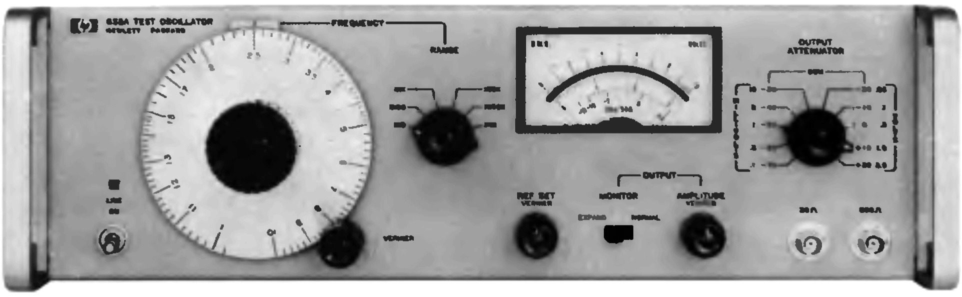
OPERATING AND SERVICE MANUAL

# TEST OSCILLATOR

## 652A




HEWLETT hp PACKARD

HP 652A

# SECTION I
# GENERAL INFORMATION

## 1-1. DESCRIPTION.

1-2. The Hewlett-Packard Model 652A Test Oscillator is a highly stable, capacitance-tuned oscillator that has a frequency range of 10 Hz to 10 MHz. The oscillator has a sine-wave output that is adjustable from 10 microvolts to 3.16 volts into 50 or 600 ohms. The Model 652A Test Oscillator is shown in Figure 1-1, and the specifications are given in Table 1-1.

1-3. Two output impedances are provided at the front panel output connectors. The 600 ohm connector provides an output with an impedance that is compatible with transmission lines and many distribution systems. The 50 ohm connector provides an output for circuits needing a low source impedance.

1-4. The Model 652A Test Oscillator output voltage is constantly monitored at the input to the attenuator by an internal voltmeter. The voltmeter has two scales for RMS voltage readings, and a dBm scale referenced to 1 milliwatt into 50 ohms. The meter scale can be expanded and used to set and maintain a reference for the output voltage, when the MONITOR switch is in the EXPAND position. The 1.0 volt scale is shaded from 0.9 to 1.0 to denote the expandable area. Other voltages can be obtained using the OUTPUT ATTENUATOR and, if desired, an external 1 dB attenuator.

1-5. The OUTPUT ATTENUATOR, in conjunction with the AMPLITUDE control, allows any output voltage from 10 microvolts to 3.16 volts to be selected, when matched into a 50 or 600 ohm load.

## 1-6. ACCESSORY FEATURES.

1-7. The accessory furnished with the Model 652A is the -hp- Model 11048C Feedthrough Termination. It is used to insure that the Test Oscillator is operating into the rated impedance, in the event that the instrument is connected to a device with an impedance greater than 50 ohms. The specifications for the Model 11048C Feedthrough Termination are listed below:

Terminating Resistance - 50 ohms +/- 0.25%
Connectors - BNC male on one end, and BNC female on the other end.

## 1-8. INSTRUMENT AND MANUAL IDENTIFICATION.

1-9. 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 within 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 your 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 or the backdating information in Appendix C will adapt this manual to earlier instruments. All correspondence with Hewlett-Packard should include the complete serial number.

**Table 1-1. Specifications**

**Frequency Range:** 10 Hz to 10 MHz, 6 bands, dial calibrations: 1 to 10.

**Dial Accuracy:** (including warm-up drift and +/- 10% line voltage variation)
+/- 2% 100 Hz (on X100 Range) to 1 MHz (on X100K Range)
+/- 3% 10 Hz to 100 Hz and 1 MHz to 10 MHz.

**Output:**
Maximum: 3.16V into 50 or 600 ohms
6.32V open circuit
+23 dBm into 50 ohms
Ranges: 0.1 mV to 3.16V full scale, 10 steps in 1, 3, 10 sequence, coarse and fine adjustable. -70 dBm to +23 dBm (50 ohm output) full scale, 10 dBm per step, coarse and fine adjustable.
Flatness (Amplitude not readjusted to a reference on the output monitor):
+/- 2% 100 Hz (on X100 range) to 1 MHz
+/- 3% 10 Hz to 100 Hz
+/- 4% 1 MHz to 10 MHz*

Flatness (Amplitude readjusted to a reference on the output monitor):

| Range | Frequency 10 Hz – 20 Hz | 20 Hz – 4 MHz | 4 MHz – 10 MHz |
|---|---|---|---|
| 3V and 1V | 2% | 1% | 2% |
| .3V to .3 mV | 2.5% | 1.5% | 2.5% |
| .1 mV | 3% | 2% | 3% |

*This specification applies only at 50 ohm output. The response above 1 MHz at the 600 ohm output is affected by capacitive loads.

Flatness (Amplitude readjusted using expanded scale on output monitor):
+/- 0.25% 3V and 1V ranges
+/- 0.75% .3V to .3 mV range
+/- 1.75% .1 mV range

Distortion: less than 1% 10Hz to 2 MHz
less than 2% at 2 MHz to 5 MHz
less than 4% 5 MHz to 10 MHz

Hum and Noise: less than 0.05% of maximum rated output between 10 Hz and 10 MHz.

**Output Monitor:**
Accuracy: +/- 2% of full scale.
Voltmeter monitors level at input of attenuator in volts or dB. Top scale calibrated in volts; bottom scale in dB. Expand scale: expands reference voltage of the Normal scale from 0.9 to 1.0 or 2.8 to 3.2.

**Attenuator:**
Range: 90 dB in 10 dB steps.
Overall Accuracy: +/- 0.075 dB, -60 dBm to 20 dBm
+/- 0.2 dB, -70 dBm to -60 dBm

**Amplitude Control:** 20 dB range: coarse and fine.

**Amplitude Stability:** +/- 2% per mo., 20° C to 30° C

**Temperature Range:** 0° C to + 50° C.

**Power Requirements:** 115V or 230V +/- 10%, 30 W, 48 Hz to 66 Hz.

# SECTION IV
# THEORY OF OPERATION

## 4-1. GENERAL DESCRIPTION.

4-2. The Model 652A Test Oscillator includes an oscillator, power amplifier, peak detector, attenuator, normal monitor circuit and expand monitor circuit. A block diagram of the instrument is shown in Figure 6-1. The oscillator circuit uses a modified Wien bridge network to generate a stable, distortionless sine wave signal which is applied to the power amplifier circuit. The automatic gain control utilizes a feedback voltage from a peak detector to the oscillator circuit to stabilize the output signal. The power amplifier circuit is used to increase the output power available at the 50-ohm and 600-ohm output connectors and to improve the frequency stability of the output signal with changing output loads. The output attenuator provides a means of attenuating the signal at the output connectors in nine steps of 10 dB each. The normal monitor circuit monitors the signal level at the input to the attenuator. The expand monitor circuit allows the top 10% of the monitor scale to be expanded, so that a reference can be set. The regulated power supply provides all voltages required by the 652A circuits.

## 4-3. CIRCUIT DESCRIPTION.

4-4. Refer to Figures 6-2 thru 6-4 for the following discussion.

### 4-5. OSCILLATOR CIRCUIT.

4-6. The oscillator circuit generates a sinusoidal signal at the frequency selected by the RANGE switch and FREQUENCY Dial located on the front panel. The RC bridge network is a modified Wien bridge circuit, consisting of an RC frequency selective network and a resistive voltage divider network. The Wien bridge in the Model 652A Test Oscillator differs from the conventional Wien bridge circuit in the design of the resistive voltage divider network. The resistor in the conventional Wien bridge is replaced with a variable impedance (Z1 on Figure 6-1) consisting of A2CR6 and A2CR7.

4-7. Oscillation at the selected frequency is made possible by the use of both positive and negative feedback. Positive feedback is provided through a frequency sensitive RC network to the differential amplifier A2Q2 and A2Q3; negative feedback is provided to the differential amplifier through a network insensitive to frequency. Only at the selected frequency will the positive feedback exceed the negative feedback voltage to sustain oscillation.

4-8. The RANGE switch, S1, selects combinations of resistors and capacitors (S1R1 through S1R24, and S1C1 through S1C15) to establish the frequency sensitive RC networks for the six frequency ranges of the Test Oscillator. The FREQUENCY Dial varies the main frequency tuning elements C1A, C1B, and C1C. The RC components maintain the proper phase relationship of the positive feedback voltage. At frequencies where $X_C = R$, the positive feedback voltage is in phase with the oscillator output voltage (refer to Figure 4-1) and exceeds the negative feedback voltage. At frequencies other than where $X_C = R$, the positive feedback voltage is neither of the right phase nor of sufficient amplitude to maintain oscillations.

4-9. The impedance converter transistor, A2Q1, provides a high impedance in series with the input impedance of the differential amplifier on the first four frequency ranges (X10 - X10K). The high impedance added prevents the RC bridge circuit from being loaded by the low input impedance of the differential amplifier, A2Q2 and A2Q3, on the lower frequency ranges. The impedance converter is bypassed on the X100K and X1M ranges due to lower resistor values in the RC bridge.

4-10. The difference between the feedback voltages from the bridge circuit is amplified by differential amplifier A2Q2 and A2Q3, and is applied to the complementary symmetry circuit A2Q5 and A2Q6, through emitter follower A2Q4. A positive feedback voltage from the output of the complementary symmetry circuit is applied between resistors A2R8 and A2R9, in the collector circuit of A2Q2, on the first four frequency ranges. The application of the feedback voltage at this point is used to make the effective resistance of the collector load higher than the input impedance of the emitter follower A2Q4, forcing the collector current into the base of the emitter follower. The increase in the signal level results in an increase in the loop gain of the oscillator circuit. The feedback voltage is removed on the X100K and X1M

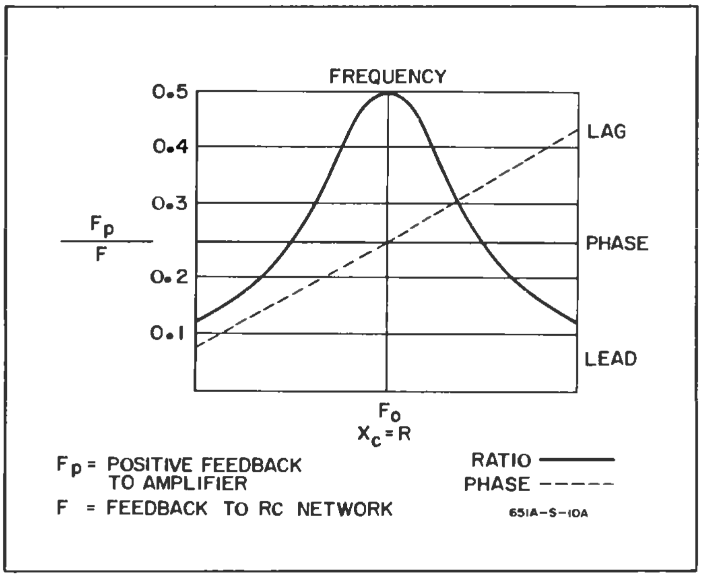



**Figure 4-1. RC Network Characteristics**

frequency range due to the value of resistors A2R8 and A2R9 exceeding the input impedance of the emitter follower at the higher frequencies.

4-11. The complementary symmetry circuit is used to provide power gain and to increase the dynamic voltage range of the oscillator; also, the low output impedance of the complementary symmetry circuit prevents the oscillator output circuit from being loaded by the RC bridge. The complementary symmetry circuit transistors are forward-biased by diodes A2CR2, A2CR3, and A2CR4, and with no signal applied, are conducting slightly to reduce cross-over distortion in the output signal.

4-12. The output of the oscillator circuit drives the power amplifier with a constant voltage set by the AMPLITUDE coarse and VERNIER controls, R2A and R2B. The voltage level applied to the power amplifier is held constant by the action of the peak detector circuit.

## 4-13. AUTOMATIC GAIN CONTROL.

4-14. The output of the oscillator circuit is superimposed on a negative reference bias at the base of A2Q7. This bias voltage is determined by the setting of the amplitude controls. The peak detector, A2Q7, will conduct only on the positive peaks when the negative bias is overcome. The average dc voltage across A2C7, A2C8, A2C9 and A2C10 biases the diodes A2CR6 and A2CR7 to determine the impedance of the negative feedback side of the Wien bridge. Thus the amplitude of the oscillations is automatically controlled. A2CR5 and A2CR9 provide temperature compensation for the bias voltage on A2Q7, and A2CR8 prevents the reverse breakdown of A2Q7. A2R17 is adjustable to compensate for differences in the operating characteristics of diodes A2CR6 and A2CR7, minimizing distortion in the negative feedback and subsequently in the oscillator output.

## 4-15. POWER AMPLIFIER.

4-16. The power amplifier circuit increases the power gain of the signal received from the oscillator circuit. The operation of the differential amplifier A2Q8 and A2Q9, emitter follower A2Q10, and complementary symmetry circuit A2Q11 and A2Q12 is similar to the corresponding stages in the oscillator circuit. The negative feedback voltage from the output of the complementary symmetry circuit is applied to the differential amplifier at a fixed level to stabilize the power amplifier output signal. The power amplifier output is continuously monitored by one of the two monitor circuits before the signal is applied to the output attenuator circuit.

## 4-17. NORMAL MONITOR CIRCUIT.

4-18. The normal monitor circuit monitors the signal level applied to the output attenuator circuit and provides a signal to the output monitor, M1, when the MONITOR switch, S4, is in the NORMAL position. The amplifier A1Q9 serves both as an impedance converter between the monitor circuit and the power amplifier output circuit and as a current source to provide full-scale monitor indications. The high input impedance of the amplifier prevents the power amplifier from being loaded with the low impedance of the output monitor, M1. The emitter follower A1Q8 provides a positive feedback voltage which is applied between resistors A1R18 and A1R19, in the collector lead of amplifier A1Q9. The application of the feedback voltage at this point is used to increase the effective resistance of the collector circuit, which results in the amplifier A1Q9 appearing as a high impedance current source to the monitor. The diode A1CR10 provides a small amount of forward bias to rectifier diodes A1CR8 and A1CR9, which keeps the diodes out of the non-linear region, thus increasing monitor accuracy at one-tenth full-scale readings. The 10 MHz adjustment, A1C15, compensates for small variations in circuit capacitance so the monitor will have a flat frequency response. The monitor calibration resistor, A1R23, provides an additional calibration adjustment which is made at 400 Hz.

## 4-19. EXPAND MONITOR CIRCUIT.

4-20. The expand monitor circuit allows the top 10% of the output monitor scale to be expanded to full scale. A reference may then be set on the scale, and deviations up to +/- 2.5% in the oscillator output will be indicated on the monitor. The circuit is comprised of an average detector, a differential amplifier, and a variable reference supply. The difference between the outputs of the detector and the reference supply is amplified by the differential amplifier, and is applied to the monitor, M1, when the MONITOR switch, S4, is in the EXPAND position. The dc output of the detector is proportional to the amplitude of the oscillator output, and the amplitude of the reference supply output may be varied by the REF SET coarse and VERNIER controls, R3A and R3B, respectively. A reference may be set at any point on the expanded monitor scale, by varying the reference supply output.

4-21. The output of the oscillator power amplifier is applied to the detector through an RCL network (A3C5, A3L1, A3R1), capacitor A3C2, and resistor A3R2. The purpose of the RCL network is to smooth the expand monitor circuit response on the X1M range. On the X10 range, A3C1 is switched in parallel with the RCL network and the input capacitor, A3C2, to improve the low frequency response of the circuit. It is not used on higher frequency ranges, due to an increase in detector time constant when it is connected.

4-22. The detector is a diode rectifier that provides a dc output proportional to the average value of the sinusoidal input from the oscillator power amplifier. The ac input is rectified by diodes A3CR1 and A3CR2, and applied to the base and emitter, respectively, of A3Q1, forward biasing the transistor. A3Q1 provides a low impedance path for the rectified signal, and allows average detection of the applied input with a single-ended output. A3L2, A3C6, and A3C7 form a filter network to remove any high frequency components which might be present on the detector output. In addition, A3C3 is switched in on the X10 range to dampen the meter by reducing low frequency ripple.

4-23. The differential amplifier, A3Q2 and A3Q3, amplifies the difference between the filtered output of the detector and the reference voltage from the variable reference power supply. The output is taken from the collector of A3Q2, is further amplified by A3Q5, and is applied to the emitter follower, A3Q6. The emitter follower has a low output impedance and is used to drive the monitor. A3Q4 acts as a current source to provide approximately 50 microamps of current to the differential amplifier.

4-24. The reference power supply is a conventional series regulator type that has a variable output. Zener diode A3CR6 maintains a constant bias on the emitter of the reference amplifier, A3Q8. The base bias of A3Q8 is changed whenever the REF SET coarse or VERNIER controls are varied. This change is amplified and applied to the base of the series regulator, A3Q7. A3Q7 will change the reference supply output in direct proportion to the amount that the REF SET coarse or VERNIER controls are changed.

4-25. Two adjustments are provided for the expand monitor circuit: A3C11 and A3R14. A3C11 adjusts the expand monitor circuit response at 10 MHz, and A3R14 calibrates the monitor at 10 kHz.

## 4-26. OUTPUT ATTENUATOR.

4-27. The output attenuator provides a means of attenuating the signal level applied to the 50-ohm and 600-ohm output connectors. The OUTPUT ATTENUATOR switch, S2, selects a combination of four resistor networks to produce the desired level of signal attenuation. Each step provides an attenuation of 10 dB. The AMPLITUDE controls, R2A and R2B, vary the level of attenuation in increments between each 10 dB step selected by the OUTPUT ATTENUATOR switch.

4-28. Output impedances other than the standard 600-ohms can be obtained by changing the value of resistor S2R13. The value of the resistor replacing S2R13 is added to the 50-ohm oscillator output impedance to obtain the new output impedance level at the 600-ohm connector.

## 4-29. REGULATED POWER SUPPLY.

4-30. The regulated power supply provides all dc voltages required by the 652A Test Oscillator circuits. The power supply consists of a + 30 V and - 25 V series regulated supply. Each power supply is protected by current limiting and foldback current limiting.

4-31. The + 30 V and - 25 V power supplies are functionally identical. Both use operational amplifiers for output voltage error amplification. A1R40 adjusts the + 30 V supply voltage and A1R41 adjusts the - 25 V supply voltage.

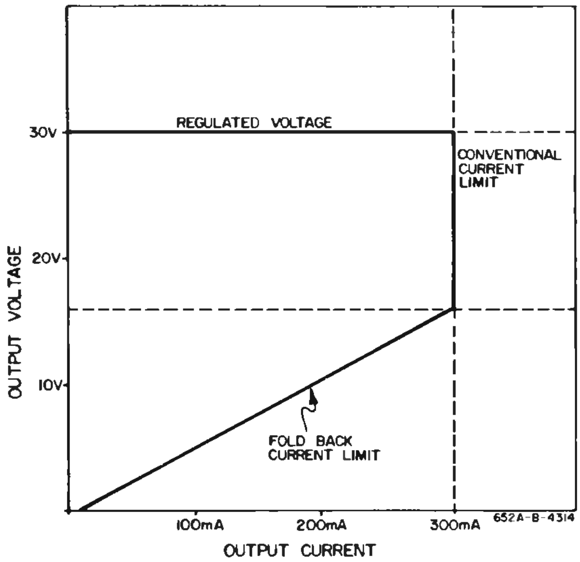



**Figure 4-2. Regulated Power Supply Output Voltage vs. Current.**

4-32. Conventional current limiting is used in both supplies to limit the output current to approximately 300 mA. Foldback current limiting further limits the output current if the output voltage is pulled below approximately 16 V by a malfunction in the 652A circuitry. A direct short to ground of either supply will result in an output current of approximately 10 mA as shown in Figure 4-2.

4-33. Figure 4-3 is a simplified schematic of the current limiting circuitry used in the 652A power supplies. The Current Limiting Transistor A1Q4(+) or A1Q7(-) is a variable shunt to the series regulator drive current. It is first switched on by the voltage drop across the Current Limit Sensing Resistor when the power supply output current reaches approximately 300 mA. The power supply will remain in this Conventional Current Limit condition until the output current decreases allowing the supply to return to normal operation, or until the power supply output voltage drops below the Foldback Reference (16.2 V). If the latter occurs, the Diode Switch is effectively closed and the power supply goes into a Foldback Current Limit condition. In this condition the Current Limiting Transistor is controlled by the power supply output voltage. As the output voltage decreases, the shunt current is increased.

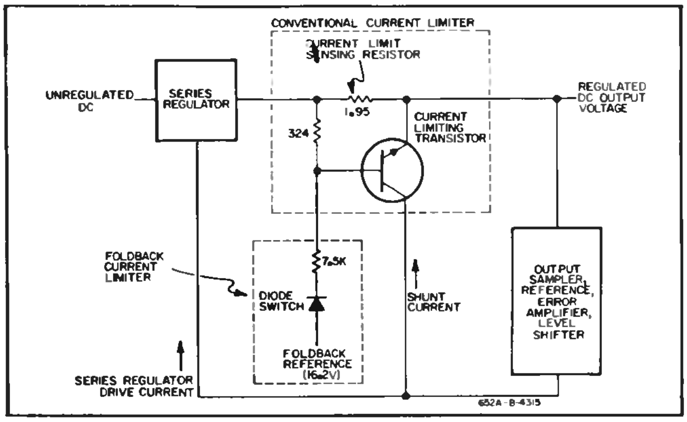



**Figure 4-3. Simplified Schematic of Current Limiting Circuitry.**

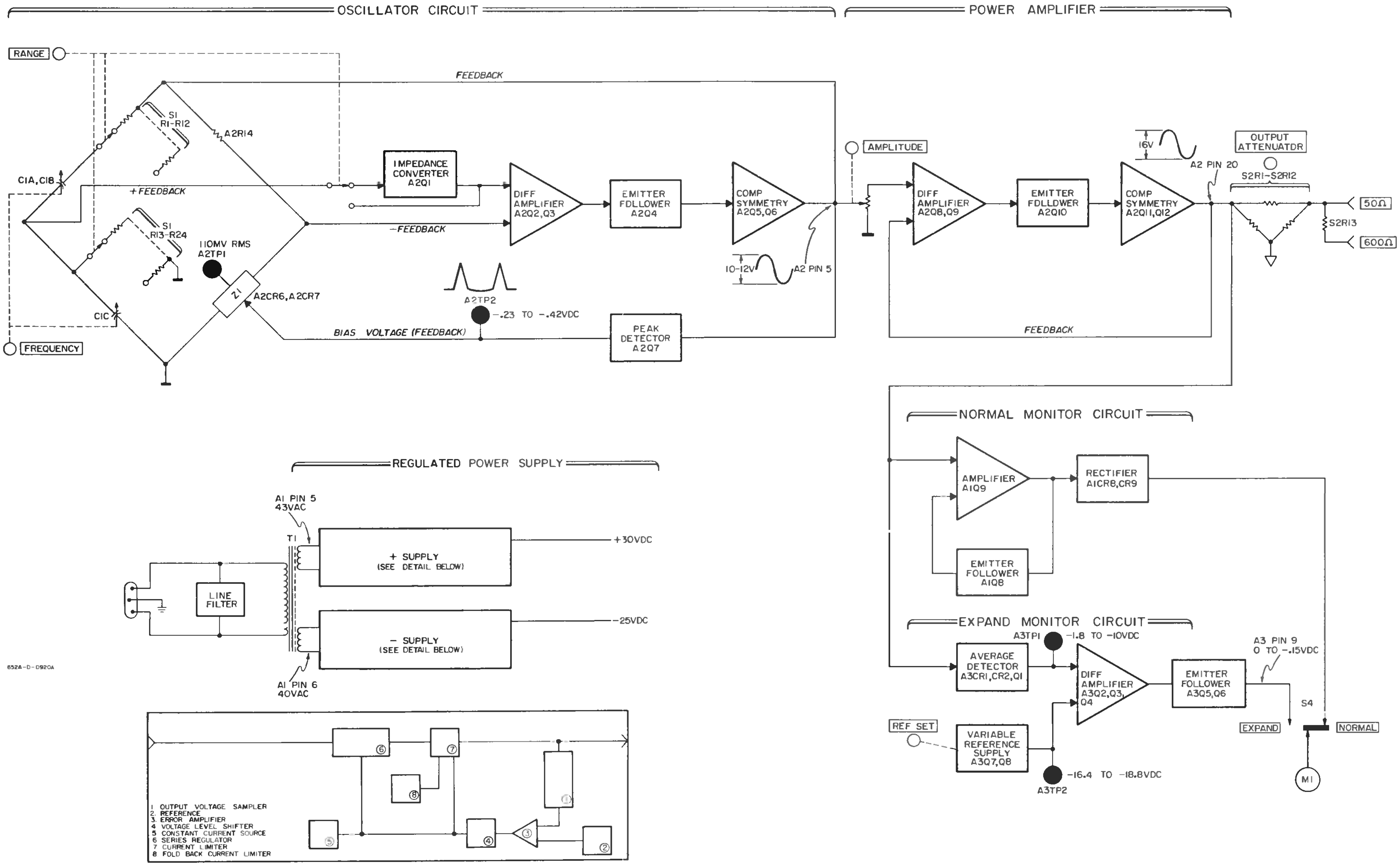
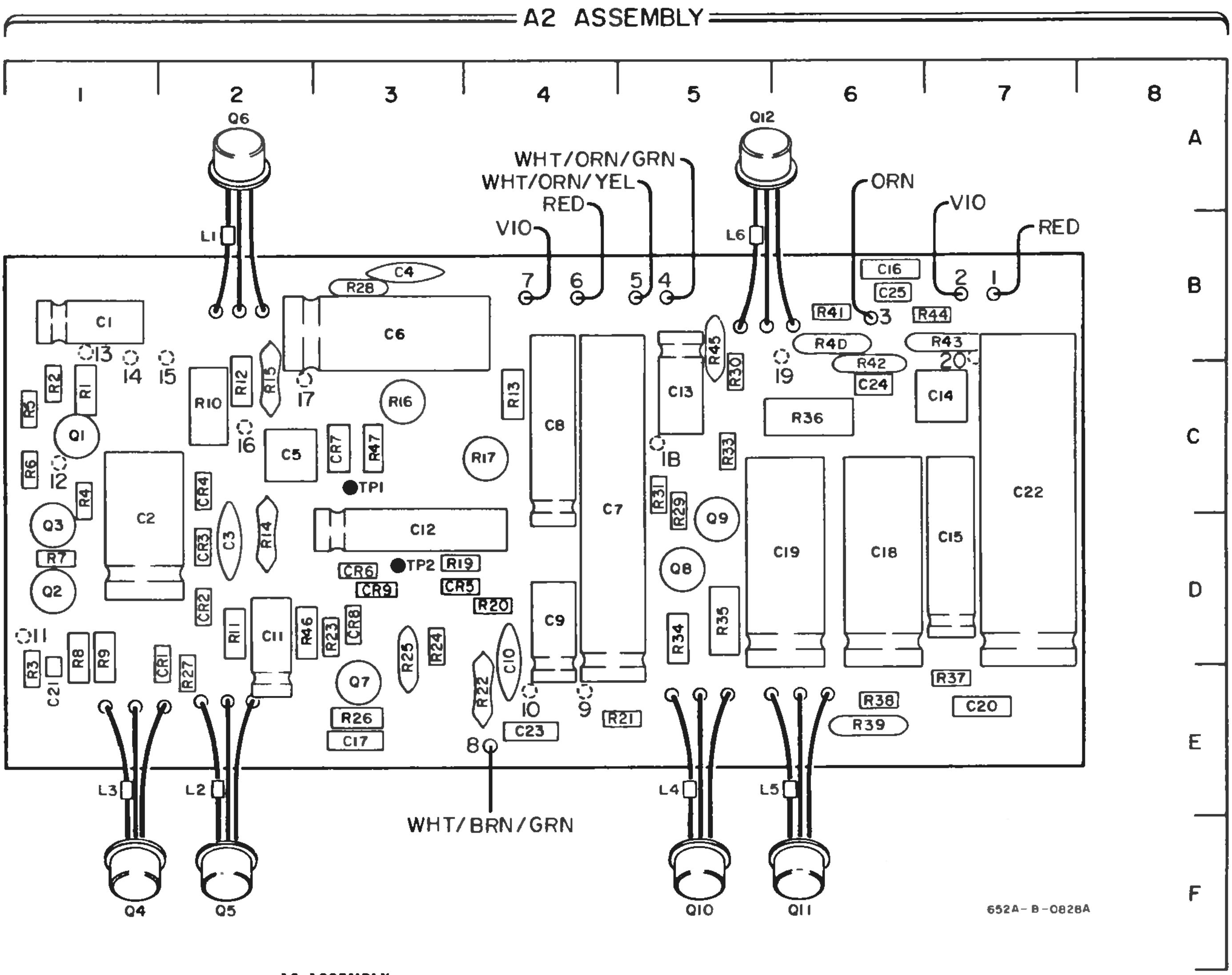



Figure 6-1. Block Diagram.

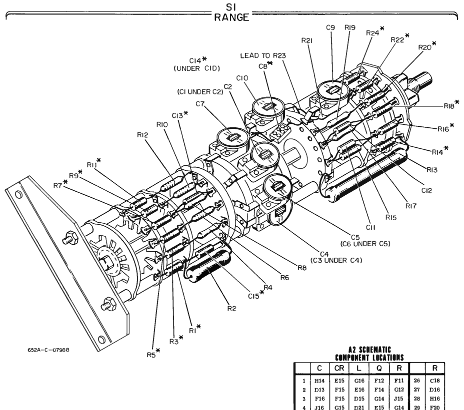



## A2 ASSEMBLY COMPONENT LOCATIONS

| | C | CR | L | Q | R | | R |
|---|---|---|---|---|---|---|---|
| 1 | B1 | D2 | B2 | C1 | C1 | 26 | E3 |
| 2 | C1 | D2 | E2 | D1 | C1 | 27 | E2 |
| 3 | D2 | D2 | F1 | D1 | E1 | 28 | B3 |
| 4 | B3 | C2 | E5 | F1 | C1 | 29 | C5 |
| 5 | C2 | D3 | E6 | F2 | C1 | 30 | C5 |
| 6 | B3 | D3 | B5 | A2 | C1 | 31 | C5 |
| 7 | C4 | C3 | | E3 | D1 | 32 | --- |
| 8 | C4 | D3 | | D5 | D1 | 33 | C5 |
| 9 | D4 | D3 | | D5 | D1 | 34 | D5 |
| 10 | D4 | | | F5 | C2 | 35 | D5 |
| 11 | D2 | | | F6 | D2 | 36 | C6 |
| 12 | D3 | | | A5 | C2 | 37 | E7 |
| 13 | C5 | | | | C4 | 38 | E6 |
| 14 | C7 | | | | D2 | 39 | E6 |
| 15 | D7 | | | | C2 | 40 | B6 |
| 16 | B6 | | | | C3 | 41 | B6 |
| 17 | E3 | | | | C3 | 42 | B6 |
| 18 | D6 | | | | C3 | 43 | B7 |
| 19 | D6 | | | | D3 | 44 | B7 |
| 20 | E7 | | | | D4 | 45 | B5 |
| 21 | E1 | | | | E5 | 46 | D2 |
| 22 | C7 | | | | E4 | | |
| 23 | E4 | | | | D3 | | |
| 24 | C6 | | | | D3 | | |
| 25 | B6 | | | | D3 | | |

## A2 ASSEMBLY WIRE COLORS (BOTTOM)

| PIN NO. | WIRE COLOR |
|---|---|
| 9 | WHITE |
| 10 | BLACK |
| 11 | WHT/ORN |
| 12 | BLACK |
| 13 | ORANGE |
| 14 | WHT/GRN |
| 15 | RED |
| 16 | WHT/YEL |
| 17 | BLACK |
| 18 | WHT/BLK |
| 19 | BLUE |
| 20 | |




**A2 SCHEMATIC COMPONENT LOCATIONS**

| | C | CR | L | Q | R | | R |
|---|---|---|---|---|---|---|---|
| 1 | H14 | E15 | G16 | F12 | F11 | 26 | C18 |
| 2 | D13 | F15 | E16 | F14 | G12 | 27 | D16 |
| 3 | F16 | F15 | D15 | G14 | J15 | 28 | H16 |
| 4 | J16 | G15 | D21 | E15 | G14 | 29 | F20 |
| 5 | F8 | F17 | E22 | F16 | H14 | 30 | H19 |
| 6 | F7 | H8 | G22 | G16 | H14 | 31 | C20 |
| 7 | J8 | H7 | | F18 | F14 | 32 | --- |
| 8 | J9 | F18 | | F20 | D14 | 33 | G20 |
| 9 | J7 | F17 | | G20 | D14 | 34 | D20 |
| 10 | J8 | | | E21 | H15 | 35 | F21 |
| 11 | G17 | | | F22 | F16 | 36 | H21 |
| 12 | C16 | | | G22 | G16 | 37 | C23 |
| 13 | C17 | | | | J12 | 38 | F22 |
| 14 | J22 | | | | D7 | 39 | F23 |
| 15 | J23 | | | | E7 | 40 | G23 |
| 16 | H19 | | | | F7 | 41 | G23 |
| 17 | D19 | | | | G7 | 42 | G23 |
| 18 | G22 | | | | G7 | 43 | J23 |
| 19 | F22 | | | | H10 | 44 | H23 |
| 20 | D23 | | | | H8 | 45 | H22 |
| 21 | D14 | | | | J8 | 46 | E18 |
| 22 | F23 | | | | H17 | | |
| 23 | J17 | | | | G17 | | |
| 24 | G23 | | | | G17 | | |
| 25 | G24 | | | | H17 | | |

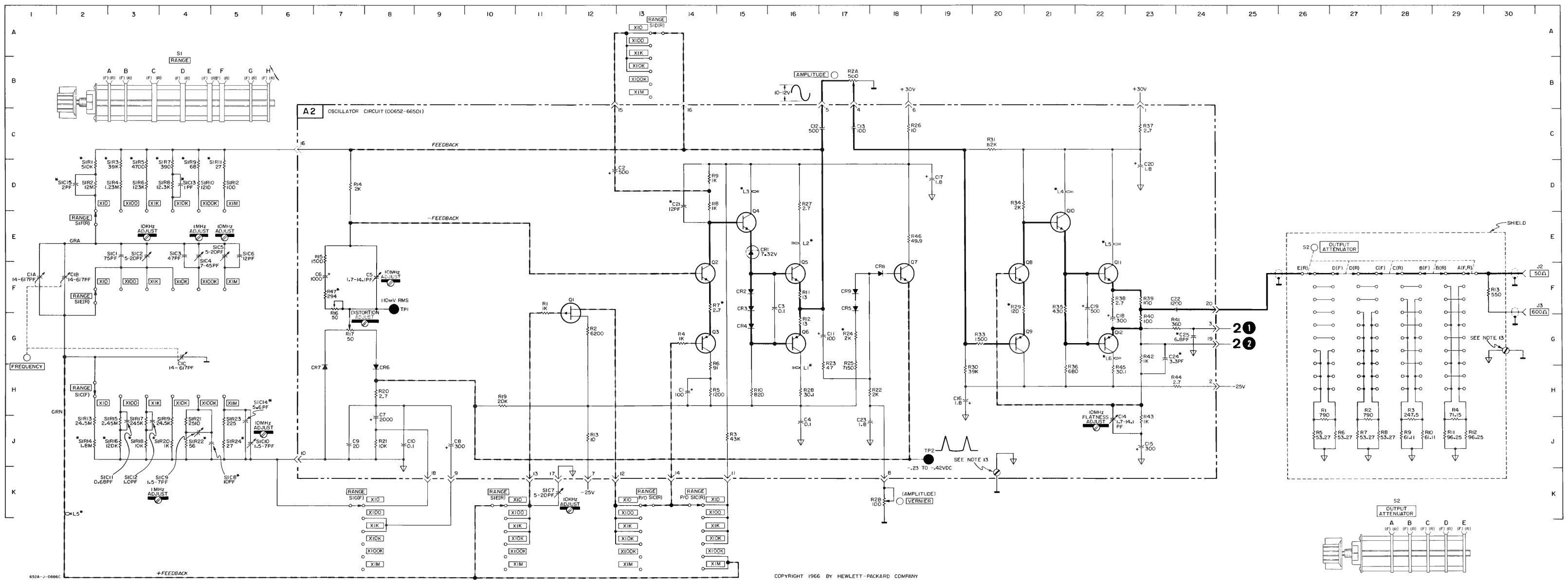



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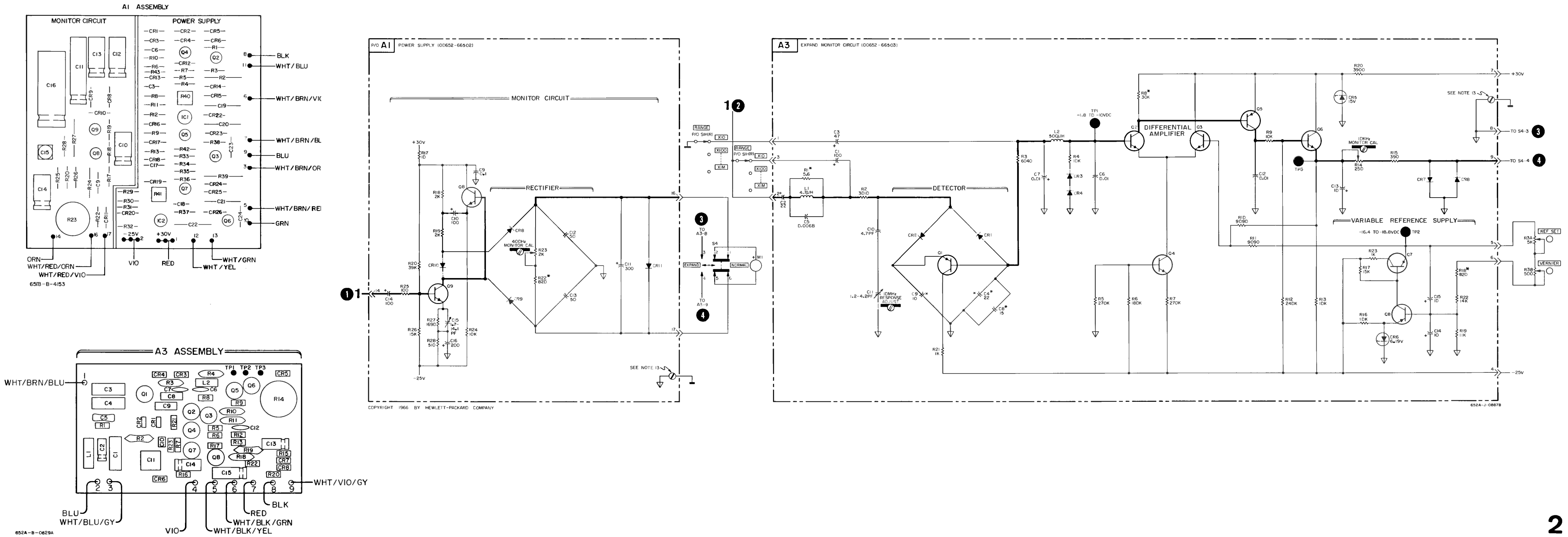
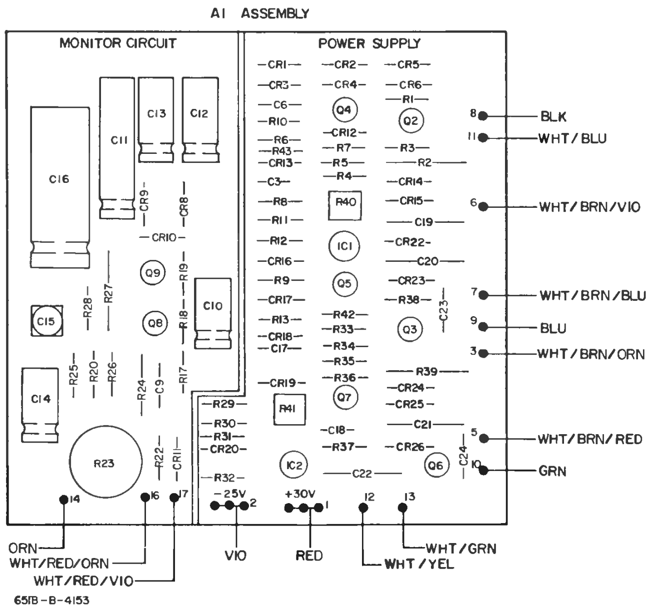
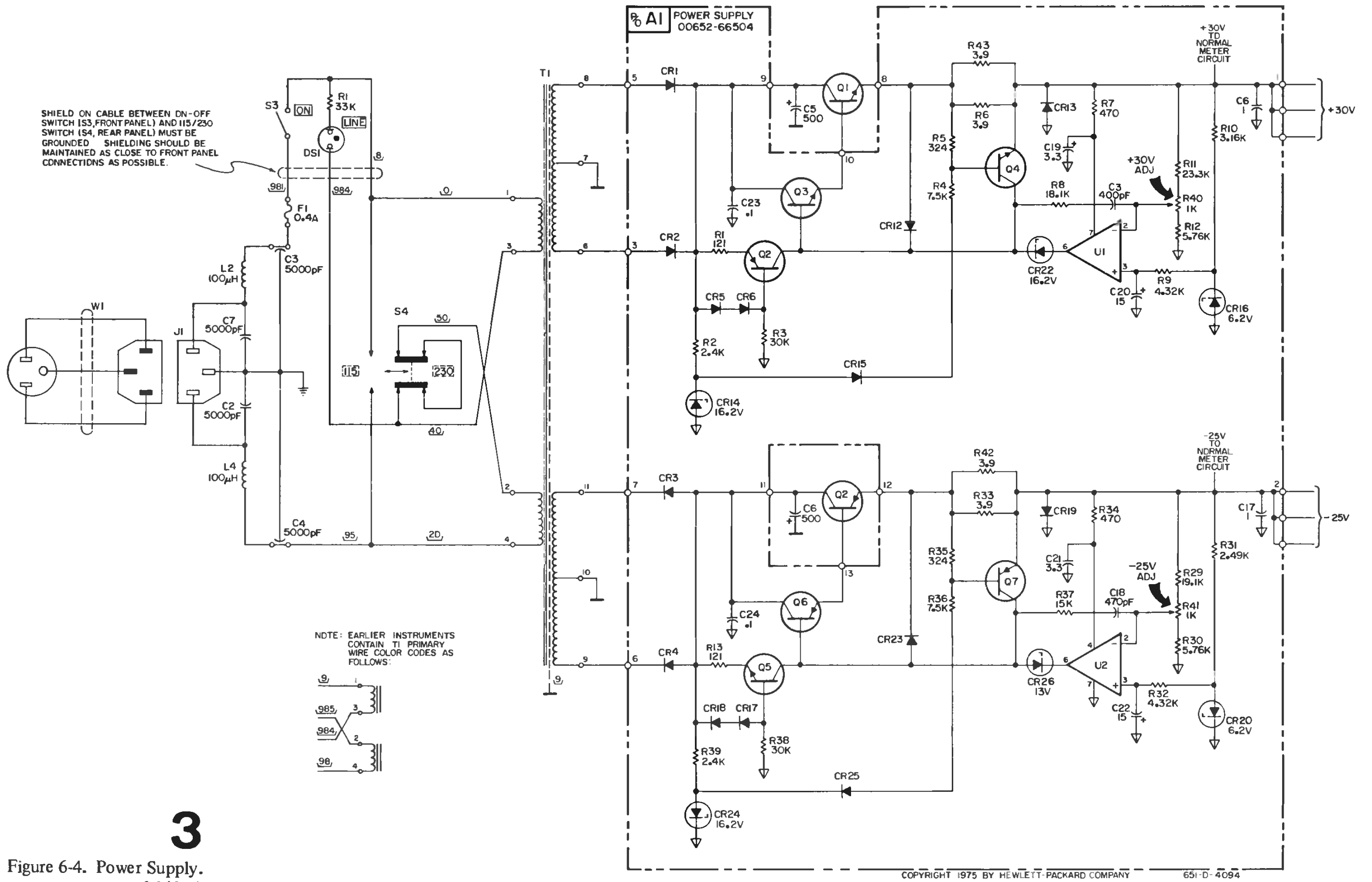
Figure 6-2. Oscillator Circuit.




**2**

Figure 6-3. Normal and Expand Monitor Circuits.




**3**

Figure 6-4. Power Supply.

# MANUAL BACKDATING CHANGES

MODEL 652A
TEST OSCILLATOR

Manual Serial Prefixed: 623, 632, 812, 826, 911, 954, 0964A.

-hp- Part No. 00652-90002

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.

| Instrument Serial Prefix | Make Manual Changes |
|---|---|
| 632-00250 and below | No. 1 |
| 954-02135 and below | No. 2 |
| Blue Instruments | No. 3 |
| Below 0964A02771 | No. 4 |
| 0964A03070 and below | No. 5 |
| 911-01736 and below | No. 6 |

| Instrument Serial Prefix | Make Manual Changes |
|---|---|
| 1226A-04170 and below | No. 7 |
| 1226A-04309 and below | No. 8 |
| | |
| | |
| | |
| | |

CHANGE No. 1

Delete A2C25*
Delete A2R46
Change A2C11 to 200 microfarads, -hp- Part No. 0180-0060.
Change A2CR5 to a breakdown diode, 7.87 V +/- 2%, -hp- Part No. 1902-0778.
Change A2Q7 to 2N3393, -hp- Part No. 1854-0218.
Change A2R25 to 11.75K, -hp- Part No. 0757-0757.

Change circuitry associated with A2Q7 in Figure C-1.

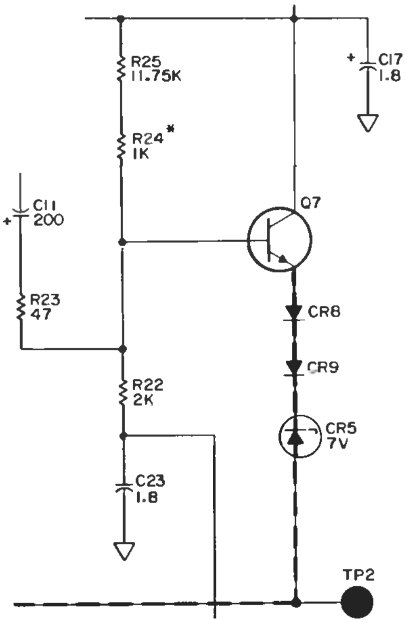



Figure C-1. P/O Oscillator Circuit.

CHANGE No. 2

Table 7-1, Page 7-9:
Change the -hp- Part No. of W1 to 8120-0078.
Table 7-1, Page 7-8:
Change the -hp- Part No. of MP32 to 00651-00202.
Table 7-1, Page 7-7:
Change the -hp- Part No. of J1 to 1251-0148.

CHANGE No. 3

Table 7-1, Page 7-8:
Change the -hp- Part No. of MP29 to 5040-0642
Change the -hp- Part No. of MP31 to 5060-0739
Change the -hp- Part No. of MP34 to 5060-0766
Change the -hp- Part No. of MP35 to 5000-0732
Change the -hp- Part No. of MP36 to 5000-0733
Change the -hp- Part No. of MP41 to 5060-0751
Change the -hp- Part No. of MP42 to 00652-00201

Table 7-1, Page 7-9:
Change the -hp- Part No. of Rack Mount Kit to 00652-84401.

CHANGE No. 4

Table 7-1, Page 7-8:
Change the -hp- Part No. of MP18 to 1205-0008
Add Nut: heat sink P/O MP18
Table 7-1, Page 7-9:
Add Insulator: washer (for MP18)

CHANGE No. 5

Table 7-1, Page 7-4:
Change the -hp- Part No. of A1Q2 to 1850-0107
Change the -hp- Part No. of A1Q3 to 1853-0007
Change the -hp- Part No. of A1Q5 to 1850-0107
Change the -hp- Part No. of A1Q6 to 1850-0062
Change the -hp- Part No. of A1Q7 to 1853-0007

**NOTE:** The recommended replacement for these five transistors is the 1853-0012 shown on Page 7-4.

CHANGE No. 6

Figure 6-3, Page 6-7/6-8:
Delete A1CR12 from A1 component locator.
Figure 6-4, Page 6-9/6-10:
Delete A1CR12 from A1 component locator and schematic.
Table 7-1, Page 7-4:
Delete A1CR12 from A1 assembly.

CHANGE No. 7

Page 4-3:

Replace Paragraphs 4-29 through 4-32 with the following paragraphs:

**4-29. REGULATED POWER SUPPLY.**

4-30. The regulated power supply provides all voltages required by the test oscillator circuits. The power supply consists of a +30 volt series regulated supply and a -25 volt series regulated supply which is referenced to the +30 volt circuit.

4-31. The +30 volt regulated supply is of the conventional series regulator type. The emitter follower A1Q2 is used to increase the loop gain of the circuit, thus improving voltage regulation. The +30 volt adjustment, A1R4, sets the +30 volt and -25 volt supply output level.

4-32. The -25 volt regulated supply is of the conventional series regulator type and operates the same as the +30 volt supply. A current limiter, A1Q7 has been added to limit the load current to a set value. When the load current exceeds the set value, the current limiter conducts, causing the series regulator Q2 to reduce the output voltage level until the load causing an excessive current is removed. Diodes A1CR6 and A1CR7 protect the control transistor, A1Q6, against short circuits between the two voltage supplies, or short circuits in the output of the -25 volt supply.

Page 5-8:

Replace Paragraph 5-26 with the following paragraph:

**5-26. Power Supply Voltage Adjustments.**

a. Connect dc voltmeter to power supply positive output, connector point 1. (Refer to Figure 6-4.)

b. Adjust A1R4 (+30 V adjust) for an indication of +30 V on dc voltmeter. If A1R4 does not have sufficient range, change A1R5*.

c. Connect dc voltmeter to power supply negative output, connector point 2; dc voltmeter should indicate -25 V ± 0.75 V. If negative supply output is not within tolerance, change value of resistor A1R13* to obtain specified output. Decrease value of A1R13* to increase negative supply voltage; increase value of A1R13* to decrease negative supply voltage.

Page 5-9, Figure 5-7 and Page 7-3, Figure 7-2.

Change A1 adjustments as in Figure C-2.

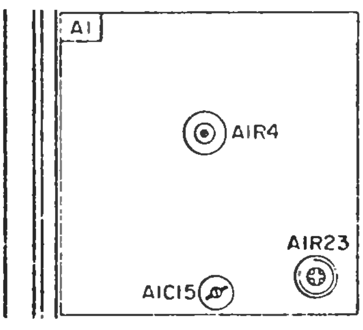



**Figure C-2. A1 Adjustments.**

Page 5-17, Paragraph 5-51:

Change troubleshooting information Steps (5) through (9) to the following:

(5) Check the power supply connections to external circuits, and check the resistors in series with the connections (A2 Pins 1, 2, 6 and 7; A3 Pin 4 and 7; A1R17, A1R24, A1R26 and A1R28).

(6) A procedure for checking the oscillator circuit is given in Paragraph 5-53.

(7) False if either or both voltages are not correct. If the + 30 V was correct in Step 4, check only A1 Pin 7.

(6) a. If only the - 25 V supply is inoperative, proceed to branch 9.

b. The - 25 V supply is referenced to the + 30 V. Lift one side of A1R13 to isolate the supplies from each other; if the + 30 V supply now operates normally, proceed to Step 9; if it does not, remove external circuits by disconnecting A2 Pins 1 and 6, A3 Pin 7 and A1R17. If the supply now operates, then the trouble is in the external circuits. If the supply still does not operate, check Q1, A1Q2, A1Q3, A1CR1 and A1CR2.

(9) Isolate the - 25 V supply from external circuits by disconnecting A2 Pins 2 and 7, A3 Pin 4 and A1R24, A1R26 and A1R28. If the supply now operates, then the trouble is in the external circuits; if the supply does not operate, check Q2, A1Q5, A1Q6, A1Q7, A1CR3 and A1CR4.

Page 5-21/5-22, Figure 5-11:

Change Step 7 of the troubleshooting tree to 43 V ac at A1 pin 5, 40 V ac at A1 pin 7.

Page 6-3, Figure 6-1:

Change the Regulated Power Supply block diagram as in Figure C-3.

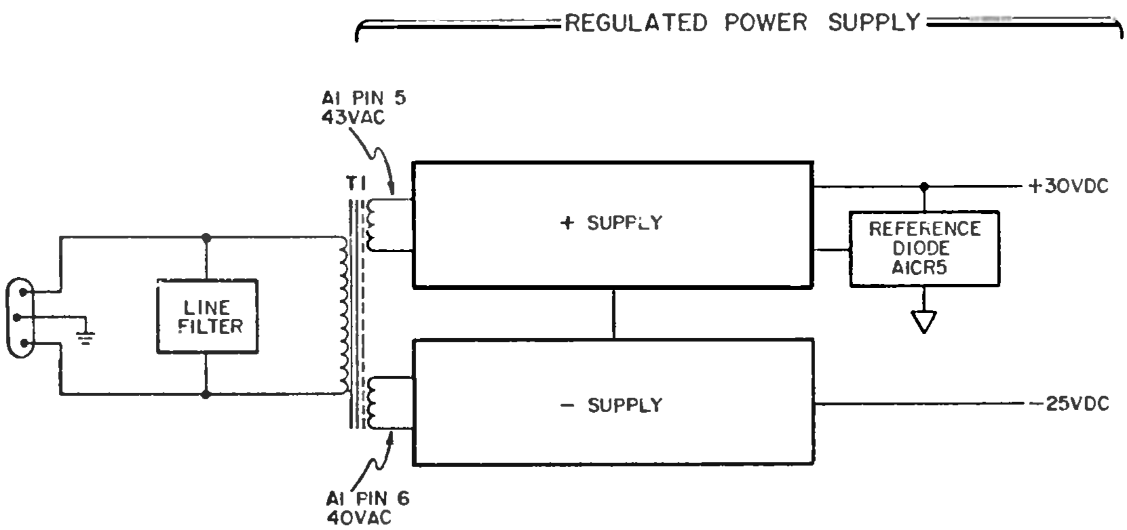



**Figure C-3. Power Supply Block Diagram.**

Page 6-7/6-8 and 6-9/6-10:
Change the A1 Component Locator drawing as in Figure C-4.

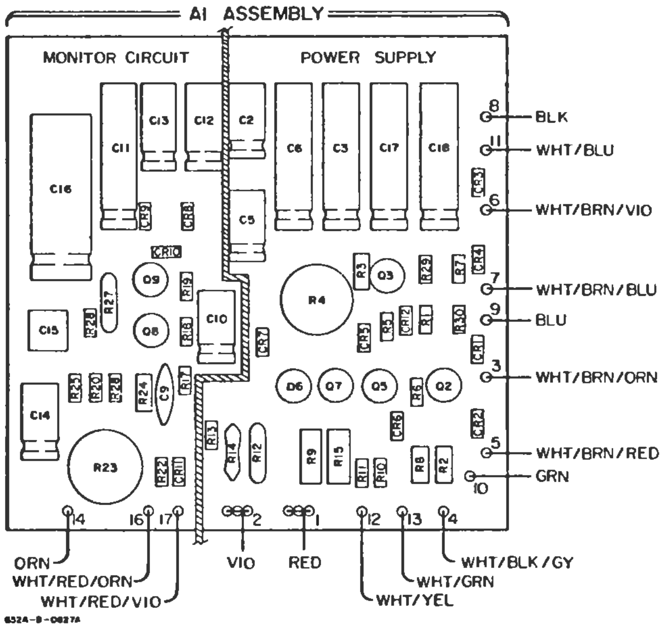



**Figure C-4. Al Component Locator, -hp- Part No. 00652-66502.**

Page 6-9/6-10, Figure 6-4:
Change the Power Schematic drawing as in Figure C-5.

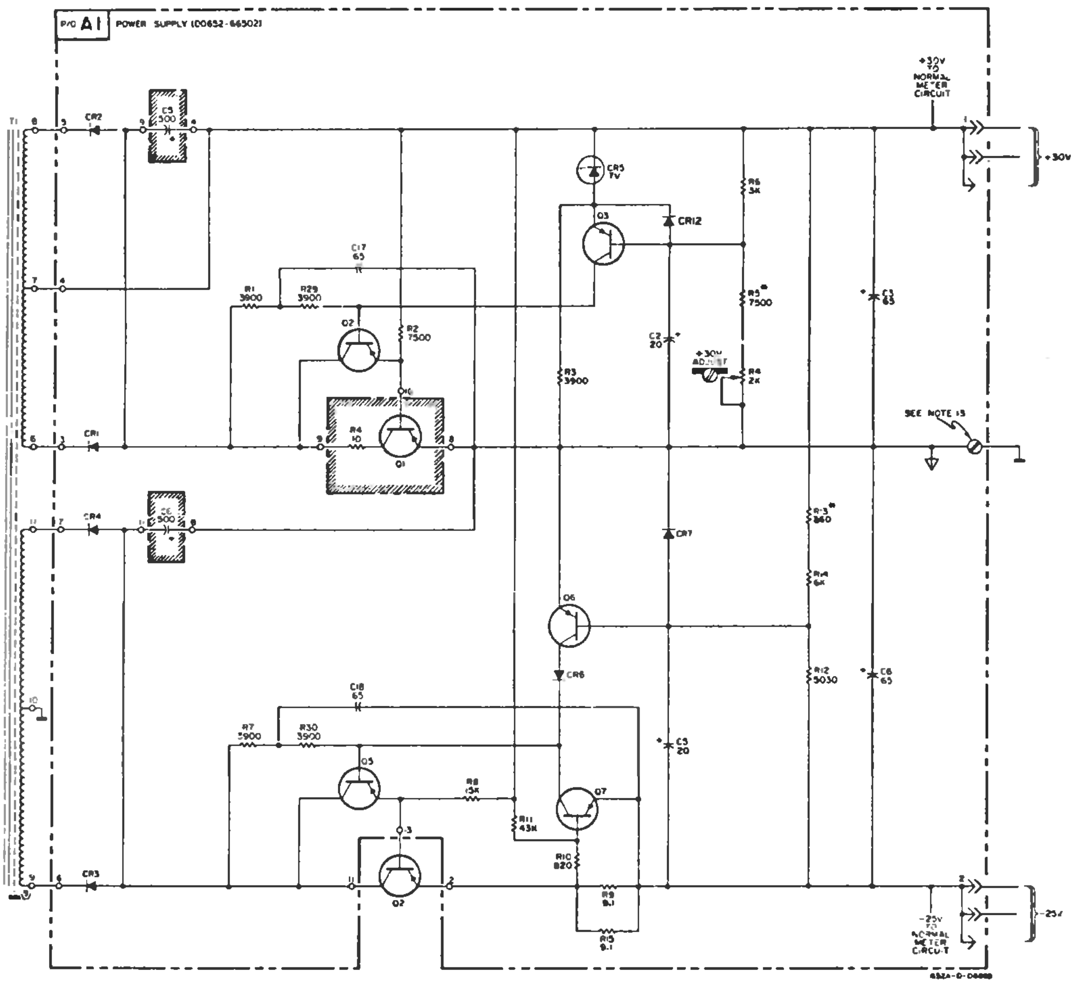


**Figure C-5. Power Supply Schematic Drawing.**

CHANGE No. 8

Page 5-9, Figure 5-7:

Change A2 adjustments as in Figure C-6.

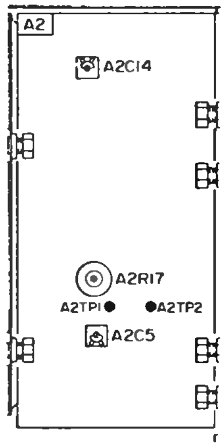



**Figure C-6. A2 Adjustments.**

Page 5-11:

Replace Paragraphs 5-29(d), (h), (i) and 5-30(c), (d), and (e) with the following:

**5-29. Frequency Dial Calibration.**

d. Record A2TP2 voltage. This voltage should be between - 0.32 V to - 0.40 V in a calibrated instrument; however, at this point in the Calibration Procedure, it could be up to 200 mV outside this range. It is not necessary to correct the voltage as this will be done later in the procedure (Paragraph 5-30).

h. Record A2TP2 voltage.

i. Set 652A FREQUENCY dial to 10. Readjust S1C2 and S1C7 alternately until counter indicates frequency of 10 kHz and A2TP2 voltage equals voltage recorded in Step h.

**5-30. X1K Range Adjustments.**

c. AC Voltmeter should indicate 110 ± 10 mV rms. If A2TP1 voltage is not in tolerance, change value of A2R16* to bring voltage within specified limits (increase value of A2R16* to decrease A2TP1 voltage, and vice versa). Do not solder A2R16* in place at this time.

d. Note dc voltage on A2TP2, which should be within -400 mV to -320 mV. If not, change the value of S1R5* and S1R18* simultaneously (See Table 5-6) until A2TP2 voltage is within tolerance and frequency is 1 kHz. Do not solder the resistors in place.

e. Repeat Steps c and d of this paragraph (if necessary) until A2TP1, A2TP2 and the frequency are all within tolerance. Solder A2R16*, S1R5* and S1R18* in place.

Page 5-18:

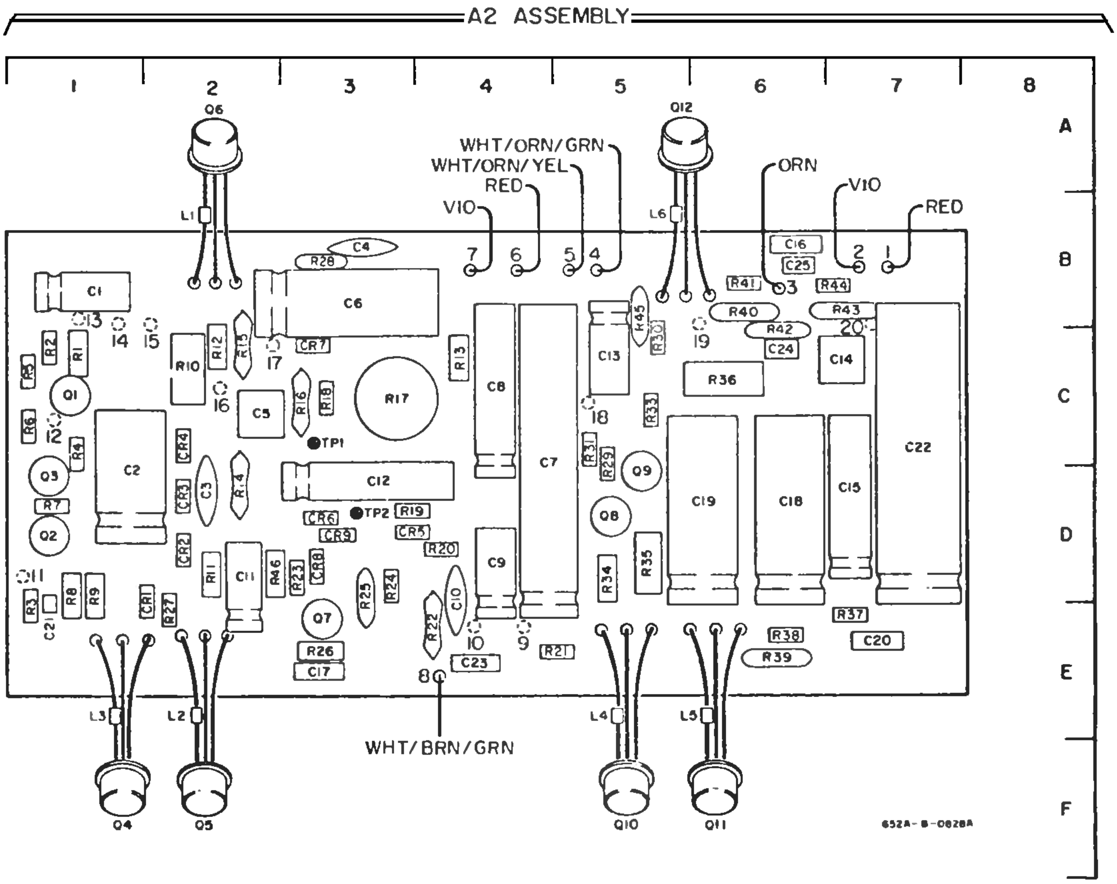
Replace Paragraph 5-53(c) with the following:

**5-53. Troubleshooting the Oscillator Circuit.**

c. If there is no signal at A2 Pin 5, isolate the Peak Detector by lifting one side of A2C11 and the emitter of A2Q7. If the oscillator comes on, check the Peak Detector components. If there is no apparent fault in the Peak Detector, it is possible that A2R16* may have an incorrect value, this is likely to occur if other components (such as A2CR6, A2CR7, A2Q2, and A2Q3) have been replaced. To check this reconnect the peak detector, replace A2R16* with a 500 ohm potentiometer, switch the 652A to the X1K range and vary the value of the potentiometer, while tuning the dial over its entire range.

Page 6-4:

Change A2 Component Locator drawings as in Figure C-7.

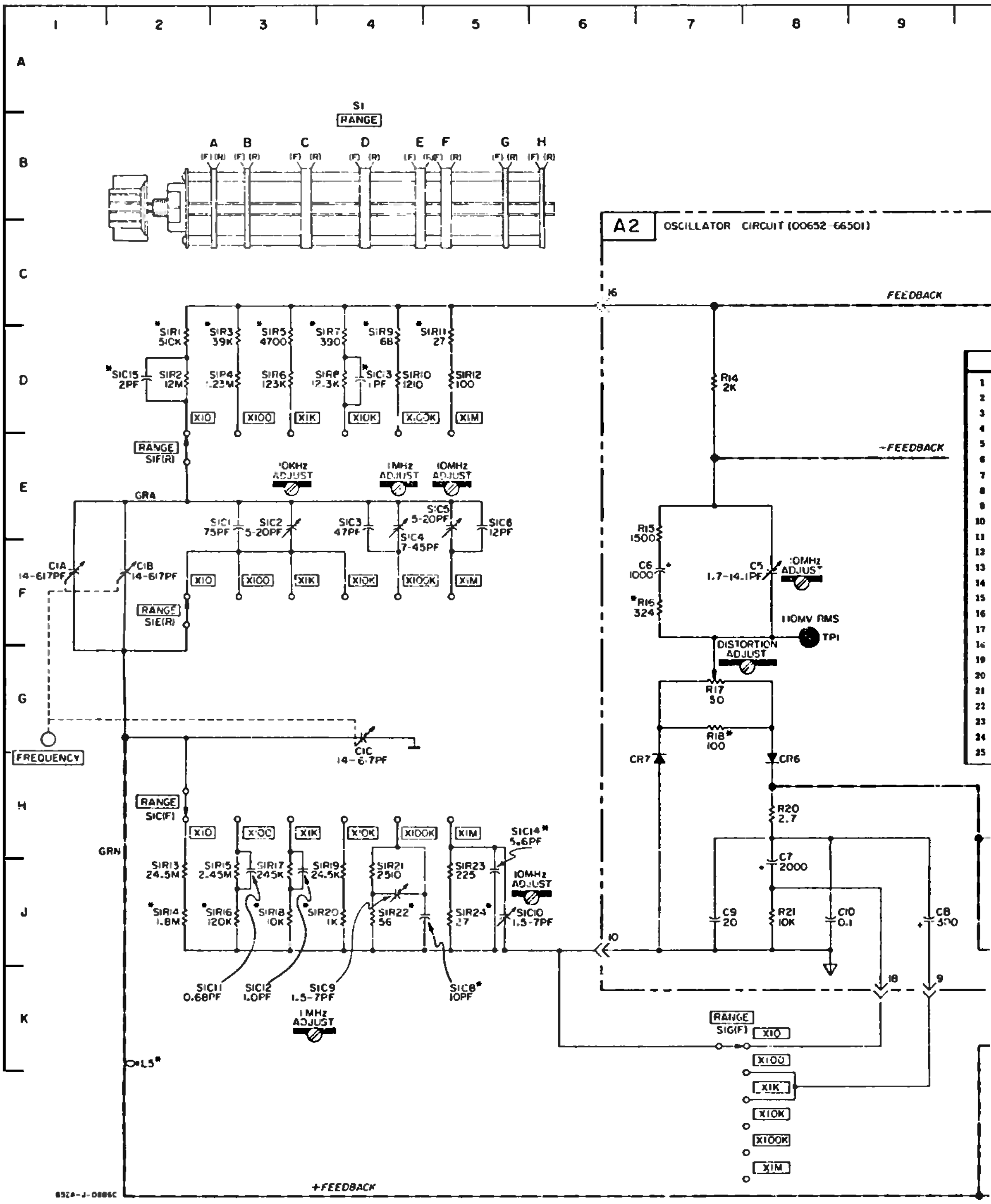



**A2 ASSEMBLY COMPONENT LOCATIONS**

| | C | CR | L | Q | R | | R |
|---|---|---|---|---|---|---|---|
| 1 | B1 | D2 | B2 | C1 | C1 | 26 | E3 |
| 2 | C1 | D2 | E2 | D1 | C1 | 27 | E2 |
| 3 | D2 | D2 | F1 | D1 | E1 | 28 | B3 |
| 4 | B3 | C2 | E5 | F1 | C1 | 29 | C5 |
| 5 | C2 | D3 | E6 | F2 | C1 | 30 | C5 |
| 6 | B3 | D3 | B5 | A2 | C1 | 31 | C5 |
| 7 | C4 | C3 | | E3 | D1 | 32 | --- |
| 8 | C4 | D3 | | D5 | D1 | 33 | C5 |
| 9 | D4 | D3 | | D5 | D1 | 34 | D5 |
| 10 | D4 | | | F5 | C2 | 35 | D5 |
| 11 | D2 | | | F6 | D2 | 36 | C6 |
| 12 | D3 | | | A5 | C2 | 37 | E7 |
| 13 | C5 | | | | C4 | 38 | E6 |
| 14 | C7 | | | | D2 | 39 | E6 |
| 15 | D7 | | | | C2 | 40 | B6 |
| 16 | B6 | | | | C3 | 41 | B6 |
| 17 | E3 | | | | C3 | 42 | B6 |
| 18 | D6 | | | | C3 | 43 | B7 |
| 19 | D6 | | | | D3 | 44 | B7 |
| 20 | E7 | | | | D4 | 45 | B5 |
| 21 | E1 | | | | E5 | 46 | D2 |
| 22 | C7 | | | | F4 | | |
| 23 | E4 | | | | D3 | | |
| 24 | C6 | | | | D3 | | |
| 25 | B6 | | | | D3 | | |

**Figure C-7. A2 Component Locator.**

Page 6-5/6-6, Figure 6-2:
Change Oscillator Schematic and Component Locator as in Figure C-8.




**A2 SCHEMATIC COMPONENT LOCATIONS**

| | C | CR | L | Q | R | | R |
|---|---|---|---|---|---|---|---|
| 1 | H14 | E15 | G16 | F12 | F11 | 26 | C18 |
| 2 | D13 | F15 | E16 | F14 | G12 | 27 | D16 |
| 3 | F16 | F15 | D15 | C14 | J15 | 28 | H16 |
| 4 | J16 | G15 | D21 | E15 | G14 | 29 | F20 |
| 5 | F8 | F17 | E22 | F16 | H14 | 30 | H19 |
| 6 | F7 | H6 | G22 | G16 | H14 | 31 | C20 |
| 7 | J8 | H7 | | F18 | F14 | 32 | --- |
| 8 | J9 | F16 | | F20 | D14 | 33 | G20 |
| 9 | J7 | F17 | | G20 | D14 | 34 | D20 |
| 10 | J8 | | | E21 | H15 | 35 | F21 |
| 11 | G17 | | | F22 | F16 | 36 | H21 |
| 12 | C16 | | | G22 | G16 | 37 | C23 |
| 13 | C17 | | | | J12 | 38 | F22 |
| 14 | J22 | | | | D7 | 39 | F23 |
| 15 | J23 | | | | E7 | 40 | G23 |
| 16 | H19 | | | | F7 | 41 | G23 |
| 17 | D19 | | | | C7 | 42 | G23 |
| 18 | G22 | | | | C7 | 43 | J23 |
| 19 | F22 | | | | H10 | 44 | H23 |
| 20 | D23 | | | | H8 | 45 | H22 |
| 21 | D14 | | | | J8 | 46 | E18 |
| 22 | F23 | | | | H17 | | |
| 23 | J17 | | | | G17 | | |
| 24 | G23 | | | | G17 | | |
| 25 | G24 | | | | H17 | | |

652A-J-0086C

**Figure C-8. Oscillator Schematic.**

Page 7-6, Table 7-1:
Change A2R16 from 2100-2604 to 0757-0410, 301 Ω, ± 1%, 1/8 W.
Add A2R18* 0684-1011, 100 Ω, ± 10%, 1/4 W.
Delete A2R47.