OPERATION AND
SERVICE MANUAL

RUBIDIUM FREQUENCY STANDARD MODEL 600

SERIAL NO. 203

12116A

September 1970

Tracor, Inc.

WARRANTY

TRACOR, Inc., warrants each instrument it manufactures to be free from defects in material and workmanship. The obligation under this warranty is limited to repairing or replacing any instrument or part thereof that shall be returned to us by the original purchaser, transportation charges prepaid, when upon examination it is disclosed to our satisfaction to be defective. This warranty is effective for one year after delivery to the original purchaser. If the fault has been caused by misuse or abnormal conditions of operation, repair will be made at cost. In this case, an estimate will be submitted before work is started.

In addition, TRACOR, Inc., warrants each Rubidium Gas Cell, utilized in its Rubidium Frequency Standards and Clocks, to be free from defects in workmanship and materials. The obligation under this warranty is limited to repair or replacing any Rubidium Gas Cell that shall be returned to us in the original instrument, by the original purchaser, transportation charges prepaid, when, upon our examination, it is disclosed to our satisfaction to be defective. This warranty is effective for five years after date of delivery to the original purchaser. If the fault has been caused by misuse or abnormal conditions of operation, repair will be made at cost. In this case, an estimate will be submitted before work is started.

If any fault develops, notify TRACOR, Inc., and give full details, including model and serial numbers. You will then be notified as to the disposition of the instrument.

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ATTN: PRODUCT SERVICE

Tracor, Inc.

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SECTION I
GENERAL DESCRIPTION

1-1. INTRODUCTION.

1-2. This section provides the purpose and general description of the Model 600 Rubidium Frequency Standard. The section also lists physical and electrical specifications and provides a brief functional description of operating controls and indicators.

1-3. PURPOSE OF EQUIPMENT.

1-4. The Model 600 Rubidium Frequency Standard operates as a precision color subcarrier generator that provides a source of phase-shiftable 3.579545MHz.

1-5. DESCRIPTION OF EQUIPMENT.

1-6. The rubidium frequency standard (figure 1-1) is a self-contained, secondary standard that uses the hyperfine resonant frequency of rubidium 87 to stabilize the frequency of a quartz crystal oscillator. The standard contains an optical microwave unit (OMU); a quartz crystal oscillator; synthesizer; and associated control, divider, and logic circuits. Outputs of 3.579 . . . MHz and 5MHz are available at the rear panel. The 5MHz output is also available at the front panel. In addition, a 1MHz output for VLF frequency verification is available as an options. Controls and indicators are listed in table 1-1.

1-7. SPECIFICATIONS.

1-8. A list of physical and electrical requirements for the standard is provided in the following paragraphs.

1-9. PHYSICAL SPECIFICATIONS.

Size:	5¼ inches high, by 19 inches wide, by 17¼ inches (behind front panel).
Weight:	40 pounds, approximately.

1-10. INPUT POWER REQUIREMENTS.

AC Input:	103 to 130 volts or 206 to 260 volts, 50 to 400Hz.		
DC Input:	23 to 30 volts.		
Power:	AC–50 watts, DC–35 watts (without options).		
Additional Power:		AC	DC
	Warm up	16	12
	Battery Option	3	0

1-11. ENVIRONMENTAL.

Operation Temperature:	0 to 50°C (to maintain $\Delta f/f < 1 \times 10^{-10}$)
Storage Temperature:	-40 to 75°C.
Humidity:	0 to 95%
Magnetic Field:	1 Gauss (to maintain $\Delta f/f < 5 \times 10^{-12}$)
Vibration:	Meets MIL-STD-167.

1-12. OUTPUTS.

Frequencies:	5MHz sinewave on front and rear panels; 3.57 . . . MHz and 1MHz (optional) sinewaves on rear panel only.
Long-term Stability:	Less than 2×10^{-11} per month.
Accuracy:	Set at factory to within 1×10^{-11} of specified time scale.
Voltage Level: ← ✻	3.57. . .MHz, 2V p-p into 75ohms; 5MHz and 1MHz Option, greater than 1Vrms into 50ohms.

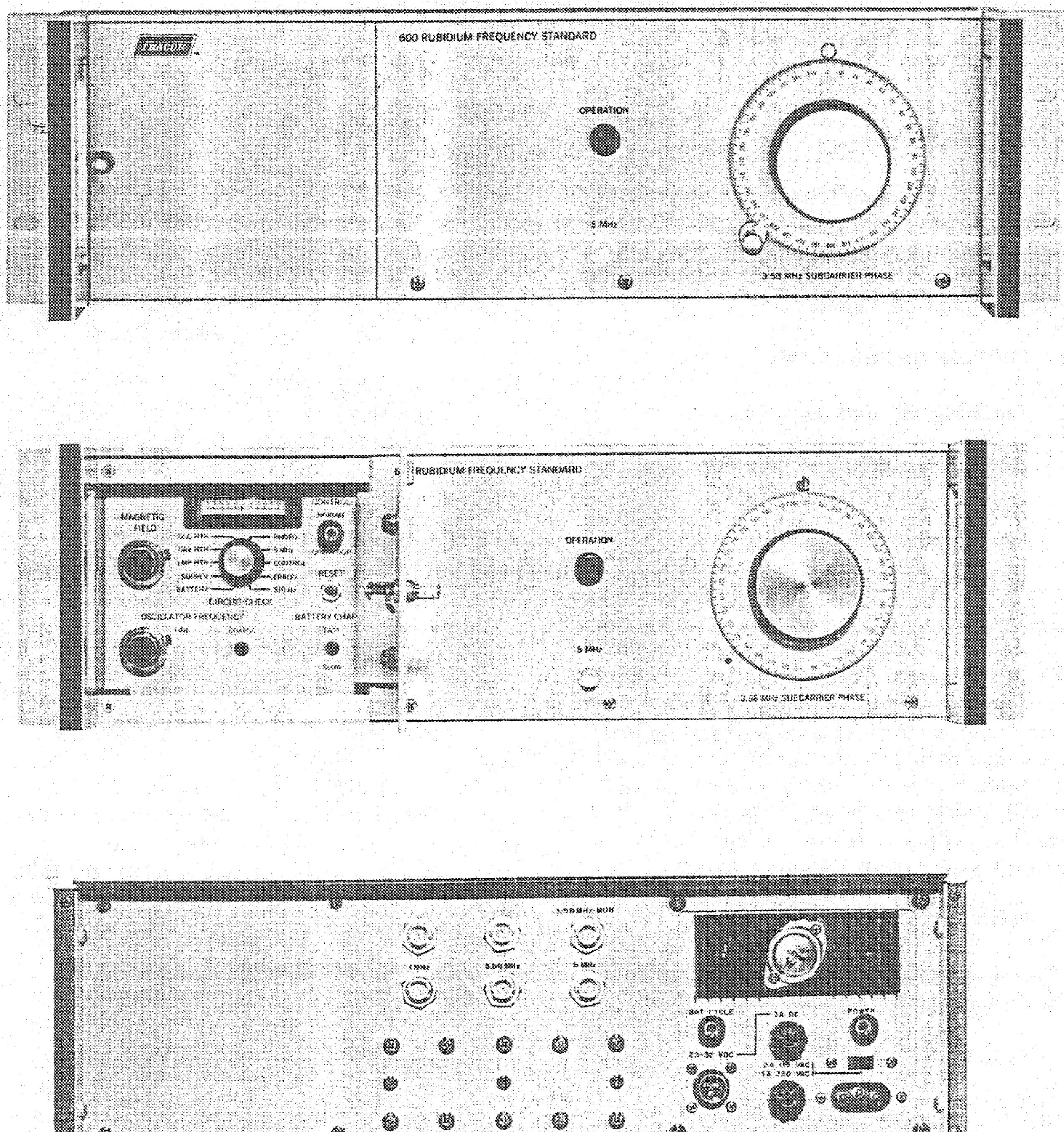

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Figure 1-1. Rubidium Frequency Standard Model 600

Impedance:	3.57 . . . MHz, 75ohms; 5MHz and 1MHz Option, less than 50ohms (30 ohms nominal).
Harmonic Distortion:	Greater than 40dB down from rated output.
Non-harmonic Distortion:	Greater than 80dB down from rated output.
Signal-to-Noise Ratio:	Greater than 87dB at rated output in 30kHz noise bandwidth. (1 and 5MHz outputs only.)
3.58MHz Test:	Greater than 1V p-p into 1000ohms.

1-13. TUNABILITY.

Frequency Synthesizer:	Range: 1000×10^{-10} Resolution: 2×10^{-9}
Mag-Field:	Range: $+2 \times 10^{-9}$ Resolution: 2×10^{-12} Linearity Error: 5% full scale

1-14. ACCURACY DURING WARM-UP.

One hour after turn-on (after 24-hour off time at 25°C ambient):	Less than 1×10^{-10}
Four hours after turn-on (after 24-hour off time at 25°C ambient):	Less than 5×10^{-11}

1-15. **OPTIONS AND ACCESSORIES.**

1-16. The items listed below are available as options for the rubidium frequency standard. Each item listed is discussed in detail in the applicable appendix to this manual as indicated.

Options	Refer to Appendix
1MHz Divider	A
Standby Battery	B

TABLE 1-1. FREQUENCY STANDARD CONTROLS AND INDICATORS

NAME	FUNCTION
MAGNETIC FIELD Control	Adjusts magnetic field current to provide an output frequency change of $+2 \times 10^{-9}$ to a resolution of 2×10^{-12}.
FINE OSCILLATOR FREQUENCY Control	Adjusts nominal frequency of crystal oscillator by changing the control voltage.
COARSE OSCILLATOR FREQUENCY Control	Adjusts nominal frequency of crystal oscillator.
CIRCUIT CHECK Meter	Indicates level of signal being monitored as determined by CIRCUIT CHECK Selector.

TABLE 1-1. (Continued)

NAME	FUNCTION
CIRCUIT CHECK Selector	Selects one of ten signals to be displayed on CIRCUIT CHECK Meter. Switch positions and functions are as follows: **Position** — **Function** BATTERY — Optional internal battery voltage. SUPPLY — 19.25VDC power supply voltage. LMP HTR — Rubidium lamp oven heater current. CAV HTR — Microwave cavity oven heater current. OSC HTR — 5MHz crystal oscillator oven heater current. PHOTO — Photocell output. 5MHz — 5MHz output voltage. CONTROL — Error signal voltage applied to loop filter integrator. 330Hz — 330Hz signal voltage.
CONTROL Switch	In OPEN LOOP position, opens automatic frequency control (AFC) loop enabling output frequency of standard to be controlled with FINE OSCILLATOR FREQUENCY control. In NORMAL position, closes frequency control loop enabling loop to control output frequency.
RESET Pushbutton	Resets OPERATION lamp logic circuits after AFC loop has been unlocked and has again acquired a lock. OPERATION lamp goes from a slow-flash to a steady-on condition.
BATTERY CHARGE Switch	Determines charging rate of optional internal standby battery. (Refer to Appendix B)

TABLE 1-1. (Continued)

NAME	FUNCTION
OPERATION Lamp	This lamp has three modes. Lights continuously when AFC loop is locked; flashes rapidly when AFC loop is out of lock; and flashes slowly when lock is acquired. Pressing RESET pushbutton returns lamp to steady-on condition.
BATTERY Lamp	Lights whenever the frequency standard is operating from the optional internal standby battery. (Refer to Appendix B for the various modes of the BATTERY lamp.)
3.58MHz SUBCARRIER PHASE Control	Permits shifting phase of 3.57. . .MHz output to any desired value.
3.58 MHz Connector	Provides 3.58 MHz sinewave output at rear panel.
3.58MHz MON Connector	Provides monitor point for 3.58 MHz output at rear panel.
5MHz Connector	Provides 5MHz sinewave output on front and rear panels.
1MHz Connector	Provides 1MHz sinewave output on rear panel (optional).
BAT CYCLE Switch	When in Up position, allows optional internal standby battery to operate frequency standard when AC and/or DC power are still connected. This is normally done to prevent battery cell plates from passivating, which reduces cell life. POWER switch must be in Down position. (Refer to Appendix B.)
23–32 VDC Connector	Allows connection of external DC power supply to provide standby power.
3A DC Fuse	Provides overload protection for frequency standard when operating from external DC power.
2A 115VAC Fuse 1A 230VAC Fuse	Provides overload protection for frequency standard when operating from AC power.
POWER Switch	Applies either AC, external DC, or internal DC (from optional standby battery) to power supply circuits to operate frequency standard.

TABLE 1-1. (Continued)

NAME	FUNCTION
115/230 Switch	Switches input to rectifier circuit in power supply to allow operation from either 115VRMS or 230VRMS power.
AC Power Connector	Allows connection of either 115 volt or 230 volt, 50-400Hz power.

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section provides instructions for unpacking, inspecting, and installing the rubidium frequency standard. Also included are instructions for connecting external power sources.

2-3. UNPACKING AND INSPECTION.

2-4. Carefully unpack the frequency standard and inspect it for possible damage during shipment. Special attention should be given to areas where the outside shipping package was damaged. If the frequency standard is damaged in any way, immediately notify the carrier. Also notify TRACOR, Inc., or any local TRACOR, Inc., Sales Office. (Refer to paragraph 5-18.)

2-5. INSTALLATION INSTRUCTIONS.

2-6. The frequency standard can be mounted in any 19-inch rack cabinet or operated on a bench. Remove the four feet before mounting the instrument in a rack. To ensure proper ventilation, do not operate the instrument on a bench without the feet.

2-7. Strong external magnetic fields will slightly affect the frequency outputs of the instrument. Therefore, do not install the instrument where large AC or DC magnetic fields are present. These fields are normally produced by large motors, generators, transformers, or magnets.

2-8. POWER CONNECTIONS.

2-9. The frequency standard is supplied with a removable three-wire power cord and a mating connector for DC standby power. Set the 115/230 switch on the rear panel to the appropriate position for the AC power source to be used. Connect the power cord supplied to the instrument and to any three-prong, NEMA approved power supplying receptacle. If a three-prong receptacle is not available, a two-prong adapter can be used, provided the ground wire is connected to an appropriate ground.

2-10. Standby DC power can be connected to the instrument through the mating connector supplied for the 23-32 VDC connector. Connect the DC power supply positive lead to pin A and the negative (ground) lead to pin B. Then connect the mating connector to the 23-32 VDC connector on the rear panel. The frequency standard will always operate from AC power as long as the AC voltage is above 105 VRMS.

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. This section provides procedures necessary to turn on and operate the rubidium frequency standard. Table 3-1 lists normal CIRCUIT CHECK meter indications that should be used as a guide during turn-on and normal operation. Refer to Appendix B for operation of the Battery Option.

3-3. TURN-ON PROCEDURE.

3-4. Before applying power to the frequency standard, ensure that the 115/230 slide switch is in the proper position and the AC fuse is 1.0 amp for 230 volt operation or 2.0 amp for 115 volt operation. The instrument will normally require about one hour to acquire lock and another three hours to provide accurate outputs. Turn on the frequency standard as follows:

a. Set CONTROL switch to NORMAL.
b. Set BAT. CYCLE switch down (rear panel).
c. Set POWER switch up (rear panel). OPERATION lamp will flash at fast rate. If battery option is installed, BATTERY lamp may light.
d. Set BATTERY CHARGE switch to FAST for 16 hours. This charges battery, which is shipped discharged.
e. Observe CIRCUIT CHECK meter indication for LMP HTR, CAV HTR, and OSC HTR switch positions. Meter should indicate full scale for all three positions.
f. When OPERATION lamp begins to flash at slow rate (in approximately 1 hour), press RESET pushbutton. OPERATION lamp should glow steadily.
g. If OPERATION lamp still flashes at slow rate, set CIRCUIT CHECK selector to CONTROL position. If meter indicates full scale, momentarily set CONTROL switch to OPEN LOOP position. Meter should indicate approximately 50. Press RESET pushbutton. OPERATION lamp should glow steadily.
h. Allow instrument to warm up for three or four hours. Unlock FINE OSCILLATOR FREQUENCY control and set to 50. Adjust COURSE OSCILLATOR FREQUENCY control for meter indication of 50 and relock control.
i. Set CIRCUIT CHECK selector to each position. These meter indications should correspond with those listed in table 3-1. Record each meter indication in Normal Indication column in table 3-1 for future reference.

3-5. The frequency standard is now ready for use. When it is shipped from the factory, it is set to the UTC frequency offset unless Atomic Time (A1) is requested. If a different offset is required, refer to paragraph 3-6.

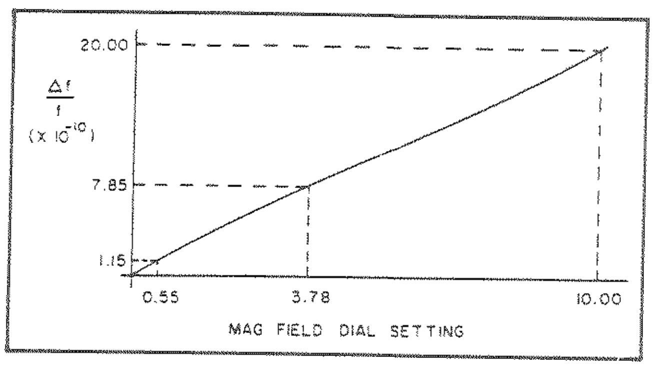


Figure 3-1. Sample Calibration Curve

3-6. CHANGING TIME SCALE.

3-7. The time scale of the frequency standard can be changed over a range of 1000 x 10^{-10}. This is accomplished using the 10 toggle switches located on the top of synthesizer assembly A6 and the MAGNETIC FIELD dial.

3-8. To set the standard to a new time scale setting, perform the following simple calculations. For a specific frequency setting, enter the data plate values in step a. For a shift from the present setting, enter the present values in step a.

TABLE 3-1. NORMAL CIRCUIT CHECK METER INDICATIONS

SWITCH	NORMAL INDICATION	FUNCTION CHECKED
BATTERY	0 (75-100 with battery option)	Indicates voltage of optional standby battery.
SUPPLY	70-80	Indicates 19.25 volt DC regulated supply voltage.
LMP HTR	55-90	Indicates heater current supplied to oven for rubidium lamp.
CAV HTR	50-90	Indicates heater current supplied to oven for microwave cavity.
OSC HTR	55-90	Indicates heater current supplied to oven for 5MHz crystal oscillator.
PHOTO	60-90	Indicates output current of photocell in OMU.
5MHz	60-80	Indicates level of 5MHz outputs.
CONTROL	0-100	Indicates DC control voltage applied to 5MHz crystal oscillator.
ERROR	50	Indicates DC error signal voltage applied to loop filter integrator.
330Hz	60-80	Indicates level of 330Hz signal applied to logic circuits.

a. Find the OFFSET in table 3-3 for the reference synthesizer SWITCH SETTING. Convert reference MAGNETIC FIELD dial setting to OFFSET using the calibration curve.

b. Enter the desired OFFSET from the reference.

c. Add the above three OFFSETS.

d. Find the nearest OFFSET in table 3-2 that is below the result of step c and set the synthesizer to the indicated SWITCH SETTINGS.

e. Subtract the OFFSET found above from the result of step c and convert the OFFSET difference to a new MAGNETIC FIELD dial setting using the calibration curve.

f. Set the MAGNETIC FIELD dial to the setting found in step e.

EXAMPLE For atomic time switch setting of 1386 and MAGNETIC FIELD setting of 3.78, desire a new time scale setting of A.T. -450×10^{-10}.

Step a.	Reference SWITCHES 1386 OFFSET from table 3-3.	.000
	Reference MAGNETIC FIELD 3.78 OFFSET from calibration curve.	7.850
Step b.	Desired OFFSET from reference settings of step a.	-450.000
Step c.	Sum of three above OFFSETS.	-442.150

Step d.	New Switches from table 3-2 <u>1786</u>	Yielding OFFSET below computation of step c <u>-443.300</u>

Step e.	New MAG FIELD from calibration curve <u>0.55</u>	Corresponding to OFFSET difference of steps c and d <u>1.150</u>

TABLE 3-2. OFFSET FREQUENCY SETTINGS

ØFFSET X10↑-10	SWITCH SETTING S10--------------S1	P	SYNTHESIZER FREQUENCY
71.008	0 0 0 1 0 1 1 0 1 1	1115	5313901.3
54.791	1 1 1 1 1 0 0 1 1 1	2023	5313890.3
52.782	1 1 0 0 0 0 1 0 0 0	1800	5313888.9
50.205	1 0 0 0 1 0 1 0 0 1	1577	5313887.1
46.779	0 1 0 1 0 0 1 0 1 0	1354	5313884.8
42.002	0 0 0 1 1 0 1 0 1 1	1131	5313881.5
38.830	1 1 1 1 1 1 0 1 1 1	2039	5313879.3
34.878	1 1 0 0 0 1 1 0 0 0	1816	5313876.6
29.821	1 0 0 0 1 1 1 0 0 1	1593	5313873.2
23.116	0 1 0 1 0 1 1 0 1 0	1370	5313868.6
17.287	1 1 0 0 1 0 1 0 0 0	1832	5313864.6
13.805	0 0 0 1 1 1 1 0 1 1	1147	5313862.2
9.841	1 0 0 1 0 0 1 0 0 1	1609	5313859.5
.000	0 1 0 1 1 0 1 0 1 0	1386	5313852.8
-9.744	1 0 0 1 0 1 1 0 0 1	1625	5313846.1
-13.615	0 0 1 0 0 0 1 0 1 1	1163	5313843.5
-16.990	1 1 0 1 0 0 1 0 0 0	1864	5313841.2
-22.589	0 1 0 1 1 1 1 0 1 0	1402	5313837.4
-28.948	1 0 0 1 1 0 1 0 0 1	1641	5313833.0
-33.691	1 1 0 1 0 1 1 0 0 0	1880	5313829.8
-40.292	0 0 1 0 0 1 1 0 1 1	1179	5313825.3
-44.668	0 1 1 0 0 0 1 0 1 0	1418	5313822.3
-47.781	1 0 0 1 1 1 1 0 0 1	1657	5313820.1
-50.110	1 1 0 1 1 0 1 0 0 0	1896	5313818.6
-66.254	0 0 1 0 1 0 1 0 1 1	1195	5313807.5
-82.130	1 1 1 0 0 0 1 0 0 0	1928	5313796.7
-84.377	1 0 1 0 0 1 1 0 0 1	1689	5313795.1
-87.364	0 1 1 0 1 0 1 0 1 0	1450	5313793.1
-91.530	0 0 1 0 1 1 1 0 1 1	1211	5313790.2
-97.745	1 1 1 0 0 1 1 0 0 0	1944	5313786.0
-102.159	1 0 1 0 1 0 1 0 0 1	1705	5313783.0
-108.013	0 1 1 0 1 1 1 0 1 0	1466	5313779.0
-113.105	1 1 1 0 1 0 1 0 0 0	1960	5313775.5
-116.147	0 0 1 1 0 0 1 0 1 1	1227	5313773.4
-119.611	1 0 1 0 1 1 1 0 0 1	1721	5313771.1
-128.216	0 1 1 1 0 0 1 0 1 0	1482	5313765.2
-136.742	1 0 1 1 0 0 1 0 0 1	1737	5313759.3
-140.130	0 0 1 1 0 1 1 0 1 1	1243	5313757.0
-143.085	1 1 1 1 0 0 1 0 0 0	1992	5313755.0
-147.988	0 1 1 1 0 1 1 0 1 0	1498	5313751.7
-153.559	1 0 1 1 0 1 1 0 0 1	1753	5313747.9
-157.716	1 1 1 1 0 1 1 0 0 0	2008	5313745.0
-163.504	0 0 1 1 1 0 1 0 1 1	1259	5313741.1

TABLE 3-2. OFFSET FREQUENCY SETTINGS

ØFFSET X10↑-10	SWITCH SETTING S10-------------S1	P	SYNTHESIZER FREQUENCY
-167.341	0 1 1 1 1 0 1 0 1 0	1514	5313738.4
-170.073	1 0 1 1 1 0 1 0 0 1	1769	5313736.6
-172.116	1 1 1 1 1 0 1 0 0 0	2024	5313735.2
-186.290	0 0 1 1 1 1 1 0 1 1	1275	5313725.5
-202.220	1 1 0 0 0 0 1 0.0 1	1801	5313714.6
-204.847	1 0 0 0 0 0 1 0 1 0	1546	5313712.8
-208.513	0 1 0 0 0 0 1 0 1 1	1291	5313710.3
-213.982	0 0 0 0 0 0 1 1 0 0	1036	5313706.6
-217.869	1 1 0 0 0 1 1 0 0 1	1817	5313703.9
-223.024	1 0 0 0 0 1 1 0 1 0	1562	5313700.4
-230.191	0 1 0 0 0 1 1 0 1 1	1307	5313695.5
-233.244	1 1 0 0 1 0 1 0 0 1	1833	5313693.4
-240.832	0 0 0 0 0 1 1 1 0 0	1052	5313688.2
-248.354	1 1 0 0 1 1 1 0 0 1	1849	5313683.1
-2[illegible].344	0 1 0 0 1 0 1 0 1 1	1323	5313681.0
-258.282	1 0 0 0 1 1 1 0 1 0	1594	5313676.3
-263.204	1 1 0 1 0 0 1 0 0 1	1865	5313672.9
-2[illegible]6.877	0 0 0 0 1 0 1 1 0 0	1068	5313670.4
-2[illegible].992	0 1 0 0 1 1 1 0 1 1	1339	5313666.9
-[illegible]75.336	1 0 0 1 0 0 1 0 1 0	1610	5313664.6
-[illegible]77.802	1 1 0 1 0 1 1 0 0 1	1881	5313662.9
-292.153	0 0 0 0 1 1 1 1 0 0	1084	531365[illegible]
-[illegible]6.264	1 1 0 1 1 1 1 0 0 1	1913	53136[illegible]3.5
-[illegible]08.593	1 0 0 1 1 0 1 0 1 0	1642	53136[illegible]
-3[illegible].843	0 1 0 1 0 1 1 0 1 1	1371	5313639.7
-316.694	0 0 0 1 0 0 1 1 0 0	1100	5313636.4
-320.141	1 1 1 0 0 0 1 0 0 1	1929	5313634.0
-324.716	1 0 0 1 1 1 1 0 1 0	1658	5313630.9
-331.079	0 1 0 1 1 0 1 0 1 1	1387	5313626.5
-333.790	1 1 1 0 0 1 1 0 0 1	1945	5313624.7
-340.531	0 0 0 1 0 1 1 1 0 0	1116	5313620.1
-347.216	1 1 1 0 1 0 1 0 0 1	1961	5313615.5
-349.875	0 1 0 1 1 1 1 0 1 1	1403	5313613.7
-356.046	1 0 1 0 0 1 1 0 1 0	1690	53136[illegible]
-360.425	1 1 1 0 1 1 1 0 0 1	1977	5313606.5
-363.694	0 0 0 1 1 0 1 1 0 0	1132	531360[illegible]
-368.248	0 1 1 0 0 0 1 0 1 1	1419	531360[illegible]
-371.270	1 0 1 0 1 0 1 0 1 0	1706	5313599.0
-373.422	1 1 1 1 0 0 1 0 0 1	1993	53135[illegible]7.4
-386.212	0 0 0 1 1 1 1 1 0 0	1148	531358[illegible]
-398.799	1 1 1 1 1 0 1 0 0 1	2025	5313580.2
-400.878	1 0 1 1 0 0 1 0 1 0	1738	5313578.[illegible]
-403.779	0 1 1 0 1 0 1 0 1 1	1451	5313576.[illegible]
-408.110	0 0 1 0 0 0 1 1 0 0	1164	5313573.[illegible]
-411.190	1 1 1 1 1 1 1 0 0 1	2041	5313571.8
-415.277	1 0 1 1 0 1 1 0 1 0	1754	5313569.0
-420.963	0 1 1 0 1 1 1 0 1 1	1467	5313565.1
-429.415	0 0 1 0 0 1 1 1 0 0	1180	5313559.3
-437.776	0 1 1 1 0 0 1 0 1 1	1483	5313553.6

TABLE 3-2. OFFSET FREQUENCY SETTINGS

ØFFSET X10↑-10	SWITCH SETTING S10--------------S1	P	SYNTHESIZER FREQUENCY
-443.300	1 0 1 1 1 1 1 0 1 0	1786	5313549.8
-450.150	0 0 1 0 1 0 1 1 0 0	1196	5313545.1
-454.230	0 1 1 1 0 1 1 0 1 1	1499	5313542.4
-456.939	1 1 0 0 0 0 1 0 1 0	1802	5313540.5
-470.337	0 0 1 0 1 1 1 1 0 0	1212	5313531.3
-483.502	1 1 0 0 1 0 1 0 1 0	1834	5313522.3
-486.107	0 1 1 1 1 1 1 0 1 1	1531	5313520.6
-489.998	0 0 1 1 0 0 1 1 0 0	1228	5313517.9
-496.439	1 1 0 0 1 1 1 0 1 0	1850	5313513.5
-501.551	1 0 0 0 0 0 1 0 1 1	1547	5313510.0
-509.154	0 0 1 1 0 1 1 1 0 0	1244	5313504.8
-516.679	1 0 0 0 0 1 1 0 1 1	1563	5313499.7
-521.653	1 1 0 1 0 1 1 0 1 0	1882	5313496.3
-527.823	0 0 1 1 1 0 1 1 0 0	1260	5313492.1
-531.500	1 0 0 0 1 0 1 0 1 1	1579	5313489.5
-533.941	1 1 0 1 1 0 1 0 1 0	1898	5313487.9
-546.024	0 0 1 1 1 1 1 1 0 0	1276	5313479.6
-557.906	1 1 1 0 0 0 1 0 1 0	1930	5313471.5
-560.259	1 0 0 1 0 0 1 0 1 1	1611	5313469.9
-563.774	0 1 0 0 0 0 1 1 0 0	1292	5313467.5
-569.593	1 1 1 0 0 1 1 0 1 0	1946	5313463.5
-574.214	1 0 0 1 0 1 1 0 1 1	1627	5313460.3
-581.089	0 1 0 0 0 1 1 1 0 0	1308	5313455.6
-587.898	1 0 0 1 1 0 1 0 1 1	1643	5313451.0
-592.400	1 1 1 0 1 1 1 0 1 0	1978	5313447.9
-597.987	0 1 0 0 1 0 1 1 0 0	1324	5313444.1
-601.317	1 0 0 1 1 1 1 0 1 1	1659	5313441.8
-603.529	1 1 1 1 0 0 1 0 1 0	1994	5313440.3
-614.480	0 1 0 0 1 1 1 1 0 0	1340	5313432.8
-625.259	1 1 1 1 1 0 1 0 1 0	2026	5313425.5
-627.394	1 0 1 0 0 1 1 0 1 1	1691	5313424.0
-630.585	0 1 0 1 0 0 1 1 0 0	1356	5313421.8
-635.869	1 1 1 1 1 1 1 0 1 0	2042	5313418.2
-640.066	1 0 1 0 1 0 1 0 1 1	1707	5313415.3
-646.314	0 1 0 1 0 1 1 1 0 0	1372	5313411.1
-652.503	1 0 1 0 1 1 1 0 1 1	1723	5313406.8
-656.597	0 0 0 0 0 0 1 1 0 1	1037	5313404.0
-661.680	0 1 0 1 1 0 1 1 0 0	1388	5313400.6
-664.711	1 0 1 1 0 0 1 0 1 1	1739	5313398.5
-676.696	0 0 0 0 0 1 1 1 0 1	1053	5313390.3
-688.465	1 0 1 1 1 0 1 0 1 1	1771	5313382.3
-691.374	0 1 1 0 0 0 1 1 0 0	1420	5313380.3
-696.193	0 0 0 0 1 0 1 1 0 1	1069	5313377.0
-700.022	1 0 1 1 1 1 1 0 1 1	1787	5313374.4
-705.724	0 1 1 0 0 1 1 1 0 0	1436	5313370.5
-711.375	1 1 0 0 0 0 1 0 1 1	1803	5313366.6
-715.115	0 0 0 0 1 1 1 1 0 1	1085	5313364.0
-719.758	0 1 1 0 1 0 1 1 0 0	1452	5313360.9

TABLE 3-2. OFFSET FREQUENCY SETTINGS

ØFFSET X10↑-10	SWITCH SETTING S10--------------S1	P	SYNTHESIZER FREQUENCY
-722.528	1 1 0 0 0 1 1 0 1 1	1819	5313359.0
-733.487	0 0 0 1 0 0 1 1 0 1	1101	5313351.5
-744.256	1 1 0 0 1 1 1 0 1 1	1851	5313344.1
-746.919	0 1 1 1 0 0 1 1 0 0	1484	5313342.3
-751.332	0 0 0 1 0 1 1 1 0 1	1117	5313339.3
-754.840	1 1 0 1 0 0 1 0 1 1	1867	5313336.9
-760.065	0 1 1 1 0 1 1 1 0 0	1500	5313333.3
-765.245	1 1 0 1 0 1 1 0 1 1	1883	5313329.8
-768.674	0 0 0 1 1 0 1 1 0 1	1133	5313327.4
-772.933	0 1 1 1 1 0 1 1 0 0	1516	5313324.5
-775.474	1 1 0 1 1 0 1 0 1 1	1899	5313322.8
-785.533	0 0 0 1 1 1 1 1 0 1	1149	5313315.9
-795.424	1 1 1 0 0 0 1 0 1 1	1931	5313309.2
-797.872	1 0 0 0 0 0 1 1 0 0	1548	5313307.5
-801.928	0 0 1 0 0 0 1 1 0 1	1165	5313304.7
-805.153	1 1 1 0 0 1 1 0 1 1	1947	5313302.5
-809.958	1 0 0 0 0 1 1 1 0 0	1564	5313299.2
-814.724	1 1 1 0 1 0 1 0 1 1	1963	5313296.0
-817.880	0 0 1 0 0 1 1 1 0 1	1181	5313293.8
-821.800	1 0 0 0 1 0 1 1 0 0	1580	5313291.1
-824.140	1 1 1 0 1 1 1 0 1 1	1979	5313289.5
-833.404	0 0 1 0 1 0 1 1 0 1	1197	5313283.2
-842.522	1 1 1 1 0 1 1 0 1 1	2011	5313277.0
-844.778	1 0 0 1 0 0 1 1 0 0	1612	5313275.4
-848.520	0 0 1 0 1 1 1 1 0 1	1213	5313272.9
-851.495	1 1 1 1 1 0 1 0 1 1	2027	5313270.8
-855.929	1 0 0 1 0 1 1 1 0 0	1628	5313267.8
-860.328	1 1 1 1 1 1 1 0 1 1	2043	5313264.8
-863.242	0 0 1 1 0 0 1 1 0 1	1229	5313262.8
-866.862	1 0 0 1 1 0 1 1 0 0	1644	5313260.3
-877.585	0 0 1 1 0 1 1 1 0 1	1245	5313253.0
-888.103	1 0 1 0 0 0 1 1 0 0	1676	5313245.8
-891.564	0 0 1 1 1 0 1 1 0 1	1261	5313243.4
-898.422	1 0 1 0 0 1 1 1 0 0	1692	5313238.8
-905.193	0 0 1 1 1 1 1 1 0 1	1277	5313234.1
-908.547	1 0 1 0 1 0 1 1 0 0	1708	5313231.8
-918.485	0 1 0 0 0 0 1 1 0 1	1293	5313225.1
-928.240	1 0 1 1 0 0 1 1 0 0	1740	5313218.4
-937.817	1 0 1 1 0 1 1 1 0 0	1756	5313211.8
-944.106	0 1 0 0 1 0 1 1 0 1	1325	5313207.5
-947.222	1 0 1 1 1 0 1 1 0 0	1772	5313205.4
-956.457	0 1 0 0 1 1 1 1 0 1	1341	5313199.1
-965.530	1 1 0 0 0 0 1 1 0 0	1804	5313192.9
-968.518	0 1 0 1 0 0 1 1 0 1	1357	5313190.9
-974.442	1 1 0 0 0 1 1 1 0 0	1820	5313186.8
-980.297	0 1 0 1 0 1 1 1 0 1	1373	5313182.8
-983.199	1 1 0 0 1 0 1 1 0 0	1836	5313180.8
-991.805	0 1 0 1 1 0 1 1 0 1	1389	5313174.9
-1000.264	1 1 0 1 0 0 1 1 0 0	1868	5313169.2

TABLE 3-2. OFFSET FREQUENCY SETTINGS

	SWITCH SETTING S10--------------S1	P	SYNTHESIZER FREQUENCY
-1003.051	0 1 0 1 1 1 1 1 0 1	1405	5313167.2
-1008.579	1 1 0 1 0 1 1 1 0 0	1884	5313163.5
-1014.044	0 1 1 0 0 0 1 1 0 1	1421	5313159.7
-1016.753	1 1 0 1 1 0 1 1 0 0	1900	5313157.9
-1024.792	0 1 1 0 0 1 1 1 0 1	1437	5313152.4
-1032.697	1 1 1 0 0 0 1 1 0 0	1932	5313147.0
-1035.303	0 1 1 0 1 0 1 1 0 1	1453	5313145.2
-1040.472	1 1 1 0 0 1 1 1 0 0	1948	5313141.7
-1045.585	0 1 1 0 1 1 1 1 0 1	1469	5313138.2
-1048.121	1 1 1 0 1 0 1 1 0 0	1964	5313136.4
-1055.646	0 1 1 1 0 0 1 1 0 1	1485	5313131.3

Table 3-3.OFFSET FREQUENCY SETTINGS

SWITCH SETTING S10--------------S1	ØFFSET X10↑-10	P	SYNTHESIZER FREQUENCY
1 1 1 1 1 1 1 0 1 1	-860.328	2043	5313264.8
1 1 1 1 1 1 1 0 1 0	-635.869	2042	5313418.2
1 1 1 1 1 1 1 0 0 1	-411.190	2041	5313571.8
1 1 1 1 1 1 0 1 1 1	38.830	2039	5313879.3
1 1 1 1 1 0 1 0 1 1	-851.495	2027	5313270.8
1 1 1 1 1 0 1 0 1 0	-625.259	2026	5313425.5
1 1 1 1 1 0 1 0 0 1	-398.799	2025	5313580.2
1 1 1 1 1 0 1 0 0 0	-172.116	2024	5313735.2
1 1 1 1 1 0 0 1 1 1	54.791	2023	5313890.3
1 1 1 1 0 1 1 0 1 1	-842.522	2011	5313277.0
1 1 1 1 0 1 1 0 0 0	-157.716	2008	5313745.0
1 1 1 1 0 0 1 0 1 0	-603.529	1994	5313440.3
1 1 1 1 0 0 1 0 0 1	-373.422	1993	5313597.6
1 1 1 1 0 0 1 0 0 0	-143.085	1992	5313755.0
1 1 1 0 1 1 1 0 1 1	-824.140	1979	5313289.5
1 1 1 0 1 1 1 0 1 0	-592.400	1978	5313447.9
1 1 1 0 1 1 1 0 0 1	-360.425	1977	5313606.5
1 1 1 0 1 0 1 1 0 0	-1048.121	1964	5313136.4
1 1 1 0 1 0 1 0 1 1	-814.724	1963	5313296.0
1 1 1 0 1 0 1 0 0 1	-347.216	1961	5313615.5
1 1 1 0 1 0 1 0 0 0	-113.105	1960	5313775.5
1 1 1 0 0 1 1 1 0 0	-1040.472	1948	5313141.7
1 1 1 0 0 1 1 0 1 1	-805.153	1947	5313302.5
1 1 1 0 0 1 1 0 1 0	-569.593	1946	5313463.5
1 1 1 0 0 1 1 0 0 1	-333.790	1945	5313624.7
1 1 1 0 0 1 1 0 0 0	-97.745	1944	5313786.0
1 1 1 0 0 0 1 1 0 0	-1032.697	1932	5313147.0
1 1 1 0 0 0 1 0 1 1	-795.424	1931	5313309.2
1 1 1 0 0 0 1 0 1 0	-557.906	1930	5313471.5
1 1 1 0 0 0 1 0 0 1	-320.141	1929	5313634.0
1 1 1 0 0 0 1 0 0 0	-82.130	1928	5313796.7
1 1 0 1 1 1 1 0 0 1	-306.264	1913	5313643.5
1 1 0 1 1 0 1 1 0 0	-1016.753	1900	5313157.9

TABLE 3-3. OFFSET FREQUENCY SETTINGS

SWITCH SETTING S10 - - - - - - - - - - - - - - S1	ØFFSET X10↑-10	P	SYNTHESIZER FREQUENCY
1 1 0 1 1 0 1 0 1 1	-775.474	1899	5313322.8
1 1 0 1 1 0 1 0 1 0	-533.941	1898	5313487.9
1 1 0 1 1 0 1 0 0 0	-50.110	1896	5313818.6
1 1 0 1 0 1 1 1 0 0	-1008.579	1884	5313163.5
1 1 0 1 0 1 1 0 1 1	-765.245	1883	5313329.8
1 1 0 1 0 1 1 0 1 0	-521.653	1882	5313496.3
1 1 0 1 0 1 1 0 0 1	-277.802	1881	5313662.9
1 1 0 1 0 1 1 0 0 0	-33.691	1880	5313829.8
1 1 0 1 0 0 1 1 0 0	-1000.264	1868	5313169.2
1 1 0 1 0 0 1 0 1 1	-754.840	1867	5313336.9
1 1 0 1 0 0 1 0 0 1	-263.204	1865	5313672.9
1 1 0 1 0 0 1 0 0 0	-16.990	1864	5313841.2
1 1 0 0 1 1 1 0 1 1	-744.256	1851	5313344.1
1 1 0 0 1 1 1 0 1 0	-496.439	1850	5313513.5
1 1 0 0 1 1 1 0 0 1	-248.354	1849	5313683.1
1 1 0 0 1 0 1 1 0 0	-983.199	1836	5313180.8
1 1 0 0 1 0 1 0 1 0	-483.502	1834	5313522.3
1 1 0 0 1 0 1 0 0 1	-233.244	1833	5313693.4
1 1 0 0 1 0 1 0 0 0	17.287	1832	5313864.6
1 1 0 0 0 1 1 1 0 0	-974.442	1820	5313186.8
1 1 0 0 0 1 1 0 1 1	-722.528	1819	5313359.0
1 1 0 0 0 1 1 0 0 1	-217.869	1817	5313703.9
1 1 0 0 0 1 1 0 0 0	34.878	1816	5313876.6
1 1 0 0 0 0 1 1 0 0	-965.530	1804	5313192.9
1 1 0 0 0 0 1 0 1 1	-711.375	1803	5313366.6
1 1 0 0 0 0 1 0 1 0	-456.939	1802	5313540.5
1 1 0 0 0 0 1 0 0 1	-202.220	1801	5313714.6
1 1 0 0 0 0 1 0 0 0	52.782	1800	5313888.9
1 0 1 1 1 1 1 0 1 1	-700.022	1787	5313374.4
1 0 1 1 1 1 1 0 1 0	-443.300	1786	5313549.8
1 0 1 1 1 0 1 1 0 0	-947.222	1772	5313205.4
1 0 1 1 1 0 1 0 1 1	-688.465	1771	5313382.3
1 0 1 1 1 0 1 0 0 1	-170.073	1769	5313736.6
1 0 1 1 0 1 1 1 0 0	-937.817	1756	5313211.8
1 0 1 1 0 1 1 0 1 0	-415.277	1754	5313569.0
1 0 1 1 0 1 1 0 0 1	-153.559	1753	5313747.9
1 0 1 1 0 0 1 1 0 0	-928.240	1740	5313218.4
1 0 1 1 0 0 1 0 1 1	-664.711	1739	5313398.5
1 0 1 1 0 0 1 0 1 0	-400.878	1738	5313578.8
1 0 1 1 0 0 1 0 0 1	-136.742	1737	5313759.3
1 0 1 0 1 1 1 0 1 1	-652.503	1723	5313406.8
1 0 1 0 1 1 1 0 0 1	-119.611	1721	5313771.1
1 0 1 0 1 0 1 1 0 0	-908.547	1708	5313231.8
1 0 1 0 1 0 1 0 1 1	-640.066	1707	5313415.3
1 0 1 0 1 0 1 0 1 0	-371.270	1706	5313599.0
1 0 1 0 1 0 1 0 0 1	-102.159	1705	5313783.0
1 0 1 0 0 1 1 1 0 0	-898.422	1692	5313238.8
1 0 1 0 0 1 1 0 1 1	-627.394	1691	5313424.0
1 0 1 0 0 1 1 0 1 0	-356.046	1690	5313609.5

TABLE 3-3. OFFSET FREQUENCY SETTINGS

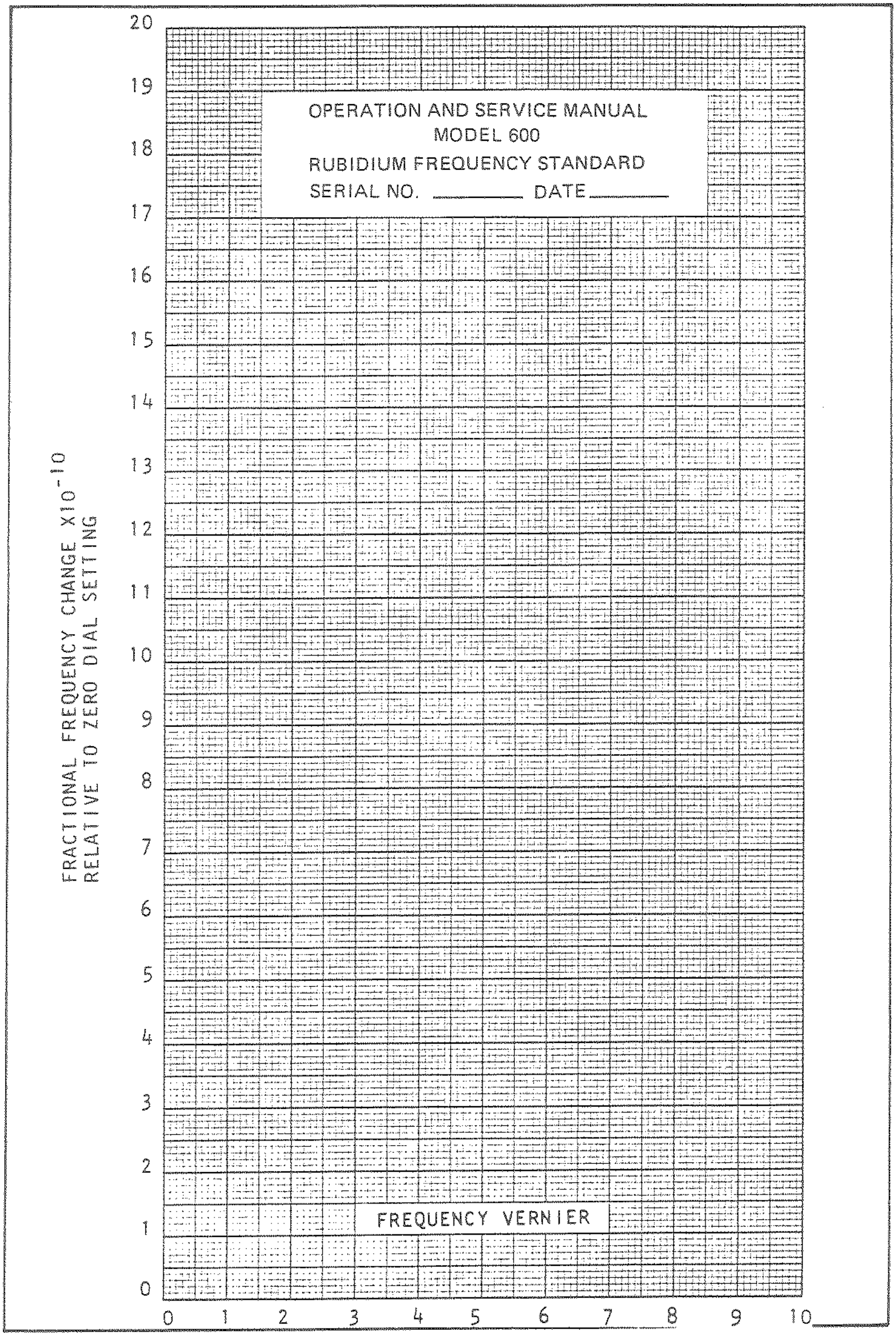
SWITCH SETTING S10--------------S1	ØFFSET X10↑-10	P	SYNTHESIZER FREQUENCY
1 0 1 0 0 1 1 0 0 1	-84.377	1689	5313795.1
1 0 1 0 0 0 1 1 0 0	-888.103	1676	5313245.8
1 0 0 1 1 1 1 0 1 1	-601.317	1659	5313441.8
1 0 0 1 1 1 1 0 1 0	-324.716	1658	5313630.9
1 0 0 1 1 1 1 0 0 1	-47.781	1657	5313820.1
1 0 0 1 1 0 1 1 0 0	-866.862	1644	5313260.3
1 0 0 1 1 0 1 0 1 1	-587.898	1643	5313451.0
1 0 0 1 1 0 1 0 1 0	-308.593	1642	5313641.9
1 0 0 1 1 0 1 0 0 1	-28.948	1641	5313833.0
1 0 0 1 0 1 1 1 0 0	-855.929	1628	5313267.8
1 0 0 1 0 1 1 0 1 1	-574.214	1627	5313460.3
1 0 0 1 0 1 1 0 0 1	-9.744	1625	5313846.1
1 0 0 1 0 0 1 1 0 0	-844.778	1612	5313275.4
1 0 0 1 0 0 1 0 1 1	-560.259	1611	5313469.9
1 0 0 1 0 0 1 0 1 0	-275.386	1610	5313664.6
1 0 0 1 0 0 1 0 0 1	9.841	1609	5313859.5
1 0 0 0 1 1 1 0 1 0	-258.282	1594	5313676.3
1 0 0 0 1 1 1 0 0 1	29.821	1593	5313873.2
1 0 0 0 1 0 1 1 0 0	-821.800	1580	5313291.1
1 0 0 0 1 0 1 0 1 1	-531.500	1579	5313489.5
1 0 0 0 1 0 1 0 0 1	50.205	1577	5313887.1
1 0 0 0 0 1 1 1 0 0	-809.958	1564	5313299.2
1 0 0 0 0 1 1 0 1 1	-516.679	1563	5313499.7
1 0 0 0 0 1 1 0 1 0	-223.024	1562	5313700.4
1 0 0 0 0 0 1 1 0 0	-797.872	1548	5313307.5
1 0 0 0 0 0 1 0 1 1	-501.551	1547	5313510.0
1 0 0 0 0 0 1 0 1 0	-204.847	1546	5313712.8
0 1 1 1 1 1 1 0 1 1	-486.107	1531	5313520.6
0 1 1 1 1 0 1 1 0 0	-772.933	1516	5313324.5
0 1 1 1 1 0 1 0 1 0	-167.341	1514	5313738.4
0 1 1 1 0 1 1 1 0 0	-760.065	1500	5313333.3
0 1 1 1 0 1 1 0 1 1	-454.230	1499	5313542.4
0 1 1 1 0 1 1 0 1 0	-147.988	1498	5313751.7
0 1 1 1 0 0 1 1 0 1	-1055.646	1485	5313131.3
0 1 1 1 0 0 1 1 0 0	-746.919	1484	5313342.3
0 1 1 1 0 0 1 0 1 1	-437.776	1483	5313553.6
0 1 1 1 0 0 1 0 1 0	-128.216	1482	5313765.2
0 1 1 0 1 1 1 1 0 1	-1045.585	1469	5313138.2
0 1 1 0 1 1 1 0 1 1	-420.963	1467	5313565.1
0 1 1 0 1 1 1 0 1 0	-108.013	1466	5313779.0
0 1 1 0 1 0 1 1 0 1	-1035.303	1453	5313145.2
0 1 1 0 1 0 1 1 0 0	-719.758	1452	5313360.9
0 1 1 0 1 0 1 0 1 1	-403.779	1451	5313576.8
0 1 1 0 1 0 1 0 1 0	-87.364	1450	5313793.1
0 1 1 0 0 1 1 1 0 1	-1024.792	1437	5313152.4
0 1 1 0 0 1 1 1 0 0	-705.724	1436	5313370.5
0 1 1 0 0 0 1 1 0 1	-1014.044	1421	5313159.7
0 1 1 0 0 0 1 1 0 0	-691.374	1420	5313380.3
0 1 1 0 0 0 1 0 1 1	-368.248	1419	5313601.1

TABLE 3-3. OFFSET FREQUENCY SETTINGS

SWITCH SETTING S10--------------S1	OFFSET X10⁻¹⁰	P	SYNTHESIZER FREQUENCY
0 1 1 0 0 0 1 0 1 0	-44.668	1418	5313822.3
0 1 0 1 1 1 1 1 0 1	-1003.051	1405	5313167.8
0 1 0 1 1 1 1 0 1 1	-349.875	1403	5313613.7
0 1 0 1 1 1 1 0 1 0	-22.589	1402	5313837.4
0 1 0 1 1 0 1 1 0 1	-991.805	1389	5313174.9
0 1 0 1 1 0 1 1 0 0	-661.660	1388	5313400.6
0 1 0 1 1 0 1 0 1 1	-331.079	1387	5313626.5
0 1 0 1 1 0 1 0 1 0	.000	1386	5313852.8
0 1 0 1 0 1 1 1 0 1	-980.297	1373	5313182.8
0 1 0 1 0 1 1 1 0 0	-646.214	1372	5313411.1
0 1 0 1 0 1 1 0 1 1	-311.843	1371	5313639.7
0 1 0 1 0 1 1 0 1 0	23.116	1370	5313868.[illegible]
0 1 0 1 0 0 1 1 0 1	-968.518	1357	5313190.9
0 1 0 1 0 0 1 1 0 0	-630.585	1356	5313421.8
0 1 0 1 0 0 1 0 1 0	46.779	1354	5313884.8
0 1 0 0 1 1 1 1 0 1	-956.457	1341	5313199.1
0 1 0 0 1 1 1 1 0 0	-614.480	1340	5313432.8
0 1 0 0 1 1 1 0 1 1	-271.992	1339	5313666.9
0 1 0 0 1 0 1 1 0 1	-944.106	1325	5313207.5
0 1 0 0 1 0 1 1 0 0	-597.987	1324	5313444.1
0 1 0 0 1 0 1 0 1 1	-251.344	1323	5313681.0
0 1 0 0 0 1 1 1 0 0	-581.089	1308	5313455.6
0 1 0 0 0 1 1 0 1 1	-230.191	1307	5313695.5
0 1 0 0 0 0 1 1 0 1	-918.485	1293	5313225.1
0 1 0 0 0 0 1 1 0 0	-563.774	1292	5313467.5
0 1 0 0 0 0 1 0 1 1	-208.513	1291	5313710.3
0 0 1 1 1 1 1 1 0 1	-905.193	1277	5313234.1
0 0 1 1 1 1 1 1 0 0	-546.024	1276	5313479.6
0 0 1 1 1 1 1 0 1 1	-186.290	1275	5313725.5
0 0 1 1 1 0 1 1 0 1	-891.564	1261	5313243.4
0 0 1 1 1 0 1 1 0 0	-527.823	1260	5313492.1
0 0 1 1 1 0 1 0 1 1	-163.504	1259	5313741.1
0 0 1 1 0 1 1 1 0 1	-877.585	1245	5313253.0
0 0 1 1 0 1 1 1 0 0	-509.154	1244	5313504.8
0 0 1 1 0 1 1 0 1 1	-140.130	1243	5313757.0
0 0 1 1 0 0 1 1 0 1	-863.242	1229	5313262.8
0 0 1 1 0 0 1 1 0 0	-489.998	1228	5313517.9
0 0 1 1 0 0 1 0 1 1	-116.147	1227	5313773.4
0 0 1 0 1 1 1 1 0 1	-848.520	1213	5313272.9
0 0 1 0 1 1 1 1 0 0	-470.337	1212	5313531.3
0 0 1 0 1 1 1 0 1 1	-91.530	1211	5313790.2
0 0 1 0 1 0 1 1 0 1	-833.404	1197	5313283.2
0 0 1 0 1 0 1 1 0 0	-450.150	1196	5313545.1
0 0 1 0 1 0 1 0 1 1	-66.254	1195	5313807.5
0 0 1 0 0 1 1 1 0 1	-817.880	1181	5313293.8
0 0 1 0 0 1 1 1 0 0	-429.415	1180	5313559.3
0 0 1 0 0 1 1 0 1 1	-40.292	1179	5313825.3
0 0 1 0 0 0 1 1 0 1	-801.928	1165	5313304.7

TABLE 3-3. OFFSET FREQUENCY SETTINGS

SWITCH SETTING S10--------------S1	ØFFSET X10↑-10	P	SYNTHESIZER FREQUENCY
0 0 1 0 0 0 1 1 0 0	-408.110	1164	5313573.9
0 0 1 0 0 0 1 0 1 1	-13.615	1163	5313843.5
0 0 0 1 1 1 1 1 0 1	-785.533	1149	5313315.9
0 0 0 1 1 1 1 1 0 0	-386.212	1148	5313588.8
0 0 0 1 1 1 1 0 1 1	13.805	1147	5313862.2
0 0 0 1 1 0 1 1 0 1	-768.674	1133	5313327.4
0 0 0 1 1 0 1 1 0 0	-363.694	1132	5313604.2
0 0 0 1 1 0 1 0 1 1	42.002	1131	5313881.5
0 0 0 1 0 1 1 1 0 1	-751.332	1117	5313339.3
0 0 0 1 0 1 1 1 0 0	-340.531	1116	5313620.1
0 0 0 1 0 1 1 0 1 1	71.008	1115	5313901.3
0 0 0 1 0 0 1 1 0 1	-733.487	1101	5313351.5
0 0 0 1 0 0 1 1 0 0	-316.694	1100	5313636.4
0 0 0 0 1 1 1 1 0 1	-715.115	1085	5313364.0
0 0 0 0 1 1 1 1 0 0	-292.153	1084	5313653.1
0 0 0 0 1 0 1 1 0 1	-696.193	1069	5313377.0
0 0 0 0 1 0 1 1 0 0	-266.877	1068	5313670.4
0 0 0 0 0 1 1 1 0 1	-676.696	1053	5313390.3
0 0 0 0 0 1 1 1 0 0	-240.832	1052	5313688.2
0 0 0 0 0 0 1 1 0 1	-656.597	1037	5313404.0
0 0 0 0 0 0 1 1 0 0	-213.982	1036	5313706.6


OPERATION AND SERVICE MANUAL
MODEL 600
RUBIDIUM FREQUENCY STANDARD
SERIAL NO. ________ DATE ________
FRACTIONAL FREQUENCY CHANGE X10^-10
RELATIVE TO ZERO DIAL SETTING
20
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FREQUENCY VERNIER
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SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. This section provides the theory of operation for the Model 600 Rubidium Frequency Standard. A description of rubidium resonance and optical pumping, simplified functional description, function description, and detailed circuit analysis are included.

4-3. RUBIDIUM RESONANCE AND OPTICAL PUMPING.

4-4. Before discussing the functional operation of the frequency standard, it is necessary to understand rubidium resonance and the optical pumping technique. The following paragraphs briefly outline the resonance theory and the pumping technique.

4-5. RUBIDIUM RESONANCE.

4-6. The hyperfine atomic resonant frequency of rubidium 87 provides a precisely known and fixed reference point in the radio frequency spectrum. This rubidium is contained in a small glass cell in the form of a vapor. The glass cell is inside a resonant microwave cavity, which is excited at approximately the rubidium resonant frequency.

4-7. Atoms can exist in a discrete set of energy states. However, any one atom can exist in only one energy state at any given time. Each energy state is characterized by a specific value of internal energy. As an atom changes from one state to another, a certain amount of electromagnetic radiation is absorbed or emitted. The frequency of this radiation is related to the change in internal energy by the equation:

$$f = \frac{E_2 - E_1}{h}$$

where: f is the radiation frequency.
$E_2 - E_1$ is the internal energy change.
h is Planck's constant (6.24×10^{-27} erg-seconds).

4-8. This frequency can be detected by either microwave or optical absorption techniques. It is detected from the interaction between the microwave cavity electromagnetic field and the resonant state of the atoms. A signal will be produced that is due to the difference in the number of atoms existing in two adjacent energy states. Of specific interest is the difference between energy states 1 and 2 for rubidium 87 atoms. As the frequency of the microwave cavity approaches the rubidium resonant frequency, the amount of electromagnetic radiation absorbed will increase, increasing the difference in the number of atoms in states 1 and 2. However, even when the frequency of the microwave cavity is exactly at the rubidium resonant frequency, the amount of electromagnetic radiation absorbed is still very small and therefore difficult to detect. For this reason, optical pumping is used.

4-9. OPTICAL PUMPING TECHNIQUE.

4-10. Optical pumping is a process of redistributing atoms among the possible energy states. By illuminating the rubidium atoms in energy state 1 with rubidium light at a wavelength of 7800A, they will absorb light energy and transfer to energy state 3. Figure 4-1 illustrates the energy states of interest for rubidium atoms. The atoms that reach energy state 3 will transfer back to energy states 1 and 2 with equal probability. The lamp also produces light at a wavelength that transfers atoms from energy state 2 to energy state 3. However, this wavelength is eliminated by a gas filter cell. Since atoms at energy state 2 cannot transfer, the total number of atoms at state 2 will be greater than the number at state 1. This increases the optical and electromagnetic radiation absorbed. Since the optical radiation absorption is greater, it is detected by a photo cell. This technique produces an output signal that has greater usability.

4-11. When the applied microwave frequency exactly matches the rubidium resonant frequency, the absorption of light from the rubidium lamp will be a maximum. To detect this absorption peak, the microwave frequency is slightly modulated about the rubidium resonant frequency. The characteristic curve of photocell output vs. microwave frequency is shown in figure 4-2.

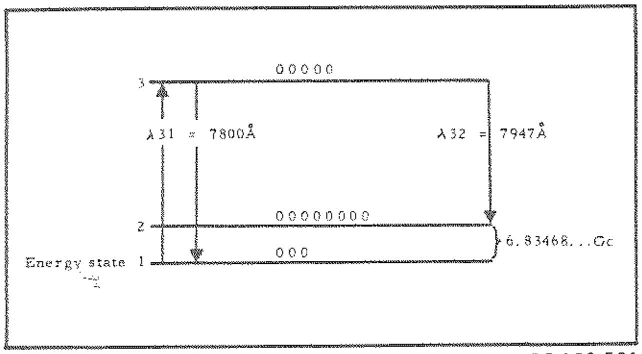

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Figure 4-1. Rubidium 87 Simplified Energy State Diagram

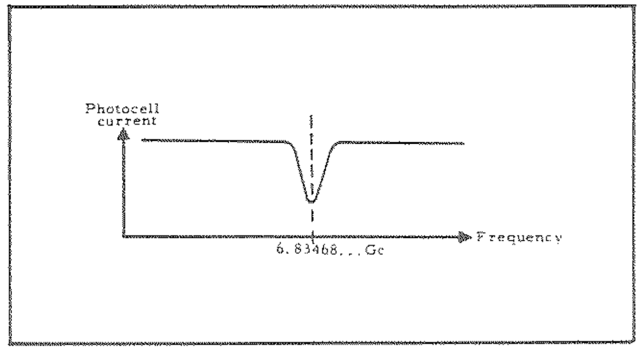

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Figure 4-2. Photocell Output Versus Frequency

4-12. SIMPLIFIED FUNCTIONAL DESCRIPTION.

4-13. Since the frequency standard operation is relatively complex, a brief, simplified functional description is provided. This description will be mainly limited to the AFC loop concept. Refer to figure 4-3 for a simplified functional block diagram of the frequency standard.

4-14. The quartz crystal oscillator initially provides an output at approximately 5MHz. This signal is applied to a frequency synthesizer and frequency multiplier. The synthesizer produces a signal at 5.313 . . . MHz, which is applied to a voltage summing network. The multiplier produces a signal at 90MHz, modulated by the 165Hz signal, which is also applied to the summing network. The voltage summing network provides an input to the microwave cavity. This signal produces a high-order harmonic within the microwave cavity, which is tuned approximately to the rubidium resonance frequency [(6840 - 5.313 . . .)MHz].

4-15. The difference in frequency between the applied microwave and the rubidium resonance produces an error signal at the photocell. This error signal is phase detected, filtered and applied to the crystal oscillator as a control voltage. This control voltage causes the crystal oscillator to change frequency in the appropriate direction to reduce the error between the microwave and rubidium resonance frequencies. When this error is maintained at zero, the crystal oscillator output is locked at 5MHz, providing the outputs of the frequency standard.

4-16. FUNCTIONAL DESCRIPTION.

4-17. The frequency standard contains a 5MHz crystal oscillator assembly, optical microwave unit, audio board, color subcarrier synthesizer, logic circuit board, synthesizer board, sync detector and loop filter board, distribution amplifier board, X18 RF multiplier board, oscillator regulator and lamp start board, and power supply assembly. Refer to figure 4-3 for a functional block diagram of the frequency standard.

4-18. The quartz crystal oscillator provides the basic 5MHz frequency used in the frequency standard. This signal is at approximately 5MHz and is applied to the distribution amplifier board. An output for monitoring the oscillator heater on the CIRCUIT CHECK meter is also provided.

4-19. The distribution amplifier board provides voltage adjustment, buffering, isolation, and filtering for the 5MHz signal input. Each 5MHz output signal is also individually buffered, with additional isolation provided for the front and rear panel 5MHz output signals. Other 5MHz output signals are provided for the optional 1MHz divider board, synthesizer board, multiplier board, and the color subcarrier synthesizer assembly. An output for monitoring the 5MHz voltage on the CIRCUIT CHECK meter is also provided.

4-20. The synthesizer board produces a 5.313 . . . MHz output signal with appropriate offset for the time scale selected. The 5MHz input is divided by a factor determined by the settings of the 10 time scale selector switches. The divider signal is sampled, filtered, and applied as a control signal to an oscillator to produce the 5.313 . . . MHz output signal. This signal is applied to the X18 RF multiplier board. The synthesizer board also produces a lock indication signal that is applied to the logic board. This signal indicates when the crystal oscillator frequency is locked to the rubidium resonant frequency.

4-21. The 5MHz signal applied to the X18 RF multiplier from the distribution amplifier is buffered and then modulated by the 165Hz from the audio board. This modulated signal is tripled to 15MHz, tripled again to 45MHz, and doubled to 90MHz. This 90 MHz signal is

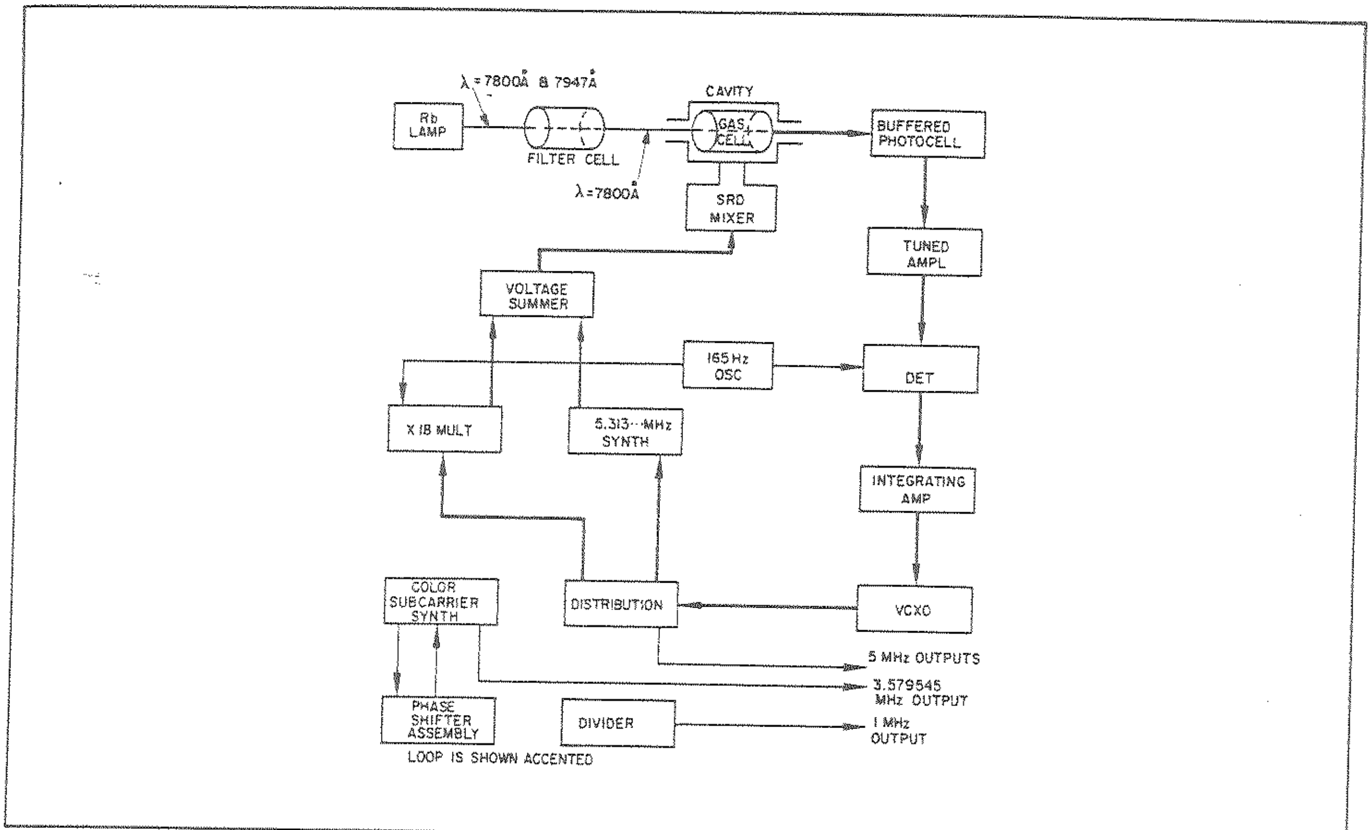

Figure 4-3. Rubidium Frequency Standard Simplified Block Diagram

voltage-summed with the 5.313 . . . MHz signal from the synthesizer and applied to the optical microwave unit.

4-22. The optical microwave unit contains the rubidium gas cell and microwave resonant cavity. The 90MHz signal from the X18 RF multiplier is applied through a filter to the step recovery diode (SRD) in the microwave cavity. The SRD produces the 76th harmonic of the 90MHz with a lower 5.313MHz sideband that is at or near the rubidium resonant frequency depending on the exact frequency of the 90MHz input. A photocell and amplifier detects the amount of light from the rubidium lamp that is not absorbed by the rubidium gas cell. Since the input signal is modulated at 165Hz, the light absorption will vary at the same rate, causing the photocell current to vary at the same rate. The 165Hz modulation is used to provide an output even when the AFC loop is in lock. Without this output, there is no control signal for the crystal oscillator. This output signal is applied to the audio board. The optical microwave unit also provides outputs for monitoring the cavity heater current and lamp heater current on the CIRCUIT CHECK meter. The FREQUENCY VERNIER control adjusts the resonant frequency of the rubidium gas vapor to fine adjust the output frequency of the standard.

4-23. The audio board preamplifies the photocell amplifier output and separately amplifies the 165Hz and 330Hz components of the signal. The 330Hz signal is applied to the logic board, and loop filter board. A rubidium lamp start signal is also generated from the preamplified signal when the standard is first turned on. This start signal is applied to the oscillator regulator and start board. The audio board also generates a 165Hz reference signal for the loop filter and a 165Hz modulating signal for the X18 RF multiplier. An output for monitoring the photocell current on the CIRCUIT CHECK meter is provided.

4-24. The loop filter board receives a 165Hz reference and the 165Hz photocell signal from the audio board. These two signals are multiplied together providing an error voltage that is integrated and applied, as a control voltage, to the logic board and the 5MHz crystal oscillator. This control voltage tends to change the output frequency of the crystal oscillator in the appropriate direction. This changes the frequency outputs of the synthesizer and multiplier, which in turn changes the frequency applied to the microwave cavity. This frequency change is such that the applied microwave frequency is now closer to the rubidium resonant frequency. This, in turn, reduces the error signal, reducing the control voltage. This continues until the crystal oscillator frequency is locked to the rubidium resonant frequency.The FINE OSCILLATOR FREQUENCY control adjusts the bias voltage to change the 5MHz crystal oscillator's nominal frequency. The CONTROL switch shorts out the control signal in the OPEN LOOP position and allows the FINE OSCILLATOR FREQUENCY control to directly change the 5MHz crystal oscillator frequency. Control voltage and error voltage outputs are provided for monitoring on the CIRCUIT CHECK meter.

4-25. The logic board receives the 330Hz signal and 165Hz photocell signal from the audio board, the control voltage signal from the loop filter, and the lock signal from the synthesizer. These four signals are applied to logic circuits that control the OPERATION lamp. When the frequency standard is in lock, the lamp is continuously on. When the frequency standard goes out of lock, the lamp flashes rapidly. The lamp flashes slowly when a lock condition is acquired. (If the signal from the loop filter board indicates an unlocked condition the lamp will be on steady when lock is acquired.) Pressing the RESET pushbutton returns the lamp from the slow flashing to the on-steady condition. An output for monitoring the 330Hz voltage on the CIRCUIT CHECK meter is also provided.

4-26. The oscillator regulator and start board provides the start pulse for the OMU rubidium lamp. This pulse is applied whenever a start signal is received from the audio board.

4-27. The optional 1MHz divider board divides the 5MHz signal by five to produce a 1MHz sinewave. The sinewave is available at the rear panel.

4-28. The color subcarrier synthesizer receives 5MHz from the distribution amplifier, squares the signal and divides the signal by 88. Within the synthesizer, a crystal ringing filter selects the 63rd harmonic of the divided signal to produce a signal of 3.579545MHz. The signal is buffered and applied through a phase shifter assembly to an output filter circuit on the color subcarrier synthesizer board. The phase shifter provides a means of shifting the phase of the 3.57 . . . MHz signal continuously through 360 degrees while the output filter removes extraneous signals that might be produced in the synthesizer.

4-29. DETAILED CIRCUIT ANALYSIS.

4-30. A detailed analysis of the circuits of each assembly in the frequency standard is provided in the following paragraphs. The assemblies are mostly discussed in numerical order according to assembly numbers. Table 4-1 provides a list of these assembly numbers and the names of the applicable assembly. References to figures in Section VII are to the applicable schematic diagram for each assembly. An interconnect schematic diagram for the frequency standard is provided in figure 7-1.

TABLE 4-1. RUBIDIUM FREQUENCY STANDARD ASSEMBLY NUMBERS

ASSEMBLY NUMBER	ASSEMBLY NAME
A1	Rubidium Frequency Standard
A2	Power Supply
A3	Divider (optional)
A4	X18 RF Multiplier
A5	Distribution Amplifier
A6	Synthesizer
A7	Audio
A8	Oscillator Regulator and Start
A9	Loop Filter
A10	Logic
A11	Subpanel
A13	Optical Microwave Unit
A14	5MHz Crystal Oscillator
A16	Battery Option
A17	Color Subcarrier Synthesizer
A18	Phase Shifter Assembly

4-31. POWER SUPPLY ASSEMBLY A2

4-32. Power Supply Assembly A2 generates 19.25, 5, and 350 volt DC power required for the circuits in the frequency standard. It operates from 115 or 230 volt, 50-400Hz power, from 23-32 volt DC power, or from the optional internal standby battery. (Refer to Appendix B for a description of the battery operation.) Refer to figure 4-4 for a block diagram of the power supply assembly and to figure 7-2 for a schematic diagram.

4-33. RECTIFIER CIRCUIT. The AC input is applied through a line filter, POWER switch S1, and 115/230 switch S2 to the two primary windings of T1. When 115 volts is used, S2 connects the primary windings in parallel; and connects them in series when 230 volts AC is used. The outputs of the two isolated secondary windings are applied to full-wave bridge rectifiers U1 and U2. The output of U1 is filtered by C1, providing 35 volts DC through standoff diode Q2 and fuse F2 to the series regulator, current limiter, differential sensor, and battery option. Fuse F2 protects the standard against shorted circuits. Standoff diode Q2 prevents the external DC or battery power from being applied to the rectifiers. The output of U2 is filtered by C2, providing 40 volts DC to the differential sensor and battery option.

4-34. SERIES REGULATOR. The series regulator is transistor Q3 in series with the 19.25 volt DC output. The DC input is applied through R1 to the emitter of Q3. Feedback from the voltage sensor varies the voltage at the base of Q3, maintaining the voltage drop across the emitter-collector junction that will provide 19.25 volts DC at the output. This output is applied to E1 for the 19.25 volt DC output to the frequency standard circuits, to the voltage sensor, and to the DC-DC converter.

4-35. VOLTAGE SENSOR. The voltage sensor uses a portion of the 19.25 volt DC output to control the series regulator. It consists of voltage divider R7, R11, and R13, U1, Q2, CR1, and CR2. The 19.25 volt output is applied to the voltage divider comprised of R7, R11, and R13. Potentiometer R11 selects a portion of this voltage and applies it to pin 2 of operational amplifier U1. It is adjusted to provide the required 19.25 volt output. Capacitor C1 damps out any oscillation generated in the feedback loop. The 19.25 volt output is also applied through R5 to CR2. Zener diode CR2 maintains a 9.1 volt DC reference through R12 to pin 3 of U1. Resistor R12 provides impedance balance between the two inputs of U1 to maintain thermal stability in the voltage sensor circuit. Operational amplifier U1 detects the difference between the two inputs and provides an output at pin 6 proportional to this difference. This output is applied to the base of Q2 controlling its conduction, thereby controlling the current into the base of Q3. Zener diode CR1 provides a 9.1 volt DC reference to ensure balanced bias between the inputs and outputs of the voltage sensor. Sense lines from

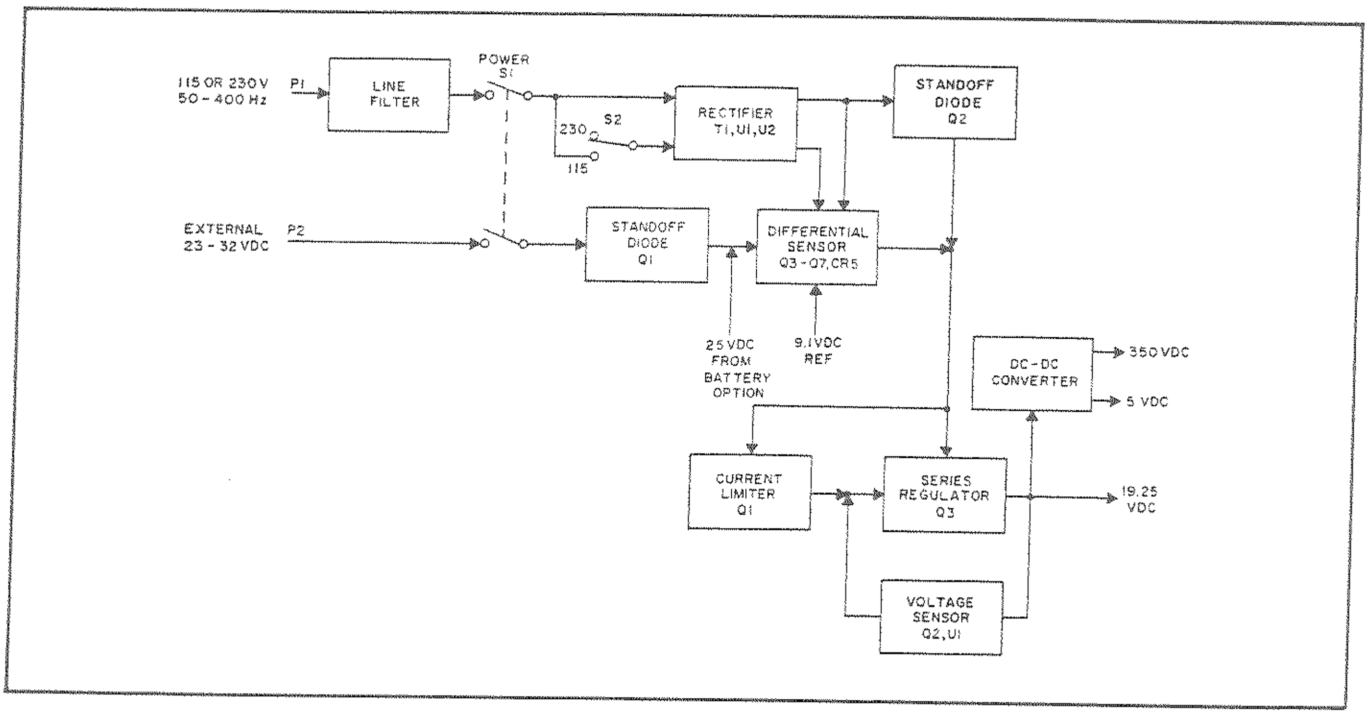

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Figure 4-4. Power Supply Assembly A2, Block Diagram the emitter and collector of Q2 are connected to the battery option to detect the low voltage cutoff point for the battery.

4-36. Assume that the 19.25 volt DC output is low. This causes the input at U1 pin 2 to be low with respect to pin 3, increasing the output at pin 6. When the output of U1 increases, Q2 conducts more increasing the current applied to the base of Q3. This increases the conduction of Q3, reducing the voltage drop across it, thereby increasing the output voltage.

4-37. CURRENT LIMITER. The current limiter protects against internal short circuits by limiting the current to 4 amps until fuse F2 blows. Without this function it would be possible for a short circuit to draw enough current, before F2 blows, to cause damage to the power supply circuits.

4-38. Resistor R1 senses the amount of current drawn by the frequency standard circuits, and biases Q1. Normally, Q1 is completely turned off. However, if the amount of current being drawn rises to 4 amps, Q1 will be forward biased, turning it on. When Q1 turns on, Q2 will draw current through Q1 instead of Q3. This reduces the conduction of Q3, reducing the output voltage, and thereby limiting the output current to 4 amps.

4-39. DC-DC CONVERTER. The DC-DC converter is a package subassembly that generates 350 volts DC and 5 volts DC from 19.25 volts DC. The 350 volt output is applied to oscillator regulator and start assembly to be used as the lamp start pulse. The 5 volt output is used as bias for the integrated circuits in the frequency standard.

4-40. DIFFERENTIAL SENSOR. The differential sensor detects a low voltage output from the rectifiers and switches in the external DC power. It consists of Q3 through Q7.

4-41. The output of rectifier U2 is applied through R14 and R22 to the base of Q7, and to the battery option. Capacitor C4 damps out any 60Hz ripple to prevent it from affecting the operation of the sensor. Diode CR6 ensures that the voltage at the base of Q7 will decay at least as fast as the 19.25 volt output, should the AC power fail or be disconnected. The voltage on the base of Q7 is compared to the 9.1 volts DC from CR1, applied to the base of Q6. The external DC voltage is applied through F3, S1, and Q1 to the collector of Q3. The DC voltage from the battery option is also applied to the collector of Q3. Standoff diode Q1 protects the external DC power supply.

4-42. Normally, Q7 is conducting and Q6, Q3, Q4, and Q5 are not conducting. With Q3 not conducting, the external DC or battery voltage is not applied to the power supply circuits. When the AC input drops below approximately 90 volts, the DC voltage applied to the base of Q7 has dropped sufficiently to reduce the conduction of Q7. This causes current to flow through the collector-emitter junction of Q6, reducing the voltage at the base of Q5. Transistor Q5 begins to conduct, increasing the voltage at the base of Q6, causing Q6 to increase conduction. The voltage at the base of Q4 is reduced, saturating it and in turn, saturating Q3. The DC voltage at the collector of Q3 is then applied through Q3 to the power supply circuits. This reverse biases Q2, removing the load from U1. By removing the load from U1 and U2, their output voltage will increase slightly. However, this is insufficient to turn off the differential sensor due to the hysteresis caused by the drop across R16.

4-43. X18 RF MULTIPLIER ASSEMBLY A4.

4-44. The X18 RF Multiplier Assembly A4 generates a 90MHz signal that is frequency modulated at a 165Hz rate, and voltage summed with a 5.313 . . . MHz signal. This signal drives the microwave cavity resonator in the OMU. The multiplier is comprised of a buffer amplifier, modulator, driver amplifier, two frequency triplers, frequency doubler, summing network, and AGC circuit. Refer to figure 4-5 for a block diagram of the X18 RF multiplier assembly and to figure 7-3 for a schematic diagram.

4-45. BUFFER AMPLIFIER. The buffer amplifier is a differential amplifier in the emitter follower (common base) configuration. It consists of transistors Q1 and Q2 and is used to buffer the multiplier circuits and isolate the 5MHz bus in the distribution amplifier from high-frequency feedback that would affect the 5MHz frequency standard output. The 5MHz input signal from J3 of Distrubution Amplifier Assembly A5 is applied at J1 to the base of Q1. The amplifier output at the collector of Q2 is applied to the modulator.

4-46. MODULATOR. The modulator consists of transistor Q3 and varicap CR2. It provides frequency modulation of the 5MHz signal at a 165Hz rate. The 5MHz signal is applied to the emitter of Q3, which drives a resonant circuit consisting of L1, C9, and CR2. Variable capacitor C9 is adjusted to resonate the circuit at 5MHz.

4-47. The 165Hz input signal from J2 of Audio Assembly A7 is applied at J2 to a decoupling and filtering network consisting of C3, C4, R9, R10, R11, and L3.

Potentiometer R11 adjusts the level of the 165Hz signal. This 165Hz voltage is applied to CR2 causing its capacitance to vary. This variation changes the 5MHz resonant frequency of the circuit at a 165Hz rate. This produces a 5MHz output signal which is frequency modulated at 165Hz. This signal is applied to the driver amplifier.

4-48. DRIVER AMPLIFIER. The driver amplifier consists of buffer amplifier Q4 and driver amplifier Q5. It provides sufficient power to drive the multiplying circuits.

4-49. The output of the modulator circuit is applied to the base of Q4, which operates in the emitter follower configuration. This buffered signal at the emitter of Q4 is applied to the base of driver amplifier Q5. The output of Q5 at the collector is applied to the first frequency tripler. Inductor L5 is adjusted to provide a 5MHz resonant circuit in conjunction with C16.

4-50. FREQUENCY TRIPLER. The multiplier contains two frequency triplers. One operates at 15MHz and the other at 45MHz. However, since both operate essentially the same, only the first tripler will be discussed.

4-51. The frequency tripler consists of balanced common base stages Q6 and Q7. The 5MHz signal from the driver amplifier is applied to the emitters of Q6 and Q7. Both Q6 and Q7 operate Class C (almost Class D) and therefore amplify that portion of the sinewave input above +0.7 volts and below -0.7 volts as shown in figure 4-6. The positive portion is amplified by Q7 and the negative portion by Q6. The balanced output, at the collectors, rings between half cycles, providing the required 15MHz output.

4-52. Because of the balanced drive of Q6 and Q7, they discriminate against even harmonics (10MHz and 20MHz) of the output signal. The output signal is applied to a double tuned circuit consisting of L8, C19, C20, L9, and C21. Variable inductors L8 and L9 are adjusted to tune the circuits to 15MHz and to discriminate against odd harmonics (5MHz and 25MHz) of the output signal.

4-53. The 15MHz signal is applied to the second frequency tripler, Q8 and Q9. The output of this tripler is 45MHz and is applied to the frequency doubler.

4-54. FREQUENCY DOUBLER. The frequency doubler provides a 90MHz output from the 45MHz input. It consists of two separate amplifiers, both in the common base configuration.

4-55. The input to the doubler is taken from both sides of center-tapped L12, which is bifilar wound for proper balance of both halves, and adjusted for resonance at 45MHz. These two 45MHz signals, which are 180 degrees out-of-phase, are applied to the emitters of Q10 and Q11. These two transistors conduct on alternate half cycles with the outputs at the collectors added together. This produces a 90MHz output signal, which is applied to the resonant circuit consisting of C33 through C35 and L17. The output is then applied to the summing network.

4-56. SUMMING NETWORK. The summing network consists of L18 and C37. It sums the voltage of the 90MHz signal with the voltage of the 5.313 . . . MHz.

4-57. The 5.313 . . . MHz input signal from J3 on Synthesizer Assembly A6 is applied through J3 to the

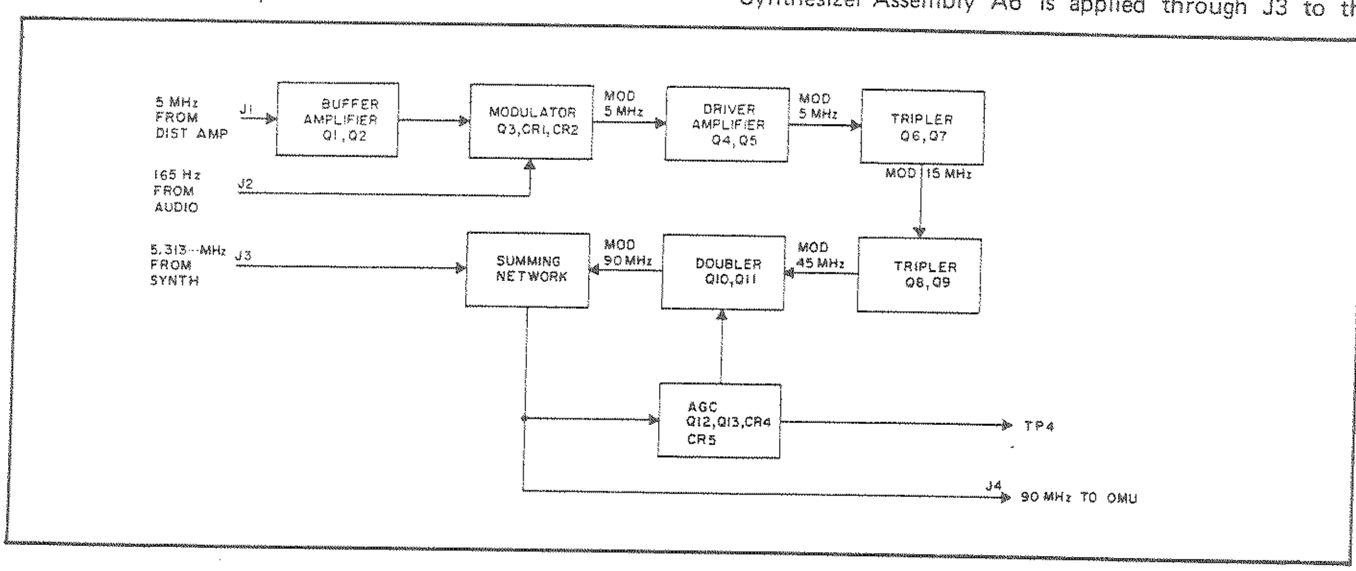

Figure 4-5. X18 RF Multiplier Assembly A4, Block Diagram

50-ohm impedance matching network R35, R36, and R42. Potentiometer R35 is adjusted to provide a 5.313 . . . MHz that will be more than 5db below the 6840MHz level in the OMU microwave cavity.

4-58. The 5.313 . . . MHz signal is easily passed through L18 and by diplexer action is summed with the 90MHz signal. A high impedance is presented to the 90MHz signal by L18. Capacitor C37 filters off the 90MHz signal that leaks through L18.

4-59. The summed signal is 90MHz riding on the 5.313 . . . MHz signal. The 165Hz frequency modulation is present in the 90MHz signal. This is applied to the AGC circuit and through J4 to OMU Assembly A13 to be used as the microwave cavity resonating signal.

4-60. AGC CIRCUIT. The AGC circuit consists of Q12, Q13, and CR3 through CR5. It controls the 90MHz output level of the multiplier. A portion of the output signal is applied to the junction of CR4 and CR5. Potentiometer R39 sets the bias on CR5, which in turn determines the 90MHz output level. The output voltage applied to CR4 and CR5 biases CR4 and determines its conduction rate of the DC voltage through R37. As the output level increases, the conduction of CR4 and CR5 increases, decreasing the voltage at the base of Q13. When the potential at the base of Q13 decreases, it will conduct less, increasing the collector voltage of Q13. This causes Q12 to conduct less, reducing the voltage applied to the bases of Q10 and Q11. This reduces the output level at the collectors, thereby controlling the 90MHz output. Diode CR3 is used to provide good temperature stability of the AGC circuit.

4-61. DISTRIBUTION AMPLIFIER ASSEMBLY A5.

4-62. Distribution Amplifier Assembly A5 is the central distribution point for the 5MHz output signal from the crystal oscillator within the frequency standard. It provides buffering and isolation for the various 5MHz output signals. Refer to figure 4-7 for a block diagram of the distribution amplifier assembly and to figure 7-4 for a schematic diagram.

4-63. The 5MHz input signal is received from connector J1 of Crystal Oscillator Assembly A14 and is applied at J1. This signal is applied to an input amplifier and filter.

4-64. INPUT AMPLIFIER AND FILTER. The input amplifier consists of transistor Q1. The 5MHz signal is applied through voltage divider network R1 and R2 to the base of Q1. Potentiometer R2 adjusts the voltage level of the 5MHz input signal. Transistor Q1, in the common emitter configuration, amplifies the 5MHz signal and applies it to T1. Transformer T1 isolates the crystal oscillator from the buffer and driver circuits. The 5MHz output of T1 is applied to crystal Y1, which filters the signal at 5MHz and applies it to the driver amplifier.

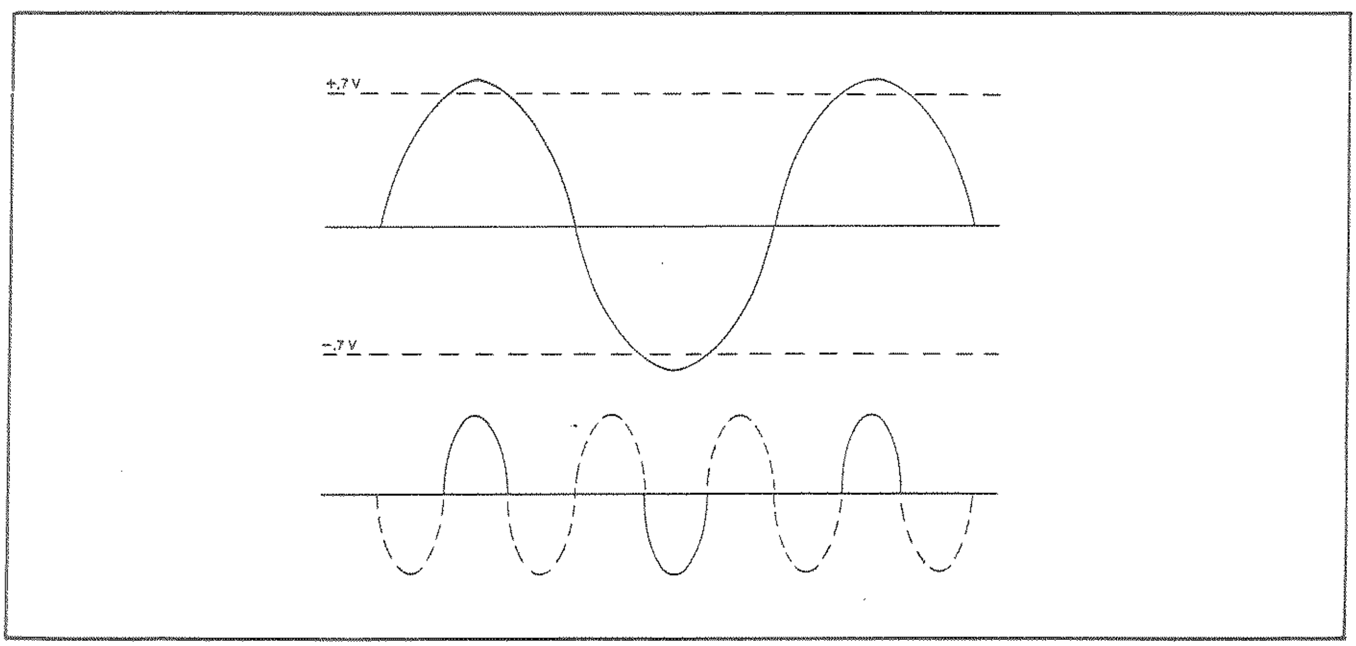

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Figure 4-6. Frequency Tripler Waveforms

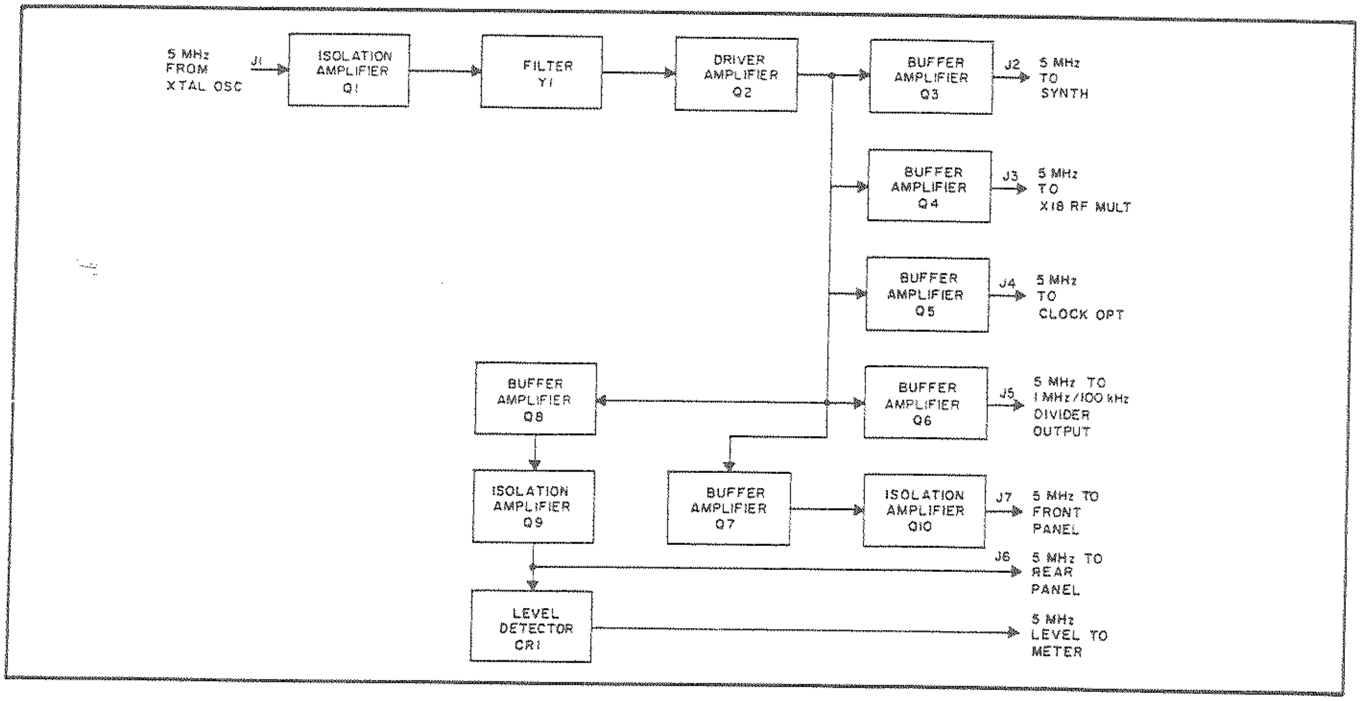

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Figure 4-7. Distribution Amplifier Assembly A5, Block Diagram

4-65. DRIVER AMPLIFIER. The driver amplifier consists of transistor Q2. This transistor provides sufficient output power to drive the several output amplifiers.

4-66. OUTPUT AMPLIFIERS. There are six identical amplifiers driven by the driver amplifier. These six are transistors Q3 through Q8, and each provides buffering for a 5MHz output signal. Table 4-2 lists the output amplifiers and their respective outputs, excluding Q7 and Q8. The 5MHz outputs of Q7 and Q8 are applied to the tuned amplifiers for the front and rear panel 5MHz outputs, respectively.

4-68. The 5MHz input is applied to the base of Q10. Transistor Q10 amplifies the signal. Transformer T3 is tuned to resonance. The output of T3 is connected to J7 to provide the 5MHz output to the front panel at J1.

4-69. The output of T2 in the other amplifier is applied to J6 to provide the 5MHz output to the rear panel at J2. It also is applied to CR1. Diode CR1 detects the voltage level of the 5MHz signal and applies it to the CIRCUIT CHECK selectors for monitoring on the CIRCUIT CHECK meter.

TABLE 4-2. OUTPUT AMPLIFIERS AND OUTPUTS

BUFFER AMPLIFIER	OUTPUT CONNECTOR	SIGNAL APPLIED TO
Q3	J2	Synthesizer Assembly A6
Q4	J3	X18 RF Multiplier Assy A4
Q5	J4	Optional 1MHz Divider Assembly A3
Q6	J5	Color Subcarrier Synthesizer Assembly A17

4-67. TUNED AMPLIFIERS. Both front and rear panel 5MHz tuned amplifiers are identical. Therefore, only the front panel amplifier will be discussed.

4-70. SYNTHESIZER ASSEMBLY A6.

4-71. Synthesizer Assembly A6 generates a 5.313 . . . MHz signal that is phase locked to the 5MHz input signal. The 5.313 . . . MHz signal is mixed with 6840MHz in the microwave cavity to achieve a signal nearly equal to the rubidium resonance frequency of 6834.686 . . . MHz according to the relationship

$$F_{Rb} = f(1368) \cdot f\frac{Q}{P} \qquad (1)$$

where f is the RFS output 5MHz. Rearranging, we have that

$$f = F_{Rb}/(1368 \cdot \frac{Q}{P}) \qquad (2)$$

It can be seen that the RFS output frequency is nearly directly proportional to the Q/P ratio if we substitute the approximation

$$\frac{1}{1368 - \frac{Q}{P}} = (1368 + \frac{Q}{P}), \text{ yielding}$$

$$f = F_{Rb}\,(1368 \cdot \frac{Q}{P}) \qquad (3)$$

Table 3-3 gives a complete list of frequency offsets achievable with P's limited to 2047 in order of decreasing offset frequency. Table 3-4 gives the same information in order of decreasing P divisor. The tables are arbitrarily referenced at zero offset with respect to atomic time for P = 1386. The actual frequency output is a function of F_{Rb}. Thus, final frequency adjustment must be accomplished with the MAGNETIC FIELD control, which has a range of zero to $+2 \times 10^{-9}$. The largest increment between two adjacent P divisor settings is about 1.7×10^{-9}. The synthesizer assembly also provides a lock signal that indicates when the synthesizer loop is locked. Refer to figure 4-8 for a block diagram of the synthesizer assembly and to figure 7-5 for a schematic diagram.

4-72. The 5MHz input sinewave is applied to a shaper to provide a train of pulses to the integrated circuits in the divider. The division ratio P of the divider is adjustable from 1024 to 2047 using ten toggle switches mounted on the assembly frame. The output of the divider is a pulse train (at 5MHz-divided-by-P) that controls the sampling switch in the zero-order-sample-and-hold (ZOSH) circuit. When the sampling switch is closed, a holding capacitor is allowed to charge to the value of a buffered and biased sinewave input. The voltage on the holding capacitor is filtered and used to control the frequency of a crystal oscillator whose nominal frequency is 5.313 . . . MHz. This VCXO signal is buffered and used as the sinewave input to the ZOSH, forming a closed loop.

4-73. When the loop is phase-locked, the switch in the ZOSH samples the same portion of the 5.313 . . . MHz phase each sampling time, presenting a steady control signal to the VCXO. Mathematically, the time required for P cycles of the 5MHz input equals the time required for some integer number of cycles of the 5.313 . . . MHz signal. Let this number be represented by Q. Then we have that

$$\frac{P}{5MHz} = \frac{Q}{F_{VCXO}} \text{ or } F_{VCXO} = \frac{Q}{P}\,5MHz \qquad (4)$$

The tolerances on the crystal are such that only a narrow range of $\frac{P}{Q}$ ratio will enable the phase-locked loop to acquire. Thus only a fraction of the total settable P's of the divider will be valid. Moreover, the crystal tolerance also dictates that a valid P will have one and only one valid Q.

4-74. SHAPER. The shaper is comprised of transistor Q1 and NAND-gates U10A, U10B, and U10D. Transistor Q1 is an emitter follower amplifier that drives U10A at pin 1. Every time the sinewave voltage drops below approximately 1.4 volts (once each cycle), the input at U10A pin 1 goes to logic 0. Assuming pin 2 of U10A was logic 1, its output goes to logic 1 at pin 3. This logic 1 is applied to pins 12 and 13 of U10D through capacitor C6, causing the output of U10D at pin 11 to go from the previously assumed logic 1 to logic 0, since U10D acts as an inverter. The logic 0 is applied to pins 4 and 5 of inverter U10B as well as to pin 2 of U10A. When C6 discharges to logic 0 through R5, the output of U10D goes to logic 1 and is inverted by U10B providing a logic 0 output at TP1 pin 6. When the input sinewave rises above approximately 1.4 volts, the input at pin 1 of U10A goes to logic 1. But since pin 2 of U10A had already returned to a logic 1 state, no further action results. The shaper has completed one cycle by providing one output pulse of one cycle of the 5MHz input. This is repeated for each cycle of the input, providing a 5MHz output pulse train that is applied to the divide-by-P divider at pin 1 of U1A.

4-75. DIVIDE-BY-P DIVIDER. The divide-by-P divider consists of J-K flip-flops U1A, U1B,..., through U6A; NAND-gates U7A, U7B, U8A, U8B, U8D, and U9; and switches S1 through S10. All J-K flip-flops have +5VDC applied to the J and K inputs (pins 3 and 14 or 10 and 7). This means that for each clock pulse applied, the output state will change from 0 to 1 or 1 to 0, depending on its previous state. Therefore, each flip-flop forms a binary divider, with the flip-flop output being used as the clock input for the next successive flip-flop. The divider functions as a preset accumulator. The switches determine the amount of preset that will be set into the accumulator. When the amount of preset and the total number of input counts equal the 2047 capacity of the accumulator, a one-shot multivibrator is triggered. The

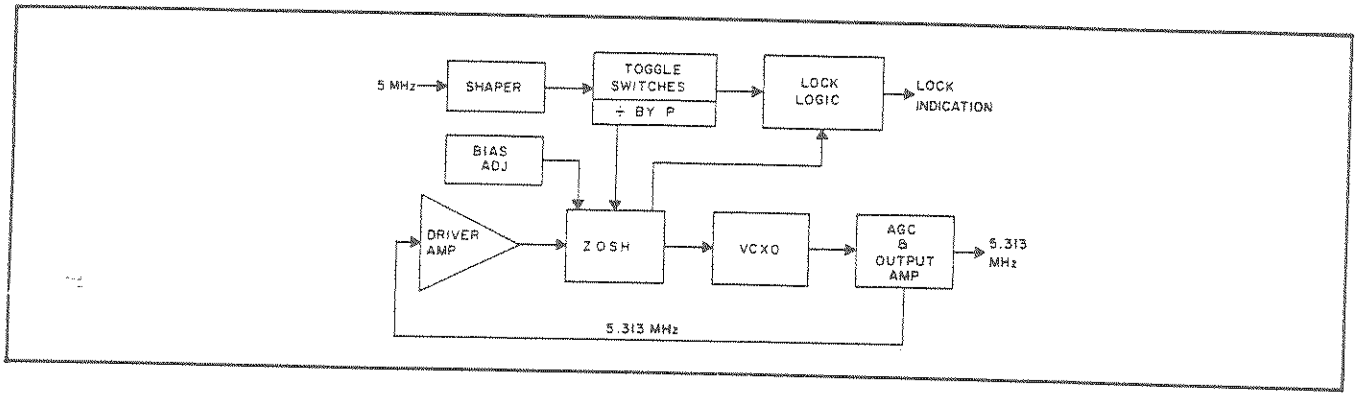

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Figure 4-8. Synthesizer Assembly A6, Simplified Block Diagram

reset one-shot output simultaneously clears all binaries in the divider to their Q = 0 state, and closes the ZOSH sampling switch. The reset pulse always sets the binaries to their Q = 0 state, yet the switches select either the Q or the $\overline{Q}$ output to drive the successive binary and to drive the 2047 coincidence detection gates. Thus the effect of the switches is to change the function of the reset from a clear to a preset mode.

4-76. The 5MHz pulse train from the shaper is applied as the clock pulse to U1A at pin 1. When this pulse drops from logic 1 to 0 (trailing edge of the pulse), the Q and $\overline{Q}$ outputs at pins 12 and 13, respectively, will change state. Switch S1 is used to select one of these outputs to drive the successive circuitry. The selected output of each binary acts as the clock input to the next binary. Each output also drives one input of either U7A or U9. The combination of U9, U8A, and U7A functions as an 11 input-NAND gate whose output at pin 6 of U7A will be at logic 0 only when all 11 inputs are at logic 1. This unique state is used to trigger the one-shot comprised of U8B, U8D, and U7B.

4-77. The normal state of pin 6 of U8B is a logic 0 requiring that pin 8 of U7B be a logic 1. As pin 4 of U8B becomes a logic 0, pin 6 of U8B and pin 12 of U8D become logic 1, supplying a feedback logic 0 to pin 5 of U8B. Pin 8 of U7B is now forced to be a logic 0, driving the clear inputs (pins 2 or 6) of each of the binaries. The first binary output that changes to a logic 0 at the input of the 11 input NAND-gate will cause pin 4 of U8B to return to a logic 1. However, the output of the one-shot will remain a logic 0 until the negative-going wave generated at pin 11 of U8D propagates through the delay network L1, L2, L3, C1, C2, C3, and C4. When this happens, the logic 0 at pin 13 of U8D will cause pin 5 of U8B to become a logic 1 again, returning the output at pin 8 of U7B to a logic 1. The pulse duration of the one-shot is about 80 nsec.

4-78. The divider was completely reset and ready for the next clock pulse from the shaper within 100 nsec.

4-79. As an example, assume a time scale offset of -300 x 10^{-10} is desired. From table 3-2, this corresponds to a division rate of 1084, which in binary is 10000111100. This binary number is set into the divider by setting S10 through S1, respectively, to 0,0,0,0,1,1,1,1,0, and 0, as indicated in table 3-2. The output of U6A is always the Q function, corresponding to a logic 1 switch setting, if a switch were used for this flip-flop. Beginning with all Q outputs at 0, the count effectively begins at 963, instead of 0, because of the switch settings. After 61 input pulses, the Q output of U6A at pin 12 goes to logic 1 (61 + 963 = 1024, the decimal equivalent for this flip-flop). It remains at logic 1 until the divider is cleared. This logic 1 is applied to pin 12 of U9. At this time, all other inputs to U9 are at logic 0. The counts continue and after 573 pulses pin 11 of U9 goes to logic 1, pin 1 after 829 pulses, pin 2 after 957 pulses, pin 3 after 1021 pulses, pin 4 after 1053 pulses, pin 5 after 1069 pulses, and pin 6 after 1077 pulses. Therefore, after the 1077th input pulse, the output of U9 at pin 8 goes to logic 0. This is inverted by U8A and applied to U7A pin 5 as a logic 1. This logic 1 remains until the divider is cleared. As the count continues, pin 1 of U7A goes to logic 1 after 1081 pulses, pin 2 after 1083 pulses, and pin 4 after 1084 pulses. Therefore after the 1084 input pulse, the output of U7A at pin 6 goes to logic 0. This is applied to pin 4 of U8B causing a repeat of the cycle as described above.

4-80. The reset pulse is also used as the output pulse from the divider. It is applied to buffer amplifier Q2 and to sampling switch Q8-Q7. The output of Q2 at J2 is used to provide a oscilloscope synchronizing pulse during synthesizer assembly test.

4-81. SAMPLING SWITCH. The divider output pulse is applied to the base of Q8. Everytime this negative pulse is applied, Q8 conducts for the length of the pulse and applies a 19-volt pulse through the collector to the gate of signal switch Q7. This pulse turns on Q7 allowing it to pass a small sample of the sinewave from the push-pull amplifier. This sample pulse is applied to the holding circuit and to the lock indicator.

4-82. HOLDING CIRCUIT. The holding circuit consists of capacitor C14, inductor L5, and varicap CR3. The sample pulse charges C14 to the value on the sinewave when Q7 turns off. This is applied through L5, as a DC voltage, to CR3, which acts as a variable capacitor in series with quartz crystal Y1 in the oscillator. The voltage on C14 determines the capacitance on CR3.

4-83. VOLTAGE CONTROLLED CRYSTAL OSCILLATOR. The crystal oscillator consists of quartz crystal Y1, FET Q9, and transistor Q11. The voltage input across CR3 tunes the oscillator frequency. The oscillator output which nominally is 5.313 . . . MHz is at the source of Q9 and is applied through C18 to buffer amplifier Q12. Transistor Q11 is boot-strapped between the source and drain of Q9 to increase its transconductance.

4-84. BUFFER AMPLIFIER. Buffer amplifier Q12 is connected in the emitter follower configuration. It buffers the crystal oscillator output and applies the 5.313 . . . MHz signal to the ZOSH driver amplifier and the AGC output amplifier.

4-85. DIFFERENTIAL AMPLIFIER. Since the differential amplifiers in the driver and output amplifiers operate essentially the same, only the output amplifier will be discussed. The differential amplifier that drives the 5.313 . . . MHz output consists of Q13 and Q14 and the one that drives the push-pull amplifier consists of Q3 and Q4.

4-86. The amplifier is operated in the emitter-follower (common base) configuration. This provides good source isolation and high impedance. The input is applied to the base of Q13. The output of Q13, at the emitter, is coupled through R30 to the emitter of Q14. The amplifier output is at the collector of Q14.

4-87. The output of Q14 is applied to the AGC circuit and to a tuned impedance matching network consisting of L7, C25, C26, and C29. This provides a 10-ohm impedance at the 5.313 . . . MHz output connector J3.

4-88. The output of Q4, in the other differential amplifier, is applied to the ZOSH driver amplifier.

4-89. AGC CIRCUIT. The AGC circuit consists of diodes CR4 and CR5 and transistor Q10. It sets the output voltage from the synthesizer assembly. The output from Q14 is applied to the junction of CR4 and CR5. The output at the anode of CR4 will be the bias voltage at the cathode of CR5, minus the peak-to-peak value of the output at the collector of Q14. This voltage (nominally 0.6 volts) is applied to the base of Q10. As the output voltage increases, Q10 conduction decreases as does the effective g_m of Q9. This reduces the oscillator output voltage, rebalancing the AGC circuit voltage.

4-90. ZOSH DRIVER AMPLIFIER. The driver amplifier consists of transistors Q5 and Q6 and diodes CR1 and CR2. It is used to provide sufficient power to charge holding capacitor C14. The negative portion of the input sinewave is applied to the base of Q6 and the positive portion is applied, through CR2 and CR1, to the base of Q5. Each transistor amplifies its part of the sinewave and provides an output at the junction of R11 and R12. This 5.313 . . . MHz sinewave is applied to the source of Q7. Potentiometer R15 adjusts the DC level added to the sinewave input of Q7 to prebias CR3.

4-91. LOCK INDICATOR. The lock indicator consists of J-K flip-flop U6B, FET Q15, transistor Q16, and diodes CR6 through CR9. The inputs are received by the lock indicator, one is the clear pulse (negative sampling pulse) and the other is the sampled signal from Q7.

4-92. Flip-flop U6B divides the clear pulse train by two and applies it to CR8 and CR9, which act as a level detector. The output of CR9 is filtered by C35 and R38 and applied to the base of Q16 causing it to conduct. When Q16 conducts, the output at the collector is a logic 0. This logic 0 indicates that the synthesizer loop is in lock. If the divide-by-P divider is not operating properly, no bias will be supplied by CR8 and CR9. This causes Q16 to stop conducting, providing a logic 1 (+5VDC) output.

4-93. The input from the sampling switch is applied to the gate of Q15. Transients due to sampling action are filtered out by R36 and C31. When the synthesizer loop is phase locked, Q15 does not conduct. When the loop is unlocked, a varying voltage at holding capacitor C14 is applied to source follower Q15. The peak-to-peak output of Q15 is detected by CR7 and CR6, forward biasing CR7. When CR7 conducts, it reduces the voltage level at the base of Q16, causing Q16 to stop conducting, providing the logic 1 output.

4-94. AUDIO ASSEMBLY A7.

4-95. Audio Assembly A7 generates 165Hz modulation and reference signals, processes the photocell output to provide a 165Hz photocell signal and 330Hz signal, and generates a lamp start signal. Refer to figure 4-9 for a block diagram of the audio assembly and to figure 7-6 for a schematic diagram.

4-96. The circuits that generate the 165Hz modulating and reference signals consist of a reference oscillator, divide-by-2 divider, phase adjust network, and buffer amplifier. The photocell output processing circuits consist of a photocell preamplifier, 165 and 330Hz post amplifiers, and lamp starter.

4-97. REFERENCE OSCILLATOR. The reference oscillator consists of transistors Q1 and Q2. These transistors form a free-running multivibrator that oscillates at a frequency of 330Hz. This frequency is divided to provide an output of 165Hz at connector J1.

4-98. DIVIDE-BY-TWO DIVIDER. The divider is formed by J-K master-slave flip-flop U1. The three J inputs at pins 3, 4, and 5 and the three K inputs at pins 9, 10, and 11 always have a logic 1 (+5 VDC) applied. Therefore, the Q and $\overline{Q}$ outputs at pins 8 and 6 respectively will change state every time the clock pulse at pin 12 goes from logic 1 to logic 0. This toggling action provides a 165Hz squarewave at the Q and $\overline{Q}$ outputs. Zener diode CR3 maintains the input voltage at pins 3, 4, 5, 9, 10, 11, and 14 at 5 VDC.

4-99. The proper phased output (Q or $\overline{Q}$) is connected to the buffer amplifier.

4-100. BUFFER AMPLIFIER. Transistors Q3 and Q8 and diode CR6 form the buffer amplifier. The 165Hz drives the base of Q3 through R16. The collector of Q3 drives Q8 and CR6. In this configuration the output at J1 is a low impedance for both the on and off states of Q3. It

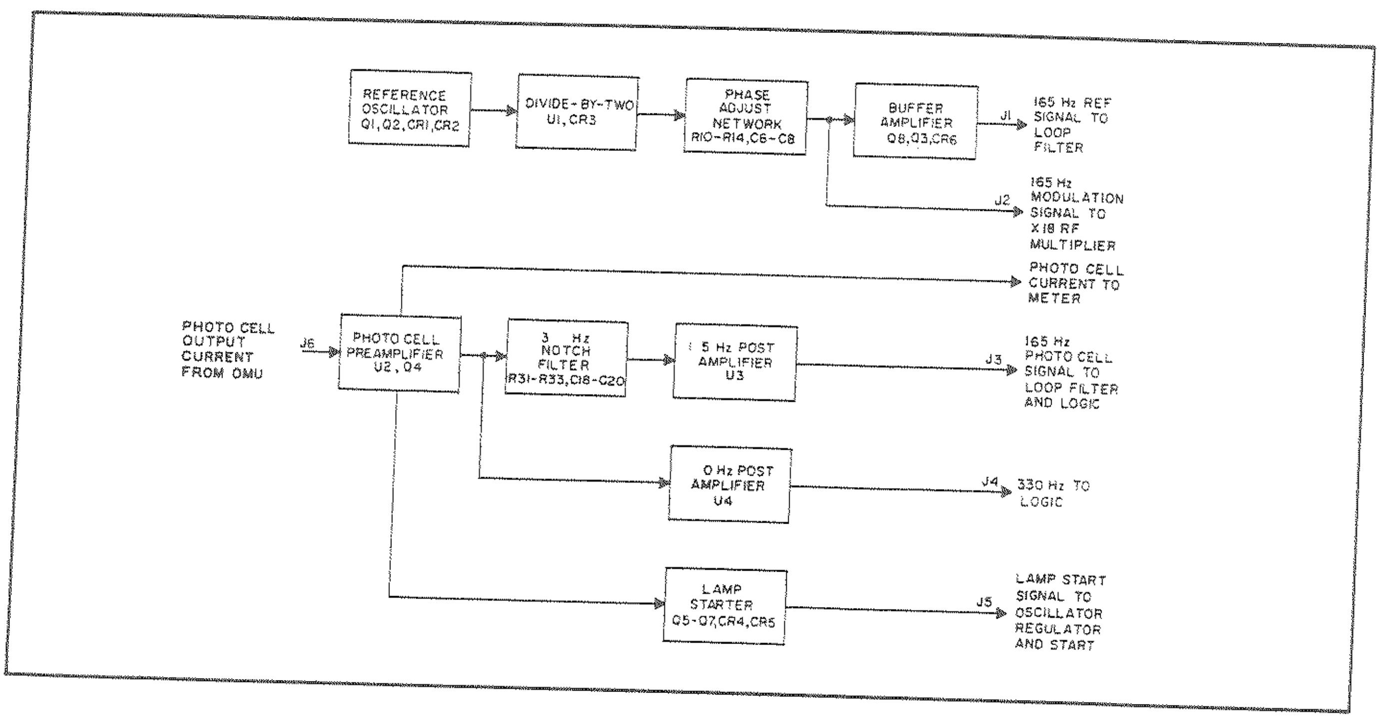

Figure 4-9. Audio Assembly A7, Block Diagram

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is used by the loop filter assembly as a demodulator reference signal.

4-101. PHASE ADJUST NETWORK. The phase adjust network consists of R10 through R13, C6 through C8, and potentiometer R14. The Q output of U1 at pin 8 is shaped by R11, R13, and C7 and the $\overline{Q}$ output at pin 6 is shaped by R10, R12, and C6. This shaping converts the two squarewave outputs of the divider to semi-sinewaves, 180 degrees out of phase. These two 165Hz sinewave signals are applied to R14 and C8. A single 165Hz sinewave output, with variable phase adjusted by R14, is supplied at J2. This signal is applied to the X18 RF multiplier assembly as a modulating signal.

4-102. PHOTOCELL PREAMPLIFIER. The photocell preamplifier is comprised of operational amplifier U2 and transistor Q4. The output of the photocell transducer from the OMU is applied to J6. Operational amplifier U2 amplifies the photocell's signal and has an output predominately 330Hz if the AFC loop is locked or 165Hz if it is unlocked. This output signal is applied to the lamp starter, through R26 to Q4, and to CIRCUIT CHECK selector to monitor the photocell output current on the CIRCUIT CHECK meter. Potentiometer R26 adjusts the level to the post amplifier.

4-103. Transistor Q4 is an emitter follower that buffers the output signal of U2 fed to the post amplifiers.

4-104. POST AMPLIFIER. The two post amplifiers receive the preamplified signal from Q4. Operational amplifier U3 forms the 165Hz post amplifier and U4 the 330Hz post amplifier.

4-105. The 165Hz post amplifier operates as a narrow band amplifier centered on the modulation frequency of 165Hz. A twin T, RC filter network consisting of R31 through R33 and C18 through C20 provides a tuned filter that rejects the 330Hz frequency. When the AFC loop is in lock, the output of U3 at pin 6 is at a minimum. This 165Hz output is applied through J3 to the logic assembly, as an AFC loop lock indication, and to the loop filter assembly as an error signal. Feedback from pin 6 to pin 2 provides a response peaked at 165Hz.

4-106. The 330Hz post amplifier operates essentially the same as the 165Hz post amplifier except that it has a maximum output when the AFC loop is in lock. The output of U4 at pin 6 is applied through J4 to the logic board as a lock indication signal. Feedback from pin 6 to pin 2 provides a response peaked at 330Hz.

4-107. LAMP STARTER. The lamp starter generates a start signal whenever the photocell output is below a set level. It consists of Q5 and Q7 and CR4 and CR5.

4-108. The output of U2 at pin 6 is applied to the base of Q5. When the lamp is not operating, there is 3.3 volts at the base of Q5. Therefore Q5 is turned off and CR4 is not conducting. This means that Q6 is turned off and 19.25 volts DC is applied through R44 to unijunction transistor Q7. This current charges C26 and causes Q7 to turn on after approximately 10 seconds. When Q7 turns on, 19.25 volts DC is applied through R45, Q7, CR5, and R47 to connector J5. C26 discharges and turns off Q7. The cycle repeats, yielding an output pulse every 10 seconds at J5. This signal goes to assembly A10 and is the lamp start signal.

4-109. This pulsing continues until the lamp in the OMU ignites. At this time the output of U2 at pin 6 forward biases CR4 causing it to conduct. This will cause Q6 to conduct, reducing the DC voltage at Q7. Without this voltage, Q7 cannot fire, and therefore, cannot generate a lamp start signal.

4-110. OSCILLATOR REGULATOR AND START ASSEMBLY A8.

4-111. Oscillator Regulator and Start Assembly A8 provides the regulated DC voltage required by the lamp oscillator in the OMU and switches the lamp start pulse on and off as required to start the lamp in the OMU. Refer to figure 4-10 for a block diagram of the oscillator regulator and start assembly and to figure 7-7 for a schematic diagram.

4-112. OSCILLATOR REGULATOR. The oscillator regulator consists of transistors Q2 and Q3, zener diode CR3, and potentiometer R7. It receives 19.25 volts DC from Power Supply Assembly A2. This is applied to the collector of Q2, which regulates the voltage to between 6 and 16 volts DC as determined by the setting of R7. The output at the emitter of Q2 is applied to the lamp oscillator in the OMU. A portion of this output is applied through R6 and R7 to the base of Q3. Using the voltage across CR3 (5.1 volts DC) as a reference, Q3 sets the current applied to the base of Q2. This current determines

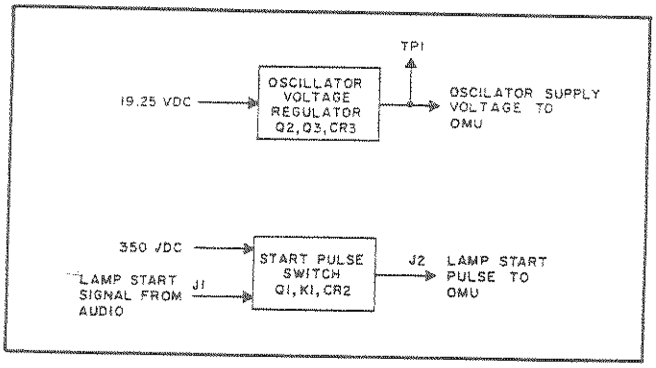


Figure 4-10. Oscillator Regulator and Start Assembly A8, Block Diagram

the series resistance of Q2 which determines the emitter output voltage.

4-113. If the voltage output becomes too high, then the voltage at the base of Q3 will increase. This increase causes Q3 to increase conduction, reducing the voltage level at its collector. When the voltage level of the collector of Q3 is reduced, the voltage level at the base of Q2 is reduced. This causes Q2 to decrease its conduction, reducing the output voltage at the emitter to the proper level. Potentiometer R7 is adjusted for an output voltage that provides the proper lamp intensity.

4-114. START PULSE SWITCH. The start pulse switch consists of relay K1 and transistor Q1. The lamp start signal is received from Audio Assembly A7 in the form of a pulse. This is applied through J1 to the base of Q1, which is normally turned off. The pulse causes Q1 to turn on and saturate. This applies a ground to the coil of K1, energizing it. When K1 energizes, capacitor C1, which has been charged to 350V, is connected through J2 to the auto-transformer in the OMU to start the lamp.

4-115. When the pulse at J1 is removed, Q1 will turn off, deenergizing K1.

4-116. LOOP FILTER ASSEMBLY A9.

4-117. Loop Filter Assembly A9 converts the 165Hz error signal to a DC control signal for the crystal oscillator. It comprises a phase detector, integrator, and voltage controller. Refer to figure 4-11 for a block diagram of the loop filter assembly and to figure 7-8 for a schematic diagram.

4-118. PHASE DETECTOR. The phase detector compares the 165Hz error signal at pin 22 with the 165Hz reference signal at pin 4. Both signals come from Audio Assembly A7. The error signal input is applied through the center-tapped secondary of T1 to the two emitters of Q1. The reference signal input is applied through the center-tapped secondary of T2 to the two bases of Q2. This reference signal will forward bias the halves of Q1 at alternate half cycles. The error voltage output is a maximum when the 165Hz error signal is at its greatest amplitude.

4-119. The 165Hz error signal will either be in phase or 180 degrees out of phase with respect to the reference signal depending on whether the microwave resonance frequency is above or below the rubidium resonance frequency. The amplitude of the error signal determines how great the difference in frequency is. When this is detected by the phase detector, an output is produced that is either positive or negative. The amplitude describes the amount of frequency difference. This voltage is applied to the integrator, and through pin B to CIRCUIT CHECK selector S1 for monitoring on CIRCUIT CHECK meter M1.

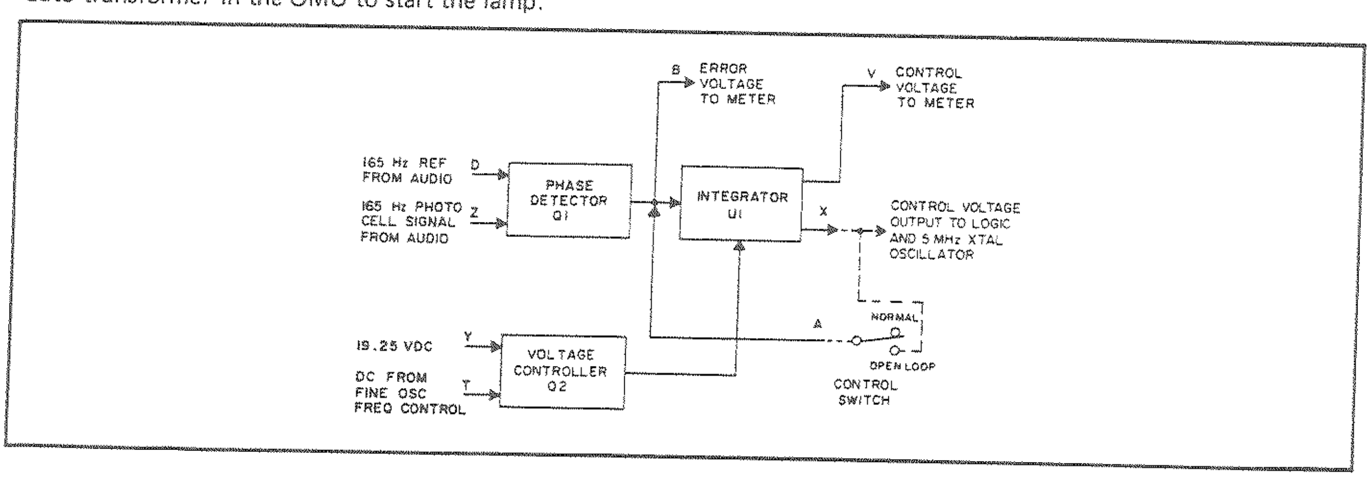


Figure 4-11. Loop Filter Assembly A9, Block Diagram

4-120. INTEGRATOR. The integrator generates a control voltage from the detected error voltage. The output of Q1 is applied to the minus input of U1. A fine frequency adjustment voltage is applied to the plus input and to the common input. The output of U1 is applied through pin 20 to 5MHz Crystal Oscillator Assembly A14 as the frequency control voltage. The control voltage is also applied through pin V to CIRCUIT CHECK selector S1 for monitoring on CIRCUIT CHECK meter M1.

4-121. In the OPEN LOOP position, CONTROL switch S2 connects a 100-ohm resistor between pin 1 and pin 20. This reduces the gain of U1 so that it no longer controls the crystal oscillator frequency. Instead, the frequency is controlled by the FINE OSCILLATOR FREQUENCY control through the voltage controller circuit.

4-122. VOLTAGE CONTROLLER. The voltage controller determines the bias voltage applied to the common input on U1. The 19.25 volt DC input at pin Y is applied through R7, R8, and pin 13 to one end of the FINE OSCILLATOR FREQUENCY potentiometer. The other end is connected through pin 10, R9, and CR1 to ground. The wiper on the potentiometer is connected through pin 16 to the base of Q1. Transistor Q1 is used to provide a low source impedance to the common of U1. The setting of the potentiometer determines the voltage level applied to the base of Q1, which determines its conduction rate. The larger the voltage at the base, the more Q1 will conduct making the voltage applied to U1 larger. This means that the output of U1 will change (with respect to ground but not with respect to the common) as the FINE OSCILLATOR FREQUENCY control is adjusted. Under normal closed loop conditions, the control is adjusted to provide 10 volts on the common.

4-123. LOGIC ASSEMBLY A10.

4-124. Logic Assembly A10 generates the lock and out-of-lock condition signals for the front panel OPERATION lamp. It is comprised of three level detectors, the associated logic circuits, and an OPERATION lamp grounding circuit. Refer to figure 4-12 for a block diagram of the logic assembly and to figure 7-9 for a schematic diagram.

4-125. CONTROL VOLTAGE LEVEL DETECTOR. The control voltage level detector consists of CR1, CR2, CR3, Q1, Q2, and U1A. It detects the oscillator control voltage and provides an out-of-lock signal whenever this voltage drops below 5 volts DC or rises above 15 volts DC.

4-126. The oscillator control voltage from pin 20 on Loop Filter Assembly A9 is applied through pin 1 to zener diodes CR1 and CR2. Under normal conditions, this voltage is between 5 and 15 volts DC. This means that CR1 is conducting and CR2 is turned off. When CR1 is

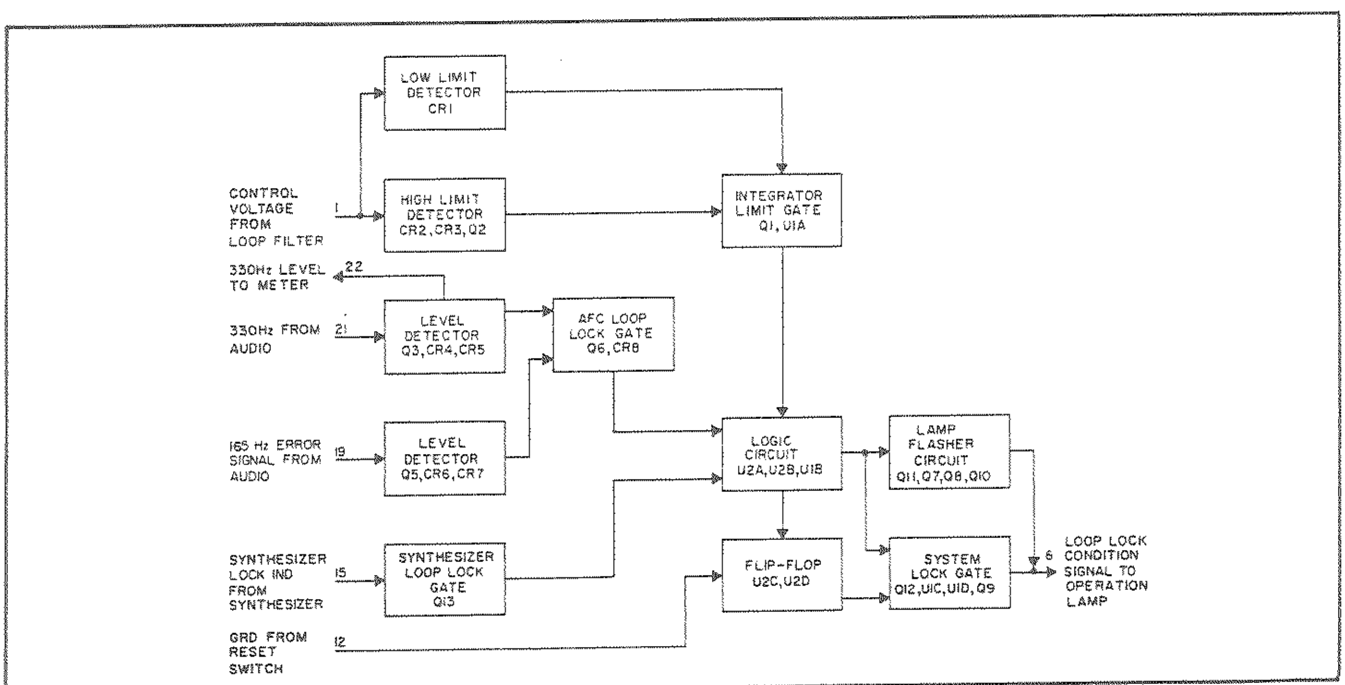


Figure 4-12. Logic Assembly A10, Block Diagram

conducting, Q1 is also conducting. This applies 19.25 volts through R5 and Q1 to ground, providing a logic 0 (OVDC) at pins 1 and 2 of NAND-gate U1A. The output at pin 3 will be a logic 1, indicating that the limits of the integrator in the loop filter are not being exceeded. This is applied to the logic circuits.

4-127. If the control voltage drops below 5 volts DC, CR1 stops conducting. This causes Q1 to stop conducting, applying a logic 1 (5 volts DC) to pins 1 and 2 on U1A. The output at pin 3 is now logic 0, indicating the integrator limit is being exceeded.

4-128. If the control voltage rises above 15 volts, CR2 conducts. This forward biases Q2, causing it to conduct. This applies 19.25 volts DC, which was reverse biasing CR3, through R4 and Q2 to ground. Diode CR3 is now forward biased, applying the control voltage at the base of Q1 to ground. Transistor Q1 now stops conducting. This applies a logic 1 to pins 1 and 2 of U1A providing a logic 0 at pin 3.

4-129. 330 Hz LEVEL DETECTOR. The 330Hz level detector generates an out-of-lock signal whenever the 330Hz signal is not present. It consists of Q3, Q4, Q6, CR4, CR5, and CR8. The 330Hz signal from J4 on Audio Assembly A7 is applied through pin 21 to Q3. Transistor Q3 amplifies the signal, which is then fed to voltage doubler CR4 and CR5 and filtered by R11, R13, C5, and C6. Under lock conditions a positive DC voltage is applied to the base of Q4. This causes Q4 to conduct applying 19.25 volts DC through R14 and Q4 to ground. This applies a ground to CR8, preventing Q6 from conducting. A logic 1 (5 volts DC) is applied to the logic circuits whenever Q6 is not conducting.

4-130. Since there is a 330Hz signal only when the rubidium lamp is lit, there will be no signal present at pin 21 when the lamp is out. With no signal there is no DC voltage at the base of Q4. Transistor Q4 stops conducting and applies 19.25 volts DC through R14 and CR8 to the base of Q6. This causes Q6 to conduct, applying 19.25 volts through R21 and Q6 to ground. A logic 0 is then applied to the logic circuits, indicating the AFC loop is out of lock.

4-131. 165Hz LEVEL DETECTOR. The 165Hz level detector generates an out-of-lock signal whenever the 165Hz error signal is present. It consists of Q5, CR6, CR7, and Q6 (in conjunction with the 330Hz level detector). The 165Hz error signal from J3 on Audio Assembly A7 is applied through pin 19 to Q5. The 165Hz level detector operates the same as the 330Hz level detector.

4-132. Under lock conditions, the 165Hz error signal is extremely small, therefore, no DC voltage is applied to the base of Q6. This applies a logic 1 to the logic circuits.

4-133. If the AFC loop is out of lock, a 165Hz error signal is applied to the level detector, providing a DC voltage at the base of Q6. This provides a logic 0 output that is applied to the logic circuits.

4-134. SYNTHESIZER LOCK GATE. The synthesizer lock gate generates an out-of-lock signal whenever the synthesizer loop is out of lock. It consists of transistor Q13. The lock signal from C38 on Synthesizer Assembly A6 is applied through pin 15 to the base of Q13.

4-135. When the synthesizer loop is locked, 0 volts DC is applied to Q13. This reverse biases Q13 and it will not conduct. A logic 1 (5 volts DC) is applied to the logic circuits indicating the synthesizer loop is in lock.

4-136. If the synthesizer loop goes out of lock, 5 volts DC is applied to Q13. This forward biases Q13, causing it to conduct, applying 0 volts DC (logic 0) to the logic circuits.

4-137. LOGIC CIRCUIT. The logic circuit combines the integrator limits, AFC loop lock, and synthesizer loop lock signals, and generates one system lock signal. It also determines the flash rate of the OPERATION lamp for an out-of-lock condition.

4-138. The AFC loop lock signal (logic 1) is applied to U2A pin 1 and the synthesizer loop lock signal (logic 1) is applied to pin 2. The resultant logic 0 output at pin 3 is applied to pins 4 and 5 of U2B, which provides a logic 1 output at pin 6. This is applied to U2C pin 9 in the reset flip-flop, and to U1B pin 5. The integrator limits signal (logic 1) is applied to U1B pin 4. A logic 0 output at U1B pin 6 is applied to the base of Q11 in the lamp flasher circuit, and to pins 9 and 10 of U1C. Pin 8 of U1C is at logic 1 and is applied to U1D pin 12. The output of the reset flip-flop at U2D pin 11 is logic 1 during lock conditions. This is applied to U1D pin 13. Along with the logic 1 at pin 12, this provides a logic 0 output at pin 11. The logic 0 (0 volts DC) is applied to the base of Q12, reverse biasing it. Transistor Q12 does not conduct, therefore 19.25 volts DC is applied through R34 and R35 to the base of Q9. This voltage causes Q9 to conduct applying a ground to pin 6. This ground is applied to the OPERATION lamp, causing the lamp to light. Therefore, under normal lock conditions, the OPERATION lamp will be lit.

4-139. INTEGRATOR LIMITS EXCEEDED. If the integrator limits are exceeded, the logic 1 at U1B pin 4 changes to logic 0 as shown in figure 4-13. Pin 6 of U1B goes to logic 1. This is applied to the base of Q11 in the lamp flasher circuit and to U1C pins 9 and 10. The output at pin 8 goes to logic 0, causing the output of U1D at pin 11 to go to logic 1, causing Q12 to conduct. When Q12 conducts, Q9 stops conducting, removing the ground from the OPERATION lamp. The ground to the lamp is now controlled, by the lamp flasher circuit, through Q10.

4-140. When the integrator signal is within limits, a logic 1 is reapplied to U1B pin 4. This returns the logic circuit to the normal state for a lock condition as explained in paragraph 4-138. This out-of-limits condition does not require resetting after returning to the normal range.

4-141. AFC LOOP OUT-OF-LOCK. When the AFC loop goes out of lock, the logic 1 at U2A pin 1 goes to logic 0 as shown in figure 4-13. The output at pin 3 goes to logic 1, causing the output of U2B at pin 6 to go to logic 0. The outputs of U1B, U1C, and U1D go to logic 0, 0, and 1, respectively. The lamp flasher now controls the lamp.

4-142. The logic 0 applied to the reset flip-flop at U2C pin 9 provides a logic 1 at pin 8. This is applied to U2D pin 12, providing a logic 0 at pin 11. This is applied to U1D pin 13 and to U2C pin 10. When lock is reacquired and U2B pin 6 returns to logic 1, the flip-flop will not reset due to the logic 0 at U2C pin 10. However, the logic 1 at the base of Q11 goes to logic 0. This changes the flash rate of the lamp flasher circuit, since the logic 0 at U1D pin 13 prevents Q9 from conducting and controlling the lamp ground.

4-143. The RESET pushbutton is pressed to reset the logic circuit. The button applies a logic 0 to U2D pin 13. The output at pin 11 goes to logic 1, causing pin 11 of U1D to go to logic 0. This returns control of the lamp ground to Q9, causing the lamp to stop flashing and light continuously.

4-144. The logic 1 at U2D pin 11 is also applied to U2C pin 10. Pin 8 of U2C goes to logic 0, returning pin 12 of U2D to logic 0. The flip-flop is now reset.

4-145. LAMP FLASHER CIRCUIT. The lamp flasher circuit determines the flash rate of the OPERATION lamp. During an out-of-lock condition the lamp flashes at the fast rate (two flashes per second) and after lock is reacquired but the logic circuits are not reset, the lamp flashes at the slow rate (one flash per second).

4-146. When an out-of-lock condition exists, a logic 1 (5 volts DC) appears at U1B pin 6. This is applied to the base of Q11, turning it on. When Q11 turns on, the voltage applied to Q7 is reduced. This causes Q7, which is oscillating at the slow rate, to oscillate at the fast rate. Every time Q7 oscillates, a pulse is applied through CR9 to the base of Q10. Transistor Q10 turns on, applying a ground to the OPERATION lamp and to the base of Q8. This lights the lamp and turns on Q8. When Q8 turns on, 19.25 volts DC is applied through Q8, R28, and C12 to

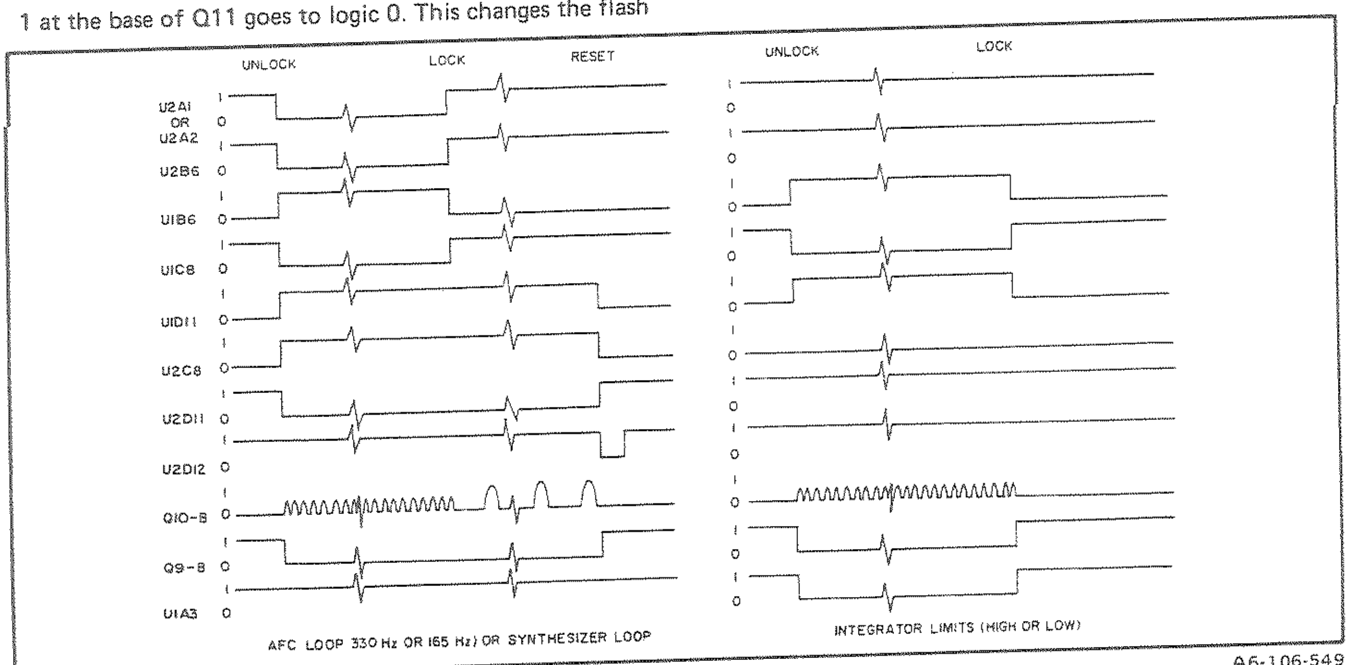


Figure 4-13. Logic Assembly Timing Diagrams

the base of Q10. This keeps Q10 turned on after the pulse from Q7 is removed. The time that Q10 remains on is determined by the time constant of R28 and C12. When C12 is charged, Q10 will turn off. This turns off Q8 and causes the lamp to go out. (Transistor Q9 is always turned off during an out-of-lock condition.) The next pulse from Q7 will repeat this cycle.

4-147. When lock is acquired, Q11 will stop conducting, increasing the voltage applied to Q7. This reduces the oscillation of Q7 to the slow rate. The operation of the flasher at this rate is the same as at the fast rate.

4-148. When the logic circuits are reset, the lamp flasher continues to operate at the slow rate, except the lamp ground is now controlled by Q9 instead of Q10.

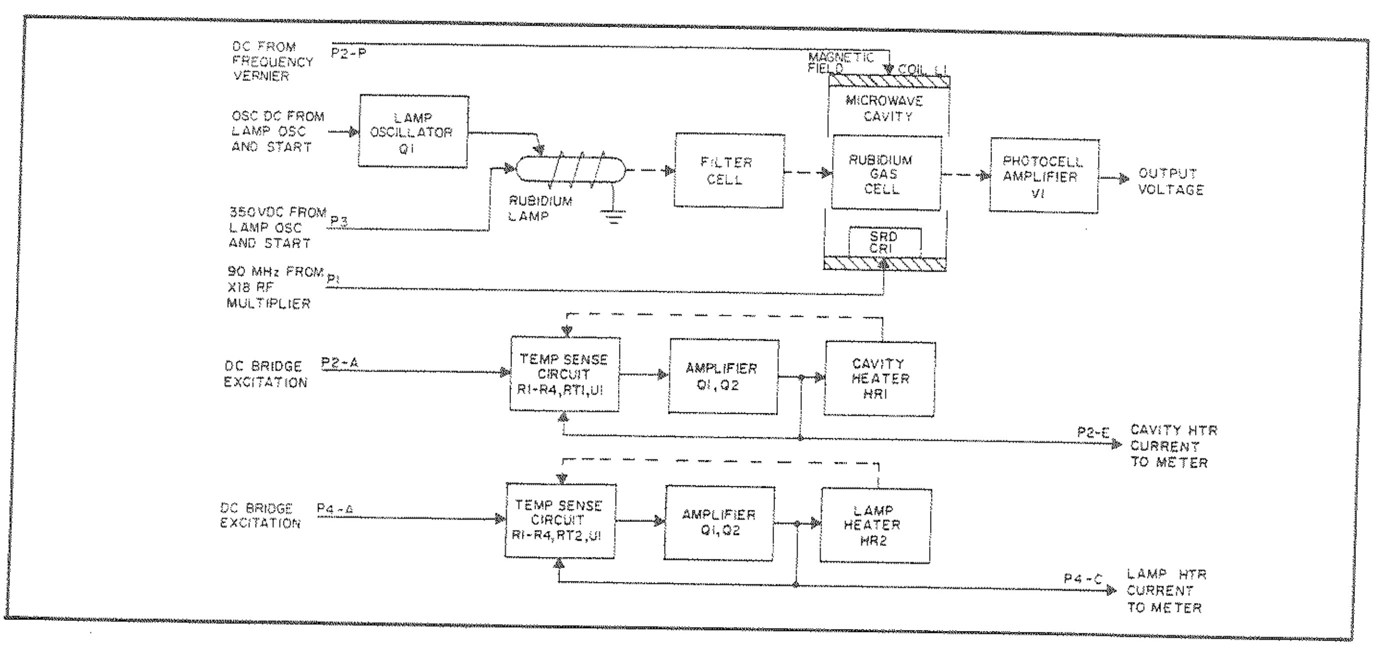
4-149. OPTICAL MICROWAVE UNIT ASSEMBLY A13.

4-150. Optical Microwave Unit Assembly A13 generates the error signal required to change the crystal oscillator frequency. The OMU consists of the optical pumping lamp, gas filter, gas cell, microwave cavity, and photocell. Double magnetic shields surround the OMU to protect it from external magnetic fields that would affect the resonant frequency of the rubidium gas cell. Electronic circuits for the OMU are the lamp oscillator, step recovery diode (SRD), magnetic field coil, cavity heater, and lamp heater. Refer to figure 4-14 for a block diagram of the OMU assembly and to figure 7-10 for a schematic diagram.

4-151. LAMP OSCILLATOR. The lamp oscillator generates the voltage that excites the rubidium lamp. It consists of Q1 and the associated resonant network. A DC voltage from Oscillator Regulator and Start Assembly A8 is applied to the oscillator through L1. This voltage causes the circuit to oscillate at about 53MHz. The amount of excitation depends on the DC input voltage, which can vary from 6 to 16 volts. The signal at the base of Q1 is applied to L2 which is wound around the rubidium lamp. This provides the excitation required to keep the lamp lit once it is started.

4-152. LAMP START PULSE. The lamp start pulse is applied, from J2 on Oscillator Regulator and Start Assembly A8, through J3 to the tap of auto-transformer T1. The high voltage output of T1 is then applied to the rubidium lamp to provide the necessary energy to start the lamp.

4-153. STEP RECOVERY DIODE. Step recovery diode (SRD) CR1 has the ability to generate high-order harmonics of the applied frequency at a power level capable of causing resonance in the microwave cavity. Tuning and biasing are provided by C1, L1, and R1 in the SRD assembly. A degree of impedance isolation from X18 RF Multiplier Assembly A4 is provided by R1, R2, and C1 of the impedance matching unit. The signal is applied at P1 from J4 on the multiplier assembly. This signal is 90MHz frequency modulated at 165Hz and riding a 5.313 . . . MHz signal. This produces a frequency of 6840MHz, that is more than 60 db from the 90MHz signal, with sidebands that are 5.313 . . . MHz on either



A6-106-547

Figure 4-14. Optical Microwave Unit Assembly A13, Block Diagram side of the 6840MHz signal. These sidebands are approximately 15db down from the 6840MHz signal.

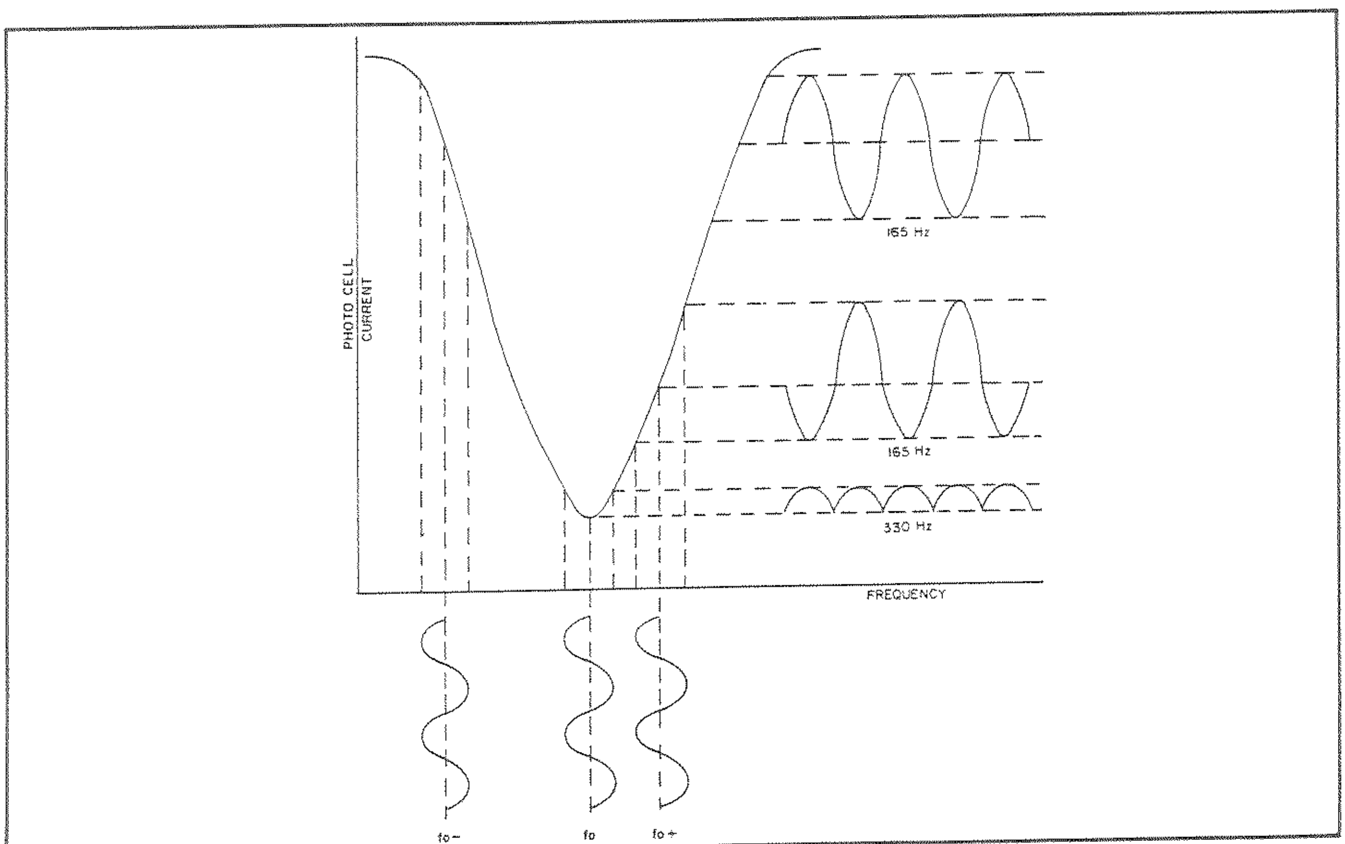
4-162. The 165Hz modulation appears as jitter in the 6840MHz signal and in the 5.313 . . . MHz sidebands. The lower sideband, which is the frequency of interest, produces a frequency of approximately 6834.687MHz modulated at 165Hz. This is the rubidium resonant frequency.

4-154. MAGNETIC FIELD COIL. A controlled magnetic field, referred to as the C-field, is produced by L1 whose axis is coincident with the rubidium lamp beam. Inductor L1 is wound around the microwave cavity. The DC voltage for L1 is received from MAGNETIC FIELD control A11R1 through P1-B. The potentiometer controls the current through L1, which in turn controls the magnetic field around the microwave cavity. This provides a method of fine tuning the rubidium standard over a small range since a change in the magnetic field produces a change in the rubidium resonant frequency.

4-155. PHOTOCELL. Photocell V1 detects the amount of light from the rubidium lamp that is not absorbed in the rubidium gas cell. The output of the photocell contains the 165 and 330Hz components, due to the 165Hz frequency modulation, as shown in figure 4-15. This output current is converted to a voltage by amplifier U2 and applied to the DET input of the audio assembly.

4-156. HEATER CIRCUITS. The OMU contains two heaters; one for the rubidium lamp and one for the microwave cavity. Since these two circuits are functionally similar only the rubidium lamp will be discussed. The heater circuit is comprised of a temperature sensing bridge (R1 through R4 and RT1), operational amplifier U1, current amplifier Q1 and Q2, and heater HR1.

4-157. Current from the 19.25 volt DC line is applied to R2 to provide sensing bridge excitation. Potentiometer R2 is adjusted to provide a temperature of approximately 97°C. When the bridge is balanced, there is no voltage differential at pins 2 and 3 of U1. The output of U1 at pin 6 is applied to the base of Q1, which forms a current amplifier in conjunction with Q2. The output at the emitter of Q2 is applied to HR1 to heat the reflector assembly. The output is also applied through R5 back to pin 2 of U1 for feedback, and through P2-C to the CIRCUIT CHECK selector to monitor the heater current on the CIRCUIT CHECK meter.



A6-106-546

Figure 4-15. Photocell Output Current for Positive, Negative, and Zero Frequency Errors

4-158. When the temperature is either high or low, the resistance of RT1 changes and unbalances the bridge. This causes current to flow through the bridge to U1 pins 2 and 3. The current will either be positive or negative depending on whether the temperature is high or low. This, in turn, changes the output of U1, which changes the output of Q2 such that more or less current is applied to HR1 to raise or lower the temperature of the lamp as sensed by RT1.

4-159. The microwave cavity heater maintains a temperature of approximately 6.25°C. Since this temperature can be close to the operating temperature range of the standard, CR1 and CR2 are used in the buffer amplifier to ensure that no current is applied to HR1 when heat is not required. The heater current is also applied through P1-E to the CIRCUIT CHECK selector to monitor the heater current on the CIRCUIT CHECK meter.

4-160. 5MHz CRYSTAL OSCILLATOR ASSEMBLY A14.

4-161. The 5MHz Crystal Oscillator Assembly A14 generates the basic 5MHz signal used in the frequency standard. It consists of an oscillator, amplifier, AGC circuit, and temperature controller. Refer to figure 4-16 for a block diagram of the 5MHz crystal oscillator assembly and to figure 7-11 for a schematic diagram.

4-162. OSCILLATOR. The oscillator consists of quartz crystal Y1 and transistor Q1. The quartz crystal drives Clapp-Gourillet Oscillator Q1 at a frequency of 5MHz, which is the fifth overtone of the fundamental crystal frequency. The crystal is controlled by the DC voltage applied at pin 8 from Loop Filter Assembly A9. This voltage changes the capacitance of CR1, which tunes the oscillator. Variable capacitor C1 provides coarse adjustment of the oscillator frequency. The 5MHz output at the collector of Q1 is applied to the amplifier.

4-163. AMPLIFIER. The amplifier consists of two common-emitter stages comprised of Q2 and Q3. It is used to maintain low crystal output power for more efficient operation. The 5MHz output at the collector of Q3 is applied through T1 to pins 5 (Hi and 9 (Lo) on P1. This output is applied to Distribution Amplifier Assembly A5. A portion of the signal at the primary of T1 is applied to the AGC circuit.

4-164. AGC CIRCUIT. The AGC circuit consists of diodes CR2 and CR3. When the crystal oscillator is first energized, the oscillation amplitude is very low. As this amplitude increases, CR2 and CR3 begin to detect the output voltage. The negative DC output from CR2 and CR3 feeds back to the base of Q1 through R28, R3, and R4, causing its base current to decrease. This stabilizes the oscillation amplitude.

4-165. TEMPERATURE CONTROLLER. The temperature controller is comprised of a temperature sensing bridge (R1, R2, R4, R5, and RT1), operational amplifier U1, current amplifier A14A2Q1 and A14Q1, and heater HR1. Current from the 19.25VDC line is applied through R3 to R2 to provide sensing bridge excitation. Potentiometer R2 is adjusted to provide the desired temperature. When the bridge is balanced there is no voltage input to U1 at pins 2 and 3. The output of U1 is then only the voltage needed to maintain the balanced condition.

4-166. When the temperature is either high or low, the resistance of RT1 changes and unbalances the bridge. This causes current to flow through the bridge to U1 at pins 2 and 3. This current will be either positive or negative

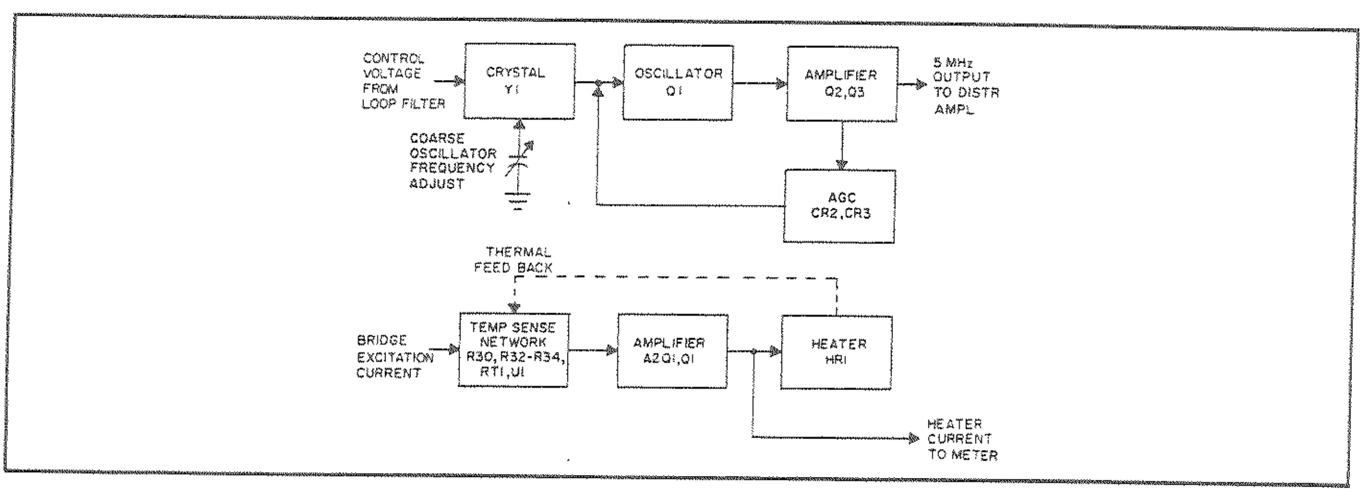


Figure 4-16. 5MHz Crystal Oscillator Assembly A14, Block Diagram

depending on whether the temperature is high or low. This, in turn, changes the output of U1, which changes the output of A14Q1 such that more or less voltage is applied to HR1 to raise or lower the temperature of the crystal as sensed by RT1.

4-167. COLOR SUBCARRIER SYNTHESIZER ASSEMBLY A17.

4-168. Color Subcarrier Synthesizer Assembly A17 generates a 3.57 . . . MHz sinewave, one of the primary output signals of the frequency standard. The assembly consists of an input isolation and shaper circuit, a divide-by-88 circuit, crystal ringing filter, and output filter. Refer to figure 4-17 for a block diagram of the assembly and to figure 7-12 for a schematic diagram.

4-169. INPUT ISOLATION AND SHAPER. The 5MHz from Distribution Amplifier Assembly A5 is applied through J4 to FET source follower Q3, which isolates the color subcarrier synthesizer from assembly A5. The output of Q3 is shaped (squared) by the combination of amplifier Q4 and NAND-gate U1. The resulting 5MHz square wave is applied to the divide-by-88 circuit.

4-170. DIVIDE-BY-88 CIRCUIT. The divide-by-88 circuit consists of dual J-K flip-flops U2 and U4, single shot U1, and decade divider U3. The 5MHz is first divided by 2, then by 11, and then by 4 to produce the required factor of 88.

4-171. Division by two occurs in flip-flop U2A with the Q output clocking U3, a decade divider with BCD outputs. The divider normally divides by 10 and then resets back to zero. However, in this instance, the count of 10 causes the $\overline{Q}$ output of U2B to change state and trigger single shot U1, which produces a short pulse applied to the 9-count reset terminal on U3. This action resets U3 to a 9 count. Now U3 makes one more count to 10 and toggles U2B causing it to again change states. This time the $\overline{Q}$ output of U2B does not trigger the single shot, but the Q output toggles U4A. The sequence then is: U3 counts to 10, is reset back to 9, then makes one more count to 10 for a total division of 11. The divider then resets back to zero for the next cycle.

4-172. Flip-flops U4A and B comprise a straight divide-by-4 circuit to complete the division factor of 88. The square wave output at the Q terminal of U4B is applied to the crystal ringing filter.

4-173. CRYSTAL RINGING FILTER. The square wave from the divide-by-88 circuit feeds amplifier Q5, which in turn feeds a crystal ringing filter operating at 3.579545MHz. Major components in the filter are T3, Y3, and C19. The Q is sufficient for the filter to produce a continuous sinewave. The sinewave is buffered by Darlington Amplifier Q6, Q7, and Q8. Transistor Q7 feeds the 3.58MHz MON connector on the rear panel and Q8 feeds Phase Shifter Assembly A18.

4-174. OUTPUT FILTER. The output filter provides additional filtering for the phase-shifted 3.579545MHz signal. The filter consists of Y1 and Y2, and associated circuitry. The phase-shifted signal enters assembly A17 at J2. Gain control R2 permits adjusting the subcarrier output level. The output circuit is untuned and has a fairly low Q. The output at J3 is 3.579545MHz with all

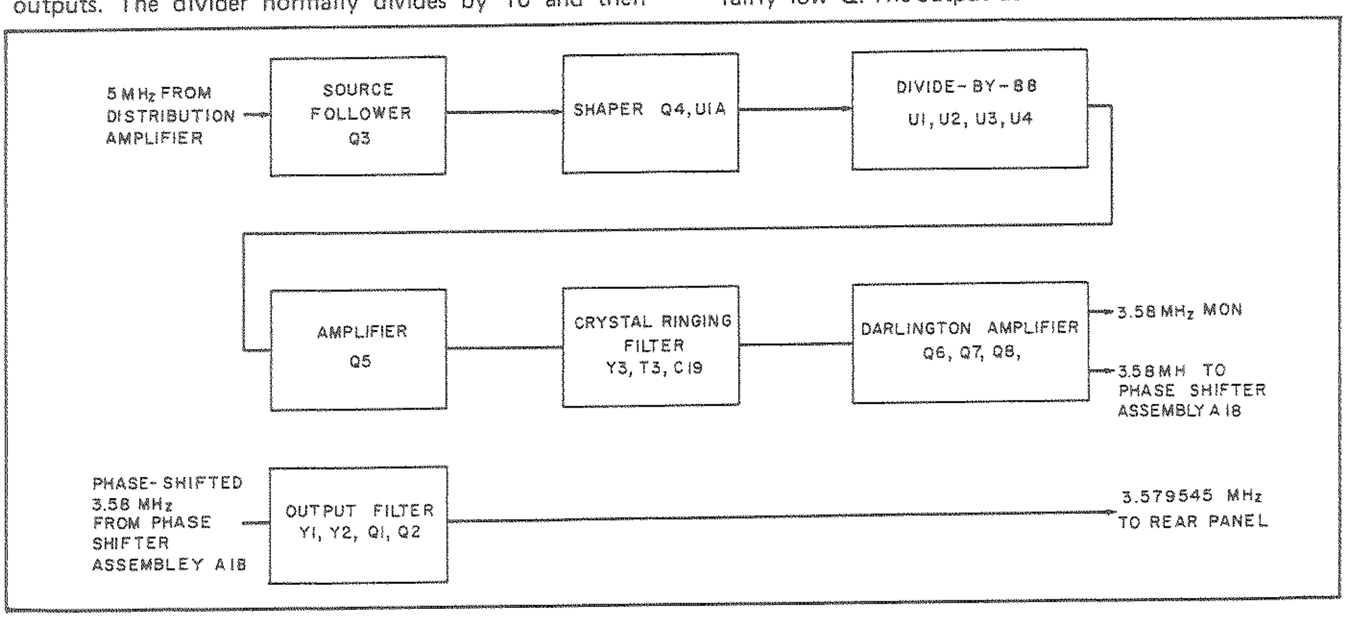


Figure 4-17. Color Subcarrier Synthesizer Assembly A17, Block Diagram

undesirable products of the synthesis reduced to a level at least 75dB below the 3.579545MHz output.

4-175. PHASE SHIFTER ASSEMBLY A18.

4-176. Phase Shifter Assembly A18 provides a convenient means of changing the phase of the 3.57 . . . MHz subcarrier. Refer to figure 7-13 for the schematic diagram of the assembly. The 3.57 . . . MHz signal from assembly A17 feeds through terminal E3 to the base of emitter follower Q1. The output of Q1 is matched to the goniometer assembly, which splits the phase of the 3.57 . . . MHz input into quadrature. A rotatable pickup coil, which is controlled by the 3.58MHz SUBCARRIER PHASE control, is coupled to the goniometer assembly. The low level signal from the pickup coil is amplified and limited by stabilized high gain amplifier Q2. The output of Q2 feeds tuned amplifier Q3 whose output is the phase-shifted 3.579545MHz signal applied back to color Subcarrier Synthesizer Assembly A17. The output is transformer-coupled.

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides the maintenance instructions for the Model 600 Rubidium Frequency Standard . The section includes periodic adjustment procedures and servicing information. Refer to Appendix B for maintenance instructions on the Battery Option.

5-3. PERIODIC ADJUSTMENTS.

5-4. The periodic adjustments for the frequency standard include adjusting the crystal oscillator frequency controls and determining the AFC loop null point. It is assumed that the frequency standard has been operating for at least four hours.

5-5. CRYSTAL OSCILLATOR CONTROLS ADJUSTMENT.

5-6. The crystal oscillator frequency will change slowly with time due to crystal aging. This will not affect the output frequency of the standard because the control voltage applied to the crystal oscillator will change to compensate for this frequency change. However, if the control voltage becomes too large, it will exceed the operating limits of the control circuits and cause output frequency errors.

5-7. In this procedure, it is assumed that the AFC loop is locked. If the loop is out of lock, proceed to paragraph 5-10. The oscillator controls should be adjusted every 30 to 60 days as follows:

NOTE

If COARSE and FINE OSCILLATOR FREQUENCY controls are not adjusted slowly, the AFC loop will not follow the change, causing a momentary out-of-lock condition. If this occurs, press RESET pushbutton to return OPERATION lamp to steady-on condition.

5-8. COARSE ADJUSTMENT.

a. Set FINE OSCILLATOR FREQUENCY control to 5.00.
b. Set CONTROL switch to OPEN LOOP position. (Operation lamp will flash rapidly.)
c. Set CIRCUIT CHECK selector to ERROR position.
d. Slowly adjust COARSE OSCILLATOR FREQUENCY control for indication of 50 midway between left and right deflections.
e. Set CONTROL switch to NORMAL position.
f. Set CIRCUIT CHECK selector to CONTROL position. Meter should indicate exactly 50.
g. Press reset pushbutton to bring operation lamp to steady on.

5-9. FINE ADJUSTMENT.

a. Set CIRCUIT SELECTOR switch to CONTROL position.
b. Slowly adjust FINE OSCILLATOR FREQUENCY control to obtain a reading of 50 on the meter.
c. Open the AFC loop.
d. Set CIRCUIT SELECTOR to ERROR.
e. Slowly adjust FINE OSCILLATOR FREQUENCY control to obtain a reading of 50 on the meter.
f. Close the AFC loop.

NOTE

If the FINE OSCILLATOR FREQUENCY control reading is below 1.50 or above 8.50 as per the above adjustment, the COARSE ADJUSTMENT should be made.

5-10. LOCATING AFC LOOP NULL.

5-11. If the AFC loop is out of lock for any reason or will not lock in due to too large an error, the loop null point should be determined as follows:

a. Set CIRCUIT CHECK selector to ERROR position.
b. Set CONTROL switch to OPEN LOOP position.

c. Set FINE OSCILLATOR FREQUENCY control to 5.00.
d. Adjust COARSE OSCILLATOR FREQUENCY control for a meter indication of 50 between the left and right deflections.
e. Set CONTROL switch to NORMAL position. Proceed to paragraph 5-7 to adjust oscillator controls.

5-12. 3.58MHz SYNTHESIZER AND PHASE SHIFTER ADJUSTMENT.

5-13. The 3.58MHz subcarrier synthesizer and phase shifter are tuned at the factory and normally should not require retuning. However, if either assembly should fail and require repair or replacement, the following procedure should be used to retune the assemblies. To retune the 3.58MHz subcarrier synthesizer and phase shifter, proceed as follows:

a. Connect scope to view 3.58MHz sinewave at 3.58MHz MON connector J4. Maximum resistive load should be 1000 ohms. Never use a capacitive load.
b. Using insulated alignment tool, tune C20 on 3.58MHz subcarrier synthesizer board for maximum signal. Tune C19 for minimum ripple.
c. Repeat step b until optimum signal is achieved.
d. Connect scope to view phase-shifted 3.58MHz at J8 on rear panel and tune C13 on phase shifter board for maximum signal.
e. Adjust R2 on 3.58MHz subcarrier synthesizer board for desired output level into 75-ohm load.

5-14. FUSE AND LAMP REPLACEMENT.

5-15. If a fuse blows or an indicator lamp burns out, they should be replaced with the following:

a. 3A DC fuse; replace with	312003
b. 2A 115VAC fuse; replace with	313002 or
1A 230VAC fuse; replace with	313001
c. Internal fuse; F2 (removing top cover, fuse is located just above main power transformer); replace with	312025
d. OPERATION and BATTERY lamps; replace with	No. 387

5-16. SERVICING INFORMATION.

5-17. If it becomes necessary to return the frequency standard to the manufacturer for repair, the entire instrument, including all assembly boards, options, and accessories, should be returned. Servicing is available on a flat fee plus parts basis. If requested, a firm quotation will be provided at the time of inspection and work will not be processed until customer authorization is received.

5-18. If further assistance is required, contact:

TRACOR, Inc.
6500 Tracor Lane
Austin, Texas 78721
512/926-2800
Attn: Product Service

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains all necessary information for quick identification and ordering of replaceable parts for the Model 600 Rubidium Frequency Standard. The section contains a list of replaceable parts, a numeric list of federal supply codes for manufacturers, and ordering information.

6-3. LIST OF REPLACEABLE PARTS.

6-4. A list of replaceable parts for the frequency standard is presented in table 6-1. Information in the table includes the reference designation, TRACOR stock number, part description, the federal supply code of a typical manufacturer that supplies the part, and that manufacturer's part number. The list is divided into subsections that correspond to the assemblies in the instrument. The subsections are listed in numeric order by assembly stock number. Parts are listed in alphanumeric order, by reference designation.

6-5. FEDERAL SUPPLY CODE FOR MANUFACTURERS (FSCM).

6-6. A list of manufacturers supplying parts for the frequency standard is provided in table 6-2. The manufacturers are listed in numerical order by federal supply code number.

6-7. ORDERING INFORMATION.

6-8. Address orders or inquiries to either an authorized TRACOR, Inc., sales representative or to:

TRACOR, Inc.
6500 Tracor Lane
Austin, Texas 78721
Attn: Product Service

6-9. To ensure prompt service, orders must include the following information:

a. Name, model, and serial number of the instrument.
b. Reference designation, if applicable.
c. Assembly or sub-assembly name and/or number.
d. TRACOR stock number.
e. Full description of the part.

6-10. The part numbers shown will change occasionally as manufacturers' items are reevaluated or as improved components become available. The component shipped will be the component used in production at the time the order is received, and will be equivalent to the component it replaces in both dimensions and performance.

TABLE 6-1 LIST OF REPLACEABLE PARTS

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
* * *	* ASSEMBLY NO G15286-0001	ACCESSORY KIT		* * * *
	G15294-0001	CONN ASSY	19397	G15294-0001
	G35277-0001	EXTENDER BRD ASSY	19397	G35277-0001
* * *	* ASSEMBLY NO G25152-0001	COMPONENT ASSY A14A3		* * * *
C 2	23969-0011	CAPACITOR 30 PFD	14674	CY10C300J
L 1	3568-0101	INDUCTOR 100 UH	99800	1537-76
* * *	* ASSEMBLY NO G34420-0001	INNER SHIELD ASSY		* * * *
	G34197-0001	SHIELD ASSY INNER CAV	19397	G34197-0001
* * *	* ASSEMBLY NO G35101-0001	SRD ASSY A13A3		* * * *
C 1	27512-0161	CAP FXD MICA 160 PFD	00853	CM05F161G03 (MIL-C-5/18)
C 2	23969-0017	CAPACITOR	99515	FR 2B4712
J 1	23969-0035	CONNECTOR	98291	51-043-0000
R 1	204-0000	RESISTOR SELECTED	19397	204-0000
CR 1	23969-0047	DIODE	01281	PSD-1009
* * *	* ASSEMBLY NO G35131-0001	OSC HEATER CONT A14A2		* * * *
Q 1	900-4921	TSTR 2N4921	04713	2N4921
R 1	211-5111	RES FXD FILM 5.11 K	81349	RN55D5111F (MIL-R-10509/7)
R 2	23969-0090	RESISTOR VAR	80294	3280W66-501
R 3	211-5111	RES FXD FILM 5.11 K	81349	RN55D5111F (MIL-R-10509/7)
R 4	211-5111	RES FXD FILM 5.11 K	81349	RN55D5111F (MIL-R-10509/7)
R 5	211-0000	RES FXD FILM SEL VALS	81349	RN55D----F (MIL-R-10509/7)
R 6	204-0155	RES FXD COMP 1.5 MEG	81349	RC07GF155J (MIL-R-11/8)
R 7	204-0394	RES FXD COMP 390 K	81349	RC07GF394J (MIL-R-11/8)
U 1	23969-0002	AMPLIFIER	07263	U5B7741312
* * *	* ASSEMBLY NO G35151-0001	HEATER ASSY A14A4		* * * *
Q 1	900-4921	TSTR 2N4921	04713	2N4921
Y 1	G15162-0001	CRYSTAL	19397	G15162-0001
RT 1	23969-0087	THERMISTER 20K	19397	GA42P1
* * *	* ASSEMBLY NO G35153-0001	XTAL OSC ASSY A14A1		* * * *
C 1	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 2	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 3	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 4	23969-0012	CAPACITOR 200 PFD	14674	CY10C201J
C 5	23969-0013	CAPACITOR 270 PFD	14674	CY10C271J
C 6	23969-0020	CAPACITOR 2.2 MFD	16509	TIM225M020P0W
C 7	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 8	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 9	23969-0020	CAPACITOR 2.2 MFD	16509	TIM225M020P0W
C 10	23969-0020	CAPACITOR 2.2 MFD	16509	TIM225M020P0W
C 11	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 12	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 13	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 14	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 15	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 16	27512-0151	CAP FXD MICA 150 PFD	00853	CM05F151G03 (MIL-C-5/18)
C 17	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 18	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 19	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 20	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 21	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 22	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 23	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 26	23969-0014	CAPACITOR 10 PFD	14674	CY10C100J
L 1	3568-0100	INDUCTOR 10 UH	99800	1537-36
L 2	3568-0560	INDUCTOR 56 UH	99800	1537-64
L 3	3568-0560	INDUCTOR 56 UH	99800	1537-64
Q 1	900-2708	TSTR 2N2708	95303	2N2708
Q 2	900-3646	TSTR SPECIAL	19397	900-3646
Q 3	900-3646	TSTR SPECIAL	19397	900-3646

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
R 1	23983-0203	RES FXD COMP 20 K	81349	RC05GF203J (MIL-R-11/11)
R 2	23983-0514	RES FXD COMP 510 K	81349	RC05GF514J (MIL-R-11/11)
R 3	23983-0103	RES FXD COMP 10 K	81349	RC05GF103J (MIL-R-11/11)
R 4	23983-0513	RES FXD COMP 51 K	81349	RC05GF513J (MIL-R-11/11)
R 5	23983-0202	RES FXD COMP 2 K	81349	RC05GF202J (MIL-R-11/11)
R 6	23983-0101	RES FXD COMP 100 OHM	81349	RC05GF101J (MIL-R-11/11)
R 7	23983-0511	RES FXD COMP 510 OHM	81349	RC05GF511J (MIL-R-11/11)
R 8	23983-0511	RES FXD COMP 510 OHM	81349	RC05GF511J (MIL-R-11/11)
R 9	23983-0301	RES FXD COMP 300 OHM	81349	RC05GF301J (MIL-R-11/11)
R 10	23983-0362	RES FXD COMP 3.6 K	81349	RC05GF362J (MIL-R-11/11)
R 11	23983-0183	RES FXD COMP 18 K	81349	RC05GF183J (MIL-R-11/11)
R 12	23983-0153	RES FXD COMP 15 K	81349	RC05GF153J (MIL-R-11/11)
R 13	23983-0181	RES FXD COMP 180 OHM	81349	RC05GF181J (MIL-R-11/11)
R 14	23983-0101	RES FXD COMP 100 OHM	81349	RC05GF101J (MIL-R-11/11)
R 15	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 16	23983-0621	RES FXD COMP 620 OHM	81349	RC05GF621J (MIL-R-11/11)
R 17	204-0181	RES FXD COMP 180 OHM	81349	RC07GF181J (MIL-R-11/8)
R 18	23983-0103	RES FXD COMP 10 K	81349	RC05GF103J (MIL-R-11/11)
R 19	23983-0103	RES FXD COMP 10 K	81349	RC05GF103J (MIL-R-11/11)
R 20	23983-0181	RES FXD COMP 180 OHM	81349	RC05GF181J (MIL-R-11/11)
R 21	204-0511	RES FXD COMP 510. OHM	81349	RC07GF511J (MIL-R-11/8)
R 22	204-0332	RES FXD COMP 3.30 K	81349	RC07GF332J (MIL-R-11/8)
R 23	23983-0101	RES FXD COMP 100 OHM	81349	RC05GF101J (MIL-R-11/11)
R 24	23983-0102	RES FXD COMP 1K	81349	RC05GF102J (MIL-R-11)
R 25	204-0302	RES FXD COMP 3.0 K	81349	RC07GF302J (MIL-R-11/8)
R 26	23983-0513	RES FXD COMP 51 K	81349	RC05GF513J (MIL-R-11/11)
R 27	23983-0432	RES FXD COMP 4.3 K	81349	RC05GF432J (MIL-R-11/11)
R 28	23983-0102	RES FXD COMP 1K	81349	RC05GF102J (MIL-R-11)
R 40	204-0271	RES FXD COMP 270. OHM	81349	RC07GF271J (MIL-R-11/8)
T 1	G24830-0001	TRANSFORMER	19397	G24830-0001
CR 1	23969-0046	DIODE	01281	V56E
CR 2	800-4148	DIODE 1N4148	14433	1N4148
CR 3	800-4148	DIODE 1N4148	14433	1N4148
* * * * ASSEMBLY NO G35161-0001 OSCILLATOR * * * *				
	G24952-0001	COVER ASSY	19397	G24952-0001
	G25152-0001	COMPONENT ASSY A14A3	19397	G25152-0001
	G34951-0001	CAN ASSY XTAL OSC	19397	G34951-0001
	G35131-0001	OSC HEATER CONT A14A2	19397	G35131-0001
	G35151-0001	HEATER ASSY A14A4	19397	G35151-0001
	G35153-0001	XTAL OSC ASSY A14A1	19397	G35153-0001
C 1	23969-0021	CAPACITOR	16509	TIM 36C
P 1	23969-0036	CONNECTOR	98291	51-011-3196
P 2	23969-0029	CONNECTOR	81312	SPE7PJ
* * * * ASSEMBLY NO G44896-0001 AUDIO BOARD A7A1 * * * *				
C 1	23969-0018	CAPACITOR .018 MFD	99515	HL2-183D
C 2	23969-0018	CAPACITOR .018 MFD	99515	HL2-183D
C 3	8914-0101	CAP FXD TA 100 MFD	01295	CS13BE107K (MIL-C-26655/2)
C 4	27512-0101	CAP FXD MICA 100 PFD	00853	CM05F101G03 (MIL-C-5/18)
C 5	8914-0101	CAP FXD TA 100 MFD	01295	CS13BE107K (MIL-C-26655/2)
C 6	23969-0009	CAPACITOR 1 MFD	73445	C281CH/A1M
C 7	23969-0009	CAPACITOR 1 MFD	73445	C281CH/A1M
C 8	23969-0009	CAPACITOR 1 MFD	73445	C281CH/A1M
C 9	21485-0470	CAP FXD TA 47 MFD	05397	CS13BF476K (MIL-C-26655/2)
C 10	21485-0150	CAP FXD TA 15 MFD	01295	CS13BF156K (MIL-C-26655/2)
C 11	8914-0390	CAP FXD TAN 39 UF	01295	CS13BE396K
C 12	21485-9331	CAP FXD TA 3.3 MFD	05397	CS13BF335K (MIL-C-26655/2)
C 13	8914-0101	CAP FXD TA 100 MFD	01295	CS13BE107K (MIL-C-26655/2)
C 14	21485-0470	CAP FXD TA 47 MFD	05397	CS13BF476K (MIL-C-26655/2)
C 15	8914-0100	CAP FXD TA 10 MFD	01295	CS13BE106K (MIL-C-26655/2)
C 16	8914-0100	CAP FXD TA 10 MFD	01295	CS13BE106K (MIL-C-26655/2)
C 17	8914-0100	CAP FXD TA 10 MFD	01295	CS13BE106K (MIL-C-26655/2)
C 18	23969-0015	CAPACITOR .05 MFD 1%	99515	EF1-503A
C 19	23969-0015	CAPACITOR .05 MFD 1%	99515	EF1-503A
C 20	23969-0016	CAPACITOR .1 MFD 1%	99515	EF1-104A
C 21	23969-0016	CAPACITOR .1 MFD 1%	99515	EF1-104A
C 22	23969-0016	CAPACITOR .1 MFD 1%	99515	EF1-104A
C 23	21485-0220	CAP FXD TA 22 MFD	05397	CS13BF226K (MIL-C-26655/2)
C 24	8914-0390	CAP FXD TAN 39 UF	01295	CS13BE396K
C 25	8914-0101	CAP FXD TA 100 MFD	01295	CS13BE107K (MIL-C-26655/2)
C 26	8914-0101	CAP FXD TA 100 MFD	01295	CS13BE107K (MIL-C-26655/2)
C 27	23969-0015	CAPACITOR .05 MFD 1%	99515	EF1-503A

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
C 28	23969-0015	CAPACITOR .05 MFD 1%	99515	EE1-503A
C 29	8914-0390	CAP FXD TAN 39 UF	01295	CS13BE396K
C 30	8914-0101	CAP FXD TA 100 MFD	01295	CS13BE107K (MIL-C-26655/2)
J 3	23969-0034	CONNECTOR	98291	51-053-0119
J 6	23969-0034	CONNECTOR	98291	51-053-0119
Q 1	900-3904	TSTR 2N3904	04713	2N3904
Q 2	900-3904	TSTR 2N3904	04713	2N3904
Q 3	900-1711	TSTR 2N1711	04713	2N1711
Q 4	900-3904	TSTR 2N3904	04713	2N3904
Q 5	900-3904	TSTR 2N3904	04713	2N3904
Q 6	900-3904	TSTR 2N3904	04713	2N3904
Q 7	900-2646	TSTR 2N2646	03508	2N2646
Q 8	900-3904	TSTR 2N3904	04713	2N3904
R 1	4403-1243	RES FXD FILM 124 K	81349	RNR60C1243FS (MIL-R-55182/30)
R 2	204-0513	RES FXD COMP 51.0 K	81349	RC07GF513J (MIL-R-11/8)
R 3	204-0222	RES FXD COMP 2.20 K	81349	RC07GF222J (MIL-R-11/8)
R 4	204-0222	RES FXD COMP 2.20 K	81349	RC07GF222J (MIL-R-11/8)
R 5	3584-0503	RES VAR WW 50 K	80294	200P-1-503
R 6	4403-1003	RES FXD FILM 100 K	81349	RNR60C1003FS (MIL-R-55182/30)
R 7	204-0513	RES FXD COMP 51.0 K	81349	RC07GF513J (MIL-R-11/8)
R 8	204-0104	RES FXD COMP 100. K	81349	RC07GF104J (MIL-R-11/8)
R 9	201-0561	RES FXD COMP 560. OHM	81349	RC20GF561J (MIL-R-11/3)
R 10	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 11	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 12	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 13	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 14	4504-0103	RES VAR CERMET 10 K	73138	77PR10 K
R 15	204-0470	RES FXD COMP 47.0 OHM	81349	RC07GF470J (MIL-R-11/8)
R 16	204-0223	RES FXD COMP 22.0 K	81349	RC07GF223J (MIL-R-11/8)
R 17	204-0332	RES FXD COMP 3.30 K	81349	RC07GF332J (MIL-R-11/8)
R 18	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 19	4403-1372	RES FXD FILM 13.7 K	81349	RNR60C1372FS (MIL-R-55182/30)
R 20	4403-1372	RES FXD FILM 13.7 K	81349	RNR60C1372FS (MIL-R-55182/30)
R 21	4403-2051	RES FXD FILM 2.05 K	81349	RNR60C2051FS (MIL-R-55182/30)
R 23	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 25	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 26	4504-0103	RES VAR CERMET 10 K	73138	77PR10 K
R 27	204-0474	RES FXD COMP 470. K	81349	RC07GF474J (MIL-R-11/8)
R 28	204-0203	RES FXD COMP 20.0 K	81349	RC07GF203J (MIL-R-11/8)
R 29	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 30	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 31	4403-1022	RES FXD FILM 10.2 K	81349	RNR60C1022FS (MIL-R-55182/30)
R 32	4403-1022	RES FXD FILM 10.2 K	81349	RNR60C1022FS (MIL-R-55182/30)
R 33	4403-5111	RES FXD FILM 5.11 K	81349	RNR60C5111FS (MIL-R-55182/30)
R 34	4403-9760	RES FXD FILM 976 OHM	81349	RNR60C9760FS (MIL-R-55182/30)
R 35	4403-1003	RES FXD FILM 100 K	81349	RNR60C1003FS (MIL-R-55182/30)
R 36	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 37	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 38	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 39	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 40	204-0104	RES FXD COMP 100. K	81349	RC07GF104J (MIL-R-11/8)
R 41	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 42	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 43	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 44	204-0334	RES FXD COMP 330. K	81349	RC07GF334J (MIL-R-11/8)
R 45	204-0123	RES FXD COMP 12.0 K	81349	RC07GF123J (MIL-R-11/8)
R 46	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 47	204-0151	RES FXD COMP 150. OHM	81349	RC07GF151J (MIL-R-11/8)
R 48	4403-9760	RES FXD FILM 976 OHM	81349	RNR60C9760FS (MIL-R-55182/30)
R 49	4403-1003	RES FXD FILM 100 K	81349	RNR60C1003FS (MIL-R-55182/30)
R 50	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 51	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 52	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 53	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 54	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
U 1	23969-0056	INTEGRATED CIRCUIT	01295	SN7472N
U 2	23969-0001	AMPLIFIER	07263	U5B7741393
U 3	23969-0001	AMPLIFIER	07263	U5B7741393
U 4	23969-0001	AMPLIFIER	07263	U5B7741393
CR 1	800-0914	DIODE 1N914	01295	1N914
CR 2	800-0914	DIODE 1N914	01295	1N914
CR 3	800-0751	DIODE 1N751	01295	1N751
CR 4	800-0751	DIODE 1N751	01295	1N751
CR 5	800-0914	DIODE 1N914	01295	1N914
CR 6	800-0914	DIODE 1N914	01295	1N914

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
* *	*	* ASSEMBLY NO 044901-0001	SYNT.COMP BRD	A6A1 * * * *
C 1	27512-0150	CAP FXD MICA 15 PFD	00853	CM05F150G03 (MIL-C-5/18)
C 2	27512-0300	CAP FXD MICA 30 PFD	00853	CM05E300G03 (MIL-C-5/18)
C 3	27512-0300	CAP FXD MICA 30 PFD	00853	CM05E300G03 (MIL-C-5/18)
C 4	27512-0150	CAP FXD MICA 15 PFD	00853	CM05F150G03 (MIL-C-5/18)
C 5	23969-0123	CAP .005	91418	SM-005
C 6	27512-0101	CAP FXD MICA 100 PFD	00853	CM05F101G03 (MIL-C-5/18)
C 7	27512-0820	CAP FXD MICA 82 PFD	00853	CM05E820G03 (MIL-C-5/18)
C 8	27512-0680	CAP FXD MICA 68 PFD	00853	CM05E680G03 (MIL-C-5/18)
C 9	3403-9503	CAP FXD CER .05 UF	80183	TG-S50
C 10	3403-9503	CAP FXD CER .05 UF	80183	TG-S50
C 11	23969-0123	CAP .005	91418	SM-005
C 12	27512-0390	CAP FXD MICA 39 PFD	00853	CM05E390G03 (MIL-C-5/18)
C 13	3403-9503	CAP FXD CER .05 UF	80183	TG-S50
C 14	27513-0501	CAP FXD MICA 500MMF	84171	DM-15-501
C 15	27513-0501	CAP FXD MICA 500MMF	84171	DM-15-501
C 16	27512-0681	CAP FXD MICA 680 PFD	00853	CM06F681G03 (MIL-C-5/18)
C 17	3403-9503	CAP FXD CER .05 UF	80183	TG-S50
C 18	27512-0500	CAP FXD MICA 50 PF	00853	CM05E500G03 (MIL-C-5/18)
C 19	8918-0560	CAP FXD TA 56 MFD	05397	CS13BB566K (MIL-C-26655/2)
C 20	3403-9503	CAP FXD CER .05 UF	80183	TG-S50
C 21	3403-9503	CAP FXD CER .05 UF	80183	TG-S50
C 22	8914-0470	CAP FXD TA 47 MFD	01295	CS13BE476K (MIL-C-26655/2)
C 23	3403-9503	CAP FXD CER .05 UF	80183	TG-S50
C 24	23969-0123	CAP .005	91418	SM-005
C 25	27512-0750	CAP FXD MICA 75 PFD	00853	CM05E750G03 (MIL-C-5/18)
C 26	3923-0035	CAP VAR CER MINAT	73899	DV11PS35D
C 27	3403-9503	CAP FXD CER .05 UF	80183	TG-S50
C 28	8918-0560	CAP FXD TA 56 MFD	05397	CS13BB566K (MIL-C-26655/2)
C 29	27512-0471	CAP FXD MICA 470 PFD	00853	CM06F471G03 (MIL-C-5/18)
C 30	23969-0123	CAP .005	91418	SM-005
C 31	27512-0101	CAP FXD MICA 100 PFD	00853	CM05F101G03 (MIL-C-5/18)
C 32	3403-9503	CAP FXD CER .05 UF	80183	TG-S50
C 33	3403-9503	CAP FXD CER .05 UF	80183	TG-S50
C 34	3403-9503	CAP FXD CER .05 UF	80183	TG-S50
C 35	3403-9503	CAP FXD CER .05 UF	80183	TG-S50
C 36	8918-0560	CAP FXD TA 56 MFD	05397	CS13BB566K (MIL-C-26655/2)
C 40	3403-9503	CAP FXD CER .05 UF	80183	TG-S50
J 1	23969-0034	CONNECTOR	98291	51-053-0119
J 2	23969-0034	CONNECTOR	98291	51-053-0119
J 3	23969-0034	CONNECTOR	98291	51-053-0119
L 1	3568-9681	INDUCTOR 6X8 UH	99800	1537-32
L 2	3568-9681	INDUCTOR 6X8 UH	99800	1537-32
L 3	3568-9681	INDUCTOR 6X8 UH	99800	1537-32
L 4	3568-0240	INDUCTOR 24.0 UH	99800	1537-46
L 5	3568-0360	INDUCTOR 36.0 UH	99800	1537-54
L 6	3568-9271	INDUCTOR 2.7 UH	99800	1537-22
L 7	3568-0100	INDUCTOR 10 UH	99800	1537-36
L 8	3568-9681	INDUCTOR 6X8 UH	99800	1537-32
Q 1	900-3904	TSTR 2N3904	04713	2N3904
Q 2	900-3904	TSTR 2N3904	04713	2N3904
Q 3	900-3904	TSTR 2N3904	04713	2N3904
Q 4	900-3904	TSTR 2N3904	04713	2N3904
Q 5	900-3904	TSTR 2N3904	04713	2N3904
Q 6	900-3906	TSTR 2N3906	01295	2N3906
Q 7	900-4351	TSTR 2N4351	04713	2N4351
Q 8	900-3906	TSTR 2N3906	01295	2N3906
Q 9	900-3819	TSTR 2N3819	01295	2N3819
Q 10	900-3904	TSTR 2N3904	04713	2N3904
Q 11	900-3906	TSTR 2N3906	01295	2N3906
Q 12	900-3904	TSTR 2N3904	04713	2N3904
Q 13	900-3904	TSTR 2N3904	04713	2N3904
Q 14	900-3904	TSTR 2N3904	04713	2N3904
Q 15	900-3819	TSTR 2N3819	01295	2N3819
Q 16	900-3904	TSTR 2N3904	04713	2N3904
R 1	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 2	204-0183	RES FXD COMP 18.0 K	81349	RC07GF183J (MIL-R-11/8)
R 3	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 4	204-0561	RES FXD COMP 560 OHM	81349	RC07GF561J (MIL-R-11/8)
R 5	204-0561	RES FXD COMP 560 OHM	81349	RC07GF561J (MIL-R-11/8)
R 6	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 7	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 8	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 9	204-0242	RES FXD COMP 2.40 K	81349	RC07GF242J (MIL-R-11/8)
R 10	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 11	204-0150	RES FXD COMP 15.0 OHM	81349	RC07GF150J (MIL-R-11/8)

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
R 12	204-0150	RES FXD COMP 15.0 OHM	81349	RC07GF150J (MIL-R-11/8)
R 13	204-0153	RES FXD COMP 15.0 K	81349	RC07GF153J (MIL-R-11/8)
R 14	204-0682	RES FXD COMP 6.80 K	81349	RC07GF682J (MIL-R-11/8)
R 15	23969-0065	RESISTOR VAR	80294	3009Y-1-103
R 16	204-0512	RES FXD COMP 5.10 K	81349	RC07GF512J (MIL-R-11/8)
R 17	204-0104	RES FXD COMP 100. K	81349	RC07GF104J (MIL-R-11/8)
R 18	204-0512	RES FXD COMP 5.10 K	81349	RC07GF512J (MIL-R-11/8)
R 19	204-0104	RES FXD COMP 100. K	81349	RC07GF104J (MIL-R-11/8)
R 20	204-0202	RES FXD COMP 2.00 K	81349	RC07GF202J (MIL-R-11/8)
R 21	204-0106	RES FXD COMP 10.0 MEG	81349	RC07GF106J (MIL-R-11/8)
R 22	204-0561	RES FXD COMP 560 OHM	81349	RC07GF561J (MIL-R-11/8)
R 23	204-0560	RES FXD COMP 56 OHM	81349	RC07GF560J (MIL-R-11/8)
R 24	204-0224	RES FXD COMP 220. K	81349	RC07GF224J (MIL-R-11/8)
R 25	204-0104	RES FXD COMP 100. K	81349	RC07GF104J (MIL-R-11/8)
R 26	204-0104	RES FXD COMP 100. K	81349	RC07GF104J (MIL-R-11/8)
R 27	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 28	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 29	204-0512	RES FXD COMP 5.10 K	81349	RC07GF512J (MIL-R-11/8)
R 30	204-0111	RES FXD COMP 110 OHM	81349	RC07GF111J (MIL-R-11/8)
R 31	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 32	204-0273	RES FXD COMP 27.0 K	81349	RC07GF273J (MIL-R-11/8)
R 33	204-0682	RES FXD COMP 6.80 K	81349	RC07GF682J (MIL-R-11/8)
R 34	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 35	204-0510	RES FXD COMP 51 OHM	81349	RC07GF510J (MIL-R-11/8)
R 36	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 37	204-0392	RES FXD COMP 3.9 K	81349	RC07GF392J (MIL-R-11/8)
R 38	204-0333	RES FXD COMP 33.0 K	81349	RC07GF333J (MIL-R-11/8)
R 39	204-0472	RES FXD COMP 4.70 K	81349	RC07GF472J (MIL-R-11/8)
U 1	23425-0001	INT CKT DUAL J-K	01295	SN7473N
U 2	23425-0001	INT CKT DUAL J-K	01295	SN7473N
U 3	23425-0001	INT CKT DUAL J-K	01295	SN7473N
U 4	23425-0001	INT CKT DUAL J-K	01295	SN7473N
U 5	23425-0001	INT CKT DUAL J-K	01295	SN7473N
U 6	23425-0001	INT CKT DUAL J-K	01295	SN7473N
U 7	23532-0001	INTEGRATED CIRCUIT	01295	SN7440N
U 8	23408-0001	INT CKT QUAD 2-INPUT	01295	SN7400N
U 9	23531-0001	INTEGRATED CIRCUIT	01295	SN7430N
U 10	23408-0001	INT CKT QUAD 2-INPUT	01295	SN7400N
Y 1	G14893-0001	CRYSTAL 5.313300 MHZ	19397	G14893-0001
CR 1	800-0914	DIODE 1N914	01295	1N914
CR 2	800-0914	DIODE 1N914	01295	1N914
CR 3	23969-0046	DIODE	01281	V56E
CR 4	800-0914	DIODE 1N914	01295	1N914
CR 5	800-0914	DIODE 1N914	01295	1N914
CR 6	800-0914	DIODE 1N914	01295	1N914
CR 7	800-0914	DIODE 1N914	01295	1N914
CR 8	800-0914	DIODE 1N914	01295	1N914
CR 9	800-0914	DIODE 1N914	01295	1N914
XY 1	3631-0001	HOLDER CRYSTAL	91506	8000-DG1

* * * * ASSEMBLY NO G44906-0001 HRD LMP OSC A13A1A2 * * * *

C 1	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 2	27512-0221	CAP FXD MICA 220 PFD	00853	CM05F221G03 (MIL-C-5/18)
C 3	27512-0500	CAP FXD MICA 50 PF	00853	CM05E500G03 (MIL-C-5/18)
C 4	27512-9501	CAP FXD MICA 5 PFD	00853	CM05C050K03 (MIL-C-5/18)
L 1	3568-9561	INDUCTOR 5.6 UH	99800	1537-30
L 2	3568-9561	INDUCTOR 5.6 UH	99800	1537-30
L 3	3568-9561	INDUCTOR 5.6 UH	99800	1537-30
Q 1	900-3553	TSTR 2N3553	95303	2N3553
R 1	204-0222	RES FXD COMP 2.20 K	81349	RC07GF222J (MIL-R-11/8)
R 2	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 3	204-0202	RES FXD COMP 2.00 K	81349	RC07GF202J (MIL-R-11/8)
R 4	202-0100	RES FXD COMP 10 OHM	81349	RC32GF100J (MIL-R-11/6)

* * * * ASSEMBLY NO G44915-0001 X18 RF MULTI A4A1 * * * *

C 1	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 2	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 3	8914-9221	CAP FXD TA 2.2 MFD	01295	CS13BE225K (MIL-C-26655/2)
C 4	3324-9103	CAP FXD MYL .01 MFD	56289	192P10392
C 5	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 6	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 7	8918-0331	CAP FXD TA 330 MFD	05397	CS13BB337K (MIL-C-26655/2)
C 8	23969-0022	CAPACITOR .01 MFD	16509	TA.01

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
C 9	23969-0023	CAPACITOR 2.25 PFD	16509	TP25C
C 10	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 11	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 12	8914-9221	CAP FXD TA 2.2 MFD	01295	CS13BE225K (MIL-C-26655/2)
C 13	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 14	3324-9473	CAP FXD MYL .047 MFD	56289	192P47392
C 15	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 16	27512-0472	CAP FXD MICA 4700 PFD	00853	CM06F472G03 (MIL-C-5/18)
C 17	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 18	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 19	27512-0221	CAP FXD MICA 220 PFD	00853	CM05F221G03 (MIL-C-5/18)
C 20	27513-0562	CAP FXD MICA 5600 PFD	84171	DM-19-562
C 21	27512-0152	CAP FXD MICA 1500 PFD	00853	CM06F152G03 (MIL-C-5/18)
C 21	27512-0152	CAP FXD MICA 1500 PFD	00853	CM06F152G03 (MIL-C-5/18)
C 22	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 23	23969-0124	CAP .001	91418	SM-001
C 24	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 25	27512-0560	CAP FXD MICA 56 PFD	00853	CM05E560G03 (MIL-C-5/18)
C 26	27512-0301	CAP FXD MICA 300 PFD	00853	CM05E301G03 (MIL-C-5/18)
C 27	27512-0301	CAP FXD MICA 300 PFD	00853	CM05E301G03 (MIL-C-5/18)
C 28	27512-0560	CAP FXD MICA 56 PFD	00853	CM05E560G03 (MIL-C-5/18)
C 29	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 30	23969-0124	CAP .001	91418	SM-001
C 31	23969-0124	CAP .001	91418	SM-001
C 32	21485-9101	CAP FXD TA 1 MFD	05397	CS13BF105K (MIL-C-26655/2)
C 33	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 34	27512-0750	CAP FXD MICA 75 PFD	00853	CM05E750G03 (MIL-C-5/18)
C 35	27512-0181	CAP FXD MICA 180 PFD	00853	CM05F181G03 (MIL-C-5/18)
C 36	8914-0101	CAP FXD TA 100 MFD	01295	CS13BE107K (MIL-C-26655/2)
C 37	27512-0271	CAP FXD MICA 270 PFD	00853	CM05F271G03 (MIL-C-5/18)
C 38	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 39	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 40	23969-0124	CAP .001	91418	SM-001
C 41	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 42	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 43	3324-9473	CAP FXD MYL .047 MFD	56289	192P47392
C 44	23969-0022	CAPACITOR .01 MFD	16509	TA.01
J 1	23969-0034	CONNECTOR	98291	51-053-0119
J 2	23969-0034	CONNECTOR	98291	51-053-0119
J 3	23969-0034	CONNECTOR	98291	51-053-0119
J 4	23969-0034	CONNECTOR	98291	51-053-0119
L 1	3568-0150	INDUCTOR 15 UH	99800	1537-40
L 2	3422-0301	INDUCTOR 300 UH	99800	2500-02
L 3	3422-0301	INDUCTOR 300 UH	99800	2500-02
L 4	3568-0360	INDUCTOR 36.0 UH	99800	1537-54
L 5	G24921-0001	INDUCTOR VARIABLE	19397	G24921-0001
L 6	3422-0301	INDUCTOR 300 UH	99800	2500-02
L 7	3568-0360	INDUCTOR 36.0 UH	99800	1537-54
L 8	G24918-0001	INDUCTOR VARIABLE	19397	G24918-0001
L 9	G24919-0001	INDUCTOR VARIABLE	19397	G24919-0001
L 10	3568-9471	INDUCTOR 4.7UH	99800	1537-28
L 11	3568-9471	INDUCTOR 4.7UH	99800	1537-28
L 12	G24922-0001	INDUCTOR VARIABLE	19397	G24922-0001
L 13	3568-9471	INDUCTOR 4.7UH	99800	1537-28
L 14	3568-9471	INDUCTOR 4.7UH	99800	1537-28
L 15	3568-9471	INDUCTOR 4.7UH	99800	1537-28
L 16	3568-9471	INDUCTOR 4.7UH	99800	1537-28
L 17	G24920-0001	INDUCTOR VARIABLE	19397	G24920-0001
L 18	3568-9331	INDUCTOR 3X3 UH	99800	1537-24
L 19	3568-9471	INDUCTOR 4.7UH	99800	1537-28
Q 1	900-3904	TSTR 2N3904	04713	2N3904
Q 2	900-3904	TSTR 2N3904	04713	2N3904
Q 3	900-3906	TSTR 2N3906	01295	2N3906
Q 4	900-3904	TSTR 2N3904	04713	2N3904
Q 5	900-3904	TSTR 2N3904	04713	2N3904
Q 6	900-3904	TSTR 2N3904	04713	2N3904
Q 7	900-3906	TSTR 2N3906	01295	2N3906
Q 8	900-3904	TSTR 2N3904	04713	2N3904
Q 9	900-3906	TSTR 2N3906	01295	2N3906
Q 10	900-3904	TSTR 2N3904	04713	2N3904
Q 11	900-3904	TSTR 2N3904	04713	2N3904
Q 12	900-3906	TSTR 2N3906	01295	2N3906
Q 13	900-3904	TSTR 2N3904	04713	2N3904
R 2	204-0473	RES FXD COMP 47.0 K	81349	RC07GF473J (MIL-R-11/8)
R 3	204-0154	RES FXD COMP 150. K	81349	RC07GF154J (MIL-R-11/8)
R 4	204-0393	RES FXD COMP 39.0 K	81349	RC07GF393J (MIL-R-11/8)
R 5	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 6	204-0122	RES FXD COMP 1.20 K	81349	RC07GF122J (MIL-R-11/8)

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
R 7	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 8	204-0560	RES FXD COMP 56 OHM	81349	RC07GF560J (MIL-R-11/8)
R 9	204-0104	RES FXD COMP 100. K	81349	RC07GF104J (MIL-R-11/8)
R 10	204-0104	RES FXD COMP 100. K	81349	RC07GF104J (MIL-R-11/8)
R 11	23969-0065	RESISTOR VAR	80294	3009Y-1-103
R 12	204-0473	RES FXD COMP 47.0 K	81349	RC07GF473J (MIL-R-11/8)
R 13	204-0563	RES FXD COMP 56.0 K	81349	RC07GF563J (MIL-R-11/8)
R 14	204-0124	RES FXD COMP 120. K	81349	RC07GF124J (MIL-R-11/8)
R 15	204-0273	RES FXD COMP 27.0 K	81349	RC07GF273J (MIL-R-11/8)
R 16	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 17	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 18	204-0332	RES FXD COMP 3.30 K	81349	RC07GF332J (MIL-R-11/8)
R 19	204-0181	RES FXD COMP 180 OHM	81349	RC07GF181J (MIL-R-11/8)
R 20	204-0181	RES FXD COMP 180 OHM	81349	RC07GF181J (MIL-R-11/8)
R 21	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 22	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 23	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 24	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 25	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 26	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 27	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 28	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 29	204-0153	RES FXD COMP 15.0 K	81349	RC07GF153J (MIL-R-11/8)
R 30	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 31	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 32	204-0562	RES FXD COMP 5.60 K	81349	RC07GF562J (MIL-R-11/8)
R 35	23969-0092	RESISTOR VAR	80294	3009Y-1-201
R 36	204-0390	RES FXD COMP 39 OHM	81349	RC07GF390J (MIL-R-11/8)
R 37	204-0224	RES FXD COMP 220. K	81349	RC07GF224J (MIL-R-11/8)
R 38	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 39	23969-0065	RESISTOR VAR	80294	3009Y-1-103
R 40	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 41	204-0201	RES FXD COMP 200 OHM	81349	RC07GF201J (MIL-R-11/8)
R 42	204-0150	RES FXD COMP 15.0 OHM	81349	RC07GF150J (MIL-R-11/8)
CR 1	801-0749	DIODE 1N749A	04713	1N749A
CR 2	23969-0046	DIODE	01281	V56E
CR 3	800-0914	DIODE 1N914	01295	1N914
CR 4	800-0914	DIODE 1N914	01295	1N914
CR 5	800-0914	DIODE 1N914	01295	1N914

* * * * ASSEMBLY NO G44925-0001 OSC REG &START A8A1 * * * *

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
C 1	23969-0006	CAPACITOR .1 MFD	02777	1M4104
C 2	21485-0220	CAP FXD TA 22 MFD	05397	CS13BF226K (MIL-C-26655/2)
C 3	23969-0022	CAPACITOR .01 MFD	16509	TA.01
C 4	23969-0022	CAPACITOR .01 MFD	16509	TA.01
K 1	23969-0062	RELAY	77342	SC11DC
Q 1	900-1711	TSTR 2N1711	04713	2N1711
Q 2	900-2270	TSTR 2N2270	01295	2N2270
Q 3	900-3904	TSTR 2N3904	04713	2N3904
R 1	204-0104	RES FXD COMP 100. K	81349	RC07GF104J (MIL-R-11/8)
R 2	204-0206	RES FXD COMP 20.0 MEG	81349	RC07GF206J (MIL-R-11/8)
R 3	204-0100	RES FXD COMP 10.0 OHM	81349	RC07GF100J (MIL-R-11/8)
R 4	204-0272	RES FXD COMP 2.70 K	81349	RC07GF272J (MIL-R-11/8)
R 5	201-0471	RES FXD COMP 470. OHM	81349	RC20GF471J (MIL-R-11/3)
R 6	204-0331	RES FXD COMP 330 OHM	81349	RC07GF331J (MIL-R-11/8)
R 7	4504-0102	RES VAR CERMET 1 K	73138	77PR1 K
R 8	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
CR 1	800-0914	DIODE 1N914	01295	1N914
CR 2	800-0914	DIODE 1N914	01295	1N914
CR 3	801-0751	DIODE 1N751A	01281	1N751A

* * * * ASSEMBLY NO G44937-0001 DISTRIBUTION BRD A5A1 * * * *

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
15	204-0510	RES FXD COMP 51 OHM	81349	RC07GF510J (MIL-R-11/8)
C 1	3403-9253	CAP FXD CER .025 UF	80183	TG-S25
C 2	3403-9253	CAP FXD CER .025 UF	80183	TG-S25
C 3	3923-0035	CAP VAR CER MINAT	73899	DV11PS350
C 4	27512-0121	CAP FXD MICA 120 PFD	00853	CM05F121G03 (MIL-C-5/18)
C 5	23969-0019	CAPACITOR	00656	MC80V103AM
C 6	3403-9253	CAP FXD CER .025 UF	80183	TG-S25
C 7	23969-0019	CAPACITOR	00656	MC80V103AM
C 8	27512-0121	CAP FXD MICA 120 PFD	00853	CM05F121G03 (MIL-C-5/18)
C 9	27512-0471	CAP FXD MICA 470 PFD	00853	CM06F471G03 (MIL-C-5/18)
C 10	3403-9253	CAP FXD CER .025 UF	80183	TG-S25
C 11	23969-0019	CAPACITOR	00656	MC80V103AM

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
C 12	23969-0019	CAPACITOR	00656	MC80V103AM
C 13	23969-0019	CAPACITOR	00656	MC80V103AM
C 14	23969-0019	CAPACITOR	00656	MC80V103AM
C 15	27512-0471	CAP FXD MICA 470 PFD	00853	CM06F471G03 (MIL-C-5/18)
C 16	27512-0471	CAP FXD MICA 470 PFD	00853	CM06F471G03 (MIL-C-5/18)
C 17	3403-9253	CAP FXD CER .025 UF	80183	TG-S25
C 18	27512-0431	CAP FXD MICA 430 PFD	84171	CM06F431G03 (MIL-C-5/18)
C 19	3403-9253	CAP FXD CER .025 UF	80183	TG-S25
C 20	3403-9253	CAP FXD CER .025 UF	80183	TG-S25
C 21	27512-0511	CAP FXD MICA 510 PFD	84171	CM06F511G03 (MIL-C-5/18)
C 22	3403-9253	CAP FXD CER .025 UF	80183	TG-S25
C 23	27512-0431	CAP FXD MICA 430 PFD	84171	CM06F431G03 (MIL-C-5/18)
C 24	3403-9253	CAP FXD CER .025 UF	80183	TG-S25
C 25	27512-0511	CAP FXD MICA 510 PFD	84171	CM06F511G03 (MIL-C-5/18)
C 28	8914-0100	CAP FXD TA 10 MFD	01295	CS13BE106K (MIL-C-26655/2)
J 1	23969-0034	CONNECTOR	98291	51-053-0119
J 2	23969-0034	CONNECTOR	98291	51-053-0119
J 3	23969-0034	CONNECTOR	98291	51-053-0119
J 4	23969-0034	CONNECTOR	98291	51-053-0119
J 5	23969-0034	CONNECTOR	98291	51-053-0119
J 6	23969-0034	CONNECTOR	98291	51-053-0119
J 7	23969-0034	CONNECTOR	98291	51-053-0119
L 1	3568-9561	INDUCTOR 5.6 UH	99800	1537-30
L 2	3568-0560	INDUCTOR 56 UH	99800	1537-64
L 3	3568-0560	INDUCTOR 56 UH	99800	1537-64
Q 1	900-2221	TSTR 2N2221	04713	2N2221
Q 2	900-3904	TSTR 2N3904	04713	2N3904
Q 3	900-3904	TSTR 2N3904	04713	2N3904
Q 4	900-3904	TSTR 2N3904	04713	2N3904
Q 5	900-3904	TSTR 2N3904	04713	2N3904
Q 6	900-3904	TSTR 2N3904	04713	2N3904
Q 7	900-3904	TSTR 2N3904	04713	2N3904
Q 9	900-2218	TSTR 2N2218	04713	2N2218
Q 10	900-2218	TSTR 2N2218	04713	2N2218
R 1	204-0100	RES FXD COMP 10.0 OHM	81349	RC07GF100J (MIL-R-11/8)
R 2	23969-0064	RESISTOR VAR	80294	3009Y-1-501
R 3	204-0473	RES FXD COMP 47.0 K	81349	RC07GF473J (MIL-R-11/8)
R 4	204-0472	RES FXD COMP 4.70 K	81349	RC07GF472J (MIL-R-11/8)
R 5	204-0510	RES FXD COMP 51 OHM	81349	RC07GF510J (MIL-R-11/8)
R 6	204-0201	RES FXD COMP 200 OHM	81349	RC07GF201J (MIL-R-11/8)
R 7	204-0100	RES FXD COMP 10.0 OHM	81349	RC07GF100J (MIL-R-11/8)
R 8	204-0000	RESISTOR SELECTED	19397	204-0000
R 9	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 10	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 11	204-0100	RES FXD COMP 10.0 OHM	81349	RC07GF100J (MIL-R-11/8)
R 12	204-0201	RES FXD COMP 200 OHM	81349	RC07GF201J (MIL-R-11/8)
R 13	204-0222	RES FXD COMP 2.20 K	81349	RC07GF222J (MIL-R-11/8)
R 14	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 16	204-0151	RES FXD COMP 150. OHM	81349	RC07GF151J (MIL-R-11/8)
R 17	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 18	204-0151	RES FXD COMP 150. OHM	81349	RC07GF151J (MIL-R-11/8)
R 19	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 20	204-0151	RES FXD COMP 150. OHM	81349	RC07GF151J (MIL-R-11/8)
R 21	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 22	204-0151	RES FXD COMP 150. OHM	81349	RC07GF151J (MIL-R-11/8)
R 23	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 24	204-0151	RES FXD COMP 150. OHM	81349	RC07GF151J (MIL-R-11/8)
R 25	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 26	204-0151	RES FXD COMP 150. OHM	81349	RC07GF151J (MIL-R-11/8)
R 27	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 28	204-0431	RES FXD COMP 430 OHM	81349	RC07GF431J (MIL-R-11/8)
R 29	204-0302	RES FXD COMP 3.0 K	81349	RC07GF302J (MIL-R-11/8)
R 30	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 31	204-0431	RES FXD COMP 430 OHM	81349	RC07GF431J (MIL-R-11/8)
R 32	204-0302	RES FXD COMP 3.0 K	81349	RC07GF302J (MIL-R-11/8)
R 33	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 34	204-0430	RES FXD COMP 43 OHM	81349	RC07GF430J (MIL-R-11/8)
R 35	204-0100	RES FXD COMP 10.0 OHM	81349	RC07GF100J (MIL-R-11/8)
R 36	204-0430	RES FXD COMP 43 OHM	81349	RC07GF430J (MIL-R-11/8)
R 37	204-0100	RES FXD COMP 10.0 OHM	81349	RC07GF100J (MIL-R-11/8)
R 38	204-0100	RES FXD COMP 10.0 OHM	81349	RC07GF100J (MIL-R-11/8)
R 39	204-0100	RES FXD COMP 10.0 OHM	81349	RC07GF100J (MIL-R-11/8)
R 40	204-0104	RES FXD COMP 100. K	81349	RC07GF104J (MIL-R-11/8)
R 41	204-0100	RES FXD COMP 10.0 OHM	81349	RC07GF100J (MIL-R-11/8)
R 42	204-0100	RES FXD COMP 10.0 OHM	81349	RC07GF100J (MIL-R-11/8)
R 43	204-0472	RES FXD COMP 4.70 K	81349	RC07GF472J (MIL-R-11/8)
T 1	G25037-0001	TRANSFORMER	19397	G25037-0001
T 2	G25038-0001	TRANSFORMER	19397	G25038-0001

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
* * *	* ASSEMBLY NO G44980-0001	X18 MULTIPLIER ASSYA4 * * * *		
	G44915-0001	X18 RF MULTI A4A1	19397	G44915-0001
C 45	23969-0004	CAPACITOR FEED-THRU	72982	2499-003-X5S0-152M
TP 4	23969-0085	TIE POINT	71279	1039-01-05
* * *	* ASSEMBLY NO G44981-0001	DISTRIBUTION ASSY A5 * * * *		
	G34943-0001	FRAME DIST.	19397	G34943-0001
	G44937-0001	DISTRIBUTION BRD A5A1	19397	G44937-0001
C 26	23969-0004	CAPACITOR FEED-THRU	72982	2499-003-X5S0-152M
C 27	23969-0004	CAPACITOR FEED-THRU	72982	2499-003-X5S0-152M
* * *	* ASSEMBLY NO G44984-0001	SYNTHESIZER ASSY A6 * * * *		
	G35052-0001	FRAME	19397	G35052-0001
	G44901-0001	SYNT.COMP BRD A6A1	19397	G44901-0001
C 37	23969-0004	CAPACITOR FEED-THRU	72982	2499-003-X5S0-152M
C 38	23969-0004	CAPACITOR FEED-THRU	72982	2499-003-X5S0-152M
C 39	23969-0004	CAPACITOR FEED-THRU	72982	2499-003-X5S0-152M
S 1	3640-0104	SWITCH TOGGLE SPDT	09353	7101
S 2	3640-0104	SWITCH TOGGLE SPDT	09353	7101
S 3	3640-0104	SWITCH TOGGLE SPDT	09353	7101
S 4	3640-0104	SWITCH TOGGLE SPDT	09353	7101
S 5	3640-0104	SWITCH TOGGLE SPDT	09353	7101
S 6	3640-0104	SWITCH TOGGLE SPDT	09353	7101
S 7	3640-0104	SWITCH TOGGLE SPDT	09353	7101
S 8	3640-0104	SWITCH TOGGLE SPDT	09353	7101
S 9	3640-0104	SWITCH TOGGLE SPDT	09353	7101
S 10	3640-0104	SWITCH TOGGLE SPDT	09353	7101
* * *	* ASSEMBLY NO G44991-0001	SUB PANEL ASSY A11 * * * *		
	G45154-0001	BRACKET ASSY	19397	G45154-0001
M 1	G14996-0001	METER	19397	G14996-0001
R 1	23969-0067	RESISTOR VAR 200 OHM	80294	3507S-201
R 2	23969-0068	RESISTOR VAR 1 K	80294	3507S-102
S 1	23969-0079	SWITCH TOGGLE	81073	42036-02-1-ADJN
S 2	3640-0104	SWITCH TOGGLE SPDT	09353	7101
S 3	3573-0001	SWITCH PUSHBUTTON NO	81073	30-1
* * *	* ASSEMBLY NO G44999-0001	LAMP HTR PCB A13A1A3 * * * *		
C 1	23969-0116	CAP FXD TA 15MFD 35V	56289	150D156X0035R2
Q 1	900-4921	TSTR 2N4921	04713	2N4921
Q 2	900-4921	TSTR 2N4921	04713	2N4921
R 1	4403-5111	RES FXD FILM 5.11 K	81349	RNR60C5111FS (MIL-R-55182/30)
R 2	23969-0091	RESISTOR VAR	80294	3280L-1-501
R 3	4403-5111	RES FXD FILM 5.11 K	81349	RNR60C5111FS (MIL-R-55182/30)
R 4	4403-2941	RES FXD FILM 2.94 K	81349	RNR60C2941FS (MIL-R-55182/30)
R 5	204-0155	RES FXD COMP 1.5 MEG	81349	RC07GF155J (MIL-R-11/8)
R 6	4403-5111	RES FXD FILM 5.11 K	81349	RNR60C5111FS (MIL-R-55182/30)
R 7	4403-3923	RES FXD FILM 392 K	81349	RNR60C3923FS (MIL-R-55182/30)
U 1	23969-0002	AMPLIFIER	07263	U5B7741312
* * *	* ASSEMBLY NO G45055-0001	LOOP FILTER ASSY A9 * * * *		
C 2	23969-0007	CAPACITOR 10 MFD	12517	1PG106J
C 3	23969-0007	CAPACITOR 10 MFD	12517	1PG106J
C 4	21485-0100	CAP FXD TA 10 MFD	05397	CS13HF106K (MIL-C-26655/2D)
C 5	23969-0008	CAPACITOR 17 MFD	73445	C281CD/A100K
Q 1	900-4937	TSTR 2N4937	04713	2N4937
Q 2	900-3904	TSTR 2N3904	04713	2N3904
R 1	4403-1002	RES FXD FILM 10.0 K	81349	RNR60C1002FS (MIL-R-55182/30)
R 2	4403-1002	RES FXD FILM 10.0 K	81349	RNR60C1002FS (MIL-R-55182/30)
R 3	4403-1503	RES FXD FILM 150 K	81349	RNR60C1503FS (MIL-R-55182/30)
R 4	4403-1503	RES FXD FILM 150 K	81349	RNR60C1503FS (MIL-R-55182/30)
R 5	4403-1503	RES FXD FILM 150 K	81349	RNR60C1503FS (MIL-R-55182/30)
R 7	4403-1009	RES FXD FILM 10 OHM	81349	RNR60C1009FS (MIL-R-55182/30)
R 8	4403-3010	RES FXD FILM 301 OHM	81349	RNR60C3010FS (MIL-R-55182/30)
R 9	4403-5110	RES FXD FILM 511 OHM	81349	RNR60C5110FS (MIL-R-55182/30)
R 10	4403-1001	RES FXD FILM 1.00 K	81349	RNR60C1001FS (MIL-R-55182/30)

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
R 40	204-0202	RES FXD COMP 2.00 K	81349	RCU7GF202J (MIL-R-11/8)
U 1	23408-0001	INT CKT QUAD 2-INPUT	01295	SN7400N
U 2	23408-0001	INT CKT QUAD 2-INPUT	01295	SN7400N
CR 1	801-0749	DIODE 1N749A	04713	1N749A
CR 2	802-0966	DIODE 1N966B	04713	1N966B
CR 3	800-0277	DIODE 1N277	93332	1N277
CR 4	800-0914	DIODE 1N914	01295	1N914
CR 5	800-0914	DIODE 1N914	01295	1N914
CR 6	800-0914	DIODE 1N914	01295	1N914
CR 7	800-0914	DIODE 1N914	01295	1N914
CR 8	800-0277	DIODE 1N277	93332	1N277
CR 9	800-0914	DIODE 1N914	01295	1N914
* * * * ASSEMBLY NO G45075-0001 AUDIO & OSC A7A8 * * * *				
	G45076-0001	AUDIO ASSY	19397	G45076-0001
	G45085-0001	OSC REG & START	19397	G45085-0001
* * * * ASSEMBLY NO G45076-0001 AUDIO ASSY * * * *				
	G35077-0001	FRAME AUDIO	19397	G35077-0001
	G44896-0001	AUDIO BOARD A7A1	19397	G44896-0001
C 31	23969-0004	CAPACITOR FEED-THRU	72982	2499-003-X5S0-152M
C 34	23969-0004	CAPACITOR FEED-THRU	72982	2499-003-X5S0-152M
J 1	23969-0035	CONNECTOR	98291	51-043-0000
J 2	23969-0035	CONNECTOR	98291	51-043-0000
J 4	23969-0035	CONNECTOR	98291	51-043-0000
J 5	23969-0035	CONNECTOR	98291	51-043-0000
* * * * ASSEMBLY NO G45078-0001 LAMP ASSY OMU A13A1 * * * *				
A 1	G45079-0001	REFLECTOR ASSY	19397	G45079-0001
A 2	G44906-0001	BRD LMP OSC A13A1A2	19397	G44906-0001
A 3	G44999-0001	LAMP HTR PCB A13A1A3	19397	G44999-0001
C 1	23969-0004	CAPACITOR FEED-THRU	72982	2499-003-X5S0-152M
E 1	23969-0081	TERMINAL	83330	73-1001
J 1	23969-0035	CONNECTOR	98291	51-043-0000
T 1	G34426-0001	XMFR LAMP STARTER	19397	G34426-0001
DS 1	G32770-0001	RUBIDIUM LAMP ASSY	19397	G32770-0001
* * * * ASSEMBLY NO G45079-0001 REFLECTOR ASSY * * * *				
HR 1	23969-0098	WIRE RES OGC 32 AWG	T0009	10.16 OHM/FT NOM HI-TEMP BNDR
RT 1	23969-0086	THERMISTER 50K	19397	GA45P1
* * * * ASSEMBLY NO G45084-0001 OMU ASSY A13 * * * *				
	G15245-0008	CABLE ASSY	19397	G15245-0008
	G15245-0009	CABLE ASSY	19397	G15245-0009
	G15245-0047	CABLE ASSY	19397	G15245-0047
	G24192-0001	FILTER CELL ASSY	19397	G24192-0001
	G24193-0001	GAS CELL ASSY	19397	G24193-0001
	G34251-0001	SOLAR CELL ASSY	19397	G34251-0001
	G34974-0001	END CAP OUTER HOUSING	19397	G34974-0001
	G35101-0001	SRD ASSY A13A3	19397	G35101-0001
	G45087-0001	CAVITY HTR PCB A13A2	19397	G45087-0001
	G45189-0001	INNER CAVITY FOAMED	19397	G45189-0001
L 1	G44341-0001	CAVITY ASSY	19397	G44341-0001
RT 1	G34340-0001	THERMISTOR ASSY	19397	G34340-0001
A13 A1	G45078-0001	LAMP ASSY OMU A13A1	19397	G45078-0001
* * * * ASSEMBLY NO G45085-0001 OSC REG & START * * * *				
	G24934-0001	FRAME	19397	G24934-0001
	G44925-0001	OSC REG &START A8A1	19397	G44925-0001
J 1	23969-0035	CONNECTOR	98291	51-043-0000
J 2	23969-0035	CONNECTOR	98291	51-043-0000
J 3	23969-0037	CONNECTOR	98291	51-046-0000
TP 1	23969-0084	TEST POINT	98291	SKT-0804

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
R 1	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 2	4504-0202	RES VAR CERMET 2 K	73138	77PR2 K
R 3	204-0470	RES FXD COMP 47.0 OHM	81349	RC07GF470J (MIL-R-11/8)
R 4	204-0152	RES FXD COMP 1.50 K	81349	RC07GF152J (MIL-R-11/8)
R 5	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 6	204-0331	RES FXD COMP 330 OHM	81349	RC07GF331J (MIL-R-11/8)
R 7	204-0331	RES FXD COMP 330 OHM	81349	RC07GF331J (MIL-R-11/8)
R 8	204-0220	RES FXD COMP 22 OHM	81349	RC07GF220J (MIL-R-11/8)
R 9	204-0220	RES FXD COMP 22 OHM	81349	RC07GF220J (MIL-R-11/8)
R 10	204-0151	RES FXD COMP 150. OHM	81349	RC07GF151J (MIL-R-11/8)
R 11	204-0331	RES FXD COMP 330 OHM	81349	RC07GF331J (MIL-R-11/8)
R 12	204-0331	RES FXD COMP 330 OHM	81349	RC07GF331J (MIL-R-11/8)
R 13	204-0332	RES FXD COMP 3.30 K	81349	RC07GF332J (MIL-R-11/8)
R 14	204-0105	RES FXD COMP 1.00 MEG	81349	RC07GF105J (MIL-R-11/8)
R 15	204-0105	RES FXD COMP 1.00 MEG	81349	RC07GF105J (MIL-R-11/8)
R 16	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 17	204-0472	RES FXD COMP 4.70 K	81349	RC07GF472J (MIL-R-11/8)
R 18	204-0472	RES FXD COMP 4.70 K	81349	RC07GF472J (MIL-R-11/8)
R 19	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 20	204-0681	RES FXD COMP 680. OHM	81349	RC07GF681J (MIL-R-11/8)
R 21	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 22	204-0223	RES FXD COMP 22.0 K	81349	RC07GF223J (MIL-R-11/8)
R 23	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 24	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 25	204-0104	RES FXD COMP 100. K	81349	RC07GF104J (MIL-R-11/8)
R 26	204-0104	RES FXD COMP 100. K	81349	RC07GF104J (MIL-R-11/8)
R 27	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 28	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 29	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 30	204-0100	RES FXD COMP 10.0 OHM	81349	RC07GF100J (MIL-R-11/8)
T 1	S28598-0001	XFMR	19397	S28598-0001
T 2	S28729-0001	XFMR	19397	S28729-0001
T 3	S28600-0001	TRANSFORMER 8-10A	19397	S28600-0001
U 1	23408-0001	INT CKT QUAD 2-INPUT	01295	SN7400N
U 2	23425-0001	INT CKT DUAL J-K	01295	SN7473N
U 3	3938-0015	INTEGRATED CIRCUIT	01295	SN7490N
U 4	23425-0001	INT CKT DUAL J-K	01295	SN7473N
Y 1	23969-0618	CRYSTAL 3.58 MHZ	74306	6020403
Y 2	23969-0618	CRYSTAL 3.58 MHZ	74306	6020403
Y 3	23969-0618	CRYSTAL 3.58 MHZ	74306	6020403
XY 1	3631-0001	HOLDER CRYSTAL	91506	8000-DG1
XY 2	3631-0001	HOLDER CRYSTAL	91506	8000-DG1
XY 3	3631-0001	HOLDER CRYSTAL	91506	8000-DG1

* * * * ASSEMBLY NO G45356-0001 3.58 MHZ SYNTH ASSY * * * *

	G45349-0001	3.58 MHZ SYNTH PCB AS	19397	G45349-0001
C 28	23969-0004	CAPACITOR FEED-THRU	72982	2499-003-X5S0-152M
C 29	23969-0004	CAPACITOR FEED-THRU	72982	2499-003-X5S0-152M

* * * * ASSEMBLY NO 18333-0001 RUBIDUM STND A1 * * * *

	G15286-0001	ACCESSORY KIT	19397	G15286-0001
	G34961-0001	SUPPORT SHORT	19397	G34961-0001
	G35060-0001	SUPPORT LONG	19397	G35060-0001
	G65243-0001	HARNESS ASSY	19397	G65243-0001
A 2	G44964-0001	POWER SUPPLY	19397	G44964-0001
A 4	G44980-0001	X18 MULTIPLIER ASSYA4	19397	G44980-0001
A 5	G44981-0001	DISTRIBUTION ASSY A5	19397	G44981-0001
A 6	G44984-0001	SYNETHESIZER ASSY A6	19397	G44984-0001
A 7	G45075-0001	AUDIO & OSC A7A8	19397	G45075-0001
A 8	G45075-0001	AUDIO & OSC A7A8	19397	G45075-0001
A 9	G45055-0001	LOOP FILTER ASSY A9	19397	G45055-0001
A 10	G45068-0001	LOGIC CIRCUIT A10	19397	G45068-0001
A 11	G44991-0001	SUB PANEL ASSY A11	19397	G44991-0001
A 13	G45084-0001	OMU ASSY A13	19397	G45084-0001
A 14	G35161-0001	OSCILLATOR	19397	G35161-0001
A 17	G45356-0001	3.58MHZ SYNTHESIZER ASSY A17	19397	G45356-0001
A 18	18456-0001	PHASE SHIFTER ASSYA18	19397	18456-0001
J141	23969-0038	CONNECTOR	98291	51-075-0000

* * * * ASSEMBLY NO G65243-0001 HARNESS ASSY * * * *

	G15245-0004	CABLE ASSY	19397	G15245-0004

TABLE 6-2. FEDERAL SUPPLY CODES FOR MANUFACTURERS

CODE NO.	MANUFACTURER	ADDRESS
T0002	LANSDALE TRANSISTOR CORP.	LANSDALE PA
T0003	PAMOTOR INC - CANCELED - SEE 23936	
T0004	PATEK PHILIPPE	GENEVA SWITZERLAND
T0005	RUSSELL INDUSTRIES INC - CANCELED - SEE 24324	
T0006	TRINITY CAPACITOR CO - CANCELED - SEE 27342	
T0007	SIEMENS AMERICA INC - CANCELED - SEE 25088	
T0008	SOUTHWEST ELECTRONICS INC	HOUSTON TEX
T0009	MOLECU-WIRE CORP.	SCOBEYVILLE ILL
T0010	PACTRA CHEMICAL CO INC	LOS ANGELES CALIFORNIA
T0011	EPCO	FLINT MICH
T0012	DABURN ELECTRONICS AND CABLE CORPORATION	NEW YORK N Y
T0013	GRAYSON-STADLER	WEST CONCORD MASS
T0014	PEERLESS IMPERIAL CO	NEWARK N J
T0015	GENERAL PACKAGING CORP	DALLAS TEX
T0016	A-1 PLASTICS	DALLAS TEX
T0017	I SQUARE R ELEMENT CO	TONAWANDA N Y
T0018	SHAEVITZ ENGINEERING CO	CAMDEN N J
T0019	ACCEL ELECTRONIC PRODUCTS	SOUTH SAN GABRIEL CALIF
T0020	VICTOR WIRE AND CABLE CO	LOS ANGELES CALIF
T0021	UNIFORM TUBES INC	COLLEGEVILLE P A
T0022	LONE STAR PAPER CO	AUSTIN TEX
T0023	NATIONWIDE PAPERS	AUSTIN TEX
T0024	RADIOEAR CORP.	CANONSBURG PENN
T0025	RING CHEMICAL CO	HOUSTON TEXAS
T0026	TACONIC PLASTICS	PETERSBURG N Y
T0027	ORGANIC PRODUCTS CO - CANCELED - SEE 01195	
T0028	AVCO CORP - CANCELED - SEE 04614	
T0029	APPLIED RESEARCH ASSOC	AUSTIN TEX
T0030	SENNHEISER ELECTRONIC CORP	NEW YORK N Y
T0031	PRECISION SAMPLING CORP	BATON ROUGE LA
T0032	KURTZ INC	HOUSTON TEX
T0033	T AND T CONTROLS CO.	MEDIA PENN
T0034	HOUSTON OMNIGRAPHIC CORP - CANCELED - SEE 27536	
T0035	NUCLEONICS PRODUCTS INC - CANCELED - SEE 08257	
T0036	NEW YORK GLASS	NEW YORK NY
T0037	MULTICORE SALES CORP - CANCELED - SEE 03051	
T0038	DELTA-CHICAGO, INC.	FRANKLIN PARK ILL
T0039	BOSCO BOLT NUT AND SCREW CO	HOUSTON TEX
T0040	ELECTRO-MECHANISMS INC.	MONROVIA CALIF
T0041	AMERICAN WIRE AND CABLE CO	CLEVELAND OHIO
T0042	MAY ALUMINUM CO.	HOUSTON TEX
T0043	ULBRICH STAINLESS STEEL AND SPECIAL METALS	WALLINGFORD CONN
T0044	WA-CHING-ALBANY	ALBANY ORE
T0045	SUMERS FINSTRIP INC.	WATERBURY CONN
T0046	CLAD-REX DIV OF DELTA CHICAGO INC.	FRANKLIN PARK ILL
T0047	COLUMBUS COATED FABRICS CO - CANCELED - SEE 71584	
T0048	STERLING PLASTICS CO	MOUNTAINSIDE N J
T0049	BISHOP IND CORP	HOLLYWOOD CALIF
T0050	POLYSPEDE ELECTRIC CORP	DALLAS TEX
T0051	GILLETE INDUSTRIES	DALLAS TEX
T0052	AIC CORP	HOUSTON TEX
T0053	RAILWAY EXPRESS AGENCY	AUSTIN TEX
T0054	DANCOR CORP	PLANO TEX
T0055	HOFMAN DIV OF MINNESOTA VALLEY ENGINEERING INC	NEW PRAGUE MINN
T0056	MICRO BALLISTICS ASSOC	SAN RAMON CALIF
T0057	HAHN SALES CO	BATON ROUGE LA
T0058	BUSACKER/HAMILTON ELECTRO CORP.	HOUSTON TEX
T0059	WRIGHT LIGHT INC	HOUSTON TEX
T0060	K AND L DISTRIBUTING CO INC	DALLAS TEX
T0061	VALCO INSTRUMENTS	HOUSTON TEX
T0061	NUCLEAR EQUIPMENT CHEMICAL COMPANY	FARMINGDALE NY
T0062	WENDELL'S	MINNEAPOLIS MINN
T0063	MCCARTY CORP, THE	BATON ROUGE LA
T0064	SWANSON ASSOC	WAYNE NJ
T0065	ANALABS INC	NORTH HAVEN CONN
T0066	TUBESALES	LOS ANGELES CALIF
T0067	HENRY MANN INC	CORNWELLS HTS PA
T0068	HOCKER H W CO INC	LEWES DEL
T0069	CONEX DIV OF ILLINOIS TOOL WORKS	DES PLAINES ILL
T0070	ESTES EB AND SON	NEW YORK NY
T0071	STP CORP	DES PLAINS ILL
T0072	THREADLINE FASTENER CORP	COVINA CALIF
T0073	PENN RARE METALS INC	NEW YORK NY
T0074	CAMIE CO INC	ST LOUIS MO
T0075	QUARTZ SCIENTIFIC INC	PALO ALTO CALIF
T0076	CANTON BIO-MEDICAL PRODUCTS, INC.	SWATHMORE PENN

TABLE 6-2. (Continued)

CODE NO.	MANUFACTURER	ADDRESS
03051	MULTICORE SALES CORP.	WESTBURY NY
03058	AVIATION INDUSTRIES CORP	HILLSIDE N J
03171	ELECTRONIC PRODUCTION AND DEVELOPMENT INC	HAWTHORNE CALIF
03296	NYLON MOLDING CORP	SPRINGFIELD N J
03481	GOODRICH B F CO AEROSPACE AND DEFENSE PRODUCTS DIVISION	AKRON OHIO
03506	GENERAL ELECTRIC SEMICONDUCTOR PRODUCTS	SYRACUSE N Y
03550	VANGUARD ELECTRONICS CO	INGLEWOOD CALIF
03688	CONAX CORP	BUFFALO NY
03743	APPLETON ELECTRIC	CHICAGO ILL
03756	APPLIED RESEARCH LABORATORIES	GLENDALE CALIF
03765	AUTOMATIC COIL CO	MINEOLA N Y
03797	ELDEMA CORP	COMPTON CALIF
03843	TAGLIABUE DIVISION OF MARSHALLTOWN MFG INC	MARSHALLTOWN IOWA
03877	TRANSITRON ELECTRONIC CORP	WAKEFIELD MASS
03878	SIGNAL MFGR COMPANY	SALEM MASS
03888	PYROFILM RESISTOR CO INC	CEDAR KNOLLS NJ
03890	MARKEL,L FRANK AND SONS	NORRISTOWN PA
03911	CLAIREX CORP	NEW YORK N Y
03945	WHITE INSTRUMENT LABORATORIES	AUSTIN TEX
03984	GENERAL ELECTRIC CO SEMICONDUCTOR PRODUCTS - USE CODE NO 09214	
04009	ARROW-HART AND HEGEMAN ELECTRIC CO	HARTFORD CONN
04013	TAURUS CORP-FORMERLY METRON INC	LAMBERTVILLE N J
04013	METRON INC-NOW TAURUS CORP	LAMBERTVILLE N J
04099	CAP CAPACITORS INC	LUBBOCK TEX
04099	CAPCO - SEE CAP CAPACITORS INC	
04136	THE HOMALITE CORP	WILMINGTON DEL
04151	MONCRIEFF CO	BURBANK CALIF
04239	GENERAL ELECTRIC CO METTALLURGICAL PRODUCTS DEPT	EDMORE MICH
04264	CIRCON COMPONENT CORP	GOLETA CALIF
04298	ELGIN NATIONAL WATCH CO ELECTRONICS DIV	BURBANK CALIF
04314	GENERAL ELECTRIC CO APPLIANCE CONTROL DEPT	BRIDGEPORT CONN
04347	HYSOL CORP	OLEAN N Y
04426	LICON SWITCH & CONTROL DIV OF ILLINOIS TOOL WORKS	CHICAGO ILL
04552	EMERSON AND CUMING INC	CANTON MASS
04614	AVCO MISSILE SYSTEMS DIV OF AVCO CORP.	WILMINGTON MASS
04618	AMERICAN PAMCOR INC (API)	PAOLI PA
04618	API (AMERICAN PAMCOR INC)	PAOLI PA
04620	RAYCO ELECTRONICS MFG INC	LOS ANGELES CALIF
04713	MOTOROLA SEMICONDUCTOR PRODUCTS INC	PHOENIX ARIZ
04773	AUTOMATIC ELECTRIC CO	NORTHLAKE ILL
04814	CHATHAM CONTROLS CORP	CHATHAM N J
04820	HERMETIC SEAL CORP	ROSE MEAD CALIF
05010	THERMISTOR- SEE GULTON INDUSTRIES	DANBURY CONN
05010	GULTON INDUSTRIES INC INSTRUMENTATION PRODUCTS DIV	METUCHEN N J
05041	MASTERITE INDUSTRIES INC	INGLEWOOD CALIF
05236	JONATHAN MFG CO	FULLERTON CALIF
05245	COMPONENTS CORP	CHICAGO ILL
05255	PENNSYLVANIA PERLITE CORP	ALLENTOWN PA
05276	POMONA ELECTRONICS CO INC	POMONA CALIF
05277	WESTINGHOUSE ELECTRIC CORP SEMI-CONDUCTOR DEPARTMENT	YOUNGWOOD PA
05301	ENGELHARD INDUSTRIES INC	NEWARK N J
05397	UNION CARBIDE CORP ELECTRONICS DIV	CLEVELAND OHIO
05397	KEMET CO - SEE UNION CARBIDE CORP ELECTRONICS DIV	
05442	FARRELOY CO	PHILADELPHIA PA
05464	INDUSTRIAL ELECTRONIC ENGINEERS INC	VAN NUYS CALIF
05574	VIKING INDUSTRIES INC	CHATSWORTH CALIF
05593	ICORE ELECTRO-PLASTICS	SUNNYVALE CALIF
05593	ILLUMITRONIC - SEE ICORE	
05614	ALTEC LANSING CORP	ANAHEIM CALIF
05624	BARBER-COLMAN CO	ROCKFORD ILL
05668	COLE-PARMER INSTRUMENTS AND EQUIPMENT CO	CHICAGO ILL
05820	WAKEFIELD ENGINEERING INC	WAKEFIELD MASS
05963	ALOE DIV BRUNSWICK CORP HEALTH AND SCIENCE DIV	ST LOUIS MO
05972	AMERICAN SEALANTS - SEE LOCTITE CORP	
05972	LOCTITE CORP	NEWINGTON CONN
06004	BASSICK DIV STEWART-WARNER CORP	BRIDGEPORT CONN
06008	NEW DEPARTURE - CANCELED - SEE 43334	
06192	LA-DEAU MFG CO	LOS ANGELES CALIF
06229	ELECTROVERT INC	MOUNT VERNON N Y
06247	GENERAL ELECTRIC CO LAMP METALS AND COMPONENTS DEPT	CLEVELAND OHIO
06317	BERMITE POWDER CO	SAUGUS CALIF
06331	MC CORMICK SELPH CO	HOLLISTER CALIF
06341	PRODUCTS TECHNIQUES INC	DOWNEY CAL
06383	PANDUIT CORP.	TINLEY PARK ILL
06491	LOCKHEED PROPULSION CO	REDLANDS CALIF
06494	BECK LEE CORP - CANCELED - SEE 98079	

TABLE 6-2. (Continued)

CODE NO.	MANUFACTURER	ADDRESS
09922	BURNDY CORP	NORWALK CONN
10108	HURST MFG CORP	PRINCETON IND
10110	SCIENTIFIC-ATLANTA INC	ATLANTA GA
10257	CAHN A L AND SONS	NEW YORK N Y
10646	CARBORUNDUM CO THE	NIAGARA FALLS NY
11139	DEUTSCH CO ELECTRONIC COMPONENTS DIVISION	BANNING CALIF
11147	EPOXYLITE CORP	SOUTH EL MONTE CALIF
11279	ROEHR PRODUCTS CO	WATERBURY CONN
11352	TRANSFORMER ELECTRONICS CO	BOULDER COLO
11432	DIAMOND METAL SALES	GARDENA CALIF
11649	CAJON CO	SOLON OHIO
11700	J H ELECTRONIC TRANSFORMERS INC	CHICAGO ILL
11707	IDEAL PRECISION METER CO INC	BROOKLYN N Y
11783	NY-GLASS INC	PARAMOUNT CALIF
11884	GENERAL MILLS,INC CHEMICAL DIV	KANKAKEE ILL
11907	CALFAX INC-CANCELED - SEE 29372	
11927	WESTINGHOUSE ELECT CORP INSULATING MATERIALS DIV	BENOLITE MANOR PA
12007	HYER HARDWARE MFG CO.	ANAHIEM CALIF
12040	NATIONAL SEMICONDUCTOR CORP.	DANBURY CONN
12045	ELECTRONIC TRANSISTORS CORP	FLUSHING N Y
12060	DIODES INC	CHATSWORTH CALIF
12136	PHILADELPHIA HANDLE CO.	CAMDEN N J
12324	STAKE FASTNER CO	SOUTH EL MONTE CALIF
12360	ALBANY PRODUCTS CO INC	SOUTH NORWALK CONN
12405	HYSOL CORP OF CALIFORNIA	EL MONTE CALIF
12515	THERMATICS INC	ELM CITY N C
12517	COMPONENT RESEARCH CO INC	SANTA MONICA CALIF
12599	FLUOROCARBON CO	ANAHEIM CALIF
12623	WHITEY RESEARCH TOOL CO.	EMERYVILLE CALIF
12673	WESCO ELECTRICAL CO INC	GREENFIELD MASS
12697	CLAROSTAT MFG CO INC	DOVER N H
12744	INDEPENDENT INK CO	GARDENA CALIF
12760	OWEN-CORNING FIBERGLAS CORP	SANTA CLARA CALIF
12770	ARNOLD ENGINEERING CO PACIFIC DIVISION	FULLERTON CALIF
12856	MICROMETALS	SIERRA MADRE CALIF
12954	DICKSON ELECTRONICS CORP	SCOTTSDALE ARIZ
12969	UNITRODE CORP	WATERTOWN MASS
13103	THERMALLOY CO	DALLAS TEX
13113	SHEPHERD CASTERS INC	BENTON HARBOR MICH
13148	VOGUE INSTRUMENT CORP	PLAINVIEW N Y
13209	BENDIX CORP THE SEMICONDUCTOR DIVISION	HOLMDEL N J
13327	SOLITRON DEVICES INC	TAPPAN N Y
13440	AMERICAN PACKING AND GASKET CO	HOUSTON TEX
13550	ATLAS CONNECTORS CO	EL MONTE CALIF
13715	FAIRCHILD CAMERA & INSTRUMENT CORP	SAN RAFAEL CALIF
13812	DIALCO ELECTRIC CORP - CANCELED - SEE 72619	
13850	TECHNIPOWER INC	SOUTH NORWALK CONN
13919	BURR-BROWN RESEARCH CORP	TUSCON ARIZ
13934	MIDWEC CORP	OSHKOSH NEBR
14099	SEMTECH CORP	NEWBURY PARK CALIF
14136	AIRWORK CORP	MIAMI FLA
14193	CALIFORNIA RESISTOR CORP	SANTA MONICA, CALIF
14195	ELECTRONIC CONTROLS INC	WILTON CONN
14433	ITT SEMICONDUCTORS	WEST PALM BEACH FLA
14604	ELMWOOD SENSORS INC	CRANSTON R I
14655	CORNELL-DUBILIER ELECTRIC CORP	NEWARK N J
14674	CORNING GLASS WORKS	CORNING N Y
14735	FERROTRAN ELECTRONICS CO INC	NEW YORK N Y
14841	WARD LEONARD ELECTRIC CO	HAGERSTOWN MD
14869	RUSTRAK - CANCELED - SEE 96853	
14889	SLOAN MFG CO	SUN VALLEY CALIF
14907	CRAMER - SEE CONRAC CORP	
14907	CONRAC CORP CRAMER DIV	OLD SAYBROOK CONN
14959	CRANE CO	CHICAGO ILL
15235	CROUSE-HINDS CO	SYRACUSE N Y
15469	TECHALLOY CO	RAHNS PA
15481	CURTIN W J AND CO	HOUSTON TEX
15584	FIEDON AVIONICS INC	VAN NUYS CALIF
15605	CUTLER-HAMMER INC - CANCELED - SEE 27191	
15653	KAYLOCK DIVISION,KAYNAR MFG. CO.	FULLERTON CALIF
15686	DISC INSTRUMENT CO INC	SANTA ANA CALIF
15733	SUGAR BEET PRODUCTS CO	SAGINAW MICH
15801	FENWALL ELECTRONICS INC	FRAMINGHAM MASS
15818	TELEDYNE INC AMELCO SEMICONDUCTOR DIV	MOUNTAIN VIEW CALIF
15849	USECO INC	MT VERNON N Y
15909	DAVEN DIV - CANCELED - SEE 17870	

TABLE 6-2. (Continued)

CODE NO.	MANUFACTURER	ADDRESS
22903	LINK GROUP ADVANCED PROD DIV GEN PRECISION SYS INC	SUNNYVALE CALIF
23050	PRODUCT COMPONENTS CORPORATION	HASTINGS-ON-HUDSON N Y
23092	MILLAFLOW CORP	RICHMOND CALIF
23347	ROTO ACTUATOR CORP	ST CLAIR SHORES MICH
23633	WESTERN ELECTROMOTIVE INC	CULVER CITY CALIF
23654	PERMANENT MAGNET CO INC	INDIANAPOLIS IND
23732	TRACOR INC	ROCKVILLE MD
23841	FISHER SCIENTIFIC CO	NEW YORK NY
23936	PAMOTOR,INC	SAN FRANCISCO CALIF
24152	SEI MANUFACTURING CO	NORTHRIDGE CALIF
24211	GRIGSBY-BARTON INC	ARLINGTON HEIGHTS ILL
24229	GEORGE RISK INDUSTRIES	COLUMBUS NEB
24248	SOUTH CHESTER CORP SOUTHCO DIV	LESTER PA
24324	RUSSELL INDUSTRIES INC	LYNBROOK N Y
24355	ANALOG DEVICES INC	CAMBRIDGE MASS
24446	GENERAL ELECTRIC (USE APPLICABLE MFG FACILITY CODE)	
24453	GENERAL ELECTRIC DISTRIBUTING CORP	BRIDGEPORT CONN
24453	GENERAL ELECTRIC DISTRIBUTING CORP	BRIDGEPORT CONN
24457	GENERAL ELECTRIC, WIRE AND CABLE DIV	BRIDGEPORT CONN
24522	HUMPHREY PRODUCTS DIV OF GENERAL GAS LIGHT CO	KALAMAZOO MICH
24618	TRANSCON MFG. CO.	DALLAS TEX
24655	GENERAL RADIO CO	WEST CONCORD MASS
24681	LTV ELECTROSYSTEMS INC MEMCOR COMPONENTS OPERATIONS	HUNTINGTON IND
24765	TRANSFORMERS INC	KENSINGTON MD
24895	HEXCEL PRODUCTS INC	LA MIRADA CALIF
25088	SIEMENS AMERICA INC.	NEW YORK N Y
25497	METERMASTER	LOS ANGELES CALIF
25709	GOW MACK INSTRUMENT CO	MADISON N J
25795	GRAINGER W W INC	CHICAGO ILL
26107	DISPLAY DEVICES INC	SANTA MONICA CALIF
26390	TRIDAIR INDUSTRIES	REDONDO BEACH CALIF
26505	GROVE VALVE AND REGULATOR CO	OAKLAND CALIF
26624	ROBINTECH INC ELECTRO MECHANICAL DIVISION	BURBANK CALIF
26844	INJECTION MOLDERS SUPPLY CO INC	CLEVELAND OHIO
26992	HAMILTON WATCH CO.	LANCASTER PA
27191	CUTLER-HAMMER INC PWR DISTRIBUTION AND CONTROL DIV	MILWAUKEE WIS
27318	STEWART-WARNER MICROCIRCUITS INC	SUNNYVALE CALIF
27342	TRINITY CAPACITOR CO.	TRINITY TEX
27440	INDUSTRIAL SCREW PRODUCTS CO	LOS ANGELES CALIF
27536	HOUSTON OMNIGRAPHIC CORP	BELLAIRE TEX
27555	SPACE DATA CORP	PHOENIX ARIZ
27697	WESTERN INDICATOR CO. INC.	SOUTH EL MONTE CALIF
27934	M B ASSOCIATES	SAN RAMON CALIF
28249	SEEZAK PRODUCTS INC.	LOS ANGELES CALIF
28307	BRADLEY INDUSTRIES	FRANKLIN PARK ILL
28480	HEWLETT-PACKARD CO	PALO ALTO CALIF
28499	CHEMELEC PRODUCTS INC	CHERRY HILL NJ
28520	HEYMAN MFG CO	KENILWORTH N J
28968	HOKE INC	CRESSKILL N J
29372	TRIDAIR INDUSTRIES FASTENER DIV	TORRANCE CALIF
29424	HOSKINS MFG CO	DETROIT MICH
29626	DAWN J B PRODUCTS	CHICAGO ILL
30106	UTICA TOOL CO INC	ORANGEBURG SC
30119	IDEAL INDUSTRIES INC	SYCAMORE ILL
30239	TECHNI-TOOL INC	PHILADELPHIA PA
30327	IMPERIAL EASTMAN CORP	CHICAGO ILL
30346	MATTESON TRANSFORMER INC	HOUSTON TEX
31040	TYTRON CORP OF AMERICA	METUCHEN NJ
31223	MICRO PLASTICS INC	CHATSWORTH CALIF
31356	J B T INSTRUMENTS INC	NEW. HAVEN CONN
31514	SAE ADVANCE PACKAGING INC	SANTA ANA CALIF
31857	TRUMP ROSS IND	BILLERICA MASS
32204	JOHNSON S C AND SON INC	RACINE WIS
33591	KIMBERLY-CLARK CORP	NEENAH WIS
35009	IRC RESISTOR DIV OF RENFREW ELECTRIC CO LTD	TORONTO ONTARIO CANADA
35529	LEEDS AND NORTHRUP	PHILADELPHIA PA
36346	UNION CARBIDE CORP LINDE DIV	NEW YORK NY
37362	M B ELECTRONICS DIV OF TEXTRON ELECTRONICS INC	NEW HAVEN CONN
37942	MALLORY P R AND CO INC	INDIANAPOLIS IND
38056	DRESSER INDUSTRIES INC INDUSTRIAL VALVE AND INSTRUMENT DIV	STRATFORD CONN
38056	MANNING MAXWELL AND MOORE - SEE DRESSER INDUSTRIES	
38443	MARLIN-ROCKWELL CORP DIV OF TRW INC	JAMESTOWN N Y
39428	MC MASTER-CARR SUPPLY CO	CHICAGO ILL
39638	MEINECKE AND CO	NEW YORK N Y
39861	METAL GOODS CORP	ST LOUIS MO
40920	MINIATURE PRECISION BEARINGS INC	KEENE N H

TABLE 6-2. (Continued)

CODE NO.	MANUFACTURER	ADDRESS
71286	CAMLOC FASTNER CORP	PARAMUS N J
71365	CENTRAL LABORATORIES - CANCELED - SEE 80737	
71400	BUSSMAN MFG DIVISION OF MCGRAW-EDISON CO	ST LOUIS MO
71450	CTS CORP	ELKHART IND
71468	ITT CANNON ELECTRIC CO	LOS ANGELES CALIF
71482	CLARE C P AND CO	CHICAGO ILL
71568	COLONIAL BRONZE CO	TORRINGTON CONN
71584	COLUMBUS COATED FABRICS CO	COLUMBUS OHIO
71590	CENTRALAB DIVISION OF GLOBE-UNION INC	MILWAUKEE WIS
71621	COMMERCIAL SOLVENTS CORP	NEW YORK NY
71643	CONNECTICUT HARD RUBBER CO	NEW HAVEN CONN
71707	COTO-COIL CO INC	PROVIDENCE R I
71729	CRESCENT BOX CORP	PHILADELPHIA PA
71742	CHICAGO METALLIC MFG CO	LAKE ZURICH ILL
71744	CHICAGO MINIATURE LAMP WORKS	CHICAGO ILL
71785	CINCH MFG CO AND HOWARD B JONES DIV	CHICAGO ILL
71827	CLAUSS CUTLERY CO	FREMONT OHIO
71855	DAVOL INC	PROVIDENCE RI
71913	DE-STA-CO CORP	DETROIT MICH
71943	DITZLER COLOR DIV OF PITTSBURG PLATE GLASS CO	DETROIT MICH
71984	DOW CORNING CORP	MIDLAND MICH
72005	DRIVER, WILBER B CO	NEWARK N J
72041	EAGLE ELECTRIC MFG CO	LONG ISLAND CITY N Y
72136	ELECTRO MOTIVE MFG CO	WILLIMANTIC CONN
72228	CONTINENTAL SCREW CO	NEW BEDFORD MASS
72259	NYTRONICS INC	BERKELEY HEIGHTS N J
72271	FUTECTIC WELDING ALLOYS CORP	FLUSHING N Y
72307	FAHNESTOCK ELECTRIC CO	LONG ISLAND CITY NY
72354	FAST JOHN E CO (BUSINESS DISCONTINUED)	
72512	DAVIES, HARRY MOLDING CO	CHICAGO ILL
72619	DIALIGHT CORP	BROOKLYN N Y
72653	G C ELECTRONICS MFG CO	ROCKFORD ILL
72656	INDIANA GENERAL CORP ELECTRONICS DIVISION	KEASBY N J
72688	DOLPH JOHN C CO	MONMOUTH JUNCTION N J
72699	GENERAL INSTRUMENT CORP	NEWARK N J
72765	DRAKE MFG CO	HARWOOD HEIGHTS ILL
72794	DZUS FASTENER CO INC	WEST ISLIP N Y
72825	EBY HUGH H INC	PHILADELPHIA PA
72913	GRIGOLEIT CO THE	DECATUR ILL
72962	ELASTIC STOP NUT CORP OF AMERICA	UNION N J
72982	ERIE TECHNOLOGICAL PRODUCTS INC	ERIE PA
73061	HANSEN MFG CO INC	PRINCETON IND
73076	HARPER, H M CO	CHICAGO ILL
73138	BECKMAN INSTRUMENT INC HELIPOT DIVISION	FULLERTON CALIF
73160	FEDERAL MOGUL DIV.OF FEDERAL MOGUL CORP.	WARREN MICH
73168	FENWAL INC	ASHLAND MASS
73219	FISKE BROS REFINING	NEWARK N J
73293	HUGHES AIRCRAFT CO ELECTRON DYNAMICS DIV	TORRANCE CALIF
73432	AMERICAN MICROPHONE CO DIV OF ELECTRO-VOICE INC	BUCHANAN MICH
73445	AMPEREX ELECTRONIC CO DIV OF NORTH AMERICAN PHILIPS CO INC	HICKSVILLE N Y
73506	BRADLEY SEMICONDUCTOR CORP	NEW HAVEN CONN
73559	CARLING ELECTRIC INC	WEST HARTFORD CONN
73612	CONSOLIDATED WIRE AND ASSOCIATED CORP	CHICAGO ILL
73653	DIAMOND MFG CO	WYOMING PA
73662	WEBCOR INC DORMEYER DIV	CHICAGO ILL
73734	FEDERAL SCREW PRODUCTS CORP	CHICAGO ILL
73774	GENERAL ELECTRIC SUPPLY - CANCELED - SEE 24455	
73779	GENERAL MOLDED PRODUCTC INC	DES PLAINES ILL
73792	GENERAL HARDWARE MFG CO INC	NEW YORK NY
73793	GENERAL INDUSTRIES CO	ELYRIA OHIO
73803	METALS AND CONTROLS INC. DIV OF TI	ATTLEBORO MASS
73842	GOODYEAR TIRE AND RUBBER CO	AKRON OHIO
73899	J F D ELECTRONICS CORP	BROOKLYN N Y
73949	GUARDIAN ELECTRIC MFG CO	CHICAGO ILL
73977	HANDY AND HARMON	NEW YORK N Y
73988	HARRINGTON AND KING PERFORATING CO. INC	CHICAGO ILL
74042	MERIT COIL AND TRASFORMER CORP	HOLLYWOOD FLA
74116	NEW ENGLAND ELECTRIC WIRE CORP	LISBON NH
74193	HEINEMANN ELECTRIC CO	TRENTON N J
74199	GUAM NICHOLS CO	CHICAGO ILL
74200	HEINZE ELECTRIC CO	LOWELL MASS
74306	PIEZO CRYSTAL CO	CARLISLE PA
74364	EASTMAN CHEMICAL PRODUCTS INC	KINGSPORT TENN
74400	HOBBS JOHN W CORP	SPRINGFIELD ILL
74438	HOLLINGSHEAD R M CORP	CAMDEN N J
74445	HOLO-KROME SCREW CORP	HARTFORD CONN

TABLE 6-2. (Continued)

CODE NO.	MANUFACTURER	ADDRESS
80411	ACRO DIV OF ROBERTSHAW CONTROLS	COLUMBUS OHIO
80583	HAMMARLUND CO INC	MARS HILL N C
80599	MCGRAW-EDISON	ELGIN ILL
80625	ROBERTSHAW FULTON CONTROLS CO.	INDIANA PA
80640	STEVENS ARNOLD CO INC	BOSTON MASS
80703	SAUEREISEN CEMENTS CO	PITTSBURG PA
80707	SAUEREISEN CEMENTS CO	PITTSBURG PA
80737	CHAPMAN CHEMICAL CO	MEMPHIS TENN
80740	BECKMAN INSTRUMENTS INC	FULLERTON CALIF
80798	CABOT CORP	BOSTON MASS
80813	DIMCO GRAY CO	DAYTON OHIO
80868	PHOTOCON RESEARCH PRODUCTS CO	PASADENA CALIF
81030	INTERNATIONAL INSTRUMENTS INC	ORANGE CONN
81073	GRAYHILL INC	LA GRANGE ILL
81074	HOLUB INDUSTRIES INC	SYCAMORE ILL
81083	KREGER L F MFG CO	CHICAGO ILL
81095	TRIAD TRANSFORMER CORP	VENICE CALIF
81134	ELECTRO-VOICE INC	BUCHANAN MICH
81150	CEMCO MFG CO	COLUMBUS OHIO
81312	WINCHESTER ELECTRONIC DIV OF LITTON INDUSTRIES	OAKVILLE CONN
81346	AMERICAN SOCIETY FOR TESTING AND MATERIALS	PHILADELPHIA PA
81348	FEDERAL SPECIFICATIONS	GENERAL SERVICES ADMINISTRATION
81349	MILITARY SPECIFICATIONS	STD DIV DIR OF LOG SER DSA
81350	JOINT ARMY-NAVY SPECIFICATIONS	STD DIV DIR OF LOG SER DSA
81453	RAYTHEON CO INDUSTRIAL COMPONENTS DIVISION - CANCELED - SEE 94144	
81483	INTERNATIONAL RECTIFIER CORP	EL SEGUNDO CALIF
81541	AIRPAX ELECTRONICS INC	CAMBRIDGE MD
81640	CONTROLS SWITCH DIV CONTROLS CO OF AMERICA	FOLCROFT PA
81646	IDEAL CORP	BROOKLYN N Y
81697	ESTERBROOK PEN COMPANY	CHERRY HILL N J
81812	TRIMM INC	LIBERTYVILLE ILL
81840	LEDEX INC	DAYTON OHIO
81904	CLOVER INDUSTRIES INC	TONAWANDA N Y
82106	BERTEA CORP	IRVINE CALIF
82107	AMERLINE CORP	CHICAGO ILL
82227	HAYDON A W CO	WATERBURY CONN
82383	STEVENS MFG CO	EBENSBERG PA
82389	SWITCHCRAFT INC	CHICAGO ILL
82647	METALS AND CONTROLS INC DIV OF TEXAS INSTRUMENTS	ATTLEBORO MASS
82742	RIPLEY CO. INC.	RIPLEY CONN
82768	PHILLIPS-ADVANCE CONTROL CO DIV OF PHILLIPS-ECKARDT ELECT CORP	JOLIET ILL
82851	NATIONAL MFG CORP	STERLING ILL
82877	ROTRON MFG CO INC	WOODSTOCK N Y
82879	ITT WIRE AND CABLE DIVISION	PAWTUCKET R I
82879	ROYAL ELECTRIC CORP - SEE ITT WIRE AND CABLE DIV	
82893	VECTOR ELECTRONIC CO	GLENDALE CALIF
82949	PURATEX CORP	BEDFORD VA
83003	VARO INC	GARLAND TEX
83008	STACO INC	DAYTON OHIO
83014	HARTWELL CORP	LOS ANGELES CALIF
83086	NEW HAMPSHIRE BALL BEARINGS INC	PETERBOROUGH NH
83125	GENERAL INSTRUMENT CORP CAPACITOR DIVISION	DARLINGTON S C
83186	VICTORY ENGINEERING CO	SPRINGFIELD N J
83241	FUSITE CORP	CINCINNATI OHIO
83259	PARKER SEAL CO	CULVER CITY CALIF
83330	SMITH HERMAN H INC	BROOKLYN N Y
83332	TECH LABORATORIES INC	PALISADES PARK N J
83334	TECHNICAL TAPE CORP	NEW ROCHELLE N Y
83337	WABASH CORP	CHICAGO ILL
83355	ATLAS SCREW AND SPECIALITY CO	NEW YORK NY
83393	COLUMBIA WIRE AND SUPPLY CO	CHICAGO ILL
83574	PRODUCTS RESEARCH AND CHEMICAL CORP	BURBANK CALIF
83594	BURROUGHS CORP ELECTRONIC COMPONENTS DIV	PLAINFIELD N J
83616	POLYMER CORP	READING PA
83740	UNION CARBIDE CORP CONSUMER PRODUCTS DIV	NEW YORK N Y
83777	MEMCOR INC - SEE LTV ELECTROSYSTEMS INC	
83777	LTV ELECTROSYSTEMS INC MEMCOR DIVISION	HUNTINGTON IND
83781	NATIONAL ELECTRONICS INC	GENEVA ILL
83833	THOMAS AND SKINNER INC	INDIANAPOLIS IND
83880	PRECISION STEEL WAREHOUSE INC.	FRANKLIN PARK ILL
83965	AIRMATIC VALVE INC	PHILADELPHIA PA
84171	ARCO ELECTRONICS INC	GREAT NECK N Y
84411	TRW CAPACITOR DIVISION	OGALLALLA NEBR
84411	GOOD-ALL ELECTRIC MFG CO - SEE TRW CAPACITOR DIVISION	
84561	HANNIFIN CYLINDER DIV PARKER HANNIFIN CORP	DES PLAINES ILL
84830	LEE SPRING CO. INC.	BROOKLYN N Y

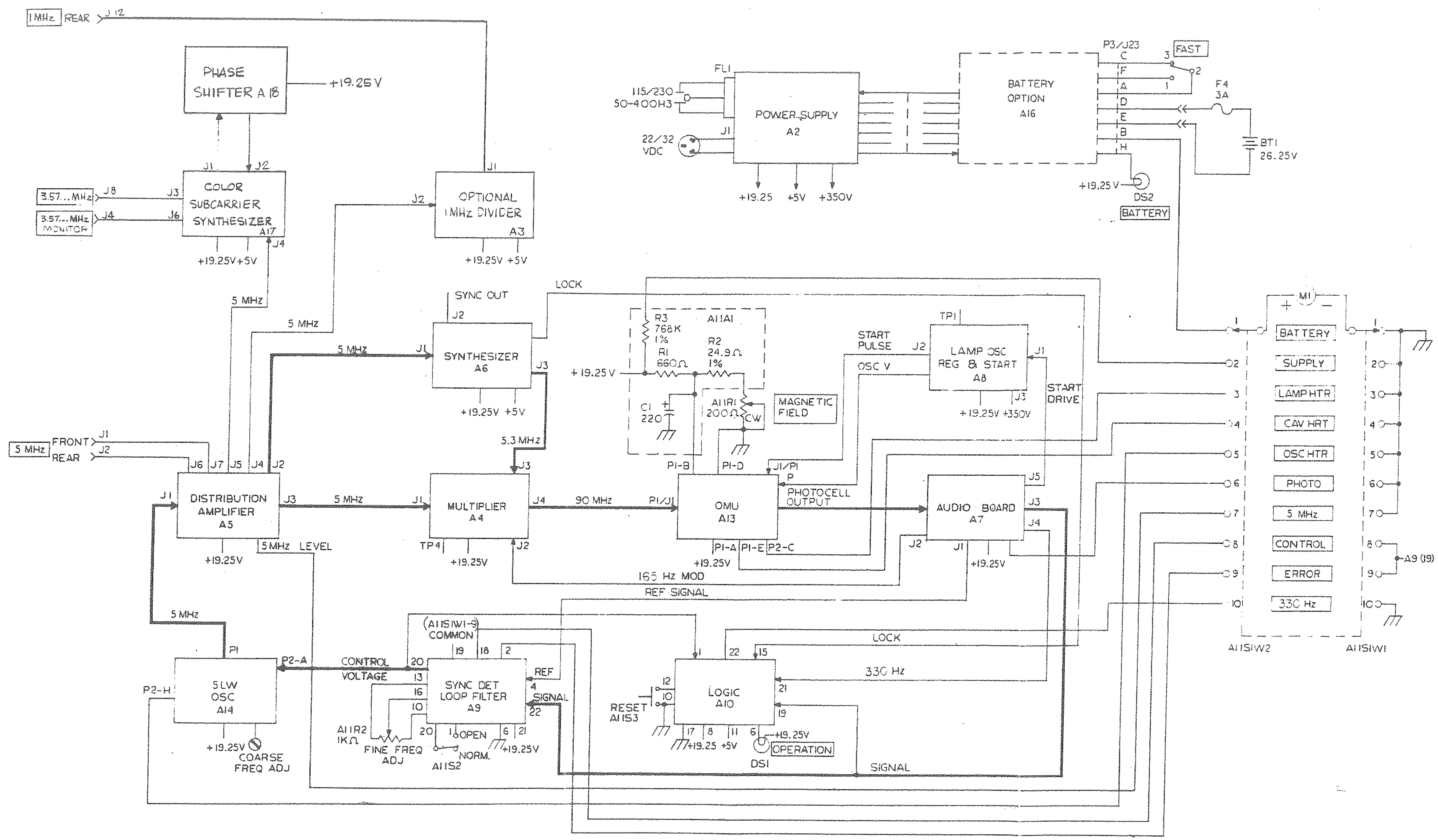


Figure 7-1. Model 600 Interconnect Schematic Diagram, Drawing 18462 Rev A

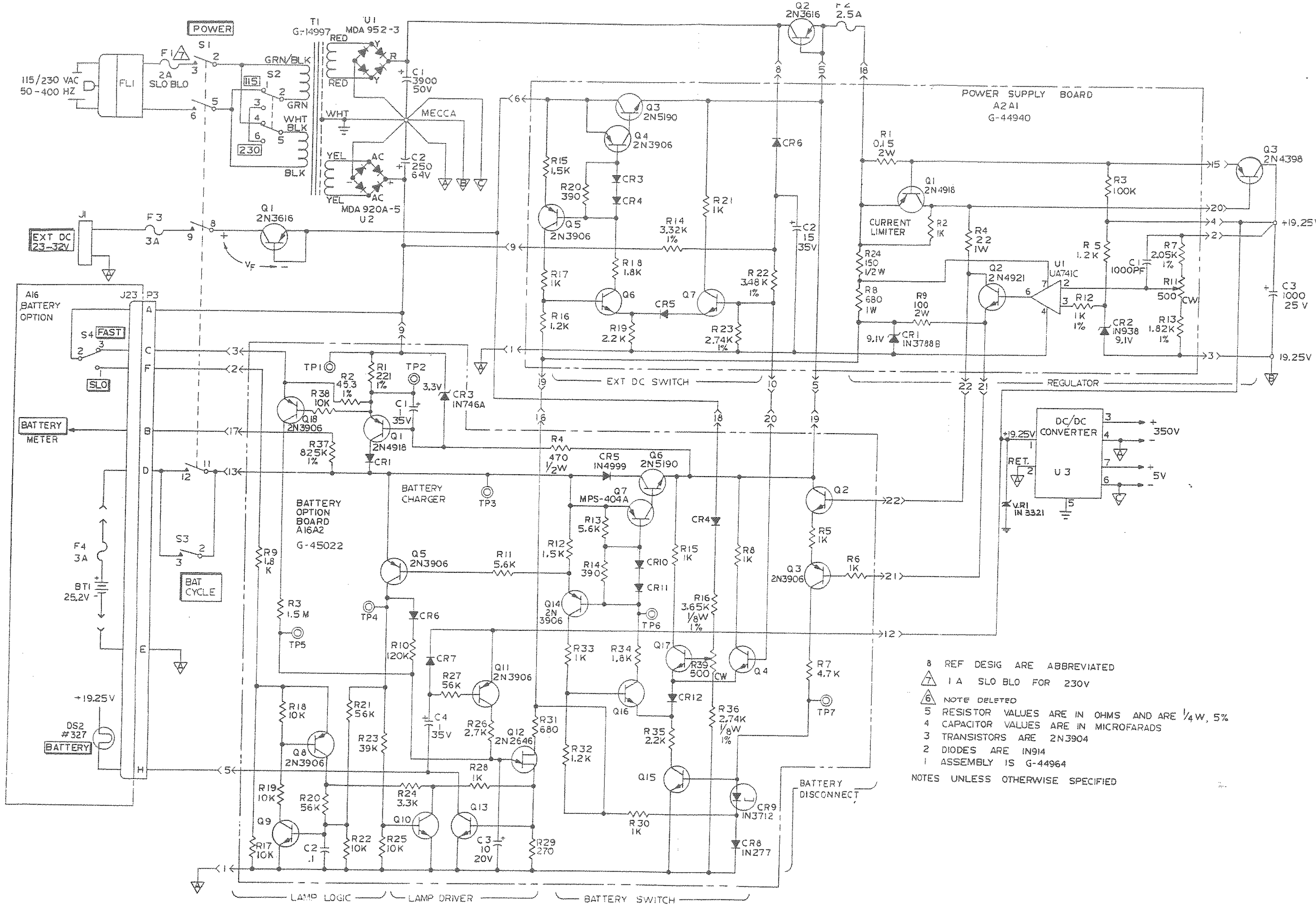
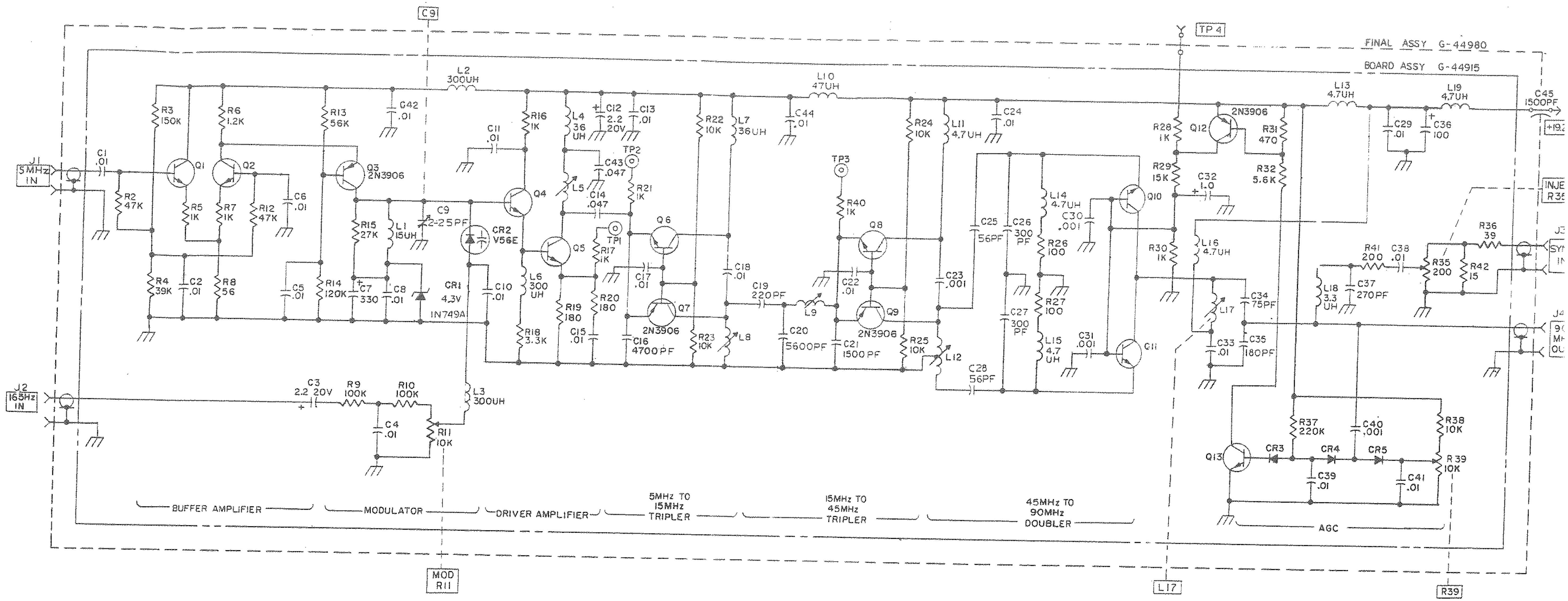


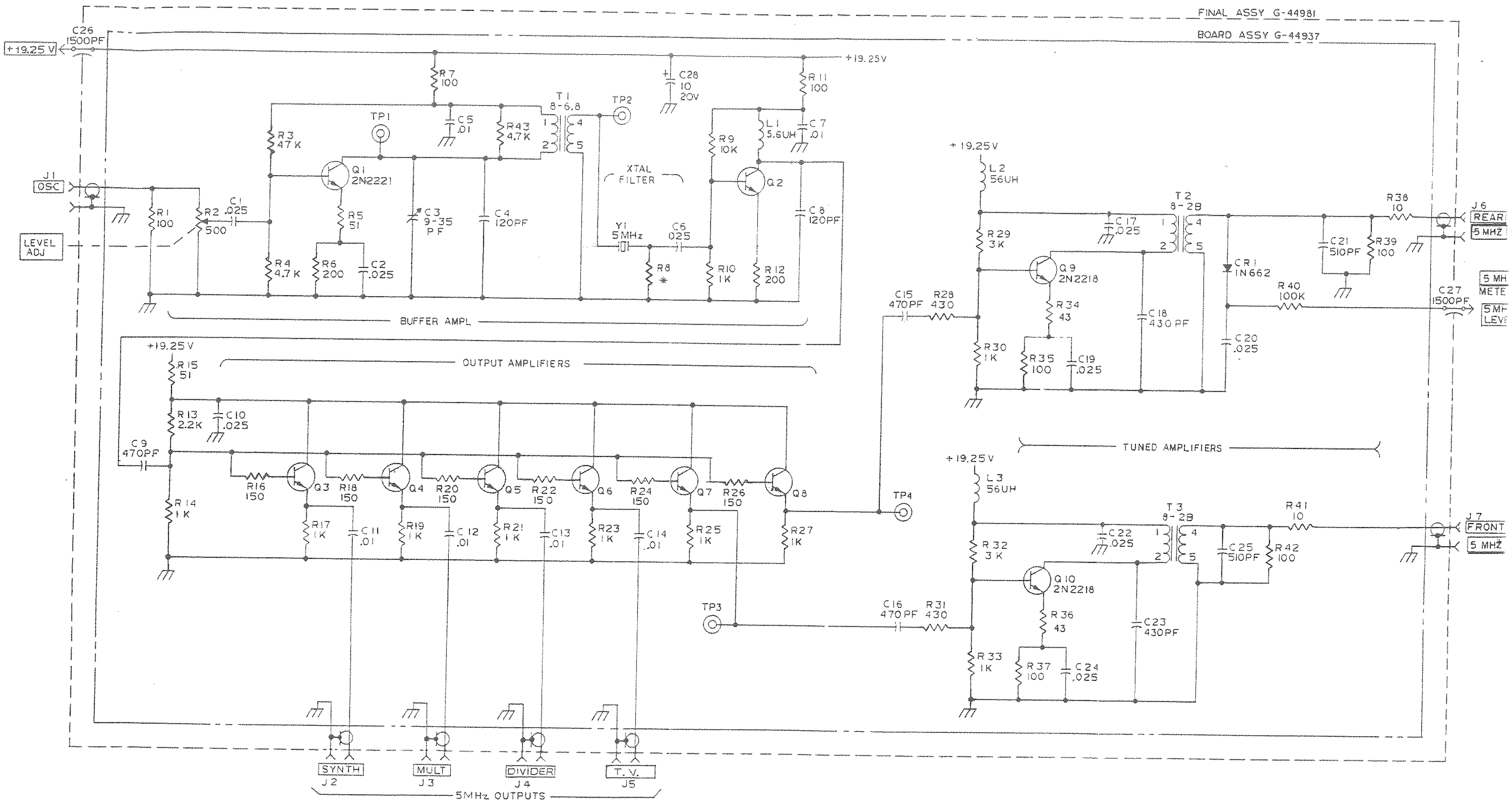
Figure 7-2. Assemblies A2 and A16, Power Supply and Battery Option Schematic Diagram, Drawing G44942 Rev D



7 ADD PREFIX-A4 TO REF. DESIGNATORS.
6 LAST REF DESIG USED C45, CR5, J4, L19, Q13, R42 & TP3
5 DIODES ARE 1N914
4 TRANSISTORS ARE 2N3904
3 ALL RESISTOR VALUES ARE IN OHMS & 1/4W, 5%
2 ALL CAPACITOR VALUES ARE IN MICROFARADS
1 ASSEMBLY IS G-44984-0001

NOTES, UNLESS OTHERWISE SPECIFIED:

Figure 7-3. Assembly A4, X18 RF Multiplier Schematic, Drawing G44917 Rev B



7 LAST REF DESIG USED C28, CR1, J7, L3, Q10, R42, T3, Y1, TP4

6 REF DESIG ARE ABBREVIATED. PREFIX DESIG WITH A5

5 TRANSISTORS ARE 2N3904

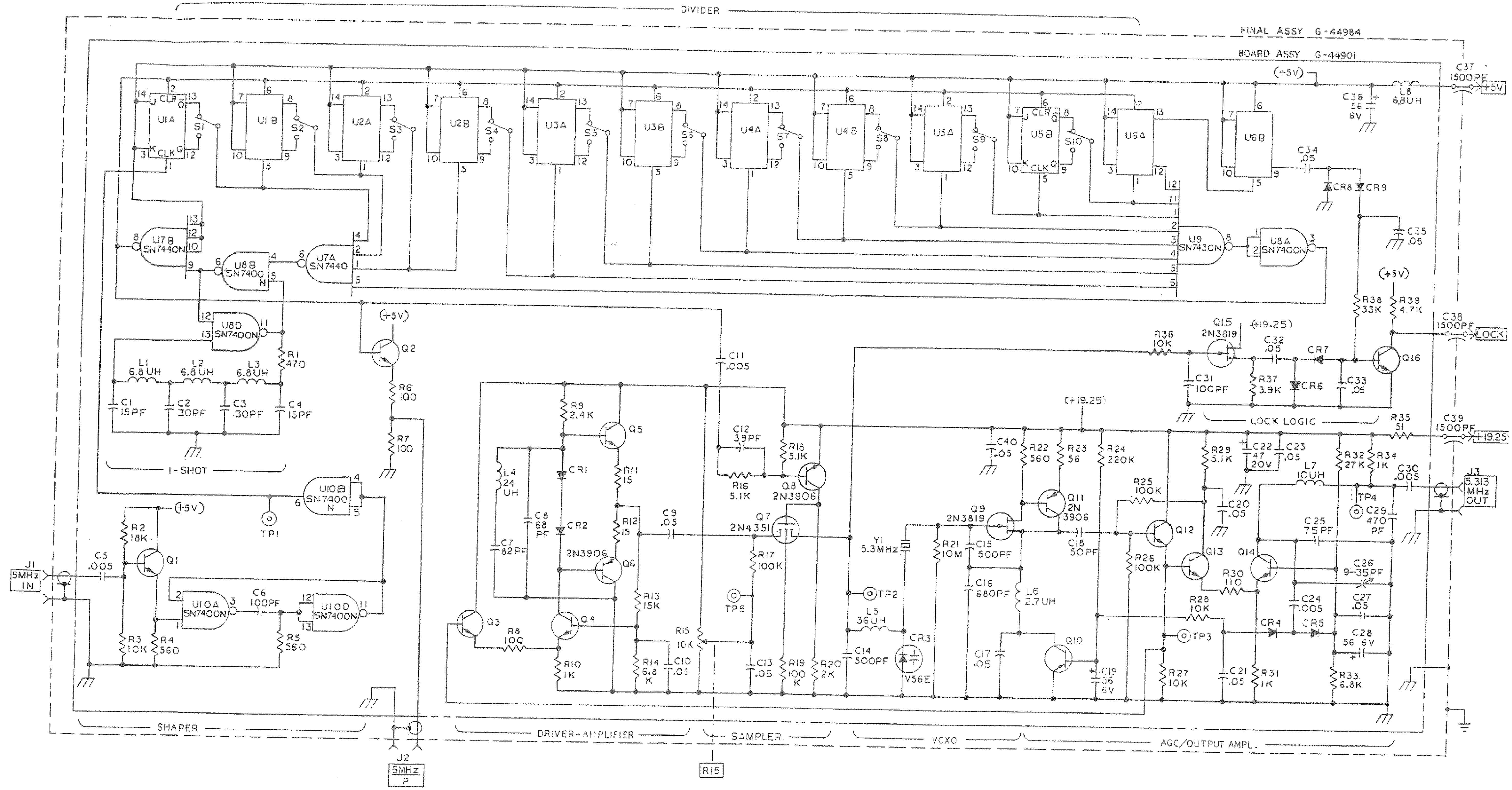
4 * INDICATES VALUE TO BE SELECTED IN TEST

3 RESISTOR VALUES ARE IN OHMS AND ARE 1/4 W, 5%

2 ALL CAPACITOR VALUES ARE MICROFARADS

NOTES: UNLESS OTHERWISE SPECIFIED

Figure 7-4. Assembly A5, Distribution Amplifier Schematic Diagram, Drawing 18410 Rev -



11. SWITCHES ARE SHOWN IN "0" POSITION

10. PIN 11 ON U1-U6 AND PIN 7 ON U7-U10 ARE GRD (⏚)

9 PIN 4 ON U1-U6 AND PIN 14 ON U7-U10 ARE +5V

8 IC'S U1-U6 ARE SN7473N

7 REF DESIG ARE ABBREVIATED PREFIX DESIG WITH A6

6 LAST REF DESIG USED: U10, C40, CR9, J3, L8, Q16, R39, TP5 & Y1.

5 DIODES ARE IN914

4 TRANSISTORS ARE 2N3904

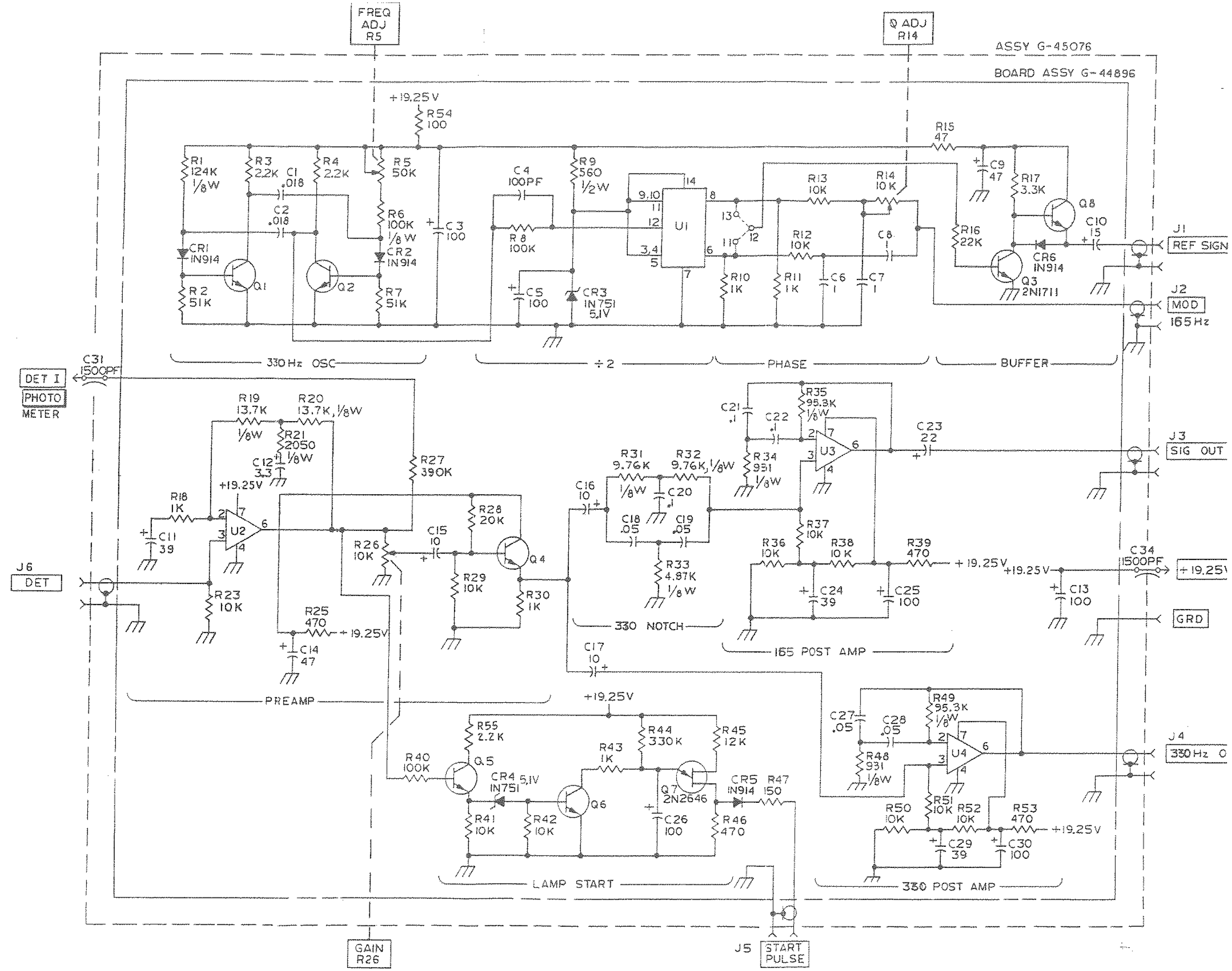
3 ALL RESISTOR VALUES ARE IN OHMS & ARE 1/4W, 5%

2 ALL CAPACITOR VALUES ARE IN MICROFARADS.

1 ASSEMBLY IS G-44984

NOTES, UNLESS OTHERWISE SPECIFIED.

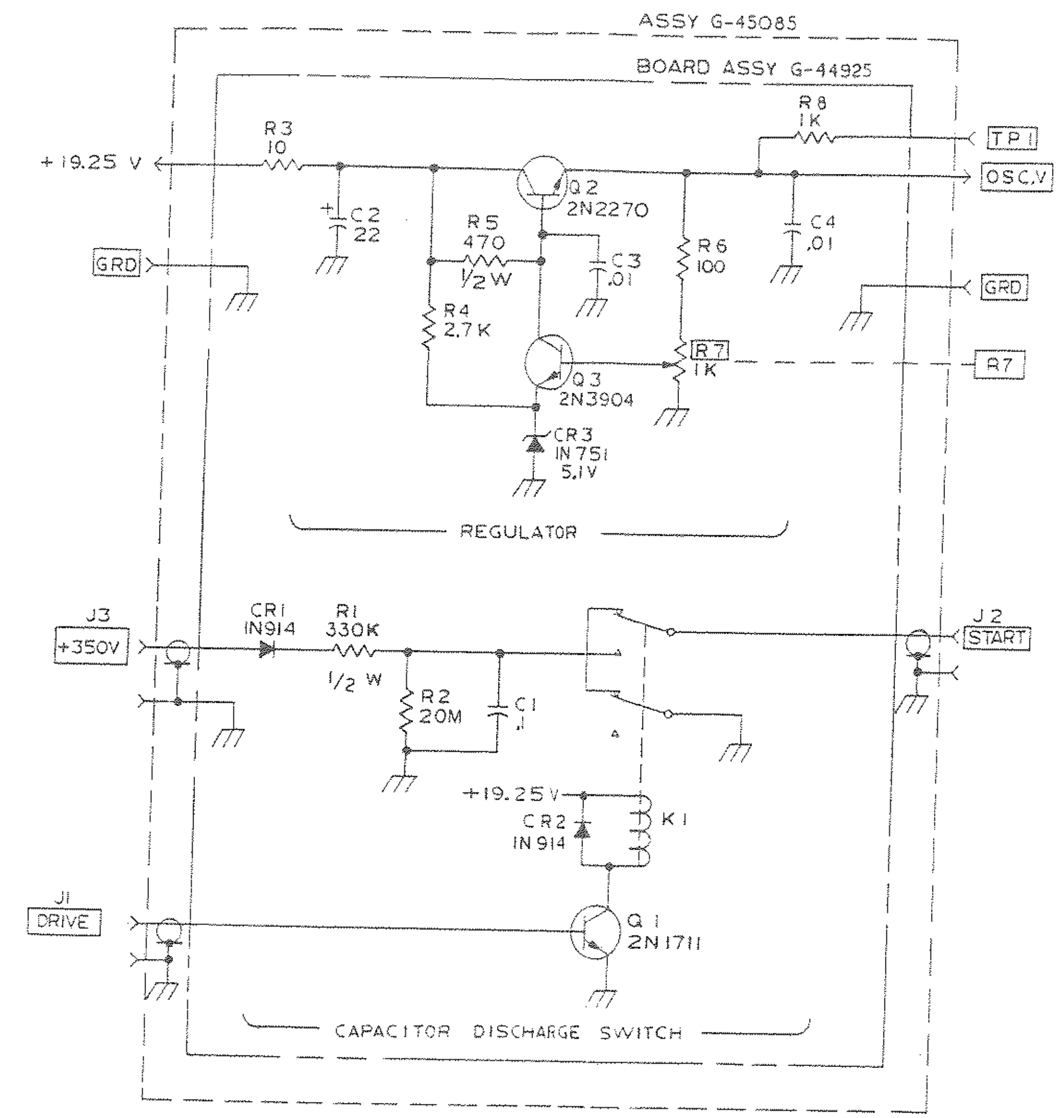
Figure 7-5. Assembly A6, Synthesizer Schematic Diagram, Drawing G44903 Rev B



9. U2,3,4 ARE μA741C
8. U1 IS AN SN7472N

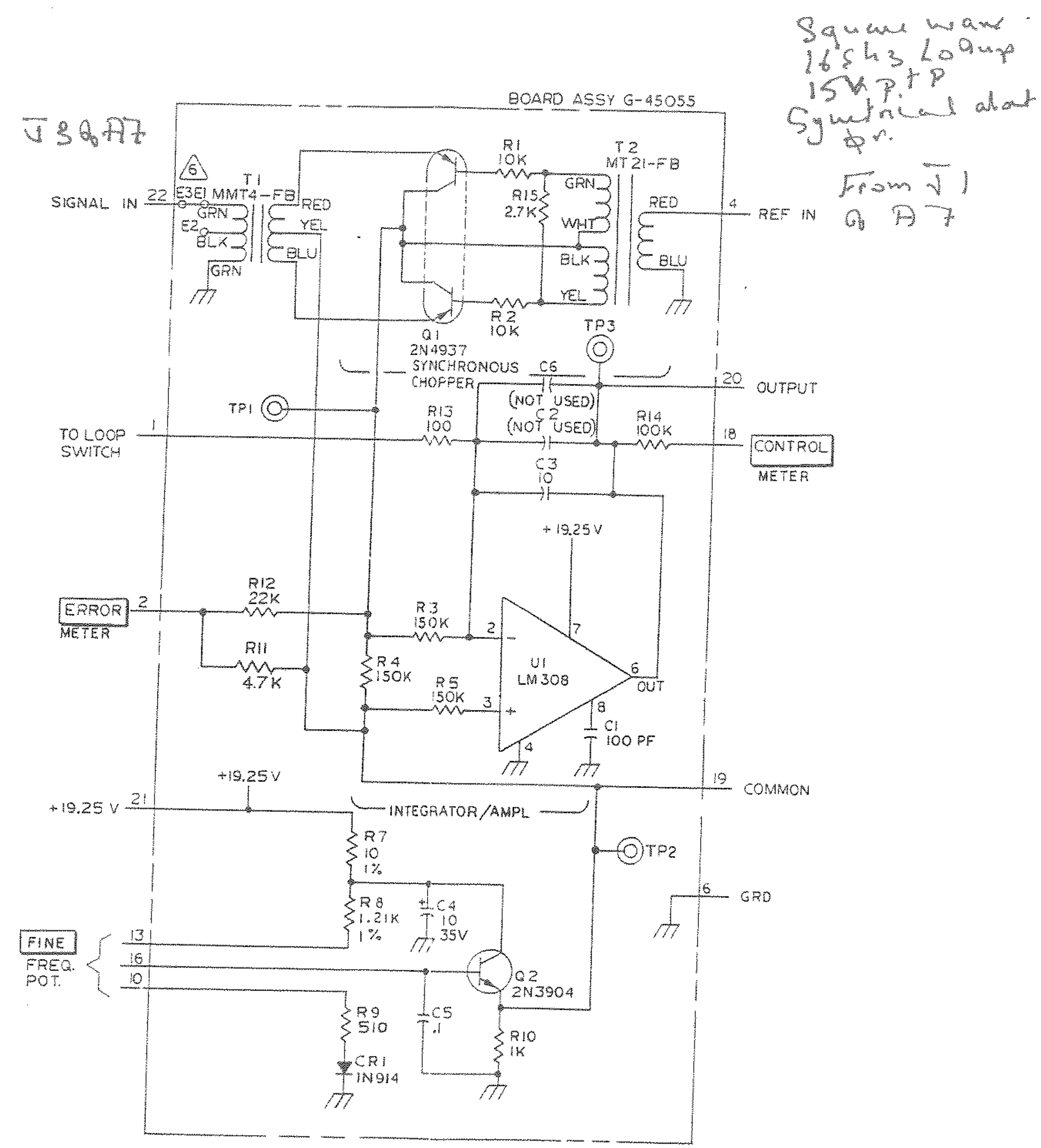
7. TRANSISTORS ARE 2N3904
6. LAST REF DESIG USED U4, C34, CR6, J5, Q8, R54
5. PREFIX ALL REF. DESIGNATORS WITH "A7"
4. ALL 1/8W RESISTORS ARE 1%
3. RESISTOR VALUES ARE IN OHMS AND ARE 1/4W, 5%
2. CAPACITOR VALUES ARE MICROFARADS
1. ASSEMBLY IS G-45076
NOTES: UNLESS OTHERWISE SPECIFIED

Figure 7-6. Assembly A7, Audio Board Schematic Diagram, Drawing G44898 Rev E



5 LAST REF DESIG USED C5, CR3, J2, K1, Q3, R8, TP1
4 PREFIX ALL REF DESIGNATORS WITH "A8"
3 RESISTOR VALUES ARE IN OHMS AND ARE 1/4 W, 5%
2 ALL CAPACITOR VALUES ARE MICROFARADS
1 ASSEMBLY IS G-45085
NOTES: UNLESS OTHERWISE SPECIFIED

Figure 7-7. Assembly A8, Oscillator Regulator and Start Schematic Diagram, Drawing G44928 Rev C



6 THE JUMPER MAY BE CHANGED TO TERMINAL E2 FOR HIGHER GAIN.

5 LAST REF DESIG USED U1, C6, CR1, Q2, R15, T2, TP3, E3

4 PRE-FIX REF. DESIGNATORS WITH 'A9'

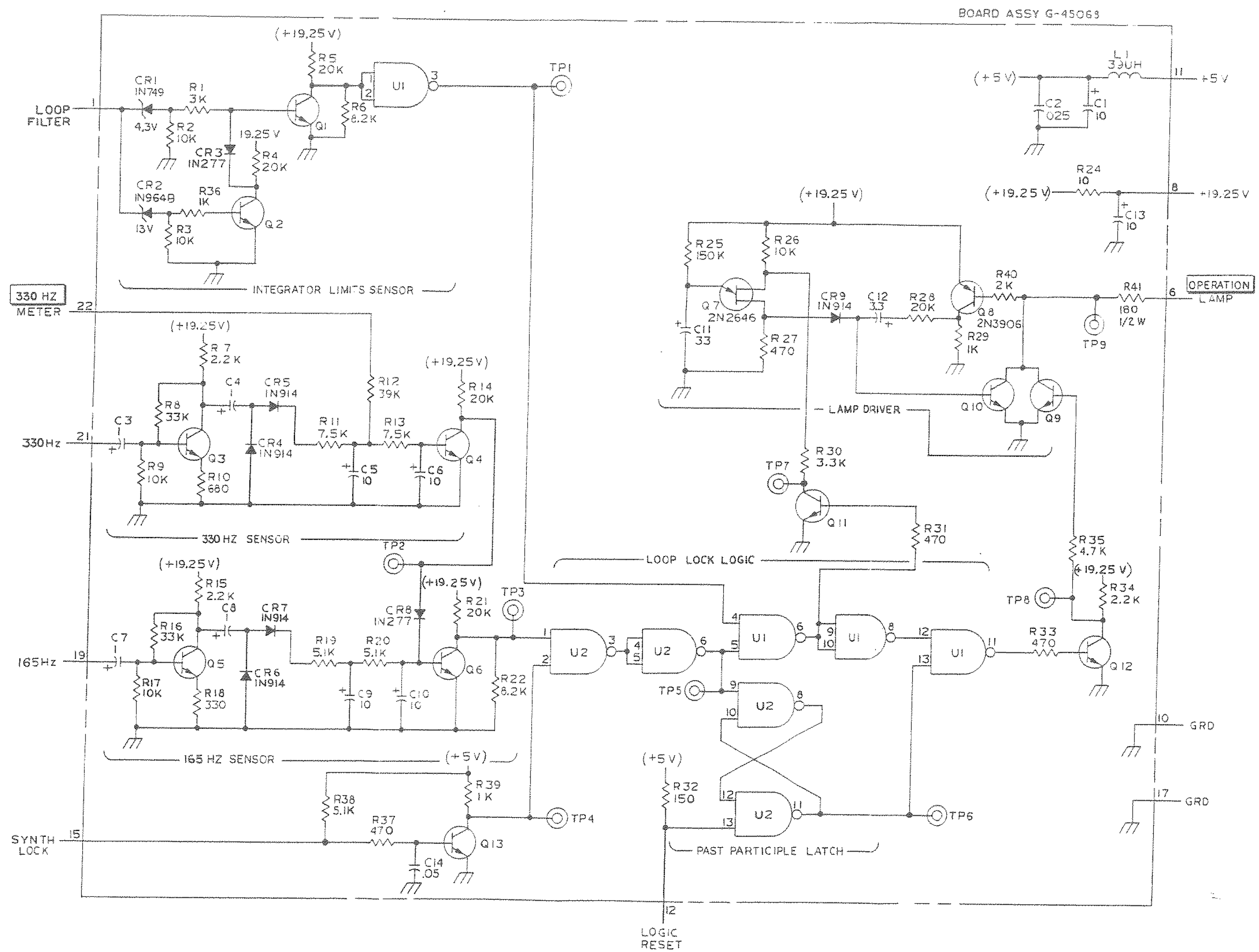
3 RESISTOR VALUES ARE IN OHMS AND ARE 1/4W, 5%

2 CAPACITOR VALUES ARE MICROFARADS

1 ASSEMBLY IS G-45055

NOTES UNLESS OTHERWISE SPECIFIED

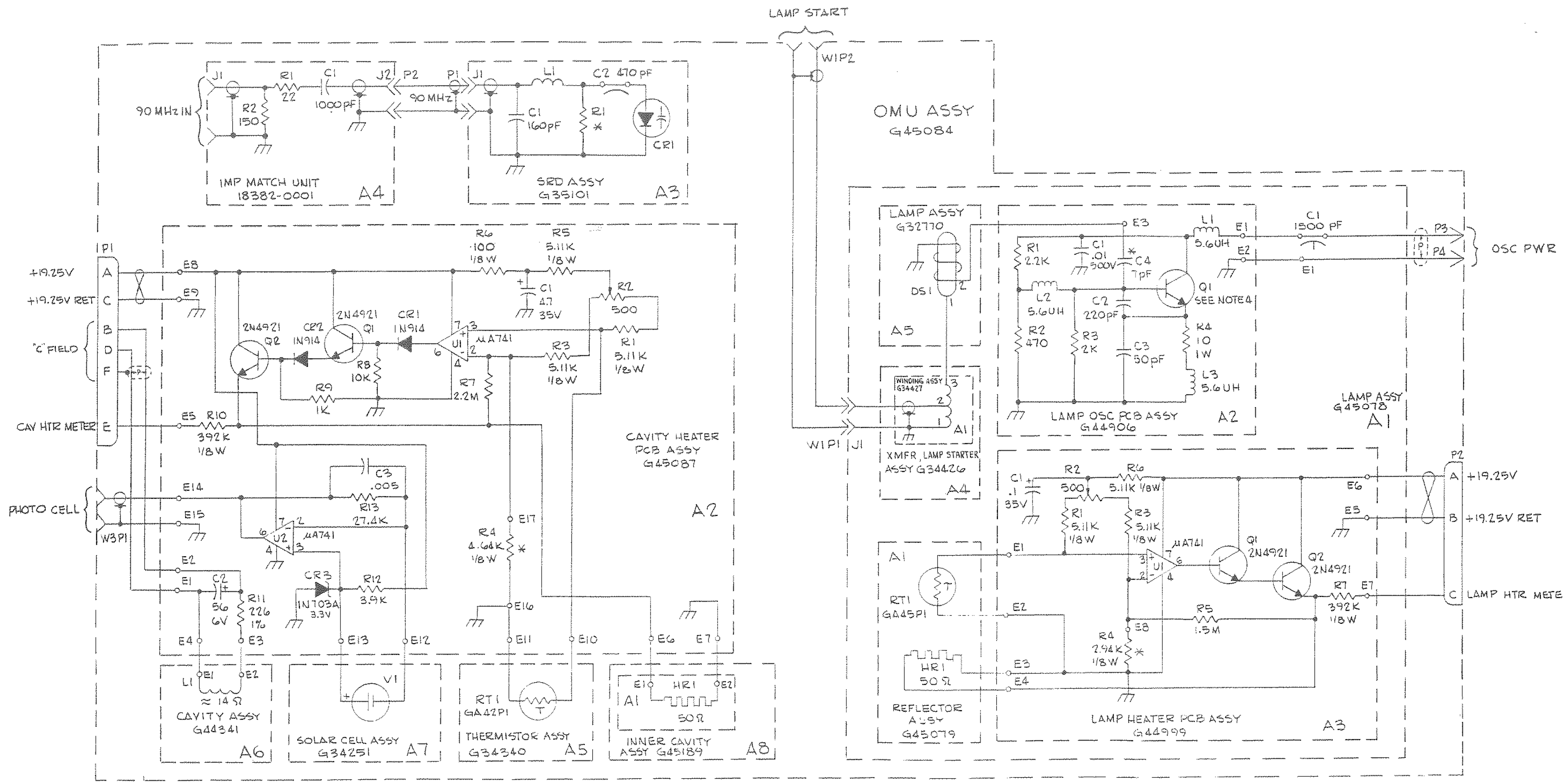
Figure 7-8. Assembly A9, Loop Filter Schematic Diagram, Drawing G45059 Rev F



NOTES: UNLESS OTHERWISE SPECIFIED

1 ASSEMBLY IS G-45068
2 CAPACITOR VALUES ARE MICROFARADS
3 RESISTOR VALUES IN OHMS AND ARE 1/4 W, 5%
4 TRANSISTORS ARE 2N3904
5 REF DESIG ARE ABBREVIATED, PREFIX DESIG WITH A10
6 LAST REF DESIG USED U2, C14, CR9, L1, Q13, R40, TP9
7 U1 AND U2 ARE S7400N
8 PIN 7 ON U1 AND U2 IS GRD
9 PIN 14 ON U1 AND U2 IS +5V

Figure 7-9. Assembly A10, Logic Board Schematic Diagram, Drawing G45072 Rev D

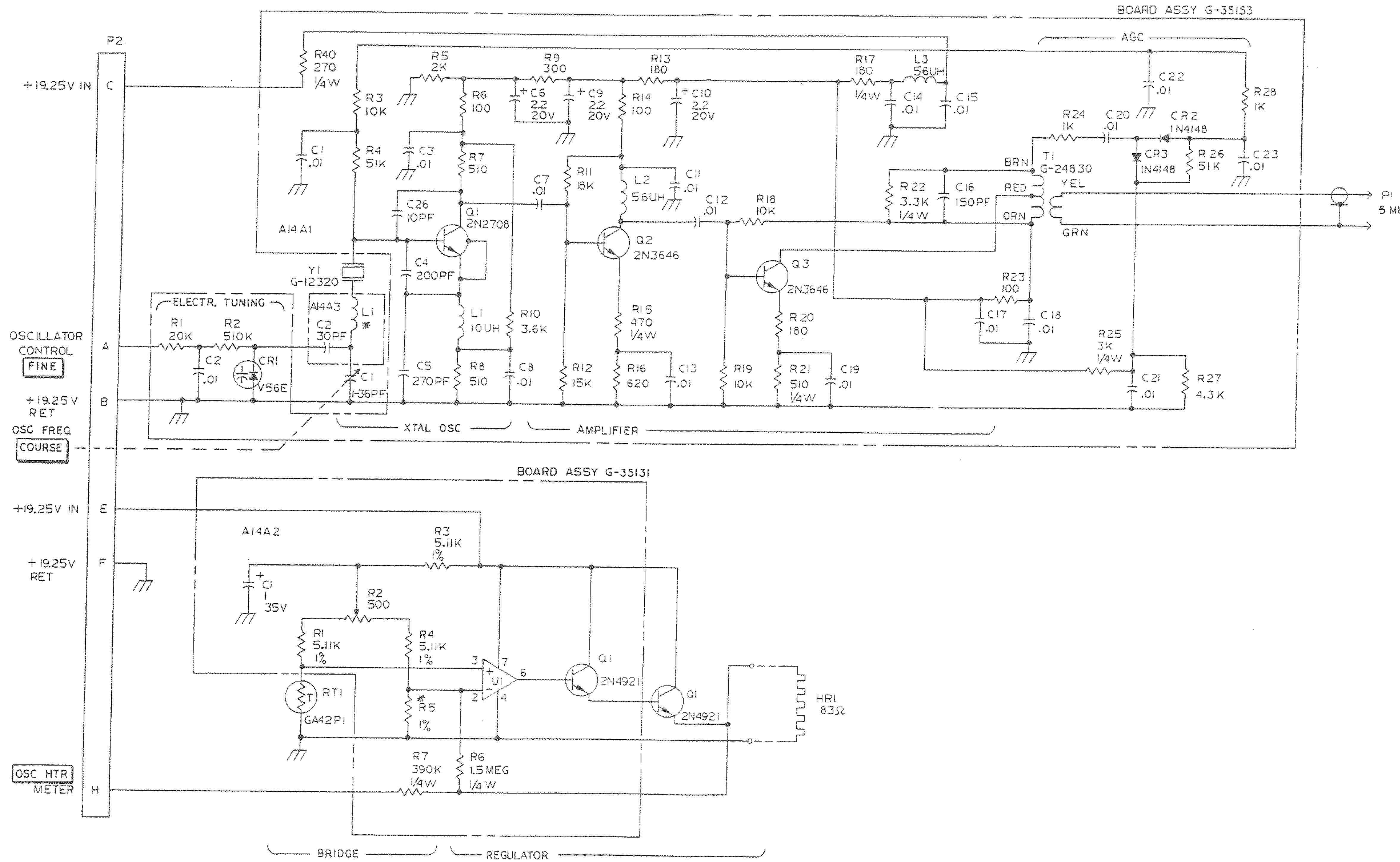


4. NOTED TSTR Q1 IS MOTOROLA SRF 230
3. * INDICATES SELECTED IN TEST
2. ALL 1/8W RESISTORS ARE 1%
1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS AND ARE 1/4W, 5%, AND CAPACITOR VALUES ARE IN MICROFARADS

NOTES:

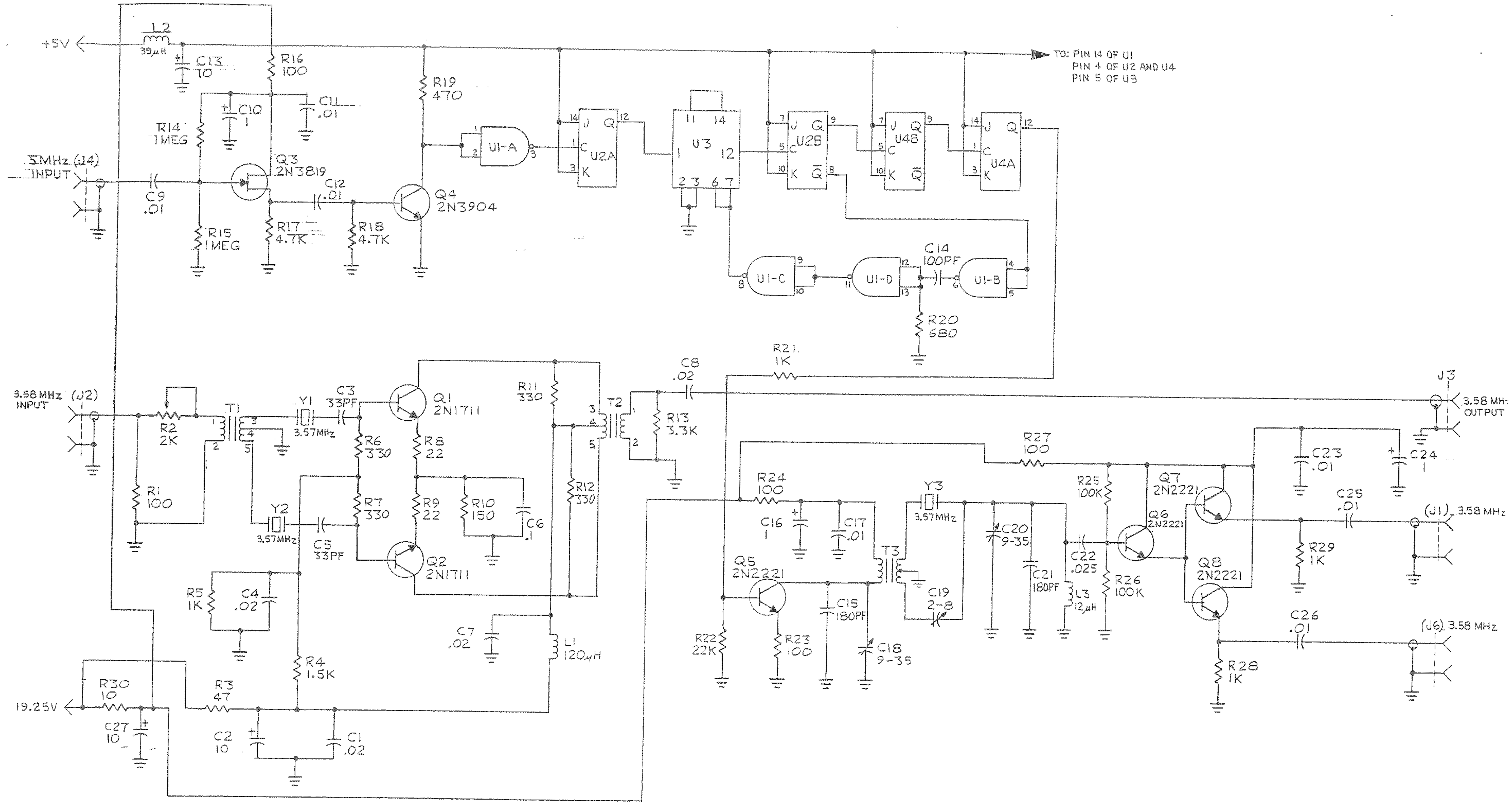
Figure 7-10 Assembly A13, Optical Microwave Unit Schematic Diagram, Drawing G45083 Rev F

From P9 pin 20



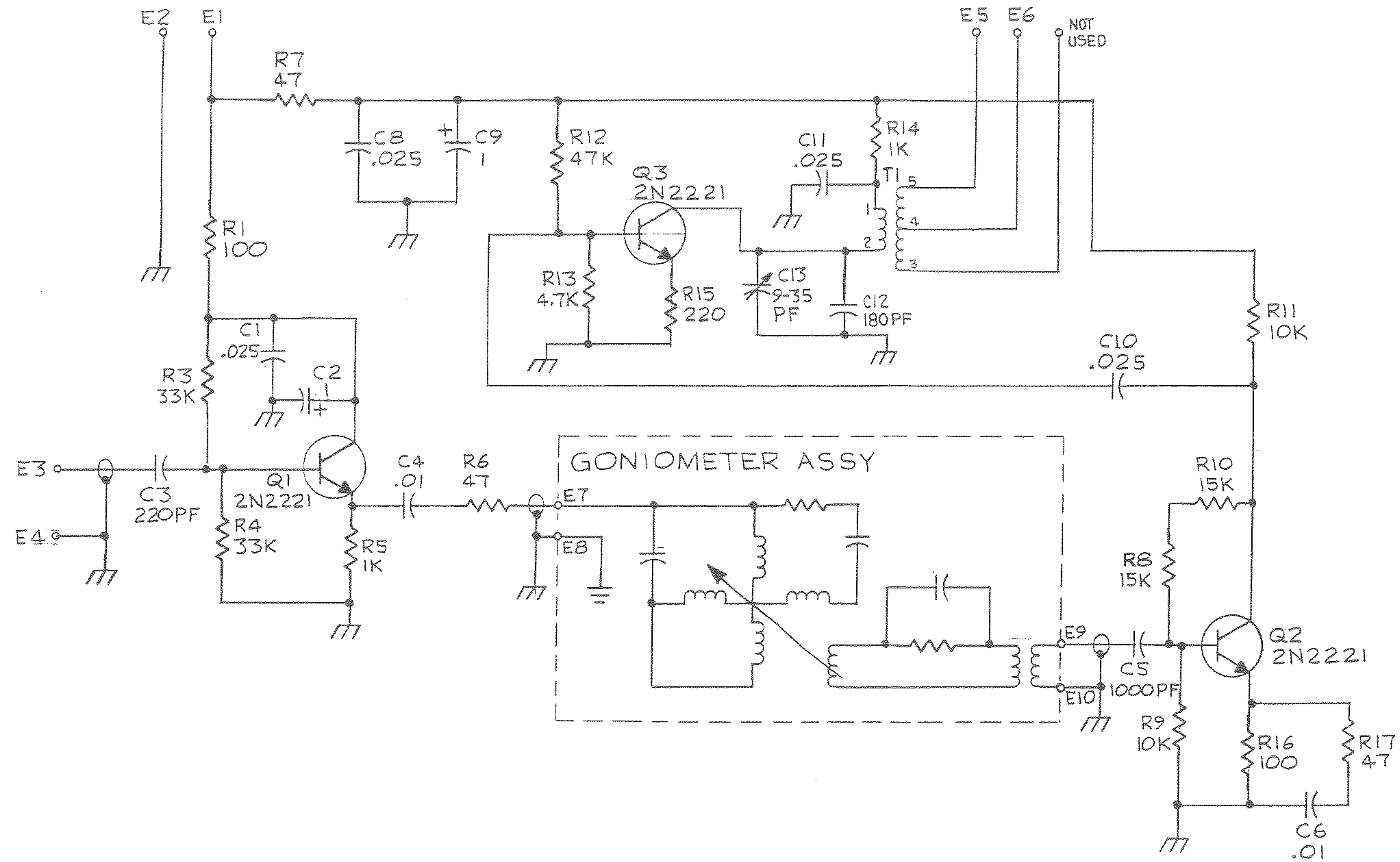
6. * SELECTED IN TEST
5. U1 IS FAIRCHILD U5B7741312
4. REF DESIG ARE ABBREVIATED
3. RESISTOR VALUES ARE IN OHMS AND 1/8 W, 5%
2. CAPACITOR VALUES ARE IN MICROFARADS
1. ASSEMBLY IS G-35161
NOTES: UNLESS OTHERWISE SPECIFIED

Figure 7-11. Assembly A14, 5MHz Crystal Oscillator Schematic Diagram, Drawing G45187 Rev A



2. LOGIC TYPES ARE: U1, SN7400N; U2, SN7473N; U3, SN7490N; U4, SN7473N
1. UNLESS OTHERWISE SPEC: RESISTORS ARE 1/4W, 10% WITH VALUES IN OHMS; CAPACITANCE IS IN MICROFARADS
NOTES:

Figure 7-12. Assembly A17, Color Sub Carrier Synthesizer Schematic Diagram, Drawing G45354 Rev C



NOTES:

1. UNLESS OTHERWISE SPEC: ALL RESISTORS ARE 1/4W, ±10% WITH VALUES IN OHMS; CAPACITOR VALUES ARE IN MICROFARADS

Figure 7-13. Assembly A18, Phase Shifter Schematic Diagram, Drawing 18436 Rev B

APPENDIX A
1 MHz DIVIDER OPTION

A-1. INTRODUCTION.

A-2. The 1MHz Divider Option, Assembly A3, provides a buffered 1MHz output to the rear panel. The option consists of a single PC board.

A-3. THEORY OF OPERATION.

A-4. See figure A-1 for a schematic diagram of the 1MHz Divider. A 5MHz signal from Distribution Amplifier Assembly A5 enters at J2 and is applied to an amplifier-shaper circuit comprised of Q1 and inverter U1A. The squared output of U1A feeds decade divider U2. The divide-by-5 terminal of U2 (pin 8) provides a 1MHz output that is buffered by amplifier U1B. The output of U1B passes through a band-pass filter that is tuned to 1MHz to produce a sinewave output. The 1MHz sinewave passes through emitter follower Q2 and feeds tuned output driver Q6. The signal at the secondary of T2 is a clean 1MHz sinewave with a minimum amplitude of one volt rms when loaded with 50 ohms.

A-5. REPLACEABLE PARTS.

A-6. Table A-1 provides a list of replaceable parts for the 1MHz Divider Option. Information concerning the use of this table is found in Section VI of this manual.

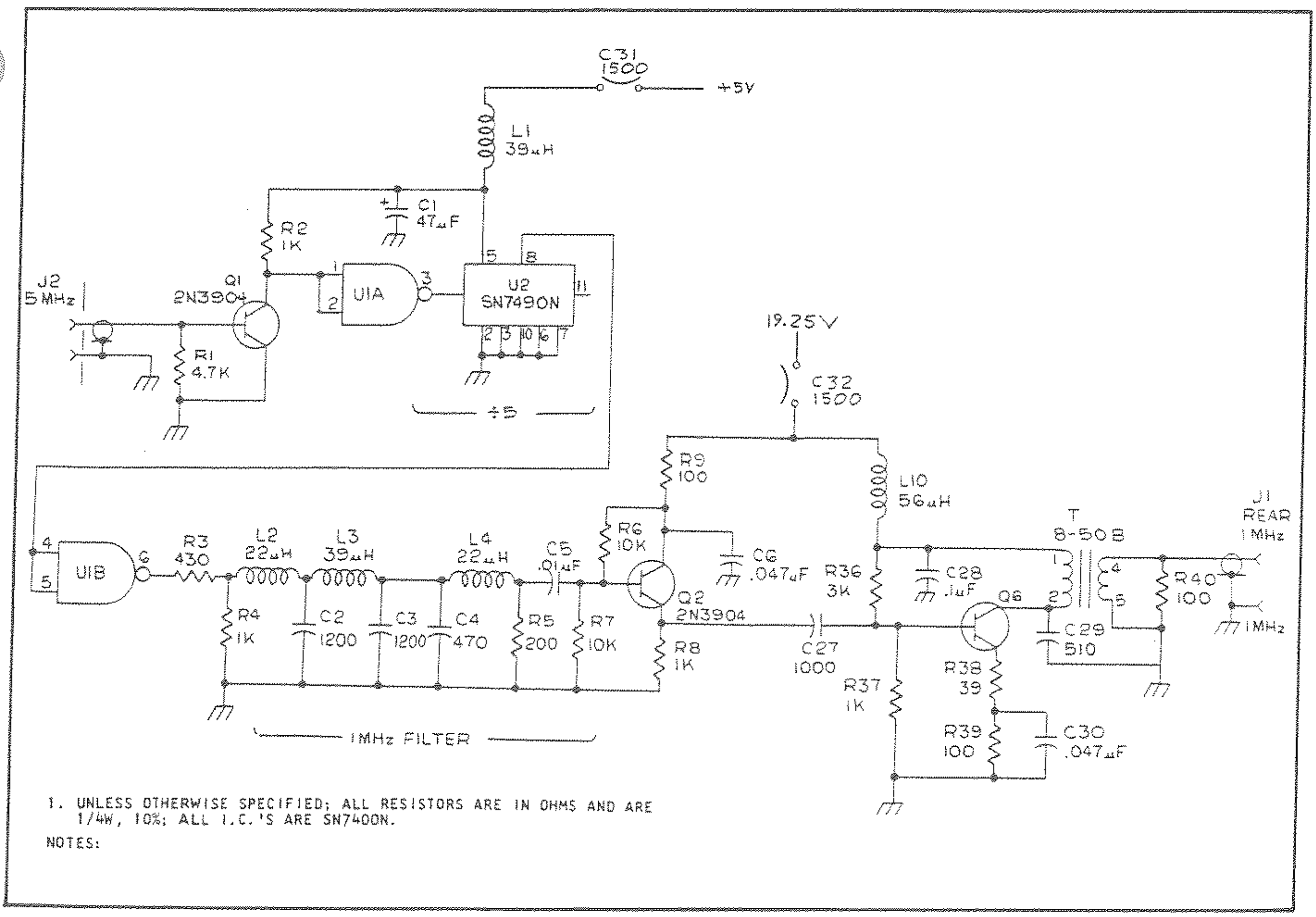


Figure A-1. Assembly A3, 1MHz. Divider Schematic Diagram, Drawing 18438 Rev-

TABLE A-1. LIST OF REPLACEABLE PARTS

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
* * *	* ASSEMBLY NO 18455-0001	ASSY 1 MHZ DIVIDER PC	* * * *	
C 1	8914-0470	CAP FXD TA 47 MFD	01295	CS13BE476K (MIL-C-26655/2)
C 2	27513-0122	CAP FXD MICA 1200 PFD	72136	DM-15-122G
C 3	27513-0122	CAP FXD MICA 1200 PFD	72136	DM-15-122G
C 4	27513-0471	CAP FXD MICA 470 PFD	84171	DM-15-471G
C 5	23969-0019	CAPACITOR	00656	MC80V103AM
C 6	3324-9473	CAP FXD MYL .047 MFD	56289	192P47392
C 27	27512-0102	CAP FXD MICA 1000 PFD	72136	CM06F102G03 (MIL-C-5/18)
C 28	3324-9102	CAP FXD MYL .1 MFD	56289	192P10492
C 29	27512-0511	CAP FXD MICA 510 PFD	84171	CM06F511G03 (MIL-C-5/18)
C 30	3324-9473	CAP FXD MYL .047 MFD	56289	192P47392
J 4	23969-0034	CONNECTOR	98291	51-053-0119
J 6	23969-0034	CONNECTOR	98291	51-053-0119
L 1	23969-0024	CHOKE 39 MH	76493	9340-34
L 2	3568-0220	INDUCTOR 22 UH	99800	1537-44
L 3	23969-0024	CHOKE 39 MH	76493	9340-34
L 4	3568-0220	INDUCTOR 22 UH	99800	1537-44
L 11	3568-0560	INDUCTOR 56 UH	99800	1537-64
Q 1	900-3904	TSTR 2N3904	04713	2N3904
Q 2	900-3904	TSTR 2N3904	04713	2N3904
Q 6	900-2218	TSTR 2N2218	04713	2N2218
R 1	204-0472	RES FXD COMP 4.70 K	81349	RC07GF472J (MIL-R-11/8)
R 2	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 3	204-0431	RES FXD COMP 430 OHM	81349	RC07GF431J (MIL-R-11/8)
R 4	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 5	204-0201	RES FXD COMP 200 OHM	81349	RC07GF201J (MIL-R-11/8)
R 6	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 7	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 8	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 9	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 36	204-0302	RES FXD COMP 3.0 K	81349	RC07GF302J (MIL-R-11/8)
R 37	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 38	204-0390	RES FXD COMP 39 OHM	81349	RC07GF390J (MIL-R-11/8)
R 39	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 40	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
T 2	G25035-0001	TRANSFORMER	19397	G25035-0001
U 1	23408-0001	INT CKT QUAD 2-INPUT	01295	SN7400N
U 2	3938-0015	INTEGRATED CIRCUIT	01295	SN7490N
	18455-0001	ASSY 1 MHZ DIVIDER PC	19397	18455-0001
C 31	23969-0004	CAPACITOR FEED-THRU	72982	2499-003-X5S0-152M
C 32	23969-0004	CAPACITOR FEED-THRU	72982	2499-003-X5S0-152M

APPENDIX B
BATTERY OPTION

B-1. INTRODUCTION.

B-2. This appendix contains information necessary to operate and maintain the Battery Option for the Model 600 Rubidium Frequency Standard.

B-3. PURPOSE AND DESCRIPTION.

B-4. The Battery Option provides standby DC power for the frequency standard if external power sources fail. It can provide standby power for approximately 10 minutes.

B-5. The Battery Option utilizes a 21-cell nickel cadmium battery for its power source. It also has a printed circuit board that contains the charging and control circuits, which operate in conjunction with the DC power supply circuits. Refer to Table B-1 for a functional description of the controls and indicators.

B-6. SPECIFICATIONS.

B-7. A list of specifications for the Battery Option is provided in the following paragraphs.

B-8. OUTPUT REQUIREMENTS.

Voltage: 25.2 volts DC, nominal

Capacity: 0.6 ampere-hour after full charge (0 to 50°C) providing 10 minutes of power.

B-9. ENVIRONMENTAL.

Operation Temperature: 0 to 50°C (to maintain $\Delta f/f < 1 \times 10^{-10}$)

Storage Temperature: -40 to 75°C.

Humidity: 0 to 95%

Vibration: Meets MIL-STD-167

TABLE B-1. BATTERY OPTION CONTROLS AND INDICATORS

NAME	Function
BATTERY CHARGE switch	Selects either fast or slow charge rate for battery. Normally in SLOW position to provide a trickle charge. Set to FAST position to recharge battery after use.
BATTERY lamp	Normally off when battery is not used. Flashes at fast rate when battery is being used. Flashes at slow rate when battery is being charged at fast rate. Lights continuously after battery has been used and AC power is reapplied.
BATT. CYCLE switch (rear panel)	When set to Up position, allows battery to operate frequency standard with and external DC still connected. This is used to discharge battery and prevent cell plates from passivating, which reduces cell life. POWER switch must initially be in Down position before switch will activate battery circuits.

B-10. BATTERY RECHARGING.

B-11. After the frequency standard has operated from battery power, the battery must be recharged at the fast rate one hour for each minute of use. If the battery was used until the low-voltage cutoff point was reached, recharge the battery at the fast rate for 16 hours.

B-12. DETAILED CIRCUIT ANALYSIS.

B-13. A detailed analysis of the Battery Option Assembly is provided in the following paragraphs. Battery Option Assembly A2A16 provides standby DC power for the frequency standard, and generates the battery charging current and a flashing signal for the front panel BATTERY lamp. The assembly consists of a differential sensor, low voltage sensor, charging circuit, and lamp flasher. Refer to figure B-1 for a block diagram of the Battery Option Assembly and to figure 7-2 for a schematic diagram.

B-14. DIFFERENTIAL SENSOR.

B-15. The differential sensor detects a low voltage output from the power supply rectifiers or a low external DC voltage, and switches in the battery to the power supply circuits. It consists of Q4, Q6, Q7, Q14, Q16, and Q17.

B-16. Assuming that Q15 is saturated, if either Q4 or Q17 is providing a voltage at the top of R35 (emitter of Q16) that is higher than the voltage at the base of Q16, Q16 will be off. When Q16 is off, the battery is isolated from the power supply circuits.

B-17. The level of the EXT DC is sensed by Q17, and the level of the AC line voltage is sensed by Q4. If both of these voltages are lower than a prescribed level, Q16 begins to conduct. As Q16 turns on, Q14 turns on and regeneratively saturates Q16. Q14 also supplies current to R32 which increases the voltage at the base of Q16 so that hysteresis voltage changes in the sense circuits will not cause oscillatory switching.

B-18. When Q16 saturates, it causes Q6 and Q7 to saturate, connecting the internal battery to the power supply circuits. Q16 saturated also causes Q5 to saturate, supplying voltage to the lamp circuitry.

B-19. LOW-VOLTAGE SENSOR.

B-20. The low-voltage sensor measures the voltage drop across Q2 in the power supply regulator circuit on the standard PC board and disconnects the battery from the power supply when the supply output starts to lose regulation. It consists of Q2, Q3, Q15, CR8, and CR9.

B-21. The voltage at the collector of power supply transistor Q2 is applied through pins 22 to the base of Q2. The emitter voltage is applied through pins 21 to the base of Q3. As long as this voltage difference is above approximately three volts DC, Q2 and Q3 will be turned on, applying approximately 2.4ma through R7 to tunnel diode CR9. Tunnel diode conducts at 1ma, applying approximately an additional 0.5 volt DC to the base of Q15. This, with the 0.4V bias from CR8, is sufficient to turn on and saturate Q15. When Q15 saturates, a ground is applied through R35 to Q16 in the differential sensor, allowing it to operate.

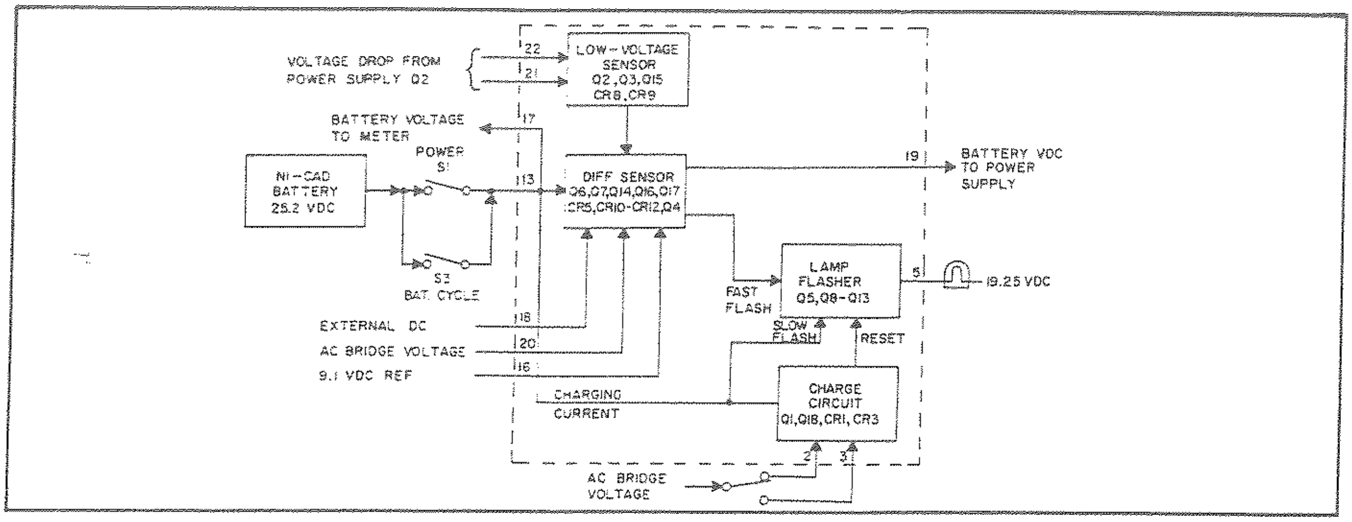
B-22. As the battery is discharged, its voltage drops. This causes Q2 in the power supply to approach saturation. When this happens, its voltage drops, causing Q2 and Q3 to decrease conduction, which causes CR9 to turn off. With CR5 off, Q15 must be off and so must Q16, Q7, Q6, Q14, and Q5. Moreover, the 19.25V output will turn off unless there is some AC or EXT DC power applied.

B-23. Resistor R6 prevents the base current of Q3 from interfering with the regulating action of Q2 in the power supply. Resistor R7 limits the current applied to CR9 to approximately four milliamperes.

B-24. BATTERY CHARGE CIRCUIT.

B-25. The battery charge circuit provides a fast charging current of approximately 72 milliamperes and a slow charging current of 12 milliamperes to maintain the charge on the battery. It consists of Q1 and CR1, CR3 and Q18.

B-26. The output of rectifier U2 in the power supply is applied to BATTERY CHARGE switch S4 and through pin 9 to the charging circuit. Zener diode CR3 sets a 3.3 V reference. With S4 in the SLOW position, this 3.3 volts is applied through R1 to Q1 to provide a charging current at the collector of Q1 that is approximately 12 milliamperes. With S4 in the FAST position, the 3.3 volts is applied through R1 in parallel with R2 to Q1 to provide a charging current that is approximately 72 milliamperes. In this position a voltage is also applied to the lamp flasher to indicate the battery is being recharged at the fast rate. The charging current is applied through pin 13 and POWER switch S1 to the battery.



A6-106-535

Figure B-1. Battery Option Assembly Block Diagram

B-27. LAMP FLASHER.

B-28. The lamp flasher provides four operating modes for front panel BATTERY lamp DS1. When the lamp is off it indicates the battery is not being used, was not used, and is not being charged at the fast rate. When the lamp flashes at the fast rate, it indicates the battery is supplying power to the power supply. When the lamp stays on, it indicates the battery was used, but external power has been reapplied. When the lamp flashes at the slow rate, it indicates the battery is being recharged at the fast rate.

B-29. The lamp flasher consists of Q5, and Q8 through Q13. Under normal operating conditions, all transistors are turned off and the lamp does not light. When the differential sensor turns on and applies battery power to the power supply, the voltage applied to the base of Q5 is reduced. This turns on and saturates Q5, applying the battery voltage at the emitter to the bases of Q10 and Q9 through R21 and R23. This turns on and saturates both Q9 and Q10. The voltage at the emitter of Q5 is also applied through CR6 and R10 to the emitter of unijunction transistor Q12, which acts as a relaxation oscillator. This voltage charges C3. When C3 reaches approximately 4.7 volts DC, Q12 turns on, applying the charge on C3 through Q12 to the base of Q13. Transistor Q13 turns on applying a ground through pin 5 to DS1, lighting the lamp. A ground is also applied to the base of Q11 through C4, causing it to turn on. This applies the voltage at the emitter of Q11 to the emitter of Q12 through R26, saturating it and preventing it from turning off. When C4 has charged, it allows Q11 to turn off, turning off Q12, which turns off Q13. This removes the ground from the lamp causing it to go out. This cycle is then repeated, causing the lamp to flash at a rate of two flashes per second (fast rate).

B-30. When external AC power is reapplied, the output of rectifier U2 is applied through the SLOW position of S4 to Q8. This turns on, applying a latch voltage to the base of Q9. When the differential sensor turns off, the voltage at the base of Q5 increases, turning Q5 off. This turns off Q10 and Q12. When Q10 turns off, the voltage at the collector of Q8 is also applied to the base of Q13 turning it on. With Q13 turned on all the time, the lamp will light continuously. To remove the latch voltage from the base of Q9, switch S4 must be set to the FAST position.

B-31. When S4 is set to the FAST position, the voltage applied to Q8 is removed. This turns off Q8, turning off Q9, which turns off Q13, causing the lamp to go out. However, with S4 in the FAST position, a voltage is applied through Q18 and R3 to the emitter of Q12. This activates Q12, Q13, and Q11 as discussed in paragraph B-29, causing the lamp to flash. However, this voltage is much lower than the battery voltage applied before. Therefore, the lamp will flash at the slow rate. Since Q5, Q10, Q9, and Q8 are not turned on, the lamp will go out when S4 is returned to the SLOW position.

B-32. MAINTENANCE.

B-33. Once every two months, the battery should be discharged for ten minutes. This is accomplished by setting the BAT. CYCLE switch on the rear panel to the Up position and the main power switch to OFF. The frequency standard must first be operating from AC or external DC power before the BAT. CYCLE switch will activate the battery circuit.

B-34. After discharge, recharge the battery as specified in paragraph B-11.

B-35. REPLACEABLE PARTS.

B-36. Table B-2 provides a list of replaceable parts for the Battery Option. Information concerning the use of this table is found in Section VI of this manual.

TABLE B-2. LIST OF REPLACEABLE PARTS

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
* * *		* ASSEMBLY NO G45194-0001 315 A BATTERY OPTION * * *		
	G64500-0001	RES TOP ASSY	19397	G64500-0001
A 2	G45022-0001	BOARD PCB ASSY A16A2	19397	G45022-0001
F 4	3348-9301	FUSE 3 AMP 250 VOLT	75915	312003.
J 23	G25180-0001	CONNECTOR ASSY	19397	G25180-0001
S 4	3640-0104	SWITCH TOGGLE SPDT	09353	7101
BT 1	G15322-0001	BATTERY	19397	G15322-0001
XA 2	G35229-0001	HARNESS ASSY BATTERY	19397	G35229-0001
XF 4	3769-0004	HOLDER FUSE	75915	342004