LOW LEVEL PREAMPLIFIER

MODELS 150-1500, 150-1500A

IM-150-1500-1

# INSTRUCTION MANUAL

HEWLETT PACKARD


SANBORN DIVISION

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# INSTRUCTION MANUAL
# SANBORN LOW LEVEL PREAMPLIFIER
## Models 150–1500 and 150–1500A

## 1. FUNCTIONAL DESCRIPTION

The Sanborn Low Level Preamplifier is a chopper type of amplifier for measuring slowly varying direct voltages, or measuring slowly varying currents by adding an external shunt resistor. These signals may be read in circuits removed from ground by as much as 300 volts DC. Model 150–1500 includes a ZERO SUPPRESSION circuit, which is omitted in Model 150–1500A. This manual applies to the Preamplifier which uses an improved chopper circuit, identified by the HUM control on the front panel, starting with serial no. 200.

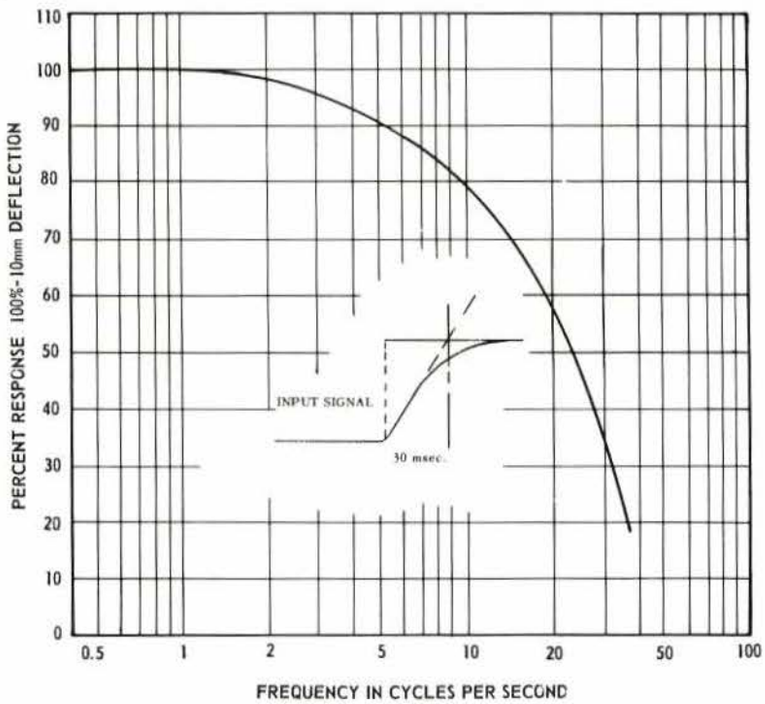



*Figure 1. Combined Response Characteristics of Sanborn Low Level Preamplifier, Driver Amplifier, and Galvanometer.*

## 2. TABULATION OF CHARACTERISTICS

| | |
|---|---|
| SENSITIVITY | 100 microvolts per centimeter to 0.1 volt per centimeter, in ten steps with panel-mounted ATTENUATOR. With external 100 ohm resistor, measures 1.0 microampere per centimeter to 1.0 milliampere per centimeter. |
| FREQUENCY RANGE | Three decibels down at 15 cycles. See fig. 1. |
| RISE TIME | 0.03 seconds. Defined as time required to reach final deflection, as measured by best straight line approximation to the initial rise of the response to unit step input. See fig. 1. |

## 2. TABULATION OF CHARACTERISTICS (Cont.)

| | |
|---|---|
| INPUT IMPEDANCE | 5300 ohms with Model 150–1500, 4400 ohms with Model 150–1500A. Input looks into transformer primary, intermittently shorted 120 times per second by chopper. (Input is insulated from chassis; may be grounded externally as required). |
| SOURCE IMPEDANCE | Up to 500 ohms, looking back into signal circuit. |
| DRIFT | 0.1 mm/hr. plus 1.0 microvolt/hr., after 30 minutes warmup. |
| OVERLOAD | Will tolerate accidental momentary overload up to 5 volts (10 times maximum rated signal). Higher voltages may damage the chopper. |
| ATTENUATOR ERROR | Most probable error: 1% Maximum possible error: 2% |
| CALIBRATION | Internal, 200 microvolts.<br>Accuracy: ±¼% (Model 150–1500), ±1.0% (Model 150–1500A) |
| ZERO SUPPRESSION | (Model 150–1500 only)100 mv.and 10 mv. ranges, controlled by 1000 division dial. 100 mv. range is accurate to 1.0 mv., and the 10 mv. range is accurate to 0.05 mv. |
| RIPPLE | Approximately 1% of the signal, at twice line frequency. |

## 3. FRONT PANEL CONTROLS

| | |
|---|---|
| POSITION | This locking control provides for adjustment of the stylus position. Clockwise rotation moves the stylus up-scale. |
| SENSITIVITY | This locking control adjusts the gain of the Preamplifier, to permit calibration. |
| HUM | This screwdriver adjustment, available through an access hole in the panel, is used to adjust the recording for minimum line-frequency component on the recording. |
| CAL 200 MICROVOLT | This button applies a 200 microvolt calibration signal to the Preamplifier input circuit. |
| INPUT | This connector is used to connect the signal to the Preamplifier. |
| STANDARD | This locking control (Model 150–1500 only) provides an accurate pre-operational adjustment of the zero suppression voltage. |
| SUPPRESSION RANGE | This switch (Model 150–1500 only) selects either standard operation, without zero suppression, or operation with zero suppression up to the full-scale suppression limits marked on the panel. |
| ZERO SUPPRESSION | This ten-turn precision control, with a dial which reads from zero to 1000, (Model 150–1500) is used to suppress DC voltages up to ± 100 millivolts. |

## 3. FRONT PANEL CONTROLS (Cont.)

| | |
|---|---|
| OUT / IN | This switch (Model 150–1500) makes the zero suppression facilities available or not, as required. |
| ATTENUATOR | This multi-position switch attenuates the input signal by any one of the factors marked on the panel. |

## 4. OPERATION: BASIC PROCEDURES

There is a sequence of five basic procedures to follow when turning on the Sanborn Low Level Preamplifier and making a recording:

| | |
|---|---|
| CONNECTING | This includes the warmup period, and connecting the input signal (paragraph 5.) |
| CHECKING FOR STRAY POTENTIALS | This helps avoid measurement errors when recording at high sensitivity (paragraph 6.) |
| CALIBRATION | This uses an accurate internal circuit (paragraph 7.) |
| STANDARDIZING | Required in Model 150–1500 only, for maximum zero suppression accuracy (paragraph 8.) |
| OPERATION | Five types of operation are available (paragraphs 9 through 13). |

## 5. CONNECTING THE SIGNAL

Apply power and allow 30 minutes warmup for maximum stability. Connect the signal to the INPUT socket on the panel, or to the connector J204 or J304 at the Driver Amplifier rear, as shown in figure 2.

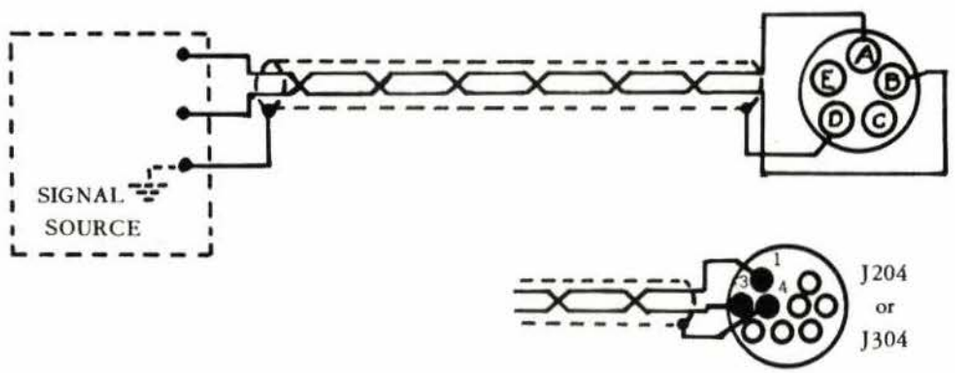



*Figure 2. Input Connections to Low Level Preamplifier.*

## 5. CONNECTING THE SIGNAL (Cont.)

A positive potential at terminal A with respect to terminal B (or of pin 1 with respect to pin 3) gives an up-scale deflection of the stylus. When measuring current, shunt the input terminals with a wire wound resistance of a material which has a low thermal potential with respect to copper, such as manganin. A value of 100 ohms gives a rated sensitivity of 1.0 microampere per centimeter. Values up to 500 ohms may be used for greater sensitivity, depending on the individual circuit. If ZERO SUPPRESSION is to be used, leave the ZERO SUPPRESSION OUT/IN switch at IN during warmup.

## 6. CHECKING FOR STRAY POTENTIALS

When measuring extremely low voltages or currents, stray potentials in the external circuit may prevent full use of the Preamplifier's abilities. These potentials appear on the record as a signal which may be difficult to distinguish from the value being measured, and can cause a baseline shift when the ATTENUATOR is turned. To check for stray potentials, proceed as follows:

1. Short terminals A and B, set the ZERO SUPPRESSION OUT / IN switch to OUT, advance the ATTENUATOR to X1, press the CAL button intermittently, and adjust the SENSITIVITY control for two centimeters of stylus deflection.

2. Connect the external circuit and set the signal to zero. Wait until the entire external circuit is at thermal equilibrium with its surroundings. The temperature of the circuit and its physical layout should be the same as for the intended measurements, with all possible sources of AC coupling or heat (transformers, soldering irons, etc.), kept at a distance during these checks and during the measurements.

3. Turn the ATTENUATOR from OFF to X1 and back again. If the resulting stylus deflection is negligible over the range of ATTENUATOR steps needed for the measurements, stray potentials may be ignored.

4. If the stylus deflection is too large to be ignored, see paragraph 14 for suggestions on eliminating some of the causes.

5. To check the Preamplifier itself for stray potentials, short the INPUT terminals and repeat the preceding test. The stylus deflection will be approximately ½millimeter or less between the OFF and the X1 positions of the ATTENUATOR.

## 7. CALIBRATION

Calibrate the Preamplifier with the external circuit connected and the signal at zero, or with the external circuit replaced by the impedance it presents to the Preamplifier. The source impedance equally attenuates both the calibration voltage and the open circuit signal voltage. The recording is therefore in terms of the equivalent open circuit signal voltage.

1. With the external circuit (or representative impedance) connected, set the ZERO SUPPRESSION OUT / IN switch (Model 150–1500 only) to OUT. Set the ATTENUATOR to OFF and adjust the POSITION control for a convenient baseline.

2. Advance the ATTENUATOR to X1 and intermittently press the CAL button. Adjust the SENSITIVITY control for two centimeters of stylus deflection as the button is pressed. Return the ATTENUATOR ot OFF.

## 7. CALIBRATION (Cont.)

3. For voltage measurements, the instrument is now calibrated to a basic sensitivity of 100 microvolts per centimeter at X1, 200 microvolts per centimeter at X2, 500 microvolts per centimeter at X5, etc. The recording is in terms of the equivalent open circuit signal voltage of the source.

4. For current measurements (with 100 ohm external resistance), the instrument is now calibrated to a basic sensitivity of 1.0 microampere per centimeter at X1, 2.0 microamperes per centimeter at X2, 5.0 microamperes per centimeter at X5, etc. The recording is in terms of the voltage drop across the external resistor alone.

## 8. STANDARDIZING (Model 150–1500 only)

Standardization insures an accurate zero suppression voltage, and is not required when recording without zero suppression.

1. Set the ATTENUATOR to OFF and the ZERO SUPPRESSION OUT / IN switch to IN. Allow 30 minutes warmup for the zero suppression cells to polarize, if this has not already been done.

2. Remove the connector from the INPUT socket or the connector at the Driver Amplifier rear, set the SUPPRESSION RANGE switch to STD, and turn the ZERO SUPPRESSION control to zero.

3. Set the stylus to mid-scale with the POSITION control.

4. Set the ATTENUATOR to STD and return the stylus to midscale with the STANDARD control.

5. Re-connect the signal.

## 9. VOLTAGE RECORDING WITHOUT ZERO SUPPRESSION

Check the pre-operational steps (see paragraph 4) and set the ZERO SUPPRESSION OUT / IN switch to OUT. Ignore the controls (present on Model 150–1500 only) marked ZERO SUPPRESSION, SUPPRESSION RANGE, and STANDARD. To record, advance the ATTENUATOR for a convenient stylus deflection. Read the equivalent open circuit signal voltage from the record at 100 microvolts per centimeter of stylus deflection when the ATTENUATOR is at X1, 200 microvolts per centimeter when the ATTENUATOR is at X2, 500 microvolts per centimeter when the ATTENUATOR is at X5, etc., or by using the formula:

microvolts = (100) X (ATTENUATOR setting) X (centimeters of deflection)

## 10. CURRENT RECORDING WITHOUT ZERO SUPPRESSION

Check the pre-operation steps (paragraph 4), and set the ZERO SUPPRESSION OUT/IN switch to OUT. Ignore the controls (present on Model 150–1500 only) marked ZERO SUPPRESSION, SUPPRESSION RANGE, and STANDARD. Be sure that the external resistor is of a material having a low thermal potential with respect to copper, such as manganin. Read the current through the external (100 ohm) resistor directly from the record at one microampere per centimeter of stylus deflection when the ATTENUATOR is at X1, two microamperes per centimeter when the ATTENUATOR is at X2, five microamperes per centimeter when the ATTENUATOR IS at X5, etc., or by using the formula:

microamperes = (ATTENUATOR setting) X (centimeters deflection)

## 11. VOLTAGE RECORDING WITH ZERO SUPPRESSION (Model 150–1500 only)

1. After calibration and standardizing, set the SUPPRESSION RANGE control for the range and direction of suppression. Set the ZERO SUPPRESSION OUT / IN switch to IN. Remember that a positive signal at terminal A with respect to terminal B results in an up-scale deflection.

| SUPPRESSION RANGE | DIRECTION OF SUPPRESSION | SENSITIVITY OF ZERO SUPPRESSION CONTROL |
|---|---|---|
| +100 mv. | down-scale | 100 microvolts / division |
| +10 mv. | down-scale | 10 microvolts / division |
| −10 mv. | up-scale | 10 microvolts / division |
| −100 mv. | up-scale | 100 microvolts / division |

2. There are two ways to use the ZERO SUPPRESSION control:

   a. Set the ZERO SUPPRESSION control to the voltage to be suppressed, advance the ATTENUATOR for a convenient deflection, and start recording.

   b. Alternate method: Advance the ZERO SUPPRESSION control and the ATTENUATOR together and start recording when there is a convenient deflection (When the RANGE switch is at ±100 mv., ATTENUATOR settings lower than X10 are not recommended; these settings are too critical with no improvement in accuracy).

3. When interpreting the final recording, voltage is found as the algebraic sum of two components (assuming calibration at 100 microvolts / cm.):

   a. *The component actually shown on the record,* from the formula
   microvolts = (100) X (ATTENUATOR setting) X (centimeters of deflection)

   b. *The component from the ZERO SUPPRESSION control* at either 10 or 100 microvolts per dial division, depending on the SUPPRESSION RANGE control setting.

## 12. CURRENT RECORDING WITH ZERO SUPPRESSION (Model 150–1500 only)

1. After calibration and standardizing, set the SUPPRESSION RANGE control for the range and direction of suppression. Set the ZERO SUPPRESSION OUT/IN switch to IN. Remember that a positive signal at terminal A with respect to terminal B results in an up-scale deflection. The table assumes a 100 ohm external resistor.

| SUPPRESSION RANGE | DIRECTION OF SUPPRESSION | SENSITIVITY OF ZERO SUPPRESSION CONTROL |
|---|---|---|
| +100 mv. | down-scale | 1.0 microamp. / division |
| +10 mv. | down-scale | 0.1 microamp. / division |
| −10 mv. | up-scale | 0.1 microamp. / division |
| −100 mv. | up-scale | 1.0 microamp. / division |

2. There are two ways to use the ZERO SUPPRESSION control.

   a. Set the ZERO SUPPRESSION control to the current to be suppressed, advance the ATTENUATOR for a convenient deflection, and start recording.

## 12. CURRENT RECORDING WITH ZERO SUPPRESSION (Model 150–1500 only)

b. Alternate method: Advance the ZERO SUPPRESSION control and the ATTENUATOR together and start recording when there is a convenient deflection. (When the RANGE switch is at ±100 mv., ATTENUATOR settings lower than X10 are not recommended; these settings are too critical, with no improvement in accuracy).

3. When interpreting the final recording, current is found as the algebraic sum of two components (assuming a 100 ohm external resistor):

   a. *The component actually shown on the record,* from the formula:
   microamperes = (ATTENUATOR setting) X (centimeters deflection)

   b. *The component from the ZERO SUPPRESSION control,* at either 1.0 or 0.1 microamperes per dial division, depending on the SUPPRESSION RANGE control setting.

## 13. OPERATION AS A NULL INDICATOR (Model 150–1500 only)

1. Warm up the Preamplifier for 30 minutes. Connect the signal circuit, check for stray potentials, and standardize. Calibration is not necessary.

2. Turn the SENSITIVITY control full right.

3. Set the ATTENUATOR to OFF, and set the stylus to mid-scale with the POSITION control. Set the ZERO SUPPRESSION OUT / IN control to IN.

4. Now advance the ZERO SUPPRESSION control and the ATTENUATOR together, until the ATTENUATOR is at X10 (SUPPRESSION RANGE = ±100) or X1 (SUPPRESSION RANGE = ±10), and the stylus is back to mid-scale again.

5. Read the voltage or current directly from the ZERO SUPPRESSION CONTROL dial at the sensitivity given in the table. The table assumes a 100 ohm external resistor when measuring current.

| SUPPRESSION RANGE | ZERO SUPPRESSION CONTROL VOLTAGE SENSITIVITY | ZERO SUPPRESSION CONTROL CURRENT SENSITIVITY |
|---|---|---|
| +100 mv. | +100 microvolts / dial division | +1.0 microamps / dial division |
| +10 mv. | +10 microvolts / dial division | +0.1 microamps / dial division |
| −10 mv. | −10 microvolts / dial division | −0.1 microamps / dial division |
| −100 mv. | −100 microvolts / dial division | −1.0 microamps / dial division |

## 14. REDUCING STRAY POTENTIALS

Paragraph 6 was a check for stray potentials. These are usually caused by magnetic coupling, capacitive coupling, or thermo-electric effects.

1. Stray magnetic coupling can be reduced or eliminated by using twisted input leads, reducing the area of any loops in the external circuit, and isolating the external circuit from any varying magnetic fields.

2. Stray capacitive coupling can be reduced or eliminated by shielding the input leads.

## 14. REDUCING STRAY POTENTIALS (Cont.)

3. Thermo-electric effects are a common source of stray potentials, and must be avoided when working at high sensitivity. These can be reduced by avoiding contacts which are of dissimilar metals and by keeping all contacts clean. The entire external circuit should be kept at the same temperature; even slight drafts blowing across some external circuits can cause enough temperature difference to shift the stylus position.

4. There may be other sources of stray potential in the circuit, such as chemical, biological, piezoelectric, or magnetostrictive effects. These are special cases which can be controlled only in conjunction with the type of measurement being made and the external circuit being used.

5. Humidity, dust, temperature extremes, age, certain vapors, chemical deterioration, and similar factors can cause leakage across insulating portions of the external circuit. This can appear on the record as a stray potential.

## 15. CHECKING THE DAMPING CONTROL ADJUSTMENT

The Damping adjustment can affect the transient or frequency response of the recording, the system gain, and the hum content on the baseline. Refer to the Instruction Manual for the Sanborn Driver Amplifier and Power Supply for this adjustment.

## 16. ADJUSTING THE HUM CONTROL

This adjustment is required only after extended use, or after a tube or some other component is replaced in the Preamplifier.

a. Calibrate normally, and then set the ATTENUATOR to X1. Center the baseline with the POSITION control.

b. Hold down the CAL button, and adjust the HUM control for mimimum ripple on the baseline. Ignore any baseline shift while making this adjustment.

## 17. REMOVING AND REPLACING PREAMPLIFIERS

1. 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.

2. 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.

## 18. THEORY OF OPERATION

Figure 3 shows the Low Level Preamplifier in relation to the other components which make up one channel of a Sanborn "150" Series System. The input signal is applied to the Preamplifier input, either directly or through the connector at the Driver Amplifier rear. The Preamplifier amplifies the signal and feeds it to the Driver Amplifier. Driver Amplifier Model 150–200 (or 150–200A, 150–200B) usually drives a Sanborn direct-writing galvanometer. Driver Amplifier Model 150–300 may feed a panel meter, an oscilloscope (or other high impedance load), or an optical galvanometer (or other low impedance load). The Power Supply provides all the plate, bias, and heater voltages for the Driver Amplifier and the Preamplifier. The Preamplifier interconnects with the Driver Amplifier through a multi-circuit connector.

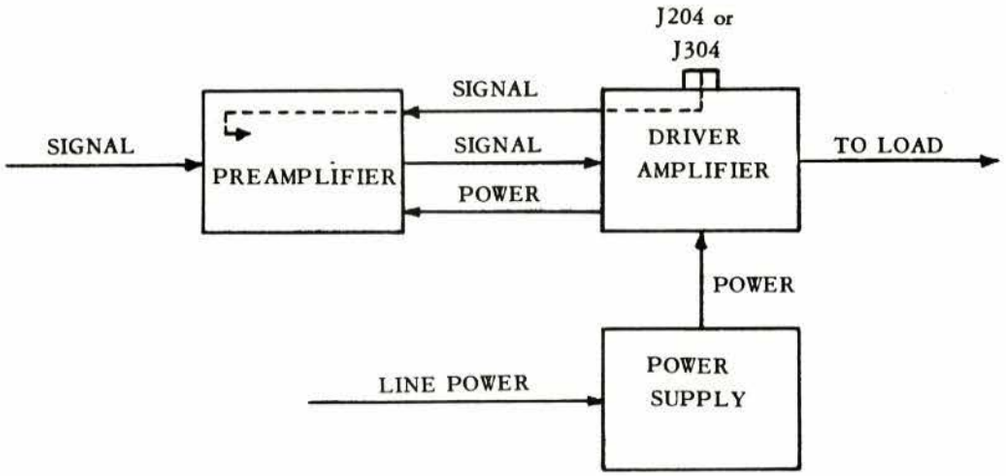



*Figure 3. Block Diagram of Low Level Preamplifier in a "150" System.*

## 19. FUNCTIONAL DESCRIPTION OF CIRCUITS

Figure 4 is a block diagram showing the Low Level Preamplifier internal circuits. The input signal is fed into the primary of the center-tapped input transformer. One input signal terminal is permanently connected to the center tap. The other input signal terminal is connected first to one end of the input transformer and then to the other, at a 60 times-per-second repetition rate, by the operation of one pair of vibrating contacts on the chopper. This changes the low frequency input signal into a 60 cycle square wave signal whose amplitude represents the amplitude of the input signal. In this way, a condenser-coupled amplifier can be used to amplify the resulting 60 cycle square wave signal, so as to avoid the drift which would occur with a direct-coupled amplifier of the same gain.

Two voltages are inserted into the input signal circuit: the calibration voltage and the zero suppression voltage. Each of these voltages is developed across a series resistance as shown in the figure. Because of this series connection, the amount of calibration voltage or zero suppression voltage appearing between the center tap and the vibrator arm is attenuated by the equivalent source resistance of the signal circuit. This is exactly the same amount of attenuation as is encountered by the equivalent open circuit signal voltage, and the preamplifier therefore measures the equivalent open circuit voltage.

## 19. FUNCTIONAL DESCRIPTION OF CIRCUITS (Cont.)

The voltage at the secondary of the input transformer is amplified by a three stage condenser coupled amplifier, designed for stable operation and a minimum of phase shift. The amplifier includes a negative voltage feedback loop, with the amount of feedback voltage selected by the SENSITIVITY control. Turning this control varies the amount of negative feedback voltage to control the gain.

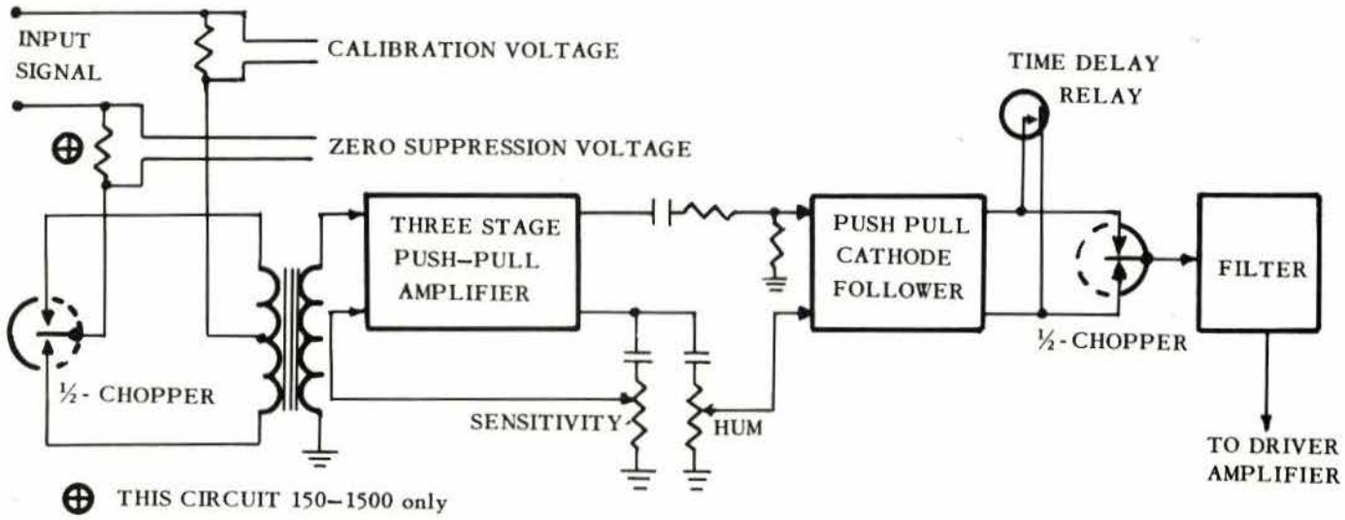



*Figure 4. Basic Circuits of Low Level Preamplifier.*

The output of the three stage amplifier is fed to the push-pull cathode follower, which in turn feeds the contacts of the output chopper. The chopper rectifies the 60–cycle square wave from the cathode follower, and supplies to the filter a signal which represents the input signal to the preamplifier. This signal is a series of positive or negative square pulses at a 120 times-per-second repitition rate, having a short dead time between pulses. With a steady input signal, successive pulses may not have exactly the same amplitude because of non-symmetry of the push-pull amplifier, and may not have exactly the same duration because of non-equality of the chopper contact time. This would appear on the record as a 60–cycle baseline ripple when near the edge of the recording. This effect is controlled by the HUM control in the cathode follower input circuit. Turning this control adjusts the amplitude of alternate pulses, so that the rectified output contains a minimum of 60–cycle interference.

The time delay relay across the chopper contacts remains closed during the preamplifier warmup period, to protect the chopper while the blocking capacitors are approaching their steady-state potentials.

SANBORN COMPANY
175 WYMAN STREET
WALTHAM, MASS. 02154
AREA CODE 617
TEL: 894-6300
JANUARY 16, 1964

INSTRUCTION MANUAL
IM-150-1500-C18-2

SANBORN CHOPPER KIT
MODEL 150-1500-C18

## 1. DESCRIPTION

When the Sanborn Low Level Preamplifier Models 150-1500, 150-1500A have output ripple that cannot be removed with the hum adjustment, a Chopper Kit should be installed. This output ripple is caused by chopper phase changes.

## 2. INSTALLATION

The Chopper Kit consists of:

0.1 Mfd capacitor Sanborn Number 8B-66, 50/60 cycle chopper Sanborn Number 62S-7, shielded lead, W120-22-1, 17" long.

Install the 0.1 Mfd capacitor from pin 4 of the chopper socket XZ1501 to ground.

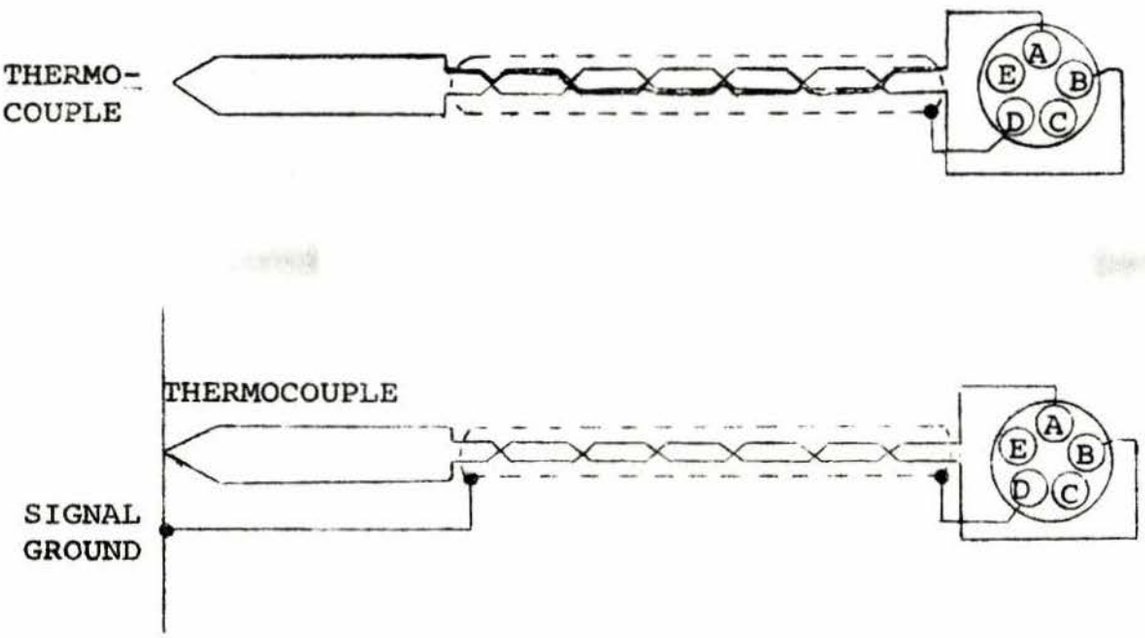
Replace the white-green wire between pin 8 on XZ1501 and pin 14 on connector J1502 with the shield lead. Ground shield at one end only.

SANBORN COMPANY
175 WYMAN STREET
WALTHAM 54, MASS.
TEL: TW-4-6300
MAY 28, 1958

INSTRUCTION MANUAL SUPPLEMENT
IM-150-1500-1E

SANBORN LOW LEVEL PREAMPLIFIER
MODEL 150-1500, 150-1500A

The signal connection shown in figure 2 of the Instruction Manual will sometimes give a-c pickup with the floating input connection as shown. Two suggested alternate connections are shown:



SANBORN COMPANY
175 WYMAN STREET
WALTHAM 54, MASS.
TEL: TW-4-6300
FEBRUARY 16, 1960

REPLACEMENT PARTS LIST SUPPLEMENTS
RPL-150-1500-3A
RPL-150-1500-3B
SANBORN LOW LEVEL PREAMPLIFIER
MODEL 150-1500

RPL-150-1500-3A
CR 9744 April 1, 1959

Resistor R1552 changed from .12M 5% 1/2W Composition Sanborn No. 50A-124J to

.10M 5% 1/2W Composition Sanborn Number 50AB-104J.

RPL-150-1500-3B
CR 10567 February 10, 1960
Schematic: 150-1500-C1 Sub 14 **(60 cycle)**
150-1500-C1P1 Sub 1 **(50 cycle)**

Sanbern Low Level Preamplifier Model 150-1500 stamped with CR 10567 or higher will have the following changes.

Capacitor C1522 .1MFD 20% 200V Mylar Sanborn Number 8B-66 is added across terminals 4 and 1 of socket XZ1501.

Wire from XZ1501-8 to J1502-14 is shielded and shield is connected to ground pin 1 of XZ1501.

Chopper K1501 becomes a 50/60 cycle chopper Sanborn Number 62S-7.

SANBORN COMPANY
175 WYMAN STREET
WALTHAM 54, MASS.
TEL: TW 4-6300
MARCH 14, 1960

REPLACEMENT PARTS LIST SUPPLEMENT
RPL-150-1500-3C

SANBORN LOW LEVEL PREAMPLIFIER
MODEL 150-1500

RPL-150-1500-3C STANDARD CHANGE
CR10567 February 10, 1960

Schematic: 150-1500-C1 Sub 14

Sanborn Low Level Preamplifier stamped with CR10567 or higher will have the following change

Add a .1 Mfd ± 20%, 200V Mylar Dielectric Capacitor C1522 from XZ1501-4 to XZ1501-1.

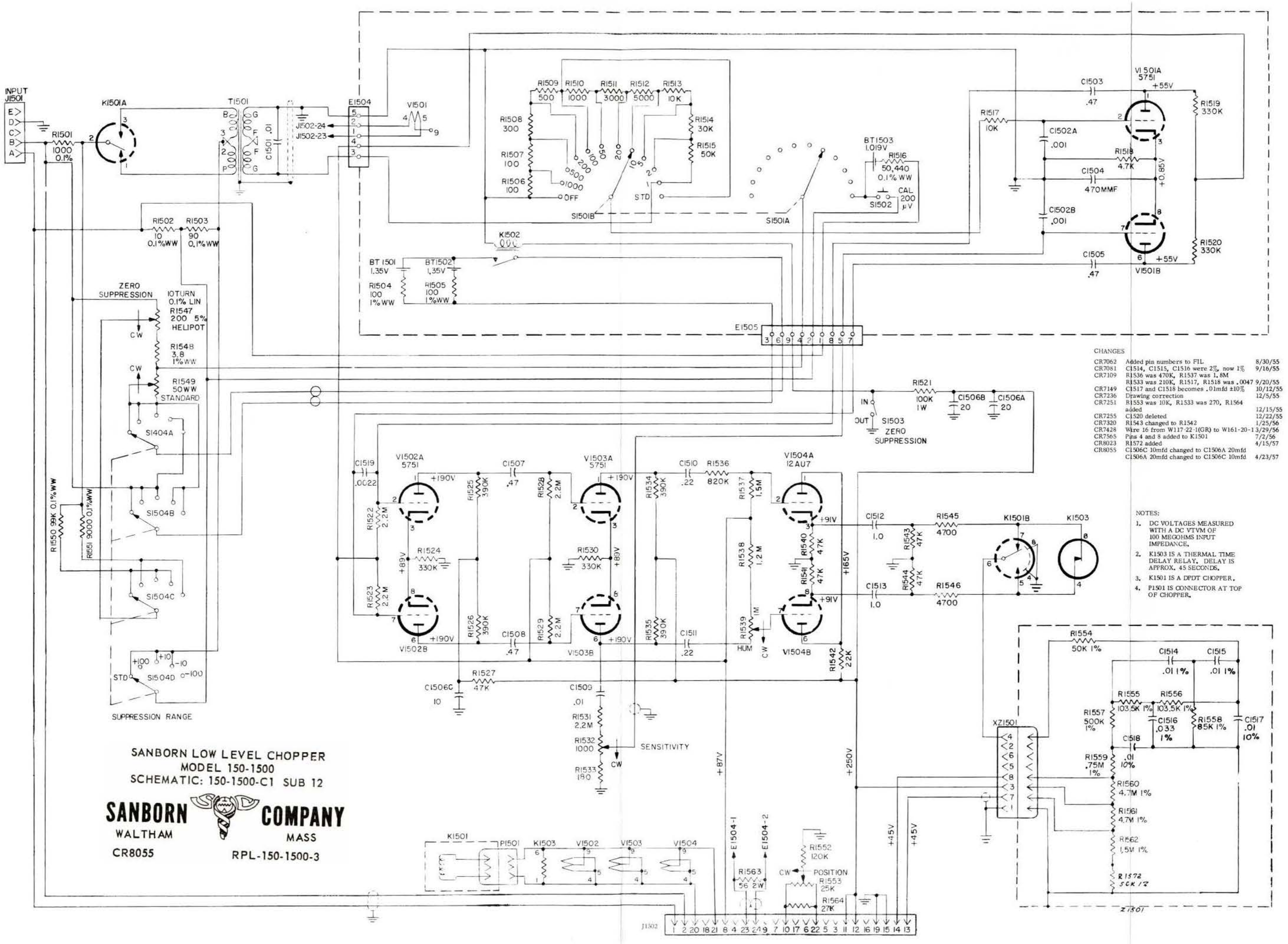
The wire from J1502-14 to XZ1501-8 is shielded.

DELETE from the parts list for the Low Level Preamplifier Model 150-1500 the following items:

| DESCRIPTION | SANBORN NO. |
|---|---|
| DPDT 60 Cycle Chopper | 62S-1 |
| DPDT 50 Cycle Chopper | 62S-1A |
| DPDT 60/50 Cycle Chopper | 62S-3 |

ADD to the parts list for the Low Level Preamplifier Model 150-1500 the following items:

| DESCRIPTION | SANBORN NO. |
|---|---|
| DPDT 50/60 Cycle Chopper | 62S-7 |
| DPDT 60 Cycle Chopper<br>"Alternate for 62S-7 for 60 Cycle use" | 62S-8 |
| DPDT 50 Cycle Chopper<br>"Alternate for 62S-7 for 50 Cycle use" | 62S-9 |
| .1 Mfd ± 20%, 200V Mylar Dielectric Capacitor | 8B-66 |




CHANGES

| | | |
|---|---|---|
| CR7062 | Added pin numbers to FIL | 8/30/55 |
| CR7081 | C1514, C1515, C1516 were 2%, now 1% | 9/16/55 |
| CR7109 | R1536 was 470K, R1537 was 1.8M<br>R1533 was 210K, R1517, R1518 was .0047 | 9/20/55 |
| CR7149 | C1517 and C1518 becomes .01mfd ±10% | 10/12/55 |
| CR7236 | Drawing correction | 12/5/55 |
| CR7251 | R1553 was 10K, R1533 was 270, R1564 added | 12/15/55 |
| CR7255 | C1520 deleted | 12/22/55 |
| CR7320 | R1543 changed to R1542 | 1/25/56 |
| CR7428 | Wire 16 from W117-22-1(GR) to W161-20-1 | 3/29/56 |
| CR7565 | Pins 4 and 8 added to K1501 | 7/2/56 |
| CR8023 | R1572 added | 4/15/57 |
| CR8055 | C1506C 10mfd changed to C1506A 20mfd<br>C1506A 20mfd changed to C1506C 10mfd | 4/23/57 |

NOTES:

1. DC VOLTAGES MEASURED WITH A DC VTVM OF 100 MEGOHMS INPUT IMPEDANCE.
2. K1503 IS A THERMAL TIME DELAY RELAY. DELAY IS APPROX. 45 SECONDS.
3. K1501 IS A DPDT CHOPPER.
4. P1501 IS CONNECTOR AT TOP OF CHOPPER.

SANBORN LOW LEVEL CHOPPER
MODEL 150-1500
SCHEMATIC: 150-1500-C1 SUB 12

**SANBORN COMPANY**
WALTHAM MASS

CR8055 RPL-150-1500-3

| SYMBOL | DESCRIPTION | SANBORN NO. | VENDOR CODE |
|---|---|---|---|
| BT1501 | Mercury Battery | 2A-10 | RM4R(MAL) |
| BT1502 | Mercury Battery | 2A-10 | RM4R(MAL) |
| BT1503 | Standard Cell | 2C-1 | Mod 3, type 4, (WES) |
| C1501 | .01 mfd 400 vdcw Paper | 8B-37 | 67P(SPR) |
| C1502A | .001 x .001 Ceramic | 8E-10 | 29C7(SPR) |
| C1502B | .001 x .001 Ceramic | 8E-10 | 29C7(SPR) |
| C1503 | .47 mfd 200 vdcw Paper | 8B-51 | 620(GA) |
| C1503 | Alternate .47 mfd 200 vdcw | 8B-79 | 621(GA) |
| C1504 | 470 mmf Ceramic | 8E-9 | HQ(AER) |
| C1505 | .47 mfd 200 vdcw Paper | 8B-51 | 620(GA) |
| C1506 | 20-20-10 mfd Electrolytic | 572-217 | QC(CD) |
| *C1507 | .47 mfd 200 vdcw Paper | 8B-51PG | 620(GA) |
| *C1508 | .47 mfd 200 vdcw Paper | 8B-51PG | 620(GA) |
| C1509 | .01 mfd 400 vdcw Paper | 8B-37 | 67P(SPR) |
| *C1510 | .22 mfd 200 vdcw Paper | 8B-52PG | 621(GA) |
| *C1511 | .22 mfd 200 vdcw Paper | 8B-52PG | 621(GA) |
| *C1512 | 1 mfd 200 vdcw Paper | 8B-59PG | 621(GA) |
| *C1513 | 1 mfd 200 vdcw Paper | 8B-69PG | 621(GA) |
| C1514 | .01 mfd 400 vdcw Paper | 8B-61 | 621(GA) |
| C1515 | .01 mfd 400 vdcw Paper | 8B-61 | 621(GA) |
| C1516 | .033 mfd 400 vdcw Paper | 8B-62 | 621(GA) |
| C1517 | .01 mfd 400 vdcw Paper | 8B-37 | 67P(SPR) |
| C1518 | .01 mfd 400 vdcw Paper | 8B-37 | 67P(SPR) |
| C1519 | .0022 mfd 600 vdcw Paper | 8B-39 | 67P(SPR) |
| J1501 | 5-Contact AN socket | 10A5-1FX | 97-3102A-145-5S(AMP) |
| J1502 | 24-Contact connector | 10B24-1MX | 26-159-24(AMP) |
| K1501 | DPDT 60 cycle chopper | 62S-1 | A-11 |
| K1502 | SPDT relay | 62R-4 | 41F6-12000S-PAL(SIG) |
| K1503 | Time delay relay | 62R-3 | 6C45T(AMP) |
| P1501 | is a connector at top of chopper | | |
| R1501 | 1K 1/10% Wire Wound | 54A-47T | TL31(TEL) |
| R1502 | 10 ohm 1/10% Wire Wound | 54A-48T | TL31(TEL) |
| R1503 | 90 ohm 1% Wire Wound | 54A-49F | TL31(TEL) |
| R1504 | 100 ohm 1% Wire Wound | 54A-51F | TL31(TEL) |
| R1505 | 100 ohm 1% Wire Wound | 54A-51F | TL31(TEL) |
| R1506 | 100 ohm 1% 1/4W Composition | 50H-101G | C-11(WEL) |
| R1507 | 100 ohm 1% 1/4W Composition | 50H-101G | C-11(WEL) |
| R1508 | 300 ohm 1$ 1/4W Composition | 50H-301G | C-11(WEL) |
| R1509 | 500 ohm 1% 1/4W Composition | 50H-501G | C-11(WEL) |
| R1510 | 1K 1% 1/4W Composition | 50H-102G | C-11(WEL) |
| R1511 | 3K 1% 1/4W Composition | 50H-302G | C-11(WEL) |
| R1512 | 5K 1% 1/4W Composition | 50H-502G | C-11(WEL) |
| R1513 | 10K 1% 1/4W Composition | 50H-103G | C-11(WEL) |
| R1514 | 30K 1% 1/4W Composition | 50H-303G | C-11(WEL) |
| R1515 | 50K 1% 1/4W Composition | 50H-503G | C-11(WEL) |
| R1516 | 50.44K 1/10% Composition | 50A-52T | TL31(TEL) |
| R1517 | 10K 5% 1/2W Composition | 50A-103J | EB(AB) |
| R1518 | 4.7K 5% 1/2W Composition | 50A-472J | EB(AB) |
| *R1519 | .33M 5% 1/2W Composition | 50AB-334JPG | EB(AB) |
| *R1520 | .33M 5% 1/2W Composition | 50AB-334JPG | EB(AB) |
| R1521 | .1M 5% 1W Composition | 51D-104J | GB(AB) |
| *R1522 | 2.2M 5% 1/2W Composition | 50AB-225JPG | EB(AB) |
| *R1523 | 2.2M 5% 1/2W Composition | 50AB-225JPG | EB(AB) |
| R1524 | .33M 5% 1/2W Composition | 50AB-334J | EB(AB) |
| *R1525 | .39M 5% 1/2W Composition | 50A-394JPG | EB(AB) |
| *R1526 | .39M 5% 1/2W Composition | 50A-394JPG | EB(AB) |
| R1527 | 47K 5% 1/2W Composition | 50AB-473J | EB(AB) |

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| *R1528 | 2.2M 5% 1/2W Composition | 50AB-225JPG | EB(AB) |
| *R1529 | 2.2M 5% 1/2W Composition | 50AB-225JPG | EB(AB) |
| R1530 | .33M 5% 1/2W Composition | 50AB-334J | EB(AB) |
| R1531 | 2.2M 5% 1/2W Composition | 50AB-225J | EB(AB) |
| R1532 | 1K Potentiometer | 56A-10 | C-1021(AB) |
| R1533 | 180 ohm 5% 1/2W Composition | 50A-181J | EB(AB) |
| *R1534 | .39M 5% 1/2W Composition | 50A-394JPG | EB(AB) |
| *R1535 | .39M 5% 1/2W Composition | 50A-394JPG | EB(AB) |
| R1536 | .82M 5% 1/2W Composition | 50A-824J | EB(AB) |
| R1537 | 1.5M 5% 1/2W Composition | 50AB-155J | EB(AB) |
| R1538 | 1.2M 5% 1/2W Composition | 50A-125J | EB(AB) |
| R1539 | 1M Potentiometer | 572-230 | JLC-1052(AB) |
| *R1540 | 47K 5% 1/2W Composition | 50AB-473JPG | EB(AB) |
| *R1541 | 47K 5% 1/2W Composition | 50AB-473JPG | EB(AB) |
| R1542 | 22K 5% 1/2W Composition | 50A-223J | EB(AB) |
| *R1543 | 47K 5% 1/2W Composition | 50AB-473JPG | EB(AB) |
| *R1544 | 47K 5% 1/2W Composition | 50AB-473JPG | EB(AB) |
| *R1545 | 4.7K 5% 1/2W Composition | 50A-472JPG | EB(AB) |
| *R1546 | 4.7K 5% 1/2W Composition | 50A-472JPG | EB(AB) |
| R1547 | 200 ohm Potentiometer | 56C-8 | 1000A2(HEL) |
| R1548 | 3.8 ohm 1% Wire Wound | 54A-50F | TL31(TEL) |
| R1549 | 50 ohm Wire Wound Pot. | 56A-67 | 2W(IRC) |
| R1550 | 99K 1/10% Wire Wound | 54A-45T | TL31(TEL) |
| R1551 | 9K 1/10$ Wire Wound | 54A-46T | TL31(TEL) |
| R1552 | .12M 5% 1/2W Composition | 50A-124J | EB(AB) |
| R1553 | 25K Potentiometer | 56A-53 | C-2431(AB) |
| R1554 | 50K 1% 1/4W Composition | 50H-503G | C-11(WEL) |
| R1555 | 103.5K 1% 1/4W Comp. | 50H-1035-2G | C-11(WEL) |
| R1556 | 103.5K 1% 1/4W Comp. | 50H-1035-2G | C-11(WEL) |
| R1557 | .5M 1% 1/4W Composition | 50H-504G | C-11(WEL) |
| R1558 | 85K 1% 1/4W Composition | 50H-853G | C-11(WEL) |
| R1559 | .75M 1% 1/4W Composition | 50H-754G | C-11(WEL) |
| R1560 | 4.7M 1% 1/2W Composition | 50J-475G | C-12(WEL) |
| R1561 | 4.7M 1% 1/2W Composition | 50J-475G | C-12(WEL) |
| R1562 | 1.5M 1% 1/2W Composition | 50J-155G | C-12(WEL) |
| R1563 | 56 ohm 5% 2W Composition | 52C-560J | HB(AB) |
| R1564 | 27K 5% 1/2W Composition | 50AB-273J | EB(AB) |
| R1572 | 50K 1% 1/4W Composition | 50H-203G | C-11(WEL) |
| S1501 | 2-Deck, 12 pos. wafer sw. | 62B-8 | 5360-4MLW-2(GRI) |
| S1502 | Acro switch | 62C-3 | 3M03-1A(ACR) |
| S1503 | SPST toggle switch | 62D-21 | 86510(ARR) |
| S1504 | 2 Deck, 5 pos. wafer sw. | 62B-28 | Special(GRI) |
| T1501 | Input transformer | 66B-27 | W5463(UTC) |
| V1501 | Type 5751 | 68A-37 | (GE)(RCA) |
| V1502 | Type 5751 | 68A-37 | (GE)(RCA) |
| V1503 | Type 5751 | 68A-37 | (GE)(RCA) |
| V1504 | Type 12AU7 | 69A-11 | Special Commercial |
| Z1501 | Filter Assembly | 150-1500-C16P1 | |

*The following condensers are matched within 2%:
(C1507, C1508), (C1510, C1511), (C1512, C1513).

*The following resistors are matched within 2%:
(R1519, R1520), (R1522, R1523), (R1525, R1526),
(R1528, R1529), (R1534, R1535), (R1540, R1541),
(R1543, R1544), (R1545, R1546).

VENDOR ABBREVIATIONS

| | |
|---|---|
| AB | Allen Bradley |
| ACR | Acro |
| AER | Aerovox |
| AMP | Amphenol |
| ARR | Arrow-Hart & Hegeman |
| GA | Good All |
| CD | Cornell Dubilier |
| GRI | Grisby-Allison |
| HEL | Helipot |
| IRC | International Resistance Co. |
| MAL | Mallory |
| RCA | Radio Corporation of America |
| SIG | Sigma |
| SPR | Sprague |
| STE | Stevens Arnold |
| TEL | Tel Labs |
| UTC | United Transformer Co. |
| WEL | Welwyn |
| WES | Westinghouse |