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Errata

Title & Document Type:

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HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

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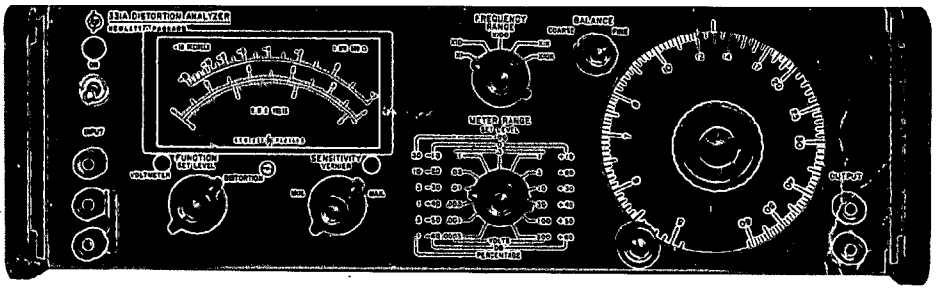
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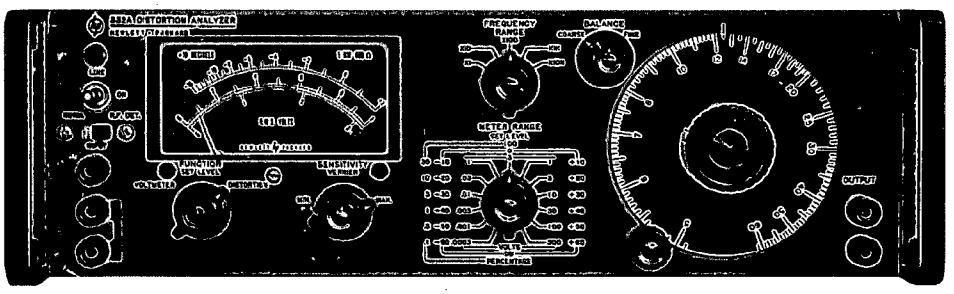
hp 331A/332A

OPERATING AND SERVICE MANUAL

DISTORTION ANALYZER

331A/332A





HEWLETT hp PACKARD

hp 331A/332A

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OPERATING AND SERVICE MANUAL

(HP Part No. 00331-90006)

MODEL 331A/332A
DISTORTION ANALYZER

SERIALS PREFIXED: 331A: 995
332A: 998

Appendix C, Manual Backdating Changes, adapts this manual to earlier instruments.

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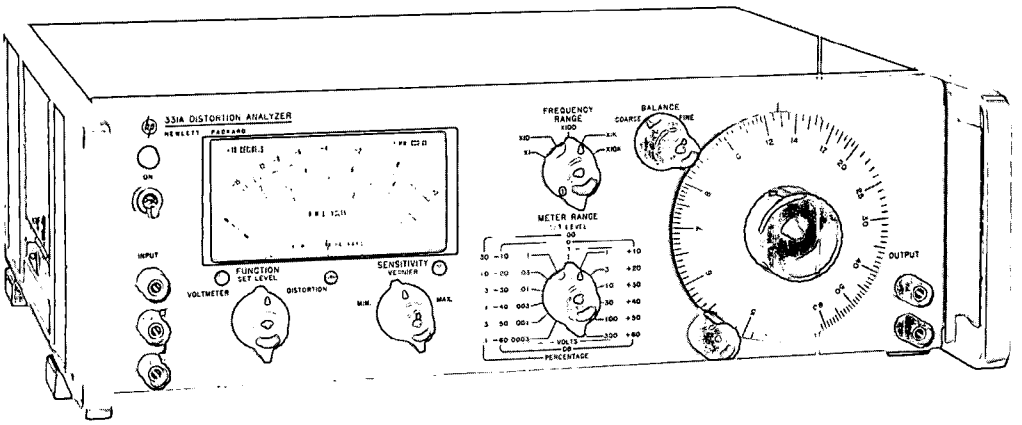
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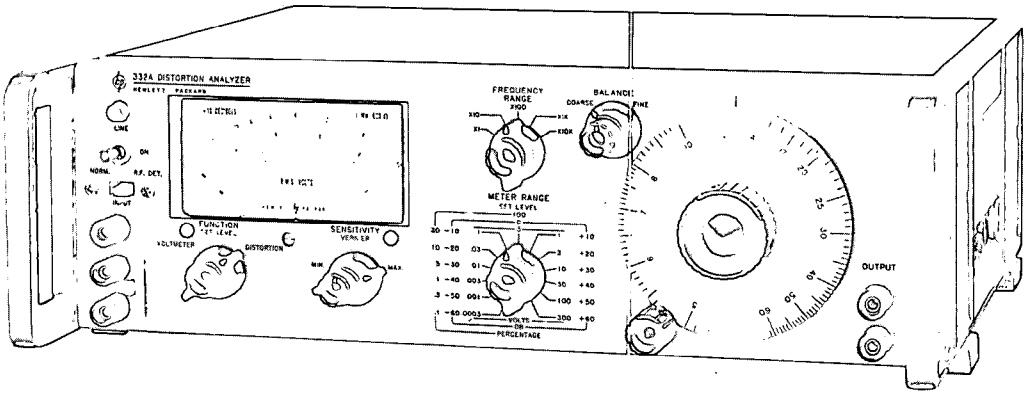
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Model 331A Distortion Analyzer



Model 332A Distortion Analyzer

Figure 1-1. Models 331A/332A Distortion Analyzers

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SECTION I

GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Hewlett-Packard Models 331A and 332A Distortion Analyzers are solid state instruments for measuring distortion and ac voltages. The Model 332A includes a high impedance AM detector which operates from 550 kHz to greater than 65 MHz.

1-3. Distortion levels of 0.1% to 100% full scale are measured in seven ranges for any fundamental frequency from 5 Hz to 600 kHz; harmonics are indicated up to 3 MHz. The high sensitivity of these instruments requires only 0.3 V rms for the 100% set level reference. An output is provided at the OUTPUT connectors for monitoring the distortion with an oscilloscope, a true rms voltmeter, or a wave analyzer. The instruments are cabable of a dc isolation voltage of 400 volts above chassis ground.

1-4. The transistorized voltmeter contained in the Model 331A and 332A can be used separately for general purpose voltage and gain measurements. The voltmeter has a frequency range of 5 Hz to 3 MHz (20 Hz to 500 kHz for 300 μV range) and a voltage range of 300 μV to 300 V rms full scale.

1-5. The AM detector included in the Model 332A is a broadband dc restoring peak detector consisting of a semiconductor diode and filter circuit. AM distortion levels as low as 0.3% can be measured on a 3 V to 8 V rms carrier modulated 30% in the standard broadcast band, and lower than 1% distortion can be measured at the same level of the carrier up to 65 MHz.

1-6. ACCESSORY FEATURES.

1-7. The accessory available with the 331A and 332A Distortion Analyzers is a voltage divider probe, -hp- Model No. 10001A. The features of the probe are:

a. 10 megohm shunted by 10 pF.
b. 10:1 attenuation dc to 30 MHz bandwidth.
c. 2% division accuracy.
d. 600 V peak input.
e. 5 nsec rise-time.

1-8. OPTION.

1-9. Option 01 is a standard -hp- Model 331A or 332A with a special meter and meter amplifier, compensated to permit response to VU (volume units) characteristics.

1-10. INSTRUMENT IDENTIFICATION.

1-11. Hewlett-Packard uses a two-section serial number. The first section (prefix) identifies a series of instruments. The last section (suffix) identifies a particular instrument with the series. If a letter is included with the serial number, it identifies the country in which the instrument was manufactured. If the serial prefix of you instrument differs from the one on the title page of this manual, a change sheet will be supplied to make this manual compatable with newer instruments. All correspondence with Hewlett-Packard should include the complete serial number.

Table 1-1. Specifications

MODEL 331A

DISTORTION MEASUREMENT RANGE
Any fundamental frequency, 5 Hz to 600 kHz. Distortion levels of 0.1% to 100% are measured full scale in 7 ranges.

INPUT LEVEL FOR DISTORTION MEASUREMENTS
0.3 V rms for 100% set level (up to 300 V may be attenuated to set level reference).

DISTORTION MEASUREMENT ACCURACY
Harmonic measurement accuracy (full scale).

Fundamental Input Less Than 30 V

RANGE	±3%	±6%	±12%
100% to 0.3%	10 Hz 1 MHz	10 Hz 3 MHz	
0.1%	30 Hz 300 kHz	20 Hz 500 kHz	10 Hz ~~1.2 MHz~~ 600KHz

CH 3

Fundamental Input Greater Than 30 V

RANGE	±3%	±6%	±12%
100% to 0.3%	10 Hz 300 kHz	10 Hz 500 kHz	10 Hz 3 MHz
0.1%	30 Hz 300 kHz	20 Hz 500 kHz	10 Hz 1.2 MHz

Elimination Characteristics:
Fundamental Rejection >80 dB
Second Harmonic Accuracy for a fundamental of:
5 Hz to 20 Hz : better than +1 dB
20 Hz to 20 kHz: better than ±0.6 dB
20 kHz to 100 kHz: better than -1 dB
100 kHz to 300 kHz: better than -2 dB
300 kHz to 600 kHz: better than -3 dB

Distortion Introduced by Instrument:
>-70 dB from 5 Hz to 200 kHz
>-64 dB from 200 kHz to 600 kHz

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Table 1-1. Specifications (Cont'd)

DC ISOLATION
Signal ground may be ±400 Vdc from external chassis.

VOLTMETER RANGE
300 μV to 300 V rms full scale (13 ranges), 10 dB per range.

VOLTMETER FREQUENCY RANGE
5 Hz to 3 MHz (300 μV range: 20 Hz to 500 kHz).

VOLTMETER ACCURACY:

RANGE	±2%	±5%
300 μV	30 Hz 300 kHz	20 Hz 500 kHz
1 mV to 30 V	10 Hz 1 MHz	5 Hz 3 MHz
100 V to 300 V	10 Hz 300 kHz	5 Hz 500 kHz

Meter indication is proportional to average value of waveform.

FREQUENCY CALIBRATION ACCURACY
Better than ± 5% from 5 Hz to 300 kHz
Better than ±10% from 300 kHz to 600 kHz

INPUT IMPEDANCE
Distortion Mode: 1 MΩ ±5% shunted by <70 pF.
Voltmeter Mode:
1 MΩ ±5% shunted by <30 pF (331A only),
1 MΩ ±5% shunted by <35 pF (332A only),
1 to 300 V ranges; 1 MΩ ±5% shunted by <70 pF, 300 μV to 0.3 V ranges.

NOISE MEASUREMENTS
Voltmeter residual noise on the 300 μV range: <25 μV rms terminated in shielded 600 Ω; <30 μV rms terminated in shielded 100 kΩ.

OUTPUT 20Hz - 600KHz
0.1 V rms ±0.01 V open circuit for full scale meter deflection; 0.05 V rms ±0.005 V into 2 kΩ for full scale meter deflection.

POWER SUPPLY
115 V or 230 V ±10%, 48 to 440 Hz, approximately 4 watts. Terminals are provided for external battery supply. Positive and negative voltages between 28 V and 50 V are required. Current drain from each voltage is 40 mA.

MODEL 332A

Same as Model 331A except as indicated below:

AM DETECTOR
High impedance dc restoring peak detector with semi-conductor diode operates from 550 kHz to greater than 65 MHz. Broadband input. Maximum input; 40 V p-p ac or 40 V peak transient.

CARRIER FREQUENCY
550 kHz to 1.6 MHz: Distortion introduced by detector is <0.3% for 3 to 8 volt carriers modulated 30%.

1.6 MHz to 65 MHz: Distortion introduced by detector is <1% for 3 to 8 volts rms carriers modulated 30%.

NOTE

Distortion measurement at carrier levels as low as 1 volt may be made with reduced accuracy.

OPTION 01

Indicating meter has VU characteristics conforming to FCC Requirements for AM, FM, and TV broadcasting.

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SECTION II
INSTALLATION

2-1. INSPECTION.

2-2. This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage in transit. Also check for supplied accessories, and test the electrical performance of the instrument using the procedure outlined in Section V. If there is damage or deficiency, see the warranty on the inside front cover of this manual.

2-3. POWER REQUIREMENTS.

2-4. The Model 331A and 332A will operate from either 115 or 230 Vac, 48 to 440 Hz. The instruments can be easily converted from 115 to 230 volt operation by changing the position of the slide switch, located on rear panel, so that the designation appearing on the switch matches the nominal voltage of the power source. A 1/16 ampere, slow-blow fuse is used for 115 V operation; a 1/32 ampere slow-blow fuse is used for 230 V operation. The instruments can be battery operated by connecting two 28 to 50 V batteries (rated at 40 milliamperes) to the battery terminals on the rear panel.

2-5. THREE-CONDUCTOR POWER CABLE.

2-6. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground wire.

2-7. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong adapter and connect the green pigtail on the adapter to ground.

2-8. INSTALLATION.

2-9. The 331A and 332A are fully transistorized; therefore, no special cooling is required. However, the instruments should not be operated where the ambient temperature exceeds 55°C (131°F).

2-10. RACK/BENCH INSTALLATION.

2-11. The 331A and 332A are initially shipped as bench-type instruments (unless ordered specifically as a rack-type) with plastic feet and a tilt stand in place. Conversion to a rack-mounted instrument can be accomplished by using the rack mounting kit and instructions furnished with your instrument.

2-12. REPACKAGING FOR SHIPMENT.

2-13. The following is a general guide for repackaging for shipment. If you have any questions, contact your local -hp- Sales and Service Office.

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or for repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be accomplished; include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number and serial number.

a. Place instrument in original container if available. If original container is not available, a suitable one can be purchased from your nearest -hp- Sales and Service Office.

If original container is not used,

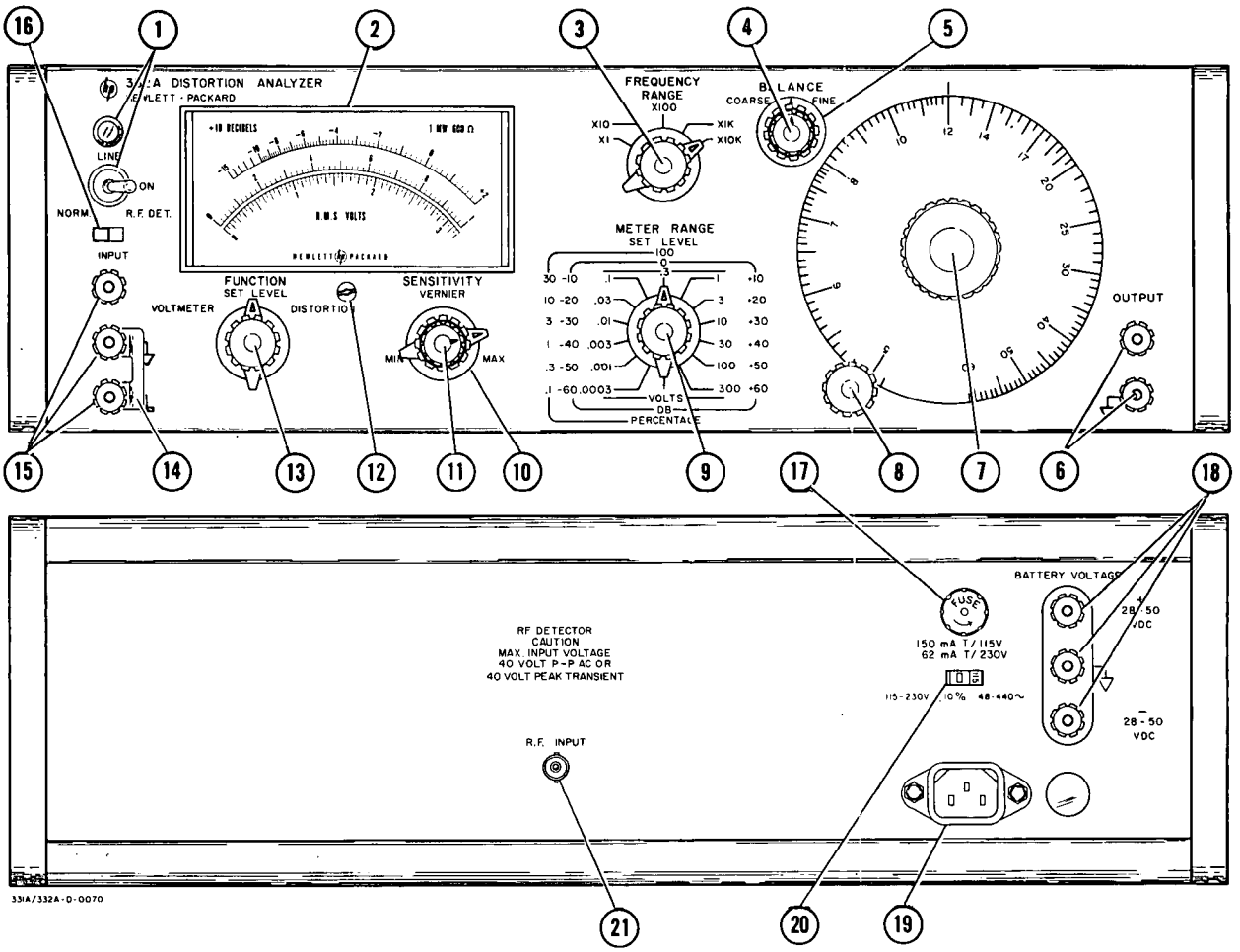
b. Wrap instrument in heavy paper or plastic before placing in an inner container.

c. Use plenty of packing material around all sides of instrument and protect panel faces with cardboard strips.

d. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

e. Mark shipping container with "DELICATE INSTRUMENT," "FRAGILE" etc.

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(1) LINE switch turns instrument ac power on. Pilot lamp glows when instrument is turned ON.

(2) Meter indicates distortion level and voltage levels of input signals.

(3) FREQUENCY RANGE switch selects frequency range which corresponds to fundamental of input signal.

(4) COARSE BALANCE control provides coarse adjustment for balancing Wien bridge circuit.

(5) FINE BALANCE control provides vernier adjustment for balancing Wien bridge circuit.

(6) OUTPUT connectors provide means of monitoring output of meter circuit with an oscilloscope, a true rms voltmeter, or a wave analyzer.

(7) Frequency dial tunes Wien bridge to fundamental of input signal.

(8) Frequency vernier control provides fine adjustment of Frequency dial.

(9) METER RANGE switch selects full scale range of meter in percent, dB, and rms volts.

(10) SENSITIVITY selector provides 0 to 50 dB attenuation of input signal in 10 dB steps in SET LEVEL and DISTORTION functions.

(11) SENSITIVITY VERNIER control provides fine adjustment of sensitivity setting.

(12) Mechanical zero adjust provides mechanical zero adjustment of meter.

(13) FUNCTION switch selects mode of operation of instrument.

(14) Shorting bar connects circuit ground (⏚) to chassis ground (⏚).

(15) INPUT terminals provide connections for input signals.

(16) NORM-RF DET switch (Model 332A only) selects front panel INPUT connectors or rear panel RF INPUT connector.

(17) FUSE provides current overload protection for instrument circuits.

(18) BATTERY VOLTAGE (+28 to +50 VDC and -28 to -50 VDC) terminals provide connections for external batteries.

(19) AC power connector provides input connections for ac power.

(20) Line voltage (115 V/230 V) switch sets instrument to operate from 115 V or 230 V ac.

(21) RF INPUT connector (Model 332A only) provides input connection for AM RF carrier input signal.

Figure 3-1. Front and Rear Panel Description

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SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. The Models 331A and 332A Distortion Analyzers measure total harmonic distortion of fundamental frequencies from 5 Hz to 600 kHz; harmonics up to 3 MHz are included. The sharp elimination characteristics (>80 dB), the low level of instrument induced distortion, and the meter accuracy of these instruments result in highly accurate measurement of low level harmonic distortion.

3-3. An rms calibrated voltmeter is inherent in the 331A and 332A. The voltmeter provides a full scale sensitivity of 300 μvolts rms (residual noise <25 μvolts). The voltmeter frequency range is from 5 Hz to 3 MHz except on the 0.0003 volt range, which is from 20 Hz to 500 kHz.

3-4. CONTROLS AND INDICATORS.

3-5. Figure 3-1 illustrates and describes the function of all front and rear panel controls, connectors, and indicators. The description of each component is keyed to the drawing included within the figure.

3-6. GENERAL OPERATING INFORMATION.

3-7. INPUT CONNECTIONS.

3-8. A signal source can be connected to the 331A and 332A through twisted pair leads or a shielded cable with banana plug connectors. Keep all test leads as short as possible to avoid extraneous pickup from stray ac fields. When measuring low-level signals, avoid ground loop currents by connecting only the 331A or 332A Distortion Analyzer directly to power-line ground through a NEMA (three-prong) connector. Connect all other instruments to the power source through a three-prong to two-prong adapter and leave the pigtail disconnected. Both the 331A and 332A have a dc isolation of ±400 Vdc from the external chassis.

WARNING

WHEN THE INSTRUMENT IS OPERATED IN A FLOATING CONDITION, THE SET SCREWS IN THE CONTROL KNOBS WILL BE AT THE FLOATED POTENTIAL. TO PROTECT OPERATING PERSONNEL, ENSURE THAT THE SET SCREW HOLES ARE FILLED WITH AN INSULATING MATERIAL SUCH AS G.E. SILICON RUBBER, RTV-108 (-hp- PART NO. 0470-0304).

3-9. VOLTMETER CHARACTERISTICS.

3-10. The RMS VOLTS markings on the meter face are based on the ratio between the average and effective (rms) values of a pure sine wave. The ratio of average to effective values in a true sine wave is approximately 0.9 to 1. When the meter is used to measure complex waves, the voltage indicated may not be the rms value of the signal applied. This deviation of meter indication exists because the ratios of average to effective values are usually not the same in a complex wave as in a sine wave. The amount of deviation depends on the magnitude and phase relation between the harmonics and fundamental frequency of the signal applied. Table 3-1 shows the deviation of the meter indication of a sine wave partly distorted by harmonics. As indicated in the table, harmonic content of less than approximately 10% results in very small errors.

Table 3-1. Effect of Harmonics on Voltage Measurements

Input Voltage Characteristics	True RMS Value	Meter Indication
Fundamental = 100	100	100
Fundamental +10% 2nd harmonic	100.5	100
Fundamental +20% 2nd harmonic	102	100 - 102
Fundamental +50% 2nd harmonic	112	100 - 110
Fundamental +10% 3rd harmonic	100.5	96 - 104
Fundamental +20% 3rd harmonic	102	94 - 108
Fundamental +50% 3rd harmonic	112	90 - 116

NOTE

This chart is universal in application since these errors are inherent in all average-responding voltage-measuring instruments.

3-11. In distortion measurements where the fundamental frequency is suppressed and the remainder of the signal is measured, the reading obtained on an average-responding meter may deviate from the true total rms value. When the residual wave contains many inharmonically related sinusoids, the maximum error in the distortion reading is about 11% low for distortion levels below 10%.

Measured Distortion	Maximum Error in Meter Indication	Total Distortion
2.5%	+0.11 x 0.025 = 0.00027	0.025 + 0.0027 = 0.0277 or 2.8%

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This example represents the maximum possible error, and in most cases the error is less. In distortion measurements, the reading of an average-responding meter is sufficiently close to the rms value to be satisfactory for most applications.

3-12. OUTPUT CHARACTERISTICS.

3-13. The OUTPUT terminals provide a 0.1 V rms open circuit output for full scale meter deflection. These terminals can be used to monitor the output signal with an oscilloscope, a true rms voltmeter, or a wave analyzer. The combinations of the distortion meter and oscilloscope provides more significant information about the device under test than the expression of distortion magnitude alone. Information obtained from the oscilloscope pattern is specific and reveals the nature of the distortion that sometimes occurs at such low levels that it is difficult to detect in the presence of hum and noise. The impedance at the OUTPUT terminals is 2000 ohms; therefore, capacitive loads greater than 50 pF should be avoided to maintain the accuracy of meter readings.

3-14. OPERATING PROCEDURES.

3-15. INSTRUMENT TURN-ON.

a. If line voltage is to be used, set 115-230 Vac switch to coincide with voltage. Turn LINE switch to ON position. Pilot lamp will glow, indicating application of primary power.

b. If batteries are to be used, connect both a +28 to +50 V and -28 to -50 V battery (or other dc source) to + and - battery terminals, respectively. (The LINE switch and pilot lamp are not in the circuit when batteries are used; therefore, an external switch may be used to provide a convenient means for disconnecting the batteries). When a dc power source is used, check the -25 V power supply output (any violet lead). If the output is not -25 V ±0.5 V, adjust the power supply according to the procedure in Paragraph 5-24.

3-16. ADJUSTMENT OF METER MECHANICAL ZERO.

3-17. The meter is properly zero-set when the pointer rests over the zero calibration mark and the instrument is in its normal operating environment and is turned off. Zero-set the meter as follows to obtain maximum accuracy and mechanical stability:

a. Turn instrument on and allow it to operate for at least 20 minutes, to let meter movement reach normal operating temperature.

b. Turn instrument off and allow 30 seconds for all capacitors to discharge.

c. Rotate zero adjustment screw clockwise until pointer is left of zero and moving upscale.

d. Continue rotating screw clockwise; stop when pointer is exactly at zero.

e. When pointer is exactly over zero, rotate adjustment screw slightly counterclockwise to relieve tension on pointer suspension. If pointer moves off zero, repeat steps c through e, but make counterclockwise rotation less.

3-18. DISTORTION MEASUREMENT.

CAUTION

DO NOT EXCEED THE INPUT VOLTAGES LISTED BELOW TO PREVENT BLOWING FUSE F2: (See Table 5-8 for symptoms of blown-fuse.)

VOLTMETER FUNCTION -1 V RANGE AND BELOW, AND DISTORTION ANALYZER FUNCTION-MAXIMUM SENSITIVITY.

1. 300 V ABOVE 100 Hz
2. 50 V ABOVE 1 KHZ

IF LOW FREQUENCIES ARE NOT TO BE MEASURED, C1 MAY BE REPLACED WITH A SMALLER CAPACITOR, AND THE VOLTAGE LIMITS OF F2 MAY BE RAISED ACCORDINGLY.

a. Turn instrument on and mechanically zero meter according to procedure in Paragraphs 3-15 and 3-16.

b. Set NORM-R.F. DET. switch to NORM.

c. Set FUNCTION switch to SET LEVEL.

d. Set SENSITIVITY selector to MIN. position, and rotate VERNIER control maximum counterclockwise.

NOTE

The bandwidth of the SENSITIVITY selector is reduced in the two extreme counterclockwise positions (positions used with an input signal greater than 30 V).

e. Set METER RANGE switch to SET LEVEL, and set BALANCE COARSE and FINE controls to center position.

f. Connect signal to be measured to 331A/332A INPUT terminals.

WARNING

REMOVE SHORTING STRAP BETWEEN CIRCUIT GROUND (⏚) AND CHASSIS GROUND (⏚) TERMINALS ON FRONT PANEL INPUT TERMINAL WHEN MEASURING DISTORTION BETWEEN TWO POINTS WHICH ARE DC OFFSET FROM GROUND POTENTIAL.

g. Set SENSITIVITY selector to obtain meter indication greater than 1/3 full scale.

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h. Adjust SENSITIVITY VERNIER for full scale meter indication if making distortion measurement in percent; if making distortion measurement in dB, adjust SENSITIVITY VERNIER for 0 dB meter indication.

NOTE

If unable to adjust for full scale or 0 dB indication (which indicates input signal is below 0.3 volts), set METER RANGE selector down-scale. Use this new setting as the 100% or 0 dB SET LEVEL position, thus making the next range 30% or -10 dB etc.

i. Set FREQUENCY RANGE switch and frequency dial to fundamental frequency of input signal.

j. Set FUNCTION switch to DISTORTION.

k. Adjust frequency dial vernier and BALANCE COARSE and FINE controls for minimum meter indication. Set METER RANGE switch down-scale as necessary to keep meter indication on scale.

NOTE

Because of the high sensitivity and narrow fundamental rejection notch, pressure applied to the top cover may cause the null to shift. This is caused by small capacitive changes between the Wien bridge and case. Accuracy of reading is not degraded, however, if the pressure is constant and the bridge is rebalanced.

l. Repeat step k until no further reduction in meter indication can be obtained.

m. Observe distortion either in percentage or dB, as indicated by meter deflection and METER RANGE switch setting. For example, if meter indicates 0.4 and METER RANGE setting is 1%, distortion measured is 0.4% of fundamental. Similarly, if meter indicates -6 dB and METER RANGE setting is -40 dB, distortion measured is -46 dB from fundamental.

NOTE

The accuracy of distortion measurements is affected by the frequency stability of the input signal. An inaccuracy in distortion indications occurs when the frequency drift of the input signal exceeds the bandwidth of the rejection curve.

p. If desired, rms voltage of input signal can be measured by setting FUNCTION switch to VOLTMETER, and setting METER RANGE switch to obtain an on-scale indication.

3-19. DISTORTION AND NOISE MEASUREMENT OF AM RF CARRIERS (332A ONLY).

CAUTION

DO NOT EXCEED MAXIMUM INPUT VOLTAGES LISTED ON REAR PANEL.

3-20. DISTORTION MEASUREMENT.

a. Turn instrument on and mechanically zero meter according to procedure in Paragraphs 3-15 and 3-16.

b. Set NORM. -R. F. DET. switch to R. F. DET.

c. Connect input signal to R. F. INPUT terminal on rear panel.

d. Refer to Paragraph 3-18 for distortion measurement procedures.

NOTE

If no meter deflection can be obtained with an RF input, diode A4CR1 should be checked. A spare diode is located on the outside of the A4 shield.

3-21. NOISE MEASUREMENT.

a. Perform steps a through c of Paragraph 3-20.

b. Set modulation of carrier to 100%, using a modulating frequency between 20 Hz and 20 kHz.

c. Set FUNCTION switch to SET LEVEL, and set METER RANGE to SET LEVEL.

d. Adjust SENSITIVITY controls for 0 dB indication on meter.

e. Reduce modulation of carrier to 0%.

f. Leave FUNCTION switch in SET LEVEL position, and adjust METER RANGE switch for on-scale meter indication.

g. Noise level of carrier is algebraic sum of meter reading and METER RANGE setting.

h. This same general procedure can be used to measure noise in an FM carrier when an external discriminator is substituted for the AM detector.

3-22. VOLTAGE MEASUREMENT.

a. Turn instrument on and mechanically zero meter according to procedure in Paragraphs 3-15 and 3-16.

b. Set NORM. -R. F. DET. switch to NORM.

c. Set FUNCTION switch to VOLTMETER.

d. Set METER RANGE switch to a range exceeding amplitude of signal to be measured.

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e. Connect signal to be measured to INPUT terminals.

f. Set METER RANGE switch to give a reading as close to full scale as possible, and observe meter indication.

g. The dB scale of the 331A/332A is calibrated in dBm, such that 0 dBm = 1 milliwatt dissipated by 600 ohms. Therefore, a dBm measurement must be made across 600 ohms. However, dB measurements across other impedances can be converted to dBm by use of the Impedance Correction Graph of Figure 3-2. For example: To convert a -30 dB reading across 200 ohms to dBm, locate the 200 ohm impedance line at the bottom of the graph. Follow the impedance line to the heavy black line, and read the meter correction at that point. The correction for 200 ohms is +5 dBm; thus the corrected reading is -25 dBm.

NOTE

When dBm measurements are made, the dB markings on the METER RANGE switch must each be lowered by 10. That is, the dB marking for the 0.3 V range becomes -10 dBm, 1 V range becomes 0 dBm, 3 V range becomes +10 dBm etc. If the other dB markings are used, the dBm readings will be 10 dBm high.

3-23. USE OF OUTPUT TERMINALS.

3-24. In VOLTMETER and SET LEVEL functions, the 331A/332A can be used as a low distortion, wideband amplifier. A portion of the meter input (0.1 V rms open circuit for full scale meter deflection) is provided at the OUTPUT terminals.

3-25. In DISTORTION function, the distortion (0.1 V rms open circuit for full scale deflection) is provided at the OUTPUT terminals for monitoring purposes.

3-26. 331A/332A WITH OPTION 01.

3-27. Operating procedures for the 331A/332A with Option 01 are the same as for the standard instrument. The only difference between the standard and optional instrument is that the Option 01 has a special meter and meter amplifier which is compensated to respond to VU (volume unit) characteristics.

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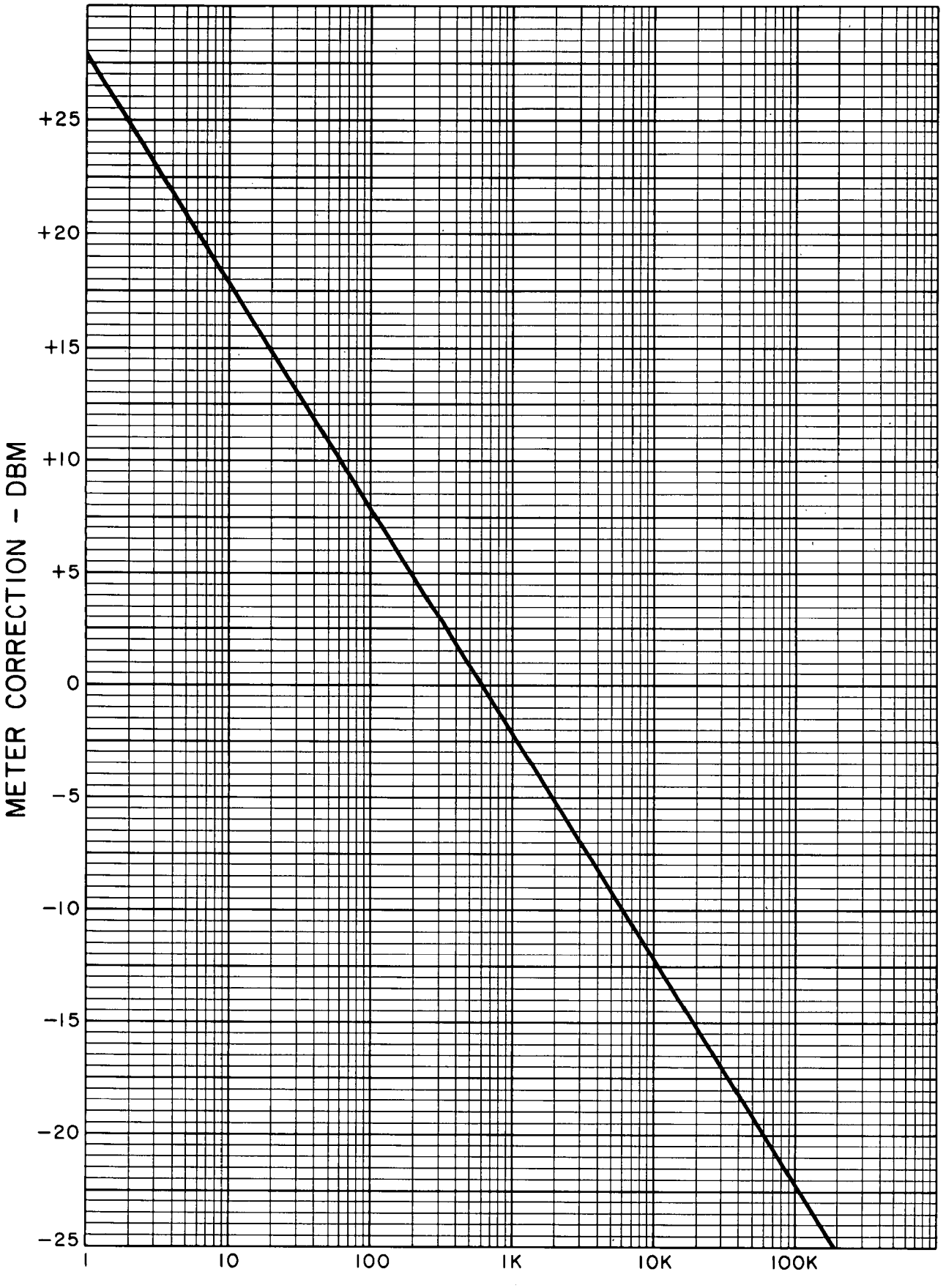


Figure 3-2. Impedance Correction Graph

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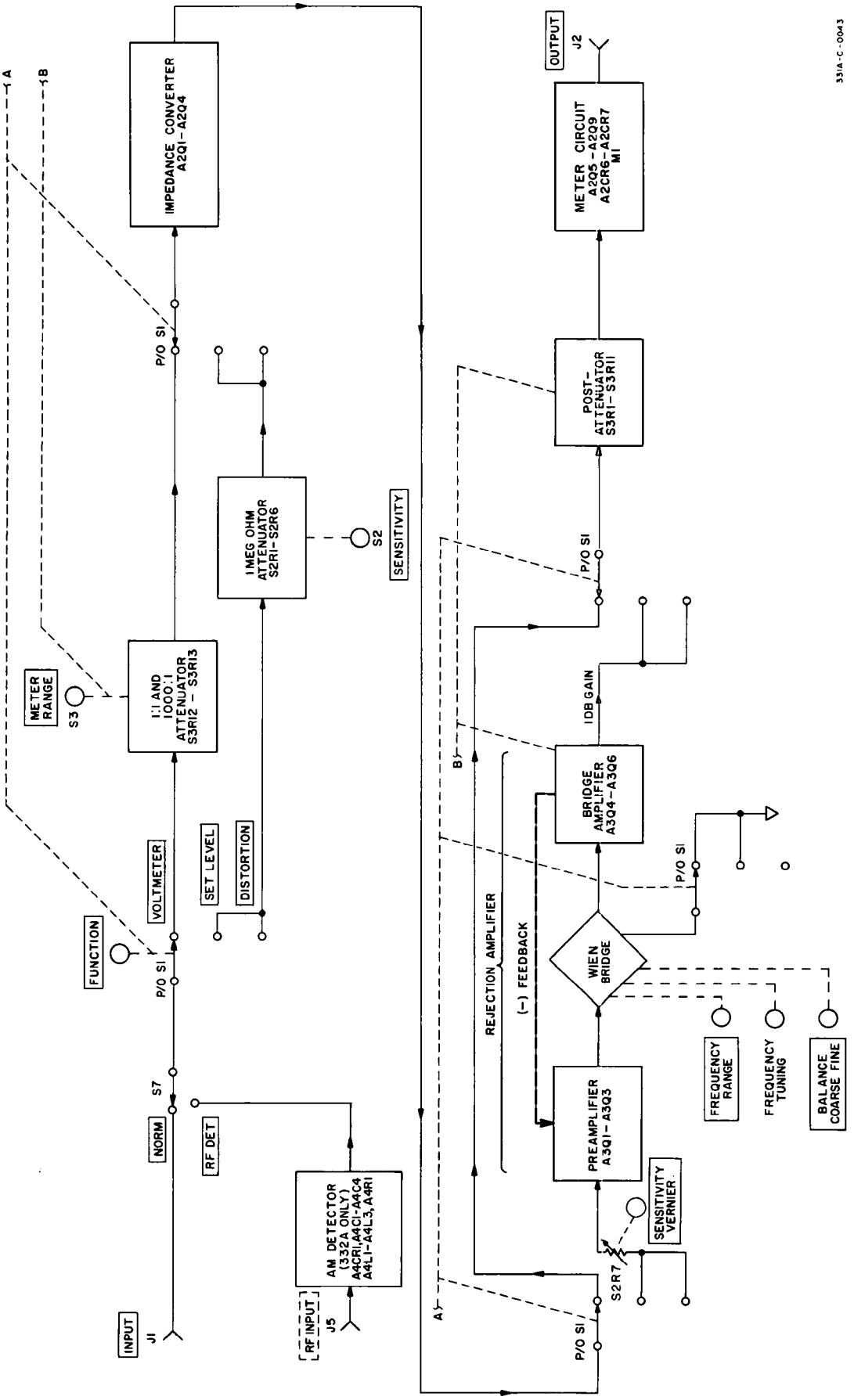


Figure 4-1. Model 331A and 332A Block Diagram

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SECTION IV
THEORY OF OPERATION

4-1. OVERALL DESCRIPTION.

4-2. Models 331A and 332A Distortion Analyzers include an impedance converter circuit, a rejection amplifier, a metering circuit, and a power supply circuit. In addition to these four circuits, the Model 332A contains an AM detector circuit. A block diagram of the instrument is shown in Figure 4-1. The impedance converter provides a low noise input circuit with a high source impedance independent of signal impedance placed at the input terminals. The rejection amplifier rejects the fundamental frequency of an input signal and passes the remaining frequency components on to the metering circuit for measuring distortion. The metering circuit provides visual indications of distortion and voltage levels on the front panel meter M1. The AM detector circuit (Model 332A only) detects the modulating signal from the RF carrier and filters any RF components from the modulating signal before it is applied to the impedance converter circuit.

4-3. BLOCK DIAGRAM DESCRIPTION.

(Refer to Figure 4-1.)

4-4. DISTORTION MEASURING OPERATION.

4-5. In the distortion measuring mode of operation, the input signal is applied to the impedance converter circuit (Assembly A2) through the FUNCTION selector, S1, and the one megohm attenuator. The attenuator is a voltage divider network which provides 50 dB attenuation in 10 dB steps. The desired level of attenuation is selected by the SENSITIVITY selector, S2. The impedance converter circuit provides an impedance conversion and unity gain between the instrument input terminals and the input of the rejection amplifier.

4-6. The rejection amplifier consists of a preamplifier, a Wien bridge, and a bridge amplifier circuit. The SENSITIVITY VERNIER control, at the input of the preamplifier circuit, provides a set level signal to obtain full scale readings on meter M1 for any input voltage level. With the FUNCTION selector in the SET LEVEL position, a ground is applied to the Wien bridge circuit to allow a signal reference level to be set up on the meter M1 in the metering circuit. With the FUNCTION selector in the DISTORTION position, the Wien bridge is used as an interstage coupling network between the preamplifier and bridge amplifier circuits. The Wien bridge is tuned and balanced to reject the fundamental frequency of the applied input signal. The remaining frequency components are passed on to the bridge amplifier circuit and are measured as distortion by the metering circuit. Negative feedback from the bridge amplifier to the preamplifier narrows the rejection response of the Wien bridge circuit.

4-7. The output of the rejection amplifier (1 dB gain) is applied to the metering circuit through the post-attenuator. The post-attenuator is used to limit the input signal level applied to the metering circuit to 1 mV for full scale deflection. The metering circuit sensitivity is increased to 300 μV for full scale deflection on the 0.0003 V range. The metering circuit provides a visual indication of the distortion level in the input signal. In addition to the visual indication provided by the meter M1, the OUTPUT terminals provide a means of monitoring the distortion with an oscilloscope, a true rms voltmeter, or a wave analyzer.

4-8. DISTORTION MEASUREMENT IN AM CARRIERS.

4-9. The Model 332A Distortion Analyzer contains an AM detector circuit for measuring envelope distortion in AM carriers. The input signal is applied to the input of the AM detector circuit where the modulating signal is recovered from the RF carrier. The signal is then applied to the impedance converter circuit through the one megohm attenuator. The signal then goes through the same circuits previously described in the distortion measuring operation.

4-10. VOLTMETER OPERATION.

4-11. In the voltmeter mode of operation, the input signal is applied to the impedance converter circuit through the 1:1 and 1000:1 attenuator. The 1:1 attenuation ratio is used in the 0.0003 to 0.3 VOLTS positions of the METER RANGE switch S3, and the 1000:1 attenuation ratio is used in the 1 to 300 VOLTS positions. With the FUNCTION selector in the VOLTMETER position, the output of the impedance converter bypasses the rejection amplifier and is applied to the metering circuit through the post-attenuator and METER RANGE selector. In the voltmeter mode, metering circuit sensitivity is increased from 1 mV for full scale deflection to 300 μV on the 0.0003 V range, the same as it was in the distortion mode of operation. The function of the post-attenuator and metering circuit is the same for the voltmeter mode as for the distortion mode.

4-12. DETAILED CIRCUIT DESCRIPTION.

4-13. IMPEDANCE CONVERTER CIRCUIT.

(Refer to Figure 7-1.)

4-14. The input signal to the distortion analyzer is applied to the impedance converter circuit through the 1:1 and 1000:1 attenuator, S3R12, in the voltmeter mode of operation and through the one megohm attenuator S2R1 through S2R6 in the distortion mode of operation. Capacitive dividers act in conjunction with the attenuators to keep the frequency response flat. The impedance converter is a low distortion, high input impedance amplifier with gain independent of the source impedance placed at the INPUT terminals.

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4-15. Instrument induced distortion of the signal being measured is prevented by keeping the input impedance and the gain of the impedance converter linear. The input impedance is made linear by "boot strapping" the protection diodes A2CR2 and A2CR3 and the gate to drain capacitance of A2Q1 with local positive feedback. By keeping the input impedance linear, signals having a high source impedance can be measured accurately and the SENSITIVITY selector S2 can be used in the high impedance positions without distorting the input signal. In addition to having a high input impedance, the impedance converter serves as a linear amplifier. The open loop gain of the circuit is increased by "boot strapping" the collector load impedances of A2Q2 and A2Q3 with local positive feedback. Overall negative feedback from the emitter circuit of A2Q4 to the source of A2Q1 results in unity gain from the impedance converter circuit and keeps the distortion generated by the circuit well within the specifications listed in Table 1-1.

4-16. The bias points of the transistors in the impedance converter circuit have been selected for optimum distortion performance. The voltage at A2TP1 is set for optimum distortion performance for each individual instrument and should not be changed from the set value unless the field effect transistor A2Q1 is replaced. The field effect transistor used in the impedance converter provides extremely low noise performance independent of the signal source impedance, and aids in producing the high impedance input to the impedance converter circuit.

4-17. REJECTION AMPLIFIER CIRCUIT.

(Refer to Figure 7-2.)

4-18. The rejection amplifier circuit consists of the preamplifier, A3Q1 through A3Q3, the Wien bridge circuit, and the bridge amplifier, A3Q4 through A3Q6. A simplified block diagram of the rejection amplifier with the typical frequency rejection characteristic is shown in Figure 4-2.

4-19. PREAMPLIFIER CIRCUIT.

4-20. The signal from the impedance converter circuit is applied to the preamplifier circuit which is operational in the SET LEVEL and DISTORTION modes of operation. Negative feedback from the junction of A3R10 and A3R11 is applied to the junction of A3R2 and A3C2 to establish the operating point for A3Q1. Negative feedback from the emitter of A3Q3 is applied to the emitter of A3Q1 to stabilize the whole preamplifier circuit. The preamplifier circuit, like the impedance converter circuit, is designed for high open loop gain to insure maximum distortion performance.

4-21. WIEN BRIDGE CIRCUIT.

4-22. The Wien bridge circuit is used, in the distortion mode of operation, as a rejection filter for the fundamental frequency of the input signal. With the FUNCTION selector S1 in the DISTORTION position, the Wien bridge is connected as an interstage coupling network between the preamplifier circuit and the bridge amplifier circuit.

4-23. The bridge is tuned to the fundamental frequency of the input signal by varying the frequency tuning capacitors, C4A through C4D, after the FREQUENCY RANGE selector S4 is set for the applicable frequency range. The bridge circuit is brought into balance by adjusting the COARSE BALANCE control R4 and the FINE BALANCE control R5. When the bridge circuit is tuned and balanced, the voltage and phase of the fundamental, which appears at junction of the series reactive arm (S4R1-S4R10 and C4A/B) and the shunt reactive arm (S4R11-S4R20 and C4C/D), is the same as at the midpoint of the resistive branch (A3R12 and A3R14). When these two voltages are equal and are in phase, no output signal will appear at the drain of the field effect transistor A3Q4. For frequencies other than the fundamental, the reactive branch of the Wien bridge offers various degrees of attenuation and phase shift. The difference voltage between the reactive branch and resistive branch is amplified by A3Q4. Figure 4-3 illustrates a typical Wien bridge circuit and the rejection characteristic for this circuit. The

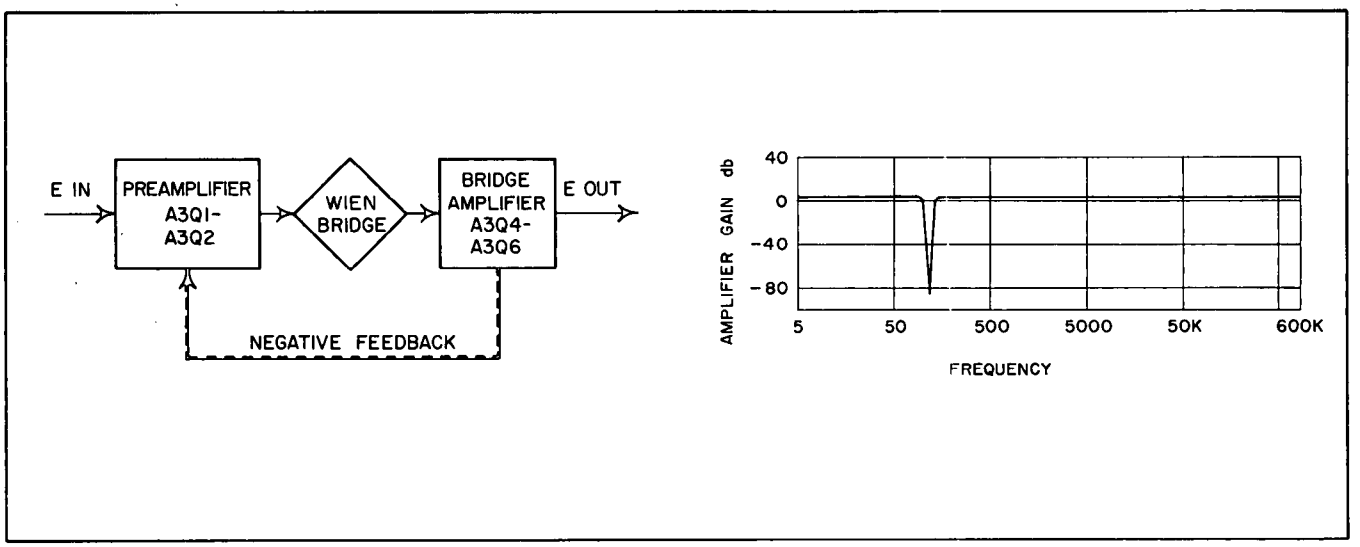


Figure 4-2. Rejection Amplifier Block Diagram and Typical Frequency Rejection Characteristic

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Wien bridge circuit is designed to cover a continuous frequency range of 12 to 1 to insure an overlap of the coarse tuning range. Coarse tuning ranges are selected by the FREQUENCY RANGE selector S4 which changes the bridge circuit constants in five decade steps.

4-24. When the FUNCTION selector is set to the VOLTMETER or SET LEVEL position, the junction of the series and shunt reactive arm of the Wien bridge is connected to circuit ground through S1BF, which disables the frequency rejection characteristic of the bridge circuit. With the bridge circuit disabled, the rejection amplifier circuit provides one dB of gain for the fundamental frequency, the harmonics, and for the residuals to establish the set level reference in the SET LEVEL mode of operation.

4-25. BRIDGE AMPLIFIER CIRCUIT.

4-26. The bridge amplifier circuit consists of three stages of amplification, A3Q4 through A3Q6. The first stage of amplification, A3Q4, is a field effect transistor which amplifies the difference signal between the gate and the source. The field effect transistor is selected for maximum noise performance with the high impedances of the Wien bridge circuit. The signal from the drain is applied to the two stage feedback amplifier A3Q5 and A3Q6. The bias potential at A3TP2 is set for maximum distortion performance for each individual instrument and should not be changed from the set value unless the field effect transistor A3Q4 is replaced.

4-27. The output of A3Q6 is coupled to the meter circuit through the post attenuator S3R1 through S3R11. Negative feedback from the output of the bridge amplifier is applied to the preamplifier circuit to narrow the frequency rejection characteristic. It can be noted from the rejection characteristic (refer to Figure 4-3) for the bridge that the rejection of harmonic voltages is not constant. Typically the second harmonic is attenuated several dB more than the third harmonic, and the third more than the fourth. The result of the negative feedback is illustrated by the rejection characteristic shown in dashed lines on the amplitude and phase characteristic of Figure 4-3. Refer to Figure 4-4, Bandwidth versus Null Depth for further detail on the rejection characteristic.

4-28. METER CIRCUIT.

(Refer to Figure 7-3.)

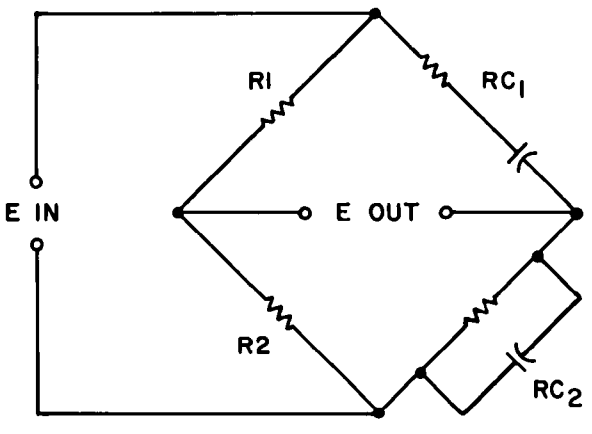
4-29. The meter circuit consists of the post attenuator, the meter amplifier circuit, and the meter rectifier circuit.

4-30. POST ATTENUATOR.

4-31. The post attenuator, S3R1 through S3R11, is a series of resistor networks which provide attenuation of input signals in 10 dB steps. The attenuator is used in conjunction with either the input sensitivity attenuator or the 1000:1 attenuator to limit the signal level to the meter amplifier to 1 mV for full scale deflection on all ranges from 1 mV to 300 V full scale. The meter circuit sensitivity is increased to 300 μ V for full scale deflection on the 0.0003 V range by switching resistors A2R29 and A2R30 into the calibration network. Resistor A2R41 and capacitor A2C29 are also switched into the calibration network on the 0.0003 V range to extend the passband of the amplifier.

4-32. METER AMPLIFIER CIRCUIT.

4-33. The meter amplifier circuit consists of five stages of amplification, A2Q5 through A2Q9, which develop the current for full scale meter deflection. Negative dc feedback from the emitter circuit of A2Q8 is applied to the base of A2Q5 to stabilize the dc operating point of the meter amplifier circuit and to minimize



TYPICAL WIEN BRIDGE

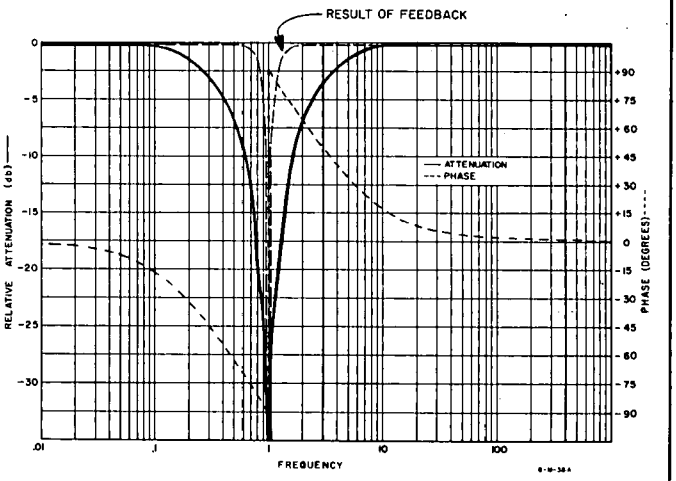


Figure 4-3. Wien Bridge Circuit and Rejection Characteristics

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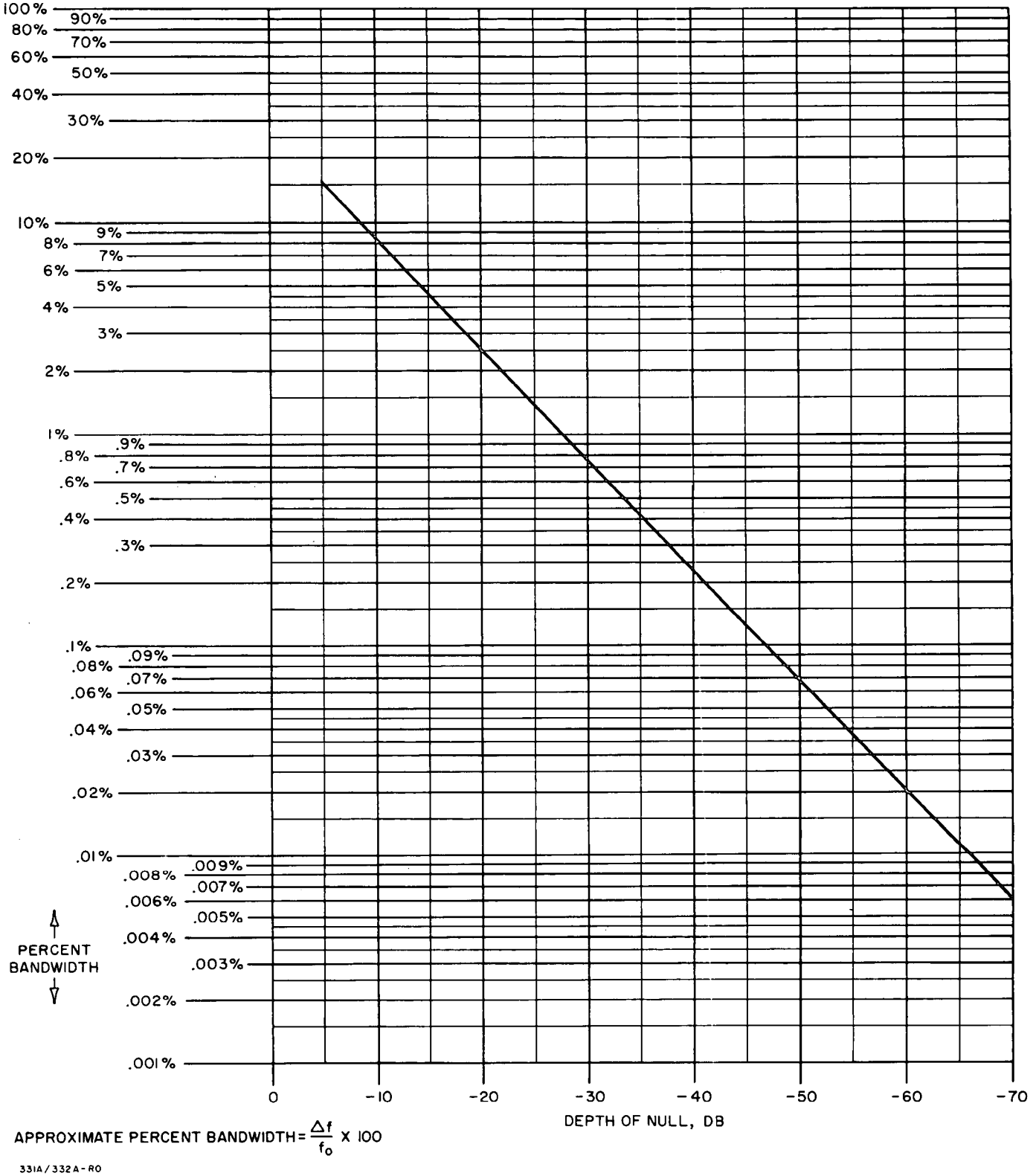


Figure 4-4. Bandwidth versus Null Depth

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the tendency for dc drift due to ambient temperature changes. Negative ac feedback is applied from the collector circuit of A2Q9 to the emitter circuit of A2Q5. This feedback is used to insure a flat frequency response, to improve linearity, and to reduce the effect of variation of transistor parameters with environmental changes. In this manner, the calibration of the instrument is made dependent on high quality passive components.

4-34. METER RECTIFIER CIRCUIT.

4-35. The meter rectifier is connected in a bridge type of configuration with a diode in each upper arm and a dc milliammeter connected across the midpoints of the bridge. The simplified meter rectifier is illustrated in Figure 4-5. The generator represented by A2Q5 through A2Q9, with the internal impedance R_O, provides the meter M1 with current for full scale deflection and develops a voltage across the calibration network which closes the ac feedback loop. Capacitors A2C27 and A2C28 are used as coupling capacitors for the ac feedback loop and the output signal to the OUTPUT connector. The mechanical inertia of the meter prevents the meter from responding to individual current pulses; therefore the meter pointer reading corresponds to the average value of the current pulses rather than the peak value. The meter calibration is to the rms value of a sine wave. Resistor A2R45 impresses a fixed bias across diodes A2CR6 and A2CR7 (biasing them close to the barrier voltage) to make the meter circuit response linear to large variations in signal amplitude. The linearity of this type of circuit is also increased by enclosing the meter circuit in the overall feedback loop.

4-36. POWER SUPPLY CIRCUIT.

(Refer to Figure 7-4.)

4-37. The power supply circuit consists of a +25 volt series regulated supply and a -25 volt series regulated supply which is the reference supply for the +25 volt supply.

4-38. The -25 volt regulated supply is of the conventional series regulator type. The amplifier A1Q5 is used to increase the loop gain of the circuit, thus improving voltage regulation. The positive feedback applied to the junction of A1R11 and A1R12 is used to further improve the line frequency suppression of the circuit.

4-39. The +25 volt regulated supply is of the conventional series regulator type and operates the same as the -25 volt regulated supply.

4-40. Diodes A1CR5 and A1CR6 are coupling and protection diodes for external battery supplies. The diodes protect the series regulator circuits from application of incorrect polarity at the battery input terminals. The diodes also protect external batteries from being charged in the wrong direction when the ac power is being used with batteries connected to the battery terminals.

4-41. RF DETECTOR CIRCUIT (332A ONLY).

(Refer to Figure 7-1.)

4-42. The RF detector circuit consists of a rectifier, A4CR1, and filter circuit. The RF signal is applied to the circuit through the RF INPUT connector on the rear panel. The rectifier diode A4CR1 recovers the modulating signal from the RF carrier and the filter circuit removes any RF components before the signal is applied to the impedance converter circuit through the NORM-RF DET switch S7.

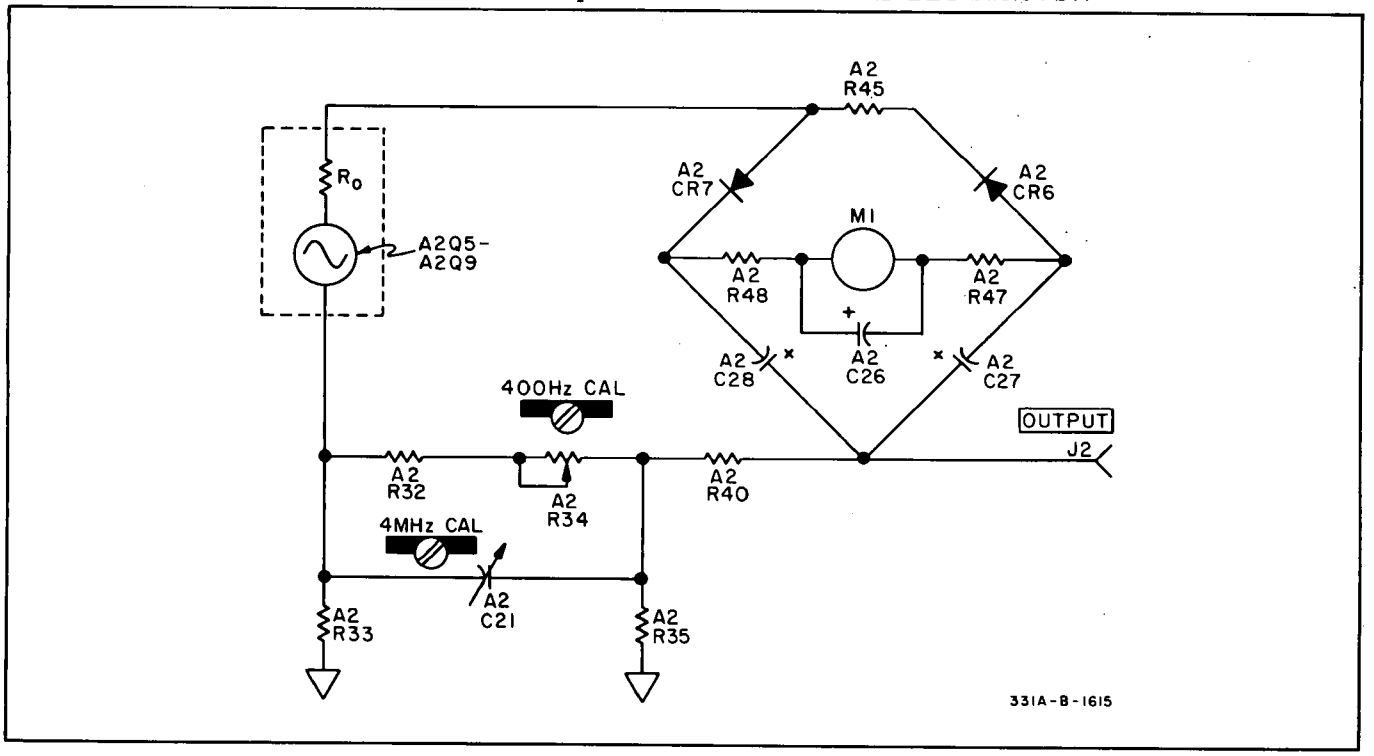


Figure 4-5. Simplified Metering Circuit

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Table 5-1. Required Test Equipment

INSTRUMENT TYPE	SPECIFICATIONS	USE	RECOMMENDED MODEL
Voltmeter Calibrator	Voltage Range: 300 μV to 300 V rms Accuracy: ±0.2% at 400 Hz	Performance Checks, Adjustment and Calibration	-hp- Model 738BR Voltmeter Calibrator
Test Oscillator	Voltage Range: 300 μV to 3 V Frequency Range: 10 Hz to 3 MHz	Performance Checks, Adjustment and Calibration	-hp- Model 652A Test Oscillator
Wave Analyzer	Bandwidth: 5 kHz to 600 kHz Dynamic Range: >80 dB	Performance Checks	-hp- Model 310A Wave Analyzer
Electronic Counter	Functions: period, 1 sec. gate Accuracy: ±2 counts	Performance Checks, Adjustment and Calibration	-hp- Model 5532A Electronic Counter
DC Voltmeter	Voltage Range: ±25 Vdc Accuracy: ±1%	Adjustment and Calibration, Troubleshooting	-hp- Model 412A DC Vacuum Tube Voltmeter
Oscilloscope	Bandwidth: dc to 10 MHz Vertical: Dual Channel	Troubleshooting	-hp- Model 140A/1402A/1420A Oscilloscope
AC Voltmeter	Voltage Range: 100 μV to 30 V Frequency Range: 20 Hz to 4 MHz	Troubleshooting	-hp- Model 400F AC Voltmeter
Filter Box	Filtered Outputs: 500 Hz, 5 kHz, 250 kHz, 600 kHz Output Distortion: <80 dB	Performance Checks	White Model 2640 Filter Set
Power Supply	Output Voltage: ±400 Vdc	Performance Checks	-hp- Model 711A Power Supply
Signal Generator	Carrier Frequency: 1 MHz Modulation: External, up to 50%	Performance Checks (Model 332A only)	-hp- Model 606A Signal Generator
Oscillator	Voltage Range: 1 V Frequency Range: 1 kHz Output: Floating, ±400 Vdc	Performance Checks	-hp- Model 204C Oscillator
AC Probe	Input Impedance: 10 MΩ shunted by 10 pF	Troubleshooting	-hp- Model 11074A Voltage Divider Probe
Terminating Resistances	Feedthru: 50 Ω ±1% and Feedthru: 600 Ω ±1%	Performance Checks, Adjustment and Calibration	-hp- Model 11048B and -hp- Model 11095A
Shielded Loads	Resistance: 600 Ω and Resistance: 100 kΩ	Performance Checks	See Figure 5-7
Resistors	Fxd: 100 kΩ ±1% 1/2 W and Fxd: 10 kΩ ±1% 1/2 W	Performance Checks	-hp- Part No. 0727-0208 and -hp- Part No. 0757-0215

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SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains maintenance and service information for the 331A and 332A Distortion Analyzers. Included are Performance Checks, Adjustment and Calibration Procedures and Troubleshooting Procedures.

5-3. REQUIRED TEST EQUIPMENT.

5-4. The equipment needed to properly maintain the Model 331A/332A is listed in Table 5-1. If the recommended model is not available, any instrument that has specifications equal to or better than the required specifications may be used.

5-5. PERFORMANCE CHECKS.

5-6. The performance checks are in-cabinet procedures that can be used to verify instrument performance. These procedures can be used for periodic maintenance, to check specifications after a repair, or for incoming quality control inspection. Performance checks for both the 331A and 332A are provided. The performance checks are applicable to both instruments except where noted in the paragraph heading. If the instrument fails to meet any of its specifications, perform the Adjustment and Calibration Procedures, Paragraph 5-21. The Performance Checks and Adjustment and Calibration Procedures should be performed at six month intervals to assure optimum operation of the instrument.

5-7. The performance checks are made with the ac power cord connected to nominal line voltage (115 V or 230 V, 48 to 440 Hz) and NORM. - R. F. DET. switch to NORM, unless otherwise specified.

5-8. A Performance Check Test Card is provided at the end of this section for recording the performance of the instrument during the performance checks. The card may be removed from the manual and used as a permanent record of the incoming inspection or of a routine performance check.

5-9. FUNDAMENTAL REJECTION CHECK.

a. Connect test equipment to 331A/332A as shown in Figure 5-1. Set filter pass frequency to 500 Hz.

NOTE

The test oscillator output is filtered so that the input to the 331A/332A is a pure signal at the desired frequency.

b. Set 331A/332A controls as follows:

FUNCTION	VOLTMETER
METER RANGE	1 VOLT
FREQUENCY RANGE	X100
Frequency Dial	5

c. Set test oscillator frequency to 500 Hz, and adjust amplitude for indication of 1.0 V on meter of 331A/332A.

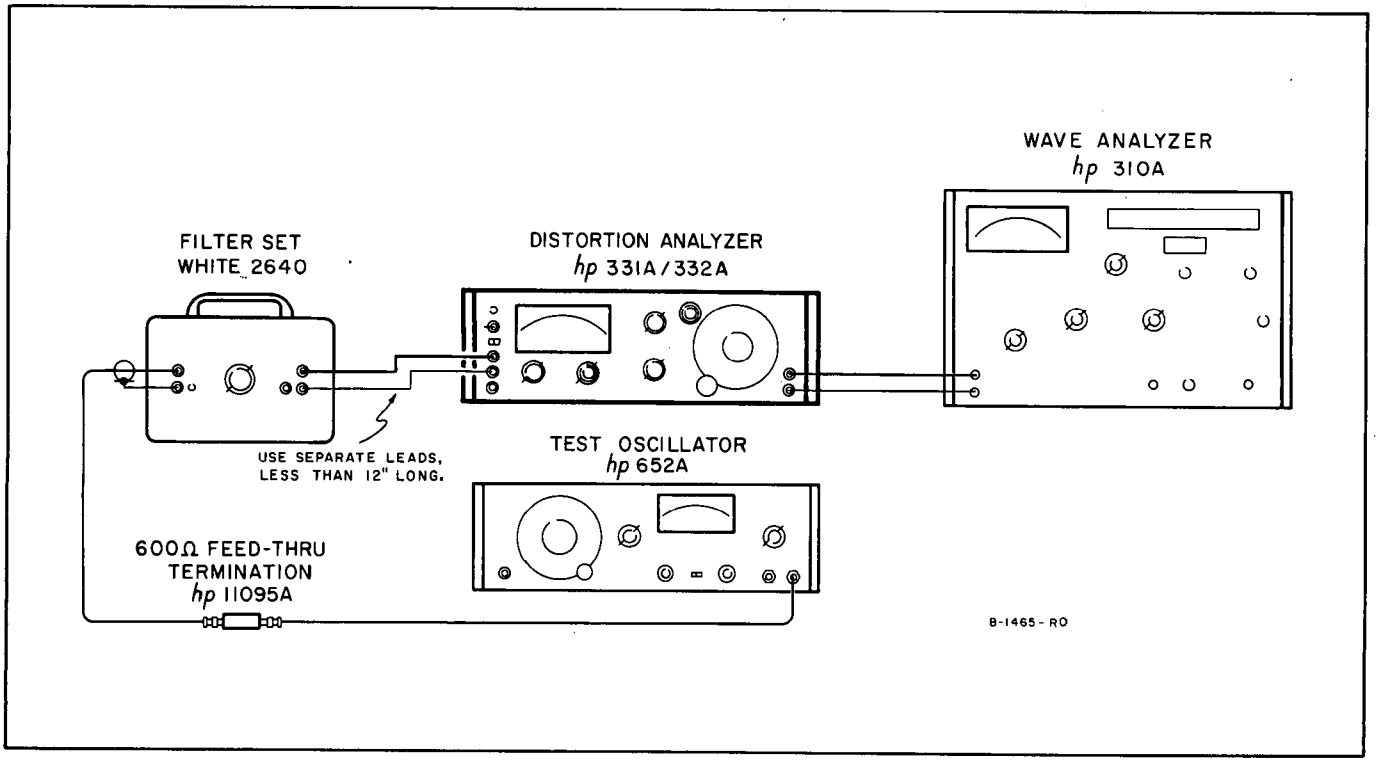


Figure 5-1. Fundamental Rejection Check

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d. Set 331A/332A FUNCTION switch to SET LEVEL, and set METER RANGE to 0.3 V. Adjust SENSITIVITY controls for 0 dB indication on 331A/332A meter.

e. Adjust wave analyzer controls for maximum reading (approximately 500 Hz), and use reading as 0 dB reference.

f. Set 331A/332A FUNCTION switch to DISTORTION.

g. Adjust 331A/332A frequency dial vernier and BALANCE controls for minimum meter indication. Reduce METER RANGE switch setting as necessary to maintain on-scale meter indication.

h. Observe wave analyzer meter, and reduce wave analyzer range setting as necessary to maintain on-scale meter indication.

NOTE

The 331A/332A OUTPUT is a 0 to 0.1 V signal that is proportional to meter deflection, regardless of METER RANGE setting. Each decrease of the METER RANGE setting represents 10 dB fundamental rejection; therefore, the total fundamental rejection is the sum of the 331A/332A METER RANGE setting and the wave analyzer reading.

i. The 331A/332A METER RANGE setting plus wave analyzer reading should total more than -80 dB.

j. Repeat steps b thru i with 331A/332A and test equipment frequencies set to 5 kHz, 50 kHz, 250 kHz, and 600 kHz.

5-10. SECOND HARMONIC ACCURACY CHECK.

a. Connect 50 Ω output of test oscillator, terminated in 50 Ω load, to 331A/332A.

b. Set 331A/332A controls as follows:

FUNCTION	SET LEVEL
METER RANGE	SET LEVEL
FREQUENCY RANGE	X1
Frequency Dial	15

c. Set test oscillator frequency to 15 Hz at an amplitude of 1 V.

d. Adjust 331A/332A SENSITIVITY controls for 0 dB indication on meter.

e. Set 331A/332A FUNCTION switch to DISTORTION. Adjust frequency dial vernier and BALANCE controls for best null indication on meter. Do not change frequency or balance settings after best null is obtained.

f. Set 331A/332A FUNCTION and METER RANGE switches to SET LEVEL.

g. Set test oscillator frequency to 30 Hz, and adjust amplitude for 0 dB indication on 331A/332A meter.

h. Set 331A/332A FUNCTION switch to DISTORTION. Meter reading should not change more than +1 dB from 0 dB reference.

i. Repeat steps b through h for each respective frequency and second harmonic listed in Table 5-2. 331A/332A meter readings should remain within tolerances listed in the table.

Table 5-2. Second Harmonic Accuracy Check

331A/332A FREQUENCY	TEST OSCILLATOR FREQUENCY (Second Harmonic)	331A/332A TOLERANCES
10 kHz	20 kHz	<±0.6 dB
50 kHz	100 kHz	<-1.0 dB
200 kHz	400 kHz	<-2.0 dB
500 kHz	1 MHz	<-3.0 dB

5-11. INSTRUMENT INDUCED DISTORTION CHECK.

a. Connect test equipment to 331A/332A as shown in Figure 5-2. Set filter pass frequency to 500 Hz.

b. Set 331A/332A controls as follows:

FUNCTION	SET LEVEL
SENSITIVITY	MAX.
SENSITIVITY VERNIER	MIN.
METER RANGE	SET LEVEL
FREQUENCY RANGE	X100
Frequency Dial	5

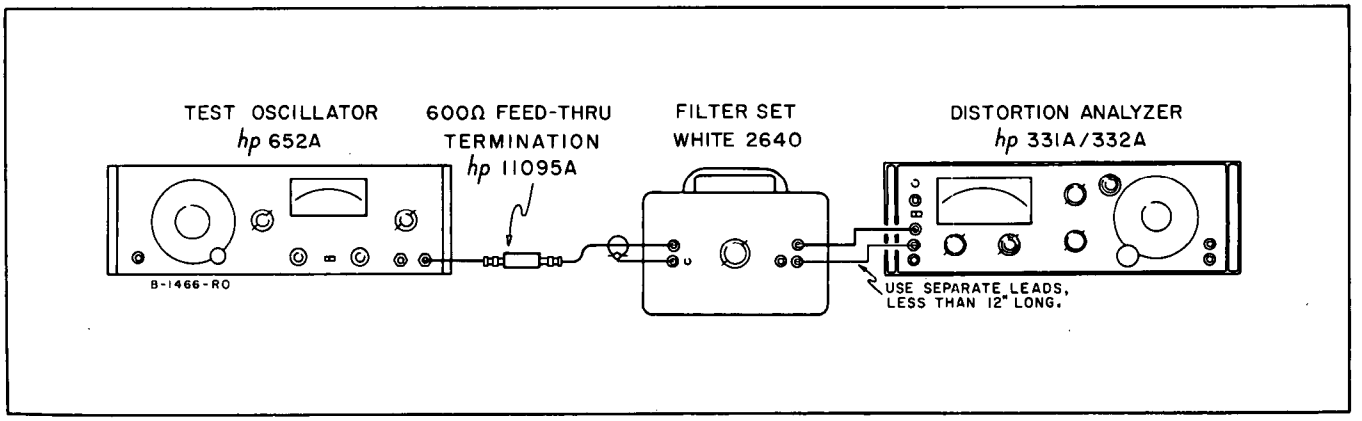


Figure 5-2. Instrument Induced Distortion Check

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c. Set test oscillator frequency to 500 Hz, and adjust amplitude for indication of +2 dB on 331A/332A meter.

d. Set 331A/332A FUNCTION switch to DISTORTION.

e. Adjust 331A/332A frequency dial vernier and BALANCE controls for minimum meter indication. Reduce METER RANGE setting as necessary to maintain on-scale meter indication.

f. 331A/332A meter indication should be at least 70 dB below +2 dB reference.

g. Repeat steps b through f with 331A/332A and test equipment frequencies set to 250 kHz and 600 kHz. 331A/332A meter indication should be at least 64 dB below +2 dB reference.

5-12. FREQUENCY CALIBRATION ACCURACY CHECK.

a. Connect test equipment to 331A/332A as shown in Figure 5-3. Set electronic counter to read period.

NOTE

In this check, the 331A/332A frequency dial is held constant and the input frequency is varied and monitored. If the dial is low, the input frequency will be high at null and vice versa.

b. Set 331A/332A controls as follows:

FUNCTION	SET LEVEL
SENSITIVITY	MAX.
METER RANGE	SET LEVEL
FREQUENCY RANGE	X1
Frequency Dial	10

c. Set test oscillator frequency to 10 Hz, and adjust amplitude for indication of +2 dB on 331A/332A meter.

d. Set 331A/332A FUNCTION switch to DISTORTION.

e. DO NOT adjust 331A/332A frequency controls. Adjust test oscillator frequency and 331A/332A BALANCE controls for minimum indication on 331A/332A meter.

f. Repeat step e until best null is indicated on 331A/332A. Reduce METER RANGE setting as necessary to maintain on-scale meter indication.

g. Electronic counter should indicate period of 100 msec ±5 msec (10 Hz ±5%).

h. Set electronic counter to read frequency. Repeat steps b through f for each frequency listed in Table 5-3. At each respective frequency setting, electronic counter should indicate that test oscillator frequency is within tolerances listed in table.

Table 5-3. Frequency Calibration Accuracy Check

331A/332A FREQUENCY	TEST OSCILLATOR FREQUENCY	ELECTRONIC COUNTER INDICATION
1 kHz	1 kHz	950 Hz to 1050 Hz
100 kHz	100 kHz	95 kHz to 105 kHz
200 kHz	200 kHz	190 kHz to 210 kHz
400 kHz	400 kHz	360 kHz to 440 kHz
600 kHz	600 kHz	540 kHz to 660 kHz

5-13. INPUT IMPEDANCE CHECK.

5-14. RESISTANCE CHECK.

a. Connect 50 Ω output of test oscillator, terminated in 50 Ω load, to 331A/332A INPUT terminals.

b. Set 331A/332A controls as follows:

FUNCTION	VOLTMETER
SENSITIVITY	MAX.
SENSITIVITY VERNIER	MAX.
METER RANGE	1 VOLT

c. Set test oscillator frequency to 100 Hz, and adjust amplitude for indication of 1 V on 331A/332A meter.

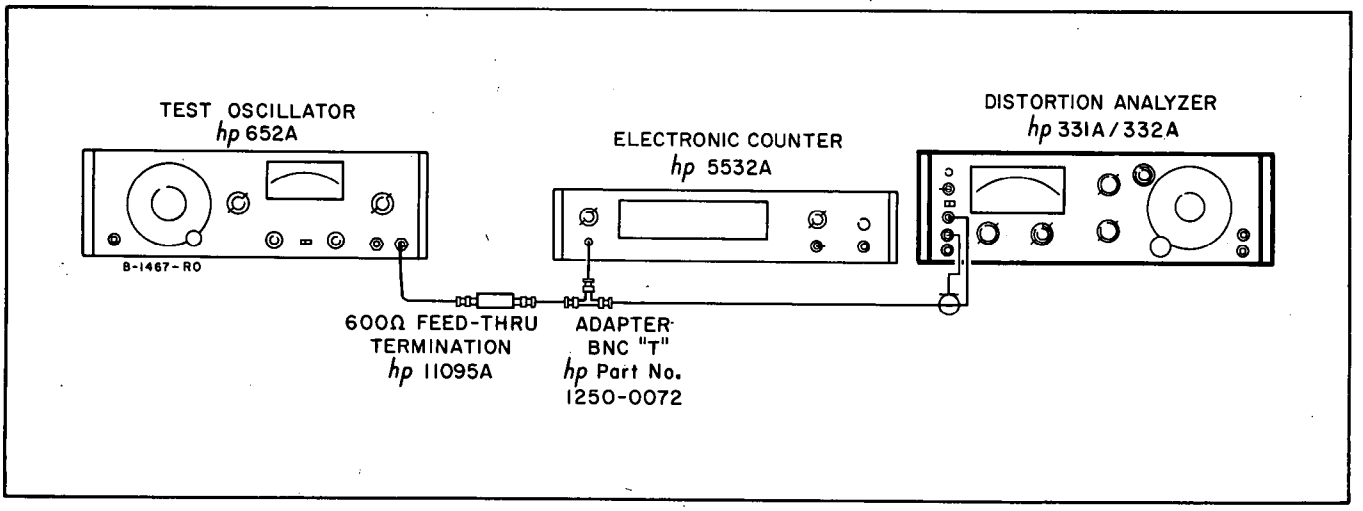


Figure 5-3. Frequency Calibration Accuracy Check

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d. Connect a 100 kΩ resistor in series with 331A/332A input.

e. 331A/332A meter should indicate between 0.9 V and 0.92 V. This verifies an input resistance of 1 MΩ ±5% in voltmeter function.

f. Remove 100 kΩ resistor, and reconnect oscillator to 331A/332A.

g. Set 331A/332A FUNCTION switch to SET LEVEL, and set METER RANGE switch to 0.1 VOLT.

h. Adjust test oscillator amplitude for 331A/332A meter indication of 0.1 V.

i. Connect 100 kΩ resistor in series with 331A/332A input.

j. 331A/332A meter should indicate between 0.090 V and 0.092 V. This verifies an input resistance of 1 MΩ ±5% in set level and distortion functions.

5-15. CAPACITANCE CHECK.

a. Connect 50 Ω output of test oscillator, terminated in 50 Ω load, and 10 kΩ resistor to 331A/332A as shown in Figure 5-4. Connect resistor lead to INPUT terminal of 331A/332A, and insert other lead directly into 50 Ω load. Connect ground lead from 331A/332A to outer shield of 50 Ω load; do not use an adapter, as it would add capacitance.

b. Set 331A/332A controls as follows:
FUNCTION . . . . . VOLTMETER
SENSITIVITY . . . . . MAX.
SENSITIVITY VERNIER . MAX.
METER RANGE . . . . . 1 VOLT

c. Set test oscillator to 100 Hz and adjust amplitude for 331A/332A meter indication of 1 V. Set a reference on meter of test oscillator and use amplitude control to maintain set reference whenever frequency of oscillator is changed.

d. Increase frequency of test oscillator to 540 (455) kHz. 331A (332A) meter should indicate 0.707 V or greater, verifying an input capacitance of 30 pF (35 pF) or less on 1 V range in voltmeter function.

e. Set 331A/332A METER RANGE switch to 0.1 V range.

f. Set test oscillator to 100 Hz and adjust amplitude for 331A/332A meter indication of 0.1 V. Set a reference on meter of test oscillator and use amplitude controls to maintain set reference whenever frequency of oscillator is changed.

g. Increase frequency of test oscillator to 230 kHz. 331A/332A meter should indicate 70.7 mV or greater, verifying an input capacitance of 70 pF or less on 0.1 V range in voltmeter function.

h. Set 331A/332A FUNCTION switch to SET LEVEL.

i. Set test oscillator to 100 Hz, and adjust amplitude for 331A/332A meter indication of 0.1 V. Set a reference on meter of test oscillator and use amplitude control to maintain set reference whenever frequency of oscillator is varied.

j. Increase frequency of test oscillator to 230 kHz. 331A/332A meter should indicate 70.7 mV or greater, verifying an input capacitance of 70 pF or less in set level and distortion functions.

5-16. MINIMUM INPUT LEVEL CHECK.

a. Connect 50 Ω output of test oscillator, terminated in 50 Ω load, to 331A/332A INPUT terminals.

b. Set 331A/332A controls as follows:
FUNCTION . . . . . VOLTMETER
SENSITIVITY . . . . . MAX.
SENSITIVITY VERNIER . MAX.
METER RANGE . . . . . 0.3 VOLTS

c. Set test oscillator to 400 Hz and adjust amplitude for 331A/332A meter indication of 0.3 V.

d. Set 331A/332A FUNCTION switch to SET LEVEL.

e. 331A/332A meter should indicate full scale or greater.

5-17. DC ISOLATION CHECK.

a. Connect test equipment to 331A/332A as shown in Figure 5-5.

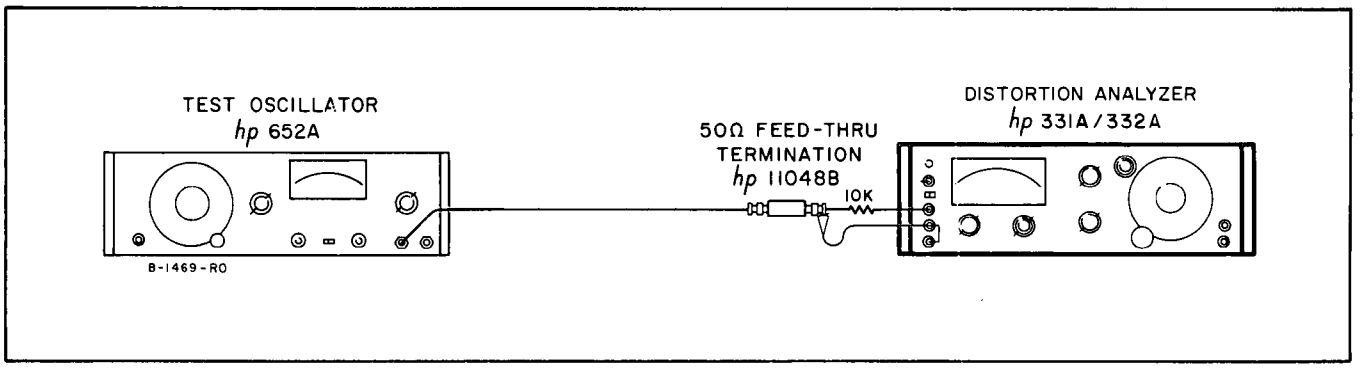


Figure 5-4. Capacitance Check

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WARNING

REMOVE SHORTING BAR BETWEEN CHASSIS GROUND (⏚) AND CIRCUIT GROUND (⏚) ON 331A/332A INPUT TERMINALS.

b. Set 331A/332A controls as follows:
FUNCTION . . . . . VOLTMETER
METER RANGE . . . . . 1 VOLT

c. Set oscillator to 1 kHz, and adjust amplitude for 331A/332A meter indication of 0.9 V.

d. Set power supply to ±400 Vdc. 331A/332A meter indication should not change, and ammeter of power supply should indicate that no current is flowing.

5-18. VOLTMETER ACCURACY AND FREQUENCY RESPONSE CHECK.

a. Connect voltmeter calibrator to 331A/332A as shown in Figure 5-6. Test oscillator will be used later in check.

b. Set 331A/332A FUNCTION switch to VOLTMETER.

c. Set voltmeter calibrator for 400 Hz rms output.

d. Check 331A/332A voltmeter full scale reading on all ranges against appropriate rms input from voltmeter calibrator. Voltmeter accuracy should be within ±2%.

e. Disconnect voltmeter calibrator and connect 50 Ω output of test oscillator, terminated in 50 Ω load, to 331A/332A.

f. Set 331A/332A METER RANGE switch to 3 VOLTS.

g. Set test oscillator to 400 Hz, and adjust for 331A/332A meter indication of 3.0 V. Set reference on meter of test oscillator and use amplitude control to maintain set reference whenever frequency of oscillator is varied.

h. Set test oscillator to each frequency listed in Table 5-4. At each respective frequency, 331A/332A meter indication should be within tolerances listed in table.

i. Set 331A/332A METER RANGE switch to 0.0003 VOLTS.

j. Set test oscillator to 400 Hz and adjust amplitude for 331A/332A meter indication of 300 μV. Set reference on meter of test oscillator and use amplitude control to maintain set reference whenever frequency of oscillator is varied.

k. Set test oscillator to each frequency listed in Table 5-4. At each respective frequency, 331A/332A meter reading should be within tolerances listed in table.

Table 5-4. Voltmeter Frequency Response Check

FREQ.	3 V RANGE METER INDICATION MIN.	MAX.	FREQ.	0.0003 V RANGE METER INDICATION MIN.	MAX.
10 Hz	2.94 V	3.06 V	20 Hz	285 μV	315 μV
1 kHz	2.94 V	3.06 V	30 Hz	294 μV	306 μV
10 kHz	2.94 V	3.06 V	1 kHz	294 μV	306 μV
100 kHz	2.94 V	3.06 V	10 kHz	294 μV	306 μV
1 MHz	2.94 V	3.06 V	100 kHz	294 μV	306 μV
2 MHz	2.85 V	3.15 V	300 kHz	294 μV	306 μV
3 MHz	2.85 V	3.15 V	500 kHz	285 μV	315 μV

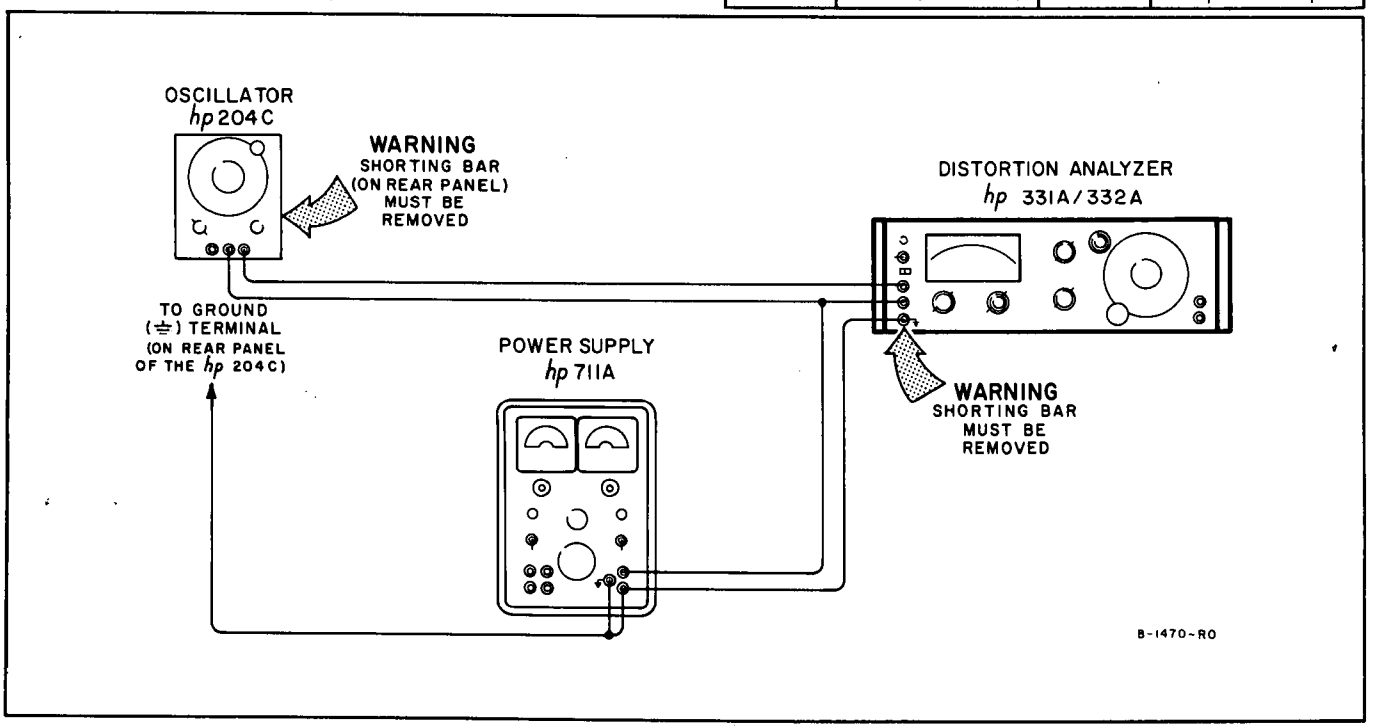


Figure 5-5. DC Isolation Check

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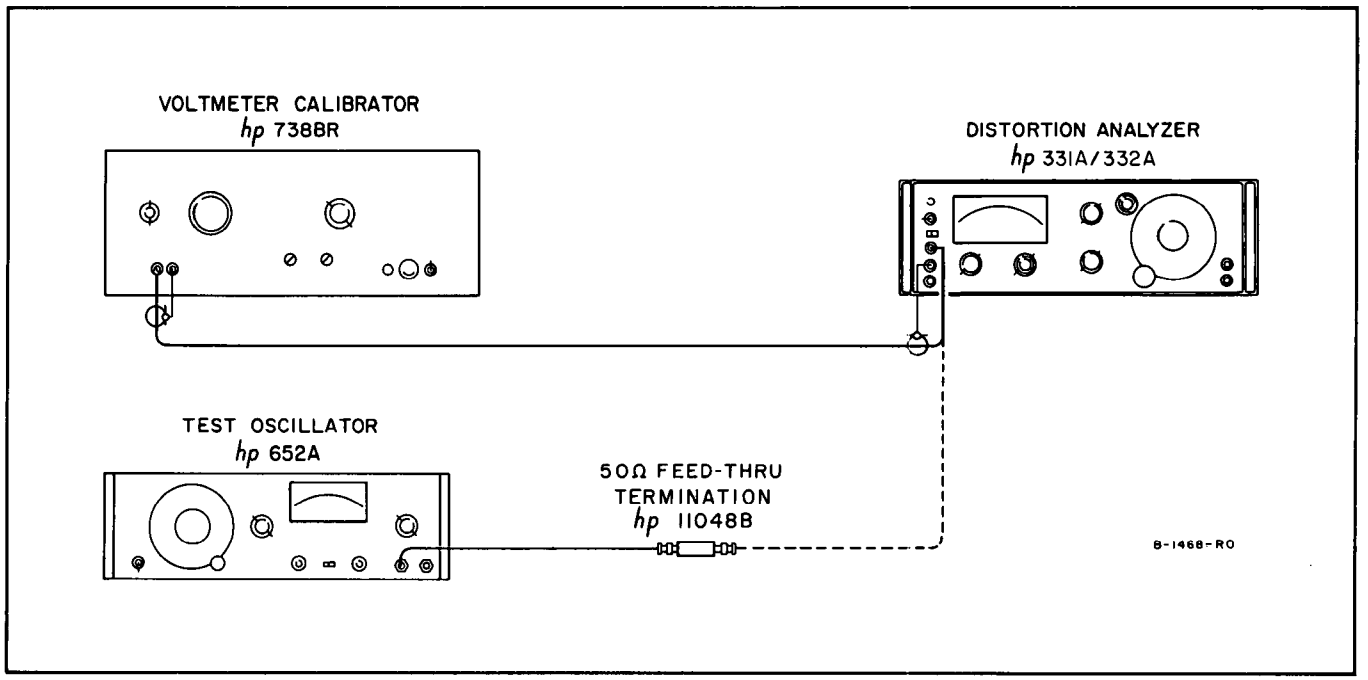


Figure 5-6. Voltmeter Accuracy and Frequency Response Check

5-19. RESIDUAL NOISE CHECK.

a. Connect a shielded 600 Ω load across 331A/332A INPUT terminals. (See Figure 5-7 for details on constructing shielded load.) Be sure that shorting bar is connected between chassis ground and circuit ground on INPUT terminals.

b. Set 331A/332A controls as follows:
FUNCTION . . . . . VOLTMETER
METER RANGE . . . . . 0.0003 VOLTS

c. Meter should indicate less than 25 μV.

d. Remove 600 Ω load. Connect a shielded 100 kΩ load across INPUT terminals. (See Figure 5-7 for details on constructing shielded load.)

e. Meter should indicate less than 30 μV.

5-20. AM DETECTOR CHECK (MODEL 332A ONLY).

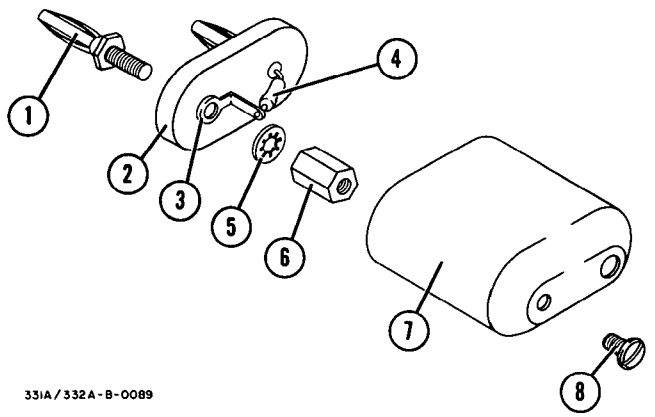
a. Connect high frequency signal generator 50 Ω RF output to 332A R. F. INPUT terminal.

b. Set 332A controls as follows:
FUNCTION . . . . . SET LEVEL
NORM. - R. F. DET. . . R. F. DET.
METER RANGE . . . . . SET LEVEL
FREQUENCY RANGE . . X100
Frequency Dial 10

c. Set high frequency signal generator to 1 MHz at an amplitude of 3 V. Modulate high frequency signal generator output 30% at 1 kHz, using a test oscillator.

d. Adjust 332A SENSITIVITY controls for 0 dB meter indication.

e. Set 332A FUNCTION switch to DISTORTION.



No.	Description	hp Part No.
1	Connector, male	1251-0174
2	Connector, male, w/insulator	1251-0175
3	Lug, terminal 90°	0360-0042
4	Resistor, 100 K Ω, 1/2 w, 5%, metal film	0758-0053
	OR	
4	Resistor, 600 Ω, 1/4 w, 0.5%, metal film	0757-1037
5	Washer, int. lock	2190-0007
6	Spacer, 6-32 threaded	0380-0058
7	Shield	1251-0173
8	Screw, bind. head, 6-32 x 1/4 in.	2470-0001

Figure 5-7. Shielded Load Assembly

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f. Adjust 332A frequency dial vernier and BALANCE controls for minimum meter indication.

g. Distortion should be more than 40 dB below 0 dB reference.

5-21. ADJUSTMENT AND CALIBRATION PROCEDURE.

5-22. The following is a complete adjustment and calibration procedure for the 331A and 332A. Before proceeding with these adjustments, the Performance Checks should be performed to determine whether adjustments are necessary. If your instrument does not meet the test limits specified in the following steps, refer to Troubleshooting Procedure, Paragraph 5-32 for possible cause and corrective action. Adjustment locations are shown in Figure 5-8.

5-23. The Adjustment and Calibration Procedure is performed with the ac power cord connected to nominal line voltage (115 V or 230 V, 48 to 440 Hz), unless otherwise specified.

5-24. POWER SUPPLY AND BIAS ADJUSTMENTS.

a. Remove top and bottom covers from instrument.

b. Be sure that shorting bar is connected between chassis ground and circuit ground INPUT terminals.

c. Connect common lead of a dc voltmeter to either INPUT ground terminal.

d. Perform the measurements and adjustments listed in Table 5-5.

CAUTION

DO NOT ALLOW PROBE TO SHORT A2TP1 TO GROUND. IF THIS HAPPENS, A2Q4 MAY BE DESTROYED.

5-25. VOLTMETER GAIN ADJUSTMENTS.

a. Connect voltmeter calibrator to 331A/332A as shown in Figure 5-6.

b. Set 331A/332A controls as follows:
FUNCTION . . . . . VOLTMETER
METER RANGE . . . . . 0.001 VOLTS

c. Set voltmeter calibrator to 1 mV rms output at 400 Hz.

d. Adjust A2R34 (400 Hz CAL.) for a meter indication of 1.0 mV.

e. Set voltmeter calibrator to 0.3 mV rms at 400 Hz. Set 331A/332A METER RANGE to 0.0003 VOLTS.

f. Meter should indicate 300 μV ±6 μV (±2%). If necessary, change value of A2R30* to set reading within limits. Increasing resistance decreases meter reading, and vice versa. Typical values for this resistor are from 150 Ω to 300 Ω.

5-26. VOLTMETER FREQUENCY RESPONSE ADJUSTMENT.

a. Connect test oscillator to 331A/332A as shown in Figure 5-6.

NOTE

Cover plate (Item 36 in Figure 6-1) must be in place while performing these adjustments.

b. Set 331A/332A controls as follows:
FUNCTION . . . . . VOLTMETER
METER RANGE . . . . . 0.0003 VOLTS

c. Set test oscillator to 400 Hz, and adjust amplitude for 331A/332A meter indication of 300 μV. Set a reference on meter of test oscillator and use amplitude control to maintain set reference whenever frequency of oscillator is changed.

d. Set test oscillator frequency to 20 Hz.

e. 331A/332A meter should indicate 300 μV ±15 μV (±5%). If reading exceeds these limits, change value of A2C30*. Typical values for this capacitor are between 10 μF and 50 μF.

f. Set 331A/332A METER RANGE switch to 0.01 VOLTS.

g. Set test oscillator to 400 Hz, and adjust amplitude for 331A/332A meter indication of 0.01 V. Set a reference on meter of test oscillator and use amplitude control to maintain set reference whenever frequency of oscillator is changed.

Table 5-5. Power Supply and Bias Adjustments

MEASUREMENT POINT	VOLTAGE LIMITS	ADJUSTMENT	REGULATION (vary line voltage between 103.5 and 127.5 VAC)
Any violet wire	-25 V ±0.5 V	A1R13	-25 V ±0.25 V
Any red wire	+25 V ±1.0 V	None*	+25 V ±1.0 V
A2 TP1	-11.3 V	A2R3	-11.3 V ±0.1 V
A2 TP2	+ 8.2 V ±0.5 V	A2R20	+ 8.2 V ±0.5 V
A3 TP1	+ 2.65 V ±0.2 V	A3R4	+ 2.65 V ±0.2 V
A3 TP2	-20.2 V ±0.3 V	A3R16	-20.2 V ±0.3 V

*Referenced to -25 volt supply; -25 volt supply must be adjusted first.

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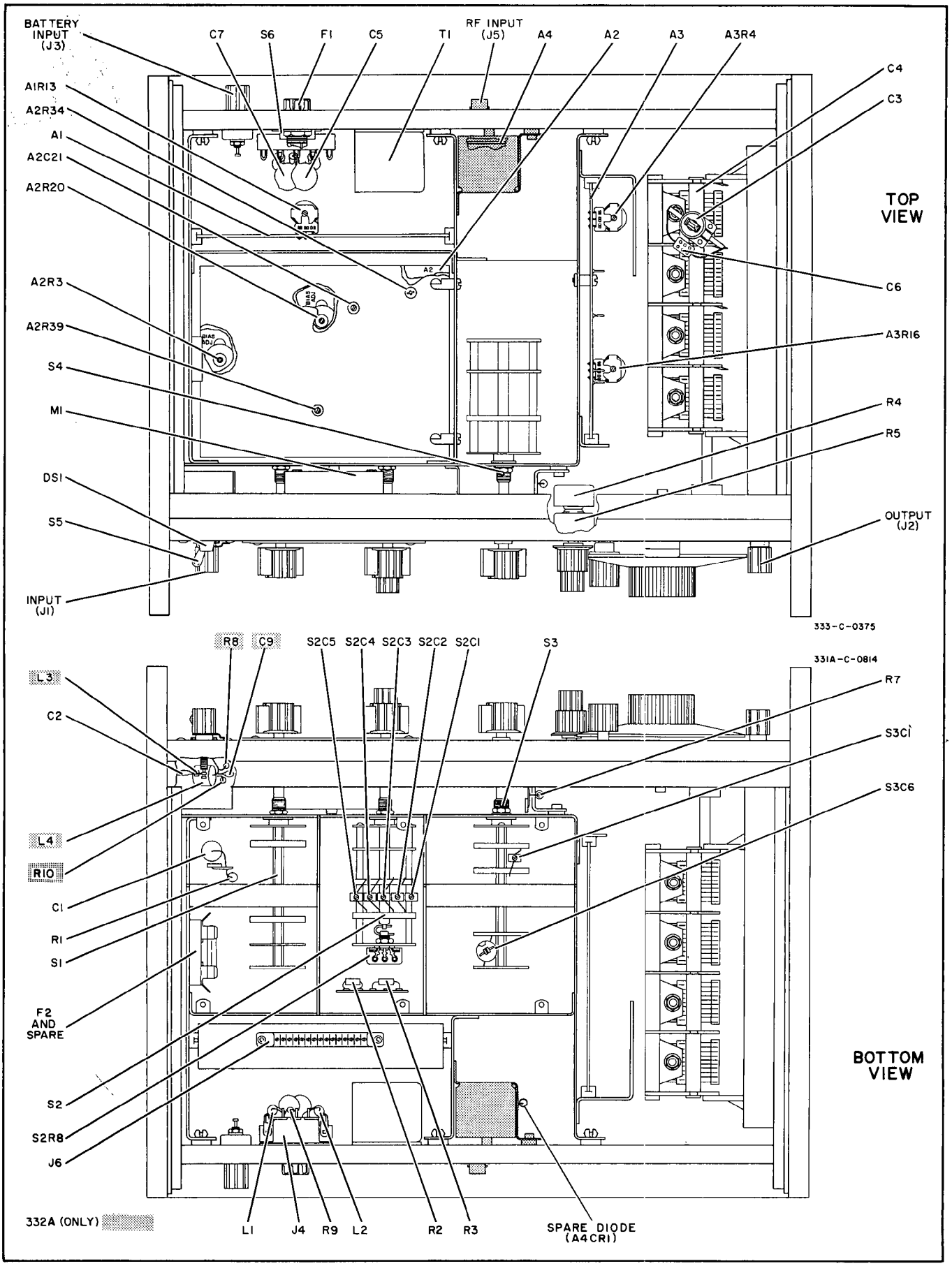


Figure 5-8. Adjustment and Chassis Mounted Component Location

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h. Set test oscillator frequency to 2 MHz.

i. Adjust A2R39 for 331A/332A meter indication of 0.01 V.

j. Set test oscillator frequency to 3 MHz.

k. Adjust A2C21 for 331A/332A meter indication of 0.01 V.

NOTE

Adjustments of A2R39 and A2C21 interact. Therefore, it may be necessary to repeat the two adjustments to bring both within tolerance.

l. Set 331A/332A METER RANGE switch to 0.3 VOLTS.

m. Set test oscillator to 400 Hz, and adjust amplitude for 331A/332A meter indication of 0.3 V. Set a reference on meter of test oscillator and use amplitude control to maintain set reference whenever frequency of oscillator is changed.

n. Set test oscillator frequency to 2.5 MHz.

o. Adjust S3C6 for 331A/332A meter indication of 0.3 V.

p. Set 331A/332A METER RANGE switch to 3 VOLTS.

q. Set test oscillator to 400 Hz, and adjust amplitude for 331A/332A meter indication of 3.0 V. Set a reference on meter of test oscillator and use amplitude control to maintain set reference whenever frequency of oscillator is changed.

r. Set test oscillator frequency to 200 kHz.

s. Adjust S3C1 for 331A/332A meter indication of 3.0 V.

5-27. SENSITIVITY SWITCH CALIBRATION.

a. Connect test oscillator to 331A/332A as shown in Figure 5-6.

NOTE

Selector positions for the SENSITIVITY selector will be referred to as follows: MIN. = Position 1, next step = Position 2, etc. to MAX. = Position 6.

b. Set 331A/332A controls as follows:

FUNCTION . . . . . SET LEVEL
SENSITIVITY . . . . . Position 5
SENSITIVITY VERNIER . MAX.
METER RANGE . . . . . 0.01 VOLTS

c. Set test oscillator to 400 Hz, and adjust amplitude for indication of 9 mV on 331A/332A meter. Set a reference on meter of test oscillator and use amplitude control to maintain set reference whenever frequency of oscillator is changed.

d. Set test oscillator frequency to 100 kHz.

e. Adjust S2C5 for 331A/332A meter indication of 9 mV.

f. Set 331A/332A SENSITIVITY switch to each position listed in Table 5-6, and increase test oscillator output by 10 dB for each respective decrease in SENSITIVITY switch position. Adjust appropriate capacitor for 331A/332A meter indication of 9 mV at each setting.

NOTE

When switching the SENSITIVITY positions, be careful not to move the SENSITIVITY VERNIER control from MAX. position.

Table 5-6. Sensitivity Switch Calibration

SENSITIVITY Switch	TEST OSCILLATOR OUTPUT (Increase)	ADJUST FOR 9 mV
Position 4	+10 dB	S2C4
Position 3	+20 dB	S2C3
Position 2	+30 dB	S2C2
Position 1	+40 dB	S2C1

5-28. BRIDGE BALANCE ADJUSTMENT.

CAUTION

MAINTAIN THE LEAD DRESS TO C3 AND THE TUNING CAPACITOR, C4. ANY CHANGE IN LEAD DRESS WILL CAUSE A CHANGE IN CAPACITANCE.

a. Connect test equipment to 331A/332A as shown in Figure 5-3.

b. Set 331A/332A controls as follows:

FUNCTION . . . . . SET LEVEL
SENSITIVITY . . . . . 1 step counter-clockwise
SENSITIVITY VERNIER . MIN.
METER RANGE . . . . . SET LEVEL
FREQUENCY RANGE . . X1K
Frequency Dial 60

c. Turn slot on trimmer capacitor C3 parallel with side casting of instrument.

d. Set test oscillator to 60 kHz, and adjust amplitude for indication of +2 dB on 331A/332A meter.

e. Set 331A/332A COARSE and FINE BALANCE controls to center of range.

f. Set 331A/332A FUNCTION switch to DISTORTION.

g. With a tuning wand, adjust C3 and test oscillator frequency vernier control for definite null indication on meter of 331A/332A. Reduce METER RANGE setting as necessary to maintain on-scale reading.

h. Observe electronic counter indication. If test oscillator frequency is not between 57 kHz and 63 kHz, 331A/332A frequency dial is out of tolerance. Follow steps below to bring frequency dial within tolerance:

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1) Set 331A/332A controls as in step b. Set test oscillator frequency for electronic counter indication of 60.00 kHz, and adjust amplitude for indication of +2 dB on meter of 331A/332A.

2) Set 331A/332A COARSE and FINE BALANCE controls to center of range.

3) Adjust 331A/332A frequency dial vernier for definite null.

4) Remove knob from frequency dial. Do not change tuning capacitor, C4, setting.

5) Loosen retaining screws in frequency dial plate, and slip dial until 60 is directly under mark on indicator. Be careful not to change C4 setting.

6) Tighten retaining screws and replace knob.

5-29. DISTORTION ADJUSTMENT. 331 thru 0995-045-26 332 998-01946 Rev.

a. Connect test equipment to 331A/332A as shown in Figure 5-2. Set filter pass frequency to 5 kHz.

b. Set 331A/332A controls as follows:

FUNCTION	SET LEVEL
SENSITIVITY	MAX
SENSITIVITY VERNIER	MAX
METER RANGE	SET LEVEL
FREQUENCY RANGE	X100
Frequency Dial	5

c. Set test oscillator to 5 kHz, and adjust amplitude for +2 dB indication on 331A/332A.

d. Set 331A/332A FUNCTION to DISTORTION. Adjust 331A/332A frequency dial vernier and BALANCE controls for definite null on the most sensitive range.

e. Turn A3R30 fully counterclockwise. Turn A3R30 clockwise until 331A/332A meter indicates minimum distortion. Continue turning A3R30 clockwise until meter indication is 1 minor division (on 0 to 1 scale) above minimum distortion reading.

5-30. ADJUSTMENT OF FACTORY SELECTED COMPONENTS.

5-31. Certain components in the Model 331A/332A are individually selected to compensate for varying circuit parameters. These components are designated by an asterisk (*) on the schematic and parts list, and the typical value is shown. Table 5-7 describes the function of the factory selected components and lists their value ranges.

5-32. TROUBLESHOOTING PROCEDURES.

5-33. This section contains procedures designed to help locate malfunctions. These procedures are based on a systematic analysis of the instrument circuits in an effort to localize the problem. These operations should be performed only if the malfunction cannot be eliminated by the Adjustment and Calibration Procedures.

Table 5-7. Factory Selected Components

COMPONENT	FUNCTION	VALUE		
		Low	Normal	High
A2C22*	Sets range of A3C21.	0 pF	47 pF	47 pF
A2C23*	Adjusts meter frequency response in 2 MHz region.	100 pF	240 pF	320 pF
A2C30*	Adjusts meter frequency response in 20 Hz region.	10 μF	22 μF	50 μF
A2C29*	Adjusts meter flatness on 0.0003 V range at 300 kHz.	0 pF	390 pF	680 pF
A2R30*	Adjusts meter amplifier gain on 0.0003 V range at 400 Hz.	150 Ω	300 Ω	300 Ω
A3C11*	Adjusts bridge amplifier frequency response on 1 MHz to 3 MHz region.	56 pF	127 pF	127 pF
A3R17*	Adjusts gain of rejection amplifier.	1 kΩ	2 kΩ	3 kΩ
C9*	Adjusts tracking of frequency dial.	0 pF	2.2 pF	6.8 pF
R3*	Adjusts range of S2R8.	0 Ω	390 Ω	390 Ω
S3C4*	Adjusts frequency response at 3 MHz	39 pF	47 pF	57 pF
S3R14*	Adjusts flatness of 1000:1 attenuator in 2 MHz to 3 MHz region.	7.5 Ω	10 Ω	10 Ω
S4R6* thru S4R26*	Must be individually matched to be ±1/4%.	---	---	---

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Table 5-8. Troubleshooting Aid

SYMPTOM	PROBABLE CAUSE
1. FRONT PANEL SYMPTOMS	
A. No meter deflection with signal at input; ON lamp not illuminated. (All FUNCTIONS)	Check Fuse (F1).
B. No meter deflection with signal at input (0.3 VOLT range); No output; ON lamp illuminated. (All FUNCTIONS)	Check Fuse (F2). Spare fuse located next to F2.
C. No meter deflection with signal at input; Output normal. (All FUNCTIONS)	Check M1.
D. No SENSITIVITY VERNIER control in SET LEVEL mode.	Check R2, R3, and S2R8.
E. BALANCE controls erratic. (DISTORTION FUNCTION only)	Check R4 and R5.
F. No meter deflection with RF input. (R.F. DET. only)	Check diode A4CR1. Spare diode located on outside of A4 shield.
2. INTERNAL ADJUSTMENT SYMPTOMS	
A. Insufficient -25 volts adjustment with A1R13, measured at any violet wire.	Check A1C1, A1C11, A1CR3, A1CR4, A1CR7 and A1Q4 through A1Q6.
B. +25 volts supply out of specs, measured at any red wire.	Check -25 volts (see Symptom 2-A above), A1C2, A1C6, A1CR1, A1CR2 and A1Q1 through A1Q3.
C. Insufficient bias adjustment with A2R3, measured at A2TP1.	Check -25 volts (see Symptom 2-A above), A2C4, A2C14 and A2Q1 through A2Q4.
D. Insufficient bias adjustment with A2R20, measured at A2TP2.	Check -25 volts (see Symptom 2-A above), +25 volts (see Symptom 2-B above), A2C15, A2Q5 through A2Q9.
E. Insufficient 400 Hz adjustment with A2R34.	Check +8.2 volts bias (see Symptom 2-D above), check for -3.2 Vdc at + meter terminal and Check M1.
F. Insufficient gain adjustment with A2R39.	Check A2Q5 through A2Q9, and A2C23.
G. Insufficient 3 MHz calibration adjustment with A2C21.	Check A2C22* (Increasing value of capacitor will decrease meter reading.)
H. Insufficient bias adjustment with A3R4, measured at A3TP1.	Check -25 volts (see Symptom 2-A above), +25 volts (see Symptom 2-B above), A3C1, A3C6 and A3Q1 through A3Q3.
J. Insufficient bias adjustment with A3R16, measured at A3TP2.	Check -25 volts (see Symptom 2-A above), A3C7, and A3Q4 through A3Q6. Change A3R17* (Increasing value of resistor will increase voltage at A3TP2.)

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5-34. Conduct a visual check of the 331A/332A for possible burned or loose components, loose connections, or any other condition that might suggest a source of trouble. An investigation should also be made to insure that the trouble is not the result of conditions external to the 331A/332A.

CAUTION

THE 331A/332A CONTAINS VERY HIGH IMPEDANCE, HIGH FREQUENCY CIRCUITS. CONTAMINATION OF THE SWITCHES, CIRCUIT BOARDS, OR TUNING CAPACITOR WILL CAUSE HIGH IMPEDANCE LEAKAGE PATHS AND SUBSEQUENT DETERIORATION OF THE PERFORMANCE OF THE INSTRUMENT. AVOID TOUCHING ANY OF THESE CIRCUITS WITH THE BARE FINGERS, AS SKIN OILS ARE EXTREMELY CONTAMINATING. IF HANDLING IS NECESSARY, WEAR CLEAN COTTON OR RUBBER GLOVES.

5-35. Table 5-8 contains a list of typical front panel and internal trouble symptoms, as well as the probable cause of trouble. If the instrument malfunction cannot be located through use of the table, refer to Paragraphs 5-36 thru 5-39. Trouble in the Model 331A/332A can generally be isolated to circuits of one of the two principle functions - voltmeter or distortion. In order for the distortion function to operate properly, the voltmeter function must operate properly. Therefore, troubleshoot the voltmeter function first to assure that it works normally before attempting to locate a trouble in the distortion function.

5-36. TROUBLESHOOTING VOLTMETER FUNCTION.

5-37. Follow the steps below to troubleshoot the voltmeter function:

a. Set 331A/332A controls as follows:
FUNCTION . . . . . VOLTMETER
METER RANGE . . . . . 1 VOLT
Connect a 1 V rms, 1 kHz signal to 331A/332A INPUT terminals.

b. Measure ac output of impedance converter at A2 Pin 4 for approximately 1 mV rms. (Use a 10 MΩ/10 pF impedance probe.) If proper signal is present, proceed to step c; if not, proceed to step d.

c. Measure ac input to meter amplifier at A2 Pin 6 for approximately 1 mV rms. If proper signal is present, check meter circuit. (See schematic diagram of Figure 7-3 for ac and dc voltage levels in meter circuit.) If proper signal is not present, check post attenuator.

d. Measure ac input to impedance converter at A2 Pin 1 for approximately 1 mV rms. If proper signal is present, check impedance converter and power supply. (See appropriate schematic diagrams for voltage levels in impedance converter and power supply.) If proper signal is not present, check input attenuator and FUNCTION switch.

5-38. TROUBLESHOOTING DISTORTION FUNCTION.

5-39. Follow the steps below to troubleshoot the distortion function:

a. Set 331A/332A controls as follows:
FUNCTION . . . . . VOLTMETER
METER RANGE . . . . . 0.3 VOLTS
SENSITIVITY . . . . . MAX.
SENSITIVITY VERNIER . MAX.
FREQUENCY RANGE . . X1K
Frequency Dial 5
Connect a 1 kHz signal to 331A/332A INPUT, and adjust amplitude for 0 dB indication on 331A/332A meter.

b. Set 331A/332A FUNCTION switch to SET LEVEL. 331A/332A meter should indicate between +0.5 dB and +1 dB, verifying gain in rejection amplifier. If sufficient gain is present, check Wien bridge circuit. If sufficient gain is not present, go to step c.

c. Set amplitude of 1 kHz input signal to 0.3 V rms. Measure ac signal at A3 Pin 7 for approximately 180 mV rms (use a 10 MΩ/10 pF impedance probe). This voltage will increase to approximately 2.4 V rms in distortion function at null. If proper voltage is present, proceed to step d; if not go to step f.

d. Measure ac output of rejection amplifier at A3 Pin 2 for approximately 0.32 V rms. If proper voltage is present, check function and meter range switch connections. If proper voltage is not present, go to step e.

e. Measure ac signal at A3 Pin 8 for approximately 310 mV rms (use a 10 MΩ/10 pF impedance probe and be sure that Wien bridge is detuned with 1 kHz input and 331A/332A frequency at 5 kHz). If proper voltage is present, check A3Q4 through A3Q6 and associated circuitry. If proper voltage is not present, check Wien bridge circuit.

f. Measure ac input to rejection amplifier at A3 Pin 1 for approximately 280 mV rms. If proper voltage is present, check A3Q1 through A3Q3 and associated circuitry. If proper voltage is not present, check sensitivity vernier and check FUNCTION switch connections.

5-40. SERVICING ETCHED CIRCUIT BOARDS.

5-41. The Model 331A has three etched circuit boards and the Model 332A has four. Use caution when removing them to avoid damaging mounted components.

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The -hp- part number for the assembly is marked on the circuit board to identify it. Refer to Section VI for parts replacement and -hp- part number information.

5-42. The etched circuit boards are of the plated-through type. The electrical connection between the two sides of the board is made by a layer of metal plated through the component hole. When working on these boards, observe the following rules:

a. Use a low-heat (25 to 30 watts) small-tip soldering iron, and a small diameter rosin core solder.

b. Remove circuit components by placing the soldering iron on the component lead on either side of the board, and pulling up on the lead. If a component is obviously damaged, clip leads off as close to the component as possible and then remove leads with a soldering iron.

CAUTION

EXCESSIVE HEAT CAN CAUSE THE CIRCUIT AND BOARD TO SEPARATE OR CAUSE DAMAGE TO THE COMPONENTS.

c. Clean component lead hole by heating the hole with the iron and inserting a wooden toothpick. Remove the toothpick after the solder has cooled and insert the new component lead.

d. To replace components, shape new leads and insert them in lead holes. Reheat the soldering iron and add a small amount of new solder as required to insure a good electrical connection.

e. Clean excessive flux from the connection and adjoining area.

5-43. SERVICING ROTARY SWITCHES.

5-44. The 331A/332A has four rotary type switches: FUNCTION, SENSITIVITY, FREQUENCY RANGE, and METER RANGE. When working on these switches, observe the following rules:

a. Use a low-heat (25 to 50 watts) small-tip soldering iron, and a small diameter rosin core solder.

b. When replacing components, attempt to dress them as nearly to their original alignment as possible.

c. Clean excessive flux from the connection and adjoining area.

d. After cleaning the switch, apply a light coat of lubriplate to the switch detent balls. DO NOT apply lubricant to the switch contacts or allow lubricant to contaminate components.

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PERFORMANCE CHECK TEST CARD

Hewlett-Packard Model 331A/332A
Distortion Analyzer
Serial No. _____

Test performed by _____
Date _____

DESCRIPTION	CHECK	
1. Fundamental Rejection Check:	Specification	Indication
500 Hz, 5 kHz, 50 kHz, 250 kHz, 600 kHz	>-80 dB	☐
2. Second Harmonic Accuracy Check:	Specification	Indication
15 Hz	<+1.0 dB	☐
10 kHz	<±0.6 dB	☐
50 kHz	<-1.0 dB	☐
200 kHz	<-2.0 dB	☐
500 kHz	<-3.0 dB	☐
3. Instrument Induced Distortion Check:	Specification	Indication
500 Hz	>-70 dB	☐
250 kHz	>-64 dB	☐
600 kHz	>-64 dB	☐
4. Frequency Calibration Accuracy Check:	Specification	Indication
10 Hz	95 msec to 105 msec	☐
1 kHz	950 Hz to 1050 Hz	☐
100 kHz	95 kHz to 105 kHz	☐
200 kHz	190 kHz to 210 kHz	☐
400 kHz	360 kHz to 440 kHz	☐
600 kHz	540 kHz to 660 kHz	☐
5. Input Impedance Check:	Specification	Indication
Resistance Check, Voltmeter	1 MΩ ±5%	☐
Resistance Check, Set Level	1 MΩ ±5%	☐
Capacitance Check, Voltmeter		
1 V	<30 pF (331A)	☐
	<35 pF (332A)	☐
0.1 V	<70 pF	☐
Capacitance Check, Set Level		
0.1 V	<70 pF	☐
6. Minimum Input Level Check:	Specification	Indication
0.3 V	100% set level	☐
7. DC Isolation Check:	Specification	Indication
331A/332A Meter	No change in indication	☐
Power Supply Ammeter	No indication	☐
8. Voltmeter Accuracy and Frequency Response Check:	Indication	
Accuracy Check	Min.	Max.
0.0003 V	294 μV ☐	306 μV
0.001 V	0.98 mV ☐	102 mV

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PERFORMANCE CHECK TEST CARD (Cont'd)

8. Accuracy Check (Cont'd)	Indication Min.		Max.
0.003 V	2.94 mV	☐	3.06 mV
0.01 V	9.8 mV	☐	10.2 mV
0.03 V	29.4 mV	☐	30.6 mV
0.1 V	98 mV	☐	102 mV
0.3 V	0.294 V	☐	0.306 V
1 V	0.98 V	☐	1.02 V
3 V	2.94 V	☐	3.06 V
10 V	9.8 V	☐	10.2 V
30 V	29.4 V	☐	30.6 V
100 V	98.0 V	☐	102.0 V
300 V	294.0 V	☐	306.0 V
Frequency Response Check, 3 V range	**Min.**		**Max.**
10 Hz	2.94 V	☐	3.06 V
1 kHz	2.94 V	☐	3.06 V
10 kHz	2.94 V	☐	3.06 V
100 kHz	2.94 V	☐	3.06 V
1 MHz	2.94 V	☐	3.06 V
2 MHz	2.85 V	☐	3.15 V
3 MHz	2.85 V	☐	3.15 V
Frequency Response Check, 0.0003 V range	**Min.**		**Max.**
20 Hz	285 μV	☐	315 μV
30 Hz	294 μV	☐	306 μV
1 kHz	294 μV	☐	306 μV
10 kHz	294 μV	☐	306 μV
100 kHz	294 μV	☐	306 μV
300 kHz	294 μV	☐	306 μV
500 kHz	285 μV	☐	315 μV

9. Residual Noise Check:	Specification	Indication
600 Ω Load	<25 μV	☐
100 kΩ Load	<30 μV	☐

10. AM Detector Check (Model 332A only)	Specification	Indication
Distortion	>-40 dB	☐

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SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alphameric order of their reference designators and indicates the description, -hp- part number of each part, together with any applicable notes, and provides the following:

a. Total quantity used in the instrument (TQ column). The total quantity of a part is given the first time the part number appears.

b. Descriptions of the part. (See list of abbreviations below.)

c. Typical manufacturer of the part in a five-digit code. (See Appendix for list of manufacturers.) Parts that are manufactured by Hewlett-Packard are identified by the abbreviation -hp-.

d. Manufacturer's part number.

6-3. Figures 6-1 through 6-3 illustrate the replaceable mechanical parts used in the 331A/332A. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION.

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (See Appendix for list of office locations.) Identify parts by their Hewlett-Packard part numbers. Include instrument model and serial numbers.

6-6. NON-LISTED PARTS.

6-7. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

ABBREVIATIONS

Ag ..... silver
Al ..... aluminum
A ..... ampere(s)
Au ..... gold

C ..... capacitor
cer ..... ceramic
coef ..... coefficient
com ..... common
comp ..... composition
conn ..... connection

dep ..... deposited
DPDT ..... double-pole double-throw
DPST ..... double-pole single-throw

elect ..... electrolytic
encap ..... encapsulated

F ..... farad(s)
FET ..... field effect transistor
fxd ..... fixed

GaAs ..... gallium arsenide
GHz ..... gigahertz = 10^{+9} hertz
gd ..... guard(ed)
Ge ..... germanium
grd ..... ground(ed)

H ..... henry(ies)
Hg ..... mercury
Hz ..... hertz (cycle(s) per second)

ID ..... inside diameter
impg ..... impregnated
incd ..... incandescent
ins ..... insulation(ed)

kΩ ..... kilohm(s) = 10^{+3} ohms
kHz ..... kilohertz = 10^{+3} hertz

L ..... inductor
lin ..... linear taper
log ..... logarithmic taper

mA ..... milliampere(s) = 10^{-3} amperes
MHz ..... megahertz = 10^{+6} hertz
MΩ ..... megohm(s) = 10^{+6} ohms
met flm ..... metal film
mfr ..... manufacturer
ms ..... millisecond
mtg ..... mounting
mV ..... millivolt(s) = 10^{-3} volts
μF ..... microfarad(s)
μs ..... microsecond(s)
μV ..... microvolt(s) = 10^{-6} volts
my ..... Mylar (R)

nA ..... nanoampere(s) = 10^{-9} amperes
NC ..... normally closed
Ne ..... neon
NO ..... normally open
NPO ..... negative positive zero (zero temperature coefficient)

ns ..... nanosecond(s) = 10^{-9} seconds
nsr ..... not separately replaceable

Ω ..... ohm(s)
obd ..... order by description
OD ..... outside diameter

p ..... peak
pA ..... picoampere(s)
pc ..... printed circuit
pF ..... picofarad(s) 10^{-12} farads
piv ..... peak inverse voltage
p/o ..... part of
pos ..... position(s)
poly ..... polystyrene
pot ..... potiometer
p-p ..... peak-to-peak
ppm ..... parts per million
prec ..... precision (temperature coefficient, long term stability, and/or tolerance)

R ..... resistor
Rh ..... rhodium
rms ..... root-mean-square
rot ..... rotary

Se ..... selenium
sect ..... section(s)
Si ..... silicon
sl ..... slide

SPDT ..... single-pole double-throw
SPST ..... single-pole single-throw

Ta ..... tantalum
TC ..... temperature coefficient
TiO_2 ..... titanium dioxide
tog ..... toggle
tol ..... tolerance
trim ..... trimmer
TSTR ..... transistor

V ..... volt(s)
vacw ..... alternating current working voltage
var ..... variable
vdcw ..... direct current working voltage

W ..... watt(s)
w/ ..... with
wiv ..... working inverse voltage
w/o ..... without
ww ..... wirewound

* ..... optimum value selected at factory, average value shown (part may be omitted)
** ..... no standard type number assigned (selected or special type

(R) Dupont de Nemours

DECIMAL MULTIPLIERS

Prefix	Symbols	Multiplier	Prefix	Symbols	Multiplier
tera	T	10^{12}	centi	c	10^{-2}
giga	G	10^{9}	milli	m	10^{-3}
mega	M or Meg	10^{6}	micro	μ	10^{-6}
kilo	K or k	10^{3}	nano	n	10^{-9}
hecto	h	10^{2}	pico	p	10^{-12}
deka	da	10	femto	f	10^{-15}
deci	d	10^{-1}	atto	a	10^{-18}

DESIGNATORS

A ..... assembly
B ..... motor
BT ..... battery
C ..... capacitor
CR ..... diode
DL ..... delay line
DS ..... lamp
E ..... misc electronic part
F ..... fuse

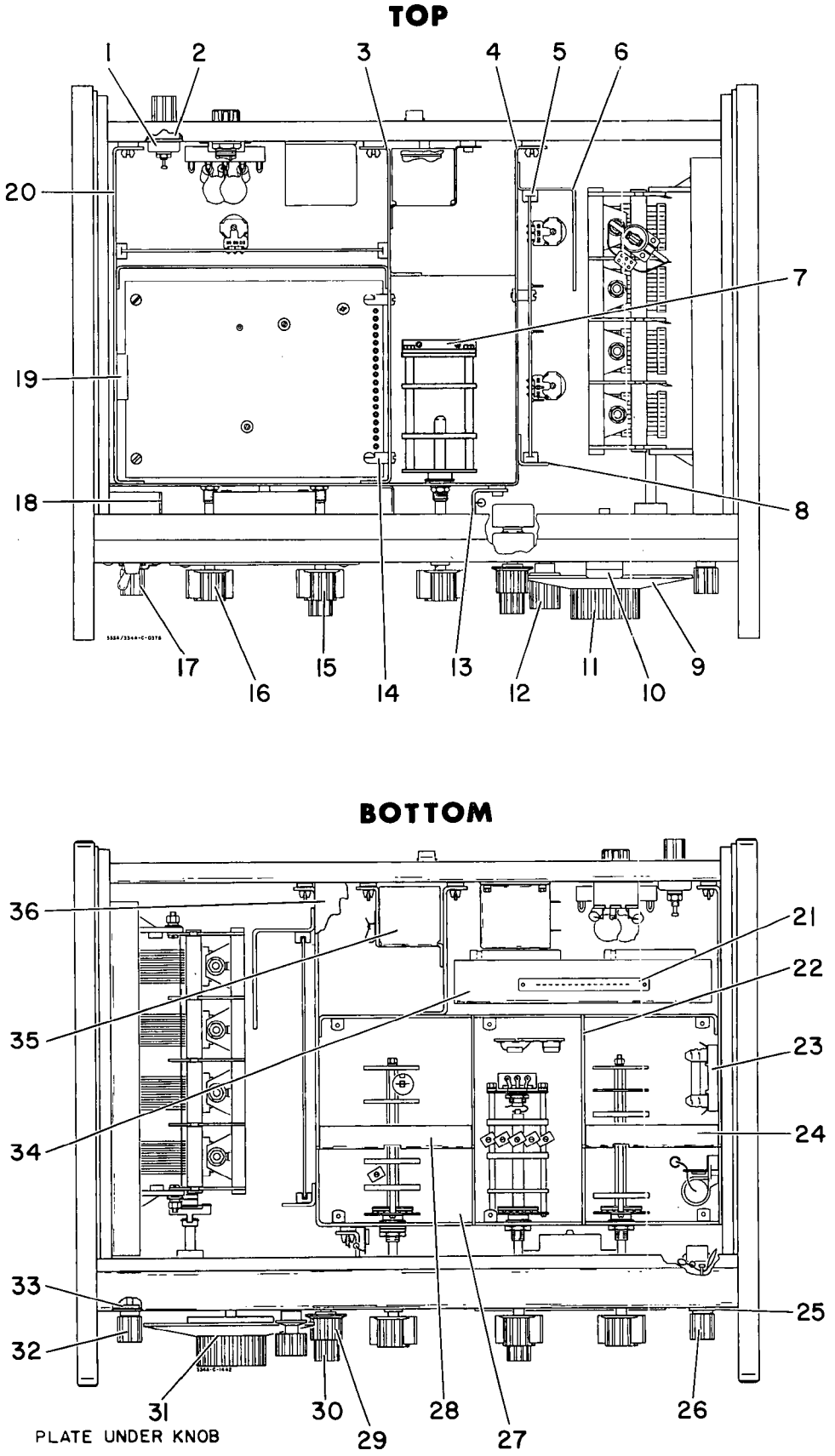
FL ..... filter
HR ..... heater
IC ..... integrated circuit
J ..... jack
K ..... relay
L ..... inductor
M ..... meter
MP ..... mechanical part
P ..... plug

Q ..... transistor
QCR ..... transistor-diode
R ..... resistor
RT ..... thermistor
S ..... switch
T ..... transformer
TB ..... terminal board
TC ..... thermocouple
TP ..... test point

TS ..... terminal strip
V ..... vacuum tube, neon bulb, photocell, etc.
W ..... cable
X ..... socket
XDS ..... lampholder
XF ..... fuseholder
Y ..... crystal
Z ..... network

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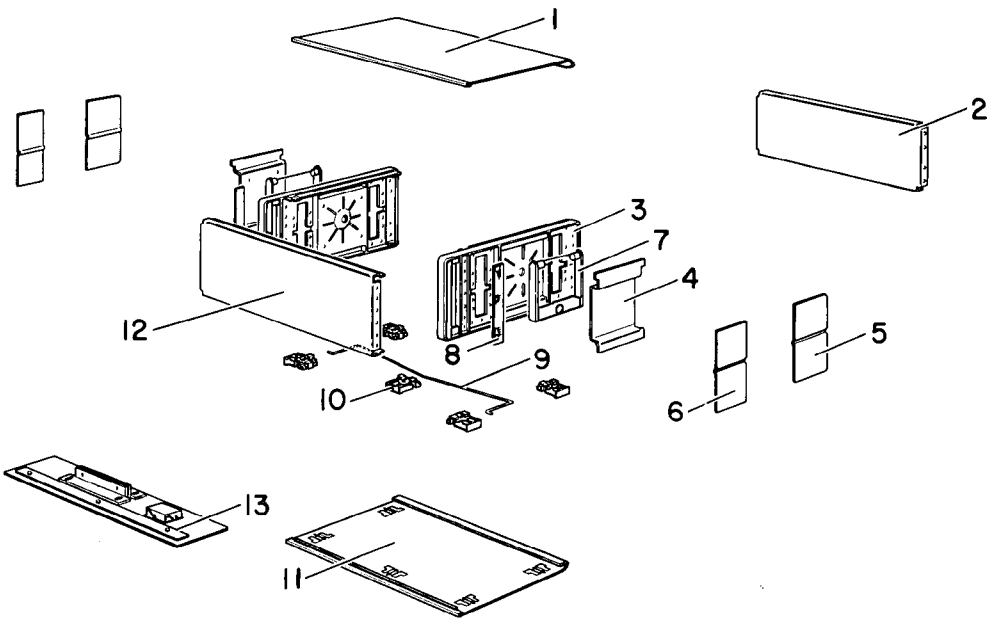
P/O Figure 6-1. Mechanical Parts

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INDEX NO.	-hp- PART NO.	TQ	DESCRIPTION
1	0340-0087	1	Insulator: binding post triple
2	0340-0091	1	Insulator: binding post triple
3	00331-00104	1	Gusset: center
4	00331-04301	1	Plate: panel
5	5040-0601	4	Glide: plastic
6	00331-01202	1	Bracket: pc board mount rear
7	00331-01205	1	Bracket: switch mtg
8	00331-01203	1	Bracket: pc mount
9	00331-04001	1	Dial plate
10	5040-0642	1	Indicator: dial
11	0370-0160	1	Knob: dial round black
12	0370-0025	1	Knob: vernier round black
13	00331-01201	1	Bracket: support
14	0380-0200	2	Standoff: hinged
15	0370-0113	1	Knob: skirted bar black
16	0370-0112	3	Knob: skirted bar black
17	1510-0010	4	Binding post assembly: red insulator
18	00332-00601	1	Shield: power
19	00333-01202	1	Bracket: pc mounting
20	00331-00103	1	Gusset: side
21	1251-0135	1	Connector: pc 15 pin
22	00331-00601	2	Shield: divider
23	0510-0748	1	Holder: fuse
24	00331-00602	1	Shield: switch function
25	0340-0099	5	Insulator: binding post
26	5060-4916	1	Binding post assembly
27	00331-00101	1	Deck: main
28	00331-00603	1	Shield: switch range
29	0370-0117	1	Knob: balance skirted black
30	0370-0114	2	Knob: vernier round red
31	61B-40D-4	1	Plate: frequency dial
32	1510-0011	3	Binding post assembly: black insulator
33	0340-0100	5	Insulator: binding post
34	00331-01204	1	Bracket: mounting
35	00332-00602	1	Shield: RF detector
36	00331-04102	1	Cover: plate

P/O Figure 6-1. Mechanical Parts

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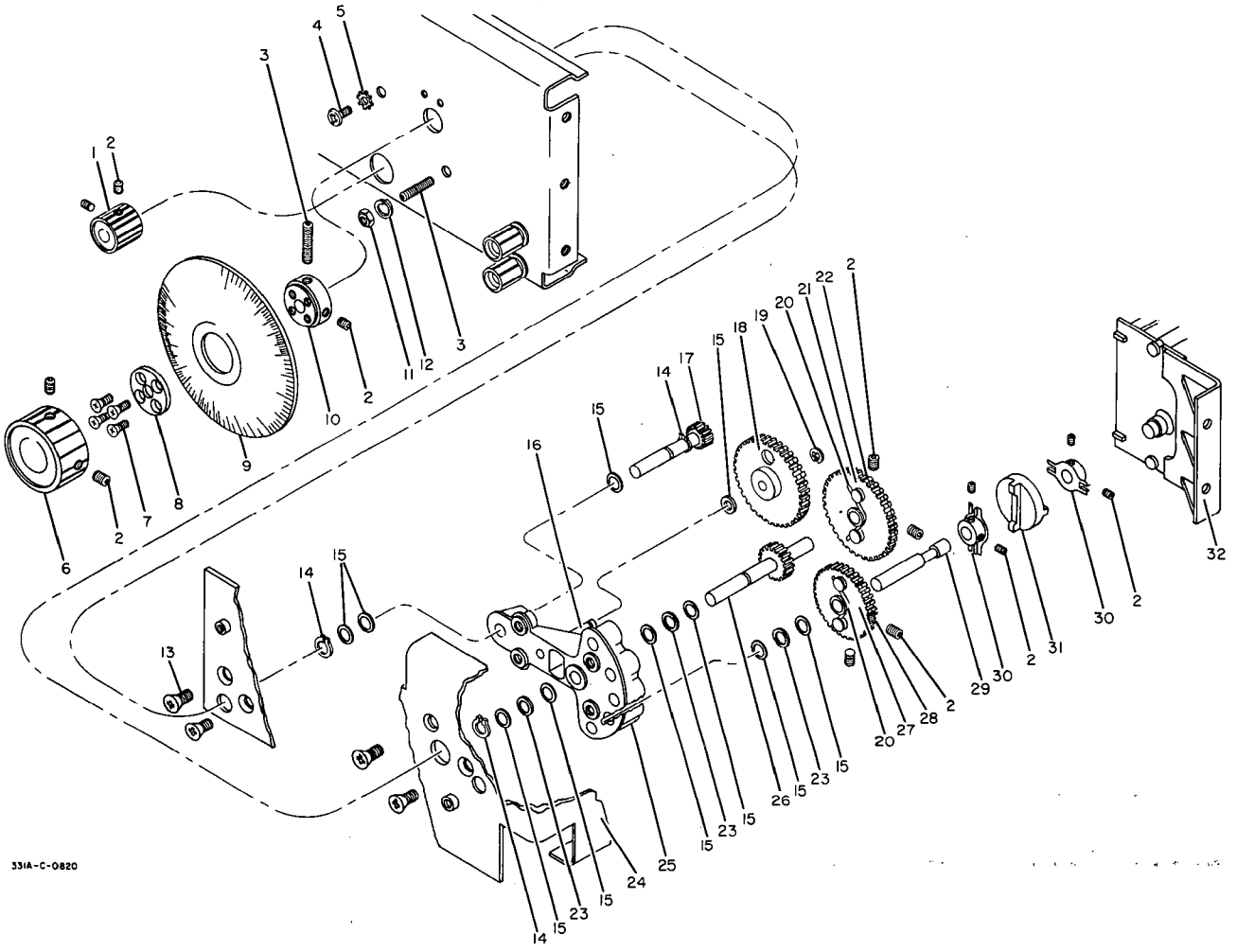


INDEX NO.	-hp- PART NO.	TQ	DESCRIPTION
1	5060-0739	1	Top cover assembly
2	#00331-00204 #00332-00204	1 1	Panel: rear (331A) Panel: rear (332A)
3	5060-0731	2	Frame assembly
4	5060-0766	2	Retainer: handle assembly
5	5000-0732	2	Side cover: rear
6	5000-0733	2	Side cover: front
7	5060-0222	2	Handle assembly:
8	5000-0051	2	Beauty strip
9	1490-0030	1	Tilt stand
10	5060-0767	5	Foot assembly
11	5060-0751	1	Bottom cover assembly
12	00331-00201 00332-00201	1 1	Panel: front (331A) Panel: front (332A)
13	5060-0775	1	Kit: rack mount

See Appendix C for backdating

Figure 6-2. Modular Cabinet Parts

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INDEX	-hp- PART NO.	DESCRIPTION
1	0370-0025	Knob: vernier
2	3030-0001	Set screw
3	3030-0004	Set screw
4	2390-0009	Screw
5	2190-0010	Lock washer
6	0370-0160	Knob: dial
7	2370-0016	Screw
8	61B-40D-4	Plate: frequency dial
9	00331-04001	Dial plate
10	5020-0630	Dial: hub
11	2580-0002	Hex nut
12	2190-0017	Lock washer
13	2530-0003	Screw
14	0510-0005	Clip: retaining
15	3050-0017	Washer
16	00331-23701	Shaft: idler
17	00331-63602	Vernier drive assembly
18	00331-63603	Gear assembly: idler
19	0510-0043	Ring, retaining
20	5000-0637	Spring: thrust
21	00331-63605	Gear assembly
22	00331-63604	Gear assembly: Reduction fixed
23	3050-0180	Spacer, nylon
24	00331-00102	Plate: cap mount
25	5020-0639	Casting: cap drive
26	00331-63601	Gear: spur assembly
27	5060-0020	Gear: assembly
28	5060-0021	Gear: assembly
29	00331-23703	Shaft: cap drive
30	1500-0253	Coupler: hub
31	5040-0004	Coupler: insulator
32	5040-0631	Bracket: cap mounting

Figure 6-3. Frequency Tuning Assembly (-hp- Part No. 00331-60701)

NOTE

C3, C4, and C6 are included in assembly, but not shown here. Items 1 thru 9 are not included in assembly, and must be ordered separately.

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Table 6-1. Replaceable Parts

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A1	00333-66501		1	Assembly: etched circuit board, power supply includes: C1 thru C11 Q1 thru Q6 CR1 thru CR7 R1 thru R15	-hp-		
A1C1 and A1C2	0180-0308		2	C: fxd Al elect 200 μF +100% -10% 50 vdcw	56289	34D207H050GL4	
A1C3	0180-0061		4	C: fxd elect 100 μF +100% -10% 15 vdcw	56289	30D107GD15DD4	
A1C4	0150-0085		1	C: fxd my 2200 pF ±10%, 400 vdcw	56289	29C332	
A1C5	0180-0058		3	C: fxd elect 50 μF +100% -10% 25 vdcw	56289	D28110	
A1C6	0180-0050		2	C: fxd Al elect 40 μF +100% -10% 50 vdcw	56289	D32538	
A1C7	0180-0039		3	C: fxd elect 100 μF 12 vdcw	56289	D32697	
A1C8				Not assigned			
A1C9	0180-0061			C: fxd elect 100 μF +100% -10% 15 vdcw	56289	30D107GD15DD4	
A1C10	0180-0059		1	C: fxd elect 10 μF +100% -10% 25 vdcw	56289	30D106G025BB4	
A1C11	0180-0050			C: fxd Al elect 40 μF +100% -15% 50 vdcw	56289	D32538	
A1CR1 thru A1CR6	1901-0158		6	Diode: Si rectifier 0.75 A 200 piv	-hp-		
A1CR7	1902-0045		1	Diode: breakdown 7.2 V +2% 400 mW	04713	SZ10939-144	
A1Q1	1854-0062		2	TSTR: Si NPN 2N1701	02735	2N1701	
A1Q2 and A1Q3	1854-0039		2	TSTR: Si NPN 2N3053	86684	2N3053	
A1Q4 and A1Q5	1853-0012		2	TSTR: Si PNP 2N2904A	04713	2N2904A	
A1Q6	1854-0062			TSTR: Si NPN 2N1701	02735	2N1701	
#A1R1				Not assigned			
A1R2	0766-0029		2	R: fxd met flm 10 Ω ±2% 3 W T/C ±250 PPM/°C	07115	LPI-3	obd
A1R3	0686-1025		3	R: fxd comp 1000 Ω ±5% 1/2 W	01121	EB1025	
A1R4	0686-7525		4	R: fxd comp 7500 Ω ±5% 1/2 W	01121	CB7525	
A1R5	0686-6825		4	R: fxd comp 6800 Ω ±5% 1/2 W	01121	EB6825	
A1R6	0698-4471		1	R: fxd met flm 7.15 kΩ ± 1% 1/8 W	91637	MF-1/10-32	obd
A1R7	0757-0440		1	R: fxd met flm 7.5 kΩ ± 1% 1/8 W	75042	CEA	obd
A1R8	0686-1025			R: fxd comp 1000 Ω ±5% 1/2 W	01121	EB1025	
A1R9	0766-0029			R: fxd met flm 10 Ω ±2% 3 W T/C ±250 PPM/°C	07115	LPI-3	obd
A1R10 and A1R11	0686-6825			R: fxd comp 6800 Ω ±5% 1/2 W	01121	EB6825	
A1R12	0686-7525			R: fxd comp 7500 Ω ±5% 1/2 W	01121	CB7525	
#A1R13	2100-2633		1	R: var lin 1 kΩ ±10% 1/2 W	-hp-		
A1R14	0686-1525		1	R: fxd comp 1500 Ω ±5% 1/2 W	01121	EB1525	
A1R15	0686-5125			R: fxd comp 5100 Ω ±5% 1/2 W	01121	EB5125	
A2	00333-66502		1	Assembly: etched circuit board, meter amplifier and impedance converter includes: C1 thru C29 Q1 thru Q9 CR1 thru CR8 R1 thru R51	-hp-		
A2	00333-66508		1	Assembly: etched circuit board, meter amplifier and impedance converter (Option 01 only) includes: C1 thru C25 Q1 thru Q9 C27 thru C29 R1 thru R51 CR1 thru CR8	-hp-		
A2C1	0140-0201		1	C: fxd mica 12 pF ±5%	04062	RDM15C120J5C	
A2C2 and A2C3	0140-0200		3	C: fxd mica 390 pF ±5%	04062	RDM15F391J3C	
A2C4	0180-0101		1	C: fxd solid Ta 1.8 μF ±10% 35 vdcw	-hp-		
A2C5	0180-0033		2	C: fxd elect 50 μF +100% -10% 6 vdcw	56289	D32653	

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Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2C6	0180-0060		2	C: fxd elect 200 μF +100% -10% 3 vdcw	56289	30D207G003DC4
A2C7	0140-0145		1	C: fxd mica 22 pF ±5%	04062	RDM15C220J5C
A2C8	0180-0224		1	C: fxd Al elect 10 μF +75% -10% 15 vdcw	56289	30D106G015BA4
A2C9	0140-0193		1	C: fxd mica 82 pF ±5%	-hp-	
A2C10	0180-0104		2	C: fxd Al elect 200 μF +100% -10% 15 vdcw	56289	30D207G015DH4
A2C11	0140-0200			C: fxd mica 390 pF ±5%	04062	RDM15F391J3C
A2C12	0180-1735		1	C: fxd Ta 0.22 μF ±10% 35 vdcw	56289	150D224X9035A2-DYS
A2C13	0160-0161		1	C: fxd my 0.01 μF ±10% 200 vdcw	-hp-	
A2C14	0180-0307		3	C: fxd Al elect 500 μF +100% -10% 15 vdcw	56289	34D507H015FJ4
A2C15	0180-1736		1	C: fxd Al elect 1300 μF +75% -10% 25 vdcw	56289	34D138G2R5FJ4-DSB
A2C16	0160-0195		1	C: fxd cer 1000 pF ±20% 250 vacw	56289	19C251
A2C17	0140-0218		1	C: fxd mica 160 pF ±2%	04062	RDM15F161G3C
A2C18	0180-0061			C: fxd elect 100 μF +100% -10% 15 vdcw	56289	30D107GD15DD4
A2C19	0140-0200		1	C: fxd mica 390 pF ±5%	-hp-	
A2C20	0180-0376		1	C: fxd solid Ta 0.47 μF ±10% 35 vdcw	56289	150D474X9035A2-DYS
A2C21	0130-0017		1	C: var cer 8 to 50 pF	72982	557-019-U2P0-34R
A2C22*	0140-0190		1	C: fxd mica 39 pF ±5%	04062	RDM15E390J3C
A2C23*	0140-0218		1	C: fxd mica 160 pF ±2%	-hp-	
A2C24	0150-0121		1	C: fxd cer 0.1 μF +80% -20% 50 vdcw	56289	5C50B1-CML
A2C25	0180-0061			C: fxd elect 100 μF +100% -10% 15 vdcw	56289	30D107GD15DD4
A2C26	0180-0033			C: fxd elect 50 μF +100% -10% 6 vdcw (omitted on Option 01)	56289	D32653
A2C27 and A2C28	0180-0058			C: fxd elect 50 μF +100% -10% 25 vdcw	56289	D28110
A2C29*	0140-0198		1	C: fxd mica 200 pF ±5%	-hp-	
A2CR1 thru A2CR4	1901-0044		4	Diode: rectifier Si 20 mA +1 V	07910	obd
A2CR5				Not assigned		
A2CR6 and A2CR7	1901-0535		1	Diode: Hot Carrier 15 V	-hp-	
A2CR8	1902-0584		1	Diode: breakdown 14.0 V ±5%	07263	FZ1960
A2Q1	1855-0052		1	TSTR: Si FET P channel **	-hp-	
A2Q2	1853-0203		1	TSTR: Si PNP **	-hp-	
#A2Q3	1854-0354		1	TSTR: Si NPN**	-hp-	
A2Q4	1853-0086			TSTR: Si PNP **	-hp-	
A2Q5	1854-0297		3	TSTR: Si NPN **	-hp-	
A2Q6	1853-0010		3	TSTR: Si PNP **	-hp-	
A2Q7	1854-0019		1	TSTR: Si NPN **	-hp-	
A2Q8 and A2Q9	1853-0010			TSTR: Si PNP **	-hp-	
A2R1	0683-3015		2	R: fxd comp 300 Ω ± 5% 1/4 W	01121	CB3015
A2R2	0683-9135		1	R: fxd comp 91 kΩ ±5% 1/4 W	01121	CB9135
#A2R3	2100-2031		1	R: var comp lin 50 kΩ ±10% 1/2 W	-hp-	
A2R4	0683-3635		1	R: fxd comp 36 kΩ ±5% 1/4 W	01121	CB3635
A2R5	0683-5145		1	R: fxd comp 510 kΩ ±5% 1/4 W	01121	CB5145
A2R6	0683-1025		2	R: fxd comp 1000 Ω ±5% 1/4 W	01121	CB1025
A2R7	0683-3025		4	R: fxd comp 3000 Ω ± 5% 1/4 W	01121	CB3025
A2R8	0683-1025			R: fxd comp 1000 Ω ±5% 1/4 W	01121	CB1025
A2R9	0683-7515		1	R: fxd comp 750 Ω ±5% 1/4 W	01121	CB7515
A2R10	0683-1535		1	R: fxd comp 15 kΩ ±5% 1/4 W	01121	CB1535
A2R11	0683-4335		1	R: fxd comp 43 kΩ ±5% 1/4 W	01121	CB4335
A2R12	0683-6215		2	R: fxd comp 620 Ω ±5% 1/4 W	01121	CB6215

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Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A2R13	0683-6815		1	R: fxd comp 680 Ω ±5% 1/4 W	01121	CB6815	
A2R14	0683-1515		1	R: fxd comp 150 Ω ±5% 1/4 W	01121	CB1515	
A2R15	0683-4715		1	R: fxd comp 470 Ω ±5% 1/4 W	01121	CB4715	
A2R16	0683-4705		1	R: fxd comp 47 Ω ±5% 1/4 W	01121	CB4705	
A2R17	0683-6215			R: fxd comp 620 Ω ±5% 1/4 W	01121	CB6215	
A2R18	0683-2405		3	R: fxd comp 24 Ω ±5% 1/4 W	01121	CB2405	
A2R19	0683-2015		2	R: fxd comp 200 Ω ±5% 1/4 W	01121	CB2015	
#A2R20	2100-1738		1	R: var cermet flm lin 10 kΩ ±10% 1/2 W	-hp-		
A2R21	0683-3025			R: fxd comp 3000 Ω ±5% 1/4 W	01121	CB3025	
A2R22	0683-5115		3	R: fxd comp 510 Ω ±5% 1/4 W	01121	CB5115	
A2R23	0683-5105		3	R: fxd comp 51 Ω ±5% 1/4 W	01121	CB5105	
A2R24	0683-6825		1	R: fxd comp 6800 Ω ±5% 1/4 W	01121	CB6825	
A2R25	0683-2015			R: fxd comp 200 Ω ±5% 1/4 W	01121	CB2015	
A2R26	0683-2025		3	R: fxd comp 2000 Ω ±5% 1/4 W	01121	CB2025	
A2R27	0683-1235		1	R: fxd comp 12 kΩ ± 5% 1/4 W	01121	CB1235	
A2R28	0683-2405			R: fxd comp 24 Ω ±5% 1/4 W	01121	CB2405	
A2R29	0698-3174		1	R: fxd carbon flm 4.42 Ω ±1% 1/2 W	94459	CVF	obd
A2R30*	0683-3015			R: fxd comp 300 Ω ±5% 1/4 W	01121	CB3015	
A2R31				Not assigned			
A2R32	0698-3147		1	R: fxd met flm 191 Ω ±1% 1/4 W	19701	MF5C T-0	obd
	0757-1102		1	R: fxd 180 Ω ±1% 1/8 W (Option 01 only)	19701	MF5C T-0	obd
A2R33	0757-0346		2	R: fxd met flm 10 Ω ±1% 1/8 W	97913	obd	
A2R34	2100-0206		1	R: fxd ww 50 Ω ±10%	79727	E870	obd
A2R35	0757-0346			R: fxd met flm 10 Ω ±1% 1/8 W	97913	obd	
A2R36	0683-3945		1	R: fxd comp 390 kΩ ±5% 1/4 W	01121	CB3945	
A2R37	0683-3025			R: fxd comp 3000 Ω ±5% 1/4 W	01121	CB3025	
A2R38	0683-1015		3	R: fxd comp 100 Ω ±5% 1/4 W	01121	CB1015	
# A2R39	2100-1788		1	R: var cermet flm lin 500 Ω ±10% 1/2 W	-hp-		
A2R40	0757-0390		1	R: fxd 36.5 Ω ±1% 1/8 W	-hp-		
A2R41	0683-1815		1	R: fxd comp 180 Ω ±5% 1/4 W	01121	CB1815	
A2R42	0683-1005		1	R: fxd comp 10 Ω ±5% 1/4 W	01121	CB1005	
A2R43	0683-2425		1	R: fxd comp 2400 Ω ±5% 1/4 W	01121	CB2425	
A2R44	0683-1015			R: fxd comp 100 Ω ±5% 1/4 W	01121	CB1015	
A2R45	0683-2405			R: fxd comp 24 Ω ±5% 1/4 W	01121	CB2405	
A2R46	0683-3025			R: fxd comp 3000 Ω ±5% 1/4 W	01121	CB3025	
A2R47 and A2R48	0683-5115			R: fxd comp 510 Ω ±5% 1/4 W	01121	CB5115	
	0683-5105			R: fxd comp 51 Ω ±5% 1/4 W (Option 01 only)	01121	CB5105	
A2R49 and A2R50	0683-2025			R: fxd comp 2000 Ω ±5% 1/4 W	01121	CB2025	
A2R51	0683-1245			R: fxd comp 120 kΩ ±5% 1/4 W	01121	CB1245	
#A3	00333-66503		1	Assembly: etched circuit board, rejection amplifier includes: C1 thru C15 R1 thru R29 Q1 thru Q6	-hp-		
A3C1	0180-0039			C: fxd elect 100 μF 12 vdcw	56289	D32697	
A3C2	0180-0060			C: fxd elect 200 μF +100% -10% 3 vdcw	56289	30D207G003DC4	
A3C3	0180-0022		2	C: fxd Ta elect 3.9 μF ±10% 35 vdcw	56289	obd	
A3C4	0140-0190		1	C: fxd mica 39 pF ±5% 500 vdcw	14655	obd	
A3C5	0140-0092		1	C: fxd mica 240 pF ±5%	04062	RCM15E241J	
A3C6	0180-0022			C: fxd Ta elect 3.9 μF ±10% 35 vdcw	56289	obd	
A3C7	0170-0040		1	C: fxd my 0.047 μF ±10%	56289	192P47392A	
A3C8	0180-0039			C: fxd elect 100 μF 12 vdcw	56289	D32697	

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Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.	
A3C9	0180-0062		1	C: fxd elect 300 μF +100% -10% 6 vdcw	56289	30D137G006DH4	
A3C10	0140-0196		1	C: fxd mica 150 pF ±5% 300 vdcw	-hp-		
# A3C11*	0140-0110		1	C: fxd mica 127 pF ±2%	-hp-		
A3C12	0180-0104			C: fxd Al elect 200 μF +100% -10% 15 vdcw	56289	30D207G015DH4	
A3C13	0180-0307			C: fxd Al elect 500 μF +100% -10% 15 vdcw	56289	34D507H015FJ4	
A3C14*	0140-0014		1	C: fxd mica 56 pF ±10%	04062	RCM15E560K	
A3C15	0180-0307			C: fxd Al elect 500 μF +100% -10% 15 vdcw	56289	34D507H015FJ4	
# A3CR1	1901-0053		1	Diode: Si 30 V	-hp-		
A3Q1	1854-0215			TSTR: Si NPN**	-hp-		
A3Q2	1854-0297			TSTR: Si NPN**	-hp-		
A3Q3	1854-0354			TSTR: Si NPN**	04713	SS2077	
A3Q4	1855-0006		2	TSTR: Si P FET channel	OOOLD	SU414A	
A3Q5	1854-0354		1	TSTR: Si NPN**	04713	SS2077	
A3Q6	1853-0036		1	TSTR: Si PNP 2N3906	04713	2N3906-18	
A3R1	0686-2415		1	R: fxd comp 240 Ω ±5% 1/2 W	01121	EB2415	
A3R2	0686-1245		1	R: fxd comp 120 kΩ ±5% 1/2 W	01121	EB1245	
A3R3	0686-1035		1	R: fxd comp 10 kΩ ±5% 1/2 W	01121	EB1035	
A3R4	2100-2522		1	R: var lin 10 kΩ ±10%	73138	62-227-1	obd
A3R5	0686-2015		2	R: fxd comp 200 Ω ±5% 1/2 W	01121	EB2015	
A3R6	0686-3625		2	R: fxd comp 3600 Ω ±5% 1/2 W	01121	EB3625	
A3R7	0686-1025			R: fxd comp 1000 Ω ±5% 1/2 W	01121	EB1025	
A3R8	0686-6825			R: fxd comp 6800 Ω ±5% 1/2 W	01121	EB6825	
A3R9	0757-0281		1	R: fxd comp 2740 Ω ±1% 1/8 W	-hp-		
A3R10	0686-1515		1	R: fxd comp 150 Ω ±5% 1/2 W	01121	EB1515	
A3R11	0686-2035		1	R: fxd comp 20 kΩ ±5% 1/2 W	01121	EB2035	
A3R12	0757-0830		1	R: fxd met flm 3920 Ω ±1% 1/2 W	-hp-		
# A3R13	0698-3537		1	R: fxd met flm 7.15 kΩ ±1% 1/2 W	-hp-		
# A3R14	0757-0827		1	R: fxd met flm 2.74 kΩ ±1% 1/2 W	-hp-		
A3R15	0686-1265			R: fxd comp 12 MΩ ±5% 1/2 W	01121	EB1265	
A3R16	2100-2439		1	R: var lin 5KΩ ±10%	73138	62-226-1	obd
# A3R17*	0686-3025		1	R: fxd comp 3000 Ω ±5% 1/2 W	-hp-		
A3R18	0686-7525			R: fxd comp 7500 Ω ±5% 1/2 W	01121	CB7525	
A3R19	0683-1015			R: fxd comp 100 Ω ±5% 1/4 W	01121	CB1015	
A3R20	0686-3625			R: fxd comp 3600 Ω ±5% 1/2 W	01121	EB3625	
A3R21	0686-5615		1	R: fxd comp 560 Ω ±5% 1/2 W	01121	EB5615	
A3R22	0686-3015		1	R: fxd comp 300 Ω ±5% 1/2 W	01121	EB3015	
A3R23	0686-3315		1	R: fxd comp 330 Ω ±5% 1/2 W	01121	EB3315	
A3R24 and A3R25	0686-2025		3	R: fxd comp 2000 Ω ±5% 1/2 W	01121	EB2025	
A3R26	0686-4705		1	R: fxd comp 47 Ω ±5% 1/2 W	01121	EB4705	
A3R27	0686-2015			R: fxd comp 200 Ω ±5% 1/2 W	01121	EB2015	
A3R28	0686-1035		1	R: fxd comp 10 kΩ ±5% 1/2 W	01121	EB1035	
A3R29	0686-7525			R: fxd comp 7500 Ω ±5% 1/2 W	01121	CB7525	
A3R31	0686-3335		2	R: fxd Comp 33 kΩ ±5% 1/2 W	-hp-		
A3R32	0757-0842		1	R: fxd met flm 13 kΩ ±1% 1/2 W	-hp-		
A3R33	0686-3335			R: fxd comp 33 kΩ ±5% 1/2 W	-hp-		
# A3R34	0683-1035		1	R: fxd comp 10 kΩ ±5% 1/4 W	01121	CB 1035	
# A3R35, R36	0683-4705		1	R: fxd comp 47 Ω ±5% 1/4 W	01121	CB 4705	
# A3R37	0683-4735		1	R: fxd 47 kΩ 5% 1/4 W	01121	CB 4735	
A4	00332-66502		1	Assembly: etched circuit board, RF detector (332A only) includes: C1 thru C3 L1 thru L2 CR1	-hp-		
A4C1 and A4C2	0140-0180		4	C: fxd mica 2000 pF ±2% 300 vdcw	14655	CD19F2026(300V)	
A4C3	0140-0156		1	C: fxd mica 1500 pF ±2%	04062	RDM19F152G3C	
A4CR1	1910-0016		1	Diode: Ge 40 V 100 mA +0.75 piv	93332	D2361	obd
A4L1 and A4L2	9140-0052		2	Coil: RF 3.3 mH	09250	18-400	obd

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Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.	
C1	0160-0953		1	C: fxd my 0.33 μF ±10% 400 vdcw	-hp-		
C2	0160-3327		3	C: fxd my 1 μF ±10% 40 vdcw	84411	663F	
C3	0130-0006		1	C: var cer 5 to 20 pF	72982	503-000 B2P028R	
C4	0121-0004		1	C: var air 12.5 to 535.1 pF 4 sect	-hp-		
C5	0160-3333			C: fxd cer 0.005 μF ±20% 250 vdcw	08988	THD-8-502M-14KV	
C6	0140-0021		2	C: fxd mica 39 pF ±10%	04062	RCM15E390K	
C7	0160-3333			C: fxd cer 0.005 μF ±20% 250 vdcw	08988	THD-8-502M-14KV	
C8	0140-0206		1	C: fxd mica 270 pF ±5% (332A only)	04062	RDM15F271J5C	
CR1	1901-0025		1	Diode: Si 100 mA 100 WV 12 pF (Option 01 only)	93332	D3072	obd
DS1	1450-0048		1	Light: indicator w/o push-on retainer	08717	858-R-C2A	obd
F1	2110-0311		1	Fuse: 1/16 slow-blow (for 115 V operation)	71400	MDL-1/16	obd
	2110-0337		1	Fuse: 1/32 slow-blow (for 230 V operation)	71400	MDL-1/32	obd
F2	2110-0318		1	Fuse: 0.125 A 250 V slow-blow	71400	MDL-1/8	obd
L1 and L2	9140-0041		2	Coil: RF 2.5 mH ±10%	95265	SA-2500-I	obd
L3	9170-0016		1	L: shielding bead (332A only)	02114	56-590-65/3B	
L4	9170-0805		1	Coil: fxd 1.6 mH (332A only)	-hp-		
M1	1120-0352		1	Meter	-hp-		
	1120-0398		1	Meter: volume units (Option 01 only)	-hp-		
R1	0767-0001		1	R: fxd 400 Ω ±5% 3 W	-hp-		
R2	0687-4701		1	R: fxd comp 47 Ω ±10% 1/2 W	01121	EB4701	
R3	0686-3915		1	R: fxd comp 390 Ω ±5% 1/2 W	01121	EB3915	
R4 and R5	2100-1736		1	R: var comp 100 Ω 3000 Ω ±10% 2 W	71590	BAS 1209	obd
R6				Not assigned			
R7	0813-0029		2	R: fxd 1 Ω ±5% 3 W	91637	RS-2B	obd
R8	0683-5125		1	R: fxd 5100 Ω ±5% (332A only)	01121	CB5125	
R9				Not assigned			
R10	0683-1325		1	R: fxd comp 1300Ω ±5% 1/4 W (332A only)	01121	CB1325	
R11	0813-0029			R: fxd 1 Ω ±5% 3 W	91637	RS-2B	obd
#R12	0686-3335		1	R: fxd comp 33 kΩ ±5% 1/2 W	-hp-		
#R13	0757-0955		1	R: fxd flm 20 kΩ ±2% 1/8 W	-hp-		
S1	3100-0878		1	Switch: function	76854		obd
S2	00331-61902		1	Switch assembly: sensitivity includes: C1 thru C10 R1 thru R7	-hp-		
S2C1 thru S2C5	0132-0004		6	C: var trim 0.7 to 3.0 pF	72982	535-009-4R	
S2C6	0160-0205		2	C: fxd mica 10 pF ±5%	04062	RDM15C100J5S	
S2C7	0140-0152		1	C: fxd mica 1000 pF ±5% 300 vdcw	04062	DM16F102J	
S2C8	0160-0958		1	C: fxd mica 390 pF ±5%	04062	RDM15F391J3S	
S2C9	0160-0990		1	C: fxd mica 100 pF ±2%	04062	RDM15F101G3S	
S2C10	0160-0205			C: fxd mica 10 pF ±5%	04062	RDM15C100J5S	
S2R1	0698-3118		1	R: fxd met flm 3240 Ω ±1% 1/2 W	19701	MF7C T-0	obd
S2R2	0698-3119		1	R: fxd met flm 6980 Ω ±1% 1/2 W	19701	MF7C T-0	obd
S2R3	0757-0846		1	R: fxd met flm 22.1 kΩ ±1% 1/2 W	19701	MF7C T-0	obd
S2R4	0698-3120		1	R: fxd met flm 69.8 kΩ ±1% 1/2 W	19701	MF7C T-0	obd
S2R5	0757-0862		1	R: fxd met flm 221 kΩ ±1% 1/2 W	19701	MF7C T-0	obd
S2R6	0698-3121		1	R: fxd met flm 698 kΩ ±1% 1/2 W	19701	MF7C T-0	obd
S2R7	2100-1438		1	R: var pot lin 1 kΩ ±10%	11237	Series 45	obd
S3	00331-61903		1	Switch assembly: meter range includes: C1 thru C6 R1 thru R14	-hp-		
S3C1	0132-0004			C: var trim 0.7 to 3.0 pF	72982	535-009-4R	
S3C2 and S3C3	0140-0180			C: fxd mica 2000 pF ±2% 300 vdcw	14655	CD19F2026(300V)	
S3C4*	0160-0182			C: fxd mica 47 pF ±5%	-hp-		
S3C5	0140-0064		1	C: fxd mica 62 pF ±5%	72136		obd
S3C6	0121-0039		1	C: var cer trim 8 to 50 pF	72982	557-062-U2P0-34R	

#See Appendix C for backdating

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Table 6-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.	
S3R1	0686-2215		1	R: fxd comp 220 Ω ±5% 1/2 W	01121	EB2215	
S3R2	0698-3138		4	R: fxd met flm 277.5 Ω ±1/4% 1/4 W	19701	MF6C T-0	obd
S3R3	0698-3139		5	R: fxd met flm 410.26 Ω ± 1/4% 1/4 W	19701	MF6C T-0	obd
S3R4	0698-3138			R: fxd met flm 277.5 Ω ±1/4% 1/4 W	19701	MF6C T-0	obd
S3R5	0698-3139			R: fxd met flm 410.26 Ω ±1/4% 1/4 W	19701	MF6C T-0	obd
S3R6	0698-3138			R: fxd met flm 277.5 Ω ±1/4% 1/4 W	19701	MF6C T-0	obd
S3R7	0698-3139			R: fxd met flm 410.26 Ω ±1/4% 1/4 W	19701	MF6C T-0	obd
S3R8	0698-3138			R: fxd met flm 277.5 Ω ±1/4% 1/4 W	19701	MF6C T-0	obd
S3R9 and S3R10	0698-3139			R: fxd met flm 410.26 Ω ±1/4% 1/4 W	19701	MF6C T-0	obd
S3R11	0698-3137		1	R: fxd met flm 189.7 Ω ±1/4% 1/4 W	19701	MF6C T-0	obd
S3R12	0698-3146		1	R: fxd met flm 999 kΩ ±1/4% 1/4 W	19701	MF6C T-0	obd
S3R13	0698-3145		1	R: fxd met flm 1 kΩ ±1/4% 1/4 W	19701	MF6C T-0	obd
S3R14*	0683-0685		1	R: fxd comp 6.8 Ω ±5% 1/4 W	01121	CB68G5	
S4	00331-61904		1	Switch assembly: FREQ. RANGE includes: C1 R1 thru R20	-hp-		
S4C1				Part of FREQ. RANGE switch assembly (nsr)			
S4R1 thru S4R20				Part of FREQ. RANGE switch assembly (nsr)			
S5	3101-0036		1	Switch: tog SPST 3 A 250 Vac-dc	88140	8280K16	
S6	3101-1234		1	Switch: sl DPDT 115 - 230 V	82389	11A-1242A	obd
S7	3101-0110		1	Switch: sl DPDT 0.5 A 125 Vdc (332A only)	82389	11A-1039A	obd
T1	9100-0300		1	Transformer: power	-hp-		
#W1	8120-1348		1	Cable assembly: power extra limp	-hp-		
				MISCELLANEOUS			
	0400-0111		4	Bushing: black plastic	28520	SB-437-5	obd
	00331-61603		1	Cable "A"	-hp-		
	00331-61604		1	Cable "B"	-hp-		
	00331-61605		1	Cable "C"	-hp-		
	00331-61602		1	Cable: main	-hp-		
	00332-61602		1	Cable: RD detector	-hp-		
	1400-0043		2	Clip: fahnstock, brass	79963	#146	obd
	1400-0084		1	Holder: fuse extractor post type	75915	342014	
	00331-90006		1	Manual: operating and service	-hp-		
	5040-0702		2	Washer: shoulder	-hp-		
#J4	1251-2357		1	Connector: power	-hp-		
J5	1250-0118		1	Connector: BNC, RF input	000LB	28JR128-1	
	0340-0089		1	Insulator: binding post	-hp-		
	0403-0150		4	Guides: pc board	-hp-		

#See Appendix C for backdating

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SECTION VII
CIRCUIT DIAGRAMS

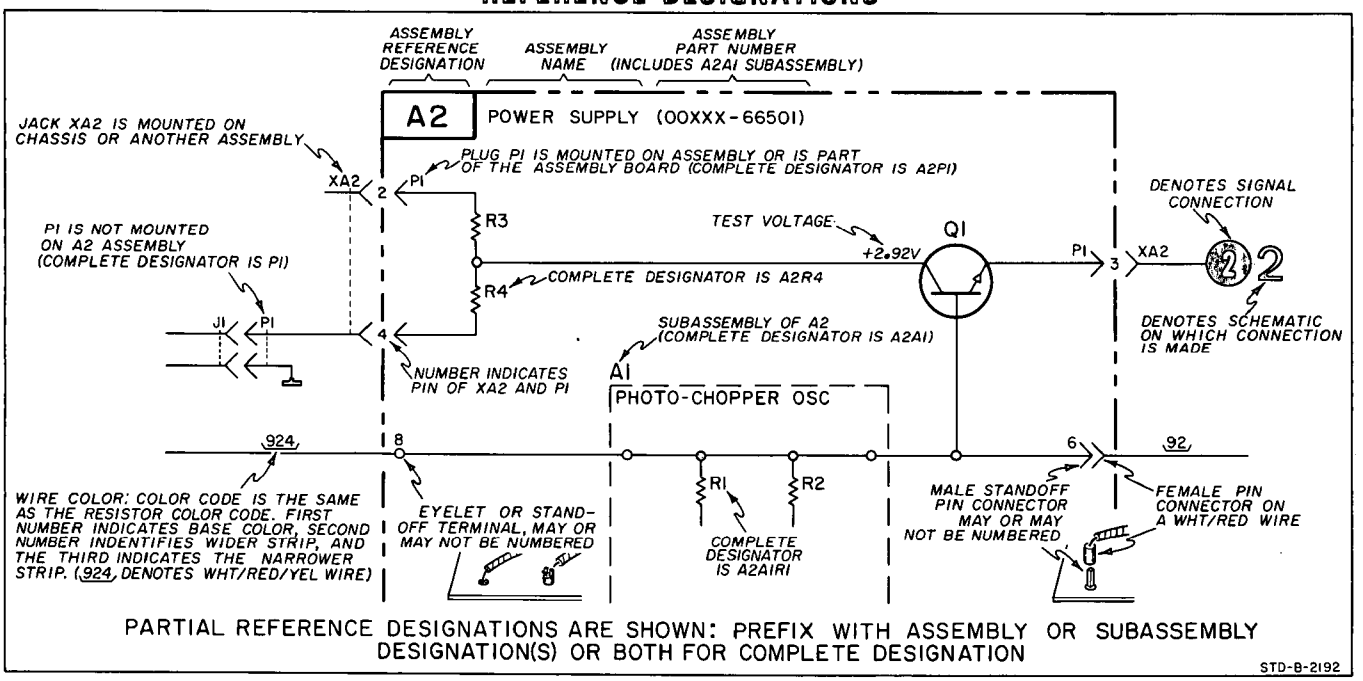
7-1. INTRODUCTION.

7-2. This section contains circuit diagrams to aid in the operation and maintenance of the Models 331A and 332A. Figures 7-1 through 7-4 contain detailed schematic diagrams as well as component location drawings of each printed circuit board.

7-3. General schematic notes, which apply to all the schematic diagrams, are listed on page 7-2.

7-4. An explanation of terms and symbols used on the schematic diagrams is given below.

REFERENCE DESIGNATIONS



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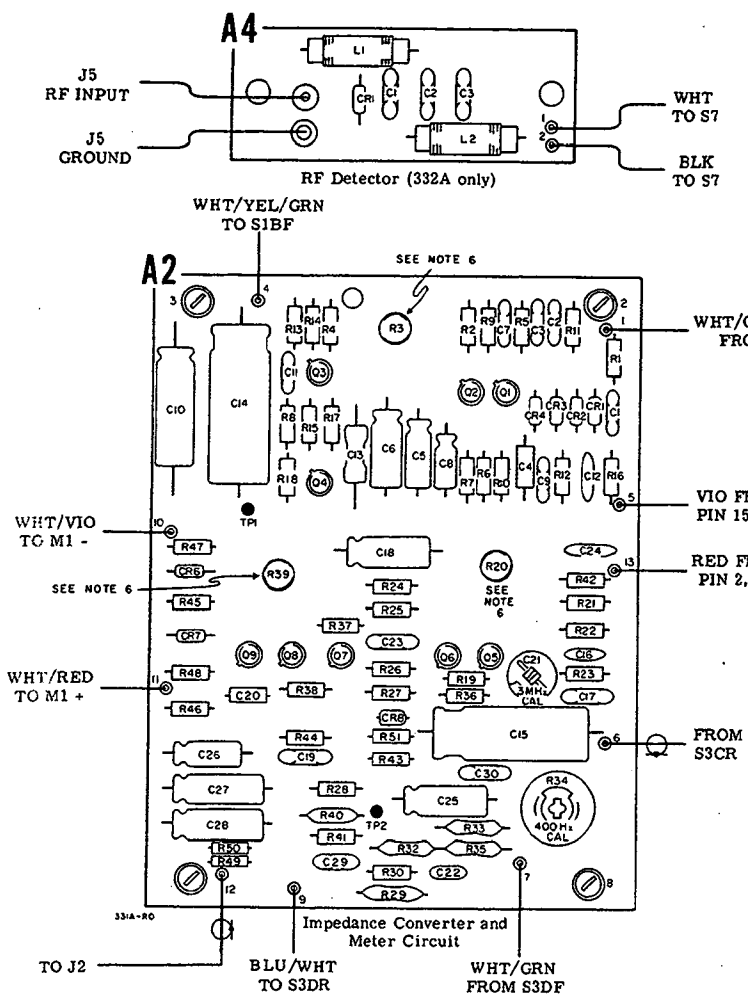
GENERAL SCHEMATIC NOTES

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.
2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED:

   RESISTANCE IN OHMS

   CAPACITANCE IN MICROFARADS
3. DENOTES CHASSIS GROUND.
4. Denotes Earth Ground.
5. DENOTES SIGNAL GROUND (FLOATABLE).
6. SIGNAL GROUND (ON BOARD).
7. DENOTES ASSEMBLY.
8. DENOTES MAIN SIGNAL PATH.
9. DENOTES FEEDBACK PATH.
10. DENOTES FRONT PANEL MARKING.
11. DENOTES REAR PANEL MARKING.
12. DENOTES SCREWDRIVER ADJUST.
13. DENOTES FRONT PANEL CONTROL.
14. * AVERAGE VALUE SHOWN, OPTIMUM VALUE SELECTED AT FACTORY.
15. DENOTES COMPONENTS NOT MOUNTED ON ASSEMBLY.
16. DENOTES TROUBLESHOOTING INFORMATION LOCATED ON APRON PAGE OF RESPECTIVE SCHEMATIC.
17. 1 DENOTES SIGNAL CONNECTION.
18. 1 DENOTES SCHEMATIC ON WHICH SIGNAL CONNECTION IS MADE.

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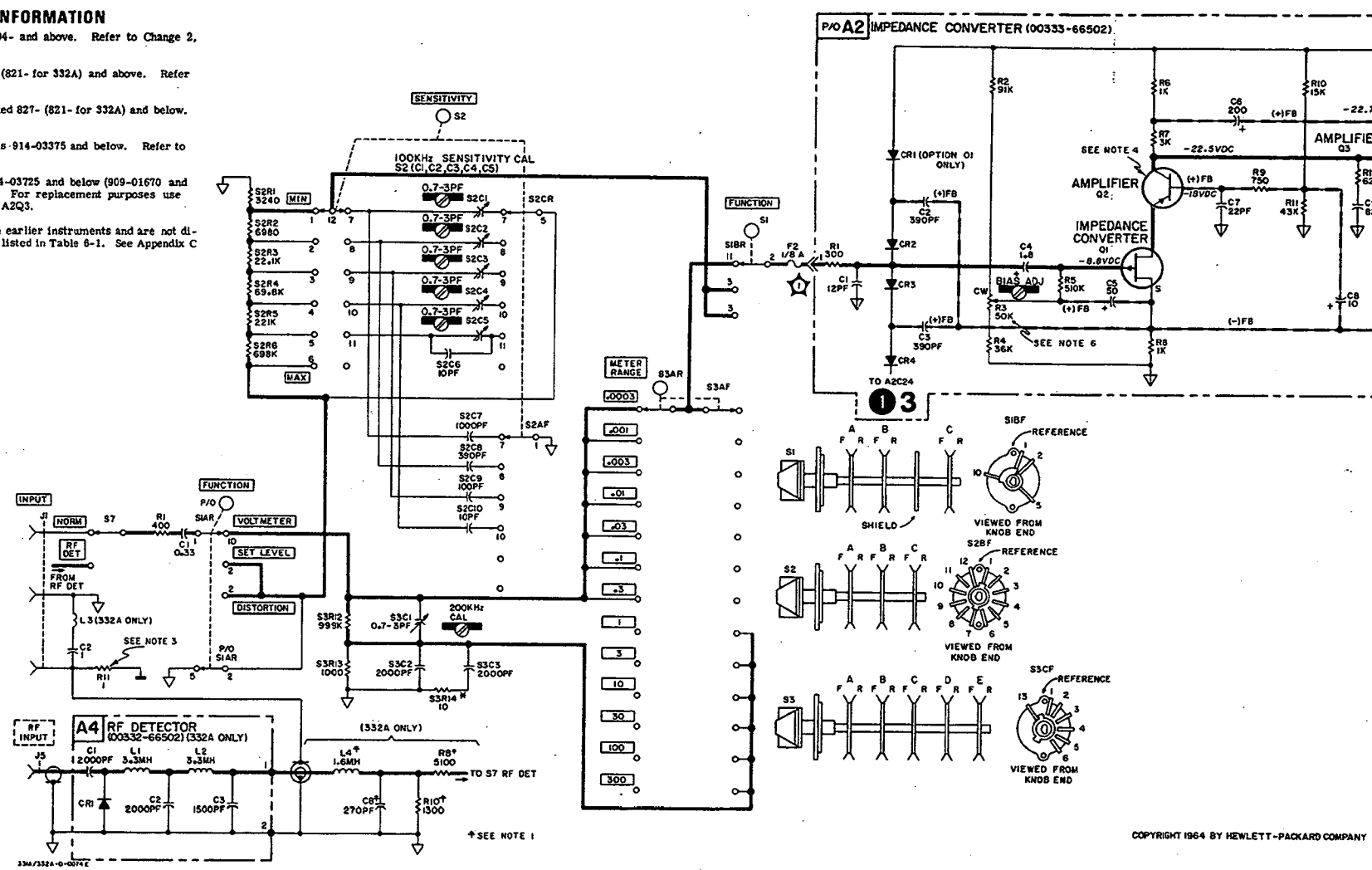
BACKDATING INFORMATION

(For 7-1)

1. (†) Only on HP 332A's prefixed 604- and above. Refer to Change 2, Appendix C.
2. Only on instruments prefixed 827- (821- for 332A) and above. Refer to Change 4, Appendix C.
3. R11 is deleted on instruments prefixed 827- (821- for 332A) and below. Refer to Change 7, Appendix C.
4. A2Q2 Part No. is changed on serials 914-03375 and below. Refer to Change 8, Appendix C.
5. Instruments with serial number 914-03725 and below (909-01670 and below for 332A) A2Q3 was different. For replacement purposes use the transistor listed in Table 6-1 as A2Q3.
6. A2R3/R20/R39 are different in some earlier instruments and are not directly interchangeable with the ones listed in Table 6-1. See Appendix C for applicable serial numbers.

TROUBLESHOOTING INFORMATION

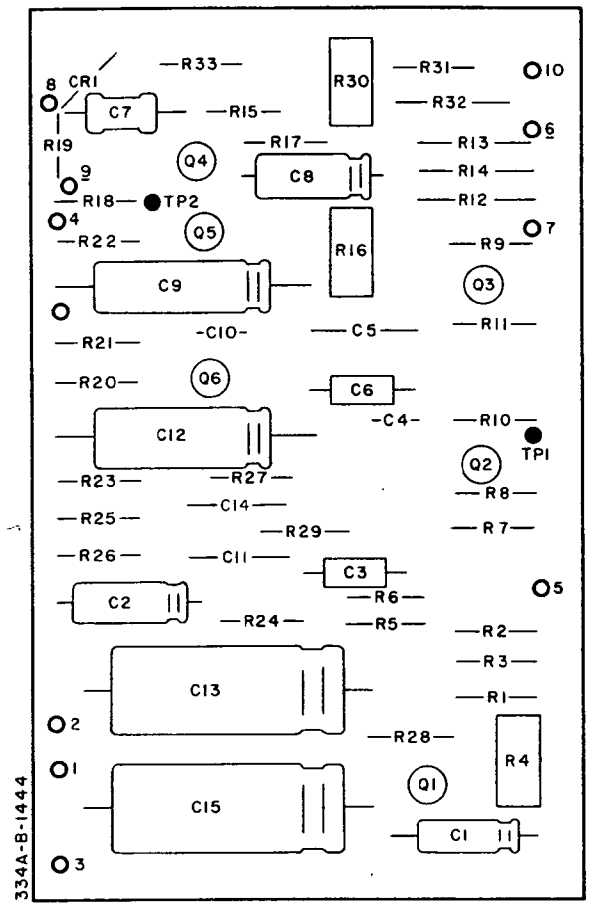
1. 1 mV rms between pin 1 and ground side of A2R12, for full scale meter deflection in VOLTMETER function on 1 V range.
2. 1 mV rms at pin 4 for full scale meter deflection in VOLTMETER function on 1 V range. Use a 10 MΩ/10 pF impedance probe for this measurement.



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Figure 7-1. Impedance Converter (P/O A2 and RF Detector (P/O A4)

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A 3
hp Part No. 00333-66503

Figure 7-1. Impedance Converter (P/O A2) and RF Detector (P/O A4)

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TROUBLESHOOTING INFORMATION

When checking the voltages and waveforms for this circuit, set the 331A/332A controls as follows, unless otherwise noted:

FUNCTION	SET LEVEL
METER RANGE	0.3 VOLTS
SENSITIVITY	MAX.
SENSITIVITY VERNIER	MAX.
FREQUENCY RANGE	X100
Frequency Dial	10
Input Signal	0.3 V rms at 1 kHz

(1) 280 mV rms at pin 1.

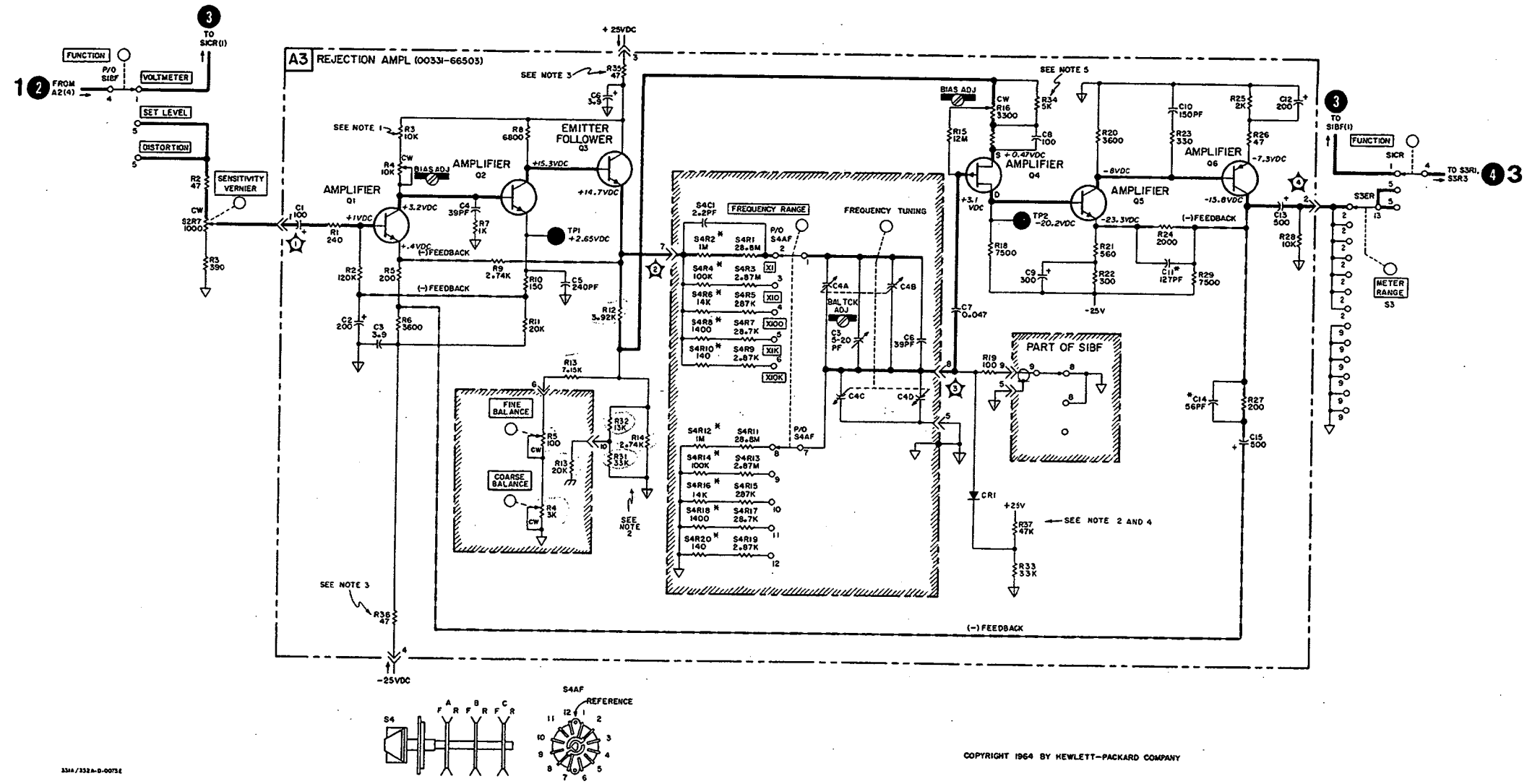
(2) 180 mV rms at pin 7. In DISTORTION function, with input nulled, signal at pin 7 should change to 2.4 V rms. Use a 10 MΩ/10 pF impedance probe for this measurement.

(3) 0 V rms at pin 8. In DISTORTION function but not nulled (frequency dial set to 50), signal at pin 8 changes to 310 mV rms. Use a 10 MΩ/10 pF impedance probe for this measurement.

(4) 0.32 V rms at pin 2.

BACKDATING INFORMATION

1. Change A3R3 to 12 kΩ for instruments prefixed 827- (821- for 332A) and below. Refer to Change 7, Appendix C.
2. Instruments with serial number 914-03825 and below (909-01710 and below for 332A) the A3 Assembly was part number 00331-66503. To make this schematic compatable with earlier instruments, change A3R13 to 7500 Ω, change A3R14 to 2.49 kΩ, delete A3R31, A3R32, A3R33, A3R30, A3CR1 and delete R13 (off board, connected to pin 10.)
3. Instruments with serial no. 982-04301 (985-01911 and below for 332A) did not have A3R35 and A3R36. Refer to Appendix C for more information.
4. See Change No. 16 in Appendix C.
5. See Change No. 15 in Appendix C.



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Figure 7-2. Rejection Amplifier (A3)

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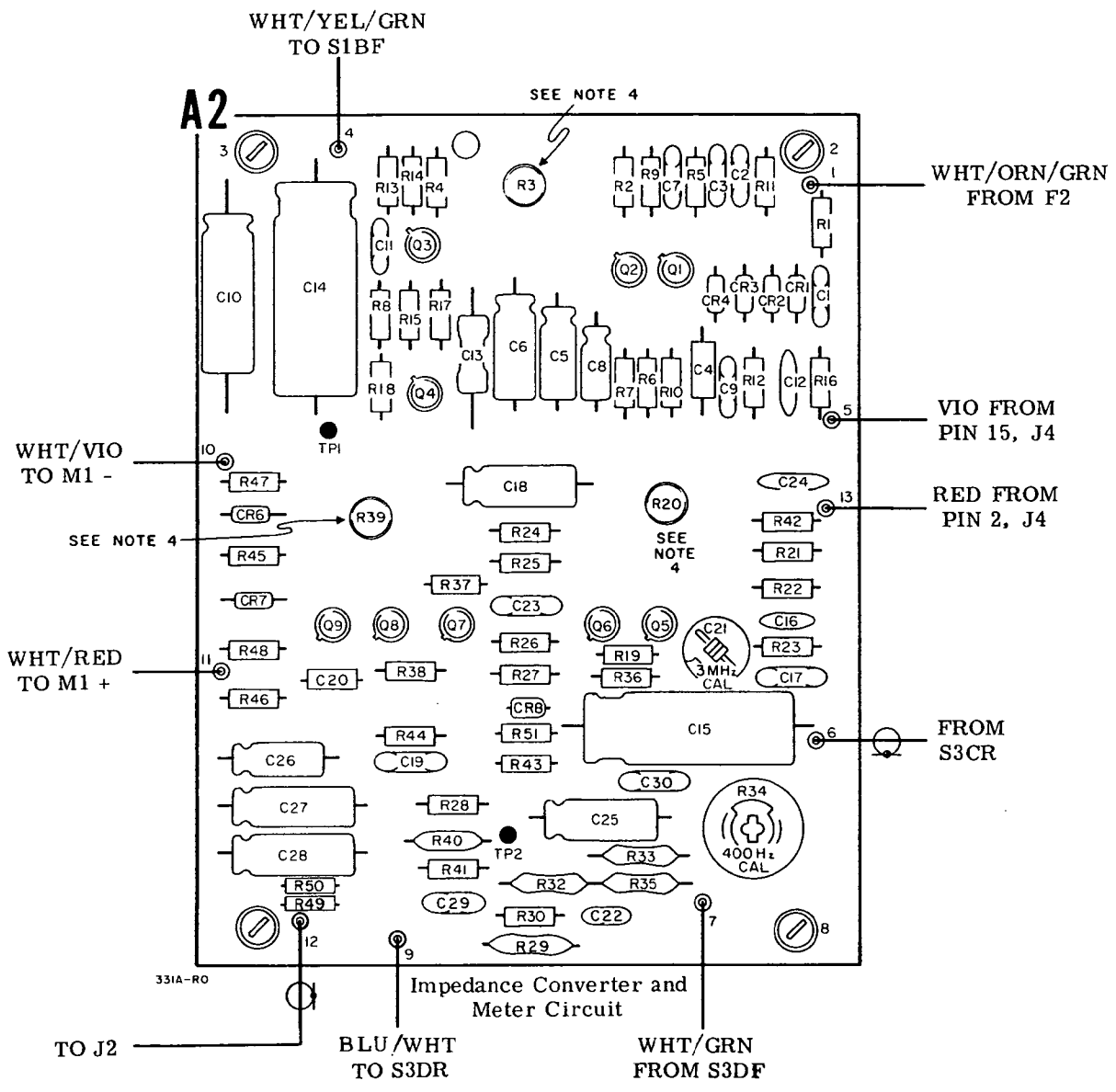


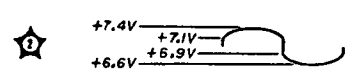
Figure 7-2. Rejection Amplifier (A3)

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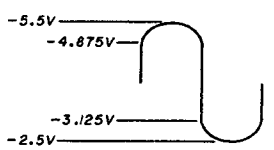
TROUBLESHOOTING INFORMATION

1 mV rms between pins 6 and 15 for full scale deflection on the 0 to 1 scale on the 0.001 V to 300 V ranges. 300 μV rms between pins 6 and 15 for 300 μV indication on 300 μV range.

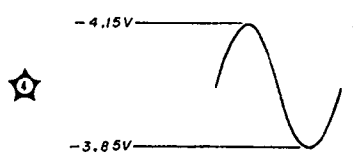
827 2 4705



Voltage between collector of A2Q7 and pin 15 for full scale deflection on the 0 to 1 scale.



Voltage between collector of A2Q9 and pin 15 for full scale deflection on the 0 to 1 scale on 0.01 V range and above. (Cannot be measured on 0.01 V range and below because the meter amplifier will oscillate.)

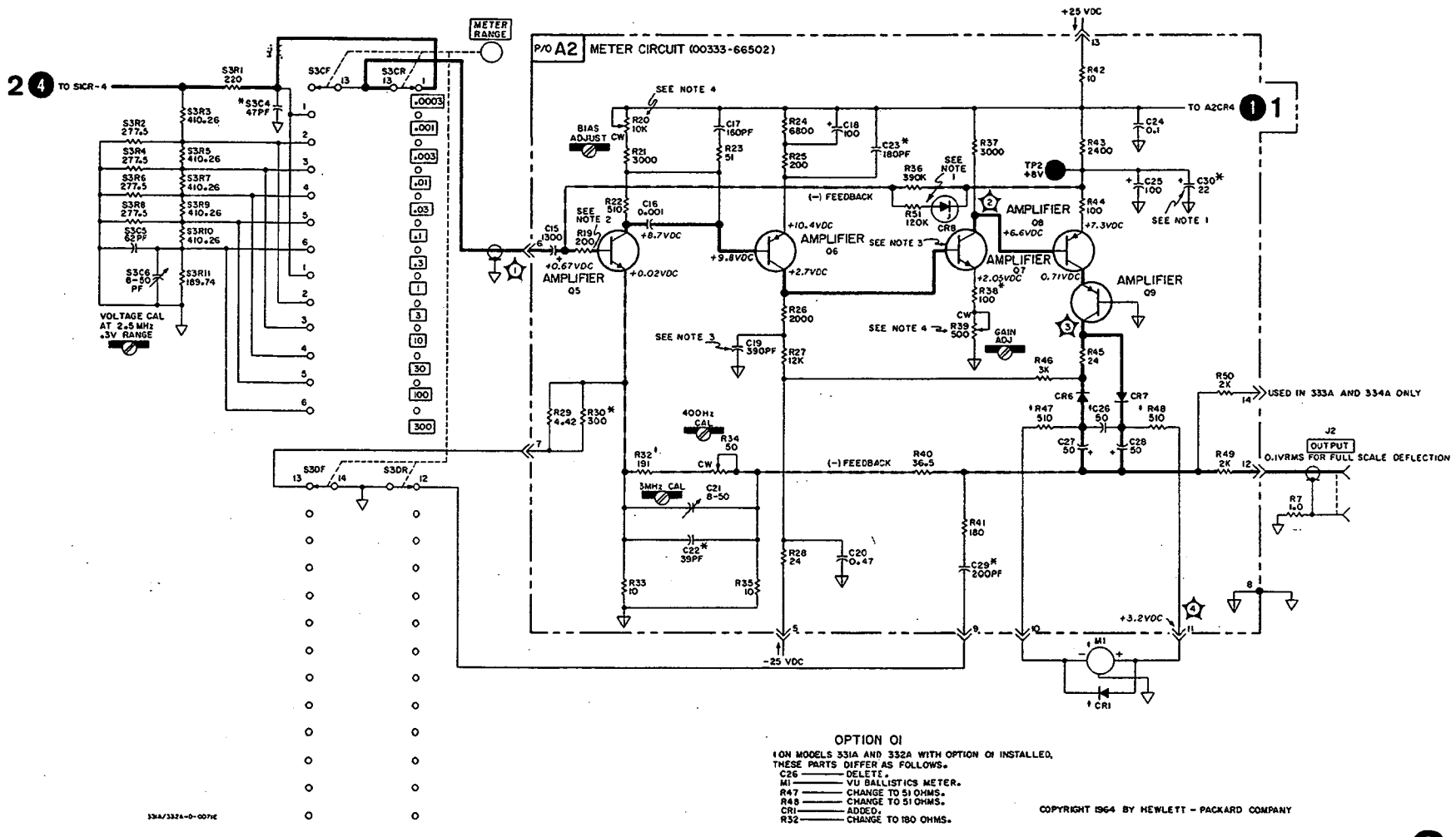


0.3 V p-p from either pin 10 or 11 to ground for full scale deflection on 0 to 1 scale.

333A-B-1471

BACKDATING INFORMATION

1. Only on instruments prefixed 716- (717- for 332A) and above. Refer to Change 3, Appendix C.
2. Only on instruments prefixed 827- (821- for 332A) and above. Refer to Change 4, Appendix C.
3. A2Q2 and A2C19 changed on prefix 827- (821- for 332A) and below. Refer to Change 7, Appendix C.
4. A2R3/R20/R39 are different in some earlier instruments and are not directly interchangeable with the ones listed in Table 6-1. See Appendix C for applicable serial numbers.



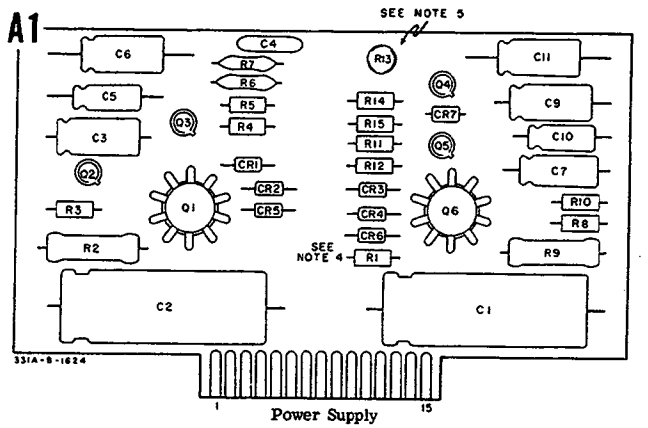
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Figure 7-3. Meter Circuit (P/O A2)

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Figure 7-3. Meter Circuit (P/O A2)

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BACKDATING INFORMATION

1. R12 was located on the A1 Assembly and designated as A1R1. The resistor was connected between pins 10 and 11 on A1. See Appendix C, Change #9 for applicable serial numbers.

2. R9 is added here on instruments prefixed 827- (821- for 332A) and below. Refer to Change 7, Appendix C.

3. Value changed on serials 827-03000 (821-01385 for 332A) and below. Refer to Change 6, Appendix C.

4. C8 is added to instruments whose serial number is 602-00820 (536- for 332A) and below. Refer to Change 1, Appendix C.

5. A1R13 was different in some earlier instruments and is not directly interchangeable with the one listed in Table 6-1. See Appendix C for applicable serial numbers.

6. In some earlier instruments A1R6 was 12.1 kΩ and A1R7 was 12.7 kΩ. To improve power supply regulation these resistors should be changed to the values shown in Figure 7-4. See Appendix C for applicable serial numbers.

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331A/332A-D-0332E

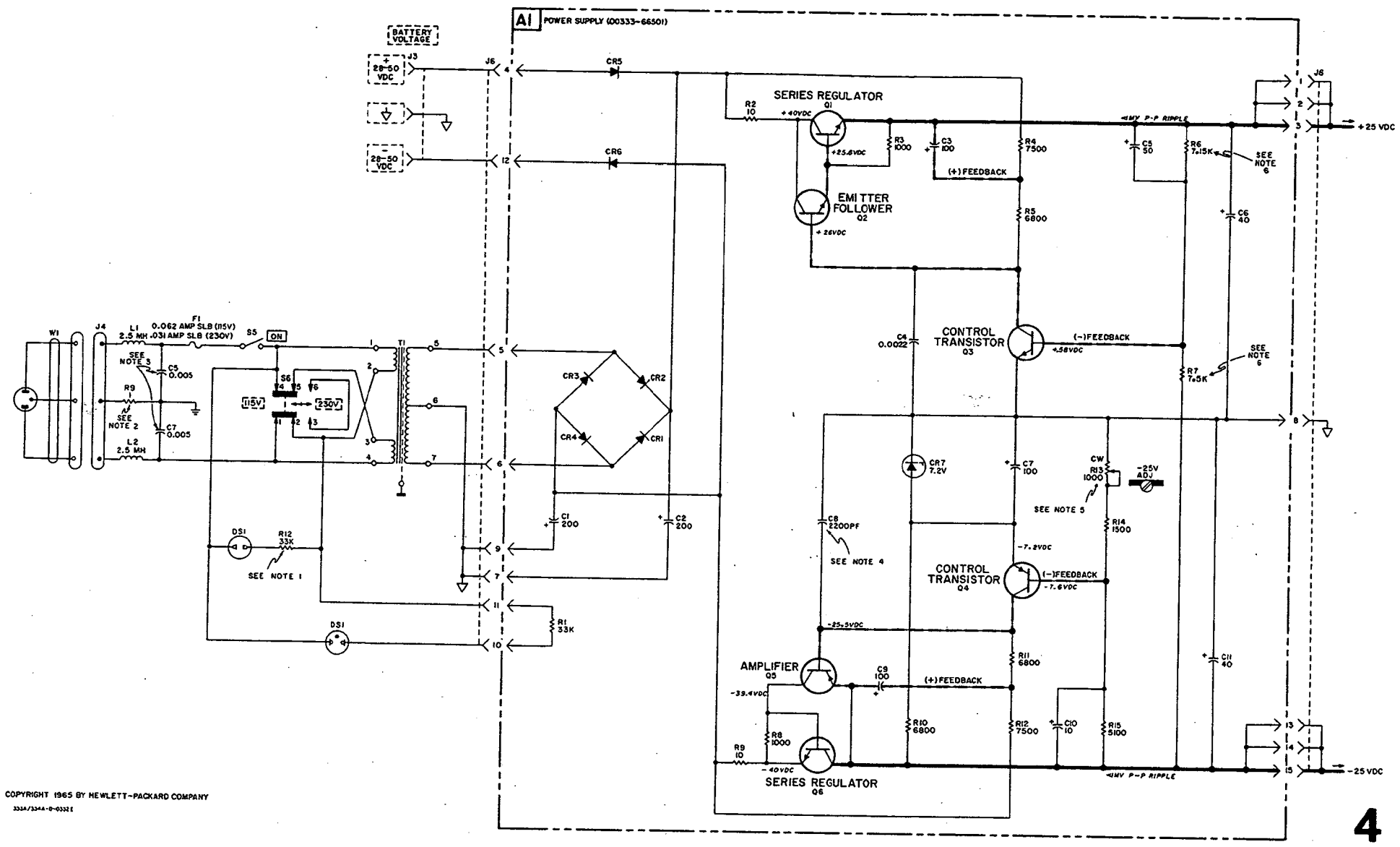


Figure 7-4. Power Supply (A1)

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CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U.S.A Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco, Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Mictron, Co., Inc.	Valley Stream, N.Y.
00373	Garlock Inc.	Cherry Hill, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00809	Croven, Ltd.	Whitby, Ontario, Canada
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Cal.
00929	Microlab Inc.	Livingston, N.J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N.Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Cal.
01281	TRW Semiconductors, Inc.	Lawndale, Cal.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co	Alliance, Ohio
01538	Small Parts Inc.	Los Angeles, Cal.
01589	Pacific Relays, Inc.	Van Nuys, Cal.
01670	Gudebrod Bros. Silk Co.	New York, N.Y.
01930	Amerock Corp.	Rockford, Ill.
01960	Pulse Engineering Co	Santa Clara, Cal.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02116	Wheelock Signals, Inc.	Long Branch, N.J.
02286	Cole Rubber and Plastics Inc	Sunnyvale, Cal.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Division	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Cal.
02875	Hudson Tool & Die	Newark, N.J.
03296	Nylon Molding Corp.	Springfield, N.J.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Cal.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div., Finderne Plant	Sumerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taruus Corp.	Lambertville, N.J.
04062	Arco Electronic Inc.	Great Neck, N.Y.
04217	Essex Wire	Los Angeles, Cal.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Wheeling, Ill
04404	Palo Alto Division of Hewlett-Packard Co.	Palo Alto, Cal.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Cal.
04673	Dakota Engr. Inc.	Culver City, Cal.
04713	Motorola Inc. Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Cal.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Cal.
04811	Precision Coil Spring Co.	El Monte, Cal.
04870	P.M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Cal.
05277	Westinghouse Electric Corp. Semiconductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Cal.
05397	Union Carbine Corp., Elect. Div.	New York, N.Y.
05574	Viking Ind. Inc.	Canoga Park, Cal.
05593	Icore Electro-Plastics Inc.	Sunnyvale, Cal.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metro-Tel Corp.	Westbury, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Cal.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Cal.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Cal.
06980	Varian Assoc. Etmac Div.	San Carlos, Cal.
07088	Kelvin Electric Co.	Van Nuys, Cal.
07126	Digitran Co.	Pasadena. Cal.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp., Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Cal.
07256	Silicon Transistor Corp.	Carle Place, N.Y.
07261	Avnet Corp.	Culver City, Cal.
07263	Fairchild Camera & Inst. Corp., Semiconductor Div.	Mountain View, Cal.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp, The	Monterey Park, Cal.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Cal.
07700	Technical Wire Products Inc.	Cranford, N.J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Cal.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Cal.
07980	Hewlett-Packard Co., New Jersey Division	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Cal.
08289	Blinn, Delbert Co.	Pomona, Cal.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Cal.
08664	Bristol Co., The	Waterbury, Conn
08717	Sloan Company	Sun Valley, Cal.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N.J.
08792	CBS Electronics Semiconductor Operations, Div. of CBS Inc	Lowell, Mass.
08806	General Electric Co., Miniature Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Cal.
09097	Electronic Enclosures Inc.	Los Angeles, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Cal.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09795	Pennsylvania Florocarbon.	Clifton Heights, Penn.
09922	Burndy Corp	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Cal.
10411	Ti-Tal, Inc.	Berkeley, Cal.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Cal.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Cal.
11314	National Seal	Downey, Cal.
11453	Precision Connector Corp.	Jamaica, N.Y.
11534	Duncan Electronics Inc.	Costa Mesa, Cal.
11711	General Instrument Corp., Semiconductor Division Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Cal.
11870	Melabs, Inc.	Palo Alto, Cal.
12136	Philadelphia Handle Co.	Camden, N.J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc., Data System Div.	Albuquerque, N.M.
12697	Clarostat Mfg. Co.	Dover, N.H.
12728	Elmar Filter Corp	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Cal.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13019	Airco Supply Co., Inc.	Witchita, Kansas
13061	Wilco Products	Detroit, Mich.
13103	Thermolloy	Dallas, Texas
13327	Solitron Devices Inc.	Tappan, N.Y.
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Cal.
14193	Calif. Resistor Corp	Santa Monica, Cal.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, a Div. of Int. Telephone and Telegraph Corporation	West Palm Beach, Fla.
14493	Hewlett-Packard Company.	Loveland, Colo.
14655	Cornell Dublier Electric Corp	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	San Gabriel, Cal.
14960	Williams Mfg. Co.	San Jose, Cal.
15106	The Sphere Co., Inc.	Little Falls, N.J.
15203	Webster Electronics Co.	New York, N.Y.
15287	Scionics Corp.	Northridge, Cal.
15291	Adjustable Bushing Co.	N. Hollywood, Cal.
15558	Micron Electronics.	Garden City, Long Island, N.Y.
15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
15631	Cabletronics	Costa Mesa, Cal.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Cal.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Amelco Inc.	Mountain View, Cal.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N.J.
16554	Electroid Co.	Union, N.J.
16585	Boots Aircraft Nut Corp.	Pasadena, Cal.
16688	Ideal Prec. Meter Co., Inc., De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Ind.
17109	Thermonetics Inc.	Canoga Park, Cal.
17474	Tranex Company	Mountain View, Cal.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Cal.
17856	Siliconix Inc.	Sunnyvale, Cal.
17870	McGraw-Edison Co.	Manchester, N.H.
18042	Power Design Pacific Inc.	Palo Alto, Cal.
18083	Clevite Corp. Semiconductor Div.	Palo Alto, Cal.
18324	Signetics Corp.	Sunnyvale, Cal.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18565	Chomerics	Plainville, Mass.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison	West Orange, N.J.
19589	Concoa	Baldwin Park, Cal.

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CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21355	Fafnir Bearing Co., The	New Britian, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23020	General Reed Co.	Metuchen, N.J.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division, Nela Park,	Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobert File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac/Hollister Co.	Hollister, Cal.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Cal.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products, Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto, Ontario, Canada
37942	P.R. Mallory & Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
40931	Honeywell Inc.	Minneapolis, Minn.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	HP Co., Med. Elec. Div.	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & System Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
58474	Superior Elect. Co.	Bristol, Conn.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electric Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincey, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst, L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Cal.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Cal.
71471	Cinema, Div. Aerovox Corp.	Burbank, Cal.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap Division	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Cal.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Cal.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Cal.
73445	Amperex Elect. Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries, Inc.	Philadelphia, Pa.
73734	Federal Screw Products, Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Cal.
73957	Groove-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronic Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights, Inc.	Sandwich, Ill.
75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Cal.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Cal.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Cal.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Cal.
77075	Pacific Metals Co.	San Francisco, Cal.
77221	Phaostran Instrument and Electronic Co.	So. Pasadena, Cal.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Division	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Cal.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Cal.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Cal.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80033	Prestole Corp.	Toledo, Ohio
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Standard tube or semi-conductor device, any manufacturer.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Cal.
80411	Arco Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Cal.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Inst. Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Cal.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	
81483	International Rectifier Corp.	El Segundo, Cal.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp., Space & Defense Systems Div.	Paramus, N.J.
82209	Magurie Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod., Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc., Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rolton Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Cal.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Cal.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Cal.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisades Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp., Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Cal.
84411	TRW Capacitor Div.	Ogallala, Neb.

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CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
94870	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A. B. Boyd Co.	San Francisco, Cal.
85474	R. M. Bracamonte & Co.	San Francisco, Cal.
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Division	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Cal.
87034	Marco Industries	Anaheim, Cal.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Cal.
87664	Van Waters & Rogers Inc.	San Francisco, Cal.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Cal.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89479	Security Co.	Detroit, Mich.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	U.S. Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90365	Belleville Speciality Tool Mfg., Inc.	Belleville, Ill.
90763	United Carr Fastener Corp.	Chicago, Ill.
90970	Bearing Engineering Co.	San Francisco, Cal.
91146	ITT Cannon Elect. Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Cal.
91345	Miller Dial & Nameplate Co.	El Monte, Cal.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91673	Epiphone Inc.	New York, N.Y.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Cal.
91886	Malco Mfg., Inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Division	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Cal.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Westbury, L.I., N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Pallisades Park, N.J.
93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Cal.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Patterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95146	Alco Elect. Mfg. Co.	Lawrence, Mass.
95236	Allies Products Corp.	Diania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West, Inc.	Sunnyvale, Cal.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Mfg. Co.	Los Angeles, Cal.
96396	Microswitch, Div. of Minn.-Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Cal.
96508	Xcelite, Inc.	Orchard Park, N.Y.
96733	San Fernando Elec. Mfg. Co.	San Fernando, Cal.
96381	Thomson Ind. Inc.	Long Island, N.Y.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Tronics, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Cal.
98220	Hewlett-Packard Co., Medical Elec. Div.	Pasadena, Cal.
98278	Microdot, Inc.	So. Pasadena, Cal.
98291	Sealectro Corp.	Mamaronech, N.Y.
98376	Zero Mfg. Co.	Burbank, Cal.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paeco Division of Hewlett-Packard Co.	Palo Alto, Cal.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Cal.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Cal.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Cal.
99707	Control Switch Division, Controls Co. of America	El Segundo, Cal.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Rembrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp., Semiconductor Division	El Monte, Cal.
99957	Technology-Instrument Corp. of California	Newbury Park, Cal.

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0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Comp. Co.	Van Nuys, Cal.
000CS	Hewlett-Packard Co., Colorado Springs Div.	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Cal.
000NN	A "N" D Mfg. Co.	San Jose, Cal.
000QQ	Cooltron	Oakland, Cal.
000WW	California Eastern Lab	Burlington, Cal.
000YY	S.K. Smith Co.	Los Angeles, Cal.

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MANUAL BACKDATING CHANGES

MODEL 331A/332A

DISTORTION ANALYZER

Manual Serial Prefixed: 995-(331A), 998-(332A)

-hp- Part No. 00331-90006

This manual backdating sheet makes this manual applicable to earlier instruments. Instrument-component values that differ from those in the manual, yet are not listed in the backdating sheet, should be replaced using the part number given in the manual.

331A		332A	
Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
427-, 517-, 536-	1 thru 18	427-, 504-, 517-	1 thru 18
602-00820 and below*	1 thru 18	536-	1 thru 18
602-	3 thru 18	604-00525 and below	3 thru 18
716-02100 and below	3 thru 18	604-, 717-, 748-	4 thru 18
716-, 724-, 801-	4 thru 18	821-01360 and below	5 thru 18
827-02925 and below	5 thru 18	821-01385 and below	6 thru 18
827-03000 and below	6 thru 18	821-	7 thru 18
827-	7 thru 18	909-01570 and below	8 thru 18
914-03375 and below	8 thru 18	909-01590 and below	9 thru 18
914-03625 and below	9 thru 18	909-01670 and below	10 thru 18
914-03725 and below	10 thru 18	909-01730 and below	11 thru 18
914-03825 and below	11 thru 18	909-01755 and below	12, 13, 18
914-04000 and below	12, 13, 18	985-01911 and below	15 thru 18
982-04301 and below	15 thru 18	998-01946 and below	16 thru 18
995-04526 and below	16 thru 18	0998-01981 and below	18
0995-04676 and below	18		

*And the following instruments above 602-00820: 602-00823 thru 602-00829, 602-00833, 602-00837, 602-00846, 602-00869, 602-00899

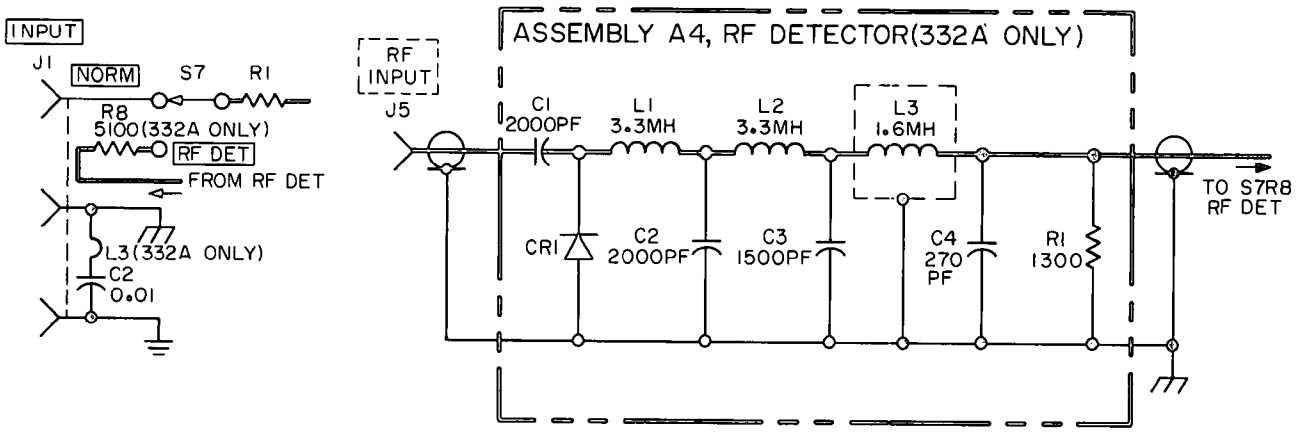
CHANGE 1 Table 6-1:
Add A1C8, C: fxd 2200 pF ±20% 500 vdcw, -hp- Part No. 0150-0085.

Figure 7-4, Power Supply Schematic:
Add capacitor, A1C8, 2200 pF, between cathode of A1CR7 and base of A1Q5.

CHANGE 2 Table 6-1:
Change A4 board, -hp- Part No. from 00332-66502 to 00332-66501.
Add A4L3, A4C4 and A4R1 on A4 board.
Delete C9, -hp- Part No. 0140-0206, C: fxd dipped mica 270 pF ±5% (332A only). Use description for A4C4.
Delete R10, -hp- Part No. 0686-1324, R: fxd comp 1300 ohms ±5% 1/2 W (332A only). Use description for A4R1.
Delete L4, -hp- Part No. 9170-0805, Coil: fxd 1.6 mH (332A only). Use description for A4L3; change -hp- Part No. to 9170-0461.
Delete R8, -hp- Part No. 0683-5125, fxd comp 5100 Ω and add S7R8 (same description).
Change Shield: bottom, -hp- Part No. 00331-04102 to Plate: cover, -hp- Part No. 00331-04101.

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Figure 7-1:
Change RF Input Circuitry to the following:



CHANGE 3 (For instruments having A2 boards with -hp- Part No. 00331-66502 or 00331-66504 only)
Figure 7-3:
Delete A2C30, A2CR8, and A2R51 from circuit.

Table 6-1:
Delete A2C30, A2CR8, and A2R51.

CHANGE 4 Table 6-1:
Delete A2R18 and A2R19.
Add A2CR5, 1901-0025, Diode: Si 50 mA ±1 V 100 piv.
Change A2Q1 to 1855-0082.

Figure 7-1:
Delete A2R18 from circuit. Replace with diode A2CR5.

Figure 7-3:
Delete A2R19 from circuit.

CHANGE 5 Figure 6-3:
Change index no. 29 to -hp- Part No. 00331-23702.
Change index no. 30 to Yoke: flex coupler -hp- Part No. 1500-0002.
Add: shim spacer -hp- Part No. 5000-4994 (2 each).
Change index no. 31 to -hp- Part No. 5040-0212.
(For smoother drive use current part no. for all three parts.)

CHANGE 6 Table 6-1 and Figure 7-1:
Change C2, C5 and C7 to 0.01 μF, 1 kV, -hp- Part No. 0150-0012. (To present a lower impedance at power line frequency use current values).

CHANGE 7 Table 6-1:
Change A2Q7 to -hp- Part No. 1854-0215 (interchangeable with 1854-0019).

Table 6-1 and Figure 7-1:
R11 and insulator at J1 ground terminal ($\doteqdot$) are removed and R11 is replaced by a short. The same resistor (as R9) is added between J4 ground connector and power line ground ($\doteqdot$).
Change A2C19 to 680 pF, -hp- Part No. 0140-0208. (To raise frequency response at 1 MHz use current value).
Change A3R3 to 12 kΩ, -hp- Part No. 0686-1235. (To extend the range of A3R4 use current value.)

CHANGE 8 Table 6-1:
Change A2Q2 to -hp- Part No. 1853-0086. (For less distortion use current part no.)

CHANGE 9 R12 was located on the A1 Assembly and designated as A1R1 on instruments with serial numbers 914-03625 and below with the following instruments excluded: for the 331A.
SN 914-03526, -03530, -03538, -03544, -03545, -03547, -03549, -03552, -03582, -03584, -03586, -03587, -03588, -03590, -03598, -03599, -03600, -03604, -03611 and -03625.

For the 332A, all instruments with Serial Number 909-01590 and below have the resistor mounted on the A1 Assembly.
For replacement purposes, use the resistor listed in Table 6-1 as R12.

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CHANGE 10 In instruments with Serial Number 914-03725 and below (909-01670 and below for 332A) A2Q3 was different. For replacement purposes, use the transistor listed in Table 6-1 as A2Q3.

CHANGE 11 In instruments with Serial Number 914-03825 and below (909-01710 and below for 332A) the A3 Assembly was Part No. 00331-66503. To make the A3 schematic in this manual compatable with these serial numbered instruments, make the following changes:

1. Change A3R13 to 7500 Ω.
2. Change A3R14 to 2.49 kΩ.
3. Delete A3R30, A3R31, A3R32, A3R33, A3CR1 and delete R18 (connected to A3 pin 10, off board).

The new 00333-66503 board may be used in the above mentioned instrument provided a 20 kΩ resistor (R13) is connected between A3 pin 10 and ground as shown on schematic #2 in this manual.

CHANGE 12 Page 6-11:

Change the Part Number of cable W1 to 8120-0078.
Change the Part Number of the power connector from 1251-2357 to 1251-1009. The power cords are not directly interchangeable.

Figure 6-2:

Change the Part Number of the 331A rear panel to 00331-00202. Change the Part Number of the 332A rear panel to 00332-00202.

CHANGE 13

Change the Part Number of A1R13 to 2100-1434.
Change the Part Number of A2R3 to 2100-0094.
Change the Part Number of A2R20 to 2100-0092.
Change the Part Number of A2R39 to 2100-0151.
These resistors are not directly interchangeable with the ones listed in Table 6-1.

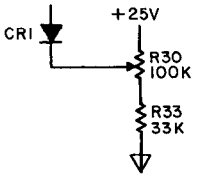
CHANGE 14 In some earlier instruments A1R6 was 12.1 kΩ and A1R7 was 12.7 kΩ. To improve power supply regulation, both of these resistors should be changed to the values shown in Table 6-1.

CHANGE 15 Figure 7-2:

Delete A3R35 and A3R36. Replace with a short. Delete these components from Table 6-1.
Change A3R16 to 3.3 kΩ and delete A3R34. Delete A3R34 from Table 6-1.

CHANGE 16 Figure 7-2:

Change Schematic as follows:



Delete A3R37, 47 kΩ.
Add A3R30 to Table 6-1
Part No. 2100-0360, R: var, 100 kΩ 30% 1/8 W

CHANGE 17

Change the rear panel Part No. as follows:
331A to 00331-00203
332A to 00332-00203

CHANGE 18 Table 6-1 and Figure 7-2:

Change A3Q3 and A3Q5 to part no. 1854-0354
Change A3C4 to 30 pF, part no. 0140-0203

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