

MODEL 204C

OSCILLATOR

SN 808-

OPERATING AND SERVICE MANUAL

HEWLETT  PACKARD

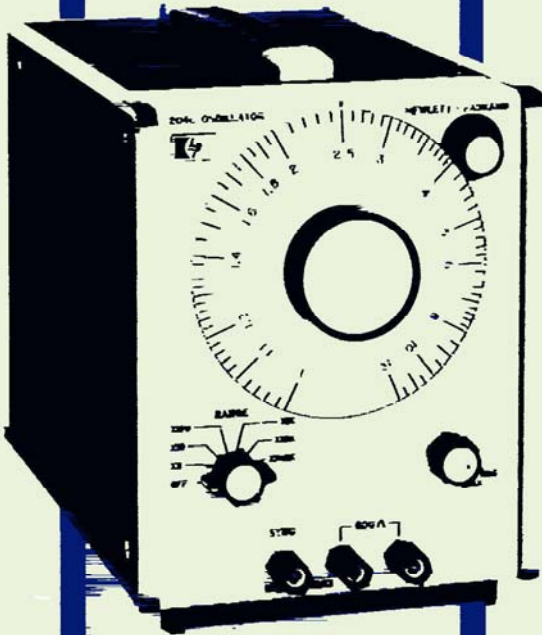
OPERATING AND SERVICE MANUAL
(-hp- Part No. 00204-90000)

MODEL 204C
OSCILLATOR

Serials Prefixed: 808-

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P. O. Box 301, Loveland, Colorado, 80537 U. S. A.

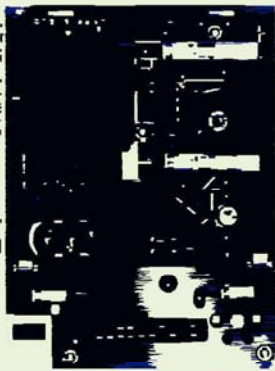
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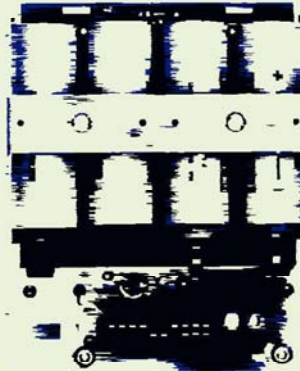
FEATURES

- CAPACITIVELY TUNED
- WIDE FREQUENCY RANGE 5Hz TO 1.2MHz
IN SIX OVERLAPPING RANGES
- LOW DISTORTION
- HIGH AMPLITUDE AND
FREQUENCY STABILITY
- BALANCED OUTPUT
- SYNCHRONIZATION

USE ANY ONE OF 3 INTERCHANGEABLE POWER PACKS.



STANDARD
AC LINE



MERCURY BATTERIES
OPTION 01



LINE/RECHARGEABLE BATTERIES
OPTION 02

P. O. Box 301, Loveland, Colorado, 80537, Tel. (303) 667-5000

Europe: 54 Route Des Acacias, Geneva, Switzerland, Cable: "HEWPACKSA" Tel. (022) 42.81.50

DESCRIPTION

The HP 204C is a small, lightweight capacitive-tuned oscillator. Interchangeable power packs, line, rechargeable batteries or mercury batteries make this instrument ideal for both field and laboratory use. Internal heat generation and temperature coefficient is small resulting in unusually low drift. Stable, accurate signals which can be synchronized with an external source are instantly available over a frequency range from 5 Hz to 1.2 MHz. Distortion can be minimized at low frequencies by a rear panel Low Distortion Mode switch; however, settling time with a rapid frequency change is increased.

Balanced and floating output can drive loads up to 500 V off ground. Excellent frequency stability, flatness and low distortion assures accurate signals. Low impedance output circuits effectively isolate the oscillator stage to minimize effects of load changes.

The modular cabinet allows easy access to the instrument and makes an attractive practical unit for both field or bench use.

SPECIFICATIONS

RANGES

Frequency: 5 Hz to 1.2 MHz in 6 overlapping ranges.

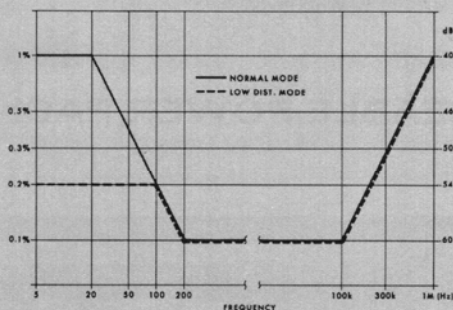
PERFORMANCE RATINGS

Dial Accuracy: $\pm 3\%$ of frequency setting.

Flatness: At maximum output into 600 Ω load
1 kHz reference.

Low Dist. Mode	$\pm 1\%$	$\pm 0.5\%$	$\pm 1\%$
Normal Mode	+5% -1%	$\pm 0.5\%$	$\pm 1\%$
	5	100	300k 1.2M (Hz)

Distortion:



Hum and Noise: Less than 0.01% of output.

OUTPUT CHARACTERISTICS

Output Voltage: 2.5V rms (10mW) into 600 Ω ;
5V rms open circuit.

Output Impedance: 600 Ω at any attenuator setting.

Output Control: >40 dB range; continuously adjustable.

Output Balance: >40 dB below 20 kHz.
Can be floated up to ± 500 V peak
between output and chassis ground.

SYNCHRONIZATION

Sync Output: Sine wave in phase with output; 1.7V
rms open circuit; impedance 10 k Ω .

Sync Input: Oscillator can be synchronized to external signal. For 5 V rms input, sync frequency can be as much as $\pm 7\%$ away from set frequency (sync range).

Sync range is a linear function of sync voltage.

GENERAL

Operating Temperature: Instrument will operate within specifications from 0°C to 55°C.

Storage Temperature: -40°C to +75°C.

Power: Standard: AC-Line 115V or 230 V $\pm 10\%$,
50 Hz to 400 Hz, <4W.

Opt 01: Mercury batteries 300 hours operation

Opt 02: Line/Rechargeable batteries 115V
or 230V $\pm 10\%$, 50 Hz to 400 Hz,
<4W.
40 hours operation per recharge

Dimensions: 6-3/32" high, 5-1/8" wide, 8" deep
(155 x 130,1 x 203,2 mm).

Weight: Net 6 lbs (2,7 kg)
Shipping 8 lbs (3,6 kg)

Accessories Available:

HP 11107A AC Power Pack for 204C

HP 11108A Mercury Power Pack for 204C

HP 11109A Rechargeable Battery/AC
Power Pack for 204C

HP 11075A Instrument Case \$45.00

Price: HP 204C, (AC Line) \$250.00

HP 204C Option 01 (Mercury batteries)
\$265.00

HP 204C Option 02, (Rechargeable batteries,
AC-Line), \$285.00

HP 11107A AC Power Pack, \$60.00

HP 11108A Mercury Power Pack, \$75.00

HP 11109A Rechargeable battery/AC
Power Pack, \$95.00

hp MANUAL CHANGES

MODEL 204C
OSCILLATOR

Manual Serial Prefixed: 808-
-hp- Part No. 00204-90000

► New or revised item

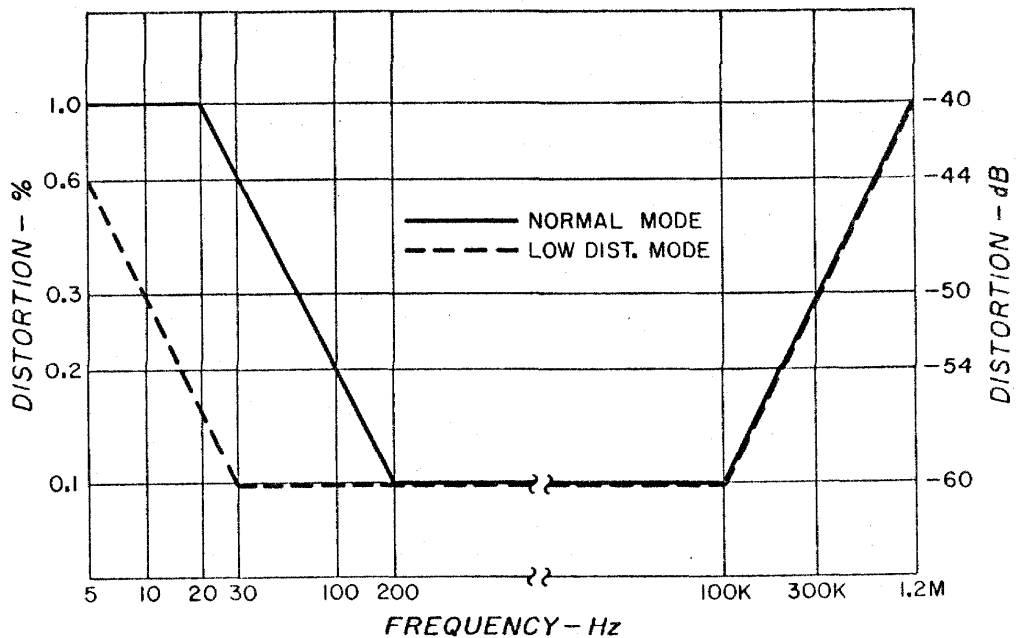
Instrument Serial Number	Make Manual Changes	Instrument Serial Number	Make Manual Changes
ALL	ERRATA		
808-00201 and above	CHANGE #1		
808-00501 and above	CHANGE #1, #2		

ERRATA

► Specifications:

Replace the distortion specification figure on the data sheet with the following figure:

Distortion:



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ERRATA (Cont'd):

▶ Page 3-1:

Add the following NOTE after paragraph 3-12:

NOTE

The Model 204C can be synchronized to any significant harmonic of an external signal. However, if a non-sinusoidal waveform is used to synchronize the Model 204C, some portion of the external sync signal will be fed to the output. This small signal will appear as distortion. The amount of this external distortion will be directly proportional to the amplitude of the sync signal. For a non-sinusoidal sync input of 2 Volts peak-to-peak, the distortion will be down about -45dB for frequencies which are normally down -60dB.

Page 3-5:

Add the following sentence to the second CAUTION:
"DO NOT CHARGE AT THE FAST RATE FOR MORE THAN 15 HOURS."

Table 6-1:

Change A1R38 and A1R39 to 604 Ω , Part No. 0757-0161.

Change A2R9 to 8660 Ω , Part No. 0698-3498.

▶ Add A2(Opt 02) T21, Part No. 9100-0172, Transformer.

Page 7-5/7-6, Figure 7-2:

Change A1R38 and A1R39 to 604 Ω

Change voltage at base of Q7 to +0.3 V.

Change voltage at base of Q8 to -1 V.

Page 7-7/7-8, Figure 7-3:

Change A2R9 to 8660 Ω .

CHANGE #1

Table 6-1:

Change A1C12 to 6.8 μ F, Part No. 0180-1701.

Change A1Q1 to Part No. 1855-0081.

Change A1R25 to 110 Ω Part No. 0757-0402.

Page 7-5/7-6, Figure 7-2:

Change A1C12 to 6.8 μ F.

Change A1R25 to 110 Ω .

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CHANGE #2

Table 6-1:

Change A1C15 to 3.3 μ F, Part No. 0180-0210.
Add A1C22, 20pF 500 Volts, Part No. 0160-2033.
Change A2C3 to 3.3 μ F, Part No. 0180-0161.

Page 7-5/7-6, Figure 7-2:

Add A1C22, 20pF, between chassis ground and the
junction of A1R34 and A1R35.

Page 7-7/7-8, Figure 7-3:

Change A2C3 to 3.3 μ F.

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Appendix

CODE LIST OF MANUFACTURERS

SALES AND SERVICE OFFICES

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This section contains general information about the -hp- Model 204C Oscillator. Throughout this manual the instrument will be referred to as the Model 204C.

1-3. SPECIFICATIONS.

1-4. The data sheet, included in the front of this manual, lists the specifications for the Model 204C.

1-5. DESCRIPTION.

1-6. The Model 204C is a stable signal source that produces sine wave frequencies between 5 Hz and 1.2 MHz in six ranges. The output level is variable from 0 to 5 volts rms from a constant 600 ohm source. When working into a 600 ohm load, the maximum output level is 2.5 volts rms.

1-7. A SYNC feature is included in the Model 204C. The SYNC jack on the front panel provides an output sync voltage of 1.7 V rms, or accepts an external signal to synchronize the oscillator. This feature permits several oscillators to be synchronized to the same frequency or harmonics thereof.

1-8. The output of the Model 204C may be isolated from the cabinet. This floating output is balanced to better than 40 dB below 200 kHz with an isolated, battery operated instrument, or better than 40 dB below 20 kHz with an instrument having an ac line connection.

1-9. The standard Model 204C contains an ac power supply that can be operated from 115/230 volts ac, 50 to 400 Hz. The instrument is also available with a mercury battery power supply as an Option 01, or with a rechargeable nickel cadmium battery power supply as an Option 02. The various power supplies can easily be interchanged by removing the instrument covers, unplugging one supply and plugging another in its place.

1-10. OPTIONS AVAILABLE.

1-11. The following power supplies are available in kit form for field installation:

- hp- 11107A AC Power Pack (standard)
- hp- 11108A Mercury Power Pack (Option 01)
- hp- 11109A Rechargeable Battery/AC Power Pack (Option 02)

1-12. WARRANTY.

1-13. The inside rear cover of this manual contains the -hp- warranty certification; it pertains to all components in the Model 204C except for the batteries supplied in the Option 01 or Option 02 instrument. These batteries are warranted for the manufacturer's specified life.

1-14. INSTRUMENT/MANUAL IDENTIFICATION.

1-15. Hewlett-Packard uses a two section, eight-digit serial number (000-00000). If the first three digits of the serial number on your instrument do not agree with those on the title page of the manual, change sheets supplied with the manual will define differences between your instrument and the Model 204C described in this manual. If a letter precedes the serial number, the instrument was manufactured outside the United States.

SECTION II

INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information and instructions necessary for installing and shipping the Model 204C Oscillator. Included are initial inspection procedures, power and grounding requirements, installation information, and instructions for repackaging for shipment.

2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of marks or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage that occurred in transit. If the instrument was damaged in transit, file a claim with the carrier. Check for supplied accessories, and test the electrical performance of the instrument using the procedure outlined in Paragraph 5-4. If there is damage or deficiency, see the warranty on the inside front cover of this manual.

2-5. POWER REQUIREMENTS.

2-6. The standard Model 204C will operate from any source of 115 or 230 volts ($\pm 10\%$), at 50 to 400 Hz. With the instrument disconnected from the ac power source, move the voltage selector switch (located on the rear panel) so the designation appearing on the switch matches the nominal voltage of the power source to be used. Power dissipation is less than 5 watts.

2-7. Line voltage requirements for Option 02 (Rechargeable Nickel-Cadmium battery supply) are identical to those given in Paragraph 2-6 for the standard Model 204C.

2-8. GROUNDING REQUIREMENTS.

2-9. To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument cabinet be grounded. The standard Model 204C 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.

2-10. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

2-11. INSTALLATION.

2-12. The Model 204C is fully transistorized; therefore, no special cooling is required. However, the instrument should not be operated where the ambient temperature exceeds 55°C (131°F).

2-13. BENCH MOUNTING.

2-14. The Model 204C is shipped with plastic feet and tilt stand in place, ready for use as a bench instrument.

2-15. RACK MOUNTING.

2-16. The Model 204C may be rack mounted by using an adapter frame (-hp- Part No. 5060-0797). The adapter frame is a rack frame that accepts any combination of -hp- submodular units. It can be rack mounted only. For additional information, address inquiries to your -hp- Sales and Service office. (See Appendix B for office locations.)

2-17. COMBINATION MOUNTING.

2-18. The Model 204C may be mounted in combination with other submodular units by using a Combining Case (-hp- Model 1051A or 1052A). The Combining Case is a full-module unit which accepts various combinations of submodular units. Being a full-module unit, it can be bench or rack mounted and is analogous to any full-module unit.

2-19. REPACKAGING FOR SHIPMENT.

2-20. The following paragraphs contain a general guide for repackaging of the instrument for shipment. Refer to Paragraph 2-21 if the original container is to be used; 2-22 if it is not. If you have any questions, contact your local -hp- Sales and Service Office. (See Appendix B for office locations.)

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or 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, serial number, and serial number prefix.

2-21. If original container is to be used, proceed as follows:

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

- b. Ensure that container is well sealed with strong tape or metal bands.

2-22. If original container is not to be used, proceed as follows:

- a. Wrap instrument in heavy paper or plastic before placing in an inner container.
- b. Place packing material around all sides of instrument and protect panel face with cardboard strips.
- c. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.
- d. Mark shipping container with "DELICATE INSTRUMENT", "FRAGILE" etc.

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section contains the information necessary for operation of the Model 204C.

3-3. INSTRUMENT DESCRIPTION.

3-4. Each operating control, indicator, and connector on the front and rear panels is identified and described in Figure 3-1.

3-5. TURN ON PROCEDURE.

3-6. To turn on the standard Model 204C, proceed as follows:

- a. Set the two-position voltage selector switch on the rear panel to the value of available line voltage.
- b. Connect AC Power Receptacle to power line voltage.
- c. Switch RANGE switch from OFF to desired frequency range.
- d. Select desired frequency and voltage output with frequency dial and amplitude controls respectively.

3-7. OPERATING CONSIDERATIONS.

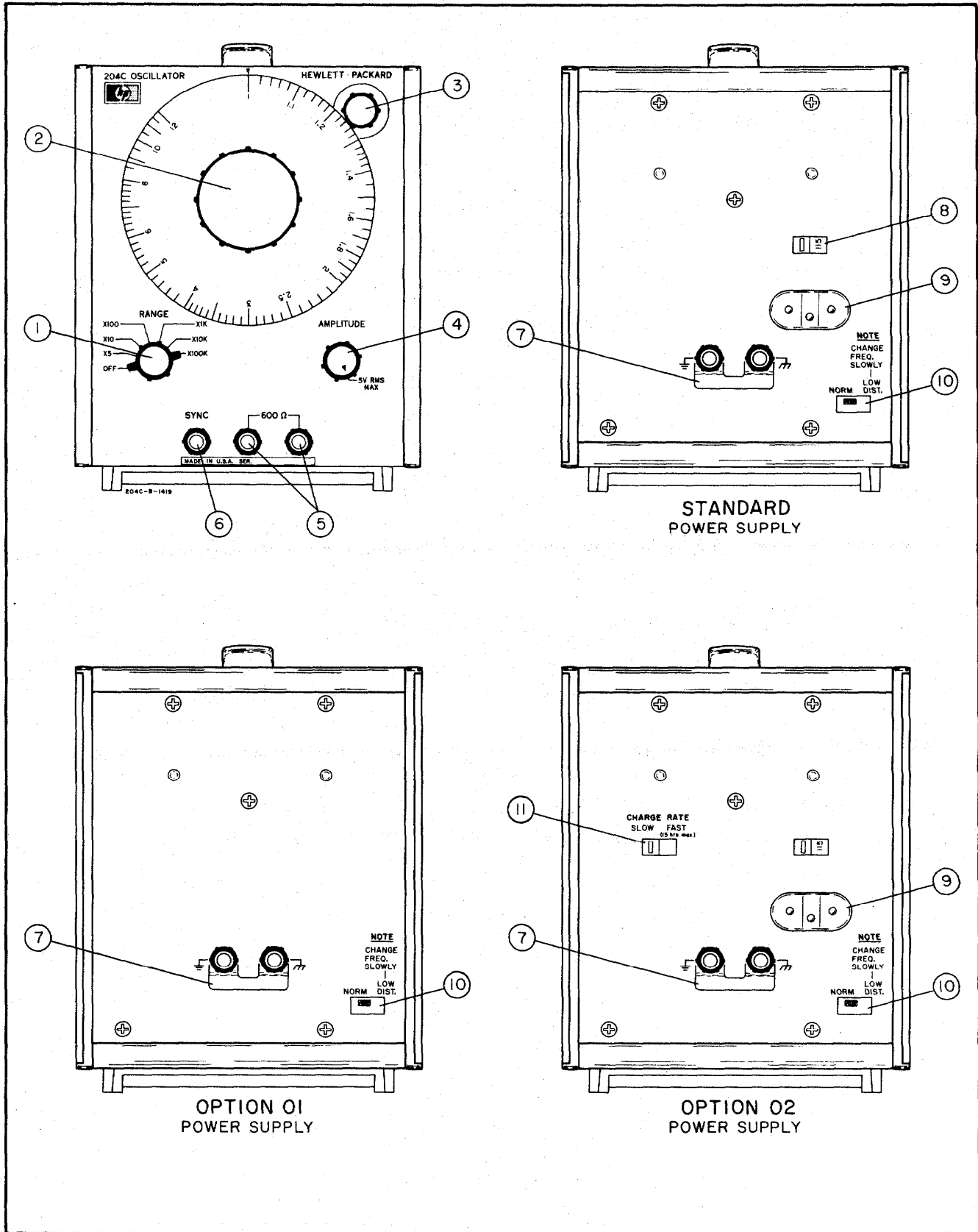
3-8. FLOATING OUTPUT.

3-9. The Model 204C chassis can be isolated from ground by disconnecting the grounding strap between the chassis and ground terminals on the rear panel. With the chassis isolated, the output may be connected to an instrument or a circuit without regard to dc potential difference (up to ± 500 volts).

3-10. SYNCHRONIZATION.

3-11. To synchronize the Model 204C connect a signal to the SYNC terminal on the front panel. An input signal of 5 volts rms may vary as much as $\pm 7\%$ in frequency and still synchronize the output at set frequency.

3-12. The SYNC terminal also provides an output sync voltage of 1.7 volts rms at the same frequency as the Model 204C output.



P/O Figure 3-1. Description of Controls, Indicators and Connectors

- ① RANGE Switch: Selects frequency range. In OFF position the oscillator is inoperative.
- ② Frequency Dial: Selects frequency within desired range. Dial calibration multiplied by RANGE switch position indicates output frequency.
- ③ Frequency Vernier: Provides fine tuning of frequency dial.
- ④ AMPLITUDE Control: Selects desired output level from 0 to 5 volts rms. (2.5 volts rms into 600 ohms).
- ⑤ Output Terminals: Provides a 600 ohm output at a frequency and amplitude determined by control settings.
- ⑥ SYNC: 1. Provides an input for an external sync signal.
2. Provides an output sync signal of 1.7 volts rms.
- ⑦ Ground Strap: Connects the floating circuit chassis to ground.
- ⑧ Voltage Selector Switch: Selects line voltage of 115 volts or 230 volts ac.
- ⑨ AC Power Receptacle: Mates with AC power cord supplied with this instrument for line voltage connection.
- ⑩ NORM/LOW DIST. Switch: Selects normal or low distortion on the X5 and X10 ranges (see Paragraph 3-14).
- ⑪ CHARGE RATE Switch: (Option 02 only) Selects SLOW or FAST rate of recharging the nickel-cadmium cells.

P/O Figure 3-1. Description of Controls, Indicators and Connectors

3-13. LOW DISTORTION.

3-14. At frequencies below 200 Hz, distortion can be reduced by switching the NORM/LOW DIST switch on the rear panel to LOW DIST. In the LOW/DIST mode the Model 204C will have a longer settling time when changing frequencies. To avoid this, set the desired frequency before switching to the LOW/DIST mode.

NOTE

The Model 204C output may appear unstable, or drop to zero when turning the frequency dial rapidly or changing the RANGE switch while in the LOW/DIST mode.

3-15. BATTERY OPERATION.

3-16. RECHARGEABLE BATTERY OPERATION.

3-17. There is no change in the operating procedure for an instrument in which the rechargeable battery supply has been installed. However, this power supply permits either ac operation for 115/230 vac $\pm 10\%$ (selected by switch on rear) 50 to 400 Hz power sources or battery operation for portable applications. Battery operation only (with charger power cord disconnected) is required at temperatures below 32° F (0°C) and is recommended at temperatures above 104°F (40°C).

3-18. When the RANGE switch is turned OFF, power is removed from the oscillator portion of the instrument and a resistor is connected across the output of the power supply. The charger will continue to operate as long as the power cord is connected to a power source. The resistor, placed across the output of the power supply, acts as a load in place of the oscillator section to maintain a constant charge rate through the batteries. A diode in the output circuit prevents battery discharge when the oscillator is not connected to a power source.

3-19. It is recommended that the power cord be connected to a power source whenever possible. This will prevent self-discharge of the battery cells and will assure a fully charged battery whenever portable operation is required. Turn the oscillator OFF when not in use, particularly when operating with the power cord disconnected.

3-20. When fully charged, the batteries will power the oscillator for approximately 35 hours of continuous or intermittent operation provided they are at a temperature of 81°F $\pm 10^\circ$. If the batteries are operated at higher or lower temperatures their capacity is reduced as the temperature extremes are approached; approximately 28 hours at 122°F (50°C) or approximately 20 hours at -4°F (-20°C). At temperatures beyond these extremes the batteries are not capable of supplying their characteristic stable discharge voltage.

3-21. The +122°F to -4°F temperature range is adequate for most users, however, keep these limits in mind when operating under field conditions. Internal temperatures in excess of 122°F are easily obtained if the instrument is left in the sun,

even with a moderate ambient temperature. Good practice would be to avoid storing, transporting, or operating in direct sunlight other than for a very short period. Also avoid placing the instrument in a location where surrounding equipment might excessively raise the internal temperature.



THE HERMETICALLY SEALED CELLS IN THESE BATTERIES MAY BE PERMANENTLY DAMAGED OR THEIR LIFE DRASTICALLY REDUCED IF EXPOSED TO EXTREMELY HIGH TEMPERATURES. THIS DANGER INCREASES UNDER PROLONGED CONDITIONS.

3-22. RECHARGING NICKEL-CADMIUM BATTERIES.

3-23. The batteries should be considered fully discharged when the voltages drop below $\pm 11V$ at the B+ and B- test points. The batteries will not operate much longer when this point is reached, and the oscillator may not meet specifications. Excessive discharge may shorten battery life.

3-24. A symptom of low battery voltage is clipping of the output waveform. If only one peak is clipped, however, check the BIAS voltage for proper setting. See Paragraph 5-21 for BIAS adjustment.

3-25. To recharge batteries, select either FAST or SLOW charge rate and 115V or 230V ac on rear panel and connect power cord to suitable power source. The oscillator can be used during recharging since the charge rate is the same whether the oscillator is off or operating.

3-26. The FAST charge rate should be used only when a quick charge is necessary. Repeated charging at a FAST rate will shorten battery life.

3-27. The batteries will be fully charged in approximately 60 hours at the 6 mA SLOW charge rate, and 15 hours at the 20 mA FAST rate if they were fully discharged initially.

3-28. The batteries can be charged at any temperature between $+32^{\circ}F$ and $+104^{\circ}F$ ($0^{\circ}C$ to $+40^{\circ}C$). However, to obtain optimum battery life, recharging should be done at a temperature of $80.6^{\circ}F \pm 10^{\circ}F$ ($27^{\circ}C \pm 5.6^{\circ}C$).



THE FOUR NICKEL-CADMIUM BATTERIES ARE HERMETICALLY SEALED AND CAN BE DAMAGED IF CHARGED AT A FAST RATE AT TEMPERATURES ABOVE $104^{\circ}F$ ($40^{\circ}C$).

3-29. CYCLE-LIFE OF NICKEL-CADMIUM BATTERIES.

3-30. As extremes in temperature are approached, the cycle-life (complete charge-discharge cycles) of the batteries is reduced. Storage at high temperatures will increase the self-discharge rate and also decrease the cycle-life. Permanent battery damage may result if the batteries are stored at a high temperature for a prolonged period.

3-31. Battery cycle-life can be extended by recharging before the batteries are completely discharged, by charging at the SLOW rate, and by not overcharging.

3-32. The cycle-life of the batteries is based, by the manufacturer, on an end point of 80% of the rated 225 milliampere-hour capacity. This is with a ten hour charge and discharge current of 22.5 milliamperes with discharge carried to the normal ten-hour end voltage ($1.10 \text{ volts/cell} \times 5 = 5.50 \text{ volts/battery}$) on every cycle. Under these conditions a cycle-life in excess of 100 cycles can be expected.

3-33. When used to power the Model 204C, the batteries are discharged at approximately a 35 hour rate. The batteries are not fully discharged if they are recharged as recommended in Paragraph 3-22.

3-34. Optimum battery life can be obtained by following these precautions:

- a. Prevent complete battery discharge.
- b. Keep FAST charges to a minimum.
- c. Operate at moderate temperatures when possible.
- d. Disconnect power cord after 60 hours of continuous charging with oscillator turned OFF (15 hours if charging batteries at a FAST rate).

SECTION IV

PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. The Model 204C is a Wien-bridge oscillator. A block diagram of the circuit is shown in Figure 4-1. This section includes a block diagram description that consists of a discussion of each section of the block diagram.

4-3. BLOCK DIAGRAM DESCRIPTION.

4-4. BRIDGE AND AMPLIFIER.

4-5. The oscillator bridge consists of two parts, the frequency selective network and the amplifier negative feedback network. The frequency selective network is C_F , R_F , C_F' , and R_F' . The negative feedback divider is R_f , R_f' , and the AGC block.

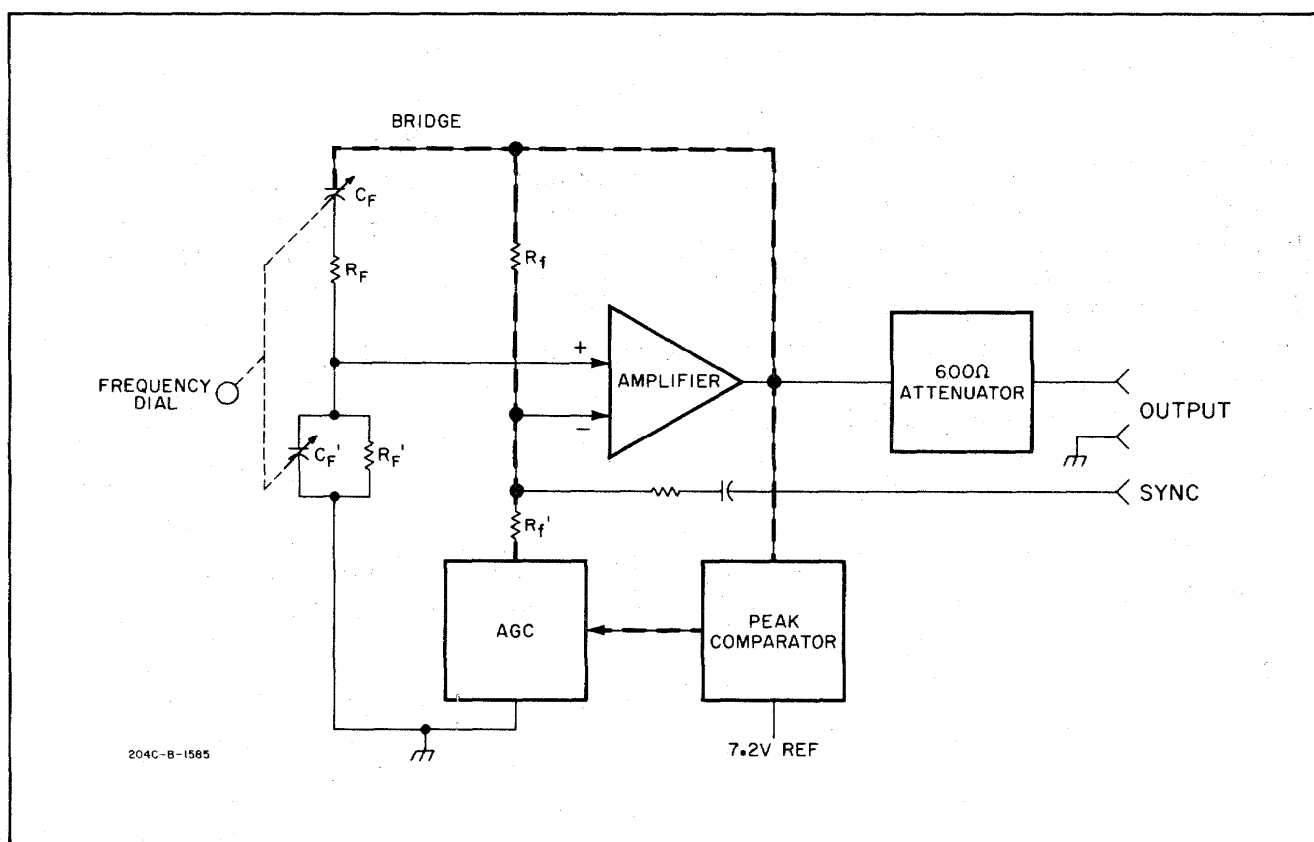


Figure 4-1. Model 204C Block Diagram

4-6. The characteristics of the RC frequency determining network are such that the operating frequency signal applied to the positive input of the AMPLIFIER is $1/3$ the amplitude of the positive feedback signal. The phase shift at the operating frequency is 0° . At all other frequencies the amplitude is less than $1/3$ and the phase shift is other than 0° .

4-7. For the oscillator circuit to oscillate, however, it must have an overall loop gain of unity. Therefore, the gain around the rest of the loop must be 3 and the phase shift any multiple of 360° , to satisfy an overall loop gain of 1, or unity.

4-8. The Model 204C AMPLIFIER, with the negative feedback divider, R_f , R_f' , and AGC, provide the necessary oscillator gain of 3.

4-9. The overall loop gain is the combination of the positive feedback and the oscillator gain. This is equal to unity at the set operating frequency.

4-10. PEAK COMPARATOR.

4-11. The PEAK COMPARATOR serves two functions. It sets and maintains the AMPLIFIER output at 7.2V peak, or 5V rms. The output is set with the 7.2V reference. The output is maintained by comparing the output to the 7.2V reference and feeding any difference voltage detected to the AGC circuit.

4-12. AGC.

4-13. The positive feedback to the input of the AMPLIFIER is not exactly one-third nor is the oscillator gain exactly three for all operating frequencies. Therefore, the purpose of the AGC is to continuously control the oscillator gain to maintain unity loop gain. The resistance of the AGC block can be varied slightly to change the divider ratio of the negative feedback network. The variable resistance of the AGC block is a FET controlled by the error signal from the PEAK COMPARATOR. Thus any change of the output level causes the PEAK COMPARATOR error signal to change the resistance of the AGC block which adjusts the oscillator gain to correct for the output level variation.

4-14. 600 OHM ATTENUATOR.

4-15. The 600 OHM ATTENUATOR is a bridged-T connected in such a manner that the output impedance is 600 ohms regardless of AMPLITUDE setting.

Table 5-1. Required Test Equipment

INSTRUMENT	REQUIRED SPECIFICATIONS	RECOMMENDED MODEL
Frequency Counter	Accuracy: ± 1 count Range: 5 Hz to 1.2 MHz	-hp- Model 5532A
AC Voltmeter	Range: 10 Hz to 1.2 MHz Sensitivity: 1 mV to 10 V Accuracy: $\pm 2\%$	-hp- Model 400E
DC Null Voltmeter	Sensitivity: 10 μ V to 20 V Accuracy: $\pm 2\%$ of full scale	-hp- Model 419A
Distortion Analyzer	Range: 5 Hz to 300 kHz Fundamental Rejection: > 60 dB	-hp- Model 334A
Test Oscillator	Range: 10 Hz to 1 MHz Output: 5 V rms open circuit	-hp- Model 651B
Wave Analyzer	Frequency Range: 20 Hz to 600 kHz Dynamic Range: > 80 dB below 0dB reference level	-hp- Model 3590A/3594A
Thermal Converter	Accuracy: $\pm 0.2\%$ Frequency Range: 5 Hz to 1.2 MHz	-hp- Model H02-11049A
Bucking Supply	See Figure 5-2 for diagram a. R: fxd $6500\Omega \pm 1\%$ b. R: var $500\Omega \pm 5\%$ c. R: var $50\Omega \pm 5\%$ d. Battery: 1.34 V	-hp- Part No. 0811-0392 -hp- Part No. 2100-0324 -hp- Part No. 2100-1481 Mallory RM-42R
1 MHz Notch Filter	See Figure 5-3 for diagram a. R: fxd $510\Omega \pm 5\%$ b. R: var $1\text{ k}\Omega \pm 10\%$ c. C: fxd $820\text{ pF} \pm 5\%$ d. C: fxd $0.002\text{ }\mu\text{F} \pm 20\%$ e. Inductor: fxd $51\text{ }\mu\text{H} \pm 5\%$	-hp- Part No. 0683-5115 -hp- Part No. 2100-0889 -hp- Part No. 0160-2216 -hp- Part No. 0150-0122 -hp- Part No. 9100-1630
Balance Network	See Figure 5-5 for diagram a. R: fxd $300\Omega \pm 0.1\%$ b. R: fxd $150\Omega \pm 1\%$	-hp- Part No. 0811-0029 -hp- Part No. 0757-0715
Terminating Resistance	R: fxd $600\Omega \pm 1\%$	-hp- Part No. 0757-1100

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains information necessary for the maintenance of the Model 204C Oscillator. Included are performance checks, adjustment and calibration procedures, and troubleshooting procedures.

5-3. The test equipment needed to properly maintain and service the Model 204C is listed in Table 5-1. If the recommended model is not available, other equipments may be substituted provided they meet the required specifications.

5-4. PERFORMANCE CHECKS.

5-5. The performance checks presented in this section are designed to compare the Model 204C with its published specifications. These checks can be used for incoming inspection, periodic maintenance checks, and to verify performance after adjustment or repair. A performance check test card appears at the end of this section which can be used to record the performance specifications.

5-6. DIAL ACCURACY CHECK.

- a. Connect the Model 204C and the Frequency Counter as shown in Figure 5-1. Set the counter to measure frequency and check the Model 204C at the frequencies listed in Table 5-2 for the tolerances indicated.

Table 5-2. Dial Accuracy Check

RANGE SWITCH	FREQUENCY DIAL	COUNTER INDICATION
X5	1	5 Hz ± 0.15 Hz
X5	6	30 Hz ± 0.9 Hz
X5	12	60 Hz ± 1.8 Hz
X10	1	10 Hz ± 0.3 Hz
X10	6	60 Hz ± 1.8 Hz
X10	12	120 Hz ± 3.6 Hz
X100	1	100 Hz ± 3.0 Hz
X100	6	600 Hz ± 18.0 Hz
X100	12	1.2 kHz ± 36 Hz
X1K	1	1.0 kHz ± 30 Hz
X1K	6	6.0 kHz ± 180 Hz
X1K	12	12.0 kHz ± 360 Hz
X10K	1	10.0 kHz ± 300 Hz
X10K	6	60.0 kHz ± 1.8 kHz
X10K	12	120.0 kHz ± 3.6 kHz
X100K	1	100.0 kHz ± 3.0 kHz
X100K	6	600.0 kHz ± 18.0 kHz
X100K	12	1.2 MHz ± 36.0 kHz

- b. If the above dial accuracy checks fail to meet the required specifications, refer to Paragraph 5-15 for calibration procedures.

5-7. FLATNESS CHECK.

- a. Connect the equipment as shown in Figure 5-2.

————— NOTE —————

The BUCKING SUPPLY should be constructed from the components listed in Table 5-1. The 500 ohm control should be used as a coarse adjust and the 50 ohm control should be used as a fine adjust.

- b. Set the Model 204C RANGE switch to X1K and the frequency dial to 1. Set the AMPLITUDE control to maximum output.
- c. Adjust the BUCKING SUPPLY 50 ohm fine control for minimum resistance, and record the THERMAL CONVERTER output as indicated on the DC NULL VOLTMETER.
- d. Adjust the BUCKING SUPPLY coarse and fine controls for a 0V indication on the DC NULL VOLTMETER. Do not readjust the BUCKING SUPPLY controls for the remainder of this check.
- e. Check the Model 204C flatness at the frequencies listed in Table 5-3 for the tolerances indicated.

————— NOTE —————

The THERMAL CONVERTER is considered a square-law device. Therefore, theoretically, the percent of change at the output of the THERMAL CONVERTER should be 2 times the percent of change at the input. Actually the value is not quite 2. The number is typically 1.7. Check the Calibration Report supplied with your THERMAL CONVERTER for the exact multiplier.

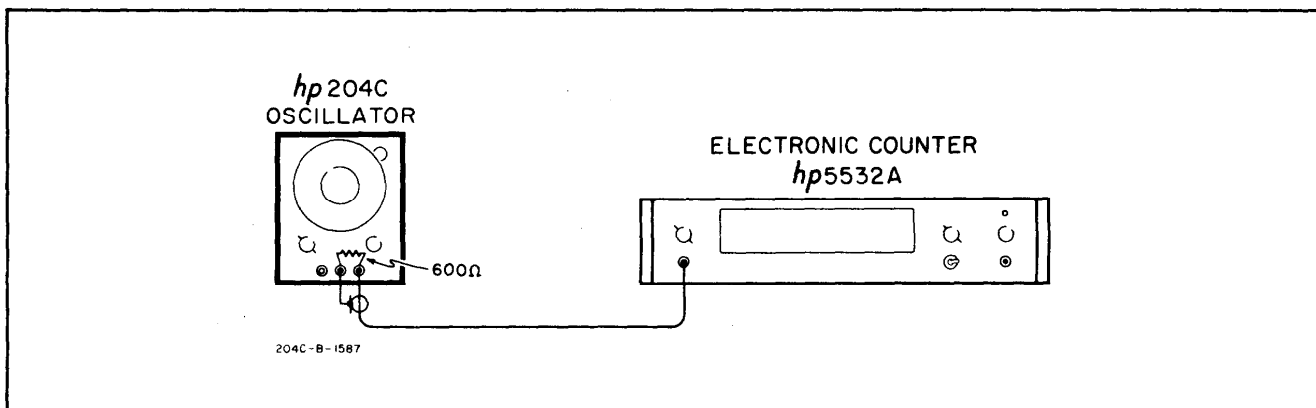


Figure 5-1. Dial Accuracy Check

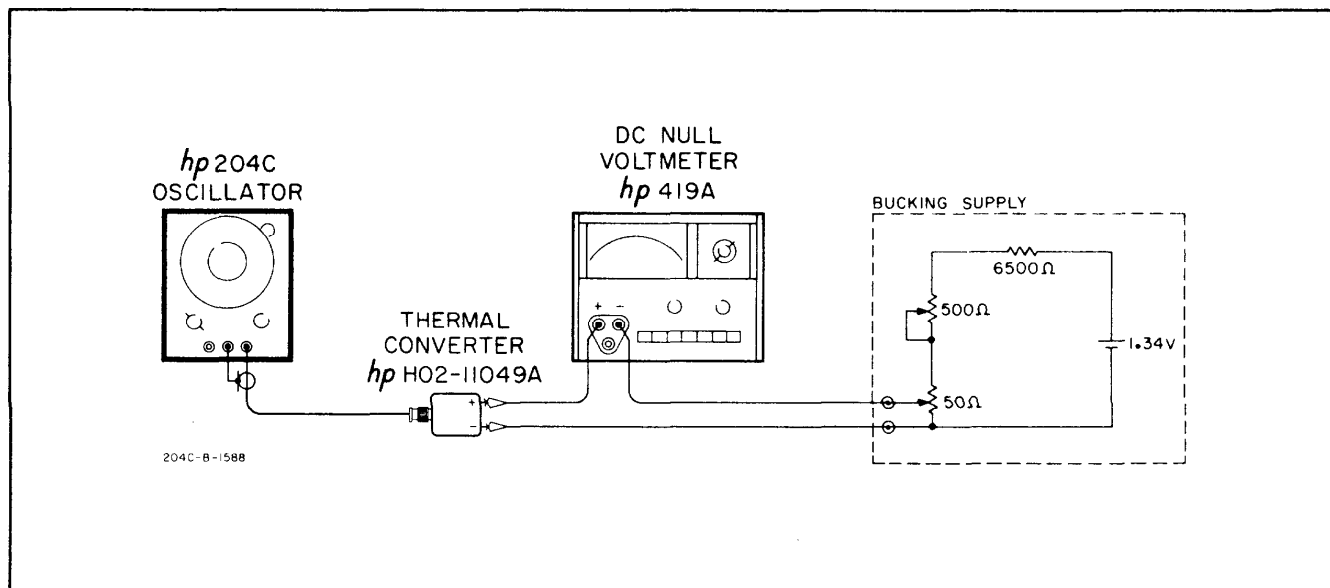


Figure 5-2. Flatness Check

- f. Convert the reading on the DC NULL VOLTMETER to the percentages listed in Table 5-3 by the following procedure. Divide the DC NULL VOLTMETER indication by the THERMAL CONVERTER output voltage recorded in step c of this paragraph. Multiply this value by 100 to get percent of output change. Divide this percentage by the Calibration Report multiplier to obtain a percentage within the tolerances listed in Table 5-3.

Example:

Frequency	100 kHz
THERMAL CONVERTER output	5 mV
DC NULL VOLTMETER reading	25 μ V
Calibration Report multiplier	1.7
Table 5-3 tolerance	$\pm 0.5\%$

$$0.025 \div 5 = 0.005$$

$$0.005 \times 100 = 0.5\% \text{ (output change)}$$

$$0.5\% \div 1.7 = 0.29\% \text{ (input change)}$$

Table 5-3. Flatness Check

Frequency		Tolerance	
Dial Setting	RANGE Setting	NORM	LOW DIST.
1	X5	+ 5% - 1%	± 1%
10	X5	+ 5% - 1%	± 1%
1	X10	+ 5% - 1%	± 1%
10	X10		± 0.5%
1	X100		± 0.5%
10	X100		± 0.5%
1	X1K		SET
10	X1K		± 0.5%
1	X10K		± 0.5%
10	X10K		± 0.5%
1	X100K		± 0.5%
3	X100K		± 0.5%
12	X100K		± 1%

5-8. DISTORTION CHECK.

a. Connect the Model 204C with a 600 ohm load to the Distortion Analyzer.

b. Set the Model 204C controls as follows:

Dial 1
 RANGE X1K
 AMPLITUDE Full CW
 NORM/LOW DIST. NORM

c. Set Distortion Analyzer controls as follows:

Dial 10
 FREQUENCY RANGE X100
 METER RANGE. 0DB
 FUNCTION SET LEVEL
 SENSITIVITY MIN
 MODE MANUAL

d. Increase the Distortion Analyzer SENSITIVITY to obtain a 0dB indication on the meter.

e. Switch Distortion Analyzer FUNCTION to DISTORTION, and adjust Distortion Analyzer dial and BALANCE controls for a null indication on the meter. (Downrange METER RANGE switch as necessary to maintain meter indication.)

- f. When an approximate null has been obtained with the Distortion Analyzer dial and BALANCE controls, switch the MODE to AUTOMATIC for minimum meter indication.
- g. Meter indication should be greater than 60 dB down from 0dB reference.
- h. Repeat steps a through f of this paragraph for all frequencies listed in Table 5-4.

Table 5-4. Distortion Check

Frequency		Tolerance	
Dial Setting	RANGE Setting	NORM	LOW DIST
1	X5	-40 dB	-54 dB
4	X5	-40 dB	-54 dB
5	X10	-46 dB	-54 dB
10	X10		-54 dB
2	X100		-60 dB
10	X100		-60 dB
1	X1K		-60 dB
10	X1K		-60 dB
1	X10K		-60 dB
10	X10K		-60 dB
1	X100K		-60 dB
3	X100K		-50 dB

- i. Connect the equipment as shown in Figure 5-3.
- j. Set the Model 204C frequency dial to 10 and the RANGE switch to X10K. Adjust the AMPLITUDE control for a 0dB indication on the AC Voltmeter.
- k. Switch to the X100K RANGE, and adjust the frequency dial and notch filter control for a minimum indication on the AC Voltmeter.
- l. The meter indication should be greater than 40 dB down from the 0dB reference.

5-9. OUTPUT VOLTAGE AND IMPEDANCE CHECK.

- a. Connect the Model 204C without a 600 ohm load to the AC Voltmeter.
- b. Set the AC Voltmeter to the 10V RANGE, and the Model 204C AMPLITUDE to maximum.
- c. The meter should indicate at least 5V rms.

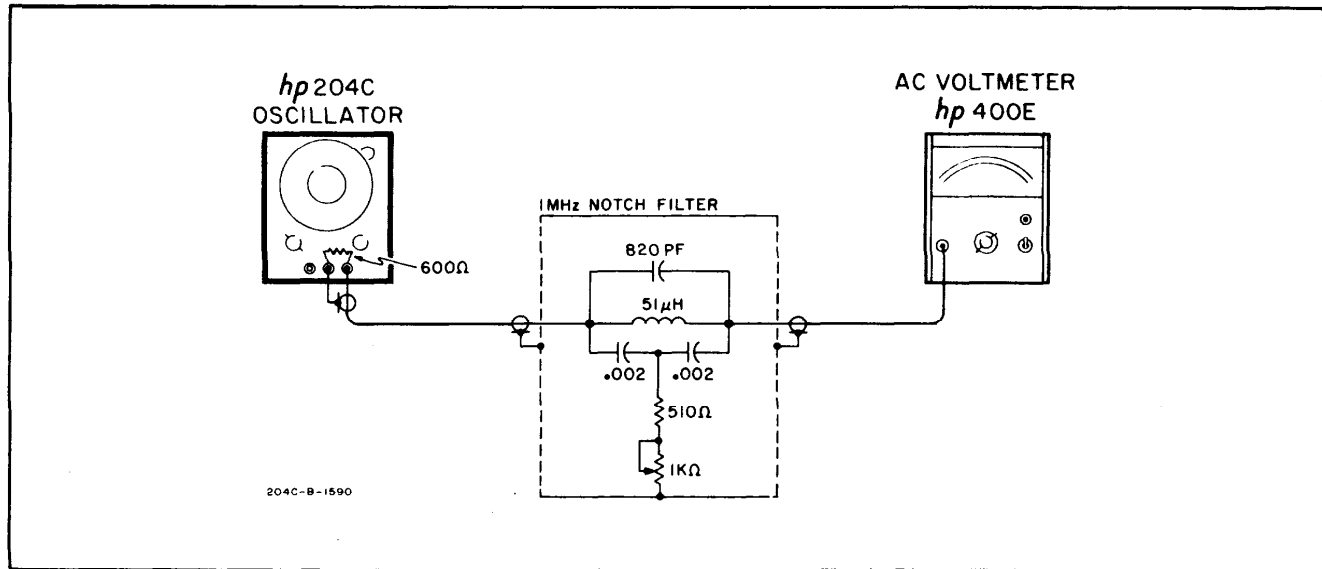


Figure 5-3. 1 MHz Distortion Check

- d. Connect a 600 ohm load to the Model 204C.
- e. The AC Voltmeter should indicate 2.5V rms, verifying the output voltage specification and an output impedance of 600 ohms.

5-10. OUTPUT CONTROL CHECK.

- a. Connect the Model 204C without a 600 ohm load to the AC Voltmeter.
- b. Adjust the Model 204C AMPLITUDE to minimum.
- c. The meter indication should be less than 50 mV rms.

5-11. SYNC OUTPUT CHECK.

- a. Connect the Model 204C SYNC output to the AC Voltmeter.
- b. The AC Voltmeter should indicate 1.7V rms.

5-12. SYNC INPUT CHECK.

- a. Connect the Test Oscillator to the AC Voltmeter and adjust controls for 5V rms at 20 kHz.
- b. Connect the Model 204C to the Electronic Counter and adjust controls for a frequency of 20 kHz.
- c. Without changing the controls set in steps a and b, connect the equipment as shown in Figure 5-4.

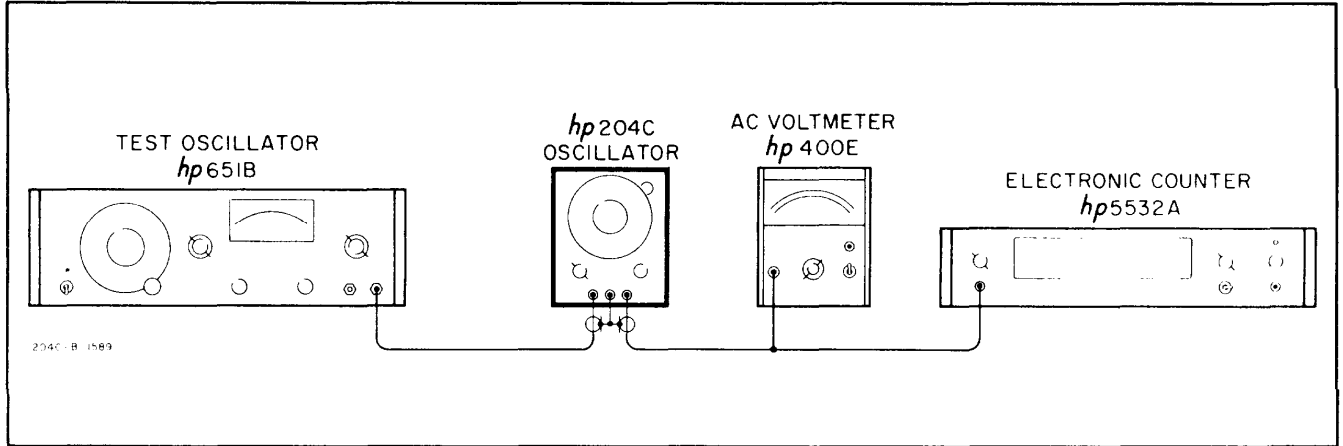


Figure 5-4. Sync Input Check

- d. Rotate the Test Oscillator dial above and below 20 kHz while watching the indication on the AC Voltmeter. When the needle starts to dip (indicating loss of sync), note the frequency indication on the Frequency Counter.
- e. The AC Voltmeter should dip at less than 18.6 kHz and greater than 21.4 kHz, indicating a sync range of $\pm 7\%$ at 5V rms.

5-13. BALANCE CHECK.

- a. Connect the Model 204C with a 600 ohm load to the AC Voltmeter.
- b. Set controls as follows:

Model 204C:

Dial 2
 RANGE X10K

AC Voltmeter:

RANGE 0DB

- c. Adjust Model 204C AMPLITUDE for a meter indication of 0dB.
- d. Remove the 600 ohm load and connect the equipment as shown in Figure 5-5.
- e. Meter indication should be greater than 40 dB down from 0dB reference.

5-14. HUM AND NOISE CHECK.

- a. Connect the Model 204C to the Wave Analyzer input and set the AMPLITUDE to maximum, and frequency to 100 kHz.

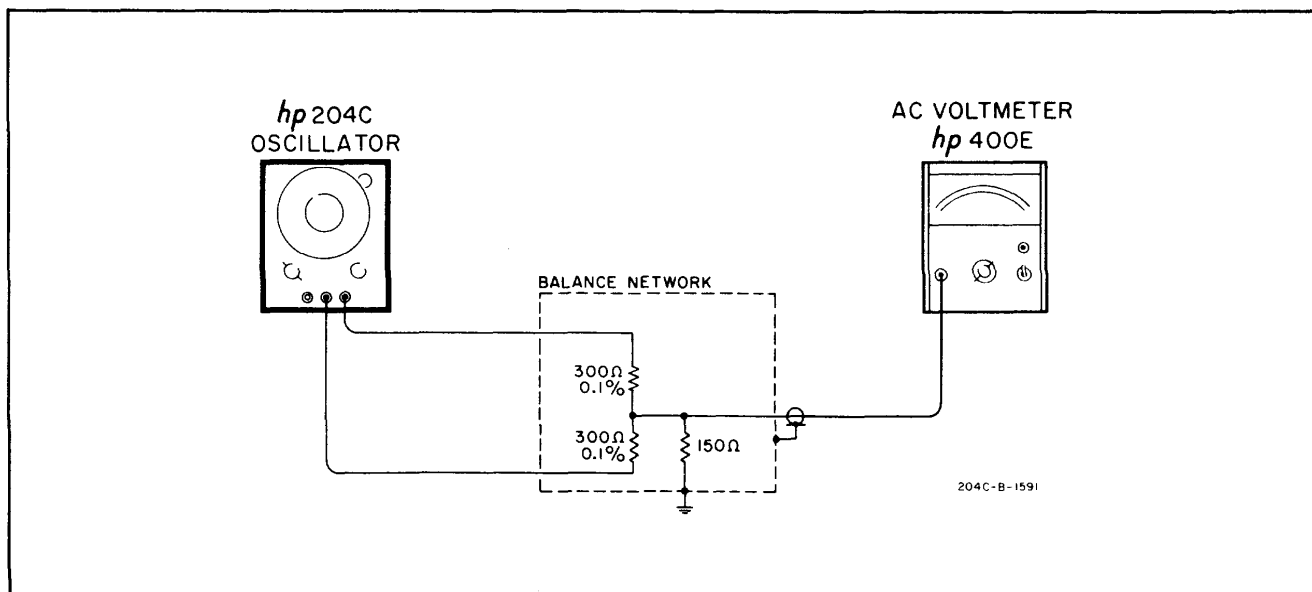


Figure 5-5. Balance Check

b. Set the Wave Analyzer controls as follows:

MAX. INPUT VOLTAGE	3
REF. ADJ. Switch	RELATIVE
METER	LIN dB
RANGE	AUTO
MODE	RESTORED
BANDWIDTH	3100
FREQUENCY	100 kHz
FREQUENCY RANGE	620 kHz
SWEEP	RESET
SWEEP RATE	1 Hz

c. Adjust the Wave Analyzer COARSE for maximum meter indication, and adjust the REF ADJ for a 0dB meter indication.

d. Reset Wave Analyzer controls as follows:

BANDWIDTH	10 Hz
FREQUENCY	25 Hz

e. Set the Wave Analyzer SWEEP to START and observe the meter indication as the Wave Analyzer sweeps to 400 Hz.

f. Reset the SWEEP RATE and BANDWIDTH at the frequencies shown in Table 5-5.

g. The meter indication should be down greater than 80 dB across the full sweep range, except for the 100 kHz fundamental and its harmonics.

Table 5-5. Hum and Noise Check

FREQUENCY	SWEEP RATE	BANDWIDTH
25 Hz	1	10 Hz
400 Hz	100	100 Hz
10 kHz	1000	1000 Hz
50 kHz	3100	3100 Hz

5-15. ADJUSTMENT AND CALIBRATION PROCEDURE.

5-16. INTRODUCTION.

5-17. The following Adjustment and Calibration Procedures should be used only if it has been determined through the Performance Checks, Paragraph 5-4 through 5-14, that the Model 204C is not performing within its specifications.

5-18. If proper performance cannot be achieved with the Adjustment and Calibration Procedure, refer to the Troubleshooting Procedures, Paragraph 5-26.

5-19. POWER SUPPLY.

5-20. Before making any adjustments, check the power supply voltages at test points 2 and 3. They should indicate +13V and -13V respectively. If the voltages have decreased to +11V and -11V the Model 204C may not meet distortion specifications.

5-21. BIAS ADJUSTMENT.

- a. Connect the DC Voltmeter to TP4 (BIAS).
- b. Adjust R20 (BIAS) for 0V indication on the meter.

5-22. AGC ADJUSTMENT.

- a. Set the Model 204C RANGE switch to X1K and the Dial to 1.
- b. Connect the DC Voltmeter to TP1 (AGC).
- c. Adjust R24 (AGC) for -1.8 V at TP1.

5-23. AGC AND FREQUENCY ADJUSTMENT.

- a. Leave the DC Voltmeter connected as in Paragraph 5-22, and connect the Model 204C output to the Frequency Counter.
- b. Set the Model 204C RANGE to X1K and the Dial to 8.

- c. Adjust C2 and C8 (AGC and FREQ CAL) for 8 kHz and -1.8 V.

————— NOTE —————

C2 and C8 are interacting controls. A little practice may be required to become proficient at making this adjustment.

- d. Repeat Paragraphs 5-22 and 5-23 a through c if the voltage at 1 kHz has been changed from -1.8 V.
- e. With the RANGE switch set on X1K, adjust the Dial for 10 kHz \pm 10 Hz.
- f. Without moving the Dial, check the frequency on ranges X5 through X10K and record the error in percent.
- g. Calculate the average between the most positive and the most negative error.
- h. Readjust C2 and C8 for the following readings:

Frequency 10 kHz minus average found above \pm 10 Hz
 AGC 1.8 V \pm 0.1 V

Example:

X5	+5%	Most positive error	+5%
X10	+1%	Most negative error	-1%
X100	-1%	Average error $\frac{(+5\%)+(-1\%)}{2}$	= +2%
X1K	0		
X10K	+2%	Adjust frequency for 9,800 Hz \pm 10 Hz.	

5-24. HIGH FREQUENCY ADJUSTMENT.

- a. Set the Model 204C RANGE switch to X100K and set the Dial to exactly 10.
- b. With the Model 204C connected to the Frequency Counter, adjust C4 (HIGH FREQ CAL) to indicate 1 MHz \pm 1 kHz on the Frequency Counter.

5-25. DISTORTION ADJUSTMENT.

- a. Connect the Model 204C to the Distortion Analyzer.
- b. Set the Model 204C RANGE switch to X1K and the Dial to 10.
- c. Set the Distortion Analyzer FUNCTION to SET LEVEL, MODE to MANUAL, and FREQUENCY RANGE to X1K.
- d. Adjust the Model 204C AMPLITUDE and Distortion Analyzer SENSITIVITY for 0dB meter indication.

- e. Set the Distortion Analyzer FUNCTION to DISTORTION and adjust the Distortion Analyzer Dial and Balance controls for minimum indication.
- f. Set the Distortion Analyzer MODE to AUTOMATIC and adjust R30 (DIST) for a meter indication of greater than 60 dB down from 0dB reference.

5-26. TROUBLESHOOTING PROCEDURE.

5-27. The following paragraphs are provided as an aid to troubleshooting the Model 204C. These operations should be undertaken only after it has been determined that the difficulty cannot be eliminated by the Adjustment and Calibration Procedures, Paragraph 5-17. An investigation should also be made to ensure that the trouble is not a result of conditions external to the Model 204C.

5-28. Before troubleshooting the Model 204C, read Section IV, Principles of Operation, for familiarization with circuit operation.

5-29. Conduct a visual check of the Model 204C for possible burned or loose components, loose connections, or any other condition which might suggest a source of trouble.

5-30. Voltages have been provided on the schematic diagram as an aid to troubleshooting. In some cases the voltages are shown to the nearest tenth of a volt. This does not mean that the voltages should be the exact value shown, but rather they are meant to indicate the base to emitter voltage drop of the transistors.

5-31. The inner cabinet provides the chassis ground path for C1. When the cabinet is removed for troubleshooting, connect a short jumper lead from the bottom of MP26 (see Figure 6-1) to the metal tab protruding just below it. This will allow the oscillator to operate with the inner cabinet removed.

5-32. Some potential malfunction symptoms and the associated probable causes are listed in Table 5-5.

Table 5-6. Troubleshooting Guide

SYMPTOM	PROBABLE TROUBLE
Waveform Clipping	Check Power Supply and BIAS level.
Ineffective BIAS control	Check BIAS control at A1Q1 gate. If ineffective, check A1S1 and BIAS path. If good, check A1Q3, A1Q7, A1Q8.
Squegging or high frequency oscillations	Check in NORM Mode at 100 Hz on X100 RANGE. If oscillations are present, replace A1C9 with a higher value. (Perform High Frequency Adjustment Paragraph 5-24.)
Insufficient range of C4 (High Freq. Cal)	Change A1C9 to lower value. (Check for high frequency oscillations after change).
Crossover Distortion	Check A1CR4, A1CR5, A1R41, and A1R42.
Microphonics or discontinuities	Check C1 wiper contacts on both rotor sections.

PERFORMANCE CHECK TEST CARD

Hewlett-Packard Model 204C Oscillator Serial No. _____	Test performed by _____ Date _____
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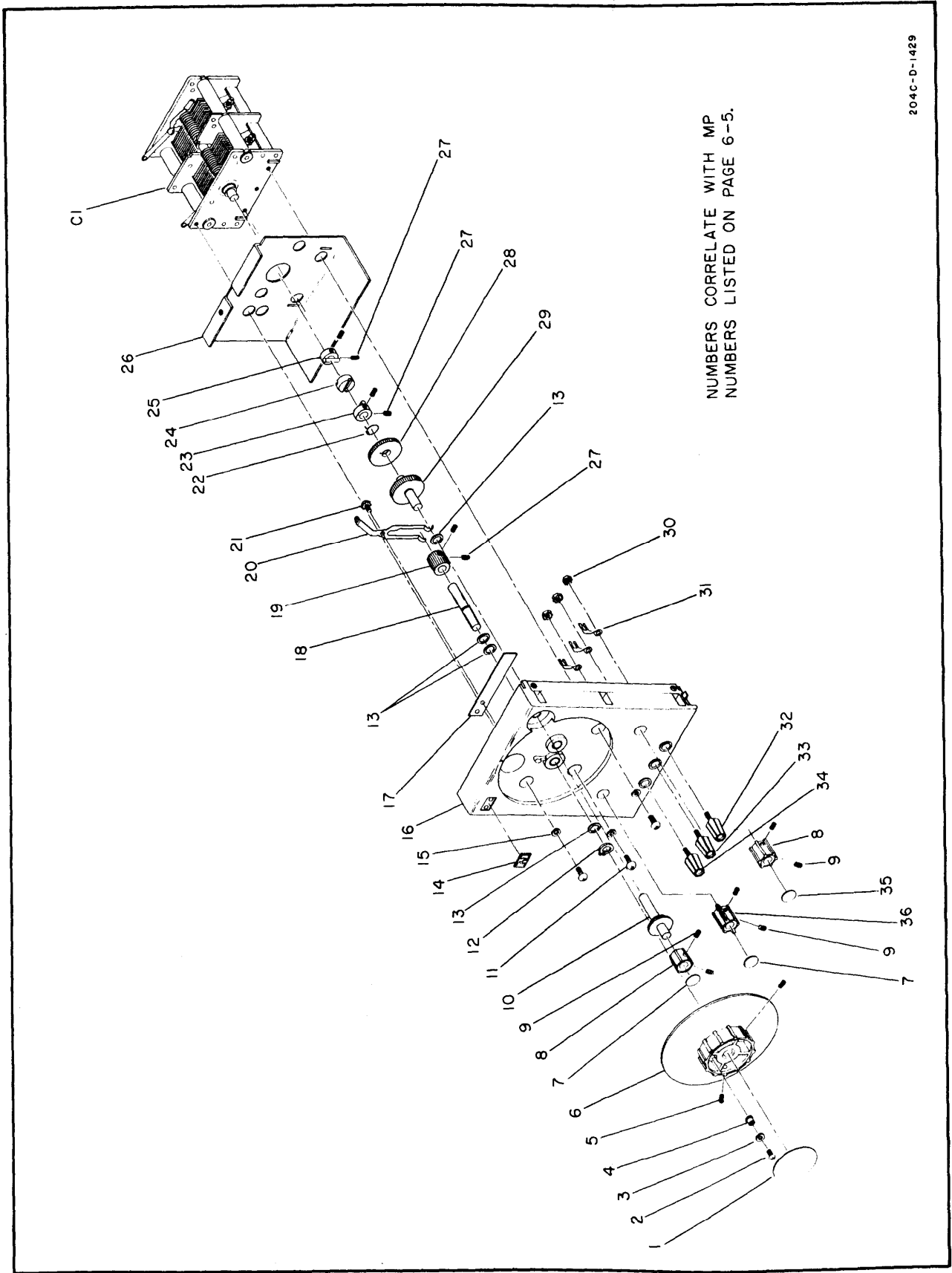
DESCRIPTION	CHECK
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<p>Dial Accuracy:</p> <table style="width:100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; border-bottom: 1px solid black;">Range</th> <th style="text-align: left; border-bottom: 1px solid black;">Dial</th> </tr> </thead> <tbody> <tr><td>X5</td><td>1</td></tr> <tr><td>X5</td><td>6</td></tr> <tr><td>X5</td><td>12</td></tr> <tr><td>X10</td><td>1</td></tr> <tr><td>X10</td><td>6</td></tr> <tr><td>X10</td><td>12</td></tr> <tr><td>X100</td><td>1</td></tr> <tr><td>X100</td><td>6</td></tr> <tr><td>X100</td><td>12</td></tr> <tr><td>X1K</td><td>1</td></tr> <tr><td>X1K</td><td>6</td></tr> <tr><td>X1K</td><td>12</td></tr> <tr><td>X10K</td><td>1</td></tr> <tr><td>X10K</td><td>6</td></tr> <tr><td>X10K</td><td>12</td></tr> <tr><td>X100K</td><td>1</td></tr> <tr><td>X100K</td><td>6</td></tr> <tr><td>X100K</td><td>12</td></tr> </tbody> </table>	Range	Dial	X5	1	X5	6	X5	12	X10	1	X10	6	X10	12	X100	1	X100	6	X100	12	X1K	1	X1K	6	X1K	12	X10K	1	X10K	6	X10K	12	X100K	1	X100K	6	X100K	12	<p>Tolerance:</p> <table style="width:100%; border-collapse: collapse;"> <tbody> <tr><td>_____ 5 Hz</td><td>_____ ± 0.15 Hz</td></tr> <tr><td>_____ 30 Hz</td><td>_____ ± 0.9 Hz</td></tr> <tr><td>_____ 60 Hz</td><td>_____ ± 1.8 Hz</td></tr> <tr><td>_____ 10 Hz</td><td>_____ ± 0.3 Hz</td></tr> <tr><td>_____ 60 Hz</td><td>_____ ± 1.8 Hz</td></tr> <tr><td>_____ 120 Hz</td><td>_____ ± 3.6 Hz</td></tr> <tr><td>_____ 100 Hz</td><td>_____ ± 3.0 Hz</td></tr> <tr><td>_____ 600 Hz</td><td>_____ ± 18.0 Hz</td></tr> <tr><td>_____ 1.2 kHz</td><td>_____ ± 36 Hz</td></tr> <tr><td>_____ 1.0 kHz</td><td>_____ ± 30 Hz</td></tr> <tr><td>_____ 6.0 kHz</td><td>_____ ± 180 Hz</td></tr> <tr><td>_____ 12.0 kHz</td><td>_____ ± 360 Hz</td></tr> <tr><td>_____ 10.0 kHz</td><td>_____ ± 300 Hz</td></tr> <tr><td>_____ 60.0 kHz</td><td>_____ ± 1.8 kHz</td></tr> <tr><td>_____ 120.0 kHz</td><td>_____ ± 3.6 kHz</td></tr> <tr><td>_____ 100.0 kHz</td><td>_____ ± 3.0 kHz</td></tr> <tr><td>_____ 600.0 kHz</td><td>_____ ± 18.0 kHz</td></tr> <tr><td>_____ 1.2 MHz</td><td>_____ ± 36.0 kHz</td></tr> </tbody> </table>	_____ 5 Hz	_____ ± 0.15 Hz	_____ 30 Hz	_____ ± 0.9 Hz	_____ 60 Hz	_____ ± 1.8 Hz	_____ 10 Hz	_____ ± 0.3 Hz	_____ 60 Hz	_____ ± 1.8 Hz	_____ 120 Hz	_____ ± 3.6 Hz	_____ 100 Hz	_____ ± 3.0 Hz	_____ 600 Hz	_____ ± 18.0 Hz	_____ 1.2 kHz	_____ ± 36 Hz	_____ 1.0 kHz	_____ ± 30 Hz	_____ 6.0 kHz	_____ ± 180 Hz	_____ 12.0 kHz	_____ ± 360 Hz	_____ 10.0 kHz	_____ ± 300 Hz	_____ 60.0 kHz	_____ ± 1.8 kHz	_____ 120.0 kHz	_____ ± 3.6 kHz	_____ 100.0 kHz	_____ ± 3.0 kHz	_____ 600.0 kHz	_____ ± 18.0 kHz	_____ 1.2 MHz	_____ ± 36.0 kHz
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<p>Flatness:</p> <table style="width:100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; border-bottom: 1px solid black;">Range</th> <th style="text-align: left; border-bottom: 1px solid black;">Dial</th> </tr> </thead> <tbody> <tr><td>X5</td><td>1</td></tr> <tr><td>X5</td><td>10</td></tr> <tr><td>X10</td><td>1</td></tr> <tr><td>X10</td><td>10</td></tr> <tr><td>X100</td><td>1</td></tr> <tr><td>X100</td><td>10</td></tr> <tr><td>X1K</td><td>1</td></tr> <tr><td>X1K</td><td>10</td></tr> <tr><td>X10K</td><td>1</td></tr> <tr><td>X10K</td><td>10</td></tr> <tr><td>X100K</td><td>1</td></tr> <tr><td>X100K</td><td>3</td></tr> <tr><td>X100K</td><td>12</td></tr> </tbody> </table>	Range	Dial	X5	1	X5	10	X10	1	X10	10	X100	1	X100	10	X1K	1	X1K	10	X10K	1	X10K	10	X100K	1	X100K	3	X100K	12	<p>Tolerance:</p> <table style="width:100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center; border-bottom: 1px solid black;">NORM</th> <th style="text-align: center; border-bottom: 1px solid black;">LOW DIST</th> </tr> </thead> <tbody> <tr> <td>+5% - 1% _____</td> <td>± 1% _____</td> </tr> <tr> <td>+5% - 1% _____</td> <td>± 1% _____</td> </tr> <tr> <td>+5% - 1% _____</td> <td>± 1% _____</td> </tr> <tr> <td></td> <td>± 0.5% _____</td> </tr> <tr> <td></td> <td>± 0.5% _____</td> </tr> <tr> <td></td> <td>± 0.5% _____</td> </tr> <tr> <td></td> <td>SET _____</td> </tr> <tr> <td></td> <td>± 0.5% _____</td> </tr> <tr> <td></td> <td>± 0.5% _____</td> </tr> <tr> <td></td> <td>± 0.5% _____</td> </tr> <tr> <td></td> <td>± 0.5% _____</td> </tr> <tr> <td></td> <td>± 0.5% _____</td> </tr> <tr> <td></td> <td>± 1% _____</td> </tr> </tbody> </table>	NORM	LOW DIST	+5% - 1% _____	± 1% _____	+5% - 1% _____	± 1% _____	+5% - 1% _____	± 1% _____		± 0.5% _____		± 0.5% _____		± 0.5% _____		SET _____		± 0.5% _____		± 0.5% _____		± 0.5% _____		± 0.5% _____		± 0.5% _____		± 1% _____
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PERFORMANCE CHECK TEST CARD (Cont'd)

DESCRIPTION	CHECK																																																								
<p>Distortion:</p> <table border="0" style="width: 100%;"> <thead> <tr> <th style="text-align: left;"><u>Range</u></th> <th style="text-align: left;"><u>Dial</u></th> <th style="text-align: left;"><u>NORM</u></th> <th style="text-align: left;"><u>LOW DIST</u></th> </tr> </thead> <tbody> <tr> <td>X5</td> <td>1</td> <td>-40 dB _____</td> <td>-54 dB _____</td> </tr> <tr> <td>X5</td> <td>4</td> <td>-40 dB _____</td> <td>-54 dB _____</td> </tr> <tr> <td>X10</td> <td>5</td> <td>-46 dB _____</td> <td>-54 dB _____</td> </tr> <tr> <td>X10</td> <td>10</td> <td>-54 dB _____</td> <td></td> </tr> <tr> <td>X100</td> <td>2</td> <td>-60 dB _____</td> <td></td> </tr> <tr> <td>X100</td> <td>10</td> <td>-60 dB _____</td> <td></td> </tr> <tr> <td>X1K</td> <td>1</td> <td>-60 dB _____</td> <td></td> </tr> <tr> <td>X1K</td> <td>10</td> <td>-60 dB _____</td> <td></td> </tr> <tr> <td>X10K</td> <td>1</td> <td>-60 dB _____</td> <td></td> </tr> <tr> <td>X10K</td> <td>10</td> <td>-60 dB _____</td> <td></td> </tr> <tr> <td>X100K</td> <td>1</td> <td>-60 dB _____</td> <td></td> </tr> <tr> <td>X100K</td> <td>3</td> <td>-50 dB _____</td> <td></td> </tr> <tr> <td>X100K</td> <td>10</td> <td>-40 dB _____</td> <td></td> </tr> </tbody> </table>	<u>Range</u>	<u>Dial</u>	<u>NORM</u>	<u>LOW DIST</u>	X5	1	-40 dB _____	-54 dB _____	X5	4	-40 dB _____	-54 dB _____	X10	5	-46 dB _____	-54 dB _____	X10	10	-54 dB _____		X100	2	-60 dB _____		X100	10	-60 dB _____		X1K	1	-60 dB _____		X1K	10	-60 dB _____		X10K	1	-60 dB _____		X10K	10	-60 dB _____		X100K	1	-60 dB _____		X100K	3	-50 dB _____		X100K	10	-40 dB _____		
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<p>Output Voltage and Impedance:</p> <p style="padding-left: 40px;">No load</p> <p style="padding-left: 40px;">600Ω load</p>	<p style="padding-left: 40px;">5 V rms _____</p> <p style="padding-left: 40px;">2.5 V rms _____</p>																																																								
<p>Output Control:</p>	<p style="padding-left: 40px;">< 50 mV rms _____</p>																																																								
<p>Sync Output:</p>	<p style="padding-left: 40px;">1.7 V rms _____</p>																																																								
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<p>Balance:</p>	<p style="padding-left: 40px;">-40 dB _____</p>																																																								
<p>Hum and Noise</p>	<p style="padding-left: 40px;">-80 dB _____</p>																																																								



204C-D-1429

Figure 6-1. Front Panel Exploded View

SECTION VI REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alphabetic 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. 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.

DESIGNATORS

A = assembly	F = fuse	MP = mechanical part	TC = thermocouple
B = motor	FL = filter	P = plug	V = vacuum tube, neon bulb, photocell, etc.
BT = battery	HR = heater	Q = transistor	W = cable
C = capacitor	IC = integrated circuit	QCR = transistor-diode	X = socket
CR = diode	J = jack	R = resistor	XDS = lampholder
DL = delay line	K = relay	RT = thermistor	XF = fuseholder
DS = lamp	L = inductor	S = switch	Z = network
E = misc electronic part	M = meter	T = transformer	

ABBREVIATIONS

Ag = silver	ID = inside diameter	ns = nanosecond (s) = 10 ⁻⁹ seconds	sl = slide
Al = aluminum	imp = impregnated	nsr = not separately replaceable	SPDT = single-pole double-throw
A = ampere (s)	incd = incandescent		SPST = single-pole single-throw
Au = gold	ins = insulation (ed)		Ta = tantalum
C = capacitor	kΩ = kilohm (s) = 10 ⁺³ ohms	Ω = ohm (s)	TC = temperature coefficient
cer = ceramic	kHz = kilohertz = 10 ⁺³ hertz	obd = order by description	TiO ₂ = titanium dioxide
coef = coefficient	L = inductor	OD = outside diameter	tog = toggle
com = common	lin = linear taper	p = peak	tol = tolerance
comp = composition	log = logarithmic taper	pc = printed circuit	trim = trimmer
conn = connection	m = milli = 10 ⁻³	pF = picofarad (s) = 10 ⁻¹² farads	TSTR = transistor
dep = deposited	mA = milliamperes (s) = 10 ⁻³ amperes	piv = peak inverse voltage	V = volt (s)
DPDT = double-pole double-throw	MHz = megahertz = 10 ⁺⁶ hertz	p/o = part of	vacw = alternating current working voltage
DPST = double-pole single-throw	MΩ = megohm (s) = 10 ⁺⁶ ohms	pos = position (s)	var = variable
elect = electrolytic	met flm = metal film	poly = polystyrene	vw = direct current working voltage
encap = encapsulated	mfr = manufacturer	pot = potentiometer	W = watt (s)
F = farad (s)	mtg = mounting	p-p = peak-to-peak	w/ = with
FET = field effect transistor	mV = millivolt (s) = 10 ⁻³ volts	ppm = parts per million	wiv = working inverse voltage
fxd = fixed	μ = micro = 10 ⁻⁶	prec = precision (temperature coefficient, long term stability, and/or tolerance)	w/o = without
GaAs = gallium arsenide	μV = microvolt (s) = 10 ⁻⁶ volts	R = resistor	ww = wirewound
GHz = gigahertz = 10 ⁺⁹ hertz	my = Mylar (R)	Rh = rhodium	* = optimum value selected at factory, average value shown (part may be omitted)
gd = guard (ed)	nA = nanoampere (s) = 10 ⁻⁹ amperes	rms = root-mean-square	** = no standard type number assigned (selected or special type)
Ge = germanium	NC = normally closed	rot = rotary	
grd = ground (ed)	Ne = neon		
H = henry (ies)	NO = normally open		
Hg = mercury	NPO = negative positive zero (zero temperature coefficient)	Se = selenium	
Hz = hertz (cycle (s) per second)		sect = section (s)	
		Si = silicon	

Table 6-1. Replaceable Parts

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1	00204-66505		1	PC Board Assembly	-hp-	
A1C1	0150-0093		2	C: fxd cer 0.01 μ F +80% -20% 100 vdcw	91418	TA obd
A1C2	0121-0105		1	C: var cer 9-35 pF	72982	538-006-94D
A1C3	0150-0043		1	C: fxd TiO ₂ 6.8 pF \pm 5% 500 vdcw	78488	Type GA
A1C4	0121-0059		2	C: var cer 2-8 pF	72982	538-006-COPO-89R
A1C5, A1C6	0150-0029		4	C: fxd TiO ₂ 1 pF \pm 10% 500 vdcw	78488	Type GA
A1C7	0180-0197		4	C: fxd Ta elect 2.2 μ F \pm 10% 20 vdcw	56289	150D225X9020A2- DYS
A1C8	0121-0059			C: var cer 2-8 pF	72982	538-006-COPO-89R
A1C9*	0150-0029			C: fxd TiO ₂ 1 pF \pm 10% 500 vdcw	78488	Type GA
A1C10	0150-0093			C: fxd cer 0.01 μ F +80% -20% 100 vdcw	91418	TA obd
A1C11	0180-0140		1	C: fxd Al elect 300 μ F +100% -10% 10 vdcw	56289	D36546 obd
A1C12	0180-0197			C: fxd Ta elect 2.2 μ F \pm 10% 20 vdcw	56289	150D225X9020A2- DYS
A1C13	0180-0228		3	C: fxd Ta elect 22 μ F \pm 10% 15 vdcw	56289	150D226X9015B2- DYS
A1C14	0180-0355		1	C: fxd Ta elect 3.4 μ F \pm 20% 35 vdcw	56289	151D 345X0035X2
A1C15	0180-0197			C: fxd Ta elect 2.2 μ F \pm 10% 20 vdcw	56289	150D225X9020A2- DYS
A1C16	0180-0376		1	C: fxd Ta elect 0.47 μ F \pm 10% 35 vdcw	56289	150D474X9035A2- DYS
A1C17, A1C18	0180-0228			C: fxd Ta elect 22 μ F \pm 10% 15 vdcw	56289	150D226X9015B2- DYS
A1C19	0180-0116		1	C: fxd Ta elect 6.8 μ F \pm 10% 35 vdcw	56289	150D685X9035B2- DYS
A1C20	0180-0039		1	C: fxd Al elect 100 μ F +75% -10% 10 vdcw	56289	30D107G012CC2- DSM
A1C21	0180-0197			C: fxd Ta elect 2.2 μ F \pm 10% 20 vdcw	56289	150D225X9020A2- DYS
A1CR1	1902-0041		1	Diode: breakdown zener 5.11V \pm 5% 400 mW	07910	CD 35622
A1CR2 thru A1CR8	1901-0025		13	Diode: Si 100 wiv 12 pF 100 mA	94145	DD 1526
A1CR9	1910-0016		3	Diode: Ge 60 wiv 1 ms	03877	S3185G
A1CR10	1902-0057		1	Diode: breakdown zener 6.49V \pm 5% 400 mW	07910	CD 35652
A1Q1, A1Q2	1855-0089		2	TSTR: FET N-channel **	-hp-	
A1Q3	1853-0036		6	TSTR: Si PNP 2N3906	04713	2N3906-18
A1Q4	1854-0092		1	TSTR: Si NPN 2N3563	07263	obd
A1Q5	1854-0215		2	TSTR: Si NPN 2N3904	04713	SPS 3611
A1Q6	1853-0036			TSTR: Si PNP 2N3906	04713	2N3906-18
A1Q7	1854-0215			TSTR: Si NPN 2N3904	04713	SPS 3611
A1Q8, A1Q9	1853-0036			TSTR: Si PNP 2N3906	04713	2N3906-18
A1R1	0683-4715		2	R: fxd comp 470 Ω \pm 10% 1/4 W	01121	CB 4715
A1R2	0698-6705		2	R: fxd met flm 2.49k Ω \pm 0.25% 1/8 W	91637	MFF 1/8 T-O
A1R3	0698-6704		4	R: fxd met flm 24.9 k Ω \pm 0.25% 1/8 W	91637	MFF 1/8 T-O
A1R4	0698-6703		2	R: fxd met flm 249 k Ω \pm 0.1% 1/8 W	91637	MFF 1/8 T-2
A1R5	0698-6714		2	R: fxd met flm 2.49 M \pm 0.25% 1/2 W	00327	M12D
A1R6	0698-6713		2	R: fxd met flm 24.3 M \pm 1% 1/2 W	00327	M12 obd
A1R7 *	0683-4745		2	R: fxd comp 470 k Ω \pm 5% 1/4 W Range 2	01121	CB 4745
A1R8	0698-6712		2	R: fxd met flm 47.5 M \pm 1% 1 W	00327	M13 obd
A1R9*	0683-2455		2	R: fxd comp 2.4 M \pm 5% 1/4 W Range 1	01121	CB 2455
A1R10	0698-6705			R: fxd met flm 2.49 k Ω \pm 0.25% 1/8 W	91637	MFF 1/8 T-O
A1R11	0698-6704			R: fxd met flm 24.9 k Ω \pm 0.25% 1/8 W	91637	MFF 1/8 T-O
A1R12	0698-6703			R: fxd met flm 249 k Ω \pm 0.1% 1/8 W	91637	MFF 1/8 T-2
A1R13	0698-6714			R: fxd met flm 2.49 M \pm 0.25% 1/2 W	00327	M12D obd
A1R14	0698-6713			R: fxd met flm 24.3 M \pm 1% 1/2 W	00327	M12 obd
A1R15 *	0683-4745			R: fxd comp 470 k Ω \pm 5% 1/4 W Range 2	01121	CB 4745

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

REFERENCE DESIGNATOR	-hp- PART NO.	T Q	DESCRIPTION	MFR.	MFR. PART NO.
A1R16	0698-6712		R: fxd met flm 47.5 M $\pm 1\%$ 1 W	00327	M13 obd
A1R17*	0683-2455		R: fxd comp 2.4 M $\pm 5\%$ 1/4 W Range 1	01121	CB 2455
A1R18	0757-0466	1	R: fxd met flm 110 k Ω $\pm 1\%$ 1/8 W	19701	MF5C T-O obd
A1R19	0757-0457	2	R: fxd met flm 47.5 k Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
A1R20	2100-2640	3	R: var carbon comp 3 sect. 50 k Ω , 250 Ω , 50 k Ω , L to R $\pm 20\%$ 1/4 W	71590	Type 70-3 obd
A1R21	0698-4443	1	R: fxd met flm 4.53 k Ω $\pm 1\%$ 1/8 W	91637	MFF 1/8 T-1
A1R22	0683-4715		R: fxd comp 470 Ω $\pm 10\%$ 1/4 W	01121	CB 4715
A1R23	0698-4408	1	R: fxd met flm 124 Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
A1R24	2100-2640		R: var carbon comp 3 sect. 50 k Ω , 250 Ω , 50 k Ω L to R $\pm 20\%$ 1/4 W	71590	Type 70-3 obd
A1R25	0698-3437	1	R: fxd met flm 133 Ω $\pm 1\%$ 1/8 W	91637	MFF 1/8 T-1
A1R26	0757-0433	1	R: fxd met flm 3.32 k Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
A1R27	0684-3931	6	R: fxd comp 39 k Ω $\pm 10\%$ 1/4 W	01121	CB 3931
A1R28	0698-4456	1	R: fxd met flm 549 Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
A1R29	0684-1031	1	R: fxd comp 10 k Ω $\pm 10\%$ 1/4 W	01121	CB 1031
A1R30	2100-2640		R: var carbon comp 3 sect. 50 k Ω , 250 Ω , 50 k Ω L to R $\pm 20\%$ 1/4 W	71590	Type 70-3 obd
A1R31	0757-0453	1	R: fxd met flm 30.1 k Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
A1R32	0757-0457		R: fxd met flm 47.5 k Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
A1R33	0684-1831	2	R: fxd comp 18 k Ω $\pm 10\%$ 1/4 W	01121	CB 1831
A1R34	0684-6811	1	R: fxd comp 680 Ω $\pm 10\%$ 1/4 W	01121	CB 6811
A1R35	0684-1831		R: fxd comp 18 k Ω $\pm 10\%$ 1/4 W	01121	CB 1831
A1R36	0684-2211	1	R: fxd comp 220 Ω $\pm 10\%$ 1/4 W	01121	CB 2211
A1R37	0684-1041	1	R: fxd comp 100 k Ω $\pm 10\%$ 1/4 W	01121	CB 1041
A1R38	0757-0280	1	R: fxd met flm 1000 Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
A1R39	0757-0414	1	R: fxd met flm 432 Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
A1R40	0684-3931		R: fxd comp 39 k Ω $\pm 10\%$ 1/4 W	01121	CB 3931
A1R41, A1R42	0684-2201	2	R: fxd comp 22 Ω $\pm 10\%$ 1/4 W	01121	CB 2201
A1R43	0684-3931		R: fxd comp 39 k Ω $\pm 10\%$ 1/4 W	01121	CB 3931
A1R44	0757-0401	1	R: fxd met flm 100 Ω $\pm 1\%$ 1/8 W	75042	CEA T-O obd
A1R45	0757-0161	3	R: fxd met flm 604 Ω $\pm 1\%$ 1/8 W	91637	MFF 1/8 T-1
A1R46A, A1R46B	2100-0113	2	R: var comp 600 Ω $\pm 20\%$ dual tandem	01121	JJ59160
A1R47, A1R48	0757-0161		R: fxd met flm 604 Ω $\pm 1\%$ 1/8 W	91637	MFF 1/8 T-1
A1S1	3100-1779	1	Range Switch: rotary 7 position	81840	1332 obd
A1S2	3101-1200	1	Switch: slide distortion DPDT miniature	79727	7145 obd
A2	00204-26506	1	PC Board Assembly	-hp-	
A2C1, A2C2	0180-1819	2	C: fxd Al elect 100 μ F +75% -10% 50 vdcw	56289	30D107G050DH2-DSM
A2C3, A2C4	0180-0119	2	C: fxd Al elect 1.0 μ F +75% -10% 25 vdcw	56289	30D105G025BA2-DSM
A2CR1 thru A2CR4	1901-0025		Diode: Si 100 wiv 12 pF 100 mA	94145	DD 1526
A2CR5	1910-0016		Diode: Ge 60 wiv 1 ms	03877	S3185G
A2CR6	1901-0025		Diode: Si 100 wiv 12 pF 100 mA	94145	DD 1526
A2CR7	1902-0048	2	Diode: breakdown zener 6.81 V $\pm 5\%$ 400 mW	07910	CD 35658
A2CR8	1901-0025		Diode: Si 100 wiv 12 pF 100 mA	94145	DD 1526
A2CR9	1910-0016		Diode: Ge 60 wiv 1 ms	03877	S3185G
A2Q1	1854-0039	2	TSTR: Si NPN 2N3053	01295	obd
A2Q2	1853-0036		TSTR: Si PNP 2N3906	04713	2N3906-18
A2Q3	1854-0071	2	TSTR: Si NPN 2N3391	01295	SKA 1124
A2Q4	1853-0036		TSTR: Si PNP 2N3906	04713	2N3906-18

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2Q5 A2Q6	1854-0071 1853-0006	1	TSTR: Si NPN 2N3391 TSTR: Si PNP 2N3134	01295 04713	SKA 1124 2N3134
A2R1	0757-0381	2	R: fxd met flm $15\Omega \pm 1\%$ 1/8 W	91637	MFF 1/8 T-1
A2R2	0698-4453	2	R: fxd met flm $402\Omega \pm 1\%$ 1/8 W	75042	CEA T-O obd
A2R3	0698-3279	2	R: fxd met flm $4.99\text{ k}\Omega \pm 1\%$ 1/8 W	75042	CEA T-O obd
A2R4, A2R5	0757-0472	2	R: fxd met flm $200\text{ k}\Omega \pm 1\%$ 1/8 W	75042	CEA T-O obd
A2R6	0698-3279		R: fxd met flm $4.99\text{ k}\Omega \pm 1\%$ 1/8 W	75042	CEA T-O obd
A2R7	0698-4453		R: fxd met flm $402\Omega \pm 1\%$ 1/8 W	75042	CEA T-O obd
A2R8	0757-0381		R: fxd met flm $15\Omega \pm 1\%$ 1/8 W	91637	MFF 1/8 T-1
A2R9	0698-4473	1	R: fxd met flm $8060\Omega \pm 1\%$ 1/8 W	19701	MF5C T-O obd
A2R10	0757-0442	1	R: fxd met flm $10.0\text{ k}\Omega \pm 1\%$ 1/8 W	19701	MF5C T-O obd
A2R11	0757-0449	1	R: fxd met flm $20.0\text{ k}\Omega \pm 1\%$ 1/8 W	19701	MF5C T-O obd
A2R12	0757-0448	1	R: fxd met flm $18.2\text{ k}\Omega \pm 1\%$ 1/8 W	19701	MF5C T-O obd
A2T1	9100-1421	1	Transformer	-hp-	
A2XA1	1251-1631	1	Connector: Printed Circuit 10 pin	07233	66-710-10
A2 (Opt. 01)	00204-66507		PC Board Assembly (Opt. 01 Mercury)	-hp-	
A2 (Opt. 01) BT1 thru BT4	1420-0010	4	Battery: mercury 6.75V 5 cell	09569	TR 235R-316469
A2 (Opt. 01) C11	0180-0061	2	C: fxd Al elect $100\ \mu\text{F} +75\% -10\%$ 15 vdcw	56289	30D107G015DC2- DSM
A2 (Opt. 01) XA1	1251-1631		Connector: Printed Circuit 10 pin	07233	66-710-10
A2 (Opt. 02)	00204-66508		PC Board Assembly (Opt.02 Nicad)	-hp-	
A2 (Opt. 02) BT21 thru BT24	1420-0015		Battery: rechargeable nicad cadmium 6V 225 mAh	000LP	5-B225J
A2 (Opt. 02) C21	0180-0149	1	C: fxd Al elect $65\ \mu\text{F} +100\% -10\%$ 60 vdcw	56289	(Type 30D) D36978-DSM
A2 (Opt. 02) C22	0180-0061		C: fxd Al elect $100\ \mu\text{F} +75\% -10\%$ 15 vdcw	56289	30D107G015DC2- DSM
A2 (Opt. 02) CR21 thru CR25	1901-0025		Diode: Si 100 wiv 12 pF 100 mA	94145	DD 1526
A2 (Opt. 02) CR26	1902-0048		Diode: breakdown zener 6.81 V $\pm 5\%$ 400 mW	07910	CD 35658
A2 (Opt. 02)Q21	1854-0039		TSTR: Si NPN 2N3053	01295	obd
A2 (Opt. 02) R21	0698-3558	1	R: fxd met flm $4.02\text{ k}\Omega \pm 1\%$ 1/8 W	91637	MFF-1/8 T-1
A2 (Opt. 02) R22	0698-4496	1	R: fxd met flm $45.3\text{ k}\Omega \pm 1\%$ 1/8 W	91637	MFF-1/8 T-1
A2 (Opt. 02) R23	0698-4454	1	R: fxd met flm $523\Omega \pm 1\%$ 1/8 W	91637	MFF-1/8 T-1
A2 (Opt. 02) R24	0698-3488	1	R: fxd met flm $442\Omega \pm 1\%$ 1/8 W	91637	MFF 1/8 T-1
A2 (Opt. 02) XA1	1251-1631		Connector: Printed Circuit 10 pin	07233	66-710-10
C1	0121-0418		C: var air 2 sect.	-hp-	
C2	0160-2322	1	C: fxd mica 18 pF $\pm 5\%$	72136	RDM15C180J1S
C3	0150-0029	1	C: fxd TiO ₂ 1 pF $\pm 10\%$ 500 vdcw	78488	Type GA

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

REFERENCE DESIGNATOR	-hp- PART NO.	TQ	DESCRIPTION	MFR.	MFR. PART NO.
J1	1251-0148	1	Power Connector: 3 pin recessed power cord receptacle (Opt. 02 and standard only)	82389	AC3G obd
MP1	5000-7121	1	Insert Knob: large	-hp-74919	obd
MP2	2360-0197	1	Screw: machine	000L1	obd
MP3	2190-0018	1	Washer: lock for No. 6 hardware	83324	RPN 6-32 SC
MP4	0510-0124	1	Nut: captive internal thread	56878	obd
MP5	3030-0033	2	Screw: set hex socket drive		
MP6	00204-64005	1	Assembly: dial and knob	-hp-	
MP7	5000-0479	2	Insert: knob plain vernier and range	-hp-	
MP8	0370-0773	2	Knob: black vernier and amplifier	-hp-	
MP9	3030-0007	2	Screw: set hex socket drive	56878	obd
MP10	5040-0607	1	Disc Assembly: vernier drive	-hp-	
MP11	2510-0002	3	Screw: machine truss head	73076	obd
MP12	0510-0054	1	Ring: retuning steel	89462	5555-25-S-MD
MP13	3050-0180	4	Washer: fluorocarbon	78471	obd
MP14	7120-1254	1	Plate: Identification	-hp-	
MP15	2190-0017	3	Washer: lock for No. 8 hardware	73734	obd
MP16	00204-40201	1	Panel: front	-hp-	
MP17	00204-09102	1	Spring: vernier	-hp-	
MP18	00204-23702	1	Shaft: 1-3/4 x 1/4	-hp-	
MP19	00312-20052	1	Gear: pinion dial shaft	-hp-	
MP20	00204-09101	1	Spring: grounding	-hp-	
MP21	2360-0255	1	Screw: machine	83385	obd
MP22	1460-0105	1	Spring: torsion anti-backlash	91260	obd
MP23	1500-0214	1	Hub Coupler: (spring hole) brass	99934	obd
MP24	1500-0004	1	Coupler: Insulator nylon	99934	A-201-1 obd
MP25	1500-0005	1	Coupler: Hub	99934	obd
MP26	00204-00105	1	Chassis: front	-hp-	
MP27	3030-0022	6	Screw: set hex socket drive	56878	obd
MP28	00204-22402	1	Gear: loading	-hp-	
MP29	00204-62401	1	Assembly: gear	-hp-	
MP30	2420-0001	3	Nut: hex steel nickel-plated	000L1	obd
MP31	5000-5881	3	Connector: binding post to P. C. board	-hp-	
MP32	1510-0059	1	Binding Post Assembly: red	-hp-	
MP33	1510-0058	2	Binding Post Assembly: black	-hp-	
MP34	1510-0060	1	Binding Post: blue	-hp-	
MP35	5000-0477	1	Insert Knob: pointer amplifier	-hp-	
MP36	0370-0772	1	Knob: bar range black	-hp-	
S1, S2 S3	3101-0033	1	Not assigned Switch: slide DPDT (Opt. 02 and standard) 115/230 V	82389	11A-1009 obd
S4	3101-0045	1	Switch: slide DPDT Battery chg. (Opt. 02)	82389	obd
<u>MISCELLANEOUS</u>					
	8120-0078	1	Assembly: cable 7.5' power cord set	70903	KH-4147 obd
	5040-0615	1	Battery Holder: (Opt. 01 and 02)	-hp-	
	1510-0056	1	Binding Post Assembly: black (rear panel)	-hp-	
	5000-5838	2	Bracket: top cover	-hp-	
	5000-0710	1	Cover: bottom	-hp-	
	5000-0702	2	Cover: side	-hp-	
	5060-5918	1	Cover Assembly: top	-hp-	
	5060-0727	2	Foot Assembly: third module	-hp-	
	5060-0702	2	Frame: Side	-hp-	
	5040-4528	2	Guide: P. C. Board gray inner box spacer	-hp-	

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

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
<u>MISCELLANEOUS (Cont'd)</u>						
	0340-0424		2	Insulator: binding post black	-hp-	
	0340-0100		1	Insulator: binding post gray	-hp-	
	00204-90000		1	Manual: operating and service	-hp-	
	00204-00206		1	Panel: rear (AC standard only)	-hp-	
	00204-00207		1	Panel: rear (Opt. 01 only)	-hp-	
	00204-00208		1	Panel: rear (Opt. 02 only)	-hp-	
	5000-0634		1	Shorting Strap: left	-hp-	
	1490-0031		1	Stand: third module tilt	91260	obd

SECTION VII
CIRCUIT DIAGRAMS

7-1. INTRODUCTION.

7-2. This section contains the circuit diagrams necessary for the maintenance of the Model 204C Oscillator. Included are schematic diagrams and component location diagrams.











7-3. SCHEMATIC DIAGRAMS.

7-4. The circuits contained within each assembly are shown in the schematic diagrams. These diagrams can be used to develop an understanding of the principles of operation and as an aid to troubleshooting.

7-5. COMPONENT LOCATION DIAGRAMS.

7-6. The component location diagrams show the physical location of each part mounted on an assembly. Each part is identified by a reference designator.

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 POWER LINE GROUND.
4.  DENOTES CHASSIS GROUND.
5.  DENOTES ASSEMBLY.
6.  DENOTES MAIN SIGNAL PATH.
7.  DENOTES FEEDBACK PATH.
8.  DENOTES FRONT PANEL MARKING.
9.  DENOTES REAR PANEL MARKING.
10.  DENOTES SCREWDRIVER ADJUST.
11.  DENOTES FRONT PANEL CONTROL.
12.  DENOTES COMPONENTS NOT MOUNTED ON ASSEMBLY.
13. * OPTIMUM VALUE SELECTED AT FACTORY.
14. † DENOTES FACTORY USE ONLY.

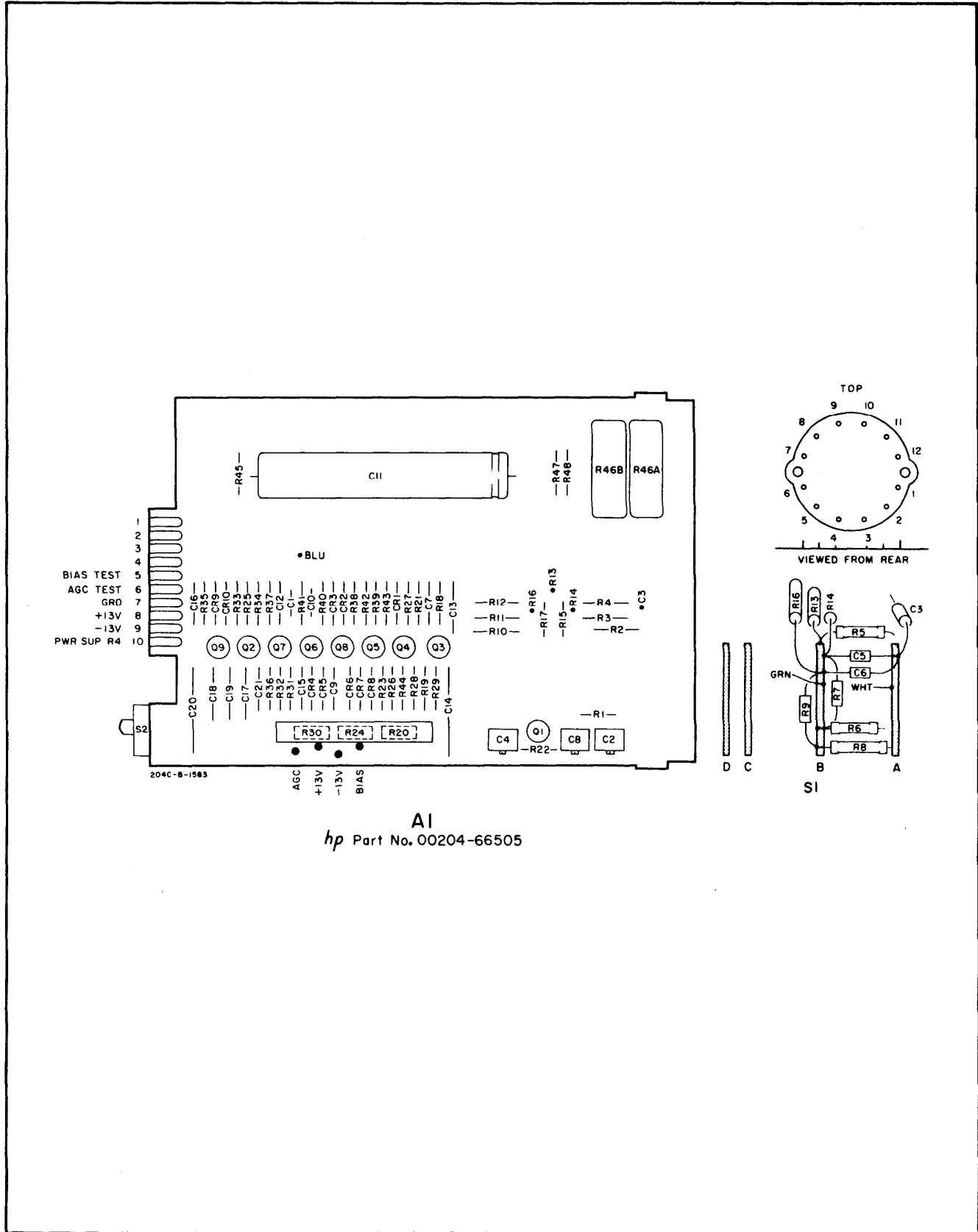
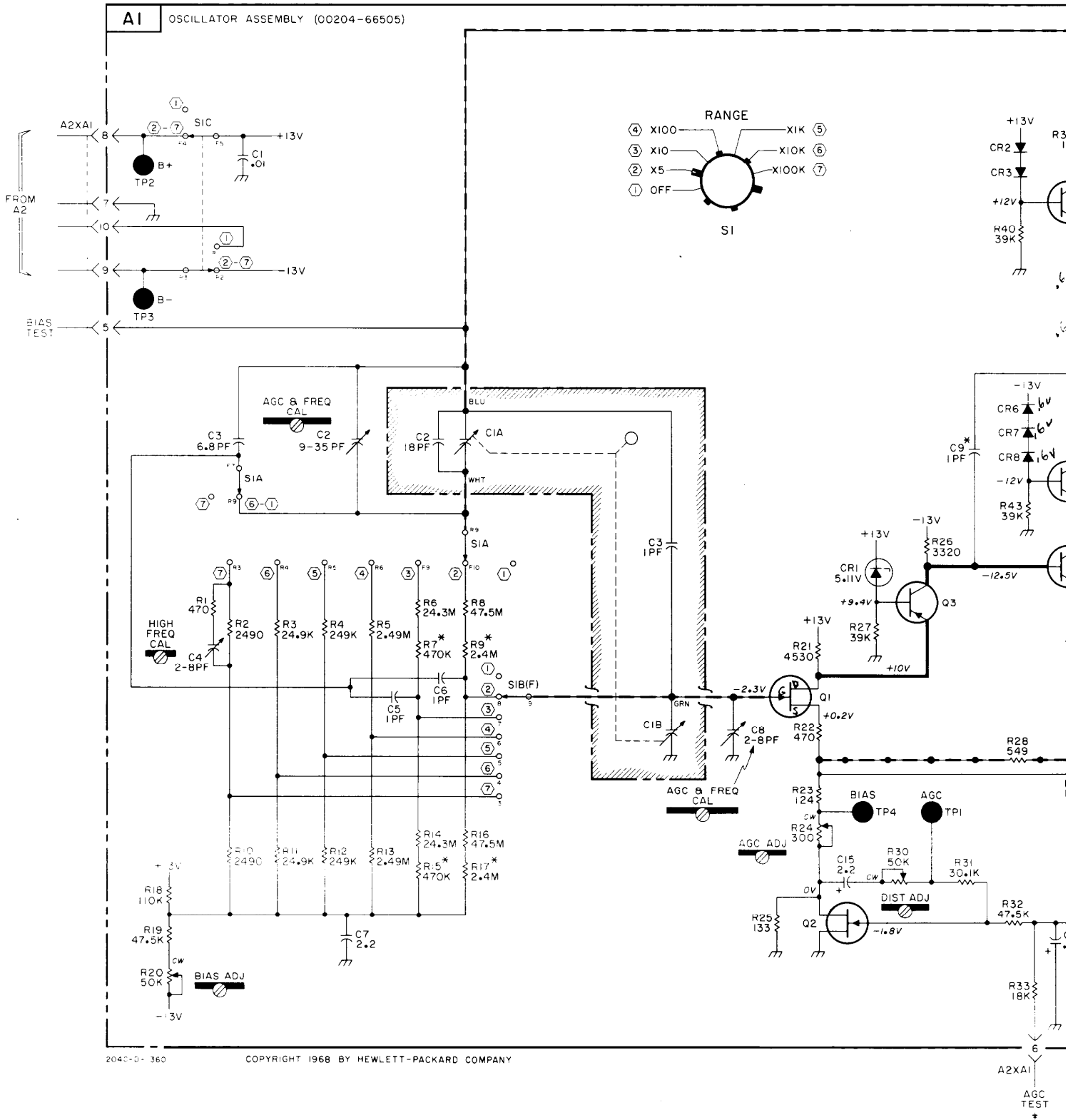


Figure 7-1. A1 Component Location Diagram



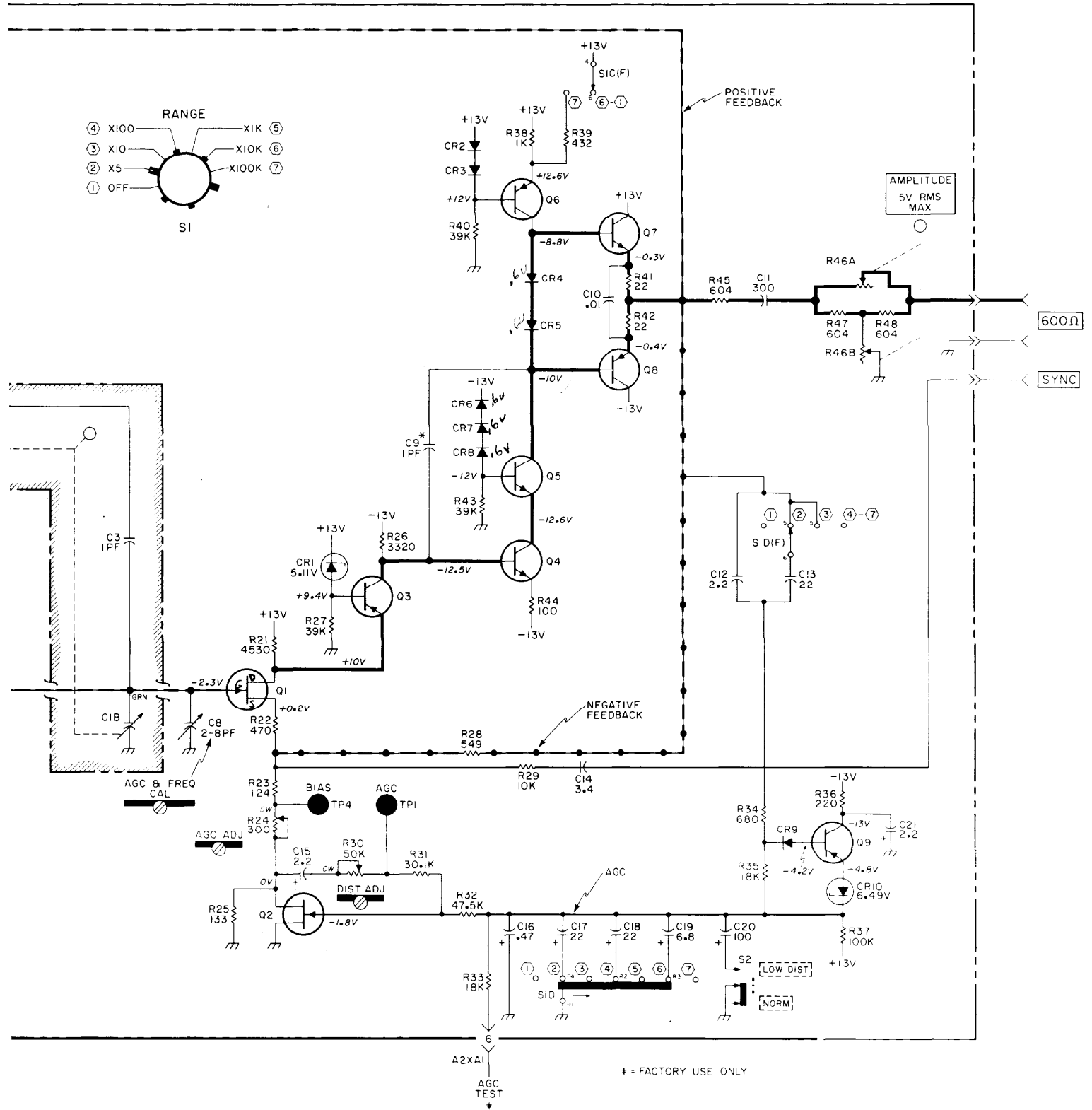
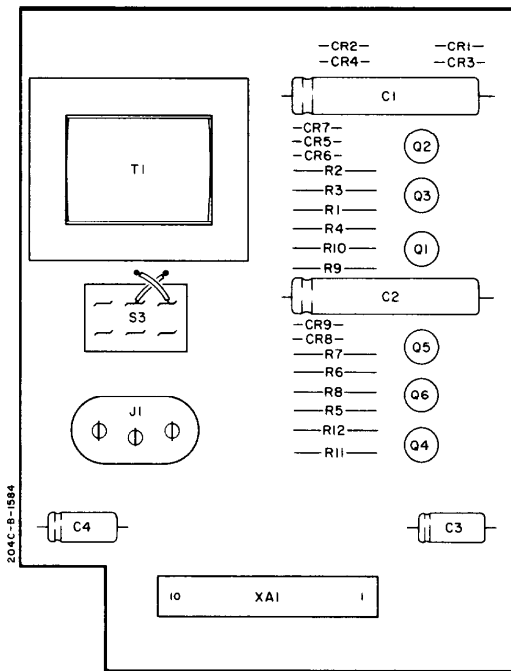
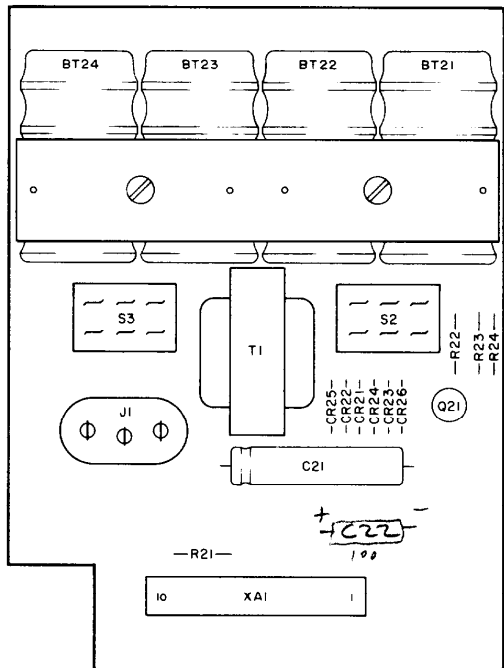
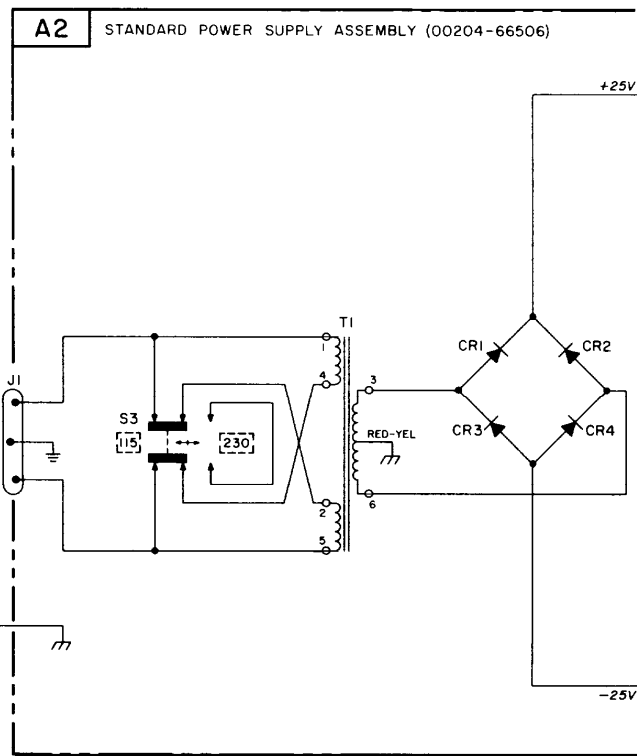


Figure 7-2. Oscillator Schematic. (A1)

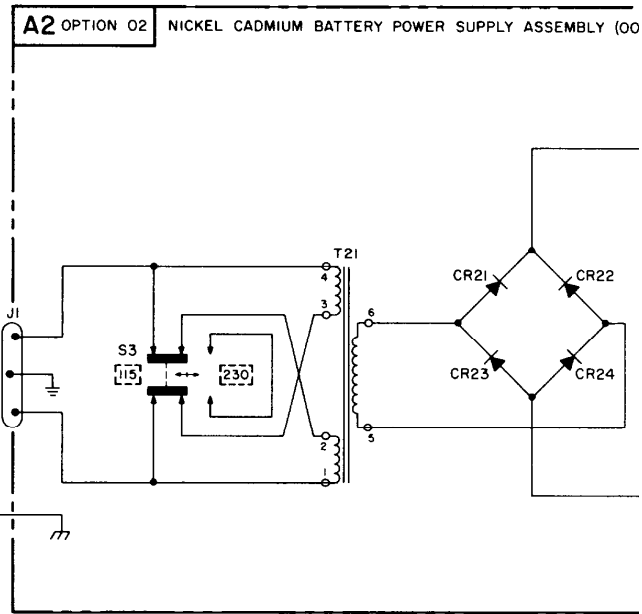


204C-B-1584

A2
STANDARD
hp Part No. 00204-66506

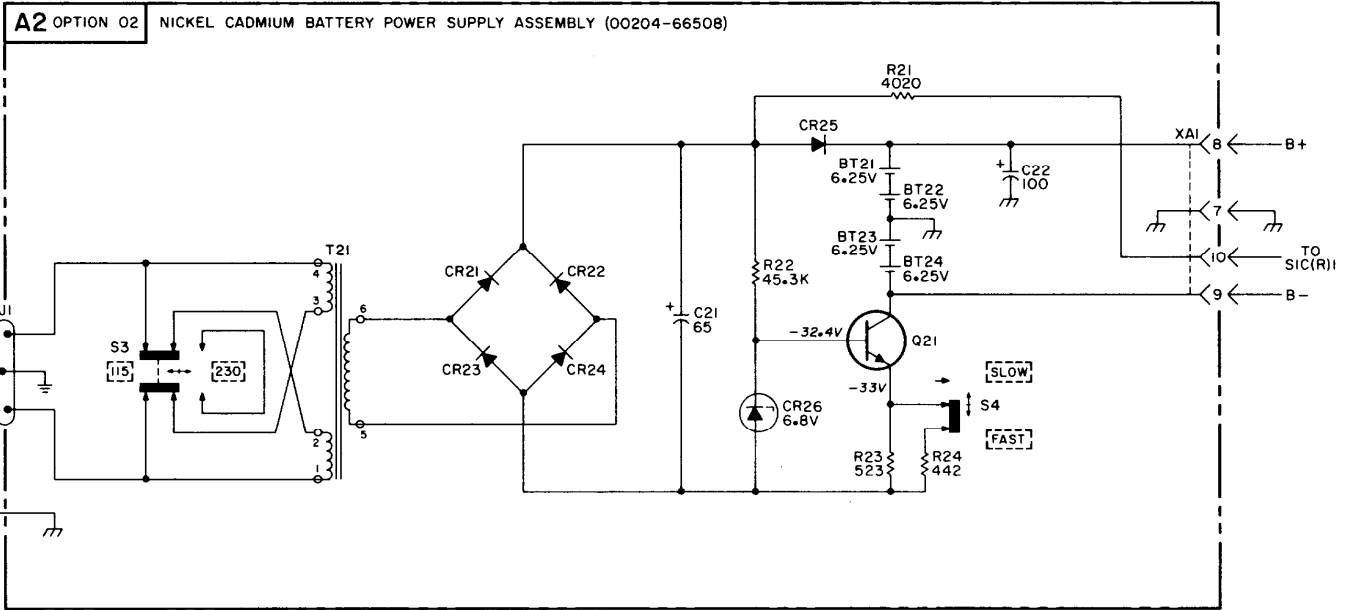
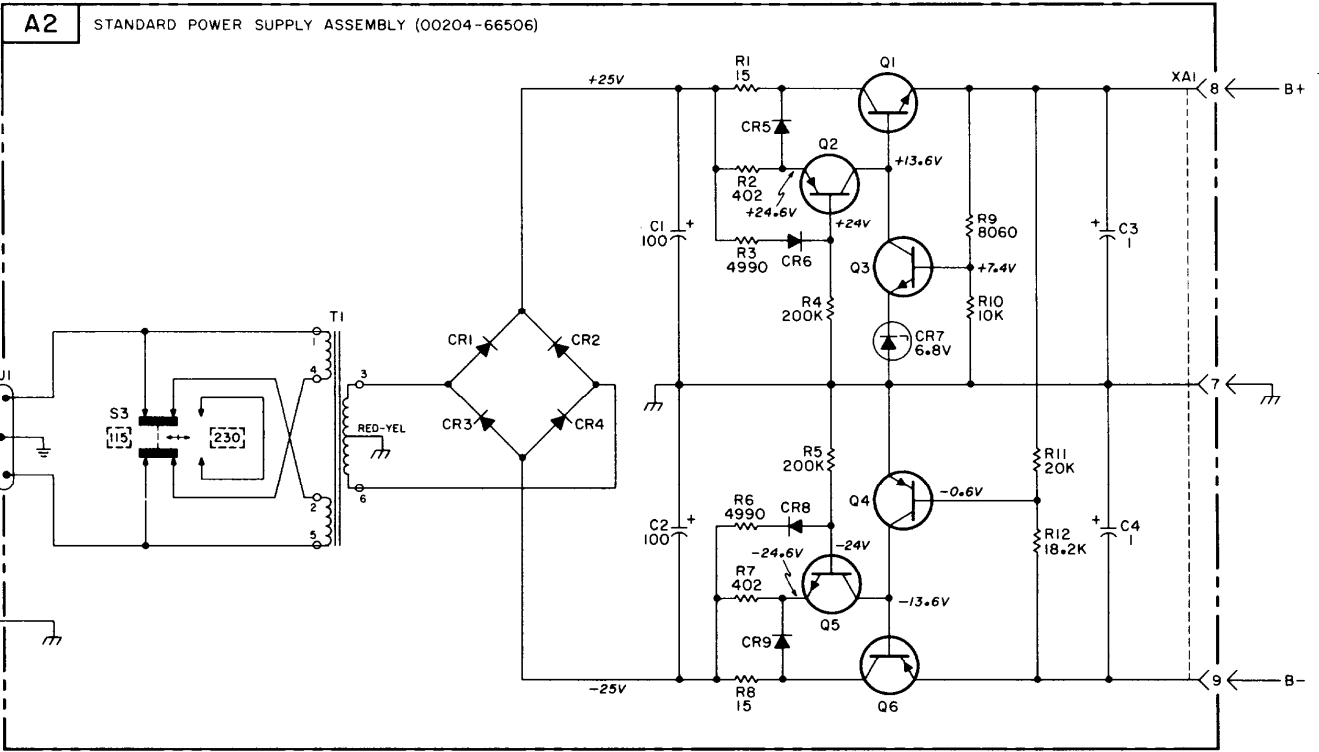


A2
OPTION 02
hp Part No. 00204-66508



204C-D-1457

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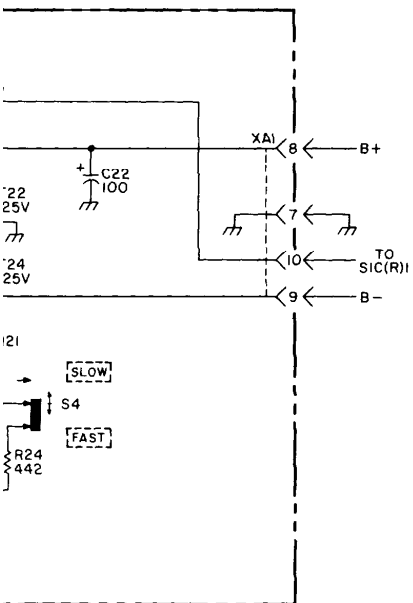
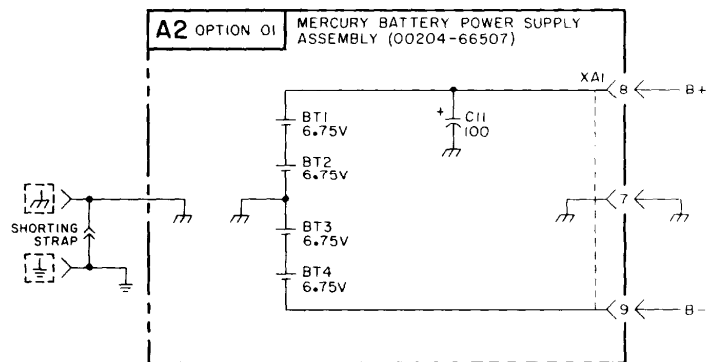
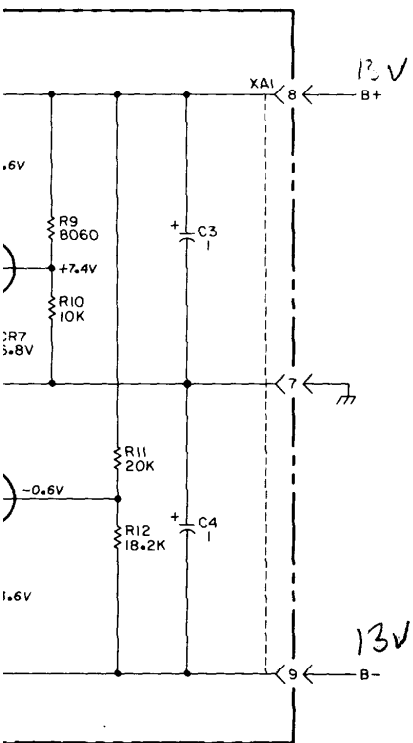


Figure 7-3. Power Supply Schematic.
(A2, A2 Opt. 01, A2 Opt. 02)

7-7/7-8

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	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
00000	U. S. A. Common	Any supplier of U. S.	05347	Ultronix, Inc.	San Mateo, Calif.	10411	Ti-Tal, Inc.	Berkeley, Calif.
00136	McCoy Electronics	Mount Holly Springs, Pa.	05397	Union Carbide Corp., Linde Div.,	Kemet Dept. Cleveland, Ohio	10646	Carborundum Co.	Niagara Falls, N. Y.
00213	Sage Electronics Corp.	Rochester, N. Y.	05574	Viking Ind. Inc.	Canoga Park, Calif.	11236	CTS of Berne, Inc.	Berne, Ind.
00287	Cemco Inc.	Danielson, Conn.	05593	Illumitronic Engineering Co.	Sunnyvale, Calif.	11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
00334	Humidial	Colton, Calif.	05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio	11242	Bay State Electronics Corp.	Waltham, Mass.
00348	Microtron Co., Inc.	Valley Stream, N. Y.	05624	Barber Colman Co.	Rockford, Ill.	11312	Teledyne Inc., Microwave Div.	Palo Alto, Calif.
00373	Garlock Inc.	Cherry Hill, N. J.	05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N. Y.	11314	National Seal	Downey, Calif.
00656	Aerovox Corp.	New Bedford, Mass.	05729	Metro-Tel Corp.	Westbury, N. Y.	11534	Duncan Electronics Inc.	Costa Mesa, Calif.
00779	Amp. Inc.	Harrisburg, Pa.	05783	Stewart Engineering Co.	Santa Cruz, Calif.	11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N. J.
00781	Aircraft Radio Corp.	Boonton, N. J.	05820	Wakefield Engineering Inc.	Wakefield, Mass.	11717	Imperial Electronic, Inc.	Buena Park, Calif.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.	06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.	11870	Melabs, Inc.	Palo Alto, Calif.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S. C.	06090	Raychem Corp.	Redwood City, Calif.	12136	Philadelphia Handle Co.	Camden, N. J.
00866	Goe Engineering Co.	City of Industry, Cal.	06175	Bausch and Lomb Optical Co.	Rochester, N. Y.	12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.	06402	E. T. A. Products Co. of America	Chicago, Ill.	12574	Gulton Ind. Inc. Data System Div.	Albuquerque, N. M.
00929	Microlab Inc.	Livingston, N. J.	06540	Amatom Electronic Hardware Co., Inc.	New Rochette, N. Y.	12697	Clarostat Mfg. Co.	Dover, N. H.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N. Y.	06555	Beede Electrical Instrument Co., Inc.	Penacook, N. H.	12728	Elmar Filter Corp.	W. Haven, Conn.
01009	Alden Products Co.	Brockton, Mass.	06666	General Devices Co., Inc.	Indianapolis, Ind.	12859	Nippon Electric Co., Ltd.	Tokyo, Japan
01121	Allen Bradley Co.	Milwaukee, Wis.	06751	Semcor Div. Components Inc.	Phoenix, Ariz.	12881	Metex Electronics Corp.	Clark, N. J.
01255	Litton Industries, Inc.	Beverly Hills, Calif.	06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.	12930	Delta Semiconductor Inc.	Newport Beach, Calif.
01281	TRW Electronics, Inc.	Lawndale, Calif.	06980	Varian Assoc. Eimac Div.	San Carlos, Calif.	12954	Dickson Electronics Corp.	Scottsdale, Arizona
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas	07088	Kelvin Electric Co.	Van Nuys, Calif.	13103	Thermolloy	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio	07126	Digitran Co.	Pasadena, Calif.	13396	Telefunken (GmbH)	Hanover, Germany
01589	Pacific Relays, Inc.	Van Nuys, Calif.	07137	Transistor Electronics Corp.	Minneapolis, Minn.	13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
01930	Amerock Corp.	Rockford, Ill.	07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N. Y.	14099	Sem-Tech	Newbury Park, Calif.
01961	Pulse Engineering Co.	Santa Clara, Calif.	07149	Filmohm Corp.	New York, N. Y.	14193	Calif. Resistor Corp.	Santa Monica, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N. Y.	07233	Cinch-Graphik Co.	City of Industry, Calif.	14298	American Components, Inc.	Conshohocken, Pa.
02116	Wheelock Signals, Inc.	Long Branch, N. J.	07256	Silicon Transistor Corp.	Carle Place, N. Y.	14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.	07261	Avnet Corp.	Culver City, Calif.	14493	Hewlett-Packard Company	Loveland, Colo.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.	07263	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.	14655	Cornell Dublier Electric Corp.	Newark, N. J.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N. J.	07322	Minnesota Rubber Co.	Minneapolis, Minn.	14752	Corning Glass Works	Corning, N. Y.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.	07387	Birtcher Corp., The	Monterey Park, Calif.	14752	Electro Cube Inc.	San Gabriel, Calif.
02777	Hopkins Engineering Co.	San Fernando, Calif.	07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Calif.	14960	Williams Mfg. Co.	San Jose, Calif.
03508	G. E. Semiconductor Prod. Dept.	Syracuse, N. Y.	07700	Technical Wire Products Inc.	Cranford, N. J.	15203	Webster Electronics Co.	New York, N. Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio	07829	Bodine Elect. Co.	Chicago, Ill.	15287	Scionics Corp.	Northridge, Calif.
03797	Eldema Corp.	Compton, Calif.	07910	Continental Device Corp.	Hawthorne, Calif.	15291	Adjustable Bushing Co.	N. Hollywood, Calif.
03818	Parker Seal Co.	Los Angeles, Calif.	07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.	15558	Micron Electronics	Garden City, Long Island, N. Y.
03877	Transitron Electric Corp.	Wakefield, Mass.	07980	Hewlett-Packard Co., Boonton Radio Div.	Mountain View, Calif.	15566	Amprobe Inst. Corp.	Lynbrook, N. Y.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N. J.	08145	U. S. Engineering Co.	Rockaway, N. J.	15631	Cabletronics	Costa Mesa, Calif.
03954	Singer Co., Diehl Div. Finderne Plant	Sumerville, N. J.	08289	Blinn, Delbert Co.	Los Angeles, Calif.	15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.	08358	Burgess Battery Co.	Pomona, Calif.	15801	Fenwal Elect. Inc.	Framingham, Mass.
04013	Taurus Corp.	Lambertville, N. J.	08524	Deutsch Fastener Corp.	Los Angeles, Calif.	15818	Amelco Inc.	Mt. View, Calif.
04062	Arco Electronic Inc.	Great Neck, N. Y.	08664	Bristol Co., The	Waterbury, Conn.	16037	Spruce Pine Mica Co.	Spruce Pine, N. C.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S. C.	08717	Sloan Company	Sun Valley, Calif.	16179	Omni-Spectra Inc.	Detroit, Ill.
04354	Precision Paper Tube Co.	Wheeling, Ill.	08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona	16352	Computer Diode Corp.	Lodi, N. J.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.	08727	National Radio Lab. Inc.	Paramus, N. J.	16688	Ideal Prec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N. Y.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.	08792	CBS Electronics Semiconductor Operations, Div. of C. B. S. Inc.	Lowell, Mass.	16758	Delco Radio Div. of G. M. Corp.	Kokoma, Ind.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona	08984	Mel-Rain	Indianapolis, Ind.	17109	Thermonetics Inc.	Canoga Park, Calif.
04732	Filtron Co., Inc. Western Div.	Culver City, Calif.	09026	Babcock Relays Div.	Costa Mesa, Calif.	17474	Tranex Company	Mountain View, Calif.
04773	Automatic Electric Co.	Northlake, Ill.	09134	Texas Capacitor Co.	Houston, Texas	17675	Hamlin Metal Products Corp.	Akron, Ohio
04796	Sequoia Wire Co.	Redwood City, Calif.	09145	Tech. Ind. Inc. Atom Elect.	Burbank, Calif.	17745	Angstrohm Prec. Inc.	No. Hollywood, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.	09250	Electro Assemblies, Inc.	Chicago, Ill.	17870	McGraw-Edison Co.	Manchester, N. H.
04870	P. M. Motor Company	Westchester, Ill.	09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada	18042	Plover Design Pacific Inc.	Palo Alto, Calif.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.	10214	General Transistor Western Corp.	Los Angeles, Calif.	18083	Clevis Corp., Semiconductor Div.	Palo Alto, Calif.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.				18324	Signetics Corp.	Sunnyvale, Calif.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.				18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.

00015-45
Revised: April, 1968

From: F.S.C. Handbook Supplements
H4-1 Dated AUGUST 1966
H4-2 Dated NOV. 1962

CODE LIST OF MANUFACTURERS (Cont'd)

Code No.	Manufacturer	Address	Code No.	Manufacturer	Address	Code No.	Manufacturer	Address
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N. J.	70998	Bird Electronic Corp.	Cleveland, Ohio	76210	C. W. Marwedel	San Francisco, Calif.
19589	Concoa	Baldwin Park, Calif.	71002	Birnbach Radio Co.	New York, N. Y.	76433	General Instrument Corp., Micamold Division	Newark, N. J.
19644	LRC Electronics	Horseheads, N. Y.	71034	Bliley Electric Co., Inc.	Erie, Pa.	76487	James Millen Mfg. Co., Inc.	Malden, Mass.
19701	Electra Mfg. Co.	Independence, Kansas	71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.	76493	J. W. Miller Co.	Los Angeles, Calif.
20183	General Atronics Corp.	Philadelphia, Pa.	71218	Bud Radio, Inc.	Willoughby, Ohio	76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Calif.
21226	Executone, Inc.	Long Island City, N. Y.	71279	Cambridge Thermionics Corp.	Cambridge, Mass.	76545	Mueller Electric Co.	Cleveland, Ohio
21335	Fafnir Bearing Co., The	New Britain, Conn.	71286	Camloc Fastener Corp.	Paramus, N. J.	76703	National Union	Newark, N. J.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.	71313	Cardwell Condenser Corp.	Lindenhurst L. I., N. Y.	76854	Oak Manufacturing Co.	Crystal Lake, Ill.
23783	British Radio Electronics Ltd.	Washington, D. C.	71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.	77068	The Bendix Corp., Electroynamics Div.	N. Hollywood, Calif.
24455	G. E. Lamp Division	Nela Park, Cleveland, Ohio	71436	Chicago Condenser Corp.	Chicago, Ill.	77075	Pacific Metals Co.	San Francisco, Calif.
24655	General Radio Co.	West Concord, Mass.	71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.	77221	Phanostran Instrument and Electronic Co.	South Pasadena, Calif.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.	71450	CTS Corp.	Elkhart, Ind.	77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
26365	Gries Reproducer Corp.	New Rochelle, N. Y.	71468	ITT Cannon Electric Inc.	Los Angeles, Calif.	77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
26462	Grobet File Co. of America, Inc.	Carlstadt, N. J.	71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.	77630	TRW Electronic Components Div.	Camden, N. J.
26851	Compac/Hollister Co.	Hollister, Calif.	71482	C. P. Clare & Co.	Chicago, Ill.	77638	General Instrument Corp., Rectifier Div.	Brooklyn, N. Y.
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28480	Hewlett-Packard Co.	Palo Alto, Calif.	71616	Commercial Plastics Co.	Chicago, Ill.	77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
28520	Heyman Mfg. Co.	Kenilworth, N. J.	71700	Cornish Wire Co., The	New York, N. Y.	78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
30817	Instrument Specialties Co., Inc.	Little Falls, N. J.	71707	Coto Coil Co., Inc.	Providence, R. I.	78277	Sigma	So. Braintree, Mass.
33173	G. E. Receiving Tube Dept.	Owensboro, Ky.	71744	Chicago Miniature Lamp Works	Chicago, Ill.	78283	Signal Indicator Corp.	New York, N. Y.
35434	Lectrohm Inc.	Chicago, Ill.	71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.	78290	Struthers-Dunn Inc.	Pitman, N. J.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada	71984	Dow Corning Corp.	Midland, Mich.	78452	Thompson-Bremer & Co.	Chicago, Ill.
36287	Cunningham, W. H. & Hill, Ltd.	Toronto Ontario, Canada	72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.	78471	Tilley Mfg. Co.	San Francisco, Calif.
37942	P. R. Mallory & Co. Inc.	Indianapolis, Ind.	72619	Dialight Corp.	Brooklyn, N. Y.	78488	Stackpole Carbon Co.	St. Marys, Pa.
39543	Mechanical Industries Prod. Co.	Akron, Ohio	72656	Indiana General Corp., Electronics Div.	Keasby, N. J.	78493	Standard Thomson Corp.	Waltham, Mass.
40920	Miniature Precision Bearings, Inc.	Keene, N. H.	72699	General Instrument Corp., Cap. Div.	Newark, N. J.	78553	Tinnerman Products, Inc.	Cleveland, Ohio
42190	Muler Co.	Chicago, Ill.	72765	Drake Mfg. Co.	Harwood Heights, Ill.	78790	Transformer Engineers	San Gabriel, Calif.
43990	C. A. Norgren Co.	Englewood, Colo.	72825	Hugh H. Eby Inc.	Philadelphia, Pa.	78947	Ucinite Co.	Newtonville, Mass.
44655	Ohmite Mfg. Co.	Skokie, Ill.	72928	Gudeman Co.	Chicago, Ill.	79136	Waldes Kohinoor Inc.	Long Island City, N. Y.
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47904	Polaroid Corp.	Cambridge, Mass.	72964	Robert M. Hadley Co.	Los Angeles, Calif.	79251	Wenco Mfg. Co.	Chicago, Ill.
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49956	Microwave & Power Tube Div.	Waltham, Mass.	73061	Hansen Mfg. Co., Inc.	Princeton, Ind.	79963	Zierick Mfg. Corp.	New Rochelle, N. Y.
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52983	Sanborn Company	Waltham, Mass.	73138	Helipol Div. of Beckman Inst., Inc.	Fullerton, Calif.	80120	Schnitzer Alloy Products Co.	Elizabeth, N. J.
54294	Shallcross Mfg. Co.	Selma, N. C.	73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.	80131	Electronic Industries Association. Tube meeting EIA Standards-Washington, DC.	Any brand
55026	Simpson Electric Co.	Chicago, Ill.	73445	Amperex Elect Co.	Hicksville, L. I., N. Y.	80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
55933	Sonolone Corp.	Elmsford, N. Y.	73506	Bradley Semiconductor Corp.	New Haven, Conn.	80223	United Transformer Corp.	New York, N. Y.
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70276	Allen Mfg. Co.	Hartford, Conn.	74868	R. F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.	81483	International Rectifier Corp.	El Segundo, Calif.
70309	Allied Control	New York, N. Y.	74970	E. F. Johnson Co.	Waseca, Minn.	81541	Airpax Electronics, Inc.	Cambridge, Maryland
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The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

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