TABLE 1-1. Model M-100 General Performance Specifications

OUTPUT CHARACTERISTICS

Frequency: 10 MHz Sine Wave, ($\pm$ $5x10^{-11}$ at shipment)

Amplitude: 0.5 vrms (-10% + 30%) into 50 ohm load

Phase Noise (SSB 1 Hz BW): > 120 dB at 100 Hz from carrier

(Signal-to-Noise) > 130 dB at 1000 Hz from carrier

Harmonic Distortion: > -30 dBc

Non-Harmonic Distortion: > -80 dBc

Warm-up: < 10 minutes to reach 10 MHz $\pm$ $2x10^{-10}$ at 25°C ambient

< 30 minutes to reach 10 MHz $\pm$ $5x10^{-11}$ at 25°C ambient

Peak current during warm-up: approx. 2.2 amps max. at 25°C with 26 vdc input.

INPUT

Voltage: 22.5 to 32.0 Vdc (50 V, 50 ms transient).

Power: 18 watts max. at 25°C with 26 vdc input.

< $1x10^{-11}$ for $\pm$ 10 % input voltage change.

STABILITY

Long-Term Drift: $\leq 6 \times 10^{-11}$ for the first month after 14 days of continuous operation. $\leq 3.6 \times 10^{-10}$ for the first year, total period; $\leq 2 \times 10^{-10}$ for the second year.

Short-Term Stability: $\sigma y(\tau) = 3 \times 10^{-11} \times (\tau^{-\frac{1}{2}})$ for 1 sec < τ < 100 seconds

Magnetic Field: $< 3 \times 10^{-13}/AM^{-1}$ worst case orientation (2.4×10^{-11}/Gauss)

GENERAL

Frequency Trim Range Adjustment: $\geq 3 \times 10^{-9}$

Settability: $1x10^{-11}$

Retrace: $\pm$ $1x10^{-11}$

Operating Temperature: $< 3 \times 10^{-10}$ from -55°C to +68°C (-67°F to 155°F) at baseplate

Storage Temperature (non-operational): -62°C to +85°C (-80°F to 185°F)

Size (inches): 4.81 high x 3.90 wide x 3.94 deep (see Outline Dwg No. 70549-1)

Weight: 4.0 lb max. without heat sink

4.5 lb max. with standard heat sink attached.

1-7 EXTERNAL ADJUSTMENT POINTS AND CONNECTIONS. Figure 1-1 illustrates the front and rear views of the M-100. Table 1-2 details all externally accessible connections and adjustments.

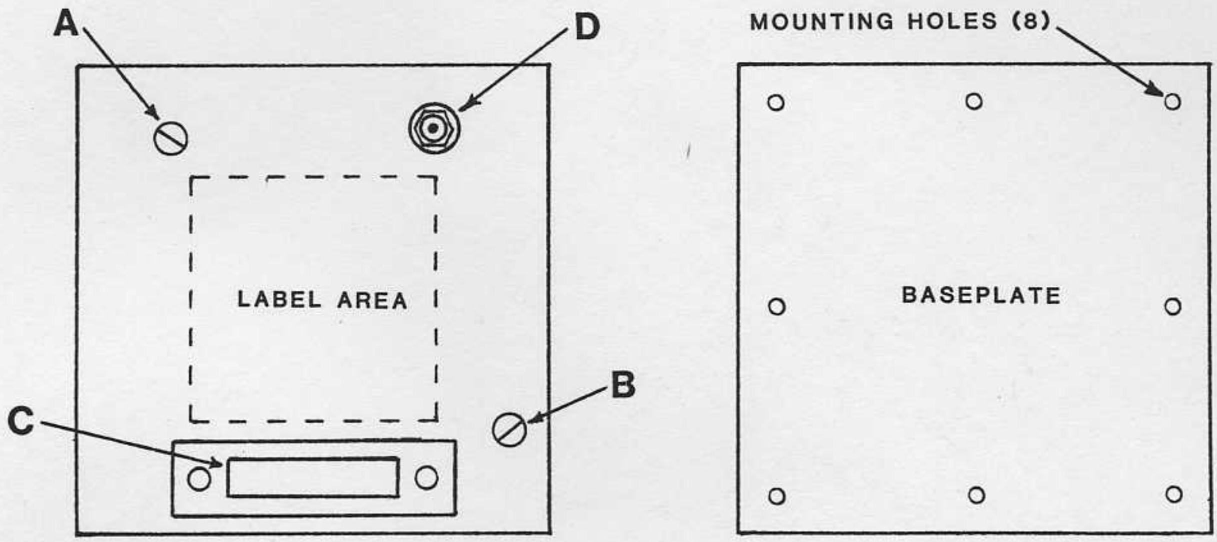


Figure 1-1. M-100 Front and Rear Views

Table 1-2

A	Crystal Trim Adjustment (Refer to Section 5-13 for adjustment procedure)
B	Frequency Adjustment (Refer to Section 3-4.7 for adjustment procedure)
C	J2 Connector M28748/7-DOOF1A (mates with M28748-18-D10LIA) Pin B = Rb Lamp Voltage Signal Pin F = Xtal Control Voltage Signal Pin H = Resonance Lock Signal Pin L = +22.5 to +32 Vdc Input Pin P = Ground
D	J1 Connector - 10 MHz Output Type SMA, MIL-C-39012

CHAPTER 2
INSTALLATION

CAUTION

THE UNIT'S OUTER COVER IS A SPECIALLY DESIGNED MAGNETIC SHIELD; DAMAGE TO THE OUTER COVER COULD CHANGE ITS SHIELDING CHARACTERISTICS.

2-1 RECEIVING AND INSPECTION. The M-100 is packaged and shipped in a foam-packed container. The unit is inspected mechanically and electrically prior to shipment. If the shipping carton is damaged, ask that the carrier's agent be present when the unit is unpacked. The unit should be inspected for external damage (i.e. scratches, dents, or broken connectors). If damage is discovered, or if the unit fails the Operational tests, notify the carrier, and Ball Corporation, Efratom Division, 3 Parker, Irvine, CA 92718-1605. Telephone (714) 770-5000; Telex 685-635. In Europe: Efratom Elektronik GmbH, Am Perlacher Forst 186, D-8000, München 90, West Germany. Telephone (089) 648059. Retain the shipping carton and the foam-packing material for the carrier's inspection.

2-2 SHIPPING. If reshipment of the unit is necessary, the original container and packing should be used. If the original container is not available, a suitable container with foam-packing is recommended.

2-3 STORAGE. Temperatures during storage should be limited as follows:

(a) maximum temperature: +85°C (185°F)

(b) minimum temperature: -62°C (-79°F)

2.4 MOUNTING. The unit's mounting plate has been drilled and tapped to accomodate installation. Although the unit is shipped ready for installation, sufficient airflow must be provided to ensure that the unit's baseplate temperature does not exceed 68°C (154°F) during operation. The unit may be mounted with the aluminum thermal baseplate in contact with a flat* metal surface.

*Surface flatness should be .005 inches rms or better.

The heat transfer characteristics of the mounting surface must be adequate to limit the rise of the unit's baseplate to +68°C. The allowable environmental temperature (Ta) for this mounting is:

$Ta = +68°C - (V_s \times I_s \times R_k)$

Where: V_s = Supply Voltage in volts.

I_s = Supply Current in amperes.

R_k = Thermal Resistance between unit and ambient, (°C/watt).

2-5 POWER REQUIREMENTS. The M-100 requires an external power source capable of providing between +22.5 vdc and +32 vdc, with a minimum output of 2.0 amp. The positive input voltage is to J2 pin L, the negative return voltage on J2 pin P.

In order to obtain the cleanest output signal close to the carrier, the maximum ac ripple on the supply voltage must be less than 100 mV peak-to-peak. If it is acceptable for the output frequency to contain spurious multiples of the powerline frequency (50, 60, or 400 Hz), the ripple can be higher, but in no case should the supply voltage AC +/- peak exceed the upper or lower input power limit of the unit.

2-6 MONITORING SIGNAL OUTPUTS. Figure 2-1 illustrates the pin connections for the J2 connector and presents a brief functional description of the connections.

J2 B. Rb LAMP VOLTAGE SIGNAL

F. XTAL CONT VOLTAGE SIGNAL

H. RESONANCE LOCK SIGNAL

L. +22.5 to +32 Vdc Input

P. GROUND

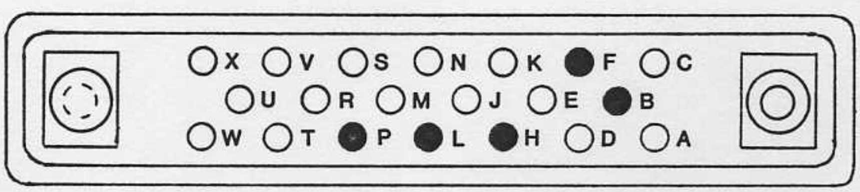


FIGURE 2-1. J2 Connector and Pin Arrangement.

2-7 INSTALLATION CONSIDERATIONS. Some consideration must be given to the operating location of the unit, regardless of its application. To minimize frequency offsets and/or non-harmonic distortion, the unit should not be installed near equipment generating strong magnetic fields such as generators, transformers, etc.

CAUTION

Care must be taken to ensure that the maximum operating temperature is not exceeded (+68°C as measured at the unit's baseplate).

CHAPTER 3
OPERATION AND FUNCTIONAL TESTS

3-1 TEST EQUIPMENT. The test equipment required to perform operational and functional tests is listed in Table 3-1. Test equipment other than those items listed may be used, provided that the performance equals or exceeds the MINIMUM USE CHARACTERISTICS as stated in Table 3-1.

TABLE 3-1. Functional Operation Test Equipment

Item	Minimum Use Characteristics	Test Equipment
3.1 DC Power Supply	Output Voltage: 0 to 30 Vdc Output Current: 3.0 Amp	Hewlett-Packard 6296A or 6433B
3.2 Digital Multimeter (DMM)	Voltage Range: 0 to 30 Vdc Accuracy: ± 1.25% Resistance Range: 0 to 150 ohm	Fluke 8000A or 8020A
3.3 Atomic Oscillator Test Set	Internal Ref Frequency: 10 MHz Accuracy: $\pm 1 \times 10^{-11}$ Stability: parts in 10^{12}	Efratom TS-105A or TS-105
3.4 Resistive Load	Feed-thru type, 50 ohm	Hewlett-Packard 10100C or Pomona Electric 4119-50
3.5 Timer	Capable of indicating 1 min to 15 min	Any wristwatch or wall clock
3.6 Optional External Frequency Ref.	Output Frequency: 10 MHz Accuracy: $\pm 5 \times 10^{-12}$ Stability: Parts in 10^{12} or as required by application	1. Efratom RGR 2. Cesium Standard 3. Efratom Hydrogen Maser 4. Efratom MVLF
3.7 Adapter	SMA Male to BNC Female	Pomona Electric Model 4119-50

3-2 NORMAL OPERATION. With the output connector J1 terminated with a 50-ohm resistive load, and the required input power applied to the pins L (+) & P (-) of connector J2, the unit will immediately begin producing a 10-MHz signal from the crystal oscillator. Within approximately 10 minutes after application of input power, the unit will "lock". At that time the crystal is stabilized by the atomic resonant frequency.

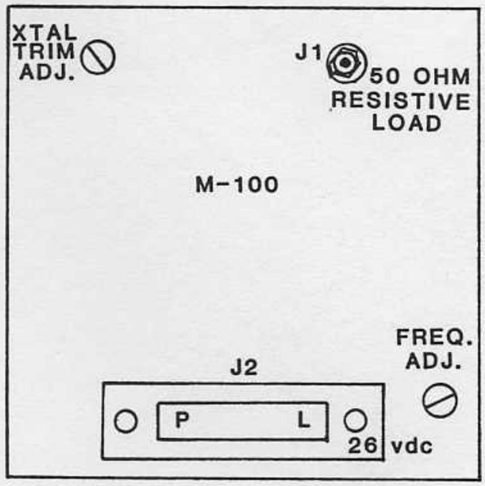


Figure 3-1. Connections for Normal Operation

NOTE

Throughout the test procedures, the Model M-100 may be referred to as the UUT (Unit Under Test). Also, all connections described or illustrated are for the standard configuration, SMA-type coaxial connector J1, and standard connector J2; if the UUT has a different connector arrangement, make the described connections to the appropriate pins as described in the pin diagram accompanying the UUT.

3-3 ATOMIC RESONANCE LOCK, AND VCXO CONTROL VOLTAGE TESTS.

3-3.1 Connect equipment as shown in Figure 3-2 with the 50-ohm feedthrough connected at the M-100 output connector J1. Do not make the dotted-line connection until instructed to do so.

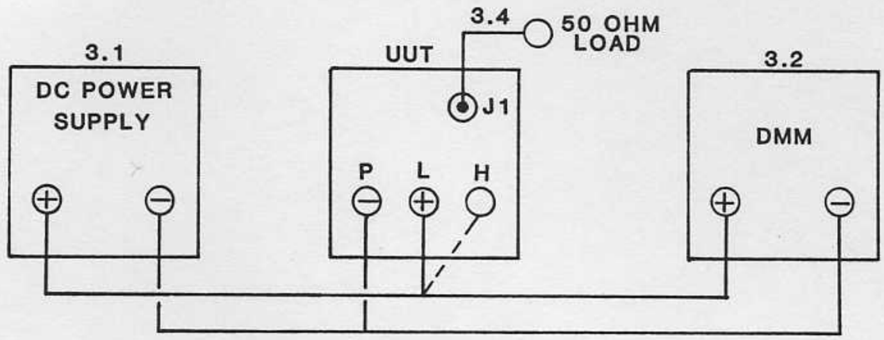


Figure 3-2 Test Setup for Atomic Resonance Lock Test

3-3.2 Adjust the dc power supply controls to obtain a 26 ± 1.3 Vdc indication on the DMM. Note the time (item 3.5) input power is applied to the unit.

3-3.3 Disconnect the DMM positive lead connected to J2 pin L without disturbing the positive input voltage connection.

3-3.4 Set the DMM to measure resistance in the 200-ohm range. (Do not use the Auto Range for this test.)

3-3.5 Connect the DMM positive lead to J2 pin H (Figure 3-2 dotted-line connection). Monitor the DMM indication during warm-up.

NOTE

During warm-up the DMM will indicate overrange. Within 10 minutes after power application, the DMM should indicate approximately 150-ohm, indicating that the crystal oscillator has become locked to the atomic reference frequency.

3-3.6 Verify that atomic lock occurs ≤ 10 minutes after application of input power to the M-100.

3-3.7 After the atomic lock has been verified, remove the DMM positive lead from J2 pin H, and set the DMM controls to measure dc voltage in the 20 volt range.

3-3.8 Connect the DMM positive lead to J2 pin F, and verify that the DMM indication is between +2 and +15 vdc.

NOTE

If the DMM indication is not between +3 and +17 vdc refer to Chapter 5, Maintenance, for the adjustment procedure.

3-4 OPERATIONAL FREQUENCY ACCURACY TEST

3-4.1 Connect the equipment as shown in Figure 3-3.

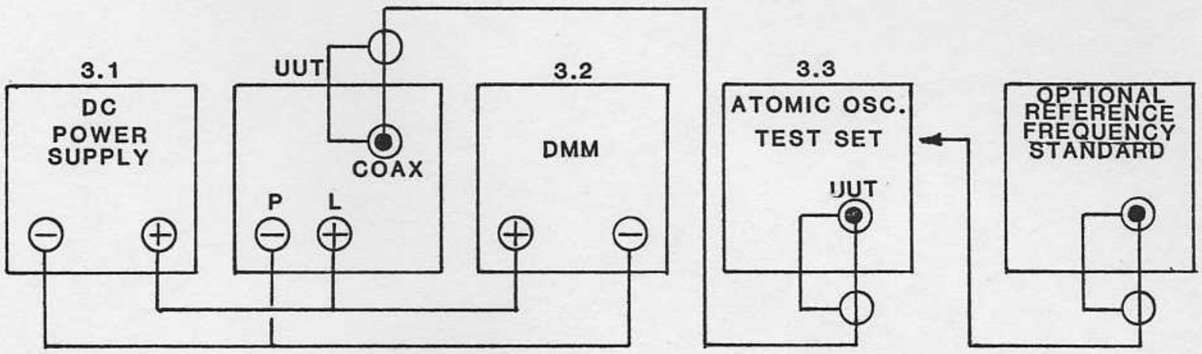


Figure 3-3 Operational Frequency Accuracy Test Setup.

3-4.2 Adjust the dc power supply controls to obtain a 26 $\pm$ 1.3 vdc indication on the DMM.

3-4.3 Allow sufficient time for equipment to stabilize.

NOTE

The UUT requires 10 minutes stabilization to obtain the following frequency accuracy: $\pm 2\text{x}10^{-10}$ of the final frequency (calibrated frequency), or the frequency before the unit was turned off (if turnoff was within 24 hours). If the UUT was in storage, the worse-case error = $\pm 2\text{x}10^{-10}$ warm-up +/- last calibration accuracy, or $5\text{x}10^{-11}$ factory setting at shipment (whichever is applicable) + *aging specification.

The UUT requires 1 hour stabilization time to obtain the following accuracy: $\pm 2\text{x}10^{-11}$ of final frequency or frequency at turnoff (if turnoff was within 24 hours). If UUT was in storage, the worse case error = $\pm 2\text{x}10^{-11}$ warm-up +/- last calibration accuracy, or $5\text{x}10^{-11}$ factory setting at shipment, whichever is applicable + *aging specification.

* Aging Specification: (refer to the Table 1-1, Specifications).

3-4.4 If necessary, press the test set's ADVANCE switch to unblank the display, then press the RESET switch to obtain the READY message.

3-4.5 Perform all necessary menu option selections and bring the READY message back to the display. Ensure that "UUT 10 MHz" is part of the bottom-line message.

3-4.6 Press the test set's RESET push button to begin the test. Allow the test set sufficient time to obtain the UUT's FREQ OFFSET indication for the 100 sec AVR TIME, and the UUT's ALLAN VARIANCE indication for at least the 10 sec AVR TIME, (the 100 sec freq offset will have to update 10 times in order to obtain the 10 sec Allan Variance test results).

3-4.7 Allow sufficient time for the test set to indicate the UUT OFFSET for the data you require. Verify that the UUT frequency offset is within the tolerance stated in the NOTE following Step 3-4.3.

NOTE

If the UUT is not within the stated tolerance limits continue with the Frequency Adjustment procedure, paragraph 3-4.7.1 and 3-4.7.2.

3-4.7.1 Refer to Figure 3-4 to locate the M-100 frequency adjustment screw access hole.

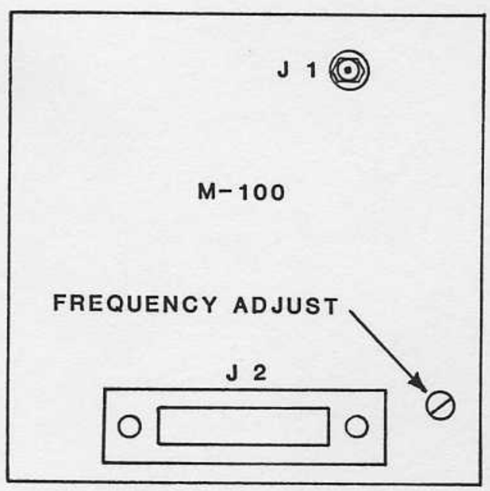


Figure 3-4 Location of M-100 Frequency Adjustment

3-4.7.2 Using the appropriate alignment tool and monitoring the test set indication, rotate the 20-turn potentiometer (adjustment screw) clockwise (frequency increase) or counterclockwise (frequency decrease) as necessary, until the test set display indicates the M-100 is within the required tolerence (or $\pm 5x10^{-11}$) for the three averaging times.

NOTE

If the unit has aged beyond the adjustment capability of the frequency adjust potentiometer, refer to the Maintenance chapter for appropriate procedures.

3-5 SHORT-TERM STABILITY TEST (ALLAN VARIANCE)

NOTE

If you have just completed 3-4 through 3-4.7, the Allan Variance (AV) indications on the test set are valid. If 3-4 was not performed, continue with 3-5.1.

3-5.1 Connect the equipment as illustrated in Figure 3-3.

3-5.2 Adjust the dc power supply controls to obtain a 26 $\pm$ 1.3 Vdc indication on the DMM.

3-5.3 Allow sufficient time for equipment to stabilize.

3-5.4 If necessary, press the test set's ADVANCE switch to unblank the display, then press the RESET switch to obtain the READY message.

3-5.5 Perform all necessary menu option selections and bring the READY message back to the display. Ensure that "UUT 10 MHz" is part of the bottom-line message.

3-5.6 Press the test set's RESET push button to begin the test. Allow the test set sufficient time to obtain the UUT's AV indication for at least the 10 sec AVR TIME. (The 100 sec FREQ OFFSET will have to update 10 times in order to obtain the 10 sec AV test results.)

3-5.7 Allow sufficient time for the test set to indicate the UUT AV, as required. Verify that the UUT AV is within the tolerance limits for short-term stability, as stated in Table 1-1.

CHAPTER 4
THEORY OF OPERATION

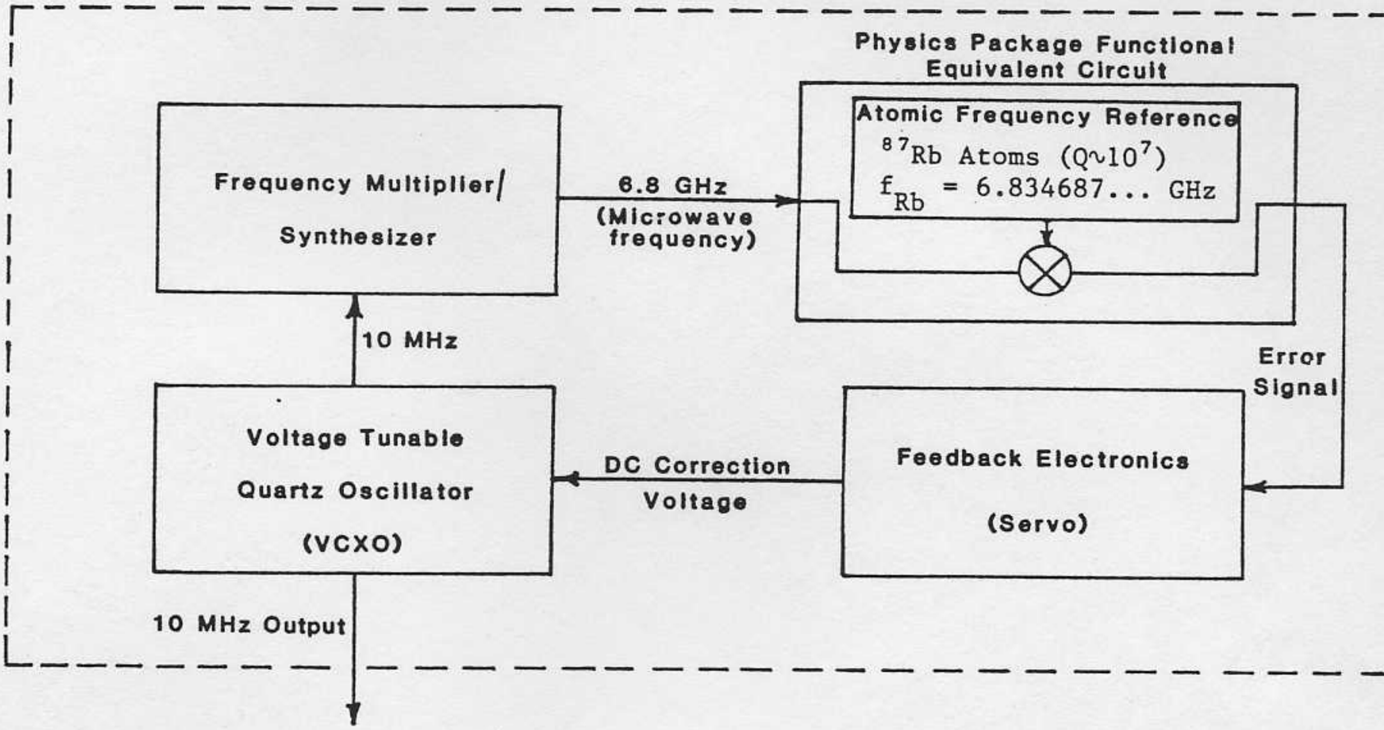
4-1 INTRODUCTION. This chapter of the manual contains a general theory of operation and circuit description of the Model M-100 rubidium frequency Standard. Schematic diagrams and parts lists are included in the Appendix.

4-2 GENERAL THEORY OF OPERATION. The M-100 generates a frequency-stable 10 MHz output signal from a Voltage-Controlled-Crystal-Oscillator (VCXO) which is locked to an atomic frequency reference. The atomic frequency reference is the 6.834 GHz ground-state hyperfine transition of ^{87}Rb (rubidium). The rubidium atoms which provide the atomic frequency reference are contained in a resonance cell within a resonator assembly. The VCXO is locked to the rubidium resonant frequency (f_{Rb}), at approximately 6.8 GHz, in the following manner. A microwave signal near f_{Rb} is synthesized from the 10 MHz VCXO output and used to excite the rubidium atoms contained within a microwave cavity. The frequency synthesis scheme is designed so that the VCXO frequency is exactly 10 MHz when the microwave frequency is exactly equal to f_{Rb}. The frequency of the signal applied to the microwave cavity can be maintained equal to f_{Rb} by generating an error signal when the microwave frequency differs from f_{Rb}. This error signal is fed back and adjusts the VCXO with a control voltage (Figure 4-1) maintaining its frequency at exactly 10 MHz.

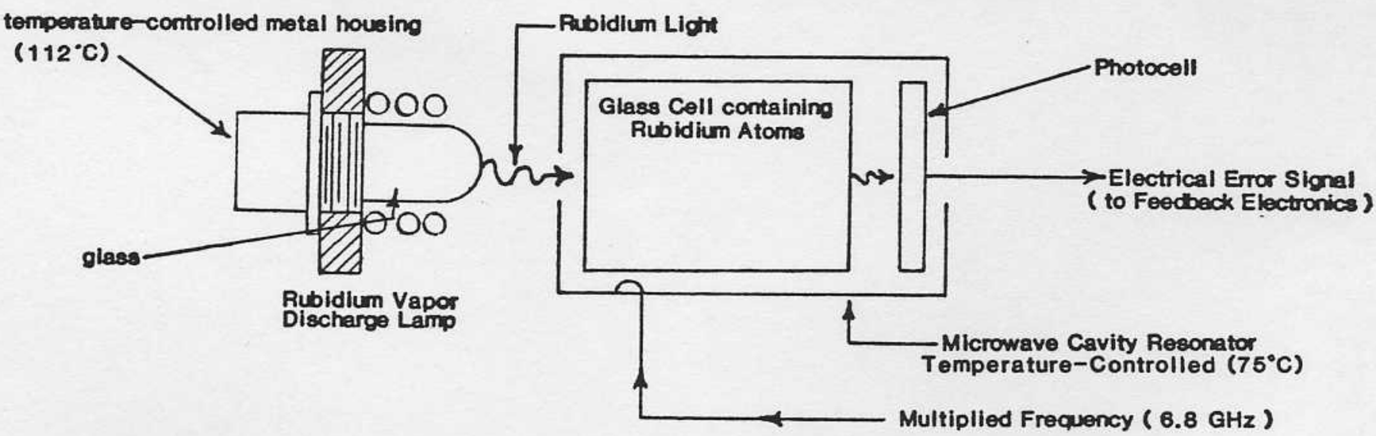
The error signal is generated by the physics package which consists of the rubidium lamp and the resonator assembly. Light from the rubidium lamp is generated by an RF-excited plasma discharge and passes into the resonator assembly where it interacts with the rubidium atoms contained in the resonance cell. Some of this light reaches the photocell inside the resonator assembly. When the applied microwave frequency is equal to f_{Rb}, the rubidium atoms resonate with the microwave field in the cavity. This causes the light reaching the photocell to decrease such that the photocell

SIMPLIFIED BLOCK DIAGRAM OF RUBIDIUM ATOMIC STANDARD

(Atomic Standards DO NOT use nuclear radioactivity)



RUBIDIUM STANDARD PHYSICS PACKAGE



When the multiplied frequency equals the rubidium atom frequency, the error signal is zero. When the two frequencies are different, an error signal is generated that is used to "steer" the Quartz Oscillator frequency to the correct value.

Figure 4-1. Simplified Block Diagram and Physics Package output current is a minimum at exact resonance (i.e., when the injected microwave frequency is exactly equal to f_{Rb}; refer to Figure 4-1). An explanation of this phenomenon requires a detailed description of the physics of rubidium atoms and their simultaneous interaction with light and microwave radiation. This description is provided in section 4-2.1.2, Optical Pumping. A microwave modulation technique is used continuously to minimize the photocell current thereby locking the VCXO to f_{Rb} (Figure 4-1).

To enhance understanding of the operation of the rubidium standard, it is suggested that the reader refer frequently to the Modulation Concept (Figure 4-2), the Simplified Block Diagram (Figure 4-1), and the Detailed Block Diagram (Figure 4-5).

4-2.1 Atomic Reference Frequency/Physics Package. The physics package consists of a resonator section and a lamp section, each supported by additional circuitry. The lamp section consists of a temperature-controlled (thermostated) Rb lamp and an RF lamp exciter. The lamp exciter is frequently referred to as the lamp oscillator. To maintain a sufficient and well-defined Rb vapor pressure in the lamp envelope, the lamp thermostat is set to approximately 115°C. A high-energy ($\sim$1 W) RF-field of approximately 80 MHz is generated by the lamp exciter. This field starts and maintains an electrodeless plasma gas discharge in the lamp envelope. The lamp light contains the desired spectral lines of Rb necessary for the optical pumping process.

The resonator contains the integrated Rb cell, a photocell, a step recovery diode (with coupling loop), and the C-field windings. The density of the Rb atoms in the cell is thermostatically controlled in a manner similar to that used for the lamp.

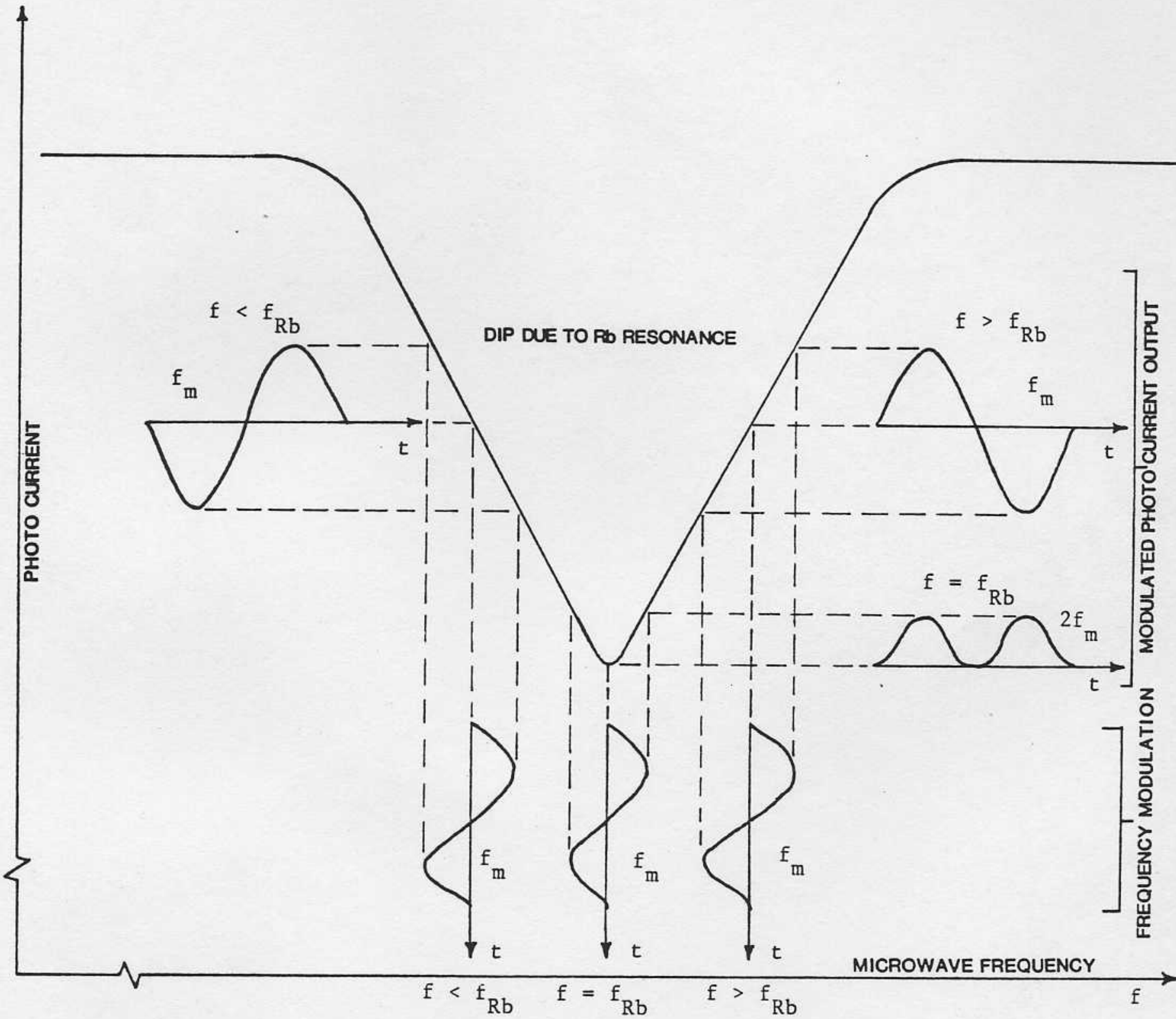


Figure 4-2. Derivation of Modulation Signal

A 60 MHz signal generated by the Multiplier printed circuit board (PCB) and a 5.3125 MHz signal from the frequency synthesizer is fed to the step recovery diode/coupling loop mounted in the resonator cavity. This circuit generates radiation having frequencies given by the expression (60n + 5.3125m) MHz, where n = a positive integer and m = an integer. The microwave frequency (f) of interest here is that for which n = 114 and m = -1:

$$\begin{array}{r} 114 \times 60 \text{ MHz} \\ - \underline{\quad 5.3125 \text{ MHz}} \\ 6\,834.687\,500 \text{ MHz.} \end{array}$$

The Rb resonance cell and the multiplication/synthesis technique are utilized so that the microwave frequency is exactly equal to the ground-state hyperfine frequency of ^{87}Rb (fRb = 6834.687500 MHz) when the external output frequency of the M-100 is exactly 10 MHz. Adjustment of the current flowing through the C-field coil allows fine tuning (parts in 10^9 and less) of the hyperfine transition frequency (via the second-order Zeeman effect) and therefore the 10 MHz output frequency.

With the correct microwave signal generated in the cavity and the proper Rb vapor pressure in the lamp and cell, the light intensity passed by the cell will be a function of the microwave frequency. Figure 4-2 illustrates this concept. The photocell output current is proportional to the intensity of the light incident upon the photocell. When the injected microwave frequency f is exactly equal to the frequency f_{Rb} of the ground-state hyperfine transition of ^{87}Rb, maximum energy is absorbed from the pumping light resulting in minimum photo current.

The "dip" in the photo-current-versus-microwave-frequency curve of Figure 4-2 is very small: on the order of 0.1% of the total photo current. For this reason, DC detection of the dip is not feasible and an AC detection method is utilized. The AC method involves frequency modulating the microwave radiation at an audio frequency f_m (= 127 Hz for the M-100). As shown in Figure 4-2, this modulation produces a corresponding modulation of the output current from the photocell. When the microwave frequency is exactly equal to the rubidium hyperfine frequency ($f = f_{Rb}$), the modulated photo current contains no AC component at the modulation frequency f_m but there is a component at twice the modulation frequency $2f_m$ (= 254 Hz for the M-100); the presence of this second harmonic of the modulation indicates that the VCXO is locked to the hyperfine transition. If the microwave frequency is greater than the rubidium frequency ($f > f_{Rb}$), then the photo current will contain an AC component at the fundamental frequency f_m that is in phase with the original modulation at frequency f_m. If the microwave frequency is lower than the rubidium frequency ($f < f_{Rb}$), then the photo current will contain an AC component at the fundamental frequency f_m that is 180° out of phase with the original modulation at frequency f_m.

The DC error signal that is used to correct the frequency of the VCXO is derived from the AC component of photo current at the fundamental frequency f_m by synchronous rectification (demodulation) of the latter. As can now be understood from the previous description of Figure 4-2, when the VCXO is exactly on frequency (10 MHz for the M-100) there is no AC component of photo current at the fundamental frequency f_m of the modulation and therefore no corresponding DC error signal (in this case, there is no need to correct the VCXO frequency). Should the VCXO frequency drift upwards, the microwave frequency will also drift up and the condition $f > f_{Rb}$ will occur. Synchronous rectification of the AC component of the photo current will, in this case, produce a positive DC error signal that is proportional to the amplitude of the fundamental component. Conversely, if the VCXO frequency drifts down instead of up, the condition $f < f_{Rb}$ will occur. In this case, the synchronous rectification will produce a negative DC error signal that is proportional to the amplitude of the fundamental component of the photo current. (The sign reversal is due to the 180° phase change in the modulated photo current when $f < f_{Rb}$). The phase information contained in the fundamental component of the photo current is used to steer the VCXO frequency and cancel the offset, therefore locking it to fRb.

The above modulation scheme is implemented by phase modulating (at f_m) the 30 MHz on the multiplier PCB which, when doubled by the doubler and multiplied by 114 by the step recovery diode, produces frequency modulation (at f_m) of the 6.8 GHz microwave signal. The resulting AC photo current is amplified and synchronously rectified on the servo PCB to provide the DC error signal. However, instead of routing the DC error signal directly to the VCXO, it is electronically integrated and then routed to the VCXO. This then completes the description of the servo loop. This type of servo loop is commonly used in passive atomic frequency standards and is known as a "frequency-locked loop."

4-2.1.1 Electronic Analogue of Physics Package. The physics package of the M-100 is a passive device in the sense that the ^{87}Rb atoms must be "interrogated" by externally-generated microwave radiation; the atoms themselves do not produce a self-sustaining oscillation at the atomic hyperfine frequency. To a first approximation, the behavior of the ^{87}Rb atoms in the resonance cell can be represented by an electrical analogue, as shown in Figure 4-3. In this analogue, the atoms behave like an ultra-stable, high Q ($Q \sim 10^7$), series-resonant RLC tank circuit that is resonant at the hyperfine frequency (f_{Rb} = 6.834 ... GHz). The analogue of the microwave signal derived from the 10 MHz VCXO is a frequency-modulated voltage source operating at f = 6.8 GHz to drive the tank circuit. Similarly, the analogue of the photocell is a square-law current detector and a low-pass filter.

4-2.1.2 Optical Pumping. In the actual physics package, the atomic resonance is detected by optical means, specifically by a decrease in the intensity of the Rb light transmitted by the resonance cell when the frequency (f) of the interrogating microwave signal is in the vicinity of the atomic resonant frequency ($f \sim f_{Rb}$). To understand why this effect occurs, it is necessary to consider the atomic physics phenomenon known as "Optical Pumping". In this section, an oversimplified description of the optical pumping process is given that serves to illustrate the basic principle involved in the detection of the atomic resonance. In all that follows, it is important to note that the frequency f_o of <u>any</u> atomic resonance transition is related to the difference in the energies E_o of the two atomic energy levels, between which the transition occurs, by the fundamental equation of physics,

$$f_o(\text{Hz}) = E_o(\text{joules})/h,$$

Where h = Planck's constant = 6.6262×10^{-34} joules/Hz.

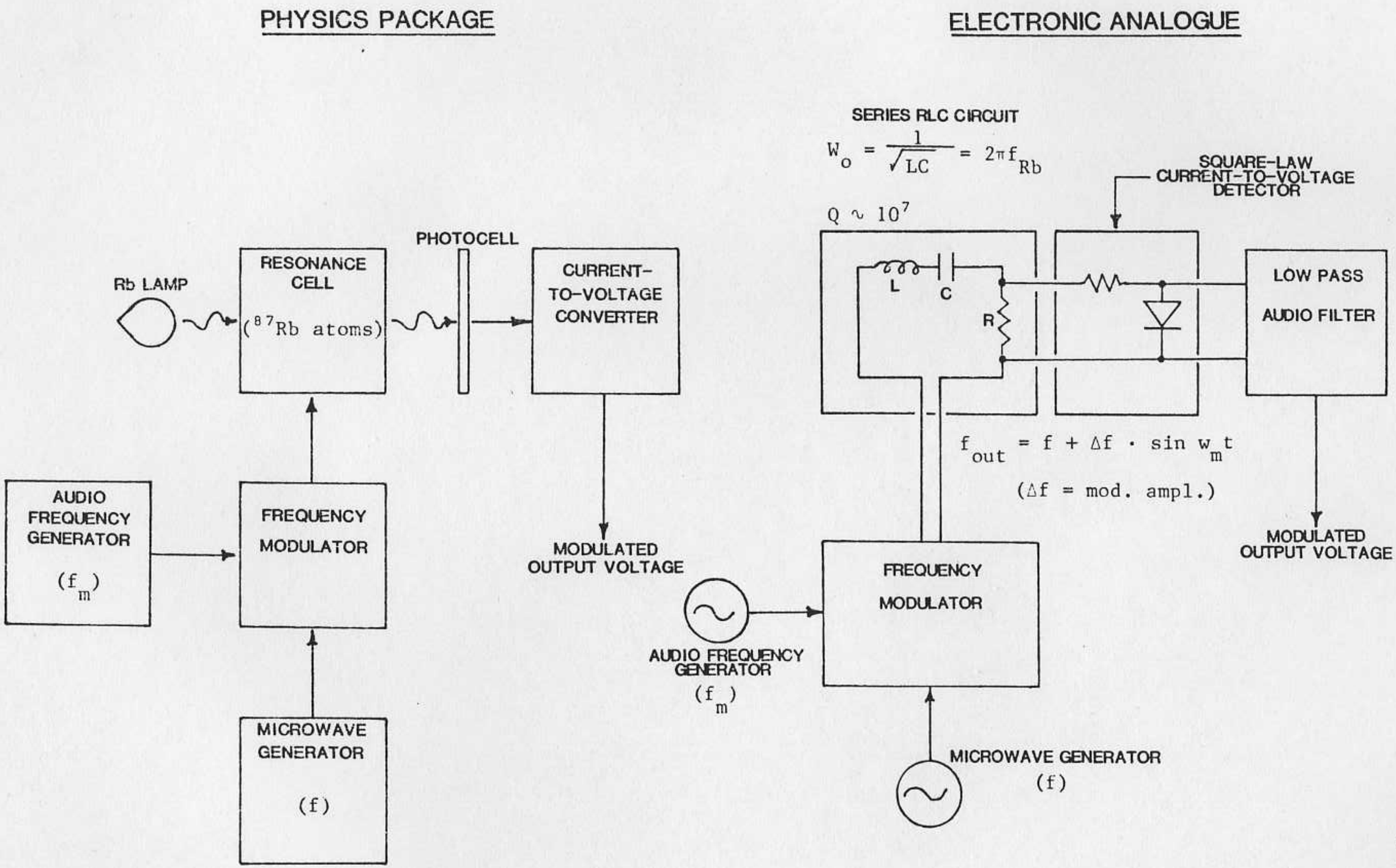
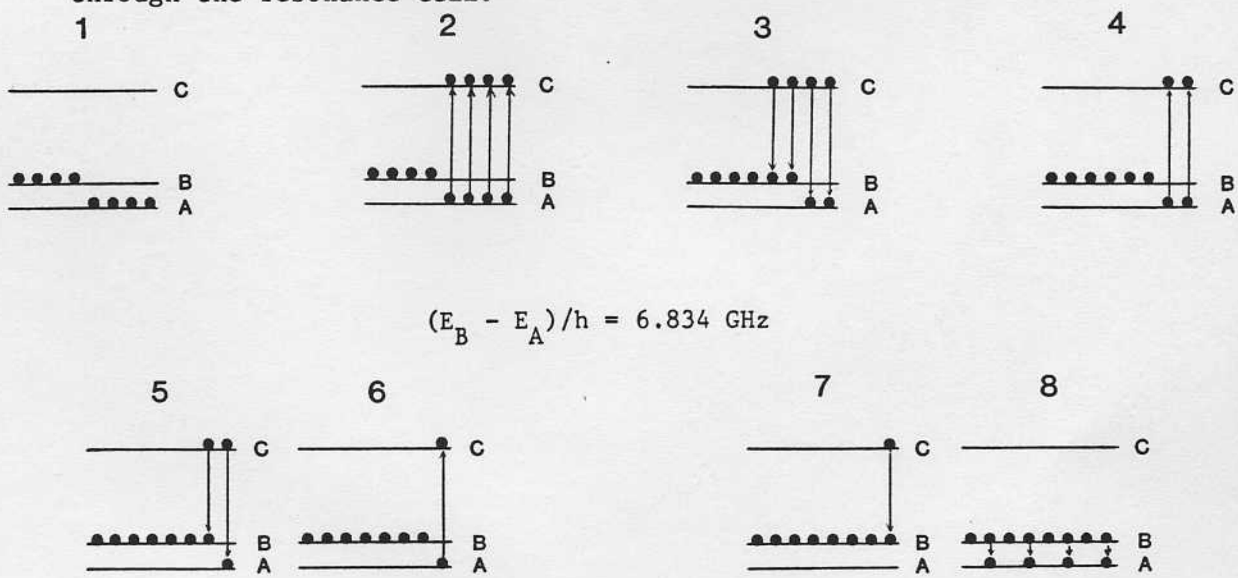


Figure 4-3. Electrical Analogue of Physics Package

Figure 4-4 is a simplified diagram of the energy levels involved in the optical pumping process. The two lower levels, A and B, are the two ground-state hyperfine levels. In the absence of light from the rubidium lamp, the rubidium atoms in the resonance cell will be equally divided between these two levels, as indicated in frame 1 of Figure 4-4. If the atoms are irradiated with microwave energy at the hyperfine frequency, then those atoms in level A will make a transition to level B and vice-versa, without changing the number of atoms in each of the two levels (both levels still equally populated), and the transitions will not be detectable. However, if a method can be found to create a difference in the atom populations of the two states A and B, then the transition can be detected (as will be explained below). The method used to create a population difference is called "optical pumping" and in the case of the M-100 it is used to transfer (or "pump") atoms from level A to level B. As the name implies, the pumping is done indirectly by optical means and involves a third energy level of atom labelled C in Figure 4-4. (For the ^{87}Rb atom, the energy spacing between level C and level A is approximately 55,000 times greater than the spacing between levels B and A, therefore, the diagram is not to scale.)

Level C is an optically-excited state of the atom which is normally vacant; for rubidium, this C level state is excited by infrared light energy of the proper wavelength from the rubidium lamp. Transitions to level C are known as "optical transitions" and can occur from either of the two hyperfine energy levels A or B. If only the spectral wavelength corresponding to one of the hyperfine levels is introduced (no microwave radiation is present), only the atoms in that hyperfine level will make transitions to level C. This condition can be realized by removing the spectral wavelength corresponding to the hyperfine level B using the method of optical hyperfine filtering. (In the M-100, the filtering process is carried out in the resonance cell itself using ^{87}Rb atoms.)

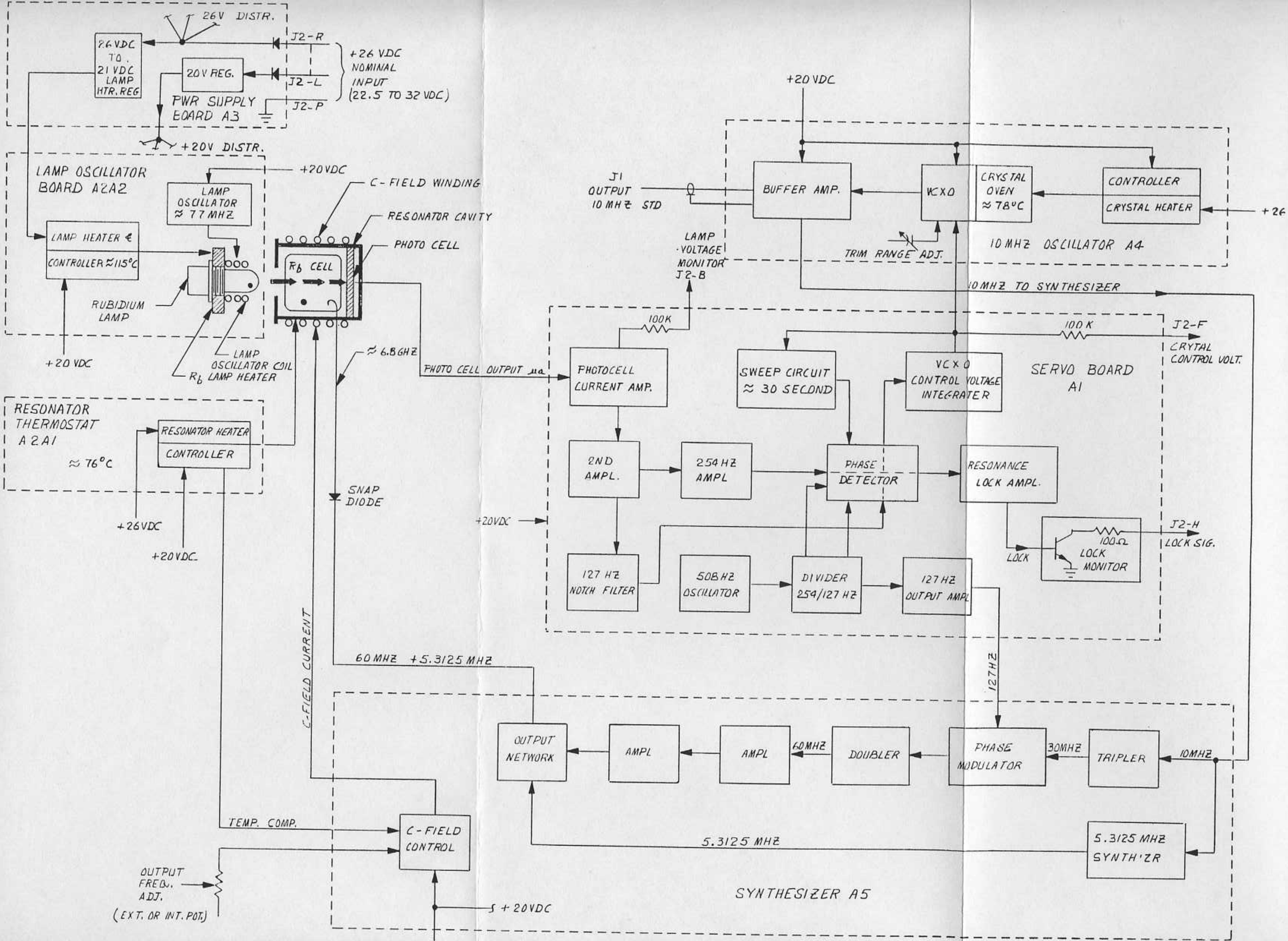
If the light energy injected into the resonance cell corresponds to the wavelength required for level A to C transitions, the rubidium atoms at the A level will absorb some of the light. As indicated in frame 2 of Figure 4-4, this absorption of light raises those atoms to the higher C level energy state. After a short time ($\sim$ 30 ns) the atoms which were raised to the C level will emit a photon of approximately the same wavelength as that which raised the atoms to the optically-excited state; they then return to the ground-state hyperfine level, redistributing themselves approximately equally between levels A and B (frame 3). The atoms which return to level A will again absorb the light and be raised to level C, where they will again remain for a short time before emitting photons and again redistributing themselves between the two hyperfine energy levels A and B (frame 4). By this optical pumping method, a population difference is produced between the two hyperfine levels whereby all of the atoms are pumped from level A into level B (frames 5-7). Once this idealized condition exists, there are no atoms left in level A to be excited to level C and the light is not the proper wavelength to excite the atoms in level B to level C (frame 7). Thereafter, no light attenuation occurs when the light passes through the resonance cell.



$$(E_B - E_A)/h = 6.834 \text{ GHz}$$

Figure 4-4. Optical Pumping Process Illustrated.

When a microwave field corresponding to the hyperfine frequency is now applied simultaneously with the pumping light, the atoms in level B make transitions to level A and are then available for excitation to level C by the light beam. Since each optical excitation of an atom from level A to level C requires the absorption of a light photon, the net effect of applying the microwave field is to cause attenuation of the light beam with the attentuation being greatest when the frequency, f, of the microwave field is exactly equal to the hyperfine frequency, $f_{Rb} = (E_B - E_A)/h$. This behavior explains the origin of the "dip" in Figure 4-2.


26V DISTR.
26 VDC TO 21 VDC LAMP HTR. REG
20 V REG.
J2-R
J2-L
J2-P
+26 VDC NOMINAL INPUT (22.5 TO 32 VDC)
PWR SUPPLY BOARD A3
+20V DISTR.
LAMP OSCILLATOR BOARD A2A2
+20 VDC
LAMP OSCILLATOR ≈ 77 MHZ
LAMP HEATER &
CONTROLLER ≈115°C
RUBIDIUM LAMP
LAMP OSCILLATOR COIL
Rb LAMP HEATER
+20 VDC
C-FIELD WINDING
RESONATOR CAVITY
PHOTO CELL
Rb CELL
≈ 6.8 GHZ
PHOTO CELL OUTPUT μa
RESONATOR THERMOSTAT A2A1
≈ 76°C
RESONATOR HEATER
CONTROLLER
+26VDC
+20VDC
SNAP DIODE
C-FIELD CURRENT
60 MHZ +5.3125 MHZ
TEMP. COMP.
C-FIELD CONTROL
OUTPUT FREQ. ADJ.
(EXT. OR INT. POT.)
+ 20VDC
+20 VDC
J1 OUTPUT 10 MHZ STD
BUFFER AMP.
VCXO
CRYSTAL OVEN ≈ 78°C
CONTROLLER
CRYSTAL HEATER
+26
TRIM RANGE ADJ.
10 MHZ OSCILLATOR A4
LAMP VOLTAGE MONITOR J2-B
10 MHZ TO SYNTHESIZER
100K
100 K
J2-F
CRYTAL CONTROL VOLT.
PHOTOCELL CURRENT AMP.
SWEEP CIRCUIT ≈ 30 SECOND
VCXO CONTROL VOLTAGE INTEGRATER
SERVO BOARD A1
2ND AMPL.
254 HZ AMPL
PHASE DETECTOR
RESONANCE LOCK AMPL.
+20VDC
LOCK
100Ω
LOCK MONITOR
J2-H
LOCK SIG.
127 HZ NOTCH FILTER
508 HZ OSCILLATOR
DIVIDER 254/127 HZ
127 HZ OUTPUT AMPL
127 HZ
OUTPUT NETWORK
AMPL
AMPL
60 MHZ
DOUBLER
PHASE MODULATOR
30 MHZ
TRIPLER
10 MHZ
5.3125 MHZ
5.3125 MHZ SYNTH'ZR
SYNTHESIZER A5

4-2.2 Detailed Block Diagram / Support Electronics. Figure 4-5 functionally illustrates the physics package and associated circuitry that encompass the operation of the rubidium frequency standard.

4-2.2.1 Power Supply PCB (Assembly Drawing No. 70509-1). The power supply provides filtered and regulated voltage (20 VDC) to the M-100 electronics. It also provides filtered voltage to the lamp heater and an unregulated voltage to the resonator and crystal heater elements. A float regulator is provided to assure in-spec performance (if a ripple voltage is superimposed on the supply voltage) and feeds a clean voltage to the lamp thermostat. The resonator thermostat and crystal thermostat are operating directly off the input power. The electronic power is dependent on the input voltage to the power supply, however, current drain is nearly constant.

4-2.2.2 Crystal Oscillator PCB (Assembly Drawing No. 70512-2). The crystal oscillator PCB consists of a 10 MHz third overtone crystal oscillator, a buffer that provides the 10 MHz output frequency, and 10 MHz to the Synthesizer/Mutiplier PCB.

4-2.2.3 Synthesizer/Multiplier PCB (Assembly Drawing No. 70515-2). The synthesizer/multiplier is driven by a 10 MHz signal from the crystal oscillator PCB and is phase modulated by a 127 Hz signal from the servo PCB. Its 60 MHz output stage is amplitude modulated by a 5.3125 MHz signal synthesized from 10 MHz. The multiplier drives the step recovery (snap) diode which is part of the physics package (section 4-2.1). The multiplier PCB also contains the C-field adjustment components.

4-2.2.4 Servo PCB (Assembly Drawing No. 705-153-1). The primary function of the servo PCB is to lock the crystal oscillator to the atomic hyperfine transition. This is accomplished by amplification of the 127 Hz error signal from the photocell followed by synchronous rectification (demodulation) and subsequent integration which generates a DC error signal that is routed back to the crystal oscillator.

The servo also contains the 127 Hz modulation generator and the lock detector. Lock detection is similar to the 127 Hz detection (synchronous rectification) of the main loop, but at twice the modulation frequency (Figure 4-2 and section 4-2.1). In addition, the servo contains a sweep/search circuit that repetitively sweeps the output frequency of the crystal oscillator within 40 seconds over its entire trim range until atomic resonance can be detected and normal operation of the servo PCB can begin.

4-2.2.5 Physics Package. Refer to section 4-2.1.

4-3 DETAILED CIRCUIT DESCRIPTION. (Refer to Appendix for schematics and parts lists. Schematics contain key voltage levels.)

4-3.1 Resonator Assembly. (Schematic Drawing No. 70522-2). The function of the resonator assembly is to compare the multiplied and synthesized output frequency of the crystal oscillator to the ground-state hyperfine transition frequency of ^{87}Rb. It also provides a 127 Hz error signal to the servo board to lock the crystal frequency to the atomic transition.

4-3.1.1 Microwave Cavity. The microwave (resonator) cavity is constructed of silver plated copper and housed in a mu metal shield. It contains the rubidium resonance cell. The photocell is mounted on the lid of the cavity and placed behind the Rb glass cell, directly in the light path of the Rb spectral lamp. The step recovery diode with coupling loop and the condenser assembly are located at the other end of the cavity. Cavity temperature is maintained by the resonator thermostat (4-3.1.5). The C-field coil is wound on the outside of the copper cylinder. The lid on the cavity contains the photocell.

4-3.1.2 Step Recovery Diode. The 60 MHz signal from the multiplier and the 5.3125 MHz from the VCXO are summed on the multiplier/synthesizer board and then applied to the step recovery diode. This diode, CR1, produces radiation having frequencies given by the expresssion (60 n + 5.3125 m) MHz, where n = a positive integer and m = an integer. The diode is part of a tuned coupling loop, tuned to the 114th harmonic of 60 MHz (n=114);

both are part of the microwave cavity that is tuned to the same frequency. The bandwidth of the microwave cavity assembly is wide in comparison with the bandwidth of the atomic transition (< 1 kHz), so that the atoms function as a narrow-band filter for the microwave signal.

4-3.1.3 Photocell. The DC component of the photocell current corresponds to the total light incident on the photocell CR2. The AC signal components result when a microwave field corresponding to the Rb hyperfine frequency is applied simultaneously with pumping light (Figure 4-2). This signal is amplified by the servo PCB. The input stage of the servo PCB is configured as a low-noise, current-to-voltage converter.

4-3.1.4 C-Field Coil. The C-field coil is wound on the microwave cavity and provides a DC magnetic field (the C-field) within the resonator cavity. This magnetic field allows fine tuning of the 10 MHz output frequency by shifting the Rb frequency hyperfine transition by the second order Zeeman effect. The "C-field" strength is determined by current from three sources:

- FIXED: R37 on the synthesizer board (70516) supplies current directly to the coil, increasing the hyperfine frequency below the lower end of the trim range.

- MANUALLY-ADJUSTABLE: The 20 turn frequency adjustment potentiometer, R35 on the synthesizer PCB, supplies an adjustable current to the C-field coil, fine tuning the output frequency over $\pm 1 \times 10^{-9}$.

- TEMPERATURE/FREQUENCY COMPENSATION: The power to heat the microwave cavity increases approximately 60 mW for every degree centigrade decrease of the ambient temperature. This results in a current change through Q5 and Q6 which are part of the resonator assembly and through R21 on the resonator thermostat assembly (70522-2). The voltage across R21 is routed to R28 on the same assembly and to the C-field coil. R28 determines the degree of temperature compensation.

4-3.1.5 Resonator Thermostat Assembly. (Schematic Drawing No. 70522). The resonator (microwave cavity) thermostat maintains the temperature of the resonator precisely at the set temperature of approximately 75°C. This temperature assures proper Rb vapor pressure in the Rb resonance cell. The thermostat is of analog design. A thermistor senses the temperature of the microwave cavity, which holds the heater transistors Q5 and Q6 and acts as a heat spreader. Heater transistors Q1 and Q2 provide very efficient heating of the resonator since the voltage drop across is only about 300 mV (less than 1.5% of the supply voltage). Thermistor RT1 is part of a balanced bridge circuit consisting of R2, R3, R7, R8, and the temperature select resistor R9. For a given resistance value of R9, the op amp will drive the resonator heaters until the desired temperature is attained. At this point, the bridge will be in a balanced condition. Operational amplifier U1 functions as an integrating amplifier, Q1 and Q3 are emitter followers providing sufficient base current to the two heater transistors. During warm-up Q2 is turned on by the current-dependent voltage drop across R21 and the supply-voltage-dependent drop across R25 and R19. This feature eliminates the dependence of the warm-up time on the input voltage by providing nearly uniform warm-up power independent of supply voltage.

4-3.2 Lamp Assembly. (Schematic Drawing No. 70507) The lamp assembly consists of the lamp oscillator circuit, the lamp housing assembly, the lamp thermostat circuit and the rubidium lamp.

4-3.2.1 Lamp Oscillator. The lamp oscillator ignites and maintains an electrodeless plasma gas discharge in the rubidium lamp that is mounted inside the oscillator's tank circuit L3, C5. The oscillator is a modified Colpitts oscillator operating at approximately 85 MHz. The active element is the RF power transistor, 2N3375 (Q1).

C5 is adjusted for optimum lamp ignition characteristics. The remaining passive elements provide RF filtering for the power input and DC bias to the RF power transistor. L2 is one of the frequency determining elements of the Colpitts oscillator.

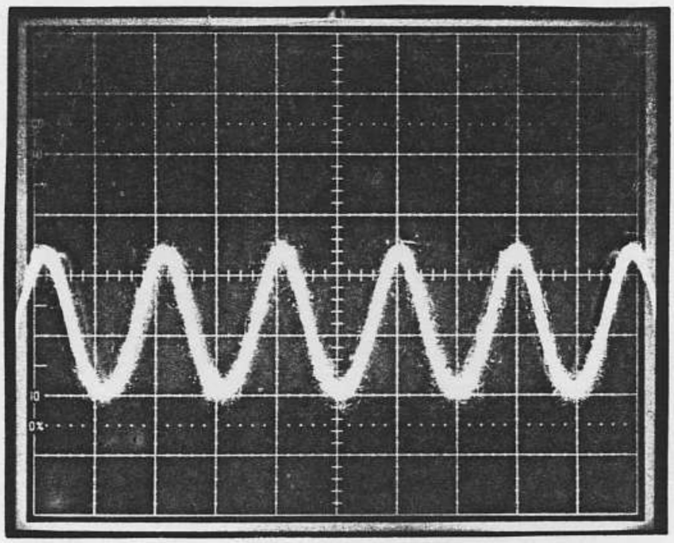
4-3.2.2 Lamp Thermostat. The lamp thermostat maintains the lamp housing temperature and therefore the lamp temperature at 115°C. It is configured as a linear temperature controller. U1 functions as the active gain element. Heater transistors Q5, Q6 and thermistor RT1 are directly mounted to the lamp housing. Q2 and Q4 are emitter followers providing sufficient basedrive to the heater transistors. The maximum current during warm-up is limited by R28 and Q3. R29 and R25 change the maximum warm-up current as a function of the supply voltage, providing warm-up time independent of supply voltage changes.

4-3.3 Servo Board Assembly. (Schematic Drawing No. 705-154). The prime function of the servo circuit is to lock the crystal oscillator frequency to the "atomic reference". A secondary function is to provide a "Lock Monitor" for the user. These functions are accomplished by providing a 127 Hz modulation signal to the multiplier/synthesizer assembly and processing the signal from the photocell to provide a crystal-control voltage and the lock-monitor signal, respectively.

Refer frequently to the Block Diagram (Figure 4-5) and the Modulation Concept illustration (Figure 4-2) while reading this section.

4-3.3.1 Preamplifier. The signal from the photocell is on terminals E3 and E4. U1 is configured as a low noise current to voltage converter. If the lamp is ignited the DC voltage on U1 pin 6 is above 5 VDC, indicating normal operation of the Rb lamp. U2, pins 1, 2, and 3 function as an inverting amplifier with a gain of about 1000 and an upper corner frequency of less than 300 Hz.

The signal at TP1 (Figure 4-6) is for normal operating conditions a 254 Hz sinewave with a very small 127 Hz component. The nominal amplitude is between .2 and 1.5 Vpp. This signal is referred to as the TP1 signal.



If no hyperfine transition is detected, the maximum noise level on TP1 is less than 100 mVpp. Excessive noise can be caused by a noisy 20 VDC supply or a faulty lamp assembly as well as a noisy photocell or preamplifier U1 and will result in reduced short-term stability of the M-100.

Figure 4-6. TP1: .2V/DIV.; 2 ms Time/Div.

4-3.3.2 Reference Signal Generation. CMOS oscillator/divider U3 on the servo board provides the 127 and 254 Hz reference signals. The 127 Hz reference signal (TP5, Figure 4-7) is needed for synchronous rectification of the fundamental AC component of the photocell signal and for modulation of the microwave frequency. The 254 Hz reference signal is needed for synchronous rectification of the 2nd harmonic of the modulation signal, indicating atomic lock. The oscillator frequency of 8.128 kHz is determined by C17, R35 and select-in-test resistor R36. The divider portion of U3 divides the oscillator frequency into the required 127 and 254 Hz signals. The 127 Hz reference signal is routed from U3 pin 4 to pin 11 of synchronous demodulator U4, and also to the input of U6 pin 2 through the RC network R55, C28. The RC network R55, C28, in addition to the feedback network R56, C30 and the output RC filters (R57, R58 and C31 on the servo board; R3, C2, and C12 on the synthesizer board), serves to filter and phase shift the 127 Hz square wave signal to provide a sinusoidal voltage that is used to modulate the 60 MHz on the multiplier PCB.

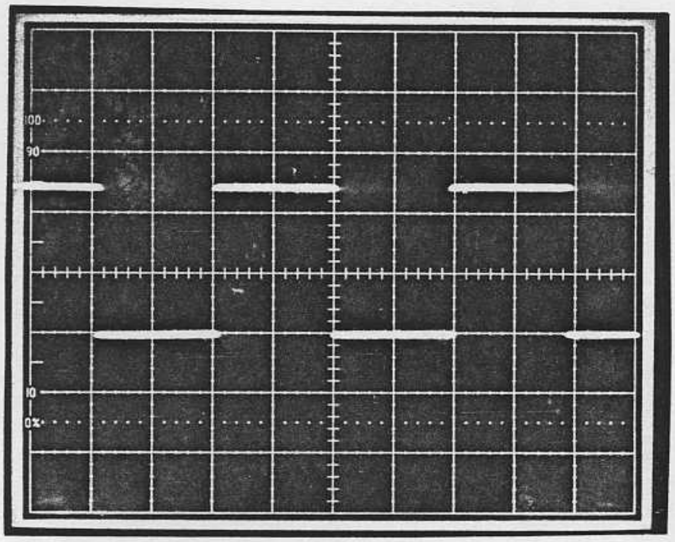


Figure 4-7. TP5: 5V/DIV; 2ms Time/DIV.

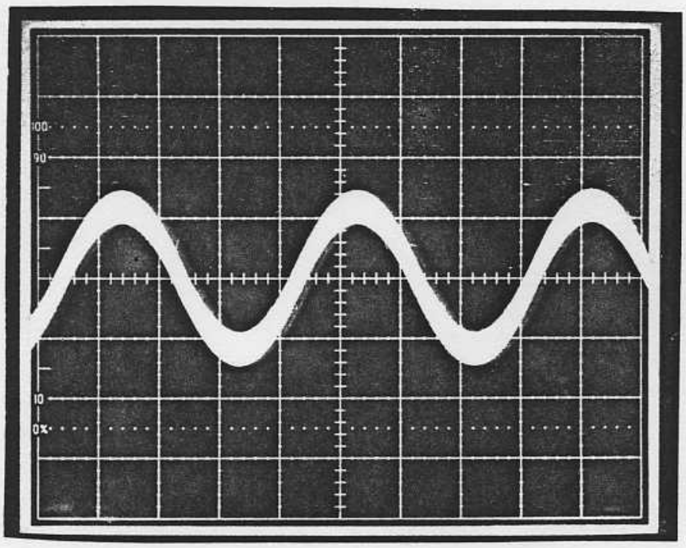


Figure 4-8. Test Point E8: 2V/DIV; 2 ms/DIV.

The 254 Hz reference signal is routed from U3 pin 5 to pin 9 of synchronous demodulator U4. The 254 and 127 Hz reference signals control the timing of the synchronous demodulators.

4-3.3.3 127 Hz Signal Processing. The preamplified photocell signal is applied to the notch filter U2 pin 12, 13, 14, which in turn provides a gain of approximately 80 for the 127 Hz signal component (TP2, Figure 4-9).

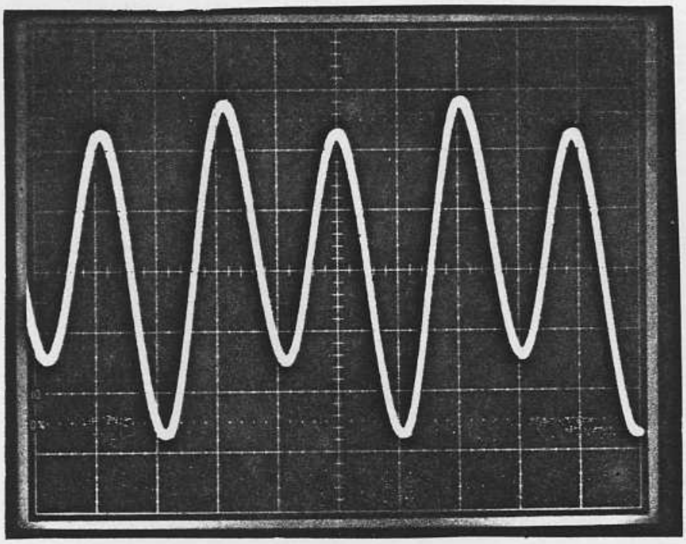


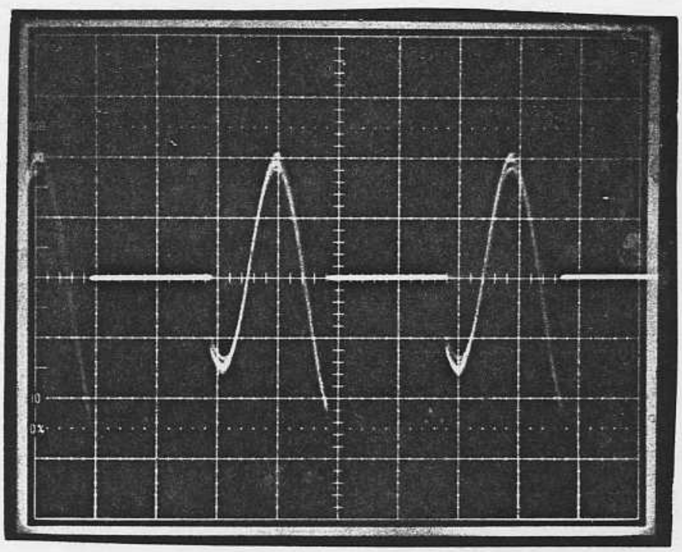
Figure 4-9. TP2: .5V/DIV.; 2ms Time/DIV.

Under normal operating conditions the signal at TP2 will have an amplitude of not less than 1 Vpp. The signal will appear as a 254 Hz sine wave, with a noticable 127 Hz component. The signal is then capacitively-coupled to the synchronous demodulator IC, U4 pin 12 where it is synchronously demodulated (rectified) by one of the three pairs of analog switches of U4. The output of the demodulator will show a positive or negative DC offset depending on the phase of the 127 Hz input signal (TP4, Figure 4-10).

If the crystal oscillator is locked to the hyperfine transition and does not require a change in its control voltage, the signal at TP4 (Figure 4-10) will be equal to the reference voltage (6.0 VDC nom) to the integrator.

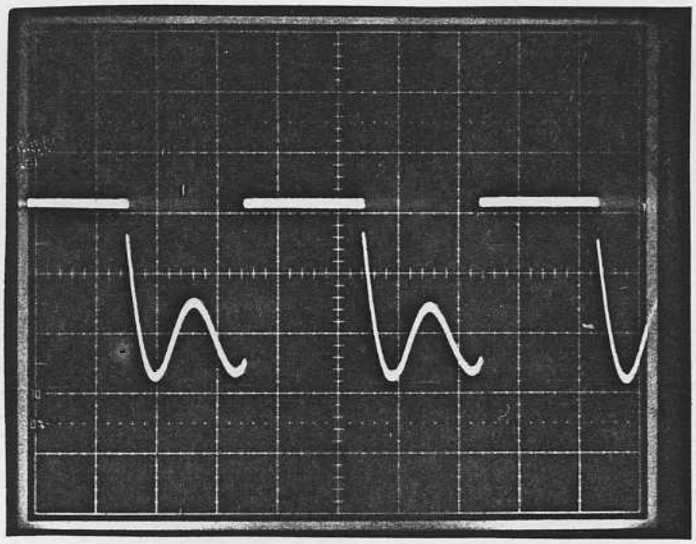
After passing through another CMOS switch, the signal is integrated by U5. The function of the other CMOS switch is outlined under "sweep circuit" in paragraph 4-3.3.4. The output voltage of U5 changes at a rate determined by the differential input voltage. As an example, an input differential of 500 mV causes an output voltage change of -500 mV per second. The changes will continue until the differential input is nulled by bringing the crystal back to center frequency, or until the op amp reaches its maximum output voltage. The output of integrator U5 is the crystal-control voltage that steers the frequency of the VCXO via a varactor diode (CR1, crystal oscillator PCB). A portion of the integrator output is also routed to the sweep control circuit at U6, pin 5. The crystal-control voltage can be monitored at the M-100 main connector, J1, pin F.

The following pictures in Figure 4-10 show the signal at TP4 for three different operating conditions. Frame A shows normal locked operation. Frames B and C show strong fundamental signals caused by frequency offsets of several parts in 10^{-8}.

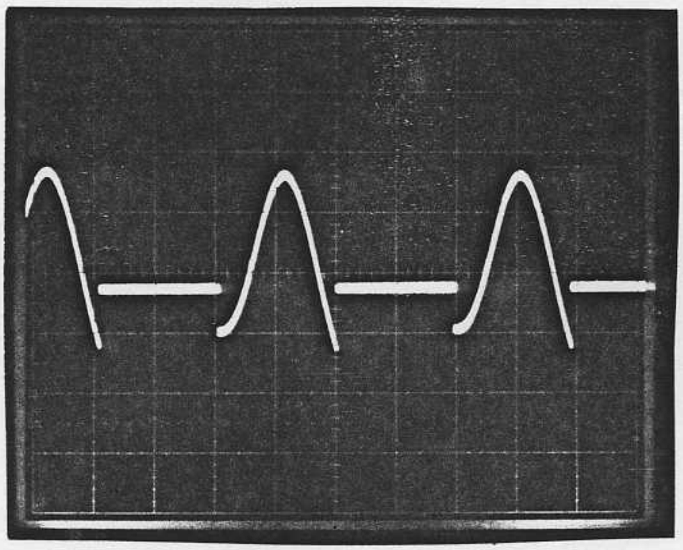


Frame A

Figure 4-10. TP4 Phase and Amplitude Characteristics
(Sheet 1 of 2)



Frame B



Frame C

Figure 4-10. TP4 Phase and Amplitude Characteristics
(Sheet 2 of 2)

4-3.3.4 Lock Circuit. The TP1 signal is also amplified by the 254 Hz notch filter U6 pins 8, 9, and 10. The output of U6, pin 8 is then synchronously demodulated by the third pair of analog switches of U4 (TP7). If atomic lock exists, a negative DC offset on C33 will drive the output of U6, pin 14 high. R60, R62 provide a threshold of 200 mV for U6 to avoid triggering the lock indication by a marginal lock signal. Q1 buffers the signal and generates the "Lock Monitor" signal at the M-100 output connector. U6, pin 14 also controls the sweep circuit.

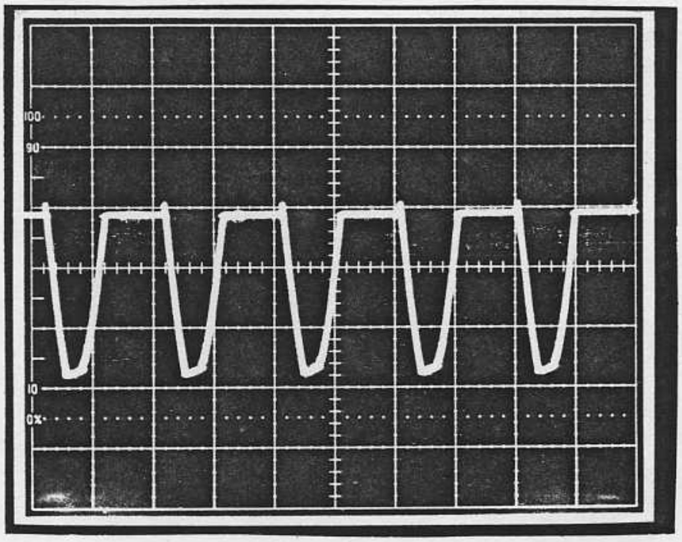


Figure 4-11. TP7: 2V/DIV.; 2 ms/DIV.

4-3.3.5 Sweep Circuit. In order to be able to compensate for several years of crystal aging in addition to frequency offsets of the crystal caused by environmental changes (e.g., temperature changes) the trim range of the oscillator is very wide compared to the width of the atomic resonance. To ensure lockup of the crystal, its frequency is swept over its trim range until atomic resonance can be detected.

This is accomplished by U4 connecting the integrator input (U5, pin 2) to U6, pin 7 as long as U6, pin 14 stays low (no atomic lock). U6, pins 5, 6, 7 functions as high hysteresis voltage comparator. The trigger points are controlled by R44 and R55 and the voltage reference. The lower trigger point is approximately 1.5 VDC, the higher trigger point is approximately 16 VDC. If the output of U5 is equal to or lower than the lower trigger point, U6's output becomes 0 VDC, resulting in a .7 V differential to the integrator. With R50 = 1 M and C22 = 1 μF its output will rise .7 V/s until the upper trigger point of 16 VDC is reached. At this point, U6's output will go high, resulting in an approximate 1 VDC offset at the integrator input. This will decrease U5's output by 1 V/s, resulting in a sweep time of about 40 s. Due to the fast sweep, atomic resonance can be detected for only 100 ms at a time during each sweep cycle. Reliable transition from sweep to locked operation is facilitated by CR9.

4-3.4 Power Supply. (Schematic Drawing No. 70510). The internal power supply provides the unregulated voltages for the oscillator thermostat and the resonator thermostat. The supply voltage for the lamp thermostat is electronically filtered to improve the immunity to low frequency conducted interference. The supply also provides filtered and regulated voltage to all subassemblies of the M-100. The input voltage line is diode protected against reverse polarity inputs. A transient voltage suppressor of 1.5 KW peak power rating triggering at not less than 44 VDC protects the M-100 from power line spikes.

4-3.4.1 +20 Vdc Regulated Power Supply. The +20 vdc Power supply consists of Q1 thru Q9 and U1 along with their respective components mounted on the power supply board. Pass transistor Q9 is heat sinked to the frame assembly. Q1 and R7 limit the maximum supply current to approximately .5 A. The supply is set to (20 ± .5 vdc).

4-3.4.2 +21 Vdc Floating Power Supply. The floating power supply consists of Q10 through Q16 and supplies the lamp thermostat. In normal operation its output voltage is 5 VDC less than its input voltage. During warm-up when maximum heater power is demanded, its output is within 2 VDC of its input voltage.

4-3.5 Crystal Oscillator (VCXO) Assembly. (Schematic Drawing No. 70513). The function of the 10 MHz oscillator is to provide a clean 10 MHz signal at the M-100 output. The 10 MHz signal is also multiplied, as well as synthesized to 5.3125 MHz. The VCXO is temperature controlled and operated at the turning point of the crystal to improve short-term stability and to limit its maximum frequency deviation due to changes in the ambient temperature well inside its trim range.

4-3.5.1 Crystal Oscillator. The crystal oscillator consists of Y1, a 10 MHz 3rd overtone AT-Cut crystal, Q2 as the oscillator transistor, Q1 as the first Buffer stage and Q3 providing automatic gain control. Variable capacitor CR1 with C3 and C4 fine tune the oscillator frequency over approximately 1.5×10^{-6} as the tuning voltage changes from 1.5 to 16 VDC. C5 and C6 set the center frequency, however changing the center frequency will affect the trim range and vice-versa. Generally, an increase in center frequency will increase the trim range.

C10, L6 and L2 are set above the fundamental mode of the crystal and prevent oscillation of the crystal in this mode. C9 and T1 are tuned to 10 MHz.

The automatic gain control can be checked at TP3 using a DVM. The nominal voltage is around 1.1 VDC. This voltage will increase to > 2 VDC if Q3 fails or if insufficient amplitude is generated by the oscillator.

4-3.5.2 Fault Location, Crystal Buffer Section. The crystal buffer is part of the oscillator assembly and consists of Q4, Q5 and Q6. It is driven by a 10 MHz signal of 1 to 1.5 Vpp at TP4. Since Q4 is an emitter follower, the signal amplitude at TP5 is about 95% of the TP4 amplitude. Q5 provides about 2 Vpp drive to Q6 which in turn drives the primary of transformer T3. This transformer is tuned to 10 MHz and transforms the output impedance of Q6 to approximately 50 ohms (E7). Q4's collector drives T2 which is tuned to 10 MHz. The secondary of T2 provides about 3 Vpp to the multiplier (E5).

4-3.5.3 Crystal Thermostat. The analog thermostat maintains the crystal at its upper turning point of approximately 80°C. Thermistor RT1 (27K ohm nominal at 25°C) is mounted on the thermostat assembly which houses crystal Y1 and is heated by Q10. RT1 is part of the bridge circuit consisting of R29, R30, R31, R32 and select resistor R33. The latter is selected for the bridge to be in a balanced condition when the operating temperature is reached. U1 is the active gain element of the loop, Q7 and Q9 are emitter followers providing base drive to the heater transistor Q10.

During warm-up the maximum heater current is limited by Q8, which is turned on by the voltage drop across R48 and R47. The voltage drop across R48 is almost entirely dependent on the heater current. The voltage across R47 is a function of the supply voltage. This feature eliminates the dependence of the warm-up time on the supply voltage. A functional check of this circuit can be performed by increasing the supply voltage to the M-100 while the heater is in a current-limiting mode. An increase of 20% of the voltage will result in approximately a 20% decrease of the heater current.

4-3.6 Synthesizer A5. (Schematic Drawing No. 70516). Synthesizer assembly (A5) contains the multiplier section and the synthesizer section in addition to the C-Field tuning elements.

4-3.6.1 Multiplier. The 10 MHz signal from the crystal oscillator is applied to the input of a frequency tripler consisting of Q3, Q4, and associated circuitry. C9 and L3 are tuned to 30 MHz, R12 limits the Q of the tank to about 30. The 30 MHz signal is capacitively coupled through C13 to transformer T1. At this point, the 127 Hz from the servo assembly modulates the rf signal via varactor CR6. The interaction of CR6 with the tuned tank circuit on the primary of T1 serves to phase modulate the rf at a 127 Hz rate. The secondary of T1 is center tapped to provide a split phase signal which drives the bases of Q5 and Q6. The result is a 60 MHz signal which is amplified by Q7, Q8. C17-L5; C20-L8 and C27-L10 are tuned to 60 MHz. Q7 and Q8 are class A inverting amplifiers. The 60 MHz signal at E6 drives the snap diode in the physics package through a coax cable. C27, C29 match the coax-cable to the driver stage. R31 and R34 provide the bias voltage for the snap diode.

NOTE

All LC circuits are of low Q and retuning during the life cycle of the M-100 is not necessary, except if components need replacement. Change of select resistors R31 or R34 change the microwave level in the cavity. Retuning requires experience and should be done with the internal crystal oscillator held at $\pm$ 5x10^{-9} of center frequency. The test point TP1 on the Servo PCB should be monitored with a scope and R31 or R34 should be selected for a broad maximum signal on TP1.

Any change of R31, R34 may change the temperature coefficient of the M-100. Typical values of R31 plus R34 are 400 to 2100 ohm.

4-3.6.2 Synthesizer. A portion of the 10 MHz signal from the crystal oscillator is applied to the base of Q2. Q2 converts the sinewave to a TTL compatible trigger signal. Power for the TTL circuits is provided by the voltage regulator VR1. VR1 is a 3 pin, +5V regulating IC. The 10 MHz TTL signal is divided down by U2 and U3 to 312.5 KHz. U1 is configured as an exclusive OR GATE and mixes the 312.5 KHz and the 5 MHz signals, resulting in a TTL signal of 4.6875 and 5.3125 MHz. The 4.6875 MHz component is suppressed by L11, C30 tuned to the upper TTL frequency. The 5.3125 MHz signal is mixed with the 60 MHz output of Q8, and routed to the step recovery diode in the resonator circuit, (paragraph 4-3.1.2).

4-3.6.3 C-Field Tuning. The C-Field tuning is outlined in detail in section 4-3.1.4.

CHAPTER 5
MAINTENANCE, TROUBLESHOOTING AND REPAIR

5-1 INTRODUCTION. This chapter provides detailed procedures and instructions for performing all maintenance and repair functions on the M-100, including incoming acceptance tests, performance tests, calibration, troubleshooting and repair. Throughout the test procedures the M-100 will be referred to as the UUT (Unit Under Test).

5-2 REQUIRED TEST EQUIPMENT. The required test equipment to properly service the UUT is listed in Table 5-1. Test equipment other than the items listed may be used provided that they meet or exceed the Minimum Use Specification stated in Table 5-1. In the event that the required test equipment or a suitable substitute is not available it is recommended that the unit be returned to Efratom for service.

Table 5.1 REQUIRED MAINTENANCE TEST EQUIPMENT

#	Item	Minimum Use Specification	Test Equipment
5.1	DC Power Supply	Voltage: 0 to 30 vdc Accuracy: Output monitored Current: 0 to 3 adc	Hewlett Packard 6296A or 6433B
5.2	Digital Multimeter (DMM) (2 required)	Voltage: 0 to 30 vdc Accuracy: ± 1.25% Current: 0 to 3 adc Resistance: 200 ohm range	John Fluke 8600 opt 01
5.3	Optional Reference Frequency Standard	Output: 10 MHz Accuracy: $5x10^{-12}$ Stability: parts in 10^{12}	1. EFRATOM RGR 2. Cesium Standard 3. EFRATOM H-Maser 4. EFRATOM MVLF
5.4	True RMS Voltmeter	Range: 0 to 1 vrms Input Frequency: 10 MHz Accuracy: ± 3%	Hewlett Packard 3403C

Table 5.1 REQUIRED MAINTENANCE TEST EQUIPMENT (cont.)

#	Item	Minimum Use Specification	Test Equipment
5.5	Spectrum Analyzer	Range: 20 Hz to 100 MHz Bandwidth: 300 KHz	Hewlett Packard 141T Display with 8552 IF section and on 8553B RF section
5.6	Strip Chart recorder	Span Range: 1 mV to 1 V	Hewlett Packard 7132A or Texas Instruments PRIMA16AFR
5.7	Oscilloscope	Range: DC to 100 MHz	Tektronix 465 or 7704 MOD 129F with 7A26 Vert. P/I and 7B53A Time Base P/I
5.8	Resistive Load	Type: Feedthrough Impedance: 50 ohm Accuracy: $\pm$ 0.5 ohm	Pomona Electric 4119-50 or Hewlett Packard 10100A
5.9	Atomic Oscillator Test Set	Int. Ref. Freq.: 10 MHz Accuracy: $\pm$ $1X10^{-11}$ Stability: Parts in 10^{12}	Efratom TS105 or TS-105A
5.10	Phase Noise Test Set	Input Frequency: 10 MHz Bandwidth: > DC to 25 KHz from carrier	Efratom Model MNT

5-3 TEST PROCEDURES. The test procedures described in subsections 5-6 through 5-11 can be used to check performance for incoming inspection and periodic unit evaluation. These tests can be performed without removing the unit's outer cover. Calibration of the M-100 is accomplished by performing the tests described in Chapter 3, in addition to sections 5-6 through 5-16.

5-4 TROUBLESHOOTING. In the event that a major section or the complete unit is inoperative, troubleshooting and/or repair will be necessary. Flowcharts at the end of this chapter will isolate the fault and provide instructions for repair. In general, internal adjustments have only a limited range and are designed to compensate for minor variations in circuit components; seldom, if ever, will an internal adjustment restore operation. The test procedures in subsection 5-6 through 5-13 will serve as an aid in further isolating a trouble to a specific circuit section.

Since the operation of some circuits is dependent on proper operation of other circuits, troubleshooting must be performed in proper flowchart sequence. If the trouble indicates a possible malfunction of a specific board, perform the troubleshooting procedure on that board. If the problem is found to be in the physics package return the unit to the factory. The physics package is not field repairable.

5-5 EQUIPMENT HISTORY. It is recommended that an Equipment History be maintained for each unit, so that the results of the performance tests can be made a part of the permanent record for the Equipment History. A blank sample Performance Check List is included at the end of this section for your convenience. The blank sample check list may be reproduced as necessary to provide a permanent record.

5-6 WARM-UP CURRENT, FREQUENCY ACCURACY AND INPUT POWER TESTS.

5-6.1 Connect the equipment as shown in Figure 5-1.

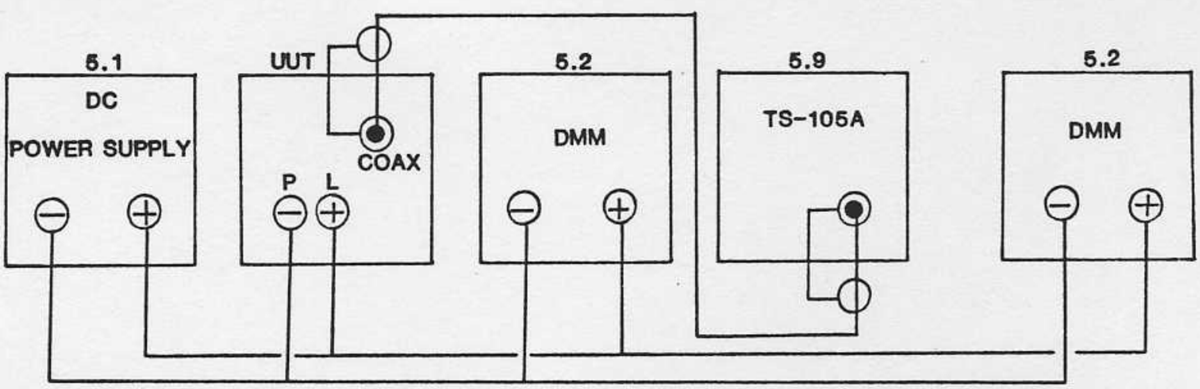


Figure 5-1. Warm-up Current, Frequency Accuracy, and Input Power Test Configuration.

5-6.1.1 Set the DMM #1 controls for voltage measurements in the 30 vdc range.

5-6.1.2 Set the DMM #2 controls for current measurements in the 3 adc range.

5-6.1.3 Ensure that all test equipment is operating and has had sufficient warm-up time.

5-6.2 Adjust the DC power supply controls to obtain a 26 $\pm$ 1.3 vdc indication on DMM #1. Note the exact indication; it will be required in step 5.6.6.

5-6.3 Allow the UUT to operate at ambient temperature for at least five hours.

NOTE

The maximum temperature fluctuation must not exceed $\pm$ 2°C. Also, continuous operation of the atomic oscillator test set is preferred over warm-up.

5-6.4 Ensure that the atomic oscillator test set has been operating at ambient temperature for at least two hours, press the RESET push button to begin the test.

5-6.5 Allow the atomic oscillator test set sufficient time to display the UUT Offset for the 100 seconds averaging time.

5-6.6 Record the UUT offset as indicated on the atomic oscillator test set. If the indicated offset is greater than $\pm$ $5x10^{-11}$, adjust the UUT Frequency Trim potentiometer (as described in Chapter 3), to obtain an in-tolerance indication. If an in-tolerance indication is not possible and the UUT frequency is too low, perform section 5-14; if the UUT frequency is too high, perform subsection 5-15.

5-6.7 Adjust the DC power supply for minimum output (0 vdc), and note the turn-off time. Allow a minimum of two hours before proceeding.

5-6.8 Monitor DMM#1 and DMM #2 while adjusting the DC power supply for the exact voltage noted in step 5-6.2, and note the turn-on time.

5-6.9 Record the DMM #2 maximum current indication during the UUT 10 minute warm-up period.

NOTE

The UUT current normally reaches maximum within 2 minutes after input power is applied.

5-6.10 Verify that the UUT maximum warm-up current is $\leq$ 2.2 adc.

5-6.11 At the end of the 10 minute warm-up, press the atomic oscillator test set RESET push button and record the UUT frequency offset for 100 seconds averaging times.

5-6.12 Verify that the UUT frequency offsets recorded for steps 5-6.6 and 5-6.11 differ by no more than $\pm$ $2x10^{-10}$.

5-6.13 Allow the UUT to operate continuously for at least 1 hour.

5-6.14 Note the voltage indication on DMM #1 and the current indication on DMM #2.

5-6.15 Using the following formula and the data from step 5.6.14 determine the UUT power comsumption.

Power Formula: P = I E

Where: P = Power

I = Current

E = Input voltage

5-6.16 Verify that the UUT power consumption after > 1 hour operation is $\leq$ 18 watts.

5-6.17 If no other tests are required, adjust the DC power supply for minimum output and disconnect the test setup.

5-7 SHORT-TERM STABILITY (Allan Variance).

5-7.1 Ensure that the equipment is connected as shown in Figure 5-1, (DMM #2 is not required for this test).

5-7.2 Adjust the DC power supply controls to obtain a 26 $\pm$ 1.3 vdc indication of DMM #1.

5-7.3 Ensure that the UUT and the Atomic Oscillator Test Set have had sufficient stabilization time. (The UUT requires 1 hour stabilization).

NOTE

The maximum temperature fluctuation must not exceed $\pm$ 2°C.

5-7.4 Press the RESET push button on the Atomic Oscillator Test Set to begin the Allan Variance tests.

5-7.5 Allow the Atomic Oscillator Test Set sufficient time to display the Allan Variance for averaging time of 1 and 10 seconds.

5-7.6 Verify that the Allan Variance for 1 second averaging time is $\leq 3\times10^{-11}$, and that the Allan Variance for 10 seconds averaging time is $\leq 1\times10^{-11}$ as indicated on the atomic oscillator test set.

NOTE

If the UUT is not within the stated tolerance it may be necessary to continue the test in order to obtain a 100 second averaging time indication. If a 100 second averaging time indication is required the tolerance is $\leq 3\times10^{-12}$.

5-7.7 If no further tests are required, adjust the DC power supply for minimum output and disconnect the test setup.

5-8 TRIM RANGE TEST.

5-8.1 Ensure that the equipment is connected as shown in Figure 5-1, (DMM #2 is not required for this test).

5-8.2 Adjust the DC power supply controls to obtain a 26 $\pm$ 1.3 vdc indication of the DMM #1.

5-8.3 Ensure that the UUT and the atomic oscillator test set have had sufficient time to stabilize. (The UUT requires 1 hour to stabilize).

5-8.4 Determine the UUT nominal output frequency from the Atomic Oscillator Test Set's Frequency Offset indication.

5-8.5 Locate the UUT frequency adjustment screw access hole (refer to Chapter 3,Figure 3-4 if necessary) and remove screw.

5-8.6 Using the appropriate adjustment tool, rotate the UUT trim potentiometer fully clockwise and verify that the frequency offset indication on the test set increases $\geq 1 \times 10^{-9}$ of the nominal output. Record the shift from the nominal.

5-8.7 Rotate the UUT trim potentiometer fully counter clockwise and verify that the frequency decreases $\geq 1 \times 10^{-9}$ of the UUT nominal output. Record the shift from nominal.

5-8.8 Using the following formula and the data recorded in steps 5-8.6 and 5-8.7, compute the UUT trim range.

$$\text{Trim range } (\Delta f/f \text{ range}) = \Delta f/f \text{ Max} + \Delta f/f \text{ Min}$$

$$\text{Where: } \Delta f/f \text{ Max} = \frac{f \text{ max} - f \text{ (test set ref)}}{f \text{ (test set reference)}}$$

$$\Delta f/f \text{ Min} = \frac{f \text{ (test set ref)} - f \text{ min}}{f \text{ (test set reference)}}$$

5-8.9 Verify that the UUT trim range is $\geq 3 \times 10^{-9}$.

5-8.10 Adjust the UUT trim potentiometer to a position which returns the UUT as close to 10 MHz as possible $\pm 5 \times 10^{-11}$. Replace screw in access hole.

5-9 OUTPUT LEVEL TEST.

5-9.1 Connect the equipment as shown in Figure 5-2.

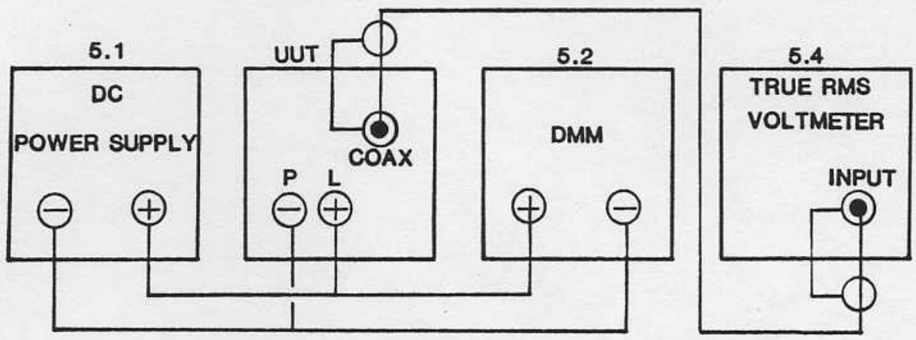


Figure 5-2. Output Level Test Configuration.

5-9.2 Adjust the DC power supply output controls to obtain a 26 $\pm$ 1.3 vdc indication on the DMM.

5-9.3 Allow a minimum of 10 minutes warm-up time for the UUT.

5-9.4 Verify that the UUT output level as indicated on the RMS voltmeter is between 0.45 and 0.65 VRMS.

5-10 HARMONIC/NON-HARMONIC DISTORTION TESTS.

5-10.1 With the equipment connected as shown in Figure 5-2, disconnect the RMS voltmeter, and connect the UUT output to the spectrum analyzer input.

5-10.2 Set the spectrum analyzer controls for 100 MHz sweep 300 KHz bandwidth.

5-10.3 Adjust the 10 MHz fundamental to REF on the spectrum analyzer display.

5-10.4 Measure the highest amplitude harmonic (in dB) below the REF.

5-10.5 Verify that the UUT Harmonic Distortion is at least 30 dB down from reference.

5-10.6 Measure the highest amplitude on Non-Harmonic signal up to 90 MHz.

5-10.7 Verify that the Non-Harmonic Distortion is at least 80 dB from the reference.

5-11 LONG-TERM STABILITY TEST.

Long-term stability refers to slow changes in the average frequency over time, due to secular changes in the UUT physics and/or electronic circuitry. Using the test set-up provided in Figure 5-3, it is recommended that daily readings be taken from the Efratom TS-105A and plotted graphically to estimate long-term drift (aging). Measurement periods should be a minimum of 30 days to obtain meaningful results. It is also important that the daily readings are taken at approximately the same time to minimize the effects of temperature fluctuations.

NOTE

During long-stability testing, the UUT should be placed in an environment with stable temperature, barometric pressure, and magnetic fields. Refer to specifications to estimate effects of environment on stability. Also ensure that the UUT has been operating 14 days continuously prior to the test.

5-11.1 With the equipment connected as shown in Figure 5-3, and the required stabilization time allowed, press the test set's RESET pushbutton to begin the test.

5-11.2 Allow sufficient time for the test set to display the data required and begin recording readings daily. After a minimum of 30 readings are plotted graphically, verify that the UUT long-term stability is within the tolerance listed in Table 1-1, SPECIFICATIONS.

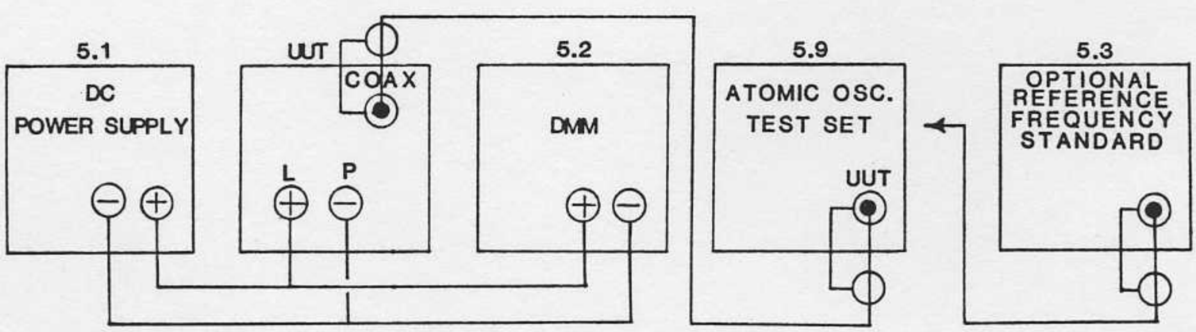


Figure 5-3. Long-Term Stability Test Setup.

5-12 VOLTAGE VARIATION TEST

5-12.1 Connect the equipment as shown in Figure 5-1.

NOTE

The ambient temperature should not vary more than ± 1°C during performance of this test.

5-12.2 Adjust the DC power supply controls to obtain a 26 ± 0.1 vdc.

5-12.3 Allow the UUT and the Atomic Oscillator Test Set sufficient time to stabilize (the UUT requires 1 hour min.).

5-12.4 At the end of the stabilization period, determine and record the UUT output frequency.

5-12.5 Adjust the DC power supply controls to obtain a 28.6 ± 0.1 vdc indication on the DMM. Allow the UUT to operate at this input voltage for at least 15 minutes. Determine and record the UUT output frequency.

5-12.6 Adjust the DC power supply controls to obtain a 23.4 ± 0.1 vdc indication on the DMM. Allow the UUT to operate at this voltage for at least 15 minutes. Determine and record the UUT output frequency.

5-12.7 Adjust the DC power supply controls to obtain 26 ± 0.1 vdc indication on the DMM. Allow the UUT to operate at this input voltage for at least 15 minutes and record the UUT output frequency.

5-12.8 Calculate the average reference frequency by utilizing the following formula:

$$f = \frac{f(\text{from step 5-12.4}) + f\ (\text{from step 5-12.7})}{2}$$

5-12.9 Verify that the frequencies obtained in steps 5-12.5 and 5-12.6 are within $\pm\ 1 \times 10^{-11}$ of the reference frequency obtained in step 5-12.8.

5-13 CRYSTAL AGING COMPENSATION.

5-13.1 If the crystal control voltage approaches the end of it's range (+2 to +15 vdc), a correction of the crystal oscillator base frequency must be made.

5-13.1.1 Connect the equipment as shown in Figure 5-4, but do not make the dotted-line connection until instructed to do so.

CAUTION

If the UUT output frequency is $\geq$ 10.000050 MHz after normal warm-up times, a check of the crystal thermostat at ambient temperature is mandatory. DO NOT attempt to reset crystal trim range as if this condition exists, the adjustment will not be effective.

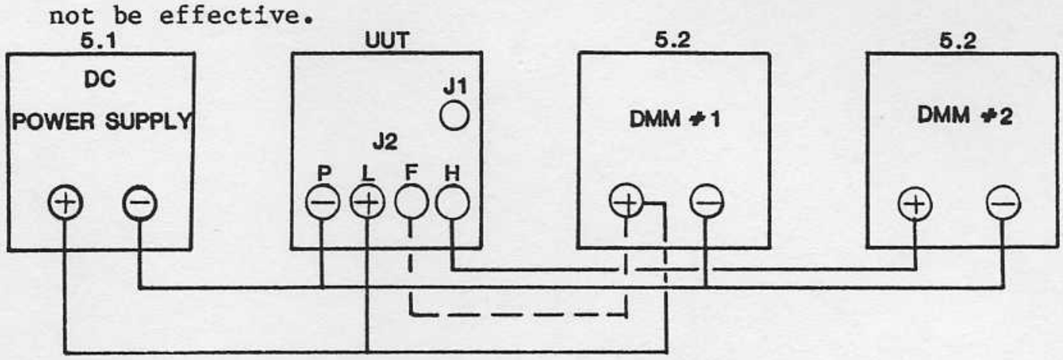


Figure 5-4. Crystal Aging Compensation Test Setup.

5-13.1.2 Set DMM #1 controls to measure dc voltage in the 30 vdc range, and DMM #2 to 200 ohm range. (Do not use auto range for this test).

5-13.1.3 Adjust the DC power supply output for a 26 $\pm$ 1.3 vdc indication on the DMM #1,

5-13.1.4 Disconnect the DMM #1 positive (+) lead connected to the DC power supply positive output connector. (Do not disturb the positive input to UUT).

5-13.1.5 Set the DMM #1 controls to measure DC voltage in the 20 volt range, and connect the positive lead to the UUT J2 pin F connection.

5-13.1.6 After the UUT has operated a minimum of 1 hour, ensure that DMM #2 indicates 120 ohm and maintains this indication throughout the remainder of the test. (This indicates that the UUT has locked onto the atomic resonance frequency.)

5-13.1.7 Refer to Figure 5-5 to locate the UUT crystal trim adjustment (C5). Remove screw to access crystal trim adjustment.

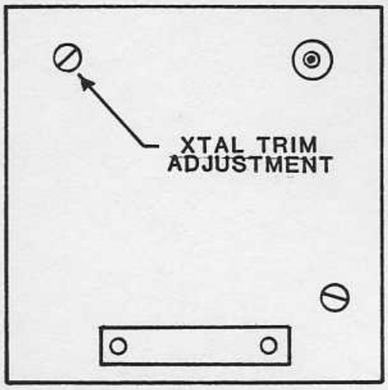


Figure 5-5. Crystal Trim Adjustment Location.

5-13.1.8 Using the proper adjustment tool or insulated screwdriver, slowly rotate the crystal trim adjustment to obtain a voltage indication, on DMM #2, of +9 vdc ($\pm$ 1V). Clockwise rotation decreases the control voltage, counterclockwise rotation increases the control voltage.

5-13.1.9 If the crystal control voltage cannot be adjusted to +9 volts ($\pm$ 1V) with the crystal trim adjustment proceed with step 5-13.2.

5.13.2 Remove the UUT outer cover by first removing the twelve (12) screws and related washers from the outer cover sides near the baseplate end of the UUT. The remove the four (4) screws and related washers from the connector end of the outer cover. Carefully slide the UUT out of the outer cover.

NOTE

The UUT comes supplied with either one (1) or two (2) spare capacitors to be used as necessary to compensate for crystal aging. The number of capacitance value(s) has been determined by the preselected value of C6 on the oscillator board. The compensation capacitors are designated A4C6+ and A4C6- (if two were necessary) and are located on the synthesizer board assembly. Refer to the final assembly drawing, Drawing No. 70500-1, top cut-away and Note (5) for further information and physical location. If the crystal control voltage was found to be too low (<+2 vdc) perform section 5-13.3, if the crystal control voltage was found to be too high (>+15 vdc) perform section 5-13.4.

5-13.3 Locate C8 on the oscillator board assembly. Refer to Drawing No. 70512-2.

5-13.3.1 Locate and remove adjustment capacitor A4C6+ from the synthesizer board assembly.

5-13.3.2 Connect the adjustment capacitor in parallel to C8 on the oscillator board.

5-13.3.3 Ensure that the crystal trim adjustment C6 is set to the center of its range.

5-13.3.4 Using the method described in steps 5-13.1.1 through 5-13.1.9 readjust the control voltage to 8 vdc (± 1V).

5-13.4 Locate C6 on the oscillator board assembly. Refer to Drawing No. 70512-2.

5-13.4.1 Locate and remove adjustment capacitor A4C6- from the synthesizer board assembly.

5-13.4.2 Remove C8 from the oscillator board and connect A4C6- in its place.

5-13.4.3 Ensure that the crystal trim adjustment C6 is set to the center of its range.

5-13.4.4 Using the method described in steps 5-13.1.1 through 5-13.1.9 readjust the control voltage to 8 vdc (± 1V).

5-13.4.5 Secure the UUT outer cover by reinstalling all of the screws and washers.

NOTE

If during the performance of Chapter 3, Operational Frequency Accuracy Test, or section 5-6 in this chapter (Frequency Accuracy portion), it was found that the Frequency Adjust potentiometer (R35) did not have sufficient range to adjust the UUT output frequency within the required $5x10^{-11}$ it will be necessary to adjust the C-field current through the resonator coil.

An increase in C-field current will increase the UUT output frequency, whereas decreasing the C-field current will decrease the output frequency. Refer to synthesizer assembly Drawing No. 70515-2 and synthesizer schematic Drawing No. 70516 to facilitate the correction compensation. If the UUT output frequency was found to be too low after adjusting the UUT frequency, adjust potentiometer R35 fully clockwise and perform the required steps in section 5-14. If the UUT output frequency was found to be too high after adjusting R35 fully counterclockwise, perform section 5-15.

5-14 UUT OUTPUT FREQUENCY LOW COMPENSATION.

5-14.1 Remove the UUT from its cover by removing the twelve (12) screws and related washers from the outer cover sides near the baseplate end of the UUT. Then remove the four (4) screws and related washers on the connector end and carefully slide the UUT out of the outer cover.

NOTE

The C-field current is adjusted by changing pre-selected jumper wires on the synthesizer board assembly. Refer to Figure 5-6.

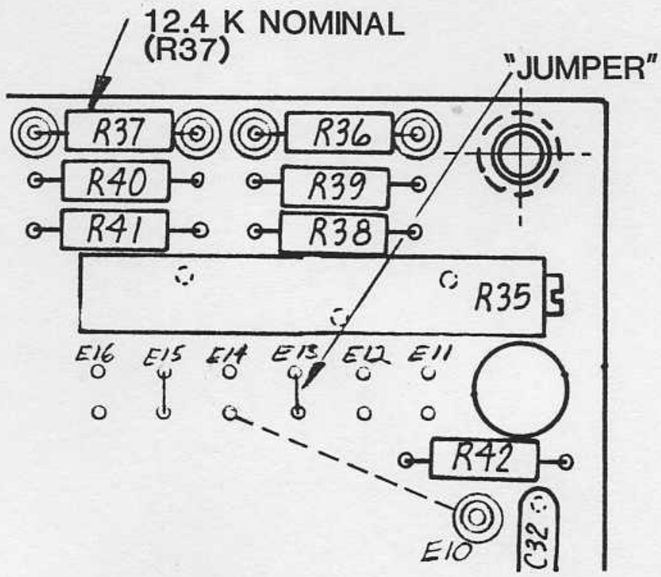


Figure 5-6. Location of Frequency Correction Compensation Jumpers on Synthesizer Board Assembly.

5-14.2 Locate the compensation jumper connections on the synthesizer board.

NOTE

Terminal E15 is normally jumpered to E10 at the factory, (dotted-line connections in Figure 5-6). On some UUT's the jumper was not required. If the UUT does not have a jumper between E10 and either E16, E15, or E14, perform section 5-14.3. If a jumper is connected between E10 and either E16 or E15, perform 5-14.4. If E10 is jumpered to E14, perform section 5-14.5.

5-14.3 Using a 35 to 40 watt soldering iron and SN63WRMAP3 solder, (Federal Specification QQ-S-571E), perform the following:

5-14.3.1 Locate terminal E16 and the corresponding E10 connection on the synthesizer board, refer to Figure 5-6.

5-14.3.2 Select a piece of uninsulated 24 gauge wire approximately 1/8 inch long.

5-14.3.3 Lay the jumper across the E16 and corresponding E10 terminals, and carefully solder the jumper in place.

5-14.3.4 Replace the UUT outer cover and secure with four (4) of the screws removed in step 5-14.1.

5-14.3.5 Perform the steps in section 3-9 to adjust and verify that the UUT output frequency is 10 MHz $\pm$ 5×10^{-11}.

5-14.3.6 Secure the UUT cover by reinstalling all of the remaining screws removed in step 5-14.1.

5-14.4 Using a 35 to 40 watt soldering iron and SN63WRMAP3 solder (Federal Specification QQ-S-571E), perform the following:

5-14.4.1 Remove the existing jumper between E10 and either E16 or E15 terminals.

NOTE

Moving the jumper from E10/E16 to E10/E15 or E10/E15 to E10/E14 will increase the UUT output frequency by approximately 1×10^{-9}.

5-14.4.2 Select a piece of uninsulated 24 gauge wire approximately 1/8 inch long.

5-14.4.3 Lay the jumper across the E10/E15 or E10/E14 terminals as illustrated in Figure 5-7 and carefully solder the jumper in place.

5-14.4.4 Replace the UUT cover with four (4) of the screws removed in step 5-14.1.

5-14.4.5 Perform the necessary steps in section 3-9 to adjust and verify that the UUT output frequency is 10 MHz $\pm$ 5×10^{-11}.

5-14.4.6 Secure the UUT cover by reinstalling all of the remaining screws removed in step 5-14.1.

5-14.5 If it was found that the E10/E14 terminals have a jumper installed it will be necessary to recalculate the value of R37 and replace the old R37 with a resistor of the new calculated value. Proceed as follows:

5-14.5.1 Locate and determine the value of R37 on the Synthesizer assembly. Refer to Appendix, Drawing No. 70515-2.

5-14.5.2 Calculate the new required value for R37 using the following formula:

$$R37\ \text{new} = \frac{40}{\frac{\Delta f}{f} + \frac{40}{R37\ \text{Original}}}$$

Where: $\frac{\Delta f}{f}$ = Anticipated positive frequency increase in parts of 10^{-9}.

R37 = K Ohms

5-14.5.3 Using a 35 to 40 watt soldering iron and SN63WRMAP3 solder (Federal Specification QQ-S-571E), remove resistor R37 and the jumper across E10/E14.

5-14.5.4 Replace R37 with a resistor of the calculated value from step 5-14.5.2.

5-14.5.5 Replace the UUT cover and secure with the screws removed in step 4-15.1.

5-14.5.6 Perform the necessary steps in section 3-9 to adjust and verify that the UUT output frequency is 10 MHz $\pm$ 5×10^{-11}.

5-14.5.7 Secure the UUT cover by reinstalling all of the remaining screws removed in step 5-14.1.

5-15 UUT OUTPUT FREQUENCY HIGH COMPENSATION.

5-15.1 Remove the UUT from its outer cover by removing the twelve (12) screws and washers from the outer cover sides located near the baseplate end of the UUT. Then remove the four (4) screws and related washers on the connector end and carefully slide the UUT out of the outer cover. The "C-field" current is adjusted by changing pre-selected jumper wires or recalculating the required value of R37 and replacing R37 if necessary. Locate the compensation jumper connections on the synthesizer board. Refer to Figure 5-7.

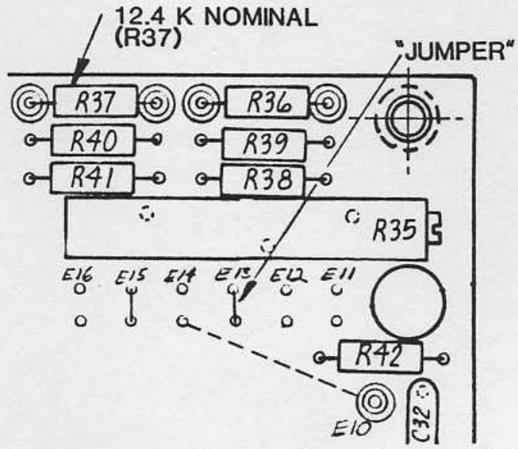


Figure 5-7 Location of Frequency Correction Compensation Jumper on Synthesizer Board Assembly.

NOTE

Terminal E15 is normally jumpered to E10 at the factory, (dotted-line connections in Figure 5-7). If a jumper is installed between E10 and either E14 or E15 perform section 5-15.3. If a jumper is installed between E10 and E16 perform 5-15.4. (It may be also necessary to perform 5-15.5). If E10 is not jumpered to either E14, E15, or E16 perform section 5-15.5.

5-15.3 Using a 35 to 40 watt soldering iron and SN63WRMAP3 solder (Federal Specification QQ-S-571E) perform the following:

5-15.3.1 Select a piece of uninsulated 24 gauge wire approximately 1/8 inch long.

5-15.3.2 If E10/E14 are jumpered, remove the existing jumper and lay the new jumper wire across the E15 and corresponding E10 terminals. If E10/E15 are jumpered, remove the existing jumper and lay the new jumper wire across the E16 and corresponding E10 terminals.

5-15.3.3 Carefully solder the jumper wire in place.

5-15.3.4 Replace the UUT cover and secure with four (4) of the screws removed in step 5-15.1.

5-15.3.5 Perform the necessary steps in section 3-9 to adjust and verify that the UUT output frequency is 10 MHz $\pm$ 5×10^{-11}.

5-15.3.6 Secure the UUT cover by reinstalling all of the remaining screws removed in step 5-15.1.

5-15.4 If it was found that the E10/E16 terminals have a jumper installed, perform the following steps.

5-15.4.1 Using a 35 to 40 watt soldering iron, remove the jumper across the E10/E16 terminal.

5-15.4.2 Replace the UUT cover and secure with four (4) of the screws removed in step 5-15.1.

5-15.4.3 Perform the required steps in section 3-9 to adjust and verify that the UUT output frequency is 10 MHz $\pm$ 5×10^{-11}.

5-15.4.4 Secure the UUT cover by reinstalling all of the remaining screws removed in step 5-15.1.

5-15.5 If no jumper exists between E10 and E14, E15, or E16 it will be necessary to replace R37 with a recalculated valued resistor. To recalculate and replace R37 perform the following steps.

5-15.5.1 Calculate the required increased resistance value for R37 using the following formula:

$$R37\ \text{new} = \frac{40}{\frac{\Delta f}{f} + \frac{40}{R37\ \text{Original}}}$$

Where: $\frac{\Delta f}{f}$ = Anticipated negative frequency shift in parts of 10^{-9}.

R37 = K ohms

5-15.5.2 Using a 35 to 40 watt soldering iron and SN63WRMAP3 solder (Federal Specification QQ-S-571E) remove the existing R37 resistor and install a new R37 resistor with the resistance value calculated in step 5-15.5.1.

5-15.5.3 Replace the UUT cover and secure with four (4) of the screws removed in step 5-15.1.

5-15.5.4 Perform the required steps in section 3-9 to adjust and verify that the UUT output frequency is 10 MHz $\pm$ 5×10^{-11}.

5-15.5.5 Secure the UUT outer cover by reinstalling all of the remaining screws removed in step 5-15.1.

5-16 PHASE NOISE TEST. Using the equipment setup in Figure 5-8, the Efratom MNT Phase Noise Test Set can be used to measure the "close-in" single side-band (SSB) phase noise [$\mathcal{L}(f)$] of the UUT. Refer to detailed procedure in the MNT manual for Calibration to the UUT and actual Phase Noise measurements.

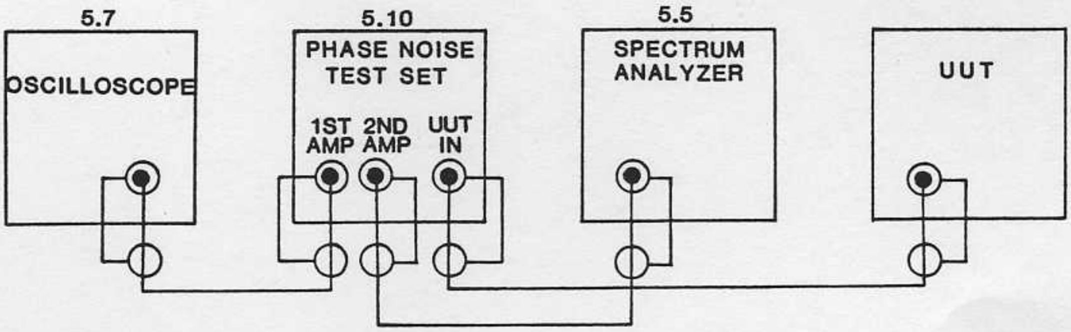


Figure 5-8. Phase Noise Measurement Test Set-up.

5-17 TROUBLESHOOTING AND REPAIR. A series of Fault Isolation Flowcharts are provided to aid the technician in the repair of a faulty board or part. The flowcharts are presented in logical fault isolation order and must be performed in the proper sequence given. The troubleshooting/repair procedures are designed to isolate a fault in the resonator (physics package) as soon as possible as this part of the M-100 is not field repairable. If the fault isolation flowcharts lead to a physics package fault, return the entire unit to Efratom for proper repair.

NOTE

The fault isolation flowcharts are designed to quickly isolate the fault or adjustment. The technician is then referred to the detailed circuit description (chapter 4) and to the schematics following the flowcharts which include key voltages and indications for component troubleshooting and replacement. Using standard circuit tracing techniques, the detailed circuit descriptions, and key indications on schematics, the mean time to repair or adjust the unit is less than 1 hour.

5-17.1 TROUBLESHOOTING / REPAIR TURN-ON.

5-17.2 Remove the UUT outer cover by first removing the twelve (12) screws and related washers from the outer cover sides near the baseplate end of the UUT. Then remove the four (4) screws and related washers from the connector end of the outer cover. Carefully slide the UUT out of the outer cover.

5-17.3 Connect the equipment as shown in Figure 5-9.

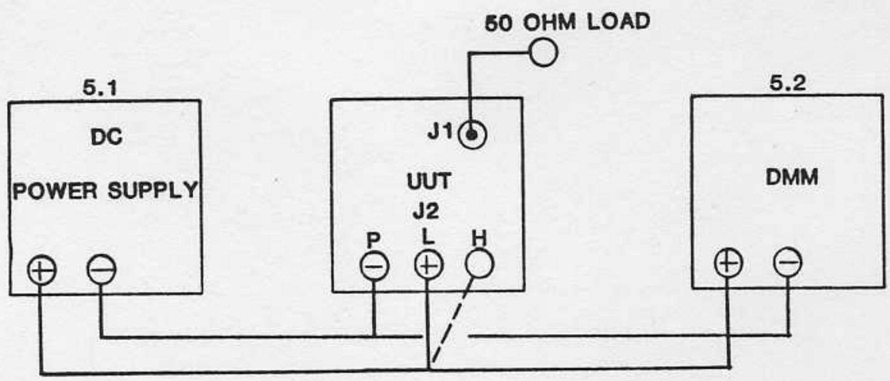


Figure 5-9. Troubleshooting / Repair Setup

5-17.4 Adjust the DC power supply controls to obtain a 26 $\pm$ 1.3 vdc indication on the DMM. Allow the UUT a minimum of 10 minutes warm-up time.

5-17.5 Fault Isolation and Repair. When performing the troubleshooting procedures contained in the fault isolation flowcharts (Figures 5-10 through 5-14), it is suggested that the technician follow the troubleshooting/repair procedures contained in the flowcharts in the given sequence. Each question or procedure will narrow the possible functional area of fault and refer the operator to the appropriate repair, adjustment or realignment, as required. Once the flowcharts have isolated a specific board, the operator should refer to the proper schematic following the flowchart section. Each schematic illustrates key points on the board and their corresponding signal, amplitude and voltage levels. This information will isolate the board fault to a specific component part for replacement or adjustment.

5-18 REPAIR, REPLACEMENT, AND REASSEMBLY TESTING.

5-18.1 SOLDERING SUGGESTIONS. SN63WRMAP3 SOLDER, per QQ-S-571, and a 35 to 40 watt soldering iron should be used to accomplish the majority of the soldering done on the M-100. If a higher wattage soldering iron is used, excessive heat can cause the etched circuit wiring to separate from the board material.

5-18.2 HIGH FREQUENCY CONTACTS. If it becomes necessary to solder in the general area of any of the high frequency contacts in the unit, clean the contacts immediately upon completion of the soldering.

5-18.3 REPLACEMENT PARTS. The parts lists located in the appendix following this chapter contain information that identifies electrical and some mechanical components for the purpose of ordering replacement parts for the M-100. Each parts list includes the following information as a minimum under the column headings listed:

a. ITEM NO. The item numbers listed sequentially on each parts list.

b. QTY REQD. Indicates quantity of each item required for the applicable sub-assembly or assembly. A/R is an abbreviation for "as required".

c. PART OF IDENT NUMBER. This column indicates the MIL-SPEC, Efratom, or manufacturer's part number to be used when ordering required replacement components.

d. DESCRIPTION. Included in this column is a brief description of the part indicating the type of component as well as mechanical dimensions or electrical characteristics as applicable. All abbreviations used are in accordance with MIL-STD-12.

e. REFERENCE. Reference designators are listed in accordance with the applicable schematic and assembly drawing. This column also includes the manufacturers name as might be required to order replacement parts.

5-18.4 ORDERING INFORMATION. To procure replacement parts, address order to the Ball Corp., Efratom Division, Attn: Marketing Department. As a minimum the request shall include parts list number, item number, part number, and quantity required.

5-19 REASSEMBLY TESTING. The adjustments, repair, or alignments required in the fault isolation flowcharts (Figure 5-10 through 5-14) should be followed by the retesting of the procedure which led to the fault isolation to ensure the unit is functioning as required. Reassembly of the UUT can be accomplished by reinstalling the screws in reverse order from section 5-17.2. It is recommended that the operator subject the UUT to the checks in chapter 3 after repair or adjustments.

FAULT ISOLATION SEQUENCE

A) GENERAL

1. Heater checks
2. Check power supply, if power supply is defective, repair and repeat heater check.
3. Warm-up as required.
4. Check Lamp Volts as required.
5. Check Crystal Trim Range as required.
6. Refer to Main Fault isolation flowchart.
7. Individual Fault Location.

B) SPECIAL CONDITIONS

	Refer To
1. Normal lock indication after warm-up, No or low 10 MHz output signal	Crystal Assy Buffer Section
2. Stable 10 MHz output (in-spec) No lock indication	Servo Lock indication
3. Output frequency $\geq$ 10.000050 MHz after warm-up	Check Crystal Thermostat

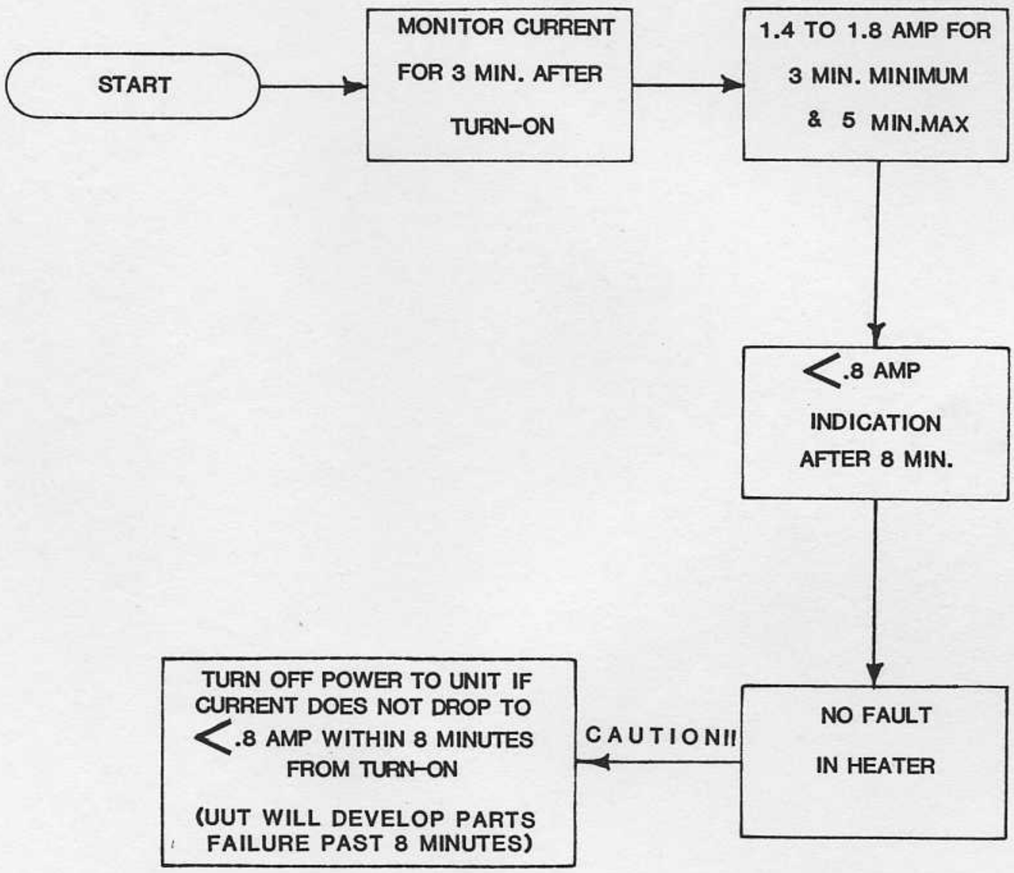
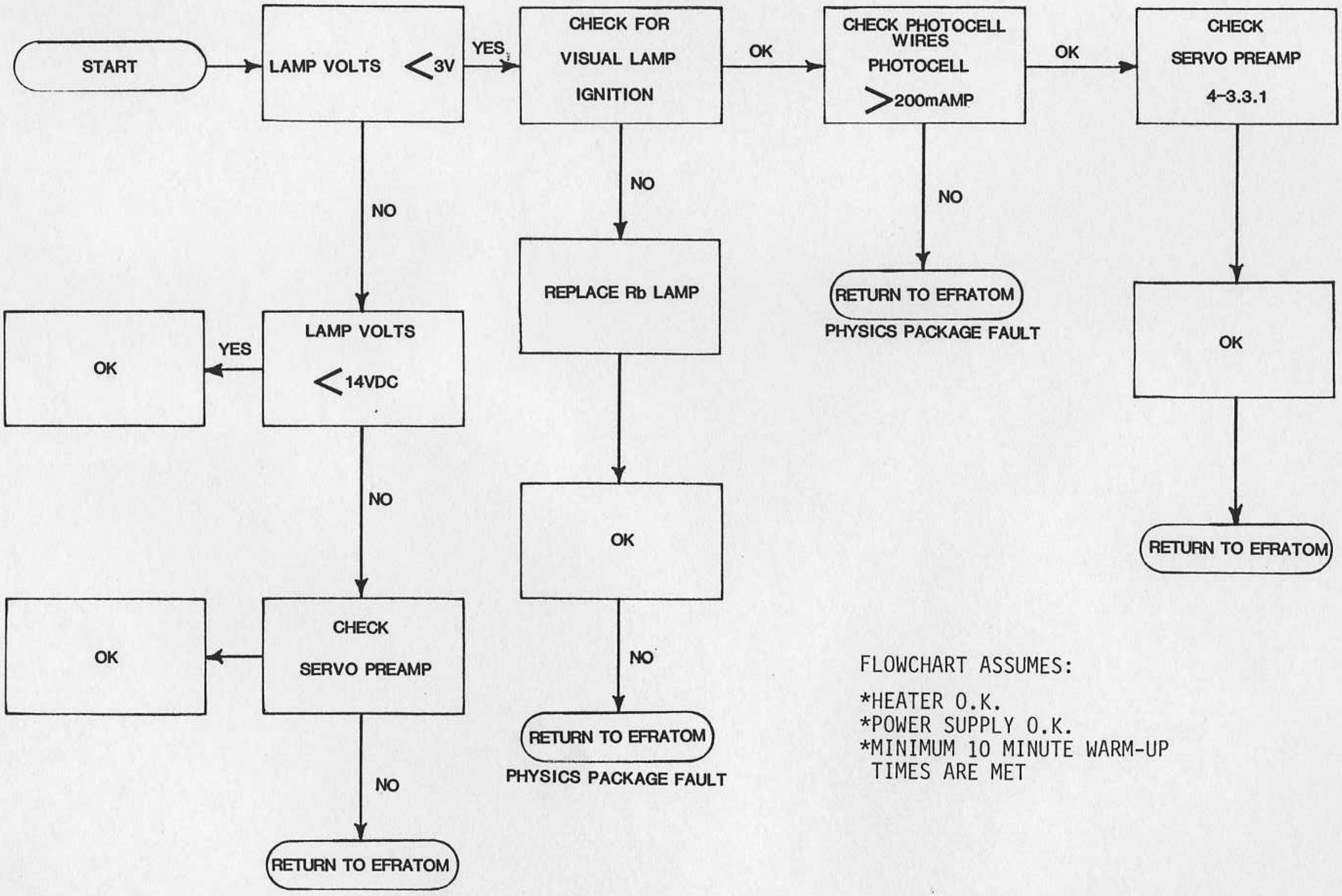


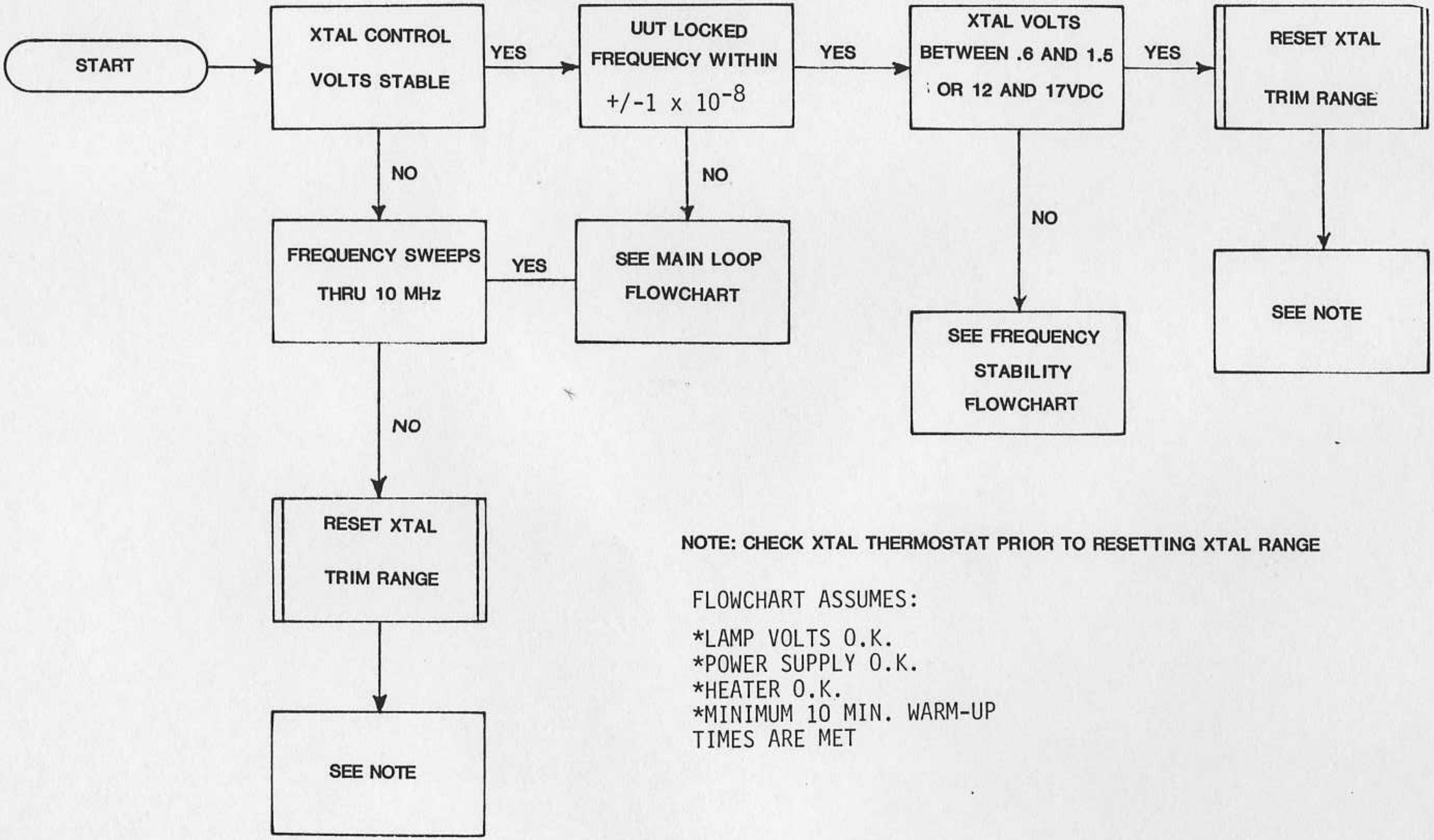
Figure 5-10. Heater Checks Fault Isolation Flowchart



FLOWCHART ASSUMES:

*HEATER O.K.
*POWER SUPPLY O.K.
*MINIMUM 10 MINUTE WARM-UP TIMES ARE MET

Figure 5-11. Lamp Volts Fault Isolation Flowchart.

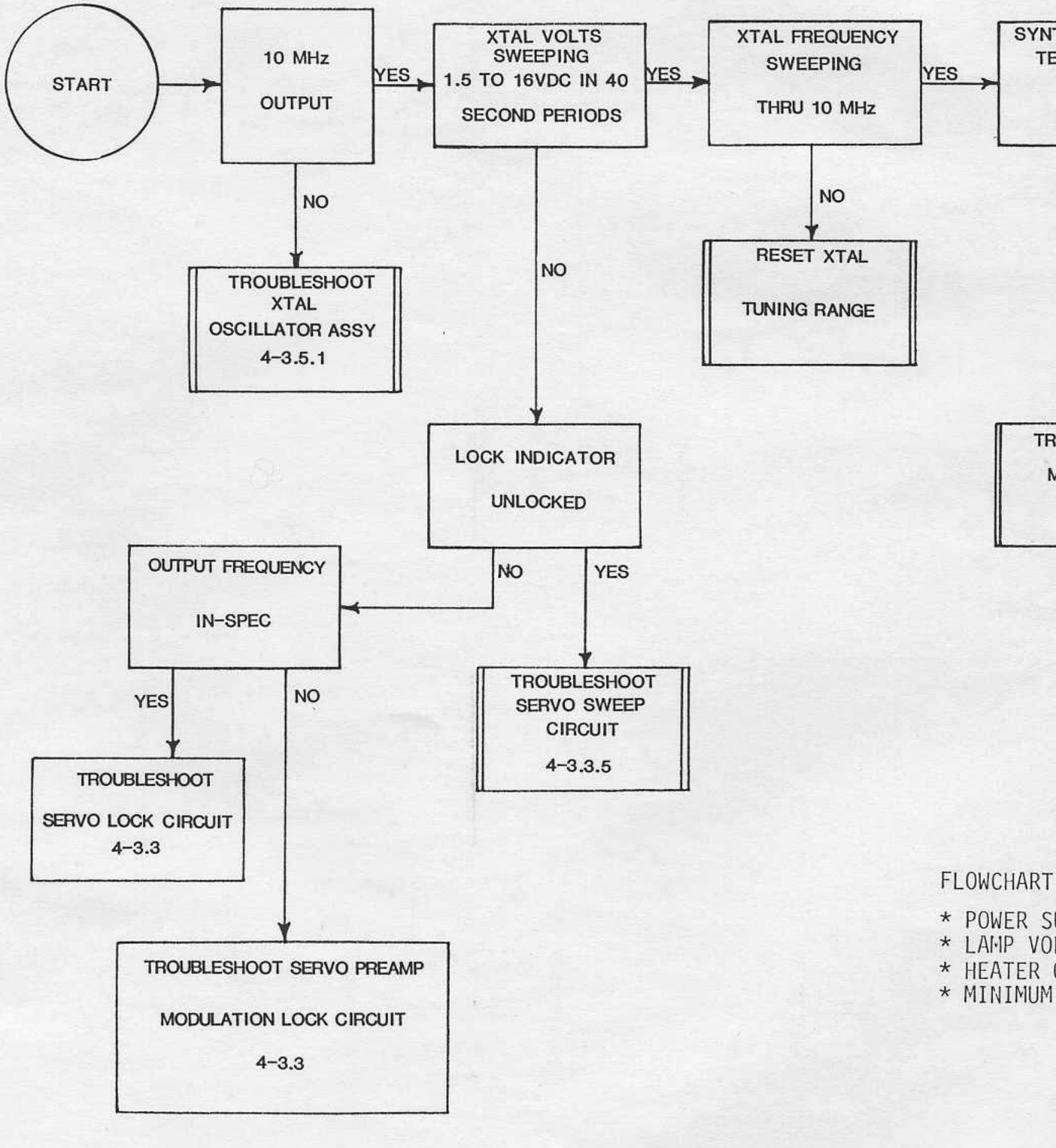


NOTE: CHECK XTAL THERMOSTAT PRIOR TO RESETTING XTAL RANGE

FLOWCHART ASSUMES:

*LAMP VOLTS O.K.
*POWER SUPPLY O.K.
*HEATER O.K.
*MINIMUM 10 MIN. WARM-UP
TIMES ARE MET

Figure 5-12. Trim Range/Crystal Volts Fault Isolation Flowchart.



FLOWCHART

* POWER S
* LAMP VO
* HEATER (
* MINIMUM

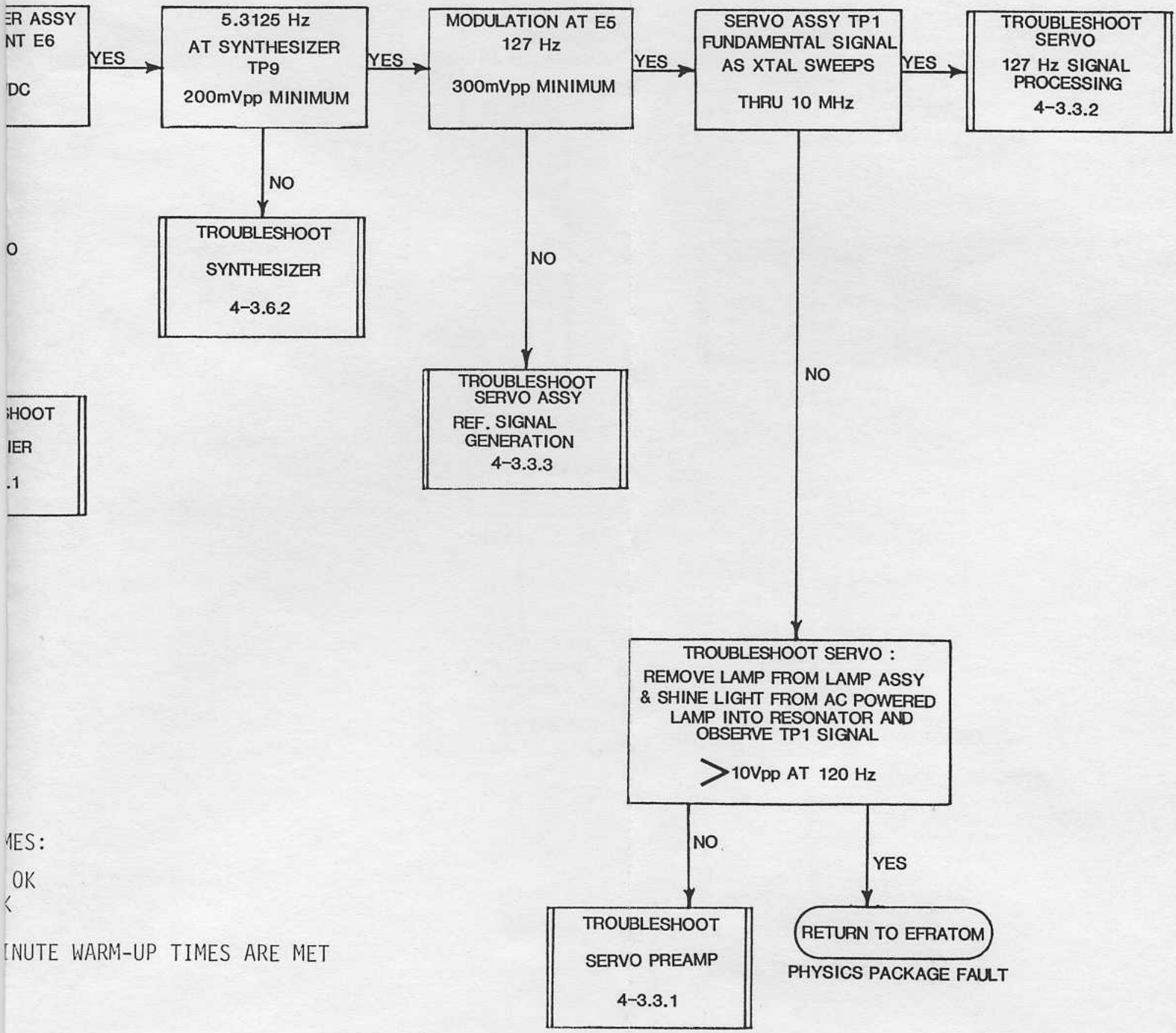
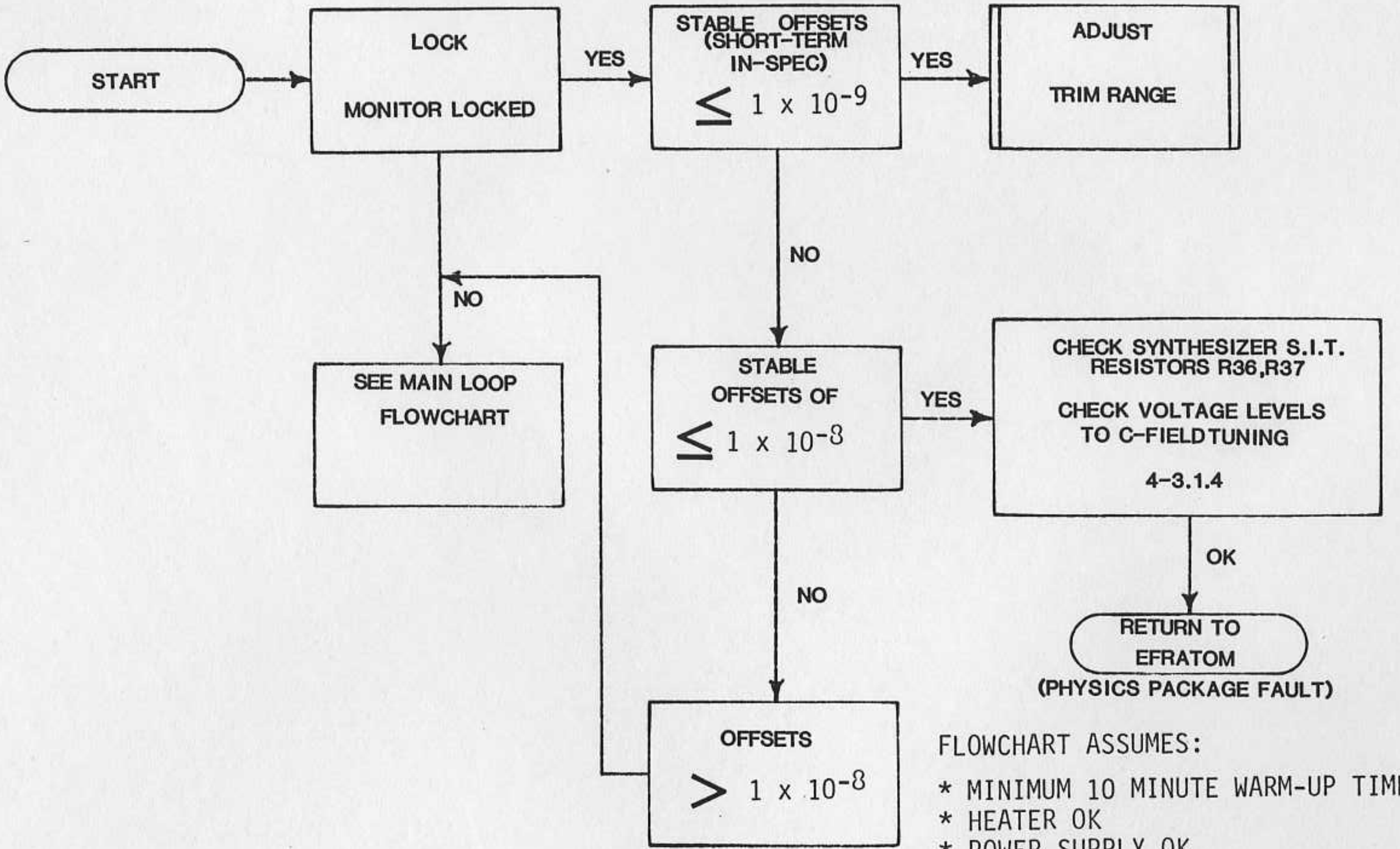


Figure 5-13. Main Fault Isolation Flowchart.



FLOWCHART ASSUMES:

* MINIMUM 10 MINUTE WARM-UP TIMES ARE MET
* HEATER OK
* POWER SUPPLY OK
* LAMP VOLTS 5.5 TO 14.0 VDC
* XTAL VOLTAGE 1.5 TO 12 VDC,(NOT SWEEPING)

Figure 5-14. Frequency Stability/Offset Fault Isolation Flowchart.

APPENDIX A

TROUBLESHOOTING SCHEMATICS, ASSEMBLY DRAWINGS, AND PARTS LISTS

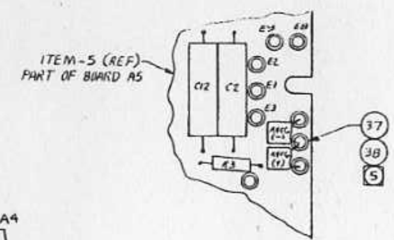
SAMPLE TEST DATA SHEET

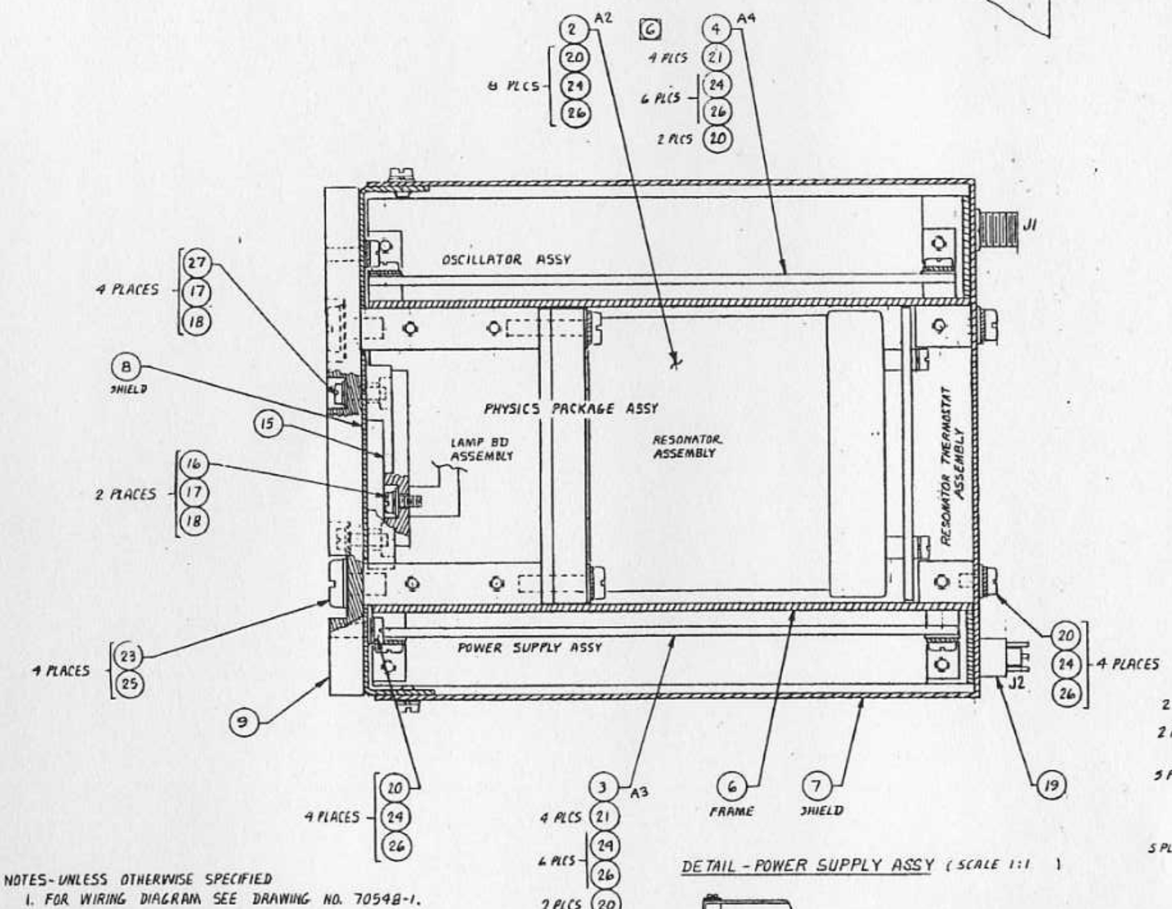
MODEL M-100 RUBIDIUM FREQUENCY STANDARD

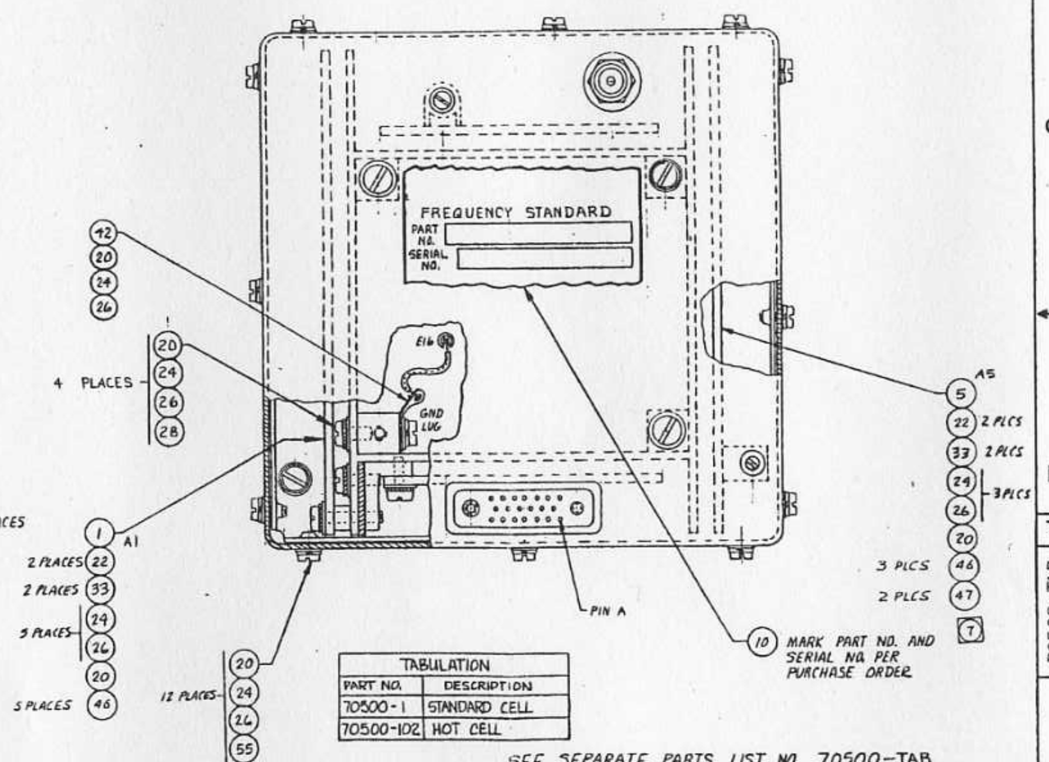
PROCEDURE STEP NO. (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES		OUT OF TOL ✓ (6)	TOLERANCE LIMITS (7)
			FIRST RUN (4)	SECOND RUN (5)		

Page OF

ZONE	LTR	REVISIONS DESCRIPTION	DATE	APPROVED
	A	RELEASED PER DRN 71138	7-16-79	HW
	B	REVISED PER ECO 71107	6-7-79	HW
	C	REVISED PER S/N 002 & ECO 711-188	9-17-79	HW
	D	REV PER ECR 711-243	12-3-79	CC
	E	REV PER ECO 711-209	12-12-79	CC
	F	REV PER ECO 711-309	5-13-79	HW
	G	REV PER ECO 411-8	8-11-81	HW
	H	REV PER ECO-191	3-11-82	HW
	J	ADDED TAB PER E.O.# 676	9-4-84	HW



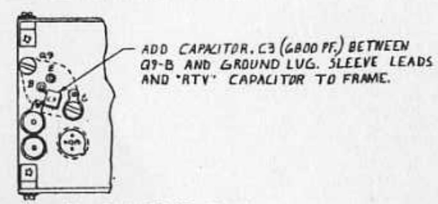




TABULATION	
PART NO.	DESCRIPTION
70500-1	STANDARD CELL
70500-102	HOT CELL

SEE SEPARATE PARTS LIST NO. 70500-TAB

DETAIL - POWER SUPPLY ASSY (SCALE 1:1)



NOTES- UNLESS OTHERWISE SPECIFIED

1. FOR WIRING DIAGRAM SEE DRAWING NO. 70548-1.
2. FOR SCHEMATIC DIAGRAM SEE DRAWING NO. 70501-1.
3. FOR SPECIFICATION SEE DRAWING NO. 70502-TAB.
4. FOR TEST PROCEDURE SEE ATP 70500-TAB.
5. STORAGE LOCATION FOR "A4C6" CAPACITORS. THE VALUE OF "A4C6+" IS 6.8 PF. THE VALUE OF "A4C6-" IS SELECTED TO BE 6 TO 8 PF LESS THAN THE VALUE OF THE "A4C6" WHICH IS INSTALLED ON "A4". THE "A4C6-" MAY BE 2 CAPACITORS AS REQD TO MAKE THE VALUE.
6. SEAL PHYSICS PACKAGE WITH ECCOFOAM.
7. INSTALL E.T. LOCK WASHER AT POINTS OF GROUND PLANE WHICH REQUIRE GROUNDING.

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS		DATE
DRAWN	[illegible]	7-10-79
CHECKED	[illegible]	4-17-79

NEXT ASSY	USED ON
	M-100
APPLICATION	

FINAL ASSEMBLY - FREQUENCY STANDARD MODEL M-100/M-100-102

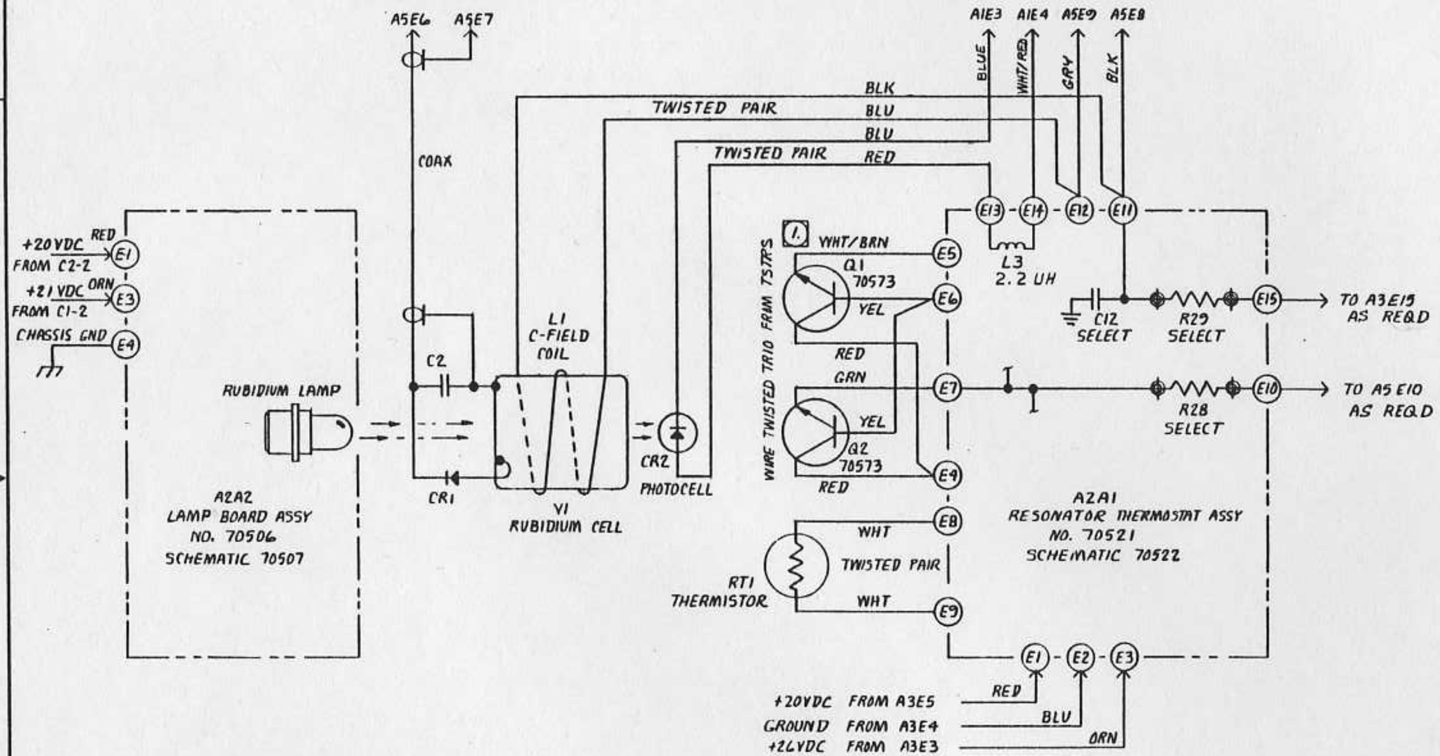
SIZE	CODE IDENT NO.	DRAWING NO.	REV
D	55761	70500-TAB	J

SCALE 2/1 | M 100 | SHEET 1 OF 1

4 | 3 | 2 | 1

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED PER ECO 711-122	6-20-79	HW
	B	REV. PER ECO 711-302	5-12-80	HW
	C	REV PER ECO 450	8-7-81	HW



NOTES-UNLESS OTHERWISE SPECIFIED

1. THE THERMISTOR (RT1) IS PHYSICALLY LOCATED AND MOUNTED NEXT TO (Q1).

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS ± DECIMALS XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

CONTRACT NO.

APPROVALS		DATE
DRAWN	Whitmore	6-20-79
CHECKED	[illegible]	6-26-79
	[illegible]	6/26/79
	C. Heacock	6/26/79

NEXT ASSY	USED ON
	M-100

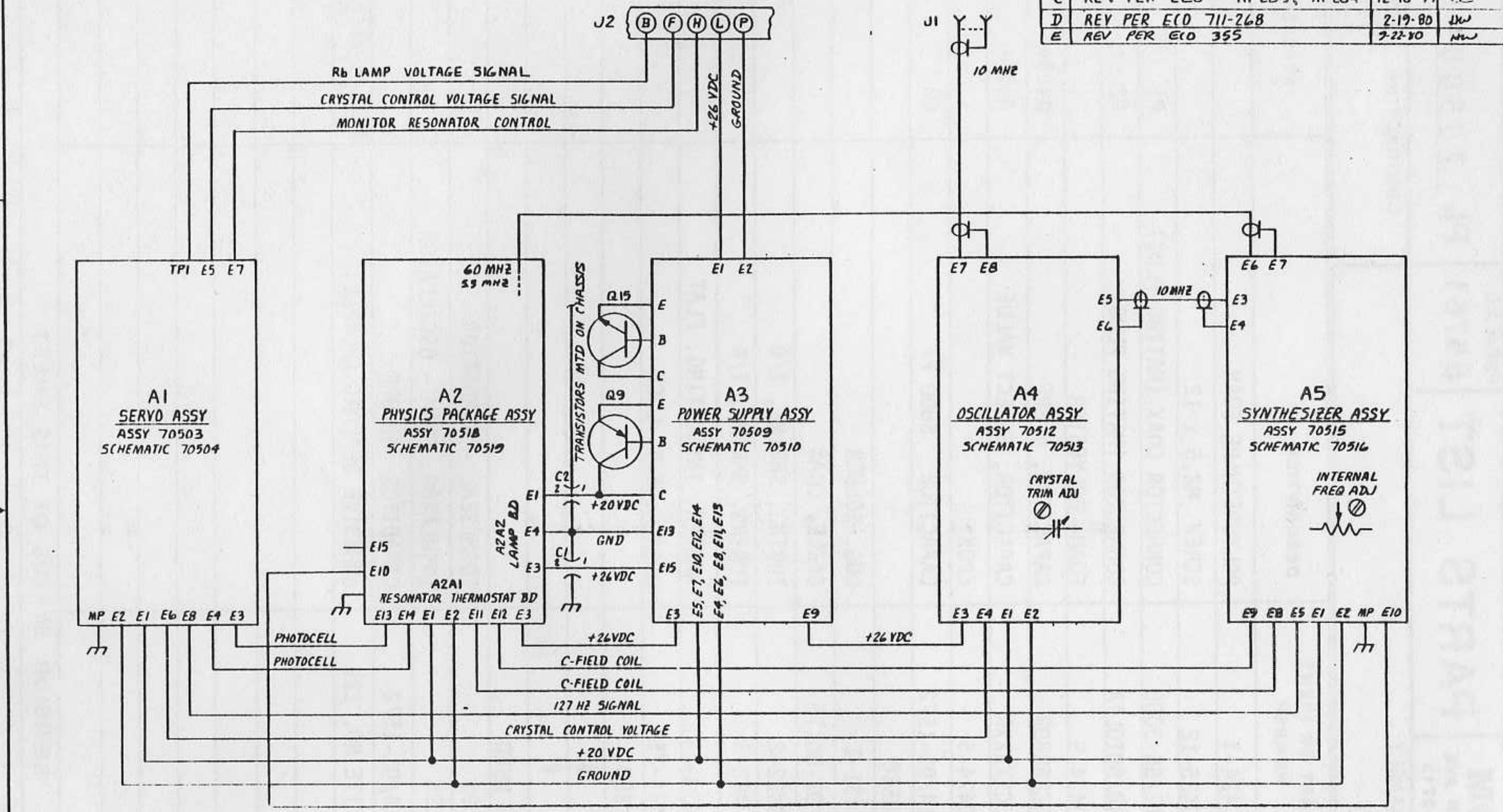
EFRATOM

SCHEMATIC - PHYSICS PACKAGE A2

SIZE	CODE IDENT NO.	DRAWING NO.	
C	55761	70519	C

70519 - C

		REVISIONS		
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED PER ECO 711-122	7-16-79	JW
	B	REVISED PER ECO 711-191	9-18-79	JW
	C	REV PER ECO 711-203, 711-204	12-18-79	
	D	REV PER ECO 711-268	2-19-80	JW
	E	REV PER ECO 355	9-22-80	



QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION
		PARTS LIST	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

CONTRACT NO.

APPROVALS		DATE
DRAWN	Whitmer	7/16/79
CHECKED		7/17/79
		7/

EFRATOM

SCHEMATIC – FREQUENCY STANDARD M-100

SIZE	CODE IDENT NO.	DRAWING NO.	
C	55761	70501-1	E

SCALE — SHEET — OF —

NEXT ASSY	USED ON
	70500

APPLICATION

DO NOT SCALE DRAWING

70501-1 E

EFRATOM 18851 BARDEEN AVE IRVINE, CAL., 92715	PARTS LIST	FSCM NO. 55761	PL 70500-1

LIST TITLE: FINAL ASSEMBLY M-100	CONTRACT NO.	SHEET 3 OF 3

ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENT NUMBER	DESCRIPTION	REFERENCE
32	AR		70424-3	POLYURETHANE FOAM	
33	4		70425-12	SCREW M2.5 x 12	
34	1		M39012/55-3006	CONNECTOR COAX (MATING PLUG)	P1
35	1		M28748/8DIOL1A	CONNECTOR (MATING PLUG)	P2
36	AR		70424-9	FOAM, POLYESTER	
37	1		CCR05CJ6R8DR	CAPACITOR, 6.8PF	A4C6+
38	AR		CCR05CXXXXXR	CAPACITOR, SELECT VALUE	A4C6-
39	AR		70424-5	EPOXY	
40	1		M39014/01-1572	CAPACITOR 6800 PF	C3
41			NOT USED		
42	1		MS35431-1	LUG, SOLDER	
43	AR		M17/93-RG178	CABLE, COAX	
44	AR		70422-2	TUBING, SHRINK, 1/8	
45	AR		70422-3	TUBING, SHRINK, 1/4	
46	AR		70414-24	WASHER, INSULATING, FLAT	
47	2		70414-25	WASHER, E.T. LOCK	
48			NOT USED		
49			↕		
50					
51			NOT USED		
52	1		70593	FOAM SEAL - RESONATOR	
53	1		70595	INSULATOR, FOAM - OSCILLATOR	
54	AR		M39014/01-1572	CAPACITOR 6800PF	
55	AR		LOCKTITE NO. 222	ADHESIVE SEALANT (PURPLE)	MIL-S-46163 TYPEII, GRADE M

REVISION STATUS OF THIS SHEET

LETTER	A	B	C	D	E	F	G	H	J	K	L
DATE	5-24-79	6-7-79	7-5-79	7-27-79	9-17-79	9-21-79	11-16-79	12-13-79	5.13-80	8-5-80	4-3-81
ECO NO.	711-67	711-107	711-133	711-152	711-188	HW ADDED -34 -35	711-209 -226	ITEM 42	711-309	350	434

EFRATOM 18851 BARDEEN AVE IRVINE, CAL., 92715

PARTS LIST

FSCM NO. 55761 | PL 705-153-1

LIST TITLE: SERVO ASSEMBLY | CONTRACT NO. | SHEET 2 OF 4

ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENT NUMBER	DESCRIPTION	REFERENCE
1	1		705-155	PRINTED WIRING BOARD	
2	1		CCR05CG101JR	CAPACITOR 100PF	C17
3	1		M39014/01-1353	560PF	C10
4	2		M39014/01-1357	1000 PF	C5, C7
5	5		M39014/01-1572	6800 PF	C1, 2, 3, 20, 21
6	1		M39014/01-1575	.01 UF	C30
7	1		M39014/02-1356	.22 UF	C33
8	12		M39014/01-1593	.1 UF	C6, 35-40, 23, 27, 28, 29, 42
9	1		M39014/02-1419	1 UF	C34
10	1		M39003/1-3006	10 UF	C4
11	4		M83421/01-1142S	.047 UF	C24, 25, 26, 31
12	4		M83421/01-1171S	.1 UF	C13, 14, 15, 16
13	2		M83421/01-1252S	CAPACITOR 1UF	C8, C22
14	3		RCR07G220JS	RESISTOR 22Ω 1/4W	R54, 73, 74
15	—		NOT USED		
16	2		RCR07G331JS	330Ω 1/4W	R77, 78
17	1		RCR07G915JS	9.1MEG 1/4W	R63
18			RCR07G105JS	1MEG 1/4W	R37, 50, 51, 56, 61
19	2		RCR07G475JS	4.7 MEG 1/4W	R65, 76
20	1		RNC55H2740FS	274Ω 1/10W	R5
21	1		RNC55H4640FS	464Ω	R67
22	1		RNC55H4990FS	499Ω	R2
23	1		RNC55H6810FS	681Ω	R6
24	2		RNC55H1001FS	1K	R8, 49
25	1		RNC55H2211FS	2.21K	R75
26	—		NOT USED		
27	1		RNC55H3011FS	3.01K	R3
28	2		RNC55H3481FS	3.48K	R20, 66
29	1		RNC55H3571FS	3.57K	R28
30	2		RNC55H9091FS	9.09K	R21, 29
31	4		RNC55H1002FS	RESISTOR 10K 1/10W	24, 60, 13, 52

REVISION STATUS OF THIS SHEET

LETTER	A	B	C								
DATE	5-20-83	10-31-83	12-12-83								
ECO NO.	JH	598	637A								

EFRATOM 18851 BARDEEN AVE IRVINE, CAL., 92715	PARTS LIST	FSCM NO. 55761	PL 705-153-1
LIST TITLE: SERVO ASSEMBLY		CONTRACT NO.	SHEET 3 OF 4

ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENT NUMBER	DESCRIPTION	REFERENCE
32	1		RNC55H1502FS	RESISTOR 15K	R4
33	1		RNC55H1872FS	18.7K	R1
34	1		RNC55H2743FS	274 K	R62
35	1		RNC55H2742FS	27.4K	R48
36	2		RNC55H3322FS	33.2K	R17, R46
37	1		RNC55H3922FS	39.2K	R47
38	1		RNC55H4752FS	47.5K	R42
39	1		RNC55H5622FS	56.2K	R18, [illegible]
40	3		RNC55H8252FS	82.5K	R27, 57, 45
41	10		RNC55H1003FS	100K R7, 9, 11, 25, 32,	38, 43, 79, 44, 8
42	—		——	NOT USED	
43	1		RNC55H3323FS	332K	R55
44	1		RNC55H4223FS	422K	R35
45	1		RNC55H1004FS	1 MEG	R59
46	1		RNC55H2004FS	2MEG	R12
47	5		RNC55H XXXX FS	RESISTOR, SELECT VALUE	R19, 22, 23, 30, 36
48	1		RWR80S1000FS	RESISTOR 100Ω 2W	R68
49	—		NOT USED		
50	—		NOT USED		
51	1		JANTX 1N4153	DIODE	CR9
52	2		MS75084-4	INDUCTOR 2.2UH	L1, 2
53	-		NOT USED		
54	1	*	JANTX2N3501	TRANSISTOR	Q1
55	2		M38510-10703BXC	VOLTAGE REG.	VR1, VR2
56	1		70495-1	INTEGRATED CKT (883/4053BC)	U4
57	1		70496-1	(μA725HMQB)	U1
58	-		NOT USED		
59	-		NOT USED		
60	1		M38510-10104BGX		U5
61	2		M38510-11005BCX	(LM124J/883B)	U6, U2
62	1		CD4060BD/3	INTEGRATED CKT	U3

REVISION STATUS OF THIS SHEET

LETTER	A	B	C	D	E	F
DATE	5-20-83	10-31-83	12-7-87	1-11-88	4-13-88	5/6/88
ECO NO.	JH	598	1393	1416	1503	1528

EFRATOM
18851 BARDEEN AVE
IRVINE, CAL., 92715

PARTS LIST

FSCM NO. 55761

PL 705-153-1

CONTRACT NO.

LIST TITLE: SERVO ASSEMBLY

ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENT NUMBER	DESCRIPTION	REFERENCE
63	21		SE16XC02	TERMINAL - TURRET	
64	3		70418-1	MOUNTING PAD	XQ1, XVR1, XVR2
65	AR		QQ-W-343, TYPE S	WIRE, TINNED COPPER 24AWG	
66	2		M38527/4-03N	MOUNTING PAD	XU1, XU5
67	10		70416-3	TERMINAL, BIFURCATED	
68	4		70417-1	STANDOFF - PEM	
69	1		RNC55H6812FS	RESISTOR 68.1K	R58
—	REF		705-154	SCHEMATIC	

*NOTE: WHEN JANTX2N3501 IS NOT AVAILABLE, USE JANTX2N5662 OR 704-262 AS AN ACCEPTABLE ALTERNATE.

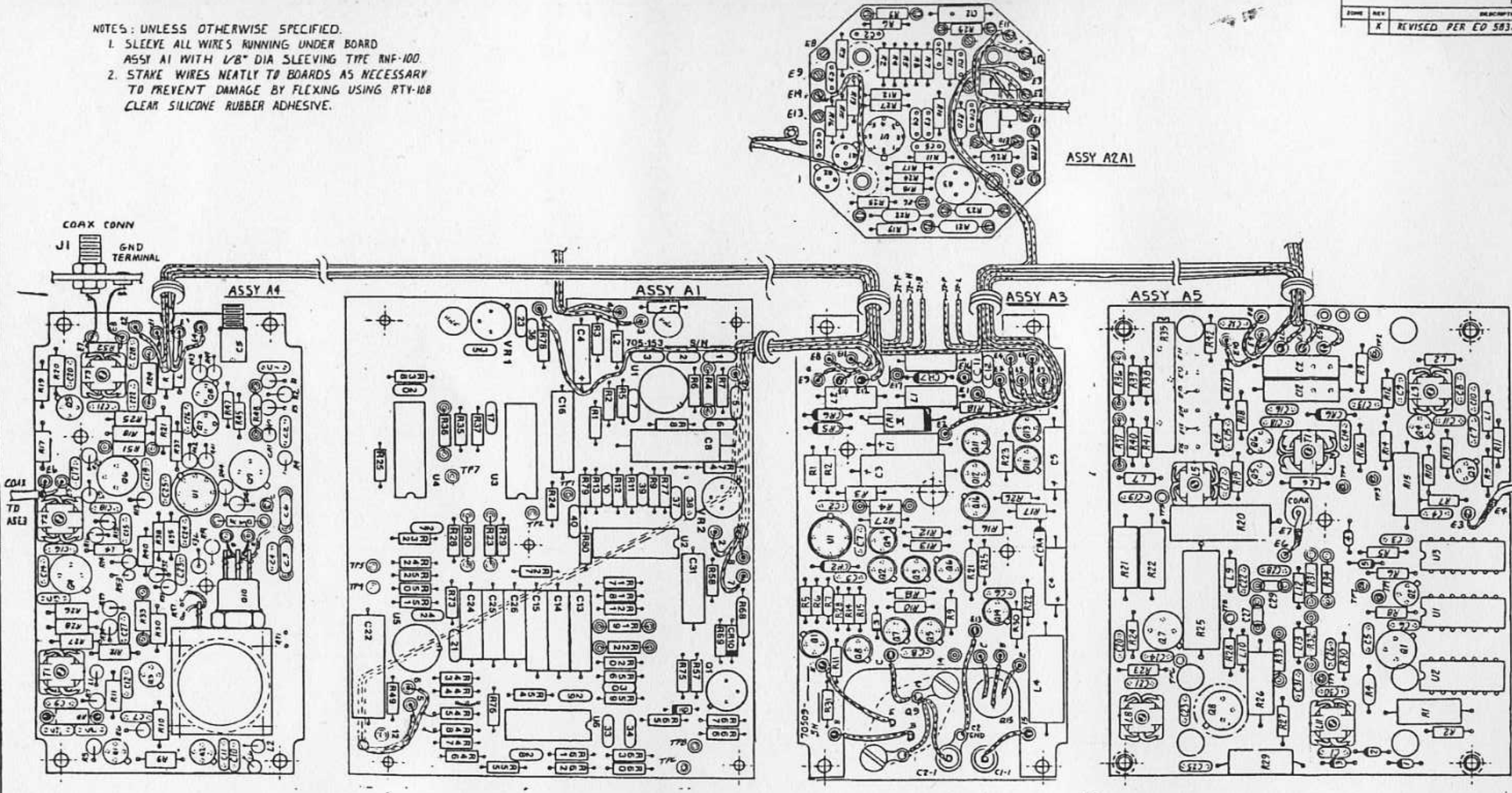
REVISION STATUS OF THIS SHEET

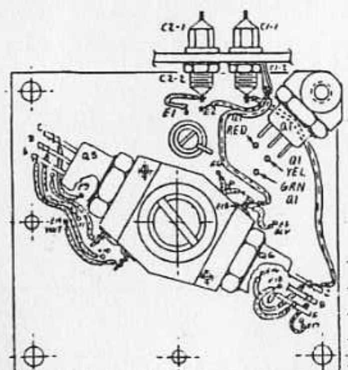
LETTER	A	B	C	D	E
DATE	5-20-83	2-17-87	1-11-88	4-13-88	5-6-88
ECO NO.	JH	1135	1416	1503	1528

ZONE	REV	DESCRIPTION	DATE	APPROVED
	K	REVISED PER EO 583A	8-19-83	

NOTES: UNLESS OTHERWISE SPECIFIED.

1. SLEEVE ALL WIRES RUNNING UNDER BOARD ASSY A1 WITH 1/8" DIA SLEEVING TYPE RNF-100.
2. STAKE WIRES NEATLY TO BOARDS AS NECESSARY TO PREVENT DAMAGE BY FLEXING USING RTV-108 CLEAR SILICONE RUBBER ADHESIVE.





SINGLE ENTRY WIRE LIST

NO.	FROM	TO	COLOR	NO.	FROM	TO	COLOR	NO.	FROM	TO	COLOR
1	A1E1	A3E12	RED	19	A3E2	J2-P	BLU	36	A5E1	A3E7	RED
2	A1E2	A3E11	BLU	20	A3E13	C2-GND	BLU	37	A5E2	A3E6	BLU
3	A1E3	A2	BLU	21	A3E15	C1-1	ORN	38	A5E6	RESONATOR	COAX
4	A1E4	A2A1E14	WHT/RED	22	A3Q9E	Q9E	GRN	—	A5E7	RESONATOR	SHIELD
5	A1E5	J2-F	GRN	23	A3Q9B	Q9B	YEL	39	A5E8	A2A1E11	BLK
6	A1E6	A4E1	YEL	24	A3Q9C	Q9C	RED	40	A5E9	A2A1E12	GRY
7	A1E7	J2-H	WHT	25	A3Q15E	Q15E	GRN	41	A5E10	A2A1E10	WHT/RED
8	A1E8	A5E5	WHT/GRN	26	A3Q15B	Q15B	YEL				
9	A1E9	J2-B	WHT/BLK	27	A3Q15C	Q15C	RED				
10	A2A1E1	A3E5	RED	28	Q9C	Q9C	JUMPER				
11	A2A1E2	A3E4	BLU	29	Q9C	C2-1	RED				
12	A2A1E3	A3E3	ORN	30	A4E1	A3E10	RED				
13	A2A2E1	C2-2	RED	31	A4E2	A3E8	BLU				
14	A2A2E2	C1-GNDLUG	BLU	32	A4E3	A3E9	ORN				
15	A2A2E15	C1-GNDLUG	BLU	33	A4E5	A5E3	COAX				
16	—	—	—	34	A4E6	A5E4	SHIELD				
17	A2A2Q6C	C1-2	ORN	—	A4E7	J1	BUS				
18	A3E1	J2-L	ORN	35	A4E8	GND TERM	BUS				

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES

DO NOT SCALE DRAWING

APPLICATION

EFRATOM

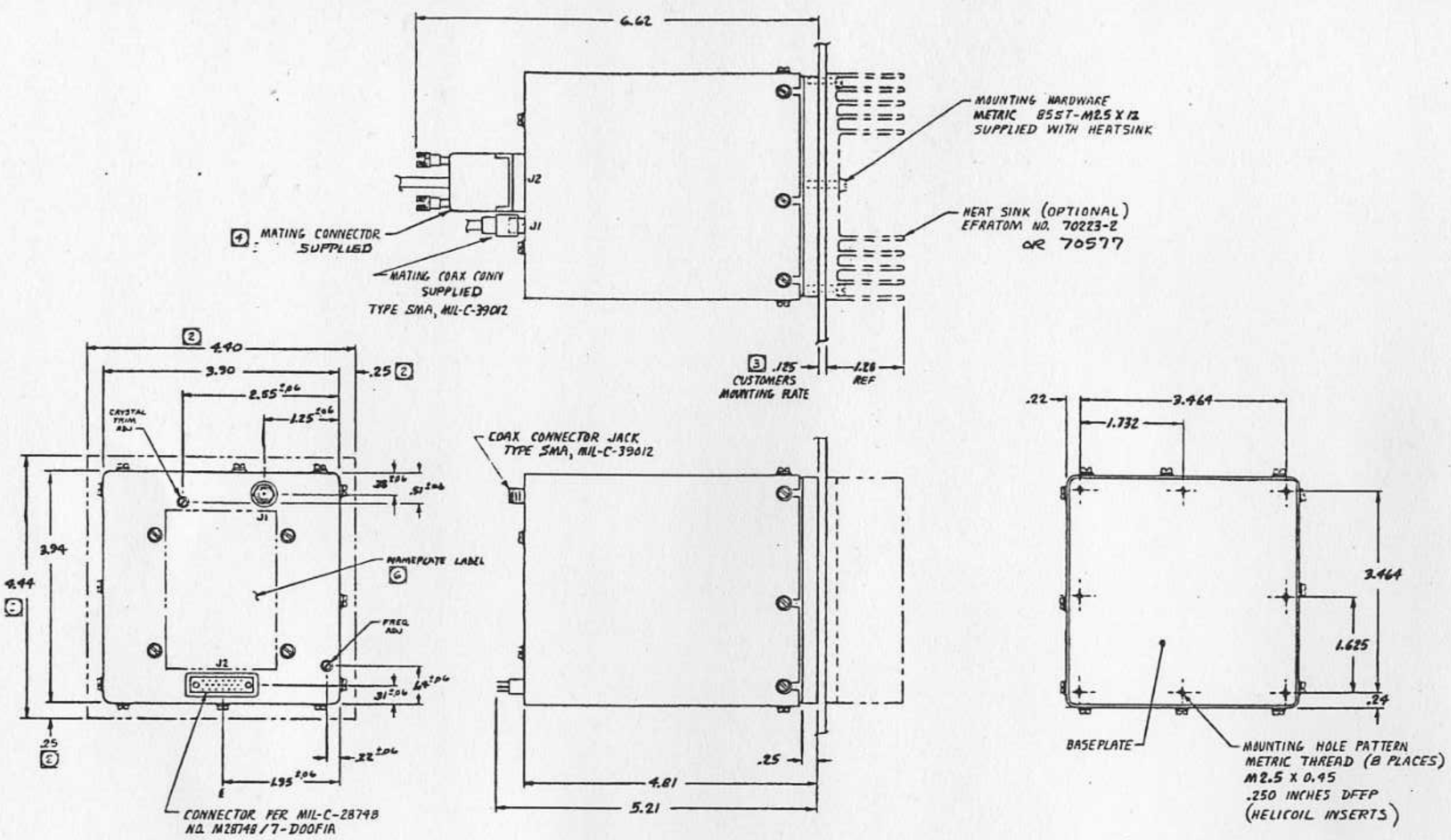
WIRING DIAGRAM — RUBIDIUM OSCILLATOR

SIZE	FSCM NO.	DWG. NO.	REV
D	55761	70548-3	K

DRAWN 4-12-83

SCALE 2X SHEET 1

ZONE	LTR	REVISIONS DESCRIPTION	DATE	APPROVED
	A	RELEASED PER ECO 711-148	7-31-79	HW
	B	REV PER ECO 711-268	2-20-80	HW



NOTES - UNLESS OTHERWISE SPECIFIED

1. FOR SPECIFICATIONS SEE DRAWING NO. 70502-1.
2. PREFERRED CLEARANCE AROUND UNIT FOR SHOCK AND VIBRATION.
3. PREFERRED THICKNESS OF MOUNTING SURFACE.
4. CONNECTOR WIRING DATA:
   - J1 ___ 10MHz OUTPUT
   - J2-L ___ +22.5 TO +32 VDC INPUT
   - J2-P ___ GROUND
   - J2-F ___ CRYSTAL CONTROL VOLTAGE SIGNAL
   - J2-H ___ RESONANCE LOCK SIGNAL
   - J2-B ___ Rb LAMP VOLTAGE SIGNAL

NOTES - CONTINUED

5. FOR ASSEMBLY DRAWINGS, SCHEMATICS, AND DETAIL PARTS OF THIS UNIT, SEE EFRATOM MASTER DRAWING LIST NO. MDL 70500-1.
6. THE NAMEPLATE LABEL IS MARKED WITH EFRATOM PART NO. AND SERIAL NO. UNLESS OTHERWISE SPECIFIED.

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± DECIMALS .XX ±.03 .XXX ±.010 ANGLES ±

MATERIAL —

FINISH —

DO NOT SCALE DRAWING

NEXT ASSY	USED ON
—	70500-1

APPLICATION

CONTRACT NO.

APPROVALS	DATE
DRAWN Whitmore	7-31-79
CHECKED Weidemann	7-31-79
[signature]	7/31/79
C. Hancock	7/31/79

EFRATOM

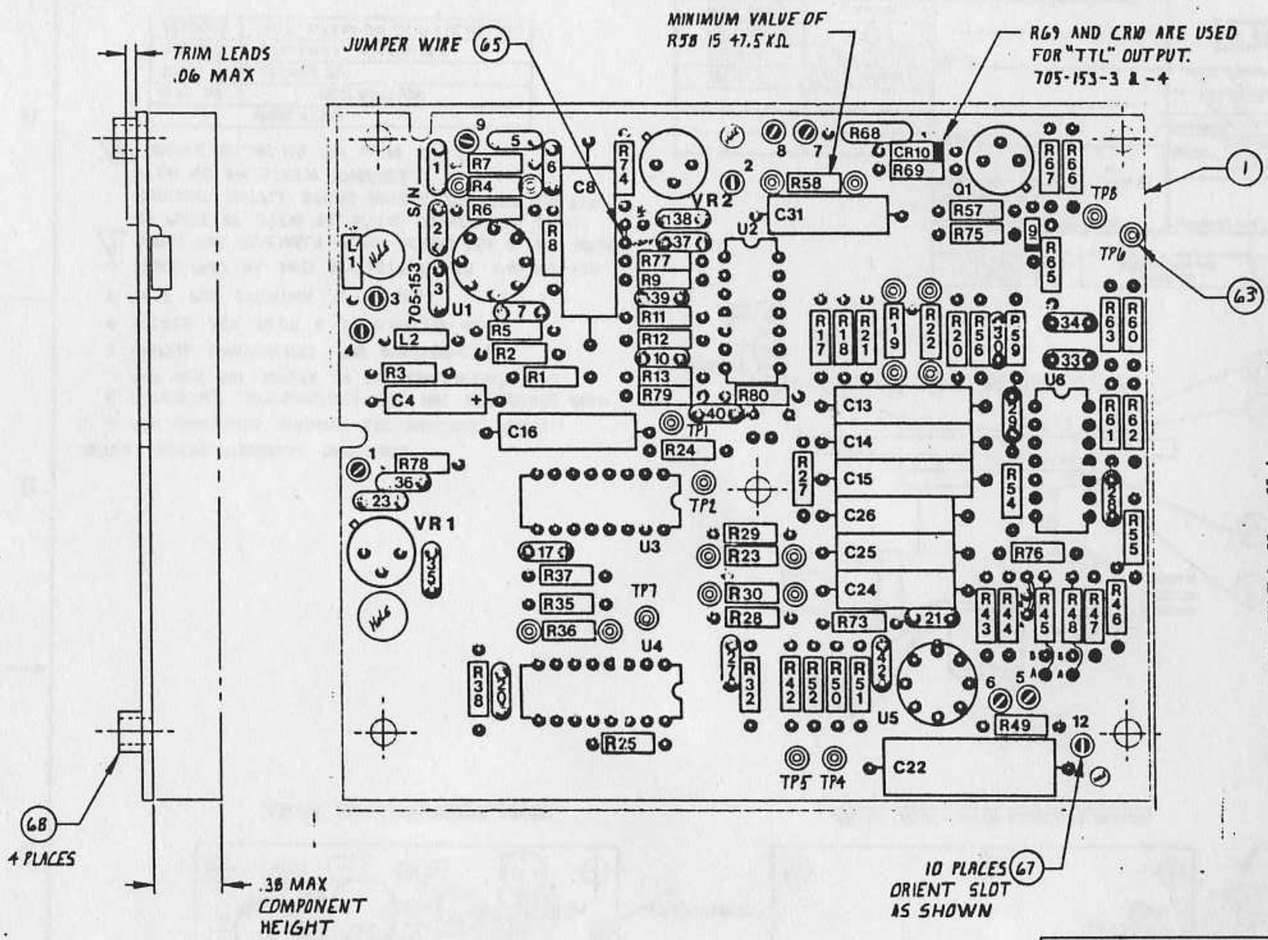
OUTLINE AND MOUNTING - RUBIDIUM FREQUENCY STANDARD MODEL M-100

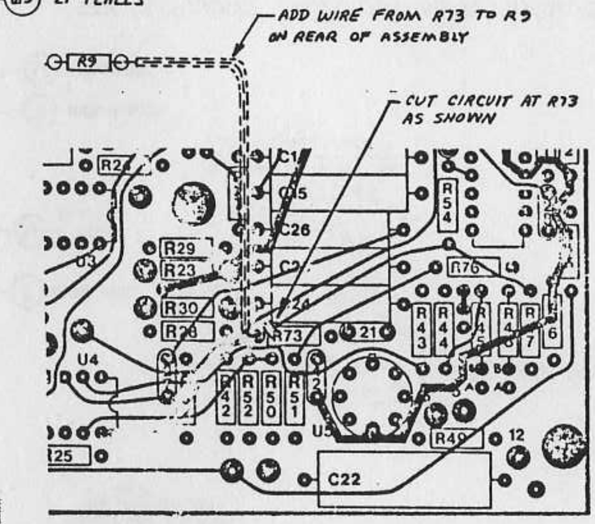
SIZE D | CODE IDENT NO. 55761 | DRAWING NO. 70549-1 | B

SCALE 1/1 | SHEET 1 OF 1

70549-1 B

ZONE	REV	DESCRIPTION	DATE	APPROVED
	A	RELEASED	5-19-83	[illegible]
	B	REVISED PER ED 583A	8-3-83	—
	C	REVISED PER EO 927	6/5/86	[illegible]
	D	REVISED PER ED 1135	2-13-87	[illegible]
	E	REVISED PER EO-1321	4/9/87	[illegible]





LN ASSEMBLY
705-153-2, 705-153-3

TABULATION

ASSEMBLY NO.	R44	R45	R46	R47	R60	R65	R76	JUMPER POSITION	R42	"TTL"
705-153-1	100K	82.5K	33.2K	39.2K	10K	4.7MEG	4.7MEG	"A"	47.5K	NO
705-153-2(LN)	47.5K	221K	15K	22.1K	2.74K	20MEG	20MEG	"B"	82.5K	NO
705-153-3TTL(LN)	47.5K	221K	15K	22.1K	2.74K	20MEG	20MEG	"B"	82.5K	YES
705-153-4 TTL	100K	82.5K	33.2K	39.2K	10K	4.7MEG	4.7MEG	"A"	47.5K	YES

NOTES: UNLESS OTHERWISE SPECIFIED.

1. FOR SCHEMATIC DIAGRAM SEE DWG NO. 705-154.
2. REFERENCE DESIGNATORS ARE FOR REFERENCE ONLY AND MAY NOT APPEAR ON THE COMPONENT PART.
3. INSTALL COMPONENTS PER MIL-STD-275.
4. SOLDER PER REQT 5 OF MIL-STD-454.
5. CONFORMAL COAT BOTH SIDES PER MIL-I-46058, TYPE UR. MASK OFF ALL SOLDER TERMINALS AND MOUNTING HOLES.
6. MARK PART NO. AND REV LETTER PER MIL-STD-130.
7. BOND COMPONENTS C4, 8, 13-16, 22, 24-26, 31 USING TRABOND 2112. CURE 35 MINUTES MIN AT 60 TO 70°C.

SEE SEPARATE PARTS LIST NO. PL 705-153 SEE TAB

QTY REQD	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

CONTRACT NO.

APPROVALS — DATE
DRAWN [illegible] 5-19-83
CHECKED
ISSUED

NEXT ASSY — USED ON
APPLICATION

DO NOT SCALE DRAWING

EFRATOM

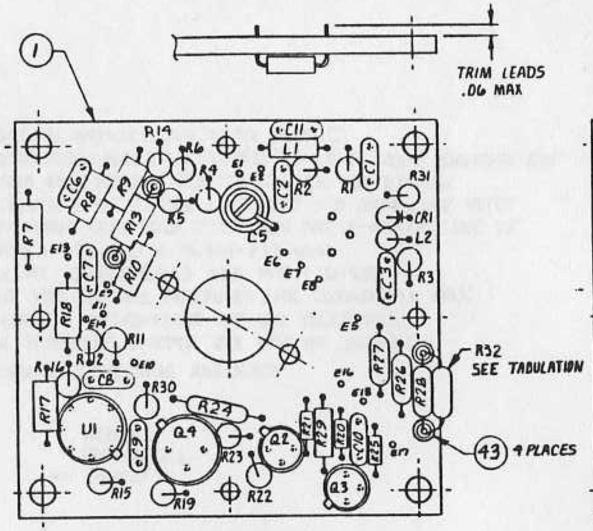
ASSY-SERVO BD.

SIZE C | FSCM NO. | DWG. NO. 705-153-TAB | REV. E

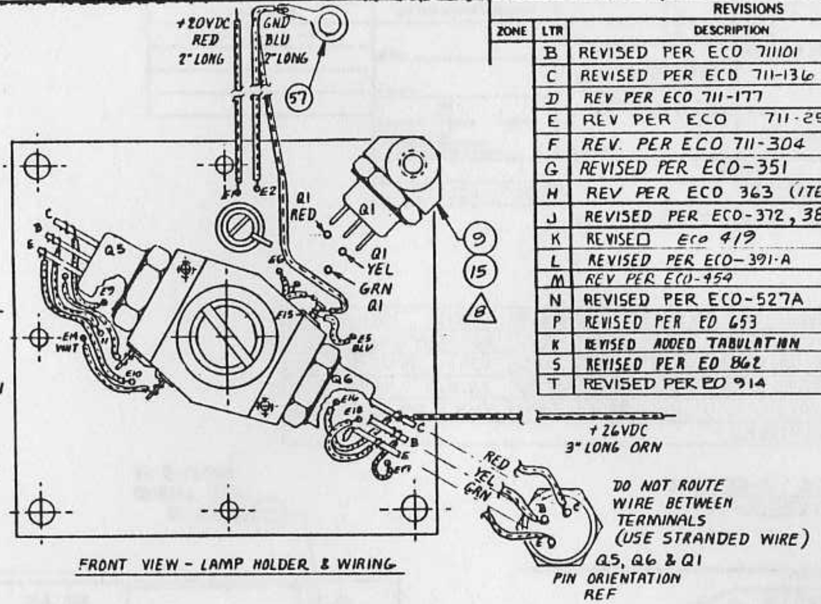
SCALE 2/1 | M100 | SHEET 1

DWG. NO. 705-153 | SH 1 | REV E

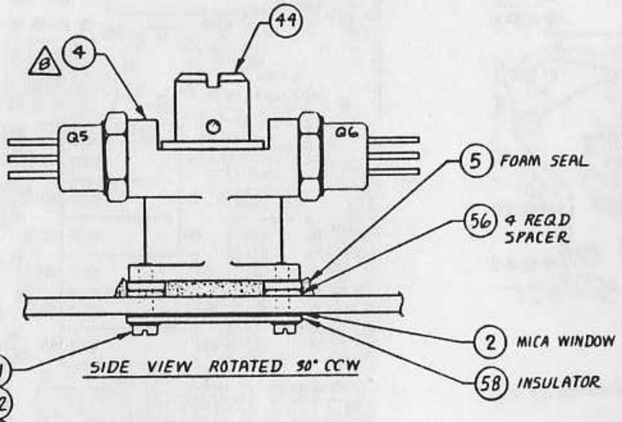
REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	B	REVISED PER ECO 711101	6-5-79	[illegible]
	C	REVISED PER ECO 711-136	7-18-79	[illegible]
	D	REV PER ECO 711-177	9-11-79	[illegible]
	E	REV PER ECO 711-250	12-3-79	CC
	F	REV. PER ECO 711-304	5-12-80	[illegible]
	G	REVISED PER ECO-351	8-5-80	[illegible]
	H	REV PER ECO 363 (ITEM-57)	7-22-80	[illegible]
	J	REVISED PER ECO-372, 382	9-30-80	[illegible]
	K	REVISED ECO 419	1-29-81	[illegible]
	L	REVISED PER ECO-391-A	2-26-81	[illegible]
	M	REV PER ECO-454	6-10-81	[illegible]
	N	REVISED PER ECO-527A	3-10-83	[illegible]
	P	REVISED PER ED 653	6-14-84	[illegible]
	R	REVISED ADDED TABULATION	8-29-85	[illegible]
	S	REVISED PER ED 862	12-18-85	[illegible]
	T	REVISED PER ED 914	3/30/86	[illegible]



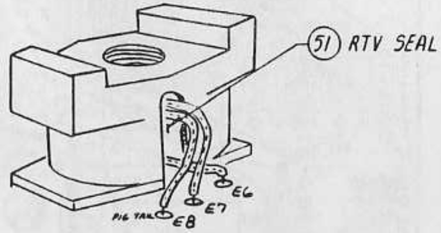
FRONT VIEW - COMPONENT LAYOUT



FRONT VIEW - LAMP HOLDER & WIRING



SIDE VIEW ROTATED 90° CCW



WIRING VIEW OF E6, E7, E8
NO SCALE

NOTES- UNLESS OTHERWISE SPECIFIED

1. FOR SCHEMATIC DIAGRAM SEE DWG NO. 70507.
2. REFERENCE DESIGNATORS ARE FOR REFERENCE ONLY AND MAY NOT APPEAR ON THE COMPONENT PART.
3. INSTALL COMPONENTS PER MIL-STD-275.
4. SOLDER PER REQT 5 OF MIL-STD-454.
5. TEST PER EFRATOM TP 70506.
6. MARK PART NO. AND REV LETTER PER MIL-STD-130.
7. (△) DURING THE ASSEMBLY AGING PERIOD USE A FLAT WASHER IN PLACE OF ITEM 42, SPRING WASHER. AT FINAL ASSEMBLY, INSTALL SPRING WASHER AND PUT LOCTITE, ITEM 45, ON SCREW THREADS.
8. (△) TORQUE Q1, Q5, Q6 TO 12-14 IN. LBS.

TABULATION	
PART NO.	DESCRIPTION
70506-1	OBSOLETE
70506-2	STANDARD ASSEMBLY
70506-3	FAST WARM-UP (ADD R32, Q5, Q6)

SEE SEPARATE PARTS LIST NO. PL 70506-2

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

NEXT ASSY	USED ON
70518-5	(FAST WARM-UP)
70518-4	(HOT CELL)
70518-3	M-100

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN Whitmore	6-5-79
CHECKED [illegible]	6-6-79
[illegible]	6-6-79
[illegible]	6/6/79

EFRATOM
A DIVISION OF Ball CORP

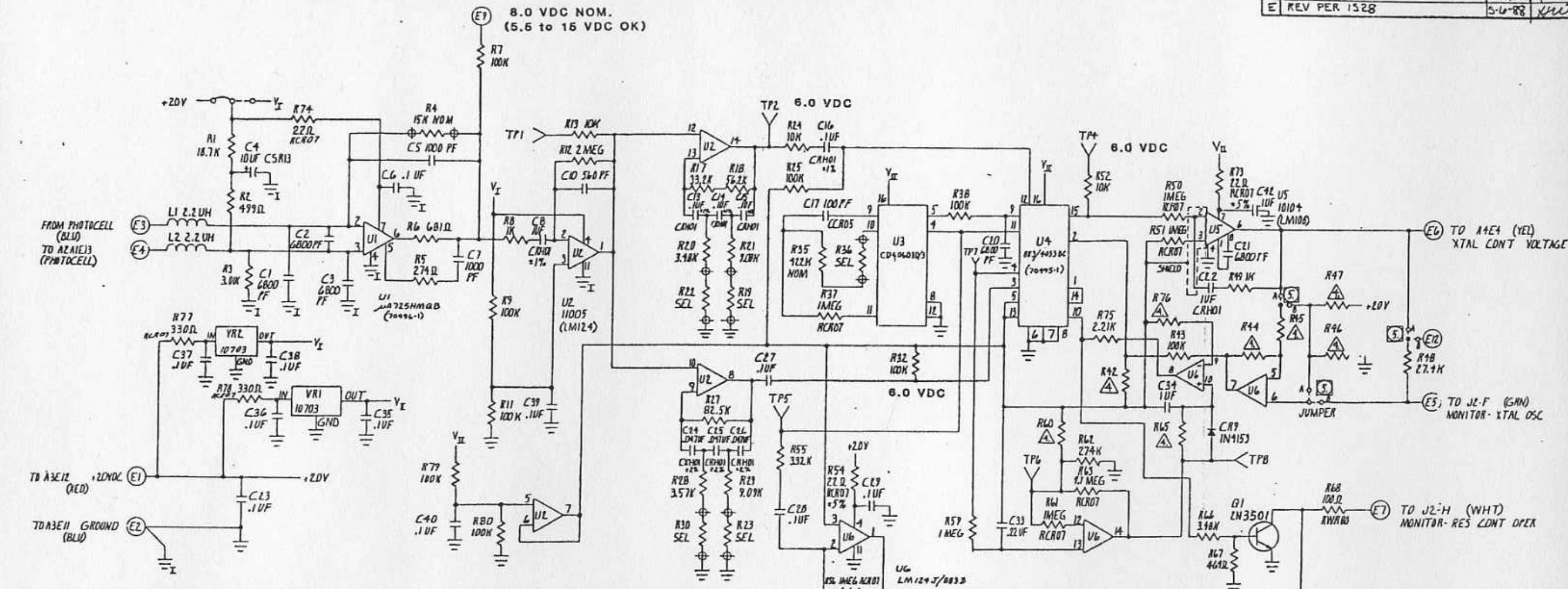
LAMP BOARD ASSEMBLY
A2A2
(BOARD 2)

SIZE	CODE IDENT NO	DRAWING NO	
C	55761	70506-TAB	T
SCALE 2/1	M100		SHEET 1 OF 1

70506-T

ZONE	REV	DESCRIPTION	DATE	APPROVED
	A	RELEASED EO-533A	5-17-83	
	B	REV (R62 WAS 270K) PER EO-578	10-31-83	
	C	REVISED PER EO 637A	12-12-83	
	D	REVISED PER EO 727	6/3/86	
	E	REV PER 1528	5-6-88	

DWG NO 705-154 SH 1 REV E



NOTES: UNLESS OTHERWISE SPECIFIED.

1. CAPACITOR VALUES ARE IN MICROFARADS (UF) OR PICOFARADS (PF). THE TOLERANCES ARE AS SHOWN AND THOSE NOT MARKED ARE ±10%.
   - MIL-C-20, STYLE CCR05 (TEMP COMP, CERAMIC).
   - MIL-C-39014, STYLE CKR05 (CERAMIC).
   - MIL-M-39003, STYLE CSR13 (TANTALUM).
   - MIL-M-83421, STYLE CRH01 (METALLIZED FILM).

   CAPACITOR STYLES ARE AS SHOWN AND THOSE NOT MARKED ARE CKR05.
2. RESISTOR VALUES ARE IN OHMS (Ω). THE TOLERANCES ARE AS SHOWN AND THOSE NOT MARKED ARE ±1%.
   - MIL-R-39007, STYLE RWR80 (WIRE WOUND) 2W.
   - MIL-R-39008, STYLE RCR07 (COMPOSITION) 1/4 W.
   - MIL-R-55182, STYLE RNC55 (METAL FILM) 1/10W.

   RESISTOR STYLES ARE AS SHOWN AND THOSE NOT MARKED ARE RNC55.
3. OTHER COMPONENTS ARE AS SPECIFIED OR CONTROLLED BY THE FOLLOWING SPECIFICATIONS.
   - MIL-S-19500, DIODES AND TRANSISTORS (JANTX).
   - MIL-M-38510, INTEGRATED CIRCUITS.
   - MIL-C-15305, INDUCTORS.
4. SEE TABULATION FOR COMPONENT VALUES.
5. FOR STANDARD MODEL R45 CONNECTS TO "A", R48 CONNECTS TO "A", U6-6 CONNECTS TO "A". FOR LOW NOISE MODEL R45 CONNECTS TO "B", R48 CONNECTS TO "B", U6-6 CONNECTS TO "B".
6. SYMBOL ⊕ INDICATES SOLDER TERMINALS. "E" POINTS AND "TEST POINTS" ARE SOLDER TERMINALS.
7. FOR ASSEMBLY DRAWING SEE DWG NO. 705-153

VOLTAGES ARE NOMINAL FOR NORMAL, LOCKED OPERATION

TABULATION

DESCRIPTION	ASSEMBLY NO.	R44	R45	R46	R47	JUMPER POSITION	R42	R69	CR10	R60	R65	R76
SERVO	705-153-1	100K	82.5K	33.2K	39.2K	"A"	47.5K	NOT USED	NOT USED	10K	4.7MEG	4.7MEG
"LN" SERVO	705-153-2	47.5K	221K	15K	22.1K	"B"	82.5K	NOT USED	NOT USED	2.74K	20MEG	20MEG
"LN" SERVO "TTL"	705-153-3	47.5K	221K	15K	22.1K	"B"	82.5K	10K	1N4625	2.74K	20MEG	20MEG
SERVO "TTL"	705-153-4	100K	82.5K	33.2K	39.2K	"A"	47.5K	10K	1N4625	10.0K	4.7MEG	4.7MEG

NEXT ASSY	USED ON
70500	M100

APPLICATION

DO NOT SCALE DRAWING

PARTS LIST

EFRATOM

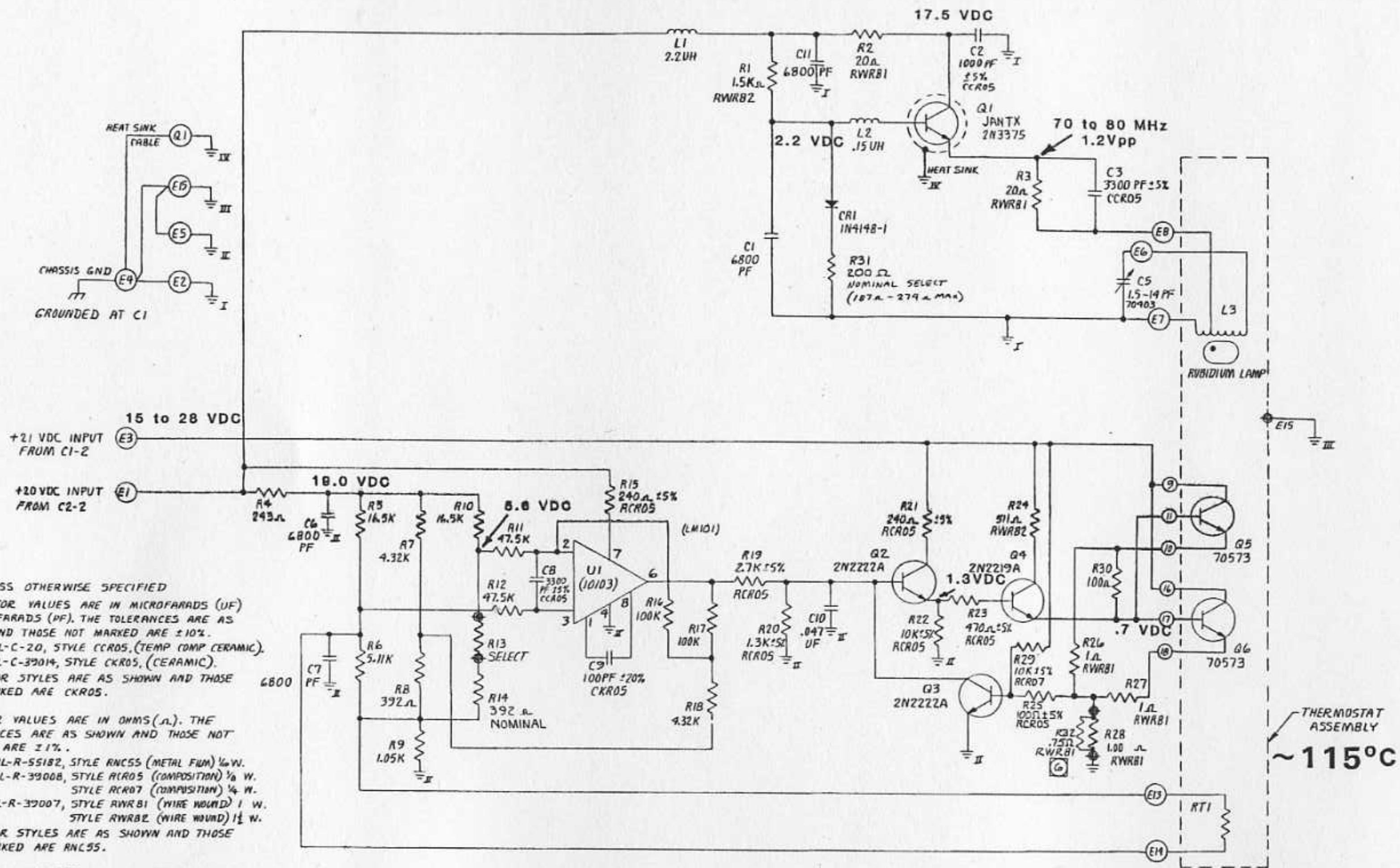
SCHEMATIC - SERVO A1

DRAWN 5-17-83

SIZE D FSCM NO 55761 DWG NO 705-154 REV E

SCALE M100 SHEET 1

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	C	REVISED AND REDRAWN PER ECO 711-122	6-18-79	HW
	D	REV PER ECO 711-183	9-10-79	HW
	E	REV PER ECO 711-253A	12-12-79	CL
	F	REV. PER ECO 711-304	5-2-80	HW
	G	REV PER ECO-466	8-14-81	HW
	H	REV (C2 WAS 3300 PF) EO-615	10-31-83	H
	J	REV R28 VALUE WAS .806 Ω EO 757	2-18-85	
	K	REVISED PER EO 914	5/30/86	HW
	L	REV PER EO-1011	8/26/86	HW



NOTES- UNLESS OTHERWISE SPECIFIED

1. CAPACITOR VALUES ARE IN MICROFARADS (UF) OR PICOFARADS (PF). THE TOLERANCES ARE AS SHOWN AND THOSE NOT MARKED ARE ±10%.
   MIL-C-20, STYLE CCR05, (TEMP COMP CERAMIC).
   MIL-C-39014, STYLE CKR05, (CERAMIC).
   CAPACITOR STYLES ARE AS SHOWN AND THOSE NOT MARKED ARE CKR05.
2. RESISTOR VALUES ARE IN OHMS (Ω). THE TOLERANCES ARE AS SHOWN AND THOSE NOT MARKED ARE ±1%.
   MIL-R-55182, STYLE RNC55 (METAL FILM) 1/8 W.
   MIL-R-39008, STYLE RCR05 (COMPOSITION) 1/8 W.
   STYLE RCR07 (COMPOSITION) 1/4 W.
   MIL-R-39007, STYLE RWR81 (WIRE WOUND) 1 W.
   STYLE RWR82 (WIRE WOUND) 1 1/2 W.
   RESISTOR STYLES ARE AS SHOWN AND THOSE NOT MARKED ARE RNC55.
3. OTHER COMPONENTS ARE AS SPECIFIED OR CONTROLLED BY THE FOLLOWING SPECIFICATIONS.
   MIL-S-19500, DIODES AND TRANSISTORS (JANTX).
   MIL-M-38510, INTEGRATED CIRCUITS
   MIL-C-15305, INDUCTORS
4. SYMBOL ⊕ INDICATES SOLDER TERMINALS.
5. FOR ASSEMBLY DRAWING SEE 70506.

(G) R32 USED ON FAST WARM-UP ONLY.

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

NEXT ASSY	USED ON
70500	M100

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS	DATE
DRAWN	6-18-79
CHECKED	6/18/79
C. Hesenal	6/19/79
	6/19/79

Efratom Division

SCHEMATIC - LAMP BOARD A2A2

SIZE	CODE IDENT NO.	DRAWING NO.	REV
D	55761	70507	L

SCALE — BOARD NO. 2 SHEET 1 OF 1

Efratom Division	PARTS LIST	FSCM NO. 55761	PL 70506-2

LIST TITLE: LAMP BOARD ASSEMBLY

CONTRACT NO.

SHEET 2 OF 3

ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENT NUMBER	DESCRIPTION	REFERENCE
1	1		70508	PRINTED WIRING BOARD	
2	1		70596	WINDOW, MICA	
3	1	MOTOROLA	705-142	TRANSISTOR, CUT OFF (JANTX2N3375)	Q1
4	1		70576	THERMOSTAT ASSEMBLY	
5	1		70597	SEAL, FOAM	
6	2		CCRO5CG332JR	CAPACITOR 3300PF, 50V	C3,C8
7	1		M39014/01-1340	CAPACITOR 100PF	C9
8	4		M39014/01-1572	CAPCITOR 6800PF	C1,6,7,11
9	1		705-141	POST, TRANSISTOR MOUNT	
10	1		M39014/01-1587	CAPACITOR, .047UF	C10
11	1		70403	CAPACITOR, VARIABLE, 1.5-14PF	C5
12	1		JANTXIN4148-1	DIODE	CR1
13	1		70412-2	INDUCTOR 2.2UH (MS75084-4)	L1
14	1		70412-1	INDUCTOR .15UH (MS75083-3)	L2
15	1		70425-15	SCREW, METRIC, M3x6	
16	2		JANTX2N2222A	TRANSISTOR	Q2,3
17	1		JANTX2N2219A	TRANSISTOR	Q4
18	1		RNC55H1000FS	RESISTOR 100Ω 1/10W	R30
19	1		RNC55H2430FS	RESISTOR 243Ω 1/10W	R4
20	2		RNC55H3920FS	RESISTOR 392Ω 1/10W (R14,NOMINAL)	R8,14
21	1		RNC55H1051FS	RESISTOR 1.05KΩ 1/10W	R9
22	2		RNC55H4321FS	RESISTOR 4.32KΩ 1/10W	R7,18
23	1		RNC55H5111FS	RESISTOR 5.11KΩ 1/10W	R6
24	2		RNC55H1652FS	RESISTOR 16.5KΩ 1/10W	R5,10
25	2		RNC55H4752FS	RESISTOR 47.5KΩ 1/10W	R11,12
26	2		RNC55H1003FS	RESISTOR 100KΩ 1/10W	R16,17
27	1		RNC55HXXXXFS	RESISTOR SELECT 1/10W	R13
28	1		RCRO5G101JS	RESISTOR 100 Ω 1/8W	R25
29	2		RCRO5G241JS	RESISTOR 240 Ω 1/8W	R15,21
30	1		RCRO5G471JS	RESISTOR 470 Ω 1/8W	R23
31	1		RCRO5G132JS	RESISTOR 1.3K Ω 1/8W	R20

REVISION STATUS OF THIS SHEET

LETTER	M										
DATE	8/26/86										
ECO NO.	615										

Efratom Division

PARTS LIST

FSCM NO.: 55761

PL 70506-2

LIST TITLE: LAMP BOARD ASSEMBLY

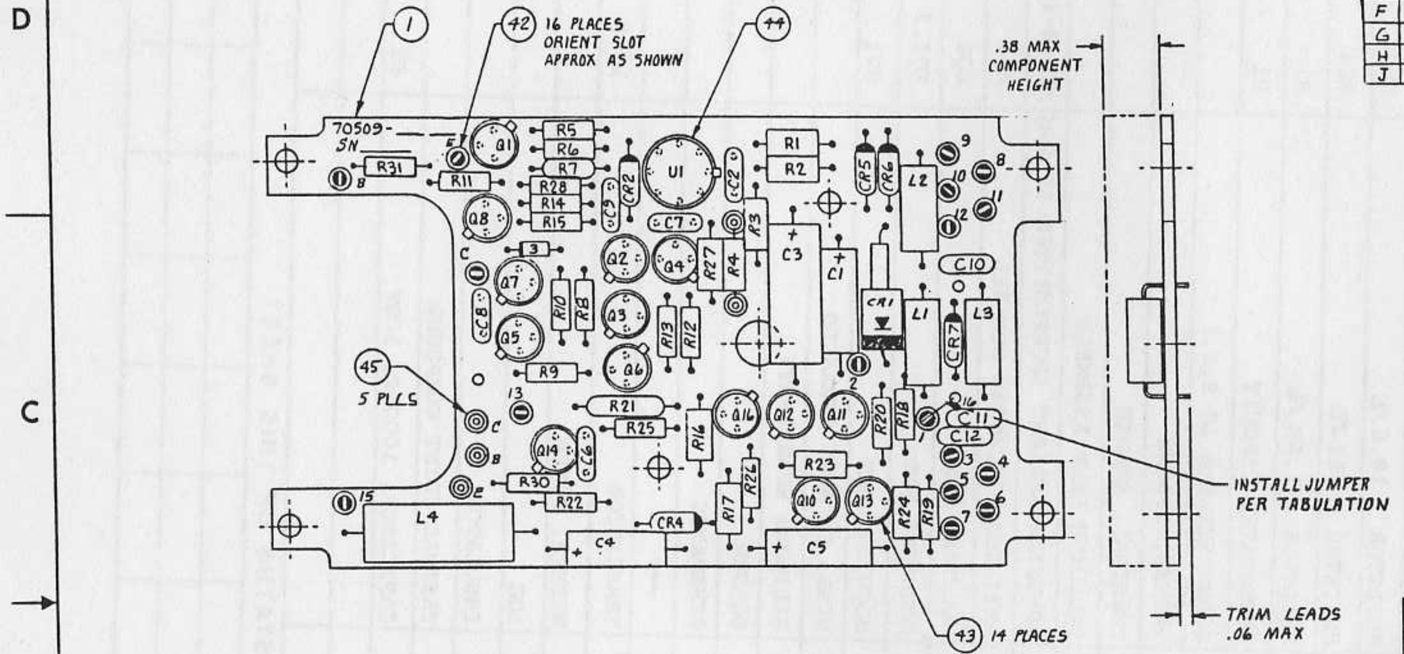
CONTRACT NO.:

SHEET 3 OF 3

ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENT NUMBER	DESCRIPTION	REFERENCE
32	1		RCR05G272JS	RESISTOR 2.7Ω 1/8W	R19
33	1		RCR05G103JS	RESISTOR 10K 1/8W	R22
34	1		RCR07G103JS	RESISTOR 10K 1/4W	R29
35	3		RWR81S1R00FS	RESISTOR 100 Ω	R26,27,28
36	—		NOT USED	—	
37	2		RWR81S19R6FS	RESISTOR 19.6 Ω	R2,3
38	1		RWR80S5110FS	RESISTOR 511 Ω	R24
39	1		RWR80S1501FS	RESISTOR 1.5K Ω	R1
40	1		M38510/10103BGX	INTEGRATED CIRCUIT	U1
41	2		70425-4	SCREW (M2x8mm LG S.S.)	
42	2		70414-19	WASHER, SPRING	
43	4		SE16XC02	TERMINAL, SOLDER	
44	1		705-110	RUBIDIUM LAMP ASSEMBLY	
45	AR		LOCTITE #222	ADHESIVE SEALANT (PURPLE) TYPE II GRM	MIL-S-46163
46	1		RNC55H2000FS	RESISTOR, 200Ω 1%W NOM SEL	R31
47	1		70418-1	MOUNTING PAD	XQ4
48	2		M38527/3-02N	MOUNTING PAD	XQ2,3
49	1		M38527/4-03N	MOUNTING PAD	XU1
50	AR		MIL-W-16878 TYPE E	WIRE, 24 AWG, STRANDED	
51	AR		70424-7	SILICONE RUBBER-RTV	
52	AR		SN63W-RMAP-3	SOLDER	
53	REF		70507	SCHEMATIC	
54	—		NOT USED	—	
55	2		70573	TRANSISTOR	Q5,6
56	4		70414-1	WASHER, FIBER	
57	1		70421-1	LUG	
58	1		70559	INSULATOR	
59	AR		70411	THERMAL JOINT COMPOUND	
60	1		CCR05CG102JR	CAPACITOR, 1000PF, 100V	C2

REVISION STATUS OF THIS SHEET

LETTER	Y										
DATE	9/26/86										
ECO NO.	1011										



ZONE	LTR	DESCRIPTION	DATE	APPROVED
	B	REVISED PER ECO 71199	6-4-79	HW
	C	REV PER ECO 711-173	9-11-79	HW
	D	ADDED NOTE -8	7-21-79	HW
	E	REV PER ECO 711-251	12-3-79	cc
	F	REV PER ECO 377	9-11-80	HW
	G	REVISED ECO 419	1-29-81	HW
	H	REVISED TABULATION	8-29-85	HW
	J	REVISED PER EO 1136	2-13-87	HW

TABULATION

PART NO.	DESCRIPTION
70509-1	STANDARD ASSEMBLY ADD JUMPER BETWEEN "E1" & "E16"
70509-2	"SEPARATE HEATER POWER" OPTION NO JUMPER AT "E16"
70509-3	FAST WARM-UP OPTION REPLACE L3, L4 WITH JUMPER. VALUE OF R21 TO BE .604 Ω. JUMPER AT E16.
70509-4	"FAST WARM-UP" AND "SEPARATE HEATER PWR" REPLACE L3, L4 WITH JUMPER. VALUE OF R21 TO BE .604 Ω. NO JUMPER AT E16

NOTES-UNLESS OTHERWISE SPECIFIED

1. FOR SCHEMATIC DIAGRAM SEE DWG NO. 70510.
2. REFERENCE DESIGNATORS ARE FOR REFERENCE ONLY AND MAY NOT APPEAR ON THE COMPONENT PART.
3. INSTALL COMPONENTS PER MIL-STD-275.
4. SOLDER PER REQT 5 OF MIL-STD-454.
5. CONFORMAL COAT BOTH SIDES PER MIL-I-46058, TYPE UR. MASK OFF ALL SOLDER TERMINALS AND MOUNTING HOLES.
6. TEST PER EFRATOM TP 70509.
7. MARK PART NO. AND REV LETTER PER MIL-STD-130.
8. BOND COMPONENTS C1, 3, 4, 5, CR1, L1, 2, 3, 4, USING TRABOND 2112. CURE 35 MINUTES MINIMUM AT 60 TO 70 °C.
9. SLEEVE CR1 TO PREVENT THE BODY FROM TOUCHING THE GROUND CIRCUIT.

SEE SEPARATE PARTS LIST NO. 70509-1

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

CONTRACT NO.

APPROVALS	DATE
DRAWN Whitmore	6-4-79
CHECKED D. Nickelmann	6-4-79
C. Heacock	6-6-79
L. Hamm	6/6/79

NEXT ASSY	USED ON
70500	HM-100

APPLICATION

DO NOT SCALE DRAWING

EFRATOM

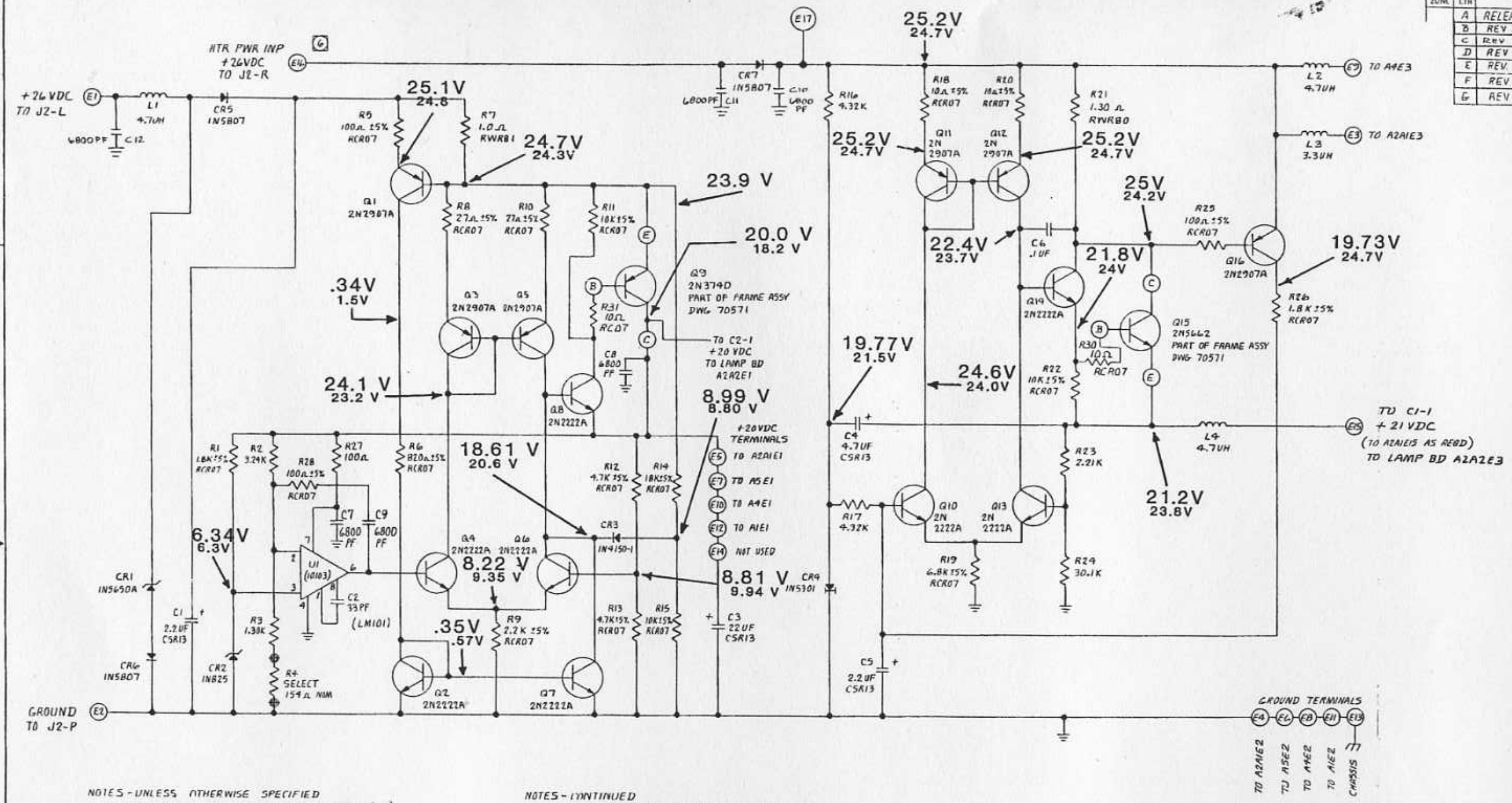
POWER SUPPLY ASSEMBLY

SIZE	CODE IDENT NO.	DRAWING NO.	REV
C	55761	70509-TAB	J

SCALE 2/1 SHEET 1 OF 1

70509-TAB J

ZONE	LTR	REVISIONS DESCRIPTION	DATE	APPROVED
	A	RELEASED PER ECO 711-122	7-18-79	
	B	REV PER ECO 711-172	9-11-79	
	C	REV PER ECO 711-251 & 234	2-12-80	CC
	D	REV PER ECO 711-284	4-14-80	
	E	REV. PER ECO 711-321	5-12-80	
	F	REV. PER ECO 711-327	7-14-80	
	G	REV PER ECO-481	3-11-82	



NOTES - UNLESS OTHERWISE SPECIFIED

1. CAPACITOR VALUES ARE IN MICROFARADS (uF) OR PICOFARADS (PF). THE TOLERANCES ARE AS SHOWN AND THOSE NOT MARKED ARE ±10%.
   - MIL-C-39014, STYLE CKR05, (CERAMIC).
   - MIL-C-39003, STYLE CSR13, (TANTALUM).

   CAPACITOR STYLES ARE AS SHOWN AND THOSE NOT MARKED ARE CKR05.

2. RESISTOR VALUES ARE IN OHMS (Ω) THE TOLERANCES ARE AS SHOWN AND THOSE NOT MARKED ARE ±1%.
   - MIL-R-55182, STYLE RNC55, (METAL FILM) 1/10 W.
   - MIL-R-39008, STYLE RCR07, (COMPOSITION) 1/4 W.
   - MIL-R-39007, STYLE RWR80, (WIRE WOUND) 2 W.
   - STYLE RWR81, (WIRE WOUND) 1 W.

   RESISTOR STYLES ARE AS SHOWN AND THOSE NOT MARKED ARE RNC55.

NOTES - CONTINUED

3. OTHER COMPONENTS ARE AS SPECIFIED OR CONTROLLED BY THE FOLLOWING SPECIFICATIONS.
   - MIL-S-19500, DIODES AND TRANSISTORS, (JANTX)
   - MIL-M-38510, INTEGRATED CIRCUITS
   - MIL-C-15305, INDUCTORS

4. SYMBOL ✦ INDICATES SOLDER TERMINALS. "E" POINTS ARE ALSO SOLDER TERMINALS.

5. FOR ASSEMBLY DRAWING SEE 70509.

6. THE "HEATER POWER INPUT" IS NOT USED IN ALL APPLICATIONS. WHEN "J2-R" IS NOT USED, A JUMPER WIRE WILL BE ADDED BETWEEN "E1" AND "E16".

SMALL LETTERED VALUES:

21 V FLOATING REGULATOR/ DURING WARM-UP

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION
PARTS LIST			

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

CONTRACT NO.

APPROVALS	DATE
DRAWN Whitmore	7/18/79
CHECKED	7/18/79
	7/18/79
	7/18/79

MATERIAL

FINISH

NEXT ASSY	USED ON
	M-100
APPLICATION	

DO NOT SCALE DRAWING

EFRATOM

SCHEMATIC - POWER SUPPLY A3

SIZE D | CODE IDENT NO. 55761 | DRAWING NO. 70510 | G

SCALE — | BOARD NO. 3 | SHEET — OF —

EFRATOM 18851 BARDEEN AVE IRVINE, CAL., 92715	PARTS LIST	FSCM NO. 55761	PL 70509-1
LIST TITLE: POWER SUPPLY ASSY A3		CONTRACT NO.	SHEET 2 OF 3

ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENT NUMBER	DESCRIPTION	REFERENCE
1	1		70511	PRINTED WIRING BOARD	
2	1		M39014/01-1330	CAPACITOR 33PF	C2
3	6		M39014/01-1572	6800PF	C7,8,9,10,11,12
4	1		M39014/01-1593	.1UF	C6
5	2		M39003/01-2951	2.2UF	C1,C5
6	1		M39003/01-2848	4.7UF	C4
7	1		M39003/01-3026	CAPACITOR 22UF	C3
8	1		70428	DIODE (IN5650A)	CR1
9	1		JANTX1N825		CR2
10	1		JANTX1N4150-1		CR3
11	1		JANTX1N5301		CR4
12	3		JANTX1N5807	DIODE	CR5-7
13	2		MS75101-3	INDUCTOR 4.7UH (MS75101-3)	L1,L2
14	1		MS75101-1	INDUCTOR 3.3UH (MS75101-1)	L3
15	1		MS91189-21	INDUCTOR 4.7UH (MS91189-21)	L4
16	8		JANTX2N2222A	TRANSISTOR Q2,	4,6,7,8,10,13,14
17	6		JANTX2N2907A	TRANSISTOR	Q1,3,5,11,12,16
18			NOT USED		
19			NOT USED		
20			NOT USED		
21	1		RNC55H1000FS	RESISTOR 100Ω	R27
22	1		RNC55H1540FS	154Ω (NOMINAL)	R4
23	1		RNC55H1301FS	1.30KΩ	R3
24	\		NOT USED		
25	1		RNC55H3241FS	RESISTOR 3.24KΩ	R2
26	2		RNC55H4321FS	RESISTOR 4.32KΩ	R16,17
27	1		RNC55H2211FS	2.21KΩ	R23
28	1		RNC55H3012FS	30.1KΩ	R24
29	4		RCR07G100JS	10Ω	R18,20,30,31
30	2		RCR07G270JS	27Ω	R8,10
31	3		RCR07G101JS	RESISTOR 100Ω	R5,25,28

REVISION STATUS OF THIS SHEET

LETTER	E	F	G	H	J	K	L				
DATE	7-18-79	9-10-79	2-12-80	4.18.80	7-14-80	3-18-82	12-4-87				
ECO NO.	N/C	711-193	711-251,234	711-271	711-327	481	1393				

EFRATOM
18851 BARDEEN AVE
IRVINE, CAL., 92715

PARTS LIST

FSCM NO. 55761

PL 70509-1

LIST TITLE: POWER SUPPLY ASSY A3

CONTRACT NO.

SHEET 3 OF 3

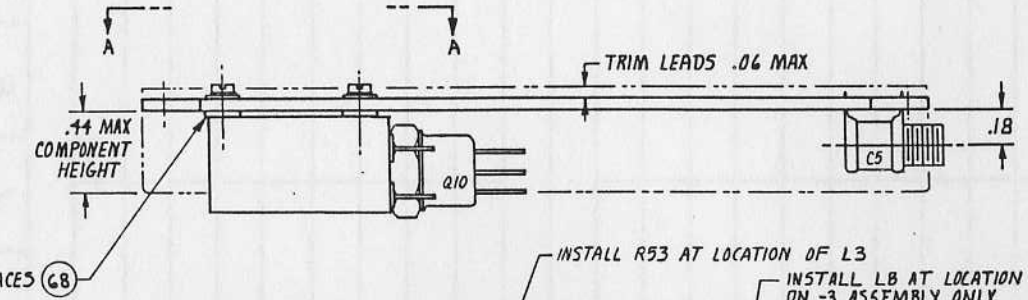
ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENT NUMBER	DESCRIPTION	REFERENCE
32	1		RCR07G821JS	RESISTOR 820	R6
33	2		RCR07G182JS	1.8K	R26, R1
34	1		RCR07G222JS	2.2K	R9
35	2		RCR07G472JS	4.7K	R12,13
36	1		RCR07G682JS	6.8K	R19
37	3		RCR07G103JS	10K	R11,15,22
38	1		RCR07G183JS	18K	R14
[1] 39	1		RWR81S1R00FS	1.0 1W	R7
[1] 40	1		RWR80S1R30FS	RESISTOR 1.30Ω 2 W	R21
41	1		M38510/10103BGX	OP AMP	U1
42	16		70416 -3	TERMINAL, SOLDER (BIFURCATED)	
43	14		M38527/3-02N	MOUNTING PAD (TO-18)	
44	1		M38527/4-03N	MOUNTING PAD (8 PIN)	
45	5		SE16XC02	TERMINAL, SOLDER (TURRET)	
REF			70510	SCHEMATIC	

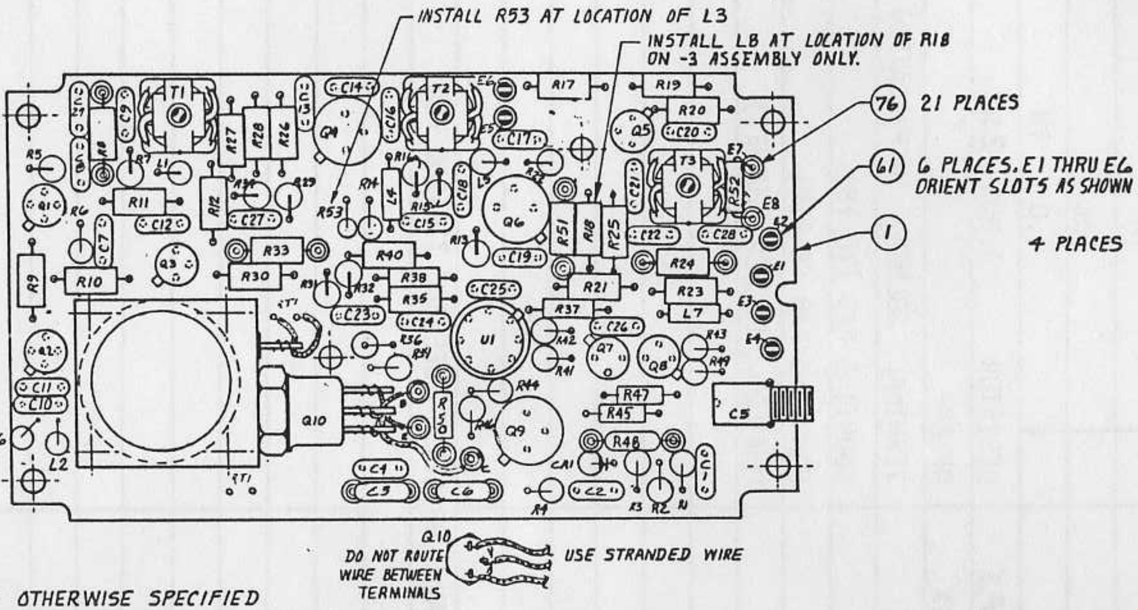
[1] ACTUAL PART MAY VARY DUE TO AVAILABILITY. SEE ECO 711-260 FOR ALTERNATE VALUES.

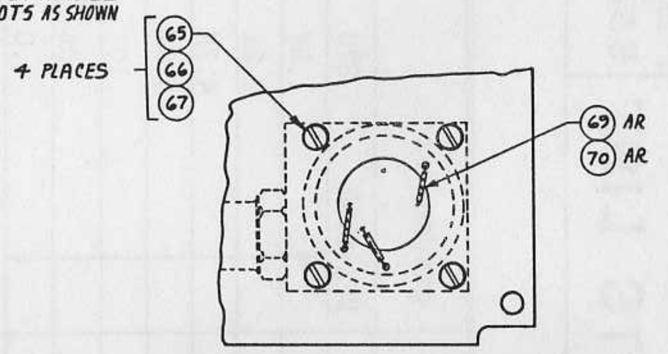
REVISION STATUS OF THIS SHEET

LETTER	E	F	G	H	J	K	L	M	N	P	R
DATE	7-18-79	9-10-79	11-16-79	1-28-80	2-12-80	2-13-80	7-14-80	9-22-80	1-29-81	3-18-82	3-10-83
ECO NO.	N/C	711-173	711-229	711-258	711-251 711-234	711-267	711-327	347	419	481	513

ZONE	LTR	REVISIONS DESCRIPTION	DATE	APPROVED
	A	RELEASED PER DRN 71108	3-5-79	HW
	B	REVISED PER ECO 71197	6-6-79	HW
	C	REV. PER ECO 711-263	4-18-80	HW
	D	REVISED PER ECO-372, 383	9-30-80	HW
	E	REVISED ECO 419	1-29-81	HW
	F	REVISED PER ECO 452	8-6-81	HW
	G	REVISED PER ECO-471	8-12-81	HW
	H	REV PER ECO-475	3-11-82	HW
	J	REV PER ED-594	8-8-83	HW
	K	REVISED PER ED 931	5/30/86	HW
	L	REVISED PER ED 1148	2-13-87	HW







WHEN USING THE CRYSTAL WITH WIRE LEADS, THE LEADS ARE TO BE SLEEVED AND LAYED DOWN FLAT AGAINST THE BOARD

VIEW A-A
ROTATED 180°

NOTES-UNLESS OTHERWISE SPECIFIED

1. FOR SCHEMATIC DIAGRAM SEE DWG NO. 70513.
2. REFERENCE DESIGNATORS ARE FOR REFERENCE ONLY AND MAY NOT APPEAR ON THE COMPONENT PART.
3. INSTALL COMPONENTS PER MIL-STD-275, INCLUDES SWAGING OF SOLDER TERMINALS.
4. SOLDER PER REQT 5 OF MIL-STD-454.
5. CONFORMAL COAT BOTH SIDES PER MIL-I-46058, TYPE UR. MASK OFF ALL SOLDER TERMINALS AND MOUNTING HOLES.
6. TEST PER EFRATOM TP 70512.
7. MARK "55761 ASSY 70512-__ REV__" PER MIL-STD-130.

TABULATION

ASSEMBLY	L8	R18	R19	R24	R51
70512-2 (Vo=.5V)	—	243Ω	56.2Ω	178Ω NOM	698Ω
70512-3 (Vo=1.0V)	6.8µH	—	243Ω	100Ω NOM	698Ω

SEE SEPARATE PARTS LIST NO. 70512-2,-3

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS ± DECIMALS .XX ±.02 .XXX ±.010 ANGLES ±

MATERIAL

FINISH

CONTRACT NO.

APPROVALS		DATE
DRAWN	H. Whitmore	3-5-79
CHECKED		3-15-79

70500	M100
NEXT ASSY	USED ON

EFRATOM

OSCILLATOR BOARD ASSEMBLY

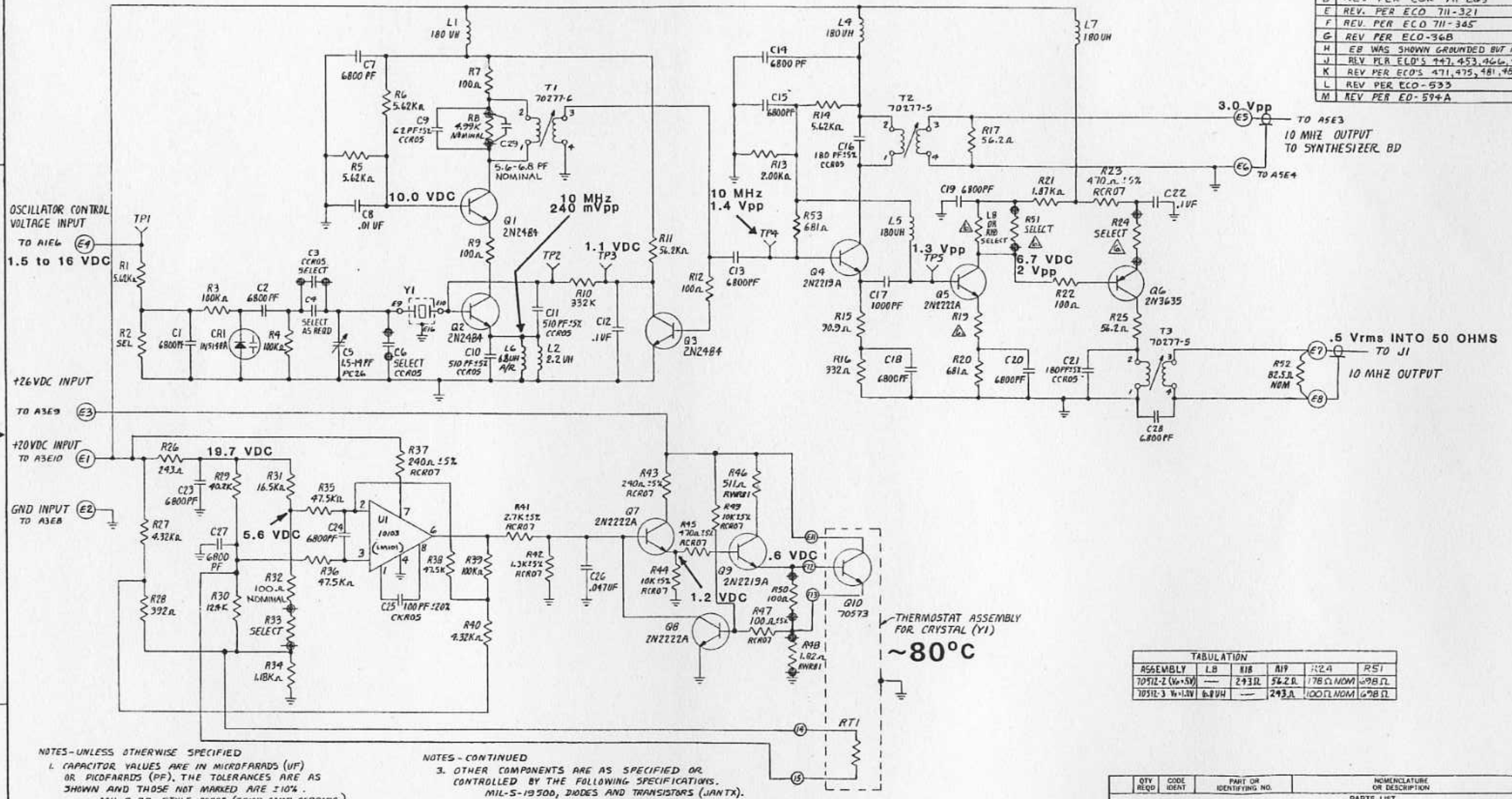
SIZE	CODE IDENT NO.	DRAWING NO.	REV
C	55761	70512-(TAB)	L

70512-(TAB) L

LTR	DESCRIPTION	DATE	APPROVED
N	REVISED PER EO 625	11-6-83	
P	REVISED VALUES IN TAB PER EO 695	10-02-89	
R	REVISED PER EO 931	5/3/94	

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED PER ECO 711-122	6-18-79	
	B	REV PER ECO 711-162,-176	9-10-79	
	C	REV PER ECO 711-212	12-18-79	
	D	REV PER ECR 711-263	2-19-80	
	E	REV. PER ECO 711-321	5-15-80	
	F	REV. PER ECO 711-345	7-15-80	
	G	REV PER ECO-368	10-2-80	
	H	E8 WAS SHOWN GROUNDED BUT ISN'T	10-2-80	
	J	REV PER ECO'S 447, 453, 466, 414	8-11-81	
	K	REV PER ECO'S 471, 475, 481, 482	3-11-82	
	L	REV PER ECO-533	3-10-83	
	M	REV PER EO-594A	8-8-83	



TABULATION					
ASSEMBLY	L8	R18	R19	R24	R51
70512-2 (V0=.5V)	—	243Ω	56.2Ω	178Ω NOM	698Ω
70512-3 V0=1.0V	6.8UH	—	243Ω	100Ω NOM	698Ω

NOTES-UNLESS OTHERWISE SPECIFIED

1. CAPACITOR VALUES ARE IN MICROFARADS (UF) OR PICOFARADS (PF). THE TOLERANCES ARE AS SHOWN AND THOSE NOT MARKED ARE ±10%.
   MIL-C-20, STYLE CCR05 (TEMP COMP CERAMIC).
   MIL-C-39014, STYLE CKR05 (CERAMIC)
   MIL-C-14409, STYLE PC26 (CERAMIC TRIMMER CAPACITOR).

   CAPACITOR STYLES ARE AS SHOWN AND THOSE NOT MARKED ARE CKR05.

2. RESISTOR VALUES ARE IN OHMS (Ω). THE TOLERANCES ARE AS SHOWN AND THOSE NOT MARKED ARE ±1%.
   MIL-R-55182, STYLE RNC55 (METAL FILM) 1/10 W.
   MIL-R-39008, STYLE RCR07 (COMPOSITION) 1/4 W.
   MIL-R-39007, STYLE RWR81 (WIRE WOUND) 1 W.

   RESISTOR STYLES ARE AS SHOWN AND THOSE NOT MARKED ARE RNC55.

NOTES-CONTINUED

3. OTHER COMPONENTS ARE AS SPECIFIED OR CONTROLLED BY THE FOLLOWING SPECIFICATIONS.
   MIL-S-19500, DIODES AND TRANSISTORS (JANTX).
   MIL-M-38510, INTEGRATED CIRCUITS.
   MIL-C-15305, INDUCTORS

4. SYMBOL ⊕ INDICATES SOLDER TERMINALS. "E" POINTS AND "TEST POINTS" ARE SOLDER TERMINALS WITH THE EXCEPTION OF (E9, E10, E16).

5. FOR ASSEMBLY DRAWING SEE 70512-2 OR 70512-3.

△ FOR COMPONENT VALUES SEE TABULATION.

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

CONTRACT NO.

APPROVALS / DATE
DRAWN 6-15-79
CHECKED 6/19/79

70500	M-100
NEXT ASSY	USED ON

APPLICATION

DO NOT SCALE DRAWING

EFRATOM

SCHEMATIC-OSCILLATOR A4

SIZE D | CODE IDENT NO. 55761 | DRAWING NO. 70513 | REV R

SCALE NONE | BOARD NO. 4 | SHEET 1 OF 1

EFRATOM 18851 BARDEEN AVE IRVINE, CAL., 92715	PARTS LIST	FSCM NO. 55761	PL 70512-1

LIST TITLE: OSCILLATOR BOARD ASSEMBLY (A4) | CONTRACT NO. | SHEET 2 OF 4

ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENT NUMBER	DESCRIPTION	REFERENCE
1	1		70514	PRINTED WIRING BOARD	
2	1		70572	CRYSTAL THERMOSTAT ASSY	
3	1		CCR05CJ5R6DR	CAPACITOR 5.6PF NOMINAL	C29
4	1		CCR05CG620JR	CAPACITOR 62PF	C9
5	2		CCR05CG181JR	180PF	C16,C21
6	2		CCR05CG511JR	510PF	C11,C10
7	-		NOT USED		
8	3		CCR05CGXXXJR	SELECT VALUE	C3,C6,C4
9	1		M39014/01-1340	100PF	C25
10	1		M39014/01-1357	1000PF	C17
11	13		M39014/01-1572	6800PF	C1,2,7,13,14,15,18,19
—	—		—	—	20,23,24,27,28
12	1		M39014/01-1575	.01UF	C8
13	1		M39014/01-1587	.047UF	C26
14	2		M39014/01-1593	CAPACITOR .1UF	C12,C22
15	1		PC26J140	CAPACITOR, VAIRABLE 1-14PF	C5
16	1		JANTX1N5148A	DIODE, VARACTOR [illegible]	CR1
17	1		MS75084-4	INDUCTOR 2.2UH (MS75084-4)	L2
18	1		70412-3	INDUCTOR 3.9UH (MS75084-7)	L3
19	1		MS75084-10	INDUCTOR 6.8UH (MS75084-10)	L6
20	4		MS75085-10	INDUCTOR 180UH (MS75085-10)	L1,4,5,7
21	3		JANTX2N2484	TRANSISTOR	Q1,2,3
22	1		JANTX2N2219A	TRANSISTOR	Q9
23	5		JANTX2N2222A	TRANSISTOR	Q4,5,7,8
24	1		JANTX2N3635	TRANSISTOR	Q6
25	1		RNC55H47R5FS	RESISTOR 47.5Ω	R18
26	3		RNC55H56R2FS	56.2Ω	R17,19,25
27	2		RNC55H90R9FS	90.9Ω (R51.. NOMINAL)	R15, R51
28	6		RNC55H1000FS	100Ω (R32 NOMINAL)	R32,7,9,12,22,50
29	1		RNC55H2430FS	243Ω	R26
30	1		RNC55H3320FS	RESISTOR 332Ω	R16

REVISION STATUS OF THIS SHEET

LETTER	A	B	C	D	E	F	G	H	J	K	
DATE	5-24-79	6-5-79	7-10-79	9-10-79	10-31-79	2-19-80	9-22-80	6-11-81	5-13-87	12-7-87	
ECO NO.	711-64 711-85	711-103	711-141	711-162 711-173	711-212	711-263	711-368	ECO-447 -453 -414	1234	1393	

EFRATOM 18851 BARDEEN AVE IRVINE, CAL., 92715	PARTS LIST	FSCM NO. 55761	PL 70512-1
LIST TITLE: OSCILLATOR BOARD ASSEMBLY (A4)		CONTRACT NO.	SHEET 3 OF 4

ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENT NUMBER	DESCRIPTION		REFERENCE
31	1		RNC55H3920FS	RESISTOR	392Ω	R28
32	1		RNC55H4750FS	↑	475Ω	R23
33	1		RNC55H6810FS		681Ω	R20
34	-		NOT USED			
35	-		*NOT USED*			
36	1		RNC55H1181FS		1.18KΩ	R34
37	1		RNC55H1871FS		1.87KΩ	R21
38	1		RNC55H2001FS		2.00KΩ	R13
39	2		RNC55H4321FS		4.32KΩ	R27,40
40	4		RNC55H5621FS		5.62KΩ	R1,5,6,14
41	1		RNC55H1242FS		12.4KΩ	R30
42	1		RNC55H1652FS		16.5KΩ	R31
43	1		RNC55H4022FS		40.2KΩ	R29
44	3		RNC55H4752FS		47.5KΩ	R35,R36,38
45	1		RNC55H5622FS		56.2KΩ	R11
46	3		RNC55H1003FS		100KΩ	R3,4,39
47	2		RNC55HXXXXFS		SELECT VALUE	R2, ,33,
48	1		RCR07G101JS		100Ω	R47
49	2		RCR07G241JS		240Ω	R37,43
50	1		RCR07G471JS		470Ω	R45
51	1		RCR07G132JS		1.3KΩ	R42
52	1		RCR07G272JS		2.7KΩ	R41
53	2		RCR07G103JS		10KΩ	R44,49
54	1		RNC55H3323FS		332KΩ	R10
55	1		RNC55H4991FS		499K NOMINAL	R8
56	1		RWR81S1R82FS	↓	1.82Ω 1W	R48
57	1		RWR81S511OFS	RESISTOR	511Ω 1W	R46
58	2		70406-5	TRANSFORMER (RED-GRN-BLU-WHT)		T2,T3
59	1		70406-6	TRANSFORMER (GRN-RED-WHT-YEL)		T1
60	1		M38510/10103BGX	INTEGRATED CIRCUIT, OP-AMP		U1
61	6		70416-3	TERMINAL, SOLDER *(BIFURCATED)*		

REVISION STATUS OF THIS SHEET

LETTER	A	B	C	D	E	F	G	H	J	K	L
DATE	5-24-79	6-5-79	9-10-79	9-26-79	10-31-79	11-16-79	1-28-80	2-19-80	4.18.80	7-15-80	10-1-80
ECO NO.	711-64	711-103	711-176 711-195	711-199	711-212 711-213	711-230	711-258	711-263	711-309	711-345	383

EFRATOM
18851 BARDEEN AVE
IRVINE, CAL., 92715

PARTS LIST

FSCM NO. 55761

PL 70512-1

LIST TITLE: OSCILLATOR BOARD ASSEMBLY (A4)

CONTRACT NO.

ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENT NUMBER	DESCRIPTION	REFERENCE
62	2		70418-1	MOUNTING PAD (TO-5)	XQ6,9
63	7		M38527/3-02N	MOUNTING PAD (TO-18)	XQ1-5,7,8
64	1		M38527/4-03N	MOUNTING PAD (8-PIN)	XU1
65	4		70425-3	SCREW	
66	4		70414-18	WASHER, SPRING	
67	4		70414-4	WASHER, FLAT	
68	4		70414-1	WASHER, FIBER	
69	AR		QQ-w-343,TYPE S	WIRE, TINNED COPPER, 30 AWG	
70	AR		MIL-I-22129	SLEEVING, TEFLON, 30 AWG	
71	AR		SN63WRMAP3	SOLDER	
72	AR		MIL-I-46058, TYPE UR	POLYURETHANE, CONFORMAL COAT	
73	REF		70513	SCHEMATIC DIAGRAM	
74	REF		TP 70512	TEST PROCEDURE	
75	AR		MIL-W-16878, TYPE E	WIRE, STRANDED, 30 AWG, TEFLON	
76	21		SE16XC02	SOLDER TERMINAL (TURRET)	
77	1		RNC55H10R0	Resistor 10Ω Nominal	R24
78	1		RNC55H82R5FS	RESISTOR 82.5Ω NOMINAL	R52

(1) ACTUAL PART MAY VARY DUE TO AVAILABILITY. SEE ECO 711-230 FOR ALTERNATE VALUES.

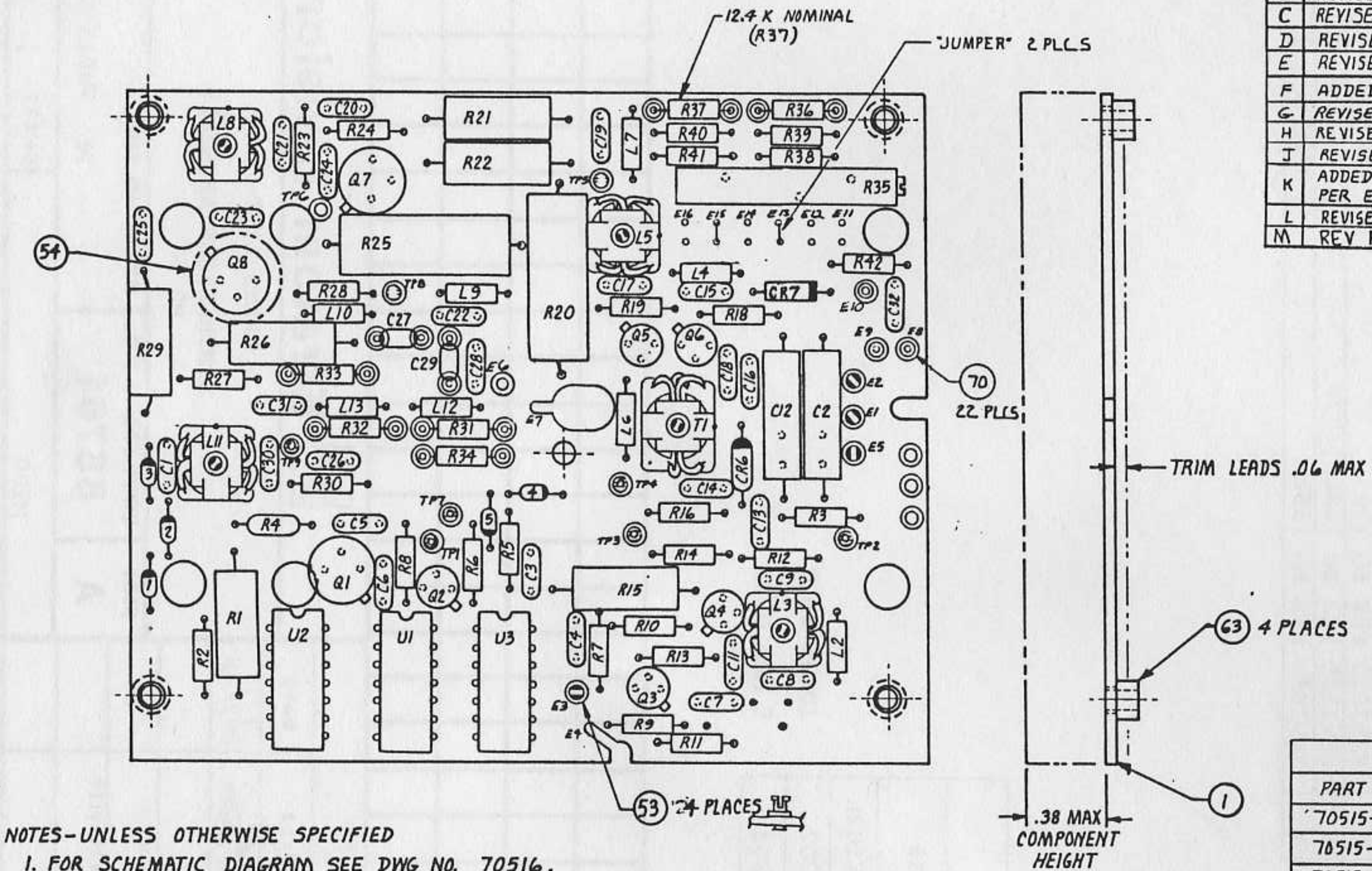
REVISION STATUS OF THIS SHEET

LETTER	A	B	C	D	E
DATE	11-16-79	9-30-80	1-29-81	12-6-83	2-13-87
ECO NO.	711-230	372 383	419	625	1148

4		3		2		1

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED PER DRN 71110	3-13-79	[illegible]
	B	REVISED PER ECO 71112	3-15-79	[illegible]
	C	REVISED PER ECO 711100	6-6-79	HW
	D	REVISED PER ECO 711-127	6-20-79	HW
	E	REVISED PER ECO 711-189	9-18-79	HW
	F	ADDED NOTE -8	9-21-79	HW
	G	REVISED TERMINALS PER ECO 383	10-1-80	HW
	H	REVISED PER ECO # 419	1-29-81	HW
	J	REVISED PER PWB REV "D1"	3-31-81	HW
	K	ADDED NOTE-9 & TABULATION -3 PER ED-541A	6-2-83	HW
	L	REVISED PER ED 850	6-5-86	HW
	M	REV PER ED 1497	5-9-88	Hw



TABULATION

PART NO.	DESCRIPTION	R7
70515-1	USES WIRE WOUND POT R35 (1K)	2.74K
70515-2	USES CERMET POT R35 (2K)	2.74K
70515-3	USES CERMET POT R35 (2K)	4.99K (9)

NOTES-UNLESS OTHERWISE SPECIFIED

1. FOR SCHEMATIC DIAGRAM SEE DWG NO. 70516.
2. REFERENCE DESIGNATORS ARE FOR REFERENCE ONLY AND MAY NOT APPEAR ON THE COMPONENT PART.
3. INSTALL COMPONENTS PER MIL-STD-275, INCLUDES SWAGING OF SOLDER TERMINALS.
4. SOLDER PER REQT 5 OF MIL-STD-454.
5. CONFORMAL COAT BOTH SIDES PER MIL-I-46058, TYPE UR. MASK OFF ALL SOLDER TERMINALS AND MOUNTING HOLES.
6. TEST PER EFRATOM TP 70515.
7. MARK "55761 ASSY 70515 REV _" PER MIL-STD-130.
8. BOND COMPONENTS C2, C12, R1, 22, 21, 15, 25, 26, 29, 35, 20, USING TRABOND 2112. CURE 35 MINUTES MINIMUM AT 60 TO 70 °C.

(9) RESISTOR VALUE OF R7 IS 4.99K ON LNO "LOW NOISE OSCILLATORS" ASSY 70515-3.

SEE SEPARATE PARTS LIST NO. 70515-TAB

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION

PARTS LIST

70500	M100
NEXT ASSY	USED ON

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

CONTRACT NO.

APPROVALS		DATE
DRAWN	H Whitmore	3-2-79
CHECKED	[illegible]	3-14-79

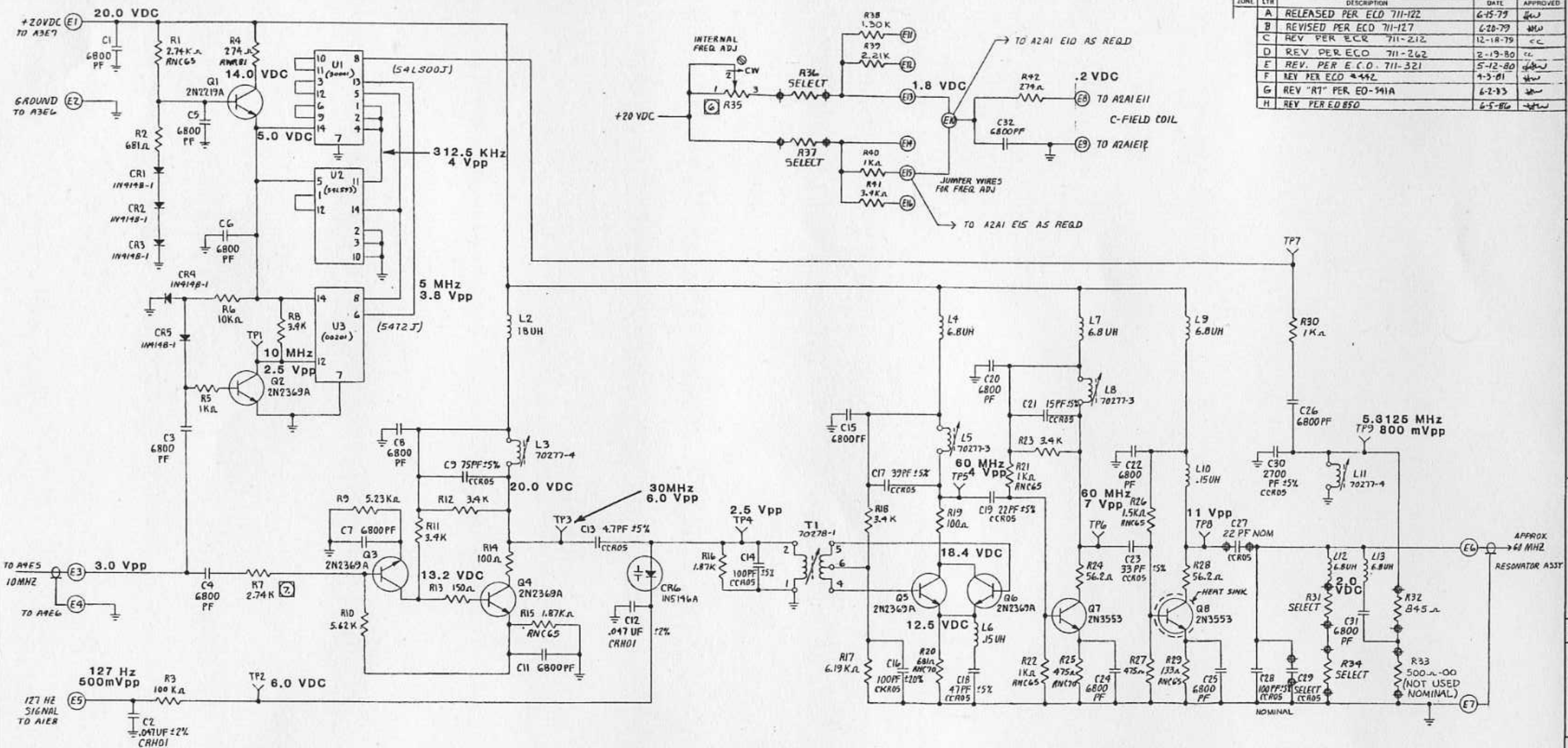
EFRATOM

SYNTHESIZER ASSEMBLY

SIZE	CODE IDENT NO.	DRAWING NO.	REV
C	55761	70515-(SEE TAB)	M

70515 M

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED PER ECO 711-122	6-15-79	
	B	REVISED PER ECO 711-127	6-20-79	
	C	REV PER ECR 711-212	12-18-79	
	D	REV PER ECO 711-262	2-19-80	
	E	REV. PER E.C.O. 711-321	5-12-80	
	F	REV PER ECO 442	4-3-81	
	G	REV "R7" PER EO-541A	6-2-83	
	H	REV PER EO 850	6-5-86	



NOTES-UNLESS OTHERWISE SPECIFIED

1. CAPACITOR VALUES ARE IN MICROFARADS (UF) OR PICOFARADS (PF). THE TOLERANCES ARE AS SHOWN AND THOSE NOT MARKED ARE ± 10%.
   - MIL-C-20, STYLE CCR05, (TEMP COMP CERAMIC)
   - MIL-C-39014, STYLE CKR05 (CERAMIC)
   - MIL-M-83421, STYLE CRH01 (METALLIZED FILM)

   CAPACITOR STYLES ARE AS SHOWN AND THOSE NOT MARKED ARE CKR05.
2. RESISTOR VALUES ARE IN OHMS (Ω). THE TOLERANCES ARE AS SHOWN AND THOSE NOT MARKED ARE ±1%.
   - MIL-R-55182, STYLE RNC 55, (METAL FILM) 1/10 W.
   - STYLE RNC 65, (METAL FILM) 1/4 W.
   - STYLE RNC 70, (METAL FILM) 1/2 W.
   - MIL-R-39007, STYLE RWR81, (WIRE WOUND) 1 W.
   - (6) MIL-R-39015, STYLE RTR 12, VARIABLE (WIRE WOUND) 3/4 W.
   - MIL-R-22097, STYLE RJ12, VARIABLE (CERMET) 1 W.

NOTES-CONTINUED

2. CONTINUED
   RESISTOR STYLES ARE AS SHOWN AND THOSE NOT MARKED ARE RNC55.
3. OTHER COMPONENTS ARE AS SPECIFIED OR CONTROLLED BY THE FOLLOWING SPECIFICATIONS.
   - MIL-S-19500, DIODES AND TRANSISTORS (JANTX)
   - MIL-M-38510, INTEGRATED CIRCUITS
   - MIL-C-15305, INDUCTORS
4. SYMBOL ◆ INDICATES SOLDER TERMINALS, "E" POINTS AND "TEST POINTS" ARE SOLDER TERMINALS.
5. FOR ASSEMBLY DRAWING SEE NO. 70515.
6. SEE ASSEMBLY DRAWING AND PARTS LIST FOR POTENTIOMETER USED.

NOTES-CONTINUED

7. RESISTOR VALUE OF R7 IS 4.99K ON LNO "LOW NOISE OSCILLATORS" ASSY 70515-3.

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION
PARTS LIST			

NEXT ASSY	USED ON
70500	M-100
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± DECIMALS XX ± XXX ± ANGLES ±

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS — DATE
DRAWN 6-15-79
CHECKED

EFRATOM

SCHEMATIC - SYNTHESIZER A5

SIZE D | CODE IDENT NO. 55761 | DRAWING NO. 70516 | REV H

SCALE — | BOARD NO. 5 | SHEET 1 OF 1

70516 H

EFRATOM 18851 BARDEEN AVE IRVINE, CAL., 92715	PARTS LIST	FSCM NO. 55761	PL 70515 - 19B
LIST TITLE: SYNTHESIZER ASSEMBLY		CONTRACT NO.	SHEET 2 OF 4

ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENT NUMBER	DESCRIPTION	REFERENCE
1	1		70517	PRINTED WIRING BOARD	EFRATOM
2	1		CCR05CG4R7DR	CAPACITOR 4.7PF	C13
3			NOT USED		
4	1		CCR05CH150JR	15PF	C21
5	2		CCR05CG220JR	22PF (C27 NOMINAL)	C19, C27
6	1		CCR05CG330JR	33PF	C23
7	1		CCR05CG390JR	39PF	C17
8	1		CCR05CG470JR	47PF	C18
9	1		CCR05CG750JR	75PF	C9
10	2		CCR05CG101JR	100PF (C28 NOMINAL)	C14,C28
11	1		CCR05CGXXXJR	SELECT (47-120PF)	C29
12	1		CCR05CG272JR	CAPACITOR 2700PF	C30
13			NOT USED		
14	17		M39014/01-1572	CAPACITOR 6800PF	C1,C3-8,11,15,16
—	—		—		C32,20,22,24,25,26,31
15	2		M83421/01-1142S	CAPACITOR .047UF	C2,C12
16	6		JANTX1N4148-1	DIODE	CR1-CR5,CR7
17	1		JANTX1N5146A	DIODE, VARACTOR	CR6
18	2		MS75083-3	INDUCTOR .15UH (MS75083-3)	L6,L10
19			NOT USED		
20	5		MS75084-10	INDUCTOR 6.8UH (MS75084-10)	L4,7,9,12,13
21	1		MS75084-15	INDUCTOR 18UH (MS75084-15)	L2
22	2		70406-3	INDUCTOR VARIABLE (RED-YEL)	L5,L8
23	2		70406-4	INDUCTOR VARIABLE (GRN-YEL)	L3,L11
24	1		JANTX2N2219A	TRANSISTOR	Q1
25	3		JANTX2N2369A	TRANSISTOR	Q2-4
26	2		JANTX2N3553	TRANSISTOR	Q7-8
27	4		RNC55H56R2FS	RESISTOR 56.2Ω	R24,28,19,20
28	1		RNC55H1000FS	RESISTOR 100Ω	R14
29	1		RNC55H1500FS	RESISTOR 150Ω	R13
30	1		RNC55H4750FS	RESISTOR 475Ω	R27

REVISION STATUS OF THIS SHEET

LETTER	A	B	C	D	E	F	G	H	J		
DATE	6-20-79	9-10-79	2-19-80	8-17-81	6-5-86	5-13-87	12-7-87	4-14-88	6-2-88		
ECO NO.	711-127	711-193 711-195	711-262	ECO-442	850	1234	1393	1497	1552		

EFRATOM 18851 BARDEEN AVE IRVINE, CAL., 92715	PARTS LIST	FSCM NO. 55761	PL 70515-TAB
LIST TITLE: SYNTHESIZER ASSEMBLY		CONTRACT NO.	SHEET 3 OF 4

ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENT NUMBER	DESCRIPTION	REFERENCE
31	1		RNC55H6810FS	RESISTOR 681Ω	R2
32	3		RNC55H1001FS	1KΩ	R5, 40,30
33	1		RNC55H1871FS	1.87KΩ	R16
34	5		RNC55H3401FS	3.4KΩ	R8, 11,12, 23,41
35	1		RNC55H5231FS	5.23KΩ	R9
36	1		RNC55H5621FS	RESISTOR 5.62KΩ	R10
37			NOT USED		
38	2		RNC55H1002FS	RESISTOR 10KΩ	R6, 18
39	1		RNC55H1003FS	100KΩ	R3
40	4		RNC55HXXXXFS	SELECT (100Ω-12KΩ)	R31,34,37,33
41	1		RNC65H1330FS	133Ω	R29
42	2		RNC65H1001FS	1KΩ	R21,22
43	1		RNC65H1501FS	1.5KΩ	R26
44	1		RNC65H1871FS	1.87KΩ	R15
45	1		RNC65H2741FS	2.74KΩ	R1
46	1		RNC70H4750FS	RESISTOR 475Ω	R25
47			NOT USED		
(1) 48	1		RWR81S2740FS	RESISTOR 274Ω	R4
49	1		70406-7	TRANSFORMER (6-PIN)	T1
50	1		M38510/30502BCX	INTEGRATED CIRCUIT	U1
51	1		M38510/32702BCX	INTEGRATED CIRCUIT	U2
52			M38510/00201BCX	INTEGRATED CIRCUIT	U3
53	4		70416-3	TERMINAL, SOLDER (BIFURCATED)	
54	1		70420-1	HEAT SINK	
55	2		70418-1	MOUNTING PAD (TO-5)	XQ1,7
56	5		M38527/3-02N	MOUNTING PAD (TO-18)	XQ2-6
57	AR		SN63WRMAP3	SOLDER	QQ-S-571
58	1		70561	WASHER, MYLAR	XQ8
59	2		JANTX2N2222A	TRANSISTOR	Q5, Q6
60	AR		MIL-I-46058 TYPE UR	POLYURETHANE (CONFORMAL COAT)	
61	1		RNC55H2740FS	RESISTOR 274Ω	R42

REVISION STATUS OF THIS SHEET

LETTER	A	B	C	D	E	F	G	H	J	K	L
DATE	6-20-79	9-10-79	9-26-79	11-16-79	1-29-80	2-19-80	4-18-80	10-1-80	1-29-81	8-10-81	6-2-83
ECO NO.	711-127	711-189 711-195	711-199	711-231	711-260	711-262	711-265	383	411	461 468	541A

EFRATOM 18851 BARDEEN AVE IRVINE, CAL., 92715	PARTS LIST	FSCM NO. 55761	PL 70515-TAB
LIST TITLE: SYNTHESIZER ASSY		CONTRACT NO.	SHEET 4 OF 4

ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENT NUMBER	DESCRIPTION	REFERENCE
62	1		RJ12FY202	POTENTIOMETER 2KΩ	R35 (70515-2 70515-3)
63	4		70417-1	STANDOFF	
64	REF		70516	SCHEMATIC	
65					
66	1		RNC55H3321FS	RESISTOR 3.32K NOMINAL	R36
67	1		RNC55H1301FS	RESISTOR 1.30K	R38
68	1		RNC55H2211FS	RESISTOR 2.21K	R39
69	1		RNC55H8450FS	RESISTOR 845Ω	R32
70	31		SE16XC02	TERMINAL, SOLDER	
71	1		RNC55H2741FS	RESISTOR 2.74K	R7 (70515-2)
72	1		RNC55H4991FS	RESISTOR 4.99K	R7 (70515-3)

ACTUAL PART MAY VARY DUE TO AVAILABILITY. SEE ECO 711-260 FOR ALTERNATE VALUES

REVISION STATUS OF THIS SHEET

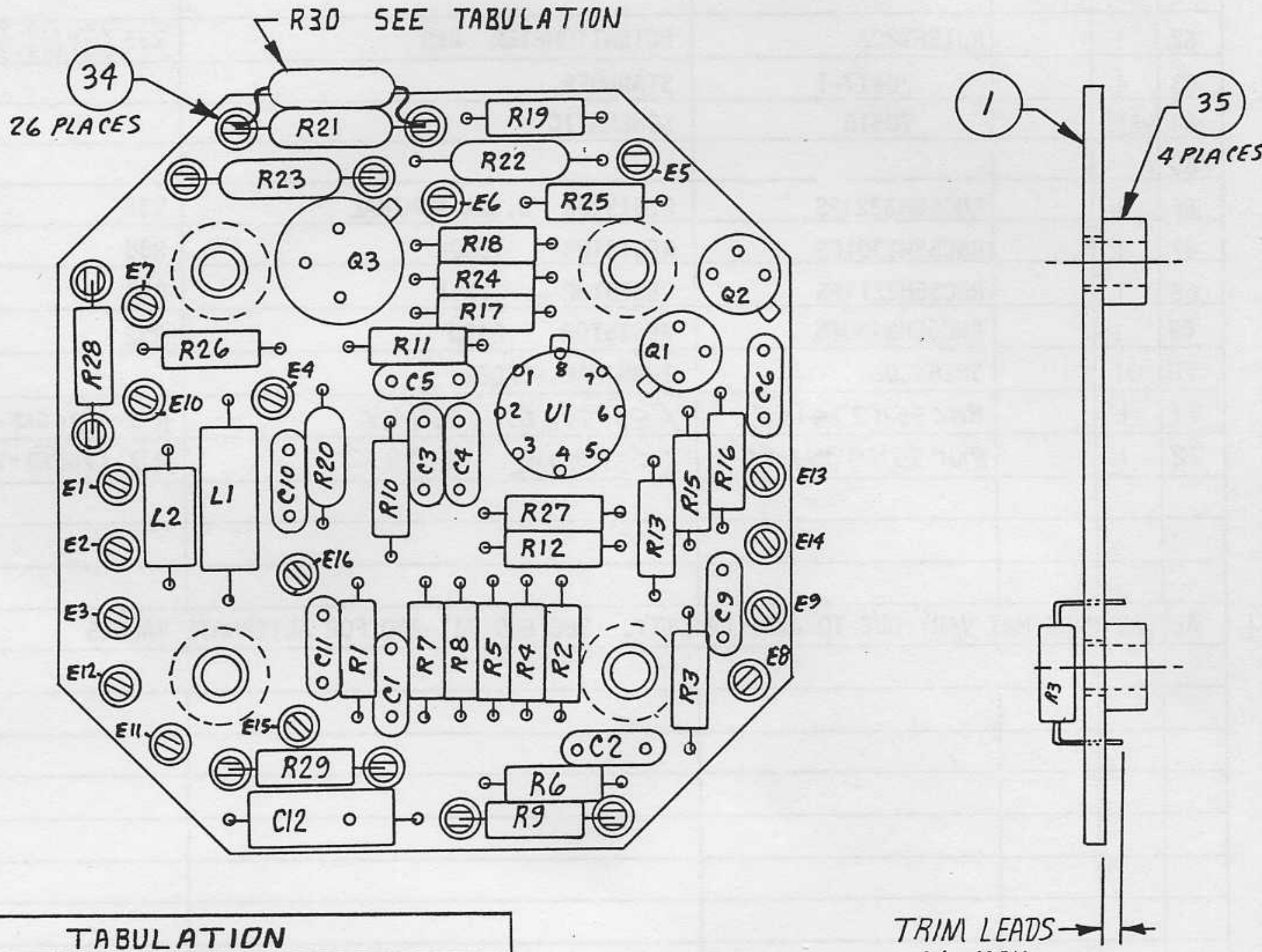
LETTER	A	B	C	D	E	F	G	H	J		
DATE	6-20-79	9-10-79	11-16-79	1-29-80	2-19-80	10-1-80	1-29-81	~~8-10-81~~ 8-10-81	6-2-83		
ECO NO.	711-127	711-189	711-231	711-260	711-262	383	419	461	541A.		

DWG. NO. 70521-TAB SH 1 REV. D

APPLICATION	
NEXT ASSY	USED ON

REVISIONS

REV.	DESCRIPTION	DATE	APPROVED
A	RELEASED PER ECO 711-224	11-12-79	HW
B	REV. PER E.O. 711-272	4-14-80	HW
C	REV PER ECO-492	3-11-82	HW
D	REVISED ADDED TABULATION	8-28-85	HW



TABULATION

PART NO.	DESCRIPTION
70521-2	STANDARD ASSEMBLY
70521-3	ADD R30 .500Ω FAST WARM-UP

SEE SEPARATE PARTS LIST NO. PL 70521-TAB

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL ~
FINISH ~
DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS		DATE
DRAWN	Whitmore	11-12-79
CHECKED	D. Dickerson	11-13-79
ISSUED		

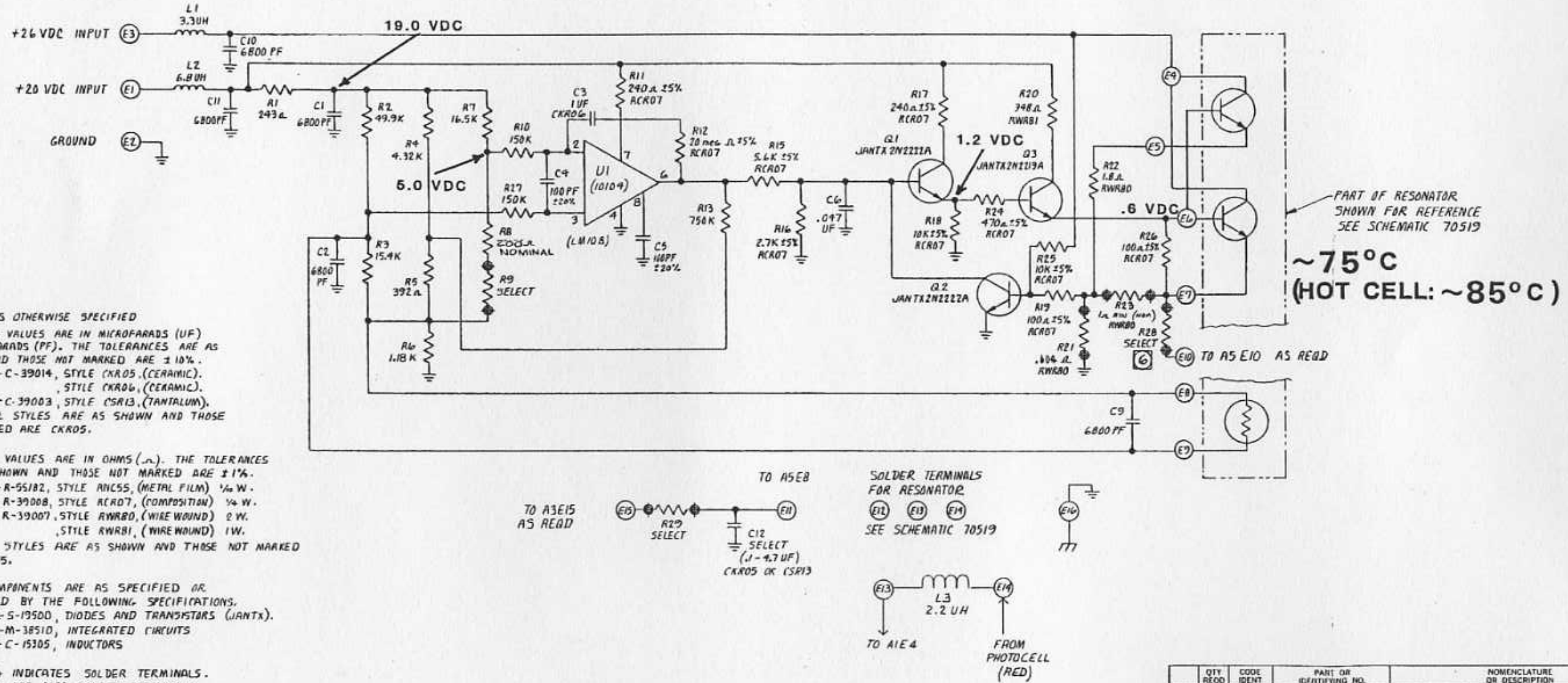
EFRATOM

RESONATOR THERMOSTAT ASSY

SIZE A | FSCM NO. 55761 | DWG. NO. 70521-TAB | REV. D

SCALE 2/1 | SHEET 1

ZONE	LTR	DESCRIPTION	DATE	APPROVED
REVISIONS				
	A	RELEASED PER ECO 711-122	7-16-79	HW
	B	REV PER ECO 711-213	12-18-79	CC
	C	REV PER ECO 711-257	1-28-80	CC
	D	REV. PER E.C.O. 711-295	4-18-80	HW
	E	REV PER E.C.O. 711-302	5.09.80	HW
	F	REV PER ECO-466	8-14-81	HW
	G	REV PER ECO-477	3-11-82	HW
	H	REV "R28" PER EO-569	6-3-83	HW
	J	REV R21 VALUE WAS .806Ω EO 757	2-18-85	[illegible]



NOTES - UNLESS OTHERWISE SPECIFIED

1. CAPACITOR VALUES ARE IN MICROFARADS (UF) OR PICOFARADS (PF). THE TOLERANCES ARE AS SHOWN AND THOSE NOT MARKED ARE ±10%.
   - MIL-C-39014, STYLE CKR05, (CERAMIC).
   - , STYLE CKR06, (CERAMIC).
   - MIL-C-39003, STYLE CSR13, (TANTALUM).

   CAPACITOR STYLES ARE AS SHOWN AND THOSE NOT MARKED ARE CKR05.
2. RESISTOR VALUES ARE IN OHMS (Ω). THE TOLERANCES ARE AS SHOWN AND THOSE NOT MARKED ARE ±1%.
   - MIL-R-55182, STYLE RNC55, (METAL FILM) 1/10 W.
   - MIL-R-39008, STYLE RCR07, (COMPOSITION) 1/4 W.
   - MIL-R-39007, STYLE RWR80, (WIRE WOUND) 2 W.
   - , STYLE RWR81, (WIRE WOUND) 1 W.

   RESISTOR STYLES ARE AS SHOWN AND THOSE NOT MARKED ARE RNC55.
3. OTHER COMPONENTS ARE AS SPECIFIED OR CONTROLLED BY THE FOLLOWING SPECIFICATIONS.
   - MIL-S-19500, DIODES AND TRANSISTORS (JANTX).
   - MIL-M-38510, INTEGRATED CIRCUITS
   - MIL-C-15305, INDUCTORS
4. SYMBOL ◈ INDICATES SOLDER TERMINALS. "E" POINTS ARE ALSO SOLDER TERMINALS.
5. FOR ASSEMBLY DRAWING SEE 70521.
6. RESISTOR R28 MINIMUM VALUE IS 4.02K FOR STANDARD UNITS, 2.43K FOR "FAST WARM-UP" UNITS.

QTY REQD	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION
PARTS LIST			

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± DECIMALS XX ± XXX ± ANGLES ±

MATERIAL

FINISH

CONTRACT NO.

APPROVALS	DATE
DRAWN Whitmore	7-16-79
CHECKED [illegible]	7-17-79
[illegible]	7/17/79
[illegible]	7/17/79

EFRATOM

SCHEMATIC - RESONATOR THERMOSTAT A2A1

SIZE D | CODE IDENT NO. 55761 | DRAWING NO. 70522-2 | J

SCALE — | BOARD NO. 6 | SHEET — OF —

NEXT ASSY	USED ON
	M-100
APPLICATION	

DO NOT SCALE DRAWING

EFRATOM 18851 BARDEEN AVE IRVINE, CAL., 92715	PARTS LIST	FSCM NO. 55761	PL 70521-2
LIST TITLE: RESONATOR THERMOSTAT ASSY		CONTRACT NO.	SHEET 2 OF 3

	ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENT NUMBER	DESCRIPTION	REFERENCE
	1	1		70587	PRINTED WIRING BOARD	
	2	1		M38510/10104BGX	OP AMP	U1
	3	2		M39014/01-1340	CAPACITOR 100PF	C4,C5
	4	5		M39014/01-1572	CAPACITOR 6800PF	C1,2,9,10,11
	5			NOT USED		
	6	1		M39014/01-1587	CAPACITOR .047UF	C6
	7	1		705-129	CAPACITOR 1UF	C3
	8	2		JANTX2N2222A	TRANSISTOR	Q1,Q2
	9	1		JANTX2N2219A	TRANSISTOR	Q3
	10			NOT USED		
	11	1		RNC55H2430FS	RESISTOR 243Ω	R1
	12	1		RNC55H3920FS	392Ω	R5
	13	1		RNC55H1181FS	1.18KΩ	R6
	14	1		RNC55H4321FS	4.32KΩ	R4
	15	1		RNC55H1542FS	15.4KΩ	R3
	16	1		RNC55H1652FS	16.5KΩ	R7
	17	1		RNC55H4992FS	49.9KΩ	R2
	18			NOT USED		
	19	1		RNC55H7503FS	750KΩ	R13
	20	1		RCR07G206JS	20 MEGΩ	R12
	21	2		RCR07G101JS	100Ω	R19,R26
	22	2		RCR07G241JS	240Ω	R11,R17
	23	1		RCR07G471JS	470Ω	R24
	24	1		RCR07G272JS	2.7KΩ	R16
	25	1		RCR07G562JS	5.6KΩ	R15
	26	2		RCR07G103JS	10KΩ	R18,R25
1	27	1		RWR80SR604FS	.604 Ω 2W	R21
1	28	1		RWR81S3480FS	RESISTOR 348Ω 1W	R20
	29			NOT USED		
	30	1		MS75101-1	INDUCTOR 3.3UH (MS75101-1)	L1
	31	1		MS75084-10	INDUCTOR 6.8UH (MS75084-10)	L2

REVISION STATUS OF THIS SHEET

LETTER	A	B	C	D	E
DATE	1-28-80	8-11-81	3-11-82	2-18-85	12-4-87
ECO NO.	711-258	466	492	757	1393

EFRATOM
18851 BARDEEN AVE
IRVINE, CAL., 92715

PARTS LIST

FSCM NO. 55761

PL 70521-2

LIST TITLE: RESONATOR THERMOSTAT ASSY

CONTRACT NO.

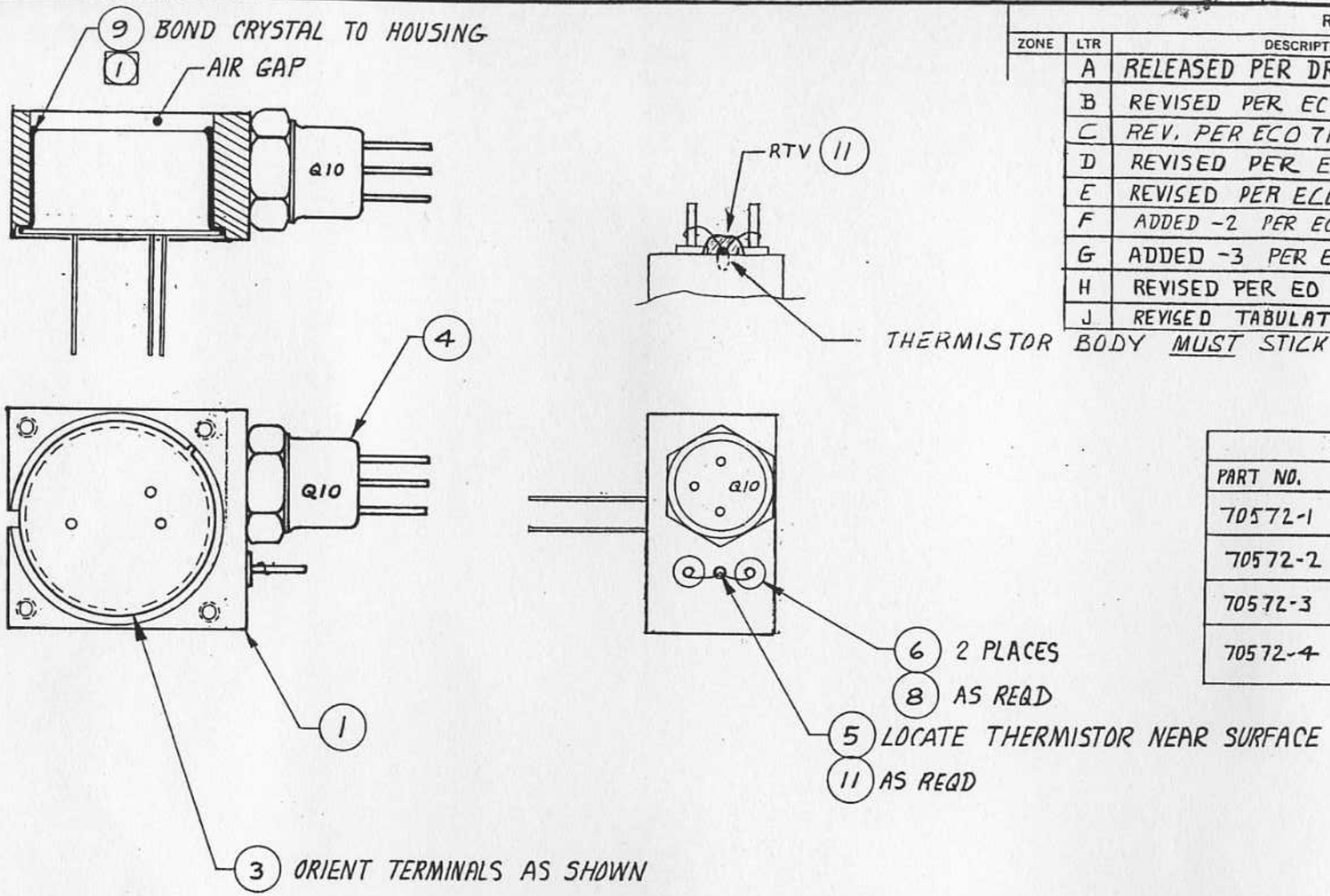
SHEET 3 OF 3

	ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENT NUMBER	DESCRIPTION	REFERENCE
	32	1		RNC55H4021FS	RESISTOR, NOMINAL VALUE 4.02 K	R28
	33	1		RNC55H2000FS	RESISTOR, NOMINAL VALUE 200Ω	R8
	34	26		70416-3	TERMINAL, SOLDER	
	35	4		70417-1	STANDOFF, SELF CLINCHING	
	36	2		RNC55 or RCR07	RESISTOR, SELECT (FS or JS)	R9, R29
	37	-		NOT USED		
	38	-		NOT USED		
	39	1		70418-1	MOUNTING PAD	XQ3
	40	2		M38527/3-02N	MOUNTING PAD	XQ1,XQ2
	41	1		M38527/4-03N	MOUNTING PAD	XU1
	42	AR		SN63WRMAP3	SOLDER	
	43	AR		MIL-I-46058, TYPE UR	CONFORMAL COAT	
	44	2		RNC55H1503FS	RESISTOR 150K	R10,R27
1	45	1		RWR80S1R82FS	RESISTOR 1.82Ω 2W	R22
1	46	1		RWR80S1R00FS	RESISTOR, NOMINAL VALUE, 2W (1Ωmin)	R23
	47	1		M39014/01-1593	CAPACITOR .1UF "SELECT"	C12
	48	1		M39003/01-2848	CAPACITOR 4.7UF "SELECT"	C12
	REF	-		TP70521	TEST PROCEDURE	
	REF	-		70522	SCHEMATIC	

1 ACTUAL PART MAY VARY DUE TO AVAILABILITY. SEE ECO 711-260 FOR ALTERNATE VALUES

REVISION STATUS OF THIS SHEET

LETTER	A	B	C	D
DATE	1-28-80	4-18-80	3-11-82	6-3-83
ECO NO.	711-257	711-269 711-297	477	569



REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED PER DRN 71108	3-14-79	HW
	B	REVISED PER ECO 71194	6-6-79	HW
	C	REV. PER ECO 711-307	5-12-80	HW
	D	REVISED PER ECO-403	2-26-81	HW
	E	REVISED PER ECO'S 452, 463	8-6-81	HW
	F	ADDED -2 PER ECO-487	1-11-82	HW
	G	ADDED -3 PER ECO-537	2-24-83	HW
	H	REVISED PER ED 614	10-21-83	HW
	J	REVISED TABULATION	8-29-85	JH

TABULATION

PART NO.	DESCRIPTION
70572-1	10 MHZ CRYSTAL
70572-2	5 MHZ SC CUT CRYSTAL
70572-3	5 MHZ SC CUT CRYSTAL $\leq 3\times10^{-9}/g$
70572-4	5 MHZ SC CUT XTAL $\leq 3\times10^{-9}/g$ WITH FAST WARM-UP TSTR

NOTES- UNLESS OTHERWISE SPECIFIED

1. BOND CRYSTAL TO HOUSING USING ITEM -9. CURE AT 2 HOURS AT 60°C TO 70°C, OR 24 HRS AT ROOM TEMP.

SEE SEPARATE PARTS LIST NO. 70572- SEE TAB

NEXT ASSY	USED ON
705-116	M100-2N
70512	M100

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS		DATE
DRAWN	Whitmore	3-14-79
CHECKED	[illegible]	3-16-79

CRYSTAL THERMOSTAT ASSY

SIZE	CODE IDENT NO.	DRAWING NO.	REV
B	55761	70572- SEE TAB	J

SCALE 2/1 SHEET 1 OF 1

EFRATOM 18851 BARDEEN AVE IRVINE, CAL., 92715	PARTS LIST	FSCM NO. 55761	PL 70572-1
LIST TITLE: CRYSTAL THERMOSTAT ASSY		CONTRACT NO.	SHEET 2 OF 2

ITEM NO.	QTY REQD	FSCM NO.	PART OR IDENT NUMBER	DESCRIPTION	REFERENCE
1	1		70543	HOUSING, CRYSTAL	
2	-		NOT USED		
3	1		70408	CRYSTAL	
4	1		70573-1	TRANSISTOR ([illegible])	Q10
5	1		70498-2	THERMISTOR, RUGGEDIZED	RT1
6	2		70276	TERMINAL, HERMETIC	
7	–		NOT USED		
8	AR		70424-15	SCOTCHWELD 2216	
9	AR		70424-4	ADHESIVE	
10	AR		70411	THERMAL JOINT COMPOUND	
11	AR		70424-13	SILICONE RUBBER-RTV-734	DOW CORNING

REVISION STATUS OF THIS SHEET

LETTER	A	B	C	D	E	F	G	H	J	K	L
DATE	6-6-79	7-5-79	9-14-79	11-16-79	2-26-81	8-14-81	8-18-81	6-13-83	11/20/86	6-2-87	9-1-87
ECO NO.	711-94	711-132	711-194	711-235	403	463	Hw	564	1093	1194	1319