OPERATION AND SERVICE MANUAL

MODEL 304D RUBIDIUM FREQUENCY STANDARD

SERIAL NO. 255

G65004 REV A

April 1971

TRACOR™

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.

TRACOR, INC.
6500 Tracor Lane
Austin, Texas 78721
512/926-2800
ATTN: PRODUCT SERVICE

TRACOR

A6-5-624 (DEC. 70)

TRACOR 6500 TRACOR LANE, AUSTIN, TEXAS 78721

ADDENDUM SHEET

Model 304D Supplied to U.S. Coast Guard

Under Contract No. GS-03S-36660 and Order No. 3PN-B-05934-1

Units supplied under this contract include the Battery Option (See Appendix B). External DC is applied by Switch S4 to the Battery Option Circuit Card when S4 is placed in EXTERNAL position. In INTERNAL position S4 connects the Internal Battery to the Battery Option Circuit Card. The external power is NOT applied through Standoff Diode Q1 and Differential Sensors Q3-Q7. As a result the lamp flash indications described in Appendix B also apply with respect to External DC when Switch S4 is in EXTERNAL position. In Figure 7-2 the wiring removed in the Coast Guard modification is shown by dash-lines.

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SECTION I
GENERAL DESCRIPTION

1-1. INTRODUCTION.

1-2. This section provides the purpose and general description of the Rubidium Frequency Standard Model 304D. It also lists the physical and electrical specifications and provides a brief functional description of the operating controls and indicators.

1-3. PURPOSE OF EQUIPMENT.

1-4. The rubidium frequency standard is designed to provide an extremely accurate and stable frequency source for laboratory and system applications. It can also be used in timekeeping systems when the clock option is installed.

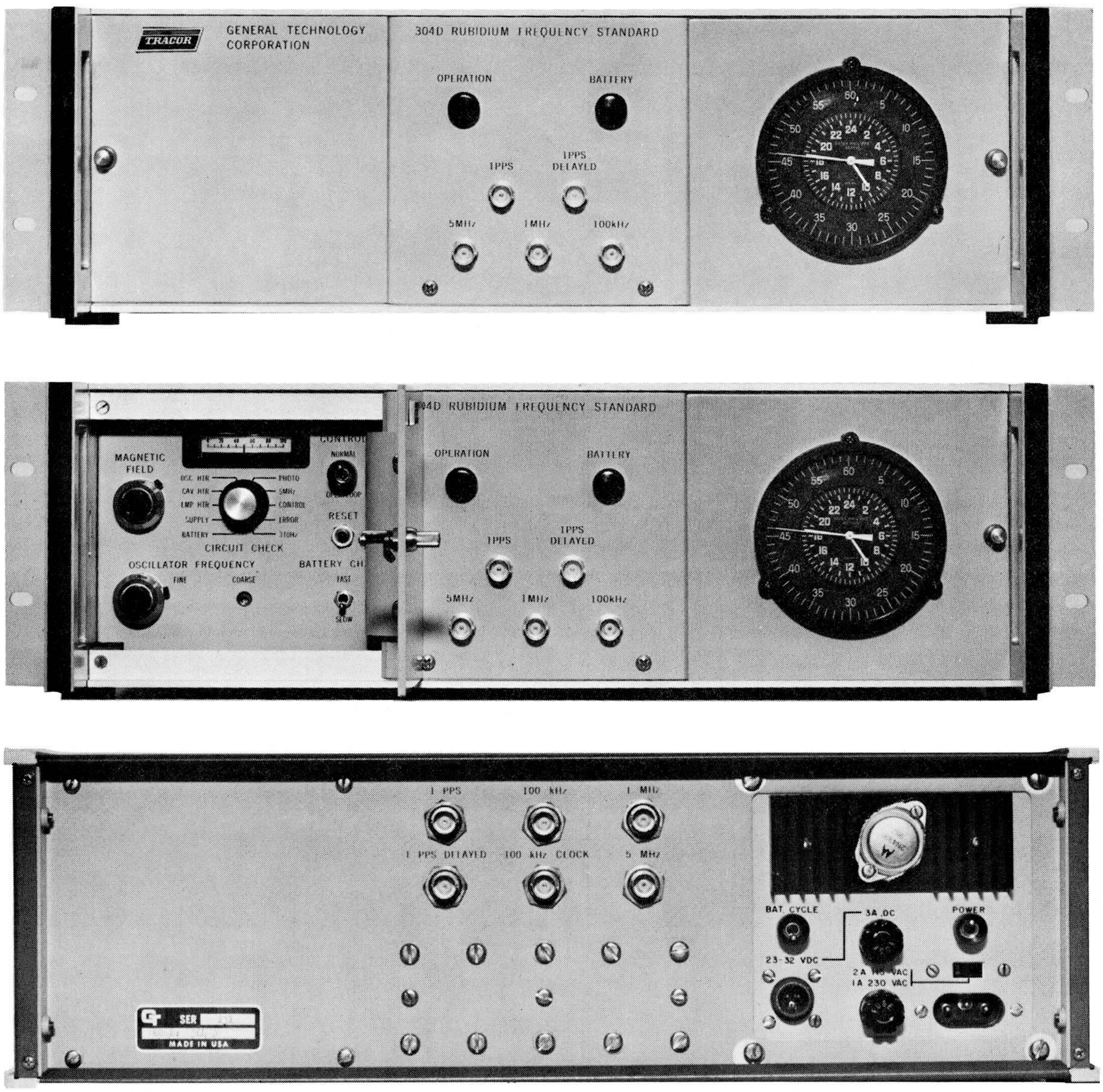

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Figure 1-1. Rubidium Frequency Standard Model 304D.

1-5. DESCRIPTION OF EQUIPMENT.

1-6. The rubidium frequency standard (figure 1-1) is a self-contained, secondary standard which uses the hyperfine resonant frequency of rubidium 87 to stabilize the frequency of a quartz crystal oscillator. It contains an optical microwave unit; a quartz crystal oscillator, a synthesizer; and the associated control, divider, and logic circuits. Outputs of 5MHz, 1MHz, and 100kHz are provided on both front and rear panels. Refer to table 1-1 for a functional description of the controls, and pilot lamp and meter indications.

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 the nominal frequency of the crystal oscillator by changing the bias to the control voltage.
COARSE OSCILLATOR FREQUENCY Control	Adjusts the nominal frequency of the crystal oscillator.
CIRCUIT CHECK Meter	Indicates the level of the signal being monitored as determined by the CIRCUIT CHECK Selector.
CIRCUIT CHECK Selector	Selects one of ten signals to be displayed by the 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	Indicates degree to which control loop must pull oscillator from its natural frequency.

Table 1-1. (Continued)

NAME	FUNCTION	
CIRCUIT CHECK Selector (Continued)	**Position**	**Function**
	ERROR	Error signal voltage applied to loop filter integrator.
	310Hz	310Hz signal voltage
CONTROL Switch	Opens the automatic frequency control (AFC) loop in the OPEN LOOP position, allowing the output frequency of the standard to be varied manually with the FINE OSCILLATOR FREQUENCY Control. Closes the frequency control loop in the NORMAL position, allowing the rubidium resonance to control the output frequency.	
RESET Pushbutton	Resets the 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 the charging rate of the optional internal standby battery. (Refer to Appendix B)	
OPERATION Lamp	This lamp has three modes. Glows continuously when AFC loop remains 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.)	
1PPS Connectors	Provide optional lpps output pulses on front and rear panels. (Refer to Appendix A)	
1PPS Delayed Connectors	Provide optional delayed 1pps output pulses on front and rear panels. (Refer to Appendix A)	
5MHz Connectors	Provide 5MHz sinewave outputs on front and rear panels.	
1MHz Connectors	Provide 1 MHz sinewave outputs on front and rear	
100kHz Connectors	Provide 100kHz sinewave outputs on FRONT and REAR panels.	
Clock & Associated Controls	Refer to Appendix A for clock option.	

Table 1-1. (Continued)

NAME	FUCTION
100kHz CLOCK Connector	Provides 100kHz clock output signal on rear panel.
BAT CYCLE Switch	When set to the "up" position, allows optional internal standby battery to operate the 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 the "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 the frequency standard when operating from external DC power.
2A 115 VAC Fuse 1A 230 VAC Fuse	Provides overload protection for 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.
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.

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
Clock Option	8	6
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, 1MHz, 100kHz sinewave on front and rear panels. All separately buffered. ($\Delta f/f$ less than 1×10^{-11} as load on any one output varies from short to 50 ohms to open.)

Long-term Stability: Less than 2×10^{-11} per month.

Short-term Stability:

$\Delta f/f$ (std. dev.)	Avging time (sec.)
$< 7 \times 10^{-12}$	1

Accuracy: Set at factory to within 1×10^{-11} of specified time scale.

Voltage Level: Greater than 1 volt rms into 50 ohms.

Impedance: Less than 50 ohms (30 ohms nominal).

Harmonic Distortion: At least 40dB down from rated output.

Non-harmonic Distortion: At least 80dB down from rated output.

Signal-to-Noise Ratio: Greater than 87dB at rated output in 30kHz noise bandwidth. (1 and 5MHz outputs only.)

Clock Drive: 100kHz squarewave on rear panel. (AC coupled) Greater than .5 volts rms into 1000 ohm load. Impedance less than 1200 ohms.

1-13. TUNABILITY.

Frequency Synthesizer: Range: 1000×10^{-10} Resolution: 2×10^{-9}

Magnetic 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
Clock	A
Time Delay	A
Standby Battery	B

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 5-157.)

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 the 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 A for operation of the clock option and to Appendix B for 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 that 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 frequency 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.

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	55-70 (25°C)	Indicates heater current supplied to oven for rubidium lamp.
CAV HTR	55-70 (25°C)	Indicates heater current supplied to oven for microwave cavity.
OSC HTR	60-85 (25°C)	Indicates heater current supplied to oven for 5MHz crystal oscillator.
PHOTO	70-85	Indicates output current of photocell in OMU.
5MHz	70-100	Indicates level of 5MHz outputs.
CONTROL	0-100	Indicates magnitude of control applied to 5MHz crystal oscillator by frequency control loop.
ERROR	50	Indicates DC error signal voltage applied to loop filter integrator. Reading of 50 (zero-error) is normal with loop closed.
310Hz	60-80	Indicates level of 310Hz signal.

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 near full scale for all three positions.
f. When OPERATION lamp begins to flash at the slow rate (in approximately 1 hour), press RESET pushbutton. OPERATION lamp should glow steadily.
g. If the OPERATION lamp still flashes at fast rate, set CIRCUIT CHECK selector to CONTROL position. If meter indicates full scale, momentarily set CONTROL switch to OPEN LOOP position and return to NORMAL. Meter should indicate approximately 50. Press RESET pushbutton. OPERATION lamp should light steadily.
h. Allow the instrument to warm up for three to four hours. With CIRCUIT CHECK switch still set to CONTROL position, unlock FINE OSCILLATOR FREQUENCY control, set to 50, and relock. Adjust COARSE OSCILLATOR FREQUENCY control for meter indication near 50. Response of meter to each adjustment will be slow. Make successive small adjustments and allow 10 seconds for meter to respond after each adjustment.
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 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. If the clock option is installed, refer to Appendix A for operating instructions.

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 1. For a shift from the present setting, enter the present values in Step 1.

Step 1. 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 on page 3-12.

Step 2. Enter the desired OFFSET from the reference.

Step 3. Add the above three OFFSETS.

Step 4. Find the nearest OFFSET in table 3-2 that is below the result of Step 3 and set the synthesizer to the indicated SWITCH SETTINGS.

Subtract the OFFSET found above from the result of Step 3 and convert the OFFSET difference to a new MAGNETIC FIELD dial setting using the calibration curve.

Set the MAGNETIC FIELD dial to the setting found in 8.

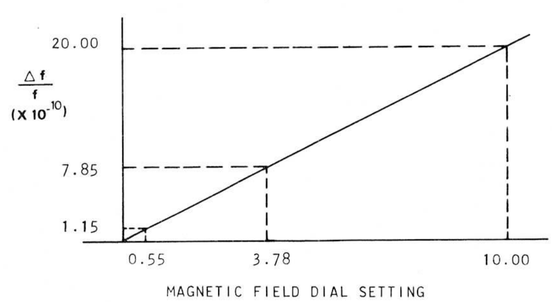

Figure 3-1. Sample Calibration Curve

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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 X 10^{-10}.

Step 1. Reference SWITCHES 1386 OFFSET from table 3-3. .000
Reference MAGNETIC FIELD 3.78 OFFSET from calibration curve 7.850

Step 2. Desired OFFSET from reference settings of Step 1 -450.000

Step 3. Sum of above three OFFSETS -442.150

Step 4. New SWITCHES from Table 3-2 1786 — Yielding OFFSET below computation of Step 3 -443.300

Step 5. New MAGNETIC FIELD from calibration curve 0.55 — Corresponding to OFFSET difference of Steps 3 and 4 1.150

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

TABLE 3-2. OFFSET FREQUENCY SETTINGS

ØFFSET X10↑-10	SWITCH SETTING S10--------------S1	P	SYNTHESIZER FREQUENCY
-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
-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
-251.344	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
-266.877	0 0 0 0 1 0 1 1 0 0	1068	5313670.4
-271.992	0 1 0 0 1 1 1 0 1 1	1339	5313666.9
-275.396	1 0 0 1 0 0 1 0 1 0	1610	5313664.6
-277.802	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	5313653.1
-306.264	1 1 0 1 1 1 1 0 0 1	1913	5313643.5
-308.593	1 0 0 1 1 0 1 0 1 0	1642	5313641.9
-311.843	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	5313609.5
-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	5313604.2
-368.248	0 1 1 0 0 0 1 0 1 1	1419	5313601.1
-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	5313597.6
-386.212	0 0 0 1 1 1 1 1 0 0	1148	5313588.8
-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	5313578.8
-403.779	0 1 1 0 1 0 1 0 1 1	1451	5313576.8

TABLE 3-2. OFFSET FREQUENCY SETTINGS

ØFFSET X10↑-10	SWITCH SETTING S10--------------S1	P	SYNTHESIZER FREQUENCY
-408.110	0 0 1 0 0 0 1 1 0 0	1164	5313573.9
-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
-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

TABLE 3-2. OFFSET FREQUENCY SETTINGS

ØFFSET X10↑-10	SWITCH SETTING S10--------------S1	P	SYNTHESIZER FREQUENCY
-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
-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

TABLE 3-2. OFFSET FREQUENCY SETTINGS

ØFFSET X10↑-10	SWITCH SETTING S10--------------S1	P	SYNTHESIZER FREQUENCY
-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
-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

TABLE 3-3. OFFSET FREQUENCY SETTINGS

SWITCH SETTING S10--------------S1	ØFFSET X10↑-10	P	SYNTHESIZER FREQUENCY
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
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

TABLE 3-3. OFFSET FREQUENCY SETTINGS

SWITCH SETTING S10--------------S1	ØFFSET X10↑-10	P	SYNTHESIZER FREQUENCY
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
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

TABLE 3-3. OFFSET FREQUENCY SETTINGS

SWITCH SETTING S10--------------S1	ØFFSET X10↑-10	P	SYNTHESIZER FREQUENCY
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
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	5313167.2
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	-661.680	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	-646.314	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	5313868.6
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

SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION.

4-2. This section provides the theory of operation for the Rubidium Frequency Standard Model 304D. It includes a functional description of the instrument, a detailed circuit analysis of the individual assemblies, and a brief description of rubidium resonance and the optical pumping technique.

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. 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, a process known as 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 7800 Å, 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. As a result, the total number of atoms at state 2 will be greater than the number at state 1. The reduced population in energy state 1 results in a reduction in radiation absorbed at 7800 Å. Optical radiation absorption is detected by a photocell. This technique produces an output signal that has greater usability than a direct measurement of microwave absorption.

4-11. When the applied microwave frequency exactly matches the rubidium resonant frequency, it will effect maximum transfer of excess state 2 atoms back to state 1 and the absorption of light at 7800 Å 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.

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

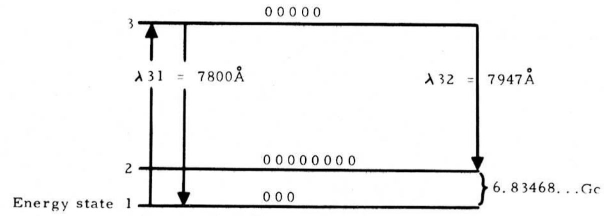

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Figure 4-1. Rubidium 87 Simplified Energy State Diagram.

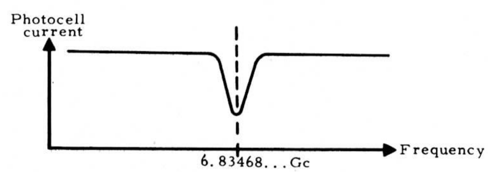

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Figure 4-2. Photo Cell Output Versus Frequency.

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 multipler produces a signal at 90MHz, modulated by the 155Hz 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 to approximately 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 Assembly, Audio Assembly, 1MHz/100kHz Divider Assembly, Logic Assembly, Synthesizer Assembly, Synchronous Detector and Loop Filter Assembly, Distribution Amplifier Assembly, X18 RF Multiplier Assembly, Oscillator Regulator and Lamp Start Assembly, 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 Assembly. An output for monitor-

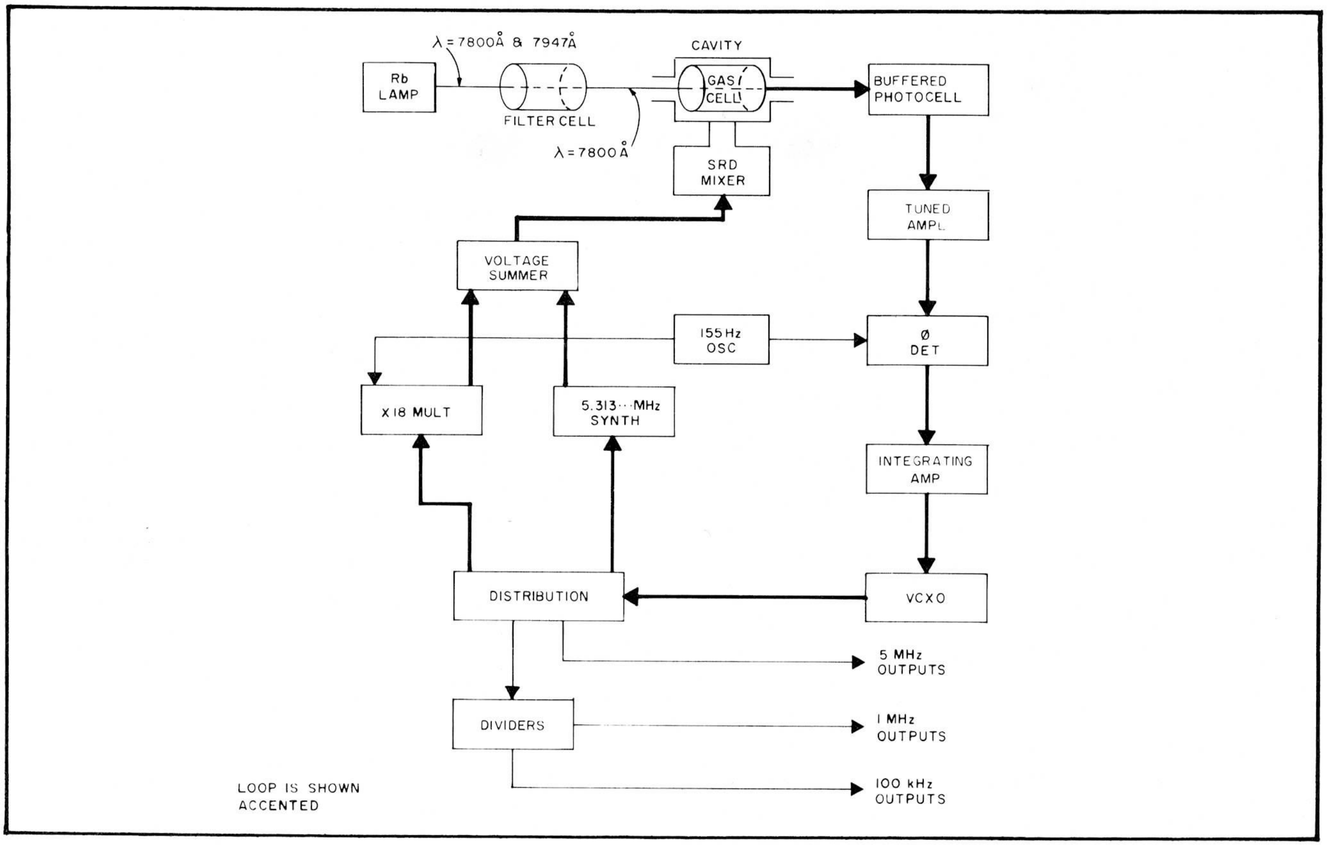


Figure 4-3. Rubidium Frequency Standard Simplified Block Diagram.

ing the oscillator heater on the CIRCUIT CHECK METER is also provided.

4-19. The Distribution Amplifier Assembly 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 output signals of 5MHz are provided for the 1MHz/100kHz Divider Output Assembly, Synthesizer Assembly, Multiplier Assembly, and the Optional Clock Assembly. An output for monitoring the 5 MHz level on the CIRCUIT CHECK meter is also provided.

4-20. The Synthesizer Assembly 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 ten time scale selector switches. The divider output 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 Assembly. The Synthesizer Assembly also produces a lock indication signal that is applied to the Logic Assembly. This signal indicates when the crystal oscillator in the synthesizer is properly locked at a harmonic of the divider output.

4-21. The 5MHz signal applied to the X18 RF multiplier from the distribution amplifier is buffered and then modulated by the 155Hz from the Audio Assembly. This modulated signal is tripled to 15MHz, tripled again to the 45MHz, and doubled to 90MHz. This 90MHz signal is 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 matching network and 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 which is at or near the rubidium resonant frequency, depending on the exact frequency of the 90MHz input. A photocell and amplifier detect the amount of light from the rubidium lamp that is not absorbed by the rubidium gas cell. The modulation at 155Hz causes the frequency to sweep back and forth across the rubidium resonance curve. If the frequency is exactly centered, the output is a signal at

310Hz, the second harmonic of the modulation frequency. If the frequency is not centered, a 155Hz component exists in the output indicating the presence of a frequency error. The exact frequency of the rubidium resonance is dependent upon the strength of the steady magnetic field (C field) existing in the microwave cavity. This field is controlled by the front panel MAGNETIC FIELD control providing a fine adjustment of the output frequency.

4-23. The Audio Assembly preamplifies the photocell amplifier output and separately amplifies the 155Hz and 310Hz components of the signal. The 310Hz signal is applied to the Logic Assembly, and the 155Hz signal to both the Logic Assembly and the Loop Filter Assembly. 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 Assembly. The Audio Assembly also generates a 155Hz reference signal for the loop filter and a 155Hz 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 Assembly receives a 155Hz reference and the 155Hz photocell signal from the Audio Assembly. These two signals are multiplied together providing an error voltage that is integrated and applied, as a control voltage, to 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. A FINE OSCILLATOR FREQUENCY control adjusts the bias voltage to change the 5MHz crystal oscillator's natural 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 Assembly receives the 310Hz signal and 155Hz photocell signal from the Audio Assembly, the control voltage 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 Assembly 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 310Hz voltage on the CIRCUIT CHECK meter is also provided.

4-26. The Oscillator Regulator and Start Assembly provides the start pulse for the OMU rubidium lamp. This pulse is applied whenever a start signal is received from the Audio Assembly. This assembly also provides an adjustable regulated voltage to the lamp oscillator circuit in the OMU.

4-27. The 1MHz/100kHz Divider Output Assembly divides the 5MHz signal down to 1MHz and 100kHz. It provides individually buffered and isolated 1MHz and 100kHz outputs on the front and rear panels.

4-28. DETAILED CIRCUIT ANALYSIS.

4-29. A detailed analysis of the circuits of each assembly in the frequency standard is provided in the following paragraphs. The assemblies are discussed in numberical order according to assembly numbers. Table 4-1 provides a list of these assembly numbers. References to figures in Section VII are references to the applicable schematic diagram for each assembly. An interconnect schematic diagram for the frequency standard is provided in figure 7-1.

4-30. POWER SUPPLY ASSEMBLY A2.

4-31. The 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.

4-32. 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 that is applied through standoff diode Q2 and fuse F2 to the

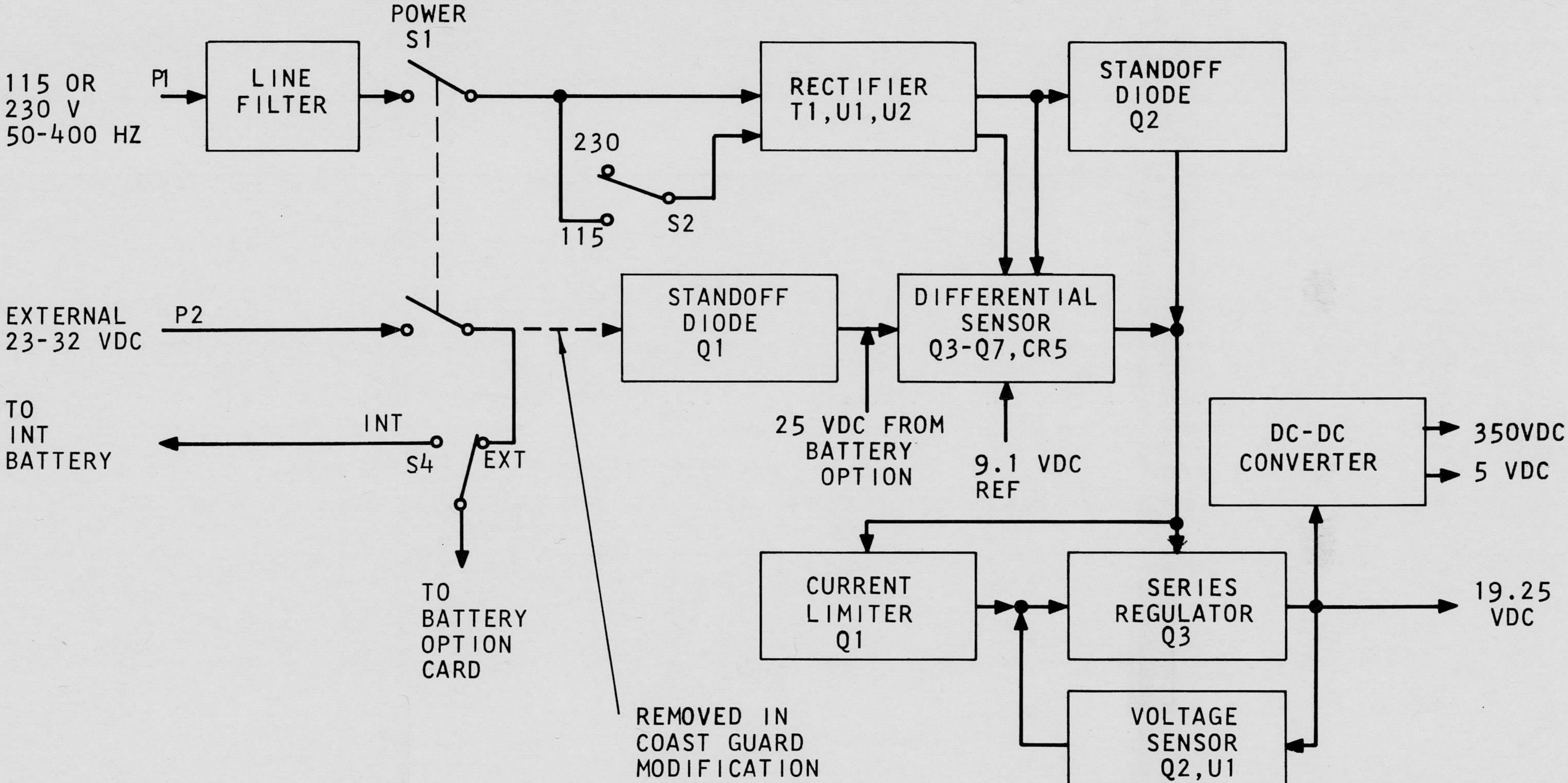


Figure 4-4. Power Supply Assembly Block Diagram

TABLE 4-1. RUBIDUM FREQUENCY STANDARD ASSEMBLT NUMBERS

ASSEMBLY NUMBER	ASSEMBLY NAME
A1	Rubidium Frequency Standard
A2	Power Supply
A3	Divider
A4	X18 RF Multiplier
A5	Distribution Amplifier
A6	Synthesizer
A7	Audio
A8	Oscillator Regulator and Start
A9	Loop Filter
A10	Logic
A11	Subpanel
A12	Clock Option (Refer to Appendix A)
A13	Optical Microwave Unit (OMU)
A14	5MHz Crystal Oscillator
A16	Battery Option (Refer to Appendix B)

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 when AC power is available. The output of U2 is filtered by C2, providing 40 volts DC that is applied to the differential sensor and battery option indicating the presence of AC power.

4-33. 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 the 19.25 volt DC supply to the frequency standard circuits, to the voltage sensor, and to the DC-DC converter.

4-34. 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 that is 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 that is applied 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 the emitter and collector of Q2 are connected to the battery option to detect the low voltage cutoff point for the battery.

4-35. 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.

4-36. CURRENT LIMITER. The current limiter protects against internal short circuits by limiting the current that can be drawn to 4 amps until fuse F2 blows. Without this function, it would be possible for a short circuit to draw enough current, before F2 would blow to cause damage to the power supply circuits.

4-37. Resistor R1 senses the amount of current being 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.

4-38. 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 the supply voltage for the integrated circuits in the frequency standard.

4-39. 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.

4-40. The output of rectifier U2 is applied through R14 and R22 to the base of Q7, and to the battery option. Capacitor C2 damps out any 60 Hz 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.

4-41. 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 from U2 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.

4-42. X18 RF MULTIPLIER ASSEMBLY A4.

4-43. The X18 RF Multiplier Assembly A4 generates a 90MHz signal frequency modulated at a 155Hz rate, that is voltage summed with a 5.313. . .MHz signal. This signal is used to drive the microwave cavity resonator in the OMU. It 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.

4-44. 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 to isolate the 5MHz in the distribution amplifier from high-frequency feedback that would affect the 5MHz frequency standard output. The 5MHz input signal, from J3 of Distribution 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.

4-45. MODULATOR. The modulator consists of transistor Q3 and variable capacitor CR2. It provides frequency modulation of the 5MHz signal at a 155Hz rate.

4-46. The 5MHz 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 155Hz input signal, from J2 of Audio Assembly A7, is applied at J2 to a filtering network consisting of C3, C4, R9, R10, R11, and L3. Potentiometer R11 adjusts the level of the 155Hz signal. This 155Hz voltage is applied to CR2 causing its capacitance to vary. This variation changes the 5MHz resonant frequency of the circuit at a 155Hz rate. This produces a 5MHz output signal which is frequency modulated at 155Hz. This signal is applied to the driver amplifier.

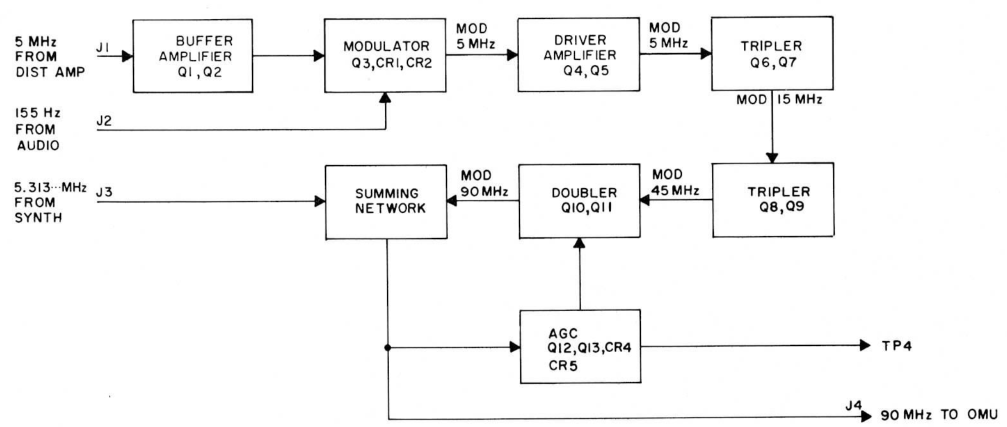
4-48. DRIVER AMPLIFIER. The driver amplifier consists of buffer amplifier Q4 and driver amplifier Q5. It provides sufficient power to drive the multiplying circuits.

4-49. The output of the modulator circuit is applied to the base of Q4, which is operated 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 in detail.

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 undesired harmonics in the output signal.



A6-106-557

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

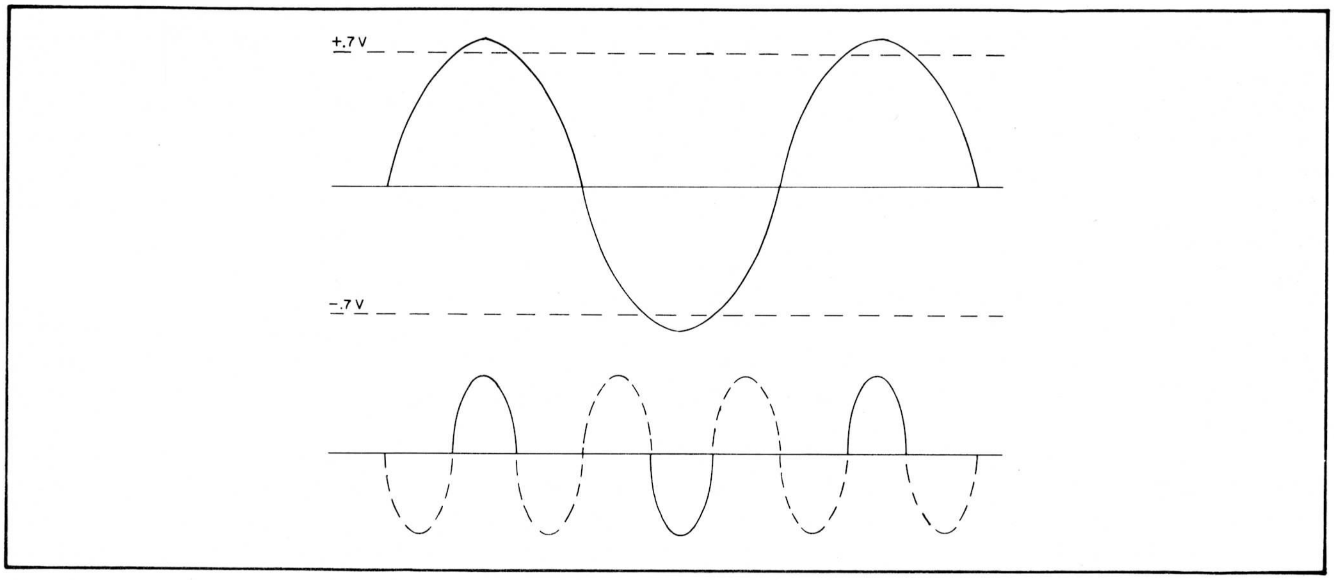


Figure 4-6. Frequency Tripler Waveforms. A6-106-556

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. It is bifilar wound for proper balance of both halves, and is 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.

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

4-57. The 5.313. . .MHz input signal from J3 on Synthesizer Assembly A6 is applied through J3 to the 50 ohm inpedance matching network R35, R36, and R42. Potentiometer R35 is adjusted to provide 5.313. . .MHz of sufficient amplitude to produce the proper microwave level in the microwave cavity of the OMU.

4-58. The 5.313. . .MHz signal is easily passed through L18 and 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 a 90MHz signal summed with the 5.313. . .MHz signal. The 155Hz frequency modulation is present in the 90MHz signal. This is applied to the AGC circuit and through J4 to the 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. The output signal is applied to the junction of CR4 and CR5. Potentiometer R39 sets a bias level at CR5 which, in turn, determines the 90MHz output level. The output signal applied to CR4 and CR5 biases CR4 and determines the conduction level of the DC current 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 base voltage of Q12. 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. The Distribution Amplifier Assembly A5 distributes the 5MHz output signal from the crystal oscillator to various circuits in 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.

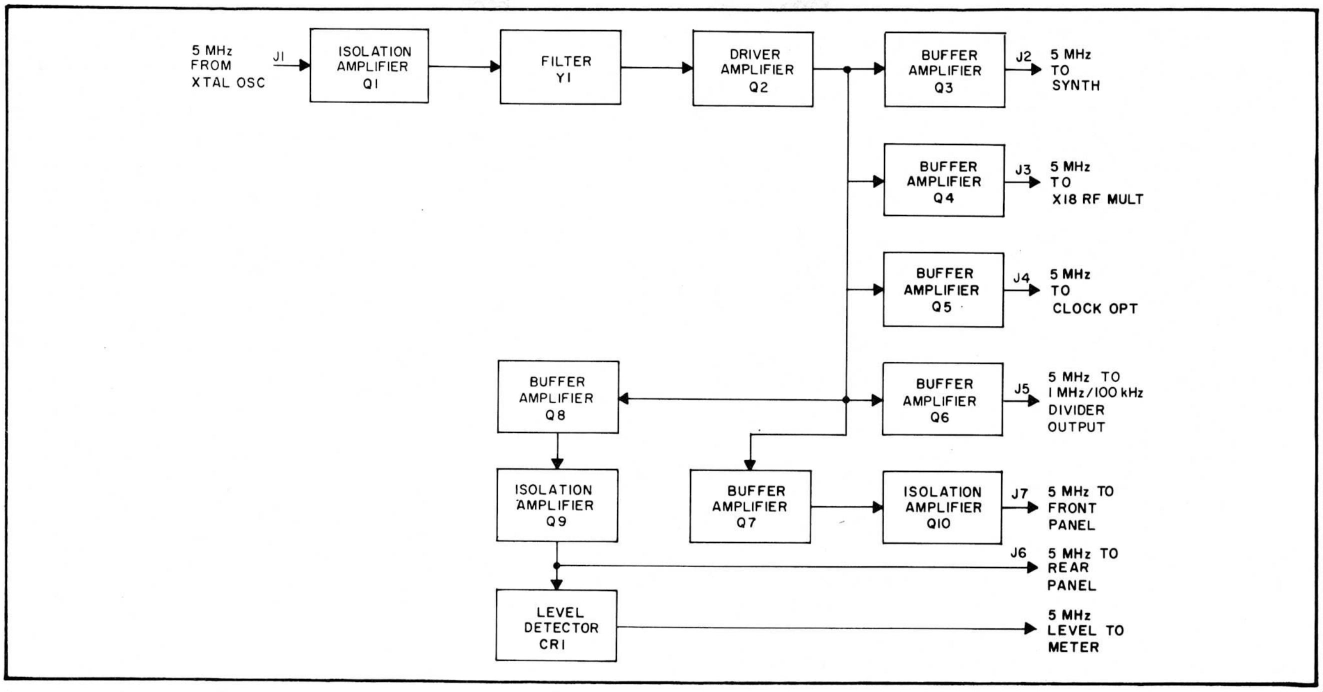


Figure 4-7. Distribution Amplifier Block Diagram.

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 a 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.

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

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

4-67. OUTPUT ISOLATION AMPLIFIER. Both front and rear panel 5MHz output isolation amplifiers are identical. Therefore, only the front panel amplifier will be discussed.

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.

TABLE 4-2. BUFFER AMPLIFIERS AND OUTPUTS

BUFFER AMPLIFIER	OUTPUT CONNECTOR	SIGNAL APPLIED TO
Q3	J2	Synthesizer Assembly A6
Q4	J3	X18 RF Multiplier Assy A4
Q5	J4	Clock Option Assembly A12
Q6	J5	1MHz/100kHz Divider Output Assembly A3

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 CIRCUIT CHECK selector, which allows the 5MHz signal to be monitored by CIRCUIT CHECK meter.

4-70. SYNTHESIZER ASSEMBLY A6.

4-71. The 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 the 6840MHz in the microwave cavity to achieve a signal nearly equal to the rubidium resonance frequency of 6834.686. . .MHz according to the relationship,

$$F_{Rb} = f(1368) - f\frac{Q}{P'}$$

where f is the RFS output 5MHz. The synthesizer divides the frequency of near 5MHz by a value P selected by means of toggle switching, and multiples the result by a number Q which produces a signal near 5.313. . .MHz. Table 3-2 gives a complete list of frequency offsets achievable with P's limited to 2047 in order of decreasing offset frequency. Table 3-3 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 dial which has a range zero to +2 X 10^{-9}. The largest increment between two adjacent P divisor settings is about 1.7 X 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 which 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 integral number of cycles of the 5.313. . .MHz signal. Let this number be represented by Q. Then we have that

$$\frac{P}{5MHz} = \frac{Q}{F_{VCXO}}, \text{ or } F_{VCXO} = \frac{Q}{P}\, 5MHz \quad (1)$$

The tolerances on the crystal are such that only a narrow range of $\frac{Q}{P}$ 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, the 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

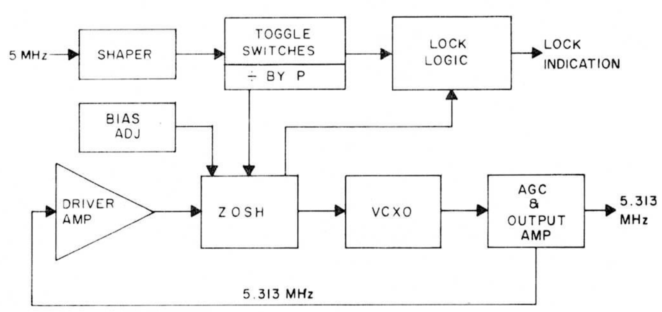


Figure 4-8. Synthesizer Assembly Simplified Block Diagram. A6-106-554

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 1.4V, 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 per 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 plus the total number of input counts equal the 2047 capacity of the accumulator, a one-shot multivibrator is triggered. The 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 $\bar{Q}$ 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 $\bar{Q}$ 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 eleven input NAND gate whose output at pin 6 of U7A will be a logic 0 only when all eleven 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 eleven input NAND 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 100nsec.

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 terminal, 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 1084 input pulses, 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 19V pulse through the collector to the gate of signal switch Q7. This 19V 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 varactor CR3. The sample pulse charges C14 to the value of the sinewave voltage existing at the top of R17 during the pulse. 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, and therefore the frequency of the oscillator.

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 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-commonbase 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, 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 vias voltage at the cathode CR5 minus the peak-to-peak value of the output at the collector Q14. This voltage (normally 0.8 VDC) is applied to the base of Q10. As the output voltage increases, Q10 conduction decreases, decreasing 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 input sinewave is applied to the base of Q6 and through CR2 and CR1, to the base of Q5. Each transistor amplifies during half of the sinewave to provide a sinusoidal 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 that is 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. Two 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. The 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, R38, and C33 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, bias will not be supplied by CR8 and CR9. This causes Q16 to stop conducting, providing a logic 1(+5VDC) output.

4-93. The other 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 operates at a steady dc level. When the loop is unlocked, a varying voltage at the holding capacitor C14 is applied to source follower Q15. The peak-to-peak output of Q15 is detected by CR7 and CR6, reducing the voltage level at the base of Q16, causing Q16 to stop conducting, and providing a logic 1 output.

4-94. AUDIO ASSEMBLY A7.

4-95. The Audio Assembly A7 generates 155Hz modulation and reference signals, processes the photocell output to provide 155Hz and 310Hz photocell signals, 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 155Hz modulating and reference signals consist of a reference oscillator, divide-by-two divider, phase adjust network, and buffer amplifier. The photocell output processing circuits consist of a photocell preamplifier, 155 and 310Hz 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 310Hz. This frequency is divided to provide an output of 155Hz 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 $\bar{Q}$ 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 155Hz squarewave at the Q and $\bar{Q}$ outputs. Zener diode CR3 maintains the input voltage at pins 3, 4, 5, 9, 10, 11, and 14 at 5VDC.

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

4-100. BUFFER AMPLIFIER. Transistors Q3 and Q8 and diode CR6 form the buffer amplifier. The 155Hz 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 the "OFF" states of Q3. It 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 $\bar{Q}$ 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 155Hz sinewave signals are applied to R14 and C8. A single 155Hz 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 signal preamplifier in the OMU is applied to J6. Operational amplifier U2 amplifies the photocell signal and has an output predominately 310Hz if the AFC loop is locked or 155Hz if it is unlocked. This output signal is applied to the lamp starter and through R26 to Q4 and to CIRCUIT CHECK selector to monitor the steady component of photocell output current on the CIRCUIT CHECK meter (PHOTO position). Potentiometer R26 adjusts the level fed to the post amplifiers.

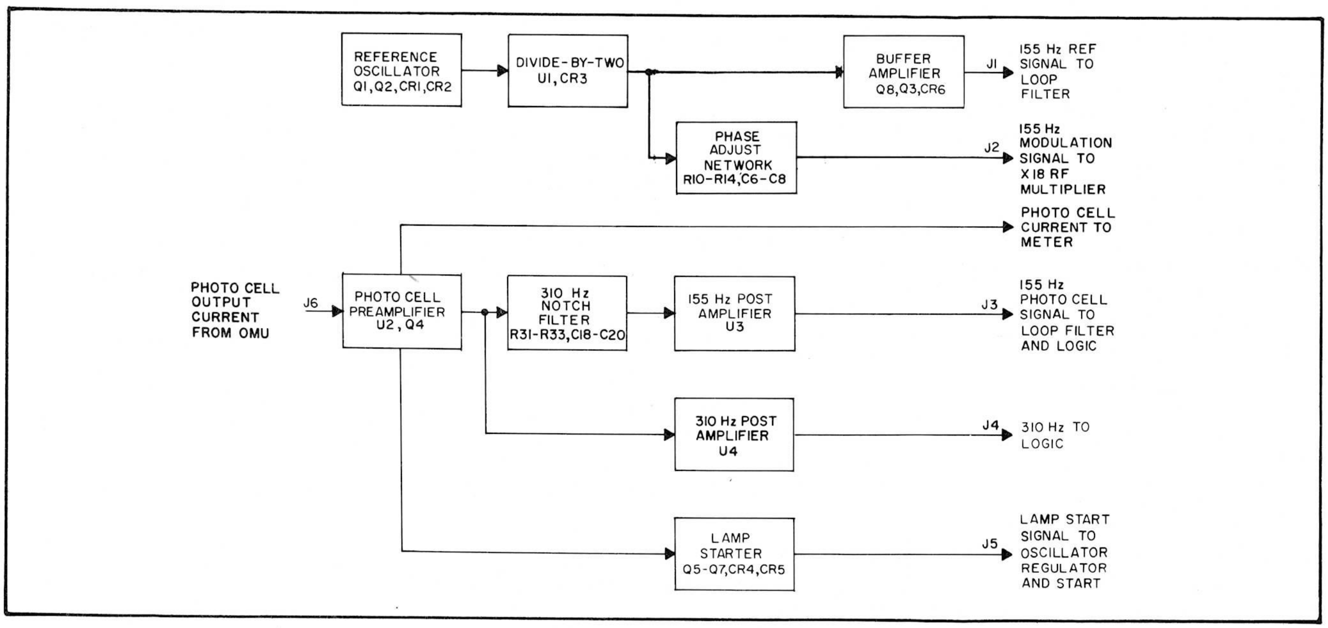


Figure 4-9. Audio Block Diagram. A6-106-553

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

4-104. POST AMPLIFIER. The two post amplifiers receive the preamplified signal from Q4. Operational amplifier U3 forms the 155Hz post amplifier and U4 the 310Hz post amplifier.

4-105. The 155Hz post amplifier operates as a narrow band amplifier centered on the modulation frequency of 155Hz. A twin-T, RC filter network consisting of R31 through R33 and C18 through C20 provides a tuned filter that rejects the 310Hz frequency. When the AFC loop is in lock, the output of U3 at pin 6 is at a minimum. This 155Hz 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 155Hz.

4-106. The 310Hz post amplifier operates essentially the same as the 155Hz 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 310Hz.

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 $\approx$ 3.3V at the base of Q5. Therefore CR4 is not conducting. This means that Q6 is turned off which applies 19.25 volts DC 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. Capacitor C26 discharges and turns off Q7. The cycle repeats, yielding an output pulse every ten seconds at J5. This signal goes to assembly A8 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. The Oscillator Regulator and Start Assembly provides the regulated DC voltage required by the lamp oscillator in the OMU and applies the lamp start pulse 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 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 the series resistance of Q2 which determines the emitter output voltage.

4-113. If the voltage output were too high, then the voltage at the base of Q3 would 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

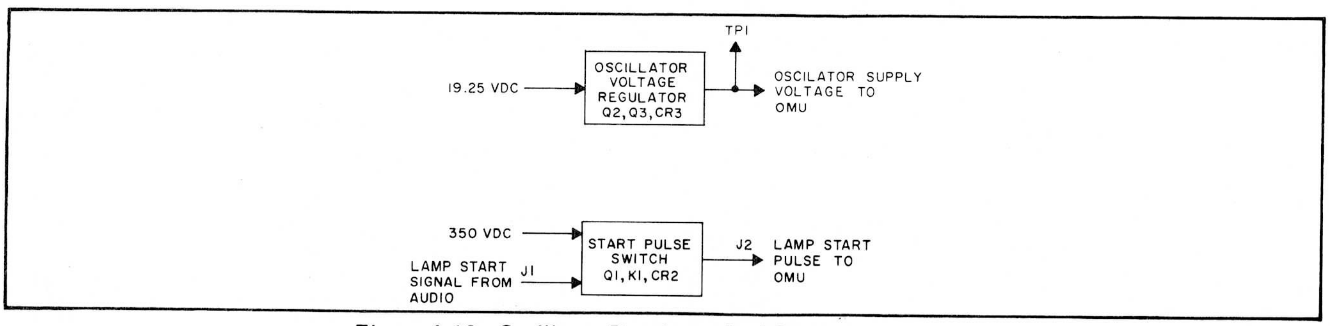


Figure 4-10. Oscillator Regulator And Start Block Diagram.

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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 connnected 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. The Loop Filter Assembly A9 converts the 155Hz 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 155Hz error signal at pin 22 with the 155Hz 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 155Hz error signal input is at its greatest amplitude.

4-119. The 155Hz error signal will either be in-phase or 180 degrees out-of-phase, with respect to the reference signal, depending 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 indicates the magnitude of frequency difference while the polarity indicates the sense of the frequency difference. This voltage is applied to the integrator and through pin 2 to CIRCUIT CHECK selector S1 for monitoring on CIRCUIT CHECK meter M1.

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 18 to CIRCUIT CHECK selector S1 for monitoring on CIRCUIT CHECK meter M1.

4-121. Front panel CONTROL switch S2, in the OPEN LOOP position, connects a 100Ω resistor between pin 1 and pin 20. This reduces the gain of U1, so that it no longer controls the crystal oscillator frequency in response to the error signal. The frequency is controlled solely by the FINE OSCILLATOR FREQUENCY control on the front panel.

4-122. VOLTAGE CONTROLLER. The voltage controller determines the bias voltage that is 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

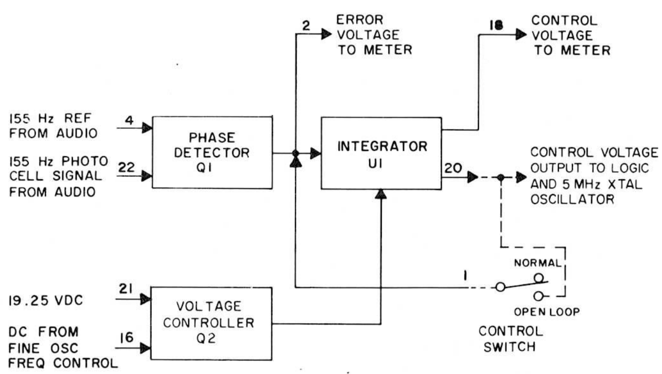

Figure 4-11. Loop Filter Block Diagram. A6-106-551

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 approximately 10 volts on the common.

4-123. LOGIC ASSEMBLY A10.

4-124. The Logic Assembly A10 generates the lock and out-of-lock 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 3 volts DC or rises above 13 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 approximately 3 and 13 volts DC. This means that CR1 is conducting and CR2 is turned off. When CR1 is conducting, Q1 is forward biased and conducts. This applies 19.25 volts through R5 and Q1 to ground, providing a logic 0 (VDC) 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 approximately 3 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 approximately 13 volts, CR 2 conducts. This forward biases Q2, causing it to conduct. This applies 19.25 volts DC, that 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 is now reverse biased and it stops conducting. This applies a logic 1 to pins 1 and 2 of U1A providing a logic 0 at pin 3.

4-129. 310 Hz LEVEL DETECTOR. The 310Hz level detector generates an out-of-lock signal whenever the 310Hz signal is not present. It consists of Q3, Q4, Q6, CR4, CR5, and CR8. The 310 Hz signal from J4 on Audio Assembly A7 is applied through pin 21 to Q3. Transistor Q3 amplifies the signal, which is then fed to the voltage doubler CR4 and CR5 and filtered by R11, R13, C5, and C6. Under lock conditions, this is a positive DC voltage that is applied to the base of Q4. This causes Q4 to conduct, grounding the base of Q6, through CR8,

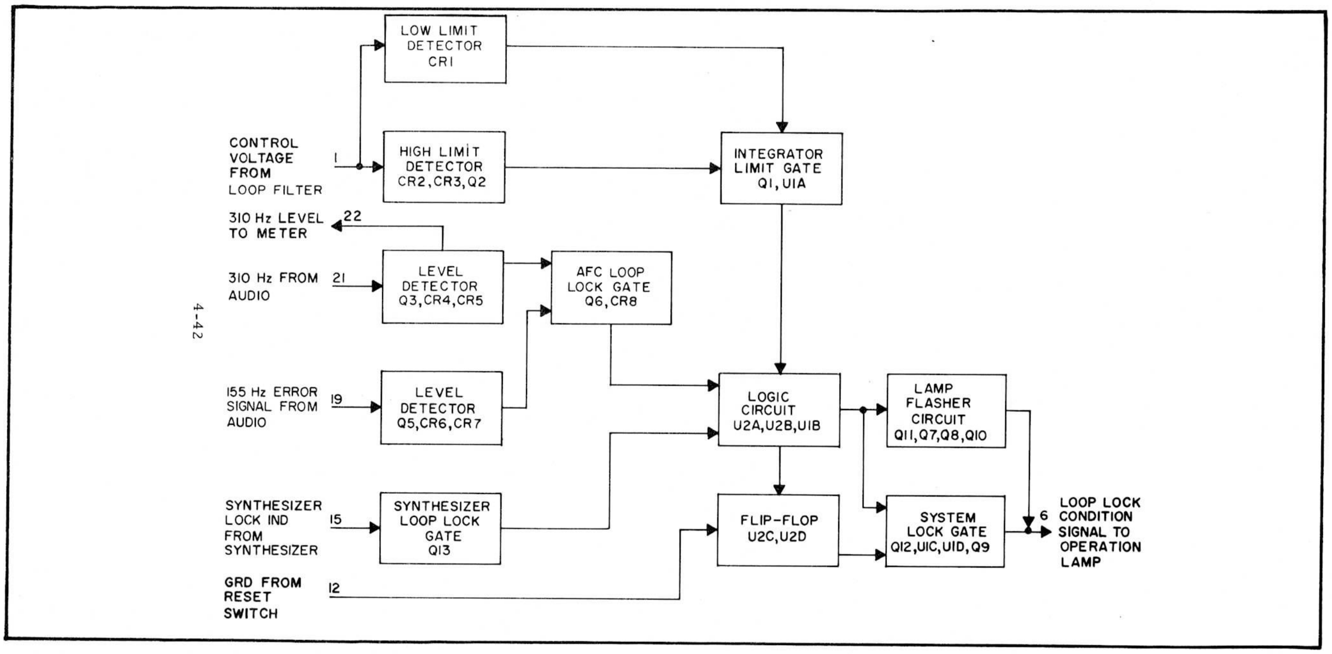

Figure 4-12. Logic Assembly Block Diagram

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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 310Hz signal only when the rubidium lamp is lit and the AFC loop is holding the crystal oscillator near the correct frequency, no signal will be present at pin 21 when the lamp is out or the AFC loop is far out of lock. 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. 155Hz LEVEL DETECTOR. The 155Hz level detector generates an out-of-lock signal whenever the 155Hz error signal is present. It consists of Q5, CR6, CR7, and Q6 (in conjunction with the 310Hz level detector). The 155Hz error signal from J3 on Audio Assembly A7 is applied through pin 19 to Q5. The 155Hz level detector operates the same as the 310Hz level detector.

4-132. Under lock conditions, the 155Hz error signal is extremely small and 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 155Hz error signal is applied to the level detector, providing a positive DC voltage at the base of Q6. This turns on Q6 and provides a logic 0 output that is applied to the logic circuits at U2 pin 1.

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 at U2 pin 2 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 front panel 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

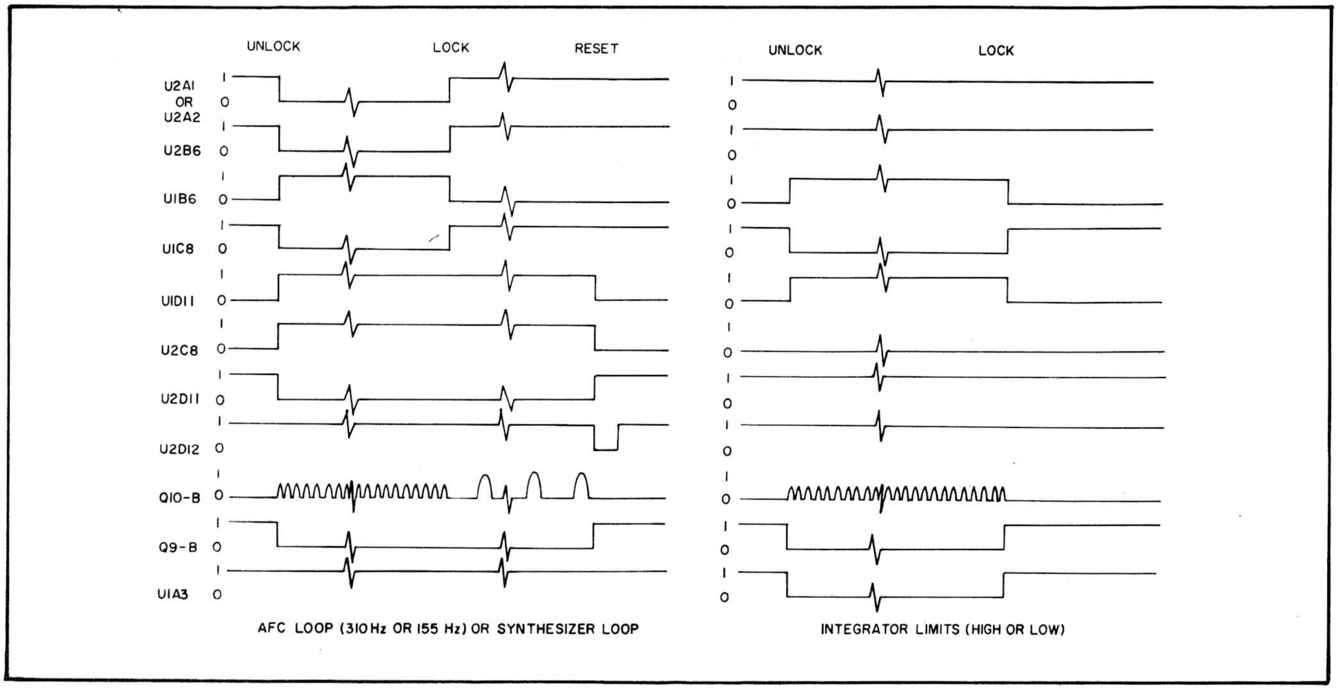

Figure 4-13. Logic Assembly Timing Diagrams

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1 at the base of Q11 goes to logic 0. This changes the flash rate of the lamp flasher circuit.

4-143. The RESET pushbutton on the front panel 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.

The logic 1 at U2D pin 11 is also applied to U2C pin

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 of 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 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, but the lamp ground is now controlled by Q9 instead of Q10, keeping the lamp continuously on.

4-149. 1MHz/100kHz DIVIDER OUTPUT ASSEMBLY A3.

4-150. The 1MHz/100kHz Divider Output Assembly provides buffered and isolated 1MHz and 100kHz outputs at both the front and rear panels. It also provides a 100kHz clock pulse at the rear panel. It is comprised of a driver amplifier, dividers, buffer amplifiers, and isolation amplifiers. Refer to figure 4-14 for a block diagram of the 1MHz/100kHz Divider Output Assembly and to figure 7-10 for a schematic diagram.

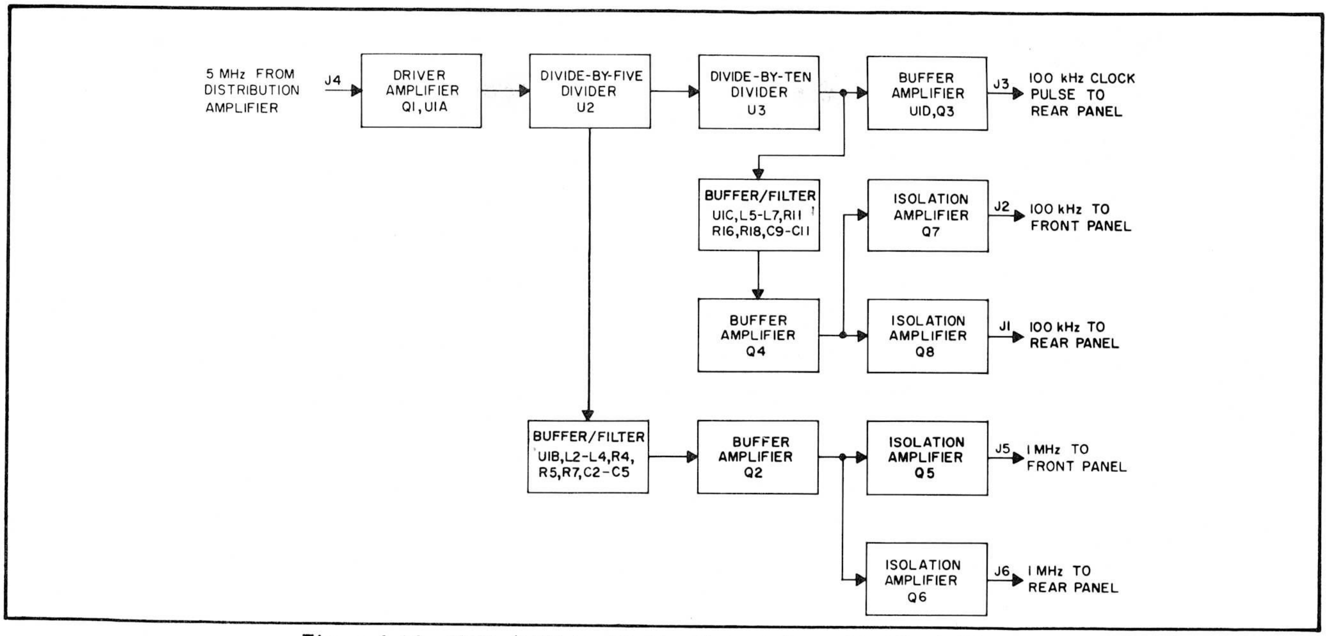


Figure 4-14. 1MHz/100kHz Divider Output Assembly Block Diagram. A6-106-548

4-151. DRIVER AMPLIFIER. The driver amplifier consists of Q1 and U1A. The 5MHz signal from J5 on Distribution Amplifier Assembly A5 is applied through J4 to the base of Q1. Transistor Q1 in the common emitter configuration provides sufficient power to drive the decade counters. The output at the collector of Q1 is applied to U1A pins 1 and 2 and provides an inverted 5MHz output pulse train at pin 3. This pulse train is applied to the first divider.

4-152. DIVIDERS. Decade counters U2 and U3 provide a divide-by-five and divide-by-ten function, respectively. The first counter, U2, has the 5MHz pulse applied to the BD input, pin 1, providing a 1MHz pulse train at the C and D outputs, pins 8 and 11, respectively. The output at pin 8 is applied to the 1MHz filter circuit and the output at pin 11 is applied to the second decade counter. This counter, U3, also receives its input at pin 1. The D output at pin 11 is connected to the A input at pin 14. This provides a 100kHz squarewave at the A output, pin 12, which is applied to the clock pulse buffer amplifier and to the 100kHz filter.

4-153. CLOCK PULSE BUFFER AMPLIFIER. The clock pulse buffer amplifier consists of U1D and Q3. The 100kHz pulse train is applied to pins 12 and 13 of U1D, providing an inverted 100kHz pulse train at pin 11. This is applied to the base of Q3. Transistor Q3, in the emitter follower configuration, buffers the pulse train, providng a 100kHz clock pulse train at J3, which is supplied to 100kHz CLOCK PULSE connector on the rear panel.

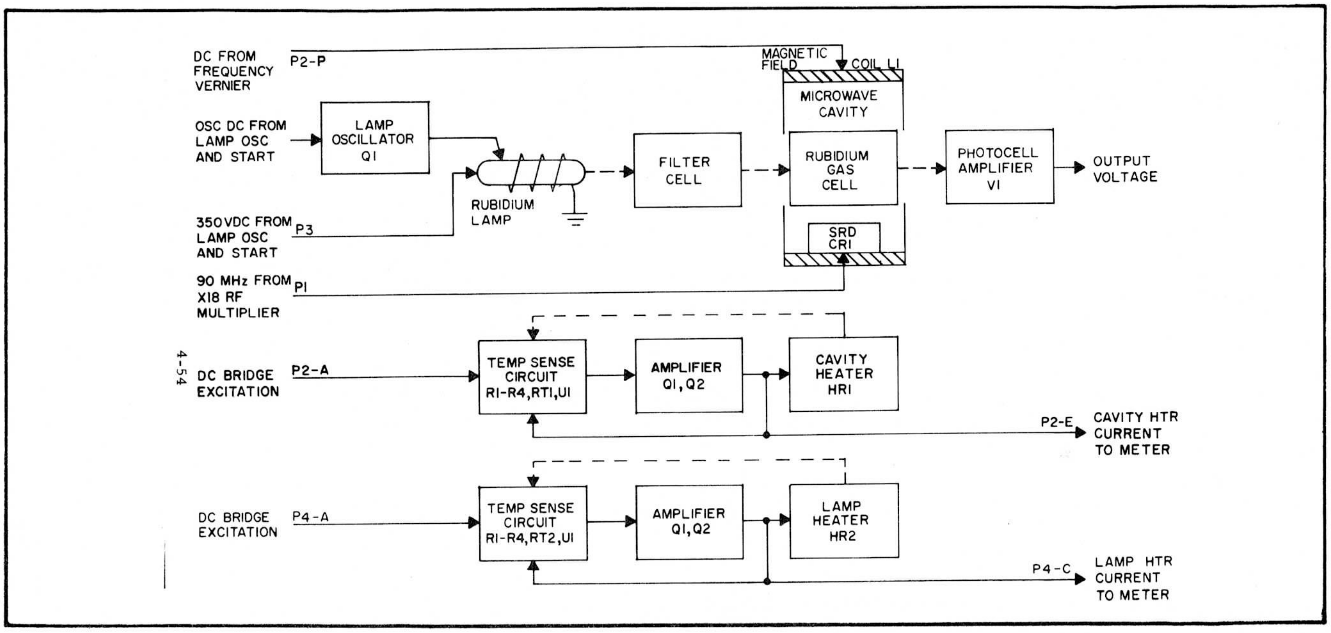
4-154. OUTPUT FILTER, BUFFER, AND ISOLATION CIRCUITS. The output filter, buffer, and isolation circuits for the 1MHz and 100kHz output signals are the same; thus, only the 1MHz circuit will be discussed.

4-155. The 1MHz pulse train from the decade counter is applied to pins 4 and 5 of U1B, providing a 1MHz pulse train at pin 6. This pulse train is applied to a 1MHz filter network consisting of L2, L3, L4, R4, R5, C2, C3, and C4. The signal applied to the base of Q2 is a 1MHz sinewave. Transistor Q2, in the emitter follower configuration buffers the 1MHz sinewave. The output at the emitter is applied to the front and rear panel output isolation amplifiers, which are identical. Only the front panel amplifier will be discussed. The 1MHz input is applied to the base of Q5. Transistor Q5 amplifies the signal and applies it to T1. Transformer T1 provides isolation for the signal to prevent loading the other output signals. The 1MHz output of T3 is applied through J5 to the front panel 1MHz connector. The 1MHz output of T2 is applied through J6 to the rear panel 1MHz connector.

4-156. The 100kHz outputs at J2 and J1 are applied to the front and rear panel 100kHz connectors.

4-157. OPTICAL MICROWAVE UNIT ASSEMBLY A13.

4-158. The Optical Microwave Unit Assembly A13 generates the error signal required to change the crystal oscillator frequency. The OMU consists of the rubidium lamp, filter cell, gas cell, microwave cavity, and photocell.



A6-106-547

Figure 4-15. Optical Microwave Unit Assembly Block Diagram.

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, lamp heater and photocell signal preamplifier. Refer to figure 4-15 for a block diagram of the OMU Assembly and to figure 7-11 for a schematic diagram.

4-159. 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 be varied from 6 to 16 volts. The signal at the base of Q1 is applied to a coil wound around the rubidium lamp. This provides the excitation required to keep the lamp lit once it is started.

4-160. LAMP START PULSE. The lamp start pulse is applied from J2 on Oscillator Regulator and Start Assembly A8, through J1 of A13A1A1, to the tap of the autotransformer T1. The high voltage output of the autotransformer is then applied to the rubidium lamp to provide the necessary energy to start the lamp.

4-161. STEP RECOVERY DIODE. Step recovery diode (SRD) CR1 on A13A2 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 isolation from the multiplier assembly is provided by R1,R2, and C1 of the impedance matching unit. The signal is applied at P1 from J4 on X18 RF Multiplier Assembly A4. It is a 90MHz signal, frequency modulated at 155Hz, that is summed with a 5.313. . .MHz signal. This produces a harmonic of 90MHz at 6840MHz, with sidebands that are 5.313. . .MHz on either side of the 6840MHz signal. These sidebands are approximately 15 db down from the 6840MHz signal.

4-162. The 155Hz modulation appears as a phase or frequency variation in the 6840MHz signal and in the 5.313. . .MHz sidebands. The frequency of the lower sideband, which is the frequency of interest, produces a frequency of approximately 6834.687MHz modulated at 155Hz. This is approximately the rubidium resonant frequency.

4-163. MAGNETIC FIELD COIL. The MAGNETIC FIELD is a controlled magnetic field, produced by coil L1 on A13A2, whose axis is coincident with the rubidium lamp beam. Coil L1 is wound around the microwave cavity. The DC voltage for L1 is received from the front panel MAGNETIC FIELD potentiometer through P1-B. The MAGNETIC FIELD 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.

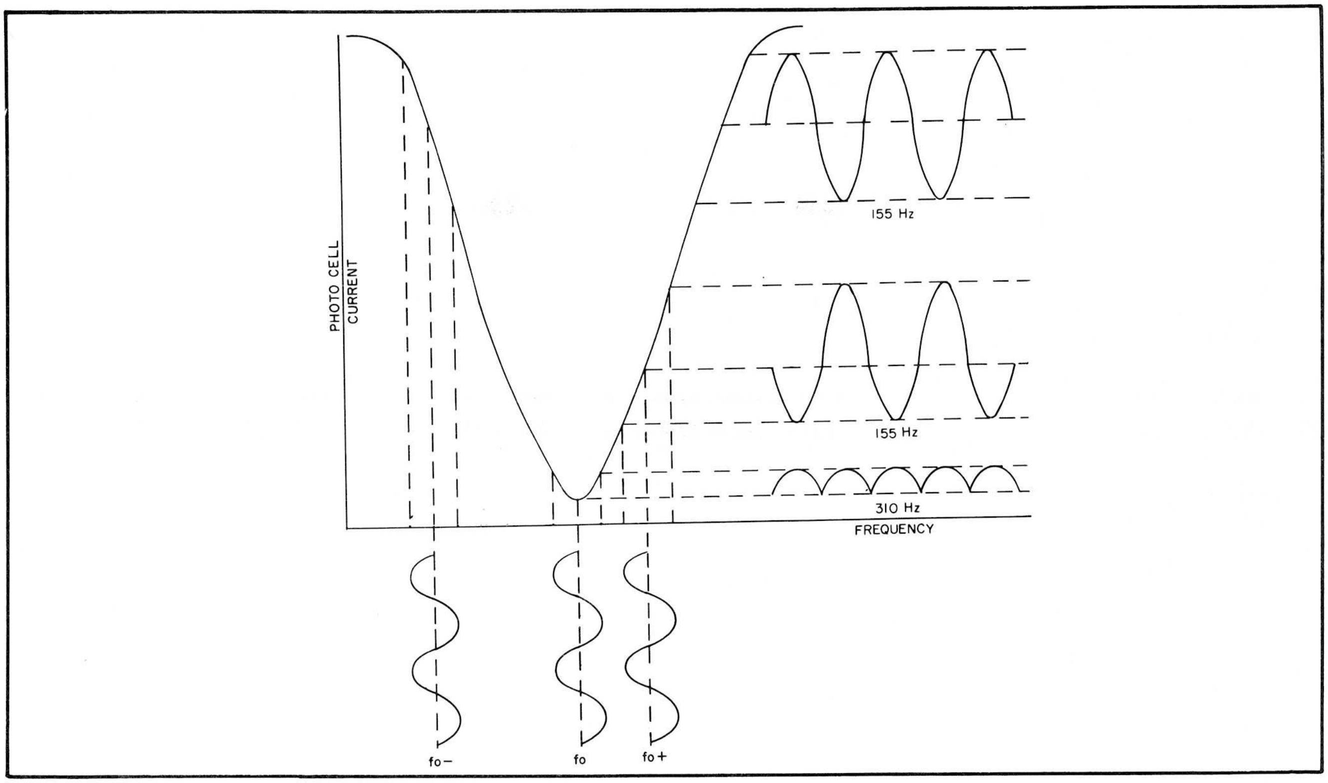


Figure 4-16. Photocell Output Current for Positive, Negative, and Zero Frequency Errors.

4-164. 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 will contain the 155 and 310Hz components, due to the 155Hz frequency modulation, as shown in figure 4-16. This output current is converted to a voltage by amplifier U2 and applied to the DET input of the Audio Assembly.

4-165. 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 heater 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.

4-166. 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. 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 heater voltage is also applied back to pin 2 of U1 through R5 for feedback and is applied through P2 to pin C to the CIRCUIT CHECK selector, to monitor the heater current on the CIRCUIT CHECK meter.

4-167. When the temperature is either high or low, the resistance of RT1 changes, unbalancing the bridge. This causes current to flow through the bridge to U1 at pins 2 and 3. This 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.

4-168. The microwave cavity heater maintains a temperature of approximately 62.5°C. Since this temperature can be close to the operating temperature range of the standard, CR1 and CR2 are used in the current 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.

4-169. 5MHz CRYSTAL OSCILLATOR ASSEMBLY A14.

4-170. 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 4-11 for a block diagram of the 5MHz Crystal Oscillator Assembly and to figure 7-12 for a schematic diagram.

4-171. OSCILLATOR. The oscillator consists of quartz crystal Y1 and transistor Q1. The quartz crystal drives the Clapp-Gourillet oscillator at the base of Q1, at a fre-

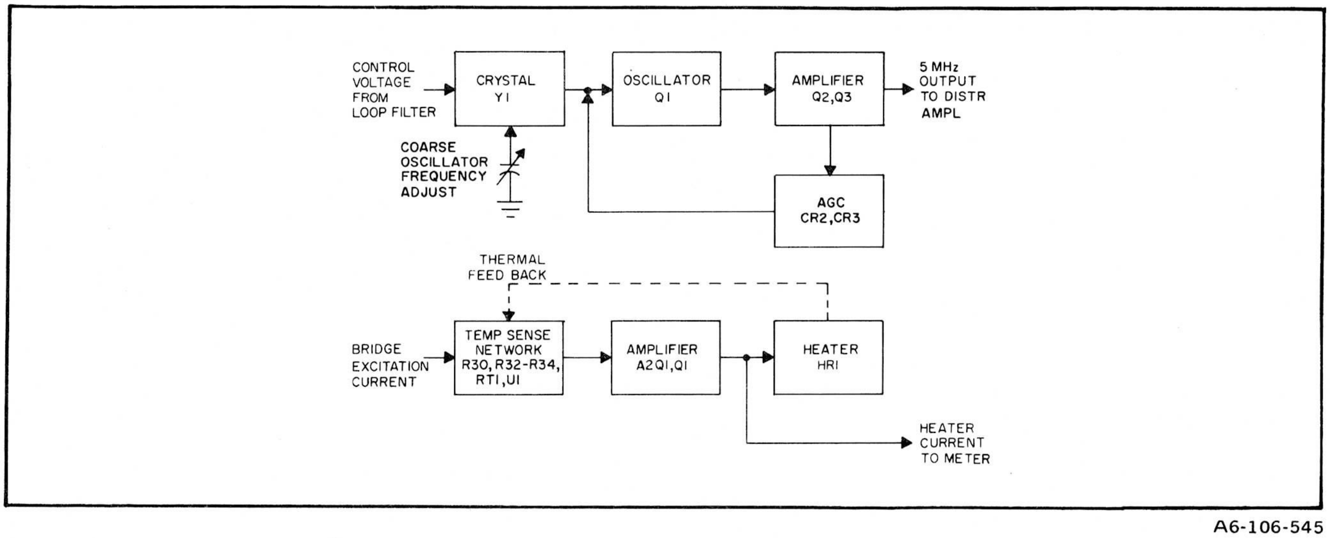


Figure 4-17. 5MHz Crystal Oscillator Assembly Block Diagram.

quency of 5MHz, which is the fifth overtone of the fundamental crystal frequency. The frequency is controlled over a narrow range by the DC voltage derived from pin 8, of 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.

4-172. AMPLIFIER. The amplifier consists of two common-emitter stages, 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 coaxial connector 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.

4-173. 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.

4-174. TEMPERATURE CONTROLLER. The temperature controller is comprised of a temperature sensing bridge (R1, R2, R4, R5, and RT1), operational amplifier U1, current amplifier A2Q1 and Q1, 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 a nearly zero differential voltage input to U1 and pins 2 and 3.

4-175. When the temperature is either high or low, the resistance of RT1 changes, unbalancing 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 depending on whether the temperature is high or low. This, in turn, changes the output of U1 which changes the output of Q1 such that more or less voltage is applied to HR1 to raise or lower the temperature of the crystal as sensed by RT1.

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides maintenance instructions for the Model 304D Rubidium Frequency Standard. The section includes adjustment and troubleshooting procedures for the complete frequency standard followed by checkout, adjustment, and troubleshooting instructions for the various subassemblies. Refer to the appropriate appendix for maintenance instructions on the battery option or clock option.

5-3. FREQUENCY STANDARD ADJUSTMENT.

5-4. PERIODIC ADJUSTMENTS.

5-5. The only periodic maintenance required is occasional re-tuning of the 5MHz crystal oscillator. This is accomplished by placing the CIRCUIT CHECK switch to ERROR position, placing the CONTROL switch to OPEN LOOP position, setting the OSCILLATOR FINE FREQUENCY control to 5.00 (center) and adjusting OSCILLATOR COARSE FREQUENCY control to center the reading on the CIRCUIT CHECK METER at 50. Be certain that a slight adjustment of the OSCILLATOR FINE FREQUENCY control will then move the ERROR indication to each side of 50. A reading of 50 also results if the frequency is set very far off in either direction. If the meter will move in only one direction from 50, turn the OSCILLATOR COARSE TUNING adjustment in such a direction as to increase the deviation from 50. Continue turning slowly in the same direction until a peak ERROR reading is passed and the reading returns again to 50. Again check that a slight adjustment of the OSCILLATOR FINE TUNING control back and forth to either side of center will cause the ERROR indication to move to each side of center. Place the CONTROL switch to NORMAL. The OPERATION lamp should now flash slowly. Push the RESET button. The OPERATION lamp should now glow continuously. The frequency adjustment is now complete.

5-6. FREQUENCY CONTROL LOOP ADJUSTMENTS.

5-7. The basic frequency control loop directly involves the following assemblies:

A4	X18 RF Multiplier
A5	Distribution Amplifier
A6	Synthesizer
A7	Audio
A9	Loop Filter
A13	Optical Microwave Unit
A14	Crystal Oscillator

5-8. The following adjustments directly affect signals within this loop:

GROUP I		
Assembly A5	Level Adj	R2
Assembly A4	AGC	R39
GROUP II		
Assembly A4	Mod	R11
Assembly A4	Inject	R35
Assembly A7	ϕ Adj	R14
Assembly A7	Gain	R26

5-9. In addition the loop action is affected by the setting of:

GROUP III		
Assembly A8	(Lamp Oscillator Voltage)	R7

5-10. GROUP I ADJUSTMENTS. Adjust the 5MHz level using Level Adj of assembly A5 for approximately 1 volt rms at J1 of A4. Adjust R39 of A4 for 12 volts at TP4. Reduce the 5MHz input until the reading at TP4 is greater than 12 volts. Slowly increase level until reading fails to decrease any further (or decrease level from excessive value to the point at which TP4 voltage just begins to increase). Again adjust R39 for 12 volts at TP4.

5-11. GROUP II ADJUSTMENTS. Observe the signal at TP1 of A9 using oscilloscope. Place CONTROL switch in the OPEN LOOP position. Adjust the OSCILLATOR FINE FREQUENCY control to null the signal at TP1, then turn the OSCILLATOR FINE FREQUENCY control one full turn clockwise. Adjust R14 of A7 to obtain the correct pattern as shown in figure 5-1.

5-12. Adjust R11 of A4 to maximize the signal observed on the oscilloscope. It is equally effective to maximize the ERROR reading on the CIRCUIT CHECK meter. Adjust R35 of A4 to maximize the oscilloscope signal. It is equally effective to maximize the ERROR reading or the 310Hz reading on the CIRCUIT CHECK meter. Adjust R26 of A7 for 1 volt peak-to-peak. Meter reading should be approximately 70. Repeat the four Group II adjustments until they are simultaneously correct.

5-13. Check the 310Hz reading on the CIRCUIT CHECK meter. This should be greater than 75. If not, open the loop and set OSCILLATOR FINE FREQUENCY control for Error reading of 60. Adjust R11 of A4 clockwise to obtain 310Hz reading of 75. Recheck ERROR reading. If it is still above 58, return it to 50 and close the loop. The adjustments are now complete. If ERROR reading is not above 58, trouble exists, probably in the 310Hz amplifier section of A7.

CAUTION

Adjustment of R7 in A8 may lead to significant change in output frequency. Do not alter adjustment without good reason. If adjustment is required proceed as follows.

5-14. GROUP III ADJUSTMENT. Adjust R7 of A8 for a PHOTO reading of 80 on the CIRCUIT CHECK meter. (If the standard was recently operating properly with a known PHOTO reading slightly different from 80, reset to the previous reading). After adjusting R7, the PHOTO reading may shift slightly, so recheck the reading at 15-minute intervals and readjust as required until a stable reading is obtained. If a new lamp is installed, the PHOTO reading may shift for several days. It should be checked daily and reset to 80 until a stable reading is achieved. It is advisable to recheck the Group II adjustments, particularly Gain control R26, if R7 is reset.

5-15. It is useful to understand the effect of setting R7 too high or too low. If the PHOTO reading is too high (about 88 or above) saturation occurs in the photocell system, obliterating the 155Hz modulation signal. If the reading is set too low there is a loss of sensitivity, which must be compensated for by increasing Gain control R26 of A7. This may reduce the short-term stability of the standard.

5-16. CHECKING THE FREQUENCY OF THE STANDARD.

5-17. Although the Rubidium Frequency Standard is extremely stable in frequency, it may be desirable to have a method of checking the frequency. Several possible reasons for this are:

a. Requirement for traceability to NBS.
b. Requirement for extreme accuracy such that even the small long term drift associated with the atomic standard is unacceptable.
c. As an aid in trouble shooting.

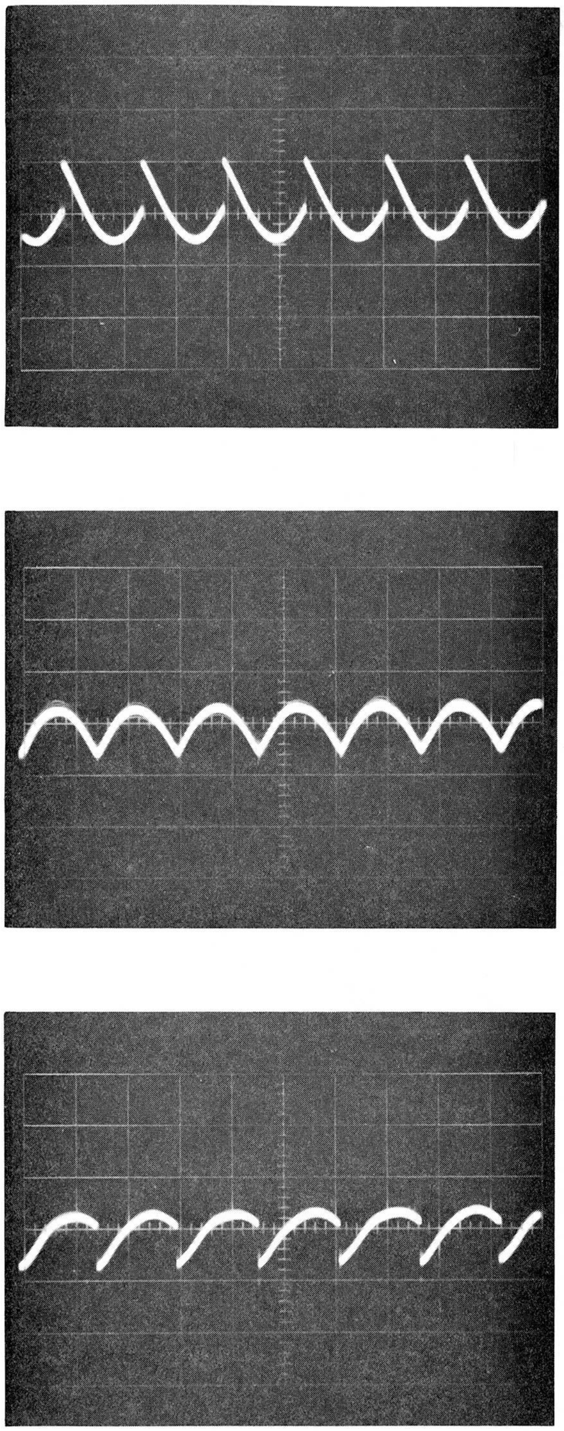
5-18. Two basic procedures are available:

a. Frequency determination via radio reception of stable VLF transmission.
b. Comparison against another frequency standard.

5-19. Reception of the VLF signal from WWVL or WWVB will provide traceability to NBS. Communications transmission from the U. S. Navy also have ultra-stable carrier frequencies and may be used for frequency checking in remote areas of the world. The TRACOR, Inc., Model 890A VLF Receiver is suitable for reception of WWVL and WWVB, and for world-wide coverage, the Model 599J or 599K is suitable.

5-20. Normally, in the United States, frequency can be measured over a period of one day via VLF, with an accuracy of approximately 1 part in $(10)^{11}$. The average frequency over a longer period of time can be measured more accurately. The best measurement period is determined from figure 5-2. It is assumed that the rubidium standard is drifting at the full specification limit of 2 x 10^{-11} per month. Clearly the optimum measurement period for best knowledge of rubidium frequency is between 5 and 6 days in the example given, and the possible accuracy is few parts in $(10)^{12}$. If a shorter period is used, the measurement accuracy decreases. But if a longer period is used, the final frequency of the standard will differ more from the average due to long term drift. If VLF reception is noisy a longer measuring period will prove optimum.

5-21. If a second frequency standard of known accuracy is available, the frequency of the Model 304D can be checked against it as shown in figure 5-3. The upper



INCORRECT

CORRECT

INCORRECT

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Figure 5-1. Waveforms Showing Correct and Incorrect Modulation Adjustment.

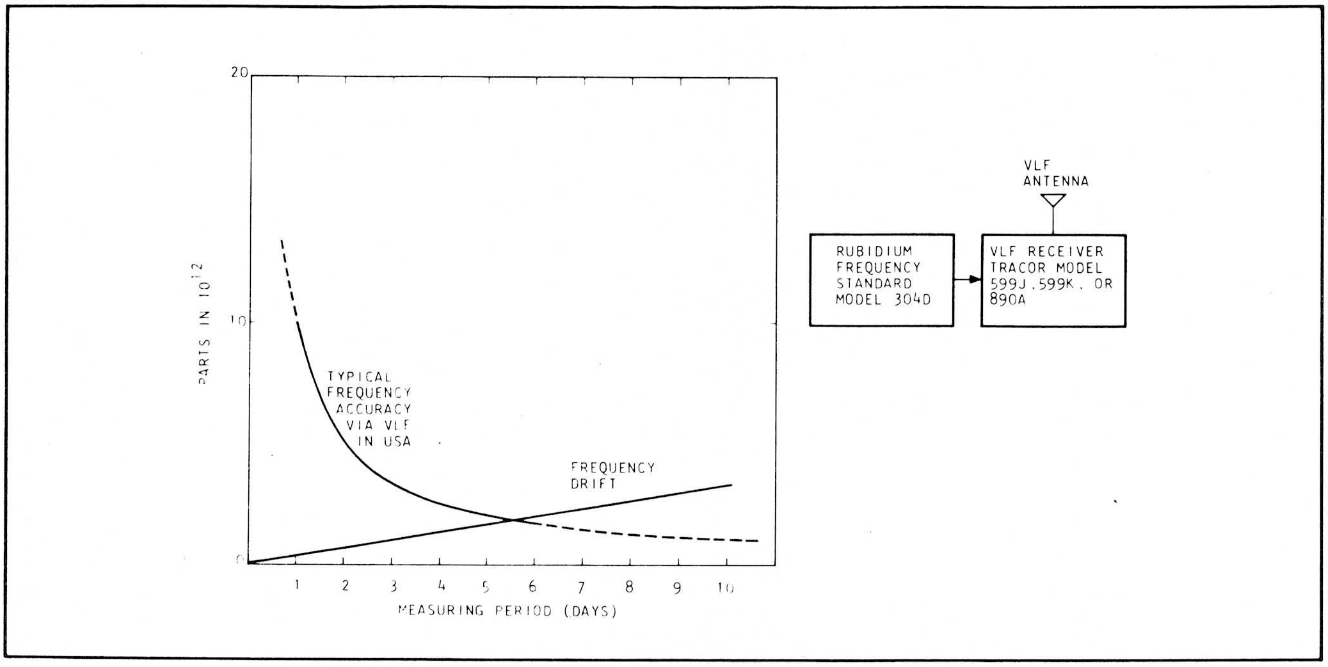

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Figure 5-2. Typical Accuracy of a Rubidium Standard Frequency Check Using VLF in the Continental U.S.

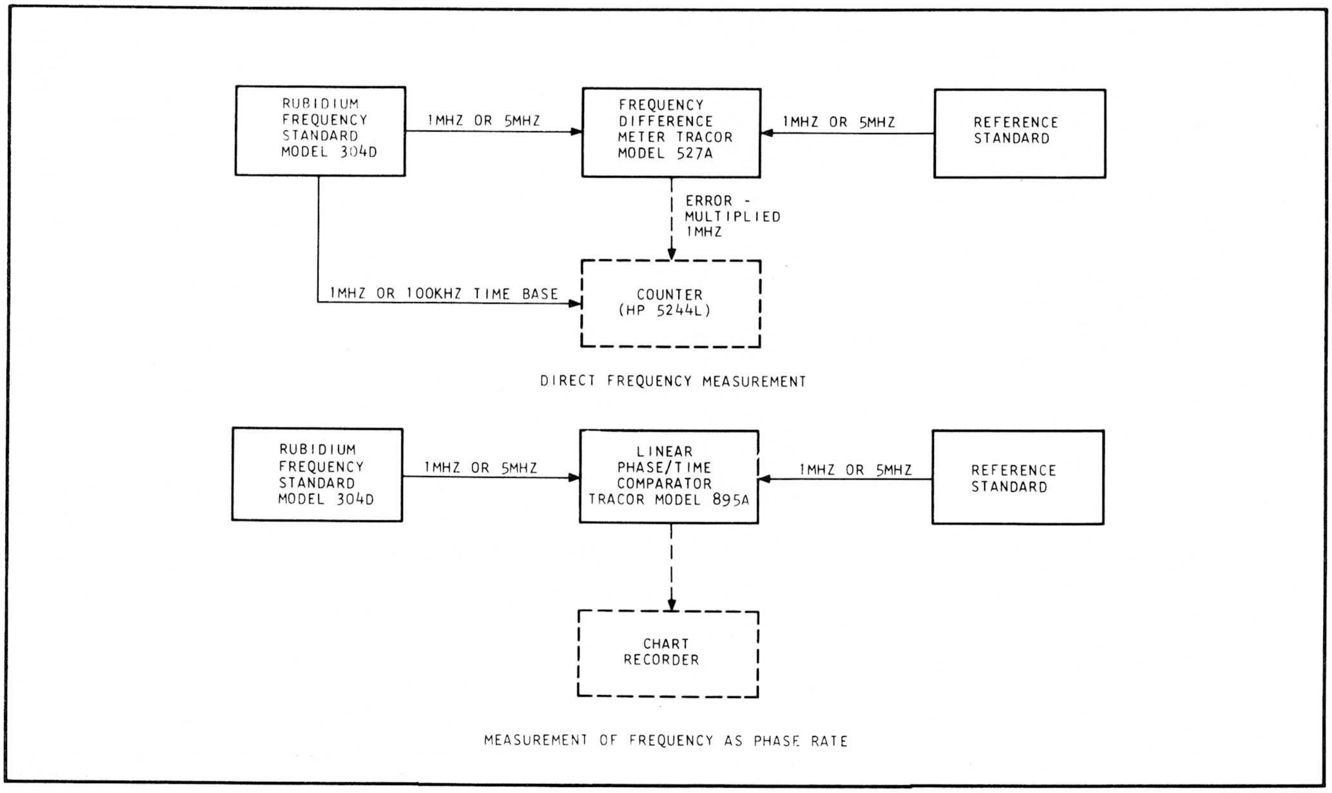

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Figure 5-3. Frequency Measurement by Comparison Against Another Standard.

diagram shows a direct frequency comparison using a TRACOR, Inc., Model 527 A Frequency Difference Meter. Frequency difference with respect to the reference standard can be made with an accuracy of approximately one part in $(10)^{11}$ using the front panel meter. For even more accurate measurements the error-multiplied signal can be counted for 10 seconds (or for 100 seconds with 100kHz time base). Repeatability of the counts also provides an indication of short-term stability for 10 or 100 second intervals.

NOTE

In checking short-term stability the reference standard must be a rubidium standard; other atomic standards have inferior short-term stability.

5-22. The frequency difference from a reference standard can also be measured using a TRACOR, Inc., Model 895 A Linear Phase/Time Comparator set for 0.1 microsecond full scale. A measurement accuracy of one part in $(10)^{11}$ can be achieved within 5 to 10 minutes using this type of measurement. Using a longer measuring time permits more precise measurement.

5-23. Availability of even an inferior reference standard kept calibrated to within a few parts in $(10)^8$ is useful if the necessity for trouble shooting arises. This permits setting the crystal oscillator of the rubidium standard with sufficient accuracy that the optical microwave unit (OMU) response can be easily located. It is also possible to tune the crystal by searching for microwave response, but if trouble exists, the question will arise as to whether a response is lacking due to trouble in the OMU or associated drive circuits, or in the crystal oscillator tuning response.

5-24. FREQUENCY STANDARD TROUBLE-SHOOTING.

5-25. INDICATIONS OF TROUBLE.

5-26. Trouble normally becomes evident through absence, noisiness, or excessive frequency displacement of an output signal; failure of the OPERATION lamp to remain on; or out-of-range readings on the CIRCUIT CHECK meter.

5-27. Very often the first indication of trouble will be flashing of the OPERATION lamp. If the instrument is not connected to a source of DC standby power, a temporary power failure may have interrupted operation. If the lamp is flashing slowly (about once per second), pushing the RESET button will restore normal operation. If the lamp is flashing rapidly (about twice per second), trouble still exists. If there is a possibility that AC power failure has occured, it is advisable to wait approximately one hour before effecting any adjustment.

5-28. Fast flashing of the OPERATION lamp indicates one of four trouble conditions:

a. Deficient 310Hz second harmonic signal
b. Excess 155Hz ERROR signal
c. Out-of-range CONTROL signal
d. Failure of synthesizer lock

5-29. The first three signals may be monitored by means of the front panel CIRCUIT CHECK meter and switch. The 310Hz signal should read above 70. With the loop locked, the ERROR reading should be 50, however, a reading between 40 and 60 will keep the OPERATION lamp on. The CONTROL reading should ideally be near 50. As time goes on, however, this reading will change due to crystal oscillator aging, and require more control signal to hold the oscillator at the rubidium resonance. A CONTROL reading between 0 and 100 will permit the operation light to remain on. Any time the reading approaches 0 or 100, it is advisable to reset the oscillator tuning as described in paragraph 5-5.

5-30. The synthesizer lock signal is not monitored by the CIRCUIT CHECK meter, but is easily checked by removing the instrument top cover and disconnecting the connector that mates to the LOCK pin located between the 5 V pin and the 5MHz jack near the front of the top side of Synthesizer Assembly A6. The DC voltage between the LOCK pin on A6, and chassis ground should be approximately zero volts. A reading near five volts indicates failure of the synthesizer to lock on frequency properly and results in flashing of the OPERATION lamp. Replace the connector on the lock pin after voltage check has been made.

5-31. USE OF CIRCUIT CHECK METER IN TROUBLE DIAGNOSIS.

5-32. The first step in trouble isolation is to look for out-of-range readings on the front panel CIRCUIT CHECK meter. Table 5-1 describes the readings available in the various positions of the CIRCUIT CHECK switch and indicates where to look for trouble in the event of abnormal reading.

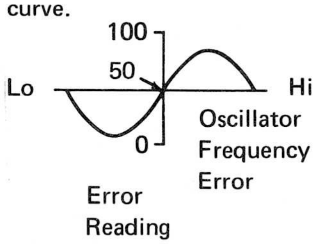
NOTE

If a record of the exact value of each meter reading is kept during the period of normal operation, it will prove helpful here.

TABLE 5-1. CIRCUIT CHECK INDICATIONS

CIRCUIT CHECK SWITCH POSITION	NORMAL READING	SIGNIFICANCE OF METER READING	INDICATED CHECKS IF READING OUTSIDE NORMAL RANGE
BATTERY	75 - 100 with battery option; 0 without	Indicates voltage of optional internal standby battery	Check PowerSupplyAssembly A2, Battery Assembly A16, associated Wiring.
SUPPLY	70 - 80	Indicates voltage of regulated DC supply (proper value is 19.25V)	Check PowerSupplyAssembly A2, line fuse, associated wiring.
LAMP HTR CAV HTR	60 - 75 at 25°C ambient 56 - 70 at 25°C ambient	Indicates current supplied to heater coils for Rubidium Lamp and Rubidium Gas Cell. Reading will be higher at low ambient temperature, lower at high ambient. During warm-up, reading will be near 100. (See WARNING in right-hand column	Check Lamp Heater Assembly, or Cavity Heater Assembly inside Assembly A13. Check that small 3-pin connector P2 located alongside front mounting bracket of the OMU is properly in place. Zero reading indicates failure to heat; this will normally result in loss of 310Hz signal. Full scale reading indicates heater is continuously on. **WARNING** **If meter reading remains at full scale after one-hour warmup, remove power. Continued operation can damage OMU.**
OSC	60 - 85 at 25° Ambient	Indicates power applied to heat oven in crystal oscillator. Reading depends on ambient temperature, and is near full scale during warm-up.	Check crystal oscillator (A14) frequency. If HTR reading is out of range, frequency will also be out of range and not susceptible to normal adjustment.
PHOTO	75 - 85	Indicates output of photocell in OMU. Normal reading indicates that rubidium lamp is on and that its light is received at photocell.	See Paragraphs 5-33 through 5-38.
5MHz	70 - 100	Indicates level of 5MHz signal at output of amplifier feeding rear panel connector.	Loss of signal indicates trouble in Crystal Oscillator Assembly A14 or in Distribution Amplifier Assembly A5.

TABLE 5-1. CIRCUIT CHECK INDICATIONS (Continued)

CIRCUIT CHECK SWITCH POSITION	NORMAL READING	SIGNIFICANCE OF METER READING	INDICATED CHECKS IF READING OUTSIDE NORMAL RANGE
CONTROL	0 - 100	Indicates extent to which frequency control loop is required to pull crystal oscillator frequency to bring it into coincidence with rubidium resonance.	Excess deviation from central reading of 50 normally indicates that natural frequency of crystal oscillator has drifted. Oscillator should be tuned as described in Paragraph 5-5. Placing the CONTROL switch in OPEN LOOP position should always return the CONTROL indication to 50. If not, look for trouble in Loop Filter Assembly A9 or associated controls. If control responds properly to opening the loop, but returns to abnormal value when loop is closed, and is unresponsive to tuning, look for trouble in synchronous detector or integrator of A9, or in signal amplifiers of A7. Crystal oscillator trouble is also a possibility.
ERROR	50 (Loop Closed) 10 - 90 (Loop Open)	Indicates deviation of crystal oscillator frequency from rubidium resonance in accordance with the following tuning curve.  	A fixed error reading indicates that the frequency control loop is open between the synchronous detector and the crystal oscillator.
310 Hz	70 - 85	Indicates level of 310Hz second harmonic signal.	This is perhaps the most significant single indication available. See paragraphs 5-39 through 5-44 for details.

5-33. USE OF PHOTO INDICATION IN TROUBLE DIAGNOSIS.

5-34. Existence of a normal PHOTO reading indicates that the rubidium lamp is glowing, the resultant light is being sensed by the photocell, and the photocell current is being amplified at least through the pre-amplifier section of A7. The usual PHOTO reading with the lamp not glowing is approximately 58. If the PHOTO reading is below about 60, the lamp start relay should click approximately once per 10 seconds. If not, look for trouble in the lamp start circuits. If the lamp start relay continues to pulse and the PHOTO reading remains low, either the lamp is not starting or the light is not being sensed properly. After turn-on, as much as 20 minutes may be required for the lamp to come on and the intensity to reach a level that will inhibit pulsing.

5-35. If after 20 minutes, the PHOTO reading has not increased, check the start pulse as described in paragraph 5-108. Also check the voltage at TP1 of A8. This should be between 8 and 12 volts. If not, the lamp oscillator is not receiving power. Check the current flowing in the lead connected to the OSC pin on A8. This should be between 75 and 150ma. If not, a trouble exists in the lamp oscillator.

5-36. Next remove the connector from J6(DET) of A7 and connect a VOM (50 volt scale) to measure voltage to ground at the connector removed from J6. This should be about three volts when the lamp is off and 15 volts when the lamp is on and fully warm. If these readings are correct, but the PHOTO reading is not, look for trouble in the preamplifier section of A7.

5-37. Check the LAMP HEATER indication on the CIRCUIT CHECK meter. If the unit is warming up, the meter should read near full scale. After warmup, it should read in the normal range as given in table 5-1. A reading near 50 indicates that proper heating is not occurring; this condition may prevent the lamp from glowing.

5-38. If all of the foregoing checks fail to reveal the source of trouble, it is almost certainly in the Optical Microwave Unit. A new OMU may be installed, or the 304D may be returned to TRACOR, Inc., for repair. Refer to paragraph 5-155.

5-39. USE OF 310HZ INDICATION IN TROUBLE DIAGNOSIS.

5-40. A normal indication at the 310Hz position of the CIRCUIT CHECK meter is evidence of normal operation for a large group of circuits. Multiplier A4 and synthesizer A6 must be supplying the OMU with properly modulated signals at the correct level and frequency. The OMU is functioning, as are most of the amplifier circuits in Audio Module A7. Therefore, failure of the loop to lock properly when a 310Hz signal exists is indicative of trouble in the 155Hz amplifier of A7, in Loop Filter Assembly A9, or associated controls or wiring. In this case the first step is to check for normal response of the CIRCUIT CHECK error indication to oscillator tuning with the CONTROL switch in OPEN LOOP position. Proper response indicates that the trouble lies after the synchronous detector of A9, while improper response indicates trouble in the synchronous detector or the circuits feeding it.

5-41. Absence of the 310Hz signal results from trouble or misadjustment in any one of several assemblies. Check the other meter indications. If any are abnormal, proceed as indicated in table 5-1. If other meter indications are normal, check the following for normal operation.

ASSEMBLY	CHECK FOR NORMAL OPERATION IN ACCORDANCE WITH
A4	Paragraphs 5-59 through 5-62
A6	Paragraphs 5-77 through 5-81

5-42. If A4 and A6 are normal, this indicates that A5 is also normal in so far as is required to produce the 310Hz signal, and that the output of assembly A14 is normal except that it might possibly be far off frequency. At this point, a frequency check of 5MHz Crystal Oscillator A14 to an accuracy of a few parts in 10^8 would be very useful, if reference oscillator and test equipment are available. If no such check is available, premature and indiscriminate rotation of the OSCILLATOR COARSE FREQUENCY control should be avoided. Check elsewhere first, and try the FINE tuning control. If as a final measure, it becomes necessary to change the setting of the COARSE tuning control, note the amount of rotation imparted so that the control can be returned to a point near the original setting.

5-43. If operation of A4 or A6 is not normal, check A5 for normal operation before trouble shooting A4 or A6.

5-44. If all meter indications other than 310Hz are normal, and A4 and A6 are normal, and if the oscillator is on frequency within a few parts in $(10)^8$ and has been varied over the fine tuning range without observing a 310Hz in dication, it must be presumed that the trouble lies in Optical Microwave Unit Assembly A13 or Audio Assembly A7. Check assembly A7 for normal operation as described in Paragraphs 5-94 through 5-100. If A7 is normal, make available field checks of assembly A13.

5-45. **POWER SUPPLY ASSEMBLY A2 MAINTENANCE.**

5-46. CHECK FOR NORMAL OPERATION.

5-47. Check DC voltage to ground at the following points:

a. +19.25-volt "mecca plate" at the rear of the power supply assembly (at the point where numerous red wires are attached). Voltage should read +19.25 $\pm$0.05 VDC.

b. +5-volt terminal on DC to DC converter unit at the front of the power supply assembly. Voltage should read 5 $\pm$0.1VDC.
c. +350-volt terminal on DC to DC converter. Voltage should read +350 BDC $\pm$ 10%. Tolerance 315 to 385 volts.

5-48. TROUBLESHOOTING.

5-49. Table 5-2 contains typical voltages to assist in isolating trouble in the Power Supply Assembly. Note that some of the voltages are typical only, exact values are dependent upon line voltage or external DC.

5-50. ADJUSTMENT.

5-51. If assembly A2 is replaced, it will be necessary to adjust R11 for 19.25 volts output. Refer to paragraph 5-47. The DC to DC Converter does not require adjustment.

5-52. 1MHZ/100KHZ OUTPUT DIVIDER ASSEMBLY A3 MAINTENANCE.

5-53. CHECK FOR NORMAL OPERATION.

5-54. Normal operation of the divider assembly is indicated by the presence of proper 1MHz and 100kHz signals at the front and rear panel connectors. The signals may be checked using a oscilloscope with a 50-ohm load connected at the oscilloscope end of the interconnecting cable. The voltage should be at least 3 volts peak-to-peak, the waveform sinusoidal. The 100kHz clock signal from the rear panel should be observed with a 1000-ohm load. Voltage should be at least 1 volt peak-to-peak with square-wave shape.

5-55. TROUBLESHOOTING.

5-56. Trouble isolation within the divider assembly is extremely simple. Lack of a signal at a particular frequency at both front and rear panels directs attention to the corresponding divider. Lack of signal at one panel directs attention to the corresponding amplifier.

5-57. ADJUSTMENT.

5-58. No adjustments are required when the divider assembly is replaced.

5-59. X18 RF MULTIPLIER ASSEMBLY A4 MAINTENANCE.

5-60. CHECK FOR NORMAL OPERATION.

5-61. Presence of proper AGC voltage, between 5 and 15 volts, is a very simple check that indicates with high probability that the module is functioning properly. More complete checks are as follows:

a. Connect the 90MHz output to a Tektronix Type 454 Oscilloscope with 50-ohm load at the oscilloscope input. Output should be between 5.5 and 6.5 volts peak-to-peak, with sinusoidal waveform.

TABLE 5-2. A2 Typical Voltages to Ground

MEASUREMENT POINT	AC PRESENT	AC ABSENT, EXTERNAL DC
Collector Q2	35	25
F2	35	25
Emitter Q3	35	25
Collector	19.25	19.25
Base Q3	34	24
Pin 2 U1	8.7	8.7
Pin 3 U1	8.7	8.7
Emitter Q2	9.6	9.6
Base Q2	9.2	9.2
Collector Q2	34	24
Base Q7	13.9	0
Base Q6	8.9	10
Collector Q6	30	16
Base Q3	31	26
Pin 9 Connector	48	0

b. With the same test set-up, remove the 5MHz input from the multiplier. With R35 (Inject) fully clockwise the SYNTH IN signal at J3 should result in approximately 0.05 volts peak-to-peak of 5.31. . .MHz as measured with the oscilloscope at J4. Replace the 5MHz input, and readjust R35 as described in paragraph 5-12.

5-62. The presence of the 155MHz modulation should be checked only when necessary because it involves several delicate adjustments. It may be checked as follows:

a. Reduce the 5MHz level, using the Level Adj control in Distribution Amplifier Assembly A5, until the AGC reading at TP4 of the multiplier is 15V.
b. Connect the input of an oscilloscope to TP4. Parallel the input with a 0.05μf capacitor.
c. Synchronize the oscilloscope externally from J2 of Audio Assembly A7.
d. At assembly A4, detune C9 approximately one-quarter turn. A 155Hz signal of approximately 10 to 40mv amplitude should appear on the oscilloscope, indicating that the desired modulation is being effected.
e. Retune C9 to eliminate the 155Hz signal. Readjust the 5MHz level (Level Adj of A5) as described in Paragraph 5-10.

5-63. TROUBLESHOOTING.

5-64. Progression of the signal through the multiplier chain can be checked at various test points using a Tektronix Type 454 Oscilloscope with 10/1 probe.

TP1	Peak with C9. Normal reading is 1.4 - 2.2 volts peak-to-peak at 5MHz.
TP2	Peak with L5 as required. Normal reading is approximately 1.5 volts peak-to-peak at 5MHz.
TP3	Place 50-ohm load at J4. Peak signal at TP3 as required with L8 and L9. Normal TP3 level is approximately 1.0 volts peak-to-peak at 15MHz.

5-65. ADJUSTMENT.

5-66. In the event that assembly replacement is required, it will be necessary to perform the Group I and II adjustments. Refer to paragraphs 5-10 and 5-11.

5-67. Tuning L12 and L17 may be accomplished by observing the AGC signal. The 5MHz input level must be reduced to increase the AGC voltage to approximately 15 volts for accurate adjustment. If the tuning is far out of adjustment it may be necessary to decrease the input level a second time so that the peak signal lies outside the AGC saturation region. Peak tuning is indicated by minimum AGC voltage. A minimum near 15 volts assures accurate setting. When adjustment is complete, reset R39 and R2 of A5 as described in paragraph 5-10.

5-68. **DISTRIBUTION AMPLIFIER ASSEMBLY A5 MAINTENANCE.**

5-69. CHECK FOR NORMAL OPERATION.

5-70. Normal distribution amplifier operation can be verified by observing the following outputs on any oscilloscope rated for 5MHz operation.

J2	Synth
J3	Mult
J4	Clock
J5	Divider
J6	Rear (or observe rear panel 5MHz output)
J7	Front (or observe front panel 5MHz output)

5-71. Signals at J2, J3, J4, and J5 should be adjustable (using R2) above and below 2 volts peak-to-peak when loaded with 1000 ohms. The output waveform should be as shown in figure 5-4.

5-72. The front and rear panel 5MHz outputs should be sine wave signals adjustable, also by R2, above and below 3 volts peak-to-peak when loaded by 50 ohms. If R2 is varied in checking the levels, be sure to return it to the correct setting as described in paragraph 5-10. Normally a check for outputs near the specified level will suffice, however if trouble exists in A3, A4, A6, or A12, a precise check of the output levels should be made. The level of the 5MHz input signal should be approximately 0.8 volts peak-to-peak.

SCOPE SETTINGS	
Vert.	Horiz.
1V/cm DIRECT	0.1μs/cm

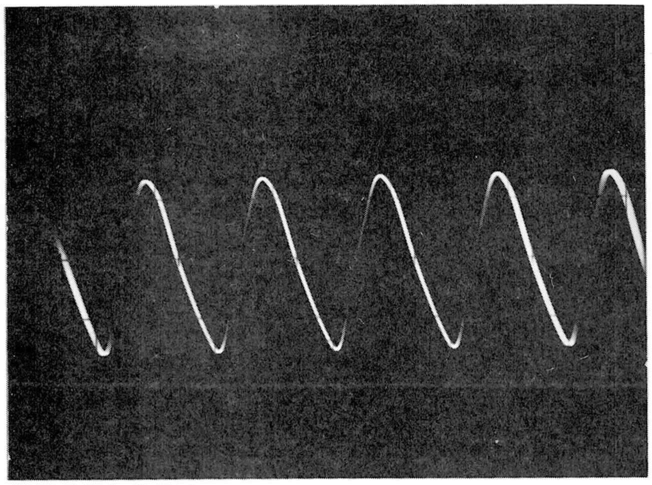


Figure 5-4. Correct Waveshape for 5MHz at J2 through J5.

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5-73. TROUBLESHOOTING.

5-74. Progression of the 5MHz signal through assembly A5 may be checked at the following points:

CHECK POINT	APPROXIMATE LEVEL	WAVEFORM
TP1	20V p-p	Sinusoidal
TP2	2V p-p	Sinusoidal
Collector Q2	2V p-p	Sinusoidal
TP3 and TP4	2V p-p	Halfway between sinewave and sawtooth
Collector Q9 or Q10	15V p-p	Sinusoidal

5-75. ADJUSTMENT.

5-76. If the Distribution Amplifier Assembly is replaced, it will be necessary to adjust R2 as described in paragraph 5-10.

5-77. **SYNTHESIZER ASSEMBLY A6 MAINTENANCE.**

5-78. CHECK FOR NORMAL OPERATION.

5-79. Normal synthesizer operation may be verified by checking the signal at J3 for proper amplitude, waveform and frequency, and checking the LOCK signal for proper voltage.

5-80. The signal at J3 may be checked for voltage and waveform by viewing it on an oscilloscope rated for 6MHz operation such as a Tektronix 531A with type L plug-in. The interconnecting cable should not be more than 3 feet in length and should be terminated in 50ohms at the oscilloscope end. The signal amplitude should be 0.7 volts peak-to-peak, with sinusoidal wave shape. To check for correct frequency replace the oscilloscope with an electronic counter such as Hewlett Packard Model 5254L. Use the 1MHz output of the frequency standard as an external time base signal for the counter. Set the counter front panel controls for 0.1 V sensitivity, 1S time base, and FREQUENCY. The frequency should be as shown in Table 3-2 of this manual. For example, if the switch settings are 0000111100, the counter should read 5.313653MHz ± 1Hz. If necessary, the internal time base of the counter may be used, but then the frequency reading may be in error by as much as 20Hz.

5-81. The voltage at the LOCK output pin should be at ground potential. Failure of the synthesizer to lock on the selected frequency will normally be indicated by +5 volts on the LOCK output pin.

5-82. TROUBLESHOOTING.

5-83. The synthesizer circuitry falls into two major sections: digital divider circuits and locked oscillator circuit.

5-84. DIGITAL DIVIDER CIRCUITS. Operation of the digital divider may be checked by the pulse rate at J2. The signal at J2 may be observed on an oscilloscope as a series of negative pulses of approximately 1.5 volts in amplitude. The pulse deviation is less than 0.1 μsec so an oscilloscope with good high frequency response is required. The Tektronix 531A with Type L plug-in is satisfactory. The very short negative pulses are superimposed upon a background signal of about 0.1 volt amplitude consisting of a series of pulses of various directions. Care must be taken to observe the desired short, negative, 1.5 volt pulses, not some of the 0.1 volt background pulses. The pulses are sufficiently short that use of an electronic counter is troublesome. However, the period may be checked using the oscilloscope to see that the pulses exist with the correct amplitude and with frequency approximately equal to 5MHz divided by number P, where P is as given in Table 3-2. The time interval between pulses in microseconds is P/5. For example, with the switches set to 0000111100, P is 1084, and the interval between pulses should be 217 μsec. Figure 5-5 is an oscilloscope photograph of the pulse train at J2 with the selector switches set for P = 1084.

5-85. If the proper signal is not available at J2, the problem is in the digital section. The 5MHz clock signal driving the first divider may be observed at TP1. The correct waveform is shown in figure 5-6. The dividers may be checked by noting the waveforms at the center contacts of switches 1 through 10, and at pin 12 of U6. The check will be simplified if all switches are placed in the "one" position. Check first the signal at U6, pin 12. This should be a square wave with a period very close to 410 μsec. If this waveform is normal, place the switches in the correct positions for the desired time scale and check that a waveform still exists at U6, pin 12. In general this will now be a square wave with unequal up and down times. If the desired waveform does not exist at U12 check the center terminals of switches S10, S9, etc. until a waveform is located. The period of the signal is cut in half at each step as follows:

SWITCH	PERIOD (APPROXIMATE)
S10	200 μs
S9	100 μs
S8	50 μs
S7	25 μs
S6	13 μs
S5	6.4 μs
S4	3.2 μs
S3	1.6 μs
S2	0.8 μs
S1	0.4 μs

5-86. If the proper signal exists at U6 pin 12, but not at J2, trace the signal through the AND-gate consisting of U9, U8B, and U7A. A pulse should appear at pin 6 of U7A with the same repetition period as expected at J2. This pulse should trigger the one-shot circuit consisting of U8B and U8D to produce a train of short pulses at U8B

SCOPE SETTINGS	
Vert.	Horiz.
1V/cm DIRECT	50μs/cm

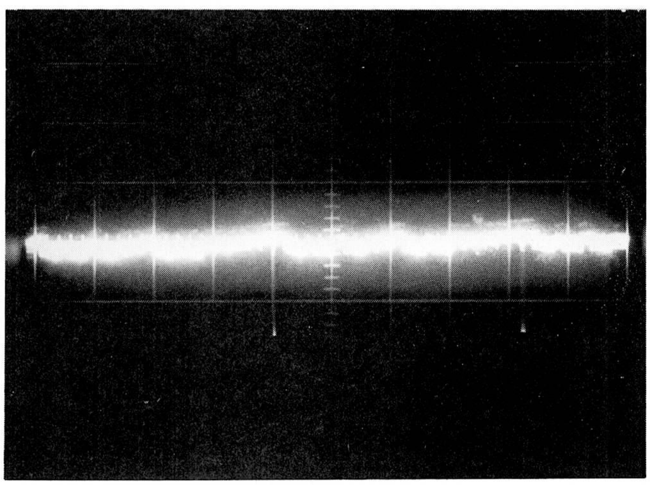

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Figure 5-5. Pulse Train at J2, P = 1084.

SCOPE SETTINGS	
Vert.	Horiz.
0.2V/cm 10:1 PROBE	0.1μs/cm

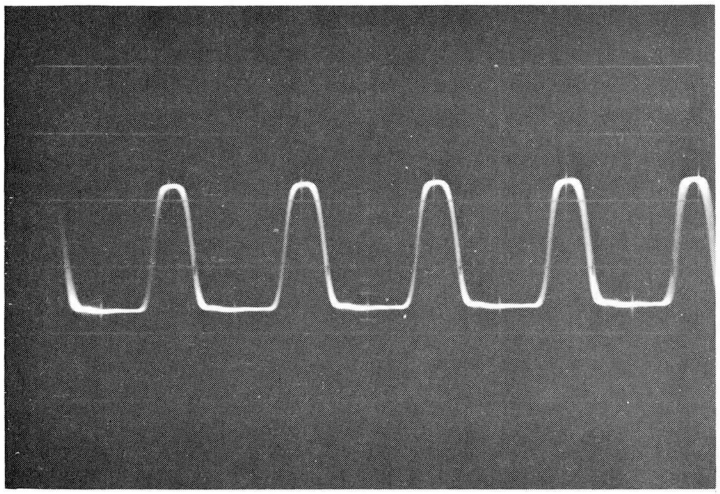

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Figure 5-6. Correct Waveshape for Assembly A6, TP1.

pin 6. The pulse should also correctly reset all dividers via U7B, and reset J2 via U7B and Q2.

5-87. LOCKED OSCILLATOR SECTION. If the signal at J2 is normal, but the signal at J3 is not, trouble in the locked oscillator is probable. Most troubles would fall into one of two classes: oscillator signal is absent or low in amplitude, or oscillator is producing the signal but is not locked at proper frequency.

5-88. Signals at TP3 and TP4 should be sine waves at 5.313 . . . MHz, with amplitudes of approximately 0.5 volts peak-to-peak at TP3 and 0.8 volts peak-to-peak at TP4. When making these measurements, J3 must be terminated in a 50-ohm load. Proper adjustment of C26 minimizes signal at TP3.

5-89. Indication of loop lock or unlock may be noted at TP2. When the loop is locked the signal is a DC voltage with only a small superimposed ripple. When the loop is unlocked a "stair-step" voltage appears at TP2. Figure 5-7 shows waveforms of both types. If the gating system is not functioning properly, however, a DC signal might appear at TP2. Grounding TP5 with a clip lead should result in the typical stair-step unlock signal at TP2. If it fails to do so, the error signal is not being properly gated through Q7. Check for absence of gating pulse at Q8 collector, absence of 5.313 . . . MHz signal at junction of R11 and R12, or failure of Q7.

5-90. Normally R15 should not require adjustment. However, if parts are changed in the course of trouble-shooting, particularly crystal tuning diode CR3, readjustment of R15 may be required. To perform the adjustment, set the synthesizer for the desired frequency, then observe the waveform at TP2 and measure the DC voltage at TP5. Turn R15 CCW until the loop becomes unlocked as indicated by a stair-step waveform at TP2, then turn R15 slowly CW until the loop locks. Note the voltage at TP5 then turn R15 CW until the loop breaks lock. Now turn R15 slowly CCW until lock is just restored. Note voltage at TP5 and set R15 for a voltage half way between the two lock-in readings. If it is desired to use the synthesizer at a variety of settings, determine the lock-in points at the extremes of the desired frequency range and set R15 half way between the highest minimum lock-in point and the lowest maximum lock-in point.

5-91. ADJUSTMENT.

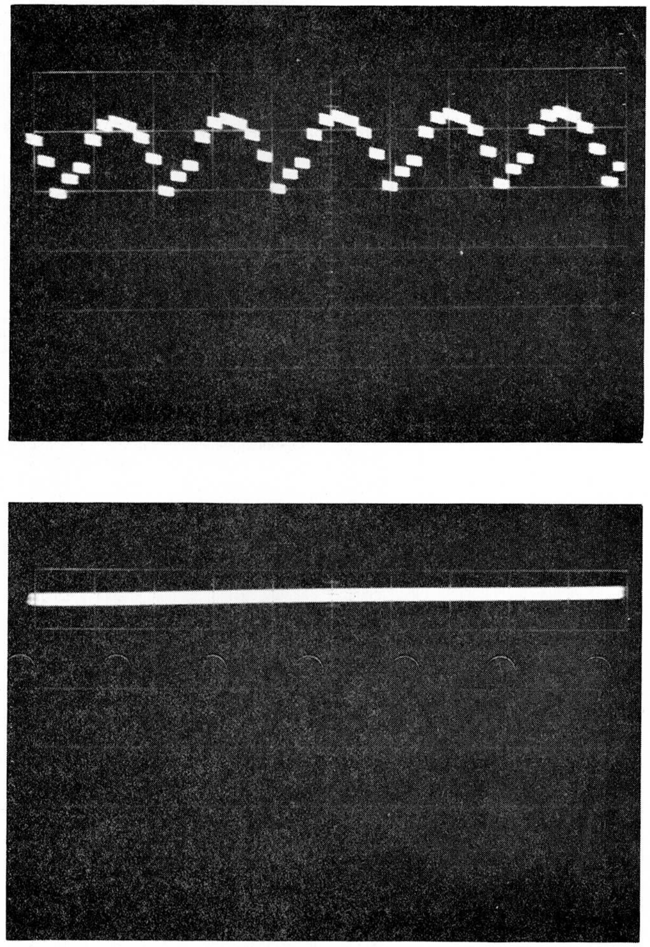
5-92. When a new synthesizer is installed in the frequency standard, Inject control R35 is the only adjustment required. Instructions for this adjustment are given in paragraph 5-12. Of course the frequency selector switches on the new synthesizer must be set for the desired frequency.

5-93. **AUDIO ASSEMBLY A7 MAINTENANCE.**

5-94. CHECK FOR NORMAL OPERATION.

5-95. The Audio Assembly consists of three groups of circuits: modulation signal generator circuits, signal amplifier circuits, and lamp start circuits.

SCOPE SETTINGS	
Vert.	Horiz.
0.2V/cm DC, 10:1 PROBE	1ms/cm



SCOPE SETTINGS	
Vert.	Horiz.
0.2V/cm DC, 10:1 PROBE	1ms/cm

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Figure 5-7. Waveforms Showing Lock and Unlock Conditions of Frequency Control Loop.

5-96. Operation of the modulation signal generator circuits can be checked completely by measuring the signals at J1 and J2. The frequency of the signal at J2, as measured with an electronic counter, should be 155Hz ± 1Hz. Frequency can be adjusted by R5 (Freq Adj). If the setting of R5 is changed, recheck all Loop Adjustments (paragraph 5-6 through 5-15. The signal at J2, as observed with an oscilloscope, should be a square wave with peak-to-peak amplitude of 15 volts.

5-97. The signal at J1 is the same frequency as that at J2, with amplitude of approximately 0.2 volts peak-to-peak. The exact amplitude and waveshape are dependent on the setting of R14 (ϕ Adj). A typical waveform is shown in figure 5-8.

5-98. The best check for normal amplifier circuit operation depends on whether or not normal signals are present. Set the CIRCUIT CHECK switch to 310Hz and read the meter. If the indication is normal it shows that the majority of the amplifier circuits are operating normally. Next set the CIRCUIT CHECK switch to the ERROR position, and place the CONTROL switch to the OPEN LOOP position. Vary the OSCILLATOR FINE FREQUENCY control. The CIRCUIT CHECK meter indication should vary. Set the meter to center position (50), then rotate the OSCILLATOR FINE FREQUENCY control one turn clockwise. The meter should now read 70. If the meter responds properly, but the reading deviates appreciably from 70, adjust R26 (Gain) for a reading of 70. Set the CIRCUIT CHECK switch to PHOTO position. Normal meter indication shows that part of the preamplifier section of the Audio Assembly is operating normally.

SCOPE SETTINGS	
VERT.	
0.2V/cm DIRECT	2ms/cm

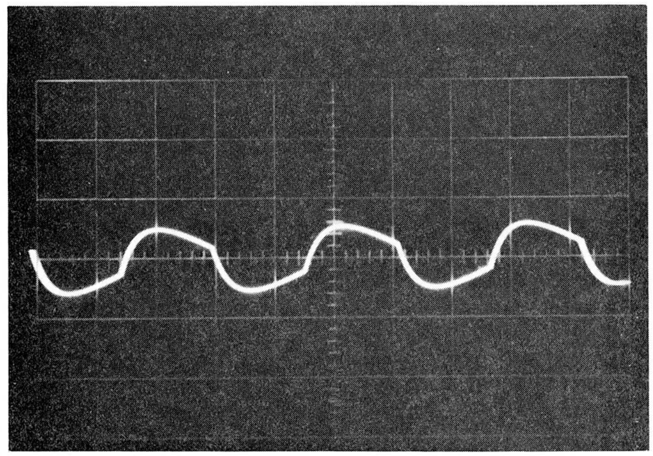

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Figure 5-8. Assembly A7 Modulation Signal Typical Waveform.

5-99. If none of the desired outputs are present, the fault may be in the audio assembly, or the lack of proper inputs from the OMU. An independent check of A7 can be made by feeding a test signal into J6 as shown in figure 5-9. Adjust the oscillator output to zero and set power supply output to 3.3 volts. Connect a DC micro-ammeter, 50 μa full scale, to measure positive current flow from the DET I pin on top of A7 to ground. (Normal connection to DET I pin pulled off.) Normal reading is approximately 6 to 8 microamperes. Connect a DC voltmeter (Simpson Model 260), set for 10 V full scale, across the output at J5 (START PULSE). When the pulse occurs, the meter will "kick" briefly up to approximately 1 volt. Pulses should occur approximately once each 10 seconds. Slowly increase the external power supply voltage from 3.3 volts to 15 volts. At approximately 4 or 5 volts the pulsing at J5 should cease. At 15 volts, the DET I current should be between 25 and 35 microamperes.

5-100. Set the DC voltage for a reading of 30 microamperes at the DET I pin. Set the oscillator output to 1 volt rms, and frequency to 155Hz. With R26 (Gain) set fully clockwise, the output at J3 should be between 1 - 2 volts peak-to-peak. Tuning the audio oscillator should result in a peak output between 150Hz and 160Hz. Tune oscillator to 310Hz. Output at J3 should now be less than 0.1 volt peak-to-peak. Output at J4 should be between 8-12 volts peak-to-peak (R-26 full clockwise). Return R26 to correct setting as described in paragraph 5-12.

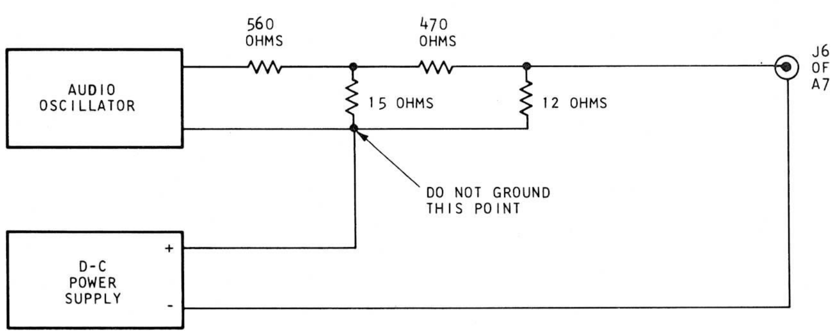

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Figure 5-9. Audio Assembly A7 Test Setup.

5-101. TROUBLESHOOTING.

5-102. The tests for normal operation will serve to isolate a trouble to a relatively small group of components such as the 155Hz amplifier, the lamp start circuit, etc. If the trouble is in the modulation signal generator section, check for a 310Hz square wave at the collector of Q2. This will check the 310Hz oscillator. Look for a 155Hz square wave at pin 8 or pin 6 of J1 to check the divider.

5-103. ADJUSTMENT.

5-104. If assembly A7 is replaced, the Group II Loop Adjustments should be performed. Refer to paragraph 5-11 through 5-14.

5-105. OSCILLATOR REGULATOR AND START ASSEMBLY A8 MAINTENANCE.

5-106. CHECK FOR NORMAL OPERATION.

5-107. The Oscillator Regulator and Start Assembly is most conveniently considered in two sections: the oscillator regulator section and the lamp start section. To check for normal operation of the oscillator regulator, connect a voltmeter between TP1 (available on top of the module) and chassis ground. The voltage should be between +8 and +12 volts. The correct setting of this voltage depends upon the characteristics of the rubidium lamp in the OMU and adjustment should not be attempted without good reason.

5-108. To check for normal operation of the lamp start section, remove the connector from J2 and connect a Simpson Model 260 VOM, set to the 250 v DC scale, between J2 and ground. Avoid grounding the center conductor of J2, and avoid electrical shock from the high-voltage pulse generated there. If the lamp start relay is clicking (approximately once per 10 seconds), a pulse should activate the meter needle at each click, driving it to a peak value between 75 and 100 volts. (Use of a meter with different mechanical damping characteristics would cause a different peak reading.) If the rubidium lamp is already on, the relay will not be clicking; normally under these conditions there would be no particular reason to check the pulse. However, if it is desired to do so, the lamp can be extinguished by removing the connector from the OSC V output pin. The start pulses should now commence. Be sure to replace the connectors after completing the check.

5-109. TROUBLESHOOTING.

5-110. On rare occasions, C1 can become defective in such manner that the output pulse appears normal but will not start the lamp. If C1 is replaced, utilize the following replacement part:

TRACOR STK. NO.	DESCRIPTION	TYPICAL MFGR.	MFGR. PART NO.
	Capacitor 0.1 μfd 400 volts	80183	96P-10494

5-111. MODULE REPLACEMENT.

5-112. Oscillator Regulator and Start Assembly A8 can be replaced independently of Audio Assembly A7, with which it is packaged, by removing A7 from the chassis, then removing the screws holding the common shield cover to A8. It is advisable to remove power to the frequency standard while changing A8 because high voltage exists within this assembly. If A8 is replaced, the only adjustment required is to set R7 for the proper oscillator voltage. If the PHOTO reading on the circuit check meter was recorded during normal operation, R7 may be adjusted for the original reading. If A8 was changed due to trouble in the start section, the voltage existing at TP1 in the old unit may be noted and reproduced in the new unit. If the correct setting is not known, set R7 for a PHOTO reading on the CIRCUIT CHECK meter of 80. Refer to paragraph 5-14 for this procedure.

5-113. LOOP FILTER ASSEMBLY A9 MAINTENANCE.

5-114. CHECK FOR NORMAL OPERATION.

5-115. The check for normal operation of Loop Filter Assembly A9 is conveniently considered in two parts: proper response to OSCILLATOR FINE FREQUENCY control, and proper response to 310Hz error signal. To check for proper response to the OSCILLATOR FINE FREQUENCY control, connect a DC voltmeter between TP3 and ground and place the CONTROL switch in the OPEN LOOP position. With the OSCILLATOR FINE FREQUENCY control at 0, the voltage at TP3 should be 2-4 volts. As the OSCILLATOR FINE FREQUENCY control is increased to 10, the voltage at TP3 should increase smoothly to approximately 10 volts. Return the OSCILLATOR FINE FREQUENCY control to a reading of 5.0.

NOTE

It is assumed that a 155Hz signal is available from A7. If not, trouble should be investigated elsewhere before proceeding with the check of assembly A9.

5-116. Place the CONTROL switch to the OPEN LOOP position. Place the CIRCUIT CHECK switch to the ERROR position and adjust the OSCILLATOR FINE FREQUENCY control for a reading of 60. With an oscilloscope, observe the waveform at TP1 of A9. It should be as shown in figure 5-1. Amplitude should be approximately 0.5 volts peak-to-peak. If necessary, adjust R14 (ϕ Adj) of A7 for the correct waveshape.

5-117. Adjust the OSC FINE FREQUENCY control for an ERROR reading of 40. The waveform at TP1 should now be inverted, with amplitude still approximately 0.5 volts peak-to-peak. Place the CONTROL switch to the NORMAL position. The ERROR reading should gradually move to 50. Three seconds after the CONTROL switch is placed to NORMAL, the reading should be approximately 47. If the ERROR goes to 50 much faster or much slower than the rate giving a reading of 47 after three seconds, check the Gain adjustment. Refer to paragraph 5-12.

5-118. TROUBLESHOOTING.

5-119. The checks for normal operation previously described should also isolate trouble to a particular circuit within A9. If the OSCILLATOR FINE FREQUENCY control fails to effect the desired change at TP3, check at TP2. This will isolate the trouble to emitter follower Q2 or to operational amplifier U1. If the waveform at TP1 is not correct, check for trouble in the synchronous chopper. If the waveform is correct at TP1, but the ERROR signal does not respond properly when the loop is closed, check the integrator circuit of U1.

5-120. ADJUSTMENT.

5-121. No adjustments are required when Loop Filter Assembly A9 is replaced.

5-122. **LOGIC ASSEMBLY A10 MAINTENANCE.**

5-123. CHECK FOR NORMAL OPERATION & TROUBLESHOOTING.

5-124. Case One: OPERATION lamp will glow continuously. In this case, it is normal to assume that the logic assembly is operating properly. It is conceivable however, that trouble could exist of such nature that the logic assembly fails to indicate a signal failure as intended. If there is reason to suspect such a condition, proceed as follows. Remove the wire from the LOCK pin on Synthesizer Assembly A6. The OPERATION lamp should now flash rapidly. Replace the wire on the LOCK pin. The OPERATION lamp should now flash slowly. Push the RESET button. The lamp should now glow continuously. Proper action throughout this test indicates proper operation of the Lamp Driver, Loop Lock Logic, Past Participle Latch, and Synth Lock driver sections of A10.

5-125. Place the CIRCUIT CHECK switch to the 310Hz position and record the meter reading. Rotate R11 (Mod) of assembly A4 slowly CCW until the lamp begins to flash rapidly. This should occur at a meter reading between 60 and 70. Rotate R11 slowly CW until the meter reads 70. The lamp should now flash slowly. Rotate R11 to restore the original meter reading. At this point, failure to record or recall the original reading will require that R11 be readjusted in accordance with Group II Loop Adjustments procedures in paragraph 5-12 and 5-13. If necessary, make this adjustment, then push the RESET button. The lamp should now glow continuously. The foregoing procedure checks the 310Hz Sensor section of A10.

5-126. Place the CONTROL switch in the OPEN LOOP position. Place CIRCUIT CHECK switch to the ERROR position and adjust OSCILLATOR FINE FREQUENCY control to center the meter at 50. Rotate OSCILLATOR FINE FREQUENCY control slowly CW until the lamp flashes rapidly. This should occur at a meter reading between 60 and 70. Re-center the meter reading at 50. The lamp should flash slowly. Turn OSCILLATOR FINE FREQUENCY control slowly CCW until the lamp begins to flash rapidly. This should occur at a meter reading between 30 and 40. Place OSCILLATOR FINE FREQUENCY control at the center of its range (5.0). Adjust OSCILLATOR COARSE FREQUENCY control to center the error reading at 50.

CAUTION

If coarse tuning is off far enough, a reading of 50 will result. Be sure a slight adjustment in either direction moves the meter indication back and forth across 50.

5-127. Place the CONTROL switch to the NORMAL position, then push the RESET button. The lamp should now glow continuously. The foregoing procedure checks the 155Hz Sensor section of A10.

5-128. Connect a DC voltmeter from TP3 of Assembly A9 to ground. Rotate the OSCILLATOR COARSE TUNING control slowly CCW. The meter reading should slowly decrease. Adjust the tuning until the meter reading stabilizes at 2 volts. It will probably be necessary to adjust the tuning in small increments, waiting some fifteen seconds after each adjustment for the meter reading to stabilize. The lamp should flash rapidly. Adjust the OSCILLATOR COARSE TUNING control slowly CW for a stable meter reading of 5 volts. The lamp should either flash slowly or glow continuously. A continuous glow will result only if the tuning adjustments were made extremely slowly so that loop lock was preserved throughout. There is no particular reason to strive for this result; a slow flash at this point is satisfactory. Now turn the OSCILLATOR COARSE TUNING control CW for a stable meter reading of 15 volts. The lamp should flash rapidly. Turn CCW for a stable reading of 10 volts. The lamp should flash slowly (or glow continuously).

5-129. Place the CIRCUIT CHECK switch to the ERROR position and the CONTROL switch to the OPEN LOOP position. Set OSCILLATOR FINE TUNING control to midscale (5.0). Adjust OSCILLATOR COARSE TUNING control to center the meter at 50.

CAUTION

If coarse tuning is off far enough from the correct position, a spurious meter reading of 50 will result. Be sure that a slight adjustment in either direction moves the meter indication to each side of center (50). If not, turn the OSCILLATOR COARSE TUNING control to increase the ERROR reading. Continue in the same direction until the ERROR reading reaches a maximum deviation from 50 and returns again to 50.

The foregoing tests check the Integrator Limits Sensor section of A10.

5-130. Case Two: OPERATION lamp will not glow continuously. Check for correct readings at the following positions of the CIRCUIT CHECK meter:

a. CONTROL — Between 25 and 75
b. ERROR — Between 45 and 55
c. 310Hz — Above 70

5-131. If the readings are not correct, the trouble is not located in assembly A10. (See table 5-1.) The only exception is with the 310Hz indication. If an indication is not present with the switch in this position, but a 310Hz output exists at J4 of A7, then look for the trouble in the 310Hz Sensor section of A10.

5-132. To further isolate the trouble in case two, remove the wire from the LOCK pin of assembly A6 and touch it to the chassis. If this permits the lamp to glow continuously when the RESET button is pushed, look for trouble in assembly A6.

5-133. If the readings are normal, look for trouble in assembly A10. The following table indicates voltages that should exist at various points in A10 when operation is normal.

CHECK POINT	NORMAL VOLTAGE
TP1	+5
TP2	0
TP3	+5
TP4	+5
U2, pin 3	0
U2, pin 6	+5
U1, pin 6	0
U2, pin 8	0
TP6	+5
U1, pin 8	+5
U1, pin 11	0
TP8	+19
TP7	Pulsing at Slower Rate

5-134. ADJUSTMENT.

5-135. No adjustments are required when Logic Assembly A10 is replaced.

5-136. **OPTICAL MICROWAVE ASSEMBLY A13 MAINTENANCE.**

5-137. CHECK FOR NORMAL OPERATION.

5-138. A normal 310Hz indication on the front panel CIRCUIT CHECK meter virtually assures that the Optical

Microwave Unit is functioning normally. In the absence of proper 310Hz indication, follow the instructions given in paragraphs 5-43 and 5-44.

5-139. TROUBLESHOOTING.

5-140. Factory repair of the Optical Microwave Assembly is recommended. If either this unit alone, or the entire standard is returned for repair, follow the instructions of paragraph 5-155 through 5-157. It is practical to replace the Optical Microwave Assembly in the field.

5-141. ASSEMBLY REPLACEMENT.

5-142. To remove the OMU, remove the top cover from the frequency standard, then remove four screws that attach the OMU to the rear panel and two screws that attach the front end of the OMU to a mounting bracket. Lift the OMU from the box by tipping it slightly to clear the lip at the top edge of the right side panel, then remove the unit. If desired, the assembly can be removed by first removing the entire right side panel (some 11 screws).

5-143. Several cable ties must be removed to permit complete removal of the OMU. Be careful not to damage cables. Then all connectors fastening the OMU cables to the rest of the unit may be disconnected. Attach the cable connectors of the new OMU taking care to connect each to the correct mate.

5-144. If desired, the new OMU can be checked for proper operation before installing it inside the chassis and replacing the cables. To do so, turn the unit on as described in paragraph 3-3 and set R7 of A8 to the correct voltage for the new OMU as measured at TP1 of A8. If this voltage is not known, set the voltage to 10 v. Within 20 minutes, there should be sufficient PHOTO current indicated on the CIRCUIT CHECK meter to inhibit further pulsing of the lamp start circuit. Within one hour (at 25° ambient), the OSC HTR, CAV HTR, and LAMP HTR indications should be in their normal range. Now make the Loop Adjustments of paragraph 5-6. Set the MAGNETIC FIELD control to the correct value for the new OMU and check that the setting of the synthesizer switches (A6) is correct.

5-145. 5MHz CRYSTAL OSCILLATOR ASSEMBLY A14 MAINTENANCE.

5-146. CHECK FOR NORMAL OPERATION.

5-147. If the 5MHz reading on the front panel CIRCUIT CHECK meter is correct, more than likely the 5MHz crystal oscillator is operating properly. A more complete check is as follows:

a. Refer to the check for normal operation of A5. If any of the A5 outputs are normal, correct input voltage is being received from the crystal oscillator.

b. If test equipment is available, check the oscillator frequency as described in paragraphs 5-16.through 5-23.

5-148. TROUBLESHOOTING.

5-149. If normal outputs are not available from A5, check the signal on the coaxial cable leaving the crystal oscillator. This cable normally plugs into a jack located on a small bracket behind the front panel, near the oscillator. The normal output is a 5MHz signal of around 0.8 volts peak-to-peak and approximately sinusoidal in shape. If the signal is not present, check for proper voltages at the 8-pin connector that mates with oscillator plug P2. Voltages should be:

PIN	VOLTAGE
A	Voltage variable from 2 to 10 volts by tuning OSCILLATOR FINE FREQUENCY dial with CONTROL switch in OPEN LOOP position.
B	Ground
C	19.25 volts
E	19.25 volts
F	Ground

5-150. If trouble exists the 5MHz Crystal Oscillator Assembly A14, it should be replaced.

5-151. ADJUSTMENT.

5-152. If assembly A14 is replaced, the periodic adjustment procedure of paragraph 5-5 should be accomplished.

5-153. **FUSE AND LAMP REPLACEMENT.**

5-154. 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 155VAC 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 31202.5
d. OPERATION and BATTERY lamps; replace with No. 387

5-155. **SERVICING INFORMATION.**

5-156. 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 repair will not begin until customer authorization is received.

5-157. 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 304D 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	18382-0001 IMP MTCH UNIT ASSY		* * * *
C 1	27512-0102	CAP FXD MICA 1000 PFD	72136	CM06F102G03 (MIL-C-5/18)
J 1	23969-0039	CONNECTOR	98291	52-043-0000
J 2	24125-0001	CONN BNC PNL MOUNT	98291	51-044-0000
R 1	200-0220	RES FXD COMP 22.0 OHM	81349	RC07GF220K (MIL-R-11/8)
R 2	200-0151	RES FXD COMP 150. OHM	81349	RC07GF151K (MIL-R-11/8)
* * *	* ASSEMBLY NO	G15286-0001 ACCESSORY KIT		* * * *
	18502-0001	JUMPER CABLE ASSY	19397	18502-0001
	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	USE DWG 24102-0300	14674	CY10C300J
L 1	3568-0100	INDUCTOR 10 UH	99800	1537-36
* * *	* 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	FB 2B4712
J 1	23969-0035	CONNECTOR	98291	51-043-0000
R 1	204-0000	RESISTOR SELECTED	19397	204-0000
CR 1	23969-0047	DIODE	28480	5082-0151
* * *	* ASSEMBLY NO	G35131-0001 OSC HEATER CONT A14A2		* * * *
C 1	21485-9101	CAP FXD TA 1 MFD	05397	CS13BF105K (MIL-C-26655/2)
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	USE DWG 4352-0015	19397	GA42P1
* * *	* ASSEMBLY NO	G35153-0001 XTAL OSC ASSY A14A1		* * * *
C 1	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 2	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 3	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 4	23969-0012	USE DWG 24102-0201	14674	CY10C201J
C 5	23969-0013	USE DWG 24102-0271	14674	CY10C271J
C 6	23969-0020	CAPACITOR 2.2 MFD	16509	TIM225M020P0W
C 7	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 8	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
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	80183	C023B101F103M
C 12	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 13	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 14	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 15	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 16	27512-0151	CAP FXD MICA 150 PFD	00853	CM05F151G03 (MIL-C-5/18)
C 17	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 18	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
C 19	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 20	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 21	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 22	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 23	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 26	23969-0014	USE DWG 24102-0100	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
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		* * * *
	G25152-0001	COMPONENT ASSY A14A3	19397	G25152-0001
	G34951-0001	CAN ASSY CRYSTAL 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	SRE7PJ
* * * * 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)

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
C 17	8914-0100	CAP FXD TA 10 MFD	01295	CS13BE106K (MIL-C-26655/2)
C 18	23969-0015	CAPACITOR .05 MFD 1%	99515	MLR-503-F1
C 19	23969-0015	CAPACITOR .05 MFD 1%	99515	MLR-503-F1
C 20	23969-0016	CAPACITOR .1 MFD 1%	99515	MLR-104-F1
C 21	23969-0016	CAPACITOR .1 MFD 1%	99515	MLR-104-F1
C 22	23969-0016	CAPACITOR .1 MFD 1%	99515	MLR-104-F1
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	MLR-503-F1
C 28	23969-0015	CAPACITOR .05 MFD 1%	99515	MLR-503-F1
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	740-1243	RES FXD FILM 124K	81349	RN60C1243F (MIL-R-10509/1)
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	740-1003	RES FXD FILM 100K	81349	RN60C1003F (MIL-R-10509/1)
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	740-1372	RES FXD FILM 1.37K	81349	RN60C1372F (MIL-R-10509/1)
R 20	740-1372	RES FXD FILM 1.37K	81349	RN60C1372F (MIL-R-10509/1)
R 21	740-2051	RES FXD FILM 2.05K	81349	RN60C2051F (MIL-R-10509/1)
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	740-1022	RES FXD FILM	81349	RN60C1022F (MIL-R-10509/1)
R 32	740-1022	RES FXD FILM	81349	RN60C1022F (MIL-R-10509/1)
R 33	740-5111	RES FXD FILM 5.11K	81349	RN60C5111F (MIL-R-10509/1)
R 34	740-9760	RES FXD FILM 976 OHM	81349	RN60C9760F (MIL-R-10509/1)
R 35	740-1003	RES FXD FILM 100K	81349	RN60C1003F (MIL-R-10509/1)
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	740-9760	RES FXD FILM 976 OHM	81349	RN60C9760F (MIL-R-10509/1)
R 49	740-1003	RES FXD FILM 100K	81349	RN60C1003F (MIL-R-10509/1)
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

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
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
* * *	* ASSEMBLY NO G44901-0001	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	3403-9504	CAP FXD CER .005 UF	80183	TG-D50
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	3403-9504	CAP FXD CER .005 UF	80183	TG-D50
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	USE DWG 27513-0500		
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	3403-9504	CAP FXD CER .005 UF	80183	TG-D50
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	3403-9504	CAP FXD CER .005 UF	80183	TG-D50
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

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
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)
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	IC SN7473N	01295	SN7473N
U 2	23425-0001	IC SN7473N	01295	SN7473N
U 3	23425-0001	IC SN7473N	01295	SN7473N
U 4	23425-0001	IC SN7473N	01295	SN7473N
U 5	23425-0001	IC SN7473N	01295	SN7473N
U 6	23425-0001	IC SN7473N	01295	SN7473N
U 7	23532-0001	INTEGRATED CIRCUIT	01295	SN7440N
U 8	23408-0001	IC SN7400N	01295	SN7400N
U 9	23531-0001	INTEGRATED CIRCUIT	01295	SN7430N
U 10	23408-0001	IC SN7400N	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 BRD LMP OSC A13A1A2 * * * *				
C 1	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 2	27512-0221	CAP FXD MICA 220 PFD	00853	CM05F221G03 (MIL-C-5/18)
C 3	27513-0500	CAP FXD MICA 50MMF	84171	DM-15-500
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	18569-0001	TSTR MOTOROLA	19397	18569-0001
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)

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
* * * * ASSEMBLY NO G44915-0001 X18 RF MULTI A4A1 * * * *				
C 1	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 2	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
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	80183	C023B101F103M
C 6	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 7	8918-0331	CAP FXD TA 330 MFD	05397	CS13BB337K (MIL-C-26655/2)
C 8	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 9	23969-0023	CAPACITOR 2.25 PFD	16509	TP25C
C 10	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 11	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 12	8914-9221	CAP FXD TA 2.2 MFD	01295	CS13BE225K (MIL-C-26655/2)
C 13	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 14	3324-9473	CAP FXD MYL .047 MFD	56289	192P47392
C 15	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 16	27512-0472	CAP FXD MICA 4700 PFD	00853	CM06F472G03 (MIL-C-5/18)
C 17	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 18	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
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	80183	C023B101F103M
C 23	23969-0124	CAP .001	91418	SM-001
C 24	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
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	80183	C023B101F103M
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	80183	C023B101F103M
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	80183	C023B101F103M
C 39	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 40	23969-0124	CAP .001	91418	SM-001
C 41	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 42	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 43	3324-9473	CAP FXD MYL .047 MFD	56289	192P47392
C 44	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
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

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
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)
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 * * * *

C 1	24025-0001	CAP FXD PPR .1 MFD	56289	96P-10494
C 2	21485-0220	CAP FXD TA 22 MFD	05397	CS13BF226K (MIL-C-26655/2)
C 3	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 4	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
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

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
		* * * * ASSEMBLY NO G44937-0001 DISTRIBUTION BRD A5A1 * * * *		
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	DV11PS35D
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	27513-0471	CAP FXD MICA 470 PFD	84171	DM-15-471G
C 10	3403-9253	CAP FXD CER .025 UF	80183	TG-S25
C 11	23969-0019	CAPACITOR	00656	MC80V103AM
C 12	23969-0019	CAPACITOR	00656	MC80V103AM
C 13	23969-0019	CAPACITOR	00656	MC80V103AM
C 14	23969-0019	CAPACITOR	00656	MC80V103AM
C 15	27513-0471	CAP FXD MICA 470 PFD	84171	DM-15-471G
C 16	27513-0471	CAP FXD MICA 470 PFD	84171	DM-15-471G
C 17	3403-9253	CAP FXD CER .025 UF	80183	TG-S25
C 18	27513-0431	CAP FXD MICA 430 MMF	84171	DM-15-431
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	27513-0431	CAP FXD MICA 430 MMF	84171	DM-15-431
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	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (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	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (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	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (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)

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
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	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 36	204-0430	RES FXD COMP 43 OHM	81349	RC07GF430J (MIL-R-11/8)
R 37	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 38	204-0100	RES FXD COMP 10.0 OHM	81349	RC07GF100J (MIL-R-11/8)
R 39	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (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	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (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 8-6.8A	19397	G25037-0001
T 2	G25038-0001	TRANSFORMER 8-2 B	19397	G25038-0001
T 3	G25038-0001	TRANSFORMER 8-2 B	19397	G25038-0001
Y 1	23969-0075	CRYSTAL 5 MHZ	74306	4051122
CR 1	800-0662	DIODE 1N662	01295	1N662
TP 1	23969-0044	COTTER PIN BRASS	73734	3/8LG X 1/16 DIA
TP 2	23969-0044	COTTER PIN BRASS	73734	3/8LG X 1/16 DIA
TP 3	23969-0044	COTTER PIN BRASS	73734	3/8LG X 1/16 DIA
TP 4	23969-0044	COTTER PIN BRASS	73734	3/8LG X 1/16 DIA
XY 1	3631-0001	HOLDER CRYSTAL	91506	8000-DG1
* * * * ASSEMBLY NO G44940-0001 POWER SUPPLY PCB A2A1 * * * *				
C 1	23969-0453	CAP FXD MICA	84171	DM-15-102J
C 2	23969-0116	CAP FXD TA 15MFD 35V	56289	150D156X0035R2
Q 1	900-4918	TSTR 2N4918	04713	2N4918
Q 2	900-4921	TSTR 2N4921	04713	2N4921
Q 3	900-5190	TSTR 2N5190	04713	2N5190
Q 4	900-3906	TSTR 2N3906	01295	2N3906
Q 5	900-3906	TSTR 2N3906	01295	2N3906
Q 6	900-3904	TSTR 2N3904	04713	2N3904
Q 7	900-3904	TSTR 2N3904	04713	2N3904
R 1	4677-0001	RES FXD WW .15 OHM	75042	BWH 2W .15 OHM
R 2	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 3	204-0104	RES FXD COMP 100. K	81349	RC07GF104J (MIL-R-11/8)
R 4	202-0220	RES FXD COMP 22 OHM	81349	RC32GF220J (MIL-R-11/6)
R 5	204-0122	RES FXD COMP 1.20 K	81349	RC07GF122J (MIL-R-11/8)
R 7	740-2051	RES FXD FILM 2.05K	81349	RN60C2051F (MIL-R-10509/1)
R 8	202-0681	RES FXD COMP 680 OHM	81349	RC32GF681J (MIL-R-11/6)
R 9	203-0101	RES FXD COMP 100. OHM	81349	RC42GF101J (MIL-R-11/7)
R 11	23969-0064	RESISTOR VAR	80294	3009Y-1-501
R 12	740-1001	RES FXD FILM 1 K	79727	RN60C1001F (MIL-R-10509/1)
R 13	740-1821	RES FXD FILM 1.82K	81349	RN60C1821F (MIL-R-10509/1)
R 14	740-3321	RES FXD FILM 3.32K	81349	RN60C3321F (MIL-R-10509/1)
R 15	204-0152	RES FXD COMP 1.50 K	81349	RC07GF152J (MIL-R-11/8)
R 16	204-0122	RES FXD COMP 1.20 K	81349	RC07GF122J (MIL-R-11/8)
R 17	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 18	204-0182	RES FXD COMP 1.80 K	81349	RC07GF182J (MIL-R-11/8)
R 19	204-0222	RES FXD COMP 2.20 K	81349	RC07GF222J (MIL-R-11/8)
R 20	204-0391	RES FXD COMP 390 OHM	81349	RC07GF391J (MIL-R-11/8)
R 21	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 22	740-3481	RES FXD FILM 3.48K	81349	RN60C3481F (MIL-R-10509/1)
R 23	740-2741	RES FXD FILM 2.74K	81349	RN60C2741F (MIL-R-10509/1)
R 24	202-0221	RES FXD COMP 220 OHM	81349	RC32GF221J (MIL-R-11/6)
U 1	23969-0001	AMPLIFIER	07263	U5B7741393
CR 1	803-3788	DIODE 1N3788B	04713	1N3788B
CR 2	800-0938	DIODE 1N938	04713	1N938
CR 3	800-0914	DIODE 1N914	01295	1N914
CR 4	800-0914	DIODE 1N914	01295	1N914
CR 5	800-0914	DIODE 1N914	01295	1N914
CR 6	800-0914	DIODE 1N914	01295	1N914
* * * * ASSEMBLY NO G44949-0001 DIVIDER 1MH2-100KA3A1 * * * *				
C 1	8914-0470	CAP FXD TA 47 MFD	01295	CS13BE476K (MIL-C-26655/2)
C 2	27512-0122	CAP FXD MICA 1200 PFD	00853	CM06F122G03 (MIL-C-5/18)
C 3	27512-0122	CAP FXD MICA 1200 PFD	00853	CM06F122G03 (MIL-C-5/18)
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 7	3324-9102	CAP FXD MYL .1 MFD	56289	192P10492

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
C 8	3324-9473	CAP FXD MYL .047 MFD	56289	192P47392
C 9	27512-0392	CAP FXD MICA 3900 PFD	00853	CM06F392G03 (MIL-C-5/18)
C 10	27512-0392	CAP FXD MICA 3900 PFD	00853	CM06F392G03 (MIL-C-5/18)
C 11	23969-0019	CAPACITOR	00656	MC80V103AM
C 12	3324-9102	CAP FXD MYL .1 MFD	56289	192P10492
C 13	23969-0019	CAPACITOR	00656	MC80V103AM
C 14	8914-0150	CAP FXD TA 15 MFD	01295	CS13BE156K (MIL-C-26655/2)
C 15	27513-0562	CAP FXD MICA 5600 PFD	84171	DM-19-562
C 16	27513-0562	CAP FXD MICA 5600 PFD	84171	DM-19-562
C 17	3324-9102	CAP FXD MYL .1 MFD	56289	192P10492
C 18	23969-0019	CAPACITOR	00656	MC80V103AM
C 19	8914-0150	CAP FXD TA 15 MFD	01295	CS13BE156K (MIL-C-26655/2)
C 20	27513-0562	CAP FXD MICA 5600 PFD	84171	DM-19-562
C 21	27513-0562	CAP FXD MICA 5600 PFD	84171	DM-19-562
C 22	3324-9102	CAP FXD MYL .1 MFD	56289	192P10492
C 23	27513-0102	CAP FXD MICA 1000 PFD	84171	DM-15-102G
C 24	3324-9102	CAP FXD MYL .1 MFD	56289	192P10492
C 25	27512-0511	CAP FXD MICA 510 PFD	84171	CM06F511G03 (MIL-C-5/18)
C 26	3324-9473	CAP FXD MYL .047 MFD	56289	192P47392
C 27	27513-0102	CAP FXD MICA 1000 PFD	84171	DM-15-102G
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 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
L 2	3568-0220	INDUCTOR 22 UH	99800	1537-44
L 3	3568-0390	INDUCTOR 39 UH	99800	1537-56
L 4	3568-0220	INDUCTOR 22 UH	99800	1537-44
L 5	3422-0501	INDUCTOR 500 UH	99800	2500-14
L 6	3422-0391	INDUCTOR 390 UH	99800	2500-08
L 7	3422-0501	INDUCTOR 500 UH	99800	2500-14
L 8	3568-0101	INDUCTOR 100 UH	99800	1537-76
L 9	3568-0101	INDUCTOR 100 UH	99800	1537-76
L 10	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 3	900-3904	TSTR 2N3904	04713	2N3904
Q 4	900-3904	TSTR 2N3904	04713	2N3904
Q 5	900-2218	TSTR 2N2218	04713	2N2218
Q 6	900-2218	TSTR 2N2218	04713	2N2218
Q 7	900-2218	TSTR 2N2218	04713	2N2218
Q 8	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 10	204-0431	RES FXD COMP 430 OHM	81349	RC07GF431J (MIL-R-11/8)
R 11	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 12	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 13	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 14	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 15	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 16	204-0201	RES FXD COMP 200 OHM	81349	RC07GF201J (MIL-R-11/8)
R 17	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 18	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 19	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 20	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 21	204-0302	RES FXD COMP 3.0 K	81349	RC07GF302J (MIL-R-11/8)
R 22	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 23	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 24	204-0330	RES FXD COMP 33 OHM	81349	RC07GF330J (MIL-R-11/8)
R 25	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 26	204-0302	RES FXD COMP 3.0 K	81349	RC07GF302J (MIL-R-11/8)
R 27	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 28	204-0330	RES FXD COMP 33 OHM	81349	RC07GF330J (MIL-R-11/8)
R 29	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 30	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 31	204-0302	RES FXD COMP 3.0 K	81349	RC07GF302J (MIL-R-11/8)

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
R 32	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 33	204-0390	RES FXD COMP 39 OHM	81349	RC07GF390J (MIL-R-11/8)
R 34	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 35	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 1	G25035-0001	TRANSFORMER 8-50 B	19397	G25035-0001
T 2	G25035-0001	TRANSFORMER 8-50 B	19397	G25035-0001
T 3	G25036-0001	TRANSFORMER 8-220B	19397	G25036-0001
T 4	G25036-0001	TRANSFORMER 8-220B	19397	G25036-0001
U 1	23408-0001	IC SN7400N	01295	SN7400N
U 2	3938-0015	IC SN7490N	01295	SN7490N
U 3	3938-0015	IC SN7490N	01295	SN7490N
L1 11	23969-0024	CHOKE 39 MH	76493	9340-34
* * *	* ASSEMBLY NO G44964-0001	POWER SUPPLY	* *	* *
	G34967-0001	BRACKET TRANSFORMER	19397	G34967-0001
	G35188-0001	HARNESS ASSY PS	19397	G35188-0001
	G35188-0001	HARNESS ASSY PS	19397	G35188-0001
	G44940-0001	POWER SUPPLY PCB A2A1	19397	G44940-0001
C 1	23969-0005	CAPACITOR 3900 MFD	56289	36D392G050AC2A
C 2	23969-0010	CAPACITOR 250 MFD	73445	C437AR/H250
C 3	3951-0013	CAP FXD ELECT 1000MFD	56289	39D108G025GL4
F 1	4323-0024	FUSE 2AMP 125VOLT	75915	313002
F 2	3348-9251	FUSE 2.5 AMP 250 VOLT	75915	31202.5
F 3	3348-9301	FUSE 3 AMP 250 VOLT	75915	312003.
J 1	3817-0960	CONN MS3102A-10SL-3P	96906	MS3102A-10SL-3P
Q 1	900-3616	TSTR 2N3616	04713	2N3616
Q 2	900-3616	TSTR 2N3616	04713	2N3616
Q 3	900-4398	TSTR 2N4398	04713	2N4398
S 1	23969-0078	SWITCH TOGGLE	09353	7401
S 2	3633-0001	SWITCH SLIDE	82389	46256LF
S 3	3640-0104	SWITCH TOGGLE SPDT	09353	7101
T 1	G14997-0001	TRANSFORMER	19397	G14997-0001
U 1	3832-0003	RECTIFIER, BRIDGE	04713	MDA952-3
U 2	23969-0061	RECTIFIER	04713	MDA-920A-5
U 3	G14992-0001	CONVERTER	19397	G14992-0001
FL 1	23969-0049	FILTER RF1	05245	TYPE 2A-1
XF 1	3769-0004	HOLDER FUSE	75915	342004
XF 2	4000-0001	HOLDER FUSE	75915	357001
XF 3	3769-0004	HOLDER FUSE	75915	342004
S 4	3640-0104	SWITCH, SPDT		
* * *	* ASSEMBLY NO G44980-0001	X18 MULTIPLIER ASSYA4	* *	* *
	18509-0001	DET ASSY X10 MULT	19397	18509-0001
	G34931-0001	FRAME	19397	G34931-0001
	G44915-0001	X18 RF MULTI A4A1	19397	G44915-0001
C 45	23969-0004	CAPACITOR FEED-THRU	72982	2499-003-X5S0-152M
TP 4	23969-0084	TEST POINT	98291	SKT-0804
* * *	* 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	SYNETHESIZER 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

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
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 G44986-0001 OUTPUT ASSY DIVIDERA3 * * * *				
	G34985-0001	FRAME	19397	G34985-0001
	G44949-0001	DIVIDER 1MH2-100KA3A1	19397	G44949-0001
C 31	23969-0004	CAPACITOR FEED-THRU	72982	2499-003-X5S0-152M
C 32	23969-0004	CAPACITOR FEED-THRU	72982	2499-003-X5S0-152M
* * * * 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	42D36-02-1-ADJN
S 2	23969-0649	SWITCH TOGGLE DPDT	09353	7101
S 3	3573-0001	SWITCH PUSHBUTTON NO	81073	30-1
* * * * ASSEMBLY NO G44999-0001 LAMP HTR PCB A13A1A3 * * * *				
C 1	23969-0017	CAPACITOR	99515	FB 2B4712
Q 1	900-4921	TSTR 2N4921	04713	2N4921
Q 2	900-4921	TSTR 2N4921	04713	2N4921
R 1	211-5111	RES FXD FILM 5.11 K	81349	RN55D5111F (MIL-R-10509/7)
R 2	23969-0091	RESISTOR VAR	80294	3280L-1-501
R 3	211-5111	RES FXD FILM 5.11 K	81349	RN55D5111F (MIL-R-10509/7)
R 4	211-2941	RES FXD FILM 2.94K	81349	RN55D2941F (MIL-P-10509/7)
R 5	204-0155	RES FXD COMP 1.5 MEG	81349	RC07GF155J (MIL-R-11/8)
R 6	211-5111	RES FXD FILM 5.11 K	81349	RN55D5111F (MIL-R-10509/7)
R 7	211-3923	RES FXD FILM 392K	81349	RN55D3923F (MIL-R-10509/7)
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	CS13BF106K (MIL-C-26655/2D)
C 5	23969-0008	CAPACITOR .1 MFD	73445	C281CD/A100K
Q 1	900-4937	TSTR 2N4937	04713	2N4937
Q 2	900-3904	TSTR 2N3904	04713	2N3904
R 1	740-1002	RES FXD FILM 10K	81349	RN60C1002F (MIL-R-10509/1)
R 2	740-1002	RES FXD FILM 10K	81349	RN60C1002F (MIL-R-10509/1)
R 3	740-1503	RES FXD FILM 150K	81349	RN60C1503F (MIL-R-10509/1)
R 4	740-1503	RES FXD FILM 150K	81349	RN60C1503F (MIL-R-10509/1)
R 5	740-1503	RES FXD FILM 150K	81349	RN60C1503F (MIL-R-10509/1)
R 7	212-1009	RES FXD FILM 10 OHM	96214	RN60D10R0F (MIL-R-10509/1)
R 8	212-1211	RES FXD FILM 1.21 K	07115	RN60D1211F (MIL-R-10509/1)
R 9	740-5110	RES FXD FILM 511 OHM	81349	RN60C5110F (MIL-R-10509/1)
R 10	740-1001	RES FXD FILM 1 K	79727	RN60C1001F (MIL-R-10509/1)
R 12	740-3012	RES FXD FILM 30.1K	81349	RN60C3012F (MIL-R-10509/1)
R 13	740-1000	RES FXD FILM 100 OHM	81349	RN60C1000F (MIL-R-10509/1)
R 14	740-1003	RES FXD FILM 100K	81349	RN60C1003F (MIL-R-10509/1)
R 15	204-0272	RES FXD COMP 2.70 K	81349	RC07GF272J (MIL-R-11/8)
T 1	23969-0088	TRANSFORMER	00348	MMT4-FB
T 2	23969-0089	TRANSFORMER	00348	MT21-FB
U 1	23969-0125	SEMICONDUCTOR	07263	AD0-278
CR 1	800-0914	DIODE 1N914	01295	1N914
* * * * ASSEMBLY NO G45068-0001 LOGIC CIRCUIT A10 * * * *				
C 1	23969-0119	CAP FXD TA 10MFD 20V	05397	K10J20KS
C 2	3403-9253	CAP FXD CER .025 UF	80183	TG-S25
C 3	23969-0120	CAP FXD TA 1MFD 35V	05397	K1J35KS
C 4	23969-0120	CAP FXD TA 1MFD 35V	05397	K1J35KS
C 5	23969-0119	CAP FXD TA 10MFD 20V	05397	K10J20KS
C 6	23969-0119	CAP FXD TA 10MFD 20V	05397	K10J20KS
C 7	23969-0120	CAP FXD TA 1MFD 35V	05397	K1J35KS

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
C 8	23969-0120	CAP FXD TA 1MFD 35V	05397	K1J35KS
C 9	23969-0119	CAP FXD TA 10MFD 20V	05397	K10J20KS
C 10	23969-0119	CAP FXD TA 10MFD 20V	05397	K10J20KS
C 11	23969-0121	CAP FXD TA 33MFD 20V	05397	K33J20KS
C 12	23969-0118	CAP FXD TA 3.3MFD 35V	05397	K3R3J35KS
C 13	23969-0122	CAP FXD TA 10MFD 35V	05397	K10J35KS
C 14	3403-9503	CAP FXD CER .05 UF	80183	TG-S50
L 1	23969-0024	CHOKE 39 MH	76493	9340-34
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	900-3904	TSTR 2N3904	04713	2N3904
Q 7	900-2646	TSTR 2N2646	03508	2N2646
Q 8	900-3906	TSTR 2N3906	01295	2N3906
Q 9	900-3904	TSTR 2N3904	04713	2N3904
Q 10	900-3904	TSTR 2N3904	04713	2N3904
Q 11	900-3904	TSTR 2N3904	04713	2N3904
Q 12	900-3904	TSTR 2N3904	04713	2N3904
Q 13	900-3904	TSTR 2N3904	04713	2N3904
R 1	204-0302	RES FXD COMP 3.0 K	81349	RC07GF302J (MIL-R-11/8)
R 2	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 3	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 4	204-0203	RES FXD COMP 20.0 K	81349	RC07GF203J (MIL-R-11/8)
R 5	204-0203	RES FXD COMP 20.0 K	81349	RC07GF203J (MIL-R-11/8)
R 6	204-0822	RES FXD COMP 8.20 K	81349	RC07GF822J (MIL-R-11/8)
R 7	204-0222	RES FXD COMP 2.20 K	81349	RC07GF222J (MIL-R-11/8)
R 8	204-0333	RES FXD COMP 33.0 K	81349	RC07GF333J (MIL-R-11/8)
R 9	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 10	204-0681	RES FXD COMP 680. OHM	81349	RC07GF681J (MIL-R-11/8)
R 11	204-0752	RES FXD COMP 7.50 K	81349	RC07GF752J (MIL-R-11/8)
R 12	204-0393	RES FXD COMP 39.0 K	81349	RC07GF393J (MIL-R-11/8)
R 13	204-0752	RES FXD COMP 7.50 K	81349	RC07GF752J (MIL-R-11/8)
R 14	204-0203	RES FXD COMP 20.0 K	81349	RC07GF203J (MIL-R-11/8)
R 15	204-0222	RES FXD COMP 2.20 K	81349	RC07GF222J (MIL-R-11/8)
R 16	204-0333	RES FXD COMP 33.0 K	81349	RC07GF333J (MIL-R-11/8)
R 17	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 18	204-0331	RES FXD COMP 330 OHM	81349	RC07GF331J (MIL-R-11/8)
R 19	204-0512	RES FXD COMP 5.10 K	81349	RC07GF512J (MIL-R-11/8)
R 20	204-0512	RES FXD COMP 5.10 K	81349	RC07GF512J (MIL-R-11/8)
R 21	204-0203	RES FXD COMP 20.0 K	81349	RC07GF203J (MIL-R-11/8)
R 22	204-0822	RES FXD COMP 8.20 K	81349	RC07GF822J (MIL-R-11/8)
R 24	204-0100	RES FXD COMP 10.0 OHM	81349	RC07GF100J (MIL-R-11/8)
R 25	204-0154	RES FXD COMP 150. K	81349	RC07GF154J (MIL-R-11/8)
R 26	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 27	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 28	204-0203	RES FXD COMP 20.0 K	81349	RC07GF203J (MIL-R-11/8)
R 29	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 30	204-0332	RES FXD COMP 3.30 K	81349	RC07GF332J (MIL-R-11/8)
R 31	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 32	204-0151	RES FXD COMP 150. OHM	81349	RC07GF151J (MIL-R-11/8)
R 33	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 34	204-0222	RES FXD COMP 2.20 K	81349	RC07GF222J (MIL-R-11/8)
R 35	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 36	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 37	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 38	204-0512	RES FXD COMP 5.10 K	81349	RC07GF512J (MIL-R-11/8)
R 39	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 40	204-0202	RES FXD COMP 2.00 K	81349	RC07GF202J (MIL-R-11/8)
U 1	23408-0001	IC SN7400N	01295	SN7400N
U 2	23408-0001	IC SN7400N	01295	SN7400N
CR 1	801-0749	DIODE 1N749A	04713	1N749A
CR 2	803-0964	DIODE 1N964B	04713	1N964B
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

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
* *	* * ASSEMBLY NO	G45076-0001 AUDIO ASSY		* * * *
	18508	DET ASSY AUDIO BD	19397	18508
	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	G45084-0001 OMU ASSY	A13	* * * *
	18382-0001	IMP MTCH UNIT ASSY	19397	18382-0001
	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
* *	* * ASSEMBLY NO	G45087-0001 CAVITY HTR PCB A13A2		* * * *
C 2	8918-0560	CAP FXD TA 56 MFD	05397	CS13BB566K (MIL-C-26655/2)
C 3	23969-0123	CAP .005	91418	SM-005
Q 1	900-4921	TSTR 2N4921	04713	2N4921
Q 2	900-4921	TSTR 2N4921	04713	2N4921
R 1	211-5111	RES FXD FILM 5.11 K	81349	RN55D5111F (MIL-R-10509/7)
R 2	23969-0066	RESISTOR VAR	80294	3262W-1-501
R 3	211-5111	RES FXD FILM 5.11 K	81349	RN55D5111F (MIL-R-10509/7)
R 4	211-4641	RES FXD FILM 4.64 K	81349	RN55D4641F (MIL-R-10509/7)
R 5	211-5111	RES FXD FILM 5.11 K	81349	RN55D5111F (MIL-R-10509/7)
R 6	211-1000	RES FXD FILM 100. OHM	81349	RN55D1000F (MIL-R-10509/7)
R 7	204-0225	RES FXD COMP 2.2 MEG	81349	RC07GF225J (MIL-R-11/8)
R 8	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 9	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 10	740-3923	RES FXD FILM 392K	81349	RN60C3923K (MIL-R-10509/1)
R 11	740-2260	RES FXD FILM 226 OHM	81349	RN60C2260F (MIL-R-10509/1)
R 12	200-0392	RES FXD COMP 3.90 K	81349	RC07GF392K (MIL-R-11/8)
R 13	211-2742	RES FXD FILM 27.4K	81349	RN55D2742F (MIL-R-10509/7)
U 1	23969-0002	AMPLIFIER	07263	U5B7741312
U 2	23969-0002	AMPLIFIER	07263	U5B7741312
CR 1	800-0914	DIODE 1N914	01295	1N914
CR 2	800-0914	DIODE 1N914	01295	1N914
CR 3	801-0703	DIODE 1N703A	81483	1N703A

TABLE 6-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
* *	* * ASSEMBLY NO G45154-0001	BRACKET ASSY		* * * *
C 1	8917-0221	CAP FXD TA 220 MFD	05397	CS13BC227K (MIL-C-26655/2)
R 1	23969-0063	RESISTOR 660 OHM 1%	91637	RS-2A
R 2	212-2499	RES FXD FILM 24.9 OHM	81349	RN60D24R9F (MIL-R-10509)1)
R 3	212-7683	RES FXD FILM 768 K	81349	RN60D7683F (MIL-R-10509/3)
* *	* * ASSEMBLY NO G45189-0001	INNER CAVITY FOAMED		* * * *
	G34420-0001	INNER SHIELD ASSY	19397	G34420-0001
* *	* * ASSEMBLY NO G64500-0500	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 3	G44986-0001	OUTPUT ASSY DIVIDERA3	19397	G44986-0001
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
J141	23969-0038	CONNECTOR	98291	51-075-0000
* *	* * ASSEMBLY NO G65243-0001	HARNESS ASSY		* * * *
	18499-0001	WIRE LIST	19397	18499-0001
	G15245-0001	CABLE ASSY	19397	G15245-0001
	G15245-0002	CABLE ASSY	19397	G15245-0002
	G15245-0003	CABLE ASSY	19397	G15245-0003
	G15245-0004	CABLE ASSY	19397	G15245-0004
	G15245-0005	CABLE ASSY	19397	G15245-0005
	G15245-0006	CABLE ASSY	19397	G15245-0006
	G15245-0007	CABLE ASSY	19397	G15245-0007
	G15245-0022	CABLE ASSY	19397	G15245-0022
	G15245-0023	CABLE ASSY	19397	G15245-0023
	G15245-0024	CABLE ASSY	19397	G15245-0024
	G15245-0025	CABLE ASSY	19397	G15245-0025
	G15245-0026	CABLE ASSY	19397	G15245-0026
	G15245-0027	CABLE ASSY	19397	G15245-0027
	G15245-0032	CABLE ASSY	19397	G15245-0032
	G15245-0040	CABLE ASSY	19397	G15245-0040
	G15245-0041	CABLE ASSY	19397	G15245-0041
	G15245-0042	CABLE ASSY	19397	G15245-0042
	G15245-0043	CABLE ASSY	19397	G15245-0043
	G15245-0044	CABLE ASSY	19397	G15245-0044
	G15245-0045	CABLE ASSY	19397	G15245-0045
	G15245-0046	CABLE ASSY	19397	G15245-0046
J131	23969-0030	CONNECTOR	81312	SRE7SJ
J132	23969-0032	CONNECTOR	81312	SM3SN
J142	23969-0030	CONNECTOR	81312	SRE7SJ
XA 8	3628-0022	CONNECTOR PCB 22 PIN	71785	50-22A-20
XA 10	3628-0022	CONNECTOR PCB 22 PIN	71785	50-22A-20

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

TABLE 6-2. (Continued)

CODE NO.	MANUFACTURER	ADDRESS
T0076	CANTON BIO-MEDICAL PRODUCTS, INC.	SWATHMORE PENN
T0077	CAPITOL RUBBER	BATON ROUGE LA
T0078	COUGAR PLASTICS	HOUSTON TEX
T0079	TRUMP ROSS IND - CANCELLED SEE 31857	
T0079	TRUMP ROSS IND	BILLERICA MASS
T0080	OASIS WATER CO	WACO TEX
T0081	BEST MFG CO, THE	MENLO GA
T0082	MAVERICK-CLARKE DIV OF LITTON IND	AUSTIN TEX
T0083	REIN LEITZKE INC	HUSTFORD WIS
T0084	LEECH PRODUCTS INC	HUTCHINSON KANSAS
T0085	OLSON ELECTRONICS	AKRON OHIO
T0088	JACO MFG CO	BEREA OHIO
T0089	EMDE PRODUCTS INC	LOS ANGELES CALIF
T0090	CHROMATRONIX INC	BERKELEY CALIF
T0091	OPTICAL INSTRUMENT LABORATORY	HOUSTON TEX
T0092	EECOSWITCH CO	SANTA ANA CALIF
T9227	WATTS REGULATOR CO	LAWRENCE MASS
00141	PIC DESIGN CORP	EAST ROCKAWAY N Y
00213	SAGE ELECTRONICS CORP	ROCHESTER NY
00327	WELWYN INTERNATIONAL INC	WESTLAKE OHIO
00328	STERLING INST DIV OF DESIGNATRONICS INC	MINEOLA N Y
00334	HUMIDIAL SALES CO	COLTON CALIF
00348	MICROTRAN CO INC	VALLEY STREAM N Y
00481	ASCO SINTERING CO	LOS ANGELES CALIF
00544	METAL CAL DIV OF AVERY ADHESIVE PRODUCTS CORP	INGLEWOOD CALIF
00656	AEROVOX CORP	NEW BEDFORD MASS
00771	DORE JOHN L CO	HOUSTON TEX
00779	AMP INC	HARRISBURG PA
00781	AIRCRAFT RADIO CORP	BOONTON N J
00815	NORTHERN ENGINEERING LABORATORIES INC	BURLINGTON WIS
00835	HEUSER MFG CO	CHICAGO ILL
00853	SANGAMO ELECTRIC CO PICKENS DIVISION	PICKENS S C
00906	SCAICO DIVISION OF WAVETRONICS INDUSTRIES INC	WEST PITTSTON PA
01009	ALDEN PRODUCTS CO	BROCKTON MASS
01121	ALLEN-BRADLEY CO	MILWAUKEE WIS
01139	GENERAL ELECTRIC SILICONE PRODUCTS DEPT	WATERFORD N Y
01170	BELLOFRAM CORP	BURLINGTON MASS
01195	ORGANIC PRODUCTS CO.	IRVING TEX
01281	TRW SEMICONDUCTORS INC	LAWNDALE CALIF
01285	SAFETY FLATOR INC	CHICAGO ILL
01295	TEXAS INSTRUMENTS INC SEMICONDUCTOR-COMPONENTS DIVISION	DALLAS TEX
01298	ODGEN CORP	NEW YORK N Y
01351	DYNAMIC GEAR CO INC	AMITYVILLE N Y
01364	ALLIED RADIO CORP	CHICAGO ILL
01490	REZOLIN INC	SANTA MONICA CALIF
01560	TITANIUM METALS CORP OF AMERICA	NEW YORK N Y
01561	CHASSIS-TRAK CORP - CANCELED - SEE 06666	
01634	ALUMINUM COMPANY OF AMERICA	PITTSBURGH PA
01686	RCL ELECTRONICS INC.	ST MANCHESTER N H
01766	INTERNATIONAL CRYSTAL MFG CO INC	OKLAHOMA CITY OKLA
01807	PETERSEN RADIO CO INC	COUNCIL BLUFFS IOWA
01881	ANACONDA AMERICAN BRASS CO	WATERBURY CONN
01930	AMEROCK CORP	ROCKFORD ILL
01938	AMERICAN CAN CO.	NEW YORK NY
01947	WEAVER MAILING ENVELOPE AND BOX CO	PHILADELPHIA PA
02111	SPECTROL ELECTRONICS CORP	CITY OF INDUSTRY CALIF
02114	FERROXCUBE CORP OF AMERICA	SAUGERTIES N Y
02116	WHEELOCK SIGNALS INC	LONG BRANCH N J
02161	SAMSCO DIV OF PERRY SHANKLE CO	SAN ANTONIO TEX
02195	AMERICAN FORK AND HOE CO - CANCELED - SEE 89753	
02289	HI-G INC	WINDSOR LOCKS CONN
02376	CONSOLIDATED AVIONICS DIVISION OF CONDEC CORP	WESTBURY N Y
02570	SWAGELOCK (CRAWFORD FITTING CO)	SOLON OHIO
02570	CRAWFORD FITTING CO(SWAGELOK)	SOLON OHIO
02622	AMERICAN OPTICAL CO.	SOUTHBRIDGE MASS
02640	TORWICO ELECTRONICS INC	LAKEWOOD N J
02660	AMPHENOL CORP	BROADVIEW ILL
02733	PENN AIRCRAFT PRODUCTS INC	DAYTON OHIO
02735	RADIO CORP OF AMERICA SOLID STATE AND REC TUBE DIV	SOMERVILLE N J
02768	FASTEX DIV OF ILLINOIS TOOL WORKS	DES PLAINES ILL
02770	BRISTOL MOTORS DIV OF VOCALINE CO OF AMERICA	OLD SAYBROOK CONN
02777	HOPKINS ENGINEERING CO	SAN FERNANDO CALIF
02811	METALPHOTO CORP	CLEVELAND OHIO
02833	ANTENNA SPECIALISTS CO DIV OF ANZAC INDUSTRIES	CLEVELAND OHIO
02863	EMCOR DIV OF INGERSOL PRODUCTS - CANCELED - SEE 85005	
02875	HUDSON TOOL AND DIE CO INC	NEWARK N J

TABLE 6-2. (Continued)

CODE NO.	MANUFACTURER	ADDRESS
02918	MARKITE CORP	NEW YORK N Y
02929	NEWARK ELECTRONICS CORP	CHICAGO ILL
02954	PREMIER METAL PRODUCTS CO INC	NEW YORK N Y
02987	BENDIX CORP FLIGHT AND ENGINE INST DIV	SOUTH MONTROSE PA
03007	H A GUDEN CO. INC.	LONG ISLAND NY
03038	LONG-LOK CORP	LOS ANGELES CALIF
03042	CARTER'S INK COMPANY	CAMBRIDGE MASS
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
03508	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

TABLE 6-2. (Continued)

CODE NO.	MANUFACTURER	ADDRESS
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	
06531	BECTON DICKINSON & CO	RUTHERFORD N J
06540	AMATOM ELECTRONIC HARDWARE CO INC	NEW ROCHELLE N Y
06542	FEDERAL STANDARDS	GENERAL SERVICES ADMINISTRATION
06549	UNITED STATES CORP - CANCELED - SEE 98571	
06555	BEEDE ELECTRICAL INSTRUMENT CO	PENACOOK N H
06666	GENERAL DEVICES CO INC	INDIANAPOLIS IND
06668	TEXAS INSTRUMENTS INC INDUSTRIAL PRODUCTS GROUP	HOUSTON TEX
06682	MAGNETIC SHIELD DIVISION OF PERFECTION MICA CO	CHICAGO ILL
06751	SEMCOR DIVISION COMPONENTS INC	PHOENIX ARIZ
06812	TORRINGTON MFG CO WESTERN DIV	VAN NUYS CALIF
06816	PALL CORPORATION	GLEN COVE NY
06915	RICHCO PLASTIC CO	CHICAGO ILL
07047	ROSS MILTON CO	SOUTHAMPTON PA
07065	LINE ELECTRIC CO	PARSIPPANY N J
07088	KELVIN ELECTRIC CO	VAN NUYS CALIF
07115	CORNING GLASS WORKS - CANCELED - SEE 14674	
07126	DIGITRAN CO	PASADENA CALIF
07183	DECCO INC	DALLAS TEX
07261	AVNET CORP	CULVER CITY CALIF
07263	FAIRCHILD CAMERA AND INST CORP SEMICONDUCTOR DIV	MOUNTAIN VIEW CALIF
07282	FAIRCHILD-HILLER CORP STRATOS DIV IND PRODUCTS	WINSTON-SALEM NC
07322	MINNESOTA RUBBER CO	MINNEAPOLIS MINN
07355	AIRPAX ELECTRONICS INC	FORT LAUDERDALE FLA
07477	BLACK SIVALLS AND BRYSON INC	KANSAS CITY MO
07514	YARDLEY PRECISION PRODUCTS CO	YARDLEY PA
07521	CARBORUNDUM CO.	NIAGAGA FALLS NY
07556	CALABRO PLASTICS	DARBY PA
07589	ARGONNE ELECTRONIC MFG CORP	NEW YORK N Y
07623	ECK AND KREBS INC	LONG ISLAND CITY N Y
07633	EPOXY PRODUCTS INC	IRVINGTON N J
07688	JOINT ELECTRON DEVICE ENGINEERING COUNCIL	WASHINGTON DC
07707	UNITED SHOE MACHINERY CORP FASTENER DIVISION	SHELTON CONN
07757	STANDARD INSERT CO., INC	PACOIMA CALIF
07776	MCDANEL REFRACTORY PORCELAIN CO	BEAVER FALLS PA
07812	NOPCO CHEMICAL CO	NORTH ARLINGTON N J
07829	BODINE ELECTRIC CO	CHICAGO ILL
07843	LEAR SIEGLER INC BOGEN COMMUNICATION DIV	PARAMUS N J
07886	NATIONAL RADIO CO INC	MELROSE MASS
07910	CONTINENTAL DEVICE CORP	HAWTHORNE CALIF
07933	RAYTHEON MFG CO SEMICONDUCTOR DIVISION	MOUNTAIN VIEW CALIF
07978	SPINCO DIV OF BECKMAN INSTR INC	PALO ALTO CALIF
08018	BORG-WARNER CORP.	CHICAGO ILL
08050	DEXTER INDUSTRIES INC.	GRAND RAPIDS MICH
08086	WAHL, WILLIAM CORP	SANTA MONICA CALIF
08242	THETA INSTRUMENT CORP	SADDLE BROOK N J
08257	NUCLEONICS PRODUCTS CO.	LOS ANGELES CALIF
08261	SPECTRA-STRIP WIRE AND CABLE CORP	GARDEN GROVE CALIF
08289	BLINN DELBERT CO	POMONA CALIF
08524	DEUTSCH FASTENER CORP	LOS ANGELES CALIF
08538	CHICAGO DYNAMIC INDUSTRIES INC	CHICAGO ILL
08703	STATIKIL INC	CLEVELAND OHIO
08726	UNIVERSAL TRANSFORMER CO INC	WYLIE TEX
08730	VEMALINE PRODUCTS CO	FRANKLIN LAKES N J
08779	SIGNAL TRANSFORMER CO	BROOKLYN NY
08795	RAYCLAD TUBES INC	REDWOOD CITY CALIF
08800	GENERAL ELECTRIC CO INSULATING MATERIALS DEPT	SCHENECTADY N Y
08801	GENERAL ELECTRIC CO LAMINATED PRODUCTS DEPT	COSHOCTON OHIO
08806	GENERAL ELECTRIC CO MINIATURE LAMP DEPT	CLEVELAND OHIO
08811	G L ELECTRONICS DIVISION OF G L INDUSTRIES	WESTVILLE N J
08815	NEW ENGLAND INST CO	NATICK MASS
08863	NYLOMATIC CORP	MORRISVILLE PA
08928	ABBOTT SCREW AND MFG CO	CHICAGO ILL
08987	HONEYWELL INC INDUSTRIAL DIVISION	FORT WASHINGTON PA
08987	BROWN INSTRUMENTS - SEE HONEYWELL INC INDUSTRIAL DIV	
09040	PHELPS DODGE COPPER PRODUCTS CORP	FORT WAYNE IND
09106	NEWMAN M M CORP	MARBLEHEAD MASS
09133	KIERULFF ELECTRONICS INC	LOS ANGELES CALIF
09134	TEXAS CAPACITOR CO	HOUSTON TEX
09145	ATHOM ELECTRONICS - SEE TECHNICAL INDUSTRIES INC	

TABLE 6-2. (Continued)

CODE NO.	MANUFACTURER	ADDRESS
09145	TECHNICAL INDUSTRIES INC. ATOHM ELECTRONICS MIL PRODUCTS DIV	BURBANK CALIF
09214	GENERAL ELECTRIC CO SEMICONDUCTOR PRODUCTS DEPT	AUBURN N Y
09353	C AND K COMPONENTS INC	NEWTON MASS
09709	BULLDOG ELECTRIC PRODUCTS INC	DETROIT MICH
09795	PENNSYLVANIA FLOUROCARBON CO INC	CLIFTON HEIGHTS PA
09808	STOCKER HINGE MFG CO	BROOKFIELD ILL
09823	BURGESS BATTERY CO DIV SERVEL INC	FREEPORT ILL
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 B 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 H AND CO	HOUSTON TEX
15584	RIEDON AVIONICS INC	VAN NUYS CALIF
15605	CUTLER-HAMMER INC - CANCELED - SEE 27191	

TABLE 6-2. (Continued)

CODE NO.	MANUFACTURER	ADDRESS
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	
15912	DIGITAL SENSORS INC	LOS ANGELES CALIF
15957	TOR MFG CO	IRWINDALE CALIF
16059	DEVCON CORP	DANVERS MASS
16084	COAST ENGINEERING LABORATORY	REDONDO BEACH CALIF
16089	MICRO TEK INSTRUMENTS INC	AUSTIN TEX
16129	CAPACITOR MOUNTING CLIP CORP	DALLAS TEX
16210	GRACE W R AND CO DAVISON CHEMICAL DIV	BALTIMORE MD
16228	BREVEL PRODUCTS CORP	CARLSTADT N J
16231	PARKER INSTRUMENT CORP	STAMFORD CONN
16238	LORD MFG CO INC.	SOUTH LANCASTER MASS
16245	CONAP INC	ALLEGANY N Y
16299	CORNING GLASS WORKS ELECTRONICS COMPONENTS DIV	RALEIGH NC
16327	DAYTON ELECTRIC MFG CO	CHICAGO ILL
16332	MILWAUKEE RELAYS INC	CEDARBURG WIS
16339	PHOTO CHEMICAL PRODUCTS	SANTA MONICA CALIF
16352	COMPUTER DIODE CORP	LODI N J
16363	SHARPE E J INSTRUMENTS OF CANADA LTD	WILLOWDALE ONTARIO CANADA
16438	MAGNETIC AIDS INC	NEW YORK N Y
16509	VOLTRONICS INC	CHICAGO ILL
16741	TRIAD TRANSFORMER CORP - CANCELED - SEE 81095	
16772	MARTIN-SENOUR	CHICAGO ILL
16888	PERCY HARMS CORP	SKOKIE ILL
16956	DENNISON MANUFACTURING COMPANY	FARMINGHAM MASS
17069	CIRCUIT STRUCTURES LAB	UPLAND CALIF
17109	THERMONETICS INC	SANTA MONICA CALIF
17276	NEXUS RESEARCH LABORATORY INC	CANTON MASS
17325	CUSTOM MATERIALS INC	CHELMSFORD MASS
17397	BURGESS BATTERY CO	NEW YORK N Y
17414	ROWAN CONTROLLER CO	OCEANPOINT N J
17569	BARRY CONTROLS DIV OF BARRY WRIGHT CORP	CHICAGO ILL
17610	EXPLOSIVE TECHNOLOGY INC	FAIRFIELD CALIF
17771	SINGER CO THE DIEHL DIVISION	SOMERVILLE N J
17771	DIEHL DIVISION OF THE SINGER CO	SOMERVILLE N J
17856	SILICONIX INC	SUNNYVALE CALIF
17864	CAMPBELL INDUSTRIES (BUSINESS DISCONTINUED)	
17870	DAVEN DIV THOMAS A EDISON INDUSTRIES MCGRAW-EDISON CO	MANCHESTER N H
17994	WILLSON PRODUCTS DIVISION	READING PA
18034	NUPRO CO-FORMERLY NUCLEAR PRODUCTS CO	CLEVELAND OHIO
18034	NUCLEAR PRODUCTS CO-SEE NUPRO CO	
18154	FLO-LOK INC	HOUSTON TEX
18210	DOMINION ELECTRIC CORP	MANSFIELD OHIO
18324	SIGNETICS CORP	SUNNYVALE CALIF
18598	MILLER-STEPHENSON CHEMICAL CO	DANBURY CONN
18626	DRIVER HARRIS CO	HARRISON N J
18632	CHEMPLAST INC	EAST NEWARK NJ
18643	ETHYLENE CORP	MURRAY HILL N J
18677	SCANBE MFG CORP	MONTEREY PARK CALIF
18702	DUCOMMUN METALS AND SUPPLY CO	LOS ANGELES CALIF
18873	DU PONT E I DE NEMOURS AND CO INC	WILMINGTON DEL
18911	DURANT MFG CO	MILWAUKEE WIS
18915	BIRTCHER CORP THE INDUSTRIAL DIVISION	MONTEREY PARK CALIF
19080	ROBISON ELECTRONICS INC	GARDENA CALIF
19139	EASTMAN KODAK COMPANY	ROCHESTER NY
19141	CAL-VAL R AND D CORP ISOMODE DIV - CANCELED - SEE 26624	
19291	ECLIPSE FUEL ENGR CO	ROCKFORD ILL
19396	PAKTRON DIV. OF ILLINOIS TOOL WORKS INC	ALEXANDRIA VA
19397	TRACOR INC	AUSTIN TEX
19397	TRACOR INC (ROBT L STONE DIV)	AUSTIN TEX
19477	ELECTRO-TECHNIQUES	LA HABRA CALIF
19541	BIMBA MFG CO	MONEE ILL
19701	ELECTRA MFG CO	INDEPENDENCE KANS
20093	ELECTRICAL INDUSTRIES DIV OF PHILIPS ELECTRONICS	MURRAY HILL N J
20512	SARGENT E H CO	SPRINGFIELD N J
20909	WATERS ASSOCIATES INC	FRAMINGHAM MASS
20999	MINNESOTA MINING AND MFG CO,ELECTRONIC PRODUCTS DIV.	SCHENECTADY N Y
21520	FANSTEEL METALLURGICAL CORP	CHICAGO ILL
21645	FERRODYNE CORP	VENICE CALIF
21649	OTTO CONTROLS	MORTON GROVE ILL

TABLE 6-2. (Continued)

CODE NO.	MANUFACTURER	ADDRESS
21842	MARYLAND PAPER PRODUCTS CO	OWINGS MILLS MD
21926	GENERAL TECHNOLOGY CORP.	TORRANCE CALIF
22238	MI-KRO CONNECTOR CORP	LONG ISLAND CITY N Y
22460	FASSON PRODUCTS-DIV.OF AVERY ADHESIVE PROD INC	PAINESVILLE OHIO
22474	NESCO INSTRUMENT DIV OF DATAPULSE INC	INGLEWOOD CALIF
22491	STEPHENSON AND LAWYER INC	GRAND RAPIDS MICH
22582	HAMILTON CO	WHITTIER CALIF
22835	TRA-CON INC	MEDFORD MASS
22893	SHELL CHEMICAL CO	PITTSBURG CALIF
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 COPR	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
31708	DU PONT E I DE NEMOURS & CO INC	WILMINGTON DEL
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

TABLE 6-2. (Continued)

CODE NO.	MANUFACTURER	ADDRESS
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
40912	MINE SAFETY APPLIANCES CO.	PITTSBURGH PA
40920	MINIATURE PRECISION BEARINGS INC	KEENE N H
41387	MOORE PRODUCTS CO	SPRINGE HOUSE PA
42190	MUTER CO	CHICAGO ILL
42498	NATIONAL CO INC	MELROSE MASS
42679	NATIONAL LEAD CO.	NEW YORK N Y
43334	NEW DEPARTURE DIVISION GENERAL MOTORS	BRISTOL CONN
43629	NEWARK WIRE CLOTH CO	NEWARK NJ
43710	NEY J M CO	BLOOMFIELD CONN
44038	NORTH ELECTRIC CO	GALION OHIO
44197	NORTON CO	WORCESTER MASS
44655	OHMITE MFG CO	SKOKIE ILL
45681	PARKER HANNIFIN CORP.	CLEVELAND OHIO
46384	PENN ENGINEERING AND MFG CORP	DOYLESTOWN PA
47904	POLAROID CORP	CAMBRIDGE MASS
48619	PRECISION SCIENTIFIC CO	CHICAGO ILL
50560	REPUBLIC STEEL CORP	CLEVELAND OHIO
52660	RYERSON JOSEPH T AND SON INC	CHICAGO ILL
53021	SANGAMO ELECTRIC CO	SPRINGFIELD ILL
53629	SCIENTIFIC GLASS APPARATUS CO	BLOOMFIELD N J
53800	SEARS ROEBUCK AND CO	CHICAGO ILL
54294	SHALLCROSS MFG CO	SELMA N C
54636	SHERWIN-WILLIAMS	CLEVELAND OHIO
54715	SHURE BROS INC	EVANSTON ILL
55026	SIMPSON ELECTRIC CO	CHICAGO ILL
55130	SKINNER PRECISION INDUSTRIES INC	NEW BRITAIN CONN
55719	SNAP-ON TOOLS CORP	KENOSHA WIS
55814	SOLA ELECTRIC CO	ELK GROVE ILL
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS MASS
56574	STANDARD BRASS AND MFG CO	PORT ARTHUR TEX
56631	STANDARD ELECTRIC TIME CO	SPRINGFIELD MASS
56878	STANDARD PRESSED STEEL CO	JENKINTOWN PA
57163	STARRETT, L.S. CO.	ATHOL MASS
57771	STIMPSON EDWIN B CO	BROOKLYN N Y
58474	SUPERIOR ELECTRIC CO	BRISTOL CONN
58553	SUPERIOR VALVE AND FITTING CO	WASHINGTON PA
59446	TELEX CORP	TULSA OKLA
59730	THOMAS AND BETTS CO	ELIZABETH N J
60380	TORRINGTON COMPANY	TORRINGTON CONN
60741	TRIPLETT ELECTRICAL INSTRUMENT CO	BLUFFTON OHIO
61349	AMETEK INC UNITED STATES GUAGE DIV	SELLERSVILLE PA
61349	UNITED STATES GAUGE - SEE AMETEK INC	
62119	UNIVERSAL ELECTRIC CO	OWOSSO MICH
63026	VICTOR EQUIPMENT CO	DENTON TEX
63060	VICTOREEN INSTRUMENT CO	CLEVELAND OHIO
63743	WARD LEONARD ELECTRIC CO	MOUNT VERNON NY
64484	WELCH SCIENTIFIC CO THE	SKOKIE ILL
65092	WESTON INSTR. INC.	NEWARK N J
65301	S S WHITE INDUSTRIAL DIVISION	NEW YORK N Y
65586	WIEGAND EDWIN L CO	PITTSBURG PA
70119	ADVANCE ELECTRIC AND RELAY - CANCELED - SEE 04298	
70269	ALLEGHENY LUDLUM STEEL CORP	PITTSBURG PA
70276	ALLEN MFG CO	HARTFORD CONN
70309	ALLIED CONTROL CO INC	NEW YORK N Y
70318	ALLMETAL SCREW PRODUCTS COMPANY INC	GARDEN CITY N Y
70331	ALPHA WIRE CORP - CANCELED - SEE 92194	
70371	AMERICAN LAVA CORP	CHATTANOOGA TENN
70472	ASSOCIATED SPRING CORP	BRISTOL CONN
70485	ATLANTIC INDIA RUBBER WORKS INC	CHICAGO ILL
70528	ATLAS TACK CORP	FAIRHAVEN MASS
70563	AMPERITE CO	UNION CITY N J
70661	ATLAS SOUND DIV OF AMERICAN TRADING AND PRODUCTION CORP	PARSIPPANY N J
70752	BAYSTATE ABRASIVES PRODUCTS CO	WESTBORO MASS
70777	AUTOMATIC LOCKING DEVICES INC	BRIDGEPORT CONN
70884	BAYSTATE STAMPING CO	WORCESTER MASS
70892	BEAD CHAIN MFG CO	BRIDGEPORT CONN
70903	BELDEN MFG CO	CHICAGO ILL

TABLE 6-2. (Continued)

CODE NO.	MANUFACTURER	ADDRESS
70958	BERGEN WIRE ROPE CO	LODI N J
71002	BIRNBACH RADIO CO INC	NEW YORK N Y
71034	BLILEY ELECTRIC CO INC	ERIE PA
71041	BOSTON GEAR WORKS DIVISION OF MURRAY CO OF TEXAS	ST QUINCY MASS
71087	BOOTS AIRCRAFT NUT DIV TOWNSEND CO	NORWALK CONN
71098	BRISTOL CO READ INDUSTRIAL INSTRUMENT DIV	WATERBURY CONN
71112	BOYLE MIDWAY INC	NEW YORK N Y
71176	BROWNING MFG CO INC	MAYSVILLE KY
71191	BROWN, ANDREW CO.	LOS ANGELES CALIF
71218	BUD RADIO INC	WILLOUGHBY OHIO
71279	CAMBRIDGE THERMIONIC CORP	CAMBRIDGE MASS
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
71983	DOW CHEMICAL CO	MIDLAND 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	EUTECTIC 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	MONMOUNTH 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 24453	
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

TABLE 6-2. (Continued)

CODE NO.	MANUFACTURER	ADDRESS
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	QUAM 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
74542	HOYT ELECTRICAL INSTRUMENT WORKS	PENACOOK N H
74545	HUBBELL HARVEY INC	BRIDGEPORT CONN
74840	ILLINOIS CONDENSER CO	CHICAGO ILL
74868	AMPHENOL CORP AMPHENOL RF DIVISION	DANBURY CONN
74900	INTERNATIONAL NICKEL CO INC	NEW YORK NY
74970	JOHNSON E F CO	WASECA MINN
75042	INTERNATIONAL RESISTANCE CO	PHILADELPHIA PA
75165	JOHNS-MANVILLE CORP	NEW YORK NY
75263	KEYSTONE CARBON CO INC	ST MARYS PA
75285	KENNEDY CAR LINER AND BAG CO INC	SHELBYVILLE IND
75297	KESTER SOLDER COMPANY	CHICAGO ILL
75358	KNAPE AND VOGT MFG CO	GRAND RAPIDS MICH
75376	KURZ-KASCH INC	DAYTON OHIO
75378	CTS KNIGHTS INC	SANDWICH ILL
75378	KNIGHTS JAMES CO - SEE CTS KNIGHT INC	
75382	KULKA ELECTRIC MFG CO	MOUNT VERNON N Y
75582	LEVITON MFG CO	BROOKLYN N Y
75665	LOVEJOY FLEXIBLE COUPLING CO	CHICAGO ILL
75915	LITTELFUSE INC	DES PLAINES ILL
76005	LORD MFG CO	ERIE PA
76055	MALLORY CONTROLS	FRANKFORT IND
76101	MAICO ELECTRONICS	MINNEAPOLIS MINN
76323	M AND T CHEMICALS	CARTERET N J
76381	MINNESOTA MINING AND MFG CO	ST PAUL MINN
76487	MILLEN JAMES MFG CO INC	MALDEN MASS
76493	MILLER J W CO	LOS ANGELES CALIF
76545	MUELLER ELECTRIC CO	CLEVELAND OHIO
76689	NATIONAL SCREW AND MFG CO	CLEVELAND OHIO
76854	OAK MFG CO	CRYSTAL LAKE ILL
76871	OHIO NUT AND BOLT CO	BEREA OHIO
77122	PALNUT CO	MOUNTIANSIDE NJ
77247	PERMATEX CO INC	WEST PALM BEACH FLA
77308	PLASTIC AND RUBBER PRODUCTS	LOS ANGELES CALIF
77342	AMERICAN MACHINE AND FOUNDRY,POTTER AND BRUMFILD DIV	PRINCETON IND
77342	POTTER AND BRUMFIELD - SEE AMERICAN MACHINE AND FOUNDRY	
77783	REYNOLDS METALS CO	CAMDEN NJ
77820	BENDIX CORP ELECTRONIC COMPONENTS DIV	SIDNEY N Y
77969	RUBBERCRAFT CORP	TORRANCE CALIF
78189	SHAKEPROOF DIVISION OF ILLINOIS TOOL WORKS	ELGIN ILL
78277	SIGMA INSTRUMENTS INC	SO BRAINTREE MASS
78290	STRUTHERS-DUNN INC	PITMAN N J
78488	STACKPOLE CARBON CO	ST MARYS PA
78553	TINNERMAN PRODUCTS INC	CLEVELAND OHIO
78580	STERLING VARNISH CO.	SWICKLEY PENN
78696	TAYLOR CORP	VALLEY FORGE PA
78711	TELEPHONICS DIV OF INSTRUMENT SYSTEMS CORP	HUNTINGTON N Y
78947	UCINITE CO DIV OF UNITED-CARR INC	NEWTONVILLE MASS
78976	UNGAR ELECTRIC TOOLS DIV OF ELDON INDUSTRIES	HAWTHORNE CALIF
79061	VACO PRODUCTS INC	CHICAGO ILL
79074	VARFLEX CORP	ROME NY
79118	WAAGE MFG CO	CHICAGO ILL
79136	WALDES KOHINOOR INC	LONG ISLAND CITY N Y
79142	VEEDER ROOT INC	HARTFORD CONN
79221	WATLOW ELECTRIC MFG CO	ST LOUIS MO
79405	WOOD ELECTRIC CORP	LYNN MASS
79409	WOODHEAD, DANIEL CO	CHICAGO ILL
79425	WOODS T B SONS CO	CHAMBERSBURG PA
79436	WORNOW PROCESS PAINT CO	LOS ANGELES CALIF
79687	WILLSON PRODUCTS INC	READING PA
79725	WIREMOLD CO THE	HARTFORD CONN
79727	CONTINENTAL-WIRT ELECTRONICS CORP	PHILADELPHIA PA
79919	RHODES MH INC	HARTFORD CONN
79948	YOUNGSTOWN SHEET AND TUBE CO	YOUNGSTOWN PA

TABLE 6-2. (Continued)

CODE NO.	MANUFACTURER	ADDRESS
79963	ZIERICK MFGR CORP	NEW ROCHELLE N Y
80009	TEKTRONIX INC	BEAVERTON OREG
80017	TRACERLAB	WALTHAM MASS
80053	BECKMAN INSTR INC ELEC INSTR DIV OFFNER OPR	SCHILLER PARK ILL
80103	LAMBDA ELECTRONICS CORP	HUNTINGTON N Y
80145	ASSEMBLY PRODUCTS INC - SEE A P I INSTRUMENTS	
80145	A P I INSTRUMENTS CO	CHESTERLAND OHIO
80183	SPRAGUE PRODUCTS CO	NORTH ADAMS MASS
80185	DUMONT CORP	GREENFIELD MASS
80195	ETNYRE E D AND CO INC	OREGON ILL
80205	NATL AEROSPACE STD COMMITTEE AERO IND ASSOC OF AMERICA	WASHINGTON DC
80223	UNITED TRANSFORMER CO	NEW YORK N Y
80251	FORMICA CORP	CINCINNATI OHIO
80294	BOURNS LABORATORIES INC	RIVERSIDE CALIF
80302	MULTI-ELECTRIC CO	CHICAGO ILL
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	RUBATEX 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

TABLE 6-2. (Continued)

CODE NO.	MANUFACTURER	ADDRESS
83574	PRODUCTS RESEARCH AND CHEMICAL CORP	BURBANK CALIF
83594	BURROUGHS CORP ELECTRONIC COMPONENTS DIV	PLAINFIELD N J
83616	POLYMER CORP	READING PA
83718	NATIONAL STANDARD CO	NILES MICH
83740	UNION CARBIDE CORP CONSUMER PRODUCTS DIV	NEW YORK N Y
83777	LTV ELECTROSYSTEMS INC MEMCOR DIVISION	HUNTINGTON IND
83777	MEMCOR INC - SEE LTV ELECTROSYSTEMS INC	
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	GOOD-ALL ELECTRIC MFG CO - SEE TRW CAPACITOR DIVISION	
84411	TRW CAPACITOR DIVISION	OGALLALLA NEBR
84561	HANNIFIN CYLINDER DIV PARKER HANNIFIN CORP	DES PLAINES ILL
84830	LEE SPRING CO. INC.	BROOKLYN N Y
84832	LEGGE WALTER G CO	NEW YORK NY
84970	SARKES TARZIAN INC BROADCAST EQUIPMENT DIV	BLOOMINGTON IND
84971	TA MFG CORP	LOS ANGELES CALIF
85005	INGERSOLL PRODUCTS, DIV OF BORG-WARNER CORP	CHICAGO ILL
85074	NATIONAL GYPSUM CO	MILLINGTON NJ
85186	DIAMOND ALKALI CO WESTERN DIV	REDWOOD CITY CALIF
85446	BOKERS INC	MINNEAPOLIS MINN
85480	BRADY, W.H. CO.	MILWAUKEE WISC
85599	GENERAL ELECTRIC CO TUBE DEPT	SCHENECTADY N Y
85925	ELECTRO MECHANICAL INSTRUMENT CO	PERKASIE PA
86104	CELLUPLASTICS CORP	FITCHBURG MASS
86197	CLIFTON PRECISION PRO DIV	COLORADO SPRINGS COLO
86335	GLENCO CORP	METUCHEN N J
86415	PAWTUCKET SCREW COMPANY	PAWTUCKET R I
86445	PENN FIBRE AND SPECIALTY CO	PHILADELPHIA PA
86459	PENNSYLVANIA REFINING CO	BUTLER PA
86523	PIONEER RUBBER CO	WILLARD OHIO
86577	PRECISION METAL PRODUCTS CO	STONEHAM MASS
86603	PROTECTION PRODUCTS MFG CO (WELDWOOD CEMENT)	KALAMAZOO MICH
86797	ROGAN BROS	SKOKIE ILL
86928	SEASTROM MFG CO INC	GLENDALE CALIF
86961	SHELL CHEMICAL CO	NEW YORK N Y
87034	MARCO-OAK INDUSTRIES DIV OF OAK ELECTRO/NETICS CORP	ANAHEIM CALIF
87187	KRYLON INC	NORRISTOWN PENN
87216	PHILCO CORP LANSDALE DIVISION	LANSDALE PA
87308	SOUTHERN SCREW CO	STATESVILLE N C
87362	YARDNEY ELECTRIC CORP	NEW YORK NY
87569	STEMCO CORP	CLEVELAND OHIO
87578	UNION CARBIDE CORP CHEMICAL DIV	CHARLESTOWN W VA
87627	SUPERIOR TUBE CO	NORRISTOWN PA
87730	UNITED MINERAL AND CHEMICAL CORP	NEW YORK NY
87775	WHITTAKER-CLARK AND DANIELS INC	NEW YORK NY
88044	AIR FORCE-NAVY AERONAUTICAL STD (AN) DWGS	DEPTS OF NAVY AND AIR FORCE
88120	JORGENSEN, EARLE M CO	LOS ANGELES CALIF
88145	IDEAL CORP - CANCELED - SEE 81646	
88220	GOULD-NATIONAL BATTERIES INC	ST PAUL MINN
88226	BUNKER HILL CO. THE PACIFIC DIVISION	SEATTLE WASH
88245	LITTON INDUSTRIES USECO DIV	VAN NUYS CALIF
88245	U S ENGINEERING CO - SEE LITTON INDUSTRIES USECO DIV	
88301	MYSTIK TAPE INC	NORTHFIELD ILL
88303	PHILLIPS PROCESS CO.	ROCHESTER NY
88499	STAYTITE PRODUCTS CO	CLEVELAND OHIO
88920	GRAPHIC CONTROLS CORP DETROIT DIV	LATHRUP VILLAGE MICH
89007	VAN BRODE MILLING CO	CLINTON MASS
89307	TELEDYNE INC SPRAGUE ENGINEERING DIV	GARDENA CALIF
89469	BUCKEYE MOLDING CO	NEW VIENNA OHIO
89482	HOLTZER CABOT CORP	BOSTON MASS
89698	REES MACKWORTH G INC - SEE AVIS INDUSTRIAL CORP	
89698	AVIS INDUSTRIAL CORP REES MACKWORTH DIVISION	DETROIT MICH
89753	TRUE TEMPER CORP	CLEVELAND OHIO
89904	WESTINGHOUSE ELECTRIC CORP LAMP DIVISION	TRENTON N J
90052	BOSTON GEAR WORKS DIV OF MURRAY CO OF TEXAS	PHILADELPHIA PA
90070	CONOFLOW CORP	PHILADELPHIA PA
90095	TECHNITROL INC	PHILADELPHIA PA
90101	ADYU ELECTRONICS LAB. INC	PASSAIC N J
90137	ACME SHEAR CO	BRIDGEPORT CONN
90179	U S RUBBER CO - SEE UNIROYAL INC	
90179	UNIROYAL INC CONSMR INDL AND PLSTC PROD DIV	PASSAIC NJ
90411	BRISCOE MFG CO	COLUMBUS OHIO
90634	GULTON INDUSTRIES INC	METUCHEN N J
90797	MAGNETICS INC	BUTLER PA

TABLE 6-2. (Continued)

CODE NO.	MANUFACTURER	ADDRESS
90974	BECKLEY PERFORATING	GARWOOD N J
91254	ALL-STATE WELDING ALLOYS CO INC	WHITE PLAINS NY
91395	BUFFALO ELECTRIC CO	BUFFALO N Y
91407	SUPERIOR ELECTRIC CO - CANCELED - SEE 58474	
91418	RADIO MATERIALS CORP	CHICAGO ILL
91506	AUGAT INC	ATTLEBORO MASS
91547	AVCO/LYCOMING DIV STRAFORD PLANT	STRATFORD CONN
91556	BROOKS INSTRUMENTS CO	HATFIELD PA
91637	DALE ELECTRONICS INC	COLUMBUS NEBR
91662	ELCO CORP	WILLOW GROVE PA
91752	HARBISON WALKER REFRACTORIES CO	PITTSBURG PA
91767	HELI-COIL CORP	DANBURY CONN
91802	INDUSTRIAL DEVICES INC	EDGEWATER NJ
91821	JOHNSON BRONZE CO	DETROIT MICH
91833	KEYSTONE ELECTRONICS CORP	NEW YORK N Y
91881	MAGNETIC METALS CO	CAMDEN N J
91886	MALCO MFG CO	CHICAGO ILL
91927	MICRO METAL PRODUCTS INC - CANCELED - SEE 83014	
91929	HONEYWELL INC MICROSWITCH DIV	FREEPORT ILL
91967	NATIONAL TELTRONICS CORP	YONKERS NY
92108	SEMCO SALES AND SERVICE INC	LOS ANGELES CALIF
92194	ALPHA WIRE CORP	ELIZABETH N J
92215	VOI-SHAN MFG CO	CULVER CITY CALIF
92219	WALDOM ELECTRONICS	CHICAGO ILL
92264	ENGINEERED PRODUCTS CO	FLINT MICH
92287	THERMO-ELECTRIC CO	CLEVELAND OHIO
92607	TENSOLITE INSULATED WIRE CO INC	TARRYTOWN N Y
92798	JOHNS-MANVILLE PRODUCTS CORP	MANVILLE N J
92966	HUDSON LAMP COMPANY	KEARNY N J
93308	CLARK ELECTRONICS LABORATORIES	PALM SPRINGS CALIF
93332	SYLVANIA ELECTRONICS SEMICONDUCTOR DIV	WOBURN MASS
93460	WHITE SS MFG CO	PRINCE BAY STATEN ISLAND N Y
93768	GORDON CLAUD S CO	RICHMOND HILL ILL
93908	CARLON PRODUCTS CORP	CLEVELAND OHIO
93990	CLIMAX METAL PRODUCTS	CLEVELAND OHIO
93994	CHART PAK INC	LEEDS MASS
94139	KEYSTONE ELECTRONICS CO (BUSINESS DISCONTINUED)	
94144	RAYTHEON CO COMPONENTS DIV INDUSTRIAL COMPONENTS OPERATION	QUINCY MASS
94222	SOUTH CHESTER CORP	CHESTER PA
94310	TRU-OHM PRODUCTS MEMCOR COMPONENTS DIV - CANCELED - SEE 24681	
94499	ALPHA MOLYKOTE CORP - SEE DOW CORNING CORP	
94499	DOW CORNING CORP ALPHA MOLYKOTE PLANT	STANFORD CONN
94696	MAGNECRAFT ELECTRIC CO	CHICAGO ILL
95023	PHILBRICK GEORGE A RESEARCHES INC	DEDHAM MASS
95146	ALCO ELECTRONICS PRODUCTS INC	LAWRENCE MASS
95263	LEECRAFT MFG CO, INC.	LONG ISLAND CITY N Y
95265	NATIONAL COIL CO	SHERIDAN WYO
95275	VITRAMON INC	BRIDGEPORT CONN
95303	RADIO CORP OF AMERICA RECEIVING TUBE AND SEMICONDUCTOR DIV	CINCINNATI OHIO
95335	ATLANTIC RESEARCH CORP	ALEXANDRIA VA
95348	GORDOS CORP	BLOOMFIELD N J
95354	METHOD MFG CO	ROLLING MEADOWS ILL
95406	EVERHOT PRODUCTS CO	CHICAGO ILL
95640	WESTRONICS INC	FORT WORTH TEX
95696	CADILLAC PLASTIC AND CHEMICAL CO	DETROIT MICH
95712	DAGE ELECTRIC CO INC.	FRANKLIN IND
95987	WECKESSER CO INC	CHICAGO ILL
96027	NORTHWESTERN TOOLS INC	DAYTON OHIO
96096	AMERICAN CARBONIC ENGINEERING CO	NEW YORK N Y
96182	MASTER SPECIALTIES CO.	COSTA MESA CALIF
96195	UNISTRUT CORP	WAYNE MICH
96214	TEXAS INSTRUMENTS INC APPARATUS DIVISION	DALLAS TEX
96256	THORDARSON-MEISSNER INC	MT CARMEL ILL
96336	ENSIGN-BRICKFORD PRODUCTS DIV OF DARWORTH INC	SIMSBURY CONN
96341	MICROWAVE ASSOCIATES INC	BURLINGTON MASS
96467	SUPERIOR MFG AND INSTRUMENT CORP	LONG ISLAND CITY N Y
96577	INDUSTRIAL TECHTONICS INC	ANN ARBOR MICH
96613	ALPHA METALS INC.	JERSEY CITY N J
96791	AMPHENOL CORP AMPHENOL CONTROLS DIVISION	JANESVILLE WIS
96820	JOHNS-MANVILLE PRODUCTS CORP	HOUSTON TEX
96853	RUSTRAK INSTRUMENT CO INC	MANCHESTER N H
96881	THOMSON INDUSTRIES INC	MANHASSET NY
96906	MILITARY STANDARD (MS) DRAWINGS	STD DIV DIR OF LOG SER DSA
97049	WELLER ELECTRIC CORP	EASTON PA
97084	GIBSON GOOD TOOLS INC	SIDNEY NY
97393	SHUR-LOK CORP	SANTA ANA CALIF

TABLE 6-2. (Continued)

CODE NO.	MANUFACTURER	ADDRESS
97464	INDUSTRIAL RETAINING RING CO	IRVINGTON N J
97539	APM-HEXSEAL CORP	ENGLEWOOD N J
97814	SEALTRON CO	CINCINNATI OHIO
97852	STAR STAINLESS SCREW CO	TOTOWA N J
97954	U S COMPONENTS INC	NEW YORK N Y
97965	STANCOR ELECTRONICS INC	CHICAGO ILL
98004	NEWTON INSERT CO	LOS ANGELES CALIF
98079	BENDIX CORP THE SCIENTIFIC INSTRUMENTS DIV	CINCINNATI OHIO
98159	RUBBER TECK INC	GARDENA CALIF
98220	HEWLETT-PACKARD CO MOSELEY DIVISION - CANCELED - SEE 28480	
98251	SYLVANIA ELECTRIC PROD INC CHEM AND MET MATL DIV	TOWANDA PA
98278	MICRODOT INC	SOUTH PASADENA CALIF
98291	SEALECTRO CORP	MAMARONECK N Y
98376	ZERO MFG CO	BURBANK CALIF
98410	ETC INC	CLEVELAND OHIO
98571	SERVOMECHANISMS INC WESTERN DIVISION	EL SEGUNDO CALIF
98587	AMCO ENGINEERING CO	CHICAGO ILL
98659	COMPUTER INST CORP	HEMPSTEAD NY
98776	BEMCO INC	PACOIMA CALIF
98787	WEST INSTRUMENTS CORP	SCHILLER PARK ILL
98795	MAGNA COATINGS AND CHEMICAL CORP	LOS ANGELES CALIF
98911	ARMSTRONG PRODUCTS COMPANY	WARSAW IND
98978	INTERNATIONAL ELECTRONIC RESEARCH CORP	BURBANK CALIF
98991	WORCESTER VALVE CO INC	WORCESTER MASS
98996	OLYMPIC SCREW AND RIVET CO	DOWNEY CAL
98997	SIGHTMASTER CORP	PROVIDENCE R I
99017	PROTECTIVE CLOSURES CO INC CAPLUGS DIV	BUFFALO NY
99114	HITEMP WIRES INC	WESTBURY N Y
99127	BALCO RESEARCH LABORATORIES	ORANGE N J
99164	ALLEN ORGAN CO.	MACUNGIA PA
99313	VARIAN	PALO ALTO CALIF
99378	ATLEE CORP	WINCHESTER MASS
99384	FURANE PLASTICS INC	LOS ANGELES CALIF
99442	ALLIED RESEARCH PRODUCTS INC	BALTIMORE MD
99515	MARSHALL INDUSTRIES ELECTRON PRODUCTS DIV	MONROVIA CALIF
99515	ELECTRON PRODUCTS - SEE MARSHALL INDUSTRIES	
99536	HARDWARE SPECIALTIES SALES CO	LOS ANGELES CALIF
99742	PERMACEL TAPE CO	NEW BRUNSWICK N J
99800	DELEVAN ELECTRONICS CORP	EAST AURORA N Y
99934	RENBRANDT INC	BOSTON MASS
99941	X-ACTO PRECISION TOOLS	LONG ISLAND CITY NY
99942	HOFFMAN ELECTRONICS CORP - SEE GLOBE-UNION INC	
99942	GLOBE-UNION INC CENTRALAB SEMICONDUCTOR	EL MONTE CALIF

SECTION VII
SCHEMATIC DIAGRAMS

G65004

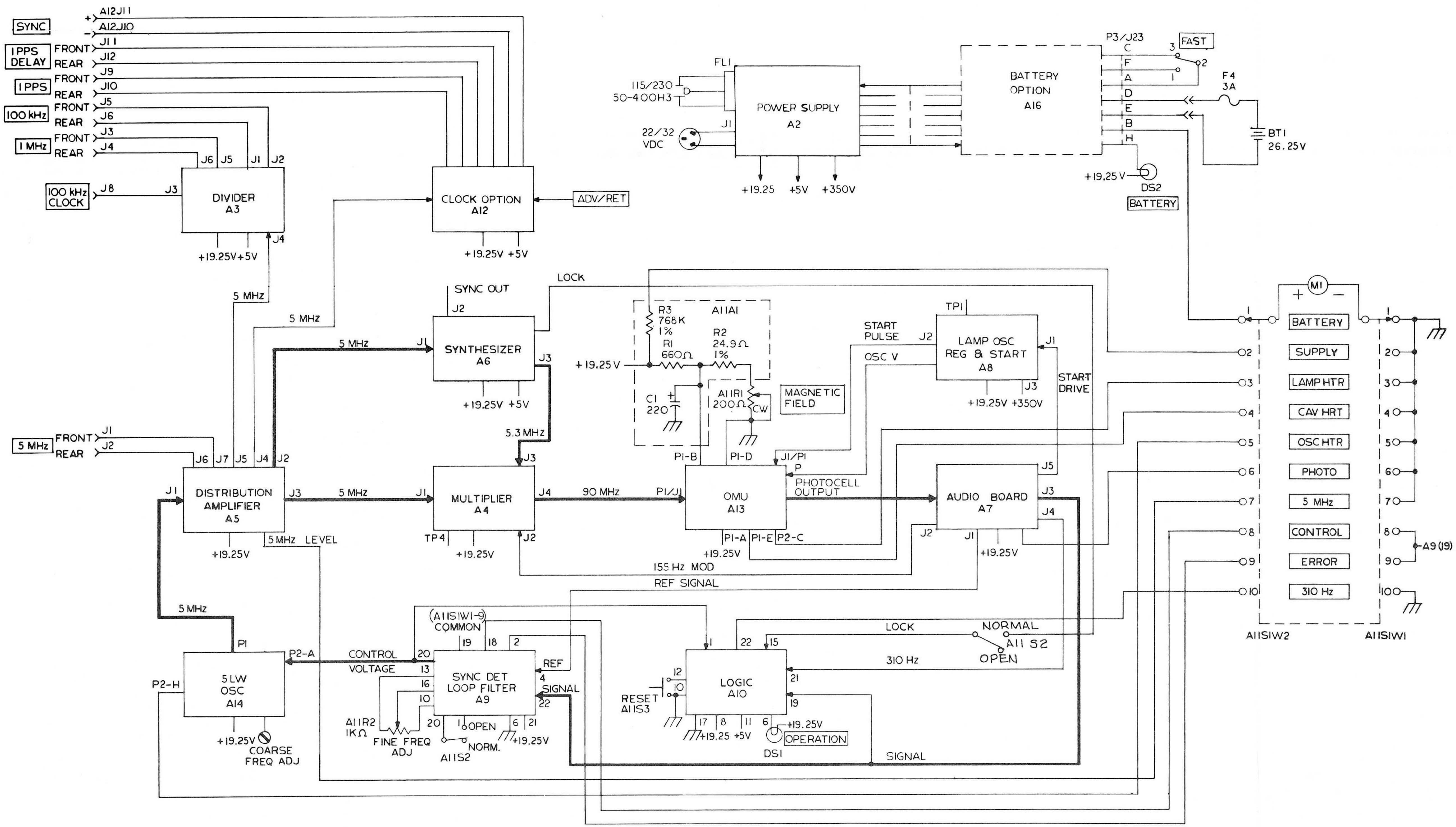


Figure 7-1. Model 304D Interconnect Schematic Diagram, Drawing G-45226 Rev -

G65004

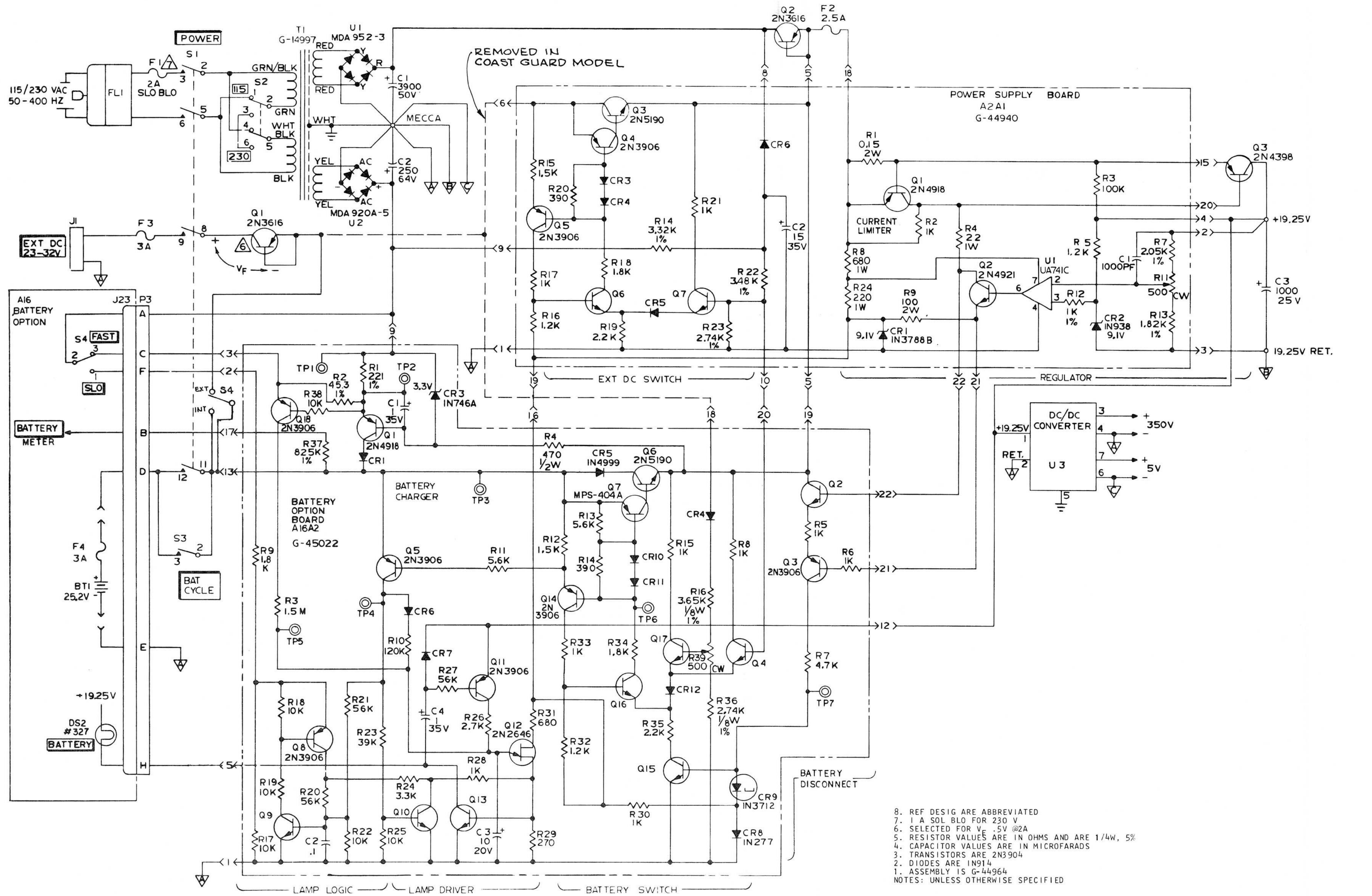
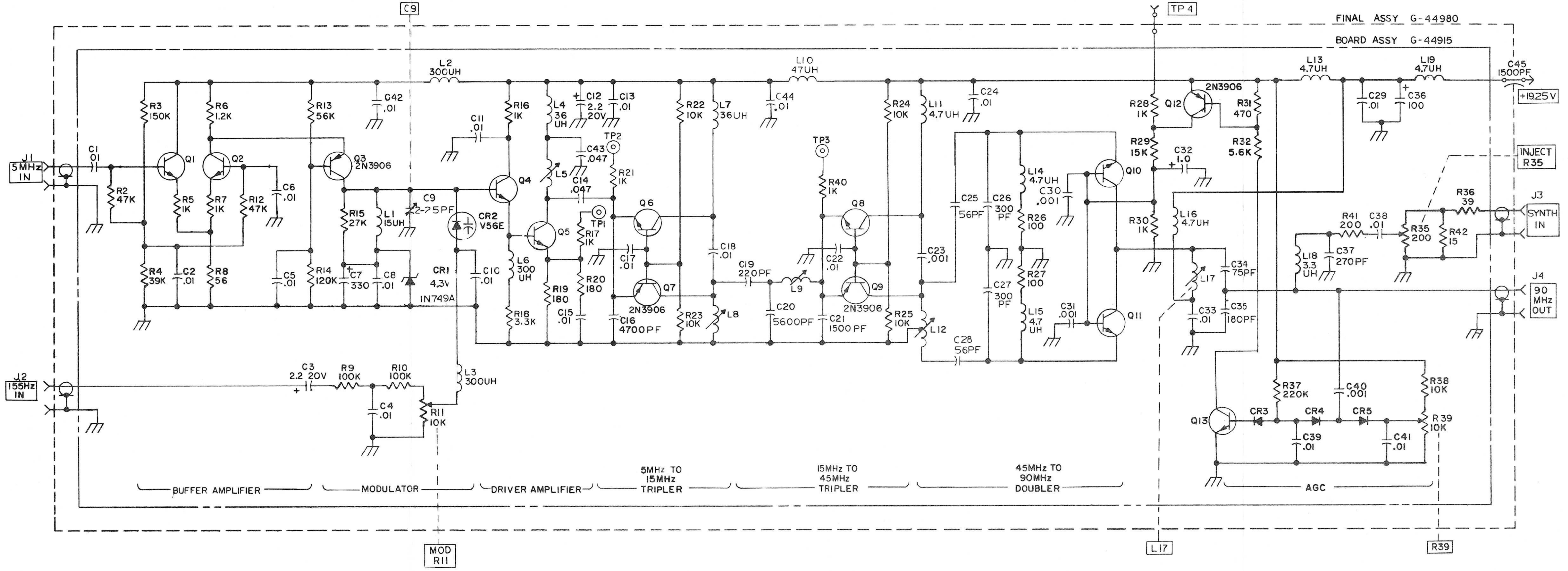
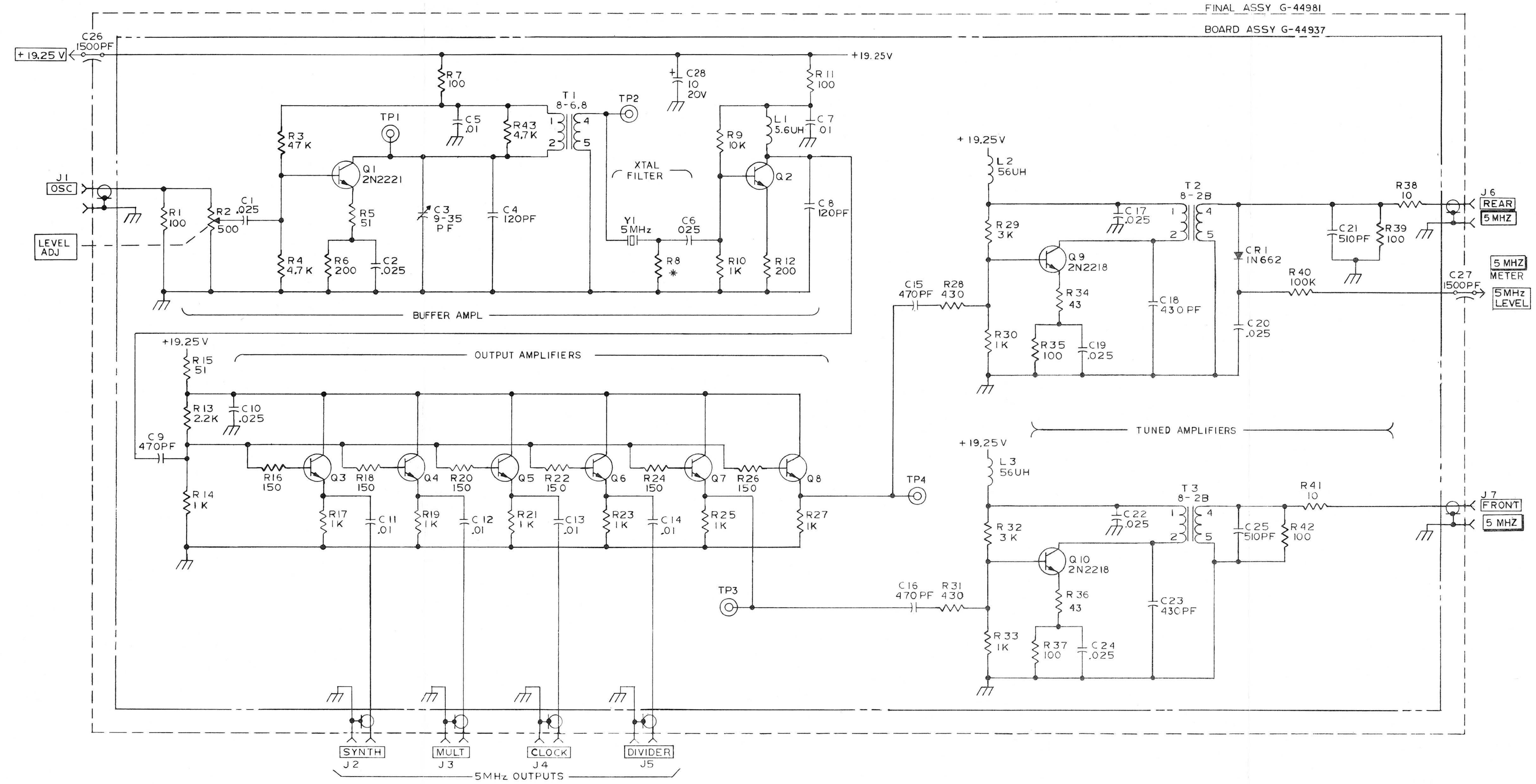


Figure 7-2. Assemblies A2 and A16, Power Supply and Battery Option Schematic Diagram, Drawing G-44942 Rev - A



7. REF DESIG ARE ABBREVIATED. PREFIX DESIG WITH A4
6. LAST REF DESIG USED C45,CR5,J4,L19,Q13,R42 & TP3
5. DIODES ARE IN914
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
NOTES: UNLESS OTHERWISE SPECIFIED:

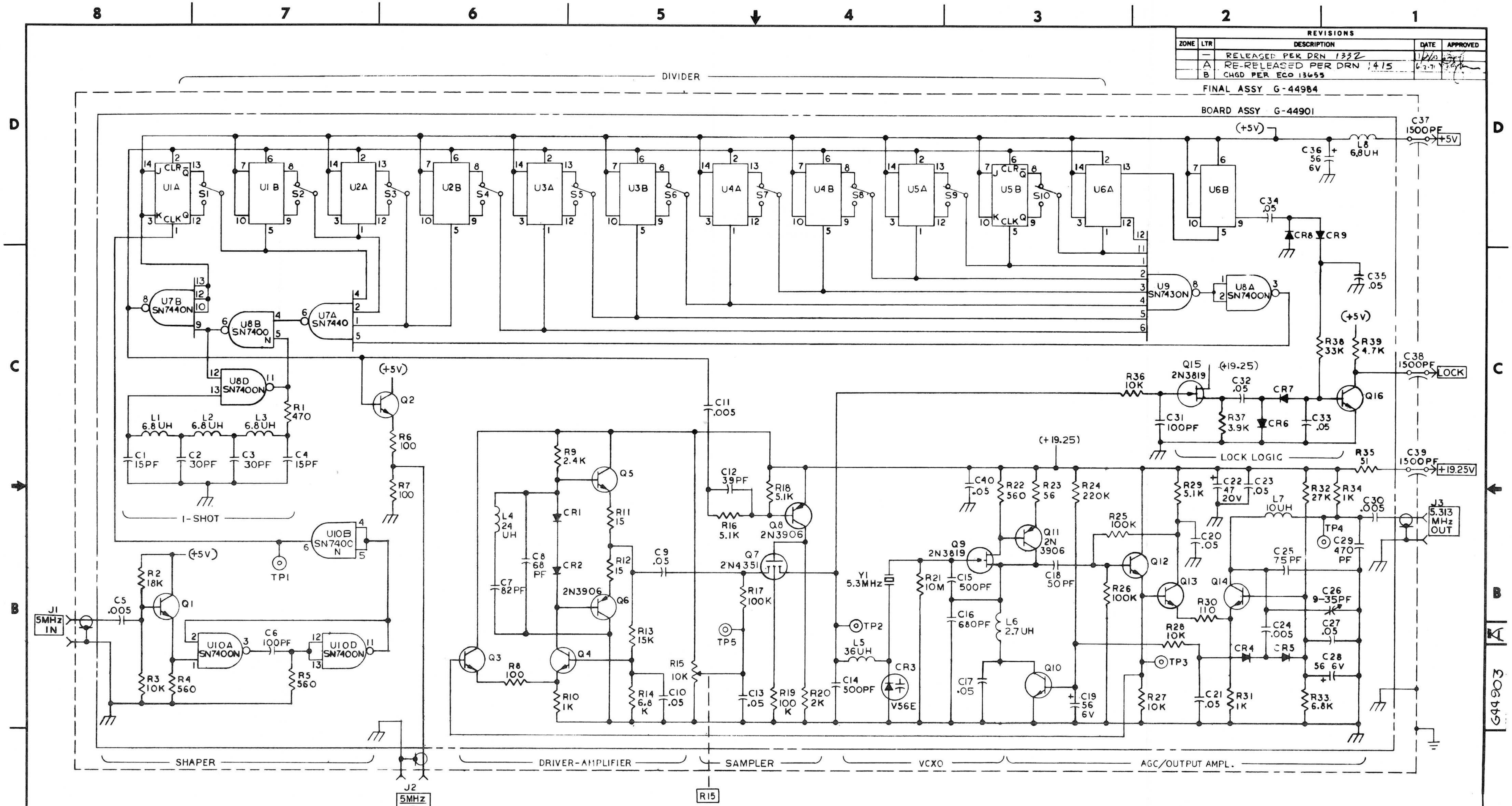
Figure 7-3. Assembly A4, X18 RF Multiplier Schematic Diagram, Drawing G-44917 Rev -



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 1/4W, 5%
2. ALL CAPACITOR VALUES ARE MICORFARADS
1. ASSEMBLY IS G-44937

NOTES: UNLESS OTHERWISE SPECIFIED

Figure 7-4. Assembly A5, Distribution Amplifier Schematic Diagram, Drawing G-44933 Rev -



11. SWITCHES ARE SHOWN IN "0" POSITION
10. PIN 11 ON U1-U6 AND PIN 7 ON U7-U10 ARE GRD
9 PIN4 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 1N914
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.

G-44984	3040
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DO NOT SCALE DRAWINGS
TOLERANCES UNLESS OTHERWISE SPECIFIED
DECIMALS — FRACTIONS — ANGLES —
MATERIAL: ---------

ENGINEER 11-17-70
CHECKED 11-17-70
DRAFTSMAN 11-16-70

TRACOR, INC. AUSTIN, TEXAS

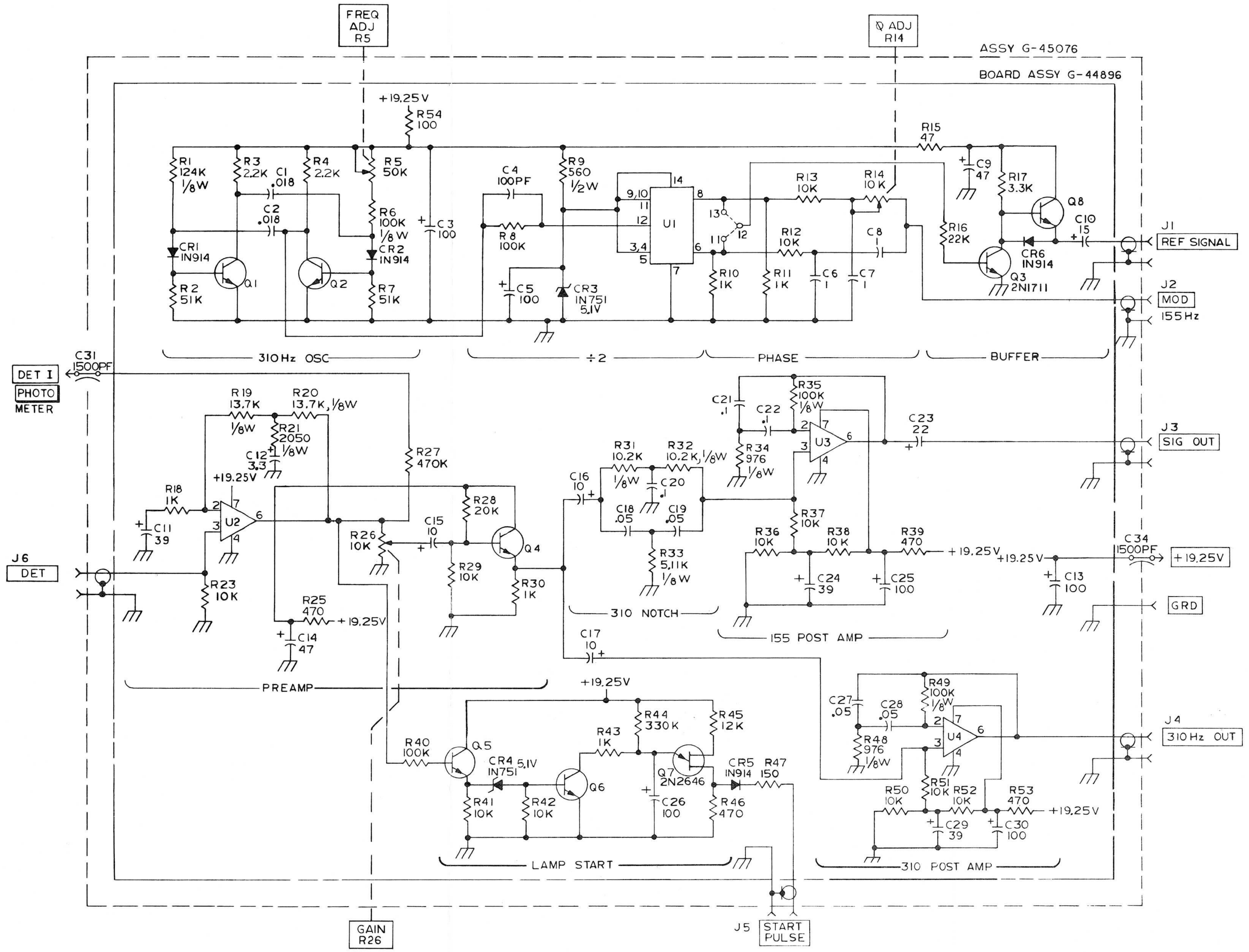
SCHEMATIC DIAGRAM - SYNTHESIZER

Figure 7-5 A6

SIZE D | CODE IDENT NO. 19397 | G44903 | B

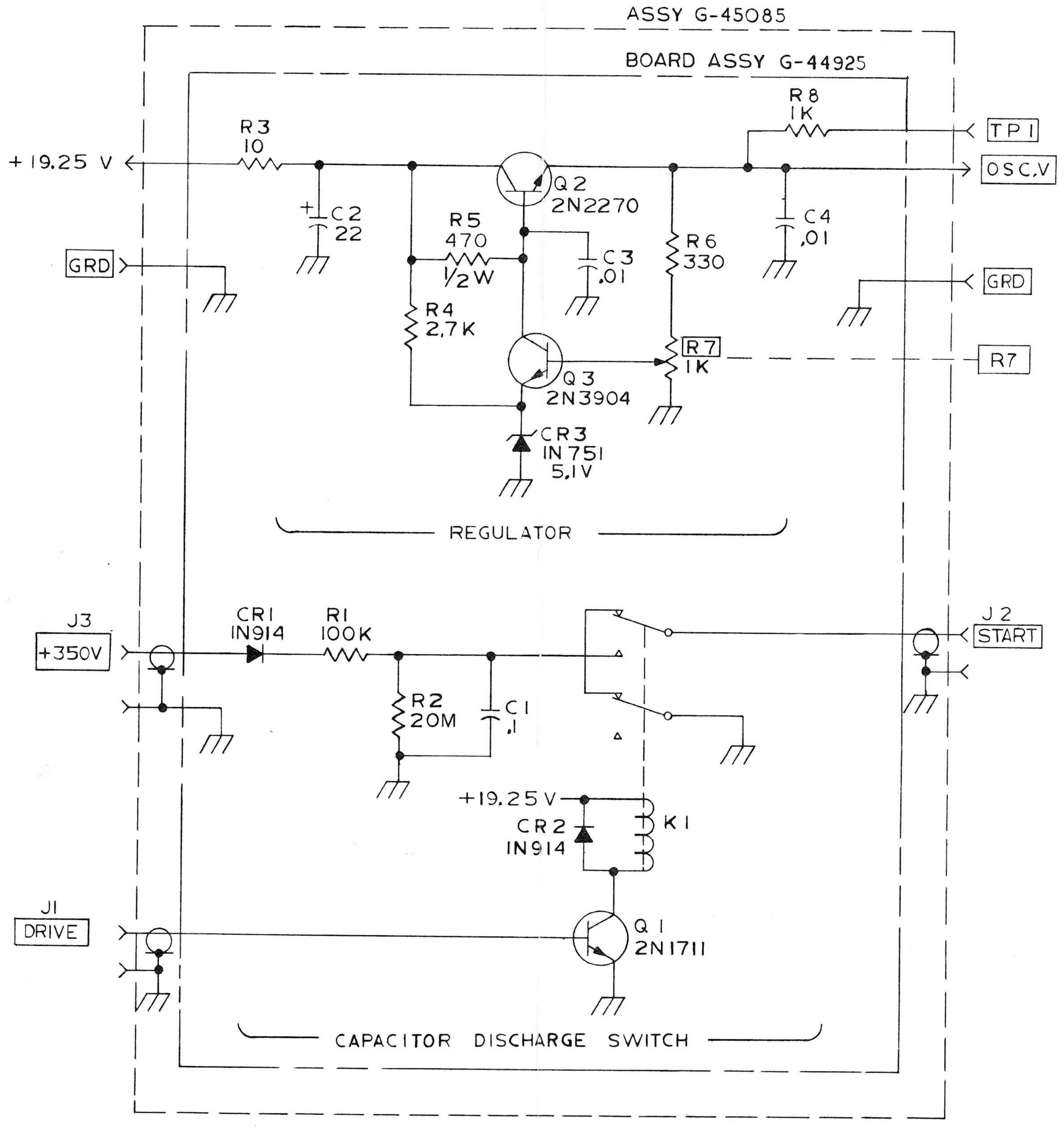
SCALE — SHEET 1 OF 1

7-11/2-12



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. REF DESIG ARE ABBREVIATED PREFIX DESIG 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

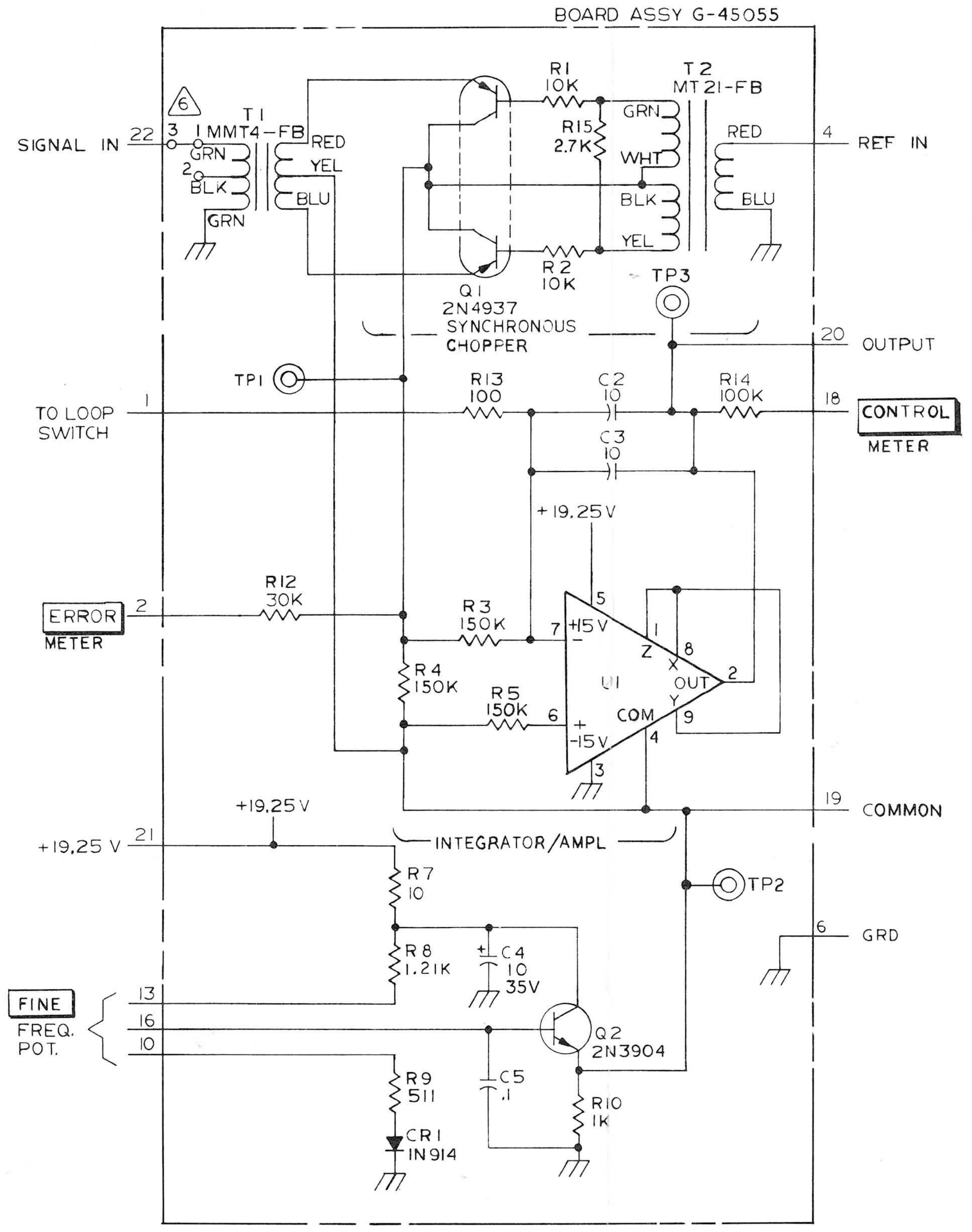
Figure 7-6. Assembly A7, Audio Schematic Diagram, Drawing G-44898 Rev -



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

NOTES: UNLESS OTHERWISE SPECIFIED

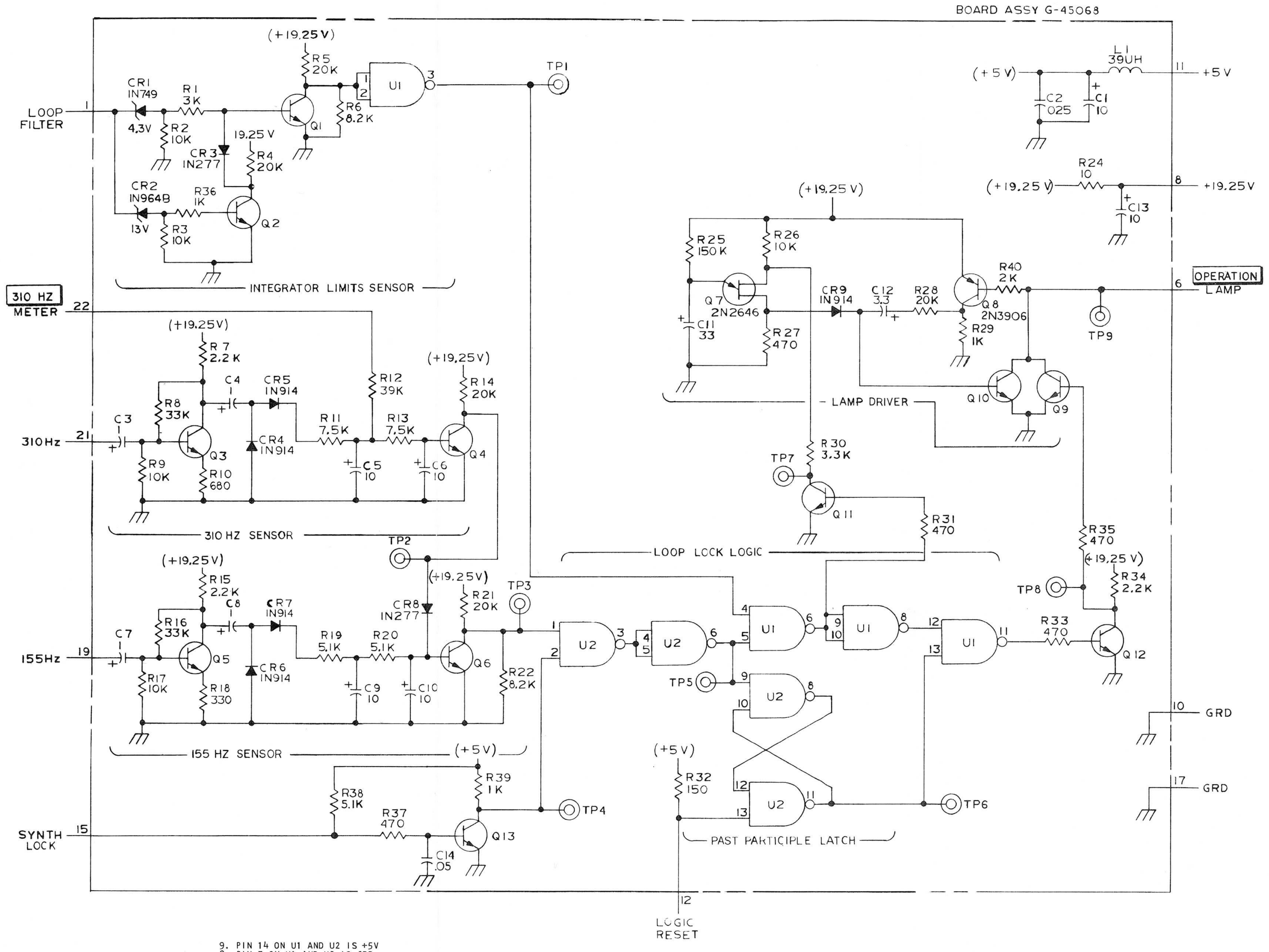
Figure 7-7. Assembly A8, Oscillator Regulator and Start Schematic Diagram, Drawing G-44928 Rev -



6. THE JUMPER MAY BE CHANGED TO TERMINAL 2 FOR HIGHER GAIN.
5. LAST REF DESIG USED U1,C5,CR1,Q2,R15,T2,TP3
4. REF DESIG ARE ABBREVIATED. PREFIX DESIG WITH A9
3. RESISTOR VALUES ARE IN OHMS AND ARE 1/8W, 1%
2. CAPACITOR VALUES ARE IN MICROFARADS
1. ASSEMBLY IS G-45055

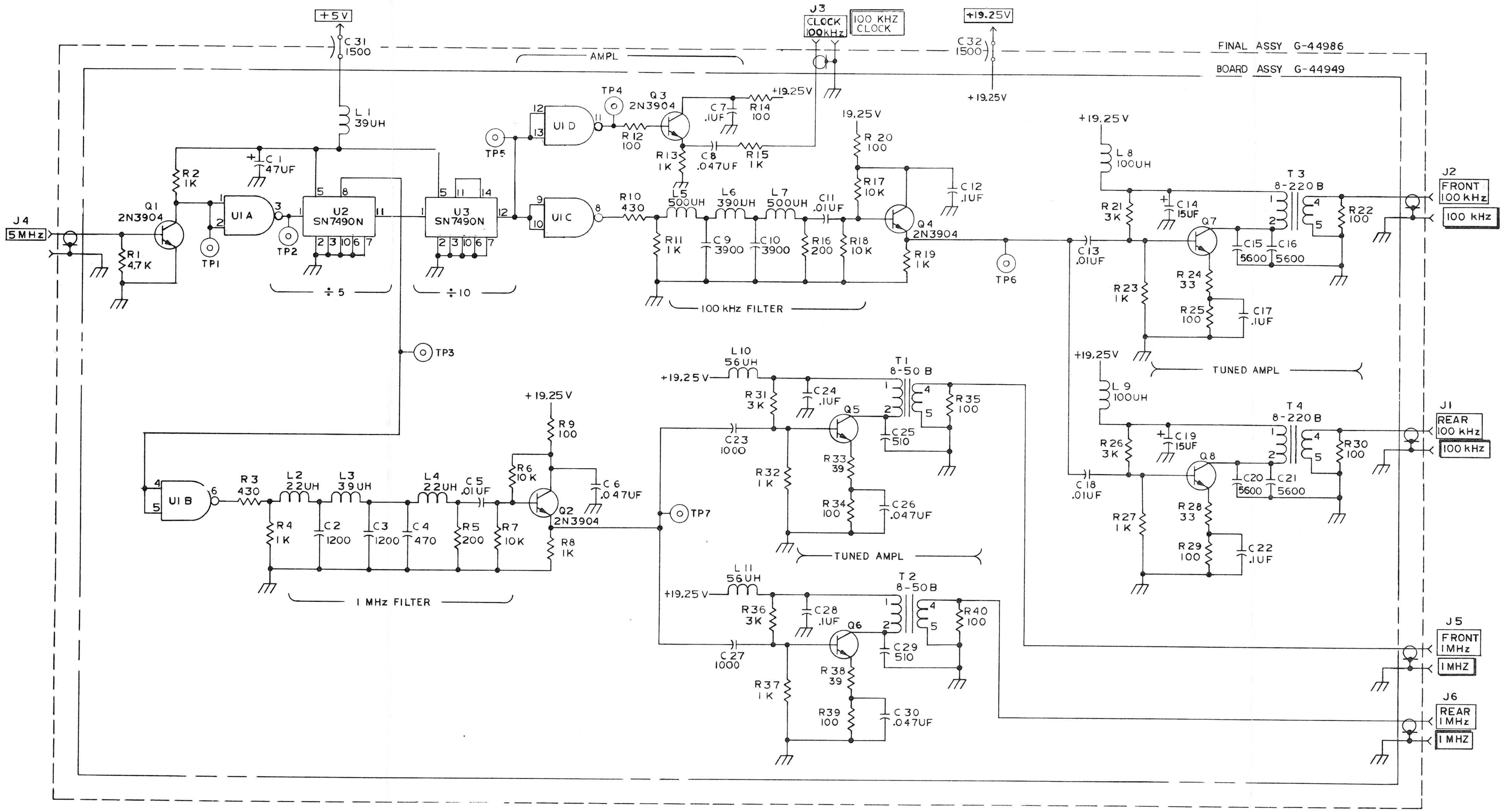
NOTES/ UNLESS OTHERWISE SPECIFIED

Figure 7-8. Assembly A9, Loop Filter Schematic Diagram, Drawing G-45059 Rev - A



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

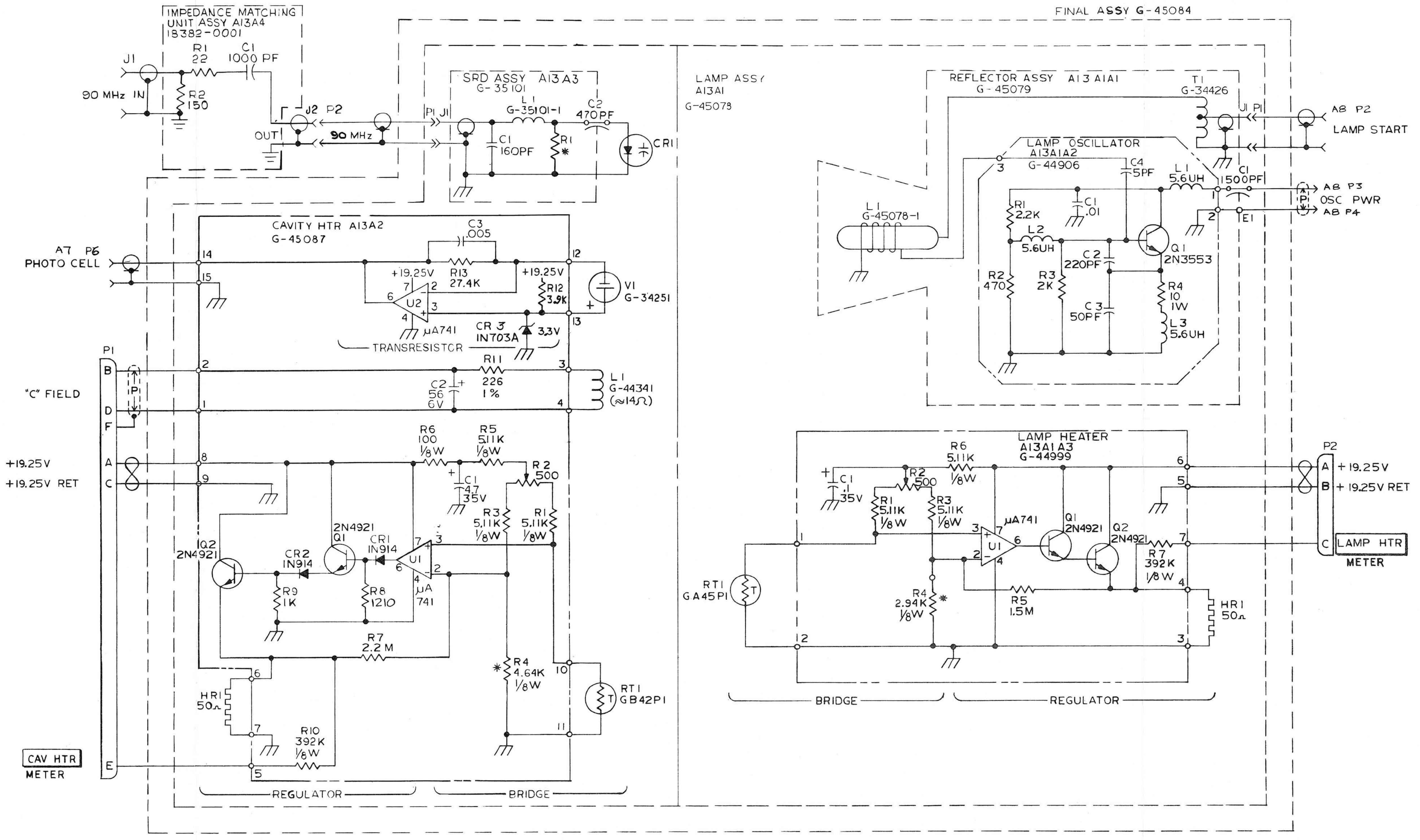
Figure 7-9. Assembly A10, Logic Schematic Diagram, Drawing G-45072 Rev - A



9. PIN 14 ON U1 & PIN 5 ON U2&U3 IS +5V
8. PIN 7 ON U1 & PIN 10 ON U2&U3 IS GND
7. U1 IS SN 7400N
6. LAST REF DESIG USED: U3,C32,J6,L11,Q8,R40,T4
5. REF DESIG ARE ABBREVIATED PREFIX WITH
4. TRANSISTORS ARE 2N2218
3. RESISTOR VALUES ARE IN OHMS AND ARE 1/4W, 5%
2. ALL CAPACITOR VALUES ARE MICROMICROFARADS.
1. ASSEMBLY IS G-44986

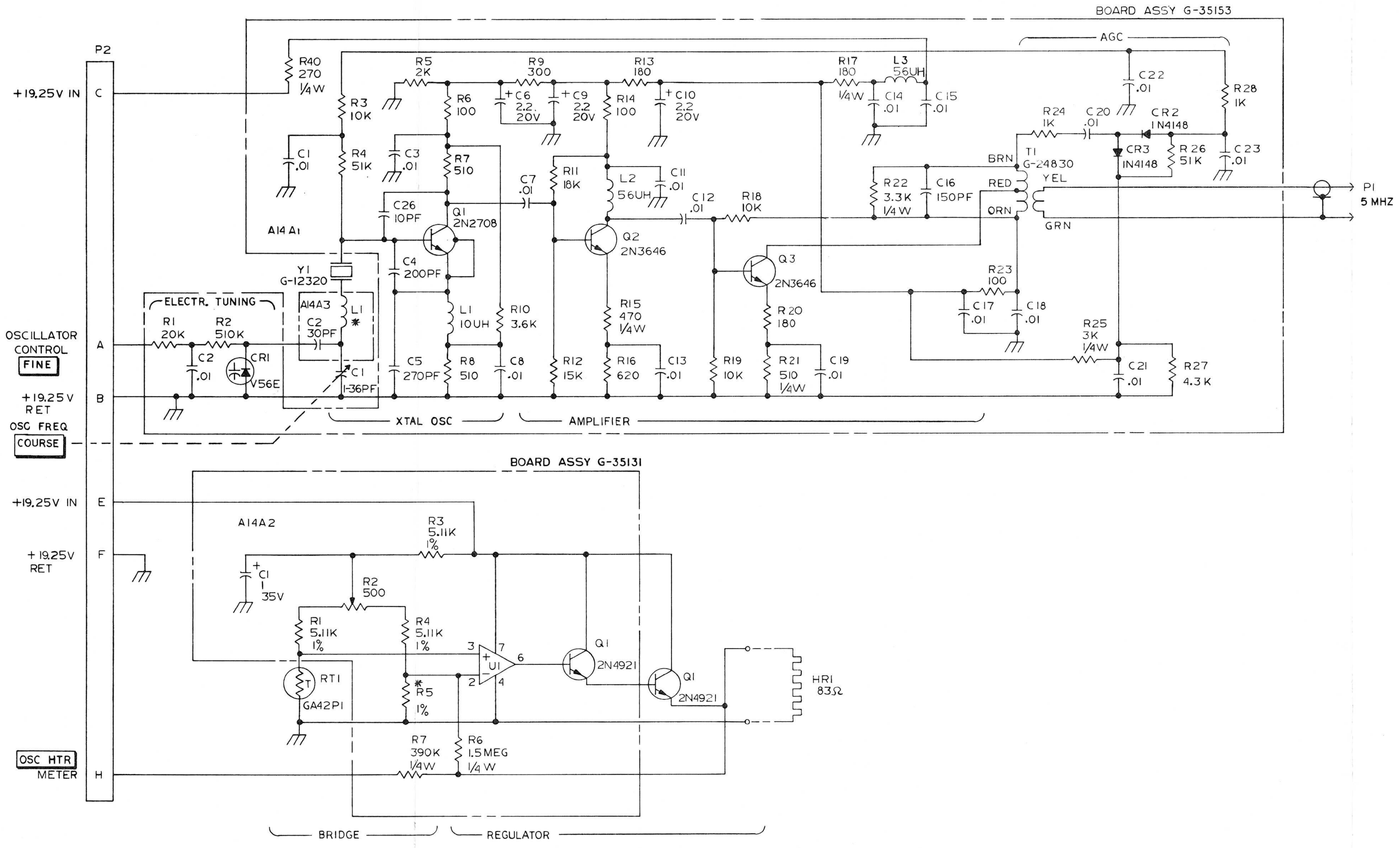
NOTES: UNLESS OTHERWISE SPECIFIED

Figure 7-10. Assembly A3, 1MHz/100kHz Divider Output Schematic Diagram, Drawing G-44950 Rev -



6. *INDICATES SELECTED IN TEST
5.• REF DESIG ARE ABBREVIATED
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-45084
NOTES: UNLESS OTHERWISE SPECIFIED

Figure 7-11. Assembly A13, Optical Microwave Unit Schematic Diagram, Drawing G-45083 Rev - B



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

Figure 7-12. Assembly A14, 5MHz Crystal Oscillator Schematic Diagram, Drawing G-45187 Rev-

SECTION AI

GENERAL INFORMATION

A1-1. INTRODUCTION.

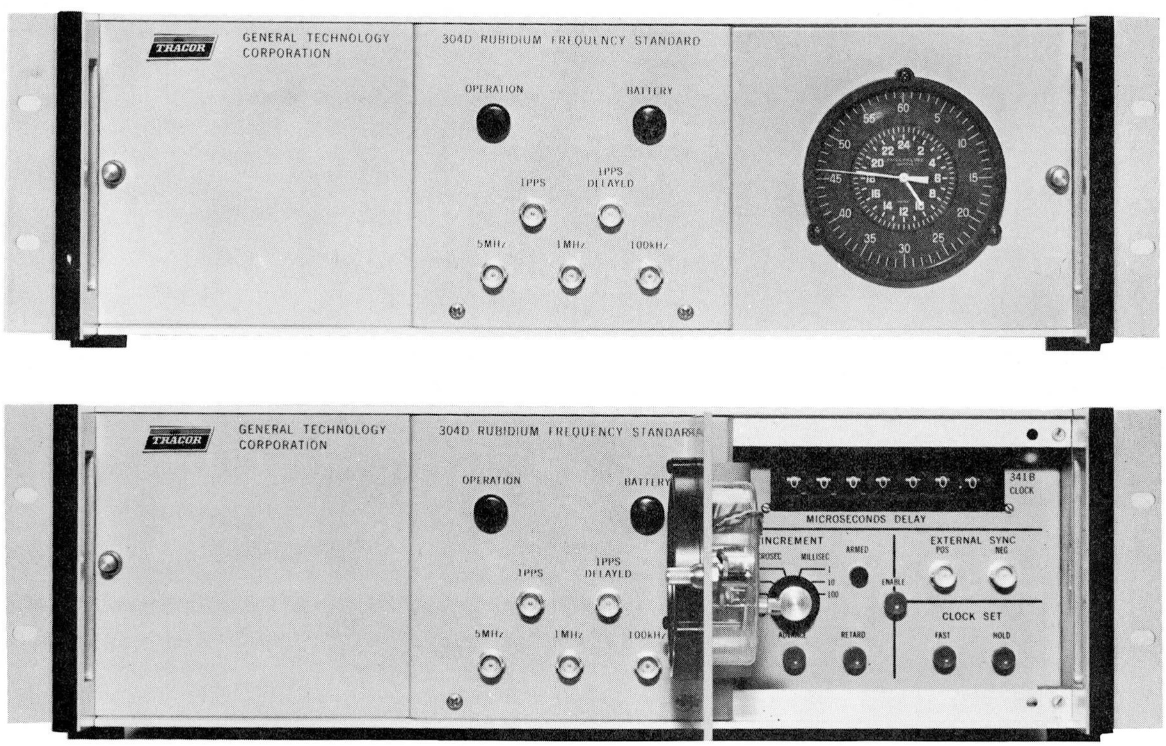
A1-2. This section provides the purpose and general description of the clock option. It also lists the electrical specifications and provides a brief functional description of the operating controls and indicators.

A1-3. PURPOSE OF EQUIPMENT.

A1-4. The clock option is designed to provide a visual time readout on the front panel of the frequency standard and to provide a 1pps output signal on both front and rear panels. With the optional time delay, a delayed 1pps output is also provided on both front and rear panels.

A1-5. DESCRIPTION OF EQUIPMENT.

A1-6. The clock option (figure A1-1) uses the stable 5MHz frequency of the frequency standard to provide a precise time reference. It contains a 24-hour clock, a main counter, and the associated control circuits. Buffered 1pps outputs are provided at both front and rear panels. Refer to table A1-1 for a functional description of the controls and indicators.



A6-106-582

Figure A1-1. Rubidium Frequency Standard With Clock Option.

TABLE A1-1. CLOCK OPTION CONTROLS AND INDICATORS

NAME	FUNCTION
Clock	Provides readout of time at which frequency standard is operating.
MICROSECONDS DELAY thumb-wheel switches	Selects time delay between 1pps and 1pps DELAYED outputs from 0 to 1 second in 0.1 micro-second steps. (Optional)
INCREMENT selector	Selects rate at which 1pps output is advanced or retarded in steps of 0.1μsec., 1μsec., 10μsec., 100μsec., 1 msec., 10 msec., or 100 msec.
ENABLE push-button	Allows ADVANCE, RETARD, FAST, and HOLD push-buttons to operate. Also applies external synchronizing pulse to circuits.
POS EXTERNAL SYNC connector	Allows connection of positive pulse to synchronize clock to an external signal.
NEG EXTERNAL SYNC connector	Allows connection of negative pulse to synchronize clock to an external signal.
FAST CLOCK SET pushbutton	When pressed and held, applies 5pps signal, instead of normal 1pps signal, to clock to drive clock at an increased rate. Used in conjunction with ENABLE pushbutton.
HOLD CLOCK SET pushbutton	When pressed and held, removes 1pps signal from clock to stop clock. Used in conjunction with ENABLE pushbutton.
1PPS connectors	Provide connection on front and rear panels of clock option 1pps output pulses.
1PPS DELAYED connectors	Provide connection on front and rear panels of clock option delayed 1pps output pulses.
ADVANCE push-button	Sets logic circuits to advance 1pps output by amount selected on INCREMENT selector. Push-button must be pressed and released everytime an advance is required. Cannot be advanced more than once each second. Used in conjunction with ENABLE pushbutton.
RETARD push-button	Same as ADVANCE pushbutton, only 1pps output is retarded.
ARMED lamp	Lights when ADVANCE or RETARD pushbuttons are pressed. Goes out when clock is advanced or retarded.

A1-7. **SPECIFICATIONS.**

A1-8. A list of electrical specifications for the clock option is provided in the following paragraphs.

A1-9. INPUT REQUIREMENTS

Voltages:	19.25VDC 5.0VDC
Power:	6 watts
Signal:	5MHz sinewave, 1VRMS (from frequency standard)
+ & - Sync Pulse:	Length – greater than 0.5μsec. Amplitude – 5 to 20 volts Rise Time – less than 50nsec.

A1-10. 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

A1-11. OUTPUTS

Frequency:	1pps
Amplitude:	Greater than 7.5 volts peak
Pulse Length:	18 to 22μsec.
Rise Time:	Less than 50 nsec.
Fall Time:	Less than 150 nsec.
Pulse-to-Pulse Jitter:	Less than 20 nsec.
Temperature Drift:	Less than 200 nsec. (0 to 50°C)
Isolation:	Less than 100 nsec. shift at one output as other output load varies from short to open.
Impedance:	40 to 60 ohms
Clock:	24-hour readout in hours, minutes, and seconds.
Synchronizing Inaccuracy:	Less than 150 nsec.
Advance & Retard Resolution:	100 nsec.

A1-12. DELAY OUTPUT (Refer to paragraph A-11)

A1-13. DELAY SETTING

Accuracy:	Within 200 nsec. of setting
Resolution:	100 nsec.

SECTION AII

OPERATION SECTION

A2-1. **INTRODUCTION.**

A2-2. This section provides the procedures necessary to operate the clock option in conjunction with the frequency standard.

A2-3. **INITIAL CLOCK ADJUSTMENT.**

A2-4. When power is applied to the frequency standard, the clock should immediately start operating. To set the hours and minutes hands, open the access door in which the clock is mounted and adjust the clock hands using the knob extending from the rear of the clock (pull to engage, push to release). Use the FAST and HOLD pushbuttons, in conjunction with the ENABLE pushbutton to set the clock to the nearest second.

A2-5. **EXTERNAL SYNCHRONIZATION.**

A2-6. The clock can be synchronized to an external signal as follows:

a. Connect external signal to either POS EXTERNAL SYNC or NEG EXTERNAL SYNC connector, whichever is applicable. Refer to paragraph A1-9 for the specifications on the external sync signal.
b. Press ENABLE pushbutton for at least 1 second. Both clock and 1pps output should be synchronized to the external signal.
c. Disconnect external sync signal from clock.

A2-7. **TIME ADJUSTMENTS.**

A2-8. If the clock is being referenced to an external time source (such as Naval Observatory Time), it will be necessary to advance or retard the clock to correspond to changes in the reference time. Adjust the time as follows:

a. Determine amount of adjustment required.
b. Set INCREMENT selector to largest increment that will not exceed required adjustment.
c. Simultaneously press and release ENABLE and either ADVANCE or RETARD pushbuttons. ARMED lamp will light. When ARMED lamp goes out, clock has been advanced or retarded by amount set on INCREMENT selector.
d. Repeat Step c, using the required increments until adjustment is accomplished.

A2-9. **DELAYED OUTPUT ADJUSTMENT.**

A2-10. The clock has an optional 1pps delayed output. This delay is set as follows:

a. Determine amount of delay required in microseconds.
b. Set MICROSECONDS DELAY thumbwheel switches to amount of delay required. The 1pps DELAYED output will be delayed from the 1pps output by the amount indicated on MICROSECONDS DELAY switches.

SECTION AIII
THEORY OF OPERATION

A3-1. **INTRODUCTION.**

A3-2. This section provides the theory of operation for the clock option. It includes a functional description of the unit and a detailed circuit analysis of individual assemblies.

A3-3. **FUNCTIONAL DESCRIPTION.**

A3-4. The clock option is comprised of a 24-hour clock, control assembly, main counter assembly, and optional preset counter assembly. Refer to figure A3-1 for a functional block diagram of the clock option.

A3-5. The 5MHz input sinewave signal is applied to Control Assembly A3. It is amplified, buffered, doubled to 10MHz, waveshaped, and applied to Preset Counter Assembly A4 and Main Counter Assembly A1. The 10MHz pulses applied to the main counter are gated and stopped for 800 nanoseconds at a 1pps rate to counteract propagation delays.

A3-6. The main counter divides the 10MHz pulse train down to 1pps and 5pps. These two pulses are applied back to the control circuit. The 1pps signal is also applied to Preset Counter Assembly A4.

A3-7. In the control assembly the 1pps signal is used to generate the two clock drive pulses and to control the advance, retard, reset, and 10MHz main counter pulses. The 5pps signal drives the clock at an increased rate during adjustment.

A3-8. When the ADVANCE or RETARD pushbutton is pressed, in conjunction with the ENABLE pushbutton, the ARMED lamp lights, indicating the advance/retard circuits will send the next advance or retard pulse to the main counter. This pulse is applied to the applicable counter as determined by the INCREMENT selector setting. This either holds or advances that counter for one count.

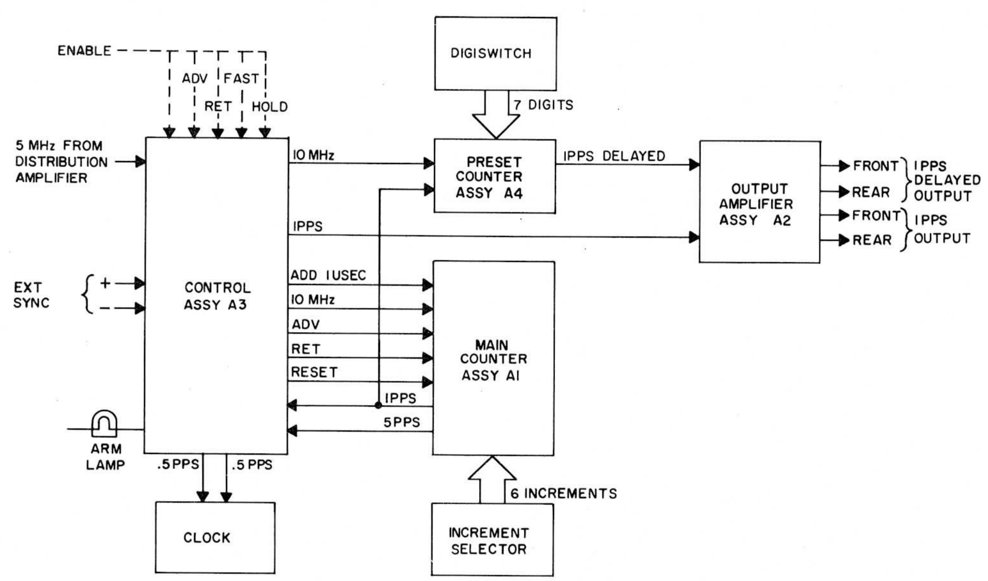


Figure A3-1. Clock Option Assembly A12 Functional Block Diagram.

A6-106-544

A3-9. When the FAST pushbutton is pressed, in conjunction with the ENABLE pushbutton, the 5pps signal is gated through to the clock drive circuits. Pressing the HOLD and ENABLE pushbuttons prevents either the 1pps or 5pps signals from being applied to the clock drive circuits.

A3-10. An external synchronizing pulse can be applied to the control assembly to synchronize the clock and 1pps outputs to an external signal. The ENABLE pushbutton initially applies this pulse to the control circuits. A reset pulse is applied to the main counter to ensure that the count is always reset to zero after each second when the synchronizing pulse is used. This reset pulse is always applied each second, whether an external sync is used or not.

A3-11. The preset counter divides down to 1pps, but also has the capability of delaying its output pulse. The seven front panel MICROSECONDS DELAY thumbwheel switches determine how much this 1pps output pulse will be delayed from the 1pps output pulse of the main counter. The delay can vary from zero to one second in 0.1 microsecond steps.

A3-12. The 1pps from the control circuit and the delayed 1pps from the preset counter are applied to output amplifier assembly A2. The output amplifier provides amplification and separate buffering for each of the 1pps and 1pps delayed front and rear panel outputs.

A3-13. DETAILED CIRCUIT ANALYSIS.

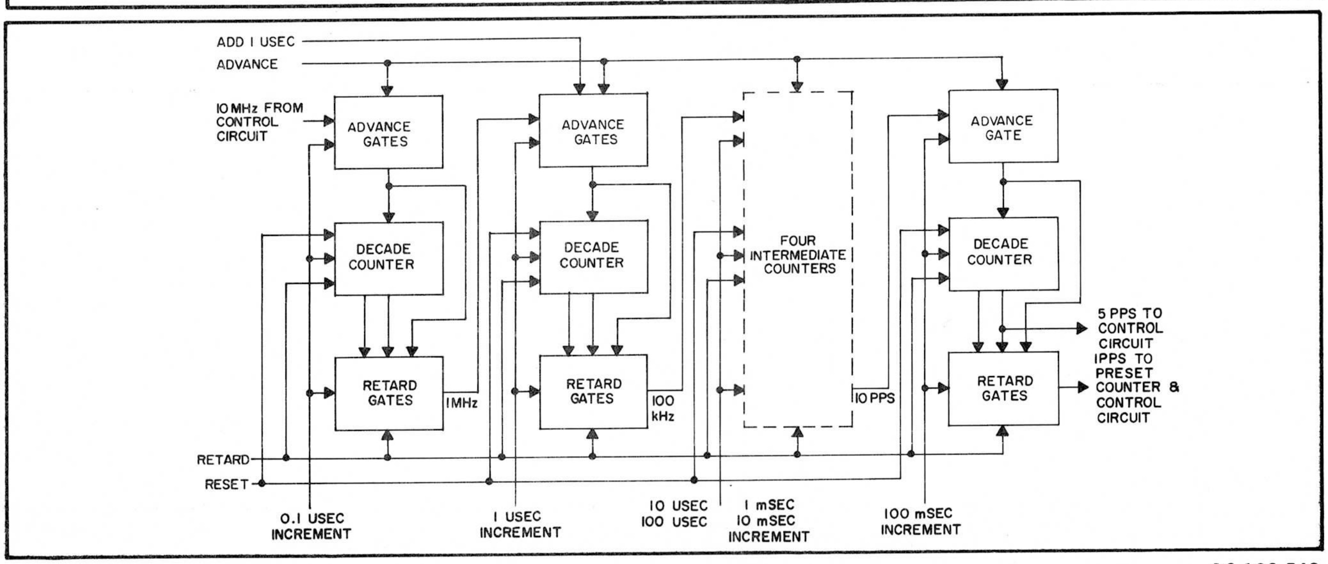
A3-14. A detailed analysis of each assembly in the clock option is provided in the following paragraphs. The assemblies are discussed in numerical order according to assembly numbers. Table A3-1 provides a list of these assemblies. References to figures in Section AVI are references to the applicable schematic diagrams for each assembly. An interconnect schematic diagram for the clock option is provided in figure A6-1.

A3-15. MAIN COUNTER ASSEMBLY A1.

A3-16. The main counter divides 10MHz down to 5pps and 1pps to provide the 1pps frequency standard output and to drive the front panel clock. Advance and retard inputs are also applied that can change the 1pps time in decade steps 0.1μsec. to 0.1sec. It consists of seven decade counters, and the associated advance and retard circuits for each counter, which together form one ripple counter. Refer to figure A3-2 for a block diagram of the main counter assembly and to figure A6-2 for a schematic diagram.

TABLE A3-1. CLOCK OPTION ASSEMBLY NUMBERS

Assembly Number	Assembly Name
A1	Main Counter
A2	Output Amplifier
A3	Control Circuit
A4	Preset Counter



A6-106-543

Figure A3-2. Main Counter Assembly Block Diagram.

A3-17. NORMAL COUNT FUNCTION. The 10MHz pulse train from Control Circuit Assembly pin 7 is applied through pin 10 to advance gate U1A pin 9. Refer to figure A3-3 for a timing diagram of the first decade counter and associated gates. Pin 10 of U1A is always at logic 1, unless the count is being advanced. Therefore, the output at pin 8 is a 10MHz inverted pulse train. These inverted pulses are applied to U3 pin 14 (A input) and U2A pin 1. Decade counter U3 provides a 5MHz output pulse at pin 1, which is applied to U3 pin 12 and U2A pin 2. The second output of U3 at pin 11 is a 1MHz pulse that is applied to U2A pin 5 and U4A pin 9. Also applied to U2A at pin 4 is the output of U4A at pin 8. This is always logic 1 unless the count is being retarded. The output of U2A at pin 6 will always be at logic 1 except when all four inputs are at logic 1. This occurs once every tenth U3 input pulse. The output at U2A pin 6 is a 1MHz pulse that is logic 1 for nine U3 input pulses and logic 0 for one U3 input pulse. This is applied to advance gate U2B at pin 9 for the next decade counter.

A3-18. The propagation delay through the main counter is about 200 nanoseconds; uncorrected, this would cause the 1pps output to be delayed from a sync signal by 200 nanoseconds. To eliminate this delay, the 10MHz input is held at logic 1, once each second for 800 nanoseconds, by the Control Circuit Assembly. This produces a total delay time of 1 microsecond. This is then eliminated by adding a pulse to the 1MHz pulse train once each second. This is equivalent to advancing the 1pps output by 1 microsecond, producing a net delay of nearly zero.

A3-19. The additional pulse is received from pin 1 of the Control Circuit Assembly at pin 5. This pulse is always at logic 1, except for approximately 100 nanoseconds at the end of the eight pulse delay. At that time it is logic 0. Since U2B pin 10 is at logic 1 unless that counter is being advanced, the output at pin 8 will be an inverted 1MHz pulse train with a pulse added once each second.

A3-20. The remaining counters function the same, each providing an output frequency that is a tenth of its input frequency. The 1pps output at U18B pin 6 is applied through pin 19 to the Control Circuit Assembly and to the Preset Counter Assembly. A 5pps signal at U20 pin is also applied to the Control Circuit Assembly through pin 17.

A3-21. During the time the counter is not counting, a reset pulse is applied to pins 2 and 3 on all decade counters. This resets each counter to a BDC 0. (Logic 0 at all outputs.) With normal operating conditions the count always ends at 0 when the counter stops counting. However, when an external synchronizing pulse is applied, the counter can stop anywhere during the count. In this case, the reset pulse ensures the count returns to 0 before counting is resumed.

A3-22. ADVANCE FUNCTION. An advance pulse is received from pin C of the Control Circuit Assembly through pin 8 and is applied to the advance gate for each counter stage. These are U1B pin 4, U4B pin 1, U6B pin 9, U11A pin 12, U14B pin 4, U15C pin 1, and U17B pin 5. Refer to figure A3-4 for timing diagram of the advance function.

A3-23. Front panel INCREMENT selector S1 determines which counter stage will be advanced by applying a logic 1 to the gate for that stage. For example, if the INCREMENT selector is in the .1 MICROSECONDS position, a logic 1 is applied to U1B pin 5. (The logic 1 applied to U1C pin 2 and U3 pin 6 are for the retard function, refer to paragraph A3-24.) The advance pulse is always applied just after the reset pulse, during the time the counter is not counting. When the advance pulse goes to logic 1, it causes a logic 0 at U1B pin 6, which is

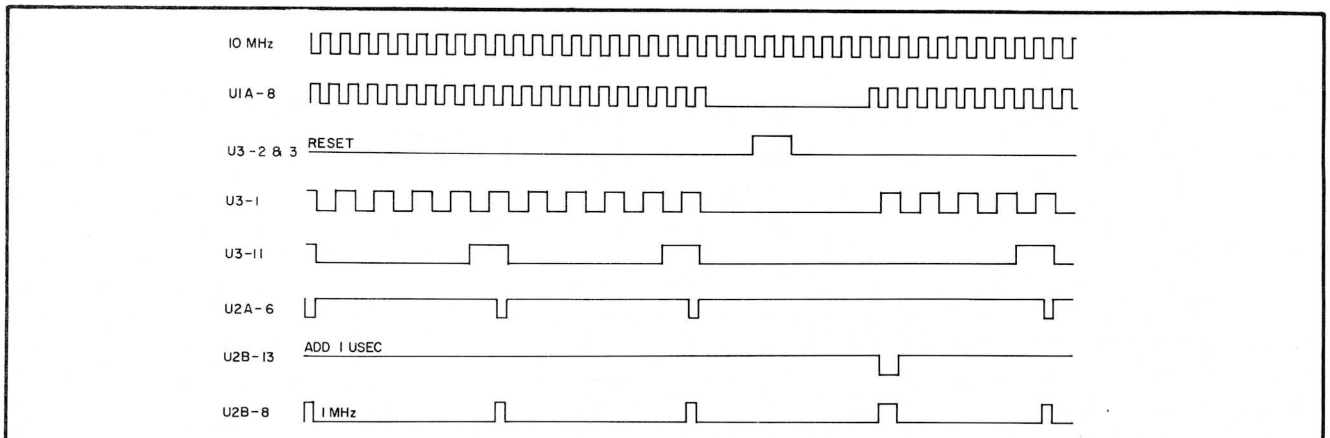


Figure A3-3. Main Counter Timing Diagram. A6-106-542

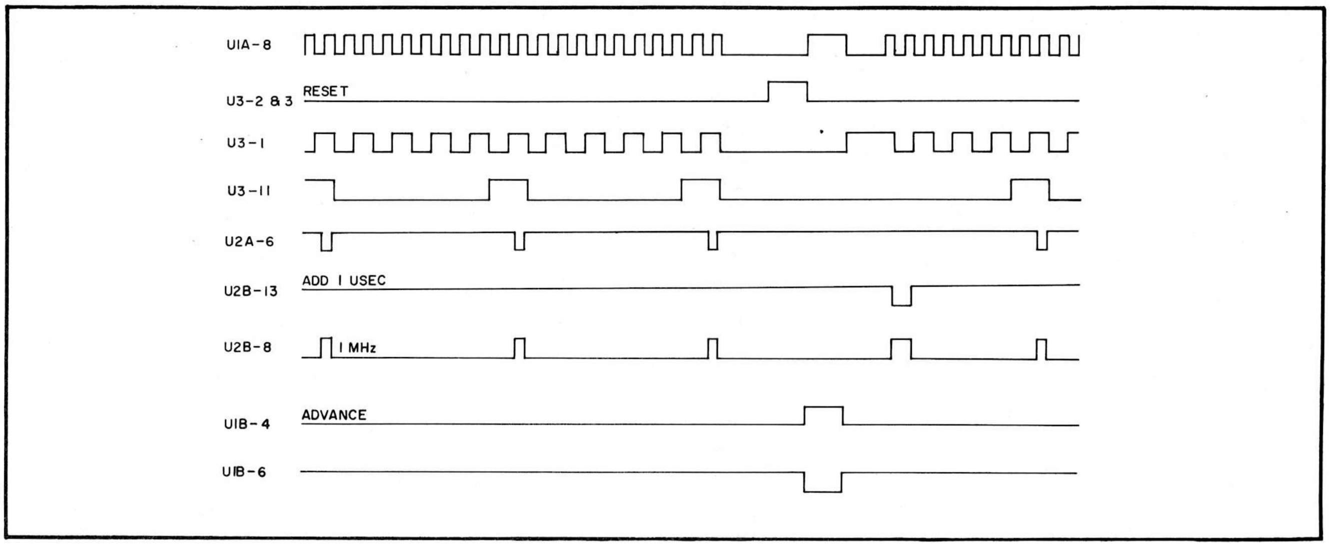


Figure A3-4. Main Counter Advance Timing Diagram. A6-106-541

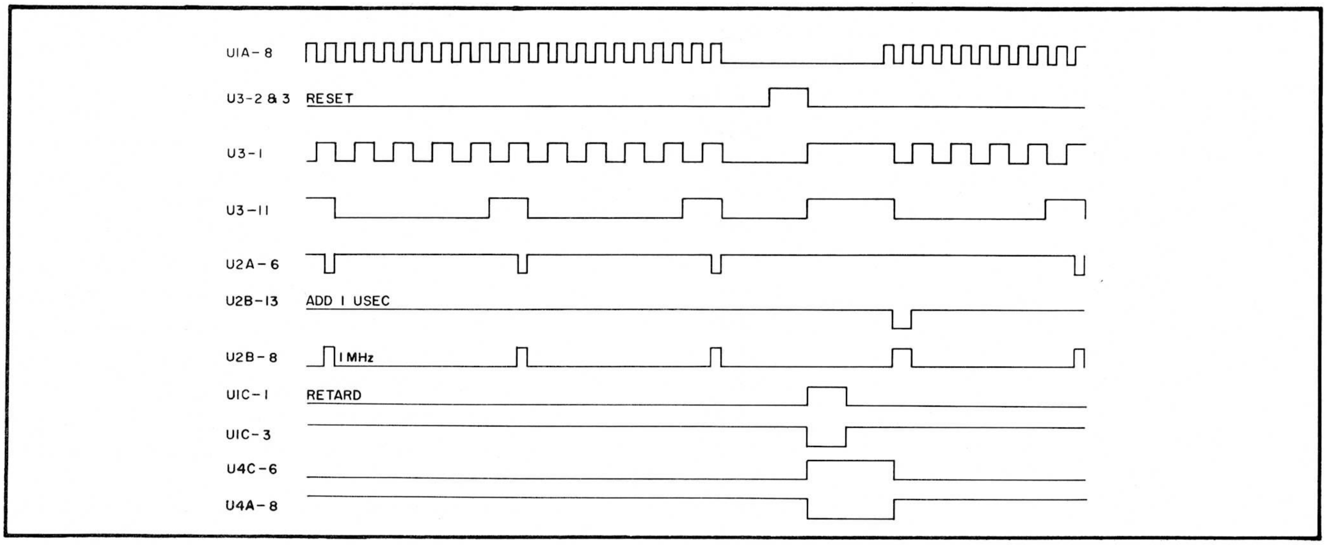


Figure A3-5. Main Counter Retard Timing Diagram. A6-106-540

applied to U1A pin 10. Since the 10MHz input at pin 9 is being held at logic 1, the logic 0 at pin 10 will cause a logic 1 at pin 8. When the advance pulse returns to logic 0, the output of U1A pin 8 returns to logic 0. This then applies one additional pulse to the counter, advancing it by one count, or 0.1 microsecond (100 nanoseconds).

A3-24. RETARD FUNCTION. A retard pulse is received from pin B of the Control Circuit Assembly through pin 7 and is applied to the retard gate and counter for each counter stage. These are U1C pin 1, U4D pin 13, U6D pin 13, U11C pin 9, U14C pin 9, U15D pin 12, U17D pin 1, and pin 7 on all decade counters. Refer to figure A3-5 for a timing diagram of the retard function.

A3-25. Front panel INCREMENT selector S1 determines which counter stage will be retarded by applying logic 1 to the gate and counter for that stage. For example, if the INCREMENT selector is in the .1 MICROSECONDS position, a logic 1 is applied to U1C pin 2 and U3 pin 6. (The logic 1 applied to U1B pin 5 is for the advance function, refer to paragraph A3-23.) The retard pulse is always applied just after the reset pulse, during the time the counter is not counting. When the retard pulse goes to logic 1, it causes a logic 0 at U1C pin 3 and presets U3 to a BCD 9 output (logic 1 at both U3 pins 6 and 7 provide this preset). Since the counter was at a 0 count, it has just retarded one count by returning to the 9 count. The 9 count provides a logic 1 at pins 1 and

11, which are applied to U2A pins 2 and 5, respectively. The logic 1 at pin 11 is also applied to U4A pin 9.

A3-26. The logic 0 output of U1C pin 3 applied to U4C pin 5, causes the output of U4C at pin 6 to go to logic 1. This is applied to U4A pin 10 providing a logic 0 at pin 8, since a logic 1 from U3 pin 11 exists at pin 9. A logic 0 is applied to U2A pin 4 and U4C pin 4. This logic 0 at pin 4 of U2A prevents the output pulse from being applied to the next counter stage. When U3 starts counting again the logic 1 outputs at pins 1 and 11 return to logic 0. At this time an output pulse from U2A would normally be provided. The logic 0 at pin 4, however, prevents this, since this is not the normal 0 count. When U3 pin 11 goes to logic 0, U4A and U4C return to their original states, applying a logic 1 to U2A pin 4. This allows the normal output pulses to be applied to the next counter stage.

A3-27. OUTPUT AMPLIFIER ASSEMBLY A2.

A3-28. The Output Amplifier Assembly provides amplification and buffering for the front and rear panel 1pps and 1pps delayed outputs. Since the circuit for the 1pps delayed outputs is the same as for the 1pps outputs, only the circuit for the 1pps outputs will be discussed. The 1pps amplifier circuit consists of a one-shot circuit and a buffer amplifier for each of the two outputs. Refer to figure A3-6 for a block diagram of the Output Amplifier Assembly and to figure A6-3 for a schematic diagram.

A3-29. ONE-SHOT CIRCUIT. The 1pps signal from the main counter assembly pin 19 is applied through J1 to the differentiator, C6 and R13. The positive spike output, at the leading edge of the input pulse, is applied to the base of Q5, turning it on. This turns on Q6, providing an output at the collector. This output is applied to the buffer amplifiers and through C8 and R17 back to the base of Q5. This feedback keeps Q5 conducting until C8 is charged, as determined by the time constant C8 and R17. At that time Q5 and Q6 turn off. This provides a 1pps output pulse of approximately 20μsec length.

A3-30. BUFFER AMPLIFIERS. Transistors Q7 and Q8, both in the emitter follower configuration provide buffering for the output 1pps pulse. Zener diodes CR3 and CR4 ensure that the output voltage never rises above 20 volts DC. The output at the emitter of Q7 is applied through J2 to provide the 1pps front panel output and the output at the emitter of Q8 is applied through J3 to provide the 1pps rear panel output.

A3-31. The 1pps delayed input is received from the Preset Counter Assembly pin A and is applied through J4. The front panel output is routed through J5 and the rear panel output through J6.

A3-32. CONTROL CIRCUIT ASSEMBLY A3.

A3-33. The Control Circuit Assembly is the central control point for the 1pps pulses. It generates a 10MHz pulse train for the main and preset counters, synchronizes the 1pps signal to an external pulse, generates the clock drive pulses (with fast drive and hold functions) from the 1pps signal, generates advance and retard pulses, and generates the 800 nanosecond delay and 1 microsecond advance signals. It consists of a 10MHz pulse input circuit, 800 nanosecond hold circuit, 800 nanosecond counter, 1pps input circuit, external sync circuit, fast clock drive input circuit, clock drive circuits, add 1 microsecond circuit, reset circuit, advance circuit, and retard circuit.

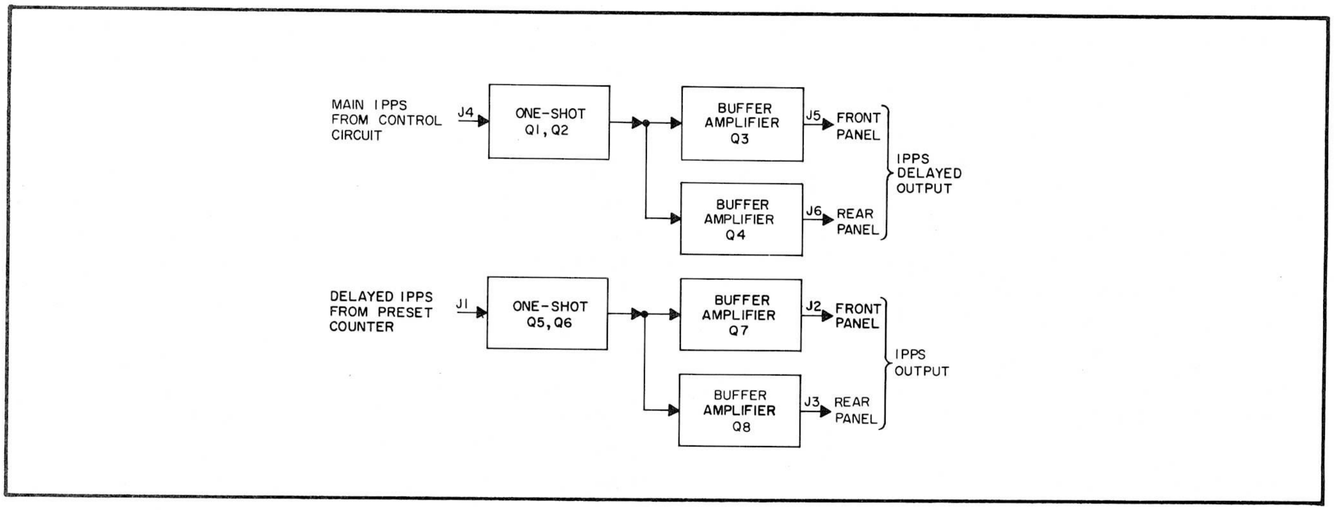


Figure A3-6. Output Amplifier Assembly Block Diagram. A6-106-539

Refer to figure A3-7 for a block diagram of the control circuit assembly and to figure A6-4 for a schematic diagram.

A3-34. 10MHz PULSE INPUT CIRCUIT. The 10MHz input circuit converts the 5MHz sinewave input to a 10MHz pulse. The 5MHz sinewave from Distribution Amplifier Assembly J4 is applied through pin 2 to the gate of FET Q1. FET Q1 amplifies the 5MHz signal and applies it to common emitter amplifier Q2. The output of Q2 is applied to the primary of T1. Two signals, 180 degrees out-of-phase, appear at the center-tapped secondary of T1. Capacitor C6 is adjusted for a maximum 5MHz output from T1. One 5MHz output is applied to the base of Q3 and the other to the base of Q4. These two transistors conduct alternately, each at a 5MHz rate. This provides a 10MHz signal at the junction of the collectors of Q3 and Q4.

A3-35. Transformer T2 reshapes current pulse from Q3 and Q4 into a sinewave at the base of Q5. Capacitor C10 is adjusted for a maximum 10MHz output from the secondary of T2. Transistor Q5 shapes the 10MHz signal into a 10MHz pulse with an amplitude of approximately 5 volts. This is applied to U1C pins 9 and 10, providing an inverted 10MHz pulse at pin 8. The 10MHz pulse is applied through pin D to the Preset Counter Assembly and to U1B pin 4 and U1A pin 2 in the 800 nanosecond hold circuit. Refer to figure A3-8 for a timing diagram of the Control Circuit Assembly.

A3-36. 1PPS INPUT CIRCUIT. The 1pps input circuit is a one-shot circuit that provides an output pulse for each

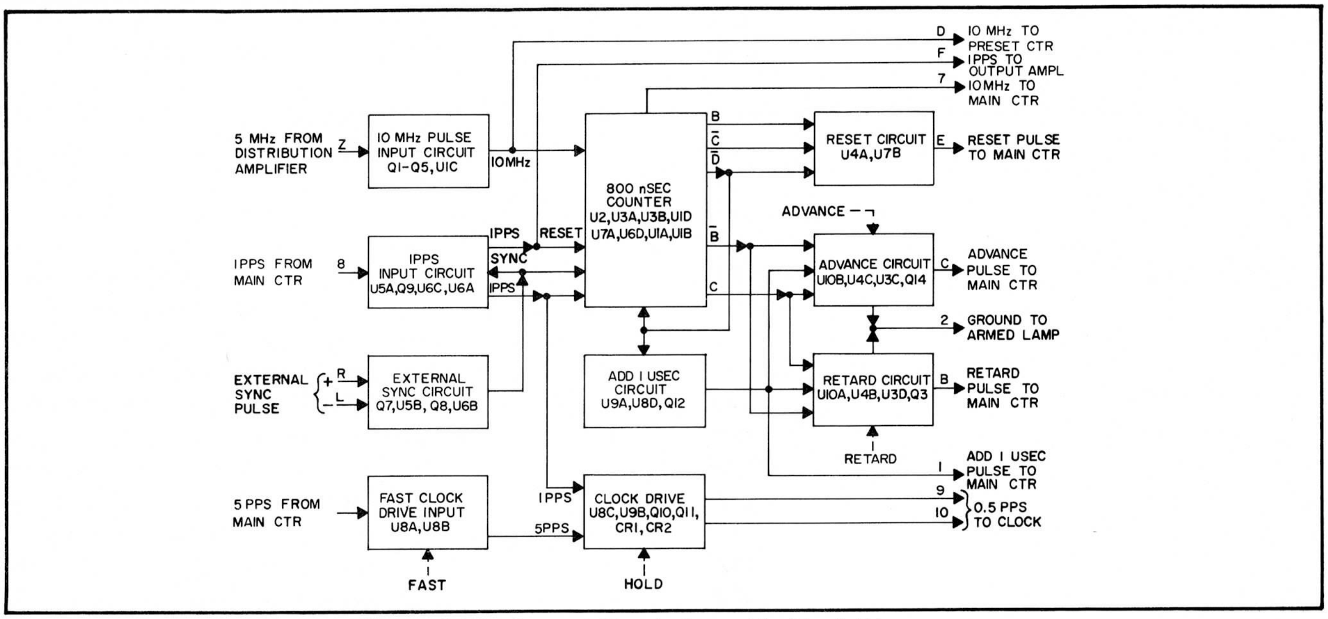


Figure A3-7. Control Circuit Assembly Block Diagram. A6-106-538

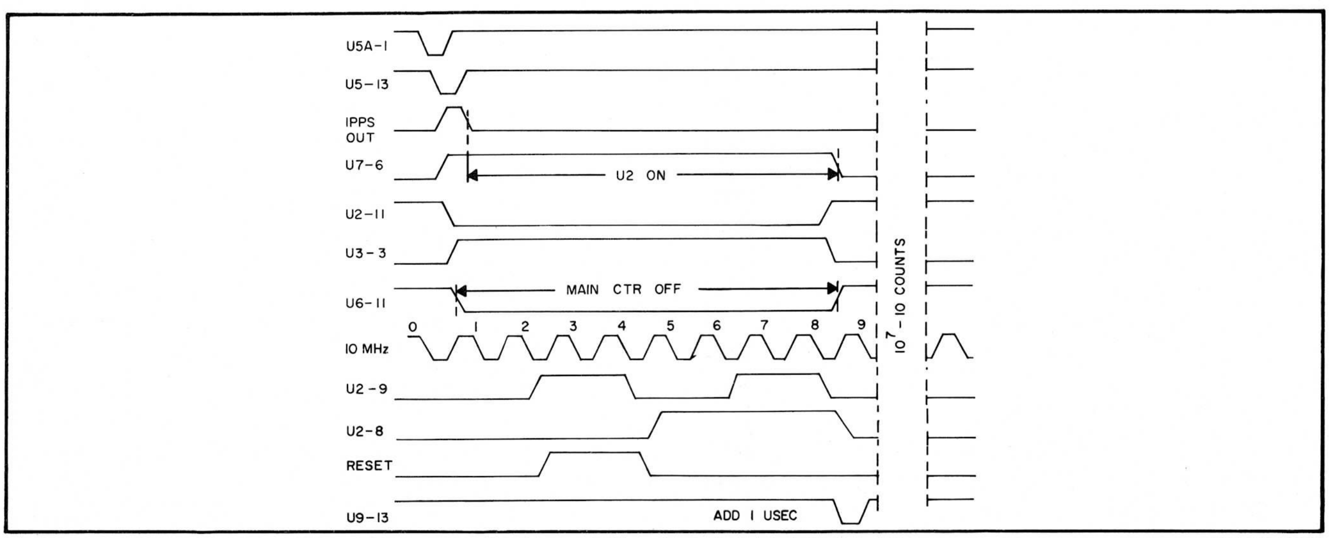


Figure A3-8. Control Circuit Assembly Timing Diagram. A6-106-537 input pulse. It consists of U5A, U6C, U6A, and Q9. The 1pps input from Main Counter Assembly pin 19 is applied through pin 8 to J-K flip-flop U5A pin 1 as the clock input. The J input, pin 14, is connected to 5 volts (logic 1) and the K input, pin 3, is connected to ground (logic 0).

A3-37. When the 1pps pulse goes to logic 0, the $\bar{Q}$ output at pin 13 goes to logic 0, which is applied to the base of Q9. This turns Q9 off, applying 5 volts through R26 to U6C pins 9 and 10. The logic 1 at pin 8 goes to logic 0 and is applied to U5A pin 2 to clear the flip-flop. The $\bar{Q}$ output then goes to logic 1, turning Q9 on, applying a logic 0 to U6C pins 9 and 10, which applies a logic 1 to U5A pin 2. This pulse output at pin 13 is applied to U6A pin 2, U7A pin 2 in the 800 nanosecond hold circuit, and U8C pin 10 in the clock drive circuit. When the next 1pps pulse goes to logic 0, the cycle is repeated. This provides a 1pps logic 0 pulse that is much shorter than the 1pps input pulse.

A3-38. The logic 0 applied to U6A pin 2 provides an inverted output at pin 3 as long as pin 1 is at logic 1. The input to pin 1 is the sync input and will be at logic 1 as long as an external sync pulse is not applied (refer to paragraph A3-55). This output is a 1pps logic 1 pulse that is applied to U2 pins 2 and 3 as a reset zero pulse and through pin F to the Output Amplifier Assembly.

A3-39. 800 NANOSECOND COUNTER. The 800 nanosecond counter holds the 10MHz pulse being applied to the main counter at a logic 1, counts eight 10MHz pulses (800 nanoseconds), and reapplies the 10MHz pulse to the main counter. It also provides the reset pulse for the main counter and the timing pulse for the advance and retard circuits. It consists of U1A, U1B, U1D, U2, U3A, U3B, U6D, and U7A.

A3-40. The 1pps logic 1 pulse at U6A pin 3 is applied to U2 pins 2 and 3 to reset the outputs at pins 8, 9, and 11 to logic 0. At the same time, the logic 0 pulse from U5A pin 13 is applied to U7A pin 1. The input to pin 2 is the sync input and will be at logic 1 as long as an external sync pulse is not applied (refer to paragraph A3-55). Since pins 4 and 5 are also at logic 1, the output at pin 6 will go to logic 1 when the logic 0 pulse is applied to pin 1. This logic 1 output is applied to U1A pin 1 and U6D pin 13. With a logic 1 at pin 1, U1A gates the 10MHz pulse at pin 2 and provides an inverted 10MHz pulse at pin 3. This is applied to U2 pin 14, starting the count. The logic 1 applied to U6D pin 13 provides a logic 0 output at pin 11 since there is a logic 1 at pin 12. This logic 0 is applied to U7A pins 4 and 5, keeping the output at logic 1 when the 1pps pulse at pin 1 returns to logic 1; and to U1B pin 5, providing a constant logic 1 output instead of the normal 10MHz output.

A3-41. Decade counter U2 provides a BCD output at pins 8, 9, and 11. The B output, pin 9, which is logic 0 for two input pulses and logic 1 for two input pulses, is applied to U4A pin 5 in the reset circuit and inverted by U1D and applied to U4C pin 2 in the advance circuit. The C output, pin 8, which is logic 0 for four input pulses and logic 1 for four input pulses, is applied to U4B pin 10 in the retard circuit, U4C pin 1 in the advance circuit, and inverted by U3B and applied to U4A pin 3 in the reset circuit. The D output, pin 11, which is logic 0 for eight pulses and logic 1 for two pulses, is inverted by U3A and applied to U4A pin 4 in the reset circuit, U9A pin 1 in the add 1 microsecond circuit, and U6D pin 12. When the eighth input pulse goes to logic 0, the logic 1 at U3A pin 3 goes to logic 0. This causes the logic 0 at U6D pin 11 to got to logic 1, reapplying the 10MHz pulse to the Main Counter Assembly, and causes the logic 1 at U7A pin 6 to go to logic 0, stopping the decade counter at the count of eight. This completes the cycle of the 800 nanosecond counter, which is repeated every time the 1pps pulse is applied.

A3-42. RESET CIRCUIT. The reset circuit generates a reset pulse once each second to reset the counters in the Main Counter Assembly. It consists of U4A and U7B. The three inputs to U4A are received from U2 pin 9, U3B pin 6, and U3A pin 3. These are the B, C, and D, pulses. Since U7B inverts the output of U4A, the output of U7B at pin 8 will only be logic 1 when pins 3, 4, and 5 of U4A are all logic 1. This occurs when the second input to U2 goes to logic 0 and remains until the fourth pulse goes to logic 0. This provides a 200 nanosecond reset pulse 200 nanoseconds after the decade counter begins counting. This pulse is applied to Main Counter Assembly A1 through pin E.

A3-43. ADD 1 MICROSECOND CIRCUIT. The add 1 microsecond circuit generates a pulse once each second that is applied to the main counter to add 1 microsecond to the count. This offsets the 200 nanosecond delay in the main counter and the delay of the 800 nanosecond counter. It consists of U9A, U8D, and Q12.

A3-44. The logic 1 pulse from U3A pin 3 is applied to U9A pin 1. This circuit operates the same as the 1pps input circuit discussed in paragraph A3-36. The output at pin 13 is a logic 0 pulse that occurs once each second, when the decade counter stops counting. This pulse is applied through pin 1 to the Main Counter Assembly and to U10A pin 1 and U10B pin 5 in the retard and advance circuits.

A3-45. ADVANCE CIRCUIT. The advance circuit generates a pulse to advance the count in the main counter by one increment as selected by the INCREMENT SELECTOR switch. When the ADVANCE and ENABLE pushbuttons are both depressed, the clear input of U10B at pin 6 becomes a logic 0 since it is grounded through the two switches. This forces the $\bar{Q}$ output at pin 8 to be logic 1. As long as the buttons are depressed, pin 8 will be a logic 1 regardless of the state of the clock input at pin 5, and the output of U3 will be clamped at a logic 0 by CR3.

A3-46. When one or both of the buttons are released U10B will remain in its $\bar{Q}$ equals 1 state and the output of U3C will be unclamped.

A3-47. The logic at pin 8 turns on Q14 through R38, lighting the ARMED lamp. It also puts a logic 1 at pin 13 of U4C. The other two inputs to U4C are received from U1D pin 11 and U2 pin 8. Since U3C inverts the output of U4C, the output of U3C at pin 8 will only be logic 1 when all three inputs are at logic 1. This occurs only after the ADVANCE and ENABLE pushbuttons are pressed and released, and for 200 nanoseconds, beginning 400 nanoseconds after the decade counter begins counting. This 200 nanosecond pulse is applied through pin C to the Main Counter Assembly. At the end of the count for the decade counter the add 1 microsecond pulse is applied to U10B pin 5. This clocks the J-K flip-flop, causing the $\bar{Q}$ output at pin 8 to go to logic 0, removing the voltage from the base of Q14, turning off the ARMED lamp.

A3-48. No matter when the pushbuttons are pressed and released, the main counter will always be advanced at exactly the same time during the count. An advance pulse can only be applied once each second. The retard pulse output at U3D pin 11 is applied through pin B to the main counter.

A3-49. RETARD CIRCUIT. The retard circuit functions in much the same way as the advance circuit except the pushbutton connects to one of the inputs of U4B instead of diode clamping the output. The other two inputs of U4B are connected to the $\bar{Q}$ output, pin 13, of U10A and to pin 8 of U2. When the RETARD and ENABLE buttons are depressed, U10A pin 13 becomes a logic 1, turning on Q13 and thus the ARMED lamp. As long as the buttons are held, pin 9 of U4B inhibits the gating of U4B. After it is released, pin 8 of U4B will become a logic 0 for 400 nsec, beginning 400 nsec after U2 begins counting. U3D inverts this signal and delivers a retard pulse at pin B to the main counter.

A3-50. CLOCK DRIVE CIRCUIT. The clock drive circuit generates the two alternate pulses that drive the front panel clock. It consists of U8C, U9B, Q10, Q11, CR1, and CR2. The 1pps output of U5A pin 13 is applied to U8C pin 10. Pin 9 of U8C is always at logic 1 unless the clock is being driven at the fast rate (refer to paragraph A3-53). This provides an inverted 1pps pulse at pin 8 that is applied as the clock input to U9B at pin 5. The J and K inputs at pins 7 and 10, respectively, are at logic 1 unless the HOLD and ENABLE pushbuttons are pressed. With both J and K inputs at logic 1, the Q and $\bar{Q}$ outputs at pins 9 and 8, respectively, will change state every time a clock pulse is applied.

A3-51. Assume the Q output is at logic 1 and the $\bar{Q}$ output at logic 0. The first clock pulse will change the Q output to logic 0 and the $\bar{Q}$ output to logic 1. The Q output is applied to the base of Q10 and the $\bar{Q}$ output to the base of Q11. This causes Q10 to stop conducting and causes Q11 to start conducting. The next 1pps pulse input changes the Q output to logic 1 and the $\bar{Q}$ output to logic 0, turning Q10 on and Q11 off. This means the Q10 and are alternately conducting, each for a one second period. When Q10 turns off, the voltage at the collector is applied to one of the two coils in the front panel clock, advancing it one second. The next second, Q11 turns off, applying the voltage at the collector to the other clock coil, again advancing it one second.

A3-52. To stop the clock during adjustment, the HOLD and ENABLE pushbuttons are pressed. This applies a ground to the J and K inputs of U9B. When a logic 0 is applied to both J and K inputs, the Q and $\bar{Q}$ outputs will not change state. Therefore, the clock will not advance each second.

A3-53. FAST CLOCK DRIVE CIRCUIT. The fast clock drive circuit drives the clock at five times the normal rate. This is used when setting the clock. It consists of U8A and U8B. When the ENABLE pushbutton and FAST pushbuttons are pressed, the voltage at U8A pins 1 and 2 is grounded through the pushbuttons. This provides a logic 1 at pin 3 that is applied to U8B pin 4. This logic 1 gates the 5pps pulse at pin 5 and provides an inverted 5pps pulse at pin 6. The 5pps pulse is received from Main Counter Assembly pin 17 and is applied through pin 1. Since the 1pps pulse at U8C pin 10 is logic 1, except when the logic 0 pulse is applied, the 5pps pulse will be gated through U8C, providing an inverted 5pps pulse at pin 8. This 5pps pulse causes the outputs of U9B to change state five times faster than normal, causing the clock to advance five times faster.

A3-54. SYNC ENABLE CIRCUIT. The sync enable circuit allows the 1pps pulse to be synchronized to an external pulse. It consists of transistor Q6. When the ENABLE pushbutton is pressed, a ground is applied to the base of Q6. This turns Q6 off, applying a logic 1 to the base of Q8. This logic 1, allows Q8 to saturate, causing a logic 1 at pin 6 of U5B. The sync pulse can now clock the flip-flop. When the pushbutton is not pressed, Q6 is conducting. This applies a logic 0 to the base of Q8, which, in conjunction with the U6B will not allow the flip-flop to be clocked by the sync pulse.

A3-55. EXTERNAL SYNC CIRCUIT. The external sync circuit provides a means of synchronizing the 1pps pulse to either a positive or negative external pulse. It consists of Q7, Q8, U5B, and U6B. A positive pulse is applied through pin L to one half of the primary of T3 or a negative pulse is applied through pin R to the other half of the primary of T3. This always provides a positive pulse at the base of Q7. When a positive pulse is applied to the base of Q7, it conducts, causing the voltage applied to U5B pin 5 to go to logic 0. Provided the enable circuit is applying a logic 1 to U5B pin 6, the $\bar{Q}$ output will go to logic 0 for approximately 100 nanoseconds and then return to logic 1 due to the clear pulse applied at pin 6 from Q8 and U6B. This logic 0 pulse is applied to U7A pin 2 and U6A pin 1. This has the same effect as applying a 1pps pulse by starting the 800 nanosecond counter and thereby resetting the main counter to a zero count. The next 1pps pulse from the main counter will be one second after the sync pulse was applied. This synchronizes the 1pps pulse to an external pulse.

A3-56. PRESET COUNTER ASSEMBLY A4.

A3-57. The Preset Counter Assembly generates a 1pps output from a 10MHz pulse input that is delayed from the main 1pps output by an amount determined by the setting of the MICROSECONDS thumbwheel switches. It consists of an input pulse circuit, seven decade counters with associated front-panel thumbwheel switches, output pulse gate, clear circuit, and preset circuit. Refer to figure A3-9 for a block diagram of the Preset Counter Assembly and to figure A6-5 for a schematic diagram.

A3-58. INPUT PULSE CIRCUIT. The input pulse circuit provides a burst of 10MHz pulses, once each second, to clock the decade counters. The exact number of pulses applied is determined by the settings of the MICRO-SECONDS DELAY thumbwheel switches. It consists of U11A, U11B, U11C, and U11D.

A3-59. The 10MHz input pulse from Control Circuit Assembly pin D is applied through pin 22 to U11A pin 12. The 1pps input pulse from Main Counter Assembly pin 19 is applied through pin 21 to U11B pin 1. When the 1pps logic 0 pulse is applied, U11B pin 3 goes to logic 1, which is applied to U1 pin 11, U11A pin 13, and U11C pin 5. The logic 1 at U11C pin 5 provides a logic 0 output at pin 6, which is applied to U11B pin 2 to maintain a logic 1 output at pin 3 when the 1pps logic 0 pulse goes to logic 1. The logic 1 applied to U1 pin 11 enables the output pulse gate. With a logic 1 at U11A pin 13, the 10MHz pulse is gated through, providing an inverted 10MHz pulse at pin 11. This is applied to the first decade counter, U4 pin 8, as the clock input.

A3-60. When the counters have counted the specified number of input pulses U12B pin 6 goes to logic 0,

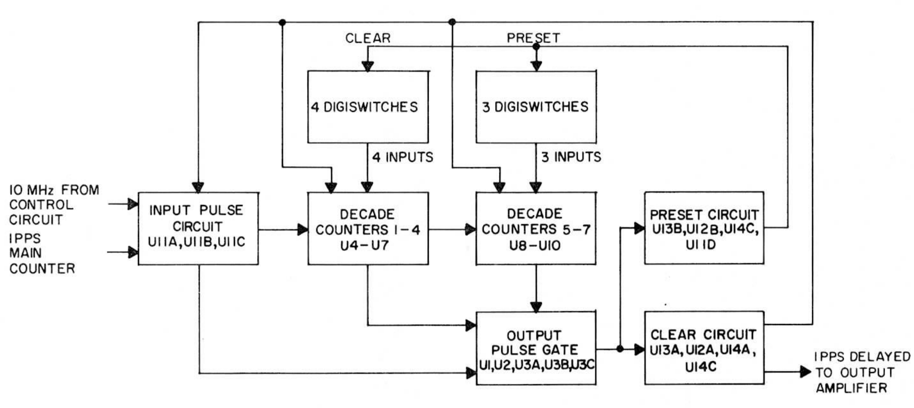


Figure A3-9. Preset Counter Assembly Block Diagram.

A6-106-536

causing U11C pin 4 to be at logic 0. The output of U11C at pin 6 goes to logic 1, and along with the logic 1 at U11B pin 1 provides a logic 0 output at U11B pin 3. This is applied to U11C pin 5, to maintain a logic 1 output when the logic 0 clear pulse at U11C pin 4 goes to logic 1, to U11A pin 13 to stop the count by providing a constant logic 1 output, and to U1 pin 11 to disable the output pulse gate.

A3-61. DECADE COUNTERS. The decade counters have BCD outputs and together form a ripple counter. They consist of U4 through U10 with a separate thumbwheel switch for each counter. The counters count from 0 to 9 with the Q4 output of each counter being used as the clock input for the next counter. The thumbwheel switches provide a preset to each counter that is the nine's complement of the switch position. For example, if a switch is set to 8, the BCD preset applied to that counter would be 1. This means that instead of beginning the count at zero, the count begins at one, requiring only eight input pulses to reach the output count of nine (pins 5 and 12 both at logic 1).

A3-62. If the counters did not have preset, they would provide an output pulse only after counting 9,999,999 pulses of the 10MHz clock pulse. (All outputs are at logic 1 at this time providing a pulse output from the output pulse gate.) This means the output pulse would be delayed from the input pulse by approximately one second. This is equivalent to setting the switches to 999,999.9 microseconds, which provides a zero preset to each counter.

A3-63. Assume that the thumbwheel switches were set to 000007.6 microseconds. Decade counter U4 will be preset to the nine's complement of 6, or 3(0011 in BCD) and decade counter U5 will be preset to nine's complement of 7, or 2(0010 in BCD). The remaining decade counters will be preset to the nine's complement of 0, or 9(1001 in BCD). This means that the count begins at 9,999,923 and that 76 of the 10MHz pulses will be required to reach 9,999,999 at which time logic 1's are provided at all outputs, providing one output pulse. This output pulse will be delayed from the 1pps input pulse, which started the count, by 76 10MHz pulses. Since the cycle time of a 10MHz pulse is 100 nanoseconds, the delay will be 7,600 nanoseconds or 7.6 microseconds, thus providing the desired delay set in on the switches.

A3-64. OUTPUT PULSE GATE. The output pulse gate provides a logic 0 output pulse whenever all inputs (15) are simultaneously at logic 1. It consists of U1, U2, U3A, U3B, and U3C. The logic 1 from U11B pin 3 is applied to U1 pin 11 when the 1pps input pulse goes to logic 0, enabling the gate. The output of U1 and U2 at pin 8 will always be logic 1, unless all inputs are logic 1. All inputs are logic 1 only when each counter is at the count of nine. At this time, the logic 1 at U1 and U2 pin 8 goes to logic 0. These two logic 0's are inverted by U3A and U3B, respectively, and applied as logic 1's to U3C. This provides a logic 0 output at U3C pin 6, that is applied to the clear and preset circuits. The clear circuit returns all inputs to U1 and U2 to logic 0, causing the logic 0 output at U3C pin 6 to return to logic 1.

A3-65. CLEAR CIRCUIT. The clear circuit generates a clear pulse to clear the decade counters and inhibit the 10MHz input. It also generates the 1pps delayed output pulse. It consists of U13B, Q2, U14C, U11D, and U12B. The logic 0 pulse from the output pulse gate is applied to U13B pin 1 as the clock pulse. This causes the Q output at pin 12 to go to logic 1 and the $\bar{Q}$ output at pin 13 to go to logic 0. The logic 0 output is applied through the delay line, consisting of Q2 and U14C, to the clear input at pin 2. This causes the Q output to return to logic 0 and the $\bar{Q}$ output to logic 1. The logic 1 pulse at pin 12 is applied through inverter U12B to the clear input (pin 13) of each decade counter except U4 to reset all outputs to zero. It is also applied to U11D pins 9 and 10 in the input pulse circuit. The output of U11D clears U4 and inhibits the 10MHz pulse, stopping the count.

A3-66. PRESET CIRCUIT. The preset circuit generates a preset pulse that is applied to the strobe input of the decade counters. It consists of U13A, Q1, U14A, U12A, and U14D. The logic 0 pulse from the output pulse gate is applied to U13A pin 5 as the clock pulse. This circuit operates the same as the clear circuit, except that the logic 1 pulse output at pin 9 is longer than the output pulse of U13B pin 12. This logic 1 pulse is inverted by U12A and applied to the seven strobe inputs of U4 through U10. The thumbwheel switches provide +5 volts (logic 1) at the appropriate preset inputs of the decade counters. Pull down resistors provide logic 0 if no connection is made. The logic 0 pulse at pin 13 is applied through inverter U14C and pin A to the Output Amplifier Assembly as the 1pps delayed pulse.

SECTION AIV
MAINTENANCE

A4-1. The clock option does not require periodic maintenance.

SECTION AV
REPLACEABLE PARTS

A5-1. **INTRODUCTION.**

A5-2. This section provides a list of replaceable parts for the clock option, presented in table A5-1. Information concerning the use of this table and parts ordering information is contained in Section VI.

TABLE A5-1. LIST OF REPLACEABLE PARTS

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
* * * * ASSEMBLY NO G35276-0001 PANEL ASSY CLOCK * * * *				
P 9	23969-0355	PLUG	81312	SM-3P
* * * * ASSEMBLY NO G35289-0001 HARNESS ASSY * * * *				
J 7	23969-0035	CONNECTOR	98291	51-043-0000
J 8	23969-0029	CONNECTOR	81312	SRE7PJ
J 9	23969-0032	CONNECTOR	81312	SM3SN
XA 1	3628-0022	CONNECTOR PCB 22 PIN	71785	50-22A-20
XA 3	3628-0122	CONNECTOR PCB 22 PIN	71785	251-22-30-160
XA 4	3628-0022	CONNECTOR PCB 22 PIN	71785	50-22A-20
R 7	211-3923	RES FXD FILM 392K	81349	RN55D3923F (MIL-R-10509/7)
U 1	23969-0002	AMPLIFIER	07263	U5B7741312
* * * * ASSEMBLY NO G45027-0001 COMP BRD ASSY COUNTER * * * *				
C 1	8914-0100	CAP FXD TA 10 MFD	01295	CS13BE106K (MIL-C-26655/2)
C 2	3403-9253	CAP FXD CER .025 UF	80183	TG-S25
L 1	23969-0024	CHOKE 39 MH	76493	9340-34
U 1	23408-0001	IC SN7400N	01295	SN7400N
U 2	23412-0001	IC SN7420N	01295	SN7420N
U 3	3938-0015	IC SN7490N	01295	SN7490N
U 4	23408-0001	IC SN7400N	01295	SN7400N
U 5	3938-0015	IC SN7490N	01295	SN7490N
U 6	23408-0001	IC SN7400N	01295	SN7400N
U 7	23412-0001	IC SN7420N	01295	SN7420N
U 8	23408-0001	IC SN7400N	01295	SN7400N
U 9	3938-0015	IC SN7490N	01295	SN7490N
U 10	3938-0015	IC SN7490N	01295	SN7490N
U 11	23408-0001	IC SN7400N	01295	SN7400N
U 12	23412-0001	IC SN7420N	01295	SN7420N
U 13	3938-0015	IC SN7490N	01295	SN7490N
U 14	23408-0001	IC SN7400N	01295	SN7400N
U 15	23408-0001	IC SN7400N	01295	SN7400N
U 16	3938-0015	IC SN7490N	01295	SN7490N
U 17	23408-0001	IC SN7400N	01295	SN7400N
U 18	23412-0001	IC SN7420N	01295	SN7420N
U 19	23408-0001	IC SN7400N	01295	SN7400N
U 20	3938-0015	IC SN7490N	01295	SN7490N
* * * * ASSEMBLY NO G45042-0001 COMP BRD ASSY CONTROL * * * *				
A 3	23408-0001	IC SN7400N	01295	SN7400N
A 6	23408-0001	IC SN7400N	01295	SN7400N
A 8	23408-0001	IC SN7400N	01295	SN7400N
A 9	23425-0001	IC SN7473N	01295	SN7473N
A 10	23425-0001	IC SN7473N	01295	SN7473N
C 1	3403-9253	CAP FXD CER .025 UF	80183	TG-S25
C 2	21485-9101	CAP FXD TA 1 MFD	05397	CS13BF105K (MIL-C-26655/2)
C 3	27512-0101	CAP FXD MICA 100 PFD	00853	CM05F101G03 (MIL-C-5/18)
C 4	3403-9253	CAP FXD CER .025 UF	80183	TG-S25
C 5	27512-0560	CAP FXD MICA 56 PFD	00853	CM05E560G03 (MIL-C-5/18)
C 6	3923-0029	CAP VAR CER MINAT	73899	DV11PS25B
C 7	21485-9101	CAP FXD TA 1 MFD	05397	CS13BF105K (MIL-C-26655/2)
C 8	3403-9253	CAP FXD CER .025 UF	80183	TG-S25
C 9	27512-0180	CAP FXD MICA 18 PFD	00853	CM05C180K03 (MIL-C-5/18)
C 10	3923-0029	CAP VAR CER MINAT	73899	DV11PS25B
C 11	3403-9253	CAP FXD CER .025 UF	80183	TG-S25
C 12	27512-0221	CAP FXD MICA 220 PFD	00853	CM05F221G03 (MIL-C-5/18)
C 14	27512-0101	CAP FXD MICA 100 PFD	00853	CM05F101G03 (MIL-C-5/18)
C 15	27512-0101	CAP FXD MICA 100 PFD	00853	CM05F101G03 (MIL-C-5/18)
C 16	23969-0022	CAPACITOR .01 MFD	80183	C023B101F103M
C 17	21485-9101	CAP FXD TA 1 MFD	05397	CS13BF105K (MIL-C-26655/2)
C 18	27512-0101	CAP FXD MICA 100 PFD	00853	CM05F101G03 (MIL-C-5/18)
C 21	8914-0100	CAP FXD TA 10 MFD	01295	CS13BE106K (MIL-C-26655/2)
C 22	3403-9253	CAP FXD CER .025 UF	80183	TG-S25
C 23	3403-9503	CAP FXD CER .05 UF	80183	TG-S50
L 1	23969-0024	CHOKE 39 MH	76493	9340-34
Q 1	900-3819	TSTR 2N3819	01295	2N3819
Q 2	900-2221	TSTR 2N2221	04713	2N2221
Q 3	900-2221	TSTR 2N2221	04713	2N2221
Q 4	900-2221	TSTR 2N2221	04713	2N2221

TABLE A5-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
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 8	900-3646	TSTR SPECIAL	19397	900-3646
Q 9	900-3646	TSTR SPECIAL	19397	900-3646
Q 10	900-3904	TSTR 2N3904	04713	2N3904
Q 11	900-3904	TSTR 2N3904	04713	2N3904
Q 12	900-3904	TSTR 2N3904	04713	2N3904
Q 13	900-3904	TSTR 2N3904	04713	2N3904
Q 14	900-3904	TSTR 2N3904	04713	2N3904
R 1	204-0105	RES FXD COMP 1.00 MEG	81349	RC07GF105J (MIL-R-11/8)
R 2	204-0105	RES FXD COMP 1.00 MEG	81349	RC07GF105J (MIL-R-11/8)
R 3	204-0472	RES FXD COMP 4.70 K	81349	RC07GF472J (MIL-R-11/8)
R 4	204-0221	RES FXD COMP 220. OHM	81349	RC07GF221J (MIL-R-11/8)
R 5	204-0104	RES FXD COMP 100. K	81349	RC07GF104J (MIL-R-11/8)
R 6	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 7	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 8	204-0470	RES FXD COMP 47.0 OHM	81349	RC07GF470J (MIL-R-11/8)
R 9	204-0472	RES FXD COMP 4.70 K	81349	RC07GF472J (MIL-R-11/8)
R 10	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 11	204-0221	RES FXD COMP 220. OHM	81349	RC07GF221J (MIL-R-11/8)
R 12	204-0221	RES FXD COMP 220. OHM	81349	RC07GF221J (MIL-R-11/8)
R 13	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 14	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 15	204-0221	RES FXD COMP 220. OHM	81349	RC07GF221J (MIL-R-11/8)
R 16	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 17	204-0151	RES FXD COMP 150. OHM	81349	RC07GF151J (MIL-R-11/8)
R 19	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 20	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 21	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 22	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 23	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 24	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 25	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 26	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 27	204-0151	RES FXD COMP 150. OHM	81349	RC07GF151J (MIL-R-11/8)
R 28	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 29	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 30	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 31	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 32	204-0470	RES FXD COMP 47.0 OHM	81349	RC07GF470J (MIL-R-11/8)
R 33	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 34	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 35	204-0151	RES FXD COMP 150. OHM	81349	RC07GF151J (MIL-R-11/8)
R 36	204-0151	RES FXD COMP 150. OHM	81349	RC07GF151J (MIL-R-11/8)
R 37	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 38	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 39	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 40	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
T 1	S28600-0001	TRANSFORMER 8-10A	19397	S28600-0001
T 2	S28595-0001	TRANSFORMER 8-4A	19397	S28595-0001
T 3	G25039-0001	TRANSFORMER S1-2	19397	G25039-0001
U 1	23408-0001	IC SN7400N	01295	SN7400N
U 2	3938-0015	IC SN7490N	01295	SN7490N
U 4	23530-0001	INTEGRATED CIRCUIT	01295	SN7410N
U 5	23425-0001	IC SN7473N	01295	SN7473N
U 7	23532-0001	INTEGRATED CIRCUIT	01295	SN7440N
CR 1	800-0960	DIODE 1N960	04713	1N960
CR 2	800-0960	DIODE 1N960	04713	1N960
CR 3	800-0914	DIODE 1N914	01295	1N914

* * * * ASSEMBLY NO G45047-0001 COMP BRD ASSY OUTPUT * * * *

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
C 1	27512-0470	CAP FXD MICA 47 PFD	00853	CM05E470G03 (MIL-C-5/18)
C 2	27512-0470	CAP FXD MICA 47 PFD	00853	CM05E470G03 (MIL-C-5/18)
C 3	27512-0471	CAP FXD MICA 470 PFD	00853	CM06F471G03 (MIL-C-5/18)
C 4	21485-9101	CAP FXD TA 1 MFD	05397	CS13BF105K (MIL-C-26655/2)
C 5	21485-9101	CAP FXD TA 1 MFD	05397	CS13BF105K (MIL-C-26655/2)
C 6	27512-0470	CAP FXD MICA 47 PFD	00853	CM05E470G03 (MIL-C-5/18)
C 7	27512-0470	CAP FXD MICA 47 PFD	00853	CM05E470G03 (MIL-C-5/18)
C 8	27512-0471	CAP FXD MICA 470 PFD	00853	CM06F471G03 (MIL-C-5/18)
C 9	21485-9101	CAP FXD TA 1 MFD	05397	CS13BF105K (MIL-C-26655/2)
C 10	21485-9101	CAP FXD TA 1 MFD	05397	CS13BF105K (MIL-C-26655/2)
J 1	23969-0034	CONNECTOR	98291	51-053-0119
J 2	23969-0034	CONNECTOR	98291	51-053-0119

TABLE A5-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
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
Q 1	900-3904	TSTR 2N3904	04713	2N3904
Q 2	900-3906	TSTR 2N3906	01295	2N3906
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	900-3904	TSTR 2N3904	04713	2N3904
Q 8	900-3904	TSTR 2N3904	04713	2N3904
R 1	204-0472	RES FXD COMP 4.70 K	81349	RC07GF472J (MIL-R-11/8)
R 2	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 3	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 4	204-0472	RES FXD COMP 4.70 K	81349	RC07GF472J (MIL-R-11/8)
R 5	204-0223	RES FXD COMP 22.0 K	81349	RC07GF223J (MIL-R-11/8)
R 6	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 7	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 8	204-0470	RES FXD COMP 47.0 OHM	81349	RC07GF470J (MIL-R-11/8)
R 9	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 10	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 11	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 12	204-0470	RES FXD COMP 47.0 OHM	81349	RC07GF470J (MIL-R-11/8)
R 13	204-0472	RES FXD COMP 4.70 K	81349	RC07GF472J (MIL-R-11/8)
R 14	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 15	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 16	204-0472	RES FXD COMP 4.70 K	81349	RC07GF472J (MIL-R-11/8)
R 17	204-0223	RES FXD COMP 22.0 K	81349	RC07GF223J (MIL-R-11/8)
R 18	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 19	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 20	204-0470	RES FXD COMP 47.0 OHM	81349	RC07GF470J (MIL-R-11/8)
R 21	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 22	204-0101	RES FXD COMP 100. OHM	81349	RC07GF101J (MIL-R-11/8)
R 23	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 24	204-0470	RES FXD COMP 47.0 OHM	81349	RC07GF470J (MIL-R-11/8)
CR 1	800-0968	DIODE 1N968	04713	1N968
CR 2	800-0968	DIODE 1N968	04713	1N968
CR 3	800-0968	DIODE 1N968	04713	1N968
CR 4	800-0968	DIODE 1N968	04713	1N968

* * * * ASSEMBLY NO G45064-0001 COMP BRD ASSY PRESET * * * *

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
C 1	8914-0100	CAP FXD TA 10 MFD	01295	CS13BE106K (MIL-C-26655/2)
C 2	3403-9253	CAP FXD CER .025 UF	80183	TG-S25
C 3	27513-0471	CAP FXD MICA 470 PFD	84171	DM-15-471G
C 4	27512-0101	CAP FXD MICA 100 PFD	00853	CM05F101G03 (MIL-C-5/18)
J 1	G15158-0001	CONN MODIFIED	19397	G15158-0001
J 2	G15158-0001	CONN MODIFIED	19397	G15158-0001
J 3	G15158-0001	CONN MODIFIED	19397	G15158-0001
J 4	G15158-0001	CONN MODIFIED	19397	G15158-0001
J 5	G15158-0001	CONN MODIFIED	19397	G15158-0001
J 6	G15158-0001	CONN MODIFIED	19397	G15158-0001
J 7	G15158-0001	CONN MODIFIED	19397	G15158-0001
L 1	23969-0024	CHOKE 39 MH	76493	9340-34
Q 1	900-3646	TSTR SPECIAL	19397	900-3646
Q 2	900-3646	TSTR SPECIAL	19397	900-3646
R 1	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 2	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 3	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 4	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 5	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 6	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 7	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 8	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 9	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
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	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 13	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 14	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 15	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (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	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 19	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)

TABLE A5-1. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
R 20	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 21	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 22	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 23	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 24	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 25	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 26	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 27	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (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	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
R 31	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 32	204-0471	RES FXD COMP 470. OHM	81349	RC07GF471J (MIL-R-11/8)
U 1	23531-0001	INTEGRATED CIRCUIT	01295	SN7430N
U 2	23531-0001	INTEGRATED CIRCUIT	01295	SN7430N
U 3	23408-0001	IC SN7400N	01295	SN7400N
U 4	23969-0788	COUNTER DECADE	18324	N8280A
U 5	23969-0788	COUNTER DECADE	18324	N8280A
U 6	23969-0788	COUNTER DECADE	18324	N8280A
U 7	23969-0788	COUNTER DECADE	18324	N8280A
U 8	23969-0788	COUNTER DECADE	18324	N8280A
U 9	23969-0788	COUNTER DECADE	18324	N8280A
U 10	23969-0788	COUNTER DECADE	18324	N8280A
U 11	23408-0001	IC SN7400N	01295	SN7400N
U 12	23532-0001	INTEGRATED CIRCUIT	01295	SN7440N
U 13	23425-0001	IC SN7473N	01295	SN7473N
U 14	23408-0001	IC SN7400N	01295	SN7400N
* * * * ASSEMBLY NO G45099-0001 CLOCK OPTION 341B * * * *				
	G35289-0001	HARNESS ASSY	19397	G35289-0001
	G45054-0001	CHASSIS ASSY	19397	G45054-0001
A 1	G45027-0001	COMP BRD ASSY COUNTER	19397	G45027-0001
A 2	G45292-0001	OUTPUT AMPLIFIER ASSY	19397	G45292-0001
A 3	G45042-0001	COMP BRD ASSY CONTROL	19397	G45042-0001
A 4	G45064-0001	COMP BRD ASSY PRESET	19397	G45064-0001
J 10	3391-0002	CONN BNC FEMALE	02660	UG-1094/U
J 11	3391-0002	CONN BNC FEMALE	02660	UG-1094/U
K 1	G15136-0001	SWITCH ROTARY	19397	G15136-0001
S 2	23969-0277	SWITCH	09353	P8121
S 3	23969-0277	SWITCH	09353	P8121
S 4	23969-0277	SWITCH	09353	P8121
S 5	23969-0277	SWITCH	09353	P8121
S 6	23969-0277	SWITCH	09353	P8121
S 7	G15160-0001	MINI-SWITCH	19397	G15160-0001
DS 1	23969-0208	LAMP PLUG	03797	CF03-GTS-1762
* * * * ASSEMBLY NO G45189-0001 INNER CAVITY FOAMED * * * *				
	G34420-0001	INNER SHIELD ASSY	19397	G34420-0001
* * * * ASSEMBLY NO G45273-0001 CLOCK OPTION 341A * * * *				
	G35289-0001	HARNESS ASSY	19397	G35289-0001
	G45054-0001	CHASSIS ASSY	19397	G45054-0001
A 1	G45027-0001	COMP BRD ASSY COUNTER	19397	G45027-0001
A 2	G45292-0001	OUTPUT AMPLIFIER ASSY	19397	G45292-0001
A 3	G45042-0001	COMP BRD ASSY CONTROL	19397	G45042-0001
J 10	3391-0002	CONN BNC FEMALE	02660	UG-1094/U
J 11	3391-0002	CONN BNC FEMALE	02660	UG-1094/U
K 1	G15136-0001	SWITCH ROTARY	19397	G15136-0001
S 2	23969-0277	SWITCH	09353	P8121
S 3	23969-0277	SWITCH	09353	P8121
S 4	23969-0277	SWITCH	09353	P8121
S 5	23969-0277	SWITCH	09353	P8121
S 6	23969-0277	SWITCH	09353	P8121
DS 1	23969-0208	LAMP PLUG	03797	CF03-GTS-1762
* * * * ASSEMBLY NO G45274-0001 CLOCK OPTION 341A * * * *				
	G15245-0050	CABLE ASSY	19397	G15245-0050
	G35276-0001	PANEL ASSY CLOCK	19397	G35276-0001
	G45273-0001	CLOCK OPTION 341A	19397	G45273-0001
P 8	23969-0295	CONN	81312	SRE7S

TABLE A5-1. (Continued)

REFERENCE DESIGNATION	T R A C O R STOCK NUMBER	DESCRIPTION		TYPICAL MFGR	MANUFACTURER PART NUMBER
* *	* * ASSEMBLY NO	G45275-0001	CLOCK OPTION 341B	* * * *	
	G15245-0050	CABLE ASSY		19397	G15245-0050
	G15245-0051	CABLE ASSY		19397	G15245-0051
	G35276-0001	PANEL ASSY CLOCK		19397	G35276-0001
	G45099-0001	CLOCK OPTION 341B		19397	G45099-0001
	G64500-0500	RUBIDUM STND	A1	19397	G64500-0500
J 8	23969-0295	CONN		81312	SRE7S
* *	* * ASSEMBLY NO	G45292-0001	OUTPUT AMPLIFIER ASSY	* * * *	
	G45047-0001	COMP BRD ASSY OUTPUT		19397	G45047-0001

SECTION AVI
SCHEMATIC DIAGRAMS

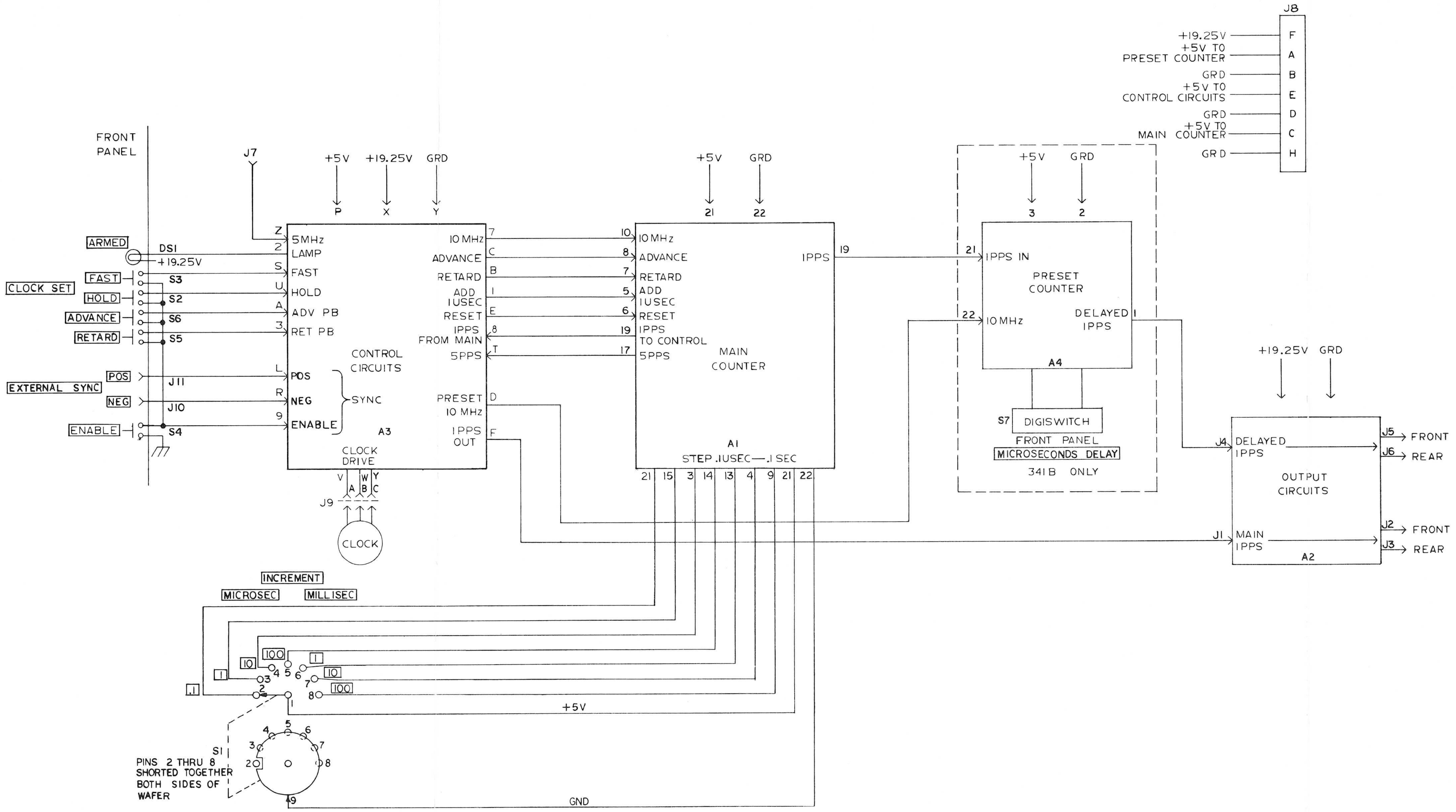
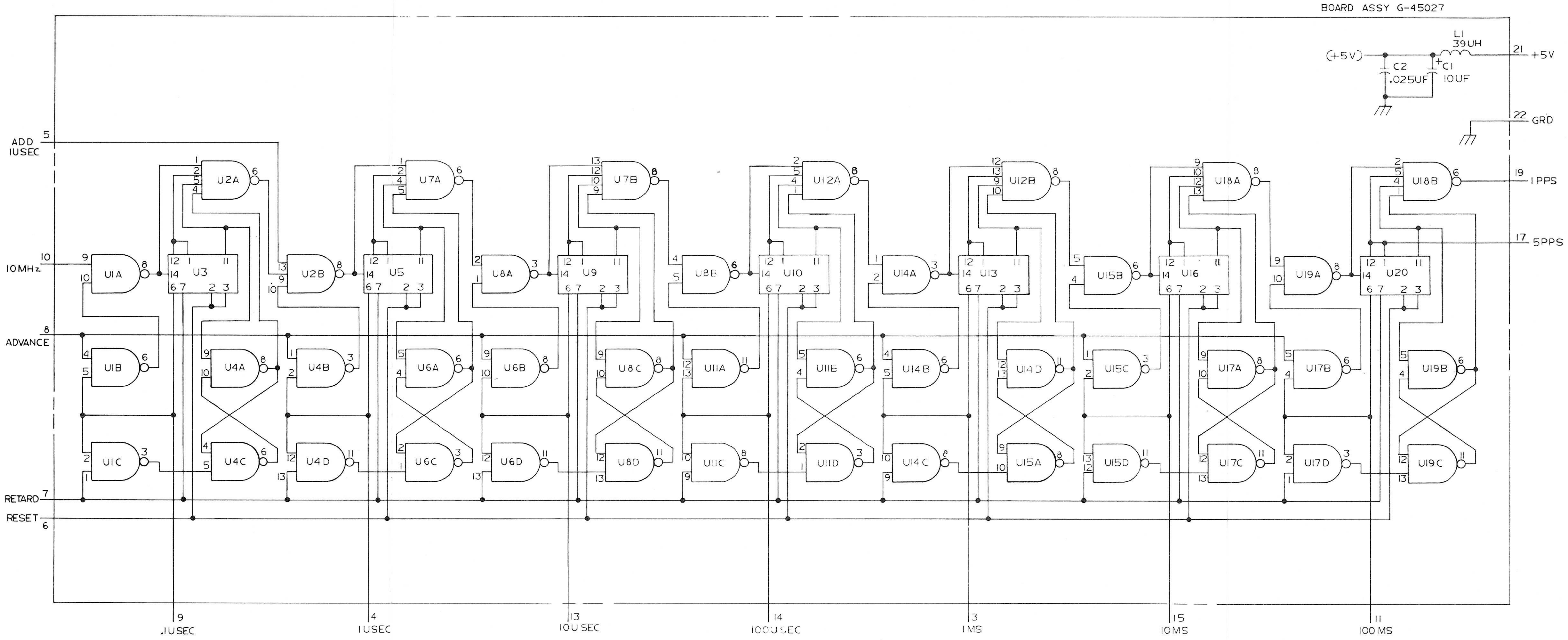


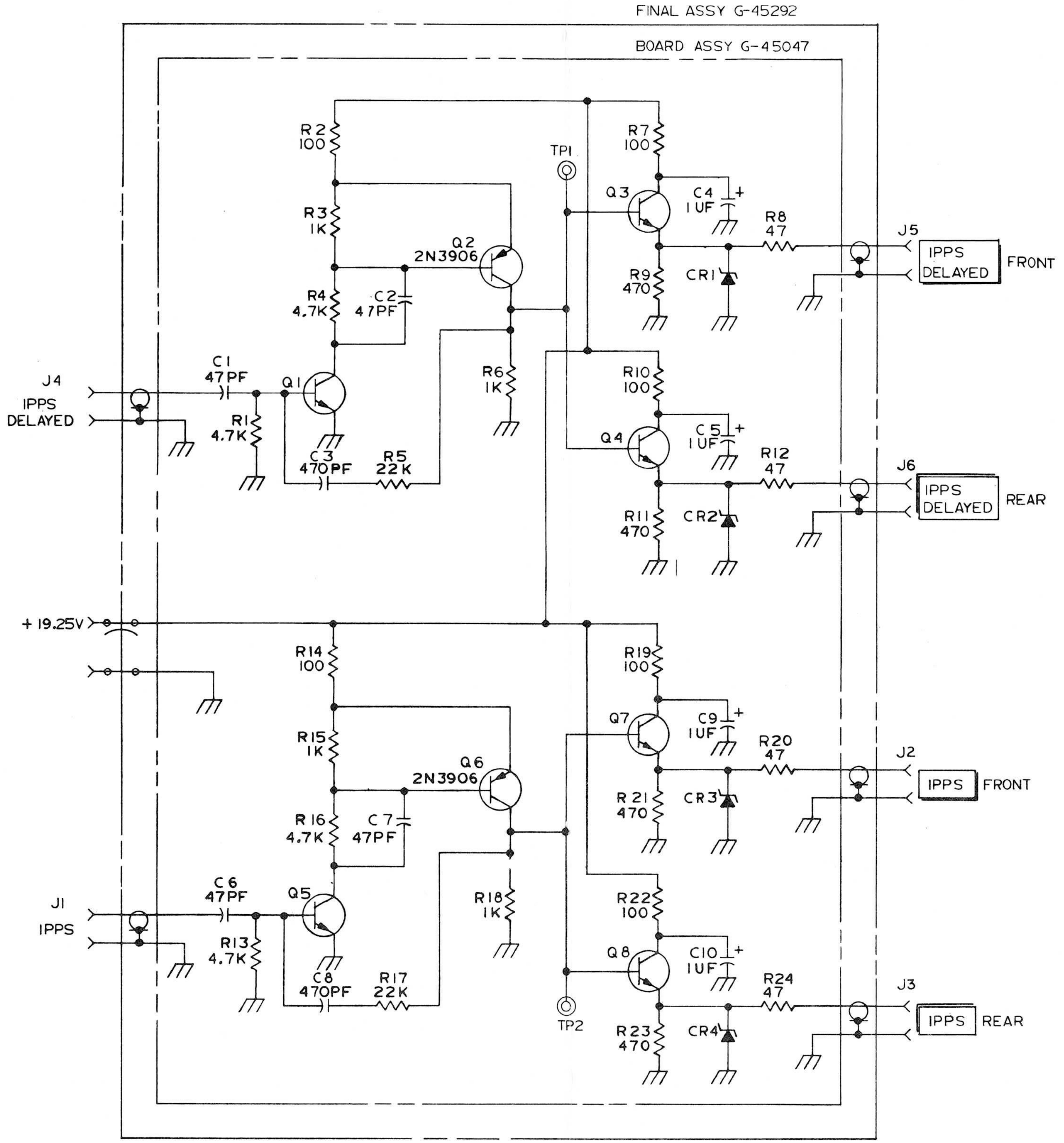
Figure A6-1. Clock Option Interconnect Schematic Diagram, Drawing G-45238 Rev -



6. LAST REF DESIG USED U19,C2,L1.
5. U3,U5,U9,U10,U13,U16,U20 ARE T.I. SN7490N, PIN 10
4. U2,U7,U12,U18 ARE T.I. SN7420N, PIN 7 IS GRD AND PIN 14 IS +5V
3. U1,U4,U6,U8,U11,U14,U15,U17,U19 ARE T.I. SN7400N, PIN 7 IS GRD AND PIN 14 IS +5V
2. REF DESIG ARE ABBREVIATED, PREFIX DESIG WITH A12A1
1. ASSEMBLY IS G-45027

NOTES: UNLESS OTHERWISE SPECIFIED

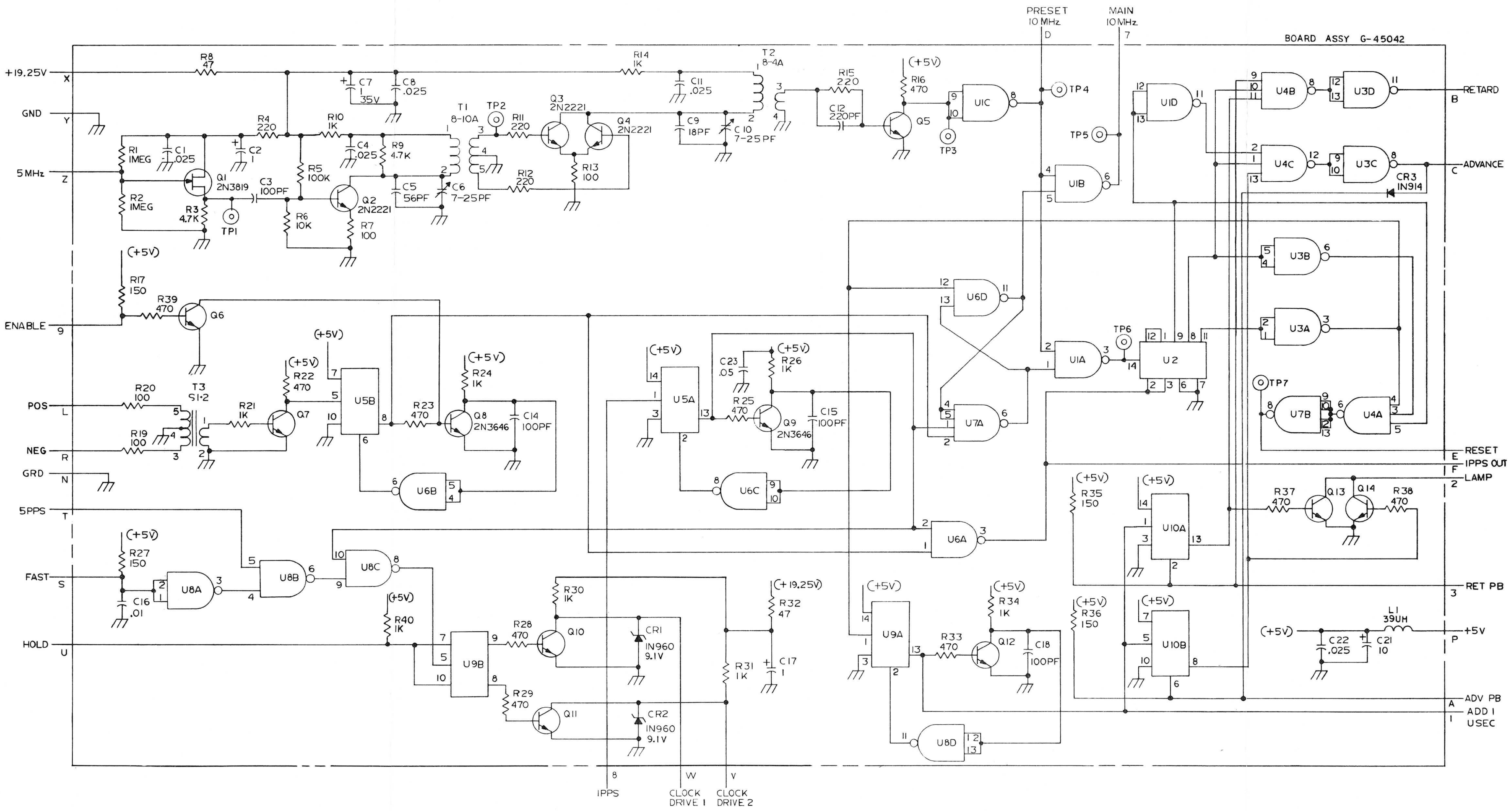
Figure A6-2. Assembly A1, Main Counter Schematic Diagram, Drawing G-45029 Rev -



6. REF DESIG ARE ABBREVIATED PREFIX DESIG WITH A12A2
5. LAST REF DESIG USED C10,CR4,J6,Q8,R24
4. RESISTOR VALUES ARE IN OHMS AND ARE 1/4W, 5%
3. DIODES ARE IN968,20V
2. TRANSISTORS ARE 2N3904
1. ASSEMBLY IS G-45047

NOTES: UNLESS OTHERWISE SPECIFIED

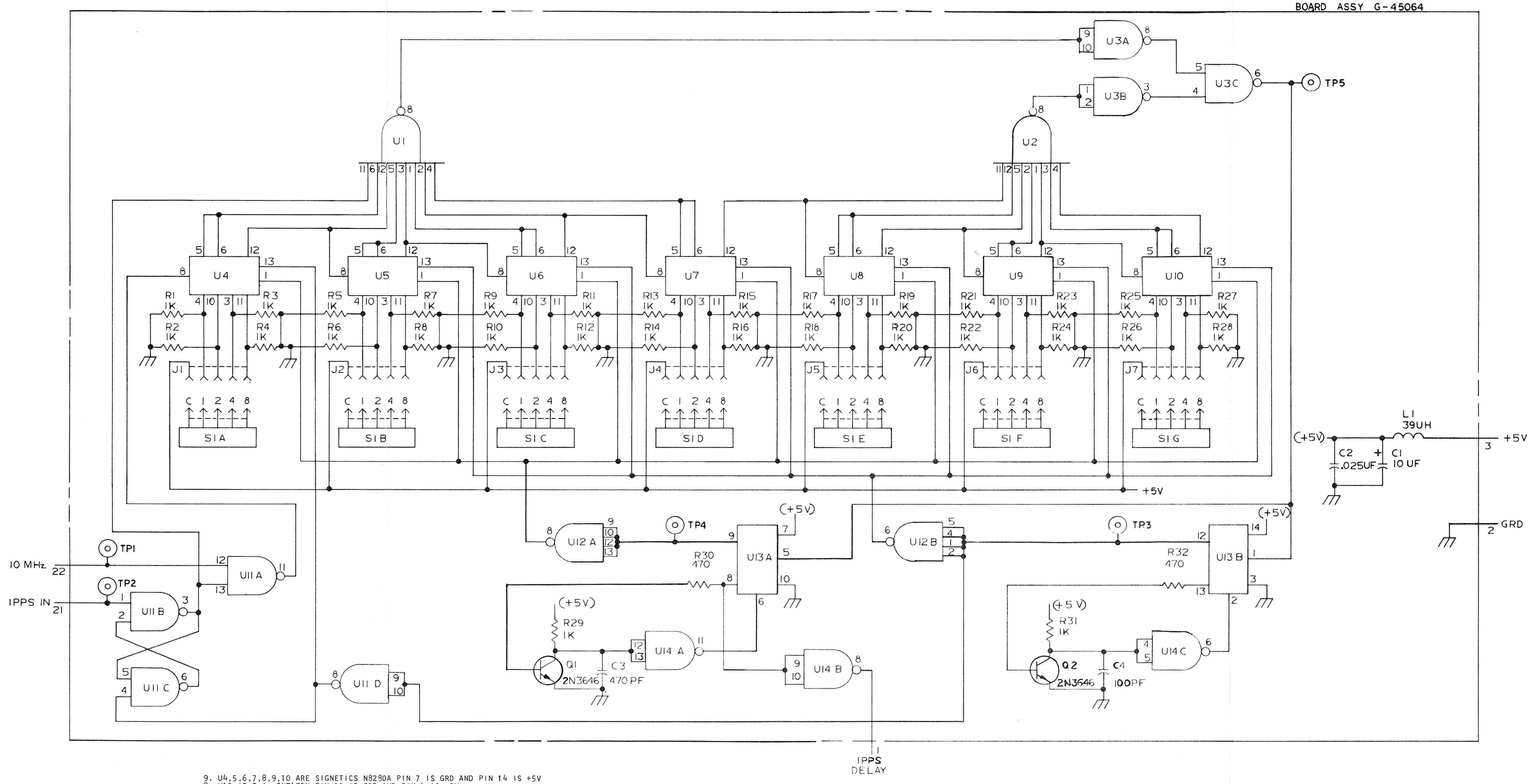
Figure A6-3. Assembly A2, Output Amplifier Schematic Diagram, Drawing G-45049 Rev -



11. U7 IS T.I. SN7440N PIN 7 IS GND AND PIN 14 IS +5V
10. U5,U9,U10 ARE T.I. SN7473N PIN 11 IS GND AND PIN 4 IS +5V
9. U4 IS T.I. SN7410N PIN 7 IS GND AND PIN 14 IS +5V
8. U2 IS T.I. SN7490N PIN 10 IS GND AND PIN 5 IS +5V
7. U1,U3,U6,U8 ARE T.I. SN7400N PIN 7 IS GND AND PIN 14 IS +5V
6. LAST REF DESIG USED U10,C22,CR2,L1,Q14,R40,T3
5. REF DESIG ARE ABBREVIATED, PREFIX DESIG WITH A12A3
4. TRANSISTORS ARE 2N3904
3. RESISTOR VALUES ARE IN OHMS AND 1/4W, 5%
2. CAPACITOR VALUES ARE IN MICROFARADS
1. ASSEMBLY IS G-45042

NOTES: UNLESS OTHERWISE SPECIFIED

Figure A6-4. Assembly A3, Control Circuit Schematic Diagram, Drawing G-45044 Rev B



9. U4,5,6,7,8,9,10 ARE SIGNETICS N8280A PIN 7 IS GRD AND PIN 14 IS +5V
8. U13 IS T.I. SN7473N PIN 11 IS GRD AND PIN 4 IS +5V
7. U12 IS T.I. SN7440N PIN 7 IS GRD AND PIN 14 IS +5V
6. U3,U11,U14 ARE T.I. SN7400N, PIN 7 IS GRD AND PIN 14 IS +5V
5. U1,U2 ARE T.I. SN7430N, PIN 7 IS GRD AND PIN 14 IS +5V
4. LAST REF DESIG USED U14,C4,L1,Q2,R32
3. REF DESIG ARE ABBREVIATED, PREFIX DESIG WITH A12A4
2. RESISTOR VALUES ARE IN OHMS AND 1/4W, 5%
1. ASSEMBLY IS G-45064
NOTES/ UNLESS OTHERWISE SPECIFIED

Figure A6-5. Assembly A4, Preset Counter Schematic Diagram, Drawing G-45066 Rev -

APPENDIX B
BATTERY OPTION

B-1. **INTRODUCTION.**

B-2. This appendix contains information necessary to operate and maintain the Battery Option for the Model 304D Rubidium Frequency Standard.

B-3. **PURPOSE OF EQUIPMENT.**

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. **DESCRIPTION OF EQUIPMENT.**

B-6. The Battery Option provides standby DC power from a 21-cell nickel-cadmium battery. It also has a printed circuit board that contains the charging and control circuits. The Battery Option is used in conjunction with the DC power supply circuits. Refer to Table B-1 for a functional description of controls and indicators.

B-7. **SPECIFICATIONS.**

B-8. A list of specifications for the Battery Option is provided in the following paragraphs.

B-9. 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-10. ENVIRONMENTAL.

Operation Temperature: 0 to 50°C

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 AC 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-11. **BATTERY RECHARGING.**

B-12. After the frequency standard has operated from battery power, the battery must be recharged. Recharge the battery at the fast rate one hour for each minute the battery was used.

B-13. If the battery was used until the low-voltage cutoff point was reached, recharge the battery at the fast rate for 16 hours.

B-14. **DETAILED CIRCUIT ANALYSIS.**

B-15. 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-16. DIFFERENTIAL SENSOR.

B-17. 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-18. 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-19. 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-20. 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-21. LOW-VOLTAGE SENSOR.

B-22. The low-voltage sensor measures the voltage drop across Q2 in the power supply regulator circuit (on PC board A2A1 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-23. The voltage at the collector of power supply transistor Q2 is applied through pins 22 (A2A1) and 22 to the base of Q2. The emitter voltage is applied through pins 21 (A2A1) and 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. The 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-24. 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 CR9 off, Q15 must be off and so must Q16, Q7, Q6, Q14, and Q5. Therefore, the 19.25V output will turn off unless there is some AC or EXT DC power applied.

B-25. 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-26. BATTERY CHARGE CIRCUIT.

B-27. 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-28. 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.

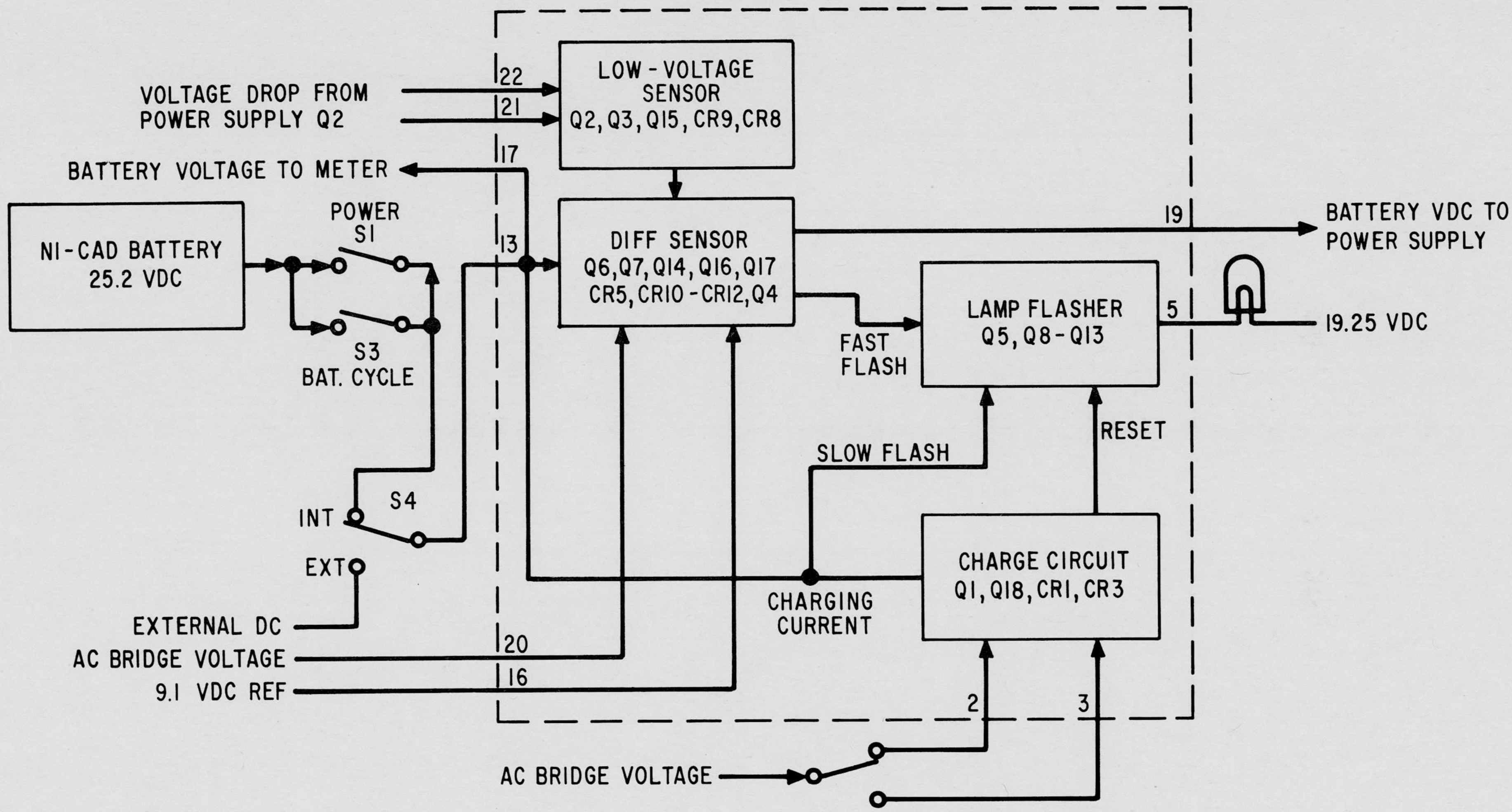


Figure B-1. Battery Option Assembly Block Diagram

B-29. LAMP FLASHER.

B-30. 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 has been 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-31. 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-32. 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 momentarily to the FAST position.

B-33. 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-31, 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-34. **MAINTENANCE.**

B-35. 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-36. After discharge, recharge the battery as specified in paragraph B-12.

B-37. REPLACEABLE PARTS.

B-38. 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 G35229-0001 HARNESS ASSY BATTERY * * * *		
P 3	3987-0018	CONN MIN HEX R AND P	02660	126-196
* * *		* ASSEMBLY NO G45022-0001 BOARD PCB ASSY A16A2 * * * *		
C 1	21485-9101	CAP FXD TA 1 MFD	05397	CS13BF105K (MIL-C-26655/2)
C 2	23969-0753	CAPACITOR	72982	5C023104X025083
C 3	8914-0100	CAP FXD TA 10 MFD	01295	CS13BE106K (MIL-C-26655/2)
C 4	21485-9101	CAP FXD TA 1 MFD	05397	CS13BF105K (MIL-C-26655/2)
Q 1	900-4918	TSTR 2N4918	04713	2N4918
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	900-3906	TSTR 2N3906	01295	2N3906
Q 6	900-5190	TSTR 2N5190	04713	2N5190
Q 7	3431-0025	TSTR MOT MPS404A	04713	MPS404A
Q 8	900-3906	TSTR 2N3906	01295	2N3906
Q 9	900-3904	TSTR 2N3904	04713	2N3904
Q 10	900-3904	TSTR 2N3904	04713	2N3904
Q 11	900-3906	TSTR 2N3906	01295	2N3906
Q 12	900-2646	TSTR 2N2646	03508	2N2646
Q 13	900-3904	TSTR 2N3904	04713	2N3904
Q 14	900-3906	TSTR 2N3906	01295	2N3906
Q 15	900-3904	TSTR 2N3904	04713	2N3904
Q 16	900-3904	TSTR 2N3904	04713	2N3904
Q 17	900-3904	TSTR 2N3904	04713	2N3904
Q 18	900-3906	TSTR 2N3906	01295	2N3906
R 1	211-2210	RES FXD FILM 221OHM	81349	RN55D2210F (MIL-R-10509/7)
R 2	212-4539	RES FXD FILM 45.3 OHM	81349	RN60D45R3F (MIL-R-10509/1)
R 3	204-0155	RES FXD COMP 1.5 MEG	81349	RC07GF155J (MIL-R-11/8)
R 4	201-0471	RES FXD COMP 470. OHM	81349	RC20GF471J (MIL-R-11/3)
R 5	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 6	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 7	204-0472	RES FXD COMP 4.70 K	81349	RC07GF472J (MIL-R-11/8)
R 8	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 9	204-0182	RES FXD COMP 1.80 K	81349	RC07GF182J (MIL-R-11/8)
R 10	204-0124	RES FXD COMP 120. K	81349	RC07GF124J (MIL-R-11/8)
R 11	204-0562	RES FXD COMP 5.60 K	81349	RC07GF562J (MIL-R-11/8)
R 12	204-0152	RES FXD COMP 1.50 K	81349	RC07GF152J (MIL-R-11/8)
R 13	204-0562	RES FXD COMP 5.60 K	81349	RC07GF562J (MIL-R-11/8)
R 14	204-0391	RES FXD COMP 390 OHM	81349	RC07GF391J (MIL-R-11/8)
R 15	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 16	211-3651	RES FXD FILM 3.65K	81349	RN55D3651F (MIL-R-10509/7)
R 17	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 18	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 19	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 20	204-0563	RES FXD COMP 56.0 K	81349	RC07GF563J (MIL-R-11/8)
R 21	204-0563	RES FXD COMP 56.0 K	81349	RC07GF563J (MIL-R-11/8)
R 22	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 23	204-0393	RES FXD COMP 39.0 K	81349	RC07GF393J (MIL-R-11/8)
R 24	204-0332	RES FXD COMP 3.30 K	81349	RC07GF332J (MIL-R-11/8)
R 25	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 26	204-0272	RES FXD COMP 2.70 K	81349	RC07GF272J (MIL-R-11/8)
R 27	204-0563	RES FXD COMP 56.0 K	81349	RC07GF563J (MIL-R-11/8)
R 28	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 29	204-0271	RES FXD COMP 270. OHM	81349	RC07GF271J (MIL-R-11/8)
R 30	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 31	204-0681	RES FXD COMP 680. OHM	81349	RC07GF681J (MIL-R-11/8)
R 32	204-0122	RES FXD COMP 1.20 K	81349	RC07GF122J (MIL-R-11/8)
R 33	204-0102	RES FXD COMP 1.00 K	81349	RC07GF102J (MIL-R-11/8)
R 34	204-0182	RES FXD COMP 1.80 K	81349	RC07GF182J (MIL-R-11/8)
R 35	204-0222	RES FXD COMP 2.20 K	81349	RC07GF222J (MIL-R-11/8)
R 36	211-2741	RES FXD FILM 2.74 K	81349	RN55D2741F (MIL-R-10509/7)
R 37	212-8253	RES FXD FILM 825. K	81349	RN60D8253F (MIL-R-10509/1)
R 38	204-0103	RES FXD COMP 10.0 K	81349	RC07GF103J (MIL-R-11/8)
R 39	23969-0064	RESISTOR VAR	80294	3009Y-1-501
CR 1	800-0914	DIODE 1N914	01295	1N914
CR 3	801-0746	DIODE 1N746A	01295	1N746A
CR 4	800-0914	DIODE 1N914	01295	1N914
CR 5	800-4999	DIODE 1N4999	04713	1N4999
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	800-3712	DIODE 1N3712	81483	1N3712
CR 10	800-0914	DIODE 1N914	01295	1N914

TABLE B-2. (Continued)

REFERENCE DESIGNATION	TRACOR STOCK NUMBER	DESCRIPTION	TYPICAL MFGR	MANUFACTURER PART NUMBER
CR 11	800-0914	DIODE 1N914	01295	1N914
CR 12	800-0914	DIODE 1N914	01295	1N914
TP 1	23969-0044	COTTER PIN BRASS	73734	3/8LG X 1/16 DIA
TP 2	23969-0044	COTTER PIN BRASS	73734	3/8LG X 1/16 DIA
TP 3	23969-0044	COTTER PIN BRASS	73734	3/8LG X 1/16 DIA
TP 4	23969-0044	COTTER PIN BRASS	73734	3/8LG X 1/16 DIA
TP 5	23969-0044	COTTER PIN BRASS	73734	3/8LG X 1/16 DIA
TP 6	23969-0044	COTTER PIN BRASS	73734	3/8LG X 1/16 DIA
TP 7	23969-0044	COTTER PIN BRASS	73734	3/8LG X 1/16 DIA
* * * * 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

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