SUPPRESSION
Helipot control with a ten–turn counting dial, calibrated from 1 to 1,000. Each division on the dial represents one millimeter of baseline suppression, providing SENSITIVITY setting is accurate.

RANGE
A multi–position switch which selects the system sensitivities marked on the panel.

CAL
Push–button switch for applying the calibration signal.

DC BALANCE
Maintains the voltage balance of the DC interstage coupling circuit.

AC BAL
A protective button covers the AC BAL control. Screwdriver–controlled adjustment, for maintaining output stage balance.

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

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

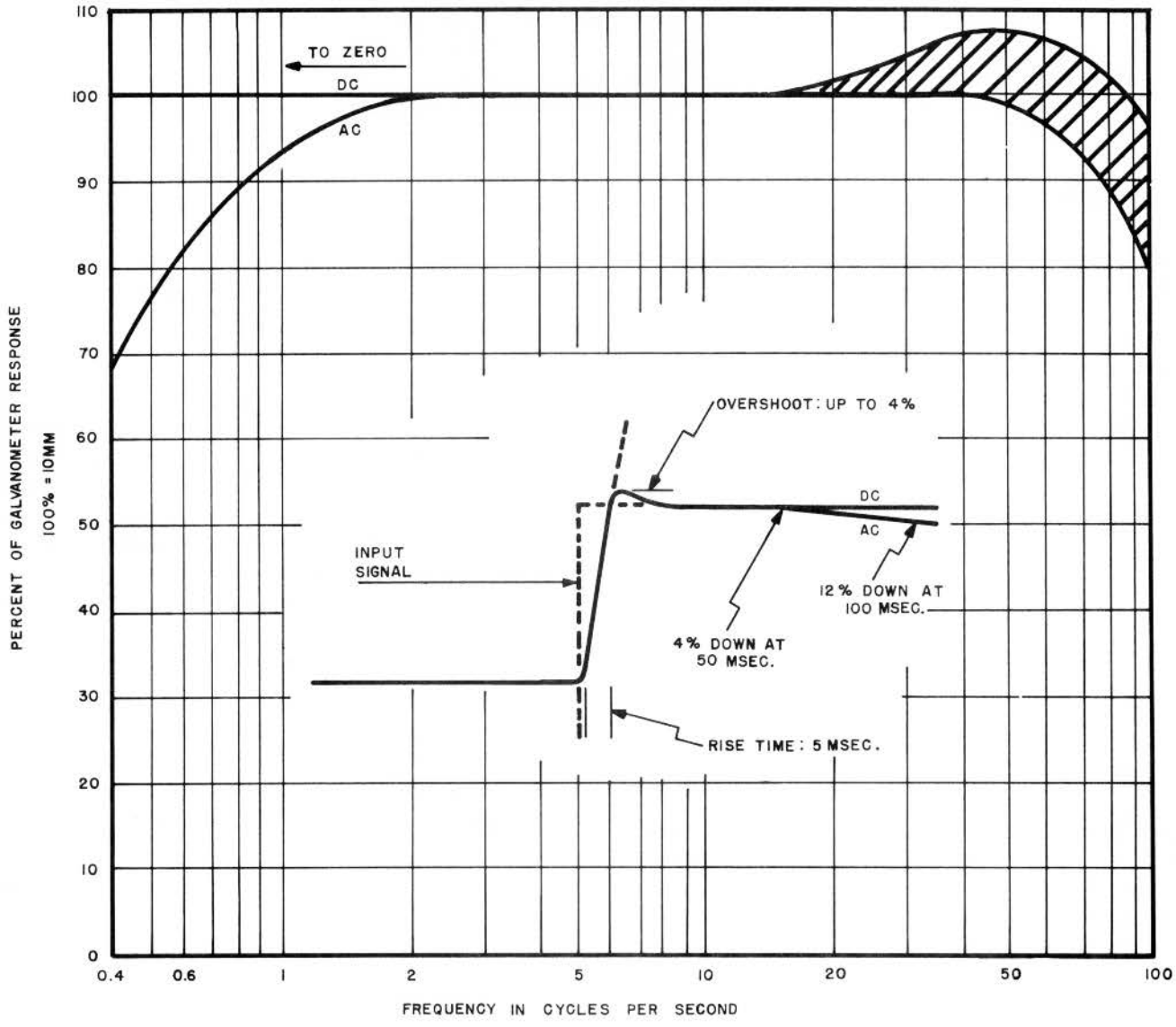


Figure 1. Combined Response Characteristics of the Sanborn AC–DC Preamplifier, Driver Amplifier and Recorder.

SECTION II

OPERATION

1. INTRODUCTION

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

2. STARTING

Apply power and allow 90 minutes warmup for maximum 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) connection, the recording shows the potential between the two signal terminals. A fraction of the in–phase signal between these two terminals and ground appears on the record (see Paragraph 2, Section I).

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

c. Operation with zero suppression requires a positive, single–ended (unbalanced) signal, connected to the phone plug tip or to J204–1. Negative signals require a series battery or equivalent, to keep the signal applied to the Preamplifier input always positive with respect to ground.

d. To record the difference of two single–ended signals, connect one signal to one push–pull input terminal and the other signal to the other input terminal. 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 page 2 for in–phase rejection data.

e. To record the algebraic sum of two (or more) voltages, connect to the Preamplifier through an external mixing circuit. Always correct for the attenuation of the mixing circuit when interpreting the recording.

3. BALANCING

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 90 minutes warmup, set the panel controls for balancing.

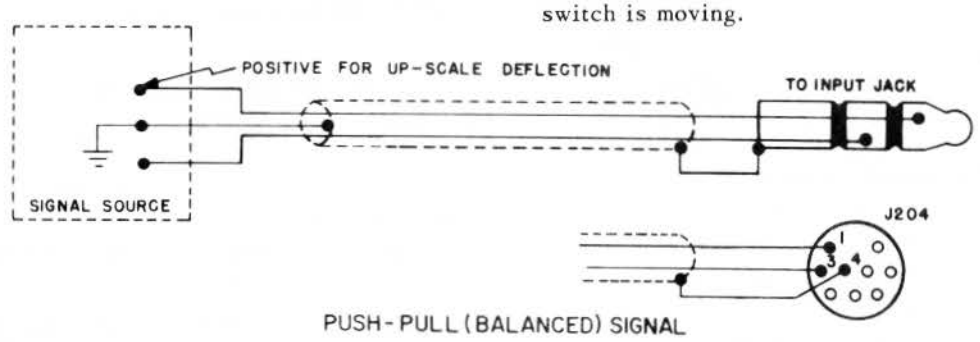
RANGE ..... OFF
AC–DC ..... AC
ZERO SUPPRESSION IN–OUT .. OUT
USE–OFF–CAL ..... OFF
POSITION ..... to center the stylus

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

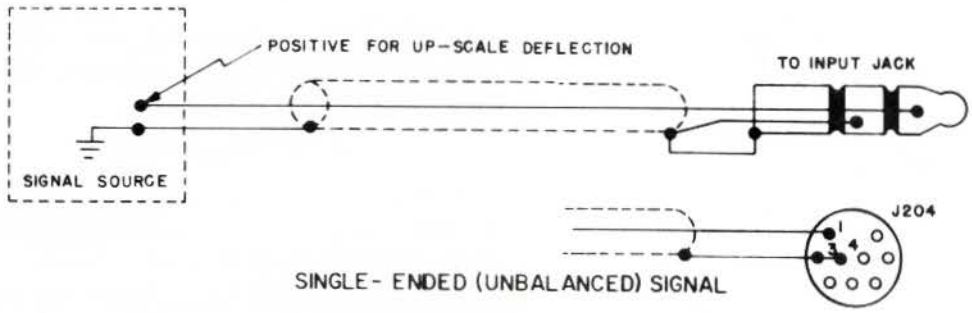
Potentiometer R1065 located behind the ZERO SUPPRESSION potentiometer R1028 is used as a coarse AC balance. When a tube is changed or balance cannot be gained with the AC Bal control, center the AC Bal control, and use R1065 as a coarse balance and then balance with AC Bal control.

c. Set the RANGE switch to .001 and the AC/DC switch to DC. Return the stylus toward mid–scale with the DC BALANCE control.

d. Turn the RANGE switch back and forth between .001 and .002, and adjust the DC BALANCE control for zero motion of the writing arm while the RANGE switch is moving.

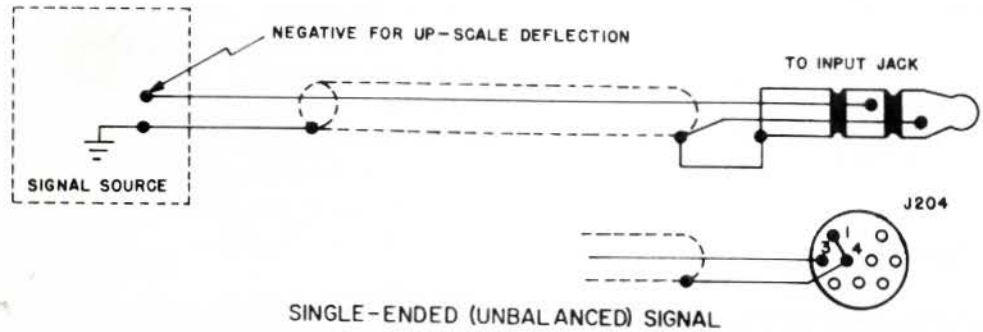


PUSH-PULL (BALANCED) SIGNAL



SINGLE-ENDED (UNBALANCED) SIGNAL

(Required for null indicator operation, or for operation with zero suppression).



SINGLE-ENDED (UNBALANCED) SIGNAL

Figure 2. Input Circuit Connections for Sanborn AC–DC Preamplifier, Model 150–1000.

4. CALIBRATION

Calibration adjusts the Preamplifier to the sensitivity values marked on the RANGE control.

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

RANGE ..... fully clockwise (.001)
ZERO SUPPRESSION IN–OUT ..... OUT
USE–OFF–CAL ..... CAL
POSITION .....to center the stylus
AC / DC .....DC

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

c. Return the RANGE switch to OFF and the USE–OFF–CAL switch to OFF. The preamplifier is now calibrated.

5. OPERATION: AS AC PREAMPLIFIER

With this type of operation, the recording shows the waveform of the input signal, with a high maximum sensitivity available. The frequency response does not extend to zero cycles.

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

RANGE ..... OFF
AC–DC ..... AC
USE–OFF–CAL ..... USE
POSITION .....to set the baseline

b. Turn the RANGE switch to the right for a convenient stylus deflection, or set to the appropriate sensitivity for the expected signal.

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

6. OPERATION
(As DC Preamplifier without zero suppression)

With this type of operation, the recording shows the waveform of the input signal, down to zero cycles.

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

RANGE ..... OFF
AC–DC ..... DC
ZERO SUPPRESSION IN–OUT ..... OUT
USE–OFF–CAL ..... USE
POSITION .....to set the baseline

b. Turn the RANGE switch to the right for a convenient stylus deflection, or set to the appropriate sensitivity for the expected signal.

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

7. OPERATION
(As DC Preamplifier with zero suppression)

With this type of operation, the input must be a single–ended signal, connected as identified in figure 2. The recording shows the waveform of the input signal, down to zero cycles.

a. After warmup, balancing, and calibration, set the panel controls for DC operation with zero suppression.

RANGE ..... OFF
AC–DC ..... DC
ZERO SUPPRESSION IN–OUT ..... IN
ZERO SUPPRESSION .....fully counterclockwise
USE–OFF–CAL ..... USE
POSITION .....to set the baseline

b. When the steady component (to be suppressed) and the varying component (to be recorded) are both known, set the RANGE switch for the varying component, and suppress the steady component by setting the ZERO SUPPRESSION control to the correct number of millimeters of suppression on the recording at the rate of one millimeter of suppression per division on the dial.

To Illustrate: When reading a signal which varies between 0.60 and 0.65 volts, the varying component is 0.05 volts. This corresponds to a

full–scale deflection with the RANGE control at .001. Suppress the 0.60 volt component by turning the DC ZERO SUPPRESSION control to 600.

c. When either the steady component (to be suppressed) or the varying component (to be recorded) are unknown, advance the RANGE switch for a reasonable deflection, and advance the ZERO SUPPRESSION control to subtract a convenient amount of the steady component. Continue until the varying component is spread over as much of the chart as convenient.

d. Turn on the paper drive motor and start the recording. Read the recording by adding algebraically the stylus deflection (in millimeters from the base–line) and the ZERO SUPPRESSION control setting (in divisions), and then multiplying this sum by the RANGE switch setting. (The operator can check the baseline position by momentarily turning the USE–OFF–CAL switch to OFF). Note that stylus deflections are positive when above the base line and negative when below the base line. To avoid algebraic errors, it is convenient to set the base–line within a few millimeters of one edge of the channel.

8. OPERATION
(As DC Preamplifier null indicator)

With this type of operation the input must be a single–ended signal, connected as identified in figure 2. Calibration is not required.

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

RANGE ..... OFF
AC–DC ..... DC
ZERO SUPPRESSION IN–OUT ..... IN
ZERO SUPPRESSION ..... fully counterclockwise
USE–OFF–CAL ..... USE
POSITION .....to set the base line
SENSITIVITY ..... fully clockwise

b. Advance the RANGE switch for a convenient stylus deflection. Bring the stylus back to its original base line position with the ZERO SUPPRESSION control. Continue advancing the RANGE control and bringing the stylus back to its original base line position with the ZERO SUPPRESSION control until the ZERO SUPPRESSION control will no longer bring the stylus back to the base line. Then turn the RANGE control to the left (counterclockwise) one step and bring the stylus back to the base line.

c. Read the signal in millivolts by multiplying the number of divisions shown on the ZERO SUPPRESSION control dial by the RANGE switch setting.

SECTION III

MAINTENANCE

1. INTRODUCTION

This Section contains the installation and maintenance data for the Sanborn AC–DC Preamplifier Model 150–1000, 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. It also includes 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 thumbnuts 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 thumbnuts.

3. ADJUSTING THE CALIBRATION CIRCUIT VOLTAGE

The calibration circuit voltage 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.

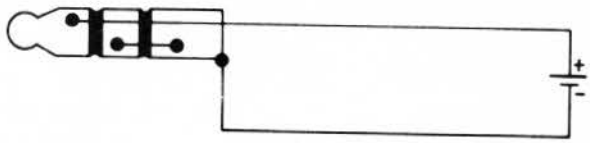


Figure 3. Connections for Calibration Voltage Control Adjustment.

b. Set the Preamplifier controls for calibration circuit adjustment:

SENSITIVITY ..... fully clockwise
POSITION .....to center the stylus
USE–OFF–CAL ..... USE

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

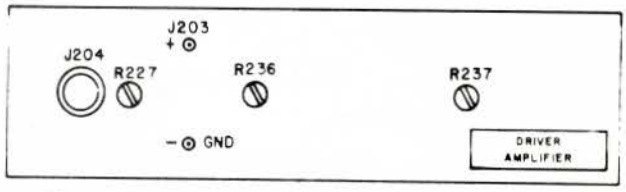


Figure 4. Calibration Voltage Control, Rear of Driver Amplifier.

d. Intermittently turn the ATTENUATOR between OFF and CAL ADJ, and adjust the +80V ADJ control R236 for minimum motion.

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

4. ADJUSTING THE DAMPING CONTROL(S)

The Damping control(s) can affect the system gain and the transient and frequency response of the recording. Refer to the Instruction Manual for the Sanborn Driver Amplifier and Power Supply Models 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 Models 150–200/400, 150–200A/400.

6. ADJUSTING THE DC GAIN CONTROL

The DC Gain control is set at manufacture, and should seldom require readjustment.

a. Warmup and balance the Preamplifier normally. Then calibrate for a two centimeter stylus deflection, with the AC–DC switch set at AC for this calibration.

b. Now set the AC–DC switch to DC and press the CAL button. If the stylus deflection is still two centimeters, the DC Gain control requires no readjustment.

c. If the deflection is not two centimeters, slide out the entire Driver Amplifier, Power Supply, and Preamplifier assembly and adjust the DC Gain control (located immediately behind the AC–DC switch) so that the calibration deflection is exactly two centimeters on both the AC–DC position.

d. Set the ZERO SUPPRESSION dial to 5.08 and the ATTENUATOR to .002. Set the ZERO SUPPRESSION OUT-IN switch to IN. Move the USE-OFF-CAL switch back and forth between USE and OFF, and adjust the +80 volt control for minimum stylus movement.

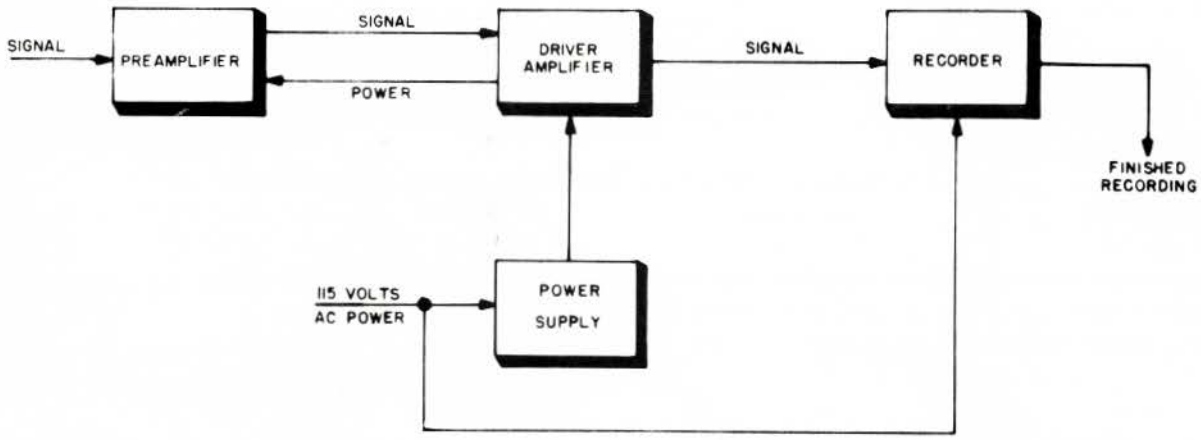


Figure 5. Sanborn "150" Series Recording System, Block Diagram.

SECTION IV

THEORY

1. INTRODUCTION

The Sanborn AC–DC Preamplifier Model 150–1000 is one of the group of plug–in Preamplifiers used in the "150" Series of Sanborn Recording Systems. It is a two–stage, push–pull direct–coupled amplifier, designed to have the great flexibility required for general–purpose voltage measurements.

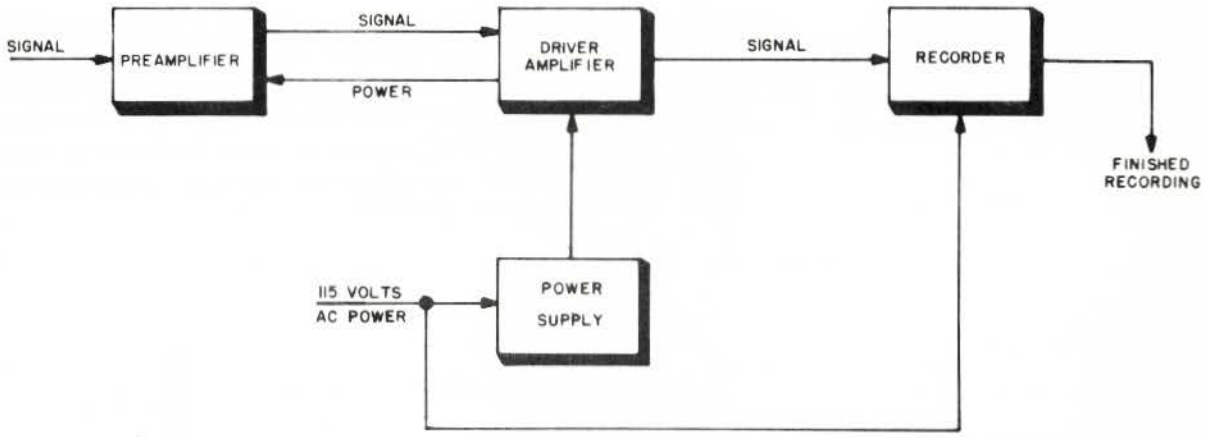


Figure 7. Sanborn "150" Series Recording System, Block Diagram.

2. COMPLETE RECORDING SYSTEM

Figure 7 shows one channel of a Sanborn Recording System using an AC–DC Preamplifier. The Preamplifier and Driver–Amplifier interconnect through a 24–contact plug. The Driver–Amplifier supplies filament, plate, and bias voltages to the Preamplifier. The Preamplifier amplifies the input signal and supplies it to the Driver Amplifier, which drives the Galvanometer in the Recorder.

3. GENERAL DESCRIPTION: AC OPERATION

Figure 8 is a simplified diagram of the AC–DC Preamplifier with the AC–DC switch (not shown) at AC.

The signal (push–pull or single–ended) is fed into the AC–DC Preamplifier through the INPUT socket J1001 or through J204 at the Driver–Amplifier rear. The USE–OFF–CAL switch S1001 sets the Preamplifier for operation, or calibration, or grounds the input circuit of the Preamplifier to protect the

system. Capacitors C1001 and C1002 block the DC component of the signal, and allow the AC component to pass. The RANGE switch S1003 controls the input signal amplitude for sensitivities in volts per centimeter which are decimal multiples of 1, 2, and 5.

The push–pull amplifier V1001 amplifies the signal, which is then coupled through capacitors C1007A and C1008A to the grids of the push–pull amplifier V1002. The AC BAL control R1050 in the cathode circuit corrects the unbalance between the two sides of the push–pull circuit. The SENSITIVITY control R1055 in the plate circuit controls the gain of the Preamplifier. The output signal is fed to the Driver Amplifier.

The POSITION control R1062 selects the position of the Galvanometer writing arm which corresponds to zero input signal to the Preamplifier. This control is physically a part of the Preamplifier, and is electrically a part of the Driver Amplifier. The CAL switch S1004 feeds a .002 volt CAL signal into the Preamplifier through the USE–OFF–CAL switch when pressing the CAL button. This calibration signal is used when setting the SENSITIVITY control to calibrate the entire system.

4. GENERAL DESCRIPTION: DC OPERATION

Figure 9 is a simplified diagram of the AC–DC Preamplifier, with the AC–DC switch (not shown) at DC. Moving this switch from AC to DC performs the following functions.

a. Shorts the capacitors C1001 and C1002.
b. Inserts the DC GAIN control R1034 into the cathode circuit of V1001.
c. Connects the zero suppression circuits.
d. Increases the calibration signal amplitude by a factor of ten.
e. Changes the circuit between V1001 and V1002 to direct coupling.

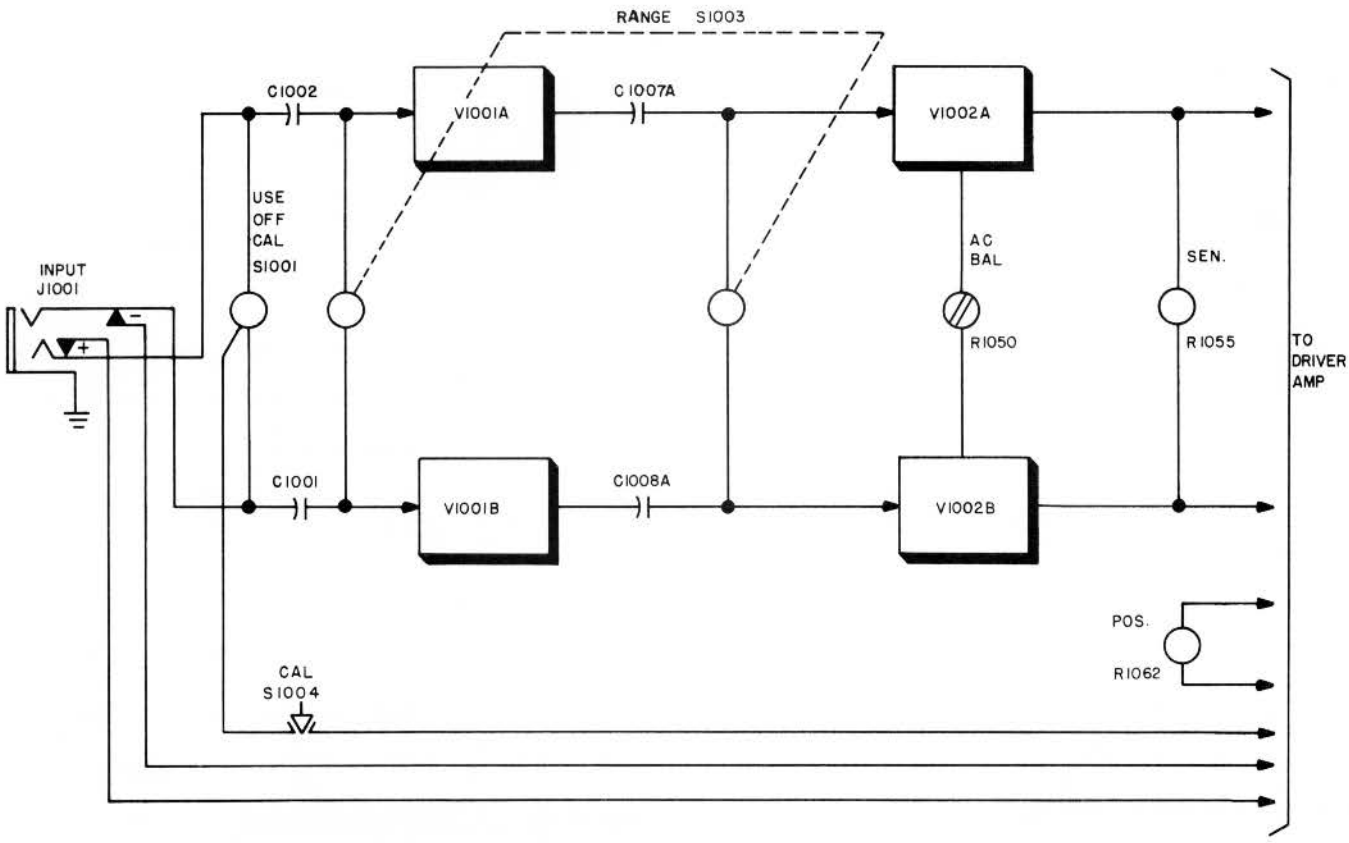


Figure 8. AC–DC Preamplifier, Simplified Diagram with AC–DC switch S1002 (not shown) set at AC.

Operation is the same as outlined in paragraph 3, with added functions. With capacitors C1001 and C1002 shorted by the AC–DC switch, the Preamplifier now responds to d–c signals. The DC GAIN control R1034 is adjusted so the gain of the Preamplifier with the AC–DC switch at DC is exactly one–tenth of the gain with the AC–DC switch at AC. The DC BAL control R1031 in the coupling circuit corrects the unbalance between the two sides of the push–pull circuit.

The ZERO SUPPRESSION OUT–IN switch S1005 in the grid circuit of V1001B selects either the signal fed from the external signal source, or an accurate controllable voltage from the ZERO SUPPRESSION control R1028. The voltage from the ZERO SUPPRESSION control offsets the baseline by a controllable amount, up to 20 times full scale potential.

The CAL switch S1004 feeds a .02 volt CAL signal into the Preamplifier through the USE–OFF–CAL switch by pressing the CAL button. This calibration signal is used when setting the SENSITIVITY control to calibrate the entire system.

The direct–coupled coupling circuit between V1001 and V1002 permits Preamplifier response to zero cycles.

5. INPUT CIRCUIT

Figure 10 shows the input circuit of the AC–DC Preamplifier. The signal is fed to the Preamplifier through the INPUT jack on the panel or through J204 at the Driver Amplifier rear. The USE–OFF–CAL switch connects the Preamplifier to the signal or grounds the Preamplifier input to protect it during connection and adjustment, or connects the Preamplifier input to the calibration voltage. The signal is

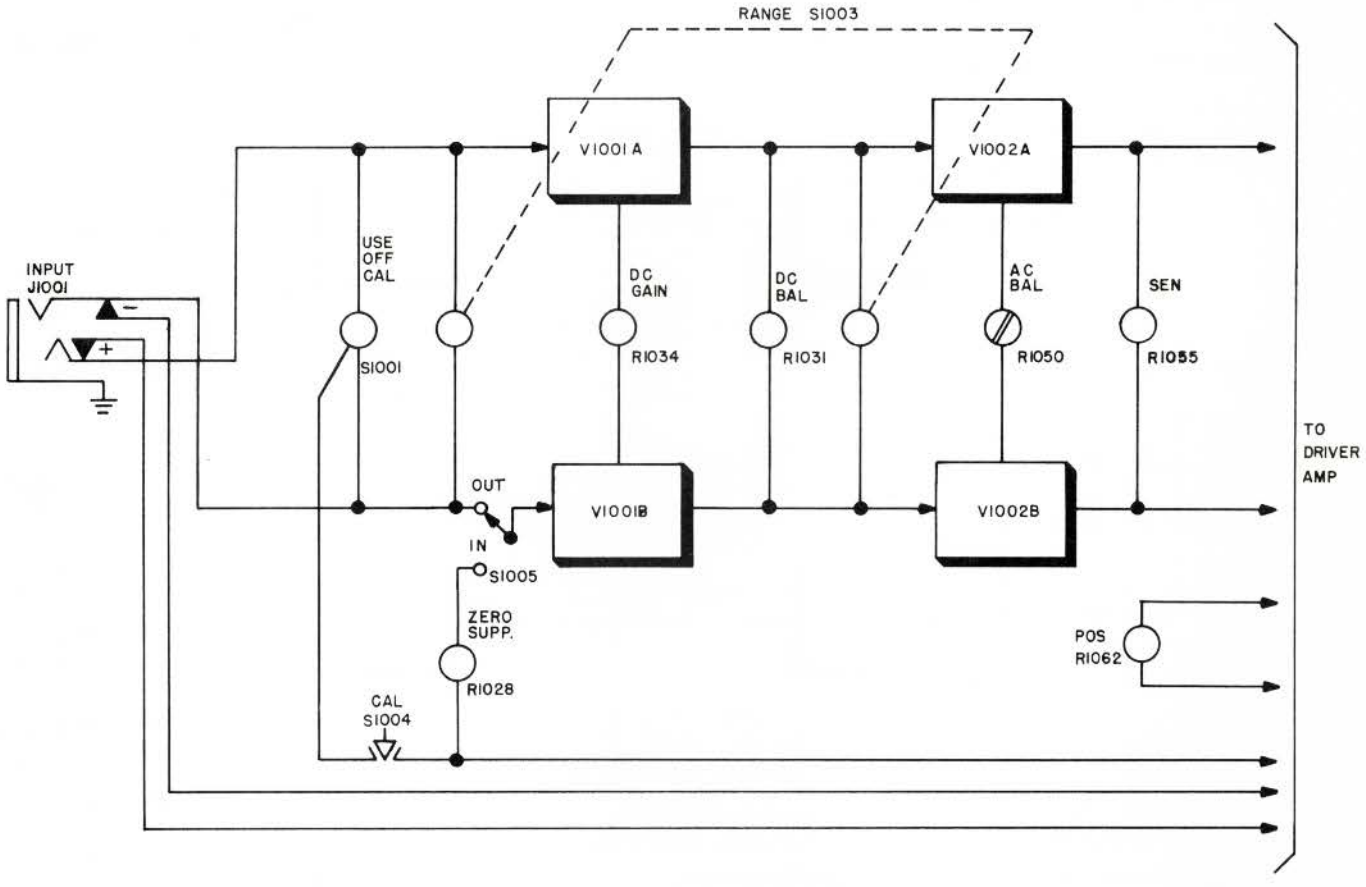


Figure 9. AC–DC Preamplifier, Simplified Diagram with AC–DC switch (not shown) set at DC.

applied directly to the RANGE switch attenuator circuit for DC operation, and is connected to the RANGE switch through capacitors for AC operation. In the .001 and .002 positions of the RANGE switch, the required attenuation is inserted between the stages.

7. ZERO SUPPRESSION CIRCUIT

Figure 12 shows the zero suppression circuit. The ZERO SUPPRESSION control R1028 is a precision ten turn Helipot, connected in a resistance circuit from the accurate +80 volt calibration voltage sup-

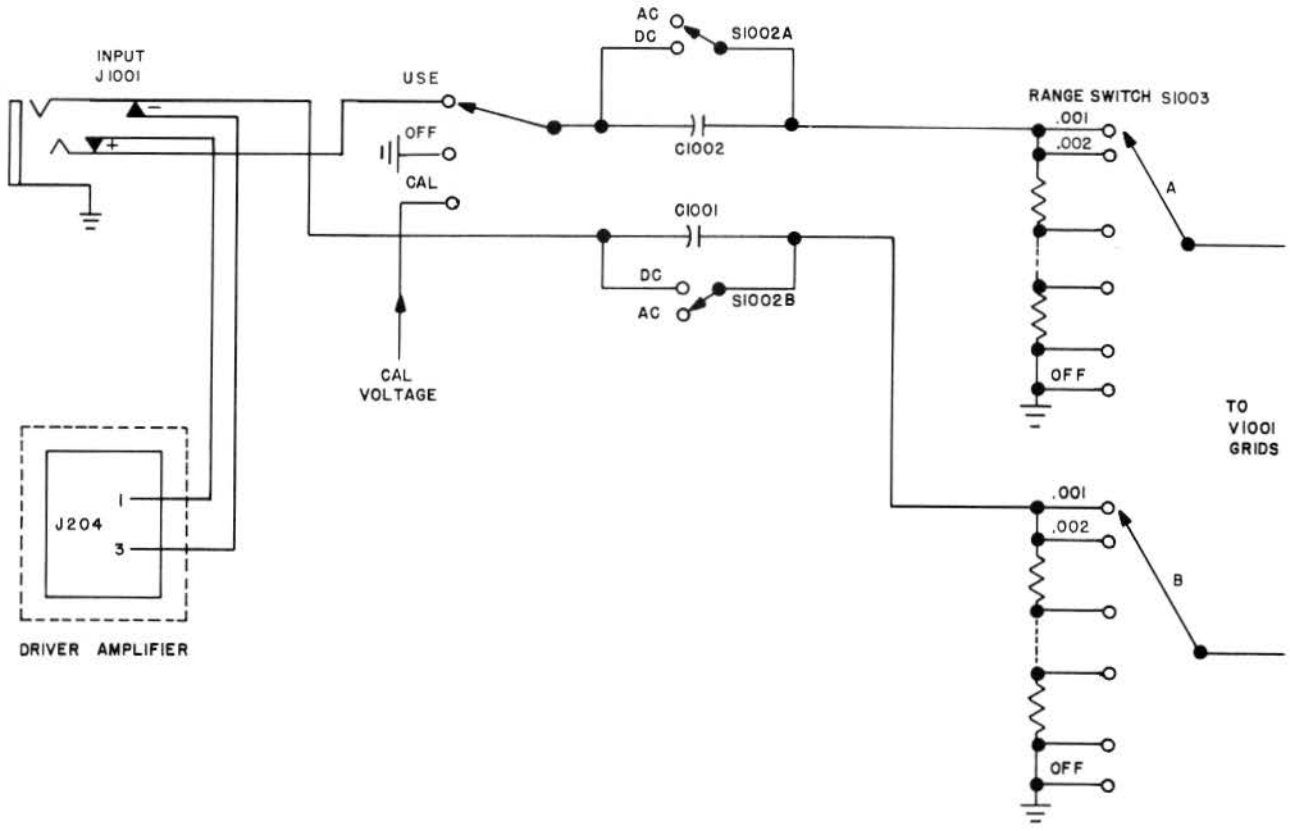


Figure 10. Input Circuit, Simplified Schematic Diagram.

6. CALIBRATION CIRCUIT

The calibration circuit is shown in figure 11. An accurate +80 volt potential is applied to the resistance network shown in the figure, through a series resistor R1029 and the CAL position of the USE–OFF–CAL switch S1001. For DC operation, the CAL voltage is 0.02 volts, and for AC operation the voltage divider R1025 and R1026 fixes the calibration signal at 0.002 volts. This allows the calibration deflection of the galvanometer to be two centimeters whether the instrument is operating at the DC sensitivity of .001 volts per millimeter, or the AC sensitivity of .001 volts per centimeter.

ply. In the .002 position of the RANGE control, and all higher positions, there is a 2:1 attenuator in the interstage coupling circuit (shown in figures 15 and 16). This attenuation is not present in the .001 position. In order for the ZERO SUPPRESSION control dial calibration to remain at its rated value of one millimeter suppression per division when the RANGE switch is at .001, decks "C" and "D" of the RANGE switch introduce a 2:1 attenuation into the ZERO SUPPRESSION circuit in the .001 position of the RANGE switch only.

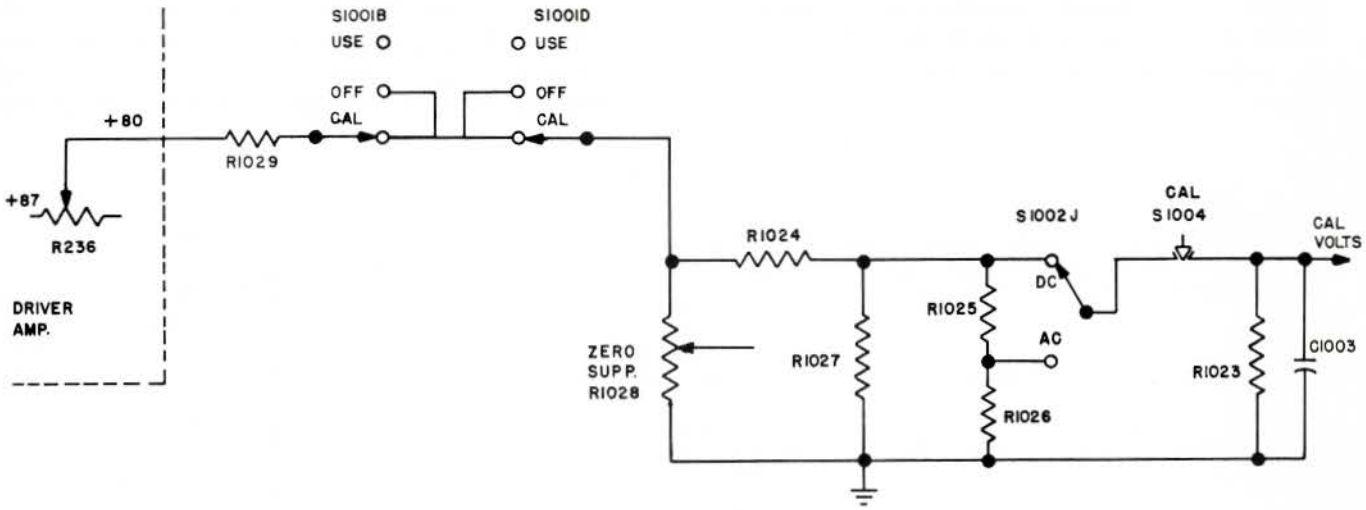


Figure 11. Calibration Circuit, Simplified Schematic Diagram.

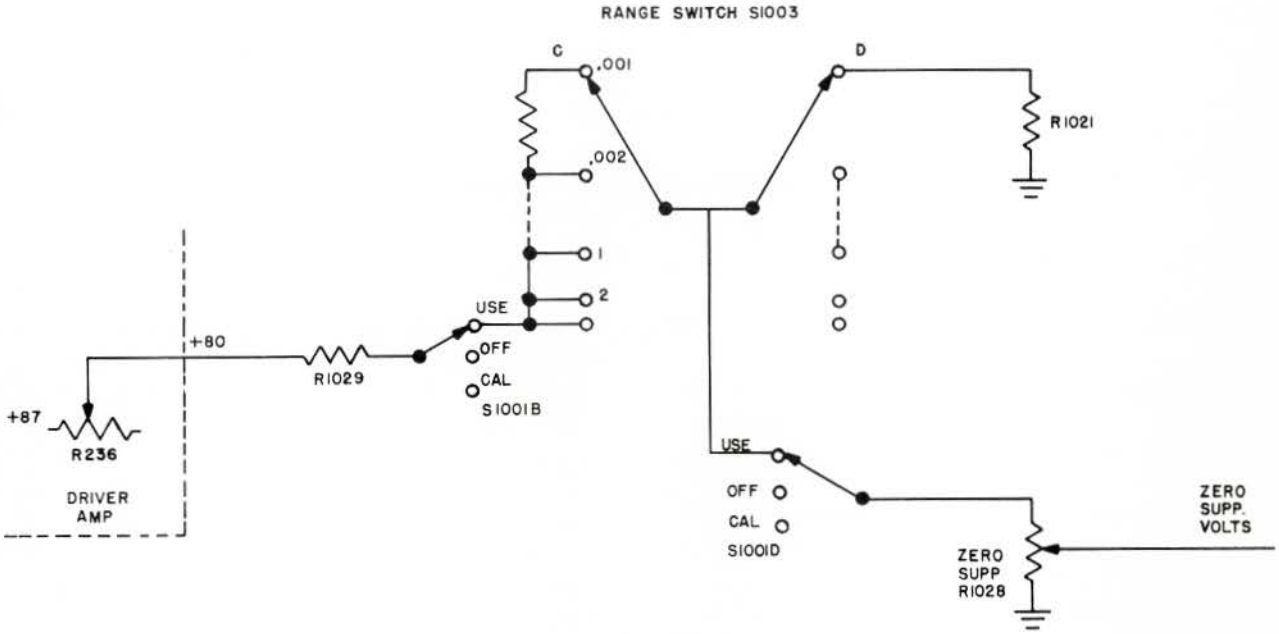


Figure 12. Zero Suppression Circuit, Simplified Schematic Diagram.

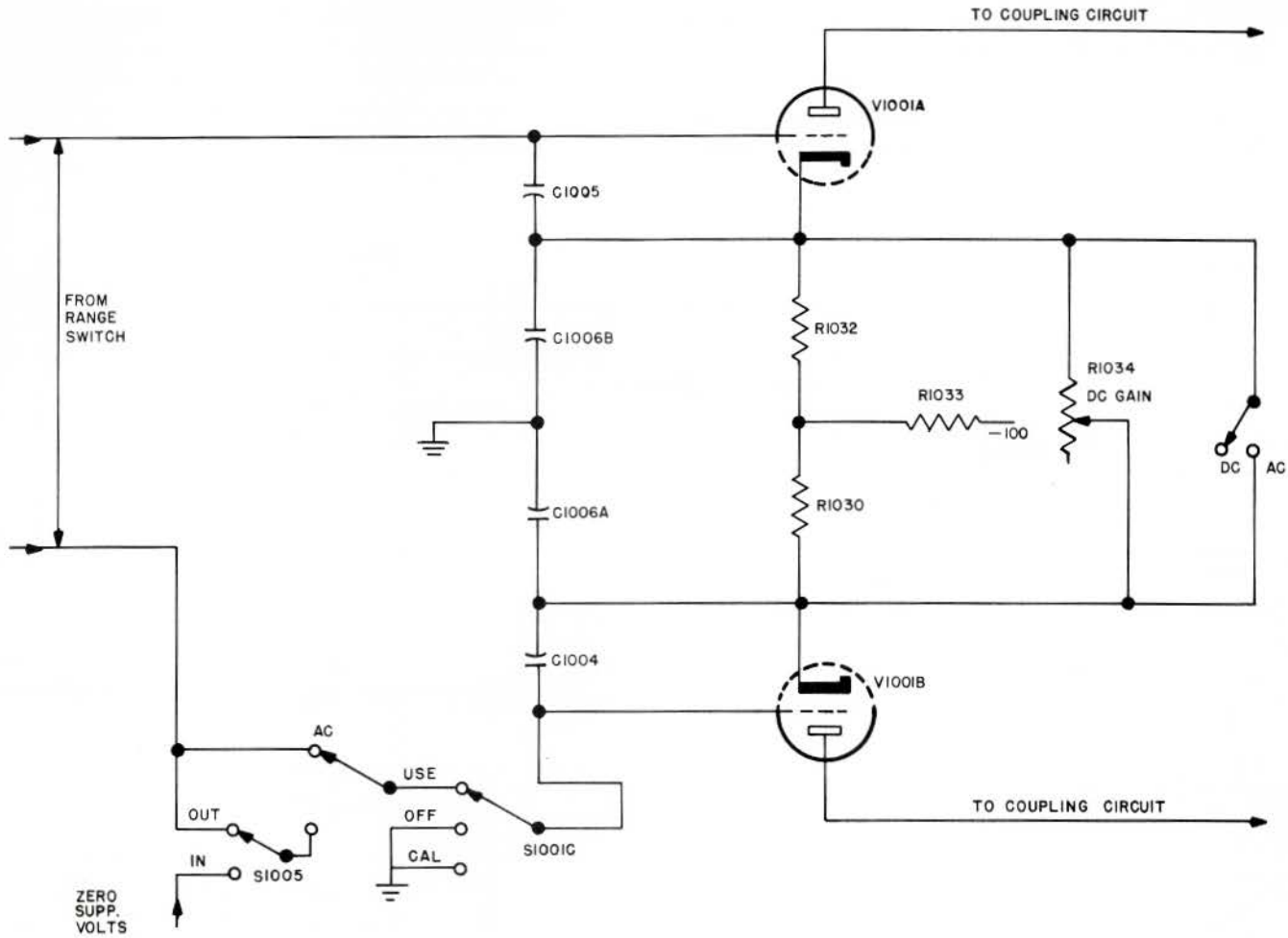


Figure 13. Input Circuit of V1001, Simplified Schematic Diagram.

8. INPUT CIRCUIT OF V1001

Figure 13 shows the input circuit of V1001. The signal from deck "A" of the RANGE switch is applied directly to the grid of V1001A, and the signal from deck "B" is applied to the grid of V1001B through the switching circuits shown. Because the zero suppression voltage is of positive polarity, this figure shows that zero suppression is possible for positive single–ended signals only, applied to the side of the circuit connecting to V1001A.

The high–value cathode resistor R1033 is common to both sides of the push–pull circuit and is returned to the –100 volt potential so that the voltage drop across it does not bias the input stage into the nonlinear region near plate current cut–off. With a push–pull signal, the signal current components of each tube flow through this resistor in opposite directions and cancel. The resistor therefore has no effect on the stage gain for push–pull signals. However, with an in–phase signal applied to the stage, the in–phase signal current components of each tube flow through this resistor in the same direction and do not balance out. This results in a voltage drop across this resistor, of a phasing which applies negative feedback to the stage. This negative feedback reduces the gain of the stage for in–phase signal components so that the stage will reject in–phase components of a push–pull signal. The same characteristic helps keep the stage in balance and makes the stage operate as a phase–inverter for single–ended signals.

Each triode also has an individual cathode resistor, for negative current feedback on each tube individually. The DC GAIN control R1034 is connected across the two individual cathode resistors, to control the amount of the individual current feedback, and thereby control the gain for DC operation. The "C" deck of the AC–DC switch shorts out these individual cathode resistors in the AC position, for more gain in AC operation.

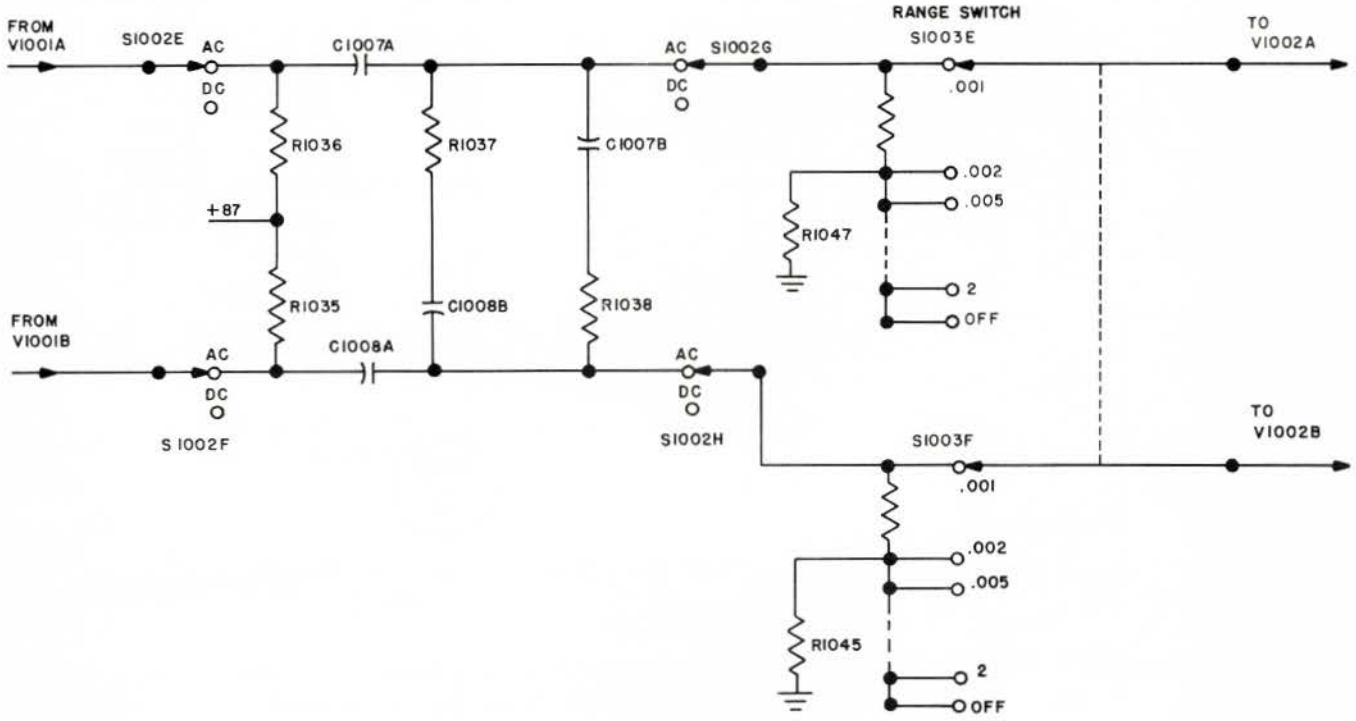


Figure 14. Interstage Circuit, AC Operation, Simplified Schematic Diagram.

9. INTERSTAGE CIRCUIT: AC OPERATION

The coupling circuit between V1001 and V1002 is shown in figure 14, for AC operation. The two RC networks connected across the circuit (R1037, R1038, C1007B, C1008B), are a phase–correcting network. The RANGE switch introduces a 2:1 attenuation in the .002 position and all higher postions; this allows the grids of input stage V1001 to operate at the full signal voltage in the first two positions of the RANGE switch.

10. INTERSTAGE CIRCUIT: DC OPERATION

The coupling circuit between V1001 and V1002 is shown in figure 15, for DC operation. The signal from the plates of V1001A is coupled through a resistance attenuation network which establishes the required biasing potentials at the grids of V1002. The RANGE switch operates as outlined in paragraph 9.

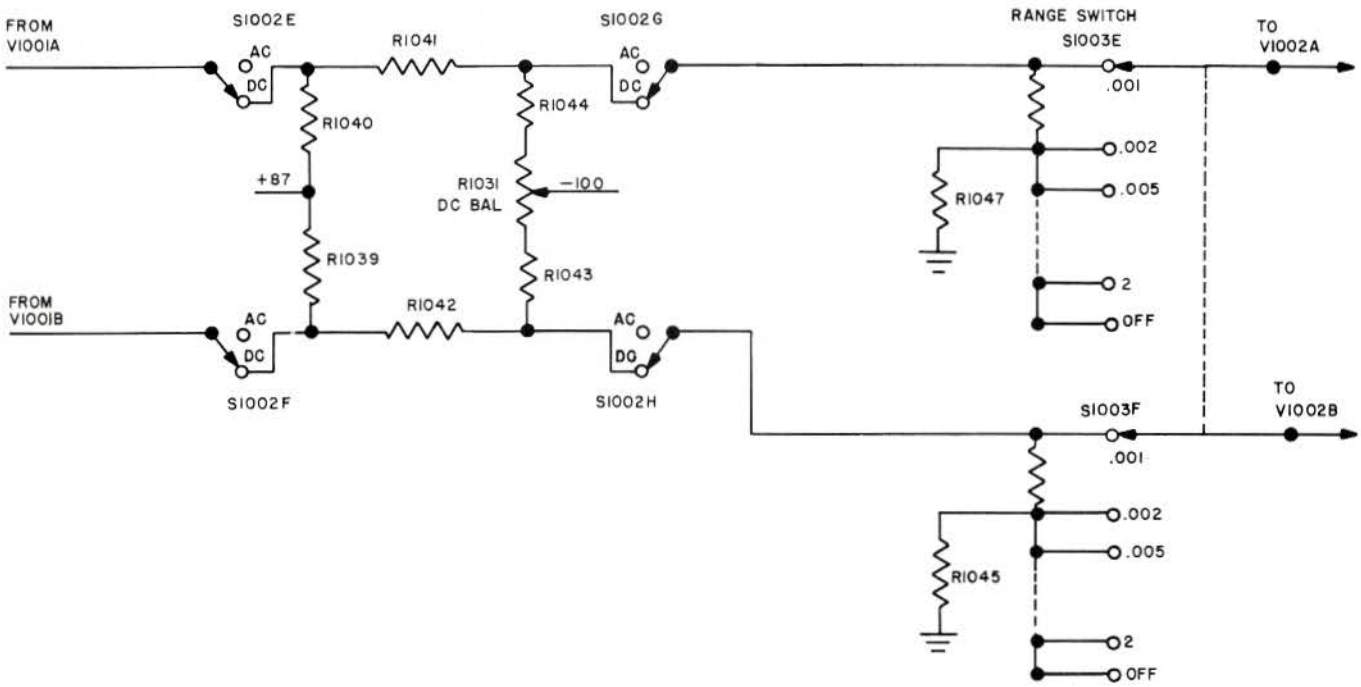
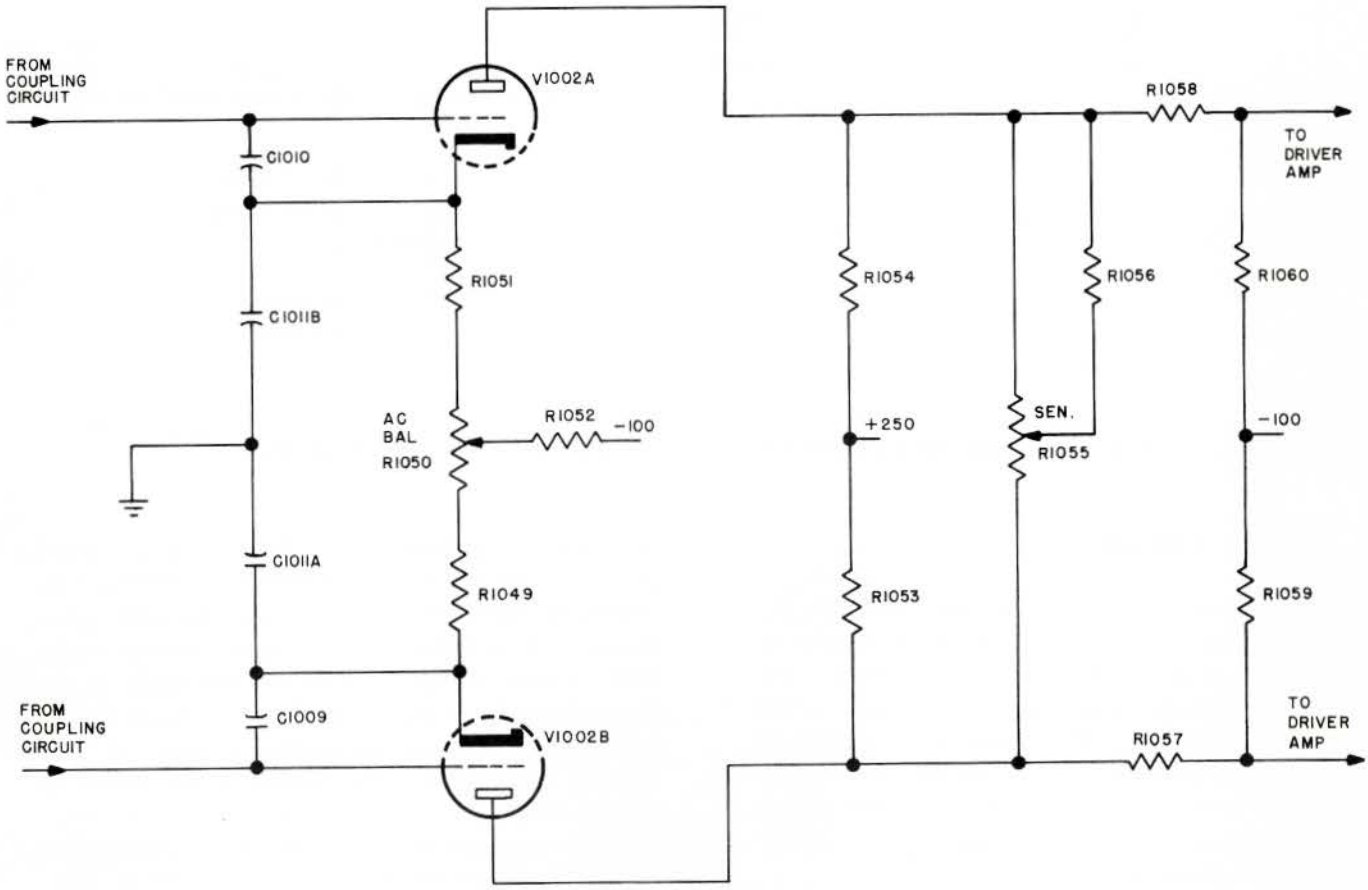


Figure 15. Interstage Circuit, DC Operation, Simplified Schematic Diagram.

11. OUTPUT CIRCUIT

The output circuit from V1002 is shown in figure 16. The signal from the coupling circuit described in paragraph 9 or 10 is fed directly to the grids. The high–value cathode resistor R1052 is common to both V1002A and V1002B. This resistor is returned to the –100 volt potential so the voltage drop across it will not bias the tubes into the non–linear portion of their characteristics near cut–off. This resistor provides in–phase rejection and improves the stage balance, to the common cathode resistor of V1001, described in paragraph 8. The AC BAL control R1050 varies the amount of individual cathode bias resistance for each tube, to control the static plate voltages. This control is adjusted to the point where there is zero voltage between the two leads to the Driver Amplifier. The SENSITIVITY control R1055 provides a continuous adjustment of gain, for calibrating the system. The signal at the plates of V1002A and V1002B is coupled to the Driver Amplifier through a resistance network which establishes the required bias potentials at the two Driver Amplifier connections.

Figure 16. Output Circuit, Simplified Schematic Diagram.



SANBORN COMPANY
175 WYMAN STREET
WALTHAM, MASS. 02154
AREA CODE 617
TEL: 894-6300
APRIL 1, 1965

REPLACEMENT PARTS LIST SUPPLEMENT
RPL-150-1000-3A, -3B

SANBORN AC DC PREAMPLIFIER
MODEL 150-1000

CHANGES TO INSTRUMENT AND SCHEMATIC
from 8/22/63 to 3/26/65 Schematic: 150-1000-C1 Sub 12

DATE	CHANGE RELEASE	SYMBOL	CHANGED TO	SANBORN NUMBER	VENDOR CODE
8/22/63	CR13718	R1065	Resistor: symbol number changed to R1067.		
		C1012	Capacitor: .0027 mfd ±20%.	8A-14	1467 (AER)
3/26/65	CR14882	V1002	Tube: type 12AX7	68A-22A	12AX7/ECC83 (TEL)

VENDOR ABBREVIATIONS

AER	Aerovox
TEL	Telefunken

MAINTENANCE MANUAL

for

SANBORN AC/DC PREAMPLIFIER

MODELS 150-1000, 150-1000A

-CONTENTS-

SANBORN COMPANY
Waltham, Mass.
December, 1957
MM-150-1000-2

SYSTEM TROUBLE CHECK
SANBORN 150 SYSTEM
RECORDER
DRIVER AMPLIFIER AND POWER SUPPLY
AC/DC PREAMPLIFIER

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 operator isn'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 millimeters 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 AC/DC PREAMPLIFIER MODEL 150-1000

This chart assumes that the fault has been traced to the Preamplifier.

SYMPTOM	POSSIBLE CAUSE	CHECK
Preamplifier will not work at all	Loose Preamplifier	Check that Preamplifier is plugged in firmly
	Defective tube	Check tubes
	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 Matched-pair resistors out of tolerance	Check R1061, R1062 Check matched-pair resistors
	Defective tubes	Check tubes
Cannot feed input signals from rear	Plug left in front INPUT jack	Remove plug
Erratic stylus motion	Defective tube	Check tubes
	Defective component	Check for leaky, noisy, or Intermittent component or contact
	Loose tube or Preamplifier	Plug in firmly
Erratic stylus motion, with signal only	Erratic signal	Check signal with meter and oscilloscope
	Loose connections to input connector	Re-connect. Should be mechanically & electrically tight
Drift with signal only, stable with no signal	Signal drift	Check signal with meter
	Drift in high-frequency signal component	High-frequency components can overload the grids and not show on the record as a signal. This causes a non-linearity, which can appear as a drift if the high frequency component drifts. Check with meter & oscilloscope
	Drift of in-phase component	Check with meter and oscilloscope

SYMPTOM	POSSIBLE CAUSE	CHECK
Drift, with or without the signal	Defective tube	Check tubes
	Line voltage drifting widely, or drifting outside the rated limits	Check with meter
	Inadequate warmup	Warmup for 90 minutes
Baseline drifts during calibration (DC operation)	Open resistor	Check R1023
Microphonics, noise, with or without signal	Defective tube	Check tubes
	Noisy circuit element	Check for noisy circuit element. An oscilloscope helps here, with the input to Preamplifier disconnected
Microphonics, noisy, with signal only	Loose connection in signal source	Check for electrically and mechanically tight joints in the input circuit
	Loose input plug	Insert connector all the way
	Noise pickup in the signal, or from an external source	Check input signal with oscilloscope for noise components. Even high-frequency components which do not record directly can overload grids with resulting nonlinearity and modulation of signal. Shield lead wires to avoid capacitive pickup. Use twisted-pair to avoid inductive pickup. Avoid ground loops.
Low sensitivity	Defective tube	Check tubes
	Low heater voltage	Readjust r-f oscillator in Driver Amplifier
	Improper calibration of Preamplifier	Check calibration technique
	+80 volt supply not adjusted	Readjust
Too sensitive to in-phase signals	Defective tube	Check tubes
	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

SYMPTOM	POSSIBLE CAUSE	CHECK
	Out-of-tolerance resistors in ATTENUATOR strings	Check for stated values within one percent
	Misadjustment of R1062 on Pre-amplifier chassis	Re-adjust
	Matched-pair resistors out of tolerance	Check matched-pair resistors
Poor a-c signal in-phase rejection	Open or out-of-tolerance condenser	Check condensers in grid-to-ground circuits of each tube. Check C1001, C1002, C1007A, C1008A.
Poor in-phase rejection with AC operation only, satisfactory with DC operation	Difference in sensitivity	Note that sensitivity with AC operation is ten times the sensitivity with DC operation; an in-phase signal which would not be apparent with DC operation can sometimes be seen with AC operation
	Defective resistors	Check R1035, R1036
	Defective condensers	Check C1001, C1002, C1007A, C1008A
Non-linear	Low heater voltage	Readjust r-f oscillator on Driver Amplifier
	Defective tube	Check tubes
	Excessive in-phase signal component or signal with high transient peaks which overload grids	Check with oscilloscope to see that there are no signal or in-phase components which exceed the rated limits
Unsatisfactory frequency or transient response, or too slow or fast a rise time, or cannot adjust damping controls in Driver Amplifier with this Pre-amplifier	Improper damping adjustments	Re-adjust
	Defective tube	Check tubes
	Defective condenser	Check C1003
	Defective resistor	Check R1023
Stylus stays at one side of recording channel while instrument on	Defective tube	Check tubes
	Defective condenser	Check condensers in grid-to ground circuits
	Out-of-tolerance resistors	Check matched-pair resistors
	Zero suppression left on (150-1000 only)	Turn zero Suppression off
	Improper use of zero Suppression (150-1000 only)	Check operating technique

SYMPTOM	POSSIBLE CAUSE	CHECK
ZERO SUPPRESSION will not work (150-1000 only)	Improper signal connection	Reconnect properly
	Improper operation	Designed for use with DC only
	Trying to suppress negative signal	Designed for positive – signal suppression only. Make a positive signal out of the signal you wish to suppress, by using a battery in series with the signal, positive terminal toward the Preamplifier.
Zero Suppression inaccurate (150-1000 only)	Inaccurate adjustment of calibration circuit voltage	Readjust as outlined in checkout chart or in the instruction Manual
	High source impedance	Input impedance of Preamplifier is 5 megohms. If source impedance of signal is appreciable with respect to 5 megohms, the Preamplifier will load down the signal source
Won't balance	Defective tube	Check tubes
	Misadjustment of R1062 on Preamplifier chassis	Readjust
	Matched-pair resistors out of tolerance	Check matched-pair resistors
Works on AC, does not work on DC	AC/DC switch	Check for proper operation
	Defective resistor	Check R1031 & R1039 through R1044
	Improper operation	Check for proper DC operation
	DC component in signal	If signal contains DC component, this will be blocked out in AC operation, and may overload the grids in DC operation if high enough
	Improper use of zero suppression (150-1000 only)	If zero suppression left in circuit, stylus may go off-scale when switching from AC to DC
	Improper adjustment of DC BALANCE control R1031	Readjust

SYMPTOM	POSSIBLE CAUSE	CHECK
Works on DC, does not work on AC	Open series condenser	Check C1001, C1002, C1007A C1008A
	Open or defective resistor	Check R1035, R1036
	AC/DC switch	Check for proper switch operation
	Improper operation	Check for proper AC operation
Calibration does not hold for both AC & DC operation	Improper adjustment of DC GAIN control R1034	Readjust

* See note below for checking electrical balance.

PERIODIC MAINTENANCE

SANBORN AC/DC PREAMPLIFIER

MODEL 150-1000

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.
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 Checkout Chart.

* NOTE: When unbalance is suspected in a balanced stage, (which may be caused by matched resistors out of tolerance, or age of selected tube, etc.), this may be conveniently checked by successively shorting together the grids, then the cathodes, then the plates of each of the balanced stages. Proper balance in the Preamplifier between the point of test and its output is indicated when the stylus comes to near mid-scale upon applying the short (POSITION control at mid-scale). This also indicates that the unbalance is located between the point of short and the Preamplifier input. This same test can also be used to trackdown drift, erratic or noisy components, interference, etc.

CHECK CHART

SANBORN AC/DC PREAMPLIFIER MODEL 150-1000

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 DC BALANCE control (panel) and R1065 (chassis) to mid-rotation. Note: R1065 is not present in all instruments.
   b. Adjust R1065 so that POSITION control can move stylus across entire recording channel. R1065 has time delay; wait after adjusting it. Leave stylus at center.
   c. Adjust AC BAL control so that moving SENSITIVITY control does not move stylus with AC/DC switch at AC. Leave stylus at center.
   d. Adjust DC BALANCE control so that moving RANGE switch back and forth between .001 and .002 does not move stylus, with AC/DC switch at DC. Leave stylus at center.
   e. Move DC BAL control off-balance in each direction; stylus should move at least one centimeter (12.5 mm. with narrow-channel Permapaper). If you can't get this movement, turn BAL control off-balance one-quarter turn toward its mechanical center and restore the baseline with R1065. Then re-set the DC BAL control.
4. Check out the sensitivity:
   a. Set AC/DC switch to AC, SENSITIVITY control full clockwise. Press CAL button and record stylus deflection - must be at least 20 mm (25 divisions with narrow-channel Permapaper).
   b. Set AC/DC switch to DC. Press CAL button and adjust DC GAIN control R1034 for same deflection as step a. Then adjust SENSITIVITY control for exactly 20 millimeters deflection (or 25 divisions with narrow-channel Permapaper) when CAL button pressed.
   c. Note stylus baseline. Set AC/DC switch to AC and record decay curve by pressing CAL button and holding it pressed for a few seconds. Place straight edge along straight portion of this curve and draw straight line to original baseline. Straight line should reach original baseline in less than 0.4 seconds after first pressing CAL button (corresponds to 10 mm. along the recording at 25 mm./sec. paper speed).
5. Check the rejection ratio

   Set RANGE switch full right, AC/DC to DC, normal sensitivity.
   Connect the two input leads together, and place them at one volt potential to ground.
   Stylus deflection should be less than one millimeter.
   Repeat with opposite polarity.
6. Check the zero suppression.

   Connect a laboratory type 1.019 volt cadmium standard cell to the Preamplifier for D C voltage measurement.
   Set the Preamplifier ATTENUATOR to .002, and set the ZERO SUPPRESSION dial to 509.5 divisions.
   Note stylus shift when switching USE/OFF/CAL switch between USE and OFF; if more than one division on the Permapaper, adjust the +80 V ADJ control at the Driver Amplifier rear.

TUBE REPLACEMENT CHART

V1001 input amplifier 5751 68A-37 Adjust all balance controls and DC GAIN control. Re-calibrate.

V1002 output amplifier 5751 68A-37 Adjust all balance controls and DC GAIN control. Re-calibrate.

VOLTAGE AND RESISTANCE CHART
SANBORN AC/DC PREAMPLIFIER
Model 150-1000

Tube No.	1	2	3	4	5	6	7	8	9
V1001	660K +67	1.2M 0	inf* +1	heater	heater	660K +67	1.2M 0	inf* +1	heater CT
V1002	780K +88	600K 0±	inf* +1.5	heater	heater	 +88	 0±	inf* +1.5	heater CT

* Affected by capacitor charging action.

SANBORN AC-DC PREAMPLIFIER
MODEL 150-1000

SANBORN COMPANY
WALTHAM, MASS.
MARCH, 1956

REPLACEMENT PARTS LIST SUPPLEMENT
RPL-150-1000-1A

RPL-150-1000-1A
CR 7427 March 28, 1956

Delete R1049 and R1051.

MECHANICAL PARTS LIST

SANBORN AC-DC PREAMPLIFIER MODEL 150-1000

PANEL AND CHASSIS LIST

DESCRIPTION	LOCATION	SANBORN NO.	REQUIRED
Preamplifier panel	Front panel of instrument	150-1001	1
Bushing	On panel; associated with the tie rod and knob assembly	150-1008	2
Locating pin	Upper corners of front panel	150-1030	2
Lift handle	At sides of front panel	150-1005	2
Tie rod and knob assembly	Knob visible behind each lift handle; rod is alongside the chassis brackets	150-1100-C13	2
Chassis	Main Chassis of instrument	150-1002	1
Bottom plate	Shield plate which covers bottom of chassis	150-1017	1
Bracket, right	Right side of chassis	150-1032	1
Bracket, Left	Left side of chassis	150-1031	1

KNOBS, DIALS, ETC.

Shaft lock knob	One each on DC BALANCE, POSITION, and SENSITIVITY controls. This knob turns the control shaft.	150-1120	3
Shaft lock bushing	One each on DC BALANCE, POSITION, and SENSITIVITY control assemblies.	150-1121	3
Shaft lock nut	One each on DC BALANCE, POSITION, and SENSITIVITY controls, This nut locks the shaft.	150-1122	3
Knob	On ATTENUATOR switch shaft	32A-27	1
Knob	On AC/DC and USE/OFF/CAL switches.	32A-16	2
Helipot Duo-Dial	On DC ZERO SUPPRESSION control	37F-4	1
MV switch plunger	Part of CAL switch assembly	51-108	1

MECHANICAL PARTS LIST

SANBORN AC-DC PREAMPLIFIER MODEL 150-1000

KNOBS, DIALS, ETC.

DESCRIPTION	LOCATION	SANBORN NO	REQUIRED
Attenuator assembly	ATTENUATOR switch, complete with all resistors and jumpers	150-1000-C9	1
Attenuator shield base	Base of shield can behind ATTENUATOR	150-1019	1
Attenuator shield cover	Top of shield can behind ATTENUATOR	150-1028	1
Switch shield base	Base of shield can behind AC/DC switch	150-1013	1
Switch shield cover	Cover of shield can behind AC/DC switch	150-1011	1
Switch shield end bracket	End of shield can behind AC/DC switch	150-1027	1
Switch shield end bracket	Rear of switch shield base shield can	150-1012	1
Switch bracket	Mounts CAL switch assembly	150-1025	1
Shock mount assembly	Mounting plate, complete with sockets and circuits	150-1000-C8	1
AC-DC Switch assembly	AC-DC switch complete with all resistors, jumpers, etc.	150-1000-C11	1

MECHANICAL PARTS LIST

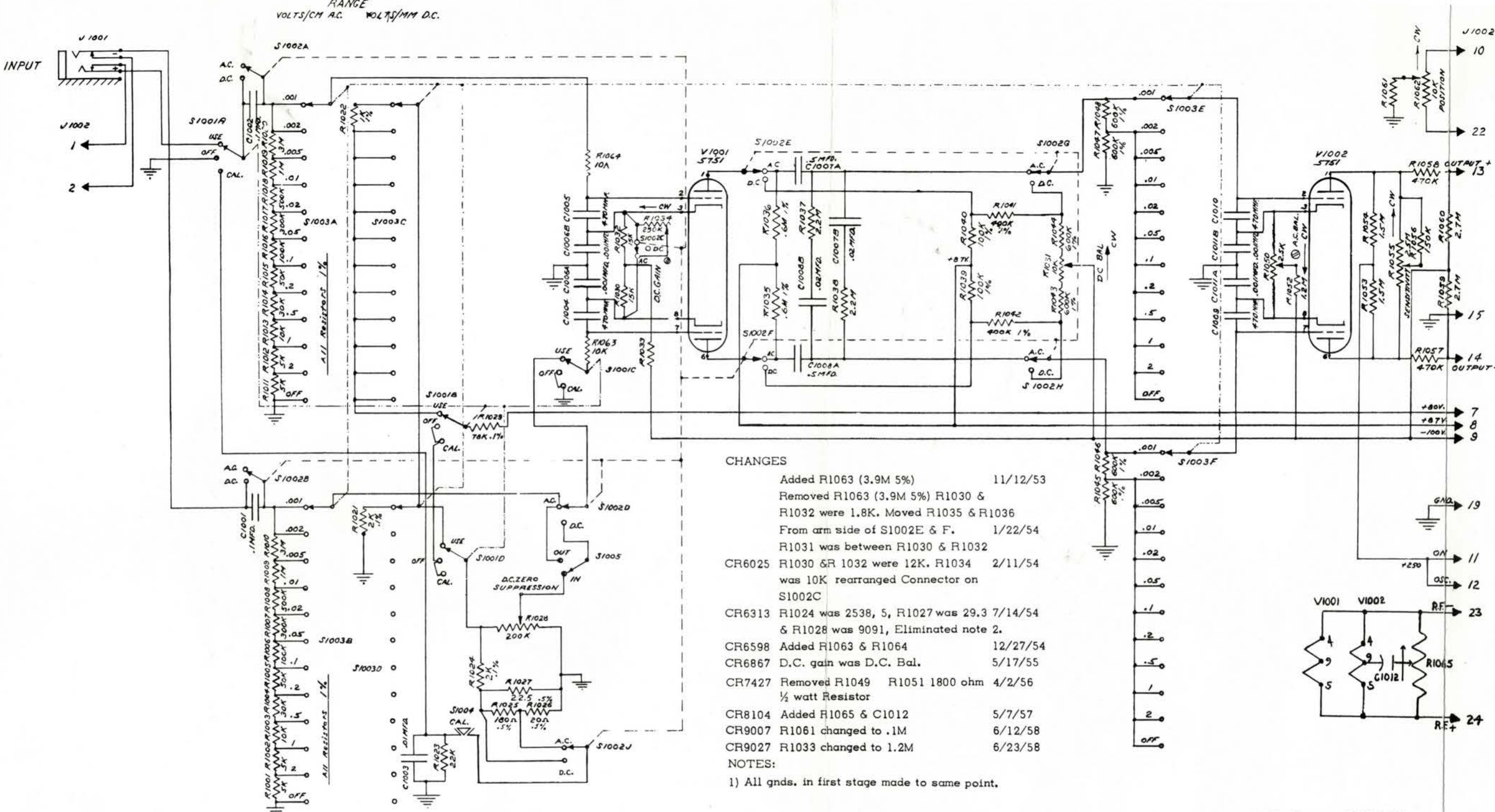
SANBORN AC-DC PREAMPLIFIER MODEL 150-1000

KNOBS, DIALS, ETC. (Cont.)

DESCRIPTION	LOCATION	SANBORN NO.	REQUIRED
Switch bushing nut	Part of CAL switch assembly	51-132P2	1
MV switch bracket threaded bushing	Part of CAL switch assembly	51-213P1	1
Plug button	For AC BAL control access.	22B-3	1
Switch bushing nut	For DC ZERO SUPPRESSION OUT/IN switch	52-116	1

RESISTORS BOARDS, SOCKETS, ETC.

9-pin miniature socket with shock shield	Mounts V1001, V1002	10G9-3FX	2
Noval tube shield	Shields V1001, V1002	68B-3	2
Resistor board assembly	Under chassis; identify by ten pairs of terminals	150-1000-C3	1
Terminal board assembly	Under chassis, adjacent to INPUT switch	150-1000-C7	1
Terminal board assembly	Under chassis; adjacent to POSITION control	150-1000-C6	1
Resistor board assembly	Inside large shield on chassis top	150-1000-C4	1
Resistor board assembly	One to each side of tube sockets	150-1000-C5	2
Potentiometer bracket	Supports the AC BAL control	150-1023	1
Resistor board mounting block	One on each side of the tube sockets	150-1020	2
Mounting plate	Plate which mounts tube sockets	150-1024	1
Shock mounts	Support the mounting plate	76A-5	



CHANGES

	Added R1063 (3.9M 5%)	11/12/53
	Removed R1063 (3.9M 5%) R1030 & R1032 were 1.8K. Moved R1035 & R1036 From arm side of S1002E & F.	1/22/54
	R1031 was between R1030 & R1032	
CR6025	R1030 &R 1032 were 12K. R1034 was 10K rearranged Connector on S1002C	2/11/54
CR6313	R1024 was 2538, 5, R1027 was 29.3 & R1028 was 9091, Eliminated note 2.	7/14/54
CR6598	Added R1063 & R1064	12/27/54
CR6867	D.C. gain was D.C. Bal.	5/17/55
CR7427	Removed R1049 R1051 1800 ohm ½ watt Resistor	4/2/56
CR8104	Added R1065 & C1012	5/7/57
CR9007	R1061 changed to .1M	6/12/58
CR9027	R1033 changed to 1.2M	6/23/58

NOTES:

1) All gnds. in first stage made to same point.

SYMBOL	DESCRIPTION	SANBORN No.
*C1001	.1 mfd 600VDCW Paper	8B-45PG
*C1002	.1 mfd 600VDCW Paper	8B-45PG
C1003	.01 mfd 500VDCW Ceramic	8E-6
*C1004	.00047 mfd 500VDCW Ceramic	8E-9P
*C1005	.00047 mfd 500V Ceramic	8E-9P
C1006A & B	.001—.001 mfd 500V Ceramic	8E-10
**C1007	.02—.5 mfd 400V part of 2 Section Paper	8B-25APG
**C1008	.02—.5 mfd 400V Part of 2 Section Paper	8B-25APG
*C1009	.00047 mfd 500V Ceramic	8E-9P
*C1010	.00047 mfd 500V Ceramic	8E-9P
C1011A & B	.001—.001 mfd 500V Ceramic	8E-10
C1012	.001 mfd 20% Mica	8A-12

** The above condensers are two section condensers. The .5 mfd section of these condensers as indicated by symbol Nos. C1007A and C1008A is matched within 2%.

* The following condensers are matched with 10%: (C1004, C1005) (C1009, C1010).

* The following condensers are matched within 2%: (C1001, C1002).

R1001	5K 1% ¼w Comp.	50H-502G
R1002	5K 1% ¼w Comp.	50H-502G
R1003	10K 1% ¼w Comp.	50H-103G
R1004	30K 1% ¼w Comp.	50H-303G
R1005	50K 1% ¼w Comp.	50H-503G
R1006	100K 1% ¼w Comp.	50H-104G
R1007	300K 1% ¼w Comp.	50H-304G
R1008	500K 1% ¼w Comp.	50H-504G
R1009	1 Meg 1% ½w Comp.	50J-105G
R1010	3 Meg 1% ½w Comp.	50J-305G
R1011	5K 1% ¼w Comp.	50H-502G
R1012	5K 1% ¼w Comp.	50H-502G
R1013	10K 1% ¼w Comp.	50H-103G
R1014	30K 1% ¼w Comp.	50H-303G
R1015	50K 1% ¼w Comp.	50H-503G
R1016	100K 1% ¼w Comp.	50H-104G
R1017	300K 1% ¼w Comp.	50H-304G
R1018	500K 1% ¼w Comp.	50H-504G
R1019	1 Meg 1% ½w Comp.	50J-105G
R1020	3 Meg 1% ½w Comp.	50J-305G
R1021	2K 1/10% ½w W.W.	54A-28T
R1022	1K 1% ½w W.W.	54A-12F
R1023	22K 5% ½w Comp.	50A-223J
R1024	2K 1/10% ½w W.W.	54A-28T
R1025	180 ½% ½w W.W.	54A-26D
R1026	20 ½% ½w W.W.	54A-1D
R1027	22.5 ½% ½w W.W.	54A-44D
R1028	200K 5% 5w 10-Turn Potentiometer	56C-7
R1029	78K 1/10% ½w W.W.	54A-29T
*R1030	15K 5% ½w Comp.	50A-153JPG
R1031	10K 5% 5w 10-Turn Pot.	56C-2
*R1032	15K 5% ½w Comp.	50A-153JPG
R1033	1.2 Meg 5% ½w Comp.	50AB-125J
R1034	250K 30% ½w Hi-Torque Linear Taper	56A-39
*R1035	600K 1% 1w W.W.	54A-3FMP
*R1036	600K 1% 1w W.W.	54A-3FMP
R1037	2.2 Meg 5% ½w Comp.	50AB-225J
R1038	2.2 Meg 5% ½w Comp.	50AB-225J
*R1039	100K 1% ½w W.W.	54A-30FMP
*R1040	100K 1% ½w W.W.	54A-30FMP
*R1041	400K 1% 1w W.W.	54A-31FMP
*R1042	400K 1% 1w W.W.	54A-31FMP
*R1043	600K 1% 1w W.W.	54A-3FMP
*R1044	600K 1% 1w W.W.	54A-3FMP
*R1045	600K 1% 1w W.W.	54A-3FMP
*R1046	600K 1% 1w W.W.	54A-3FMP
*R1047	600K 1% 1w W.W.	54A-3FMP
*R1048	600K 1% 1w W.W.	54A-3FMP
R1050	2.5K 20% ½w Hi-Torque Linear Taper	56A-48
R1052	1.2 Meg 5% ½w Comp.	50A-125J
*R1053	1.5 Meg 5% ½w Comp.	50AB-155JPG
*R1054	1.5 Meg 5% ½w Comp.	50AB-155JPG
R1055	2.5 Meg 30% ½w Modified Log C.C. Taper	56A-54
R1056	150K 5% ½w Comp.	50A-154J
*R1057	470K 5% ½w Comp.	50AB-474JPG

*R1058	470K 5% ½w Comp.	50AB-474JPG
*R1059	2.7 Meg 5% ½w Comp.	50A-275JPG
*R1060	2.7 Meg 5% ½w Comp.	50A-275JPG
R1061	.1M 5% ½w Comp.	50AB-104J
R1062	10K 10% 2w Linear Taper	56A-11
R1063	10K 5% ½w Comp.	50AB-103J
R1064	10K 5% ½w Comp.	50AB-103J
R1065	200 Wire Wound Pot.	56A-55

* The following resistors are matched within 2%: (R1030, R1032) (R1053, R1054) (R1057, R1058) (R1059, R1060).

* The following resistors are matched within .1%: (R1035, R1036) (R1039, R1040) (R1041, R1042) (R1043, R1044) (R1045, R1046)(R1047, R1048).

MISCELLANEOUS

J1001	2-contact junior jack	10G2-6FX
J1002	Amphenol 24-contact male connector	10B24-1MX
S1001A B,C,D	3-position, 2-deck rotary selector switch	62B-14
S1002A B,C,D,E, F,G,H,J	2-position, 3-deck rotary selector switch	62B-10
S1003A B,C,D,E,F	12-position, 6-deck rotary selector switch	62B-13
S1004	Micro switch	62C-3
S1005	SPDT Toggle switch	62D-22
V1001	Type 5751 tube	68A-37
V1002	Type 5751 tube	68A-37

MECHANICAL PARTS LIST

DESCRIPTION	LOCATION	SANBORN NO.
Lift handle	At sides of front panel	150-1005
Tie rod & knob assem	Knob visible behind each lift handle; rod is alongside the chassis brackets	150-1100-C13
Shaft lock knob	One each on DC BALANCE, POSITION, & SENSITIVITY controls. This knob turns the control shaft	150-1120
Shaft lock bushing	One each on DC BALANCE, POSITION, & SENSITIVITY control assemblies	150-1121
Shaft lock nut	One each on DC BALANCE, POSITION, & SENSITIVITY controls. This nut locks the shaft	150-1122
Knob	On ATTENUATOR switch shaft	32A-27
Knob	On AC/DC and USE/CAL switches	32A-16
Helipot Duo-Dial	On DC ZERO SUPPRESSION control	37F-4
MV switch plunger	Part of CAL switch assembly	51-108
Plug button	For AC BAL control	22B-3

SANBORN A.C. – D.C. PREAMPLIFIER
MODEL 150-1000
SCHEMATIC: 150-1000-C1 SUB 10

SANBORN COMPANY
WALTHAM, MASS.

CR9027 RPL-150-1000-3

RANGE
VOLTS/CM A.C. VOLTS/MM D.C.

INPUT

J 1001

J 1002
1
2

S1001A USE OFF CAL.

S1002A A.C. D.C.

C1002 .1MFD.

R1011 R1012 R1013 R1014 R1015 R1016 R1017 R1018 R1019 R1020 R1021
.001 .002 .005 .01 .02 .05 .1 .2 .5 1 2 OFF
All Resistors 1%

R1022 1%

S1003A S1003C

S1001B USE OFF CAL.

R1029 78K .1%

S1002B A.C. D.C.
.001 .002 .005 .01 .02 .05 .1 .2 .5 1 2 OFF
R1001 R1002 R1003 R1004 R1005 R1006 R1007 R1008 R1009 R1010
All Resistors 1%

C1001 .1MFD.

R1021 2K .1%

S1003B S1003D

S1001D USE OFF CAL.

S1002D A.C. D.C.

S1005 OUT IN

D.C. ZERO SUPPRESSION

R1028 200K

R1024 2K .1%

R1027 22.5 .5%

R1025 180Ω .5%

R1026 20Ω .5%

S1004 CAL.

C1003 .01MFD.

R1023 22K

S1002J A.C. D.C.

R1064 10A

C1006B C1005 470MMF.

C1006A C1004 470MMF.

R1034 250K

R1032 1.5K

S1002C D.C. AC

R1030 1.5K

D.C. GAIN

S1001C USE OFF CAL.

R1063 10K

R1033 1.5K

V1001 5751

S1002E A.C. D.C.

.5MFD. C1007A

R1036 .6M 1%

R1035 .6M 1%

R1037 2.2M

C1007B .02MFD.

C1008B .02MFD.

R1038 2.2M

S1002F A.C. D.C.

C1008A .5MFD.

S1002G A.C. D.C.

R1040 100K 1%

+87K

R1039 100K 1%

R1041 400K 1%

R1042 400K 1%

R1043 600K 1%

R1044 600K 1%

S1002H A.C. D.C.

DC BAL CW

R1047 R1048 600K 1%

R1045 R1046 600K 1%

S1003E .001 .002 .005 .01 .02 .05 .1 .2 .5 1 2 OFF

S1003F .001 .002 .005 .01 .02 .05 .1 .2 .5 1 2 OFF

C1009 C1011A C1011B C1010 470MMF. .001MFD.

R1049 1.8K

R1050 2.5K A.C. BAL.

R1051 1.8K

R1052 4.2M

V1002 5751

R1053 1.5M

R1054 1.5M

R1055 SENSITIVITY

R1056 50K

R1057 470K OUTPUT −

R1058 470K OUTPUT +

R1059 2.7M

R1060 2.7M

R1061 20K

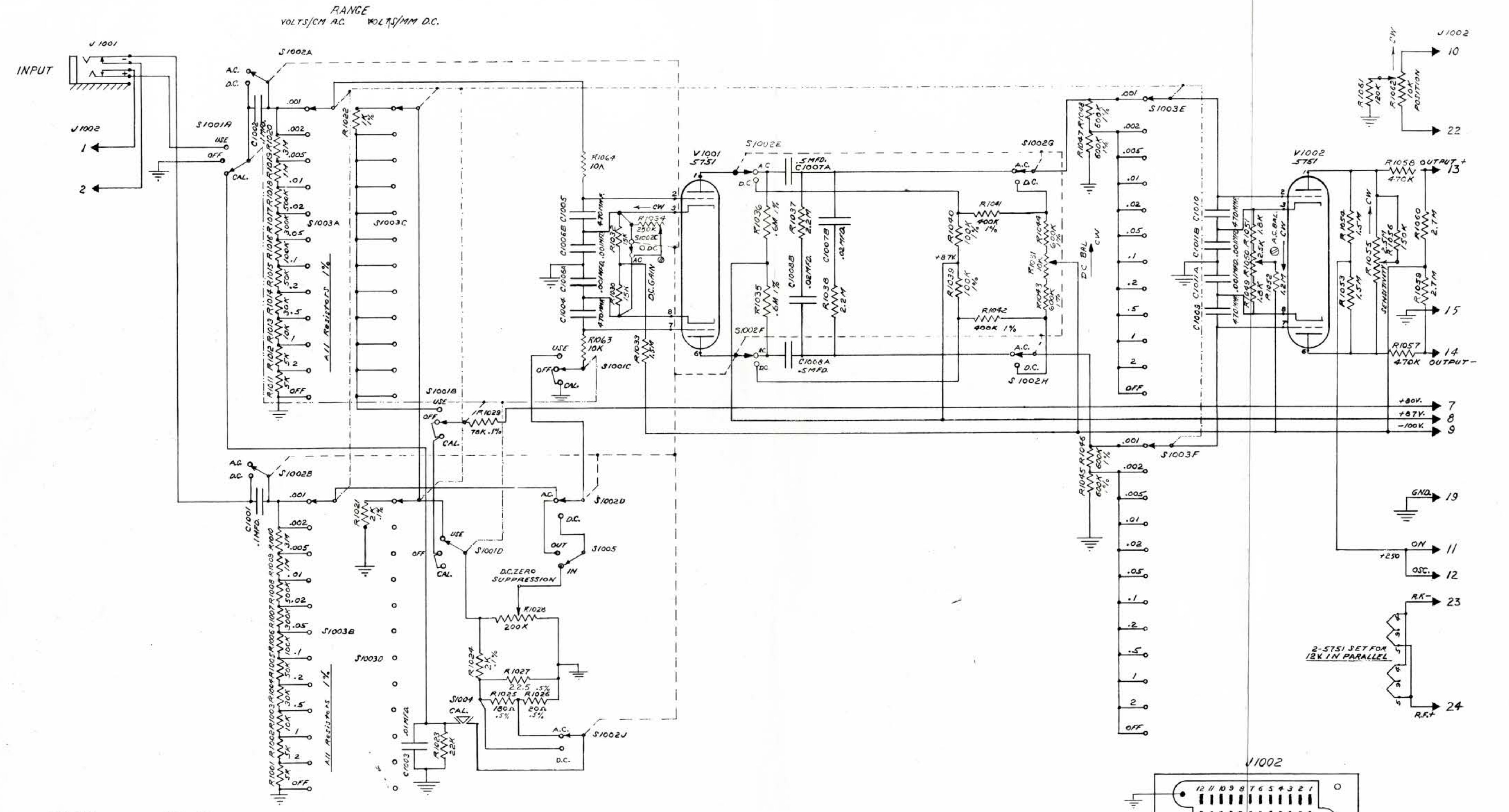
R1062 10K POSITION

J1002
10
22
+80V. 7
+87V. 8
−100V. 9
GND. 19
ON 11
+250
OSC. 12
R.F.− 23
R.F.+ 24

2-5751 SET FOR 12K IN PARALLEL

J1002
12 11 10 9 8 7 6 5 4 3 2 1
24 23 22 21 20 19 18 17 16 15 14 13

CHANGES	DATE	APP
1. ADDED R1063 (3.9M 5%)	11-12-58	
2. REMOVED R1063 (3.9M 5%) R1030 & R1032 WERE 1.8K. MOVED R1035 & R1036 FROM ARM SIDE OF S1002E & F. R1031 WAS BETWEEN R1030 & S1002E.	1-22-59	TWP
3. (#6025) R1030 & R1032 WERE 1.2K. R1039 WAS 10K REARRANGED CAM ON S1002C	2-11-59	
4. CR6313 R1029 WAS 2558.3, R1027 WAS 29.3 & R1028 WAS 9031. ELIMINATED NOTE 2	1-14-59	TWP
5. CR6598 ADDED R1063 & R1064	12-27-59	
6. (CR6867) D.C. GAIN WAS D.C. BAL.	5/1/59	TWP



NOTES:

1.) All gnds. in first stage made to same point.

3.) Resistor Pairs R1030-R1032, R1053-R1054; R1057-R1058; R1059-R1060 are 5% Resistors matched within 2%.

4.) Capacitor pairs C1004-C1005; C1009-C1010; 470 mmfd. are matched within 10%. C1001-& C1002; C1007A & C1008A are matched within 2%.

5.) R1028 is 10 turn potentiometer 200K Ω ±5% with .1% linearity. R1031 is 10 turn potentiometer 10K Ω ±5% with .5% linearity.

6.) Resistor pairs R1035-R1036; R1039-R1040; R1041-R1042; R1043-R1044; R1045-R1046; R1047-R1048 are 1% W.W. matched within .1%.

7.) R1023, R1030, R1032, R1033, R1037, R1038, R1049, R1051, R1052, R1056, R1061 ARE 5% RESISTORS

8.) R1001 thru R1020 are 1% composition resistors. All other 1%, .5% & .1% resistors are W.W.

CHANGES	DATE	APP
1. ADDED R1063 (3.9M 5%)	11-12-53	
2. REMOVED R1063 (3.9M 5%) R1030 & R1032 WERE 1.8K. MOVED R1035 & R1036 FROM ARM SIDE OF S1002E & F. R1031 WAS BETWEEN R1030 & R1032	1-22-54	TWP
3. (#6025) R1030 & R1032 WERE 12K. R1034 WAS 10K REARRANGED CON. ON S1002C	2-11-54	
4. CR6313 R1024 WAS 2538.5, R1027 WAS 29.3 & R1028 WAS 9091. ELIMINATED NOTE 2	7-14-54	TWP
5. CR6598 ADDED R1063 & R1064	12-27-54	
6. (CR6867) D.C. GAIN WAS D.C. BAL.	5/1/55	TWP

Schematic
Model 150
A.C.-D.C. Pre-Amplifier

2/3/53 KN TWP

150-1000-C1