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### Ⓜ MODELS 330B, 330C, & 330D DISTORTION ANALYZERS TEST PROCEDURE

#### INSTRUMENTS REQUIRED -

The instruments required for any particular test procedure may be determined by referring to the corresponding heading in the following listing:

Power Supply Voltage Regulation - A dc voltmeter such as Ⓜ Model 412A or 410B is required along with a means of continuous control of the input line voltage to the 300B under test.

Internal Voltmeter Calibration - A 400 cps signal source such as Ⓜ Model 738AR (was Spec. 23678) Voltmeter Calibrator delivering 300 volts at not more than 1% distortion is recommended for fastest, most convenient calibrating. Conventional signal generators, monitor voltmeters, and precision attenuators may also be used.

Frequency Response Checks - A signal source covering the range from 10 cps to 100 kc (60 kc for a 330C or 330D) with not more than 1.0% distortion. This source should be capable of delivering enough output voltage between 1000 cps and 100 kc for checking the 300 volt range. In lieu of equipment for making quantitative tests, response on 100 and 300 volt ranges may be adjusted with a square wave signal and an oscilloscope.

Follow this signal source with an attenuator for voltage control. These attenuators need not be accurate since the input to the 330 must be monitored by an ac voltmeter with known frequency response characteristics. An Ⓜ Model 400D, 400H, or 400L Vacuum Tube Voltmeter is ideal.

Residual Hum and Noise Check - A shielded plug (Ⓜ Stock No. 125-23) capable of shielding both input terminals and containing a shunt resistor of 10 megohms.

Output - An ac voltmeter to monitor output at "OSCILLOSCOPE" terminals. Vacuum tube voltmeters such as Ⓜ Models 400D, 400H or 400L are excellent for this application. A test voltage of 1 volt at approximately 400 cps with not more than 1.0% distortion and an oscilloscope are also required.

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Setting Amplifier Gains - A signal source capable of delivering at least 10 volts from 20 cps to 20,000 cps with not more than 1.0% distortion. A voltmeter with a flat response over this same range is also required. See listing of recommended voltmeters under Output.

Frequency Dial Calibration - Frequency measuring equipment covering the range from 20 to 20,000 cps. Any electronic counter such as Ⓜ Model 521A, 522B, 523B, 524A, or 524B is more than adequate. Frequency standards such as Ⓜ Models 100A, 100B, 100C and 100D when used in conjunction with an oscilloscope are also suitable.

Distortion Check - A pure wave source, such as the Ⓜ Model 206A, covering the range from 20 to 20,000 cps with not more than 0.1% distortion is required. A signal source covering this frequency range with not more than 1.0% distortion can be used provided a pure wave filter is used between this source and the 330 under test.

Second Harmonic Attenuation Check - A signal source covering the range from 40 to 40,000 cps with not more than 1.0% distortion such as Ⓜ Models 200AB, 200CD, or 202C will be required.

#### IMPORTANT SCHEMATIC NOTE

THE SCHEMATIC DIAGRAMS ARE GIVEN IN THESE SERVICE NOTES FOR THE SOLE PURPOSE OF IDENTIFYING ADJUSTMENTS. PRODUCTION CHANGES HAVE BEEN MADE FROM TIME TO TIME AND NO ATTEMPT SHOULD BE MADE TO MAKE CIRCUIT CONSTANTS OR THE WIRING OF A PARTICULAR INSTRUMENT AGREE EXACTLY WITH THESE DIAGRAMS. CROSS CHECKING AND COMPARISON WITH THE DIAGRAMS ORIGINALLY SUPPLIED WITH A PARTICULAR INSTRUMENT WILL FACILITATE PARTS IDENTIFICATION.

#### TEST PROCEDURE FOR VOLTMETER SECTION -

All voltages are measured between the points indicated in the procedures that follow and the chassis unless otherwise designated. All tests



are made with the function switch in the "METER" position. The ac line voltage is adjusted to 115 volts unless otherwise designated.

Adjust Regulated Power Supply - Connect dc voltmeter to the cathode of series regulator tube V8. Adjust control R43 for a reading of 225 volts with the line voltage set to 115 volts.

Vary the line voltage from 105 to 125 volts. The reading on the dc voltmeter should remain within the limits of 223 to 227 volts.

Adjust Meter Mechanical Zero - Set Range to 300 volts. Remove any test leads from METER and AF INPUT terminals. Turn instrument on and allow to warm up. Keep instrument on and turn zero adjust screw in meter case clockwise only until pointer is on-scale and travels downscale to exactly zero. If pointer overshoots, repeat.

Check Meter Tracking - Turn to the 1 volt range and connect a 100 cps signal of exactly 1 volt to the 330 "METER" terminals. Adjust control R62 for a reading of 1 volt on the 330 voltmeter.

Check meter tracking by applying accurately known tracking voltages (0.1v, 0.2v, etc.) on 1 volt range. Tracking is determined by diode V14 (6H6) and can be compromised with mechanical zero adjustment of meter and R62. Replacement of 6H6 tube with silicon diodes and modification of circuit is recommended for increased stability of meter circuit if poor tracking is encountered with vacuum tube diodes. Components and modification instructions are available from your ☎ Representative or the factory.

Residual Noise and Hum in Voltmeter - Shield meter input terminals completely after shunting them with a resistor of ten megohms. Switch to the 0.03 volt range and note voltmeter reading which should not be more than 1 division on the scale calibrated 0 to 3.

Excessively high residual noise and hum can normally be corrected by replacing any one or all tubes for V11, V12, V13, and V14.

Line Voltage Response - Connect a 100 kc (60 kc for a 330C or 330D) reference voltage to the meter input terminals and adjust for a voltmeter reading of approximately 0.8 of

full scale. The meter reading should not vary by more than  $\pm 3\%$  of full scale from

this reference level when the line voltage is varied from 105 to 125 volts.

Replacement of tubes V12, V13, and/or V14 will usually correct for an excessively high variation. Readjust control R62 for a 1 volt full scale reading as described under Check Meter Tracking.

Voltmeter Frequency Response for 330B Analyzer Only - Establish a reference level on the 30 volt range at about 1000 cps and check that the frequency response from 1000 cps to 100 kc is within  $\pm 3\%$  of full scale. There is no frequency response adjustment for the 30 volt range but replacement of the 6AC7 tube and/or feedback resistor R61 may correct the response. Line voltage must be set to 115 volts.

Check the 0.03 volt range from 1 kc to 100 kc. If there are no ground loops in the connections to the 330B, the frequency response will be within  $\pm 3.0\%$  of full scale. It may be necessary to insulate the 300B from a metal bench plate to eliminate all ground loops which normally cause an increased reading at higher frequencies.

Check the 0.1 volt range from 1 kc to 100 kc. Adjust response at 100 kc to within  $\pm 3\%$  of full scale with variable capacitor C25.

\*Check the 100 volt range from 1 kc to 100 kc. Adjust response at 100 kc to within  $\pm 3\%$  of full scale with variable capacitor C20.

\*Use either the square wave method or the transformer method as follows:

#### Square wave method

Apply 1 kc square wave (20 to 100 v peak-to-peak) to voltmeter input. Connect oscilloscope to OSCILLOSCOPE terminals. Set adjustment for best square wave pattern. Calibrator of ☎ Model 150A Oscilloscope may be used as signal source.

#### Transformer method

Connect transformer 200CD-9 as shown in figure 1 and check frequency response on 100- and 300-volt ranges. Establish a 5000-cps reference level on each range and check response from 5000 cps to 100,000 cps. Adjust C20 at 100,000 cps (60,000 cps for Models 330C and 330D) on 100 RMS VOLTS range to bring the high-frequency reading within  $\pm 0.3$  of reference reading. Adjust C23 at 100,000 cps on 300 RMS VOLTS range to bring the high-frequency reading to within  $\pm 0.3$  of reference reading.

\*Check the 300 volt range in the same manner as the 100 volt range. A reference level of 200 volts is adequate. Adjust response at 100 kc with variable capacitor C23.

Switch to the 0.1 volt range. Establish a 1000 cps reference level and check response from 1000 cps down to 10 cps. The response should be within  $\pm 3\%$  of full scale. If response is not correct, instrument repair involving location and replacement of a defective component will be required.

Voltmeter Frequency Response for 330C and 330D Analyzers Only - Set line voltage to 115 volts. Set signal generator frequency to 1000 cps at a reference level corresponding to 0.9 on the meter scale on each range. It is also advisable to insulate the instruments from a metal workbench to eliminate ground loops which produce false readings. The ground loop effect is particularly noticeable on the lower voltage ranges at the upper test frequencies.

Check the 0.1, 0.03, and 30 volt ranges from 1 kc to 60 kc. Adjust C33 as necessary to obtain a compromise setting to meet the following specifications.

- $\pm 3\%$  of full scale between 10 cps and 20 kc.
- $\pm 6\%$  of full scale between 10 cps and 60 kc.
- At least 40 db attenuation at 500 kc.

\*Check the 100 volt range from 1 kc to 60 kc. Adjust C20 at 60 kc to meet above specifications.

\*Check the 300 volt range from 1 kc to 60 kc using a signal reference level of 200 to 300 volts. Adjust C23 at 60 kc to meet above specifications.

If the specifications at the upper frequencies cannot be satisfied, replace V12 (6AC7) and/or replace feedback resistor, R61.

Switch to 0.1 volt range and check response from 1000 cps to 10 cps. The response should be within  $\pm 3\%$  of full scale.

If specification at the lower frequencies cannot be satisfied, a defective circuit component is indicated.

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Voltmeter Calibration - Check and if necessary readjust the 1 volt range as described under Check Meter Tracking.

Check the 100 volt range. Adjust by changing the value of R77 which is in series with R52.

Check the 300 volt range. Adjust by changing the value of R78 which is in series with R53.

Changing the value of R77 or R78 will necessitate checking the frequency response of the particular range in which the resistor has been changed.

Check Output - Set the 330B voltmeter to the 1 volt range and remove any external connections at the "METER" terminals. Shunt the "METER" terminals with a resistor of 10 megohms and completely shield both terminals. The reading obtained on an ac voltmeter connected to the "OSCILLOSCOPE" terminals should not be more than 0.5 volt.

Remove shield and shunt resistor and connect a 1 volt signal of approximately 400 cps to the "METER" terminals. The output voltage at the "OSCILLOSCOPE" terminals should be from 12 to 24 volts rms.

Microphonics - Microphonics can be reduced to a minimum by using selected 6AC7 tubes, particularly for those in the voltmeter input circuit.

#### TEST PROCEDURE FOR AMPLIFIER AND FILTER SECTION -

Testing of the amplifier and filter section should follow after completing the voltmeter section test procedure. The 330 voltmeter is used for testing the amplifier and filter section. All voltages are measured between the chassis and the points indicated in the following procedures. The ac line voltage is adjusted to 115 volts unless otherwise designated.

Adjust Internal Amplifier Gain - Turn function switch to "METER", METER RANGE switch to 300, FREQUENCY RANGE to X10, and FREQUENCY dial to 20. Remove type 6AC7 tube V6, rotate "INPUT" gain control full clockwise to "MAX" and connect an external signal source of approximately 1000 cps to the "AF INPUT" terminals.

Adjust the external signal source to obtain an indication of 0 db on an external voltmeter switched to the 1 volt range and connected across the "AF INPUT" terminals.

Switch external voltmeter to 10 volt (+20db) range and reconnect to cathode pin 8 of 6J5 tube for V4.

Pad the value of R13 (27,000 ohms) to obtain a voltmeter reading of -2 to -1 db which will indicate a gain of 7.9 to 8.9 times or 18 to 19 db. Maintain a constant signal input level during adjustment.

Reinsert type 6AC7 tube V6 after adjustment is completed.

Adjust Amplifier "SET LEVEL" Gain - Turn function switch to "METER", switch internal voltmeter to 1.0 volt range, and connect an external signal source of approximately 1000 cps to the "METER" terminals.

Adjust the external signal source to obtain an indication of 0 db on the internal voltmeter.

Switch internal voltmeter to 10 volt range, rotate "INPUT" control to full clockwise to "MAX", and transfer external signal source from "METER" terminals to "AF INPUT" terminals. Switch function switch to "SET LEVEL".

Adjust potentiometer R38 for a meter reading of 0 db which shows that the overall amplifier gain is 20 db.

Adjust Amplifier "NOISE" Gain - Turn function switch to "METER", switch internal voltmeter to 0.1 volt range, and connect an external signal source of approximately 1000 cps to the "METER" terminals.

Adjust the external signal source to obtain an indication of 0 db on the internal voltmeter.

Switch internal voltmeter to 10 volt range, rotate "INPUT" control full clockwise to "MAX", and transfer external signal source from "METER" terminals to "AF INPUT" terminals. Switch function switch to "NOISE".

Adjust potentiometer R5 for a meter reading of 0 db which shows that the overall amplifier gain is 40 db.

Check Amplifier Frequency Response - Follow the basic procedure given under Adjust Amplifier "SET LEVEL" Gain to spot check the amplifier frequency response. Use the 1000 cps setting as the reference voltage and do not disturb the setting of R38.

Check a 330B at frequencies of 20 cps, 20 kc, 100 kc, and 200 kc. Specifications are  $\pm 1$  db from 20 cps to 20 kc and  $\pm 2$  db from 20 cps to 200 kc.

Check a 330C or 330D at frequencies of 20 cps, 20 kc, and 60 kc. Specifications are  $\pm 1$  db from 20 cps to 20 kc and  $\pm 2$  db from 20 cps to 60 kc.

Use the basic procedure given under Adjust Amplifier "NOISE" Gain to check frequency response at 20 cps and 20 kc. Do not disturb the setting of R5 and use the 1000 cps setting as the reference voltage. Specifications require a frequency response of  $\pm 1$  db from 20 cps to 20 kc.

Hum Check - Shield the "AF INPUT" terminals completely after shunting them with a resistor of 10 megohms. Rotate "INPUT" control to "MAX", set "RANGE" switch to "X1", set function switch to "DISTORTION", and switch the internal voltmeter to the ".03" range. Adjust the "FREQUENCY" control at a dial indication of 60 for a maximum reading on the voltmeter. Instrument top and bottom metal covers must be in place or instrument must be in a metal cabinet for these tests.

Adjust potentiometer R41 (at rear of instrument) for a minimum voltmeter reading which should be less than 3 mv.

Set the function switch to "SET LEVEL" and again note voltmeter reading which should be less than 1 mv.

Set the function switch to "NOISE" and again note voltmeter reading which should be not less than 7 mv.

Change tubes V2, V3, V4, V5, and/or V6 one at a time if any of the above readings are above specifications.

Changing any one or all of these five tubes will necessitate checking and resetting "SET LEVEL" and "NOISE" gain as previously described.

Check BALANCE Control - Connect a 200 cps external signal source to the "AF INPUT" terminals, set the "RANGE" switch to "X10", frequency dial to 20, and function switch to "DISTORTION". Use an internal voltmeter range no higher than the ten volt range and set the external signal level as required to obtain a useable meter indication.

Adjust "BALANCE" and "FREQUENCY" control for a minimum voltmeter reading.

Adjust internal potentiometer R89 to provide approximately the same voltmeter reading with the "BALANCE" control rotated full clockwise and then full counterclockwise. Keep input signal level constant and switch to a higher voltmeter range to keep readings on scale when rotating "BALANCE" control. This setting of R89 centers the "BALANCE" control adjustment range.

Potentiometer R89 was added in series with R25 which was then changed to a fixed value of 12,000 ohms only in later instruments. Consequently, in some instruments, it will be necessary to change or pad the value of R25 instead of adjusting R89.

Change external signal source to 2000 cps and turn "FREQUENCY" dial to 200. Adjust "FREQUENCY" and "BALANCE" controls for a minimum reading on the internal voltmeter.

Adjust internal variable capacitor C12 to provide the same voltmeter reading when the "BALANCE" control is rotated from one extreme to the other as when adjusting potentiometer R89.

These two adjustments interact and should be repeated several times.

Adjustment of capacitor C12 will effect the calibration of the "FREQUENCY" dial and a compromise adjustment may be necessary.

Check FREQUENCY Dial Calibration - Check the calibration of the FREQUENCY dial on all three ranges. See INSTRUMENTS REQUIRED for suggested frequency determining

methods. A slight adjustment of the padding resistors mounted on the "RANGE" switch may be required to bring the calibration within  $\pm 2\%$ .

Check Distortion - Check distortion at 20 cps, 1000 cps, and 20 kc. The external signal source must have no more than 0.1% distortion and be connected to the "AF INPUT" terminals. The "INPUT" control should be rotated full clockwise to "MAX".

At each test frequency, turn function switch to "SET LEVEL" and adjust the input signal level for a reading of 0 db with the voltmeter set to the 10 volt range. Then turn function switch to "DISTORTION" and adjust for a minimum voltmeter reading with the "FREQUENCY" and "BALANCE" controls. Do not change the level of the input signal. Switch to a lower voltmeter range as required to obtain a useable reading.

The distortion readings should be at least -60 db at all frequencies.

High distortion is usually caused by defective tubes in the analyzer section. If tubes are replaced, recheck residual hum, set level amplifier gain, noise amplifier gain, and balance control.

Check 330 voltmeter calibration on the 1 volt range at a frequency of 400 cps and make any final adjustments that may be necessary. See Check Meter Tracking under TEST PROCEDURE FOR VOLTMETER SECTION.

Check Second Harmonic Attenuation - Check filter section for amount of second harmonic attenuation at frequencies of 100, 1,500, 5,000, and 20,000 cps. The external signal source is connected to the "AF INPUT" terminals. IMPORTANT - The external source is used to introduce a signal frequency twice that indicated by the "RANGE" and "FREQUENCY" dial settings.

At each test frequency, turn function switch to "SET LEVEL" and adjust the "INPUT" control or the input signal level for a reading of 0 db with the voltmeter set to the 10 volt range. Then turn function switch to "DISTORTION" and note the db change in the voltmeter reading.

At fundamental frequencies (indicated by "RANGE" and "FREQUENCY" dial settings) between 20 cps and 5 kc, the voltmeter reading should not drop more than 1.5 db.

At fundamental frequencies from 5 kc to 20 kc the voltmeter reading should not drop by more than 3 db.

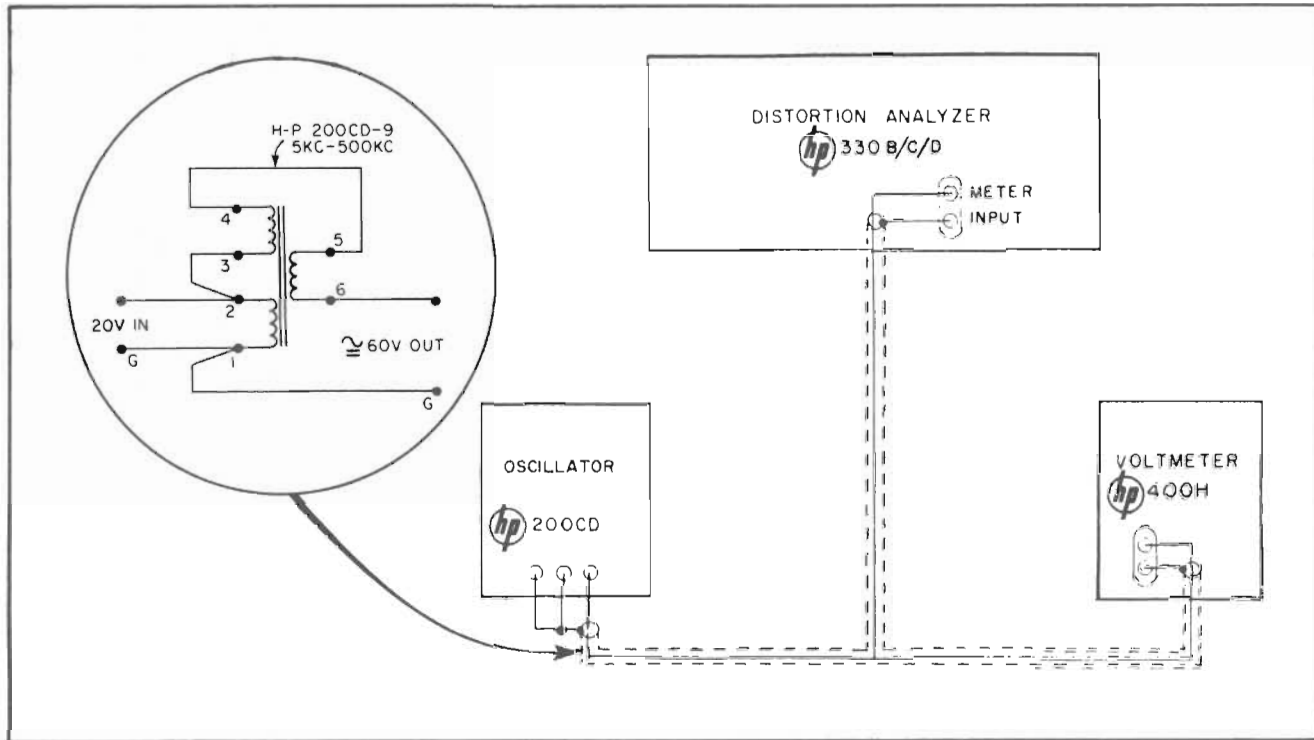


Figure 1. Frequency Response Test Setup

THIS CIRCUIT IS BASICALLY CORRECT, BUT SMALL DIFFERENCES MAY EXIST FOR ANY PARTICULAR INSTRUMENT. COMPARISON AND CROSS-CHECKING WILL ENABLE IDENTIFICATION OF NECESSARY PARTS.

— NOTES —

CONDITIONS OF DC VOLTAGE MEASUREMENT

1. LINE VOLTAGE AT 115/230 VOLTS, 50/60 Hz.
2. INPUT AT MIN
3. RANGE AT X1
4. INPUT SELECTOR AT AF
5. FREQUENCY AT 100
6. FUNCTION SELECTOR AT NOISE
7. VOLTMETER RANGE AT 300 R.M.S. VOLTS
8. BALANCE AT MAXIMUM CLOCKWISE POSITION.
9. VOLTAGES MEASURED BETWEEN INDICATED POINTS AND CHASSIS WITH VOLTMETER HAVING AN INPUT RESISTANCE OF 122 MEGOHMS. (hp MODEL 410B)

CONDITIONS OF AC VOLTAGE MEASUREMENT

1. THRU 8 SAME AS DC CONDITIONS
9. VOLTAGES MEASURED BETWEEN INDICATED POINTS WITH A 1000 OHMS/VOLT OR BETTER AC METER. ALL VOLTAGES R.M.S.

ALL CAPACITANCE VALUES IN  $\mu\text{F}$  UNLESS OTHERWISE NOTED

ALL RESISTANCE VALUES IN OHMS UNLESS OTHERWISE NOTED

1K = 1000 OHMS.

1M = 1 MEGOHM

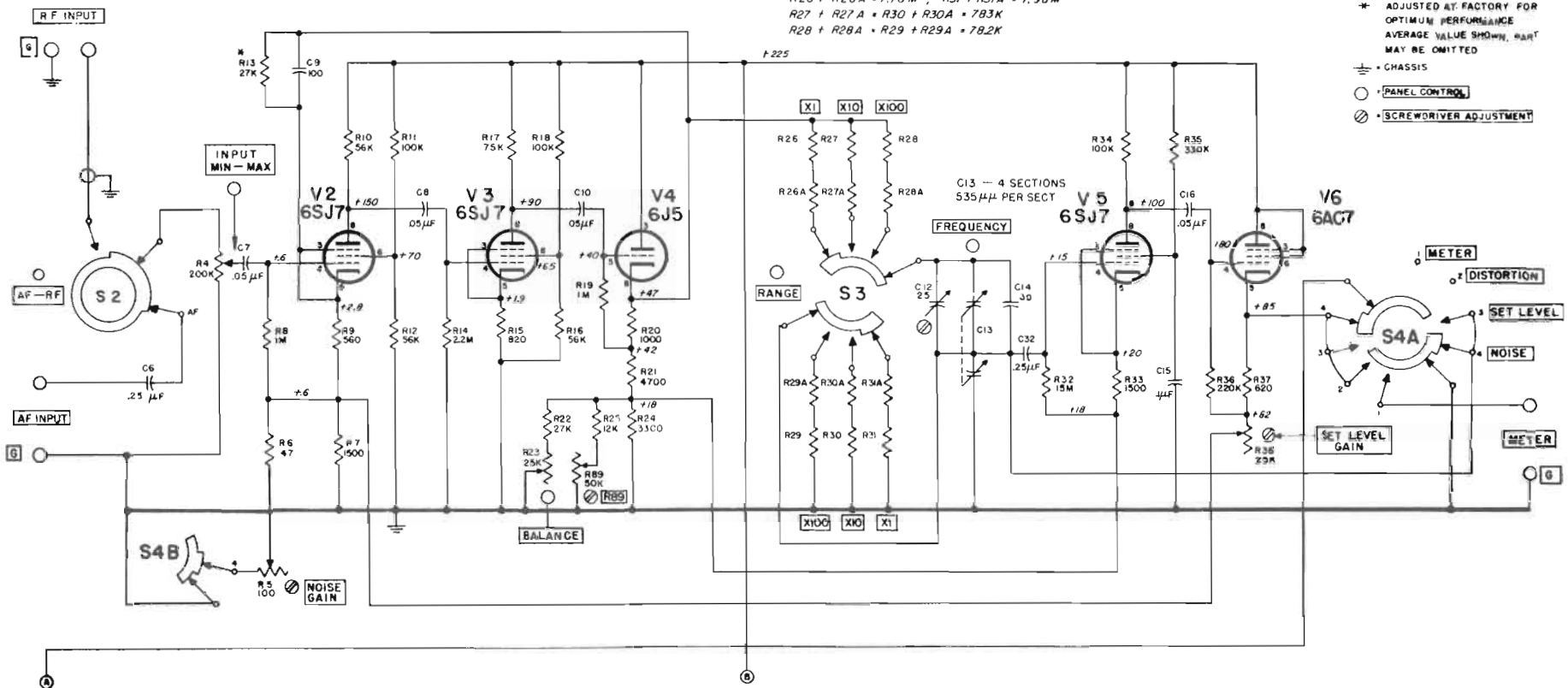
\* ADJUSTED AT FACTORY FOR OPTIMUM PERFORMANCE AVERAGE VALUE SHOWN. PART MAY BE OMITTED

⊖ = CHASSIS

○ = PANEL CONTROL

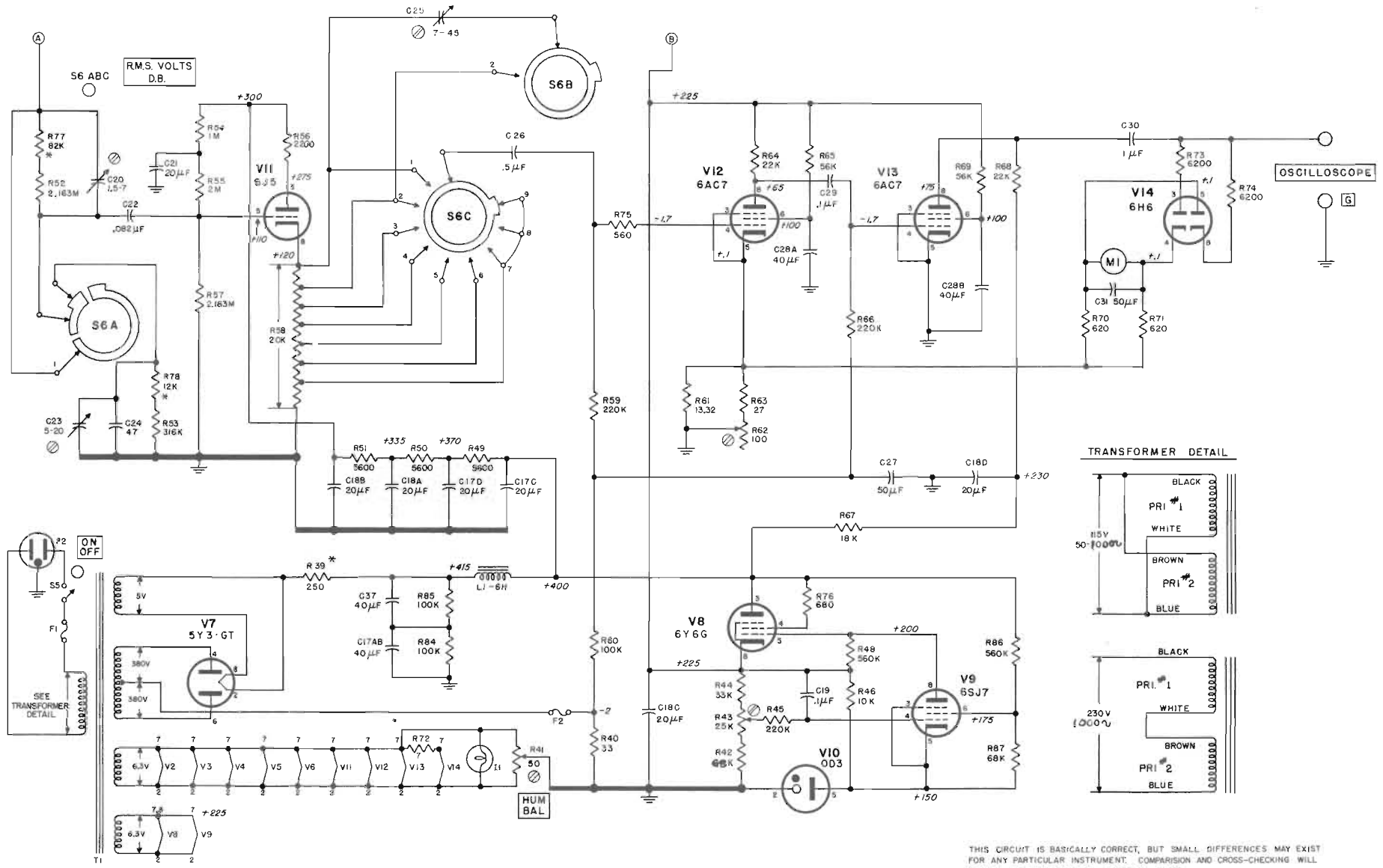
⊗ = SCREWDRIVER ADJUSTMENT

$R26 + R26A = 7.78M$ ,  $R31 + R31A = 7.98M$   
 $R27 + R27A = R30 + R30A = 783K$   
 $R28 + R28A = R29 + R29A = 78.2K$

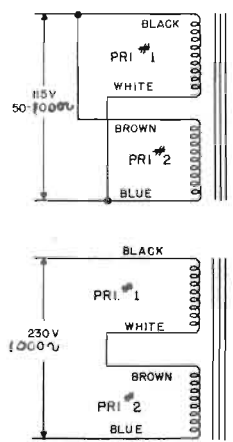


SCHMATIC DIAGRAM OF MODEL 330 B  
 AMPLIFIER & FILTER SECTION





TRANSFORMER DETAIL

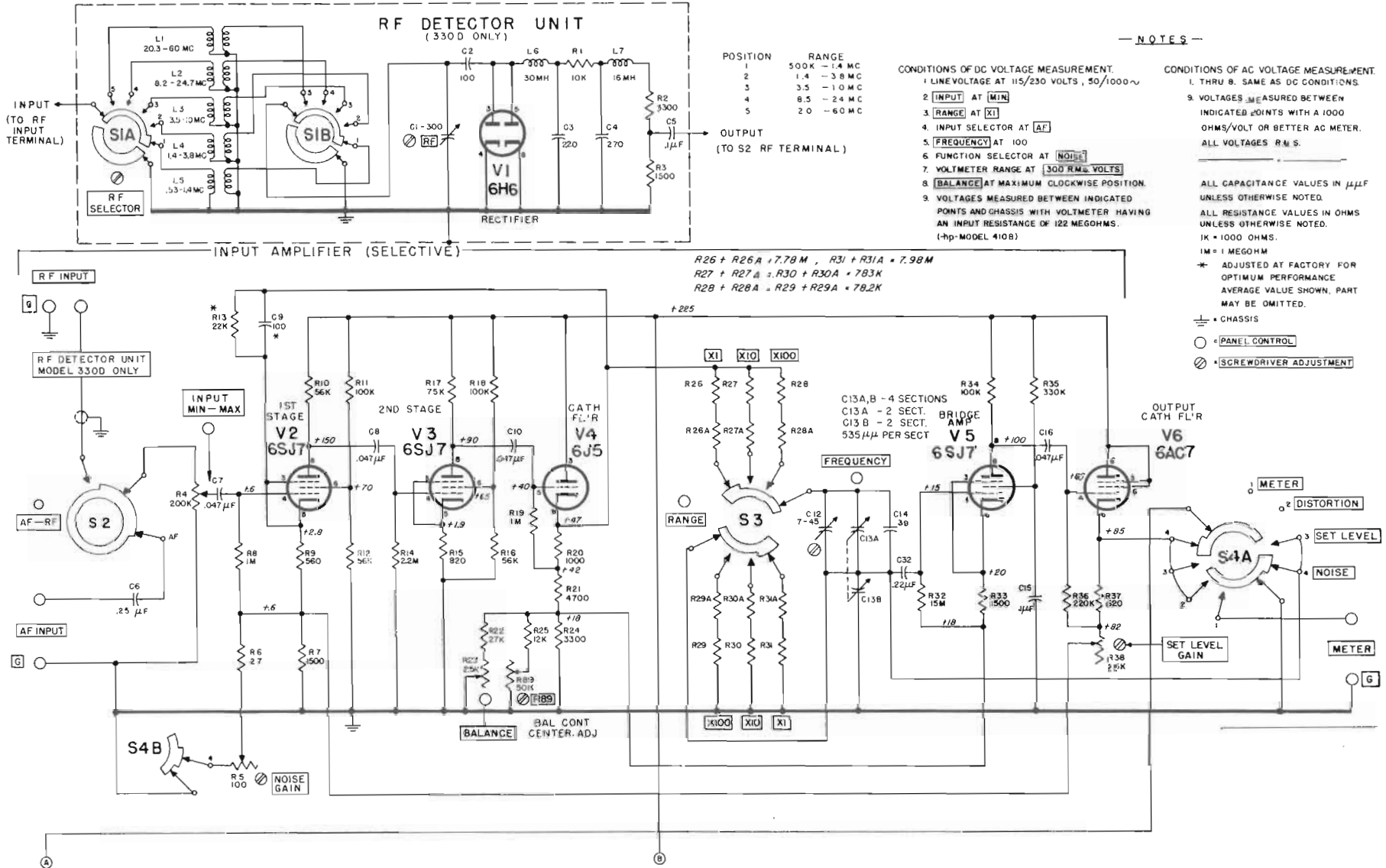


THIS CIRCUIT IS BASICALLY CORRECT, BUT SMALL DIFFERENCES MAY EXIST FOR ANY PARTICULAR INSTRUMENT. COMPARISON AND CROSS-CHECKING WILL ENABLE IDENTIFICATION OF NECESSARY PARTS.

SCHEMATIC DIAGRAM OF MODEL 330 B  
POWER SUPPLY & VOLTMETER SECTION

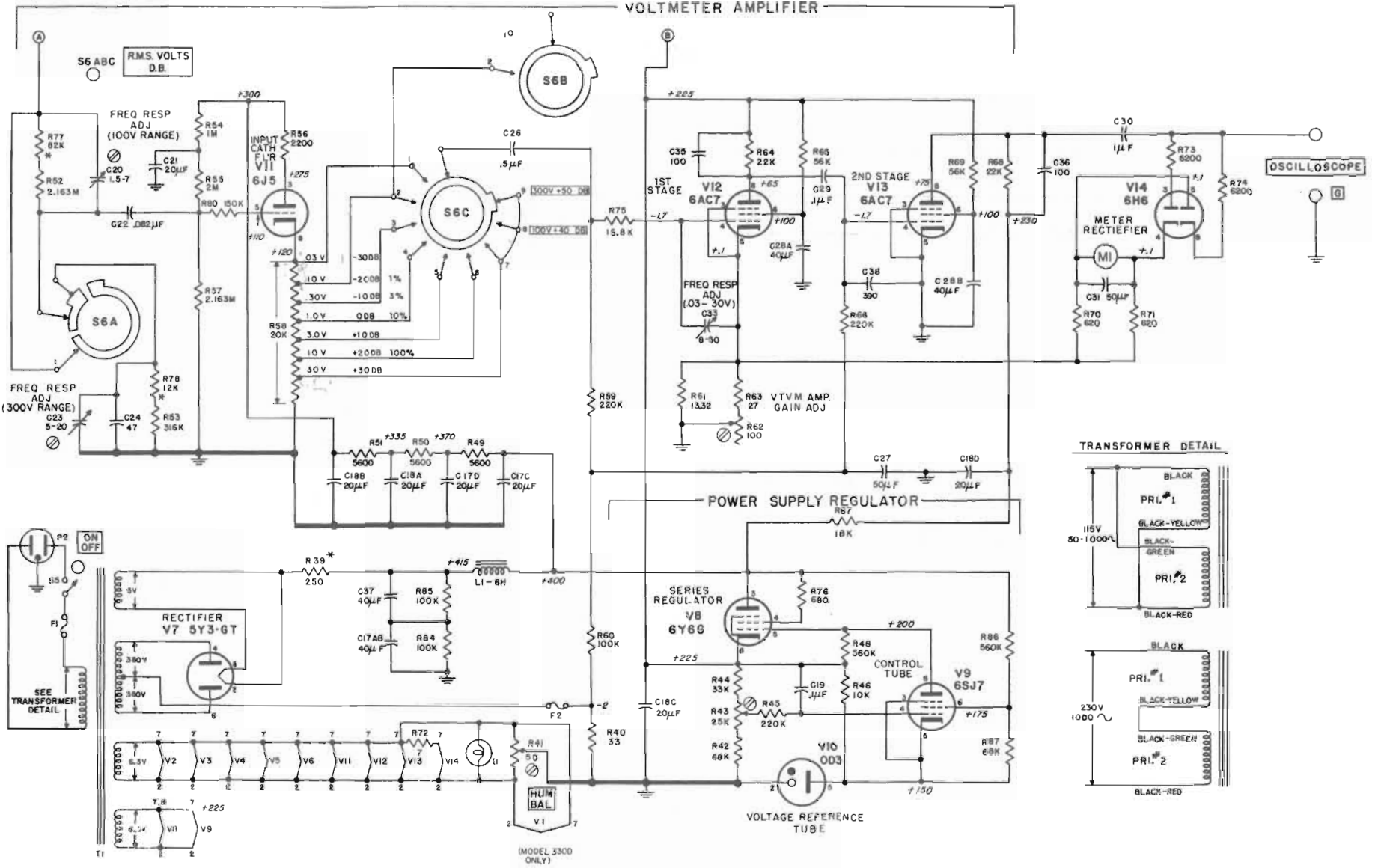
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hp MODEL 330 C/D  
AMPLIFIER & FILTER SECTION

THIS CIRCUIT IS ESSENTIALLY CORRECT, BUT SMALL DIFFERENCES MAY EXIST FOR ANY PARTICULAR INSTRUMENT. COMPARISON AND CROSS-CHECKING WILL ENABLE IDENTIFICATION OF NECESSARY PARTS.



**SCHEMATIC DIAGRAM OF MODELS 330C/D  
POWER SUPPLY & VOLTMETER SECTION**

THIS CIRCUIT IS BASICALLY CORRECT, BUT SMALL DIFFERENCES MAY EXIST FOR ANY PARTICULAR INSTRUMENT. COMPARISON AND CROSS-CHECKING WILL ENABLE IDENTIFICATION OF NECESSARY PARTS.

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330B-31E